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FY 23 ORNL Integral Experiment and DOE-EM work summary

2024 Annual NCSP Technical Program Review

February 20–22, 2024, Hyatt Place Long Island/East End
Hosted by Brookhaven National Laboratory

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U.S. DEPARTMENT OF ENERGY

ORNL Integral Experiment and DOE-EM work during FY 23

- CeDT support
- IE designs leads
- DOE-EM summary

ORNL Integral Experiment work during FY 23

CeDT support:

IER #	IER description	Action	Staff in charge
IER-537	"Copper Critical Cerberus"	CED-3a and 3b sign off	Jordan McDonnell
IER-305	"7uPCX fuel with Mo sleeves"	CED-3b sign off	BJ Marshall
IER-329	"TEX-U-233"	CED-2 sign off	
IER-499	"TEX-Cl"	CED-2 sign off	
IER-523	"UO2-BeO Critical"	CED-1 sign off	
IER-532	"TEX-Hf"	CED-3b sign	

Integral Experiment Design leads from ORNL

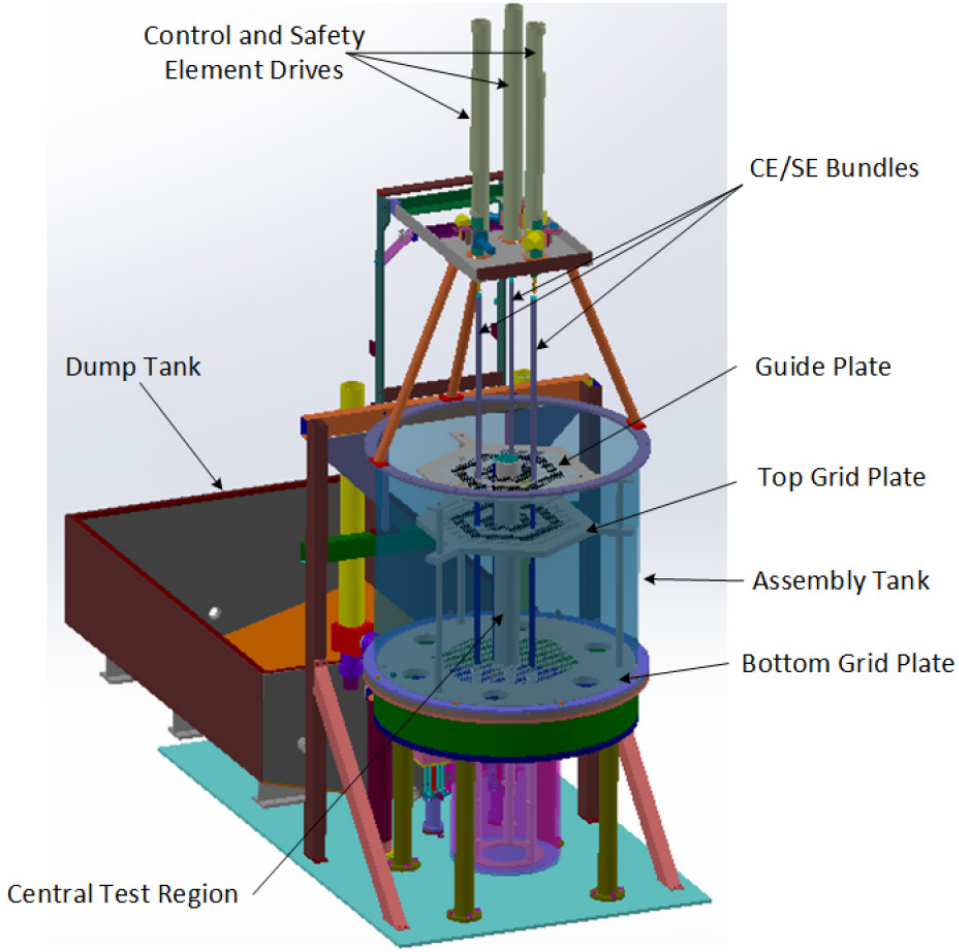
- IER-554: Neutron Absorber Plates in SPRF/CX
  - CED-2 completed [**1**]
- IER-498: Godiva IV CAAS Shielding Benchmark
  - CED-2 completed in FY21 [**2**], noting further characterization was needed for CED-3
  - Support to associated IER-557: GODIVA Pulse Repeatability
- IER-441: Tantalum rods effects on critical system
  - Support to SNL on CED-3a
  - Delays in new guide plate procurement, experiment in FY24
- IER-304: Temperature-dependent experiments
  - Experiment lower on priority list, FY24 or later

