Status of ETOE-2/MC^2-2/SDX Code System for Multi-Group Cross Section Generation for Fast System Analyses

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Brookhaven National Laboratory

Won Sik Yang and Changho Lee

Nuclear Engineering Division

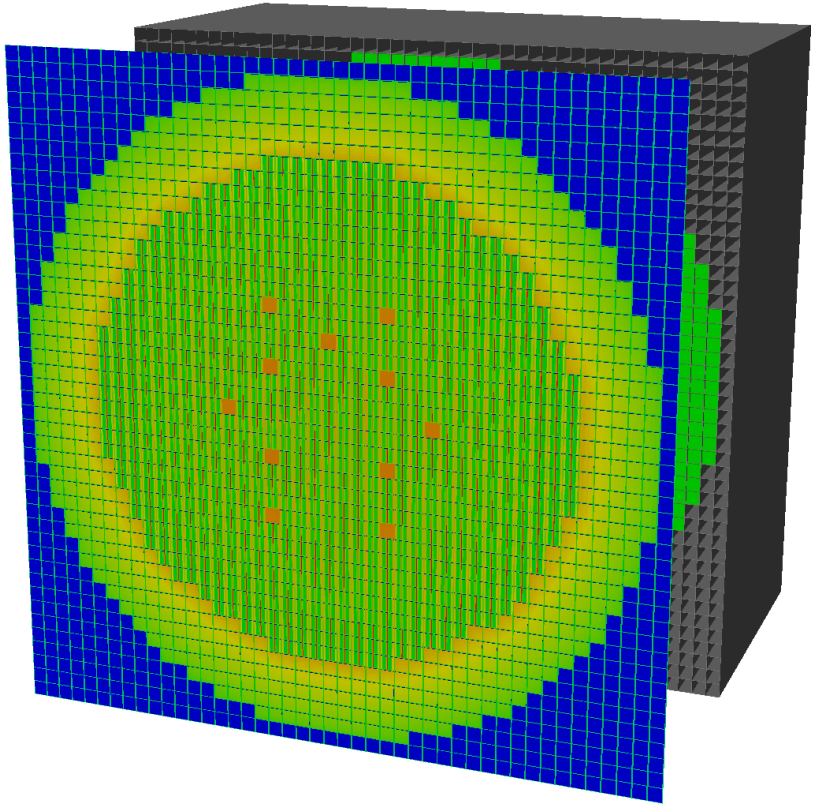
Argonne National Laboratory

New Multi-group Cross Section Generation Code MC^2-3

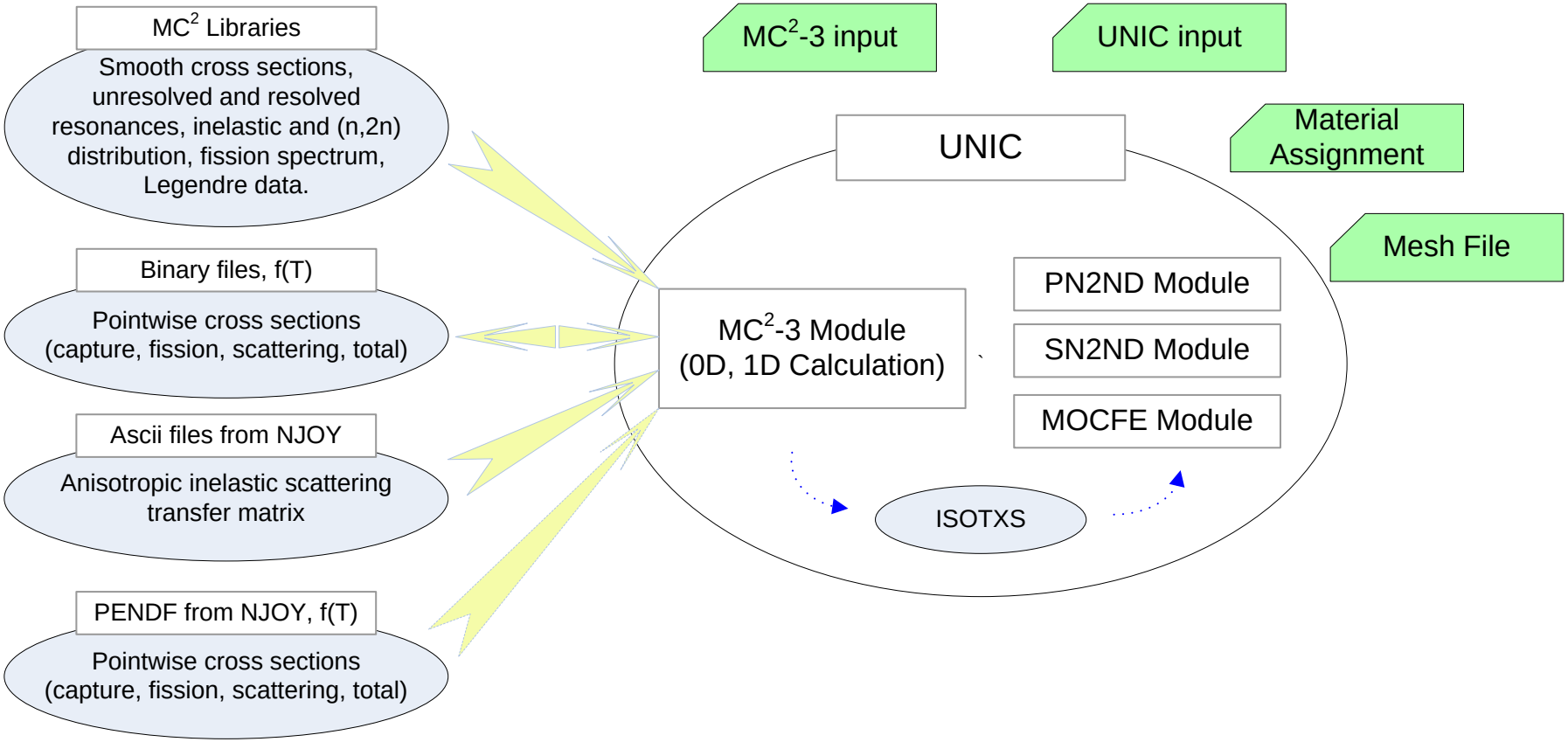
- Developed MC^2-3 by rebuilding the legacy codes MC^2-2 and SDX and incorporating the new methodologies
- Ultrafine group (2082 groups) transport calculations
  - Homogeneous mixture, and 1-D slab and cylindrical geometries
  - Resolved resonance self-shielding with numerical integration of point-wise cross sections using the narrow resonance (NR) approximation
  - Unresolved resonance self-shielding with the generalized resonance integral method
  - Elastic scattering transfer matrices obtained with numerical integration of isotopic scattering kernel in ENDF/B data
- Hyperfine group (pointwise XS) transport capability
  - Consistent P_1 transport calculation for entire resolved resonance energy range (up to ~1 MeV for structural materials) with anisotropic scattering sources
  - Optionally used for accurate resolved resonance self-shielding and scattering transfer matrix generation
- Being integrated with 2-D MOC transport solver

MC^2-3 Code (Cont'd)

