INL/CON-12-27139
PREPRINT

Advanced Test Reactor National Scientific User Facility Progress

Fifth International Symposium on Material Test Reactors

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October 2012

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ABSTRACT

The Advanced Test Reactor (ATR) at the Idaho National Laboratory (INL) is one of the world's premier test reactors for studying the effects of intense neutron radiation on reactor materials and fuels. The ATR began operation in 1967, and has operated continuously since then, averaging approximately 250 operating days per year. The combination of high flux, large test volumes, and multiple experiment configuration options provide unique testing opportunities for nuclear fuels and material researchers. The ATR is a pressurized, light-water moderated and cooled, beryllium-reflected highly-enriched uranium fueled, reactor with a maximum operating power of 250 MWth. The ATR peak thermal flux can reach 1.0 $x10^{15}$ n/cm^2-sec, and the core configuration creates five main reactor power lobes (regions) that can be operated at different powers during the same operating cycle. In addition to these nine flux traps there are 68 irradiation positions in the reactor core reflector tank. The test positions range from 1.25 – 12.5 cm diameter and are all 1.2 m in length. The INL also has several hot cells and other laboratories in which irradiated material can be examined to study material radiation effects.

In 2007 the US Department of Energy (DOE) designated the ATR as a National Scientific User Facility (NSUF) to facilitate greater access to the ATR and the associated INL laboratories for material testing research by a broader user community. Goals of the ATR NSUF are to define the cutting edge of nuclear technology research in high temperature and radiation environments, contribute to improved industry performance of current and future light water reactors, and stimulate cooperative research between user groups conducting basic and applied research. The ATR NSUF has developed partnerships with other universities and national laboratories to enable ATR NSUF researchers to perform research at these other facilities, when the research objectives cannot be met using the INL facilities. The ATR NSUF program includes a robust education program enabling students to participate in their research at INL and the partner facilities, attend the ATR NSUF annual User Week, and compete for prizes at sponsored conferences. Development of additional research capabilities is also a key component of the ATR NSUF Program; user surveys are conducted to identify priorities for capability development. Some ATR irradiation experiment projects irradiate more specimens than are tested, resulting in irradiated materials available for post irradiation examination by other researchers. These "extra" specimens comprise the ATR NSUF Sample Library. This paper highlights the current status of all the ATR NSUF Program elements. Many of these were not envisioned in 2007, when DOE established the ATR NSUF.

1. INTRODUCTION

The Advanced Test Reactor (ATR), located at the Idaho National Laboratory (INL), which is owned by the US Department of Energy (DOE), is one of the most versatile operating research reactors in the United States. The ATR has a long history of supporting reactor fuel and material research for the US government and other test sponsors. The ATR has been operating since 1967, and is expected to continue operating for several more decades. Also at the INL are several facilities used for experiment preparation and post irradiation examination (PIE). In 2007, DOE designated the ATR as a National Scientific User Facility (NSUF), enabling a broader user community the ability to perform research (irradiation testing and PIE) in the INL facilities. This paper provides a brief introduction to the ATR design features, testing options, future plans for the ATR capabilities and experiments, an overview of the PIE capabilities at the INL and broader discussion of the ATR NSUF program. Detailed information about the facilities and the ATR NSUF program can be found on the ATR NSUF web site, http://atrnsuf.inl.gov.

2. ATR DESCRIPTION

The ATR, owned by US Department of Energy (DOE), is a pressurized, light-water moderated and cooled, beryllium-reflected, highly-enriched uranium fueled, nuclear research reactor with a maximum operating power of 250 MWth. The ATR is one of the most versatile operating research reactors in the United States. The unique serpentine configuration of the fuel elements, as shown in Figure 1, creates five main reactor power lobes (regions) and nine flux traps for high neutron flux/large volume testing. In addition to these nine flux traps there are 68 additional irradiation positions in the reactor core reflector tank. The height of all experiment locations is 1.2 m (the active fuel length), and the experiment position diameter ranges from 1.25 – 12.5 cm.

