New features in X4Pro, X5.json and X4+

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News in X4Pro

X4Pro - universal, fully relational EXFOR database

by V.Zerkin, IAEA-NRDC, 2021-2025, version 2025-03-09

Part-5. Search for mistakes in EXFOR library using X4Pro (for NRDC-EXFOR compilers)

python Retrieve data from X4Pro and store them as plain text, CSV and JSON files

sqlite3 Simple command-line program (shell) for SQLite

SQL Structured Query Language used as instuctions for programs above.

1.	part5-0-sql **2024**	1) NRDC-2024/A47: Analyse the zero values coded under the headings PARITY, ERR-T and DATA-ERR. 2) Text plotting DATA from a Dataset	-NA-	Find non-physical values of parity (==0) and uncertainties (<=0)	program:[err-t.py] found:[csv] [json] program:[data-err.py] found:[csv] [json] program:[exec1sql.py] • inc.Energy<=0: [SQL] [CSV] [JSON] • Parity==0: [SQL] [CSV] [JSON] utility code:[sqlite3] script:[runme.sh] • inc.Energy<=0: [SQL] [-csv] [-box] • histogram: [SQL] result:[-header -box]	[howto]

Part-6. X4Pro for evaluators: ratios to cross sections + automatic renormalization + evaluators flags and scores

1.	part6-0-eval1flags **2025**	Summary of tables with evaluators' flags and scores	-NA-	Flags: accepted/rejected Scores:good/doubtful/outlier	Overview: [sql] [txt] Experts: [sql] [txt] IAEA-CRP review: [sql] [txt] Stastical test: [sql] [txt] ---Save eval-score tables to CSV/JSON: program:[exec2sql1.py] select:[sql] result:[csv],[json] select:[sql] result:[csv],[json]	[howto] EXFOR-online [evaluators_flags]
9.	part6-1-eval2sig **2025**	Retrieve CS, ratios, monitor data; convert ratios to cross sections, renormalize CS to new standards and new decay data. MyPlot: advanced interactive graphics.	SIG	(N,ABS),,ALF → SIG Ratio×std → SIG Zn-64(N,P):SIG → renorm.	Python:[code][x4evalscore][rx4dbr] • U235ng.html/pdf • Pu240nf.html/pdf • Al27na.html/pdf • Al27na2.html/pdf • zn64np.html/pdf MyPlot:[code], [endf2plot_js.py], [exfor2plot_js.py] • Pu240nf-myplot • Mn-55-myplot	CALC: ALF×SIG:(n,f) → SIG(n,g) CALC: (R1)/(R2)×std(R2) → SIG(R1) CALC: SIG/mon×std → SIG MyPlot: plotting stored JSON files with more interactions (JavaScript)

Part-5. Find mistakes in EXFOR library using X4Pro

/for NRDC-EXFOR compilers/

Tools:

python: retrieve data from X4Pro and store them as plain text, CSV and JSON files

sqlite3: simple command-line program (shell) for SQLite

SQL: structured Query Language used as instructions for programs above

1) NRDC-2024/A47: find/analyze zero values coded under the headings EN, PARITY, ERR-T and DATA-ERR
2) Advanced usage of sqlite3: text plotting DATA from a Dataset

Content

- program:[err-t.py] found:[csv] [json]
- program:[data-err.py] found:[csv] [json]
- program:[exec1sql.py]
  - inc.Energy<=0: [SQL] [CSV] [JSON]
  - Parity==0: [SQL] [CSV] [JSON]
- utility code:[sqlite3] script:[runme.sh]
  - inc.Energy<=0: [SQL] [-csv] [-box]
  - histogram: [SQL] result:[-header –box]

SQL

```
SELECT substr(DatasetID,1,5) as Entry
  ,DatasetID,idat
  ,CAST(json_extract(x4.xdat,'$.EN') AS FLOAT) as EN
  ,REACODE.FullCode
--  ,xdat
FROM x4pro_x4data as x4
inner join REACODE on REACODE.ReacodeID=x4.DatasetID
where json_extract(x4.xdat,'$.EN') is not null
 and json_extract(x4.xdat,'$.EN') <=0
```

JSON

```
{ "Entry": 14687,
  "DatasetID": 14687003,
  "idat": 0,
  "EN": -0.022,
  "fullCode": "48-CD-0(N,TOT),,SIG"
},
{ "Entry": 14688,
  "DatasetID": 14688002,
  "idat": 0,
  "EN": -0.11,
  "fullCode": "79-AU-197(N,TOT),,SIG"
},
```

Run sqlite3 on x4pro.db using only SQL /without any other programming/

Dataset	year	Author1	REACTION	EN	DATA	ERR-T	MF	MT	Pt.
22703002	1992	Y. Uwamino	13-AL-27(N,A)11-NA-24,,SIG	MEV	B	B	3	107	36

n	E	SIG	dSIG	SIG(E)
3	5.5	0.0006735	8.6e-05	#
4	6.5	0.01293	0.0017	####
5	7.5	0.03269	0.0042	###########
6	8.5	0.0606	0.0072	###################
7	9.5	0.08368	0.0089	############################
8	10.5	0.09789	0.0096	##################################
9	11.5	0.1089	0.0095	###################################
10	12.5	0.1192	0.0093	##
11	13.5	0.1166	0.0087	###
12	14.5	0.1066	0.0076	###################################
13	15.5	0.09402	0.0074	################################
14	16.5	0.07627	0.0068	#########################
15	17.5	0.06219	0.006	####################
16	18.5	0.04926	0.0051	################
17	19.5	0.03626	0.0042	###########
18	20.5	0.02808	0.0036	#########
19	21.5	0.02462	0.003	########
20	22.5	0.02488	0.0026	########
21	23.5	0.02461	0.0022	########
22	24.5	0.02145	0.0018	#######
23	25.5	0.01773	0.0015	######
24	26.5	0.01455	0.0012	#####
25	27.5	0.009771	0.001	###
26	28.5	0.005502	0.00081	##
27	29.5	0.003916	0.00063	#