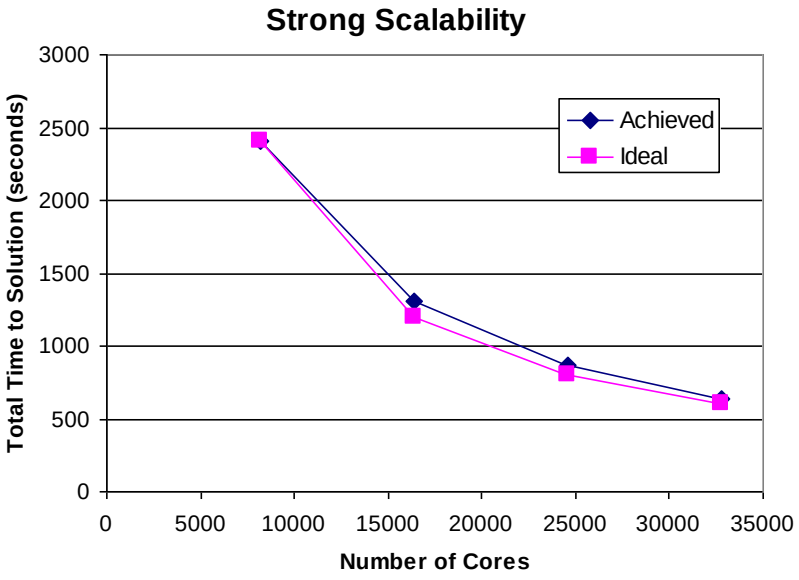
- Efficient strategy to generate accurate multi-group cross sections for heterogeneous assembly or full-core calculations is being developed by combining various solution options
  - 1-D hyperfine group cell calculation
  - 1-D ultrafine group whole-core calculation (with homogenized regions)
  - 1-D CPM or MOC calculation
  - 2-D MOC calculation in several hundred groups

