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International Nuclear Data Evaluation Network (INDEN) on Actinide Evaluation in the Resonance Region (4)

Summary Report of the IAEA Consultants' Meeting

IAEA Headquarters, Vienna Austria
1-4 November 2021

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September 2022

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ABSTRACT

A Consultants' Meeting on Actinide Evaluation in the Resonance Region (4) of the International Nuclear Data Evaluation Network (INDEN) was held as a hybrid meeting from 1 to 4 November 2021. The meeting was a follow-up of the working group on evaluations in the resonance region of actinide nuclei. On-going evaluation work on ^{233}U, ^{238}U, ^{235}U and ^{239}Pu was discussed. Particular attention was paid to Prompt Fission Neutron Spectra, neutron multiplicities and reference integrals for fission cross sections were proposed for TOF fission data of fissile targets.

September 2022

Contents

1. Introduction

The fourth Consultants' Meeting on Actinide Evaluation in the Resonance Region of the International Nuclear Data Evaluation Network (INDEN (https://www-nds.iaea.org/INDEN/)) was held from 1 to 4 November 2021. In his opening remarks, Arjan Koning (NDS Section Head), pointed out the importance of the INDEN meetings on the resonance range of actinides. The work includes the coordination of upcoming nuclear data libraries (JENDL-5.0, ENDF/B-VIII.8.1 and JEFF-4.0) to consolidate high quality resonance data sets in view of solving integral benchmarks issues, such as inconsistent integral trends observed as a function of burnup.

Yaron Danon was designated chairman of the meeting. Gilles Noguere, Oscar Cabellos, Denise Neudecker and Andrej Trkov agreed to act as rapporteurs.

The present report summarizes the on-going evaluation work on ^{233}U, ^{238}U, ^{235}U and ^{239}Pu. Particular attention is paid to Prompt Fission Neutron Spectra, neutron multiplicities and reference integrals for fission cross sections.

The adopted agenda, participants list and links to participants' presentations are provided in Annex I-III, respectively.

2. Evaluation of the Resolved Resonance Range

The meeting offered the opportunity to review the evaluation work performed at ORNL (Marco Pigni), IRSN (Luiz Leal), JRC-Geel (Stefan Kopecky) and CEA/DES Cadarache (Gilles Noguere) with the SAMMY, REFIT and CONRAD codes. The latest working versions of the ENDF files are available on the INDEN web page (https://www-nds.iaea.org/INDEN/). Dimitri Rochman presented the RRR capabilities of the resonance formatting and analysing tool TARES-1.4, the results of which will be released through TENDL-2021 with covariance matrices.

Results obtained on ^{235}U highlight the achievements made in the evaluation of the resonance range over the past five years (Ref. [1]). Major improvements come from the experimental work performed at the RPI and n_TOF facilities (Refs [2,3]). The release of experimental capture yields and fission cross sections that cover the thermal and resonance ranges avoid mismatches in the determination of the normalization factors. The existing sets of resonance parameters will be slightly adapted to take into account the reference integrals for fission cross section provided by Ignacio Duran (see Section 5). The latest issue concerns the difference observed between the thermal fission cross section recommended by the IAEA Neutron Data Standards group (587.3(14) barns) (Ref. [4]) and the one obtained from the evaluation procedure (close to 586 barns). **Although it remains within the lower limit of the quoted uncertainties, such a difference has to be clarified in the framework of meetings dedicated to Neutron Data Standards.**

For ^{239}Pu, **many issues are still under investigation**. Some of them are listed below:

- The ^{239}Pu resonance parameters were revisited by including the thermal neutron constants (TNC) recommended by the IAEA Neutron Data Standards group. However, as for ^{235}U, differences are observed with the evaluated thermal values.
- The normalization of the capture cross section of Mosby Shea (Ref. [5]) is not yet fully solved.
- A few interferences between the resonances have to be improved, especially between 9 and 20 eV (= I3 integral range defined by Ignacio Duran)
- The extension of the resonance range up to 4-5 keV is still in progress.
- The transmission data sets measured at ORELA, which are available in the EXFOR database, are wrong. They have to be replaced by those used in the SAMMY database.

Marco Pigni revisited the ^{233}U resonance parameters with the SAMMY code and preliminary results were published in Ref. [6]. The resolved resonance range was extended up to 2 keV. The authors recall the importance of the thermal prompt neutron fission spectra for solving integral biases as a function of the neutron flux hardness; the IAEA evaluated thermal PFNS was used for U-233 as done previously for Pu-239 and U-235. This evaluation work also confirms the good quality of the capture cross section extracted from nTOF data by Berthoumieux (Ref. [7]). **Future evaluation work will take advantage of the new ^{233}U capture data recently measured in the framework of the nTOF collaboration (Ref. [8]). Data are expected to be released within two years.**

