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Neutronics Benchmark Studies on the Hallam Nuclear Power Facility (HNPF) First Core Loading

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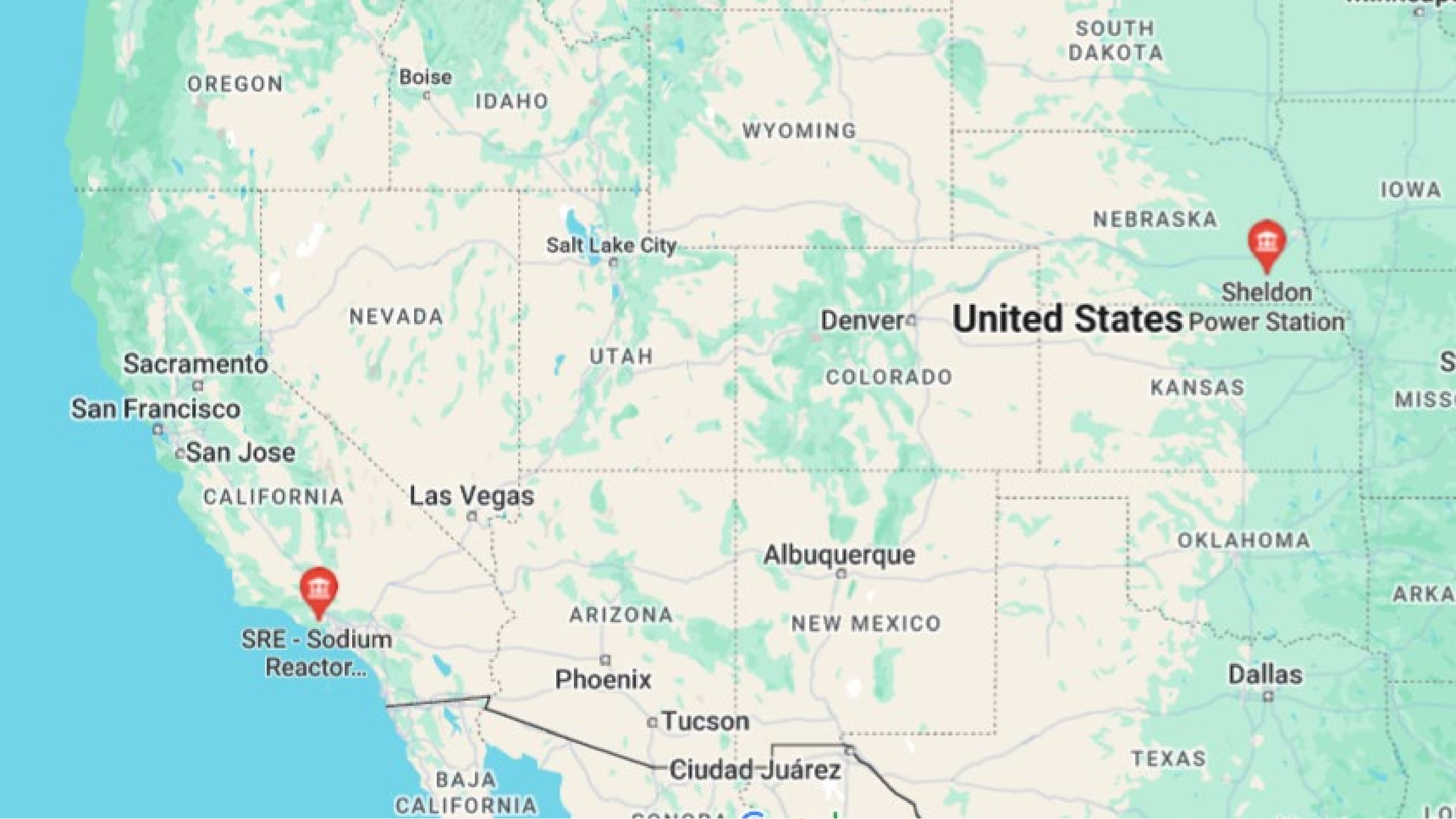
