UPM Activities in Nuclear Data

Third International Workshop on Nuclear Data for the Next Decade (P(ND)^2-3), March 9-13, 2026

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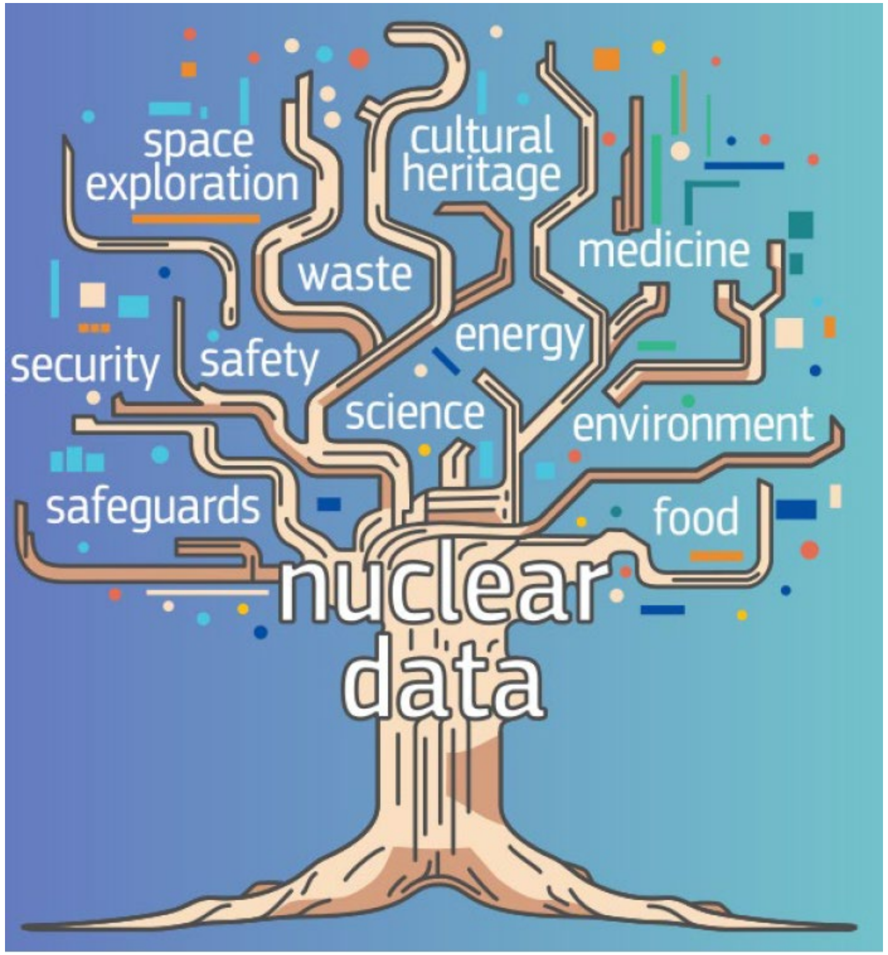

courtesy by A.Plompen (ND2025)

1. The Speaker

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Oscar Cabellos
(UPM)

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- I am Oscar Cabellos, full professor in nuclear engineering at the Polytechnic University of Madrid (UPM)
- I am coordinator of UPM courses on "Introduction on Nuclear Technology", "*Simulation of Nuclear Power Plants*" and "*Design and Simulation of PWRs*" which is one of the UPM coursed based on the CDIO (Conceive, Design, Implement and Operate) initiative
- My background is reactor physicist, specifically in PWR (Pressure Water Reactors) simulations where I did my PhD in 1998
- Since 2005 I have been involved in EU projects working on nuclear data activities: EUROTRANS (2005-2010), ANDES(2010-2013), CHANDA(2013-2018), SANDA (2019-2023), APRENDE (2024-2028)
- In 2014-2017, I moved to OECD/Nuclear Energy Agency (NEA)/Data Bank as Nuclear Data Scientist working in the development of EXFOR and JEFF databases, and JANIS and NDaST web-tools
- Currently, I am actively working in the JEFF (Joint Evaluation Fission and Fusion) project and WPEC (Working Party on International Nuclear Data Evaluation and Cooperation) activities of the OECD/NEA
- Member of the JEFF-Coordination Group, WPEC (co-coordinator WPEC/SG46 and monitor of WPEC/SG47) and WPNCS (Working Party on Nuclear Criticality and Safety)
- Member of the OECD/NEA/NSC – (Nuclear Science Committee) and OECD/NEA/MBDAV – (Management Board for the Development, Application and Validation of Nuclear Data and Codes)
- Member of the IAEA - International Nuclear Data Committee (INDC)

2. UPM Activities and Projects in ND

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1. Processing and verification: NJOY – PREPRO – AMPX – FRENDY
   1.1 OECD/NEA/DB/CPS: Processed Libraries – JEFF-3.1, JEFF-3.1.1, JEFF-3.3
   1.2 Formats: PENDF, GENDF, **HENDF/JANIS**, WIMSD, ACE, AMPX/CE, …, COVERX, BOXER,…
2. Benchmarking: ICSBEP/Mosteller – IRPhEP – SINBAD – SFCOMPO – CONDERc
   2.1 The **Mosteller Suite**, … SINBAD/Oktavian, FNS, …, LLNL/PS…
3. Validation: BUC/Benchmarks – NNPP/Almaraz – Advanced Reactors Design & SMRs
   3.1 TMI Pin-cell **Burnup** Benchmark (WPRS/UAM-2012)
4. Sensitivity Analysis: TSUNAMI, MCNP/PERT/KSEN, … perturbation techniques,…
   4.1 **Sensitivity profiles**: SMRs, Advanced Reactors Designs, PWRs, … LLNL pulsed spheres,…
   4.2 Supporting evaluators with **NDAST calculation**: Perturbation analysis, …
5. Uncertainty Quantification (UQ): Criticality (+NNPP values), decay heat, isotopic inventory, ... due to uncertainties in cross-sections, angular distributions, TSLs, fission yields, …
   5.1 Necessity of **credible ND** uncertainties: processing ND Cov, FYs correlations, Angular distributions,…
   5.2 UQ: Overview of UQ in ICSBEP using **NDAST tool**
   5.3 **TAR Exercise (WPEC/SG46) for HPRL**

2. UPM Activities and Projects in ND

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EUROTRANS (**NUDATRA-DM5**) Nudatra: nuclear data for transmutation (2005-2010)

Accurate Nuclear Data for nuclear Energy Sustainability (**ANDES**) FP7-Fission-2009 –249671 (2010-2013)

Solving Challenges in Nuclear Data (**CHANDA**) FP7-605203. 8 (2013-2018)

Supplying Accurate Nuclear Data for Energy and non-Energy Applications (**SANDA**) EU Project No. 847552. (2019-2023)

“Addressing PRiorities of Evaluated Nuclear Data in Europe (**APRENDE**) EU Project No. 101164596. (2024-2027)

2006 | 2008 | 2010 | 2012 | 2014 | 2016 | 2018 | 2020 | 2022 | 2024 | 2026 | 2028

JEFF-3.1 (2005)

JEFF-3.1.1 (2009)

JEFF-3.1.2 (2011)

JEFF-3.2 (2014)

JEFF-3.3 (2017)

ENDF/B-VIII.0 (2018)

ENDF/B-VIII.1 (2024)

JEFF-4.0 (2025)

“Graduate and Executive Nuclear Training and Lifelong Education” (GENTLE), FP7- 323304. (2013-2016)

GREaT-PIONEeR – Graduate Education Alliance for Teaching the Physics and safety of Nuclear Reactors (2020-2023)

GREaT-PIONEeR (2) (2025-2028)

2. UPM Activities and Projects in ND

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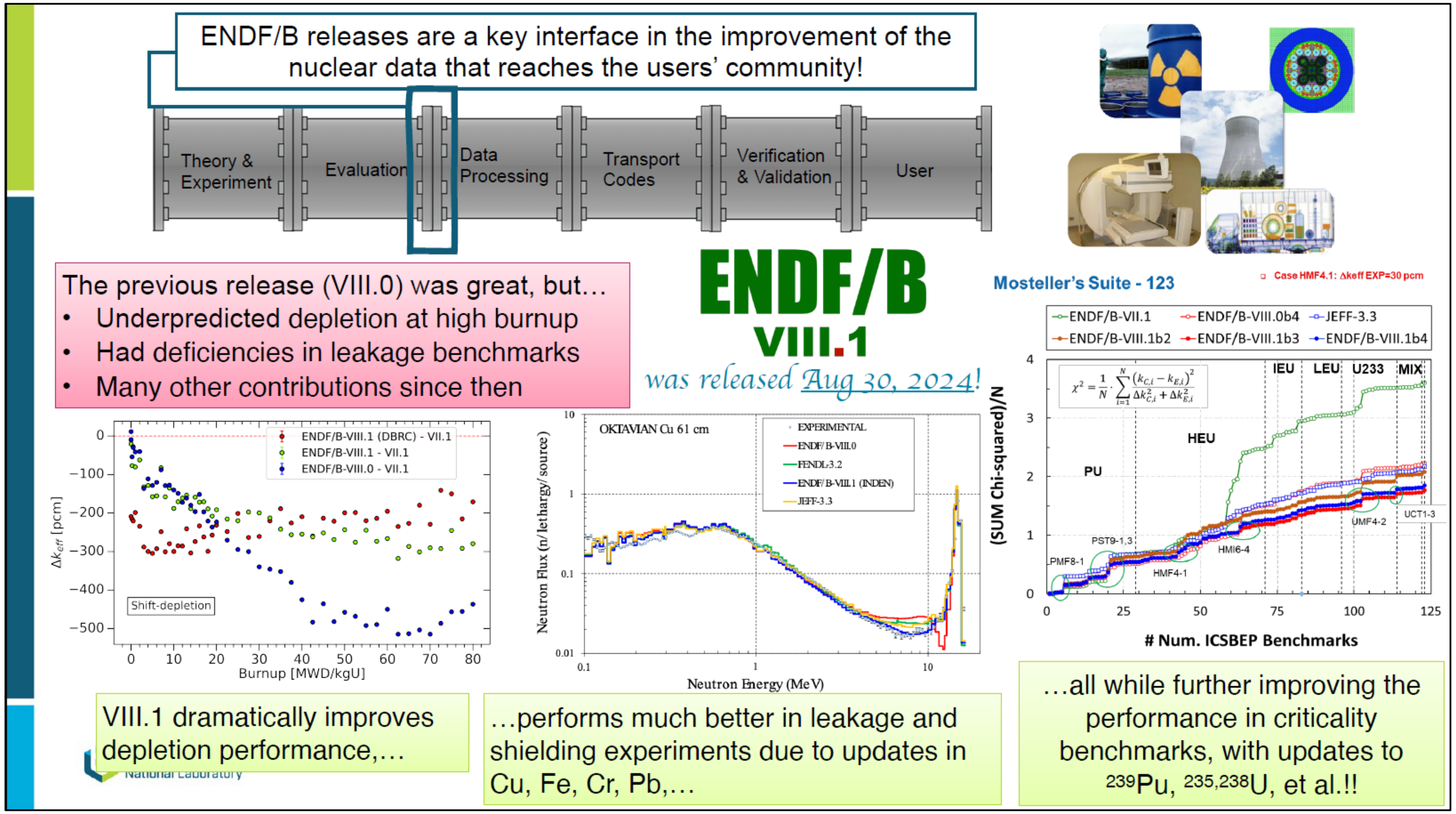

