Experimental (EXFOR) and evaluated (ENDF) databases. Retrieving, plotting, processing of cross section and covariance data

Lecture II.

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Topics:

1. On-line re-calculations of cross sections: inverse reactions, inverse kinematics
2. EXFOR data correction (re-normalization) system
    1. Automatic re-normalization
    2. User's corrections, experts' corrections
3. Constructing a covariance matrix from EXFOR uncertainties
4. Uploading systems for nuclear data professionals
5. Uploading data for plotting
6. Uploading ENDF file for checking, plotting, processing
7. Uploading EXFOR file
8. Uploading your experimental data for various operations

On-line re-calculations of cross sections

Inverse reactions in EXFOR

View: extended → "Invert data" → Advanced plot via C5

Inverse reactions in EXFOR. Cont.

Output Data

Format	Data (Size)
EXFOR Interpreted	X4+ (74Kb) Generate: X4± XML:: v1: X4.xml X4.html v2: X4.xml X4.html
EXFOR Output	X4Out X4Out.xml X4Comp Test: C5 C5M:see:[doc]
EXFOR Original	EXFOR (122Kb) zip (20Kb)
Bibliography	html (9Kb) BibTeX (3Kb)
Computational	
C4	C4(C5) (170Kb) C4.ZIP (21Kb) C5 (175Kb) LST (3Kb) -

The cross sections of inverse reaction follow the principle of detailed balance:

$$\sigma_{B(b,a)A} = \sigma_{A(a,b)B} \frac{(2j_a+1)(2j_A+1)}{(2j_b+1)(2j_B+1)} \frac{p_a^2}{p_b^2}$$

where:

j : spin of a particle;

p : relative momentum in the center-of-mass system

$$Q = (m_a + m_A) - (m_b + m_B)$$

$$E_b = \left(E_a \frac{m_A}{m_a + m_A} + Q\right) / \left(\frac{m_B}{m_b + m_B}\right)$$

$$\Delta E_b = \Delta E_a \left(\frac{m_A}{m_a + m_A}\right) / \left(\frac{m_B}{m_b + m_B}\right)$$

$$\sigma_{B(b,a)A}(E_b) = \frac{(2j_a+1)(2j_A+1)}{(2j_b+1)(2j_B+1)} \frac{m_a m_A{}^2}{(m_a + m_A)^2} \frac{(m_b + m_B)^2}{m_b m_B{}^2} \frac{E_a}{E_b} \cdot \sigma_{A(a,b)B}(E_a)$$

$$\Delta\sigma_{B(b,a)A} = \sigma_{B(b,a)A} \left(\frac{\Delta\sigma_{A(a,b)B}}{\sigma_{A(a,b)B}}\right)$$

Advanced Plotting: LST (1Kb)

Select experimental data for plotting...

Go to		Quantity type	#Plots
σ (E)	SIG	Cross section data	1

Go to plot evaluated data...

ENDF Retrieve evaluated data and plot...

Advanced plot via C5

Limitations

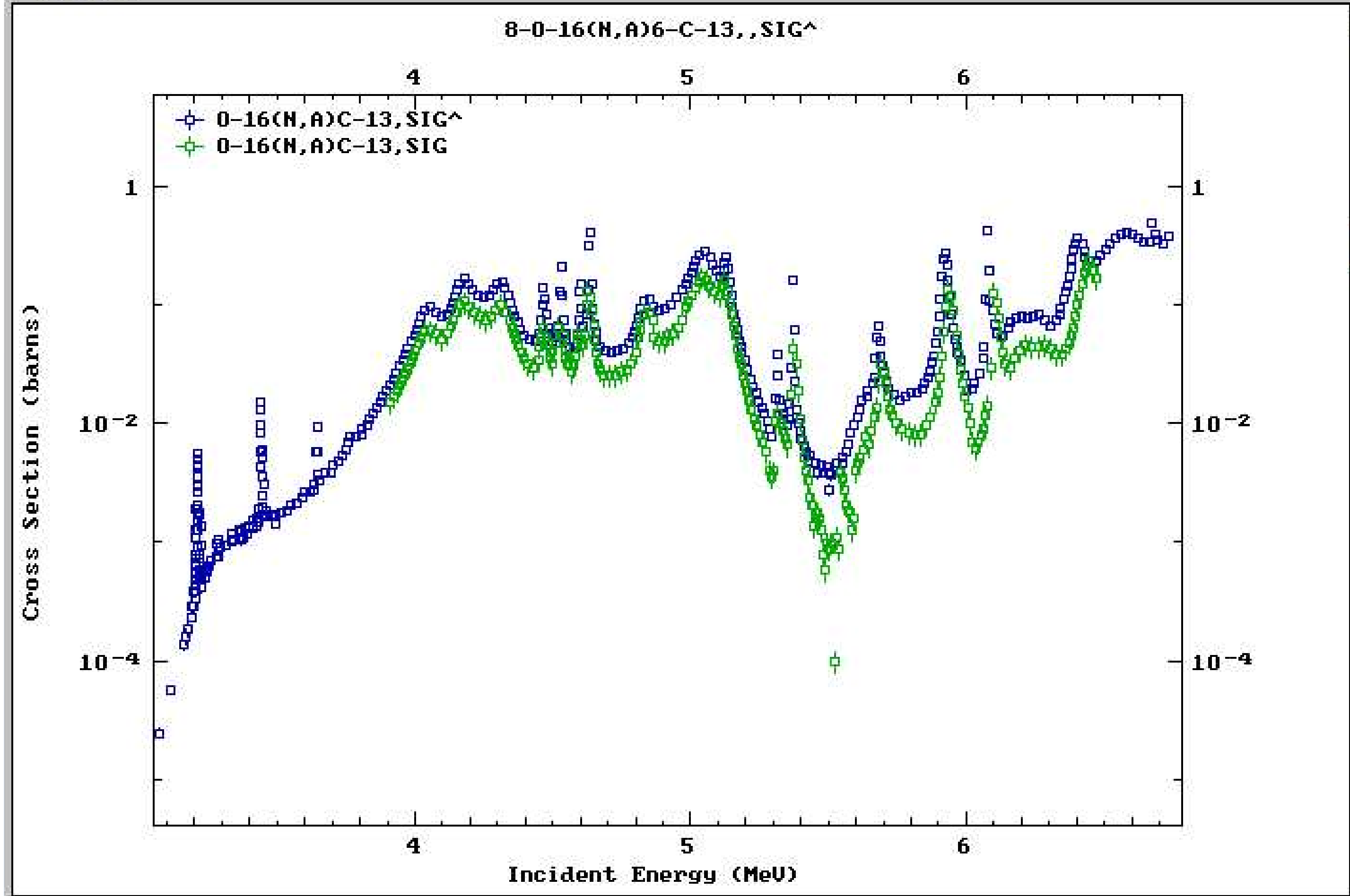
```
Convert EXFOR to C5 computational format
Program x4toc5 (version 2015-04-14)
V.Zerkin, IAEA, Vienna, 2010-2015
Running: 2015/04/17:17:03:48 on nds121.iaea.org
          -i: # inverse selected reactions
          -cm2lab  # Try to convert all C.M. to Lab.

===========================================================================
Translation Log
===========================================================================
DATASET   MF  MT    REFERENCE                 REACTION
===========================================================================
30092002  3   107  A.S.Divatia,ET.AL.    (66) 8-O-16(N,A)6-C-13,,SIG
A0613003  3   4    H.W.DROTLEFF,ET.AL.   (93) 6-C-13(A,N)8-O-16,,SIG
        CONVERT INC-ENERGY: C.M. TO LAB K=1.3078132
        DATA CONVERTED TO INVERSE REACTION MFMT=3:107 8-O-16(N,A)6-C-13,,SIG
                E1=(E0*0.76463526 + 2.2153838)/0.94067925 MeV
                SIG1=SIG0*E0/E1*8.457255
            Product:8-O-16        : Level1(MeV)=6.049
                Q(MeV)=2.2153838     Level1-Q=3.833616
                E0_threshold for Level1 (MeV)=5.0136533
                         E1(E0_threshold),MeV=6.4304595
            Product:6-C-13        : Level1(MeV)=3.089
                Q(MeV)=-2.2153838    Level1-Q=5.3043838
                E1_threshold for Level1 (MeV)=5.638887
            Reaction inversion is correct up to E1=5.638887
C0489002  3   4    J.K.Bair,ET.AL.       (73) 6-C-13(A,N)8-O-16,,SIG
        DATA CONVERTED TO INVERSE REACTION MFMT=3:107 8-O-16(N,A)6-C-13,,SIG
                E1=(E0*0.76463526 + 2.2153838)/0.94067925 MeV
                SIG1=SIG0*E0/E1*8.457255
            Product:8-O-16        : Level1(MeV)=6.049
                Q(MeV)=2.2153838     Level1-Q=3.833616
                E0_threshold for Level1 (MeV)=5.0136533
                         E1(E0_threshold),MeV=6.4304595
            Product:6-C-13        : Level1(MeV)=3.089
                Q(MeV)=-2.2153838    Level1-Q=5.3043838
                E1_threshold for Level1 (MeV)=5.638887
            Reaction inversion is correct up to E1=5.638887
===========================================================================
Translation Summary
===========================================================================
ENTRY                   3
SUBENT                  3
DATASETS                3
TRANSLATED DATASETS     3
TRANSLATED DATA POINTS  1316
===========================================================================
```

Inverse reactions in EXFOR. Cont.

^ flag : inverted (for reactions and authors)

EXFOR-Request #1342

Plot #1



Select data for plotting [all] [none]

1) O-16(N,A)C-13,SIG^

1993 H.W.DROTLEFF^, A0613003

1973 J.K.Bair^, C0489002

2) O-16(N,A)C-13,SIG

1966 A.S.Divatia, 30092002

3) Use my data [example]

See: plotted data (117Kb)

Log: XY X Y Lin: XY X Y Auto-range: XY X Y Page: >> << Zoom: <> >< Grid: VH 0 V H Pts: Txt Box PL Print

Reset Repaint Legend Authors Info+ PostScript Manual options:[+] Clipboard: Copy Paste

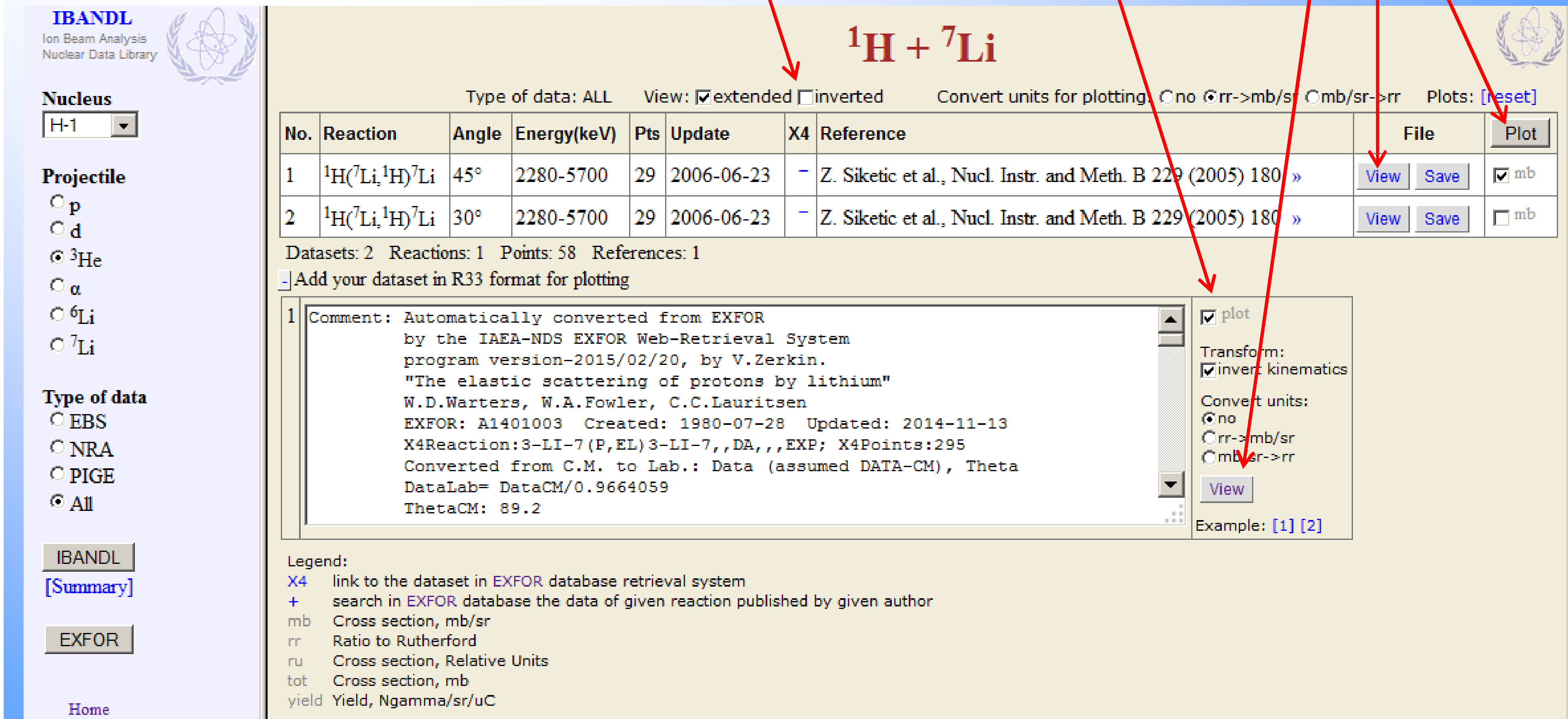
Shift legend:x=0 y=0 Split:0 1:xy;2:y Plot data or ratio:0 0:data; 1:ratio to dataset-1; 2:ratio to 2-nd, etc.

Data for plotting: ZVD (106Kb), send to ZVView; download ZVView; upload and plot your ZVD file

Inverse kinematics in IBANDL Web interface

Flag to transform data to invert kinematics

when presenting data



IBANDL contains angular distributions *dσ/dΩ(θ,E)* for incident charged particle reactions

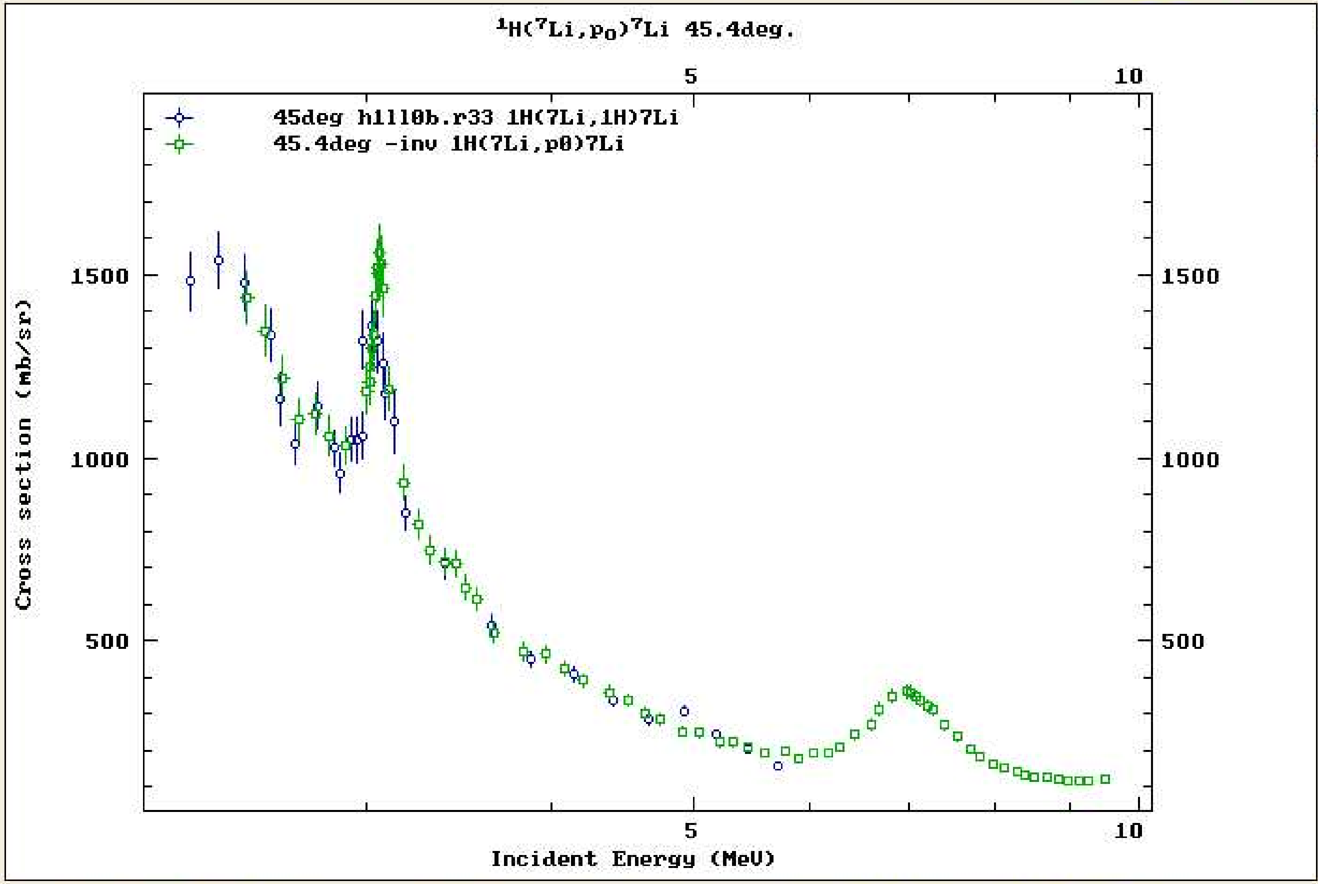
Inverse kinematics in IBANDL Web interface

Welcome to Web-ZVView!

Interactive plotting of IBANDL and SigmaCalc data

1) θ=45° E_1=2.3-5.7MeV Source: Z. Siketic et al., Nucl. Instr. and Meth. B 229 (2005) 180 +

2) θ=45.4° E_1=2.5-9.5MeV Source: W.D.Warters+(1953), Jour. Physical Review, Vol.91, Issue.4, p.917 [inv] Original: $^7Li(p,p_0)^7Li$ E_1=0.4-1.4MeV φ=45.4° θ=81.1° +



- Select data for plotting [all] [none]
- [x] 1) 45deg h1ll0b.r33 1H(7Li,1H)7Li
- [x] 2) 45.4deg -inv 1H(7Li,p0)7Li

+ [ ] 3) Use my data [example]

See: plotted data (6Kb)

Details of calculations

Log: XY | X | Y | Lin: XY | X | Y | Auto-range: XY | X | Y | Page: >> | << | Zoom: <> | >< | Grid: VH | 0 | V | H | Pts: Txt | Box | PL | Print

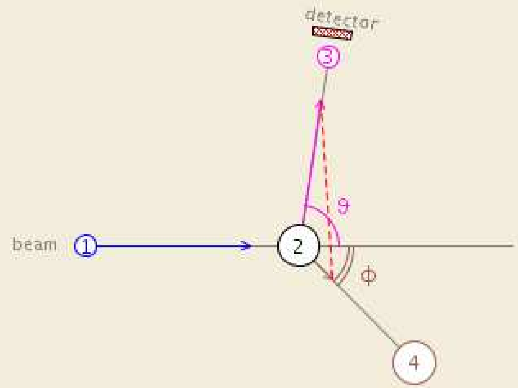
Reset | Repaint | [x] Legend | [ ] Authors | [ ] Info+ | PostScript | Manual options:[+] | Clipboard: Copy [ ] Paste

Shift legend:x= 0 y= 0 Split: 0 1:xy;2:y Plot data or ratio: 0 0:data; 1:ratio to dataset-1; 2:ratio to 2-nd, etc.

Data for plotting: ZVD (4Kb), send to ZVView; download ZVView; upload and plot your ZVD file

Inverse kinematics in IBANDL Web interface

Original (direct)



Original (direct)

Reaction: $^{7}Li(p,p_0)^{7}Li$ Qvalue=0 nPoint:71

M1: Incident p $M_1=1.007825$ $E_1=1367.0keV$

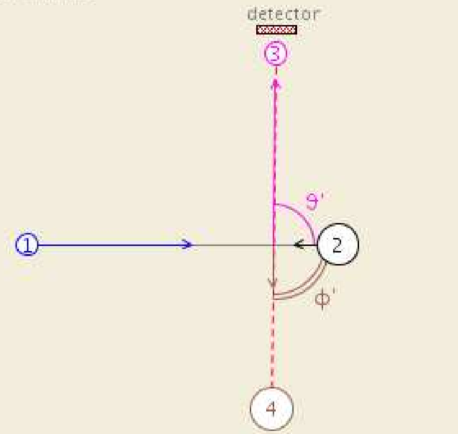
M2: Target 7Li $M_2=7.0160046$

M3: Scattered p $M_3=1.007825$ $E_3=1070.6keV$ $\theta=81.1°$ $\sigma(\theta)=45.1053mb/sr\pm5.0\%$

M4: Recoil 7Li $M_4=7.0160046$ $E_4=296.4keV$ $\varphi=45.4°$

C.M.