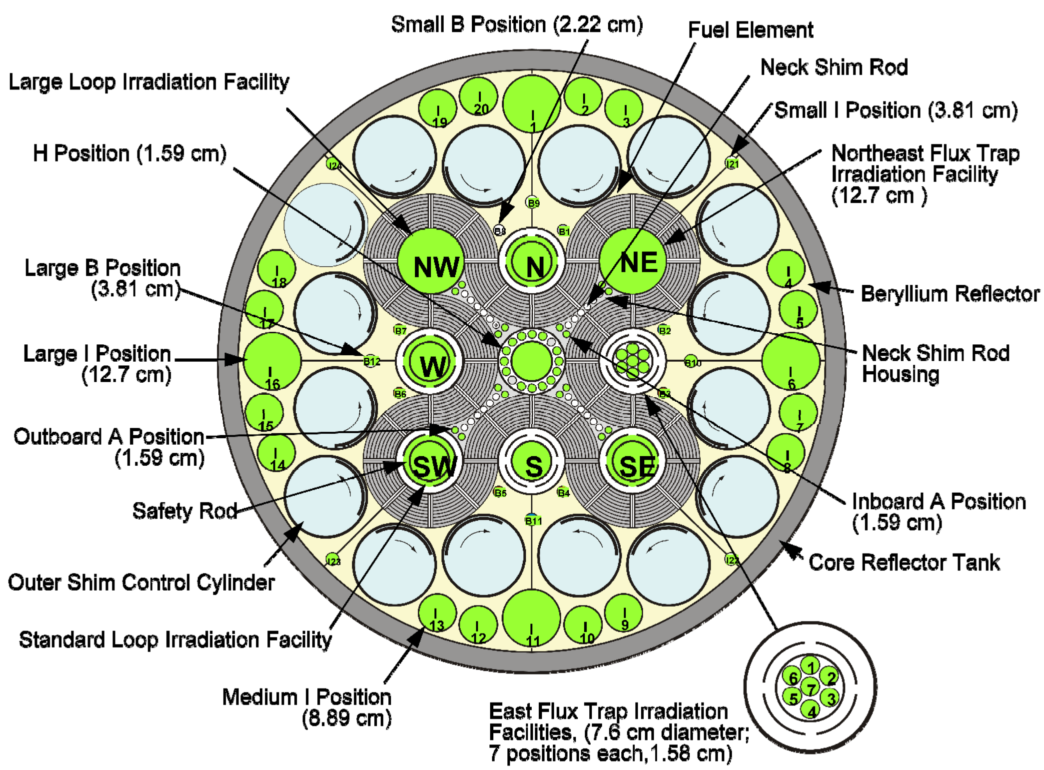

Figure 1. ATR Core Cross Section

General design information and operating characteristics for the ATR are presented in Table 1. The ATR has several unique features that enable the reactor to perform diverse simultaneous tests for multiple test sponsors. The ATR control devices permits large power variations among its nine flux traps using rotating control cylinders, made of beryllium with hafnium plates that can be rotated toward and away from the core. Within bounds, the power level in each corner lobe of the reactor can be controlled independently to allow for different power and flux levels in the four corner lobes during the same operating cycle. A typical operating cycle for the ATR consists of 42 to 56 operating days and 14 outages days, during which operators refuel the reactor and insert, remove, or reposition experiments. There are usually 6 operating cycles each year, for an average total of approximately 250 operating days each year. Approximately every ten years the beryllium reflector must be replaced, so all other core components are replaced at the same time, requiring a six-month outage, but resulting in essentially a new reactor at startup.

Table 1. ATR Design and Operating Information

Thermal Power (Maximum Design Power)	250 MW_{th}
Power Density	1.0 MW/liter
Maximum Thermal Neutron Flux	1.0 $x10^{15}$ n/cm^2-sec
Maximum Fast Neutron Flux	5.0 $x10^{14}$$n/cm^2$-sec
Total number of Experiment Positions	77 (includes 9 flux traps)
Coolant Temperature (Operating)	< 52°C (125°F) inlet, < 71°C (160°F) outlet
Primary System Operating Pressure	~2.5 MPa (360 psig)
Maximum Coolant Flow Rate	3.09 m^3/sec (49,000 gpm)

The ATR building also contains a separate facility referred to as the Advanced Test Reactor Critical (ATRC) facility, which is a full-size replica of the ATR operated at low power (5 kW maximum) and used to evaluate the potential impact on the ATR core of experiment test trains and assemblies. Mock-ups of experiments can be inserted in the ATRC, and such parameters as control rod worths, reactivities, thermal and fast neutron distributions, ATR fuel loading requirements, and reactivity coefficients can be determined prior to experiment insertion into the ATR.