courtesy by G. Nobre
(CSEWG Meeting - November 5-7, 2024)

2006	2008	2010	2012	2014	2016	2018	2020	2022	2024	2026	2028

JEFF-3.1 (2005)
JEFF-3.1.1 (2009)
JEFF-3.1.2 (2011)
JEFF-3.2 (2014)
JEFF-3.3 (2017)
ENDF/B-VIII.0 (2018)
ENDF/B-VIII.1 (2024)
JEFF-4.0 (2025)

2. UPM Activities and Projects in ND

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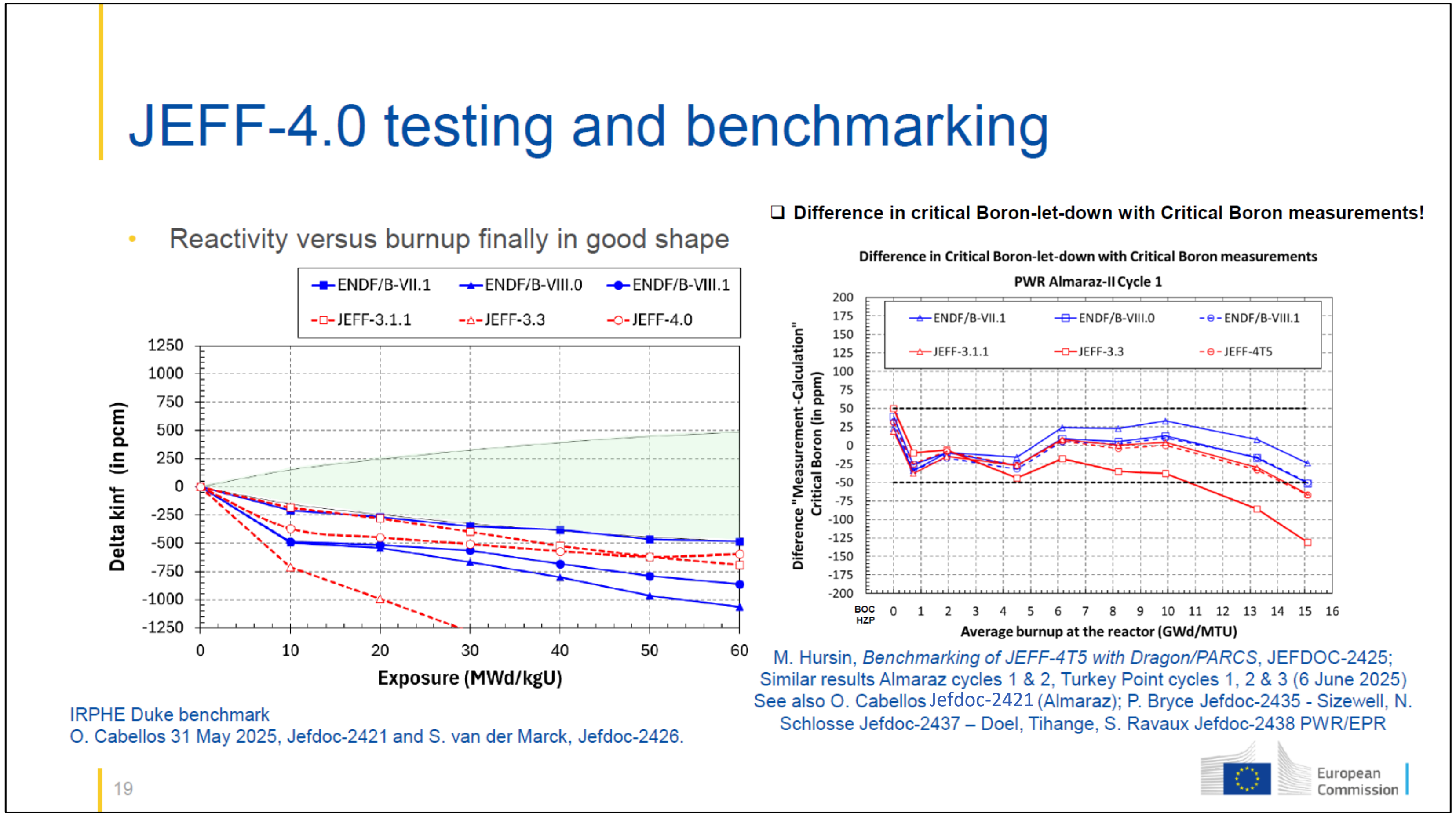

courtesy by A. Plopem (ND2025, June 22-27, 2025)

2006 | 2008 | 2010 | 2012 | 2014 | 2016 | 2018 | 2020 | 2022 | 2024 | 2026 | 2028

JEFF-3.1 (2005)

JEFF-3.1.1 (2009)

JEFF-3.1.2 (2011)

JEFF-3.2 (2014)

JEFF-3.3 (2017)

ENDF/B-VIII.0 (2018)

ENDF/B-VIII.1 (2024)

JEFF-4.0 (2025)

3. UPM Activities in EU/APRENDE

Oscar Cabellos

Nuria García-Herranz

Diana Cuervo

Emilio Castro

Gonzalo F. Garcia-Fernández

Alejandro Marro

Iñigo Gayo

Ismael Manzano

3. UPM Activities in EU/APRENDE

WP	Task	Subtask	Milestone	Leader-UPM	Milestones	Deliverables
WP6. Communication, transnational access, education & training, dissemination & exploitation	Task 6.4 Training of early-stage researchers and scientific visits (M1-M48) Task leader: HZDR. Other participants: USE, UPM, CIEMAT		The objective is to organize 15 scientific visits for early-stage researchers and external senior experts up to 8 weeks length. (D6.5)	O. Cabellos		
	Task 6.5 Organisation of two summer schools (M1-M48) Task leader: USE Other participants: USE, UPM, ESS, HZDR		**Summer School** **“Nuclear data: The path from the detector to the reactor calculation”** (UPM, D6.7) **To be held in June 2027 at UPM , Madrid (Spain)**	O. Cabellos		D6.7 Report on the theoretical school in Madrid (Lead by UPM) (M48)

3. UPM Activities in EU/APRENDE

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WP	Task	Subtask	Milestone	Leader-UPM	Milestones	Deliverable
WP4. Nuclear Data Evaluation	**Task 4.3 Fission yield evaluation** Task leader: CEA Other participants: CEA, UPM, CNRS, SCK, IRSN	*Subtask 4.3.2 Fission yield benchmarking.* Partners: UPM, CEA, CNRS, SCK, IRSN	ENDF-6 evaluated files for the actinides and energies defined in subtask 4.3.1 must be validated on quantities of interest for the user community. The impact of the thermal neutron-induced fission yields evaluations of 233,235U and 239,241Pu will be quantified on reactor observables, based on the expertise of the CEA, UPM and IRSN (MS4.1).	O. Cabellos	MS4.1 Presentation on the validation of the fission yield libraries (M36)	D4.6 Report on the validation of the fission yield libraries (thermal and fast): MYRRHA-like fast systems and thermal systems for decay heat (Lead by CEA) (M42)
	Task 4.4 Cross section evaluation Task leader: CEA Other participants: DES, CEA DAM, NRG, PSI, JSI, EPFL, JRC-Geel, CIEMAT, UU, UPM, SCK, KIT, UBU	*Subtask 4.4.2 File processing and cross section benchmarking*	JSI, SCK and EPFL will perform a series of benchmarks on the reactivity dependence on the burnup for PWR assemblies	O. Cabellos	MS4.3 Presentation of various benchmarks based on new evaluations (M36)	D4.13 Performance report of the pre-release JEFF-4 library (Lead by EPFL) (M46)
		Subtask 4.4.2 File processing and cross section benchmarking	UPM will be processing the complete pre-release of the JEFF-4 library and convert it to standard formats used in simulation codes (MCNP, SCALE, SERPENT) and deliver them to the NEA databank.	O. Cabellos		
			UPM will make recommendations of reliable benchmarks for validating structural and shielding materials (Cu, Fe).			
			For the benchmarking step, different expertise will be applied, taking advantage of the specialization of the different institutes			