Center of mass



C.M.

Reaction: $^{7}Li(p,p_0)^{7}Li$ Qvalue=0 nPoint:71

$E'_{cm}=1195.3keV$

M1: Incident p $M_1=1.007825$ $E_1'=1045.2keV$

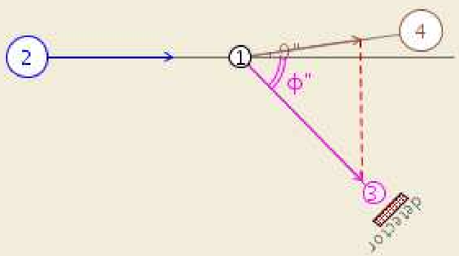
M2: Target 7Li $M_2=7.0160046$ $E_2'=150.1keV$

M3: Scattered p $M_3=1.007825$ $E_3'=1045.2keV$ $\theta'=89.3°$ $\sigma'(\theta')=43.5874mb/sr\pm5.0\%$

M4: Recoil 7Li $M_4=7.0160046$ $E_4'=150.1keV$ $\varphi'=90.7°$

Inverse

Inverse-kinematics



Inverse

Reaction: $^{7}Li(p,p_0)^{7}Li$ Qvalue=0 nPoint:71

M2: Incident 7Li $M_2=7.0160046$ $E_2''=9516.4keV$

M1: Target p $M_1=1.007825$

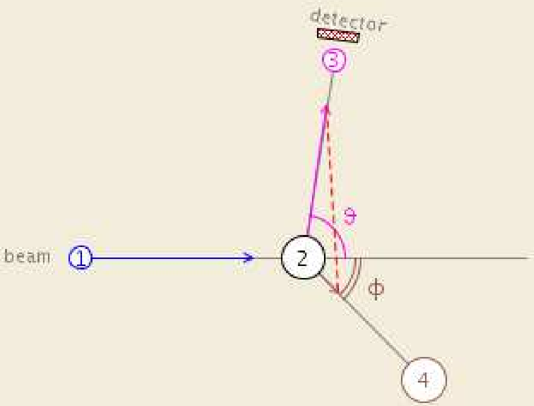
M3: Recoil p $M_3=1.007825$ $E_3''=2063.3keV$ $\varphi''=45.4°$ $\sigma''(\varphi'')=122.484mb/sr\pm5.0\%$

M4: Scattered 7Li $M_4=7.0160046$ $E_4''=7453.1keV$ $\theta''=8.2°$

Equivalent to elastic scattering of p on ^{7}Li measurements of recoil nucleus ^{7}Li

Inverse kinematics in IBANDL Web interface

Original (direct)



Original (direct)

Reaction: $^{7}Li(p,p_0)^{7}Li$ Qvalue=0 nPoint:71

M1: Incident p M_1=1.007825 E_1=1367.0keV

M2: Target 7Li M_2=7.0160046

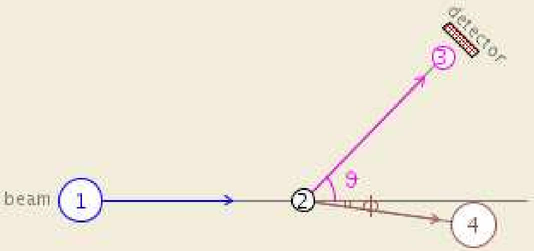
M3: Scattered p M_3=1.007825 E_3=1070.6keV θ=81.1° σ(θ)=45.1053mb/sr±5.0%

M4: Recoil 7Li M_4=7.0160046 E_4=296.4keV φ=45.4°

C.M.

Inverse

Result: inverse-kinematics data presented in R33 format



Result: inverse-kinematics data presented in R33 format

Reaction: $^{1}H(^{7}Li,p_0)^{7}Li$ Qvalue=0 nPoint:71

M1: Incident 7Li M_1=7.0160046 E_1=9516.4keV

M2: Target 1H M_2=1.007825

M3: Ejectile p M_3=1.007825 E_3=2061.1keV θ=45.4° σ(θ)=122.484mb/sr±5.0%

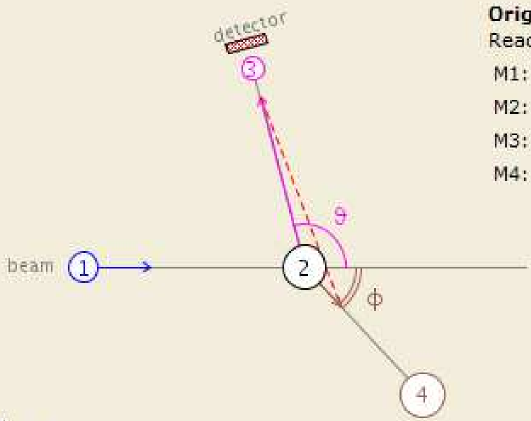
M4: Residual 7Li M_4=7.0160046 E_4=7455.3keV φ=8.2°

Calculations

	Original (lab.): $^{7}Li(p,p_0)^{7}Li$ Q=0							Center of mass								Inverse kinametics						
#	E_1, keV	θ°	σ(θ), mb/sr	φ	σ(φ)	E_3	E_4	E'_{cm}	θ'	φ'	σ'(θ')	E'_1	E'_2	E'_3	E'_4	E_2''	φ''	σ''(φ'')	θ''	σ''(θ'')	E_3''	E_4''
1	358.6	81.1	529.741	45.4	4.35366e6	280.851	77.7494	313.558	89.3	90.7	511.914	274.174	39.3842	274.174	39.3842	2496.4	45.4	1438.52	8.2	164261.	541.3	1955.2
2	368.3	81.1	497.427	45.4	4.08809e6	288.447	79.8525	322.04	89.3	90.7	480.687	281.591	40.4495	281.591	40.4495	2563.9	45.4	1350.77	8.2	154241.	555.9	2008
3	378.5	81.1	450.076	45.4	3.69894e6	296.436	82.064	330.959	89.3	90.7	434.93	289.389	41.5698	289.389	41.5698	2634.9	45.4	1222.18	8.2	139559.	571.3	2063.6
4	388.2	81.1	407.779	45.4	3.35132e6	304.033	84.1671	339.441	89.3	90.7	394.056	296.805	42.6351	296.805	42.6351	2702.5	45.4	1107.33	8.2	126444.	585.9	2116.5
5	398.4	81.1	413.26	45.4	3.39637e6	312.021	86.3786	348.359	89.3	90.7	399.353	304.604	43.7553	304.604	43.7553	2773.5	45.4	1122.21	8.2	128143.	601.3	2172.1
6	407.1	81.1	391.875	45.4	3.22062e6	318.835	88.2649	355.967	89.3	90.7	378.687	311.256	44.7108	311.256	44.7108	2834	45.4	1064.14	8.2	121512.	614.5	2219.6
7	417.8	81.1	382.085	45.4	3.14016e6	327.215	90.5848	365.323	89.3	90.7	369.227	319.437	45.886	319.437	45.886	2908.5	45.4	1037.55	8.2	118476.	630.6	2277.9
8	432.2	81.1	435.468	45.4	3.57888e6	338.493	93.7069	377.914	89.3	90.7	420.813	330.446	47.4675	330.446	47.4675	3008.8	45.4	1182.52	8.2	135029.	652.3	2356.4
9	433.7	81.1	445.21	45.4	3.65895e6	339.668	94.0321	379.226	89.3	90.7	430.227	331.593	47.6322	331.593	47.6322	3019.2	45.4	1208.97	8.2	138050.	654.6	2364.6
10	434.2	81.1	461.032	45.4	3.78898e6	340.059	94.1405	379.663	89.3	90.7	445.517	331.976	47.6872	331.976	47.6872	3022.7	45.4	1251.94	8.2	142956.	655.4	2367.3
11	435.1	81.1	480.354	45.4	3.94778e6	340.764	94.3357	380.45	89.3	90.7	464.189	332.664	47.786	332.664	47.786	3029	45.4	1304.4	8.2	148948.	656.7	2372.2
12	437	81.1	493.156	45.4	4.05299e6	342.252	94.7476	382.111	89.3	90.7	476.56	334.116	47.9947	334.116	47.9947	3042.2	45.4	1339.17	8.2	152917.	659.6	2382.6

1) θ=63.1° E_1=0.4-2.9MeV Source: A.J.Elwyn+(1977), Jour. Physical Review, Part C, Nuclear Physics, Vol.16, p.1744 [inv] Original: $^6Li(d,p_1)^7Li$ E_1=0.1-1MeV φ=61.3°-46.3° θ=105°

Original (direct)



Original (direct)

Reaction: $^6Li(d,p_1)^7Li$ Qvalue=4547.4keV nPoint:11

M1: Incident d M_1=2.0141017 E_1=975.0keV

M2: Target 6Li M_2=6.015123

M3: Ejectile p M_3=1.007825 E_3=4394.0keV θ=105.0° σ(θ)=2.65000

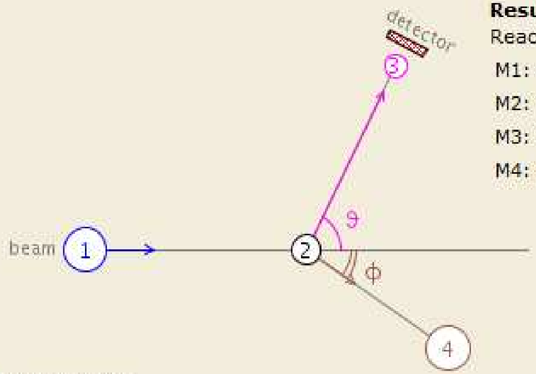
M4: Residual 7Li M_4=7.0160046 E_4=1128.4keV φ=46.3°

$^6Li(d,p_1)^7Li$

C.M.

Inverse

Result: inverse-kinematics data presented in R33 format



Result: inverse-kinematics data presented in R33 format

Reaction: $^2H(^6Li,p_1)^7Li$ Qvalue=4547.4keV nPoint:11

M1: Incident 6Li M_1=6.015123 E_1=2911.8keV

M2: Target 2H M_2=2.0141017

M3: Ejectile p M_3=1.007825 E_3=5446.3keV θ=63.1° σ(θ)=3.46672r

M4: Residual 7Li M_4=7.0160046 E_4=2013.0keV φ=33.8°

```
Comment:     Automatically converted from EXFOR
             by IAEA-NDS EXFOR Web-Retrieval System (v-2008/11/03)
             "Absolute cross sections for deuteron-induced reactions
              on 6Li at energies below 1 MeV."
             A.J.Elwyn, R.E.Holland, C.N.Davids, L.Meyer-Schuetzmeister,
             J.E.Monahan, F.P.Mooring, W.Ray Jr
             EXFOR: T0134004    Created: 2000-11-21  Updated: 2001-03-30
             X4Reaction:3-LI-6(D,P)3-LI-7,PAR,DA; X4Points:370
             LevelEnergy: 478.00
             Theta groupping interval=3.0 deg.

        ## Transformed to inverse kinematics: 2015-04-17,19:24:38
        ## Orig.File:        li6dp1$9.r33 (direct kinematics)
        ## Orig.Reaction:    6Li(d,p1)7Li
        ## Orig.Masses_amu: 2.0141017, 6.015123, 1.007825, 7.0160046
        ## Orig.Theta:       105.0
        ## Orig.En:          145.0 .. 975.0
        ## Orig.Phi:         61.3 .. 46.3
        ## Calculated: inverse kinematins
        ## Calc.Reaction:    2H(6Li,p1)7Li
        ## Calc.Theta:       67.8 .. 58.5 (Recoil)
        ## Program-version: 2015/03/17

Version:       R33
X4Number:      T0134004
Source:        A.J.Elwyn+(1977), Jour. Physical Review, Part C, Nuclear
Reaction:      2H(6Li,p1)7Li
Distribution: Energy
Sigfactors:    1.0, 0.0
Enfactors:     1.0, 0.0, 0.0, 0.0
Units:         mb
Composition:
Masses:        6.0, 2.0, 1.0, 7.0
Zeds:          3.0, 1.0, 1.0, 3.0
Qvalue:        4547.4, 0.00, 0.00, 0.00, 0.00
Theta:         63.1
Data:
     433.043     0.00000    0.0633396     0.00000
     543.544     0.00000    0.0995302     0.00000
     785.451     0.00000     0.351321     0.00000
     794.410     0.00000     0.362960     0.00000
     1093.06     0.00000     0.698637     0.00000
     1102.02     0.00000     0.710805     0.00000
     1702.31     0.00000      1.66925     0.00000
     2009.92     0.00000      2.11322     0.00000
     2308.57     0.00000      2.29090     0.00000
     2613.19     0.00000      2.17612     0.00000
     2911.84     0.00000      3.46672     0.00000
EndData:
```

Calculations

	Original (lab.): $^6Li(d,p_1)^7Li$ Q=4547.4keV							Center of mass								Inverse kinematics						
#	E_1, keV	θ°	σ(θ), mb/sr	φ	σ(φ)	E_3	E_4	E'_{cm}	θ'	φ'	σ'(θ')	E'_1	E'_2	E'_3	E'_4	E_2''	φ''	σ''(φ'')	θ''	σ''(θ'')	E_3''	E_4''
1	145	105	0.058	61.3	0.657303	3996.7	695.703	108.627	106.9	73.1	0.0590504	81.3785	27.2488	4071.21	584.816	433	67.8	0.0633396	67	0.0831837	4348.1	632.3
2	182	105	0.09	59.9	0.99946	4011.21	718.192	136.346	107.1	72.9	0.0918301	102.144	34.2019	4095.45	588.297	543.5	67	0.0995302	63.1	0.146473	4415.3	675.6
3	263	105	0.31	57.3	3.32075	4045.45	764.953	197.027	107.5	72.5	0.317601	147.604	49.4236	4148.51	595.919	785.5	65.5	0.351321	56.6	0.656984	4555	777.9
4	266	105	0.32	57.3	3.42385	4046.76	766.637	199.275	107.5	72.5	0.327892	149.287	49.9874	4150.47	596.201	794.4	65.5	0.36296	56.4	0.684576	4560	781.8
5	366	105	0.6	54.8	6.20191	4092.	821.397	274.19	107.9	72.1	0.617389	205.411	68.7796	4215.98	605.611	1093.1	64	0.698637	50.7	1.72735	4723.5	916.9
6	369	105	0.61	54.7	6.29947	4093.39	823.006	276.438	107.9	72.1	0.627752	207.094	69.3434	4217.94	605.893	1102	64	0.710805	50.5	1.77102	4728.3	921.1
7	570	105	1.37	51.1	13.434	4189.66	927.739	427.018	108.6	71.4	1.41956	319.902	107.116	4349.61	624.807	1702.3	61.7	1.66925	43	6.64402	5041.1	1208.6
8	673	105	1.7	49.6	16.3212	4240.65	979.746	504.18	108.8	71.2	1.76676	377.709	126.472	4417.08	634.499	2009.9	60.8	2.11322	40.3	10.3753	5196.4	1360.9
9	773	105	1.81	48.4	17.0642	4290.89	1029.51	579.096	109.1	70.9	1.88606	433.832	145.264	4482.59	643.908	2308.6	59.9	2.2909	38.1	13.5864	5345	1510.9
10	875	105	1.69	47.2	15.6695	4342.73	1079.67	655.509	109.3	70.7	1.76542	491.077	164.432	4549.4	653.506	2613.2	59.2	2.17612	36.2	15.4581	5494.9	1665.7
11	975	105	2.65	46.3	24.2084	4394.01	1128.39	730.425	109.5	70.5	2.77457	547.2	183.224	4614.91	662.916	2911.8	58.5	3.46672	34.7	29.1078	5640.4	1818.9

EXFOR data renormalization

EXFOR data correction system

(re-normalization system)

Main ideas:

1) to re-normalize data using old monitors and new standards
2) to re-normalize data using modern decay data
3) to create a convenient tool for data modifications: multiply data to a factor, correct wrong units, set up uncertainties, ignore part of a data set, recalculate data using isotope abundances, etc.

We DO NOT change EXFOR data - we re-normalize output from EXFOR system

Final goals:

1) to re-normalize data from EXFOR automatically (using EXFOR information)
2) to collect experts' corrections to a database
3) to preserve and possibly re-use evaluators knowledge
4) to develop Web system offering options to use automatic, experts' and user's corrections
5) to generate and distribute renormalized data of whole EXFOR database

Correction System: Concept

- **We <u>DO NOT</u> change EXFOR data.**

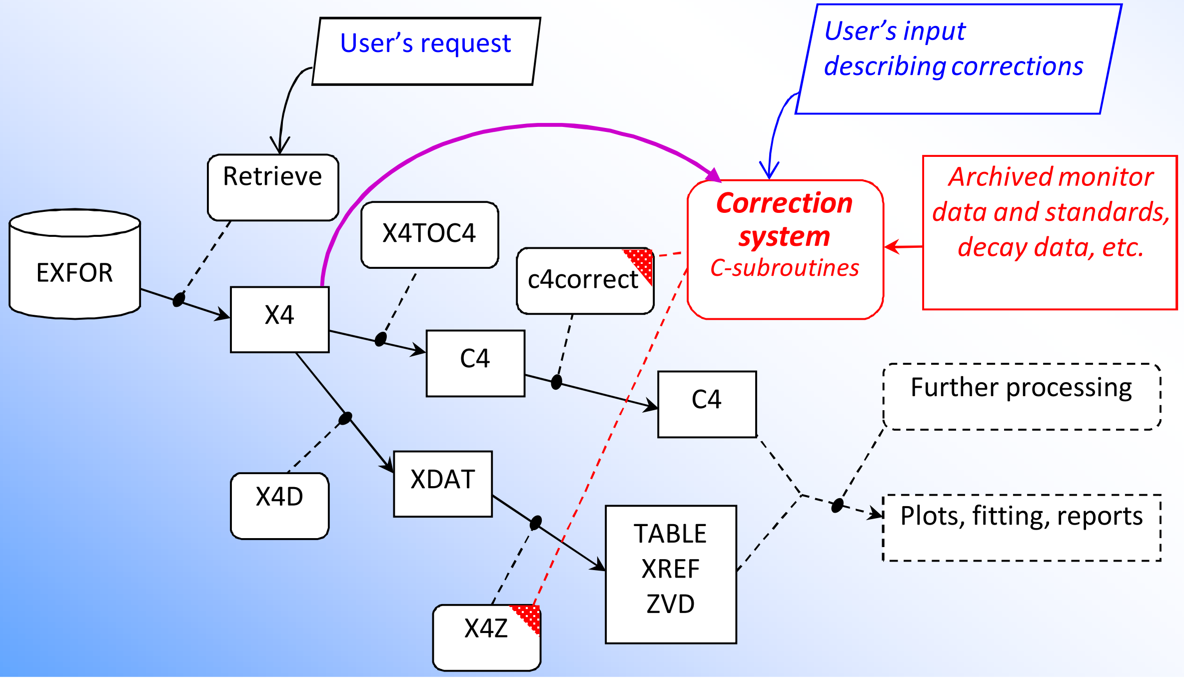
  We re-normalize output from EXFOR system, i.e. we modify data extracted from EXFOR:

  - computational format C4
  - TABLE, XREF (NNDC computational formats)
  - XDAT (intermediate format used for plotting)

  Results can be plotted as:

    - Quick plots
    - Advanced plots … + comparison to evaluated data (ENDF)

Software structure and data flow



“Manual” and “automatic” corrections

“Manual” corrections are based user’s knowledge and experience – therefore can include subjective judgment.

We are going to collect database of experts’ corrections.

“Automatic” corrections are based on the information given in EXFOR file: keywords MONITOR and MONIT-REF, monitor data in the DATA and COMMON sections.

This method is objective.

