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BNL-1987

Subject Category: PHYSICS

UNITED STATES ATOMIC ENERGY COMMISSION

INTRACELL FLUX TRAVERSES AND THERMAL UTILIZATIONS FOR 1.15% ENRICHED URANIUM RODS IN ORDINARY WATER

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August 11, 1954

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Work performed under Contract No. AT-30-2-Gen-16.

Date Declassified: October 31, 1955.

Printed in USA, Price 30 cents. Available from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

INTRACELL FLUX TRAVERSES AND THERMAL UTILIZATIONS FOR 1.15% ENRICHED URANIUM RODS IN ORDINARY WATER

By Herbert Kouts

Abstract: The measurements reported are those of the spacial distribution of thermal neutrons in typical lattice cells of slightly enriched uranium rod-ordinary water assemblies. Flux traverses were made both with pure water and boron poisoned water for the moderator. The detectors used were small foils of dysprosium oxide dispersed in lucite or polyethelene.

Experimental Methods: These measurements were begun after completion of those done with 1.3% enriched rods (reported in BNL Log No. C-7568). They were stopped temporarily to permit rushing through work with the 1% enriched rods (BNL Log No. C-7931), and were then resumed later.

As a result, the first intracells were done with the lucite-dysprosium foils foils mentioned in C-7568, and the last set was done with the polyethelene-dysprosium foils mentioned in C-7931.

The experimental procedures used throughout are described in the above-mentioned reports.

Results: The measured flux plots are shown in figures 1-16, with each curve so normalized as to give the value 1.00 at the center of the fuel rod. The values of the fluxes measured by the individual foils are listed in tables I-XV, normalized the same way as are the curves.

In each case flux averages for the uranium and the water were calculated;

these are listed in table XVI, and are plotted figure 16 as a function of volume ratio for the unpoisoned lattices. The flux averages in the uranium were calculated from numerical integration of

$$\bar{\phi}_u = \frac{2}{R^2} \int_0^R \phi\,(r)\, r\,dr$$

The flux averages in the water were calculated by numerical integration of

$$\bar{\phi}_w = \frac{2}{R_1^2 - R_o^2} \int_{R_o}^{R_1} \phi\,(r)\, r\,dr$$

ϕ (r) being the average of the fluxes on the two lines along which traverses were taken, with R_o the outer diameter of the aluminum rod cladding, and R_1 the radius of the cylinder having an area equal to that of the basic hexagonal lattice cell. Table XVI also gives the metal and moderator disadvantage factors computed from $\bar{\phi}_u$ and $\bar{\phi}_w$.

Thermal utilizations were calculated according to

$$f = \frac{\bar{\phi}_u \Sigma_u}{\bar{\phi}_u \Sigma_u + \bar{\phi}_w (\Sigma_w + \Sigma_b) V_w + \bar{\phi}_{al} \Sigma_{al} V_{al}}$$

Here u, w, al, b refer respectively to uranium, water, aluminum, and boron. The Σ's are the corresponding macroscopic absorption cross-sections, and V_w, V_{al} are respectively the water-to-uranium and the aluminum-to-uranium volume ratios. The constants assumed are:

Σ_u = .4445 cm^{-1}

Σ_w = .0195 cm^{-1}

Σ_{al} = .0115

Σ_b = .01150 for 1 mg B_2O_3/Ml H_2O

Table XVI lists also the thermal utilizations obtained from these calculations. The values of f for the clean lattices are plotted as a function of volume ratio in figure 17. Figure 18 gives values of f as a function of boron concentration in the moderator for the different volume ratios.

Since the polyethelene foils disintegrated at the end of this set of measurements, it was not possible to obtain a good intracell in the 1:1 volume ratio lattice with clean water. However, measurements made in the lattices with other volume ratios show that the flux plots are not greatly changed by the addition of the boron, and so we have listed where applicable a value of f for the 1:1 lattice based on the flux plot made with poisoned water. The error cannot be large, because for this tight lattice f does not depend strongly on the flux average in the moderator.

Table I

Intracell Flux Distribution, .600 Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. 2.950 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.000	Flux
.084	1.012	in
.167	1.048	Uranium
.250	1.138	
.378	1.315	Flux in
.478	1.383	Water
.578	1.371	(Diagonal)
.677	1.342	
.779	1.386	
.379	1.275	Flux in
.479	1.305	Water
		(Center-to-center)

Table II

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. Unpoisoned.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.000	Flux
.084	1.017	in
.167	1.068	Uranium
.250	1.179	
.372	1.398	Flux in
.438	1.467	Water
.504	1.525	(Diagonal)
.569	1.519	
.634	1.524	
.700	1.511	
.765	1.491	
.831	1.541	
.381	1.424	Flux in
.442	1.501	Water
.508	1.499	(Center-to-center)
.578	1.405	

Table III

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. .993 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.004	Flux
.084	1.017	in
.167	1.086	Uranium
.250	1.185	
.378	1.392	Flux in
.442	1.501	Water
.507	1.520	(Diagonal)
.573	1.521	
.639	1.523	
.704	1.506	
.770	1.479	
.831	1.524	
.370	1.387	Flux in
.434	1.494	Water
.498	1.464	(Center-to-center)
.564	1.371	

Table IV

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. 2.022 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.008	Flux
.084	1.013	in
.167	1.056	Uranium
.250	1.152	
.372	1.424	Flux in
.438	1.428	Water
.504	1.491	(Diagonal)
.569	1.540	
.634	1.505	
.700	1.500	
.765	1.464	
.831	1.498	
.381	1.376	Flux in
.442	1.443	Water
.508	1.460	(Center-to-center)
.578	1.374	

Table V

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. 2.950 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	.941	Flux
.083	1.017	in
.167	1.066	Uranium
.250	1.149	
.372	1.323	Flux in
.438	1.389	Water
.504	1.452	(Diagonal)
.569	1.468	
.634	1.473	
.700	1.481	
.765	1.479	
.831	1.444	
.381	1.327	Flux in
.442	1.422	Water
.508	1.424	(Center-to-center)
.578	1.323	

Table VI

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. Unpoisoned.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	.982	Flux
.084	1.013	in
.167	1.053	Uranium
.250	1.148	
.376	1.447	Flux in
.445	1.555	Water
.518	1.604	(Diagonal)
.590	1.616	
.659	1.572	
.730	1.578	
.798	1.591	
.868	1.579	
.375	1.447	Flux in
.445	1.568	Water
.514	1.592	(Center-to-center)
.583	1.565	
.655	1.423	

Table VII

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. Unpoisoned.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	.979	Flux
.083	1.019	in
.167	1.080	Uranium
.250	1.171	
.376	1.413	Flux in
.445	1.535	Water
.518	1.639	(Diagonal)
.590	1.587	
.659	1.608	
.730	1.594	
.798	1.553	
.868	1.615	
.375	1.440	Flux in
.445	1.559	Water
.514	1.595	(Center-to-center)
.583	1.548	
.655	1.473	

Table VIII

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. 1.911 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.000	Flux
.084	1.028	in
.167	1.069	Uranium
.250	1.178	
.376	1.377	Flux in
.445	1.489	Water
.518	1.479	(Diagonal)
.590	1.591	
.659	1.587	
.730	1.522	
.798	1.500	
.868	1.530	
.375	1.383	Flux in
.445	1.503	Water
.514	1.539	(Center-to-center)
.583	1.528	
.655	1.415	

Table IX

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. 2.920 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.017	Flux
.084	1.015	in
.167	1.052	Uranium
.250	1.151	
.376	1.350	Flux in
.445	1.436	Water
.518	1.513	(Diagonal)
.590	1.521	
.659	1.528	
.730	1.547	
.798	1.557	
.868	1.571	
.375	1.320	Flux in
.445	1.501	Water
.514	1.507	(Center-to-center)
.583	1.409	
.665	1.372	

Table X

Intracell Flux Distribution, .600" Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. Unpoisoned.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.000	Flux
.084	1.025	in
.167	1.080	Uranium
.250	1.182	
.375	1.412	Flux in
.444	1.550	Water
.513	1.631	(Diagonal)
.582	1.666	
.654	1.688	
.723	1.705	
.793	1.700	
.866	1.685	
.934	1.659	
1.006	1.691	
.370	1.386	Flux in
.441	1.587	Water
.512	1.598	(Center-to-center)
.581	1.660	
.651	1.678	
.721	1.626	
.791	1.491	

Table XI

Intracell Flux Distribution, .600 Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. 1.300 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.000	Flux
.084	1.016	in
.167	1.065	Uranium
.250	1.190	
.375	1.454	Flux in
.444	1.536	Water
.513	1.633	(Diagonal)
.582	1.617	
.654	1.695	
.723	1.742	
.793	1.761	
.866	1.762	
.934	1.808	
1.006	1.713	
.370	1.436	Flux in
.441	1.569	Water
.512	1.656	(Center-to-center)
.581	1.678	
.651	1.602	
.721	1.591	
.791	1.452	

Table XII

Intracell Flux Distribution, .600 Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. Unpoisoned.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.000	Flux
.084	1.012	in
.167	1.076	Uranium
.250	1.172	
.372	1.432	Flux in
.463	1.600	Water
.552	1.671	(Diagonal)
.644	1.707	
.734	1.763	
.824	1.740	
.914	1.753	
1.002	1.745	
1.094	1.746	
.377	1.462	Flux in
.469	1.658	Water
.558	1.701	(Center-to-center)
.648	1.744	
.738	1.730	
.829	1.612	
.918	1.454	

Table XIII

Intracell Flux Distribution, .600 Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. .344 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	.991	Flux
.084	1.036	in
.167	1.084	Uranium
.250	1.211	
.372	1.452	Flux in
.463	1.651	Water
.552	1.694	(Diagonal)
.644	1.775	
.734	1.787	
.824	1.774	
.914	1.814	
1.002	1.895	
1.094	1.898	
.377	1.453	Flux in
.469	1.611	Water
.558	1.687	(Center-to-center)
.648	1.752	
.738	1.749	
.829	1.651	
.918	1.474	

Table XIV

Intracell Flux Distribution, .600 Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. .746 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	.999	Flux
.084	1.019	in
.167	1.078	Uranium
.250	1.199	
.372	1.443	Flux in
.463	1.651	Water
.552	1.677	(Diagonal)
.644	1.752	
.734	1.784	
.824	1.758	
.914	1.780	
1.002	1.734	
1.094	1.807	
.377	1.504	Flux in
.469	1.730	Water
.558	1.748	(Center-to-center)
.648	1.714	
.738	1.742	
.829	1.602	
.918	1.455	

Table XV

Intracell Flux Distribution, .600 Diameter Rods of 1.15% Enriched Uranium in Light Water. Water-to-Metal Volume Ratio = 4:1. 1.300 Mg B_2O_3/Ml H_2O.

