Task 4.3. Processing and sensitivity

Coordinator UPM: O Cabellos

Partners:

- CIEMAT: V. Bécares
- UPM: O. Cabellos
- CNRS/Subatech: M. Fallot

SANDA Task 4.3: UPM, CIEMAT and CNRS/Subatech

- From task description in SANDA DoW:

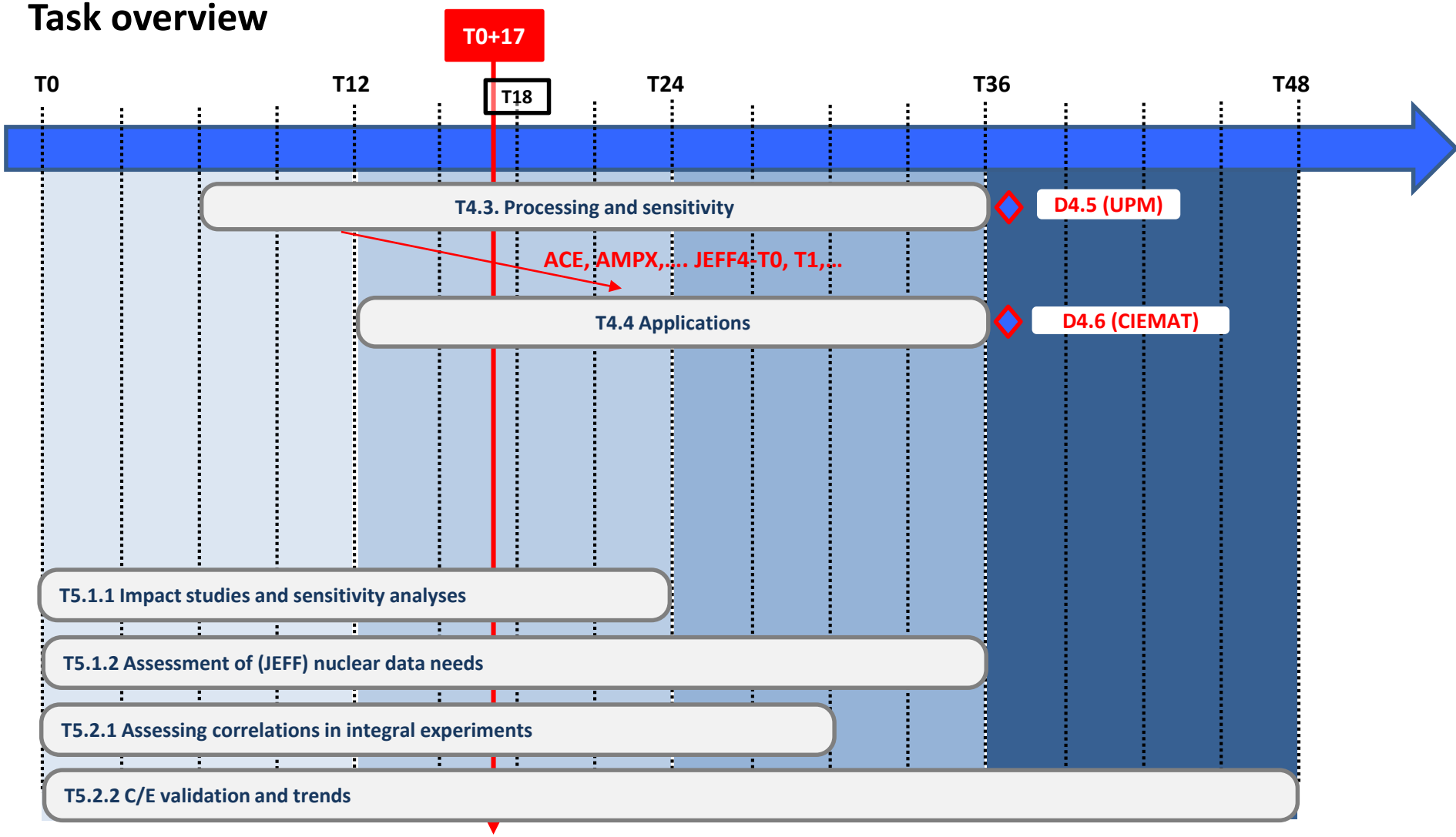
"As a continuation of the work done in CHANDA and in consonance with efforts done by OECD-NEA, CIEMAT proposes ***to define and validate a processing route for AMPX*** *and GEANT4 in order to process state-of-the-art nuclear data. Best processing parameters will be identified and input decks for processing CE libraries with the AMPX system will be generated".*

"Additionally, state-of-the-art nuclear data libraries (e.g., ***JEFF-3.3****, ENDF/B-VIII.0 and JENDL-4.0u2) will be* ***processed and validated using the same criticality validation suite used by MCNP****. Additionally, UPM will perform the checking, processing and verification of evaluated nuclear data files: (1)* ***review of the processing tools****, (2)* ***processing and verification of evaluated nuclear data files and covariances****, and (3)* ***verification of covariance nuclear data*** *in criticality, shielding and spent nuclear fuel assay data".*

"The second part of this task will concern the ***sensitivity calculations and uncertainty propagation based on the processed files****".*

SANDA Task 4.3: UPM, CIEMAT and CNRS/Subatech

Task overview



SANDA Task 4.3: UPM activities (I)

1. Review of the processing tools (1 of 2)

- *O. Cabellos, "P&V of JEFF-3.3 by using **FRENDY code**"*
  JEFF Meeting, Nov 2019. JEFDOC-1987
  - *Feedbacks on formatting issues in: D, ^{54}Fe,^{58}Fe, ^{178}Hf, ^{155}Gd, ^{243}Am*
  - *Comparison FRENDY versus NJOY2016 in Mosteller's suite*
  - *Introduction to FRENDY perturbation mode: perturbed/sampling ACE files*

Table: Comparison of results in the Extended (123) Criticality Mosteller's suite

#	CASE	FRENDY 1.01.007 keff	FRENDY 1.01.007 Dkeff-stat	NJOY 2016.46 keff	NJOY 2016.46 Dkeff-stat	Diff. (FRENDY1.01.007 - NJOY2016.46) in pcm
1	heu-comp-inter-003-case7	1.00294	0.00011	1.00291	0.00011	3
2	heu-met-fast-001	1.00008	0.00008	1.00001	0.00009	7
3	heu-met-fast-003-case10	1.00524	0.00010	1.00493	0.00009	31
4	heu-met-fast-003-case11	1.00996	0.00010	1.00986	0.00009	10
5	heu-met-fast-003-case12	1.00537	0.00009	1.00538	0.00010	-1
6	heu-met-fast-003-case1	0.99574	0.00009	0.99596	0.00009	-22
7	heu-met-fast-003-case2	0.99507	0.00009	0.99528	0.00009	-21
8	heu-met-fast-003-case3	0.99999	0.00009	0.99998	0.00009	1
9	heu-met-fast-003-case4	0.99826	0.00009	0.99835	0.00009	-9
10	heu-met-fast-003-case5	1.00241	0.00009	1.00276	0.00009	-35
11	heu-met-fast-003-case6	1.00300	0.00010	1.00329	0.00009	-29
12	heu-met-fast-003-case7	1.00366	0.00010	1.00389	0.00009	-23
13	heu-met-fast-003-case8	1.00143	0.00009	1.00148	0.00009	-5
14	heu-met-fast-003-case9	1.00160	0.00009	1.00175	0.00009	-15

SANDA Task 4.3: UPM activities (I)