3. UPM Activities in EU/APRENDE

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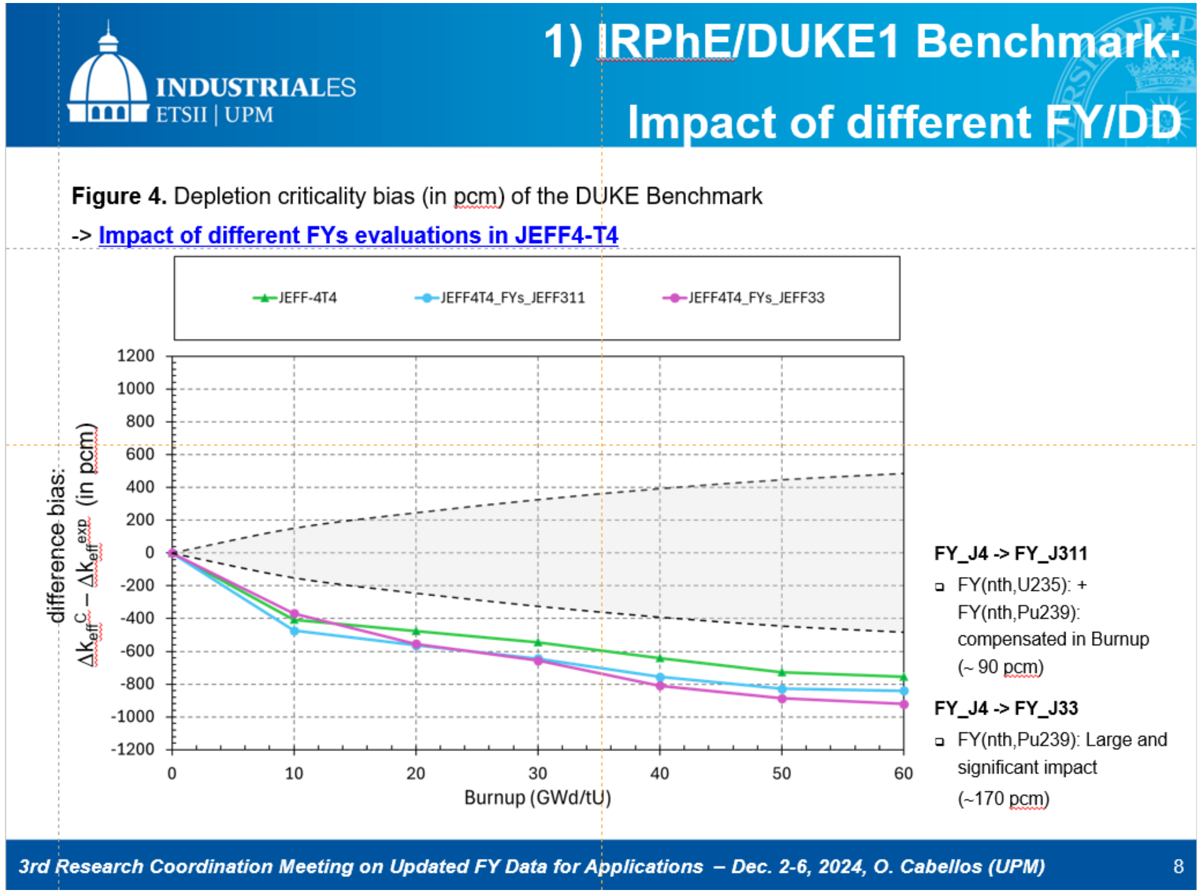

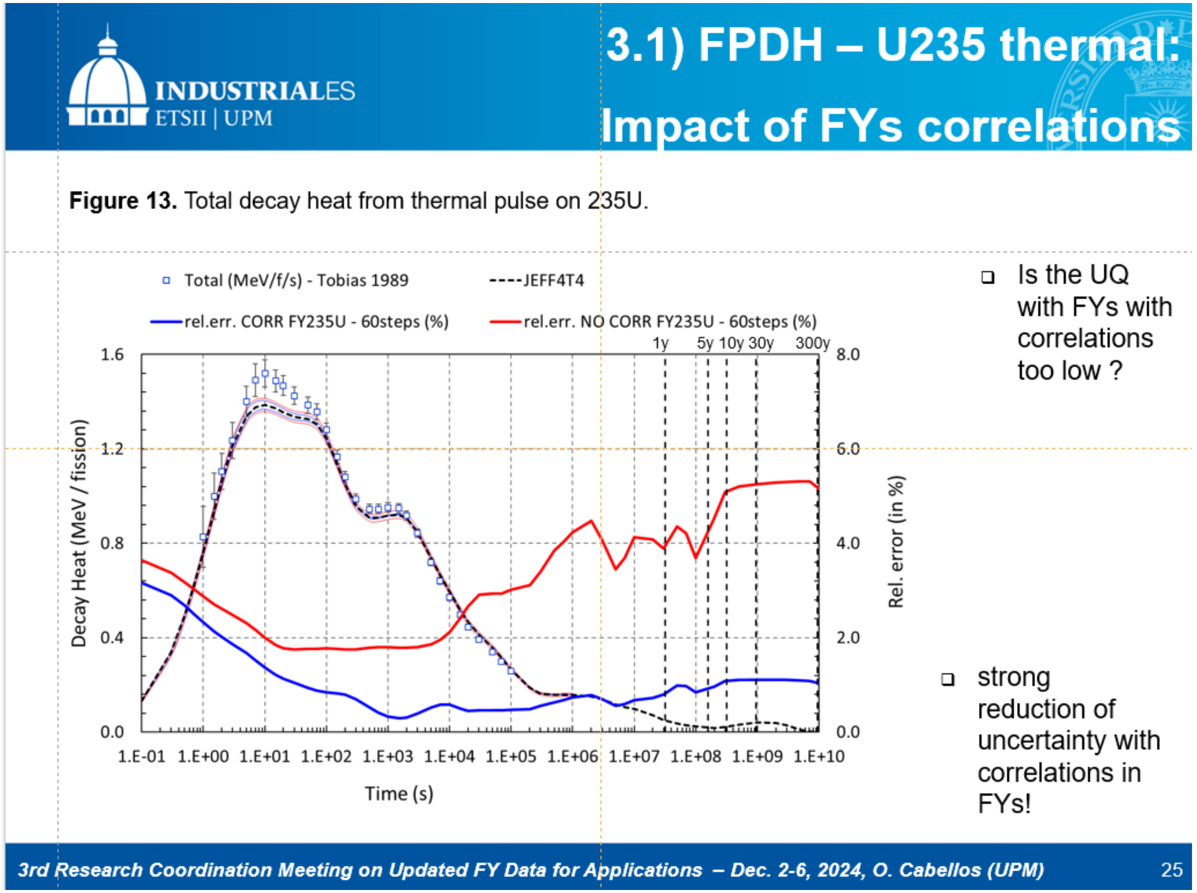

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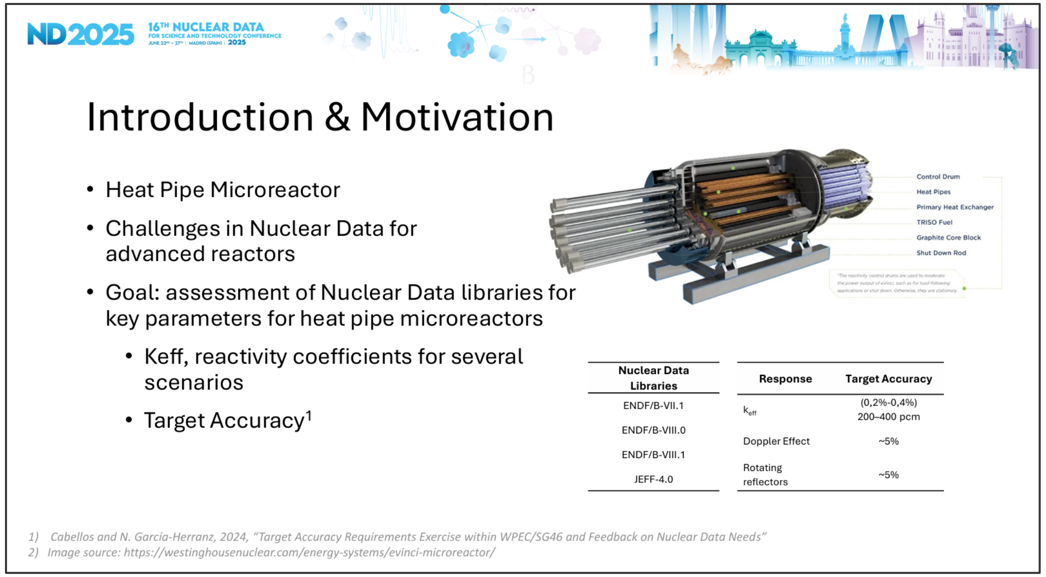
WP	Task	Subtask	Milestone	Leader-UPM	Milestones	Deliverables
WP5. Nuclear data validation, sensitivity analyses and impact studies	Task 5.1. Sensitivity analyses, uncertainty quantification, impact studies. Task leader: CIEMAT Other participants: SCK, STUBA, UPM, UMAR, CNRS, JSI, UKAEA	*Subtask 5.1.1. Sensitivity analyses and priorities for nuclear data improvements*	CIEMAT, UPM, STUBA and CNRS will calculate sensitivity profiles of quantities such as reactivity, Doppler coefficient, spectral indices, dose rates, inventories, decay heat, neutrino emissions and eventually others, to nuclear data for a variety of core models, ranking nuclear data by the importance of the uncertainty contribution. Systems of interest include LWRs with accident tolerant fuels, SFR, GFR, AMR (fast SMR), ADS, MSFR. The focus will be on steady-state equilibrium operating conditions, accounting for fuel depletion	N. García-Herranz, E. Castro	MS5.1 Calculation of sensitivity profiles for ADS, MSR, LWRs, GFR and SFR (M24)	D5.1 Sensitivity analyses and priorities for ND improvements (Lead by CIEMAT) (M48)
			UPM SA will address a non-energy application: neutron activation of concrete shields of proton therapy centres (PTC) (MS5.1 and D5.1).	Gonzalo F. García		
		Subtask 5.1.2. Nuclear data uncertainty propagation in reactor and shielding applications	For power transients, the calculations will use coupled neutronics-thermal hydraulics models to propagate nuclear data uncertainties to power and temperature distributions, reactivity, etc., while accounting for feedback effects and time-dependent phenomena.	Diana Cuervo		D5.2 ND uncertainty propagation in reactor, shielding and advanced fuels (Lead by CIEMAT) (M48)

