3D Multiphysics Analyses to Support Low Enriched Uranium (LEU) Conversion of HFIR

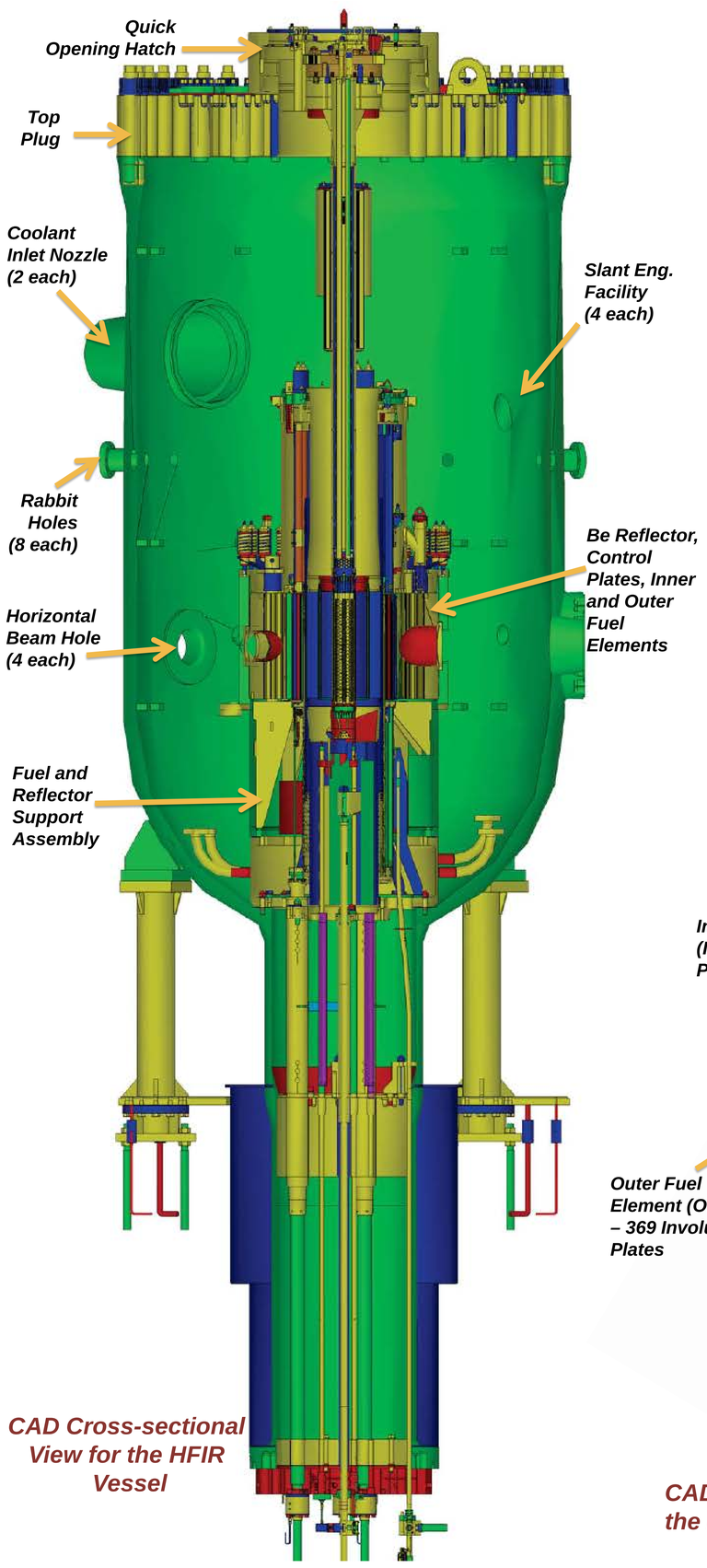
OAK RIDGE National Laboratory | RNSD Reactor and Nuclear Systems Division

Prashant K. Jain and James D. Freels

jainpk@ornl.gov, freelsjd@ornl.gov

HFIR | U.S. DEPARTMENT OF ENERGY

High Flux Isotope Reactor (HFIR)



