PAUL SCHERRER INSTITUT

PSI

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Detailed comparison of Progressive Incremental Adjustment (PIA) sequence results involving adjustments of spectral indices and coolant density effects on the basis of the SG33 benchmark

NEA Nuclear Data Week, WPEC/SG-39

In this study: 14 integral parameters to assimilate

Experimental configurations with integral parameters part of the data assimilation

Configuration	Integral parameters
GODIVA	*F28/F25*, *F49/F25*, *F37/F25*
JEZEBEL-Pu239	*F28/F25*, *F49/F25*, *F37/F25*
ZPR6-7	*F28/F25*, *F49/F25*, *C28/F25*
ZPPR9	*F28/F25*, *F49/F25*, *C28/F25*, Na Void Step 3, Na Void Step 5

- *F28*, *F25*, *F49*, and *F37*: respectively used for ^{238}U, ^{235}U, ^{239}Pu, and ^{237}Np microscopic fission reaction rates per atom.
  C28: ^{238}U capture reaction rate per ^{238}U atom.
  All spectral indices, Table, at core center.
- Na Void Step 3 and Na Void Step 5: reactivity effects (ZPPR9) due to Na removal from small zone near core center and from leakage dominated larger configuration.
- 10 nuclides adjusted: ^{16}O, ^{23}Na, ^{52}Cr, ^{56}Fe, ^{58}Ni, ^{235}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu.

12 target configurations

Target experimental configurations with integral parameters

Configuration	Integral parameters
GODIVA	*F28/F25*, *F49/F25*, *F37/F25*, k_{eff}[(a)]
JEZEBEL-Pu239	*F28/F25*, *F49/F25*, *F37/F25*, k_{eff}[(a)]
ZPR6-7	*F28/F25*, *F49/F25*, *C28/F25*, k_{eff}[(a)]
ZPPR9	*F28/F25*, *F49/F25*, *C28/F25*, Na Void Step 3, Na Void Step 5, k_{eff}[(a)]
JEZEBEL-Pu240	k_{eff}
ZPR6-7 Pu240	k_{eff}
JOYO	k_{eff}
FLATTOP-Pu	*F28/F25*, *F37/F25*, k_{eff}
FLATTOP-25	*F28/F25*, *F49/F25*, *F37/F25*, k_{eff}
MIX-MET-FAST-001	k_{eff}
PU-MET-FAST-010	k_{eff}
PU-MET-FAST-009	k_{eff}

[(a)]Also part of the adjustment in one of the simulations.

8 configurations not part of the data assimilation

- JEZEBEL-Pu240, ZPR6-7 Pu240, JOYO.
- FLATTOP-Pu: Pu sphere reflected by natural U.
- FLATTOP-25: ^{235}U sphere reflected by natural U.
- MIX-MET-FAST-001: Pu sphere surrounded by highly enriched U.
- PU-MET-FAST-010: Pu sphere surrounded by Al.
- PU-MET-FAST-009: δ-phase Pu sphere reflected by natural U.

Sensitivity coefficients

- ERANOS (2.2-N), explicit, 33 group by means of flux, adjoint flux, generalized importance.
- Generalized Perturbation Theory (GPT) : spectral indices.
- Equivalent Generalized Perturbation Theory (EGPT): reactivity effects.
- [Standard Perturbation Theory (SPT) : k_{eff}, limited use.]

Data adjustment: Asymptotic GLLS method

Iterative procedure used in individual incremental steps within PIA:

For $i = 0, 1, 2, \ldots$ $\boldsymbol{i = 0}$**: a priori, starting point:**

$$\boldsymbol{\Delta T_i = M_i G_i^T \left(G_i M_i G_i^T + V_E + V_M\right)^{-1} CE_i \ , \ CE_i = \left(CE_{i,k}\right) = \left(\frac{R_{E,k} - \left(R_c(T_i)\right)_{,k}}{\left(R_c(T_i)\right)_{,k}}\right)} \qquad \textbf{(1)}$$

with

$M_i = \left(M_{i,j,j'}\right) = cov\left(T_{i,j}, T_{i,j'}\right) / \left(T_{i,j} T_{i,j'}\right)$: nuclear data variance/covariance matrix in relative terms.

$i = 0$: M_0: derived from COMMARA-2.0, this study.

$$\boldsymbol{M_{i+1} = \left(M_{i+1,j,j'}\right) = M_i - M_i G_i^T \left(G_i M_i G_i^T + V_E + V_M\right)^{-1} G_i M_i} \qquad \textbf{(2)}$$

GLLS method

Additionally, Eq. (1):

$$\Delta T_i = (\Delta T_{i,j}) = \left(\frac{T_{i+1,j} - T_{i,j}}{T_{i,j}}\right) = \left(\frac{T_{i+1,j}}{T_{i,j}} - 1\right) = (F_{i,j} - 1) \qquad \Rightarrow$$

$$\boldsymbol{T_{i+1}} = (\boldsymbol{T_{i+1,j}}) = (\boldsymbol{T_{i,j}F_{i,j}}), \qquad \boldsymbol{F_i} = (\boldsymbol{F_{i,j}}) = (\mathbf{1} + \boldsymbol{\Delta T_{i,j}}) \qquad \textbf{(3)}$$

$T_i = (T_{i,j})$: data set vector. Starting from JEFF-3.1, this study.

$R_C(T_i) = \left((R_C(T_i))_{,k}\right)$: analytical values vector. Through ERANOS (2.2-N), this study.
PIA: for integral parameters $\boldsymbol{k}$ dealt with in specific step.

$F_i = (F_{i,j})$: adjustment factor vector i.e. $\boldsymbol{T_{i+1,j}} = (\prod_{\boldsymbol{m=0}}^{\boldsymbol{i}} \boldsymbol{F_{m,j}})\boldsymbol{T_{0,j}}$.

$R_E = (R_{E,k})$: vector of the central values of the experimental integral parameters.

GLLS method

$$G_i = \left(G_{i,k,j}\right) = \left(\frac{d\left(\left(R_c(T_i)\right)_{,k}\right)}{\left(R_c(T_i)\right)_{,k}} \Big/ \frac{dT_{i,j}}{T_{i,j}} \right)$$

: in the form of sensitivity coefficient vector by using appropriate indexing.

$$V_E = \left(V_{E,k,k'}\right) = cov\left(R_{E,k}, R_{E,k'}\right) / \left(R_{E,k} R_{E,k'}\right)$$

: experimental variance/covariance matrix.

$$V_M = \left(V_{M,k,k'}\right) = cov\left(\left(R_c(T)\right)_{,k}, \left(R_c(T)\right)_{,k'}\right) / \left(\left(R_c(T)\right)_{,k} \left(R_c(T)\right)_{,k'}\right)$$

: analytical modeling matrix.

Iterations loop

From iteration i to $i+1$, two steps:

(1) $M_i, G_i, V_E, V_M, R_E, R_C(T_i) \xrightarrow{\text{Eq. 1}} \Delta T_i \xrightarrow{\text{Eq. 3}} F_i, T_{i+1}$

$M_i, G_i, V_E, V_M \xrightarrow{\text{Eq. 2}} M_{i+1}$

} In house tool GLLS

(2) $T_{i+1} \xrightarrow{\text{In house tool MICADJ}}$ ERANOS (2.2-N) $\Rightarrow$ $R_C(T_{i+1}), G_{i+1}$;

together with M_{i+1}: go to (1)

and replace i by $i+1$.

(1), (2) until $F_n = 1$ → n iterations needed to converge.

Practical reason: $0.99 < F_{n,j} < 1.01$, this study.

Adjustment: this study, 6 cases

- Simulation 1: integral parameters assimilated simultaneously.

PIA: Simulations 2, 2A, 2B, 3, 3A, 3B:

- 2:

GODIVA spectral indices → ZPPR9 coolant density effects → ZPPR9 spectral indices → ZPR6-7 spectral indices → JEZEBEL-Pu239 spectral indices.

