

DE LA RECHERCHE À L'INDUSTRIE



NUCLEAR DATA VERIFICATION USING GALILEE AND TRIPOLI-4

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GALILEE-1 Code : GALVANE Module (GALilée Verification of the Accuracy of Nuclear Evaluations)

Library (# nuclei / #nuclei with DD)	JENDL40 (406 / 3)	JEFF32 (472 / 169)	JEFF33 (562 / 328)	ENDFB7R1 (423 / 41)	ENDFB8 (557 / 114)
Inconsistencies					
Mass comparison (> 1 MeV)	4	24	12	27	26
Resonance parameters	0	9	4	3	2
Q-reactions (> 500 keV)	5	53	31	92	93
Anisotropy	5	35	2	39	33
Radioactive production	1	41	95	14	17
Missing gamma production for radiative capture	139	104	1	138	142

328 Nuclei with Radioactive Production

- Inelastic scattering (MT4) :

Final state with $\text{Exc} > 0 \text{ MeV}$ and $\text{LFS} = 0$ (GS identification) : 85 evaluations

TALYS correction ?

- Inconsistencies between GP data and JEFF33/DD

for ID state (Energy Level) or Excitation Energy value

Δ ID STATE J33-GP / J33-DD : 95

Δ ENER STATE J33-GP / J33-DD : 5

Delta ID STATE J33-GP / ENDFB8-DD : 33

Delta ENER STATE J33-GP / ENDFB8-DD : 7

Delta ID STATE J33-GP / ENSDF : 31

Delta ENER STATE J33-GP / ENSDF : 5

→ Source of inconsistencies for depletion calculations → Corrections in JEFF33/DD ?

ENDF/B-VIII : (114 nuclei). No problem with MT4 final states

Delta ID STATE ENDFB8-GP / ENDFB8-DD : 17

Delta ENER STATE ENDFB-GP / ENDFB8-DD : 0

OUTGOING PARTICLE KINEMATICS / ENERGY BALANCE

- JEFF-3.3/MF5 : Cd isotopes, (n,2n) and (n,3n) reactions for various incident energies :
 $\sum E_n > E_{\text{available}}$
 - MF6, MT91 (continuous inelastic scattering) :
 JEFF-3.3 / TENDL15 : 335 nuclei with $E_\gamma < E_{\text{exc}}$ at threshold
 ENDF/B-VIII : 102 nuclei ($E_\gamma < E_{\text{exc}}$)
 - MF6, Gamma production : Discrete probability + continuous probability $\neq 1$:
 JEFF-3.3 : 5 nuclei ENDF/B-VIII : 7 nuclei
 - MF6 used for discrete inelastic scatterings (MT51-90).
 JEFF-3.3 : 56 nuclei
 ENDF/B-VIII : 95 nuclei
- Gamma production in MF6 should be moved in MF12
 Solution : generate MF4 (neutron angular distribution) + MF12 (gamma production)
 JEFDOC-1841 (2017) : 31 nuclei in JEFF-3.3
- MF6 for inelastic scattering : Yield gamma < 1. (Take care of metastable nucleus production)
 JEFF-3.3 : 65 nuclei
 ENDF/B-VIII : 106 nuclei
 - MF12 : gamma production (inelastic scatterings, (n,p),...) : incoherence MF3 / MF12 level states
 ENDF/B-VIII : 39 nuclei. Iron isotopes from CIELO

26-Fe- 56 CIELO EVAL-DEC17 CIELO Collaboration 2631 1451

MF12 : MT69, MT70, MT72, MT73, MT74, MT79, MT82, MT83, MT84, MT86, MT87, MT88, MT89 : unknown gamma transition, unknown excited state.

