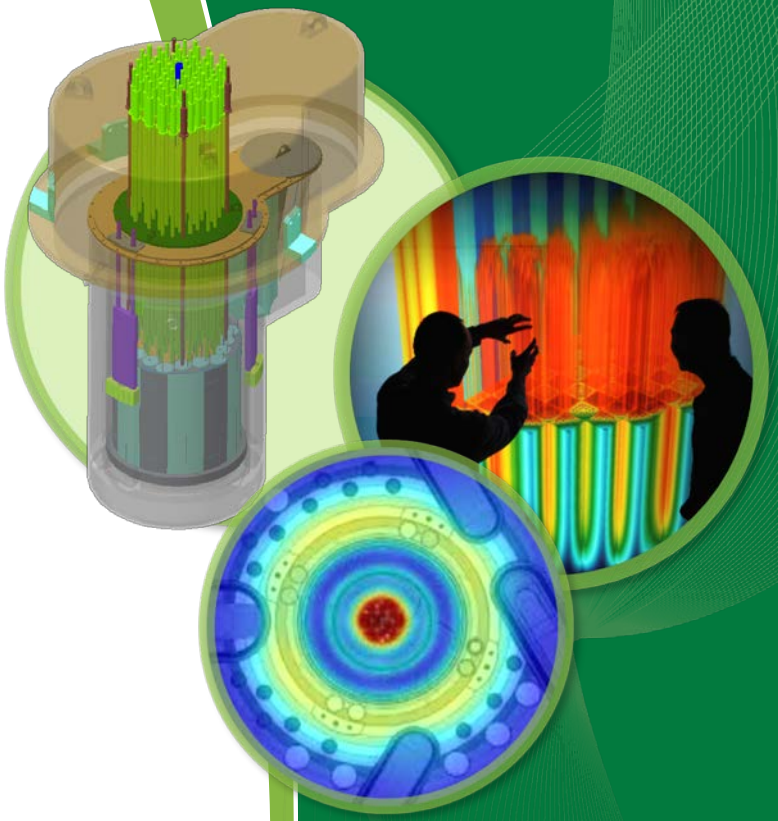
IER-441
Preliminary Design of Epithermal/Intermediate Spectrum Test Capability with the Sandia Pulsed Reactor–Critical Experiments (SPR/CX) Facility



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- Goal: design an epithermal-intermediate cross section testing capability using the SPR/CX facility at Sandia National Laboratories
- Complements Thermal/Epithermal eXperiments (TEX) at National Criticality Experiment Research Center (NCERC)
- Lattice developed by Mike Westfall and Don Mueller
- Intermediate spectra cross sections must meaningfully contribute to thermal reactor k_{eff}
  - Epithermal subcritical reactor
  - Thermal critical reactor
- Substitution experiments allow for highlighting a reasonably minor effect
- Thermal self-shielding and integration of thermal neutron-absorbing central region will be used to tailor the absorption reaction rate profile

