NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

LLNL-PRES-770094

IER-329 CED-2: Final Design for TEX with ^{233}U ZPPR Plates and High-Density Polyethylene

TEX-23

W. Zywiec, J. Norris, C. Percher, A. Nelson, D. Heinrichs
Lawrence Livermore National Laboratory

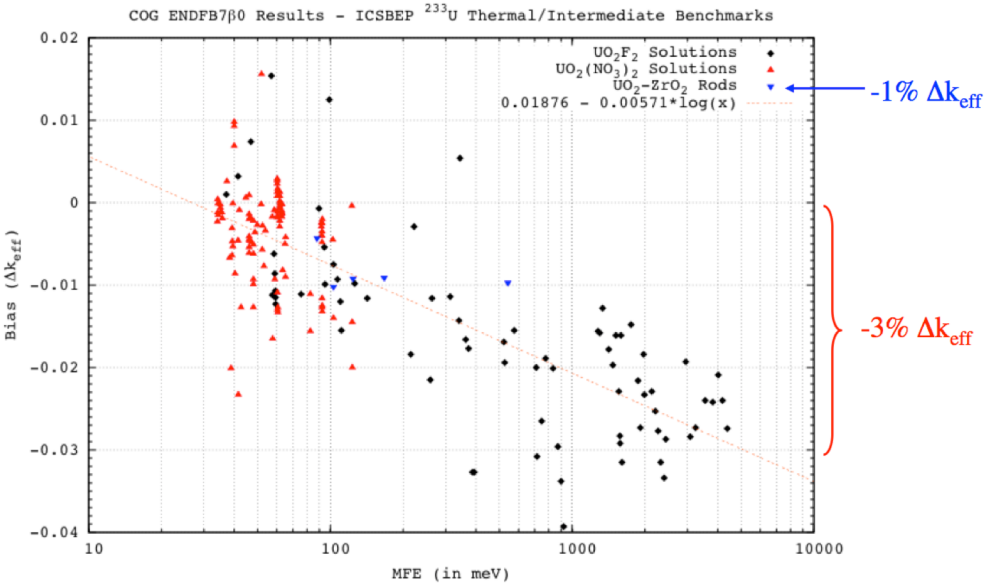
Lawrence Livermore National Laboratory, P.O. Box 808, L-198, Livermore, CA 94551-0808
This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

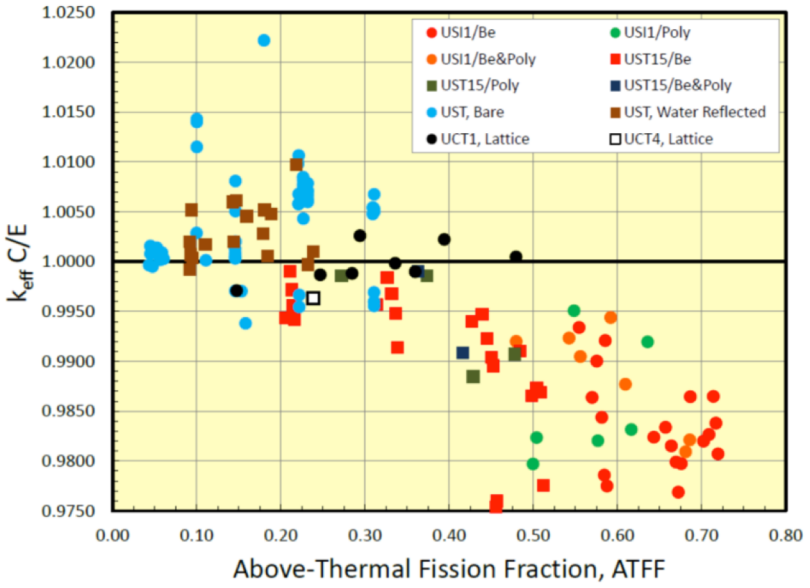
TEX-23 Overview

- **TEX Goals**
  - New critical experiments to address high priority nuclear data needs
  - Special emphasis on intermediate energy range
- **TEX-23** IER-329 CED-1 (Completed FY18)
  - 14 critical assemblies for benchmarking ^{233}U
- **TEX-23** IER-329 CED-2 (In Progress)