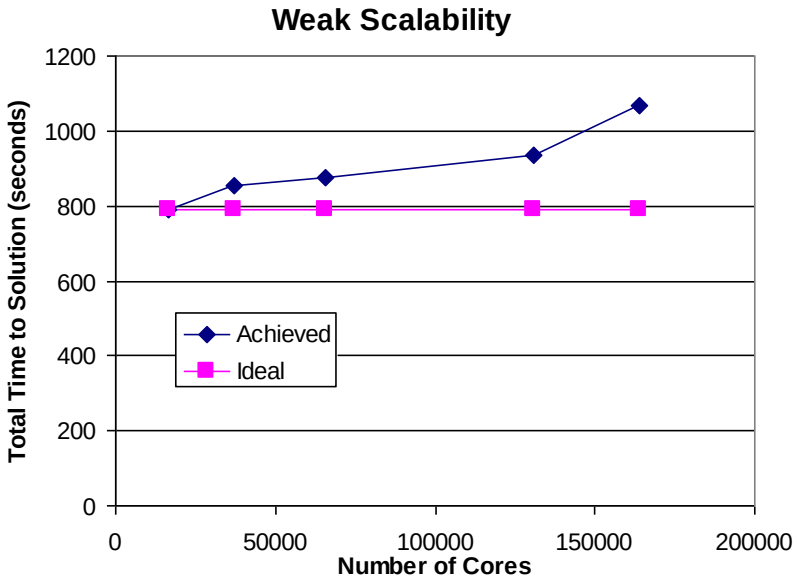


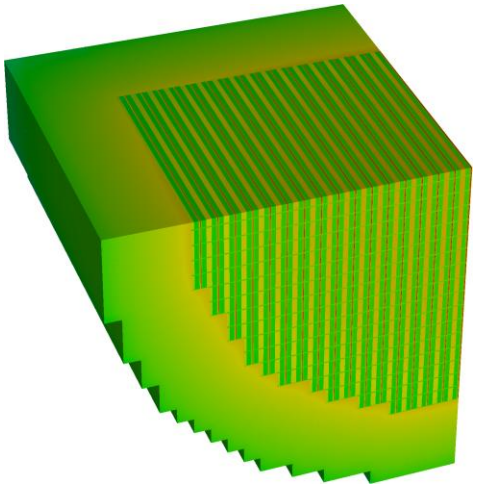
Integration of MC^2-3 into UNIC

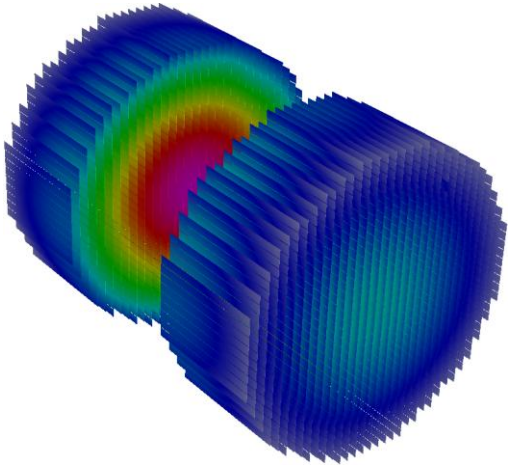


Scalability of UNIC's SN2ND Solver

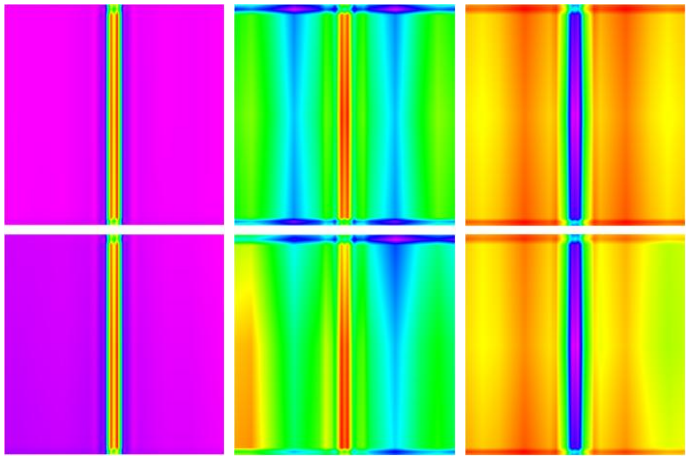