Other IE-related contributions from ORNL

- TEX 2.0 Meeting
- NEA Zero-power reactor workshop
- NCSP mission and vision update
- National and international conferences papers

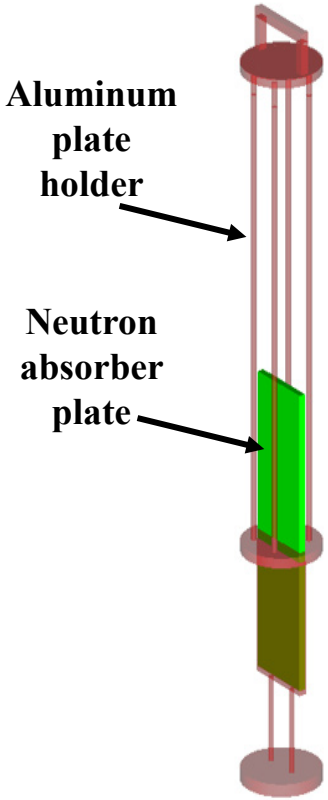
IER-554: Neutron Absorber Plates in SPRF/CX

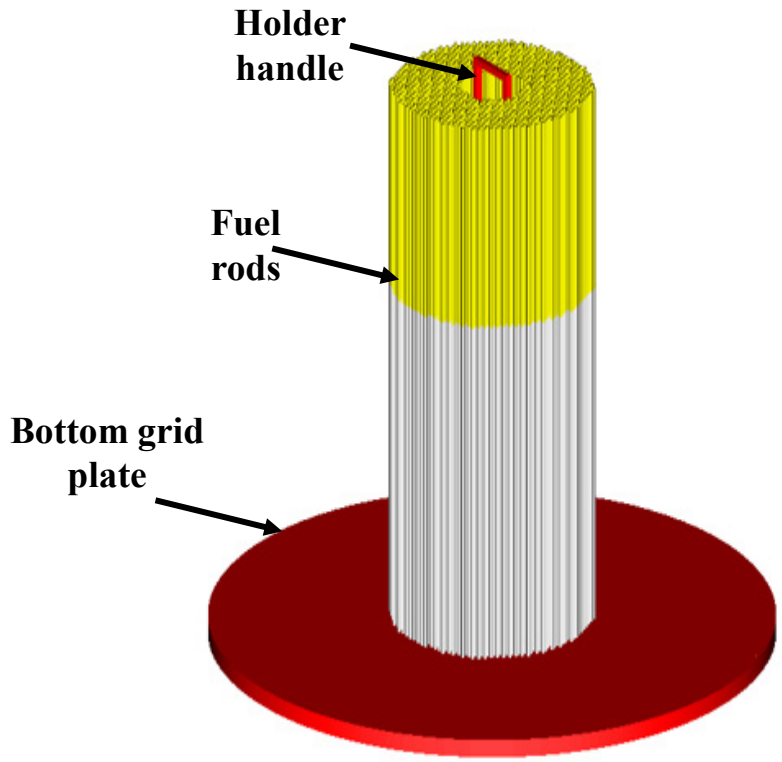
- Effects of commercially available neutron absorber plate insertion in light water assembly (SPRF/CX) on k_{eff}
- Use of another currently designed experiment apparatus, IER-441:
  - Testing of epithermal/intermediate energy cross sections of materials placed in the central region
  - Specific grid plates designed for this experiment
- The neutron absorber plates can be inserted into that same central hole region