1. Review of the processing tools (2 of 2)

- *O. Cabellos, N. García-Herranz, "Processing ND with **AMPX/SCALE code in CE**"*
  - *Released SCALE-6.3beta received by the end of July 2020*
  - *Attending SCALE Users Workshop (video-conference) in July 2020*
  - *Collaboration with C.J. Díez (ex NEA/DB) in October 2020*
  - *Identifying best processing parameters for processing CE libraries with the AMPX code. Bugs/problems? reported to ORNL, January 2021*

- *O. Cabellos, "**Processing (NJOY2016.57): JEFF-4.0T0**"*
  Private communication by email with NEA/DB), October 2020
  - *Reporting processing issues in ACE format : ^{175}Lu, ^{99}Tc, ^{242m}Am and ^{10}B*

SANDA Task 4.3: UPM activities (I)

2. Processing and verification of evaluated nuclear data files and covariances (1 of 4)

- *O. Cabellos, "**Criticality Benchmarking: JEFF-4.0T0**". JEFF Meeting and JEFF-CG, Nov 2020. JEFDOC-2015*
  - *Reporting potential problems: W, ^{103}Rh and Ni*

Table: Reduced-chi squared values in the Extended (123) Criticality Mosteller's suite

	JEFF-3.3	JEFF-4.0T0
PU	3.05	3.13
HEU	2.64	**6.76**
IEU	3.33	4.29
LEU	2.14	2.60
U233	1.55	2.35
MIX	0.91	0.88
SPEC (C/E) Dexp=0.00340	0.99173	0.99479
All	2.25	3.80

SANDA Task 4.3: UPM activities (I)

2. Processing and verification of evaluated nuclear data files and covariances (2 of 4)

- *O. Cabellos, "Feedbacks on JEFF-3.3 Evaluation: Uncertainty in keff for some ICSBEP Outliers,* ***PWR Critical Boron Letdown Curve, Additional integral data testing using reaction rates in critical assemblies"*** *JEFF Meeting, Nov 2019. JEFDOC-1991*

Figure: Differences "Calculated-Measurement" in Critical Boron Letdown curve

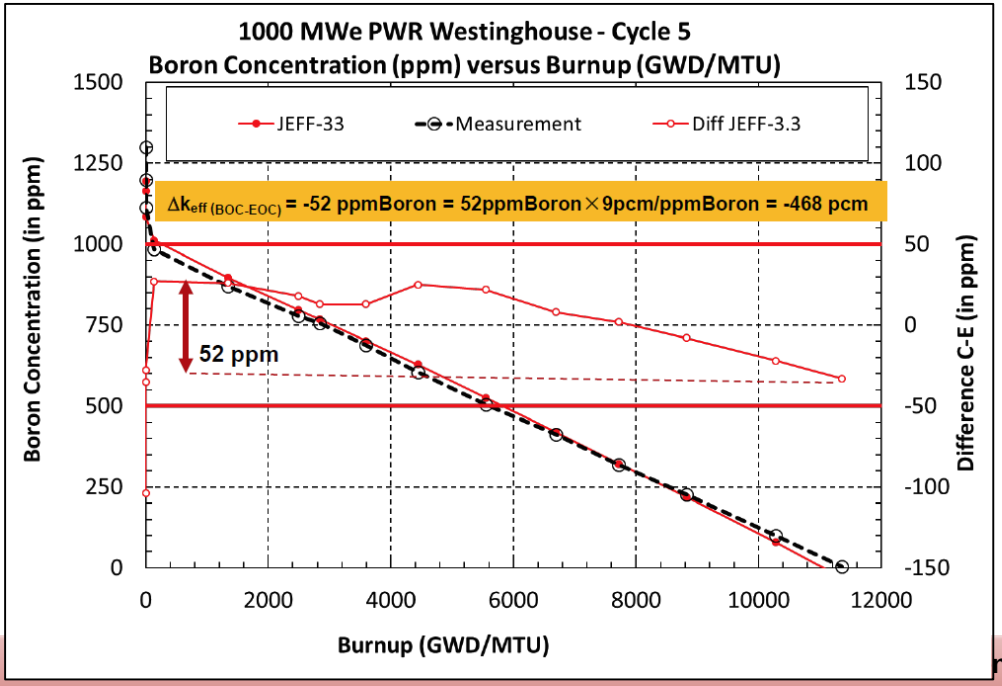


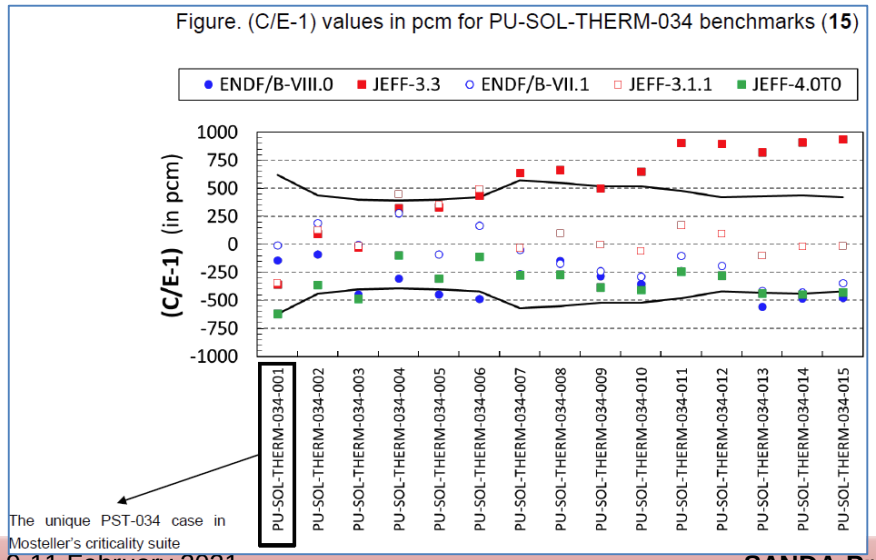
Table: Reaction Rates in critical assemblies: BigTen

Quantity	$\Delta E_{exp}/E$	C/E	
		JEFF-3.3	ENDF/B-VIII.0
$^{238}U(n,f) / ^{235}U(n,f)$	±0.02	0.90	0.96
$^{238}U(n,\gamma) / ^{235}U(n,f)$	±0.03	0.92	0.96
K-eff (detailed model)	±70 (pcm)	1.00041	0.99979
K-eff (Improved simplified model)	±80 (pcm)	0.99997	0.99951

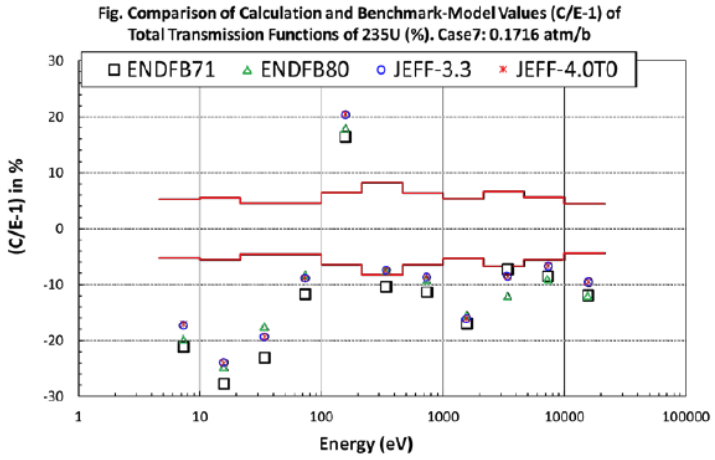
SANDA Task 4.3: UPM activities (I)

