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Modeling Report of the CEA Cadarache MINERVE Reactor for the OSMOSE Project

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Modeling report of the CEA Cadarache MINERVE reactor for the OSMOSE project

G. Perret[1], R. Klann[1], JP. Hudelot[2], M. Antony[2]

[1]Argonne National Laboratory
9700 South Cass Ave.
Argonne, IL 60439
USA

[2]Commissariat à l'Energie Atomique
Cadarache
13109 St Paul lez Durance
France

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1 INTRODUCTION

The OSMOSE program (Oscillation in Minerve of isotopes in “Eupraxic” spectra) is a collaboration between the U.S. Department of Energy (DOE) and the Commissariat à l’Energie Atomique (CEA). It aims at measuring integral absorption rates of minor actinides by the oscillation technique in the MINERVE experimental facility located at the CEA Cadarache Research Center. The OSMOSE program also includes a complete analytical program to understand and resolve potential discrepancies between calculated and measured values. The OSMOSE program began in 2001 and will continue until 2013.

The Argonne National Laboratory has developed Monte Carlo and deterministic calculation models of the MINERVE facility to determine core and safety parameters such as axial and radial fission rate distributions, control rod worth, spectral indices, and the reactivity worth of oscillated samples. Oscillation samples include calibration samples with different uranium enrichments and boron concentrations and the OSMOSE samples - separated actinides including ^{232}Th, ^{233}U, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{243}Am, ^{244}Cm and ^{245}Cm. Seven different neutron spectra will be created in the MINERVE facility: an overmoderated UO_2 matrix (representative of a fuel processing plant or flooded storage cask), a UO_2 matrix in water (representative of LWRs), a mixed oxide fuel matrix (representative of cores containing MOX fuels), two epithermal spectra (representative of under-moderated reactors), a moderated fast spectrum (representative of fast reactors which have some slowing down due to moderators such as lead-bismuth or sodium), and a very hard spectrum (representative of fast reactors with little moderation from reactor coolant). The different spectra are achieved by changing the experimental lattice within the MINERVE reactor. The currently investigated core configurations are R1UO2 and R1MOX, representative of a LWR loaded with UO_2 and a mixed oxide matrix, respectively.

The goal of this report is to synthesize the reactor analysis work performed within the framework of the OSMOSE program by Argonne National Laboratory until September 2004. The Monte Carlo and deterministic models are detailed, and the calculated safety and core parameters as well as the reactivity worth of the calibration samples are compared with the experimental data for the R1UO2 and R1MOX core loadings.

2 REACTOR MODELING

Monte Carlo and deterministic models of the MINERVE facility in the R1UO2 and R1MOX configurations were developed to assess core and safety parameters. The deterministic model is also used to calculate the reactivity worth of oscillation samples in the central channel of the core. The models are based on the composition and geometry specifications identified in the Material Specification Report for the MINERVE reactor (ref. 1).

2.1 Monte Carlo model

The Monte Carlo model was created using the MCNP-4C code system (ref. 2) and the continuous energy cross sections of the ENDFB-VI library. This model fully describes the neutronic region of interest of the MINERVE reactor by avoiding any unnecessary homogenization. It is extensively based on the material specification report (ref. 1).

2.1.1 General description

The MCNP model describes the MINERVE core surrounded by at least 30 cm of water and/or structural material, resulting in a 271.5 cm by 271.5 cm by 220 cm region. The core can be schematically described as an experimental zone surrounded by a driver zone (in 4 quadrants). Fuel pins in the experimental zone are used to generate the appropriate flux spectrum in the center and the driver zone feeds the experimental zone with neutrons. The experimental fuel pin lattice is surrounded by an aluminum buffer within a chimney. The driver zone is located outside the chimney and graphite is used as reflector around it. Figure 1 and Figure 2 show radial and axial views of the complete MCNP geometry.

To describe the different regions of the core, the core has been arbitrarily subdivided into:

- The driver zone for all regions outside the chimney
- The experimental zone for all regions inside the chimney

Descriptions of the modeled regions are listed in the next two sections. Differences in composition and geometry between the MCNP model and the material specification report (ref. 1) are emphasized. MCNP input files for the R1UO2 and R1MOX configurations are listed in Appendix 1.

2.1.2 Driver zone

The driver zone is subdivided into the driver zone supports (including the support table, the caissons and part of the grid plate), the driver elements and the graphite blocks (Figure 2).

2.1.2.1 Driver zone supports

2.1.2.1.1 Support table

The support table is modeled as a 22.1 cm-thick plate with a 211.36 cm by 211.36 cm squared cross section and sits below the caissons of the driver zones (Figure 3). This plate is perforated in its center by a 45 cm-diameter hole to insert the lower portion of the chimney. The table is modeled as a mixture of 82% AG-3 aluminum and 18% water. The composition of this region is not listed in ref. 1 because of the minimal effect on the neutronic behavior of the reactor.

2.1.2.1.2 Caissons

The caissons supporting the grid plates of the driver zone are modeled by 40.3cm-thick blocks of a homogenized material composed of 20% AG-3 aluminum and 80% water. This region was considered as water in ref. 1. The radial dimensions of the caissons are adjusted to fit those of the grid plates.

The caissons supporting the large graphite blocks surrounding the driver elements have a height of 51.3 cm and are composed of the same homogenized material as that used for the caissons supporting the grid plates.

2.1.2.1.3 Grid plate

The grid plates located above the caissons are modeled in two different ways depending on if it supports an element. If it does not support an element, it is modeled as a 16 cm-thick AL-5 aluminum plate (Figure 3). If it supports an element, the grid plate region is as described in section 2.1.2.2.2.

2.1.2.1.4 L-shape assembly

L-shape assemblies are attached to the 4 grid plates to support 4 additional graphite elements in the corners of the aluminum wedges (as shown in Figure 1 and described in section 2.1.2.2). The L-shape assemblies have not been modeled.

2.1.2.2 Graphite blocks and driver element

2.1.2.2.1 Graphite blocks

The large, medium and small graphite blocks and their AG-3 aluminum clads (Figure 1 and Figure 3) are modeled according to ref. 1. No description of the lower and upper hardware used for positioning and handling has been included in the model. The dimension of the graphite blocks are listed in Table 1. The clad thickness is the same above and below the graphite block and right and left the graphite block.

Table 1:Geometry specification of the graphite blocks						
	Large		Medium		Small	
	Graphite	Graphite + clad*	Graphite	Graphite + clad*	Graphite	Graphite + clad*
Height (cm)	70.0	81.0	74.5	75.0	69.5	70.0
Length (cm)	92.0	92.55	32.0	32.5	18.0	18.5
Width (cm)	45.0	45.55	22.5	23.0	7.5	8.3

* The clad thickness is the same on both sides of the graphite region

2.1.2.2.2 Driver zone elements

The driver zone is composed of the following types of elements:

- Graphite elements
- Fuel elements (18-plates of 90 % or 93% enriched uranium, 12-plates, or 9-plates)
- Control elements (12-plates with two regions to allow the insertion of the control rods)
- Special elements (automatic pilot rod, start-up source element, detector element and thermal column)

Each driver zone element type has been described as a separate universe and used in four lattices to make the inner part of the driver zone. Each universe can be seen as a lower portion made of the foot of the element inserted in the grid plate and an upper portion, made of graphite or fuel plates, which is surrounded by water.

Graphite elements

The MCNP geometry and composition of the graphite elements is shown in Figure 4. The lower portion of the graphite element is made of the foot inserted in the grid plate. The foot has been modeled by AG-3 aluminum cylinder and plate accommodating a void tube in the center. The geometry specification of the foot is presented in Figure 4 and Table 2. This description is based on the plan in ref. 1 and differs from the homogenization recommended by CEA. The upper portion of the element is composed of the graphite block and AG-3 aluminum overclad. Both are described according to ref. 1 and reported in Table 2.

Table 2:Geometry specification of the graphite element					
	Foot			Upper portion	
	AG-3 cylinder	AG-3 plate	Void tube	Graphite	Graphite + clad
Height (cm)	13.8	3.7	74.5	63.25	70.00
Diameter (cm)	6.1	-	1.21	-	-
Length (cm)	-	8.0	-	7.5	8.00
Width (cm)	-	7.61	-	7.2	7.61

Fuel elements

The fuel element is composed of an upper portion made of fuel plates and a lower portion called the foot. The foot has been modeled as an AG-3 aluminum cylinder (Ø 6.1 cm) inserted in the grid plate, and an AG-3 aluminum plate (8.0 cm by 7.61 cm) above the grid plate. Both pieces have a 5.08 cm-diameter water hole in their centers. The position and dimension of the foot is illustrated in Figure 5. The upper portion is composed of an array of fuel plates. The 18-plate and 12-plate fuel elements are described in Figure 5 and Figure 6, respectively. The dimensions and compositions are listed in ref. 1 and details of the upper portions are shown in Figure 8. Note that the border plates surrounding the graphite blocks in the 12- and 9-plate fuel elements do not contain notches.

Control rod elements

The control element is a standard 18-plate element where six fuel plates have been removed leaving 12 fuel plates. Four of the plates are replaced with AG-3 aluminum plates to center the fork-type control rods. The AG-3 aluminum plates are modeled with the same dimensions as the fuel plate with the expectation that the height is 62.5 cm instead of 60.3 cm.

The control element has been modeled with the control rods in different positions according to ref. 1. Figure 9 shows an elevation view and cross sections of the control element when the absorbers are withdrawn. In this case, the hafnium lines up with the upper part of the fuel meat (Figure 10).The control rods are described according to ref. 1 except for the stainless steel extender (upper portion of the rod) which is 0.439 cm thick instead of 0.339 cm.

The travel of the control rods is 60 cm. The portion of the control rod above the fuel plates is always modeled. When a control rod is inserted in the core, the stainless steel extender is lengthened to reach the upper boundary of the model.

Special elements – Automatic pilot rod

The automatic pilot rod element is shown in Figure 11. The foot is the same as for the graphite element. The cadmium sheets of the rotor and the stator have been homogenized with AG-3. The rotor is composed of 89% of AG-3 and 11% of cadmium; the stator is composed of 93.22% of AG-3 and 6.78% of cadmium. The height of the rotor, the stator and the pipe is 72.2 cm. The homogenization of the cadmium on both the stator and the rotor has an influence on the multiplication factor such that any comparison of absolute reactivity between experiments and calculations cannot be made.

Special elements –Detector

The detector element is modeled as a standard graphite element with a 5.0cm-diameter hole in the center. The homogenized foot recommended in ref. 1 has been replaced by the foot of a graphite element. The other dimensions are shown in Figure 12. A detector has been simulated in the void space.

Special elements –Start-up source

The source element is modeled as an AG-3 aluminum tube with an AG-3 aluminum base plate on top of a standard graphite element foot. An elevation view and cross sections of the element are shown in Figure 13. A source has not been modeled in the calculation.

Special elements –Thermal column

The thermal column is modeled as a graphite element containing two holes. Only the lower portion of the thermal column presented in ref. 1 is modeled, the upper portion is outside of the boundary of the MCNP model. The dimensions and regions are described in Figure 14.

2.1.2.2.3 Additional elements

The four quadrants of the driver zone form a 74×74 cm^2 square cavity as shown in Figure 1. In order to fill the gap between this cavity and the cylindrical chimney, AG-3 aluminum wedges and 4 additional graphite elements are used. Figure 15 presents an axial and a radial view of the AG-3 aluminum wedges. The axial position of the AG-3 wedges is not specified in ref. 1. Only an approximate 80 cm height is mentioned. In the model, the AG-3 wedges extend from the lower boundary of the grid plate to the upper boundary of the graphite element (Figure 15). The additional graphite elements are located at the same height as the elements of the driver zone (Figure 15).

2.1.3 Experimental zone

The experimental zone is defined as all regions within the chimney. It is composed of the MELODIE massif, a supporting spool and a protection plate.

2.1.3.1 Spool

The spool supporting the MELODIE massif is recommended to be homogenized as water in ref. 1. Only the upper supporting plate of the spool has been modeled by a 56 cm-diameter cylindrical plate. A central 3.2×3.2 cm^2 square cavity allows the oscillation of samples in the central channel of the experimental fuel lattice (Figure 16).

2.1.3.2 Protection plate

The protection plate is located above the MELODIE massif and is a 71.2 cm-diameter cylindrical plate. This plate is usually modeled without a hole in its center except for measurement with the POLINE overclad (section 2.1.3.4).

2.1.3.3 MELODIE massif

The MELODIE massif is composed of:

- A lower stainless steel plate
- An upper and a lower AG-3 grid plate drilled with 801 holes forming a lattice with a square pitch of 1.26 cm
- Aluminum blocks filling the space around the lattice

An elevation view and cross sections are presented in Figure 16.

2.1.3.3.1 Lower stainless steel plate

The lower stainless steel plate supporting the AG-3 aluminum blocks and the lower grid plate is modeled according to ref. 1 with a diameter of 71.2 cm and a height of 1.75 cm. Like the spool, it includes a central square cavity (cross section: 3.2×3.2 cm^2).

2.1.3.3.2 Grid plates

The grid plates are modeled somewhat differently than from ref. 1. The lower grid plate is made of AG-3 aluminum and has a cross section matching the experimental lattice. It is 2.15 cm thick except where the 801 holes of the lattice where the thickness is 1.65 cm (see Figure 33 of ref. 1). The upper grid plate is modeled as a 2.0 cm-thick AG-3 aluminum plate with a cross section matching the experimental lattice. It is extended by a stainless steel plate to form a 71.2cm-diameter plate (Figure 16, section E). The grid plates are joined by aluminum tubes – internal diameter of 0.970 cm and external diameter of 1.10 cm. These tubes are the overclad of the pins. The geometry specification of the grid plates and the overclad are shown in Figure 16 and Figure 17.

2.1.3.3.3 AG-3 blocks

The AG-3 aluminum blocks fill the gap between the experimental lattice and the chimney forming a cylinder with an outer diameter of 71.2 cm. The height of the AG-3 aluminum blocks is 81.65 cm. The blocks line up with the lower stainless steel plate and the upper grid plate.

2.1.3.4 Experimental lattice – Pins and POLINE overclad

The experimental lattice has a square pitch of 1.26 cm. The R1UO2 and R1MOX experimental loadings have been modeled. These loadings include UO_2 fuel pins, UO_2-PuO_2 fuel pins and aluminum pins. Some models also included an overclad inserted in the central channel of the core to perform measurements. The POLINE overclad has been modeled as well.

UO_2 fuel pin cell

The UO_2 fuel pins are completely described in agreement with ref. 1. The geometry specification is shown in Figure 17.

UO_2-PuO_2 fuel pin cell

The UO_2-PuO_2 fuel pins are completely described in agreement with ref. 1. The geometry specification is shown in Figure 18 and Figure 19.

Aluminum pin cell

The aluminum pins are completely described in agreement with ref. 1. The geometry specification is shown in Figure 20.

POLINE overclad cell

The POLINE overclad cell is used in the center of the experimental lattice to measure spectral indices, axial fission distribution and reactivity rod worth. The stainless steel cane used to move the detector inside the POLINE overclad has not been modeled. Note that the POLINE overclad is lengthened above the experimental lattice to the upper boundary of the MCNP model (Figure 21).

2.2 Deterministic model

The deterministic model is based on the REBUS code system (ref. 3). REBUS has been used to solve the diffusion equation in XYZ geometry with the finite difference method. The self-shielded cross sections used in REBUS are provided by the one-dimensional-transport-code-system WIMS-ANL 5.07 (ref. 4).

Contrary to the Monte Carlo model, regions and materials need to be homogenized in the REBUS calculation due to the X-Y-Z coordinate geometry. In the next sections, the REBUS model is fully described. Particularly, each homogenized region and its volume fraction is reported. The WIMS calculations providing the microscopic cross sections used in REBUS are then described. Each cross section is linked to specific regions of the REBUS geometry.

2.2.1 General description

The physical size of the REBUS and MCNP model are the same (section 2.1.1). Figure 22 and Figure 23 show a radial and an axial view of the complete geometry.

The number of mesh used in the R1UO2 and R1MOX configurations is 190×190×116 and 202×202×116, respectively. In the XY plan, one mesh is used for each cell of the experimental fuel pin lattice (every 1.26 cm) and the mesh size is roughly the same in all the driver elements. The graphite blocks (large and medium) are mapped using a mesh every 2 cm in the X and Y dimension and an approximate 5cm-mesh-size is used for the surrounding water in the XY plan. Axially, the mesh size is mainly defined by the fuel elements and pins of the geometry. The surrounding water is mapped with a 10 cm mesh size, the structural material around the fuel (grid plate of the driver regions, lower and upper end plug and stainless steel spacers) is mapped using a 1-2 cm mesh size, and the fuel and the Plexiglas spacers of the experimental zone are mapped with a 1 cm mesh size.

Microscopic cross sections for the different homogenized regions have been calculated using the one-dimensional-transport-code-system WIMS-ANL 5.07. The starting 69 group structure of the ENDFB-VI library was collapsed to 7 groups (Table 3).

Table 3: REBUS group structure

Group	Energy
1	500 keV – 10 MeV
2	9.118 keV – 500 keV
3	1.123 eV – 9.118 keV
4	0.4 eV – 1.123 eV
5	0.14 eV – 0.4 eV
6	0.05 eV – 0.4 eV
7	- 0.05 eV

REBUS input files for the R1UO2 and R1MOX configurations are listed in Appendix 2.

2.2.2 Driver zone

2.2.2.1 Driver zone supports

2.2.2.1.1 Support table

The support table is homogenized in the same way as in the MCNP model (section 2.1.2.1.1).

2.2.2.1.2 Caissons

The caissons are homogenized in the same way as in the MCNP model (section 2.1.2.1.2).

2.2.2.1.3 Grid plate

The portions of the grid plates containing no graphite or fuel element are modeled as bare AL-5 aluminum plates (section 2.1.2.1.3). The portions of the grid plates containing driver elements are described in section 2.2.2.2.2.

2.2.2.1.4 L-shaped assembly

The L-shaped assemblies are not modeled.

2.2.2.2 Graphite blocks and driver element

2.2.2.2.1 Graphite blocks

The AG-3 aluminum cladding of the large, medium and small graphite blocks have been homogenized with the graphite. The dimension and volume fraction of each material is given in Table 4.

Table 4: Geometry and material specification of the graphite blocks

Type	Large	Medium	Small
Height (cm)	81.0	75.0	70.0
Length (cm)	92.55	32.5	18.5
Width (cm)	45.55	23.0	8.3
Volume fractions	Graphite: 84.87% AG-3: 15.13%	Graphite: 95.68% AG-3: 4.32%	Graphite: 95.68% AG-3: 4.32%

2.2.2.2.2 Driver zone elements

<u>*Graphite elements*</u>

The radial dimensions of the graphite elements are the same as in the MCNP model. Individual graphite elements are not defined. Figure 22 shows the graphite element region (in red).

The graphite element region has been homogenized in 3 axial zones: the foot inside the grid plate, the graphite block, and the upper end plug. The REBUS model of the graphite element region is compared with the MCNP model of a graphite element in Figure 24. The geometry and volume fraction of the different sections are shown in Table 5.

Table 5: Geometry and material specification of the graphite element			
	Foot	Graphite	Upper end plug
Height (cm)	19.7	63.25	2.95
Volume fractions	AL-5: 84.87% AG-3: 15.13% Water: 4.48% Void: 1.84%	Graphite: 86.47% AG-3: 11.02% Water: 2.51%	AG-3: 97.49% Water: 2.51%

Fuel elements

The 18-plate fuel element has been homogenized into 4 axial regions: the foot, the lower and upper plate-clad region and the fuel plate region. The fuel plate region includes all of the fuel in the element. The upper and lower ends of the fuel plates are made of aluminum clad. These portions are homogenized with water and the AG-3 aluminum border plate of the element in the plate-clad region. The homogenized regions have a cross section of $8.1 \times 7.61\ cm^2$. The axial dimensions and the volume fractions of the different regions are presented in Table 6 and in Figure 25.

Table 6: Geometry and material specification of the 18-plate fuel element				
	Foot	Lower plate-clad	Fuel plate	Upper plate-clad
Height (cm)	22	1.3	60	1.25
Volume fractions	Water: 43.46% AL-5: 38.58% AG-3: 17.96%	Water: 58.56% Al: 31.20% AG-3: 10.24%	Water: 58.56% Al: 21.68% AG-3: 10.24% Fuel: 9.52%	Water: 58.56% Al: 31.20% AG-3: 10.24%

The lower and upper plate-clad region should have slightly different volume fractions because of a minor height difference. To simplify, the same volume fractions are used for both regions.

The 12- and 9-plate fuel elements have been homogenized into 5 different regions. Two distinctive regions have been created for the graphite block and for the fuel plates (Figure 26 and Figure 27). The foot region is the same as the foot for the 18-plate fuel element. The geometry and material specification of the other regions is described for the 12- and 9- plate fuel element in Table 7 and Table 8, respectively.

Table 7: Geometry and material specification of the 12-plate fuel element				
	Lower plate-clad	Fuel plate	Graphite	Upper plate-clad
Height (cm)	1.3 / 1.25	60	60	1.3 / 1.25
Length (cm)	8.1	5.4	2.7	8.1
Width (cm)	7.61	7.61	7.61	7.61
Volume fractions	Water: 43.16% Graphite: 22.86% Al: 20.79% AG-3: 13.19%	Water: 52.46% Al: 21.68% AG-3: 16.34% Fuel: 9.52%	Graphite: 71.44% AG-3: 16.16% Water: 12.40%	Water: 43.16% Graphite: 22.86% Al: 20.79% AG-3: 13.19%

Table 8: Geometry and material specification of the 9-plate fuel element				
	Lower plate-clad	Fuel plate	Graphite	Upper plate-clad
Height (cm)	1.3 / 1.25	60	60	1.3 / 1.25
Length (cm)	8.1	4.1	4.0	8.1
Width (cm)	7.61	7.61	7.61	7.61
Volume fractions	Water: 33.84% Graphite: 36.32% Al: 15.60% AG-3: 14.24%	Water: 58.92% Al: 21.27% AG-3: 10.27% Fuel: 9.40%	Graphite: 76.60% AG-3: 15.26% Water: 8.14%	Water: 33.84% Graphite: 36.32% Al: 15.60% AG-3: 14.24%

The lower and upper plate-clad regions have been homogenized in the same manner as before.

Control elements

The control element has been modeled with the rods completely inserted or withdrawn. The control element is homogenized in four regions: the foot (similar to the fuel element), the lower and upper plate clad and the control rod-fuel plate region. The insertion of the rods has been modeled by changing the composition of the control rod-fuel plate region. The control rod has not been modeled above this region. When the rods are inserted, it is necessary to homogenize the hafnium with the water and the fuel because of the diffusion approximation used. The dimension and volume fractions of the control element are listed in Table 9 and Figure 28.

Table 9: Geometry and material specification of the control element			
	Plate-clad	Control rod – fuel plates (absorber withdrawn)	Control rod – fuel plates (absorber inserted)
Height (cm)	1.3 / 1.25	60	60
Length (cm)	8.1	8.1	8.1
Width (cm)	7.61	7.61	7.61
Volume fractions	Water: 61.82% Al: 27.72% AG-3: 10.46%	Water: 61.82% Al: 21.38% AG-3: 10.46% Fuel: 6.34%	Water: 52.68% Al: 21.38% AG-3: 10.46% Fuel: 6.34% Hf: 6.95% SS: 2.19%

Other simulations where the control rods have been modeled above the fuel plates and at the critical positions have been performed. In these cases, the results do not change except for the absolute value of the multiplication factor.

Special elements

No special element like the pilot rod, the detector, the start-up source and the thermal column have been modeled.

2.2.2.2.3 Additional elements

The additional elements include the four graphite elements located in the corner of the 74×74 cm^2 square cavity, the AG-3 wedges and the chimney. Because of the XYZ geometry, the chimney (and the material at the circular interface) was homogenized in different radial regions (Figure 22). Figure 29 represents a quarter of the central square cavity with the chimney, and the chosen radial decomposition. It has been divided into:

- 8 different regions that contain the chimney (Type-1 and Type-2)
- 8 different regions containing the AG-3 wedges outside of the chimney (Type-3)
- 4 graphite elements in the corners of the cavity

The four graphite elements are considered as standard graphite elements and their lower part has not been changed to take into account the AG-3 aluminum wedges or the L-shape plate. The radial description is given in Figure 24.

The radial description of the AG-3 wedges region is presented in Figure 30. No homogenization has been performed.

The radial description of the region containing the chimney is shown in Figure 31. This region is homogenized in 6 axial sections. Table 10 summarized the contents and volume fractions of each region.

Table 10: Geometry and material specification of the chimney region

Section	A	B	C	D	E	F
Description	Water Chimney Wedge	SS plate Chimney Water	AG-3 block Chimney Wedge Water	AG-3 block Chimney Water	SS plate Chimney Water	AG-3 plate Chimney Water
Height (cm)	48.7	2.25	75.25	6.4	2	6.4
Volume fractions	Water: 78.44% AG-3: 21.56%	SS: 43.65% AG-3: 41.84% Water: 14.51%	AG-3: 97.96% Water: 2.04%	AG-3: 69.61% Water: 30.39%	SS: 56.13% Water: 30.39% AG-3: 13.48%	Water: 68.98% AG-3: 31.02%

The tank-region above the elements is composed of water only (Figure 31). The chimney was not considered above the core.

The AG-3 aluminum blocks inside the chimney are described in section 2.2.3.1.

2.2.3 Experimental zone

The same element descriptions for the MCNP model have been used for the REBUS model, except they have been homogenized into different regions. The experimental zone is divided into different radial regions including:

- The AG-3 buffer region
- The UO_2 fuel pin region
- The UO_2-PuO_2 fuel pin region
- The AG-3 pin region
- The POLINE overclad region
- The Oscillation tube region

Each radial region is divided into several axial regions.

2.2.3.1 AG-3 buffer region

The radial location of the AG-3 aluminum buffer region is shown in Figure 22.The radial decomposition of the AG-3 aluminum buffer region is presented in Figure 32. The height and volume fraction of each section is shown in Table 11.

Table 11: Geometry and material specification of the AG-3 buffer region

Section	A	B	C	D	E
Description	Water Chimney Table	SS plate Water	AG-3 block	SS plate	AG-3 plate Water
Height (cm)	70.8	2.25	81.65	2	6.4
Volume fractions	Water: 70.26% AG-3: 29.74%	SS: 86.17% Water: 13.83%	AG-3: 100%	SS: 100%	Water: 68.75% AG-3: 31.25%

2.2.3.2 UO2 fuel pin region

The UO_2 fuel pin region is divided into six axial regions (Figure 33). Three other zones describe the water above and below the fuel pin cell, the stainless steel plates composing the upper part of the spool and the lower stainless steel plate (sections 2.1.3.1 and 2.1.3.3.1). The lower stainless steel plate and the spool contain a 3.2×3.2 cm^2 square cavity in the center of the experimental zone. The 9-pin region modeled in the center of the experimental zone does not take this cavity into account.

The homogenization for each axial region A-F included the following items:

(A) The lower end plug, the lower grid plate and the lower stainless steel spacer
(B) The lower Plexiglas spacer with the clad and overclad
(C) The fuel
(D) The upper Plexiglas spacer
(E) The upper stainless steel spacer, the upper grid plate and the upper end plug
(F) The gripping device and the protection plate

The volume fractions and the heights of the sections are presented in Table 12 and Figure 33.

Table 12: Geometry and material specification of the UO_2 fuel pins region

Section		A	B	C	D	E	F
Height (cm)		4.65	13	50	13	3	6.4
Volume fractions (%)	AG-3	48.39	13.31	13.31	13.31	40.07	31.25
	Water	27.81	42.98	42.98	42.98	16.22	66.74
	SS	11.32	-	-	-	17.04	2.01
	ZR4	11.29	10.45	10.45	10.45	25.09	-
	Void	1.19	3.17	1.23	3.17	1.58	-
	Plexiglas	-	30.09	-	30.09	-	-
	Fuel	-	-	32.03	-	-	-

2.2.3.3 UO2 – PuO2 fuel pin region

The UO_2-PuO_2 fuel pin region is divided into the same axial regions as the UO_2 fuel pin region. Table 13 and Figure 34 show the height and the volume fraction of each region. The volume fractions are the same for the pins with 3.6% and 4% plutonium oxide enrichment.

Table 13: Geometry and material specification of the UO_2-PuO_2 fuel pins region

Section		A	B	C	D	E	F
Height (cm)		4.85	12.8	50	13	3	6.4
Volume fractions (%)	AG-3	45.85	13.31	13.31	13.31	40.07	31.25
	Water	27.28	42.98	42.98	42.98	13.54	61.65
	SS	13.22	-	-	-	10.17	7.10
	ZR2	6.78	8.71	8.71	8.71	31.89	-
	Styrene	5.35	-	-	-	-	-
	Void	1.52	4.91	2.79	4.91	4.33	-
	Plexiglas	-	30.09	-	30.09	-	-
	Fuel	-	-	32.21	-	-	-

2.2.3.4 Aluminum pin region

The aluminum pin region is homogenized into four axial sections plus the three sections used for water above and below the core and the lower stainless steel plate and spool section. The homogenization for each axial region A-D included the following items:

(A) The lower grid plate and the bottom of the aluminum pins
(B) The aluminum pin between the upper and lower grid plate
(C) The upper grid plate and the head of the aluminum pin
(D) The gripping device of the aluminum pin and the protection plate

The volume fractions and heights of the different sections are summarized in Table 14 and Figure 35.

Table 14: Geometry and material specification of the Aluminum pin region

Section	A	B	C	D
Height (cm)	4.85	12.8	50	13
Volume fractions	AG-3: 96.54% Water: 3.46%	Water: 55.03% AG-3: 44.97%	AG-3: 85.11% Water: 14.89%	AG-3: 35.55% Water: 64.45%

2.2.3.5 POLINE overclad region

The POLINE overclad is used in the central channel of the experimental lattice for safety and core parameter measurements. The POLINE overclad is homogenized with the surrounding water and an inner void (Figure 36). The composition is 44.65% void, 43.36% water and 11.99% AW-2017 aluminum.

2.2.3.6 Oscillation cane region

The oscillation cane is used to oscillate two samples between the center of the core and a position of negligible neutronic importance. For static calculations there are two positions of interest: the 'up' position when the first sample and the fuel mid-plane are lined up and the second sample is above the core, and the 'down' position when the second sample is lined up with the fuel mid-plane and the first sample is below the core. Both 'up' and 'down' positions have the same geometry within the fuel pin region. Considering that the materials of the oscillation cane located above and below the fuel pins lattice are of negligible neutronic importance, both positions 'up' and 'down' are modeled using the same geometry. A schematic of the oscillation cane in the 'up' position and the chosen homogenized volumes are shown in Figure 37. The corresponding volume fractions are listed in Table 15.

Table 15: Geometry and material specification of the oscillation cane region

Section	SS bottom	AG-3 rod	Oscillation sample
Height (cm)	1.5	30 & 99.125	10.35
Volume fractions	AG-3: 36.15% Water: 49.06% SS: 14.79%	AG-3: 55.59% Water: 33.03% SS: 11.38%	See section 2.2.3.7

2.2.3.7 Oscillation sample

There are several different kinds of oscillation samples: uranium calibration samples, boron loaded calibration samples, OSMOSE separated actinide samples, and absorber samples. Only the calibration samples have been considered in this report. The samples are composed of fuel pellets (height~9.35 cm, diameter ~ 0.81cm) clad with zircomium-4 (inner diameter = 0.836, outer diameter = 0.956 cm) and terminated by two zirconium-4 end plugs (same outer diameter, height of 0.2 cm). The sample has a second clad (inner diameter = 1.02 cm, outer diameter = 1.06 cm) with a lower end plug of 0.2 cm height and two upper end plug of 0.2 cm height. The external diameter of the entire sample is 1.06 cm with a total height of 10.35 cm (ref. 5).

The total height of the fuel pellets height is often larger than 9.35 cm. In order to keep the total height constant (10.35 cm) the upper end plug of the outer clad was modeled with a smaller height to accommodate the different fuel pellet heights.

The characteristics of the U-235 calibration sample fuel pellets are listed in ref. 6 and are reported in Table 16. The associated volume fractions of the homogenized oscillation sample in the oscillation cane are shown in Table 17.

Table 16: Geometry and material specification of the U-235 calibration sample

Sample	F0025	F0050	N0071	S0100	S0200	S0300	S0400	S0495
U235 enrichment (%)	0.25	0.49	0.71	1.00	2.01	3.01	4.00	4.93
Height (mm)	94.08	94.1	94.06	94.04	94.1	94.08	94.06	94.1
Diameter (mm)	8.0943	8.0946	8.0943	8.1114	8.0986	8.1032	8.0999	8.1036
Density (g/cc)	10.442	10.464	10.515	10.594	10.606	10.62	10.629	10.648

Table 17: Volume fraction of the homogenized U-235 calibration sample inserted in the oscillation cane

Sample		F0025	F0050	N0071	S0100	S0200	S0300	S0400	S0495
Volume fractions (%)	Sample	29.46	29.47	29.46	29.58	29.50	29.53	29.50	29.53
	Void	7.9	7.89	7.89	7.76	7.87	7.83	7.85	7.83
	Zr4	18.23	18.22	18.24	18.24	18.22	18.23	18.24	18.22
	SS	11.38	11.38	11.38	11.38	11.38	11.38	11.38	11.38
	Water	33.04	33.04	33.04	33.04	33.04	33.04	33.04	33.04

The characteristics of the borated UO_2 calibration sample fuel pellets are reported in Table 18. The associated volume fractions of the homogenized oscillation sample in the oscillation cane are shown in Table 19.

Table 18: Geometry and material specification of the borated UO_2 calibration sample

Sample	1B0000	1B0071	1B0150	1B0419	2B0000	2B0333	2B1062	2B2360
U235 enrichment (%)	0.25	0.25	0.25	0.25	0.53	0.53	0.53	0.53
Boron fraction (ppm)	0	71	150	419	0	333	1062	2360
Height (mm)	99.96	100	99.98	99.82	99.7	99.5	99.62	98.7
Diameter (mm)	8.079	8.08	8.106	8.084	8.203	8.2	8.202	8.2
Density (g/cc)	9.551	9.545	9.380	9.523	2.854	9.801	9.701	9.504

Table 19: Volume fraction of the homogenized boron calibration sample inserted in the oscillation cane

Sample		1B0000	1B0071	1B0150	1B0419	2B0000	2B0333	2B1062	2B2360
Volume fractions (%)	Sample	31.19	31.21	31.40	31.18	32.07	31.98	32.03	31.72
	Void	8.49	8.49	8.28	8.44	7.51	7.52	7.51	7.46
	Zr4	15.91	15.89	15.90	15.96	16.01	16.09	16.04	16.41
	SS	11.38	11.38	11.38	11.38	11.38	11.38	11.38	11.38
	Water	33.04	33.04	33.04	33.04	33.04	33.04	33.04	33.04

2.2.4 Cross sections for the materials

The cross sections used in the REBUS code for the materials are calculated in two steps. First microscopic cross sections for different elements (such as Al-27, U-235, Fe-54…) are calculated using WIMS. The macroscopic cross sections of the materials are then generated in REBUS from the microscopic cross sections and the atom densities of the different elements.

Because the self shielding of the microscopic cross sections is performed in WIMS, it is often necessary to define different sets of cross sections for a given element. It is particularly important for the constituents of the fuel and the absorber.

In this section, the compositions of the materials used in REBUS in terms of atom density, and the minor adjustments to be able to use the WIMS 69-group library are addressed. The WIMS models are described and related to the different REBUS regions for the R1UO2 and the R1MOX configurations. The WIMS input files are included in Appendix 3.

2.2.4.1 The elemental composition of the materials

The elemental composition of each material is based on the composition listed in Appendix 2 of ref. 1. Because the WIMS 69-group library (ref. 4) extracted from ENDFB-VI does not contain cross sections for Zn, Sn, S and P, the number densities of AG-3, AL5, AW-2017, SS, Zr-4 and Zr-2 have been slightly changed. Some elements like iron, chromium, nickel and copper have cross sections listed for individual isotopes. The natural abundance used to calculate the corresponding number densities are reported in Appendix 4.
The atom densities of the structural material used in the deterministic model are reported in Table 20-Table 25.

Table 20: AG-3 aluminum alloy composition	
Element	Number density (at / b.cm)
Al	5.457E-02
Mg	1.959E-03
Mn	6.988E-05
Fe-54	3.215E-06
Fe-56	5.046E-05
Fe-57	1.165E-06
Fe-58	1.551E-07
Cr-50	1.925E-06
Cr-52	3.712E-05
Cr-53	4.209E-06
Cr-54	1.048E-06
Ti	2.406E-05
Si	1.094E-04
Cu-63	8.358E-06
Cu-65	3.725E-06
total	**5.684E-02**

Table 21: AL5 aluminum alloy composition	
Element	Number density (at / b.cm)
Al	6.010E-02
Mg	1.676E-05
Mn	7.413E-06
Fe-54	3.410E-06
Fe-56	5.353E-05
Fe-57	1.236E-06
Fe-58	1.645E-07
Ti	8.508E-06
Si	7.250E-05
Cu-63	4.433E-06
Cu-65	1.976E-06
total	**6.027E-02**

Table 22: AW-2017 aluminum alloy composition	
Element	Number density (at / b.cm)
Al	5.827E-02
Mg	4.839E-04
Mn	2.141E-04
Fe-54	6.155E-06
Fe-56	9.662E-05
Fe-57	2.231E-06
Fe-58	2.970E-07
Cr-50	7.020E-07
Cr-52	1.354E-05
Cr-53	1.535E-06
Cr-54	3.821E-07
Si	2.991E-04
Cu-63	4.433E-06
Cu-65	1.976E-06
total	**5.940E-02**

Table 23: Zr-4 zirconium alloy composition	
Element	Number density (at / b.cm)
Zr	4.247E-02
H	4.899E-05
Fe-54	8.683E-06
Fe-56	1.363E-04
Fe-57	3.148E-06
Fe-58	4.189E-07
Cr-50	3.301E-06
Cr-52	6.366E-05
Cr-53	7.219E-06
Cr-54	1.797E-06
O	3.086E-04
C	4.440E-05
Hf	1.107E-06
total	**4.310E-02**

Table 24: Zr-2 zirconium alloy composition	
Element	Number density (at / b.cm)
Zr	4.248E-02
H	4.899E-05
Fe-54	5.582E-06
Fe-56	8.763E-05
Fe-57	2.024E-06
Fe-58	2.693E-07
Cr-50	3.301E-06
Cr-52	6.366E-05
Cr-53	7.219E-06
Cr-54	1.797E-06
O	3.086E-04
C	4.440E-05
Hf	1.107E-06
total	**4.305E-02**

Table 25: Stainless steel composition	
Element	Number density (at / b.cm)
Fe-54	3.387E-03
Fe-56	5.316E-02
Fe-57	1.228E-03
Fe-58	1.634E-04
C	5.904E-05
Cr-50	7.111E-04
Cr-52	1.371E-02
Cr-53	1.555E-03
Cr-54	3.870E-04
Ni-58	6.031E-03
Ni-60	2.323E-03
Ni-61	1.010E-04
Ni-62	3.220E-04
Ni-64	8.201E-05
Mn	8.605E-04
Si	8.416E-04
Mo	4.927E-04
total	**8.542E-02**

The fuel material number densities used in the WIMS and REBUS codes are taken directly from ref. 1. The UO_2-PuO_2 fuel atom density used is the one calculated for the year 2004.

The number density of the U-235 calibration sample has been deduced from measurements in ref. 6 and is reported in Table 26. On the contrary, the number density of the borated calibration sample has not been measured. The number density of the borated calibration sample is reported in Table 27 and was calculated using the total density, geometry and boron enrichment of the sample from ref.7 and listed in Table 18.

Table 26: Number density of the U-235 calibration samples								
Isotope	Sample identification							
	F0025 (0.25%)	F0050 (0.49%)	N0071 (0.71%)	S0100 (1.00%)	S0200 (2.01%)	S0300 (3.01%)	S0400 (4.00%)	S0495 (4.93%)
U-234	2.328E-07	7.933E-07	1.290E-06	1.913E-06	4.258E-06	6.513E-06	8.773E-06	1.093E-05
U-235	5.849E-05	1.154E-04	1.666E-04	2.367E-04	4.745E-04	7.124E-04	9.479E-04	1.171E-03
U-236	6.985E-08	7.000E-08	1.172E-07	1.181E-07	1.183E-07	9.474E-08	1.186E-07	1.188E-07
U-238	2.322E-02	2.322E-02	2.328E-02	2.338E-02	2.317E-02	2.297E-02	2.276E-02	2.257E-02
O	4.663E-02	4.672E-02	4.695E-02	4.734E-02	4.736E-02	4.747E-02	4.747E-02	4.762E-02
total	**6.991E-02**	**7.006E-02**	**7.039E-02**	**7.096E-02**	**7.101E-02**	**7.116E-02**	**7.118E-02**	**7.137E-02**

Table 27: Number density of the Boron calibration samples								
Isotope	Sample identification							
	1B0000 (0 ppm)	1B0071 (71 ppm)	1B0150 (150 ppm)	1B0419 (419 ppm)	2B0000 (0 ppm)	2B0333 (333 ppm)	2B1062 (1062 ppm)	2B2360 (2360 ppm)
U-235	5.393E-05	5.389E-05	5.356E-05	5.375E-05	1.180E-04	1.173E-04	1.160E-04	1.135E-04
U-238	2.125E-02	2.123E-02	2.110E-02	2.117E-02	2.186E-02	2.173E-02	2.150E-02	2.103E-02
O	4.260E-02	4.257E-02	4.231E-02	4.246E-02	4.395E-02	4.370E-02	4.322E-02	4.229E-02
B-10	-	7.513E-06	1.578E-05	4.423E-05	-	3.618E-05	1.142E-04	2.486E-04
B-11	-	3.024E-05	6.350E-05	1.780E-04	-	1.456E-04	4.597E-04	1.001E-03
total	**6.390E-02**	**6.389E-02**	**6.354E-02**	**6.391E-02**	**6.593E-02**	**6.573E-02**	**6.541E-02**	**6.468E-02**

2.2.4.2 Cross sections for the R1UO2 configuration

For the R1UO2 configuration, 7 WIMS calculations generate all the necessary cross sections when the central channel is filled with the POLINE overclad or a standard UO_2 fuel pin. An additional WIMS calculation is performed to generate each calibration sample cross section.

2.2.4.2.1 The driver zone

The driver zone cross sections have been generated using calculations for:

- The 18- 12- and 9- plate fuel element (90% U-235 enrichment) [file: 18p90]
- The 18- plate fuel element (93% U-235 enrichment) [file: 18p93]
- The Control elements with the rod withdrawn [file: CElt]
- The Graphite elements and blocks [file: G18p90]
- The Control elements with the rod inserted [file: rod]

The methodology of these calculations is described and the input files are included in Appendix 3.

Calculation 18p90 and 18p93

The purpose of these calculations was to generate the fuel-plate and water cross sections for the 18-plate fuel element with enrichment of 90% and 93% in U-235. The cross sections generated from the 18p90 calculation are also used for the fuel portion of the 12- and 9- plate fuel elements.

The calculation is a simple cell model with no leakage treatment. The geometry is presented in Figure 38. The composition of each material is reported in ref. 1 and in section 2.2.4.1. The U-235, U-238, Al, O and H microscopic cross sections are generated by smearing materials over the 3 regions.

The cross sections from the "18p90" calculation are used in REBUS to describe:

- the water and the aluminum of the 'plate clad' region of the 18-plate (90%), 12-plate and 9-plate fuel elements (Figure 25-Figure 27)
- the water, the aluminum and the fuel of the 'fuel plate' region of the 18-plate (90%), 12-plate and 9-plate fuel elements (Figure 25-Figure 27)
- the water of the 'graphite' region of the 12-plate and 9-plate fuel elements (Figure 26 and Figure 27)

Similarly, the cross sections from the "18p93" calculation are used to describe:

- the water and the aluminum of the 'plate clad' region of the 18-plate fuel element (93%) (Figure 25)
- the water, the aluminum and the fuel of the 'fuel plate' region of the 18-plate fuel element (93%) (Figure 25)

Calculation CElt

The calculation CElt is used to generate the cross sections for water and aluminum in a control element when the rods are withdrawn. The WIMS calculation is a cell model (without leakage treatment) where half the radial section of the control rod element is described when the rod is withdrawn (Figure 38). The composition of each material is reported in ref. 1 and in section 2.2.4.1.

More precisely, the generated cross sections are smeared on all the regions of the WIMS calculation and are used in the REBUS calculation to describe:

- The fuel, water and aluminum of the fuel plate sections of the control rod element (Figure 28)
- The water and aluminum of the plate clad regions of the control rod element (Figure 28)

Calculation rod

The calculation Rod is used to generate the microscopic cross sections for the fuel, the AG-3 alloy, the stainless steel, the hafnium and the water in the control element when the rods are inserted in the core.

This is a Super-cell calculation with two auxiliary cells (Figure 39). The first auxiliary cell describes an infinite array of fuel plates (93% U-235 enrichment) and is used to homogenize the fuel material in the Super-cell. The second auxiliary cell helps define the spectra for the hafnium, the water, the stainless steel and the AG-3 used in the Super-cell.

These microscopic cross sections are only used in REBUS for the fuel-plate and the plate-clad regions of the control rod element when the rods are fully inserted in the core (Figure 28).

Calculation G18p90

The calculation G18p90 is used to generate the cross sections for the graphite, the AG-3 alloy, and the water of the graphite element and graphite blocks.

It is a Super-Cell model describing an 18-plate fuel element (90% U-235 enrichment) that is homogenized from an auxiliary cell, 2 graphite elements and a large graphite block. This arrangement allow the generation of different cross sections for the graphite elements for each row in the driver zone. The geometry of the WIMS calculation is presented in Figure 40.

The cross sections smeared over the fuel element region of the WIMS calculation are used to generate the AG-3 cross section for the fuel elements of the REBUS model. The cross sections smeared over the 1st graphite element region of the WIMS calculation are used to generate the Graphite, AG-3 and water cross section for the graphite elements adjacent to a fuel element in the REBUS model. The cross sections smeared over the 2nd graphite element region of the WIMS calculation are used to generate the Graphite, AG-3 and water cross section for the graphite elements not adjacent to a fuel element in the REBUS model. The cross sections smeared over the graphite block region of the WIMS calculation are used to generate the graphite, AG-3 and water cross sections for the graphite blocks of the REBUS model.

Figure 41 shows the two graphite element regions used in the REBUS model for the R1UO2 configuration.

Substituting 93% U-235 enrichment resulted in cross sections for these materials that were similar to the results with 90% U-235 enrichment. Therefore, 93% U-235 enrichment fuel was not used to generate cross sections for these materials.

2.2.4.2.2 The experimental zone

The cross sections used in the experimental zone resulted from calculations of:

- The UO_2 pin cell, files: U(3) and U(3)Ax for the radial and axial views
- The samples inside the oscillation cane, file: sample

Calculation U(3) and U(3)Ax

The calculation U(3) describes the UO_2 pin cell. It is the radial description in the fuel mid-plane. The geometry is presented in Figure 42. The calculation is a cell model with no leakage treatment. The UO_2 fuel, the Zr-4, the AG-3 alloy and the water cross sections were generated.

In order to obtain the cross sections of all the elements composing the stainless steel, the calculation U(3)Ax was run. It is an axial view of the UO_2 fuel pin with its Plexiglas and stainless steel spacer. The calculation also used the cell model without leakage. The geometry is reported in Figure 42.

The generated cross sections are used in the REBUS model for:

- Every section of the UO_2 pin cell (Figure 33)
- Every section of the Al pin cell (Figure 35)
- Every section of the AG-3 buffer (Figure 32)
- Every section of the Chimney (Figure 31)
- The foot section of the fuel and control element of the driver zone (Figure 25 and Figure 28)
- The foot and upper section of the graphite element (Figure 24)
- The grid plates, caisson, supporting table and tank water of the driver zone

Calculation Sample

A calculation, file: sample, is performed for each calibration sample. These calculations are Super-Cell models. The main cell describes the radial view of the sample inside the oscillation cane surrounded by a circular buffer composed of a homogenized UO_2 fuel pin cell that constitutes the auxiliary cell (Figure 43). The cross sections for U-235, U-238, U-234, U-236, O, B-10, B-11 and H, are generated by smearing the material over the sample region.

A summary of the main characteristics of the WIMS calculations and of the generated microscopic cross sections are reported in Table 28 for the driver zone and in Table 29 for the experimental zone. Figure 41 illustrates the cross sections that are used in the REBUS model for the different regions in the R1UO2 configuration.

Table 28: Characteristic of the WIMS calculation used to generate cross sections for the driver zone					
File name	18p90	18p93	Celt	G18p90	Rod
Title	Fuel plate (90% U-235)	Fuel plate (93% U-235)	Control element (rods up)	Graphite element	Control element (rods down)
Calculation Type	Cell	Cell	Cell	SuperCell	SuperCell
Boundary condition	Infinite lattice	Infinite lattice	Infinite lattice	Infinite lattice	Infinite lattice
Description	90% U-235 fuel plate and Clad and water	93% U-235 fuel plate and Clad and water	Half the control element : 93% U-235 fuel plate and Clad and water	Homogenized 18-plate fuel element + 3 graphite elements	Homogenized 93% U-235 fuel plate+ Clad + water + AG-3 plate and water + Hafnium and SS and water
Cross sections generated	U-235, U-238, Al, H, O	U-235, U-238, Al, H, O	U-235, U-238, Al, H, O	Al, Mg, Mn, Fe-54,Fe-56, Fe-57, Fe-58, Cr-60, Cr-62, Cr-63, Cr-63, Cr-64, Ti, Si, Cu-63, Cu-65, H, O, C	Al, Mg, Mn, Fe-54,Fe-56, Fe-57, Fe-58, Cr-60, Cr-62, Cr-63, Cr-63, Cr-64, Ti, Si, Cu-63, Cu-65, H, O, Mo, C, Hf, Ni-58, Ni-60, Ni61, Ni62, Ni-64

Table 29: Characteristic of the WIMS calculation used to generate cross sections for the experimental zone			
File name	U(3)	U(3)Ax	Sample
Title	UO_2 (3%) pin cell	UO_2 (3%) pin cell In axial view	Sample in the oscillation cane
Calculation Type	Cell	Cell	SuperCell
Boundary condition	Infinite lattice	Infinite lattice	Infinite lattice
Description	UO_2 (3%) pin, void, clad, water, overclad, water	Fuel, Plexiglas, SS	Sample, water, Oscillation cane, water + UO2 pin cell buffer region
Cross sections generated	U-234, U-235, U-236, U-238, O,H,Zr,ZH, Fe-54,Fe-56, Fe-57, Fe-58, Cr-60, Cr-62, Cr-63, Cr-63, Cr-64,C,Hf, Al, Mg, Mn, Ti, Si, Cu-63, Cu-65	Ni-58, Ni-60, Ni61, Ni62, Ni-64, Mo	U-235, U-238, O, B-10, B-11

2.2.4.3 Cross sections for the R1MOX configuration

The cross sections for the driver zone are calculated in the same manner as for the R1UO2 configuration. In the R1MOX experimental zone, there are UO_2 fuel pin cells, Al fuel pin cells and UO_2-PuO_2 fuel pin cells (3.6% and 4% of PuO_2). Cross sections have been generated depending on the pin cell and its surrounding cells. The chosen configuration to take into account the interface between regions is:

- UO_2 fuel pin cell near Al fuel pin: UAl calculation
- UO_2 fuel pin cell near Al buffer: UAlB calculation
- UO_2 fuel pin adjacent to UO_2 PuO_2 fuel pin : UPuPu1 calculation
- UO_2 fuel pin cell surrounded by UO_2 fuel pin cell: U(3) and U(3)Ax calculation
- UO_2-PuO_2 (4%) fuel pin adjacent to UO_2 pin cell: UPu calculation
- UO_2-PuO_2 (4%) fuel pin adjacent to POLINE cell: UPOL calculation
- UO_2-PuO_2 (4%) fuel pin surrounded by UO_2-PuO_2 pin cell: Pu(4) and Pu(4)Ax calculation
- UO_2-PuO_2 (3.6%) fuel pin between a UO_2-PuO_2 (4%) pin cell and a UO_2 pin cell: UPuPu2 calculation
- Aluminum pins: U(3) calculation
- POLINE: U(3) calculation
- Calibration sample inside the oscillation channel : Sample calculation

The configuration of the experimental zone is shown in Figure 44. The WIMS calculations are detailed in the following sections. Table 32 and Table 33 summarize the characteristics of the WIMS models.

Calculation U(3) and U(3)Ax

These calculations are the same as for the R1UO2 configuration. The use of the cross sections in the REBUS model differs slightly. These calculations were used to generate cross sections for the following regions:

- Every section of the UO_2 pin cell completely surrounded by the same fuel pins (Figure 33)
- Every section except section C (fuel) of the other UO_2 pin cell (Figure 33)
- Every section of the Al pin cell (Figure 35)
- Every section of the AG-3 buffer (Figure 32)
- Every section of the Chimney (Figure 31)
- The foot section of the fuel and control element of the driver zone (Figure 25 and Figure 28)
- The foot and upper section of the graphite element (Figure 24)
- The grid plates, caisson, supporting table and tank water of the driver zone

Only the cross sections of section C of the fuel pin cell in Figure 33 is treated differently for the UO_2 pin cell located near a UO_2-PuO_2 pin cell, aluminum cell or aluminum buffer.

Calculation UAl and UAlB

The goal of these calculations is to take into account the effect of an aluminum pin or aluminum buffer on the cross sections for the neighboring UO_2 pin cell. A simple cell model representative of a UO_2 pin cell surrounded by 5 UO_2 pin cells and 3 aluminum pin (or buffer) cells is considered. In the model, the UO_2 pin cell is surrounded by a buffer where the materials of the 8 adjacent cells have been homogenized. The geometry of the calculation is shown in Figure 45. The material composition of each region is reported in ref. 1 and section 2.2.4.1 except for the buffer region composition which is listed in Table 30.

Cross sections are generated for the Zr-4 alloy, the AG-3 alloy, the UO_2 fuel and the water and are only used in section C (Figure 33) of the UO_2 pins adjacent to aluminum pins and aluminum buffer (Figure 44).

Table 30: Buffer composition

Element	"UAl" Number density (at / b.cm)	"UAlB" Number density (at / b.cm)
U-234	9.243E-07	9.243E-07
U-235	1.381E-04	1.381E-04
U-236	1.100E-06	1.100E-06
U-238	4.404E-03	4.404E-03
O-16	2.517E-02	1.829E-02
Zr	2.773E-03	2.774E-03
Zr in ZRH	3.199E-06	3.200E-06
Fe-54	1.377E-06	2.040E-06
Fe-56	2.161E-05	3.202E-05
Fe-57	4.989E-07	7.394E-07
Fe-58	6.641E-08	9.842E-08
Cr-50	7.003E-07	1.098E-06
Cr-52	1.350E-05	2.117E-05
Cr-53	1.531E-06	2.400E-06
Cr-54	3.812E-07	5.975E-07
C	2.873E-06	2.874E-06
Hf	7.229E-08	7.230E-08
H	3.170E-02	1.793E-02
Al	1.374E-02	2.500E-02
Mg	4.933E-04	8.976E-04
Mn	1.760E-05	3.202E-05
Ti	6.058E-06	1.102E-05
Si	2.755E-05	5.013E-05
Cu-63	2.105E-06	3.830E-06
Cu-65	9.380E-07	1.707E-06

Calculation UPuPu1

The calculation "UPuPu1" is used to generate cross sections for the UO_2 pin cells that are adjacent to a UO_2-PuO_2 (3.6%) pin cell (Figure 44). The calculation used a Multi-Cell model with one cell for the UO_2 pin, one for the UO_2-PuO_2 (3.6%) and another for the UO_2-PuO_2 (4%). The geometry of each cell and the interaction probabilities used are presented in Figure 46.

The cross section of the Zr-4 alloy, the AG-3 alloy, the UO_2 fuel and the water are smeared on the UO_2 fuel pin cell region. They are only used in the REBUS model for section C (Figure 33) of the UO_2 pins adjacent to UO_2-PuO_2 (3.6%) pins (Figure 44).

Calculation Pu(4) and Pu(4)Ax

The calculations Pu(4) and Pu(4)Ax have a similar purpose as the calculation "U(3)" and "U(3)Ax" used for the UO_2 fuel pins. They provide the fuel, the water, the AG-3 alloy, the Zr-2 alloy, the stainless steel and the Styrene cross sections for the UO_2-PuO_2 (4%) pin cells. The calculation used the cell model without leakage treatment and the geometry is presented in Figure 47. The generated cross sections are used in the REBUS model for:

- Every section of the UO_2-PuO_2 (4%) fuel pin cell (Figure 34) completely surrounded by the same pins
- Sections A, B, D, E and F (Figure 34) of the UO_2-PuO_2 fuel pins (regardless of the PuO_2 enrichment or the location of the pin)

Only the cross sections for section C (Figure 34) of the UO_2-PuO_2 pin cell differs for different PuO_2 enrichment and different neighboring pins.

Calculation UPu

The purpose of the calculation UPu is to provide the cross sections for section C (fuel section) of the UO_2-PuO_2 (4%) pin cells next to UO_2 pin cells (Figure 44). The WIMS calculation is a Multi-Cell model with one cell for the UO_2 pin and the other for the UO_2-PuO_2 (4%). The geometry is reported in Figure 48. The Zr-2 alloy, the AG-3 alloy, the UO_2-PuO_2 (4%) fuel and the water cross sections are generated by smearing materials over the UO_2-PuO_2 (4%) fuel pin cell.

Calculation PuPOL

The purpose of the calculation PuPOL is to provide the cross sections for section C (fuel section) of the UO_2-PuO_2 (4%) pin cells which are next to the POLINE overclad inserted in the central channel of the experimental lattice for some experiments (Figure 44). The WIMS calculation is a cell model of the UO_2-PuO_2 (4%) pin cell surrounded by a buffer taking into account the materials of the 8 surrounding pins. The geometry is presented in Figure 49. The material of one POLINE overclad cell and seven UO_2-PuO_2 (4%) pin cells is homogenized to form the buffer. The number density of the buffer is reported in Table 31.

Cross sections for the Zr-2 alloy, the AG-3 alloy, the UO_2-PuO_2 (4%) fuel and the water are generated by smearing the materials over the UO_2-PuO_2 (4%) fuel pin cell. They are only used in the REBUS model for section C (Figure 34) of the UO_2-PuO_2 (4%) pins (Figure 44).

Calculation UPuPu2

The calculation UPuPu2 is the same as "UPuPu1" except that the Zr-2 alloy, the AG-3 alloy, the UO_2-PuO_2 (3.6%) fuel and the water cross sections are generated by smearing materials over the UO_2-PuO_2 (3.6%) fuel pin cell region. They are only used in the REBUS model for section C (Figure 34) of the UO_2-PuO_2 (3.6%) pins (Figure 44).

Table 31: Buffer composition in the "PuPOL" calculation	
Element	Number density (at / b.cm)
U-234	8.847E-07
U-235	4.456E-05
U-238	6.144E-03
Pu-238	2.036E-06
Pu-239	1.799E-04
Pu-240	4.349E-05
Pu-241	6.012E-06
Pu-242	5.076E-06
Am-241	1.890E-05
Np-237	5.671E-07
O-16	2.727E-02
Zr	3.238E-03
Zr in ZRH	3.734E-06
Fe-54	8.921E-07
Fe-56	1.400E-05
Fe-57	3.234E-07
Fe-58	4.304E-08
Cr-50	4.863E-07
Cr-52	9.378E-06
Cr-53	1.063E-06
Cr-54	2.647E-07
C	3.384E-06
Hf	8.437E-08
H	2.872E-02
Al	7.229E-03
Mg	2.354E-04
Mn	1.135E-05
Ti	2.802E-06
Si	1.722E-05
Cu-63	1.040E-06
Cu-65	4.634E-07

Calculation Sample

A different calculation sample is performed for each calibration sample. The geometry and composition of the regions are the same as for the R1UO2 configuration except that the buffer region is now composed of homogenized PuO_2-UO_2 (4%) fuel pin cells (Figure 50). The cross sections for U-235, U-238, U-234, U-236, O, B-10, B-11 and H are generated by smearing the materials over the sample region.

The characteristics of the WIMS calculation are summarized in Table 32 and Table 33. The input files are included in Appendix 3.

Table 32: Characteristics of the WIMS calculations used to generate cross sections for the UO_2 pin cell of the experimental zone					
File name	U(3)	U(3)Ax	UAl	UAlB	UPuPu1
Title	UO_2 (3%) pin cell	UO_2 (3%) pin cell In axial view	UO_2 (3%) pin cell adjacent to an Al pin	UO_2 (3%) pin cell adjacent to an Al pin	UO_2 (3%) pin cell adjacent to an Al pin
Calculation Type	Cell	Cell	Cell	Cell	Multi-Cell
Boundary condition	Infinite lattice	Infinite lattice	Infinite lattice	Infinite lattice	Infinite lattice
Description	UO_2 (3%) pin, void, clad, water, overclad, water	Fuel, Plexiglas, SS	UO_2 (3%) pin, void, clad, water, overclad, water + Buffer (3/8 Al pin and 5/8 UO_2 pin)	UO_2 (3%) pin, void, clad, water, overclad, water + Buffer (3/8 Al block and 5/8 UO_2 pin)	UO_2 (3%) pin cell + UO_2-PuO_2 (3.6%) pin cell + UO_2-PuO_2 (4%) pin cell
Cross sections generated	U234, U235, U236, U238, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr54, C, Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65	Ni58, Ni60, Ni61, Ni62, Ni64, Mo	U234, U235, U236, U238, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr54,C ,Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65	U234, U235, U236, U238, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr54, C, Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65	U234, U235, U236, U238, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr54, C, Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65

Table 33: Characteristics of the WIMS calculations used to generate cross sections for the UO_2 -PuO_2 pin cells of the experimental zone					
File name	Pu(4)	Pu(4)Ax	UPu	PuPOL	UPuPu2
Title	UO_2-PuO_2 (4%) pin cell	UO_2-PuO_2 (4%) pin cell In axial view	UO_2-PuO_2 (4%) pin cell adjacent to a UO_2 pin cell	UO_2-PuO_2 (4%) pin cell adjacent to the POLINE overclad	UO_2-PuO_2 (3.6%) pin cell in between a UO_2 pin cell and a UO_2-PuO_2 (4%) pin cell
Calculation Type	Cell	Cell	Multi-Cell	Cell	Multi-Cell
Boundary condition	Infinite lattice	Infinite lattice	Infinite lattice	Infinite lattice	Infinite lattice
Description	UO_2-PuO_2 (4%) pin, void, inner clad, void, outer clad, water, overclad, water	Fuel, Plexiglas, SS, foot	UO_2-PuO_2 (4%) pin cell + UO_2-PuO_2 (3.6%) pin cell + UO_2-PuO_2 (4%) pin cell	UO_2-PuO_2 (4%) pin cell + Buffer (7/8 UO_2-PuO_2 (4%) pin and 1/8 POLINE cell)	UO_2-PuO_2 (4%) pin cell + UO_2-PuO_2 (3.6%) pin cell + UO_2-PuO_2 (4%) pin cell
Cross sections generated	U234, U235, U238, Pu238, Pu239, Pu240, Pu241, Pu242, Np237, Am241, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr-54, C, Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65	Ni58, Ni60, Ni61, Ni62, Ni64, Mo, N	U234, U235, U238, Pu238, Pu239, Pu240, Pu241, Pu242, Np237, Am241, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr-54, C, Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65	U234, U235, U238, Pu238, Pu239, Pu240, Pu241, Pu242, Np237, Am241, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr-54, C, Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65	U234, U235, U238, Pu238, Pu239, Pu240, Pu241, Pu242, Np237, Am241, O, H, Zr, ZH, Fe54, Fe56, Fe57, Fe58, Cr50, Cr52, Cr53, Cr-54, C, Hf, Al, Mg, Mn, Ti, Si, Cu63, Cu65

3 REACTOR DATA ANALYSIS

The MCNP and REBUS models have been used to predict safety and core parameters for the R1UO2 and R1MOX configurations. Results of the MCNP and REBUS calculations are compared with one another and also with the experimental results whenever possible. The experimental results reported in this section are provided by CEA in accordance with an agreement between CEA and DOE (ref. 8). The safety and core parameters of interest are:

- The reactivity worth of the control rods
- The spectral indices in the oscillation channel at core mid-plane
- The axial power profile
- The radial power profile
- The conversion ratio

The reactivity worths of the calibration samples calculated with the REBUS model are compared with the experimental values in the R1UO2 and R1MOX configuration.

3.1 The control rod reactivity worth

3.1.1 Experimental technique

The reactivity worth of each control rod and of the four rods taken together is assessed for safety purposes. When measuring the reactivity worth of a control rod, all rods are withdrawn except the studied rod which is inserted in the core to achieve criticality. The studied rod is then completely withdrawn to measure the asymptotic period and reinserted to the critical height. After stabilization, the rod is completely inserted to perform a rod drop measurement. The sum of the reactivity derived from the asymptotic period and the rod drop measurements is the rod worth (ref. 9).

During the rod drop, the time dependant neutron population is recorded using a U-235 fission chamber located either in the central channel of the experimental lattice, or in the thermal column (ref. 9). Analysis of the rod-drop measurement is based on the point kinetic model. Considering that the investigated reactivity worth is greater than 700 pcm[1], it is necessary to take into account spatial and energetic effects. One method is to calculate Modified Source Multiplication factors (ref. 10) and use these to adjust the values for the rod worths.

3.1.2 Calculation technique

In the MCNP model, the reactivity worths of the rods have been evaluated using two static calculations: one when all rods are withdrawn and the other when the rod of interest is fully inserted in the core.

[1] 1pcm = 10^{-5}

The REBUS calculation used the same two static cases, except that the rods are never modeled above the core (section 2.2.2.2.2).

3.1.3 Results and comparison

The reactivity worth determined experimentally is relative to the delayed neutron fraction and expressed in dollars. MCNP and REBUS calculate multiplication factor. The conversion in relative reactivity uses a delayed neutron fraction of 716 pcm and 681 pcm for the R1UO2 and R1MOX configuration, respectively. The uncertainty on the reactivity worth of the rod determined by MCNP does not take into account the uncertainty on the delayed neutron fraction. A statistical uncertainty is not derived for the REBUS model.

The rods are designated as R1, R2, R3 and R4 and are inserted in the east, south, west and north driver zone, respectively (ref. 1). The experimental reactivity worths of rods in the R1UO2 configuration are reported in Table 34 for the two locations of the fission chamber (during the rod drop). The difference between the two experiments range from 5% to 20% for individual rods and is approximately 40% for the four rods; advocating the need for spatial and energy corrections. Spatial and energy effects appear to be less critical in the thermal column than in the center of the core. Therefore, a primary comparison between experiment and calculation can be made when the fission chamber is located in the thermal column.

Table 34: Experimental rod worth in the R1UO2 configuration

Rods inserted	Detector in the central channel ($)	Detector in the thermal column ($)	Central/Thermal - 1
R1	1.18 ± 0.06	1.37 ± 0.06	16.1%
R2	1.32 ± 0.06	1.25 ± 0.06	-5.3%
R3	1.40 ± 0.07	1.52 ± 0.07	8.6%
R4	1.32 ± 0.08	1.55 ± 0.08	17.4%
4 rods	5.62 ± 0.43	7.98 ± 0.43	42.0%

Experiments and MCNP calculations are reported in Table 35 and agree within one standard deviation for all rods but R3. This agreement is still valid for the large reactivity worth of the four rods; suggesting small spatial and energy corrections. On the contrary, the difference between experiments and REBUS calculations increases with the reactivity worth. The REBUS calculations result in lower reactivity worth estimates than the MCNP calculations except for the rod R1. The MCNP and REBUS rod worths differ by more than 10% for the rods R3 and R4 and the four rods. The difference in the MCNP and REBUS geometries, i.e. is the description of the pilot rod and the control rods when withdrawn from the core (section 2.2.2.2.2), does not explain the discrepancy. The WIMS model used to smear, condense to 7 groups and self shield the cross sections for the absorber and the high enriched uranium fuel plates might be inadequate because of the strong flux gradient at the fuel plates, water and absorber interfaces. In the REBUS model, the difference of composition between the rod element (when the rod is inserted) and a standard fuel element induces a flux gradient at the interface that can be more accurately described by increasing the number of mesh (currently one mesh every 1.26 cm). Additional tests of the REBUS and WIMS models are being performed to identify the source of the discrepancy between the MCNP and REBUS control rod worths.

Table 35: Experimental and calculated rod worth in the R1UO2 configuration						
Rods inserted	Exp. ($)	MCNP ($)	REBUS ($)	MCNP C/E-1	REBUS C/E -1	REBUS/MCNP -1
R1	1.37 ± 0.06	1.38 ± 0.03	1.45	1.0%	5.8%	4.8%
R2	1.25 ± 0.06	1.33 ± 0.03	1.29	6.0%	3.0%	-2.8%
R3	1.52 ± 0.07	1.66 ± 0.03	1.35	9.4%	-10.9%	-18.5%
R4	1.55 ± 0.08	1.60 ± 0.03	1.38	3.0%	-11.2%	-13.8%
4 rods	7.98 ± 0.43	7.83 ± 0.03	6.81	-1.9%	-14.6%	-13.0%

In the R1MOX configuration, the rod-drop experiments have only been recorded with a U-235 fission chamber located in the central channel of the experimental lattice. The MCNP and REBUS rod worths are compared in Table 36. The trend between the MCNP and the REBUS calculations is the same as in the R1UO2 configuration.

Table 36: Calculated rod worth reactivity in the R1MOX configuration			
Rods inserted	MCNP ($)	REBUS ($)	MCNP/REBUS -1
R1	1.51 ± 0.03	1.77	17.3%
R2	1.61 ± 0.03	1.61	-0.2%
R3	1.76 ± 0.03	1.58	-10.4%
R4	1.69 ± 0.03	1.62	-4.2%
4 rods	10.03 ± 0.03	9.43	-6.0%

Further investigations require calculation of spatial/energy correction factors such as Modified Source Multiplication factors to correct measurements in the thermal column or at least make sure that such corrections are negligible. Complementary REBUS models and experiments will be needed.

3.2 Spectral indices

Spectral indices have been measured using U-235, Pu-239, Pu-241 and Np-237 fission chambers located inside the POLINE overclad in the middle of the experimental lattice. The reactor is held critical during the measurement by inserting the rods R1 and R3 in the core.

The spectral indices have been determined in MCNP by using the track length estimate of the cell flux tally (ref. 2) on a 10 cm height and a 0.9 cm diameter void cylinder located in the center of the core. The height matches that of the oscillation samples and the diameter maximizes the statistic of the tally. Calculations are performed with all rods withdrawn, which should not influence the spectrum in the center of the core.

The spectral indices are reported in Table 37 and Table 38 for the R1UO2 and R1MOX configurations, respectively. Calculated and measured spectral indices agree within one standard deviation except for the Np-237/Pu-239 index in the R1UO2 configuration which agrees within two standard deviations.

Table 37: Spectral indices for the R1UO2 configuration			
Spectral Index	Experiment	MCNP	MCNP/Exp. -1
Pu-239/U-235	1.913 (1.2%)	1.918 (1.1%)	-0.3%
Pu-241/Pu-239	1.133 (1.3%)	1.142 (1.1%)	0.8%
Np-237/Pu-239	0.00383 (3.6%)	0.00361 (0.9%)	-5.7%

Table 38: Spectral indices for the R1MOX configuration			
Spectral Index	Experiment	MCNP	MCNP/Exp. -1
Pu-239/U-235	1.941 (1.2%)	1.954 (1.9%)	0.7%
Pu-241/Pu-239	1.158 (1.3%)	1.147 (1.8%)	-0.9%
Np-237/Pu-239	0.00742 (3.6%)	0.00745 (1.4%)	0.4%

Due to problems with the calibration of the Pu-240, Pu-242, U-238 and Am-241 fission chambers, the spectral indices performed with these detectors are not reliable. Corresponding spectral indices calculated with MCNP are reported in Table 39 for future consideration.

Table 39: Spectral indices calculated with MCNP		
Spectral Index	R1UO2 configuration	R1MOX configuration
U-238/U-235	0.001323 (0.98%)	0.002827 (1.45%)
Pu-240/Pu-239	0.004312 (0.93%)	0.008697 (1.48%)
Pu-242/Pu-239	0.003029 (0.90%)	0.006270 (1.41%)
Am-241/Pu-239	0.009162 (0.89%)	0.007452 (1.40%)

3.3 Axial power profile

3.3.1 Experimental technique

Axial power profiles have been measured in the R1UO2 and R1MOX configurations using an integral gamma counting technique on selected pins and U-235 and Np-237 fission chambers inserted in the POLINE overclad in the oscillation channel.

In the R1UO2 configuration, two experimental-zone loadings have been used. In the first one, the POLINE overclad is inserted in the oscillation channel and the fission chamber measurements are performed. In the second, the oscillation channel is filled with a standard UO_2 pin and the integral gamma counting measurements are performed.

In the R1MOX configuration both integral gamma counting and fission chamber measurements are performed with the POLINE overclad inserted in the oscillation channel.

The types of measurements and the location of the studied pins are reported in Table 40 and Figure 51.

Table 40: Axial power profile measurements		
Configuration	Fission chamber	Pins
R1UO2	U-235 Np-237	17-17 (central pin) 17-18 (1st pin East) 17-21 (4th pin East)
R1MOX	U-235 Np-237	18-17 (1st pin North) 20-17 (3rd pin North)

Fission chamber measurements using the linear positioning device POLINE have been performed with a non constant step which does not exceeded 2 cm. The fission rate of the pins is measured every 2 cm by integral gamma counting.

3.3.2 Calculation technique

The REBUS model has been used to generate the axial power profile in the studied pins of the R1UO2 and R1MOX configurations. The fission rate is evaluated for each axial mesh; corresponding to at least one data point every centimeter.

Axial power profiles are also computed with the MCNP model for comparison with the fission chamber and integral gamma counting measurements. The power profile is calculated every 2 cm using the track length estimate of the cell flux tally (ref. 2). This resolution is time consuming but necessary to have enough points for comparisons.

The oscillation basket, regrouping the 9 holes in the center of the experimental zone, has two plates of Styrene at about ± 12-15 cm of the fuel center line (ref. 1). Because Styrene contains carbon and hydrogen, neutrons are locally slowed down enhancing the thermal neutron fission rate. The styrene plates have not been included in the MCNP and REBUS models.

3.3.3 The R1UO2 configuration

The measured and calculated axial power profile for the 17-17, 17-18 and 17-21 pins are shown in Figure 52 and Figure 53. For all pins, the REBUS and experimental power profiles match each other in the range of ±19 cm of the core mid-plane. MCNP power profiles exhibit fluctuations due to an insufficient number of particles in each tallied cell (section 3.3.2). The effect of the Styrene plate on the experimental fission rates (section 3.3.1) can not be detected. On the contrary, the neutron slowing down induced by the lower and upper Plexiglas spacer of the pins is starting to be observed at 20 cm from the core mid-plane.

The axial power profiles derived from U-235 and Np-237 fission chamber measurements are compared with MCNP calculations in Figure 54. There is a very good overall agreement between calculation and experiment for the U-235 and Np-237 fission chamber profiles. The region of interest (between -20 cm and 20 cm) is shown in Figure 55. MCNP profiles oscillated near the core mid-plane. The influence of the styrene spacers is shown in the U-235 fission chamber measurement at about -13 cm and 15 cm, but does not appear in the Np-237 fission chamber measurement because of the threshold for the Np-237 fission.

3.3.3.1 Axial buckling

Considering the fundamental mode established on an axial region centered on the core mid-plane, the axial fission rate distribution is a cosine function characterized by the axial buckling B^2. The fission rate distribution can be fitted by the function f(z) = A cos(B (z-z_0)), where z_0 accounts for any offset.

Practically, the cosine function can be used in a region where the influence of the Plexiglas and Styrene spacer are negligible. The effect of the Plexiglas spacer can be neglected by narrowing the region around the core mid-plane. The influence of Styrene spacers are difficult to remove but are generally too small to significantly disturb the cosine shape.

To find the best value of the axial buckling from the measurements, parametric studies of the buckling versus the height of the axial region have been performed. Results of the buckling parametric study for the experimental power profiles of the studied pins are reported in Table 41 and Figure 56. When the axial region is larger than [-12 cm, 12 cm], values of the buckling agree within one standard deviation for all pins. The buckling converges when increasing the axial region from [-12 cm, 12 cm] to [-20 cm, 20 cm]. The influence of the styrene spacers on pin 17-17 can be noticed by the significant increase of χ^2 when the fitting range is larger than [-14 cm, 14 cm]. A similar effect is not observed for pin 17-18. The influence of the Plexiglas is negligible for the fitting range [-20 cm, 20 cm] (Figure 57).

Table 41: Buckling vs. fitting range issued from pin measurement in the R1UO2 configuration

Range (cm)	Pin 17-17		Pin 17-18		Pin 17-21	
	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2
[-20,20]	1.944 ± 0.010	2.94	1.940 ± 0.010	1.43	1.934 ± 0.010	1.53
[-18,18]	1.939 ± 0.013	3.02	1.932 ± 0.013	1.53	1.940 ± 0.013	1.39
[-16,16]	1.899 ± 0.018	2.67	1.925 ± 0.017	1.64	1.914 ± 0.018	1.13
[-14,14]	1.849 ± 0.025	1.66	1.899 ± 0.024	1.66	1.886 ± 0.025	1.07
[-12,12]	1.861 ± 0.037	1.54	1.908 ± 0.035	1.66	1.914 ± 0.037	1.03
[-10,10]	1.915 ± 0.057	1.22	2.057 ± 0.054	0.37	1.838 ± 0.057	0.37

For the MCNP calculations, a similar study was performed and the results are displayed in Table 42 and Figure 58. Bucklings agree within one standard deviation and converge when increasing the fitting zone until the range [-18 cm, 18 cm]. The sudden increase of χ^2 for the range [-20 cm, 20 cm] is due to the effect of the Plexiglas reflector.

The REBUS estimate of the buckling was performed without considering statistical uncertainty. It is therefore hard to interpret the buckling convergence with the increase of the fitting region (Figure 59).

Table 42: Buckling vs. fitting range issued from MCNP simulation of the R1UO2 configuration

Range (cm)	Pin 17-17		Pin 17-18		Pin 17-21	
	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2
[-20,20]	1.872 ± 0.024	1.37	1.875 ± 0.024	1.01	1.867 ± 0.023	1.71
[-18,18]	1.906 ± 0.030	1.14	1.926 ± 0.030	0.58	1.930 ± 0.031	1.26
[-16,16]	1.873 ± 0.041	1.16	1.933 ± 0.041	0.59	1.971 ± 0.041	1.19
[-14,14]	1.961 ± 0.056	0.87	1.941 ± 0.058	0.63	1.910 ± 0.058	1.14
[-12,12]	1.979 ± 0.084	1.03	2.031 ± 0.084	0.52	1.878 ± 0.086	1.11
[-10,10]	1.955 ± 0.131	0.87	2.029 ± 0.130	0.58	1.741 ± 0.134	1.11

The evolution of the buckling for the U-235 fission chamber measurement is particularly sensitive to the styrene spacers. Figure 60 presents the bucklings with the styrene plate and 'without' - that is by removing the obvious distorted points. The buckling values become more uniform (particularly in the range of 12-15 cm) and χ^2 is reduced from approximately 3.5 to 1.5. For the range [-18 cm, 18 cm], the buckling has converged to an asymptotic value. The Np-237 measurement shows a similar convergence for the fitting range [-18 cm, 18 cm].

The MCNP simulation does not include the styrene spacers. Based on χ^2 estimates and analysis of the residuals and the convergence of the buckling with the fitting range, the best value for the buckling is shown to be for the range [-18 cm, 18 cm].

The best estimates of the buckling for the measurements and calculations is for the range [-18 cm, 18 cm]. The range can fluctuate slightly because of the position of the mesh size in REBUS and of the offset in the measurements. The bucklings are reported in Table 43.

Table 43: Experimental and calculated axial buckling (*1e-3) in the R1UO2 configuration

Source	Experiment	MCNP	REBUS	MCNP-Expt	REBUS-Expt	REBUS-MCNP
U-235	1.917 ± 0.011	1.901 ± 0.032	-	-0.016	-	-
Np-237	1.973 ± 0.011	1.877 ± 0.020	-	-0.096	-	-
Pin 17-17	1.939 ± 0.013	1.906 ± 0.030	1.944	-0.033	0.005	0.038
Pin 17-18	1.932 ± 0.013	1.926 ± 0.030	1.942	-0.006	0.010	0.016
Pin 17-21	1.940 ± 0.013	1.930 ± 0.031	1.921	-0.010	-0.019	-0.009

The experimental bucklings agree within one standard deviation except for the Np-237 fission chamber measurement. The bucklings calculated using MCNP all agree within one standard deviation. There is also a good agreement between the bucklings calculated using REBUS. The same conclusion can be drawn when comparing experimental and calculated results for a given pin. The only source of disagreement is observed for the Np-237 axial buckling. The reason can be an error in the measurement or an inaccuracy of the Np-237 cross section in ENDF-BVI as pointed out by the spectral indices (section 3.2).

3.3.4 The R1MOX configuration

The axial power profile obtained by integral gamma scanning for the pins 18-17 and 20-17 are compared with the REBUS and MCNP calculations in Figure 61 and Figure 62. The uncertainty for the experimental data is not shown in the figures to ease comparison with the calculated values. REBUS profiles are in very good agreement with the experimental profiles whereas the MCNP profiles fluctuate because of poor statistics.

The experimental and MCNP axial power profiles are compared for the U-235 and Np-237 fission chambers in Figure 63. The U-235 fission profile calculated with MCNP overestimates the experimental profile by approximately 10 to 20% at ±30 cm from the core mid-plane. The increases are due to the Plexiglas spacers in the pins. The increase in fission rate occurs slightly closer (less than 1 cm) to the core mid-plane for the MCNP U-235 fission profile. This may be due to uncertainty in the exact location and composition of the Plexiglas spacers in the UO_2-PuO_2 pins. The region of interest [-20 cm, 20 cm] is shown in Figure 64. The MCNP profiles are not well converged and the effect of the Styrene spacers is readily observed in the experimental U-235 fission profile at around ±14 cm from the core mid-plane.

3.3.4.1 Axial buckling

The evolution of the buckling as a function of the fitting range has also been investigated. The experimental results are reported in Figure 65 and Table 44. The convergence of the buckling when increasing the number of points is difficult to observe. The buckling of the pins 18-17 exhibit a drop near 13 to 15 cm that can be due to the styrene spacer (section 3.3.3). The U-235 fission chamber measurement has been corrected for the styrene spacers and therefore fewer buckling values are reported. From the χ^2 value of Table 44, the range [-18 cm, 18 cm] seems the most appropriate with the exception of the pin 18-17. However, the buckling for the U-235 fission profile should be considered as less reliable because of the uncertainty in the correction needed to account for the Styrene spacers.

Table 44: Experimental buckling as a function of the fitting range in the R1MOX configuration

Range (cm)	Pin 18-17		Pin 20-17		U-235 fission chamber		Np-237 fission chamber	
	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2
[-20,20]	1.854 ± 0.007	3.47	1.859 ± 0.007	2.36	1.900 ± 0.010	2.24	1.873 ± 0.009	1.36
[-18,18]	1.840 ± 0.009	2.65	1.863 ± 0.009	0.92	1.883 ± 0.016	1.79	1.885 ± 0.012	1.10
[-16,16]	1.803 ± 0.013	1.94	1.844 ± 0.013	0.76	-	-	1.880 ± 0.015	1.07
[-14,14]	1.801 ± 0.017	1.77	1.827 ± 0.017	0.66	-	-	1.847 ± 0.021	0.89
[-12,12]	1.827 ± 0.024	1.82	1.856 ± 0.024	0.63	-	-	1.856 ± 0.029	0.92
[-10,10]	1.858 ± 0.034	1.58	1.842 ± 0.033	0.67	1.848 ± 0.053	1.38	1.840 ± 0.040	0.85

The evolution of the buckling as a function of the fitting range obtained with MCNP is reported in Figure 66 and Table 45. The convergence of the buckling with the increase of the fitting range is readily seen. Because of the values of χ^2, we can reject the range [-20 cm, 20 cm] for the pin 18-17 and the U-235 fission chamber. The range [-18 cm, 18 cm] is appropriate for all profile.

The buckling calculated with REBUS evolves similarly for the R1UO2 configuration (section 3.3.3). The lack of statistical uncertainty on the calculations precludes judging the convergence of the buckling when the fitting range is increased.

Table 45: MCNP buckling as a function of the fitting range in the R1MOX configuration

Range (cm)	Pin 18-17		Pin 20-17		U-235 fission chamber		Np-237 fission chamber	
	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2	B (*1e-3 cm^{-2})	χ^2
[-20,20]	1.752 ± 0.037	1.61	1.835 ± 0.037	0.52	1.761 ± 0.039	0.89	1.775 ± 0.018	0.71
[-18,18]	1.753 ± 0.050	1.09	1.836 ± 0.050	0.57	1.830 ± 0.052	0.66	1.778 ± 0.024	0.69
[-16,16]	1.732 ± 0.067	1.23	1.773 ± 0.068	0.48	1.854 ± 0.070	0.56	1.743 ± 0.028	0.56
[-14,14]	1.767 ± 0.093	1.41	1.750 ± 0.095	0.43	1.881 ± 0.098	0.62	1.737 ± 0.045	0.60
[-12,12]	1.763 ± 0.135	1.55	1.693 ± 0.139	0.49	1.858 ± 0.145	0.70	1.758 ± 0.068	0.49
[-10,10]	2.050 ± 0.206	1.50	1.739 ± 0.214	0.60	2.071 ± 0.191	0.45	1.766 ± 0.100	0.61

The buckling of the experimental data obtained from the pin 18-17 and the U-235 fission chamber is not compatible with the other data regardless of the data range. Nevertheless, the most appropriate fitting region is [-18 cm, 18 cm] for the other data. The data range varies slightly between the experimental data and the REBUS model due to the axial offset of the measurement and the position of the mesh size. The final bucklings are reported in Table 46.

Table 46: Experimental and calculated axial buckling (*1e3) in the R1MOX configuration						
Source	Experiment	MCNP	REBUS	MCNP-Exp	REBUS-Exp	REBUS-MCNP
U-235	1.900 ± 0.010	1.830 ± 0.052	-	-0.070	-	-
Np-237	1.885 ± 0.012	1.778 ± 0.024	-	-0.107	-	-
Pin 18-17	1.840 ± 0.009	1.753 ± 0.050	1.875	-0.087	0.035	0.122
Pin 20-17	1.863 ± 0.009	1.836 ± 0.050	1.865	-0.027	0.002	0.029

The experimental bucklings agree within two standard deviations. The uncertainties on the bucklings from MCNP are 2 to 5 times larger than the experimental uncertainties. The bucklings from MCNP are in agreement within one standard deviation. The MCNP and experimental bucklings agree within two standard deviations (4 to 5%) for the pins 18-17 and 20-17 and for the U-235 fission chamber measurement. The bucklings from REBUS is well predicted (0.1%) for the 20-17 pin but not for the 18-17 pin (2%).

The use of MCNP to determine the axial buckling is strongly limited by the poor statistics on the power profile even for a huge number of particles (300 million). An experimental buckling is also hard to be derived for pin 18-17 and the U-235 fission chamber because of the influence of the Styrene spacers.

3.4 Radial power profile

The radial power profiles have been determined experimentally on a horizontal and a diagonal traverse in the R1MOX configuration (Figure 67). Each pin of the traverse has been measured by integral gamma scanning. The fission rate of specific UO_2 and UO_2-PuO_2 pins (Figure 67) was obtained by gamma spectroscopy of the La-140 peak at 1596.17 keV. The fission rate of the other pins was calculated assuming that the ratio of integral counting to fission rate is the same for a given fuel pin type (ref. 9).

The horizontal and diagonal radial power profiles have been calculated in both configurations by MCNP and REBUS. The MCNP fission rates are calculated using the track length estimate of the cell flux tally (ref. 2) on the fuel meat of the studied pins. The REBUS fission rates were calculated on regions accounting for individual pins (1.26×1.26 cm^2) composed of homogenized materials (Figure 33 and Figure 34).

3.4.1 The R1UO2 configuration

The horizontal and the diagonal radial power profiles are compared for the MCNP and REBUS models in Figure 68 and Figure 69. The power profiles are normalized to the total power of the traverse. In both cases, there is a poor agreement between REBUS and MCNP. The absence of specific self-shielding for the UO_2 pins close to the AG-3 buffer in the REBUS model might be a source of error. Further investigation to determine the source of the difference will require experimental data.

3.4.2 The R1MOX configuration

The measured horizontal power profile is compared to the calculated values from REBUS and MCNP in Figure 70. The power of each pin is normalized to the total power of the traverse. The pin numbers are centered on the oscillation channel (pin 0). The interface between the UO_2-PuO_2 (4%) and UO_2 pins is observed for pins [-6, -7, 6, 7]. The pins [-15, 15] are adjacent to AG-3 pins.

The MCNP power profile matches the experimental values on the North side of the traverse, especially the interface between UO_2-PuO_2 (4%) and UO_2 pins. On the South side, the change of power between the adjacent UO_2 and UO_2-PuO_2 pins predicted by MCNP is 50% higher than the change of power obtained experimentally. The power of the UO_2-PuO_2 (4%) pins is well predicted with MCNP and the power of the UO_2 pins agrees within nearly one standard deviation.

The power of the UO_2 pins calculated with REBUS underestimates the experimental power on both sides of the traverse. On the contrary, the power of the UO_2-PuO_2 (4%) pins calculated with REBUS, overestimates the experimental values. The power at the interface between the UO_2-PuO_2 (4%) and UO_2 pins is similar to the MCNP values.

The REBUS model uses slightly different cross sections for pins # 1, 5, 6 and 15 to account for self-shielding due to an adjacent buffer region (section 2.2.4.3). From a model where the effect of the buffer was not taken into account for pins #1 and 15, Figure 71 shows an improvement of the results for the pins next to the POLINE overclad (cell # 0) but no significant change for the power of the pins next to the Aluminum buffer.

To improve the REBUS power profile, the cross sections of the UO_2-PuO_2 (4%) and the UO_2 pins might have to be self-shielded by taking into account more than the 8 adjacent pins.

The South East – North West traverse calculated with MCNP and REBUS is compared with the experimental value in Figure 72. The MCNP model well predicts the fission rates in the UO_2 pins and the change of fission rate at the interface between the UO_2 and UO_2-PuO_2 fuel pins (nearly within one standard deviation). The fission rates of the UO_2-PuO_2 fuel pins calculated with MCNP agree with the experimental values within two standard deviations. The REBUS model has similar problems to estimate the fission rate of the pins in the South-North traverse and the South East – North West traverse. The REBUS model underestimates the power of the pins near the aluminum buffer and tends to overestimate the UO_2-PuO_2 (4%) power on the South East side of the traverse.

3.5 Conversion ratio

The conversion ratio is defined as the ratio of neutron capture in U-238 to the total fission rate. The conversion ratios of the pins 24-17 and 27-17 have been measured in the R1MOX configuration (Figure 67). The two conversion ratios have been calculated with MCNP and are compared with the experimental values in Table 47. The measured and calculated conversion ratios agree within one standard deviation for the pin 24-17 and within two standard deviations for the pin 27-17. The overestimation of the calculated conversion ratio for the pin 27-17 implies an overestimation of the U-238 capture because the total fission rate is in good agreement with the experimental value as shown in Figure 70 for pin #10.

Table 47: Conversion ratio in the R1MOX configuration			
Pin	Experiment	MCNP	MCNP-Exp
24-17	0.583 (2.1%)	0.592 (1.5%)	1.6%
27-17	0.502 (2.0%)	0.527 (1.5%)	5.0%

3.6 Calibration sample reactivity worth

Experimentally, the oscillation of two calibration samples induces a change in position of the pilot rod to sustain criticality. The mean change of the pilot rod, noted $\Delta\theta$, is expressed in an arbitrary unit (pilot units) and is proportional to the change in reactivity of the core. The value $\Delta\theta$ is characteristic of the two calibration samples used.

In the REBUS model, a multiplication factor is calculated when each calibration sample is inserted in the core (the other sample not being modeled). A reactivity value ρ is deduced for each calibration sample. The variation of reactivity $\Delta\rho$ between the calibrated sample and the reference sample (sample 1B0071) is then derived. The relation $\Delta\theta = f(\Delta\rho)$ should be linear and the slope should only be dependant on the configuration. The measured pilot rod angle variation $\Delta\theta$ and the calculated reactivity variation $\Delta\rho$ are listed in Table 48 for the UO_2 calibration samples oscillated in the R1-UO2 configuration. The linear fit of the points ($\Delta\rho$,$\Delta\theta$) is shown in Figure 73 and the results of the fit, that is the slope $\Delta\theta/\Delta\rho$ and the χ^2 are listed in Table 48.

Table 48: UO_2 calibration sample in the R1-UO2 configuration								
Sample	F0025	F0050	N0071	S0100	S0200	S0300	S0400	S0495
^{235}U enrichment (%)	0.25	0.49	0.71	1.00	2.01	3.01	4.00	4.93
Measured $\Delta\theta$ (pilot unit)	11528 ± 2153	42000 ±2153	73467 ±2153	104953 ±2153	219321 ±2153	313875 ±4734	403243 ±2153	475926 ±2153
Calculated $\Delta\rho$ (pcm)	1.315	1.945	2.479	3.195	5.434	7.421	9.178	10.71
Linear fit	$\Delta\theta/\Delta\rho$ = 49491 ± 234 pilot unit / pcm χ^2=1.0							

The measured pilot rod angle variation, the calculated reactivity and the results of the linear fit for the borated oscillation sample oscillated in the R1-UO2 configuration are listed in Table 49 and shown in Figure 73.

Table 49: Borated UO_2 calibration sample in the R1-UO2 configuration					
Sample	1B0000	1B0150	1B0419	2B0000	2B0333
Boron fraction (ppm)	0	150	419	0	333
^{235}U enrichment (%)	0.25	0.25	0.25	0.53	0.53
Measured $\Delta\theta$ (pilot unit)	22299 ±3757	-124638 ±4417	-428772 ±2153	34973 ±2153	-316500 ±2153
Calculated $\Delta\rho$ (pcm)	1.411	-1.524	-6.355	2.085	-4.424
Linear fit	$\Delta\theta/\Delta\rho$ = 55535 ± 322 pilot unit / pcm χ^2=30.3				

For the R1-UO2 configuration, the value of the χ^2 confirm the linear trend of $\Delta\theta = f(\Delta\rho)$ for the UO_2 calibration samples. The relation $\Delta\theta = f(\Delta\rho)$ obtained with the borated calibration samples is clearly not linear (χ^2 = 30.3 >> 1) and the slope $\Delta\theta/\Delta\rho$ does not agree with that of the UO_2 calibration sample.

The same study is performed for the R1-MOX configuration and the results are listed in Table 50 and Table 51 for the UO_2 and borated calibration samples. The linear fits are shown in Figure 74.

Table 50: UO_2 calibration sample in the R1-MOX configuration								
Sample	F0025	F0050	N0071	S0100	S0200	S0300	S0400	S0495
^{235}U enrichment (%)	0.25	0.49	0.71	1.00	2.01	3.01	4.00	4.93
Measured $\Delta\theta$ (pilot unit)	-11907 ±5027	-5157 ±1552	-67 ±1700	6856 ±1267	36727 ±2349	61321 ±3768	85974 ±3152	104687 ±4720
Calculated $\Delta\rho$ (pcm)	0.3857	0.5760	0.7402	0.9591	1.656	2.273	2.833	3.327
Linear fit	$\Delta\theta/\Delta\rho$ = 40379 ± 151 pilot unit / pcm χ^2=0.6							

Table 51: Borated UO_2 calibration sample in the R1-MOX configuration							
Sample	1B0000	1B0150	1B0419	2B0000	2B0333	2B1062	2B2360
Boron fraction (ppm)	0	150	419	0	333	1062	2360
^{235}U enrichment (%)	0.25	0.25	0.25	0.53	0.53	0.53	0.53
Measured $\Delta\theta$ (pilot unit)	-10964 ±1343	-41613 ±5013	-104193 ±3232	-7551 ±1551	-72967 ±3844	-216175 ±1699	-389847 ±1699
Calculated $\Delta\rho$ (pcm)	0.4172	-0.4523	-1.898	0.6317	-1.311	-4.883	-9.628
Linear fit	$\Delta\theta/\Delta\rho$ = 37650 ± 189 pilot unit / pcm χ^2=2.8						

For the R1-MOX configuration, the same conclusion as for the R1-UO2 configuration can be drawn for the UO_2 and borated calibration samples.

The bad agreement between the experimental signal issued from the oscillations of the borated calibration samples and their calculated reactivity is thought to come from uncertainties in the composition of the borated samples and a possible migration of the boron to the periphery of the sample during the sintering of the fabrication process inducing self shielding effects. New borated calibration samples with a well known composition are under fabrication and will permit to confirm these conclusions.

The UO_2 calibration samples have been recently fabricated and the uncertainty on their compositions is well known (ref. 6). As expected, the linear trend is excellent for the R1-UO2 and R1-MOX configurations.

Because the predictions of the reactivity worth of the UO_2 calibration samples are well behaved compared to the experimental measurements, the REBUS model can be used to calculate the reactivity worth of the OSMOSE samples with a high degree of confidence for the R1-UO2 and R1-MOX configurations. If a difference is observed between measurements and calculations for an OSMOSE sample, it will most likely be the result of an error in the isotopic cross section.