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SRE - Sodium Reactor...
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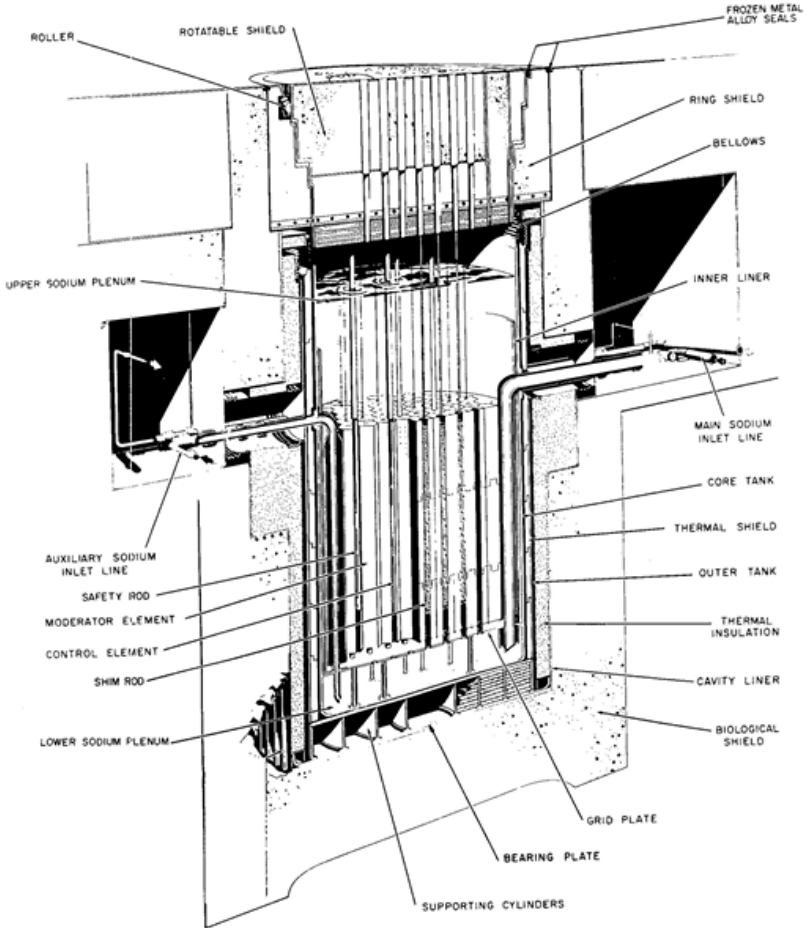
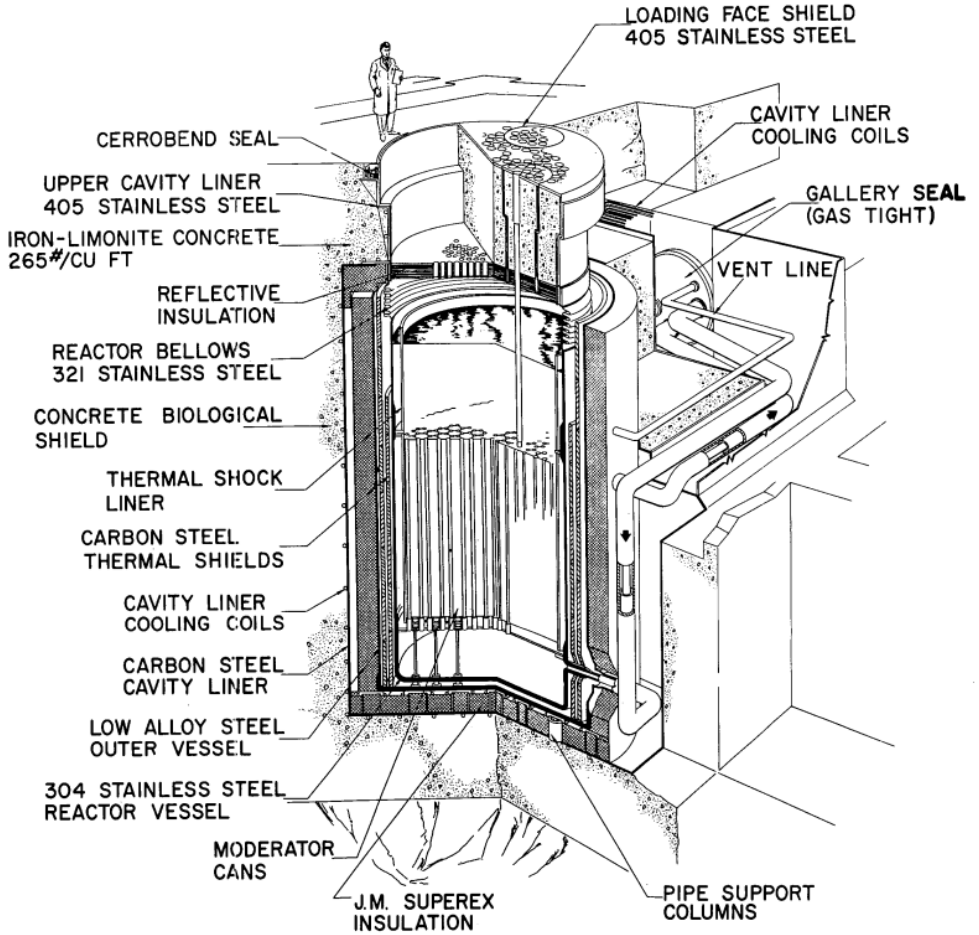
SRE Reactor Fact Sheet