2. Processing and verification of evaluated nuclear data files and covariances (3 of 4)

- *O. Cabellos, M. García-Hormigos, B. Moreno and S. Sánchez-Fernández, "The importance of using different integral benchmarks to provide valuable feedbacks to the evaluation process" JEFF Meeting, Nov 2020. JEFDOC-2015*
  - *Criticality and reaction rates: Indications on 238U/JEFF-3.3 evaluation: BigTen*
  - *Criticality and depletion benchmarks: Indications on 239Pu evaluation*
    - *ICSBEP/PST034 and depleted PWR-Fuel Assembly (4.8%wo)*
  - *Neutron transmission experiments: Indications on 235U evaluation*
  - *Shielding Benchmarks: An example for LLNL-235U*



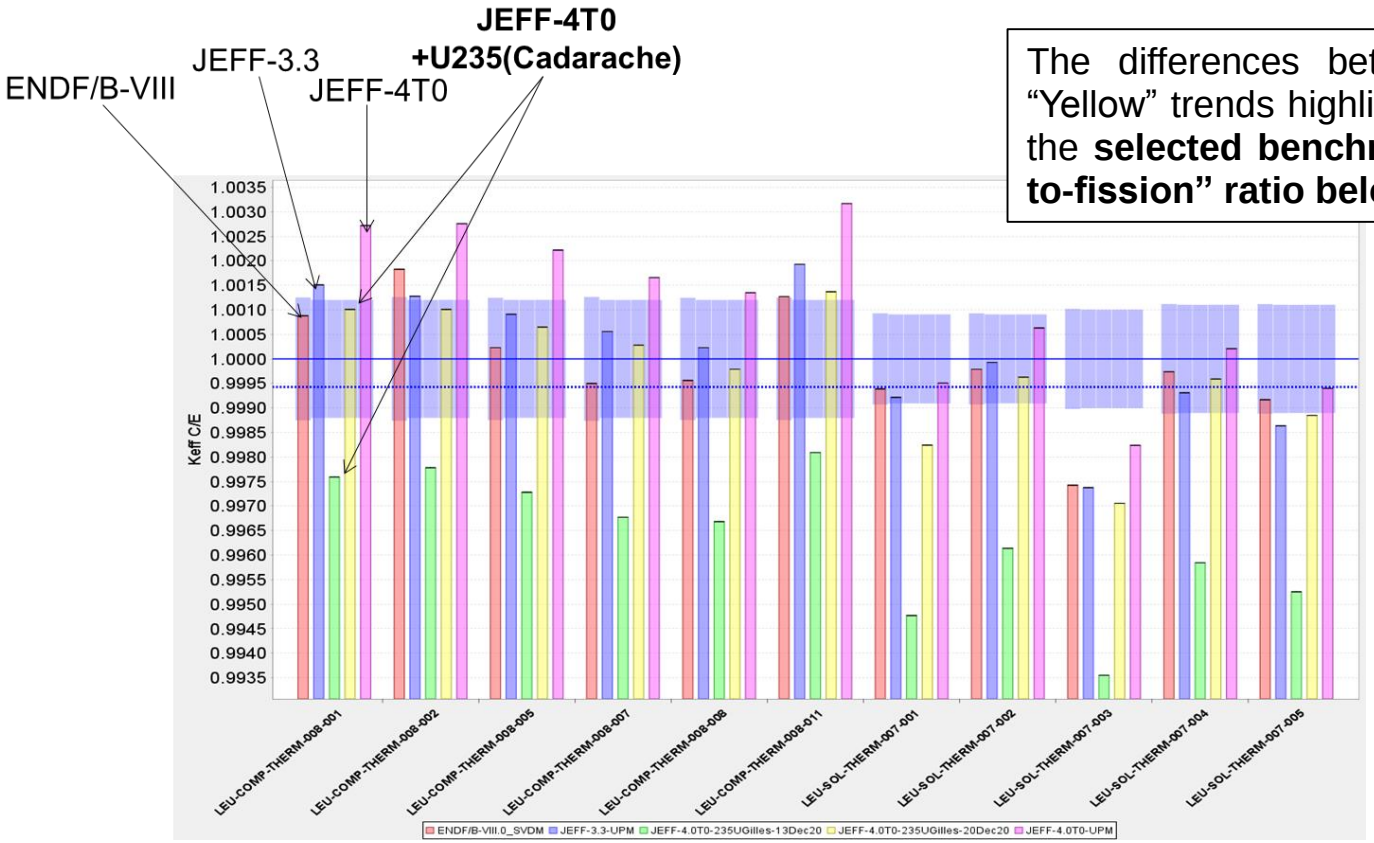
- **IPPE ^{235}U-Transmission Benchmark:** Sample 7= 0.17160 atm/b



SANDA Task 4.3: UPM activities – CEA/DES Cadarache

2. Processing and verification of evaluated nuclear data files and covariances (3bis of 4)

- *G. Noguere (CEA/DES Cadarache), O. Cabellos (UPM): "Testing new resolved resonance parameters for U235 with the CONRAD code".*



The differences between the "Green" and "Yellow" trends highlight the high sensitivity of the **selected benchmarks to the "capture-to-fission" ratio below 5 eV**.

SANDA Task 4.3: UPM activities (I)

2. Processing and verification of evaluated nuclear data files and covariances (4 of 4)

- *Contribution to the paper "WPEC Subgroup 44 Computational Inter-comparison Exercise On Correlations in Nuclear Data Libraries", V. Sobes, C. de Saint Jean, D. Rochman, O. Cabellos, A. Holcomb, E. Bauge, R. Capote, A. Trkov, M. Fleming.*
  To be published in Annals of Nuclear Energy, January 2021

Table: Mean and uncertainty spectrum-averaged values for ν , σ_f and σ_γ in ENDF/B-VIII.0, JEFF-3.3, and JENDL-4 libraries. Values calculated with NJOY2016 (IWT=4), i.e., correspond to the fast neutron range.

		$\bar{\nu}$	$\delta\bar{\nu}$(%)	σ_f (b)	$\delta\sigma_f$ (%)	σ_γ(b)	$\delta\sigma_\gamma$(%)
U-235	ENDF/B-VIII.0	2.587	0.6	1.31	1.2	0.19	20.0
	JEFF-3.3	2.567	0.4	1.31	1.1	0.20	6.6
	JENDL-4	2.592	0.11	1.296	0.62	0.186	39.6
	Average (unc):	**2.582**	**0.51**	**1.305**	**0.5**	**0.192**	**3.8**
Pu-239	ENDF/B-VIII.0	3.101	0.6	1.703	1.3	0.107	36.2
	JEFF-3.3	3.089	0.4	1.709	0.5	0.101	5.1
	JENDL-4	3.097	0.2	1.705	0.7	0.1095	38.3
	Average (unc):	**3.096**	**0.2**	**1.706**	**0.2**	**0.1058**	**4.1**

SANDA Task 4.3: UPM activities (I)