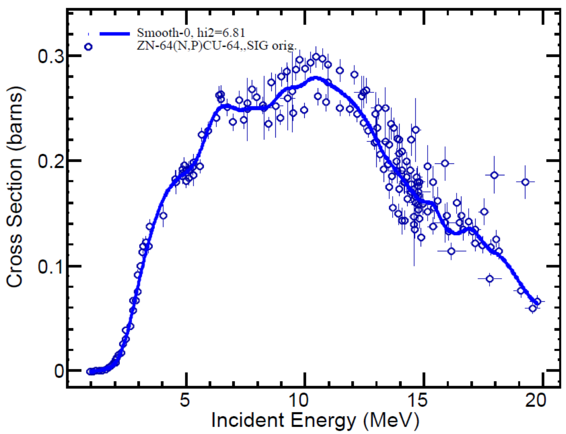
It needs “clever” EXFOR software.

Both methods need:

- archive of old monitors
- library of “recommended” monitors (standards)
- software, database, information, Web support
- participation of nuclear data experts

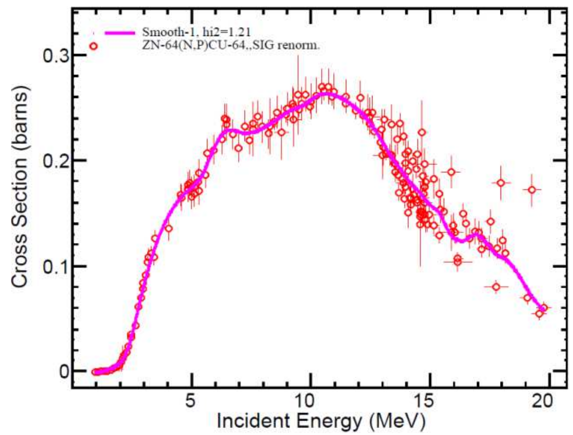
Example of “manual” corrections results

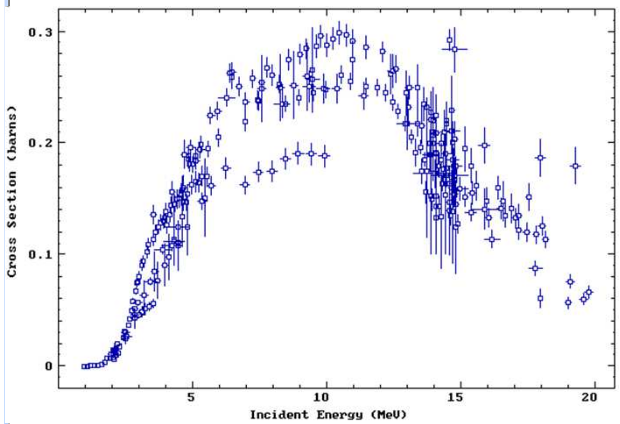
by K.Zolotarev, 2011

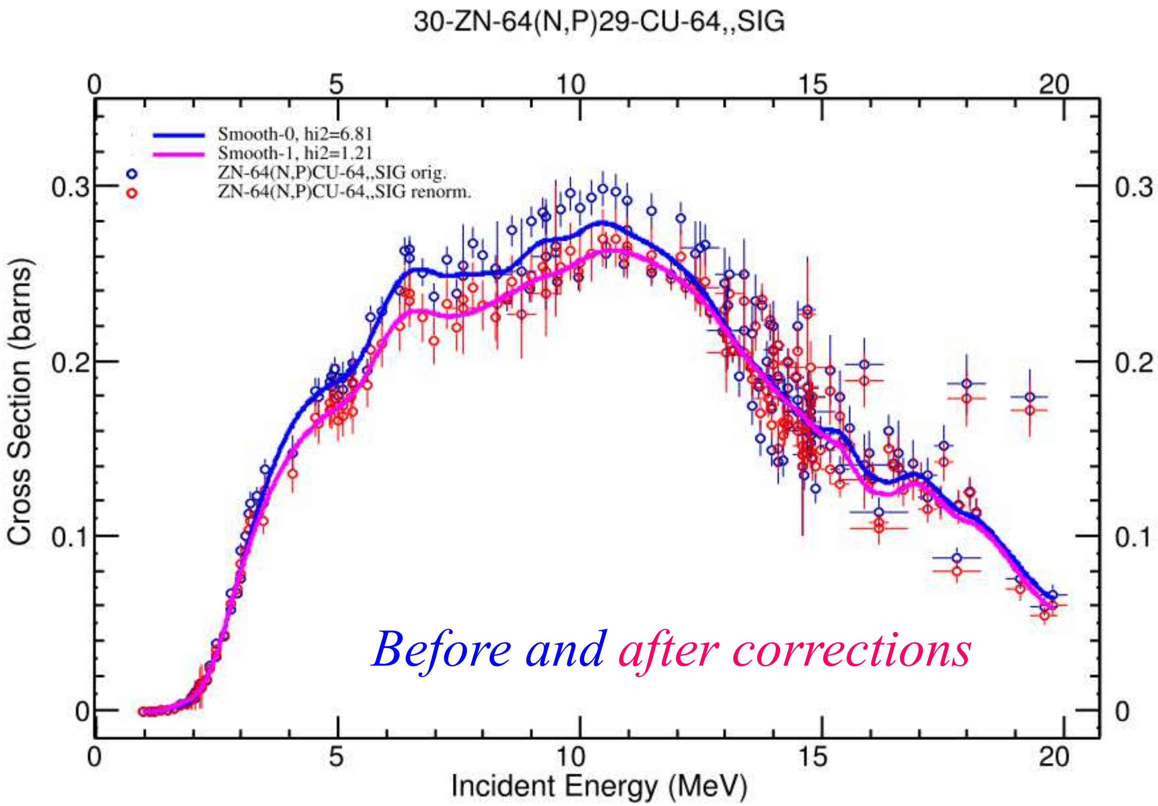


Data selected

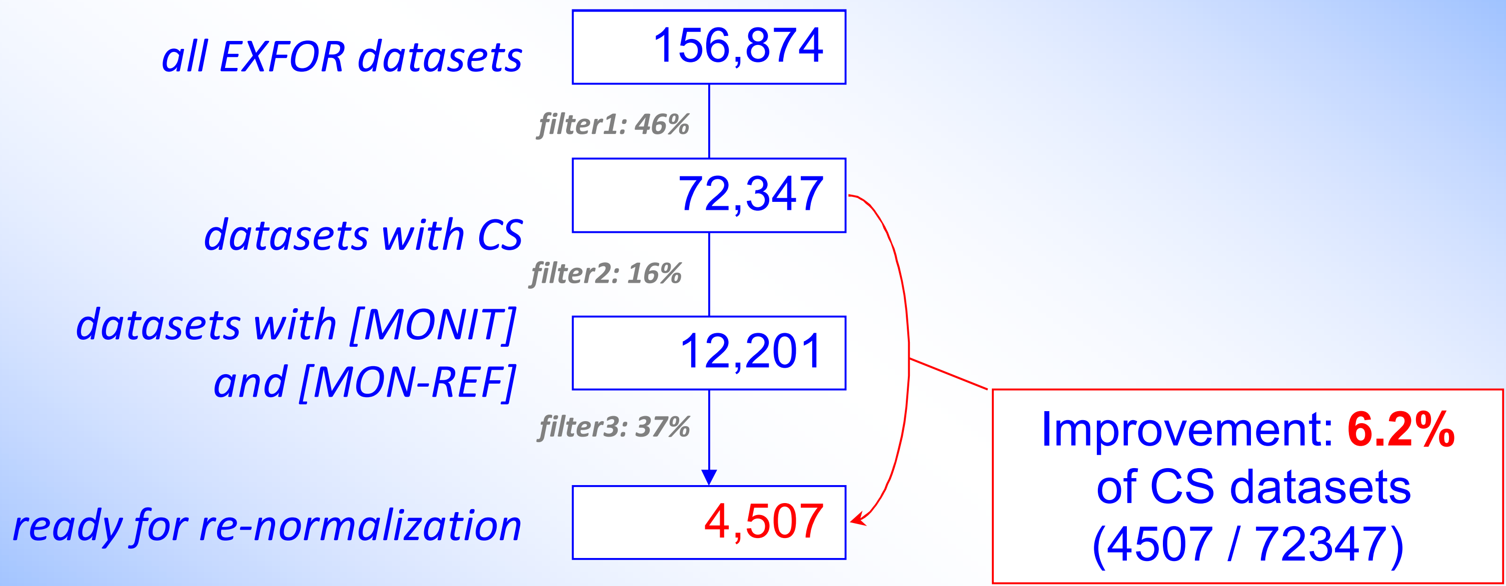
Data corrected →



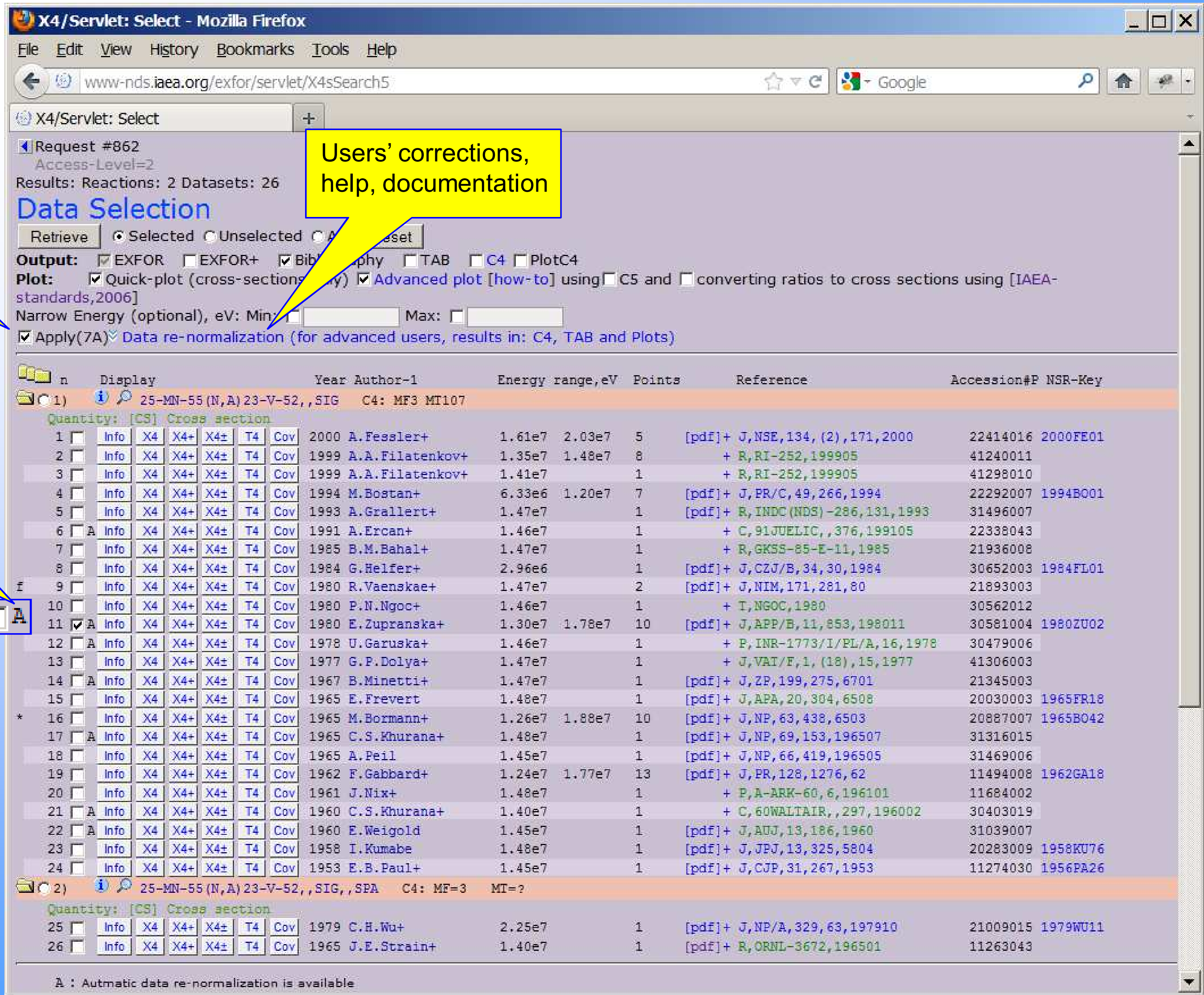




Available automatic EXFOR data correction /as of 2014/



Apply automatic data re-normalization



X4/Servlet: Select - Mozilla Firefox

File Edit View History Bookmarks Tools Help

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

X4/Servlet: Select

Request #862
Access-Level=2
Results: Reactions: 2 Datasets: 26

Data Selection

Retrieve ◉ Selected ○ Unselected ○ A... ...set

Output: ☑ EXFOR ☐ EXFOR+ ☑ Bib...phy ☐ TAB ☐ C4 ☐ PlotC4

Plot: ☑ Quick-plot (cross-sections ...y) ☑ Advanced plot [how-to] using ☐ C5 and ☐ converting ratios to cross sections using [IAEA-standards,2006]

Narrow Energy (optional), eV: Min: ☐ Max: ☐

☑ Apply(7A) Data re-normalization (for advanced users, results in: C4, TAB and Plots)

1) 25-MN-55(N,A)23-V-52,,SIG C4: MF3 MT107

Quantity: [CS] Cross section

	n		Display	Year	Author-1	Energy range,eV		Points	Reference	Accession#P	NSR-Key
	1		Info X4 X4+ X4± T4 Cov	2000	A.Fessler+	1.61e7	2.03e7	5	[pdf]+ J,NSE,134,(2),171,2000	22414016	2000FE01
	2		Info X4 X4+ X4± T4 Cov	1999	A.A.Filatenkov+	1.35e7	1.48e7	8	+ R,RI-252,199905	41240011	
	3		Info X4 X4+ X4± T4 Cov	1999	A.A.Filatenkov+	1.41e7		1	+ R,RI-252,199905	41298010	
	4		Info X4 X4+ X4± T4 Cov	1994	M.Bostan+	6.33e6	1.20e7	7	[pdf]+ J,PR/C,49,266,1994	22292007	1994BO01
	5		Info X4 X4+ X4± T4 Cov	1993	A.Grallert+	1.47e7		1	[pdf]+ R,INDC(NDS)-286,131,1993	31496007	
	6	A	Info X4 X4+ X4± T4 Cov	1991	A.Ercan+	1.46e7		1	+ C,91JUELIC,,376,199105	22338043	
	7		Info X4 X4+ X4± T4 Cov	1985	B.M.Bahal+	1.47e7		1	+ R,GKSS-85-E-11,1985	21936008	
	8		Info X4 X4+ X4± T4 Cov	1984	G.Helfer+	2.96e6		1	[pdf]+ J,CZJ/B,34,30,1984	30652003	1984FL01
f	9		Info X4 X4+ X4± T4 Cov	1980	R.Vaenskae+	1.47e7		2	[pdf]+ J,NIM,171,281,80	21893003	
	10		Info X4 X4+ X4± T4 Cov	1980	P.N.Ngoc+	1.46e7		1	+ T,NGOC,1980	30562012	
	11	☑ A	Info X4 X4+ X4± T4 Cov	1980	E.Zupranska+	1.30e7	1.78e7	10	[pdf]+ J,APP/B,11,853,198011	30581004	1980ZU02
	12	A	Info X4 X4+ X4± T4 Cov	1978	U.Garuska+	1.46e7		1	+ P,INR-1773/I/PL/A,16,1978	30479006	
	13		Info X4 X4+ X4± T4 Cov	1977	G.P.Dolya+	1.47e7		1	+ J,VAT/F,1,(18),15,1977	41306003	
	14	A	Info X4 X4+ X4± T4 Cov	1967	B.Minetti+	1.47e7		1	[pdf]+ J,ZP,199,275,6701	21345003	
	15		Info X4 X4+ X4± T4 Cov	1965	E.Frevert	1.48e7		1	[pdf]+ J,APA,20,304,6508	20030003	1965FR18
*	16		Info X4 X4+ X4± T4 Cov	1965	M.Bormann+	1.26e7	1.88e7	10	[pdf]+ J,NP,63,438,6503	20887007	1965BO42
	17	A	Info X4 X4+ X4± T4 Cov	1965	C.S.Khurana+	1.48e7		1	[pdf]+ J,NP,69,153,196507	31316015	
	18		Info X4 X4+ X4± T4 Cov	1965	A.Peil	1.45e7		1	[pdf]+ J,NP,66,419,196505	31469006	
	19		Info X4 X4+ X4± T4 Cov	1962	F.Gabbard+	1.24e7	1.77e7	13	[pdf]+ J,PR,128,1276,62	11494008	1962GA18
	20		Info X4 X4+ X4± T4 Cov	1961	J.Nix+	1.48e7		1	+ P,A-ARK-60,6,196101	11684002	
	21	A	Info X4 X4+ X4± T4 Cov	1960	C.S.Khurana+	1.40e7		1	+ C,60WALTAIR,,297,196002	30403019	
	22	A	Info X4 X4+ X4± T4 Cov	1960	E.Weigold	1.45e7		1	[pdf]+ J,AUJ,13,186,1960	31039007	
	23		Info X4 X4+ X4± T4 Cov	1958	I.Kumabe	1.48e7		1	[pdf]+ J,JPJ,13,325,5804	20283009	1958KU76
	24		Info X4 X4+ X4± T4 Cov	1953	E.B.Paul+	1.45e7		1	[pdf]+ J,CJP,31,267,1953	11274030	1956PA26

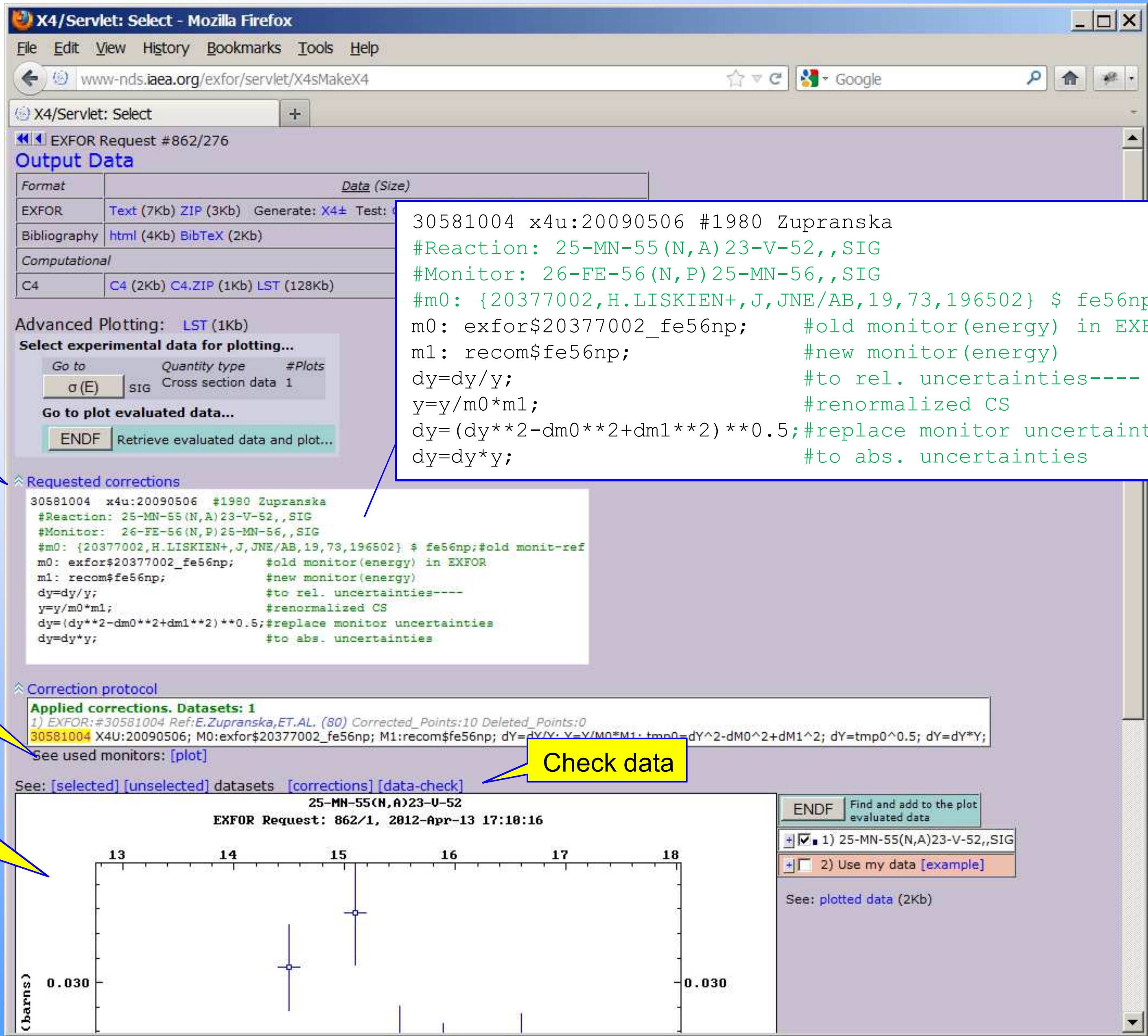
2) 25-MN-55(N,A)23-V-52,,SIG,,SPA C4: MF=3 MT=?

