The European Commission's science and knowledge service

Joint Research Centre

European
Commission

The Joint Evaluated Fission and Fusion (JEFF) Nuclear Data Library

Arjan Plompen

OECD-NEA, WPEC, June 2019

核数据2019

2019 International Conference on Nuclear Data for Science and Technology

May 19-24, 2019 · China National Convention Center · Beijing

European Commission

Contents

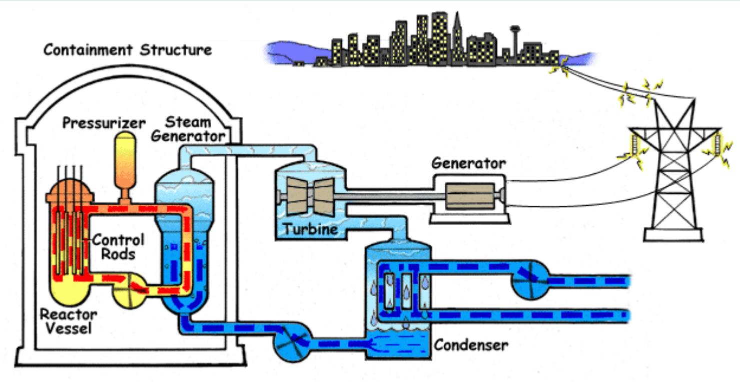
- JEFF-3.3
- JEFF-4.0 directions

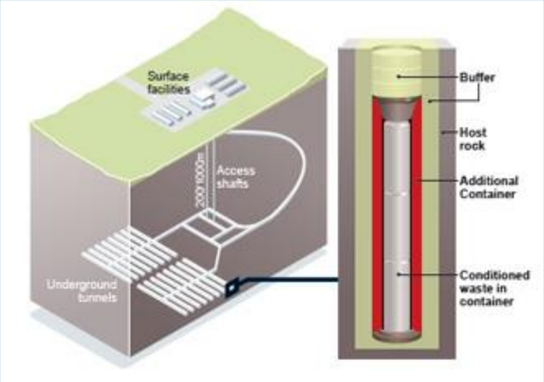
Nuclear data and applications of JEFF

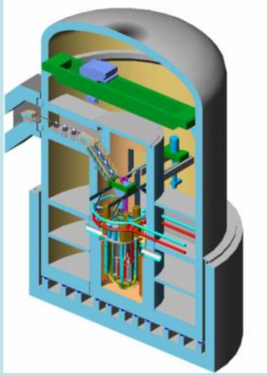
Towards a general purpose library

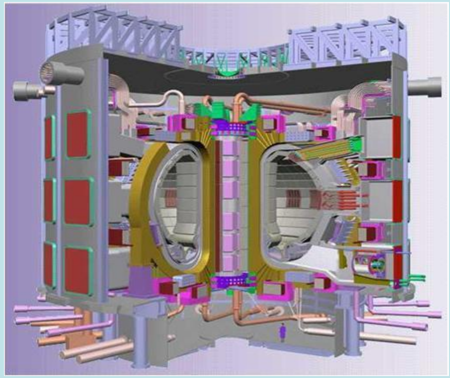
Applications: fission and fusion, radiation protection, nuclear medicine, (nuclear) security, object and materials analysis

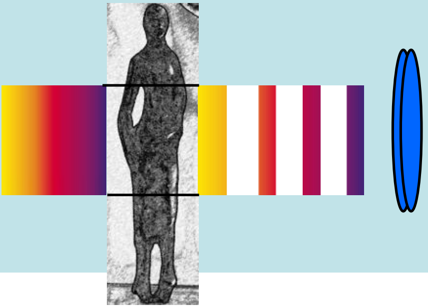
Science: reactions and structure of nuclei, astrophysics, basic physics

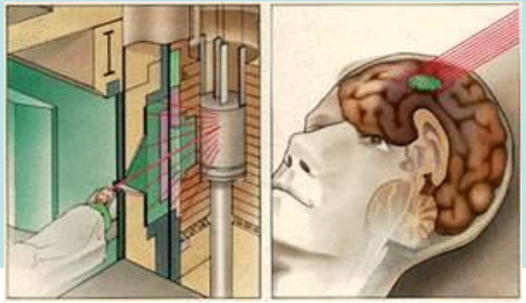












European Commission

Challenge: Climate Change - carbon free energy

Nuclear energy can be an important component in the mix

2016	CO2	CO2-free	Nuclear	Bio+waste
world	81%	19%	5%	10%
EU 28	72%	**28%**	14%	10%
Belgium	71%	29%	20%	7%
France	47%	**53%**	42%	7%
Germany	79%	21%	7%	10%
Sweden	29%	**71%**	33%	25%

Countries with a high percentage CO_2-free energy use (nuclear) electricity for heating.

Still a lot to do for CO_2-free transport.

Data International Energy Agency, Total primary energy supply

Challenges for nuclear energy

- Cost of construction
- Perception of risk & public opinion

  Legacy of historical major accidents, Fukushima and Chernobyl, and the shadow they project over the future.

- Communication in a difficult era

EUROfusion

Nuclear Data Activities of the EUROfusion Consortium

U. Fischer, KIT – I 423

Co-ordinator Power Plant Physics & Technology - Neutronics & Nuclear Data

KIT Karlsruhe Institute of Technology
IFIN-HH
PAUL SCHERRER INSTITUT PSI
CCFE CULHAM CENTRE FOR FUSION ENERGY
UPPSALA UNIVERSITET
TU WIEN
UNED
IJS
NEA NUCLEAR ENERGY AGENCY

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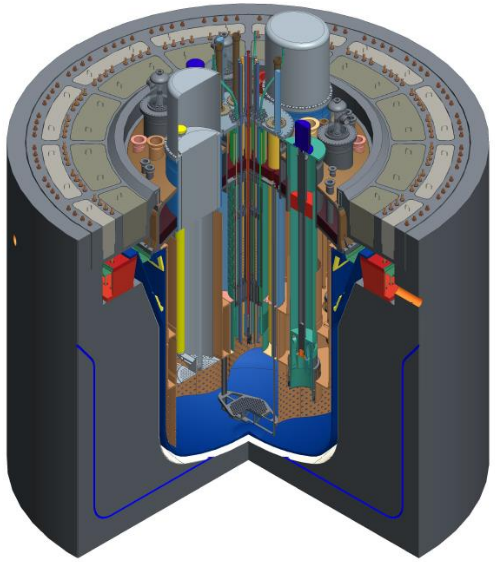
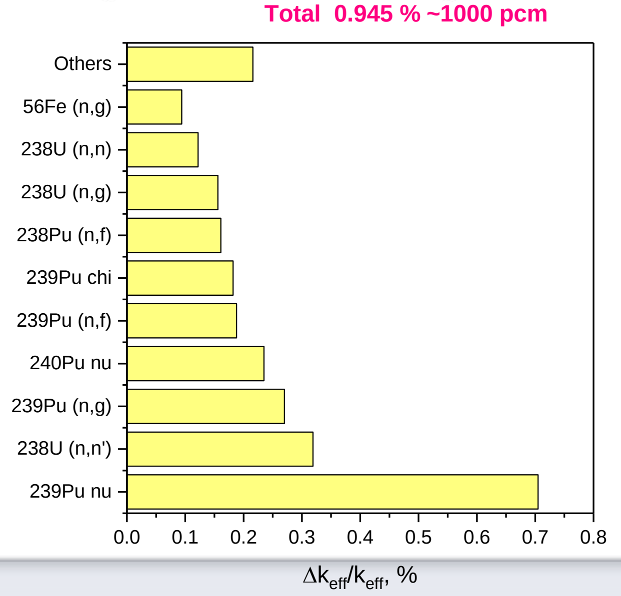
Alexey Stankovskiy R191 & R367

MYRRHA K_{eff} uncertainty and data priorities



Cov. data	$\Delta k_{eff}/k_{eff}$, %
SCALE-6.0m	0.945
COMMARA-2	~0.5
JENDL-4.0	0.553

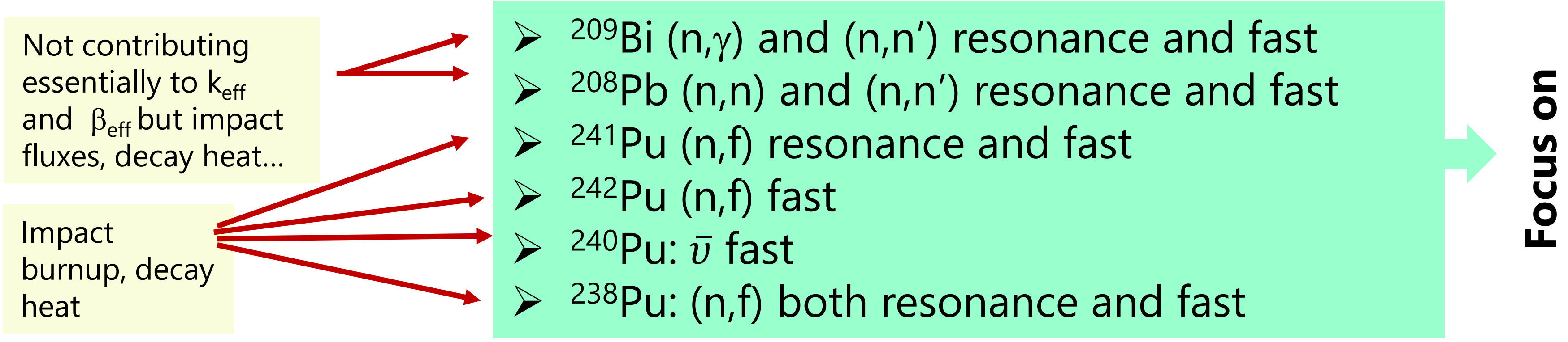
Target accuracy satisfactory: $\frac{\Delta k_{eff}}{k_{eff}} \sim 300pcm$



Increase of confidence by reducing the uncertainties is needed for

- ^{239}Pu: (n,γ) both in resonance and fast energy region, (n,f) fast, χ and $\bar{\upsilon}$ fast
- ^{238}U: (n,n') fast, (n,γ) resonance and fast, (n,n) resonance and fast
- ^{56}Fe: (n,γ) resonance and fast
- ^{235}U: $\bar{\upsilon}$, (n,f), (n,γ) resonance and fast

Already covered by CIELO project



Not contributing essentially to k_{eff} and β_{eff} but impact fluxes, decay heat…

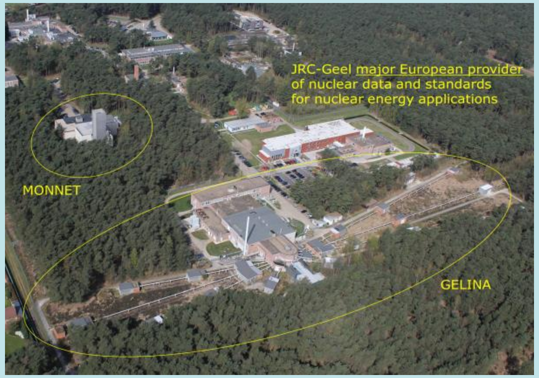
Impact burnup, decay heat

- ^{209}Bi (n,γ) and (n,n') resonance and fast
- ^{208}Pb (n,n) and (n,n') resonance and fast
- ^{241}Pu (n,f) resonance and fast
- ^{242}Pu (n,f) fast
- ^{240}Pu: $\bar{\upsilon}$ fast
- ^{238}Pu: (n,f) both resonance and fast

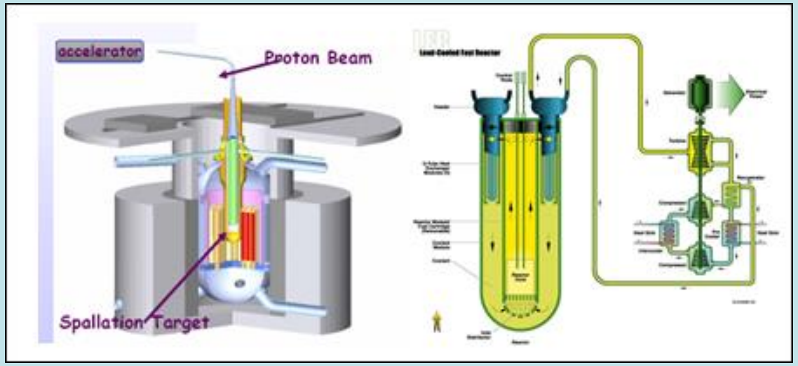
Focus on

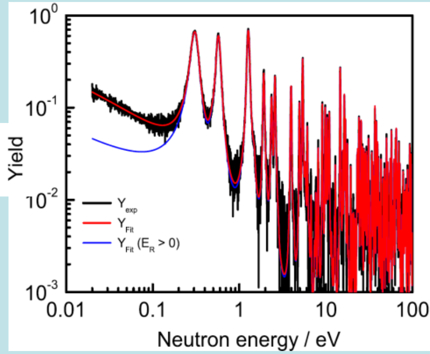
From science to application

Reactive versus proactive: ensure best science for every application


JRC-Geel major European provider of nuclear data and standards for nuclear energy applications

Feedback & new needs





Microscopic data

Theory

Benchmark data

Evaluation, verification & validation

Data Library

Research & Development

Industry

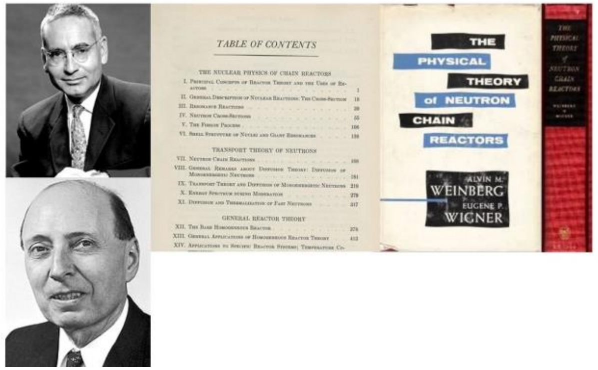
Regulatory bodies

Modeling for cost reduction

- Reliable predictions with credible uncertainty margins.
- We are a far cry from that in the nuclear field
- Lots of expert judgement and ad-hoc methods and codes.
- Lots of tests needed for innovative ideas.
- Knowledge management through data libraries, codes and procedures can make major steps forward with modern software technology
- JEFF-4 development goal for 2018-2024

The physical theory of neutron chain reactors

Alvin M. Weinberg and Eugene P. Wigner,
University of Chicago Press (1958)



Nuclear Reactor Physics

Weston M. Stacey, Wiley-VCH, 2nd ed. (2007)

PART 1 BASIC REACTOR PHYSICS
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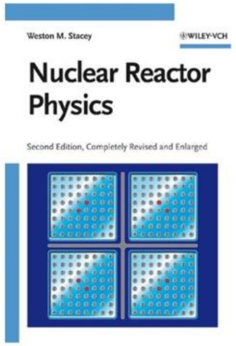
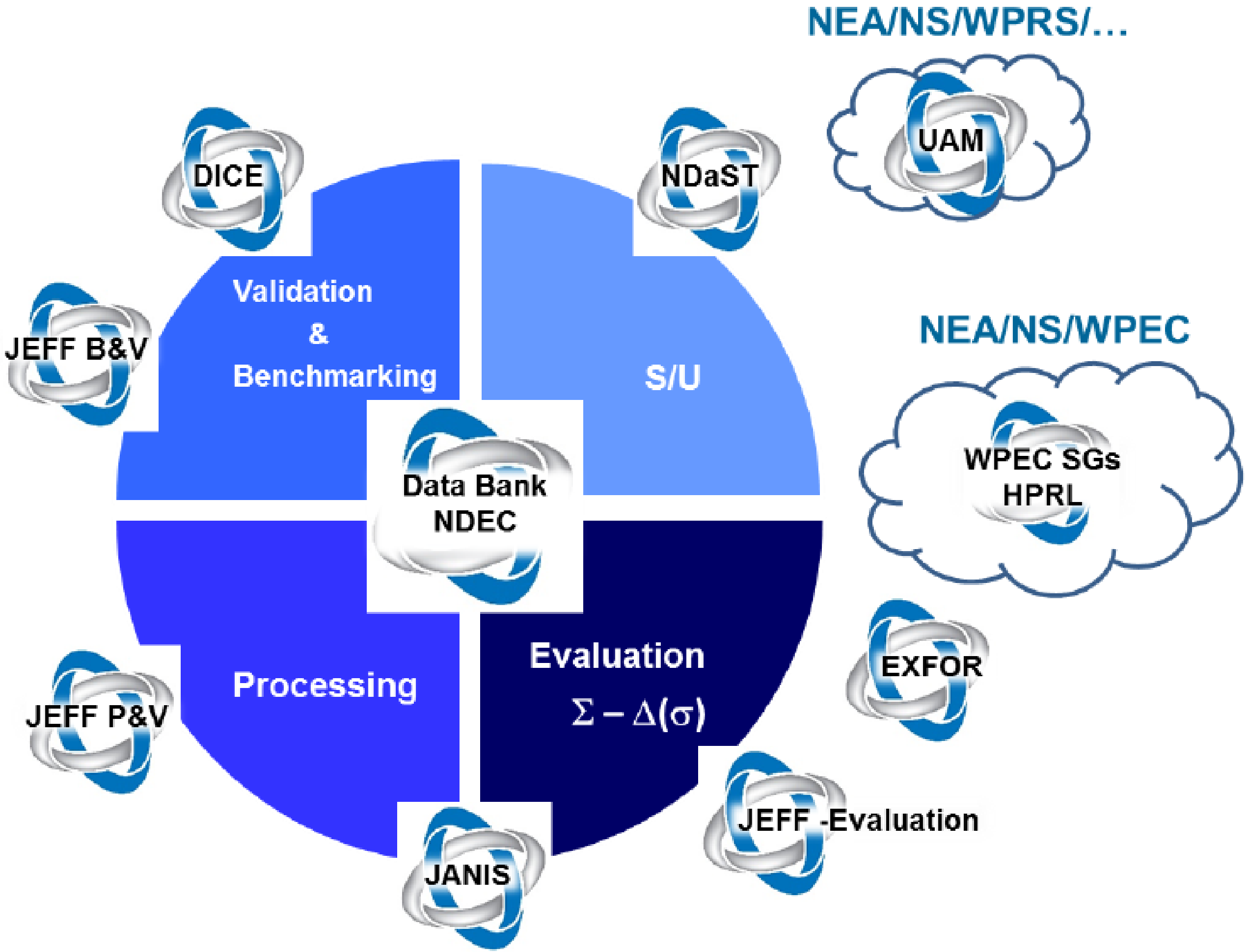


- One set of data for all applications
- One suite of modeling codes

The JEFF collaboration

- NEA Databank member countries
- Large fraction of contributors is from Europe
- 2 meetings per year
- 40-100 participants
- Voluntary contributions: resources of contributors
- Maintain close links with data projects in Europe
- Joint meetings.

