EXFOR fortified to better serve

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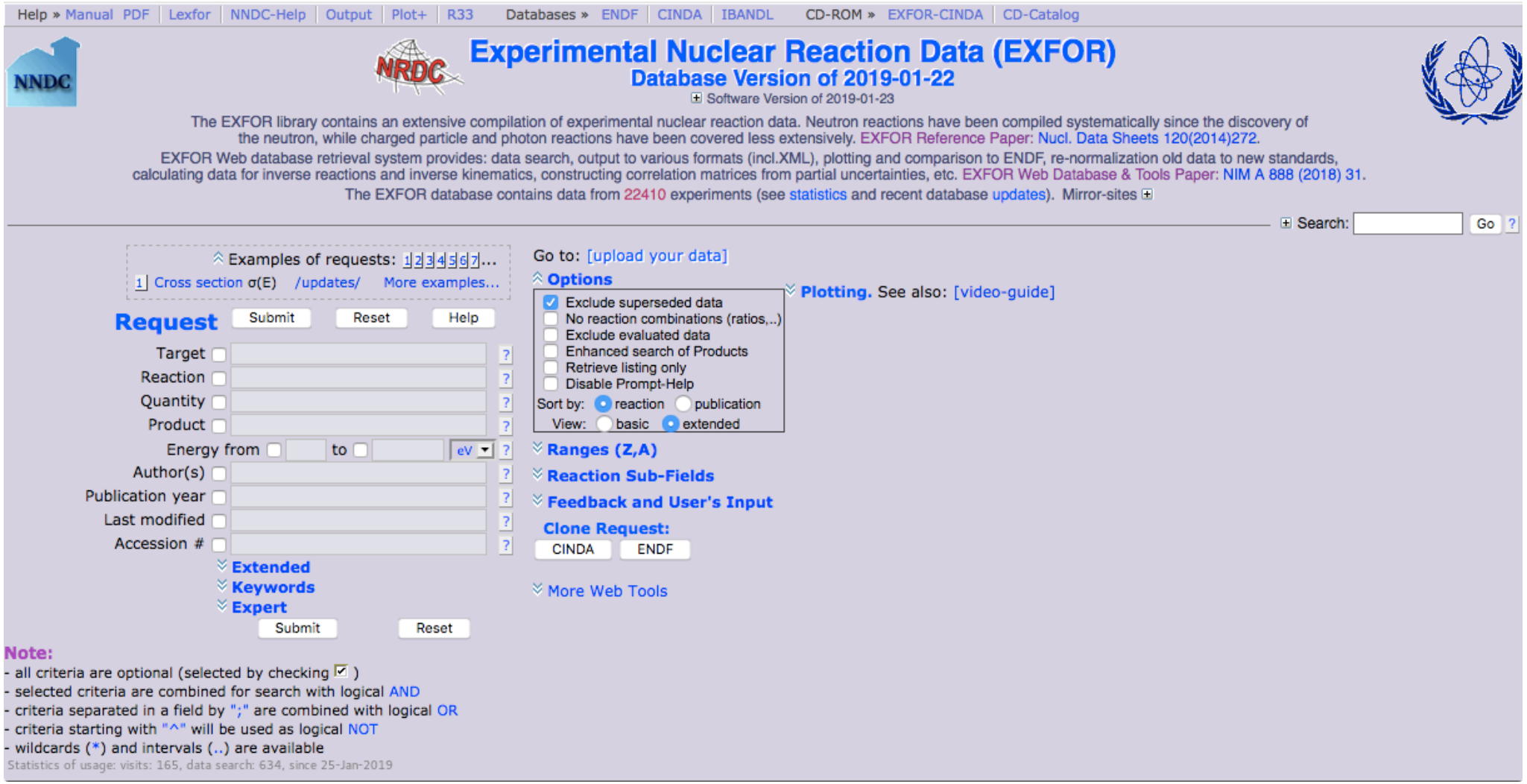
EXFOR web database entry point, since 2005

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



15 years of age !

EXFOR metrics: 42 quantities ! what was really measured?

ALF	α-value ($\sigma_{\text{capt}}/\sigma_{\text{fis}}$)
AMP	Length or amplitude
CHG	Fragment charge
CS	Cross section
CSN	Differential with respect to number of particles
CSP	Partial cross section
CST	Temperature dependent cross section
D3A	Triple differential $\mathrm{d}\Omega_1/\mathrm{d}\Omega_2/\mathrm{d}E'$
D3E	Triple differential $\mathrm{d}\Omega/\mathrm{d}E'_1/\mathrm{d}E'_2$
D4A	Quadruple diff. $\mathrm{d}\Omega_1/\mathrm{d}\Omega_2/\mathrm{d}E'_1/\mathrm{d}E'_2$
DA	Differential $\mathrm{d}/\mathrm{d}\Omega$
DAA	Double differential $\mathrm{d}\Omega_1/\mathrm{d}\Omega_2$
DAE	Double differential $\mathrm{d}\Omega/\mathrm{d}E'$
DAP	Partial differential $\mathrm{d}/\mathrm{d}\Omega$
DAT	Temperature-dependent Legendre coefficient
DE	Differential $\mathrm{d}/\mathrm{d}E'$
DEP	Energy spectrum for specific group
DP	Diff. by linear momentum of outgoing part.
DT	Diff. by 4-momentum transfer squared
ETA	η-value $\bar{\nu}\sigma_{\text{fis}}/(\sigma_{\text{capt}}+\sigma_{\text{fis}})$
EVL	Evaluation
FY	Fission product yield
INT	Cross section integral over incident energy
KE	Kinetic energy
KER	Kerma factor
MLT	Multiplicity
NQ	Nuclear quantity
NU	Fission neutron multiplicity $\bar{\nu}$
NUD	Delayed fission neutron multiplicity $\bar{\nu}_d$
NUF	Fragment neutrons
POL	Polarization
POD	Differential polarization
PY	Product yield (other than fission)
RI	Resonance integral
RP	Resonance parameter
RR	Reaction rate
SIF	Self indication
SPC	Gamma spectrum
TSL	Thermal scattering
TT	Thick target yield
TTD	Differential thick target yield, $\mathrm{d}/\mathrm{d}\Omega$
TTP	Partial thick target yield

Special codes in incident energy field

Fast	Fast reactor spectrum average	Maxw	Maxwellian spectrum average
Fiss	Fission spectrum average	Spont	Spontaneous (for fission)