MF3 MT55 Excited Energy $2.959973\text{e}+06$

MF12 MT55 Excited energy $2.959973\text{e}+06$

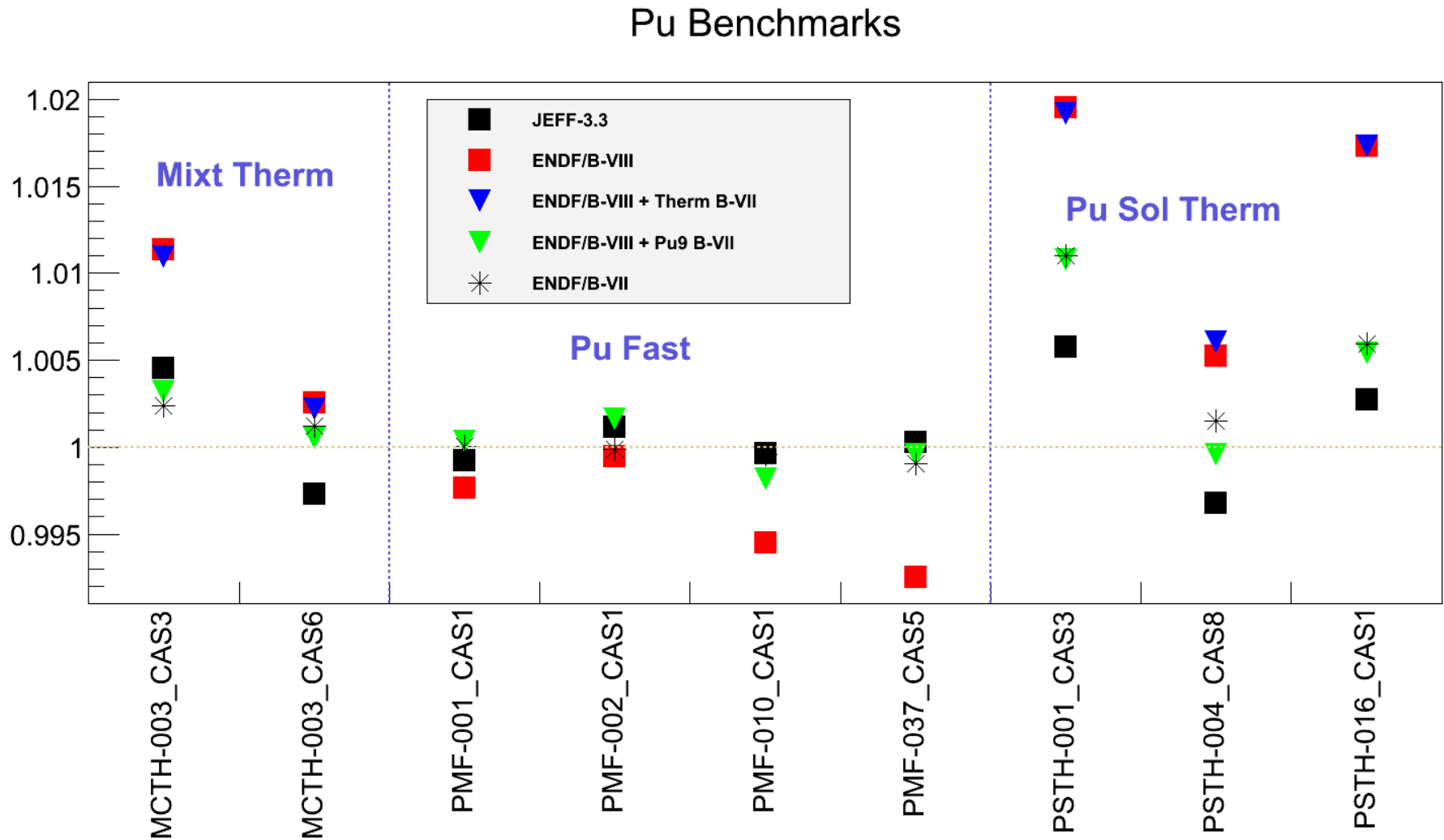
MF12 MT69 : decrease towards an excited state of $2.959972\text{e}+06$

