RAPID code system and its use for physics-based AI/ML model development

Haghighat A[1], Mascolino V[2], Stroh B[1]
[1]Virginia Tech, 900 N. Glebe Road, Arlington, Virginia, USA
[2]Colorado School of Mines, 1610 Illinois St., Golden, Colorado, USA

Objectives:
To present the RAPID code system, based on the Multistage Response-function Transport (MRT) methodology, and demonstrate how its real-time simulation capability and validated datasets can support the development of physics-based AI/ML models for reactor analysis, optimization, and digital-twin applications. Participants will learn to integrate RAPID and its Virtual Reality System (VRS-RAPID) for data-driven multiphysics modeling in an immersive visualization environment.

Expected Audience:
Researchers, graduate students, software developers, and industry engineers interested in nuclear-system simulation, digital twins, and AI/ML-enhanced modeling for design, safety, and operations.

Main Topics:

- Overview of MRT, RAPID formulations and its coding (Python and C++)
- RAPID modules for 3-D burnup (bRAPID) and kinetics (tRAPID)
- Benchmarking and validation using JSI TRIGA reactor experiments
- Integration of RAPID with VRS for real-time visualization
- Applications to AI/ML-based reactor digital twins

Requirements / Preparation:
Participants should bring a **personal laptop** with **Google Chrome** and wireless access; VRS-RAPID also runs on tablets/iPads. Prior to the workshop, attendees are encouraged to contact **Prof. Haghighat (haghighat@vt.edu)** to obtain login credentials for hands-on exercises. Basic familiarity with Monte Carlo or deterministic transport methods is helpful but not mandatory.