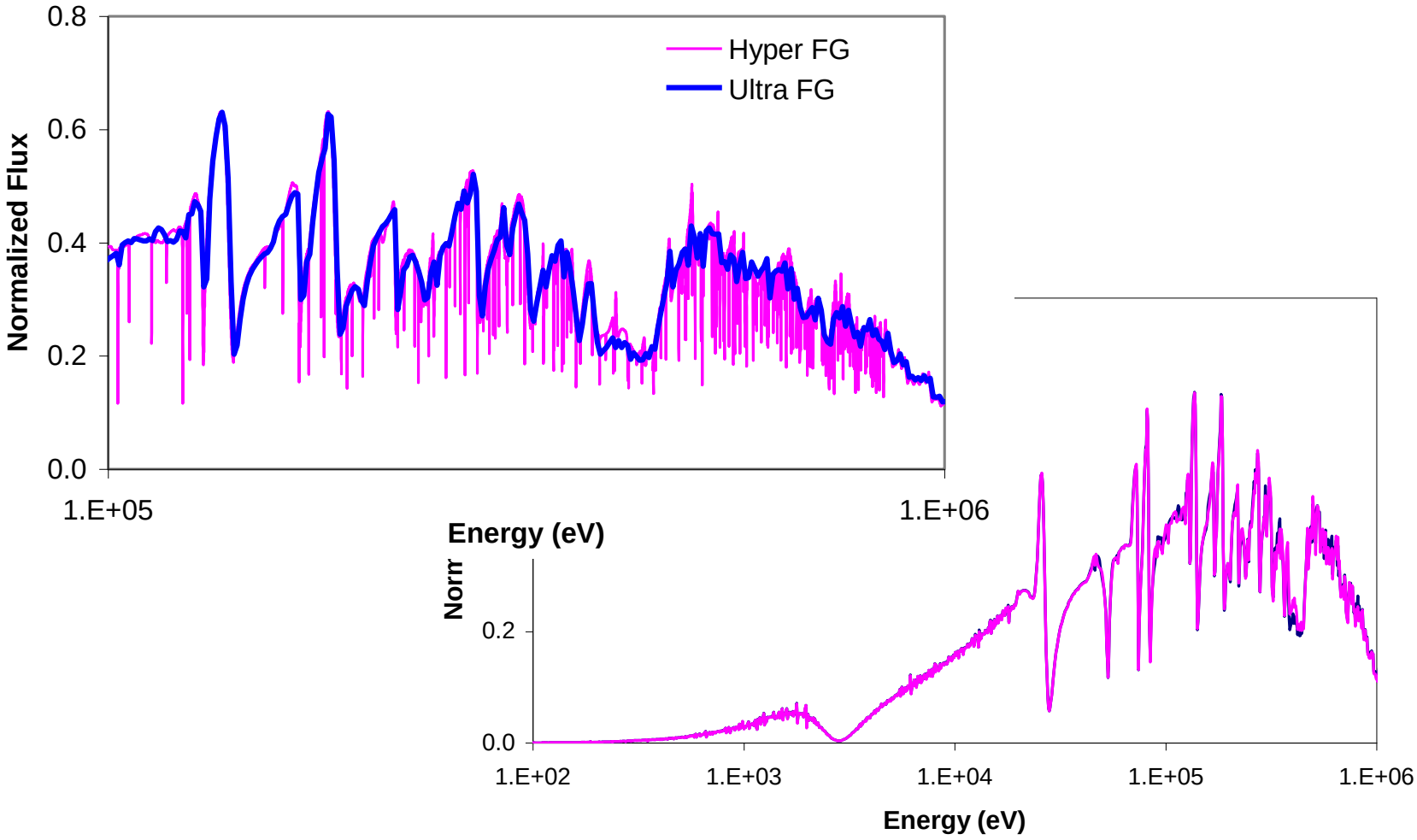
Just EU plates



1.1 MeV 243 keV 221 eV

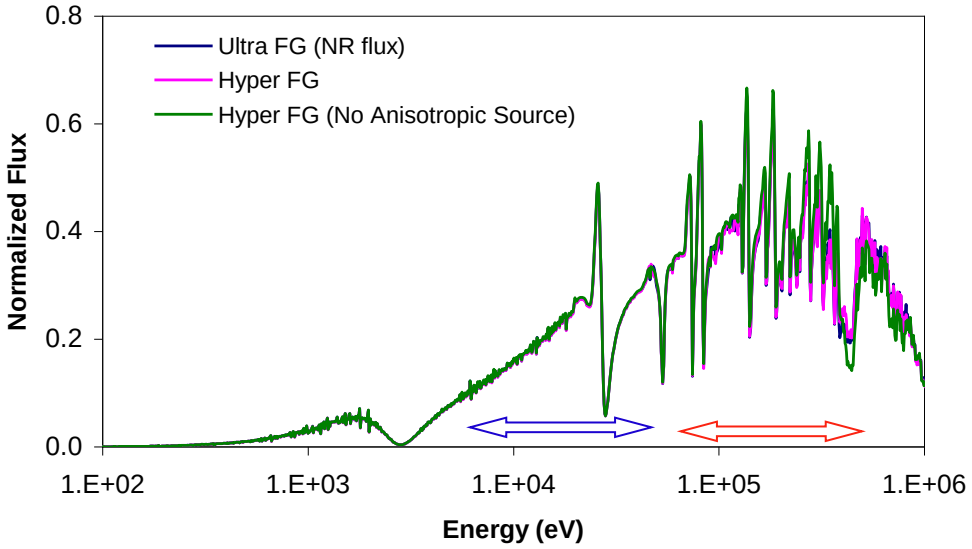
Hyperfine-Group Spectrum Calculation

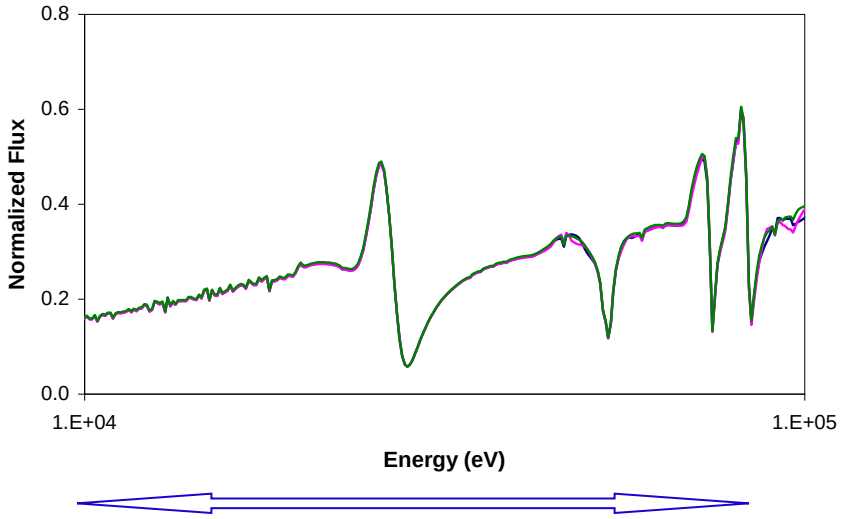
- Inner core composition of ZPR-6 Assembly 6A