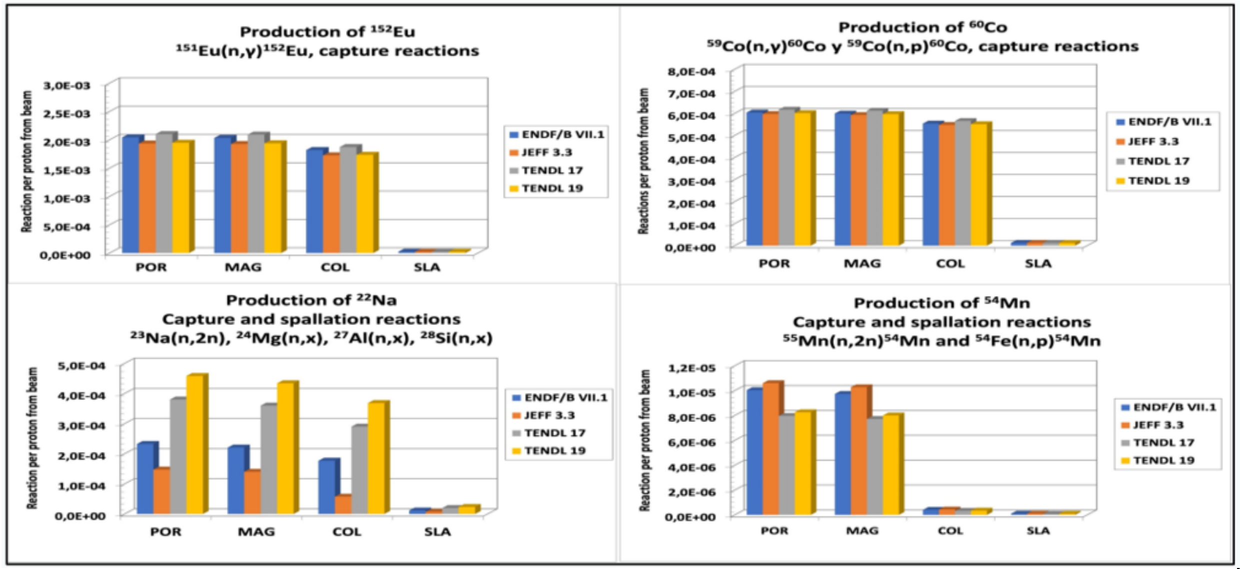
3. UPM Activities in EU/APRENDE

WP	Task	Subtask	Milestone
WP5. Nuclear data validation, sensitivity analyses and impact studies	Task 5.1. Sensitivity analyses, uncertainty quantification, impact studies.	*Subtask 5.1.1. Sensitivity analyses and priorities for nuclear data improvements*	CIEMAT, UPM, STUBA and CNRS will calculate sensitivity profiles of quantities such as reactivity, Doppler coefficient, spectral indices, dose rates, inventories, decay heat, neutrino emissions and eventually others, to nuclear data for a variety of core models, ranking nuclear data by the importance of the uncertainty contribution. Systems of interest include LWRs with accident tolerant fuels, SFR, GFR, AMR (fast SMR), ADS, MSFR. The focus will be on steady-state equilibrium operating conditions, accounting for fuel depletion
			UPM SA will address a non-energy application: neutron activation of concrete shields of proton therapy centres (PTC) (MS5.1 and D5.1).

Nuclear Data Sensitivity Analysis of Key Parameters for eVinci-like Heat Pipes Nuclear Microreactors



Activation in proton therapy centers depending on type of concrete and nuclear data



3. UPM Activities in EU/APRENDE

WP	Task	Subtask	Milestone	Leader-UPM	Milestones	Deliverables
WP5. Nuclear data validation, sensitivity analyses and impact studies	Task 5.2: Analysis of experiments, validation, and data assimilation. Task leader: UPM Other participants: EPFL, UMAR, IRSN, UU, SCK, CEA, STUBA, UKAEA, CIEMAT	*Subtask 5.2.1 Analyses of integral measurements, reactor data*	Integral measurements such as ex-core calculations in SINBAD benchmark H.B. Robinson-2 for comparison of computed neutron spectrum, fast neutron fluence and iron dpa (UPM)	N. García-Herranz	MS 5.3 Results of nuclear data impact studies	D5.3 Analyses of integral measurements, reactor data and correlations between integral data (Lead by UPM) (M48)
		Subtask 5.2.2. Correlations between integral data	Consistency between the data assimilation results using different choices of integral benchmarks (ICSBEP, IRPhEP and SEFOR experiments) and experimental data (k_eff, spectral indices and reactivity coefficients such as coolant voiding, Doppler broadening, or reflector-worth values) will be studied (UPM)	N. García-Herranz		
		Subtask 5.2.3. Assimilation using group-averaged data, derivation of JEFF4 trends	In addition, one outcome of these techniques will be the prioritization of new experiments which will be added to the HPRL with the corresponding Target Accuracy Requirement (TAR) calculations (UPM, SCK) (D5.4).	O. Cabellos		D5.4 Assimilation techniques for the derivation of ND trends (Lead by UPM) (M48)

3. UPM Activities in EU/APRENDE

WP	Task	Subtask	Milestone
WP5. Nuclear data validation, sensitivity analyses and impact studies	Task 5.2: Analysis of experiments, validation, and data assimilation.	*Subtask 5.2.1 Analyses of integral measurements, reactor data*	Integral measurements such as ex-core calculations in SINBAD benchmark H.B. Robinson-2 for comparison of computed neutron spectrum, fast neutron fluence and iron dpa (UPM)

On the potential of H.B. Robinson-2 benchmark for nuclear data validation

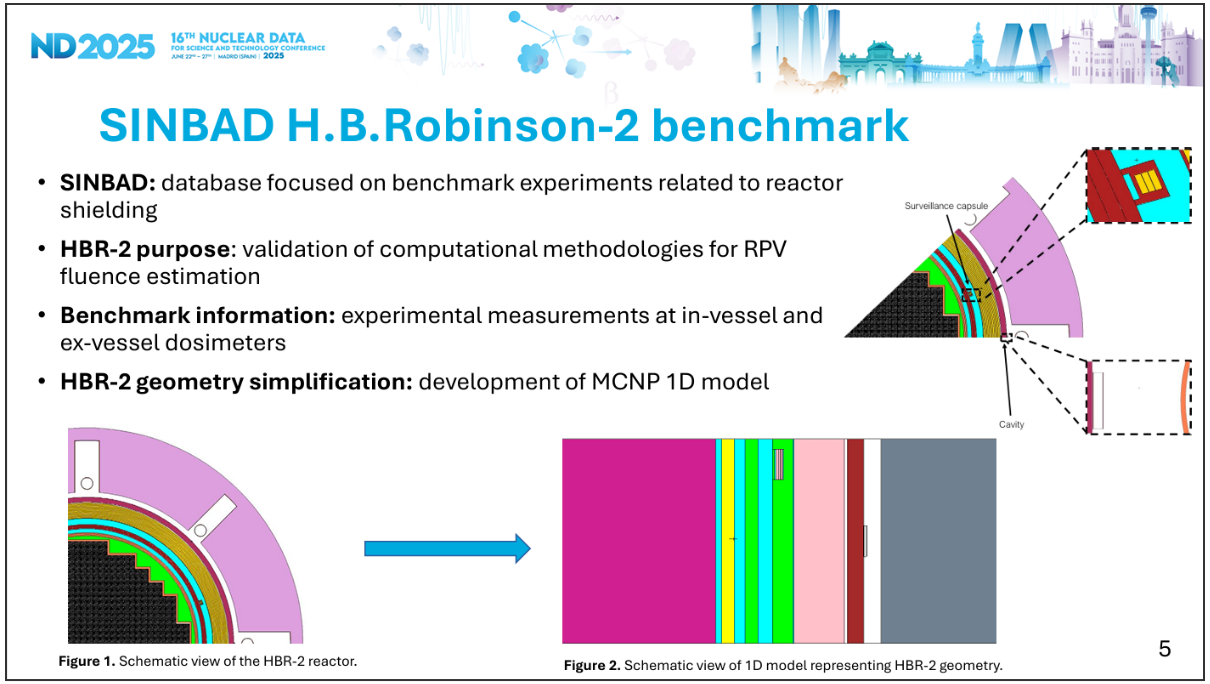
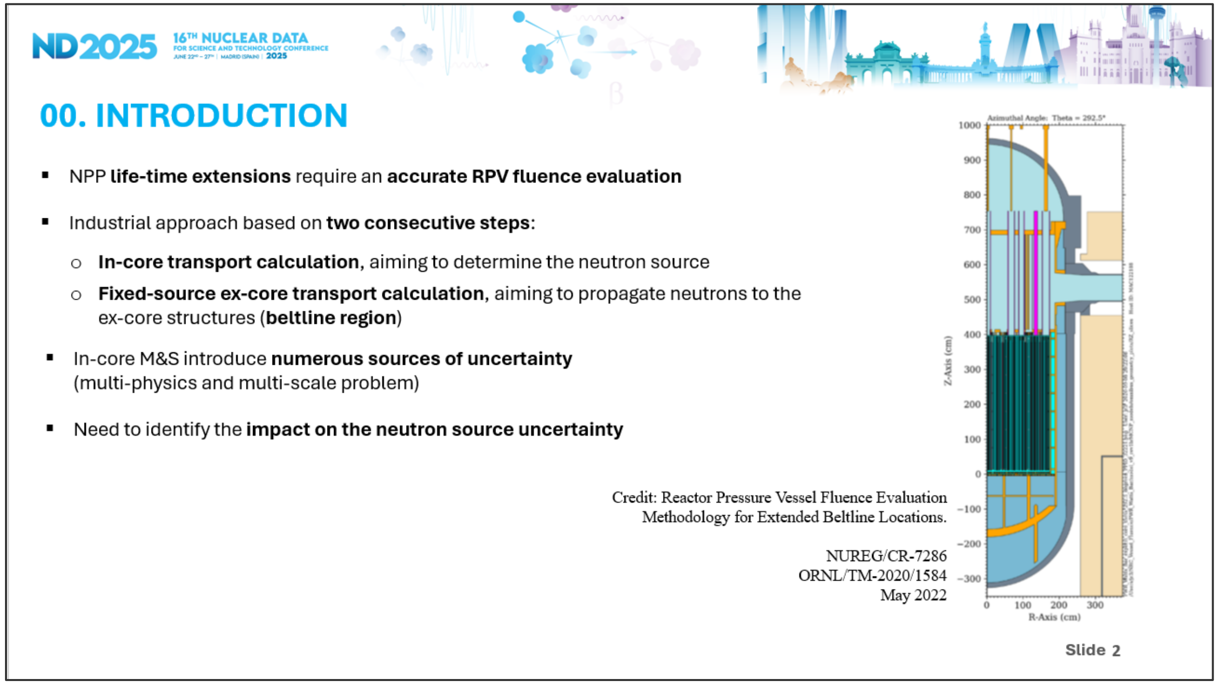


