NNL Transport Code - MC21

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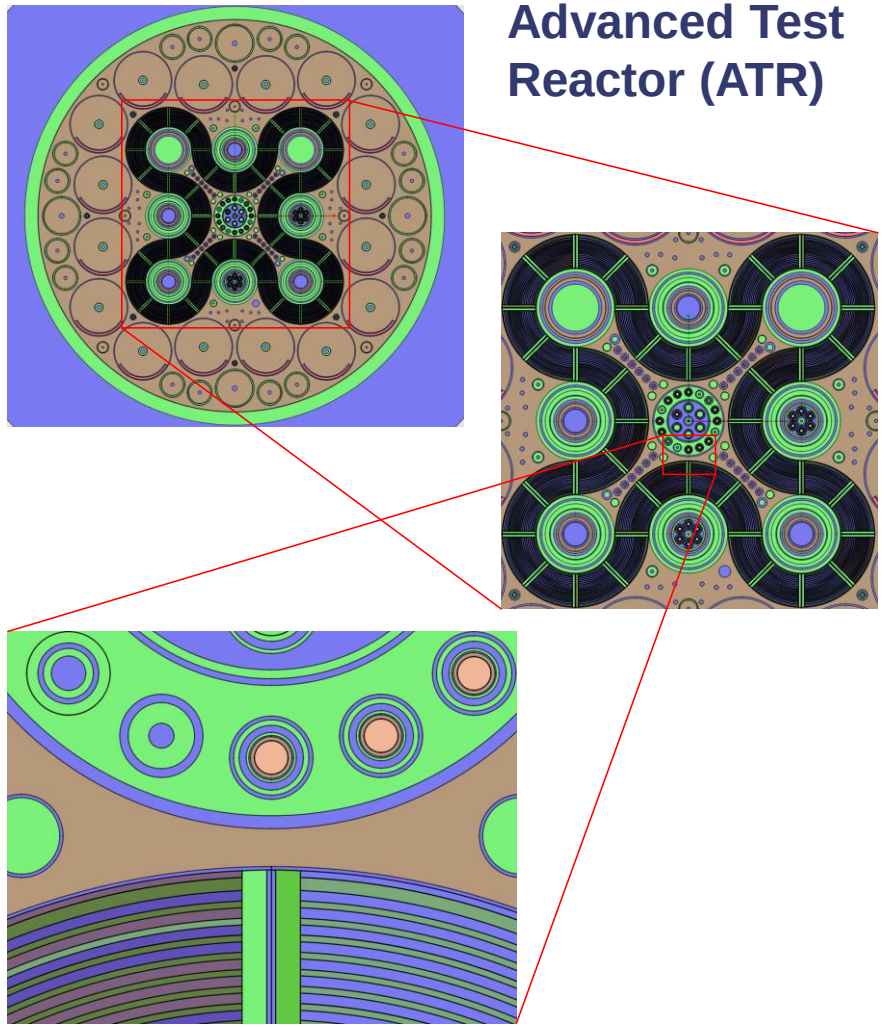
MC21 Applications

- Reactor Engineering
- Reactor Physics Design
- Criticality Safety
- Radiation Shielding