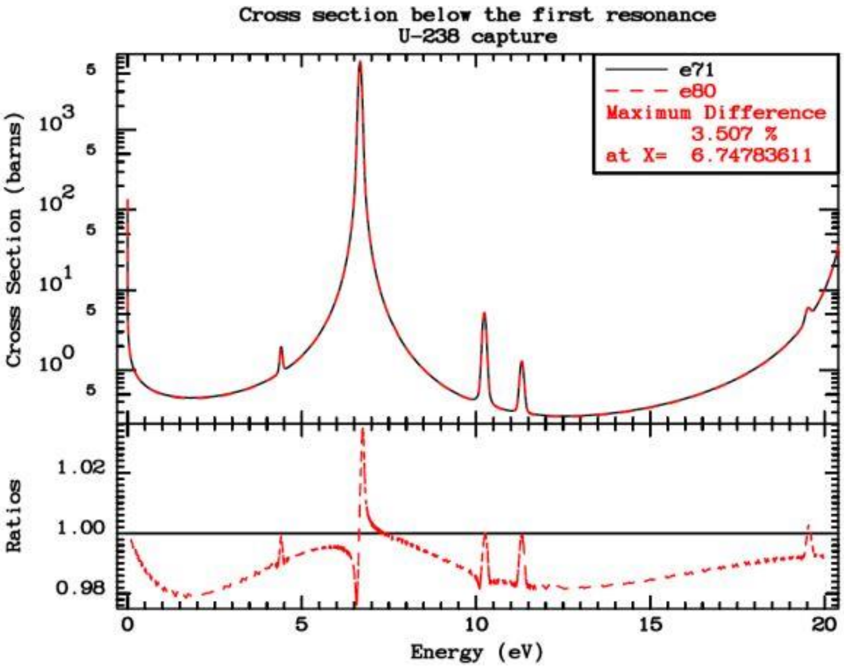


Fig. 1. Comparison of the ^{238}U capture cross section reconstructed from the resonance parameters available in the ENDF\B-VII.1 and ENDF\B-VIII.0 libraries (see Annex III, presentation A. Trkov)

A new important issue on ^{238}U was discussed during the meeting. A computational exercise in a simple PWR 3x3 pin cell arrangement, presented by Andrej Trkov, questioned a possible underestimation of the ^{238}U capture cross section available in the ENDF\B-VIII and JEFF-3.3 libraries, as firstly reported by ORNL in Ref. [9]. Figure 1 shows the differences below 20 eV that reach 2% in the wings of the resonances. Such an underestimation leads to a loss of reactivity for high burnup (End Of Cycle), which is related to the ^{239}Pu production. This trend could be wrongly compensated in the evaluation procedure by increasing the eta value of ^{239}Pu. However, this solution will lead to overestimate the reactivity of the PST benchmarks. The ^{238}U resonance range in ENDF\B-VIII and JEFF-3.3 were revisited by Stefan Kopecky with the REFIT code by using new capture data measured at the GELINA facility (Ref. [10]) and older transmission data measured by Olsen at the ORELA facility (Ref. [11]). Klaus Guber provided the transmission data used in the REFIT analysis. Significant differences were reported between the ^{238}U evaluation of ENDF\B-VII.0 (Refs [12,13]) and the thick transmission data. A good agreement between the REFIT calculations and the data was achieved by optimizing the parameters of the negative resonances. The full evaluation work leads to a slight decrease of the average radiation width (from 23 meV to 22.5 meV). Such differences make the consistency of the ORELA data used in the past/new ^{238}U evaluations questionable. Some actions are summarized below:

- **Clarification of the consistency of the data used in the ^{238}U evaluations;**
- **New resonance parameters are expected by taking care of the radiation widths, response function of the ORELA facility and coherent scattering length (8.63 fm from Koster in Atomic Data Table vs. NIST value of 8.402 fm);**
- **Additional data sets should be introduced in the evaluation (capture data from nTOF);**
- **The question of new transmission measurements is left open.**

3. Evaluation of the Unresolved Resonance Range

The most challenging task in the description of the unresolved resonance range (URR) is to avoid double counting in self-shielding calculations due to the superposition of fine Porther-Thomas fluctuations on broader structures, observed in fission cross sections of fissile isotopes. However, it is difficult to distinguish the broad structures produced by cluster of Porther-Thomas fluctuations from those coming from class-II or class-III state contributions. In addition, the direct contribution should be correctly removed from the URR treatment. In that case, optical model calculations are required. A few simplifications were already discussed in previous INDEN meetings in order to get a simple description of the URR which fulfil the ENDF constraints.

The unresolved resonance range of ^{238}U was evaluated by Ivan Sirakov under the statistical hypothesis. He provided smooth energy-dependent average parameters (MF=2, MT=151) consistent with cross sections stored in MF=3 from 20 to 150 keV. The proposed capture cross section agrees with the capture cross section recommended by the IAEA Neutron Data Standards group.