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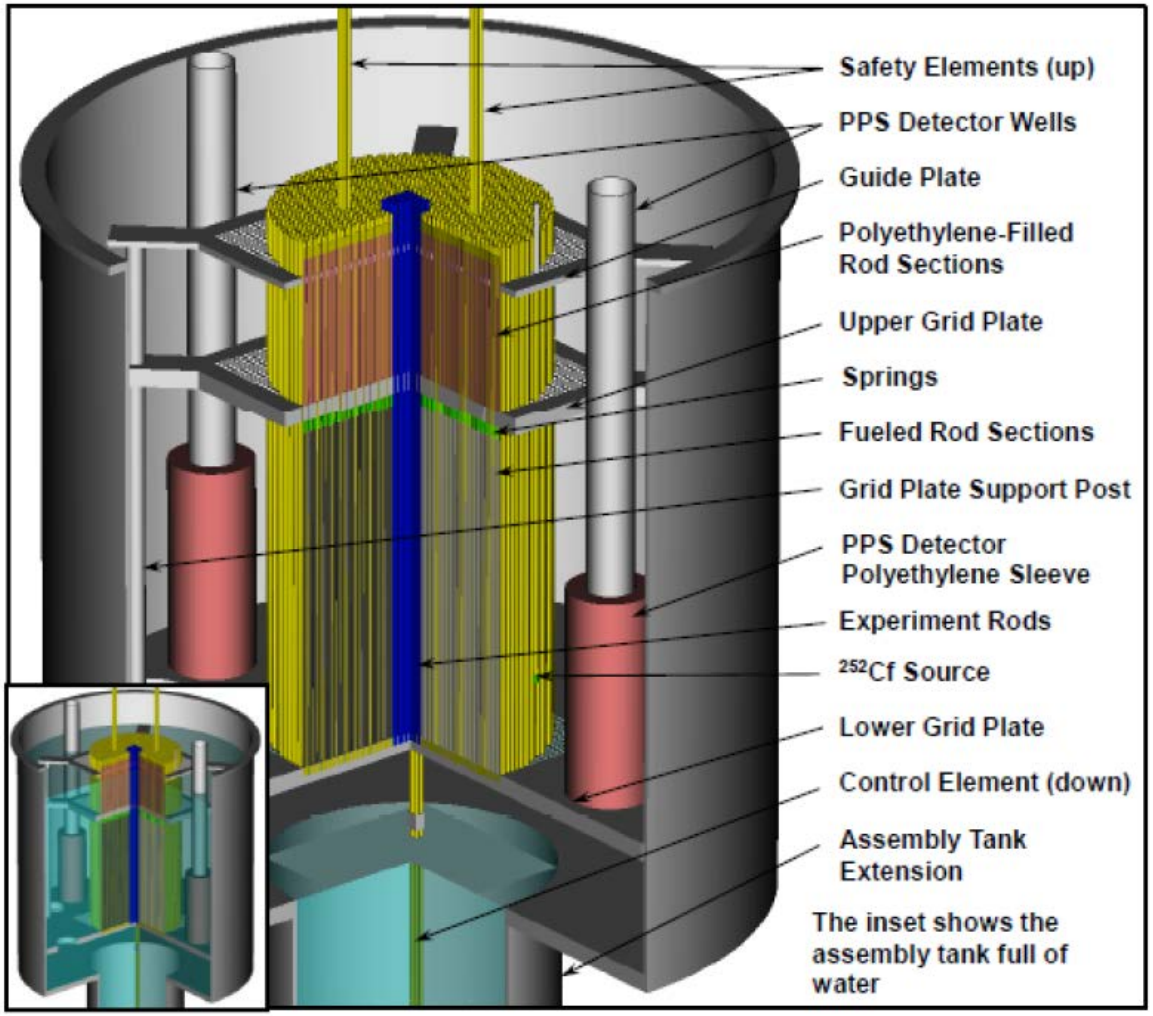
SPR/CX setup



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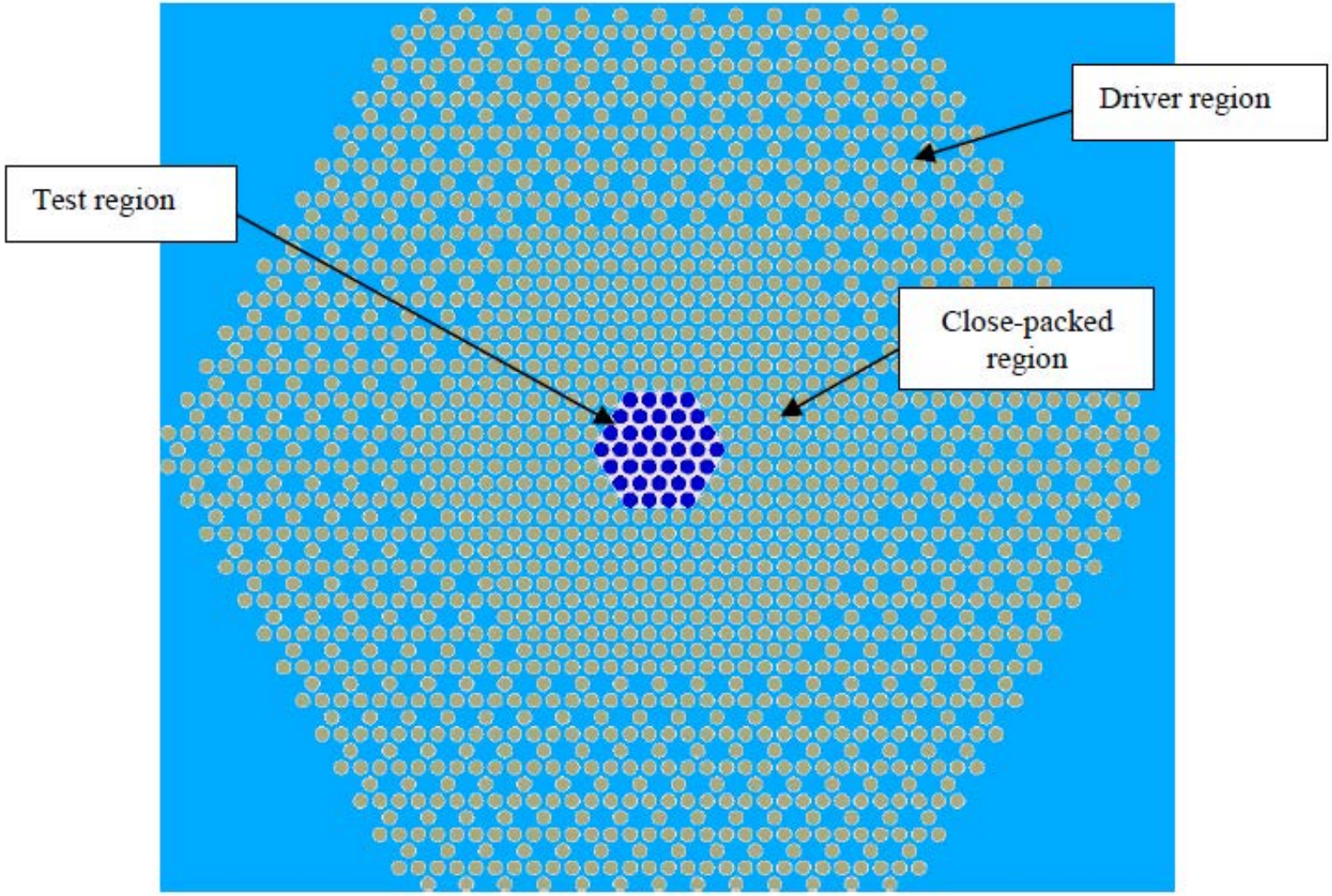
STEM-NEXUS lattice



