The European Commission's science and knowledge service

Joint Research Centre

European Commission

Status of the JEFF project

Arjan Plompen

OECD-NEA, 14 May 2020

European Commission

- The JEFF-3.3 paper is in production at Springer

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)

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.

Nov 2019

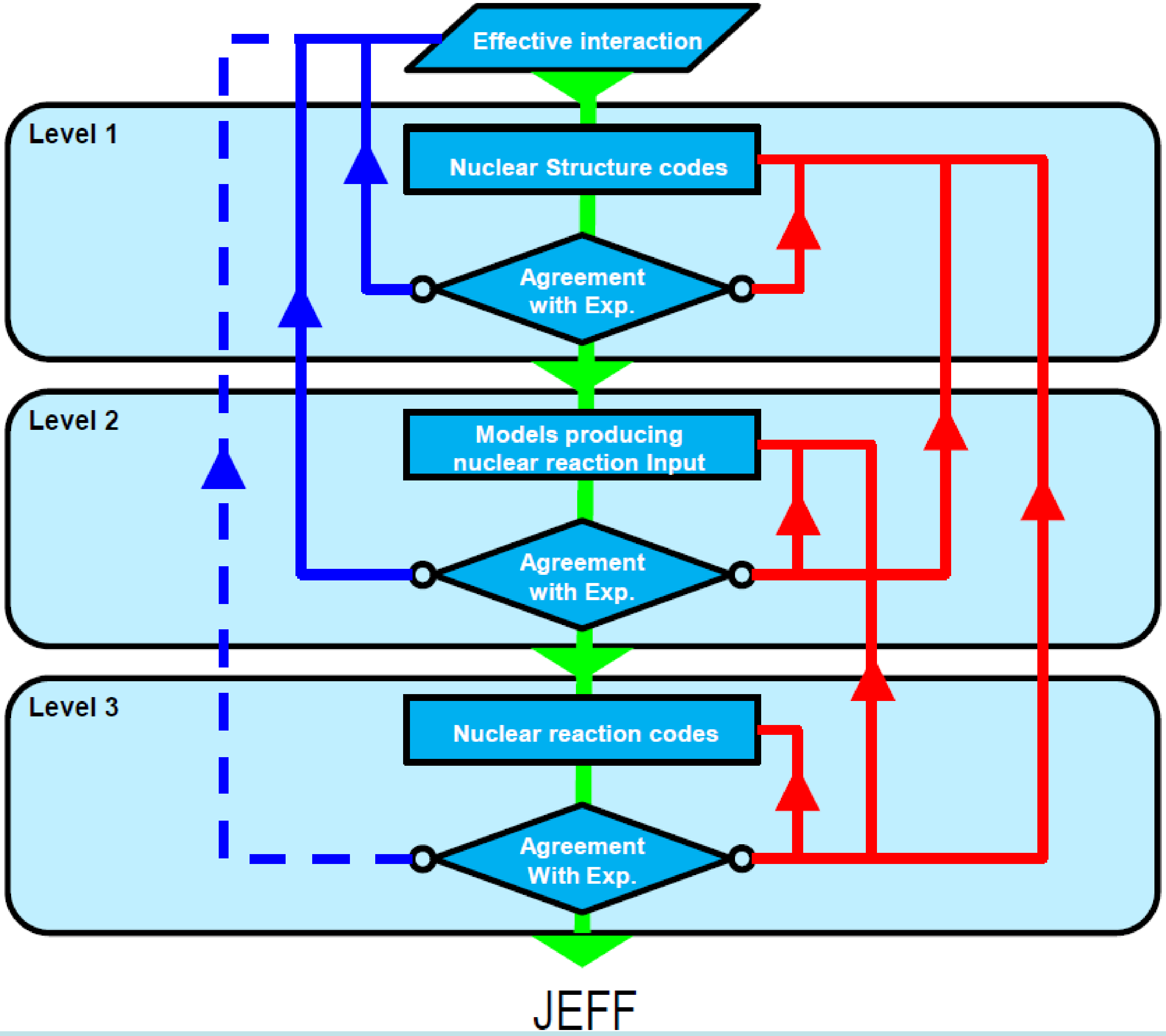
09:30	JEFFDOC-1975	Stephane	HILAIRE	*Introduction to the modeling session*	CEA
10:00	JEFFDOC-1976	Stephane	GORIELY	*Towards more reliable evaluations on the basis of microscopic models*	ULB
10:30	***Coffee break***				
11:00	JEFFDOC-1977	Marc	DUPUIS	*Neutron inelastic scattering: what can we learn from microscopic models*	CEA
11:30	JEFFDOC-1978	Roberto	CAPOTE	*Advanced modeling of neutron induced reactions on actinides*	IAEA
12:00	JEFFDOC-1979	Olivier	SEROT	*Potential use of the FIFRELIN code for the future evaluations in JEFF-4*	CEA
12:30	***Lunch break***				
13:30	JEFFDOC-1980	Erwin	ALHASSAN	*Iterative Bayesian Monte Carlo for nuclear data evaluation*	PSI
14:00	JEFFDOC-1981	Gilles	NOGUERE	*Experimental validation of the thermal scattering laws*	CEA
14:30	JEFFDOC-1982	Gregoire	KESSEDJIAN	*235 U(nth,f) Fission Yield evaluation - status and perspectives*	LPSC
15:00	JEFFDOC-1983	Robert	MILLS	*Measurement of the 13C absorption cross section via neutron irradiation and AMS*	UKNNL
15:15	JEFFDOC-1984	Camilo	CORDERO RAMIREZ	*Gamma production for inelastic scatterings using TRIPOLI-4, MCNP and PHITS*	CEA

Nov 2019

Structure data

Ingredient data

Reaction data

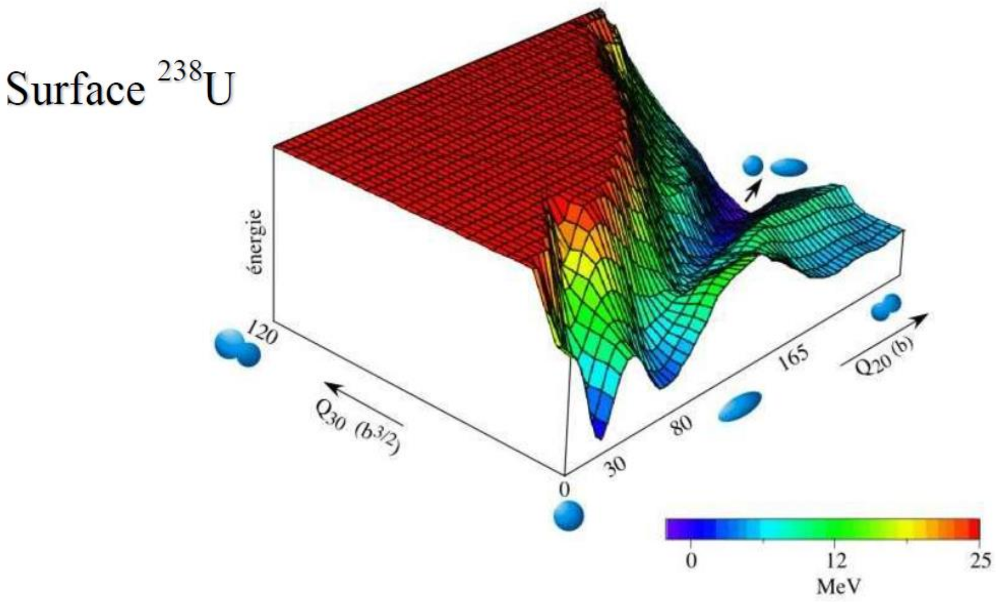


Microscopy for evaluation (Goriely)

FISSION PATHS

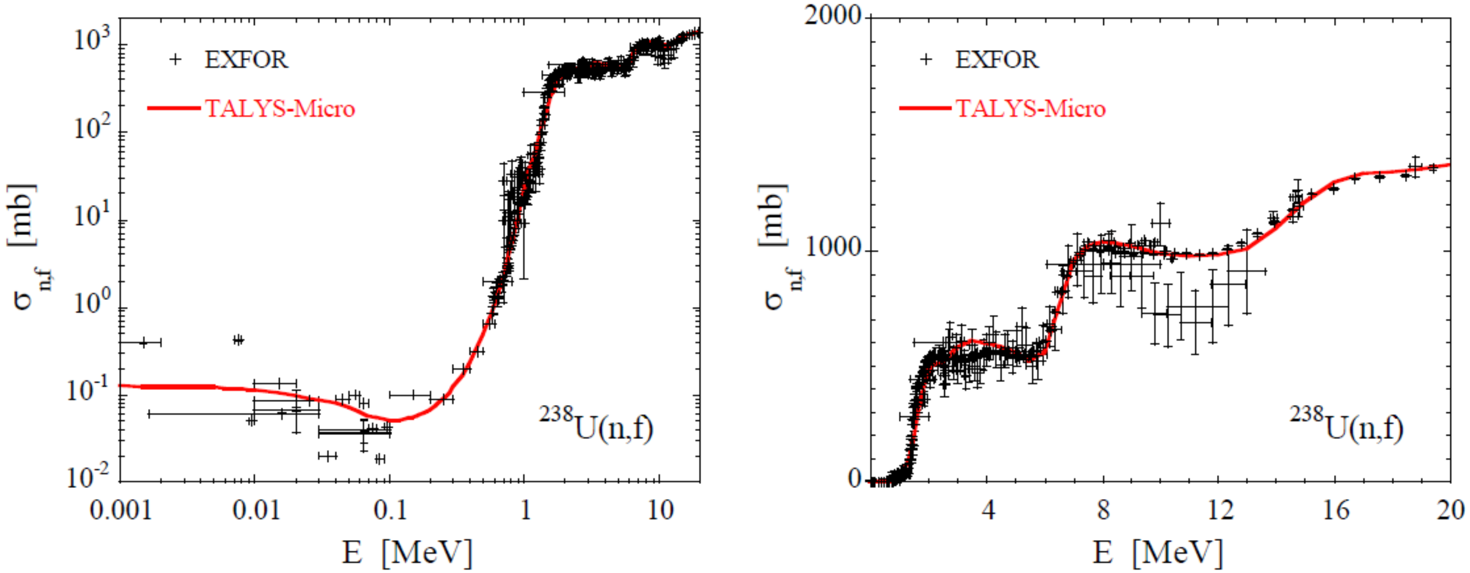
Potential energy surface determined from

$$E(\beta_2,\beta_3)=E_{HFB}+\Delta E_{Quad}+\Delta E_{triax}+\Delta E_{ZPE}$$



"Unconstrained" fit to ^{238}U(n,f) cross section in the 0.001 – 20 MeV range

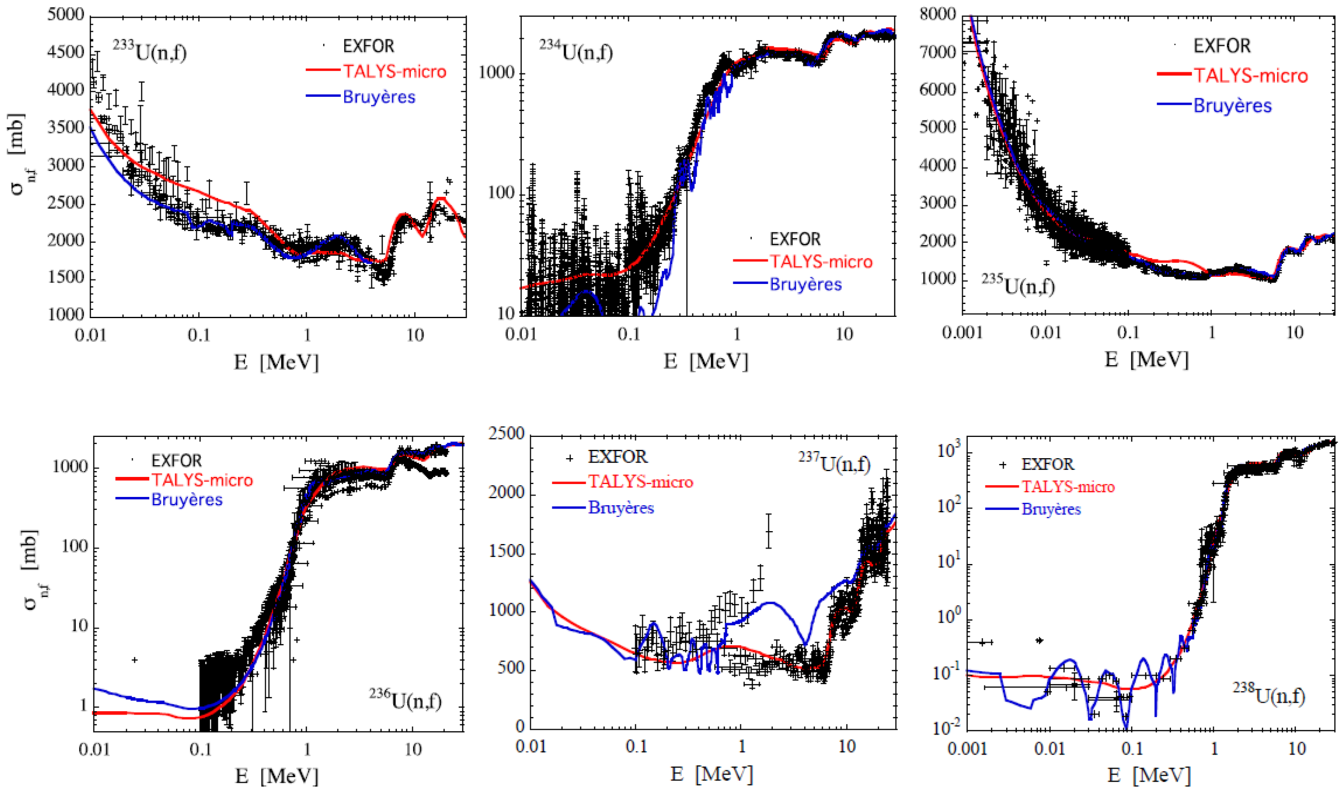
adjustement of height of fission path and saddle NLD