Distance from rod center (inches)	Measured relative flux	Remarks
.000	1.009	Flux
.083	1.013	in
.167	1.059	Uranium
.250	1.165	
.372	1.377	Flux in
.463	1.543	Water
.552	1.630	(Diagonal)
.644	1.702	
.734	1.671	
.824	1.706	
.914	1.718	
1.002	1.647	
1.094	1.759	
.377	1.373	Flux in
.469	1.525	Water
.558	1.662	(Center-to-center)
.648	1.684	
.738	1.613	
.829	1.568	
.918	1.411	

Table XVI

Volume Ratio $\frac{V_w}{V_u}$	Boron Concentration $\frac{Mg\ B_2O_3}{Ml\ H_2O}$	$\bar{\phi}_w$	$\bar{\phi}_u$	$\bar{\phi}_{al}$	Rod Disadvantage Factor	Water Disadvantage Factor	f
1*	0	1.319	1.097	1.210	1.103	1.090	.945*
1	2.950	1.319	1.097	1.210	1.103	1.090	.869
1.5	0	1.449	1.127	1.280	1.136	1.132	.917
1.5	0.933	1.449	1.133	1.283	1.132	1.129	.880
1.5	2.022	1.420	1.109	1.251	1.128	1.135	.840
1.5	2.950	1.415	1.112	1.240	1.115	1.141	.809
2	0	1.527	1.109	1.250	1.127	1.222	.888
2	0	1.514	1.124	1.252	1.114	1.209	.890
2	1.911	1.472	1.125	1.275	1.133	1.155	.800
2	2.920	1.450	1.108	1.251	1.129	1.159	.758
3	0	1.565	1.135	1.290	1.137	1.213	.842
3	1.300	1.597	1.133	1.292	1.140	1.236	.750
4	0	1.643	1.129	1.285	1.138	1.279	.793
4	0.344	1.670	1.140	1.290	1.132	1.295	.760
4	0.746	1.670	1.140	1.290	1.132	1.295	.727
4	1.300	1.593	1.116	1.27$	1.142	1.249	.690

*Not measured directly. See text

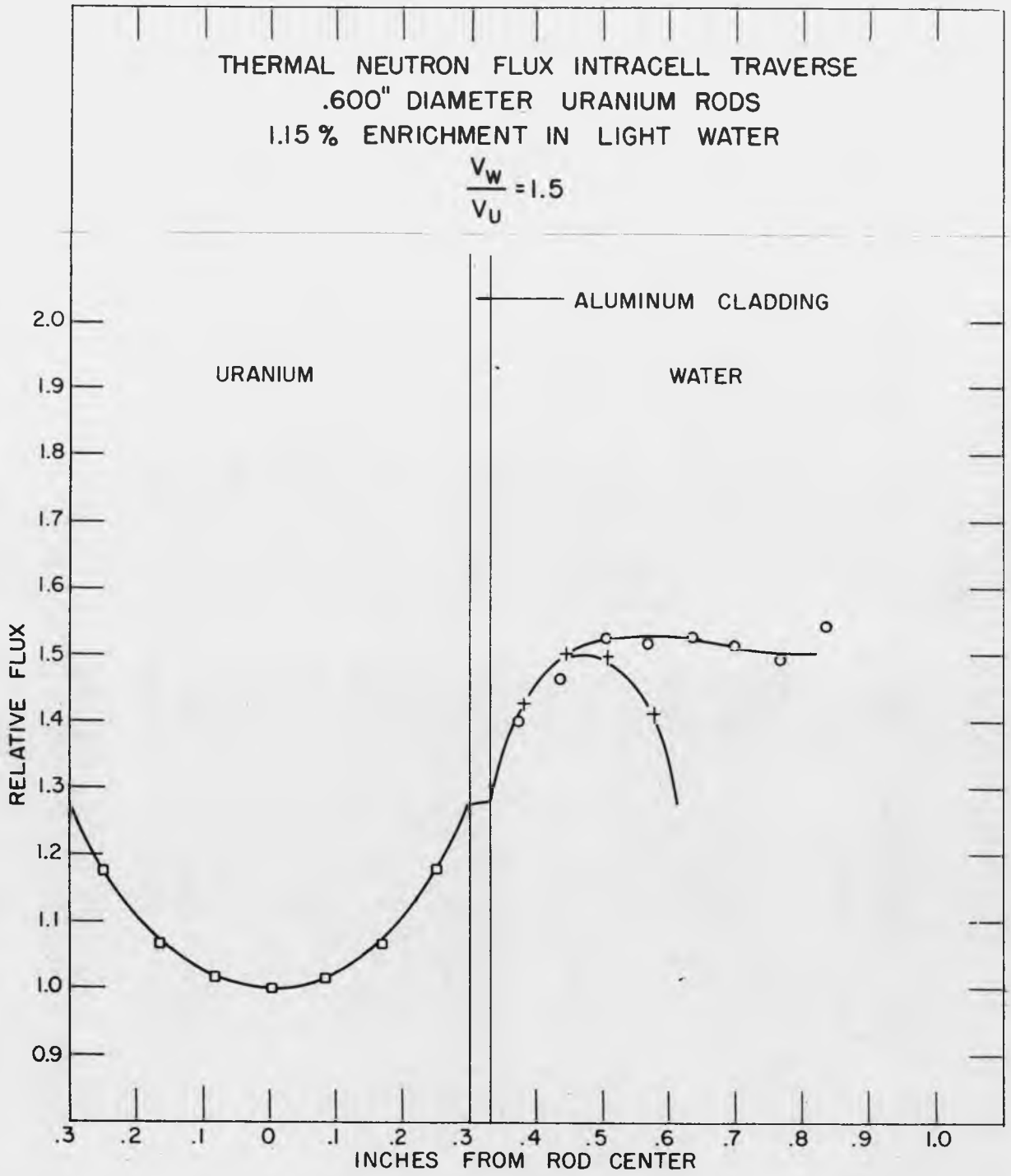
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15 % ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U} = 1.5$
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
INCHES FROM ROD CENTER

Fig. 1

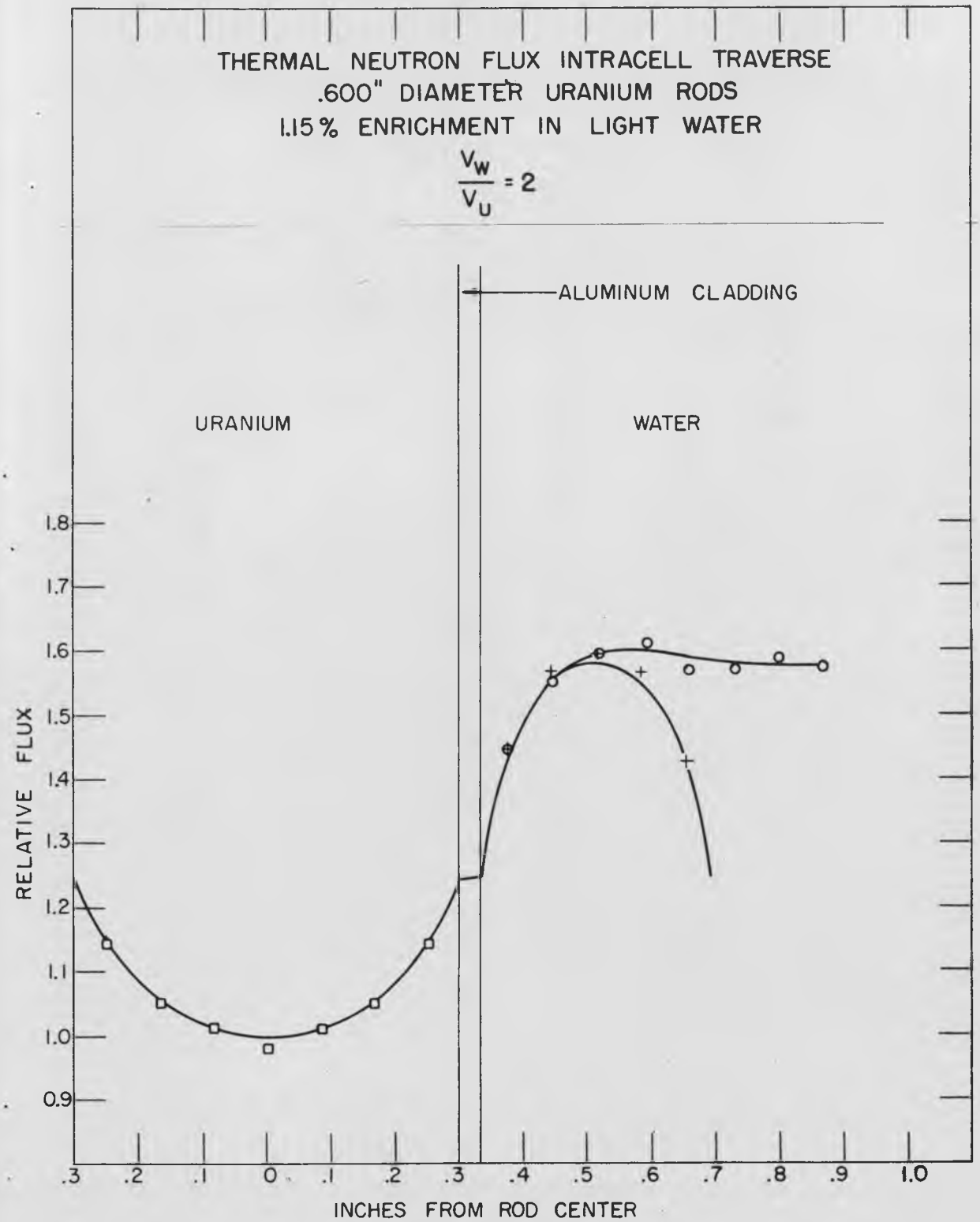
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U} = 2$
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 2