4 CONCLUSION

Monte Carlo and deterministic models using the MCNP and REBUS code systems have been developed to interpret safety and core parameters of the MINERVE reactor and to calculate the reactivity effect of the UO_2 and borated UO_2 calibration samples in the R1UO2 and R1MOX configurations. The complete description of the models was provided in this document.

The safety and core parameters (control rod worth, spectral indices, axial and radial power profile, and conversion ratio) were studied. MCNP and REBUS estimates have been compared with the experimental values.

In the R1UO2 configuration, the reactivity worth of the control rods calculated by MCNP agrees within 10% with the experimental values measured with a U-235 fission chamber located in the thermal column. The REBUS calculations tend to underestimate the MCNP results when the reactivity worth increases and agree within 15% with the experimental data. A more accurate comparison between experimental and calculated values will need to consider spatial and energy effects on the measurements.

The Pu-239/U-235 and Pu-241/Pu-239 spectral indices calculated with MCNP agree within one standard deviation (<2.2%) in both R1UO2 and R1MOX configurations. The Np-237/Pu-239 spectral index only agrees within one standard deviation in the R1MOX configuration. The reason is thought to be an inaccuracy in the Np-237 fission cross section at thermal energies in the ENDFB-VI library.

The axial power profile, in the region within ± 20 cm from the core mid-plane, is well estimated by the REBUS code system. The use of MCNP requires long run times and results in a profile that is not well-behaved (fluctuation due to poor statistics). The effect of the styrene spacers located in the core is observed with the U-235 fission chamber.

In the R1UO2 configuration, REBUS predicts the experimental axial buckling extracted from measurement on UO_2 pins within one standard deviation (<1%). The MCNP calculations predict the experimental bucklings within one standard deviation except for the Np-237 fission chamber measurement. The experimental axial buckling obtained with the Np-237 fission chamber is significantly different (3 standard deviations) from the other experimental bucklings.

In the R1MOX configuration, the experimental buckling does not agree within one standard deviation. The reason might be the emphasized spectrum perturbation due to the Styrene and Plexiglas spacers. MCNP bucklings agree within one standard deviation but uncertainties are high (~ 3%). MCNP predicts the experimental buckling within two standard deviations except for the Np-237 measurement. The agreement between the REBUS results and the experiments is better than 2%.

The radial power profiles determined by REBUS and MCNP differ significantly in the R1UO2 configuration. This is due to the absence of specific self shielding in REBUS for the UO_2 pins close to the AG-3 buffer. In the R1MOX configuration, the radial profile for the horizontal traverse was well predicted by MCNP except for the UO_2 / UO_2-PuO_2 interface in the south region where the change in power is overestimated by 50%. The REBUS model does not predict well the power of the individual UO_2 and UO_2-PuO_2 pins. A more complex self-shielding procedure in the WIMS calculations might improve the REBUS results. Similar conclusions apply for the diagonal traverse.

In the R1MOX configuration, the conversion ratios are estimated within 5% by MCNP (2 standard deviations).

Finally, the REBUS model can accurately calculate the reactivity worth of the UO_2 and borated UO_2 calibration samples. Comparison with the experimental signal, proportional to reactivity, is excellent. The REBUS model can thus be used to assess the reactivity of the OSMOSE samples and the oscillation technique can be used to assess the integral cross-sections of the actinide isotopes in the R1UO2 and R1MOX configurations.

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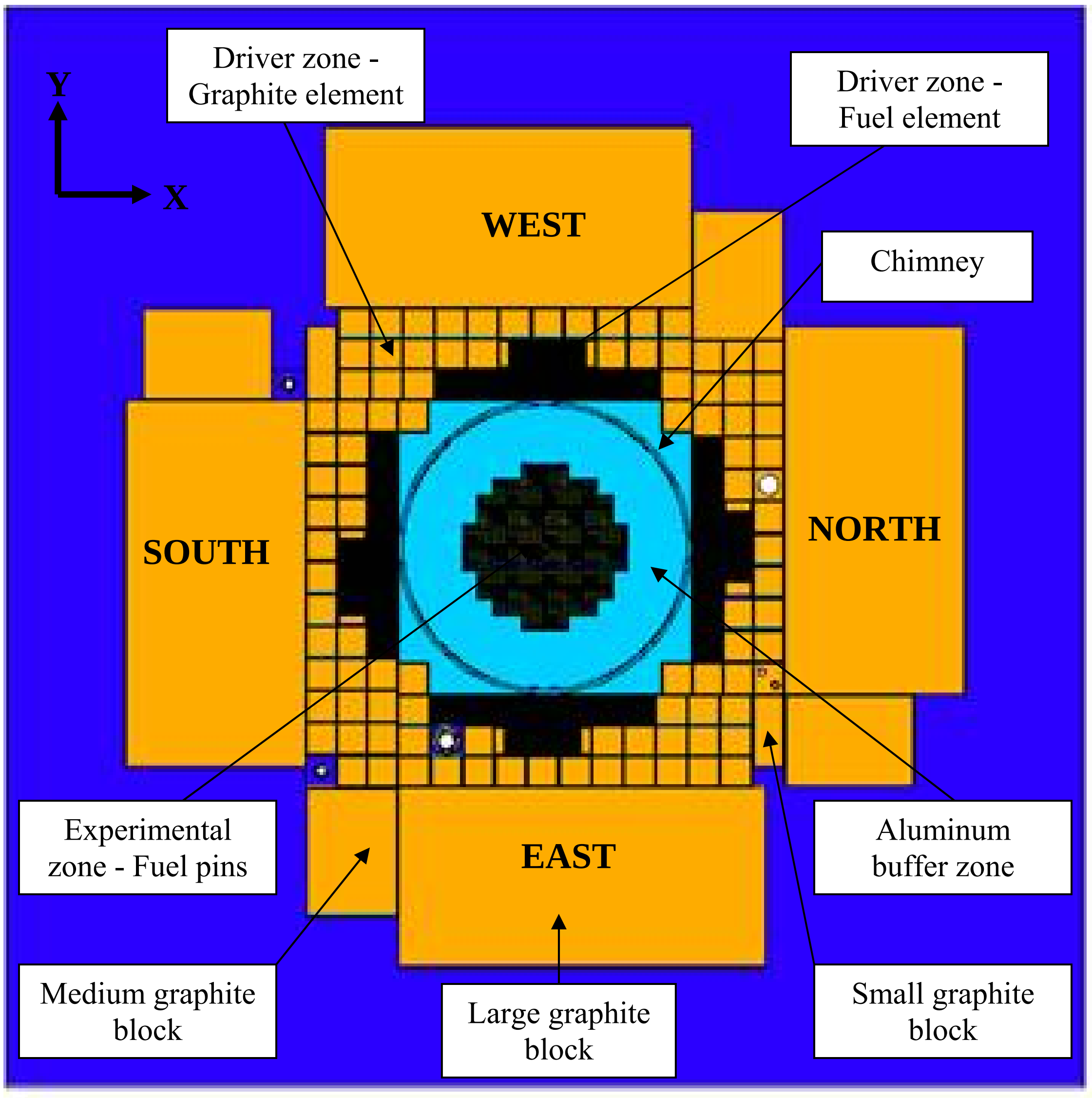
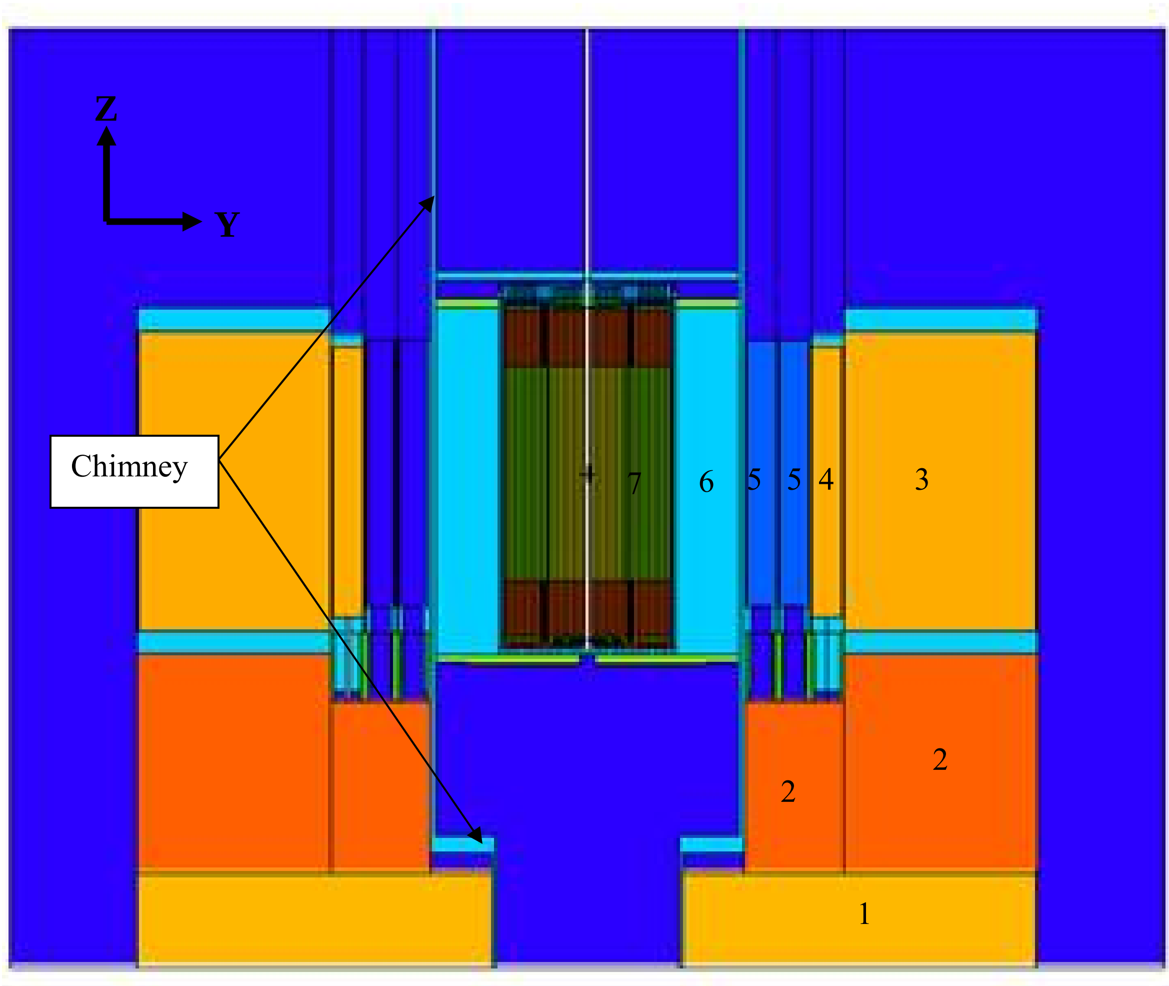


Figure 1: Radial view of the MCNP model



1: Support table
2: Caissons
3: Large graphite block
4: Driver zone –Graphite element
5: Driver Zone – Fuel element
6: Experimental zone – Aluminum buffer
7: Experimental Zone – Fuel Pins

Figure 2: Axial view of the MCNP model

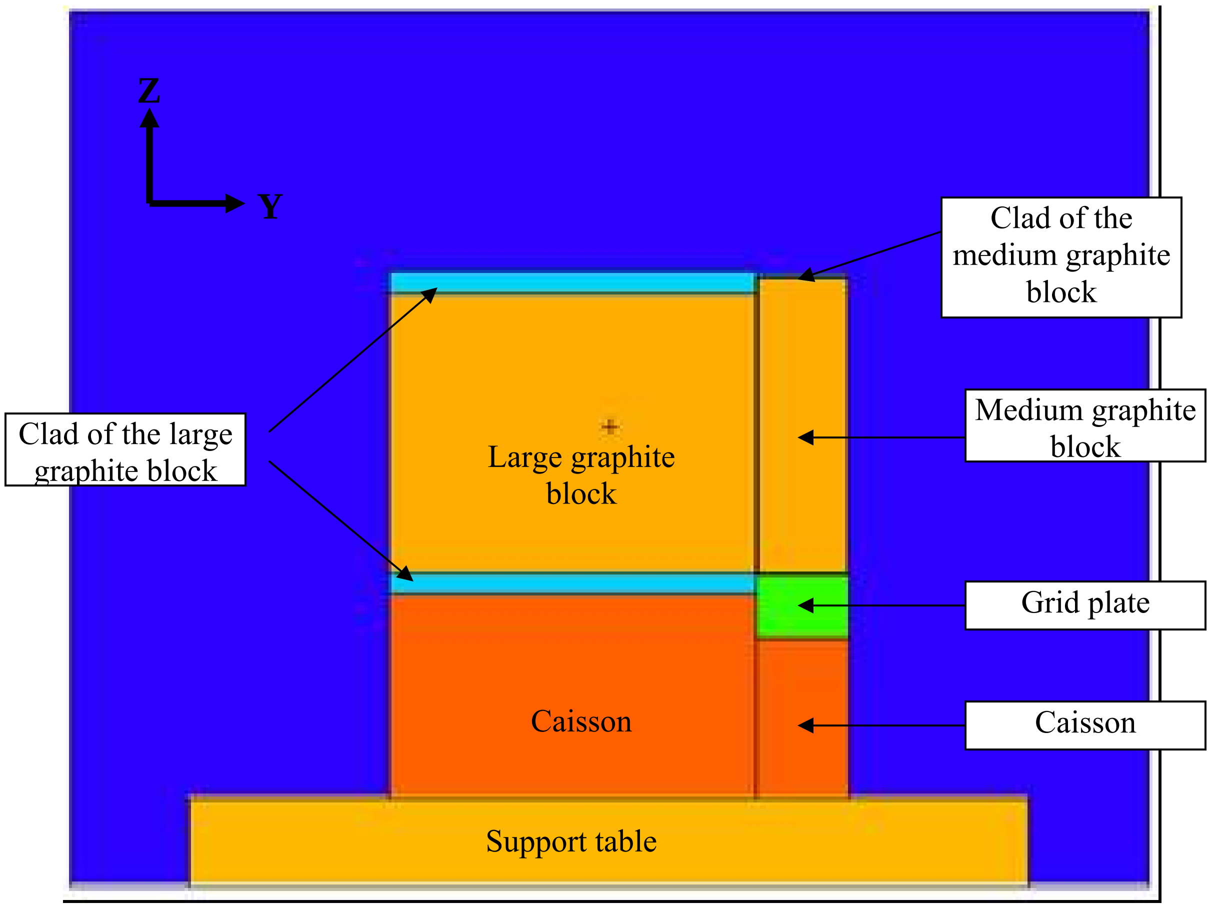


Figure 3: Support element and graphite blocks of the driver zone - MCNP model

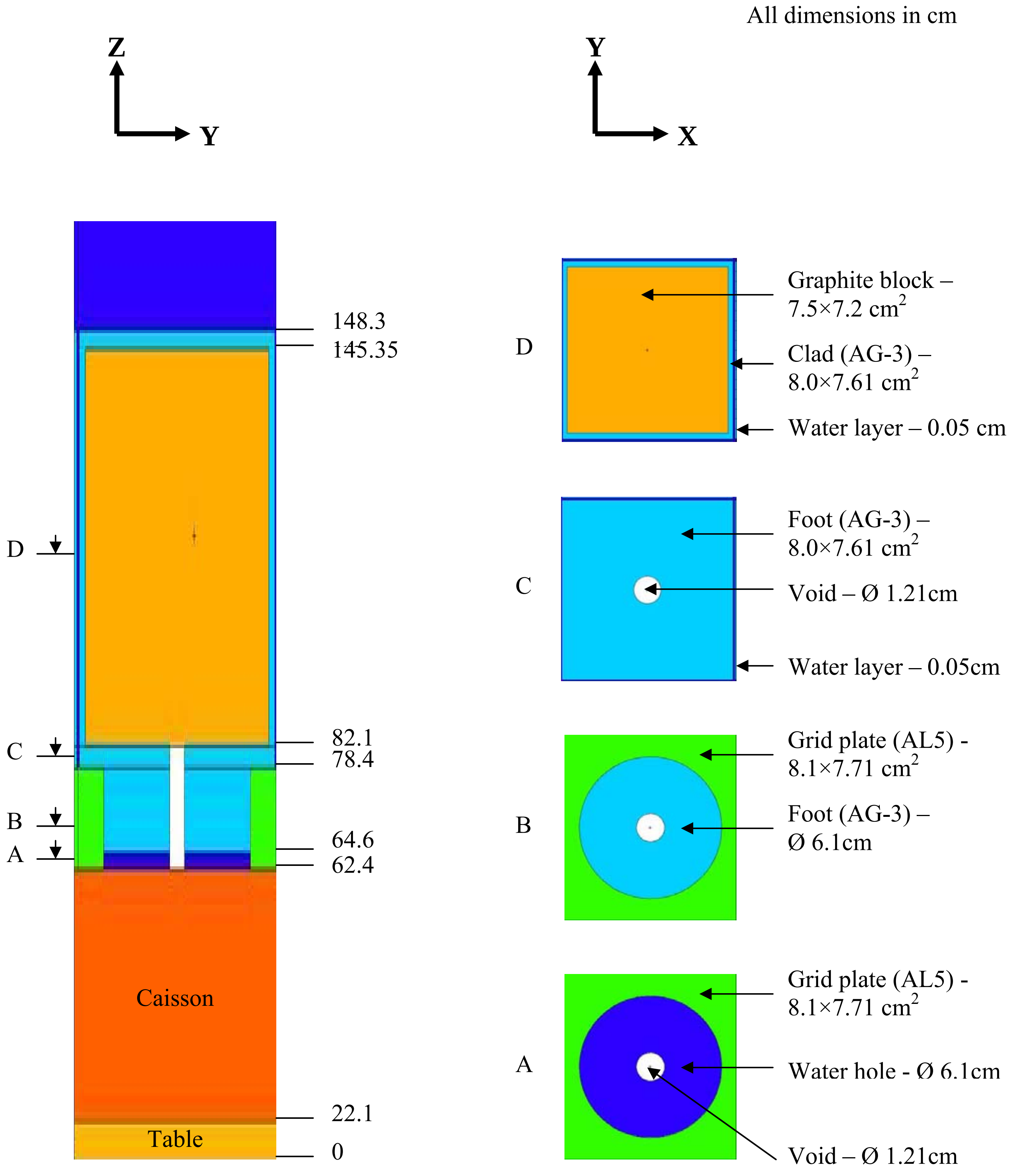


Figure 4: Graphite element – MCNP model

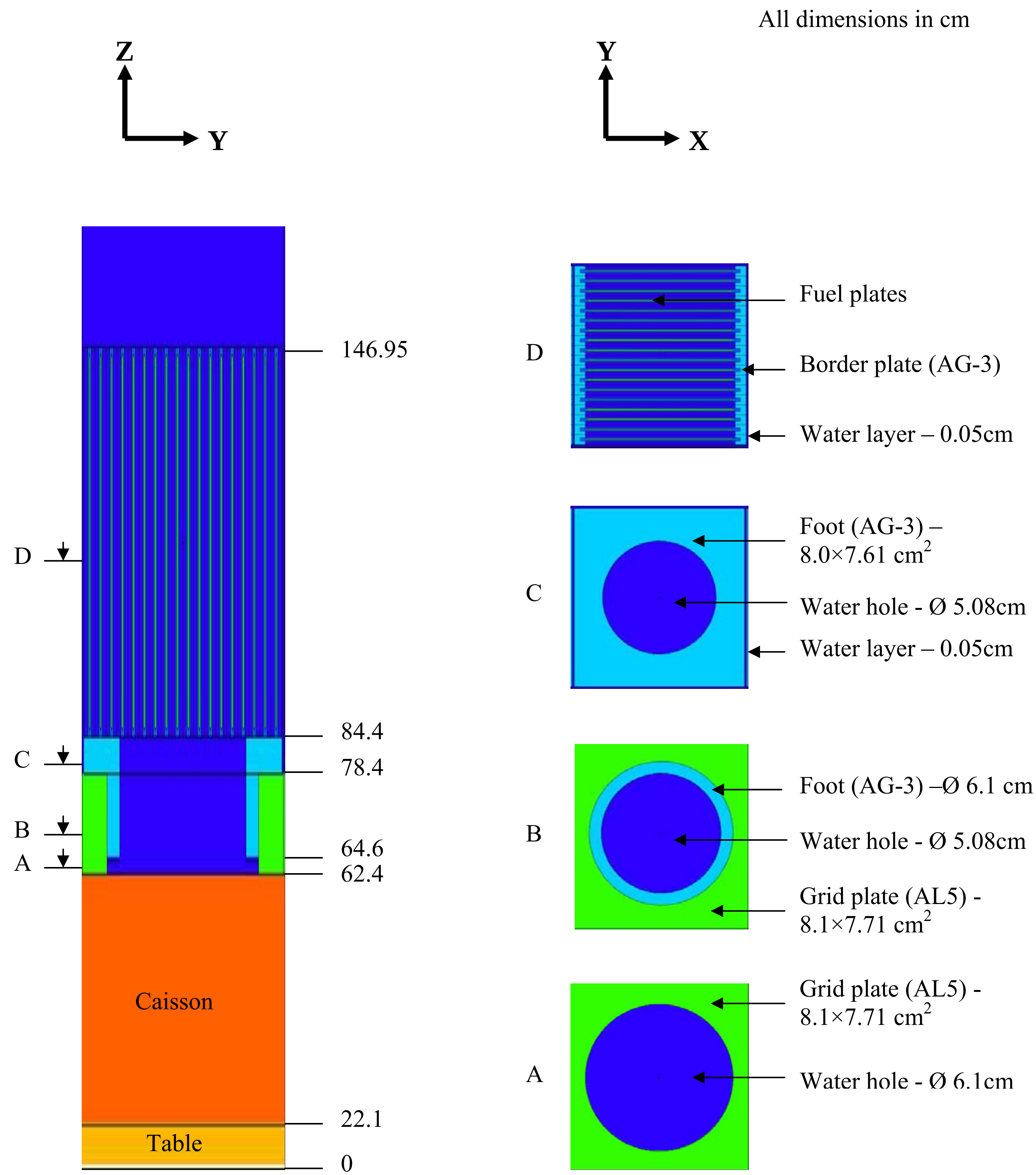


Figure 5: 18-plate fuel element – MCNP model

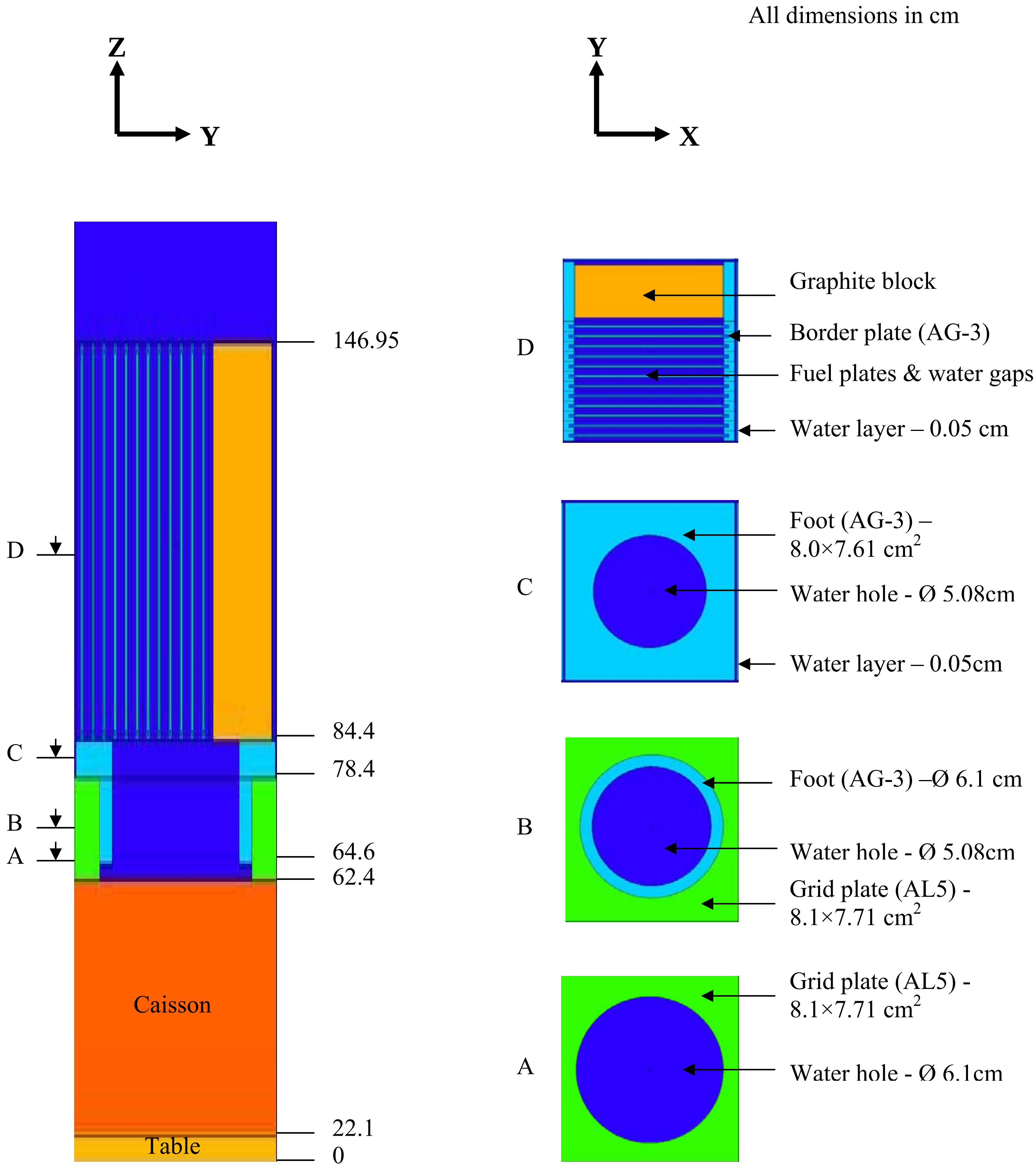


Figure 6: 12-plate fuel element – MCNP model

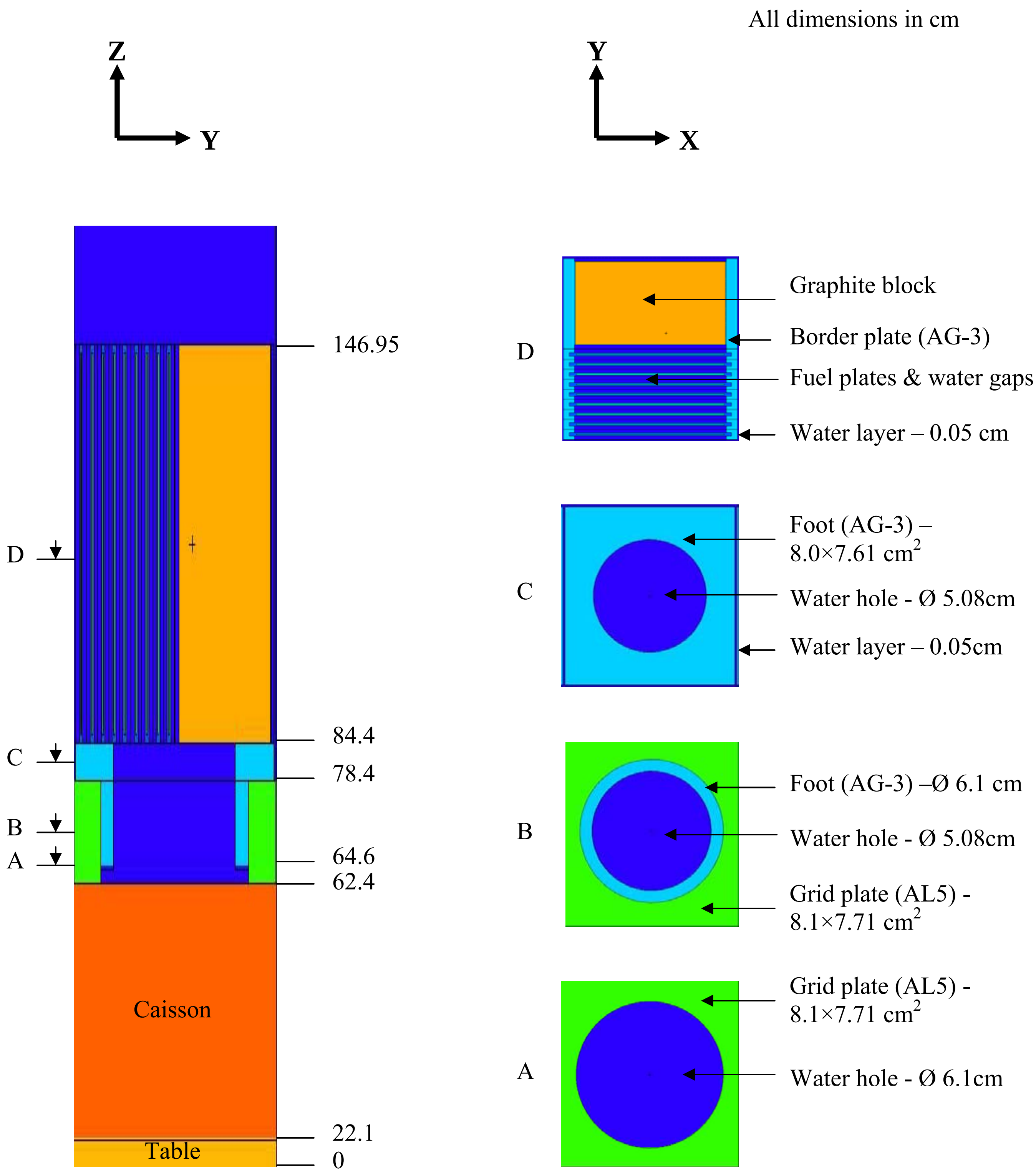


Figure 7: 9-plate fuel element – MCNP model

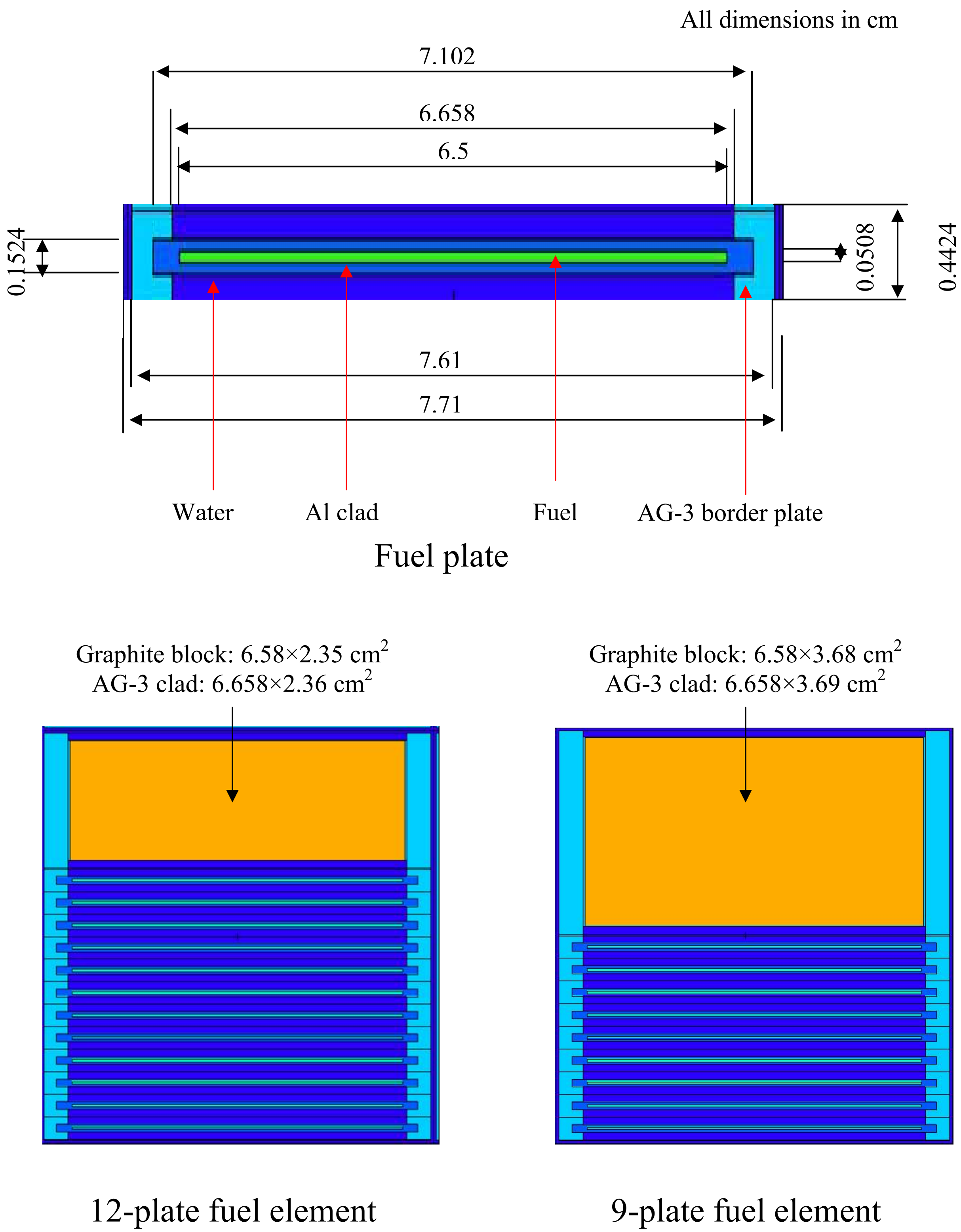


Figure 8: Details of the fuel elements – MCNP model

All dimensions in cm

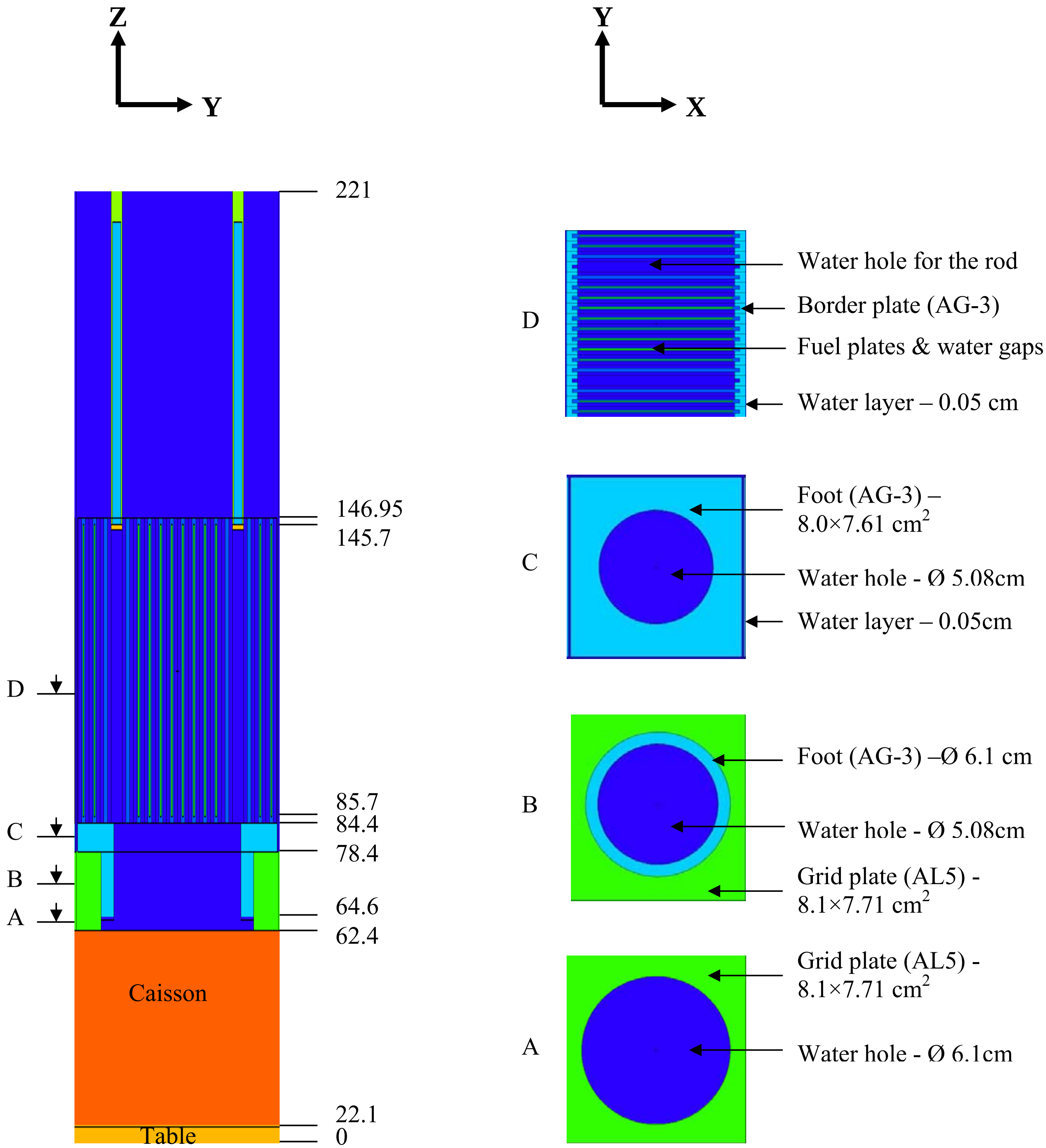


Figure 9: Control element - MCNP model

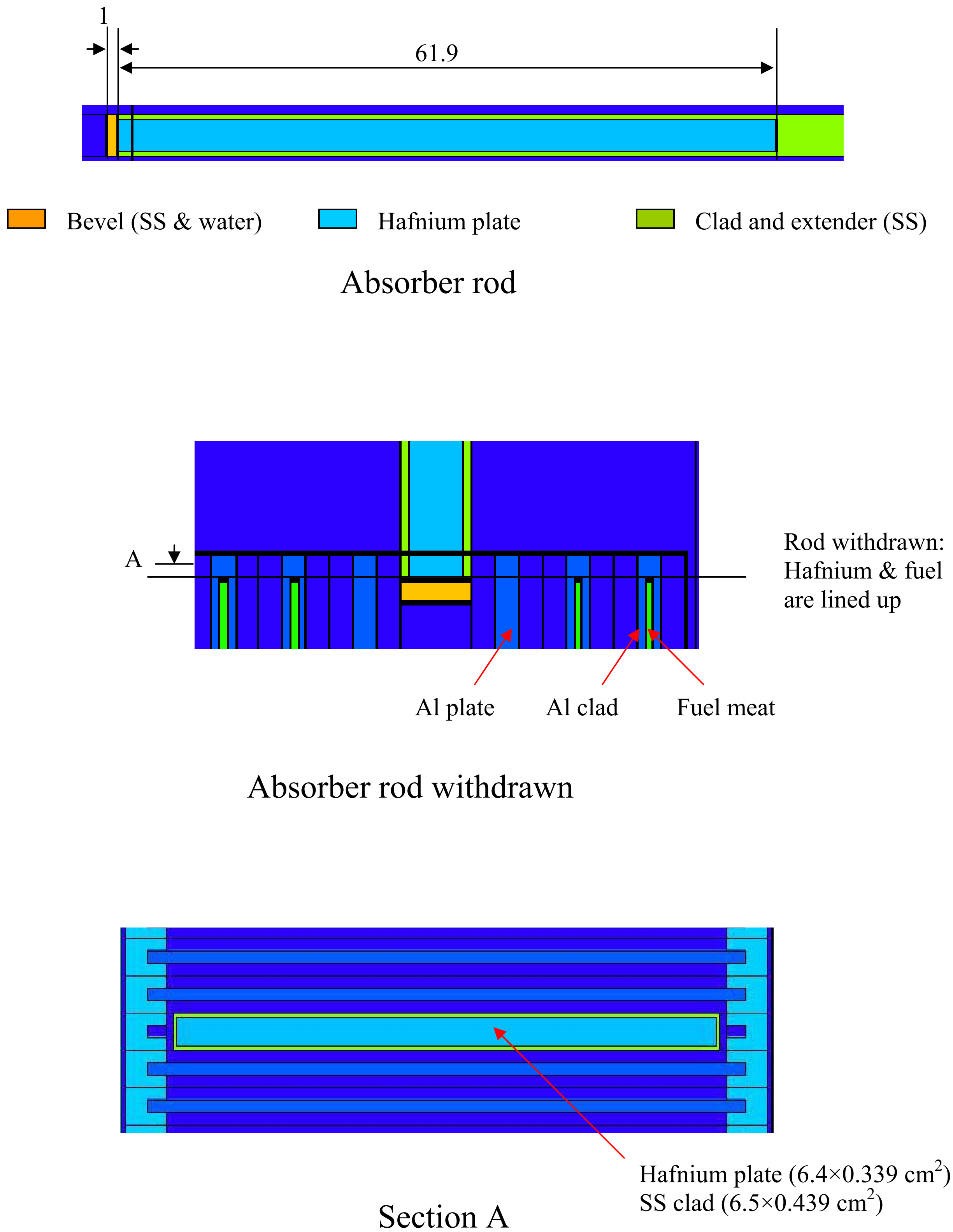


Figure 10: Details of the control element and the rods – MCNP model

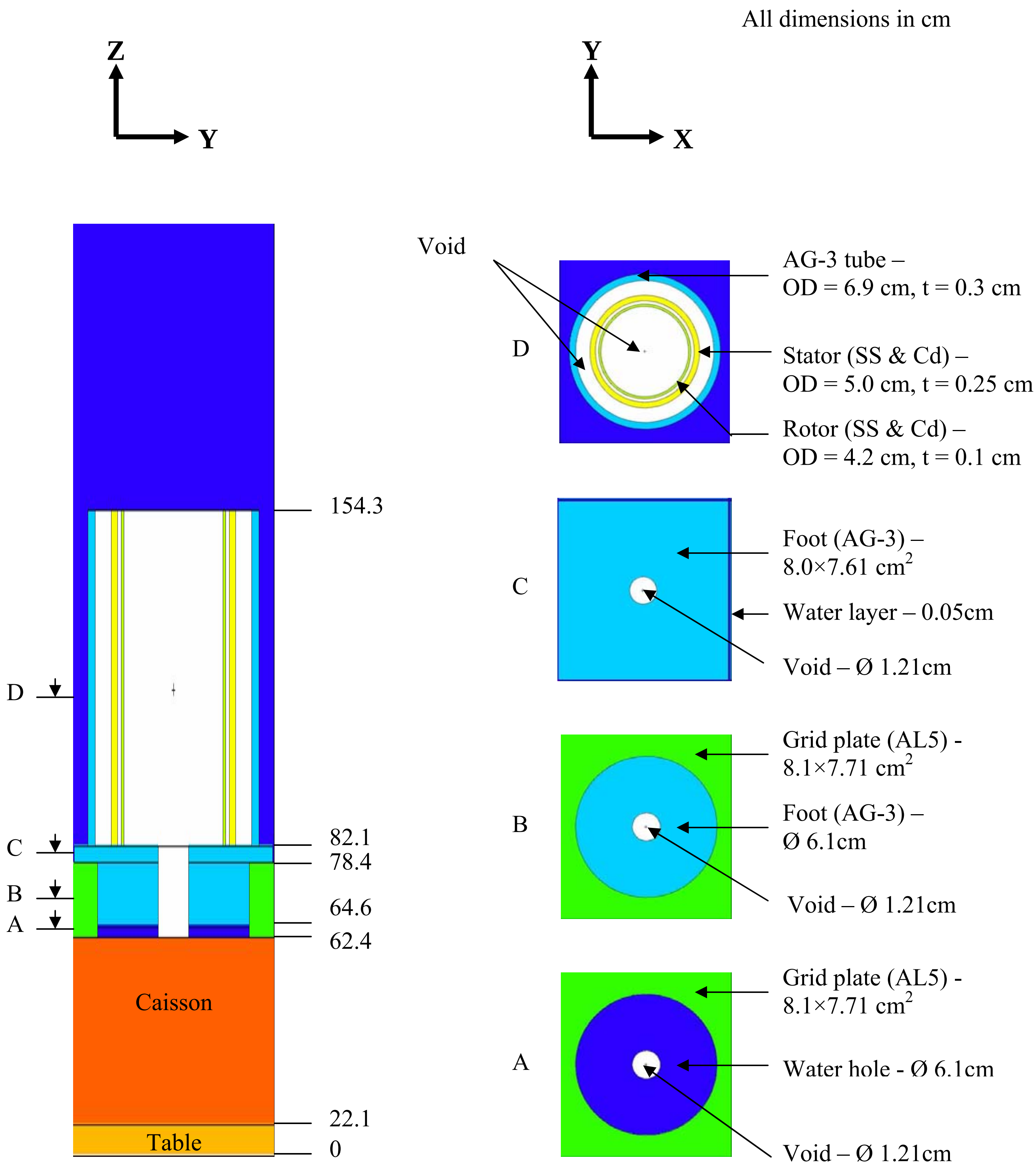


Figure 11: Pilot rod element – MCNP model

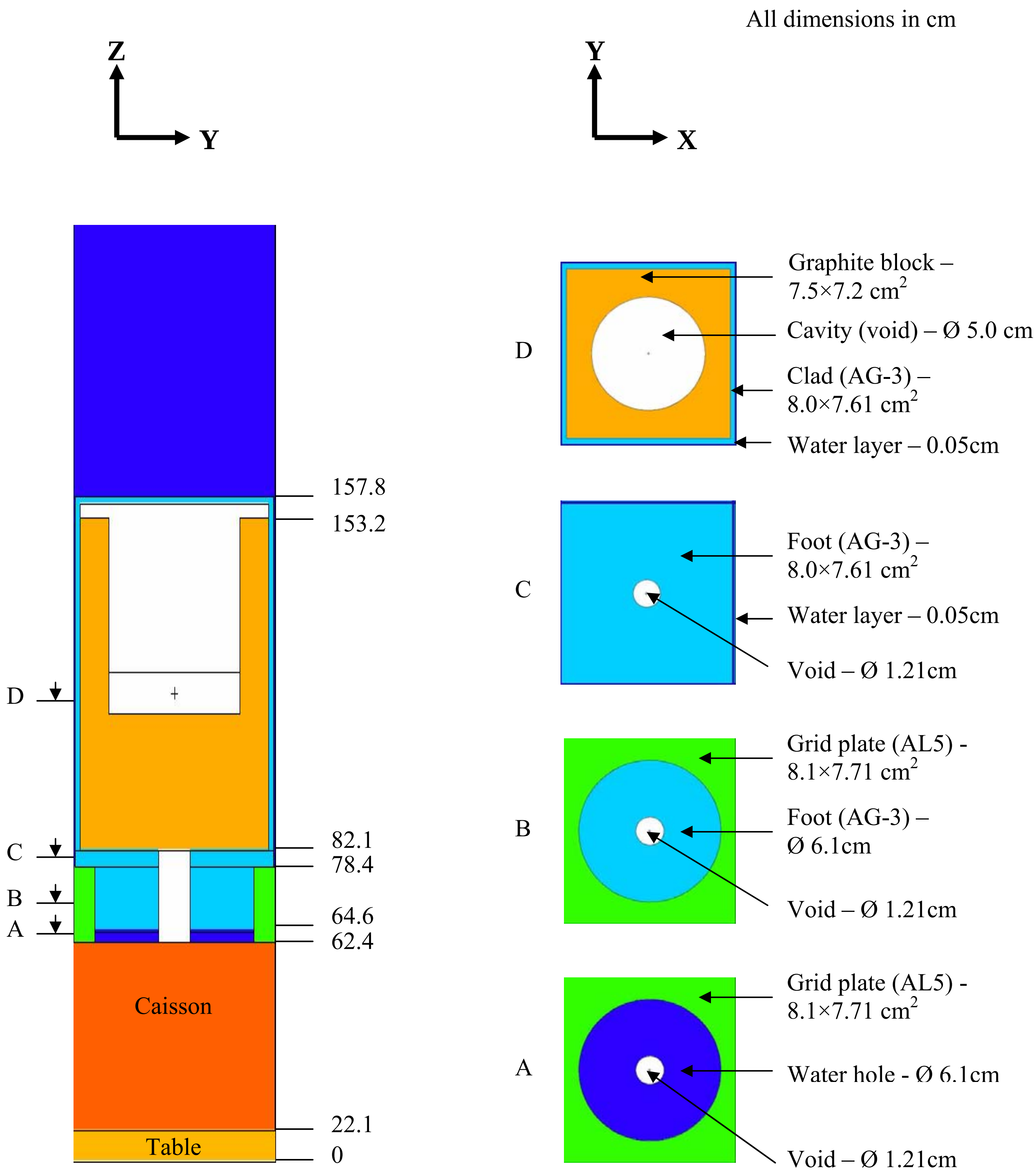


Figure 12: Detector element – MCNP model

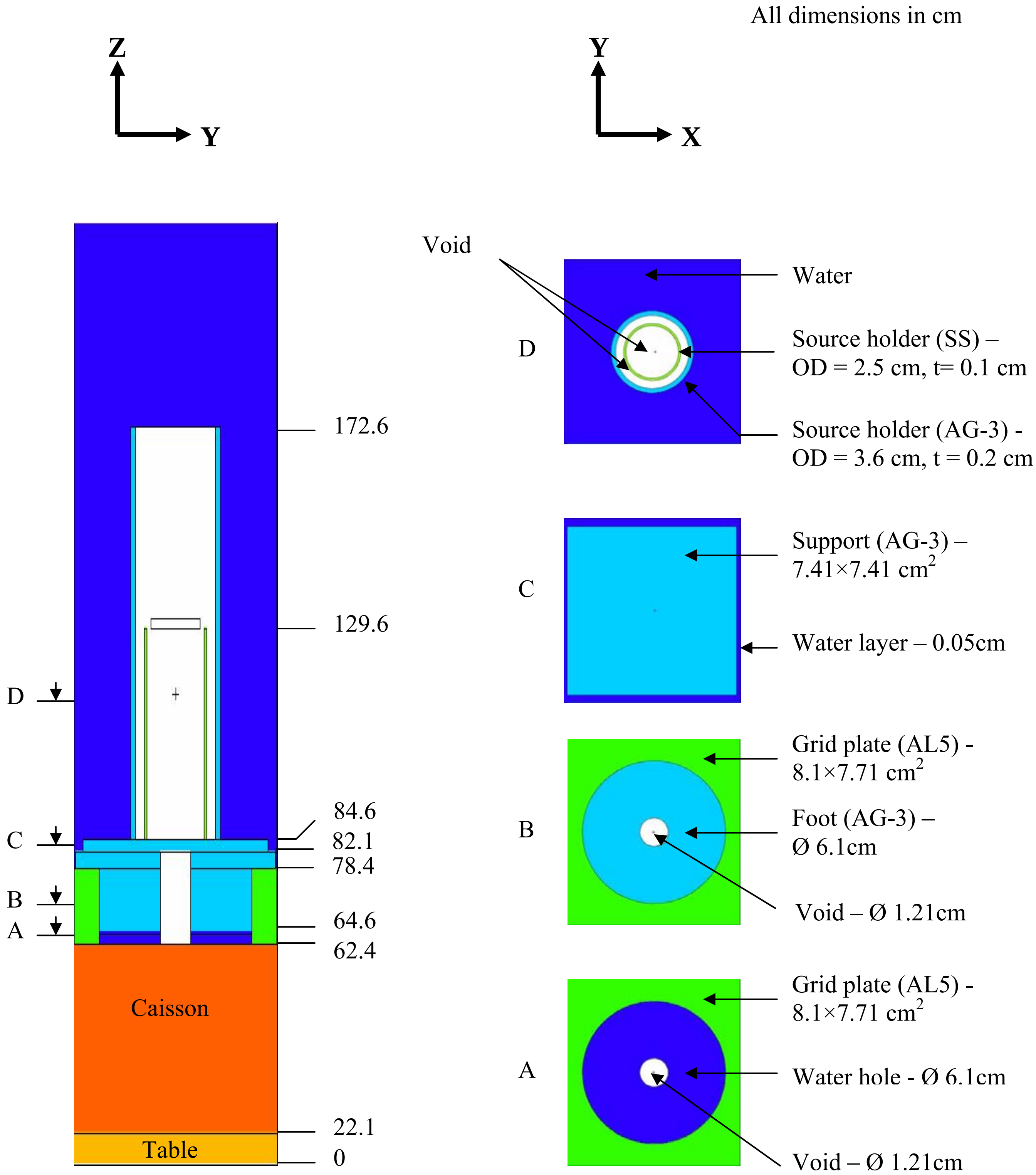


Figure 13: Start-up source elements – MCNP model

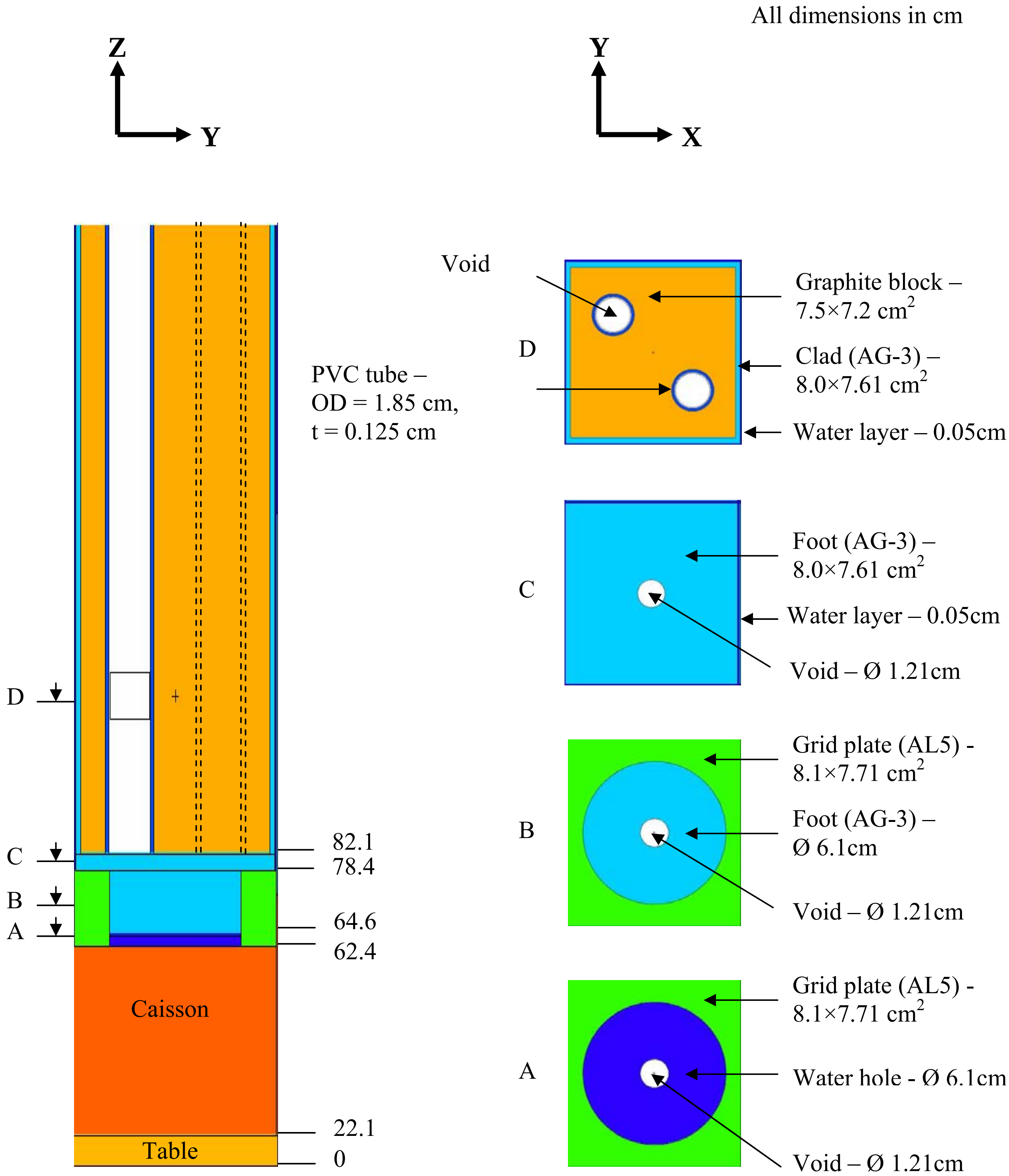
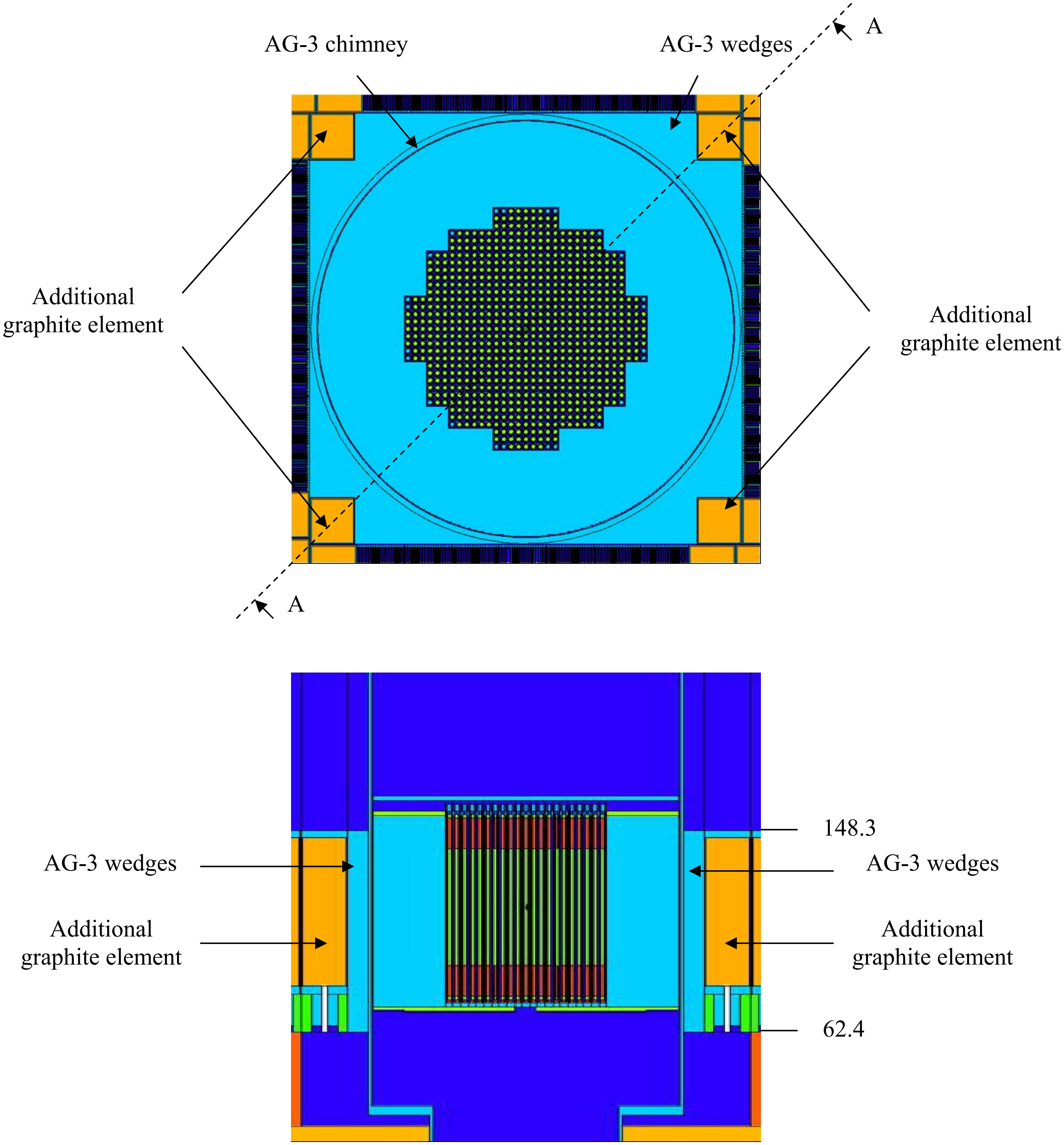


Figure 14: Thermal column – MCNP model



Section A-A

Figure 15: AG-3 wedges and additional graphite element – MCNP model

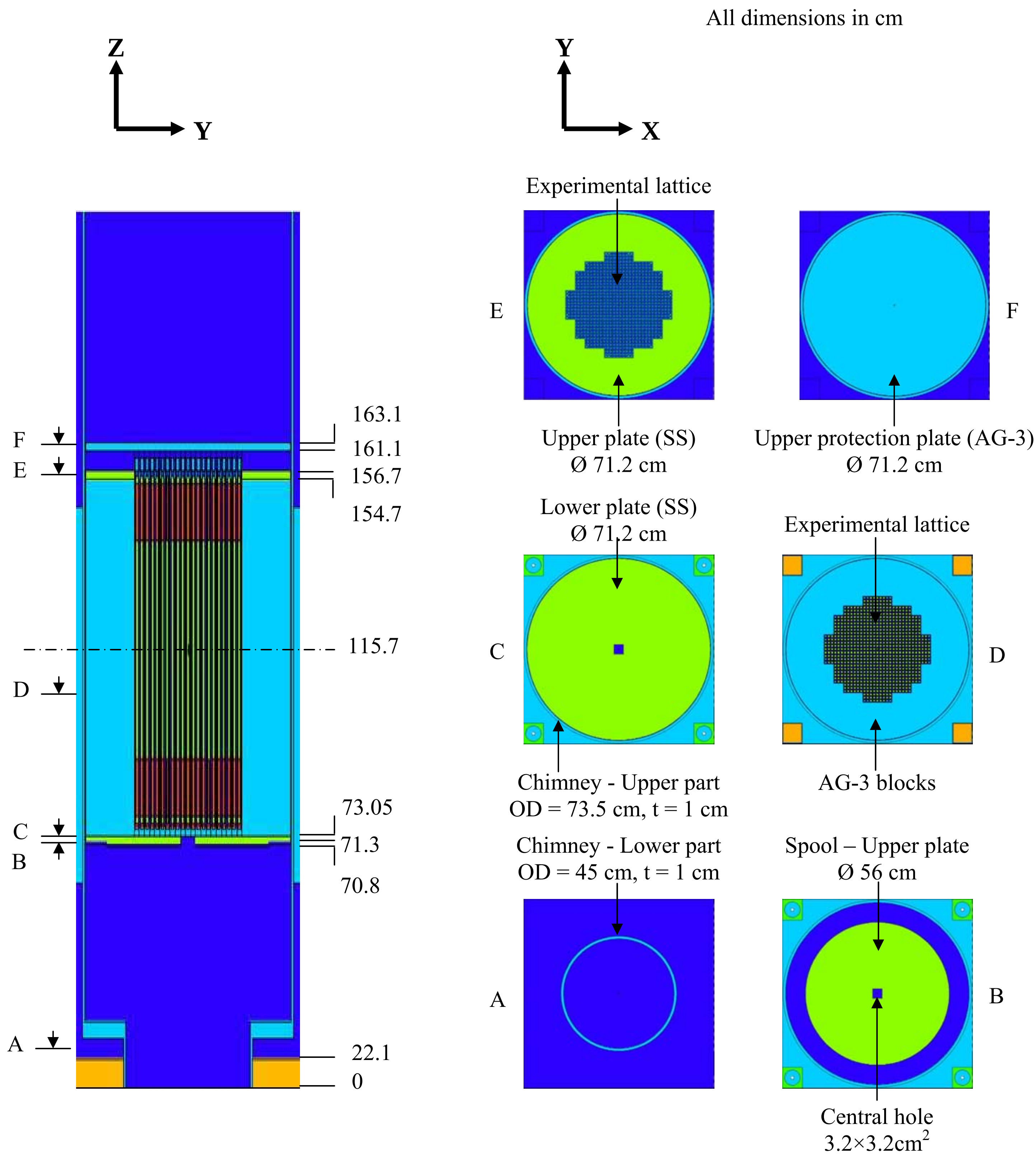


Figure 16: Experimental zone & MELODIE massif – MCNP model

All dimensions in cm

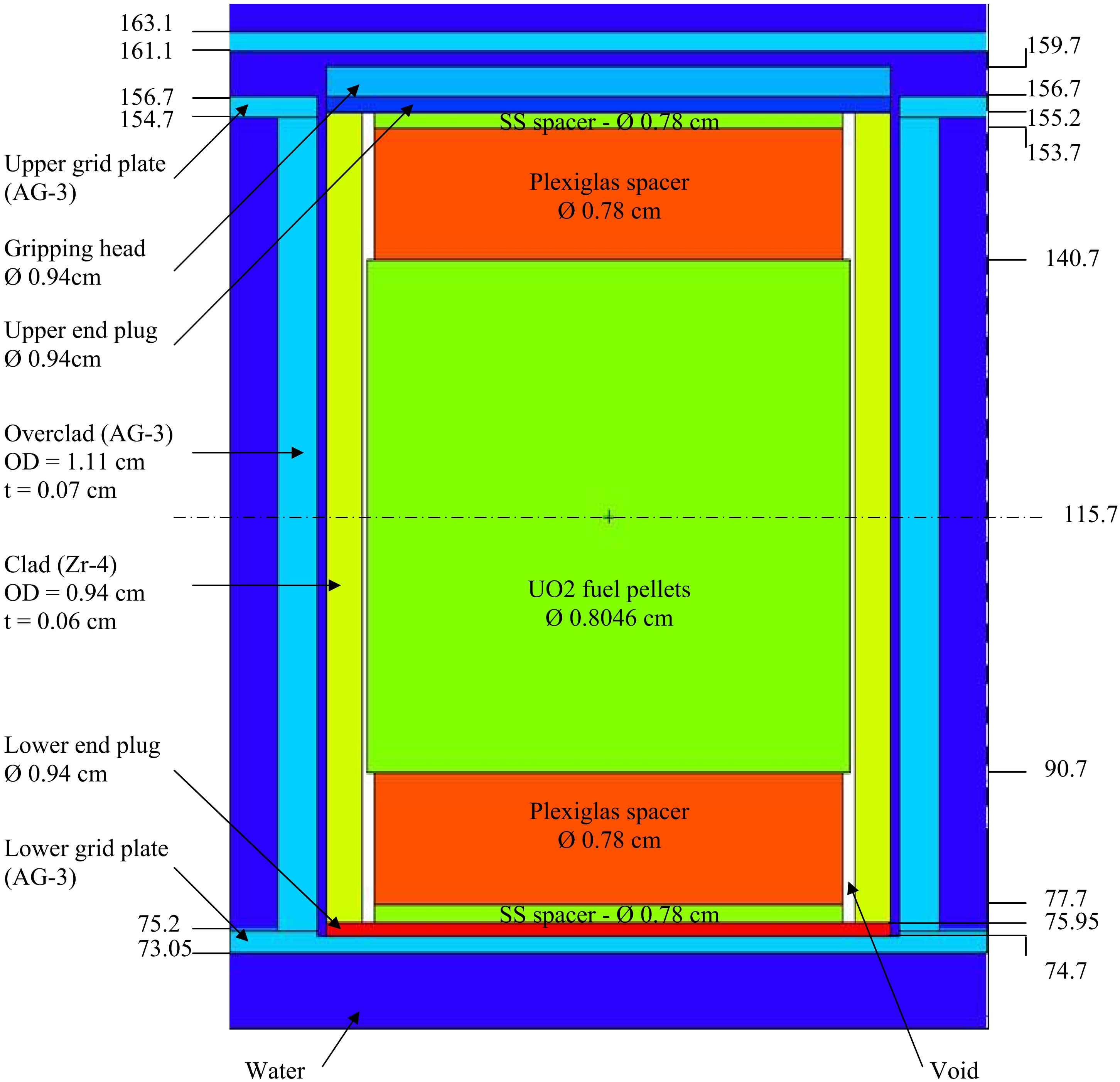


Figure 17: UO2 pin – MCNP model

All dimensions in cm

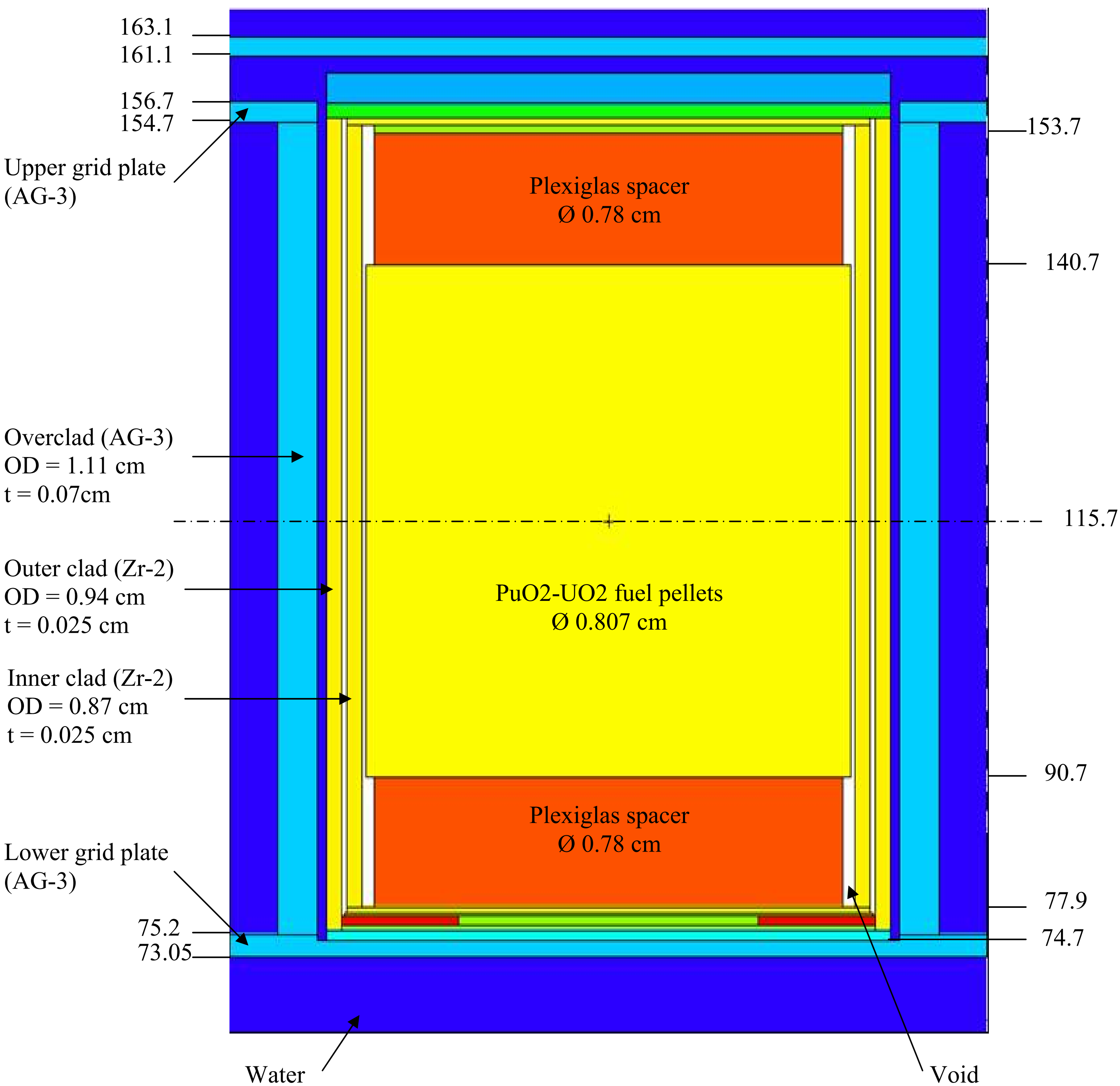
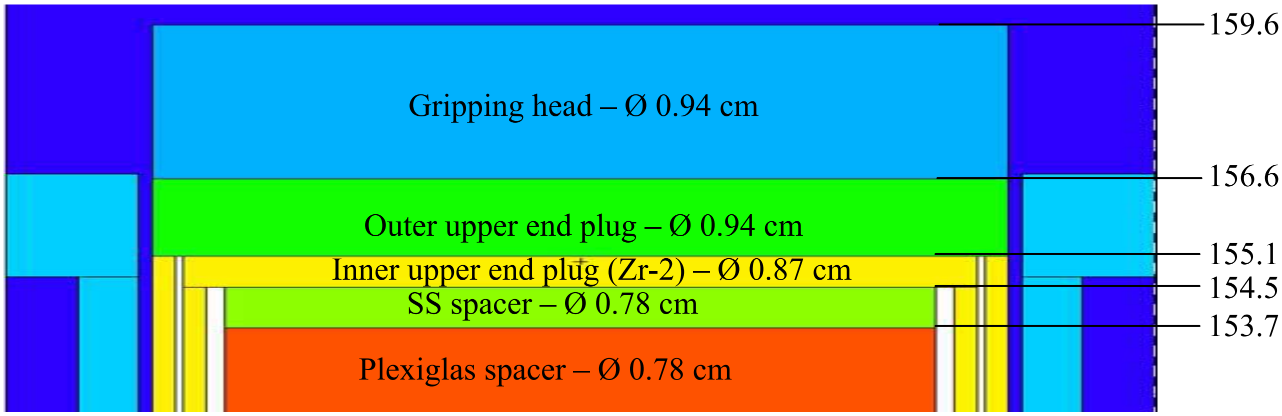
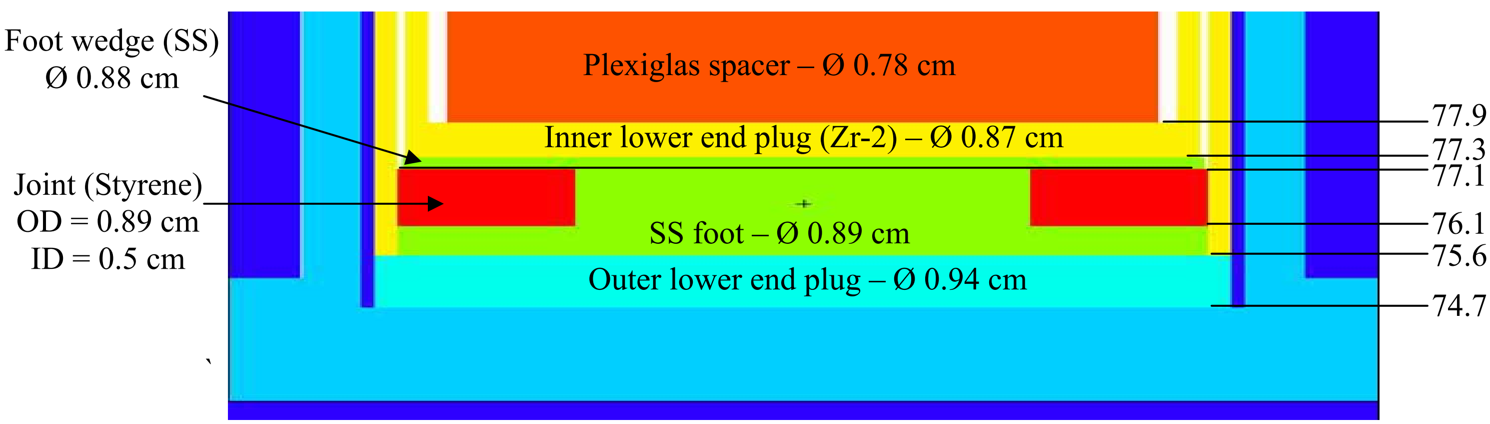