TEX-23 Justification

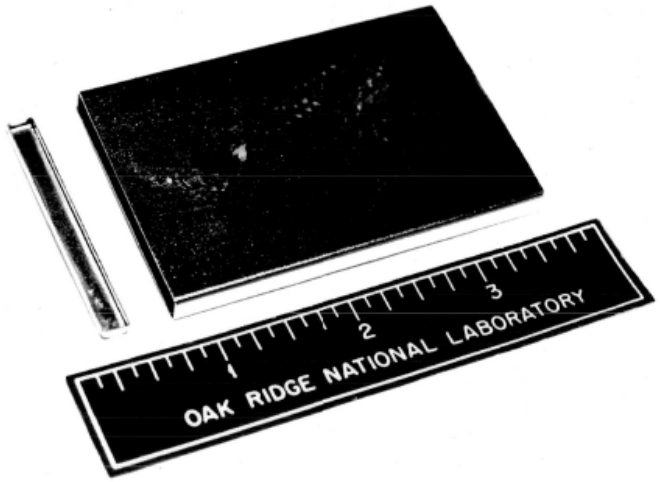
- COG and MCNP calculated results show a downward trend in bias for existing ^{233}U benchmarks.
  - For thermal systems, k_{eff} values are **over-predicted** by **2%**.
  - Intermediate systems are **under-predicted** by up to **4%**.
  - Bad nuclear data, bad critical experiments, or both?