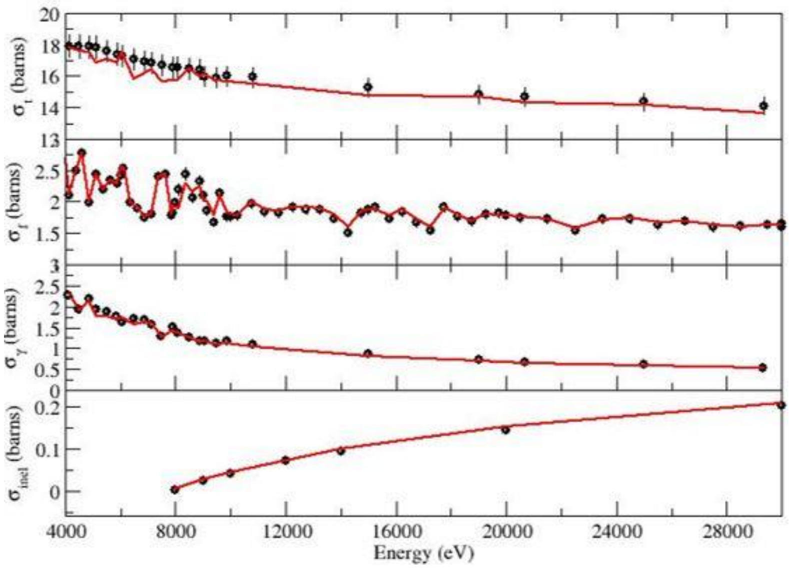
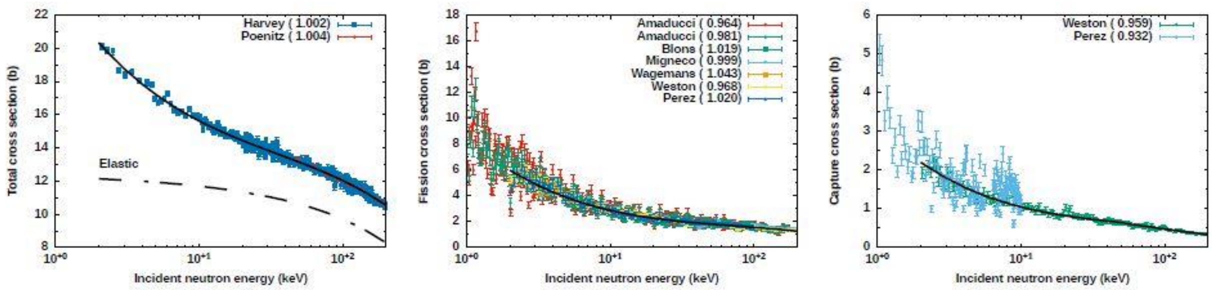


Fig. 2. Preliminary description of the unresolved resonance range of ^{239}Pu obtained with the SAMMY code (see Annex III, presentation L. Leal)

Luiz Leal presented preliminary results for the unresolved resonance range of ^{239}Pu (Fig. 2). He used SAMMY to establish average parameters, which fluctuate with the incident neutron energy in order to reproduce the broad structures observed in the cross sections. Current URR evaluations includes s- and p-wave angular momentum for average cross section calculations. New evaluations will include the d-wave contribution. Such an approach ensures a consistent description of the average parameters and of the neutron cross sections from 4 to 30 keV.



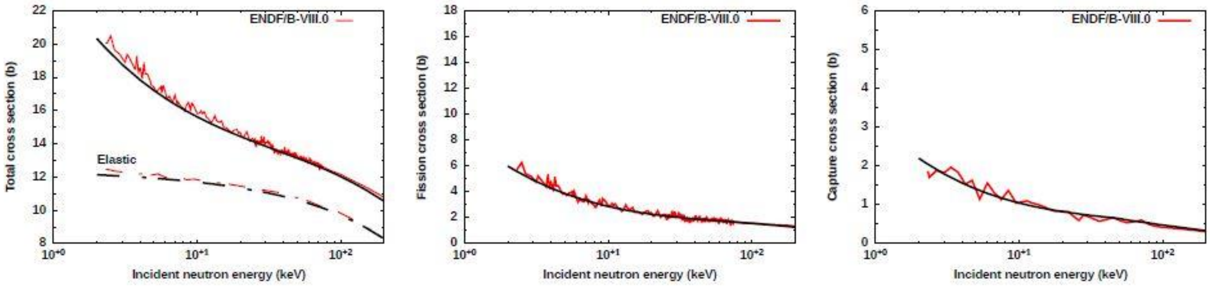


Fig. 3. Preliminary description of the unresolved resonance range of ^{235}U (see Annex III, presentation M. Pigni)

For ^{235}U, Marco Pigni presented a preliminary description of the unresolved resonance range under the statistical hypothesis. Fig. 3 shows that the neutron cross sections reconstructed by a set of smoothly energy-dependent average parameters nicely follow the data on average. Andrej Trkov presented an additional work on ^{235}Uwith the objective to reproduce the broad fluctuations observed on the fission cross sections. The new INDEN evaluation with "higher resolution" (using flag LSSF=1) is shown in Fig. 4 on a narrow energy range. This evaluated data file matches the fission cross-section of Duran et al.'s evaluation, which is in excellent agreement with the cross sections recommended by the IAEA Neutron Data Standard group (established over a broader energy mesh). The agreement is close to -0.8% on average. The present result could serve as input for the subsequent analysis of the fluctuations planned by Marco Pigni, which will influence all open channels. These planned evaluations, together with the fission cross section of Amaducci et al. (Ref. [3]), offer the opportunity to revise the ^{235}U fission cross section recommended by the IAEA Neutron Data Standard group between 9 to 10 keV (a single node is used to cover this broad energy range).

