

Adjustment Phase I SG33 INL Preliminary Solution

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Calculation Data

- **Cross Section Used: ENDF/B-VII data**
- **Covariance Used: AFCI 2.0**
- **20 experiments used (no covariance among them). MCNP solutions for JEZEBEL, FLATTOP, ZPR6-7. Deterministic S_4P_1 with JAEA corrective factors for ZPPR-9 and JOYO**
- **Sensitivity coefficients calculated in S_4P_1 with ERANOS and ENDF/B-VII data**
- **Isotopes considered: U235, U238, Pu239, Pu240, Pu241, Fe56, Cr52, Ni58, O16, Na23, B10**
- **Reaction considered: Capture, Fission, Nu, Elastic, Inelastic**
- **398 cross sections were selected using the following criteria on uncertainty produced by a single cross section:**
 - **0.01% for K_{eff}**
 - **0.1% for spectral indices**
 - **0.1% for sodium void**

Calculated and Experimental Values

Experiment	C ± σ	E ± σ	Experiment	C ± σ	E ± σ
JEZEBEL_Pu239 Keff	0.99986 ± 9pcm	1.00000 ± 0.001	ZPR6-7 Pu239 F49/F25	0.9093 ± 0.0065	0.9414 ± 0.022
JEZEBEL_Pu239 F28/F25	0.2084 ± 0.0009	0.214 ± 0.002	ZPR6-7 Pu239 C28/F25	0.1336 ± 0.0008	0.1323 ± 0.003
JEZEBEL_Pu239 F49/F25	1.4248 ± 0.0018	1.448 ± 0.029	ZPR6-7 Pu240 Keff	1.00017 ± 11pcm	1.00080 ± 0.001
JEZEBEL_Pu239 F37/F25	0.9707 ± 0.0013	0.962 ± 0.016	ZPPR9 Keff	0.99604 ± 4pcm	1.00080 ± 0.00154
JEZEBEL_Pu240 Keff	0.99981 ± 9pcm	1.00000 ± 0.001	ZPPR9 F28/F25	0.02107 ± 0.00018	0.02210 ± 0.00061
FLATTOP Keff	1.00097 ± 0.001	1.00000 ± 0.001	ZPPR9 F49/F25	0.9077 ± 0.0044	0.9295 ± 0.0185
FLATTOP F28/F25	0.1767 ± 0.0013	0.1799 ± 0.0024	ZPPR9 C28/F25	0.1394 ± 0.0009	0.1379 ± 0.0026
FLATTOP F37/F25	0.8523 ± 0.0013	0.8561 ± 0.012	ZPPR9 Na Void Step 3	30.42 ± 1.85	29.39 ± 0.36
ZPR6-7 Pu239 Keff	1.00094 ± 7pcm	1.00051 ± 0.001	ZPPR9 Na Void Step 5	29.65 ± 1.83	31.68 ± 0.36
ZPR6-7 Pu239 F28/F25	0.0224 ± 0.0002	0.0233 ± 0.007	JOYO Keff	0.98675 ± 14pcm	1.00105 ± 0.0180

C/E Before and After Normalized $\chi^2=0.92$

Experiment	old C/E $\pm \sigma$	new C/E $\pm \sigma$	Experiment	old C/E $\pm \sigma$	new C/E $\pm \sigma$
JEZEBEL_Pu239 Keff	0.9999 \pm 0.001	0.9997 \pm 0.001	ZPR6-7 Pu239 F49/F25	0.9659 \pm 0.023	0.9703 \pm 0.006
JEZEBEL_Pu239 F28/F25	0.9738 \pm 0.009	0.9905 \pm 0.007	ZPR6-7 Pu239 C28/F25	1.0098 \pm 0.025	1.008 \pm 0.009
JEZEBEL_Pu239 F49/F25	0.9840 \pm 0.020	0.9873 \pm 0.005	ZPR6-7 Pu240 Keff	0.9994 \pm 0.001	0.9999 \pm 0.001
JEZEBEL_Pu239 F37/F25	1.0090 \pm 0.017	1.0154 \pm 0.006	ZPPR9 Keff	0.9952 \pm 0.0015	0.9984 \pm 0.001
JEZEBEL_Pu240 Keff	0.9998 \pm 0.001	1.0000 \pm 0.001	ZPPR9 F28/F25	0.9534 \pm 0.028	1.0081 \pm 0.017
FLATTOP Keff	1.00097 \pm 0.001	1.0002 \pm 0.001	ZPPR9 F49/F25	0.9765 \pm 0.020	0.9813 \pm 0.006
FLATTOP F28/F25	0.9822 \pm 0.013	1.0061 \pm 0.006	ZPPR9 C28/F25	1.0109 \pm 0.019	1.0089 \pm 0.009
FLATTOP F37/F25	0.9956 \pm 0.014	1.0061 \pm 0.006	ZPPR9 Na Void Step 3	0.9602 \pm 0.012	1.0064 \pm 0.009
ZPR6-7 Pu239 Keff	1.0004 \pm 0.001	1.0009 \pm 0.001	ZPPR9 Na Void Step 5	0.9359 \pm 0.011	0.9957 \pm 0.010
ZPR6-7 Pu239 F28/F25	0.9614 \pm 0.033	1.0054 \pm 0.015	JOYO Keff	0.9857 \pm 0.0018	0.9990 \pm 0.0018

