NEUP Nuclear Energy University Program
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Construction of a Flexible Fast Flux Facility for Cross Section Measurement, Benchmarking, and Education

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Abstract:
The goal of this NEUP-Infrastructure project is to construct, license and operate a facility that can be used to measure nuclear physics properties in a specific fast reactor flux specta. This project will deliver to the nation a Fast Flux Facility (FFF) that supports a variety of fast reactor designs including sodium, lead, and salt; through improved cross sections and neutronics codes for advanced reactor design and licensing. The FFF facility will be located in a specially designed and heavily shielded vault that is part of a new engineering building that opened in the late fall of 2021.

Advanced reactors, specifically fast-spectrum designs, are proposing to use materials in neutron spectra where there is little operating experience and data as compared to materials used in the light-water reactor fleet and spectra. Therefore, modeling and simulation, play a large role in the design and licensing of these advanced reactors. However, the lack of experimental data on the neutronic performance of the proposed materials causes a large amount of uncertainty in the computational models. Until the computational models can be validated and the uncertainty reduced, costly engineering safety margins will have to be built into the design. This, in turn, negatively impacts the economic competitiveness of advanced fast reactors. With a wide range of advanced reactor designs proposed, the FFF will be a flexible experimental facility that will be able to address the data needs of multiple advanced reactor designs.

Achievement of our goals, as defined above, will lead to more economically competitive fast reactor designs through more accurate modeling and simulation codes. Successful construction and operation of the proposed FFF, will make it a unique, flexible facility to provide highly accurate reactor physics measurements for cross section and modeling-code validation. With a lack of available experimental facilities capable of reproducing fast reactor neutronic environments, the FFF will provide invaluable data to support a more optimal design and licensing of advanced fast reactors. Developed artificial intelligence methods, coupled to reactor physics codes, allow a rapid design and reconfiguration of fuel, structural, and simulated coolant materials to tune the FFF spectrum to the neutron spectrum of choice.

The facility will be used for other research including the design and validation of optimal neutron filters for isotope production. The same codes used to design and optimize the FFF core will be used to design isotope production neutrons filters to reduce parasitic capture events and increase the interactions of interest. The FFF will be utilized to validate the filter designs and measure their performance.

The proposed FFF stands on a mature design concept and a significant investment ($129 M) from the University of Tennessee in a newly completed building which houses the Nuclear Engineering Department. The building has 23 new nuclear engineering laboratories including a heavily shielded space in the lower level specifically constructed for the preliminary design of the FNS. Having a fast flux facility located at the University of Tennessee will provide operational training and research experience to the largest Nuclear Engineering PhD program in the country and the second largest BS program. These opportunities can also be made available to others throughout the nation through the National Scientific User Facility network. The location near Oak Ridge National Laboratory will also allow the analysis of new short lived materials that may originate from the High Flux Isotope Reactor.