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Nuclear Energy University Programs (NEUP) Fiscal Year (FY) 2016 Annual Planning Webinar

RC-03: Computational Methodologies to Support Design and Analysis of Sodium-cooled Fast Reactors

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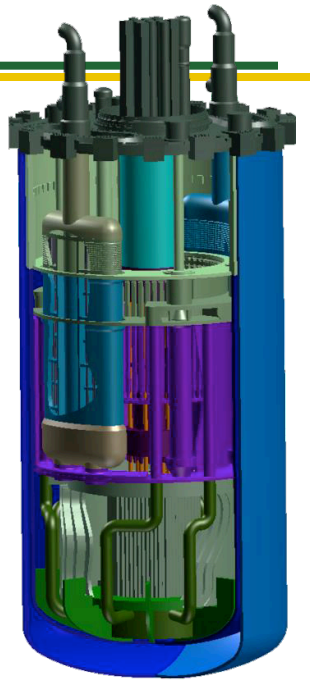
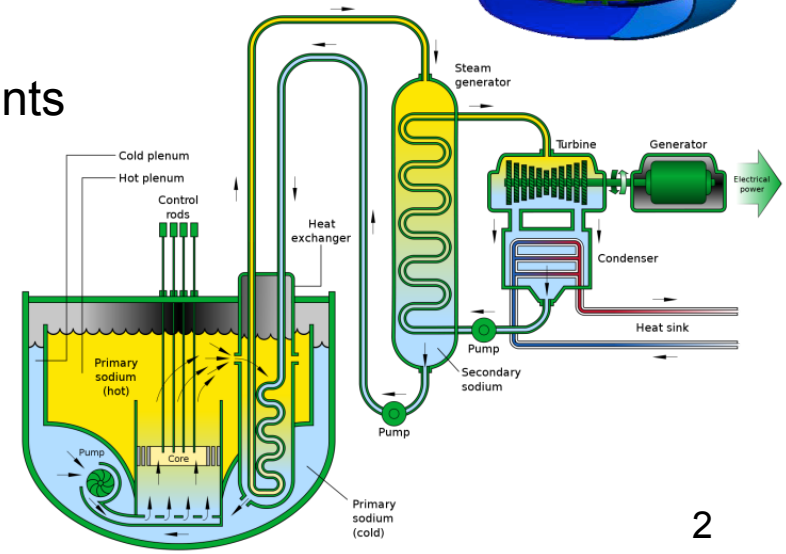
ART Fast Reactor Methods Program Objectives

- **Develop and validate computational tools to support design and analysis of Sodium-cooled Fast Reactors**
  - Neutronics / Thermal-Hydraulics / Structural Mechanics
  - Systems Analyses to Support Integral Plant Behavior
    - Reactor core, primary and intermediate coolant systems, decay heat removal systems, sodium accidents, containment response
  - Normal Operations and Postulated Accidents
- **Raise technical readiness of SFR Concepts**
  - Support commercial deployment





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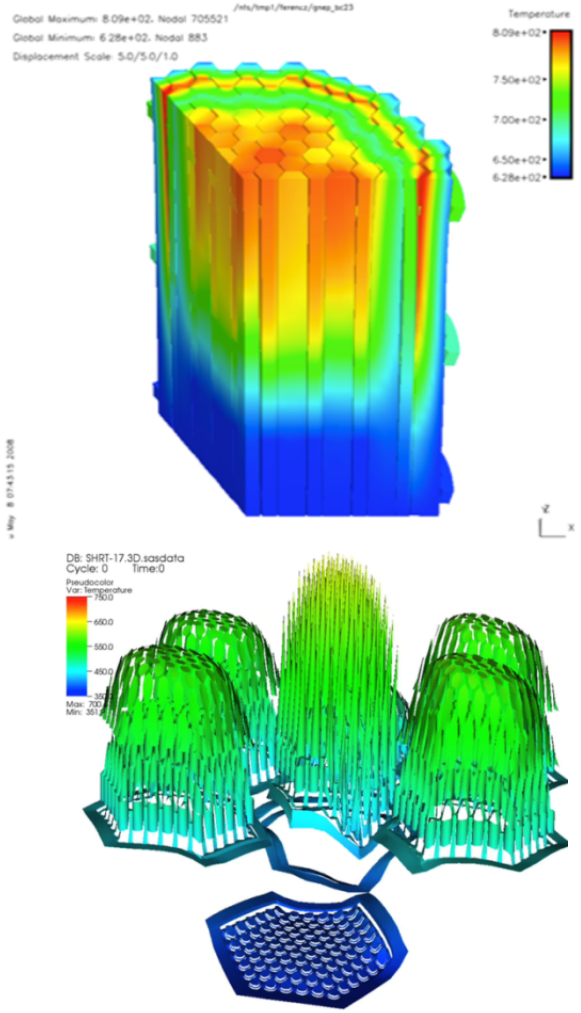
ART Fast Reactor Methods Program Overview

- **Sodium-cooled Fast Reactor neutronics analysis tools and methods**
  - Point and space-time kinetics
  - Neutron transport
  - Complex reactivity feedback mechanisms
    - Doppler, sodium density and void worth, fuel/clad axial expansion, core radial expansion etc.
- **Thermal-hydraulics analysis tools**
  - Systems analysis codes for whole-plant transient analyses and modeling inherent safety behavior
  - Computational Fluid Dynamics (CFD) methods for component modeling with very low Prandtl-number liquid metal flow and heat transfer
- **Thermo-structural analysis tools**
  - Core/fuel behavior and primary coolant boundary
  - Containment response to sodium fires