Quantity: [CS] Cross section

	n		Display	Year	Author-1	Energy range,eV		Points	Reference	Accession#P	NSR-Key
	25		Info X4 X4+ X4± T4 Cov	1979	C.H.Wu+	2.25e7		1	[pdf]+ J,NP/A,329,63,197910	21009015	1979WU11
	26		Info X4 X4+ X4± T4 Cov	1965	J.E.Strain+	1.40e7		1	[pdf]+ R,ORNL-3672,196501	11263043	

A : Autmatic data re-normalization is available

Automatic data re-normalization: simple plot




```
30581004 x4u:20090506 #1980 Zupranska
#Reaction: 25-MN-55(N,A)23-V-52,,SIG
#Monitor: 26-FE-56(N,P)25-MN-56,,SIG
#m0: {20377002,H.LISKIEN+,J,JNE/AB,19,73,196502} $ fe56np;#old monit-ref
m0: exfor$20377002_fe56np;     #old monitor(energy) in EXFOR
m1: recom$fe56np;              #new monitor(energy)
dy=dy/y;                       #to rel. uncertainties----
y=y/m0*m1;                     #renormalized CS
dy=(dy**2-dm0**2+dm1**2)**0.5;#replace monitor uncertainties
dy=dy*y;                       #to abs. uncertainties
```

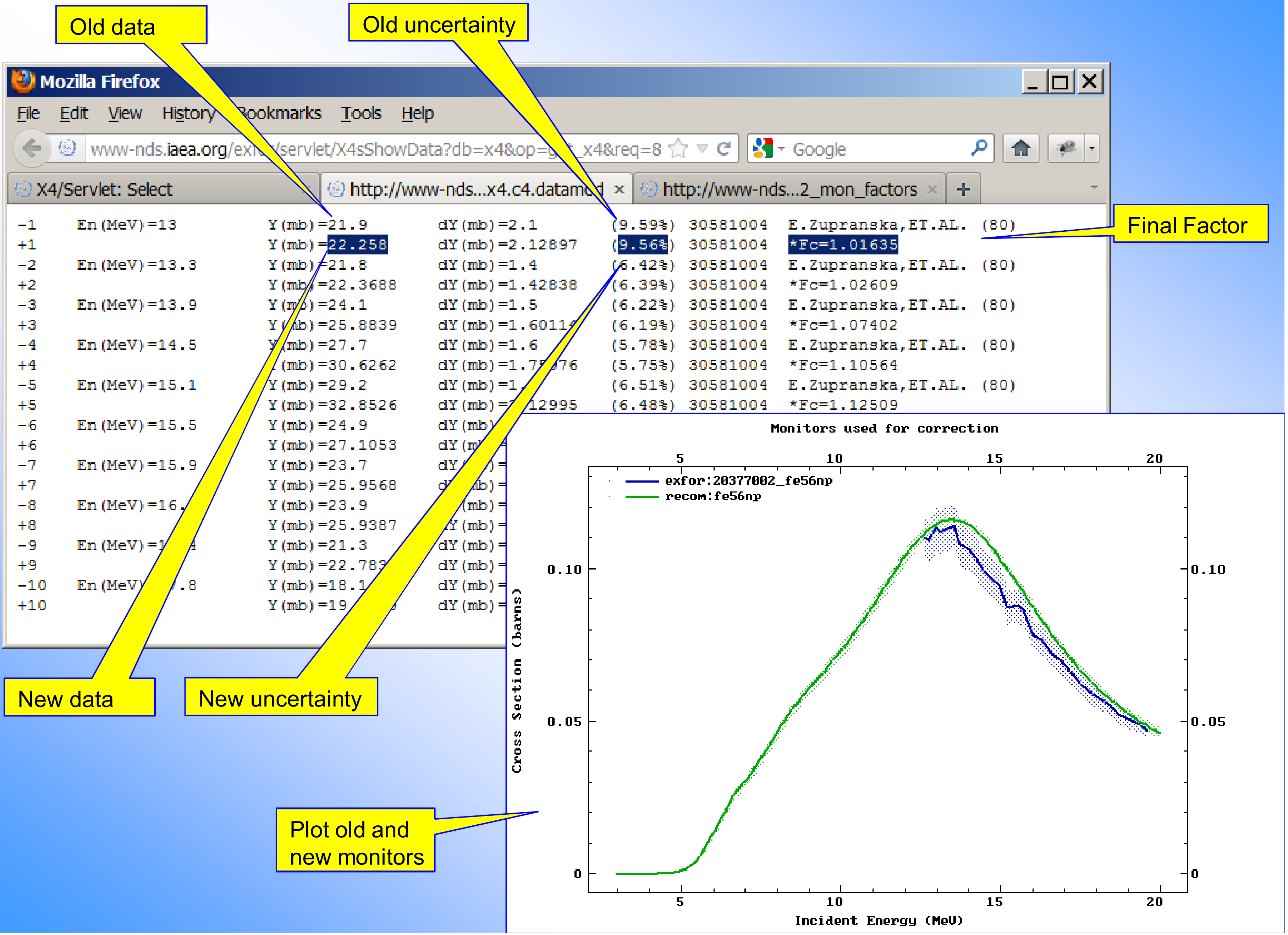
Applied corrections

Check Monitors

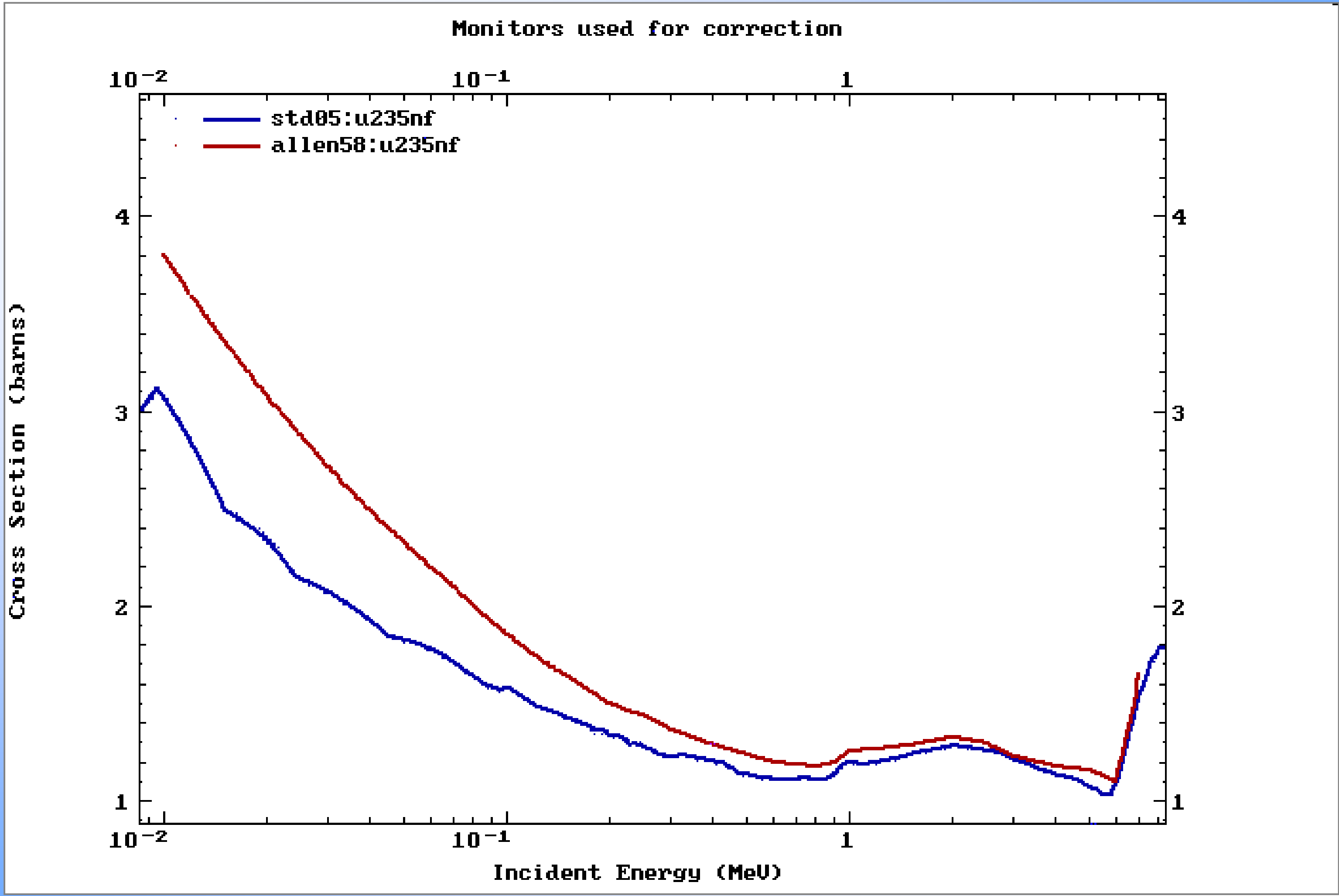
Check data

Plot result of corrections

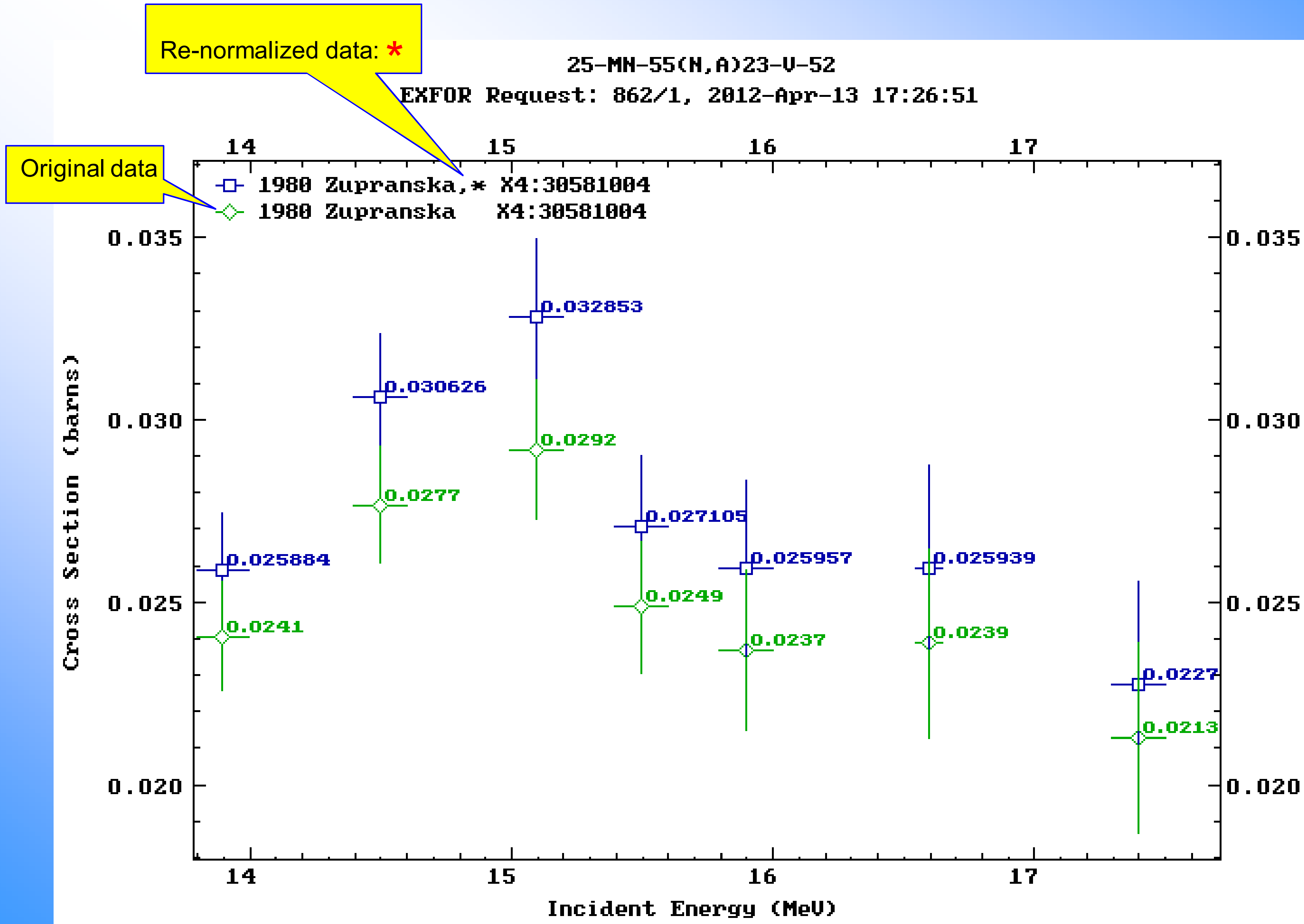
Automatic data re-normalization: data checking



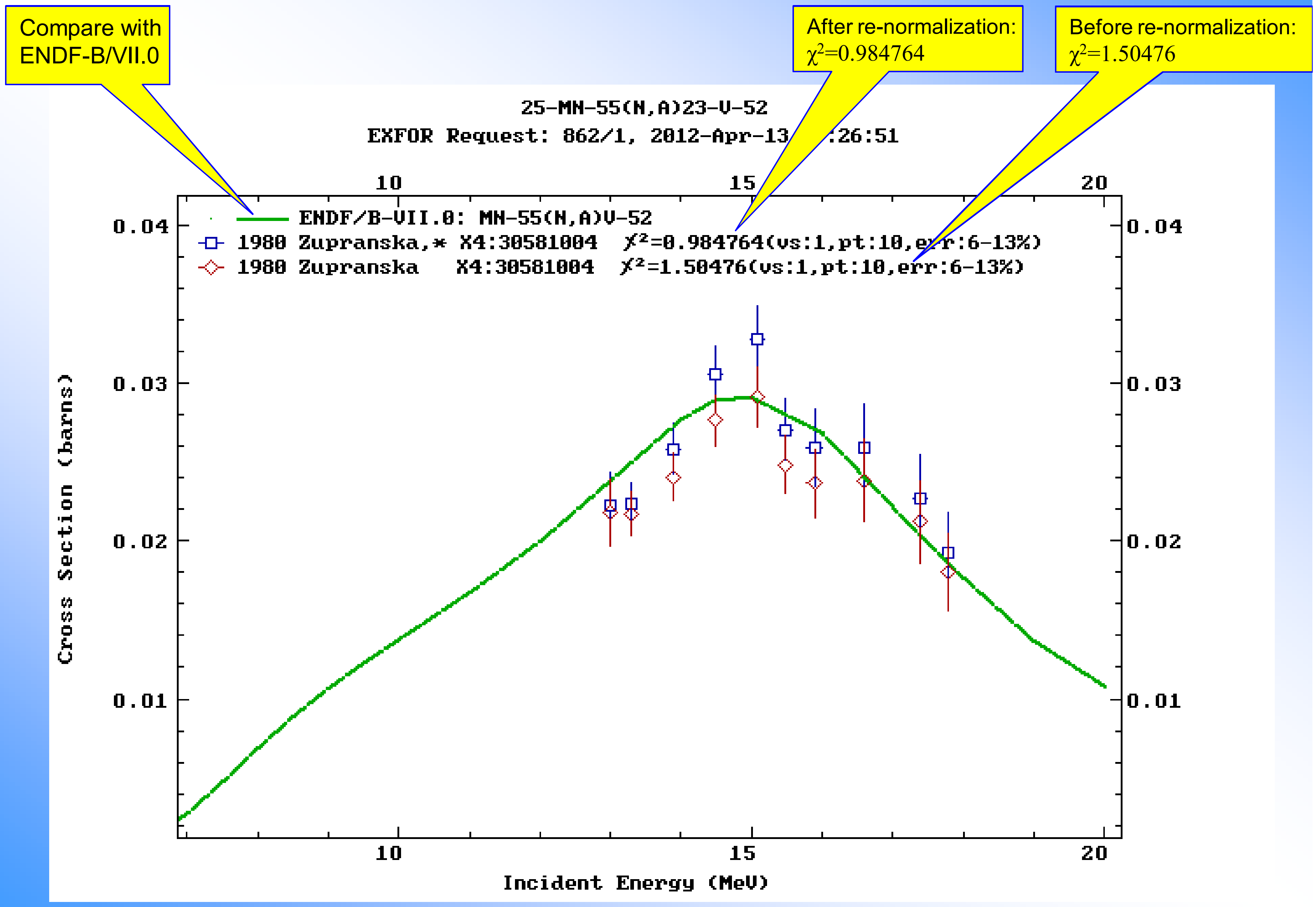
Checking used monitors



Automatic data re-normalization: common plot



Automatic data renormalization: comparing to ENDF



Corrected C4 file

Mozilla Firefox

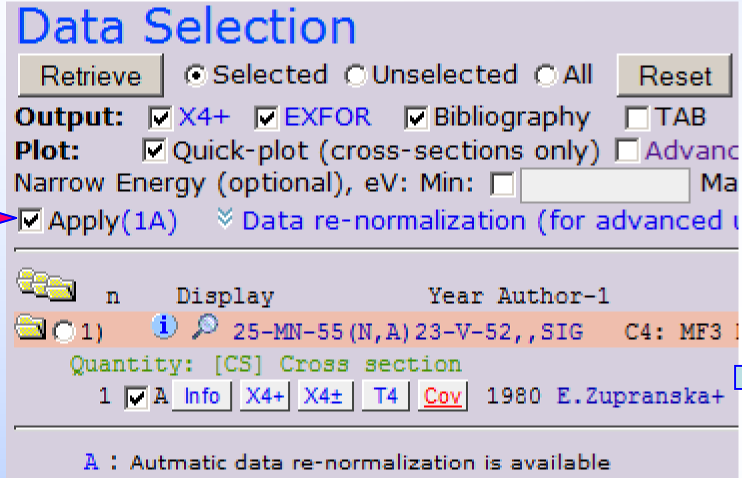
File Edit View History Bookmarks Tools Help

http://161.5.1...=X4R932_C4.C4 | http://161.5....hkPen=1&MF=30 | http://161.5.1...X4R932_x4.zvd

```
    1 79197    3 102    145000.0          0.277017 2.2161-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    200000.0          0.247612 1.9809-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    245000.0          0.236903 1.8952-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    305000.0          0.228891 1.8311-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    400000.0          0.181638 1.4531-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    445000.0          0.146107 1.1689-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    495000.0          0.132444 1.0595-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    520000.0           0.14657 1.1726-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    550000.0          0.137886 1.1031-2                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    595000.0          0.115702 9.2562-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    800000.0          9.8683-2 7.8946-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    1000000.          8.5288-2 6.8231-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    1190000.          9.0501-2 7.2401-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    1400000.          7.8014-2 6.2411-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    1400000.          9.1334-2 7.3067-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    1400000.          8.5625-2 6.8500-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    1800000.          6.4448-2 5.1558-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    2200000.          4.5408-2 3.6327-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    2550000.          4.3207-2 3.4565-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    4800000.          1.3540-2 1.0832-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
    1 79197    3 102    5400000.          1.4246-2 1.1397-3                                        A.E.Johnsrud*,ET.AL.(59) 11675 26
```