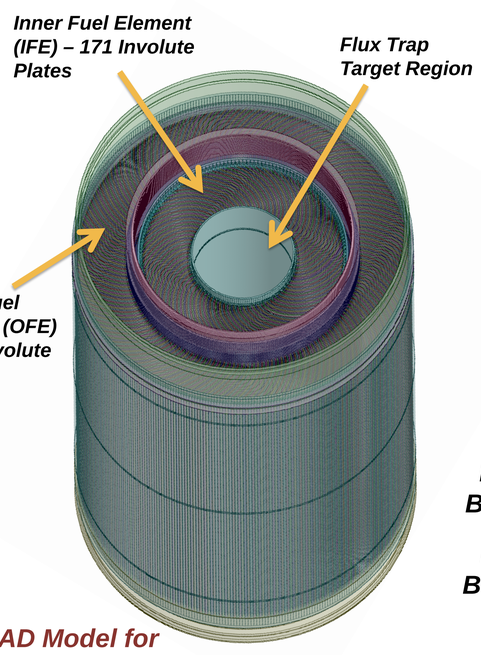
CAD Cross-sectional View for the HFIR Vessel

Operated since 1966 with one of the world's highest thermal neutron fluxes ~2.5x10^{15} neutrons/(cm^2-s)

Involute-shaped fuel plates, beryllium reflected, light water-cooled and –moderated, pressurized, flux-trap type research reactor

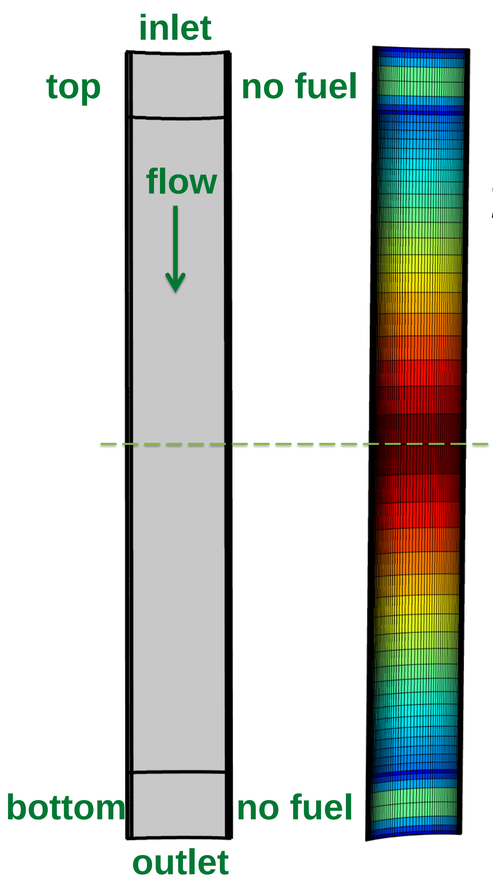
Highly enriched uranium (~93% ^{235}U/U) fuel embedded in aluminum-6061 clad

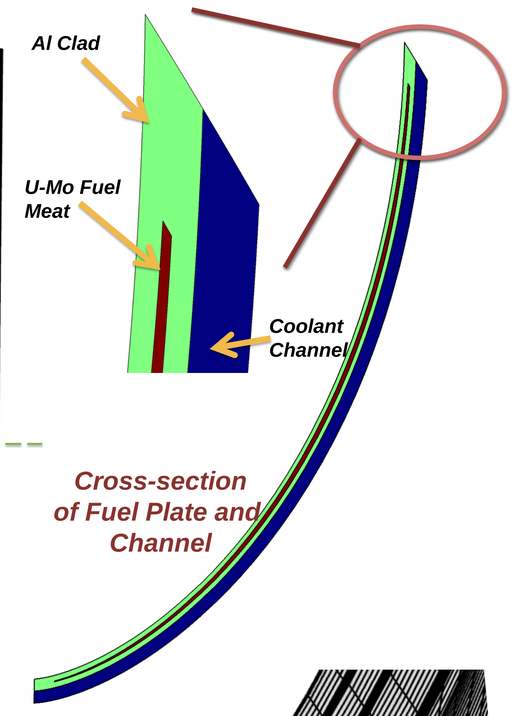
Cold and thermal neutron scattering, materials irradiation, isotope production, neutron activation analysis



CAD Model for the HFIR Core

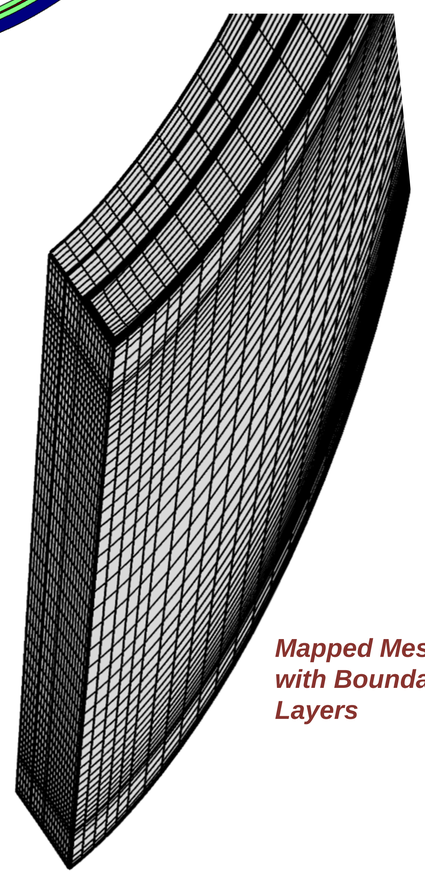
COMSOL Thermal-Hydraulics Models for the HFIR Core