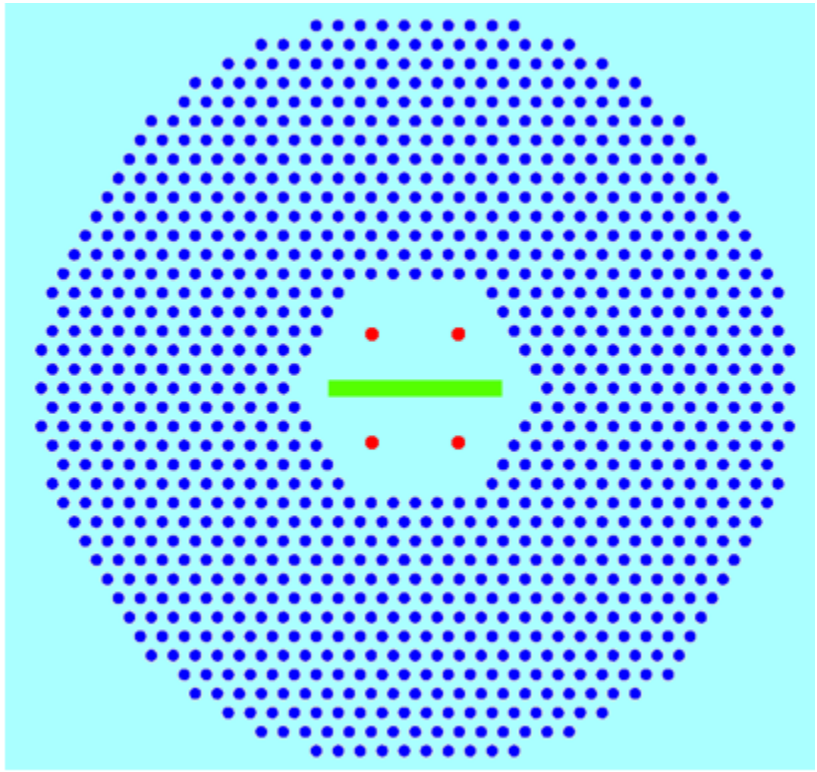
IER 441: Experiments to Measure the Effect of Tantalum on Critical Systems (SNL/ORNL), David Ames, NCSP Technical Program Review 2023 [3]

IER-554: Neutron Absorber Plates in SPRF/CX





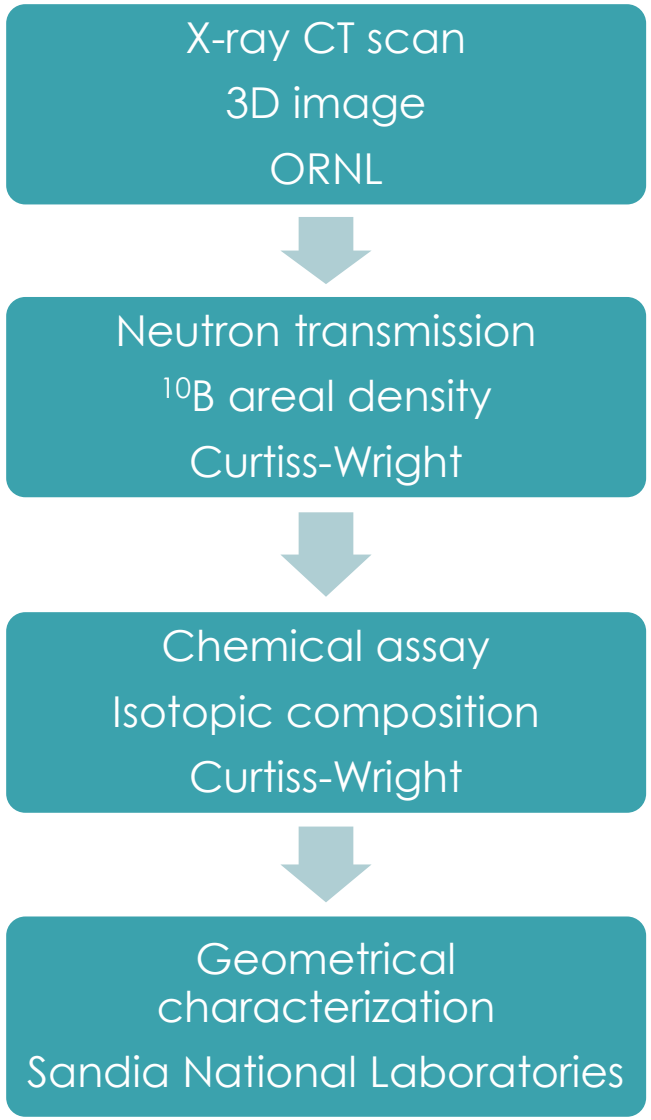
Simplified assembly with a neutron absorber plate in its center



