Progress in EXFOR/ENDF/IBANDL databases, retrieval systems and tools

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Nuclear Data Section, 1999-2023

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IAEA Headquarters + WebEx, Vienna, Austria, 14 - 17 May 2024

Main news. Summary

1. EXFOR

1) Further development X5json, C5
2) EXFOR/Git: procedures for regular maintenance and distribution on GitHub:
   1) EXFOR-Archive/Backup - all Entries from official TRANS files starting from 2005
   2) EXFOR-C5 - all EXFOR Entries translated to computational format C5, six versions
   3) EXFOR-X5json - all EXFOR Entries translated to X5
   4) JSON-Tree Editor – universal editor with specific nuclear data interpreter
3) Web-API for search/downloading data: JSON, CSV, XML, EXFOR, C5, C5M

2. ENDF

1) Plotting fission product yield from EXFOR and ENDF as a function of energy
2) New evaluated libraries in the ENDF database:
   1. TENDL-2023 TALYS-based Evaluated Nuclear Data Library
   2. JENDL-5 Japanese evaluated nuclear data library (update)
   3. INDEN-Aug2023 evaluations produced by International Nuclear Data Evaluators Network (coord. by the IAEA)
3) Web-API for search/downloading data: JSON (MF3+33, MF4+34, MF8:MT455,457,459)

3. EXFOR-NSR PDF database

1) Updates: 42, added 2,208 PDF files
   1. Total: +2,208 => 227,581
   2. EXFOR-PDF: +763 => 28,519 (78% of 36,087)
   3. NSR-PDF: +1,445 => 191,562 (~79% of 243,751)

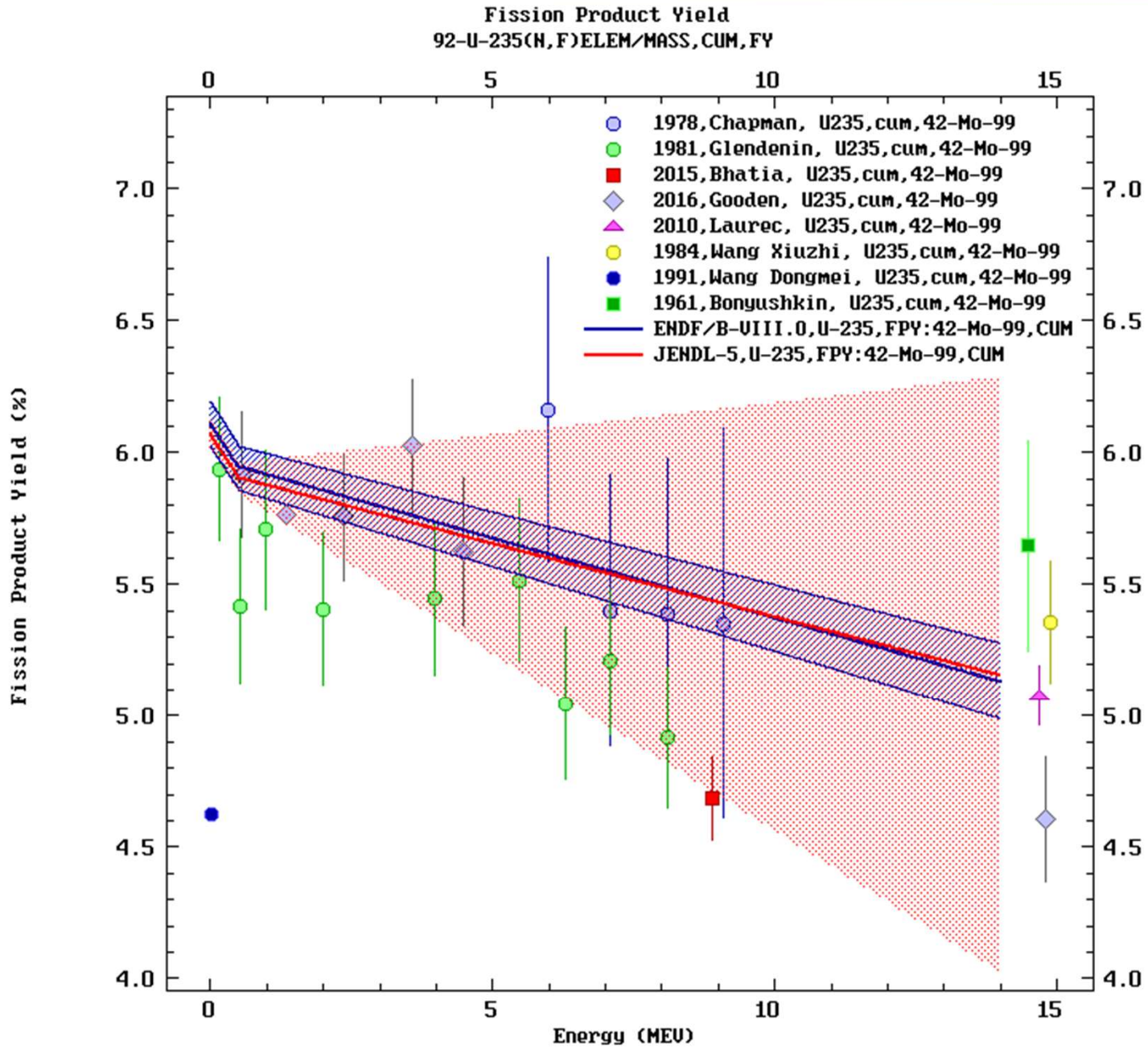
4. IBANDL

1) 4 database updates (total: 4,537 Datasets)
2) Output single dataset: CSV
3) IBANDL-Archive on GitHub (trial)
4) Web-API for download list and data: CSV, JSON, R33 +convert to MB and RR +inv. kinematics +SC