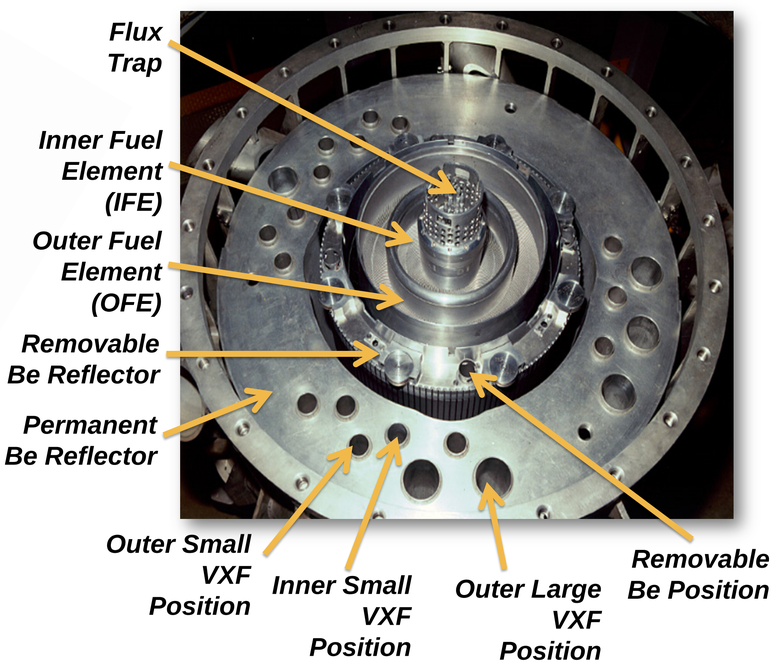
Cross-section of Fuel Plate and Channel

COMSOL Geometry and Meshing for the HFIR Plate-Channel Model

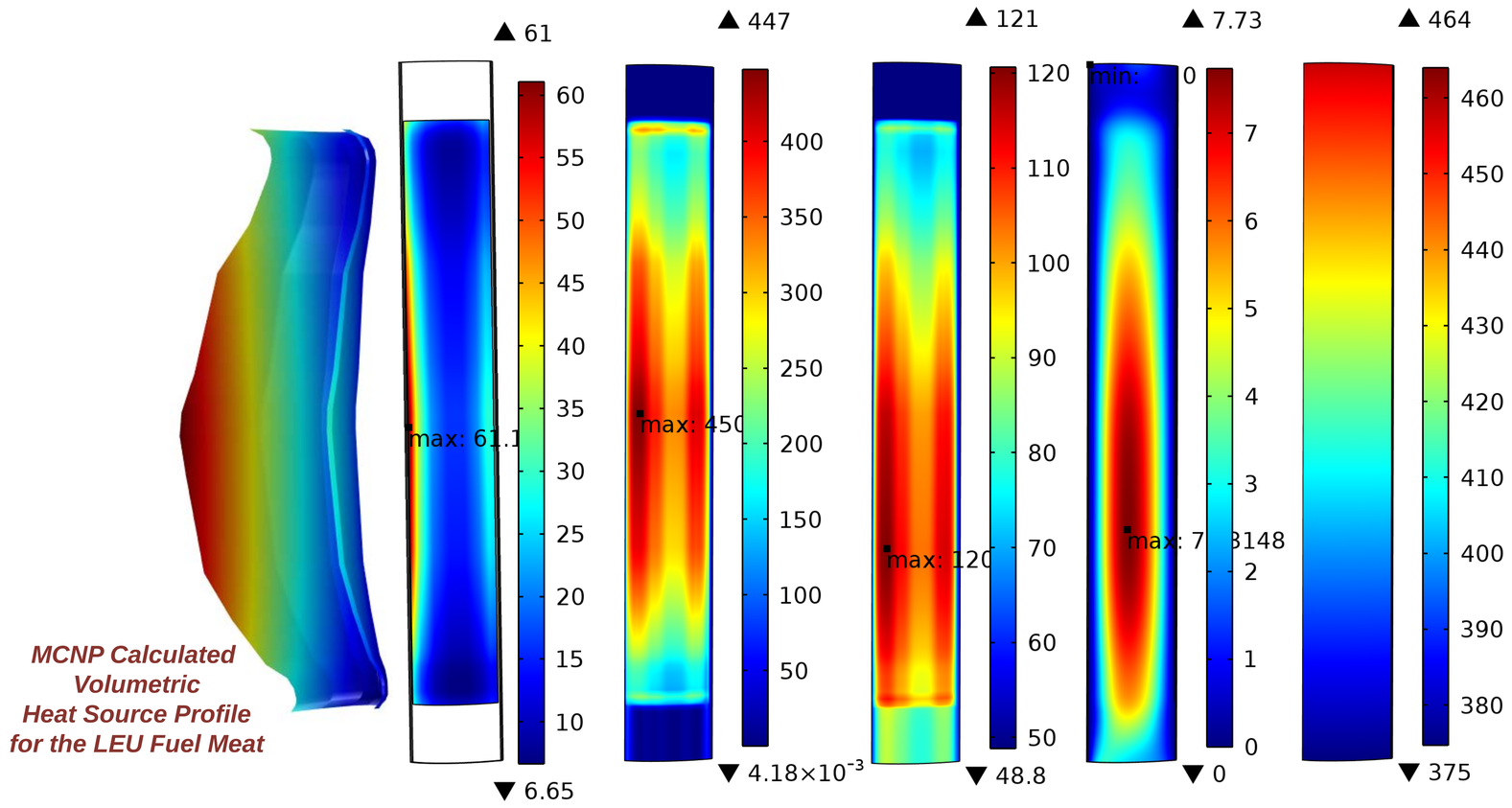


Mapped Mesh with Boundary Layers

HFIR Core Facilities



Inner Fuel Element under 100 MW Nominal Conditions



MCNP Calculated Volumetric Heat Source Profile for the LEU Fuel Meat