MF3 MT60 Excited Energy $3.445349\text{e}+06$

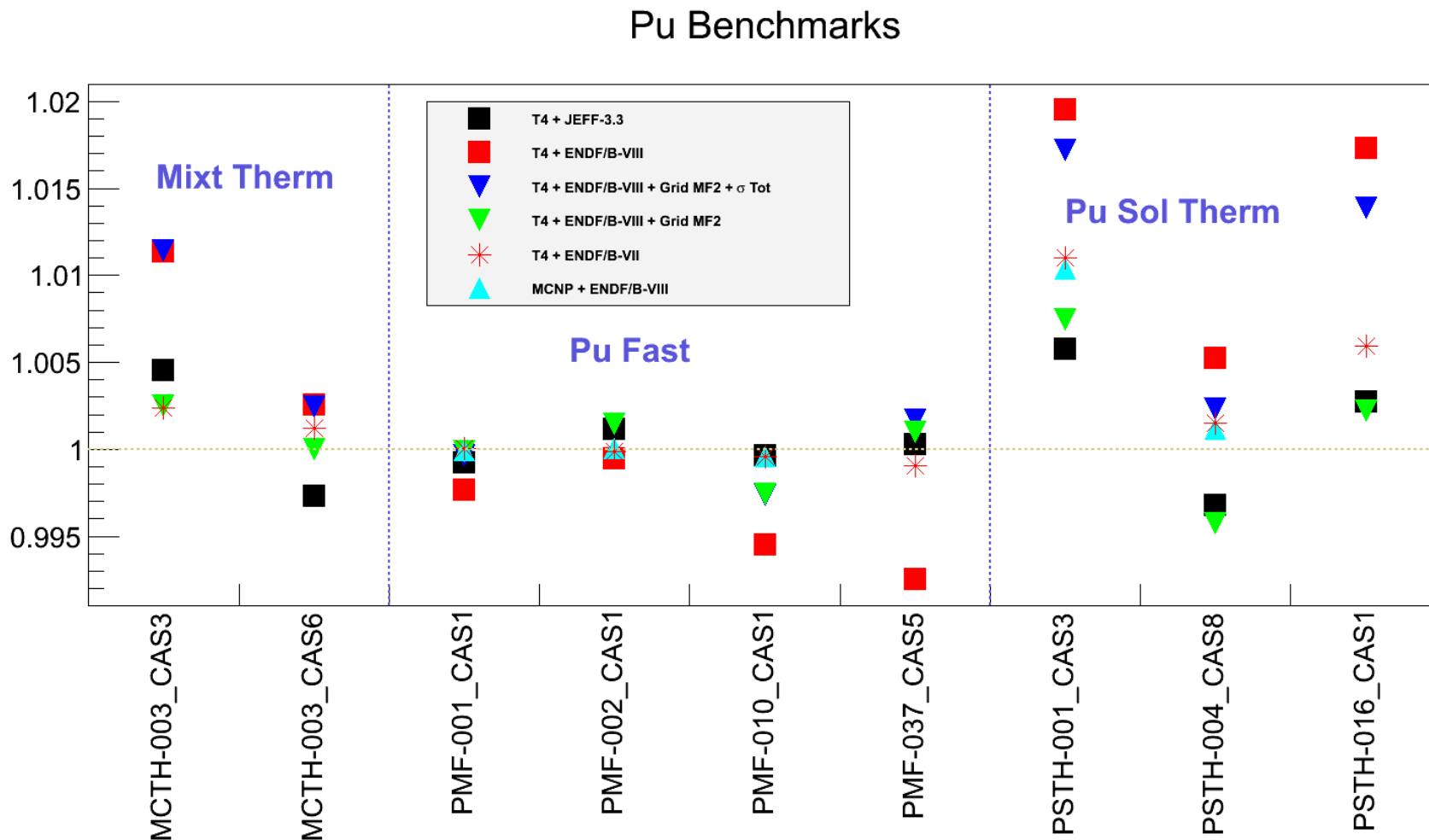
MF12 MT60 Excited Energy: $3.445349\text{e}+06$

MF12 MT69 : decrease towards an excited state of $3.445348\text{e}+06$

FOCUS ON PU BENCHMARKS (TRIPOLI-4)