NEA Data Bank: Tools and Databases



NEA/NS/WPRS/…

UAM

NEA/NS/WPEC

WPEC SGs
HPRL

DICE

NDaST

JEFF B&V

Validation
&
Benchmarking

S/U

Data Bank
NDEC

Processing

Evaluation
$\Sigma - \Delta(\sigma)$

JEFF P&V

EXFOR

JEFF -Evaluation

JANIS

NEA Data Bank Services

- ☐ Secretariat activities
- ☐ Technical services:
    - Consistency checks
    - Conversion to formats
    - Testing/verification
    - Benchmarking (e.g. ICSBEP, ….
    - Web/Compilation library
    - Feedbacks
- ☐ New tool NDEC (Nuclear Data Evaluated Cycle).

Fig : NEA Data Bank tools and databases. JEFF Working Groups on Nuclear Data activities on Benchmarking & Validation (B&V), Processing & Verification (P&V) and Evaluation are shown

IAEA-NDS: CRPs, DDPs, CMs

- INDEN
- IRDFF
- Standards
- RIPL
- EXFOR
- Medical isotopes
- IBANDL
- …

THANKS TO ALL PROJECT PARTICIPANTS

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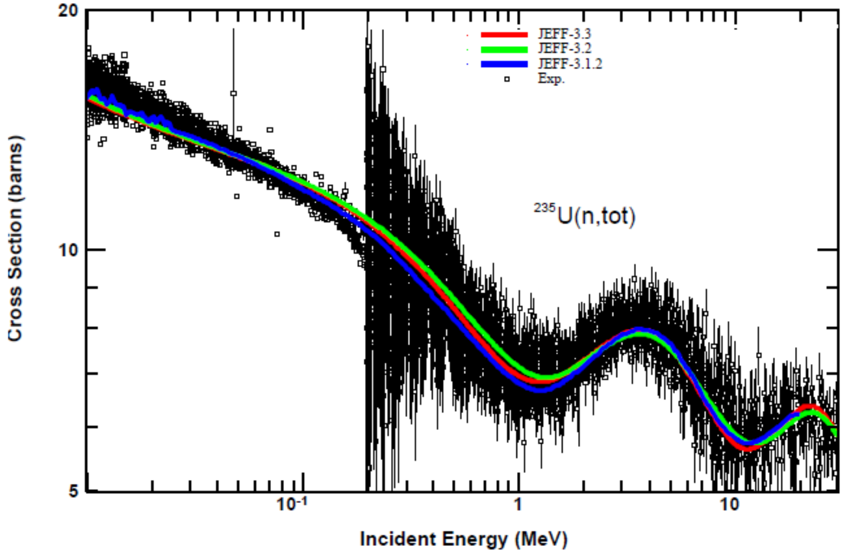
15th Varenna Conference on Nuclear Reaction Mechanisms
11-15 June 2018, Villa Monastero, Varenna, Italy

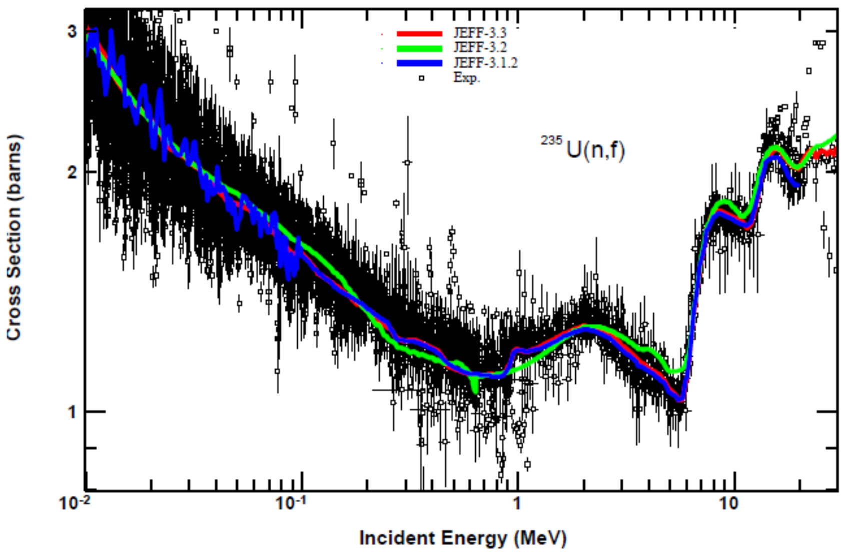
Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
Web: http://www-nds.iaea.org

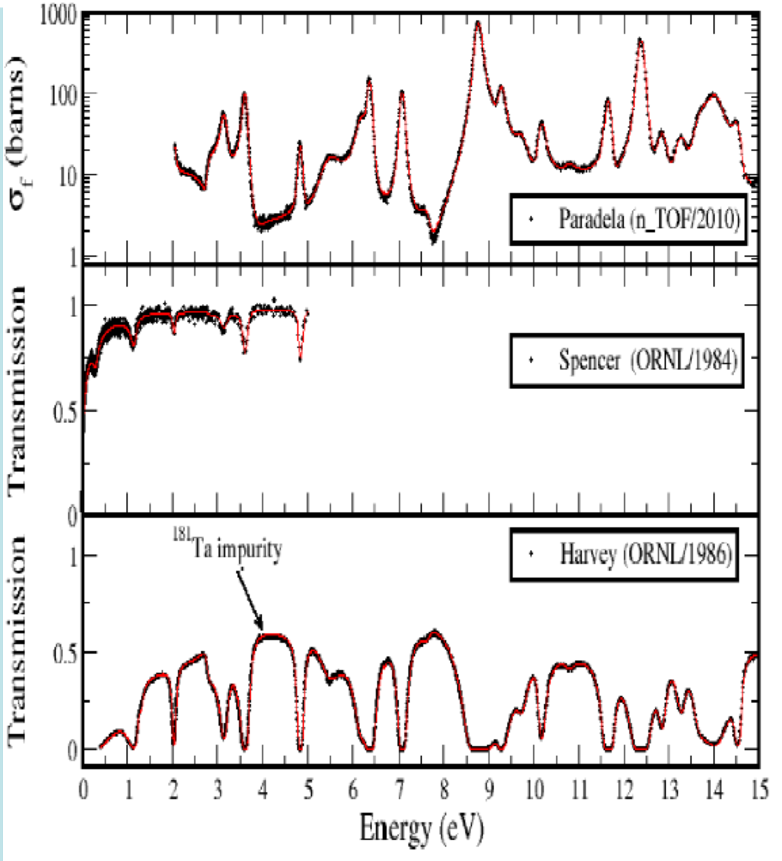
JEFF – 3.3, 20 November 2017

- New major actinides (CEA Cadarache & Bruyeres-le-Chatel, IRSN)
- FY beta file UKFY3.7 (NNL)
- Radioactive Decay Data File (CEA Saclay)
- New covariances
- Increased reliance on TENDL for completeness and decay heat (D. Rochman, M. Fleming)
- New Cu files (Pereslavtsev, Leal) solved important issue with JEFF-3.2
- Improved gamma-emission data (C. Jouanne, R. Perry, G. Noguere, O. Serot, …)
- Restoration of 8 group structure for delayed neutrons (P. Leconte)
- New thermal scattering data (Cantargi, Granada, Marquez Damian, Noguere)
- Removal of legacy files, update of adopted files to latest release
- Many issues resolved (many contributors)

JEFF-3.3 U-235







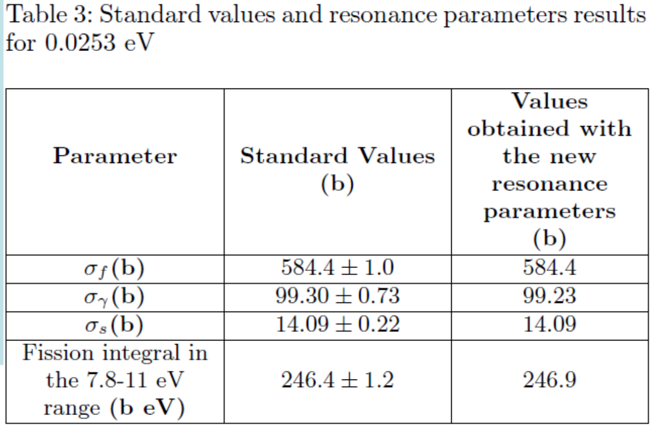
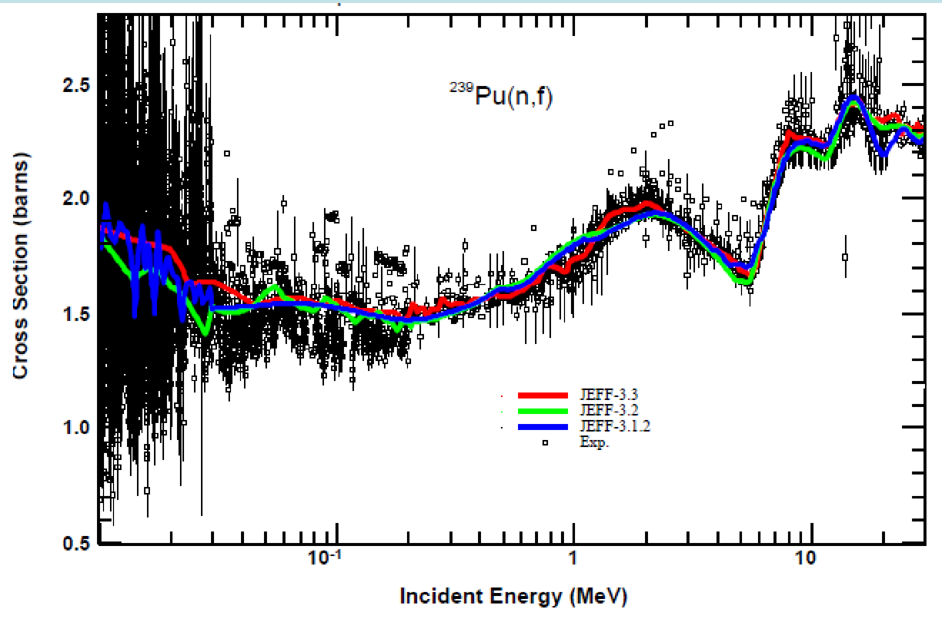


Table 3: Standard values and resonance parameters results for 0.0253 eV

Parameter	Standard Values (b)	Values obtained with the new resonance parameters (b)
σ_f(b)	584.4 ± 1.0	584.4
σ_γ(b)	99.30 ± 0.73	99.23
σ_s(b)	14.09 ± 0.22	14.09
Fission integral in the 7.8-11 eV range (b eV)	246.4 ± 1.2	246.9

JEFF-3.3 Pu-239



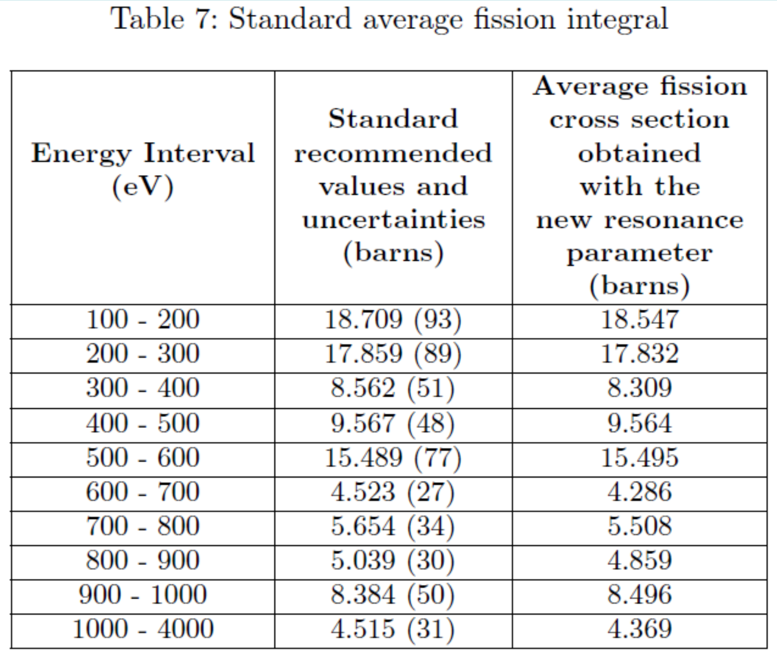
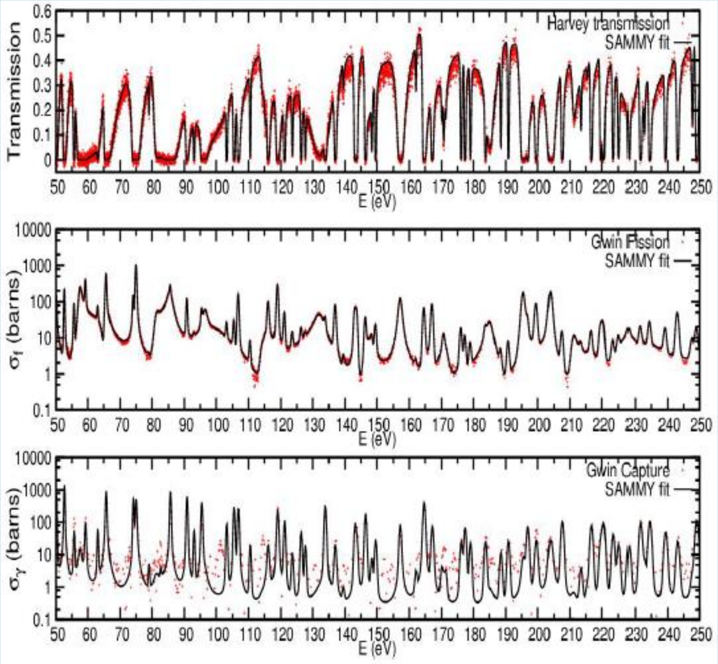
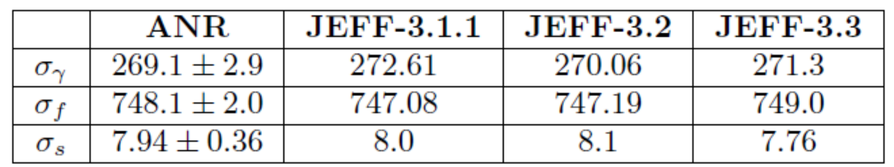