Figure 18: PuO2-UO2 pin – MCNP model

All dimensions in cm



Upper portion of the fuel pin



Lower portion of the fuel pin

Figure 19: Details of the PuO2-UO2 pin – MCNP model

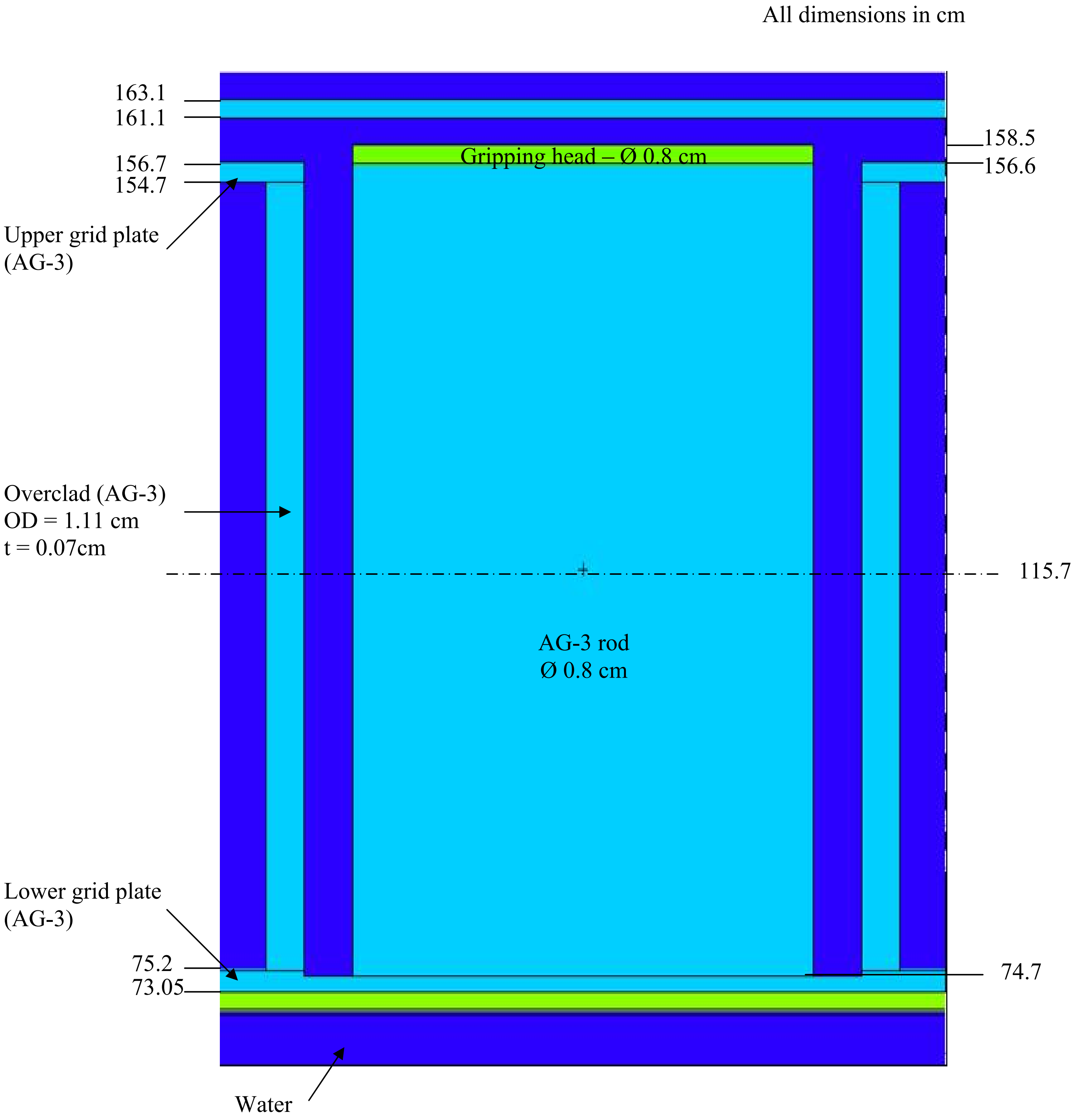


Figure 20: Aluminum pin – MCNP model

All dimensions in cm

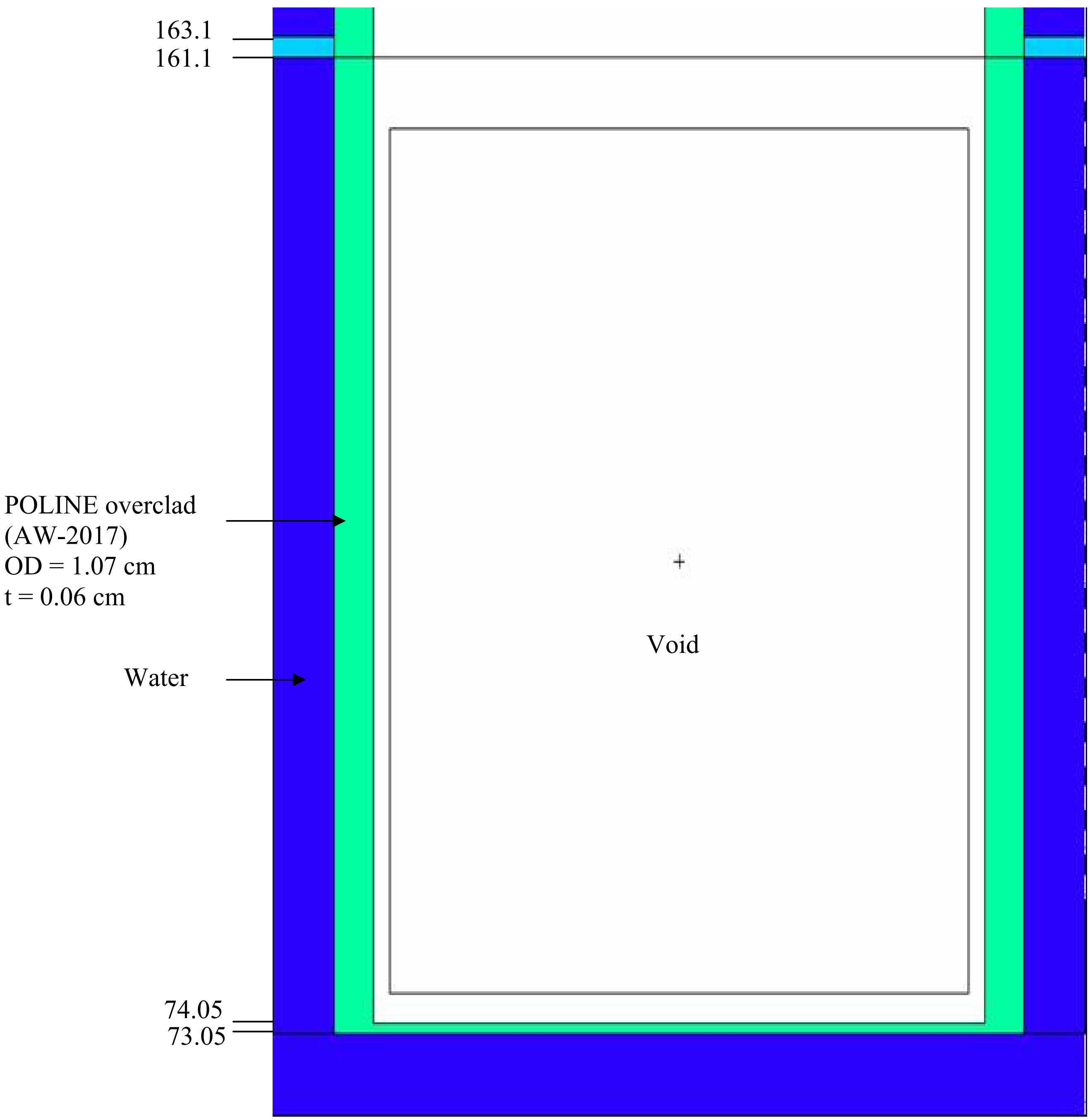


Figure 21: POLINE overclad – MCNP model

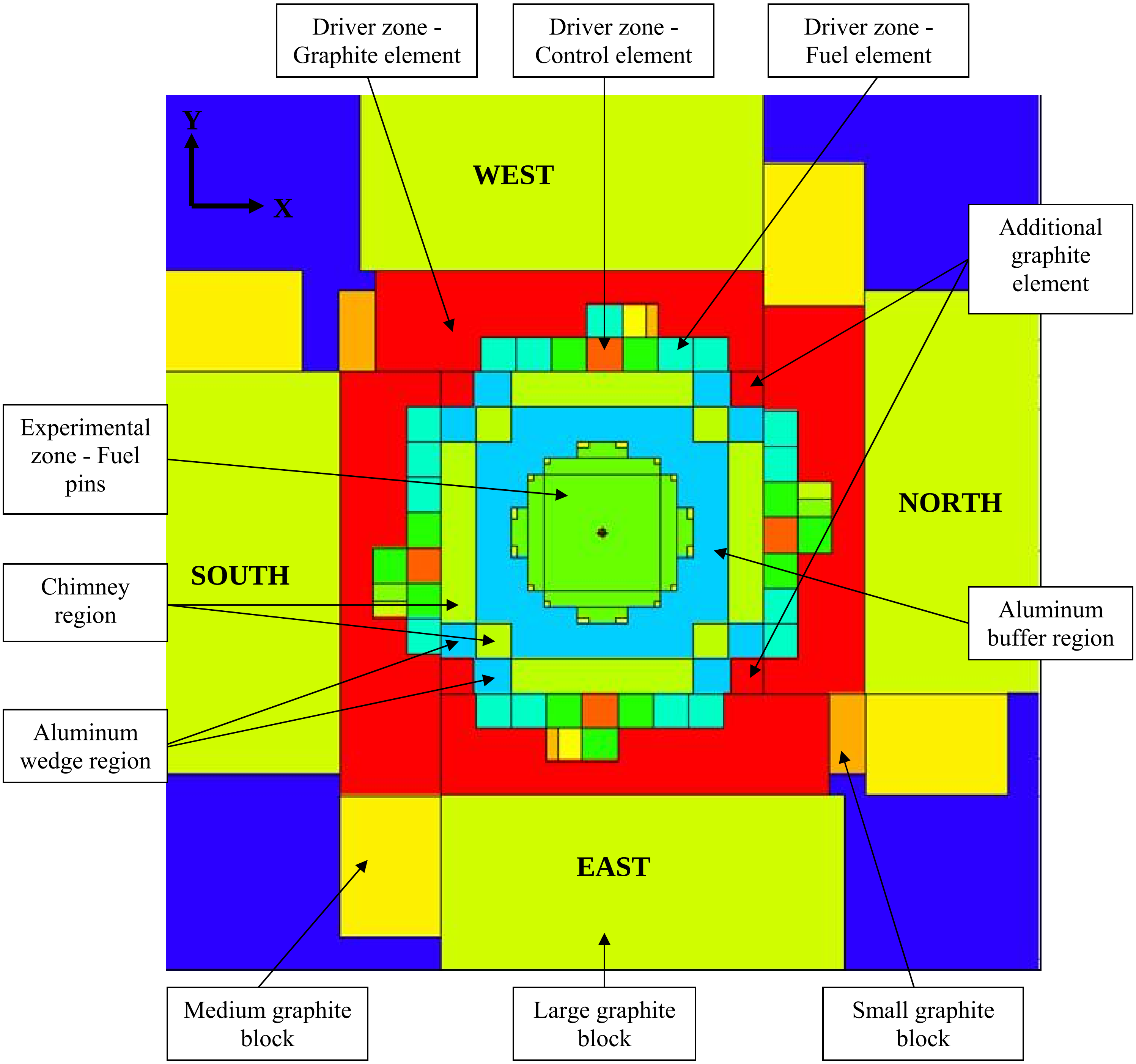


Figure 22: Radial view of the REBUS model in the R1UO2 configuration

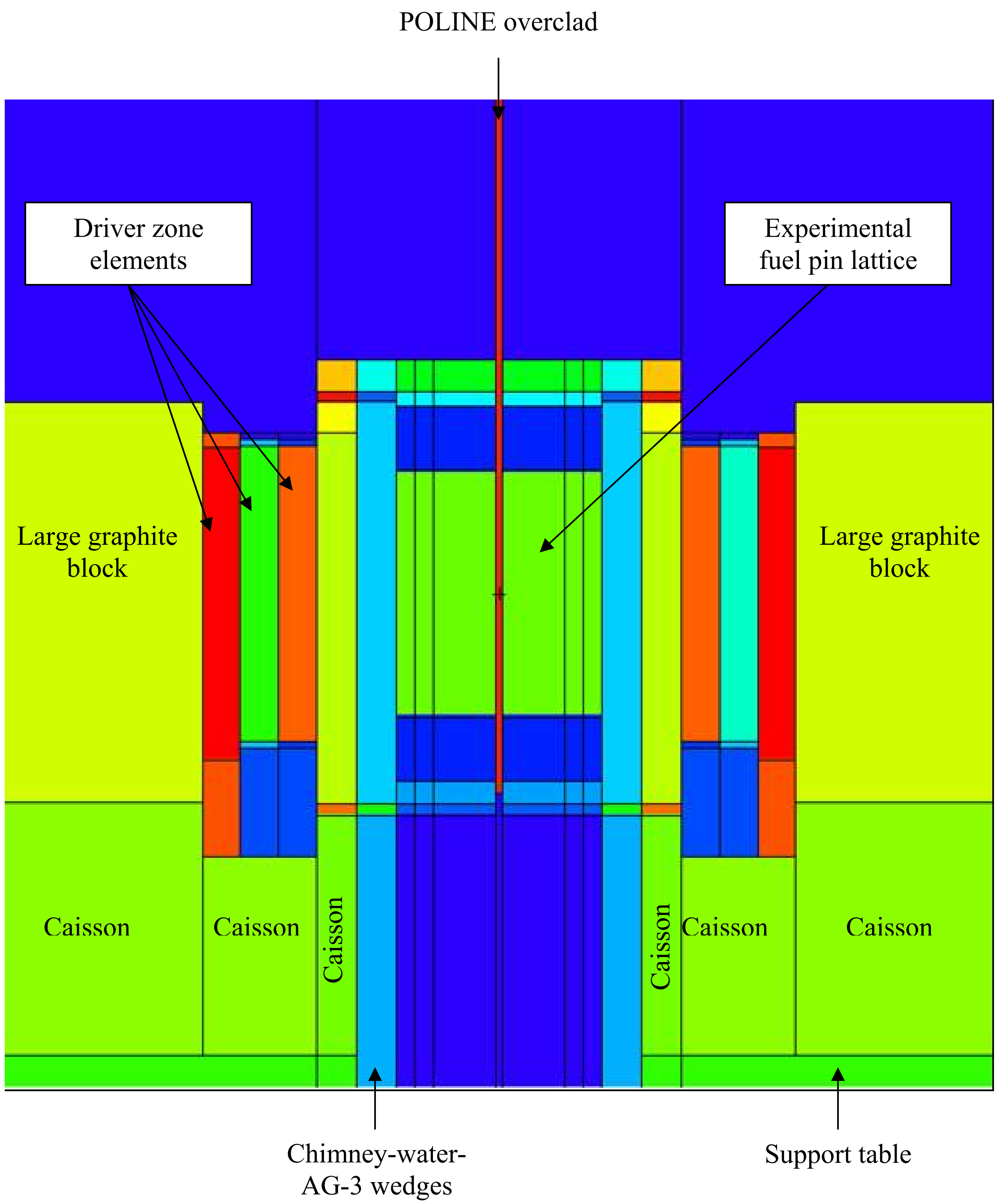


Figure 23: Axial view of the REBUS model in the R1UO2 configuration

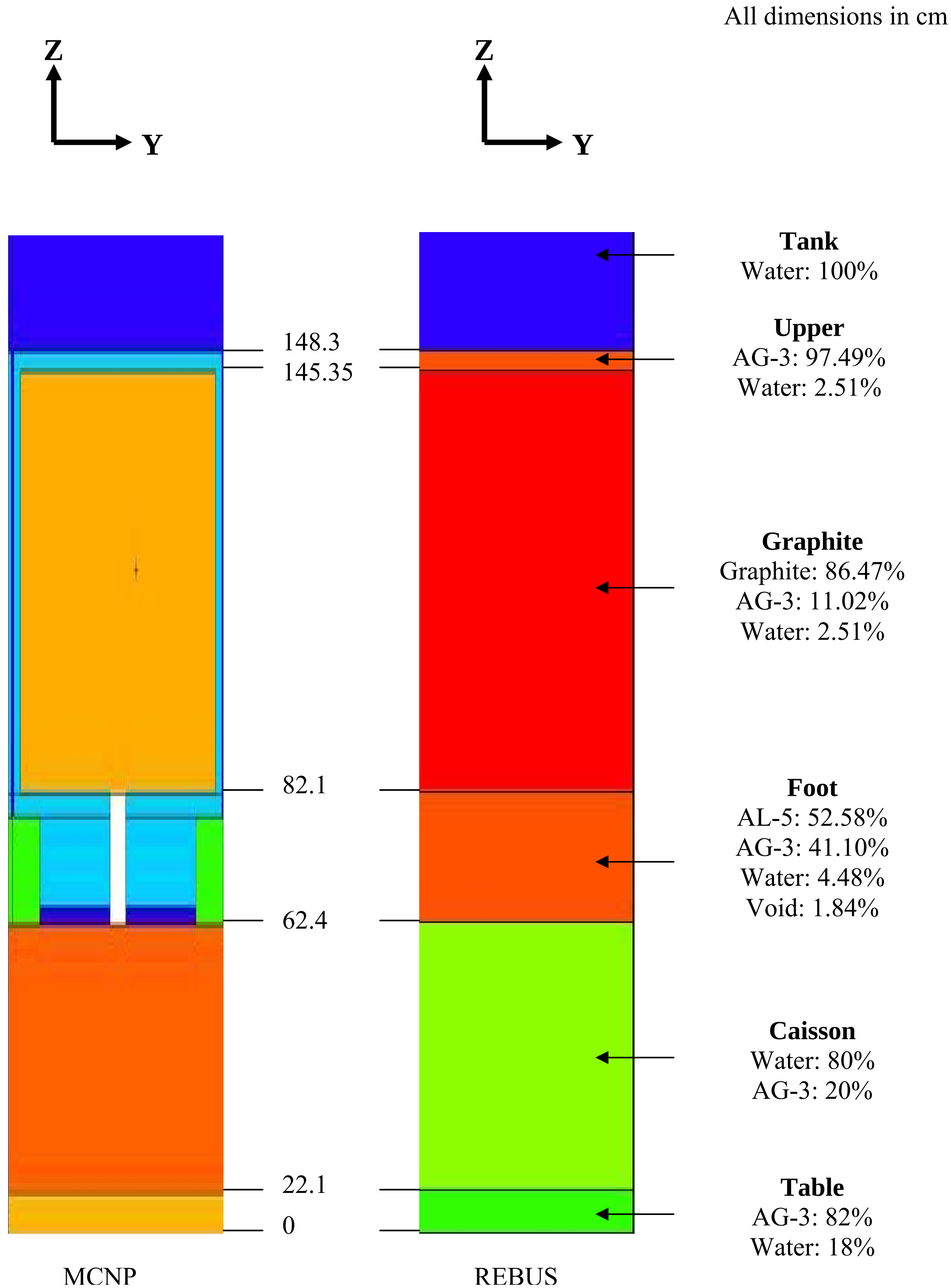


Figure 24: Graphite element – MCNP & REBUS models

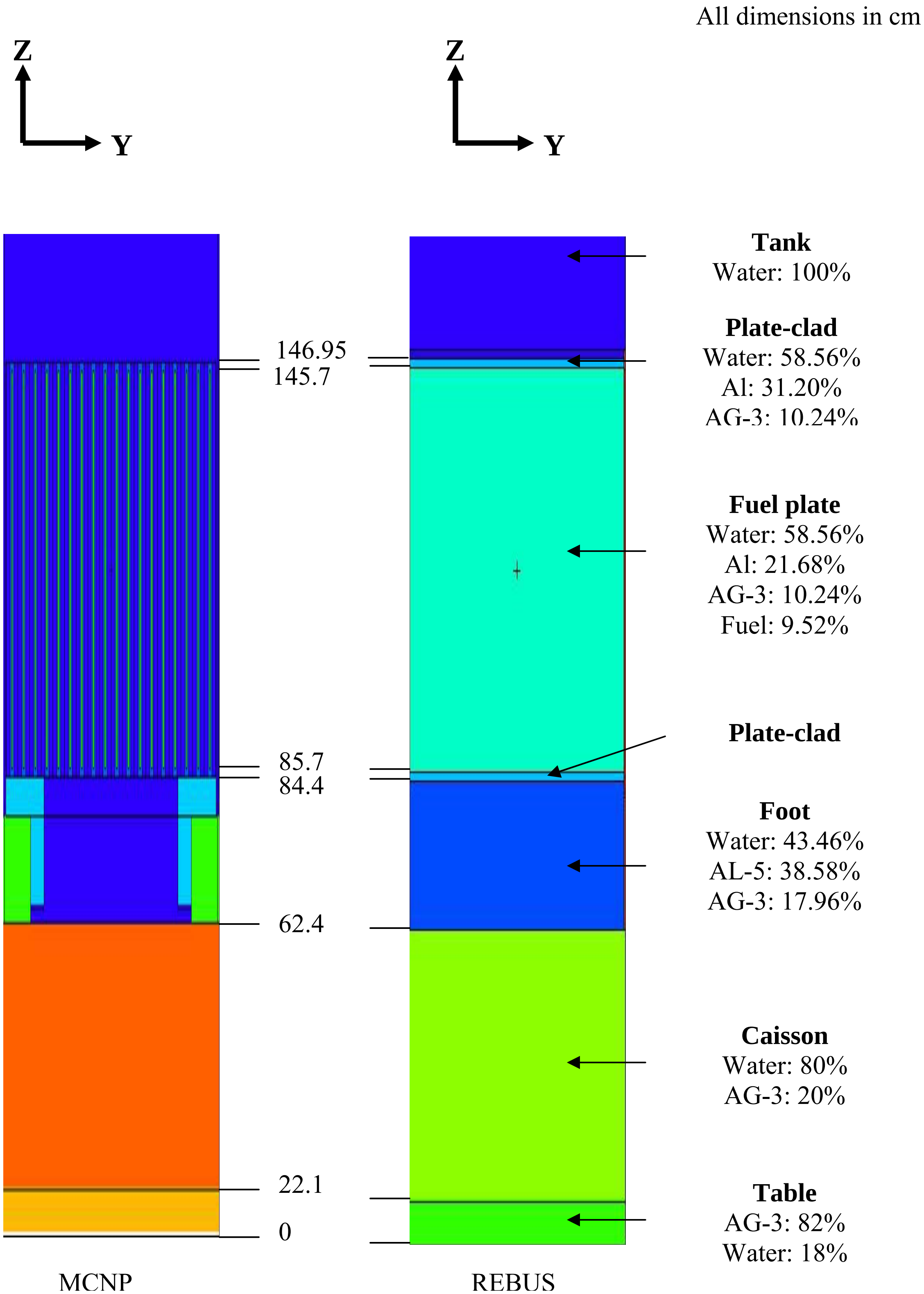


Figure 25: 18-plate fuel element – MCNP & REBUS models

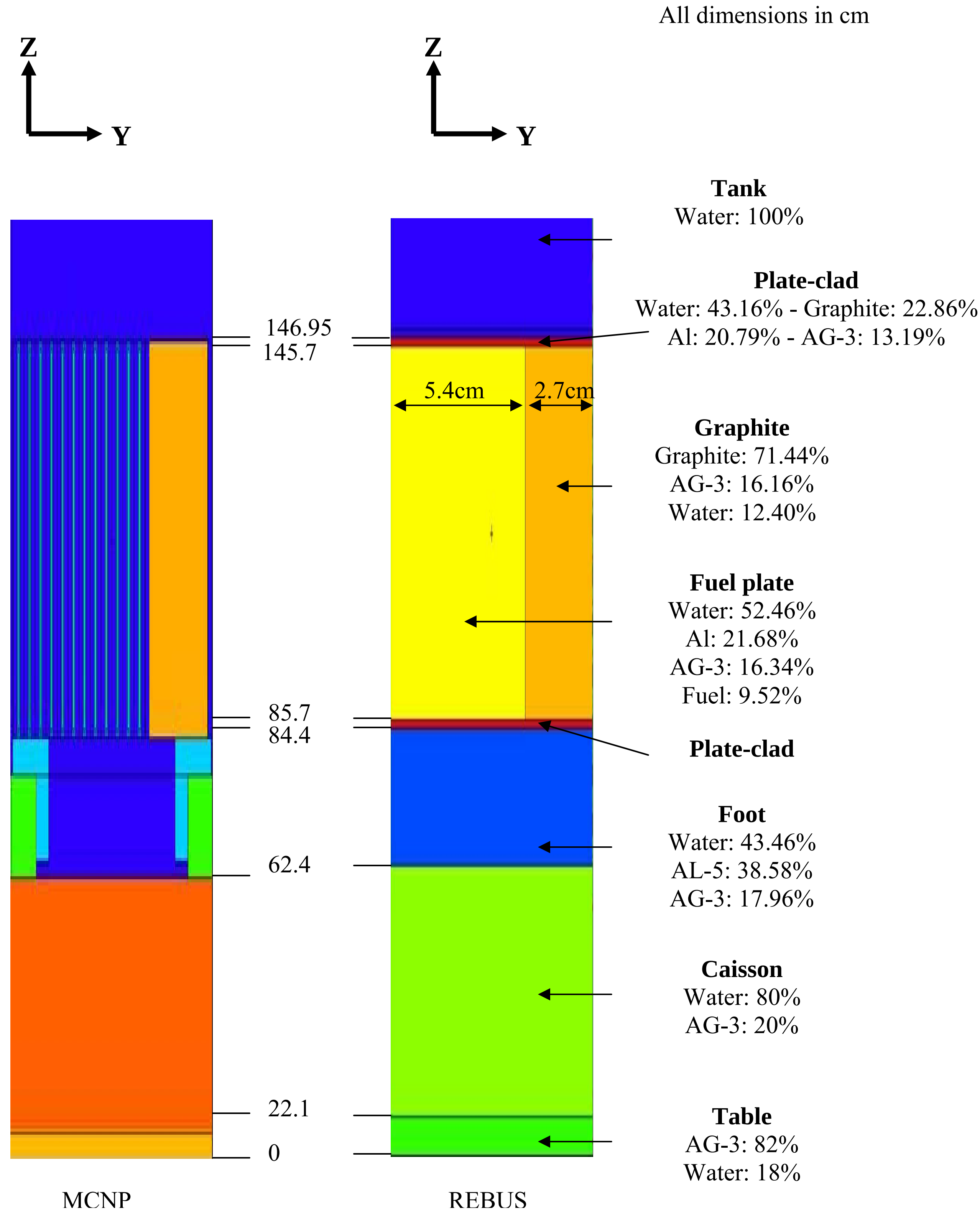


Figure 26: 12-plate fuel element – MCNP & REBUS models

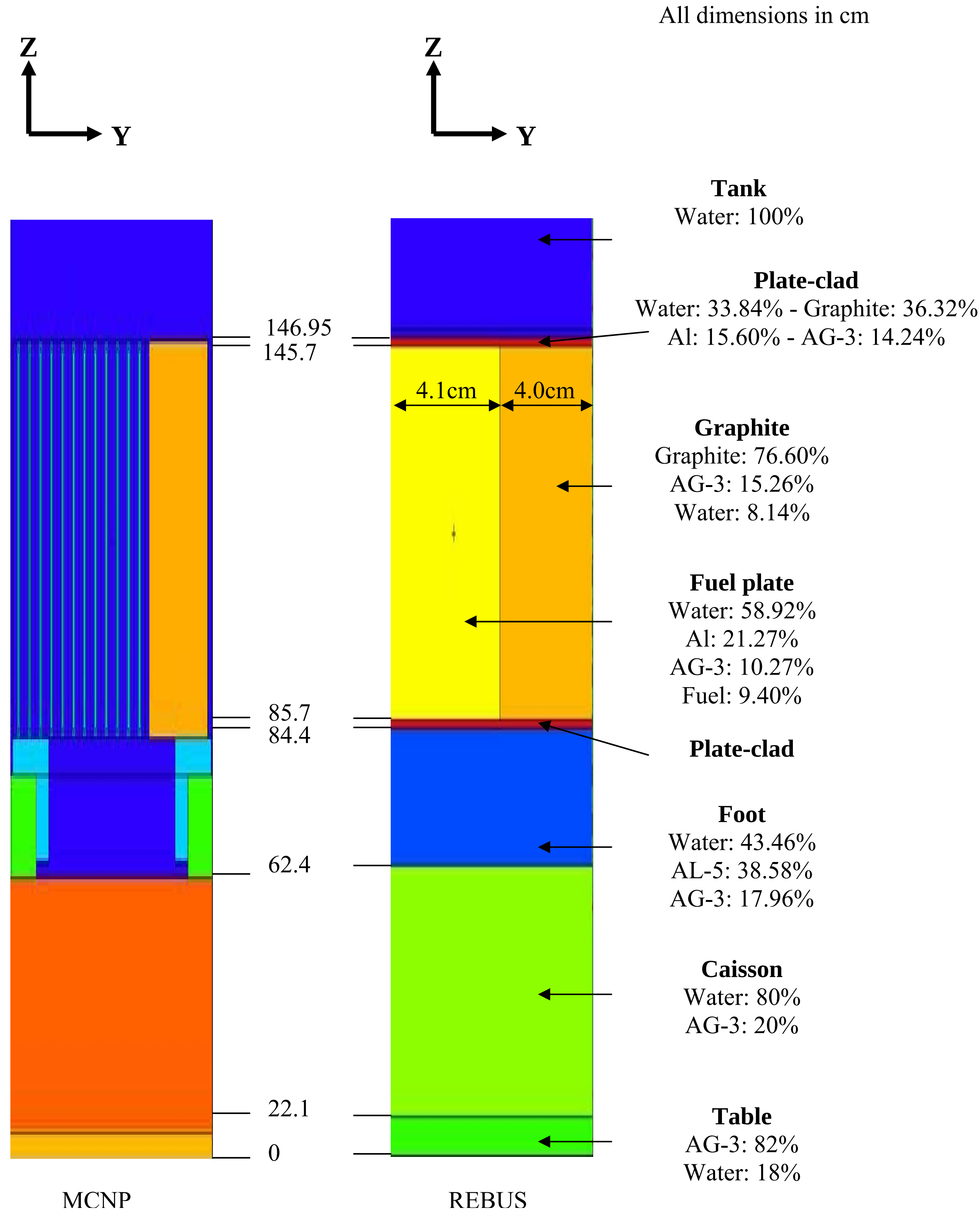


Figure 27: 9-plate fuel element – MCNP & REBUS models

All dimensions in cm

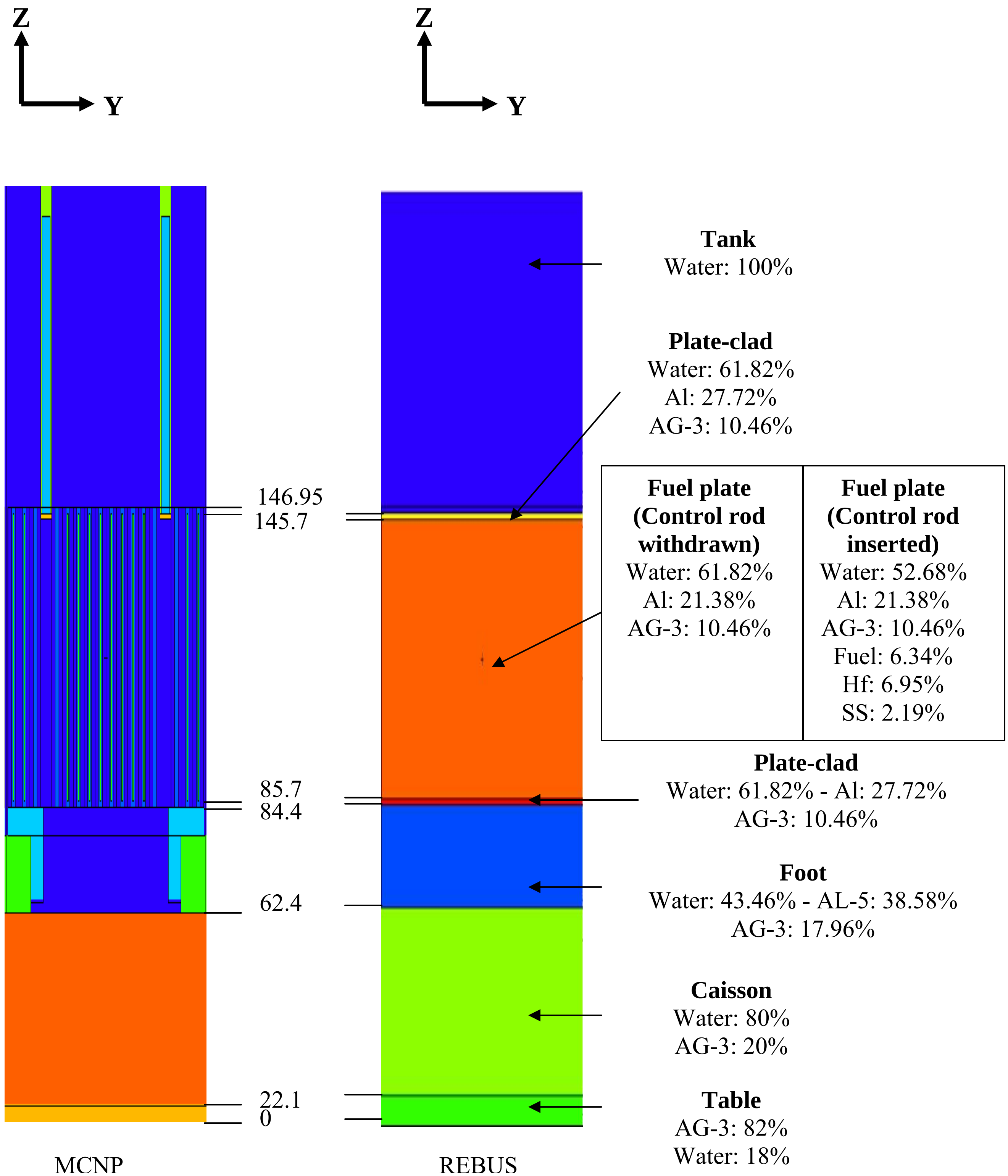


Figure 28: Control element – MCNP & REBUS models

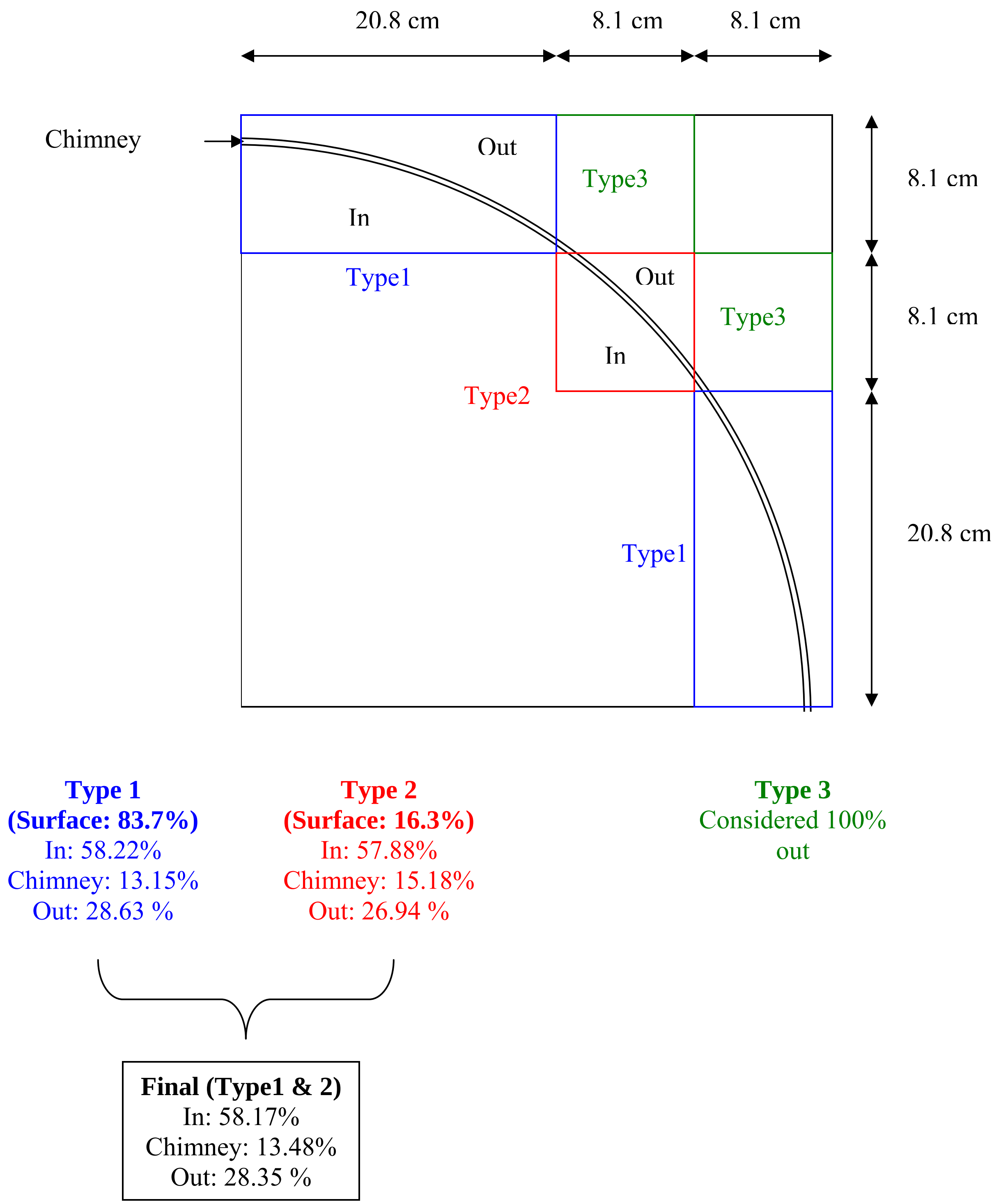


Figure 29: Radial decomposition of the chimney interface

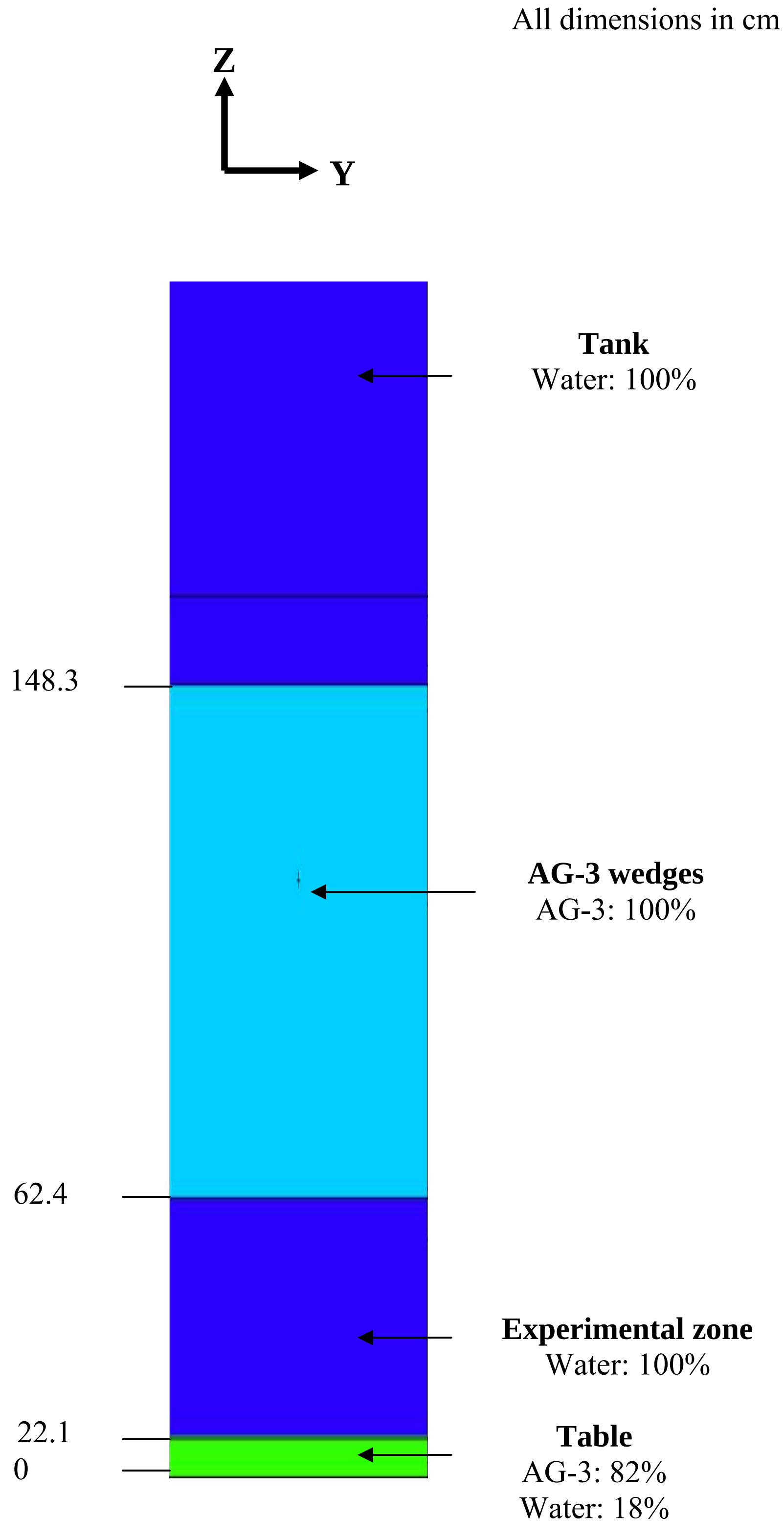


Figure 30: AG-3 wedges – REBUS models

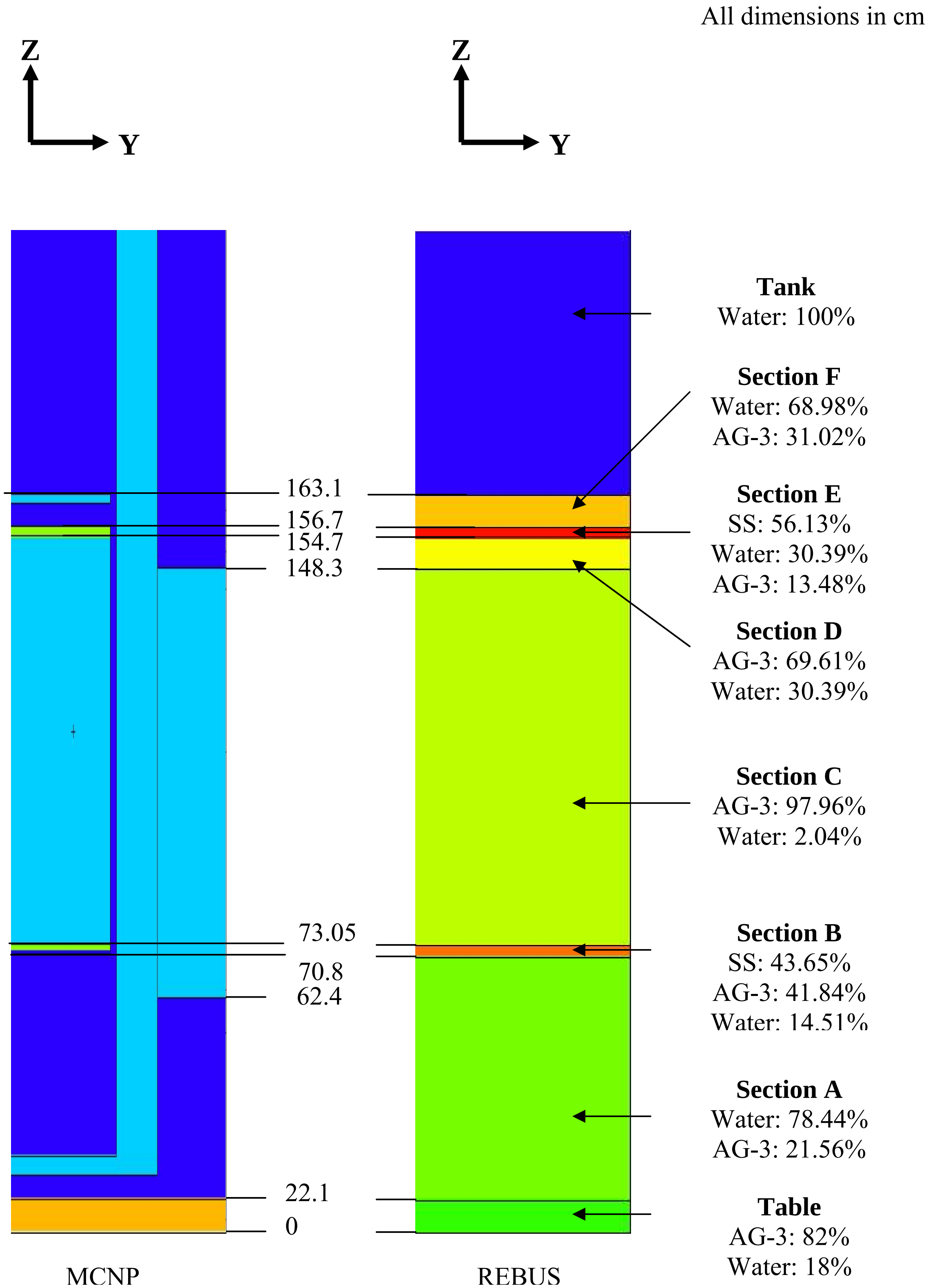


Figure 31: Chimney – MCNP & REBUS models

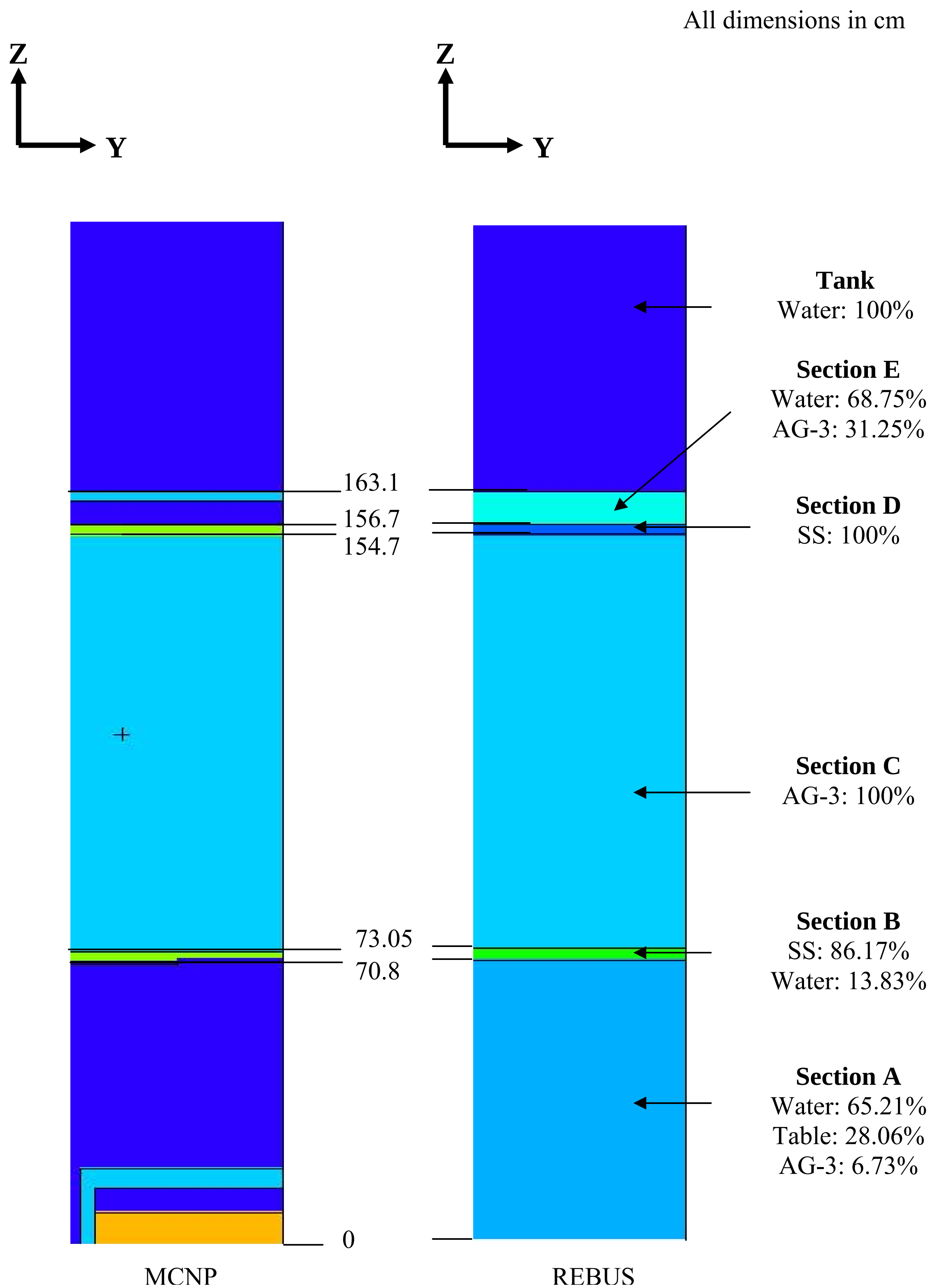


Figure 32: Aluminum buffer – MCNP & REBUS models

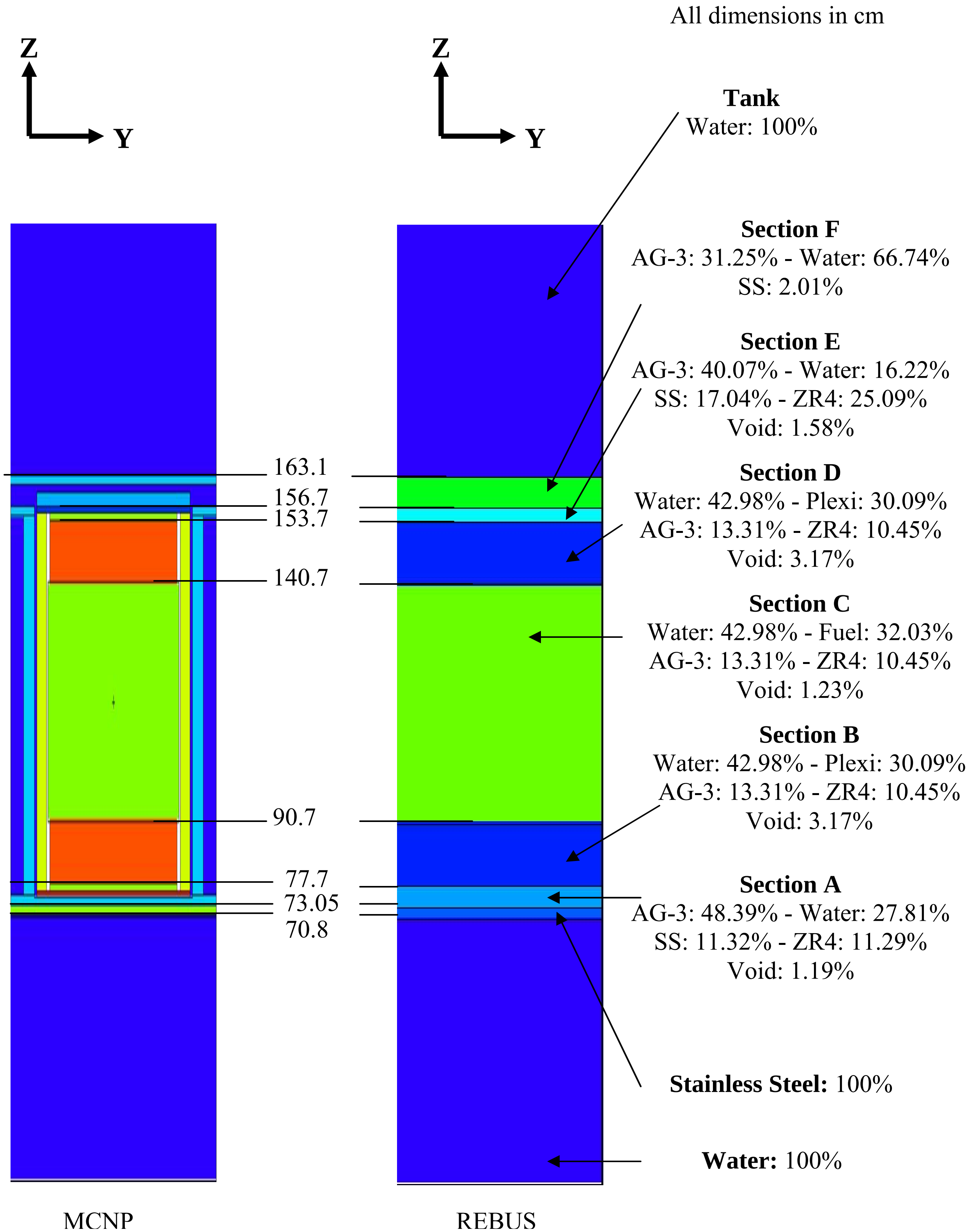


Figure 33: UO_2 fuel pin region – MCNP & REBUS models

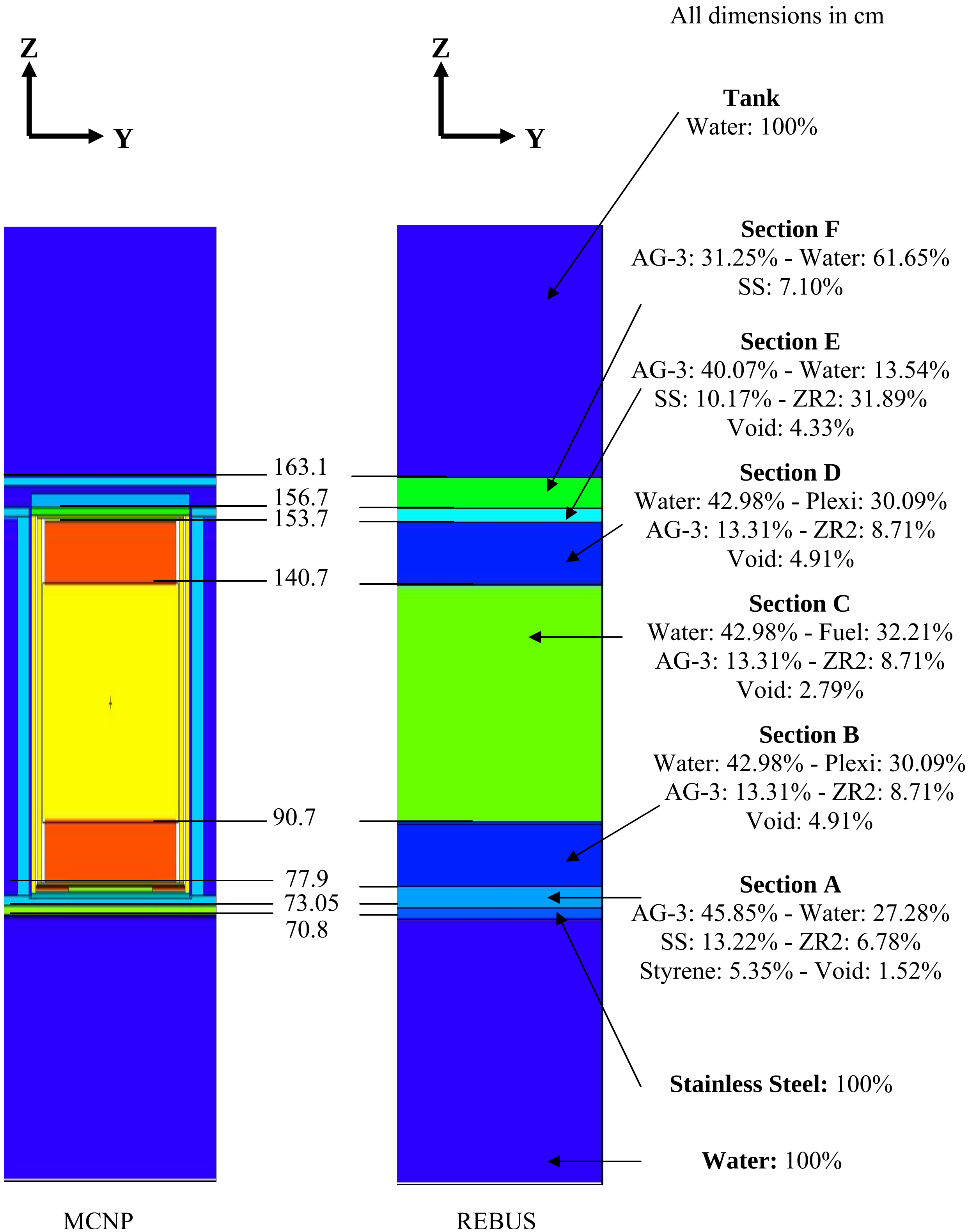


Figure 34: UO_2-PuO_2 fuel pin region – MCNP & REBUS models

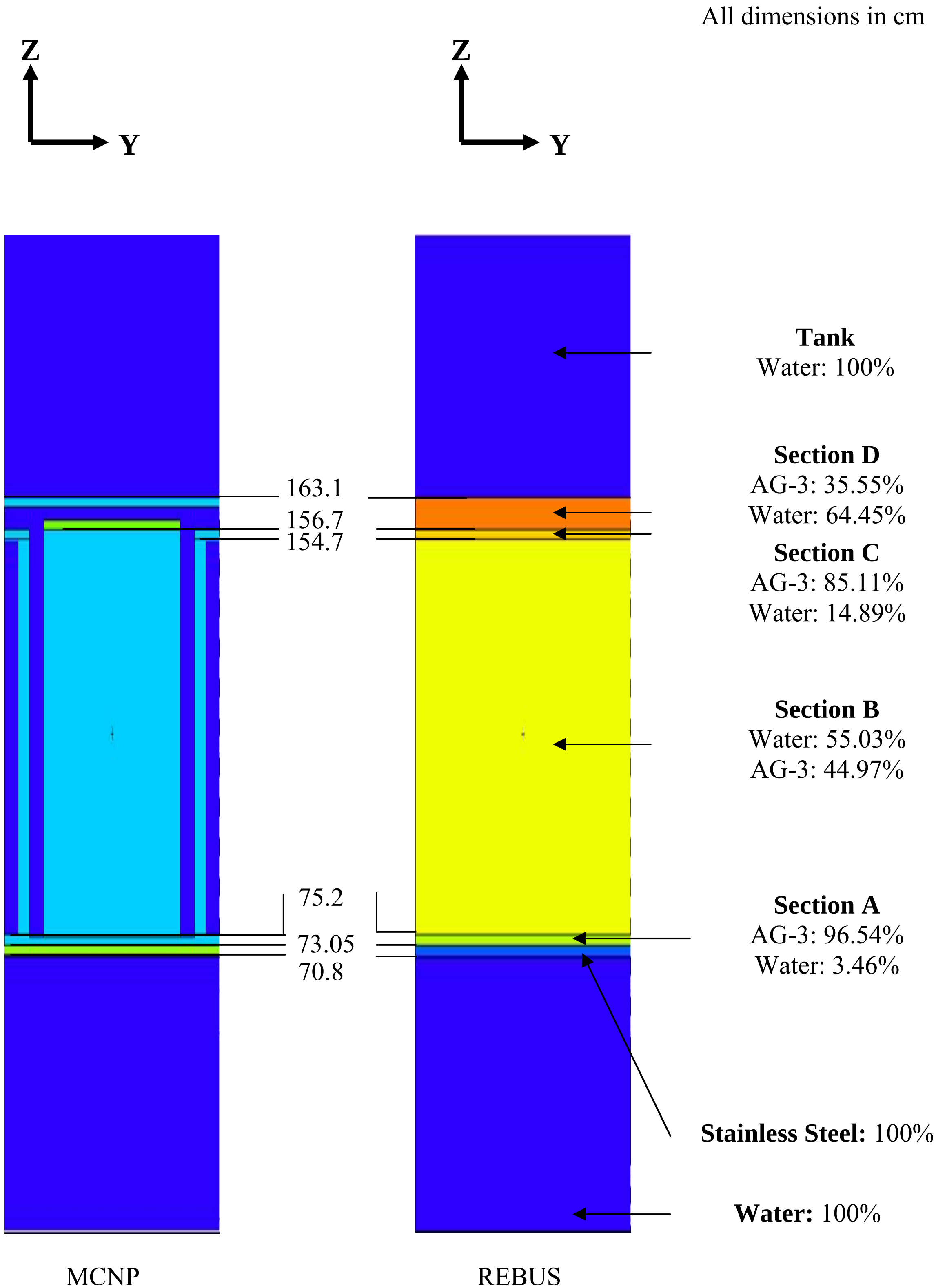


Figure 35: Aluminum fuel pin region – MCNP & REBUS models

All dimensions in cm

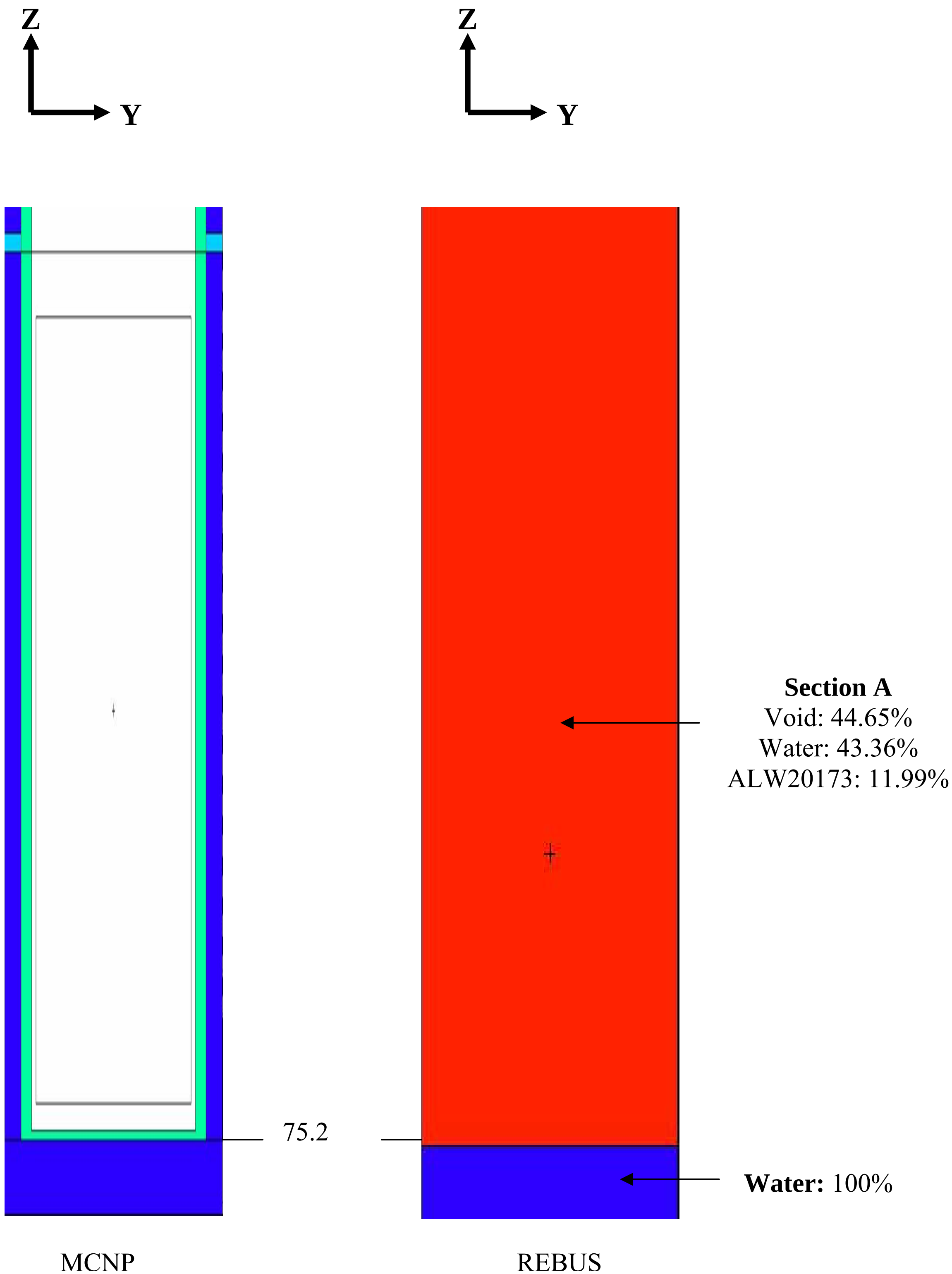


Figure 36: POLINE region – MCNP & REBUS models

All dimensions in cm

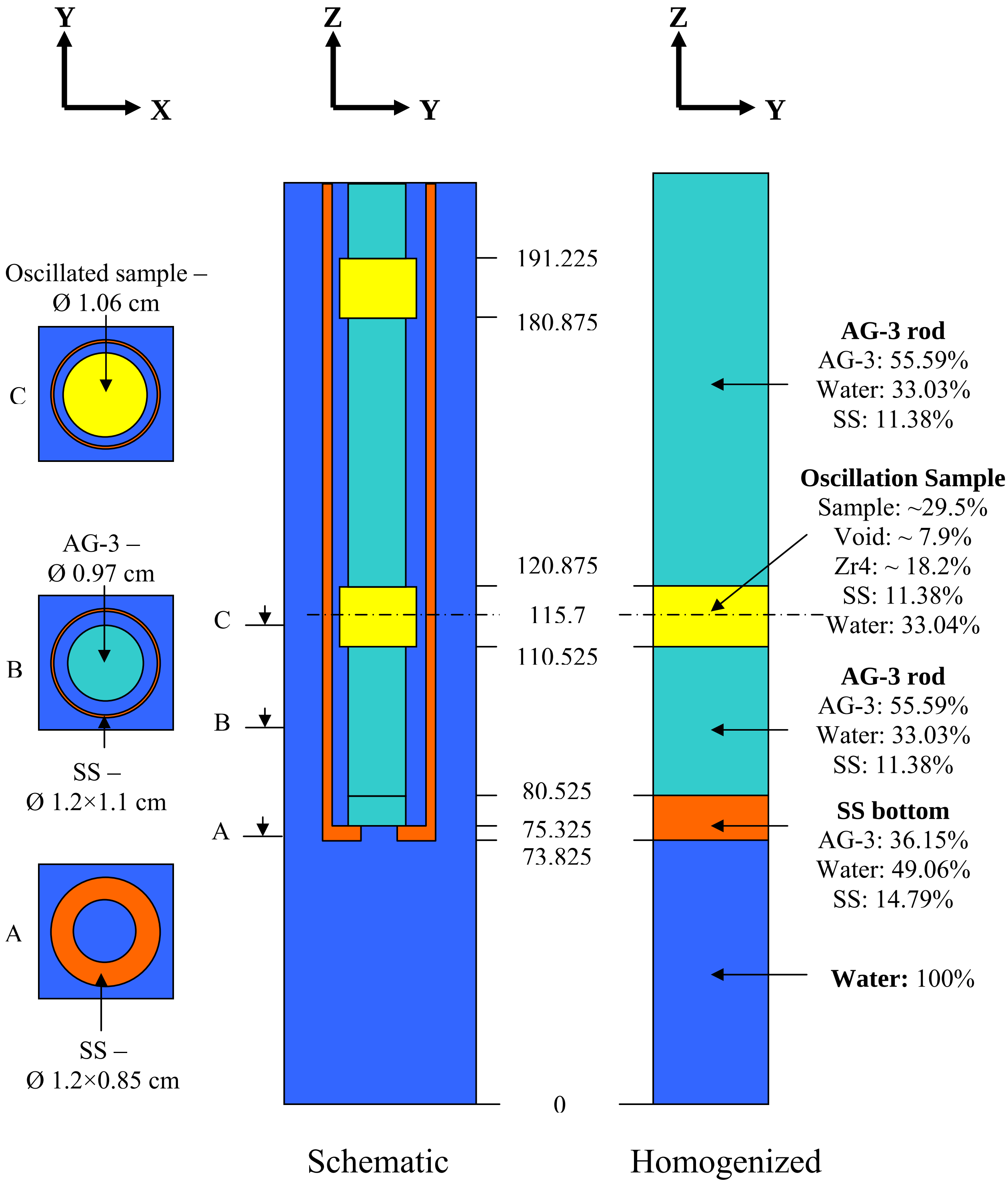


Figure 37: Oscillation rod region in the up position – REBUS models

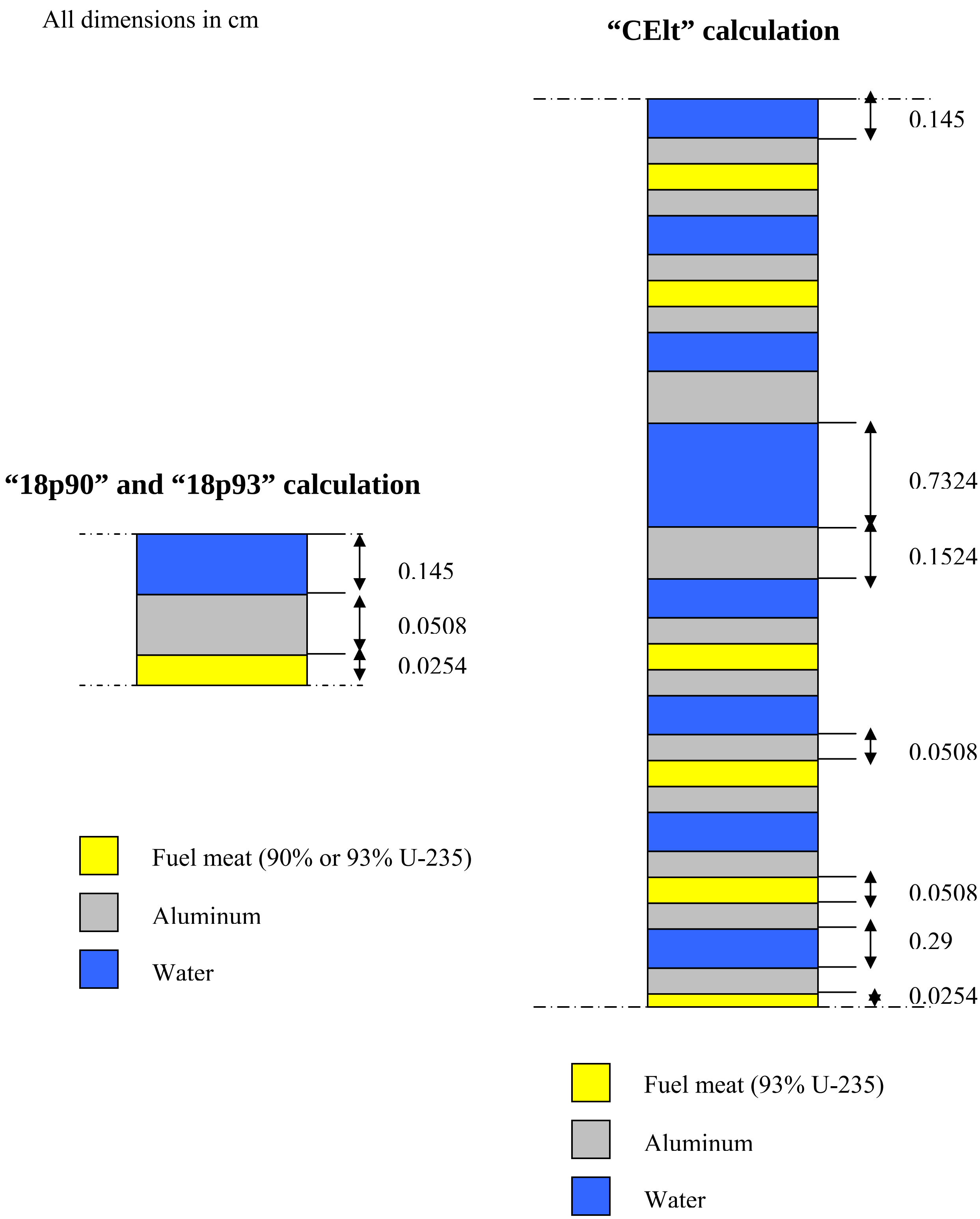


Figure 38: Geometry of the WIMS calculation “18p90”, “18p93” and “CElt”

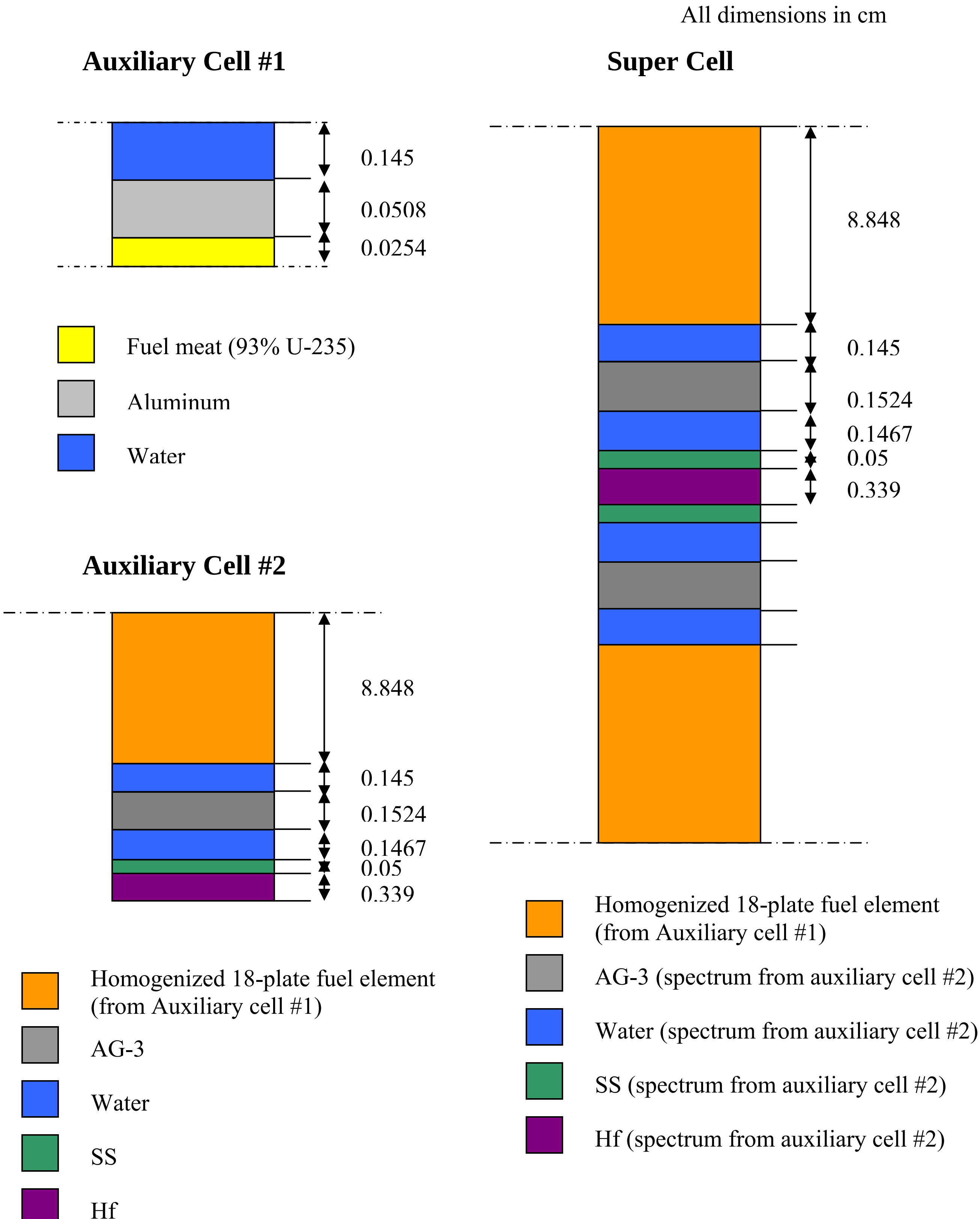


Figure 39: Geometry of the WIMS calculation "rod"

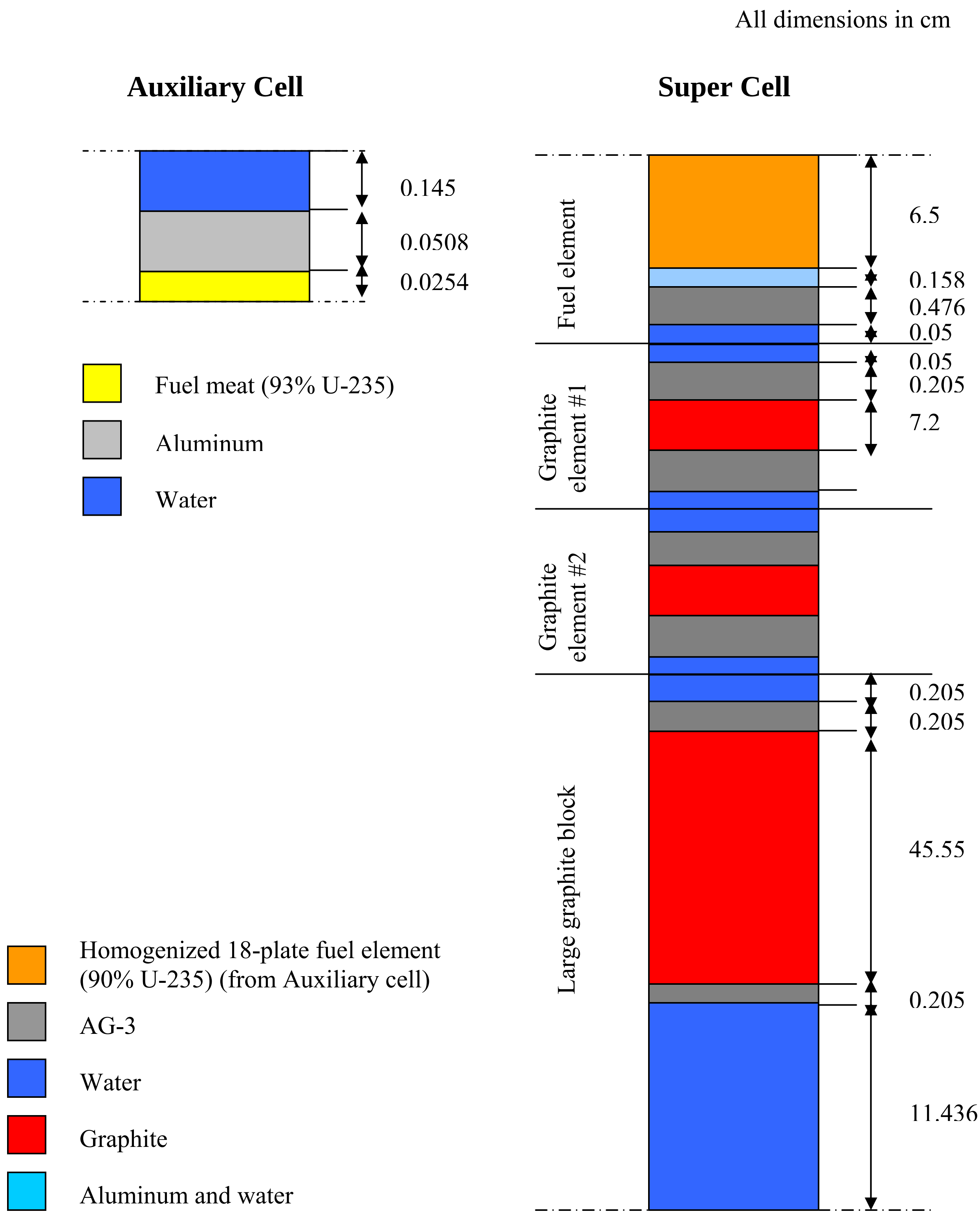


Figure 40: Geometry of the WIMS calculation “G18p90”

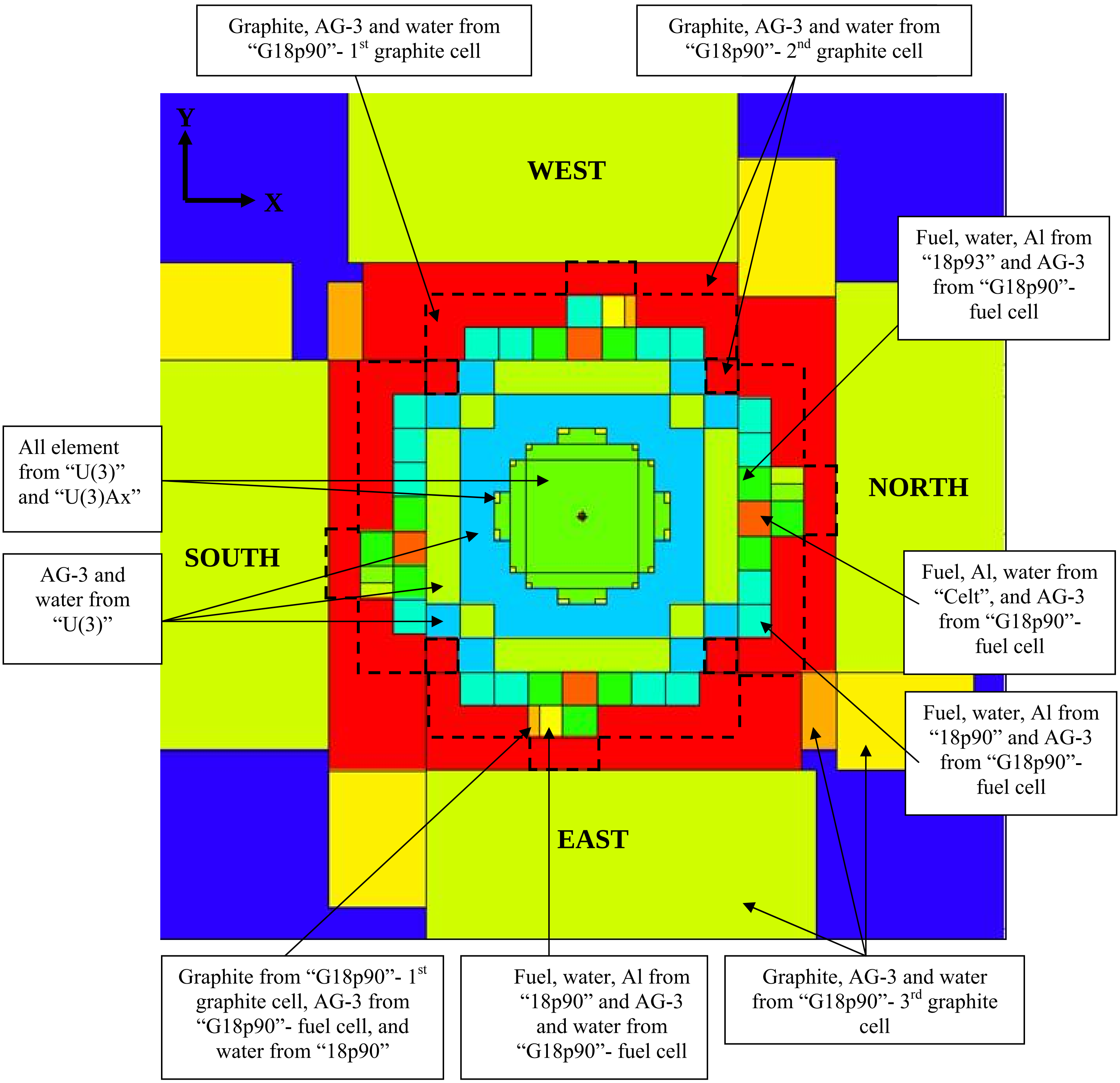


Figure 41: Cross sections used in the REBUS model in the R1UO2 configuration

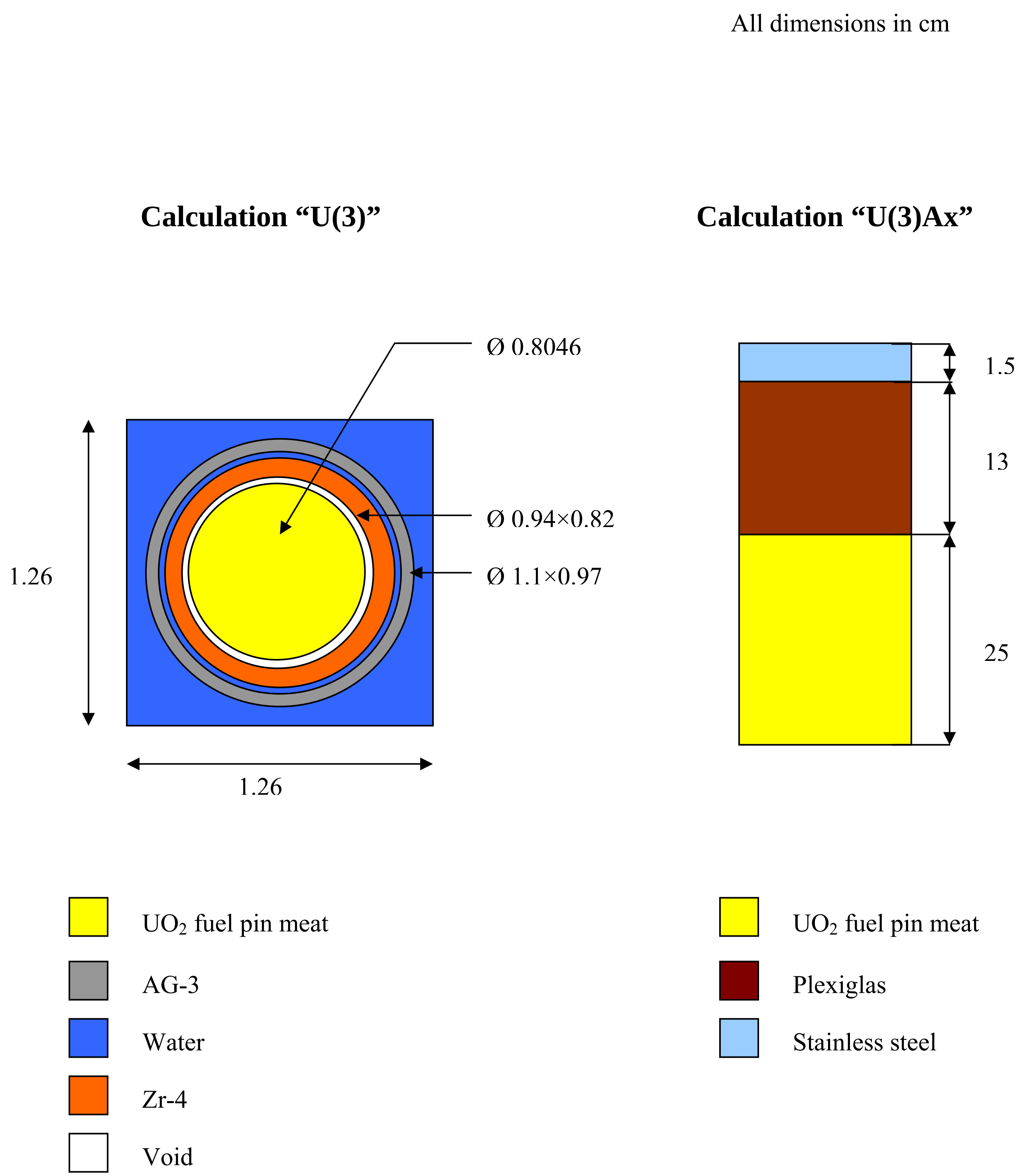


Figure 42: Geometry of the WIMS calculation "U(3)" and "U(3)Ax"

All dimensions in cm

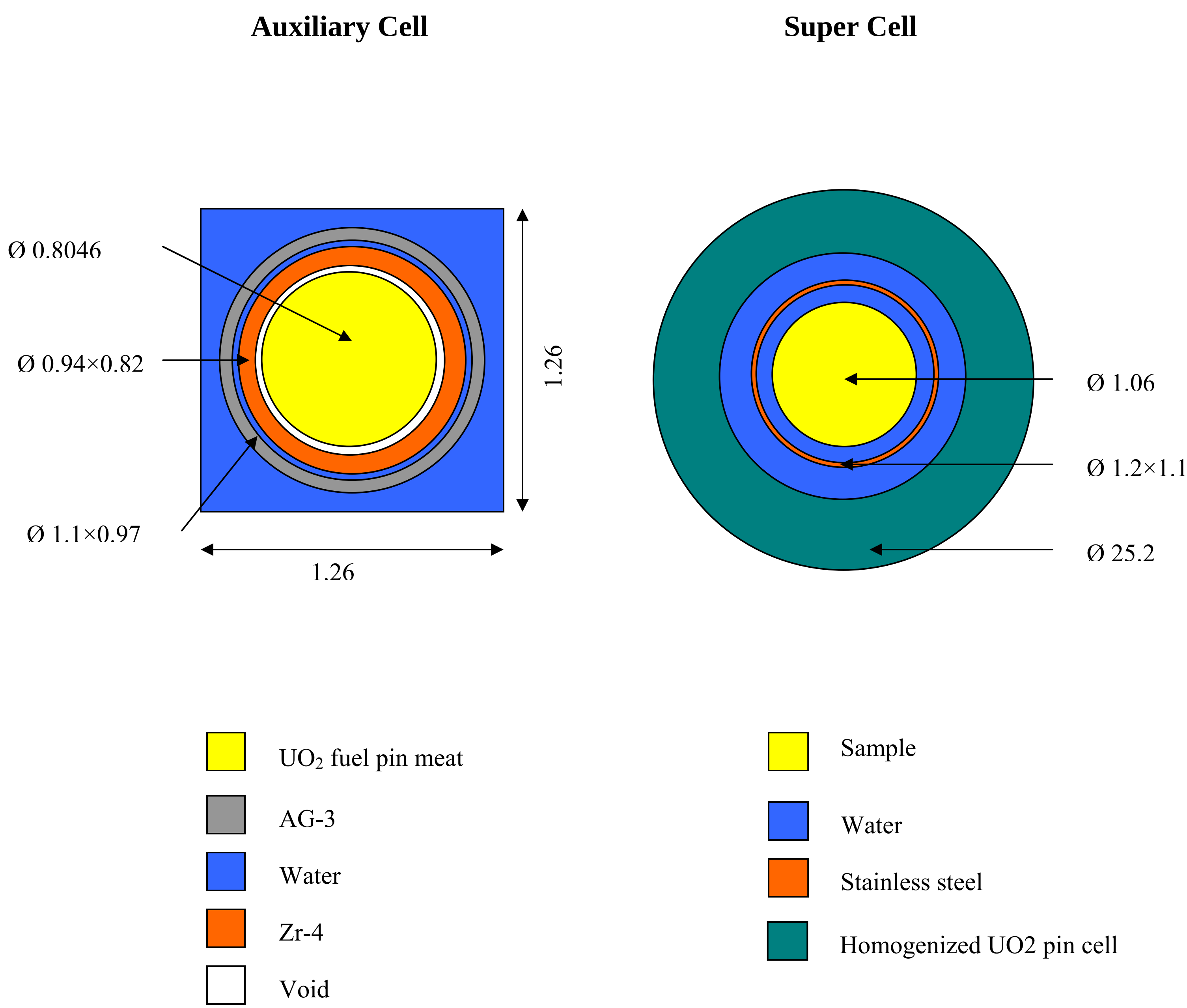
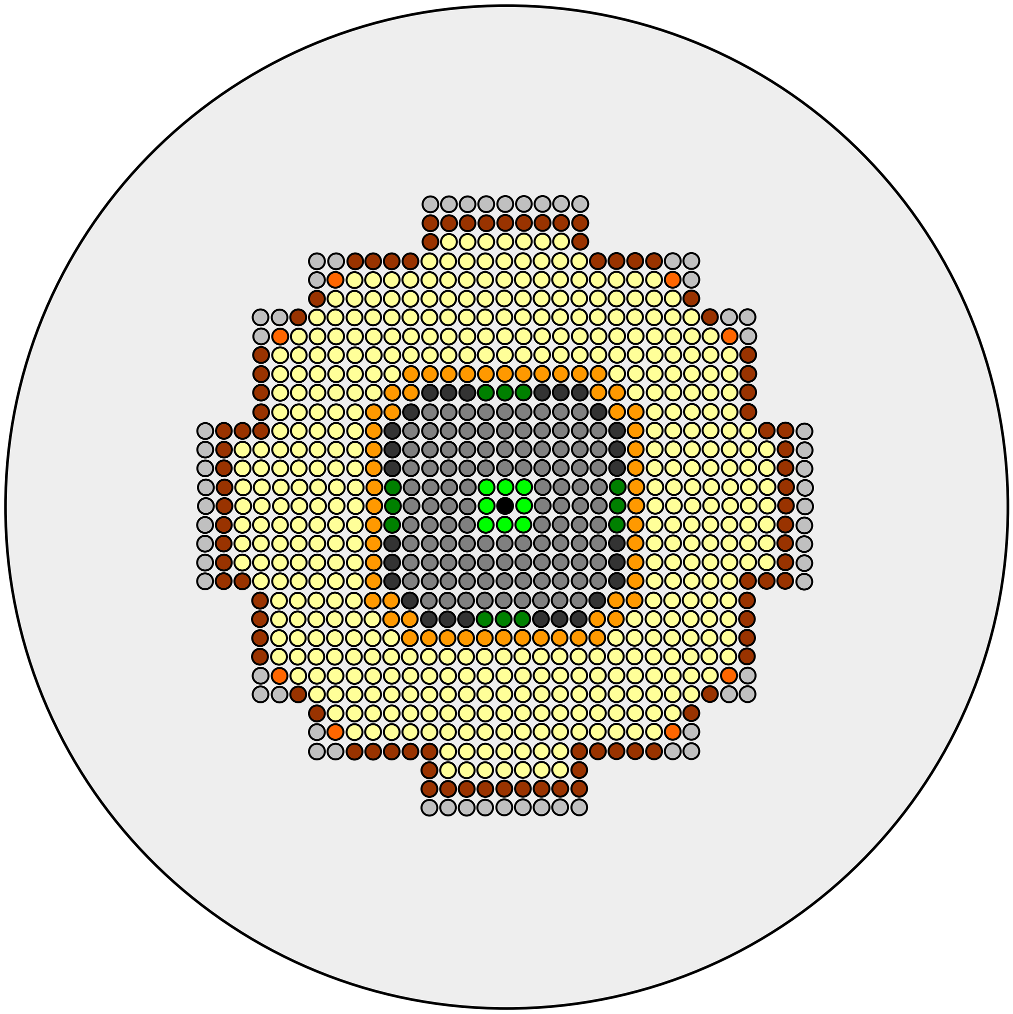
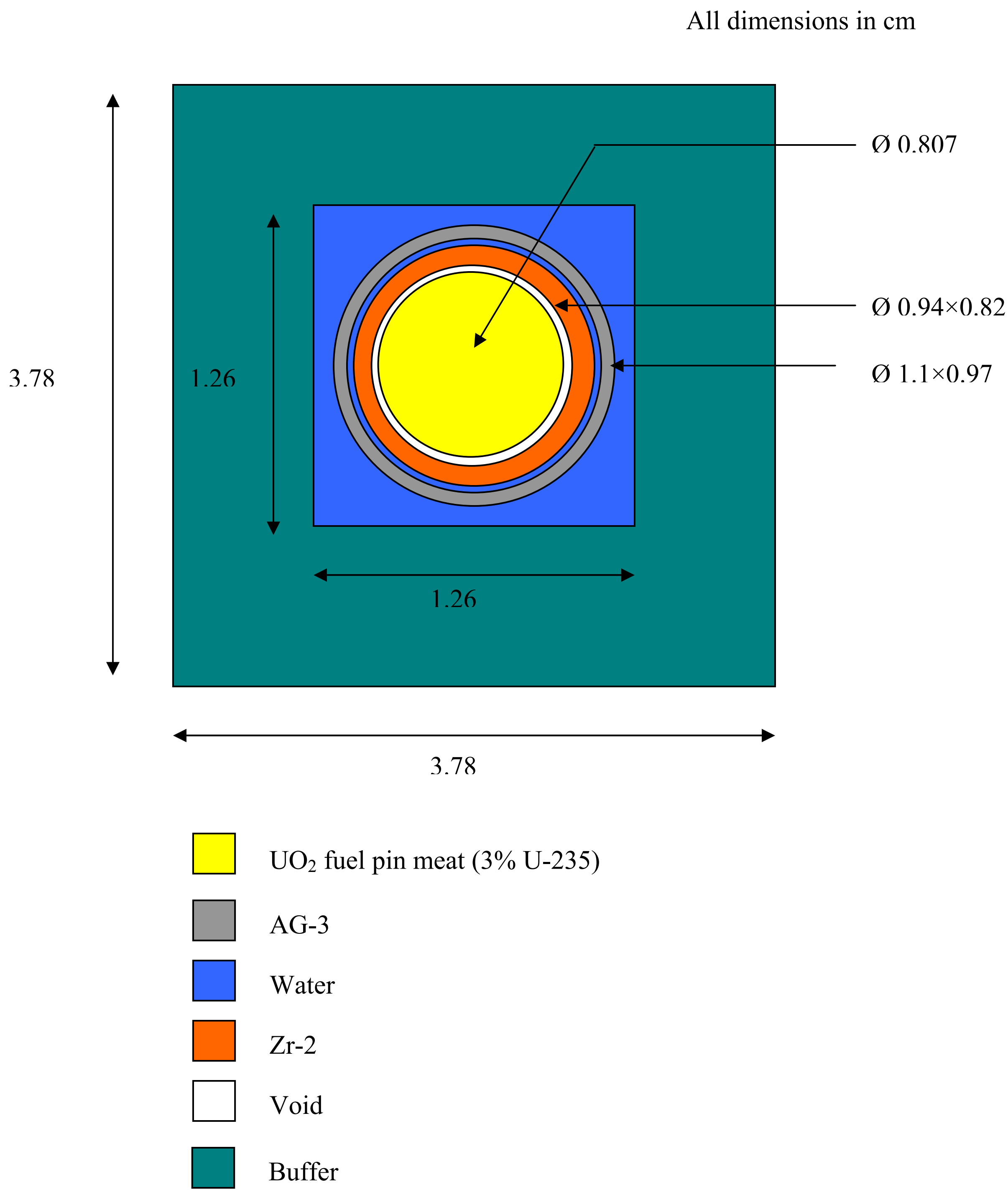


Figure 43: Geometry of the WIMS calculation “Sample” in the R1UO2 configuration



- Aluminum pins – cross section from “U(3)”
- UO_2 pins with 3% U-235 enrichment – cross sections from “U(3)” - Homogeneous
- UO_2 pins with 3% U-235 enrichment – cross sections from “UAl” – Interface U pin / Al pin
- UO_2 pins with 3% U-235 enrichment – cross sections from “UAl” – Interface U pin / Al block
- UO_2 pins with 3% U-235 enrichment – cross sections from “UPuPu2” – Interface Pu(4%) pin Pu(3.6%) / U pin
- UO_2-PuO_2 pins with 4% of PuO_2 – cross sections from “Pu(4)” - Homogeneous
- UO_2-PuO_2 pins with 4% of PuO_2 – cross sections from “UPu” – Interface Pu(4%) pin / Upin
- UO_2-PuO_2 pins with 4% of PuO_2 – cross sections from “UPOL” – Interface Pu(4%) pin / POLINE
- UO_2-PuO_2 pins with 3.6% of PuO_2 – cross sections from “UPuPu2” – Interface Pu(4%) pin Pu(3.6%) / U pin
- Oscillation position: POLINE

Figure 44: Cross sections used in the REBUS model in the R1UO2 configuration



- Case “UAl”: 5/8 UO2 pin cell and 3/8 AG-3 pin cell
- Case “UAlB”: 5/8 UO2 pin cell and 3/8 AG-3 block

Figure 45: Geometry of the WIMS calculation “UAl” and “UAlB”

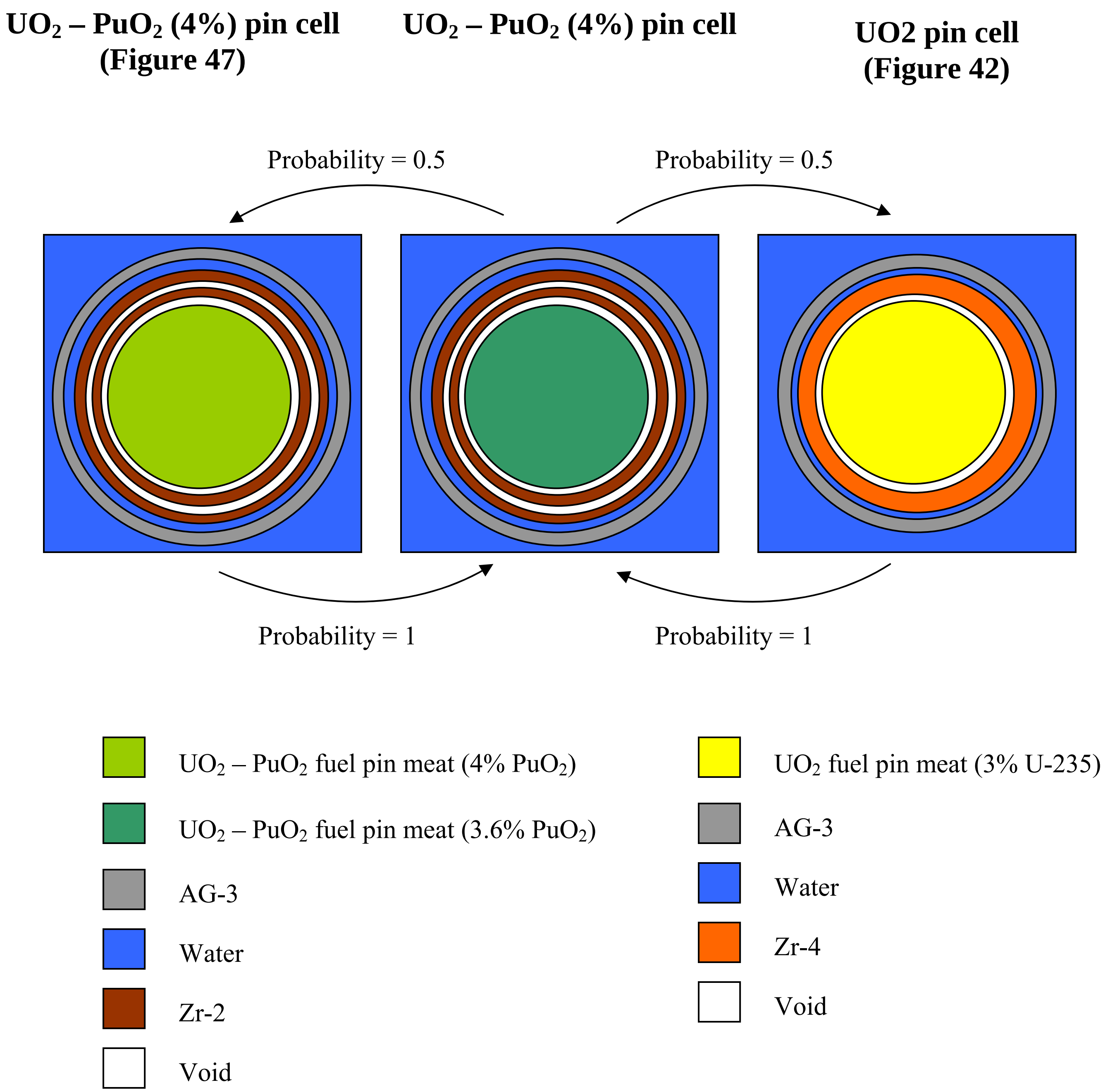


Figure 46: Geometry of the WIMS calculation “UPuPu1” and “UPuPu2”

All dimensions in cm

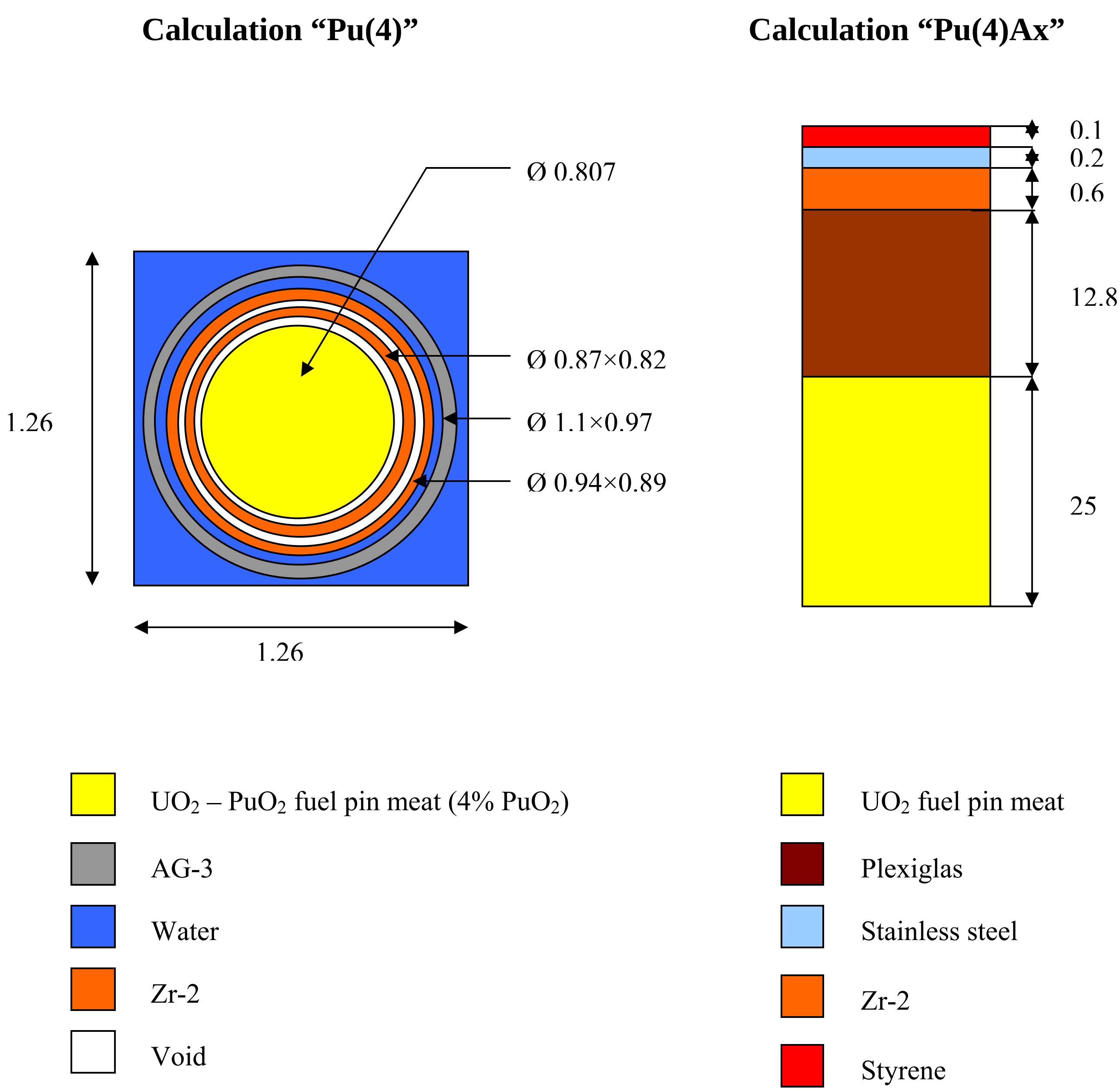


Figure 47: Geometry of the WIMS calculation “Pu(4)” and “Pu(4)Ax”

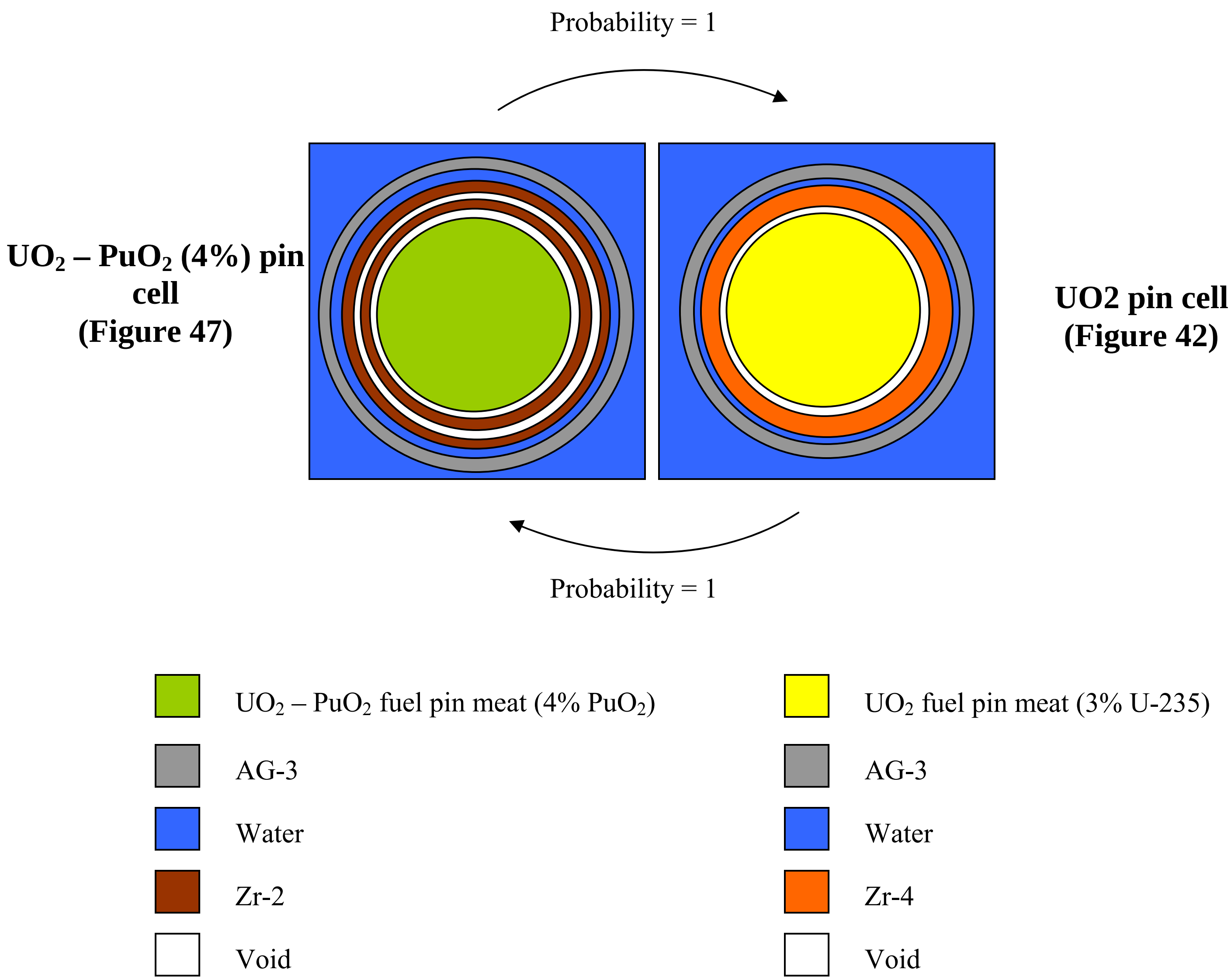


Figure 48: Geometry of the WIMS calculation "UPu"

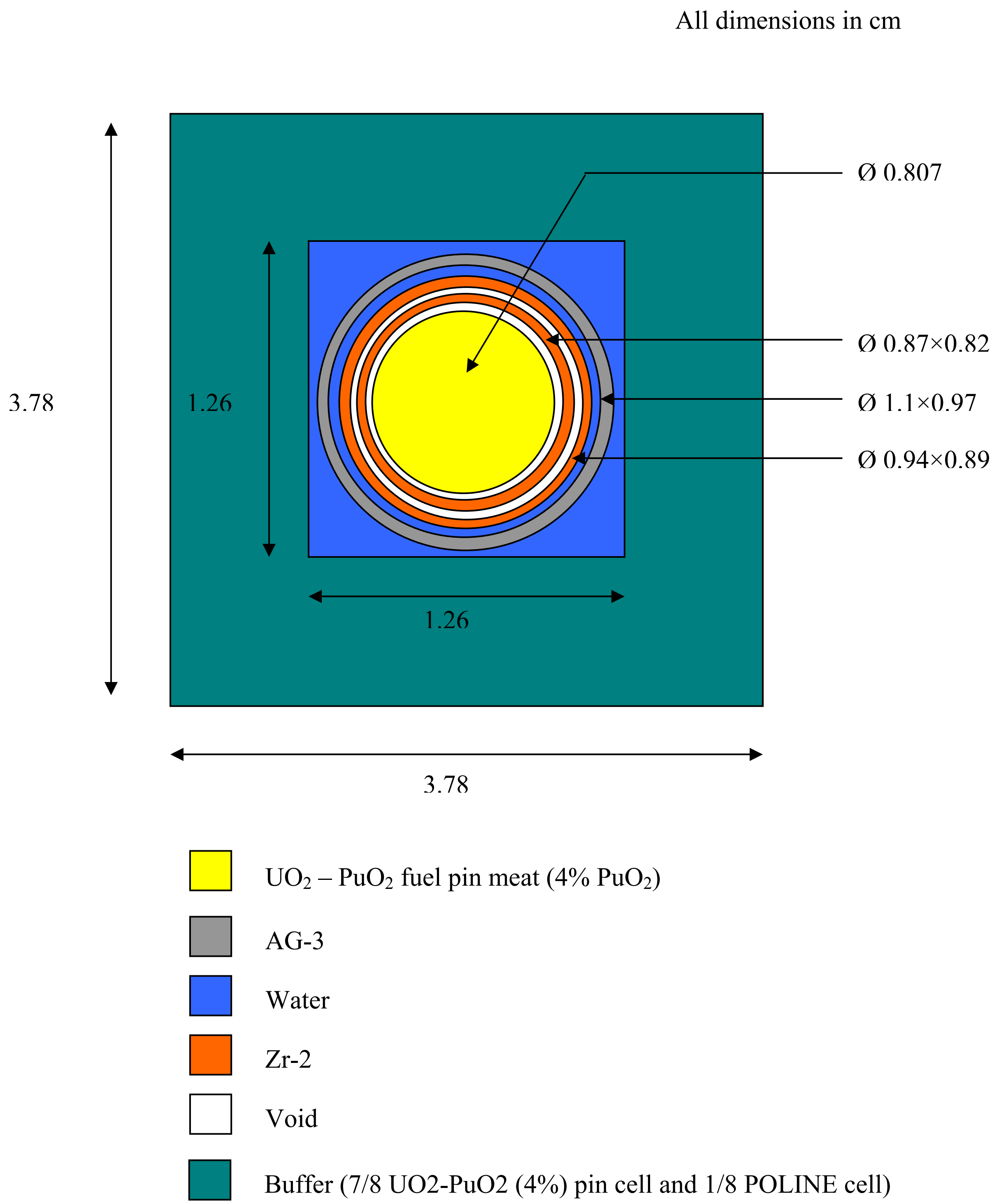


Figure 49: Geometry of the WIMS calculation "PuPOL"

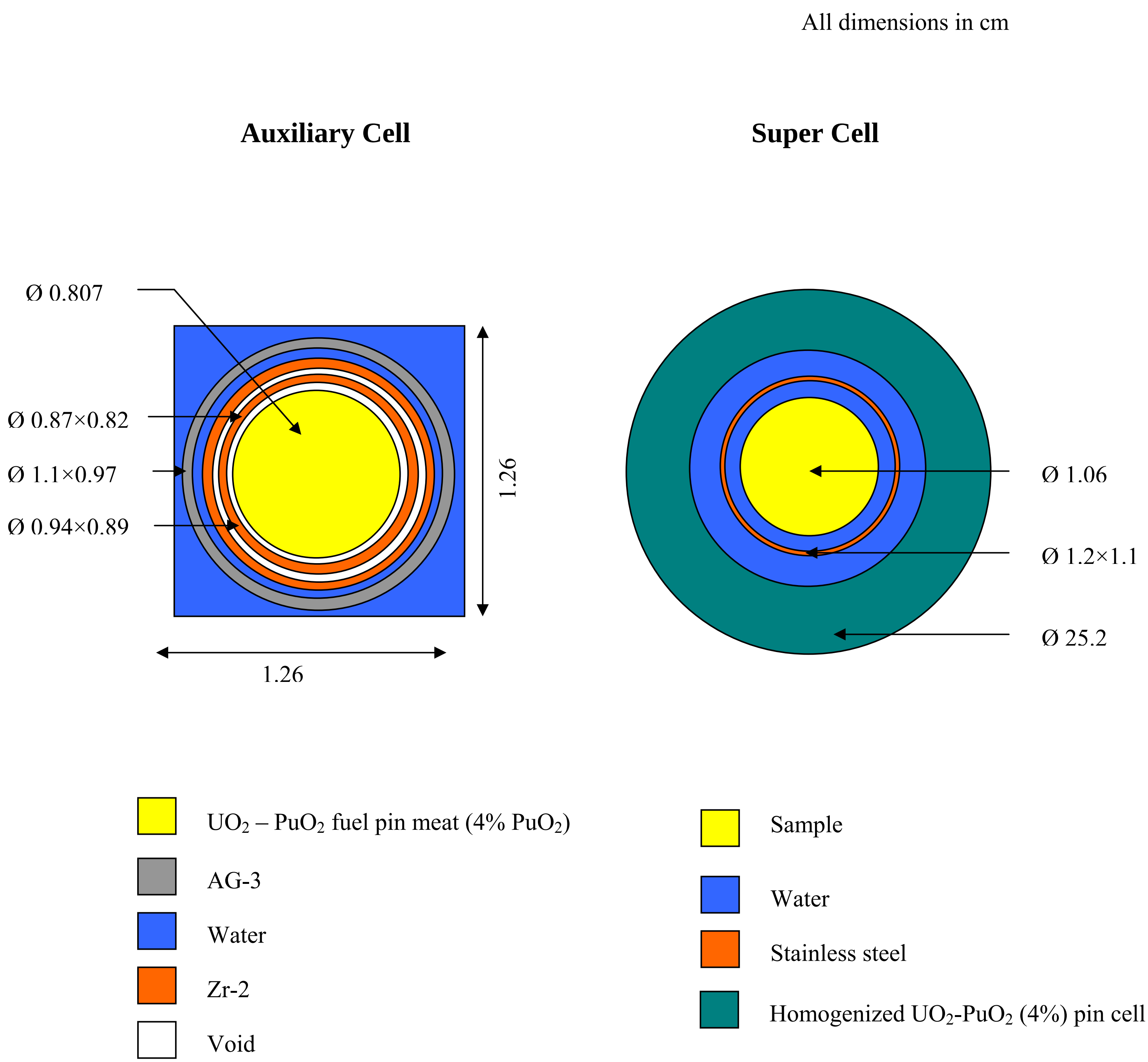
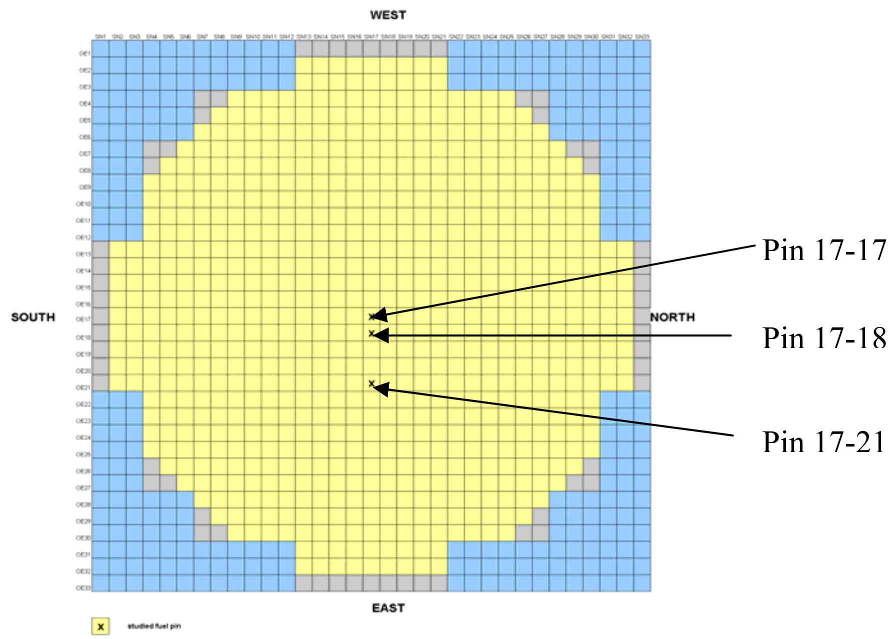
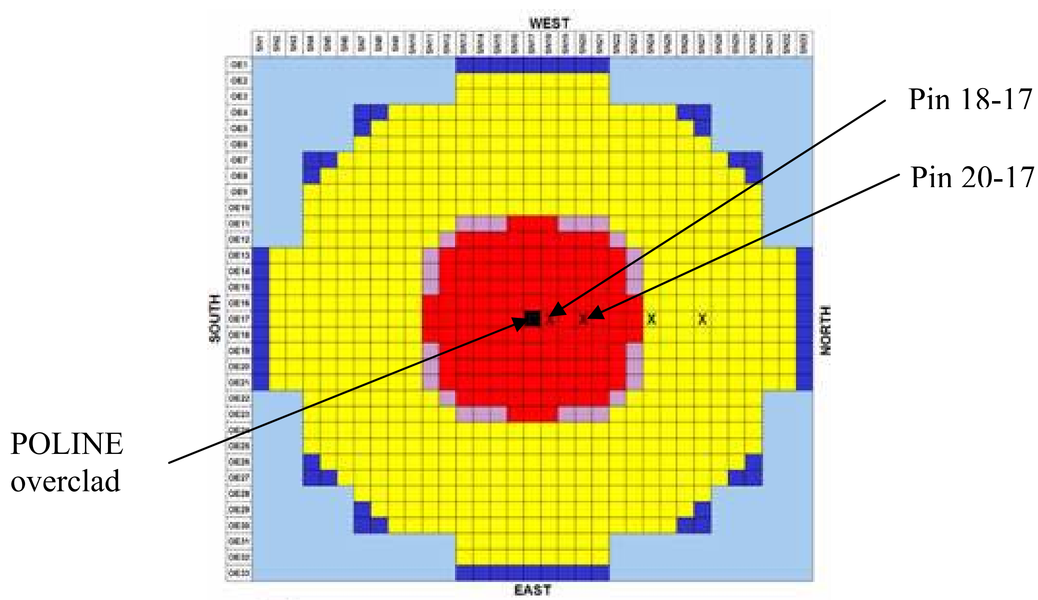


