



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
WASHINGTON, D.C. 20555-0001

Grant # 31310020M0006

Grantee: Rensselaer Polytechnic Institute

Title of Grant: Development of a Modular Paradigm to Enhance Monte Carlo Neutronics for NRC Comprehensive Reactor Analysis Bundle (CRAB)

Period of Performance: 9/25/2020-9/24/2023 (FY2020 Notice of Funding Opportunity NOFO)

Executive Summary

The objective of the proposed research program is to develop a modular and code-agnostic paradigm to enhance Monte Carlo neutronics capability for NRC Comprehensive Reactor Analysis Bundle (CRAB). Monte Carlo (MC) reactor analysis tools, such as MCNP, a widely used U.S. MC code, can play important roles in nuclear reactor analysis by providing required few-group cross section data or providing reference solutions to benchmark routine analysis tools. Built upon existing efforts of developing a user-friendly environment (editor services with syntactic validation) to prepare MCNP models, we propose to develop a general model-driven software interface (with semantic validation capabilities) for the use of MCNP and more importantly, implement the reactor model translation between MCNP and other tools in CRAB. Thus, NRC regulators can easily deploy MCNP (with minimum learning curve) and convert existing MCNP models of advanced reactor designs to other regulatory tools for licensing evaluations. The project will ultimately improve NRC's future capabilities and organizational effectiveness for analysis and evaluation of emerging or anticipated reactor and fuel cycle technologies.

Principal Investigator: Dr. Wei Ji, jiw2@rpi.edu

Presentations and Publications

The list of publications was submitted with the final report after grant expiration.

P.J. Kowal, K. A. Dominesey, C. E. Blake, R. A. Lefebvre, F. B. Brown, and W. Ji, "Monte Carlo Workflow Unification for Nuclear Reactor Analysis with Metamodel-Driven Modeling," under review, submitted to the *Nuclear Science and Engineering* (2023)

P. J. Kowal, C.E. Blake, and W. Ji, "Programmatic Modeling and Unification for Monte Carlo Codes," *Proceedings of International Conference on Mathematics and Computational Methods Applied to Nuclear Science & Engineering (M&C 2023)*, Niagara Falls, Ontario, Canada, August 13 – 17, 2023.

P. J. Kowal, "Enhancing Monte Carlo Modeling Workflows with a Metamodel-Driven Approach for Nuclear Reactor Analysis," PhD dissertation, Rensselaer Polytechnic Institute 2023.

P.J. Kowal, C. E. Blake, K. A. Dominesey, R. A. Lefebvre, F. B. Brown, and W. Ji, "Enhancing Monte Carlo Workflows for Nuclear Reactor Analysis with Metamodel-Driven Modeling," *Nuclear Science and Engineering*, **197**, 1600-1620 (2023)
<https://doi.org/10.1080/00295639.2022.2153617>

P.J. Kowal, C.E. Blake, J.A. McPherson, and W. Ji, "Monte Carlo Modeling Unification via a Metamodel-Driven Approach," *Trans. Am. Nucl. Soc.*, **127**, 1133-1136 (2022)

P.J. Kowal, C.E. Blake, K.A. Dominesey, and W. Ji, "A Programmatic Metamodel-Driven Modeling Paradigm for MCNP," *Proceedings of International Conference on Physics of Reactors 2022 (PHYSOR 2022)*, pp. 2985-2994, Pittsburgh, PA, USA, May 15-20, 2022

Patents

N/A