Table 7: Standard average fission integral

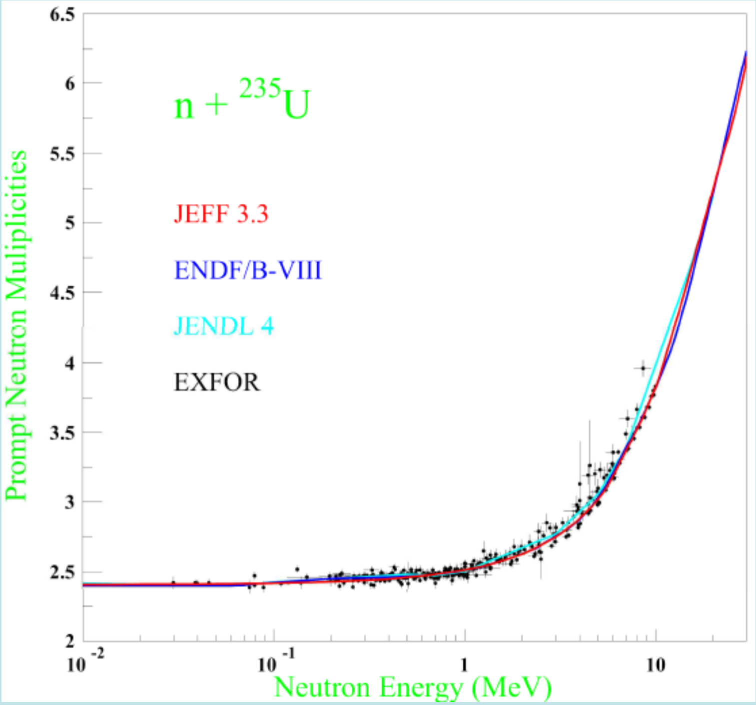
Energy Interval (eV)	Standard recommended values and uncertainties (barns)	Average fission cross section obtained with the new resonance parameter (barns)
100 - 200	18.709 (93)	18.547
200 - 300	17.859 (89)	17.832
300 - 400	8.562 (51)	8.309
400 - 500	9.567 (48)	9.564
500 - 600	15.489 (77)	15.495
600 - 700	4.523 (27)	4.286
700 - 800	5.654 (34)	5.508
800 - 900	5.039 (30)	4.859
900 - 1000	8.384 (50)	8.496
1000 - 4000	4.515 (31)	4.369

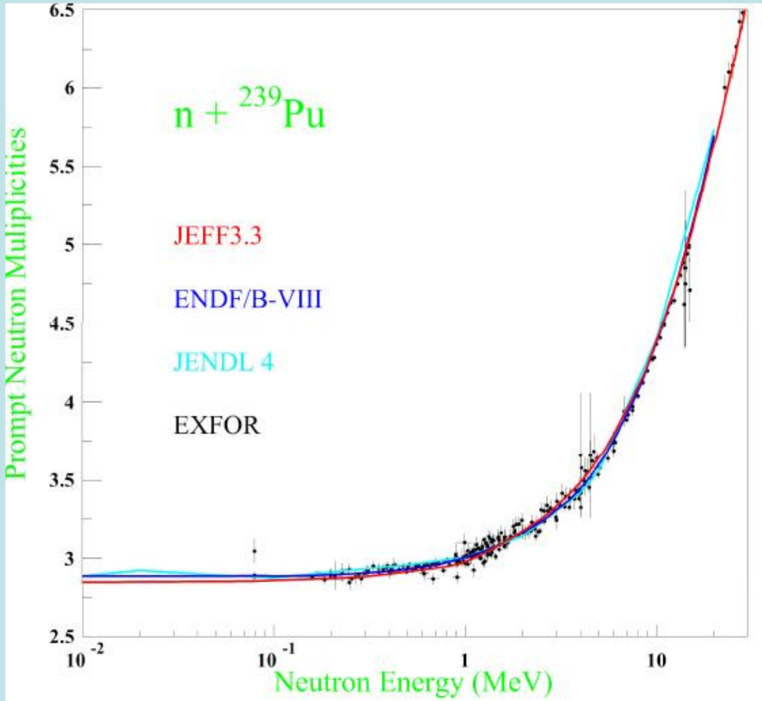


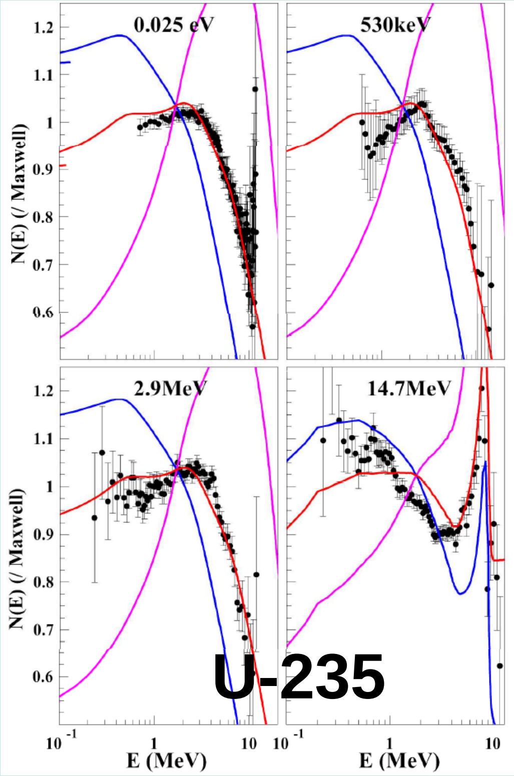


	ANR	**JEFF-3.1.1**	**JEFF-3.2**	**JEFF-3.3**
σ_γ	269.1 ± 2.9	272.61	270.06	271.3
σ_f	748.1 ± 2.0	747.08	747.19	749.0
σ_s	7.94 ± 0.36	8.0	8.1	7.76

U-235, Pu-239 nu-bar and pfns

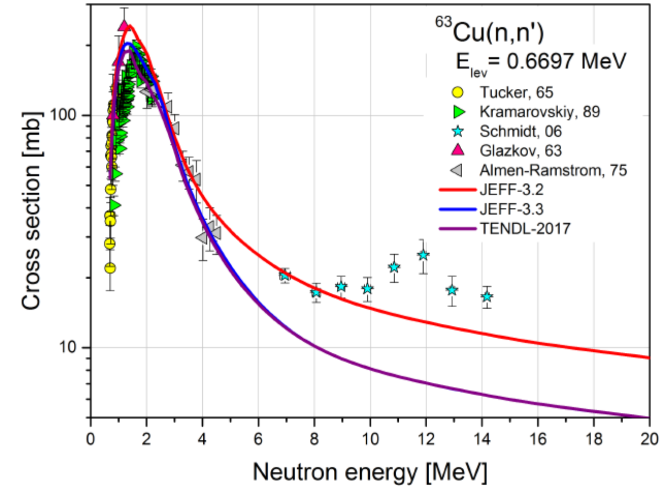


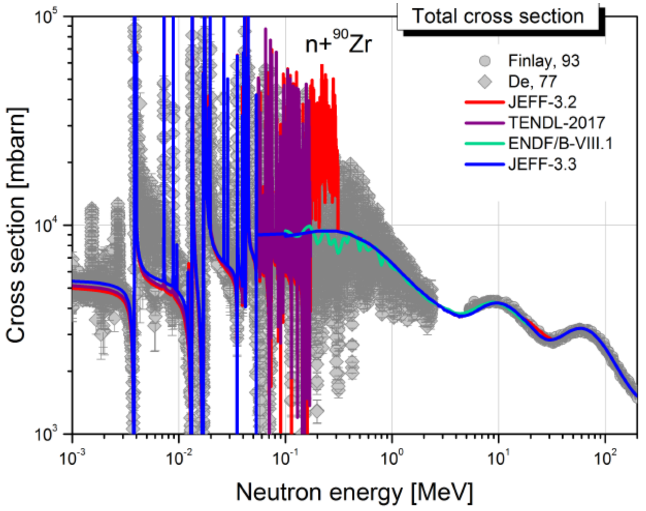




U-235

Structural materials, coolants





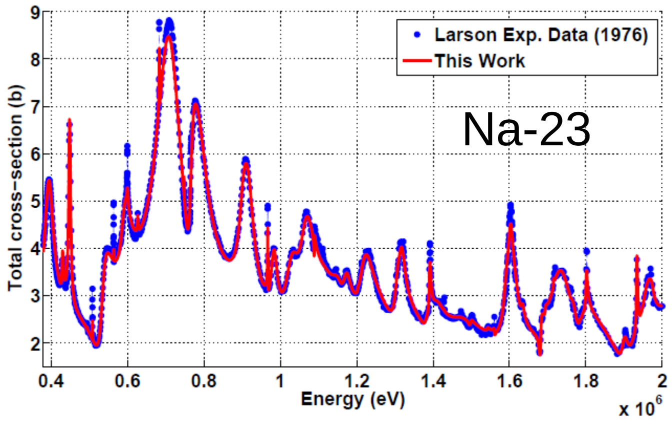
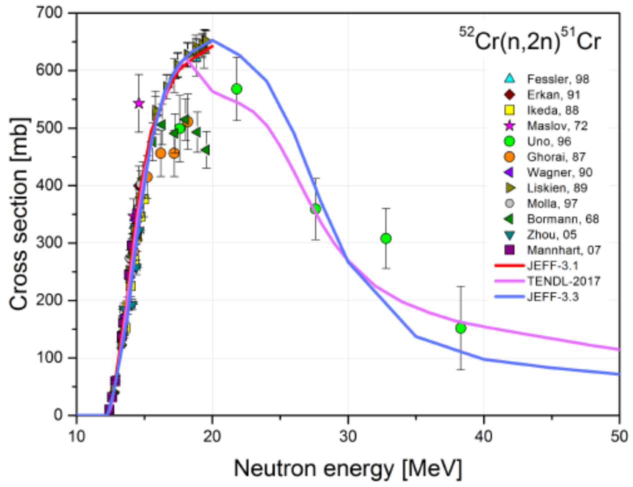
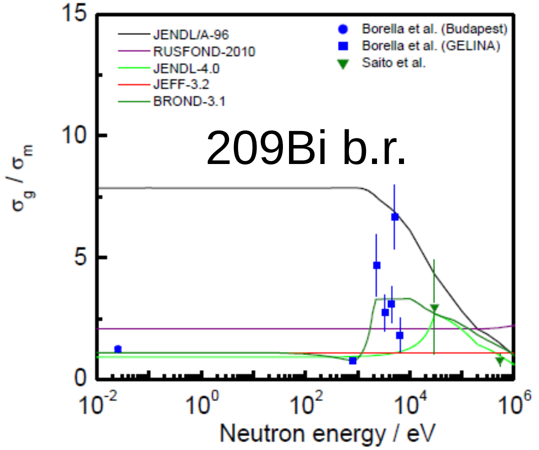
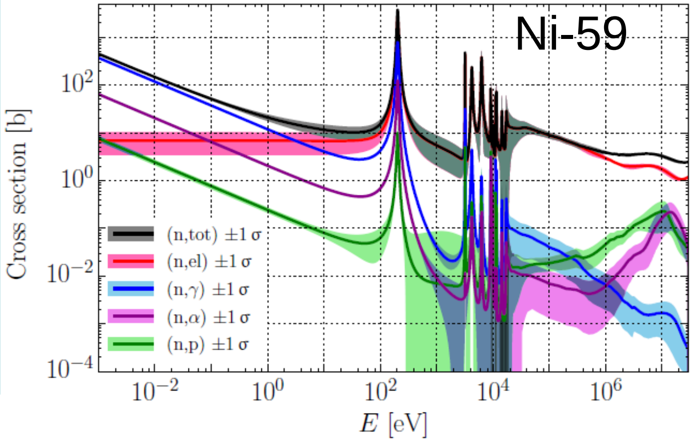


Fig. 31: Evaluated ^{23}Na total cross-section (red) compared to Larson experimental data (blue dots)



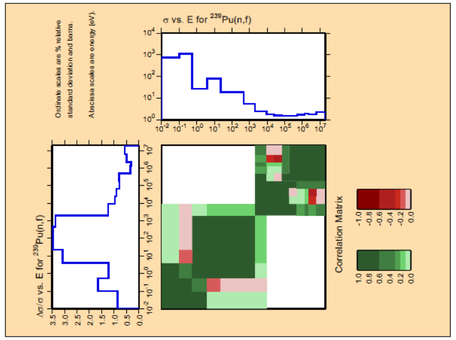




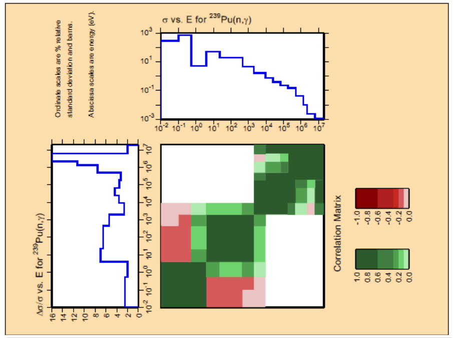
Cyrille De Saint Jean

^{239}Pu

(n,f)

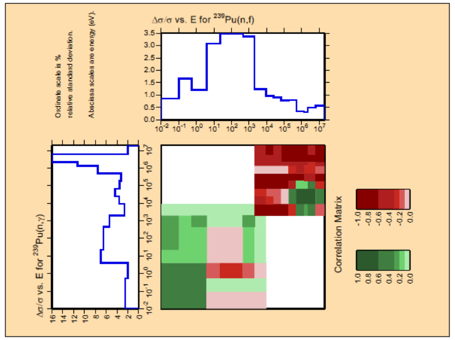


(n,g)



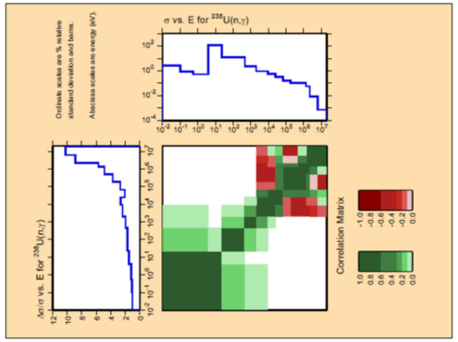
(n,f) x

(n,g)

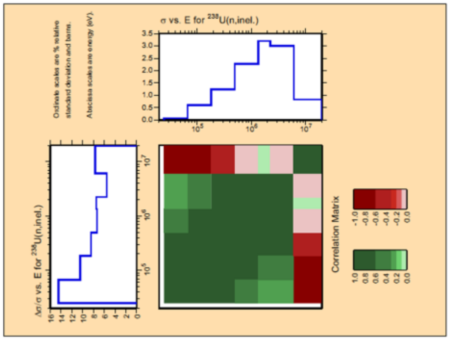


^{238}U

(n,g)

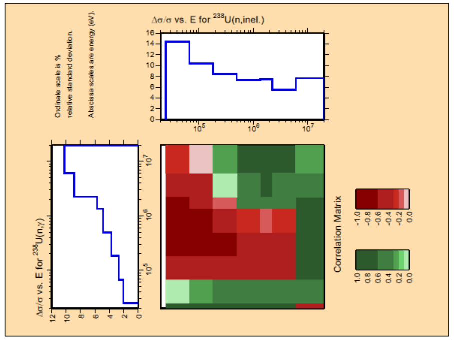


(n,inl)



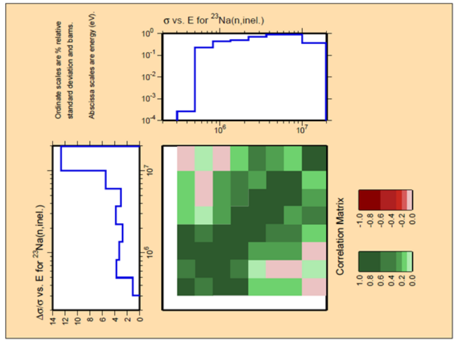
(n,g) x

(n,inl)



^{23}Na

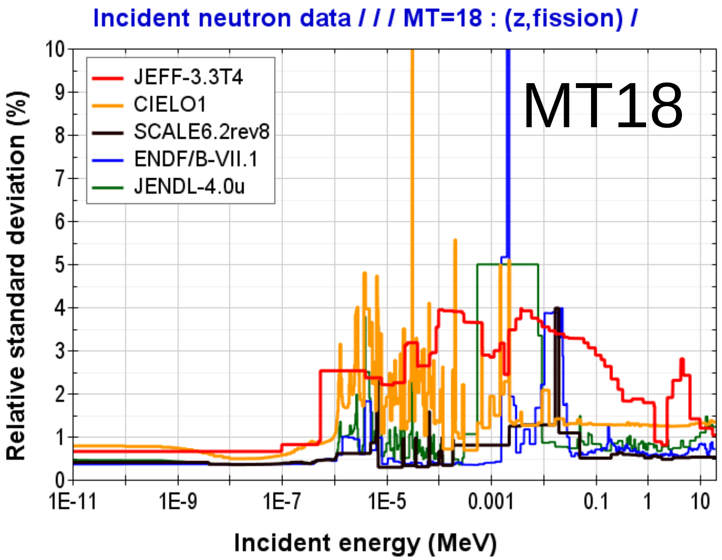
(n,inl)



Further covariances for Hf

Many from TENDL (D. Rochman)