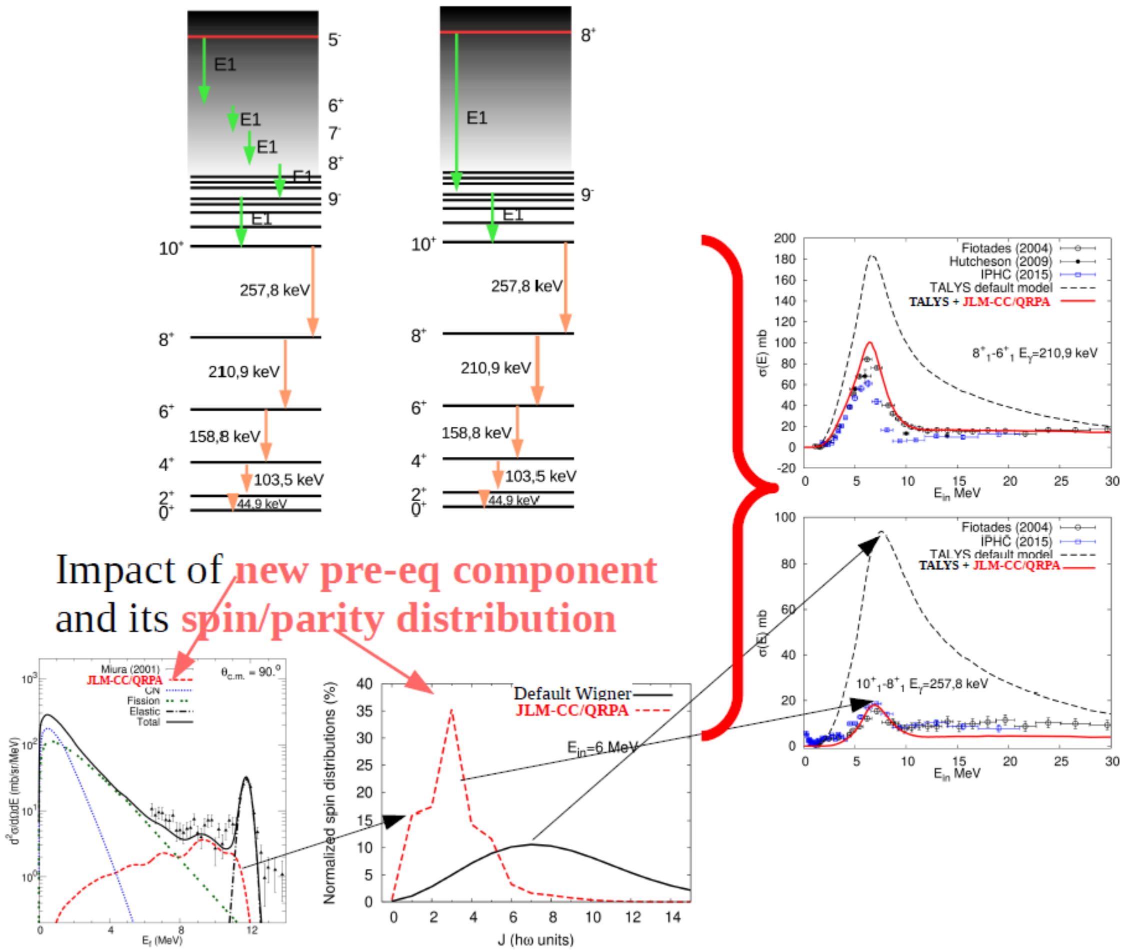


Goriely and Dupuis

Fit to ^{23x}U+n cross sections in the 0.001 – 30 MeV range

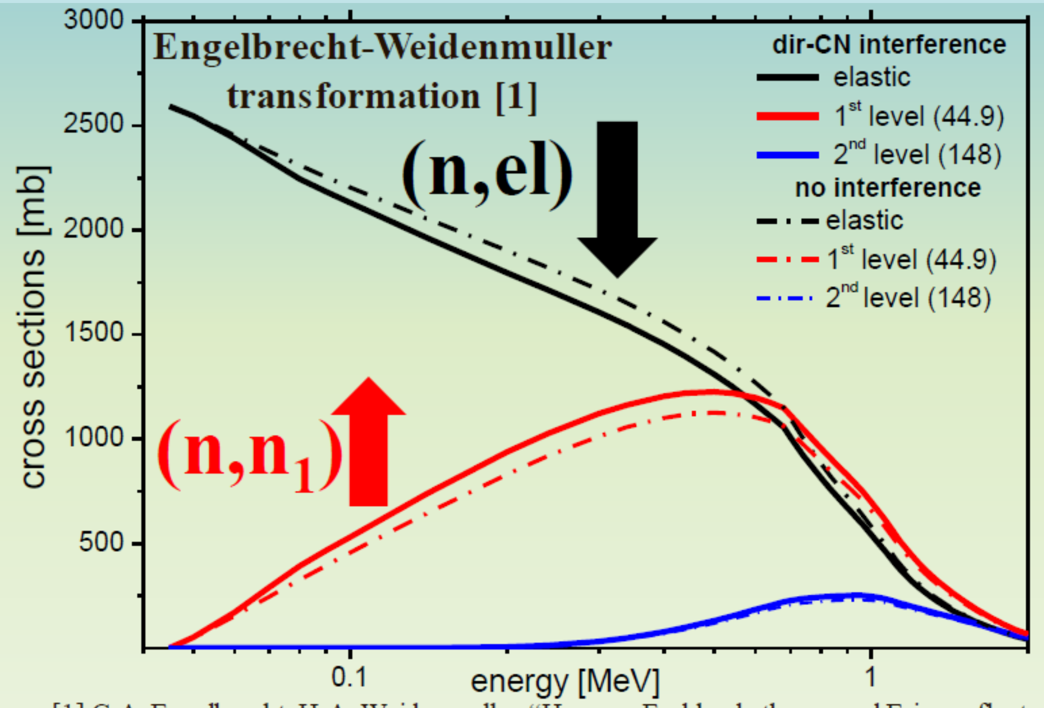
1 UNIQUE set of “microscopic” nuclear ingredients





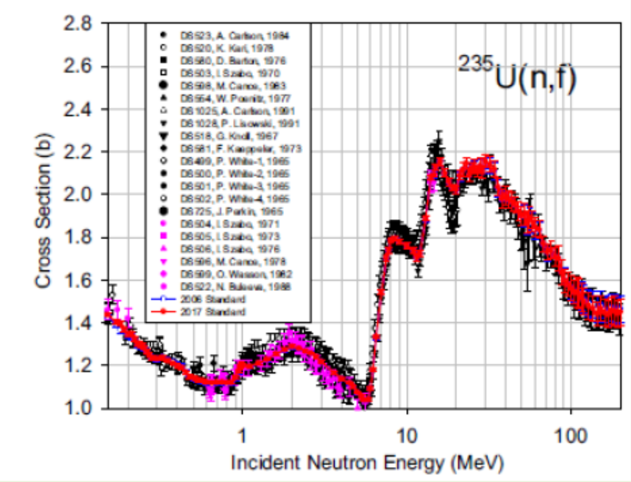
Capote

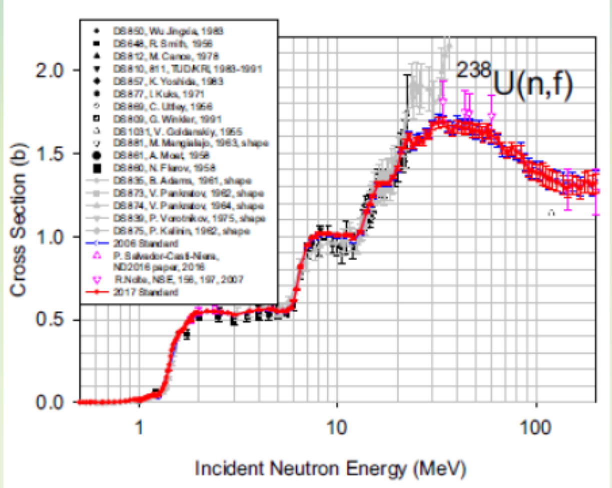
- IAEA approach



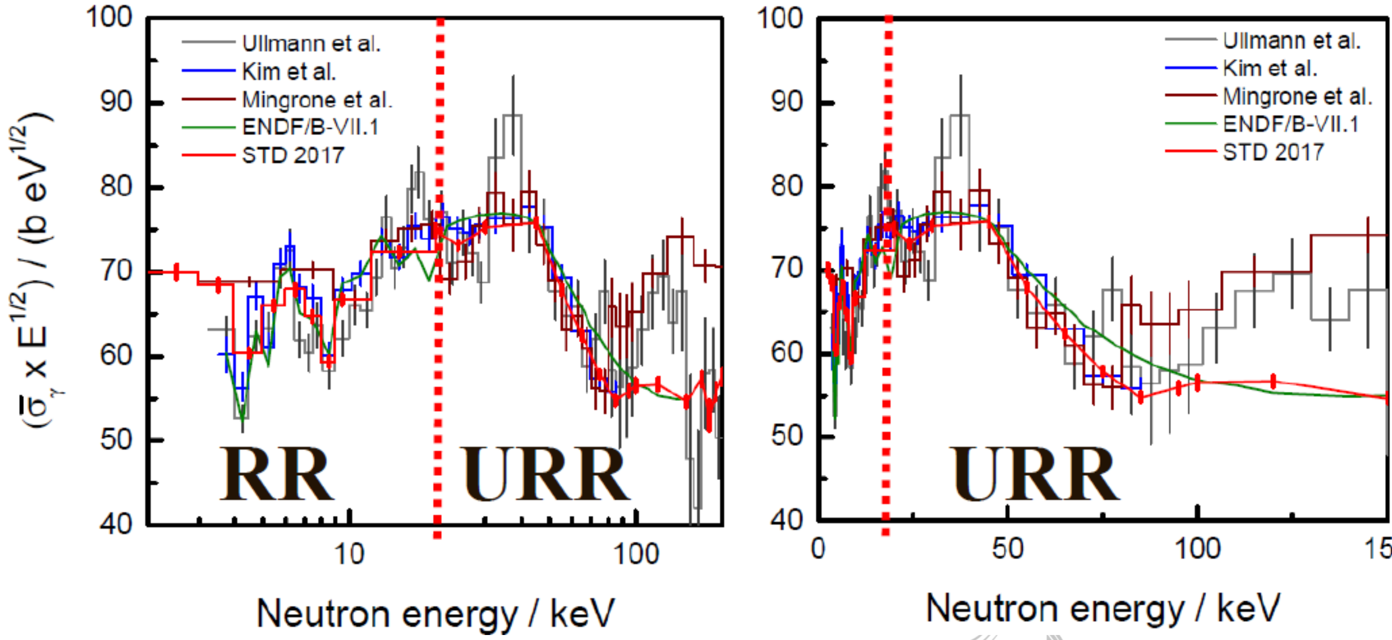
[1] C.A. Engelbrecht, H.A. Weidenmuller, "Hauser--Feshbach theory and Ericson fluctuations in the presence of direct reactions", Phys.Rev. **C8** (1974) 859-862