Full Name	Sodium Reactor Experiment
Acronym	SRE reactor
Type	Sodium Graphite Reactor
Coolant	Sodium
Moderator	Graphite
Fuel	U-10Mo metal fuel [1]
Thermal Power	20 MWth [1]
Electrical Power	6 MWe [1]
Location	Santa Susana Field Laboratory, California [1]

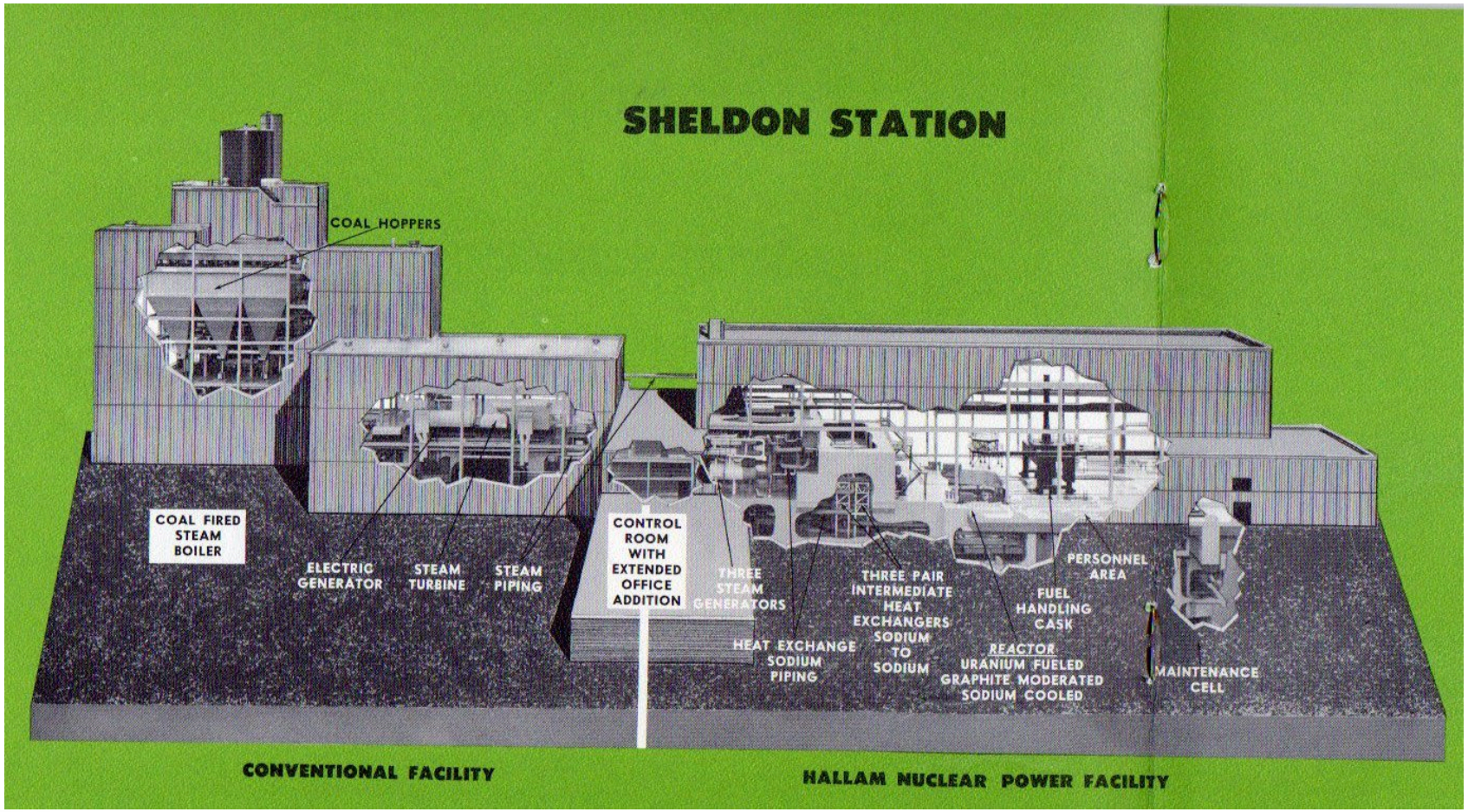


HNPF Reactor Fact Sheet

Full Name	Hallam Nuclear Power Facility
Acronym	HNPF reactor
Type	Sodium Graphite Reactor
Coolant	Sodium
Moderator	Graphite
Fuel	Uranium Molybdenum Alloy [1]
Thermal Power	240 MWth [1]
Electrical Power	75 MWe [1]
Location	Hallam Nebraska [1]



Why the shutdown?



Sheldon Power Station [4]

HNPF Benchmark: Why and How

Limited experimental data exists from the Hallam nuclear reactor.

- Necessitates reactor neutronics benchmarking
- Verification of benchmark by comparison to experimental data.

Preliminary comparisons between model and reactor promising.