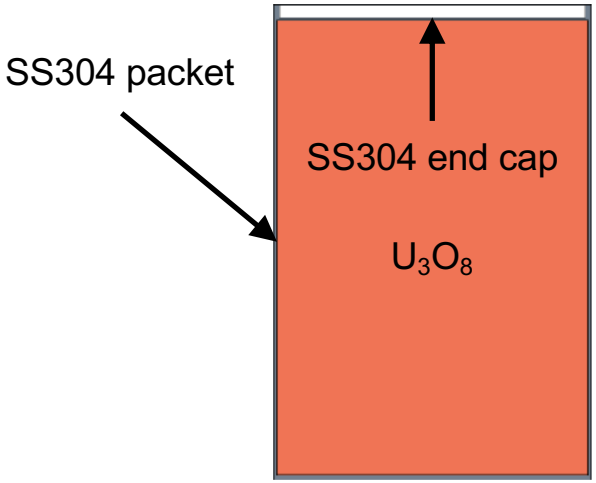




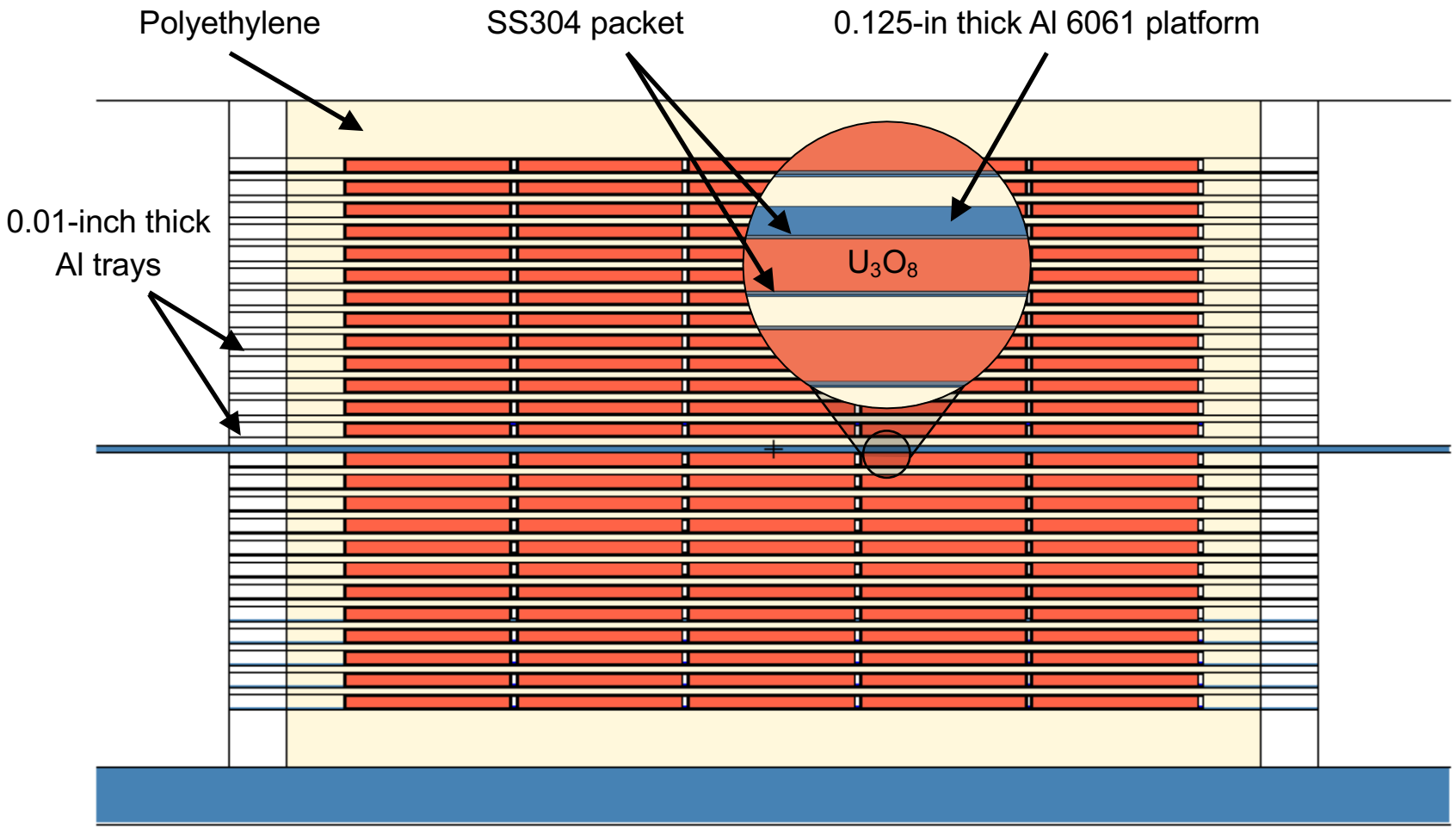
TEX-23 Models

- **^{233}U ZPPR Plates**
  - Stainless steel (SS304) packets
  - Uranium oxide (U_3O_8 powder) fill
    - Density ~1.62 g/cm^3
    - 33 grams ± 2% (~28 grams ^{233}U)
    - Impurities are quantified





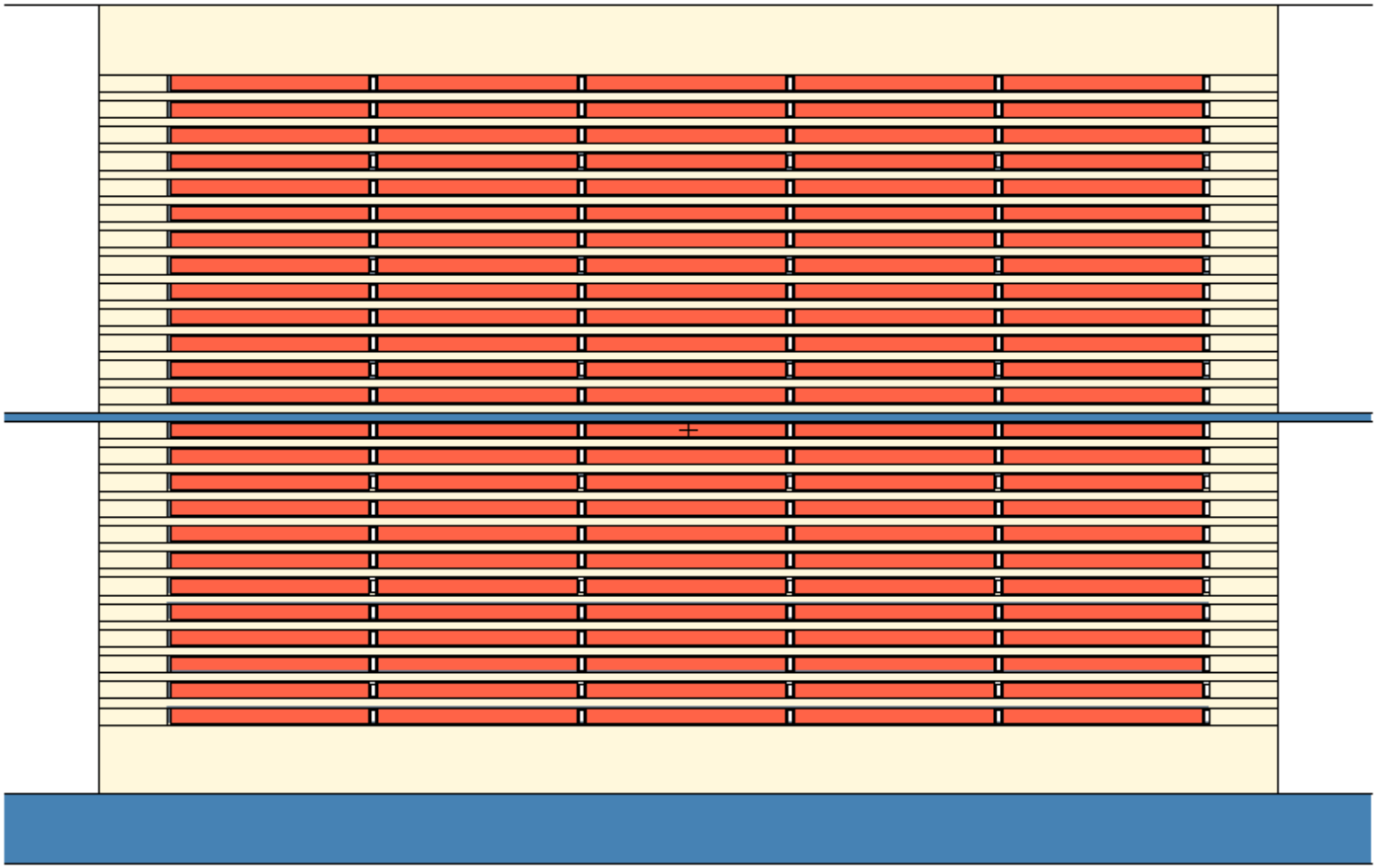
TEX-23 Design using Optimus (CED-1)