- 2A: Simulation 2 → k_{eff} of the 4 configurations just for $\bar{\nu}$.
- 2B: Similar to Simulation 2: no iterations.
- 3 : Reversed order as compared to Simulation 2: JEZEBEL-Pu239 first.
- 3B: Similar to Simulation 3: no iterations.

A posteriori *C/E*s for target experiments

Configuration	Integral parameter	Experimental uncertainty (%)	Simulation			
			1	2	2A	3
			C/E			
GODIVA	*F28/F25*	1.1	1.000	0.998	0.998	1.000
	F49/F25	1.0	1.001	1.001	1.001	1.001
	F37/F25	1.4	1.000	0.996	0.996	1.000
	k_{eff}	0.1	0.976	0.977	0.998	0.977
JEZEBEL-Pu239	*F28/F25*	1.1	0.990	0.997	0.997	0.990
	F49/F25	0.9	0.998	0.999	0.999	0.998
	F37/F25	1.4	1.006	1.005	1.005	1.006
	k_{eff}	0.2	0.995	0.995	0.999	0.995
ZPR6-7	*F28/F25*	3.0	1.030	1.020	1.021	1.037
	F49/F25	2.1	0.982	0.977	0.977	0.977
	C28/F25	2.4	1.004	1.001	1.001	1.003
	k_{eff}	0.2	1.015	1.007	1.002	1.008
ZPPR9	*F28/F25*	2.7	0.979	0.951	0.951	0.971
	F49/F25	2.0	1.004	0.997	0.997	0.996
	C28/F25	1.9	0.996	0.994	0.994	0.996
	Na Void Step 3	1.9	1.020	1.033	1.031	1.034
	Na Void Step 5	1.9	0.985	0.975	0.972	0.979
	k_{eff}	0.1	1.013	1.006	1.000	1.007
JEZEBEL-Pu240	k_{eff}	0.2	1.000	0.999	1.006	0.999
ZPR6-7 Pu240	k_{eff}	0.2	1.012	1.007	1.002	1.008
JOYO	k_{eff}	0.2	0.998	0.993	0.999	0.994
FLATTOP-Pu	*F28/F25*	1.1	0.954	0.981	0.983	0.978
	F37/F25	1.4	0.990	1.004	1.006	1.002
	k_{eff}	0.3	1.013	0.991	0.992	0.995
FLATTOP-25	*F28/F25*	1.1	0.983	0.996	0.998	0.994
	F49/F25	0.9	1.003	1.005	1.005	1.004
	F37/F25	1.3	1.000	1.005	1.006	1.003
	k_{eff}	0.1	0.990	0.972	0.988	0.976
MIX-MET-FAST-001	k_{eff}	0.2	0.994	0.993	1.000	0.993
PU-MET-FAST-010	k_{eff}	0.2	0.992	0.985	0.987	0.987
PU-MET-FAST-009	k_{eff}	0.3	0.990	0.988	0.991	0.988

A posteriori *C/E*s for target experiments

Configuration	Integral parameter	Experimental uncertainty (%)	Simulation 2B *C/E*	Simulation 3B *C/E*
GODIVA	*F28/F25*	1.1	0.991	0.991
	F49/F25	1.0	0.994	0.994
	F37/F25	1.4	0.995	0.995
	k_{eff}	0.1	0.978	0.978
JEZEBEL-Pu239	*F28/F25*	1.1	0.990	0.991
	F49/F25	0.9	0.994	0.994
	F37/F25	1.4	1.010	1.011
	k_{eff}	0.2	0.991	0.991
ZPR6-7	*F28/F25*	3.0	1.033	1.036
	F49/F25	2.1	0.969	0.969
	C28/F25	2.4	1.004	1.004
	k_{eff}	0.2	1.012	1.012
ZPPR9	*F28/F25*	2.7	0.976	0.979
	F49/F25	2.0	0.989	0.990
	C28/F25	1.9	0.996	0.995
	Na Void Step 3	1.9	1.042	1.041
	Na Void Step 5	1.9	0.984	0.984
	k_{eff}	0.1	1.005	1.005
JEZEBEL-Pu240	k_{eff}	0.2	0.996	0.996
ZPR6-7 Pu240	k_{eff}	0.2	1.006	1.006
JOYO	k_{eff}	0.2	0.993	0.993
FLATTOP-Pu	*F28/F25*	1.1	0.957	0.956
	F37/F25	1.4	0.996	0.995
	k_{eff}	0.3	1.001	1.002
FLATTOP-25	*F28/F25*	1.1	0.985	0.985
	F49/F25	0.9	0.997	0.997
	F37/F25	1.3	1.003	1.002
	k_{eff}	0.1	0.977	0.978
MIX-MET-FAST-001	k_{eff}	0.2	0.990	0.990
PU-MET-FAST-010	k_{eff}	0.2	0.983	0.983
PU-MET-FAST-009	k_{eff}	0.3	0.992	0.993

- Spectral indices:
  within experimental uncertainty or just slightly outside, most cases.
  Exception: some of the *F28/F25*s:
  maximum discrepancy 4σ.
  As expected: 2 and 2A similar results.
  2B and 3B also similar.
- Coolant density effects:
  discrepancy < 2σ.
- k_{eff}:
  improvement with 2A especially for configurations considered in assimilation.

A posteriori nuclear data uncertainties

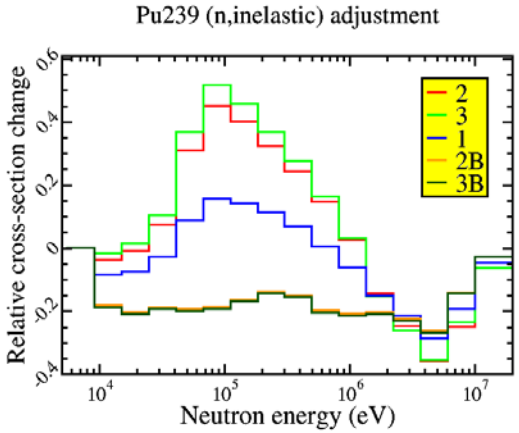
Configuration	Integral parameter	Experimental uncertainty (%)	Simulation			
			1	2	2A	3
			Uncertainty (%)			
GODIVA	*F28/F25*	1.1	0.2	0.6	0.6	0.5
	F49/F25	1.0	0.2	0.2	0.2	0.3
	F37/F25	1.4	0.2	0.5	0.5	0.5
	k_{eff}	0.1	0.6	0.7	0.7	0.7
JEZEBEL-Pu239	*F28/F25*	1.1	0.5	0.3	0.3	0.4
	F49/F25	0.9	0.2	0.2	0.2	0.3
	F37/F25	1.4	0.4	0.3	0.3	0.5
	k_{eff}	0.2	0.3	0.3	0.2	0.3
ZPR6-7	*F28/F25*	3.0	0.5	0.9	0.9	0.7
	F49/F25	2.1	0.3	0.4	0.4	0.4
	C28/F25	2.4	0.3	0.7	0.7	0.5
	k_{eff}	0.2	0.5	0.6	0.5	0.5
ZPPR9	*F28/F25*	2.7	0.4	1.2	1.2	0.7
	F49/F25	2.0	0.3	0.4	0.4	0.4
	C28/F25	1.9	0.3	0.7	0.7	0.5
	Na Void Step 3	1.9	0.7	1.9	1.9	1.1
	Na Void Step 5	1.9	0.8	2.2	2.2	1.3
	k_{eff}	0.1	0.5	0.6	0.5	0.5
JEZEBEL-Pu240	k_{eff}	0.2	0.5	0.5	0.4	0.5
ZPR6-7 Pu240	k_{eff}	0.2	0.5	0.6	0.5	0.5
JOYO	k_{eff}	0.2	0.8	0.9	0.8	0.9
FLATTOP-Pu	*F28/F25*	1.1	0.5	0.4	0.3	0.4
	F37/F25	1.4	0.5	0.4	0.4	0.5
	k_{eff}	0.3	0.3	0.4	0.3	0.3
FLATTOP-25	*F28/F25*	1.1	0.4	0.6	0.6	0.6
	F49/F25	0.9	0.2	0.2	0.2	0.3
	F37/F25	1.3	0.4	0.6	0.6	0.5
	k_{eff}	0.1	0.8	0.9	0.9	0.9
MIX-MET-FAST-001	k_{eff}	0.2	0.2	0.2	0.2	0.2
PU-MET-FAST-010	k_{eff}	0.2	0.3	0.4	0.3	0.3
PU-MET-FAST-009	k_{eff}	0.3	0.2	0.3	0.2	0.3

