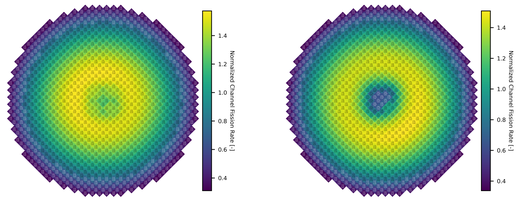
ARFC: **Advanced Reactors** and **Fuel Cycles**

PI: **Prof. Katy Huff**, kdhuff@illinois.edu

Moltres

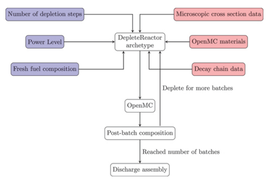
S_N-D method for accurate time-dependent control rod modeling in Moltres, an open-source MOOSE application for the simulation of molten salt reactors [1].



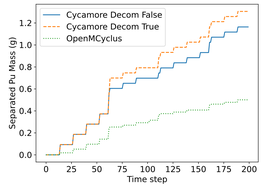
MSRE full core scalar flux error as calculated with pure diffusion, $S_N - D$, and OpenMC for all control rods removed (left) and all control rods inserted (right)

OpenMCyclus

Reactor-physics informed fuel cycle analysis on the impacts of deploying HALEU-fueled reactors using OpenMCyclus, a coupling of OpenMC with Cyclus [2].



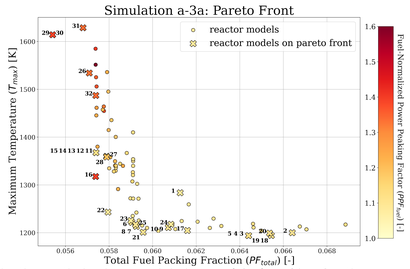
Depletion methodology in OpenMCyclus. Blue comes from Cyclus and Red is provided through user-inputs.



Comparison of the cumulative mass of separated plutonium traded after using the OpenMCyclus and Cycamore reactor.

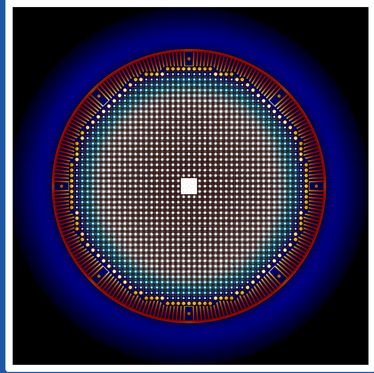
ROLLO

Evolutionary algorithm techniques applied to optimize nuclear reactor design by coupling nuclear software to the DEAP evolutionary algorithm driver [3] .



Triple-objective optimization to minimize total fuel packing fraction, max temp, and fuel-normalized power peaking factor in the one-third assembly

Coupled Multiphysics of Advanced Reactors



Nuclear Fuel Cycle Analysis

Advanced Computation

Open-Source Nuclear Research Codes

OpenMC

ROLLO

Moltres

https://arfc.github.io/

U.S. DEPARTMENT of ENERGY

National Nuclear Security Administration

U.S.NRC

OAK RIDGE National Laboratory

Argonne NATIONAL LABORATORY

Idaho National Laboratory
70 YEARS OF SCIENCE & INNOVATION

References

[1] S. M. Park, "Advancements in Moltres for Time-Dependent Multiphysics Molten Salt Reactor Modeling," Doctoral Dissertation, University of Illinois Urbana-Champaign, Urbana, 2025.

[2] A. M. Bachmann, "Investigation of the impacts of deploying reactors fueled by high-assay low enriched uranium," Doctoral Dissertation, University of Illinois at Urbana-Champaign, 2023.

[3] G. J. Y. Chee, "Fluoride-Salt-Cooled High Temperature Reactor Design Optimization with Evolutionary Algorithms," Doctoral Dissertation, University of Illinois at Urbana-Champaign, Urbana, 2022.

[4] Z. Richter, E. Davidson, S. Skutnik, and M. Munk, "MODELING AND SIMULATION OF AN XE-100 TYPE PEBBLE BED GAS-COOLED REACTOR WITH SCALE," Technical Report ORNL/TM-2023/2959, 2023.

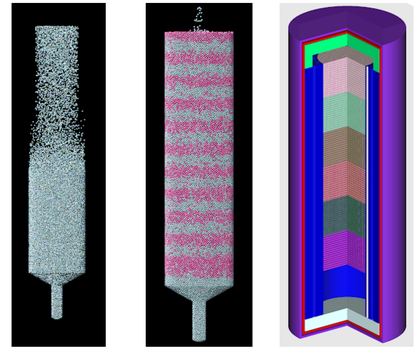
ARFC

Physics of Advanced Reactors

Variance reduction methods for time-dependent Monte Carlo neutron transport.

Updated models of DNP group parameters for Molten Salt Reactors.

Computational modeling of flowing pebble-bed reactor systems.

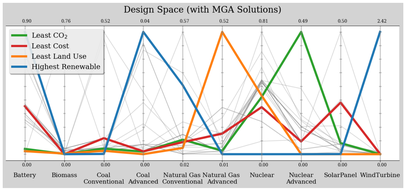


Simulation of a generic pebble bed HTGR core being filled (left) and online pebble recirculation (middle) using LAMMPS, and a Xe-100-like full-core pebble bed HTGR (right) using SCALE [4].

Fuel Cycle and Energy System Optimization

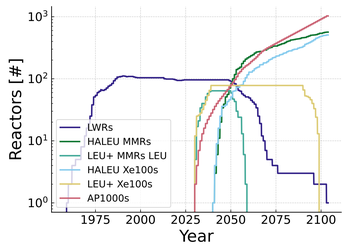
Modeling and simulating scaled isotopic consequences of deploying Accelerators Driven Systems.

Techno-economic analysis of hybrid nuclear renewable energy systems (e.g. hydrogen microgrids).



The design space for a four objective problem including alternative solutions suggested by MGA.

Fuel cycle transition scenarios for advanced reactors.



Greedy AP1000 deployment along with Xe-100s and MMRs fueled by LEU+ and HALEU fuel.