- Keff vs U-10Mo fuel enrichment
- Keff vs Loaded fuel rods

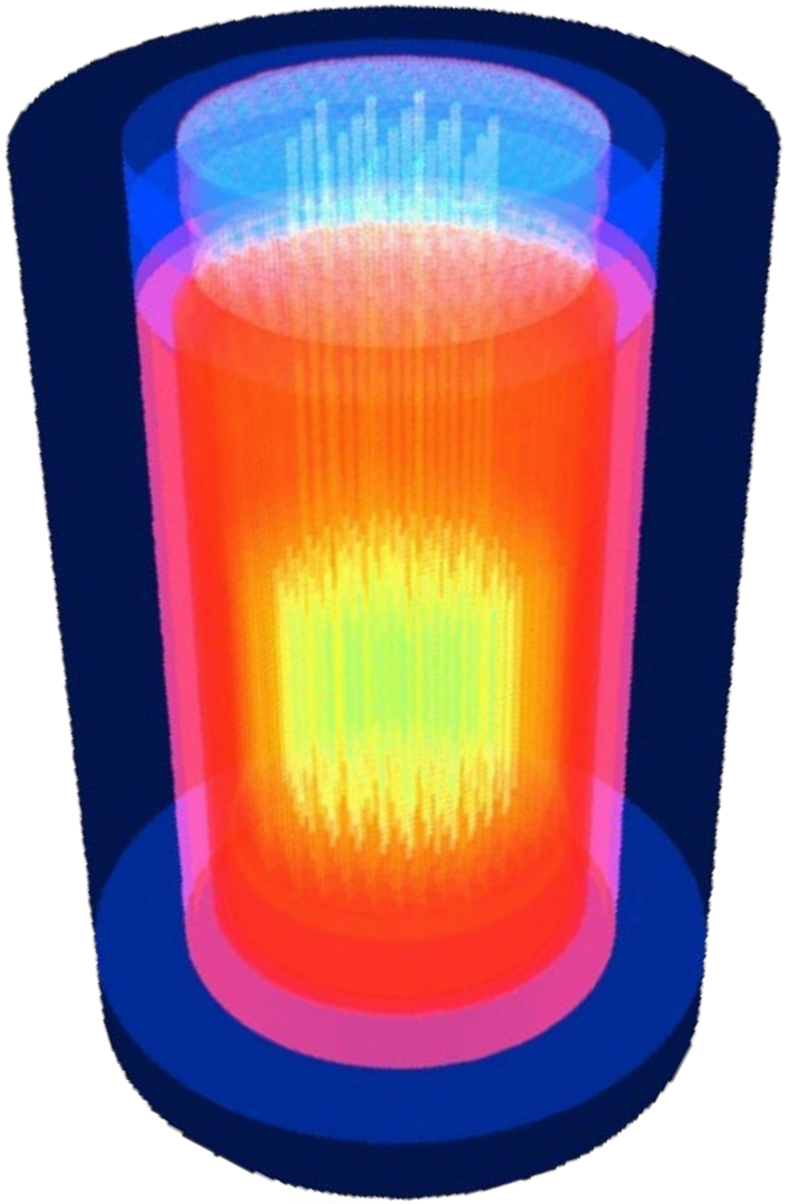
Reactor Modeling Process

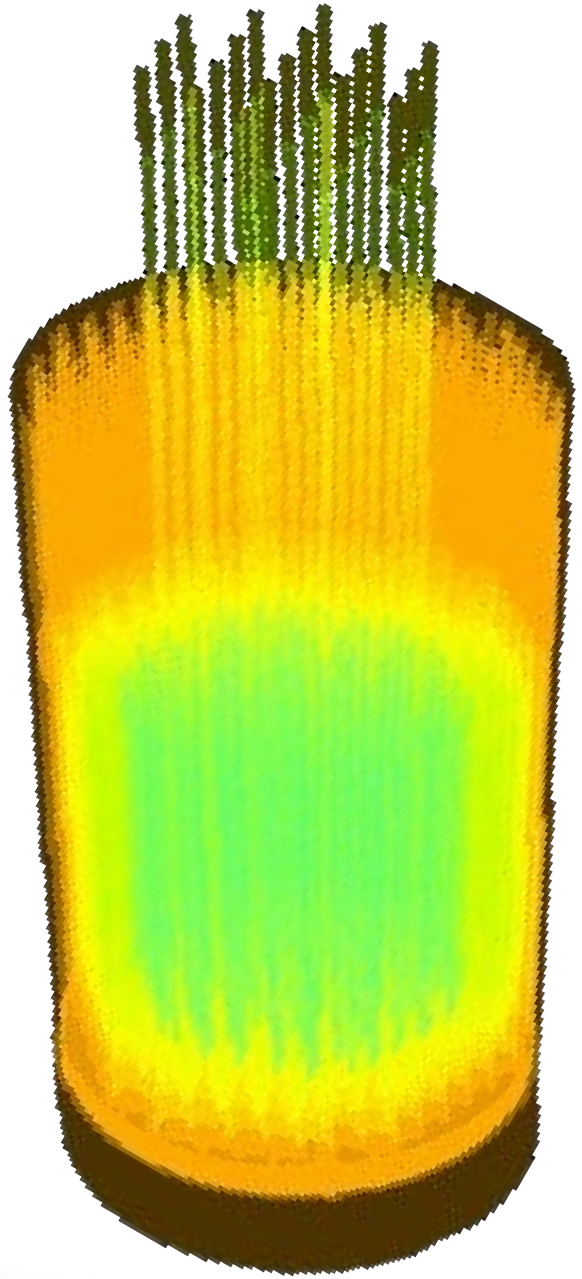
Known and unchanging:

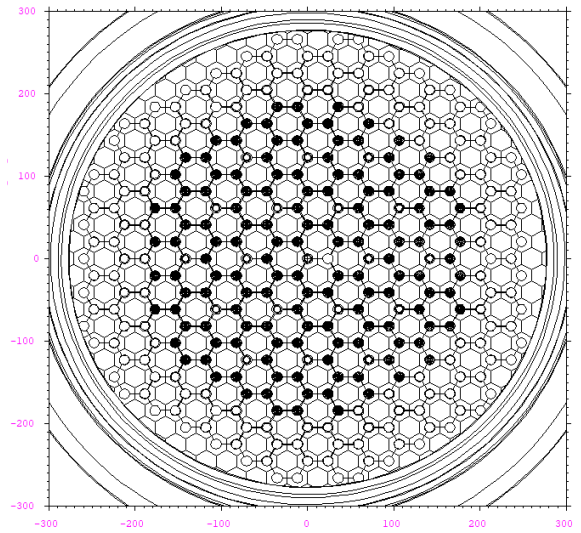
- Lattice Geometry
  - Fuel assemblies
  - Moderator elements
  - Reflector/Dummy rods
- Material specification*
- Core periphery and vessel
- Reactor surroundings

Varied in comparisons:

- Temperature*
  - Fuel
  - Moderator
  - Coolant
  - Surroundings
- Number of rods loaded
- Fuel enrichment
- Control rod positions*



