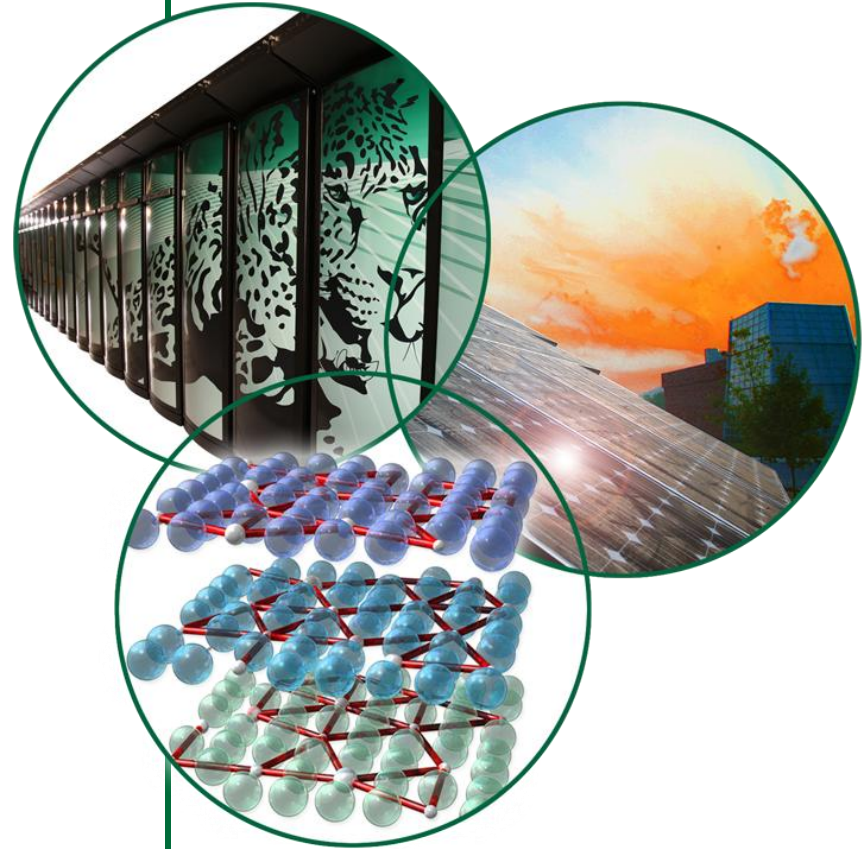


WPEC Subgroup 33 Benchmark Results

Dr. Christopher Perfetti

Dr. Bradley Rearden

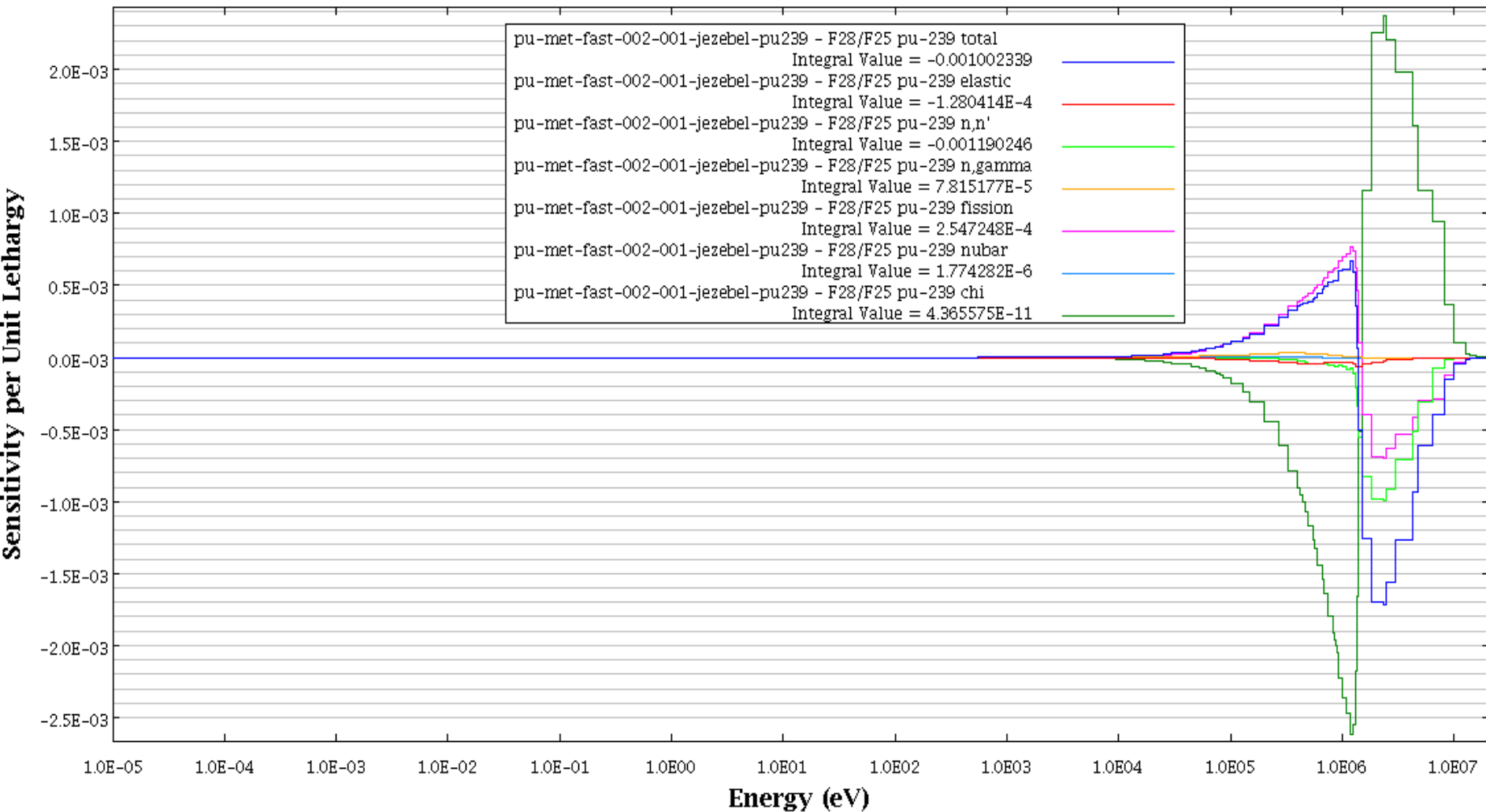
Reactor and Nuclear Systems
Division



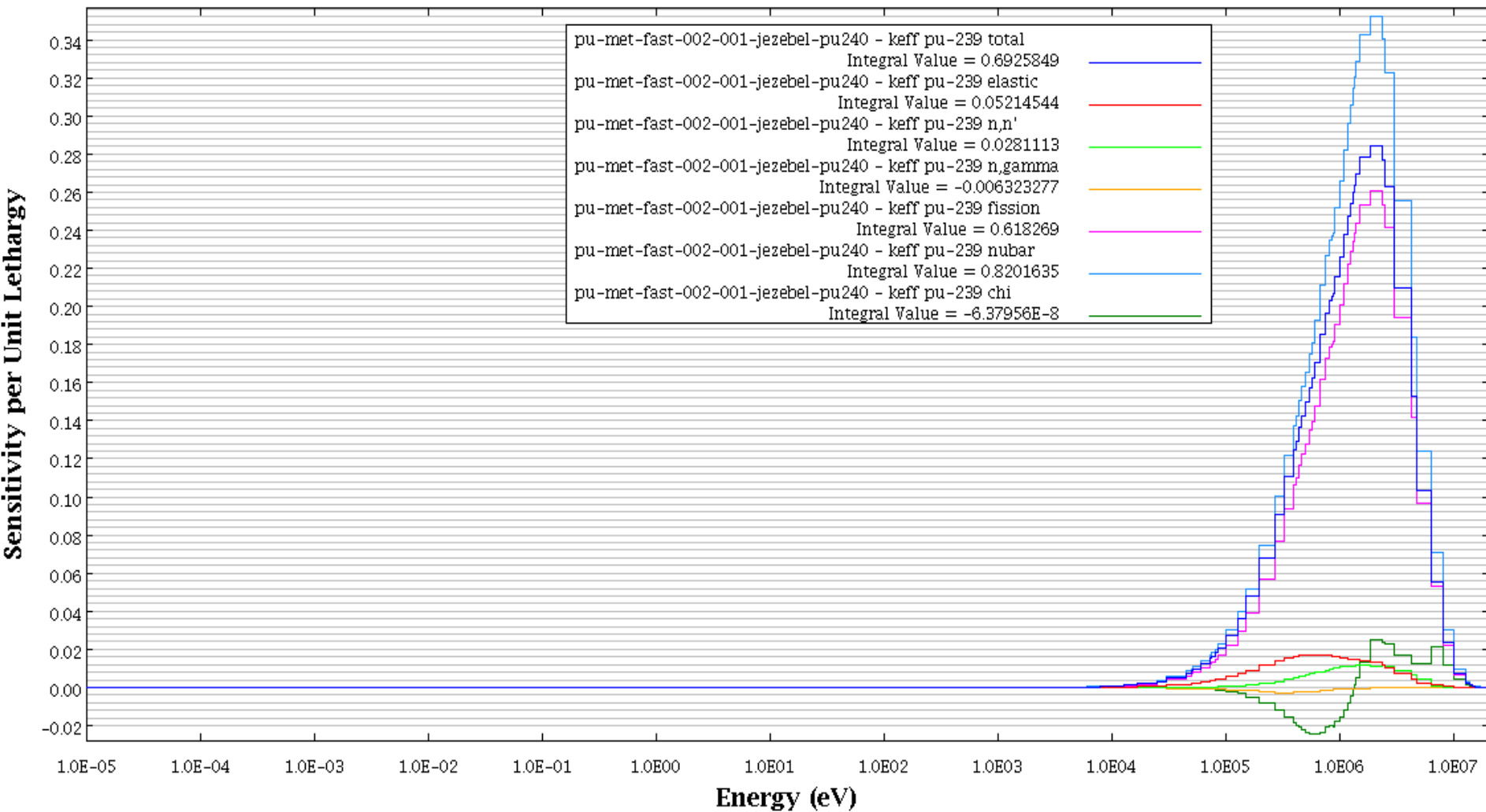
Methodology

- Sensitivity coefficients were generated for k_{eff} and spectral index responses using TSUNAMI-1D from SCALE 6.1.
- Because TSUNAMI-1D uses the one-dimensional XSDRNPM code to solve the forward, adjoint, and generalized-adjoint transport equations, the scope of this analysis was limited to the one-dimensional benchmark cases (JEZEBEL239, JEZEBEL240, and FLATTOP-PU).
- The Sensitivity Data Files (SDFs) generated from these calculations were input to the TSURFER code, which used them to guide the cross-section adjustment in this study.
- TSURFER calculates a χ^2 value based on the difference between the experimental and application responses and the amount of adjustment made to the cross-section data and applies a Generalized Linear Least Squares (GLLS) approach to minimize the value of this χ^2 statistic.
- TSURFER also filters the experimental and application cases to identify outlier cases which are ignored during the data adjustment process. The Delta-Chi-Square filtering method was used in this study.
- All calculations used ORNL ENDF/B-VII 238-group cross-section data and SCALE 6.1 44-group covariance data.