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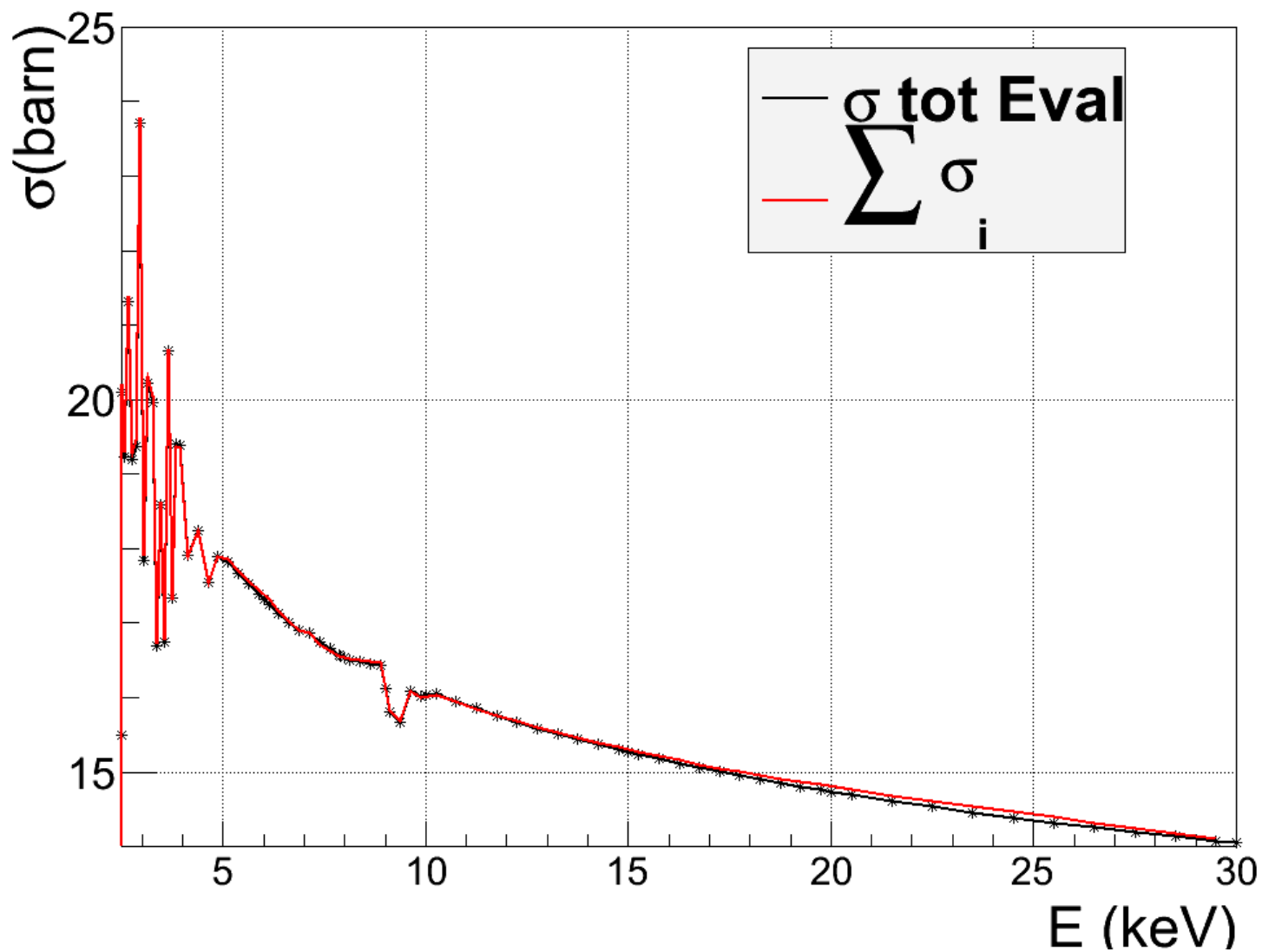