Web - interactive plotting fission product yield as a function of energy

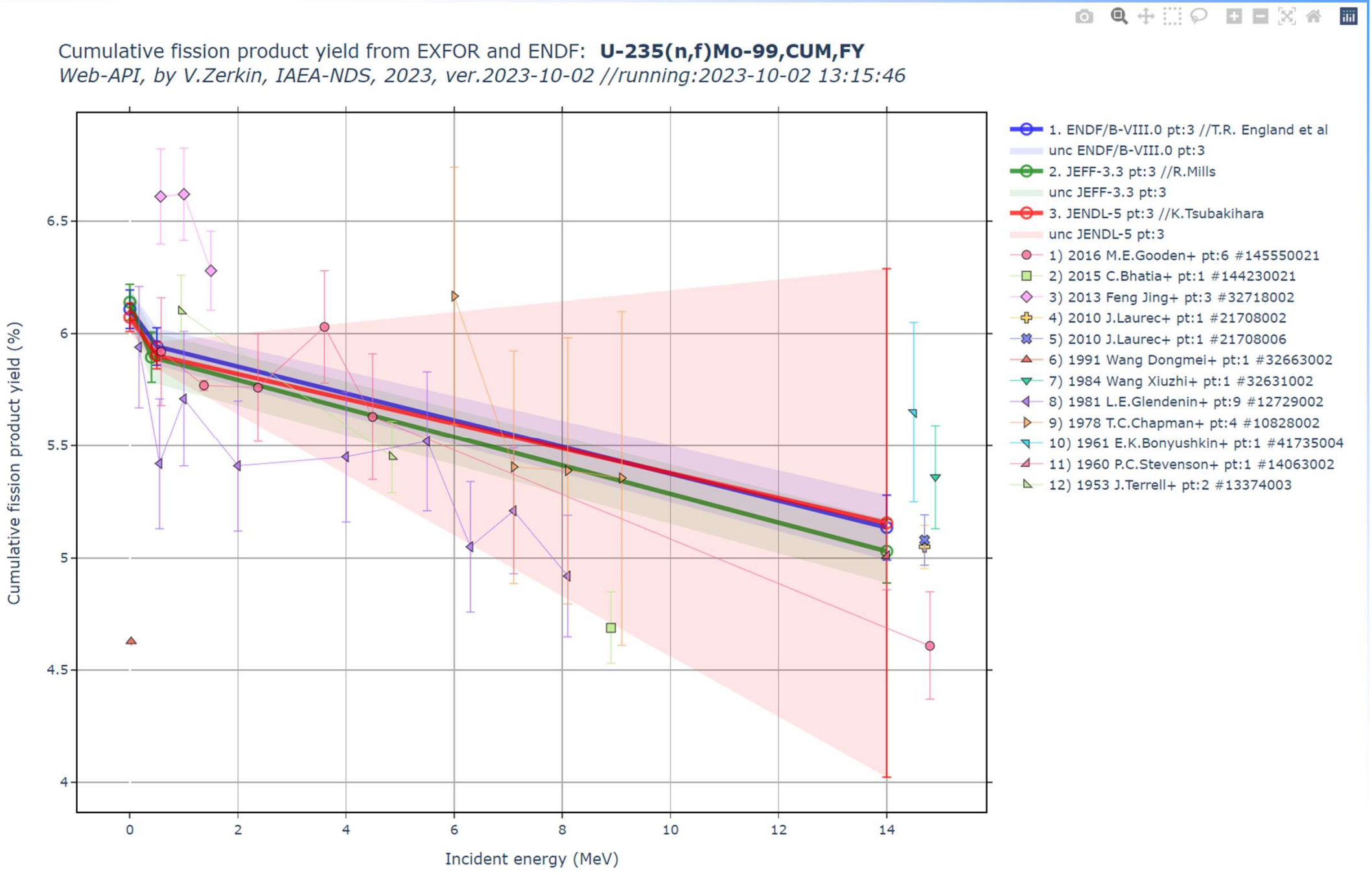
Search and plot and cumulative fission product yield data on example of 92-U-235(N,F)42-MO-99,CUM,FY

Instruction: https://nds.iaea.org/exfor/x4guide/FPY/web-fpy_e.pdf



Web-API plotting fission product yield as a function of energy: example on Python + Plotly

https://nds.iaea.org/exfor/x4guide/API/#FY



Web-API for EXFOR, ENDF, IBANDL

Web-API (Application Programming Interface) is available via NDS Web Retrieval system and provides a tool for remote access to data by user's programs. Data are sent through Internet using Http connection.

✓ EXFOR-API provides search and downloading data in EXFOR, C4, X5 and C5 with options: automatic re-normalization and generation of correlation matrix as plain text, CSV, XML and JSON files.

- Search: get list of Entries and Datasets
- Get data from individual Dataset
- One step retrieval: search and download data
- Entry/Subentry
- Entry from Archive (old version)
- Fast Retrieval (EE-View)

✓ ENDF-API provides data search and retrieval mostly in JSON: cross sections, angular distributions, fission yield decay and other data. The ENDF-API is used in X4Pro/Python with a lot of examples for different data types and in EE-Viewer.