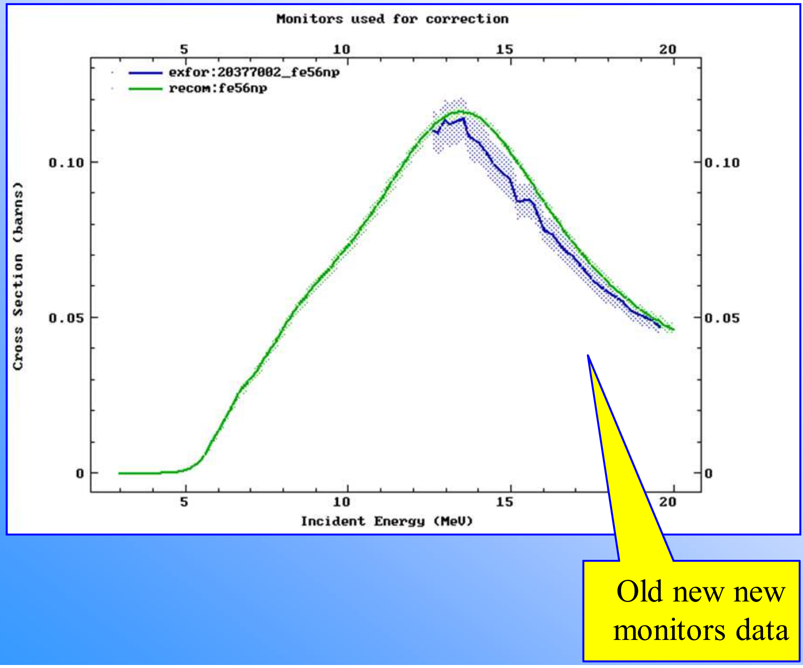
*** Flag: corrected data**

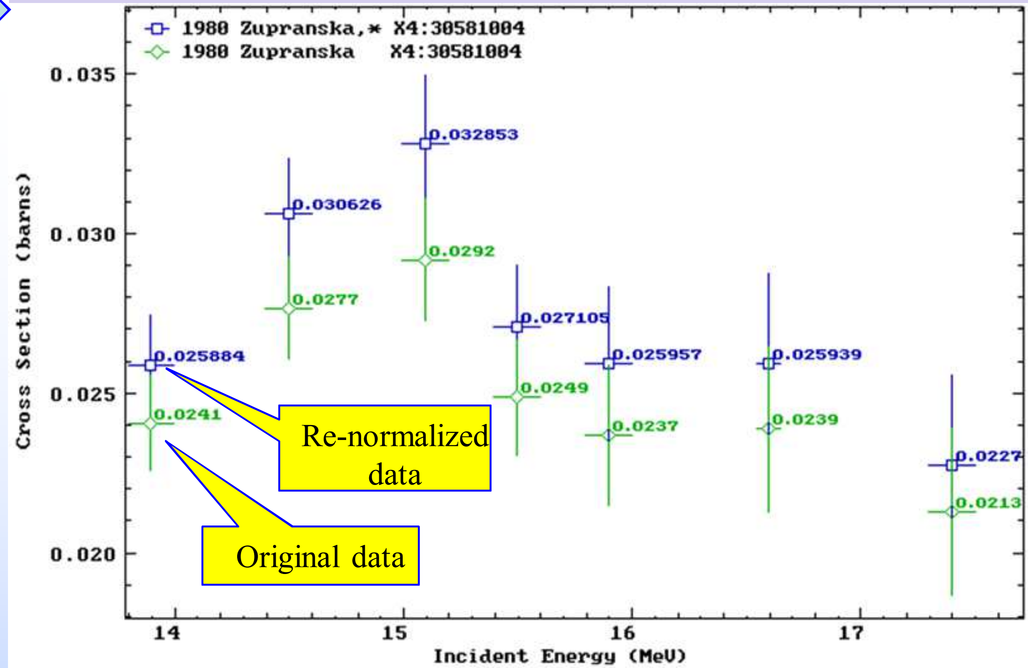
Summary: automatic EXFOR data re-normalization on Web **by one click**



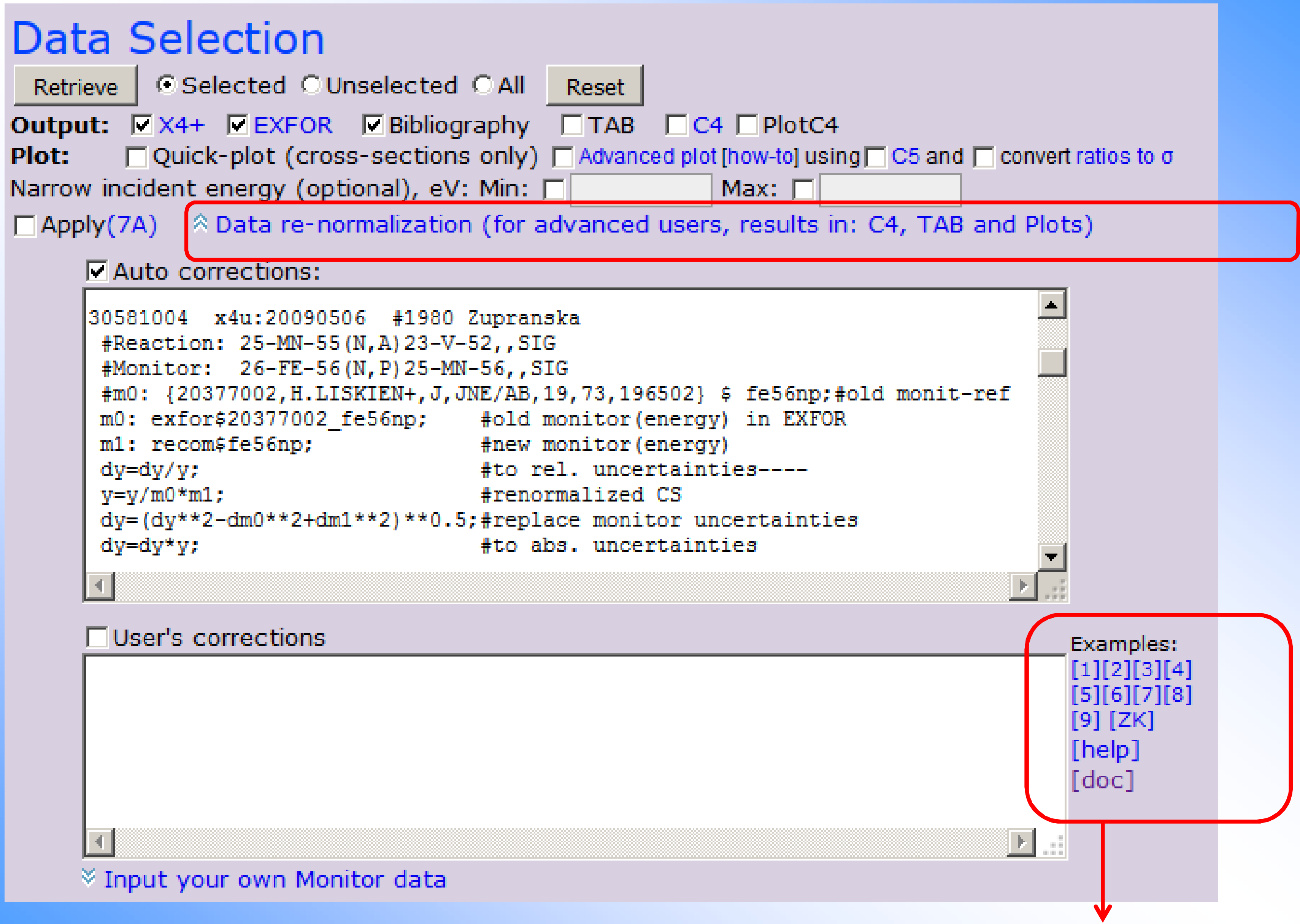
Requested corrections

```
30581004  x4u:20090506  #1980 Zupranska
 #Reaction: 25-MN-55(N,A)23-V-52,,SIG
 #Monitor:  26-FE-56(N,P)25-MN-56,,SIG
 #m0: {20377002,H.LISKIEN+,J,JNE/AB,19,73,196502} $ fe56np;#old monit-
 m0: exfor$20377002_fe56np;     #old monitor(energy) in EXFOR
 m1: recom$fe56np;              #new monitor(energy)
 dy=dy/y;                       #to rel. uncertainties----
 y=y/m0*m1;                     #renormalized CS
 dy=(dy**2-dm0**2+dm1**2)**0.5;#replace monitor uncertainties
 dy=dy*y;                       #to abs. uncertainties
```





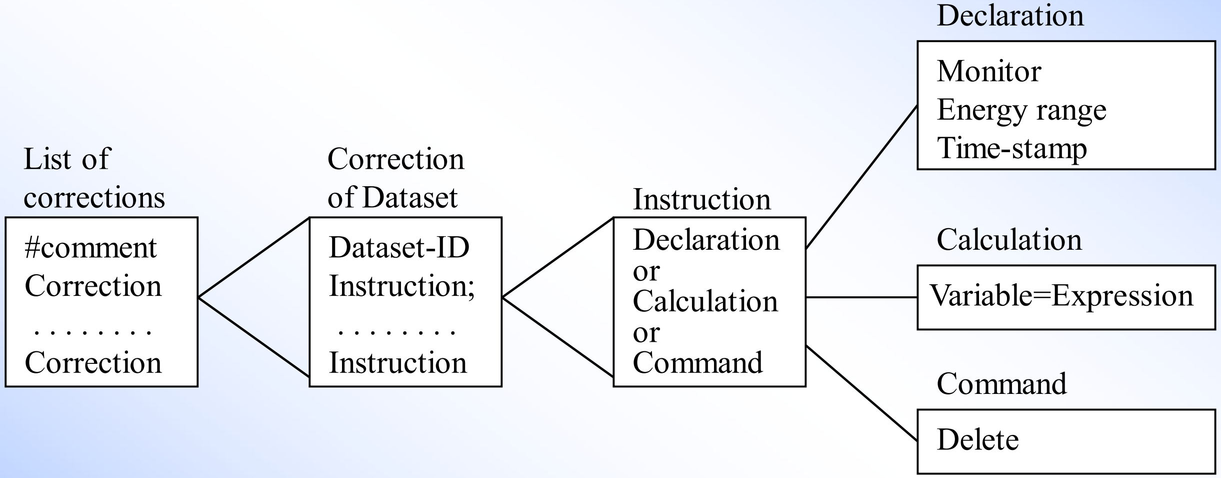
Add/edit corrections. Get help and manual



Documentation: www-nds.iaea.org/exfor/x4guide/x4corrections/x4corrections.pdf

Corrections. Structure and syntax.

Corrections (data modifications) are described in a text file with following structure



Datasets from EXFOR are identified by the
DatasetID := SubentryPointer

All operations described in the list of corrections will be applied to the current dataset.

Corrections. First examples

```
40274002A  y=y*0.85
```

This means: take data from Subentry 40274.002 having Pointer=<A>, and for every data point perform action: multiply data value (y) by factor 0.85

```
10221039 dSys=y*0.02;
```

This means: set systematic uncertainties equal to 2% of data for Subentry 10221039

```
10221039 m0:endfb4 $ u235nf;     #old monitor
         m1:iaeastd2006 $ u235nf; #new monitor
         dy=dy/y;                 #abs. to relative uncertainty
         y=y/m0*m1;               #re-normalize data value
         dy=dy**2 -(dm0/m0)**2 +(dm1/m1)**2;   #re-calc.errors
         dy=dy**0.5*y;            #back to abs. uncertainty
```

Monitor data used for measurements: CS from ENDF-B/IV, reaction U-235(n,f). We define for renormalization old and new monitors: data from ENDF-B/IV, U-235(n,f) and modern data from IAEA Standards-2006 library; re-calculate data values and uncertainty using old and new monitors for every data point.

Corrections. Declarations.

Energy dependent monitor from the Archive.

Energy dependent monitor must be “declared” before first time used.

syntax: m0:Library$Reaction;

the same for m1,m2,m3,..,m7

example: m0:allen58$u235nf;

m1:std05$u235nf;

Use value interpolated for the current energy in the variable m1 and dm1

example: y=y*m1/m0;

Energy dependent monitor from EXFOR file.

Energy dependent monitor must be “declared” before first time used.

syntax1: m0:[EN, MONIT];

where EN and MONIT are headers of EXFOR data columns

syntax2: m0:[EN-MIN ! EN-MAX, MONIT];

energy value will be average between two columns: EN-MIN and EN-MAX

syntax3: m0:[EN, MONIT, MONIT-ERR];

to describe column with monitor uncertainties (after that, dm0 will have a value)

syntax4: m0:[EN, MONIT:2];

to describe column having pointer

Use value interpolated for the current energy in the variable m0 and dm0

example: y=y*m1/m0;

After you declare monitor (as m0, m1, etc.), you can use variable m0 (or m1, etc.) in your expressions

Example: y=y*m1/m0;

dy=((dy/y)**2 -(dm0/m0)**2 +(dm1/m1)**2)**0.5*y;

Corrections. Variables. Data.

mf mt e de y dy a da e2 de2 dSys

C4 file

```
Proj.TargetM MF MT PXC  Energy  dEnergy  Data      dData    Cos/LO   dCos/LO   LVL/HL  dLVL/HL I78 Refer (YY)              EntrySubP
---->< ---->o<-><-->ooo<-------><-------><-------><-------><-------><-------><-------><-------><-><----------------------><---><->o
    1  9019    69000     1.4830+7 150000.0 1.3600-8 1.2000-9 0.939692       1.9 1.5900+7 100000.0 E2A.Takahashi,ET.AL.  (83)   21875 42
    1  9019    69000     1.4830+7 150000.0 4.1600-8 2.0000-9 0.939692       1.9 1.5700+7 100000.0 E2A.Takahashi,ET.AL.  (83)   21875 42
    1  9019    69000     1.4830+7 150000.0 9.3400-8 3.0000-9 0.939692       1.9 1.5500+7 100000.0 E2A.Takahashi,ET.AL.  (83)   21875 42
    1  9019    69000     1.4830+7 150000.0 2.1200-7 5.0000-9 0.939692       1.9 1.5300+7 100000.0 E2A.Takahashi,ET.AL.  (83)   21875 42
    1  9019    69000     1.4830+7 150000.0 3.8400-7 6.0000-9 0.939692       1.9 1.5100+7 100000.0 E2A.Takahashi,ET.AL.  (83)   21875 42
    1  9019    69000     1.4830+7 150000.0 5.8700-7 8.0000-9 0.939692       1.9 1.4900+7 100000.0 E2A.Takahashi,ET.AL.  (83)   21875 42
    1  9019    69000     1.4830+7 150000.0 7.5100-7 9.0000-9 0.939692       1.9 1.4700+7 100000.0 E2A.Takahashi,ET.AL.  (83)   21875 42
```

COLUMNS	NAME	VARIABLE	MEANING
1- 5	Prj		Projectile ZA (e.g. neutron =1, proton =1001)
6- 11	Targ		Target ZA (e.g. 26-Fe-56 = 26056)
12	M		Target metastable state (e.g. 26-FE-56m = M)
13-15	MF	MF	MF (ENDF conventions, plus additions)
16- 19	MT	MT	MT (ENDF conventions, plus additions)
20	P		Product metastable state (e.g. 26-FE-56M = M)
21	X		EXFOR status
22	C		Center-of-mass flag (C=center-of-mass, blank=lab)
23- 94	....		8 data fields (each in E9.3 format)
23- 31	Energy	E	Projectile incident energy
32- 40	dEnergy	dE	Projectile incident energy uncertainty
41- 49	Data	Y	Data, e.g., cross section, angular distribution, etc.
50- 58	dData	dY	Data uncertainty
59- 67	Cos/LO	A	Cosine or legendre order
68- 76	dCos/LO	dA	Cosine uncertainty
77- 85	LVL/HL	E2	Identified by columns 95-97 (e.g.,level E, half-life)
86- 94	dLVL/HL	dE2	Identified by columns 95-97 (e.g.,level E, uncertainty)
95- 97	I78		Identification of data fields 7 and 8 (e.g., LVL=level, HL=half-life, etc.).
98-122	Refer		Reference (first author and year)
123-127	ENTRY		EXFOR accession number
128-130	Sub		sub-accession number
131	P		Multi-dimension table flag (Pointer)
132-140	dSys	dSys	Multi-dimension table flag (Pointer)
141-149	dStat	dStat	Multi-dimension table flag (Pointer)

Corrections. Other variables and constants.

Numerical values

These values can be used in expressions in the format of REAL numbers in Fortran. It is assumed that values without units are presented in “basic” units (e.g. 20 means 20eV). Expressions allow also usage of units (which must be presented in special working dictionary), then units will be replaced by factor, e.g. 2hr will be replaced by (2*3600)., 2% will be replaced by (2*0.01), 20kev will be replaced by (20*1e3).

Intermediate variables.

syntax: a0, a1, a2, a3, a4, a5, a6, a7, c0, c1, c2, c3, c4, c5, c6, Fc
default value=0

Monitor point.

Monitor value for given point (e.g. thermal cross section) can be used in any expression:

syntax: Library$Reaction[Energy]
example: a1=iaea05$au197ng[0.0253];

It is also possible to use energy value from COMMON block:

a1=iaea05$au197ng[EN-NRM];

Monitor point from EXFOR.

Single monitor value is usually given in EXFOR file in COMMON block. This value can be used in an expression referring to Header of the column in the COMMON block by using [Header], e.g.

a0=[MONIT1];

So, renormalization by single point can also be described without using intermediate variables, e.g.:

y = y * iaea05$au197ng[0.0253] / [MONIT1];

Other constants and operations.

Abundance

When necessary, cross sections can be corrected by using natural abundance of isotopes and cross section of competing reaction. Abundance is coded as abu[isotope], can be used in expressions and will be replaced by value taken from internal library. For example:

```
20388002   m2:rrdf07$ni61nnp;
           y = y - abu[ni61]/abu[ni60]*m2;
```

Half-life

If necessary (for long-lived residuals), cross sections can be corrected by using new half-life value, which is coded as t12[isotope]. It can be used in expressions and will be replaced by value taken from internal library. For example:

```
30449003   y=y*t12[bi207]/38yr;     # converted to y=y*32.9yr/38yr;
```

Operations.

Traditional operations:

+ - * / **

parentheses () change default order of operations

Calculations

syntax: variable=expression;

Traditional for programming languages

Applying your corrections

Plot: ☑ Quick-plot (cross-sections only) ☐ Advanced plot [how-to] using ☐ C5 and ☐ convert ratios to σ

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

☑ Apply(7A) Data re-normalization (for advanced users, results in: C4, TAB and Plots)

☑ Auto corrections:

```
30581004  x4u:20090506  #1980 Zupranska
 #Reaction: 25-MN-55(N,A)23-V-52,,SIG
 #Monitor:  26-FE-56(N,P)25-MN-56,,SIG
 #m0: {20377002,H.LISKIEN+,J,JNE/AB,19,73,196502} $ fe56np;#old monit-ref
 m0: exfor$20377002_fe56np;    #old monitor(energy) in EXFOR
 m1: recom$fe56np;             #new monitor(energy)
 dy=dy/y;                      #to rel. uncertainties----
 y=y/m0*m1;                    #renormalized CS
 dy=(dy**2-dm0**2+dm1**2)**0.5;#replace monitor uncertainties
 dy=dy*y;                      #to abs. uncertainties
```

☑ User's corrections

```
30581004
 a1=2;
 y=y*a1;
 dy=dy*a1;
```

Examples: [1][2][3][4] [5][6][7][8] [9] [ZK] [help] [doc]

Put your corrections here

Constructing covariance matrix from EXFOR uncertainties

You can do this on Web using interactive tool and non-interactive software. In order to apply these methods for your data you should input your data to the EXFOR system.

http://www.epj-conferences.org/articles/epjconf/pdf/2012/09/epjconf_ncsc2_00009.pdf

Motivation

"Technical Meeting Neutron Cross Section Covariances, IAEA Headquarters Vienna, Austria 27-30 September 2010":

8. Documentation and instructions to authors of experimental data on how to prepare uncertainty information should be drafted and made easily accessible (e.g. on the IAEA website). Instructions should include practical examples.

9. The EXFOR formats should be flexible enough to accommodate information as provided by the experimenters. The EXFOR format should be extended to accommodate the full explicit covariance matrix, if provided by the authors or, alternatively, data required by a recipe for constructing covariance matrices based on providing partial error and correlation components.

10. Authors of experimental data are urged to provide partial components of the uncertainties and correlation information as needed to generate the full covariance matrix.

14. The present computational format (C4) should be extended to accommodate partial uncertainty information consistent with that available in EXFOR. In addition, a new format should be developed, capable of accommodating experimental covariance information.

Interactive Web tool. How it works

Convert EXFOR dataset to C5

↓

Set up new uncertainties

user can setup new values of uncertainties (or confirm existing uncertainties), introduce new (artificial) uncertainties splitting systematic uncertainties to parts, etc.

↓

Set up grouping factor, energy ranges and how to fill in gaps

↓

Select uncertainties for calc. fractional covariance matrices

user selects uncertainties for calculation of fractional covariance matrix from:

- C5 uncertainties,
- EXFOR uncertainties and
- new artificial uncertainties

↓

Define types of algorithm for every fractional matrix

user defines how to calculate fractional covariance matrix: correlation type (uncorrelated SERC, fully correlated LERC and partially correlated). For partially correlated uncertainties (MERC) user defines additional parameters: correlation length and scale.