3. Verification of covariance nuclear data in criticality, shielding and spent nuclear fuel assay data (1 of 2)

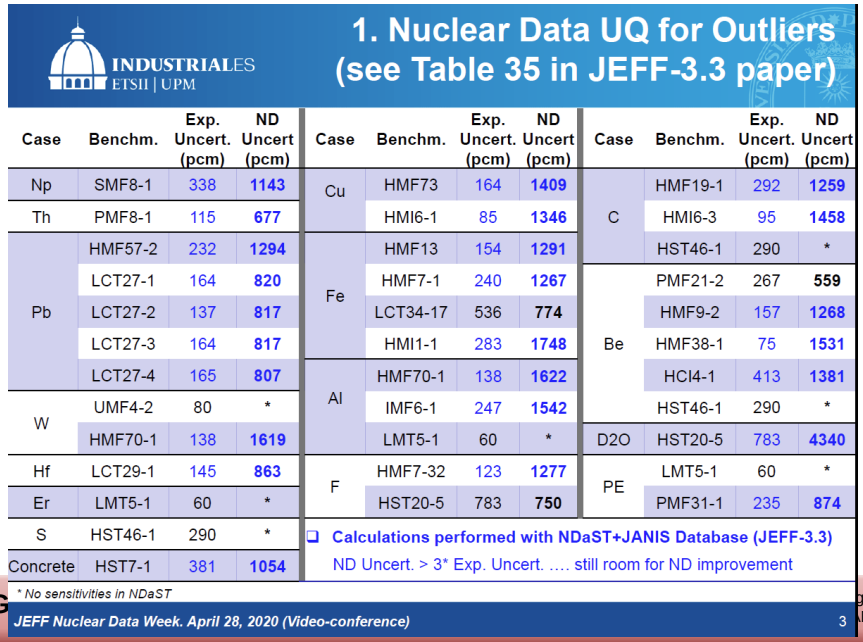
- *O. Cabellos, "Feedbacks on JEFF-3.3 Evaluation:* ***Uncertainty in keff for some ICSBEP Outliers****, PWR Critical Boron Letdown Curve, Additional integral data testing using reaction rates in critical assemblies". JEFF Meeting, Nov 2019. JEFDOC-1991*

Figure: Identifying outliers in criticality benchmarks for materials other than actinides. Ref. JEFF-3.3, EPJ/A. 2020

Table 35: Non-actinide materials (mat.) featuring in outliers of the NEA and IRSN suites. N is the number of cases. Bold are cases off by more than 3 experimental standard uncertainties.

mat.	N	Cases
PE	2	**lmt5-1**, pmf31-1
D_2O	1	hst20-5
Be&BeO	5	hmf9-2, **hst46-1, pmf21-2, hmf38-1, hci4-1**
C	3	hmf19-1, hmi6-3, hst46-1
F	2	**hmf7-32**, hst20-5
Al	3	**hmf70-1**, imf6-1, **lmt5-1**
concrete	1	**hst7-1**
S	1	**hst46-1**
Steel	4	hmf13, hmf7-1, lct34-17, **hmi1-1**
Cu	2	**hmf73**, hmi6-1
Er	1	**lmt5-1**
Hf	1	lct29-8
W	2	**umf4-2, hmf70-1**
Pb	5	hmf57-2, **lct27-1 to -4**,
Th	1	**pmf8-1**
Np	1	smf8-1

Figure: UQ for outliers, Table 35 in JEFF-3.3 paper



Case	Benchm.	Exp. Uncert. (pcm)	ND Uncert (pcm)
Np	SMF8-1	338	1143
Th	PMF8-1	115	677
Pb	HMF57-2	232	1294
	LCT27-1	164	820
	LCT27-2	137	817
	LCT27-3	164	817
	LCT27-4	165	807
W	UMF4-2	80	*
	HMF70-1	138	1619
Hf	LCT29-1	145	863
Er	LMT5-1	60	*
S	HST46-1	290	*
Concrete	HST7-1	381	1054
Cu	HMF73	164	1409
	HMI6-1	85	1346
Fe	HMF13	154	1291
	HMF7-1	240	1267
	LCT34-17	536	774
	HMI1-1	283	1748
Al	HMF70-1	138	1622
	IMF6-1	247	1542
	LMT5-1	60	*
F	HMF7-32	123	1277
	HST20-5	783	750
C	HMF19-1	292	1259
	HMI6-3	95	1458
	HST46-1	290	*
Be	PMF21-2	267	559
	HMF9-2	157	1268
	HMF38-1	75	1531
	HCI4-1	413	1381
	HST46-1	290	*
D2O	HST20-5	783	4340
PE	LMT5-1	60	*
	PMF31-1	235	874

SANDA Task 4.3: UPM activities (I)

3. Verification of covariance nuclear data in criticality, shielding and spent nuclear fuel assay data (2 of 2)

- *O. Cabellos, M. García-Hormigos, B. Moreno and S. Sánchez-Fernández, "The importance of using different integral benchmarks to provide valuable feedbacks to the evaluation process". JEFF Meeting, Nov 2020. JEFDOC-2015*
  - Comparison UQ using FRENDY and SANDY versus NDaST: Application in Godiva

Table. HEU-MET-FAST-001: Godiva. Calculations performed with MCNP-6.1. Nuclear Data: JEFF-3.3.

	NDaST	SANDY	FRENDY
#	(pcm)	(pcm)	(pcm)
ν (nubar)	510	503	477
PFNS	364	216	315
Fission	648	643	643
Elastic	109	-	-
Inelastic	698	-	-
Capture	375	-	-
All cross-sections	1187	1137	1169
Correlated Sum	±1342	±1262	±1301
Exp. Uncert	±100	±100	±100
| C – E |	16	16	16

SANDA Task 4.3: UPM activities (I)

4. Sensitivity calculations and uncertainty propagation based on the processed files (1 of 3)

- *O. Cabellos, M. García-Hormigos, B. Moreno and S. Sánchez-Fernández, "The importance of using different integral benchmarks to provide valuable feedbacks to the evaluation process" JEFF Meeting, Nov 2020. JEFDOC-2015*
  - *Criticality and reaction rates: Indications on 238U/JEFF-3.3 evaluation: BigTen*
  - *Criticality and depletion benchmarks: Indications on 239Pu evaluation*
    - ***ICSBEP/PST034 and depleted PWR-Fuel Assembly** (4.8%wo)*
  - ***Neutron transmission experiments**: Indications on 235U evaluation*
  - *Shielding Benchmarks: An example for LLNL-235U*

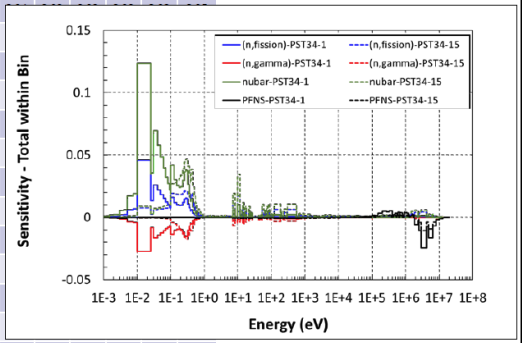
❑ **Searching for similarities in ICSBEP**

Table. Representative ck-values for PST-034 benchmarks and a PWR – 17x17 4.8wt% at 34GWD/MTU

