

H2020 ARIEL: Hands-on school on “Nuclear data from Research Reactors”
25-29 September 2023. Budapest, Hungary.

Practical Demonstration of the use of Nuclear Data Libraries

Prof. Oscar Cabellos
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0. Evaluation

Evaluated Data

- ND evaluation
- ND Formats

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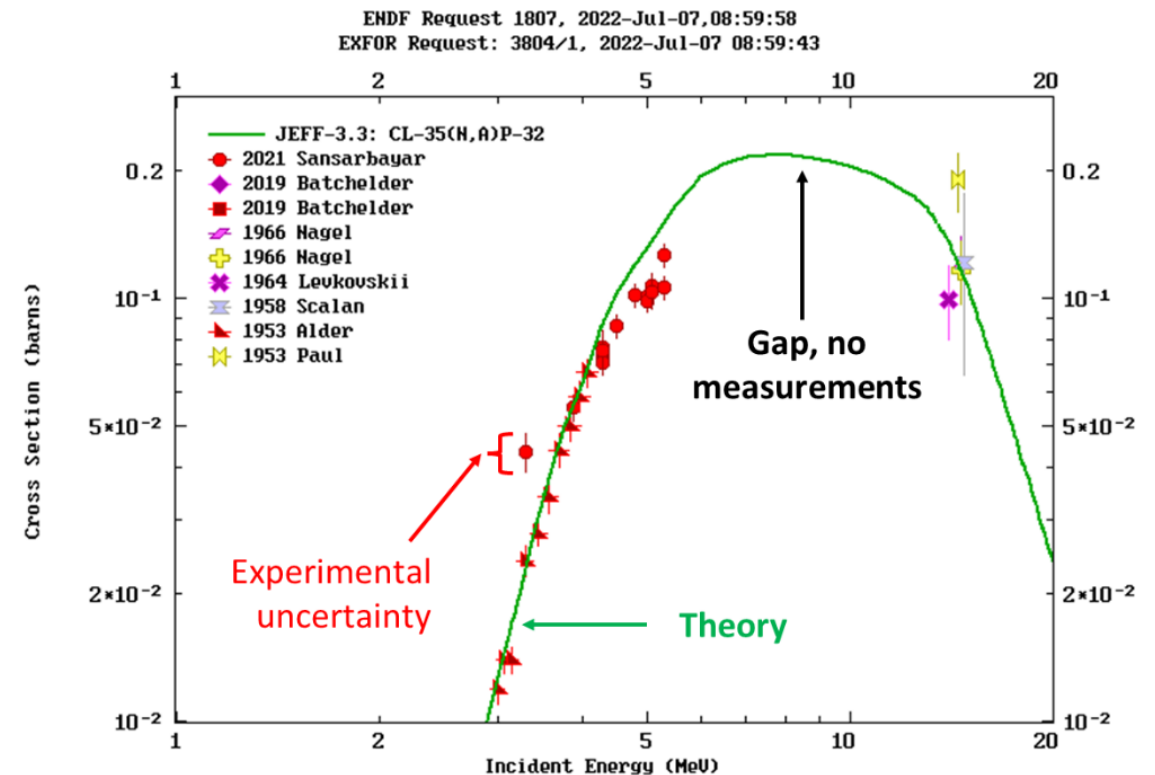
The ND evaluation pipeline

Briefly, the nuclear data evaluation “pipeline” can be summarized in the following steps:

- Collection of experimental EXFOR data
- Correction/normalization of experimental data
- Fitting a model to the corrected experimental data:
 - GLLS methods directly to experimental data
 - Nuclear physics model (based on robust fundamental nuclear physics formulation)
 - TALYS
 - EMPIRE
 - ...

Bayesian methods for model fitting are very familiar in the evaluation of nuclear data
- Finally, the last step is the generation of Evaluated Data files:
 - ENDF-6 format
 - GNDS format

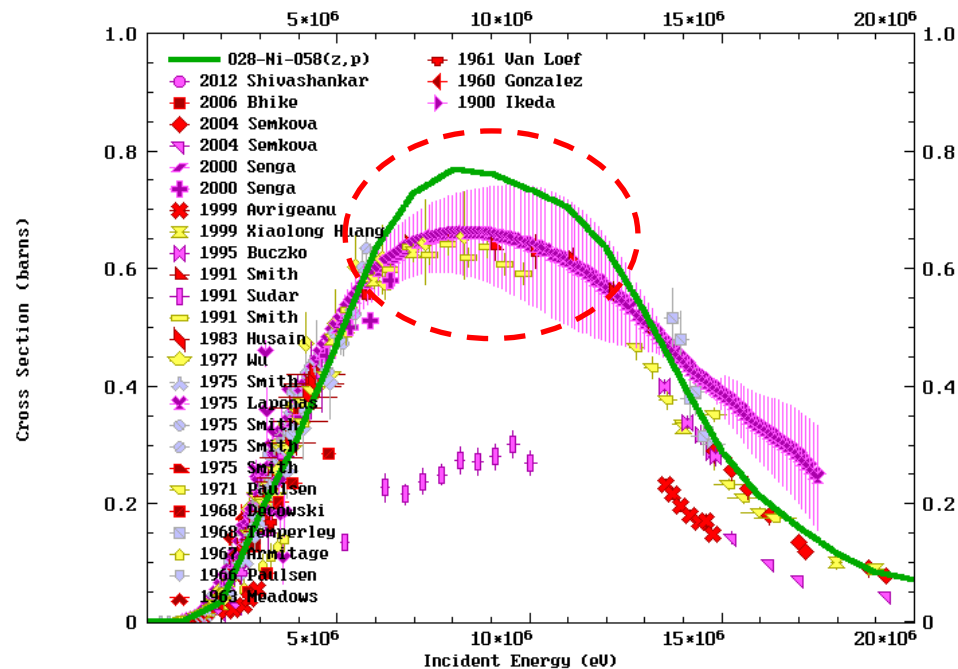
Figure 1. $^{35}\text{Cl}(n,\alpha)$ reaction cross section: modelling versus experimental data



Nuclear reaction models and codes

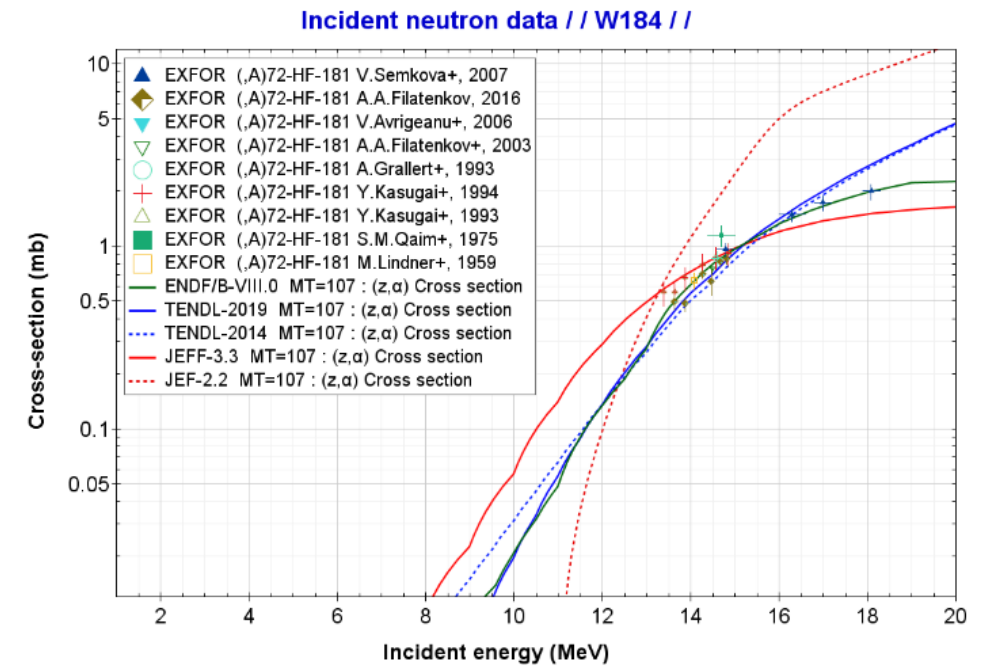
There are codes (EMPIRE, TALYS, ...) used for the simulation of nuclear reactions which provide a complete description of all reaction channels and observable (e.g. cross-sections, angular distributions,...).

Figure 2. Comparison between EMPIRE code (green line) and EXFOR data for $^{58}\text{Ni}(n,p)$



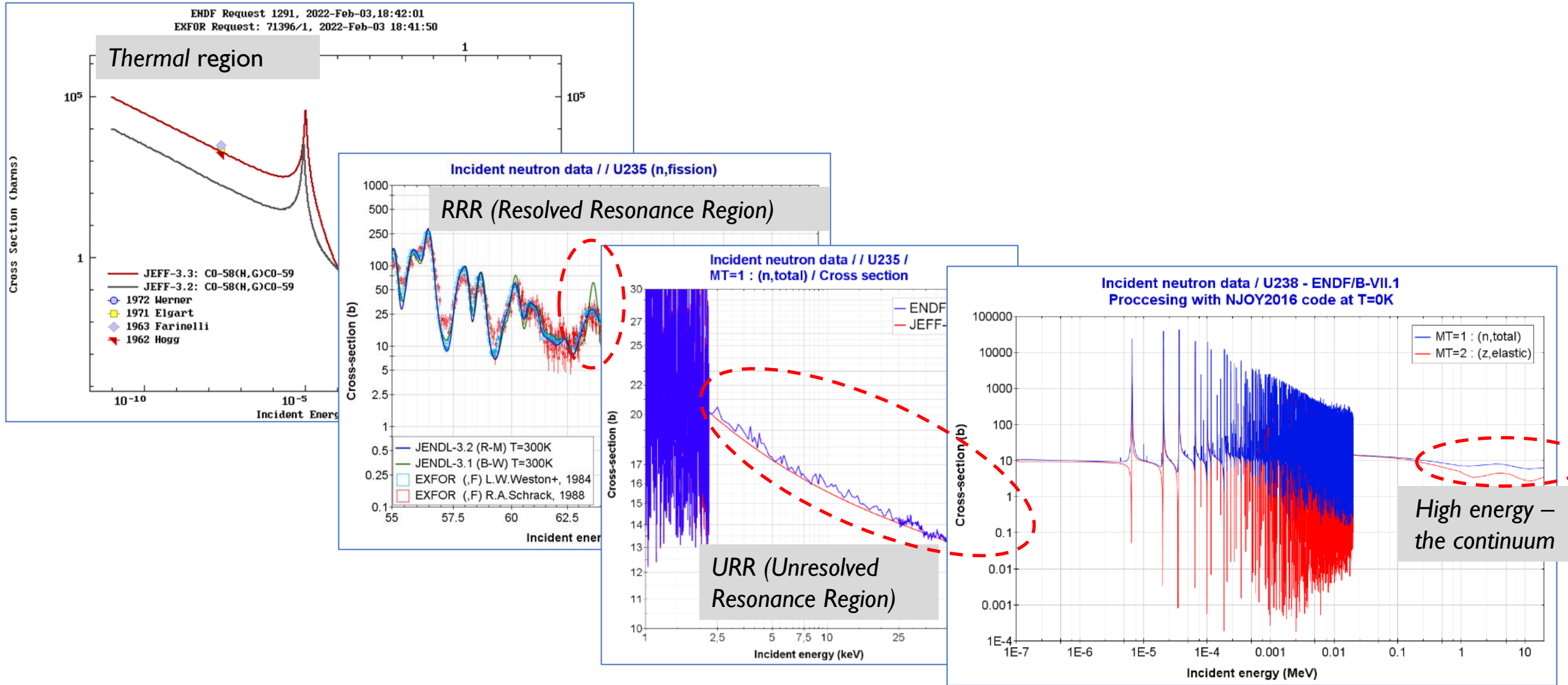
- A good agreement is shown in general except for 10-12 MeV which may reflect deficiencies in the nuclear model parameters for this reaction.

Figure 3. The cross section $^{184}\text{W}(n,\alpha)$

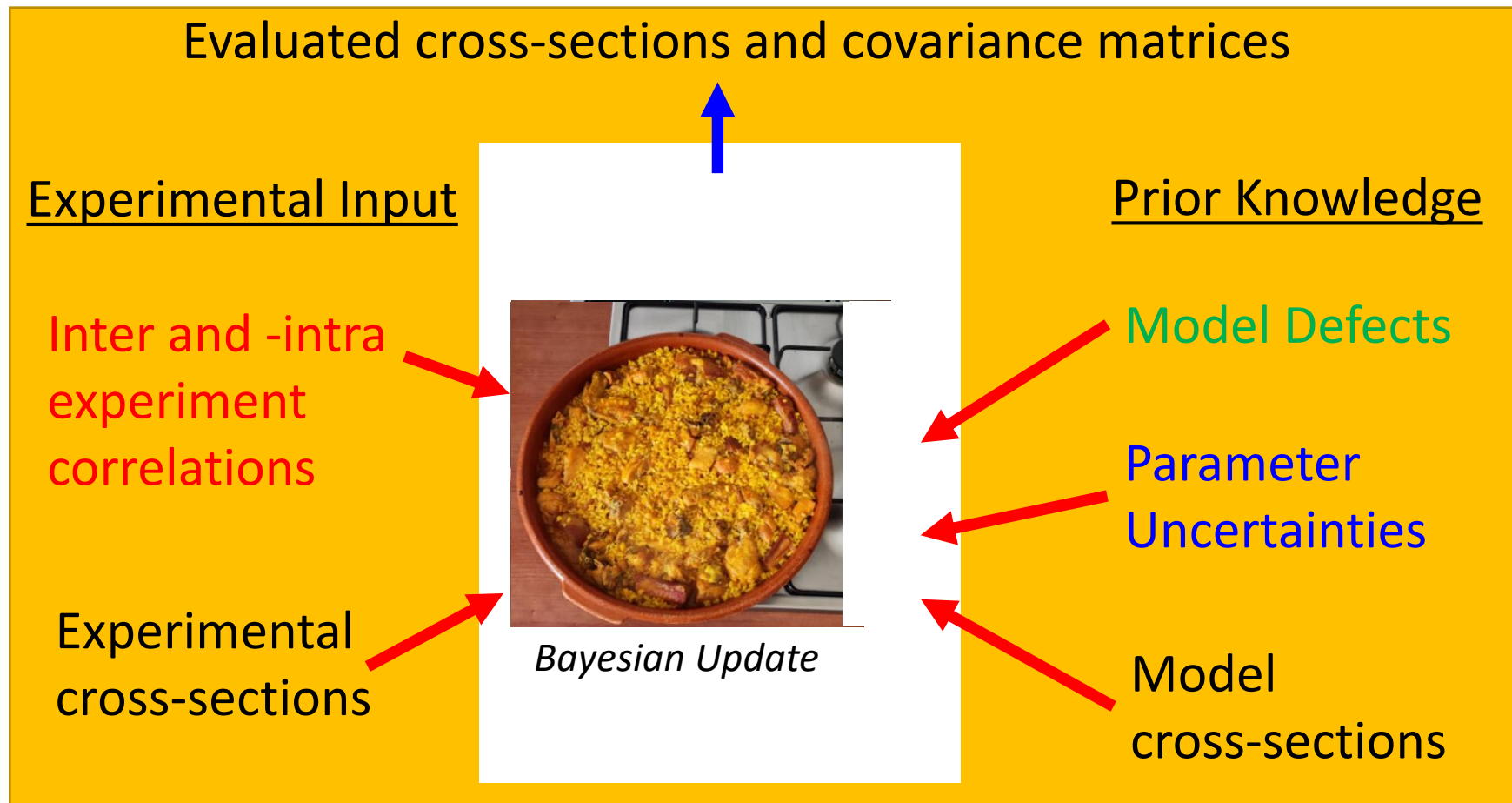


- Exp. data are used for calibration of nuclear parameters in models
- But, some nuclear models show lack accuracy for detailed prediction of cross-sections in the whole energy range

Evaluation of XSs in different energy ranges



ND Evaluation: The Bayesian's Approach



- Bayesian methods are very familiar in the evaluation of nuclear data

Figure 14. Example of the Bayesian procedure to evaluate cross-section and covariances