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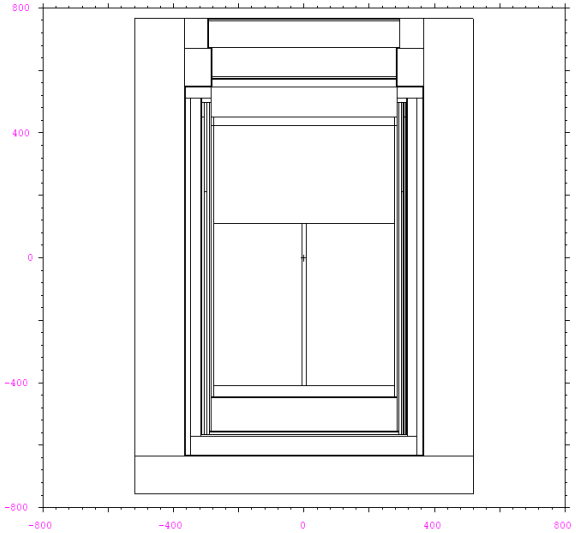
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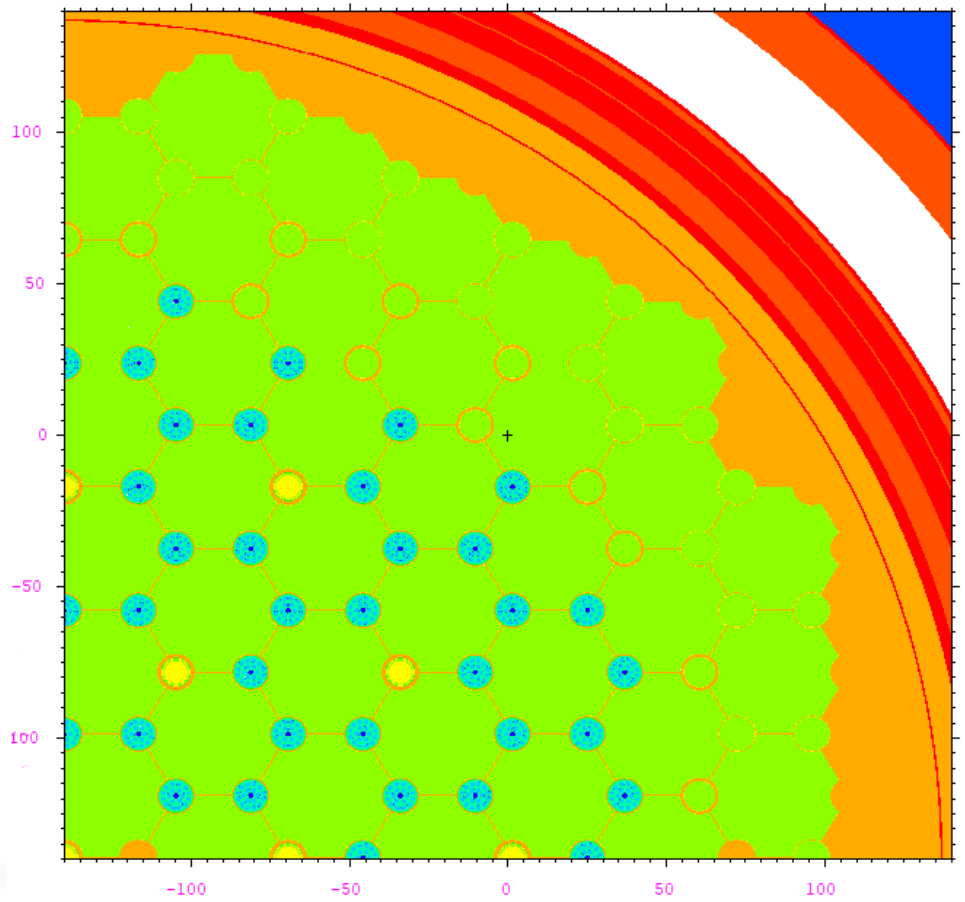