MC21 Capabilities

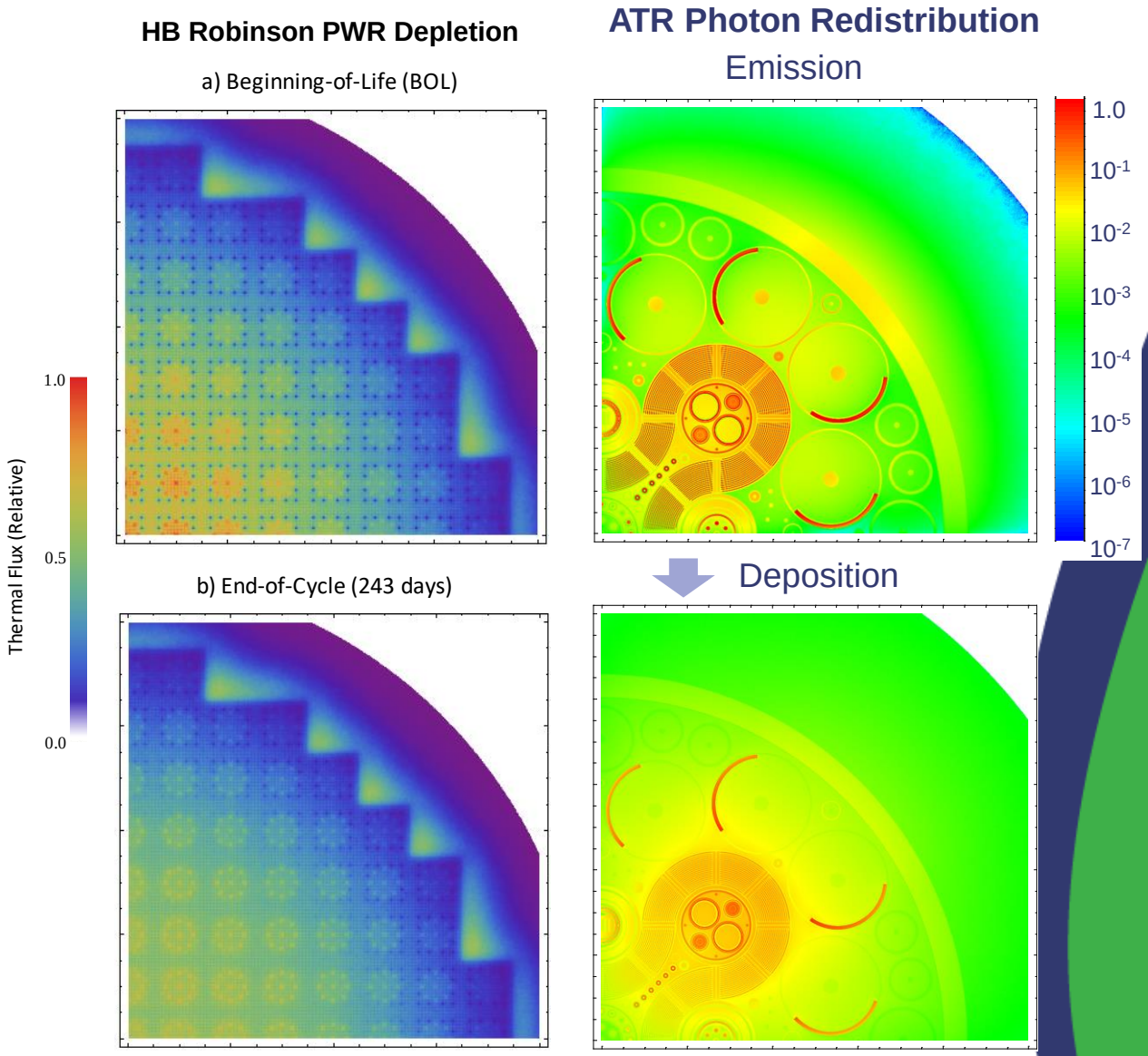
- Continuous-Energy Monte Carlo neutron and photon transport code
  - Complete neutron and photon physics support
- General geometry
- General tallies
- In-Line Feedback
  - Xe
  - Depletion & decay
  - T/H feedback
  - Eigenvalue search
- Neutron and photon heating
- In-Line kinetics parameters
- In-Line (α,n) capability
- MPI & OpenMP parallelization
- Variance Reduction



Advanced Test Reactor (ATR)

Nuclear Data Used

- Neutron cross sections
  - Reaction data
  - Fission spectra
  - Thermal neutron scattering laws (TSLs)
  - Gamma production data
- Gamma cross sections
  - Reaction cross section
  - Photoneutron reactions
- (α,n) cross sections
- Decay Data
- Fission Project Yields