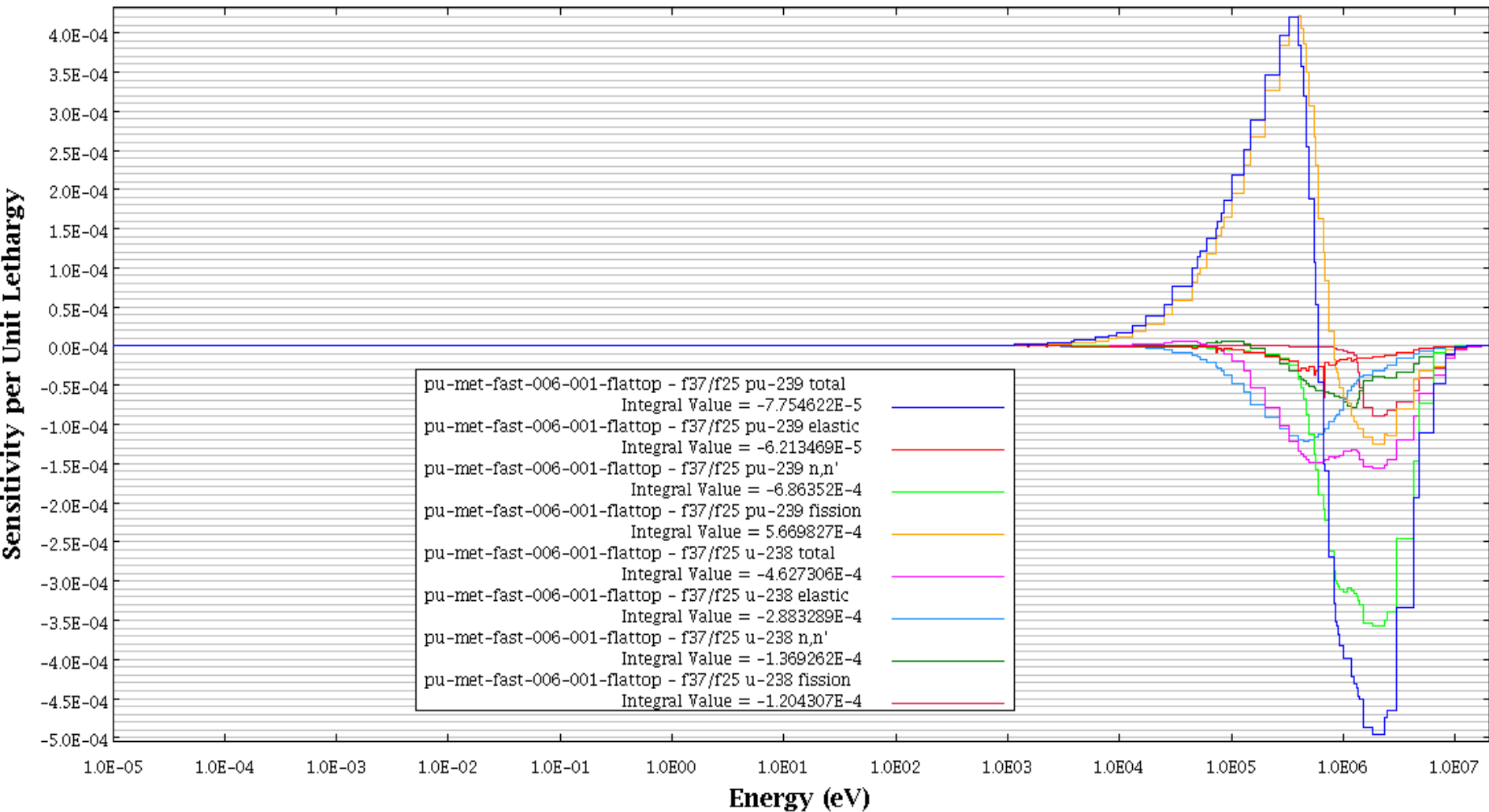
Results: JEZEBEL239 Sensitivity Coefficients for F28/F25