- Cross Sections (CS: x, y, dy)
- Covariances of CS (m×n)
- Angular Distributions
- Fission Yield
- Decay data

✓ IBANDL-API provides database list, individual datasets and grouped data. Data can be converted (Rutherford Ratio to barn per steradian and vise versa) and recalculated to inverse kinematics and finally sent to user as text, CSV, R33, JSON files.

- List of Datasets
- Single Dataset
- Group of Datasets
- Data from IBANDL and Sigmacalc

✓ Code example using Web-API in Python:

1. Retrieve cross section covariance data from ENDF in JSON and plot by Plotly
2. Plot cumulative fission product yield from EXFOR and ENDF as a function of energy
3. Retrieve IBANDL data and plot by Plotly
4. Retrieve and plot IBANDL and Sigmacalc data
5. Retrieve and plot IBANDL and Sigmacalc data in direct and inverse kinematics

Short description, examples, codes: https://nds.iaea.org/exfor/x4guide/API/

Web-API for EXFOR, ENDF, IBANDL

https://nds.iaea.org/exfor/x4guide/API/

Web API for EXFOR, ENDF, IBANDL

/under development by V.Zerkin, IAEA, 2023, v.2023-10-19/

Web API service is implemented via GET requests to Web server using URL
https://nds.iaea.org/exfor/program? followed by parameters separated by '&'.
Parameter could be given as pair 'name=value' or just 'name' (flag).

EXFOR API

· Usually two steps: find data (get list) and download data.
· Data types: original/interpreted EXFOR (Entry/Subentry) and Datasets (Subentry+Pointer).
· Archival versions: previous versions of Entry/Subentry can be downloaded using date of update.
· Output data: plain text, Html, JSON, XML, CSV.

Examples

Some examples of programs request parameters:

----Get List of Datasets----

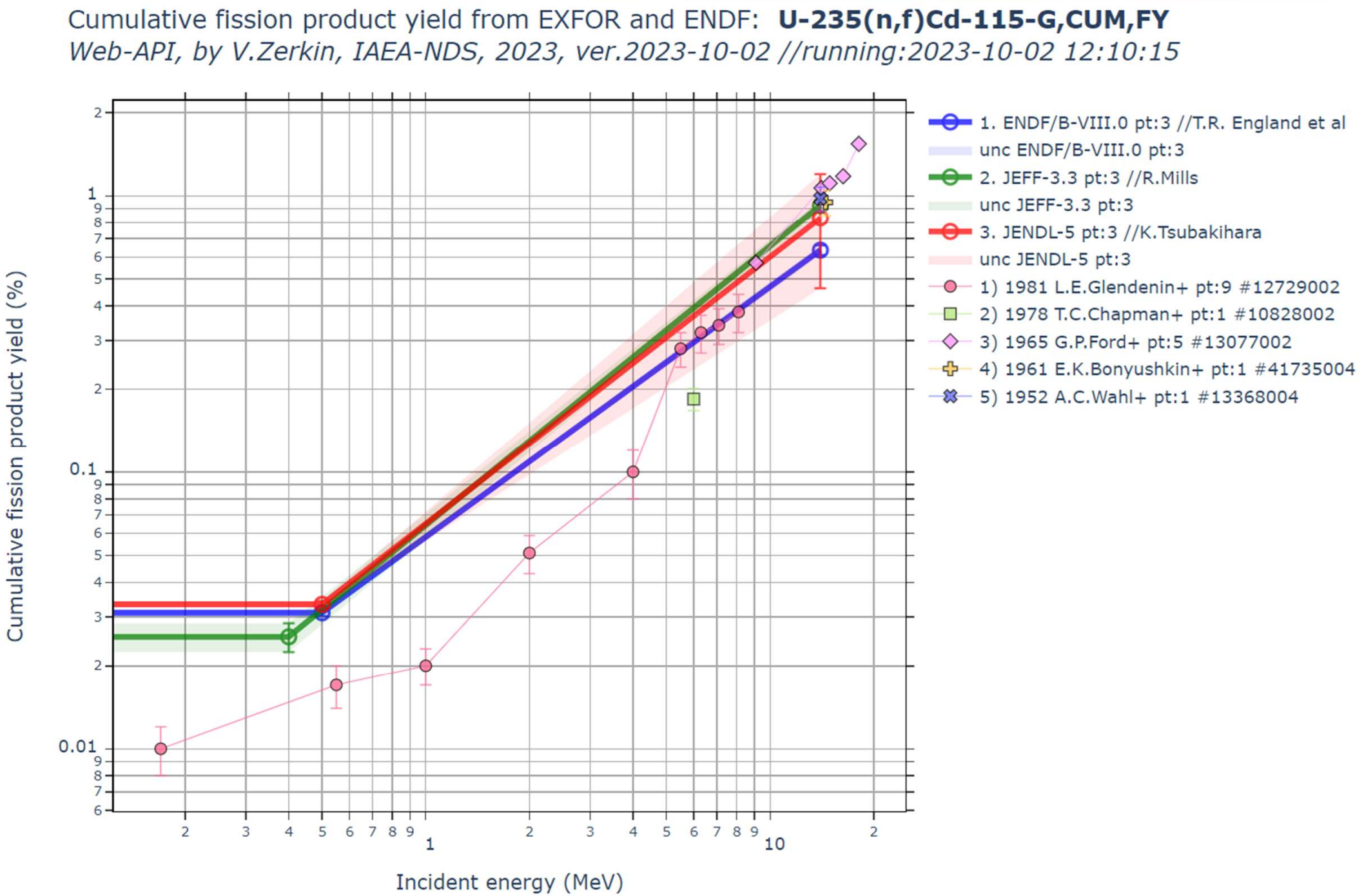
1. x4list?Target=PB-204;pb-0&Reaction=n,g&Quantity=SIG&txt try
   Find data, get list of Datasets in plain text.
2. x4list?Target=PB-*&Reaction=n,*&Quantity=SIG&Author1=Michel&xml try
   Find data, get list of Datasets in XML.
3. x4list?Target=PB-204&Reaction=n,g&Quantity=SIG&json try
   Find data, get list of Datasets as JSON output.
4. x4list?Target=Li-6*&Reaction=he3,p&Quantity=dap&csv try
   Find data, get list of Datasets in CSV.