❑ U-235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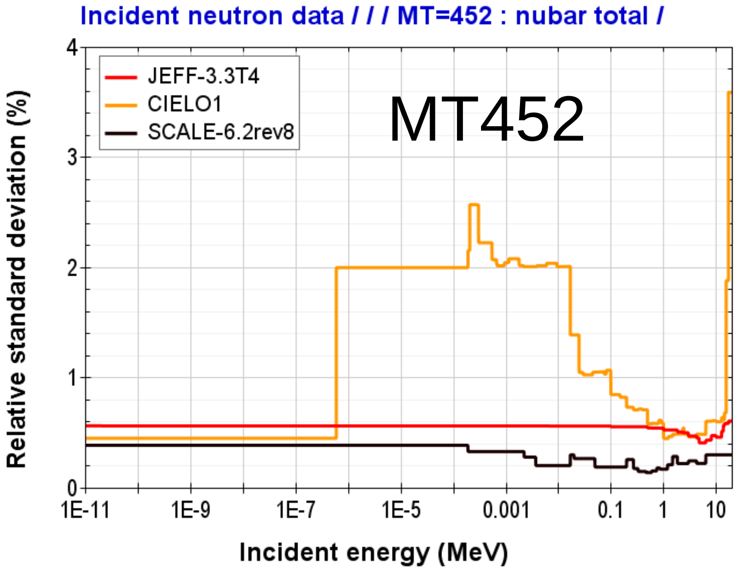
MT18
JEFF-3.3T4
CIELO1
SCALE6.2rev8
ENDF/B-VII.1
JENDL-4.0u
Relative standard deviation (%)
0
1
2
3
4
5
6
7
8
9
10
1E-11
1E-9
1E-7
1E-5
0.001
0.1
1
10
Incident energy (MeV)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JEFF-3.3T4
CIELO1
SCALE-6.2rev8
Relative standard deviation (%)
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1
2
3
4
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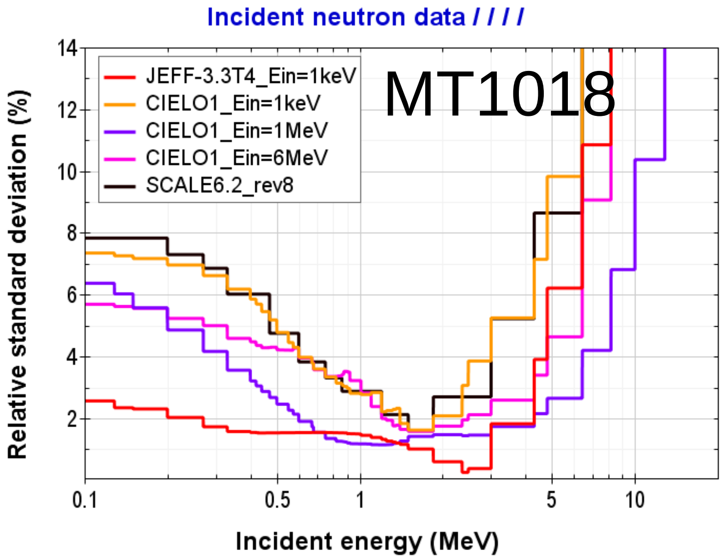
0.001
0.1
1
10
Incident energy (MeV)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MT1018
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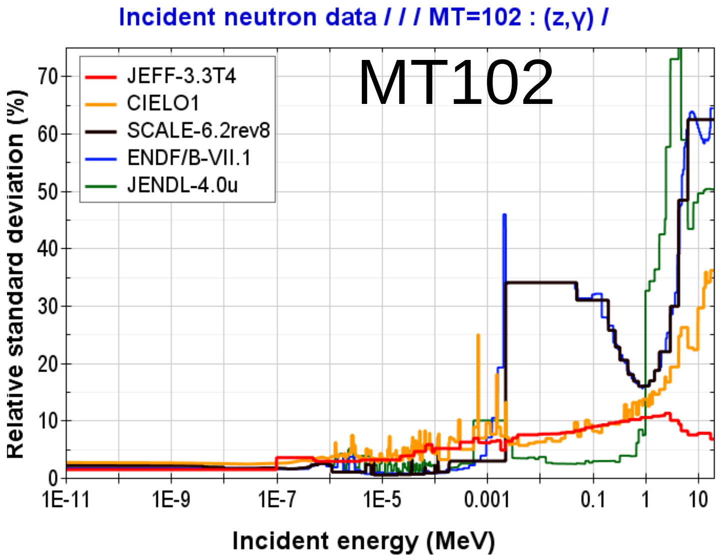
CIELO1_Ein=1MeV
CIELO1_Ein=6MeV
SCALE6.2_rev8
Relative standard deviation (%)
2
4
6
8
10
12
14
0.1
0.5
1
5
10
Incident energy (MeV)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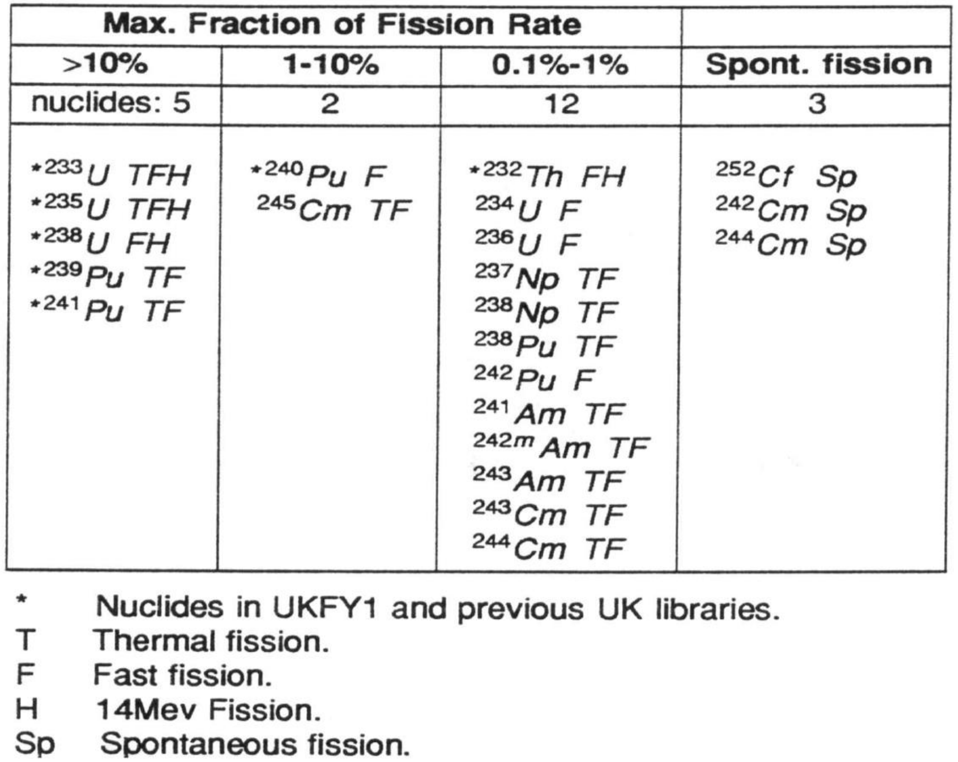
CIELO1
SCALE-6.2rev8
ENDF/B-VII.1
JENDL-4.0u
Relative standard deviation (%)
0
10
20
30
40
50
60
70
1E-11
1E-9
1E-7
1E-5
0.001
0.1
1
10
Incident energy (MeV)

Robert Mills, NNL, UKFY-3.7 = JEFF-3.3 FY



Max. Fraction of Fission Rate			
>10%	1-10%	0.1%-1%	Spont. fission
nuclides: 5	2	12	3
*^{233}U TFH *^{235}U TFH *^{238}U FH *^{239}Pu TF *^{241}Pu TF	*^{240}Pu F ^{245}Cm TF	*^{232}Th FH ^{234}U F ^{236}U F ^{237}Np TF ^{238}Np TF ^{238}Pu TF ^{242}Pu F ^{241}Am TF ^{242m}Am TF ^{243}Am TF ^{243}Cm TF ^{244}Cm TF	^{252}Cf Sp ^{242}Cm Sp ^{244}Cm Sp

* Nuclides in UKFY1 and previous UK libraries.
T Thermal fission.
F Fast fission.
H 14Mev Fission.
Sp Spontaneous fission.

Neutron spectra	Fissioning nuclide	UKFY3.6	New data	UKFY3.7
Thermal	Th229	337	72	409
Thermal	U233	757	188	945
Thermal	U235	2390	151	2541
Thermal	Np238	115	63	178
Thermal	Pu239	861	225	1086
Thermal	Pu241	334	63	397
Thermal	Cm245	161	219	380
Thermal	Cf249	305	239	544
Fast	U235	724	5	729
Fast	Pu239	390	5	395
Fast	Pu241	111	5	116

New JEFF-3.3 DD file, Mark Kellett, CEA Saclay

- **FROM JEFF-3.1.1 TO JEFF-3.3**

JEFF-3.3 (released October 2016):

Complete re-assessment and update to all 900 evaluations coming from ENSDF

Assessment of IAEA actinide decay data (85 nuclei)

Assessment of IRDFF decay data library (~80 nuclei)

Inclusion of updated UKPADD-6.12 library (~50 additional nuclei)

Assessment of new DDEP evaluations (~30 additional nuclei)

Inclusion of initial TAGS results from University of Valencia *(2010)*

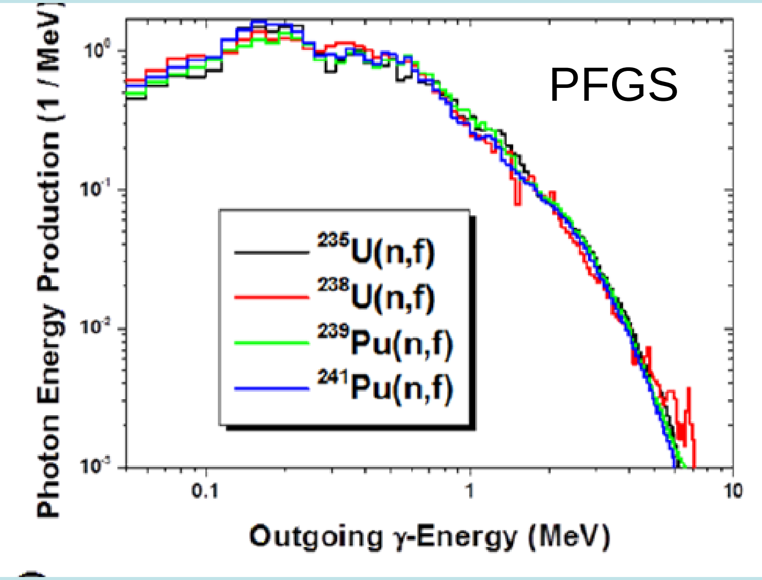
Inclusion of first TAGS results from University of Nantes *(2015)*

Inclusion of further TAGS results from University of Valencia *(2016)*

Corrections based on limited feedback to JEFF-3.1.1

JEFF-3.3 Gamma yields

- Prompt fission (Serot)
- Capture (Perry, Noguere, Serot)
- Inelastic (Jouanne)



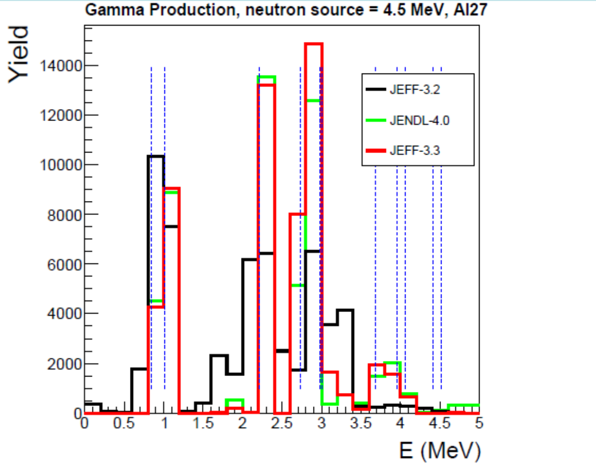
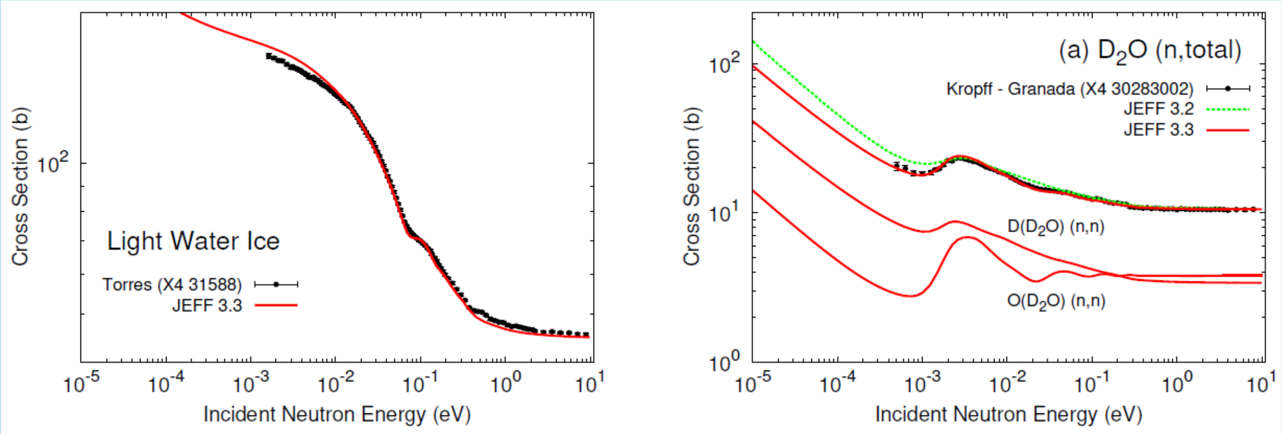


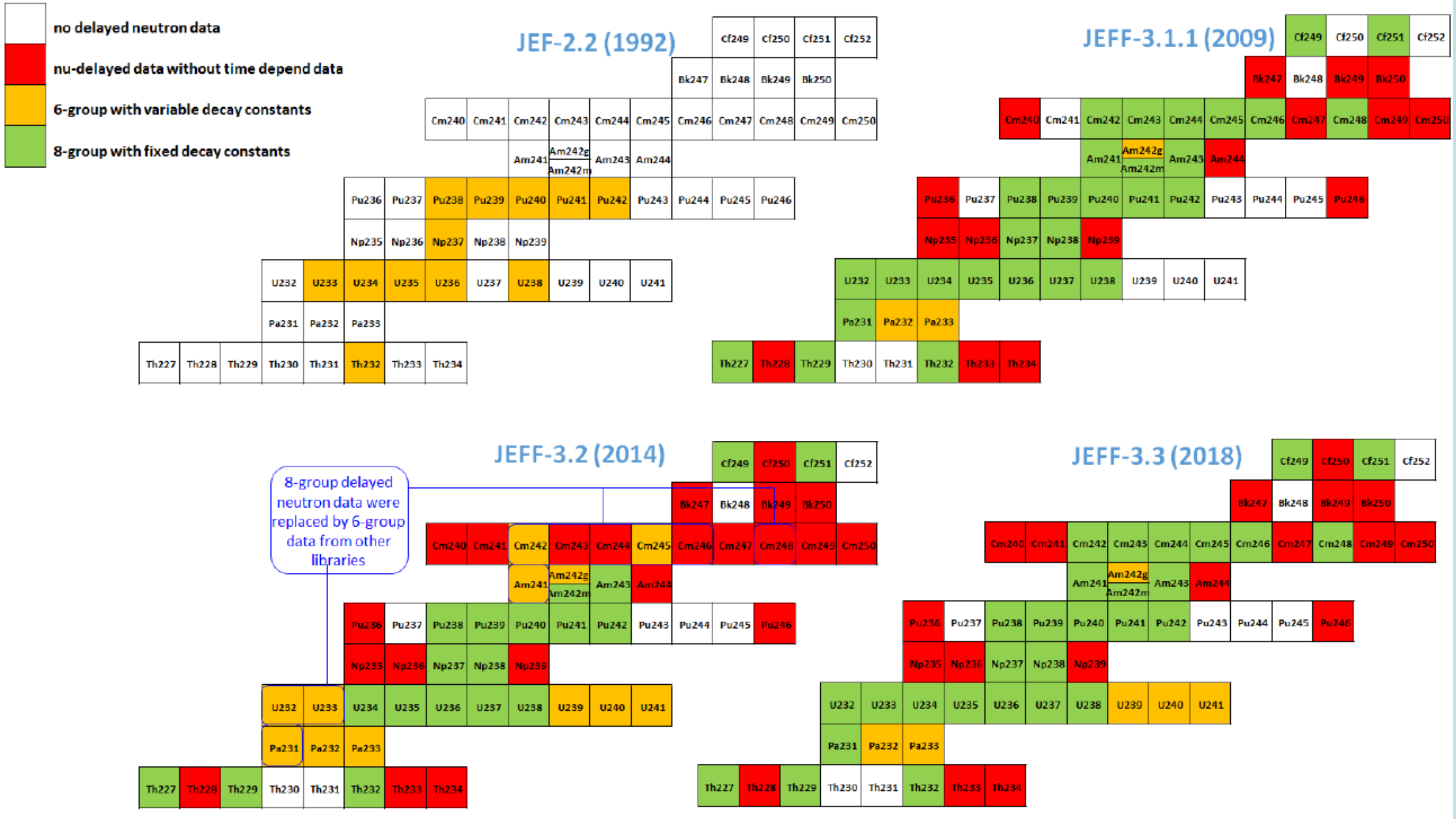
Fig. 71: Monte-Carlo simulations of gamma spectra from Al-27 inelastic scattering with 4.5 MeV neutrons, with excited level energies of Al-27 shown in blue.

