BLUE WATERS
SUSTAINED PETASCALE COMPUTING

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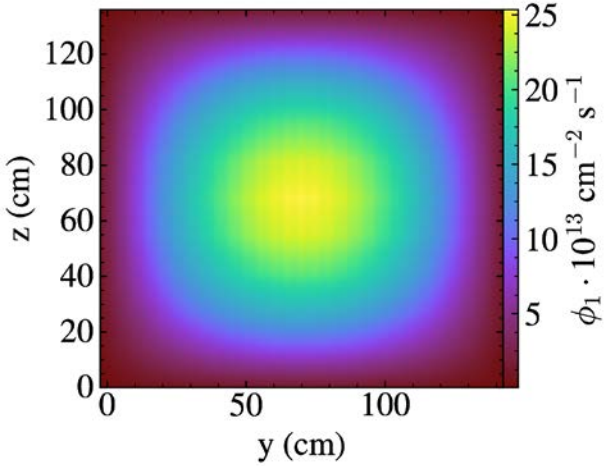

The neutron flux in a 2D cylindrical axisymmetric model of a molten-salt reactor. This flux has the anticipated magnitude and canonical cosine shape (r = 0 is center of core) and is undergoing validation against experimental results from the Molten-Salt Reactor Experiment

COUPLED MULTI-PHYSICS OF ADVANCED MOLTEN SALT NUCLEAR REACTORS

Research Challenge

- The current state-of-the-art advanced nuclear reactor simulation (e.g., the CASL DOE innovation hub) is focused primarily on traditional light-water reactor design types.
- This work extends state of the art nuclear reactor simulation for more advanced reactor designs that have the potential to improve the safety and sustainability of nuclear power.
- High-fidelity simulation of dynamic reactor performance of these designs requires development of models and tools for representing unique materials, geometries, and physical phenomena.

Methods & Codes

- Moltres is a collection of physics kernels material definitions, to extend the ecosystem of applications built on the highly scalable, fully implicit, Multiphysics Object-Oriented Simulation Environment (MOOSE) framework from Idaho National Laboratory.
- MOOSE and LibMesh translate data from Moltres into inputs for solution routines.

Results & Impact

- A first-of-its-kind, scalable, finite-element model of the transient neutronics and thermal hydraulics in a liquid-fueled molten salt reactor design.
- Future Moltres work includes generating a high-fidelity, 3D model as well as investigating various transient accident scenarios, additional reactor configurations, and numerous design concepts.

Why Blue Waters

There is a need for many CPU cores to process the many two-dimensional and three-dimensional finite-elements needed to assess nuclear reactor performance under a various conditions and dynamic transients. These simulations often occupy tens of thousands of CPU cores at a time and vary in completion time. Transient and multiscale simulations, which require greater capability per simulation, are on the horizon for our work. These may occupy up to 100,000 CPU cores at a time.