----Get data from individual Dataset----

5. x4get?DatasetID=11679024&op=c4 try
   Get data from Dataset in C4 format.
6. x4get?DatasetID=13597002&op=c5 try
   Get data from Dataset in C5 format.

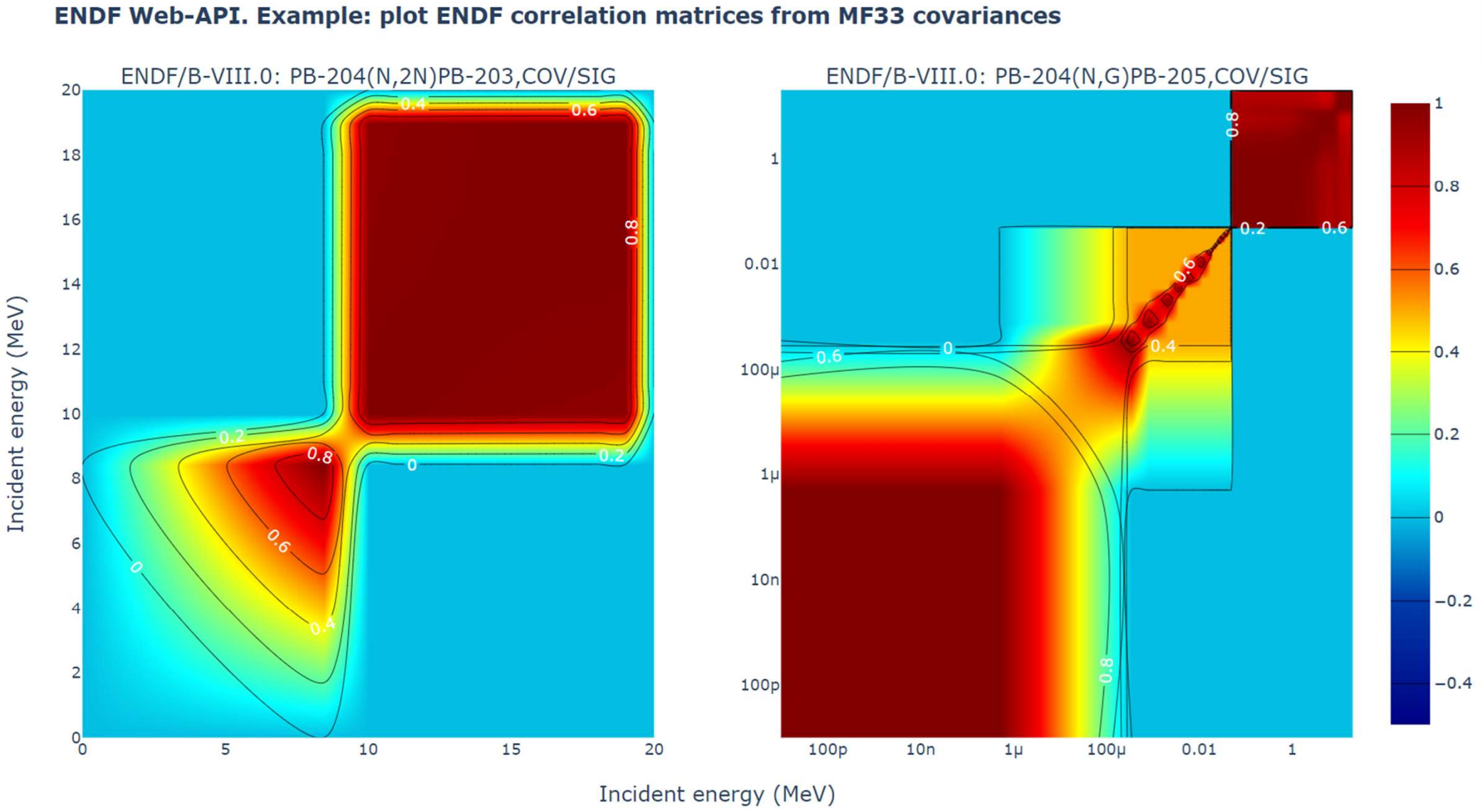
Web-API: Python code example

Retrieve and plot cumulative fission product yield from EXFOR and ENDF as a function of energy