Thermal scattering

- 20 files, 14 new, first covariances for H in H_2O.
- Cantargi, Granada, Marquez Damian
  - D in D_2O, Ortho D_2, Para D_2
  - H in ice, mesitylene, Ortho H_2, Para H_2, toluene
  - O-16 in D_2O, Al_2O_3
  - Al in Al2O$_3$
  - Si in Si
- Mg in Mg (Mounier)
- H in CaH_2, Ca in CaH_2 (Serot)
- Keinert, Mattes
  - H in H_2O, CH_2, ZrH (Keinert, Mattes)
  - Be in Be (Keinert, Mattes)
  - C in graphite (Keinert, Mattes)



Delayed neutrons – 8 groups structure

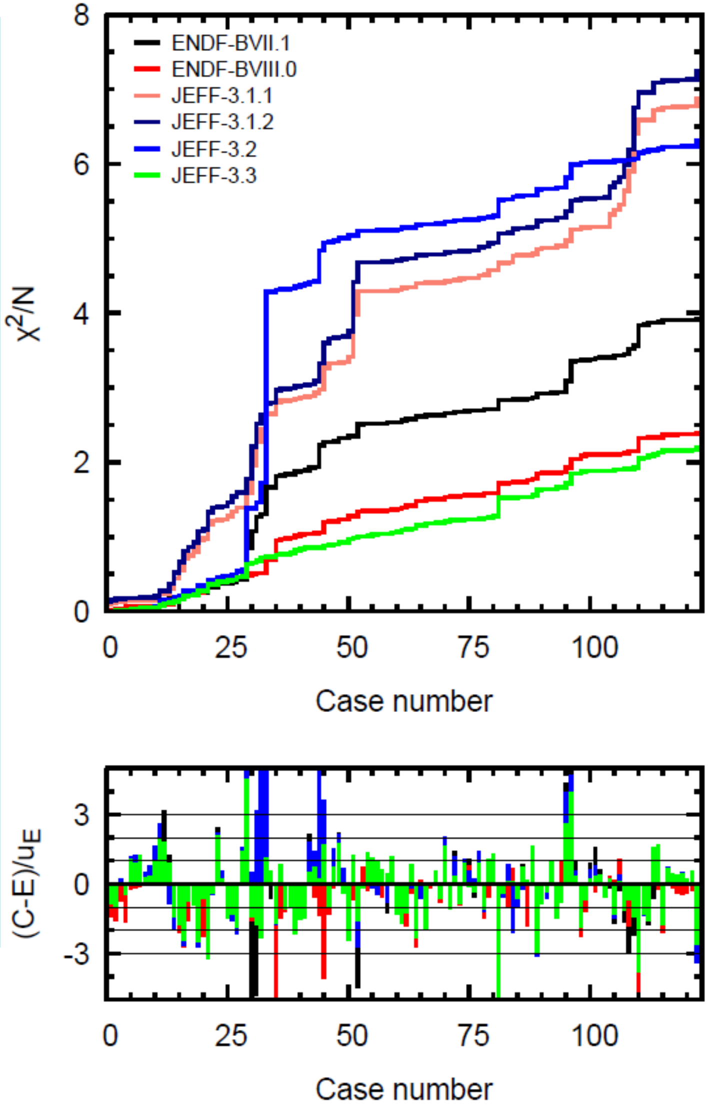


- ⬜ no delayed neutron data
- 🟥 nu-delayed data without time depend data
- 🟨 6-group with variable decay constants
- 🟩 8-group with fixed decay constants

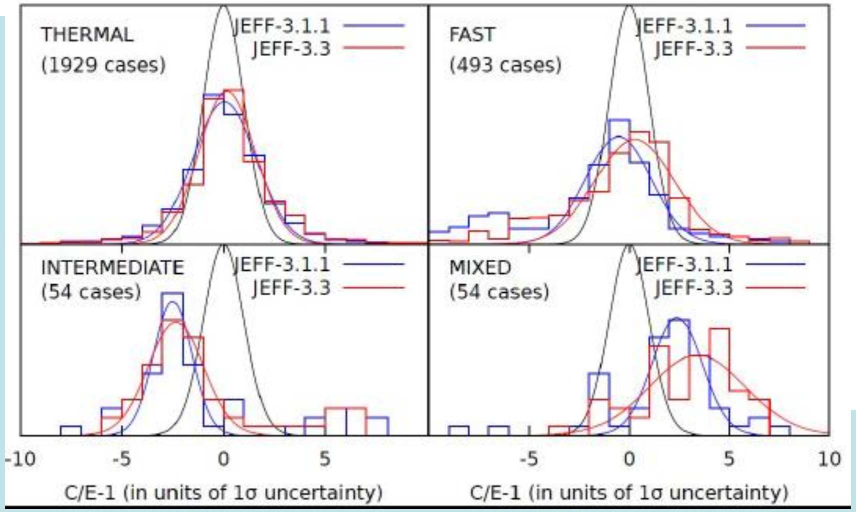
8-group delayed neutron data were replaced by 6-group data from other libraries

Benchmarking

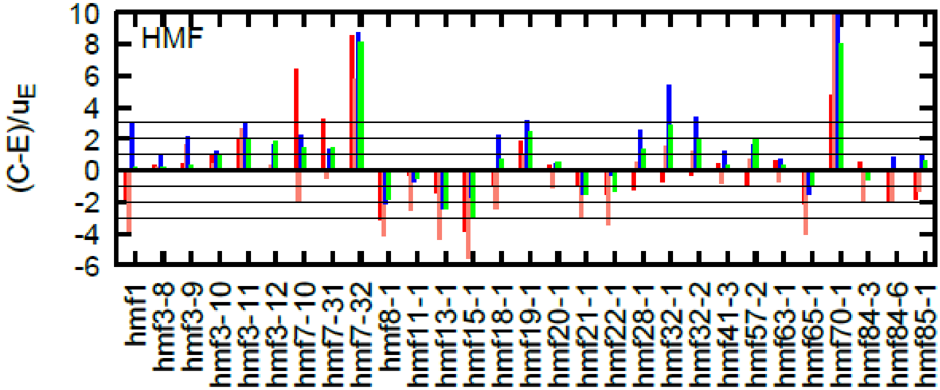
NEA-Mosteller

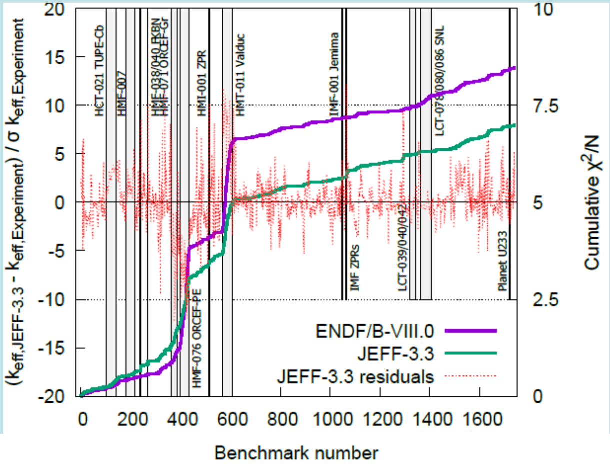


NRG - Van der Marck



IRSN - Leclaire





Trkov

JEFF-3.3 is considerably better than JEFF-3.2 and JEFF-3.1.1&2

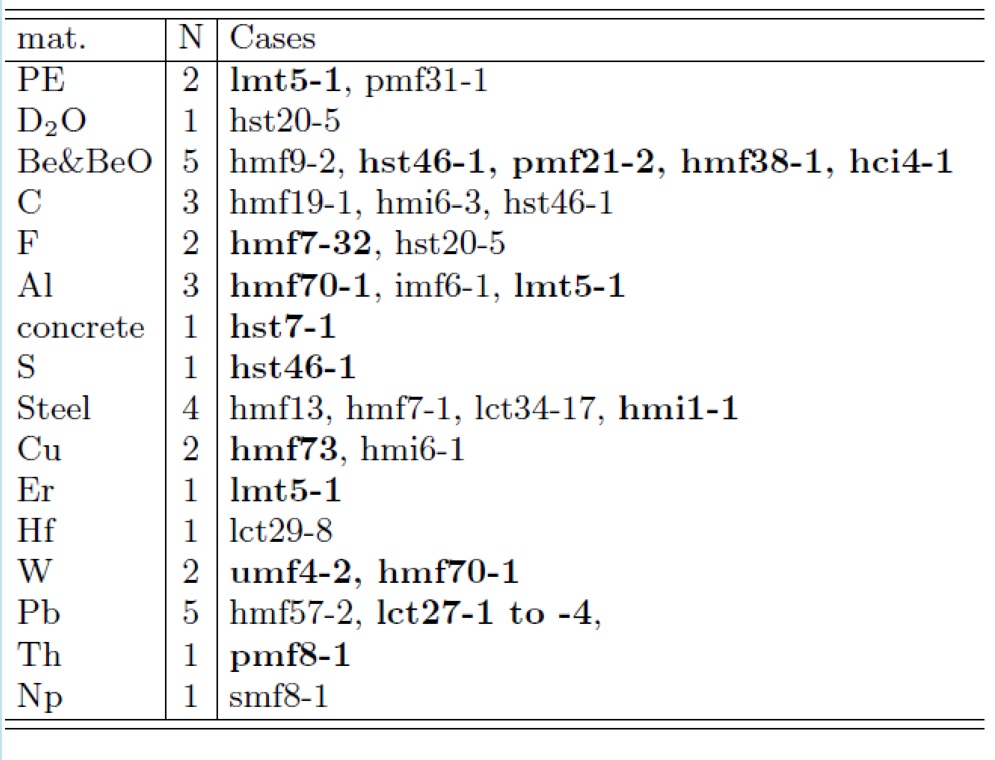
JEFF-3.3 is comparable to ENDF/B-VIII.1

Distributions over benchmarks are strongly affected by outliers

Outlier analysis

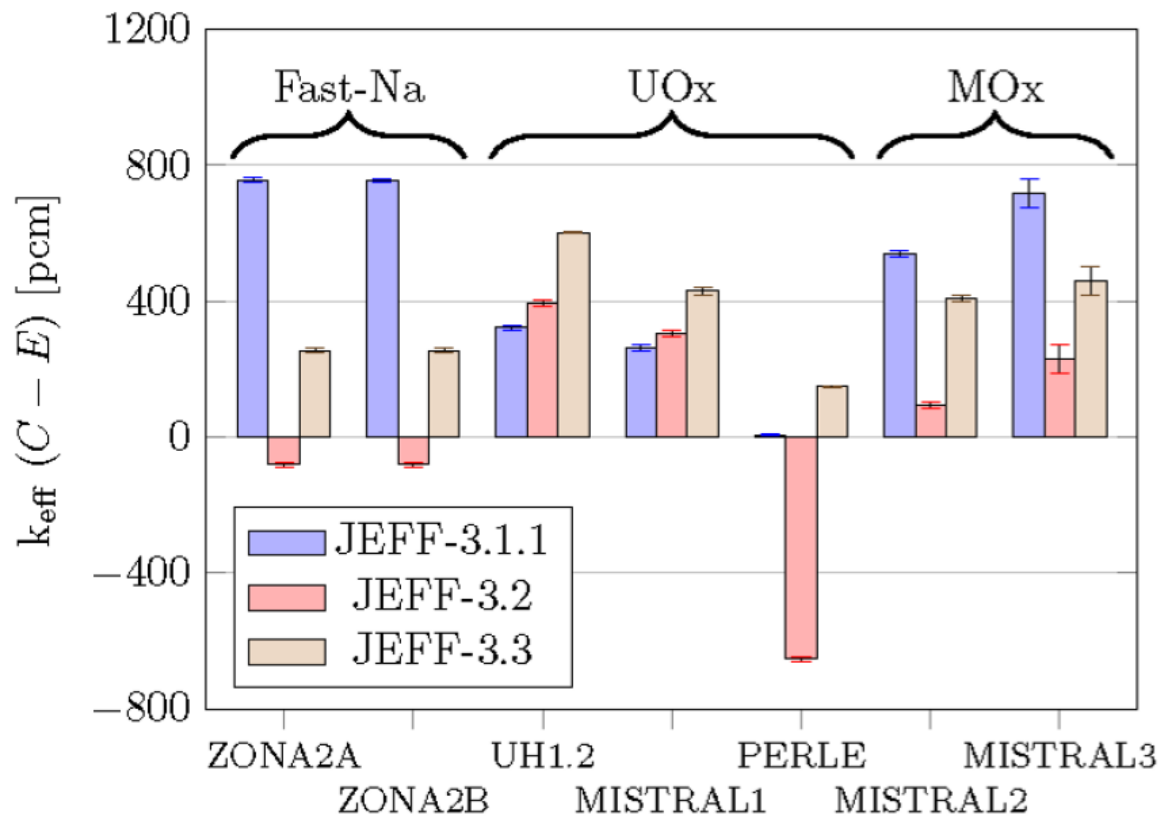
- NEA+IRSN suite implied materials other than actinides (2-3s and **>3s**)
- The remainder of outliers (16 out of 45) are **actinide+water+oxygen** only.
- IAEA suite: 1/3 of cases are outliers > 2s. Many due to small benchmark unc.
- PE, Be/BeO, F, Al, concrete, S, steel, Cu, Er, W, Pb, Th
- (D2O, C, Hf, Np) … (Gd, Cr).

- Most important remain the major actinides

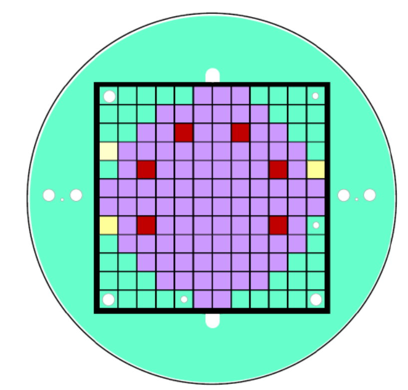


mat.	N	Cases
PE	2	**lmt5-1**, pmf31-1
D_2O	1	hst20-5
Be&BeO	5	hmf9-2, **hst46-1**, **pmf21-2**, **hmf38-1**, **hci4-1**
C	3	hmf19-1, hmi6-3, hst46-1
F	2	**hmf7-32**, hst20-5
Al	3	**hmf70-1**, imf6-1, **lmt5-1**
concrete	1	**hst7-1**
S	1	**hst46-1**
Steel	4	hmf13, hmf7-1, lct34-17, **hmi1-1**
Cu	2	**hmf73**, 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

Additional critical experiments



VENUS-F



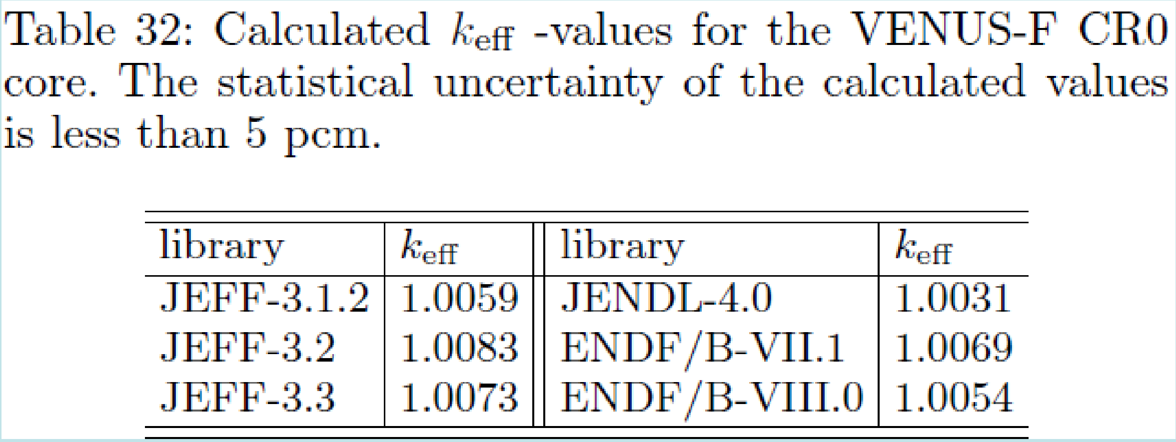
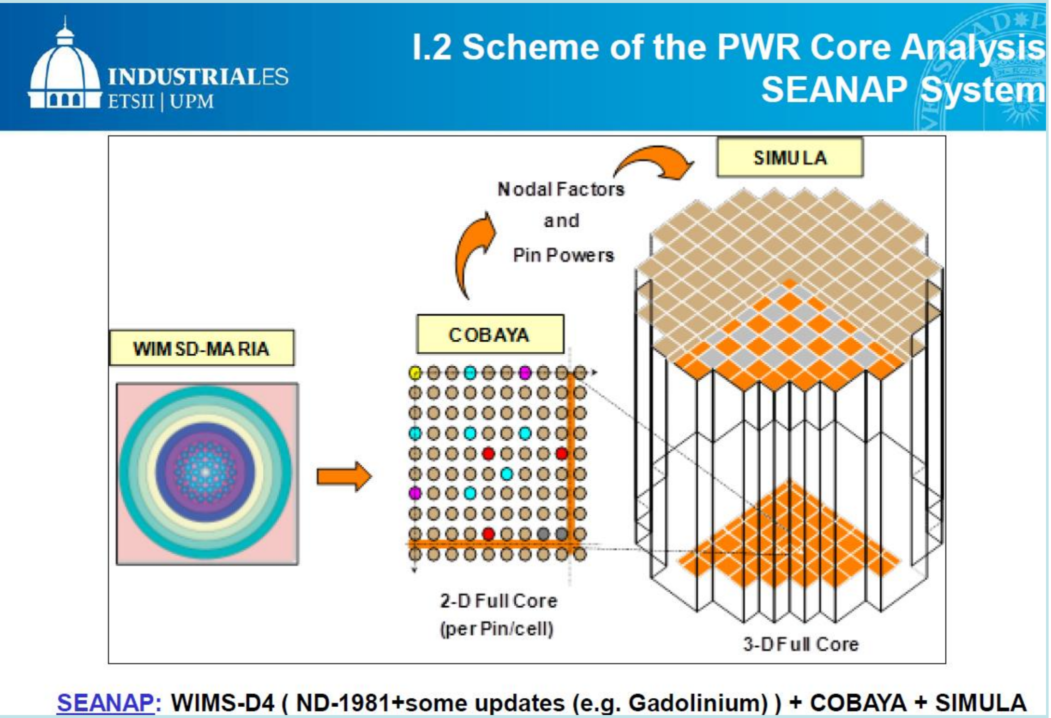