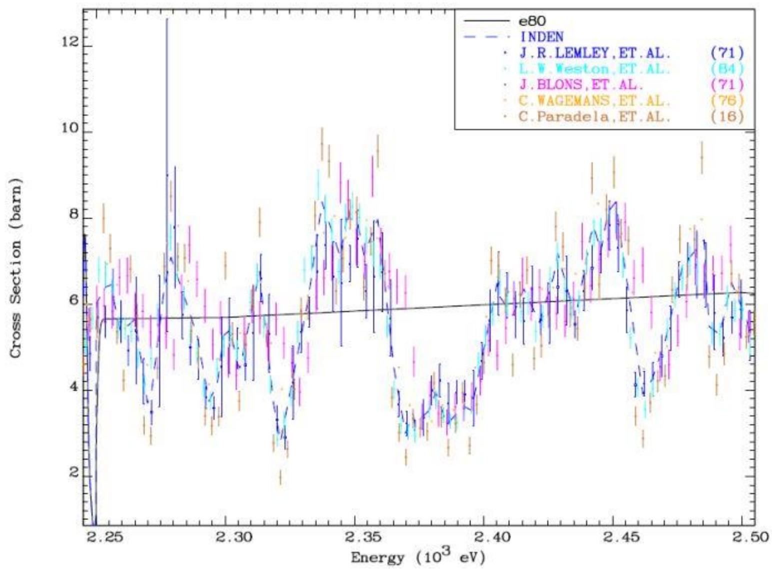
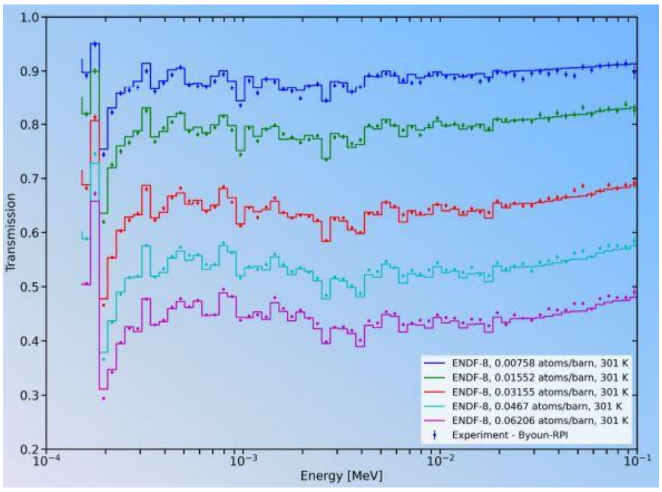


Fig. 4. Experimental fluctuations observed on the ^{235}U fission cross section between 2.25 and 2.5 keV compared to the latest INDEN evaluation (see Annex III, presentation A. Trkov).



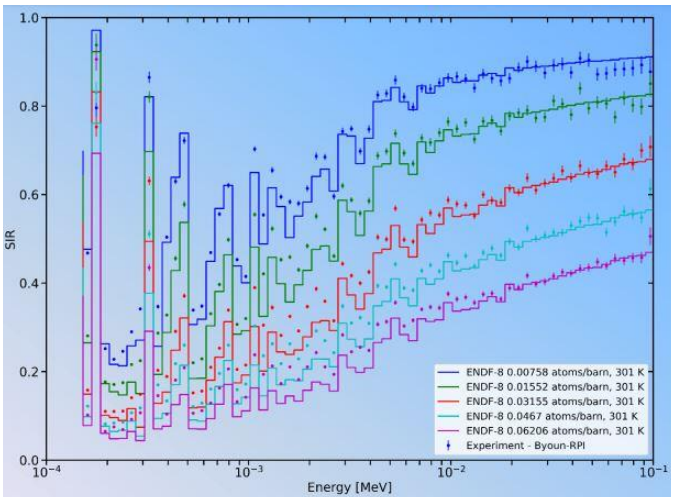


Fig. 5. Experimental ^{238}U transmission and self-indication ratio (SIR) at room temperature (Ref. [14]) compared to ENDF\B-VIII (see Annex III, presentation Y. Danon)

These new evaluations of the unresolved resonance range of ^{235}U and ^{239}U will affect shielding and criticality benchmarks, which are sensitive to cross section fluctuations in the keV energy range. Andrej Trkov presented the impact of his ^{235}U evaluation for the self-shielding in the URR at full shielding and in typical LWR lattices. Jean-Christophe Sublet suggested to use BIG TEN (for ^{235}U and ^{238}U) and Gilles Noguere suggested to use SNEAK sodium free configurations (for ^{239}Pu).

4. Experimental validation using transmission and self-indication ratio

Yaron Danon illustrated the experimental validation of ENDF files (^{238}U and Tantalum) with temperature-dependent transmission and self-indication ratio (SIR). Measurements are described in Ref. [14]. In Fig. 5, the comparison of MCNP calculations with data measured at room temperature indicates that the ^{238}U evaluation of ENDF\B-VIII correctly reproduces the transmission data in the resolved and unresolved resonance range. This result confirms the quality of the unresolved resonance parameters used to calculate the probability tables. By contrast, if the comparison of the calculations with the SIR data still confirms the correct description of the unresolved resonance range, large differences are observed in the resolved resonance range, below 20 keV. Experimental biases (such as impurities, background and resolution) or alternatively an incorrect description of the capture channel can explain the origin of such differences. No straightforward solutions exist to tackle this issue. Therefore, **the use of these temperature-dependent data sets in the fitting procedure of the resonance parameters is recommended. Similar SIR data for ^{235}U would be useful.**

5. Reference integrals for fission cross section

Reference integrals for fission are proposed to normalize fission cross section data. The energy limits of the integrals are reported in Table 1. The ratios σ_0/I1 and I3/I1 for ^{233}U, ^{235}U, ^{239}Pu et ^{241}Pu are given in Table 2. Detailed explanations can be found in Ref. [15] (see also Ignacio Duran's presentation). The quoted uncertainties are mainly due to the dispersion between the selected data sets.