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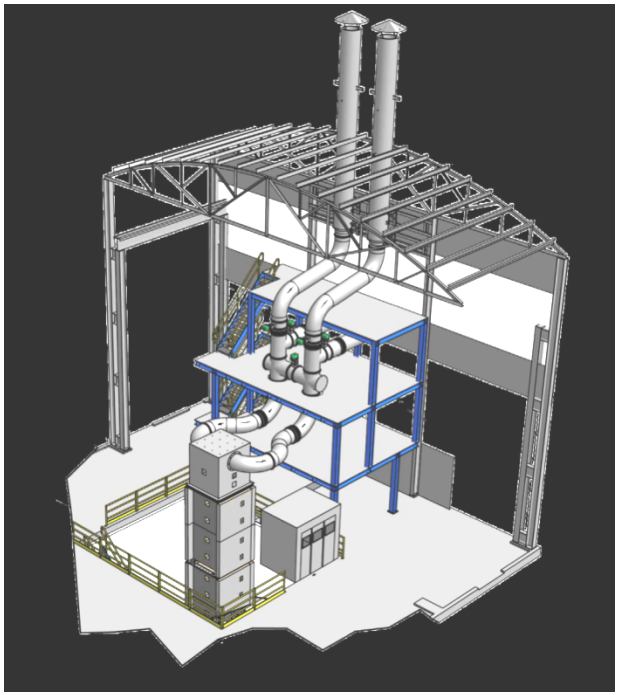
ART Fast Reactor Methods Program Current Activities

- **Experimental Work**
  - Archiving past integral transient testing data from EBR-II, FFTF, and TREAT reactors to support code validation efforts
- **Code development activities**
  - Enhancement of SAS4A/SASSYS-1 systems analysis code to support accident analysis including ATWS events
  - Incorporating sodium accident analysis capabilities of CONTAIN-LMR under MELCOR code to support containment design-basis assessments with respect to sodium fires



Strong consideration will be given to continued enhancement, validation & verification, and use in uncertainty analyses of the above codes and analysis capabilities

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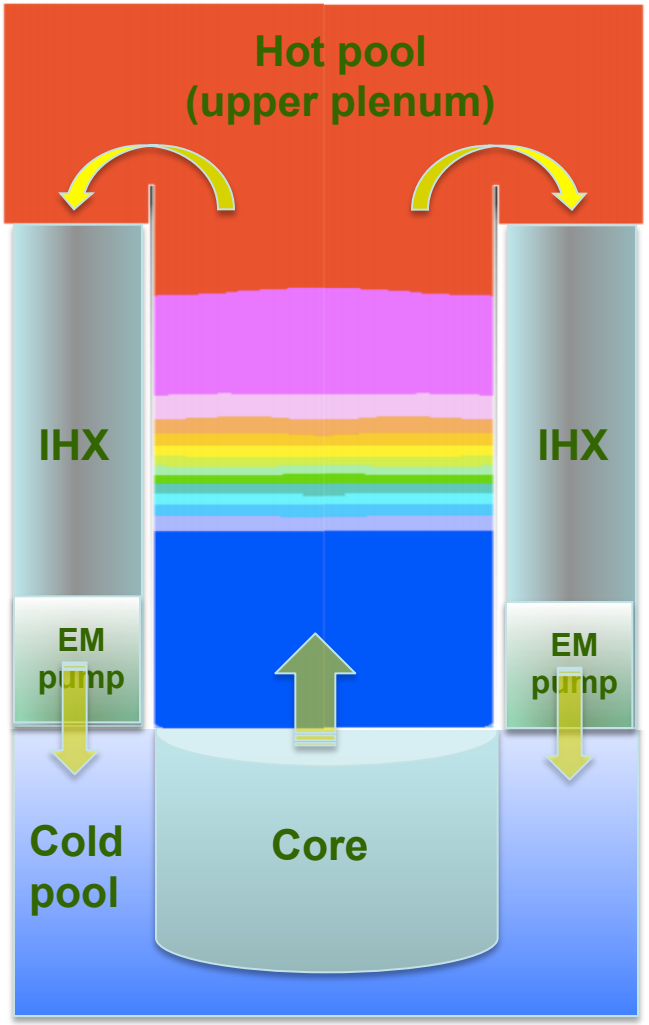
Specific FY16 Topic of Interest

- **In FY16, contributions to development and validation of reduced-order thermal stratification models is sought**
  - In system analyses, the reactor plena are typically modeled as mixed 0-D volumes
  - Computational resource requirements make 3-D CFD tools prohibitively expensive within the context of system analyses
  - Therefore, the reduced-dimension and/or reduced-fidelity modeling approaches are needed to predict natural circulation flow rates in decay heat removal
- **Development and assessment of thermal stratification models or proposals that provide the experimental data needed for validation of these models will be primarily considered**



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Summary

- **Develop tools to support design and analysis of Sodium-cooled Fast Reactors to raise technical readiness and support commercial deployment**
  - Emphasis on development of an integrated multi-physics system analysis tools and validation of their components/modules
- **Strong consideration given to enhancement, verification and validation of state of the art codes and analysis capabilities**
  - Development of advanced modules and/or conducting tests to provide validation data
- **Specific topic of interest in FY16**
  - Modeling mixing and thermal stratification in upper plenum of a pool type SFR with reduced-order methods for accurate prediction of natural circulation decay heat removal

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