Part-6. X4Pro with evaluators flags and scores

Summary

#	Date	Evaluator/Compiler	itype	Datasets	Rejected	Accepted
0	2020-06-15	Erwin Alhassan for protons on Co59 and Cd111 (2018)	quality	166	105	61
1	2021-02-22	Natalia Dzysiuk for neutron-induced activation XS for F4E (2018)	quality	1768	140	1628
2	2021-02-19	Natalia Dzysiuk for neutron-induced activation XS on Ni isotopes (2019)	quality	570	40	530
3	2021-02-23	Natalie Gaughan for proton induced reactions (2019)	quality	90	31	59
4	2021-02-19	Arjan Koning, statistical verification of EXFOR neutron-ind.react.XS(2020)	stat	19144	1074	18070
5	2014-07-03	A.Trkov 2012	expert_x4	21	21	0
6	2014-07-03	D.Smith and R.Capote 2010	expert_x4	42	42	0
7	2018-09-12	H.Sjoestrand 2018, Ni59(n,*)	expert_x4	3	3	0

itype= "expert_x4"

12	22335006	2011-01-31	REJECTED	A.Trkov 2012	expert_x4	#[20] Soewarsono 1992, Included by Zolotarev, # but it seems shifted (DATA REJECTED)
13	30264011	2008-12-03	REJECTED	A.Trkov 2012	expert_x4	#[29] Araminowicz, Normalisation included in IAEA general updates # Exclusion recommended by Zolotarev

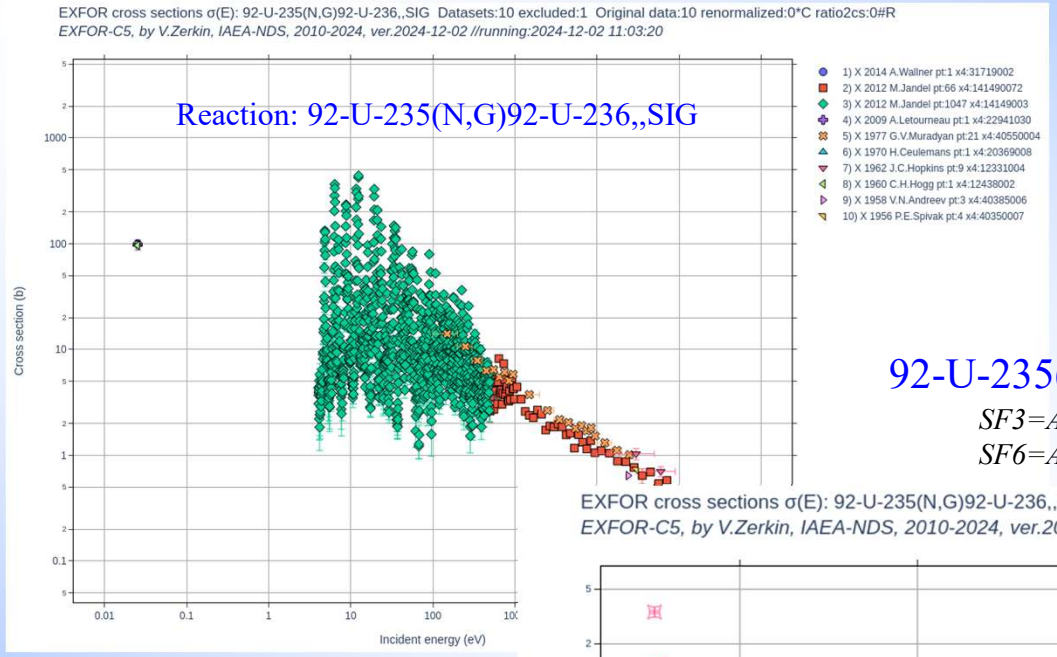
itype= "quality"

33	B00980121 2001-12-20	REJECTED	Erwin Alhassan	quality	Reasons for exclusion 1) Experiments are not consistent with other experiments such as Michel(1997) and Ditroi(2013) 2) This data set is not consistent with the trend of other evaluations (TENDL-2017 and JENDL/He-2007) 3) No experimental uncertainties in cross sections were reported 4) The data set are systematically higher than other experiments in the same energy range

itype="stat"

n	DatasetID	x4upd	accepted	evaluator	itype	comment2
1	10013010	2017-03-30	REJECTED	Arjan Koning	stat	#flag=T3 #[T]:Theoretical comparison #[3]:Clear outlier
7	10055002	2010-10-16	REJECTED	Arjan Koning	stat	#flag=N3 #[N]:No pdf file available #[3]:Clear outlier
18	10088018	1981-11-25	REJECTED	Arjan Koning	stat	#flag=R3 #[R]:Reviewed #[3]:Clear outlier
1075	10004002	1999-06-17	accepted	Arjan Koning	stat	#flag=N1 #[N]:No pdf file available #[1]:Good
1720	10405003	2003-02-07	accepted	Arjan Koning	stat	#flag=N2 #[N]:No pdf file available #[2]:Doubtful
2139	10634024	2003-06-02	accepted	Arjan Koning	stat	#flag=R1 #[R]:Reviewed #[1]:Good
2202	10693004	2012-02-22	accepted	Arjan Koning	stat	#flag=R2 #[R]:Reviewed #[2]:Doubtful
2223	10715002	2008-12-19	accepted	Arjan Koning	stat	#flag=T1 #[T]:Theoretical comparison #[1]:Good
2224	10716012	2009-07-09	accepted	Arjan Koning	stat	#flag=T2 #[T]:Theoretical comparison #[2]:Doubtful