The non-1/v slope of the fission cross section was also discussed by Ignacio Duran during the meeting. A simple method was proposed to complement the information provided by the Westcott factor. In the energy range between E_1=20 meV and E_2=60 meV, the fission cross section is well-approximated by $\sigma_f(E) = aE^b$, leading to the following expression for *b*:

$$b = \frac{\ln(\sigma_f(E_2)) - \ln(\sigma_f(E_1))}{\ln(E_2) - \ln(E_1)}$$

For ^{235}U, the difference between the value *b* reported during the meeting and those calculated with the ENDF\B-VIII and JEFF-3.3 evaluations are close to 2%. For ^{241}Pu, the energy dependence of the obtained curve seems to slightly deviate from a straight line in the log-log scale. This trend might be due to impurities in the ^{241}Pu samples. However, no more work is required for the moment as long as the selected ^{241}Pu fission cross section data seem to be consistent within the limit of the reported uncertainties. The future evaluations of ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu will consider such useful information.

TABLE 1. REFERENCE INTEGRAL LIMITS DEFINITION PROVIDED BY IGNACIO DURAN

Isotope	I1 [meV]	I3 [eV]
^{233}U(n,f)	20.0 – 60.0	8.1 – 14.7
^{235}U(n,f)	20.0 – 60.0	7.8 – 11.0
^{239}Pu(n,f)	20.0 – 60.0	9.0 – 20.0
^{241}Pu(n,f)	20.0 – 60.0	11.7 – 19.5

TABLE 2. RATIO σ_0/I1 AND I3/I1 PROVIDED BY IGNACIO DURAN

Isotope	σ_0/I1	I3/I1
^{233}U(n,f)	30.40(16) - 0.5%	39.31(54) - 1.4%
^{235}U(n,f)	31.20(14) - 0.4%	13.08(20) - 1.5%
^{239}Pu(n,f)	29.60(7) - 0.2%	41.65(22) - 0.5%
^{241}Pu(n,f)	29.95(35) - 1.2%	40.46(85) - 2.1%

6. Prompt Fission Neutron Spectrum and neutron multiplicity

Denis Neudecker, Marco Pigni and Gilles Noguere presented the ongoing work on PFNS and neutron multiplicity (nu-bar). In the resonance range, the fluctuations of the neutron multiplicity are described via the two-step (n,γf) process. Above 0.1 MeV, the neutron multiplicity is described with models implemented in the CGMF code (Ref. [16]). Results obtained for ^{235}U and ^{239}Pu are shown in Figs 6 and 7. Discussions during the meeting mainly focused on the achievements of ^{239}Pu.

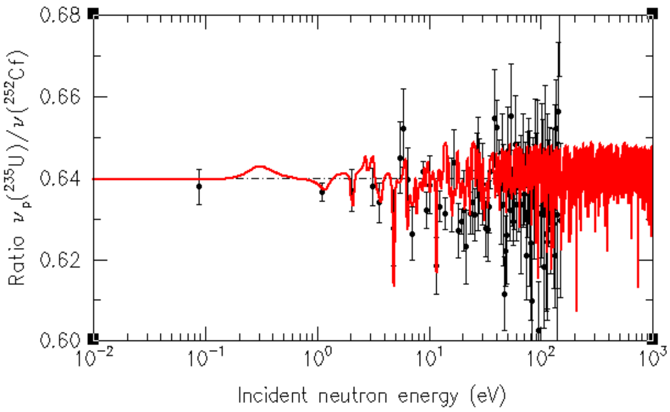


Fig. 6. ^{235}U neutron multiplicity obtained with the CONRAD code (E<2.5 keV) and compared to the Gook's data measured at the JRC-Geel (see Annex III, presentation G. Noguere).

In the resonance range, the new evaluations of the neutron multiplicity (CEA Cadarache and ORNL) are based on older data reported in EXFOR. No sizeable differences are expected compared to ENDF\B-VIII and JEFF-3.3 . In the discussion, the magnitude of the uncertainties was questioned, considering the uncertainty in the nu-bar of Cf-252, which is the standard to which ratio measurements were made. Uncertainties ranging from 0.4% to 0.6 were obtained with the code CONRAD .

The CGMF evaluations of the average prompt fission neutron multiplicity of ^{239}Pu(n,f) from 100 keV to 30 MeV account for the latest data reported by the Chi-Nu collaboration and CEA of Bruyère Le Chatel (Ref. [17]) between 1 and 20 MeV. The impact of Marini's data on the evaluation was discussed. A few older data sets (Huanqiao, Johnstone, Leroy, Nesterov, Smirenkin) were rejected for physical reasons. The nu-bar evaluated CGMF parameters predict reasonably well other fission observables, such as Y(A), TKE, P(nu), γ-production and the mean energy of PFNS. Examples of PFNS including newest Chi-Nu (Ref. [18]) and CEA (Ref. [17]) PFNS obtained at 500 keV and 2 MeV are shown in Fig. 8. The mean energies are 2.106 MeV and 2.142 MeV, respectively.

One of the problems discussed during the meeting is the connection between the low and high energy model evaluations for nu-bar and PFNS. For nu-bar, Roberto Capote suggested to use a non-model evaluation procedure to follow the Gwin's data covering both energy ranges. For PFNS the question is left open.

7. Integral validation

The last part of the presentation of Denise Neudecker was devoted to the integral validation of the INDEN evaluations for ^{235}U, ^{238}U and ^{239}Pu. The EUCLID program for large-scale nuclear validation was mentioned. The aim of the program is to identify:

- Which integral responses can be used for the purpose,
- What tools and processes are available,
- Which questions can be answered regarding the deficiencies of nuclear data.

It includes a set of integral responses such as:
- Criticality benchmarks,
- LLNL pulsed sphere benchmarks,
- Reaction rate measurements,
- Beta-effective of reactor cores,
- Parameters of sub-critical assemblies,
- Reactivity worth measurements (reactivity change with/without small sample in the assembly).