Different critical lattice configurations [1]

- Effects of commercially available neutron absorber plate insertion in light water assembly (SPRF/CX) on k_{eff}

IER-554: Neutron Absorber Plates in SPRF/CX

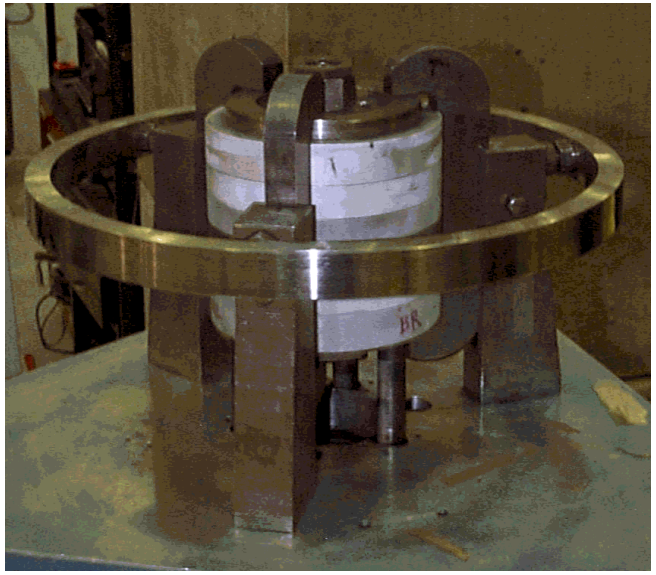


IER-554: Neutron Absorber Plates in SPRF/CX

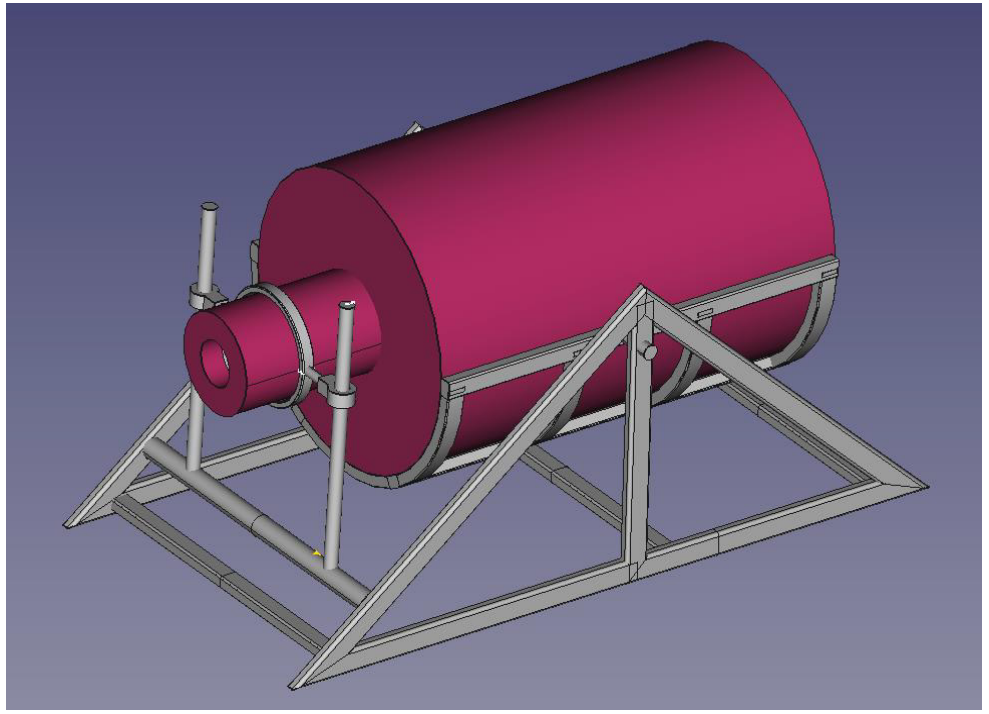
- Conclusions
  - The experiment is feasible with at least 6 critical configurations, and low expected benchmark uncertainty (~100 pcm)
  - Potential high impact for the understanding of commercially used neutron absorber plates
  - Use of preliminary design apparatus from IER-441 to save time and money without losing any scientific impact