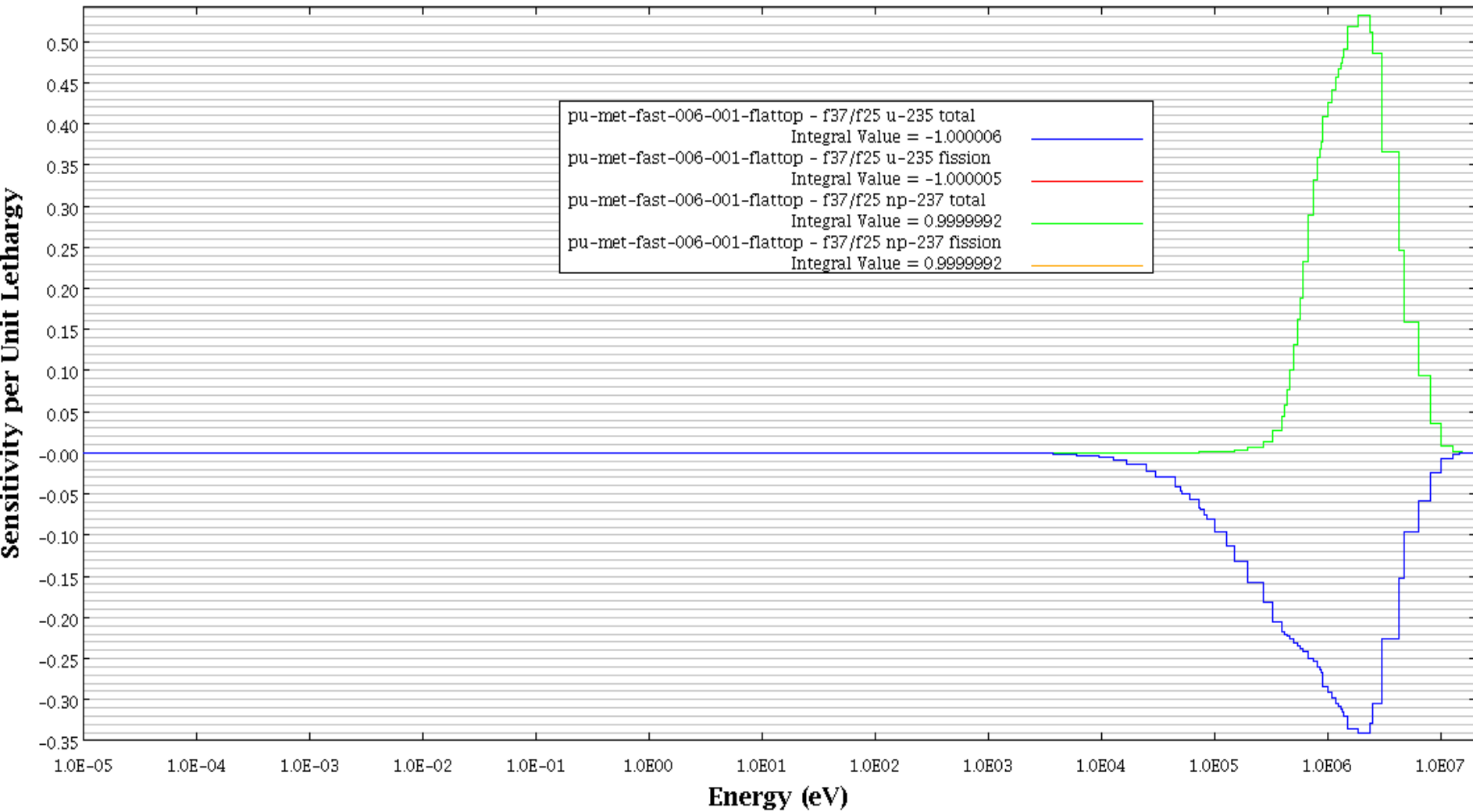
Results: JEZEBEL240 Sensitivity Coefficients for k_{eff}