International efforts on evaluation of ND

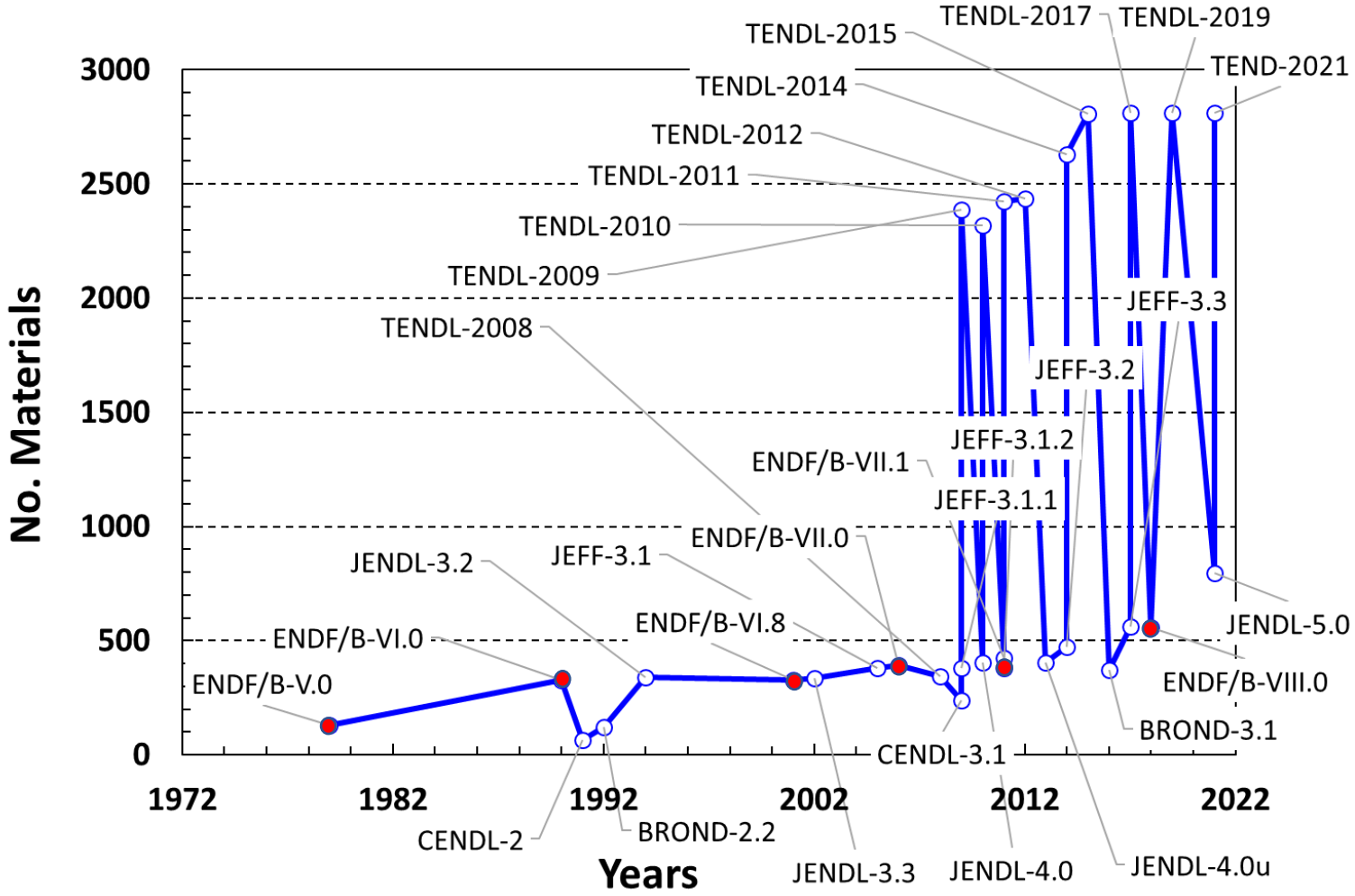


Figure 15. Nuclear data libraries of today versus MAT

The structure/format for the Evaluated ND

Figure 16. Structure of ENDF format

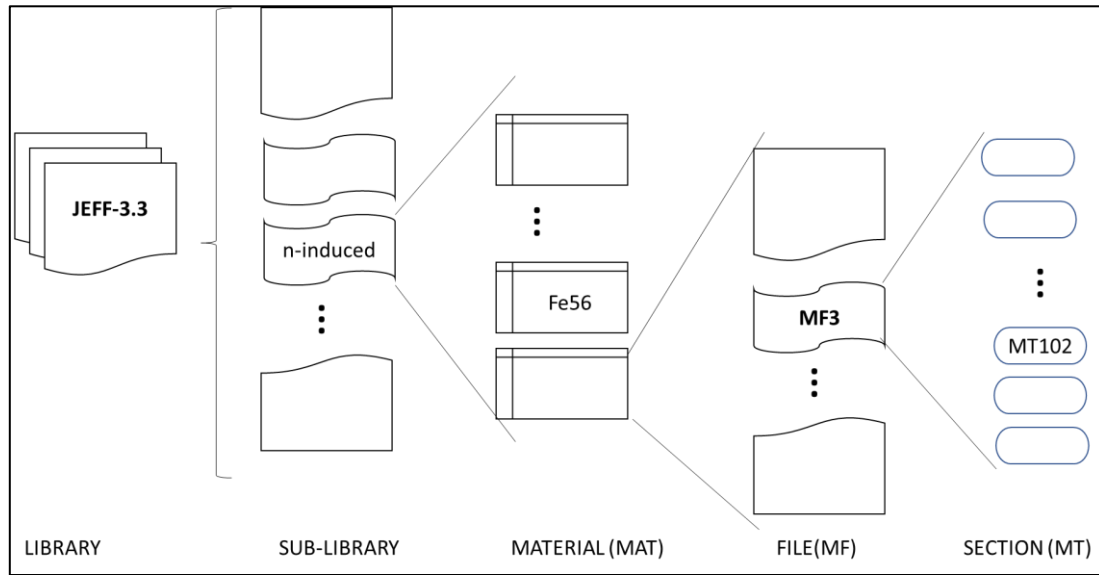


Table 1. An extract/example of ENDF-6 format (top) and GNDS/XML (bottom) for the $IH(n,elastic)$ in ENDF/B-VIII.0

ENDF-6						MAT MF MT			
1.001000+3	9.991673-1	0	0	0	0	125	3	2	1
0.000000+0	0.000000+0	0	0	1	153	125	3	2	2
	153		2			125	3	2	3
1.000000-5	2.043608+1	2.000000-5	2.043608+1	5.000000-5	2.043608+1	125	3	2	4
1.000000-4	2.043608+1	2.000000-4	2.043608+1	5.000000-4	2.043608+1	125	3	2	5
...									
1.900000+7	5.079599-1	1.950000+7	4.945948-1	2.000000+7	4.818408-1	125	3	2	54
0.000000+0	0.000000+0	0	0	0	0	0	125	3	099999

GNDS
<pre> <crossSection nativeData="linear"> <linear xData="XYs" length="153" accuracy="0.001"> <axes> <axis index="0" label="energy_in" unit="eV" interpolation="linear,linear" frame="lab"/> <axis index="1" label="crossSection" unit="b" frame="lab"/> </axes> <data> 1e-5 20.43608 2e-5 20.43608 5e-5 20.43608 1e-4 20.43608 2e-4 20.43608 5e-4 20.43608 ... 1.75e7 0.5521863 1.8e7 0.5367046 1.85e7 0.5219803 1.9e7 0.5079599 1.95e7 0.4945948 2e7 0.4818408 </data> </linear> </crossSection> </pre>

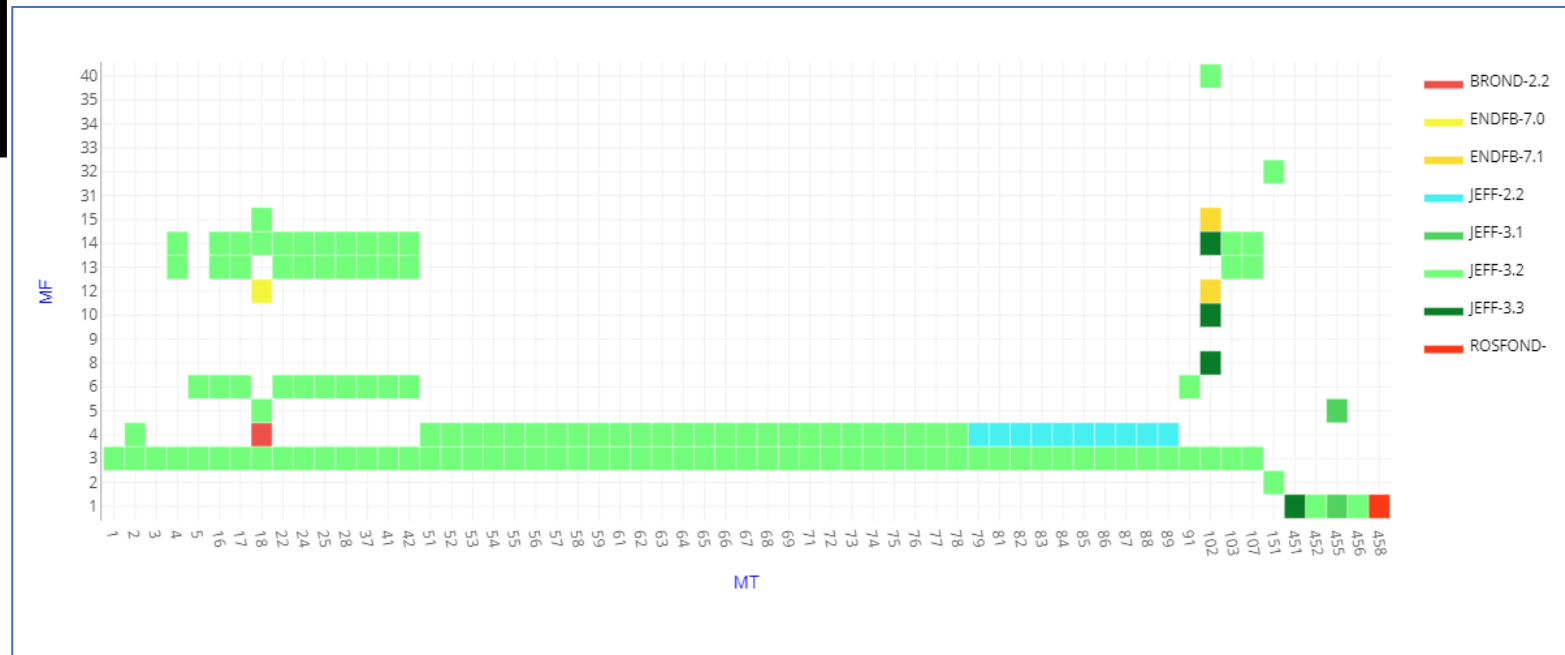
EXERCISE I.

EXERCISE in Handbook/Chapter03/Exercise2

Exercise I. Explore the map of information of 95-AM-24 I g/JEFF-3.3 using the tool: <https://www.oecd-nea.org/dbdata/jeff/jeff33/Maps.html>

Q/A: Indicate the MFs/MTs which are...

Total MFs/MTs	146
Updated (changed from previous evaluations: JEFF-3.2)	6
New (included in ENDF/B-VII.1)	2
Unchanged	138
Erased (from JEFF-3.2)	2



EXERCISE 2.

EXERCISE in Handbook/Chapter03/Exercise2

Explore the different formats of the evaluated. Download libraries in different formats with: <https://www-nds.iaea.org/exfor/endl.htm>

Q/A: Indicate who are the coordinators of this ^{14}N library for ENDF/B-VIII and JEFF-3.3: **M.B.Chadwick,P.G.Young**

Advanced Request Examples: 1|2|3|4|5|6|7 Go to: [Standard Request](#); [ENDF-Explorer](#)

Examples of requests:
1 Cross section: MF3
2 Angular distributions: MF4
3 Energy distributions of secondary particles: MF5
4 Product energy-angle distributions: MF6
5 Cross sections for production of radioactive elements: MF10
6 Search for production cross section (MF6/MT5/Law=0) [Photo](#) [PD](#)
7 Covariances of neutron cross sections: MF33 [Li-6\(n,t\)](#)
8 Covariances for production of radioactive nuclei: MF40
9 Covariances for energy distributions of secondary particles: MF35
10 Search for decay data in the ENDF files (NSUB=4)
11 Differential data for ion beam analysis (IBA-EVAL); [Li-6\(p\)](#)
12 Search for "smooth" photon interaction cross sections: MF23
13 Fission product yield /MF8/: [Ind.](#) [Cum.](#)
14 He-4 production cross section from n → ^7Li
15 Radioactive decay data [N-16](#) [Y-98](#) [Pm-148M](#) [Th-230](#)

Parameters:

Sub-Lib (projectile) N
Target N-14
MF (quantity) #
MT (reaction) #
LR flag #
Product
Energy extends above MeV
Laboratory
Author(s)

Ranges:

	Target	Product
Z	<input type="checkbox"/>	<input type="checkbox"/>
A	<input type="checkbox"/>	<input type="checkbox"/>
Isomer	<input type="checkbox"/>	<input type="checkbox"/>

Libraries: All Selected(1)

Major Libraries

- 1) ENDF/B-VIII.0 (USA,2018)
- 2) JEFF-3.3 (Europe,2017)
- 3) JENDL-5 (Japan,2021)
- 4) JENDL-4.0u2 (Japan,2012)
- 5) CENDL-3.2 (China,2020)
- 6) BROND-3.1 (Russia,2016)
- 7) TENDL-2019 (TALYS, 2019)

IAEA Project Libraries

- 8) FENDL-3.2b, Fusion, 2022
- 9) INDEN-2022
- 10) IAEA-Med radioisot.prod.2019
- 11) IAEA-Med diagnostic ri.prod.2001
- 12) IAEA-Med therapeutical ri.prod.2009
- 13) IAEA-Photonuclear, 2019
- 14) IAEA Standards, 2017
- 15) IAEA Reference cross sections, 2017
- 16) IAEA High-Energy fission ref., 2015
- 17) ADS-HE High energy, 2013
- 18) IRDFF-II Dosimetry, 2019
- 19) INDL/TSL Thermal Scattering Law, 2006
- 20) IBA-EVAL diff.data for ion beam analysis, 2013
- 21) Wind, U,Np,Pu (up to 100 MeV), 1996
- 22) HE fission by Yashits for Pb-Pu, 2000

Special Libraries

- Archival
- Derived

Options:

Sort by: Reactions Evaluations Extended

View: Basic Extended

Retrieve: Sections Sub-Sections

Clone Request:

Feedback:

- MAT is ENDF-6 format
- GNDS format
- PEN is pointwise at 293.16K
- INTER is output of INTER code

Request #395

ENDF Data Selection

Selected Unselected All

Plotting options: Quick plot (cross-sections only: σ) MF3-Plot
 Universal plot ($\sigma \pm \Delta\sigma$, $d\sigma/d\Omega$, $d\sigma/dE$, $d^2\sigma/dE/d\Omega$) *beta version*

Sorted by: [Libraries] Reorder by: [Reactions] View: basic extended: get MAT, PEN, GND, run Inter, resonance integrals, etc.

1	Info	Summary	MAT	GND-1.2	PEN	Inter	7-N-14	MAT=725 NSUB=10(N)	150MeV	ENDF/B-VIII.0	LANL		20111222
MAT=725 MF2 [RES] Resonance parameters													
1	ENDF-6		N-14(N,RES),RES		MT151								

Q/A: Value of $\sigma(0.0253 \text{ eV})$ for the total cross-section in ENDF/B-VIII.0: **1.21699E+01 b**

Sources of Nuclear Databases

- The IAEA/NDS: <https://www-nds.iaea.org/>
- The OECD/NEA: <https://www.oecd-nea.org/>

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IAEA/NDS – ENDF Archive

Figure 1. IAEA/NDS website - <https://www-nds.iaea.org/>

The screenshot shows the IAEA Nuclear Data Services website. The browser address bar displays <https://www-nds.iaea.org/>. The page header includes the IAEA logo and the text "International Atomic Energy Agency Nuclear Data Services Sección Datos Nucleares, OIEA". A search bar is located in the top right corner. Below the header, there are navigation links for "Hot Topics" and "News". The main content area features a "NEW" section with announcements for TENDL-2021, JENDL-5, and a β -delayed neutrons reference database. Below this, there are tabs for "Main", "All", "Reaction Data", "Structure & Decay", "by Applications", "Doc & Codes", "Index", "Events", "Links", and "News". The main content is organized into a grid of service tiles, including EXFOR, LiveChart of Nuclides, CINDA, ENDF, ENSDF, NSR, NuDat-3, RIPL, IBANDL, Charged particle reference cross section, PGAA, FENDL, Photonuclear, IRDFF-II, NAA, Safeguards Data, and Medical Portal. A sidebar on the left contains "Quick Links" with a red arrow pointing to the "ENDF Archive" link. The footer contains copyright information and contact details for the IAEA Nuclear Data Section.

International Atomic Energy Agency
Nuclear Data Services
Sección Datos Nucleares, OIEA

Hot Topics » IAEA-CIELO • TENDL-2021 • JENDL-5 • ENDF/B-VIII.0 News » Pointwise2020//TENDL-2019

NEW
TENDL-2021 TALYS-based Evaluated Nuclear Data Library, 2021: [page] [list] [retrieve]
JENDL-5 Japanese evaluated nuclear data library, 2021: [page] [errata] [list] [retrieve]
 β -delayed neutrons reference database for beta-delayed neutron emission [page]

Main | All | Reaction Data | Structure & Decay | by Applications | Doc & Codes | Index | Events | Links | News

EXFOR Experimental nuclear reaction data
LiveChart of Nuclides Interactive Chart of Nuclides Mobile App: Isotope Browser
CINDA Nuclear reaction bibliography
ENDF Evaluated nuclear reaction libraries
ENSDF evaluated nuclear structure and decay data (+XUNDL) **
NSR Nuclear Science References *

NuDat-3 selected evaluated nuclear structure data **	RIPL reference parameters for nuclear model calculations	IBANDL Ion Beam Analysis Nuclear Data Library	Charged particle reference cross section Beam monitor reactions
PGAA Prompt gamma rays from neutron capture	FENDL Fusion Evaluated Nuclear Data Library	Photonuclear - IAEA Photonuclear Data Library, 2019 - EPICS Electron & Photon Interaction Data, 2017	IRDFF-II International Reactor Dosimetry and Fusion File
NAA Neutron Activation Analysis Portal	Safeguards Data Last updated: May 2021	Medical Portal Medical Portal	Standards - Neutron cross-sections, 2017 - Decay data, 2005

*Database at the IAEA, Vienna **Database at the US NNDC

IAEA Nuclear Data Section

IAEA-NDS Mission | A+M Atomic and Molecular Data | Meetings Workshops | Newsletters | Coordinated Research Projects | NRDC Nuclear Reaction Data Center Network | NSDD Nuclear Structure & Decay Data Network | INDEN International Network of Nuclear Data Evaluators | Technical Documents INDC Reports Publications | Computer Codes | IAEA-NA Department of Nuclear Sciences and Applications

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Last Updated: 25-October-2022

Web design: V.Zerkin, IAEA, 2008

OECD/NEA – Data Bank

Figure 2. OECD/NEA – Data Bank - website - <https://www.oecd-nea.org/dbdata/>

The screenshot shows the website for Nuclear Data Services (NDS) under the Nuclear Energy Agency (NEA). The main heading is "Nuclear Data Services" with the tagline "Developing, compiling, testing and disseminating nuclear data and tools". Below this, there are three search options: "Evaluated files Search ENDF-6", "Experimental entries Search EXFOR", and "Bibliographical entries Search CINDA". A paragraph describes the Joint Evaluated Fission and Fusion (JEFF) Nuclear Data Library as a collaboration between NEA Data Bank and participating countries. A "Contact" section provides information on how to reach the NEA Data Bank Nuclear Data Service team, with a "Last modified" date of 21 January 2022. On the right side, there are sections for "Latest JEFF Libraries" (listing JEFF-3.3), "Evaluated Releases" (listing BROND-3.1, ENDF/B-VIII.0, JEFF-3.3, JENDL-4.0, TENDL-2017, and "Other Libraries (description)"), and "2021 Events" (listing "Hybrid" and "Remote" meetings). A red circle highlights the "Evaluated Archive" link under "Other Libraries (description)", with a red arrow pointing to it from the right. The left sidebar contains "NEA Tools and Databases" (listing HPRL, ICSBEP/DICE, IRPHE/IDAT, JANIS, NDAST, NDEC, SFCOMPO, SINBAD), "Nuclear Data Links" (listing IAEA NDS (Vienna), NNDC (Brookhaven), NRDC), and "More info on" (listing Evaluated nuclear data, Experimental nuclear data, Nuclear structure data, and Bibliographic data).

EXERCISE I.

EXERCISE in Handbook/Chapter03/Exercise I.

Exercise I. Explore website: <https://www-nds.iaea.org/public/download-endf/> to identify in **JEFF.3.3** and **ENDF/B-VIII.0**

- Sub-libraries per type of incident particle incident particles and types of data
- Number of evaluated files for each material

For **JEFF-3.3**:

At <https://www-nds.iaea.org/public/download-endf/>

- | | | |
|----------------------------------|-------------------------------|-------------------|
| • n-induced reactions (562) | TSL libraries (20) | |
| • Spontaneous Fission Yields (3) | N-induced Fission Yields (19) | Decay data (3852) |

At <https://www.oecd-nea.org/dbdata/jeff/jeff33/>

- | | | |
|--|-------------------------------|-------------------------|
| • n-induced reactions (562) | TSL libraries (20) | |
| • Processed files in ACE format at different temperatures <ul style="list-style-type: none">○ 293K, 600K, 900K, 1200K, 1500K and 1800K○ TSL at the temperatures available | | |
| • Neutron activation files | | |
| • Spontaneous Fission Yields (3) | N-induced Fission Yields (19) | Decay data (3852) |
| • Alpha induced reactions | Deuteron induced reactions | Gamma induced reactions |
| • He3 induced reactions | Proton induced reactions | |
| • DPA sub-library for atomic displacement | | |

EXERCISE I.

EXERCISE in Handbook/Chapter03/Exercise I.