Table 32: Calculated k_{eff} -values for the VENUS-F CR0 core. The statistical uncertainty of the calculated values is less than 5 pcm.

library	k_{eff}	library	k_{eff}
JEFF-3.1.2	1.0059	JENDL-4.0	1.0031
JEFF-3.2	1.0083	ENDF/B-VII.1	1.0069
JEFF-3.3	1.0073	ENDF/B-VIII.0	1.0054

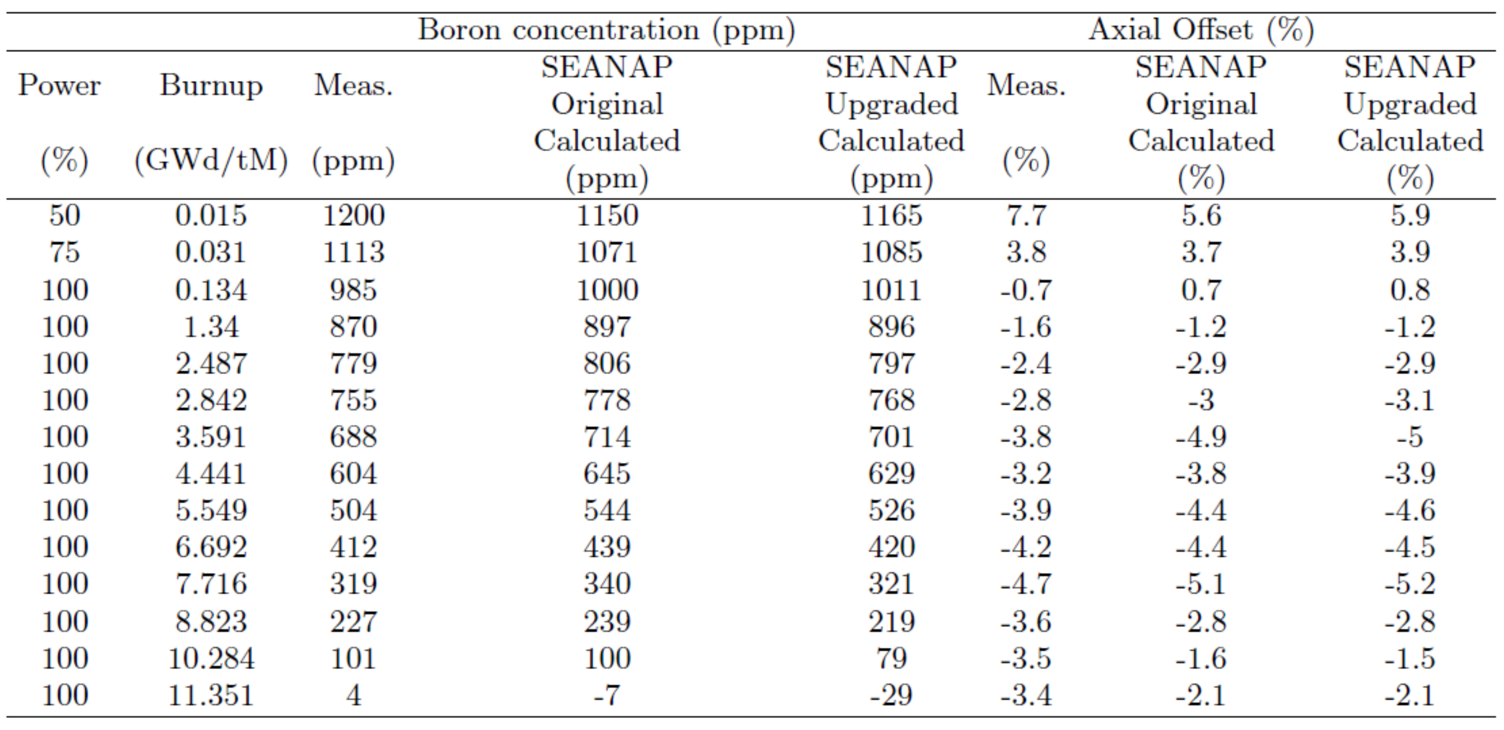
Application to PWR – UPM – SEANAP

Boron concentration and axial offset



I.2 Scheme of the PWR Core Analysis SEANAP System

SEANAP: WIMS-D4 (ND-1981+some updates (e.g. Gadolinium)) + COBAYA + SIMULA

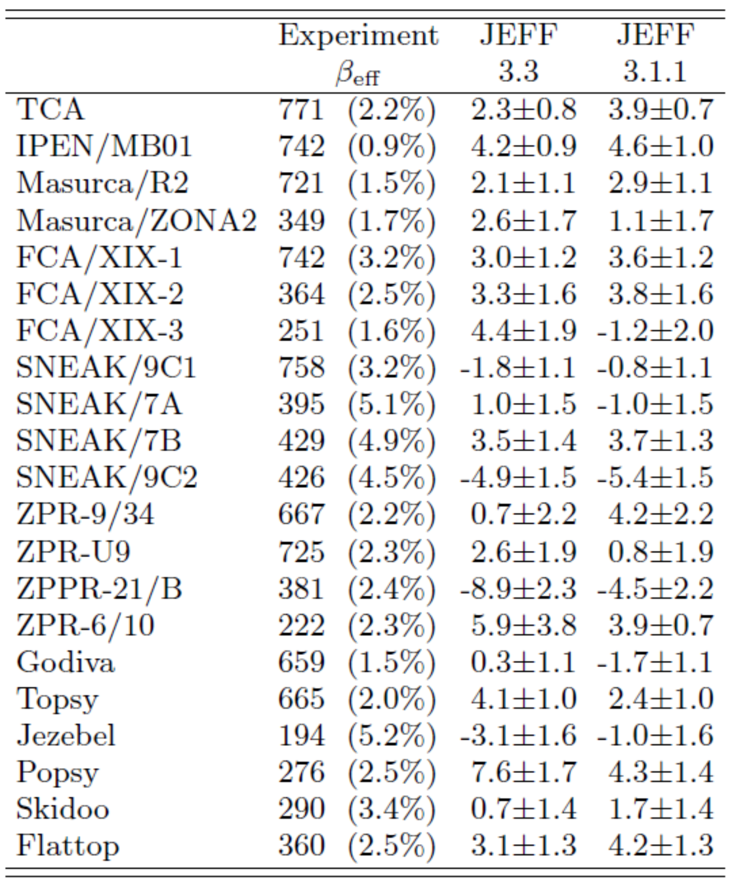


		Boron concentration (ppm)			Axial Offset (%)		
Power (%)	Burnup (GWd/tM)	Meas. (ppm)	SEANAP Original Calculated (ppm)	SEANAP Upgraded Calculated (ppm)	Meas. (%)	SEANAP Original Calculated (%)	SEANAP Upgraded Calculated (%)
50	0.015	1200	1150	1165	7.7	5.6	5.9
75	0.031	1113	1071	1085	3.8	3.7	3.9
100	0.134	985	1000	1011	-0.7	0.7	0.8
100	1.34	870	897	896	-1.6	-1.2	-1.2
100	2.487	779	806	797	-2.4	-2.9	-2.9
100	2.842	755	778	768	-2.8	-3	-3.1
100	3.591	688	714	701	-3.8	-4.9	-5
100	4.441	604	645	629	-3.2	-3.8	-3.9
100	5.549	504	544	526	-3.9	-4.4	-4.6
100	6.692	412	439	420	-4.2	-4.4	-4.5
100	7.716	319	340	321	-4.7	-5.1	-5.2
100	8.823	227	239	219	-3.6	-2.8	-2.8
100	10.284	101	100	79	-3.5	-1.6	-1.5
100	11.351	4	-7	-29	-3.4	-2.1	-2.1

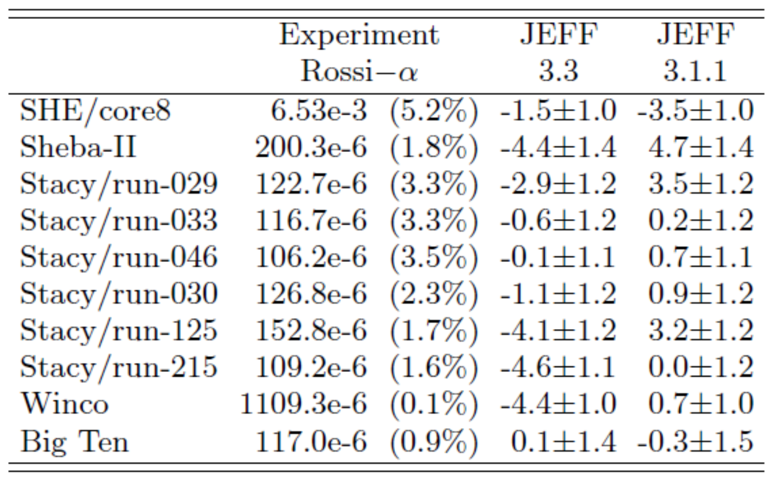
- JEFF-3.3 does very well when applied to an actual PWR code system

Delayed neutron testing

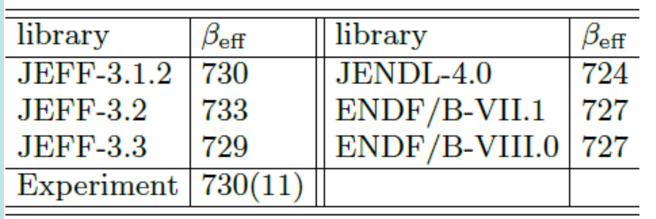
- Beta-eff versus 20 cases in literature and VENUS-F
- JEFF-3.3 comes out well (JEFF-3.1.1 somewhat better)



	Experiment β_{eff}		JEFF 3.3	JEFF 3.1.1
TCA	771	(2.2%)	2.3±0.8	3.9±0.7
IPEN/MB01	742	(0.9%)	4.2±0.9	4.6±1.0
Masurca/R2	721	(1.5%)	2.1±1.1	2.9±1.1
Masurca/ZONA2	349	(1.7%)	2.6±1.7	1.1±1.7
FCA/XIX-1	742	(3.2%)	3.0±1.2	3.6±1.2
FCA/XIX-2	364	(2.5%)	3.3±1.6	3.8±1.6
FCA/XIX-3	251	(1.6%)	4.4±1.9	-1.2±2.0
SNEAK/9C1	758	(3.2%)	-1.8±1.1	-0.8±1.1
SNEAK/7A	395	(5.1%)	1.0±1.5	-1.0±1.5
SNEAK/7B	429	(4.9%)	3.5±1.4	3.7±1.3
SNEAK/9C2	426	(4.5%)	-4.9±1.5	-5.4±1.5
ZPR-9/34	667	(2.2%)	0.7±2.2	4.2±2.2
ZPR-U9	725	(2.3%)	2.6±1.9	0.8±1.9
ZPPR-21/B	381	(2.4%)	-8.9±2.3	-4.5±2.2
ZPR-6/10	222	(2.3%)	5.9±3.8	3.9±0.7
Godiva	659	(1.5%)	0.3±1.1	-1.7±1.1
Topsy	665	(2.0%)	4.1±1.0	2.4±1.0
Jezebel	194	(5.2%)	-3.1±1.6	-1.0±1.6
Popsy	276	(2.5%)	7.6±1.7	4.3±1.4
Skidoo	290	(3.4%)	0.7±1.4	1.7±1.4
Flattop	360	(2.5%)	3.1±1.3	4.2±1.3



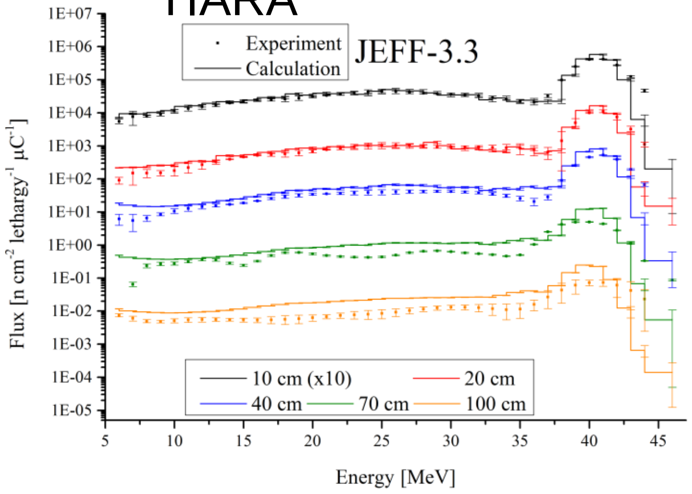
	Experiment Rossi−α		JEFF 3.3	JEFF 3.1.1
SHE/core8	6.53e-3	(5.2%)	-1.5±1.0	-3.5±1.0
Sheba-II	200.3e-6	(1.8%)	-4.4±1.4	4.7±1.4
Stacy/run-029	122.7e-6	(3.3%)	-2.9±1.2	3.5±1.2
Stacy/run-033	116.7e-6	(3.3%)	-0.6±1.2	0.2±1.2
Stacy/run-046	106.2e-6	(3.5%)	-0.1±1.1	0.7±1.1
Stacy/run-030	126.8e-6	(2.3%)	-1.1±1.2	0.9±1.2
Stacy/run-125	152.8e-6	(1.7%)	-4.1±1.2	3.2±1.2
Stacy/run-215	109.2e-6	(1.6%)	-4.6±1.1	0.0±1.2
Winco	1109.3e-6	(0.1%)	-4.4±1.0	0.7±1.0
Big Ten	117.0e-6	(0.9%)	0.1±1.4	-0.3±1.5



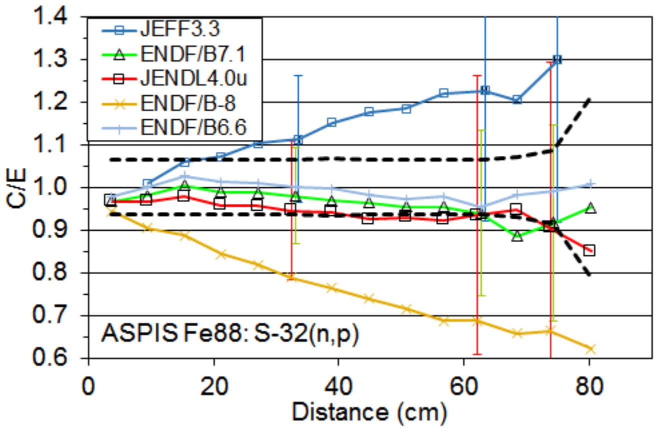
library	β_{eff}	library	β_{eff}
JEFF-3.1.2	730	JENDL-4.0	724
JEFF-3.2	733	ENDF/B-VII.1	727
JEFF-3.3	729	ENDF/B-VIII.0	727
Experiment	730(11)		