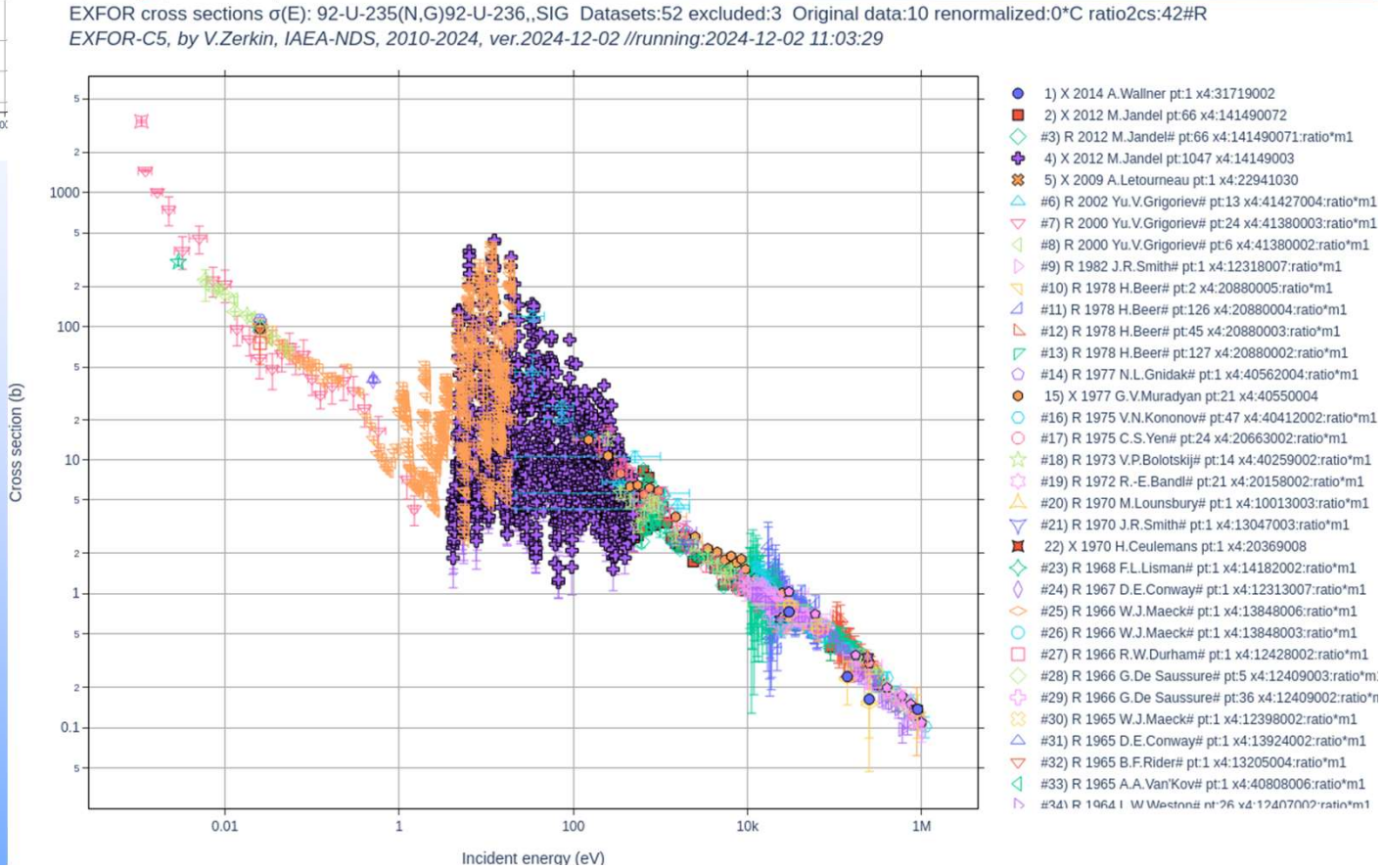
X4Pro. Part-6.1. Cross sections + ratios to cross sections