Figure 50: Geometry of the WIMS calculation “Sample” in the R1MOX configuration



R1UO2 homogeneous configuration



R1MOX configuration

Figure 51: Studied pins for axial power profile measurements

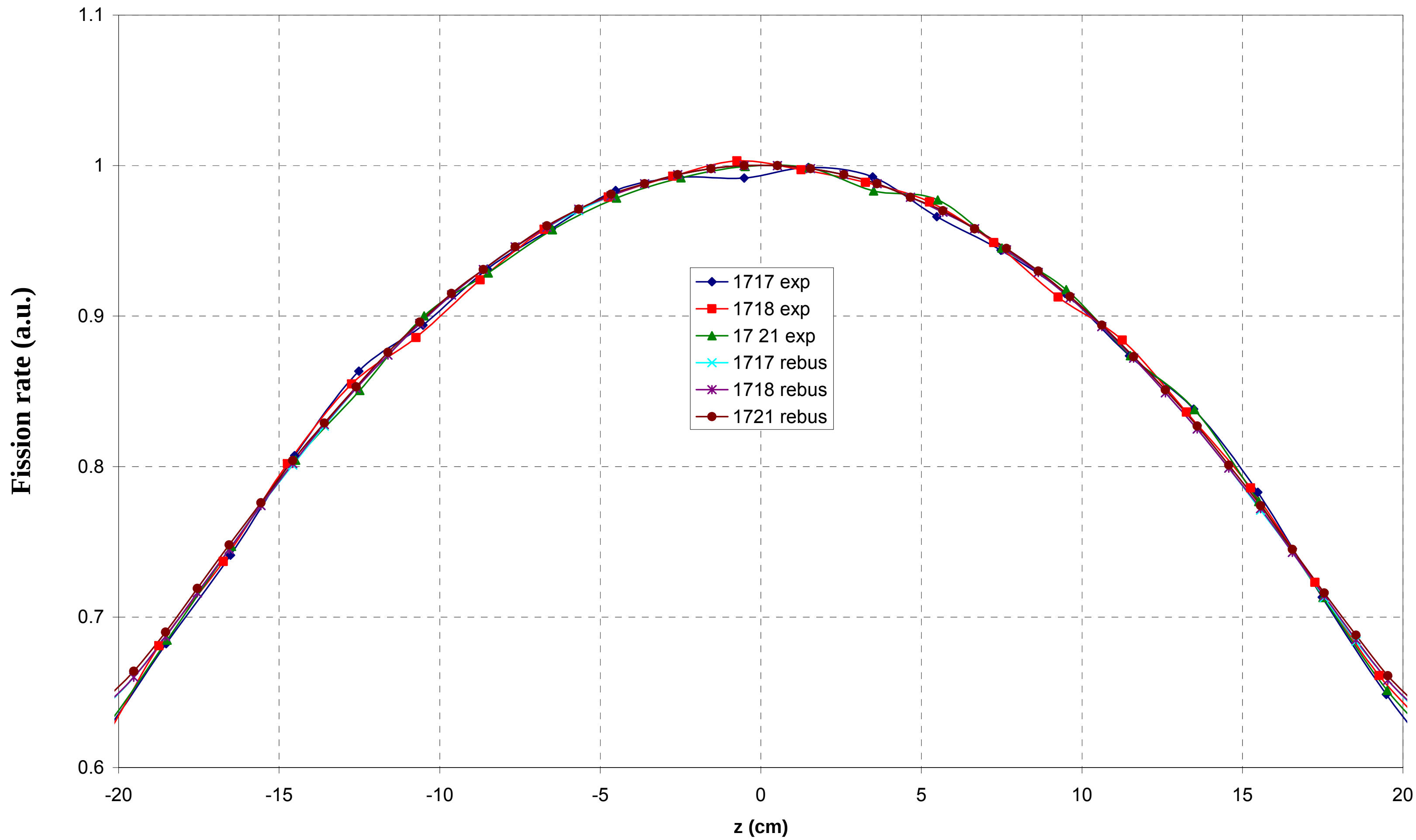


Figure 52: Axial power profile for specific pins in the R1UO2 configuration – Comparison of REBUS results to measurements

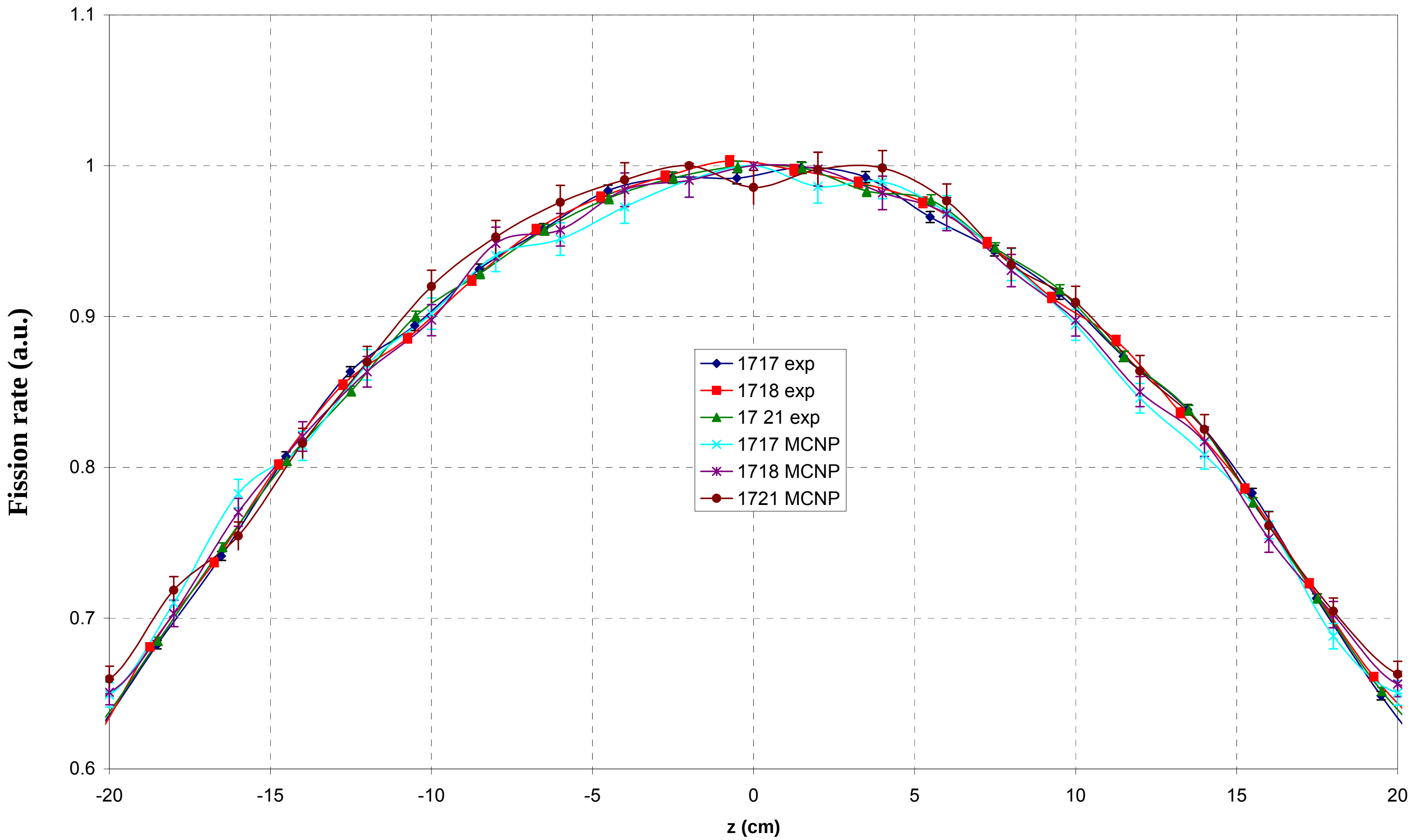


Figure 53: Axial power profile for specific pins in the R1UO2 configuration – Comparison of MCNP results to measurements

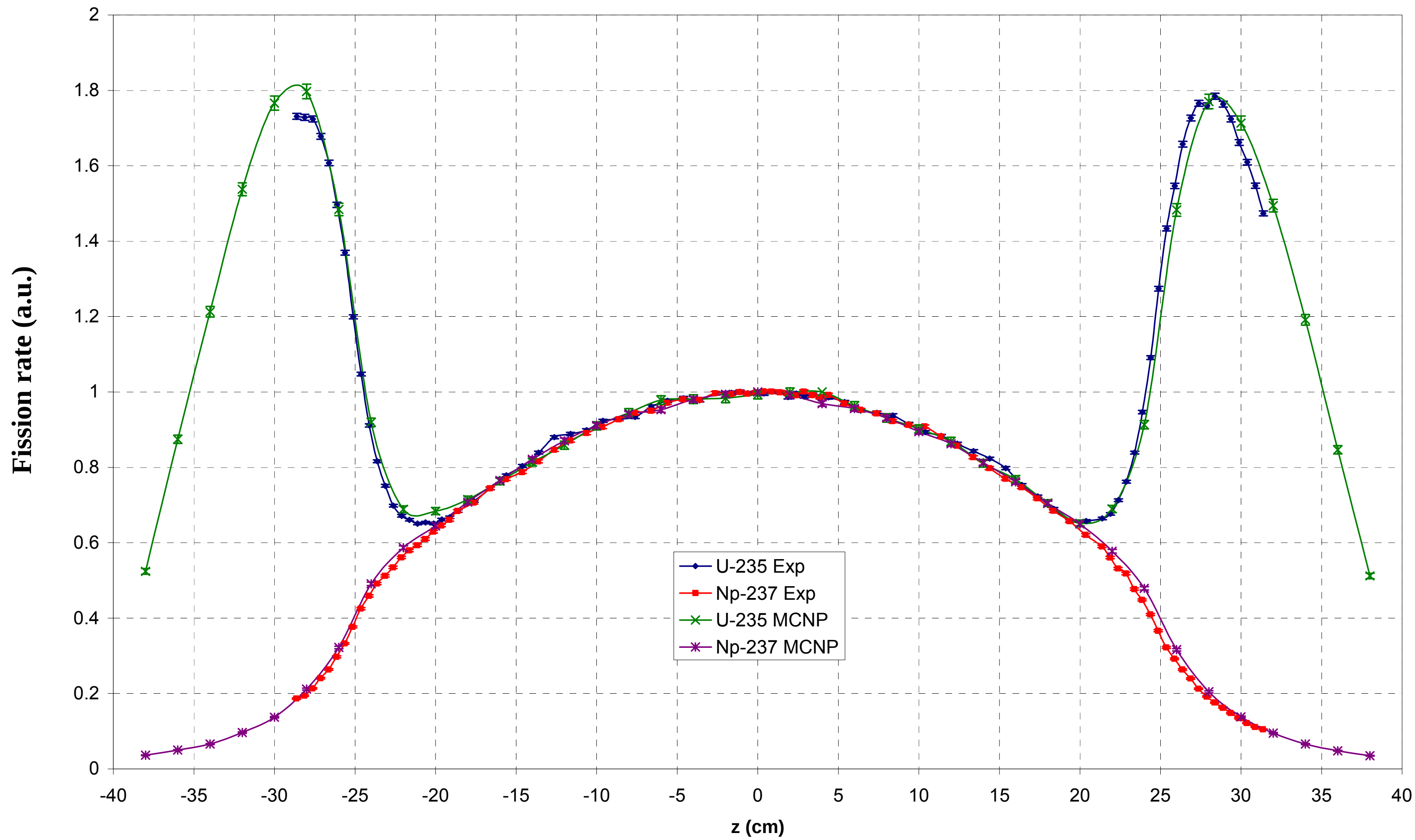


Figure 54: Axial fission rate profile of U-235 and Np-237 fission chambers in the R1UO2 configuration – Comparison of MCNP results to measurements

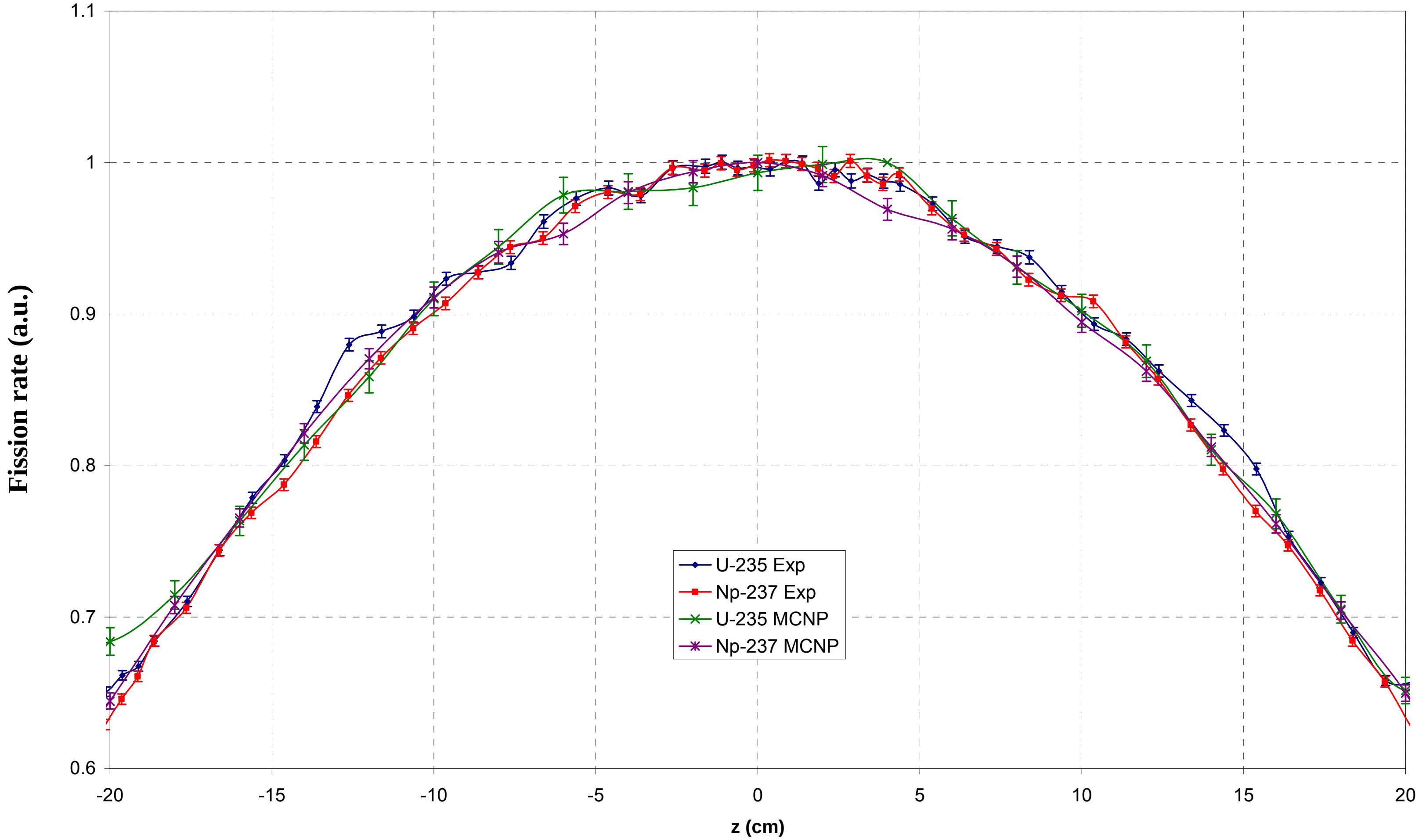


Figure 55: Axial fission rate profile of U-235 and Np-237 fission chambers in the R1UO2 configuration – Comparison of MCNP results to measurements over range of ±20 cm

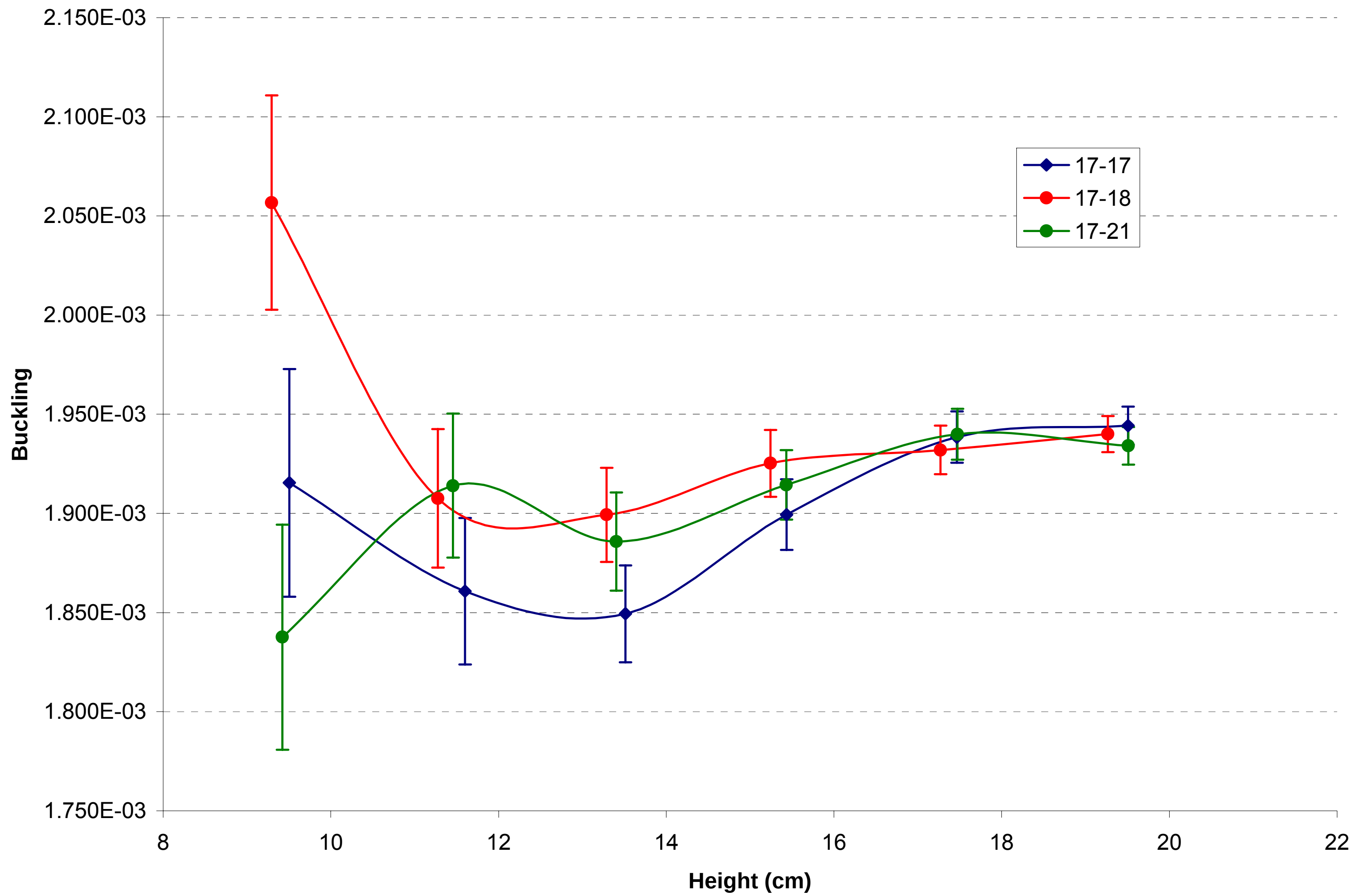


Figure 56: Buckling for the R1UO2 configuration calculated with experimental data within a limited range (± height from centerline)

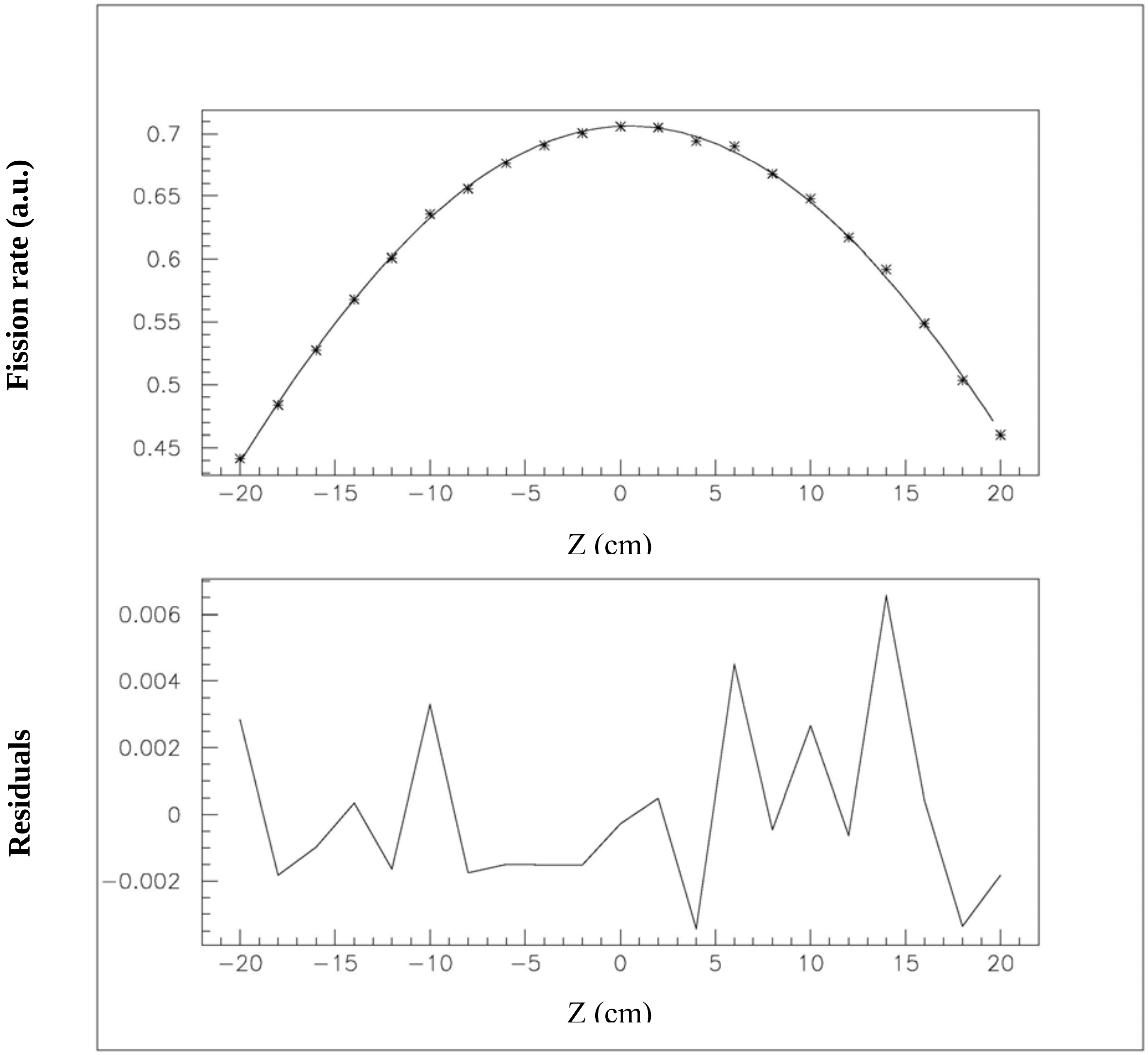


Figure 57: Fit of the experimental axial power profile of the pin 17-21 of the R1UO2 configuration over the range [-20 cm, 20 cm]

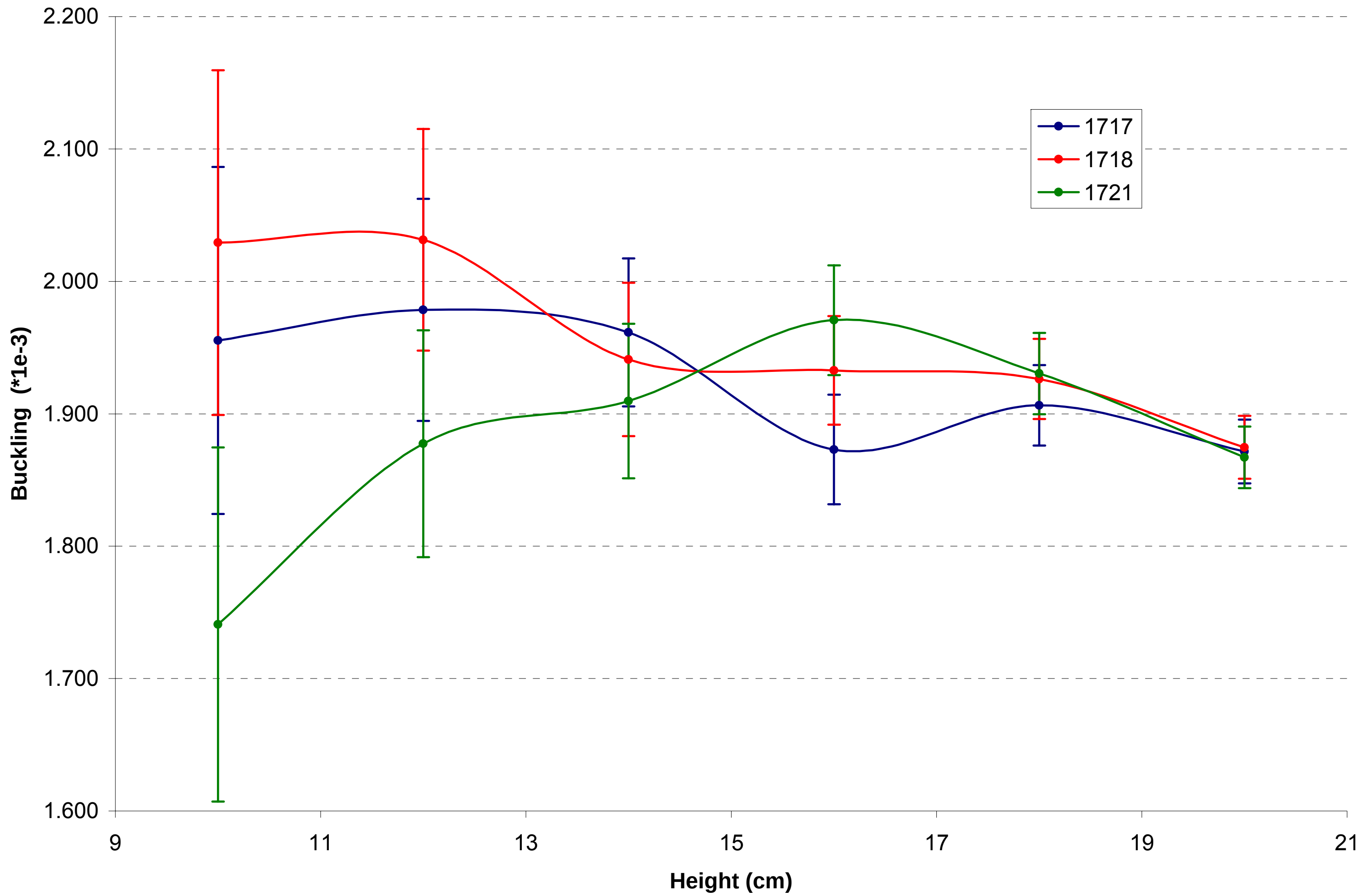


Figure 58: Buckling for the R1UO2 configuration calculated with data from MCNP within a limited range (± height from centerline)

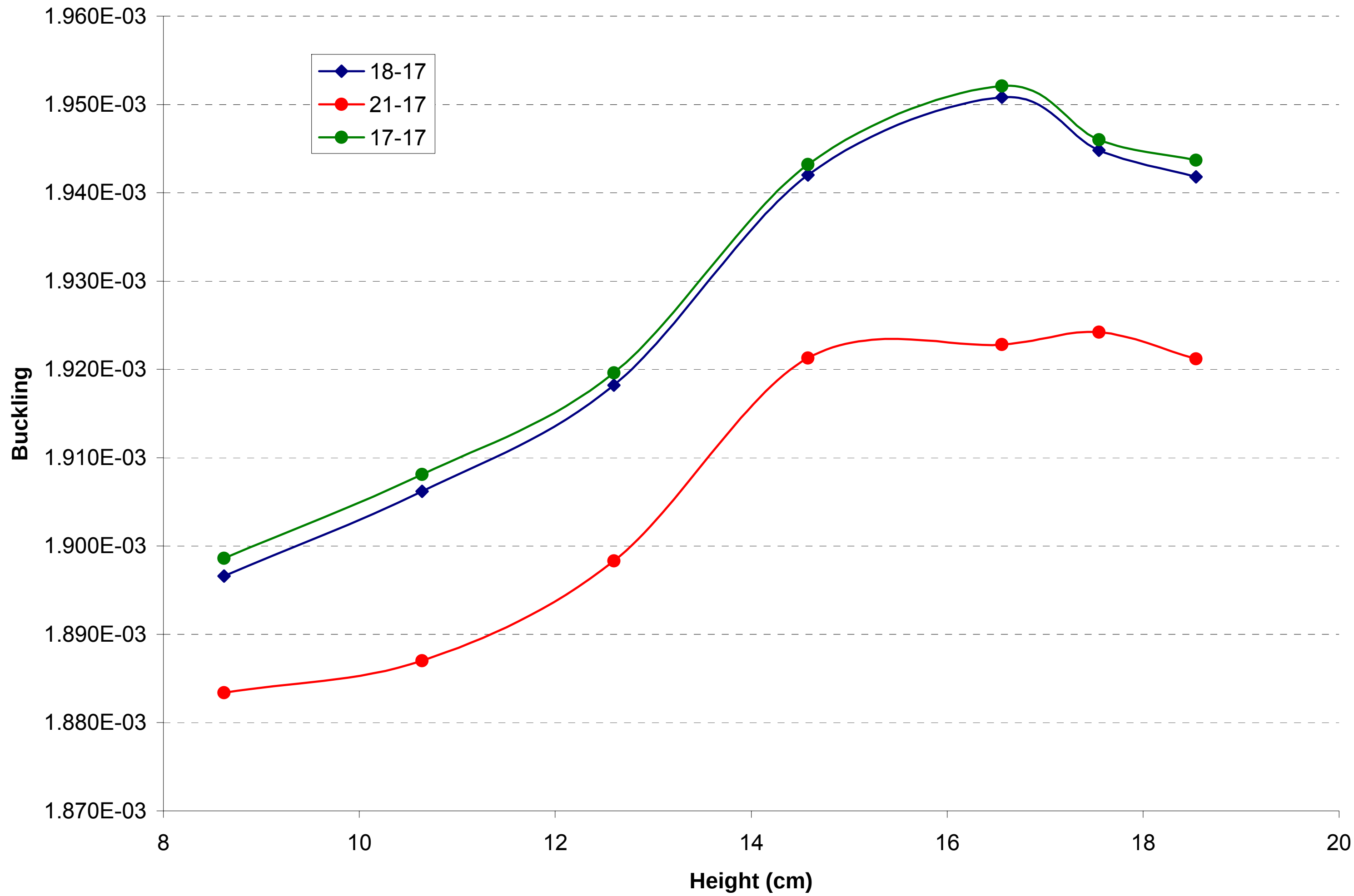


Figure 59: Buckling for the R1UO2 configuration calculated with data from REBUS within a limited range (± height from centerline)

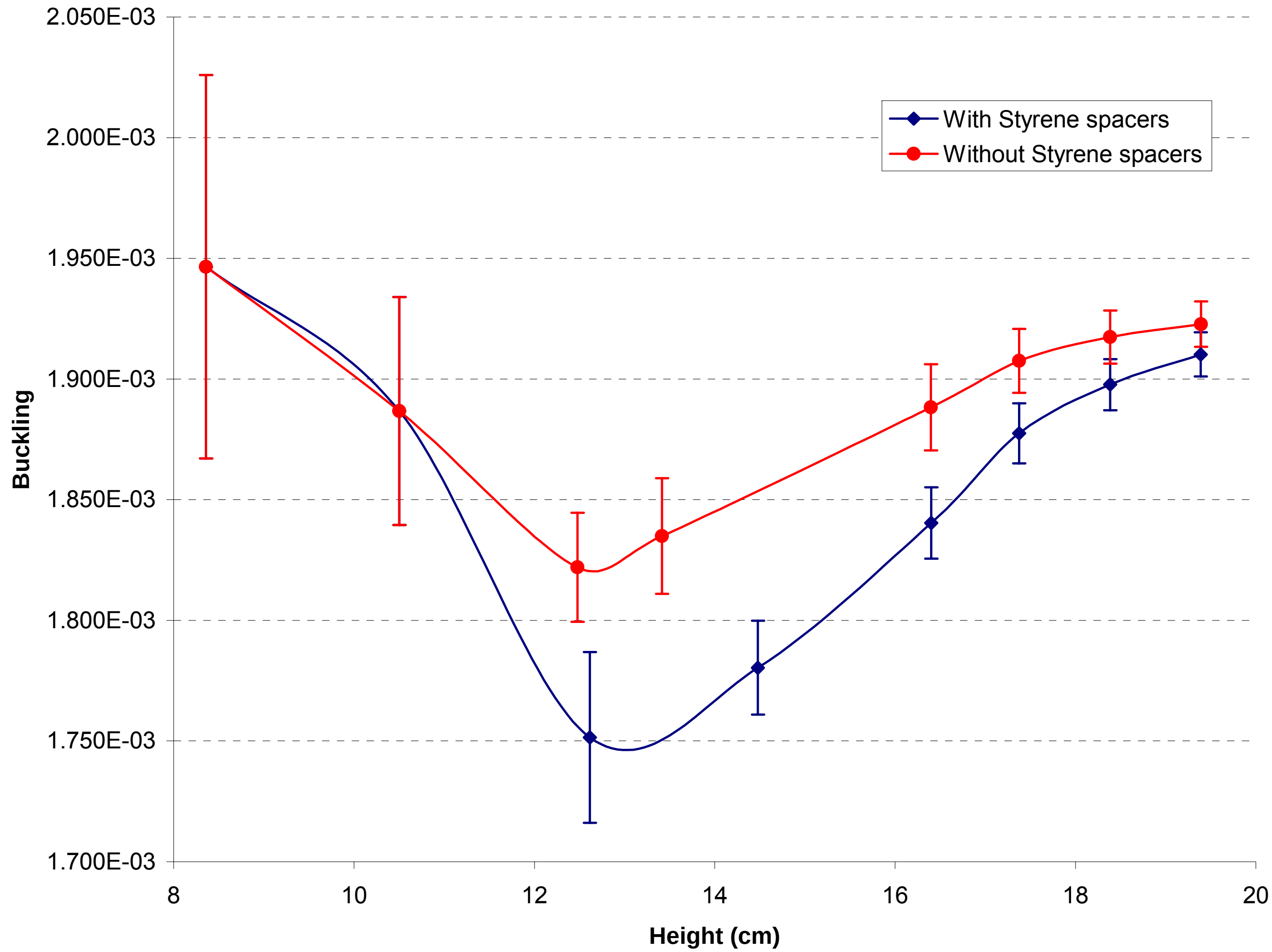


Figure 60: Buckling calculated from the fission rate profile measured by U-235 fission chamber in the R1UO2 configuration using data within a limited range (± height from centerline)

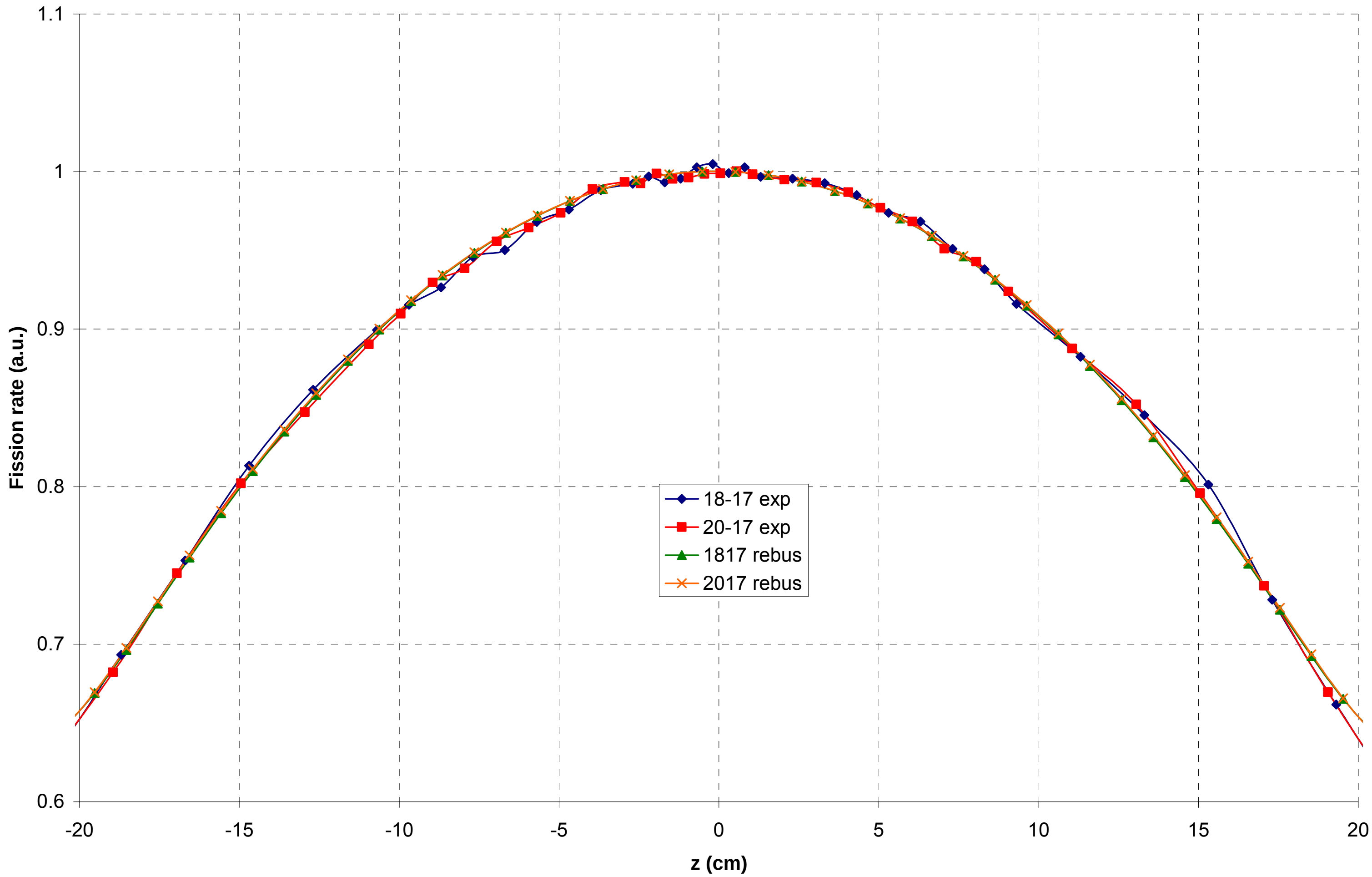


Figure 61: Axial power profile for specific pins in the R1MOX configuration – Comparison of REBUS results to measurements

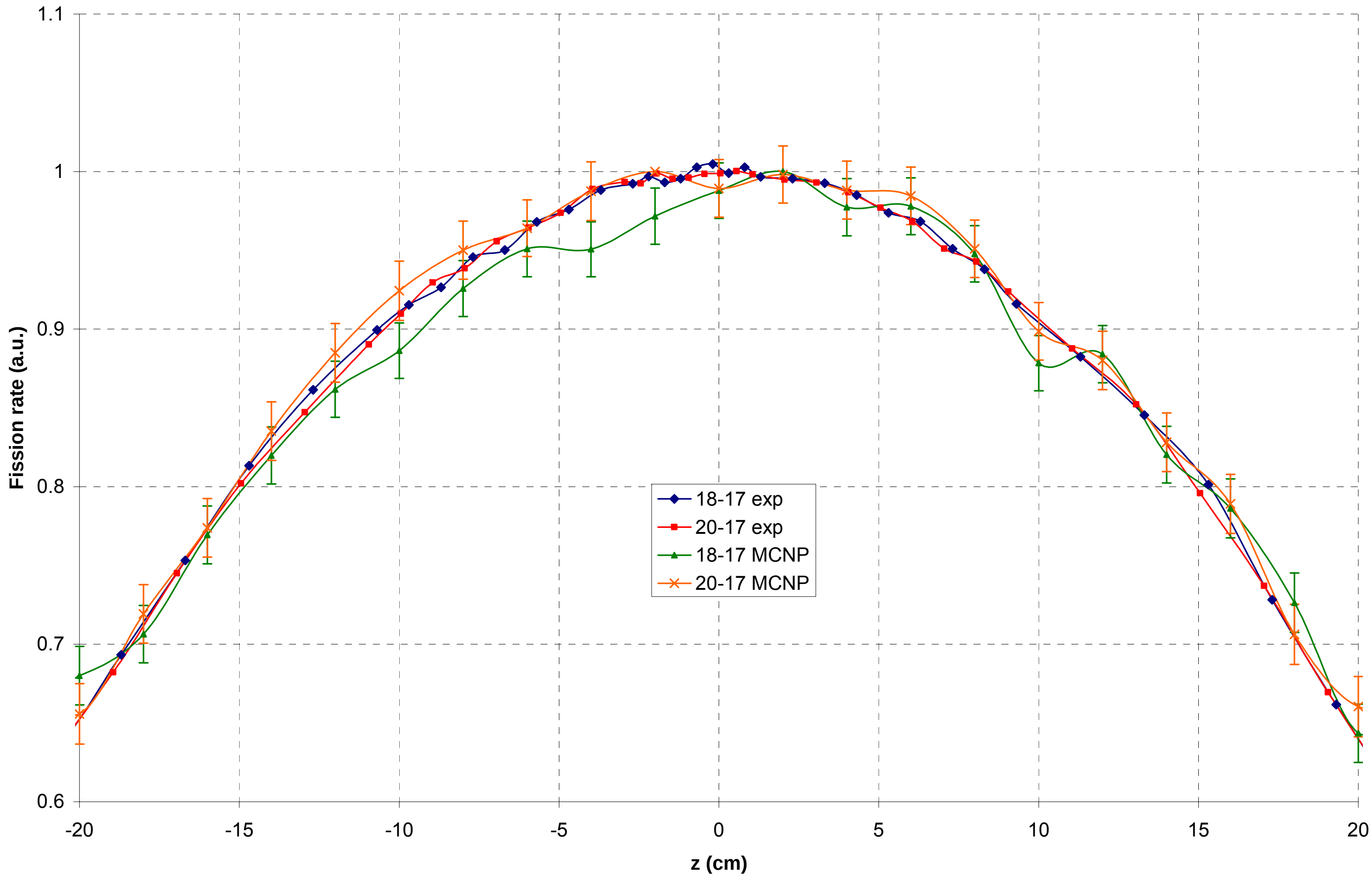


Figure 62: Axial power profile for specific pins in the R1MOX configuration – Comparison of MCNP results to measurements

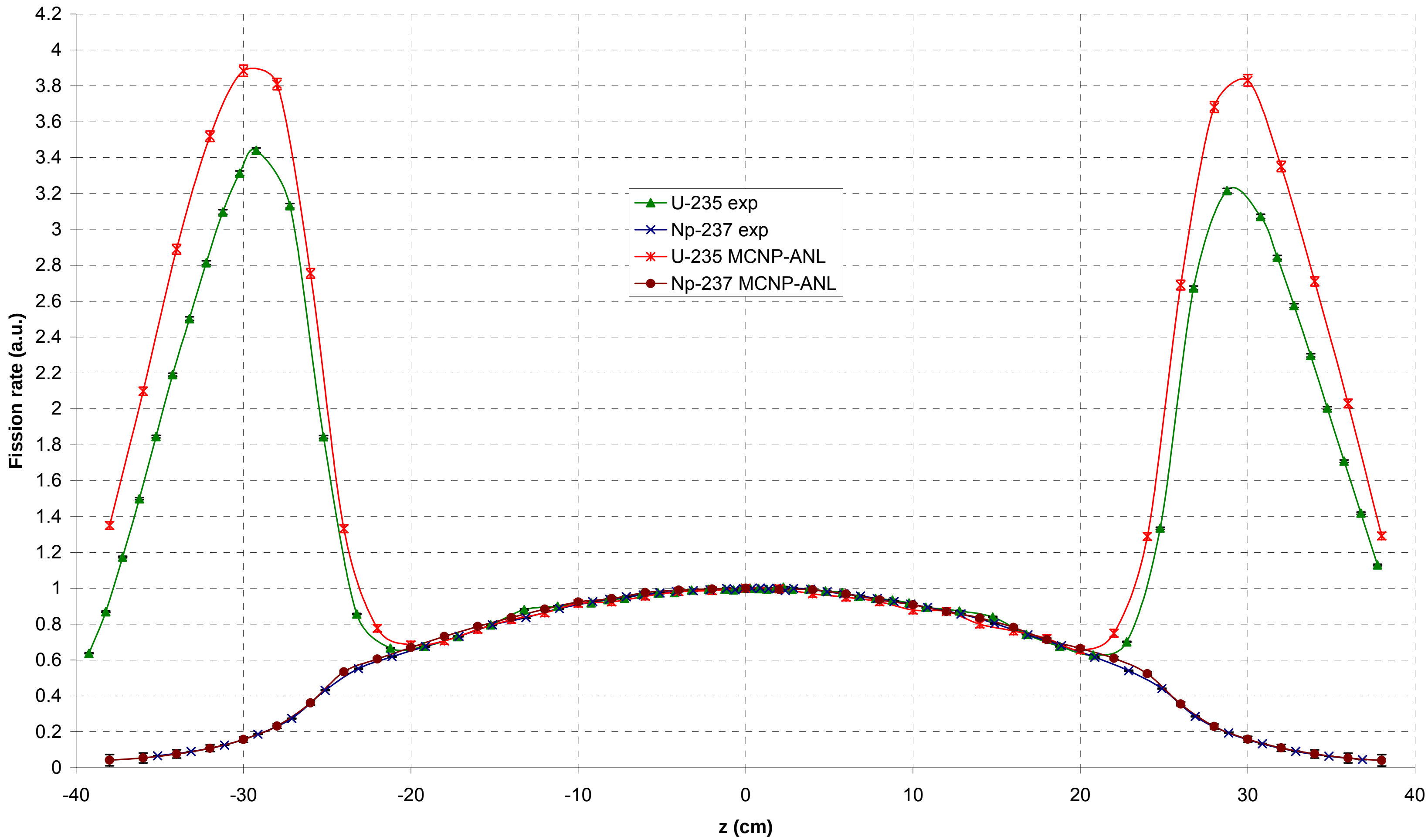


Figure 63: Axial fission rate profile of U-235 and Np-237 fission chambers in the R1MOX configuration – Comparison of MCNP results to measurements

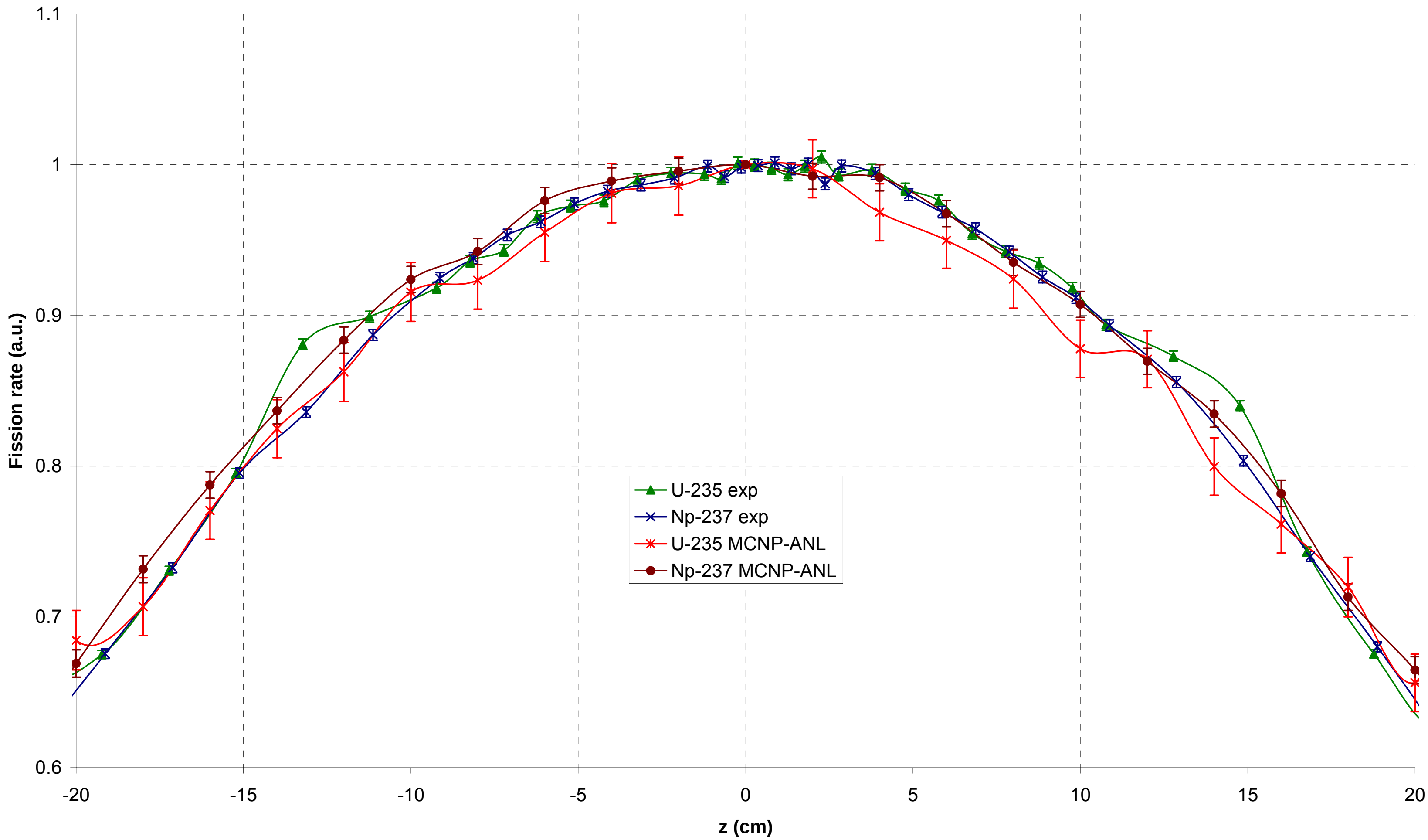


Figure 64: R1MOX Axial fission rate profile of U-235 and Np-237 fission chambers in the R1MOX configuration – Comparison of MCNP results to measurements over range of ±20 cm

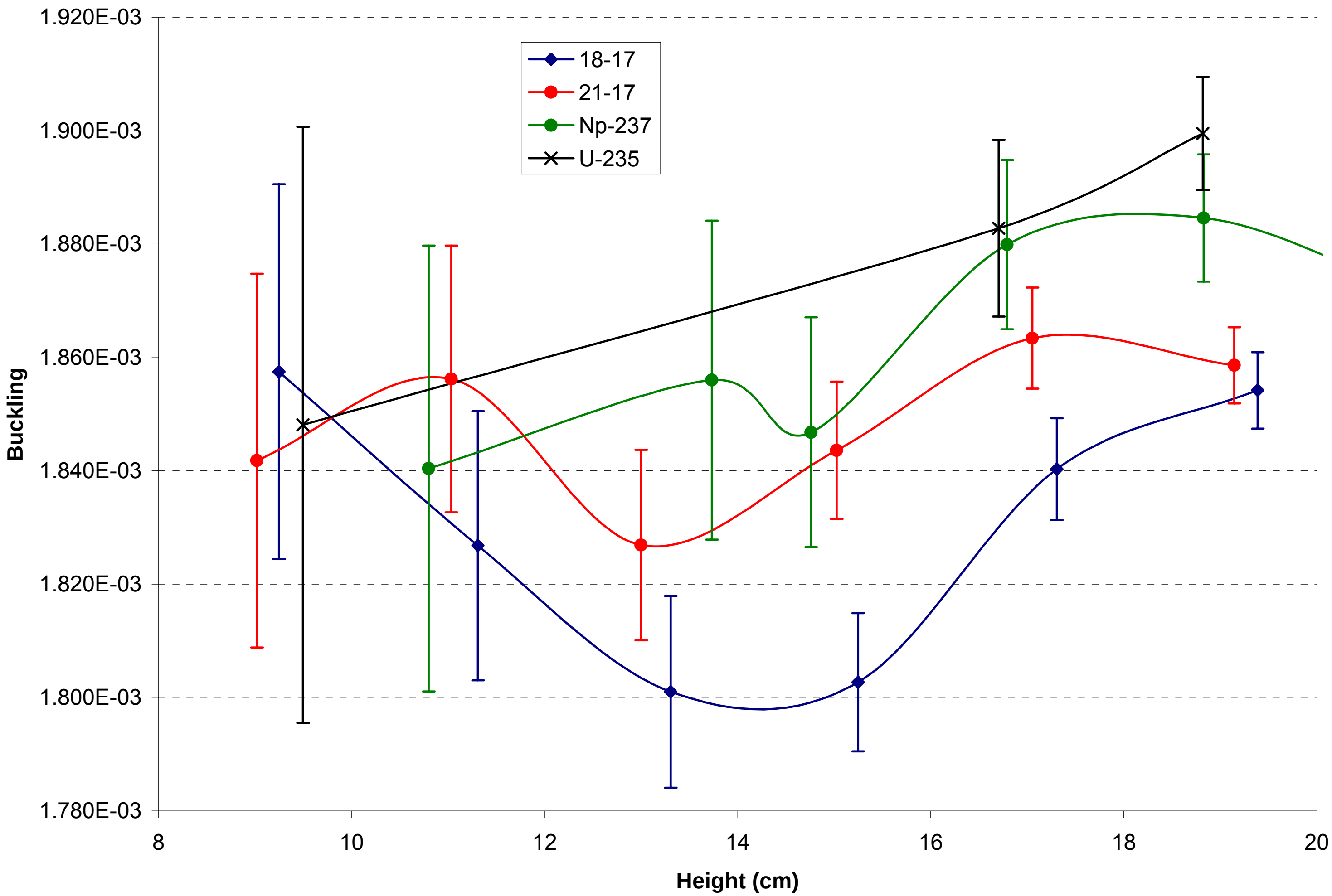


Figure 65: Buckling for the R1MOX configuration calculated with experimental data within a limited range (± height from centerline)

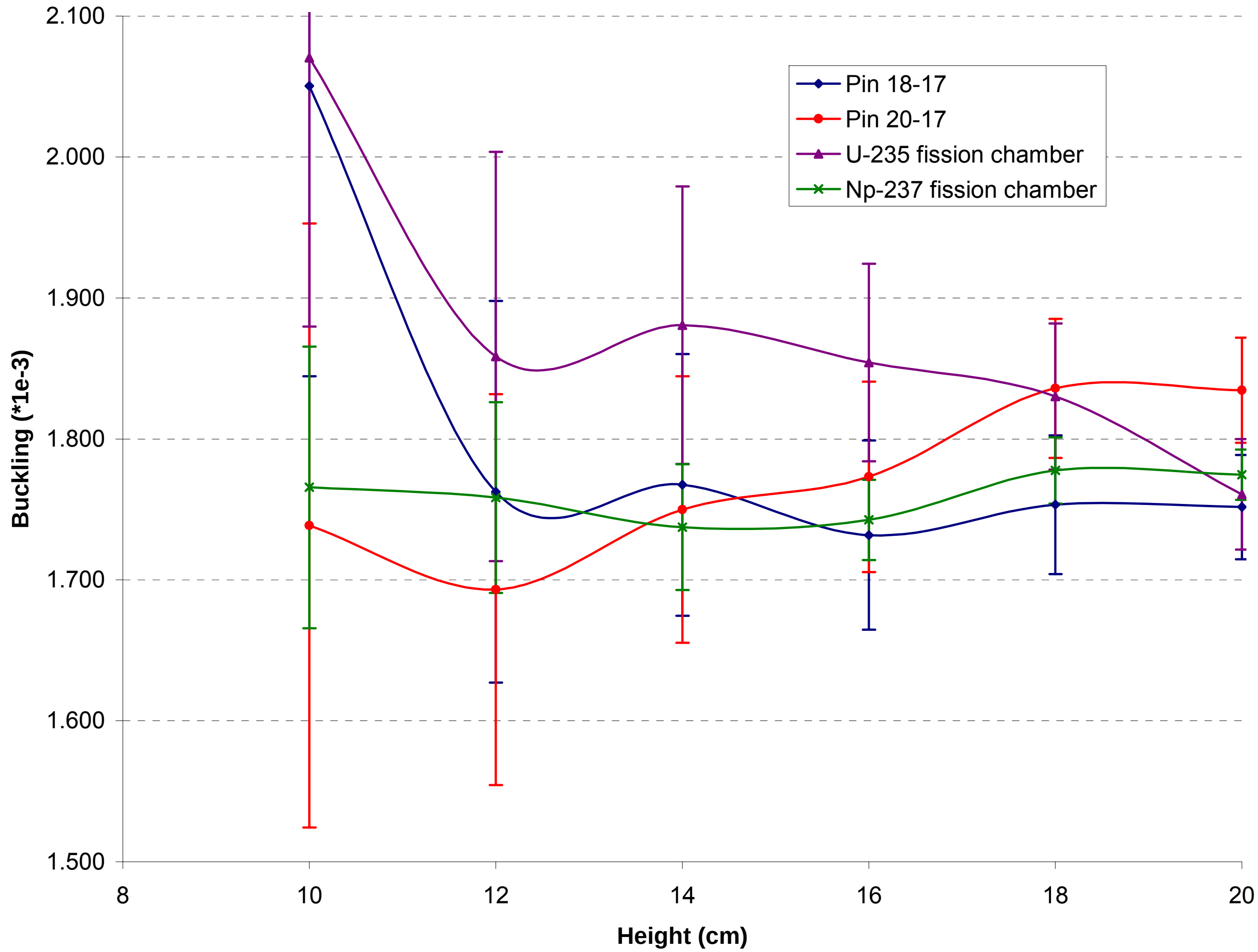


Figure 66: Buckling for the R1MOX configuration calculated with data from MCNP within a limited range (± height from centerline)

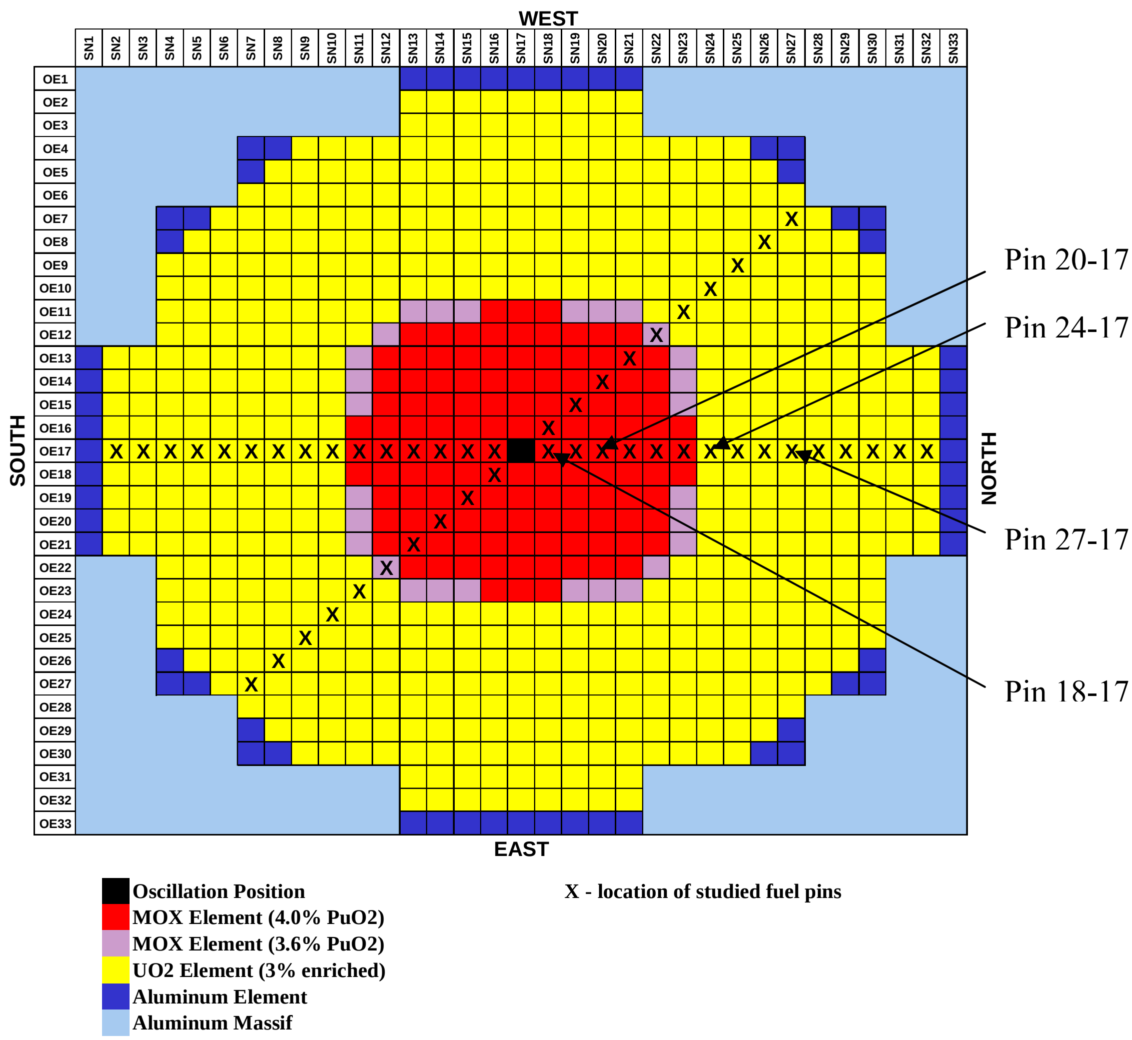


Figure 67: Location of the studied fuel pins for the radial power profile measurements in the R1MOX configuration

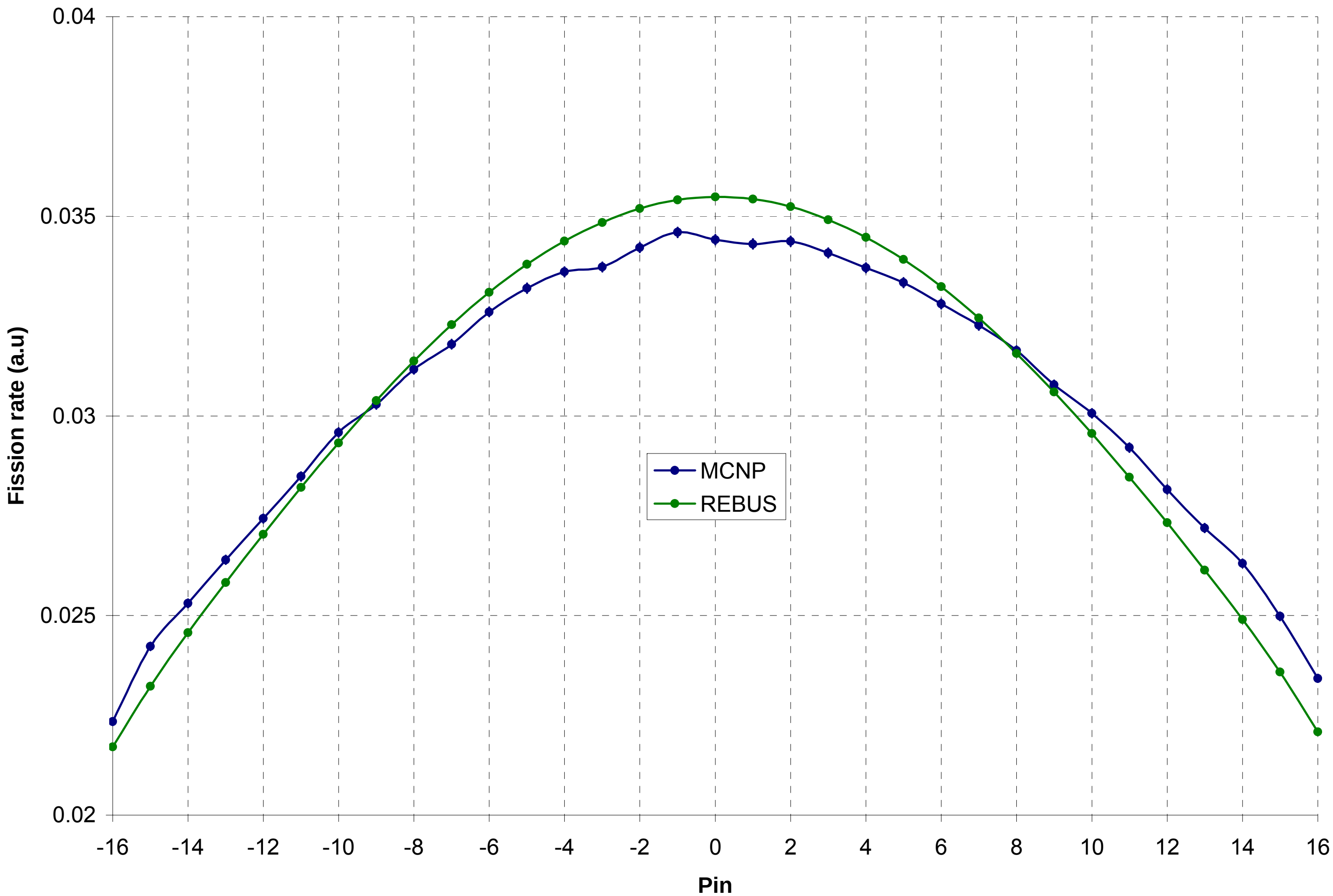


Figure 68: Fission rate distribution in the R1UO2 configuration for the S-N traverse

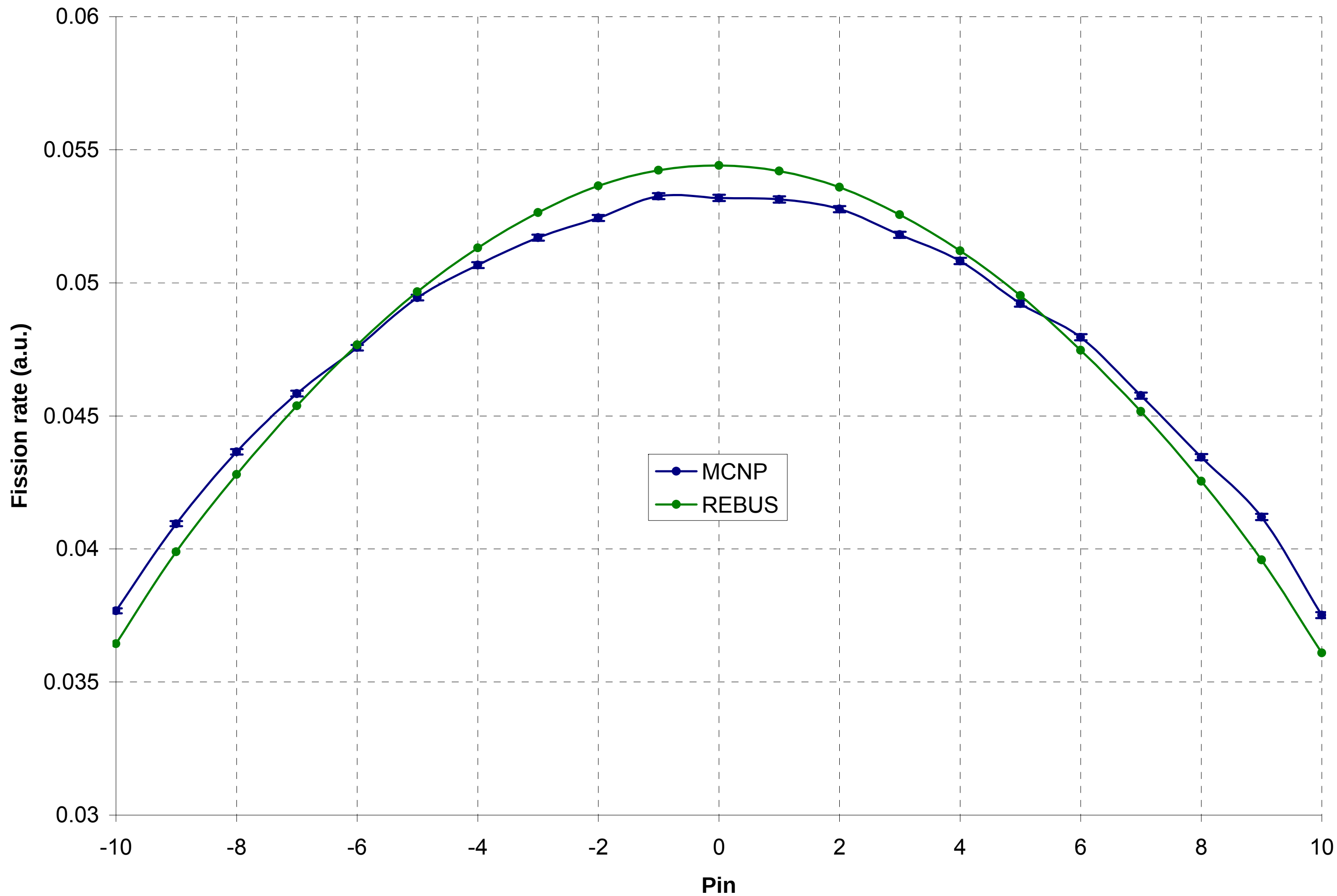


Figure 69: Fission rate distribution in the R1UO2 configuration for the SE-NW traverse

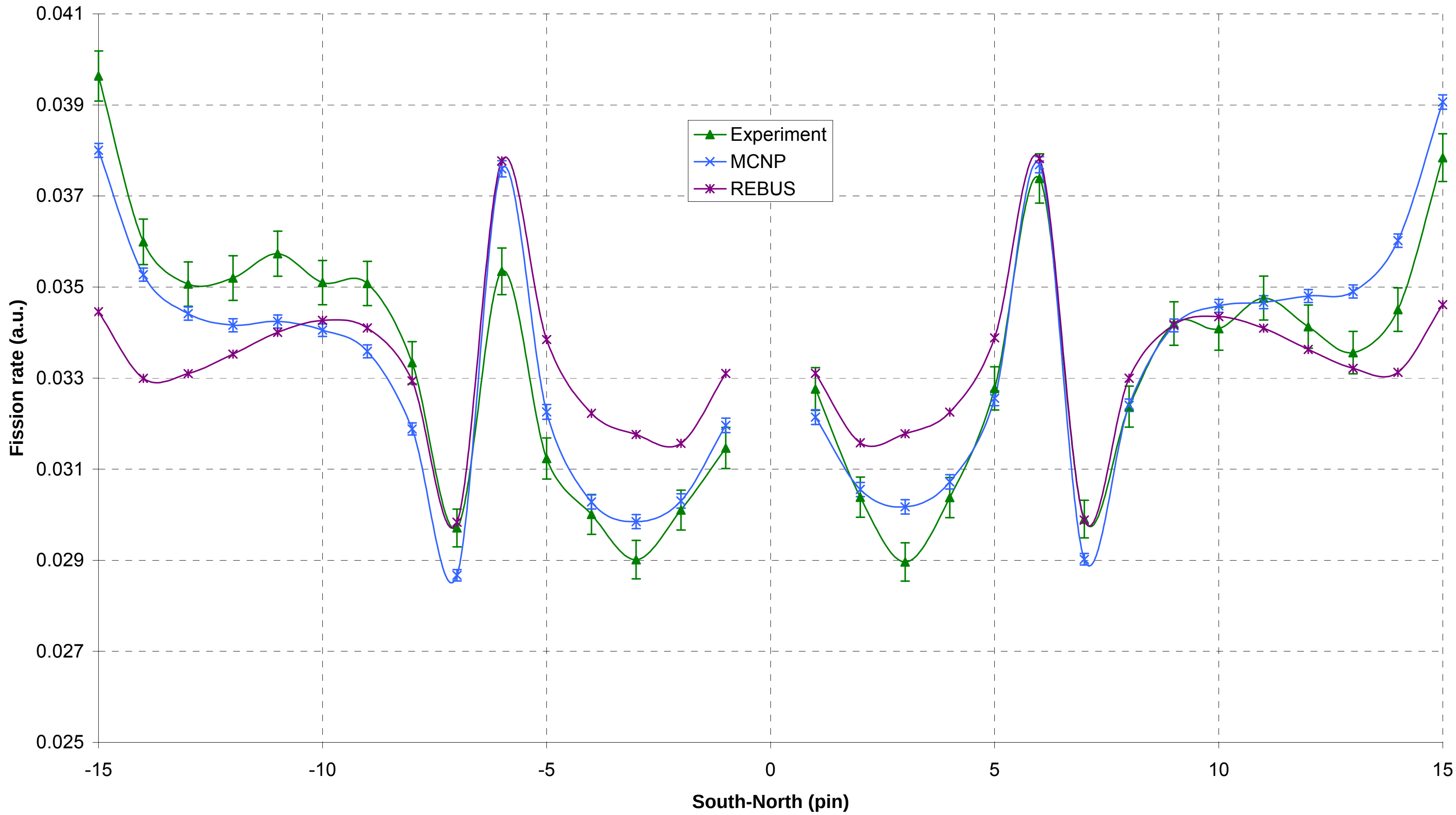


Figure 70: Fission rate distribution in the R1MOX configuration for the S-N traverse

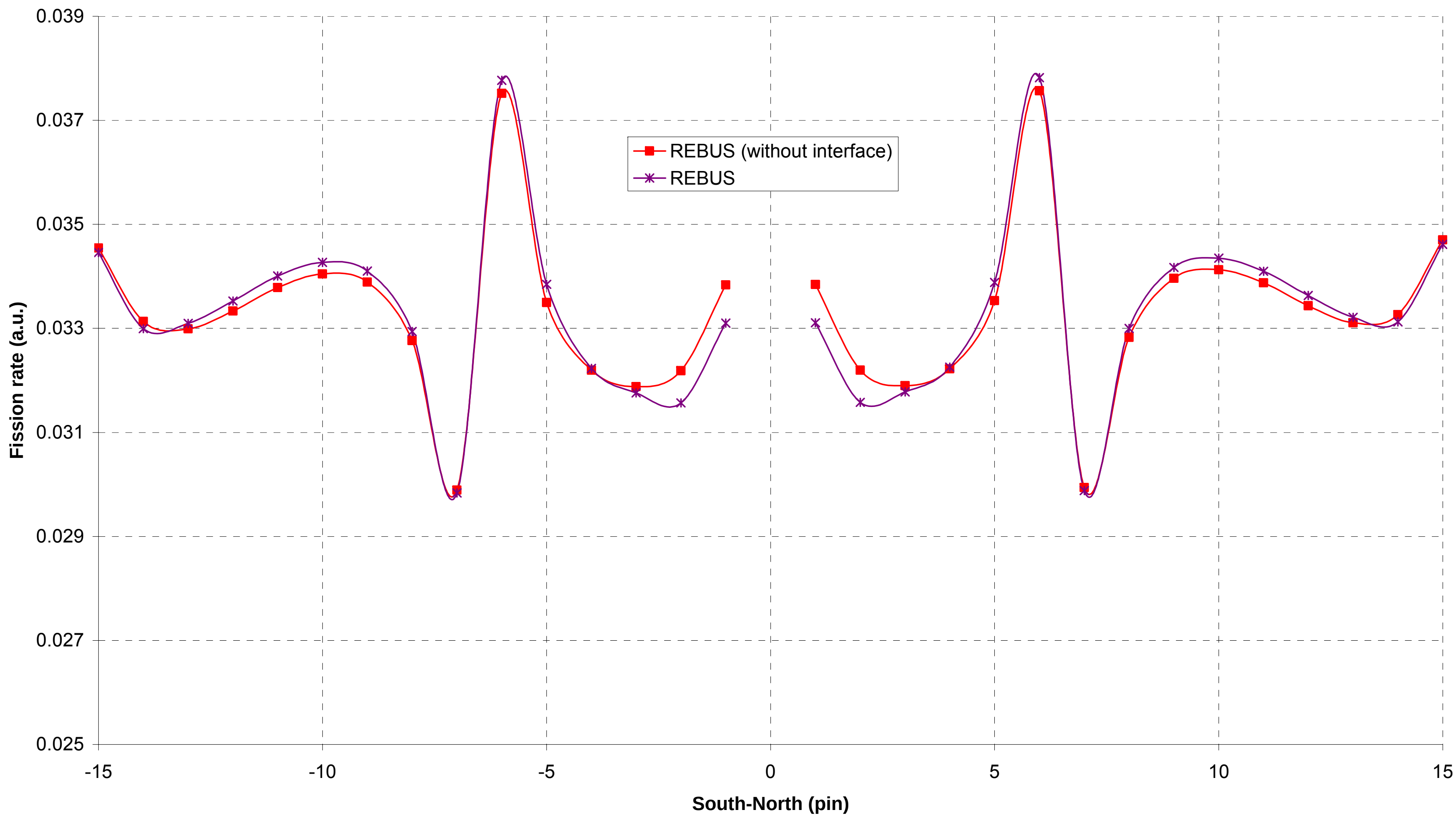


Figure 71: Fission rate distribution in the R1MOX configuration for the S-N traverse calculated with REBUS

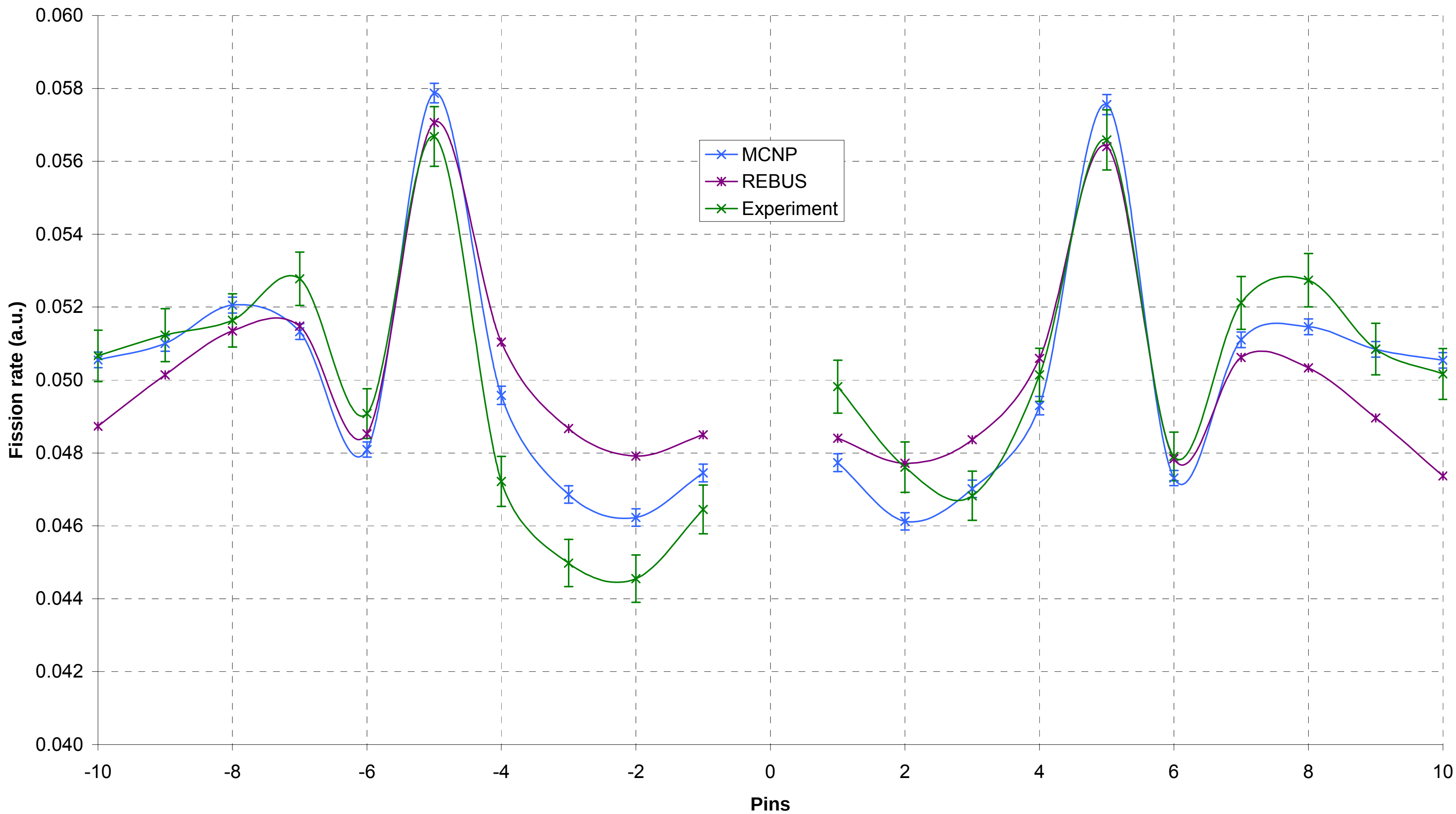
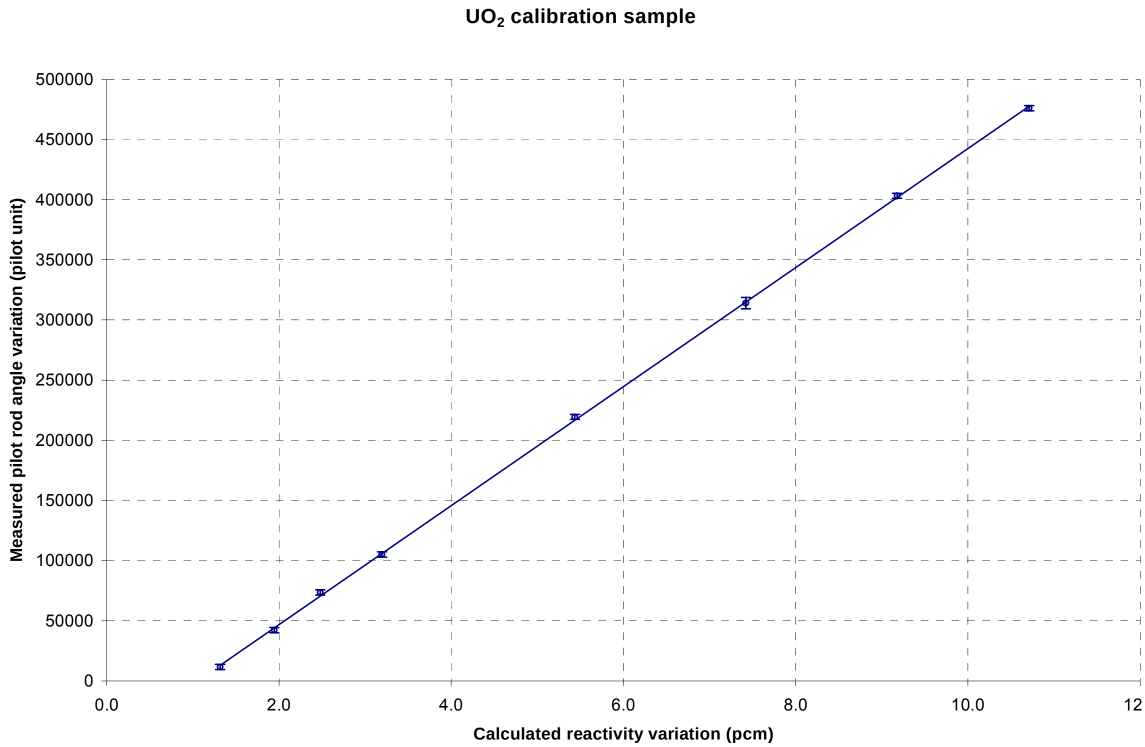


Figure 72: Fission rate distribution in the R1MOX configuration for the SE-NW traverse



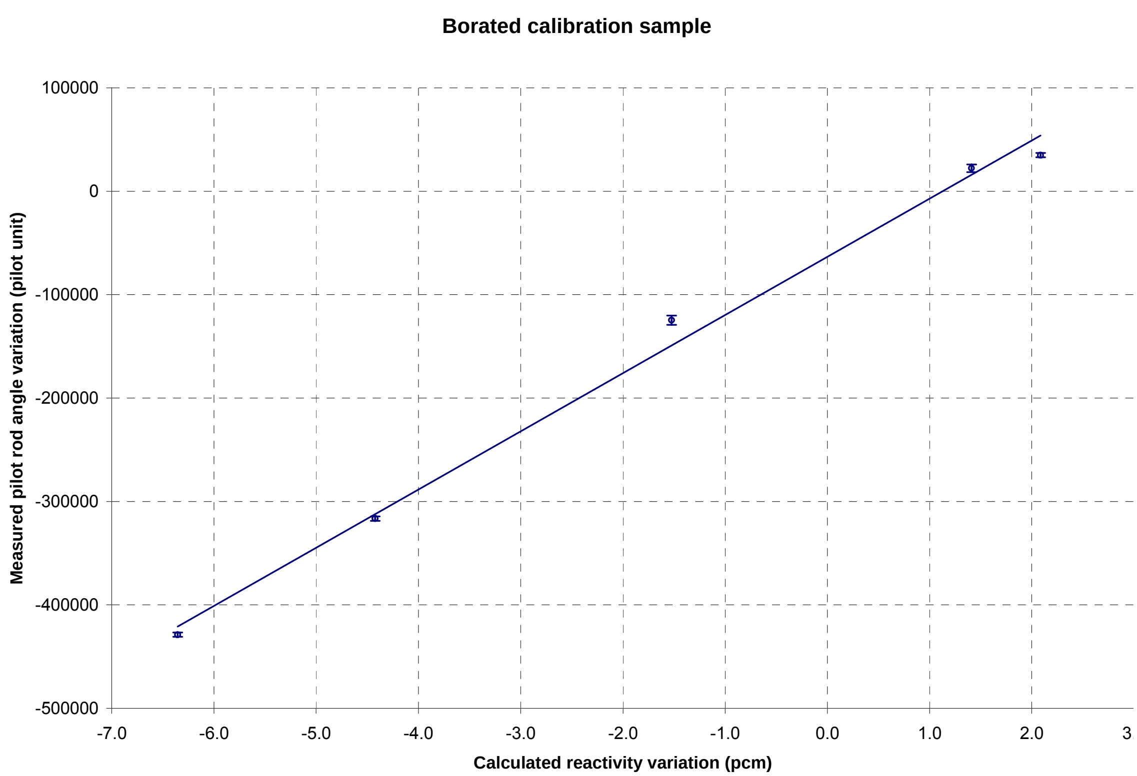
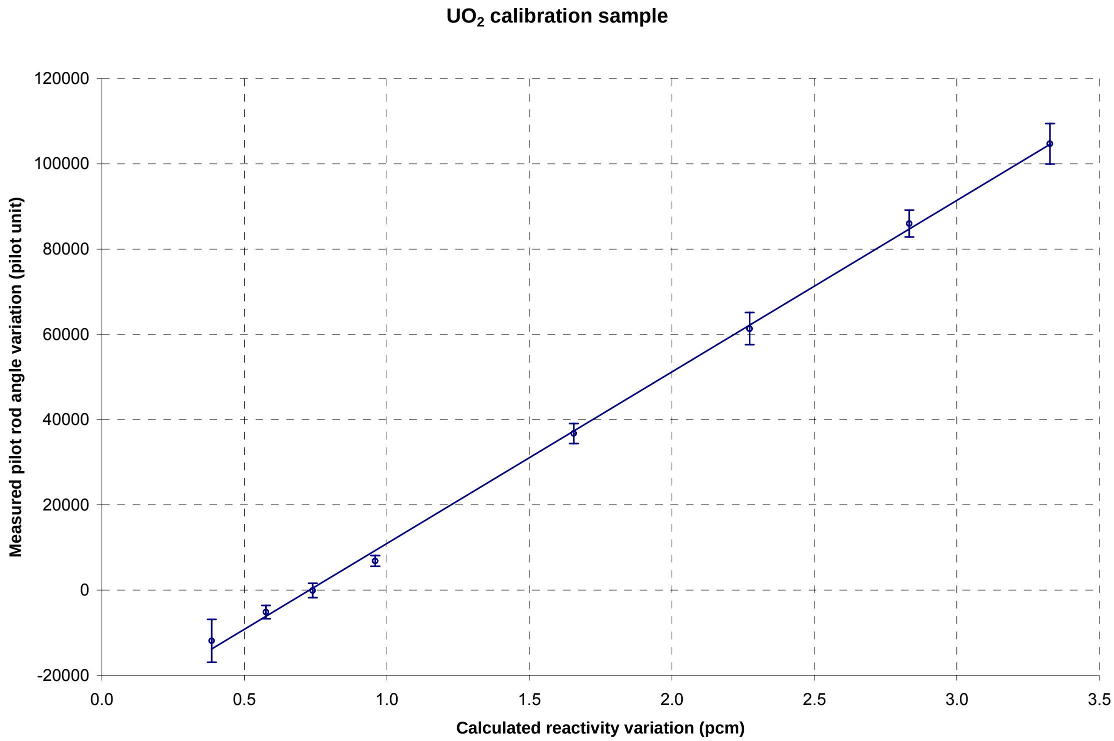


Figure 73: Experimental and calculated reactivity worth of the calibration samples in the R1UO2 configuration



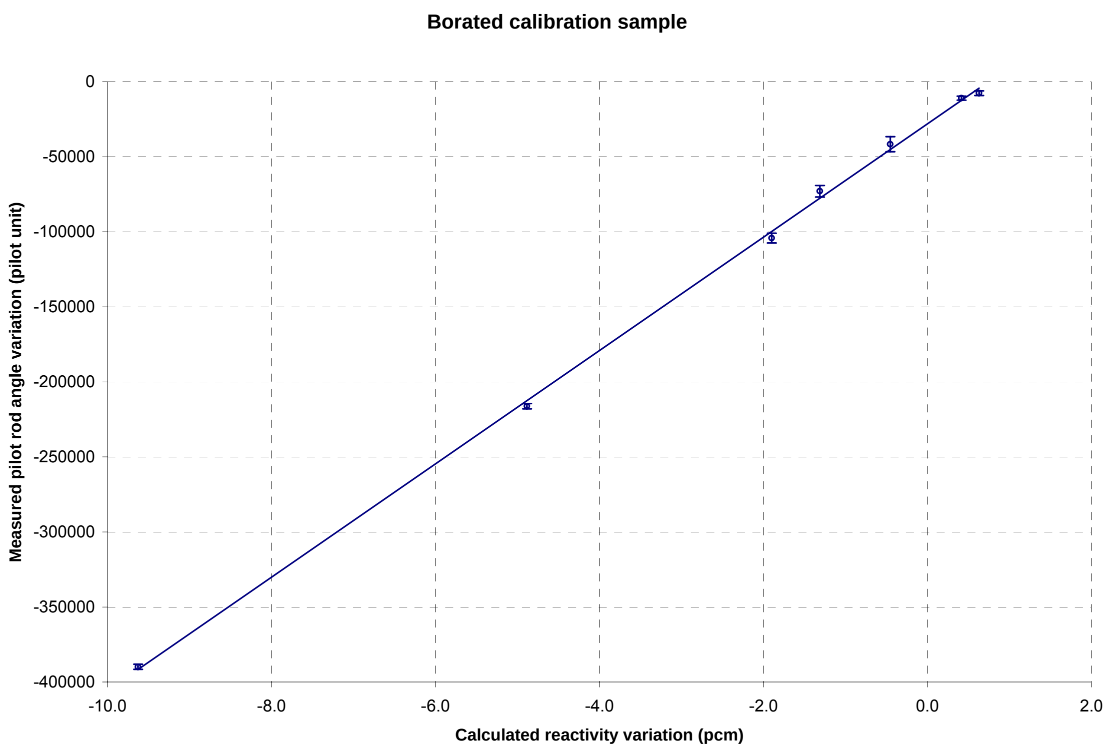


Figure 74: Experimental and calculated reactivity worth of the calibration samples in the R1MOX configuration

Appendix 1: MCNP input files

MCNP input files representative of the R1UO2 and R1MOX configuration are listed in this appendix. The listed files are:

- R1UO2 configuration with the POLINE overclad in the oscillation channel [UO2I]
- R1MOX configuration with the POLINE overclad in the oscillation channel [MOXI]