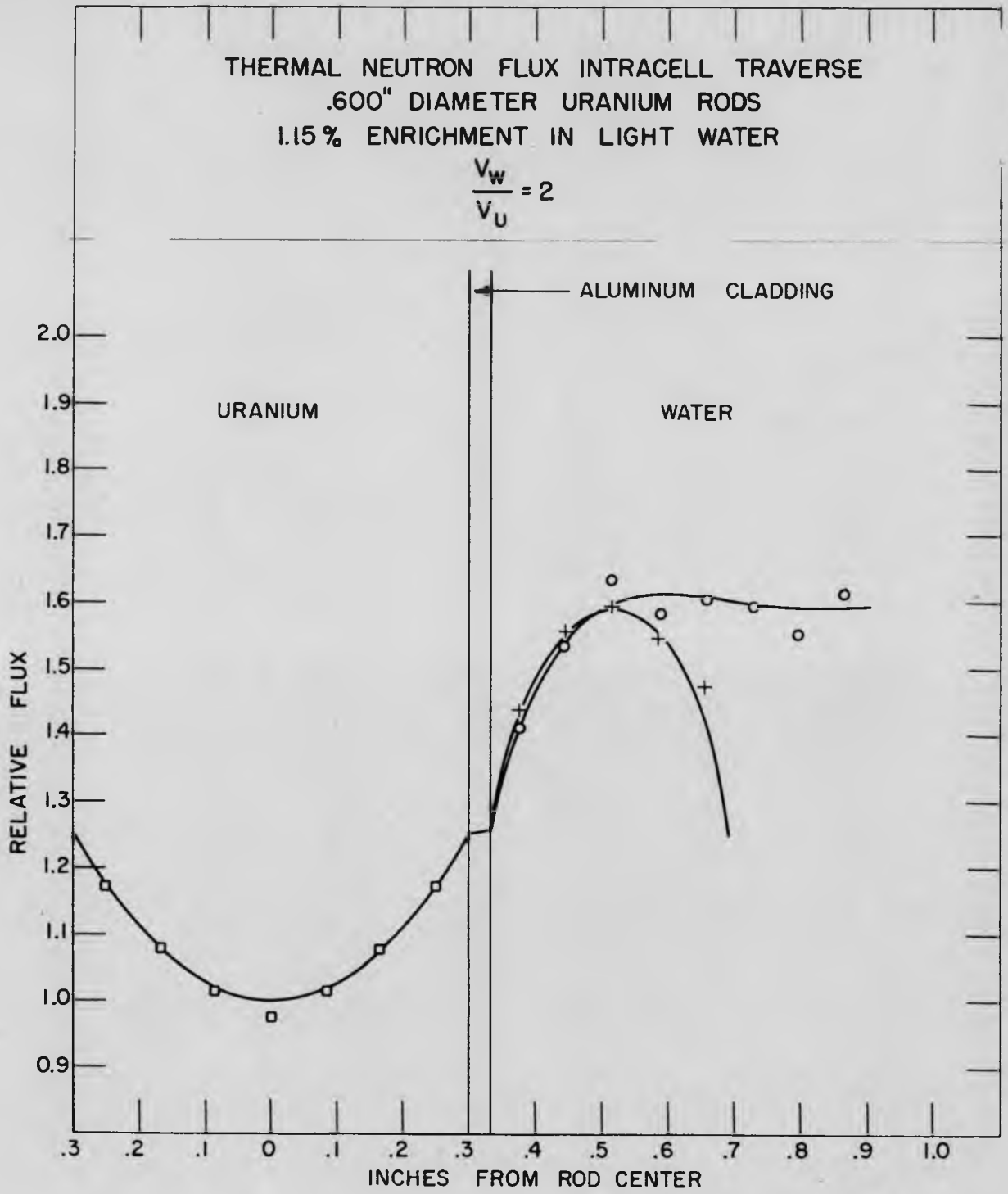
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U} = 2$
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 3

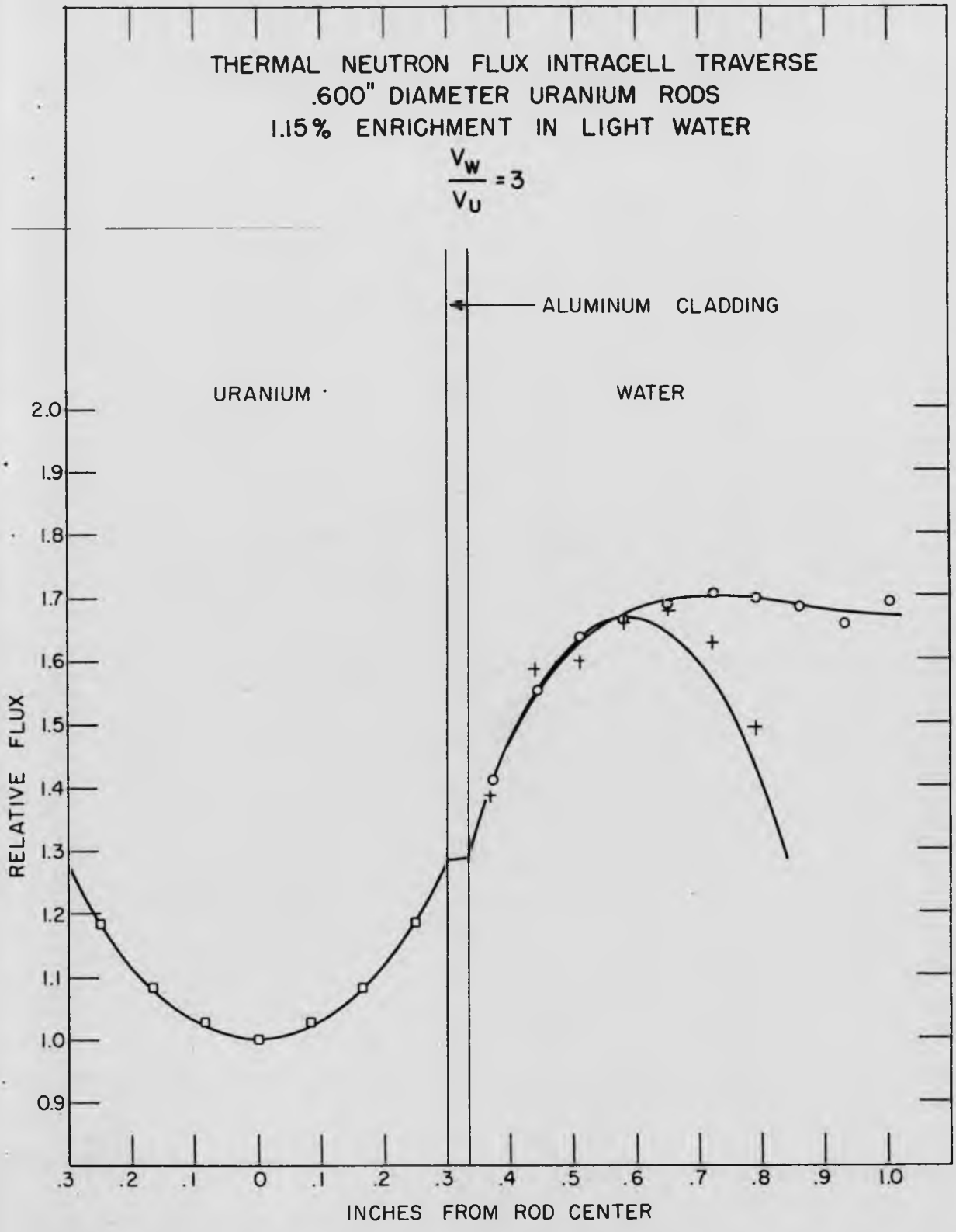
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U} = 3$
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 4

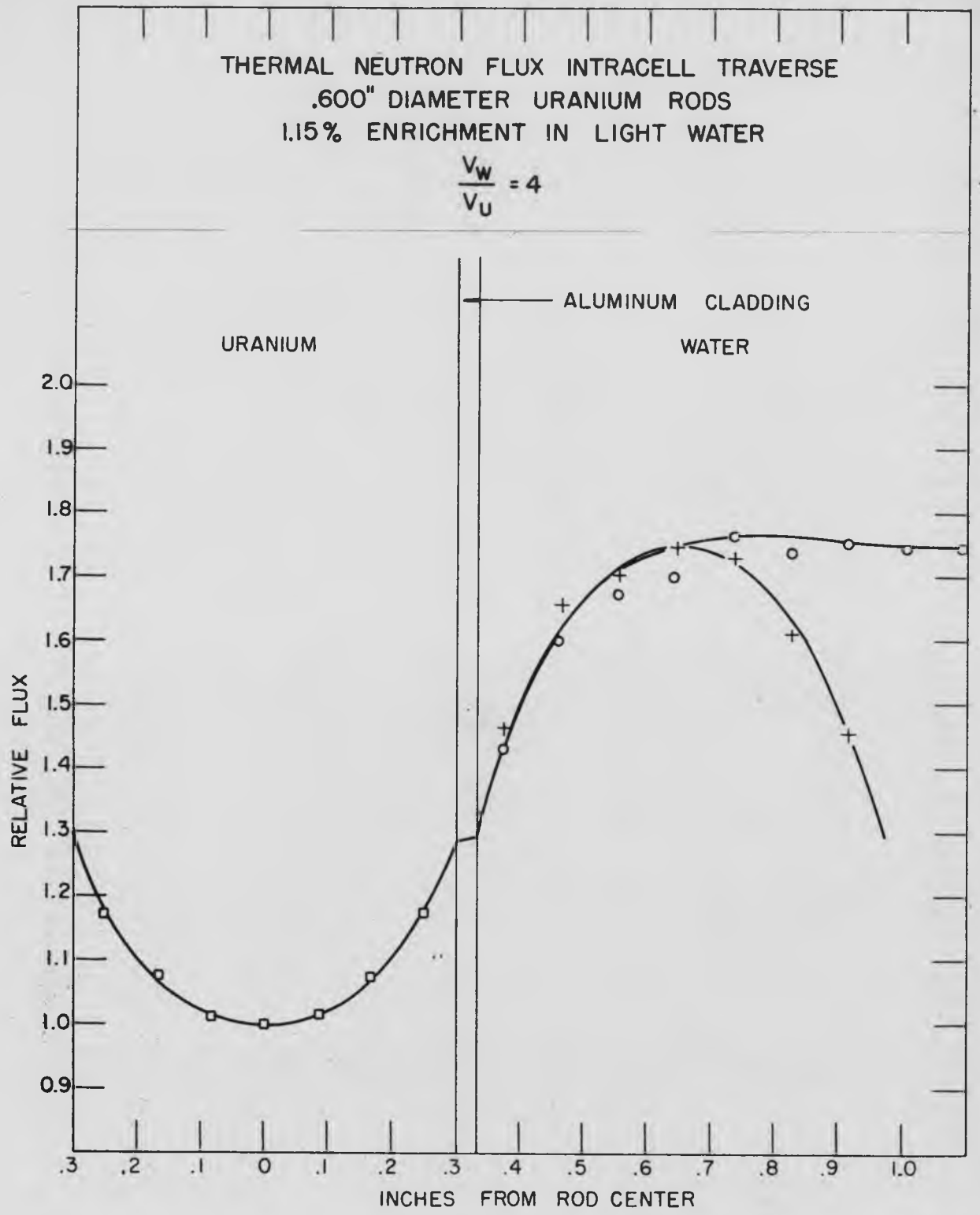
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U} = 4$
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 5