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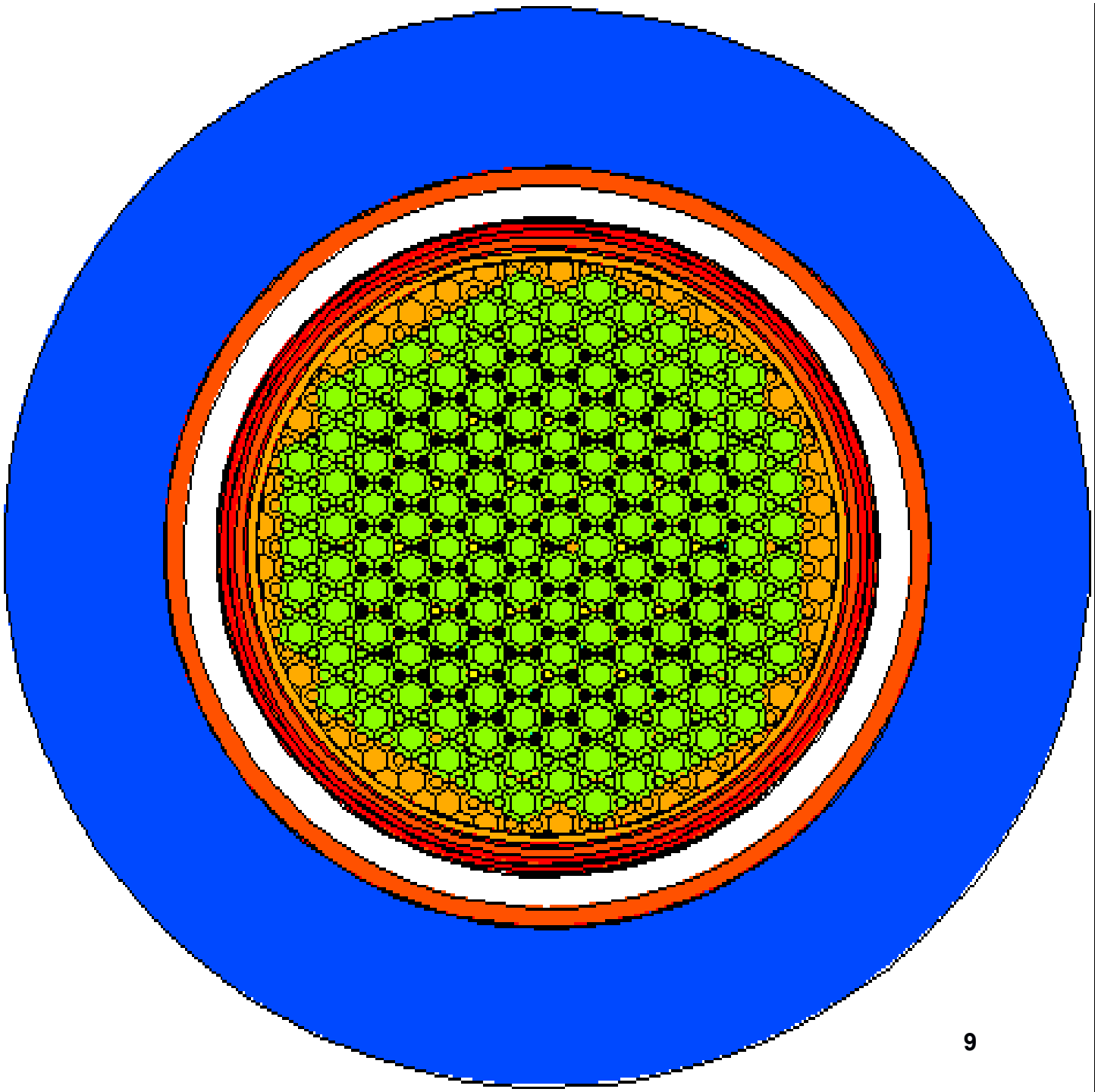
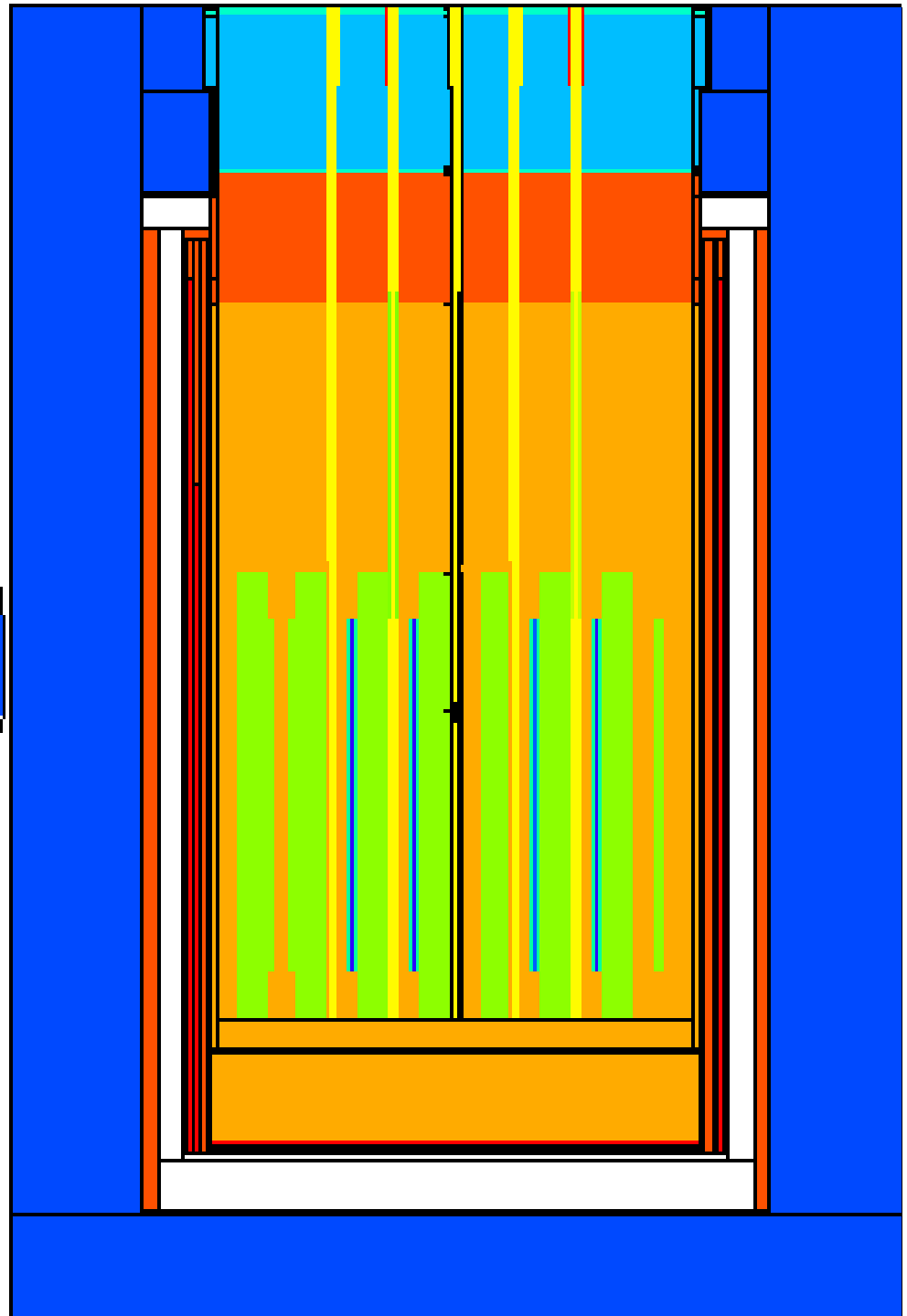
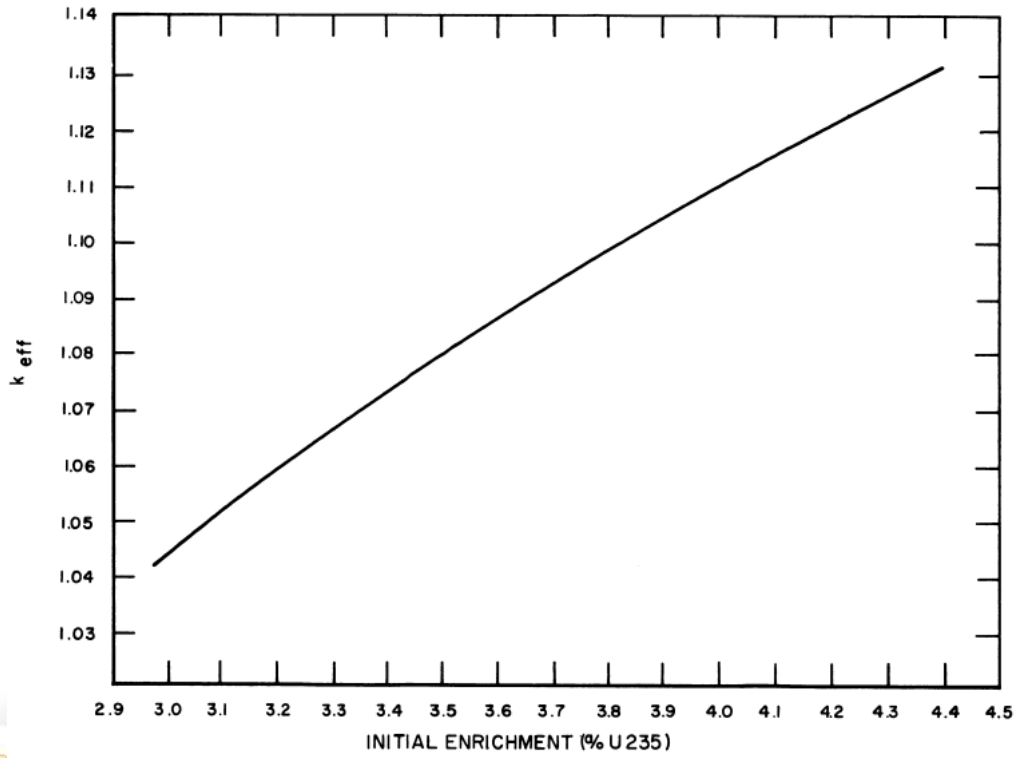