File UO2I

```
OSMOSE - R1-UO2 Lattice
c
c  R1-UO2 lattice of 3% UO2 pins
c  central channel = POLINE overclad
c  pitch = 1.26 cm
c
c
c **********************
c CELL DEFINITIONS
c **********************
c
1 0 1                                    imp:n=0    $Outside of tank
2 1 -0.99823  -1
              #3       $table
              4 6 8    $chimney
              10 11 13 14 16 17 19 20 $large graphite blocks
              30 31 32 33 40 41 42 43 $caissons & grid plates
              50 52 54 56 60 62       $medium & small graphite blocks
              110 120 130 140         $driver zones
              #150 151 152 153 154    $wedges & corner elt
              160                     $Start-up source 1
                                         imp:n=1    $Tank
3 30 6.463e-2 -2 4                       imp:n=1    $Table
4 3  -2.55    (-4 3) : (-6 5) : (-8 7)   imp:n=1    $Chimney
c
c Large Graphite blocks
10 31 9.197e-2 -10                       imp:n=1     $N LB caisson
11 3 -2.55     -11 12                    imp:n=1     $N LB clad
12 9 -1.7      -12                       imp:n=1     $N LB graphite
c
13 31 9.197e-2 -13                       imp:n=1     $S LB caisson
14 3 -2.55     -14 15                    imp:n=1     $S LB clad
15 9 -1.7      -15                       imp:n=1     $S LB graphite
c
16 31 9.197e-2 -16                       imp:n=1     $E LB caisson
17 3 -2.55     -17 18                    imp:n=1     $E LB clad
18 9 -1.7      -18                       imp:n=1     $E LB graphite
c
19 31 9.197e-2 -19                       imp:n=1     $W LB caisson
20 3 -2.55     -20 21                    imp:n=1     $W LB clad
21 9 -1.7      -21                       imp:n=1     $W LB graphite
c
c Caissons of the Driver Zone
30 31 9.197e-2 -30                       imp:n=1     $N DZ caisson
31 31 9.197e-2 -31                       imp:n=1     $S DZ caisson
32 31 9.197e-2 -32                       imp:n=1     $E DZ caisson
33 31 9.197e-2 -33                       imp:n=1     $W DZ caisson
c
c Grid plates of the Driver Zone
40 5 -2.705    -40                       imp:n=1     $N DZ grid plate
41 5 -2.705    -41                       imp:n=1     $S DZ grid plate
42 5 -2.705    -42                       imp:n=1     $E DZ grid plate
43 5 -2.705    -43                       imp:n=1     $W DZ grid plate
c
c Medium and Small Graphite blocks
50 3 -2.55    -50 51                     imp:n=1     $N MB clad
51 9 -1.7     -51                        imp:n=1     $N MB graphite
52 3 -2.55    -52 53                     imp:n=1     $S MB clad
53 9 -1.7     -53                        imp:n=1     $S MB graphite
54 3 -2.55    -54 55                     imp:n=1     $E MB clad
55 9 -1.7     -55                        imp:n=1     $E MB graphite
56 3 -2.55    -56 57                     imp:n=1     $W MB clad
57 9 -1.7     -57                        imp:n=1     $W MB graphite
60 3 -2.55    -60 61                     imp:n=1     $N SB clad
61 9 -1.7     -61                        imp:n=1     $N SB graphite
62 3 -2.55    -62 63                     imp:n=1     $S SB clad
63 9 -1.7     -63                        imp:n=1     $S SB graphite
c
c Driver Zone Elts
110   0 -110  fill=11 imp:n=1 $North Driver Zone
111   0 -100  lat=1 trcl=1 &
     fill 0:2 0:11 0:0 &
     25  25  28 &
     20  25  25 &
     20  25  25 &
     21  25  25 &
     22  21  25 &
     21  24  25 &
```

```
     20  25  27 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     u=11 imp:n=1 $North Driver Zone lattice
c
120   0 -120  fill=12 imp:n=1 $South Driver Zone
121   0 -100  lat=1 trcl=3 &
     fill 0:2 0:11 0:0 &
     25  25  25 &
     20  25  25 &
     20  25  25 &
     20  25  25 &
     21  25  25 &
     22  21  25 &
     21  24  25 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  29 &
     u=12 imp:n=1 $South Driver Zone lattice
c
130   0 -130  fill=13 imp:n=1 $East Driver Zone
131   0 -100  lat=1 trcl=5 &
     fill 0:2 0:11 0:0 &
     25  25  25 &
     20  26  25 &
     20  25  25 &
     21  23(6)  25 &
     22  21  25 &
     21  25  25 &
     20  25  25 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     u=13 imp:n=1 $East Driver Zone lattice
c
140   0 -140  fill=14 imp:n=1 $West Driver Zone
141   0 -100  lat=1 trcl=7 &
     fill 0:2 0:10 0:0 &
     25  25  25 &
     20  25  25 &
     20  25  25 &
     21  23(8) 25 &
     22  21  25 &
     21  25  25 &
     20  25  25 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     u=14 imp:n=1 $West Driver Zone lattice
c
c AG3 wedges (outside the chimney) and corner graphite elts
150 0        -150 fill=25   (168.895 168.7 0)   imp:n=1   $NW corner graphite elt
151 0        -151 fill=25   (102.605 168.7 0)   imp:n=1   $SW corner graphite elt
152 0        -152 fill=25   (102.605 102.8 0)   imp:n=1   $SE corner graphite elt
153 0        -153 fill=25   (168.895 102.8 0)   imp:n=1   $NE corner graphite elt
154 3 -2.55  -154 150 151 152 153 8      imp:n=1   $AG3 weges
c
c Start-up source 1
160 0        -160 fill=16                       imp:n=1   $Startup source close to the
South LGB
161 0        -100 lat=1 trcl=9 fill=29          imp:n=1 u=16
c
c
c
c
c Driver Elt - 18 plate 90% (N-S quadrant) - U=20 and 30 - Level 1 and 2
200 5 -2.705   202 -200                             u=20 imp:n=1 $Grid plate
201 3 -2.55    203 -202 201 -200                    u=20 imp:n=1 $Foot in the grid plate
202 1 -0.99823 (-202 -201):(-203 201 -200)          u=20 imp:n=1 $Water in the grid plate
203 1 -0.99823 -204 -203                            u=20 imp:n=1 $Water above the grid
plate
204 1 -0.99823 204 205 200                          u=20 imp:n=1 $Water above the grid
plate
```

```
205 3 -2.55    -204  203                            u=20 imp:n=1 $Foot above the grid
plate
206 0 -205 fill=30                                  u=20 imp:n=1 $Box for fuel plates
207 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 40 &
                                                    u=30 imp:n=1 $Lattice of cell filled
with u=41
c
c Driver Elt - 18 plate 93% (N-S quadrant) - U=21 and 31 - Level 1 and 2
210 like 200 but u=21
211 like 201 but u=21
212 like 202 but u=21
213 like 203 but u=21
214 like 204 but u=21
215 like 205 but u=21
216 0 -205 fill=31                                  u=21 imp:n=1 $Box for fuel plates
217 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 40 &
                                                    u=31 imp:n=1 $Lattice of cell filled
with u=42
c
c Driver Elt - Control Elt (N-S quadrant) with withdrawn rods - U=22 and 32 - Level 1 and
2
220 like 200 but u=22
221 like 201 but u=22
222 like 202 but u=22
223 like 203 but u=22
224 1 -0.99823 204 205 200 230 231                  u=22 imp:n=1 $Water above the grid
plate
225 like 205 but u=22
226 0 -205 fill=32                                  u=22 imp:n=1 $Box for fuel plates
227 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 42 42 43 44 43 42 42 42 42 42 42 42 42 43 44 43 42 42 40 &
                                                    u=32 imp:n=1
320 6  -7.85  -230 232                              u=22 imp:n=1 $Upper part of the
absorber plate #1 (clad)
321 13 -13.31 -232                                  u=22 imp:n=1 $Upper part of the
absorber plate #1 (hafnium)
322 6  -7.85  -231 233                              u=22 imp:n=1 $Upper part of the
absorber plate #2 (clad)
323 13 -13.31 -233                                  u=22 imp:n=1 $Upper part of the
absorber plate #2 (hafnium)
c
c Driver Elt - Control Elt (N-S quadrant) with inserted rods - U=52 and 62 - Level 1 and
2
520 like 220 but u=52
521 like 221 but u=52
522 like 222 but u=52
523 like 223 but u=52
524 like 224 but u=52
525 like 225 but u=52
526 0 -205 fill=62                                  u=52 imp:n=1 $Box for fuel plates
527 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 42 42 43 45 43 42 42 42 42 42 42 42 42 43 45 43 42 42 40 &
                                                    u=62 imp:n=1
530 6  -7.85  -230 234                              u=52 imp:n=1 $Upper part of the
absorber plate #1 (clad)
531 13 -13.31 -234                                  u=52 imp:n=1 $Upper part of the
absorber plate #1 (hafnium)
532 6  -7.85  -231 235                              u=52 imp:n=1 $Upper part of the
absorber plate #2 (clad)
533 13 -13.31 -235                                  u=52 imp:n=1 $Upper part of the
absorber plate #2 (hafnium)
c
c Driver Elt - 12 plate 90% (N-S quadrant) - U=23 and 33 - Level 1
230 like 200 but u=23
231 like 201 but u=23
232 like 202 but u=23
233 like 203 but u=23
234 like 204 but u=23
235 like 205 but u=23
236 0 -210 fill=33                                  u=23 imp:n=1 $Box for fuel plates
237 0 -300 lat=1 trcl=(0 -3.7604 0) &
    fill=0:0 -1:12 0:0 &
    40 41 41 41 41 41 41 41 41 41 41 41 41 40 &
                                                    u=33 imp:n=1 $Lattice of cell filled
with u=41
```

```
330 3 -2.55    -211 -401                              u=23 imp:n=1 $Al border plate next to
graphite block
331 3 -2.55    -211  402                              u=23 imp:n=1 $Al border plate next to
graphite block
332 3 -2.55    -212  213                              u=23 imp:n=1 $Graphite block (clad)
333 9 -1.7     -213                                   u=23 imp:n=1 $Graphite block
(graphite)
334 1 -0.99823 -211  212 401 -402                     u=23 imp:n=1 $Water around the
graphite block
c
c Driver Elt -  9 plate 90% (N-S quadrant) - U=24 and 34 - Level 1 and 2
240 like 200 but u=24
241 like 201 but u=24
242 like 202 but u=24
243 like 203 but u=24
244 like 204 but u=24
245 like 205 but u=24
246 0 -220 fill=34                                    u=24 imp:n=1 $Box for fuel plates
247 0 -300 lat=1 trcl=(0 -3.7604 0) &
    fill=0:0 -1:9 0:0 &
    40 41 41 41 41 41 41 41 41 41 40 &
                                                      u=34 imp:n=1 $Lattice of cell filled
with u=41
340 3 -2.55    -221 -401                              u=24 imp:n=1 $Al border plate next to
graphite block
341 3 -2.55    -221  402                              u=24 imp:n=1 $Al border plate next to
graphite block
342 3 -2.55    -222  223                              u=24 imp:n=1 $Graphite block (clad)
343 9 -1.7     -223                                   u=24 imp:n=1 $Graphite block
(graphite)
344 1 -0.99823 -221  222 401 -402                     u=24 imp:n=1 $Water around the
graphite block
c
c Graphite Elt (N-S quadrant) - U=25 - Level 1
250 5 -2.705   202 -200                               u=25 imp:n=1 $Grid plate
251 3 -2.55    250 -202 201 -200                      u=25 imp:n=1 $Foot in the grid plate
(AG3)
252 0          -250                                   u=25 imp:n=1 $Void channel
253 1 -0.99823 250 -202 -201                          u=25 imp:n=1 $Water in the grid plate
254 1 -0.99823 251 252 200                            u=25 imp:n=1 $Water above the grid
plate
255 3 -2.55    -251 250                               u=25 imp:n=1 $Foot above the grid
plate
256 3 -2.55    -252 253                               u=25 imp:n=1 $Graphite block (clad)
257 9 -1.7     -253                                   u=25 imp:n=1 $Graphite block
(graphite)
c
c Pilot rod Elt - U=26 - Level 1
260 like 250 but u=26
261 like 251 but u=26
262 like 252 but u=26
263 like 253 but u=26
264 1 -0.99823  251 265 200                           u=26 imp:n=1 $Water above the grid
plate
265 like 255 but u=26
266 0           -260                                  u=26 imp:n=1 $Void inside the rotor
267 38 5.570e-2 -261 260                              u=26 imp:n=1 $Rotor
268 0           -262 261                              u=26 imp:n=1 $Void inside the stator
269 39 5.615e-2 -263 262                              u=26 imp:n=1 $Stator
360 0           -264 263                              u=26 imp:n=1 $Void inside the AG3
liner
361 3 -2.55     -265 264                              u=26 imp:n=1 $AG3 liner
c
c Grahpite Elt for the detector - U=27 - Level 1
270 like 250 but u=27
271 like 251 but u=27
272 like 252 but u=27
273 like 253 but u=27
274 1 -0.99823  251 270 200                           u=27 imp:n=1 $Water above the grid
plate
275 like 255 but u=27
276 3 -2.55     -270 271 272                          u=27 imp:n=1 $Graphite block (clad)
277 9 -1.7      -271 273                              u=27 imp:n=1 $Graphite block
(graphite)
278 0           (-272:-273) 274                       u=27 imp:n=1 $Void
279 0           -274                                  u=27 imp:n=1 $Detector
c
c
c Semi thermal column - U=28 - Level 1
280 like 250 but u=28
281 like 251 but u=28
```

```
282 like 252 but u=28
283 like 253 but u=28
284 1 -0.99823 251 280 200                          u=28 imp:n=1 $Water above the grid
plate
285 like 255 but u=28
286 3 -2.55     -280 281                           u=28 imp:n=1 $Graphite block (clad)
287 9 -1.7      -281 283 286                       u=28 imp:n=1 $Graphite block (clad)
288 12 -0.9106  -281 -283 282                      u=28 imp:n=1 $PVC Tube 1
289 0           -281 -282 284                      u=28 imp:n=1 $Detector channel 1
380 0           -284                               u=28 imp:n=1 $Detector 1
381 12 -0.9106  -281 -286 285                      u=28 imp:n=1 $PVC Tube 2
382 0           -281 -285 287                      u=28 imp:n=1 $Detector channel 2
383 0           -287                               u=28 imp:n=1 $Detector 2
c
c Source holder - U=29 - Level 1
290 like 250 but u=29
291 like 251 but u=29
292 like 252 but u=29
293 like 253 but u=29
294 1 -0.99823 251 290 292 200                      u=29 imp:n=1 $Water above the grid
plate
295 like 255 but u=29
296 3 -2.55     -290                                u=29 imp:n=1 $Support
297 3 -2.55     -292 291                            u=29 imp:n=1 $AG-3 Tube
298 6 -7.85     -294 293                            u=29 imp:n=1 $Source support
299 0           -295                                u=29 imp:n=1 $Source
390 0           (-291 294 295) : -293               u=29 imp:n=1 $Void
c
c
c
c
c Border plate & water for the Driver Elts (N-S quadrant) - U=40 - Level 3
402 1 -0.99823   401 -402                          u=40 imp:n=1 $Water gap
403 3 -2.55     -401                               u=40 imp:n=1 $Border plate
404 3 -2.55      402                               u=40 imp:n=1 $Border plate
c
c 90% U-5 plate for the Driver Elt (N-S quadrant) - U=41 - Level 3
410 20 5.985e-2 -404                               u=41 imp:n=1 $Fuel meat
411 2  6.026e-2  404 -403                          u=41 imp:n=1 $Fuel clad
412 1 -0.99823   401 -402 403                      u=41 imp:n=1 $Water gap
413 3 -2.55     -401  403                          u=41 imp:n=1 $Border plate
414 3 -2.55      402  403                          u=41 imp:n=1 $Border plate
c
c 93% U-5 plate for the Driver Elt (N-S quadrant) - U=42 - Level 3
420 21 5.973e-2 -404                               u=42 imp:n=1 $Fuel meat
421 like 411 but u=42
422 like 412 but u=42
423 like 413 but u=42
424 like 414 but u=42
c
c Al plate for the Driver Elt (N-S quadrant) - U=43 - Level 3
431 2  6.026e-2  -403                              u=43 imp:n=1 $Inertial Al plate
432 like 412 but u=43
433 like 413 but u=43
434 like 414 but u=43
c
c Absorber plate for the Driver Elt (N-S quadrant) - Withdrawn - U=44 - Level 3
440 13 -13.31    -406                              u=44 imp:n=1 $Hafnium rod withdrawn
(hafnium)
441 6 -7.85      -405 406                          u=44 imp:n=1 $Hafnium rod withdrawn
(clad)
447 40 9.354e-2  -409                              u=44 imp:n=1 $Hafnium rod withdrawn
(bevel)
442 1 -0.99823   405 401 -402 409                  u=44 imp:n=1 $Water gap
445 1 -0.99823   -401 -403                         u=44 imp:n=1 $Water gap
446 1 -0.99823   402 -403                          u=44 imp:n=1 $Water gap
443 like 413 but u=44
444 like 414 but u=44
c
c Absorber plate for the Driver Elt (N-S quadrant) - Inserted - U=45 - Level 3
450 13 -13.31    -408                              u=45 imp:n=1 $Hafnium rod inserted of
60cm in the fuel plates (hafnium)
451 6 -7.85      -407 408                          u=45 imp:n=1 $Hafnium rod inserted of
60cm in the fuel plates (clad)
457 40 9.354e-2  -410                              u=45 imp:n=1 $Hafnium rod inserted of
60cm in the fuel plates (bevel)
452 1 -0.99823   407 401 -402 410                  u=45 imp:n=1 $Water gap
455 1 -0.99823   -401 -403                         u=45 imp:n=1 $Water gap
456 1 -0.99823   402 -403                          u=45 imp:n=1 $Water gap
453 like 413 but u=45
454 like 414 but u=45
```

```
c
c
c EXPERIMENTAL ZONE
c
500  6  -7.85    -500 505                          imp:n=1 $Spool (upper portion)
501  6  -7.85    -501 505                          imp:n=1 $Massif lower SS plate
502  3  -2.55    -502 (510 511 512 513)            imp:n=1 $Massif AG3 blocks
503  6  -7.85    -503 (510 511 512 513)            imp:n=1 $Massif upper SS plate
c 504  3  -2.55    -504                              imp:n=1 $Upper protection plate
c 505  1  -0.99823 (-3 : -5 : -7)
c                  #500 #501 #502 #503 #504
c                  (510 511 512 513)                 imp:n=1 $Water in the chimney
c
c c To activate for the POLINE overclad (upper part)
504  3  -2.55    -504 506                          imp:n=1 $Upper protection plate
505  1  -0.99823 (-3 : -5 : -7)
                 #500 #501 #502 #503 #504 #506 #507
                 (510 511 512 513)                 imp:n=1 $Water in the chimney
506 4   -2.75     -506 507                         imp:n=1 $AW-2017 overclad
507 0             -507                             imp:n=1 $Inside Void
c
c
510  0  (-510:-511:-512:-513) fill=1               imp:n=1 $Experimental lattice box
511  0 -600 lat=1 trcl=(135.75 135.75 0) &
   fill -16:16 -16:16 0:0 &
   1 1 1 1 1 1 1 1 1 1 1 1 5 5 2 2 2 2 2 5 5 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 1 1 1 &
   1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 &
   1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 &
   1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 &
   2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 &
   2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 &
   2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 6 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 & $central row
   2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 &
   2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 &
   5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 &
   1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 &
   1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 &
   1 1 1 1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 5 5 2 2 2 2 2 5 5 1 1 1 1 1 1 1 1 1 1 1 1 &
   u=1  imp:n=1  $Experimental lattice
c
c UO2 fuel pin (U-235 3% wt.) - U=2 - Level 1
620  22  6.917e-2  -620                            u=-2 imp:n=1 $Fuel pellets
621  10  -1.18     -621                            u=-2 imp:n=1 $Plexiglas spacer
(lower)
622  10  -1.18     -622                            u=-2 imp:n=1 $Plexiglas spacer
(upper)
623   6  -7.85     -623                            u=-2 imp:n=1 $SS spacer (lower)
624   6  -7.85     -624                            u=-2 imp:n=1 $SS spacer (upper)
625   0            -625 620 621 622 623 624        u=-2 imp:n=1 $Void inside the clad
626   7  -6.56     -626 625                        u=-2 imp:n=1 $Zr4 clad
627  32  6.468e-2  -627                            u=-2 imp:n=1 $Lower end plug (Zr4 +
water)
628  33  4.742e-2  -628                            u=-2 imp:n=1 $Upper end plug (Zr4 +
SS)
629  34  9.503e-2  -629                            u=-2 imp:n=1 $Gripping head (SS +
water)
720  3   -2.55     -610 611                        u=2 imp:n=1 $Lower grid plate
721  3   -2.55     -613 612                        u=2 imp:n=1 $Overclad
722  3   -2.55     -614 615                        u=2 imp:n=1 $Upper grid plate
723  1   -0.99823   626 627 628 629
                    #720 #721 #722                 u=2 imp:n=1 $Water
```

```
c
c PuO2-UO2 fuel pin (PuO2 3.6% wt.) - U=3 - Level 1
630  23  6.861e-2  -630                         u=-3 imp:n=1 $Fuel pellets
631  10  -1.18     -631                         u=-3 imp:n=1 $Plexiglas spacer
(lower)
632  10  -1.18     -622                         u=-3 imp:n=1 $Plexiglas spacer
(upper)
633  6   -7.85     -633                         u=-3 imp:n=1 $SS spacer(upper)
634  0             -634 630 631 622 633         u=-3 imp:n=1 $Void inside the inner
clad
635  8   -6.56     -635 634                     u=-3 imp:n=1 $Zr2 Inner clad
636  8   -6.56     -636                         u=-3 imp:n=1 $Lower end plug of the
inner clad
637  8   -6.56     -637                         u=-3 imp:n=1 $Upper end plug of the
inner clad
638  6   -7.85     -638                         u=-3 imp:n=1 $SS Foot wedge
639  6   -7.85     -639                         u=-3 imp:n=1 $SS Inside joint
730  11  -1.15     -730 639                     u=-3 imp:n=1 $Joint
731  6   -7.85     -731                         u=-3 imp:n=1 $Foot A (SS)
732  0             -732 635 636 637 638 639
                     730 731                    u=-3 imp:n=1 $Void inside the outter
clad
733  8   -6.56     -733 732                     u=-3 imp:n=1 $Zr2 Outter clad
734  35  9.100e-2  -734                         u=-3 imp:n=1 $Lower end plug of the
outter clad (SS + water)
735  36  4.738e-2  -735                         u=-3 imp:n=1 $Upper end plug of the
outter clad (Zr2 + SS)
736  34  9.503e-2  -736                         u=-3 imp:n=1 $Gripping head
830 like 720 but u=3
831 like 721 but u=3
832 like 722 but u=3
833  1   -0.99823   733 734 735 736
                     #830 #831 #832             u=3 imp:n=1 $Water
c
c PuO2-UO2 fuel pin (PuO2 4.0% wt.) - U=4 - Level 1
640  24  6.860e-2  -630                         u=-4 imp:n=1 $Fuel pellets
641 like 631 but u=-4
642 like 632 but u=-4
643 like 633 but u=-4
644 like 634 but u=-4
645 like 635 but u=-4
646 like 636 but u=-4
647 like 637 but u=-4
648 like 638 but u=-4
649 like 639 but u=-4
740 like 730 but u=-4
741 like 731 but u=-4
742 like 732 but u=-4
743 like 733 but u=-4
744 like 734 but u=-4
745 like 735 but u=-4
746 like 736 but u=-4
840 like 830 but u=4
841 like 831 but u=4
842 like 832 but u=4
843 like 833 but u=4
c
c Al fuel pin - U=5 - Level 1
650  3   -2.55     -650                         u=-5 imp:n=1 $Al pin
651  37  7.925e-2  -651                         u=-5 imp:n=1 $Gripping head
750 like 720 but u=5
751 like 721 but u=5
752 like 722 but u=5
753 1   -0.99823   650 651 #750 #751 #752       u=5 imp:n=1 $Water
c
c POLINE cell - U=6 - Level 1
660 4   -2.75     -660 661                      u=6 imp:n=1 $AW-2017 overclad
661 0             -661 662                      u=6 imp:n=1 $Inside Void
662 0             -662                          u=6 imp:n=1 $Detector volume
663 1   -0.99823  660                           u=6 imp:n=1 $Water

c *********************
c BOUNDARY DEFINITIONS
c *********************
c General
1 rpp 0 271.5 0 271.5 0 220                 $Reactor tank
2 rpp 30.07 241.43 30.07 241.03 0 22.1      $Table
c
c Chimney
3 rcc 135.75 135.75 0      0 0 27.0    21.5           $Lower chimney ID
4 rcc 135.75 135.75 0      0 0 27.0    22.5           $Lower chimney OD
```

```
5 rcc 135.75 135.75 27.0   0 0 3.8     21.5           $Intr. chimney ID
6 rcc 135.75 135.75 27.0   0 0 3.8     36.75          $Intr. chimney OD
7 rcc 135.75 135.75 30.8   0 0 189.2   35.75          $Upper chimney ID
8 rcc 135.75 135.75 30.8   0 0 189.2   36.75          $Upper chimney OD
c
c Large graphite blocks and their caissons
10 rpp 195.88 241.43  98.75 191.30  22.10 73.40       $N large block (caisson)
11 rpp 195.88 241.43  98.75 191.30  73.40 154.40      $N large block (clad)
12 rpp 196.155 241.155 99.025 191.025 78.90 148.90    $N large block (graphite)
c
13 rpp 30.07 75.62 80.20 172.75     22.10 73.40       $S large block (caisson)
14 rpp 30.07 75.62 80.20 172.75     73.40 154.40      $S large block (clad)
15 rpp 30.345 75.345 80.475 172.475   78.90 148.90    $S large block (graphite)
c
16 rpp  98.75 191.30  30.07  75.62  22.10 73.40       $E large block (caisson)
17 rpp  98.75 191.30  30.07  75.62  73.40 154.40      $E large block (clad)
18 rpp 99.025 191.025 30.345 75.345 78.90 148.90      $E large block (graphite)
c
19 rpp  80.20 172.75 195.88 241.43  22.10 73.40       $W large block (caisson)
20 rpp  80.20 172.75 195.88 241.43  73.40 154.40      $W large block (clad)
21 rpp 80.475 172.475 196.155 241.155 78.90 148.90    $W large block (graphite)
c
c Caissons of the Driver Zone
30 rpp 172.75 195.88  98.75 236.45 22.1 62.4          $N caisson
31 rpp  75.62  98.75  35.05 172.75 22.1 62.4          $S caisson
32 rpp  98.75 236.45  75.62  98.75 22.1 62.4          $E caisson
33 rpp  35.05 172.75 172.75 195.88 22.1 62.4          $W caisson
c
c Grid plates of the Driver Zone (w.o. elt with foot)
40 rpp 172.75 195.88 187.85 236.45 62.4 78.4          $N grid plate
41 rpp  75.62  98.75  35.05  75.55 62.4 78.4          $S grid plate
42 rpp 187.85 236.45  75.62  98.75 62.4 78.4          $E grid plate
43 rpp  35.05  83.65 172.75 195.88 62.4 78.4          $W grid plate
c
c Medium and Small Graphite blocks
50 rpp 196.15 228.65 75.75   98.75  78.40 153.40      $N medium block (clad)
51 rpp 196.40 228.40 76.00   98.50  78.65 153.15      $N medium block (graphite)
52 rpp 34.75 67.25 172.75 195.75    78.40 153.40      $S medium block (clad)
53 rpp 35.00 67.00 173.00 195.50    78.65 153.15      $S medium block (graphite)
54 rpp  75.75  98.75  43.05  75.55  78.40 153.40      $E medium block (clad)
55 rpp  76.00  98.50  43.30  75.30  78.65 153.15      $E medium block (graphite)
56 rpp 172.75 195.75 187.85 220.35  78.40 153.40      $W medium block (clad)
57 rpp 173.00 195.50 188.10 220.10  78.65 153.15      $W medium block (graphite)
60 rpp 187.85 196.15 80.25 98.75 78.40 148.40         $N small block (clad)
61 rpp 188.25 195.75 80.50 98.50 78.40 148.40         $N small block (graphite)
62 rpp 75.35 83.65 172.75 191.25 78.40 148.40         $S small block (clad)
63 rpp 75.75 83.25 173.00 191.00 78.40 148.40         $S small block (graphite)
c
c
c DRIVER ZONES
110 rpp 172.75 195.88  98.75 187.85  62.4 220         $N Driver Zone (graphite & driver
elts & above the caisson)
120 rpp  75.62  98.75  75.55 172.75  62.4 220         $S Driver Zone (graphite & driver
elts & above the caisson)
130 rpp  98.75 187.85  75.62  98.75  62.4 220         $E Driver Zone (graphite & driver
elts & above the caisson)
140 rpp  83.65 172.75 172.75 195.88  62.4 220         $W Driver Zone (graphite & driver
elts & above the caisson)
c
c Driver zone Cell (level 1)
100 rpp -3.855 3.855 -4.05 4.05   0 300             $N & S Driver Zone Cell
c
c AG3 wedges (outside the chimney) and corner graphite elts
150 rpp 165.04 172.75 164.65 172.75  62.4 220.0     $NW corner graphite elt
151 rpp  98.75 106.46 164.65 172.75  62.4 220.0     $SW corner graphite elt
152 rpp  98.75 106.46  98.75 106.85  62.4 220.0     $SE corner graphite elt
153 rpp 165.04 172.75  98.75 106.85  62.4 220.0     $NE corner graphite elt
154 rpp  98.75 172.75  98.75 172.75  62.4 220.0     $AG3 wedges outside the chimney
c
c Startup source 1
160 rpp  67.25 75.35 172.75 180.46    78.4  220     $Starting source
c
c
c
c Fuel Elt Cells (level 1)
200 pz 78.4                                         $Grid plate
201 pz 64.6                                         $Foot
202 cz 3.05                                         $Foot & grid plate
203 cz 2.54                                         $Foot
204 rpp -3.805 3.805 -4.0 4.0 78.4 84.4             $Foot
205 rpp -3.805 3.805 -4.0 4.0  84.4 146.95          $Box for fuel plates
```

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c
c 12-plate fuel elt cell
210 rpp -3.805 3.805 -4.0 1.3456 84.4 146.95        $Box for the fuel plate of the 12-
plate elt
211 rpp -3.805 3.805 1.3456 4.0  84.4 146.95        $Box for the graphite block & water &
Al border plate
212 rpp -3.329 3.329 1.495 3.855 84.4 146.95        $Box for the graphite block (clad)
213 rpp -3.29  3.29  1.50  3.85  84.45 146.90       $Box for the graphite block
(graphite)
c
c 9-plate fuel elt cell
220 rpp -3.805 3.805 -4.0 0.0184 84.4 146.95        $Box for the fuel plate of the 9-
plate elt
221 rpp -3.805 3.805 0.0184 4.0  84.4 146.95        $Box for the graphite block & water &
Al border plate
222 rpp -3.329 3.329 0.18  3.87  84.4 146.95        $Box for the graphite block (clad)
223 rpp -3.29  3.29  0.185 3.865 84.45 146.90       $Box for the graphite block
(graphite)
c
c Control elt cell
230 rpp -3.25 3.25 2.2137 2.6527     146.95 220      $Hafnium rod (clad)    (Zmin =
146.95, Zmax = 220)
231 rpp -3.25 3.25 -2.6527 -2.2137   146.95 220      $Hafnium rod (clad)    (Zmin =
146.95, Zmax = 220)
232 rpp -3.2 3.2   2.2637 2.6027     146.95 207.6    $Hafnium rod withdrawn (hafnium)
(Zmin = 146.95, Zmax = 145.7 + 61.9 )
233 rpp -3.2 3.2   -2.6027 -2.2637   146.95 207.6    $Hafnium rod withdrawn (hafnium)
(Zmin = 146.95, Zmax = 145.7 + 61.9 )
234 rpp -3.2 3.2   2.2637 2.6027     146.95 147.6    $Hafnium rod inserted (Zin=60cm)
(hafnium) (Zmin = 146.95, Zmax = 145.7 - Zin + 61.9 )
235 rpp -3.2 3.2   -2.6027 -2.2637   146.95 147.6    $Hafnium rod inserted (Zin=60cm)
(hafnium) (Zmin = 146.95, Zmax = 145.7 - Zin + 61.9 )
c
c Graphite Elt Cells (level 1)
250 rcc  0 0 62.39   0 0 19.7   0.605               $Foot (void)
251 rpp -3.805 3.805 -4.0 4.0  78.4 82.1            $Foot
252 rpp -3.805 3.805 -4.0 4.0  82.1 148.3           $Graphite block (clad)
253 rpp -3.6 3.6 -3.75 3.75    82.1 145.35          $Graphite block (graphite)
c
c Pilot rod Elt Cell (level 1)
260 rcc 0 0 82.1  0 0 72.2  2.0                     $Rotor ID
261 rcc 0 0 82.1  0 0 72.2  2.1                     $Rotor OD
262 rcc 0 0 82.1  0 0 72.2  2.25                    $Stator ID
263 rcc 0 0 82.1  0 0 72.2  2.5                     $Stator OD
264 rcc 0 0 82.1  0 0 72.2  3.15                    $AG3 Liner ID
265 rcc 0 0 82.1  0 0 72.2  3.45                    $AG3 Liner OD
c
c Graphite Elt for detector Cell (level 1)
270 rpp -3.805 3.805 -4.0 4.0    82.1 157.8         $Graphite block (clad)
271 rpp -3.6 3.6 -3.75 3.75      82.1 153.2         $Graphite block (graphite)
272 rpp -3.6 3.6 -3.75 3.75      153.2 156.2        $Upper void
273 rcc 0 0 111.2  0 0 42  2.5                      $Detector location
274 rcc 0 0 111.2  0 0  9  2.5                      $Detector
c
c Semi thermal column Cell (level 1)
280 rpp -3.805 3.805 -4.0 4.0  82.1 220             $Graphite block (clad)
281 rpp -3.6 3.6 -3.75 3.75    82.1 220             $Graphite block (graphite)
282 c/z -1.739 1.654 0.8                            $Tube 1 (ID)
283 c/z -1.739 1.654 0.925                          $Tube 1 (OD)
284 rcc -1.739 1.654 110.7  0 0 10 0.75             $Detector 1
285 c/z 1.739 -1.654 0.8                            $Tube 2 (ID)
286 c/z 1.739 -1.654 0.925                          $Tube 2 (OD)
287 rcc 1.739 -1.654 110.7  0 0 10 0.75             $Detector 2
c
c Source holder Cell (level 1)
290 rpp -3.705 3.705 -3.705 3.705 82.1 84.6         $Support
291 rcc 0 0 84.6  0 0 88  1.6                       $AG3 Tube (ID)
292 rcc 0 0 84.6  0 0 88  1.8                       $AG3 Tube (OD)
293 rcc 0 0 84.6  0 0 45  1.15                      $Source support (ID)
294 rcc 0 0 84.6  0 0 45  1.25                      $Source support (OD)
295 rcc 0 0 129.6 0 0 2   1.0                       $Source
c
c
c
c Fuel Plates Cells (level 2)
300 rpp -10 10 -0.2212 0.2212 1 301                 $Box for the fuel plate cell (infinte
in X and Z)
401 px -3.329                                       $Al border plate
402 px  3.329                                       $Al border plate
403 rpp -3.551 3.551 -0.0762 0.0762  84.39 146.96   $Box for Al clad   (infinite in Z)
404 rpp -3.25 3.25 -0.0254 0.0254    85.7 145.7     $Box for fuel meat (infinite in Z)
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405 rpp -3.25 3.25 -0.2195 0.2195    145.7 146.96   $Hafnium rod withdrawn (clad)
(Zmin = 145.7, Zmax > 146.95)
406 rpp -3.2 3.2 -0.1695 0.1695      145.7 146.96   $Hafnium rod withdrawn (hafnium)
(Zmin = 145.7, Zmax > 146.95)
409 rpp -3.25 3.25 -0.2195 0.2195    144.7 145.7    $Hafnium rod withdrawn (bevel)
(Zmin = 144.7, Zmax = 145.7 )
407 rpp -3.25 3.25 -0.2195 0.2195     85.7 146.96   $Hafnium rod inserted of 60cm in the
fuel plates (clad)    (Zmin = 145.7 - Zin, Zmax > 146.95)
408 rpp -3.2 3.2 -0.1695 0.1695       85.7 146.96   $Hafnium rod inserted of 60cm in the
fuel plates (hafnium) (Zmin = 145.7 - Zin, Zmax > 146.95)
410 rpp -3.25 3.25 -0.2195 0.2195     84.7  85.7    $Hafnium rod inserted of 60cm in the
fuel plates (bevel)   (Zmin = Zmax  - 1.0, Zmax = 145.7 - Zin)
c
c EXPERIMENTAL ZONE (inside the chimney)
c
c Melodie massif
500 rcc 135.75 135.75 70.8   0 0 0.5    28.0        $Spool upper portion (OD)
501 rcc 135.75 135.75 71.3   0 0 1.75   35.6        $SS lower plate OD
502 rcc 135.75 135.75 73.05  0 0 81.65  35.6        $Al block OD
503 rcc 135.75 135.75 154.7  0 0 2.0    35.6        $SS upper plate OD
504 rcc 135.75 135.75 161.1  0 0 2.0    35.6        $Upper protection plate
505 rpp 133.94 137.56 133.94 137.56  70.8  161.1    $Hole for the oscillation removable
device
506 rcc 135.75 135.75 161.1  0 0 58.9   0.535       $POLINE overclad upper part (OD)
507 rcc 135.75 135.75 161.1  0 0 58.9   0.475       $POLINE overclad upper part (ID)
510 rpp 114.96 156.54 130.08 141.42  73.05 161.1    $Box for the experimental lattice
511 rpp 118.74 152.76 122.52 148.98  73.05 161.1    $Box for the experimental lattice
512 rpp 122.52 148.98 118.74 152.76  73.05 161.1    $Box for the experimental lattice
513 rpp 130.08 141.42 114.96 156.54  73.05 161.1    $Box for the experimental lattice
c
c Experimental zone Cell (level 1)
600 rpp -0.63 0.63 -0.63 0.63  73.04 161.2          $Experimental Zone Cell (Infinite in
Z)
c 600 rpp -0.63 0.63 -0.63 0.63  73.05 161.1          $Experimental Zone Cell
c
c Grid and overclad (level 1)
610 pz 75.2                                        $Lower grid plate (Infinite in X & Y)
611 rcc  0 0 74.7  0 0 0.5   0.485                 $Lower grid plate
612 rcc  0 0 75.2  0 0 79.5  0.485                 $Overclad ID
613 rcc  0 0 75.2  0 0 79.5  0.55                  $Overclad OD
614 rpp -1.0 1.0 -1.0 1.0  154.7 156.7             $Upper grid plate (Infinite in X & Y)
615 rcc  0 0 154.7 0 0 2.0   0.485                 $Upper grid plate
c
c UO2 fuel pin (U-235 3% wt.) (level 1)
620 rcc  0 0 90.7   0 0 50.0   0.4023              $Fuel pellets
621 rcc  0 0 77.7   0 0 13.0   0.39                $Plexiglas spacer (lower)
622 rcc  0 0 140.7  0 0 13.0   0.39                $Plexiglas spacer (upper)
623 rcc  0 0 75.95  0 0 1.75   0.39                $SS spacer (lower)
624 rcc  0 0 153.7  0 0 1.5    0.39                $SS spacer (upper)
625 rcc  0 0 75.95  0 0 79.25  0.41                $Clad ID
626 rcc  0 0 75.95  0 0 79.25  0.47                $Clad OD
627 rcc  0 0 74.7   0 0 1.25   0.47                $Lower end plug
628 rcc  0 0 155.2  0 0 1.5    0.47                $Upper end plug
629 rcc  0 0 156.7  0 0 3.0    0.47                $Gripping head
c
c PuO2-UO2 fuel pin (PuO2 3.6% and 4% wt.) (level 1)
630 rcc  0 0 90.7   0 0 50.0   0.4035              $Fuel pellets
631 rcc  0 0 77.9   0 0 12.8   0.39                $Plexiglas spacer (lower) (the upper
is the same as for the UO2 pins)
633 rcc  0 0 153.7  0 0 0.8    0.39                $SS spacer(upper)
634 rcc  0 0 77.9   0 0 76.6   0.41                $Inner clad ID
635 rcc  0 0 77.9   0 0 76.6   0.435               $Inner clad OD
636 rcc  0 0 77.3   0 0 0.6    0.435               $Lower end plug of the inner clad
637 rcc  0 0 154.5  0 0 0.6    0.435               $Upper end plug of the inner clad
638 rcc  0 0 77.1   0 0 0.2    0.44                $SS Foot wedge
639 rcc  0 0 76.1   0 0 1.0    0.25                $Joint ID
730 rcc  0 0 76.1   0 0 1.0    0.445               $Joint OD
731 rcc  0 0 75.6   0 0 0.5    0.445               $Foot A (SS)
732 rcc  0 0 75.6   0 0 79.5   0.445               $Outter clad ID
733 rcc  0 0 75.6   0 0 79.5   0.47                $Outter clad OD
734 rcc  0 0 74.7   0 0 0.9    0.47                $Lower end plug of the outter clad
735 rcc  0 0 155.1  0 0 1.5    0.47                $Upper end plug of the outter clad
736 rcc  0 0 156.6  0 0 3.0    0.47                $Gripping head
c
c Al fuel pin (level 1)
650 rcc  0 0 74.7   0 0 81.9   0.4                 $Al pin
651 rcc  0 0 156.6  0 0 1.9    0.4                 $Gripping head
c
c POLINE cell (level 1)
660 rcc  0 0 73.05  0 0 300    0.535               $POLINE overclad (OD)
661 rcc  0 0 74.05  0 0 300    0.475               $POLINE overclad (ID)
```

```
662 rcc  0 0 76.7   0 0 78     0.45                $Cylinder for tallies
c
c
c Surfaces for Tallies
800 pz 78.7
801 pz 80.7
802 pz 82.7
803 pz 84.7
804 pz 86.7
805 pz 88.7
806 pz 90.7
807 pz 92.7
808 pz 94.7
809 pz 96.7
810 pz 98.7
811 pz 100.7
812 pz 102.7
813 pz 104.7
814 pz 106.7
815 pz 108.7
816 pz 110.7
817 pz 112.7
818 pz 114.7
819 pz 116.7
820 pz 118.7
821 pz 120.7
822 pz 122.7
823 pz 124.7
824 pz 126.7
825 pz 128.7
826 pz 130.7
827 pz 132.7
828 pz 134.7
829 pz 136.7
830 pz 138.7
831 pz 140.7
832 pz 142.7
833 pz 144.7
834 pz 146.7
835 pz 148.7
836 pz 150.7
837 pz 152.7

c **********************
c MATERIAL DEFINITIONS
c **********************
c
c Structural materials
m1    1001.60c  6.674E-02  $Water
      8016.60c  3.337E-02
c     tot 1.001E-01
mt1   lwtr.01t
c
m2    13027.60c 1.         $Pure Al (density = 6.026e-2 at/b.cm)
c
m3    13027.60c 5.457E-02  $AG-3 (density = 2.55)
      12000.60c 1.959E-03
      25055.60c 6.988E-05
      26054.60c 3.214E-06
      26056.60c 5.046E-05
      26057.60c 1.165E-06
      26058.60c 1.551E-07
      24050.60c 1.925E-06
      24052.60c 3.712E-05
      24053.60c 4.209E-06
      24054.60c 1.048E-06
      22000.60c 2.405E-05
      14000.60c 1.094E-04
      29063.60c 8.358E-06
      29065.60c 3.725E-06
      30000.42c 2.348E-05 $add
c     tot 5.686E-02
c
m4    13027.60c 5.827E-02 $AL AW-2017 (density = 2.79)
      12000.60c 4.839E-04
      25055.60c 2.141E-04
      26054.60c 6.155E-06
      26056.60c 9.662E-05
      26057.60c 2.231E-06
      26058.60c 2.969E-07
      24050.60c 7.020E-07
```

```
      24052.60c 1.354E-05
      24053.60c 1.535E-06
      24054.60c 3.821E-07
      14000.60c 2.991E-04
      29063.60c 4.433E-06
      29065.60c 1.976E-06
      30000.42c 3.212E-05 $add
c     tot 6.048E-02
c
m5    13027.60c 6.010E-02 $AL-5 (density = 2.705)
      12000.60c 1.676E-05
      25055.60c 7.413E-06
      26054.60c 3.410E-06
      26056.60c 5.353E-05
      26057.60c 1.236E-06
      26058.60c 1.645E-07
      22000.60c 8.506E-06
      14000.60c 7.250E-05
      29063.60c 4.433E-06
      29065.60c 1.976E-06
      30000.42c 8.719E-06 $add
c     tot 6.028E-02
c
m6    26054.60c 3.387E-03 $SS (density = 7.85)
      26056.60c 5.316E-02
      26057.60c 1.228E-03
      26058.60c 1.634E-04
      6000.60c  5.904E-05  $C-nat replace C-12
      24050.60c 7.111E-04
      24052.60c 1.371E-02
      24053.60c 1.555E-03
      24054.60c 3.870E-04
      28058.60c 6.031E-03
      28060.60c 2.323E-03
      28061.60c 1.010E-04
      28062.60c 3.220E-04
      28064.60c 8.200E-05
      25055.60c 8.605E-04
      14000.60c 8.416E-04
      16000.60c 2.221E-05 $add
      15031.60c 3.434E-05 $add
      42000.60c 4.927E-04
c     tot 8.548E-02
c
m7    40000.60c 4.247E-02 $Zr4 (density = 6.56)
      1001.60c  4.899E-05
      50000.42c 4.826E-04
      26054.60c 8.683E-06
      26056.60c 1.363E-04
      26057.60c 3.148E-06
      26058.60c 4.189E-07
      24050.60c 3.301E-06
      24052.60c 6.366E-05
      24053.60c 7.219E-06
      24054.60c 1.797E-06
      8016.60c  3.086E-04
      6000.60c  4.440E-05 $C-nat replace C-12
      72000.60c 1.107E-06
c mt7   zr/h.01t
c
m8    40000.60c 4.248E-02 $Zr2 (density = 6.56)
      1001.60c  4.899E-05
      50000.42c 4.826E-04
      26054.60c 5.582E-06
      26056.60c 8.763E-05
      26057.60c 2.024E-06
      26058.60c 2.693E-07
      24050.60c 3.301E-06
      24052.60c 6.366E-05
      24053.60c 7.219E-06
      24054.60c 1.797E-06
      8016.60c  3.086E-04
      6000.60c  4.440E-05 $C-nat replace C-12
      72000.60c 1.107E-06
c
m9    6000.60c  1.0       $Graphite (density = 1.7)
mt9   grph.01t
c
m10   6000.60c  0.33333   $Plexiglas (C5H8O2 - methyl methacrylate) (density = 1.18)
      1001.60c  0.53334
      8016.60c  0.13333
```

```
c mt10  poly.60t
c
m11   6000.60c  0.78463   $Styrene (density = 1.15)
      1001.60c  0.08466
      7014.60c  0.13071
c mt11  poly.60t
c
m12    6000.60c  0.33333  $PVC (density = 0.9106)
       1001.60c  0.50000
      17000.60c  0.16667
c mt12  poly.60t   c
c
m13   72000.60c  1.0      $Natural Hafnium (density = -13.31)
c
c
c Fuels
m20   92235.60c 1.397E-03 $90% U-235 U-Al plate (density = 5.985e-2 at/bcm)
      92238.60c 1.550E-04
      13027.60c 5.830E-02
c
m21   92235.60c 1.894E-03 $93% U-235 U-Al plate (density = 5.973e-2 at/bcm)
      92238.60c 1.390E-04
      13027.60c 5.770E-02
c
m22   92234.60c 4.617E-06 $UO2 pellet (U-235 3% wt.) (density = 6.917e-2 at/bcm)
      92235.60c 6.900E-04
      92236.60c 5.493E-06
      92238.60c 2.200E-02
       8016.60c 4.647E-02
c
m23  92234.60c  2.951E-06 $MOX (PuO2 3.6% wt. in July 2004) (density = 6.861e-2 at/bcm)
     92235.60c  1.588E-04
     92238.60c  2.189E-02
     94238.60c  6.501E-06
     94239.60c  5.743E-04
     94240.60c  1.389E-04
     94241.60c  1.920E-05
     94242.60c  1.621E-05
     95241.60c  6.036E-05
     93237.60c  1.811E-06
     8016.60c   4.574E-02
c
m24  92234.60c  3.139E-06 $MOX (PuO2 4.0% wt. in July 2004) (density = 6.860e-2 at/bcm)
     92235.60c  1.581E-04
     92238.60c  2.180E-02
     94238.60c  7.223E-06
     94239.60c  6.382E-04
     94240.60c  1.543E-04
     94241.60c  2.133E-05
     94242.60c  1.801E-05
     95241.60c  6.706E-05
     93237.60c  2.012E-06
     8016.60c   4.574E-02
c
c
c Mixtures
m30   1001.60c 1.201E-02  $Volume fractions:
      8016.60c 6.007E-03  $ 18% H2O, 82% AG3
      13027.60c 4.475E-02
      12000.60c 1.606E-03
      25055.60c 5.730E-05
      26054.60c 2.635E-06
      26056.60c 4.138E-05
      26057.60c 9.553E-07
      26058.60c 1.272E-07
      24050.60c 1.579E-06
      24052.60c 3.044E-05
      24053.60c 3.451E-06
      24054.60c 8.594E-07
      22000.60c 1.973E-05
      14000.60c 8.971E-05
      29063.60c 6.854E-06
      29065.60c 3.055E-06
c      tot 6.463E-02
mt30   lwtr.01t
c
m31   1001.60c 5.339E-02   $Volume fractions:
      8016.60c 2.670E-02   $ 80 % H2O , 20% AG3
      13027.60c 1.165E-02
      12000.60c 9.678E-05
      25055.60c 4.282E-05
```

```
      26054.60c 1.231E-06
      26056.60c 1.932E-05
      26057.60c 4.462E-07
      26058.60c 5.938E-08
      24050.60c 1.404E-07
      24052.60c 2.708E-06
      24053.60c 3.070E-07
      24054.60c 7.642E-08
      14000.60c 5.982E-05
      29063.60c 8.866E-07
      29065.60c 3.952E-07
c       tot 9.197E-02
mt31    lwtr.01t
c
m32   40000.60c 2.662E-02 $Zr4 (62.67%) + H2O (37.33%) (density = 6.468e-2 at/bcm)
       1001.60c 2.494E-02 $used for the lower end plug of the UO2 pins
      50000.42c 3.024E-04
      26054.60c 5.442E-06
      26056.60c 8.542E-05
      26057.60c 1.973E-06
      26058.60c 2.625E-07
      24050.60c 2.069E-06
      24052.60c 3.990E-05
      24053.60c 4.524E-06
      24054.60c 1.126E-06
       8016.60c 1.265E-02
       6000.60c 2.783E-05
      72000.60c 6.938E-07
c tot 6.468E-02
mt32    lwtr.01t
c
m33   40000.60c 3.858E-02 $Zr4 (90.83%)+ SS (9.17%) (density = 4.742e-2 at/bcm)
       1001.60c 4.450E-05 $used for the upper end plug of the UO2 pins
      50000.42c 4.383E-04
      26054.60c 3.185E-04
      26056.60c 4.999E-03
      26057.60c 1.155E-04
      26058.60c 1.536E-05
      24050.60c 6.821E-05
      24052.60c 1.315E-03
      24053.60c 1.492E-04
      24054.60c 3.712E-05
       8016.60c 2.803E-04
       6000.60c 4.574E-05
      72000.60c 1.005E-06
      28058.60c 5.530E-04
      28060.60c 2.130E-04
      28061.60c 9.262E-06
      28062.60c 2.953E-05
      28064.60c 7.519E-06
      25055.60c 7.891E-05
      14000.60c 7.717E-05
      16000.60c 2.037E-06
      15031.60c 3.149E-06
      42000.60c 4.518E-05
c tot 4.742E-02
c
m34   26054.60c 1.174E-03 $SS (34.67%) + H2O (65.33%)  (density = 9.503e-2 at/bcm)
      26056.60c 1.843E-02 $used for the gripping head of the UO2 pins
      26057.60c 4.257E-04
      26058.60c 5.665E-05
       6000.60c 2.047E-05
      24050.60c 2.465E-04
      24052.60c 4.753E-03
      24053.60c 5.391E-04
      24054.60c 1.342E-04
      28058.60c 2.091E-03
      28060.60c 8.054E-04
      28061.60c 3.502E-05
      28062.60c 1.116E-04
      28064.60c 2.843E-05
      25055.60c 2.983E-04
      14000.60c 2.918E-04
      16000.60c 7.700E-06
      15031.60c 1.191E-05
      42000.60c 1.708E-04
       1001.60c 4.360E-02
       8016.60c 2.180E-02
c tot 9.503E-02
mt34    lwtr.01t
c
```

```
m35   26054.60c 2.109E-03 $SS (62.26%) + H2O (37.74%)  (density = 9.100e-2 at/bcm)
      26056.60c 3.310E-02 $used for the lower end plug of the MOX pins
      26057.60c 7.646E-04
      26058.60c 1.017E-04
       6000.60c 3.676E-05
      24050.60c 4.427E-04
      24052.60c 8.536E-03
      24053.60c 9.681E-04
      24054.60c 2.409E-04
      28058.60c 3.755E-03
      28060.60c 1.446E-03
      28061.60c 6.288E-05
      28062.60c 2.005E-04
      28064.60c 5.105E-05
      25055.60c 5.357E-04
      14000.60c 5.240E-04
      16000.60c 1.383E-05
      15031.60c 2.138E-05
      42000.60c 3.068E-04
       1001.60c 2.519E-02
       8016.60c 1.259E-02
c tot 9.100E-02
mt35  lwtr.01t
c
m36   40000.60c 3.858E-02 $Zr2 (90.83%)+ SS (9.17%) (density = 4.738e-2 at/bcm)
       1001.60c 4.450E-05 $used for the upper end plug of the MOX pins
      50000.42c 4.383E-04
      26054.60c 3.157E-04
      26056.60c 4.954E-03
      26057.60c 1.144E-04
      26058.60c 1.523E-05
      24050.60c 6.821E-05
      24052.60c 1.315E-03
      24053.60c 1.492E-04
      24054.60c 3.712E-05
       8016.60c 2.803E-04
       6000.60c 4.574E-05
      72000.60c 1.005E-06
      28058.60c 5.530E-04
      28060.60c 2.130E-04
      28061.60c 9.262E-06
      28062.60c 2.953E-05
      28064.60c 7.519E-06
      25055.60c 7.891E-05
      14000.60c 7.717E-05
      16000.60c 2.037E-06
      15031.60c 3.149E-06
      42000.60c 4.518E-05
c tot 4.738E-02
c
m37   13027.60c 2.633E-02 $AG-3 (48.25%) + H2O (51.75%)  (density = 7.925e-2 at/bcm)
      12000.60c 9.452E-04 $used for the gripping head of the Al pins
      25055.60c 3.372E-05
      26054.60c 1.551E-06
      26056.60c 2.435E-05
      26057.60c 5.621E-07
      26058.60c 7.484E-08
      24050.60c 9.288E-07
      24052.60c 1.791E-05
      24053.60c 2.031E-06
      24054.60c 5.057E-07
      22000.60c 1.160E-05
      14000.60c 5.279E-05
      29063.60c 4.033E-06
      29065.60c 1.797E-06
      30000.42c 1.133E-05
       1001.60c 3.454E-02
       8016.60c 1.727E-02
c tot 7.925E-02
mt37   lwtr.01t
c
m38   13027.60c 4.857E-02 $AG-3 (89.00%) + Cd nat (0.11%) (density = 5.570e-2 at/bcm)
      12000.60c 1.744E-03 $used for the Rotor of the pilot rod
      25055.60c 6.219E-05
      26054.60c 2.860E-06
      26056.60c 4.491E-05
      26057.60c 1.037E-06
      26058.60c 1.380E-07
      24050.60c 1.713E-06
      24052.60c 3.304E-05
      24053.60c 3.746E-06
```

```
      24054.60c 9.327E-07
      22000.60c 2.140E-05
      14000.60c 9.737E-05
      29063.60c 7.439E-06
      29065.60c 3.315E-06
      30000.42c 2.090E-05
      48000.50c 5.093E-03
c
m39   13027.60c 5.087E-02 $AG-3 (93.22%) + Cd nat (6.78%) (density = 5.615e-2 at/bcm)
      12000.60c 1.826E-03 $used for the Stator of the pilot rod
      25055.60c 6.514E-05
      26054.60c 2.996E-06
      26056.60c 4.704E-05
      26057.60c 1.086E-06
      26058.60c 1.446E-07
      24050.60c 1.794E-06
      24052.60c 3.460E-05
      24053.60c 3.924E-06
      24054.60c 9.769E-07
      22000.60c 2.242E-05
      14000.60c 1.020E-04
      29063.60c 7.791E-06
      29065.60c 3.472E-06
      30000.42c 2.189E-05
      48000.50c 3.139E-03
c
m40   1001.60c 3.679E-02 $Water (55.13%) + SS (44.87%) (density = 9.354e-2 at/bcm)
      8016.60c 1.840E-02
      26054.60c 1.520E-03
      26056.60c 2.385E-02
      26057.60c 5.510E-04
      26058.60c 7.332E-05
      6000.60c 2.649E-05
      24050.60c 3.191E-04
      24052.60c 6.152E-03
      24053.60c 6.977E-04
      24054.60c 1.736E-04
      28058.60c 2.706E-03
      28060.60c 1.042E-03
      28061.60c 4.532E-05
      28062.60c 1.445E-04
      28064.60c 3.679E-05
      25055.60c 3.861E-04
      14000.60c 3.776E-04
      16000.60c 9.966E-06
      15031.60c 1.541E-05
      42000.60c 2.211E-04
mt40  lwtr.01t
c
c Material for tallies
m50  92235.60c  1.
m51  92238.60c  1.
m52  94238.60c  1.
m53  94239.60c  1.
m54  94240.60c  1.
m55  94241.60c  1.
m56  94242.60c  1.
m57  95241.60c  1.
m58  93237.60c  1.
c
c **********************
c TRANSFORMATION DEFINITIONS
c **********************
tr1  176.605 102.8 0                         $North Driver Zone - Translation
tr2  176.605 102.8 0  -1 0 0 0 -1 0 0 0 1    $North Driver Zone - Translation +
rotation of +PI (for 9 and 12 plates)
tr3  94.895  168.7 0  -1 0 0 0 -1 0 0 0 1    $South Driver Zone - Translation +
rotation of +PI
tr4  94.895  168.7 0                         $South Driver Zone - Translation (for 9
and 12 plates)
tr5  102.8  94.895 0  0 -1 0 1 0 0 0 0 1     $East Driver Zone - Translation +
rotation of -PI/2
tr6  102.8  94.895 0  0 1 0 -1 0 0 0 0 1     $East Driver Zone - Translation +
rotation of +PI/2 (for 9 and 12 plates)
tr7  168.7 176.605 0  0 1 0 -1 0 0 0 0 1     $West Driver Zone - Translation +
rotation of +PI/2
tr8  168.7 176.605 0  0 -1 0 1 0 0 0 0 1     $West Driver Zone - Translation +
rotation of -PI/2 (for 9 and 12 plates)
tr9  71.3  176.605 0  0 1 0 -1 0 0 0 0 1     $Start-up source 1 - Translation +
rotation of +PI/2
c
```

```
c *********************
c SOURCE DEFINITIONS
c *********************
sdef cel=d1 erg=d2 rad=fcel d3 axs=fcel d4 ext=fcel d5
            x=fcel d6 y=fcel d7 z=fcel d8
c
c cell
si1  S d10 d11
sp1  1 1
si10 L 510:511:620
sp10 1
si11 L 110:111:206:207:410 110:111:216:217:420
       120:121:206:207:410 120:121:216:217:420
       130:131:206:207:410 130:131:216:217:420
       140:141:206:207:410 140:141:216:217:420
sp11 4 3 4 3 4 3 4 3
c
c erg
sp2 -3 0.988 2.249
c
c rad
ds3 s 30 0
si30 0 0.41
sp30 -21 1.0
c
c axs
ds4 s 40 0
si40 L 0 0 1
sp40 1
c
c ext
ds5 s 50 0
si50 90.7 140.7
sp50 0 1
c
c x
ds6 s 0 60
si60 -3.25 3.25
sp60 0 1
c
c y
ds7 s 0 70
si70 -0.0254 0.0254
sp70 0 1
c
c z
ds8 s 0 80
si80 85.7 145.7
sp80 0 1
c
c
c *********************
c TALLY DEFINITIONS
c *********************
c
c Radial flux, fission rate and power profile in the experimental zone
fc4 Radial flux & fission rate
f4:n (620<u=2<510)
fm4 (1) (-2.54226E+01 22 -6)
c
c Axial flux and fission chamber traverses (U-5 & Np-7)
fc14 Axial flux & fission rate
f14:n (662<u=6<510)
fm14 (1) (1 50 -6) (1 58 -6)
fs14  -800 -801 -802 -803 -804 -805 -806 -807 -808 -809
      -810 -811 -812 -813 -814 -815 -816 -817 -818 -819
      -820 -821 -822 -823 -824 -825 -826 -827 -828 -829
      -830 -831 -832 -833 -834 -835 -836 -837
sd14  (1.2723 38r)
c
c Spectral indices
f24:n (662<u=6<510)
fm24  (1 50 -6) (1 51 -6) (1 52 -6) (1 53 -6) (1 54 -6)
      (1 55 -6) (1 56 -6) (1 57 -6) (1 58 -6)
fs24 -816 -821
sd24  (21.6299 6.36173 21.6299)
c
c
c
c *********************
c RUN DEFINITIONS
```

```
c **********************
c
mode n
totnu
c kcode 1000 1.0 20 120 2000 0
kcode 100000 1.0 20 270 2000 0
prdmp 1j -240 1 2
lost 50 50
print
```

File MOXI

```
OSMOSE - R1-MOX Lattice
c
c  R1-MOX lattice of 3% UO2 pins & 3.6% & 4% PuO2
c  central channel = POLINE overclad
c  pitch = 1.26 cm
c
c
c **********************
c CELL DEFINITIONS
c **********************
c
1 0 1                                      imp:n=0    $Outside of tank
2 1 -0.99823  -1
              #3       $table
              4 6 8    $chimney
              10 11 13 14 16 17 19 20 $large graphite blocks
              30 31 32 33 40 41 42 43 $caissons & grid plates
              50 52 54 56 60 62       $medium & small graphite blocks
              110 120 130 140         $driver zones
              #150 151 152 153 154    $wedges & corner elt
              160                     $Start-up source 1
                                           imp:n=1    $Tank
3 30 6.463e-2 -2 4                         imp:n=1    $Table
4 3  -2.55    (-4 3) : (-6 5) : (-8 7)     imp:n=1    $Chimney
c
c Large Graphite blocks
10 31 9.197e-2 -10                         imp:n=1     $N LB caisson
11 3 -2.55     -11 12                      imp:n=1     $N LB clad
12 9 -1.7      -12                         imp:n=1     $N LB graphite
c
13 31 9.197e-2 -13                         imp:n=1     $S LB caisson
14 3 -2.55     -14 15                      imp:n=1     $S LB clad
15 9 -1.7      -15                         imp:n=1     $S LB graphite
c
16 31 9.197e-2 -16                         imp:n=1     $E LB caisson
17 3 -2.55     -17 18                      imp:n=1     $E LB clad
18 9 -1.7      -18                         imp:n=1     $E LB graphite
c
19 31 9.197e-2 -19                         imp:n=1     $W LB caisson
20 3 -2.55     -20 21                      imp:n=1     $W LB clad
21 9 -1.7      -21                         imp:n=1     $W LB graphite
c
c Caissons of the Driver Zone
30 31 9.197e-2 -30                         imp:n=1     $N DZ caisson
31 31 9.197e-2 -31                         imp:n=1     $S DZ caisson
32 31 9.197e-2 -32                         imp:n=1     $E DZ caisson
33 31 9.197e-2 -33                         imp:n=1     $W DZ caisson
c
c Grid plates of the Driver Zone
40 5 -2.705    -40                         imp:n=1     $N DZ grid plate
41 5 -2.705    -41                         imp:n=1     $S DZ grid plate
42 5 -2.705    -42                         imp:n=1     $E DZ grid plate
43 5 -2.705    -43                         imp:n=1     $W DZ grid plate
c
c Medium and Small Graphite blocks
50 3 -2.55    -50 51                       imp:n=1     $N MB clad
51 9 -1.7     -51                          imp:n=1     $N MB graphite
52 3 -2.55    -52 53                       imp:n=1     $S MB clad
53 9 -1.7     -53                          imp:n=1     $S MB graphite
54 3 -2.55    -54 55                       imp:n=1     $E MB clad
55 9 -1.7     -55                          imp:n=1     $E MB graphite
56 3 -2.55    -56 57                       imp:n=1     $W MB clad
57 9 -1.7     -57                          imp:n=1     $W MB graphite
60 3 -2.55    -60 61                       imp:n=1     $N SB clad
61 9 -1.7     -61                          imp:n=1     $N SB graphite
62 3 -2.55    -62 63                       imp:n=1     $S SB clad
63 9 -1.7     -63                          imp:n=1     $S SB graphite
c
c
c Driver Zone Elts
110   0 -110  fill=11 imp:n=1 $North Driver Zone
111   0 -100  lat=1 trcl=1 &
     fill 0:2 0:11 0:0 &
     25  25  28 &
     20  25  25 &
     20  25  25 &
     21  24(2)  25 &
```

```
     22  21  25 &
     21  23  25 &
     20  25  27 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     u=11 imp:n=1 $North Driver Zone lattice
c
120   0 -120  fill=12 imp:n=1 $South Driver Zone
121   0 -100  lat=1 trcl=3 &
     fill 0:2 0:11 0:0 &
     25  25  25 &
     20  25  25 &
     20  25  25 &
     20  25  25 &
     21  23(4)  25 &
     22  21  25 &
     21  23  25 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  29 &
     u=12 imp:n=1 $South Driver Zone lattice
c
130   0 -130  fill=13 imp:n=1 $East Driver Zone
131   0 -100  lat=1 trcl=5 &
     fill 0:2 0:11 0:0 &
     25  25  25 &
     20  26  25 &
     20  25  25 &
     21  23(6)  25 &
     22  21  25 &
     21  23  25 &
     20  25  25 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     u=13 imp:n=1 $East Driver Zone lattice
c
140   0 -140  fill=14 imp:n=1 $West Driver Zone
141   0 -100  lat=1 trcl=7 &
     fill 0:2 0:10 0:0 &
     25  25  25 &
     20  25  25 &
     20  25  25 &
     21  23(8) 25 &
     22  21  25 &
     21  23  25 &
     20  25  25 &
     20  25  25 &
     25  25  25 &
     25  25  25 &
     25  25  25 &
     u=14 imp:n=1 $West Driver Zone lattice
c
c AG3 wedges (outside the chimney) and corner graphite elts
150 0        -150 fill=25   (168.895 168.7 0)   imp:n=1   $NW corner graphite elt
151 0        -151 fill=25   (102.605 168.7 0)   imp:n=1   $SW corner graphite elt
152 0        -152 fill=25   (102.605 102.8 0)   imp:n=1   $SE corner graphite elt
153 0        -153 fill=25   (168.895 102.8 0)   imp:n=1   $NE corner graphite elt
154 3 -2.55  -154 150 151 152 153 8      imp:n=1   $AG3 weges
c
c Start-up source 1
160 0        -160 fill=16                      imp:n=1   $Startup source close to the
South LGB
161 0        -100 lat=1 trcl=9 fill=29          imp:n=1 u=16
c
c
c
c
c Driver Elt - 18 plate 90% (N-S quadrant) - U=20 and 30 - Level 1 and 2
200 5 -2.705   202 -200                                u=20 imp:n=1 $Grid plate
201 3 -2.55    203 -202 201 -200                       u=20 imp:n=1 $Foot in the grid plate
202 1 -0.99823 (-202 -201):(-203 201 -200)             u=20 imp:n=1 $Water in the grid plate
203 1 -0.99823 -204 -203                               u=20 imp:n=1 $Water above the grid
plate
```

```
204 1 -0.99823 204 205 200                           u=20 imp:n=1 $Water above the grid
plate
205 3 -2.55    -204  203                             u=20 imp:n=1 $Foot above the grid
plate
206 0 -205 fill=30                                   u=20 imp:n=1 $Box for fuel plates
207 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 41 40 &
                                                     u=30 imp:n=1 $Lattice of cell filled
with u=41
c
c Driver Elt - 18 plate 93% (N-S quadrant) - U=21 and 31 - Level 1 and 2
210 like 200 but u=21
211 like 201 but u=21
212 like 202 but u=21
213 like 203 but u=21
214 like 204 but u=21
215 like 205 but u=21
216 0 -205 fill=31                                   u=21 imp:n=1 $Box for fuel plates
217 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 40 &
                                                     u=31 imp:n=1 $Lattice of cell filled
with u=42
c
c Driver Elt - Control Elt (N-S quadrant) with withdrawn rods - U=22 and 32 - Level 1 and
2
220 like 200 but u=22
221 like 201 but u=22
222 like 202 but u=22
223 like 203 but u=22
224 1 -0.99823 204 205 200 230 231                   u=22 imp:n=1 $Water above the grid
plate
225 like 205 but u=22
226 0 -205 fill=32                                   u=22 imp:n=1 $Box for fuel plates
227 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 42 42 43 44 43 42 42 42 42 42 42 42 42 43 44 43 42 42 40 &
                                                     u=32 imp:n=1
320 6  -7.85  -230 232                               u=22 imp:n=1 $Upper part of the
absorber plate #1 (clad)
321 13 -13.31 -232                                   u=22 imp:n=1 $Upper part of the
absorber plate #1 (hafnium)
322 6  -7.85  -231 233                               u=22 imp:n=1 $Upper part of the
absorber plate #2 (clad)
323 13 -13.31 -233                                   u=22 imp:n=1 $Upper part of the
absorber plate #2 (hafnium)
c
c Driver Elt - Control Elt (N-S quadrant) with inserted rods - U=52 and 62 - Level 1 and
2
520 like 220 but u=52
521 like 221 but u=52
522 like 222 but u=52
523 like 223 but u=52
524 like 224 but u=52
525 like 225 but u=52
526 0 -205 fill=62                                   u=52 imp:n=1 $Box for fuel plates
527 0 -300 lat=1 trcl=(0 0.2212 0)&
    fill=0:0 -10:9 0:0 &
    40 42 42 43 45 43 42 42 42 42 42 42 42 42 43 45 43 42 42 40 &
                                                     u=62 imp:n=1
530 6  -7.85  -230 234                               u=52 imp:n=1 $Upper part of the
absorber plate #1 (clad)
531 13 -13.31 -234                                   u=52 imp:n=1 $Upper part of the
absorber plate #1 (hafnium)
532 6  -7.85  -231 235                               u=52 imp:n=1 $Upper part of the
absorber plate #2 (clad)
533 13 -13.31 -235                                   u=52 imp:n=1 $Upper part of the
absorber plate #2 (hafnium)
c
c Driver Elt - 12 plate 90% (N-S quadrant) - U=23 and 33 - Level 1
230 like 200 but u=23
231 like 201 but u=23
232 like 202 but u=23
233 like 203 but u=23
234 like 204 but u=23
235 like 205 but u=23
236 0 -210 fill=33                                   u=23 imp:n=1 $Box for fuel plates
237 0 -300 lat=1 trcl=(0 -3.7604 0) &
    fill=0:0 -1:12 0:0 &
    40 41 41 41 41 41 41 41 41 41 41 41 41 40 &
```

```
                                                        u=33 imp:n=1 $Lattice of cell filled
with u=41
330 3 -2.55    -211 -401                                u=23 imp:n=1 $Al border plate next to
graphite block
331 3 -2.55    -211  402                                u=23 imp:n=1 $Al border plate next to
graphite block
332 3 -2.55    -212  213                                u=23 imp:n=1 $Graphite block (clad)
333 9 -1.7     -213                                     u=23 imp:n=1 $Graphite block
(graphite)
334 1 -0.99823 -211  212 401 -402                       u=23 imp:n=1 $Water around the
graphite block
c
c Driver Elt -  9 plate 90% (N-S quadrant) - U=24 and 34 - Level 1 and 2
240 like 200 but u=24
241 like 201 but u=24
242 like 202 but u=24
243 like 203 but u=24
244 like 204 but u=24
245 like 205 but u=24
246 0 -220 fill=34                                      u=24 imp:n=1 $Box for fuel plates
247 0 -300 lat=1 trcl=(0 -3.7604 0) &
    fill=0:0 -1:9 0:0 &
    40 41 41 41 41 41 41 41 41 41 40 &
                                                        u=34 imp:n=1 $Lattice of cell filled
with u=41
340 3 -2.55    -221 -401                                u=24 imp:n=1 $Al border plate next to
graphite block
341 3 -2.55    -221  402                                u=24 imp:n=1 $Al border plate next to
graphite block
342 3 -2.55    -222  223                                u=24 imp:n=1 $Graphite block (clad)
343 9 -1.7     -223                                     u=24 imp:n=1 $Graphite block
(graphite)
344 1 -0.99823 -221  222 401 -402                       u=24 imp:n=1 $Water around the
graphite block
c
c Graphite Elt (N-S quadrant) - U=25 - Level 1
250 5 -2.705   202 -200                                 u=25 imp:n=1 $Grid plate
251 3 -2.55    250 -202 201 -200                        u=25 imp:n=1 $Foot in the grid plate
(AG3)
252 0          -250                                     u=25 imp:n=1 $Void channel
253 1 -0.99823 250 -202 -201                            u=25 imp:n=1 $Water in the grid plate
254 1 -0.99823 251 252 200                              u=25 imp:n=1 $Water above the grid
plate
255 3 -2.55    -251 250                                 u=25 imp:n=1 $Foot above the grid
plate
256 3 -2.55    -252 253                                 u=25 imp:n=1 $Graphite block (clad)
257 9 -1.7     -253                                     u=25 imp:n=1 $Graphite block
(graphite)
c
c Pilot rod Elt - U=26 - Level 1
260 like 250 but u=26
261 like 251 but u=26
262 like 252 but u=26
263 like 253 but u=26
264 1 -0.99823  251 265 200                             u=26 imp:n=1 $Water above the grid
plate
265 like 255 but u=26
266 0           -260                                    u=26 imp:n=1 $Void inside the rotor
267 38 5.570e-2 -261 260                                u=26 imp:n=1 $Rotor
268 0           -262 261                                u=26 imp:n=1 $Void inside the stator
269 39 5.615e-2 -263 262                                u=26 imp:n=1 $Stator
360 0           -264 263                                u=26 imp:n=1 $Void inside the AG3
liner
361 3 -2.55     -265 264                                u=26 imp:n=1 $AG3 liner
c
c Grahpite Elt for the detector - U=27 - Level 1
270 like 250 but u=27
271 like 251 but u=27
272 like 252 but u=27
273 like 253 but u=27
274 1 -0.99823  251 270 200                             u=27 imp:n=1 $Water above the grid
plate
275 like 255 but u=27
276 3 -2.55     -270 271 272                            u=27 imp:n=1 $Graphite block (clad)
277 9 -1.7      -271 273                                u=27 imp:n=1 $Graphite block
(graphite)
278 0           (-272:-273) 274                         u=27 imp:n=1 $Void
279 0           -274                                    u=27 imp:n=1 $Detector
c
c
c Semi thermal column - U=28 - Level 1
```

```
280 like 250 but u=28
281 like 251 but u=28
282 like 252 but u=28
283 like 253 but u=28
284 1 -0.99823 251 280 200                         u=28 imp:n=1 $Water above the grid
plate
285 like 255 but u=28
286 3 -2.55     -280 281                          u=28 imp:n=1 $Graphite block (clad)
287 9 -1.7      -281 283 286                      u=28 imp:n=1 $Graphite block (clad)
288 12 -0.9106  -281 -283 282                     u=28 imp:n=1 $PVC Tube 1
289 0           -281 -282 284                     u=28 imp:n=1 $Detector channel 1
380 0           -284                              u=28 imp:n=1 $Detector 1
381 12 -0.9106  -281 -286 285                     u=28 imp:n=1 $PVC Tube 2
382 0           -281 -285 287                     u=28 imp:n=1 $Detector channel 2
383 0           -287                              u=28 imp:n=1 $Detector 2
c
c Source holder - U=29 - Level 1
290 like 250 but u=29
291 like 251 but u=29
292 like 252 but u=29
293 like 253 but u=29
294 1 -0.99823 251 290 292 200                     u=29 imp:n=1 $Water above the grid
plate
295 like 255 but u=29
296 3 -2.55     -290                               u=29 imp:n=1 $Support
297 3 -2.55     -292 291                           u=29 imp:n=1 $AG-3 Tube
298 6 -7.85     -294 293                           u=29 imp:n=1 $Source support
299 0           -295                               u=29 imp:n=1 $Source
390 0           (-291 294 295) : -293              u=29 imp:n=1 $Void
c
c
c
c
c Border plate & water for the Driver Elts (N-S quadrant) - U=40 - Level 3
402 1 -0.99823   401 -402                         u=40 imp:n=1 $Water gap
403 3 -2.55     -401                              u=40 imp:n=1 $Border plate
404 3 -2.55      402                              u=40 imp:n=1 $Border plate
c
c 90% U-5 plate for the Driver Elt (N-S quadrant) - U=41 - Level 3
410 20 5.985e-2 -404                              u=41 imp:n=1 $Fuel meat
411 2  6.026e-2  404 -403                         u=41 imp:n=1 $Fuel clad
412 1 -0.99823   401 -402 403                     u=41 imp:n=1 $Water gap
413 3 -2.55     -401  403                         u=41 imp:n=1 $Border plate
414 3 -2.55      402  403                         u=41 imp:n=1 $Border plate
c
c 93% U-5 plate for the Driver Elt (N-S quadrant) - U=42 - Level 3
420 21 5.973e-2 -404                              u=42 imp:n=1 $Fuel meat
421 like 411 but u=42
422 like 412 but u=42
423 like 413 but u=42
424 like 414 but u=42
c
c Al plate for the Driver Elt (N-S quadrant) - U=43 - Level 3
431 2  6.026e-2  -403                             u=43 imp:n=1 $Inertial Al plate
432 like 412 but u=43
433 like 413 but u=43
434 like 414 but u=43
c
c Absorber plate for the Driver Elt (N-S quadrant) - Withdrawn - U=44 - Level 3
440 13 -13.31    -406                             u=44 imp:n=1 $Hafnium rod inserted of
10cm in the fuel plates (hafnium)
441 6 -7.85      -405 406                         u=44 imp:n=1 $Hafnium rod inserted of
10cm in the fuel plates (clad)
447 40 9.354e-2  -409                             u=44 imp:n=1 $Hafnium rod withdrawn
in the fuel plates (bevel)
442 1 -0.99823   405 401 -402 409                 u=44 imp:n=1 $Water gap
445 1 -0.99823   -401 -403                        u=44 imp:n=1 $Water gap
446 1 -0.99823   402 -403                         u=44 imp:n=1 $Water gap
443 like 413 but u=44
444 like 414 but u=44
c
c Absorber plate for the Driver Elt (N-S quadrant) - Inserted - U=45 - Level 3
450 13 -13.31    -408                             u=45 imp:n=1 $Hafnium rod inserted of
10cm in the fuel plates (hafnium)
451 6 -7.85      -407 408                         u=45 imp:n=1 $Hafnium rod inserted of
10cm in the fuel plates (clad)
457 40 9.354e-2  -410                             u=45 imp:n=1 $Hafnium rod inserted of
10cm in the fuel plates (bevel)
452 1 -0.99823   407 401 -402 410                 u=45 imp:n=1 $Water gap
455 1 -0.99823   -401 -403                        u=45 imp:n=1 $Water gap
456 1 -0.99823   402 -403                         u=45 imp:n=1 $Water gap
```

```
453 like 413 but u=45
454 like 414 but u=45
c
c
c EXPERIMENTAL ZONE
c
500  6  -7.85    -500 505                          imp:n=1 $Spool (upper portion)
501  6  -7.85    -501 505                          imp:n=1 $Massif lower SS plate
502  3  -2.55    -502 (510 511 512 513)            imp:n=1 $Massif AG3 blocks
503  6  -7.85    -503 (510 511 512 513)            imp:n=1 $Massif upper SS plate
c 504  3  -2.55    -504                              imp:n=1 $Upper protection plate
c 505  1  -0.99823 (-3 : -5 : -7)
c                  #500 #501 #502 #503 #504
c                  (510 511 512 513)                 imp:n=1 $Water in the chimney
c
c c To activate for the POLINE overclad (upper part)
504  3  -2.55    -504 506                          imp:n=1 $Upper protection plate
505  1  -0.99823 (-3 : -5 : -7)
                 #500 #501 #502 #503 #504 #506 #507
                 (510 511 512 513)                 imp:n=1 $Water in the chimney
506 4   -2.75     -506 507                         imp:n=1 $AW-2017 overclad
507 0             -507                             imp:n=1 $Inside Void
c
c
510  0  (-510:-511:-512:-513) fill=1               imp:n=1 $Experimental lattice box
511  0 -600 lat=1 trcl=(135.75 135.75 0) &
   fill -16:16 -16:16 0:0 &
   1 1 1 1 1 1 1 1 1 1 1 1 5 5 5 5 5 5 5 5 5 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 5 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 5 1 1 1 1 1 1 &
   1 1 1 1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 1 1 1 &
   1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 &
   1 1 1 5 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 5 1 1 1 &
   1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 3 3 3 4 4 4 3 3 3 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 1 1 1 &
   5 2 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 6 4 4 4 4 4 4 2 2 2 2 2 2 2 2 2 5 & $central row
   5 2 2 2 2 2 2 2 2 2 4 4 4 4 4 4 4 4 4 4 4 4 4 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 2 5 &
   5 2 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 2 5 &
   1 1 1 2 2 2 2 2 2 2 2 3 4 4 4 4 4 4 4 4 4 3 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 3 3 3 4 4 4 3 3 3 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 &
   1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 &
   1 1 1 5 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 5 1 1 1 &
   1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 &
   1 1 1 1 1 1 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 1 1 1 1 1 1 &
   1 1 1 1 1 1 5 5 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 5 5 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 1 1 1 1 1 1 1 1 1 1 1 1 &
   1 1 1 1 1 1 1 1 1 1 1 1 5 5 5 5 5 5 5 5 5 1 1 1 1 1 1 1 1 1 1 1 1 &
   u=1  imp:n=1  $Experimental lattice
c
c UO2 fuel pin (U-235 3% wt.) - U=2 - Level 1
620  22  6.917e-2  -620                            u=-2 imp:n=1 $Fuel pellets
621  10  -1.18     -621                            u=-2 imp:n=1 $Plexiglas spacer
(lower)
622  10  -1.18     -622                            u=-2 imp:n=1 $Plexiglas spacer
(upper)
623   6  -7.85     -623                            u=-2 imp:n=1 $SS spacer (lower)
624   6  -7.85     -624                            u=-2 imp:n=1 $SS spacer (upper)
625   0            -625 620 621 622 623 624        u=-2 imp:n=1 $Void inside the clad
626   7  -6.56     -626 625                        u=-2 imp:n=1 $Zr4 clad
627  32  6.468e-2  -627                            u=-2 imp:n=1 $Lower end plug (Zr4 +
water)
628  33  4.742e-2  -628                            u=-2 imp:n=1 $Upper end plug (Zr4 +
SS)
629  34  9.503e-2  -629                            u=-2 imp:n=1 $Gripping head (SS +
water)
720  3   -2.55     -610 611                        u=2 imp:n=1 $Lower grid plate
721  3   -2.55     -613 612                        u=2 imp:n=1 $Overclad
722  3   -2.55     -614 615                        u=2 imp:n=1 $Upper grid plate
```

```
723  1   -0.99823   626 627 628 629
                     #720 #721 #722                u=2 imp:n=1 $Water
c
c PuO2-UO2 fuel pin (PuO2 3.6% wt.) - U=3 - Level 1
630  23  6.861e-2  -630                            u=-3 imp:n=1 $Fuel pellets
631  10  -1.18     -631                            u=-3 imp:n=1 $Plexiglas spacer
(lower)
632  10  -1.18     -622                            u=-3 imp:n=1 $Plexiglas spacer
(upper)
633  6   -7.85     -633                            u=-3 imp:n=1 $SS spacer(upper)
634  0             -634 630 631 622 633            u=-3 imp:n=1 $Void inside the inner
clad
635  8   -6.56     -635 634                        u=-3 imp:n=1 $Zr2 Inner clad
636  8   -6.56     -636                            u=-3 imp:n=1 $Lower end plug of the
inner clad
637  8   -6.56     -637                            u=-3 imp:n=1 $Upper end plug of the
inner clad
638  6   -7.85     -638                            u=-3 imp:n=1 $SS Foot wedge
639  6   -7.85     -639                            u=-3 imp:n=1 $SS Inside joint
730  11  -1.15     -730 639                        u=-3 imp:n=1 $Joint
731  6   -7.85     -731                            u=-3 imp:n=1 $Foot A (SS)
732  0             -732 635 636 637 638 639
                     730 731                       u=-3 imp:n=1 $Void inside the outter
clad
733  8   -6.56     -733 732                        u=-3 imp:n=1 $Zr2 Outter clad
734  35  9.100e-2  -734                            u=-3 imp:n=1 $Lower end plug of the
outter clad (SS + water)
735  36  4.738e-2  -735                            u=-3 imp:n=1 $Upper end plug of the
outter clad (Zr2 + SS)
736  34  9.503e-2  -736                            u=-3 imp:n=1 $Gripping head
830 like 720 but u=3
831 like 721 but u=3
832 like 722 but u=3
833  1   -0.99823   733 734 735 736
                     #830 #831 #832                u=3 imp:n=1 $Water
c
c PuO2-UO2 fuel pin (PuO2 4.0% wt.) - U=4 - Level 1
640  24  6.860e-2  -630                            u=-4 imp:n=1 $Fuel pellets
641 like 631 but u=-4
642 like 632 but u=-4
643 like 633 but u=-4
644 like 634 but u=-4
645 like 635 but u=-4
646 like 636 but u=-4
647 like 637 but u=-4
648 like 638 but u=-4
649 like 639 but u=-4
740 like 730 but u=-4
741 like 731 but u=-4
742 like 732 but u=-4
743 like 733 but u=-4
744 like 734 but u=-4
745 like 735 but u=-4
746 like 736 but u=-4
840 like 830 but u=4
841 like 831 but u=4
842 like 832 but u=4
843 like 833 but u=4
c
c Al fuel pin - U=5 - Level 1
650  3   -2.55     -650                            u=-5 imp:n=1 $Al pin
651  37  7.925e-2  -651                            u=-5 imp:n=1 $Gripping head
750 like 720 but u=5
751 like 721 but u=5
752 like 722 but u=5
753 1   -0.99823   650 651 #750 #751 #752          u=5 imp:n=1 $Water
c
c POLINE cell - U=6 - Level 1
660 4   -2.75     -660 661                         u=6 imp:n=1 $AW-2017 overclad
661 0             -661 662                         u=6 imp:n=1 $Inside Void
662 0             -662                             u=6 imp:n=1 $Detector volume
663 1   -0.99823  660                              u=6 imp:n=1 $Water
c

c **********************
c BOUNDARY DEFINITIONS
c **********************
c « SAME AS FOR THE FILE UO2I »
c
```

```
c **********************
c MATERIAL DEFINITIONS
c **********************
c « SAME AS FOR THE FILE UO2I »
c
c **********************
c TRANSFORMATION DEFINITIONS
c **********************
tr1  176.605 102.8 0                              $North Driver Zone - Translation
tr2  176.605 102.8 0  -1 0 0 0 -1 0 0 0 1         $North Driver Zone - Translation +
rotation of +PI (for 9 and 12 plates)
tr3  94.895  168.7 0  -1 0 0 0 -1 0 0 0 1         $South Driver Zone - Translation +
rotation of +PI
tr4  94.895  168.7 0                              $South Driver Zone - Translation (for 9
and 12 plates)
tr5  102.8  94.895 0  0 -1 0 1 0 0 0 0 1          $East Driver Zone - Translation +
rotation of -PI/2
tr6  102.8  94.895 0  0 1 0 -1 0 0 0 0 1          $East Driver Zone - Translation +
rotation of +PI/2 (for 9 and 12 plates)
tr7  168.7 176.605 0  0 1 0 -1 0 0 0 0 1          $West Driver Zone - Translation +
rotation of +PI/2
tr8  168.7 176.605 0  0 -1 0 1 0 0 0 0 1          $West Driver Zone - Translation +
rotation of -PI/2 (for 9 and 12 plates)
tr9  71.3  176.605 0  0 1 0 -1 0 0 0 0 1          $Start-up source 1 - Translation +
rotation of +PI/2
c
c **********************
c SOURCE DEFINITIONS
c **********************
sdef cel=d1 erg=d2 rad=fcel d3 axs=fcel d4 ext=fcel d5
            x=fcel d6 y=fcel d7 z=fcel d8
c
c cell
si1  S d10 d11
sp1  1 1
si10 L 510:511:620
sp10 1
si11 L 110:111:206:207:410 110:111:216:217:420
       120:121:206:207:410 120:121:216:217:420
       130:131:206:207:410 130:131:216:217:420
       140:141:206:207:410 140:141:216:217:420
sp11 4 3 4 3 4 3 4 3
c
c erg
sp2 -3 0.988 2.249
c
c rad
ds3 s 30 0
si30 0 0.41
sp30 -21 1.0
c
c axs
ds4 s 40 0
si40 L 0 0 1
sp40 1
c
c ext
ds5 s 50 0
si50 90.7 140.7
sp50 0 1
c
c x
ds6 s 0 60
si60 -3.25 3.25
sp60 0 1
c
c y
ds7 s 0 70
si70 -0.0254 0.0254
sp70 0 1
c
c z
ds8 s 0 80
si80 85.7 145.7
sp80 0 1
c
c
c **********************
c TALLY DEFINITIONS
c **********************
```

```
c
c Radial flux, fission rate and power profile in the experimental zone
fc4 UO2 Radial flux & fission rate
f4:n (620<u=2<510)
fm4 (1) (-2.54226E+01 22 -6)
c
fc14 PuO2 (3.6%) Radial flux & fission rate
f14:n (630<u=3<510)
fm14 (1) (-2.55745E+01 23 -6)
c
fc24 PuO2 (4.0%) Radial flux & fission rate
f24:n (640<u=4<510)
fm24 (1) (-2.55745E+01 24 -6)
c
c Axial flux and fission chamber traverses (U-5 & Np-7)
fc34 Axial flux & fission rate
f34:n (662<u=6<510)
fm34 (1) (1 50 -6) (1 58 -6)
fs34  -800 -801 -802 -803 -804 -805 -806 -807 -808 -809
      -810 -811 -812 -813 -814 -815 -816 -817 -818 -819
      -820 -821 -822 -823 -824 -825 -826 -827 -828 -829
      -830 -831 -832 -833 -834 -835 -836 -837
sd34  (1.2723 38r)
c
c Spectral indices
f44:n (662<u=6<510)
fm44  (1 50 -6) (1 51 -6) (1 52 -6) (1 53 -6) (1 54 -6)
      (1 55 -6) (1 56 -6) (1 57 -6) (1 58 -6)
fs44 -816 -821
sd44  (21.6299 6.36173 21.6299)
c
c Axial flux and fission rate in the pins (17-18 and 17-21 (MOX 4%))
fc54 In pin Axial flux & fission rate
f54:n (640<511[1 0 0] 511[3 0 0]<510)
fm54 (1) (-1 24 -6)
fs54  -800 -801 -802 -803 -804 -805 -806 -807 -808 -809
      -810 -811 -812 -813 -814 -815 -816 -817 -818 -819
      -820 -821 -822 -823 -824 -825 -826 -827 -828 -829
      -830 -831 -832 -833 -834 -835 -836 -837
sd54  (1.0229 38r) (1.0229 38r)
c
c **********************
c RUN DEFINITIONS
c **********************
c
mode n
totnu
c kcode 1000 1.0 20 120 2000 0
kcode 100000 1.0 20 270 2000 0
prdmp 1j -240 1 2
lost 50 50
print
```

Appendix 2: REBUS input files

REBUS input files representative of the R1UO2 and R1MOX configuration are listed in this appendix. The listed files are:

- R1UO2 configuration with a calibration sample in the oscillation channel [UO2C]
- R1MOX configuration with the POLINE overclad in the oscillation channel [MOXI]

For the UO2H and MOXI files, special regions have been modeled to calculate South-North and SouthEast – NorthWest power profile traverses. The regions have the size of a pin cell (1.26×1.26 cm^2) to calculate an averaged fission rate on each pin cell of the traverses.

File UO2C

```
BLOCK=OLD
DATASET=ISOTXS
BLOCK=STP027
DATASET=A.BURN
01    R1UO2 loading - No Sample

  STORAGE AND CONVERGENCE CRITERIA SPECIFICATIONS:
   ... CONVERGENCE (eq: 0.001, 0.001, 0.0001; noneq: 0.001, 1.0, 1.0)
   ... REGION DENSITY ITER (1-init, 5-final), CYCLIC MODE ITER (eq)

02         0 54500     0       0.001         1.0         1.0     1     0
  02         0   860     0       0.001         1.0         1.0     1     0

  GENERAL PROBLEM DEFINITION DATA:
   PREVIOUS CYCLES, SHUTDOWN TIME, BEG TIME, CYCLE TIME,
    CONVERGENCE, SUBINTERVALS, OPERATIONS-1 (noneq)

03         0    0.0              0.0    0.0              1.0     0     0

  GENERAL FUEL MANAGEMENT SPECIFICATIONS:
   PATH LABEL, PRIMARY COMP, FUEL MGMT LABEL, BEG STAGE, END STAGE

35    PL     UO2  FML        1    01

  FUEL MANAGEMENT GROUP SPECIFICATIONS: FUEL MGMT LABEL, REGION/AREA LABEL

45    FML   F1CC

  ISOTOPIC CHAIN: ISOTOPE, TYPE, PRODUCT, YIELD FRACTION, ETC.
  REACTION TYPES: 0=NO REACTION, 1=(N,GAMMA), 2=(N,FISSION), 3=(N,P),
                  4=(N,ALPHA), 5=(N,2N), 6=(BETA- DECAY), 7=(BETA+ DECAY),
                  8=(ALPHA DECAY), 9=(N,D), 10=(N,T)

09    U235       0

  ISOTOPE EQUIVALENCE LIST: ISOTOPE, LIBRARY NAME

10    U235  EU5  0

  ACTIVE ISOTOPE DATA: ISOTOPE, BREEDING RATIO FLAG, ATOMIC MASS

24    U235       1           235.044


UNFORM=A.DIF3D
01 R1UO2 loading - No Sample
02 10 30
03 0 0 0 36100 50 0 1000000000 0 1 0 50
  02    999    5100
  03 0 0 0 36100 50 0 1000000000 5 1 1 100
  03 0 0 0 4500 50 0 1000000000 0 1 0 50
04 1 1 0 01 101 22 110 0 1 0 0
05 1.0-7  1.0-5  1.0-5
06 1.0 0.001 0.04 1.0

UNFORM=A.HMG4C
01  R1UO2 Loading- No Sample
02   100000 0 1 1
  02  5000000

DATASET=A.NIP3
01    R1UO2 Loading- No Sample
02               0     1    50     0     1     0     0     1     1     1
03              44
04               4     4     4     4     4     4

      ----MESH DEFINITIONS (TYPE-9 CARDS)----
      Core center is at (135.75, 135.75, 115.70)
      X DIMENSIONS - +X is North
09         X     6      30.07
09         X     2      34.75
09         X     1      35.05
09         X    16      67.25
09         X     4      75.35
09         X     1      75.62
09         X     1      75.75
09         X     3      80.20
09         X     3      83.33
```

09	X	1	83.65
09	X	8	91.04
09	X	1	91.75
09	X	8	98.75
09	X	1	99.85
09	X	7	106.46
09	X	1	106.85
09	X	1	107.95
09	X	8	114.95
09	X	1	114.96
09	X	1	116.05
09	X	1	116.22
09	X	1	117.48
09	X	1	118.74
09	X	1	120.00
09	X	1	121.26
09	X	1	122.52
09	X	1	123.05
09	X	1	123.78
09	X	1	124.15
09	X	1	125.04

Add-on for the east 12 plate

09	X	1	125.75

09	X	1	126.30
09	X	1	127.56
09	X	1	128.82
09	X	1	130.08
09	X	1	131.15
09	X	1	131.34
09	X	1	132.25
09	X	1	132.60
09	X	1	133.86
09	X	1	135.12
09	X	1	136.38
09	X	1	137.64
09	X	1	138.90
09	X	1	139.25
09	X	1	140.16
09	X	1	140.35
09	X	1	141.42
09	X	1	142.68
09	X	1	143.94
09	X	1	145.20

Add-on for the west 12 plate

09	X	1	145.75

09	X	1	146.46
09	X	1	147.35
09	X	1	147.72
09	X	1	148.45
09	X	1	148.98
09	X	1	150.24
09	X	1	151.50
09	X	1	152.76
09	X	1	154.02
09	X	1	155.28
09	X	1	155.45
09	X	1	156.54
09	X	1	156.55
09	X	8	163.55
09	X	1	164.65
09	X	1	165.04
09	X	7	171.65
09	X	1	172.75
09	X	8	179.75
09	X	1	180.46
09	X	8	187.85
09	X	1	188.17
09	X	2	191.30
09	X	2	195.75
09	X	1	195.88
09	X	1	196.15
09	X	16	228.65
09	X	4	236.45
09	X	2	241.43
09	X	6	271.50

Y DIMENSIONS - +Y is West

09	Y	6	30.07
09	Y	3	35.05
09	Y	4	43.05
09	Y	16	75.55
09	Y	1	75.62
09	Y	1	75.75
09	Y	3	80.20
09	Y	1	80.25
09	Y	2	83.33
09	Y	1	83.65
09	Y	8	91.04
09	Y	1	91.75
09	Y	8	98.75
09	Y	1	99.85
09	Y	8	106.85
09	Y	1	107.95
09	Y	8	114.95
09	Y	1	114.96
09	Y	1	116.05
09	Y	1	116.22
09	Y	1	117.48
09	Y	1	118.74
09	Y	1	120.00

Add-on for the south 9 plate

09	Y	1	120.05

09	Y	1	121.26
09	Y	1	122.52
09	Y	1	123.05
09	Y	1	123.78
09	Y	1	124.15
09	Y	1	125.04
09	Y	1	126.30
09	Y	1	127.56
09	Y	1	128.82
09	Y	1	130.08
09	Y	1	131.15
09	Y	1	131.34
09	Y	1	132.25
09	Y	1	132.60
09	Y	1	133.86
09	Y	1	135.12
09	Y	1	136.38
09	Y	1	137.64
09	Y	1	138.90
09	Y	1	139.25
09	Y	1	140.16
09	Y	1	140.35
09	Y	1	141.42
09	Y	1	142.68

Add-on for the north 9 plate

09	Y	1	143.35

09	Y	1	143.94
09	Y	1	145.20
09	Y	1	146.46
09	Y	1	147.35
09	Y	1	147.72
09	Y	1	148.45
09	Y	1	148.98
09	Y	1	150.24
09	Y	1	151.50
09	Y	1	152.76
09	Y	1	154.02
09	Y	1	155.28
09	Y	1	155.45
09	Y	1	156.54
09	Y	1	156.55
09	Y	8	163.55
09	Y	1	164.65
09	Y	8	171.65
09	Y	1	172.75
09	Y	8	179.75
09	Y	1	180.46
09	Y	8	187.85
09	Y	1	188.17
09	Y	2	191.25
09	Y	1	191.30
09	Y	2	195.75

```
09         Y     1      195.88
09         Y    12      220.35
09         Y     8      236.45
09         Y     2      241.43
09         Y     6      271.50

      Z DIMENSIONS - +Z is Up
09         Z     2       22.10
09         Z     3       62.40
09         Z     2       70.80
09         Z     1       73.05
09         Z     1       73.40
09         Z     1      73.825
09         Z     1       75.20
09         Z     2       77.70
09         Z     1       78.40
09         Z     2      80.525
09         Z     2       82.10
09         Z     2       84.40
09         Z     2       85.70
09         Z     3       90.70

  Add-on for the interface Fuel/Plexi
09         Z     9       93.70

09         Z    17     110.525
09         Z    10     120.875

  Add-on for the interface Fuel/Plexi
09         Z    17      137.70

09         Z     9      140.70
09         Z     5      145.35
09         Z     1      145.70
09         Z     2      146.95
09         Z     2      148.30
09         Z     5      153.40
09         Z     1      153.70
09         Z     1      154.30
09         Z     1      154.40
09         Z     1      154.70
09         Z     1      156.70
09         Z     2     161.225
09         Z     1      163.10
09         Z     6      220.00