MF2/MT151 B8 = MF2/MT151 B7 from 2.5 keV to 30 keV

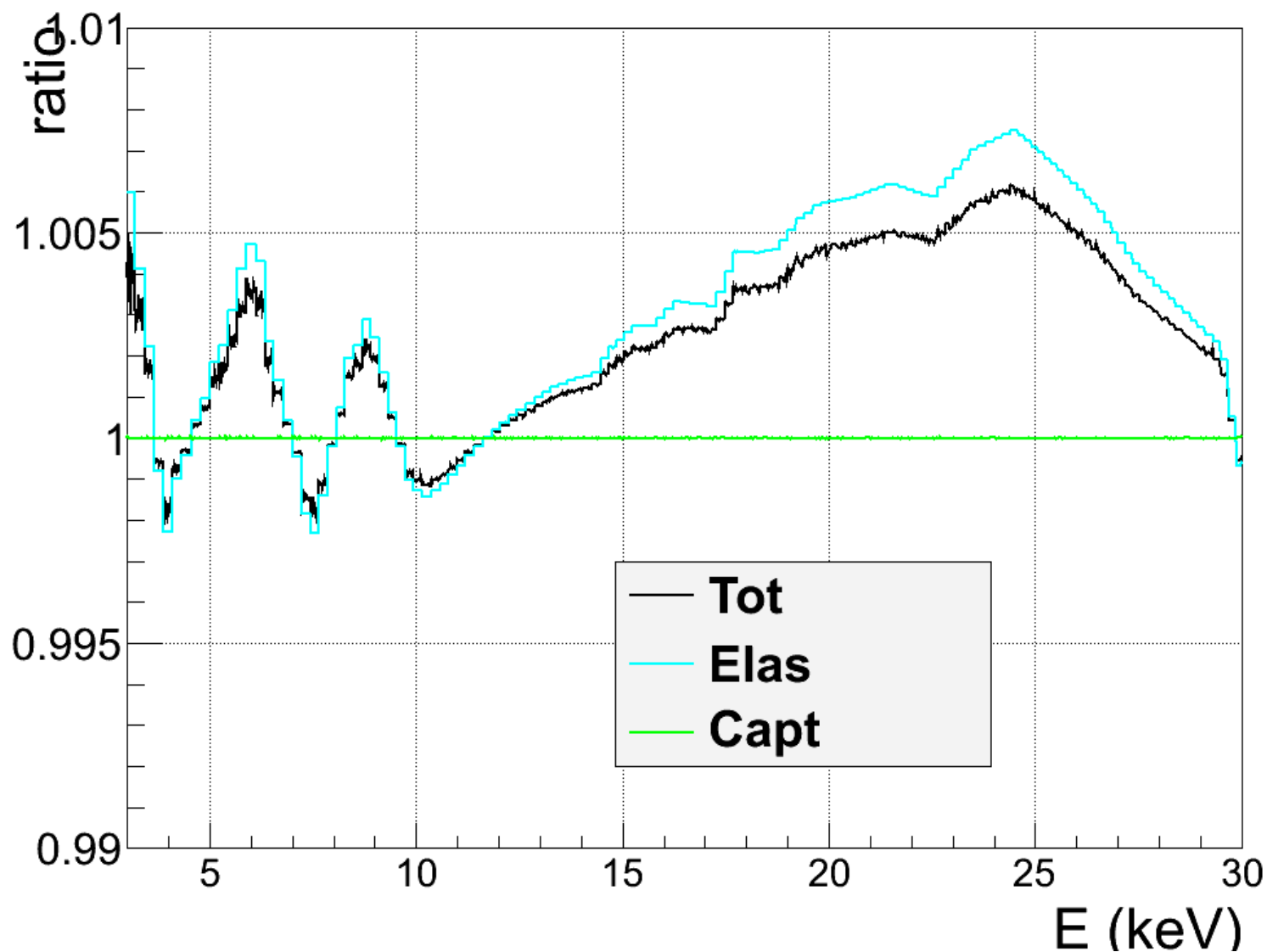
B8 : URR LSSF=1 ; B7 : URR LSSF=0

JEFF-3.3 URR from 4 keV to 30 keV ; LSSF=1. 1st Inel : 7.8 keV

U238 (n,tot)



U238 ratio TP CALENDF (Sum / Eval)



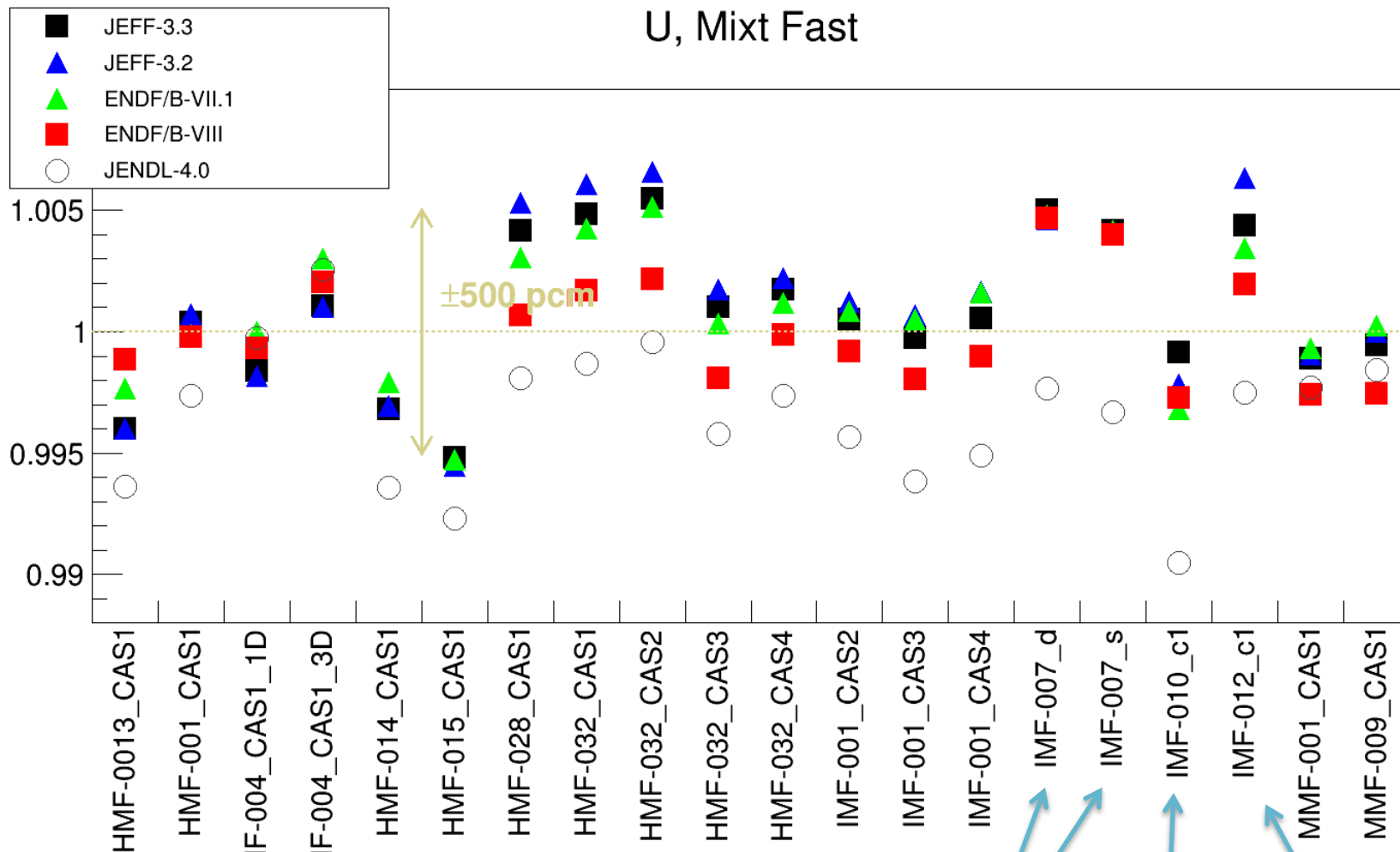
Libraries :