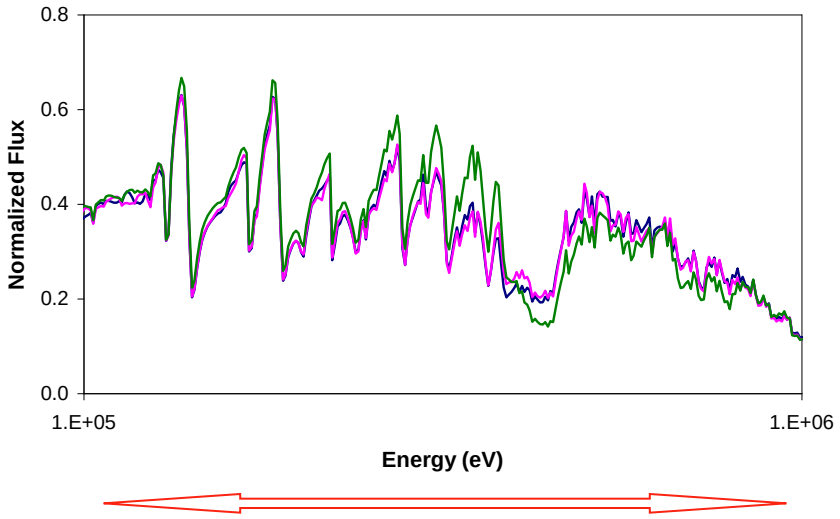


Hyperfine-Group vs. Ultra-Fine-Group Spectra

- Hyperfine group transport calculation with or without anisotropic scattering source contribution in the Center-of-Mass system