Modelling goal: 1st) Description; 2nd) Prediction





A. Carlson et al, *Nucl. Data Sheets* **148** (2018) 143-188



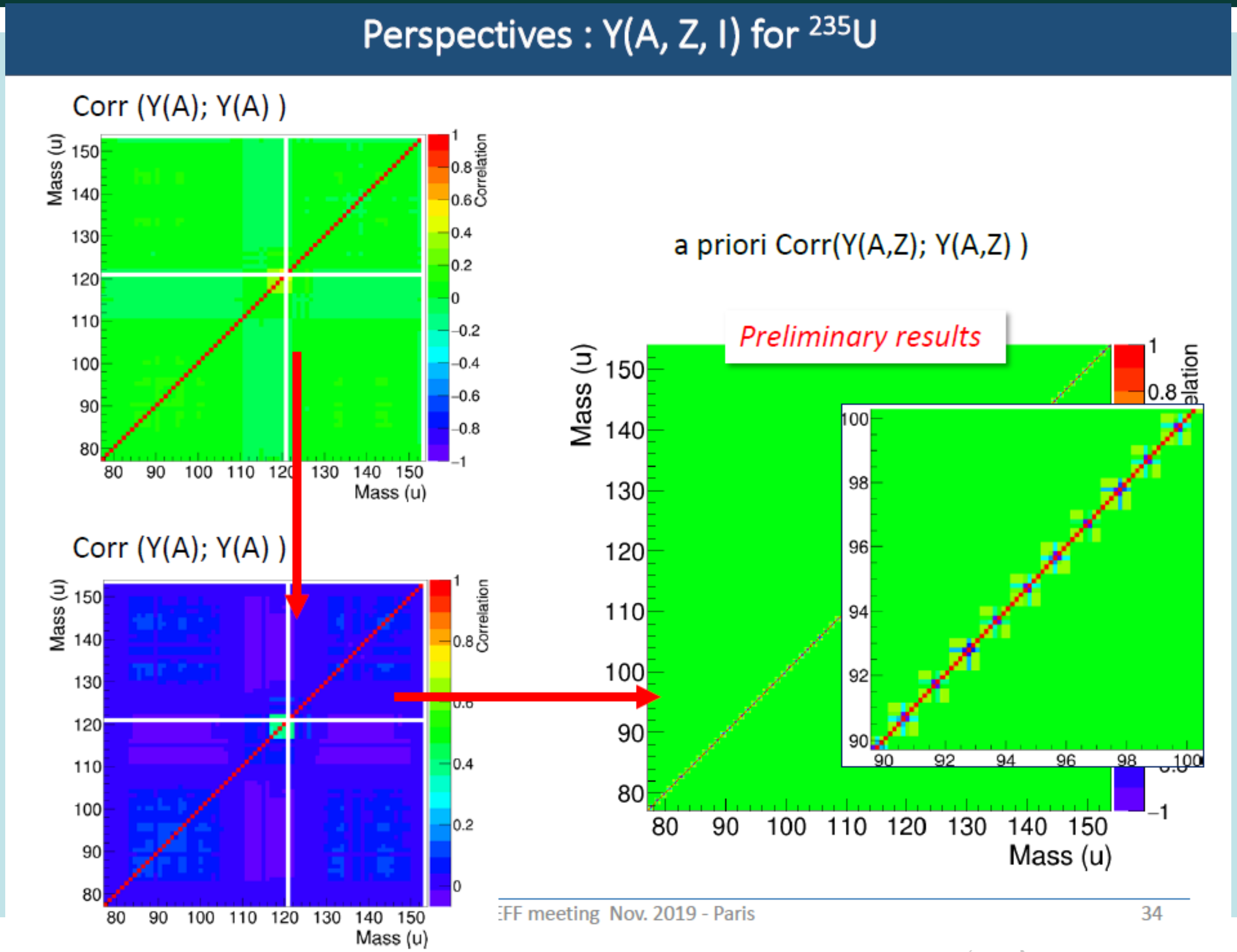
Serot, Kessedjian: fission yields

Potential use of the FIFRELIN code for the future evaluations in JEFF-4

O. Litaize, <u>O. Serot</u>, A. Chebbouibi

CEA DEN Cadarache
13108 Saint Paul Lez Durance
France

Jeff meeting - November 28, 2019



Duhamel

Conclusion (1/2)

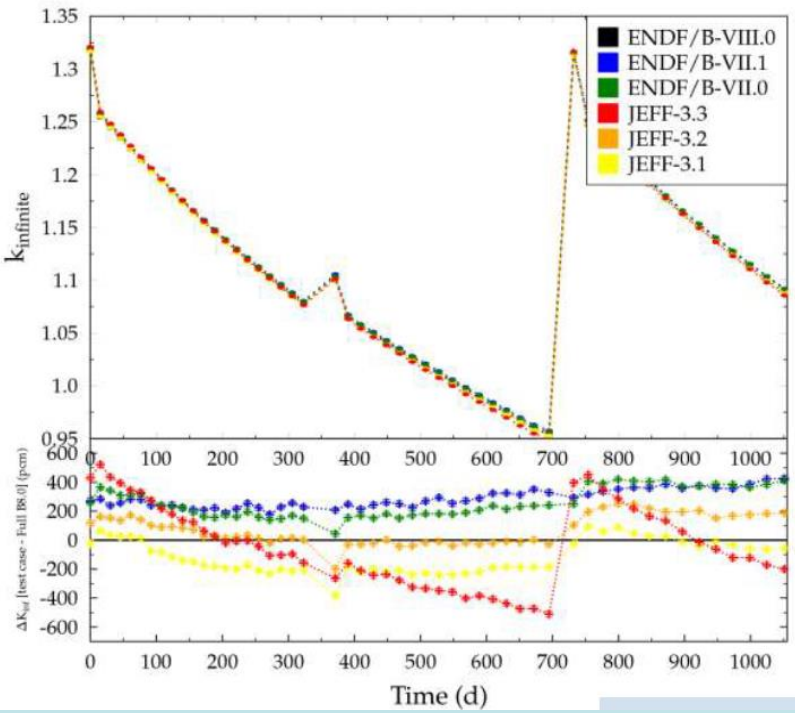
- Improvement of the codes validation suites
  - Used for sensitivity/uncertainty studies
- Feedback to ICSBEP
  - Experimental data quality
  - Misunderstanding in benchmark model
  - Suspicious data or experimental uncertainties
- Feedback to Nuclear Data Community
  - JEFF-3.3 and ENDF/B-VIII.0 improvements and isotopes to focus on
  - Processing tools
  - New evaluations needed

MAIN CONCLUSIONS

- Improvement with JEFF-3.3 and ENDF/B-VIII.0 libraries for Pu in thermal spectra
- ^{235}U in thermal spectra quite well evaluated in ENDF/B-VII.1, ENDF/B-VIII.0 and JEFF-3.3
- Good results retained with ENDF/B-VIII.0 and JEFF-3.3 for ^{235}U and ^{239}Pu in fast spectra
- ENDF/B-VIII.0 and JEFF-3.3: improvement of Ni scattering cross section in fast spectra
- Improvement with ENDF/B-VIII.0 for Be reflected configurations in fast spectra
- Vanadium nuclear data to be improved

Ichou (Nov ‘19 and Apr ‘20)

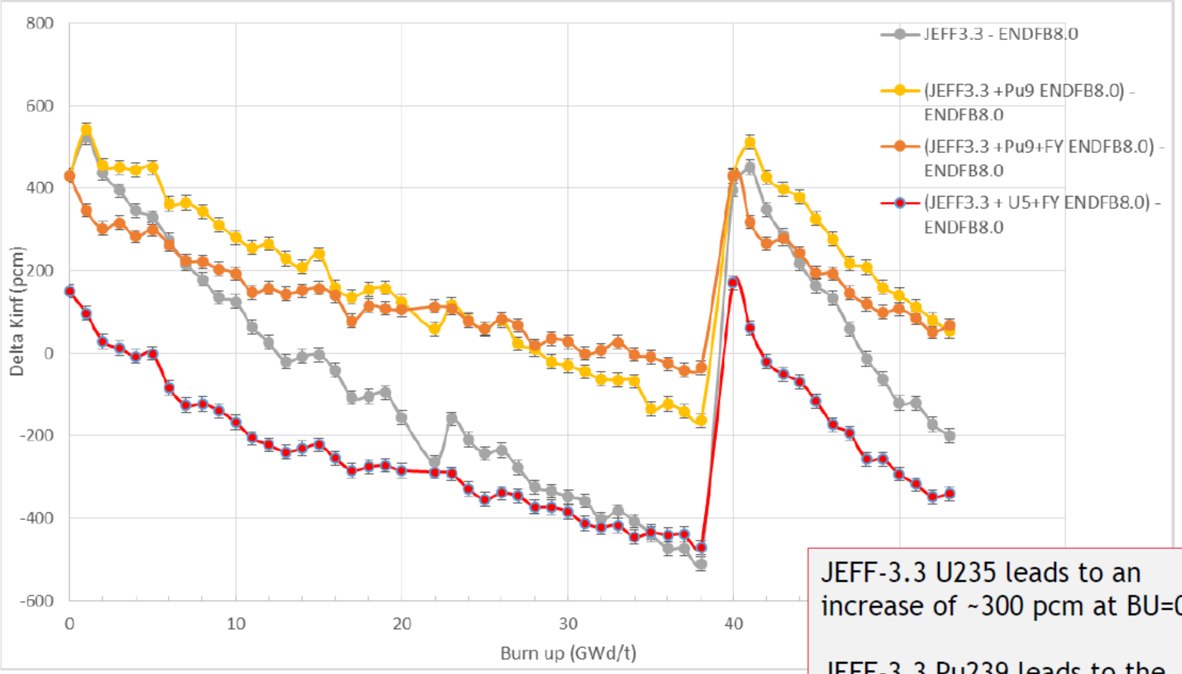
ARIANE GU3 results



- Dk_{inf} with respect to ENDF/B-VIII.0 stay more or less constant.
- The JEFF-3.3 results show a huge burn up effect!
- A huge jump. of around 1000 pcm is observed during the rod change of assembly at 3rd cycle.
- Explanation candidate:

The increase of ^{239}Pu capture cross section of 2 % in JEFF-3.3 (compared to JEFF-3.2)