Special codes in outgoing particle field

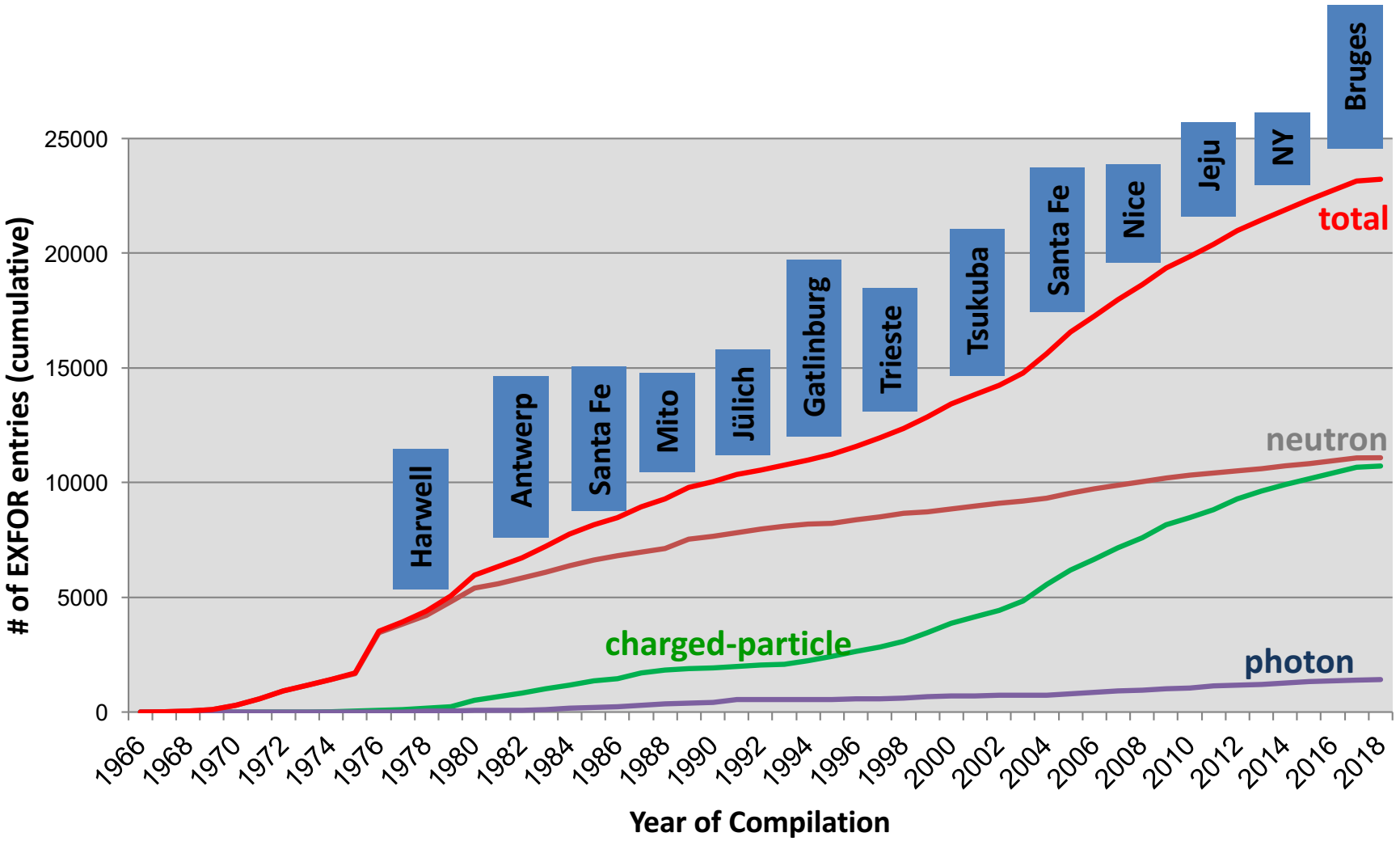
abs	Absorption	fus	Fusion	sct	Scattering	tot	Total
el	Elastic	inel	Inelastic	tcx	Total charge changing		
fis	Fission	non	Nonelastic	ths	Thermal scattering		

EXFOR metrics

EXFOR Quantity

#	Code	Quantity	Counts	Percent
1	CS	Cross section data	11495	51.2
2	DAP	Partial differential data with respect to angle	4338	19.3
3	DA	Differential data with respect to angle	4333	19.3
4	RP	Resonance parameters	1996	8.9
5	CSP	Partial cross section data	1923	8.58
6	FY	Fission product yields	1119	4.99
7	POL	Polarization data	1114	4.97
8	DAE	Differential data with respect to angle and energy	1094	4.88
9	MFQ	Fission neutron quantities	529	2.36
10	SP	Gamma spectra	464	2.07
11	RI	Resonance integrals	458	2.04
12	DE	Differential data with respect to energy	383	1.7
13	TT	Thick target yields	342	1.52
14	E	Kinetic energies	338	1.5
15	L	Scattering amplitudes	222	0.99
16	INT	Cross section integral over incident energy	193	0.86
17	PY	Product yields	176	0.78
18	NQ	Nuclear quantities	112	0.49
19	MLT	Outgoing particle multiplicities	109	0.48
20	RR	Reaction rates	105	0.46
21	TTD	Differential thick target yields	51	0.22
22	CST	Temperature dependent cross section data	40	0.17
23	DEP	Partial differential data with respect to energy	12	0.053
24	SQ	Special quantities	8	0.035
25	COR	Secondary particle correlations	3	0.013
26	TTP	Partial thick target yields	3	0.013

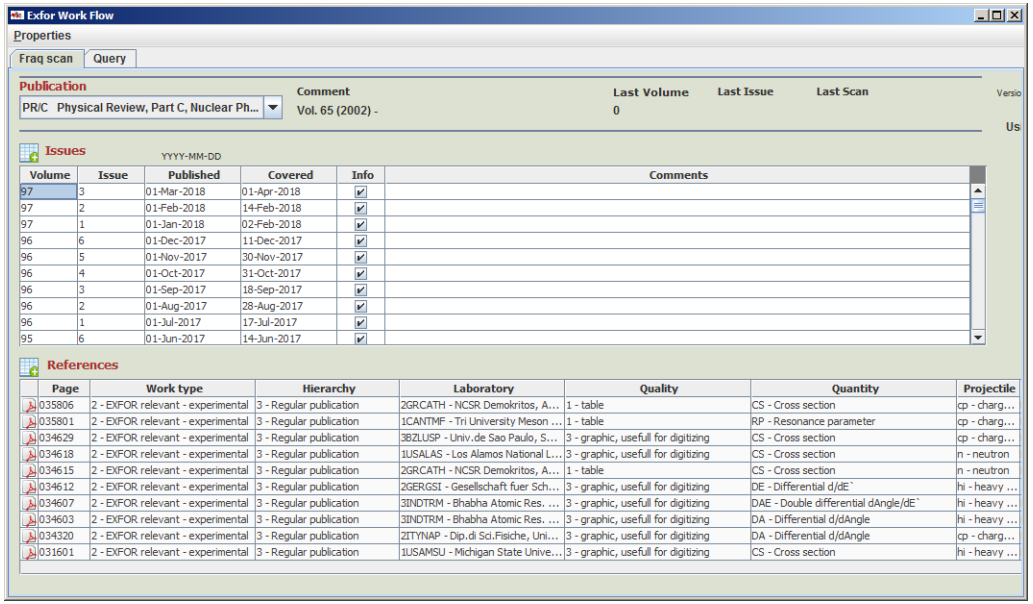
Growth of EXFOR's content



As of today more than **22,400 experimental works** have been compiled in EXFOR, corresponding to ten's of billions in investment the World over

EXFOR coverage control

- NDS regularly scans 40 journals
- NDS also regularly receives reports of journal scanned by NNDC, CNPD (Sarov) and JAEA



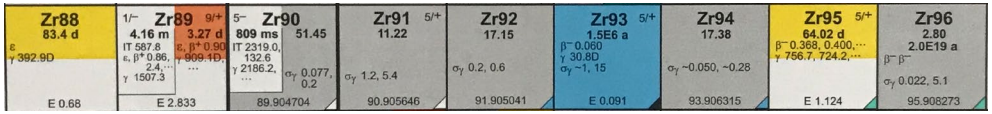
Internal database for article registration