3. ATR EXPERIMENT CAPABILITIES

There are four basic types of experiment configurations utilized in the ATR – the static capsule, the instrumented lead, the pressurized water loop experiment, and the Hydraulic Shuttle Irradiation System (HSIS) experiment. Each is described in more detail below, with some examples of the experiments performed using each type of configuration.

3.1 Static Capsule Experiment

The simplest experiment performed in the ATR is a static capsule experiment. The material to be irradiated is sealed in aluminum, zircaloy, or stainless steel tubing, which is placed in the ATR. A single capsule can be the full 1.2 m core height, or may be shorter, such that a series of stacked capsules may comprise a single test. Some capsule experiments can be in contact with the ATR primary coolant; these capsules will not be sealed, but in an open configuration, such that the capsule is exposed to and cooled by the ATR primary coolant system. Examples of this are fuel plate testing, such that the fuel to be tested is in a cladding material similar to (or compatible with) the ATR fuel element cladding. Static capsules typically have no instrumentation, but can include flux-monitor wires and temperature melt wires for examination following the irradiation. Limited temperature control can be designed into the capsule through the design of an insulating gas gap between the test specimen and the outside capsule wall.

3.2 Instrumented Lead Experiment

The next level in complexity of ATR experiments is an instrumented lead experiment, which provides active monitoring and control of experiments parameters during the irradiation period.

The primary difference between the static capsule and the instrumented lead experiment is an umbilical tube that runs from the experiment in the reactor through the reactor vessel and houses instrumentation connections that lead to a monitoring/control station elsewhere in the reactor building. In a temperature-controlled experiment, thermocouples continuously monitor the temperature in the experiment and provide feedback to a gas control system to provide the necessary gas cooling mixture to the experiments to achieve the desired experiment conditions. Another feature of the instrumented lead experiment is the ability to monitor the gas around the test specimen for changes to the experiment conditions, such as fission gas monitors on a fueled experiment. The instrument leads allow for a real time display of the experiment parameters on an operator control panel. For any monitored experiment parameter, a data acquisition and archive capability can be provided. Typically the data are saved for six months on a circular first-in, first-out format.

3.3 Pressurized Water Loop Experiment

The pressurized water loop (PWL) experiment is the most complex and comprehensive type of testing performed in the ATR. Six of the ATR flux traps contain in-pile tubes (IPTs), connected to pressurized water loops, that provide a barrier between the reactor primary coolant system and a secondary pressurized water loop coolant system, allowing material to be tested a prototypical commercial pressurized water reactor conditions (~15.5 MPa, ~340 C). The secondary cooling system includes pumps, coolers, ion exchangers, heaters to control experiment temperature, and chemistry control systems. As in the instrumented lead experiments, all of the secondary loop parameters are continuously monitored, and computer controlled to ensure precise testing conditions. The data from the experiment instruments are collected and archived similar to the data in the instrumented lead experiments.

3.4 Hydraulic Shuttle Irradiation System Experiment

The HSIS enables a researcher to develop an experiment that can be inserted into and removed from ATR while the reactor is operating. The system is designed to accommodate up to 14 shuttle capsules in one "train" that can be inserted into the ATR at one time. The shuttle capsule can hold 25 grams of material and has a volume of 7.8 cm^3 is hollow and the cap is welded on. HSIS irradiations can be for material test as well as for production of medical isotopes.

4. POST-IRRADIATION EXAMINATION CAPABILITIES

Post-irradiation examination (PIE) capabilities are available to ATR NSUF users at numerous facilities at the Materials and Fuels Complex (MFC) at INL, including the Hot Fuel Examination Facility (HFEF), a large hot cell facility, shown in Figure 2. Additional laboratories for PIE work at INL include the Analytical Laboratory (AL, focused on analysis of irradiated and radioactive materials), Electron Microscopy Laboratory (EML), a radiological facility containing optical, scanning, and analytical microscopes, and Fuels and Applied Science Building (FASB), used for fuel development, materials characterization, and irradiated materials testing at INL. These INL-based facilities house equipment and processes used for nondestructive examination; sample preparation; chemical, isotope, and radiological analysis; mechanical and thermal property examination; and microstructure property analysis. Testing capability for Irradiation Assisted Stress Corrosion Cracking (IASCC) will be available in FASB starting in 2013.