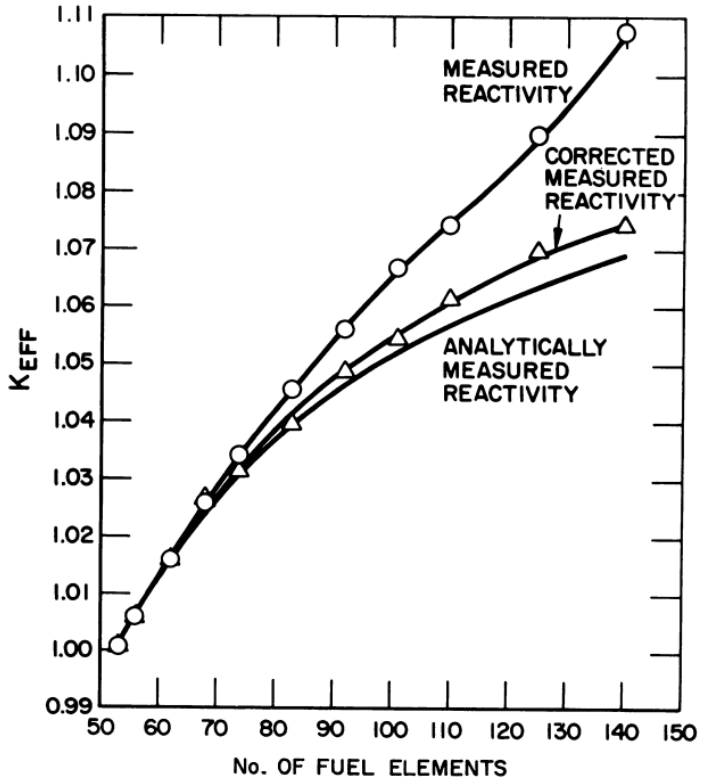


Model Comparison - Legacy data

- Keff vs Enrichment

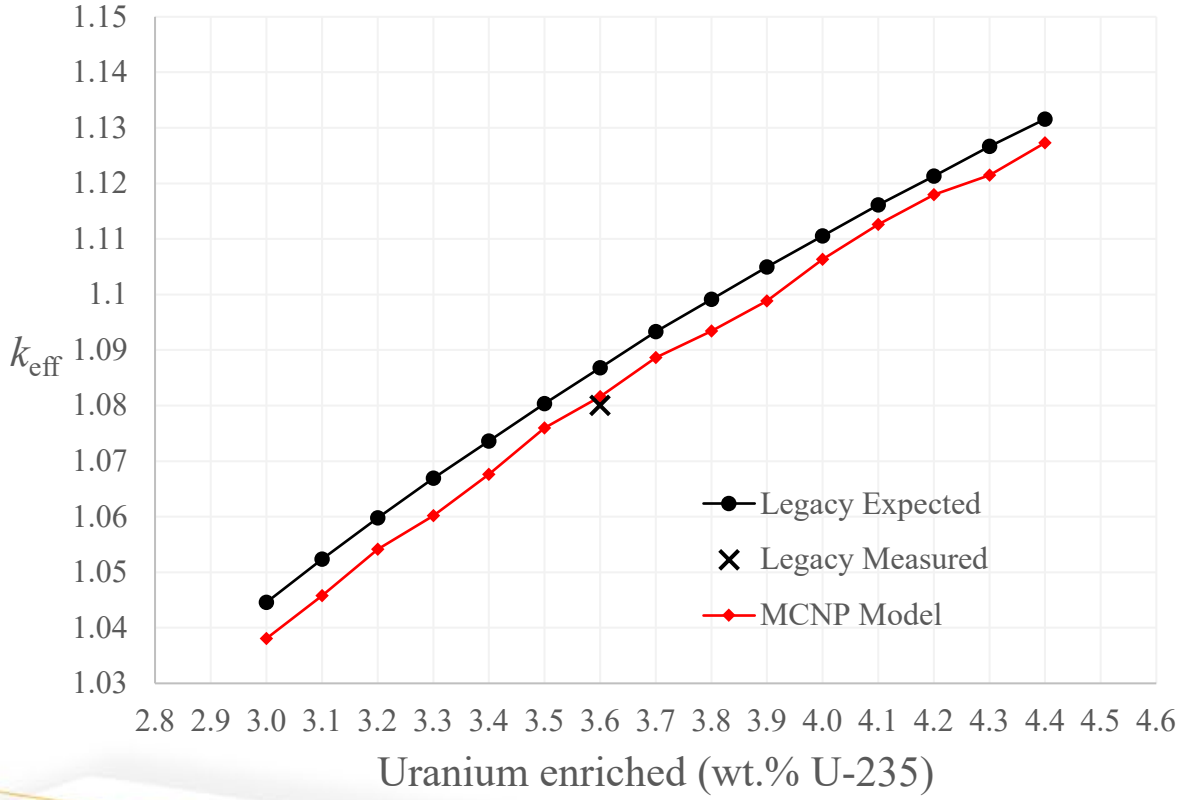


- Keff vs Loading

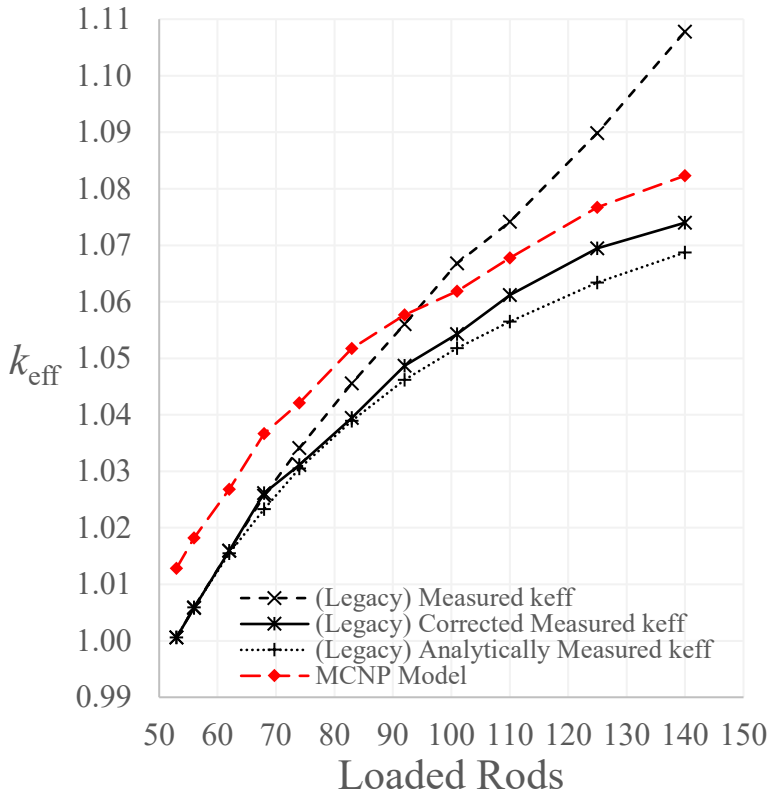


Model Comparison - Results

- Keff vs Enrichment



- Keff vs Loading



Future Work

Additional tests/comparisons:

- Feedback coefficients (calc)
- Control rod worth (calc)
- Uncertainty Quantification
- Flux shape, spectrum (calc)
- Burnup, xenon worth (calc)