Exercise I. Explore website: <https://www-nds.iaea.org/public/download-endf/> to identify in **JEFF.3.3** and **ENDF/B-VIII.0**

Questions/Answers

- **Q/A:** Number of n-induced reactions in ENDF/B-VIII.0 ? : **557**
- **Q/A:** Name of coordinator/institution responsible of U235 evaluation in JEFF-3.3 and ENDF/B-VIII.0 ?:
 - **Q/A:** JEFF-3.3: **IRSN-CEA DAM/DEN COLLAB.**
 - **Q/A:** ENDF/B-VIII.0: **IAEA CIELO Collaboration**
- **Q/A:** Will you have the same information for JEFF-3.3 at www-nds.iaea.org and at <https://www.oecd-nea.org/dbdata/jeff/jeff33/> ? **NO**
- **Q/A:** Do you find any (significant) differences in the file between 27Al/JEFF-3.3 at www-nds.iaea.org and <https://www.oecd-nea.org/dbdata/jeff/jeff33/> ? **NO**

Sources/Tools for ND Visualization

- The IAEA/NDS/EXFOR: <https://www-nds.iaea.org/exfor>
- The OECD/NEA/JANIS: <https://www.oecd-nea.org/janis>

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OECD/NEA – JANIS Tool

Figure 1. OECD/NEA/JANIS Tool - <https://www.oecd-nea.org/janis>

Nuclear Energy Agency (NEA) - J x +
https://www.oecd-nea.org/janis

NEA
Nuclear Energy Agency

ABOUT US TOPICS NEWS AND RESOURCES LEARNING AND TOOLS

DATA BANK MY/NEA

Search the whole site...

Homepage > Data bank > JANIS

JANIS

Databases Nuclear data

JANIS NEA - Nuclear properties - Nubase 2016 - Basic properties

File Database Search Chart Help

HALFLIFE

No parity filter

Nucleide / Compound

Databases

JANIS screenshot

- What is JANIS?
- Screenshots
- What's new in 4.1 (Sept 2020)

Launch JANIS 4.1
Java Web Start

Downloads
Software, Manual, DVD 4.0 ISO

JANIS Web
Online version, no Java required

JANIS Books
Experimental and evaluated cross-sections

Related topics

- Nuclear Data Services
- Nuclear data

The NEA/JANIS Software

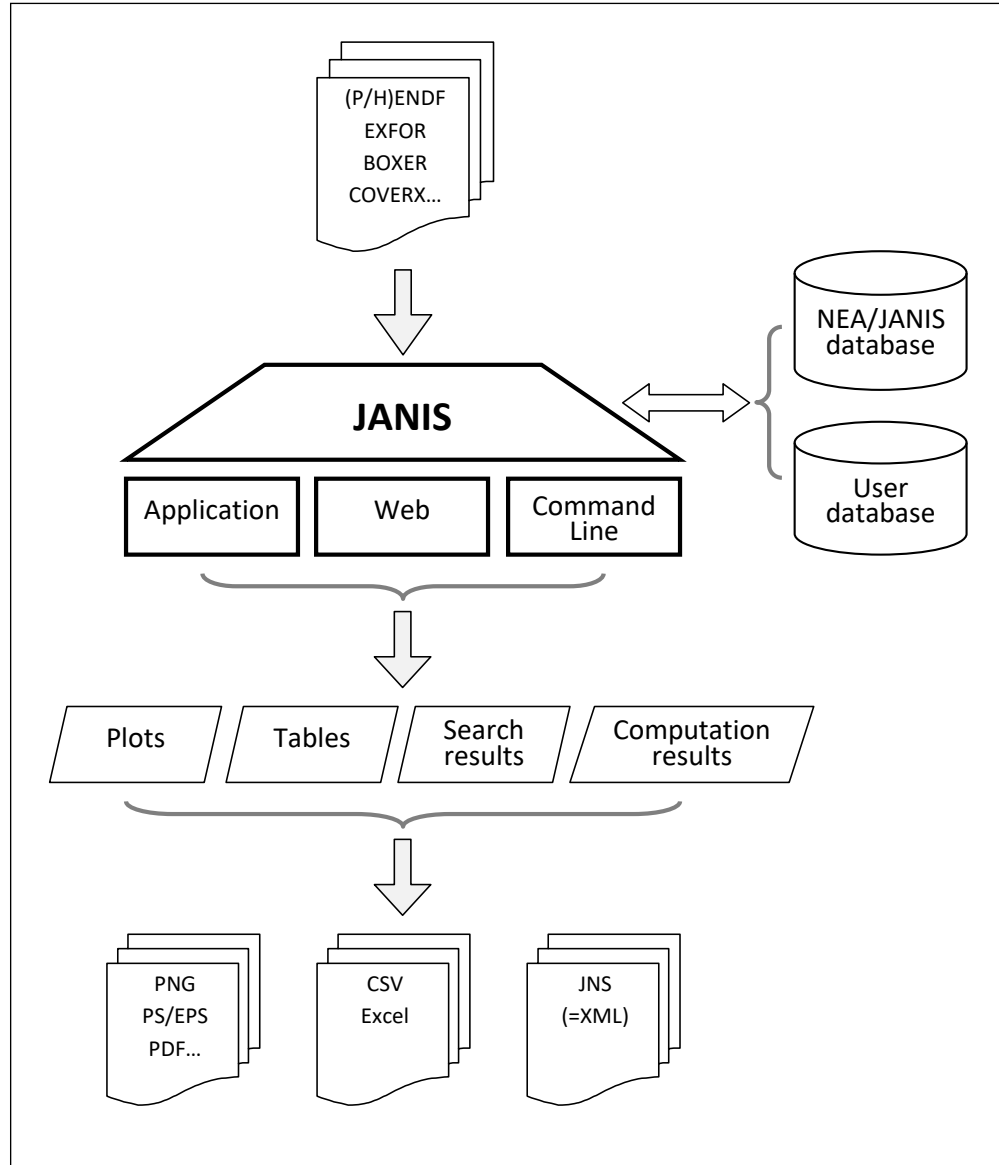
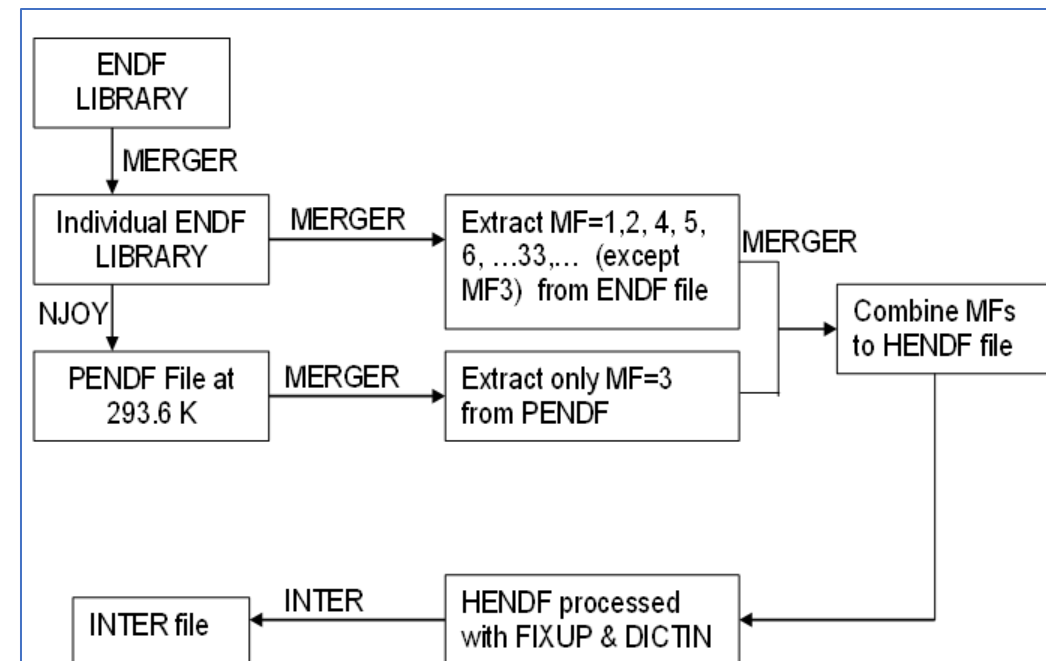


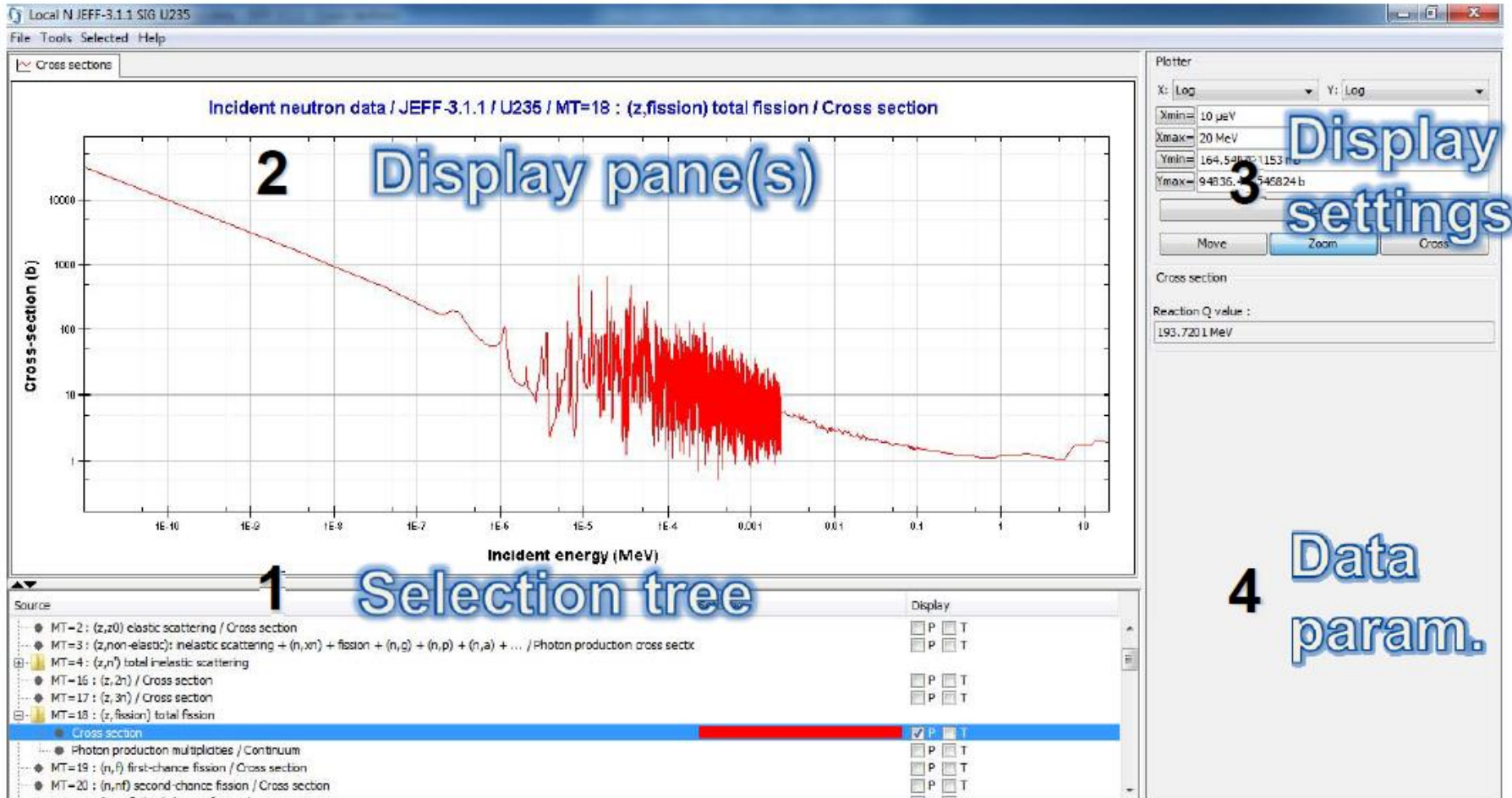
Figure 2. Database, capabilities and input/output information flow in JANIS

Figure 3. Flowchart of processing JANIS database from ENDF tapes



The NEA/JANIS Software

Figure 4. The JANIS – Plot (renderer) window.

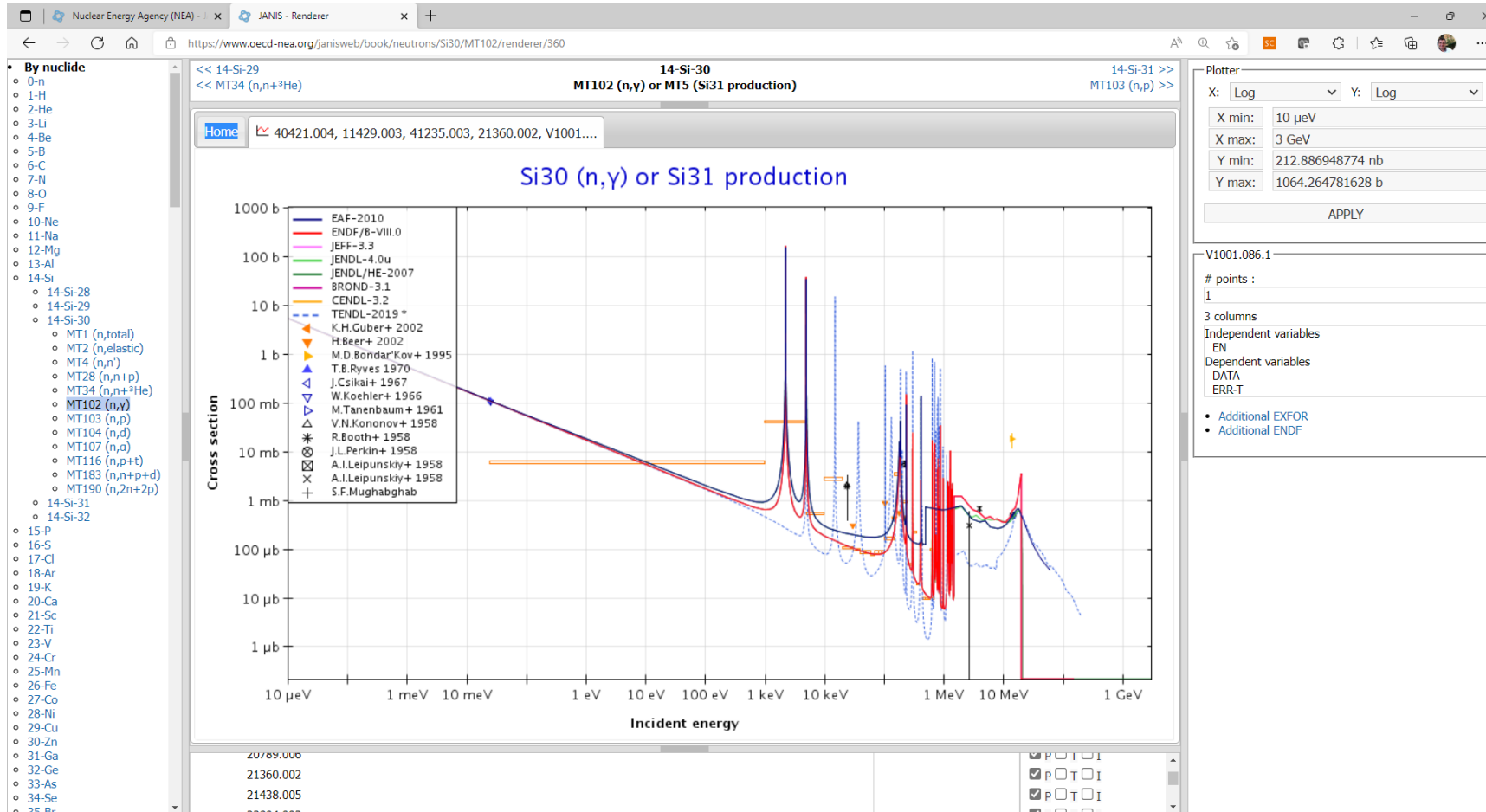


JANIS provides ways for:

- exploring nuclear data libraries and databases
- visualization and comparison of data
- arithmetic operations (normalisation, ratio, linear combination)
- some processing (weighted average)

The NEA/JANIS Software

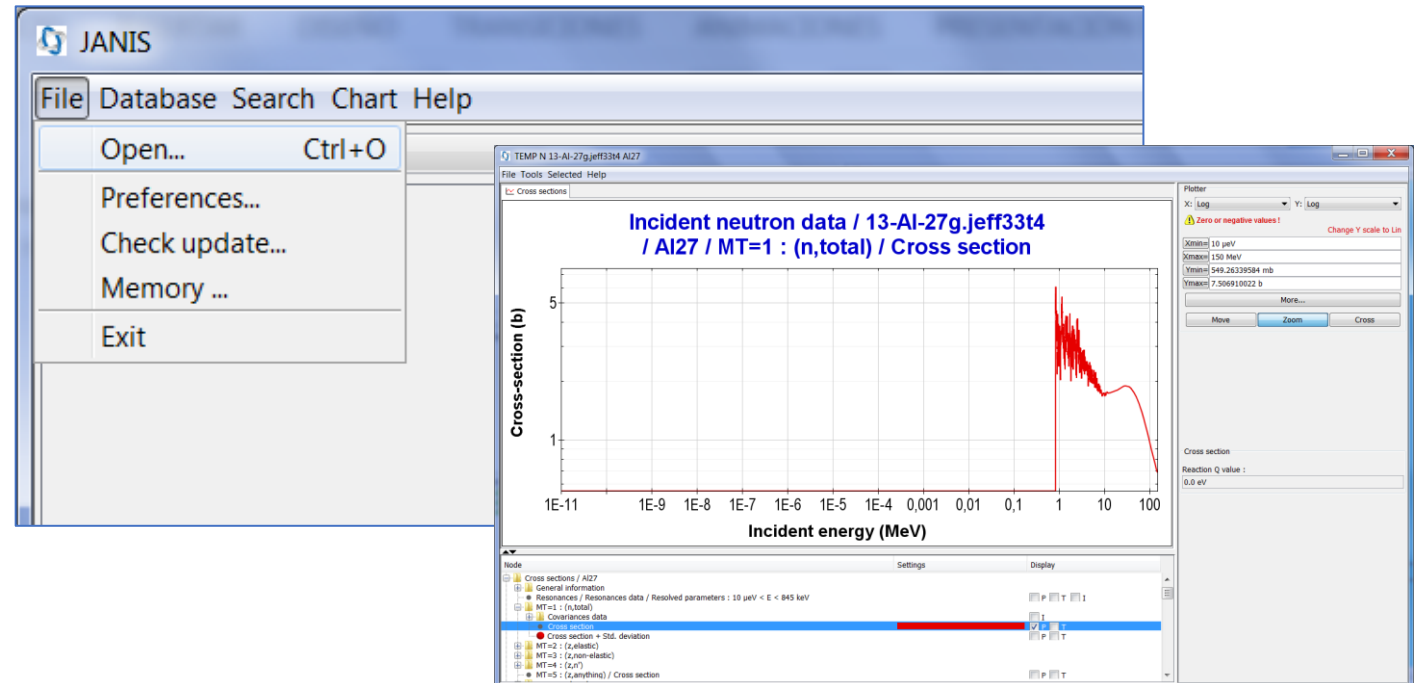
Figure 5. The JANIS – “online Handbook”