CED-1 Results

P_x	P_y	L_z	$t_{moderator}$ (in)	$t_{reflector}$ (in)	H/D	^{233}U Mass (kg)	k_{eff}	Fission Fraction Integral		
								Thermal	Intermediate	Fast
6	4	11	0.3125	1	0.5	7.39	1.0054	0.53	0.41	0.06
6	4	11	0.25	1.5	0.5	7.39	0.9969	0.52	0.42	0.06
6	4	15	0.1875	1.5	0.5	10.08	1.0067	0.46	0.47	0.08
6	4	18	0.1875	1	0.5	12.10	0.9968	0.41	0.51	0.08
6	4	22	0.125	1.5	0.6	14.78	0.9909	0.38	0.52	0.10
6	5	16	0.1875	1	0.4	13.44	1.0006	0.41	0.51	0.08
6	5	25	0.125	1	0.5	21	1.0008	0.32	0.57	0.11
7	4	17	0.1875	1	0.5	13.33	1.0096	0.41	0.51	0.08
7	4	26	0.125	1	0.6	20.38	0.9976	0.32	0.57	0.11
7	5	6	1.875	1	0.7	5.88	1.0334	0.81	0.16	0.03
8	6	13	0.1875	1	0.3	17.47	1.0036	0.41	0.51	0.08
8	6	19	0.125	1	0.3	25.54	1.0037	0.32	0.57	0.11
9	6	13	0.1875	1	0.3	19.66	1.0227	0.41	0.51	0.08
9	6	18	0.125	1	0.3	27.22	1.0032	0.32	0.57	0.11

TEX-23 Design using Optimus (CED-2)