- Spectral indices:
  < experimental uncertainties.
- Coolant density effects:
  ≈ experimental uncertainties.
- k_{eff}:
  > experimental uncertainties
  (consistent with *C/E*s, several σs deviations).
- Simulation 1: smaller uncertainties.
- 2, 2A and 3 comparable.
- 2B ≈ 3B, larger in most cases.

A posteriori nuclear data uncertainties

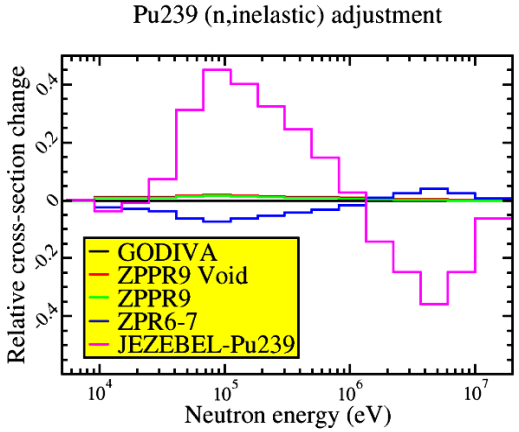
Configuration	Integral parameter	Experimental uncertainty (%)	Simulation	
			2B	3B
			Uncertainty (%)	
GODIVA	*F28/F25*	1.1	0.9	0.9
	F49/F25	1.0	0.5	0.5
	F37/F25	1.4	0.7	0.7
	k_{eff}	0.1	0.7	0.7
JEZEBEL-Pu239	*F28/F25*	1.1	0.8	0.8
	F49/F25	0.9	0.5	0.5
	F37/F25	1.4	0.6	0.6
	k_{eff}	0.2	0.4	0.4
ZPR6-7	*F28/F25*	3.0	1.8	1.7
	F49/F25	2.1	0.6	0.6
	C28/F25	2.4	1.1	1.1
	k_{eff}	0.2	0.6	0.6
ZPPR9	*F28/F25*	2.7	2.1	2.1
	F49/F25	2.0	0.6	0.6
	C28/F25	1.9	1.1	1.1
	Na Void Step 3	1.9	2.5	2.5
	Na Void Step 5	1.9	3.0	3.0
	k_{eff}	0.1	0.6	0.6
JEZEBEL-Pu240	k_{eff}	0.2	0.5	0.5
ZPR6-7 Pu240	k_{eff}	0.2	0.6	0.6
JOYO	k_{eff}	0.2	0.9	0.9
FLATTOP-Pu	*F28/F25*	1.1	0.7	0.7
	F37/F25	1.4	0.6	0.6
	k_{eff}	0.3	0.4	0.4
FLATTOP-25	*F28/F25*	1.1	0.9	0.9
	F49/F25	0.9	0.5	0.5
	F37/F25	1.3	0.8	0.8
	k_{eff}	0.1	0.9	0.9
MIX-MET-FAST-001	k_{eff}	0.2	0.3	0.3
PU-MET-FAST-010	k_{eff}	0.2	0.5	0.5
PU-MET-FAST-009	k_{eff}	0.3	0.4	0.4

Adjustment of the ^{239}Pu inelastic scattering cross-section with respect to JEFF-3.1 a priori data in 33 groups

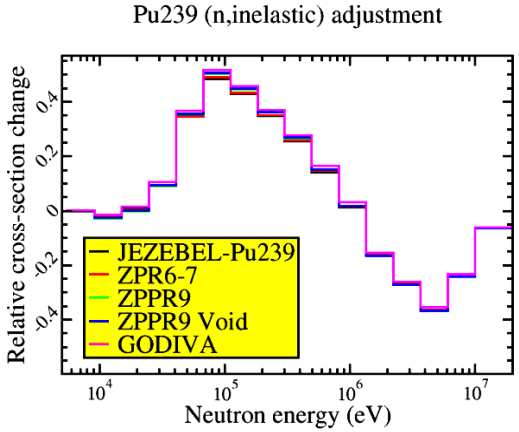


Adjustment: strong, max. 1σ COMMARA-2.0.

- 2 ≡ 3; 2B ≡ 3B: sequence independent.
- 2 ≠ 2B: important role of iterations.
- 1 similar to 2,
  smaller magnitude: compensations.



Simulation 2 (steps)

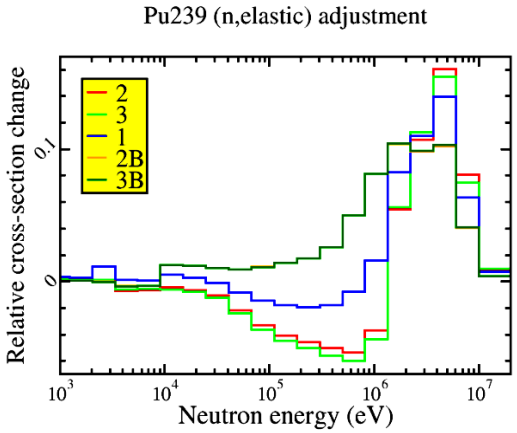


Simulation 3 (steps)

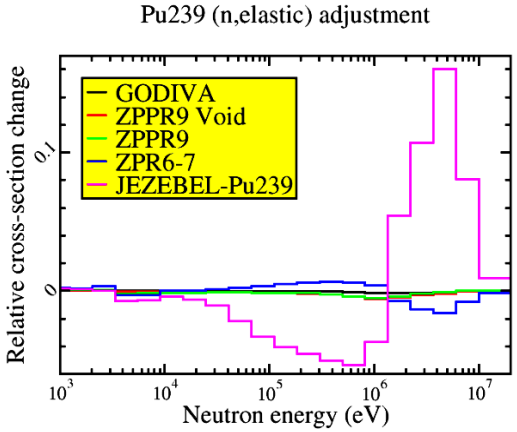
Adjustment, PIA:

- Coming from assimilating JEZEBEL-Pu239 data.

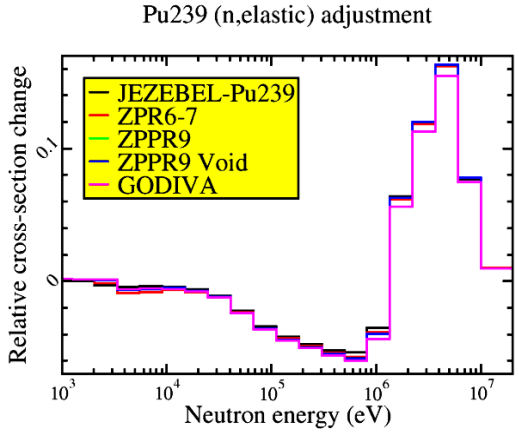
Adjustment of the ^{239}Pu elastic scattering cross-section



- 2 ≡ 3. 2B ≡ 3B.
- 2 ≠ 2B.
- 1: between 2 and 2B having partly different sign.