Original data: 10 datasets
Ratio2CS: 42 datasets

92-U-235(N,ABS),,ALF → 92-U-235(N,G)92-U-236,,SIG

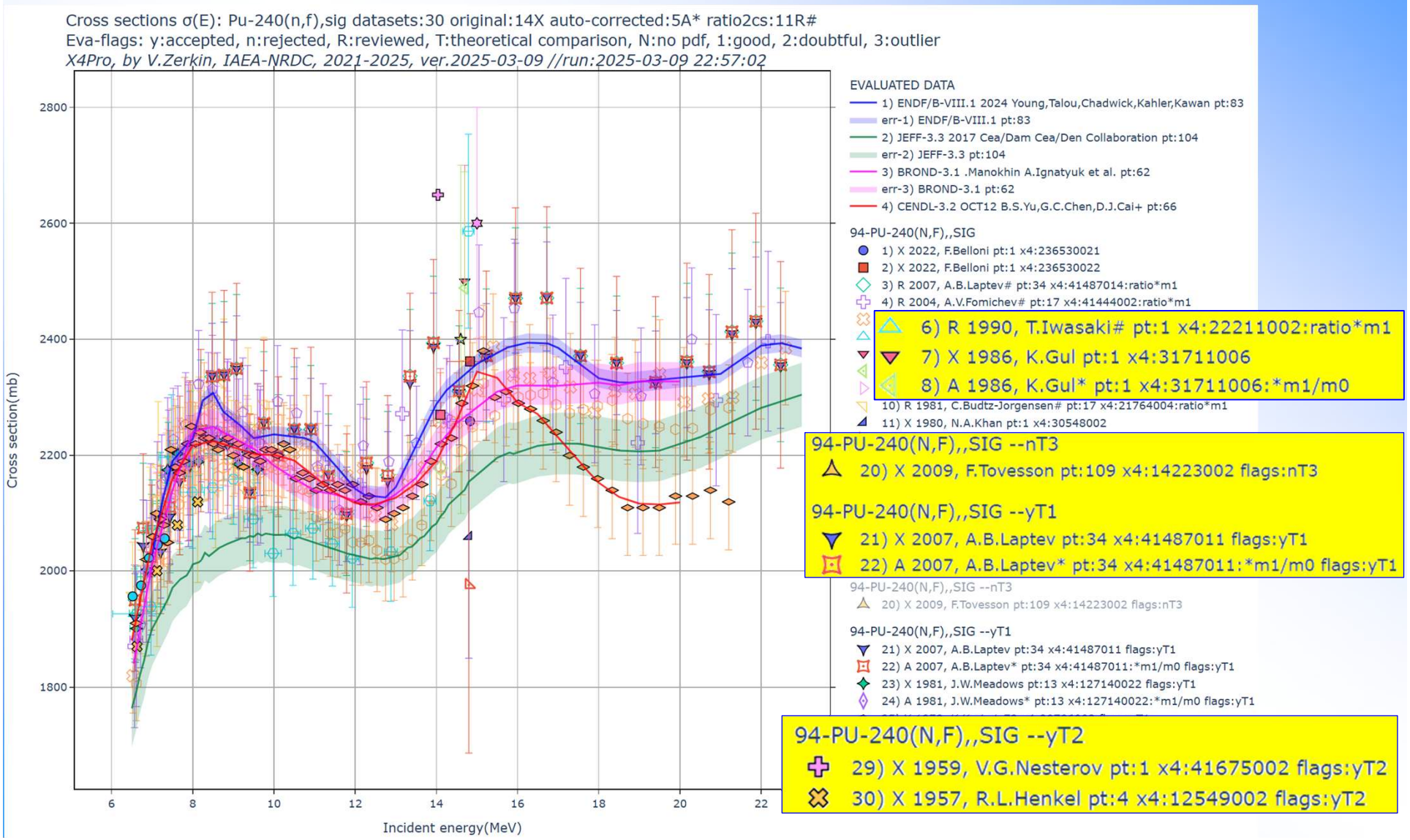
SF3=ABS *Absorption*
SF6=ALF *Alpha = capture/fission cross-section ratio*



X4Pro, x5, c5 were extended with data from reaction-denominator for reactions ratios

X4Pro. Part-6.1. Cross sections with automatic-correction, ratio-to-cs, evaluators-flags

Cross sections σ(E): Pu-240(n,f),sig datasets:30 original:14X auto-corrected:5A* ratio2cs:11R#
Eva-flags: y:accepted, n:rejected, R:reviewed, T:theoretical comparison, N:no pdf, 1:good, 2:doubtful, 3:outlier



X4Pro. Part-6.1. Advanced interactive plot

X4Pro - advanced plot
by V.Zerkin, 2025

Data
Reset Plot x4:B/W endf:error
1. ENDF: PU-240(N,F),SIG MF:3 MT:18
1. ENDF/B-VIII.1 2024 Young+ pt:83 E:7÷23
2. JEFF-3.3 2017 Cea/Dam Cea... pt:104 E:6.5÷23
3. BROND-3.1 .Manokhin A.Igna... pt:62 E:6.55÷20
4. CENDL-3.2 OCT12 B.S.Yu+ pt:66 E:6.5÷20
1) EXFOR: 94-PU-240(N,F),,SIG
1) 236530021 2022, F.Belloni pt:1 E:14.8
2) 236530022 2022, F.Belloni pt:1 E:14.8
3) 41487014 2007, A.B.Laptev# pt:34 E:[6.58,22.5]
4) 41444002 2004, A.V.Fomichev# pt:17 E:[6.57,22.2]
5) 13801003 1998, P.Staples# pt:43 E:[6.53,22.6]
6) 22211002 1990, T.Iwasaki# pt:1 E:6.57
7) 31711006 1986, K.Gul pt:1 E:14.7
8) 31711006 1986, K.Gul* pt:1 E:14.7
9) 127140021 1981, J.W.Meadows# pt:13 E:[6.61,9.6]
10) 21764004 1981, C.Budtz-Jorgensen# pt:17 E:[6.52,9.75]
11) 30548002 1980, N.A.Khan pt:1 E:14.8
12) 30548002 1980, N.A.Khan* pt:1 E:14.8
13) 40509002 1979, V.M.Kupriyanov# pt:5 E:[6.6,7.4]
14) 10597002 1978, J.W.Behrens# pt:25 E:[6.71,21.7]
15) 20786003 1978, K.Kari# pt:72 E:[6.61,21.2]
16) 20488002 1974, J.Frehaut# pt:14 E:[6.97,14.8]
17) 211950081 1967, P.H.White# pt:1 E:14.1
18) 40636005 1961, M.I.Kazarinova pt:1 E:14.6
19) 41675003 1959, V.G.Nesterov pt:1 E:15
2) EXFOR: 94-PU-240(N,F),,SIG --nT3
20) 14223002 2009, F.Tovesson pt:109 E:[6.57,22.8]
3) EXFOR: 94-PU-240(N,F),,SIG --yT1
21) 41487011 2007, A.B.Laptev pt:34 E:[6.58,22.5]
22) 41487011 2007, A.B.Laptev* pt:34 E:[6.58,22.5]
23) 127140022 1981, J.W.Meadows pt:13 E:[6.61,9.6]
24) 127140022 1981, J.W.Meadows* pt:13 E:[6.61,9.6]
25) 20786002 1978, K.Kari pt:72 E:[6.61,21.2]
26) 41656004 1973, B.I.Fursov pt:5 E:[6.52,7.31]
27) 211950082 1967, P.H.White pt:1 E:14.1
28) 211950082 1967, P.H.White* pt:1 E:14.1
4) EXFOR: 94-PU-240(N,F),,SIG --yT2
29) 41675002 1959, V.G.Nesterov pt:1 E:14
30) 12549002 1957, R.L.Henkel pt:4 E:[6.63,8.12]