# \ #	001	002	003	004	005	006	007	008	009	010	011	012	013	014	015	PWR
PST34-001	1.00	0.99	0.98	0.96	0.94	0.93	0.93	0.92	0.92	0.90	0.90	0.89	0.88	0.87	0.86	0.95
PST34-002	0.99	1.00	1.00	0.99	0.98	0.96	0.95	0.94	0.94	0.93	0.92	0.92	0.91	0.90	0.90	0.95
PST34-003	0.98	1.00	1.00	1.00	0.99	0.98	0.95	0.95	0.95	0.94						
PST34-004	0.96	0.99	1.00	1.00	1.00	0.99	0.95	0.95	0.95	0.94						
PST34-005	0.94	0.98	0.99	1.00	1.00	1.00	0.95	0.94	0.94	0.94						
PST34-006	0.93	0.96	0.98	0.99	1.00	1.00	0.94	0.94	0.94	0.94						
PST34-007	0.93	0.95	0.95	0.95	0.95	0.94	1.00	1.00	1.00	1.00						
PST34-008	0.92	0.94	0.95	0.95	0.94	0.94	1.00	1.00	1.00	1.00						
PST34-009	0.92	0.94	0.95	0.95	0.94	0.94	1.00	1.00	1.00	1.00						
PST34-010	0.90	0.93	0.94	0.94	0.94	0.94	1.00	1.00	1.00	1.00						
PST34-011	0.90	0.92	0.94	0.94	0.94	0.94	1.00	1.00	1.00	1.00						
PST34-012	0.89	0.92	0.93	0.94	0.94	0.94	0.99	1.00	1.00	1.00						
PST34-013	0.88	0.91	0.92	0.93	0.93	0.93	0.99	0.99	1.00	1.00						
PST34-014	0.87	0.90	0.92	0.93	0.93	0.93	0.99	0.99	0.99	1.00						
PST34-015	0.86	0.90	0.92	0.92	0.92	0.92	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	0.85
PWR 34GWD/MTU	0.95	0.95	0.95	0.94	0.93	0.93	0.89	0.88	0.88	0.87	0.87	0.86	0.85	0.85	0.85	1.00

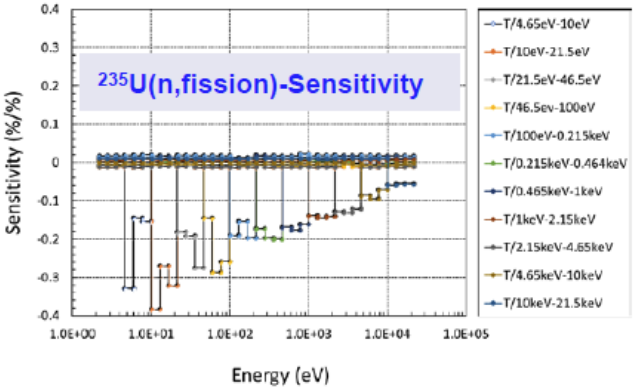
NOTE: Values calculated with NDaST

Figure. ^{239}Pu sensitivity coefficients (Total within bin) for PST34-001 and 015.



❑ **IPPE ^{235}U-Transmission Benchmark:** Sample 7= 0.17160 atm/b

Figure. ^{235}U(n,fission)-Sensitivity (%/%) to 235U-Total Transmission Function in Sample 7.



SANDA Task 4.3: UPM activities (I)

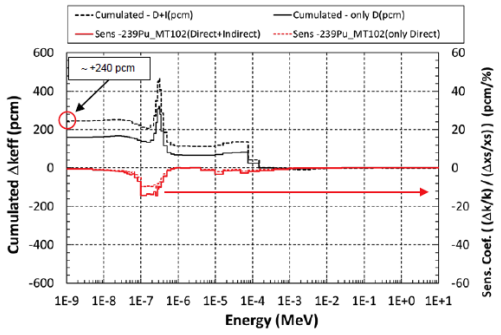
4. Sensitivity calculations and uncertainty propagation based on the processed files (2 of 3)

- *O. Cabellos, "Indications from integral benchmarks on U-235, U-238 and Pu-239 evaluations"*
  IAEA CM of the INDEN on Actinide Evaluation in the RR, 17-19 Nov 2020
  - *IEU-MET-FAST-007/Big Ten: … criticality and reaction rates*
  - *ICSBEP/PST-034 and **burnup calculations**: … criticality and depletion benchmarks*
  - *ICSBEP/FUND-JINR-1/E-MULT-TRANS-001: … neutron transmission experiments*

❑ **keff-Sensitivities ^{239}Pu :** In PWRs Fuel Assemblies 17x17-4.8wt%

Figure. 239Pu sensitivity coefficients and relative perturbation in keff to (**n, gamma)** between ENDF/B-VIII.0 and JEFF-3.3 in a PWR Fuel assembly 17x17 - 4.8wt% **at 32GWd/MTU**.

- "Only Direct" (D) - only changes in cross-sections
- "Direct + Indirect" takes into account changes in ΔN



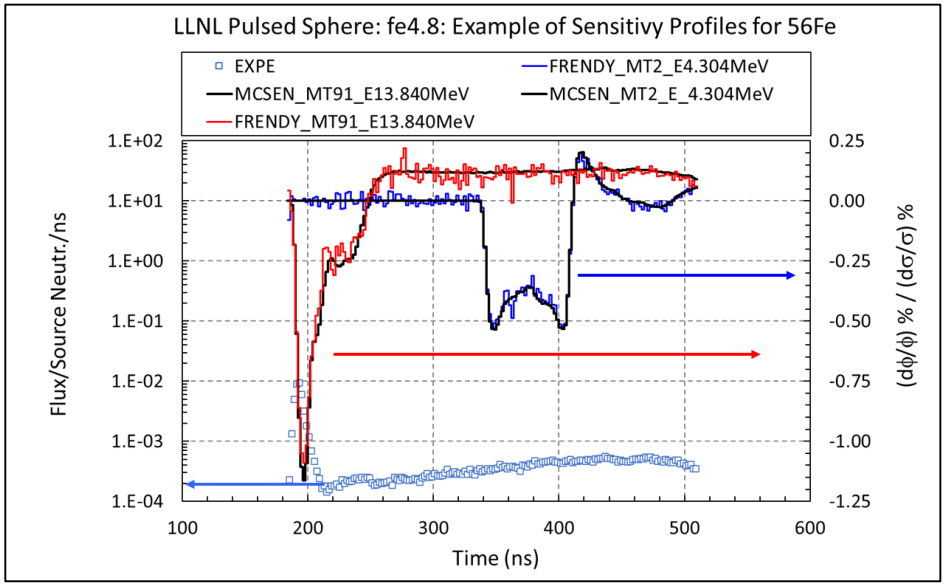
- The cumulated change is the cumulative change from high (g=G) to thermal energy (g=1):

$$\Delta k_{eff}^{i} = \sum_{g=G}^{1} S_g^i \cdot \Delta\sigma_g^i$$

SANDA Task 4.3: UPM activities (I)

4. Sensitivity calculations and uncertainty propagation based on the processed files (3 of 3)

- *O. Cabellos, "Remarks on LLNL pulsed sphere work"*
  WPEC/SG47 Meeting, December 2020
  - ***Sensitivity analysis in LLNL pulsed spheres**: **FRENDY** (cross-sections, nubar and CHI) and **SANDY** (cross-sections, nubar, CHI and MF4; MF6 requested to author) codes*



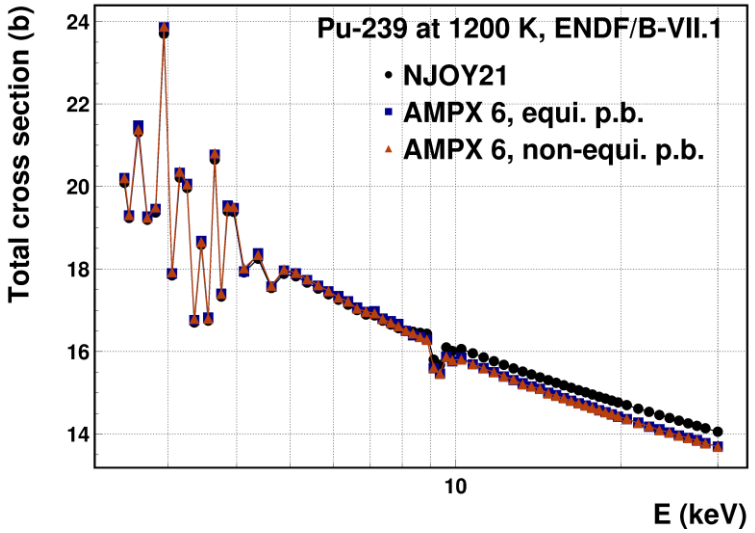
SANDA Task 4.3: CIEMAT activities (II)