JANIS: Display your own data

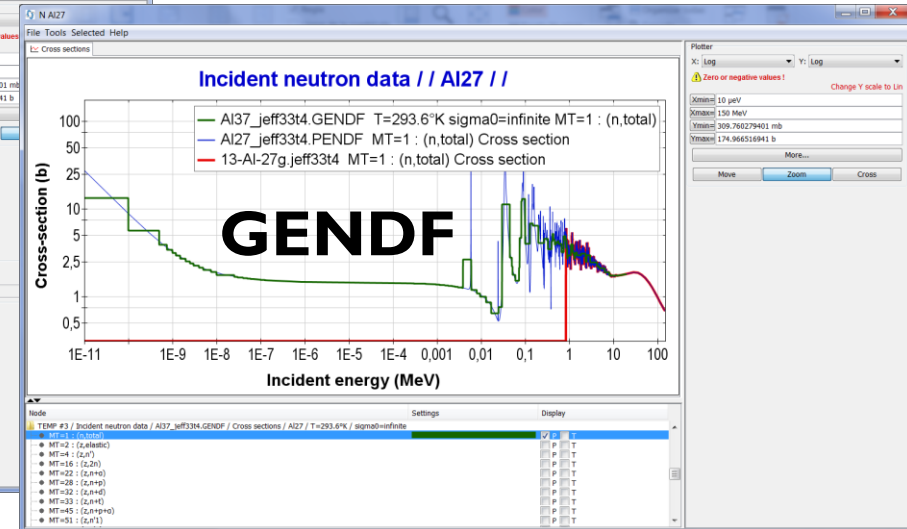
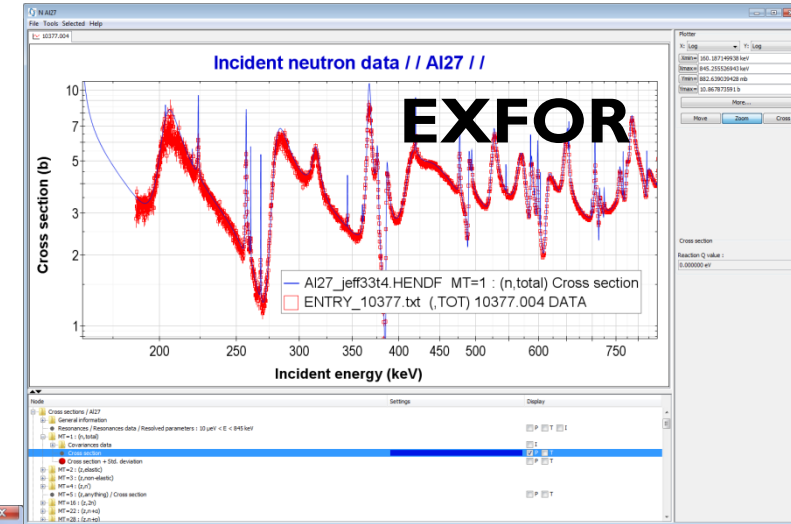
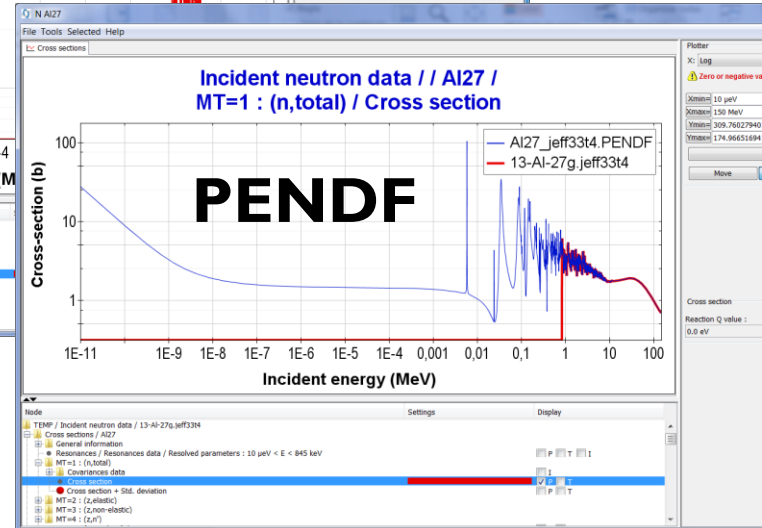
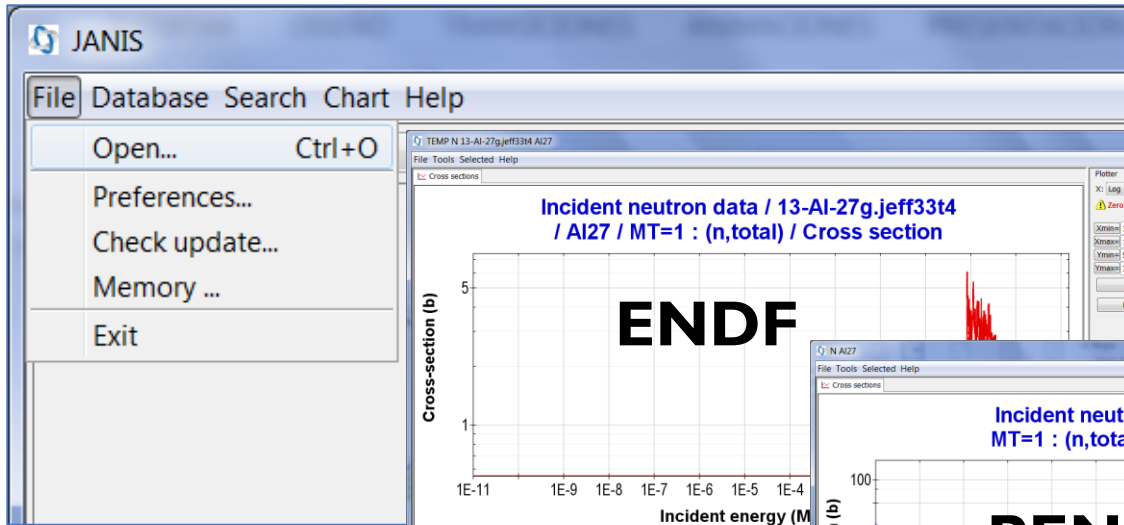
❑ Visualization of evaluated and processed data

- **FILE, OPEN Tool** : ENDF, PENDF, GENDF, ACE2ENDF, ...
- **Plot covariance data**: ENDF/MF33 and ERRORR-BOXER, COVERX...
- **EXPORT** (PNG, EPS) and **SAVE** (JNS)
- **JANIS's COMMAND LINE**: "C:\java -jar janis.jar -o FILE.png -render FILE.jns png 1024 768"
- **COMPUTATION** : Ratio of (n,g) cross-sections
- **WEIGHTING**: (n,g) in 238 energy groups
- **SEARCH and COMPARISON**:
 - SEARCH, EXFOR Tool
 - COMPARISON with other evaluations



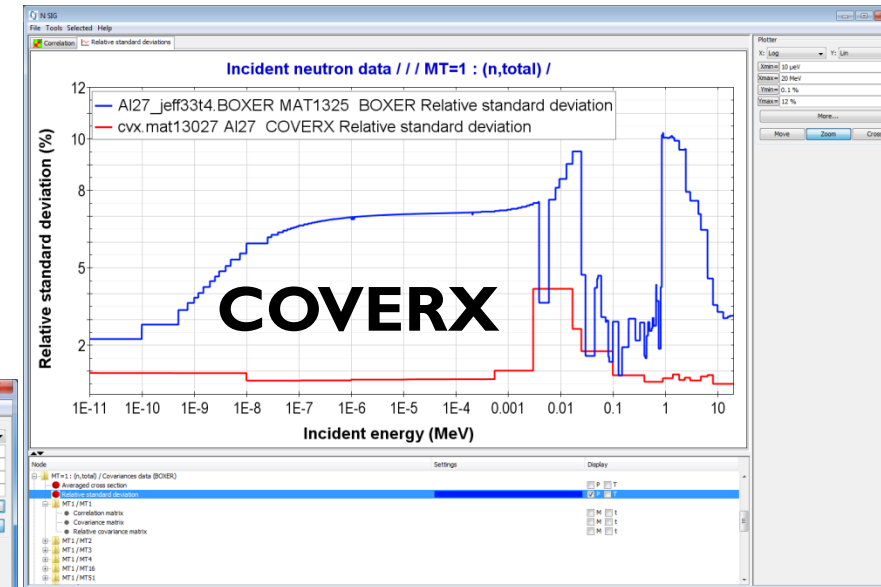
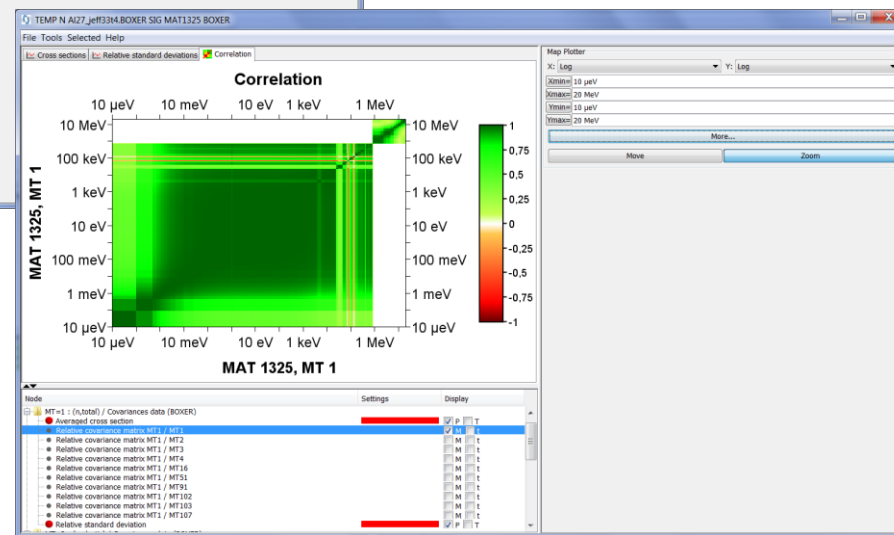
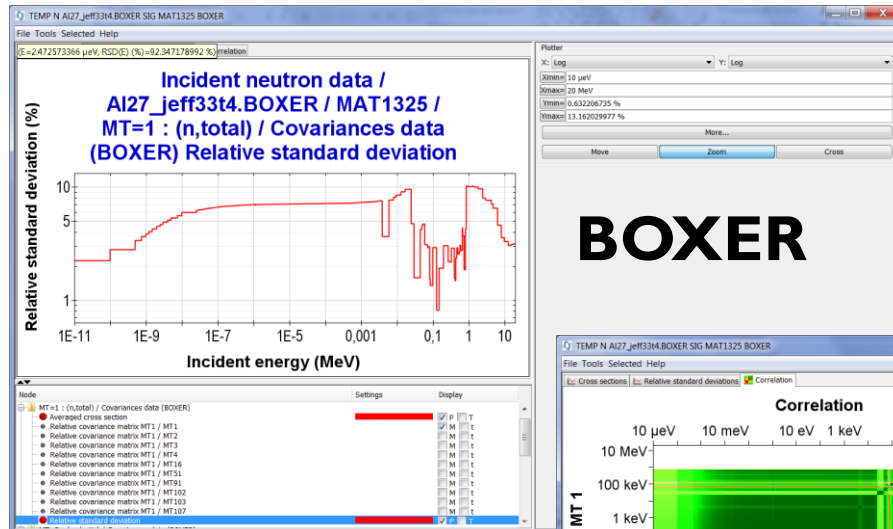
JANIS: Display your own data

- ❑ Visualization of evaluated and processed data
 - **FILE, OPEN Tool** : ENDF, PENDF, GENDF, ACE2ENDF, ...



JANIS: Display your own data

- ❑ Visualization of evaluated and processed data
 - Plot covariance data: ENDF/MF33 and ERRORR-BOXER, COVERX...



JANIS: Save option

- ❑ **EXPORT** (PNG, EPS) and **SAVE** (JNS) : “File > Save...”

```
<data refs="~N~ENDF/B-VII.1~SIG~A127~MT1~xs">
  <layer>
    <color>#ff0000</color>
    <stroke>1.0|2|0|10.0|null|0.0</stroke>
  </layer>
</data>
<data refs="~N~JEFF-3.2~SIG~A127~MT1~xs">
  <layer>
    <color>#00ff00</color>
    <stroke>1.0|2|0|10.0|null|0.0</stroke>
  </layer>
</data>
<data refs="~N~JENDL-4.0~SIG~A127~MT1~xs">
  <layer>
    <color>#0000ff</color>
    <stroke>1.0|2|0|10.0|null|0.0</stroke>
  </layer>
</data>
```

A1_27_XS_tot.jns

JANIS identifiers

...

IAEA/NDS – EXFOR Tool

Figure 6. IAEA/NDS/EXFOR Tool - <https://www-nds.iaea.org/exfor/>

EXFOR: Experimental Nuclear Reactions

https://www-nds.iaea.org/exfor/

Help » Manual PDF Lexfor Output Plot+ R33 Databases » ENDF CINDA IBANDL CD-ROM » EXFOR-CINDA X4Lite CD-Catalog

Experimental Nuclear Reaction Data (EXFOR)
Database Version of 2022-10-21
Software Version of 2022-10-20

The EXFOR library contains an extensive compilation of experimental nuclear reaction data. Neutron reactions have been compiled systematically since the discovery of the neutron, while charged particle and photon reactions have been covered less extensively. [EXFOR Reference Paper: Nucl. Data Sheets 120\(2014\)272](#), [arxiv].

EXFOR Web database retrieval system provides: data search, output to various formats (incl.XML), plotting and comparison to ENDF, re-normalization old data to new standards, calculating data for inverse reactions and kinematics, constructing correlation matrices from partial uncertainties, etc. [EXFOR Web Database & Tools Paper: NIM A 888 \(2018\) 31](#), [arxiv].

The EXFOR database contains data from 24400 experiments (see [statistics](#) and recent database [updates](#)). Mirror-sites

Search: Go ?

Examples of requests: [1](#) [2](#) [3](#) [4](#) [5](#) [6](#) [7](#) [8](#) [9](#) [10](#) [11](#) [12](#) [13](#) [14](#) [15](#) [16](#) [17](#) [18](#) [19](#) [20](#) [Less examples...](#)

1 Cross section $\sigma(E)$ /updates/ MF3

2 Angular distributions $d\sigma/d\Omega(E,\theta)$ MF4

3 Emission spectra $d\sigma/dE_{out}$ MF5

4 Double differential cross section MF6 $d^2\sigma/d\Omega/dE_{out}$

5 Corrections data from EXFOR Ex.1 ZK1 ZK2 AT1 RC1

6 Search by outgoing particles: [$\alpha+\gamma$] P.XG (P.XG).DA

6+ Search data for IBANDL, $^{12}C(\alpha,\alpha)^{12}C$, $\theta=167^\circ$, Err-Sys

7 Enhanced search by product with filtering product coded as ELEM/MASS for quick plot

8 Search by wildcards in full reaction code

9 Ratios converted to cross sections (C4)

10 NUBAR: average number of neutrons per fission PR DL ^DL

10+ PFNS plot

11 Constructing a covariance matrix from EXFOR uncertainties

12 Extended listing of references (authors, title, DOI, NSR, Web)

13 EXFOR - CINDA sequential search N.F

14 Automatic re-normalization (output data and plots); $^{55}Mn(n,\alpha)$

15 Find data: [digitized] from plots, [not digitized], [from table] [experimental data only] [not empty datasets] [empty]

16 Search by authors using aliases Ex.2 Ex.3

17 Fission spectra b Thick target neutron spectra c Delayed neutrons d Kerma factor

18 Invert reaction using detailed balance $^{13}C(\alpha,n)^{16}O \rightarrow ^{16}O(n,\alpha)^{13}C$: σ $d\sigma/d\Omega$ Ex.2: $^3He(d,p)^4He \rightarrow ^4He(p,d)^3He$ $d\sigma/d\Omega$ [plot]

19 Various fission quantities: a Yield (chain, primary FF, secondary FF) b Cumulative yield of ^{147}Nd b2 c Total kinetic energy d Multiplicity of prompt fission neutrons

20 Plotting cross-section coded with SF8=DAM; all

Go to: [upload your data]

Options

Exclude superseded data

No reaction combinations (ratios...)

Exclude evaluated/calculated data

Enhanced search of Products

Show evaluators flags #/2021

Retrieve listing only

Disable Prompt-help

Sort by: reaction publication

Reaction-Accession#

View: basic extended

Ranges (Z,A)

Reaction Sub-Fields

SF1 Target

SF2 Incident Particle

SF3 Product Particle/Process

SF4 Product

SF5 Branch

SF6 Parameters

SF7 Particles Considered

SF8 Modifiers

SF9 Data Code

SF58 Quantity Code

Plotting. See also: [video-guide]

How-to video-guide

- Plot EXFOR-ENDF double differential cross-sections

Advanced plotting

- Cross sections
- Angular distribution
- Emission spectra
- Double differential
- NUBAR

Default

- Map

Request

Target

Reaction

Quantity

Product

Energy from to eV

Author(s)

Feedback and User's Input

Comments/questions?

Send experimental data to EXFOR team

Send message about mistake in EXFOR

Clone Request:

IAEA/NDS – ENDF Tool

Figure 7. IAEA/NDS/EXFOR Tool - <https://www-nds.iaea.org/exfor/endif.htm>

The screenshot displays the IAEA/NDS/EXFOR Tool interface. At the top, the browser address bar shows the URL <https://www-nds.iaea.org/exfor/endif.htm>. The main header reads "Evaluated Nuclear Data File (ENDF) Database Version of 2022-10-07" with the IAEA logo on the right. A "News & History" pop-up window is visible, listing recent updates such as "2022/10 New software feature: plotting covariances for angular distributions of secondary particles MF34" and "2022/10 New library: INDEN-Oct2022 evaluations".

The "Standard Request" section is the primary focus, containing a list of request examples (e.g., "Cross section: MF3", "Angular distributions: MF4") and a "Parameters" form. The "Parameters" form includes fields for "Target", "Reaction", and "Quantity", each with a dropdown menu and a "Submit" button. A red circle highlights this form. Below the form is a "More Parameters..." link and another "Submit" button.

To the right of the "Parameters" form is a "Libraries" section with radio buttons for "All", "Selected", "Check", and "Reset". It lists various nuclear data libraries such as "ENDF/B-VIII.0 (USA,2018)", "JEFF-3.3 (Europe,2017)", and "IAEA Project Libraries". There are also "Special Libraries" options for "Archival" and "Derived".

Further right is a "How to plot" section with a "video" icon and a list of plotting options: "Plot MF33 from ENDF database", "Plot your own MF33 by Web-ZVView", "How-to video-guide", "Plot EXFOR-ENDF data", "EXFOR-ENDF plotting" (with sub-options for cross sections, angular distributions, emission spectra, etc.), and "Default" (with a "Map" option).

At the bottom, there are "Options" for sorting by "Reactions" or "Evaluations", and "Clone Request" and "Feedback" buttons. The "Feedback" button includes a "Comments/Questions?" field.