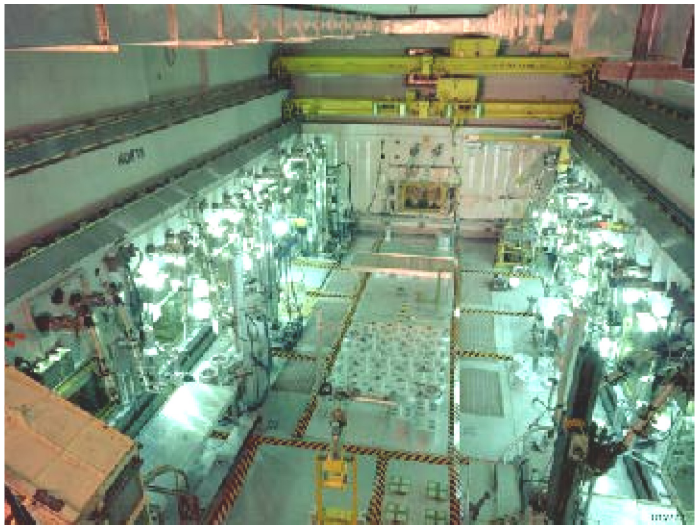

Figure 2. Hot Fuel Examination Facility

Due to requests from ATR NSUF users to provide more direct access to investigation instruments, additional capability is available in the Idaho Falls facility, Center for Advanced Energy Studies (CAES), which is a joint collaboration between INL, University of Idaho, Boise State University, and Idaho State University. In 2010, the Microscopy and Characterization Suite (MaCS) laboratory, in CAES, was developed and outfitted with several instruments; it became fully operational in 2011. Small radioactive samples can be brought into the MaCS lab, and the lab can be used directly by students and faculty without INL staff, so it is more accessible to the ATR NSUF user community than the other INL laboratories. It houses a nanoindenter, atomic force microscope, FIB, FEG-STEM, and local electron atom probe. These instruments are capable of conducting nanoscale characterization of low-level radioactive materials. Currently, approximately 50% of the MaCS instrumentation time is dedicated to ATR NSUF users.

5. PARTNER FACILITY CAPABILITIES

Early in the ATR NSUF Program, it was recognized that the INL facilities were not sufficient to meet all user demands for all types of irradiation projects that were being proposed by the ATR NSUF user community. For example, in some cases, the ATR neutron flux is higher than needed for some irradiations. In other cases, the PIE equipment is not available for ATR NSUF projects in a timely manner. Thus, the ATR NSUF developed the Partnership Program, the objective of which is to offer a wider range of experimental facilities than is available at INL to the ATR NSUF user community, as well as to enable increased utilization of the partner facilities. The first partnership was with the Massachusetts Institute of Technology reactor (MITR) to perform a material irradiation. Experimenters may need to use more than one facility to accomplish their research objectives, and, for awarded projects, the ATR NSUF will coordinate the work at the different facilities. This is also expected to enhance cooperation opportunities between the users and the partner facility research teams. There are now ten ATR NSUF partner facilities, some of which allow access to more than one laboratory or instrument for the ATR NSUF users. Information about capabilities of all INL and partner facilities, including information on applying for becoming an ATR NSUF partner, may be found on the ATR NSUF web site.

5.1 Massachusetts Institute of Technology (MIT)

The MIT reactor is a 5 MW_{th} tank-type research reactor with three positions available for in-core fuel and materials experiments in water loops at pressurized water reactor/boiling water reactor conditions, high-temperature gas reactor environments at temperatures up to 1400°C and fuel tests at LWR temperatures have been operated and custom conditions can also be provided. Fast and thermal neutron fluxes are up to 1×10^{14} and 5×10^{14} n/cm^2–s, respectively.

5.2 North Carolina State University (NCSU)

The NCSU PULSTAR reactor is a 1 MW_{th} research reactor, fueled by uranium dioxide pellets in zircaloy cladding. The fuel provides response characteristics that are similar to commercial LWRs, which allows teaching experiments to measure moderator temperature, power reactivity coefficients, and Doppler feedback.