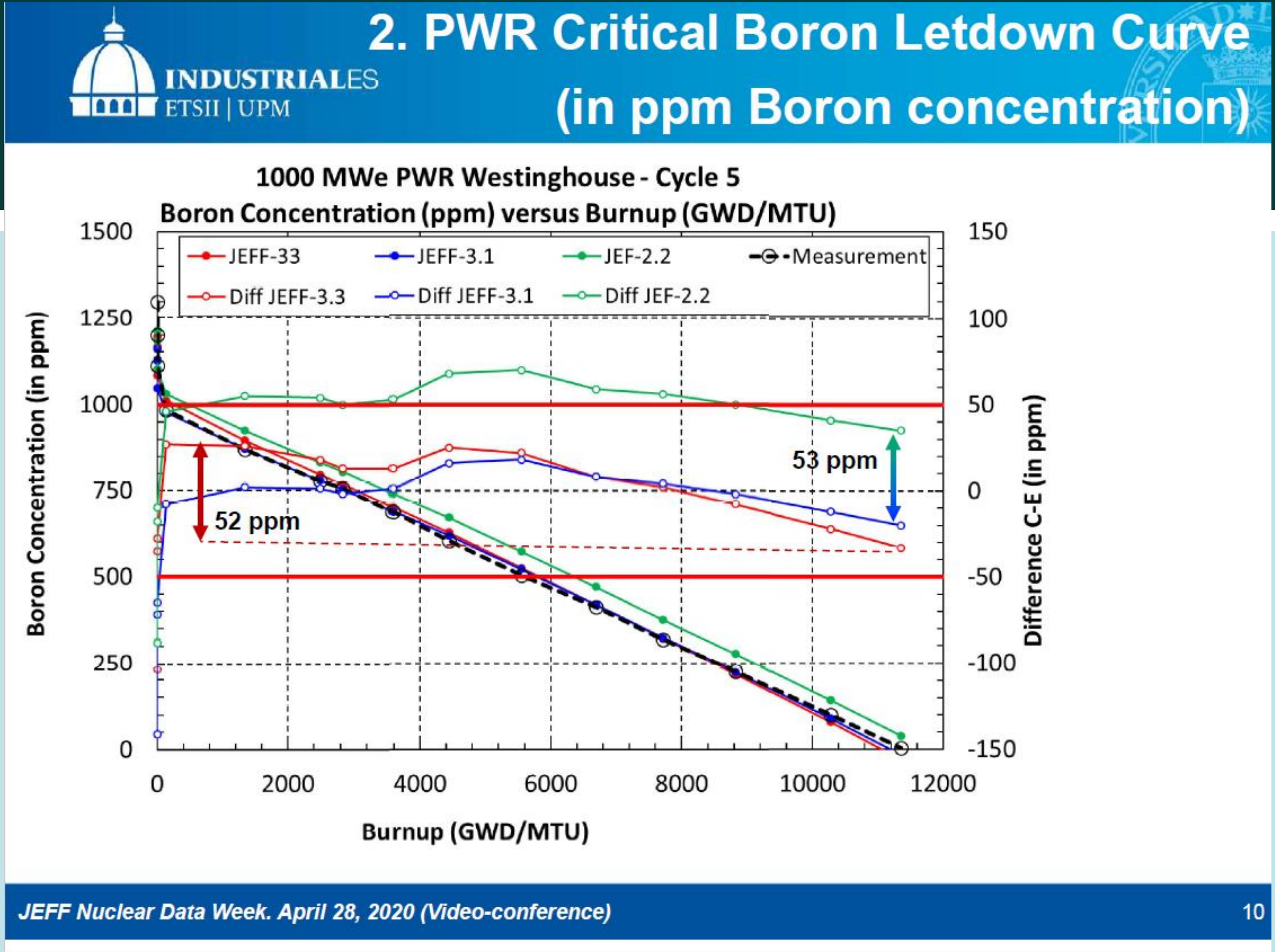
K-inf bias investigations



JEFF-3.3 U235 leads to an increase of ~300 pcm at BU=0

JEFF-3.3 Pu239 leads to the decrease of kinf with burn-up

Cabellos



European Commission

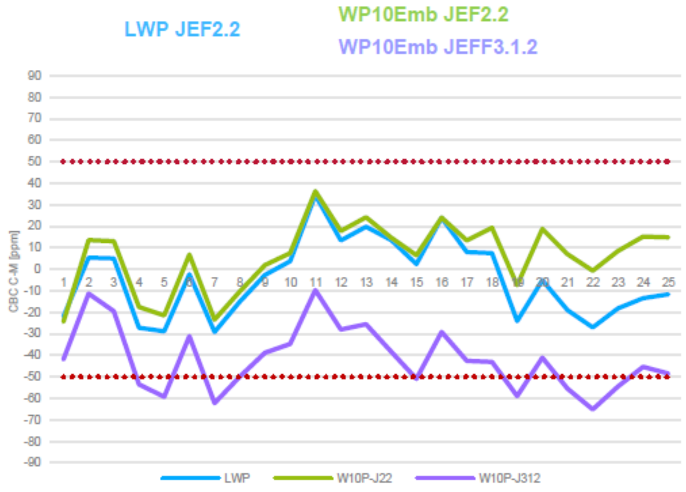
Schneidesch

Core physics suite evolution

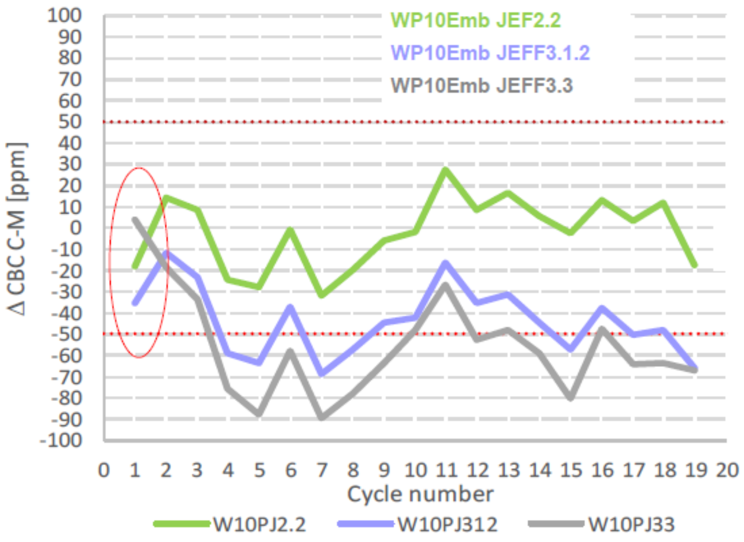
Plant validation/ Impact of the nuclear data library

- Example of library effects on plant data validation : Δ boron concentration HZP

Belgian test Unit



2019



2020

Fresh <> Depletion

Bernard - detailed analysis to follow up

- *JEFF-4.0* Big 3: $n_{th+epith} \rightarrow$ ^{235,238}U (having in mind errors in PCGS+yields) + ^{239}Pu (subthermal, 1^{rst} reso and 40-140eV)

- ^{156}Eu(n,γ) and ^{105}Rh(n,γ) and some FY.

- To be in-depth analysed: large cores radial power maps (and small cores reactivity) which are sensitive to:
  - ^{235}U+n_{th} PFNS
  - ^{238}U($n_{[1;5]MeV}$,n_c') xs + SAED, ^{238}U($n_{[1;5]MeV}$,f) xs+PFNS
  - …

UOx	BOL	EOL
JEFF-3.2/JEFF-3.1.1	+60pcm	-229pcm
JEFF-3.3/JEFF-3.1.1	+188pcm	**-1126pcm**

MOx	BOL	EOL
JEFF-3.2/JEFF-3.1.1	-640pcm	-242pcm
JEFF-3.3/JEFF-3.1.1	-150pcm	**-517pcm**

SUPPLYING ACCURATE NUCLEAR DATA FOR ENERGY AND NON-ENERGY APPLICATIONS

Basic data

Coordinator: CIEMAT, Enrique Gonzalez Romero

H2020 Grant Agreement number: 847552

A proposal in negotiation for the EURATOM WP2018 for NFRP-2018-4

Proposed Start date: 01/09/2019

Duration: 48 months

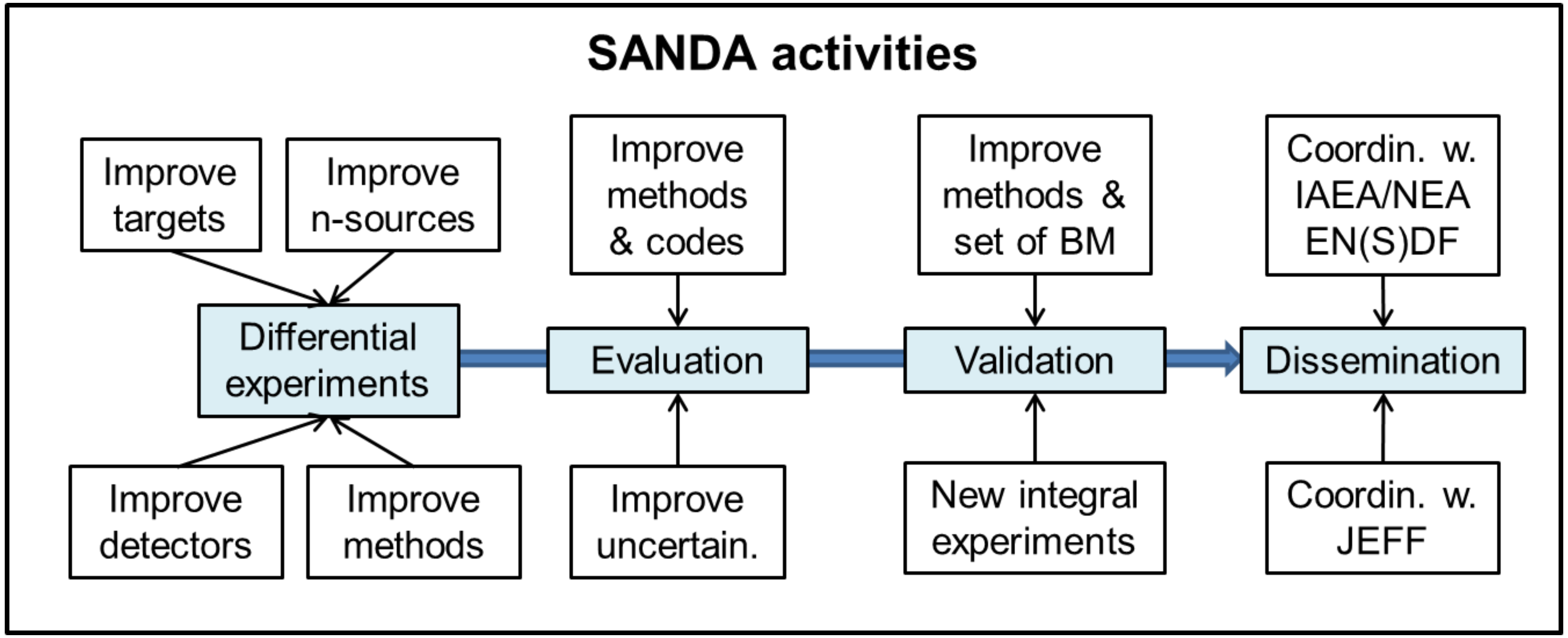
Requested contributions: 3.5 MEuros

35 Partners: *CIEMAT*, Atomki, CEA, CERN, CNRS, CSIC, CVREZ, ENEA,
HZDR, IFIN-HH, IRSN, IST-ID, JRC, JSI, JYU, KIT, NPI, NPL,
NRG, NTUA, PSI, PTB, SCK-CEN, Sofia, TUW, UB, ULODZ,
UMAINZ, UMANCH, UOI, UPC, UPM, USC, USE, UU.

19 countries (A, B, Bg, Cz, D, Es, Fi, F, Gr, H, I, NL, Pol, Pt, Ro, Slo, S, UK)

SANDA Objectives

- Address aspects of nuclear data research producing accurate and reliable data, codes and methodologies for the safety of nuclear energy and non-energy applications.
- Take into account the High Priority Nuclear Data from OECD/NEA and needs identified by IAEA-NDS.
- Prepare experimental infrastructures, detectors, measurement capabilities and methodologies.
- Maintain close contact with OECD/NEA, the IAEA Nuclear Data Section and the organizations contributing to the JEFF project.
- Maintain close contacts with the ARIEL proposal for access to Nuclear Data related facilities also approved by EURATOM WP 2018 NFRP7.