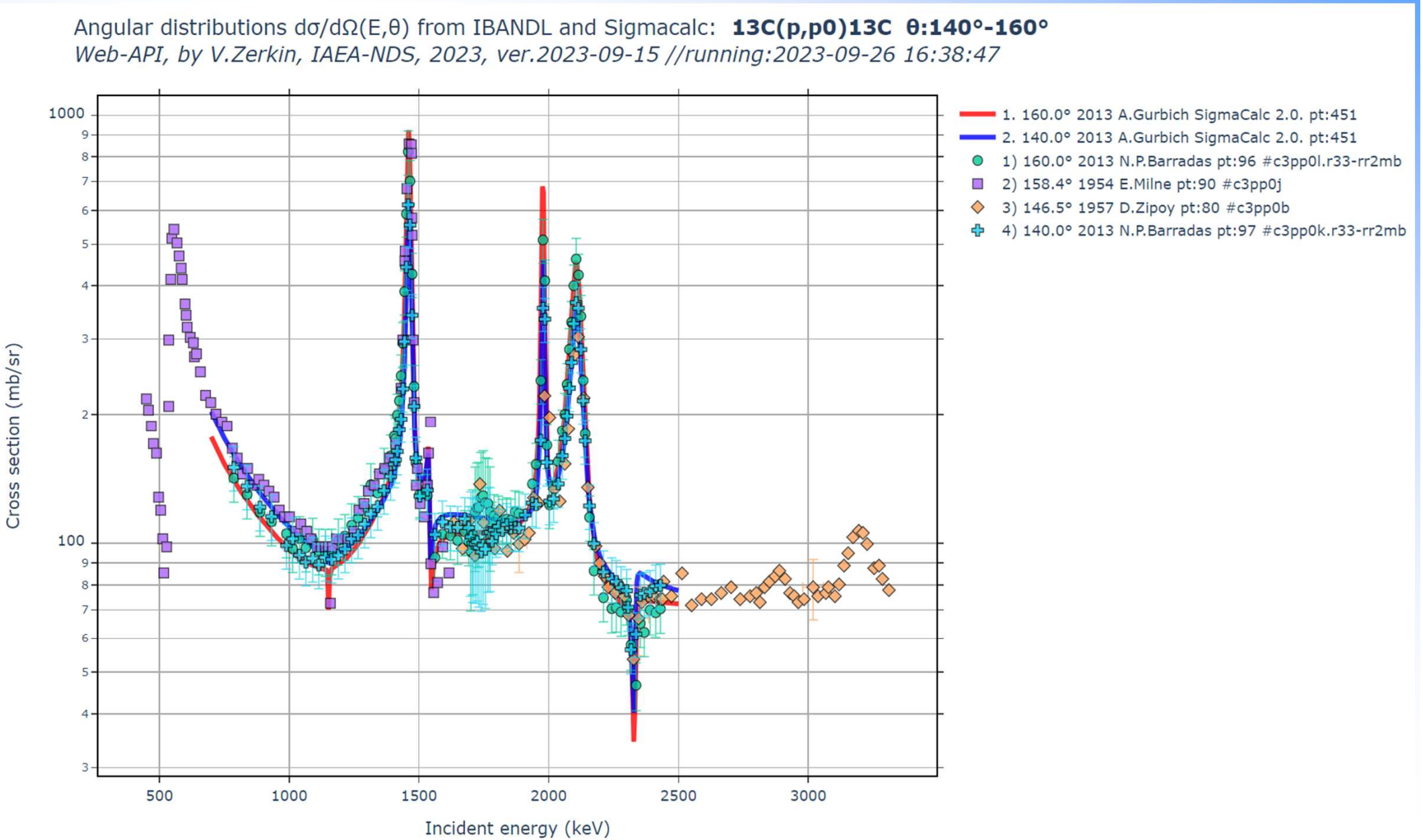
Web-API: Python code example

Retrieve and plot correlation matrices from ENDF/MF33



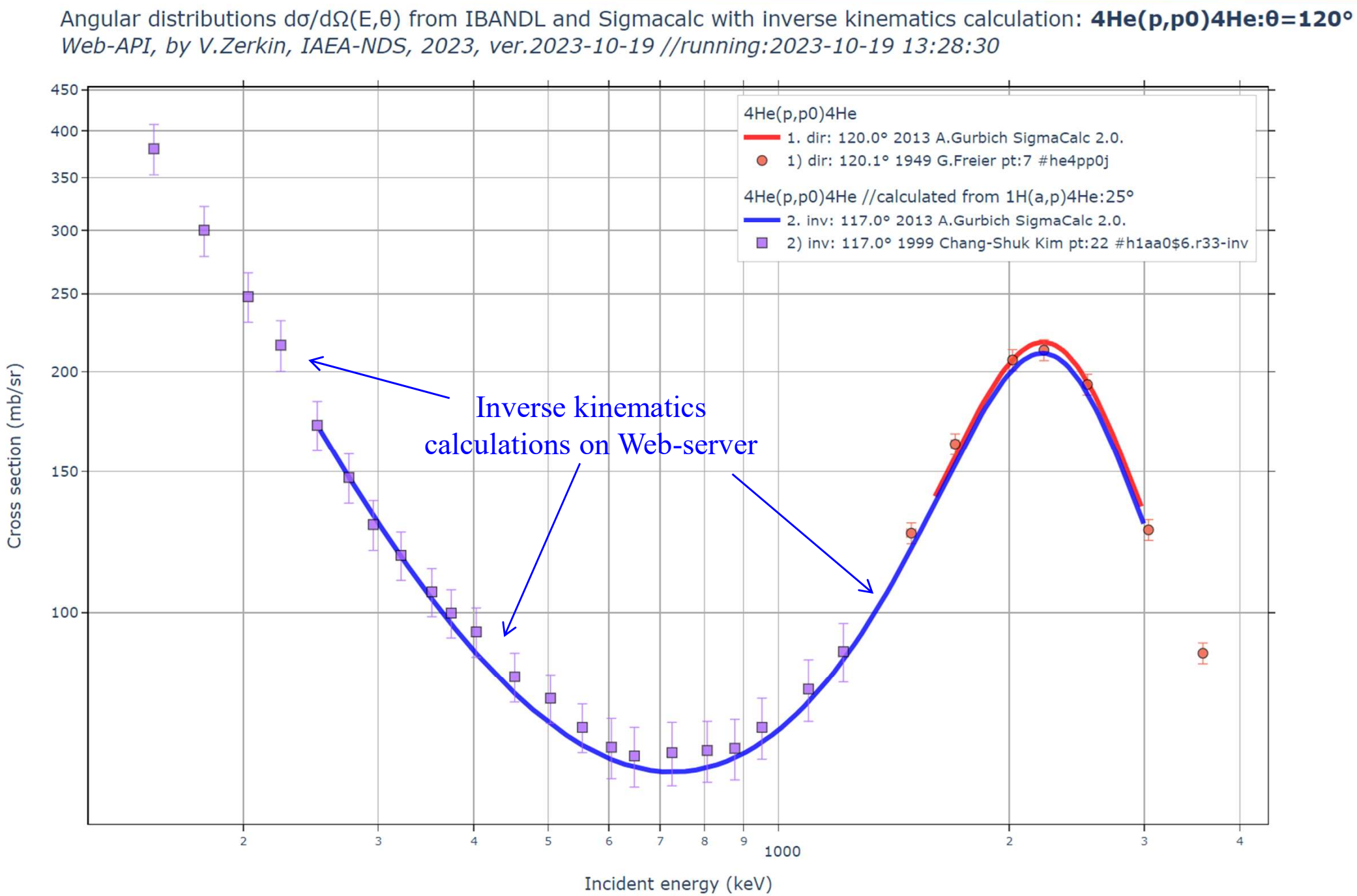
Web-API for IBANDL-Sigmacalc data