- Next steps
  - Plate procurement and characterization plan must be scheduled
  - Coordinate with SNL for the CED-3a and CED-3b steps (Integral experiment initiation and execution)

IER-498: GODIVA CAAS Shielding Benchmark



The Godiva IV assembly [4]



Conceptual rendering of room return shield [2]

- Effects of different shielding samples on detector responses from a Godiva IV pulsed or steady-state operation

IER-498: GODIVA CAAS Shielding Benchmark

- CED-2: Final design completed
- Next steps: CED-3a
- Supported side task: IER-557 GODIVA reproducibility
  - It found acceptable relative uncertainty in the number of neutrons produced per burst for a same ΔT
  - This helps reduce the experimental uncertainty in IER-498

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Questions?

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ORNL and DOE-EM Work

Alex Lang,

Presented by Lisa Reed Fassino

Similarity Assessment of IER-519 for SRS Waste Tanks

- This initiative is work funded by DOE-EM HQ
  - a follow-up from a nuclear data review of absorbers within waste tanks
- A point to address is the lack of applicable experiments:

  Validation of calculational methods are required to be performed by comparison to critical and exponential experiments, and the area of applicability for the validation should be established from this comparison.
  (ANSI/ANS-8.1)

- At the start of this work, IER-519 was in CD-2
  - IER-519 was designed for Hanford Waste Tanks
  - SRS waste tanks credit the same poisons
  - The group agreed it would be beneficial to assess applicability of IER-519 to SRS Waste Tanks
- We obtained CD-2 models from LLNL and Process CSEs from SRS for the assessment

Similarity Assessment of IER-519 for SRS Waste Tanks

- The similarity assessment was performed by obtaining c_k between IER-1519 and SRS Waste Tank
- Compared to benchmarks in VALID, IER-519 is one of the most applicable cases for waste tanks
- Similarity results were similar to that of Hanford Tank Farms
  - Only a couple of cases where $c_k > 0.8$
- Even with IER-519, the need for more applicable benchmarks for SRS and Hanford still holds
- Future benchmark designs for DOE-EM should have an opportunity for assessment to look at complex wide benefits

References

[1] M. N. Dupont, D. Ames, G. Harms, W. J. Marshall, and M Pigni "Integral Experiment Request 554: CED-2 Summary Report," ORNL/TM-2023/3124, Oak Ridge National Laboratory (2023).

[2] R. Cumberland, C. Celik, M. Dupont, and D. Bowen "Criticality Accident Alarm System Shielding Benchmark: Integral Experiment Request 498, Critical Engineering Decision 2 Report," ORNL/TM-2021/2172, Oak Ridge National Laboratory (2022).