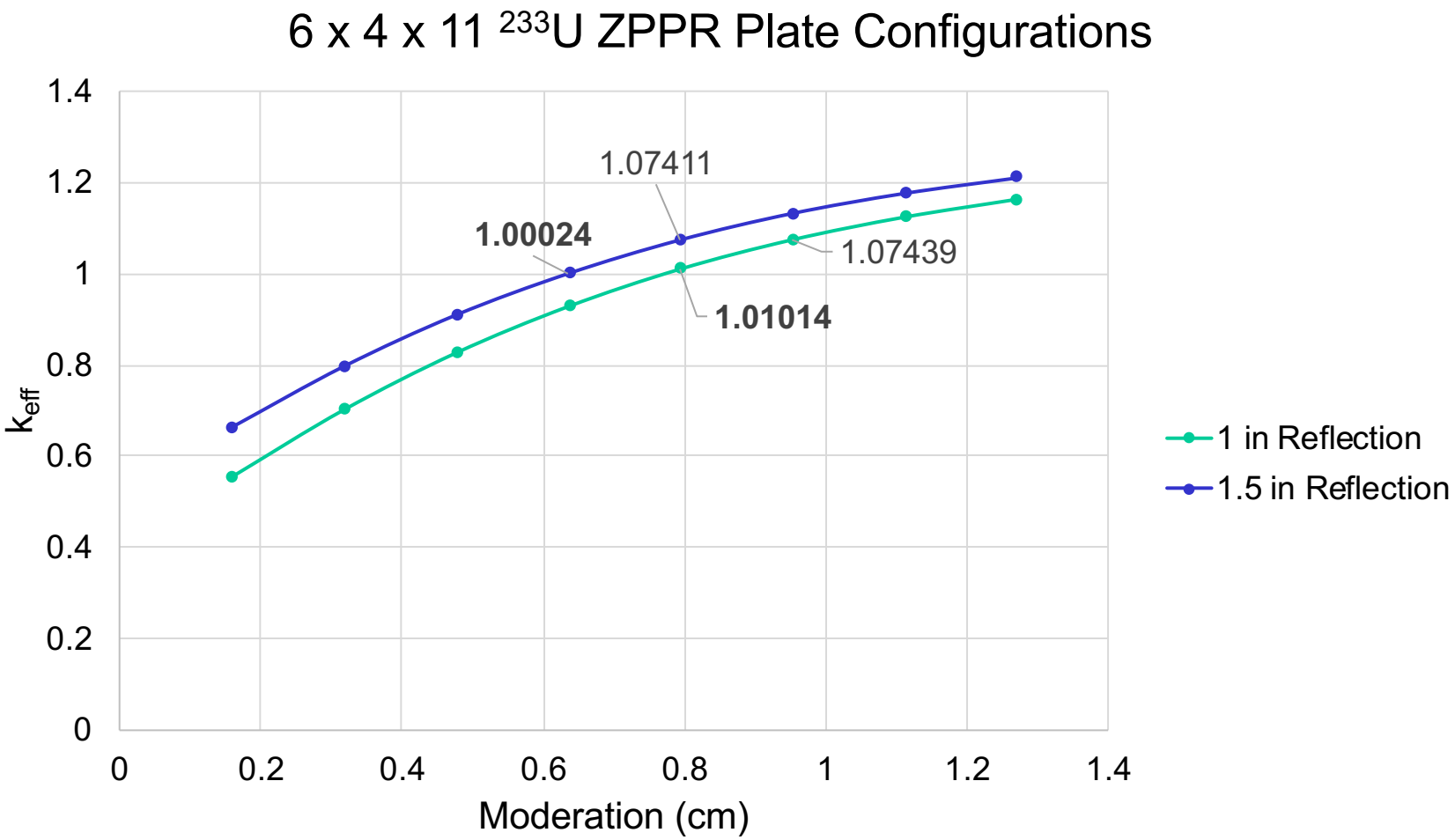
CED-2 Changes

- Removed interstitial aluminum sheets
- Adjusted uranium impurities
- For each of the 14 critical assembly configurations identified in CED-1, parametric calculations were performed