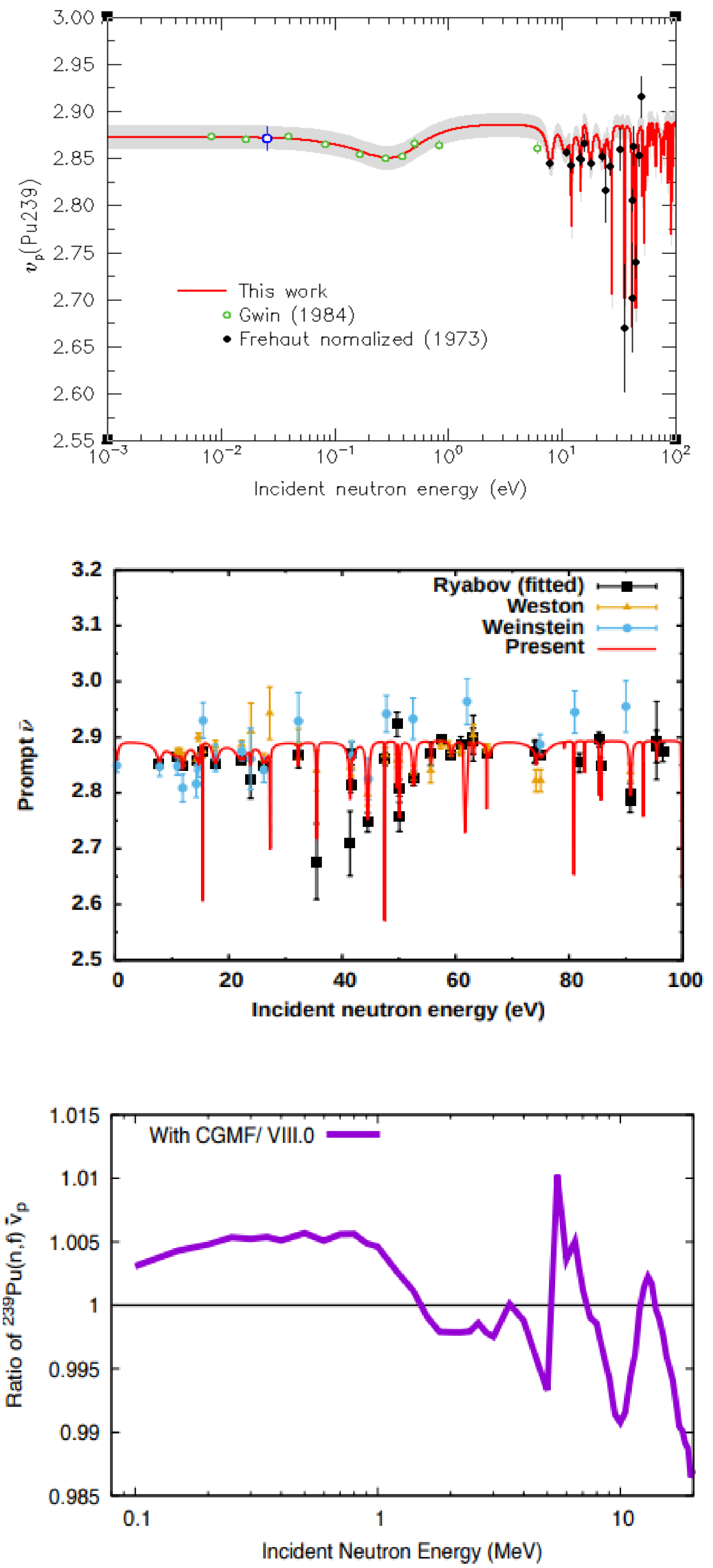


Fig. 7. ^{239}Pu neutron multiplicity obtained up to 20 MeV. The top, middle and bottom plots were shown by G. Noguere, M. Pigni and D. Neudecker, respectively.

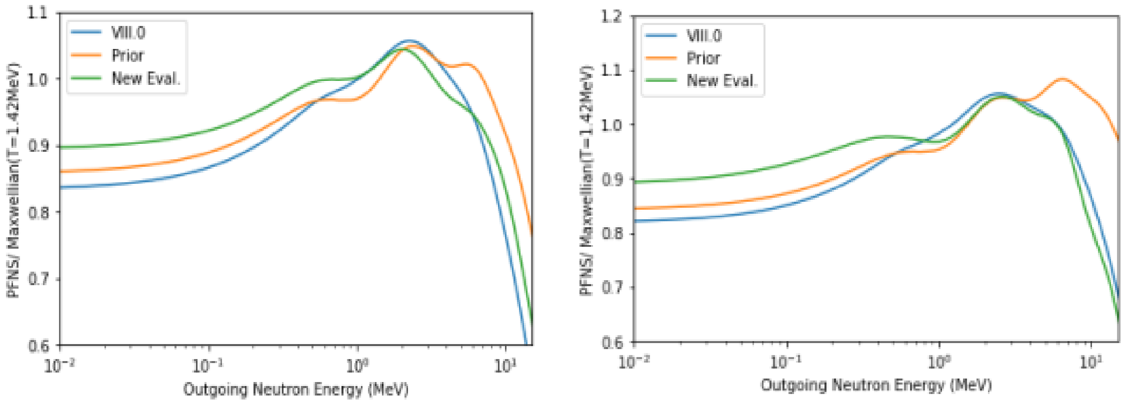


Fig. 8. Examples of PFNS (^{239}Pu) presented by D. Neudecker at two incident neutron energies (500 keV and 2 MeV).