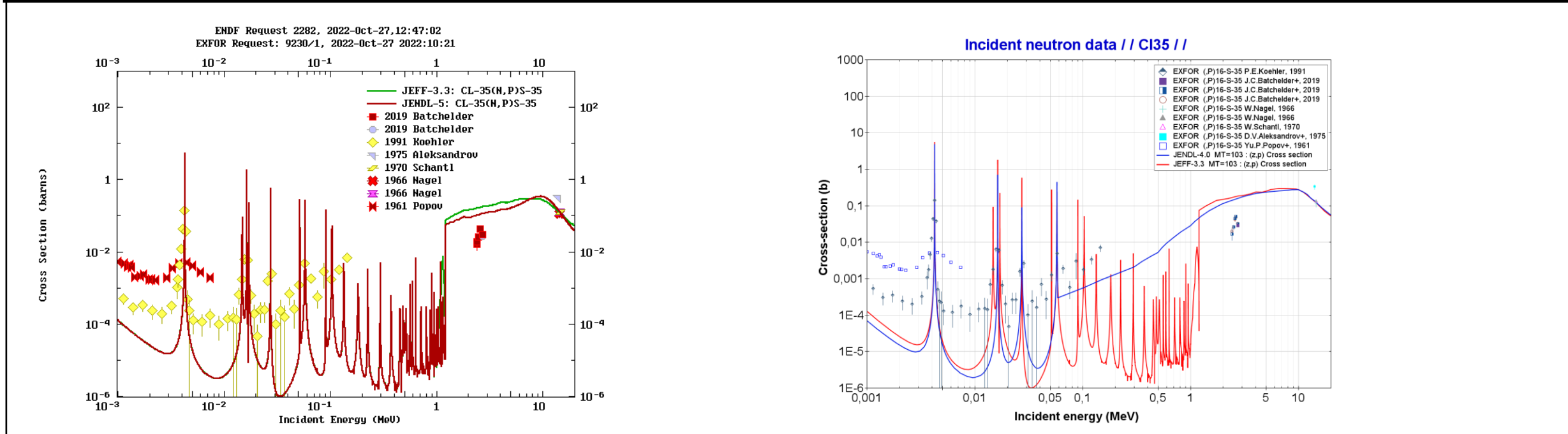
EXERCISE I.

EXERCISE in Handbook/Chapter01/Figure 2

Exercise I. Plot $^{35}\text{Cl}(n,p)$ cross-section - MT103 - (experimental data and evaluated data) using JANIS tool <https://www.oecd-nea.org/janis> or <https://www-nds.iaea.org/exfor/>. Use the JEFF-3.3 and JENDL-5.0 or JENDL-4.0 evaluations.

Q/A: Options: Log x – Log y, min_x=1keV max_x=20 MeV , min_y=1 μb max_x=1000b. Use font size enough to visualization in a presentation.

Q/A: Are you able to create a JANIS jns file ? **YES**



EXERCISE 2.

EXERCISE in Handbook/Chapter04/Exercise I

Exercise I. Identify EXFOR entries for the eta-value in ²³⁵U.
 Search **ETA** data using <https://www-nds.iaea.org/exfor/> (select: **advance Expert**) and/or using <https://www.jcprg.org/exfor/> (select: **advance user**)

Q/A: How many entries do you find using <https://www-nds.iaea.org/exfor/>? **15**

Q/A: How many entries do you find using <https://www.jcprg.org/exfor/>? **15**

Request Submit Reset Help

Target ?

Reaction ?

Quantity ?

Product ?

Energy from to eV ?

Author(s) ?

Publication year ?

Last modified ?

Accession # ?

Extended Keywords Expert ¹

Outgoing particle ?

Angle range (deg.) ?

Data Header ?

Units ?

Points ?

Trans ID ?

Center ID ?

EXFOR User ?

EXFOR Compiler ?

Full reaction code 92-U-235(N,ABS),,ETA ?

Evaluator Submit Reset

Submit in new Window

Note:

- all criteria are optional (selected by checking)
- selected criteria are combined for search with logical **AND**

EXFOR / ENDF - Search
 (17 Dec. 2019 Updated - [new data] [feedback] [Q and A: Eng / Jpn.])

EXFOR Citation: N.Otuka, E.Dupont, V.Semkova et al., Nucl. Data Sheets 120(2014)272

[basic] [advance] [beginner]
 (Use "" (semicolon) for logical OR, "*" (asterisk) for wildcard)

Search Example1 Example2 Example3 Reset

Basic

Target U-235 selector (fe-56, 56fe, he-4, a,...)

Projectile selector (n, p, a, g, c-12,...)

Emission selector (el, inl, f, g, x+n, n+p, 2p,...)

Residual selector (fe-56, 56fe,...)

Quantity selector (CS,DA,...)

Energy (eV) (1.0e-5:2.0e+7)

Data No. (10468,E1901002,...)

Plot axis

Horizontal (1) EN selector (EN,EN-CM,...)

Horizontal (2) selector (ANG,ANG-CM,...)

Vertical DATA selector (DATA,DATA-CM,...)

Bibliography

Pub. Year selector (1988-1990)

Journal selector (NP,A,ORNL-4013,...)

1st Author selector (Kato,...)

Author selector (Schwerner,...)

Options

EXFOR include exclude

ENDF include exclude

Quantity ratio include exclude

Superseded data include exclude

Inverse kinematics reaction reference

Sort by reaction reference

Quantity

CINDA quant. selector (CS,...)

Branch selector (PAR,...)

Parameter ETA selector (DA,...)

Particle Consid. selector (P,...)

Modifier selector (ANA,...)

Data Type selector (EXP,...)

Result selector (FRUCM,...)

NSUB selector (10,...)

MF selector (3,...)

MT selector (2,...)

Hokkaido University Nuclear Reaction Data Centre (JCPRG)
EXFOR / ENDF - Results
 (EXFOR: 25 hits, ENDF: 0 hits)

Plot Reset

Plot	Author	Year	Inc. energy (eV)	WorkType	Reference	Library	Data ID
<input type="checkbox"/>	92-U-235(N,NON),,ETA (Neutron yield (Eta))						
<input type="checkbox"/>	F.D Brooks et al.	1966	1.7e-01	2.0e+02 Expt	Rept AERE-M-1670,1966	EXFOR	20938.029
<input type="checkbox"/>	F.D Brooks et al.	1966	1.1e-01	2.0e+02 Expt	Rept AERE-M-1670,1966	EXFOR	20938.024
<input type="checkbox"/>	A.A Van Kov et al.	1965	2.4e+07	2.4e+07 Expt	Jour SJA,19,903,1965	EXFOR	40808.007
<input type="checkbox"/>	N.N Flerov et al.	1958	1.4e+07	1.4e+07 Expt	Jour SJA,5,1593,1958	EXFOR	40806.002
<input type="checkbox"/>	V.N Andreev	1958	2.4e+04	3.8e+05 Expt	Jour SJA,4,247,1958	EXFOR	40385.004
<input type="checkbox"/>	P.E Spryak et al.	1957	3.0e+04	9.0e+05 Expt	Jour JNE,4,79,1957	EXFOR	40350.003.2
<input type="checkbox"/>	P.E Spryak et al.	1957	3.0e+04	9.0e+05 Expt	Jour JNE,4,79,1957	EXFOR	40350.003.1
<input type="checkbox"/>	92-U-235(N,NON),,ETA,SFA (Neutron yield (Eta)-spectrum average)						
<input type="checkbox"/>	P.E Spryak et al.	1957	3.0e+04	1.3e+02 Expt	Jour JNE,4,79,1957	EXFOR	40350.018
<input type="checkbox"/>	92-U-235(N,ABS),,ETA (Neutron yield (Eta))						
<input type="checkbox"/>	H.Weigmann et al.	1990	1.5e-00	1.5e+02 Expt	Conf 90MARSEL3,(PI),33,1990	EXFOR	22194.003
<input type="checkbox"/>	H.Weigmann et al.	1990	1.8e+00	4.6e+02 Expt	Conf 90MARSEL3,(PI),33,1990	EXFOR	22194.002
<input type="checkbox"/>	J.R Smith et al.	1984	2.5e-02	6.0e-02 Expt	Rept EPRI-NP-3436,(2),1984	EXFOR	13805.003
<input type="checkbox"/>	J.R Smith et al.	1970	2.5e-02	2.5e-02 Expt	Priv SMITH,1982	EXFOR	12318.004
<input type="checkbox"/>	J.R Smith et al.	1970	1.6e-01	1.6e-01 Expt	Prog IN-1407,39,1970	EXFOR	13101.003
<input type="checkbox"/>	J.R Smith et al.	1968	2.5e-02	6.0e-02 Expt	Conf 68WASH,1,589,1968	EXFOR	12554.004
<input type="checkbox"/>	F.D Brooks et al.	1966	3.5e-02	1.6e-01 Expt	Rept AERE-M-1670,1966	EXFOR	20938.028
<input type="checkbox"/>	F.D Brooks et al.	1966	1.8e-01	8.7e-01 Expt	Rept AERE-M-1670,1966	EXFOR	20938.027
<input type="checkbox"/>	F.D Brooks et al.	1966	9.2e-01	3.9e+00 Expt	Rept AERE-M-1670,1966	EXFOR	20938.026
<input type="checkbox"/>	F.D Brooks et al.	1966	2.5e-02	6.0e-02 Expt	Rept AERE-M-1670,1966	EXFOR	20938.025
<input type="checkbox"/>	R.G Igaru et al.	1964	3.0e-02	1.2e+00 Expt	Jour SJA,16,121,1964	EXFOR	40156.002
<input type="checkbox"/>	R.L Macklin et al.	1960	2.5e-02	2.5e-02 Expt	Jour NSE,8,210,1960	EXFOR	12349.003
<input type="checkbox"/>	H.M Skarsgard et al.	1958	6.0e-03	3.0e-02 Expt	Jour JNE,6,212,1958	EXFOR	21202.002
<input type="checkbox"/>	J.R Smith et al.	1957	1.0e-01	3.3e+00 Expt	Prog IDO-16373,37,1957	EXFOR	12411.002
<input type="checkbox"/>	H Palerovsky et al.	1956	1.0e-02	1.7e-01 Expt	Jour JNE,3,177,1956	EXFOR	12322.003
<input type="checkbox"/>	92-U-235(N,ABS),,ETA,REL (Neutron yield (Eta)-relative data)						
<input type="checkbox"/>	B.R Leonardi et al.	1955	2.5e-02	4.5e-01 Expt	Rept HW-38202,41,1955	EXFOR	12393.002
<input type="checkbox"/>	92-U-235(N,ABS),,ETA,MAXW (Neutron yield (Eta)-Maxwellian average)						
<input type="checkbox"/>	C.O Muehlhaue et al.	1959	2.5e-02	2.5e-02 Expt	Jour NSE,5,225,1959	EXFOR	12361.001

Experimental Data: EXFOR database

- The NRDC: <https://www-nds.iaea.org/nrdc/>
- EXFOR : <https://www-nds.iaea.org/exfor/>

Prof. Oscar Cabellos
Polytechnic University of Madrid



The IAEA/NRDC

Figure 1. IAEA/NRDC website

The screenshot shows the IAEA/NRDC website interface. At the top, the IAEA logo and 'Nuclear Data Services' are displayed. A navigation bar includes 'Databases' with links to EXFOR, ENDF, CINDA, IBANDL, Medical, PGAA, NGAtlas, RIPL, FENDL, and IRDF. The main content area features the NRDC logo and the title 'International Network of Nuclear Reaction Data Centres (NRDC)'. Below this, it lists the coordinator, Naohiko Otsuka, and provides a link to a site map. The text explains that the NRDC is a worldwide cooperation of nuclear data centres under the IAEA's auspices, established to coordinate the collection, compilation, and dissemination of nuclear reaction data. It outlines the primary goal and specific tasks, such as compiling bibliographic information, experimental data, and evaluated data, as well as exchanging data and developing software. A world map highlights various member centres, including CDFE (Moscow), CID (Obninsk), NINDC (Upton), NEA DB (Paris), IAEA NDS (Vienna), ATOMKI (Debrecen), UkrNDC (Kyiv), CNPD (Sarov), NDPCI (Mumbai), CNDC (Beijing), JNDC (Daejeon), JAEI NDC (Tokai), and JCRPG (Sapporo). The right sidebar contains sections for 'Documents', 'Codes', and 'NRDC Meetings', each with a list of links to various resources and past meetings.

International Atomic Energy Agency
Nuclear Data Services
قسم البيانات النووية ومقدمة من

IAEA.org | NDS Mission | Mirrors: India | China | Russia

Search Go

Databases » EXFOR | ENDF | CINDA | IBANDL | Medical | PGAA | NGAtlas | RIPL | FENDL | IRDF

NRDC
International Network of Nuclear Reaction Data Centres (NRDC)
Coordinator: Naohiko Otsuka (IAEA NDS)
(Site map)

What is NRDC?

The International Network of Nuclear Reaction Data Centres (NRDC) constitutes a worldwide cooperation of nuclear data centres under the auspices of the International Atomic Energy Agency. The Network was established to coordinate the world-wide collection, compilation and dissemination of nuclear reaction data.

Objectives and Tasks

The primary goal of the Network is the dissemination of nuclear reaction data and associated documentation to users. The following specific tasks must be carried out in order to accomplish this important aim:

- Compilation of relevant bibliographic information (CINDA),
- Compilation of experimental nuclear reaction data (EXFOR),
- Collection of evaluated nuclear reaction data (ENDF),
- Exchange of nuclear reaction data of all types,
- Promotion of the development of special purpose evaluated data files,
- Development of common formats for computerized exchange of nuclear data,
- Coordinated development of computer software for managing and disseminating nuclear data,
- Coordination of the development and dissemination of end user software for both on line and local access to nuclear data,
- Documentation of current and future data needs in order to be able to meet changing user demands.

Reference

N.Otsuka, E.Dupont, V.Semkova, B.Pritychenko, A.I.Blokhin, M.Aikawa, S.Babykina, M.Bossant, G.Chen, S.Dunaeva, R.A.Forrest, T.Fukahori, N.Furutachi, S.Ganesan, Z.Ge, O.O.Gritzay, M.Herman, S.Hlavač, K.Katō, B.Lalremruata, Y.O.Lee, A.Makinaga, K.Matsumoto, M.Mikhaylyukova, C.Pikulina, V.G.Pronyayev, A.Saxena, O.Schworer, S.P.Simakov, N.Sonnaga, B.Suzuki, S.Takács, X.Tao, F.Tsaya, F.Tóthkóvi, V.V.Vadamey, J.Wang

Documents
Network Document
EXFOR Basics (pdf)
EXFOR Basics (html)
EXFOR Formats
LEXFOR
NRDC Protocol
Dictionary Manual
EXFOR Leaflet
Marina's Short Guide
ENDF-6 Formats
Reports to ND Conf.
More Documents

Codes
Codes
Comments on ZCHEX
Digitization Procedure

NRDC Meetings
2021 (Vienna)
2019 (Vienna)
2018 (Bahadurgarh)
2017 (Vienna)
2016 (Beijing)
2015 (Vienna)
2014 (Smolenice)
2013 (Vienna)
2012 (Paris)
2011 (Vienna)
2010 (Sapporo)
2009 (Vienna)
2008 (Obninsk)

Databases
EXFOR
- What is EXFOR?
- EXFOR News
- Articles for compilation
- Journals for scanning
- Entries for corrections
- EXFOR Citation
CINDA
- What is CINDA?
- Feedback list
ENDF
- What is ENDF?
- ENDF Citation

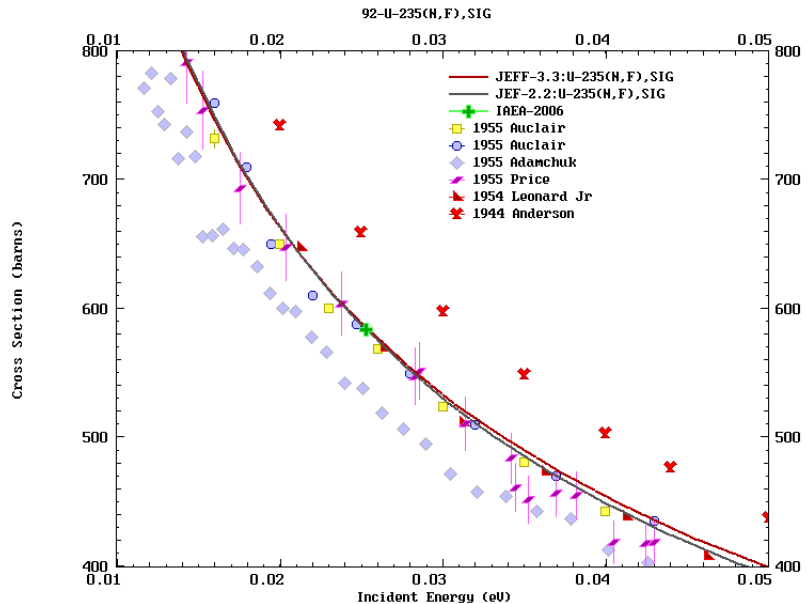
NRDC Centres
ATOMKI (Hungary)
CDFE (Russia)
CID (Russia)
CNDC (China)
CNPD (Russia)
JAEA (Japan)
JCPRG (Japan)
KNDC (Korea)
NDPCI (India)
NDS (IAEA)
NEADB (OECD)
NNDC (USA)
UkrNDC (Ukraine)

Contacts
EXFOR Helpdesk
Memo distribution

EXFOR: “the mother of all libraries”

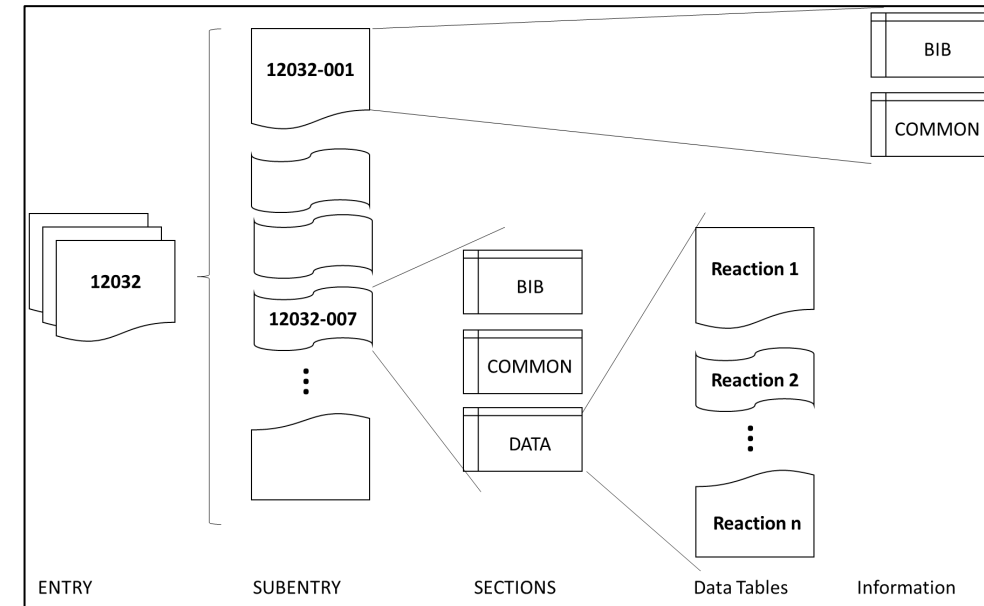
- Currently, EXFOR is the library of experimental nuclear reaction data, cross-sections and other nuclear reaction quantities (e.g. integral resonances, ...)
- EXFOR contains nuclear measurements in more than 22.000 experiments, not only for neutron beam but also for photon, proton and other charged-particle beam.