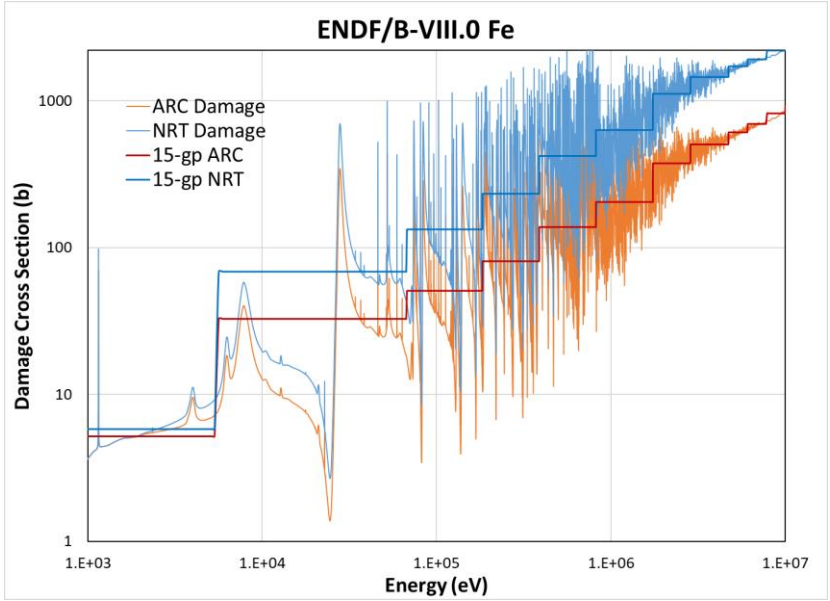


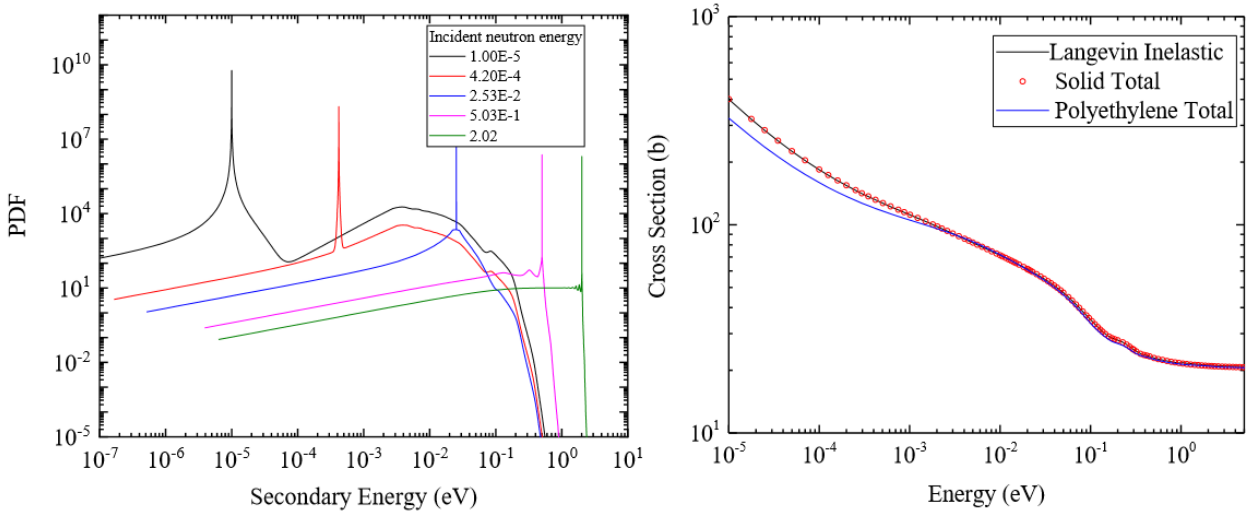
NNL Nuclear Data Needs

- Light water reactor materials
  - Zirconium, Hafnium
  - U-236 & Np-237 neutron capture
- Radiation shielding
  - Fe-56 cross sections
  - Scattering angular distributions
- Long-lived fission products (fission product credit)

Mo-95	Tc-99	Ru-101	Rh-103
Cs-133	Cs-135	Pr-141	Nd-143
Nd-145	Sm147	Sm-145	Sm-150
Sm-152	Eu-153		

- Irradiation damage (DPA)
- Thermal scattering law data



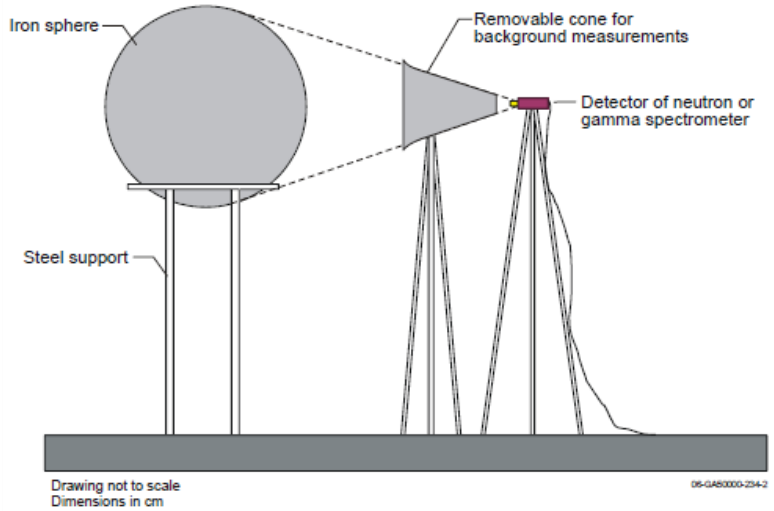


TSL for heavy paraffinic oil (C. A. Manring, PHYSOR-2018)

Observation on Shielding Validation Needs

- Significant improvements have been made in shielding design and analysis methods
  - Predictability changed from factor of ~20 (historical) to ~2 (current)
  - **Broad industry**, not just NNL
- Improvement due to combination of new methods, computer code capabilities, and nuclear data
- Shielding validation benchmarks still relatively course
  - Based historical expectations (factor of ~20)
- Best benchmarks for nuclear data validation are set of historical Russian benchmarks
- **Personal Opinion** - new more precise shielding benchmarks needed to support factor ~2 design uncertainties
  - Hardware cost savings in reactor design and spent fuel transport applications
  - Drive improvement of Fe-56 and other cross sections for shielding applications
- **Expect multiple DOE programs, NRC, and commercial nuclear industry have similar need**

ALARM-CF-FE-SHIELD-001



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