My points
plot x y [dy [dx]] [example]

```
#My points test-1
#fx 1    !MeV
#fy 1    !mbarn
#comment: this is an example...
7.5    2336  192.   0.5
10     2588  134.   0.5
```

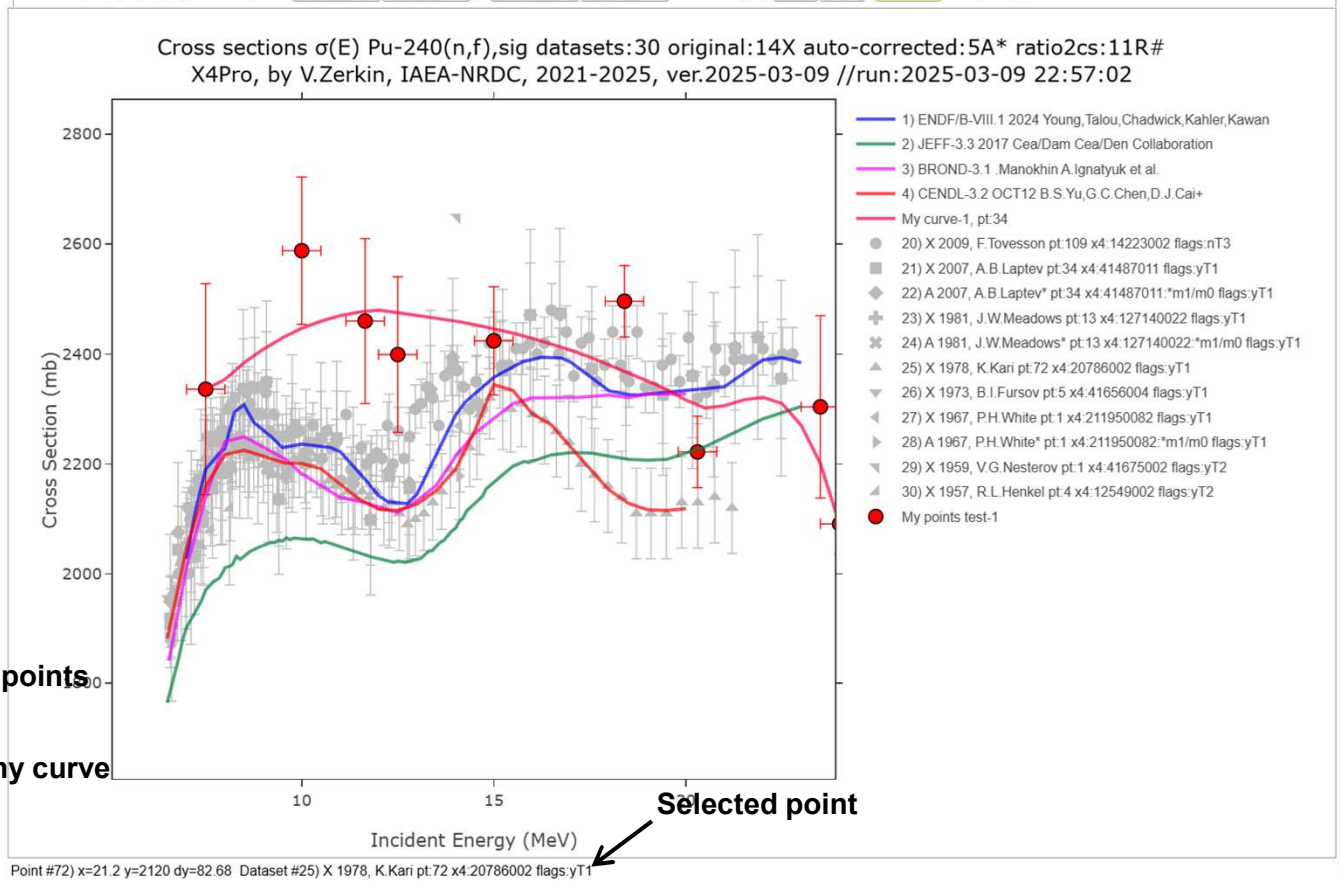
Add my points

My curve
plot x y [dy] [example]

```
#My curve-1
#fx 1    !MeV
#fy 1    !mbarn
#color 255,0,63 !R,G,B or #rgb or name
 7.5  2336    152
```