- Recent comparison between EXFOR and NSR (Nuclear Science References) databases shows that at least 3% of proton, 20% of alpha induced data are still not in EXFOR

LETTER

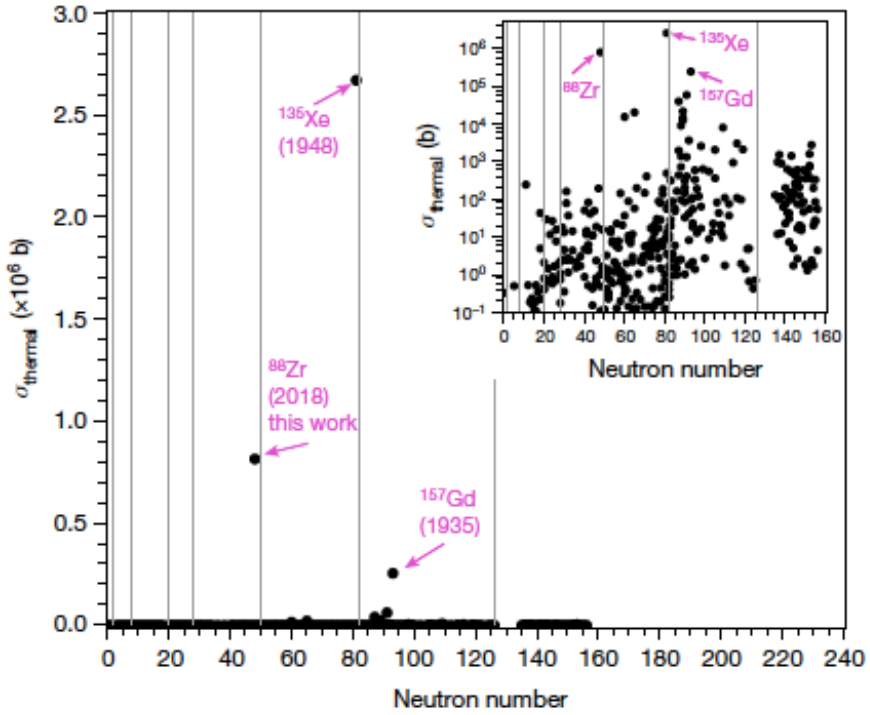
2019 from Nature (already 17 entries)

https://doi.org/10.1038/s41586-018-0838-z



The surprisingly large neutron capture cross-section of ^{88}Zr

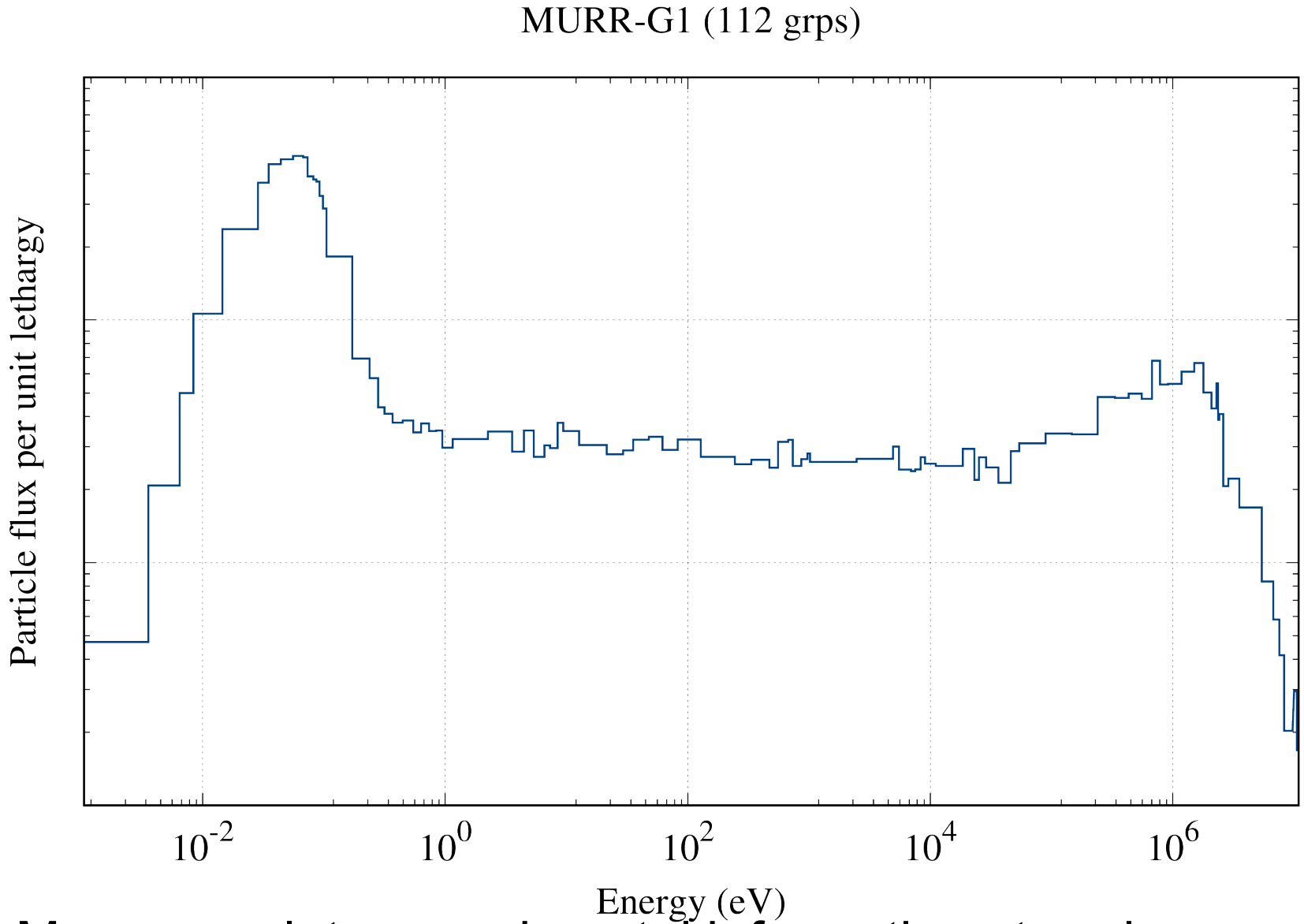
Jennifer A. Shusterman[1,2,3]*, Nicholas D. Scielzo[1], Keenan J. Thomas[1], Eric B. Norman[4], Suzanne E. Lapi[5], C. Shaun Loveless[5], Nickie J. Peters[6], J. David Robertson[6], Dawn A. Shaughnessy[1] & Anton P. Tonchev[1]



- ^{88}Zr $T_{1/2}$ = 83.4 d
- σ_{th}= 861,000 +/- 69,000 barns
- Fortunately not produced in the Zircalloy of the World's PWRs

University of Missouri Research Reactor MURR

- 7.3 10^{13} n cm^{-2} s^{-1} average thermal



- More complete experimental information stored

New impetus: completeness check of FPY

- Reference list (Bibliographic) in Robert William Mills' Ph.D. thesis and England-Rider's evaluation.