Figure 1. Schematic view of the HBR-2 reactor.

Figure 2. Schematic view of 1D model representing HBR-2 geometry.

Nuclear Data Validation Using LWR Measurements: Insights from the OECD/NEA TVA-WB1 Benchmark



3. UPM Activities in EU/APRENDE

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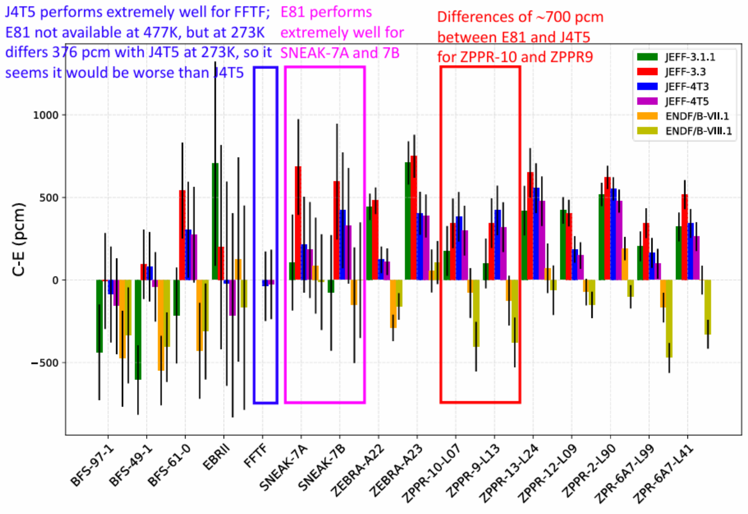
WP	Task	Subtask	Milestone
WP5. Nuclear data validation, sensitivity analyses and impact studies	Task 5.2: Analysis of experiments, validation, and data assimilation.	*Subtask 5.2.2. Correlations between integral data*	Consistency between the data assimilation results using different choices of integral benchmarks (ICSBEP, IRPhEP and SEFOR experiments) and experimental data (k_eff, spectral indices and reactivity coefficients such as coolant voiding, Doppler broadening, or reflector-worth values) will be studied (UPM)

Evaluating JEFF4T5 for the modelling and simulation of liquid metal fast reactors, JEFDOC-2433

C–E results for k-eff



- JEFF4T5 improves biases with respect to JEFF3.3 (strongly) and JEFF4T3 (slightly) except EBRII (but within σ_{exp})
- JEFF4T5 tends to overestimate k-eff in MOX-fueled benchmarks …
- … with opposite biases with respect to ENDF/B-VIII.1

Analysing Differences of Evaluated ND for 235U, 238U, and 239Pu in the Fast Energy Region with a Focus on Angular Distributions

ND2025 16TH NUCLEAR DATA FOR SCIENCE AND TECHNOLOGY CONFERENCE 2025

Background: Good performance of ND libraries for small fast energy systems

- ❑ Since overall, biases (C-E) predicted with different evaluations lie within 1σ-Benchmark exp. unc. except for ZEBRA-8H Benchmark

Table 1. Summary of deviation (C-E) values (in pcm) in comparison with the 1σ-Benchmark exp. unc.

Case/nickname	1σ keff exp. unc.	ENDF/B-VIII.0	ENDF/B-VIII.1	JEFF-3.3	JEFF-4.0
Godiva	100	5	0	20	-93
Flattop-25	160	90	90	401	-33
Jezebel	110	74	13	21	78
Flattop-Pu	300	-19	2	340	39
BIG TEN	70	-30	0	38	5
ZEBRA-8H	240	-666	-585	-370	-605

JEFF Nuclear Data Week, 14-19 April 2025, JEFDOC-2433

3. UPM Activities in EU/APRENDE

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Analysing Differences of Evaluated ND for 235U, 238U, and 239Pu in the Fast Energy Region with a Focus on Angular Distributions
ND-2025, INDEN/ACT-2025 and PHYSOR-2026

(1) The MT4 – "inelastic scattering's Puzzle" in Godiva for 235U …. it is solved using SED (secondary energy distributions) !

Example of Perturbation Calculation: "in Godiva"

Table 6. Comparison of calculations using substitutions of nuclear data and perturbation with sensitivities in 235U

$$\frac{\Delta k_{eff}}{k_{eff}} = \sum_{x=(n,n')} \sum_{g=1}^{33} S^{x}_{g,ENDF} \cdot \frac{\sigma_g^{x,E80} - \sigma_g^{x,J33}}{\sigma_g^{x,J33}}$$

Quantity	My Work with MCNP substitutions of ND (JEFFDOC-2413, April 2025)	J33 -> E80 Perturbation with JEFF-3.3 Sensitivities (33g)	J33 -> E80 Perturbation with ENDF/B-VIII.0 Sensitivities (33g)
nubar	125	140	146
Resonances (MF2)	-24	-	-
n,gamma	152	165	124
n,2n	-58	-46	-33
n,elastic (MF3/MT2) + MF4/MT2	-35	-	-
n,inelastic (MF3/MT51…MT91) +MF4+MF6	-387	-	-
CHI	89	-	-
n,fission	84	104	104
Sum ALL Perturbations (in pcm)=	-54		
Diff Full libraries (in pcm)=	-20		
Comparison for elastic & inelastic XSs:			
n,elastic (MF3/MT2)	-87	-86	-92
n,inelastic (MF3/MT4)	-245	16	33
n,inelastic as sum of MF3/MT51…MT91		-369	97716*

Work presented in JEFFDOC-2413, April 2025

NOTE: lack of sensitivities for angular distributions

NOTE: lack of sensitivities for CHI

(1) The MT4 - "inelastic scattering's Puzzle"

* **NOTE:** "wrong" sensitivity causes the unreasonably huge values.

IAEA/NDS 2025 14

3. UPM Activities in EU/APRENDE

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Analysing Differences of Evaluated ND for 235U, 238U, and 239Pu in the Fast Energy Region with a Focus on Angular Distributions
ND-2025, INDEN/ACT-2025 and PHYSOR-2026

(2) No negligeable IMPACT of SAD (secondary angular distributions) in inelastic in Godiva for 235U

Example of Perturbation Calculation: "in Godiva"

Table 7. Comparison of calculations using substitutions of nuclear data and perturbation with sensitivities in 235U

		J33 -> E80
Quantity	**My Work with MCNP** substitutions of ND	$\frac{\Delta k_{eff}}{k_{eff}} = \sum_{x=(n,n')} \sum_{g=1}^{33} S_{g,ENDF}^{x} \cdot \frac{\sigma_g^{x,E80} - \sigma_g^{x,J33}}{\sigma_g^{x,J33}}$ Perturbation with **JEFF-3.3 Sensitivities** (70g)
nubar	129	130
n,gamma	160	162
n,2n	-53	-27
n,elastic (MF3/MT2) + MF4/MT2	**-16**	MF3(-84) + SAD (+35) = -49
n,inelastic (MF3/MT51...MT91) +MF4+MF6	**-374**	SED (-282) + ?SAD?
CHI	84	103
n,fission	99	103
Sum ALL Perturbations (in pcm)=		
Diff Full libraries (in pcm)=		

Comparison for elastic & inelastic XSs:		
n,elastic (MF3/MT2)	-90	-84
n,inelastic (MF3/MT4)	-234	22
n,inelastic as sum of SED		SED (-282)

(2) No negligeable IMPACT of "SAD - inelastic"

Work presented in ND2025, June 2025

Sensitivity Analysis for Perturbation Analysis:

- **For Elastic**
  - XS + SAD is fine
  - SED is not needed
- **For Inelastic**
  - XS (MT4) is not good
  - SED is needed
  - SAD is not working

IMPACT of the "inelastic scattering's Puzzle" for the Nuclear Data Adjustment?