Figure 2. Experimental data before 1955 for $^{235}\text{U}(n_{\text{thermal}}, \text{fission})$ cross-section



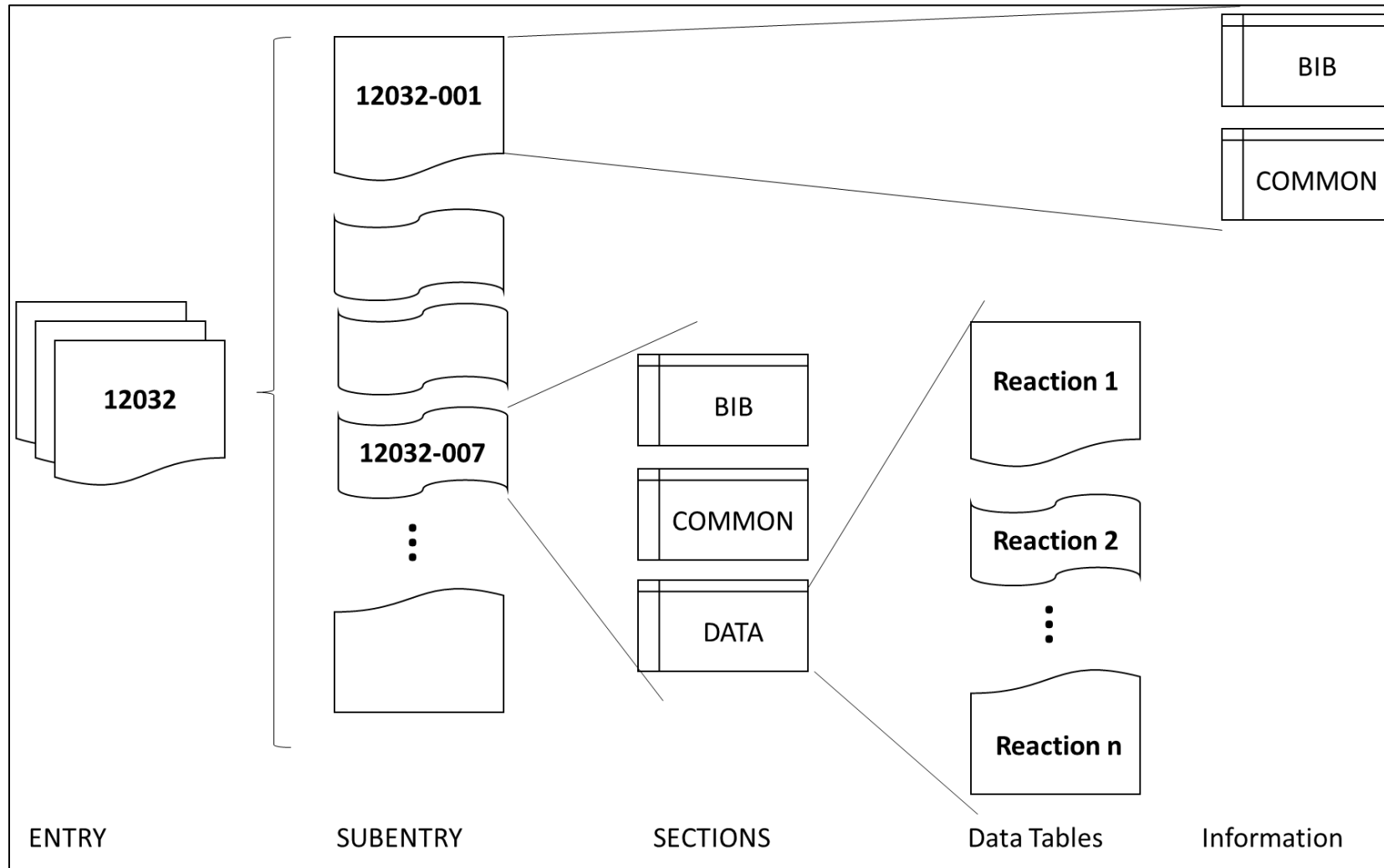
- The basic structure of the EXFOR format

Figure 3. Structure of information in EXFOR



IAEA/NDS – EXFOR Tool

Figure 4. Structure of information in EXFOR



The EXFOR format

ENTRY	12032	830802	20050926	000012032000	1
SUBENT	12032001	830802	20050926	000012032001	1
BIB	7	10		12032001	2
INSTITUTE	(1USAORL)			12032001	3
REFERENCE	(J, PR, 115, 1693, 59)			12032001	4
AUTHOR	(E.C.SMITH, G.S.PAWLICKI, P.E.F.THURLOW, G.W.PARKER, W.J.MARTIN, G.E.CREEK, P.M.LANTZ, S.BERNSTEIN)			12032001	5
TITLE	TOTAL NEUTRON CROSS SECTION OF XE135 AS A FUNCTION OF ENERGY.			12032001	7
FACILITY	(CHOPF) FAST CHOPPER			12032001	9
STATUS	(SCSRS)			12032001	10
HISTORY	(760802T) TRANSLATED FROM SCISRS			12032001	11
	(830802A) CONVERTED TO REACTION FORMALISM			12032001	12
ENDBIB	10			12032001	13
NOCOMMON	0	0		12032001	14
ENDSUBENT	13			1203200199999	
SUBENT	12032002	830802	20050926	000012032002	1
BIB	3	3		12032002	2
REACTION	(54-XE-135 (N, TOT) , , SIG)			12032002	3
METHOD	(TOF) TIME-OF-FLIGHT			12032002	4
SAMPLE	SAMPLE THICKNESS 2.5*10**18ATOMS/CM2. XE135 GAS.			12032002	5
ENDBIB	3			12032002	6
NOCOMMON	0	0		12032002	7
DATA	3	77		12032002	8
EN	EN-RSL	DATA		12032002	9
MEV	MICROSEC/M B			12032002	10
1.05	-08 10.	3.5	+06	12032002	11
1.1	-08 10.	3.55	+06	12032002	12
...					
...					
3.12	-07 3.3	1.62	+05	12032002	86
3.25	-07 3.3	1.75	+05	12032002	87
ENDDATA	79			12032002	88
ENDSUBENT	87			1203200299999	
ENDENTRY	2			1203299999999	

Figure 5. Example of EXFOR compilation for $^{135}\text{Xe}(n,\text{tot})$

The EXFOR retrieval

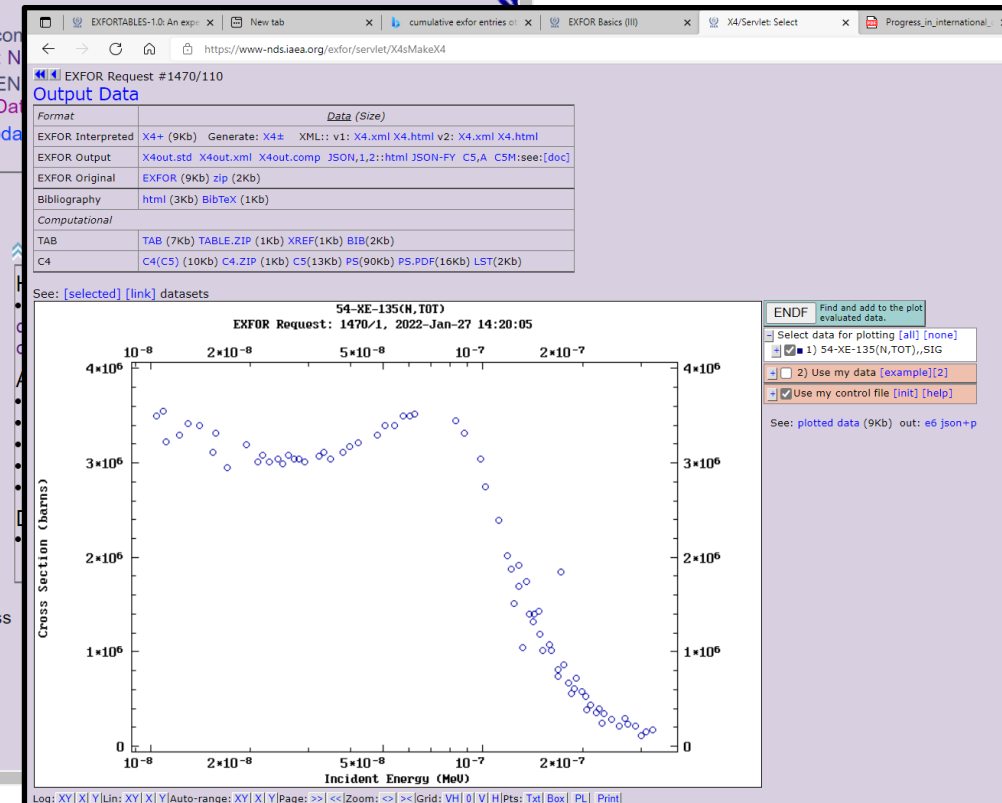
Figure 6. Example of EXFOR retrieval

The screenshot shows the EXFOR website interface. The main header includes the NNDC logo and the text "Experimental Nuclear Reaction Data (EXFOR) Database Version of 2022-01-26". Below this, a paragraph describes the database's content. The search interface is divided into several sections:

- Request:** Includes fields for Target (Xe-135), Reaction (n,tot), Quantity, Product, Energy from/to, Author(s) (E.C. Smith), Publication year, Last modified, and Accession #.
- Options:** A list of checkboxes for filtering results, such as "Exclude superseded data", "No reaction combinations (ratios,...)", "Exclude evaluated/calculated data", "Enhanced search of Products", "Show evaluators flags //2021", "Retrieve listing only", and "Disable Prompt-help".
- Sort by:** Radio buttons for "reaction" and "publication".
- View:** Radio buttons for "basic" and "extended".
- Ranges (Z,A) and Reaction Sub-Fields:** Lists of checkboxes for SF1 through SF7, each with a corresponding field name like "Target", "Incident Particle", "Product Particle/Process", "Product", "Branch", "Parameters", and "Particles Considered".

Buttons for "Submit", "Reset", and "Help" are visible throughout the interface.

Figure 7. Output data after EXFOR retrieval



The EXFOR retrieval with JANIS software

TEMP N EXFOR SIG Xe135 (TOT) E.C.Smith+, 1959

File Tools Selected Help

12032.002

12032

INSTITUTE	USAORL - Oak Ridge National Laboratory, Oak Ridge, TN (USA)
REFERENCE	J,PR,115,1693,59 Physical Review, volume 115, page 1693, 1959
AUTHOR	- E.C.Smith - G.S.Pawlicki - P.E.F.Thurlow - G.W.Parker - W.J.Martin - G.E.Creek - P.M.Lantz - S.Bernstein
TITLE	TOTAL NEUTRON CROSS SECTION OF XE135 AS A FUNCTION OF ENERGY.
FACILITY	CHOPF Fast chopper FAST CHOPPER
STATUS	SCSRS - Data converted from SCISRS file
HISTORY	1976/08/02 : T - Converted from previous compilation TRANSLATED FROM SCISRS 1983/08/02 : A - Important alterations CONVERTED TO REACTION FORMALISM

12032.002

REACTION	54-XE-135(I,TOT),SIG
METHOD	TOF - Time-of-flight TIME-OF-FLIGHT
SAMPLE	SAMPLE THICKNESS 2.5*10**18ATOMS/CM2. XE135 GAS.

12032.002, 1959, E.C.S.

points : 77

3 columns

Independent variables
EN
EN-RSL
Dependent variables
DATA

Node

TEMP / Incident neutron data / EXFOR / Cross sections / Xe135 / (,TOT) / 12032.002, 1959, E.C.Smith+ (77 pts) T P T I

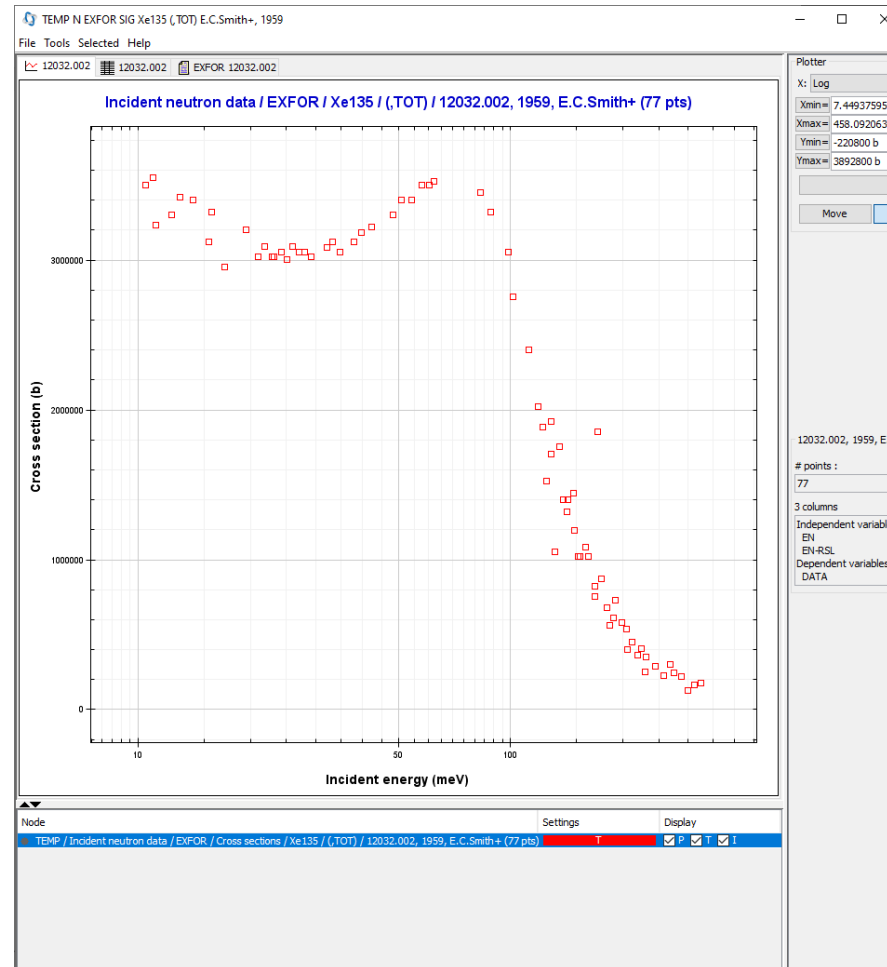


Figure 8. Visualizing X4 file with JANIS tool

EXERCISE I.

EXERCISE in Handbook/Chapter04/Exercise 2

Exercise I. Search and download: EXFOR "ENTRY-10377" for Al-27 from using <https://www-nds.iaea.org/exfor/> or <https://www.oecd-nea.org/janis>

Q/A: How many experimental point contains this entry using IAEA/EXFOR retrieval system? **3701**

Q/A: How many experimental point contains this entry using JANIS Tool? **3701**

Experimental Nuclear Reaction Data (EXFOR)
Database Version of 2022-10-21

Search: Go!

Request: al-27

Options: Exclude superseded data, No reaction combinations (ratios...), Exclude evaluated/calculated data, Enhanced search of Products, Show evaluators flags /2021, Retrieve listing only, Disable Prompt-help

Sort by: reaction, publication

View: basic, extended

Ranges (Z,A):

Reaction Sub-Fields:

Feedback and User's Input: Clone Request: CINDA | ENDF

More Web Tools

Note:
- all criteria are optional (selected by checking)
- selected criteria are combined for search with logical AND
- criteria separated in a field by ";" are combined with logical OR
- criteria starting with "*" will be used as logical NOT
- wildcards (*) and intervals (...) are available
Statistics of usage: hits: 635, requests: 2995, since 20-Oct-2022

Database Manager: Viktor Zerkin, NDS, International Atomic Energy Agency (V.Zerkin@iaea.org)
Web and Database Programming: Viktor Zerkin, NDS, International Atomic Energy Agency (V.Zerkin@iaea.org) 2022-10-20
Data Source: Network of Nuclear Reaction Data Centres (NRDC)

EXFOR search

Target: A: State:

Quantity:

General:

Detailed:

Reaction:

Incident Projectile:

Process:

Product: A: State:

Energy Range: <= E <= eV

Subentry: # points: min: max:

Title and Author:

Author(s):

Reference:

Type:

Date: from

Institute / Laboratory:

Area: Country:

Lab:

Keywords:

Keyword:

History:

Results:

7 rows

Search	Subentry	Target	Product	Reaction	Q	Q	#pts	E min	E max	Author(s)	Title	Institute	Ref. Type	Reference
NEA	10377.002	CNat	-	6-C-0(N,TOT),SIG	CS	,SIG	3701	181.10 keV	29.44899 MeV	F.G.Perey+	A test of neutron total cross-section evaluations fr...	IUSAORL	R	R_ORNL-4823,197212
NEA	10377.003	ONat	-	8-O-0(N,TOT),SIG	CS	,SIG	3688	187.38 keV	48.66988 MeV	F.G.Perey+	A test of neutron total cross-section evaluations fr...	IUSAORL	R	R_ORNL-4823,197212
NEA	10377.004	al27	-	13-Al-27(N,TOT),SIG	CS	,SIG	3701	187.38 keV	48.66988 MeV	F.G.Perey+	A test of neutron total cross-section evaluations fr...	IUSAORL	R	R_ORNL-4823,197212
NEA	10377.005	SiNat	-	14-Si-0(N,TOT),SIG	CS	,SIG	3693	187.34 keV	48.49900 MeV	F.G.Perey+	A test of neutron total cross-section evaluations fr...	IUSAORL	R	R_ORNL-4823,197212
NEA	10377.006	CaNat	-	20-Ca-0(N,TOT),SIG	CS	,SIG	3501	200.02 keV	29.44518 MeV	F.G.Perey+	A test of neutron total cross-section evaluations fr...	IUSAORL	R	R_ORNL-4823,197212
NEA	10377.007	FeNat	-	26-Fe-0(N,TOT),SIG	CS	,SIG	3701	187.36 keV	48.60811 MeV	F.G.Perey+	A test of neutron total cross-section evaluations fr...	IUSAORL	R	R_ORNL-4823,197212
NEA	10377.008	Si OXI	-	14-Si-0(N,TOT),SIG	CS	,SIG	3692	187.38 keV	48.66988 MeV	F.G.Perey+	A test of neutron total cross-section evaluations fr...	IUSAORL	R	R_ORNL-4823,197212

Q/A: Are you able to download X4 file using EXFOR retrieve? **YES**

Q/A: Are you able to download X4 file using JANIS? **NO**

EXERCISE 2.