Number of Bibliographic in Robert William Mills' Ph.D. thesis

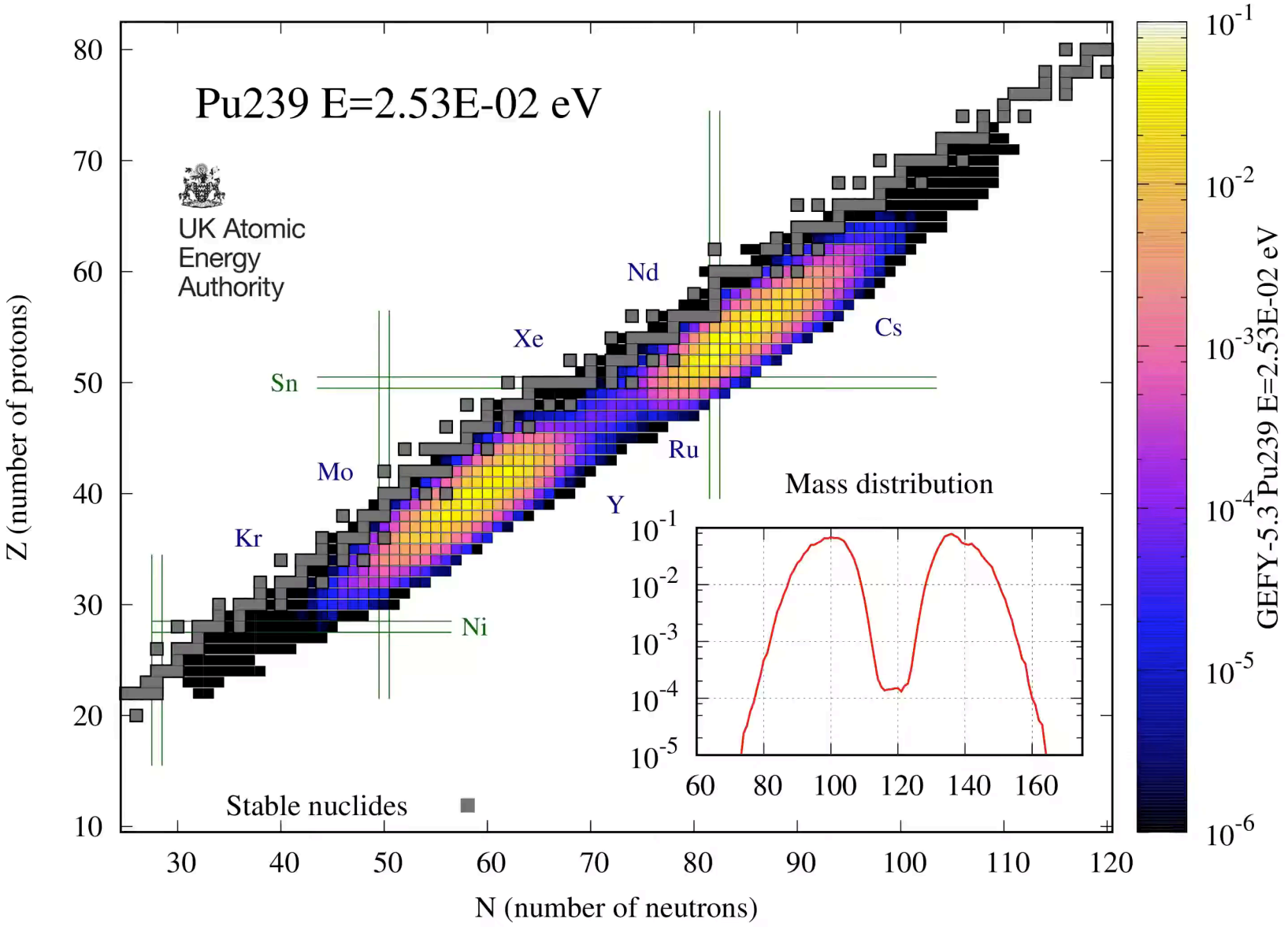
	Mills' list	**In EXFOR**
Data 1	498	361
2	16	8
3	69	30
4	56	19

  - Most of the missing data is from old issues of two journals (written in Russian and German), some conference proceedings, and master or others Ph.D. thesis.

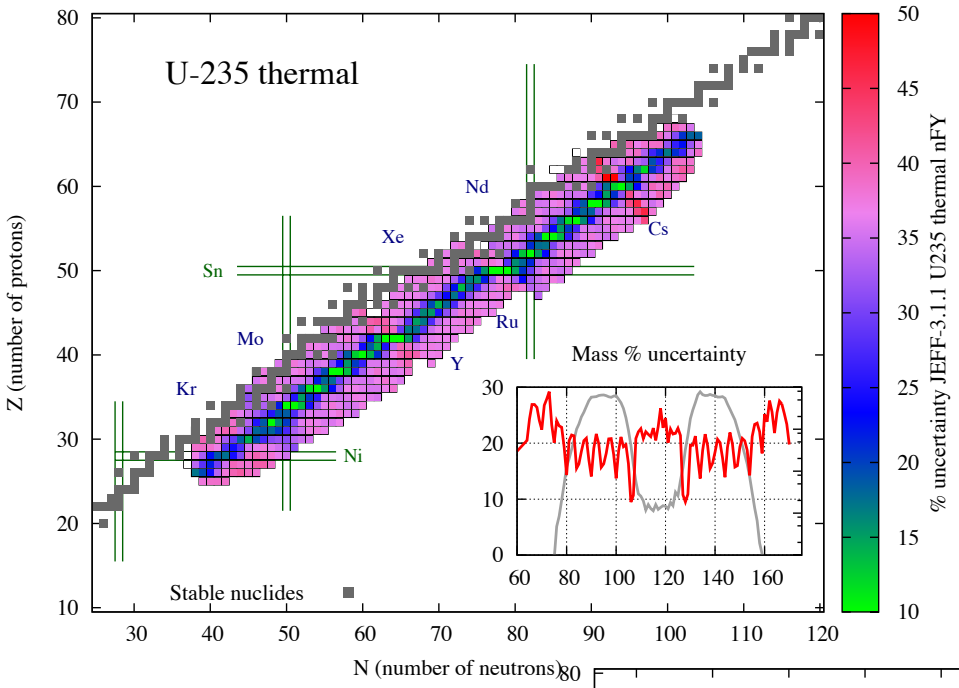
- Compilations need to be done while a CRP on FPY is running
  1. Completeness check and statistical analysis by NDS
  2. Assemblage of missing entries by NDS
  3. Compilation by NRDC

