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## **Expanding pre- and post-irradiation examination capabilities to include mechanical test frames**

**PI:** Sean Fayfar (MIT)

**Collaborators:** Gordon Kohse, Lance Snead (MIT)

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### **ABSTRACT:**

In this proposal, we suggest the continued modernization of Post-Irradiation-Examination capability at the Nuclear Reactor Laboratory (NRL) through the installation of two universal test frames (UTFs) within our newly commissioned Von Gahlen hot cells. The MIT Reactor (MITR) and the NRL are partners to the Nuclear Science User Facility (NSUF), providing unique abilities to irradiate materials and perform post-irradiation examination (PIE) to investigate the effects of irradiation on materials. While the irradiation capabilities at MITR are world-class, a prior de-prioritized of investment during difficult financial times resulted in deficiencies in certain basic PIE equipment at the NRL, essential for providing fundamental data to the NSUF and our local research community. This situation has been reversed over the last few years through the installation of modern thermophysical equipment. In this project, we aim to continue modernizing our capabilities by investing in high-quality, mechanical testing equipment, specifically by installing in-cell Shimadzu universal test frames. These “tabletop” test frames can produce stress-strain curves with a maximum force of 10 kN, maximum rate of 10 kHz, and maximum temperature of 1200 °C. Operating within our new Von Gahlen cells, this tabletop testing equipment allows for “campaign mode” operation, where the equipment is fixed to a transfer pallet and easily installed for a testing campaign, then cleaned, removed, and bagged awaiting the next campaign. This mechanical testing capability complements our recently installed PIE instrument suite which now includes a Netzsch Laser Flash Analyzer (LFA), Netzsch dilatometer DIL 402, profilometer, SEM/FIB, and Flash Differential Scanning Calorimeter (DSC). The combination of these techniques provides robust thermomechanical capabilities for NSUF projects to conduct irradiations and characterize the thermal and mechanical property changes at the NRL.

Upgrading the PIE capabilities at the MITR aligns with the goals of the DOE’s Office of Nuclear Energy (NE) by enhancing the research capabilities for NSUF projects. The next generation of reactors require new advanced materials, each of which needs thorough characterization to support and sustain reactors for their lifetime. Mechanical testing is crucial for screening a material’s irradiation behavior and providing engineering data on a range of properties such as tensile, compression, and fatigue behavior. As an important side benefit, carrying out mechanical testing within the NRL hot cells allows for the sectioning of the broken sample remains and other metallurgical samples in preparation for higher-value testing, such as TEM, SEM, X-ray diffraction. Since all this will be completed in hot cells, the cost and radiological burden of the PIE process will be reduced. Having this PIE equipment available at MITR will be instrumental in the development of new alloys, ceramic, fuel matrices, and composites within a reactor’s core as well as advanced moderators such as nuclear graphites and metal hydrides. As an educational institution, this upgrade will also expand MITR’s ability to attract students and educate them about the effects of irradiation on a material’s mechanical properties.