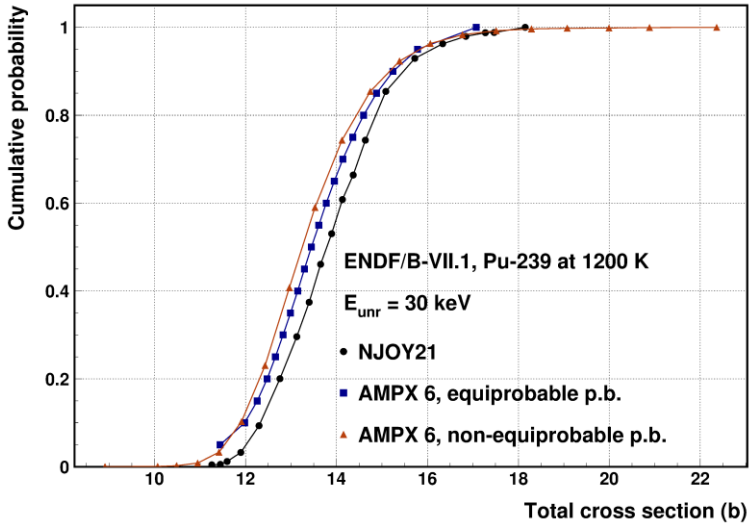
*"As a continuation of the work done in CHANDA and in consonance with efforts done by OECD-NEA, CIEMAT proposes to define and validate a **processing route for AMPX** and GEANT4 in order to process state-of-the-art nuclear data. Best processing parameters will be identified and input decks for processing CE libraries with the AMPX system will be generated".*

- Major nuclear data processing steps:
  1. Reconstructing the pointwise cross section from the evaluated nuclear data files ✓
  2. Doppler-broadening the reconstructed data ✓
  3. **Generating probability tables in the unresolved resonance range** ✓
  4. Generating pointwise neutron scattering data
- Step (3) has been investigated in detail as there was previous work identifying significant discrepancies between AMPX and NJOY in this step.
  - Jiménez-Carrascosa *et al.*, *About the impact of the Unresolved Resonance Region in Monte Carlo simulations of Sodium Fast Reactors*. ICAPP-2019, Juan-les-Pins (France) 12-15 May 2019.

SANDA Task 4.3: CIEMAT activities (II)

- Tasks performed:
  - Intercomparison of Bondarenko cross sections and probability tables obtained with AMPX and NJOY (ENDF/B-VII.1 and the JEFF-3.3 libraries) → **No apparent major difference** observed in several relevant isotopes (U-235, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, Am-241).
  - AMPX URR results converted into PENDF and ACE formats and applied to criticality calculations with MCNP for the case of a simplified model of an SFR fuel rod (ESFR-SMART) → **Minor difference in k_{eff}** of about 10 pcm.
- Results presented in:
  - V. Bécares *et al.*, *Processing the unresolved resonances of neutron cross sections with the AMPX and NJOY codes.* In Virtual meeting of the Spanish Nuclear Society, 16-19 November 2020.





SANDA Task 4.3: CNRS/Subatech (III)

- Tasks performed: by A. Beloeuvre, E. Bonnet, M. Estienne, M. Fallot, L. Giot, R. Kean, A. Laureau et A. Porta

*"The second part of this task will concern the **sensitivity calculations and uncertainty propagation based on the processed files**".*

*"Such sensitivity will be performed **for fission yields (CNRS/Subatech)**."*

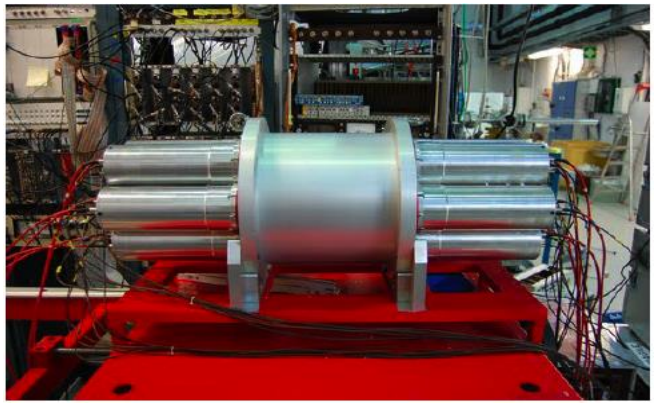
TAS Campains at IGISOL Jyväskylä in 2009 and 2014

- IGISOL@Jyväskylä:
  - Proton induced fission ion-guide source
  - Mass separator magnet
  - Double Penning trap system to clean the beams
- 2 (segmented) TAS campains :

B. Rubio, J. L. Tain, A. Algora et al., Proceedings of the Int. Conf. For nuclear Data for Science and technology (ND2013)

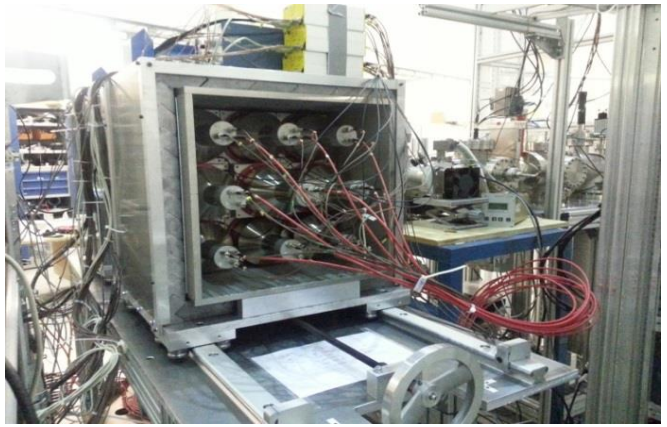
J.L. Tain et al., NIMA 803 (2015) 36
V. Guadilla et al., submitted to NIMA (2018)

❑ ROCINANTE (IFIC Valencia/Surrey):



- ✓ 12 BaF_2 covering 4π
- ✓ Detection efficiency of γ ray cascade >80% (up to 10 MeV)
- ✓ Coupled with a Si detector for β
- ✓ 7 nuclei (4 delayed neutron emitters) measured (6 for DH and 2 for anti-ν)

❑ DTAS (IFIC Valencia & DESPEC):



- ✓ 18 NaI(Tl) crystals of 15cm×15cm×25 cm
- ✓ Individual crystal resolutions: 7-8%
- ✓ Total efficiency: 80-90%
- ✓ Coupled with plastic scintillator for β
- ✓ 12 nuclei for anti-ν measured & 11 for Decay Heat

Impact of recent TAGS data on Decay Heat

Figures extracted from « β-decay studies for applied and basic nuclear physics », accepted in EPJA, Algora et al., 2020 https://arxiv.org/pdf/2007.07918.pdf