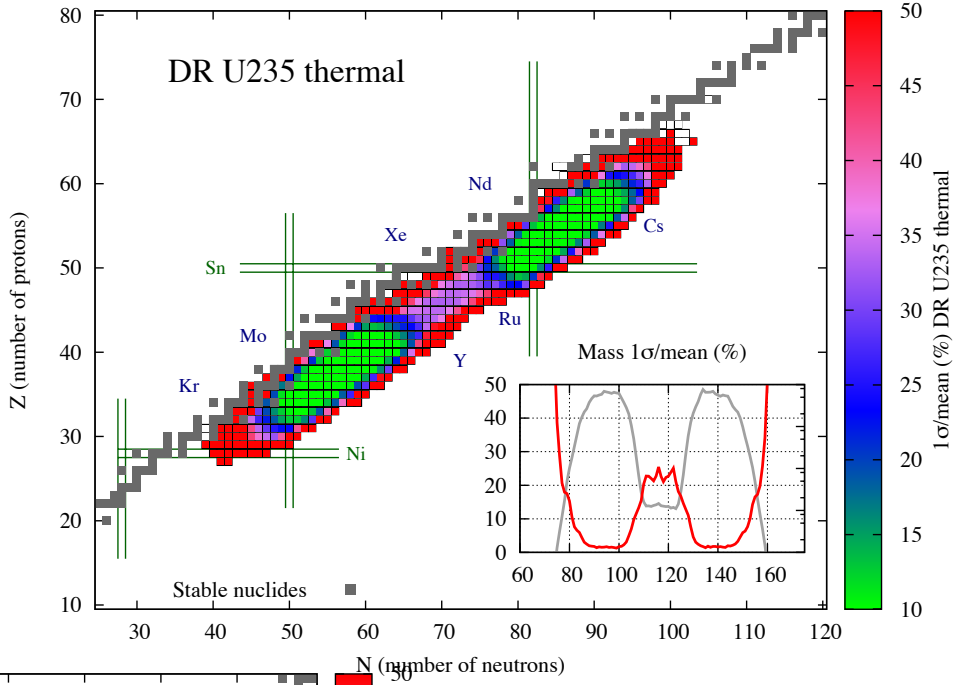
- Fission cross-sections are well known, but what about the others fission observables?