Simulation 2 (steps)

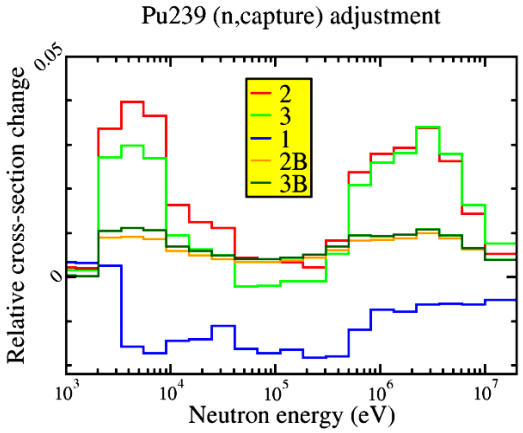


Simulation 3 (steps)

Adjustment, PIA:

- JEZEBEL-Pu239.

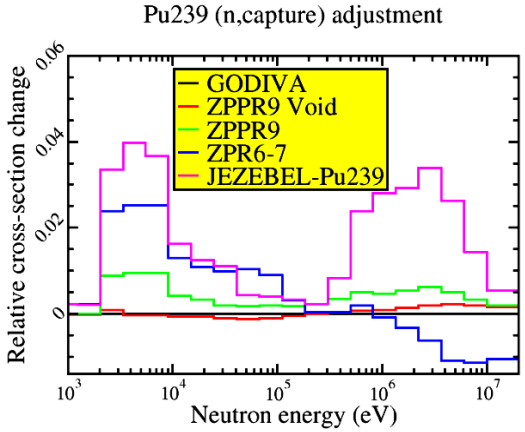
Adjustment of the ^{239}Pu capture cross-section



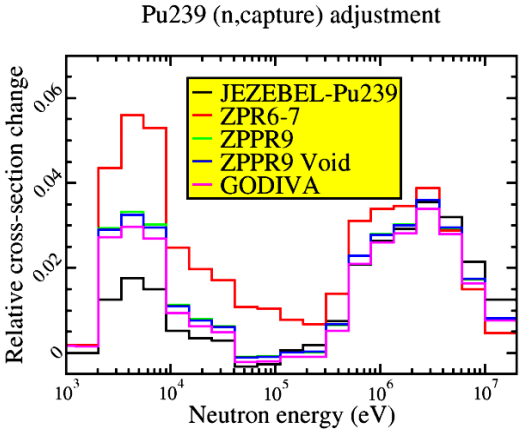
Adjustment, PIA:

- Fission source range: JEZEBEL-Pu239.
- Near main Na resonance 2.85keV: ZPR6-7.
- ZPPR9: seems unimportant or redundant.

- 2 ≡ 3. 2B ≡ 3B.
- 2 ≠ 2B ≠ 1.

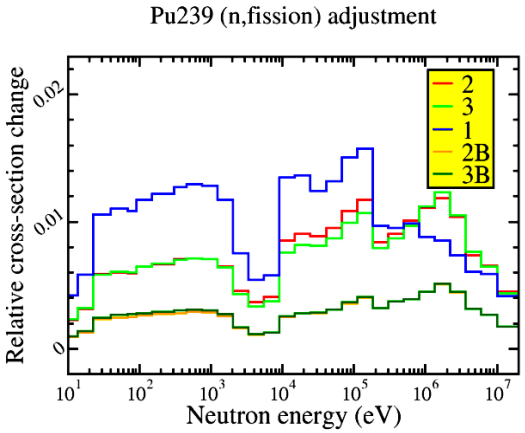


Simulation 2 (steps)



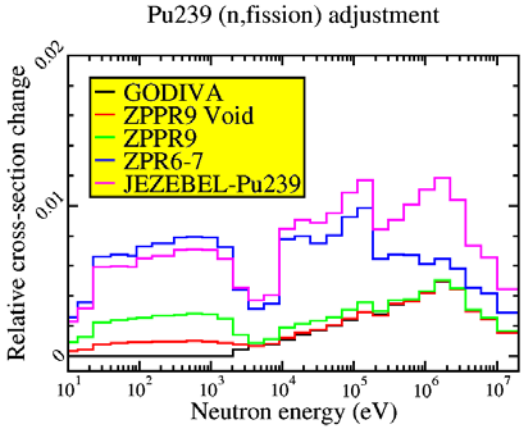
Simulation 3 (steps)

Adjustment of the ^{239}Pu fission cross-section

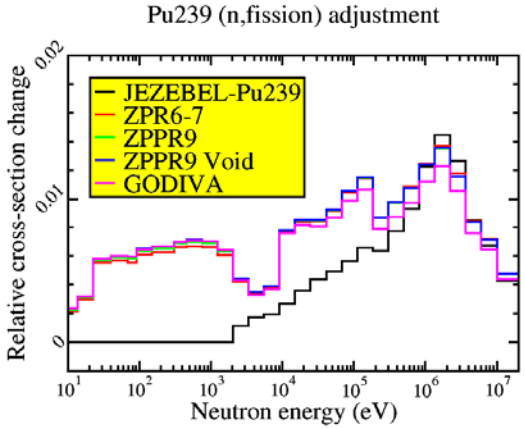


Adjustment: weak.

- 2 ≡ 3. 2B ≡ 3B.
- 2 ≠ 2B ≠ 1.



Simulation 2 (steps)

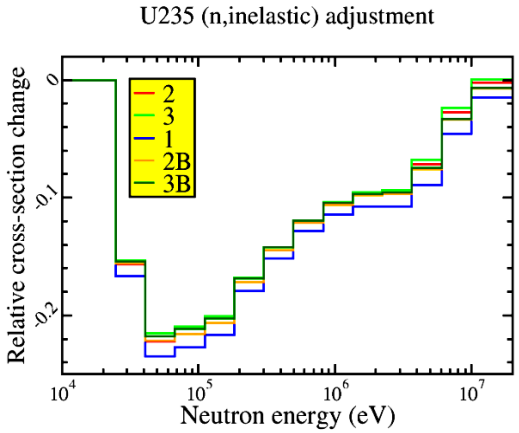


Simulation 3 (steps)

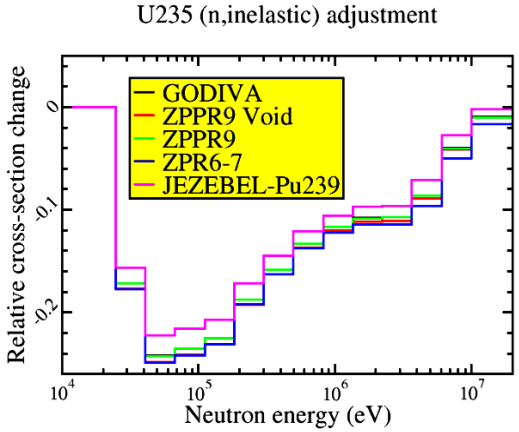
Adjustment, PIA:

- JEZEBEL-Pu239, super fast range.
- ZPR6-7 < 100keV.

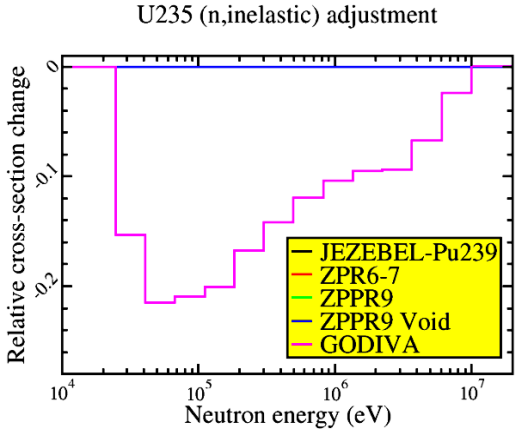
Adjustment of the ^{235}U inelastic scattering cross-section



- 2 ≡ 2B ≡ 3 ≡ 3B ≡ 1.