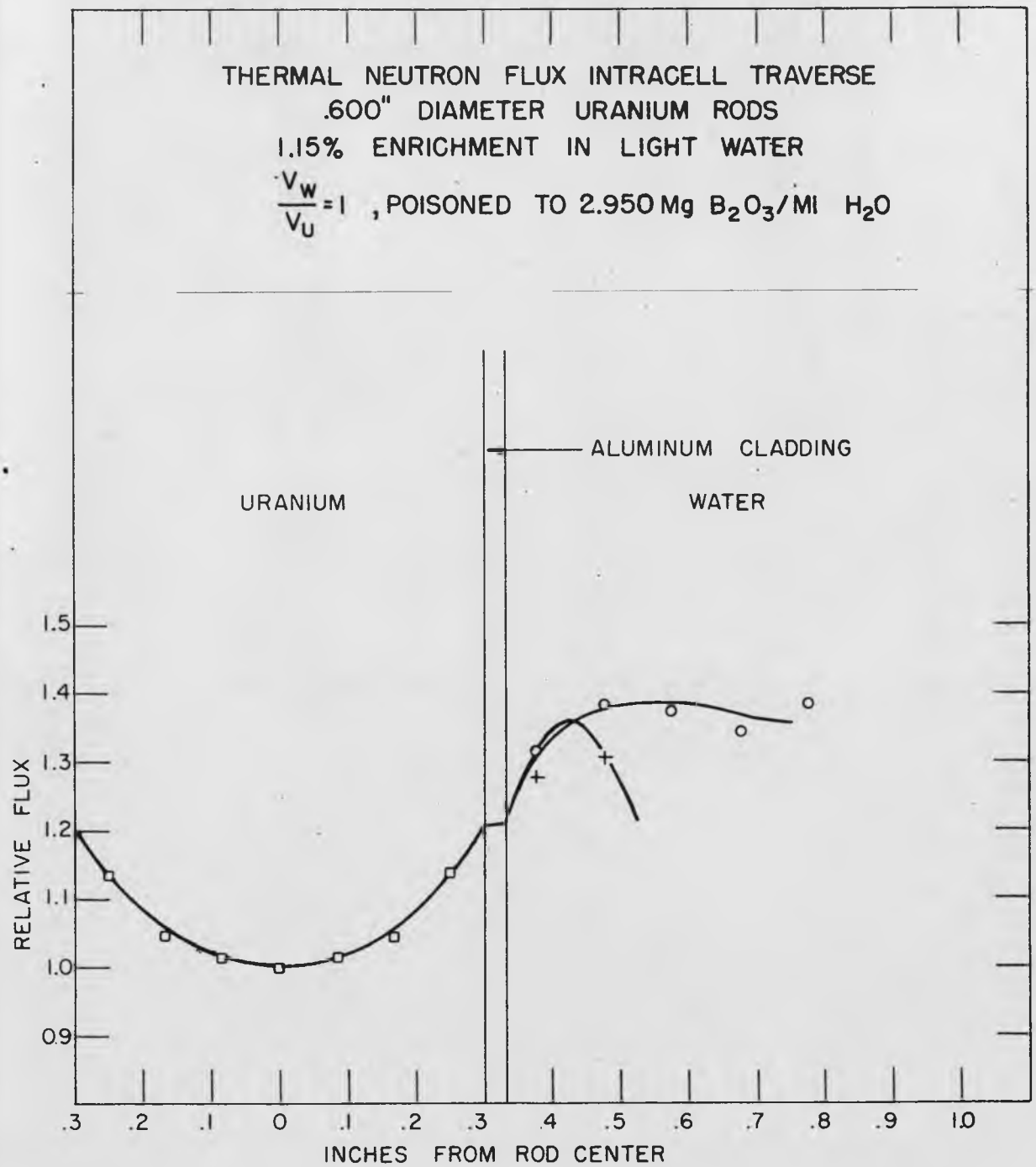
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 1 , POISONED TO 2.950 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 6

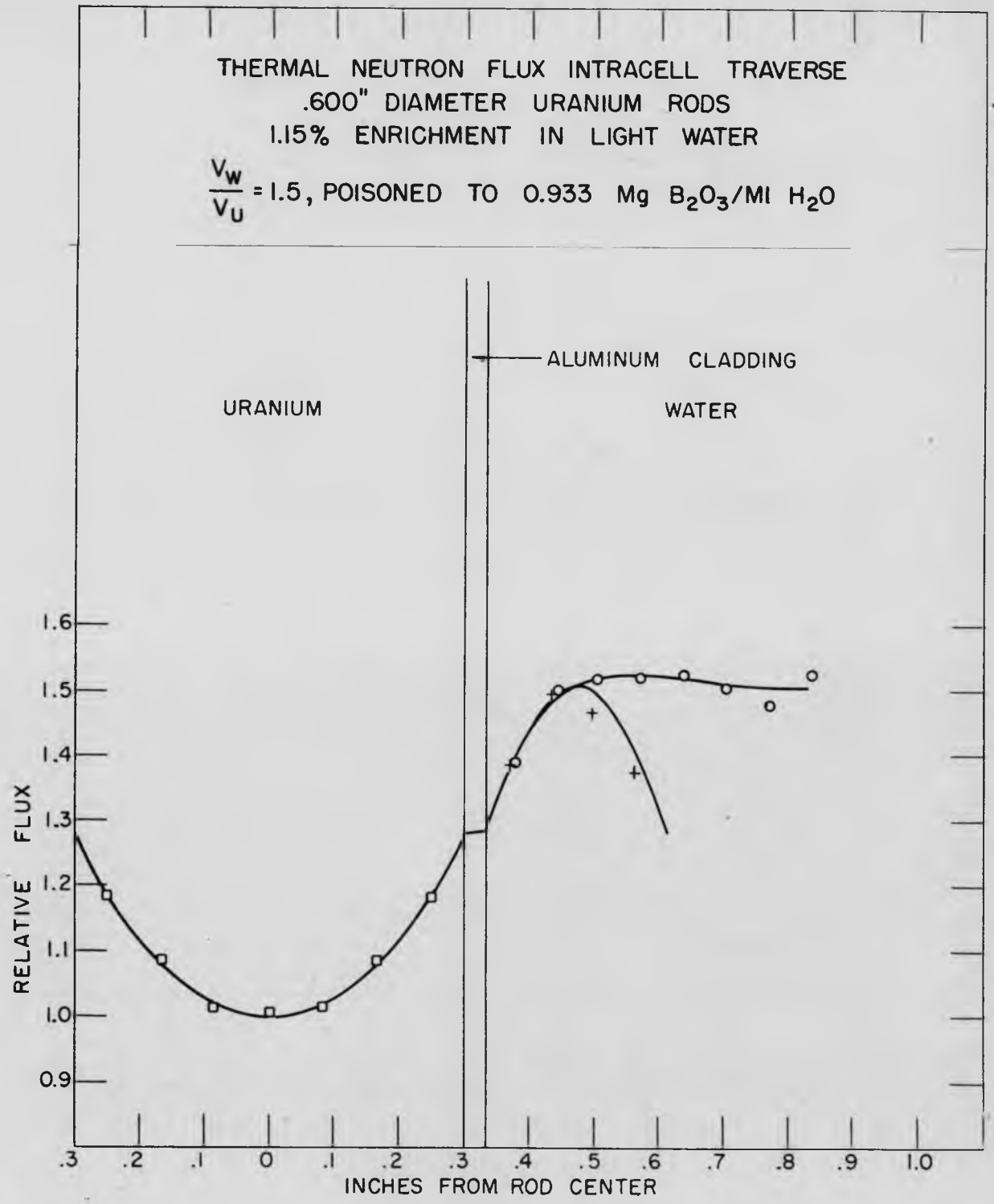
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 1.5, POISONED TO 0.933 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 7

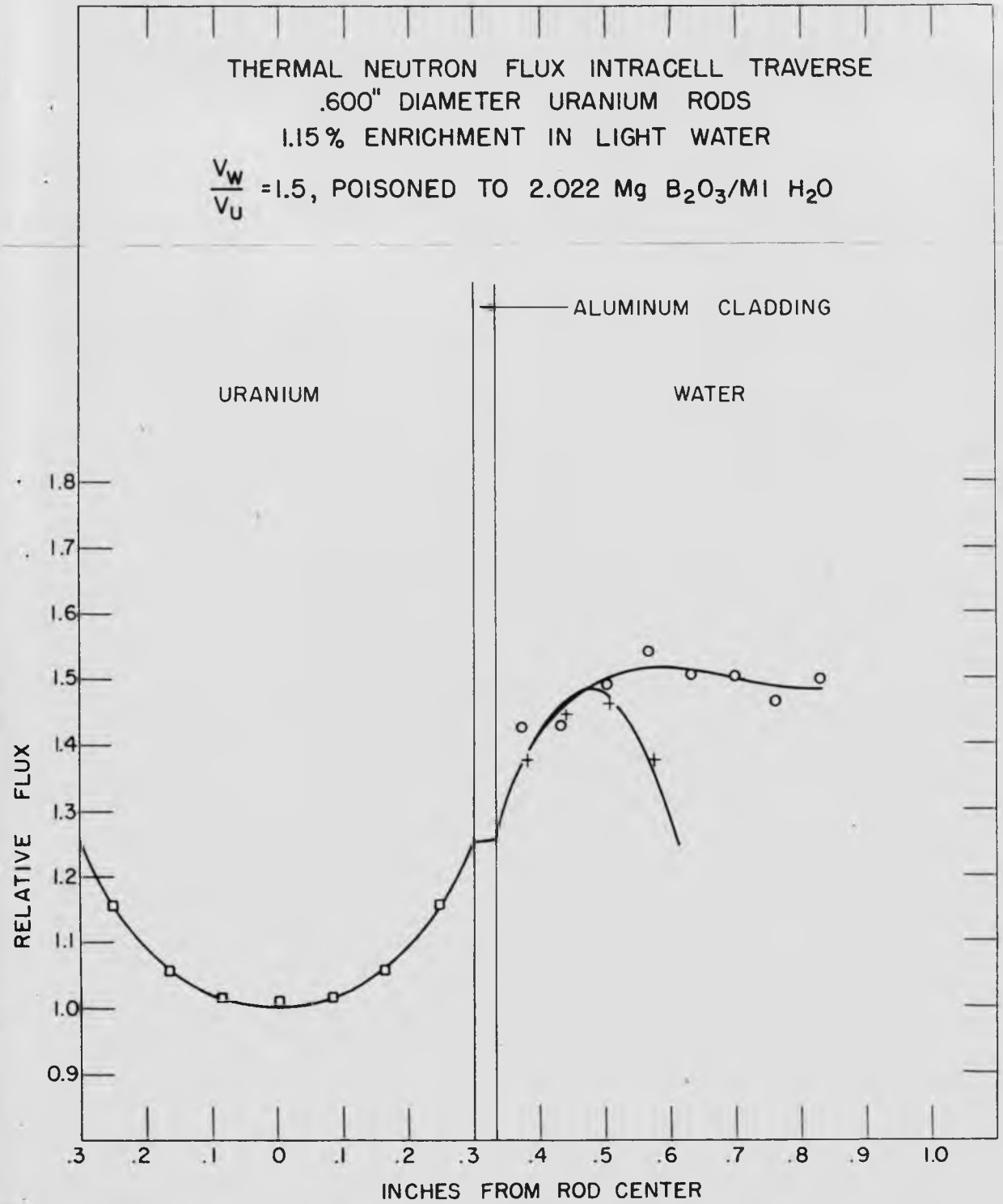
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ =1.5, POISONED TO 2.022 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 8