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Procedure for determining usefulness of this setup

1. Run calculations for a large number of potential test materials
2. Determine the worth for a fully loaded test region with and without boron present to determine measurability
3. Observe the change in the reaction rate spectrum with the addition of the number of rods and the addition of boron to the block
4. Determine which materials would be best to use in testing

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Worth of configurations examined

Element	Unborated 37-pin worth	1 wt% boron 37-pin worth	2 wt% boron 37-pin worth	5 wt% boron 37-pin worth
Dy	0.03112	0.02077	0.01677	0.01272
Hf	0.03066	0.02021	0.01619	0.01162
Ag	0.02886	0.01825	0.01501	0.01094
Ta	0.02840	0.01951	0.01617	0.01252
In	0.02664	0.01663	0.01312	0.00877
Co	0.02019	0.01043	0.00725	0.00379
W	0.02032	0.01221	0.00953	0.00581
Mn	0.01185	0.00495	0.00284	0.00101
Sb	0.01070	0.00632	0.00491	0.00431
Mo	0.00586	0.00274	0.00175	NC
Ti	0.00533	0.00094	NC[a]	NC
V	0.00453	0.00015	NC	NC
Cu	0.00437	0.00031	NC	NC
Cr	0.00312	0.00030	NC	NC
Nb	0.00275	0.00092	NC	NC
Fe	0.00220	-0.00065	NC	NC
Sr	0.00130	NC	NC	NC
Sn	0.00093	NC	NC	NC
Ca	-0.00015	NC	NC	NC
Al	-0.00035	NC	NC	NC
Ce	-0.00075	NC	NC	NC
Mg	-0.00146	NC	NC	NC
Pb	-0.00156	NC	NC	NC
Bi	-0.00157	NC	NC	NC