- Sigmacalc data retrieved from Sigmacalc-2.0:2013
- Data converted from RR to MB/SR



Web-API: Python code example

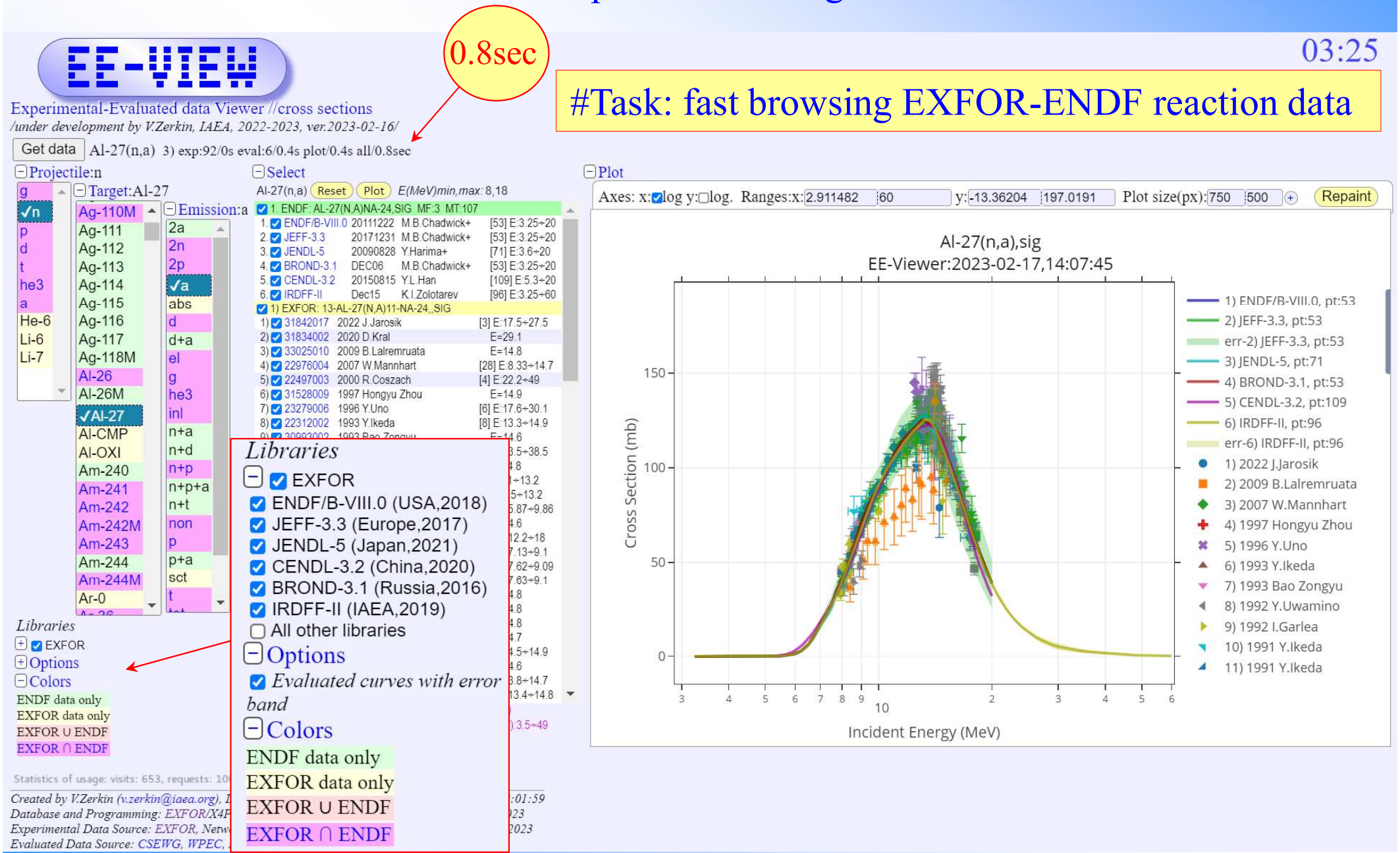
Retrieve and plot IBANDL and Sigmacalc data (+inverse kinematics calculations)