IAEA/NDS - Technical Meeting of the International Nuclear Data Evaluation Network (INDEN) on Nuclear Data Evaluation of Fissile Actinides. December 8-12, 2025 15

3. UPM Activities in EU/APRENDE

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Analysing Differences of Evaluated ND for 235U, 238U, and 239Pu in the Fast Energy Region with a Focus on Angular Distributions
ND-2025, INDEN/ACT-2025 and PHYSOR-2026

(3) No negligeable IMPACT of SAD in elastic in Godiva for 238U

Impact of SAD in the elastic scattering

(3) No negligeable IMPACT of "SAD - elastic" for the Nuclear Data Adjustment.

- **Sensitivities for angular distributions: P1, P2 and P3**

Table 10. Summary of JEFF-3.3 (J33) and ENDF/B-VIII.0 (E80) deviations (C -E) values (in pcm) caused by **238U elastic angular distributions**

Δkeff (C-E) in pcm	Godiva	Flattop -25	Jezebel	Flattop-Pu	BIG TEN	Zebra-8H
"U8_J3_MF3MT2_E80" – J33	-32	-300		-324	-236	12
"U8_J3_MF3MT2_MF4MT2_E80" – J33	-44	-597		-606	-452	47
Sum of elastic sensitivities: MF3/MT2+MF4/MT2	-28	-593	0	-577	-439	19
Sensitivities-> (n,elastic) MF3/MT2	-15	-320	-	-309	-233	15
Sensitivities-> (n,elastic): MF4/MT2	-13	-273	0	-268	-206	4
	P1=-13	**P1=-319**	P1=	**P1=-340**	**P1=-207**	P1=6
	P2=1	**P2=53**	P2=	**P2=90**	P2=2	P2=-3
	P3=0	P3=-7	P3=	P3=-19	P3=-1	P3=1

3. UPM Activities in EU/APRENDE

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Analysing Differences of Evaluated ND for 235U, 238U, and 239Pu in the Fast Energy Region with a Focus on Angular Distributions
ND-2025, INDEN/ACT-2025 and PHYSOR-2026

(4) Uncertainty Quantification: For some reactions, the deviations in the evaluations are larger than the associated uncertainties

Uncertainty Quantification

- **Uncertainty Quantification including 235U, 238U and 239Pu**

Table 11. Summary of results including the bias, the experimental benchmark uncertainties and calculated uncertainties caused by nuclear data covariances (in pcm).

		Godiva	Flattop-25	Jezebel	Flattop-Pu	BIG TEN	Zebra-8H
Benchmark	Exp. Unc. (pcm)	100	300	110	300	70	240
JEFF4.0	Bias (C-E)	-93	-33	78	39	5	-605
	ND uncert	1366	1483	689	1036	1829	**2231**
ENDF/B-VIII.0	Bias (C-E)	5	90	74	-19	-30	-666
	ND uncert	1039	1087	1009	1050	1044	1424
ENDF/B-VIII.1	Bias (C-E)	0	90	13	2	0	-585
	ND uncert	1020	980	732	719	1006	1328

- It seems a general overestimation in keff-uncertainty due to ND uncertainties
- Does it true for all/individual nuclear reactions?

IAEA/NDS - Technical Meeting of the International Nuclear Data Evaluation Network (INDEN) on Nuclear Data Evaluation of Fissile Actinides. December 8-12, 2025

Table. Main contributions (> 100 pcm) to the JEFF-3.3 ("J33") vs ENDF/B-VIII.0 ("E80") multiplication factor deviations in pcm.
Comparison with uncertainties from the nuclear covariance data (values in pcm)

Case	Main contributor	E80/J33* Substitution MF/MT	E80/J33 Perturbation S/A	JEF-3.3 =JEFF-4.0 uncertainty	ENDF/B-VIII.0 uncertainty	ENDF/B-VIII.1 uncertainty
Godiva	U235(n,n')	-234	22	695	236	236
Flattop-25	U238(n,n')	430	440	444	282	282
	U238(n,n)	-300	-320	141	354	354
	U235(n,n')	-255	-49	324	100	100
	U238(n,gamma)	-182	-198	129	80	80
Jezebel	Pu239(n,n')	742	773	131	679	578
	Pu239(n,n)	-339	-337	101	528	393
	Pu239(n,chi)	189	189	509	217	95
Flattop-Pu	U238(n,n')	349	382	453	266	266
	U238(n,n)	-324	-309	125	342	342
	Pu239(n,n')	254	274	43	236	191
	Pu239(n,chi)	199	180	553	232	100
	U238(n,gamma)	-157	-166	110	67	67
	Pu239(n,n)	-141	-128	35	201	156
BigTen	U238(n,gamma)	-970	-985	614	396	396
	U238(n,n')	490	501	506	267	267
	U238(n,n)	-236	-233	126	262	262
	U238(n,fission)	211	216	390	178	178
ZEBRA-8H	U238(n,gamma)	-1463	-1456	860	583	582
	U235(n,gamma)	327	320	446	299	299
	U238(n,fission)	207	229	394	182	182
	U235(n,n')	127	38	136	43	43
	U238(n,n')	-39	-207	1326	786	786

3. UPM Activities in EU/APRENDE

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Analysing Differences of Evaluated ND for 235U, 238U, and 239Pu in the Fast Energy Region with a Focus on Angular Distributions
ND-2025, INDEN/ACT-2025 and PHYSOR-2026

(5) Large uncertainties due to MF34/P1 they are not negligible. What's the impact on the NDA if it is neglected?

Uncertainty Quantification

(5) Large uncertainties due to MF34/P1
they are not negligible
What's the impact on the NDA ?

- **Uncertainty Quantification: Angular Distributions (MF34) …** NOTE: This is only for P1

Table 14. Summary of keff-uncertainties results using covariances of nuclear data in **MF34**

		Godiva	Flattop-25	Jezebel	Flattop-Pu	BIG TEN	Zebra-8H
ENDF/B-VIII.0	U235	422	162	0	2	13	4
	U238	17	366	0	469	163	7
	Pu239	0	0	161	63	0	0
	Summ All=	422	400	161	473	163	9
ENDF/B-VIII.1	U235	225	87	0	1	9	2
	U238	9	191	0	218	108	3
	Pu239	0	0	161	63	0	0
	Summ All=	**225**	**210**	**161**	**226**	**108**	**3**

4. Future and Challenges in JEFF-4.1

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See F. Michel-Sendis talk in P(ND)²-2, 2014
(https://www.oecd-nea.org/science/meetings/pnd22/presentations/2-MICHEL-SENDIS.pdf)

Motivations for "JEFF-4"

JEFF-4 (4Cs?): Completeness, Consistency, Covariance and Credibility (by R. Jacqmin)

- *"Next decade" : JEFF-4 after 2020 ?*
- *Leap forward warrants a change : JEFF "Business as usual" practices will not meet the qualitative leap needed.*

Motivations for "JEFF-4.1" … evolving the 4Cs toward 2030-2035

An example, to supporting SMR deployment

Completeness → **Application-Relevant Completeness**
Coverage focused on what matters most for advanced reactor applications

Consistency → **Integral-Consistent Evaluation**
Data that are physically coherent and reproduce relevant integral benchmarks

Covariance → **Decision-Ready Covariance**
Uncertainty information that directly supports reliable design decisions

Credibility → **Licensing-Oriented Confidence**
Demonstrated performance in benchmarks representative of target systems

5. Conclusion… final reflections

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- **How do we learn from the past activities?**
  - CASE1: Pu-239 evaluation at thermal energies in JEFF-3.3 - hidden issues emerging from PST-034 benchmarking**… we need AI/ML!**
  - CASE 2: Burnup issue in JEFF-3.3 - hidden issues from TMI pin-cell burnup… **we need expert judgment** (by e-mail A. Santamarina , 2016)!
  - CASE 3: How to improve discussions between evaluators (CIELO/SG40, INDEN, …) and users (WPEC/SG39, SG46,…- Nuclear data adjustment) for improvement of nuclear data files – WPEC/SG52?

- **Other issues that may affect future nuclear data evaluations, of course, my personal view…**
  - A risk is the low compilation rate of experimental data in EXFOR… see following websites
    - https://nds.iaea.org/exfor-master/x4compil/exfor_input.htm: The table shows updated EXFOR entries per year
    - https://nds.iaea.org/nrdc/alloc/: The table at the top shows EXFOR entries since the last NRDC meeting
  - Some final reflections:
    - The era of AI/ML … how do we integrate these tools into the evaluation of nuclear data?
    - The era of Open Science… how do we promote transparency while preserving strategic autonomy in codes and data?
    - The era of global collaboration …. are we losing dedicated technical spaces for nuclear data discussion & dissemination?

Thank you !