Add my curve

Plot
Axes: x:log y:log grid Ranges:x: 5.087049 23.88607 y: 1625.413 2861.82 Plot size(px): 1000 650 Repaint Legend:out



Selected point

Point #72) x=21.2 y=2120 dy=82.68 Dataset #25) X 1978, K.Kari pt:72 x4:20786002 flags:yT1

Plotted data

Plotted datasets:JSON

```
[
  {
    "LIBRARY": "EXFOR",
    "mode": "points",
    "DatasetID": "14223002",
    "Reacode": "94-PU-240(N,F),,SIG --nT3",
    "year": 2009,
```

Selected EXFOR datasets:

```
14223002;  #20) X 2009, F.Tovesson pt:109 x4:14223002 flags:nT3
41487011;  #21) X 2007, A.B.Laptev pt:34 x4:41487011 flags:yT1
41487011;  #22) A 2007, A.B.Laptev* pt:34 x4:41487011:*m1/m0 flags:yT1
127140022; #23) X 1981, J.W.Meadows pt:13 x4:127140022 flags:yT1
127140022; #24) A 1981, J.W.Meadows* pt:13 x4:127140022:*m1/m0 flags:y
20786002;  #25) X 1978, K.Kari pt:72 x4:20786002 flags:yT
41656004;  #26) X 1973, B.I.Fursov pt:5 x4:41656004 flags
```

Selected point

Automatic corrections

Evaluators flags

Working data

Selected point: 72) x=21.2 y=2120 dy=82.68 dx=0 //Dataset: 25) X 1978, K.Kari pt:72 x4:20786002 flags:yT1 Download:[20786002]

Dataset 41487011 94-PU-240(N,F),,SIG 2007, A.B.Laptev*

```
{
    "LIBRARY":"EXFOR"
   ,"mode":"points"
   ,"DatasetID":"41487011"
   ,"Reacode":"94-PU-240(N,F),,SIG --yT1"
   ,"year":2007
   ,"x4lbl":"2007, A.B.Laptev*"
```

Dataset-JSON

Comment:? [save]

My comments

Data: 41487011 points:34 columns:[x,y,dy,dx,Fc]

```
#22) A 2007, A.B.Laptev* pt:34 x4:41487011:*m1/m0 f
6.58   ,1949.83  ,122.053  ,0  ,1.01607
6.78   ,2074.95  ,127.863  ,0  ,1.01514
6.989  ,2023.59  ,125.    ,0  ,1.01129
7.208  ,2054.    ,127.724  ,0  ,1.01045
7.438  ,2111.    ,131.773  ,0  ,1.00814
7.679  ,2165.51  ,136.805  ,0  ,1.00487
```

Data points

EXFOR automatic corrections:41487011

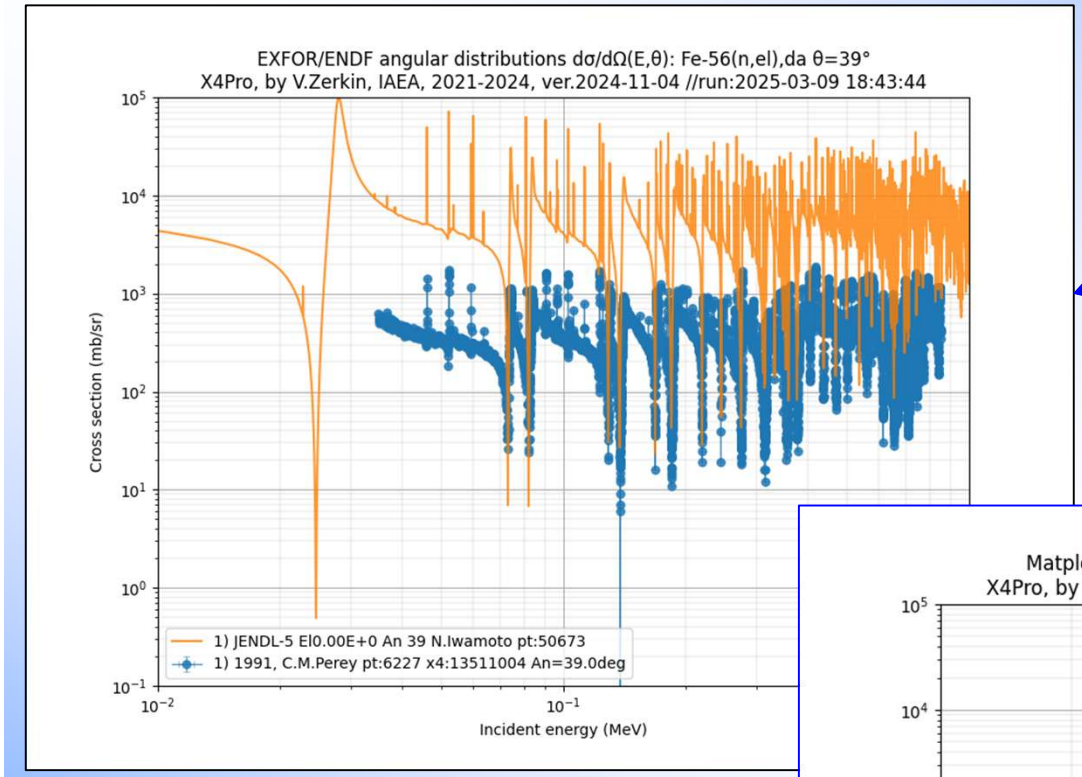
```
#[0]#---Monitor xs-data
#[0]#Reaction: 94-PU-240(N,F),,SIG
#[0]#Monitor:  92-U-235(N,F),,SIG
#m0: {,A.Carlson,C,2007NICE,,1233,2007}
m0: carlson08$u235nf;          #[0]#old r
m1: recom$u235nf;              #[0]#new r
dy=dy/y;                       #[0]#to re
```

