

Kinetic Plasma Simulation in the MOOSE Framework



NC STATE UNIVERSITY

Grayson S. Gall¹, Logan H. Harbour², Casey T. Icenhour²,
Pierre-Clément A. Simon², Derek Gaston², Amanda M. Lietz¹

¹North Carolina State University, North Carolina, USA
²Idaho National Laboratory, Idaho Falls, Idaho



Abstract

As interest in producing energy from magnetic confinement fusion has increased in recent years, unsolved engineering challenges that prevent bringing this technology to the grid have also become more important than ever. One such challenge is the design of plasma facing components (PFCs). In order to create high-fidelity multiphysics simulations of these systems, a new Multiphysics Object-Oriented Simulation Environment (MOOSE)-based framework is being developed, the Fusion Energy Integrated multiphys-X (FENIX) framework. While other frameworks for modeling PFCs exist [1, 2, 3, 4], FENIX is open-source, meets high software quality standards, and leverages the unique capability of the MOOSE framework to tightly couple relevant physics. FENIX builds on several core MOOSE modules—Electromagnetics, Heat Transfer, Ray Tracing, Solid Mechanics, and Thermal Hydraulics—as well as existing MOOSE-based applications: the Tritium Migration Analysis Program, Version 8 (TMAP8) and Cardinal. This work focuses on the development of discrete-particle-based simulations for kinetic plasma modeling using a technique commonly known as Particle In Cell (PIC).

Left Section 2

Middle Section 1

Middle Section 2

Right Section 1

Right Section 2

Acknowledgements

References

[1] V Badalassi et al. “FERMI: fusion energy reactor models integrator”. In: *Fusion Science and Technology* 79.3 (2023), pp. 345–379.
X Bonnin et al. “Presentation of the New SOLPS-ITER Code Package for”. In: *Plasma and Fusion Research* 11.Specialissue1 (2016), pp. 1–6.
Jeff Candy. *AToM (Advanced Tokamak Modeling)*. Tech. rep. General Atomics, San Diego, CA (United States), 2017.
Arpan Sircar et al. *FERMI: A multi-physics simulation environment for fusion reactor blanket*. Tech. rep. Lawrence Livermore National Lab.(LLNL), Livermore, CA (United States), 2022.