ARIEL

Accelerator and Research Reactor Infrastructures for Education and Learning

- EURATOM WP 2018 Coordination and Support Action
- Scheme offering access to research & training facilties
  ➔ Integration of access to neutron facilties with education and training in collaboration with ENEN
  - 23 participants, 1.7 M€
- Activities linked with the SANDA project, OECD/NEA, IAEA/NDS and TSOs (GRS, IRNS)
- Experiments in international teams at first rate facilities as „hands on“ training for early stage researchers
  PAC to select projects of highest scientific value
- Maintenance of competencies and development of multidisciplinary nuclear competencies

This could be
Your logo

ARIEL main activities

- Transnational Access to Neutron facilities
  (30 typical experiments, 3000 beam time hours and
  4 users per experiment supported)
- Training of early stage researchers and scientific visits
  (30 research stays of up to 12 weeks)
- Summer schools and scientific workshops

  4 summer schools reach to attract students to the nuclear data field organized by University of Seville, CIEMAT, Johannes Gutenberg University and Uppsala University

  3 scientific meetings to keep the nuclear data network: JRC, NPL,IPN Orsay

ARIEL Facilities for Transnational Access

24 ARIEL partners from 13 countries

ARIEL Facilities for Nuclear Data Research:

- 3 Linear accelerators (e, p)
- 6 Cyclotrons
- 8 Electrostatic accelerators
- 3 DD and DT generators
- 5 Research reactors

Neutron energies: thermal to GeV

Continuous and monoenergetic neutron energy distributions

Ion beams for surrogate method

Detectors system for neutron, photon and charged particle detection

ARIEL Transnational Access Facilities

Many ARIEL facilities have a long record of EURATOM-funded TA projects:

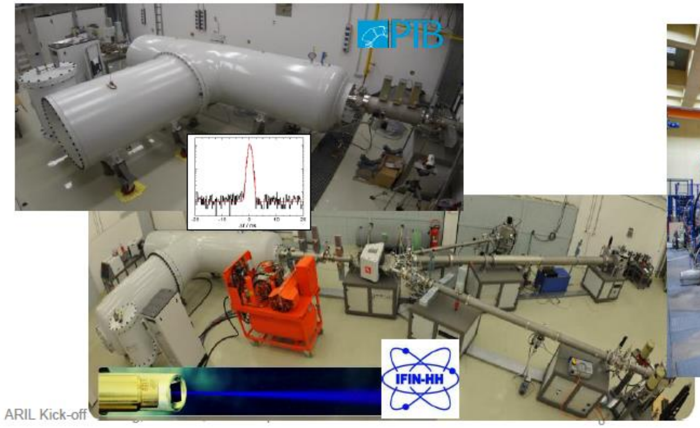
HZDR, JRC Geel, n_TOF, CENRS-ALTO, CNRS-AIFIRA, CEA Ile de France, PTB, NPI, MTA-EK, IFIN, NPL, UU, OU

Some have new or significantly upgraded facilities:

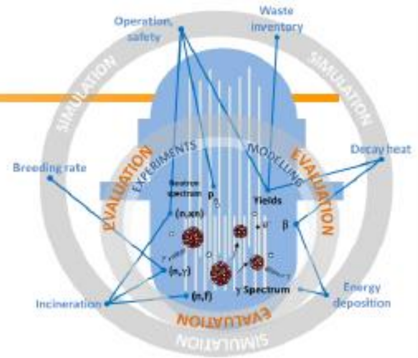
JRC Geel, n_TOF, JYU, PTB, UU

… and some are the 'new kids on the block':

CNRS-GENESIS, NFS, ENEA, ILL, CNA, SCK*CEN, JGU, CVŘ



NACRE : some figures



DEN,DER,SPRC,LEPh
DRF,IRFU,SPhN
DRT,LNHB
DAM,DIF

cea

cnrs IN2P3 Les deux infinis

UNIVERSITIES
& High SCHOOLS

IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE

GANIL spiral2

lpc caen

Subatech

IPN

IPHC Institut Pluridisciplinaire Hubert Curien Strasbourg

CENBG

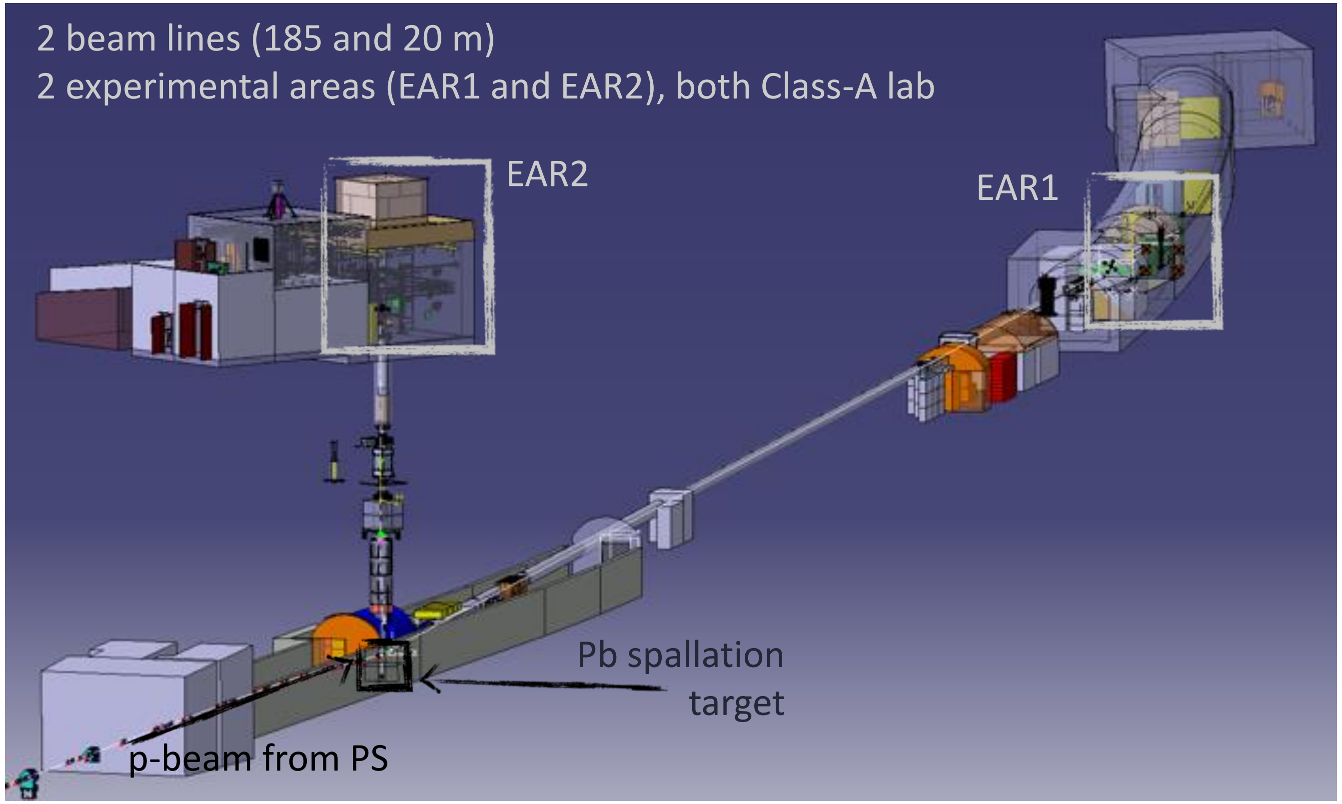
LPSC Grenoble

7 IN2P3 laboratories, 4 CEA directions and 1 IRSN department clustered in NACRE.

Manpower:

CEA : 13 m.year,
CNRS : 12 m.year,
IRSN : 0,2 m.year.

CERN n_TOF – Enrico Chiaveri I135



42 Institutions

(EU, India, Japan, Russia and Australia)

130 scientists

2 experimental areas at CERN

Nuclear Astrophysics

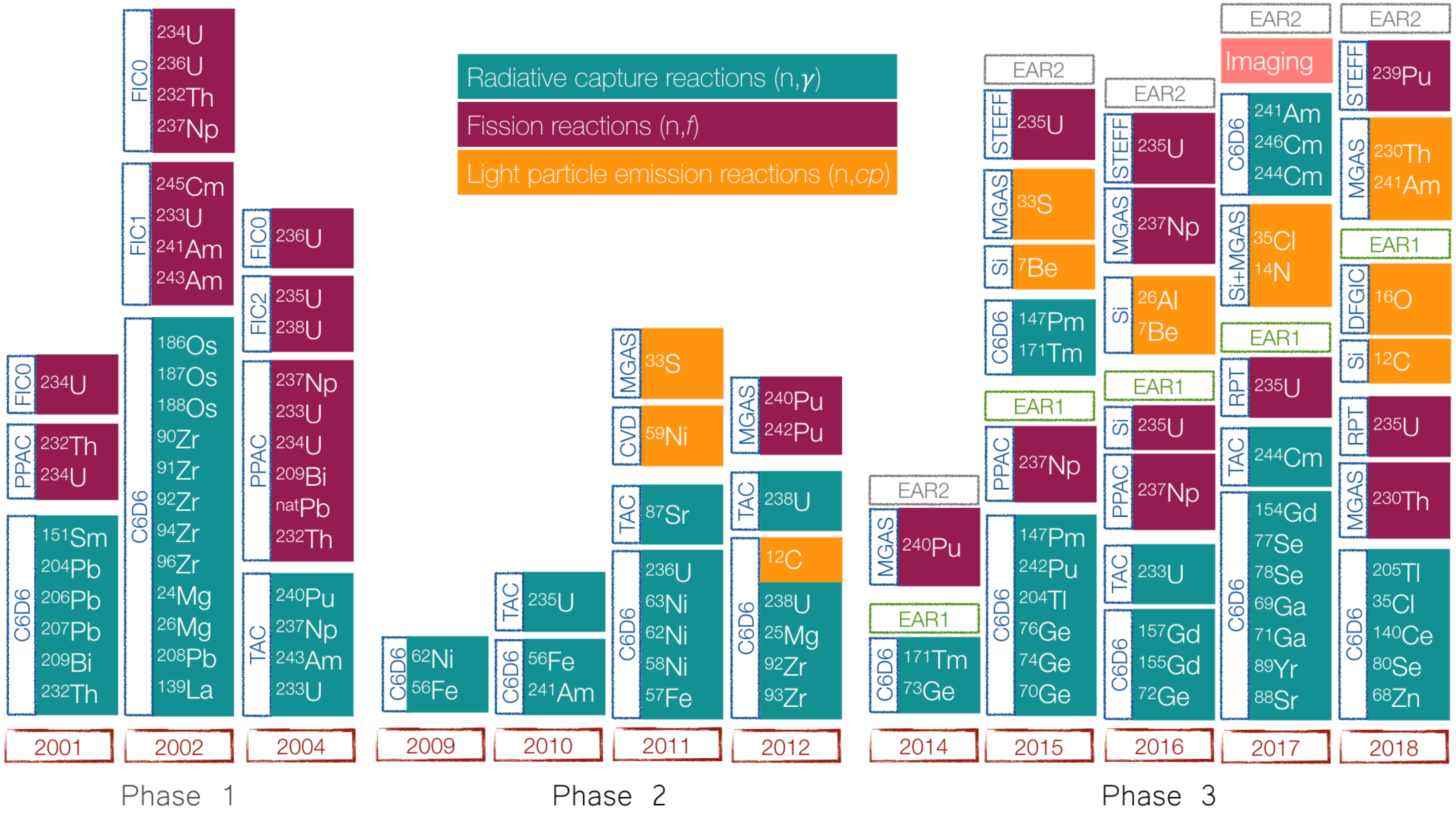
Nuclear Physics

Nuclear Application:

- Nuclear reactors (fission and fusion)
- Nuclear Waste Transmutation
- Nuclear Medicine

- Main feature of n_TOF is the synthesis of extremely high instantaneous neutron flux and excellent energy resolution
- Unique facility for measurements of radioactive isotopes (maximize S/N)
  - Branch point isotopes (astrophysics)
  - Actinides (nuclear technology)

