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Lessons Learned from the BEAVRS Benchmark

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With escalating costs of nuclear experiments, there has been a growing reliance on Monte Carlo simulations for the design of advanced reactors and the "validation"of high-fidelity deterministic transport codes, but validation is also needed for Monte Carlo codes. The current integral experimental database is composed of many simple critical experiments and small research reactors, but often lack the complexity and pitfalls of real nuclear systems. In this talk, I will present the BEAVRS benchmark that was developed as a realistic test of high-fidelity methods and discuss some of the limitations of both the methods and benchmark. The benchmark has been used by many groups to test both deterministic and stochastic codes with great success, but the results also highlight some of the limitations of the benchmark from the difficulties in modelling the geometric complexity of a relatively "simple"reactor design to the limitations of the measurement acquisition systems. Additionally, while the design is meant to be symmetric, a large tilt is observed in the core detector measurements which is unexplained from the core description. Without accounting for this tilt through post-processing of the results, the comparison with high-fidelity codes is quite poor and the addition of corrections increases the uncertainties of the measurements.

The benchmark and the results gathered from the literature also present another interesting conclusion in that deterministic codes provide just as good results at the Monte Carlo results. While this is not entirely surprising since no one publishes bad results, it also highlights the fidelity of multigroup self-shielding methods and the limitations of Monte Carlo codes in getting statistically significant results in many small regions and convergence issues on such large systems.

In the latter part of this presentation, a recent validation effort for the energy domain will be presented. An analytical benchmark was developed where the flux is resolved analytically in energy. This benchmark definition relies on the pole representation of nuclear data and provides an analytical expression for the scalar flux. Additionally, the benchmark was extended to also compute the adjoint flux, thus allowing for the validation of uncertainty quantification methods.

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