Benchmark issues, unknowns:

- Temperature profiles
- Control rod positions
- Initial calculation method
- Fission chamber positions
- Geometric details absent

References

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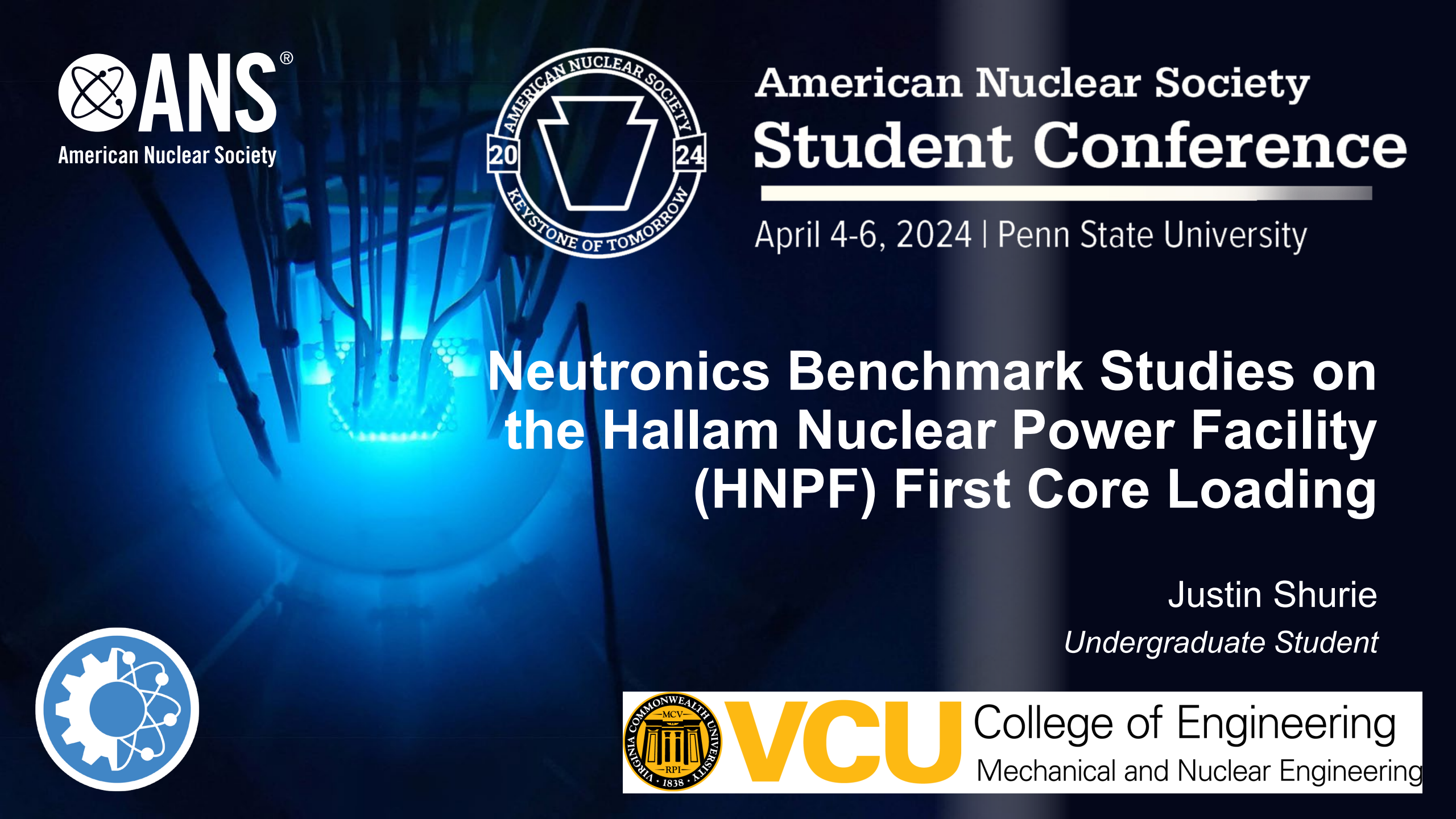
6. Aronchick, M P. "Nuclear Startup Experiments for HNPF." *HathiTrust*, https://babel.hathitrust.org/cgi/pt?id=mdp.39015095164060&seq=1. Accessed 31 Mar. 2024.



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