      ----REGION DEFINITIONS (TYPE-6 CARDS)----

      ----DRIVER ZONE----
      ----GENERAL----
06    TANK         0.00      271.50     0   116       0.00      271.50
06    TABLE       30.07      241.43     0     2      30.07      241.43

      ----CAISSONS----
06    NCAIS      172.75      195.88     2     5      98.75      236.45
06    SCAIS       75.62       98.75     2     5      35.05      172.75
06    ECAIS       98.75      236.45     2     5      75.62       98.75
06    WCAIS       35.05      172.75     2     5     172.75      195.88

      ----GRID PLATES----
06    NGRID      172.75      195.88     5    14      98.75      236.45
06    SGRID       75.62       98.75     5    14      35.05      172.75
06    EGRID       98.75      236.45     5    14      75.62       98.75
06    WGRID       35.05      172.75     5    14     172.75      195.88

      ----LARGE GRAPHITE BLOCKS----
      -----NOTATION - NLG NORTH LARGE GRAPHITE
      -----          - C-CAISSON, B-BLOCK: GRAPHITE + ALUMINUM CLAD
06    NLGC       195.88      241.43     2     9      98.75      191.30
06    NLGB       195.88      241.43     9   105      98.75      191.30

06    SLGC        30.07       75.62     2     9      80.20      172.75
06    SLGB        30.07       75.62     9   105      80.20      172.75

06    ELGC        98.75      191.30     2     9      30.07       75.62
06    ELGB        98.75      191.30     9   105      30.07       75.62

06    WLGC        80.20      172.75     2     9     195.88      241.43
06    WLGB        80.20      172.75     9   105     195.88      241.43
```

```
        ----MEDIUM AND SMALL GRAPHITE BLOCKS----
        -----NOTATION - NMG NORTH MEDIUM GRAPHITE, A-AL CLAD, G-GRAPHITE
06      NMGB         196.15      228.65    14   102        75.75        98.75
06      SMGB          34.75       67.25    14   102       172.75       195.75
06      EMGB          75.75       98.75    14   102        43.05        75.55
06      WMGB         172.75      195.75    14   102       187.85       220.35

06      NSGB         187.85      196.15    14   102        80.25        98.75
06      SSGB          75.35       83.65    14   102       172.75       191.25

        ----NORTH REGION OF DRIVER ZONE----
        ----GRAPHITE ELEMENT
        ----NOTATION NG0 NORTH GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
        ----         NG1 NORTH GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
        ----         NG2 NORTH GRAPHITE ZONE 2 (REST OF THE ZONE)
        ----         AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06      NG2AL        172.75      195.88     5    18        98.75       187.85
06      NG2G         172.75      195.88    18    92        98.75       187.85
06      NG2AU        172.75      195.88    92    97        98.75       187.85

06      NG1AL        172.75      188.17     5    18        98.75       171.65
06      NG1G         172.75      188.17    18    92        98.75       171.65
06      NG1AU        172.75      188.17    92    97        98.75       171.65

06      NG0AL        188.17      195.88     5    18       131.15       147.35
06      NG0G         188.17      195.88    18    92       131.15       147.35
06      NG0AU        188.17      195.88    92    97       131.15       147.35

        ----FUEL ELEMENT
        ----NOTATION N01 - NORTH 1 OF 9 NUMBERED FROM INNER ROW - LEFT SIDE
        ----LAST LETTER IS REGION IN Z DIRECTION
        ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06      N01B         172.75      180.46     5    20       106.85       114.95
06      N01AL        172.75      180.46    20    22       106.85       114.95
06      N01F         172.75      180.46    22    93       106.85       114.95
06      N01AU        172.75      180.46    93    95       106.85       114.95
06      N01WU        172.75      180.46    95    97       106.85       114.95

06      N02B         172.75      180.46     5    20       114.95       123.05
06      N02AL        172.75      180.46    20    22       114.95       123.05
06      N02F         172.75      180.46    22    93       114.95       123.05
06      N02AU        172.75      180.46    93    95       114.95       123.05
06      N02WU        172.75      180.46    95    97       114.95       123.05

06      N03B         172.75      180.46     5    20       123.05       131.15
06      N03AL        172.75      180.46    20    22       123.05       131.15
06      N03F         172.75      180.46    22    93       123.05       131.15
06      N03AU        172.75      180.46    93    95       123.05       131.15
06      N03WU        172.75      180.46    95    97       123.05       131.15

06      N04B         172.75      180.46     5    20       131.15       139.25
06      N04AL        172.75      180.46    20    22       131.15       139.25
06      N04F         172.75      180.46    22    93       131.15       139.25
06      N04AU        172.75      180.46    93    95       131.15       139.25
06      N04WU        172.75      180.46    95    97       131.15       139.25

06      N05B         172.75      180.46     5    20       139.25       147.35
06      N05AL        172.75      180.46    20    22       139.25       147.35
06      N05F         172.75      180.46    22    93       139.25       147.35
06      N05AU        172.75      180.46    93    95       139.25       147.35
06      N05WU        172.75      180.46    95    97       139.25       147.35

06      N06B         172.75      180.46     5    20       147.35       155.45
06      N06AL        172.75      180.46    20    22       147.35       155.45
06      N06F         172.75      180.46    22    93       147.35       155.45
06      N06AU        172.75      180.46    93    95       147.35       155.45
06      N06WU        172.75      180.46    95    97       147.35       155.45

06      N07B         172.75      180.46     5    20       155.45       163.55
06      N07AL        172.75      180.46    20    22       155.45       163.55
06      N07F         172.75      180.46    22    93       155.45       163.55
06      N07AU        172.75      180.46    93    95       155.45       163.55
06      N07WU        172.75      180.46    95    97       155.45       163.55

06      N08B         180.46      188.17     5    20       131.15       139.25
06      N08AL        180.46      188.17    20    22       131.15       139.25
06      N08F         180.46      188.17    22    93       131.15       139.25
06      N08AU        180.46      188.17    93    95       131.15       139.25
06      N08WU        180.46      188.17    95    97       131.15       139.25

06      N09B         180.46      188.17     5    20       139.25       147.35
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06    N09AL       180.46      188.17    20    22      139.25      147.35
06    N09F        180.46      188.17    22    93      139.25      143.35
06    N09GR       180.46      188.17    22    93      143.35      147.35
06    N09AU       180.46      188.17    93    95      139.25      147.35
06    N09WU       180.46      188.17    95    97      139.25      147.35


      ----SOUTH REGION OF DRIVER ZONE----
      ----GRAPHITE ELEMENT
      ----NOTATION SG0 SOUTH GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
      ----         SG1 SOUTH GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
      ----         SG2 SOUTH GRAPHITE ZONE 2 (REST OF THE ZONE)
      ----         AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06    SG2AL        75.62       98.75     5    18       75.55      172.75
06    SG2G         75.62       98.75    18    92       75.55      172.75
06    SG2AU        75.62       98.75    92    97       75.55      172.75

06    SG1AL        83.33       98.75     5    18       99.85      172.75
06    SG1G         83.33       98.75    18    92       99.85      172.75
06    SG1AU        83.33       98.75    92    97       99.85      172.75

06    SG0AL        75.62       83.33     5    18      116.05      132.25
06    SG0G         75.62       83.33    18    92      116.05      132.25
06    SG0AU        75.62       83.33    92    97      116.05      132.25

      ----FUEL ELEMENT
      ----NOTATION S01 - SOUTH 1 OF 9 NUMBERED FROM INNER ROW - LEFT SIDE
      ----LAST LETTER IS REGION IN Z DIRECTION
      ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06    S01B         91.04       98.75     5    20      156.55      164.65
06    S01AL        91.04       98.75    20    22      156.55      164.65
06    S01F         91.04       98.75    22    93      156.55      164.65
06    S01AU        91.04       98.75    93    95      156.55      164.65
06    S01WU        91.04       98.75    95    97      156.55      164.65

06    S02B         91.04       98.75     5    20      148.45      156.55
06    S02AL        91.04       98.75    20    22      148.45      156.55
06    S02F         91.04       98.75    22    93      148.45      156.55
06    S02AU        91.04       98.75    93    95      148.45      156.55
06    S02WU        91.04       98.75    95    97      148.45      156.55

06    S03B         91.04       98.75     5    20      140.35      148.45
06    S03AL        91.04       98.75    20    22      140.35      148.45
06    S03F         91.04       98.75    22    93      140.35      148.45
06    S03AU        91.04       98.75    93    95      140.35      148.45
06    S03WU        91.04       98.75    95    97      140.35      148.45

06    S04B         91.04       98.75     5    20      132.25      140.35
06    S04AL        91.04       98.75    20    22      132.25      140.35
06    S04F         91.04       98.75    22    93      132.25      140.35
06    S04AU        91.04       98.75    93    95      132.25      140.35
06    S04WU        91.04       98.75    95    97      132.25      140.35

06    S05B         91.04       98.75     5    20      124.15      132.25
06    S05AL        91.04       98.75    20    22      124.15      132.25
06    S05F         91.04       98.75    22    93      124.15      132.25
06    S05AU        91.04       98.75    93    95      124.15      132.25
06    S05WU        91.04       98.75    95    97      124.15      132.25

06    S06B         91.04       98.75     5    20      116.05      124.15
06    S06AL        91.04       98.75    20    22      116.05      124.15
06    S06F         91.04       98.75    22    93      116.05      124.15
06    S06AU        91.04       98.75    93    95      116.05      124.15
06    S06WU        91.04       98.75    95    97      116.05      124.15

06    S07B         91.04       98.75     5    20      107.95      116.05
06    S07AL        91.04       98.75    20    22      107.95      116.05
06    S07F         91.04       98.75    22    93      107.95      116.05
06    S07AU        91.04       98.75    93    95      107.95      116.05
06    S07WU        91.04       98.75    95    97      107.95      116.05

06    S08B         83.33       91.04     5    20      124.15      132.25
06    S08AL        83.33       91.04    20    22      124.15      132.25
06    S08F         83.33       91.04    22    93      124.15      132.25
06    S08AU        83.33       91.04    93    95      124.15      132.25
06    S08WU        83.33       91.04    95    97      124.15      132.25

06    S09B         83.33       91.04     5    20      116.05      124.15
06    S09AL        83.33       91.04    20    22      116.05      124.15
06    S09F         83.33       91.04    22    93      120.05      124.15
06    S09GR        83.33       91.04    22    93      116.05      120.05
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06    S09AU         83.33        91.04    93    95       116.05      124.15
06    S09WU         83.33        91.04    95    97       116.05      124.15

      ----EAST REGION OF DRIVER ZONE----
      ----GRAPHITE ELEMENT
      ----NOTATION EG0 EAST GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
      ----          EG1 EAST GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
      ----          EG2 EAST GRAPHITE ZONE 2 (REST OF THE ZONE)
      ----          AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06    EG2AL         98.75       187.85     5    18        75.62       98.75
06    EG2G          98.75       187.85    18    92        75.62       98.75
06    EG2AU         98.75       187.85    92    97        75.62       98.75

06    EG1AL         98.75       171.65     5    18        83.33       98.75
06    EG1G          98.75       171.65    18    92        83.33       98.75
06    EG1AU         98.75       171.65    92    97        83.33       98.75

06    EG0AL        123.05       139.25     5    18        75.62       83.33
06    EG0G         123.05       139.25    18    92        75.62       83.33
06    EG0AU        123.05       139.25    92    97        75.62       83.33

      ----FUEL ELEMENT
      ----NOTATION E01 - EAST 1 OF 9 NUMBERED FROM INNER ROW - LEFT SIDE
      ----LAST LETTER IS REGION IN Z DIRECTION
      ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06    E01B         106.85       114.95     5    20        91.04       98.75
06    E01AL        106.85       114.95    20    22        91.04       98.75
06    E01F         106.85       114.95    22    93        91.04       98.75
06    E01AU        106.85       114.95    93    95        91.04       98.75
06    E01WU        106.85       114.95    95    97        91.04       98.75

06    E02B         114.95       123.05     5    20        91.04       98.75
06    E02AL        114.95       123.05    20    22        91.04       98.75
06    E02F         114.95       123.05    22    93        91.04       98.75
06    E02AU        114.95       123.05    93    95        91.04       98.75
06    E02WU        114.95       123.05    95    97        91.04       98.75

06    E03B         123.05       131.15     5    20        91.04       98.75
06    E03AL        123.05       131.15    20    22        91.04       98.75
06    E03F         123.05       131.15    22    93        91.04       98.75
06    E03AU        123.05       131.15    93    95        91.04       98.75
06    E03WU        123.05       131.15    95    97        91.04       98.75

06    E04B         131.15       139.25     5    20        91.04       98.75
06    E04AL        131.15       139.25    20    22        91.04       98.75
06    E04F         131.15       139.25    22    93        91.04       98.75
06    E04AU        131.15       139.25    93    95        91.04       98.75
06    E04WU        131.15       139.25    95    97        91.04       98.75

06    E05B         139.25       147.35     5    20        91.04       98.75
06    E05AL        139.25       147.35    20    22        91.04       98.75
06    E05F         139.25       147.35    22    93        91.04       98.75
06    E05AU        139.25       147.35    93    95        91.04       98.75
06    E05WU        139.25       147.35    95    97        91.04       98.75

06    E06B         147.35       155.45     5    20        91.04       98.75
06    E06AL        147.35       155.45    20    22        91.04       98.75
06    E06F         147.35       155.45    22    93        91.04       98.75
06    E06AU        147.35       155.45    93    95        91.04       98.75
06    E06WU        147.35       155.45    95    97        91.04       98.75

06    E07B         155.45       163.55     5    20        91.04       98.75
06    E07AL        155.45       163.55    20    22        91.04       98.75
06    E07F         155.45       163.55    22    93        91.04       98.75
06    E07AU        155.45       163.55    93    95        91.04       98.75
06    E07WU        155.45       163.55    95    97        91.04       98.75

06    E08B         123.05       131.15     5    20        83.33       91.04
06    E08AL        123.05       131.15    20    22        83.33       91.04
06    E08F         125.75       131.15    22    93        83.33       91.04
06    E08GR        123.05       125.75    22    93        83.33       91.04
06    E08AU        123.05       131.15    93    95        83.33       91.04
06    E08WU        123.05       131.15    95    97        83.33       91.04

06    E09B         131.15       139.25     5    20        83.33       91.04
06    E09AL        131.15       139.25    20    22        83.33       91.04
06    E09F         131.15       139.25    22    93        83.33       91.04
06    E09AU        131.15       139.25    93    95        83.33       91.04
06    E09WU        131.15       139.25    95    97        83.33       91.04
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        ----WEST REGION OF DRIVER ZONE----
        ----GRAPHITE ELEMENT
        ----NOTATION WG0 WEST GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
        ----         WG1 WEST GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
        ----         WG2 WEST GRAPHITE ZONE 2 (REST OF THE ZONE)
        ----         AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06      WG2AL         83.65      172.75     5     18       172.75      195.88
06      WG2G          83.65      172.75    18     92       172.75      195.88
06      WG2AU         83.65      172.75    92     97       172.75      195.88

06      WG1AL         99.85      172.75     5     18       172.75      188.17
06      WG1G          99.85      172.75    18     92       172.75      188.17
06      WG1AU         99.85      172.75    92     97       172.75      188.17

06      WG0AL        132.25      148.45     5     18       188.17      195.88
06      WG0G         132.25      148.45    18     92       188.17      195.88
06      WG0AU        132.25      148.45    92     97       188.17      195.88

        ----FUEL ELEMENT
        ----NOTATION W01 - WEST 1 OF 9 NUMBERED FROM INNER ROW - LEFT SIDE
        ----LAST LETTER IS REGION IN Z DIRECTION
        ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06      W01B         156.55      164.65     5     20       172.75      180.46
06      W01AL        156.55      164.65    20     22       172.75      180.46
06      W01F         156.55      164.65    22     93       172.75      180.46
06      W01AU        156.55      164.65    93     95       172.75      180.46
06      W01WU        156.55      164.65    95     97       172.75      180.46

06      W02B         148.45      156.55     5     20       172.75      180.46
06      W02AL        148.45      156.55    20     22       172.75      180.46
06      W02F         148.45      156.55    22     93       172.75      180.46
06      W02AU        148.45      156.55    93     95       172.75      180.46
06      W02WU        148.45      156.55    95     97       172.75      180.46

06      W03B         140.35      148.45     5     20       172.75      180.46
06      W03AL        140.35      148.45    20     22       172.75      180.46
06      W03F         140.35      148.45    22     93       172.75      180.46
06      W03AU        140.35      148.45    93     95       172.75      180.46
06      W03WU        140.35      148.45    95     97       172.75      180.46

06      W04B         132.25      140.35     5     20       172.75      180.46
06      W04AL        132.25      140.35    20     22       172.75      180.46
06      W04F         132.25      140.35    22     93       172.75      180.46
06      W04AU        132.25      140.35    93     95       172.75      180.46
06      W04WU        132.25      140.35    95     97       172.75      180.46

06      W05B         124.15      132.25     5     20       172.75      180.46
06      W05AL        124.15      132.25    20     22       172.75      180.46
06      W05F         124.15      132.25    22     93       172.75      180.46
06      W05AU        124.15      132.25    93     95       172.75      180.46
06      W05WU        124.15      132.25    95     97       172.75      180.46

06      W06B         116.05      124.15     5     20       172.75      180.46
06      W06AL        116.05      124.15    20     22       172.75      180.46
06      W06F         116.05      124.15    22     93       172.75      180.46
06      W06AU        116.05      124.15    93     95       172.75      180.46
06      W06WU        116.05      124.15    95     97       172.75      180.46

06      W07B         107.95      116.05     5     20       172.75      180.46
06      W07AL        107.95      116.05    20     22       172.75      180.46
06      W07F         107.95      116.05    22     93       172.75      180.46
06      W07AU        107.95      116.05    93     95       172.75      180.46
06      W07WU        107.95      116.05    95     97       172.75      180.46

06      W08B         140.35      148.45     5     20       180.46      188.17
06      W08AL        140.35      148.45    20     22       180.46      188.17
06      W08F         140.35      145.75    22     93       180.46      188.17
06      W08GR        145.75      148.45    22     93       180.46      188.17
06      W08AU        140.35      148.45    93     95       180.46      188.17
06      W08WU        140.35      148.45    95     97       180.46      188.17

06      W09B         132.25      140.35     5     20       180.46      188.17
06      W09AL        132.25      140.35    20     22       180.46      188.17
06      W09F         132.25      140.35    22     93       180.46      188.17
06      W09AU        132.25      140.35    93     95       180.46      188.17
06      W09WU        132.25      140.35    95     97       180.46      188.17


        ----EXPERIMENTAL ZONE----
        ----WEDGE IS THE ALUMINUM CORNERS OUTSIDE THE CHIMNEY
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      ----PLATES INSIDE THE CHIMNEY : SSL- LOWER SS PLATES,

06    EZONE        98.75      172.75     2   116       98.75      172.75
06    WEDGE        98.75      172.75     5    97       98.75      172.75

      ----ANGLE GRAPHITE ELEMENTS----
      ----NOTATION G-GRAPHITE ELEMENT, 1-ELEMENT ARE NUMBERED 1-4
      ----AXIAL LOCATION AL-LOWER AL CLAD, AU-UPPER AL CLAD, G-GRAPHITE
06    G1AL        165.04      172.75     5    18      164.65      172.75
06    G1G         165.04      172.75    18    92      164.65      172.75
06    G1AU        165.04      172.75    92    97      164.65      172.75

06    G2AL         98.75      106.46     5    18       98.75      106.85
06    G2G          98.75      106.46    18    92       98.75      106.85
06    G2AU         98.75      106.46    92    97       98.75      106.85

06    G3AL        165.04      172.75     5    18       98.75      106.85
06    G3G         165.04      172.75    18    92       98.75      106.85
06    G3AU        165.04      172.75    92    97       98.75      106.85

06    G4AL         98.75      106.46     5    18      164.65      172.75
06    G4G          98.75      106.46    18    92      164.65      172.75
06    G4AU         98.75      106.46    92    97      164.65      172.75

      ----ALUMINUM MASSIF----
      ----NOTATION ALB-ALUMINUM BLOCK, A-E ARE AXIAL SEGMENTS
06    ALBA        106.85      164.65     0     7      106.85      164.65
06    ALBB        106.85      164.65     7     8      106.85      164.65
06    ALBC        106.85      164.65     8   106      106.85      164.65
06    ALBD        106.85      164.65   106   107      106.85      164.65
06    ALBE        106.85      164.65   107   110      106.85      164.65

      ----CHIMNEY PIECES----
      ----NOTATION CHI-CHIMNEY, 1-PIECES ARE NUMBERED 1-8
      ----A-G ARE AXIAL SEGMENTS EXCEPT FOR T- TABLE

06    CHI1T       164.65      172.75     0     2      114.95      156.55
06    CHI1A       164.65      172.75     2     7      114.95      156.55
06    CHI1B       164.65      172.75     7     8      114.95      156.55
06    CHI1C       164.65      172.75     8    97      114.95      156.55
06    CHI1D       164.65      172.75    97   106      114.95      156.55
06    CHI1E       164.65      172.75   106   107      114.95      156.55
06    CHI1F       164.65      172.75   107   110      114.95      156.55

06    CHI2T        98.75      106.85     0     2      114.95      156.55
06    CHI2A        98.75      106.85     2     7      114.95      156.55
06    CHI2B        98.75      106.85     7     8      114.95      156.55
06    CHI2C        98.75      106.85     8    97      114.95      156.55
06    CHI2D        98.75      106.85    97   106      114.95      156.55
06    CHI2E        98.75      106.85   106   107      114.95      156.55
06    CHI2F        98.75      106.85   107   110      114.95      156.55

06    CHI3T       114.95      156.55     0     2       98.75      106.85
06    CHI3A       114.95      156.55     2     7       98.75      106.85
06    CHI3B       114.95      156.55     7     8       98.75      106.85
06    CHI3C       114.95      156.55     8    97       98.75      106.85
06    CHI3D       114.95      156.55    97   106       98.75      106.85
06    CHI3E       114.95      156.55   106   107       98.75      106.85
06    CHI3F       114.95      156.55   107   110       98.75      106.85

06    CHI4T       114.95      156.55     0     2      164.65      172.75
06    CHI4A       114.95      156.55     2     7      164.65      172.75
06    CHI4B       114.95      156.55     7     8      164.65      172.75
06    CHI4C       114.95      156.55     8    97      164.65      172.75
06    CHI4D       114.95      156.55    97   106      164.65      172.75
06    CHI4E       114.95      156.55   106   107      164.65      172.75
06    CHI4F       114.95      156.55   107   110      164.65      172.75

06    CHI5T       156.55      164.65     0     2      156.55      164.65
06    CHI5A       156.55      164.65     2     7      156.55      164.65
06    CHI5B       156.55      164.65     7     8      156.55      164.65
06    CHI5C       156.55      164.65     8    97      156.55      164.65
06    CHI5D       156.55      164.65    97   106      156.55      164.65
06    CHI5E       156.55      164.65   106   107      156.55      164.65
06    CHI5F       156.55      164.65   107   110      156.55      164.65

06    CHI6T       106.85      114.95     0     2      106.85      114.95
06    CHI6A       106.85      114.95     2     7      106.85      114.95
06    CHI6B       106.85      114.95     7     8      106.85      114.95
06    CHI6C       106.85      114.95     8    97      106.85      114.95
06    CHI6D       106.85      114.95    97   106      106.85      114.95
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06    CHI6E        106.85      114.95   106   107      106.85      114.95
06    CHI6F        106.85      114.95   107   110      106.85      114.95

06    CHI7T        156.55      164.65     0     2      106.85      114.95
06    CHI7A        156.55      164.65     2     7      106.85      114.95
06    CHI7B        156.55      164.65     7     8      106.85      114.95
06    CHI7C        156.55      164.65     8    97      106.85      114.95
06    CHI7D        156.55      164.65    97   106      106.85      114.95
06    CHI7E        156.55      164.65   106   107      106.85      114.95
06    CHI7F        156.55      164.65   107   110      106.85      114.95

06    CHI8T        106.85      114.95     0     2      156.55      164.65
06    CHI8A        106.85      114.95     2     7      156.55      164.65
06    CHI8B        106.85      114.95     7     8      156.55      164.65
06    CHI8C        106.85      114.95     8    97      156.55      164.65
06    CHI8D        106.85      114.95    97   106      156.55      164.65
06    CHI8E        106.85      114.95   106   107      156.55      164.65
06    CHI8F        106.85      114.95   107   110      156.55      164.65


      ----ELEMENTS IN MELODIE R1UO2 CONFIGURATION----

      ----R1UO2 FUEL PINS
      ----1 CENTRAL ZONE, 2 ZONES ON EACH SIDE
      ----NOTATION: F1C- FUEL TYPE-1 CENTRAL REGION
      ----F1W1- REGION WEST 1, F1W2- REGION WEST 2 ...
      ----A LAST LETTER (A-Z) GIVES THE AXIAL LOCATION EXCEPT
      ----SS-STAINLESS STEEL LOWER PLATE, W-LOWER WATER
06    F1CW         122.52      148.98     0     7      122.52      148.98
06    F1CSS        122.52      148.98     7     8      122.52      148.98
06    F1CA         122.52      148.98     8    13      122.52      148.98
06    F1CB         122.52      148.98    13    25      122.52      148.98
06    F1CC         122.52      148.98    25    87      122.52      148.98
06    F1CD         122.52      148.98    87   103      122.52      148.98
06    F1CE         122.52      148.98   103   107      122.52      148.98
06    F1CF         122.52      148.98   107   110      122.52      148.98

06    F1N1W        148.98      152.76     0     7      122.52      148.98
06    F1N1SS       148.98      152.76     7     8      122.52      148.98
06    F1N1A        148.98      152.76     8    13      122.52      148.98
06    F1N1B        148.98      152.76    13    25      122.52      148.98
06    F1N1C        148.98      152.76    25    87      122.52      148.98
06    F1N1D        148.98      152.76    87   103      122.52      148.98
06    F1N1E        148.98      152.76   103   107      122.52      148.98
06    F1N1F        148.98      152.76   107   110      122.52      148.98

06    F1N2W        152.76      156.54     0     7      130.08      141.42
06    F1N2SS       152.76      156.54     7     8      130.08      141.42
06    F1N2A        152.76      156.54     8    13      130.08      141.42
06    F1N2B        152.76      156.54    13    25      130.08      141.42
06    F1N2C        152.76      156.54    25    87      130.08      141.42
06    F1N2D        152.76      156.54    87   103      130.08      141.42
06    F1N2E        152.76      156.54   103   107      130.08      141.42
06    F1N2F        152.76      156.54   107   110      130.08      141.42

06    F1S1W        118.74      122.52     0     7      122.52      148.98
06    F1S1SS       118.74      122.52     7     8      122.52      148.98
06    F1S1A        118.74      122.52     8    13      122.52      148.98
06    F1S1B        118.74      122.52    13    25      122.52      148.98
06    F1S1C        118.74      122.52    25    87      122.52      148.98
06    F1S1D        118.74      122.52    87   103      122.52      148.98
06    F1S1E        118.74      122.52   103   107      122.52      148.98
06    F1S1F        118.74      122.52   107   110      122.52      148.98

06    F1S2W        114.96      118.74     0     7      130.08      141.42
06    F1S2SS       114.96      118.74     7     8      130.08      141.42
06    F1S2A        114.96      118.74     8    13      130.08      141.42
06    F1S2B        114.96      118.74    13    25      130.08      141.42
06    F1S2C        114.96      118.74    25    87      130.08      141.42
06    F1S2D        114.96      118.74    87   103      130.08      141.42
06    F1S2E        114.96      118.74   103   107      130.08      141.42
06    F1S2F        114.96      118.74   107   110      130.08      141.42

06    F1E1W        122.52      148.98     0     7      118.74      122.52
06    F1E1SS       122.52      148.98     7     8      118.74      122.52
06    F1E1A        122.52      148.98     8    13      118.74      122.52
06    F1E1B        122.52      148.98    13    25      118.74      122.52
06    F1E1C        122.52      148.98    25    87      118.74      122.52
06    F1E1D        122.52      148.98    87   103      118.74      122.52
06    F1E1E        122.52      148.98   103   107      118.74      122.52
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06	F1E1F	122.52	148.98	107	110	118.74	122.52
06	F1E2W	130.08	141.42	0	7	114.96	118.74
06	F1E2SS	130.08	141.42	7	8	114.96	118.74
06	F1E2A	130.08	141.42	8	13	114.96	118.74
06	F1E2B	130.08	141.42	13	25	114.96	118.74
06	F1E2C	130.08	141.42	25	87	114.96	118.74
06	F1E2D	130.08	141.42	87	103	114.96	118.74
06	F1E2E	130.08	141.42	103	107	114.96	118.74
06	F1E2F	130.08	141.42	107	110	114.96	118.74
06	F1W1W	122.52	148.98	0	7	148.98	152.76
06	F1W1SS	122.52	148.98	7	8	148.98	152.76
06	F1W1A	122.52	148.98	8	13	148.98	152.76
06	F1W1B	122.52	148.98	13	25	148.98	152.76
06	F1W1C	122.52	148.98	25	87	148.98	152.76
06	F1W1D	122.52	148.98	87	103	148.98	152.76
06	F1W1E	122.52	148.98	103	107	148.98	152.76
06	F1W1F	122.52	148.98	107	110	148.98	152.76
06	F1W2W	130.08	141.42	0	7	152.76	156.54
06	F1W2SS	130.08	141.42	7	8	152.76	156.54
06	F1W2A	130.08	141.42	8	13	152.76	156.54
06	F1W2B	130.08	141.42	13	25	152.76	156.54
06	F1W2C	130.08	141.42	25	87	152.76	156.54
06	F1W2D	130.08	141.42	87	103	152.76	156.54
06	F1W2E	130.08	141.42	103	107	152.76	156.54
06	F1W2F	130.08	141.42	107	110	152.76	156.54

----R1UO2 ALUMINUM PINS
----NOTATION: ALC- FUEL TYPE-1 CENTRAL REGION
----ALW1- AL PIN #1 REGION WEST , NUMBERED FROM LEFT AND INNER MOST
----A LAST LETTER (A-Z) GIVES THE AXIAL LOCATION EXCEPT
----SS-STAINLESS STEEL LOWER PLATE, W-LOWER WATER

06	ALN1W	151.50	152.76	0	7	147.72	148.98
06	ALN1SS	151.50	152.76	7	8	147.72	148.98
06	ALN1A	151.50	152.76	8	11	147.72	148.98
06	ALN1B	151.50	152.76	11	106	147.72	148.98
06	ALN1C	151.50	152.76	106	107	147.72	148.98
06	ALN1D	151.50	152.76	107	110	147.72	148.98
06	ALN2W	151.50	152.76	0	7	122.52	123.78
06	ALN2SS	151.50	152.76	7	8	122.52	123.78
06	ALN2A	151.50	152.76	8	11	122.52	123.78
06	ALN2B	151.50	152.76	11	106	122.52	123.78
06	ALN2C	151.50	152.76	106	107	122.52	123.78
06	ALN2D	151.50	152.76	107	110	122.52	123.78
06	ALN3W	155.28	156.54	0	7	138.90	141.42
06	ALN3SS	155.28	156.54	7	8	138.90	141.42
06	ALN3A	155.28	156.54	8	11	138.90	141.42
06	ALN3B	155.28	156.54	11	106	138.90	141.42
06	ALN3C	155.28	156.54	106	107	138.90	141.42
06	ALN3D	155.28	156.54	107	110	138.90	141.42
06	ALN4W	155.28	156.54	0	7	130.08	132.60
06	ALN4SS	155.28	156.54	7	8	130.08	132.60
06	ALN4A	155.28	156.54	8	11	130.08	132.60
06	ALN4B	155.28	156.54	11	106	130.08	132.60
06	ALN4C	155.28	156.54	106	107	130.08	132.60
06	ALN4D	155.28	156.54	107	110	130.08	132.60
06	ALS1W	118.74	120.00	0	7	122.52	123.78
06	ALS1SS	118.74	120.00	7	8	122.52	123.78
06	ALS1A	118.74	120.00	8	11	122.52	123.78
06	ALS1B	118.74	120.00	11	106	122.52	123.78
06	ALS1C	118.74	120.00	106	107	122.52	123.78
06	ALS1D	118.74	120.00	107	110	122.52	123.78
06	ALS2W	118.74	120.00	0	7	147.72	148.98
06	ALS2SS	118.74	120.00	7	8	147.72	148.98
06	ALS2A	118.74	120.00	8	11	147.72	148.98
06	ALS2B	118.74	120.00	11	106	147.72	148.98
06	ALS2C	118.74	120.00	106	107	147.72	148.98
06	ALS2D	118.74	120.00	107	110	147.72	148.98
06	ALS3W	114.96	116.22	0	7	130.08	132.60
06	ALS3SS	114.96	116.22	7	8	130.08	132.60
06	ALS3A	114.96	116.22	8	11	130.08	132.60
06	ALS3B	114.96	116.22	11	106	130.08	132.60

06	ALS3C	114.96	116.22	106	107	130.08	132.60
06	ALS3D	114.96	116.22	107	110	130.08	132.60
06	ALS4W	114.96	116.22	0	7	138.90	141.42
06	ALS4SS	114.96	116.22	7	8	138.90	141.42
06	ALS4A	114.96	116.22	8	11	138.90	141.42
06	ALS4B	114.96	116.22	11	106	138.90	141.42
06	ALS4C	114.96	116.22	106	107	138.90	141.42
06	ALS4D	114.96	116.22	107	110	138.90	141.42
06	ALE1W	147.72	148.98	0	7	118.74	120.00
06	ALE1SS	147.72	148.98	7	8	118.74	120.00
06	ALE1A	147.72	148.98	8	11	118.74	120.00
06	ALE1B	147.72	148.98	11	106	118.74	120.00
06	ALE1C	147.72	148.98	106	107	118.74	120.00
06	ALE1D	147.72	148.98	107	110	118.74	120.00
06	ALE2W	122.52	123.78	0	7	118.74	120.00
06	ALE2SS	122.52	123.78	7	8	118.74	120.00
06	ALE2A	122.52	123.78	8	11	118.74	120.00
06	ALE2B	122.52	123.78	11	106	118.74	120.00
06	ALE2C	122.52	123.78	106	107	118.74	120.00
06	ALE2D	122.52	123.78	107	110	118.74	120.00
06	ALE3W	138.90	141.42	0	7	114.96	116.22
06	ALE3SS	138.90	141.42	7	8	114.96	116.22
06	ALE3A	138.90	141.42	8	11	114.96	116.22
06	ALE3B	138.90	141.42	11	106	114.96	116.22
06	ALE3C	138.90	141.42	106	107	114.96	116.22
06	ALE3D	138.90	141.42	107	110	114.96	116.22
06	ALE4W	130.08	132.60	0	7	114.96	116.22
06	ALE4SS	130.08	132.60	7	8	114.96	116.22
06	ALE4A	130.08	132.60	8	11	114.96	116.22
06	ALE4B	130.08	132.60	11	106	114.96	116.22
06	ALE4C	130.08	132.60	106	107	114.96	116.22
06	ALE4D	130.08	132.60	107	110	114.96	116.22
06	ALW1W	122.52	123.78	0	7	151.50	152.76
06	ALW1SS	122.52	123.78	7	8	151.50	152.76
06	ALW1A	122.52	123.78	8	11	151.50	152.76
06	ALW1B	122.52	123.78	11	106	151.50	152.76
06	ALW1C	122.52	123.78	106	107	151.50	152.76
06	ALW1D	122.52	123.78	107	110	151.50	152.76
06	ALW2W	147.72	148.98	0	7	151.50	152.76
06	ALW2SS	147.72	148.98	7	8	151.50	152.76
06	ALW2A	147.72	148.98	8	11	151.50	152.76
06	ALW2B	147.72	148.98	11	106	151.50	152.76
06	ALW2C	147.72	148.98	106	107	151.50	152.76
06	ALW2D	147.72	148.98	107	110	151.50	152.76
06	ALW3W	130.08	132.60	0	7	155.28	156.54
06	ALW3SS	130.08	132.60	7	8	155.28	156.54
06	ALW3A	130.08	132.60	8	11	155.28	156.54
06	ALW3B	130.08	132.60	11	106	155.28	156.54
06	ALW3C	130.08	132.60	106	107	155.28	156.54
06	ALW3D	130.08	132.60	107	110	155.28	156.54
06	ALW4W	138.90	141.42	0	7	155.28	156.54
06	ALW4SS	138.90	141.42	7	8	155.28	156.54
06	ALW4A	138.90	141.42	8	11	155.28	156.54
06	ALW4B	138.90	141.42	11	106	155.28	156.54
06	ALW4C	138.90	141.42	106	107	155.28	156.54
06	ALW4D	138.90	141.42	107	110	155.28	156.54

----R1UO2 CENTRAL CHANNEL
----OSCILLATION TUBE (UP)

06	ORW	135.12	136.38	0	10	135.12	136.38
06	ORB	135.12	136.38	10	16	135.12	136.38
06	ORL	135.12	136.38	16	51	135.12	136.38
06	ORSAM	135.12	136.38	51	61	135.12	136.38
06	ORU	135.12	136.38	61	116	135.12	136.38

----POLINE OVERCLAD

06	POLW	135.12	136.38	0	11	135.12	136.38
06	POLC	135.12	136.38	11	116	135.12	136.38

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    ----MATERIAL DEFINITION (TYPE-13 CARDS)----
   UO2(3) pin
13          LEU3  EU4  0 4.617E-06  EU5  0 6.900E-04  EU6  0 5.493E-06
13          LEU3  EU8  0 2.200E-02  EO   0 4.647E-02

   U-235 90% plate
13          HEU90 90U5 0 1.397E-03  90U8 0 1.550E-04  90Al 0 5.830E-02

   U-235 93% plate
13          HEU93 93U5 0 1.894E-03  93U8 0 1.390E-04  93Al 0 5.770E-02

   U-235 93% plate CONTROL ELEMENT
13          CFUEL CU5  0 1.894E-03  CU8  0 1.390E-04  CAl  0 5.770E-02

   WATER
   NOTATION: E - EXPERIMENTAL PINS, 90 - 90%U-5 ELT, 93 - 93%U-5 ELT
             1 - 1st GRAPHITE ELT, 2 - 2nd GRAPHITE ELT
13         H2OE  EH   0 6.674E-02  EO   0 3.337E-02
13         H2O90 90H  0 6.674E-02  90O  0 3.337E-02
13         H2O93 93H  0 6.674E-02  93O  0 3.337E-02
13         H2OC  CH   0 6.674E-02  CO   0 3.337E-02
13         H2O1  1H   0 6.674E-02  1O   0 3.337E-02
13         H2O2  2H   0 6.674E-02  2O   0 3.337E-02

   GRAPHITE
   NOTATION: 1 - 1st GRAPHITE ELT, 2 - 2nd GRAPHITE ELT, 3 - GRAPHITE BLOCKS
13         GR1   1G   0 8.524E-02
13         GR2   2G   0 8.524E-02
13         GR3   3G   0 8.524E-02

   STAINLESS STEEL
13         SS    EFe4 0 3.387E-03  EFe6 0 5.316E-02  EFe7 0 1.228E-03
13         SS    EFe8 0 1.634E-04  EC   0 5.904E-05  ECr0 0 7.111E-04
13         SS    ECr2 0 1.371E-02  ECr3 0 1.555E-03  ECr4 0 3.870E-04
13         SS    ENi8 0 6.031E-03  ENi0 0 2.323E-03  ENi1 0 1.010E-04
13         SS    ENi2 0 3.220E-04  ENi4 0 8.200E-05  EMn  0 8.605E-04
13         SS    ESi  0 8.416E-04  EMo  0 4.927E-04

   PURE ALUMINUM
13         ALE   EAl  0 6.026E-02
13         AL90  90Al 0 6.026E-02
13         AL93  93Al 0 6.026E-02
13         ALC   CAl  0 6.026E-02

   ALUMINUM ALLOY AG3
   NOTATION: E - EXPERIMENTAL PINS, D - 90%U-5 ELT and 93 - 93%U-5 ELT
             1 - 1st GRAPHITE ELT, 2 - 2nd GRAPHITE ELT, 3 - GRAPHITE BLOCKS
13         AL3E  EAl  0 5.457E-02  EMg  0 1.959E-03  EMn  0 6.988E-05
13         AL3E  EFe4 0 3.214E-06  EFe6 0 5.046E-05  EFe7 0 1.165E-06
13         AL3E  EFe8 0 1.551E-07  ECr0 0 1.925E-06  ECr2 0 3.712E-05
13         AL3E  ECr3 0 4.209E-06  ECr4 0 1.048E-06  ETi  0 2.406E-05
13         AL3E  ESi  0 1.094E-04  ECu3 0 8.358E-06  ECu5 0 3.725E-06

13         AL30  0Al  0 5.457E-02  0Mg  0 1.959E-03  0Mn  0 6.988E-05
13         AL30  0Fe4 0 3.214E-06  0Fe6 0 5.046E-05  0Fe7 0 1.165E-06
13         AL30  0Fe8 0 1.551E-07  0Cr0 0 1.925E-06  0Cr2 0 3.712E-05
13         AL30  0Cr3 0 4.209E-06  0Cr4 0 1.048E-06  0Ti  0 2.406E-05
13         AL30  0Si  0 1.094E-04  0Cu3 0 8.358E-06  0Cu5 0 3.725E-06

13         AL31  1Al  0 5.457E-02  1Mg  0 1.959E-03  1Mn  0 6.988E-05
13         AL31  1Fe4 0 3.214E-06  1Fe6 0 5.046E-05  1Fe7 0 1.165E-06
13         AL31  1Fe8 0 1.551E-07  1Cr0 0 1.925E-06  1Cr2 0 3.712E-05
13         AL31  1Cr3 0 4.209E-06  1Cr4 0 1.048E-06  1Ti  0 2.406E-05
13         AL31  1Si  0 1.094E-04  1Cu3 0 8.358E-06  1Cu5 0 3.725E-06

13         AL32  2Al  0 5.457E-02  2Mg  0 1.959E-03  2Mn  0 6.988E-05
13         AL32  2Fe4 0 3.214E-06  2Fe6 0 5.046E-05  2Fe7 0 1.165E-06
13         AL32  2Fe8 0 1.551E-07  2Cr0 0 1.925E-06  2Cr2 0 3.712E-05
13         AL32  2Cr3 0 4.209E-06  2Cr4 0 1.048E-06  2Ti  0 2.406E-05
13         AL32  2Si  0 1.094E-04  2Cu3 0 8.358E-06  2Cu5 0 3.725E-06

13         AL33  3Al  0 5.457E-02  3Mg  0 1.959E-03  3Mn  0 6.988E-05
13         AL33  3Fe4 0 3.214E-06  3Fe6 0 5.046E-05  3Fe7 0 1.165E-06
13         AL33  3Fe8 0 1.551E-07  3Cr0 0 1.925E-06  3Cr2 0 3.712E-05
13         AL33  3Cr3 0 4.209E-06  3Cr4 0 1.048E-06  3Ti  0 2.406E-05
13         AL33  3Si  0 1.094E-04  3Cu3 0 8.358E-06  3Cu5 0 3.725E-06

   ALUMINUM ALLOY EN AW-2017 OR A-U4G
13         AL4   EAl  0 5.827E-02  EMg  0 4.839E-04  EMn  0 2.141E-04
13         AL4   EFe4 0 6.155E-06  EFe6 0 9.662E-05  EFe7 0 2.231E-06
13         AL4   EFe8 0 2.969E-07  ECr0 0 7.020E-07  ECr2 0 1.354E-05
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13          AL4   ECr3 0 1.535E-06  ECr4 0 3.821E-07  ESi  0 2.991E-04
13          AL4   ECu3 0 4.433E-06  ECu5 0 1.976E-06

   ALUMINUM ALLOY AL5
13          AL5   EAl  0 6.010E-02  EMg  0 1.676E-05  EMn  0 7.413E-06
13          AL5   EFe4 0 3.410E-06  EFe6 0 5.353E-05  EFe7 0 1.236E-06
13          AL5   EFe8 0 1.645E-07  ETi  0 8.508E-06  ESi  0 7.250E-05
13          AL5   ECu3 0 4.433E-06  ECu5 0 1.976E-06

   ZIRCONIUM 4
13          ZR4   EZr  0 4.248E-02  EZH  0 4.899E-05  EO   0 3.086E-04
13          ZR4   EFe4 0 8.683E-06  EFe6 0 1.363E-04  EFe7 0 3.148E-06
13          ZR4   EFe8 0 4.189E-07  ECr0 0 3.301E-06  ECr2 0 6.366E-05
13          ZR4   ECr3 0 7.219E-06  ECr4 0 1.797E-06  EC   0 4.405E-05
13          ZR4   EHf  0 1.107E-06

   VOID
13          VOID  EO   0 1.000E-15

   PLEXIGLAS
13          PLEXI EC   0 3.549E-02  EH   0 5.678E-02  EO   0 1.420E-02

     OSCILLATION SAMPLE 1B0071
13          SAMP  SAU5 0 5.389E-05  SAU8 0 2.123E-02  SAO  0 4.257E-02
13          SAMP  SB10 0 7.513E-06  SB11 0 3.024E-05

     NATURAL HAFNIUM
  13          HFC   CHf  0 4.491E-02

     PVC
  13          PVC   EC   0 1.755E-02  EH   0 2.632E-02

     POLYETHYLENE
  13          POLY  EC   0 3.950E-02  EH   0 7.899E-02



      ----COMPOSITIONS (TYPE-14 CARDS)----
14          WATER H2OE   1.00
14          A5    AL5    1.00
14          AG3   AL3E   1.00
14          SS1   SS     1.00

14          ZRSS  ZR4    0.9083     SS     0.0917
14          ZRW   ZR4    0.6267     H2OE   0.3733
14          SSW   SS     0.3467     H2OE   0.6533

14          ALW1  H2OE   0.1800     AL3E   0.8200
14          ALWT  H2OE   0.1800     AL3E   0.8200
14          ALW2  H2OE   0.8000     AL3E   0.2000

14          GAL1  GR3    0.8487     AL33   0.1513
14          GAL2  GR3    0.9568     AL33   0.0432
14          GAL3  GR3    0.8729     AL33   0.1271

14          GFOOT AL5    0.5258     AL3E   0.4110     H2OE   0.0448
14          GFOOT VOID   0.0184
14          GELT1 GR1    0.8647     AL31   0.1102     H2O1   0.0251
14          GELT2 GR2    0.8647     AL32   0.1102     H2O2   0.0251
14          GCLAD AL3E   0.9749     H2OE   0.0251

14          FFOOT AL5    0.3858     AL3E   0.1796     H2OE   0.4346

14          ALW90 H2O90  0.5856     AL90   0.3120     AL30   0.1024
14          ALW93 H2O93  0.5856     AL93   0.3120     AL30   0.1024

14          D9018 HEU90  0.0952     AL90   0.2168     H2O90  0.5856
14          D9018 AL30   0.1024
14          D9318 HEU93  0.0952     AL93   0.2168     H2O93  0.5856
14          D9318 AL30   0.1024
14          D9009 HEU90  0.0940     AL90   0.2141     H2O90  0.5892
14          D9009 AL30   0.1027
14          G9009 GR1    0.7660     AL30   0.1526     H2O90  0.0814
14          D9012 HEU90  0.0952     AL90   0.2168     H2O90  0.5246
14          D9012 AL30   0.1634
14          G9012 GR1    0.7144     AL30   0.1616     H2O90  0.1240
14          DCRUP CFUEL  0.0634     ALC    0.2138     H2OC   0.6182
14          DCRUP AL30   0.1046

14          GAL12 GR1    0.2286     AL90   0.2079     H2O90  0.4316
14          GAL12 AL30   0.1319
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14          GAL09 GR1    0.3632     AL90   0.1560     H2O90  0.3384
14          GAL09 AL30   0.1424
14          ALCRUPALC    0.2772     H2OC   0.6182     AL30   0.1046

14          ALWM1 H2OE   0.6536     AL3E   0.0658     ALWT   0.2806
14          ALWM2 H2OE   0.6875     AL3E   0.3125
14          SSWM1 H2OE   0.1383     SS     0.8617
14          ALWC1 H2OE   0.7776     AL3E   0.2224
14          ALWC2 H2OE   0.0204     AL3E   0.9796
14          ALWC3 H2OE   0.3039     AL3E   0.6961
14          ALWC4 H2OE   0.6898     AL3E   0.3102
14          SSWC1 H2OE   0.1451     AL3E   0.4184     SS     0.4365
14          SSWC2 H2OE   0.3039     AL3E   0.1348     SS     0.5613
14          F1PPG PLEXI  0.3009     VOID   0.0317     ZR4    0.1045
14          F1PPG AL3E   0.1331     H2OE   0.4298
14          F1LPG SS     0.1132     VOID   0.0119     ZR4    0.0393
14          F1LPG ZRW    0.1175     AL3E   0.4839     H2OE   0.2342
14          F1UPG SS     0.1504     VOID   0.0158     ZR4    0.0523
14          F1UPG ZRSS   0.2186     AL3E   0.4007     H2OE   0.1622
14          F1UP  SSW    0.0580     AL3E   0.3125     H2OE   0.6295
14          SUO2  LEU3   0.3203     VOID   0.0123     ZR4    0.1045
14          SUO2  AL3E   0.1331     H2OE   0.4298
14          UO2   SUO2   1.00
14          ALWP1 H2OE   0.0346     AL3E   0.9654
14          ALWP2 H2OE   0.5503     AL3E   0.4497
14          ALWP3 H2OE   0.1489     AL3E   0.8511
14          ALWP4 H2OE   0.6445     AL3E   0.3555
14          ASWO1 H2OE   0.4906     AL3E   0.3615     SS     0.1479
14          ASWO2 H2OE   0.3303     AL3E   0.5559     SS     0.1138

14          SAMPL SAMP   0.3121     H2OE   0.3304     SS     0.1138
14          SAMPL ZR4    0.1589     VOID   0.0849
 14           POLCLDH2O    0.4336     AL4E   0.1199     VOID   0.4465


      ----ASSIGN COMPOSITIONS TO REGIONS (TYPE-15 CARDS)----

      ----DRIVER ZONE----
      ----GENERAL----
15    WATER TANK
15    ALW1  TABLE
15    ALW2  NCAIS SCAIS ECAIS WCAIS
15    A5    NGRID SGRID EGRID WGRID

      ----GRAPHITE BLOCKS-----
15    ALW2  NLGC  SLGC  ELGC  WLGC
15    GAL1  NLGB  SLGB  ELGB  WLGB
15    GAL2  NMGB  SMGB  EMGB  WMGB
15    GAL3  NSGB  SSGB

      ----GRAPHITE ELEMENTS----
15    GFOOT NG0AL SG0AL EG0AL WG0AL
15    GFOOT NG1AL SG1AL EG1AL WG1AL
15    GFOOT NG2AL SG2AL EG2AL WG2AL
15    GELT1 NG0G  SG0G  EG0G  WG0G
15    GELT1 NG1G  SG1G  EG1G  WG1G
15    GELT2 NG2G  SG2G  EG2G  WG2G
15    GCLAD NG0AU SG0AU EG0AU WG0AU
15    GCLAD NG1AU SG1AU EG1AU WG1AU
15    GCLAD NG2AU SG2AU EG2AU WG2AU

      ----FUEL ELEMENTS----
      ---- 18-PLATE 90% U-235 FUEL ELEMENT
15    FFOOT N01B  N02B  N06B  N07B
15    ALW90 N01AL N02AL N06AL N07AL
15    D9018 N01F  N02F  N06F  N07F
15    ALW90 N01AU N02AU N06AU N07AU
15    WATER N01WU N02WU N06WU N07WU
15    FFOOT S01B  S02B  S03B  S07B
15    ALW90 S01AL S02AL S03AL S07AL
15    D9018 S01F  S02F  S03F  S07F
15    ALW90 S01AU S02AU S03AU S07AU
15    WATER S01WU S02WU S03WU S07WU
15    FFOOT E01B  E02B  E06B  E07B
15    ALW90 E01AL E02AL E06AL E07AL
15    D9018 E01F  E02F  E06F  E07F
15    ALW90 E01AU E02AU E06AU E07AU
15    WATER E01WU E02WU E06WU E07WU
15    FFOOT W01B  W02B  W06B  W07B
15    ALW90 W01AL W02AL W06AL W07AL
15    D9018 W01F  W02F  W06F  W07F
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15     ALW90 W01AU W02AU W06AU W07AU
15     WATER W01WU W02WU W06WU W07WU

       ---- 18-PLATE 93% U-235 FUEL ELEMENT
15     FFOOT N03B  N05B  N08B
15     ALW93 N03AL N05AL N08AL
15     D9318 N03F  N05F  N08F
15     ALW93 N03AU N05AU N08AU
15     WATER N03WU N05WU N08WU
15     FFOOT S04B  S06B  S08B
15     ALW93 S04AL S06AL S08AL
15     D9318 S04F  S06F  S08F
15     ALW93 S04AU S06AU S08AU
15     WATER S04WU S06WU S08WU
15     FFOOT E03B  E05B  E09B
15     ALW93 E03AL E05AL E09AL
15     D9318 E03F  E05F  E09F
15     ALW93 E03AU E05AU E09AU
15     WATER E03WU E05WU E09WU
15     FFOOT W03B  W05B  W09B
15     ALW93 W03AL W05AL W09AL
15     D9318 W03F  W05F  W09F
15     ALW93 W03AU W05AU W09AU
15     WATER W03WU W05WU W09WU

       ---- 9-PLATE 90% U-235 FUEL ELEMENT
15     FFOOT N09B  S09B
15     GAL09 N09AL S09AL
15     D9009 N09F  S09F
15     G9009 N09GR S09GR
15     GAL09 N09AU S09AU
15     WATER N09WU S09WU

       ---- 12-PLATE 90% U-235 FUEL ELEMENT
15     FFOOT E08B  W08B
15     GAL12 E08AL W08AL
15     D9012 E08F  W08F
15     G9012 E08GR W08GR
15     GAL12 E08AU W08AU
15     WATER E08WU W08WU

       ---- CONTROL ELEMENT - ROD UP
15     FFOOT N04B  S05B  E04B  W04B
15     ALCRUPN04AL S05AL E04AL W04AL
15     DCRUP N04F  S05F  E04F  W04F
15     ALCRUPN04AU S05AU E04AU W04AU
15     WATER N04WU S05WU E04WU W04WU


       ----EXPERIMENTAL ZONE----
       ----GENERAL----
15     WATER EZONE
15     AG3   WEDGE

       ----ANGLE GRAPHITE ELEMENTS----
15     GFOOT G1AL  G2AL  G3AL  G4AL
15     GCLAD G1AU  G2AU  G3AU  G4AU
15     GELT2 G1G   G2G   G3G   G4G

       ----ALUMINUM MASSIF----
15     ALWM1 ALBA
15     SSWM1 ALBB
15     AG3   ALBC
15     SS1   ALBD
15     ALWM2 ALBE

       ----CHIMNEY PIECES----
15     ALW1  CHI1T CHI2T CHI3T CHI4T CHI5T CHI6T CHI7T CHI8T
15     ALWC1 CHI1A CHI2A CHI3A CHI4A CHI5A CHI6A CHI7A CHI8A
15     SSWC1 CHI1B CHI2B CHI3B CHI4B CHI5B CHI6B CHI7B CHI8B
15     ALWC2 CHI1C CHI2C CHI3C CHI4C CHI5C CHI6C CHI7C CHI8C
15     ALWC3 CHI1D CHI2D CHI3D CHI4D CHI5D CHI6D CHI7D CHI8D
15     SSWC2 CHI1E CHI2E CHI3E CHI4E CHI5E CHI6E CHI7E CHI8E
15     ALWC4 CHI1F CHI2F CHI3F CHI4F CHI5F CHI6F CHI7F CHI8F

      ----UO2 FUEL PINS----
15     WATER F1CW  F1N1W F1N2W F1S1W F1S2W F1E1W F1E2W F1W1W F1W2W
15     SS1   F1CSS F1N1SSF1N2SSF1S1SSF1S2SSF1E1SSF1E2SSF1W1SSF1W2SS
15     F1LPG F1CA  F1N1A F1N2A F1S1A F1S2A F1E1A F1E2A F1W1A F1W2A
15     F1PPG F1CB  F1N1B F1N2B F1S1B F1S2B F1E1B F1E2B F1W1B F1W2B
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15    UO2   F1CC  F1N1C F1N2C F1S1C F1S2C F1E1C F1E2C F1W1C F1W2C
15    F1PPG F1CD  F1N1D F1N2D F1S1D F1S2D F1E1D F1E2D F1W1D F1W2D
15    F1UPG F1CE  F1N1E F1N2E F1S1E F1S2E F1E1E F1E2E F1W1E F1W2E
15    F1UP  F1CF  F1N1F F1N2F F1S1F F1S2F F1E1F F1E2F F1W1F F1W2F

     ----AL PINS----
15    WATER ALN1W ALN2W ALN3W ALN4W ALS1W ALS2W ALS3W ALS4W
15    WATER ALE1W ALE2W ALE3W ALE4W ALW1W ALW2W ALW3W ALW4W
15    SS1   ALN1SSALN2SSALN3SSALN4SSALS1SSALS2SSALS3SSALS4SS
15    SS1   ALE1SSALE2SSALE3SSALE4SSALW1SSALW2SSALW3SSALW4SS
15    ALWP1 ALN1A ALN2A ALN3A ALN4A ALS1A ALS2A ALS3A ALS4A
15    ALWP1 ALE1A ALE2A ALE3A ALE4A ALW1A ALW2A ALW3A ALW4A
15    ALWP2 ALN1B ALN2B ALN3B ALN4B ALS1B ALS2B ALS3B ALS4B
15    ALWP2 ALE1B ALE2B ALE3B ALE4B ALW1B ALW2B ALW3B ALW4B
15    ALWP3 ALN1C ALN2C ALN3C ALN4C ALS1C ALS2C ALS3C ALS4C
15    ALWP3 ALE1C ALE2C ALE3C ALE4C ALW1C ALW2C ALW3C ALW4C
15    ALWP4 ALN1D ALN2D ALN3D ALN4D ALS1D ALS2D ALS3D ALS4D
15    ALWP4 ALE1D ALE2D ALE3D ALE4D ALW1D ALW2D ALW3D ALW4D

     ----CENTRAL CHANNEL----
     ----OSCILLATION TUBE (UP)
15    WATER ORW
15    ASWO1 ORB
15    ASWO2 ORL   ORU
15    SAMPL ORSAM
       ----POLINE OVERCLAD
  15    WATER POLW
  15    POLCLDPOLC


DATASET=A.STP027
01          0     0     0     1     0     1     0     0     0          0
02          1     0     1     1     0     0     0     0     0     0    0
  02          1     1     1     1     0     0     0     0     0     0    0
03          0     0     0     0     0     1     0     0000000000
04          0500000     0
05          0     0     1     1
```

File MOXI

```
BLOCK=OLD
DATASET=ISOTXS
BLOCK=STP027
DATASET=A.BURN
01    R1MOX loading

  STORAGE AND CONVERGENCE CRITERIA SPECIFICATIONS:
   ... CONVERGENCE (eq: 0.001, 0.001, 0.0001; noneq: 0.001, 1.0, 1.0)
   ... REGION DENSITY ITER (1-init, 5-final), CYCLIC MODE ITER (eq)

02         0 45000     0       0.001         1.0         1.0     1     0
  02         0   860     0       0.001         1.0         1.0     1     0

  GENERAL PROBLEM DEFINITION DATA:
   PREVIOUS CYCLES, SHUTDOWN TIME, BEG TIME, CYCLE TIME,
    CONVERGENCE, SUBINTERVALS, OPERATIONS-1 (noneq)

03         0    0.0              0.0    0.0              1.0     0     0

  GENERAL FUEL MANAGEMENT SPECIFICATIONS:
   PATH LABEL, PRIMARY COMP, FUEL MGMT LABEL, BEG STAGE, END STAGE

35    PL     UO2H FML        1    01

  FUEL MANAGEMENT GROUP SPECIFICATIONS: FUEL MGMT LABEL, REGION/AREA LABEL

45    FML   F1CC

  ISOTOPIC CHAIN: ISOTOPE, TYPE, PRODUCT, YIELD FRACTION, ETC.
  REACTION TYPES: 0=NO REACTION, 1=(N,GAMMA), 2=(N,FISSION), 3=(N,P),
                  4=(N,ALPHA), 5=(N,2N), 6=(BETA- DECAY), 7=(BETA+ DECAY),
                  8=(ALPHA DECAY), 9=(N,D), 10=(N,T)

09    U235       0

  ISOTOPE EQUIVALENCE LIST: ISOTOPE, LIBRARY NAME

10    U235  EU5  0

  ACTIVE ISOTOPE DATA: ISOTOPE, BREEDING RATIO FLAG, ATOMIC MASS

24    U235       1           235.044


UNFORM=A.DIF3D
01 R1MOX loading
02 10 30
03 0 0 0 36100 50 0 1000000000 0 1 0 50
  02    999    5100
  03 0 0 0 36100 50 0 1000000000 5 1 1 100
  03 0 0 0 4500 50 0 1000000000 0 1 0 50
04 1 1 0 01 121 12 112 0 1 0 0
05 1.0-7  1.0-5  1.0-5
06 1.0 0.001 0.04 1.0

UNFORM=A.HMG4C
01 R1MOX loading
02  1000000 0 1 1
  02  5000000

DATASET=A.NIP3
01 R1MOX loading
02              0     1    50     0     1     0     0     1     1     1
03             44
04              4     4     4     4     4     4

      ----MESH DEFINITIONS (TYPE-9 CARDS)----
      Core center is at (135.75, 135.75, 115.70)
      X DIMENSIONS - +X is North
09         X     6      30.07
09         X     2      34.75
09         X     1      35.05
09         X    16      67.25
09         X     4      75.35
09         X     1      75.62
09         X     1      75.75
09         X     3      80.20
09         X     3      83.33
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09	X	1	83.65
09	X	8	91.04
09	X	1	91.75
09	X	8	98.75
09	X	1	99.85
09	X	7	106.46
09	X	1	106.85
09	X	1	107.95
09	X	8	114.95
09	X	1	114.96
09	X	1	116.05
09	X	1	116.22
09	X	1	117.48
09	X	1	118.74
09	X	1	120.00
09	X	1	121.26
09	X	1	122.52
09	X	1	123.05
09	X	1	123.78
09	X	1	124.15
09	X	1	125.04
Add-on for the east 12 plate			
09	X	1	125.75
09	X	1	126.30
Add-on for the west 12 plate			
09	X	1	126.85
09	X	2	127.56
09	X	3	128.82
09	X	3	130.08
09	X	1	131.15
09	X	1	131.34
09	X	1	132.25
09	X	1	132.60
09	X	1	133.86
09	X	1	135.12
09	X	1	136.38
09	X	1	137.64
09	X	1	138.90
09	X	1	139.25
09	X	1	140.16
09	X	1	140.35
09	X	1	141.42
09	X	3	142.68
09	X	3	143.94
Add-on for the east 12 plate			
09	X	2	144.65
09	X	1	145.20
Add-on for the west 12 plate			
09	X	1	145.75
09	X	1	146.46
09	X	1	147.35
09	X	1	147.72
09	X	1	148.45
09	X	1	148.98
09	X	1	150.24
09	X	1	151.50
09	X	1	152.76
09	X	1	154.02
09	X	1	155.28
09	X	1	155.45
09	X	1	156.54
09	X	1	156.55
09	X	8	163.55
09	X	1	164.65
09	X	1	165.04
09	X	7	171.65
09	X	1	172.75
09	X	8	179.75
09	X	1	180.46
09	X	8	187.85
09	X	1	188.17
09	X	2	191.30
09	X	2	195.75

09	X	1	195.88
09	X	1	196.15
09	X	16	228.65
09	X	4	236.45
09	X	2	241.43
09	X	6	271.50

Y DIMENSIONS - +Y is West

09	Y	6	30.07
09	Y	3	35.05
09	Y	4	43.05
09	Y	16	75.55
09	Y	1	75.62
09	Y	1	75.75
09	Y	3	80.20
09	Y	1	80.25
09	Y	2	83.33
09	Y	1	83.65
09	Y	8	91.04
09	Y	1	91.75
09	Y	8	98.75
09	Y	1	99.85
09	Y	8	106.85
09	Y	1	107.95
09	Y	8	114.95
09	Y	1	114.96
09	Y	1	116.05
09	Y	1	116.22
09	Y	1	117.48
09	Y	1	118.74

Add-on for the south 12 plate

09	Y	1	118.75

09	Y	1	120.00
09	Y	1	121.26
09	Y	1	122.52
09	Y	1	123.05
09	Y	1	123.78
09	Y	1	124.15
09	Y	1	125.04
09	Y	1	126.30

Add-on for the north 9 plate

09	Y	2	127.05

09	Y	1	127.56
09	Y	3	128.82
09	Y	3	130.08
09	Y	1	131.15
09	Y	1	131.34
09	Y	1	132.25
09	Y	1	132.60
09	Y	1	133.86
09	Y	1	135.12
09	Y	1	136.38
09	Y	1	137.64

Add-on for the south 12 plate

09	Y	1	137.65

09	Y	1	138.90
09	Y	1	139.25
09	Y	1	140.16
09	Y	1	140.35
09	Y	1	141.42
09	Y	3	142.68
09	Y	3	143.94

Add-on for the north 12 plate

09	Y	2	144.65

09	Y	1	145.20
09	Y	1	146.46
09	Y	1	147.35
09	Y	1	147.72
09	Y	1	148.45
09	Y	1	148.98
09	Y	1	150.24
09	Y	1	151.50
09	Y	1	152.76

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09        Y     1      154.02
09        Y     1      155.28
09        Y     1      155.45
09        Y     1      156.54
09        Y     1      156.55
09        Y     8      163.55
09        Y     1      164.65
09        Y     8      171.65
09        Y     1      172.75
09        Y     8      179.75
09        Y     1      180.46
09        Y     8      187.85
09        Y     1      188.17
09        Y     2      191.25
09        Y     1      191.30
09        Y     2      195.75
09        Y     1      195.88
09        Y    12      220.35
09        Y     8      236.45
09        Y     2      241.43
09        Y     6      271.50

      Z DIMENSIONS - +Z is Up
09        Z     2       22.10
09        Z     3       62.40
09        Z     2       70.80
09        Z     1       73.05
09        Z     1       73.40
09        Z     1      73.825
09        Z     1       75.20
09        Z     2       77.70
09        Z     1       78.40
09        Z     2      80.525
09        Z     2       82.10
09        Z     2       84.40
09        Z     2       85.70
09        Z     3       90.70

  Add-on for the interface Fuel/Plexi
09        Z     9       93.70

09        Z    17     110.525
09        Z    10     120.875

  Add-on for the interface Fuel/Plexi
09        Z    17      137.70

09        Z     9      140.70
09        Z     5      145.35
09        Z     1      145.70
09        Z     2      146.95
09        Z     2      148.30
09        Z     5      153.40
09        Z     1      153.70
09        Z     1      154.30
09        Z     1      154.40
09        Z     1      154.70
09        Z     1      156.70
09        Z     2     161.225
09        Z     1      163.10
09        Z     6      220.00


      ----REGION DEFINITIONS (TYPE-6 CARDS)----

      ----DRIVER ZONE----
      ----GENERAL----
06    TANK          0.00      271.50     0   116        0.00       271.50
06    TABLE        30.07      241.43     0     2       30.07       241.43

      ----CAISSONS----
06    NCAIS       172.75      195.88     2     5       98.75       236.45
06    SCAIS        75.62       98.75     2     5       35.05       172.75
06    ECAIS        98.75      236.45     2     5       75.62        98.75
06    WCAIS        35.05      172.75     2     5      172.75       195.88

      ----GRID PLATES----
06    NGRID       172.75      195.88     5    14       98.75       236.45
06    SGRID        75.62       98.75     5    14       35.05       172.75
06    EGRID        98.75      236.45     5    14       75.62        98.75
06    WGRID        35.05      172.75     5    14      172.75       195.88
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        ----LARGE GRAPHITE BLOCKS----
        -----NOTATION - NLG NORTH LARGE GRAPHITE
        -----         - C-CAISSON, B-BLOCK: GRAPHITE + ALUMINUM CLAD
06      NLGC        195.88      241.43     2     9       98.75      191.30
06      NLGB        195.88      241.43     9   105       98.75      191.30

06      SLGC         30.07       75.62     2     9       80.20      172.75
06      SLGB         30.07       75.62     9   105       80.20      172.75

06      ELGC         98.75      191.30     2     9       30.07       75.62
06      ELGB         98.75      191.30     9   105       30.07       75.62

06      WLGC         80.20      172.75     2     9      195.88      241.43
06      WLGB         80.20      172.75     9   105      195.88      241.43

        ----MEDIUM AND SMALL GRAPHITE BLOCKS----
        -----NOTATION - NMG NORTH MEDIUM GRAPHITE, A-AL CLAD, G-GRAPHITE
06      NMGB        196.15      228.65    14   102       75.75       98.75
06      SMGB         34.75       67.25    14   102      172.75      195.75
06      EMGB         75.75       98.75    14   102       43.05       75.55
06      WMGB        172.75      195.75    14   102      187.85      220.35

06      NSGB        187.85      196.15    14   102       80.25       98.75
06      SSGB         75.35       83.65    14   102      172.75      191.25

        ----NORTH REGION OF DRIVER ZONE----
        ----GRAPHITE ELEMENT
        ----NOTATION NG0 NORTH GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
        ----         NG1 NORTH GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
        ----         NG2 NORTH GRAPHITE ZONE 2 (REST OF THE ZONE)
        ----         AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06      NG2AL       172.75      195.88     5    18       98.75      187.85
06      NG2G        172.75      195.88    18    92       98.75      187.85
06      NG2AU       172.75      195.88    92    97       98.75      187.85

06      NG1AL       172.75      188.17     5    18       98.75      171.65
06      NG1G        172.75      188.17    18    92       98.75      171.65
06      NG1AU       172.75      188.17    92    97       98.75      171.65

06      NG0AL       188.17      195.88     5    18      123.05      147.35
06      NG0G        188.17      195.88    18    92      123.05      147.35
06      NG0AU       188.17      195.88    92    97      123.05      147.35

        ----FUEL ELEMENT
        ----NOTATION N01 - NORTH 1 OF 10 NUMBERED FROM INNER ROW - LEFT SIDE
        ----LAST LETTER IS REGION IN Z DIRECTION
        ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06      N01B        172.75      180.46     5    20      106.85      114.95
06      N01AL       172.75      180.46    20    22      106.85      114.95
06      N01F        172.75      180.46    22    93      106.85      114.95
06      N01AU       172.75      180.46    93    95      106.85      114.95
06      N01WU       172.75      180.46    95    97      106.85      114.95

06      N02B        172.75      180.46     5    20      114.95      123.05
06      N02AL       172.75      180.46    20    22      114.95      123.05
06      N02F        172.75      180.46    22    93      114.95      123.05
06      N02AU       172.75      180.46    93    95      114.95      123.05
06      N02WU       172.75      180.46    95    97      114.95      123.05

06      N03B        172.75      180.46     5    20      123.05      131.15
06      N03AL       172.75      180.46    20    22      123.05      131.15
06      N03F        172.75      180.46    22    93      123.05      131.15
06      N03AU       172.75      180.46    93    95      123.05      131.15
06      N03WU       172.75      180.46    95    97      123.05      131.15

06      N04B        172.75      180.46     5    20      131.15      139.25
06      N04AL       172.75      180.46    20    22      131.15      139.25
06      N04F        172.75      180.46    22    93      131.15      139.25
06      N04AU       172.75      180.46    93    95      131.15      139.25
06      N04WU       172.75      180.46    95    97      131.15      139.25

06      N05B        172.75      180.46     5    20      139.25      147.35
06      N05AL       172.75      180.46    20    22      139.25      147.35
06      N05F        172.75      180.46    22    93      139.25      147.35
06      N05AU       172.75      180.46    93    95      139.25      147.35
06      N05WU       172.75      180.46    95    97      139.25      147.35

06      N06B        172.75      180.46     5    20      147.35      155.45
06      N06AL       172.75      180.46    20    22      147.35      155.45
06      N06F        172.75      180.46    22    93      147.35      155.45
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06    N06AU       172.75      180.46    93    95      147.35      155.45
06    N06WU       172.75      180.46    95    97      147.35      155.45

06    N07B        172.75      180.46     5    20      155.45      163.55
06    N07AL       172.75      180.46    20    22      155.45      163.55
06    N07F        172.75      180.46    22    93      155.45      163.55
06    N07AU       172.75      180.46    93    95      155.45      163.55
06    N07WU       172.75      180.46    95    97      155.45      163.55

06    N08B        180.46      188.17     5    20      123.05      131.15
06    N08AL       180.46      188.17    20    22      123.05      131.15
06    N08F        180.46      188.17    22    93      127.05      131.15
06    N08GR       180.46      188.17    22    93      123.05      127.05
06    N08AU       180.46      188.17    93    95      123.05      131.15
06    N08WU       180.46      188.17    95    97      123.05      131.15

06    N09B        180.46      188.17     5    20      131.15      139.25
06    N09AL       180.46      188.17    20    22      131.15      139.25
06    N09F        180.46      188.17    22    93      131.15      139.25
06    N09AU       180.46      188.17    93    95      131.15      139.25
06    N09WU       180.46      188.17    95    97      131.15      139.25

06    N10B        180.46      188.17     5    20      139.25      147.35
06    N10AL       180.46      188.17    20    22      139.25      147.35
06    N10F        180.46      188.17    22    93      139.25      144.65
06    N10GR       180.46      188.17    22    93      144.65      147.35
06    N10AU       180.46      188.17    93    95      139.25      147.35
06    N10WU       180.46      188.17    95    97      139.25      147.35


      ----SOUTH REGION OF DRIVER ZONE----
      ----GRAPHITE ELEMENT
      ----NOTATION SG0 SOUTH GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
      ----         SG1 SOUTH GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
      ----         SG2 SOUTH GRAPHITE ZONE 2 (REST OF THE ZONE)
      ----         AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06    SG2AL        75.62       98.75     5    18       75.55      172.75
06    SG2G         75.62       98.75    18    92       75.55      172.75
06    SG2AU        75.62       98.75    92    97       75.55      172.75

06    SG1AL        83.33       98.75     5    18       99.85      172.75
06    SG1G         83.33       98.75    18    92       99.85      172.75
06    SG1AU        83.33       98.75    92    97       99.85      172.75

06    SG0AL        75.62       83.33     5    18      116.05      140.35
06    SG0G         75.62       83.33    18    92      116.05      140.35
06    SG0AU        75.62       83.33    92    97      116.05      140.35

      ----FUEL ELEMENT
      ----NOTATION S01 - SOUTH 1 OF 9 NUMBERED FROM INNER ROW - LEFT SIDE
      ----LAST LETTER IS REGION IN Z DIRECTION
      ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06    S01B         91.04       98.75     5    20      156.55      164.65
06    S01AL        91.04       98.75    20    22      156.55      164.65
06    S01F         91.04       98.75    22    93      156.55      164.65
06    S01AU        91.04       98.75    93    95      156.55      164.65
06    S01WU        91.04       98.75    95    97      156.55      164.65

06    S02B         91.04       98.75     5    20      148.45      156.55
06    S02AL        91.04       98.75    20    22      148.45      156.55
06    S02F         91.04       98.75    22    93      148.45      156.55
06    S02AU        91.04       98.75    93    95      148.45      156.55
06    S02WU        91.04       98.75    95    97      148.45      156.55

06    S03B         91.04       98.75     5    20      140.35      148.45
06    S03AL        91.04       98.75    20    22      140.35      148.45
06    S03F         91.04       98.75    22    93      140.35      148.45
06    S03AU        91.04       98.75    93    95      140.35      148.45
06    S03WU        91.04       98.75    95    97      140.35      148.45

06    S04B         91.04       98.75     5    20      132.25      140.35
06    S04AL        91.04       98.75    20    22      132.25      140.35
06    S04F         91.04       98.75    22    93      132.25      140.35
06    S04AU        91.04       98.75    93    95      132.25      140.35
06    S04WU        91.04       98.75    95    97      132.25      140.35

06    S05B         91.04       98.75     5    20      124.15      132.25
06    S05AL        91.04       98.75    20    22      124.15      132.25
06    S05F         91.04       98.75    22    93      124.15      132.25
06    S05AU        91.04       98.75    93    95      124.15      132.25
06    S05WU        91.04       98.75    95    97      124.15      132.25
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06    S06B          91.04       98.75     5    20       116.05      124.15
06    S06AL         91.04       98.75    20    22       116.05      124.15
06    S06F          91.04       98.75    22    93       116.05      124.15
06    S06AU         91.04       98.75    93    95       116.05      124.15
06    S06WU         91.04       98.75    95    97       116.05      124.15

06    S07B          91.04       98.75     5    20       107.95      116.05
06    S07AL         91.04       98.75    20    22       107.95      116.05
06    S07F          91.04       98.75    22    93       107.95      116.05
06    S07AU         91.04       98.75    93    95       107.95      116.05
06    S07WU         91.04       98.75    95    97       107.95      116.05

06    S08B          83.33       91.04     5    20       132.25      140.35
06    S08AL         83.33       91.04    20    22       132.25      140.35
06    S08F          83.33       91.04    22    93       132.25      137.65
06    S08GR         83.33       91.04    22    93       137.65      140.35
06    S08AU         83.33       91.04    93    95       132.25      140.35
06    S08WU         83.33       91.04    95    97       132.25      140.35

06    S09B          83.33       91.04     5    20       124.15      132.25
06    S09AL         83.33       91.04    20    22       124.15      132.25
06    S09F          83.33       91.04    22    93       124.15      132.25
06    S09AU         83.33       91.04    93    95       124.15      132.25
06    S09WU         83.33       91.04    95    97       124.15      132.25

06    S10B          83.33       91.04     5    20       116.05      124.15
06    S10AL         83.33       91.04    20    22       116.05      124.15
06    S10F          83.33       91.04    22    93       118.75      124.15
06    S10GR         83.33       91.04    22    93       116.05      118.75
06    S10AU         83.33       91.04    93    95       116.05      124.15
06    S10WU         83.33       91.04    95    97       116.05      124.15


      ----EAST REGION OF DRIVER ZONE----
      ----GRAPHITE ELEMENT
      ----NOTATION EG0 EAST GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
      ----          EG1 EAST GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
      ----          EG2 EAST GRAPHITE ZONE 2 (REST OF THE ZONE)
      ----          AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06    EG2AL         98.75      187.85     5    18        75.62       98.75
06    EG2G          98.75      187.85    18    92        75.62       98.75
06    EG2AU         98.75      187.85    92    97        75.62       98.75

06    EG1AL         98.75      171.65     5    18        83.33       98.75
06    EG1G          98.75      171.65    18    92        83.33       98.75
06    EG1AU         98.75      171.65    92    97        83.33       98.75

06    EG0AL        123.05      147.35     5    18        75.62       83.33
06    EG0G         123.05      147.35    18    92        75.62       83.33
06    EG0AU        123.05      147.35    92    97        75.62       83.33

      ----FUEL ELEMENT
      ----NOTATION E01 - EAST 1 OF 9 NUMBERED FROM INNER ROW - LEFT SIDE
      ----LAST LETTER IS REGION IN Z DIRECTION
      ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06    E01B         106.85      114.95     5    20        91.04       98.75
06    E01AL        106.85      114.95    20    22        91.04       98.75
06    E01F         106.85      114.95    22    93        91.04       98.75
06    E01AU        106.85      114.95    93    95        91.04       98.75
06    E01WU        106.85      114.95    95    97        91.04       98.75

06    E02B         114.95      123.05     5    20        91.04       98.75
06    E02AL        114.95      123.05    20    22        91.04       98.75
06    E02F         114.95      123.05    22    93        91.04       98.75
06    E02AU        114.95      123.05    93    95        91.04       98.75
06    E02WU        114.95      123.05    95    97        91.04       98.75

06    E03B         123.05      131.15     5    20        91.04       98.75
06    E03AL        123.05      131.15    20    22        91.04       98.75
06    E03F         123.05      131.15    22    93        91.04       98.75
06    E03AU        123.05      131.15    93    95        91.04       98.75
06    E03WU        123.05      131.15    95    97        91.04       98.75

06    E04B         131.15      139.25     5    20        91.04       98.75
06    E04AL        131.15      139.25    20    22        91.04       98.75
06    E04F         131.15      139.25    22    93        91.04       98.75
06    E04AU        131.15      139.25    93    95        91.04       98.75
06    E04WU        131.15      139.25    95    97        91.04       98.75

06    E05B         139.25      147.35     5    20        91.04       98.75
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06    E05AL       139.25      147.35     20     22        91.04        98.75
06    E05F        139.25      147.35     22     93        91.04        98.75
06    E05AU       139.25      147.35     93     95        91.04        98.75
06    E05WU       139.25      147.35     95     97        91.04        98.75

06    E06B        147.35      155.45      5     20        91.04        98.75
06    E06AL       147.35      155.45     20     22        91.04        98.75
06    E06F        147.35      155.45     22     93        91.04        98.75
06    E06AU       147.35      155.45     93     95        91.04        98.75
06    E06WU       147.35      155.45     95     97        91.04        98.75

06    E07B        155.45      163.55      5     20        91.04        98.75
06    E07AL       155.45      163.55     20     22        91.04        98.75
06    E07F        155.45      163.55     22     93        91.04        98.75
06    E07AU       155.45      163.55     93     95        91.04        98.75
06    E07WU       155.45      163.55     95     97        91.04        98.75

06    E08B        123.05      131.15      5     20        83.33        91.04
06    E08AL       123.05      131.15     20     22        83.33        91.04
06    E08F        125.75      131.15     22     93        83.33        91.04
06    E08GR       123.05      125.75     22     93        83.33        91.04
06    E08AU       123.05      131.15     93     95        83.33        91.04
06    E08WU       123.05      131.15     95     97        83.33        91.04

06    E09B        131.15      139.25      5     20        83.33        91.04
06    E09AL       131.15      139.25     20     22        83.33        91.04
06    E09F        131.15      139.25     22     93        83.33        91.04
06    E09AU       131.15      139.25     93     95        83.33        91.04
06    E09WU       131.15      139.25     95     97        83.33        91.04

06    E10B        139.25      147.35      5     20        83.33        91.04
06    E10AL       139.25      147.35     20     22        83.33        91.04
06    E10F        139.25      144.65     22     93        83.33        91.04
06    E10GR       144.65      147.35     22     93        83.33        91.04
06    E10AU       139.25      147.35     93     95        83.33        91.04
06    E10WU       139.25      147.35     95     97        83.33        91.04

      ----WEST REGION OF DRIVER ZONE----
      ----GRAPHITE ELEMENT
      ----NOTATION WG0 WEST GRAPHITE ZONE 0 (NEXT TO A FUEL ASSEMBLY)
      ----         WG1 WEST GRAPHITE ZONE 1 (NEXT TO A FUEL ASSEMBLY)
      ----         WG2 WEST GRAPHITE ZONE 2 (REST OF THE ZONE)
      ----         AL: LOWER AL CLAD, AU: UPPER AL CLAD, G: GRAPHITE
06    WG2AL        83.65      172.75      5     18       172.75       195.88
06    WG2G         83.65      172.75     18     92       172.75       195.88
06    WG2AU        83.65      172.75     92     97       172.75       195.88

06    WG1AL        99.85      172.75      5     18       172.75       188.17
06    WG1G         99.85      172.75     18     92       172.75       188.17
06    WG1AU        99.85      172.75     92     97       172.75       188.17

06    WG0AL       124.15      148.45      5     18       188.17       195.88
06    WG0G        124.15      148.45     18     92       188.17       195.88
06    WG0AU       124.15      148.45     92     97       188.17       195.88

      ----FUEL ELEMENT
      ----NOTATION W01 - WEST 1 OF 9 NUMBERED FROM INNER ROW - LEFT SIDE
      ----LAST LETTER IS REGION IN Z DIRECTION
      ----B-BOTTOM, AL-AL CLAD LOWER, F-FUEL, AU-AL CLAD UPPER, WU-WATER UP
06    W01B        156.55      164.65      5     20       172.75       180.46
06    W01AL       156.55      164.65     20     22       172.75       180.46
06    W01F        156.55      164.65     22     93       172.75       180.46
06    W01AU       156.55      164.65     93     95       172.75       180.46
06    W01WU       156.55      164.65     95     97       172.75       180.46

06    W02B        148.45      156.55      5     20       172.75       180.46
06    W02AL       148.45      156.55     20     22       172.75       180.46
06    W02F        148.45      156.55     22     93       172.75       180.46
06    W02AU       148.45      156.55     93     95       172.75       180.46
06    W02WU       148.45      156.55     95     97       172.75       180.46

06    W03B        140.35      148.45      5     20       172.75       180.46
06    W03AL       140.35      148.45     20     22       172.75       180.46
06    W03F        140.35      148.45     22     93       172.75       180.46
06    W03AU       140.35      148.45     93     95       172.75       180.46
06    W03WU       140.35      148.45     95     97       172.75       180.46

06    W04B        132.25      140.35      5     20       172.75       180.46
06    W04AL       132.25      140.35     20     22       172.75       180.46
06    W04F        132.25      140.35     22     93       172.75       180.46
06    W04AU       132.25      140.35     93     95       172.75       180.46
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06    W04WU      132.25     140.35     95    97      172.75     180.46

06    W05B       124.15     132.25      5    20      172.75     180.46
06    W05AL      124.15     132.25     20    22      172.75     180.46
06    W05F       124.15     132.25     22    93      172.75     180.46
06    W05AU      124.15     132.25     93    95      172.75     180.46
06    W05WU      124.15     132.25     95    97      172.75     180.46

06    W06B       116.05     124.15      5    20      172.75     180.46
06    W06AL      116.05     124.15     20    22      172.75     180.46
06    W06F       116.05     124.15     22    93      172.75     180.46
06    W06AU      116.05     124.15     93    95      172.75     180.46
06    W06WU      116.05     124.15     95    97      172.75     180.46

06    W07B       107.95     116.05      5    20      172.75     180.46
06    W07AL      107.95     116.05     20    22      172.75     180.46
06    W07F       107.95     116.05     22    93      172.75     180.46
06    W07AU      107.95     116.05     93    95      172.75     180.46
06    W07WU      107.95     116.05     95    97      172.75     180.46

06    W08B       140.35     148.45      5    20      180.46     188.17
06    W08AL      140.35     148.45     20    22      180.46     188.17
06    W08F       140.35     145.75     22    93      180.46     188.17
06    W08GR      145.75     148.45     22    93      180.46     188.17
06    W08AU      140.35     148.45     93    95      180.46     188.17
06    W08WU      140.35     148.45     95    97      180.46     188.17

06    W09B       132.25     140.35      5    20      180.46     188.17
06    W09AL      132.25     140.35     20    22      180.46     188.17
06    W09F       132.25     140.35     22    93      180.46     188.17
06    W09AU      132.25     140.35     93    95      180.46     188.17
06    W09WU      132.25     140.35     95    97      180.46     188.17

06    W10B       124.15     132.25      5    20      180.46     188.17
06    W10AL      124.15     132.25     20    22      180.46     188.17
06    W10F       126.85     132.25     22    93      180.46     188.17
06    W10GR      124.15     126.85     22    93      180.46     188.17
06    W10AU      124.15     132.25     93    95      180.46     188.17
06    W10WU      124.15     132.25     95    97      180.46     188.17

      ----EXPERIMENTAL ZONE----
      ----WEDGE IS THE ALUMINUM CORNERS OUTSIDE THE CHIMNEY
      ----PLATES INSIDE THE CHIMNEY : SSL- LOWER SS PLATES,

06    EZONE       98.75     172.75      2   116       98.75     172.75
06    WEDGE       98.75     172.75      5    97       98.75     172.75

      ----ANGLE GRAPHITE ELEMENTS----
      ----NOTATION G-GRAPHITE ELEMENT, 1-ELEMENT ARE NUMBERED 1-4
      ----AXIAL LOCATION AL-LOWER AL CLAD, AU-UPPER AL CLAD, G-GRAPHITE
06    G1AL       165.04     172.75      5    18      164.65     172.75
06    G1G        165.04     172.75     18    92      164.65     172.75
06    G1AU       165.04     172.75     92    97      164.65     172.75

06    G2AL        98.75     106.46      5    18       98.75     106.85
06    G2G         98.75     106.46     18    92       98.75     106.85
06    G2AU        98.75     106.46     92    97       98.75     106.85

06    G3AL       165.04     172.75      5    18       98.75     106.85
06    G3G        165.04     172.75     18    92       98.75     106.85
06    G3AU       165.04     172.75     92    97       98.75     106.85

06    G4AL        98.75     106.46      5    18      164.65     172.75
06    G4G         98.75     106.46     18    92      164.65     172.75
06    G4AU        98.75     106.46     92    97      164.65     172.75

      ----ALUMINUM MASSIF----
      ----NOTATION ALB-ALUMINUM BLOCK, A-E ARE AXIAL SEGMENTS
06    ALBA       106.85     164.65      0     7      106.85     164.65
06    ALBB       106.85     164.65      7     8      106.85     164.65
06    ALBC       106.85     164.65      8   106      106.85     164.65
06    ALBD       106.85     164.65    106   107      106.85     164.65
06    ALBE       106.85     164.65    107   110      106.85     164.65

      ----CHIMNEY PIECES----
      ----NOTATION CHI-CHIMNEY, 1-PIECES ARE NUMBERED 1-8
      ----A-G ARE AXIAL SEGMENTS EXCEPT FOR T- TABLE

06    CHI1T      164.65     172.75      0     2      114.95     156.55
06    CHI1A      164.65     172.75      2     7      114.95     156.55
06    CHI1B      164.65     172.75      7     8      114.95     156.55
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06    CHI1C        164.65      172.75    8    97       114.95      156.55
06    CHI1D        164.65      172.75   97   106       114.95      156.55
06    CHI1E        164.65      172.75  106   107       114.95      156.55
06    CHI1F        164.65      172.75  107   110       114.95      156.55

06    CHI2T         98.75      106.85    0     2       114.95      156.55
06    CHI2A         98.75      106.85    2     7       114.95      156.55
06    CHI2B         98.75      106.85    7     8       114.95      156.55
06    CHI2C         98.75      106.85    8    97       114.95      156.55
06    CHI2D         98.75      106.85   97   106       114.95      156.55
06    CHI2E         98.75      106.85  106   107       114.95      156.55
06    CHI2F         98.75      106.85  107   110       114.95      156.55

06    CHI3T        114.95      156.55    0     2        98.75      106.85
06    CHI3A        114.95      156.55    2     7        98.75      106.85
06    CHI3B        114.95      156.55    7     8        98.75      106.85
06    CHI3C        114.95      156.55    8    97        98.75      106.85
06    CHI3D        114.95      156.55   97   106        98.75      106.85
06    CHI3E        114.95      156.55  106   107        98.75      106.85
06    CHI3F        114.95      156.55  107   110        98.75      106.85

06    CHI4T        114.95      156.55    0     2       164.65      172.75
06    CHI4A        114.95      156.55    2     7       164.65      172.75
06    CHI4B        114.95      156.55    7     8       164.65      172.75
06    CHI4C        114.95      156.55    8    97       164.65      172.75
06    CHI4D        114.95      156.55   97   106       164.65      172.75
06    CHI4E        114.95      156.55  106   107       164.65      172.75
06    CHI4F        114.95      156.55  107   110       164.65      172.75

06    CHI5T        156.55      164.65    0     2       156.55      164.65
06    CHI5A        156.55      164.65    2     7       156.55      164.65
06    CHI5B        156.55      164.65    7     8       156.55      164.65
06    CHI5C        156.55      164.65    8    97       156.55      164.65
06    CHI5D        156.55      164.65   97   106       156.55      164.65
06    CHI5E        156.55      164.65  106   107       156.55      164.65
06    CHI5F        156.55      164.65  107   110       156.55      164.65

06    CHI6T        106.85      114.95    0     2       106.85      114.95
06    CHI6A        106.85      114.95    2     7       106.85      114.95
06    CHI6B        106.85      114.95    7     8       106.85      114.95
06    CHI6C        106.85      114.95    8    97       106.85      114.95
06    CHI6D        106.85      114.95   97   106       106.85      114.95
06    CHI6E        106.85      114.95  106   107       106.85      114.95
06    CHI6F        106.85      114.95  107   110       106.85      114.95

06    CHI7T        156.55      164.65    0     2       106.85      114.95
06    CHI7A        156.55      164.65    2     7       106.85      114.95
06    CHI7B        156.55      164.65    7     8       106.85      114.95
06    CHI7C        156.55      164.65    8    97       106.85      114.95
06    CHI7D        156.55      164.65   97   106       106.85      114.95
06    CHI7E        156.55      164.65  106   107       106.85      114.95
06    CHI7F        156.55      164.65  107   110       106.85      114.95

06    CHI8T        106.85      114.95    0     2       156.55      164.65
06    CHI8A        106.85      114.95    2     7       156.55      164.65
06    CHI8B        106.85      114.95    7     8       156.55      164.65
06    CHI8C        106.85      114.95    8    97       156.55      164.65
06    CHI8D        106.85      114.95   97   106       156.55      164.65
06    CHI8E        106.85      114.95  106   107       156.55      164.65
06    CHI8F        106.85      114.95  107   110       156.55      164.65


      ----ELEMENTS IN MELODIE R1MOX CONFIGURATION----

      ----UO2 FUEL PINS
      ----1 CENTRAL ZONE, 2 ZONES ON EACH SIDE
      ----NOTATION: F1C- FUEL TYPE-1 CENTRAL REGION
      ----F1C1- REGION CENTRAL 1, F1C2-, F1C3  (SELF SHIELDING INTERFACE UO2/PuO2)
      ----F1W1- REGION WEST 1, F1W2- REGION WEST 2
      ----F1W3, F1W8, F1W9 (SELF SHIELDING INTERFACE UO2/AL PIN)
      ----F1W4, F1W5, F1W6, F1W7, F1WA, F1WB (SELF SHIELDING INTERFACE UO2/AL BLOCK)
      ----A LAST LETTER (A-Z) GIVES THE AXIAL LOCATION EXCEPT
      ----SS-STAINLESS STEEL LOWER PLATE, W-LOWER WATER
06    F1CW         122.52      148.98    0     7       122.52      148.98
06    F1CSS        122.52      148.98    7     8       122.52      148.98
06    F1CA         122.52      148.98    8    13       122.52      148.98
06    F1CB         122.52      148.98   13    25       122.52      148.98
06    F1CC         122.52      148.98   25    87       122.52      148.98
06    F1CD         122.52      148.98   87   103       122.52      148.98
06    F1CE         122.52      148.98  103   107       122.52      148.98
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06	F1CF	122.52	148.98	107	110	122.52	148.98
06	F1C1W	127.56	143.94	0	7	127.56	143.94
06	F1C1SS	127.56	143.94	7	8	127.56	143.94
06	F1C1A	127.56	143.94	8	13	127.56	143.94
06	F1C1B	127.56	143.94	13	25	127.56	143.94
06	F1C1C	127.56	143.94	25	87	127.56	143.94
06	F1C1D	127.56	143.94	87	103	127.56	143.94
06	F1C1E	127.56	143.94	103	107	127.56	143.94
06	F1C1F	127.56	143.94	107	110	127.56	143.94
06	F1C2W	128.82	142.68	0	7	126.30	145.20
06	F1C2SS	128.82	142.68	7	8	126.30	145.20
06	F1C2A	128.82	142.68	8	13	126.30	145.20
06	F1C2B	128.82	142.68	13	25	126.30	145.20
06	F1C2C	128.82	142.68	25	87	126.30	145.20
06	F1C2D	128.82	142.68	87	103	126.30	145.20
06	F1C2E	128.82	142.68	103	107	126.30	145.20
06	F1C2F	128.82	142.68	107	110	126.30	145.20
06	F1C3W	126.30	145.20	0	7	128.82	142.68
06	F1C3SS	126.30	145.20	7	8	128.82	142.68
06	F1C3A	126.30	145.20	8	13	128.82	142.68
06	F1C3B	126.30	145.20	13	25	128.82	142.68
06	F1C3C	126.30	145.20	25	87	128.82	142.68
06	F1C3D	126.30	145.20	87	103	128.82	142.68
06	F1C3E	126.30	145.20	103	107	128.82	142.68
06	F1C3F	126.30	145.20	107	110	128.82	142.68
06	F1N1W	148.98	152.76	0	7	122.52	148.98
06	F1N1SS	148.98	152.76	7	8	122.52	148.98
06	F1N1A	148.98	152.76	8	13	122.52	148.98
06	F1N1B	148.98	152.76	13	25	122.52	148.98
06	F1N1C	148.98	152.76	25	87	122.52	148.98
06	F1N1D	148.98	152.76	87	103	122.52	148.98
06	F1N1E	148.98	152.76	103	107	122.52	148.98
06	F1N1F	148.98	152.76	107	110	122.52	148.98
06	F1N2W	152.76	156.54	0	7	130.08	141.42
06	F1N2SS	152.76	156.54	7	8	130.08	141.42
06	F1N2A	152.76	156.54	8	13	130.08	141.42
06	F1N2B	152.76	156.54	13	25	130.08	141.42
06	F1N2C	152.76	156.54	25	87	130.08	141.42
06	F1N2D	152.76	156.54	87	103	130.08	141.42
06	F1N2E	152.76	156.54	103	107	130.08	141.42
06	F1N2F	152.76	156.54	107	110	130.08	141.42
06	F1N3W	154.02	155.28	0	7	130.08	141.42
06	F1N3SS	154.02	155.28	7	8	130.08	141.42
06	F1N3A	154.02	155.28	8	13	130.08	141.42
06	F1N3B	154.02	155.28	13	25	130.08	141.42
06	F1N3C	154.02	155.28	25	87	130.08	141.42
06	F1N3D	154.02	155.28	87	103	130.08	141.42
06	F1N3E	154.02	155.28	103	107	130.08	141.42
06	F1N3F	154.02	155.28	107	110	130.08	141.42
06	F1N4W	152.76	155.28	0	7	140.16	141.42
06	F1N4SS	152.76	155.28	7	8	140.16	141.42
06	F1N4A	152.76	155.28	8	13	140.16	141.42
06	F1N4B	152.76	155.28	13	25	140.16	141.42
06	F1N4C	152.76	155.28	25	87	140.16	141.42
06	F1N4D	152.76	155.28	87	103	140.16	141.42
06	F1N4E	152.76	155.28	103	107	140.16	141.42
06	F1N4F	152.76	155.28	107	110	140.16	141.42
06	F1N5W	152.76	155.28	0	7	130.08	131.34
06	F1N5SS	152.76	155.28	7	8	130.08	131.34
06	F1N5A	152.76	155.28	8	13	130.08	131.34
06	F1N5B	152.76	155.28	13	25	130.08	131.34
06	F1N5C	152.76	155.28	25	87	130.08	131.34
06	F1N5D	152.76	155.28	87	103	130.08	131.34
06	F1N5E	152.76	155.28	103	107	130.08	131.34
06	F1N5F	152.76	155.28	107	110	130.08	131.34
06	F1N6W	151.50	152.76	0	7	141.42	146.46
06	F1N6SS	151.50	152.76	7	8	141.42	146.46
06	F1N6A	151.50	152.76	8	13	141.42	146.46
06	F1N6B	151.50	152.76	13	25	141.42	146.46
06	F1N6C	151.50	152.76	25	87	141.42	146.46
06	F1N6D	151.50	152.76	87	103	141.42	146.46