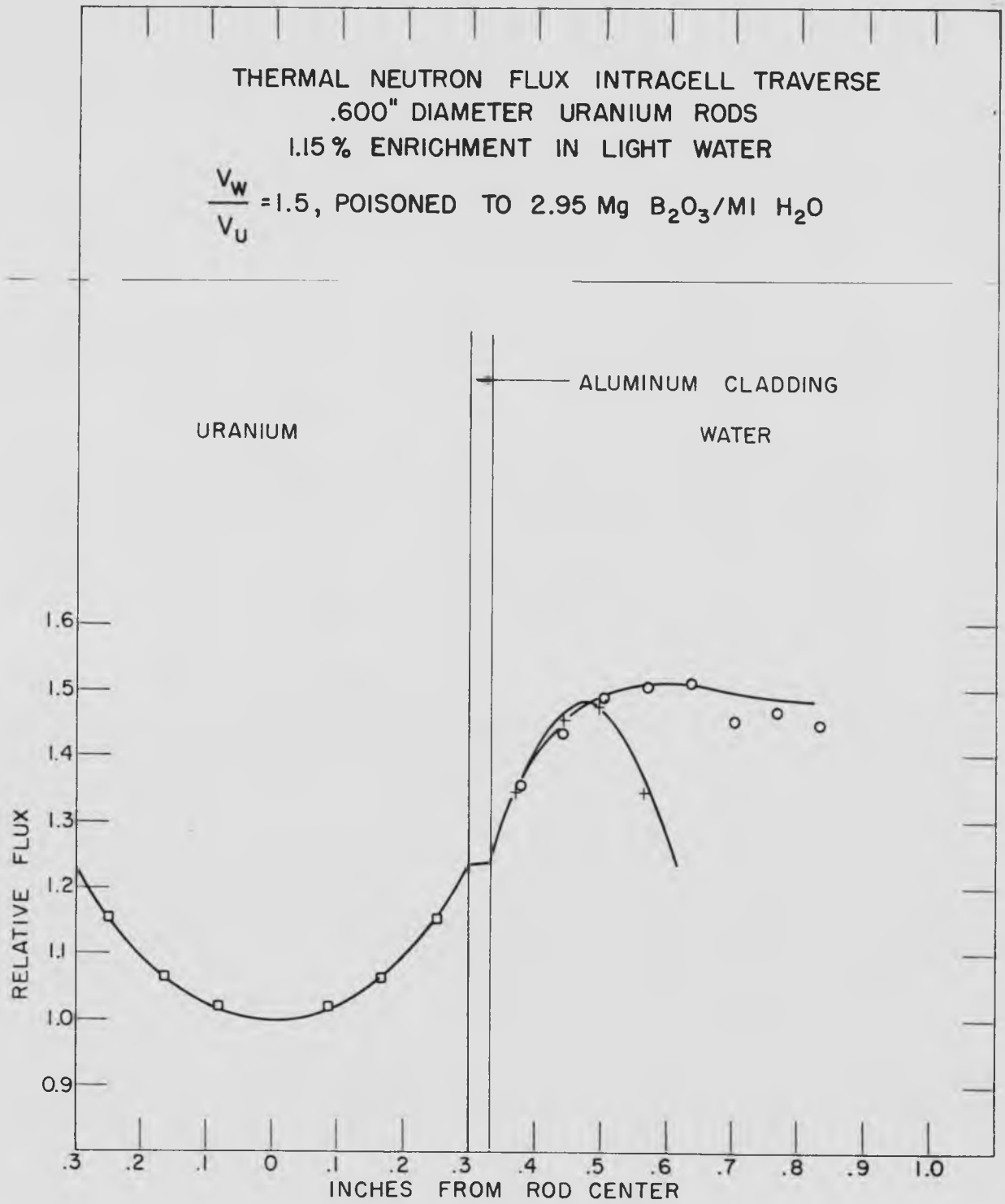
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15 % ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 1.5, POISONED TO 2.95 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 9

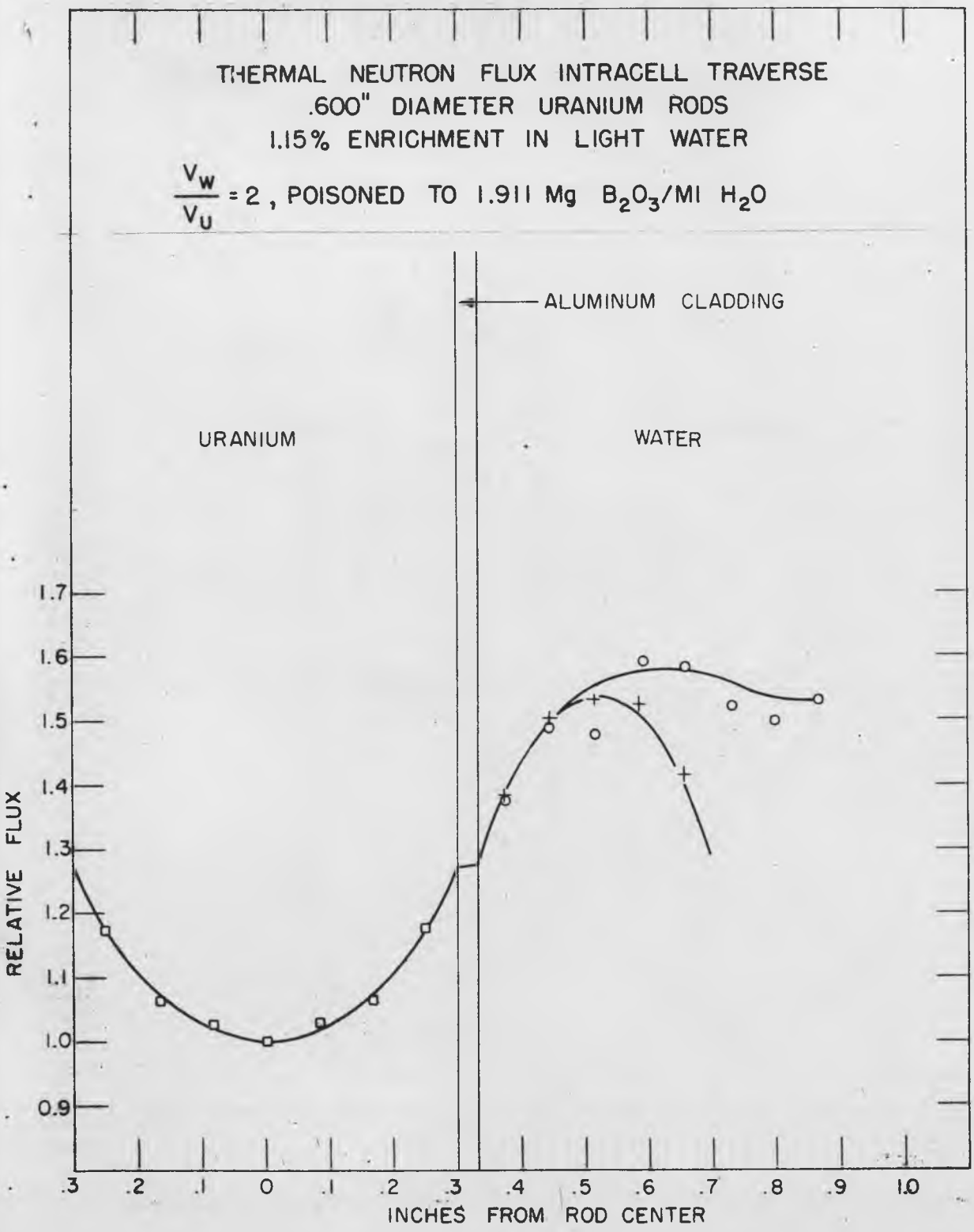
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 2 , POISONED TO 1.911 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
INCHES FROM ROD CENTER