- Use of MF12 (Transition probabilities) instead of MF6 for gamma cascade (discrete inelastic scatterings)
→ Improvement of Analog simulations
- Unit Base Interpolation for outgoing energy distribution (MF5, MF6, MF15)
→ Energy balance
- Depletion calculations : DD and GP should be in agreement
- Kinematics of outgoing particles at high energy (> 20 MeV) should be improved
- URR data. PURR doesn't treat reactions in addition to MT2, MT18, MT102, "MT1"



ICSBEP BENCHMARKS : U, MIXT FAST (TRIPOLI 4)

U, Mixt Fast



Godiva

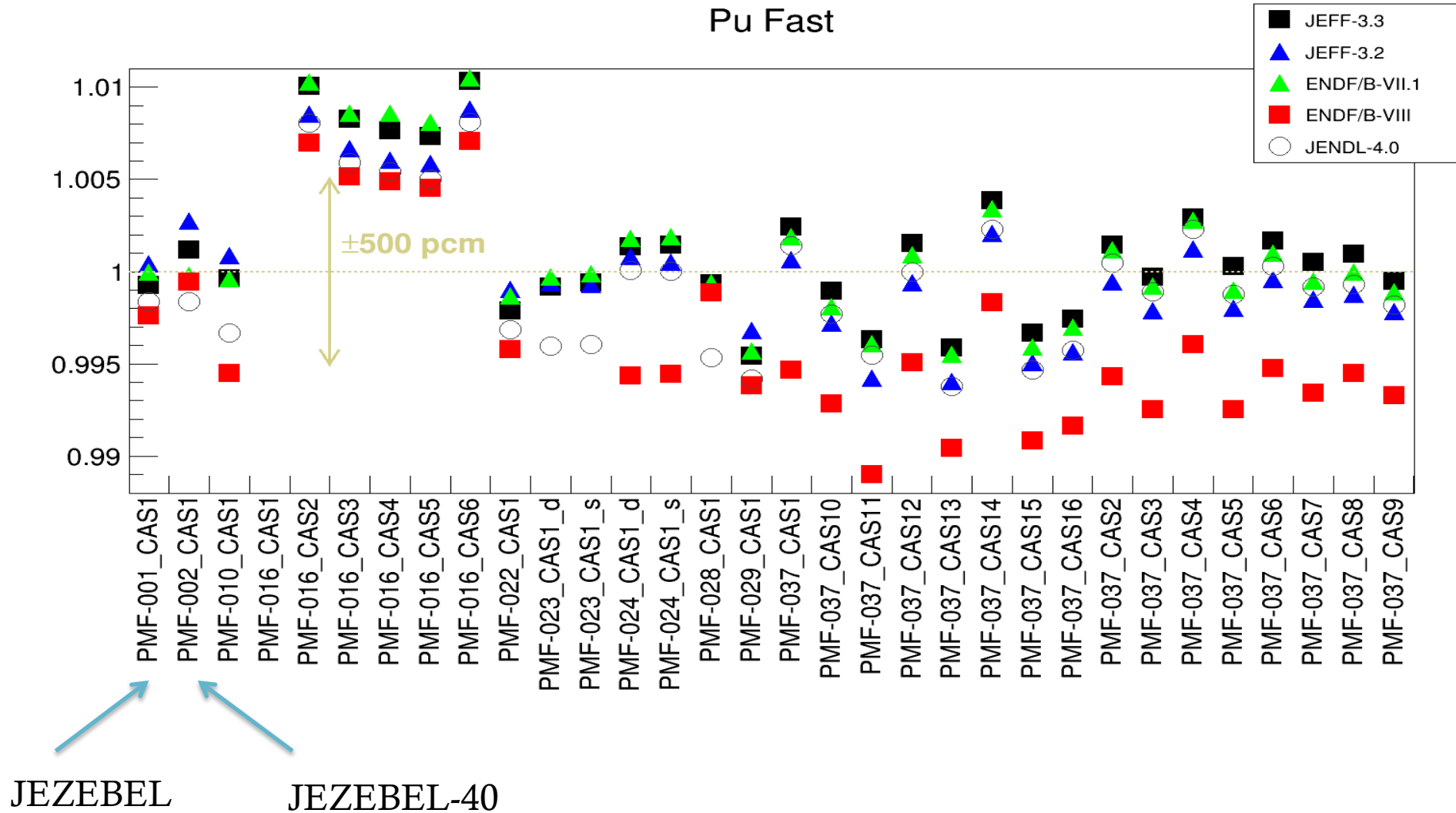
Flattop-25

Big-10

ZPR-U9

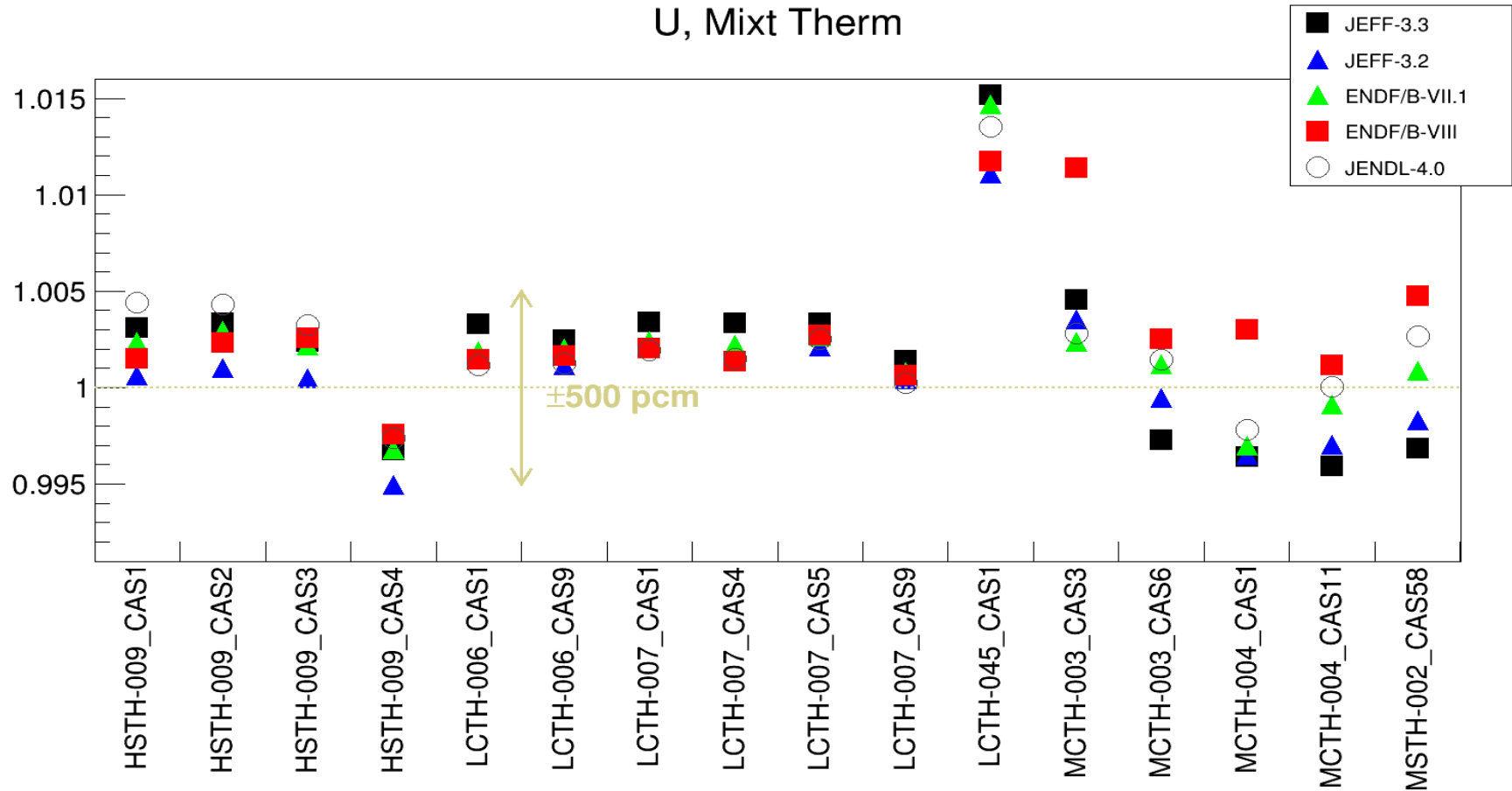
ZPR-16%

ICSBEP BENCHMARKS : PU FAST (TRIPOLI 4)

