NUCLEAR ENERGY UNIVERSITY PROGRAMS

Improvements to Nuclear Data and Its Uncertainties by Theoretical Modeling

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Project Number: 09-783

Initiative/Campaign: AFCI/Reactors

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Abstract

This project addresses three important gaps in existing evaluated nuclear data libraries that represent a significant hindrance against highly advanced modeling and simulation capabilities for the Advanced Fuel Cycle Initiative (AFCI). This project will:

- Develop advanced theoretical tools to compute prompt fission neutrons and gamma-ray characteristics well beyond average spectra and multiplicity, and produce new evaluated files of U and Pu isotopes, along with some minor actinides
- Perform state-of-the-art fission cross-section modeling and calculations using global and microscopic model input parameters, leading to truly predictive fission cross-sections capabilities. Consistent calculations for a suite of Pu isotopes will be performed.
- Implement innovative data assimilation tools, which will reflect the nuclear data evaluation process much more accurately, and lead to a new generation of uncertainty quantification files. New covariance matrices will be obtained for Pu isotopes and compared to existing ones.

The deployment of a fleet of safe and efficient advanced reactors that minimize radiotoxic waste and are proliferation-resistant is a clear and ambitious goal of AFCI. While in the past the design, construction and operation of a reactor were supported through empirical trials, this new phase in nuclear energy production is expected to rely heavily on advanced modeling and simulation capabilities. To be truly successful, a program for advanced simulations of innovative reactors will have to develop advanced multi-physics capabilities, to be run on massively parallel super-computers, and to incorporate adequate and precise underlying physics. And all these areas have to be developed simultaneously to achieve those ambitious goals. Of particular interest are reliable fission cross-section uncertainty estimates (including important correlations) and evaluations of prompt fission neutrons and gamma-ray spectra and uncertainties.