Fig. 10

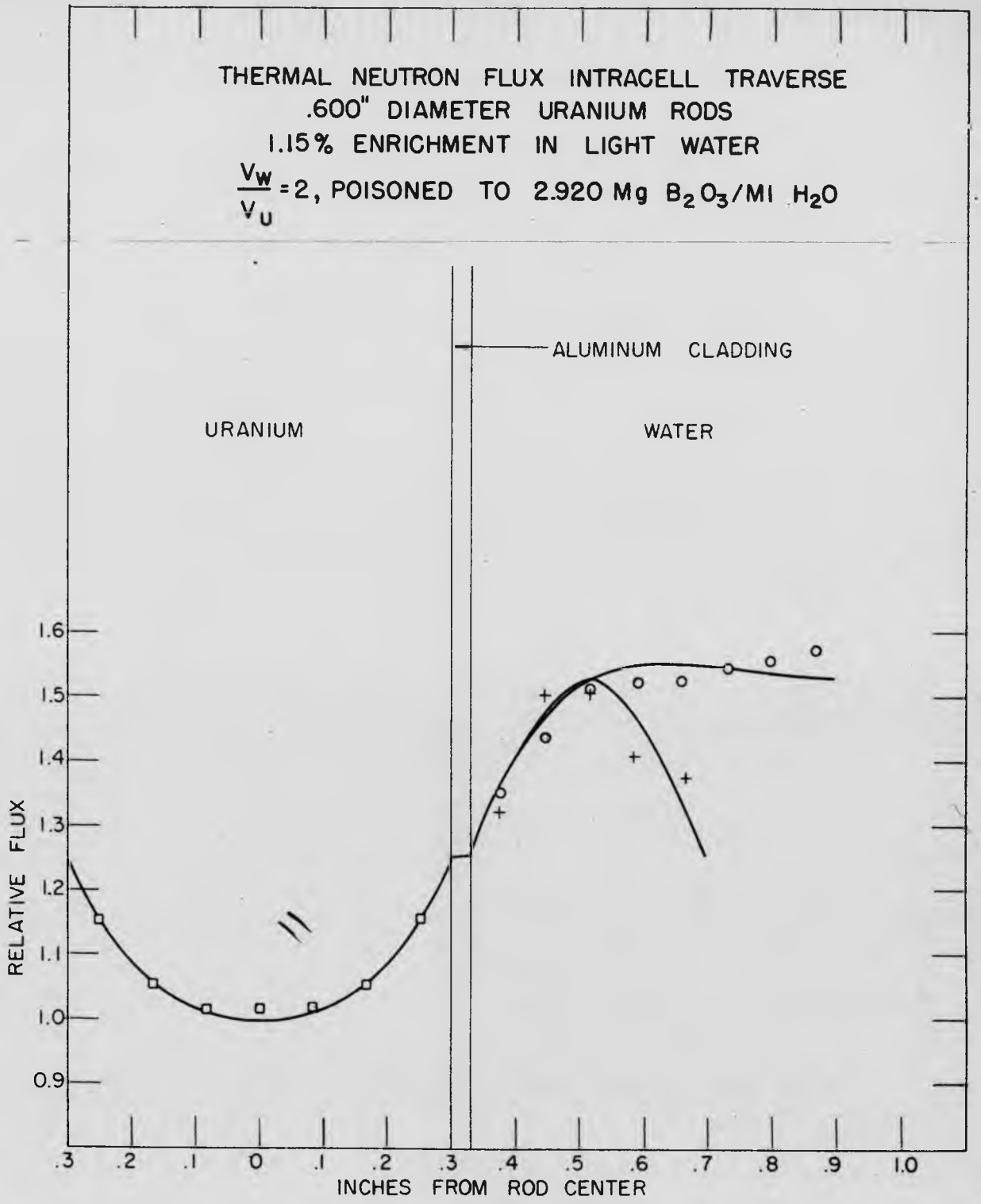
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 2, POISONED TO 2.920 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3 .2 .1 0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
INCHES FROM ROD CENTER

Fig. 11

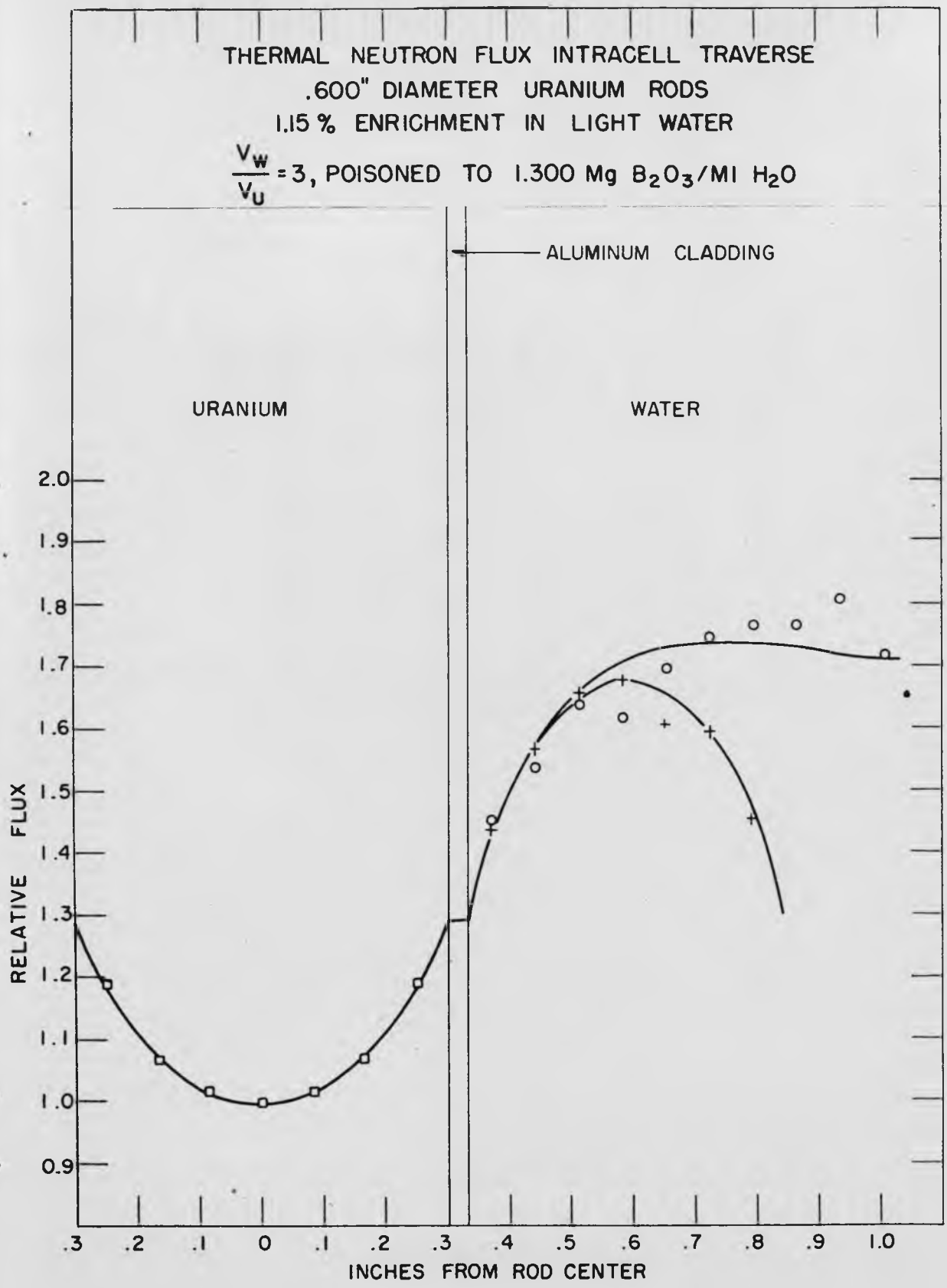
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15 % ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 3, POISONED TO 1.300 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
INCHES FROM ROD CENTER

Fig.12

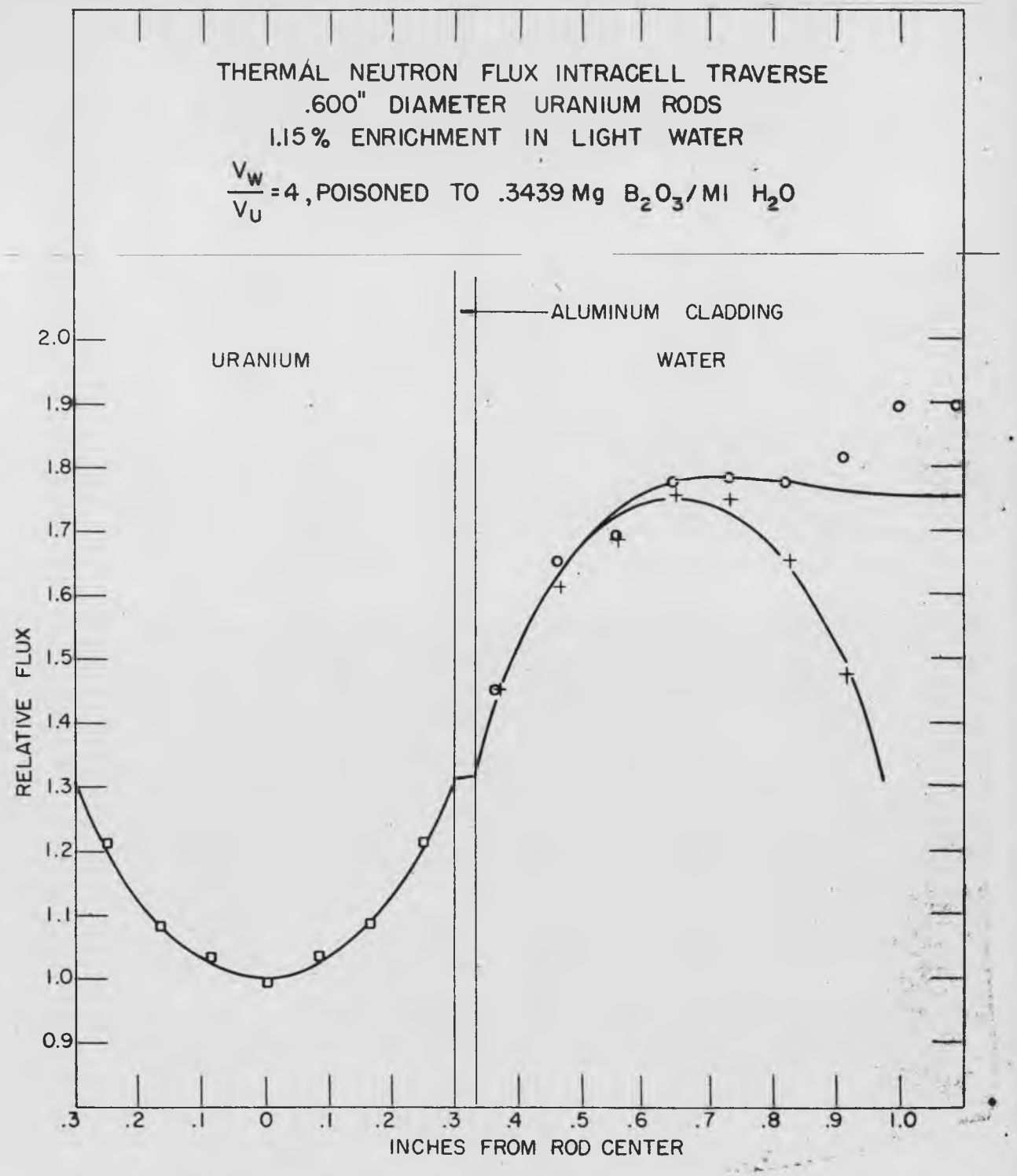
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 4, POISONED TO .3439 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
INCHES FROM ROD CENTER