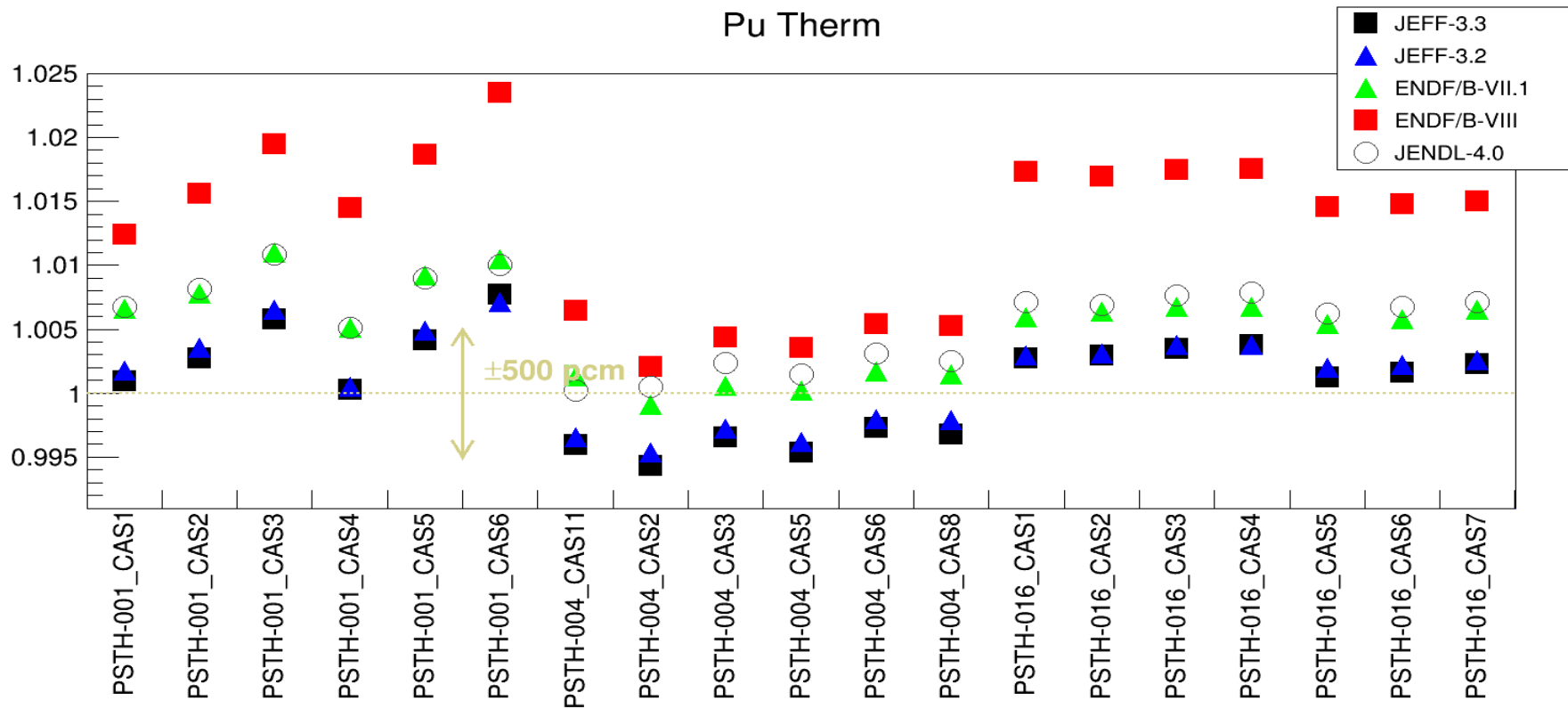


ICSBEP BENCHS : U, MIXT THERM (TRIPOLI 4)

U, Mixt Therm



ICSBEF BENCHMARKS : PU THERM (TRIPOLI 4)



Comparison to Mass Excess (NUBASE2012) : $\Delta > 1 \text{ MeV}$.

Cd106, Cd113, Ce141, Eu155, I135, La139,
Ru103, Ru104, Ru105, Th230, Xe134

→ Corrections on AWR + Q + Thresholds (MF4, MF5, MF6,)