ANNEX I: "Pu-239 evaluation at thermal energy in JEFF-3.3"

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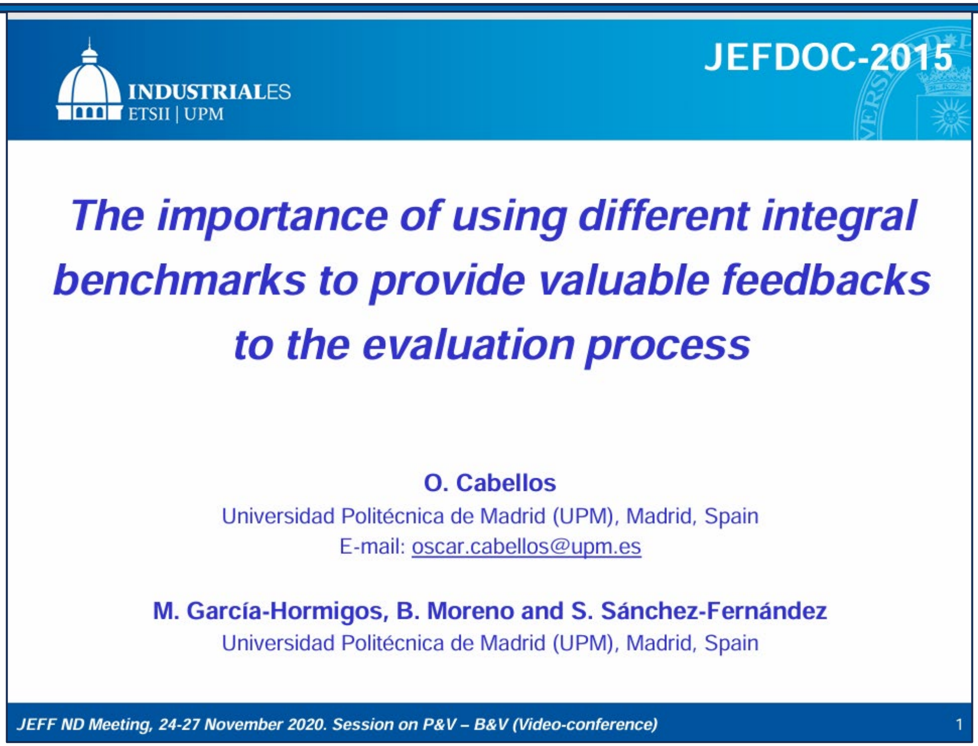
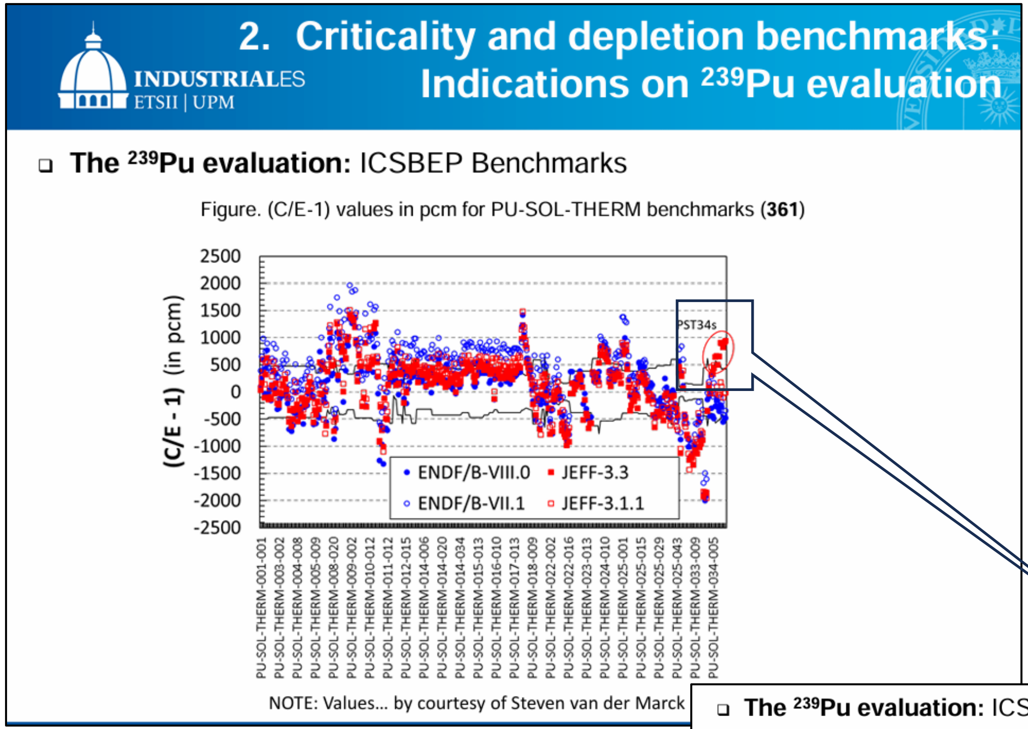
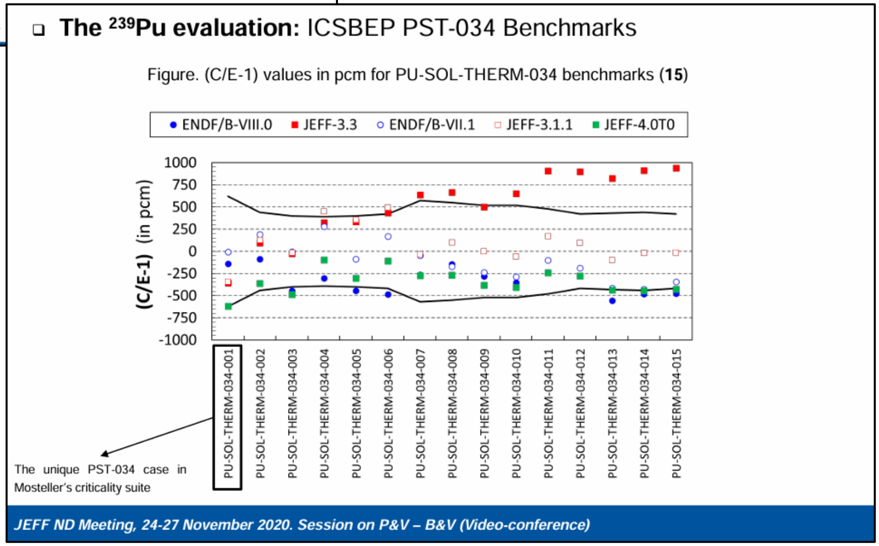
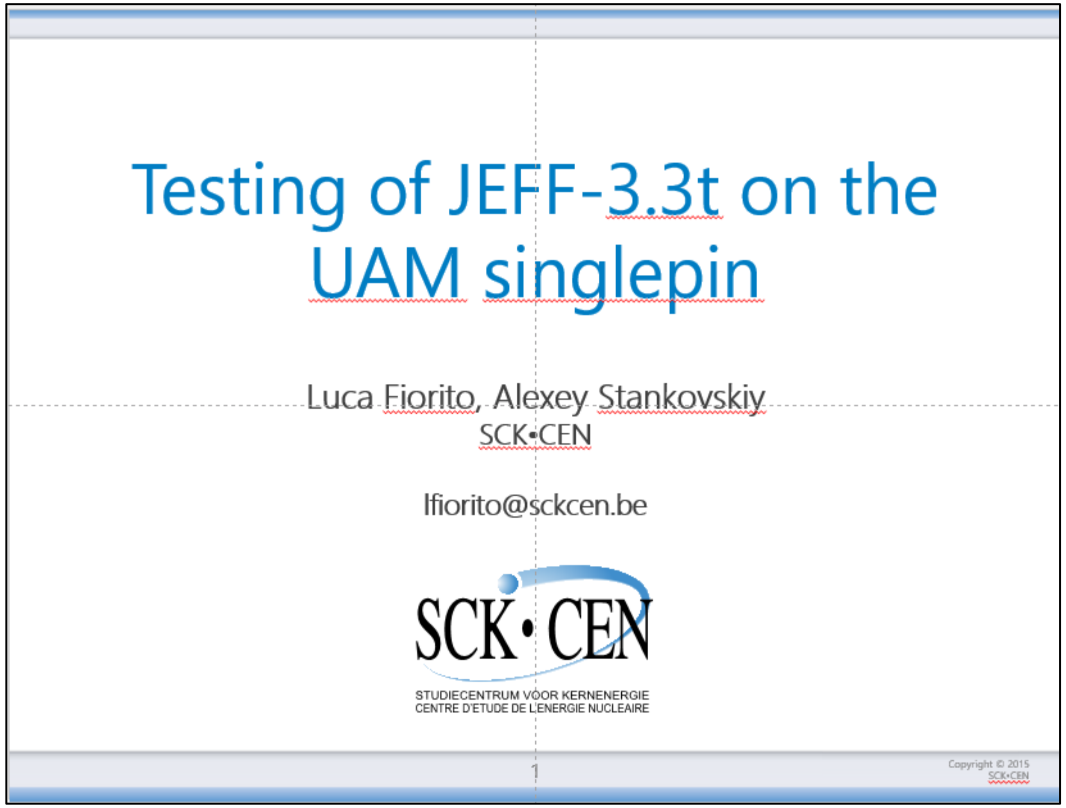