Web-Application based on Web-API

EE-View Experimental-Evaluated data Viewer

Cross sections: https://nds.iaea.org/exfor/eeview.htm



Web-Application based on Web-API

EE-View Experimental-Evaluated data Viewer

Angular distribution: https://nds.iaea.org/exfor/eeview-da.htm

04:18

EE-VIEW

2.7sec

Experimental-Evaluated data Viewer //angular distributions

/under development by V.Zerkin, IAEA, 2022-2023, ver.2023-02-16/

#Note: plot evaluated angular distributions with uncertainties (MF34)

Projectile n | *Target* Mn-55 | *Emission* el | *Inc.Energy* 3.5 MeV | *Libraries* EXFOR | *Options* Evaluated curves with error band

Get data | 3) exp:80/0s eval:5/2.6s plot/0.1s all/2.7sec

Select

Mn-55(n,el) Reset Plot Ei=3.5MeV

1.	ENDF: MN-55(N,EL)MN-55-L0,DA MF:4 MT:2			
1.	ENDF/B-VIII.0	20111222	IAEA Evaluation ...	[137] Ei:3.5e6
2.	JEFF-3.3	20171231	IAEA Evaluation ...	[46] Ei:3.5e6
3.	JENDL-5	20210607	N.Iwamoto	[82] Ei:3.5e6
4.	BROND-3.1	20111222	IAEA Evaluation ...	[137] Ei:3.5e6
5.	CENDL-3.2	950817	B.S.Yu+	[74] Ei:3.5e6
1)	EXFOR: 25-MN-55(N,EL)25-MN-55,,DA			
1)	22155082	1992	A.Takahashi Ei:1.41e7	[16] An:15÷160
2)	21722038	1972	I.Fujita Ei:1.41e7	An=110
3)	20019082	1969	B.Holmqvist Ei:2.47e6	[19] An:19.9÷160
4)	20019082	1969	B.Holmqvist Ei:3.00e6	[20] An:19.9÷160
5)	20019082	1969	B.Holmqvist Ei:3.49e6	[20] An:19.9÷160
6)	20019082	1969	B.Holmqvist Ei:4.00e6	[20] An:19.9÷160
7)	20019082	1969	B.Holmqvist Ei:4.56e6	[20] An:19.9÷160
8)	20019082	1969	B.Holmqvist Ei:6.09e6	[19] An:19.9÷160
9)	20019082	1969	B.Holmqvist Ei:7.05e6	[19] An:19.9÷160
10)	20019082	1969	B.Holmqvist Ei:8.05e6	[19] An:19.9÷160
11)	11511008	1966	R.L.Becker Ei:3.20e6	[14] An:20÷150
12)	11519005	1966	S.A.Cox Ei:6.77e5	[8] An:20÷160
13)	11519005	1966	S.A.Cox Ei:6.86e5	[8] An:20÷160
14)	11519005	1966	S.A.Cox Ei:6.94e5	[8] An:20÷160
15)	11519005	1966	S.A.Cox Ei:7.03e5	[8] An:20÷160
16)	11519005	1966	S.A.Cox Ei:7.11e5	[8] An:20÷160
17)	11519005	1966	S.A.Cox Ei:7.19e5	[8] An:20÷160
18)	11519005	1966	S.A.Cox Ei:7.28e5	[8] An:20÷160
19)	11519005	1966	S.A.Cox Ei:7.36e5	[8] An:20÷160
20)	11519005	1966	S.A.Cox Ei:7.45e5	[8] An:20÷160
21)	11519005	1966	S.A.Cox Ei:7.53e5	[8] An:20÷160
22)	11519005	1966	S.A.Cox Ei:7.61e5	[8] An:20÷160
23)	11519005	1966	S.A.Cox Ei:7.70e5	[8] An:20÷160
24)	11519005	1966	S.A.Cox Ei:7.78e5	[8] An:20÷160
25)	11519005	1966	S.A.Cox Ei:7.87e5	[8] An:20÷160
26)	11519005	1966	S.A.Cox Ei:7.95e5	[8] An:20÷160
27)	11519005	1966	S.A.Cox Ei:8.03e5	[8] An:20÷160
28)	11519005	1966	S.A.Cox Ei:8.12e5	[8] An:20÷160

