Overview and Status of the US Nuclear Science User Facilities (NSUF)

J. Rory Kennedy

Nuclear Science User Facilities, Idaho National Laboratory, Idaho Falls, USA
Corresponding author: J. Rory Kennedy < rory.kennedy@inl.gov>

The Nuclear Science User Facilities (NSUF) was established in 2007 under the US Department of Energy Office of Nuclear Energy (DOE-NE) in order to better enable access of the nuclear energy research community to the unique and specialized nuclear energy capabilities operating across the US and developed over many decades. Although initially intended as a single institution government funded user facility at the Idaho National Laboratory (INL), the NSUF has grown and expanded to include facilities at an additional seven National Laboratories, eleven universities (plus four universities at the Center for Advanced Energy Studies in Idaho), one industry site, and one international affiliate. Access to the NSUF capabilities is gained through competitively reviewed proposal processes. For larger projects that can include the complete range of activities from full reactor irradiations through post irradiation examination (PIE) studies and can last many years, the annual Consolidated Innovative Nuclear Research (CINR) solicitation is appropriate. For more “standard” user facility access, i.e. small projects with limited instrumentation time, the thrice yearly Rapid Turnaround Experiments solicitation is appropriate. Information on all aspects of the NSUF can be found at the website (nsuf.inl.gov).

Capabilities of the NSUF

Figure 58 illustrates the breath of capabilities offered through the NSUF and the institutions with which these capabilities are associated. The NSUF offers a full suite of neutron reactor irradiation capabilities covering a range of powers and fluxes. Gamma and ion irradiations are also possible, providing also coupled *in-situ* TEM observation capabilities with the latter. Critically important hot cell and shielded cell capabilities enable not only “classic” PIE studies but also advanced materials science studies on highly radioactive nuclear fuels and materials using state-of-the-art instrumentation. As to be expected, most of these are located at National Laboratories. Driven in large part by the application of focused ion beam (FIB) sample preparation techniques to radioactive materials, whereby very small samples can be prepared with concomitant reduction in radioactivity, even more advanced instrumentation has become available in laboratories able to handle materials with only low activity. Of particular note here are micro- and nano-mechanical property measurements, advanced microscopy, and high resolution chemical analysis (atom probe tomography). Specialized and intense beamlines available at other US national or institutional user facilities can be accessed through the NSUF and include X-ray, neutron, and positron spectroscopic and scattering analyses. Finally, in addition to all the experimental capabilities available for the study of nuclear fuels and materials, the NSUF offers high performance computing access at INL and promotes the coupling of experiment with modelling and simulation.

The NSUF continues to maintain and expand the Nuclear Energy Infrastructure Database (NEID) and the Nuclear Fuels and Materials Library (NFML), two initiatives undertaken to more effectively and efficiently utilize the nuclear energy assets of the US. Both databases are web-based searchable

tools with the former populated with a variety of linked information on instrumentation, facilities, and institutions and the latter populated with specimens and samples from irradiation tests performed over the decades. The NEID can assist users in formulating projects and enables DOE-NE to better manage their capabilities and future investments. The NFML is intended to reduce costs, avoid redundancy in irradiation tests, and secure irradiated fuels and materials for future studies as new ideas and instrumentation become available. Significant effort is being exerted to identify caches of materials, check and document the provenance of each, and position the materials in easy to access locations. The NSUF has recently begun work on the CoMET, the Combined Materials Experiment Toolkit, that will offer users an integrated platform incorporating the NEID, NFML, a subject matter expert database, and a projects database. CoMET will likewise be offered as a web-based searchable utility.

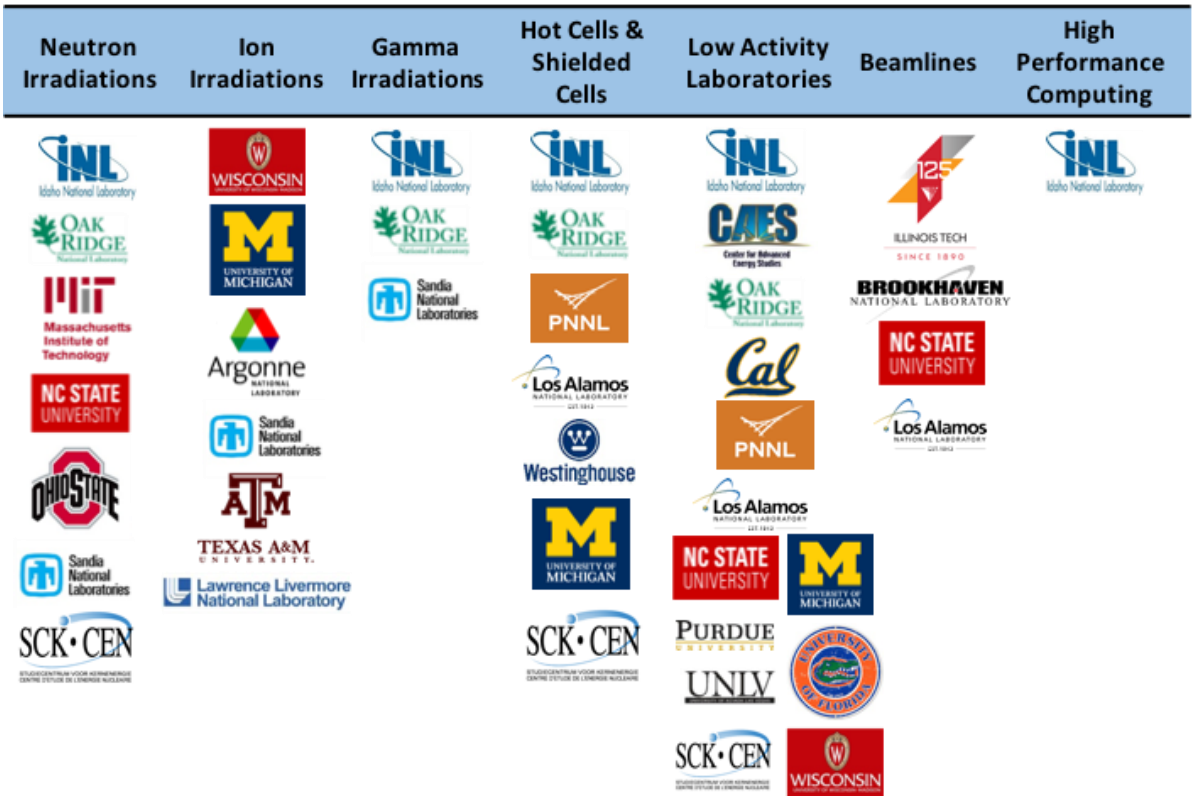

Figure 58: The capabilities of the NSUF according to the institutions that house them. The institutions are represented with their logos. (Figure courtesy of Brenden Heidrich and Alison Hahn).

Investigative Areas of the NSUF

The focus of the NSUF is irradiation effects in nuclear fuels and materials. Within this scope, NSUF projects investigate specific scientific questions that remain open to complete our understanding of the irradiation behavior of fuels and materials, regardless of the Technical Readiness Level of the material. Thus, NSUF projects study materials that are new and innovative all the way to materials that have been long implemented in the commercial realm in order to deepen our scientific understanding. Topical areas of NSUF projects include advanced fuels, advanced cladding and structural materials, radiation resistant materials, sensors, materials from advanced manufacturing techniques, fundamental understanding of reactor materials, welding and joining behavior of materials, and high-performance computing associated with modeling and simulation including model validation. Under these general topic areas, the NSUF currently manages and conducts approximately 130 projects both large and small.