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OpenMC: a modern, high-performance nuclear design and analysis toolkit for fusion power plants

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Aggressive timelines for commercial fusion deployment by the private sector necessitate rapid design iterations to facilitate the build-measure-learn cycle. Many challenges to this process arise in the design of fusion power plants due to the highly integrated nuclear nature of these systems. In particular, nuclear responses throughout the facility are responsible for establishing requirements across many different subsystems; from the safety and shielding requirements of surrounding buildings to the detailed nuclear heating and activation of materials like superconducting magnets, these analyses span the entire lifetime of the facility from design & procurement to construction to operation and decommissioning. This talk discusses the complexities of fusion nuclear analyses and presents the rapidly expanding fusion design capabilities of the open source, community-developed, Monte Carlo code, OpenMC. Over the past five years, many critical features have been added to the code including fixed source transmutation methods, Rigorous 2-Step and Direct-1-Step shutdown dose rate workflows, advanced variance reduction techniques, novel hybrid stochastic-deterministic methods for adjoint transport solutions, and much more. Furthermore, theses tools have undergone, numerous validation studies across many applications, and have been used within uncertainty quantification workflows for determining engineering margins. This talk presents the wealth of recent community-developed features in OpenMC for fusion power plant design and the associated widespread impact across academia, industry, and international organizations.

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