Nuclear Services laboratories at NCSU offer neutron activation analysis, radiography, imaging, instrumentation testing, and positron spectrometry capabilities. Additionally, the NCSU PULSTAR reactor facility offers a selection of dedicated irradiation beam port facilities with capabilities for neutron powder diffraction, neutron imaging, intense positron source and ultra-cold neutron source. An intense positron source has been developed to supply a high rate positron beam to two different positron/positronium annihilation lifetime spectrometers.

5.3 University of Michigan (UM)

The UM Irradiated Materials Complex (IMC) houses laboratories and hot cells for conducting high-temperature mechanical property, corrosion and stress corrosion cracking experiments on neutron irradiated materials in an aqueous environment and for characterizing fracture surfaces after failure.

The 1.7 MV Tandetron accelerator in the Michigan Ion Beam Laboratory at UM offers controlled temperature proton irradiation capabilities with energies up to 3.4 MeV as well as heavy ion irradiation.

5.4 Illinois Institute of Technology (IIT)

The Materials Research Collaborative Access Team (MRCAT) beamline at Argonne National Laboratory's (ANL) Advanced Photon Source (APS) offers synchrotron radiation experiment capabilities, including x-ray diffraction, x-ray absorption, x-ray fluorescence and 5 µm spot size fluorescence microscopy.

5.5 University of Nevada, Las Vegas (UNLV)

The Radiochemistry Laboratories at UNLV's Harry Reid Center for Environmental Studies offer metallographic microscopy, x-ray powder diffraction, Rietveld analysis, SEM and STEM, electron probe microanalysis, and x-ray fluorescence spectrometry.

5.6 University of Wisconsin at Madison (UW-M)

The Characterization Laboratory for Irradiated Materials at the UW-M can be used for SEM and STEM on neutron-irradiated materials. Capabilities also include sample preparation by grinding and polishing.

A 1.7 MV terminal voltage tandem ion accelerator at UW-M features dual ion sources for producing negative ions with a sputtering source or using a radio frequency plasma source. The analysis beamline is capable of elastic recoil detection and nuclear reaction analysis.

5.7 University of California at Berkeley (UCB)

At the UCB Nuclear Engineering laboratory, nanoindenter capabilities are available for testing on low radioactive samples. The nanoindenter has two load ranges, is housed in an environmental controlled enclosure, and is equipped with a high power optical microscope and an automated lends change to allow accurate positioning of indents on a sample.

5.8 Oak Ridge National Laboratory (ORNL)

The High Flux Isotope Reactor (HFIR) provides a high flux (up to $5x10^{15}$ n/cm^2-s thermal) material irradiation test capabilities are similar to those available at the ATR. In-core irradiations are performed for medical, industrial, and isotope production and research on severe neutron damage to materials.

The Low Activation Materials Development and Analysis Laboratory (LAMDA) facility at ORNL is a set of multipurpose laboratories for evaluation of materials with low radiological activities. Testing capabilities include tensile, fracture toughness, electrical diffusivity, optical microscopy, microhardness, thermal diffusivity, etc. Samples must have gamma/beta activity corresponding to a dose of less than 60 mR/hr (at one foot).

5.9 Purdue University

Purdue's Interaction of Materials with Particles and Components Testing (IMPACT) experimental facility was designed to study in-situ dynamic heterogeneous surfaces at the nano-scale exposed to varied environments that modify surface and interface properties. In-situ techniques used in the IMPACT experiment include: low-energy ion scattering spectroscopy (LEISS), direct recoil spectroscopy, X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES), EUV (13.5-nm) reflectometry (EUVR), EUV photoelectron spectroscopy (EUVPS), and mass spectrometry.

5.10 Pacific Northwest Nuclear Laboratory (PNNL)

PNNL's Material Science and Technology Laboratory includes advanced characterization and testing facilities for both non-radioactive and radioactive structural materials for nuclear power systems, both fission and fusion materials. The characterization includes all types of microscopy, including TEM, SEM, and Optical. Mechanical property testing is available for both hot and cold samples. A high-temperature furnace on a test frame is located in a large walk-in fume hood in one of the labs for testing dispersible ceramics. A high-precision density apparatus is available for irradiated materials.