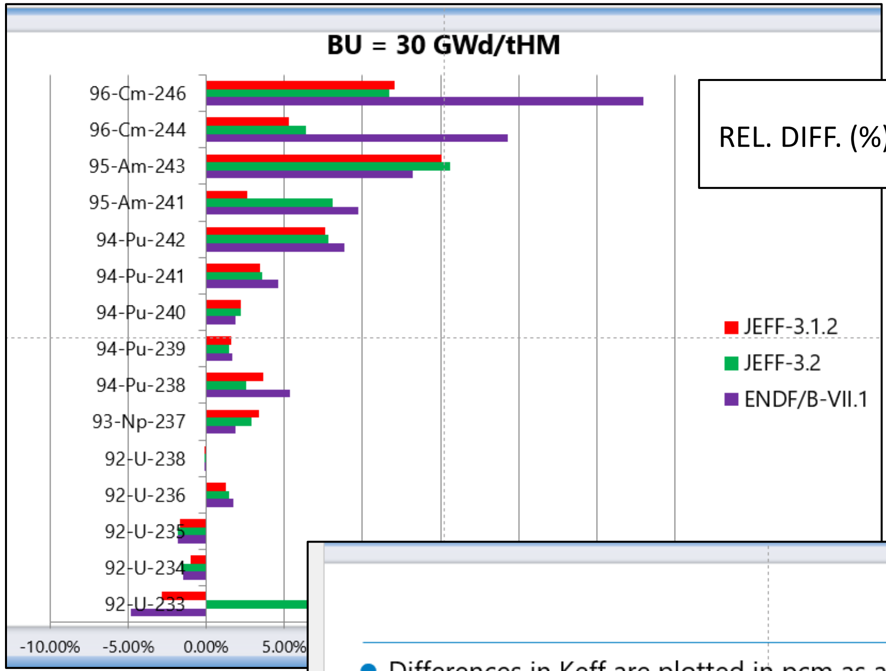




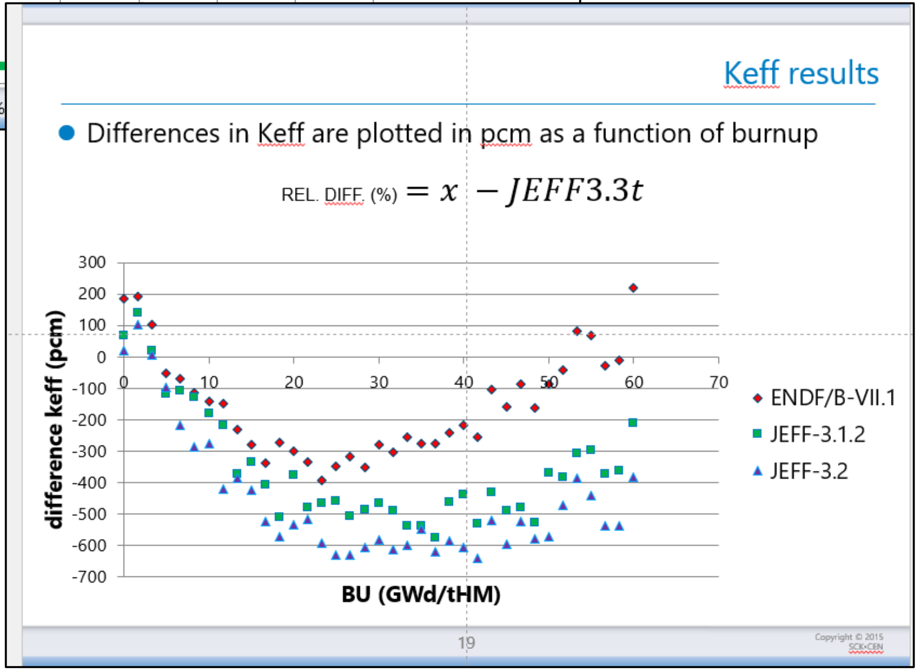
- **CASE1: "Pu-239 evaluation at thermal energy in JEFF-3.3"…hidden issues within PSTs benchmarking … we need help provided by AI/ML!**

ANNEX II: “Burnup issue in JEFF-3.3”





$$\text{REL. DIFF. (\%)} = \frac{x - JEFF3.3t}{JEFF3.3t}$$



27 April 2016 … (JEFF-3.3 is released in Nov 2027)

- Lack of JEFF partners working in burnup, only SCK·CEN
- B&V work mainly devoted to criticality in ICSBEP
- Significant changes in major isotopes in the last JEFF-3.3T versions

○ **CASE 2: “Burnup issue in JEFF-3.3”… we need expert judgment !**

ANNEX II: "Burnup issue in JEFF-3.3"

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-----Message d'origine-----
De : Oscar.Cabellos@oecd.org [mailto:Oscar.Cabellos@oecd.org] Envoyé : vendredi 29 avril 2016 12:08 À : SANTAMARINA Alain 081917 Objet : RE: Burnup calculations with JEFF33T1
Dear Alain
Thanks a lot for your comments on this presentation. I have included your comments in the session of JEFF/CG and they are appreciated very much your comments.
Most of the times the impact on burnup calculations is forgotten in the Benchmarking phase before release a new library. From my point of view, these calculations are important to complete the general performance of the library.
Thanks again!! I will keep you informed on new steps in the benchmarking of JEFF-3.3T2.
My best regards
Oscar Cabellos, Ph.D.
Nuclear Data Scientist, NEA Data Bank

-----Original Message-----
From: SANTAMARINA Alain 081917 [mailto:alain.santamarina@cea.fr]
Sent: 28 April 2016 11:44 AM
To: CABELLOS Oscar, NEA/DB
Subject: RE: Burnup calculations with JEFF33T1

Dear Oscar,
This actinide build-up with burnup in JEFF3.3T is fully wrong in my opinion : From all the French PIEs, it is clear that the current Pu isotopic content is correct with JEFF3.1.1 (or JEFF3.1.2). On the contrary, Pu238 is in the wrong direction for JEFF33, and all the other Pu isotopes are clearly underestimated (as well as U236) for current LWR burnups in this presentation
Kind regards
Alain

-----Message d'origine-----
De : Oscar.Cabellos@oecd.org [mailto:Oscar.Cabellos@oecd.org] Envoyé : mercredi 27 avril 2016 08:27 À : SANTAMARINA Alain 081917 Objet : Burnup calculations with JEFF33T1

Dear Alain
Sorry for disturb you**, I need your advice and comments** about the attached presentation.
We are in the JEFF meeting, and your comments will be very much appreciated.
Could you conclude something from the new JEFF33T1 library comparing the data from other evaluations?
My best regards
Oscar Cabellos
NEA Data Bank

Acknowledgments

*This work is part of the APRENDE project (****A****ddressing* ***PR****iorities of* ***E****valuated* ***N****uclear* ***D****ata in* ***E****urope) that has received funding from the European Union's HORIZON-EURATOM under grant agreement No. 101164596*

European Commission

APRENDE

ANNEX III: UPM Activities in EU/APRENDE

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October 2024 – March 2026

CSEWG

[1] O. Cabellos, “ENDF/B-VIII.1 Covariance Testing”, CSEWG Meeting November 4-8, 2024

IAEA

[2] O. Cabellos, “Some User' Feedbacks and Potential new Demands”, IAEA TM on Nuclear Data Retrieval, Dissemination, and Data Portals – November 11-5, 2024

[5] O. Cabellos, “Benchmarking and validation of 235U(nth,f) and 239Pu(nth,f) JEFF-4 fission yield evaluations. Uncertainty quantification using new correlation matrices”, 3rd Research Coordination Meeting on Updated FY Data for Applications – December. 2-6, 2024

[6] O. Cabellos, “Benchmark of evaluation changes in 232Th, 233U, 235U and 239Pu”, Technical Meeting of INDEN on ND Evaluation of Fissile Actinides – December 9-13, 2024

JEFF Meetings

[3] O. Cabellos, “Assessing the Impact of JEFF-4T4 FY (Correlations) in Depletion Calculations”, JEF/DOC-2373, JEFF November Meeting “Fission Observables Session” – November 25-28, 2024

[4] O. Cabellos, N. Otsuka, L. leal, “A Tentative Evaluation of 233U Neutron Capture Cross-Section in keV Energy Region”, JEF/DOC-2377, JEFF November Meeting “Evaluation Session” – November 25-28, 2024

[7] O. Cabellos, I. Kodeli, W. Zwermann, I. Hill, N. Garcia-Herranz, “Review on Compensating Effects in keff: The Importance of the Sensitivities to the Secondary Energy Distributions of the Inelastic Scattering”, JEF/DOC-2413, JEFF Nuclear Data Week - Evaluation Session, April 15, 2025

[8] O. Cabellos, “Feedbacks on Processing and Benchmarking for JEFF4-T5 (official release February 27th, 2025)”, JEF/DOC-2421, JEFF Nuclear Data Week - Evaluation Session, April 14-18, 2025

[9] N. García-Herranz, O. Cabellos, A. Jiménez-Carrascosa, W. Zwermann, Evaluating JEFF4T5 for the modelling and simulation of liquid metal fast reactors (updating JEFDOC-2352), JEFF Nuclear Data Week, 14-19 April 2025, JEFDOC-2433

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16th Nuclear Data for Science and Technology Conference (ND2025), Madrid, (Spain), June 22-27, 2025.

[10] G. F. Garcia-Fernández, N. García-Herranz, O. Cabellos, “Activation in proton therapy centers depending on type of concrete and nuclear data”

[11] O. Cabellos, M. Cotelo, D. Cuervo, G.F. García, N. García-Herranz, E. Oliva, “Nuclear data Education and Training at the Universidad Politécnica de Madrid: The CDIO/INGENIA-NUCLEAR Experience and the Active Learning/GreatPioneer Project”

[12] O. Cabellos, I. Kodeli, W. Zwermann, I. Hill, N. Garcia-Herranz, “Analysing Differences of Evaluated Nuclear Data for 235U, 238U, and 239Pu in the Fast Energy Region with a Focus on Angular Distributions”

[13] Nuria García-Herranz, Oscar Cabellos, Emilio Castro, Ian Hill, David Sauvan, “Towards establishing experimental correlations among criticality experiments for reliable data assimilation studies”

[14] Alejandro Marro, Nuria García-Herranz, Emilio Castro, Oscar Cabellos, Kostadin Ivanov, “On the potential of H.B. Robinson-2 benchmark for nuclear data validation”

[15] Ismael Manzano, Nuria García-Herranz, Oscar Cabellos, Emilio Castro , “Nuclear Data Sensitivity Analysis of Key Parameters for eVinci-like Heat Pipes Nuclear Microreactors”

[16] Iñigo Gayo, Emilio Castro, Oscar Cabellos, Nuria García-Herranz, Diana Cuervo, Kostadin Ivanov, “Nuclear Data Validation Using LWR Measurements: Insights from the OECD/NEA TVA-WB1 Benchmark”

NRDC-2025

[17] O. Cabellos, “Some User' Feedbacks and Potential new Demands”, NRDC-2025 Meeting, Madrid (Spain) June 19, 2025.

PHYSOR-2026

[18] O. Cabellos, N. García-Herranz, I. Hill, I. Kodeli, W. Zwermann, “Impact of Nuclear Data Uncertainties of 235U, 238U, and 239Pu in Benchmarks Representative of Small Fast Reactors”, PHYSOR 2026 - The International Conference on Physics of Reactors · Torino, Italy · April 19 – 23, 2026

SNE-2025

[19] D. Cuervo, M.N. Avramova M.N., A. Abarca A.SEFOR experiment case modelling: first step to S/U in SFR transient analysis using CTF at the APRENDE project, SNE 2025.reunión Annual Sociedad Nuclear Española, Cáceres España. September 25, 2025