The n_TOF physics program: neutron-induced reaction measurements



http://dx.doi.org/10.1051/epjconf/201714607003

http://www.nea.fr/dbdata/nds_jefreports/

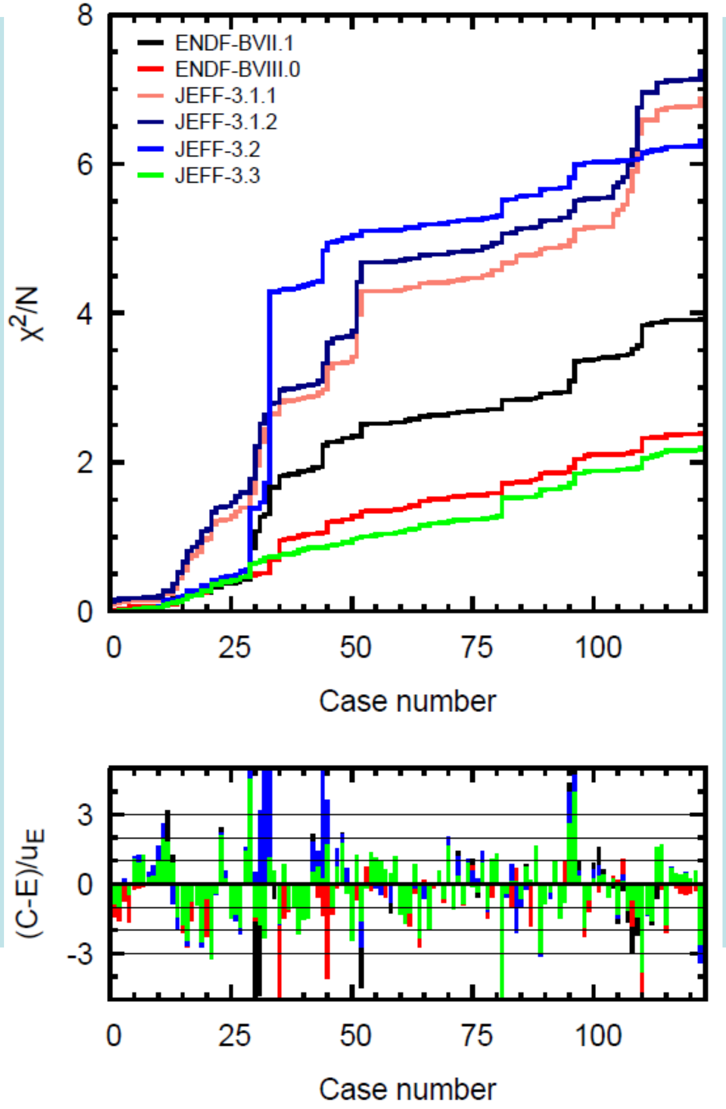
http://dx.doi.org/10.1016/j.nds.2018.02.001

http://dx.doi.org/10.3327/jnst.48.1

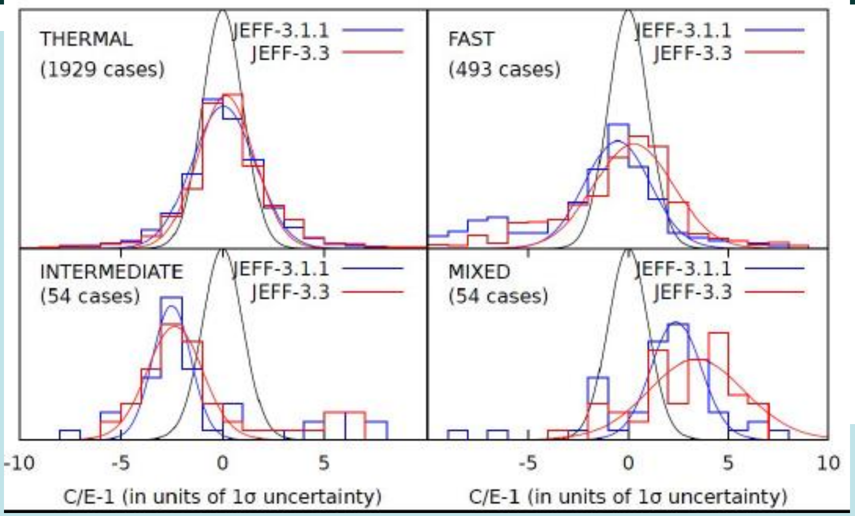
https://twiki.cern.ch/NTOFPublic/DataDissemination

Benchmarking

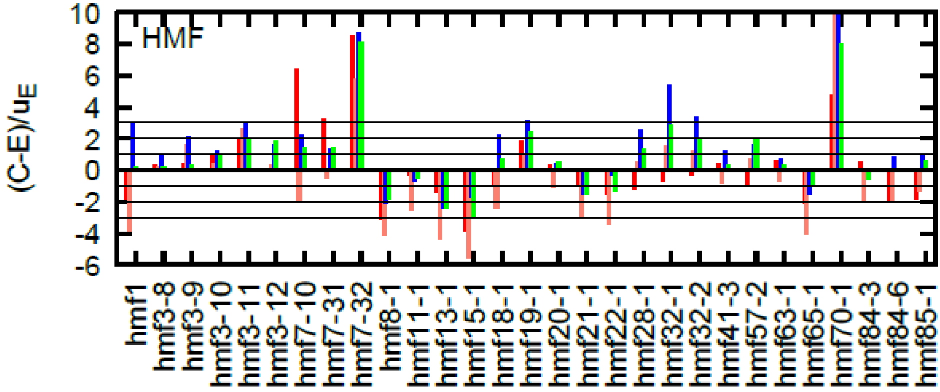
NEA-Mosteller

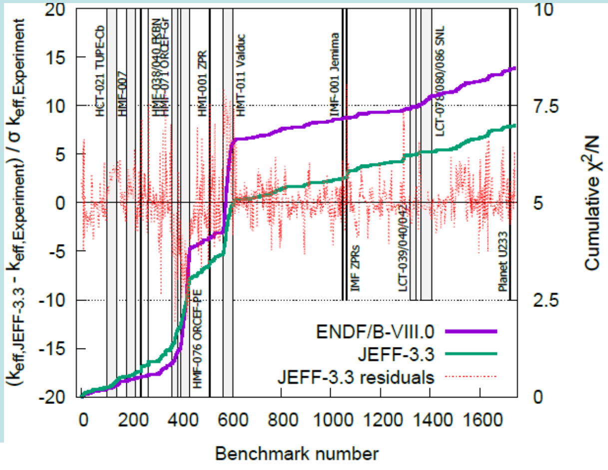


NRG - Van der Marck



IRSN - Leclaire





Trkov - Fleming

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

Leads to a non-Gaussian distribution!

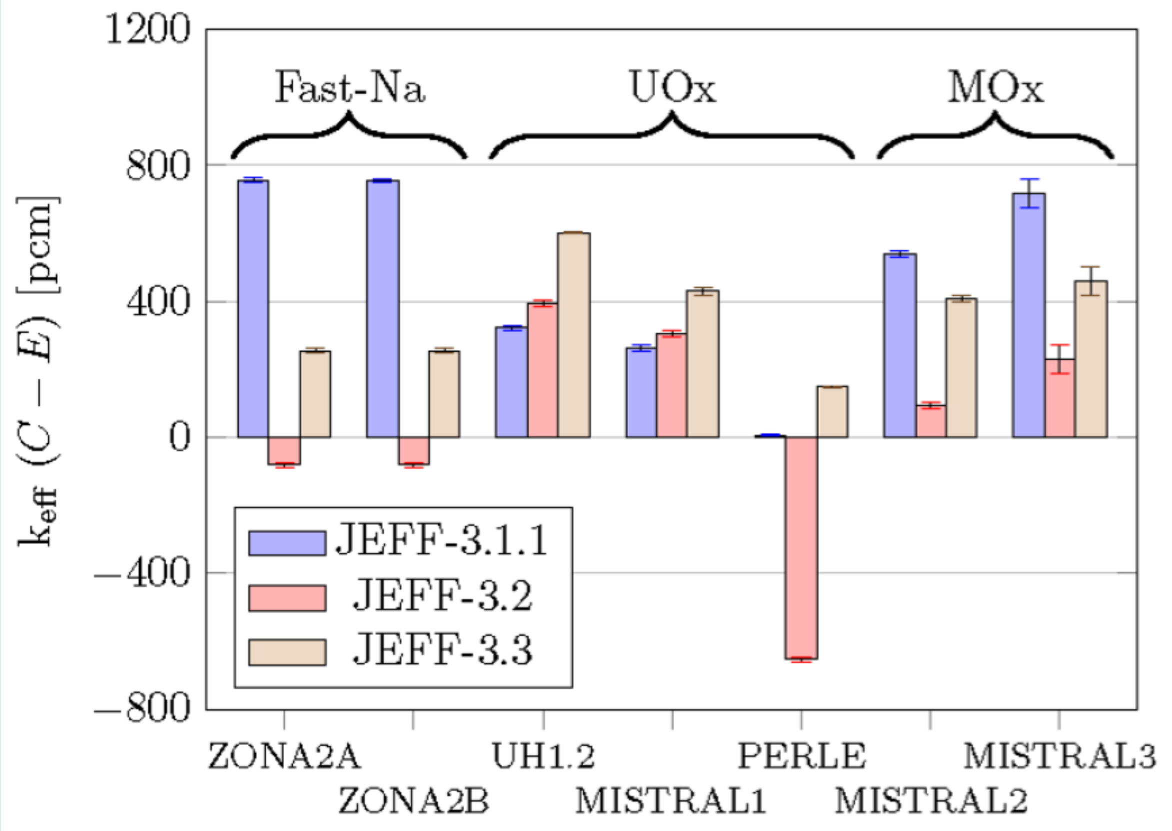
European Commission

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 is an outlier > 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

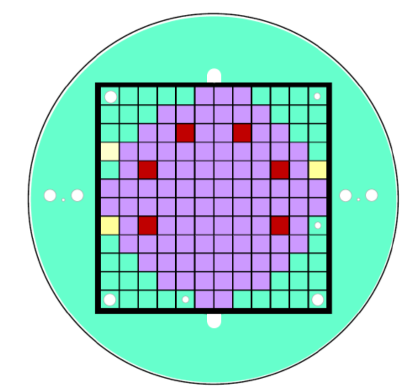
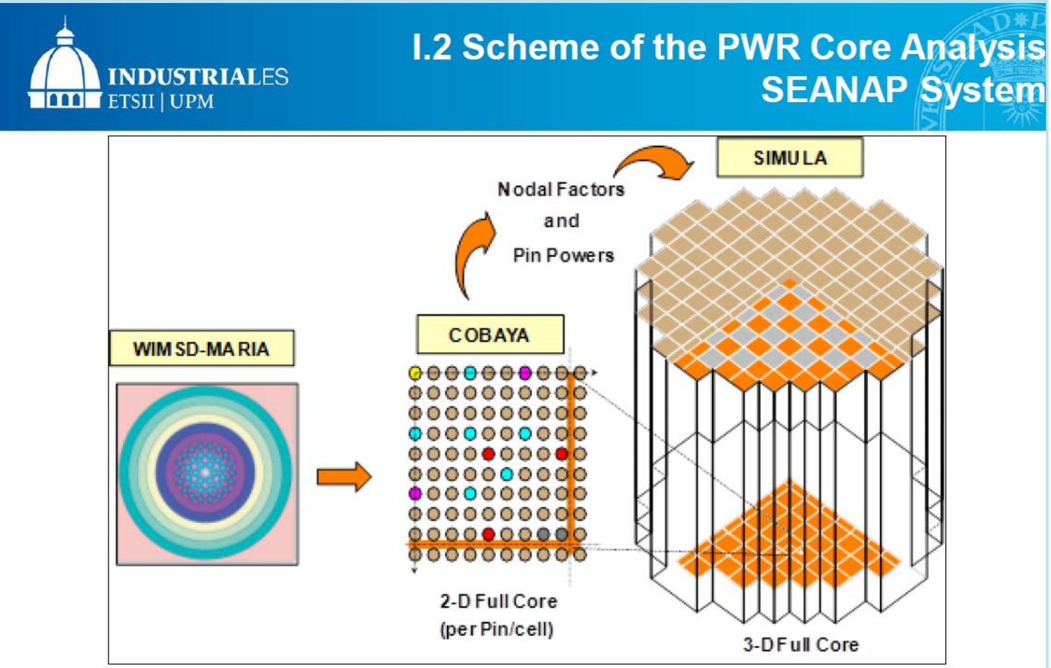


Table 32: Calculated k_{eff} -values for the VENUS-F CR0 core. The statistical uncertainty of the calculated values is less than 5 pcm.