Cross section validation using shielding benchmarks from SINBAD Ivo Kodeli I443

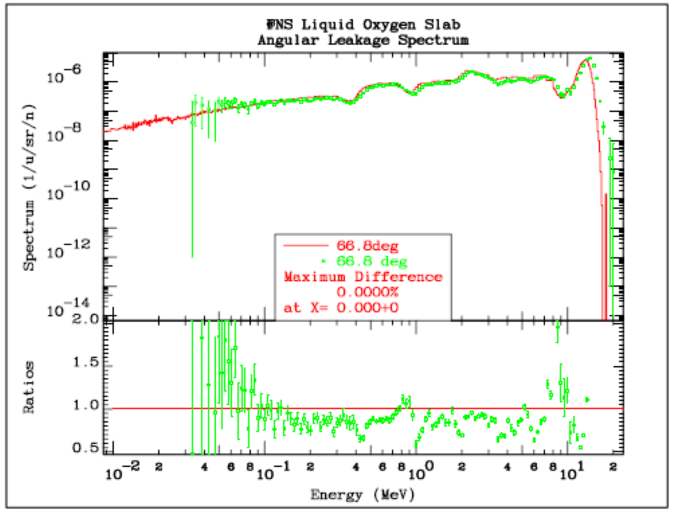
TIARA



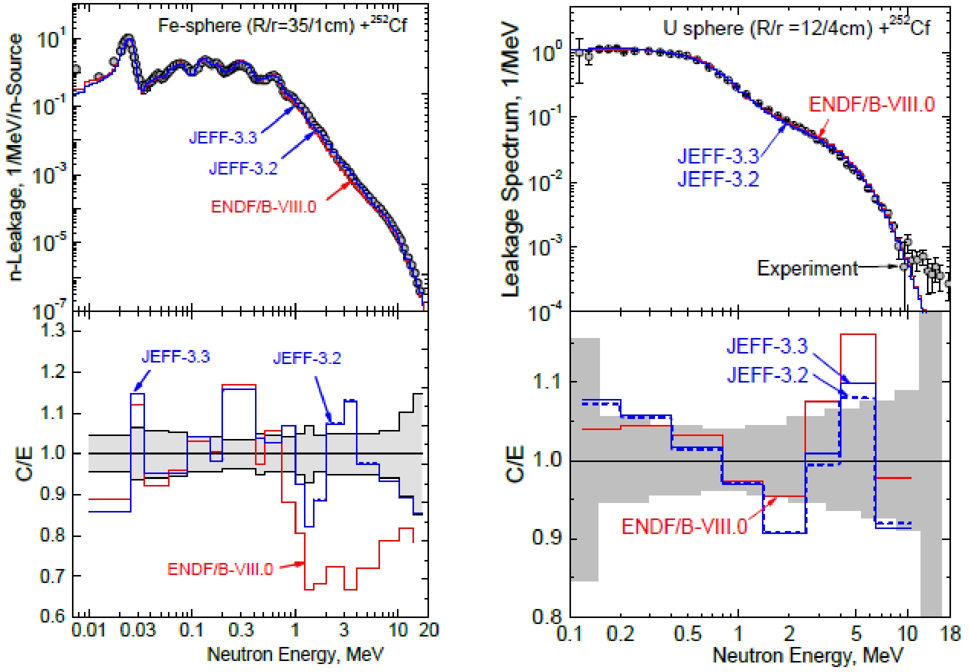
ASPIS IRON-88



FNS Oxygen



Cf-252 leakage spectra Fe and U - IPPE



Decay Heat, Pu-239 & Inconel-600 examples

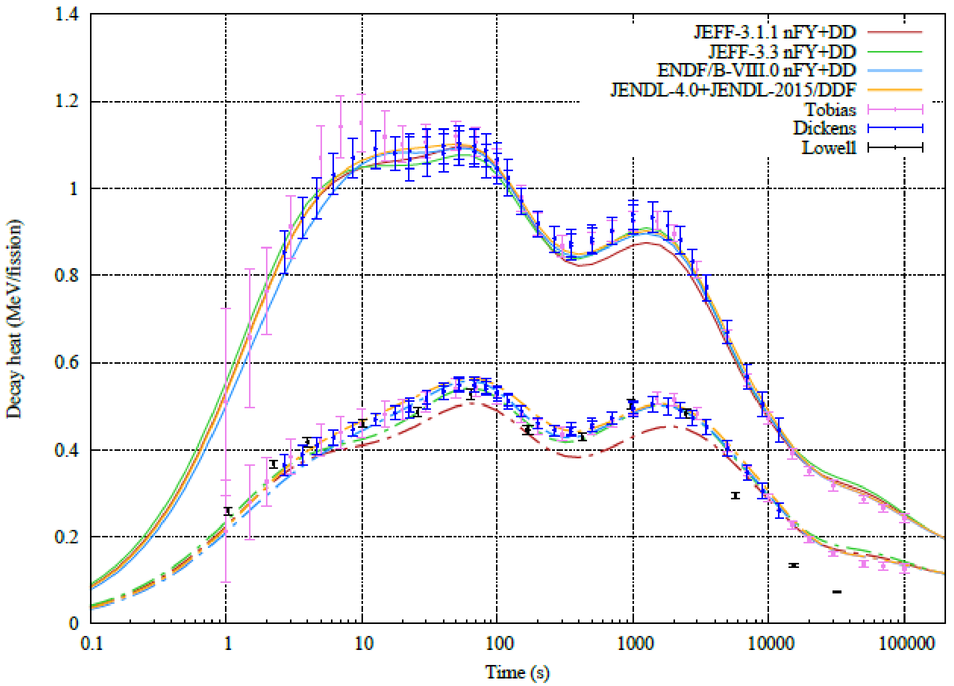


Fig. 98: Total and gamma fission decay heat pulse for ^{239}Pu, showing simulations with a range of nuclear data files, as calculated by FISPACT-II. Note the significant under-prediction of gamma heat for JEFF-3.1.1, over a range of cooling periods from 10 to 2000 seconds.

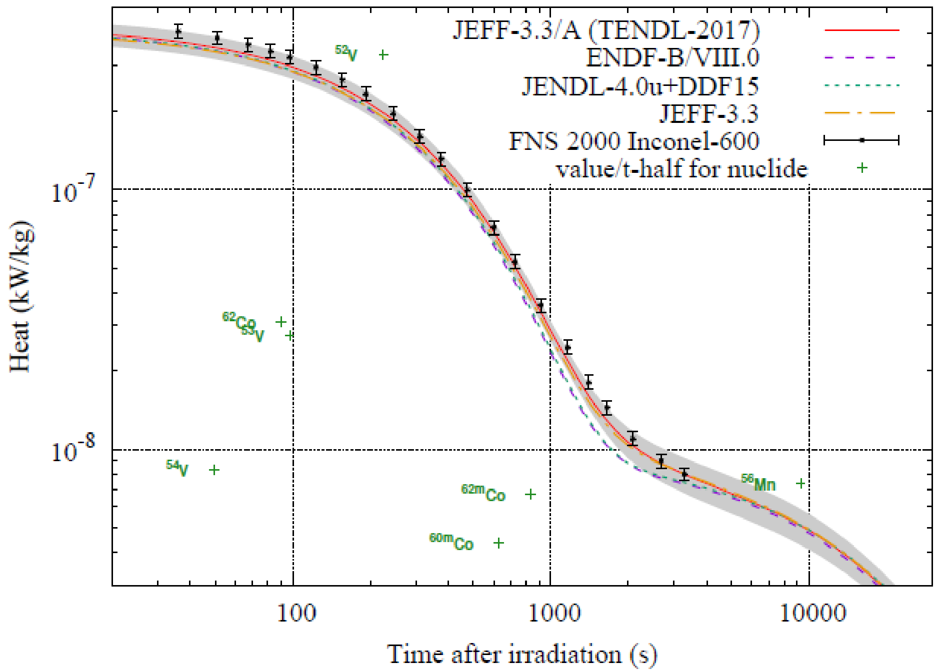
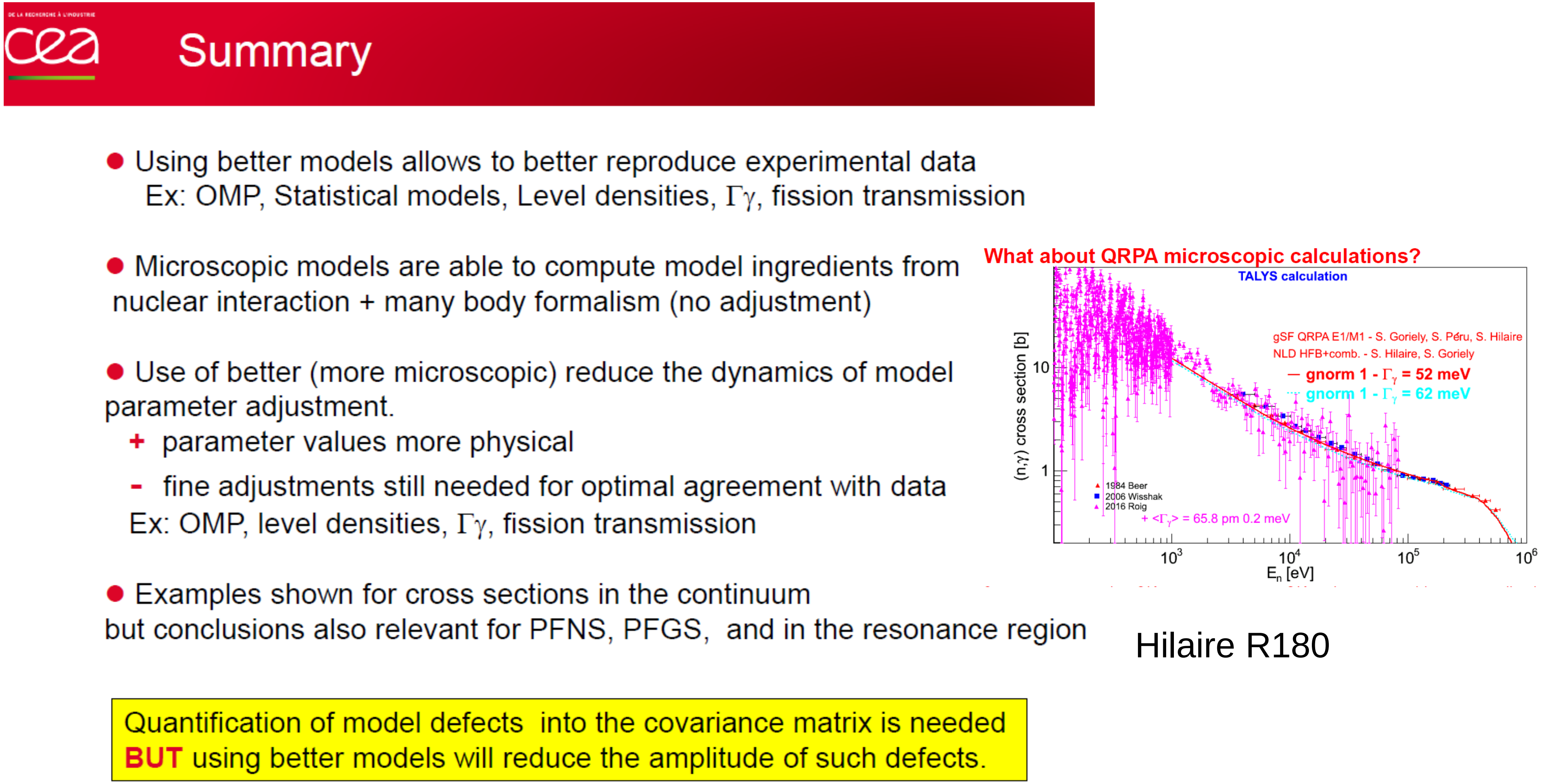


Fig. 100: Decay heat simulations and measurements from the JAEA Fusion Neutron Source, considering Inconel-600 irradiation and the most recent nuclear data libraries. Dominant nuclides are labeled at (x,y) coordinates that are their half-life and post-irradiation quantity, respectively.

JEFF-4.0

- We want JEFF-4 to be a fundamental change
- Best knowledge for users – best physics
- Completeness – large reliance on TALYS and TENDL
- Agreed ways of integrating contributions
- Version and documentation control
- Use modern tools for inspection and checking
- Use modern tools for benchmarking and validation
- Eliminate limitations (formats, correlated emissions)
- Method development 2018-2020
- JEFF-4 development 2021-2024

CEA model development for improved evaluations



Summary

- Using better models allows to better reproduce experimental data
  Ex: OMP, Statistical models, Level densities, $\Gamma\gamma$, fission transmission

- Microscopic models are able to compute model ingredients from nuclear interaction + many body formalism (no adjustment)

- Use of better (more microscopic) reduce the dynamics of model parameter adjustment.
  - \+ parameter values more physical
  - \- fine adjustments still needed for optimal agreement with data

  Ex: OMP, level densities, $\Gamma\gamma$, fission transmission

- Examples shown for cross sections in the continuum but conclusions also relevant for PFNS, PFGS, and in the resonance region

Quantification of model defects into the covariance matrix is needed
BUT using better models will reduce the amplitude of such defects.

What about QRPA microscopic calculations?

Hilaire R180

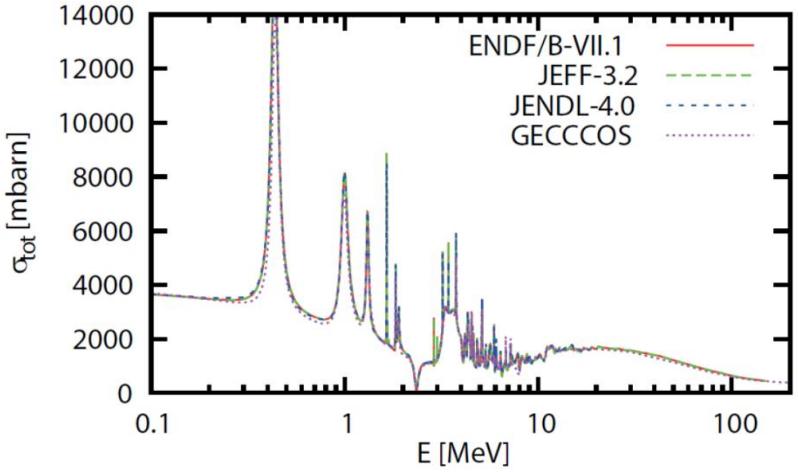
Evaluation of n + ^{16}O cross-section data using Hybrid R-Matrix approach

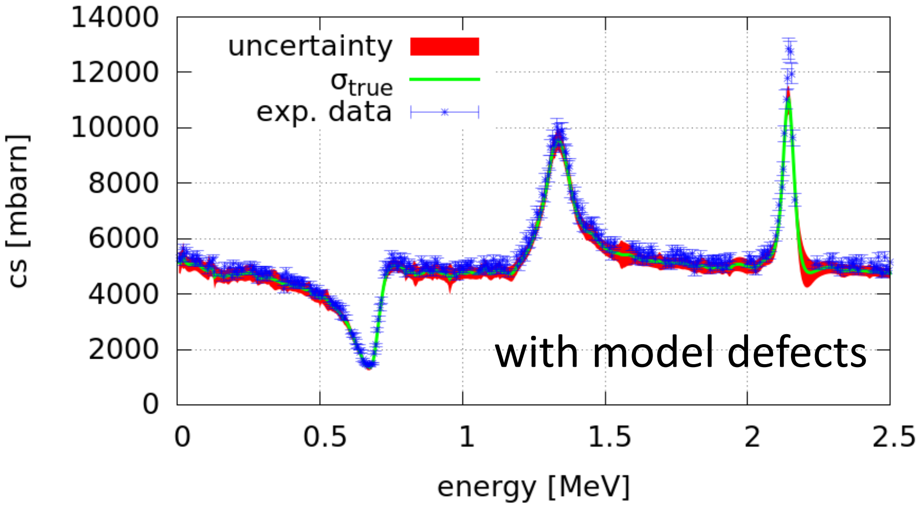
- ***Hybrid R-matrix fit*** *in energy range 1 keV – 14 MeV using TUW code system* ***GECCCOS***
- *Statistical model fit using TALYS with optimized optical potentials (1 keV – 200 MeV)*
- *Unified Bayesian evaluation* ***accounting for model defects*** *(in resonance and statistical energy range) providing co-variance matrices*

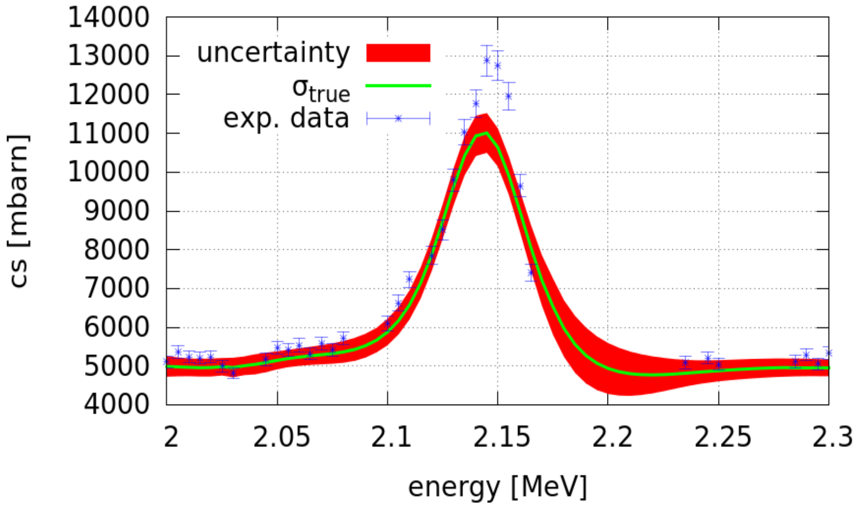
⇒ *Production of full ENDF prototype data file for use in benchmark analyses*

