Introduction to OpenMC

Technical Meeting on the Development and Application of Open-Source Modelling and Simulation Tools for Nuclear Reactors

Milan, Italy

June 20th, 2022

Objectives

The overarching objectives of the OpenMC project:

- Open source contribution model, freely available
- Extensible for research purposes
- Adopt best practices for software development
- Ease of installation, minimize third-party dependencies
- High performance, scalable on HPC resources
- Use best physics models when possible
- Fun to use with a thriving user and developer community!

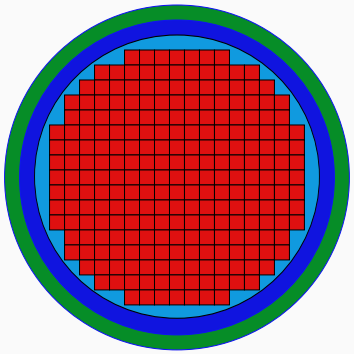
OpenMC: Overview of features

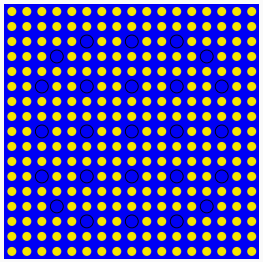
- **Modes**: Fixed source, k-eigenvalue calculations, stochastic volume calculation, geometry plotting
- **Geometry**: Constructive solid geometry, CAD-based, unstructured mesh (tallies only)
- **Solvers**: Neutron and photon transport, depletion
- **Data**: Continuous energy or multigroup cross sections, multipole for Doppler broadening

What makes OpenMC unique?

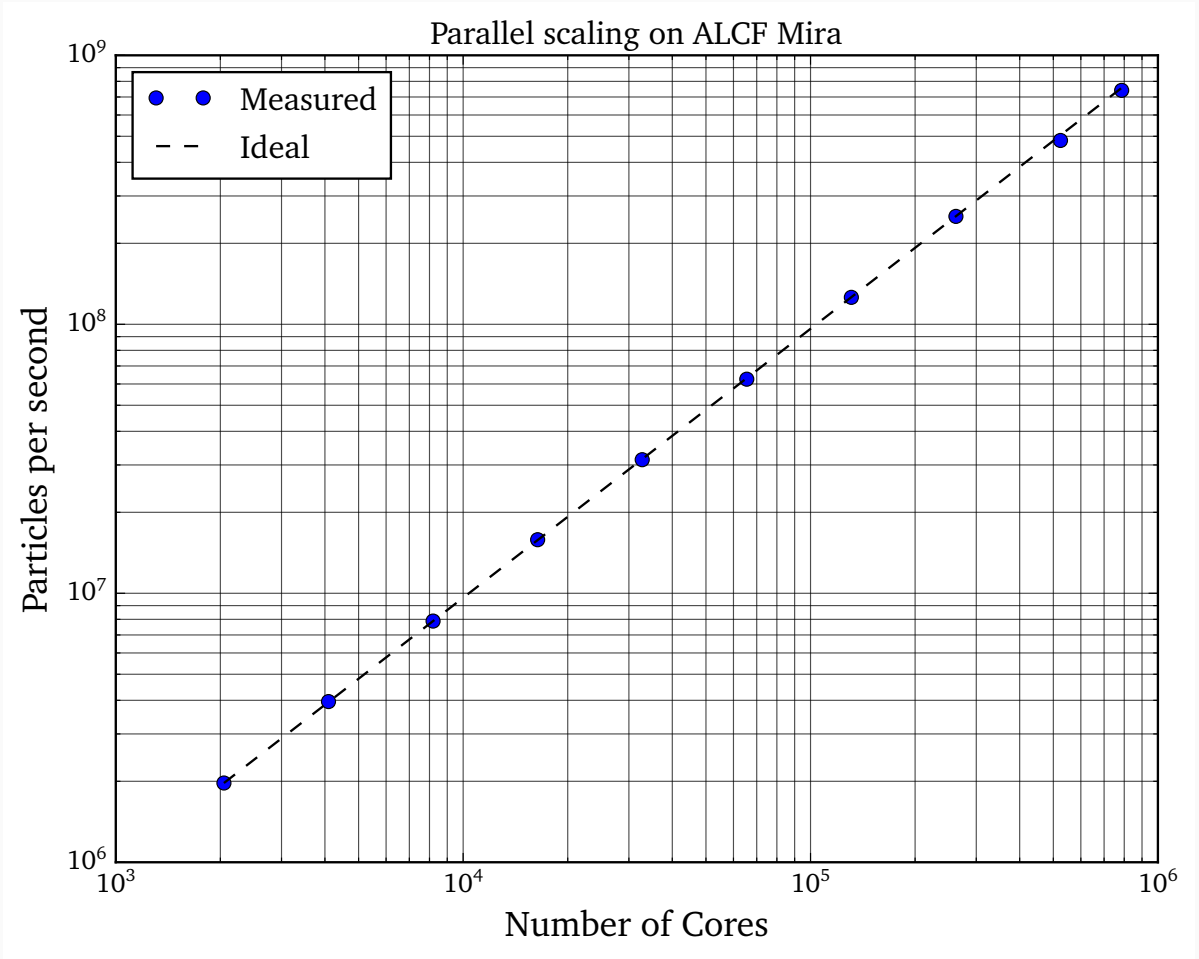
- Programming interfaces (C/C++ and Python)
- Nuclear data interfaces and representation
- Tally abstractions
- Parallel performance
- Development workflow and governance

Parallel Performance


Core


Assembly

- ALCF Mira supercomputer
- 49,152 nodes, 786,432 cores
- 4 hw threads/core = 3,145,728 threads



Software Architecture

- Mixed **C++** and **Python** codebase
- **CMake** build system for portability
- Distributed-memory parallelism via **MPI**
- Shared-memory parallelism via **OpenMP**
- Version control through **git**
- Code hosting, bug tracking through **GitHub**
- Regression/unit tests run on **GitHub Actions** CI platform

Other Capabilities

- Depletion
- Multi-group cross sections
- CAD-based geometry
- Unstructured meshes
- Python C-API

Resources

- **Code:** https://github.com/openmc-dev/openmc
- **Docs:** https://docs.openmc.org
- **Nuclear Data:** https://openmc.org
- **Forum:** https://openmc.discourse.group
- **Examples:**
  https://github.com/openmc-dev/openmc-notebooks

Workshop Logistics

Logistics

- Instructors: Patrick Shriwise, Jon Shimwell, Ben Forget, and others
- We will provide each of you with a unique URL that lets you connect to a Jupyter Lab instance running on a cloud server with OpenMC preinstalled
  - **URL**: https://oncore-#.openmccourse.org
  - **Password**: openmc2022
  - https://tinyurl.com/oncore-22-urls
- Due to time constraints we won't be covering Python basics today, but here is a link to a "cheat sheet"
- Follow along and type the same commands as we go (or not!)
- Feel free to ask questions on (either live or on the chat) at any point