EXERCISE in Handbook/Chapter02/Section2.3.a

Exercise I. Example of covariance experimental data in EXFOR for the C. Sage et al. , $^{241}\text{Am}(n,2n)$ - ENTRY 23114 using <https://www-nds.iaea.org/exfor/>

Request #3016 www-nds.iaea.org 2022-10-28,08:01:16
Results: Reactions: 1 Datasets: 1

Data Selection

Retrieve Selected Unselected All in new Window

Output: X4+ EXFOR Bibliography TAB C4 PlotC4

Plot: Quick-plot (cross-sections) ungroup /product: Advanced plot [how-to] using C5 with cm2lab; convert ratios to σ

Narrow incident energy (optional), eV: Min: Max:

Apply Data re-normalization (for advanced users, results in: C4, TAB and Plots)

n	Display	Year	Author-1	Energy range, eV	Points	Reference	Subentry#P	NSR-Key	Info+
1	<input type="checkbox"/> <input checked="" type="checkbox"/> X4 <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> X4+ <input checked="" type="checkbox"/> Cov	1977	Sage, C	8.34e6 - 2.06e7	9	J, PR/C, 81, 064604, 2010	23114002 (R)	2010SA15	

Quantity: [CS] Cross section

Full coincidence of independent variables for different experimental points:
r : raw data from the experiment
f : having flag explaining the difference
* : without flag (to be checked)

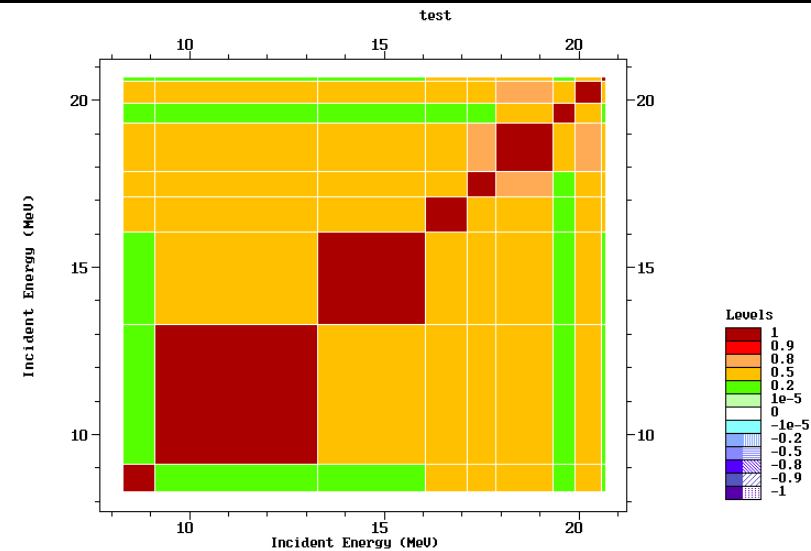
Type of data source:
g : graphics (data digitized from plot)

Info+ contains data ranges and links (NSR and Web) for secondary publications.
Flags of the data ranges (angles, secondary energies, etc.):
As - angle, θ EXC - excitation energy EGN - energy gain PLR - polarity
E2 - outgoing particle energy QVL - Q value LVN - level number NUM - Number of emitted particles
LVL - level energy EDG - energy degradation MOM - linear momentum

Search similar data in CINDA
 Submit Submit in new Window
 Include lines from old CINDA
 Include lines imported from EXFOR
 Include lines imported from NSR
 Include only lines having Web links

Page generated: 2022-10-28,08:01:16 by X4Search5 on localhost [fwd:www-nds.iaea.org]
Project: "Multi-platform EXFOR-CINDA-ENDP", V.Zerkin, IAEA-ND5, 1999-2022
Request from: 0:0:0:0:0:0:1 [fwd:138.100.75.85,172.68.102.141]

Q/A: How many energy groups are in the covariance plot? **9**



Q/A: Give in the energy group 19.95MeV-20.61MeV:

- Total uncertainty (in %) **8.80**
- Uncorrelated uncertainty (in %): **6.08**
- Fully correlated uncertainty (in %): **3.29**
- Partially correlated uncertainty(in %): **5.41**

Processing Nuclear Data

- NJOY, PREPRO
- JANIS

Prof. Oscar Cabellos
Polytechnic University of Madrid



Tools for Processing Nuclear Data

❑ ENSDF Analysis and Utility Programs

❑ ENDF Processing and Utility Programs

○ ENDF Utility Codes

- CHECKR - Format checking code
- FIZCON - Procedures & simple physics checking code
- PSYCHE - More complicated physics checking code
- STANEF - Creates directory, adds tape label & converts numeric fields and convert to binary format
- **INTER - Calculates selected cross sections and integrals**

○ Processing codes (processing evaluated nuclear data into the format required in particle (n/γ/p...)-transport codes)

- ACEMAKER is a code package to produce ACE-formatted files for MCNP calculations
- AMPX (A Comprehensive Modeling and Simulation Suite for Nuclear Safety Analysis and Design) within the SCALE system developed by ORNL
- CALENDF nuclear data processing system developed by CEA
- **FRENDY (FRom Evaluated Nuclear Data librarY to any application) developed by JAEA**
- FUDGE (For Updating Data and Generating Evaluations): LLNL code for managing nuclear data
- GAIA is an IRSN computer software developed to generate nuclear data libraries
- GRUCON - evaluated data processing code package developed by IPPE-NRCKI
- NECP-Atlas is data processing code developed at Xi'an Jiaotong University in China
- **NJOY is the nuclear data processing code developed at Los Alamos National Laboratory**
- **PREPRO is a collection of 18 computer codes developed by D.E. Cullen**

PREPRO system

(<https://github.com/IAEA-NDS/PREPRO>)

A brief description of programs:

- **LINEAR**: Linearize cross sections
- **RECENT**: Reconstruct cross sections from resonance parameters
- **SIGMAI**: Doppler broaden cross sections
- **ACTIVATE**: Generate activation cross sections (MF=10) from MF=3 and 9 data
- **LEGEND**: Calculate/correct angular distributions
- **SIXPAK**: Convert double differential data (MF=6) to single differential
- **FIXUP**: Correct format and cross sections, define cross sections by summation
- **DICTIN**: Create reaction dictionary (MF=1, MT=451)
- **MERGER**: Retrieve and/or Merge evaluated data
- **GROUPIE**: Calculate group averages and multi-band parameters
- **COMPLIT**: Plot comparisons of cross sections (MF=3, 23); Comhard for hardcopy
- **EVALPLOT**: Plot evaluated data (MF=3, 4, 5, 23, 27); Evalhard for hardcopy
- **MIXER**: Calculate mixtures of cross sections
- **VIRGIN**: Calculated transmitted uncollided (virgin) flux and reactions
- **CONVERT**: Convert codes for computer/precision/compiler
- **RELABEL**: Relabel and sequence programs

NJOY code (<http://www.njoy21.io/>)

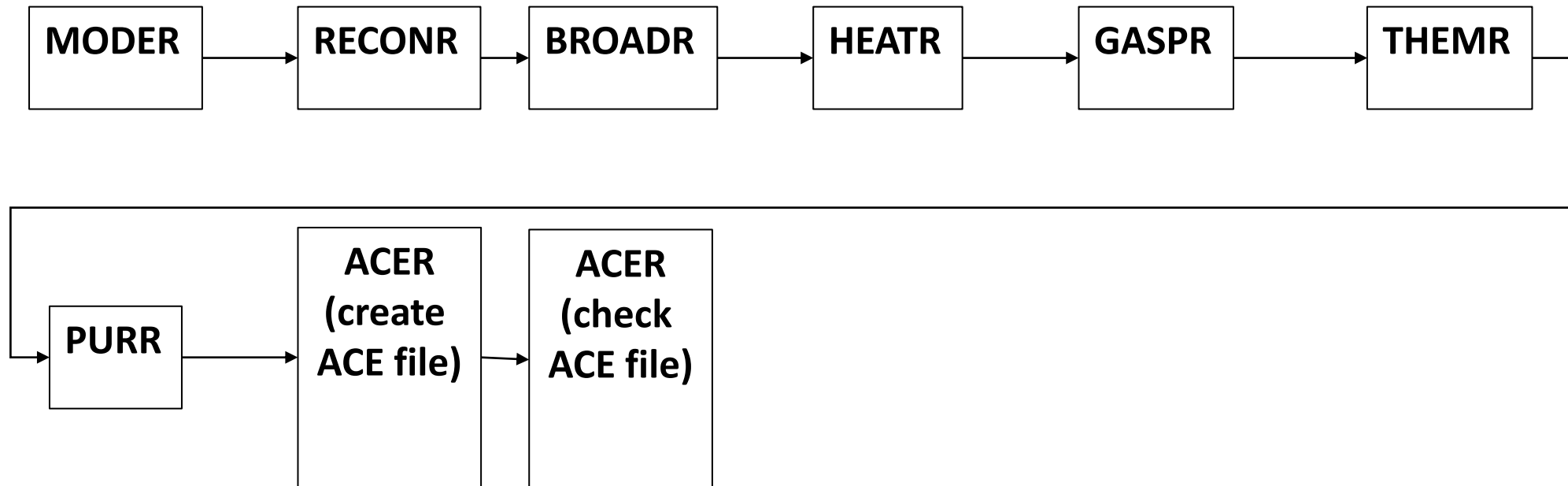
A brief description of modules:

MODER	<ul style="list-style-type: none"> converts ENDF "tapes" back and forth between ASCII format and the special NJOY blocked-binary format extract a single evaluation from a multi-tape add an evaluation to an existing tape
RECONR	<ul style="list-style-type: none"> reconstruct pointwise cross sections from resonance parameters and interpolation schemes linearization mesh unionization
BROADR	<ul style="list-style-type: none"> doppler broadening to user specified temperature broadens mesh thinning pointwise cross sections
UNRESR	<ul style="list-style-type: none"> URR processing
GROUPT	<ul style="list-style-type: none"> self-shielded multigroup cross sections group-to-group scattering and photon production matrices
PURR	<ul style="list-style-type: none"> unresolved-resonance probability tables user define amount of random sampling
ACER	<ul style="list-style-type: none"> prepare library in ACE (A Compact ENDF) format [4] for continuous energy Monte Carlo codes: MCNP, SERPENT, OPENMC
ERRORD	<ul style="list-style-type: none"> multigroup cross section and distribution covariances from uncertainty files MF31-MF40
COVR	<ul style="list-style-type: none"> process covariance data from ERRORD
PLOTR	<ul style="list-style-type: none"> plot endf, pendf, genf, or exp. cross sections, distributions, or matrices to be processed by VIEWR
VIEWR	<ul style="list-style-type: none"> view plots from PLOTR and COVR in postscript format
HEATR	<ul style="list-style-type: none"> pointwise heat production cross sections (KERMA factors) radiation-damage production cross sections in both derived data types: total and /or by reaction
GASPR	<ul style="list-style-type: none"> gas-production cross sections for: p, d, t, He3 and a
MIXR	<ul style="list-style-type: none"> to combine cross sections from different materials/reactions
LEAPR	<ul style="list-style-type: none"> to produce thermal scattering law, $S(a,b)$ from specifications of bound moderators
THERMR	<ul style="list-style-type: none"> cross sections and scattering distributions for free or bound scatterers in the thermal energy range

WIMSR	<ul style="list-style-type: none"> multigroup data into libraries for WIMSD and WIMSE codes
GAMINR	<ul style="list-style-type: none"> photo-atomic group data
DTFR	<ul style="list-style-type: none"> cross sections for DTF-IV SN discrete ordinates code (obsolete)
CCCCR	<ul style="list-style-type: none"> CCCC interface files ISOTXS, BRKOXS and DLAYXS
POWR	<ul style="list-style-type: none"> libraries for EPRI-CEL and EPRI-CPM codes (obsolete)
MATXSR	<ul style="list-style-type: none"> cross sections in MATXS format compatible with TRANSX code (obsolete)
RESXSR	<ul style="list-style-type: none"> pointwise resonance cross sections for TRANSX code

NJOY code (<http://www.njoy21.io/>)

Figure 1. Example of sequential NJOY modules to process evaluated files into ACE format



```

moder / Convert data
20 -21
reconr / Reconstruct XS for neutrons
-21 -22
'JEFF33 PENDF for 94-Pu-239'/
9437 2/
0.01 0.0/
'JEFF33: 94-Pu-239'/
'Processed by NJOY2016.64'/
0/
broadr / Doppler broaden neutron xs
-21 -22 -23
9437 1 0 0 0./
0.01 /
300
0/
heatr / Add heating kerma and damage energy
-21 -23 -24/
9437 7 0 0 0 2/
302 303 304 318 402 443 444/
gaspr / Add gas production
-21 -24 -25
thermr / Add thermal scattering data
0 -25 -26
0 9437 12 1 1 0 1 1 221 1/
300
0.001 4.0
moder
-26 36
purr / Process Unresolved Resonance Range
-21 -26 -27
9437 1 5 20 64/
300
1.E+10 1.E+04 1.E+03 1.E+02 1.E+01
0/
acer / Prepare ACE files
-21 -27 0 28 29
1 0 1 .03 /
'94-Pu-239 from JEFF33, NJOY2016.64 '/
9437 300
1 1/
/
acer / Check ACE files
0 28 40 38 39
7 1 1 -1/
/
viewr
40 48/
stop

```

Figure II. Input deck to generate ACE files: “**n-094_PU_239.INP**”

Running NJOY in command line:

“njoy2016_64.exe < n-094_PU_239.INP”

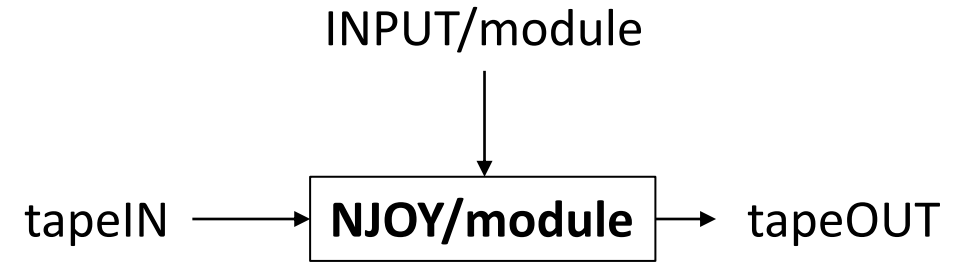


Table I. “run.bat” procedure to run NJOY input

```

copy .\Lib\n_9437_94-Pu-239.dat .\tape20
copy .\Input\n-094_PU_239.INP .\n-094_PU_239.INP

set LIB=JEFF33

echo ' Running NJOY ... '
.\njoy2016_64.exe < n-094_PU_239.INP

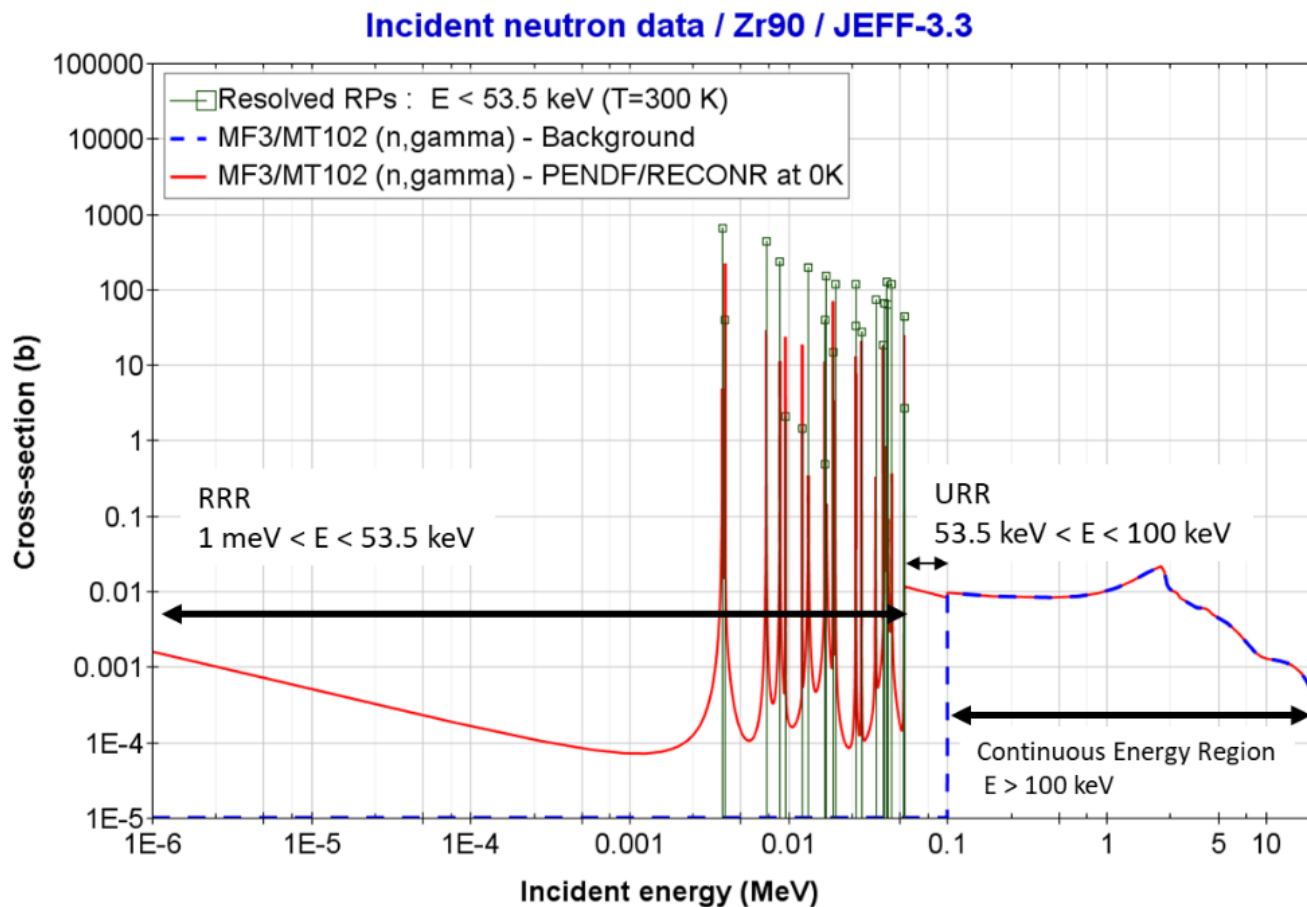
echo ' Moving and Deleting Files ... '
move output n-094_PU_239_%LIB%.out
move tape36 n-094_PU_239_%LIB%.pendf
move tape38 n-094_PU_239_%LIB%.ACE
move tape39 n-094_PU_239_%LIB%.XSDIR
move tape48 n-094_PU_239_%LIB%.ps

del tape*

```

Point-wise reconstruction with RECONR at 0K

Figure 2. $^{90}\text{Zr}(n, \text{gamma})$ from JEFF-3.3 at 0K



- In the evaluated files, both MF2 and MF3 (background) data are at 0K
- RECONR carries out the resonance reconstruction consisting of merging the MF2 and MF3, if MF3 exists, and using the resonance formalism used in the evaluation:
 - LRF1= Single level Breit-Wigner (SLBW) for old evaluations
 - LRF2= Multi-level Breit-Wigner (MLBW) common in non-actinides
 - LRF3= Reich-Moore (RM) in modern actinide evaluations
 - LRF4= Adler-Adler
 - LRF5= General R-Matrix
 - LRF6= Hybrid R-Function
 - LRF7= Limited Reich-Moore which is relatively new (e.g. JEFF-3.2 for $^{63,65}\text{Cu}$)

EXERCISE I.

