Contribution ID: **199** Type: **Oral Presentation**

#4-199 Development of an Event Tracking Feature in OpenMC for Neutron Noise Analysis.

We outline the development of explicit neutron noise simulations via Monte Carlo codes to determine integral kinetic parameters such as the prompt decay constant of fissile systems. Experimentally, measuring the prompt decay constant during steady-state reactor operation offers a non-invasive way to determine point kinetic parameters, which are important for predicting reactor behaviour during transients or can be used for code validation or nuclear data feedback. Simulating detector responses explicitly (i.e. tracking individual events as opposed to averaging scores) is necessary in certain scenarios, where e.g. the timing information of events is important –such as noise, time-of-flight or imaging experiments. Currently, this kind of capability is available in export controlled codes such as MCNPX PoliMi or MCNP 6.3. For this purpose, we present a new event tracking feature that we developed for OpenMC. OpenMC is a community-driven, open-source Monte Carlo radiation transport code. Tracking individual interactions in Monte Carlo transport can be memory-intensive, and thus the implementation consists of a suite of customizable filters—including reaction type, energy, cell, and material—in which it discriminates then saves single neutron interaction information. The user can also choose to save to a separate external file in two formats: OpenMC's native HDF5-based format or Monte Carlo particle lists (MCPL). With the main focus being on neutron noise simulation, we present how to use the new event tracking feature and how to determine integral kinetic parameters, such as the prompt decay constant, via the Rossi-alpha method. The Rossi-alpha method is a neutron noise analysis technique used to estimate the prompt neutron decay constant (α), which characterizes the time-dependent behaviour of neutron populations in a reactor. In this method, the time intervals between detected neutron events are measured and analysed statistically via auto-correlation. To achieve results to match with experiment we propose this simulation procedure: first, a k-static calculation is run, and the fission distribution is saved after convergence. This is followed by an external source simulation, where the source is defined as the saved distribution from the previous k-static simulation. In the external source simulation, filters from the event tracking feature are set to record individual fission events in the external file. After collecting a sufficient number of fission events, the Rossi-alpha method is applied to the data to calculate the prompt decay constant via curve fitting. We verified our OpenMC results with simulations conducted using Serpent 2, employing benchmark geometries like Godiva and Jezebel, as well as a model of the CROCUS zero-power research reactor. JEFF 3.3 was utilized as our library for nuclear data in both OpenMC and Serpent 2. We also provided a first validation case of the feature for critical and subcritical states of the CROCUS reactor from previous experimental campaigns. The calculated prompt decay constants in OpenMC showed agreement with the simulation in Serpent 2 as well as with the experimental data of CROCUS. Our results therefore confirm the reliability of the new feature in accurately simulating noise experiments. The feature is intended to be part of the official OpenMC release and paves the way to open source Monte Carlo simulations of reactor physics experiments.

Primary author: SALIBA, Michel (École Polytechnique Fédérale de Lausanne)

Co-authors: PAUTZ, Andreas (Ecole Polytechnique Fédérale de Lausanne); PAKARI, Oskari (EPFL)

Presenter: SALIBA, Michel (École Polytechnique Fédérale de Lausanne)

Session Classification: #04 - Research Reactors and Particle Accelerators

Track Classification: 04 Research Reactors and Particle Accelerators