The Radiochemical Processing Laboratory (RPL) at PNNL houses specialized facilities for work with microgram-to-kilogram quantities of fissionable materials and megacurie activities of other radionuclides. These provide a platform for radiochemical process development, chemical and physical separations, radiomaterial characterization, radioisotope research, reactor dosimetry and radioactive and hazardous waste management.

6. SAMPLE LIBRARY

Many of the ATR NSUF awarded projects result in irradiation of more samples than need to be or can be investigated during the PIE phase of the project. In an effort to take advantage of the effort to irradiate these specimens, ATR NSUF has established a sample library of materials that can be accessed by researchers wanting to propose an experiment. This library contains both irradiated and unirradiated samples including samples irradiated in fast reactors and in the ATR. The various materials include reactor stainless steel (EBR-II reflector and duct material), HT9, aluminum, Inconel alloys, Hastelloy alloys, ceramics (ZrC, TiC, TiN, ZrN, AlN, α-SiC) as well as stellite, tantalum, beryllium-copper, and aluminum bronze. The dose and irradiation temperatures for these samples varies, but specific information on each sample is available to the interested researcher. Excess samples from future ATR NSUF projects will be added to the library upon completion of each project, ensuring that the principal investigator (PI) has sufficient opportunity to complete his or her project first. The majority of the materials are located in HFEF. Based on radiation levels, samples may need to be size-reduced to facilitate transfer to facilities that can receive contact-handled radioactive materials (EML, FASB, AL, CAES, and partner facilities).

7. PROPOSAL OPPORTUNITIES

ATR NSUF offers several opportunities for researchers to submit proposals for research to be performed at the ATR NSUF facilities. In addition to the proposals that can be submitted directly to the ATR NSUF, a PI may also submit a joint proposal to both the ATR NSUF and Nuclear Energy university Programs (NEUP) research call, if the PI needs both developmental research funds and access to the ATR NSUF research facilities. Proposals that are suitable may also be proposed for access to both ATR NSUF and the ANL's APS. Guidelines and information related to all proposal submittals are available on the NSUF web site. All proposals are submitted through a web-based submittal system designed to help prospective researchers develop, edit, review, and submit their proposals. Information on the two primary ATR NSUF proposal calls is provided below:

Open Calls: One proposal option is continuously open rolling call for reactor irradiation or major PIE proposals with project selections twice a year, in the fall and in the spring. Proposals for these calls focus on irradiation/post irradiation examination of materials and fuels and on post irradiation examination of previously irradiated materials or fuels from the ATR NSUF Sample Library (described previously). These calls also offer researchers the option to submit proposals for synchrotron radiation experiments through the ATR NSUF partnership with IIT. This partnership has resulted in awards of 5 synchrotron radiation experiments since the partnership was formed in FY 2010.

Rapid-Turnaround Experiments (RTEs). Another option is for RTEs that can be performed in two months or less, such as PIE of previously irradiated fuels or materials, ion beam irradiation, and neutron scattering experiments. The call for RTEs is always open, allowing proposals to be submitted at any time. RTE proposals are reviewed quarterly and awarded throughout the year based on proposal review ranking and the availability of funds.

All proposals received against open calls and RTEs are subject to a peer-review process before selection. An accredited U.S. university or college must lead research proposals for irradiation/post-irradiation experiments. Collaborations with other national laboratories, federal agencies, non-U.S. universities, and industry are encouraged. Any U.S.-based entities, including universities, national laboratories, and industry can propose research that would use the MRCAT beamline at the APS or would be conducted as an RTE.

In response to requests from a number of university faculty members, ATR NSUF developed "New-User Experiment" projects. This provides an opportunity for university researchers to experience first-hand the intricacies of designing and conducting an in-reactor test. ATR NSUF selects the materials to be irradiated and each university researcher involved in the project can work with a variety of INL staff to design a capsule that meets the needs of the experiment. The project ends when the capsule is inserted into the reactor. To participate, researchers submit a letter of interest, which can be uploaded via the calls for proposals webpage. Initiation of a project will be dependent on funding available for the project and interest from the research community.