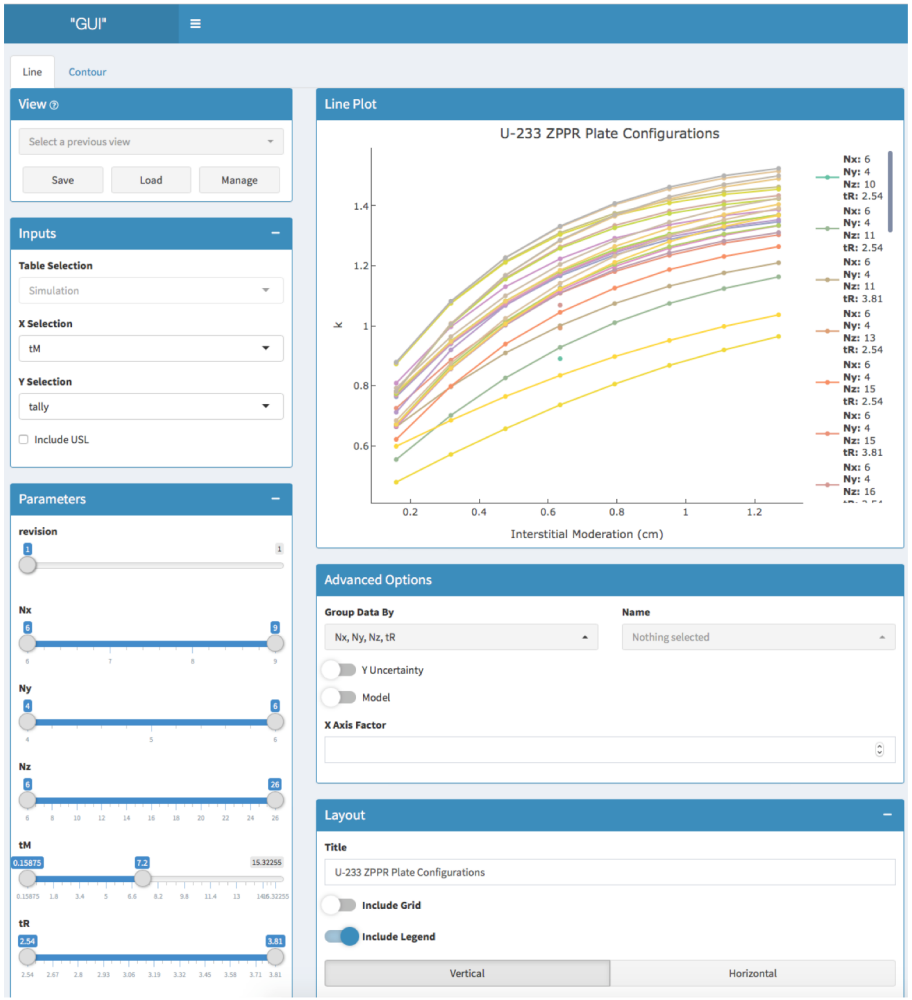
CED-2 Changes

- Removed interstitial aluminum sheets
- Adjusted uranium impurities
- For each of the 14 critical assembly configurations identified in CED-1, parametric calculations were performed
  - Varied polyethylene moderation
  - Varied polyethylene reflection