Fig. 13

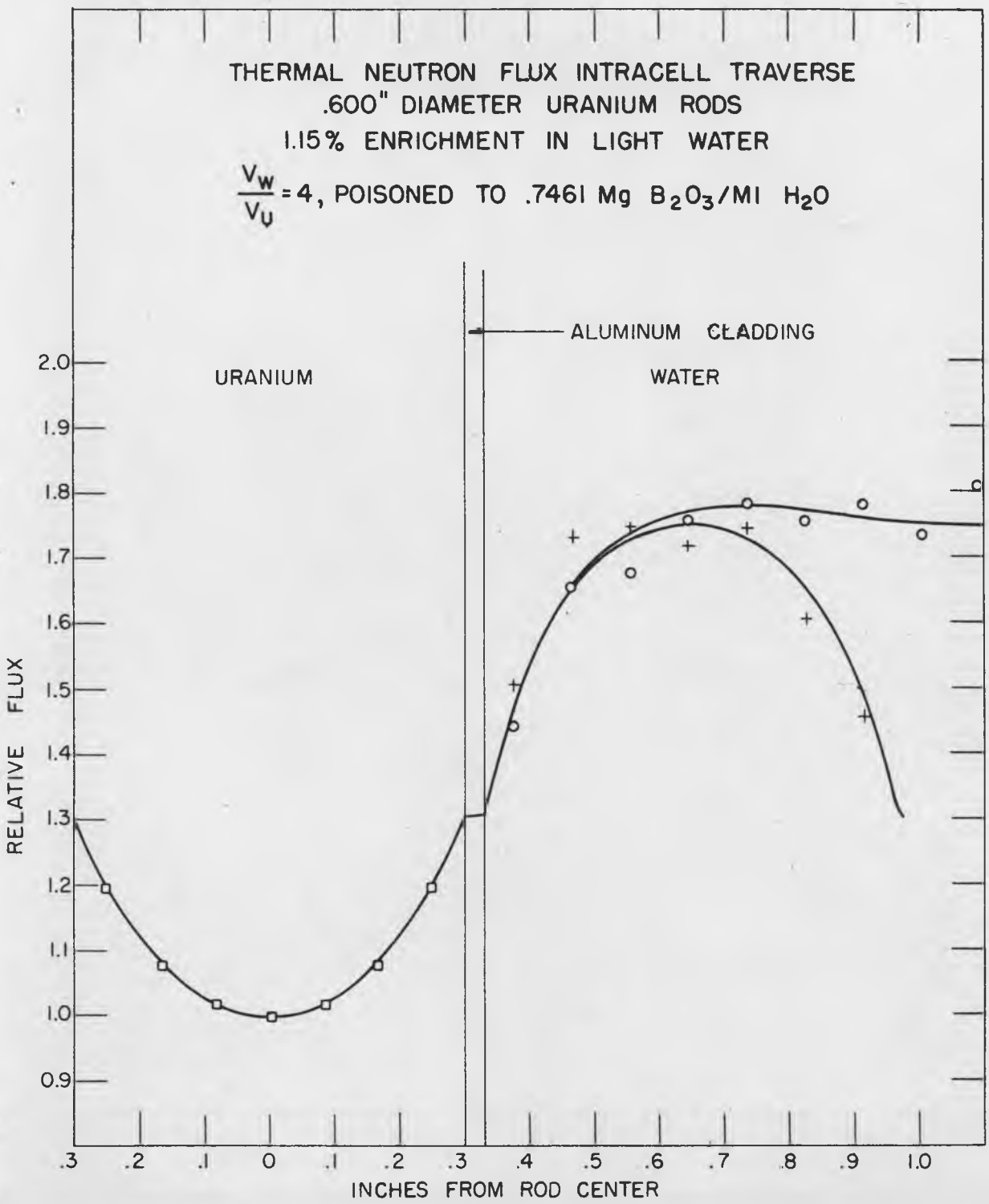
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 4, POISONED TO .7461 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
INCHES FROM ROD CENTER

Fig.14

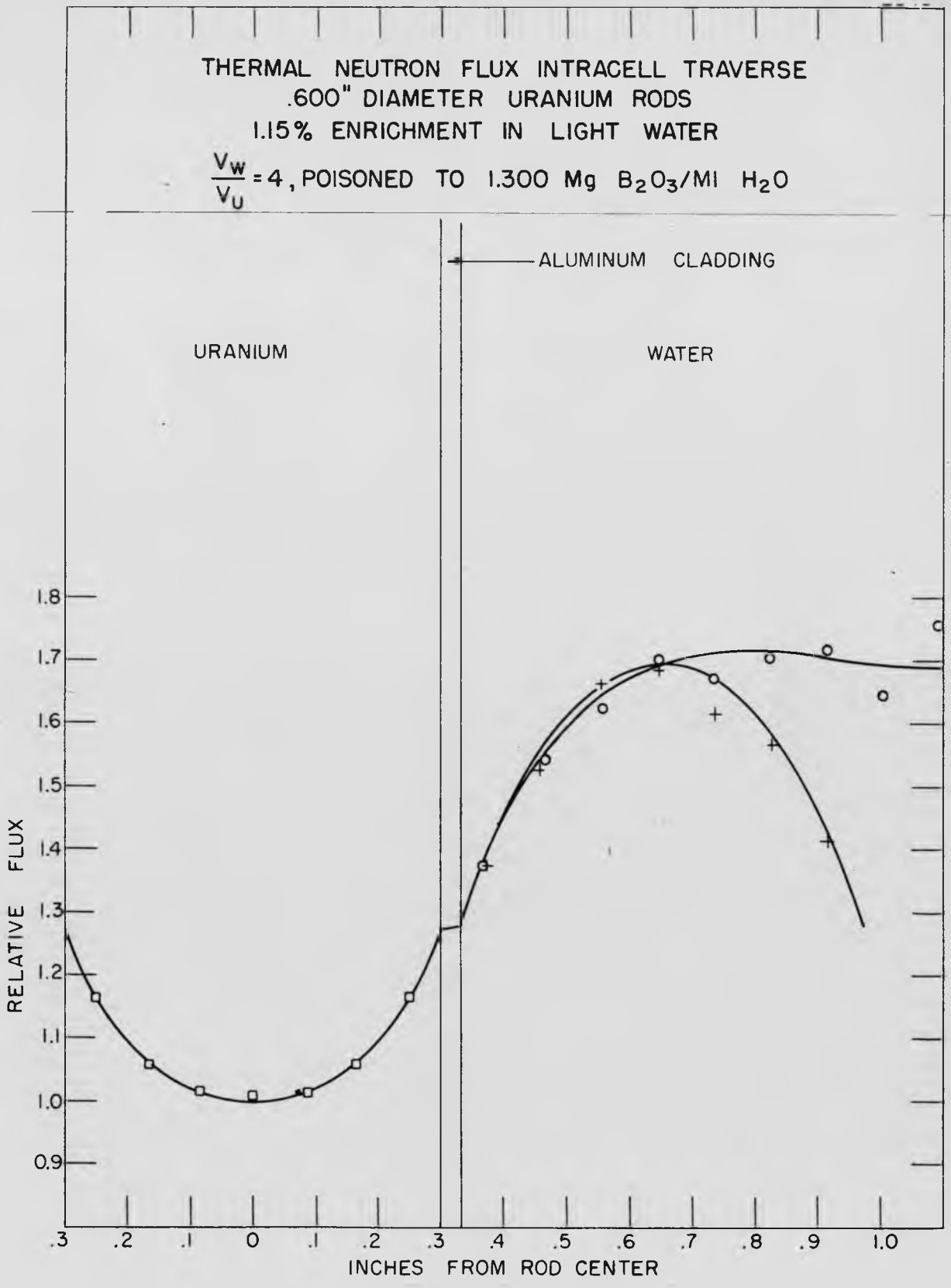
THERMAL NEUTRON FLUX INTRACELL TRAVERSE
.600" DIAMETER URANIUM RODS
1.15% ENRICHMENT IN LIGHT WATER
$\frac{V_W}{V_U}$ = 4, POISONED TO 1.300 Mg B_2O_3/Ml H_2O
ALUMINUM CLADDING
URANIUM
WATER
RELATIVE FLUX
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
INCHES FROM ROD CENTER