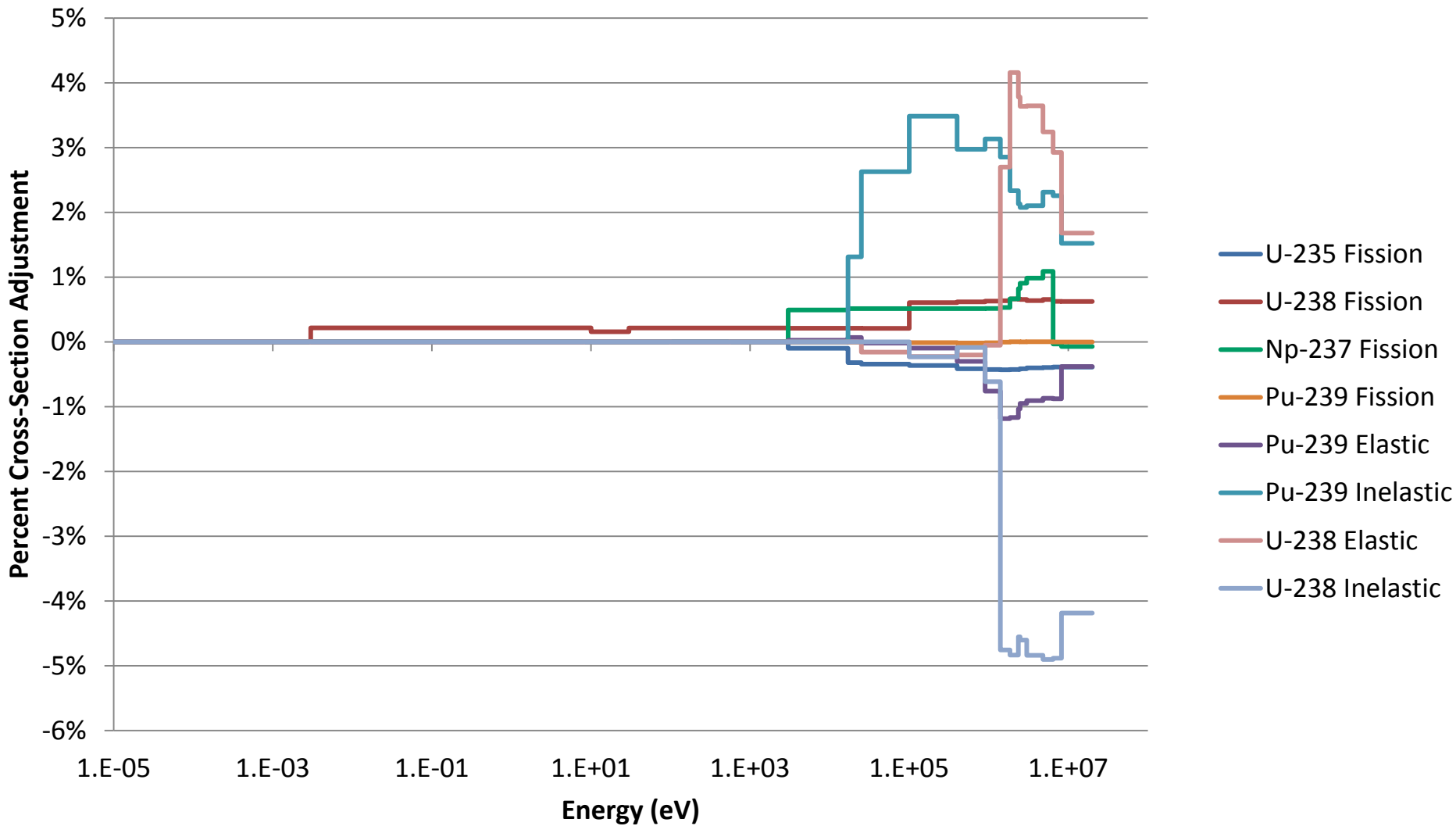
Results: FLATTOP-PU Sensitivity Coefficients for F37/F25