↓

Submit calculation

↓

Control calculations and get results

Calling interactive Web tool

Data Selection

Retrieve ● Selected ○ Unselected ○ All Reset

Output: ☑ X4+ ☑ EXFOR ☑ Bibliography ☐ TAB ☐ C4 ☐ PlotC4

Plot: ☐ Quick-plot (cross-sections only) ☐ Advanced plot [how-to] using ☐ C5 and ☐ 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
1)	95-AM-241(N,2N)95-AM-240,,SIG C4: MF3 MT16							
	Quantity: [CS] Cross section							
1	+ Info X4+ X4± T4 Cov	2010 C.Sage+	8.34e6	2.06e7	9	+ J,PR/C,81,064604,2010	23114002	2010SA15

Constructing a covariance matrix from EXFOR uncertainties

by V.Zerkin, IAEA, October 2010 - April 2012

Request: #27001

Dataset: 23114002 LX=9 Set default: [1] [2] Examples: [1] [2] → → Calculate matrix

+ Restore your previous Recipe /test-version/

Reaction: 95-AM-241(N,2N)95-AM-240,,SIG

C4Referer: C.Sage,ET.AL. (10)

- Data and uncertainties (data points: 9)

Data									
No.	1	2	3	4	5	6	7	8	9
Energy (eV) *0.001	8340.	9150.	13330.	16100.	17160.	17900.	19360.	19950.	20610.
Data (B) *1000.	96.8	162.9	241.8	152.4	116.1	105.7	89.5	102.1	77.9
Uncertainties defined in C5 (C4++)									
Total (%)	6.5	5.7	4.6	4.6	4.4	4.4	8.2	5.8	8.8
Statistical (%) *empty*	-	-	-	-	-	-	-	-	-
Systematic (%)	6.4	5.6	4.5	4.5	4.3	4.3	8.1	5.7	8.8
Uncertainties given in EXFOR									
ERR-T (%)	6.5	5.7	4.6	4.6	4.4	4.4	8.2	5.8	8.8
ERR-1 (%)	5.0	4.0	2.5	2.1	1.5	1.3	6.3	1.4	5.7

Step-1. Use default-2 and [Submit]

```
ERR-ANALYS (ERR-T,,,P) Total uncertainty
           (MONIT-ERR,,,P) 27Al(n,a) standard x-section (1.6-5.4%)
           (ERR-1,,,U) Counting of 240Am activity      (1.4-6.3%)
           (ERR-2,,,U) Counting of 24Na activity       (0.7-2.0%)
           (ERR-3,,,F) Intensity of 240Am gamma line        (1.2%)
           (ERR-4,,,U) Number of 27Al in sample             (0.1%)
           (ERR-5,,,P) Number of 241Am in sample            (0.3%)
           (ERR-6,,,F) 24Na/240Am efficiency ratio          (3.0%)
           (ERR-7,,,F) Correction for decay of 240Am   (0.4-0.9%)
           (ERR-8,,,U) Correction for secondary neutron    (<1.4%)
#/SUBENT 23114002
```

...Method Time-Of-Flight: **No**

[-] Set/Add uncertainties (%) More myErr: [+] [-]

Name	Status	Set all values to	Set if empty	Comment
Total	full	% of [Data]		[myErr-*] are uncertainties defined by user; they can be used e.g. to split [Systematic] uncertainty to components: a) fully correlated and b) medium energy range correlated or for using uncertainties given in free EXFOR text under [ERR-ANALYS]
Statistical	empty	50 % of Total		
Systematic	full	Auto		
myErr-1	empty	50 % of Systematic		
myErr-2	empty	50 % of Systematic		
myErr-3	empty	2 % of Data		

Input parameters and run calculation

Request [Submit] [Reset] ☑ Submit in new Window ☐ Include uncertainty arrays to the Recipe-report

Groupping Factor: 1 data points (required if final covariance matrix is too large)

No.	Name	Apply	Correlation-type	Parameters ☐ Use energy intervals (default: 8.34 20.61 MeV)
1	Statistical	☑	Uncorrelated	
2	Systematic	☐	Fully-correlated	
3	myErr-1	☑	Fully-correlated	
4	myErr-2	☑	MERC-correlated	Corr-Length: 0.5 of the Range(eV): 8.34e6 to 2.061e Scale: Lin >>
5	myErr-3	☐	MERC-correlated	Corr-Length: 0.5 of the Range(eV): 8.34e6 to 2.061e Scale: Lin >>

Step-2. Check calculations, call plot, recipe, etc.

Covariance matrix from EXFOR uncertainties

by V.Zerkin, IAEA, October 2010 - April 2012

Request: #27001
Dataset: 23114002 LX=9
Reaction: 95-AM-241(N,2N)95-AM-240,,SIG
C4Referer: C.Sage,ET.AL. (10)

+ Data and uncertainties (data points: 9)
+ Summary: available uncertainties L=16
+ Text in EXFOR under keywords "ERR-ANALYS" and "METHOD"

...Method Time-Of-Flight: **No**

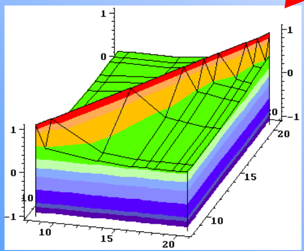
+ **Calculations...**

Final results: Plot | Raw data | [ENDF-MF33] Your recipe:[xml]/test-version/

Covariance matrix positive definited: **Yes**

Plot partial:[matrices] [uncertainties]

Page generated: 2015/10/29,09:46:08 by X4-Servlet on localhost [fwd:www-nds.iaea.org]
Project: "Multi-platform EXFOR-CINDA-ENDF", V.Zerkin, IAEA-NDS, 1999-2015
Request from: 127.0.0.1 [fwd:140.105.43.213]




```
 9.52410+04 1.90482+05          0          0          0          1 55533 16    1
        0.0        0.0          0         16          0          1 55533 16    2
        0.0        0.0          1          5         66         11 55533 16    3
 1.00000-05 8.34000+06 9.15000+06 1.33300+07 1.6
 1.79000+07 1.93600+07 1.99500+07 2.06100+07 2.0
        0.0        0.0        0.0        0.0
        0.0        0.0        0.0 4.22500-03 1.7
 7.47500-04 7.15000-04 7.15000-04 1.33250-03 9.4
 3.24900-03 8.64384-04 6.55500-04 6.27000-04 6.2
 8.26500-04 1.25400-03 2.11600-03 8.19152-04 6.9
 9.59139-04 6.67000-04 1.01200-03 2.11600-03 9.2
 1.38491-03 9.15426-04 1.28005-03 1.93600-03 9.0
 9.85858-04 1.39165-03 1.93600-03 1.58934-03 1.0
 6.72400-03 2.26365-03 3.24044-03 3.36400-03 2.4
          0          0          0          0
          0          0          0          0
```



```xml
- <CovRecipe DatasetID="23114002" Created="2015-10-29 09:46:08" Software="Web-tool:2012.03.16">
    <Subent id="23114002" x4upd="20130924"/>
    <Reacode code="95-AM-241(N,2N)95-AM-240,,SIG"/>
    <defineErr name="Statistical" type="C5" cmd="Setup" src="Total" koeff="0.5"/>
    <defineErr name="myErr-1" type="myErr" cmd="Setup" src="Systematic" koeff="0.5"/>
    <defineErr name="myErr-2" type="myErr" cmd="Setup" src="Systematic" koeff="0.5"/>
    <addCovarFraction errName="Statistical" errType="C5" corrType="SERC" fracType="Uncorrelated"/>
    <addCovarFraction errName="myErr-1" errType="myErr" corrType="LERC" fracType="Fully-correlated"/>
    <addCovarFraction errName="myErr-2" errType="myErr" corrType="MERC" fracType="MERC-correlated"
    MercType="Lin" MercInterval="0.5" MercEnMin="8.34e6" MercEnMax="2.061e7" EnUnits="eV"/>
  - <myStamp>
      EXFOR-Web-Covariance-Recipe, V.Zerkin, IAEA-NDS, 2012-03-19.
    </myStamp>
  </CovRecipe>
```

Options, parameters

Grouping.
If dimension of the final matrix > 100 x 100
Statistical uncertainties: ~smaller (square average)
Systematic uncertainties: ~the same (average)
Total uncertainties: recalculated from sys. and stat.

Gaps (empty fields in EXFOR).
User defines how to fill in existing gaps
(current version: constant)

Energy intervals.
Can be used if experiment had different conditions for the different energy intervals (e.g. different samples were used on the different energy intervals)

Types of correlations [see ENDF Manual, GMA doc]

SERC: Short Energy Range Correlations
Applicable for uncorrelated data
Example: statistical uncertainties

LERC: Long Energy Range Correlations
Applicable for fully-correlated data
Example: uncertainties in the determination of mass of the sample

MERC: Medium Energy Range Correlations
Example: uncertainties in detector efficiency
Parameters:
1) correlation length energy range of which correlations between data in two energy points disappear
2) scale (Log/Lin):
Log. scale for energy correlations is more common for the time of flight measurements;
Linear scale - for discrete energy source measurements [V.Pronyaev]

Correlation coefficients: $a_{ij}(E_i,E_j)$

Uncorrelated
SERC (Short Energy Range)

1	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	0	0	1	0	0	0	0
0	0	0	0	1	0	0	0
0	0	0	0	0	1	0	0
0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	1

Fully-correlated
LERC (Long Energy Range)

1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1

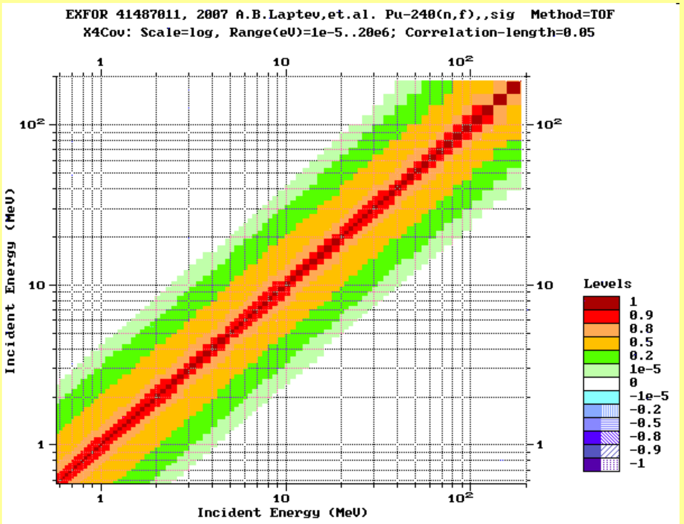
Partially-correlated
MERC (Medium Energy Range)

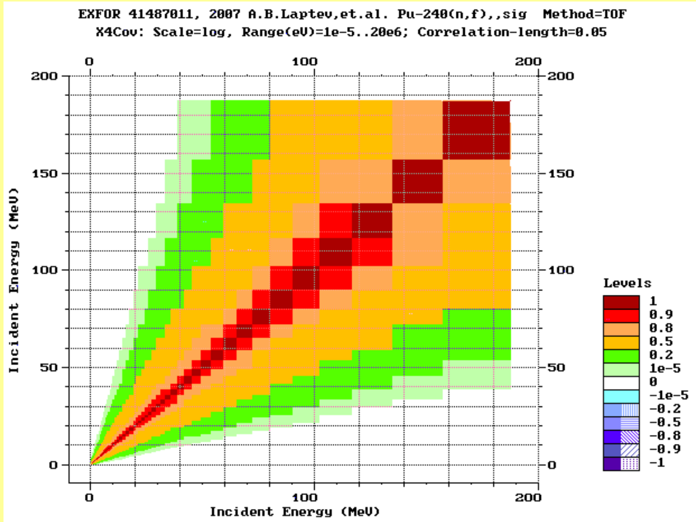
1	.7	.4	.1	0	0	0	0
.7	1	.7	.4	.1	0	0	0
.4	.7	1	.7	.4	.1	0	0
.1	.4	.7	1	.7	.4	.1	0
0	.1	.4	.7	1	.7	.4	.1
0	0	.1	.4	.7	1	.7	.4
0	0	0	.1	.4	.7	1	.7
0	0	0	0	.1	.4	.7	1

Fractional covariance matrix: Cov[i,j] = a[i,j] * Err[i] * Err[j]
SERC: a[i,i]=1; a[i,j]=0 (i≠j)
LERC: a[i,j]=1
MERC: a[i,j]=a(E_i,E_j,scale,length)
a[i,j] – coefficient of correlation between data at energies E[i] and E[j]
Err[i] – relative uncertainty of given type for given energy E[i]

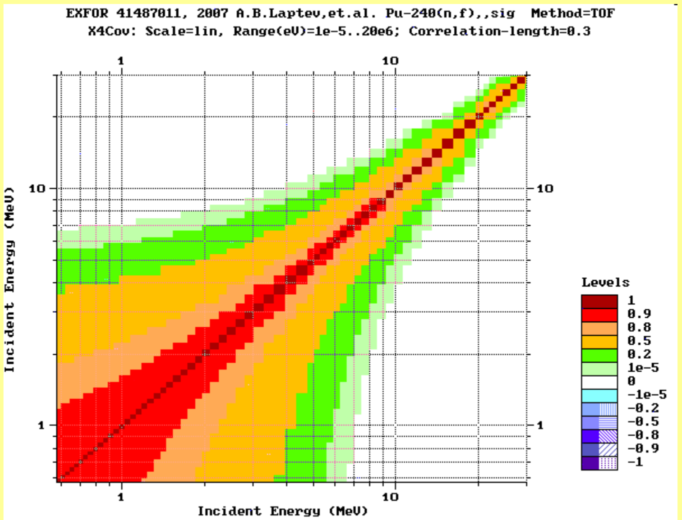
Examples of MERC parameters

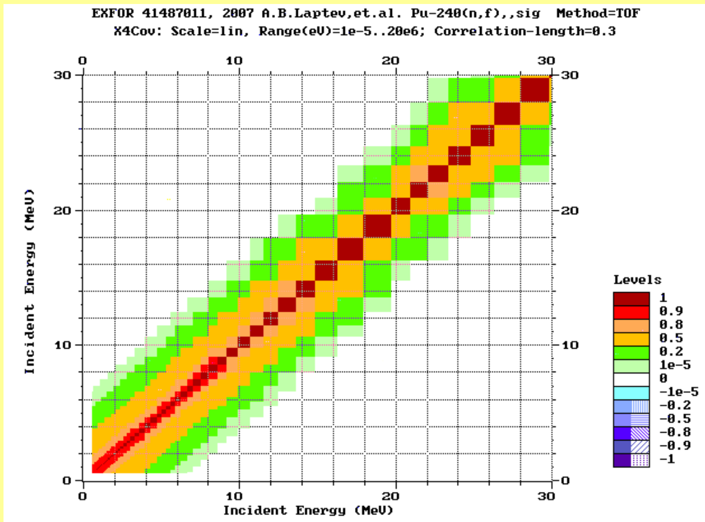
Scale=Log; Full energy range (eV)=1e-5..20e6; Correlation-length=0.05





Scale=Lin; Full energy range (eV)=1e-5..20e6; Correlation-length=0.3

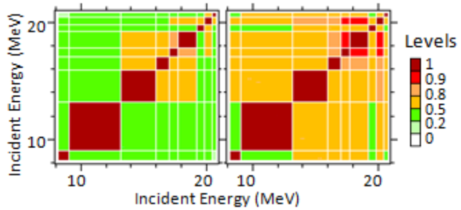




Summary. Web Tool for constructing a covariance matrix from EXFOR uncertainties

1. Using partial uncertainties (or own assumptions) user defines types of their correlations and calculate full correlation matrix
2. The tools provides two default algorithms based on EXFOR definitions of types of uncertainties (generalized in C5), and offers interactive procedure to build more precise matrix using components, offers Web plotting of full matrix and all components, output to ENDF and EXFOR formats; user can store “recipe” and re-use it
3. Such tools can be the only way to construct covariance matrices for old data

Default-1

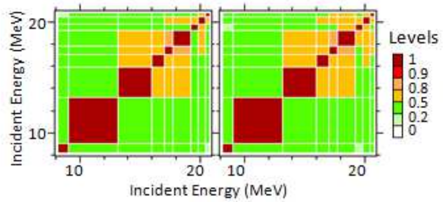


red, green: difference>20%

En,MeV	Err-T,%	Original matrix,%	Err-T,%	Constructed matrix,%
8.34	6.5	100	6.5	100
9.15	5.7	35 100	5.7	46 100
13.33	4.6	37 42 100	4.6	54 60 100
16.1	4.6	38 43 53 100	4.6	57 63 75 100
17.16	4.4	40 45 57 58 100	4.4	60 67 79 84 100
17.9	4.4	41 45 57 59 84 100	4.4	61 68 80 85 90 100
19.36	8.2	21 24 30 31 39 39 100	8.2	41 46 54 57 60 61 100
19.95	5.8	30 34 44 45 58 59 51 100	5.8	62 69 81 86 91 93 62 100
20.61	8.8	20 22 29 30 40 42 39 65 100	8.8	49 54 64 68 72 73 49 74 100

Correlation matrices: experimental reported by authors (left) and constructed using only C5 uncertainties (right)

Default-2

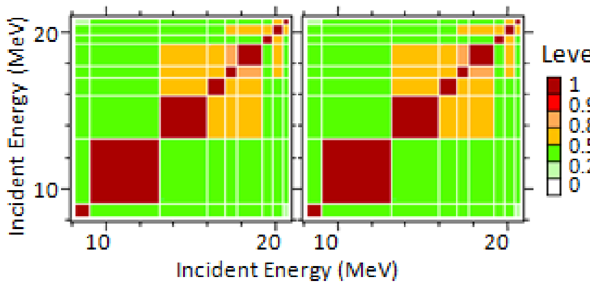


red, green: difference>10%

En,MeV	Err-T,%	Original matrix,%	Err-T,%	Constructed matrix,%
8.34	6.5	100	6.5	100
9.15	5.7	35 100	5.7	43 100
13.33	4.6	37 42 100	4.6	32 39 100
16.1	4.6	38 43 53 100	4.6	28 32 58 100
17.16	4.4	40 45 57 58 100	4.4	30 33 54 76 100
17.9	4.4	41 45 57 59 84 100	4.4	31 34 50 73 84 100
19.36	8.2	21 24 30 31 39 39 100	8.2	20 23 27 42 49 54 100
19.95	5.8	30 34 44 45 58 59 51 100	5.8	31 35 41 59 70 77 59 100
20.61	8.8	20 22 29 30 40 42 39 65 100	8.8	24 27 32 43 51 57 44 70 100

Correlation matrices: experimental (left) and constructed using C5 uncertainties split to fully- and MERC-correlated uncertainties with default parameters (right)

Recipe from authors



En, MeV	Err-T,%	Original matrix,%	Err-T,%	Constructed matrix, %
8.34	6.5	100	6.4	100
9.15	5.7	35 100	5.6	35 100
13.33	4.6	37 42 100	4.5	37 42 100
16.1	4.6	38 43 53 100	4.5	38 43 53 100
17.16	4.4	40 45 57 58 100	4.3	40 45 57 58 100
17.9	4.4	41 45 57 59 84 100	4.3	41 45 57 59 84 100
19.36	8.2	21 24 30 31 39 39 100	8.1	21 24 30 31 39 39 100
19.95	5.8	30 34 44 45 58 59 51 100	5.7	30 34 44 45 58 59 51 100
20.61	8.8	20 22 29 30 40 42 39 65 100	8.8	20 22 29 30 40 42 39 66 100

Experimental (left) and constructed correlation matrices using full “recipe” provided by the authors (right).