[3] D. E. Ames, M. N. Dupont, G. A. Harms, A. Chapa and E. Lutz, IER-441: Experiments to Measure the Effect of Tantalum on Critical Systems (SNL/ORNL), Nuclear Criticality Safety Program Review Meeting, February 21-23, Albuquerque, NM (2023).

[4] R. D. Mosteller, "Godiva-IV Delayed-Critical Experiments and Description of an Associated Prompt-Burst Experiment," Los Alamos National Laboratory, NEA/NSC/DOC/(95)03/II, HEU-MET-FAST-086 (2014).

Acknowledgment

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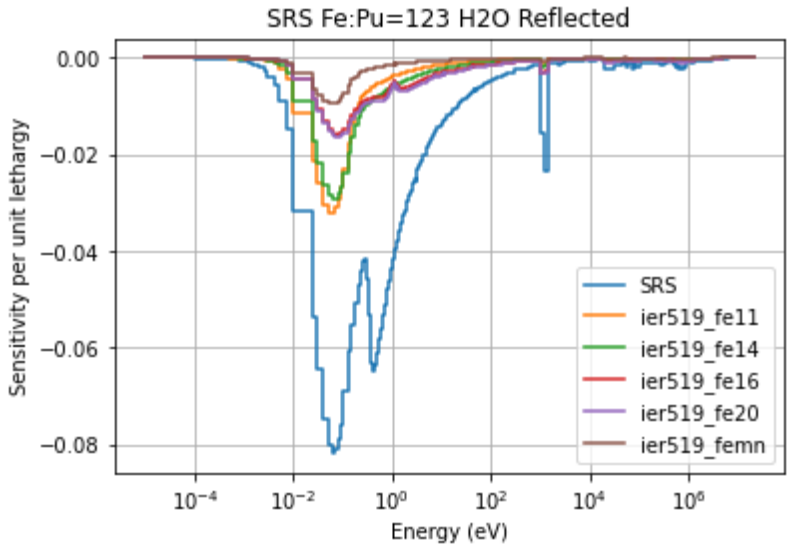
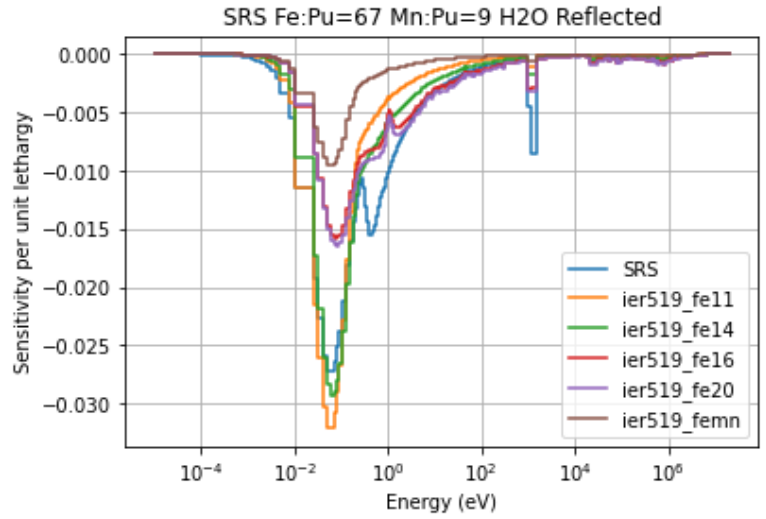
Questions?