EXFOR:41487011 Evaluator flags:[vT1]: scores:#1

```
    "myComment": "Arjan Koning, statistical
    "itype": "stat",
    "accepted": 1,
    "evalflag": "T1",
    "comment2": [
      "#flag=T1  #[T]:Theoretical comparison
    ]
```

X4Pro. Part2-3. Example from O.Cabellos

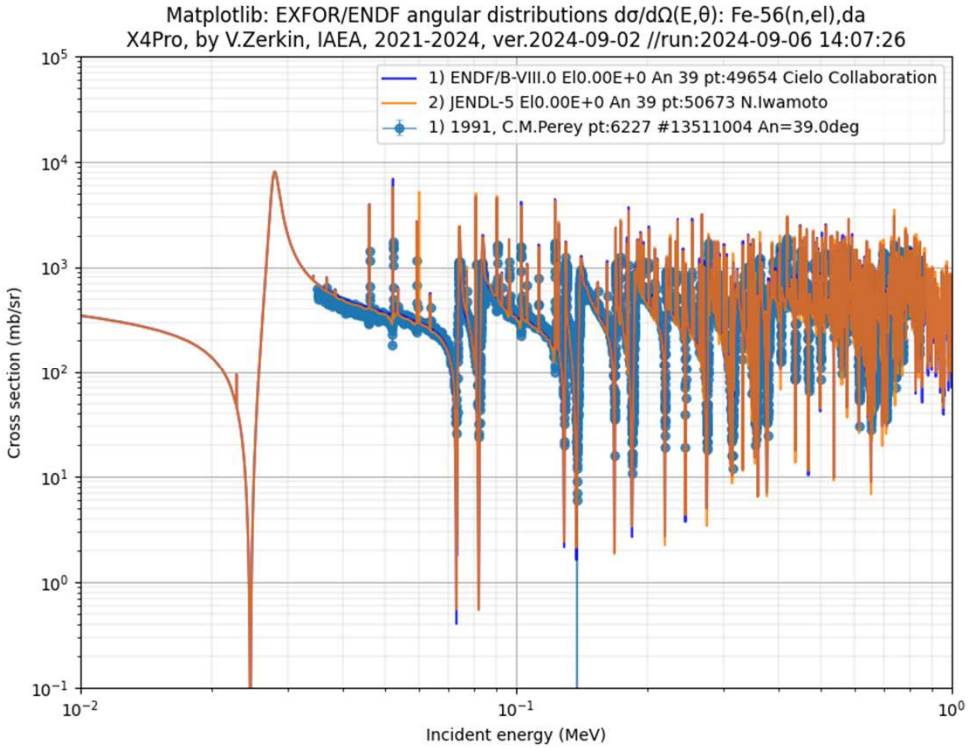
dσ/dΩ(E,θ): Fe-56(n,el),da



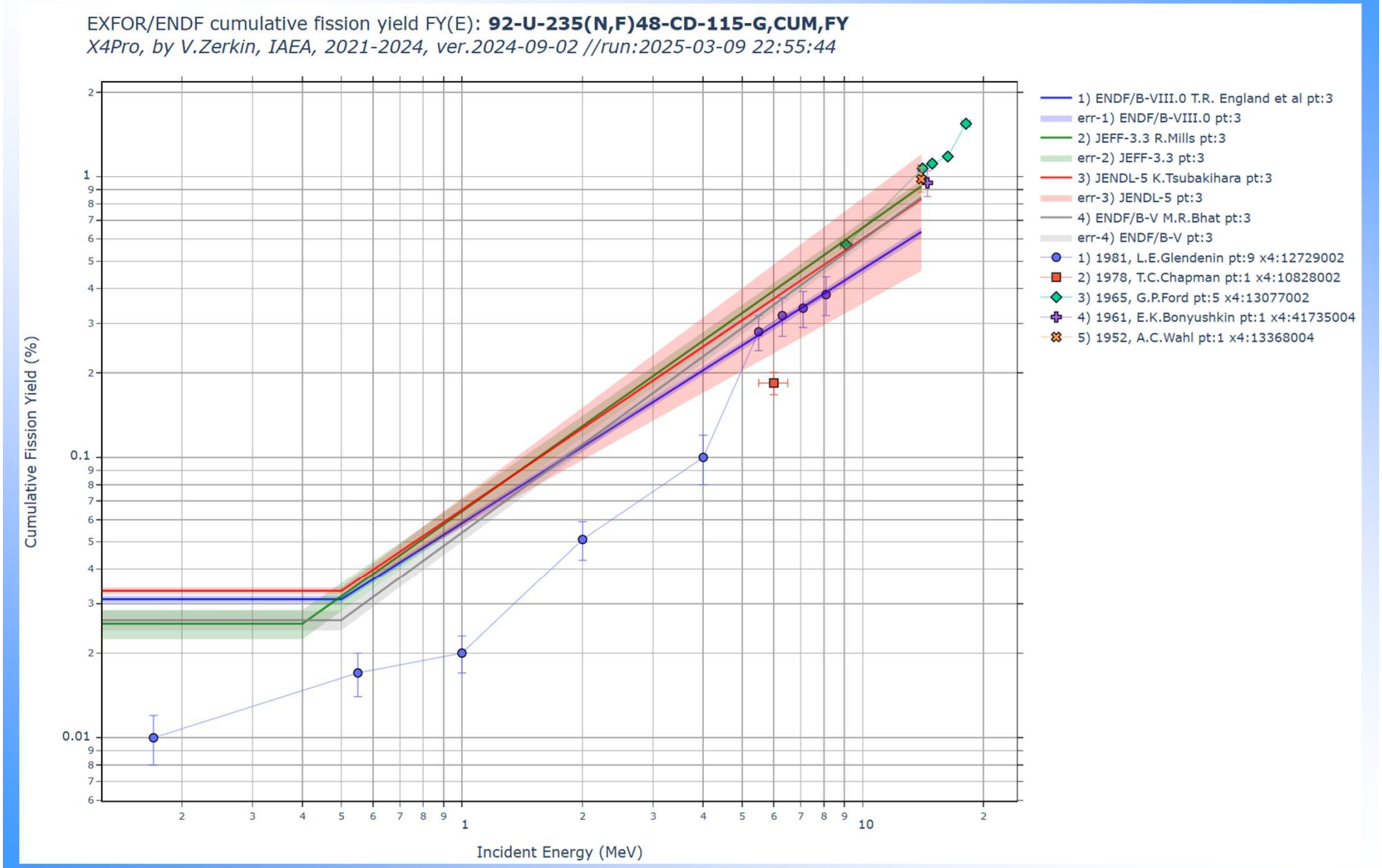
26-FE-56(N,EL)26-FE-56,,DA
EXFOR: 13511004 1991 C.M.Perey

From Oscar /2022-11-10/

Improved /2024-09-02/
(local Web-system)



X4Pro. Part2-7. Fission yield: energy distribution



News in EXFOR-Interpreted (X4+)

two updates sent to CNPD for EXFOR-Editor

1) REL-REF //new

Old

```
REL-REF     (I,,C.M.Logan+,J,JNM,108-109,29,1982)
INC-SOURCE  (D-T)
```

New

```
REL-REF     (I,,C.M.Logan+,J,JNM,108-109,29,1982)
            #(I,,C.M.Logan+,J,JNM,108-109,29,1982) Author:C.M.Logan+, Jour: Journal of Nuclear Materials, Vol.108-109, p.29 (1982), Netherlands
            #+      (I) Reference to experimental instruments
INC-SOURCE  (D-T)
```

2) MONIT-REF //new

Old

```
MONIT-REF   (10709002,D.R.Nethaway,J,JIN,40,1285,1978)
DECAY-DATA  All half-lives and branching ratios taken from
```

New

```
MONIT-REF   (10709002,D.R.Nethaway,J,JIN,40,1285,1978)
            #(10709002,D.R.Nethaway,J,JIN,40,1285,1978) EXFOR:10709002 Author:D.R.Nethaway, Jour: Journal of Inorganic and Nuclear Chemistry, Vol.40, p.128
DECAY-DATA  All half-lives and branching ratios taken from
```

3) DECAY-DATA with FLAG in the code //debug

```
DECAY-DATA  ((1.)35-BR-84-G,31.8MIN,DG,881.5,0.42)