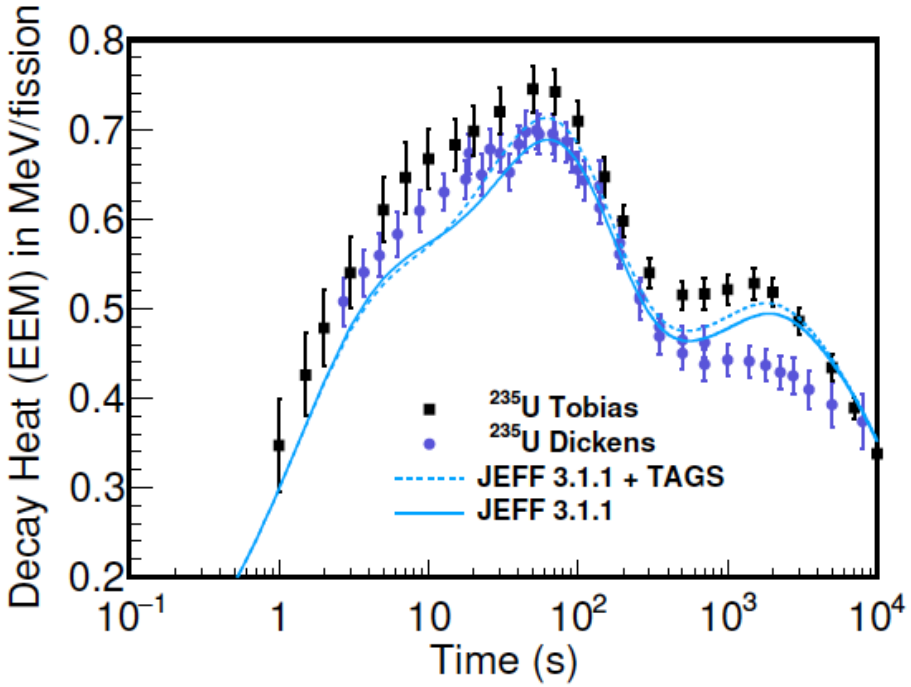


Fig. 14. Impact of the inclusion of the total absorption measurements performed for 13 decays in the gamma component of the decay heat calculations for ^{235}U (see Figure 13 for more details).

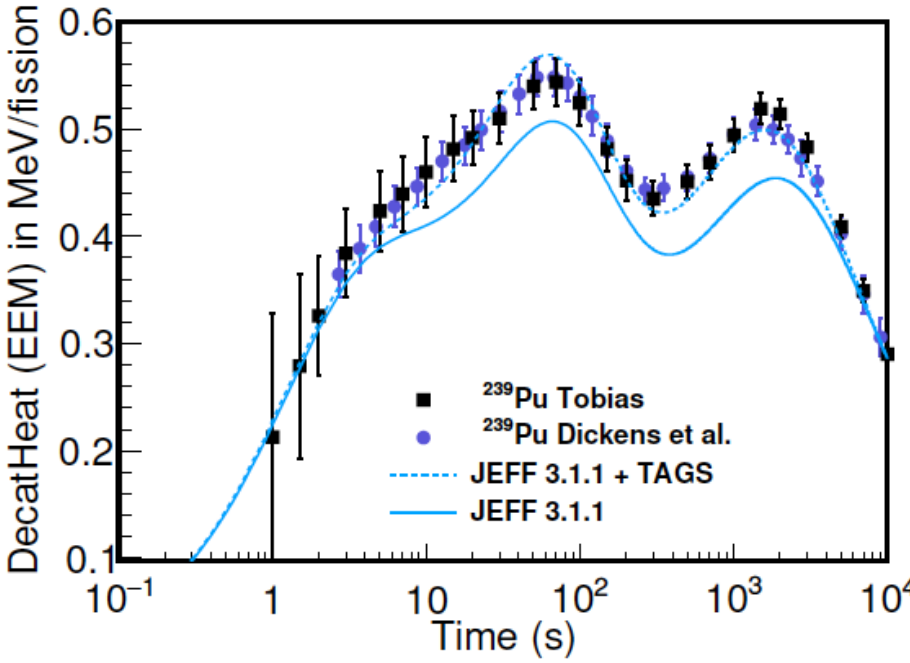
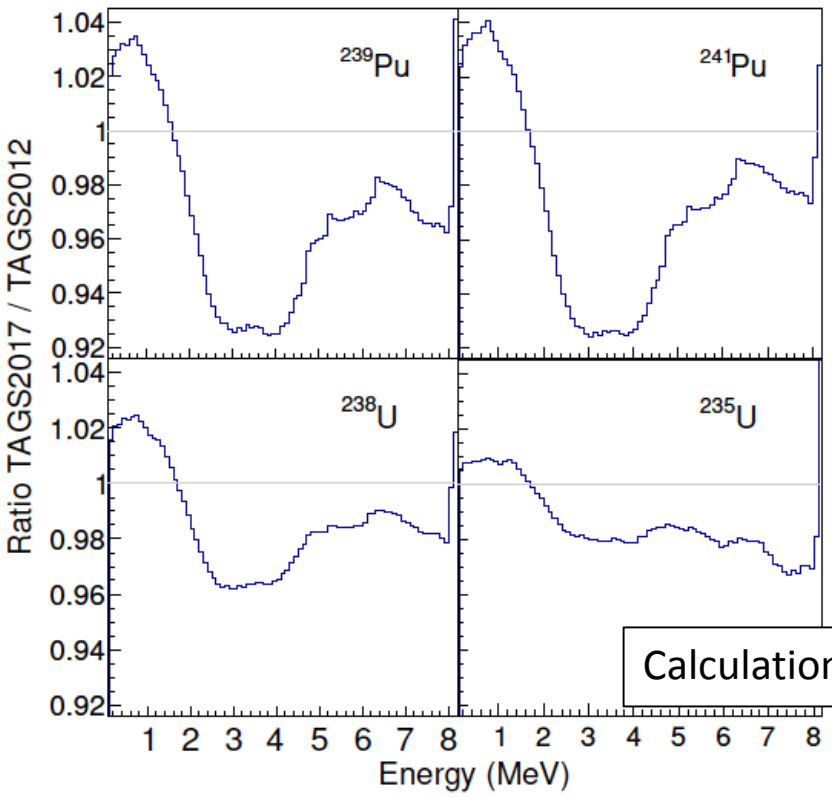


Fig. 13. Impact of the inclusion of the total absorption measurements performed for 13 decays (^{86,87,88}Br, ^{91,91,94}Rb, ^{101}Nb, ^{105}Mo, ^{102,104,105,106,107}Tc) published in Refs. [7,8,24, 62,67] in the gamma component of the decay heat calculations for ^{239}Pu.