The advantages of reaction rate measurements with different thresholds are their mapping out energy slices of the PFNS. Note that Beta-effective experiments are complementary to criticality because they offer different sensitivity profiles.

As a conclusion, the tested ^{235}U, ^{238}U and ^{239}Pu evaluations perform reasonably well on k_{eff} of PMFs and PMIs as well as on pulsed sphere benchmarks and reaction rates in Jezebel.

8. Conclusions

This 4th edition of the INDEN-AC meeting highlights the experimental and evaluation efforts performed by participants during the last four years. Some of the evaluation issues identified in previous meetings have been resolved. The remaining actions, discussed in this meeting, for improving the ^{238}U, ^{235}U and ^{239}Pu evaluations are summarized below.

For ^{238}U, the discussions highlight the deficiencies of the new RRR evaluation available in JEFF-3.3 and ENDF\B-VIII for k_{eff} calculations as a function of burnup. It is recommended to:

- Revisit the parameters of the low-energy resonances by taking care of the negative resonances, scattering radius and radiation widths,
- Include the temperature-dependent transmission data and self-indication ratios measured at RPI,
- Cross-check the ORELA data available in the EXFOR database, included in the SAMMY analysis of Herve Derrien (ORNL) and used in the latest REFIT analysis of Stefan Kopecky (JRC-Geel).

For ^{233}U, ^{235}U and ^{239}Pu, the RRR evaluations have to be revisited in order to:

- Account for fission integrals I1 and I3 as proposed by Ignacio Duran,
- Tackle the observed differences with the thermal neutron constant,
- Include the fine-energy ^{235}U fission cross section measured at n_TOF (Amaducci's data),
- Follow the status of the latest ^{233}U capture-to-fission measurement performed at n_TOF.

For the unresolved resonance range, the strategies presented for fissile isotopes during the meeting to account for the fine Porther-Thomas fluctuations and the broad structures due to fission are matured to provide results in the ENDF format for further benchmarking tests.

For the neutron multiplicity and PFNS, the promising results obtained for ^{239}Pu only remain to be complemented by a consistent description of the post-fission observables between the low and high-energy ranges. A non-model procedure could be used to solve this issue.

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APPENDIX: PRESENTATION SUMMARIES

A.1. Validation of RRR and URR using transmission and self-indication experiments, Y. Danon, R. Block, D. Barry (RPI, NNL, US)

The purpose of Danon's talk was to highlight the usefulness of energy grouped transmission and self-indication ratio (SIR) experiments as validation of total and capture cross sections for different sample materials including actinides.

Yaron Danon showed comparisons of ENDF/B-8 evaluations for U-238 (and Ta-181) with experimental transmission and SIR. The data is available in reference Ref. [1] and also in EXFOR. For U-238 transmission, five sample thicknesses were measured covering the thickness range of 0.00758 - 0.06206 atoms/barn, and the energy range from 0.2 – 100 keV which includes parts of the Resolved Resonance Region (RRR) and Unresolved Resonance Region (URR). When comparing with such experiments for the purpose of validation of the total cross section it is important to look at the overall agreement of each sample and trends with thickness that are outside the experimental uncertainty. The calculation of the transmission and SIR were done by simulating the experiment with MCNP 6.2 (Ref. [2]) such that the URR was treated with probability tables. For transmission, the agreement between experiment and calculation was within about +/-2.5 over the entire energy range. For energy between 3 – 100 keV there is some trend with thickness where the thicker samples have lower transmission (higher cross section). Since the data were grouped with multiple resonances in each energy bin, such a trend in transmission is similar to what is observed when self-shielding correction is incomplete, this could indicate missing levels in the RRR and higher self-shielding might be needed in the URR. However, this effect is small.

A SIR experiment is similar to a transmission experiment with the neutron detector replaced by a capture detector with the same transmission sample material in it. In this case, it was a thin sample of U-238. The SIR U-238 data showed much larger deviation between the experiment and MCNP simulation compared to transmission. This might be an indication that the capture in the U-238 ENDF/B-8 evaluation has issues that need to be addressed. A similar comparison of tantalum data measured in the same experiment shows much better agreement of calculated and measured SIR.

The original transmission and SIR measurements for U-238 were conducted at effective temperatures of 101, 301 and 975 K and the changes in transmission and SIR as a function of temperature can be explored. These include the effect of sample contraction/expansion and Doppler broadening. The presentation included one slide showing the transmission and SIR data at different temperatures but did not compare with the evaluations.

References

[1] Tae Y. Byoun, Experimental investigation of the resonance self-shielding and Doppler effect in uranium and tantalum, PhD thesis, Rensselaer Polytechnic Institute, Troy, NY, May 1973.

[2] C.J. Werner, et al., MCNP6.2 Release Notes, Los Alamos National Laboratory, report LA-UR-18-20808 (2018).

A.2. URR development, L. Leal (IRSN Fontenay aux Roses, France)

Luiz Leal presented the ongoing work performed at IRSN on the evaluation of the ^{239}Pu with focus on the unresolved resonance range (URR). The discussion on the URR representation was based on combinations of smooth cross section and resonance fluctuations. Current URR evaluations includes s- and p-wave angular momentum for average cross section calculations. New evaluation will include d-wave. A brief discussion on the impact of the thermal utilization factor on criticality calculation was presented.