8. EDUCATIONAL PROGRAMS

The ATR NSUF education program was established to develop a cadre of nuclear energy researchers, facilitating the advancement of nuclear science and technology through reactor-based testing. ATR NSUF uses focused internships, fellowships, and faculty/student exchanges to encourage faculty and student access to cutting-edge and one-of-a-kind tools for conducting reactor-base research in nuclear science and technology, fuels, and materials. The ATR NSUF User's Week is held at INL and includes research forums and specialized workshops. ATR NSUF is also developing a new text on irradiation test planning and execution. The ATR NSUF sponsors a colloquium series, with speakers from the INL and university community of researchers. The emphasis of all education programs is to allow for maximum interaction and access to the nation's experimental nuclear research infrastructure. Full details regarding ATR NSUF educational programs are on the web site and primary programs are summarized below.

8.1 Internships and Fellowships

Internships are the direct mechanism by which undergraduate and graduate students can access the ATR NSUF and be introduced to mentors. Each year, approximately 15 interns are exposed to research and gain experience with tools in reactor-based nuclear science and technology. Typically interns spend 10 to 12 weeks in the summer on a paid internship sponsored by the ATR NSUF. Graduate students may use their intern experience to conduct thesis or dissertation research, and these internships can last for up to one year. Internships are also used to support the increased impact of the ATR NSUF on facility operations. Post-doctoral fellowships give recent doctoral graduates an opportunity for a short (up to 3 years) duration appointment in areas that align with current or future ATR NSUF research.

8.2 Visiting Scientists

The ATR NSUF education program has two programs for visiting scientists and students. The Faculty and Student Research Team (FSRT) program awards faculty-led team contracts to partner with an INL mentor and work on building capability needed in the user facility. In addition, teams gain an understanding of INL, build technical knowledge, and establish relationships with INL researchers. The ATR NSUF also uses an existing INL program called the Faculty and Staff Exchange program. Participants in this program are sent to universities or other research facilities and are encouraged to spend time at a university/INL to teach, perform research, collaborate, and be involved in campus/laboratory life.

8.3 User's Week

Annually, the ATR NSUF hosts a User's Week to provide a venue to inform the nuclear science and technology community of current issues and the tools and facilities available through the use of the ATR NSUF to address these issues. User's Week is comprised of a research forum that discusses current collaborative nuclear technology research being conducted in the NSUF. Sessions are also held to familiarize participants with the ATR NSUF research facilities and capabilities. User's Week also has extended courses on fuels and materials and how to conduct and execute irradiation experiments. Scholarships to cover travel expenses are available to some of the faculty and student participants.

8.4 Additional Workshops

ATR NSUF sponsors other workshops at student meetings and as requested by users. These include tutorials on ATR experiments, reactor experiment instrumentation, and PIE techniques. Additionally, student posters and presentations are judged at both national and student meetings; winners are awarded the opportunity to visit INL as a colloquium speaker.

9. FUTURE PLANS

The ATR NSUF will continue to offer an increasing variety of experiment options for the user community. In order to ensure that the appropriate capability is available, routine inquiries are made to the user community about the research needs. The ATR NSUF Scientific Review Board and User Group also provide feedback and input to the ATR NSUF program to ensure that the user community is being appropriately served. In response to the user comments, DOE has invested in several testing capability enhancements. PIE capabilities are continuing to be upgraded, with new capabilities added each year; establishment of the MaCS laboratory was the direct result of user needs. A PWR test loop was added to ATR to enable tests for the commercial nuclear power industry, with initial testing to be performed in 2013. These first specimens irradiated in the new loop will undergo PIE testing with new IASCC test capability. Instrumentation for ATR experiments continues to evolve and new sensors are being developed and made available for testing as user needs dictate. To house the growing suite of examination equipment available for PIE at the INL, a new facility, the Irradiated Materials Characterization Laboratory (IMCL), was built. The IMCL will contain space for installation of instruments and equipment within shielding structures that can be redesigned and refitted when necessary and will allow easy routine maintenance of the instruments, which will initially include an electron probe microanalzyer, Focused Ion Beam (FIB), micro x-ray diffraction, and thermal analysis systems, with additional instruments to be added as user needs increase and funding is available. As new irradiation experiments are completed, more specimens will be added to the Sample Library to enable all researchers to have access to the irradiated materials for new types of testing. The ATR NSUF educational program continues to evolve, based on user input and needs, in an effort to continue to reach more experimenters.

10. ACKNOWLEDGEMENTS

This work was supported by the United States Department of Energy (DOE) under DOE Idaho Field Office Contract Number DE-AC07-05ID14517.