An evaluation, GEFY Pu239, 59 steps

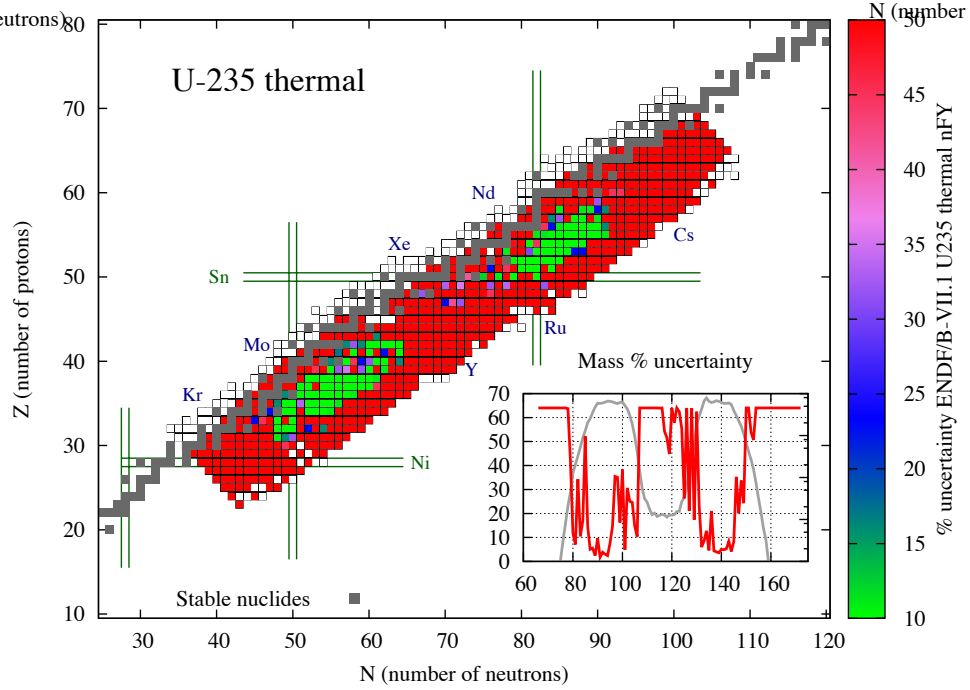


U235 FY's uncertainty @ 0.0253 eV



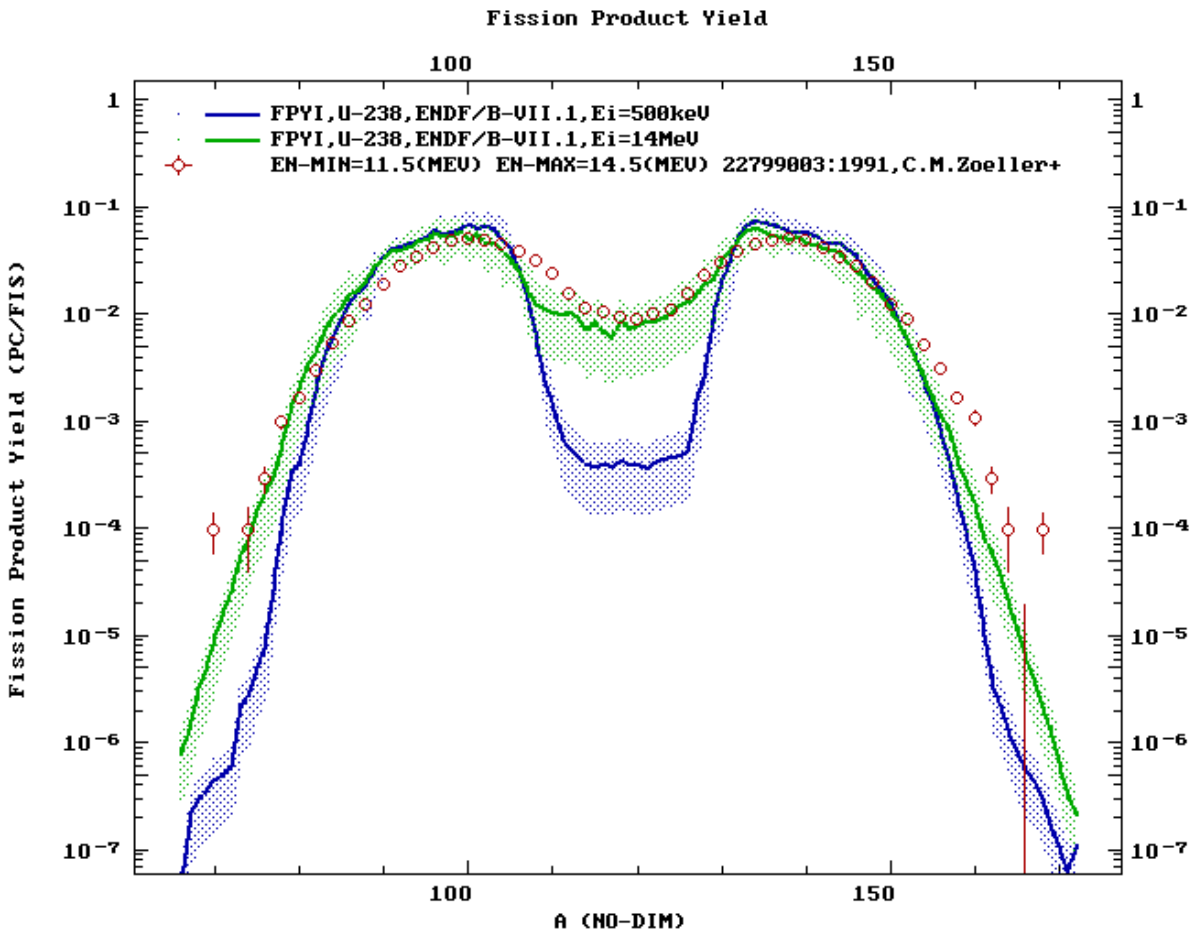


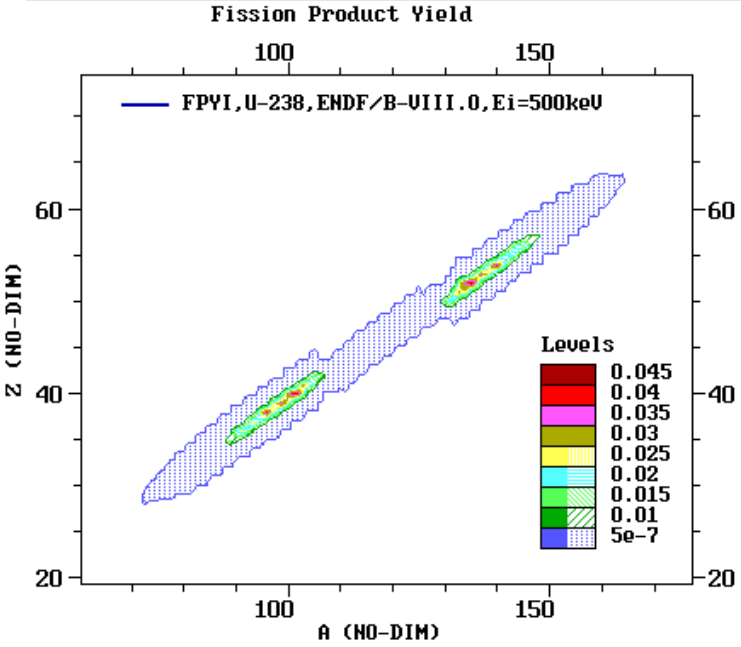
Depend on the method?

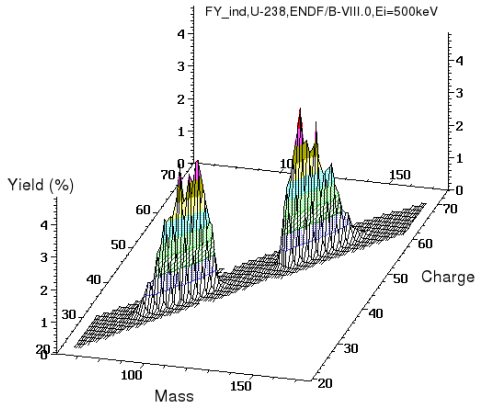


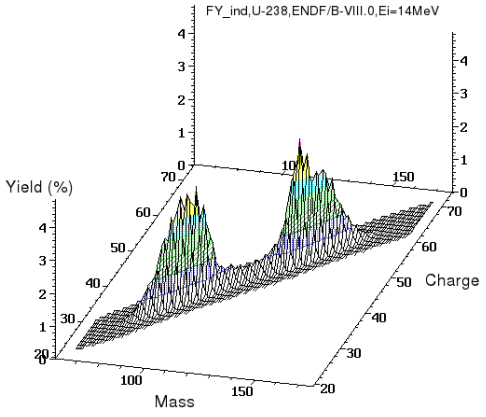
Depend on the Data ?

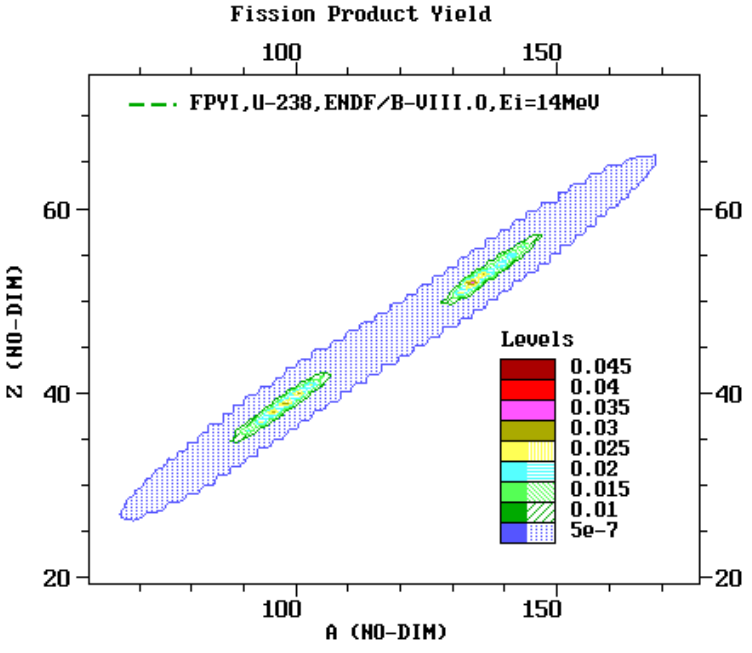
FPY Plotting ENDF vs. EXFOR data -under development-