Simulation 2 (steps)

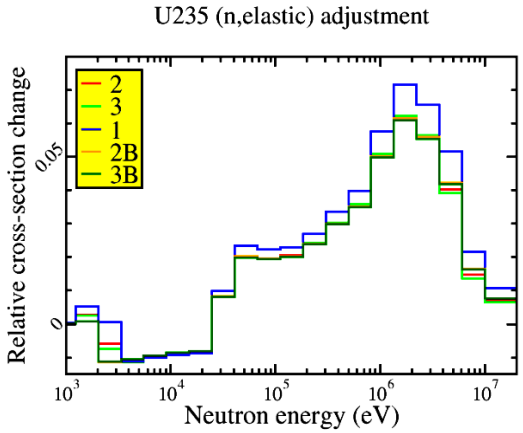


Simulation 3 (steps)

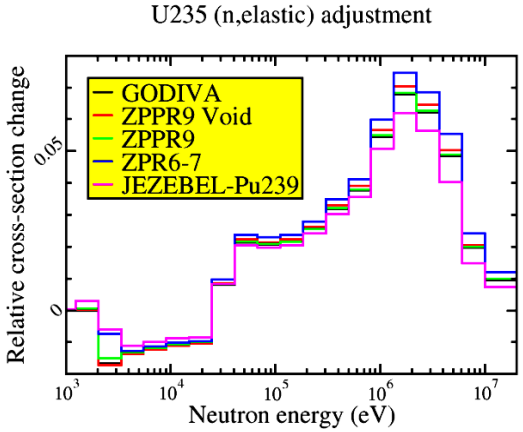
Adjustment, PIA:

- GODIVA.

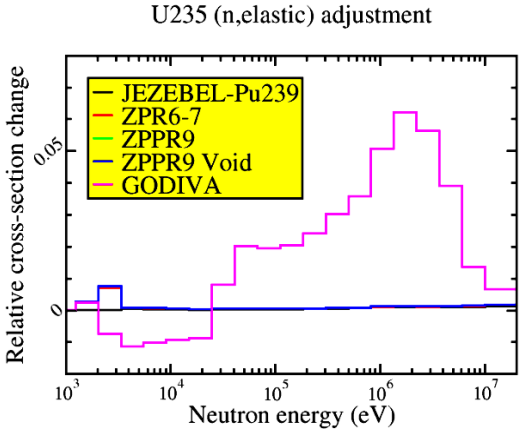
Adjustment of the ^{235}U elastic scattering cross-section



- 2 ≡ 2B ≡ 3 ≡ 3B ≡ 1.



Simulation 2 (steps)

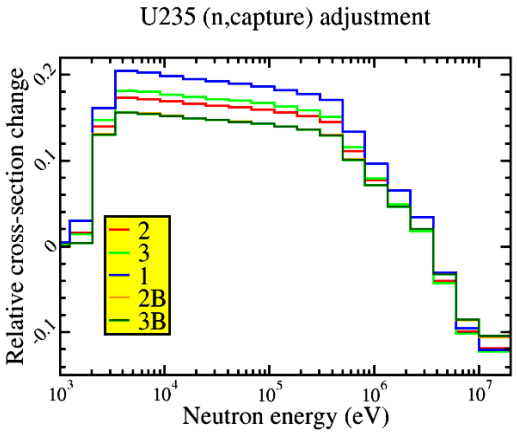


Simulation 3 (steps)

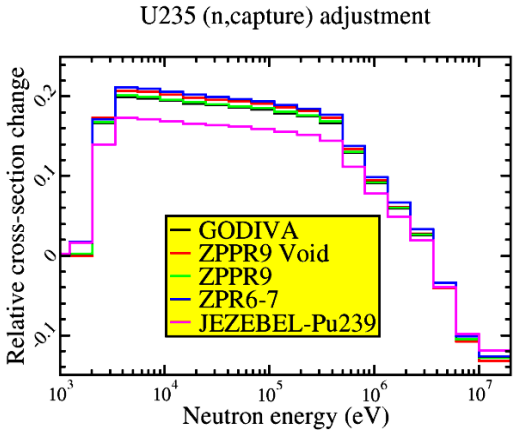
Adjustment, PIA:

- GODIVA.

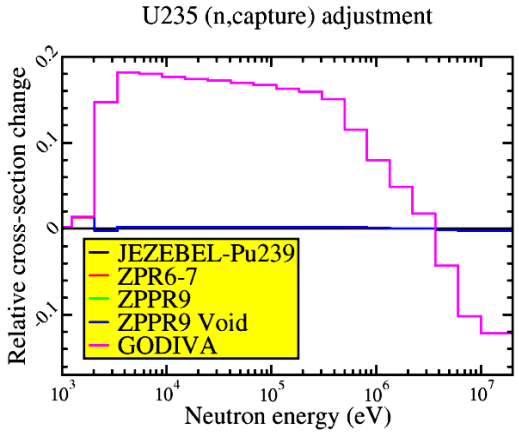
Adjustment of the ^{235}U capture cross-section



- 2 ≡ 3. 2B ≡ 3B.
- 2 ≈ 2B ≈ 1.



Simulation 2 (steps)

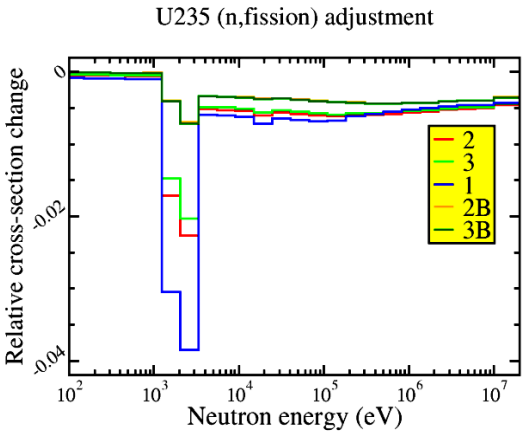


Simulation 3 (steps)

Adjustment, PIA:

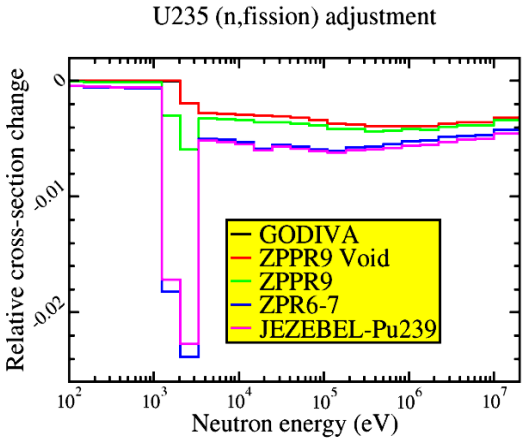
- GODIVA.

Adjustment of the ^{235}U fission cross-section

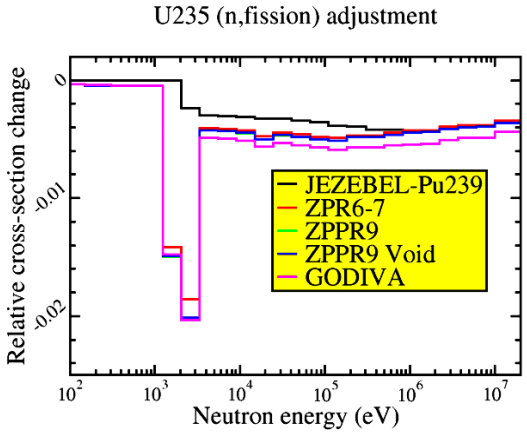


Adjustment: weak.

- 2 ≡ 3. 2B ≡ 3B.
- 2 ≠ 2B ≠ 1.



