

Overview of the capabilities in the Multiphysics Object Oriented Simulation Environment and recent activities in modeling and simulation for fusion energy systems

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The Multiphysics Object Oriented Simulated Environment (MOOSE) is being developed by United States National Laboratories and partner institutions around the world to support multi-fidelity multi-physics modeling and simulation of advanced nuclear systems. Among its many physics modules, it offers computational fluid dynamics, thermal hydraulics, solid mechanics (including contact), and electromagnetics capabilities. These are further extended by applications leveraging MOOSE's finite element and finite volume capabilities, such as the Tritium Migration Analysis Program version 8 (TMAP8) code for tritium transport, Cardinal for high-fidelity Multiphysics, and the Software for Advanced Large-scale Analysis of MAGnetic confinement for Numerical Design, Engineering & Research (SALAMANDER) code for scrape-off layer kinetic plasma analysis and blanket modeling. The tools cover a wide range of applications, are leveraged by academic and private actors, and are supported by an international community of institutions and developers. Further, MOOSE and many MOOSE-based applications follow the Nuclear Quality Assurance, Level 1 (NQA-1) software quality assurance standard, enabling trusted code and model development suitable for licensing of device designs.

In this presentation, we will introduce and highlight features developed in MOOSE for multiphysics coupling over the last few years, summarize the open-source applications available online for fusion energy modeling, and present on projects and collaborations of interest to the community, notably the newly developed capability to create Functional Mockup Units (FMU) using MOOSE. Please note that projects pertaining to modeling divertor components using MOOSE and Salamander will be the focus of a sister presentation.

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