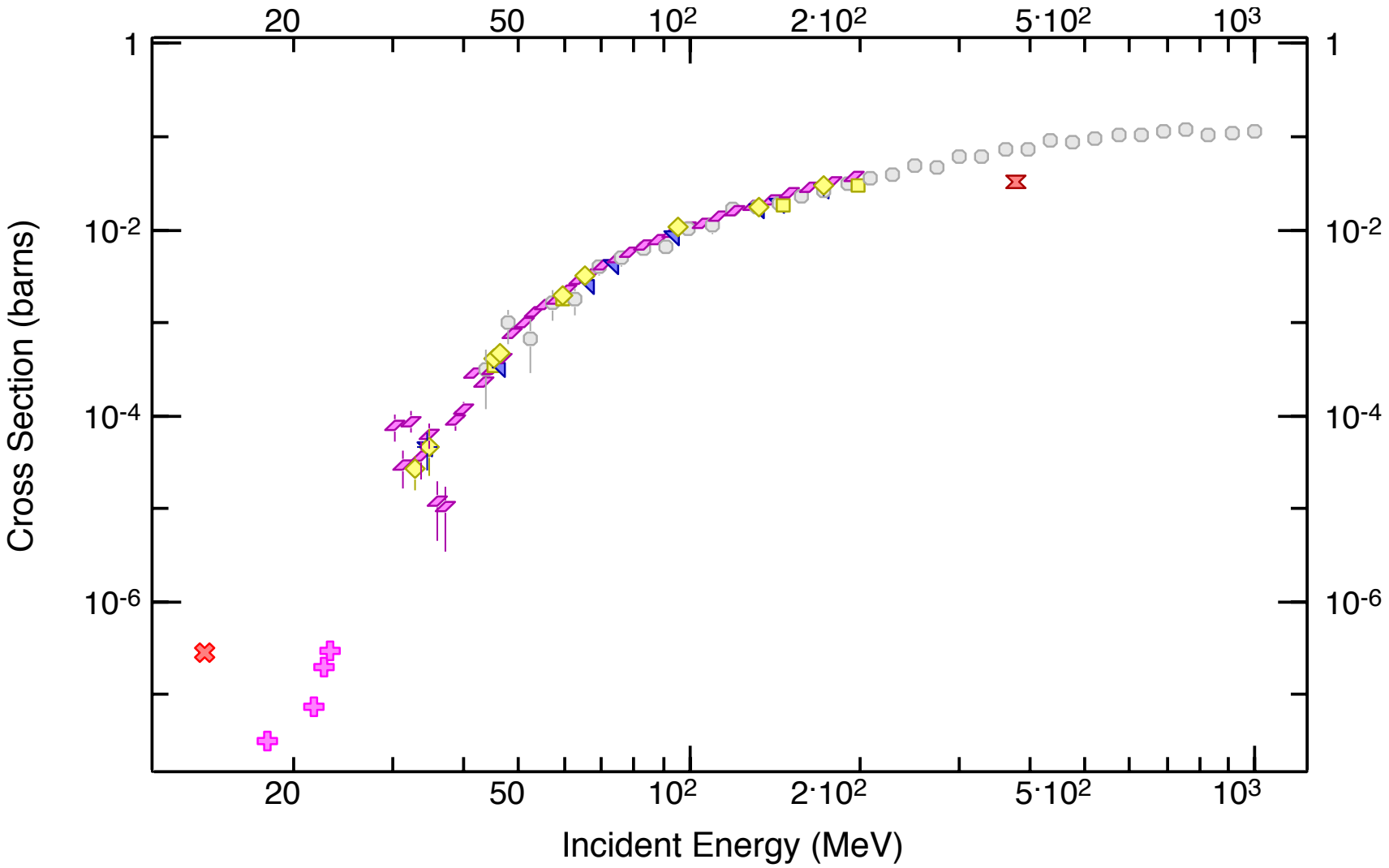






Sub-actinides Pb-0 fission

- An entry of the lesser world… of evaluation

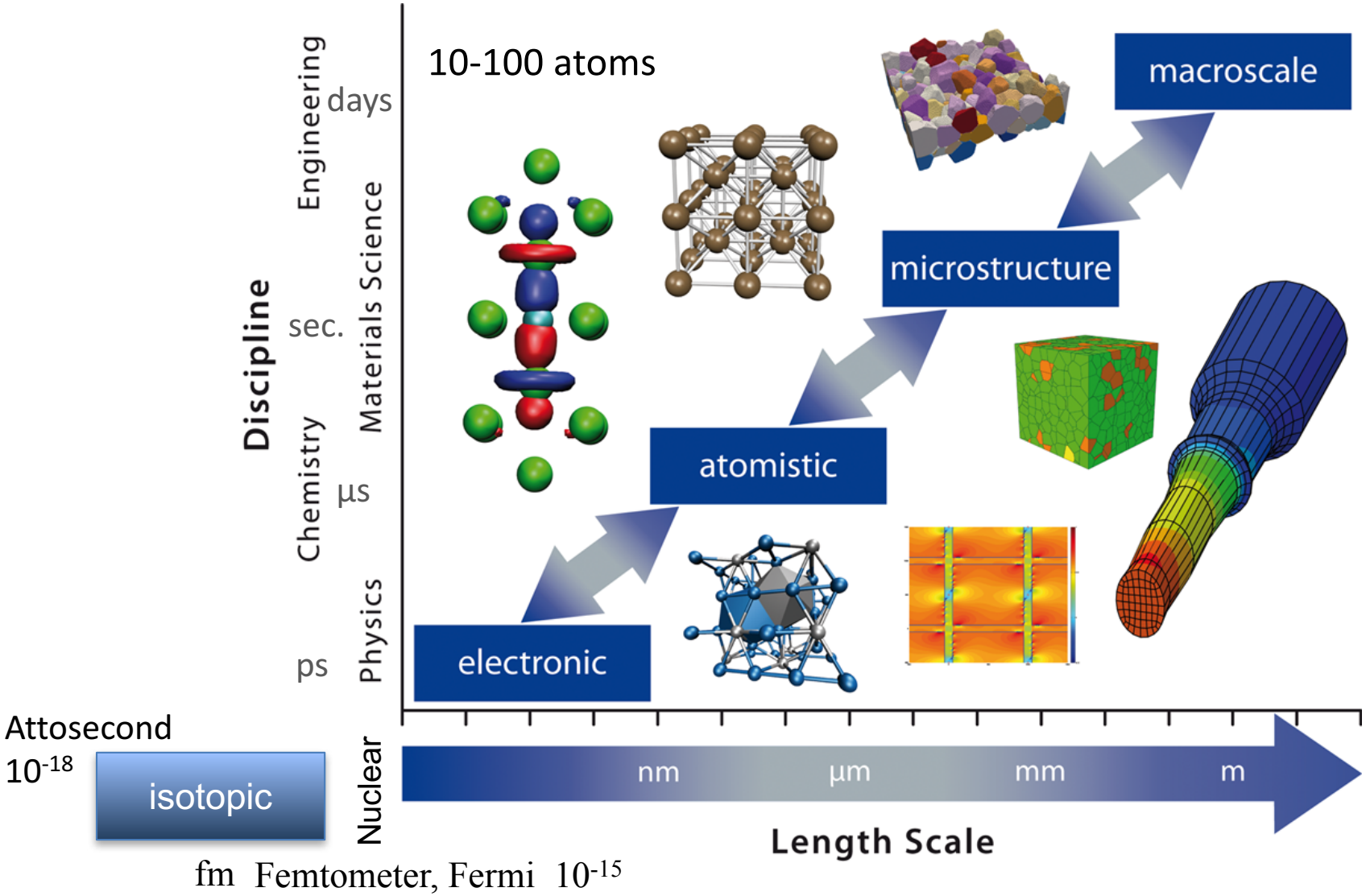


EXFOR's clients

EXFOR serves different scientific communities, the World over and those are traditionally involved in:

- Physics models
  - Allows to pin down the physics at play
- Nuclear data evaluation
  - Allows to shape/shift the different data forms
- Verification and Validation of codes
  - Allows to constrain the simulation results

Multi-scales modelling: material sciences

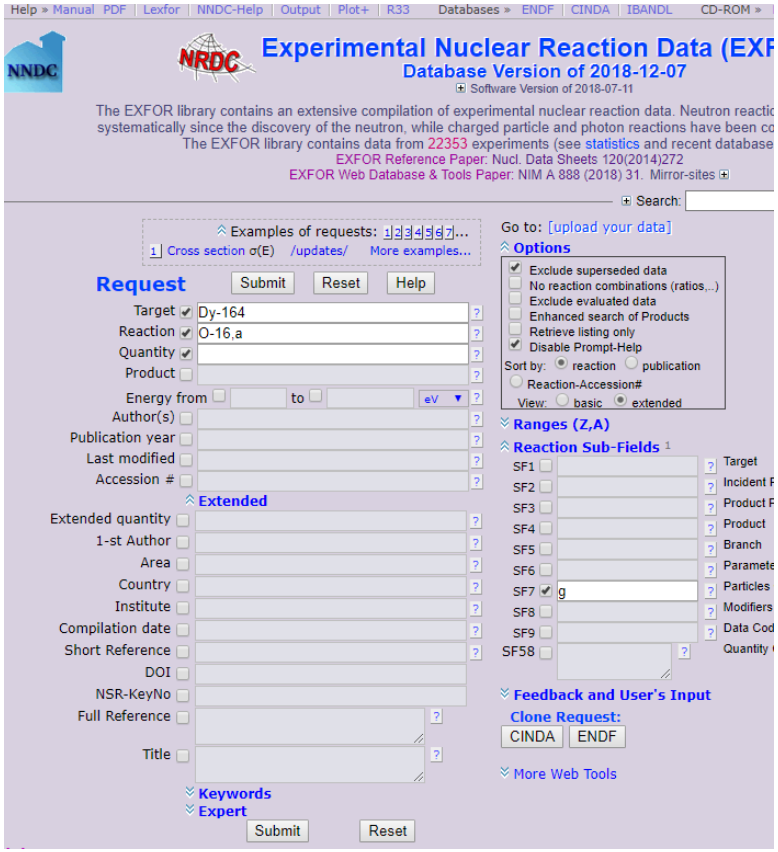


Traditionally different disciplines focus on different length scales. Multiscale modelling of materials across the length scales requires overcoming the borders between the disciplines for a seamless integration of the models on different length scales into one coherent multi-scale modelling framework (After D. Pettifor, 1991).