A.3. RRR for minor actinides in TENDL-2021, D. Rochman (PSI, Suizeland)

D. Rochman presented the existing evaluations from the TENDL-2021 library regarding minor actinides. In the resolved resonance range, the TENDL resonances represent a compilation from different sources, with the advantage to include them in a complete ENDF-6 file, following the TENDL approach. Specific examples were highlighted, such as ^{244}Pu, or ^{230}U, where comparisons with other libraries and different compilation sources indicated potential improvements. Finally, an example on ^{239}Pu and Monte Carlo adjustment of resonance parameters was presented, leading to an improved agreement for criticality benchmarks.

A.4. Status of the ^{238}U, ^{235}U and ^{239}Pu evaluations, G. Noguere (CEA/DES Cadarache)

Gilles Noguere presented the status of the ^{238}U, ^{235}U and ^{239}Pu evaluations performed at the CEA/DES of Cadarache for nu(prompt), RRR/URR parameters and continuum cross-sections.

Integral feedbacks based on JEFF-3.1.1 and JEFF-3.2 suggest a slight increase of ^{235}U (n,γ) (+1.2%), ^{239}Pu (n,γ) (+0.5%), K1(^{239}Pu) (+0.4%) and $\nu\Sigma_f$(^{239}Pu) (+1%). The interpretation of fast integral experiments (PROFIL) suggests to normalize the ^{239}Pu capture cross section of Mosby by a factor +1.07, which is in agreement with MOX fuel trends (MISTRAL program in EOLE suggests an increase of ^{239}Pu (n,γ) above a few eV).

For the resonance analysis, Gilles Noguere presented a review of data sets for ^{235}U (40 sets from 1966 to 2020) and ^{239}Pu (50 sets from 1951 to 2014) which are used in the CONRAD code for the GLS fitting. A comparison of the “thermal neutron constants” obtained with the CEA and INDEN evaluations highlighted some differences, especially for the fission integral of ^{235}U between 7.8 and 11 eV (251.9 barns compared to 256.9 barns). Information provided by the residuals between the CONRAD fit and the data sets indicate that for total, fission and capture reactions a good agreement for ^{235}U is found, thanks to the experimental work done at the RPI facility. However, larger differences are obtained for ^{239}Pu, mainly below 50eV, indicating some mismatches between the different overlapping data sets.

The neutron multiplicity with covariances is also presented for ^{235}U and ^{239}Pu. The relative uncertainty can reach 2% for small resonances where the (n,γf) reaction seems to be the dominant process. Differences between the theory and the data above a few tens of eV are still not yet explained. An improved theoretical framework is needed for reproducing the fluctuations of nu(prompt) in the RRR.

Finally, a comparison of reactivity as a function of burnup for UOX and MOX fuels between the new CEA evaluation and JEFF-3.1.1 seems to correct the strong decrease of reactivity observed with JEFF-3.3. This trend can result from compensation effects due to ^{238}U capture cross section. Further investigations are needed to clarify the role of ^{238}U as a function of burnup.

ANNEX I

IAEA Consultants' Meeting of the International Nuclear Data Evaluation Network (INDEN) on Actinide Evaluation in the Resonance Region

1-4 November 2021
IAEA, Vienna (hybrid)

ADOPTED AGENDA

Monday 1 November

13:00 -18:00	Opening of the meeting, A. Koning (Section Head NDS)
	Election of Chair and Rapporteur(s), discussion of the Agenda
	Introduction, R. Capote
	Presentations: On the fluctuations in the fission cross section of U-235 in the URR in ENDF/B-VIII.0, A. Trkov

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Tuesday 2 November

13:00 - 18:00	**Presentations** cont'd: Validation of RRR and URR using transmission and self-indication experiments, Y. Danon
	Status of the U-238, U-235 and Pu-239 evaluations, G. Noguere
	URR developments, L. Leal

Wednesday 3 November

10:00 -17:00	**Presentations** cont'd: On the integral references for TOF (n,f) measurements, I. Duran
	New ^{239}Pu(n,f) prompt neutron multiplicity and PFNS evaluations and their validation within INDEN Files, D. Neudecker
	RRR for minor actinides in TENDL-2021, D. Rochman
	Evaluated data for fissile actinides in the resonance region and their coupling to neutron multiplicities, M. Pigni
	Discussion

Thursday 4 November

10:00 -17:00	**Discussion** cont'd
	Drafting of the Meeting Summary Report

ANNEX II

IAEA Consultancy Meeting of the International Nuclear Data Evaluation Network (INDEN) on Actinide Evaluation in the Resonance Region

1-4 November 2021
IAEA, Vienna

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ANNEX III

PARTICIPANTS' PRESENTATIONS

#	Author	Title	Link
1	Y. Danon	Validation of RRR and URR using transmission and self-indication experiments	PDF
2	D. Neudecker	New ^{239}Pu(n,f) Prompt Neutron Multiplicity and PFNS Evaluations and their Validation within INDEN Files	PDF
3	G. Noguere	Status of the U238, U235 and Pu239 evaluations	PDF
4	L. Leal	URR developments	PDF
5	I. Duran	On the integral references for TOF (n,f) measurements	PDF
6	A. Trkov	On the Fluctuations in the Fission Cross Section of U-235 in the URR in ENDF/B-VIII.0	PDF
7	A. Trkov	On the Reactivity Trends in ENDF/B-VIII.0 With Burnup Due to U-238 Cross Sections	PDF
8	D. Rochman	RRR for minor actinides in TENDL-2021	PDF
9	M.T. Pigni	Evaluated Data for Fissile Actinides in the Resonance Region and their Coupling to Neutron Multiplicities	PDF

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