Calculations by L. Giot

Impact of recent TAGS data on Reactor Antineutrinos

Figures extracted from « β-decay studies for applied and basic nuclear physics », accepted in EPJA, Algora et al., 2020 https://arxiv.org/pdf/2007.07918.pdf



Calculations by M. Estienne

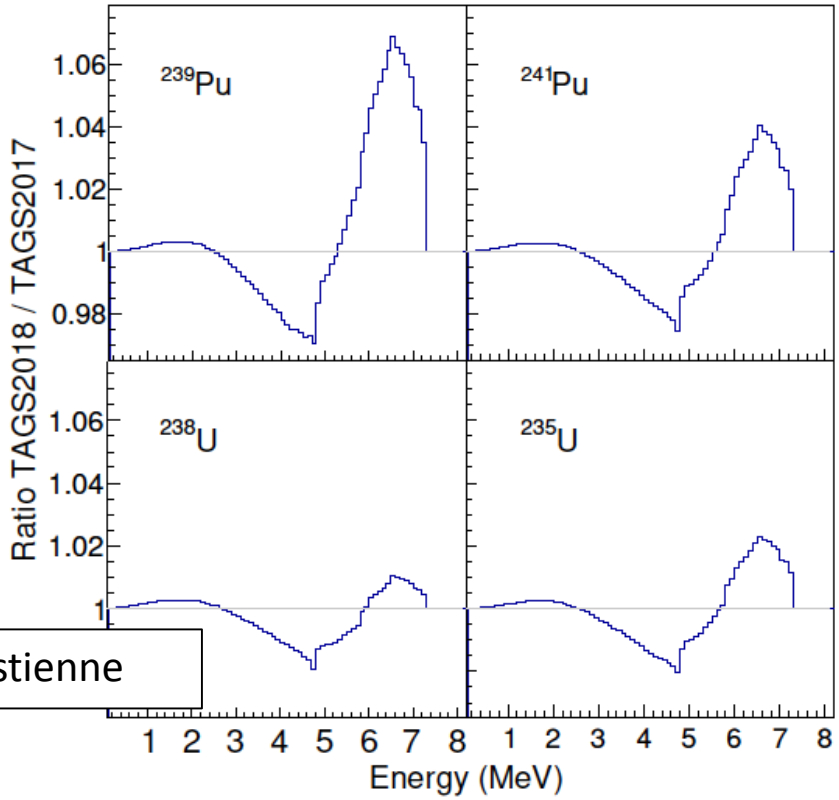
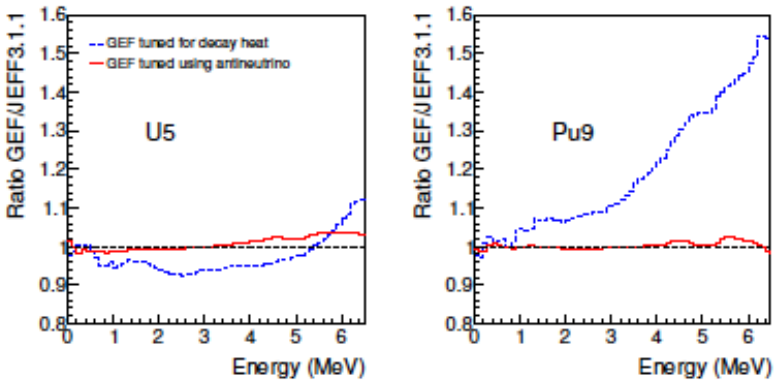


Fig. 17. Accumulated impact of the beta intensities of the ^{86,87,88}Br and ^{91,92,94}Rb [24,62,67] decays measured with the total absorption spectrometer *Rocinante* on the antineutrino spectra with respect to that published in [99] (relative ratios) for the thermal fissions of ^{235}U, ^{239}Pu and ^{241}Pu, and the fast fission of ^{238}U [107].

Fig. 18. Accumulated impact of the beta intensities measured with the DTAS detector on the antineutrino spectra with respect to that presented in Figure 17 (relative ratios) for the thermal fissions of ^{235}U, ^{239}Pu and ^{241}Pu, and the fast fission of ^{238}U [107]. The figure represents the relative impact of the ^{100,100m,102,102m}Nb decays [13].

Fission Yield Evaluation, GEF & Antineutrinos

- **Estienne et al. collaborate with K.-H. Schmidt** for several years with the purpose to use the **GEF FY** with their uncertainties. First results are:
  - **Antineutrinos are a very sensitive probe for fission yields**
  - A **new version of the GEF code improved t**hanks to the antineutrino spectral studies
  - An assessment of the experimentally available fission yields with the GEF model showing that the **discrepancies btw FY from JEFF3.1.1 and JEFF3.3 are not always understood**
  - **New predictions compared with the Daya Bay flux**
  - **New predictions of actinide antineutrino spectra for applications**



Extensive study of the quality of fission yields from experiment, evaluation and GEF for antineutrino studies and applications
K.-H. Schmidt, M. Estienne, M. Fallot et al.
http://arxiv.org/abs/2012.08199

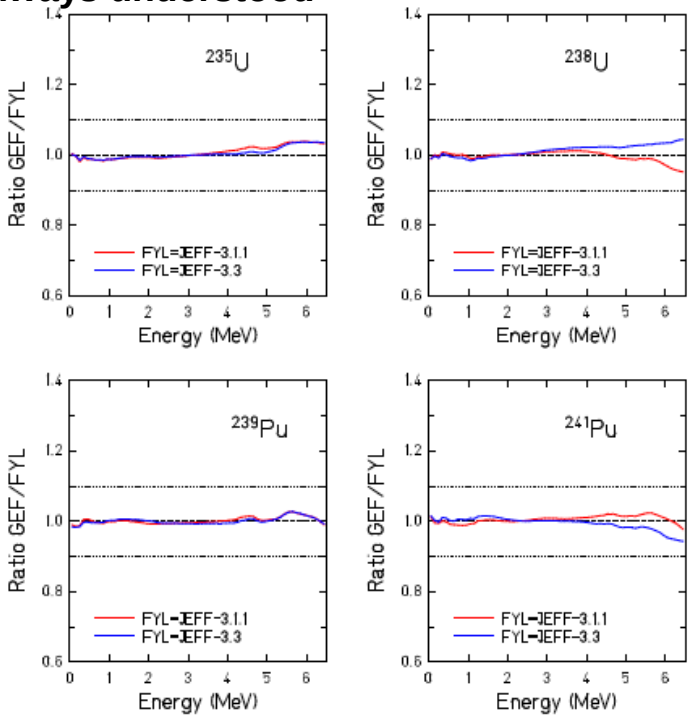


FIG. 63. Ratio of the antineutrino spectra calculated with yields from GEF and from the fission-yield libraries (FYL) JEFF-3.1.1, respectively JEFF-3.3, after tuning.

Fission Yield Evaluation, GEF & Antineutrinos

- **Estienne et al. collaborate with K.-H. Schmidt** for several years with the purpose to use the **GEF FY** with their uncertainties. First results are:
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Calculation of uncertainties on SM with GEF is on-going…

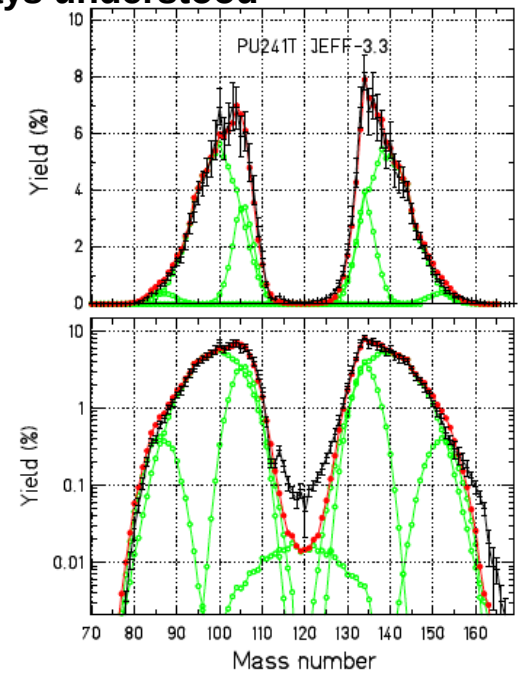

FIG. 58. Mass yields of ^{241}Pu(n_{th},f), linear (upper frame) and logarithmic (lower frame) scale. GEF result (red points) in comparison with JEFF-3.3 (black symbols).

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