            ((2.)36-KR-87,1.267HR,DG,402.47,0.473,
             DG,2554.92,0.0847)
              . . .
            ((29.)63-EU-156,15.19D,B)
            # Decay-data: [0--0]
```

Old

New

```
            ((29.)63-EU-156,15.19D,B)
            # Decay-data:[35-BR-84] (1.)35-BR-84-G,31.8MIN,DG,881.5,0.42
            # Decay-data:[36-KR-87] (2.)36-KR-87,1.267HR,DG,402.47,0.473,DG,2554.92,0.0847
            # Decay-data:[38-SR-89] (3.)38-SR-89,50.55D,B
```

4) New coding of STATUS //new

```
STATUS      (TABLE,,H.Sauvageon+,J,PR/C,24,2667,1981) Table I
            #(TABLE Data presented by authors
            #,H.Sauvageon+
            #,J
            #,PR/C
            #,24
            #,2667
            #,1981)
```

Old

New

```
STATUS      (TABLE,,H.Sauvageon+,J,PR/C,24,2667,1981) Table I
            #(TABLE,,H.Sauvageon+,J,PR/C,24,2667,1981) Jour: Physical Review, Part C, Nuclear Physics, Vol.24, p.2667 (1981), USA
            #+      #TABLE Data presented by authors
```

5) DATA in CSV

New: [copy] to Clipboard for Excel.

Concluding remarks

1. X4Pro can be used as local tool for specific tasks of NRDC compilers related to whole EXFOR, such as: search of rare mistakes in EXFOR library, using advanced SQL without programming, etc.

2. X4Pro was extended to include evaluators' flags with software support

3. Recent extension in both X4Pro and X5.json allows to calculate CS from ratios coded in EXFOR as reaction-ratios (R1)/(R2) and as (N,ABS),,ALF

4. X4+ extended by interpretation of keyword codes; two updates sent to CNPD for EXFOR-Editor

Thank you.