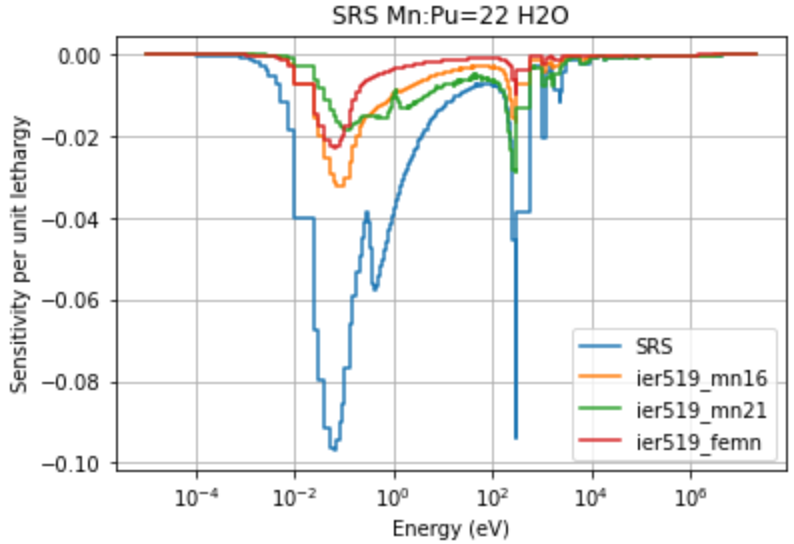
Extra Slides – IER-519 Fe/Mn Sesnsitivity

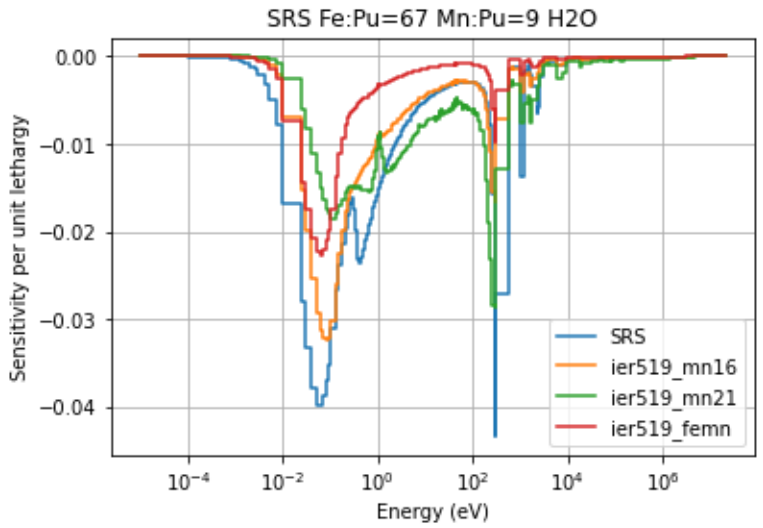
Sensitivity of ^{56}Fe(n,γ)





Sensitivity of ^{55}Mn(n,γ)