Simulation 2 (steps)

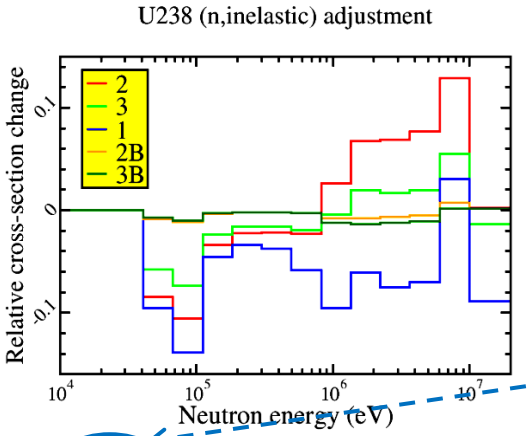


Simulation 3 (steps)

Adjustment, PIA:

- ZPR6-7, main Na resonance.

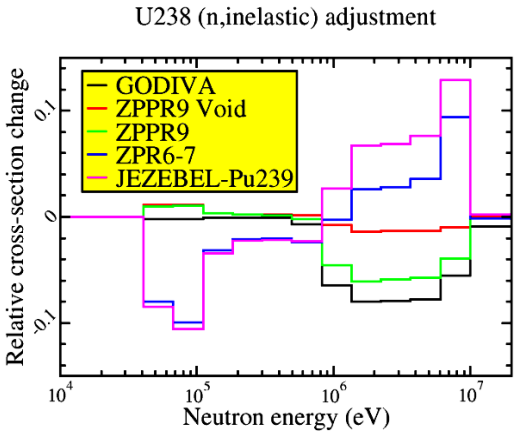
Adjustment of the ^{238}U inelastic scattering cross-section



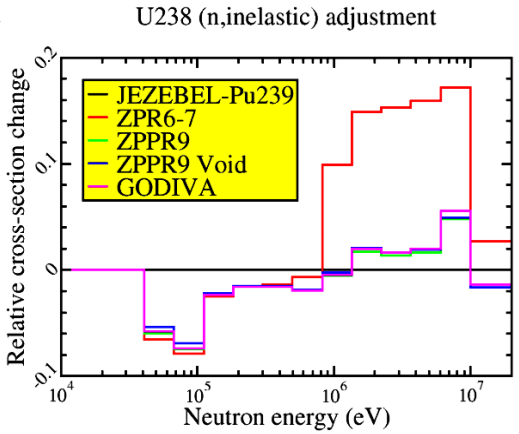
- 2 ≠ 3 ≠ 1 with different trends.
- 2B ≡ 3B, almost no adjustment.

Adjustment unreliable, PIA:

- Inconsistent, contradictory separation of effects e.g. between GODIVA and ZPPR9.

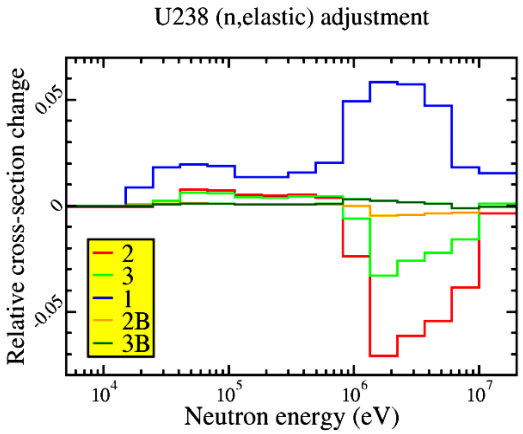


Simulation 2 (steps)



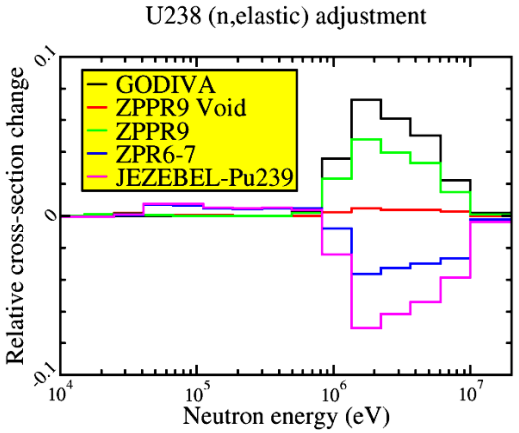
Simulation 3 (steps)

Adjustment of the ^{238}U elastic scattering cross-section

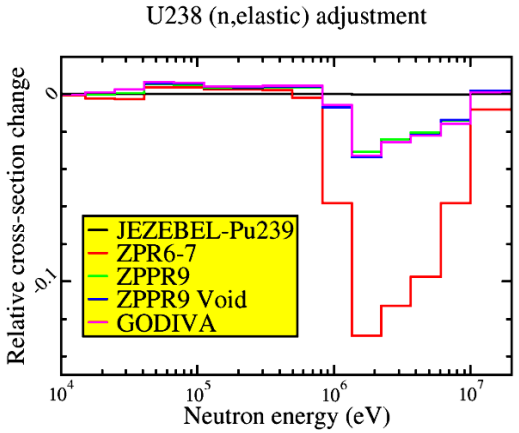


- 2 ≠ 3 ≠ 1, high energy.
- 2B, 3B: weak.
- 2 ≠ 2B.

Adjustment: inconsistent, PIA.

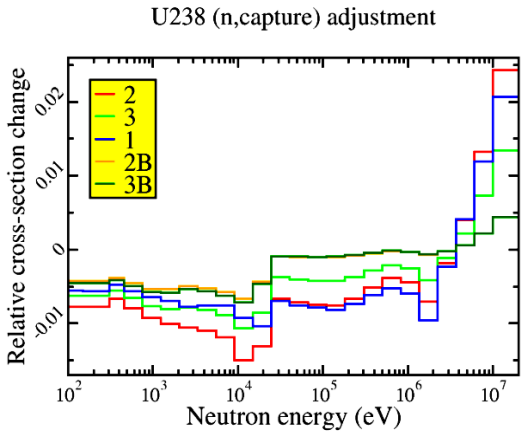


Simulation 2 (steps)



Simulation 3 (steps)

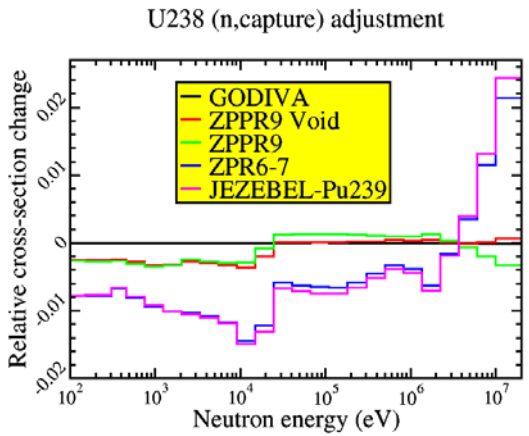
Adjustment of the ^{238}U capture cross-section



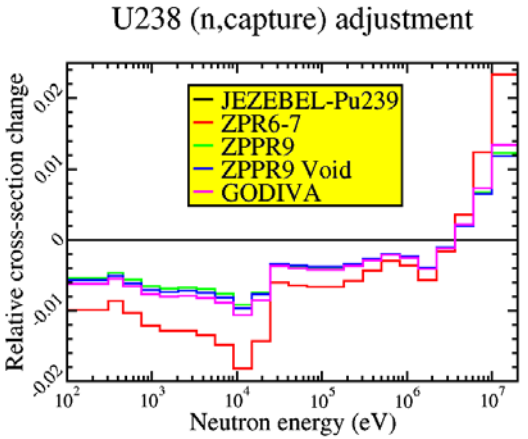
- 2 ≠ 3 ≠ 1.
- 2B ≡ 3B: almost no adjustment.

Adjustment, weak:

- Conflicting between ZPPR9 and ZPR6-7, PIA: unreliable.