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



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)

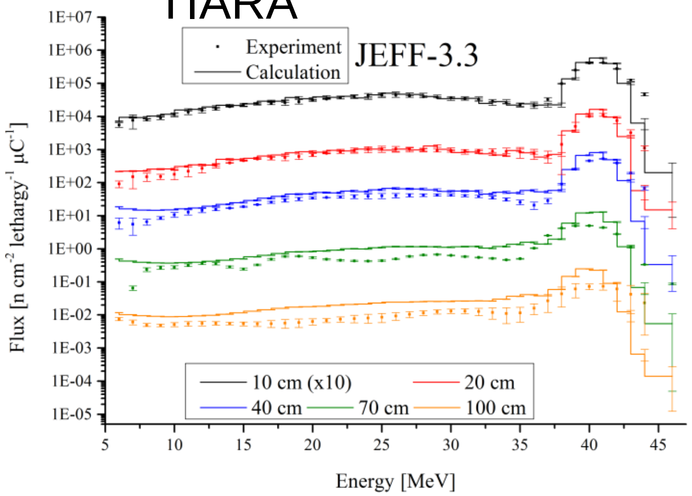
	Experiment β_{eff}		JEFF 3.3	JEFF 3.1.1
TCA	771	(2.2%)	2.3±0.8	3.9±0.7
IPEN/MB01	742	(0.9%)	4.2±0.9	4.6±1.0
Masurca/R2	721	(1.5%)	2.1±1.1	2.9±1.1
Masurca/ZONA2	349	(1.7%)	2.6±1.7	1.1±1.7
FCA/XIX-1	742	(3.2%)	3.0±1.2	3.6±1.2
FCA/XIX-2	364	(2.5%)	3.3±1.6	3.8±1.6
FCA/XIX-3	251	(1.6%)	4.4±1.9	-1.2±2.0
SNEAK/9C1	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

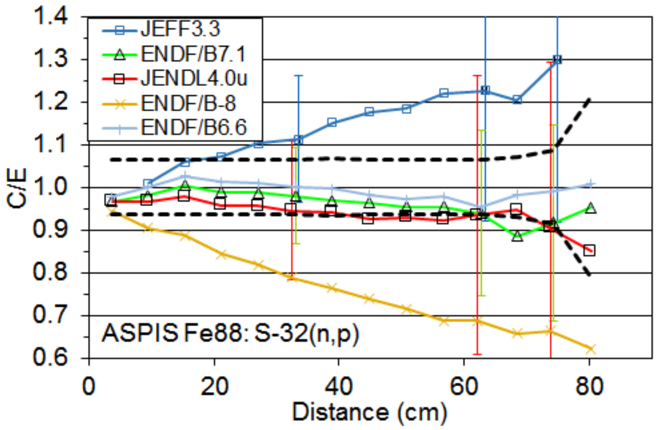
library	β_{eff}	library	β_{eff}
JEFF-3.1.2	730	JENDL-4.0	724
JEFF-3.2	733	ENDF/B-VII.1	727
JEFF-3.3	729	ENDF/B-VIII.0	727
Experiment	730(11)		

Cross section validation using shielding benchmarks from SINBAD Ivo Kodeli I443

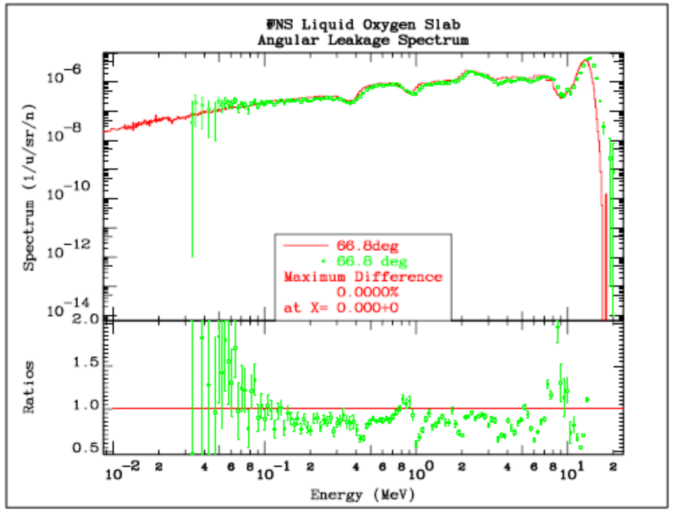
TIARA



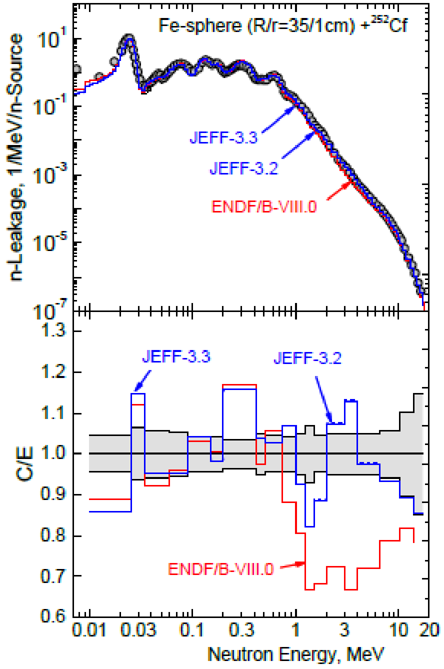
ASPIS IRON-88

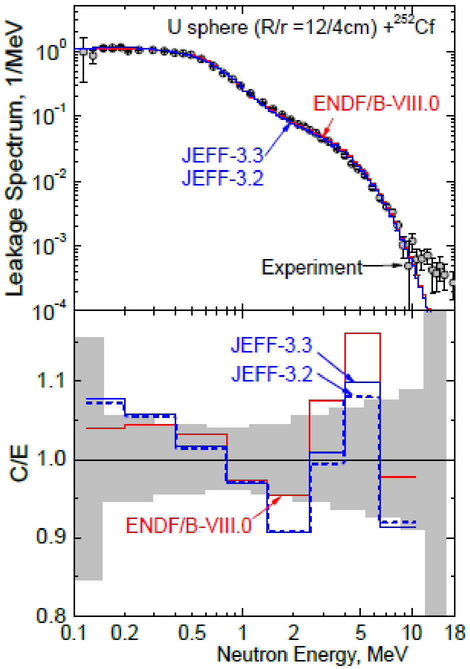


FNS Oxygen



Cf-252 leakage spectra Fe and U - IPPE





JEFF-4.0

- We are in the process of establishing the starter file (Summer 2020)
- JEFF-4 development 2020-2024
- 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)

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

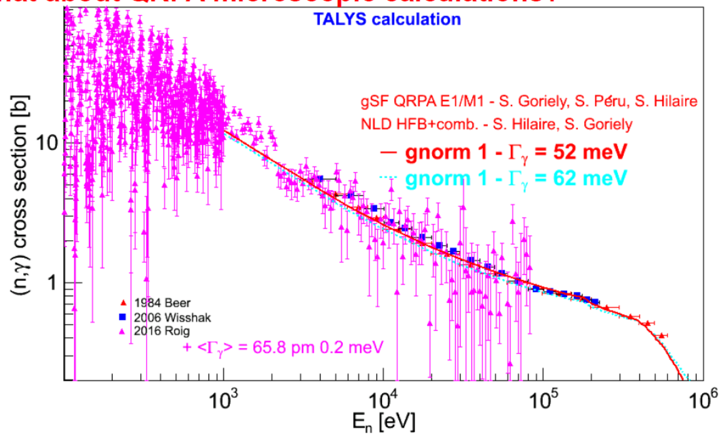
- Microscopic models are able to compute model ingredients from nuclear interaction + many body formalism (no adjustment)

- 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

What about QRPA microscopic calculations?



Hilaire R180

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

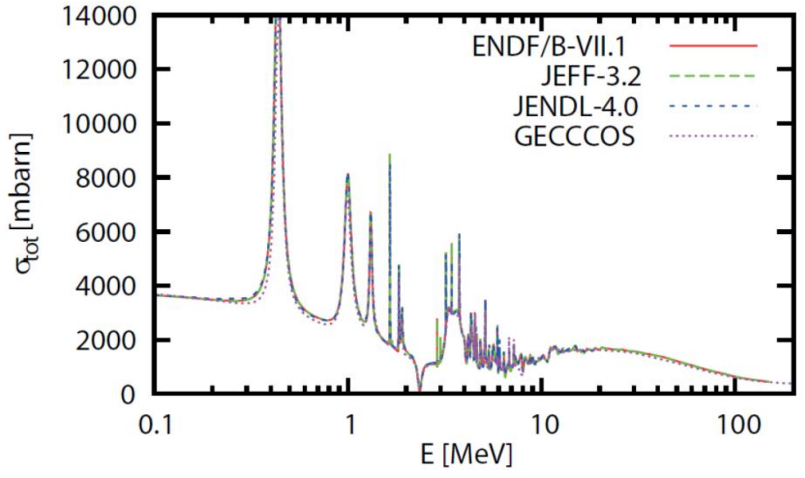
Evaluation of n + ^{16}O cross-section data using Hybrid R-Matrix approach

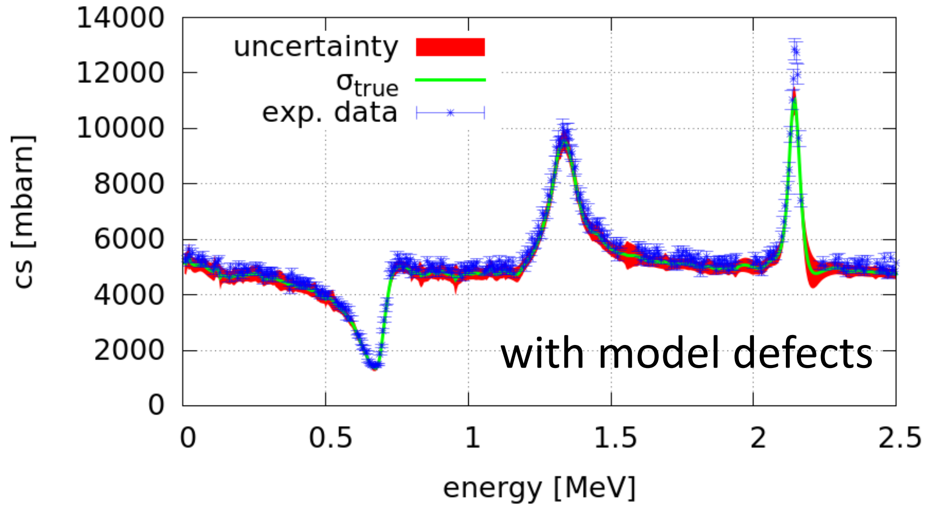
- ***Hybrid R-matrix fit*** *in energy range 1 keV – 14 MeV using TUW code system* ***GECCCOS***
- *Statistical model fit using TALYS with optimized optical potentials (1 keV – 200 MeV)*
- *Unified Bayesian evaluation* ***accounting for model defects*** *(in resonance and statistical energy range) providing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

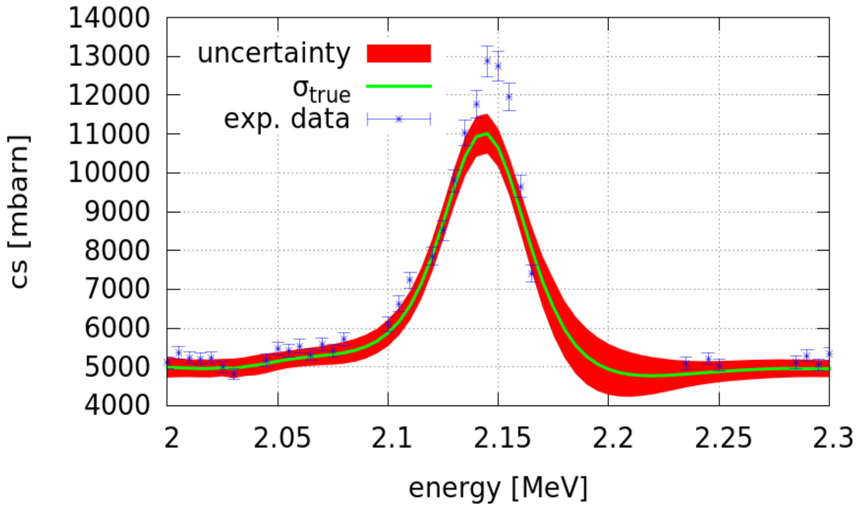
$\Rightarrow$ *Production of full ENDF prototype data file for use in benchmark analyses*

$\Rightarrow$ ***H. Leeb, R046***

Total cross-section n + ^{16}O



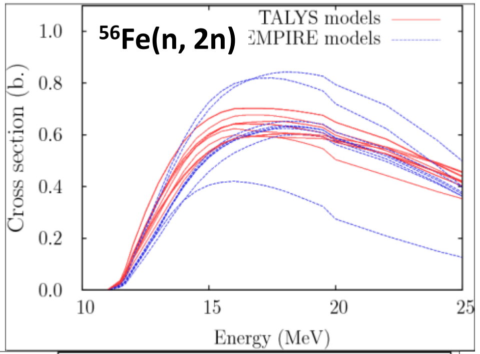


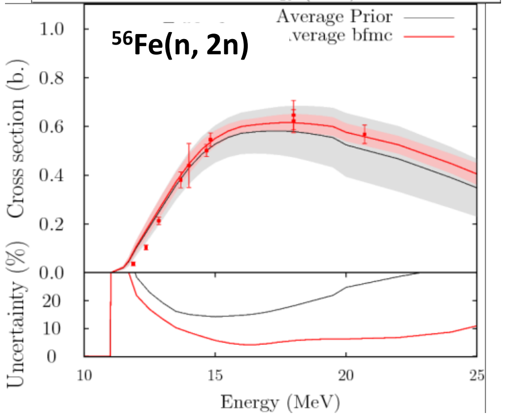


Evaluation of fast n + ^{56}Fe cross-sections using advanced evaluation methodologies Arjan Koning L451