Major Contributors to Improved C/E

ZPR6-7 F28/F25

Cross Section	Contribution (%)
U238 σ^{inel} gr. 4.	1.8
U238 σ^{inel} gr. 5	1.6
U238 σ^{inel} gr. 3	0.7
Fe56 σ^{inel} gr. 5	-0.4
U238 σ^{inel} gr. 6.	0.2
Pu239 σ^{inel} gr. 4	0.1
Total	4.6

ZPPR9 Keff

Cross Section	Contribution (pcm)
U238 σ^{inel} gr. 4.	260
U238 σ^{inel} gr. 5	240
U238 σ^{inel} gr. 3	100
U238 σ^{inel} gr. 6	70
Pu239 σ^{cap} gr. 16	-60
Pu239 σ^{cap} gr. 17	-50
Total	314

Major Contributors to Improved C/E

ZPPR9 F28/F25

Cross Section	Contribution (%)
U238 σ^{inel} gr. 4.	2.2
U238 σ^{inel} gr. 5	2.0
U238 σ^{inel} gr. 3	0.9
Fe56 σ^{inel} gr. 5	-0.3
U238 σ^{inel} gr. 6.	0.2
Pu239 σ^{inel} gr. 4	0.1
Total	5.7

ZPPR9 Na Void Step 3

Cross Section	Contribution (%)
U238 σ^{inel} gr. 4.	1.7
U238 σ^{inel} gr. 5	1.1
U238 σ^{inel} gr. 3	0.6
U238 σ^{inel} gr. 6	0.6
Pu239 σ^{cap} gr. 16	0.3
Pu239 σ^{cap} gr. 18	-0.3
Total	4.8

Major Contributors to Improved C/E

ZPPR9 Na Void Step 5

Cross Section	Contribution (%)
U238 σ^{inel} gr. 4.	2.2
U238 σ^{inel} gr. 5	1.3
U238 σ^{inel} gr. 3	0.8
U238 σ^{inel} gr. 6	0.7
Pu239 σ^{cap} gr. 16	0.4
Pu239 σ^{cap} gr. 18	-0.4
Total	6.4

JOYO Keff

Cross Section	Contribution (pcm)
U235 σ^{cap} gr. 11.	190
U235 σ^{cap} gr. 10	190
U235 σ^{cap} gr. 12	180
U235 σ^{cap} gr. 13	160
U235 σ^{cap} gr. 14	150
U235 σ^{cap} gr. 9	140
Total	1347

Major Cross Section Adjustments

U238

U235

Cross Sect.	Adjus. %	Stand. Deviat. %	
		Initial	Adj.
σ^{inel} gr. 3	-13.8	20.1	8.1
σ^{inel} gr. 4	-13.9	19.4	5.1
σ^{inel} gr. 5	-13.3	20.6	8.1
σ^{inel} gr. 6	-12.4	16.9	6.6

Param.	Adjus. %	Stand. Deviat. %	
		Initial	Adj.
σ^{cap} gr. 9	-42.7	20.0	9.8
σ^{cap} gr. 10	-42.8	20.0	9.8
σ^{cap} gr. 11	-42.8	20.0	9.8
σ^{cap} gr. 12	-42.7	20.0	9.8
σ^{cap} gr. 13	-42.7	20.0	9.8
σ^{cap} gr. 14	-42.7	20.0	9.8

Major Cross Section Adjustments

Pu239

Fe56

Cross Sect.	Adjus. %	Stand. Deviat. %	
		Initial	Adj.
σ^{inel} gr. 4	2.3	19.4	9.8
σ^{cap} gr. 16	12.5	16.5	14.7
σ^{cap} gr. 17	12.5	16.5	14.7
σ^{cap} gr. 18	8.1	10.7	9.6

Param.	Adjus. %	Stand. Deviat. %	
		Initial	Adj.
σ^{inel} gr. 5	4.6	12.0	11.5

Conclusions

- **A preliminary adjustment was performed using AFCI 2.0 covariance data and ENDF/B-VII cross sections.**
- **The major modifications indicated regard the U238 and Fe56 inelastic, and the U235 and Pu239 capture.**
- **The adjustment provide a good consistency test, however some of the adjustment on U235 cross sections are outside the 1 sigma standard deviation.**
- **The possible cause has to be related to a very bad “a priori” C/E for the JOYO critical mass, likely due to an inconsistent corrective factor.**
- **The issue of the uncertainties associated to the C/E should also be revisited.**