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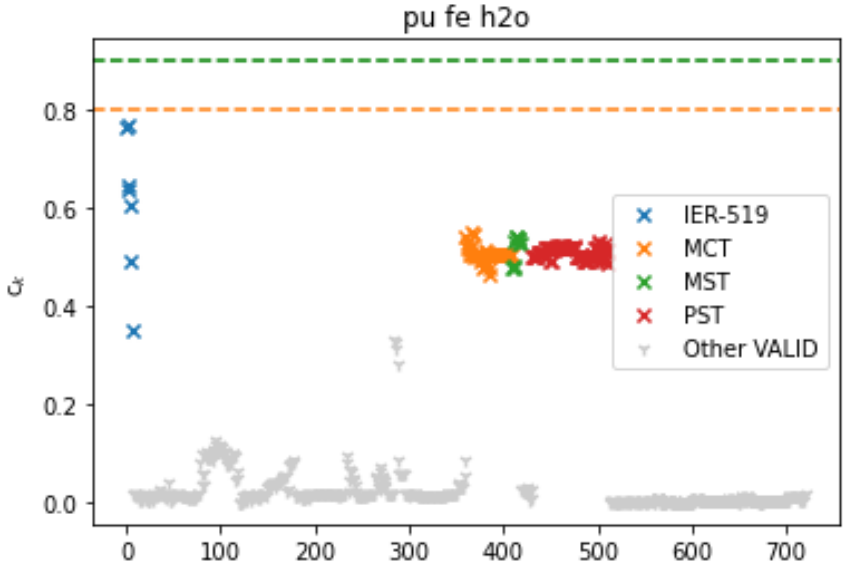
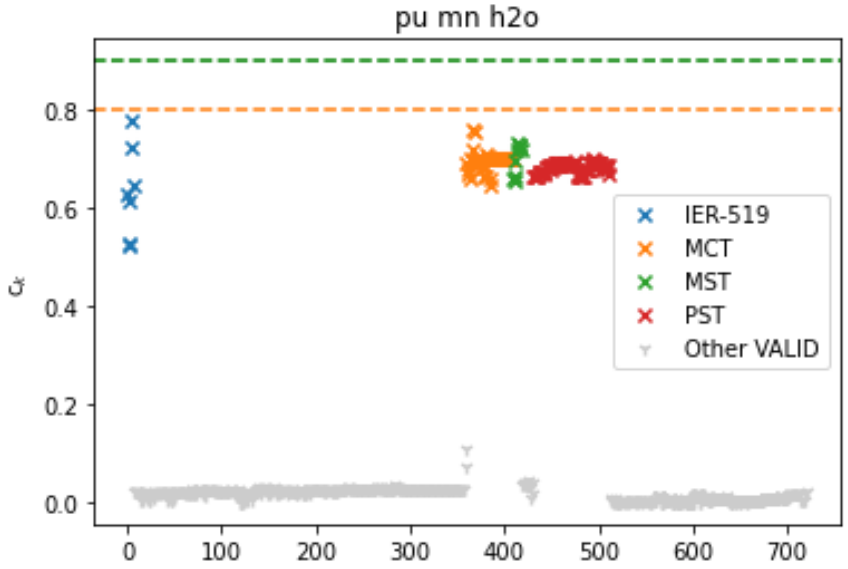
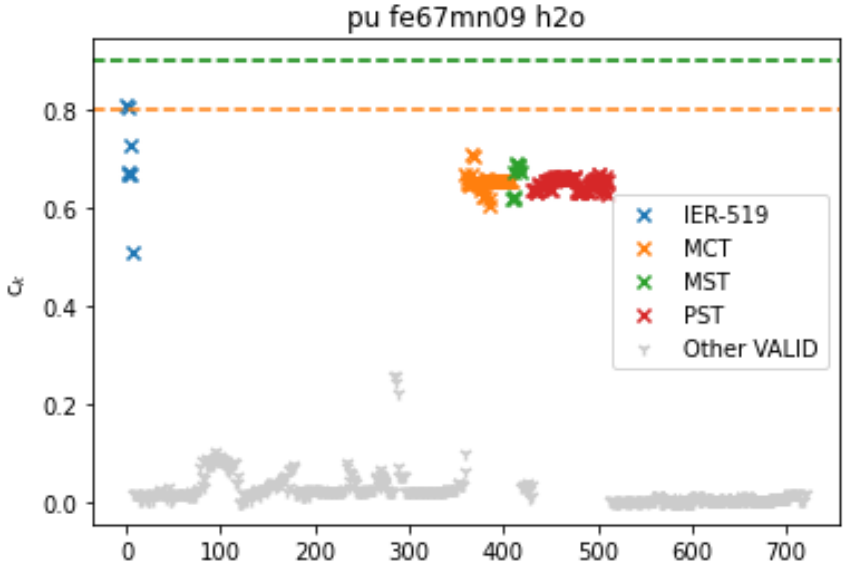
Extra Slides – IER-519 Fe/Mn S/U Comparison







Extra Slides – Comparison of the SRS models to IER-519 models

Absorber	Model	EALF (eV)	H/^{239}Pu	Absorber:Fissile Material Ratio
Fe	SRS Waste Tanks	0.114-1.237	50-500	0-120
	IER-519	3-65	~30-5000	~0.3-0.5
Mn	SRS Waste Tanks	0.119-2.567	50-500	0-22
	IER-519	5-117	~4500-10,000	0.1-0.2