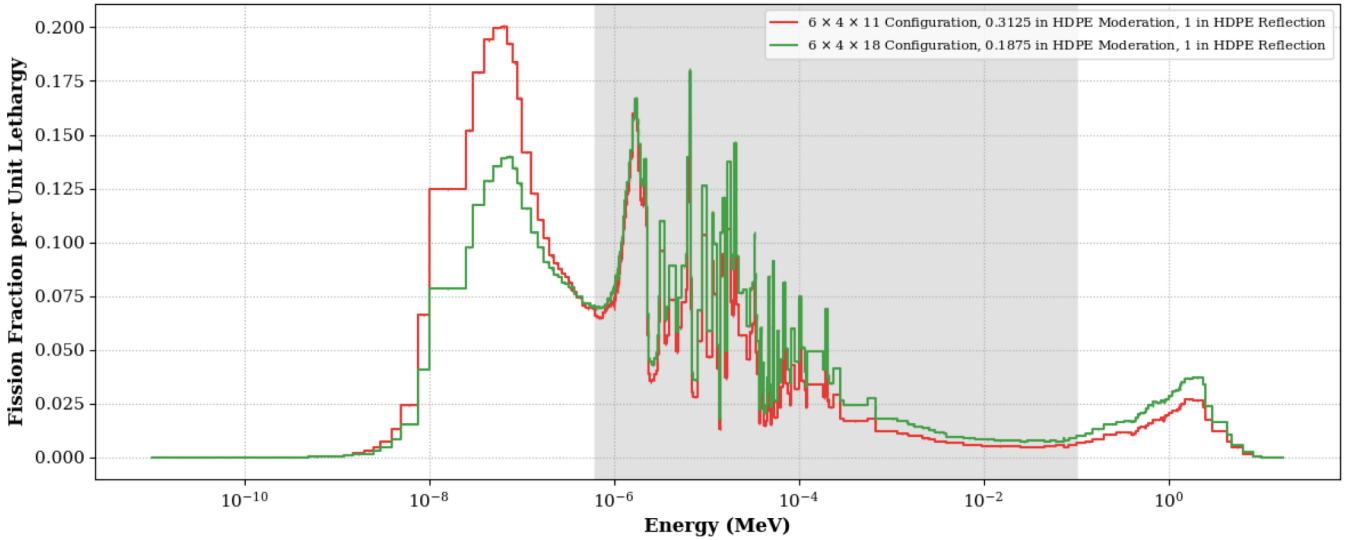
CED-2 Preliminary Results

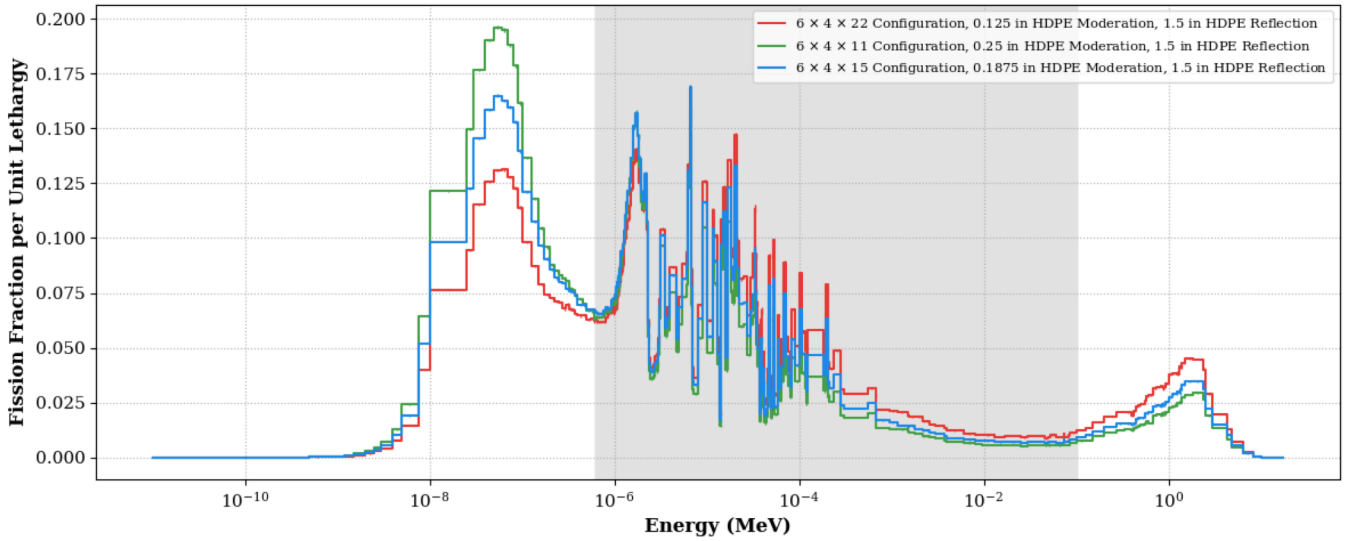


CED-2 Preliminary Results

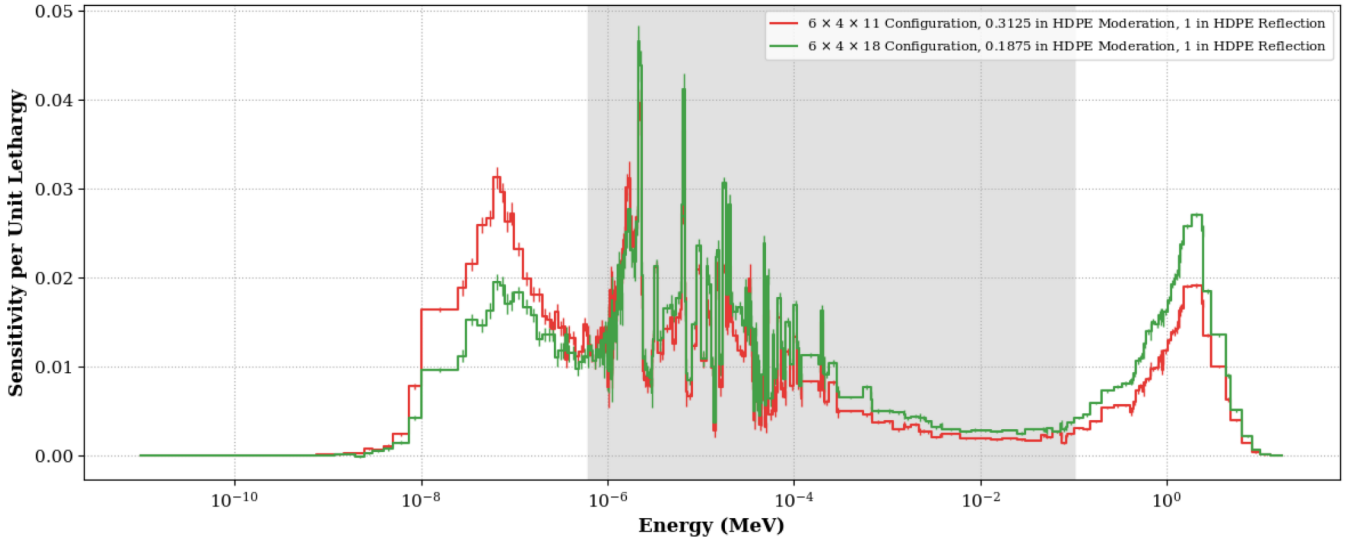


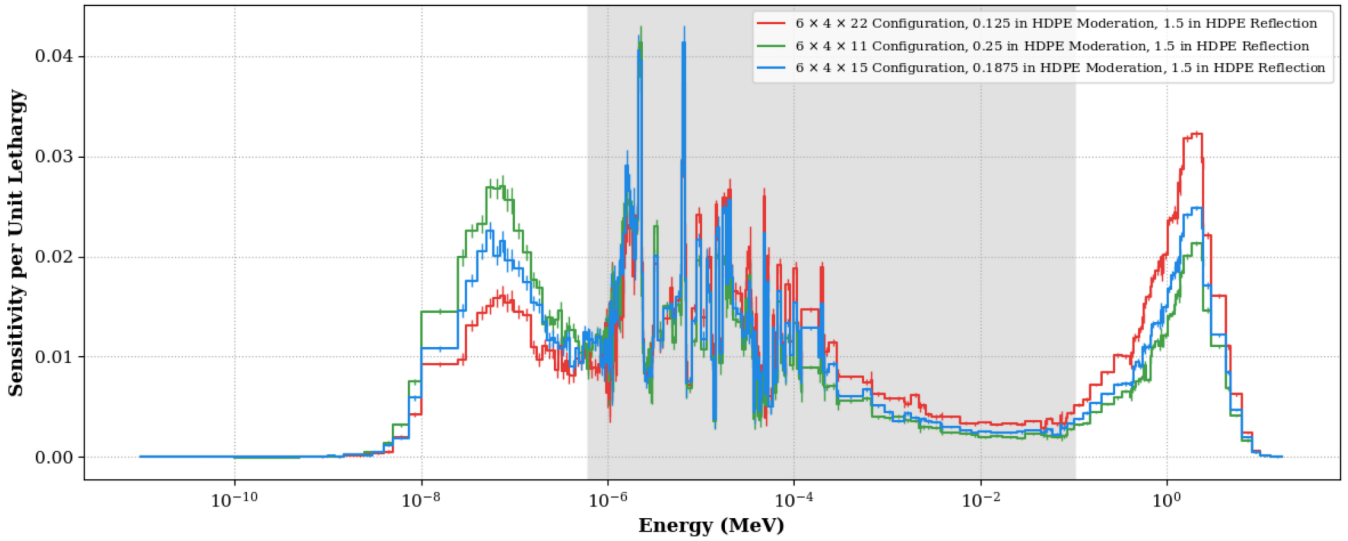
^{233}U Fission Spectra





^{233}U Fission Sensitivity





CED-2 Preliminary Results

- Removing interstitial aluminum sheets and adjusting impurities did not significantly change the results
  - k_{eff} went up 0.001-0.003
  - ^{233}U fission spectra did not change
  - ^{233}U fission and capture sensitivity changes were minimal

Continuing Work on CED-2

- FY18
  - Completed CED-1
  - Started CED-2
  - Removed interstitial aluminum sheets
  - Adjusted uranium impurities
  - Vary polyethylene moderation and reflection
- FY19
  - Vary uranium oxide mass ± 0.66 grams
  - Vary uranium oxide density
  - Vary stainless steel cladding thickness and impurities
  - Analyze spacing
  - Send CED-2 out for review
  - Complete CED-2