ENDF: datasets:5, data points:476, Energy(MeV):1.8e-4÷0.e0

EXFOR: reactions:2, datasets:80, data points:740, E(MeV):1.5e-5÷1.6e-4

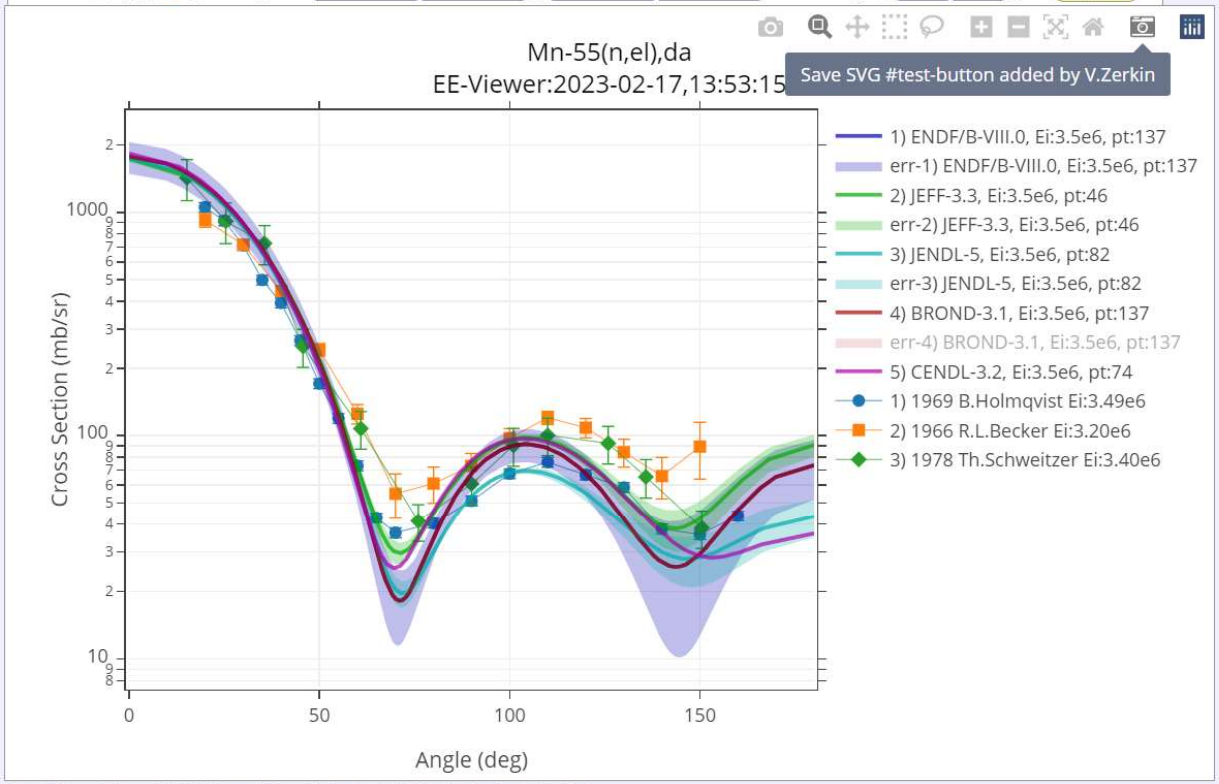
Download selected EXFOR data: [csv] [csv+]

Plotted data: Copy Paste

Plot

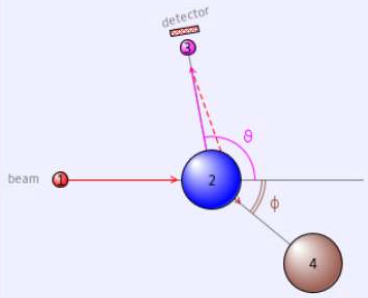
Axes: x:log y:log. Ranges:x: 0 180 y: 7.546586 2770.051 Plot size(px): 780 500 Repaint

Save SVG #test-button added by V.Zerkin



Point #9) x=100 y=97.4617 dy=9.93493 Dataset #2) 1966 R.L.Becker Ei:3.20e6

Point #9) Dataset #2) 1966 R.L.Becker Ei:3.20e6



25-MN-55(N,EL)25-MN-55,,DA Qvalue=0.0(keV)

1 Projectile:	n	M_1=1.008665
2 Target:	Mn-55	M_2=54.938046
3 Scattered:	n	M_3=1.008665
4 Recoil:	Mn-55	M_4=54.938046
	Laboratory System	
E_1=3200.0	E_3=3065.0	θ=100.0° σ(θ)=97.4617 ±10.2%
E_2=0.0	E_4=134.995	φ=39.5° σ(φ)=302.871
	Center of Mass System	
E_{cm}=3142.31		
E_1'=3085.65	E_3'=3085.65	θ'=101.0° σ'(θ')=98.1023
E_2'=56.6528	E_4'=56.6528	φ'=79.0° σ'(φ')=98.1023

Units: M:(amu); E:(keV); σ:(mb/sr)

Statistics of usage: visits: 652, requests: 998, since 01-Feb-2023

Created by V.Zerkin (v.zerkin@iaea.org), IAEA-NDS, 28-Dec-2022. Last updated:2023-02-16,12:01:53

Database and Programming: EXFOR/X4Pro/ENDF-Relational by V.Zerkin, IAEA-NDS, 1999-2023

Experimental Data Source: EXFOR, Network of Nuclear Reaction Data Centres (NRDC), 1970-2023

Evaluated Data Source: CSEWG, WPEC, IAEA-NDS, IPPE, CNDC, JAEA, NRG, CCFE, FZK

Concluding remarks

1. Web-API – powerful tool allowing to build lightweight user's applications:
   1) all done "on-the-fly", no need to download huge databases
   2) flexible - useful server [re]calculations can be applied

2. Web-API examples can be used as starting point for user's applications

3. Web-API Web-page describing parameters with link [try] is enough (?) for practical usage

Thank you.