Results: FLATTOP-PU Sensitivity Coefficients for F37/F25



Results: Cross-Section Adjustments



Results: Response Integral Data Correlations

- All experimental responses were assumed to be completely uncorrelated.

Initial Application Response Correlation Matrix

	Model	Response	1	2	3	4	5	6	7	8
1	JEZEBEL239	keff	1000	-3	186	-1	967	901	-2	-1
2	JEZEBEL239	F28/F25	-3	1000	402	36	-1	21	999	36
3	JEZEBEL239	F49/F25	186	402	1000	37	182	171	400	37
4	JEZEBEL239	F37/F25	-1	36	37	1000	-1	0	35	1000
5	JEZEBEL240	keff	967	-1	182	-1	1000	892	1	-1
6	FLATTOP-PU	keff	901	21	171	0	892	1000	22	0
7	FLATTOP-PU	F28/F25	-2	999	400	35	1	22	1000	36
8	FLATTOP-PU	F37/F25	-1	36	37	1000	-1	0	36	1000

Adjusted Application Response Correlation Matrix

	Model	Response	1	2	3	4	5	6	7	8
1	JEZEBEL239	keff	1000	-10	OMIT	0	243	98	-10	0
2	JEZEBEL239	F28/F25	-10	1000	OMIT	4	-2	20	998	3
3	JEZEBEL239	F49/F25	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT	OMIT
4	JEZEBEL239	F37/F25	0	4	OMIT	1000	0	0	3	994
5	JEZEBEL240	keff	243	-2	OMIT	0	1000	73	0	0
6	FLATTOP-PU	keff	98	20	OMIT	0	73	1000	19	0
7	FLATTOP-PU	F28/F25	-10	998	OMIT	3	0	19	1000	4
8	FLATTOP-PU	F37/F25	0	3	OMIT	994	0	0	4	1000

Results: Response Integral Data

- The TSURFER cross-section adjustments were found to significantly improve the C/E values for each experiment and lower the χ^2 statistic for the system responses.

Initial χ^2 (per degree of freedom): 1.334

Final χ^2 (per degree of freedom): 0.976

	Case	Response	C/E Initial	Exp. Unc.	App. Unc.	C/E Adjusted	Adj. Unc.
1	JEZEBEL239	KEFF	0.99984	0.20%	1.39%	0.99970	0.18%
2	JEZEBEL239	F28/F25(CC)	0.97835	1.10%	0.66%	0.98871	0.51%
3	JEZEBEL239	F49/F25(CC)	OMITTED	OMITTED	OMITTED	OMITTED	OMITTED
4	JEZEBEL239	F37/F25(CC)	0.98782	1.40%	7.14%	0.99865	0.99%
5	JEZEBEL240	KEFF	1.00059	0.20%	1.21%	1.00009	0.17%
6	FLATTOP-PU	KEFF	1.00235	0.30%	1.26%	1.00062	0.26%
7	FLATTOP-PU	F28/F25(CC)	0.97074	1.10%	0.66%	0.98100	0.51%
8	FLATTOP-PU	F37/F25(CC)	0.99029	1.40%	7.11%	1.00109	0.99%

Future work includes developing 3-D Monte Carlo methods for calculating generalized sensitivity coefficients.