[a] NC= not calculated

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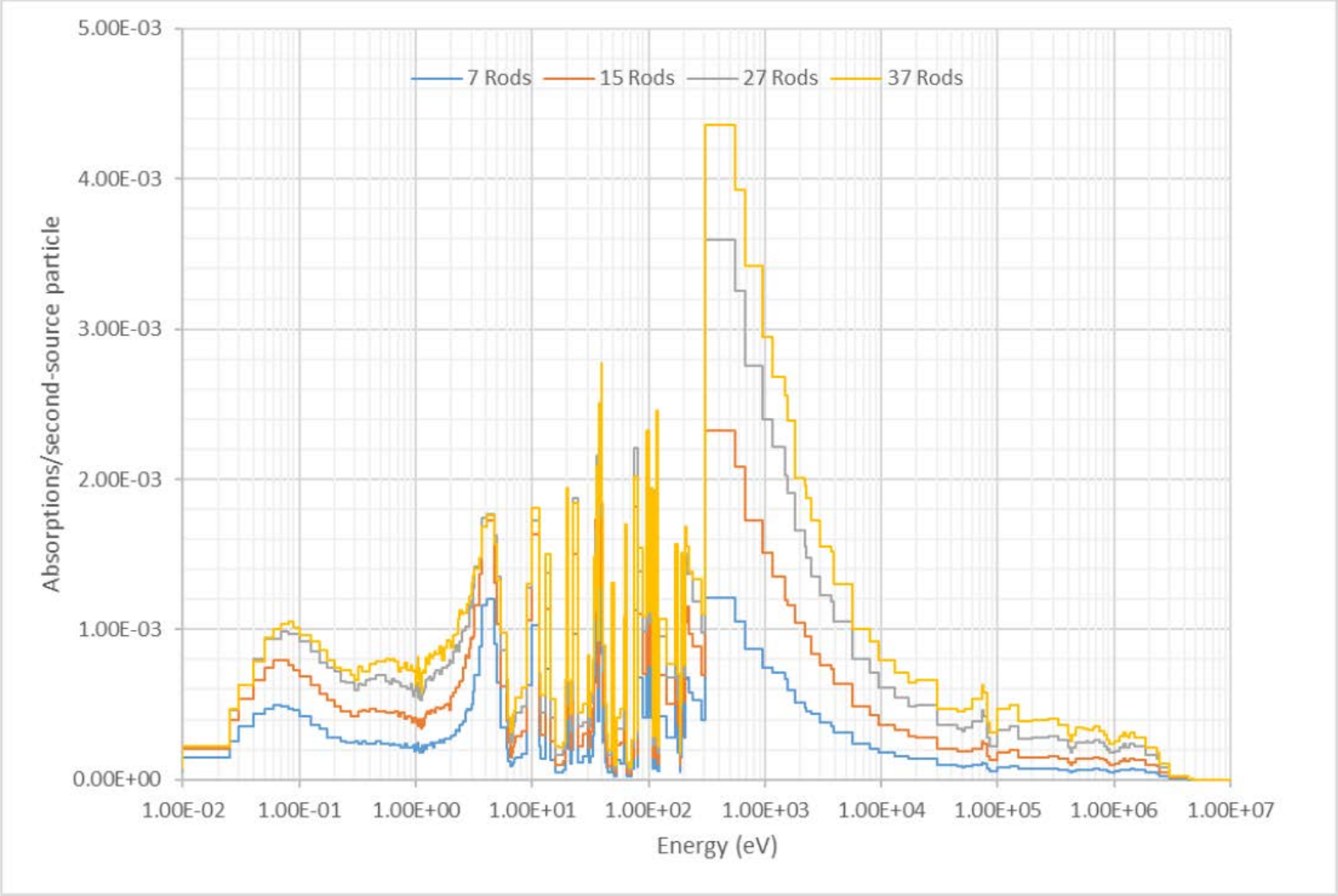
Number of rods in test region