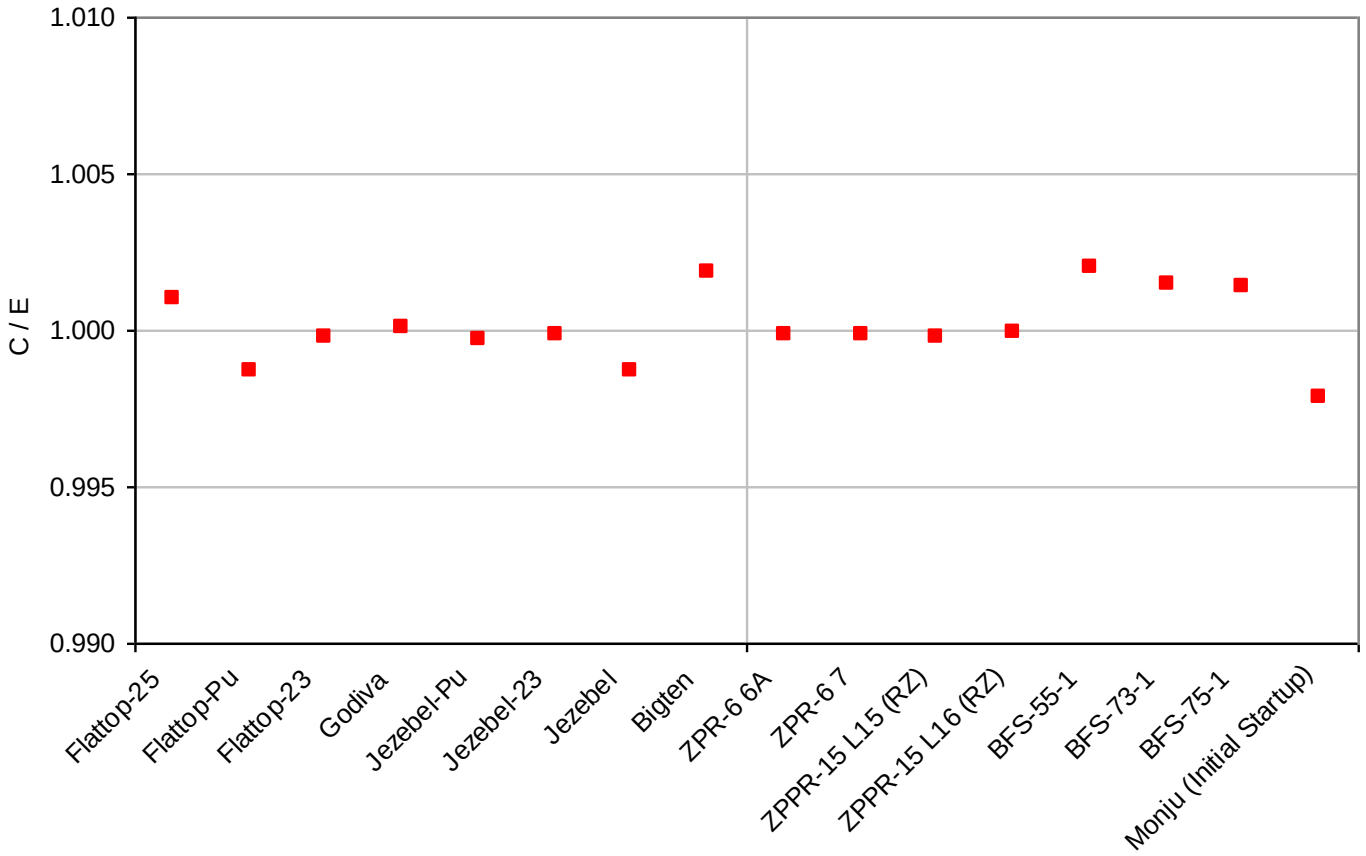






Criticality Benchmarks (UFG Calculation)

- LANL critical assemblies, ZPR-6, ZPPR-15, BFS, and Monju
- Multiplication factors are in an excellent agreement within ~200 pcm Δk



Preliminary Analyses of MONJU Startup Tests

- Assembly averaged 230-group cross sections at different temperatures
  - 1D Heterogeneous calculations for 10 fuel, blanket and control assembly regions
  - Homogeneous medium calculations for 21 structure regions
- Nodal transport calculations with VARIANT

Fully inserted C1 Rod	Fully withdrawn C1 Rod	C1 Rod Worth (%Δρ)	C/E
0.99033	1.00021	0.997	1.025

C1 withdrawal length (mm)	195.7 °C	302.5 °C	%Δρ/ °C	C/E
442	0.99843	0.99521	-0.00311	1.032
703	1.00170	0.99844	-0.00313	1.038

* Measurement uncertainty: 5%

Future Work

- Further optimization to reduce memory requirement and computational time
- Further validation of 1-D and 2-D MOC solvers
- Parallel execution
- Finalize cross section storage procedure for use in coupled physics calculations
  - HDF5 format which supports random access retrieval of cross section data in massively parallel environments
- Seamless coupling with UNIC for online cross section generation