06	F1N6E	151.50	152.76	103	107	141.42	146.46
06	F1N6F	151.50	152.76	107	110	141.42	146.46
06	F1N7W	151.50	152.76	0	7	125.04	130.08
06	F1N7SS	151.50	152.76	7	8	125.04	130.08
06	F1N7A	151.50	152.76	8	13	125.04	130.08
06	F1N7B	151.50	152.76	13	25	125.04	130.08
06	F1N7C	151.50	152.76	25	87	125.04	130.08
06	F1N7D	151.50	152.76	87	103	125.04	130.08
06	F1N7E	151.50	152.76	103	107	125.04	130.08
06	F1N7F	151.50	152.76	107	110	125.04	130.08
06	F1N8W	150.24	151.50	0	7	146.46	147.72
06	F1N8SS	150.24	151.50	7	8	146.46	147.72
06	F1N8A	150.24	151.50	8	13	146.46	147.72
06	F1N8B	150.24	151.50	13	25	146.46	147.72
06	F1N8C	150.24	151.50	25	87	146.46	147.72
06	F1N8D	150.24	151.50	87	103	146.46	147.72
06	F1N8E	150.24	151.50	103	107	146.46	147.72
06	F1N8F	150.24	151.50	107	110	146.46	147.72
06	F1N9W	150.24	151.50	0	7	123.78	125.04
06	F1N9SS	150.24	151.50	7	8	123.78	125.04
06	F1N9A	150.24	151.50	8	13	123.78	125.04
06	F1N9B	150.24	151.50	13	25	123.78	125.04
06	F1N9C	150.24	151.50	25	87	123.78	125.04
06	F1N9D	150.24	151.50	87	103	123.78	125.04
06	F1N9E	150.24	151.50	103	107	123.78	125.04
06	F1N9F	150.24	151.50	107	110	123.78	125.04
06	F1NAW	148.98	150.24	0	7	147.72	148.98
06	F1NASS	148.98	150.24	7	8	147.72	148.98
06	F1NAA	148.98	150.24	8	13	147.72	148.98
06	F1NAB	148.98	150.24	13	25	147.72	148.98
06	F1NAC	148.98	150.24	25	87	147.72	148.98
06	F1NAD	148.98	150.24	87	103	147.72	148.98
06	F1NAE	148.98	150.24	103	107	147.72	148.98
06	F1NAF	148.98	150.24	107	110	147.72	148.98
06	F1NBW	148.98	150.24	0	7	122.52	123.78
06	F1NBSS	148.98	150.24	7	8	122.52	123.78
06	F1NBA	148.98	150.24	8	13	122.52	123.78
06	F1NBB	148.98	150.24	13	25	122.52	123.78
06	F1NBC	148.98	150.24	25	87	122.52	123.78
06	F1NBD	148.98	150.24	87	103	122.52	123.78
06	F1NBE	148.98	150.24	103	107	122.52	123.78
06	F1NBF	148.98	150.24	107	110	122.52	123.78
06	F1S1W	118.74	122.52	0	7	122.52	148.98
06	F1S1SS	118.74	122.52	7	8	122.52	148.98
06	F1S1A	118.74	122.52	8	13	122.52	148.98
06	F1S1B	118.74	122.52	13	25	122.52	148.98
06	F1S1C	118.74	122.52	25	87	122.52	148.98
06	F1S1D	118.74	122.52	87	103	122.52	148.98
06	F1S1E	118.74	122.52	103	107	122.52	148.98
06	F1S1F	118.74	122.52	107	110	122.52	148.98
06	F1S2W	114.96	118.74	0	7	130.08	141.42
06	F1S2SS	114.96	118.74	7	8	130.08	141.42
06	F1S2A	114.96	118.74	8	13	130.08	141.42
06	F1S2B	114.96	118.74	13	25	130.08	141.42
06	F1S2C	114.96	118.74	25	87	130.08	141.42
06	F1S2D	114.96	118.74	87	103	130.08	141.42
06	F1S2E	114.96	118.74	103	107	130.08	141.42
06	F1S2F	114.96	118.74	107	110	130.08	141.42
06	F1S3W	116.22	117.48	0	7	130.08	141.42
06	F1S3SS	116.22	117.48	7	8	130.08	141.42
06	F1S3A	116.22	117.48	8	13	130.08	141.42
06	F1S3B	116.22	117.48	13	25	130.08	141.42
06	F1S3C	116.22	117.48	25	87	130.08	141.42
06	F1S3D	116.22	117.48	87	103	130.08	141.42
06	F1S3E	116.22	117.48	103	107	130.08	141.42
06	F1S3F	116.22	117.48	107	110	130.08	141.42
06	F1S4W	116.22	118.74	0	7	140.16	141.42
06	F1S4SS	116.22	118.74	7	8	140.16	141.42
06	F1S4A	116.22	118.74	8	13	140.16	141.42
06	F1S4B	116.22	118.74	13	25	140.16	141.42
06	F1S4C	116.22	118.74	25	87	140.16	141.42
06	F1S4D	116.22	118.74	87	103	140.16	141.42

06	F1S4E	116.22	118.74	103	107	140.16	141.42
06	F1S4F	116.22	118.74	107	110	140.16	141.42
06	F1S5W	116.22	118.74	0	7	130.08	131.34
06	F1S5SS	116.22	118.74	7	8	130.08	131.34
06	F1S5A	116.22	118.74	8	13	130.08	131.34
06	F1S5B	116.22	118.74	13	25	130.08	131.34
06	F1S5C	116.22	118.74	25	87	130.08	131.34
06	F1S5D	116.22	118.74	87	103	130.08	131.34
06	F1S5E	116.22	118.74	103	107	130.08	131.34
06	F1S5F	116.22	118.74	107	110	130.08	131.34
06	F1S6W	118.74	120.00	0	7	141.42	146.46
06	F1S6SS	118.74	120.00	7	8	141.42	146.46
06	F1S6A	118.74	120.00	8	13	141.42	146.46
06	F1S6B	118.74	120.00	13	25	141.42	146.46
06	F1S6C	118.74	120.00	25	87	141.42	146.46
06	F1S6D	118.74	120.00	87	103	141.42	146.46
06	F1S6E	118.74	120.00	103	107	141.42	146.46
06	F1S6F	118.74	120.00	107	110	141.42	146.46
06	F1S7W	118.74	120.00	0	7	125.04	130.08
06	F1S7SS	118.74	120.00	7	8	125.04	130.08
06	F1S7A	118.74	120.00	8	13	125.04	130.08
06	F1S7B	118.74	120.00	13	25	125.04	130.08
06	F1S7C	118.74	120.00	25	87	125.04	130.08
06	F1S7D	118.74	120.00	87	103	125.04	130.08
06	F1S7E	118.74	120.00	103	107	125.04	130.08
06	F1S7F	118.74	120.00	107	110	125.04	130.08
06	F1S8W	120.00	121.26	0	7	146.46	147.72
06	F1S8SS	120.00	121.26	7	8	146.46	147.72
06	F1S8A	120.00	121.26	8	13	146.46	147.72
06	F1S8B	120.00	121.26	13	25	146.46	147.72
06	F1S8C	120.00	121.26	25	87	146.46	147.72
06	F1S8D	120.00	121.26	87	103	146.46	147.72
06	F1S8E	120.00	121.26	103	107	146.46	147.72
06	F1S8F	120.00	121.26	107	110	146.46	147.72
06	F1S9W	120.00	121.26	0	7	123.78	125.04
06	F1S9SS	120.00	121.26	7	8	123.78	125.04
06	F1S9A	120.00	121.26	8	13	123.78	125.04
06	F1S9B	120.00	121.26	13	25	123.78	125.04
06	F1S9C	120.00	121.26	25	87	123.78	125.04
06	F1S9D	120.00	121.26	87	103	123.78	125.04
06	F1S9E	120.00	121.26	103	107	123.78	125.04
06	F1S9F	120.00	121.26	107	110	123.78	125.04
06	F1SAW	121.26	122.52	0	7	147.72	148.98
06	F1SASS	121.26	122.52	7	8	147.72	148.98
06	F1SAA	121.26	122.52	8	13	147.72	148.98
06	F1SAB	121.26	122.52	13	25	147.72	148.98
06	F1SAC	121.26	122.52	25	87	147.72	148.98
06	F1SAD	121.26	122.52	87	103	147.72	148.98
06	F1SAE	121.26	122.52	103	107	147.72	148.98
06	F1SAF	121.26	122.52	107	110	147.72	148.98
06	F1SBW	121.26	122.52	0	7	122.52	123.78
06	F1SBSS	121.26	122.52	7	8	122.52	123.78
06	F1SBA	121.26	122.52	8	13	122.52	123.78
06	F1SBB	121.26	122.52	13	25	122.52	123.78
06	F1SBC	121.26	122.52	25	87	122.52	123.78
06	F1SBD	121.26	122.52	87	103	122.52	123.78
06	F1SBE	121.26	122.52	103	107	122.52	123.78
06	F1SBF	121.26	122.52	107	110	122.52	123.78
06	F1E1W	122.52	148.98	0	7	118.74	122.52
06	F1E1SS	122.52	148.98	7	8	118.74	122.52
06	F1E1A	122.52	148.98	8	13	118.74	122.52
06	F1E1B	122.52	148.98	13	25	118.74	122.52
06	F1E1C	122.52	148.98	25	87	118.74	122.52
06	F1E1D	122.52	148.98	87	103	118.74	122.52
06	F1E1E	122.52	148.98	103	107	118.74	122.52
06	F1E1F	122.52	148.98	107	110	118.74	122.52
06	F1E2W	130.08	141.42	0	7	114.96	118.74
06	F1E2SS	130.08	141.42	7	8	114.96	118.74
06	F1E2A	130.08	141.42	8	13	114.96	118.74
06	F1E2B	130.08	141.42	13	25	114.96	118.74
06	F1E2C	130.08	141.42	25	87	114.96	118.74
06	F1E2D	130.08	141.42	87	103	114.96	118.74

06	F1E2E	130.08	141.42	103	107	114.96	118.74
06	F1E2F	130.08	141.42	107	110	114.96	118.74
06	F1E3W	130.08	141.42	0	7	116.22	117.48
06	F1E3SS	130.08	141.42	7	8	116.22	117.48
06	F1E3A	130.08	141.42	8	13	116.22	117.48
06	F1E3B	130.08	141.42	13	25	116.22	117.48
06	F1E3C	130.08	141.42	25	87	116.22	117.48
06	F1E3D	130.08	141.42	87	103	116.22	117.48
06	F1E3E	130.08	141.42	103	107	116.22	117.48
06	F1E3F	130.08	141.42	107	110	116.22	117.48
06	F1E4W	130.08	131.34	0	7	116.22	118.74
06	F1E4SS	130.08	131.34	7	8	116.22	118.74
06	F1E4A	130.08	131.34	8	13	116.22	118.74
06	F1E4B	130.08	131.34	13	25	116.22	118.74
06	F1E4C	130.08	131.34	25	87	116.22	118.74
06	F1E4D	130.08	131.34	87	103	116.22	118.74
06	F1E4E	130.08	131.34	103	107	116.22	118.74
06	F1E4F	130.08	131.34	107	110	116.22	118.74
06	F1E5W	140.16	141.42	0	7	116.22	118.74
06	F1E5SS	140.16	141.42	7	8	116.22	118.74
06	F1E5A	140.16	141.42	8	13	116.22	118.74
06	F1E5B	140.16	141.42	13	25	116.22	118.74
06	F1E5C	140.16	141.42	25	87	116.22	118.74
06	F1E5D	140.16	141.42	87	103	116.22	118.74
06	F1E5E	140.16	141.42	103	107	116.22	118.74
06	F1E5F	140.16	141.42	107	110	116.22	118.74
06	F1E6W	125.04	130.08	0	7	118.74	120.00
06	F1E6SS	125.04	130.08	7	8	118.74	120.00
06	F1E6A	125.04	130.08	8	13	118.74	120.00
06	F1E6B	125.04	130.08	13	25	118.74	120.00
06	F1E6C	125.04	130.08	25	87	118.74	120.00
06	F1E6D	125.04	130.08	87	103	118.74	120.00
06	F1E6E	125.04	130.08	103	107	118.74	120.00
06	F1E6F	125.04	130.08	107	110	118.74	120.00
06	F1E7W	141.42	146.46	0	7	118.74	120.00
06	F1E7SS	141.42	146.46	7	8	118.74	120.00
06	F1E7A	141.42	146.46	8	13	118.74	120.00
06	F1E7B	141.42	146.46	13	25	118.74	120.00
06	F1E7C	141.42	146.46	25	87	118.74	120.00
06	F1E7D	141.42	146.46	87	103	118.74	120.00
06	F1E7E	141.42	146.46	103	107	118.74	120.00
06	F1E7F	141.42	146.46	107	110	118.74	120.00
06	F1E8W	123.78	125.04	0	7	120.00	121.26
06	F1E8SS	123.78	125.04	7	8	120.00	121.26
06	F1E8A	123.78	125.04	8	13	120.00	121.26
06	F1E8B	123.78	125.04	13	25	120.00	121.26
06	F1E8C	123.78	125.04	25	87	120.00	121.26
06	F1E8D	123.78	125.04	87	103	120.00	121.26
06	F1E8E	123.78	125.04	103	107	120.00	121.26
06	F1E8F	123.78	125.04	107	110	120.00	121.26
06	F1E9W	146.46	147.72	0	7	120.00	121.26
06	F1E9SS	146.46	147.72	7	8	120.00	121.26
06	F1E9A	146.46	147.72	8	13	120.00	121.26
06	F1E9B	146.46	147.72	13	25	120.00	121.26
06	F1E9C	146.46	147.72	25	87	120.00	121.26
06	F1E9D	146.46	147.72	87	103	120.00	121.26
06	F1E9E	146.46	147.72	103	107	120.00	121.26
06	F1E9F	146.46	147.72	107	110	120.00	121.26
06	F1EAW	122.52	123.78	0	7	121.26	122.52
06	F1EASS	122.52	123.78	7	8	121.26	122.52
06	F1EAA	122.52	123.78	8	13	121.26	122.52
06	F1EAB	122.52	123.78	13	25	121.26	122.52
06	F1EAC	122.52	123.78	25	87	121.26	122.52
06	F1EAD	122.52	123.78	87	103	121.26	122.52
06	F1EAE	122.52	123.78	103	107	121.26	122.52
06	F1EAF	122.52	123.78	107	110	121.26	122.52
06	F1EBW	147.72	148.98	0	7	121.26	122.52
06	F1EBSS	147.72	148.98	7	8	121.26	122.52
06	F1EBA	147.72	148.98	8	13	121.26	122.52
06	F1EBB	147.72	148.98	13	25	121.26	122.52
06	F1EBC	147.72	148.98	25	87	121.26	122.52
06	F1EBD	147.72	148.98	87	103	121.26	122.52

06	F1EBE	147.72	148.98	103	107	121.26	122.52
06	F1EBF	147.72	148.98	107	110	121.26	122.52
06	F1W1W	122.52	148.98	0	7	148.98	152.76
06	F1W1SS	122.52	148.98	7	8	148.98	152.76
06	F1W1A	122.52	148.98	8	13	148.98	152.76
06	F1W1B	122.52	148.98	13	25	148.98	152.76
06	F1W1C	122.52	148.98	25	87	148.98	152.76
06	F1W1D	122.52	148.98	87	103	148.98	152.76
06	F1W1E	122.52	148.98	103	107	148.98	152.76
06	F1W1F	122.52	148.98	107	110	148.98	152.76
06	F1W2W	130.08	141.42	0	7	152.76	156.54
06	F1W2SS	130.08	141.42	7	8	152.76	156.54
06	F1W2A	130.08	141.42	8	13	152.76	156.54
06	F1W2B	130.08	141.42	13	25	152.76	156.54
06	F1W2C	130.08	141.42	25	87	152.76	156.54
06	F1W2D	130.08	141.42	87	103	152.76	156.54
06	F1W2E	130.08	141.42	103	107	152.76	156.54
06	F1W2F	130.08	141.42	107	110	152.76	156.54
06	F1W3W	130.08	141.42	0	7	154.02	155.28
06	F1W3SS	130.08	141.42	7	8	154.02	155.28
06	F1W3A	130.08	141.42	8	13	154.02	155.28
06	F1W3B	130.08	141.42	13	25	154.02	155.28
06	F1W3C	130.08	141.42	25	87	154.02	155.28
06	F1W3D	130.08	141.42	87	103	154.02	155.28
06	F1W3E	130.08	141.42	103	107	154.02	155.28
06	F1W3F	130.08	141.42	107	110	154.02	155.28
06	F1W4W	130.08	131.34	0	7	152.76	155.28
06	F1W4SS	130.08	131.34	7	8	152.76	155.28
06	F1W4A	130.08	131.34	8	13	152.76	155.28
06	F1W4B	130.08	131.34	13	25	152.76	155.28
06	F1W4C	130.08	131.34	25	87	152.76	155.28
06	F1W4D	130.08	131.34	87	103	152.76	155.28
06	F1W4E	130.08	131.34	103	107	152.76	155.28
06	F1W4F	130.08	131.34	107	110	152.76	155.28
06	F1W5W	140.16	141.42	0	7	152.76	155.28
06	F1W5SS	140.16	141.42	7	8	152.76	155.28
06	F1W5A	140.16	141.42	8	13	152.76	155.28
06	F1W5B	140.16	141.42	13	25	152.76	155.28
06	F1W5C	140.16	141.42	25	87	152.76	155.28
06	F1W5D	140.16	141.42	87	103	152.76	155.28
06	F1W5E	140.16	141.42	103	107	152.76	155.28
06	F1W5F	140.16	141.42	107	110	152.76	155.28
06	F1W6W	125.04	130.08	0	7	151.50	152.76
06	F1W6SS	125.04	130.08	7	8	151.50	152.76
06	F1W6A	125.04	130.08	8	13	151.50	152.76
06	F1W6B	125.04	130.08	13	25	151.50	152.76
06	F1W6C	125.04	130.08	25	87	151.50	152.76
06	F1W6D	125.04	130.08	87	103	151.50	152.76
06	F1W6E	125.04	130.08	103	107	151.50	152.76
06	F1W6F	125.04	130.08	107	110	151.50	152.76
06	F1W7W	141.42	146.46	0	7	151.50	152.76
06	F1W7SS	141.42	146.46	7	8	151.50	152.76
06	F1W7A	141.42	146.46	8	13	151.50	152.76
06	F1W7B	141.42	146.46	13	25	151.50	152.76
06	F1W7C	141.42	146.46	25	87	151.50	152.76
06	F1W7D	141.42	146.46	87	103	151.50	152.76
06	F1W7E	141.42	146.46	103	107	151.50	152.76
06	F1W7F	141.42	146.46	107	110	151.50	152.76
06	F1W8W	123.78	125.04	0	7	150.24	151.50
06	F1W8SS	123.78	125.04	7	8	150.24	151.50
06	F1W8A	123.78	125.04	8	13	150.24	151.50
06	F1W8B	123.78	125.04	13	25	150.24	151.50
06	F1W8C	123.78	125.04	25	87	150.24	151.50
06	F1W8D	123.78	125.04	87	103	150.24	151.50
06	F1W8E	123.78	125.04	103	107	150.24	151.50
06	F1W8F	123.78	125.04	107	110	150.24	151.50
06	F1W9W	146.46	147.72	0	7	150.24	151.50
06	F1W9SS	146.46	147.72	7	8	150.24	151.50
06	F1W9A	146.46	147.72	8	13	150.24	151.50
06	F1W9B	146.46	147.72	13	25	150.24	151.50
06	F1W9C	146.46	147.72	25	87	150.24	151.50
06	F1W9D	146.46	147.72	87	103	150.24	151.50

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06    F1W9E        146.46      147.72   103   107       150.24      151.50
06    F1W9F        146.46      147.72   107   110       150.24      151.50

06    F1WAW        122.52      123.78     0     7       148.98      150.24
06    F1WASS       122.52      123.78     7     8       148.98      150.24
06    F1WAA        122.52      123.78     8    13       148.98      150.24
06    F1WAB        122.52      123.78    13    25       148.98      150.24
06    F1WAC        122.52      123.78    25    87       148.98      150.24
06    F1WAD        122.52      123.78    87   103       148.98      150.24
06    F1WAE        122.52      123.78   103   107       148.98      150.24
06    F1WAF        122.52      123.78   107   110       148.98      150.24

06    F1WBW        147.72      148.98     0     7       148.98      150.24
06    F1WBSS       147.72      148.98     7     8       148.98      150.24
06    F1WBA        147.72      148.98     8    13       148.98      150.24
06    F1WBB        147.72      148.98    13    25       148.98      150.24
06    F1WBC        147.72      148.98    25    87       148.98      150.24
06    F1WBD        147.72      148.98    87   103       148.98      150.24
06    F1WBE        147.72      148.98   103   107       148.98      150.24
06    F1WBF        147.72      148.98   107   110       148.98      150.24


      ----MOX 4% FUEL PINS
      ----1 CENTRAL ZONE, 2 ZONES ON EACH SIDE
      ----NOTATION: F2C1- FUEL TYPE-2 CENTRAL REGION #1
      ----F2C1- FUEL TYPE-2 CENTRAL REGION #2
      ----F2W- (SELF SHIELDING INTERFACE Pu4%/Uo2)
      ----F2O- (SELF SHIELDING INTERFACE Pu4%/OSCILLATION CHANNEL)
      ----A LAST LETTER (A-Z) GIVES THE AXIAL LOCATION EXCEPT
      ----SS-STAINLESS STEEL LOWER PLATE, W-LOWER WATER
06    F2C1W        128.82      142.68     0     7       130.08      141.42
06    F2C1SS       128.82      142.68     7     8       130.08      141.42
06    F2C1A        128.82      142.68     8    13       130.08      141.42
06    F2C1B        128.82      142.68    13    25       130.08      141.42
06    F2C1C        128.82      142.68    25    87       130.08      141.42
06    F2C1D        128.82      142.68    87   103       130.08      141.42
06    F2C1E        128.82      142.68   103   107       130.08      141.42
06    F2C1F        128.82      142.68   107   110       130.08      141.42

06    F2C2W        130.08      141.42     0     7       128.82      142.68
06    F2C2SS       130.08      141.42     7     8       128.82      142.68
06    F2C2A        130.08      141.42     8    13       128.82      142.68
06    F2C2B        130.08      141.42    13    25       128.82      142.68
06    F2C2C        130.08      141.42    25    87       128.82      142.68
06    F2C2D        130.08      141.42    87   103       128.82      142.68
06    F2C2E        130.08      141.42   103   107       128.82      142.68
06    F2C2F        130.08      141.42   107   110       128.82      142.68

06    F2NW         142.68      143.94     0     7       133.86      137.64
06    F2NSS        142.68      143.94     7     8       133.86      137.64
06    F2NA         142.68      143.94     8    13       133.86      137.64
06    F2NB         142.68      143.94    13    25       133.86      137.64
06    F2NC         142.68      143.94    25    87       133.86      137.64
06    F2ND         142.68      143.94    87   103       133.86      137.64
06    F2NE         142.68      143.94   103   107       133.86      137.64
06    F2NF         142.68      143.94   107   110       133.86      137.64

06    F2SW         127.56      128.82     0     7       133.86      137.64
06    F2SSS        127.56      128.82     7     8       133.86      137.64
06    F2SA         127.56      128.82     8    13       133.86      137.64
06    F2SB         127.56      128.82    13    25       133.86      137.64
06    F2SC         127.56      128.82    25    87       133.86      137.64
06    F2SD         127.56      128.82    87   103       133.86      137.64
06    F2SE         127.56      128.82   103   107       133.86      137.64
06    F2SF         127.56      128.82   107   110       133.86      137.64

06    F2EW         133.86      137.64     0     7       127.56      128.82
06    F2ESS        133.86      137.64     7     8       127.56      128.82
06    F2EA         133.86      137.64     8    13       127.56      128.82
06    F2EB         133.86      137.64    13    25       127.56      128.82
06    F2EC         133.86      137.64    25    87       127.56      128.82
06    F2ED         133.86      137.64    87   103       127.56      128.82
06    F2EE         133.86      137.64   103   107       127.56      128.82
06    F2EF         133.86      137.64   107   110       127.56      128.82

06    F2WW         133.86      137.64     0     7       142.68      143.94
06    F2WSS        133.86      137.64     7     8       142.68      143.94
06    F2WA         133.86      137.64     8    13       142.68      143.94
06    F2WB         133.86      137.64    13    25       142.68      143.94
06    F2WC         133.86      137.64    25    87       142.68      143.94
06    F2WD         133.86      137.64    87   103       142.68      143.94
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06    F2WE        133.86      137.64   103   107      142.68      143.94
06    F2WF        133.86      137.64   107   110      142.68      143.94

06    F2OW        133.86      137.64     0     7      133.86      137.64
06    F2OSS       133.86      137.64     7     8      133.86      137.64
06    F2OA        133.86      137.64     8    13      133.86      137.64
06    F2OB        133.86      137.64    13    25      133.86      137.64
06    F2OC        133.86      137.64    25    87      133.86      137.64
06    F2OD        133.86      137.64    87   103      133.86      137.64
06    F2OE        133.86      137.64   103   107      133.86      137.64
06    F2OF        133.86      137.64   107   110      133.86      137.64

      ----MOX 3.6% FUEL PINS
      ----2 ZONES ON EACH SIDE, 4 CORNER ELTS
      ----NOTATION: F3W1 - FUEL TYPE-3 REGION WEST 1  (SELF SHIELDING Pu4%/Pu3.6%/UO2)
      ----F3NW- CORNER NORTH-WEST   (SELF SHIELDING Pu4%/Pu3.6%/UO2)
      ----A LAST LETTER (A-Z) GIVES THE AXIAL LOCATION EXCEPT
      ----SS-STAINLESS STEEL LOWER PLATE, W-LOWER WATER
06    F3N1W       142.68      143.94     0     7      137.64      141.42
06    F3N1SS      142.68      143.94     7     8      137.64      141.42
06    F3N1A       142.68      143.94     8    13      137.64      141.42
06    F3N1B       142.68      143.94    13    25      137.64      141.42
06    F3N1C       142.68      143.94    25    87      137.64      141.42
06    F3N1D       142.68      143.94    87   103      137.64      141.42
06    F3N1E       142.68      143.94   103   107      137.64      141.42
06    F3N1F       142.68      143.94   107   110      137.64      141.42

06    F3N2W       142.68      143.94     0     7      130.08      133.86
06    F3N2SS      142.68      143.94     7     8      130.08      133.86
06    F3N2A       142.68      143.94     8    13      130.08      133.86
06    F3N2B       142.68      143.94    13    25      130.08      133.86
06    F3N2C       142.68      143.94    25    87      130.08      133.86
06    F3N2D       142.68      143.94    87   103      130.08      133.86
06    F3N2E       142.68      143.94   103   107      130.08      133.86
06    F3N2F       142.68      143.94   107   110      130.08      133.86

06    F3S1W       127.56      128.82     0     7      130.08      133.86
06    F3S1SS      127.56      128.82     7     8      130.08      133.86
06    F3S1A       127.56      128.82     8    13      130.08      133.86
06    F3S1B       127.56      128.82    13    25      130.08      133.86
06    F3S1C       127.56      128.82    25    87      130.08      133.86
06    F3S1D       127.56      128.82    87   103      130.08      133.86
06    F3S1E       127.56      128.82   103   107      130.08      133.86
06    F3S1F       127.56      128.82   107   110      130.08      133.86

06    F3S2W       127.56      128.82     0     7      137.64      141.42
06    F3S2SS      127.56      128.82     7     8      137.64      141.42
06    F3S2A       127.56      128.82     8    13      137.64      141.42
06    F3S2B       127.56      128.82    13    25      137.64      141.42
06    F3S2C       127.56      128.82    25    87      137.64      141.42
06    F3S2D       127.56      128.82    87   103      137.64      141.42
06    F3S2E       127.56      128.82   103   107      137.64      141.42
06    F3S2F       127.56      128.82   107   110      137.64      141.42

06    F3E1W       137.64      141.42     0     7      127.56      128.82
06    F3E1SS      137.64      141.42     7     8      127.56      128.82
06    F3E1A       137.64      141.42     8    13      127.56      128.82
06    F3E1B       137.64      141.42    13    25      127.56      128.82
06    F3E1C       137.64      141.42    25    87      127.56      128.82
06    F3E1D       137.64      141.42    87   103      127.56      128.82
06    F3E1E       137.64      141.42   103   107      127.56      128.82
06    F3E1F       137.64      141.42   107   110      127.56      128.82

06    F3E2W       130.08      133.86     0     7      127.56      128.82
06    F3E2SS      130.08      133.86     7     8      127.56      128.82
06    F3E2A       130.08      133.86     8    13      127.56      128.82
06    F3E2B       130.08      133.86    13    25      127.56      128.82
06    F3E2C       130.08      133.86    25    87      127.56      128.82
06    F3E2D       130.08      133.86    87   103      127.56      128.82
06    F3E2E       130.08      133.86   103   107      127.56      128.82
06    F3E2F       130.08      133.86   107   110      127.56      128.82

06    F3W1W       130.08      133.86     0     7      142.68      143.94
06    F3W1SS      130.08      133.86     7     8      142.68      143.94
06    F3W1A       130.08      133.86     8    13      142.68      143.94
06    F3W1B       130.08      133.86    13    25      142.68      143.94
06    F3W1C       130.08      133.86    25    87      142.68      143.94
06    F3W1D       130.08      133.86    87   103      142.68      143.94
06    F3W1E       130.08      133.86   103   107      142.68      143.94
06    F3W1F       130.08      133.86   107   110      142.68      143.94
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06    F3W2W      137.64      141.42     0     7      142.68      143.94
06    F3W2SS     137.64      141.42     7     8      142.68      143.94
06    F3W2A      137.64      141.42     8    13      142.68      143.94
06    F3W2B      137.64      141.42    13    25      142.68      143.94
06    F3W2C      137.64      141.42    25    87      142.68      143.94
06    F3W2D      137.64      141.42    87   103      142.68      143.94
06    F3W2E      137.64      141.42   103   107      142.68      143.94
06    F3W2F      137.64      141.42   107   110      142.68      143.94

06    F3NWW      141.42      142.68     0     7      141.42      142.68
06    F3NWSS     141.42      142.68     7     8      141.42      142.68
06    F3NWA      141.42      142.68     8    13      141.42      142.68
06    F3NWB      141.42      142.68    13    25      141.42      142.68
06    F3NWC      141.42      142.68    25    87      141.42      142.68
06    F3NWD      141.42      142.68    87   103      141.42      142.68
06    F3NWE      141.42      142.68   103   107      141.42      142.68
06    F3NWF      141.42      142.68   107   110      141.42      142.68

06    F3SWW      128.82      130.08     0     7      141.42      142.68
06    F3SWSS     128.82      130.08     7     8      141.42      142.68
06    F3SWA      128.82      130.08     8    13      141.42      142.68
06    F3SWB      128.82      130.08    13    25      141.42      142.68
06    F3SWC      128.82      130.08    25    87      141.42      142.68
06    F3SWD      128.82      130.08    87   103      141.42      142.68
06    F3SWE      128.82      130.08   103   107      141.42      142.68
06    F3SWF      128.82      130.08   107   110      141.42      142.68

06    F3SEW      128.82      130.08     0     7      128.82      130.08
06    F3SESS     128.82      130.08     7     8      128.82      130.08
06    F3SEA      128.82      130.08     8    13      128.82      130.08
06    F3SEB      128.82      130.08    13    25      128.82      130.08
06    F3SEC      128.82      130.08    25    87      128.82      130.08
06    F3SED      128.82      130.08    87   103      128.82      130.08
06    F3SEE      128.82      130.08   103   107      128.82      130.08
06    F3SEF      128.82      130.08   107   110      128.82      130.08

06    F3NEW      141.42      142.68     0     7      128.82      130.08
06    F3NESS     141.42      142.68     7     8      128.82      130.08
06    F3NEA      141.42      142.68     8    13      128.82      130.08
06    F3NEB      141.42      142.68    13    25      128.82      130.08
06    F3NEC      141.42      142.68    25    87      128.82      130.08
06    F3NED      141.42      142.68    87   103      128.82      130.08
06    F3NEE      141.42      142.68   103   107      128.82      130.08
06    F3NEF      141.42      142.68   107   110      128.82      130.08


      ----ALUMINUM PINS
      ----NOTATION: ALC- FUEL TYPE-1 CENTRAL REGION
      ----ALW1- AL PIN #1 REGION WEST , NUMBERED FROM LEFT AND INNER MOST
      ----A LAST LETTER (A-Z) GIVES THE AXIAL LOCATION EXCEPT
      ----SS-STAINLESS STEEL LOWER PLATE, W-LOWER WATER
06    ALN1W      150.24      151.50     0     7      147.72      148.98
06    ALN1SS     150.24      151.50     7     8      147.72      148.98
06    ALN1A      150.24      151.50     8    11      147.72      148.98
06    ALN1B      150.24      151.50    11   106      147.72      148.98
06    ALN1C      150.24      151.50   106   107      147.72      148.98
06    ALN1D      150.24      151.50   107   110      147.72      148.98

06    ALN2W      151.50      152.76     0     7      146.46      148.98
06    ALN2SS     151.50      152.76     7     8      146.46      148.98
06    ALN2A      151.50      152.76     8    11      146.46      148.98
06    ALN2B      151.50      152.76    11   106      146.46      148.98
06    ALN2C      151.50      152.76   106   107      146.46      148.98
06    ALN2D      151.50      152.76   107   110      146.46      148.98

06    ALN3W      150.24      151.50     0     7      122.52      123.78
06    ALN3SS     150.24      151.50     7     8      122.52      123.78
06    ALN3A      150.24      151.50     8    11      122.52      123.78
06    ALN3B      150.24      151.50    11   106      122.52      123.78
06    ALN3C      150.24      151.50   106   107      122.52      123.78
06    ALN3D      150.24      151.50   107   110      122.52      123.78

06    ALN4W      151.50      152.76     0     7      122.52      125.04
06    ALN4SS     151.50      152.76     7     8      122.52      125.04
06    ALN4A      151.50      152.76     8    11      122.52      125.04
06    ALN4B      151.50      152.76    11   106      122.52      125.04
06    ALN4C      151.50      152.76   106   107      122.52      125.04
06    ALN4D      151.50      152.76   107   110      122.52      125.04

06    ALN5W      155.28      156.54     0     7      130.08      141.42
06    ALN5SS     155.28      156.54     7     8      130.08      141.42
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06	ALN5A	155.28	156.54	8	11	130.08	141.42
06	ALN5B	155.28	156.54	11	106	130.08	141.42
06	ALN5C	155.28	156.54	106	107	130.08	141.42
06	ALN5D	155.28	156.54	107	110	130.08	141.42
06	ALS1W	120.00	121.26	0	7	122.52	123.78
06	ALS1SS	120.00	121.26	7	8	122.52	123.78
06	ALS1A	120.00	121.26	8	11	122.52	123.78
06	ALS1B	120.00	121.26	11	106	122.52	123.78
06	ALS1C	120.00	121.26	106	107	122.52	123.78
06	ALS1D	120.00	121.26	107	110	122.52	123.78
06	ALS2W	118.74	120.00	0	7	122.52	125.04
06	ALS2SS	118.74	120.00	7	8	122.52	125.04
06	ALS2A	118.74	120.00	8	11	122.52	125.04
06	ALS2B	118.74	120.00	11	106	122.52	125.04
06	ALS2C	118.74	120.00	106	107	122.52	125.04
06	ALS2D	118.74	120.00	107	110	122.52	125.04
06	ALS3W	120.00	121.26	0	7	147.72	148.98
06	ALS3SS	120.00	121.26	7	8	147.72	148.98
06	ALS3A	120.00	121.26	8	11	147.72	148.98
06	ALS3B	120.00	121.26	11	106	147.72	148.98
06	ALS3C	120.00	121.26	106	107	147.72	148.98
06	ALS3D	120.00	121.26	107	110	147.72	148.98
06	ALS4W	118.74	120.00	0	7	146.46	148.98
06	ALS4SS	118.74	120.00	7	8	146.46	148.98
06	ALS4A	118.74	120.00	8	11	146.46	148.98
06	ALS4B	118.74	120.00	11	106	146.46	148.98
06	ALS4C	118.74	120.00	106	107	146.46	148.98
06	ALS4D	118.74	120.00	107	110	146.46	148.98
06	ALS5W	114.96	116.22	0	7	130.08	141.42
06	ALS5SS	114.96	116.22	7	8	130.08	141.42
06	ALS5A	114.96	116.22	8	11	130.08	141.42
06	ALS5B	114.96	116.22	11	106	130.08	141.42
06	ALS5C	114.96	116.22	106	107	130.08	141.42
06	ALS5D	114.96	116.22	107	110	130.08	141.42
06	ALE1W	147.72	148.98	0	7	118.74	121.26
06	ALE1SS	147.72	148.98	7	8	118.74	121.26
06	ALE1A	147.72	148.98	8	11	118.74	121.26
06	ALE1B	147.72	148.98	11	106	118.74	121.26
06	ALE1C	147.72	148.98	106	107	118.74	121.26
06	ALE1D	147.72	148.98	107	110	118.74	121.26
06	ALE2W	146.46	147.72	0	7	118.74	120.00
06	ALE2SS	146.46	147.72	7	8	118.74	120.00
06	ALE2A	146.46	147.72	8	11	118.74	120.00
06	ALE2B	146.46	147.72	11	106	118.74	120.00
06	ALE2C	146.46	147.72	106	107	118.74	120.00
06	ALE2D	146.46	147.72	107	110	118.74	120.00
06	ALE3W	122.52	123.78	0	7	118.74	121.26
06	ALE3SS	122.52	123.78	7	8	118.74	121.26
06	ALE3A	122.52	123.78	8	11	118.74	121.26
06	ALE3B	122.52	123.78	11	106	118.74	121.26
06	ALE3C	122.52	123.78	106	107	118.74	121.26
06	ALE3D	122.52	123.78	107	110	118.74	121.26
06	ALE4W	123.78	125.04	0	7	118.74	120.00
06	ALE4SS	123.78	125.04	7	8	118.74	120.00
06	ALE4A	123.78	125.04	8	11	118.74	120.00
06	ALE4B	123.78	125.04	11	106	118.74	120.00
06	ALE4C	123.78	125.04	106	107	118.74	120.00
06	ALE4D	123.78	125.04	107	110	118.74	120.00
06	ALE5W	130.08	141.42	0	7	114.96	116.22
06	ALE5SS	130.08	141.42	7	8	114.96	116.22
06	ALE5A	130.08	141.42	8	11	114.96	116.22
06	ALE5B	130.08	141.42	11	106	114.96	116.22
06	ALE5C	130.08	141.42	106	107	114.96	116.22
06	ALE5D	130.08	141.42	107	110	114.96	116.22
06	ALW1W	122.52	123.78	0	7	150.24	152.76
06	ALW1SS	122.52	123.78	7	8	150.24	152.76
06	ALW1A	122.52	123.78	8	11	150.24	152.76
06	ALW1B	122.52	123.78	11	106	150.24	152.76
06	ALW1C	122.52	123.78	106	107	150.24	152.76
06	ALW1D	122.52	123.78	107	110	150.24	152.76

06	ALW2W	123.78	125.04	0	7	151.50	152.76
06	ALW2SS	123.78	125.04	7	8	151.50	152.76
06	ALW2A	123.78	125.04	8	11	151.50	152.76
06	ALW2B	123.78	125.04	11	106	151.50	152.76
06	ALW2C	123.78	125.04	106	107	151.50	152.76
06	ALW2D	123.78	125.04	107	110	151.50	152.76
06	ALW3W	147.72	148.98	0	7	150.24	152.76
06	ALW3SS	147.72	148.98	7	8	150.24	152.76
06	ALW3A	147.72	148.98	8	11	150.24	152.76
06	ALW3B	147.72	148.98	11	106	150.24	152.76
06	ALW3C	147.72	148.98	106	107	150.24	152.76
06	ALW3D	147.72	148.98	107	110	150.24	152.76
06	ALW4W	146.46	147.72	0	7	151.50	152.76
06	ALW4SS	146.46	147.72	7	8	151.50	152.76
06	ALW4A	146.46	147.72	8	11	151.50	152.76
06	ALW4B	146.46	147.72	11	106	151.50	152.76
06	ALW4C	146.46	147.72	106	107	151.50	152.76
06	ALW4D	146.46	147.72	107	110	151.50	152.76
06	ALW5W	130.08	141.42	0	7	155.28	156.54
06	ALW5SS	130.08	141.42	7	8	155.28	156.54
06	ALW5A	130.08	141.42	8	11	155.28	156.54
06	ALW5B	130.08	141.42	11	106	155.28	156.54
06	ALW5C	130.08	141.42	106	107	155.28	156.54
06	ALW5D	130.08	141.42	107	110	155.28	156.54

----TRAVERSE SOUTH-NORTH

06	P01W	114.96	116.22	0	7	135.12	136.38
06	P01SS	114.96	116.22	7	8	135.12	136.38
06	P01A	114.96	116.22	8	11	135.12	136.38
06	P01B	114.96	116.22	11	106	135.12	136.38
06	P01C	114.96	116.22	106	107	135.12	136.38
06	P01D	114.96	116.22	107	110	135.12	136.38
06	P02W	116.22	117.48	0	7	135.12	136.38
06	P02SS	116.22	117.48	7	8	135.12	136.38
06	P02A	116.22	117.48	8	13	135.12	136.38
06	P02B	116.22	117.48	13	25	135.12	136.38
06	P02C	116.22	117.48	25	87	135.12	136.38
06	P02D	116.22	117.48	87	103	135.12	136.38
06	P02E	116.22	117.48	103	107	135.12	136.38
06	P02F	116.22	117.48	107	110	135.12	136.38
06	P03W	117.48	118.74	0	7	135.12	136.38
06	P03SS	117.48	118.74	7	8	135.12	136.38
06	P03A	117.48	118.74	8	13	135.12	136.38
06	P03B	117.48	118.74	13	25	135.12	136.38
06	P03C	117.48	118.74	25	87	135.12	136.38
06	P03D	117.48	118.74	87	103	135.12	136.38
06	P03E	117.48	118.74	103	107	135.12	136.38
06	P03F	117.48	118.74	107	110	135.12	136.38
06	P04W	118.74	120.00	0	7	135.12	136.38
06	P04SS	118.74	120.00	7	8	135.12	136.38
06	P04A	118.74	120.00	8	13	135.12	136.38
06	P04B	118.74	120.00	13	25	135.12	136.38
06	P04C	118.74	120.00	25	87	135.12	136.38
06	P04D	118.74	120.00	87	103	135.12	136.38
06	P04E	118.74	120.00	103	107	135.12	136.38
06	P04F	118.74	120.00	107	110	135.12	136.38
06	P05W	120.00	121.26	0	7	135.12	136.38
06	P05SS	120.00	121.26	7	8	135.12	136.38
06	P05A	120.00	121.26	8	13	135.12	136.38
06	P05B	120.00	121.26	13	25	135.12	136.38
06	P05C	120.00	121.26	25	87	135.12	136.38
06	P05D	120.00	121.26	87	103	135.12	136.38
06	P05E	120.00	121.26	103	107	135.12	136.38
06	P05F	120.00	121.26	107	110	135.12	136.38
06	P06W	121.26	122.52	0	7	135.12	136.38
06	P06SS	121.26	122.52	7	8	135.12	136.38
06	P06A	121.26	122.52	8	13	135.12	136.38
06	P06B	121.26	122.52	13	25	135.12	136.38
06	P06C	121.26	122.52	25	87	135.12	136.38
06	P06D	121.26	122.52	87	103	135.12	136.38

06	P06E	121.26	122.52	103	107	135.12	136.38
06	P06F	121.26	122.52	107	110	135.12	136.38
06	P07W	122.52	123.78	0	7	135.12	136.38
06	P07SS	122.52	123.78	7	8	135.12	136.38
06	P07A	122.52	123.78	8	13	135.12	136.38
06	P07B	122.52	123.78	13	25	135.12	136.38
06	P07C	122.52	123.78	25	87	135.12	136.38
06	P07D	122.52	123.78	87	103	135.12	136.38
06	P07E	122.52	123.78	103	107	135.12	136.38
06	P07F	122.52	123.78	107	110	135.12	136.38
06	P08W	123.78	125.04	0	7	135.12	136.38
06	P08SS	123.78	125.04	7	8	135.12	136.38
06	P08A	123.78	125.04	8	13	135.12	136.38
06	P08B	123.78	125.04	13	25	135.12	136.38
06	P08C	123.78	125.04	25	87	135.12	136.38
06	P08D	123.78	125.04	87	103	135.12	136.38
06	P08E	123.78	125.04	103	107	135.12	136.38
06	P08F	123.78	125.04	107	110	135.12	136.38
06	P09W	125.04	126.30	0	7	135.12	136.38
06	P09SS	125.04	126.30	7	8	135.12	136.38
06	P09A	125.04	126.30	8	13	135.12	136.38
06	P09B	125.04	126.30	13	25	135.12	136.38
06	P09C	125.04	126.30	25	87	135.12	136.38
06	P09D	125.04	126.30	87	103	135.12	136.38
06	P09E	125.04	126.30	103	107	135.12	136.38
06	P09F	125.04	126.30	107	110	135.12	136.38
06	P10W	126.30	127.56	0	7	135.12	136.38
06	P10SS	126.30	127.56	7	8	135.12	136.38
06	P10A	126.30	127.56	8	13	135.12	136.38
06	P10B	126.30	127.56	13	25	135.12	136.38
06	P10C	126.30	127.56	25	87	135.12	136.38
06	P10D	126.30	127.56	87	103	135.12	136.38
06	P10E	126.30	127.56	103	107	135.12	136.38
06	P10F	126.30	127.56	107	110	135.12	136.38
06	P11W	127.56	128.82	0	7	135.12	136.38
06	P11SS	127.56	128.82	7	8	135.12	136.38
06	P11A	127.56	128.82	8	13	135.12	136.38
06	P11B	127.56	128.82	13	25	135.12	136.38
06	P11C	127.56	128.82	25	87	135.12	136.38
06	P11D	127.56	128.82	87	103	135.12	136.38
06	P11E	127.56	128.82	103	107	135.12	136.38
06	P11F	127.56	128.82	107	110	135.12	136.38
06	P12W	128.82	130.08	0	7	135.12	136.38
06	P12SS	128.82	130.08	7	8	135.12	136.38
06	P12A	128.82	130.08	8	13	135.12	136.38
06	P12B	128.82	130.08	13	25	135.12	136.38
06	P12C	128.82	130.08	25	87	135.12	136.38
06	P12D	128.82	130.08	87	103	135.12	136.38
06	P12E	128.82	130.08	103	107	135.12	136.38
06	P12F	128.82	130.08	107	110	135.12	136.38
06	P13W	130.08	131.34	0	7	135.12	136.38
06	P13SS	130.08	131.34	7	8	135.12	136.38
06	P13A	130.08	131.34	8	13	135.12	136.38
06	P13B	130.08	131.34	13	25	135.12	136.38
06	P13C	130.08	131.34	25	87	135.12	136.38
06	P13D	130.08	131.34	87	103	135.12	136.38
06	P13E	130.08	131.34	103	107	135.12	136.38
06	P13F	130.08	131.34	107	110	135.12	136.38
06	P14W	131.34	132.60	0	7	135.12	136.38
06	P14SS	131.34	132.60	7	8	135.12	136.38
06	P14A	131.34	132.60	8	13	135.12	136.38
06	P14B	131.34	132.60	13	25	135.12	136.38
06	P14C	131.34	132.60	25	87	135.12	136.38
06	P14D	131.34	132.60	87	103	135.12	136.38
06	P14E	131.34	132.60	103	107	135.12	136.38
06	P14F	131.34	132.60	107	110	135.12	136.38
06	P15W	132.60	133.86	0	7	135.12	136.38
06	P15SS	132.60	133.86	7	8	135.12	136.38
06	P15A	132.60	133.86	8	13	135.12	136.38
06	P15B	132.60	133.86	13	25	135.12	136.38
06	P15C	132.60	133.86	25	87	135.12	136.38
06	P15D	132.60	133.86	87	103	135.12	136.38

06	P15E	132.60	133.86	103	107	135.12	136.38
06	P15F	116.22	117.48	107	110	135.12	136.38
06	P16W	133.86	135.12	0	7	135.12	136.38
06	P16SS	133.86	135.12	7	8	135.12	136.38
06	P16A	133.86	135.12	8	13	135.12	136.38
06	P16B	133.86	135.12	13	25	135.12	136.38
06	P16C	133.86	135.12	25	87	135.12	136.38
06	P16D	133.86	135.12	87	103	135.12	136.38
06	P16E	133.86	135.12	103	107	135.12	136.38
06	P16F	133.86	135.12	107	110	135.12	136.38
06	P18W	136.38	137.64	0	7	135.12	136.38
06	P18SS	136.38	137.64	7	8	135.12	136.38
06	P18A	136.38	137.64	8	13	135.12	136.38
06	P18B	136.38	137.64	13	25	135.12	136.38
06	P18C	136.38	137.64	25	87	135.12	136.38
06	P18D	136.38	137.64	87	103	135.12	136.38
06	P18E	136.38	137.64	103	107	135.12	136.38
06	P18F	136.38	137.64	107	110	135.12	136.38
06	P19W	137.64	138.90	0	7	135.12	136.38
06	P19SS	137.64	138.90	7	8	135.12	136.38
06	P19A	137.64	138.90	8	13	135.12	136.38
06	P19B	137.64	138.90	13	25	135.12	136.38
06	P19C	137.64	138.90	25	87	135.12	136.38
06	P19D	137.64	138.90	87	103	135.12	136.38
06	P19E	137.64	138.90	103	107	135.12	136.38
06	P19F	137.64	138.90	107	110	135.12	136.38
06	P20W	138.90	140.16	0	7	135.12	136.38
06	P20SS	138.90	140.16	7	8	135.12	136.38
06	P20A	138.90	140.16	8	13	135.12	136.38
06	P20B	138.90	140.16	13	25	135.12	136.38
06	P20C	138.90	140.16	25	87	135.12	136.38
06	P20D	138.90	140.16	87	103	135.12	136.38
06	P20E	138.90	140.16	103	107	135.12	136.38
06	P20F	138.90	140.16	107	110	135.12	136.38
06	P21W	140.16	141.42	0	7	135.12	136.38
06	P21SS	140.16	141.42	7	8	135.12	136.38
06	P21A	140.16	141.42	8	13	135.12	136.38
06	P21B	140.16	141.42	13	25	135.12	136.38
06	P21C	140.16	141.42	25	87	135.12	136.38
06	P21D	140.16	141.42	87	103	135.12	136.38
06	P21E	140.16	141.42	103	107	135.12	136.38
06	P21F	140.16	141.42	107	110	135.12	136.38
06	P22W	141.42	142.68	0	7	135.12	136.38
06	P22SS	141.42	142.68	7	8	135.12	136.38
06	P22A	141.42	142.68	8	13	135.12	136.38
06	P22B	141.42	142.68	13	25	135.12	136.38
06	P22C	141.42	142.68	25	87	135.12	136.38
06	P22D	141.42	142.68	87	103	135.12	136.38
06	P22E	141.42	142.68	103	107	135.12	136.38
06	P22F	141.42	142.68	107	110	135.12	136.38
06	P23W	142.68	143.94	0	7	135.12	136.38
06	P23SS	142.68	143.94	7	8	135.12	136.38
06	P23A	142.68	143.94	8	13	135.12	136.38
06	P23B	142.68	143.94	13	25	135.12	136.38
06	P23C	142.68	143.94	25	87	135.12	136.38
06	P23D	142.68	143.94	87	103	135.12	136.38
06	P23E	142.68	143.94	103	107	135.12	136.38
06	P23F	142.68	143.94	107	110	135.12	136.38
06	P24W	143.94	145.20	0	7	135.12	136.38
06	P24SS	143.94	145.20	7	8	135.12	136.38
06	P24A	143.94	145.20	8	13	135.12	136.38
06	P24B	143.94	145.20	13	25	135.12	136.38
06	P24C	143.94	145.20	25	87	135.12	136.38
06	P24D	143.94	145.20	87	103	135.12	136.38
06	P24E	143.94	145.20	103	107	135.12	136.38
06	P24F	143.94	145.20	107	110	135.12	136.38
06	P25W	145.20	146.46	0	7	135.12	136.38
06	P25SS	145.20	146.46	7	8	135.12	136.38
06	P25A	145.20	146.46	8	13	135.12	136.38
06	P25B	145.20	146.46	13	25	135.12	136.38
06	P25C	145.20	146.46	25	87	135.12	136.38
06	P25D	145.20	146.46	87	103	135.12	136.38

06	P25E	145.20	146.46	103	107	135.12	136.38
06	P25F	145.20	146.46	107	110	135.12	136.38
06	P26W	146.46	147.72	0	7	135.12	136.38
06	P26SS	146.46	147.72	7	8	135.12	136.38
06	P26A	146.46	147.72	8	13	135.12	136.38
06	P26B	146.46	147.72	13	25	135.12	136.38
06	P26C	146.46	147.72	25	87	135.12	136.38
06	P26D	146.46	147.72	87	103	135.12	136.38
06	P26E	146.46	147.72	103	107	135.12	136.38
06	P26F	146.46	147.72	107	110	135.12	136.38
06	P27W	147.72	148.98	0	7	135.12	136.38
06	P27SS	147.72	148.98	7	8	135.12	136.38
06	P27A	147.72	148.98	8	13	135.12	136.38
06	P27B	147.72	148.98	13	25	135.12	136.38
06	P27C	147.72	148.98	25	87	135.12	136.38
06	P27D	147.72	148.98	87	103	135.12	136.38
06	P27E	147.72	148.98	103	107	135.12	136.38
06	P27F	147.72	148.98	107	110	135.12	136.38
06	P28W	148.98	150.24	0	7	135.12	136.38
06	P28SS	148.98	150.24	7	8	135.12	136.38
06	P28A	148.98	150.24	8	13	135.12	136.38
06	P28B	148.98	150.24	13	25	135.12	136.38
06	P28C	148.98	150.24	25	87	135.12	136.38
06	P28D	148.98	150.24	87	103	135.12	136.38
06	P28E	148.98	150.24	103	107	135.12	136.38
06	P28F	148.98	150.24	107	110	135.12	136.38
06	P29W	150.24	151.50	0	7	135.12	136.38
06	P29SS	150.24	151.50	7	8	135.12	136.38
06	P29A	150.24	151.50	8	13	135.12	136.38
06	P29B	150.24	151.50	13	25	135.12	136.38
06	P29C	150.24	151.50	25	87	135.12	136.38
06	P29D	150.24	151.50	87	103	135.12	136.38
06	P29E	150.24	151.50	103	107	135.12	136.38
06	P29F	150.24	151.50	107	110	135.12	136.38
06	P30W	151.50	152.76	0	7	135.12	136.38
06	P30SS	151.50	152.76	7	8	135.12	136.38
06	P30A	151.50	152.76	8	13	135.12	136.38
06	P30B	151.50	152.76	13	25	135.12	136.38
06	P30C	151.50	152.76	25	87	135.12	136.38
06	P30D	151.50	152.76	87	103	135.12	136.38
06	P30E	151.50	152.76	103	107	135.12	136.38
06	P30F	151.50	152.76	107	110	135.12	136.38
06	P31W	152.76	154.02	0	7	135.12	136.38
06	P31SS	152.76	154.02	7	8	135.12	136.38
06	P31A	152.76	154.02	8	13	135.12	136.38
06	P31B	152.76	154.02	13	25	135.12	136.38
06	P31C	152.76	154.02	25	87	135.12	136.38
06	P31D	152.76	154.02	87	103	135.12	136.38
06	P31E	152.76	154.02	103	107	135.12	136.38
06	P31F	152.76	154.02	107	110	135.12	136.38
06	P32W	154.02	155.28	0	7	135.12	136.38
06	P32SS	154.02	155.28	7	8	135.12	136.38
06	P32A	154.02	155.28	8	13	135.12	136.38
06	P32B	154.02	155.28	13	25	135.12	136.38
06	P32C	154.02	155.28	25	87	135.12	136.38
06	P32D	154.02	155.28	87	103	135.12	136.38
06	P32E	154.02	155.28	103	107	135.12	136.38
06	P32F	154.02	155.28	107	110	135.12	136.38
06	P33W	155.28	156.54	0	7	135.12	136.38
06	P33SS	155.28	156.54	7	8	135.12	136.38
06	P33A	155.28	156.54	8	11	135.12	136.38
06	P33B	155.28	156.54	11	106	135.12	136.38
06	P33C	155.28	156.54	106	107	135.12	136.38
06	P33D	155.28	156.54	107	110	135.12	136.38
	----TRAVERSE DIAGONAL						
06	D07W	122.52	123.78	0	7	122.52	123.78
06	D07SS	122.52	123.78	7	8	122.52	123.78
06	D07A	122.52	123.78	8	13	122.52	123.78
06	D07B	122.52	123.78	13	25	122.52	123.78
06	D07C	122.52	123.78	25	87	122.52	123.78
06	D07D	122.52	123.78	87	103	122.52	123.78

06	D07E	122.52	123.78	103	107	122.52	123.78
06	D07F	122.52	123.78	107	110	122.52	123.78
06	D08W	123.78	125.04	0	7	123.78	125.04
06	D08SS	123.78	125.04	7	8	123.78	125.04
06	D08A	123.78	125.04	8	13	123.78	125.04
06	D08B	123.78	125.04	13	25	123.78	125.04
06	D08C	123.78	125.04	25	87	123.78	125.04
06	D08D	123.78	125.04	87	103	123.78	125.04
06	D08E	123.78	125.04	103	107	123.78	125.04
06	D08F	123.78	125.04	107	110	123.78	125.04
06	D09W	125.04	126.30	0	7	125.04	126.30
06	D09SS	125.04	126.30	7	8	125.04	126.30
06	D09A	125.04	126.30	8	13	125.04	126.30
06	D09B	125.04	126.30	13	25	125.04	126.30
06	D09C	125.04	126.30	25	87	125.04	126.30
06	D09D	125.04	126.30	87	103	125.04	126.30
06	D09E	125.04	126.30	103	107	125.04	126.30
06	D09F	125.04	126.30	107	110	125.04	126.30
06	D10W	126.30	127.56	0	7	126.30	127.56
06	D10SS	126.30	127.56	7	8	126.30	127.56
06	D10A	126.30	127.56	8	13	126.30	127.56
06	D10B	126.30	127.56	13	25	126.30	127.56
06	D10C	126.30	127.56	25	87	126.30	127.56
06	D10D	126.30	127.56	87	103	126.30	127.56
06	D10E	126.30	127.56	103	107	126.30	127.56
06	D10F	126.30	127.56	107	110	126.30	127.56
06	D11W	127.56	128.82	0	7	127.56	128.82
06	D11SS	127.56	128.82	7	8	127.56	128.82
06	D11A	127.56	128.82	8	13	127.56	128.82
06	D11B	127.56	128.82	13	25	127.56	128.82
06	D11C	127.56	128.82	25	87	127.56	128.82
06	D11D	127.56	128.82	87	103	127.56	128.82
06	D11E	127.56	128.82	103	107	127.56	128.82
06	D11F	127.56	128.82	107	110	127.56	128.82
06	D12W	128.82	130.08	0	7	128.82	130.08
06	D12SS	128.82	130.08	7	8	128.82	130.08
06	D12A	128.82	130.08	8	13	128.82	130.08
06	D12B	128.82	130.08	13	25	128.82	130.08
06	D12C	128.82	130.08	25	87	128.82	130.08
06	D12D	128.82	130.08	87	103	128.82	130.08
06	D12E	128.82	130.08	103	107	128.82	130.08
06	D12F	128.82	130.08	107	110	128.82	130.08
06	D13W	130.08	131.34	0	7	130.08	131.34
06	D13SS	130.08	131.34	7	8	130.08	131.34
06	D13A	130.08	131.34	8	13	130.08	131.34
06	D13B	130.08	131.34	13	25	130.08	131.34
06	D13C	130.08	131.34	25	87	130.08	131.34
06	D13D	130.08	131.34	87	103	130.08	131.34
06	D13E	130.08	131.34	103	107	130.08	131.34
06	D13F	130.08	131.34	107	110	130.08	131.34
06	D14W	131.34	132.60	0	7	131.34	132.60
06	D14SS	131.34	132.60	7	8	131.34	132.60
06	D14A	131.34	132.60	8	13	131.34	132.60
06	D14B	131.34	132.60	13	25	131.34	132.60
06	D14C	131.34	132.60	25	87	131.34	132.60
06	D14D	131.34	132.60	87	103	131.34	132.60
06	D14E	131.34	132.60	103	107	131.34	132.60
06	D14F	131.34	132.60	107	110	131.34	132.60
06	D15W	132.60	133.86	0	7	132.60	133.86
06	D15SS	132.60	133.86	7	8	132.60	133.86
06	D15A	132.60	133.86	8	13	132.60	133.86
06	D15B	132.60	133.86	13	25	132.60	133.86
06	D15C	132.60	133.86	25	87	132.60	133.86
06	D15D	132.60	133.86	87	103	132.60	133.86
06	D15E	132.60	133.86	103	107	132.60	133.86
06	D15F	132.60	133.86	107	110	132.60	133.86
06	D16W	133.86	135.12	0	7	133.86	135.12
06	D16SS	133.86	135.12	7	8	133.86	135.12
06	D16A	133.86	135.12	8	13	133.86	135.12
06	D16B	133.86	135.12	13	25	133.86	135.12
06	D16C	133.86	135.12	25	87	133.86	135.12
06	D16D	133.86	135.12	87	103	133.86	135.12

06	D16E	133.86	135.12	103	107	133.86	135.12
06	D16F	133.86	135.12	107	110	133.86	135.12
06	D18W	136.38	137.64	0	7	136.38	137.64
06	D18SS	136.38	137.64	7	8	136.38	137.64
06	D18A	136.38	137.64	8	13	136.38	137.64
06	D18B	136.38	137.64	13	25	136.38	137.64
06	D18C	136.38	137.64	25	87	136.38	137.64
06	D18D	136.38	137.64	87	103	136.38	137.64
06	D18E	136.38	137.64	103	107	136.38	137.64
06	D18F	136.38	137.64	107	110	136.38	137.64
06	D19W	137.64	138.90	0	7	137.64	138.90
06	D19SS	137.64	138.90	7	8	137.64	138.90
06	D19A	137.64	138.90	8	13	137.64	138.90
06	D19B	137.64	138.90	13	25	137.64	138.90
06	D19C	137.64	138.90	25	87	137.64	138.90
06	D19D	137.64	138.90	87	103	137.64	138.90
06	D19E	137.64	138.90	103	107	137.64	138.90
06	D19F	137.64	138.90	107	110	137.64	138.90
06	D20W	138.90	140.16	0	7	138.90	140.16
06	D20SS	138.90	140.16	7	8	138.90	140.16
06	D20A	138.90	140.16	8	13	138.90	140.16
06	D20B	138.90	140.16	13	25	138.90	140.16
06	D20C	138.90	140.16	25	87	138.90	140.16
06	D20D	138.90	140.16	87	103	138.90	140.16
06	D20E	138.90	140.16	103	107	138.90	140.16
06	D20F	138.90	140.16	107	110	138.90	140.16
06	D21W	140.16	141.42	0	7	140.16	141.42
06	D21SS	140.16	141.42	7	8	140.16	141.42
06	D21A	140.16	141.42	8	13	140.16	141.42
06	D21B	140.16	141.42	13	25	140.16	141.42
06	D21C	140.16	141.42	25	87	140.16	141.42
06	D21D	140.16	141.42	87	103	140.16	141.42
06	D21E	140.16	141.42	103	107	140.16	141.42
06	D21F	140.16	141.42	107	110	140.16	141.42
06	D22W	141.42	142.68	0	7	141.42	142.68
06	D22SS	141.42	142.68	7	8	141.42	142.68
06	D22A	141.42	142.68	8	13	141.42	142.68
06	D22B	141.42	142.68	13	25	141.42	142.68
06	D22C	141.42	142.68	25	87	141.42	142.68
06	D22D	141.42	142.68	87	103	141.42	142.68
06	D22E	141.42	142.68	103	107	141.42	142.68
06	D22F	141.42	142.68	107	110	141.42	142.68
06	D23W	142.68	143.94	0	7	142.68	143.94
06	D23SS	142.68	143.94	7	8	142.68	143.94
06	D23A	142.68	143.94	8	13	142.68	143.94
06	D23B	142.68	143.94	13	25	142.68	143.94
06	D23C	142.68	143.94	25	87	142.68	143.94
06	D23D	142.68	143.94	87	103	142.68	143.94
06	D23E	142.68	143.94	103	107	142.68	143.94
06	D23F	142.68	143.94	107	110	142.68	143.94
06	D24W	143.94	145.20	0	7	143.94	145.20
06	D24SS	143.94	145.20	7	8	143.94	145.20
06	D24A	143.94	145.20	8	13	143.94	145.20
06	D24B	143.94	145.20	13	25	143.94	145.20
06	D24C	143.94	145.20	25	87	143.94	145.20
06	D24D	143.94	145.20	87	103	143.94	145.20
06	D24E	143.94	145.20	103	107	143.94	145.20
06	D24F	143.94	145.20	107	110	143.94	145.20
06	D25W	145.20	146.46	0	7	145.20	146.46
06	D25SS	145.20	146.46	7	8	145.20	146.46
06	D25A	145.20	146.46	8	13	145.20	146.46
06	D25B	145.20	146.46	13	25	145.20	146.46
06	D25C	145.20	146.46	25	87	145.20	146.46
06	D25D	145.20	146.46	87	103	145.20	146.46
06	D25E	145.20	146.46	103	107	145.20	146.46
06	D25F	145.20	146.46	107	110	145.20	146.46
06	D26W	146.46	147.72	0	7	146.46	147.72
06	D26SS	146.46	147.72	7	8	146.46	147.72
06	D26A	146.46	147.72	8	13	146.46	147.72
06	D26B	146.46	147.72	13	25	146.46	147.72
06	D26C	146.46	147.72	25	87	146.46	147.72
06	D26D	146.46	147.72	87	103	146.46	147.72

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06    D26E        146.46      147.72   103   107      146.46      147.72
06    D26F        146.46      147.72   107   110      146.46      147.72

06    D27W        147.72      148.98     0     7      147.72      148.98
06    D27SS       147.72      148.98     7     8      147.72      148.98
06    D27A        147.72      148.98     8    13      147.72      148.98
06    D27B        147.72      148.98    13    25      147.72      148.98
06    D27C        147.72      148.98    25    87      147.72      148.98
06    D27D        147.72      148.98    87   103      147.72      148.98
06    D27E        147.72      148.98   103   107      147.72      148.98
06    D27F        147.72      148.98   107   110      147.72      148.98

      ----R1MOX CENTRAL CHANNEL
        ----OSCILLATION TUBE (UP)
  06    ORW         135.12      136.38     0    10      135.12      136.38
  06    ORB         135.12      136.38    10    16      135.12      136.38
  06    ORL         135.12      136.38    16    51      135.12      136.38
  06    ORSAM       135.12      136.38    51    61      135.12      136.38
  06    ORU         135.12      136.38    61   116      135.12      136.38
      ----POLINE OVERCLAD
06    POLW        135.12      136.38     0    11      135.12      136.38
06    POLC        135.12      136.38    11   116      135.12      136.38



      ----MATERIAL DEFINITION (TYPE-13 CARDS)----
   UO2(3) pin
13          U3H   EU4  0 4.617E-06  EU5  0 6.900E-04  EU6  0 5.493E-06
13          U3H   EU8  0 2.200E-02  EO   0 4.647E-02

13          U3I1  DU4  0 4.617E-06  DU5  0 6.900E-04  DU6  0 5.493E-06
13          U3I1  DU8  0 2.200E-02  DO   0 4.647E-02

13          U3I2  UU4  0 4.617E-06  UU5  0 6.900E-04  UU6  0 5.493E-06
13          U3I2  UU8  0 2.200E-02  UO   0 4.647E-02

13          U3I3  VU4  0 4.617E-06  VU5  0 6.900E-04  VU6  0 5.493E-06
13          U3I3  VU8  0 2.200E-02  VO   0 4.647E-02

   PuO2(4%) pin
13          P4H   AU4  0 3.139E-06  AU5  0 1.581E-04  AU8  0 2.180E-02
13          P4H   APu8 0 7.223E-06  APu9 0 6.382E-04  APu0 0 1.543E-04
13          P4H   APu1 0 2.133E-05  APu2 0 1.801E-05  AAm1 0 6.706E-05
13          P4H   ANp7 0 2.012E-06  AO   0 4.574E-02

13          P4I1  BU4  0 3.139E-06  BU5  0 1.581E-04  BU8  0 2.180E-02
13          P4I1  BPu8 0 7.223E-06  BPu9 0 6.382E-04  BPu0 0 1.543E-04
13          P4I1  BPu1 0 2.133E-05  BPu2 0 1.801E-05  BAm1 0 6.706E-05
13          P4I1  BNp7 0 2.012E-06  BO   0 4.574E-02

13          P4I2  PU4  0 3.139E-06  PU5  0 1.581E-04  PU8  0 2.180E-02
13          P4I2  PPu8 0 7.223E-06  PPu9 0 6.382E-04  PPu0 0 1.543E-04
13          P4I2  PPu1 0 2.133E-05  PPu2 0 1.801E-05  PAm1 0 6.706E-05
13          P4I2  PNp7 0 2.012E-06  PO   0 4.574E-02

   PuO2(3.6%) pin
13          P3    FU4  0 2.951E-06  FU5  0 1.588E-04  FU8  0 2.189E-02
13          P3    FPu8 0 6.501E-06  FPu9 0 5.743E-04  FPu0 0 1.389E-04
13          P3    FPu1 0 1.920E-05  FPu2 0 1.621E-05  FAm1 0 6.036E-05
13          P3    FNp7 0 1.811E-06  FO   0 4.574E-02


   U-235 90% plate
13          HEU90 90U5 0 1.397E-03  90U8 0 1.550E-04  90Al 0 5.830E-02

   U-235 93% plate
13          HEU93 93U5 0 1.894E-03  93U8 0 1.390E-04  93Al 0 5.770E-02

   U-235 93% plate CONTROL ELEMENT
13          CFUEL CU5  0 1.894E-03  CU8  0 1.390E-04  CAl  0 5.770E-02

   WATER
   NOTATION: E - PIN UO2-HOMO
             A - PIN PuO2 4%-HOMO
             C -
             D - PIN UO2-INTERFACE PuO2
             F - PIN PuO2 3.6%
             B - PIN PuO2 4%-INTERFACE UO2
             P - PIN PuO2 4%-INTERFACE OSCILATIION CHANNEL : POLINE overclad
             U - PIN UO2-INTERFACE AL PIN
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            V - PIN UO2-INTERFACE AL BLOCK
            90 - 90%U-5 ELT, 93 - 93%U-5 ELT
             1 - 1st GRAPHITE ELT, 2 - 2nd GRAPHITE ELT
13          H2OE  EH   0 6.674E-02  EO   0 3.337E-02
13          H2OA  AH   0 6.674E-02  AO   0 3.337E-02
13          H2O90 90H  0 6.674E-02  90O  0 3.337E-02
13          H2O93 93H  0 6.674E-02  93O  0 3.337E-02
13          H2OC  CH   0 6.674E-02  CO   0 3.337E-02
13          H2O1  1H   0 6.674E-02  1O   0 3.337E-02
13          H2O2  2H   0 6.674E-02  2O   0 3.337E-02
13          H2OD  DH   0 6.674E-02  DO   0 3.337E-02
13          H2OP  PH   0 6.674E-02  PO   0 3.337E-02
13          H2OB  BH   0 6.674E-02  BO   0 3.337E-02
13          H2OF  FH   0 6.674E-02  FO   0 3.337E-02
13          H2OU  UH   0 6.674E-02  UO   0 3.337E-02
13          H2OV  VH   0 6.674E-02  VO   0 3.337E-02

   GRAPHITE
   NOTATION: 1 - 1st GRAPHITE ELT, 2 - 2nd GRAPHITE ELT, 3 - GRAPHITE BLOCKS
13          GR1   1G   0 8.524E-02
13          GR2   2G   0 8.524E-02
13          GR3   3G   0 8.524E-02

   STAINLESS STEEL
   NOTATION: E - PIN UO2-HOMO
             A - PIN PuO2 4%-HOMO
13          SSE   EFe4 0 3.387E-03  EFe6 0 5.316E-02  EFe7 0 1.228E-03
13          SSE   EFe8 0 1.634E-04  EC   0 5.904E-05  ECr0 0 7.111E-04
13          SSE   ECr2 0 1.371E-02  ECr3 0 1.555E-03  ECr4 0 3.870E-04
13          SSE   ENi8 0 6.031E-03  ENi0 0 2.323E-03  ENi1 0 1.010E-04
13          SSE   ENi2 0 3.220E-04  ENi4 0 8.200E-05  EMn  0 8.605E-04
13          SSE   ESi  0 8.416E-04  EMo  0 4.927E-04

13          SSA   AFe4 0 3.387E-03  AFe6 0 5.316E-02  AFe7 0 1.228E-03
13          SSA   AFe8 0 1.634E-04  AC   0 5.904E-05  ACr0 0 7.111E-04
13          SSA   ACr2 0 1.371E-02  ACr3 0 1.555E-03  ACr4 0 3.870E-04
13          SSA   ANi8 0 6.031E-03  ANi0 0 2.323E-03  ANi1 0 1.010E-04
13          SSA   ANi2 0 3.220E-04  ANi4 0 8.200E-05  AMn  0 8.605E-04
13          SSA   ASi  0 8.416E-04  AMo  0 4.927E-04

   PURE ALUMINUM
13          ALE   EAl  0 6.026E-02
13          AL90  90Al 0 6.026E-02
13          AL93  93Al 0 6.026E-02
13          ALC   CAl  0 6.026E-02

   ALUMINUM ALLOY AG3
   NOTATION: E - PIN UO2-HOMO
             A - PIN PuO2 4%-HOMO
             D - PIN UO2-INTERFACE PuO2
             F - PIN PuO2 3.6%
             B - PIN PuO2 4%-INTERFACE UO2
             P - PIN PuO2 4%-INTERFACE OSCILATIION CHANNEL : POLINE overclad
             U - PIN UO2-INTERFACE AL PIN
             V - PIN UO2-INTERFACE AL BLOCK
             1 - 1st GRAPHITE ELT, 2 - 2nd GRAPHITE ELT
13          AL3E  EAl  0 5.457E-02  EMg  0 1.959E-03  EMn  0 6.988E-05
13          AL3E  EFe4 0 3.214E-06  EFe6 0 5.046E-05  EFe7 0 1.165E-06
13          AL3E  EFe8 0 1.551E-07  ECr0 0 1.925E-06  ECr2 0 3.712E-05
13          AL3E  ECr3 0 4.209E-06  ECr4 0 1.048E-06  ETi  0 2.406E-05
13          AL3E  ESi  0 1.094E-04  ECu3 0 8.358E-06  ECu5 0 3.725E-06

13          AL3A  AAl  0 5.457E-02  AMg  0 1.959E-03  AMn  0 6.988E-05
13          AL3A  AFe4 0 3.214E-06  AFe6 0 5.046E-05  AFe7 0 1.165E-06
13          AL3A  AFe8 0 1.551E-07  ACr0 0 1.925E-06  ACr2 0 3.712E-05
13          AL3A  ACr3 0 4.209E-06  ACr4 0 1.048E-06  ATi  0 2.406E-05
13          AL3A  ASi  0 1.094E-04  ACu3 0 8.358E-06  ACu5 0 3.725E-06

13          AL30  0Al  0 5.457E-02  0Mg  0 1.959E-03  0Mn  0 6.988E-05
13          AL30  0Fe4 0 3.214E-06  0Fe6 0 5.046E-05  0Fe7 0 1.165E-06
13          AL30  0Fe8 0 1.551E-07  0Cr0 0 1.925E-06  0Cr2 0 3.712E-05
13          AL30  0Cr3 0 4.209E-06  0Cr4 0 1.048E-06  0Ti  0 2.406E-05
13          AL30  0Si  0 1.094E-04  0Cu3 0 8.358E-06  0Cu5 0 3.725E-06

13          AL31  1Al  0 5.457E-02  1Mg  0 1.959E-03  1Mn  0 6.988E-05
13          AL31  1Fe4 0 3.214E-06  1Fe6 0 5.046E-05  1Fe7 0 1.165E-06
13          AL31  1Fe8 0 1.551E-07  1Cr0 0 1.925E-06  1Cr2 0 3.712E-05
13          AL31  1Cr3 0 4.209E-06  1Cr4 0 1.048E-06  1Ti  0 2.406E-05
13          AL31  1Si  0 1.094E-04  1Cu3 0 8.358E-06  1Cu5 0 3.725E-06

13          AL32  2Al  0 5.457E-02  2Mg  0 1.959E-03  2Mn  0 6.988E-05
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13          AL32  2Fe4 0 3.214E-06  2Fe6 0 5.046E-05  2Fe7 0 1.165E-06
13          AL32  2Fe8 0 1.551E-07  2Cr0 0 1.925E-06  2Cr2 0 3.712E-05
13          AL32  2Cr3 0 4.209E-06  2Cr4 0 1.048E-06  2Ti  0 2.406E-05
13          AL32  2Si  0 1.094E-04  2Cu3 0 8.358E-06  2Cu5 0 3.725E-06

13          AL33  3Al  0 5.457E-02  3Mg  0 1.959E-03  3Mn  0 6.988E-05
13          AL33  3Fe4 0 3.214E-06  3Fe6 0 5.046E-05  3Fe7 0 1.165E-06
13          AL33  3Fe8 0 1.551E-07  3Cr0 0 1.925E-06  3Cr2 0 3.712E-05
13          AL33  3Cr3 0 4.209E-06  3Cr4 0 1.048E-06  3Ti  0 2.406E-05
13          AL33  3Si  0 1.094E-04  3Cu3 0 8.358E-06  3Cu5 0 3.725E-06

13          AL3D  DAl  0 5.457E-02  DMg  0 1.959E-03  DMn  0 6.988E-05
13          AL3D  DFe4 0 3.214E-06  DFe6 0 5.046E-05  DFe7 0 1.165E-06
13          AL3D  DFe8 0 1.551E-07  DCr0 0 1.925E-06  DCr2 0 3.712E-05
13          AL3D  DCr3 0 4.209E-06  DCr4 0 1.048E-06  DTi  0 2.406E-05
13          AL3D  DSi  0 1.094E-04  DCu3 0 8.358E-06  DCu5 0 3.725E-06

13          AL3F  FAl  0 5.457E-02  FMg  0 1.959E-03  FMn  0 6.988E-05
13          AL3F  FFe4 0 3.214E-06  FFe6 0 5.046E-05  FFe7 0 1.165E-06
13          AL3F  FFe8 0 1.551E-07  FCr0 0 1.925E-06  FCr2 0 3.712E-05
13          AL3F  FCr3 0 4.209E-06  FCr4 0 1.048E-06  FTi  0 2.406E-05
13          AL3F  FSi  0 1.094E-04  FCu3 0 8.358E-06  FCu5 0 3.725E-06

13          AL3B  BAl  0 5.457E-02  BMg  0 1.959E-03  BMn  0 6.988E-05
13          AL3B  BFe4 0 3.214E-06  BFe6 0 5.046E-05  BFe7 0 1.165E-06
13          AL3B  BFe8 0 1.551E-07  BCr0 0 1.925E-06  BCr2 0 3.712E-05
13          AL3B  BCr3 0 4.209E-06  BCr4 0 1.048E-06  BTi  0 2.406E-05
13          AL3B  BSi  0 1.094E-04  BCu3 0 8.358E-06  BCu5 0 3.725E-06

13          AL3U  UAl  0 5.457E-02  UMg  0 1.959E-03  UMn  0 6.988E-05
13          AL3U  UFe4 0 3.214E-06  UFe6 0 5.046E-05  UFe7 0 1.165E-06
13          AL3U  UFe8 0 1.551E-07  UCr0 0 1.925E-06  UCr2 0 3.712E-05
13          AL3U  UCr3 0 4.209E-06  UCr4 0 1.048E-06  UTi  0 2.406E-05
13          AL3U  USi  0 1.094E-04  UCu3 0 8.358E-06  UCu5 0 3.725E-06

13          AL3V  VAl  0 5.457E-02  VMg  0 1.959E-03  VMn  0 6.988E-05
13          AL3V  VFe4 0 3.214E-06  VFe6 0 5.046E-05  VFe7 0 1.165E-06
13          AL3V  VFe8 0 1.551E-07  VCr0 0 1.925E-06  VCr2 0 3.712E-05
13          AL3V  VCr3 0 4.209E-06  VCr4 0 1.048E-06  VTi  0 2.406E-05
13          AL3V  VSi  0 1.094E-04  VCu3 0 8.358E-06  VCu5 0 3.725E-06

13          AL3P  PAl  0 5.457E-02  PMg  0 1.959E-03  PMn  0 6.988E-05
13          AL3P  PFe4 0 3.214E-06  PFe6 0 5.046E-05  PFe7 0 1.165E-06
13          AL3P  PFe8 0 1.551E-07  PCr0 0 1.925E-06  PCr2 0 3.712E-05
13          AL3P  PCr3 0 4.209E-06  PCr4 0 1.048E-06  PTi  0 2.406E-05
13          AL3P  PSi  0 1.094E-04  PCu3 0 8.358E-06  PCu5 0 3.725E-06


   ALUMINUM ALLOY EN AW-2017 OR A-U4G
13          AL4   EAl  0 5.827E-02  EMg  0 4.839E-04  EMn  0 2.141E-04
13          AL4   EFe4 0 6.155E-06  EFe6 0 9.662E-05  EFe7 0 2.231E-06
13          AL4   EFe8 0 2.969E-07  ECr0 0 7.020E-07  ECr2 0 1.354E-05
13          AL4   ECr3 0 1.535E-06  ECr4 0 3.821E-07  ESi  0 2.991E-04
13          AL4   ECu3 0 4.433E-06  ECu5 0 1.976E-06

   ALUMINUM ALLOY AL5
13          AL5   EAl  0 6.010E-02  EMg  0 1.676E-05  EMn  0 7.413E-06
13          AL5   EFe4 0 3.410E-06  EFe6 0 5.353E-05  EFe7 0 1.236E-06
13          AL5   EFe8 0 1.645E-07  ETi  0 8.508E-06  ESi  0 7.250E-05
13          AL5   ECu3 0 4.433E-06  ECu5 0 1.976E-06

   ZIRCONIUM 4
   NOTATION: E - PIN UO2-HOMO
             D - PIN UO2-INTERFACE PuO2
             U - PIN UO2-INTERFACE AL PIN
             V - PIN UO2-INTERFACE AL BLOCK
13          ZR4E  EZr  0 4.248E-02  EZH  0 4.899E-05  EO   0 3.086E-04
13          ZR4E  EFe4 0 8.683E-06  EFe6 0 1.363E-04  EFe7 0 3.148E-06
13          ZR4E  EFe8 0 4.189E-07  ECr0 0 3.301E-06  ECr2 0 6.366E-05
13          ZR4E  ECr3 0 7.219E-06  ECr4 0 1.797E-06  EC   0 4.405E-05
13          ZR4E  EHf  0 1.107E-06

13          ZR4D  DZr  0 4.248E-02  DZH  0 4.899E-05  DO   0 3.086E-04
13          ZR4D  DFe4 0 8.683E-06  DFe6 0 1.363E-04  DFe7 0 3.148E-06
13          ZR4D  DFe8 0 4.189E-07  DCr0 0 3.301E-06  DCr2 0 6.366E-05
13          ZR4D  DCr3 0 7.219E-06  DCr4 0 1.797E-06  DC   0 4.405E-05
13          ZR4D  DHf  0 1.107E-06

13          ZR4U  UZr  0 4.248E-02  UZH  0 4.899E-05  UO   0 3.086E-04
13          ZR4U  UFe4 0 8.683E-06  UFe6 0 1.363E-04  UFe7 0 3.148E-06
13          ZR4U  UFe8 0 4.189E-07  UCr0 0 3.301E-06  UCr2 0 6.366E-05
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13          ZR4U  UCr3 0 7.219E-06  UCr4 0 1.797E-06  UC   0 4.405E-05
13          ZR4U  UHf  0 1.107E-06

13          ZR4V  VZr  0 4.248E-02  VZH  0 4.899E-05  VO   0 3.086E-04
13          ZR4V  VFe4 0 8.683E-06  VFe6 0 1.363E-04  VFe7 0 3.148E-06
13          ZR4V  VFe8 0 4.189E-07  VCr0 0 3.301E-06  VCr2 0 6.366E-05
13          ZR4V  VCr3 0 7.219E-06  VCr4 0 1.797E-06  VC   0 4.405E-05
13          ZR4V  VHf  0 1.107E-06


   ZIRCONIUM 2
   NOTATION: A - PIN PuO2 4%-HOMO
             F - PIN PuO2 3.6%
             B - PIN PuO2 4%-INTERFACE UO2
             P - PIN PuO2 4%-INTERFACE OSCILATIION CHANNEL : POLINE overclad
13          ZR2A  AZr  0 4.248E-02  AZH  0 4.899E-05  AO   0 3.086E-04
13          ZR2A  AFe4 0 5.582E-06  AFe6 0 8.763E-05  AFe7 0 2.024E-06
13          ZR2A  AFe8 0 2.693E-07  ACr0 0 3.301E-06  ACr2 0 6.366E-05
13          ZR2A  ACr3 0 7.219E-06  ACr4 0 1.797E-06  AC   0 4.405E-05
13          ZR2A  AHf  0 1.107E-06

13          ZR2F  FZr  0 4.248E-02  FZH  0 4.899E-05  FO   0 3.086E-04
13          ZR2F  FFe4 0 5.582E-06  FFe6 0 8.763E-05  FFe7 0 2.024E-06
13          ZR2F  FFe8 0 2.693E-07  FCr0 0 3.301E-06  FCr2 0 6.366E-05
13          ZR2F  FCr3 0 7.219E-06  FCr4 0 1.797E-06  FC   0 4.405E-05
13          ZR2F  FHf  0 1.107E-06

13          ZR2B  BZr  0 4.248E-02  BZH  0 4.899E-05  BO   0 3.086E-04
13          ZR2B  BFe4 0 5.582E-06  BFe6 0 8.763E-05  BFe7 0 2.024E-06
13          ZR2B  BFe8 0 2.693E-07  BCr0 0 3.301E-06  BCr2 0 6.366E-05
13          ZR2B  BCr3 0 7.219E-06  BCr4 0 1.797E-06  BC   0 4.405E-05
13          ZR2B  BHf  0 1.107E-06

13          ZR2P  PZr  0 4.248E-02  PZH  0 4.899E-05  PO   0 3.086E-04
13          ZR2P  PFe4 0 5.582E-06  PFe6 0 8.763E-05  PFe7 0 2.024E-06
13          ZR2P  PFe8 0 2.693E-07  PCr0 0 3.301E-06  PCr2 0 6.366E-05
13          ZR2P  PCr3 0 7.219E-06  PCr4 0 1.797E-06  PC   0 4.405E-05
13          ZR2P  PHf  0 1.107E-06


   VOID
13          VOID  EO   0 1.000E-15

   PLEXIGLAS
   NOTATION: E - PIN UO2-HOMO, A - PIN PuO2 4%-HOMO
13          PLEXE EC   0 3.549E-02  EH   0 5.678E-02  EO   0 1.420E-02
13          PLEXA AC   0 3.549E-02  AH   0 5.678E-02  AO   0 1.420E-02

   STYRENE
   NOTATION: A - PIN PuO2 4%-HOMO
13          STYRA AC   0 3.672E-02  AH   0 6.732E-02  AO   0 6.120E-03
13          STYRA AN   0 6.120E-03

     OSCILLATION SAMPLE F0025
  13          SAMP  SAU4 0 2.3282E-7  SAU5 0 5.8485E-5  SAU6 0 6.9846E-8
  13          SAMP  SAU8 0 2.3223E-2  SAO  0 4.6632E-2

     NATURAL HAFNIUM
  13          HFC   CHf  0 4.491E-02

     PVC
  13          PVC   EC   0 1.755E-02  EH   0 2.632E-02

     POLYETHYLENE
  13          POLY  EC   0 3.950E-02  EH   0 7.899E-02



      ----COMPOSITIONS (TYPE-14 CARDS)----
14          WATER H2OE   1.00
14          A5    AL5    1.00
14          AG3   AL3E   1.00
14          SS1   SSE    1.00

14          ZRSSE ZR4E   0.9083     SSE    0.0917
14          ZRWE  ZR4E   0.6267     H2OE   0.3733
14          SSWE  SSE    0.3467     H2OE   0.6533

14          ZRSSA ZR2A   0.9083     SSA    0.0917
14          SSWA1 SSA    0.6226     H2OA   0.3774
14          SSWA2 SSA    0.3467     H2OA   0.6533
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14          ALW1  H2OE   0.1800     AL3E   0.8200
14          ALWT  H2OE   0.1800     AL3E   0.8200
14          ALW2  H2OE   0.8000     AL3E   0.2000

14          GAL1  GR3    0.8487     AL33   0.1513
14          GAL2  GR3    0.9568     AL33   0.0432
14          GAL3  GR3    0.8729     AL33   0.1271

14          GFOOT AL5    0.5258     AL3E   0.4110     H2OE   0.0448
14          GFOOT VOID   0.0184
14          GELT1 GR1    0.8647     AL31   0.1102     H2O1   0.0251
14          GELT2 GR2    0.8647     AL32   0.1102     H2O2   0.0251
14          GCLAD AL3E   0.9749     H2OE   0.0251

14          FFOOT AL5    0.3858     AL3E   0.1796     H2OE   0.4346

14          ALW90 H2O90  0.5856     AL90   0.3120     AL30   0.1024
14          ALW93 H2O93  0.5856     AL93   0.3120     AL30   0.1024

14          D9018 HEU90  0.0952     AL90   0.2168     H2O90  0.5856
14          D9018 AL30   0.1024
14          D9318 HEU93  0.0952     AL93   0.2168     H2O93  0.5856
14          D9318 AL30   0.1024
14          D9009 HEU90  0.0940     AL90   0.2141     H2O90  0.5892
14          D9009 AL30   0.1027
14          G9009 GR1    0.7660     AL30   0.1526     H2O90  0.0814
14          D9012 HEU90  0.0952     AL90   0.2168     H2O90  0.5246
14          D9012 AL30   0.1634
14          G9012 GR1    0.7144     AL30   0.1616     H2O90  0.1240
14          DCRUP CFUEL  0.0634     ALC    0.2138     H2OC   0.6182
14          DCRUP AL30   0.1046

14          GAL12 GR1    0.2286     AL90   0.2079     H2O90  0.4316
14          GAL12 AL30   0.1319
14          GAL09 GR1    0.3632     AL90   0.1560     H2O90  0.3384
14          GAL09 AL30   0.1424
14          ALCRUPALC    0.2772     H2OC   0.6182     AL30   0.1046

14          ALWM1 H2OE   0.6536     AL3E   0.0658     ALWT   0.2806
14          ALWM2 H2OE   0.6875     AL3E   0.3125
14          SSWM1 H2OE   0.1383     SSE    0.8617
14          ALWC1 H2OE   0.7776     AL3E   0.2224
14          ALWC2 H2OE   0.0204     AL3E   0.9796
14          ALWC3 H2OE   0.3039     AL3E   0.6961
14          ALWC4 H2OE   0.6898     AL3E   0.3102
14          SSWC1 H2OE   0.1451     AL3E   0.4184     SSE    0.4365
14          SSWC2 H2OE   0.3039     AL3E   0.1348     SSE    0.5613

14          F1PPG PLEXE  0.3009     VOID   0.0317     ZR4E   0.1045
14          F1PPG AL3E   0.1331     H2OE   0.4298
14          F1LPG SSE    0.1132     VOID   0.0119     ZR4E   0.0393
14          F1LPG ZRWE   0.1175     AL3E   0.4839     H2OE   0.2342
14          F1UPG SSE    0.1504     VOID   0.0158     ZR4E   0.0523
14          F1UPG ZRSSE  0.2186     AL3E   0.4007     H2OE   0.1622
14          F1UP  SSWE   0.0580     AL3E   0.3125     H2OE   0.6295
14          SUO2H U3H    0.3203     VOID   0.0123     ZR4E   0.1045
14          SUO2H AL3E   0.1331     H2OE   0.4298
14          UO2H  SUO2H  1.00
14          SUO2I1U3I1   0.3203     VOID   0.0123     ZR4D   0.1045
14          SUO2I1AL3D   0.1331     H2OD   0.4298
14          UO2I1 SUO2I1 1.00
14          SUO2I2U3I2   0.3203     VOID   0.0123     ZR4U   0.1045
14          SUO2I2AL3U   0.1331     H2OU   0.4298
14          UO2I2 SUO2I2 1.00
14          SUO2I3U3I3   0.3203     VOID   0.0123     ZR4V   0.1045
14          SUO2I3AL3V   0.1331     H2OV   0.4298
14          UO2I3 SUO2I3 1.00

14          ALWP1 H2OE   0.0346     AL3E   0.9654
14          ALWP2 H2OE   0.5503     AL3E   0.4497
14          ALWP3 H2OE   0.1489     AL3E   0.8511
14          ALWP4 H2OE   0.6445     AL3E   0.3555
14          ASWO1 H2OE   0.4906     AL3E   0.3615     SSE    0.1479
14          ASWO2 H2OE   0.3303     AL3E   0.5559     SSE    0.1138

14          F2PPG PLEXA  0.3009     VOID   0.0491     ZR2A   0.0871
14          F2PPG AL3A   0.1331     H2OA   0.4298
14          F2LPG SSA    0.0817     VOID   0.0152     ZR2A   0.0678
14          F2LPG SSWA1  0.0811     AL3A   0.4585     H2OA   0.2422
14          F2LPG STYRA  0.0535
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14          F2UPG SSA    0.0803     VOID   0.0433     ZR2A   0.1072
14          F2UPG ZRSSA  0.2331     AL3A   0.4007     H2OA   0.1354
14          F2UP  SSWA2  0.2049     AL3A   0.3125     H2OA   0.4826
14          F3PPG PLEXA  0.3009     VOID   0.0491     ZR2A   0.0871
14          F3PPG AL3A   0.1331     H2OA   0.4298
14          F3LPG SSA    0.0817     VOID   0.0152     ZR2A   0.0678
14          F3LPG SSWA1  0.0811     AL3A   0.4585     H2OA   0.2422
14          F3LPG STYRA  0.0535
14          F3UPG SSA    0.0803     VOID   0.0433     ZR2A   0.1072
14          F3UPG ZRSSA  0.2331     AL3A   0.4007     H2OA   0.1354
14          F3UP  SSWA2  0.2049     AL3A   0.3125     H2OA   0.4826
14          SPU4H P4H    0.3221     VOID   0.0279     ZR2A   0.0871
14          SPU4H AL3A   0.1331     H2OA   0.4298
14          PU4H  SPU4H  1.00
14          SPU4I1P4I1   0.3221     VOID   0.0279     ZR2B   0.0871
14          SPU4I1AL3B   0.1331     H2OB   0.4298
14          PU4I1 SPU4I1 1.00
14          SPU4I2P4I2   0.3221     VOID   0.0279     ZR2P   0.0871
14          SPU4I2AL3P   0.1331     H2OP   0.4298
14          PU4I2 SPU4I2 1.00
14          SPU3  P3     0.3221     VOID   0.0279     ZR2F   0.0871
14          SPU3  AL3F   0.1331     H2OF   0.4298
14          PU3   SPU3   1.00

  14          SAMPL SAMP   0.2946     H2OE   0.3304     SS     0.1138
  14          SAMPL ZR4E   0.1823     VOID   0.0790
14          POLCLDH2OE   0.4336     AL4    0.1199     VOID   0.4465


      ----ASSIGN COMPOSITIONS TO REGIONS (TYPE-15 CARDS)----

      ----DRIVER ZONE----
      ----GENERAL----
15    WATER TANK
15    ALW1  TABLE
15    ALW2  NCAIS SCAIS ECAIS WCAIS
15    A5    NGRID SGRID EGRID WGRID