Conclusions

- Increases charged particle entries
- Completes/corrects/clean up the neutron entries
- Fills up the fission yields, other observables entries
- Search/prototype for new ways to:
  - Better exploit the data, all of them: elemental and isotopic
  - Deploys, pushes some of its metrics further
  - Develops analytics
  - Serves a broader community
  - Sub-package EXFOR, with dedicated wrapping
  - …

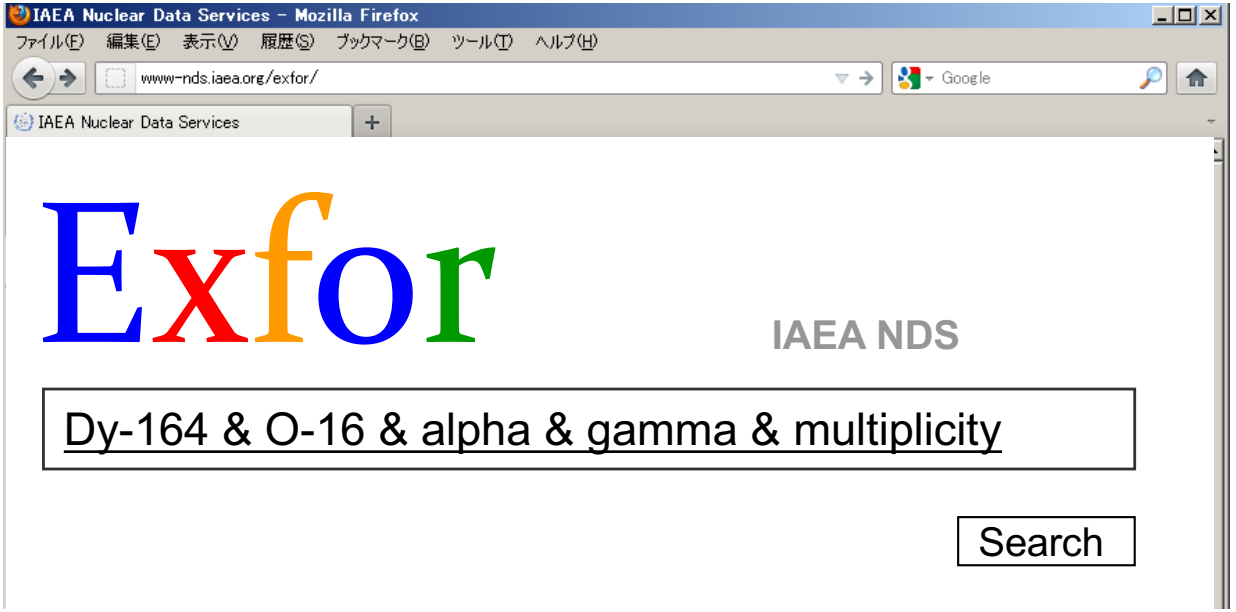
EXFOR entry point future, modernisation, deployment?



Many input forms
(Relational database oriented design)

Why not providing multiple interfaces, not just the one?

Single form (with a clever interpreter)



Dy-164 & O-16 & alpha & gamma & multiplicity

Experimental Nuclear Reaction Data (EXFOR)

Database Version of 2019-01-22

Software Version of 2019-01-30

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.

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 inverse kinematics, constructing correlation matrices from partial uncertainties, etc. EXFOR Web Database & Tools Paper: NIM A 888 (2018) 31.

The EXFOR database contains data from 22410 experiments (see statistics and recent database updates). Mirror-sites

Search: F-19 & O-16 & alpha & gamma & multiplicity Go ?

Sort by: Year Author Entry

View: extended Page: 20 Entries

Text search help is [here].

[Hide] options. [Reset] form.

https://www-nds.iaea.org/exfor/servlet/X4sSearch5

Request #379

Access-Level=2 /pdf/

Text search Dy-164&O-16&alpha&gamma&multiplicity

Found EXFOR Entries: 1 List: [full] [compact]

Page: 1.

1) 2009, Y.K.Gupta+, Jour: Physical Review, Part C, Nuclear Physics, Vol.80, p.054611 (2009). ENTRY #C1772: [E] [R] [x4+]

REACTION: (66-DY-164(8-O-16,X)2-HE-4,,DA/DE,,MSC)

REACTION: (66-DY-164(8-O-16,X)2-HE-4,,DA/DE,,MSC)

DETECTOR: (TELES,SIBAR,SIBAR)The alpha particles emitted in

detector: (BGO) Gamma-ray multiplicity setup consisting of 14

detector: (BGO) Gamma-ray multiplicity setup consisting of 14

Subent:21 Pnt:393 Ene=77-86MeV An=125-153° Target:Dy-164;Ta-181 Reaction:(c-12,x);(o-16,x)

1) [pdf]+ Jour: Physical Review, Part C, Nuclear Physics, Vol.80, p.054611 (2009) DOI: 10.1103/PhysRevC.80.054611 NSR: 2009GU30 [pdf]

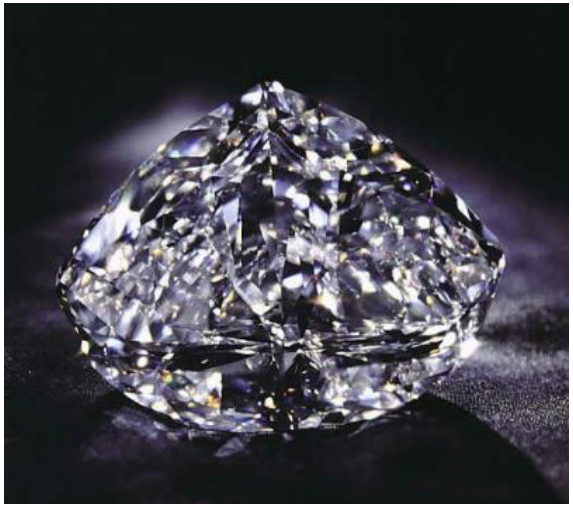
Nuclear level-density parameters of nuclei in the Z ≈ 70 and A ≈ 180 mid-shell regions

Y.K.Gupta, D.C.Biswas, B.John, B.K.Nayak, A.Saxena, R.K.Choudhury

Select Entries on the Page: [all] [none]

Go to EXFOR [Request] with selected Entries (0):

Moving from raw to shaped diamond



Blue Zoe