Calling non-interactive software

EXFOR Request #27001/172

Output Data

Format	*Data (Size)*
EXFOR Interpreted	X4+ (32Kb) Generate: X4± XML:: v1: X4.xml X4.html v2: X4.xml X4.html
EXFOR Output	X4Out X4Out.xml X4Comp Test: C5 C5M see:[doc]
EXFOR Original	EXFOR (22Kb) zip (6Kb)
Bibliography	html (3Kb) BibTeX (1Kb)

C5 = C4 + ErrSys + ErrStat

C5M = C5 + correlation matrix

```
COVARIANCE     2               Generated
COMMENT        Default2. EXFOR software ver.2012/05/17, by V.Zerkin@iaea.org (IAEA-NDS)
+              1) If only total uncertainties are given, assume uncertainties: statistical/systematic=50/50.
+              2) Statistical uncertainties ara added to full covariance matrix as uncorrelated components
+              3) Total systematic uncertainties are split to (50/50) and added as fully correlated and MERC-correlated components
ALGORITHM      2           1           100.        50.         50.         0           8340000.0   2.061E7     0.5
+              Type        Groupping   Stat.SERC   Syst.LERC   Syst.MERC   Log/Lin     En-Min      En-Max      Length
COVARDATA      1           9           9
EnMin(eV)  EnMax(eV)   Data(b)     Std.dev.(%) Correlations(%)
----------><----------><----------><----------><---Values: separated by space; line length: unlimited....
340000.    8340000.    0.0968      6.5         100
150000.    9150000.    0.1629      5.7         91 100
.333E7     1.333E7     0.2418      4.6         58 64 100
.61E7      1.61E7      0.1524      4.6         48 48 75 100
.716E7     1.716E7     0.1161      4.4         48 48 66 87 100
.79E7      1.79E7      0.1057      4.4         48 48 60 81 88 100
.936E7     1.936E7     0.0895      8.2         49 49 50 71 79 84 100
.995E7     1.995E7     0.1021      5.8         48 48 49 66 74 79 93 100
.061E7     2.061E7     0.0779      8.8         49 49 49 62 70 75 89 93 100
/COVARDATA
/COVARIANCE
```

Uploading systems for nuclear data professionals

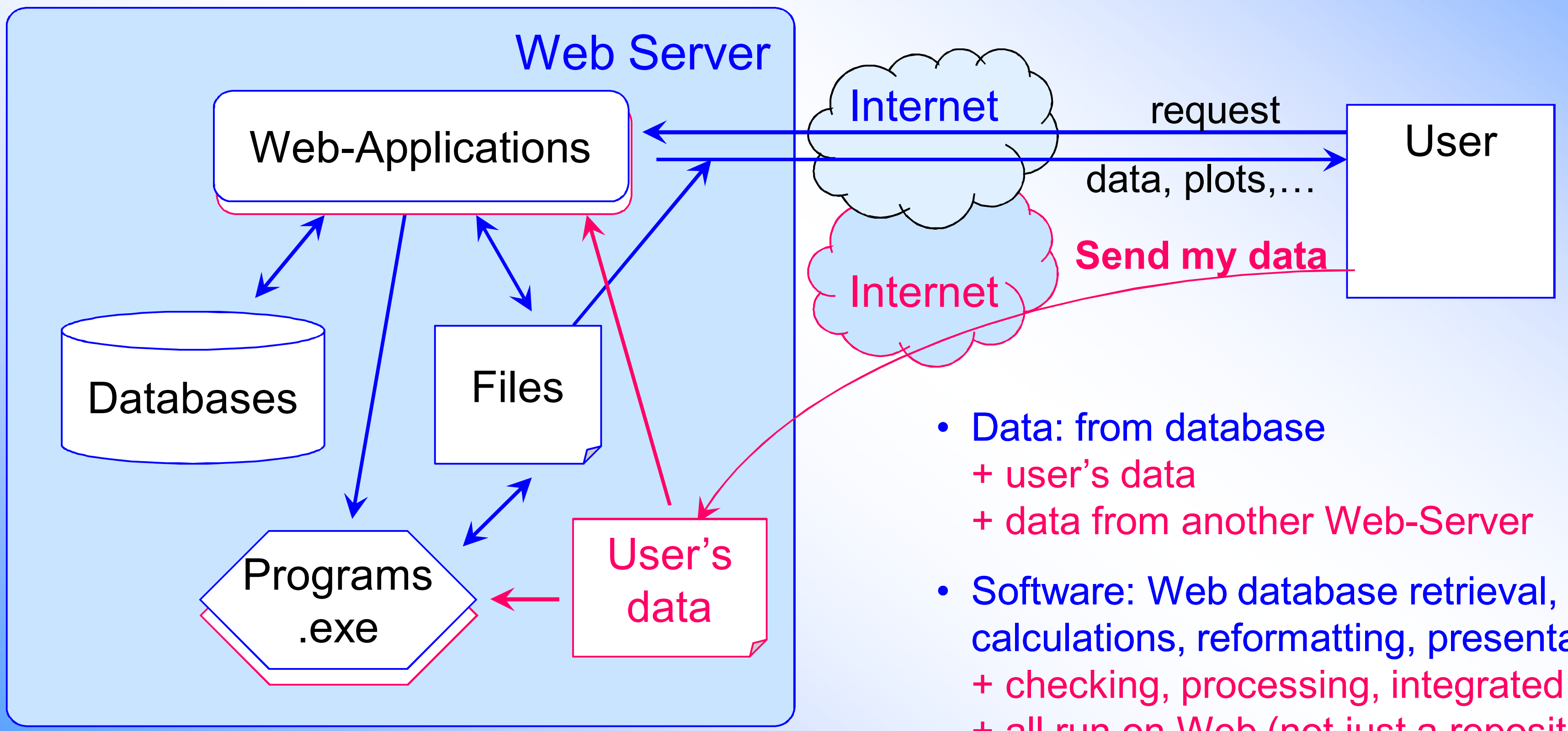
Processing user's data on Web-Server

Oriented to nuclear data professionals producing nuclear data

Modern definition: "Cloud computing" / "SaaS" = Software as a Service

Other types of cloud computing: IaaS (Infrastructure as a Service: disk space) and PaaS (Platform as a Service)

Structure and basic ideas

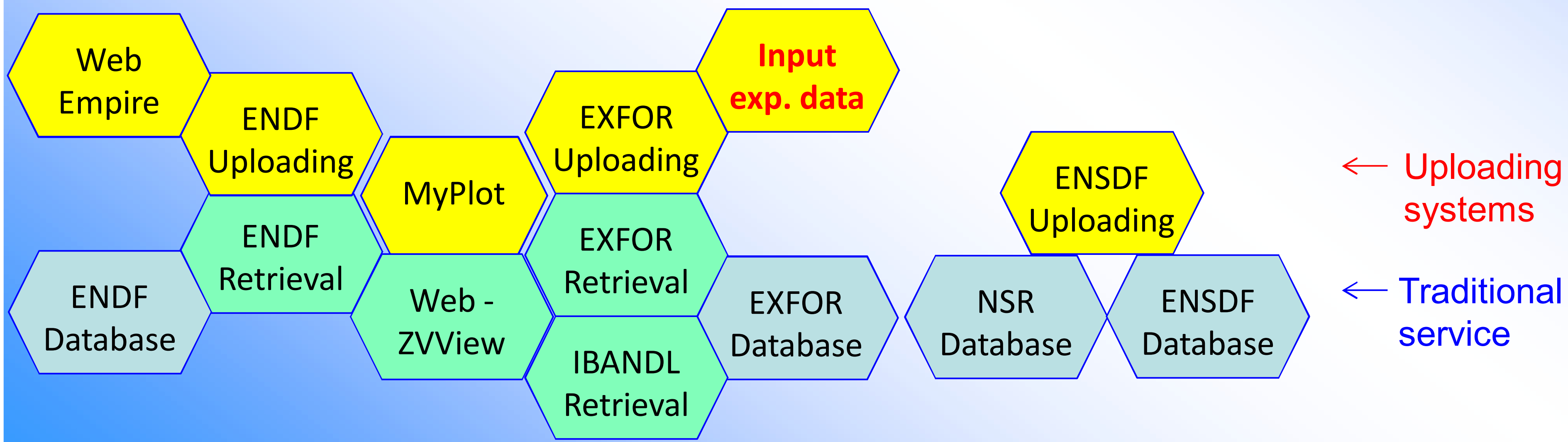


- Data: from database
  + user's data
  + data from another Web-Server
- Software: Web database retrieval, calculations, reformatting, presentation
  + checking, processing, integrated codes
  + all run on Web (not just a repository)
- User's data can be processed together with data from databases

Beyond traditional Nuclear Data Services we can offer Nuclear Data Software as a Service oriented to the nuclear data compilers and evaluators

NDS Web server applications

MyPlot	Plotting with Web-ZVView (2009)
MyEXFOR	Uploading System for /EXFOR compilers/ (2010) ZCHEX, ZORDER, XTRACT, X4TOC4; Web-EXFOR
MyENDF	Uploading System (2010-2015) CHECKR, FIZCON, STANEF, PSYCHE, INTER, PREPRO, ENDVER, FUDGE, GRUCON, Web-EXFOR-ENDF
MyENSDF	Uploading System (2011-2015) FMTCHK, chk_ENSDF, PREPRO, XPQCHK, ALPHAD, GTOL, BrIcc, BrIccMixing, GABS, LOGFT, PANDORA, RADLST, RULER, NDSPUB
EMPIRE-3.1	Web Interface to Empire-3.1 /test-version/ (2013)
MyX4Data	Uploading experimental data as text to EXFOR system for constructing covariance matrices, plotting, inverse reaction calculations, etc. (2015)



Integrating Web systems

Input para-meters

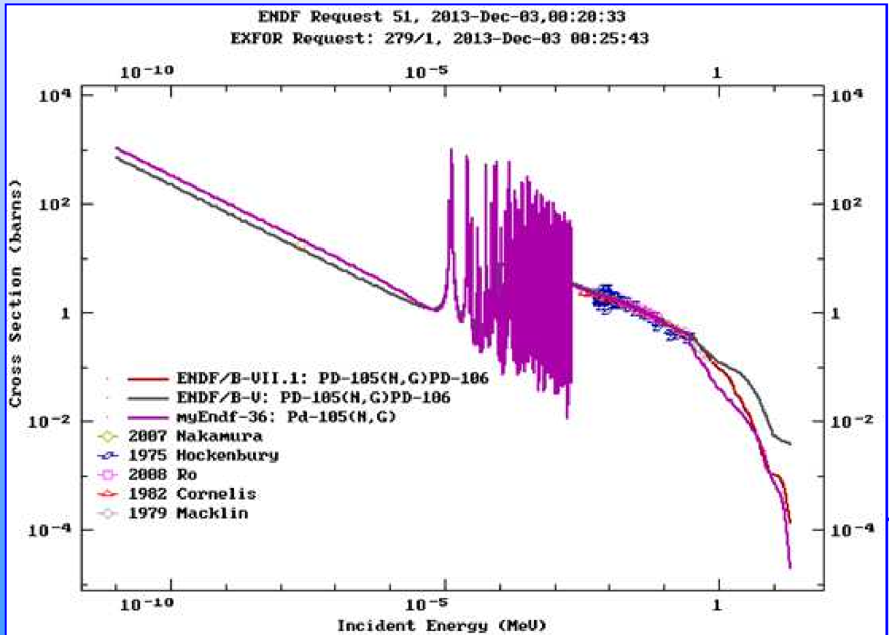
Web Empire functions (today):
- Running:
  - Empire-3.1
  - Formatting
  - Add resonances
- File management (view, sort, delete)
- Send ENDF file to MyENDF

User

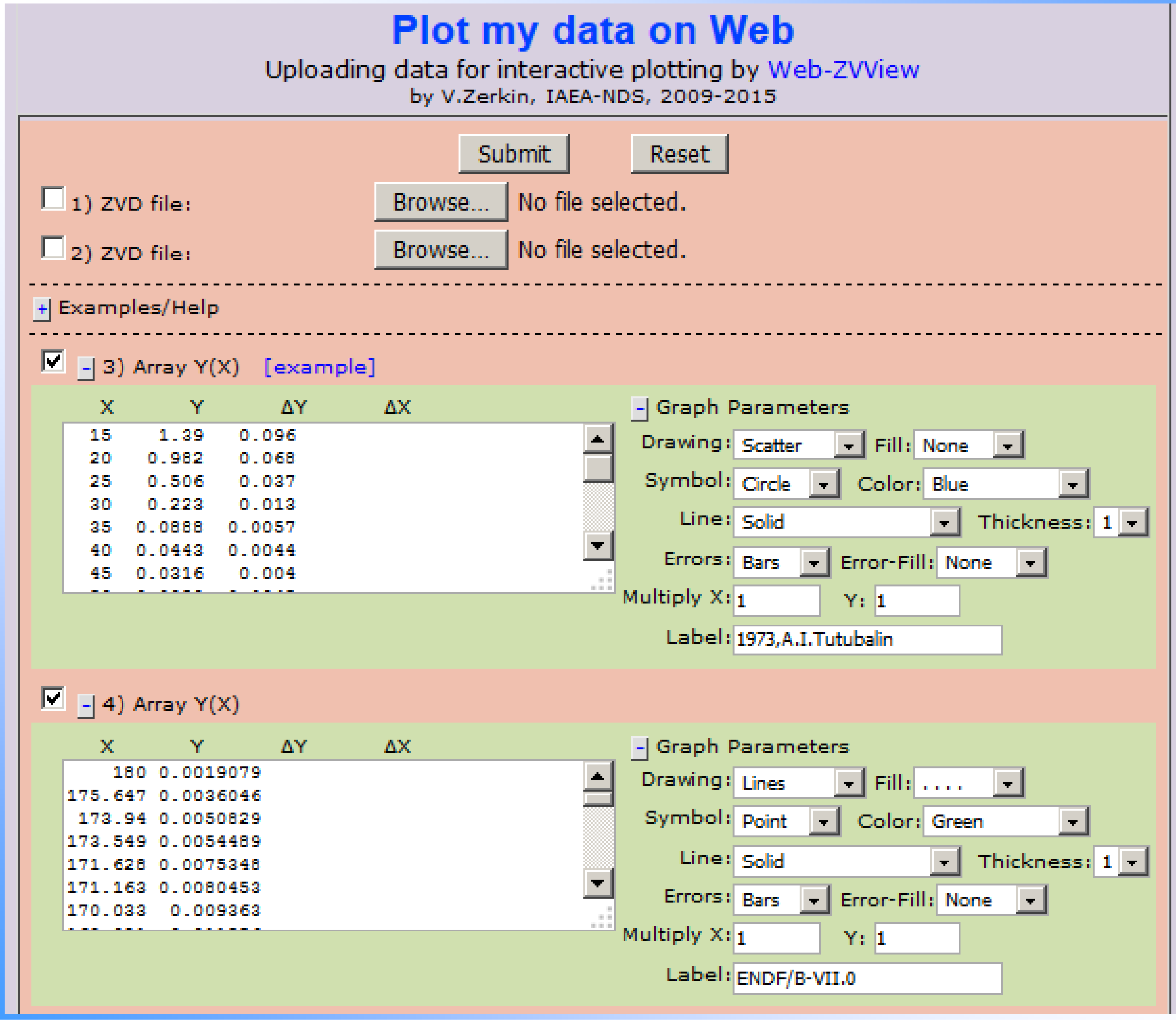
MyENDF functions:
- Running on ENDF file:
  - Checking and verification codes
  - Re-formatting
  - Endf2gnd (Fudge, LLNL)
  - Prepro-2015
  - GRUCON, etc.
- File management (view, sort, delete)
- Send ENDF file to ENDF-Retrieval

ENDF Retrieval:
- Search in database
- Display, plot
- Send request to EXFOR-Retrieval

EXFOR Retrieval:
- Search in database
- Select and renormalize data
- Display, plot