      ----GRAPHITE BLOCKS-----
15    ALW2  NLGC  SLGC  ELGC  WLGC
15    GAL1  NLGB  SLGB  ELGB  WLGB
15    GAL2  NMGB  SMGB  EMGB  WMGB
15    GAL3  NSGB  SSGB

      ----GRAPHITE ELEMENTS----
15    GFOOT NG0AL SG0AL EG0AL WG0AL
15    GFOOT NG1AL SG1AL EG1AL WG1AL
15    GFOOT NG2AL SG2AL EG2AL WG2AL
15    GELT1 NG0G  SG0G  EG0G  WG0G
15    GELT1 NG1G  SG1G  EG1G  WG1G
15    GELT2 NG2G  SG2G  EG2G  WG2G
15    GCLAD NG0AU SG0AU EG0AU WG0AU
15    GCLAD NG1AU SG1AU EG1AU WG1AU
15    GCLAD NG2AU SG2AU EG2AU WG2AU

      ----FUEL ELEMENTS----
      ---- 18-PLATE 90% U-235 FUEL ELEMENT
15    FFOOT N01B  N02B  N06B  N07B
15    ALW90 N01AL N02AL N06AL N07AL
15    D9018 N01F  N02F  N06F  N07F
15    ALW90 N01AU N02AU N06AU N07AU
15    WATER N01WU N02WU N06WU N07WU
15    FFOOT S01B  S02B  S03B  S07B
15    ALW90 S01AL S02AL S03AL S07AL
15    D9018 S01F  S02F  S03F  S07F
15    ALW90 S01AU S02AU S03AU S07AU
15    WATER S01WU S02WU S03WU S07WU
15    FFOOT E01B  E02B  E06B  E07B
15    ALW90 E01AL E02AL E06AL E07AL
15    D9018 E01F  E02F  E06F  E07F
15    ALW90 E01AU E02AU E06AU E07AU
15    WATER E01WU E02WU E06WU E07WU
15    FFOOT W01B  W02B  W06B  W07B
15    ALW90 W01AL W02AL W06AL W07AL
15    D9018 W01F  W02F  W06F  W07F
15    ALW90 W01AU W02AU W06AU W07AU
15    WATER W01WU W02WU W06WU W07WU

      ---- 18-PLATE 93% U-235 FUEL ELEMENT
15    FFOOT N03B  N05B  N09B
15    ALW93 N03AL N05AL N09AL
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15     D9318 N03F  N05F  N09F
15     ALW93 N03AU N05AU N09AU
15     WATER N03WU N05WU N09WU
15     FFOOT S04B  S06B  S09B
15     ALW93 S04AL S06AL S09AL
15     D9318 S04F  S06F  S09F
15     ALW93 S04AU S06AU S09AU
15     WATER S04WU S06WU S09WU
15     FFOOT E03B  E05B  E09B
15     ALW93 E03AL E05AL E09AL
15     D9318 E03F  E05F  E09F
15     ALW93 E03AU E05AU E09AU
15     WATER E03WU E05WU E09WU
15     FFOOT W03B  W05B  W09B
15     ALW93 W03AL W05AL W09AL
15     D9318 W03F  W05F  W09F
15     ALW93 W03AU W05AU W09AU
15     WATER W03WU W05WU W09WU

       ---- 9-PLATE 90% U-235 FUEL ELEMENT
15     FFOOT N08B
15     GAL09 N08AL
15     D9009 N08F
15     G9009 N08GR
15     GAL09 N08AU
15     WATER N08WU

       ---- 12-PLATE 90% U-235 FUEL ELEMENT
15     FFOOT N10B  S08B  S10B  E08B  E10B  W08B  W10B
15     GAL12 N10AL S08AL S10AL E08AL E10AL W08AL W10AL
15     D9012 N10F  S08F  S10F  E08F  E10F  W08F  W10F
15     G9012 N10GR S08GR S10GR E08GR E10GR W08GR W10GR
15     GAL12 N10AU S08AU S10AU E08AU E10AU W08AU W10AU
15     WATER N10WU S08WU S10WU E08WU E10WU W08WU W10WU

       ---- CONTROL ELEMENT - ROD UP
15     FFOOT N04B  S05B  E04B  W04B
15     ALCRUPN04AL S05AL E04AL W04AL
15     DCRUP N04F  S05F  E04F  W04F
15     ALCRUPN04AU S05AU E04AU W04AU
15     WATER N04WU S05WU E04WU W04WU



       ----EXPERIMENTAL ZONE----
       ----GENERAL----
15     WATER EZONE
15     AG3   WEDGE

       ----ANGLE GRAPHITE ELEMENTS----
15     GFOOT G1AL  G2AL  G3AL  G4AL
15     GCLAD G1AU  G2AU  G3AU  G4AU
15     GELT2 G1G   G2G   G3G   G4G

       ----ALUMINUM MASSIF----
15     ALWM1 ALBA
15     SSWM1 ALBB
15     AG3   ALBC
15     SS1   ALBD
15     ALWM2 ALBE

       ----CHIMNEY PIECES----
15     ALW1  CHI1T CHI2T CHI3T CHI4T CHI5T CHI6T CHI7T CHI8T
15     ALWC1 CHI1A CHI2A CHI3A CHI4A CHI5A CHI6A CHI7A CHI8A
15     SSWC1 CHI1B CHI2B CHI3B CHI4B CHI5B CHI6B CHI7B CHI8B
15     ALWC2 CHI1C CHI2C CHI3C CHI4C CHI5C CHI6C CHI7C CHI8C
15     ALWC3 CHI1D CHI2D CHI3D CHI4D CHI5D CHI6D CHI7D CHI8D
15     SSWC2 CHI1E CHI2E CHI3E CHI4E CHI5E CHI6E CHI7E CHI8E
15     ALWC4 CHI1F CHI2F CHI3F CHI4F CHI5F CHI6F CHI7F CHI8F

      ----UO2 FUEL PINS----
          TYPE HOMOGENOUS
15     WATER F1CW  F1N1W F1N2W F1S1W F1S2W F1E1W F1E2W F1W1W F1W2W
15     SS1   F1CSS F1N1SSF1N2SSF1S1SSF1S2SSF1E1SSF1E2SSF1W1SSF1W2SS
15     F1LPG F1CA  F1N1A F1N2A F1S1A F1S2A F1E1A F1E2A F1W1A F1W2A
15     F1PPG F1CB  F1N1B F1N2B F1S1B F1S2B F1E1B F1E2B F1W1B F1W2B
15     UO2H  F1CC  F1N1C F1N2C F1S1C F1S2C F1E1C F1E2C F1W1C F1W2C
15     F1PPG F1CD  F1N1D F1N2D F1S1D F1S2D F1E1D F1E2D F1W1D F1W2D
15     F1UPG F1CE  F1N1E F1N2E F1S1E F1S2E F1E1E F1E2E F1W1E F1W2E
15     F1UP  F1CF  F1N1F F1N2F F1S1F F1S2F F1E1F F1E2F F1W1F F1W2F
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15     WATER P03W  P04W  P05W  P06W  P07W  P08W  P09W
15     SS1   P03SS P04SS P05SS P06SS P07SS P08SS P09SS
15     F1LPG P03A  P04A  P05A  P06A  P07A  P08A  P09A
15     F1PPG P03B  P04B  P05B  P06B  P07B  P08B  P09B
15     UO2H  P03C  P04C  P05C  P06C  P07C  P08C  P09C
15     F1PPG P03D  P04D  P05D  P06D  P07D  P08D  P09D
15     F1UPG P03E  P04E  P05E  P06E  P07E  P08E  P09E
15     F1UP  P03F  P04F  P05F  P06F  P07F  P08F  P09F

15     WATER P25W  P26W  P27W  P28W  P29W  P30W  P31W
15     SS1   P25SS P26SS P27SS P28SS P29SS P30SS P31SS
15     F1LPG P25A  P26A  P27A  P28A  P29A  P30A  P31A
15     F1PPG P25B  P26B  P27B  P28B  P29B  P30B  P31B
15     UO2H  P25C  P26C  P27C  P28C  P29C  P30C  P31C
15     F1PPG P25D  P26D  P27D  P28D  P29D  P30D  P31D
15     F1UPG P25E  P26E  P27E  P28E  P29E  P30E  P31E
15     F1UP  P25F  P26F  P27F  P28F  P29F  P30F  P31F

15     WATER D07W  D08W  D09W  D10W  D24W  D25W  D26W  D27W
15     SS1   D07SS D08SS D09SS D10SS D24SS D25SS D26SS D27SS
15     F1LPG D07A  D08A  D09A  D10A  D24A  D25A  D26A  D27A
15     F1PPG D07B  D08B  D09B  D10B  D24B  D25B  D26B  D27B
15     UO2H  D07C  D08C  D09C  D10C  D24C  D25C  D26C  D27C
15     F1PPG D07D  D08D  D09D  D10D  D24D  D25D  D26D  D27D
15     F1UPG D07E  D08E  D09E  D10E  D24E  D25E  D26E  D27E
15     F1UP  D07F  D08F  D09F  D10F  D24F  D25F  D26F  D27F

          TYPE INTERFACE #1 (UO2-PuO2)
15     WATER F1C1W F1C2W F1C3W
15     SS1   F1C1SSF1C2SSF1C3SS
15     F1LPG F1C1A F1C2A F1C3A
15     F1PPG F1C1B F1C2B F1C3B
15     UO2I1 F1C1C F1C2C F1C3C
15     F1PPG F1C1D F1C2D F1C3D
15     F1UPG F1C1E F1C2E F1C3E
15     F1UP  F1C1F F1C2F F1C3F

15     WATER P10W  P24W
15     SS1   P10SS P24SS
15     F1LPG P10A  P24A
15     F1PPG P10B  P24B
15     UO2I1 P10C  P24C
15     F1PPG P10D  P24D
15     F1UPG P10E  P24E
15     F1UP  P10F  P24F

15     WATER D11W  D23W
15     SS1   D11SS D23SS
15     F1LPG D11A  D23A
15     F1PPG D11B  D23B
15     UO2I1 D11C  D23C
15     F1PPG D11D  D23D
15     F1UPG D11E  D23E
15     F1UP  D11F  D23F

          TYPE INTERFACE #2 (UO2-Al PIN)
15     WATER F1N3W F1N8W F1N9W
15     SS1   F1N3SSF1N8SSF1N9SS
15     F1LPG F1N3A F1N8A F1N9A
15     F1PPG F1N3B F1N8B F1N9B
15     UO2I2 F1N3C F1N8C F1N9C
15     F1PPG F1N3D F1N8D F1N9D
15     F1UPG F1N3E F1N8E F1N9E
15     F1UP  F1N3F F1N8F F1N9F

15     WATER F1S3W F1S8W F1S9W
15     SS1   F1S3SSF1S8SSF1S9SS
15     F1LPG F1S3A F1S8A F1S9A
15     F1PPG F1S3B F1S8B F1S9B
15     UO2I2 F1S3C F1S8C F1S9C
15     F1PPG F1S3D F1S8D F1S9D
15     F1UPG F1S3E F1S8E F1S9E
15     F1UP  F1S3F F1S8F F1S9F

15     WATER F1E3W F1E8W F1E9W
15     SS1   F1E3SSF1E8SSF1E9SS
15     F1LPG F1E3A F1E8A F1E9A
15     F1PPG F1E3B F1E8B F1E9B
15     UO2I2 F1E3C F1E8C F1E9C
15     F1PPG F1E3D F1E8D F1E9D
15     F1UPG F1E3E F1E8E F1E9E
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15     F1UP  F1E3F F1E8F F1E9F

15     WATER F1W3W F1W8W F1W9W
15     SS1   F1W3SSF1W8SSF1W9SS
15     F1LPG F1W3A F1W8A F1W9A
15     F1PPG F1W3B F1W8B F1W9B
15     UO2I2 F1W3C F1W8C F1W9C
15     F1PPG F1W3D F1W8D F1W9D
15     F1UPG F1W3E F1W8E F1W9E
15     F1UP  F1W3F F1W8F F1W9F

15     WATER P02W  P32W
15     SS1   P02SS P32SS
15     F1LPG P02A  P32A
15     F1PPG P02B  P32B
15     UO2I2 P02C  P32C
15     F1PPG P02D  P32D
15     F1UPG P02E  P32E
15     F1UP  P02F  P32F

          TYPE INTERFACE #3 (UO2-Al)
15     WATER F1N4W F1N5W F1N6W F1N7W F1NAW F1NBW
15     SS1   F1N4SSF1N5SSF1N6SSF1N7SSF1NASSF1NBSS
15     F1LPG F1N4A F1N5A F1N6A F1N7A F1NAA F1NBA
15     F1PPG F1N4B F1N5B F1N6B F1N7B F1NAB F1NBB
15     UO2I3 F1N4C F1N5C F1N6C F1N7C F1NAC F1NBC
15     F1PPG F1N4D F1N5D F1N6D F1N7D F1NAD F1NBD
15     F1UPG F1N4E F1N5E F1N6E F1N7E F1NAE F1NBE
15     F1UP  F1N4F F1N5F F1N6F F1N7F F1NAF F1NBF

15     WATER F1S4W F1S5W F1S6W F1S7W F1SAW F1SBW
15     SS1   F1S4SSF1S5SSF1S6SSF1S7SSF1SASSF1SBSS
15     F1LPG F1S4A F1S5A F1S6A F1S7A F1SAA F1SBA
15     F1PPG F1S4B F1S5B F1S6B F1S7B F1SAB F1SBB
15     UO2I3 F1S4C F1S5C F1S6C F1S7C F1SAC F1SBC
15     F1PPG F1S4D F1S5D F1S6D F1S7D F1SAD F1SBD
15     F1UPG F1S4E F1S5E F1S6E F1S7E F1SAE F1SBE
15     F1UP  F1S4F F1S5F F1S6F F1S7F F1SAF F1SBF

15     WATER F1E4W F1E5W F1E6W F1E7W F1EAW F1EBW
15     SS1   F1E4SSF1E5SSF1E6SSF1E7SSF1EASSF1EBSS
15     F1LPG F1E4A F1E5A F1E6A F1E7A F1EAA F1EBA
15     F1PPG F1E4B F1E5B F1E6B F1E7B F1EAB F1EBB
15     UO2I3 F1E4C F1E5C F1E6C F1E7C F1EAC F1EBC
15     F1PPG F1E4D F1E5D F1E6D F1E7D F1EAD F1EBD
15     F1UPG F1E4E F1E5E F1E6E F1E7E F1EAE F1EBE
15     F1UP  F1E4F F1E5F F1E6F F1E7F F1EAF F1EBF

15     WATER F1W4W F1W5W F1W6W F1W7W F1WAW F1WBW
15     SS1   F1W4SSF1W5SSF1W6SSF1W7SSF1WASSF1WBSS
15     F1LPG F1W4A F1W5A F1W6A F1W7A F1WAA F1WBA
15     F1PPG F1W4B F1W5B F1W6B F1W7B F1WAB F1WBB
15     UO2I3 F1W4C F1W5C F1W6C F1W7C F1WAC F1WBC
15     F1PPG F1W4D F1W5D F1W6D F1W7D F1WAD F1WBD
15     F1UPG F1W4E F1W5E F1W6E F1W7E F1WAE F1WBE
15     F1UP  F1W4F F1W5F F1W6F F1W7F F1WAF F1WBF

      ----PuO2 FUEL PINS 4%----
          TYPE HOMOGENOUS
15     WATER F2C1W F2C2W
15     SS1   F2C1SSF2C2SS
15     F2LPG F2C1A F2C2A
15     F2PPG F2C1B F2C2B
15     PU4H  F2C1C F2C2C
15     F2PPG F2C1D F2C2D
15     F2UPG F2C1E F2C2E
15     F2UP  F2C1F F2C2F

15     WATER P12W  P13W  P14W  P15W  P19W  P20W  P21W  P22W
15     SS1   P12SS P13SS P14SS P15SS P19SS P20SS P21SS P22SS
15     F2LPG P12A  P13A  P14A  P15A  P19A  P20A  P21A  P22A
15     F2PPG P12B  P13B  P14B  P15B  P19B  P20B  P21B  P22B
15     PU4H  P12C  P13C  P14C  P15C  P19C  P20C  P21C  P22C
15     F2PPG P12D  P13D  P14D  P15D  P19D  P20D  P21D  P22D
15     F2UPG P12E  P13E  P14E  P15E  P19E  P20E  P21E  P22E
15     F2UP  P12F  P13F  P14F  P15F  P19F  P20F  P21F  P22F

15     WATER D13W  D14W  D15W  D19W  D20W  D21W
15     SS1   D13SS D14SS D15SS D19SS D20SS D21SS
15     F2LPG D13A  D14A  D15A  D19A  D20A  D21A
15     F2PPG D13B  D14B  D15B  D19B  D20B  D21B
```

```
15    PU4H  D13C  D14C  D15C  D19C  D20C  D21C
15    F2PPG D13D  D14D  D15D  D19D  D20D  D21D
15    F2UPG D13E  D14E  D15E  D19E  D20E  D21E
15    F2UP  D13F  D14F  D15F  D19F  D20F  D21F

         TYPE INTERFACE #1  (Pu4%/Uo2)
15    WATER F2NW  F2SW  F2EW  F2WW
15    SS1   F2NSS F2SSS F2ESS F2WSS
15    F2LPG F2NA  F2SA  F2EA  F2WA
15    F2PPG F2NB  F2SB  F2EB  F2WB
15    PU4I1 F2NC  F2SC  F2EC  F2WC
15    F2PPG F2ND  F2SD  F2ED  F2WD
15    F2UPG F2NE  F2SE  F2EE  F2WE
15    F2UP  F2NF  F2SF  F2EF  F2WF

15    WATER P11W  P23W
15    SS1   P11SS P23SS
15    F2LPG P11A  P23A
15    F2PPG P11B  P23B
15    PU4I1 P11C  P23C
15    F2PPG P11D  P23D
15    F2UPG P11E  P23E
15    F2UP  P11F  P23F

         TYPE INTERFACE #2  (Pu4%/Oscillation channel POLINE)
15    WATER F2OW
15    SS1   F2OSS
15    F2LPG F2OA
15    F2PPG F2OB
15    PU4I2 F2OC
15    F2PPG F2OD
15    F2UPG F2OE
15    F2UP  F2OF

15    WATER P16W  P18W
15    SS1   P16SS P18SS
15    F2LPG P16A  P18A
15    F2PPG P16B  P18B
15    PU4I2 P16C  P18C
15    F2PPG P16D  P18D
15    F2UPG P16E  P18E
15    F2UP  P16F  P18F

15    WATER D16W  D18W
15    SS1   D16SS D18SS
15    F2LPG D16A  D18A
15    F2PPG D16B  D18B
15    PU4I2 D16C  D18C
15    F2PPG D16D  D18D
15    F2UPG D16E  D18E
15    F2UP  D16F  D18F

     ----PuO2 FUEL PINS 3.6%----
         TYPE INTERFACE
15    WATER F3N1W F3N2W F3S1W F3S2W F3E1W F3E2W F3W1W F3W2W
15    SS1   F3N1SSF3N2SSF3S1SSF3S2SSF3E1SSF3E2SSF3W1SSF3W2SS
15    F3LPG F3N1A F3N2A F3S1A F3S2A F3E1A F3E2A F3W1A F3W2A
15    F3PPG F3N1B F3N2B F3S1B F3S2B F3E1B F3E2B F3W1B F3W2B
15    PU3   F3N1C F3N2C F3S1C F3S2C F3E1C F3E2C F3W1C F3W2C
15    F3PPG F3N1D F3N2D F3S1D F3S2D F3E1D F3E2D F3W1D F3W2D
15    F3UPG F3N1E F3N2E F3S1E F3S2E F3E1E F3E2E F3W1E F3W2E
15    F3UP  F3N1F F3N2F F3S1F F3S2F F3E1F F3E2F F3W1F F3W2F

15    WATER F3NWW F3NEW F3SWW F3SEW
15    SS1   F3NWSSF3NESSF3SWSSF3SESS
15    F3LPG F3NWA F3NEA F3SWA F3SEA
15    F3PPG F3NWB F3NEB F3SWB F3SEB
15    PU3   F3NWC F3NEC F3SWC F3SEC
15    F3PPG F3NWD F3NED F3SWD F3SED
15    F3UPG F3NWE F3NEE F3SWE F3SEE
15    F3UP  F3NWF F3NEF F3SWF F3SEF

15    WATER D12W  D22W
15    SS1   D12SS D22SS
15    F3LPG D12A  D22A
15    F3PPG D12B  D22B
15    PU3   D12C  D22C
15    F3PPG D12D  D22D
15    F3UPG D12E  D22E
15    F3UP  D12F  D22F
```

```
     ----AL PINS----
15    WATER ALN1W ALN2W ALN3W ALN4W ALN5W ALS1W ALS2W ALS3W ALS4W ALS5W
15    WATER ALE1W ALE2W ALE3W ALE4W ALE5W ALW1W ALW2W ALW3W ALW4W ALW5W
15    SS1   ALN1SSALN2SSALN3SSALN4SSALN5SSALS1SSALS2SSALS3SSALS4SSALS5SS
15    SS1   ALE1SSALE2SSALE3SSALE4SSALE5SSALW1SSALW2SSALW3SSALW4SSALW5SS
15    ALWP1 ALN1A ALN2A ALN3A ALN4A ALN5A ALS1A ALS2A ALS3A ALS4A ALS5A
15    ALWP1 ALE1A ALE2A ALE3A ALE4A ALE5A ALW1A ALW2A ALW3A ALW4A ALW5A
15    ALWP2 ALN1B ALN2B ALN3B ALN4B ALN5B ALS1B ALS2B ALS3B ALS4B ALS5B
15    ALWP2 ALE1B ALE2B ALE3B ALE4B ALE5B ALW1B ALW2B ALW3B ALW4B ALW5B
15    ALWP3 ALN1C ALN2C ALN3C ALN4C ALN5C ALS1C ALS2C ALS3C ALS4C ALS5C
15    ALWP3 ALE1C ALE2C ALE3C ALE4C ALE5C ALW1C ALW2C ALW3C ALW4C ALW5C
15    ALWP4 ALN1D ALN2D ALN3D ALN4D ALN5D ALS1D ALS2D ALS3D ALS4D ALS5D
15    ALWP4 ALE1D ALE2D ALE3D ALE4D ALE5D ALW1D ALW2D ALW3D ALW4D ALW5D

15    WATER P01W  P33W
15    SS1   P01SS P33SS
15    ALWP1 P01A  P33A
15    ALWP2 P01B  P33B
15    ALWP3 P01C  P33C
15    ALWP4 P01D  P33D

     ----CENTRAL CHANNEL----
       ----OSCILLATION TUBE (UP)
  15    WATER ORW
  15    ASWO1 ORB
  15    ASWO2 ORL   ORU
  15    SAMPL ORSAM
     ----POLINE OVERCLAD
15    WATER POLW
15    POLCLDPOLC


DATASET=A.STP027
01         0     0     0     1     0     1     0     0     0          0
02         1     0     1     1     0     0     0     0     0     0    0
  02         1     1     1     1     0     0     0     0     0     0    0
03         0     0     0     0     0     1     0     0000000000
04         0500000     0
05         0     0     1     1
```

Appendix 3: WIMS input files

The WIMS input files used to generate cross sections for the driver zone are:

- [file 18p90]: The 18- 12- and 9- plate fuel element (90% U-235 enrichment)
- [file 18p93]: The 18- plate fuel element (93% U-235 enrichment)
- [file CElt]: The Control element with the rod withdrawn
- [file G18p90]: The Graphite element and blocks, namely
- [file rod]: The Control element with the rod inserted

The WIMS input files used to generate cross section of the experimental zone for the R1MOX configuration are:

- [file UAl]: calculation UO_2 fuel pin cell near Al fuel pin
- [file UAlB]: UO_2 fuel pin cell near Al buffer
- [file UPuPu1]: UO_2 fuel pin 8-adjacent to UO_2 PuO_2 fuel pin
- [file U(3) and U(3)Ax]: UO_2 fuel pin cell surrounded by UO_2 fuel pin cell
- [file UPu]: UO_2-PuO_2 (4%) fuel pin 4-adjacent to UO_2 pin cell
- [file UPOL]: UO_2-PuO_2 (4%) fuel pin 8-adjacent to POLINE cell
- [file Pu(4) and Pu(4)Ax]: UO_2-PuO_2 (4%) fuel pin surrounded by UO_2-PuO_2 pin cell
- [file UPuPu2]: UO_2-PuO_2 (3.6%) fuel pin between a UO_2-PuO_2 (4%) pin cell and a UO_2 pin cell
- [file Sample]: Calibration sample inside the oscillation channel : "Sample" calculation

Only some of the files are used for the R1UO2 configuration.

File 18p90

```
* MINERVE - DRIVER ZONE - 18 PLATE 90% U-235 FUEL ELEMENT
*
* PERSEUS Collision Probabilities Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
* Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
* Beeone : To improve the diffusion coefficient treatment
* Al is pure (density = 2.7 g/cc)
* Al from the ENDF-BIV library
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 2
NGROUPS 69 2 7
NMATERIAL 3
NPLATE 1
NREGION 3 0 3
NMESH 18 18
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
SLAB 1 0.0254 1
SLAB 2 0.0762 2
SLAB 3 0.2212 3
*Composition data
MATERIAL 1 -1 300 1   235    1.397E-3      $U-AL 90%
                      238    1.550E-4      $
                      27     5.830E-2
```

```
MATERIAL 2 -1 300 2   27     6.026E-2       *Pure aluminum
MATERIAL 3 -1 300 3   2001   6.674E-2       $
                      16     3.337E-2
*Cross section & flux solution
MESH 4 2 12
BELL 1.40
*Printout control
PRTOPT  0                     $
       913 -11 -12 13 14 22 23 $
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE
18PLATE90
HSETID
HTR Standard Fuel Design 69 Broad Groups
*Microscopic ISOTXS control
EDITCELLS 1 1 1
VECTOR 6 14 34 47 55 60 69
ISOTOPES 235 238 27 2001 16
ISONAMES
90U5  90U8  90Al  90H   90O
*Macroscopic ISOTXS control
*LABELS 1
*FULL
*REGION 1 3
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 3 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 238 300 27 300
BEGINC
```

File 18p93

```
* MINERVE - DRIVER ZONE - 18 PLATE 93% U-235 FUEL ELEMENT
*
* PERSEUS Collision Probabilities Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al is pure (density = 2.7 g/cc)
* Al from the ENDF-BIV library
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 2
NGROUPS 69 2 7
NMATERIAL 3
NPLATE 1
NREGION 3 0 3
NMESH 18 18
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
SLAB 1 0.0254 1
SLAB 2 0.0762 2
SLAB 3 0.2212 3
*Composition data
MATERIAL 1 -1 300 1   235    1.894E-3       $
                      238    1.390E-4       $
                      27     5.770E-2       *Pure aluminum
```

```
MATERIAL 2 -1 300 2    27      6.026E-2       *Pure aluminum
MATERIAL 3 -1 300 3    2001    6.674E-2       $
                       16      3.337E-2
*Cross section & flux solution
MESH 4 2 12
BELL 1.40
*Printout control
PRTOPT  0                      $
       913 -11 -12 13 14 22 23 $
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE
18PLATE93
HSETID
HTR Standard Fuel Design 69 Broad Groups
*Microscopic ISOTXS control
EDITCELLS 1 1 1
VECTOR 6 14 34 47 55 60 69
ISOTOPES 235 238 27 2001 16
ISONAMES
93U5  93U8  93Al  93H   93O
*Macroscopic ISOTXS control
*LABELS 1
*FULL
*REGION 1 3
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 3 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 238 300 27 300
BEGINC
```

File CElt

```
* MINERVE - DRIVER ZONE - CONTROL ELEMENT 93% U-235
*
* PERSEUS Collision Probabilities Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al is pure (density = 2.7 g/cc)
* Al from the ENDF-BIV library
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 3
NPLATE 6
NREGION 27 0 27
NMESH 310 310
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
SLAB 1 0.0254 1
SLAB 2 0.0762 2
SLAB 3 0.3662 3
SLAB 4 0.4170 2
SLAB 5 0.4678 1
SLAB 6 0.5186 2
SLAB 7 0.8086 3
```

```
SLAB 8 0.8594 2
SLAB 9 0.9102 1
SLAB 10 0.9610 2
SLAB 11 1.2510 3
SLAB 12 1.3018 2
SLAB 13 1.3526 1
SLAB 14 1.4034 2
SLAB 15 1.6934 3
SLAB 16 1.8458 2
SLAB 17 2.5782 3
SLAB 18 2.7306 2
SLAB 19 3.0206 3
SLAB 20 3.0714 2
SLAB 21 3.1222 1
SLAB 22 3.1730 2
SLAB 23 3.4630 3
SLAB 24 3.5138 2
SLAB 25 3.5646 1
SLAB 26 3.6154 2
SLAB 27 3.7604 3
*Composition data
MATERIAL 1 -1 300 1   235    1.894E-3      $
                      238    1.390E-4      $
                      27     5.770E-2      *Pure aluminum
MATERIAL 2 -1 300 2   27     6.026E-2      *Pure aluminum
MATERIAL 3 -1 300 3   2001   6.674E-2      $
                      16     3.337E-2
*Cross section & flux solution
MESH 5 5 20 5 10 5 20 5 10 5 20 5 10 5 20 10 50 10 20 5 10 5 20 5 10 5 10
BELL 1.40
*Printout control
PRTOPT  0                     $
       913 -11 -12 13 14 22 23 $
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE
CONTROL93
HSETID
HTR Control Element Design 69 Broad Groups
*Microscopic ISOTXS control
EDITCELLS 1 1 1
VECTOR 6 14 34 47 55 60 69
ISOTOPES 235 238 27 2001 16
ISONAMES
CU5   CU8   CAl   CH    CO
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 3 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 238 300 16 300 2001 300 27 300
*Miscellaneous Edit Control
BEGINC
```

File G18p90

```
* MINERVE - DRIVER ZONE
* GRAPHITE REFLECTOR ELEMENT NEAR 18 PLATE 90% U-235 FUEL ELEMENT
*
* SUPERCELL Calculation
* DSN
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
* Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
* Al from the ENDF-BIV library
*
*                 *****PRELUDE INPUT DATA******
```

```
CELL 8
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 16
NCELL 3
NREGION 39 0 39
NMESH 186 186
NREACT 1
NPLATE 1
PREOUT
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*
*SUPERCELL 1 : All
CELL 1 1 1 1
CSPECTRUM -1
*Geometry data
*Elt0
SLAB 1 6.500  1 *Fuel + Al + Water : homogenized
SLAB 2 6.658  2 *Al + water (edge of the fuel plate)
SLAB 3 7.134  3 *AG3 border plate
SLAB 4 7.184  4 *Water
*Elt1
SLAB 5 7.234  5 *Water
SLAB 6 7.439  6 *AG3 clad
SLAB 7 14.639 7 *Graphite 1
SLAB 8 14.844 6 *AG3 clad
SLAB 9 14.894 5 *Water
*Elt2
SLAB 10 14.944 8 *Water
SLAB 11 15.149 9 *AG3 clad
SLAB 12 22.349 10 *Graphite 2
SLAB 13 22.554 9 *AG3 clad
SLAB 14 22.604 8 *Water
*Elt3
SLAB 15 22.809 12 *AG3 clad
SLAB 16 68.359 13 *Graphite 3
SLAB 17 68.564 12 *AG3 clad
SLAB 18 80.000 11 *Water
*
MESH 6 2 2 3 3 2 6 2 3 3 2 6 2 3 3 2 20 2 10 *82
*
*SUPERCELL 2 : Homogenized fuel with resonance treatment included
CELL 2 1 1 0
CSPECTRUM 2
*Geometry data
SLAB 1 0.0254 14 *U-Al 90%
SLAB 2 0.0762 15 *Al
SLAB 3 0.2212 16 *water
MESH 5 2 15 *22
*
*SUPERCELL 3 : Improved reflector spectrum
CELL 3 1 1 1
CSPECTRUM 3 1
*Geometry data
*Geometry data
*Elt0
SLAB 1 6.500  1 *Fuel + Al + Water : homogenized
SLAB 2 6.658  2 *Al + water (edge of the fuel plate)
SLAB 3 7.134  3 *AG3 border plate
SLAB 4 7.184  4 *Water
*Elt1
SLAB 5 7.234  5 *Water
SLAB 6 7.439  6 *AG3 clad
SLAB 7 14.639 7 *Graphite 1
SLAB 8 14.844 6 *AG3 clad
SLAB 9 14.894 5 *Water
*Elt2
SLAB 10 14.944 8 *Water
SLAB 11 15.149 9 *AG3 clad
SLAB 12 22.349 10 *Graphite 2
SLAB 13 22.554 9 *AG3 clad
SLAB 14 22.604 8 *Water
*Elt3
SLAB 15 22.809 12 *AG3 clad
SLAB 16 68.359 13 *Graphite 3
SLAB 17 68.564 12 *AG3 clad
SLAB 18 80.000 11 *Water
*
```

```
MESH 6 2 2 3 3 2 6 2 3 3 2 6 2 3 3 2 20 2 10 *82
*
*Assigning spectrum to material + homogeneization
NEWXS 1  1 2 14 15 16
NEWXS 2 -1 2
NEWXS 3 -1 2
NEWXS 4 -1 2
NEWXS 5 -1 3
NEWXS 6 -1 3
NEWXS 7 -1 3
NEWXS 8 -1 3
NEWXS 9 -1 3
NEWXS 10 -1 3
NEWXS 11 -1 3
NEWXS 12 -1 3
NEWXS 13 -1 3
NEWXS 14 -1 2
NEWXS 15 -1 2
NEWXS 16 -1 2
*Composition data
MATERIAL 1 -1 300 1    235     1.000E-15       *Material for homogeneization
MATERIAL 2 -1 300 3     27       2.079E-02     $Mix Al(34.5%) + Water(65.5%)
                        2001     4.372E-02     $
                        16     2.186E-02
MATERIAL 3 -1 300 2    27      5.457E-02       $AG3 (density = 2.55 g/cc)
                       24      1.959E-03       $No Zn in the library
                       55      6.988E-05       $
                       1054    3.215E-06       $
                       56      5.046E-05       $
                       57      1.165E-06       $
                       158     1.551E-07       $
                       50      1.925E-06       $
                       52      3.712E-05       $
                       53      4.209E-06       $
                       54      1.048E-06       $
                       48      2.406E-05       $
                       29      1.094E-04       $
                       63      8.358E-06       $
                       65      3.725E-06
MATERIAL 4 -1 300 3    2001    6.674E-2        $Water
                       16      3.337E-2
MATERIAL 5 -1 300 3    2001    6.674E-2        $Water
                       16      3.337E-2
MATERIAL 6 -1 300 2    27      5.457E-02       $AG3 (density = 2.55 g/cc)
                       24      1.959E-03       $No Zn in the library
                       55      6.988E-05       $
                       1054    3.215E-06       $
                       56      5.046E-05       $
                       57      1.165E-06       $
                       158     1.551E-07       $
                       50      1.925E-06       $
                       52      3.712E-05       $
                       53      4.209E-06       $
                       54      1.048E-06       $
                       48      2.406E-05       $
                       29      1.094E-04       $
                       63      8.358E-06       $
                       65      3.725E-06
MATERIAL 7 -1 300 4    12      8.065E-2        *Graphite
MATERIAL 8 -1 300 3    2001    6.674E-2        $Water
                       16      3.337E-2
MATERIAL 9 -1 300 2    27      5.457E-02       $AG3 (density = 2.55 g/cc)
                       24      1.959E-03       $No Zn in the library
                       55      6.988E-05       $
                       1054    3.215E-06       $
                       56      5.046E-05       $
                       57      1.165E-06       $
                       158     1.551E-07       $
                       50      1.925E-06       $
                       52      3.712E-05       $
                       53      4.209E-06       $
                       54      1.048E-06       $
                       48      2.406E-05       $
                       29      1.094E-04       $
                       63      8.358E-06       $
                       65      3.725E-06
MATERIAL 10 -1 300 4   12      8.065E-2        *Graphite
MATERIAL 11 -1 300 3   2001    6.674E-2        $Water
                       16      3.337E-2
MATERIAL 12 -1 300 2   27      5.457E-02       $AG3 (density = 2.55 g/cc)
                       24      1.959E-03       $No Zn in the library
```

```
                      55      6.988E-05      $
                      1054    3.215E-06      $
                      56      5.046E-05      $
                      57      1.165E-06      $
                      158     1.551E-07      $
                      50      1.925E-06      $
                      52      3.712E-05      $
                      53      4.209E-06      $
                      54      1.048E-06      $
                      48      2.406E-05      $
                      29      1.094E-04      $
                      63      8.358E-06      $
                      65      3.725E-06
MATERIAL 13 -1 300 4  12      8.065E-2       *Graphite
MATERIAL 14 -1 300 1  235     1.397E-3       $U-AL 90%
                      238     1.550E-4       $
                      27      5.830E-2
MATERIAL 15 -1 300 2  27      6.026E-2       *Al
MATERIAL 16 -1 300 3  2001    6.674E-2       $Water
                      16      3.337E-2
*Cross section & flux solution
S 32
BELL 1.40
*Printout control
PRTOPT  0                 $
       913 -11 -12 13 14 22 23 $
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
*         1 2 3 4   5 6 7   8 9 10   11 12 13   14 15 16
EDITCELLS 0 1 1 1   0 0 0   0 0  0    0  0  0    0  0  0
VECTOR 6 14 34 47 55 60 69
ISOTOPES       27 24 55 1054 56 57 158 50 52 53 $AG3
               54 48 29 63 65                $
                2001 16                               *Water
ISONAMES
0Al   0Mg   0Mn   0Fe4  0Fe6  0Fe7  0Fe8  0Cr0  0Cr2  0Cr3  0Cr4  0Ti
0Si   0Cu3  0Cu5  0H    0O
*Macroscopic ISOTXS control
*LABELS 1
*REF1
*REGION 1 5
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*Reaction Rate Edits
PARTITION  45 69
REACTION 12 300
*Miscellaneous Edit Control
BEGINC
```

File rod

```
* MINERVE - DRIVER ZONE - CONTROL ELEMENT 93% U-235 WITH HAFNIUM ROD
*
* SUPERCELL Calculation
* DSN
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
*                 *****PRELUDE INPUT DATA******
CELL 8
```

```
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 8
NCELL 3
NREGION 20 0 20
NMESH 509 258
*NPLATE 5
PREOUT
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*
*SUPERCELL : Half the control rod element
CELL 1 1 1 1
CSPECTRUM -1
*Geometry data
SLAB 1  0.8848 5 *Homogenized fuel + al + water from 18 plates (2*(0.29+0.1524)cm)
SLAB 2  1.0298 1 *Water (0.29/2 cm)
SLAB 3  1.1822 2 *AG3 (0.1524 cm)
SLAB 4  1.3289 1 *Water (0.1467 cm)
SLAB 5  1.3789 3 *SS (0.05cm)
SLAB 6  1.6679 4 *Hf (0.339 cm)
SLAB 7  1.7179 3 *SS (0.05cm)
SLAB 8  1.8646 1 *Water (0.1467 cm)
SLAB 9  2.0170 2 *AG3 (0.1524 cm)
SLAB 10 2.1620 1 *Water (0.29/2 cm)
SLAB 11 3.9316 5 *Homogenized fuel + al + water from 18 plates (4*(0.29+0.1524)cm)
MESH 10 5 2 5 2 200 2 5 2 5 20  *258
*
*AUXILARY CELL 1 : 93% U-235 PLATES
CELL 2 1 1 1
CSPECTRUM 2
SLAB 1  0.0254 6 *U(93%)+Al
SLAB 2  0.0762 7 *Al
SLAB 3  0.2212 8 *Water
MESH 5 2 10 *17
*
*AUXILARY CELL 2 : Hafnium plate
CELL 3 1 1 1
CSPECTRUM 3
SLAB 1  0.1695 4 *Hf (0.339 cm)
SLAB 2  0.2195 3 *SS (0.05cm)
SLAB 3  0.3662 1 *Water (0.1467 cm)
SLAB 4  0.5186 2 *AG3 (0.1524 cm)
SLAB 5  0.6636 1 *Water (0.29/2 cm)
SLAB 6  1.5484 5 *Homogenized fuel + al + water from 18 plates (2*(0.29+0.1524)cm)
MESH 200 2 5 2 5 20 *234
*
*Assigning spectrum to material + homogeneization
NEWXS 1 -1 3
NEWXS 2 -1 3
NEWXS 3 -1 3
NEWXS 4 -1 3
NEWXS 5  1 2 6 7 8
NEWXS 6 -1 2
NEWXS 7 -1 2
NEWXS 8 -1 2
*
*Composition data
MATERIAL 1 -1 300 3   2001   6.674E-2       $Water
                      16     3.337E-2
MATERIAL 2 -1 300 2   27     5.457E-02      $AG3 (density = 2.55 g/cc)
                      24     1.959E-03      $No Zn in the library
                      55     6.988E-05      $
                      1054   3.215E-06      $
                      56     5.046E-05      $
                      57     1.165E-06      $
                      158    1.551E-07      $
                      50     1.925E-06      $
                      52     3.712E-05      $
                      53     4.209E-06      $
                      54     1.048E-06      $
                      48     2.406E-05      $
                      29     1.094E-04      $
                      63     8.358E-06      $
                      65     3.725E-06
MATERIAL 3 -1 300 3   1054    3.387E-03     $SS (density = 7.85 g/cc)
                      56      5.316E-02     $P and S are not used (af<0.1%)
                      57     1.228E-03      $
                      58     1.634E-04      $
```

```
                      12      5.904E-05      $
                      50      7.111E-04      $
                      52      1.371E-02      $
                      53      1.555E-03      $
                      54      3.870E-04      $
                      58      6.031E-03      $
                      60      2.323E-03      $
                      61      1.010E-04      $
                      62      3.220E-04      $
                      64      8.201E-05      $
                      55      8.605E-04      $
                      29      8.416E-04      $
                      4200    4.927E-04
MATERIAL 4 -1 300 1   178     4.491E-02       *Hafnium (density = 13.31 g/cc)
MATERIAL 5 -1 300 1   235     1.000E-15      $Material for homogeneization
                      238     1.000E-15
MATERIAL 6 -1 300 1   235     1.894E-3       $U(93%) + Al
                      238     1.390E-4       $
                      27      5.770E-2       *Pure Al
MATERIAL 7 -1 300 2   27      6.026E-2       *Pure Al
MATERIAL 8 -1 300 3   2001    6.674E-2       $Water
                      16      3.337E-2
*
S 16
TOLERANCE .000001
BELL 1.40
*Printout control
PRTOPT 0 904 7 906 7
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS 1 1 1 1 1 0 0 0
VECTOR 6 14 34 47 55 60 69
ISOTOPES       235 238                       $U
                27                           $Al
                2001 16                              $H2O
               24 55 1054 56 57 158 50 52 53         $AG3
               54 48 29 63 65                $
               58 60 61 62 64 4200 12          $
                178
ISONAMES
RU5   RU8   RAl   RH    RO    RMg   RMn   RFe4  RFe6  RFe7  RFe8  RCr0
RCr2  RCr3  RCr4  RTi   RSi   RCu3  RCu5  RNi8  RNi0  RNi1  RNi2  RNi4
RMo   RC    RHf
*Reaction Rate Edits
BEGINC
```

File U(3)

```
* MINERVE - EXPERIMENTAL ZONE - MINERVE TYPE-II FUEL PIN U(3)
*
* PERSEUS Collision Probabilities Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 5
NPLATE 0
NREGION 6 0 6
```

```
NMESH 130 130
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
ANNULUS 1 0.4023 1
ANNULUS 2 0.41 2
ANNULUS 3 0.47 3
ANNULUS 4 0.485 4
ANNULUS 5 0.55 5
SQUARE  6 1.26 4
*Composition data
MATERIAL 1 -1 300 1   234    4.617E-6       $U(3)
                      235    6.900E-4       $
                      236    5.493E-6       $
                      2238   2.200E-2       $
                      16     4.647E-2
MATERIAL 2 -1 300 2   16     1.000E-10
MATERIAL 3 -1 300 2   91     4.247E-02      $Zr4 (density = 6.56 g/cc)
                      2191   4.899E-05      $No Sn in the library
                      1054   8.683E-06      $Element with af<0.1% are not used
                      56     1.363E-04      $except Hf
                      57     3.148E-06      $
                      158    4.189E-07      $
                      50     3.301E-06      $
                      52     6.366E-05      $
                      53     7.219E-06      $
                      54     1.797E-06      $
                      16     3.086E-04      $
                      1212   4.400E-05
*                     1212   4.400E-05      $
*                     178    1.107E-06
MATERIAL 4 -1 300 3   2001   6.674E-2       $Water
                      16     3.337E-2
MATERIAL 5 -1 300 2   27     5.457E-02      $AG3 (density = 2.55 g/cc)
                      24     1.959E-03      $No Zn in the library
                      55     6.988E-05      $
                      1054   3.215E-06      $
                      56     5.046E-05      $
                      57     1.165E-06      $
                      158    1.551E-07      $
                      50     1.925E-06      $
                      52     3.712E-05      $
                      53     4.209E-06      $
                      54     1.048E-06      $
                      48     2.406E-05      $
                      29     1.094E-04      $
                      63     8.358E-06      $
                      65     3.725E-06
*Cross section & flux solution
S 32
MESH 20 10 10 40 10 40
BELL 1.16
*Printout control
PRTOPT  0                  $
        913 -11 -12 13 14 22 23 $
        915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE
U(3)PIN-1
HSETID
MINERVE type-2 fuel pins U(3) 69 Broad Groups
*Microscopic ISOTXS control
EDITCELLS 1 1 1 1 1
VECTOR 6 14 34 47 55 60 69
ISOTOPES       234 235 236 2238 16 2001 91 2191 1054 56 57   $
               158 50 52 53 54 1212 178 27 24 55 48 29 63 65
ISONAMES
EU4   EU5   EU6   EU8   EO    EH    EZr   EZH   EFe4  EFe6  EFe7  EFe8
ECr0  ECr2  ECr3  ECr4  EC    EHf   EAl   EMg   EMn   ETi   ESi   ECu3
ECu5
*Leakage calculation
*LEAKAGE 8 1
```

```
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1 0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 3 0. 0. 0. 3.086E-4 0. 8.683E-6 0.
*DNB 4 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
*Miscellaneous Edit Control
BEGINC
```

File U(3)Ax

```
* MINERVE - EXPERIMENTAL ZONE - AXIAL OF A PIN U(3)
*
* PERSEUS Collision Probabilities Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al is taken from the AG3 of the MSR w.o. impurities
* Al from the ENDF-BIV library
*
*                  *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 3
NPLATE 1
NREGION 3 0 3
NMESH 110 110
NREACT 1
PREOUT
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
SLAB 1 25.0 1
SLAB 2 38.0 2
SLAB 3 39.5 3
*Composition data
MATERIAL 1 -1 300 1    234     4.617E-6       $U(3)
                       235     6.900E-4       $
                       236     5.493E-6       $
                       2238    2.200E-2       $
                       16      4.647E-2
MATERIAL 2 -1 300 2    12       3.549E-02     $PLEXI (density = 1.18 g/cc)
                       2001     5.678E-02     $
                       16       1.420E-02
MATERIAL 3 -1 300 3    1054     3.387E-03     $SS (density = 7.85 g/cc)
                       56       5.316E-02     $P and S are not used (af<0.1%)
                       57      1.228E-03      $
                       58      1.634E-04      $
                       12      5.904E-05      $
                       50      7.111E-04      $
                       52      1.371E-02      $
                       53      1.555E-03      $
                       54      3.870E-04      $
                       58      6.031E-03      $
                       60      2.323E-03      $
                       61      1.010E-04      $
                       62      3.220E-04      $
                       64      8.201E-05      $
                       55      8.605E-04      $
                       29      8.416E-04      $
                       4200    4.927E-04
*Cross section & flux solution
S 32
MESH 50 50 10
BELL 1.40
*Printout control
PRTOPT  0                      $
        913 -11 -12 13 14 22 23 $
```

```
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS 0 0 1
VECTOR 6 14 34 47 55 60 69
ISOTOPES 58 60 61 62 64 4200
ISONAMES
ENi8  ENi0  ENi1  ENi2  ENi4  EMo
*Macroscopic ISOTXS control
*LABELS 1
*FULL
*REGION 1 3
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1 0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 2 0.05678 0. 0.03549 0.01420 0. 0. 0.
*DNB 3 0. 0. 5.904E-5 0. 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION  58 300
BEGINC
```

File UAl

```
* MINERVE - EXPERIMENTAL ZONE - INTERFACE MINERVE TYPE-II FUEL PIN U(3) / PIN AL
*
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 6
NPLATE 0
NREGION 7 0 7
NMESH 210 210
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
ANNULUS 1 0.4023 1
ANNULUS 2 0.41 2
ANNULUS 3 0.47 3
ANNULUS 4 0.485 4
ANNULUS 5 0.55 5
SQUARE  6 1.26 4
SQUARE  7 3.78 6
*Composition data
MATERIAL 1 -1 300 1   234    4.617E-6      $U(3)
                      235    6.900E-4      $
                      236    5.493E-6      $
                      2238   2.200E-2      $
                      16     4.647E-2
MATERIAL 2 -1 300 2   16     1.000E-10
```

```
MATERIAL 3 -1 300 2   91     4.247E-02      $Zr4 (density = 6.56 g/cc)
                      2191   4.899E-05      $No Sn in the library
                      1054   8.683E-06      $Element with af<0.1% are not used
                      56     1.363E-04      $except Hf
                      57     3.148E-06      $
                      158    4.189E-07      $
                      50     3.301E-06      $
                      52     6.366E-05      $
                      53     7.219E-06      $
                      54     1.797E-06      $
                      16     3.086E-04      $
                      1212   4.400E-05      $
                      178    1.107E-06
MATERIAL 4 -1 300 3   2001   6.674E-2       $Water
                      16     3.337E-2
MATERIAL 5 -1 300 2   27     5.457E-02      $AG3 (density = 2.55 g/cc)
                      24     1.959E-03      $No Zn in the library
                      55     6.988E-05      $
                      1054   3.215E-06      $
                      56     5.046E-05      $
                      57     1.165E-06      $
                      158    1.551E-07      $
                      50     1.925E-06      $
                      52     3.712E-05      $
                      53     4.209E-06      $
                      54     1.048E-06      $
                      48     2.406E-05      $
                      29     1.094E-04      $
                      63     8.358E-06      $
                      65     3.725E-06
MATERIAL 6 -1 300 1   234    9.243E-07      $Mixture 5/8 U-pin, 3/8 Al-pin
                      235    1.381E-04      $
                      236    1.100E-06      $
                      2238   4.404E-03      $
                      16     2.517E-02      $
                      91     2.773E-03      $
                      2191   3.199E-06      $
                      1054   1.377E-06      $
                      56     2.161E-05      $
                      57     4.989E-07      $
                      158    6.641E-08      $
                      50     7.003E-07      $
                      52     1.350E-05      $
                      53     1.531E-06      $
                      54     3.812E-07      $
                      1212   2.873E-06      $
                      178    7.229E-08      $
                      2001   3.170E-02      $
                      27     1.374E-02      $
                      24     4.933E-04      $
                      55     1.760E-05      $
                      48     6.058E-06      $
                      29     2.755E-05      $
                      63     2.105E-06      $
                      65     9.380E-07
*Cross section & flux solution
S 32
MESH 20 10 10 40 10 40 80
BELL 1.16
*Printout control
PRTOPT  0                $
        913 -11 -12 13 14 22 23 $
        915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                   *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS 1 1 1 1 1 0
VECTOR 6 14 34 47 55 60 69
ISOTOPES       234 235 236 2238 16 2001 91 2191 1054 56 57   $
               158 50 52 53 54 1212 178 27 24 55 48 29 63 65
ISONAMES
UU4   UU5   UU6   UU8   UO    UH    UZr   UZH   UFe4  UFe6  UFe7  UFe8
UCr0  UCr2  UCr3  UCr4  UC    UHf   UAl   UMg   UMn   UTi   USi   UCu3
```

```
UCu5
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1 0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 3 0. 0. 0. 3.086E-4 0. 8.683E-6 0.
*DNB 4 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
*Miscellaneous Edit Control
BEGINC
```

File UALB

```
* MINERVE - EXPERIMENTAL ZONE - INTERFACE MINERVE TYPE-II FUEL PIN U(3) / AL BUFFER
(BLOCK)
*
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                  *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 6
NPLATE 0
NREGION 7 0 7
NMESH 210 210
NREACT 1
PREOUT
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
ANNULUS 1 0.4023 1
ANNULUS 2 0.41 2
ANNULUS 3 0.47 3
ANNULUS 4 0.485 4
ANNULUS 5 0.55 5
SQUARE  6 1.26 4
SQUARE  7 3.78 6
*Composition data
MATERIAL 1 -1 300 1    234     4.617E-6       $U(3)
                       235     6.900E-4       $
                       236     5.493E-6       $
                       2238    2.200E-2       $
                       16      4.647E-2
MATERIAL 2 -1 300 2    16      1.000E-10
MATERIAL 3 -1 300 2    91      4.247E-02      $Zr4 (density = 6.56 g/cc)
                       2191    4.899E-05      $No Sn in the library
                       1054    8.683E-06      $Element with af<0.1% are not used
                       56      1.363E-04      $except Hf
                       57      3.148E-06      $
                       158     4.189E-07      $
                       50      3.301E-06      $
                       52      6.366E-05      $
                       53      7.219E-06      $
                       54      1.797E-06      $
                       16      3.086E-04      $
                       1212    4.400E-05      $
                       178     1.107E-06
MATERIAL 4 -1 300 3    2001    6.674E-2       $Water
                       16      3.337E-2
MATERIAL 5 -1 300 2    27      5.457E-02      $AG3 (density = 2.55 g/cc)
                       24      1.959E-03      $No Zn in the library
                       55      6.988E-05      $
```

```
                      1054   3.215E-06     $
                      56     5.046E-05     $
                      57     1.165E-06     $
                      158    1.551E-07     $
                      50     1.925E-06     $
                      52     3.712E-05     $
                      53     4.209E-06     $
                      54     1.048E-06     $
                      48     2.406E-05     $
                      29     1.094E-04     $
                      63     8.358E-06     $
                      65     3.725E-06
MATERIAL 6 -1 300 1   234    9.243E-07     $Mixture 5/8 U-pin, 3/8 Al-buffer
                      235    1.381E-04     $
                      236    1.100E-06     $
                      2238   4.404E-03     $
                      16     1.829E-02     $
                      91     2.774E-03     $
                      2191   3.200E-06     $
                      1054   2.040E-06     $
                      56     3.202E-05     $
                      57     7.394E-07     $
                      158    9.842E-08     $
                      50     1.098E-06     $
                      52     2.117E-05     $
                      53     2.400E-06     $
                      54     5.975E-07     $
                      1212   2.874E-06     $
                      178    7.230E-08     $
                      2001   1.793E-02     $
                      27     2.500E-02     $
                      24     8.976E-04     $
                      55     3.202E-05     $
                      48     1.102E-05     $
                      29     5.013E-05     $
                      63     3.830E-06     $
                      65     1.707E-06
*Cross section & flux solution
S 32
MESH 20 10 10 40 10 40 80
BELL 1.16
*Printout control
PRTOPT  0                    $
       913 -11 -12 13 14 22 23 $
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS 1 1 1 1 1 0
VECTOR 6 14 34 47 55 60 69
ISOTOPES       234 235 236 2238 16 2001 91 2191 1054 56 57   $
               158 50 52 53 54 1212 178 27 24 55 48 29 63 65
ISONAMES
VU4   VU5   VU6   VU8   VO    VH    VZr   VZH   VFe4  VFe6  VFe7  VFe8
VCr0  VCr2  VCr3  VCr4  VC    VHf   VAl   VMg   VMn   VTi   VSi   VCu3
VCu5
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1 0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 3 0. 0. 0. 3.086E-4 0. 8.683E-6 0.
*DNB 4 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
*Miscellaneous Edit Control
BEGINC
```

File UPuPu1

```
* MINERVE - EXPERIMENTAL ZONE - MINERVE INTERFACE TYPE-II AND TYPE-III FUEL PINS
U(3)/Pu(3.6)/Pu(4)
*
* Sn Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                  *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 2
NGROUPS 69 2 7
NCELLS 3
NMATERIAL 15
NPLATE 0
NREGION 15 0 22
NMESH 215 215
NREACT 1
PREOUT
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*
*UO2 FUEL CELL
CELL 1 1
ANNULUS 1 0.4023 1     *Fuel
ANNULUS 2 0.41 2       *Void
ANNULUS 3 0.47 3       *Clad
ANNULUS 4 0.485 4      *Water
ANNULUS 5 0.55 5       *Overclad
SQUARE  6 1.26 4       *Water
MESH 10 5 5 20 5 20
PCELL 1 (0.0 1.0 0.0)
*
*Pu(3.6%) FUEL CELL
CELL 2 1
ANNULUS 1 0.4035 6     *Fuel
ANNULUS 2 0.41 7       *Void
ANNULUS 3 0.435 8      *Inner clad
ANNULUS 4 0.445 7      *Void
ANNULUS 5 0.47 8       *Outer clad
ANNULUS 6 0.485 9      *Water
ANNULUS 7 0.55 10      *Overclad
SQUARE  8 1.26 9       *Water
MESH 10 5 5 5 5 20 5 20
PCELL 2 (0.5 0.0 0.5)
*
*Pu(4.0%) FUEL CELL
CELL 3 1
ANNULUS 1 0.4035 11    *Fuel
ANNULUS 2 0.41 12      *Void
ANNULUS 3 0.435 13     *Inner clad
ANNULUS 4 0.445 12     *Void
ANNULUS 5 0.47 13      *Outer clad
ANNULUS 6 0.485 14     *Water
ANNULUS 7 0.55 15      *Overclad
SQUARE  8 1.26 14      *Water
MESH 10 5 5 5 5 20 5 20
PCELL 3 (0.0 1.0 0.0)
*
*Composition data
*UO2 FUEL CELL
MATERIAL 1 -1 300 1    234    4.617E-6       $U(3)
                       235    6.900E-4       $
                       236    5.493E-6       $
                       2238   2.200E-2       $
                       16     4.647E-2
MATERIAL 2 -1 300 2    16     1.000E-10
MATERIAL 3 -1 300 2    91     4.247E-02      $Zr4 (density = 6.56 g/cc)
                       2191   4.899E-05      $No Sn in the library
                       1054   8.683E-06      $Element with af<0.1% are not used
```

```
                      56      1.363E-04      $except Hf
                      57      3.148E-06      $
                      158     4.189E-07      $
                      50      3.301E-06      $
                      52      6.366E-05      $
                      53      7.219E-06      $
                      54      1.797E-06      $
                      16      3.086E-04      $
                      1212    4.440E-05      $
                      178     1.107E-06
MATERIAL 4 -1 300 3   2001    6.674E-2       $Water
                      16      3.337E-2
MATERIAL 5 -1 300 2   27      5.457E-02      $AG3 (density = 2.55 g/cc)
                      24      1.959E-03      $No Zn in the library
                      55      6.988E-05      $
                      1054    3.215E-06      $
                      56      5.046E-05      $
                      57      1.165E-06      $
                      158     1.551E-07      $
                      50      1.925E-06      $
                      52      3.712E-05      $
                      53      4.209E-06      $
                      54      1.048E-06      $
                      48      2.406E-05      $
                      29      1.094E-04      $
                      63      8.358E-06      $
                      65      3.725E-06
*Pu(3.6%) FUEL CELL
MATERIAL 6 -1 300 1   234     2.951E-6       $Pu(3.6)
                      235     1.588E-4       $
                      2238    2.189E-2       $
                      1238    6.501E-6       $
                      3239    5.743E-4       $
                      240     1.389E-4       $
                      241     1.920E-5       $
                      242     1.621E-5       $
                      1241    6.036E-5       $
                      237     1.811E-6       $
                      16      4.574E-2
MATERIAL 7 -1 300 2   16      1.000E-10
MATERIAL 8 -1 300 2   91      4.248E-02      $Zr2 (density = 6.56 g/cc)
                      2191    4.899E-05      $No Sn in the library
                      1054    5.582E-06      $Element with af<0.1% are not used
                      56      8.763E-05      $except Hf
                      57      2.024E-06      $
                      158     2.693E-07      $
                      50      3.301E-06      $
                      52      6.366E-05      $
                      53      7.219E-06      $
                      54      1.797E-06      $
                      16      3.086E-04      $
                      1212    4.440E-05      $
                      178     1.107E-06
MATERIAL 9 -1 300 3   2001    6.674E-2       $Water
                      16      3.337E-2
MATERIAL 10 -1 300 2  27      5.457E-02      $AG3 (density = 2.55 g/cc)
                      24      1.959E-03      $No Zn in the library
                      55      6.988E-05      $
                      1054    3.215E-06      $
                      56      5.046E-05      $
                      57      1.165E-06      $
                      158     1.551E-07      $
                      50      1.925E-06      $
                      52      3.712E-05      $
                      53      4.209E-06      $
                      54      1.048E-06      $
                      48      2.406E-05      $
                      29      1.094E-04      $
                      63      8.358E-06      $
                      65      3.725E-06
*Pu(4.0%) FUEL CELL
MATERIAL 11 -1 300 1  234     3.139E-6       $Pu(4)
                      235     1.581E-4       $
                      2238    2.180E-2       $
                      1238    7.223E-6       $
                      3239    6.382E-4       $
                      240     1.543E-4       $
                      241     2.133E-5       $
                      242     1.801E-5       $
                      1241    6.706E-5       $
                      237     2.012E-6       $
```

```
                         16      4.574E-2
MATERIAL 12 -1 300 2  16      1.000E-10
MATERIAL 13 -1 300 2  91      4.248E-02      $Zr2 (density = 6.56 g/cc)
                      2191    4.899E-05      $No Sn in the library
                      1054    5.582E-06      $Element with af<0.1% are not used
                      56      8.763E-05      $except Hf
                      57      2.024E-06      $
                      158     2.693E-07      $
                      50      3.301E-06      $
                      52      6.366E-05      $
                      53      7.219E-06      $
                      54      1.797E-06      $
                      16      3.086E-04      $
                      1212    4.440E-05      $
                      178     1.107E-06
MATERIAL 14 -1 300 3  2001    6.674E-2       $Water
                      16      3.337E-2
MATERIAL 15 -1 300 2  27      5.457E-02      $AG3 (density = 2.55 g/cc)
                      24      1.959E-03      $No Zn in the library
                      55      6.988E-05      $
                      1054    3.215E-06      $
                      56      5.046E-05      $
                      57      1.165E-06      $
                      158     1.551E-07      $
                      50      1.925E-06      $
                      52      3.712E-05      $
                      53      4.209E-06      $
                      54      1.048E-06      $
                      48      2.406E-05      $
                      29      1.094E-04      $
                      63      8.358E-06      $
                      65      3.725E-06
*Cross section & flux solution
*S 32
BELL 1.16
*Printout control
PRTOPT  1
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS   1 1 1 1 1   0 0 0 0 0   0 0 0 0 0
VECTOR 6 14 34 47 55 60 69
*UO2 FUEL CELL
ISOTOPES       234 235 236 2238 16 2001 91 2191 1054 56 57   $
               158 50 52 53 54 1212 178 27 24 55 48 29 63 65
ISONAMES
DU4   DU5   DU6   DU8   DO    DH    DZr   DZH   DFe4  DFe6  DFe7  DFe8
DCr0  DCr2  DCr3  DCr4  DC    DHf   DAl   DMg   DMn   DTi   DSi   DCu3
DCu5
**Pu(3.6%) FUEL CELL
*ISOTOPES      234 235 2238 1238 3239 240 241 242 1241 237 16 $
*              2001 91 2191 1054 56 57 158 50 52 53 54 1212 $
*              178 27 24 55 48 29 63 65
*ISONAMES
*FU4   FU5   FU8   FPu8  FPu9  FPu0  FPu1  FPu2  FAm1  FNp7  FO    FH
*FZr   FZH   FFe4  FFe6  FFe7  FFe8  FCr0  FCr2  FCr3  FCr4  FC    FHf
*FAl   FMg   FMn   FTi   FSi   FCu3  FCu5
*
*Leakage calculation
*LEAKAGE 6 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1  0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 6  0. 0. 0. 4.665E-2 0. 0. 0.
*DNB 11 0. 0. 0. 4.665E-2 0. 0. 0.
*DNB 3  0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 8  0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 13 0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 4  0.06674 0. 0. 0.03337 0. 0. 0.
*DNB 9  0.06674 0. 0. 0.03337 0. 0. 0.
*DNB 14 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
```

```
*Miscellaneous Edit Control
BEGINC
```

File Pu(4)

```
* MINERVE - EXPERIMENTAL ZONE - MINERVE TYPE-III FUEL PIN Pu(4)
*
* Sn Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                  *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 5
NPLATE 0
NREGION 8 0 8
NMESH 150 150
NREACT 1
PREOUT
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
ANNULUS 1 0.4035 1     *Fuel
ANNULUS 2 0.41 2       *Void
ANNULUS 3 0.435 3      *Inner clad
ANNULUS 4 0.445 2      *Void
ANNULUS 5 0.47 3       *Outer clad
ANNULUS 6 0.485 4      *Water
ANNULUS 7 0.55 5       *Overclad
SQUARE  8 1.26 4       *Water
*Composition data
MATERIAL 1 -1 300 1    234    3.139E-6       $Pu(4)
                       235    1.581E-4       $
                       2238   2.180E-2       $
                       1238   7.223E-6       $
                       3239   6.382E-4       $
                       240    1.543E-4       $
                       241    2.133E-5       $
                       242    1.801E-5       $
                       1241   6.706E-5       $
                       237    2.012E-6       $
                       16     4.574E-2
MATERIAL 2 -1 300 2    16     1.000E-10
MATERIAL 3 -1 300 2    91     4.248E-02      $Zr2 (density = 6.56 g/cc)
                       2191   4.899E-05      $No Sn in the library
                       1054   5.582E-06      $Element with af<0.1% are not used
                       56     8.763E-05      $except Hf
                       57     2.024E-06      $
                       158    2.693E-07      $
                       50     3.301E-06      $
                       52     6.366E-05      $
                       53     7.219E-06      $
                       54     1.797E-06      $
                       16     3.086E-04      $
                       1212   4.440E-05      $
                       178    1.107E-06
MATERIAL 4 -1 300 3    2001   6.674E-2       $Water
                       16     3.337E-2
MATERIAL 5 -1 300 2    27     5.457E-02      $AG3 (density = 2.55 g/cc)
                       24     1.959E-03      $No Zn in the library
                       55     6.988E-05      $
                       1054   3.215E-06      $
                       56     5.046E-05      $
                       57     1.165E-06      $
                       158    1.551E-07      $
```

```
                      50      1.925E-06      $
                      52      3.712E-05      $
                      53      4.209E-06      $
                      54      1.048E-06      $
                      48      2.406E-05      $
                      29      1.094E-04      $
                      63      8.358E-06      $
                      65      3.725E-06
*Cross section & flux solution
S 32
MESH 20 10 10 10 10 40 10 40
BELL 1.16
*Printout control
PRTOPT  0                  $
       913 -11 -12 13 14 22 23 $
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS 1 1 1 1 1
VECTOR 6 14 34 47 55 60 69
ISOTOPES       234 235 2238 1238 3239 240 241 242 1241 237 16 $
               2001 91 2191 1054 56 57 158 50 52 53 54 1212 $
               178 27 24 55 48 29 63 65
ISONAMES
AU4   AU5   AU8   APu8  APu9  APu0  APu1  APu2  AAm1  ANp7  AO    AH
AZr   AZH   AFe4  AFe6  AFe7  AFe8  ACr0  ACr2  ACr3  ACr4  AC    AHf
AAl   AMg   AMn   ATi   ASi   ACu3  ACu5
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1 0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 3 0. 0. 0. 3.086E-4 0. 8.683E-6 0.
*DNB 4 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
*Miscellaneous Edit Control
BEGINC
```

File Pu(4)Ax

```
* MINERVE - EXPERIMENTAL ZONE - MINERVE TYPE-III FUEL PIN Pu(4) AXIAL VIEW
*
* Sn Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 5
NPLATE 1
NREGION 5 0 5
NMESH 130 130
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
```

```
*
INITIATE
*Geometry data
SLAB 1 25.0 1  *Fuel
SLAB 2 37.8 2  *Plexi
SLAB 3 38.4 3  *Zy2
SLAB 4 38.6 4  *SS
SLAB 5 39.6 5  *Styrene
*Composition data
MATERIAL 1 -1 300 1    234     3.139E-6       $Pu(4)
                       235     1.581E-4       $
                       2238    2.180E-2       $
                       1238    7.223E-6       $
                       3239    6.382E-4       $
                       240     1.543E-4       $
                       241     2.133E-5       $
                       242     1.801E-5       $
                       1241    6.706E-5       $
                       237     2.012E-6       $
                       16      4.574E-2
MATERIAL 2 -1 300 2    12       3.549E-02     $PLEXI (density = 1.18 g/cc)
                       2001     5.678E-02     $
                       16       1.420E-02
MATERIAL 3 -1 300 2    91      4.248E-02      $Zr2 (density = 6.56 g/cc)
                       2191    4.899E-05      $No Sn in the library
                       1054    5.582E-06      $Element with af<0.1% are not used
                       56      8.763E-05      $except Hf
                       57      2.024E-06      $
                       158     2.693E-07      $
                       50      3.301E-06      $
                       52      6.366E-05      $
                       53      7.219E-06      $
                       54      1.797E-06      $
                       16      3.086E-04      $
                       1212    4.440E-05      $
                       178     1.107E-06
MATERIAL 4 -1 300 3    1054     3.387E-03     $SS (density = 7.85 g/cc)
                       56       5.316E-02     $P and S are not used (af<0.1%)
                       57      1.228E-03      $
                       58      1.634E-04      $
                       12      5.904E-05      $
                       50      7.111E-04      $
                       52      1.371E-02      $
                       53      1.555E-03      $
                       54      3.870E-04      $
                       58      6.031E-03      $
                       60      2.323E-03      $
                       61      1.010E-04      $
                       62      3.220E-04      $
                       64      8.201E-05      $
                       55      8.605E-04      $
                       29      8.416E-04      $
                       4200    4.927E-04
MATERIAL 5 -1 300 2    2001    6.732E-02      $Styrene
                       1212    3.672E-02      $
                       14      6.120E-03      $
                       16      6.120E-03
*Cross section & flux solution
S 32
MESH 50 50 10 10 10
BELL 1.40
*Printout control
PRTOPT  0                   $
        913 -11 -12 13 14 22 23 $
        915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS 0 0 0 1 1
VECTOR 6 14 34 47 55 60 69
ISOTOPES 58 60 61 62 64 4200 14
ISONAMES
ANi8  ANi0  ANi1  ANi2  ANi4  AMo   AN
```

```
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1 0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 3 0. 0. 0. 3.086E-4 0. 8.683E-6 0.
*DNB 4 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION  58 300
*Miscellaneous Edit Control
BEGINC
```

File UPu

```
* MINERVE - EXPERIMENTAL ZONE - MINERVE INTERFACE TYPE-II AND TYPE-I FUEL PINS U(3)/Pu(4)
*
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 2
NGROUPS 69 2 7
NCELLS 2
NMATERIAL 10
NPLATE 0
NREGION 14 0 14
NMESH 180 180
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
*
INITIATE
*
*UO2 FUEL CELL
CELL 1 1
ANNULUS 1 0.4023 1     *Fuel
ANNULUS 2 0.41 2       *Void
ANNULUS 3 0.47 3       *Clad
ANNULUS 4 0.485 4      *Water
ANNULUS 5 0.55 5       *Overclad
SQUARE  6 1.26 4       *Water
MESH 10 5 5 20 5 20
PCELL 1 (0.0 1.0)
*
*Pu(4.0%) FUEL CELL
CELL 2 1
ANNULUS 1 0.4035 6     *Fuel
ANNULUS 2 0.41 7       *Void
ANNULUS 3 0.435 8      *Inner clad
ANNULUS 4 0.445 7      *Void
ANNULUS 5 0.47 8       *Outer clad
ANNULUS 6 0.485 9      *Water
ANNULUS 7 0.55 10      *Overclad
SQUARE  8 1.26 9       *Water
MESH 10 5 5 5 5 20 5 20
PCELL 2 (1.0 0.0)
*
*Composition data
*UO2 FUEL CELL
MATERIAL 1 -1 300 1    234    4.617E-6      $U(3)
                       235    6.900E-4      $
                       236    5.493E-6      $
                       2238   2.200E-2      $
                       16     4.647E-2
MATERIAL 2 -1 300 2    16     1.000E-10
MATERIAL 3 -1 300 2    91     4.247E-02     $Zr4 (density = 6.56 g/cc)
```

```
                      2191   4.899E-05      $No Sn in the library
                      1054   8.683E-06      $Element with af<0.1% are not used
                      56     1.363E-04      $except Hf
                      57     3.148E-06      $
                      158    4.189E-07      $
                      50     3.301E-06      $
                      52     6.366E-05      $
                      53     7.219E-06      $
                      54     1.797E-06      $
                      16     3.086E-04      $
                      1212   4.440E-05      $
                      178    1.107E-06
MATERIAL 4 -1 300 3   2001   6.674E-2       $Water
                      16     3.337E-2
MATERIAL 5 -1 300 2   27     5.457E-02      $AG3 (density = 2.55 g/cc)
                      24     1.959E-03      $No Zn in the library
                      55     6.988E-05      $
                      1054   3.215E-06      $
                      56     5.046E-05      $
                      57     1.165E-06      $
                      158    1.551E-07      $
                      50     1.925E-06      $
                      52     3.712E-05      $
                      53     4.209E-06      $
                      54     1.048E-06      $
                      48     2.406E-05      $
                      29     1.094E-04      $
                      63     8.358E-06      $
                      65     3.725E-06
*Pu(4%) FUEL CELL
MATERIAL 6 -1 300 1   234    3.139E-6       $Pu(4)
                      235    1.581E-4       $
                      2238   2.180E-2       $
                      1238   7.223E-6       $
                      3239   6.382E-4       $
                      240    1.543E-4       $
                      241    2.133E-5       $
                      242    1.801E-5       $
                      1241   6.706E-5       $
                      237    2.012E-6       $
                      16     4.574E-2
MATERIAL 7 -1 300 2   16     1.000E-10
MATERIAL 8 -1 300 2   91     4.248E-02      $Zr2 (density = 6.56 g/cc)
                      2191   4.899E-05      $No Sn in the library
                      1054   5.582E-06      $Element with af<0.1% are not used
                      56     8.763E-05      $except Hf
                      57     2.024E-06      $
                      158    2.693E-07      $
                      50     3.301E-06      $
                      52     6.366E-05      $
                      53     7.219E-06      $
                      54     1.797E-06      $
                      16     3.086E-04      $
                      1212   4.440E-05      $
                      178    1.107E-06
MATERIAL 9 -1 300 3   2001   6.674E-2       $Water
                      16     3.337E-2
MATERIAL 10 -1 300 2  27     5.457E-02      $AG3 (density = 2.55 g/cc)
                      24     1.959E-03      $No Zn in the library
                      55     6.988E-05      $
                      1054   3.215E-06      $
                      56     5.046E-05      $
                      57     1.165E-06      $
                      158    1.551E-07      $
                      50     1.925E-06      $
                      52     3.712E-05      $
                      53     4.209E-06      $
                      54     1.048E-06      $
                      48     2.406E-05      $
                      29     1.094E-04      $
                      63     8.358E-06      $
                      65     3.725E-06
*
*Cross section & flux solution
*S 32
BELL 1.16
*Printout control
PRTOPT 1
BEGINC
*
*                   *****EDIT INPUT DATA******
```

```
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS   0 0 0 0 0   1 1 1 1 1
VECTOR 6 14 34 47 55 60 69
**UO2 FUEL CELL
*ISOTOPES      234 235 236 2238 16 2001 91 2191 1054 56 57   $
*              158 50 52 53 54 1212 178 27 24 55 48 29 63 65
*ISONAMES
*DU4   DU5   DU6   DU8   DO    DH    DZr   DZH   DFe4  DFe6  DFe7  DFe8
*DCr0  DCr2  DCr3  DCr4  DC    DHf   DAl   DMg   DMn   DTi   DSi   DCu3
*DCu5
*
*Pu(4.0%) FUEL CELL
ISOTOPES       234 235 2238 1238 3239 240 241 242 1241 237 16 $
               2001 91 2191 1054 56 57 158 50 52 53 54 1212 $
               178 27 24 55 48 29 63 65
ISONAMES
BU4   BU5   BU8   BPu8  BPu9  BPu0  BPu1  BPu2  BAm1  BNp7  BO    BH
BZr   BZH   BFe4  BFe6  BFe7  BFe8  BCr0  BCr2  BCr3  BCr4  BC    BHf
BAl   BMg   BMn   BTi   BSi   BCu3  BCu5
*
*Leakage calculation
*LEAKAGE 6 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1  0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 6  0. 0. 0. 4.665E-2 0. 0. 0.
*DNB 11 0. 0. 0. 4.665E-2 0. 0. 0.
*DNB 3  0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 8  0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 13 0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 4  0.06674 0. 0. 0.03337 0. 0. 0.
*DNB 9  0.06674 0. 0. 0.03337 0. 0. 0.
*DNB 14 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
*Miscellaneous Edit Control
BEGINC
```

File PuPOL

```
* MINERVE - EXPERIMENTAL ZONE - INTERFACE MINERVE TYPE-III FUEL PIN Pu(4) - POLINE
*
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                  *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 1
NGROUPS 69 2 7
NMATERIAL 6
NPLATE 0
NREGION 9 0 9
NMESH 230 230
NREACT 1
PREOUT
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*Geometry data
ANNULUS 1 0.4035 1     *Fuel
ANNULUS 2 0.41 2       *Void
```

```
ANNULUS 3 0.435 3      *Inner clad
ANNULUS 4 0.445 2      *Void
ANNULUS 5 0.47 3       *Outer clad
ANNULUS 6 0.485 4      *Water
ANNULUS 7 0.55 5       *Overclad
SQUARE  8 1.26 4       *Water
SQUARE  9 3.78 6        *Homogenized buffer
*Composition data
MATERIAL 1 -1 300 1    234     3.139E-6       $Pu(4)
                       235     1.581E-4       $
                       2238    2.180E-2       $
                       1238    7.223E-6       $
                       3239    6.382E-4       $
                       240     1.543E-4       $
                       241     2.133E-5       $
                       242     1.801E-5       $
                       1241    6.706E-5       $
                       237     2.012E-6       $
                       16      4.574E-2
MATERIAL 2 -1 300 2    16      1.000E-10
MATERIAL 3 -1 300 2    91      4.248E-02      $Zr2 (density = 6.56 g/cc)
                       2191    4.899E-05      $No Sn in the library
                       1054    5.582E-06      $Element with af<0.1% are not used
                       56      8.763E-05      $except Hf
                       57      2.024E-06      $
                       158     2.693E-07      $
                       50      3.301E-06      $
                       52      6.366E-05      $
                       53      7.219E-06      $
                       54      1.797E-06      $
                       16      3.086E-04      $
                       1212    4.440E-05      $
                       178     1.107E-06
MATERIAL 4 -1 300 3    2001    6.674E-2       $Water
                       16      3.337E-2
MATERIAL 5 -1 300 2    27      5.457E-02      $AG3 (density = 2.55 g/cc)
                       24      1.959E-03      $No Zn in the library
                       55      6.988E-05      $
                       1054    3.215E-06      $
                       56      5.046E-05      $
                       57      1.165E-06      $
                       158     1.551E-07      $
                       50      1.925E-06      $
                       52      3.712E-05      $
                       53      4.209E-06      $
                       54      1.048E-06      $
                       48      2.406E-05      $
                       29      1.094E-04      $
                       63      8.358E-06      $
                       65      3.725E-06
MATERIAL 6 -1 300 1    234     8.847E-07      $ Homogenized material 7/8 Pu(4%) and 1/8
POLINE overclad
                       234     8.847E-07      $
                       235     4.456E-05      $
                       2238    6.144E-03      $
                       1238    2.036E-06      $
                       3239    1.799E-04      $
                       240     4.349E-05      $
                       241     6.012E-06      $
                       242     5.076E-06      $
                       1241    1.890E-05      $
                       237     5.671E-07      $
                       16      2.727E-02      $
                       91      3.238E-03      $
                       2191    3.734E-06      $
                       1054    8.921E-07      $
                       56      1.400E-05      $
                       57      3.234E-07      $
                       158     4.304E-08      $
                       50      4.863E-07      $
                       52      9.378E-06      $
                       53      1.063E-06      $
                       54      2.647E-07      $
                       1212    3.384E-06      $
                       178     8.437E-08      $
                       2001    2.872E-02      $
                       27      7.229E-03      $
                       24      2.354E-04      $
                       55      1.135E-05      $
                       48      2.802E-06      $
                       29      1.722E-05      $
```

```
                      63      1.040E-06      $
                      65      4.634E-07
*Cross section & flux solution
S 32
MESH 20 10 10 10 10 40 10 40 80
BELL 1.16
*Printout control
PRTOPT  0                       $
        913 -11 -12 13 14 22 23 $
        915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS 1 1 1 1 1 0
VECTOR 6 14 34 47 55 60 69
ISOTOPES       234 235 2238 1238 3239 240 241 242 1241 237 16 $
               2001 91 2191 1054 56 57 158 50 52 53 54 1212 $
               178 27 24 55 48 29 63 65
ISONAMES
PU4   PU5   PU8   PPu8  PPu9  PPu0  PPu1  PPu2  PAm1  PNp7  PO    PH
PZr   PZH   PFe4  PFe6  PFe7  PFe8  PCr0  PCr2  PCr3  PCr4  PC    PHf
PAl   PMg   PMn   PTi   PSi   PCu3  PCu5
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1 0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 3 0. 0. 0. 3.086E-4 0. 8.683E-6 0.
*DNB 4 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
*Miscellaneous Edit Control
BEGINC
```

File UPuPu2

```
* MINERVE - EXPERIMENTAL ZONE - MINERVE INTERFACE TYPE-II AND TYPE-III FUEL PINS
U(3)/Pu(3.6)/Pu(4)
*
* Sn Flux Spectrum Calculation
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Macroscopic Cross-sections
*
*NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
*NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                 *****PRELUDE INPUT DATA******
CELL 6
SEQUENCE 2
NGROUPS 69 2 7
NCELLS 3
NMATERIAL 15
NPLATE 0
NREGION 15 0 22
NMESH 215 215
NREACT 1
PREOUT
*
*                  *****MAIN INPUT DATA******
*
INITIATE
*
*UO2 FUEL CELL
```

```
CELL 1 1
ANNULUS 1 0.4023 1     *Fuel
ANNULUS 2 0.41 2       *Void
ANNULUS 3 0.47 3       *Clad
ANNULUS 4 0.485 4      *Water
ANNULUS 5 0.55 5       *Overclad
SQUARE  6 1.26 4       *Water
MESH 10 5 5 20 5 20
PCELL 1 (0.0 1.0 0.0)
*
*Pu(3.6%) FUEL CELL
CELL 2 1
ANNULUS 1 0.4035 6     *Fuel
ANNULUS 2 0.41 7       *Void
ANNULUS 3 0.435 8      *Inner clad
ANNULUS 4 0.445 7      *Void
ANNULUS 5 0.47 8       *Outer clad
ANNULUS 6 0.485 9      *Water
ANNULUS 7 0.55 10      *Overclad
SQUARE  8 1.26 9       *Water
MESH 10 5 5 5 5 20 5 20
PCELL 2 (0.5 0.0 0.5)
*
*Pu(4.0%) FUEL CELL
CELL 3 1
ANNULUS 1 0.4035 11    *Fuel
ANNULUS 2 0.41 12      *Void
ANNULUS 3 0.435 13     *Inner clad
ANNULUS 4 0.445 12     *Void
ANNULUS 5 0.47 13      *Outer clad
ANNULUS 6 0.485 14     *Water
ANNULUS 7 0.55 15      *Overclad
SQUARE  8 1.26 14      *Water
MESH 10 5 5 5 5 20 5 20
PCELL 3 (0.0 1.0 0.0)
*
*Composition data
*UO2 FUEL CELL
MATERIAL 1 -1 300 1    234     4.617E-6       $U(3)
                       235     6.900E-4       $
                       236     5.493E-6       $
                       2238    2.200E-2       $
                       16      4.647E-2
MATERIAL 2 -1 300 2    16      1.000E-10
MATERIAL 3 -1 300 2    91      4.247E-02      $Zr4 (density = 6.56 g/cc)
                       2191    4.899E-05      $No Sn in the library
                       1054    8.683E-06      $Element with af<0.1% are not used
                       56      1.363E-04      $except Hf
                       57      3.148E-06      $
                       158     4.189E-07      $
                       50      3.301E-06      $
                       52      6.366E-05      $
                       53      7.219E-06      $
                       54      1.797E-06      $
                       16      3.086E-04      $
                       1212    4.440E-05      $
                       178     1.107E-06
MATERIAL 4 -1 300 3    2001    6.674E-2       $Water
                       16      3.337E-2
MATERIAL 5 -1 300 2    27      5.457E-02      $AG3 (density = 2.55 g/cc)
                       24      1.959E-03      $No Zn in the library
                       55      6.988E-05      $
                       1054    3.215E-06      $
                       56      5.046E-05      $
                       57      1.165E-06      $
                       158     1.551E-07      $
                       50      1.925E-06      $
                       52      3.712E-05      $
                       53      4.209E-06      $
                       54      1.048E-06      $
                       48      2.406E-05      $
                       29      1.094E-04      $
                       63      8.358E-06      $
                       65      3.725E-06
*Pu(3.6%) FUEL CELL
MATERIAL 6 -1 300 1    234     2.951E-6       $Pu(3.6)
                       235     1.588E-4       $
                       2238    2.189E-2       $
                       1238    6.501E-6       $
                       3239    5.743E-4       $
                       240     1.389E-4       $
```

```
                        241     1.920E-5       $
                        242     1.621E-5       $
                        1241    6.036E-5       $
                        237     1.811E-6       $
                        16      4.574E-2
MATERIAL 7 -1 300 2     16      1.000E-10
MATERIAL 8 -1 300 2     91      4.248E-02      $Zr2 (density = 6.56 g/cc)
                        2191    4.899E-05      $No Sn in the library
                        1054    5.582E-06      $Element with af<0.1% are not used
                        56      8.763E-05      $except Hf
                        57      2.024E-06      $
                        158     2.693E-07      $
                        50      3.301E-06      $
                        52      6.366E-05      $
                        53      7.219E-06      $
                        54      1.797E-06      $
                        16      3.086E-04      $
                        1212    4.440E-05      $
                        178     1.107E-06
MATERIAL 9 -1 300 3     2001    6.674E-2       $Water
                        16      3.337E-2
MATERIAL 10 -1 300 2    27      5.457E-02      $AG3 (density = 2.55 g/cc)
                        24      1.959E-03      $No Zn in the library
                        55      6.988E-05      $
                        1054    3.215E-06      $
                        56      5.046E-05      $
                        57      1.165E-06      $
                        158     1.551E-07      $
                        50      1.925E-06      $
                        52      3.712E-05      $
                        53      4.209E-06      $
                        54      1.048E-06      $
                        48      2.406E-05      $
                        29      1.094E-04      $
                        63      8.358E-06      $
                        65      3.725E-06
*Pu(4.0%) FUEL CELL
MATERIAL 11 -1 300 1    234     3.139E-6       $Pu(4)
                        235     1.581E-4       $
                        2238    2.180E-2       $
                        1238    7.223E-6       $
                        3239    6.382E-4       $
                        240     1.543E-4       $
                        241     2.133E-5       $
                        242     1.801E-5       $
                        1241    6.706E-5       $
                        237     2.012E-6       $
                        16      4.574E-2
MATERIAL 12 -1 300 2    16      1.000E-10
MATERIAL 13 -1 300 2    91      4.248E-02      $Zr2 (density = 6.56 g/cc)
                        2191    4.899E-05      $No Sn in the library
                        1054    5.582E-06      $Element with af<0.1% are not used
                        56      8.763E-05      $except Hf
                        57      2.024E-06      $
                        158     2.693E-07      $
                        50      3.301E-06      $
                        52      6.366E-05      $
                        53      7.219E-06      $
                        54      1.797E-06      $
                        16      3.086E-04      $
                        1212    4.440E-05      $
                        178     1.107E-06
MATERIAL 14 -1 300 3    2001    6.674E-2       $Water
                        16      3.337E-2
MATERIAL 15 -1 300 2    27      5.457E-02      $AG3 (density = 2.55 g/cc)
                        24      1.959E-03      $No Zn in the library
                        55      6.988E-05      $
                        1054    3.215E-06      $
                        56      5.046E-05      $
                        57      1.165E-06      $
                        158     1.551E-07      $
                        50      1.925E-06      $
                        52      3.712E-05      $
                        53      4.209E-06      $
                        54      1.048E-06      $
                        48      2.406E-05      $
                        29      1.094E-04      $
                        63      8.358E-06      $
                        65      3.725E-06
*Cross section & flux solution
*S 32
```

```
BELL 1.16
*Printout control
PRTOPT 1
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE

HSETID

*Microscopic ISOTXS control
EDITCELLS   0 0 0 0 0   1 1 1 1 1   0 0 0 0 0
VECTOR 6 14 34 47 55 60 69
**UO2 FUEL CELL
*ISOTOPES      234 235 236 2238 16 2001 91 2191 1054 56 57   $
*              158 50 52 53 54 1212 178 27 24 55 48 29 63 65
*ISONAMES
*DU4   DU5   DU6   DU8   DO    DH    DZr   DZH   DFe4  DFe6  DFe7  DFe8
*DCr0  DCr2  DCr3  DCr4  DC    DHf   DAl   DMg   DMn   DTi   DSi   DCu3
*DCu5
*Pu(3.6%) FUEL CELL
ISOTOPES       234 235 2238 1238 3239 240 241 242 1241 237 16 $
               2001 91 2191 1054 56 57 158 50 52 53 54 1212 $
               178 27 24 55 48 29 63 65
ISONAMES
FU4   FU5   FU8   FPu8  FPu9  FPu0  FPu1  FPu2  FAm1  FNp7  FO    FH
FZr   FZH   FFe4  FFe6  FFe7  FFe8  FCr0  FCr2  FCr3  FCr4  FC    FHf
FAl   FMg   FMn   FTi   FSi   FCu3  FCu5
*
*Leakage calculation
*LEAKAGE 6 1
*BUCKLING 1.E-15 1.E-15
*BEEONE 1
*DNB 1  0. 0. 0. 4.647E-2 0. 0. 0.
*DNB 6  0. 0. 0. 4.665E-2 0. 0. 0.
*DNB 11 0. 0. 0. 4.665E-2 0. 0. 0.
*DNB 3  0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 8  0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 13 0. 0. 0. 3.086E-4 0. 4.899E-5 0.
*DNB 4  0.06674 0. 0. 0.03337 0. 0. 0.
*DNB 9  0.06674 0. 0. 0.03337 0. 0. 0.
*DNB 14 0.06674 0. 0. 0.03337 0. 0. 0.
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 234 300 236 300 16 300
*Miscellaneous Edit Control
BEGINC
```

File Sample

```
* MINERVE - EXPERIMENTAL ZONE - MINERVE TYPE-II FUEL PIN U(3)
* SAMPLE N0071 : 0.71% of U-235
* Diameter = 0.80943 mm
*
* 69 Main Transport Groups
* 2 Groups Reaction Rate Edits
* 7 Groups ISOTXS Microscopic Cross-sections
*
* NO Leakage: Axial Buckling = 1E-15 and Radial Buckling adjust to achieve criticality
* NO Beeone : To improve the diffusion coefficient treatment
* Al from the ENDF-BIV library
*
* All material cross section in the ISOTXS file
*
*                 *****PRELUDE INPUT DATA******
CELL 8
SEQUENCE 1
NGROUPS 69 2 7
NCELL 2
NMATERIAL 8
NREGION 17 0 17
NMESH 100 100
NREACT 1
PREOUT
```

```
*
*                   *****MAIN INPUT DATA******
*
INITIATE
*
*SUPERCELL 1 : All
CELL 1 1 1 1
CSPECTRUM -1
*Geometry data
ANNULUS 1 0.404715 7
ANNULUS 2 0.418 2
ANNULUS 3 0.478 3
ANNULUS 4 0.510 2
ANNULUS 5 0.530 3
ANNULUS 6 0.550 4
ANNULUS 7 0.600 6
ANNULUS 8 0.711 4
ANNULUS 9 12.6  8
MESH 5 2 4 2 4 6 4 6 20
*
*SUPERCELL 2 : Homogenized fuel with resonance treatment included
*Standard PU(4%) pin
CELL 2 1 1 0
CSPECTRUM 2
*Geometry data
ANNULUS 1 0.4035 1     *Fuel
ANNULUS 2 0.41 2       *Void
ANNULUS 3 0.435 3      *Inner clad
ANNULUS 4 0.445 2      *Void
ANNULUS 5 0.47 3       *Outer clad
ANNULUS 6 0.485 4      *Water
ANNULUS 7 0.55 5       *Overclad
SQUARE  8 1.26 4       *Water
MESH 5 2 4 2 4 6 4 20
*
*Assigning spectrum to material + homogeneization
NEWXS 1 -1 2
NEWXS 2 -1 2
NEWXS 3 -1 2
NEWXS 4 -1 2
NEWXS 5 -1 2
NEWXS 6 -1 2
NEWXS 7 -1 2
NEWXS 8  1 2 1 2 3 4 5
*Composition data
MATERIAL 1 -1 300 1   234     3.139E-6       $Pu(4)
                      235     1.581E-4       $
                      2238    2.180E-2       $
                      1238    7.223E-6       $
                      3239    6.382E-4       $
                      240     1.543E-4       $
                      241     2.133E-5       $
                      242     1.801E-5       $
                      1241    6.706E-5       $
                      237     2.012E-6       $
                      16      4.574E-2
MATERIAL 2 -1 300 2   16      1.000E-8
MATERIAL 3 -1 300 2   91      4.248E-02      $Zr2 (density = 6.56 g/cc)
                      2191    4.899E-05      $No Sn in the library
                      1054    5.582E-06      $Element with af<0.1% are not used
                      56      8.763E-05      $except Hf
                      57      2.024E-06      $
                      158     2.693E-07      $
                      50      3.301E-06      $
                      52      6.366E-05      $
                      53      7.219E-06      $
                      54      1.797E-06      $
                      16      3.086E-04      $
                      1212    4.440E-05      $
                      178     1.107E-06
MATERIAL 4 -1 300 3   2001    6.674E-2       $Water
                      16      3.337E-2
MATERIAL 5 -1 300 2   27      5.457E-02      $AG3 (density = 2.55 g/cc)
                      24      1.959E-03      $No Zn in the library
                      55      6.988E-05      $
                      1054    3.215E-06      $
                      56      5.046E-05      $
                      57      1.165E-06      $
                      158     1.551E-07      $
                      50      1.925E-06      $
                      52      3.712E-05      $
```

```
                      53      4.209E-06      $
                      54      1.048E-06      $
                      48      2.406E-05      $
                      29      1.094E-04      $
                      63      8.358E-06      $
                      65      3.725E-06
MATERIAL 6 -1 300 2   1054     3.387E-03     $SS (density = 7.85 g/cc)
                      56       5.316E-02     $P and S are not used (af<0.1%)
                      57      1.228E-03      $
                      58      1.634E-04      $
                      12      5.904E-05      $
                      50      7.111E-04      $
                      52      1.371E-02      $
                      53      1.555E-03      $
                      54      3.870E-04      $
                      58      6.031E-03      $
                      60      2.323E-03      $
                      61      1.010E-04      $
                      62      3.220E-04      $
                      64      8.201E-05      $
                      55      8.605E-04      $
                      29      8.416E-04      $
                      4200    4.927E-04
MATERIAL 7 -1 300 1   234     1.2896E-06     $Sample (composition of C. Doderlin)
                      235     1.6656E-04     $
                      236     1.1723E-07     $
                       2238    2.3279E-02       $
                      16      4.6947E-02
MATERIAL 8 -1 300 1   235     1.000E-15      *Material for homogeneization
*
*Cross section & flux solution
BELL 1.16
*Printout control
PRTOPT  0                   $
       913 -11 -12 13 14 22 23 $
       915 -4 6 7 -11 12 13 14
SUPPRESS 0 0 0 0 1 1 1 1 1 1 1 1 0 1 0 0
BEGINC
*
*                  *****EDIT INPUT DATA******
*Micro and Macroscopic ISOTXS control
ISOXS 0 1 0 0 0 1 0 0
HUSE
SAMPLE
HSETID
MINERVE oscillaiton sample
*Microscopic ISOTXS control
EDITCELLS 0 0 0 0 0 0 1 0
VECTOR 6 14 34 47 55 60 69
ISOTOPES 234 235 236 2238 16
ISONAMES
SAU4  SAU5  SAU6  SAU8  SAO
*Leakage calculation
*LEAKAGE 8 1
*BUCKLING 1.E-15 1.E-15
*Reaction Rate Edits
PARTITION  45 69
REACTION 235 300 2238 300 16 300
*Miscellaneous Edit Control
BEGINC
```

Appendix 4: Elemental compositions

Table A1-1: Iron	
Element	Abundance (atom %)
Fe-54	5.845
Fe-56	91.754
Fe-57	2.119
Fe-58	0.282
Fe	100

Table A1-2: Chromium	
Element	Abundance (atom %)
Cr-50	4.345
Cr-52	83.789
Cr-53	9.501
Cr-54	2.365
Cr	100

Table A1-3: Nickel	
Element	Abundance (atom %)
Ni-58	68.0769
Ni-60	26.2231
Ni-61	1.1399
Ni-62	3.6345
Ni-64	0.9256
Ni	100

Table A1-4: Copper	
Element	Abundance (atom %)
Cu-63	69.17
Cu-65	30.83
Ni	100