Volumetric Heat Source (kW/cm^3) | Clad Surface Heat Flux (W/cm^2) | Clad Surface Temperature (C) | Plate Deflection (mil) | Coolant Pressure (psi)

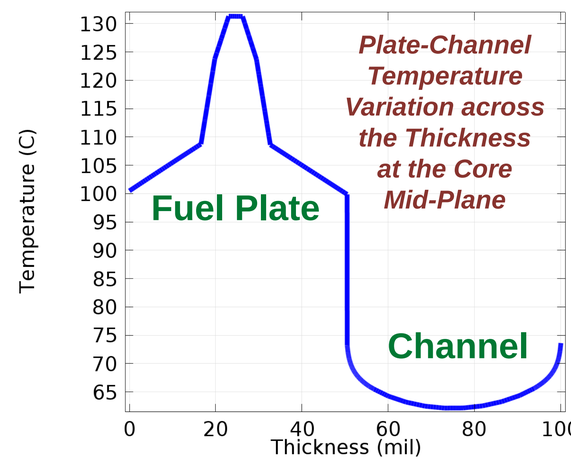


Plate-Channel Temperature Variation across the Thickness at the Core Mid-Plane

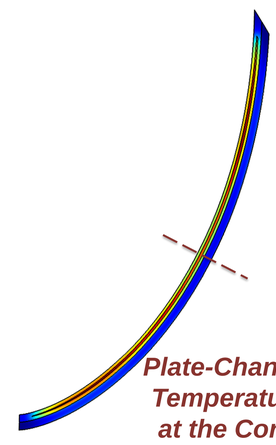
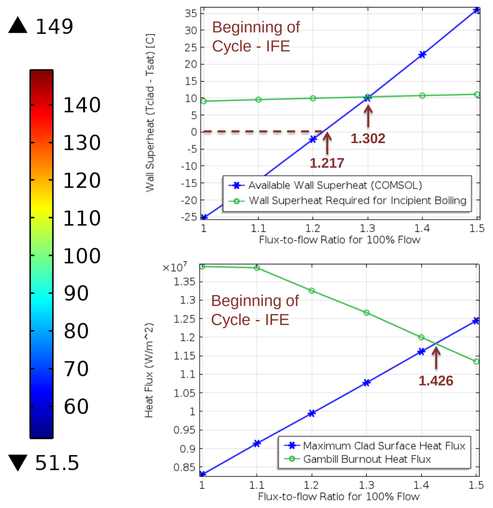


Plate-Channel Temperature at the Core Mid-Plane (C)



Excerpt from the Proceedings of the 2014 COMSOL Conference in Boston