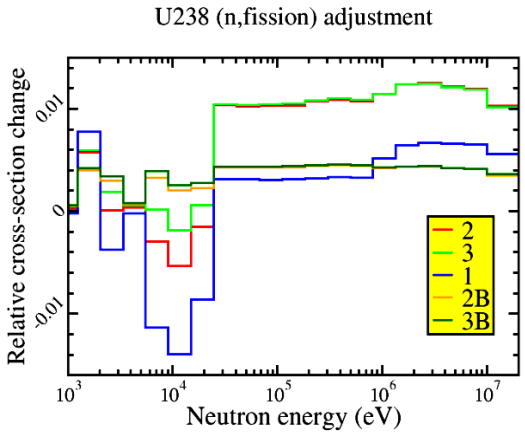


Simulation 2 (steps)



Simulation 3 (steps)

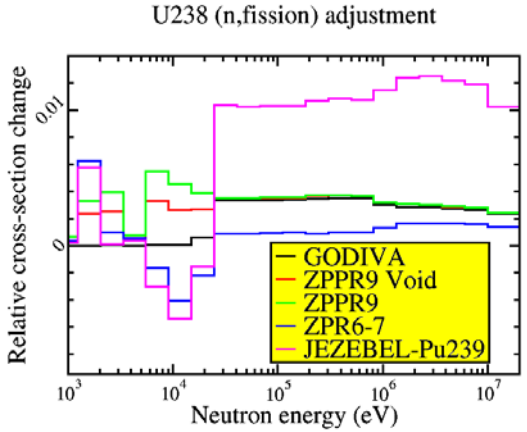
Adjustment of the ^{238}U fission cross-section



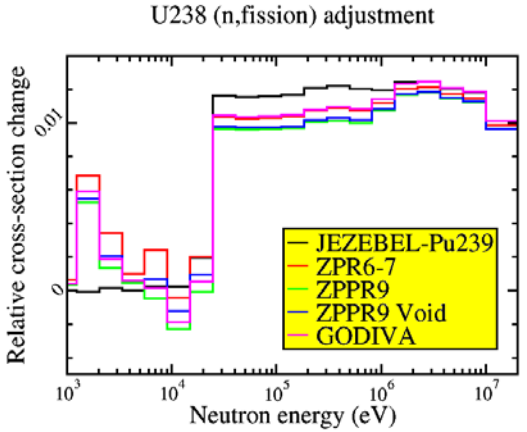
- 2 ≡ 3, E > 30keV.
- 2 ≠ 3, E < 30keV.
- 2B ≡ 3B.

Adjustment, weak:

- E > 30keV: JEZEBEL-Pu239, reliable, PIA.
- E < 30keV: Conflicting between ZPPR9 and ZPR6-7, unreliable, PIA.

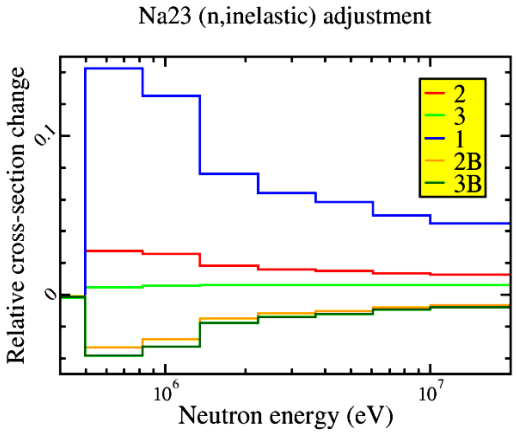


Simulation 2 (steps)



Simulation 3 (steps)

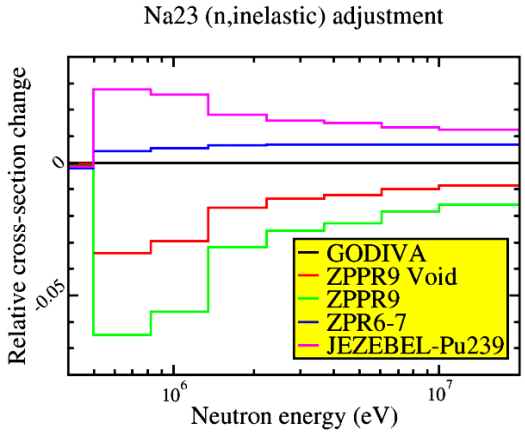
Adjustment of the ^{23}Na inelastic scattering cross-section



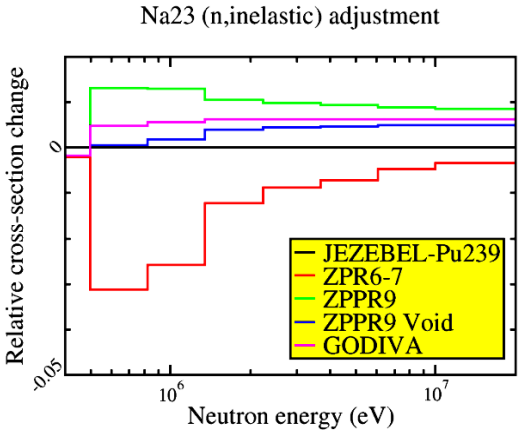
- 2 ≠ 3 ≠ 1.
- 2B ≡ 3B.

Adjustment: stronger without PIA.

- Conflicting between ZPPR9 and ZPR6-7, PIA.

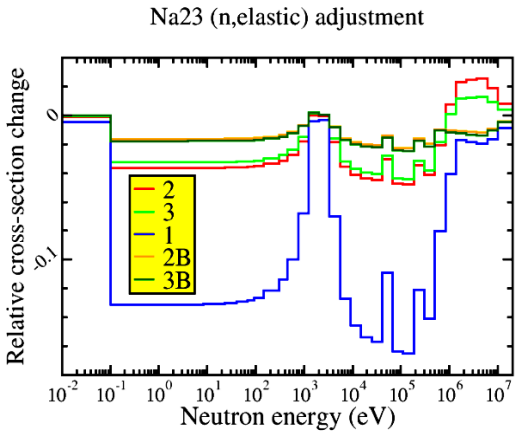


Simulation 2 (steps)



Simulation 3 (steps)

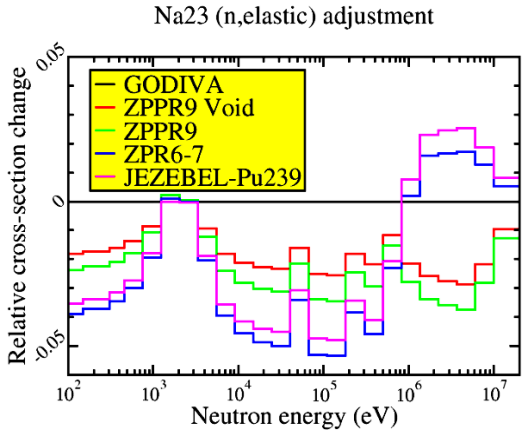
Adjustment of the ^{23}Na elastic scattering cross-section



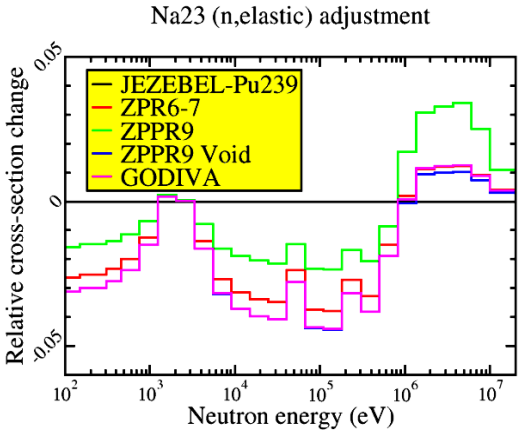
- E > 1MeV: 2 ≠ 3.
- E < 1MeV: 2 ≡ 3.
- 2B ≡ 3B.

Adjustment without PIA stronger, different trend.

- E > 1MeV: conflicting between ZPPR9 and ZPR6-7.
- E < 1MeV: ZPPR9 coolant density effects + ZPR6-7, PIA.