Fig. 15

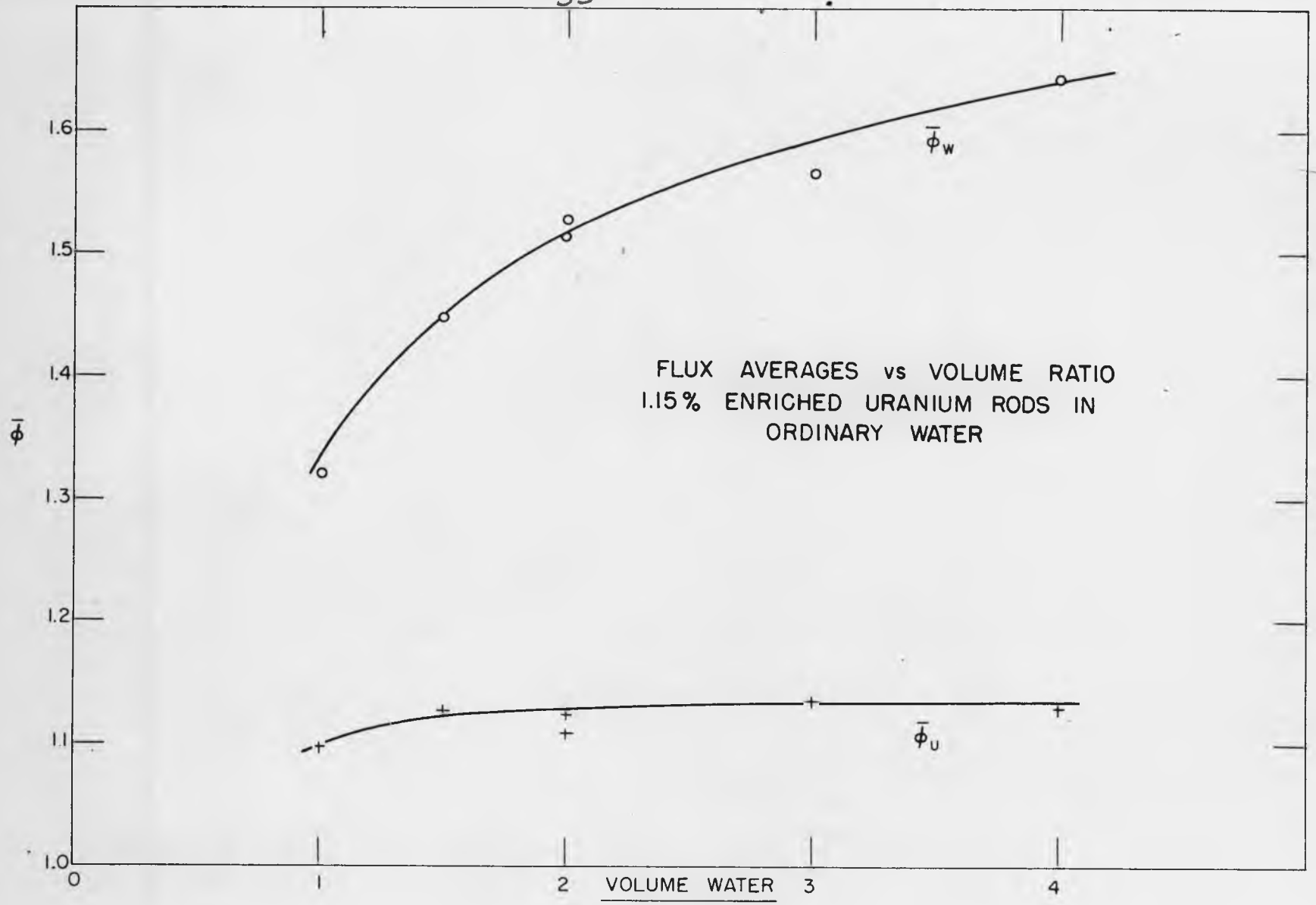
FLUX AVERAGES vs VOLUME RATIO
1.15% ENRICHED URANIUM RODS IN
ORDINARY WATER
$\bar{\phi}_w$
$\bar{\phi}_u$
$\bar{\phi}$
1.0
1.1
1.2
1.3
1.4
1.5
1.6
0
1
2
3
4
VOLUME WATER
VOLUME URANIUM

Fig. 16

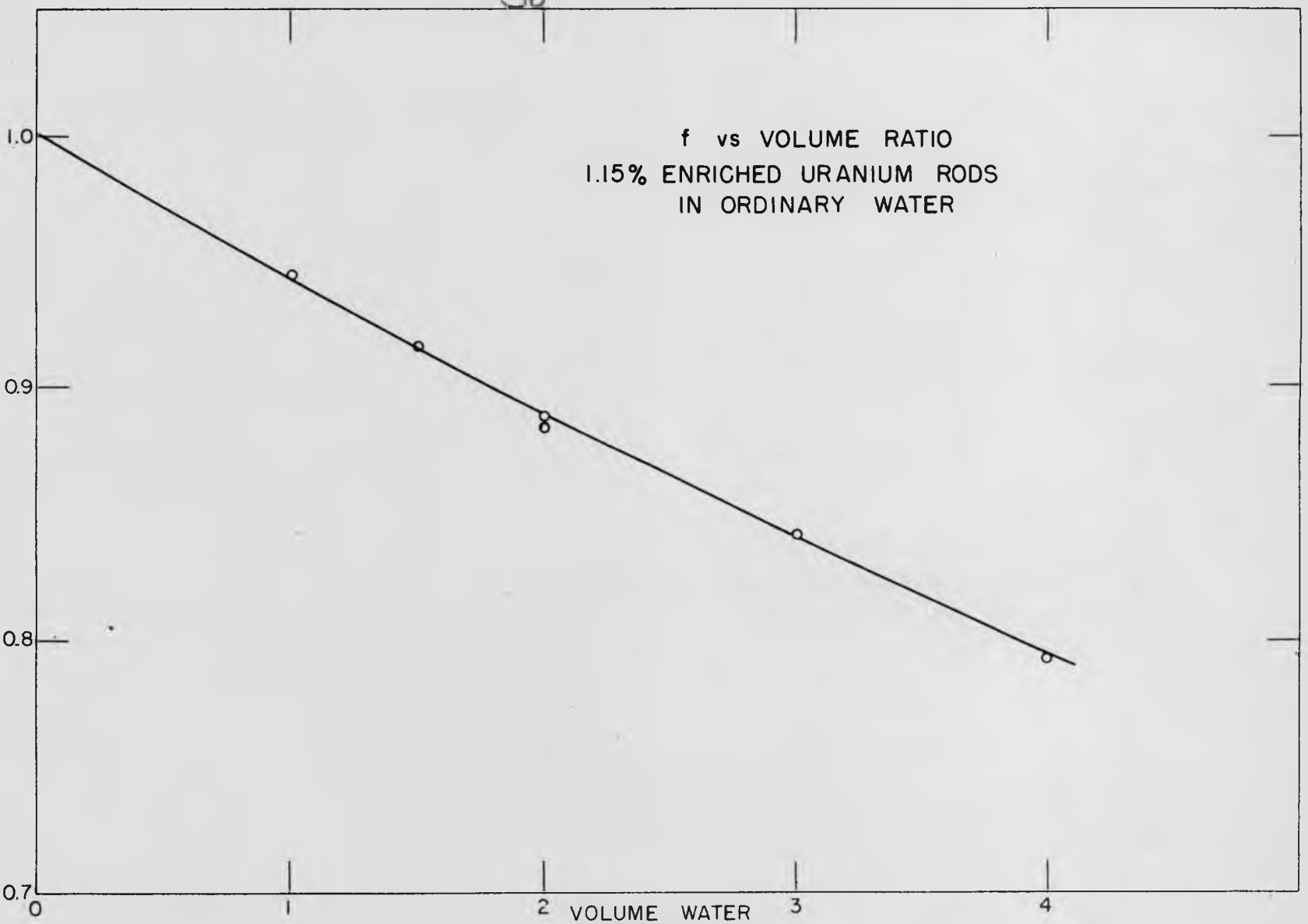
f vs VOLUME RATIO
1.15% ENRICHED URANIUM RODS
IN ORDINARY WATER
1.0
0.9
0.8
0.7
0
1
2
3
4
VOLUME WATER
VOLUME URANIUM

Fig. 17

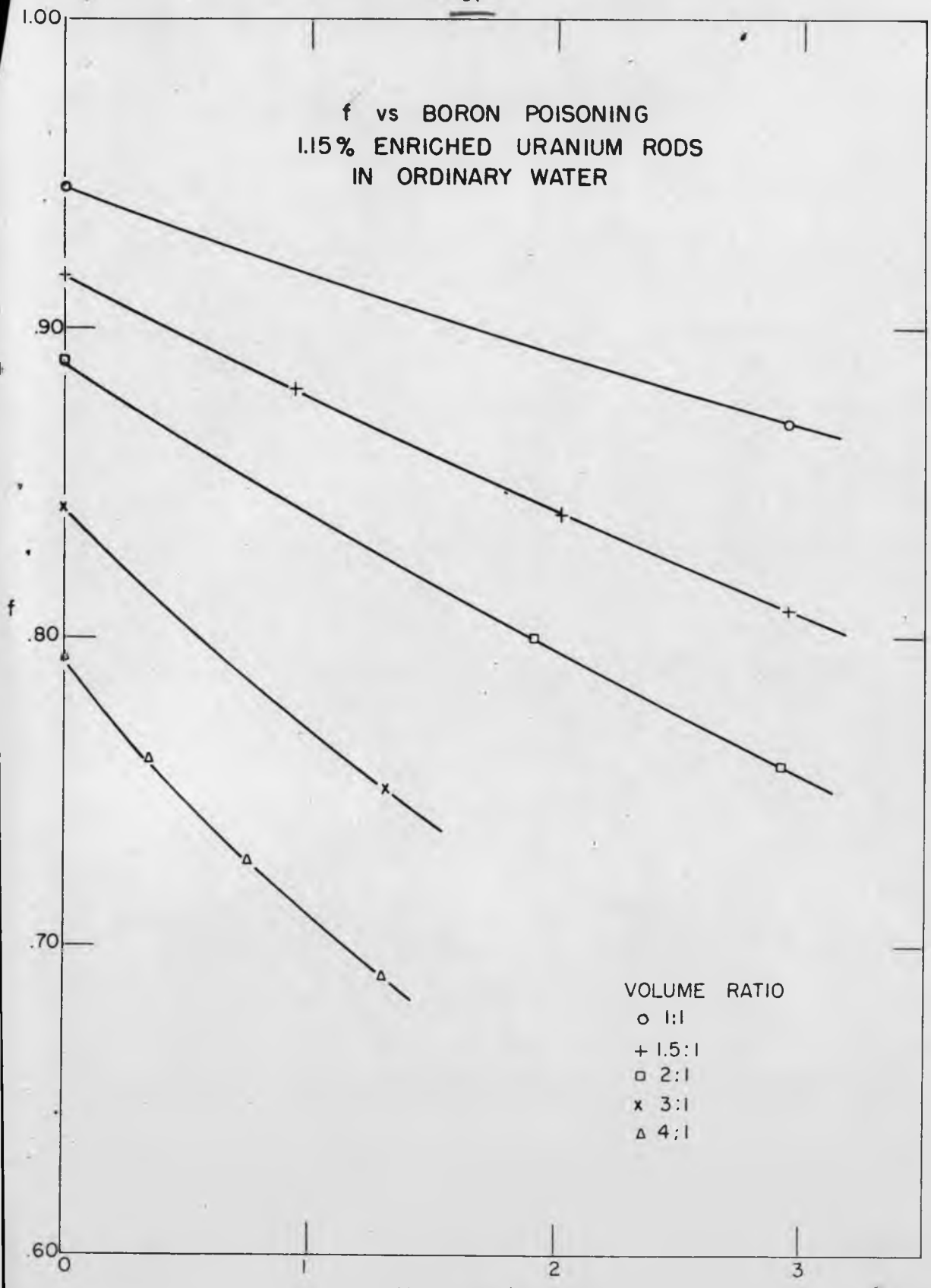

Fig. 18

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