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*





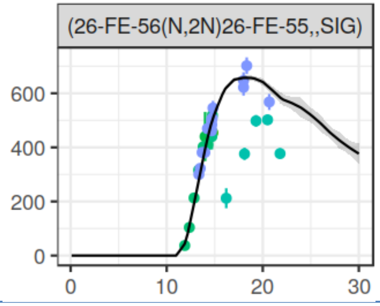
- ***Model defects to describe imperfect physical models and data inconsistencies***

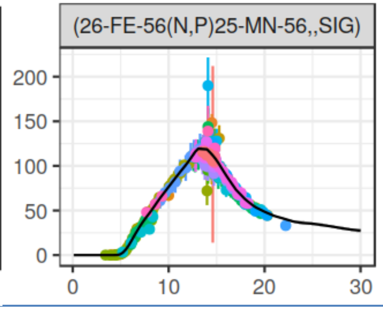
⇒ G. Schnabel, R033

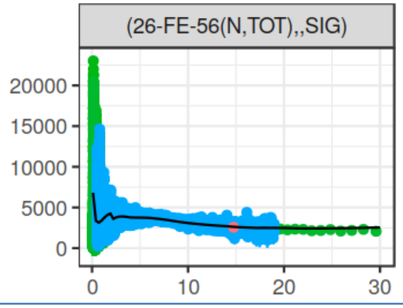
  - *Simulation of model defects by energy-dependent parameters in TALYS code*
  - *Parameter functions modelled as Gaussian processes fitted together with energy-independent parameters*

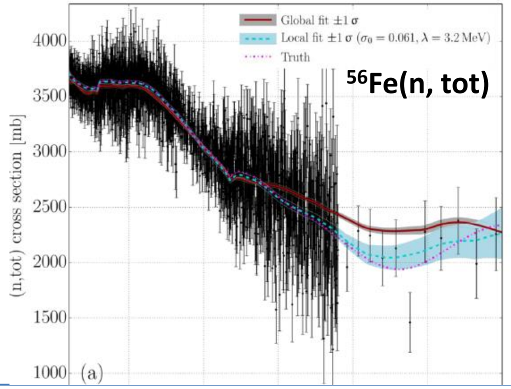
UPPSALA UNIVERSITET

⇒ Demonstration ENDF data file up to 30 MeV





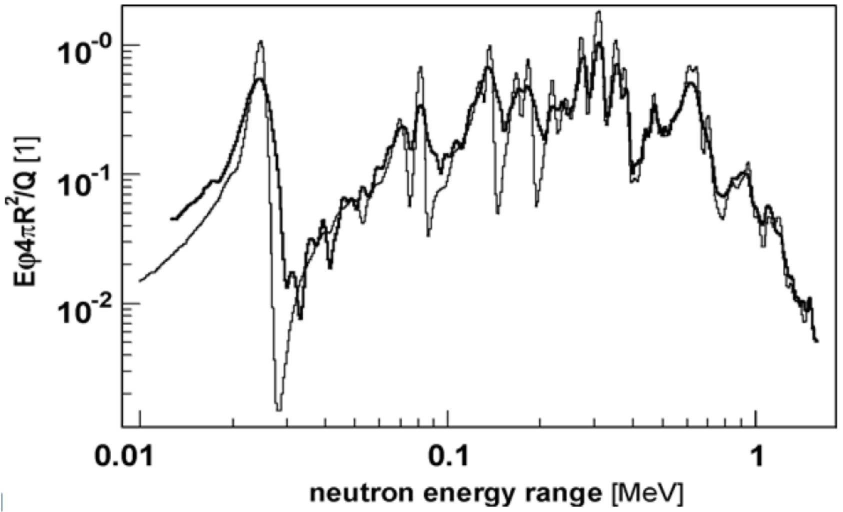




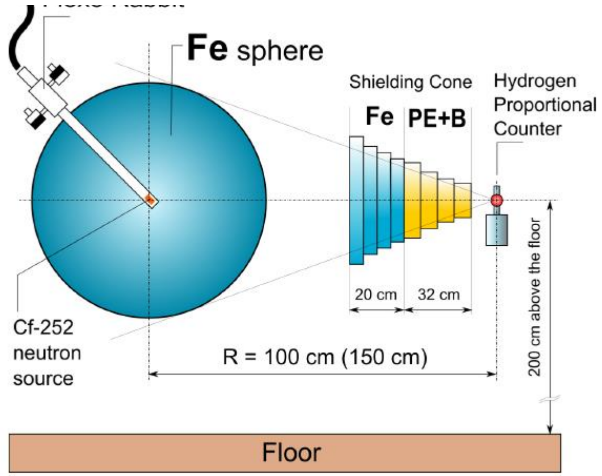
jefdoc-1918

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

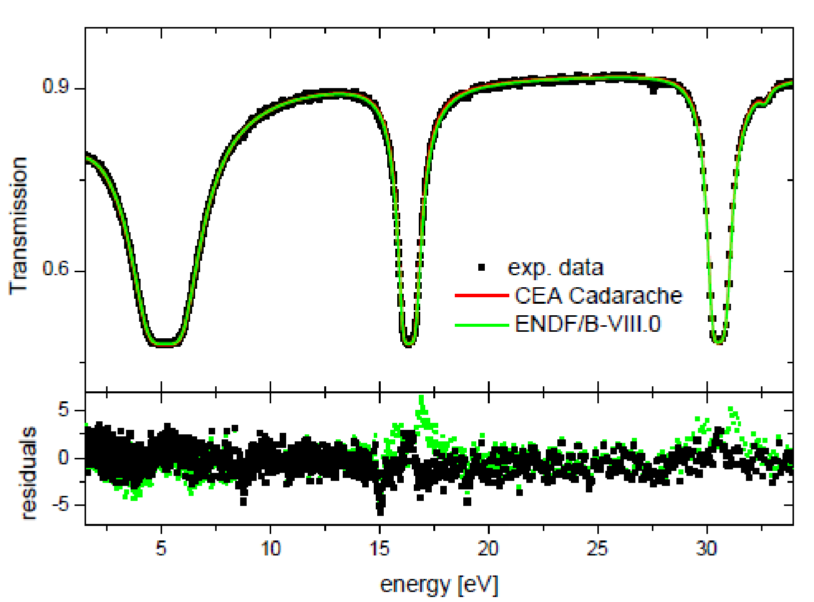
KAERI
- Rh
- Gd (+ INFN Bologna + ENEA)

JAEA
- Cu
- Bi (+SCK-CEN)

INFN Bari
- Y
- Zr

IRSN priority list ***(to be completed)***

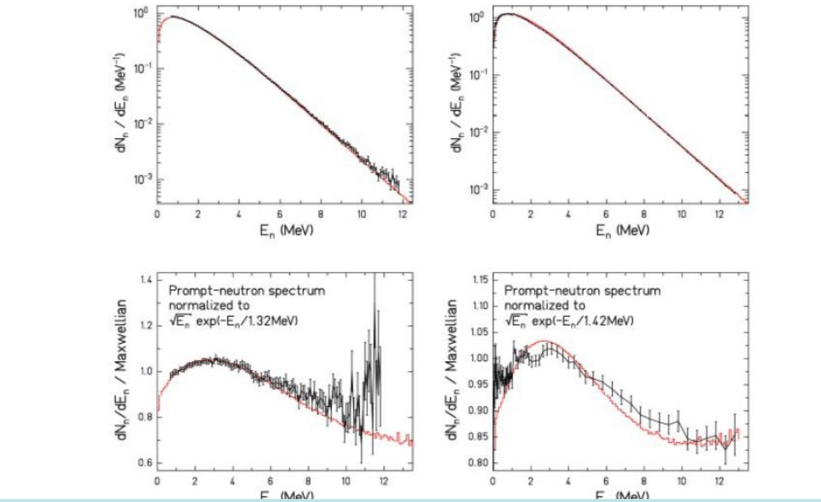
Pu-239
Pu-240, Pu-241, Am-241,
U-235, U-238, U-234
Gd isotopes, Mo isotopes, Fe-54, Fe56, Pb-204, Pb-206, Pb-207, Pb-208
Cl-35, Cl-37, F-19, Nickel isotopes, Sm-149, Sm-152, Cs-133, Si isotopes, Ca isotopes, Mn-55, Nd-143



- 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

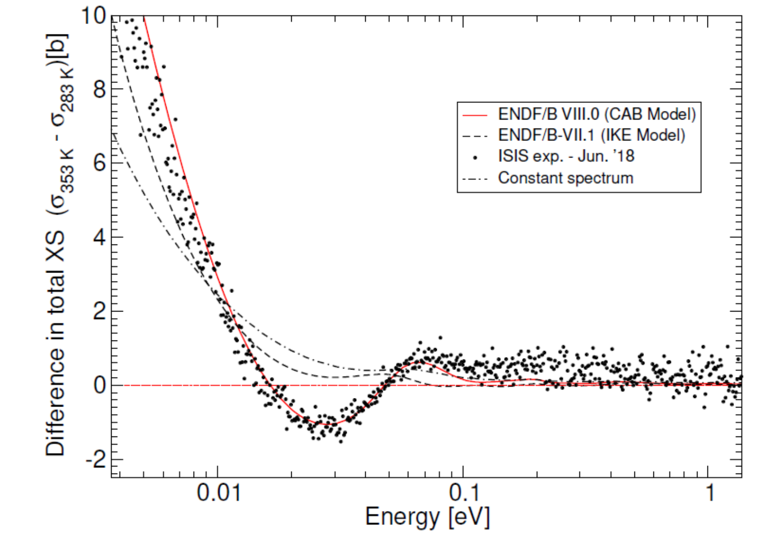
B.Voirin [1,2], G.Kessedjian[1], A.Chebboubi[2] & O.Serot[2]

Comparative study between experiment, evaluation and GEF

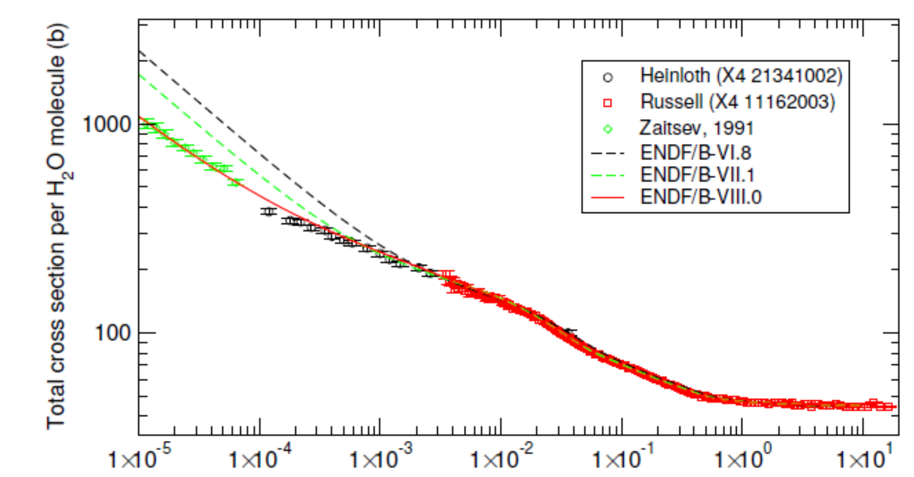
Karl-Heinz Schmidt

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
- Investigate high temperature behaviour



Summary

- Successful collaboration in Europe on nuclear data
- Close relation with JEFF project, WPEC and IAEA
- JEFF-3.3 delivered in November 2017 – good performance
- JEFF-4 is expected in 2024.
- Important developments are underway.
  - Automation of generating libraries for completeness and reproducibility
  - Significant advances in modeling for better evaluation and extrapolation
  - Widening of the scope of verification, benchmarking and validation
  - Prospects for improved interaction with stakeholders