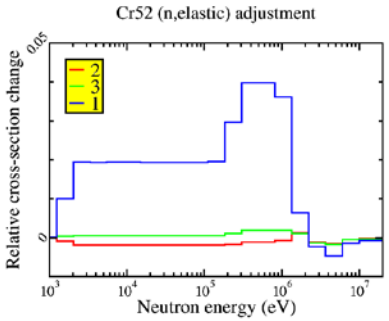


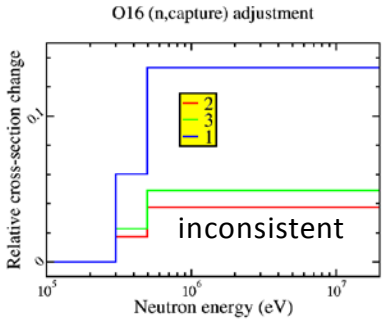
Simulation 2 (steps)

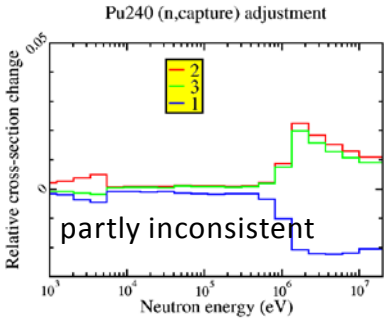


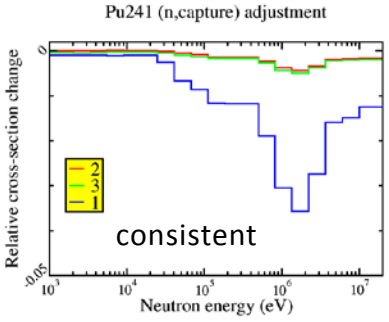
Simulation 3 (steps)

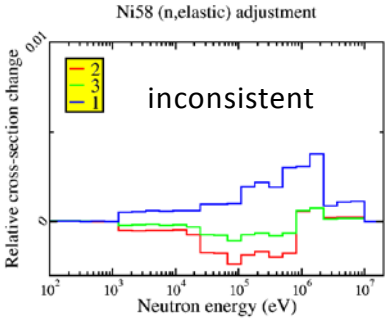
Additional stronger adjustments

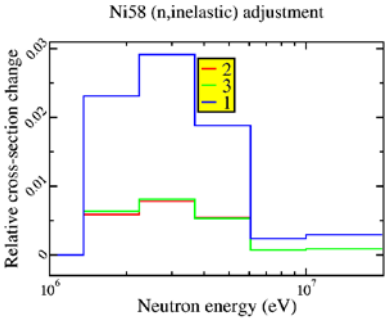


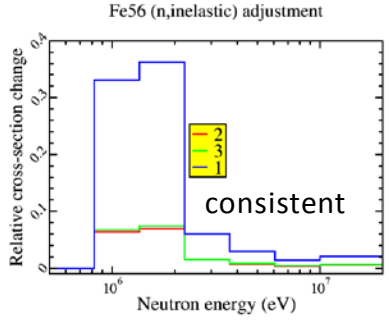


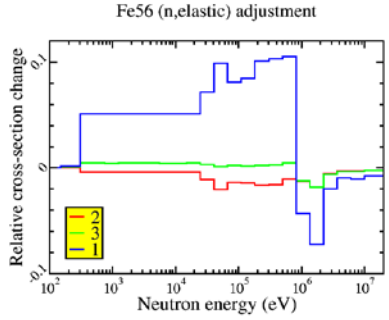


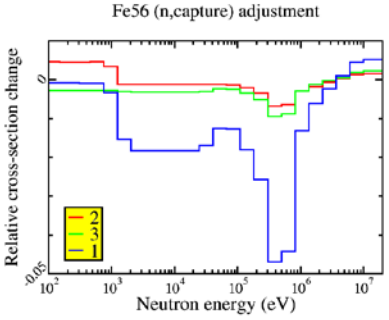




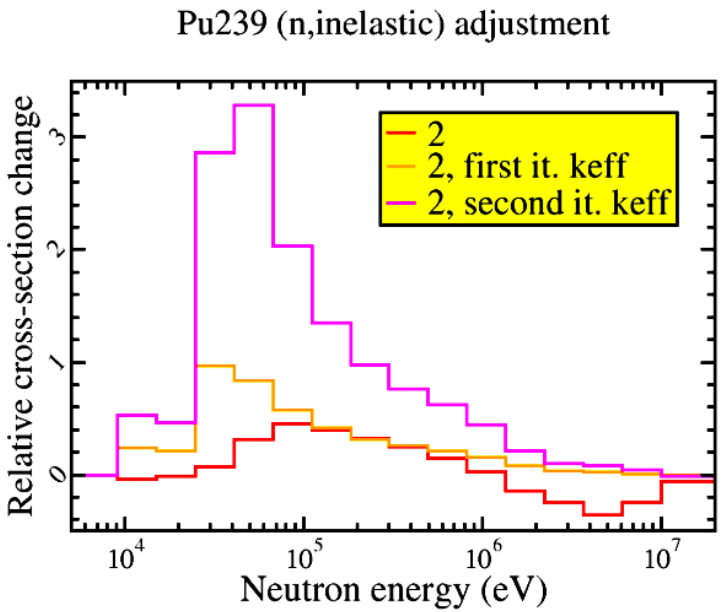


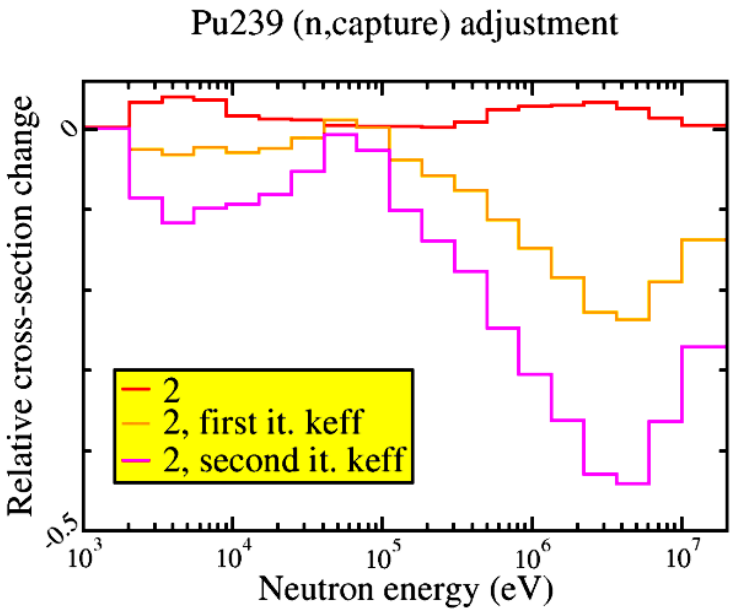






PIA: adjusting k_{eff}





- Divergence, "Tsunami" effect reversing trends → Adjusting k_{eff} should be avoided.

Summary, 1

I. PIA, integral parameters to assimilate: spectral indices and local reactivity effects.

II. PIA, reject adjustment for cross-section of given isotope, data type and energy group or range when:

Adjustment depends on sequence, inconsistent ↔

- Conflicting effects between different steps.
- A posteriori sensitivity coefficients of the integral parameters to this cross-section also sequence dependent.

Summary, 2

III. Conversely, PIA reliable adjustment:

Largely independent of sequence, consistent.

- Clear separation of effects coming from individual steps without inconsistencies: though some integral parameters may be unneeded in cases where their assimilation does not have any impact on the adjustment, redundancy.
- The a posteriori sensitivity coefficients to the cross section under study independent of the sequence.

Summary, 3

IV. Limited data base, this study: ^{238}U and ^{23}Na cross-sections not adjustable. Needs considering additional experiments.