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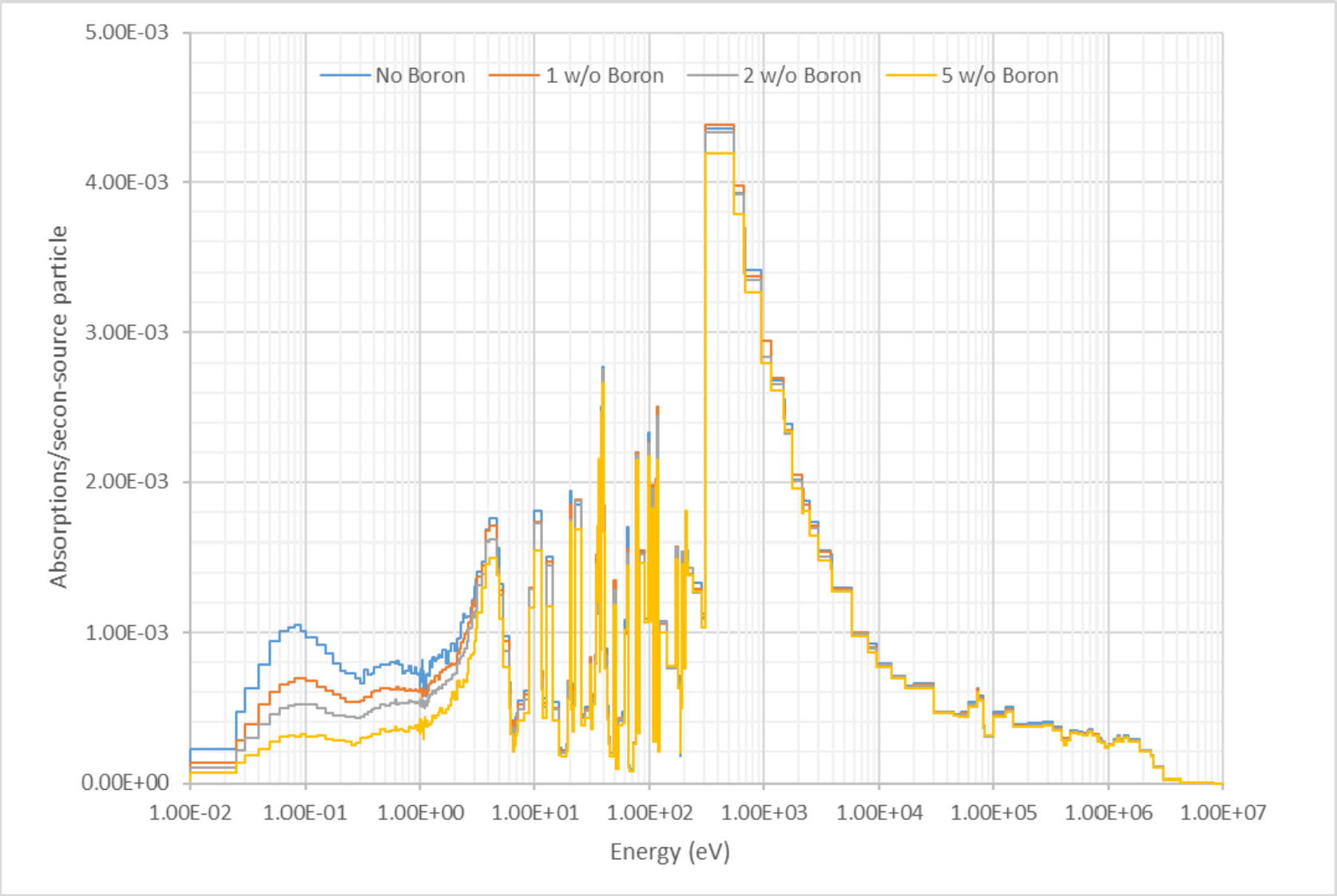
Boron loading in test region



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Summary results for tantalum

Number of rods	Boron loading (wt%)	E < 1 eV (%)	1 eV < E < 100 eV (%)	100 eV < E < 1 keV (%)	1 keV < E < 1 MeV (%)	E > 1 MeV (%)
7	0	21.13	29.77	26.02	22.19	0.89
15	0	19.30	27.42	27.24	25.02	1.01
27	0	17.45	24.13	28.36	28.87	1.19
37	0	16.00	22.38	28.85	31.46	1.31
37	1	11.99	22.84	30.68	33.12	1.38
37	2	9.88	22.82	31.75	34.13	1.42
37	5	6.72	21.94	33.37	36.45	1.51

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Qualitative results

Material	Qualitative result
Dysprosium (Dy)	Good
Indium (In)	Good
Hafnium (Hf)	Good
Silver (Ag)	Good
Tantalum (Ta)	Good
Antimony (Sb)	Moderately good
Cobalt (Co)	Moderately good
Tungsten (W)	Moderately good
Manganese (Mn)	Fair
Vanadium (V)	Poor
Strontium (Sr)	Poor
Molybdenum (Mo)	Poor
Copper (Cu)	Poor
Chromium (Cr)	Poor
Titanium (Ti)	Poor
Niobium (Nb)	Poor
Tin (Sn)	Poor
Iron (Fe)	Poor
Calcium (Ca)	Poor

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Detailed design

- Based on these results, the second step of the design will be implemented with tantalum as test material
- The uncertainties associated with experimental configuration must be addressed:
  - Acquire source of tantalum
  - Consider alternative central regions based on ability to fabricate
    - Borated aluminum does not seem to be feasible based on fabricability
  - Placement of test samples for spectral tailoring must be optimized
- Modern analytical methods will be integrated with the experimental setup
  - Use TSAR to generate sensitivity difference profiles between cases with different number of rods/thermal flux filters
  - Use results of experiments with TSURFER to recommend XS adjustments
  - There are many highly correlated experiments with SPR/CX

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Questions???

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