⇒ H. Leeb, R046

Total cross-section n + ^{16}O







Evaluation of fast n + ^{56}Fe cross-sections using advanced evaluation methodologies Arjan Koning L451

PAUL SCHERRER INSTITUT

- ***Randomly generated nuclear data evaluations/files***
  - *Extension of TMC method (A. Koning, D. Rochman)*
  - *Varying nuclear models (e. g. gamma strength functions, leve densities, optical models, … from TALYS & EMPIRE) and parameters (n + ^{56}Fe: 18 000 random files created)*
  - *BMC/BFMC method to find best final evaluation*
  - *Testing with criticality and shielding benchmarks*

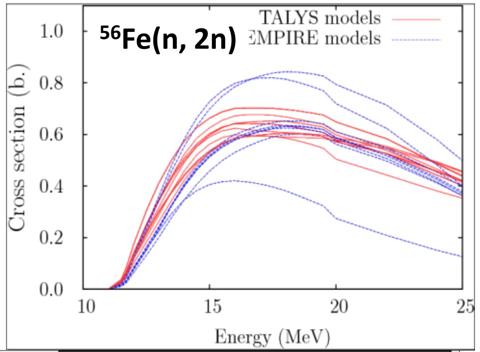
- ***Model defects to describe imperfect physical models and data inconsistencies***

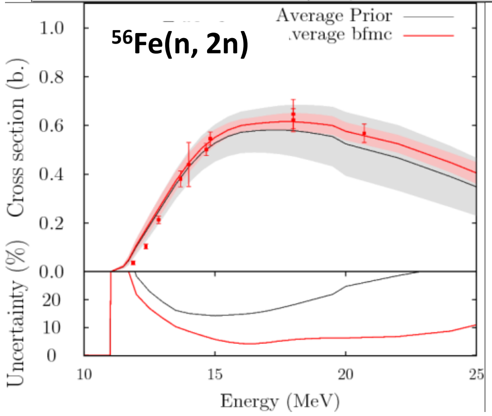
  ⇒ G. Schnabel, R033

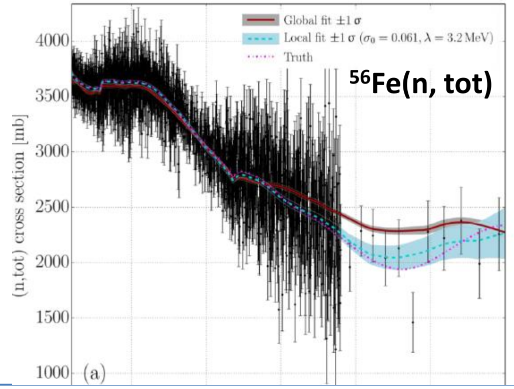
  - *Simulation of model defects by energy-dependent parameters in TALYS code*
  - *Parameter functions modelled as Gaussian processes fitted together with energy-independent parameters*

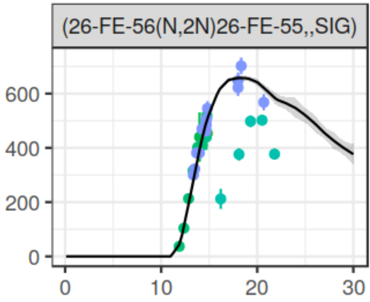
  ⇒ *Demonstration ENDF data file up to 30 MeV*

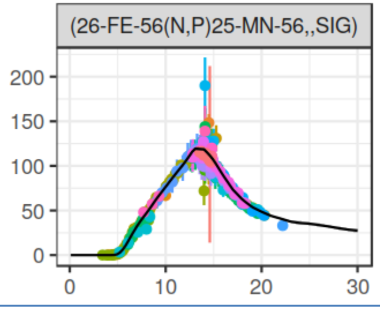
UPPSALA UNIVERSITET

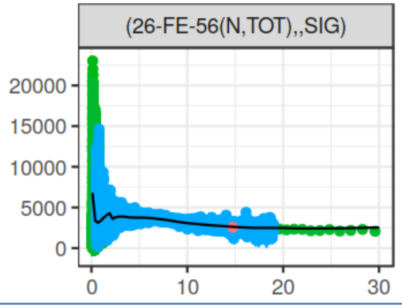








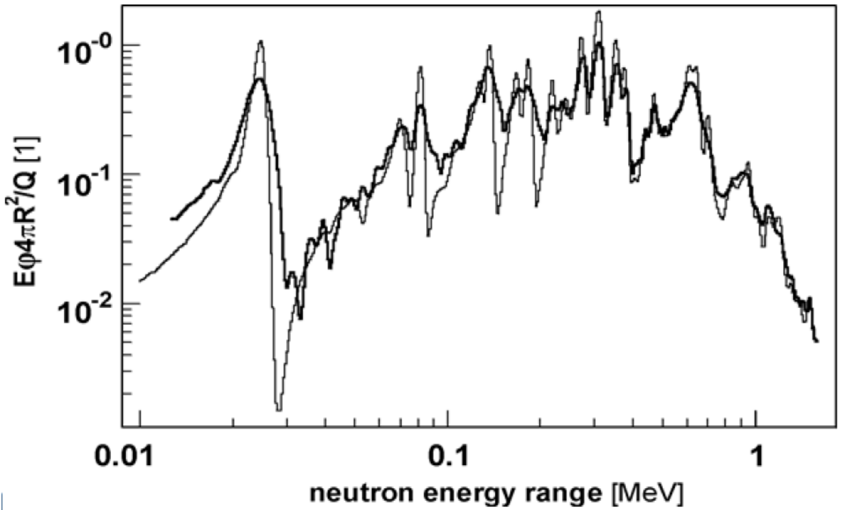




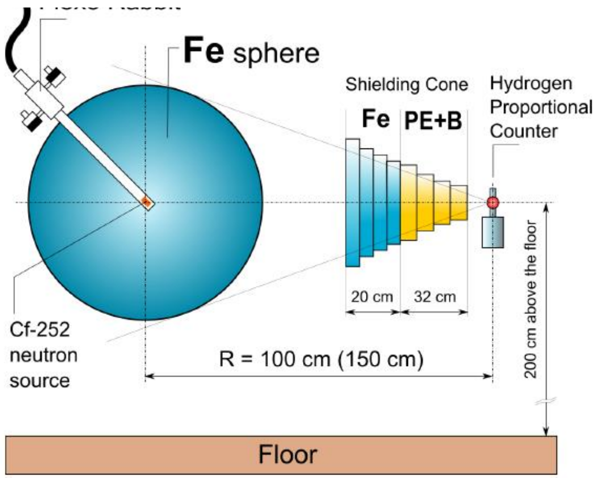
jefdoc-1918

NEA Nuclear Data Week - JEFF Meetings
18 - 20 April 2018, CIEMAT, Moncloa Centre,
Madrid, Spain

Research Centre Rez. Czech Republic



Iron-56, problem with the elastic cross section in neutron energy region around 300 keV and natural iron isotopes influence on the neutron transport through iron



B. Jansky.1.*, J. Rejchrt .1, M.Schulc.1, A. I. Blokhin. 2

1 Department of Neutron Physics. Research Centre. Rez. Czech Republic
2 Nuclear Safety Institute. Russian Academy of Sciences. Moscow. Russia

Resonance range evaluations

JRC & partners

- Au (500 eV <->5 keV)

CEA/Cadarache
- Lu
- Ag

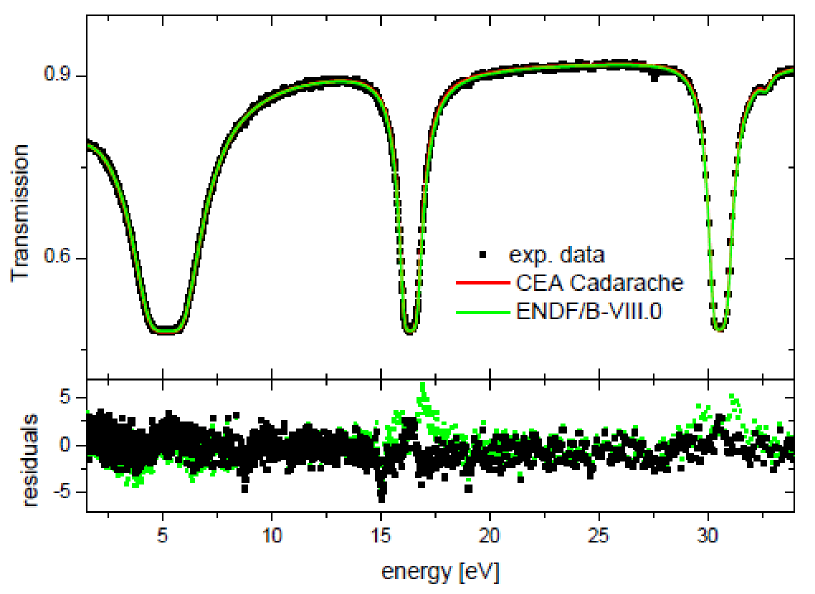
KAERI
- Rh
- Gd (+ INFN Bologna + ENEA)

JAEA
- Cu
- Bi (+SCK-CEN)

INFN Bari
- Y
- Zr

IRSN priority list *(to be completed)*

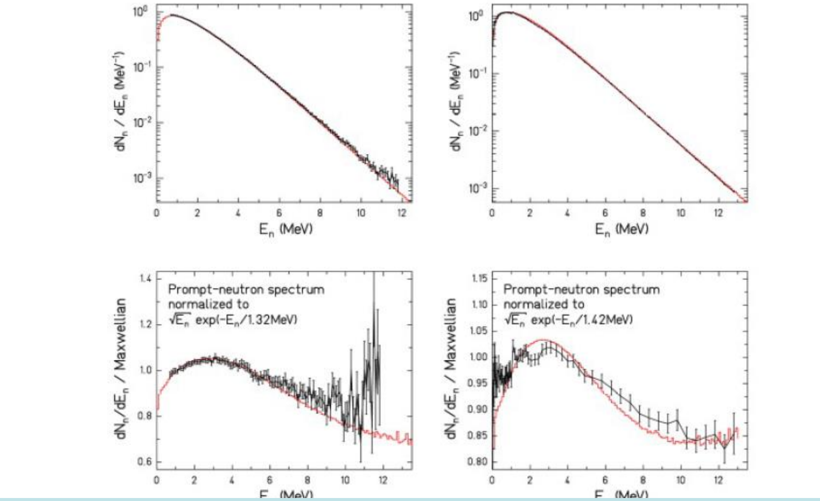
Pu-239
Pu-240, Pu-241, Am-241,
U-235, U-238, U-234
Gd isotopes, Mo isotopes, Fe-54, Fe56, Pb-204, Pb-206, Pb-207, Pb-208
Cl-35, Cl-37, F-19, Nickel isotopes, Sm-149, Sm-152, Cs-133, Si isotopes,
Ca isotopes, Mn-55, Nd-143

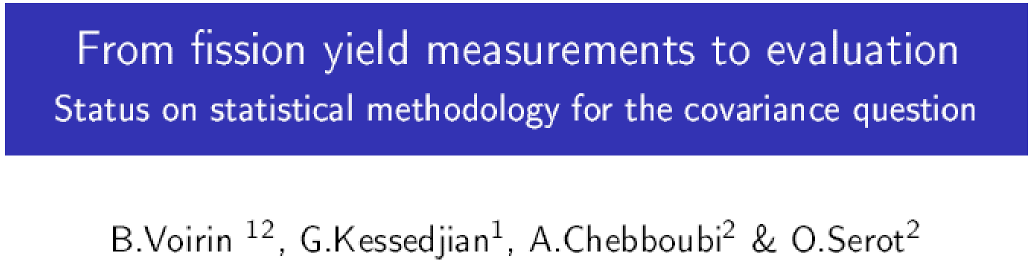


- CEA Cadarache
- ^{237}Np,
- ^{240,242}Pu,
- ^{241,243}Am,
- ^{103}Rh,
- ^{99}Tc,
- ^{234}U,
- ^{235,238}U,
- ^{239}Pu

Fission yields

- Support for new evaluation was very fragile
- Considerable new experimental and modeling efforts
- Database needs to be secured
- Evaluation process needs to be secured
- Alignment with radioactive decay data evaluation
- Completeness is possible using FIFRELIN & GEF
- Resolution needed between accuracy from experiment and complete modeling (similar to reaction evaluations)

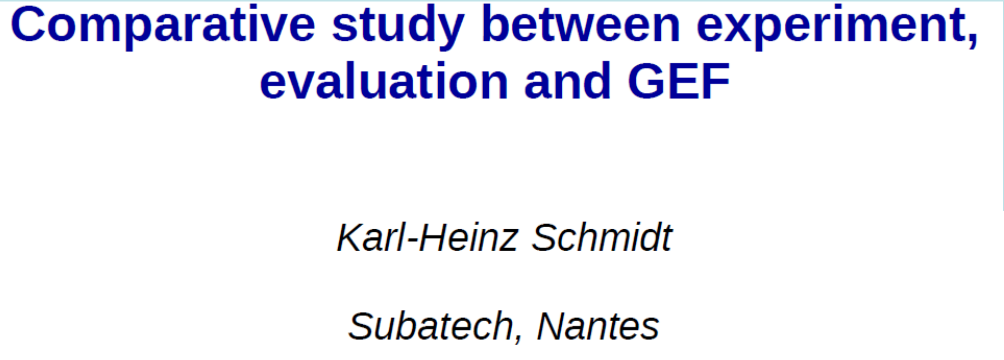




From fission yield measurements to evaluation

Status on statistical methodology for the covariance question

B.Voirin [12], G.Kessedjian[1], A.Chebboubi[2] & O.Serot[2]



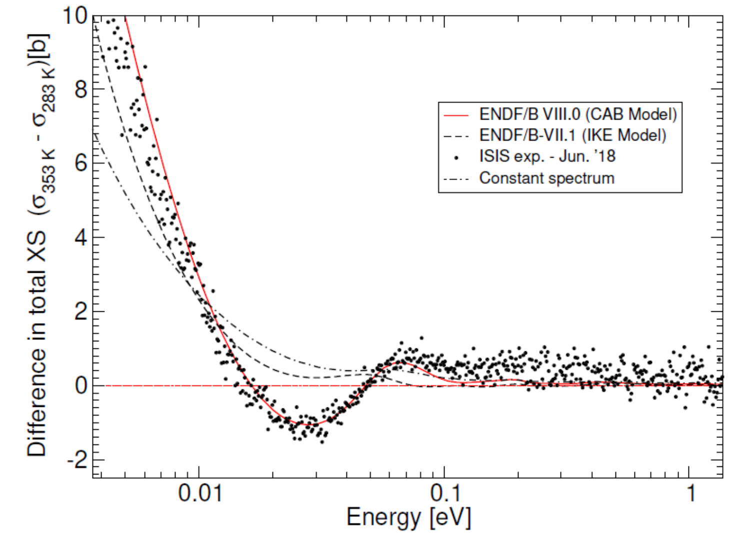
Comparative study between experiment, evaluation and GEF

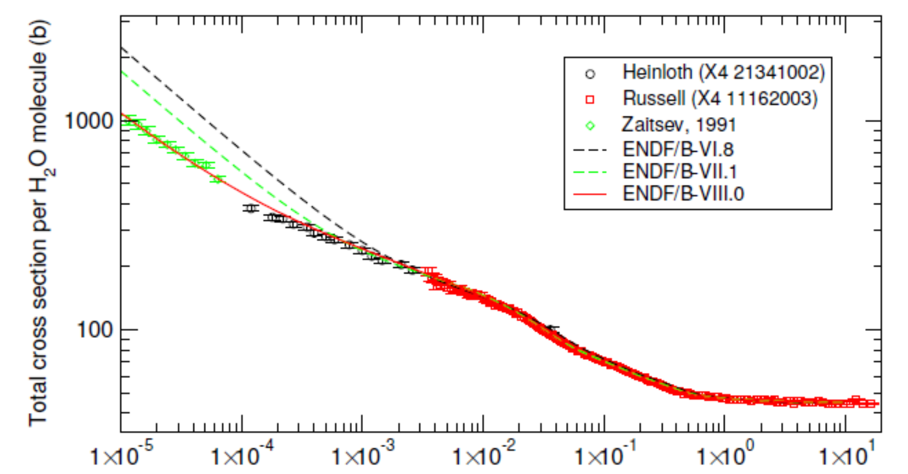
Karl-Heinz Schmidt

Subatech, Nantes

Thermal scattering

- Important new modeling developments.
- New experimental data.
- Only partly on board in JEFF-3.3.
- We should fully adopt the new modeling as it is supported by old and new data, better than JEFF-3.3.
- Use covariance information.





Summary

- JEFF-3.3 delivered in November 2017 – good performance
- JEFF-4 is expected in 2024.
- Important developments are underway.