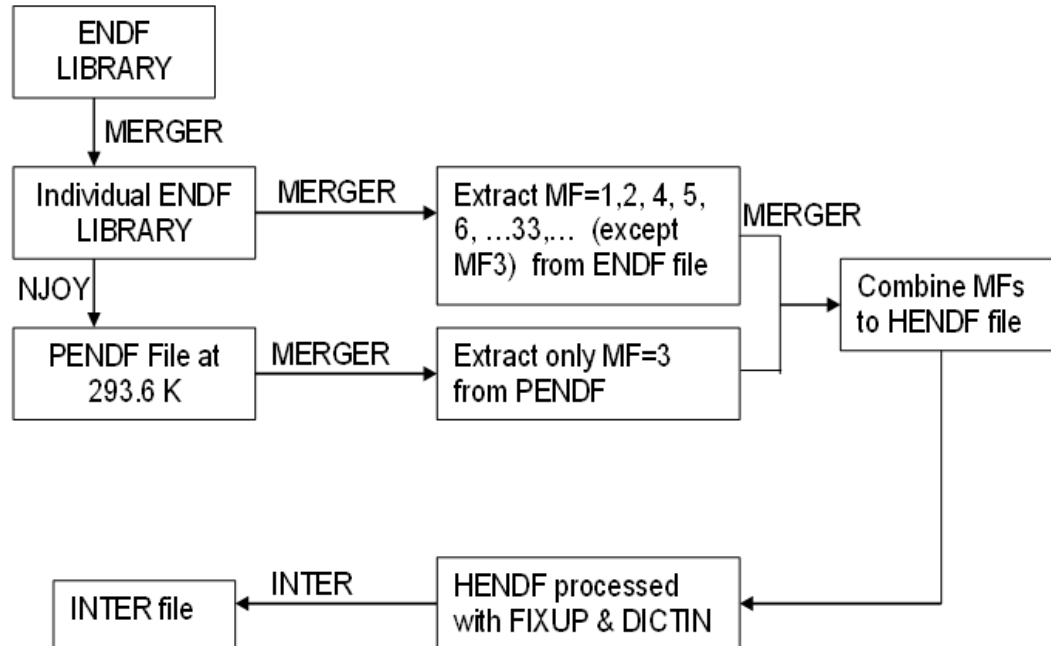
EXERCISE Chapter04/Exercise2: HENDF+BOXER+INTER - Create JANIS Database



Exercise 5. Processing 27AI/JEFF-3.3 into HENDF

Q/A: A “db.h2.db” for JANIS can be created with Wizard Tool. Give the size of “db.h2.db” in KBytes : **182 KBytes**

Figure 2. Flowchart of processing JANIS database from ENDF tapes



EXERCISE I.

EXERCISE Chapter04/Exercise2: HENDF+BOXER+INTER - Create JANIS Database



Exercise 5. Processing 27A1/JEFF-3.3 into HENDF

Procedure to create a personal database using the import **WIZARD JANIS** tool : Use the **“Database > Import Wizard”**

1. New folder shall be created with three sub-folders, one per type of file (i.e. hendf, boxer and inter). Then, the files generated shall be copied to their corresponding sub-folders (advice: delete those empty files)
2. Open JANIS, and at the toolbar click on “database -> import wizard“
3. Add HENDF files. For that use either “Add directory” or “add files” options. Then, click on “next“
4. “Automatic detection” should work fine. Click on “next”
5. Choose a library name (e.g. **JEFF-3.3**) with less than 20 characters. Click on “next“
6. Select “a new base “when importing HENDF, that means for the first import. For BOXER and INTER files, “an existing base” shall be selected, and then, selecting the created database for HENDF files
7. Choose “path to the folder” where the database will be created. Click on “next”
8. The “base root” shall point to the folder created with the three sub-folders (one for each kind of file type). Click on “next”
9. Type a “database” name (e.g. **GPIONEER**) for showing later in JANIS. Click on “next”
10. A summary of the task to do, plus input parameters, is presented before importing data from files. Click on “Finish”
11. Once imported HENDF files, for BOXER and INTER files repeat these instructions until step (5), where to change to “existing base” option
12. At the end of this process, a “db.h2.db” file is created, plus the importing logs. This database can be distributed and share between other JANIS users.

EXERCISE I.

EXERCISE Chapter04/Exercise2: HENDF+BOXER+INTER - Create JANIS Database

Base opened in 320ms

5.42MB to import

MF=32 MT skipped [MF=32 MT=151]

@C:\Users\oscar\Desktop\GREAT_PIONER\Curso-Valencia-

Assignments\SOLUTION-Processing\Exercise-HENDF-JANIS-

Wizard\JANIS\A127.HENDF line=66678 offset=5467596 @NLIB_NVER=EFF-

3.3,NSUB=10,MAT=1325,NMOD=0,MF=32,MT=151,Z=13,A=27,State=0

Base closed in 1s9ms

Total time = 2s17ms

Import achieved

with 1 warning

Logs importing A127.HENDF

Base opened in 6ms

48.61KB to import

Base closed in 1s1ms

Total time = 1s158ms

Import achieved

Logs importing A127.BOXER

Base opened in 14ms

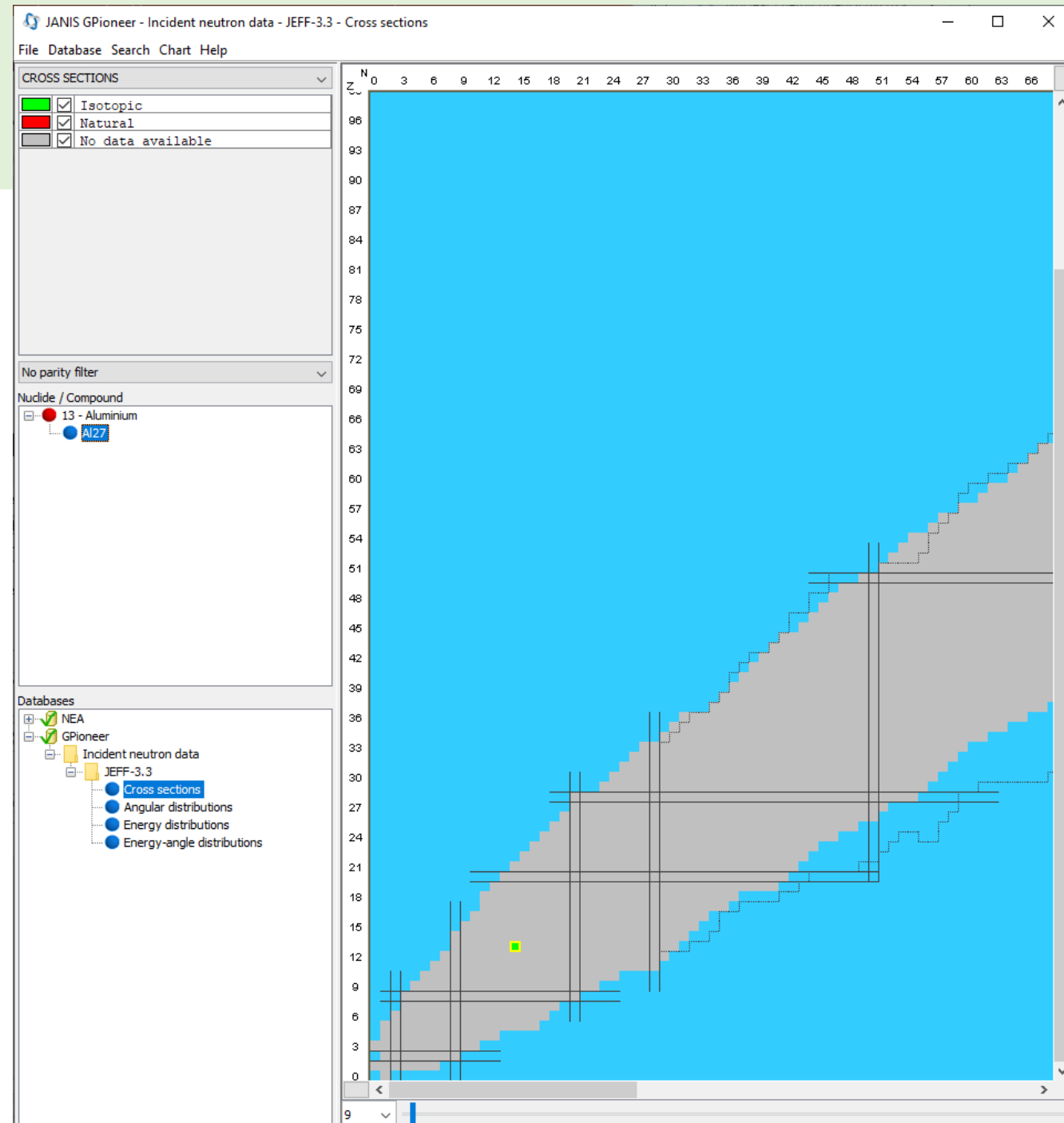
2.63KB to import

Base closed in 1s3ms

Total time = 1s53ms

Import achieved

Logs importing A127.INTER



JANIS: Download a database



❑ **Import WIZARD tool** : Use the “Database > Import Wizard”

Following steps:

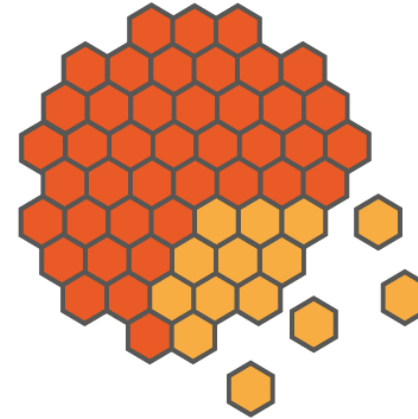
- 1) Use “JANIS toolbar -> Database -> Load” function
- 2) Set “.h2.db file” to select the downloaded “h2.db” file
- 3) Set “Root Folder” to the folder where the “h2.fb” is located

(Leave the other default options as they are)

Acknowledgment

*Some slides taken from Gre@t-Pioneer course on “Nuclear Data for Energy and non-Energy Applications”
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Sources of information on ND

Table I. List the major EVALUATED databases currently maintained by the nuclear data community

Database	Comments	Website
Basic Data		
• Evaluated Nuclear Structure Data File(ENSDF)	Evaluated structure and decay data	https://www.nndc.bnl.gov/ensdf/
• Atlas of Neutron Resonances	Evaluated neutron data	None
Evaluation projects		
• Evaluated Nuclear Data File (ENDF)	Evaluated reaction data	https://www.nndc.bnl.gov/exfor/endl00.jsp
• Joint Evaluated Fission and Fusion Nuclear Data Library (JEFF)	Evaluated reaction data	https://www.oecd-nea.org/dbdata/jeff/jeff33/
• Japanese Evaluated Nuclear Data Library (JENDL)	Evaluated reaction data	https://www.nndc.jaea.go.jp/jendl/j40/j40.html
• Chinese Evaluated Nuclear Data Library (CENDL)	Evaluated reaction data	None
• Russian File of Evaluated Neutron Data (ROSFOND)	Evaluated reaction data	https://www.ippe.ru/reactors/reactor-constantsdatacenter/abbn-reactor-group-constant-database
• Russian Evaluated Neutron Data Library (BROND)	Evaluated reaction data	https://www.oecd-nea.org/dbdata/data/nds_eval_libs.htm
• TALYS Evaluated Nuclear Data Library (TENDL)	Evaluated reaction data	https://tendl.web.psi.ch/tendl_2017/tendl2017.html
Special libraries		
• International Reactor Dosimetry File (IRDF)	Evaluated neutron reaction data with uncertainties	https://www.oecd-nea.org/dbforms/data/eva/evatapes/irdf_2002/
• Fusion Evaluated Nuclear Data Library (FENDL)	Evaluated reaction data	https://www-nds.iaea.org/fendl/
• Evaluated Gamma-ray Activation File (EGAF)	Evaluated thermal capture γ -ray data	https://www-nds.iaea.org/pgaa/egaf.html
• European Activation File (EAF)	Derived decay data	https://www.oecd-nea.org/dbforms/data/eva/evatapes/eaf_2010/
Integral data		
• International Criticality Safety Benchmark Evaluation Project (ICSBEP)	Compiled critical and subcritical assembly data	https://www.oecd-nea.org/science/wpncs/icsbep/handbook.html
• International Reactor Physics Experiment Evaluation Project (IRPhE)	More complex experiments than the ICSBEP but still useful for validation	https://www.oecd-nea.org/science/wprs/irphe

Sources of information on ND

Table II. List the major COMPILATION databases currently maintained by the nuclear data community

Database	Comments	Website
Compilation		
• Nuclear Science References (NSR)	List of published nuclear data articles	https://www.nndc.bnl.gov/nsr/
• Computer Index of Nuclear Reaction Data (CINDA)	Compiled neutron reaction data	https://www.nndc.bnl.gov/exfor/cinda.htm
• Experimental Nuclear Reaction Data (EXFOR)	Compiled reaction data	https://www.nndc.bnl.gov/exfor/exfor.htm
• Experimental Unevaluated Nuclear Data List (XUNDL)	Compiled structure data	https://www.nndc.bnl.gov/ensdf/ensdf/xundl.jsp
• Atlas of Gamma-Ray Spectra from the Inelastic Scattering of Reactor Fast Neutrons	Compiled reaction data	http://nucleardata.berkeley.edu
Derived data		
• Reference Input Parameter Library (RIPL)	Data for nuclear model calculations	https://www-nds.iaea.org/RIPL-3/
• Live Chart of Nuclides	Nuclear structure and decay data	https://www-nds.iaea.org/livechart/
• Medical Internal Radiation Dose (MIRD)	Derived decay data	https://www.nndc.bnl.gov/mird/
• Nuclear Structure and Decay Data (NUDAT)	Graphical interface for structure and decay data	https://www.nndc.bnl.gov/nudat3/
• Java-Based Nuclear Data Information System (JANIS)	Graphical interface for reaction, structure, and decay data	https://www.oecd-nea.org/janis/
Integral data		
• Shielding Integral Benchmark Archive and Database (SINBAD)	Database of LLNL pulsed spheres and other shielding/transmission experiments	https://www.oecd-nea.org/science/wprs/shielding
• Measured Isotopic Concentrations of Spent Nuclear Fuel (SFCOMPO)	Database of measured isotopic concentrations of spent nuclear fuel with operational histories and design data	https://www.oecd-nea.org/sfcompo

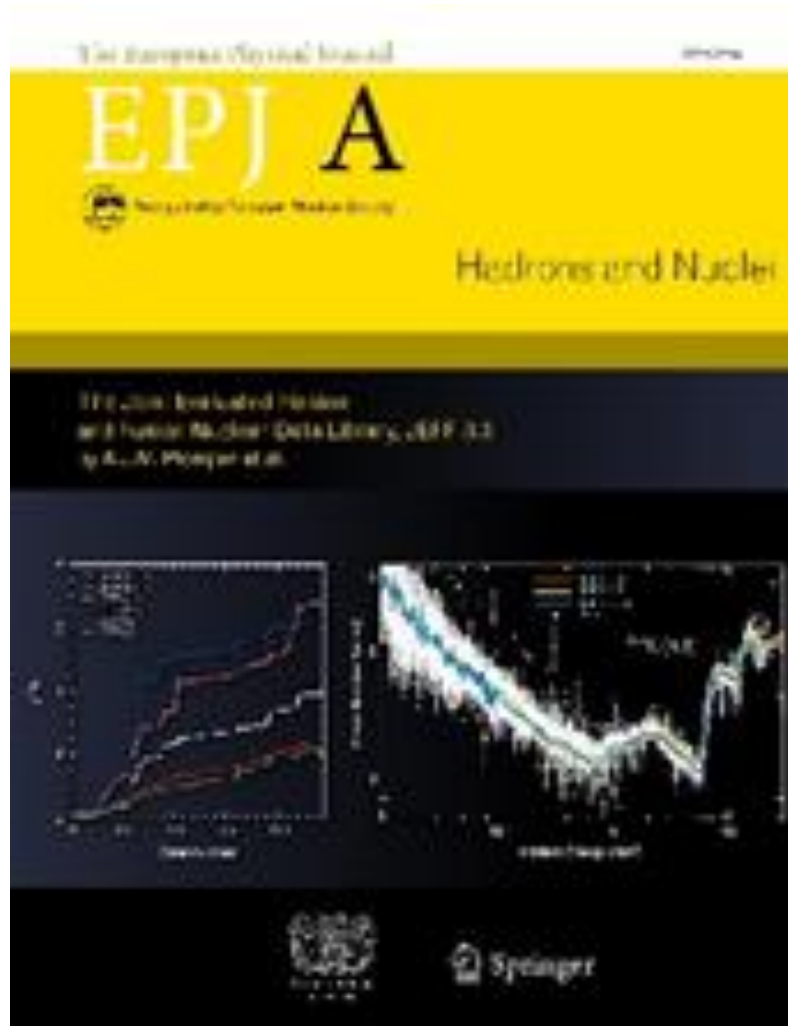
The JEFF Project

Table I. *The evolution of the OECD/NEA/Data Bank – JEFF Project*

Version	Year released	Comments
	1981	The Joint Evaluated File (JEF) project started in 1981 to bring together European and Japanese effort on nuclear data evaluation in order to create an evaluation for fission applications.
JEF-1	1986	The library contains information for neutron induced reactions and decay data. Evaluated files from different institutions were converted into a standard ENDF-5 format. For curiosity, this file was not available in the US.
JEF-2.2	1992	The Joint Evaluated File (JEF)-2.2 contains data for 313 materials as well as thermal scattering law data for 5 materials as well as special purpose files with radioactive decay data (2345 isotopes), fission yields data (fissile nuclides)
JEFF-3.0	2002	The Joint Evaluated Fission and Fusion File (JEFF)-3.0 contains data for 340 materials as well as thermal scattering law data for 5 materials
JEFF-3.1	2005	JEFF-3.1 contains neutron reaction data (381 isotopes or elements), thermal neutron scattering law data (9 materials), and incident proton data (26 materials) for transport calculations, as well as special purpose files with radioactive decay data (3852 isotopes), fission yields data, and activation data. JEFF-3.1 combines the efforts of the JEFF and EFF/EAF working groups who have contributed to this combined fission and fusion file.
JEFF-3.1.1	2009	The JEFF-3.1.1 was an updated neutron file from JEFF-3.1, whereas incident proton data and thermal neutron scattering law data are identical to JEFF-3.1. The JEFF-3.1.1 library contains also updated special purpose files with radioactive decay data (3852 isotopes) and fission yields data
JEFF-3.1.2		This release was an update from JEFF-3.1.1 for the neutron data. In total, 381 isotopes or elements were included which 115 material files were modified since JEFF-3.1.1
JEFF-3.2	2014	JEFF-3.2 was an update of the neutron file which contains 472 nuclides or elements and thermal neutron scattering law data for 10 materials
JEFF-3.3	2017	JEFF-3.3 is a thorough update of the neutron (563 materials), decay data (3852 files), fission yields, dpa (81 materials) and neutron activation libraries in the EAF format, with neutron thermal scattering files (20 compounds). Special sub-libraries for incident alphas (2809 files), deuterons (2811), gammas (2809), helium-3 (2806), protons (2804) and tritons have been contributed by the TENDL-2017 library and adopted as part of the JEFF-3.3 release

The JEFF Project: JEFF-3.3 – November 2017

Figure 1. The JEFF-3.3



<https://link.springer.com/content/pdf/10.1140/epja/s10050-020-00141-9.pdf>