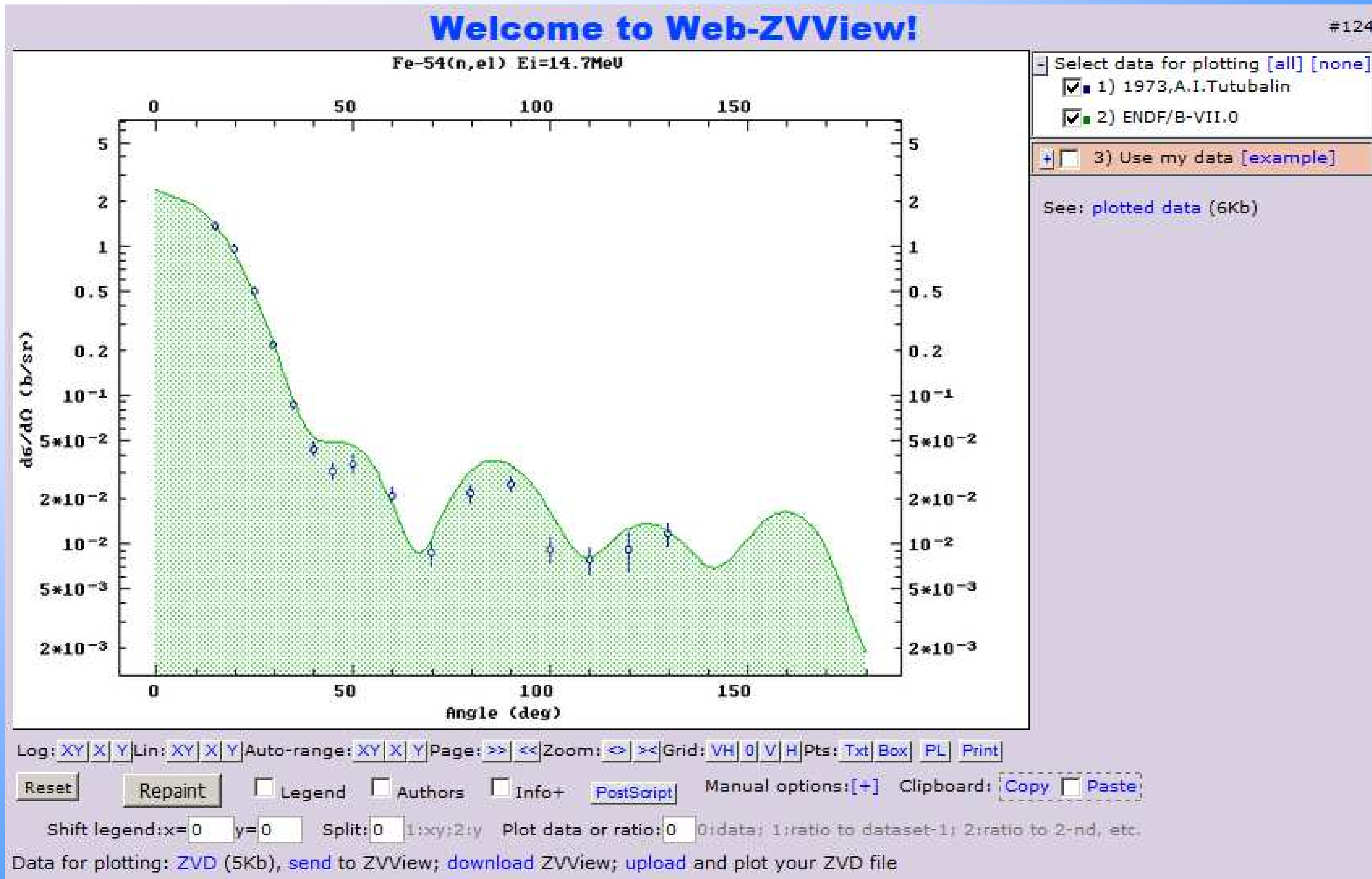
MyPlot: myplot.htm



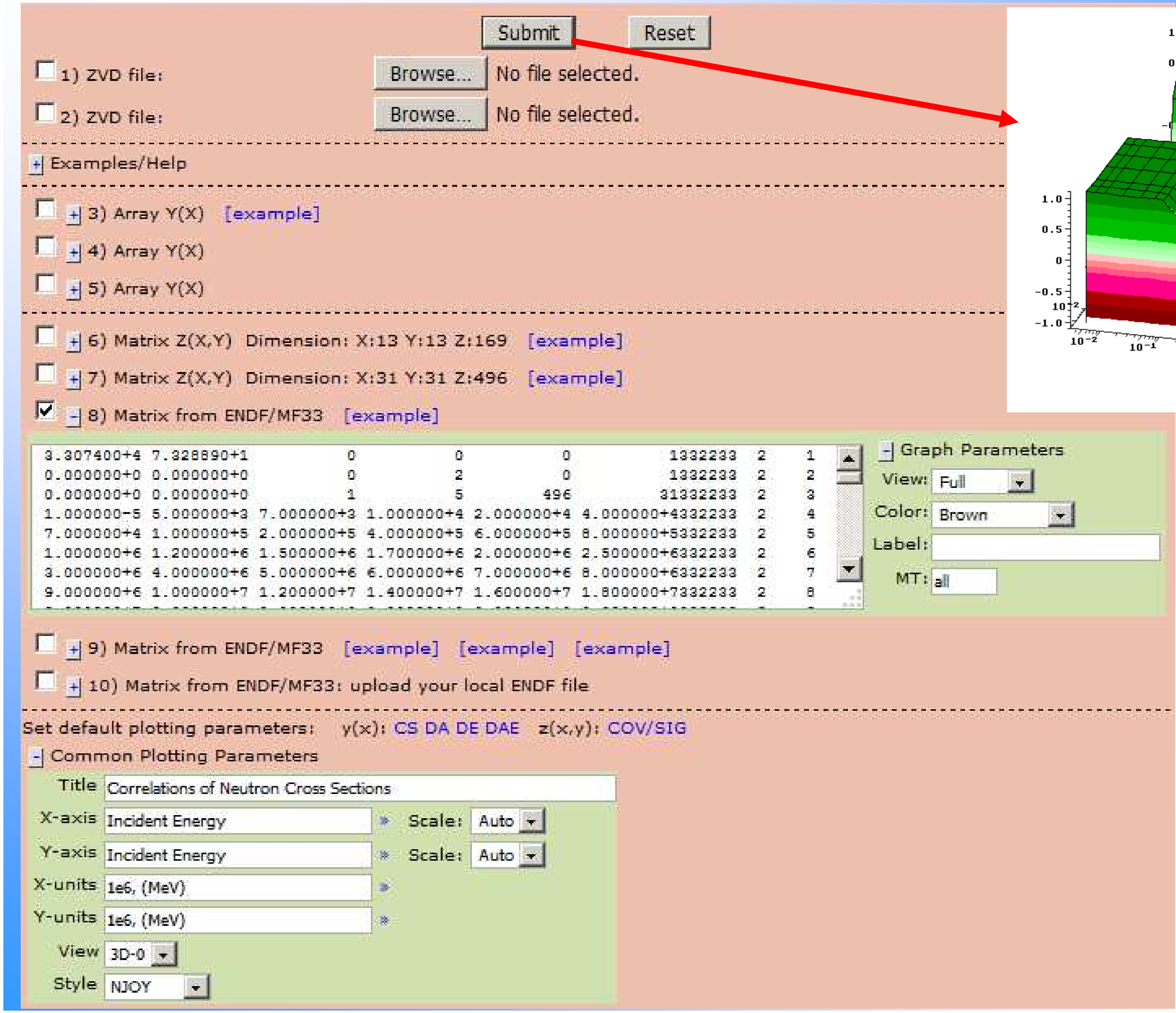
Submit

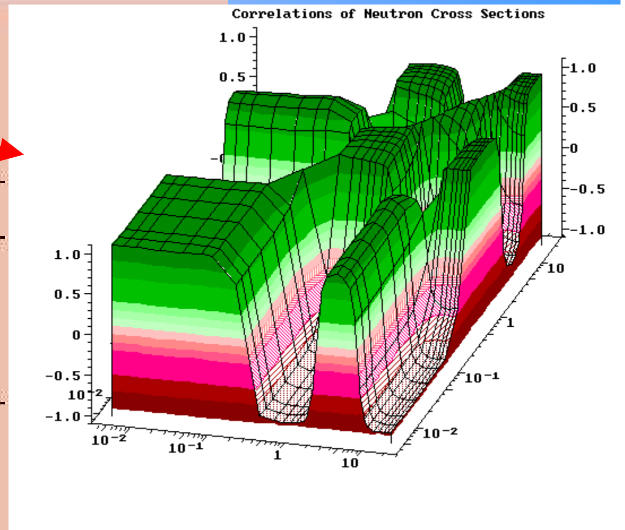
Sends data to Web-ZVView

Web-ZVView



Input ENDF section of MF33





Input link to Web address

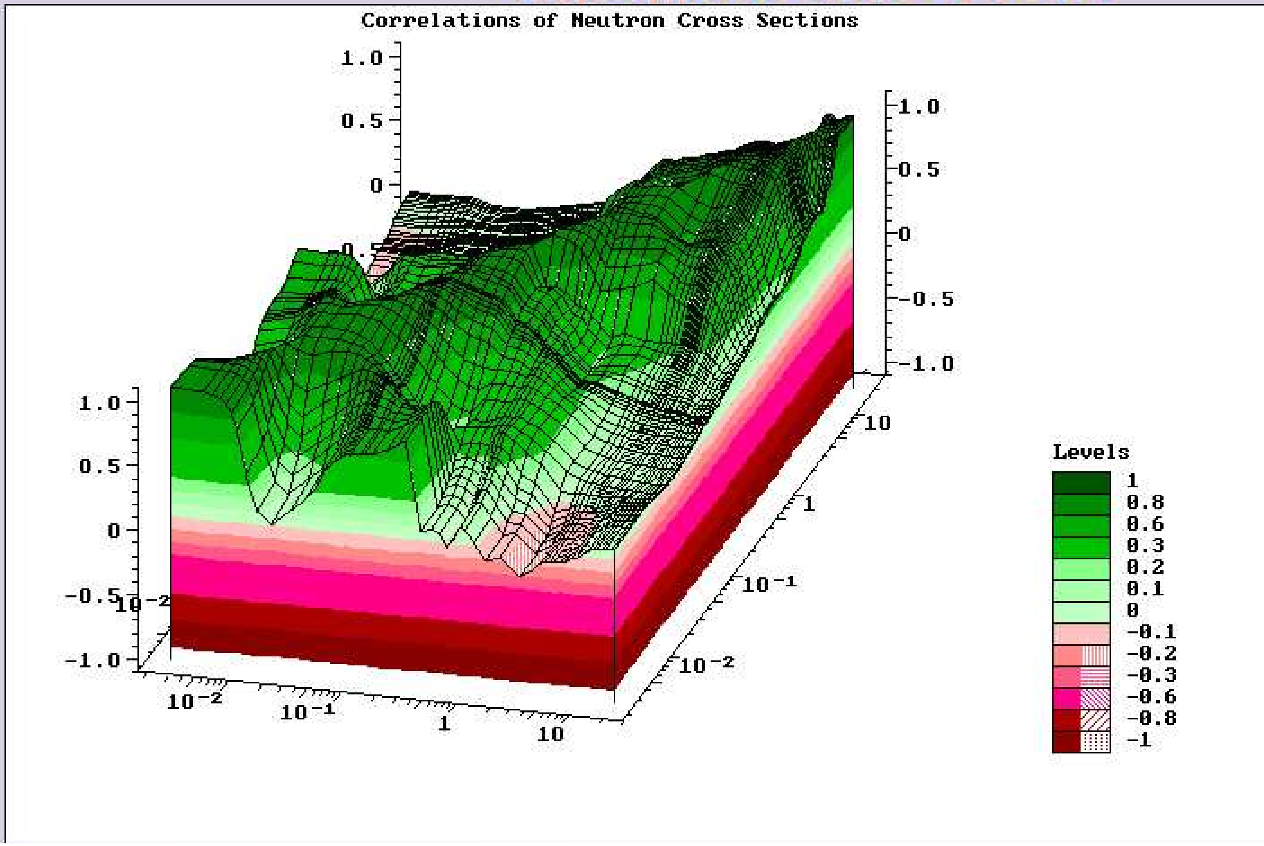
☑ [-] 9) Matrix from ENDF/MF33 [example] [example] [example]

```
http://t2.lanl.gov/nis/data/data/ENDFB-VII.1-neutron/Gd/152
```

Remote file: http://t2.lanl.gov/nis/data/data/ENDFB-VII.1-neutron/Gd/152 filter MT=102
Additional plot: Uncertanties
Additional plot: Cross Sections

Welcome to Web-ZVView!

#128

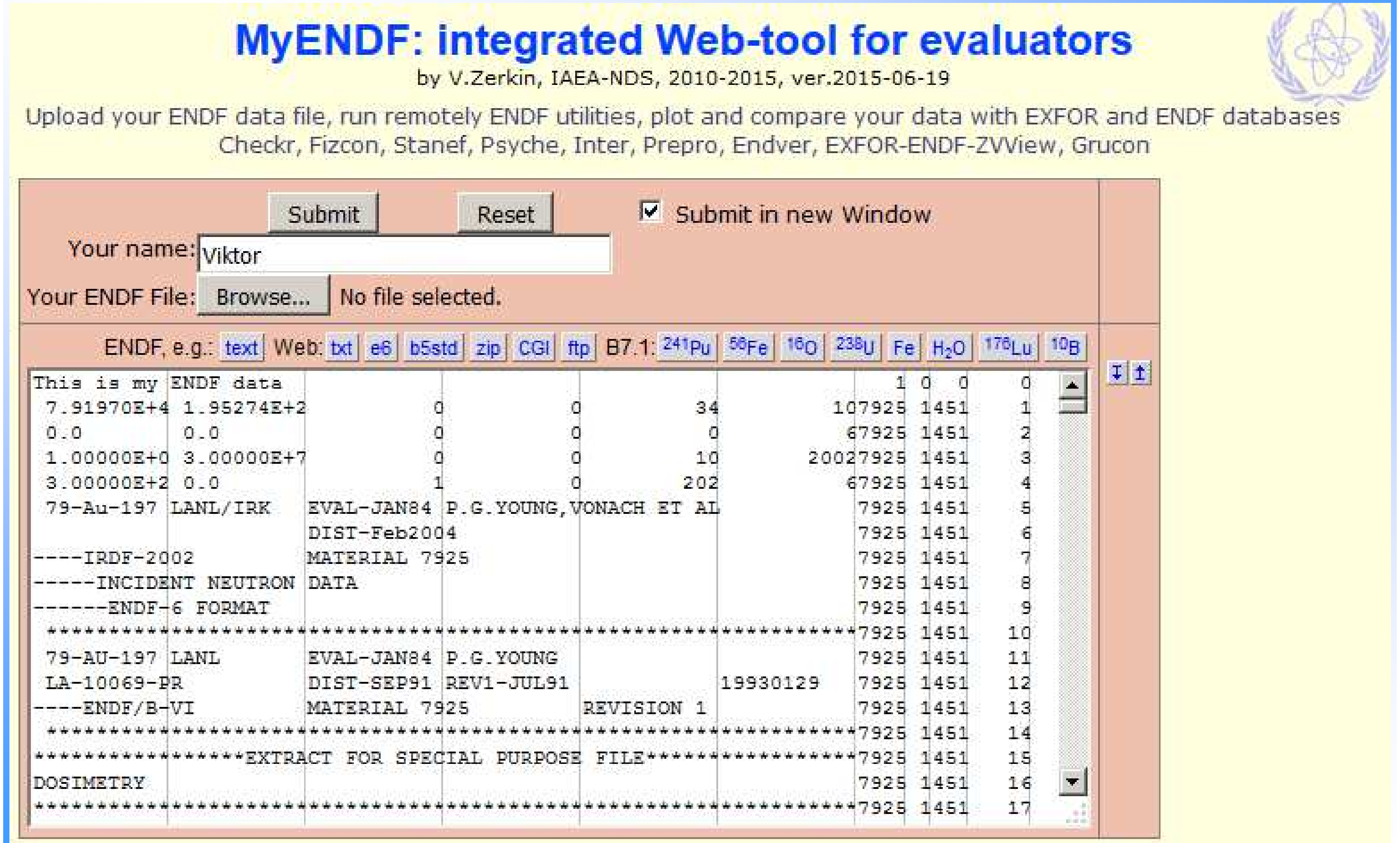


[-] Select data for plotting [all] [none]
☑ 1) Gd-152 MT102:gamma

[+] ☐ 2) Use my data [example]

See: plotted data (92Kb) out:x4,T,F,e6

Uploading ENDF file for checking, plotting, processing



Uploading EXFOR /tools for compilers/

Web tool for EXFOR compilers

Uploading EXFOR files for checking and comparison with central database

by V.Zerkin, IAEA-NDS, 2009-2015, ver.2015-09-17

Submit | Reset | Show details | Submit in new Window

Your name: Viktor

Your EXFOR File: Browse... No file selected.

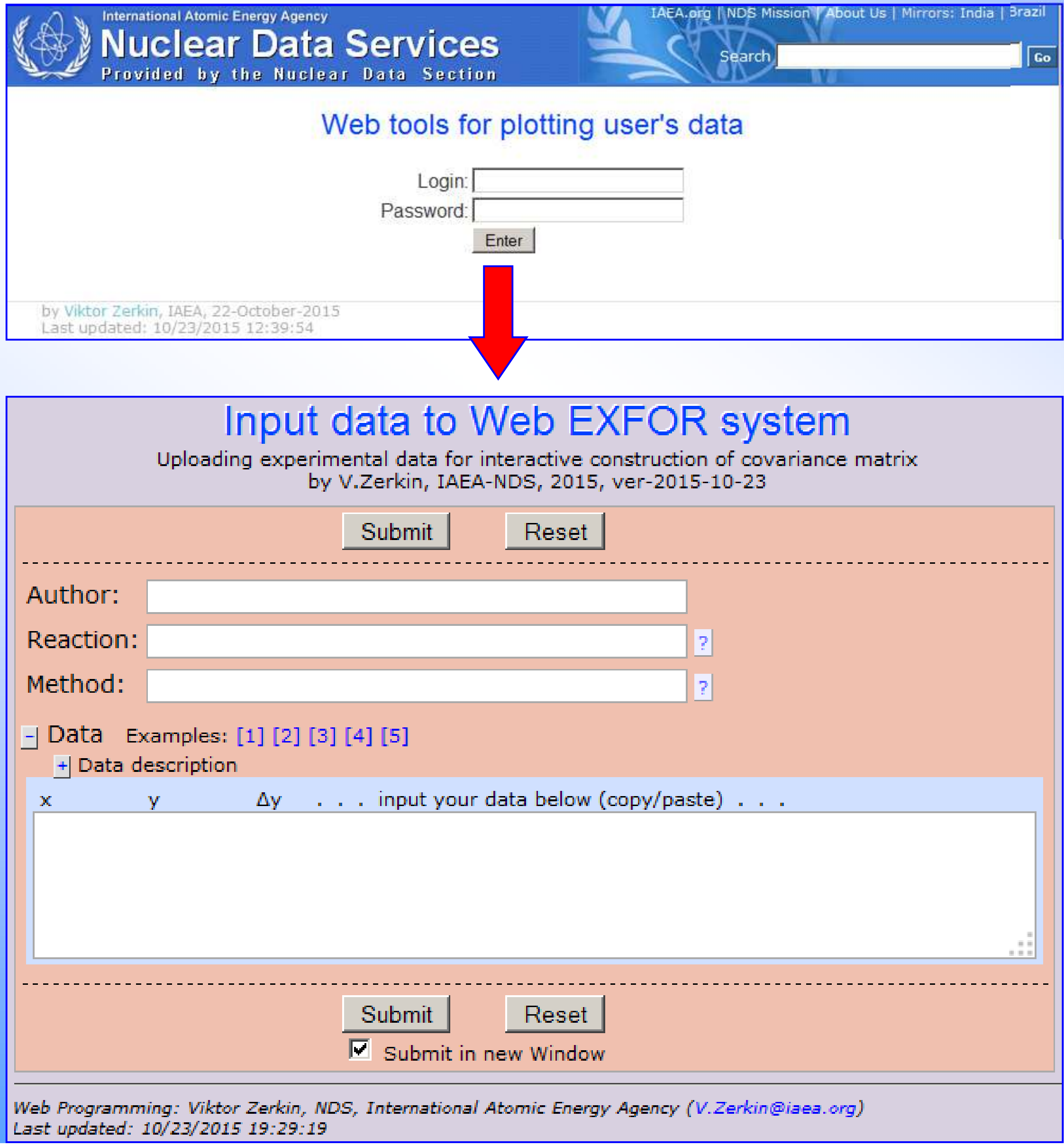
EXFOR text below. + Examples text links: txt x4 77 zip CGI covariance: 1 2 3 4 5

```
ENTRY            32619       950627
SUBENT        32619001       950627
BIB                 10           35
TITLE      Fast neutron excitation curve of Al, Ti, V, In and
           I nuclides
AUTHOR     (LU HANLIN, WANG DAHAI, CUI YUNFENG, HUANG JIANZHOU,
            ZHAO WENRONG, FAN PEIGUO, XIA YIJUN, CHEN BAOLIN,
            MA HONGCHANG, LI JIZHOU)
REFERENCE  (J,CST,9,(2),113,7505)
INSTITUTE  (3CPRAEP)
FACILITY   (VDG) 2.5 MeV Van De Graaff.
           (CYCLO) The variable energy cyclotron.
           (CCW)
INC-SOURCE (D-D) The average energy 1.35 and 1.80 MeV deuteron
           beam from the Van De Graaff bombarding a D-Ti target
           to generate 4.5 and 5.0 MeV neutrons.
           The deuteron beam of 3.7 and 5.03 MeV from the cyclo-
           tron bombarding the solid Ti-D target (thickness=2.04
```

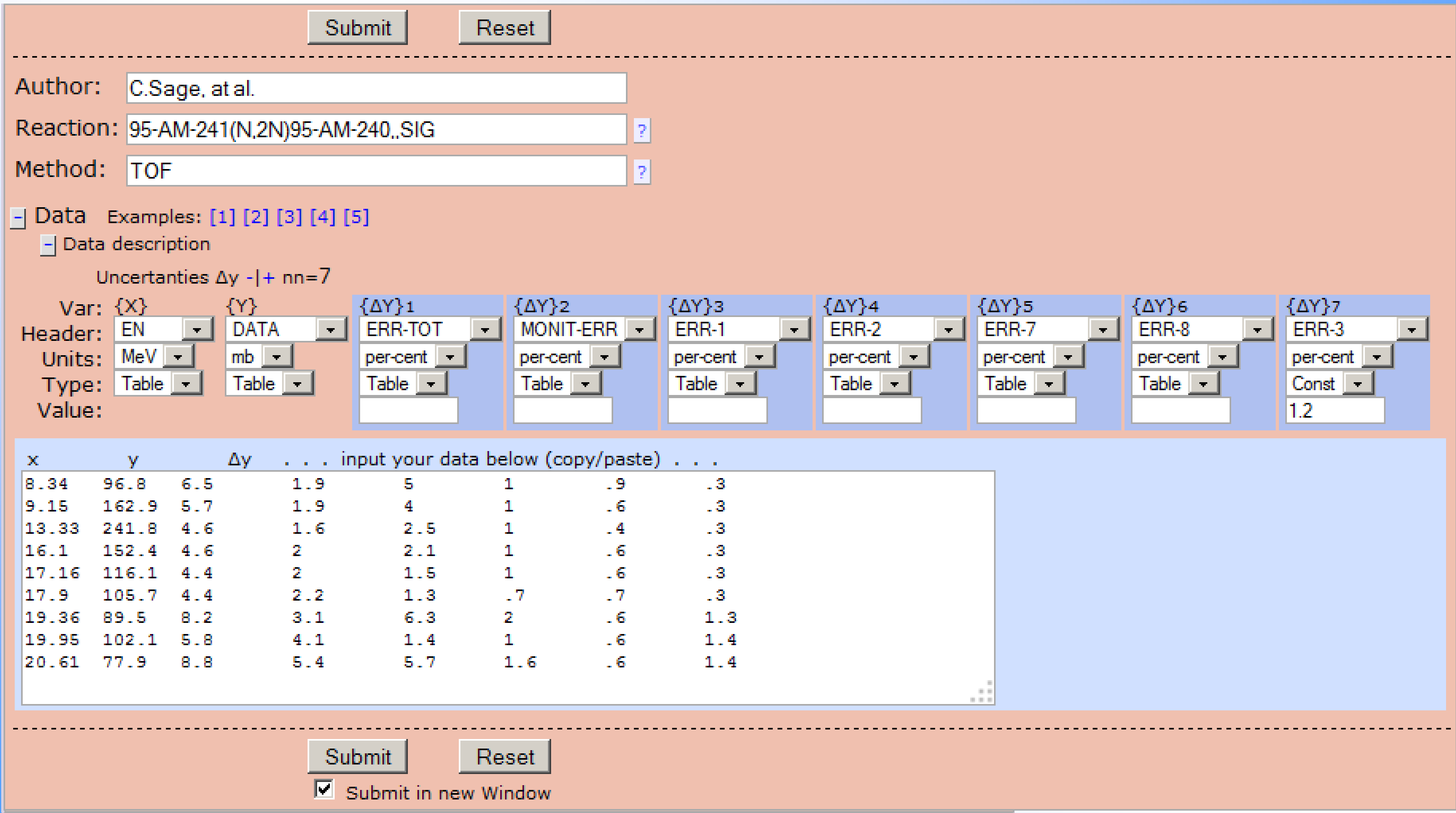
Useful links:
- -IAEA-NDS
- -NRDC
- -EXFOR-Web
- -EXFOR-Map
- -myPlot
- -myEndf
- -myEnsdf
- -x4ref1*

Uploading your experimental data

http://www-nds.iaea.org/exfor/x4datal.htm



Input your data to the EXFOR system



Submit Reset

Author: C.Sage, at al.

Reaction: 95-AM-241(N,2N)95-AM-240,,SIG ?

Method: TOF ?

- Data Examples: [1] [2] [3] [4] [5]

- Data description

Uncertanties Δy -|+ nn=7

Var:	{X}	{Y}	{ΔY}1	{ΔY}2	{ΔY}3	{ΔY}4	{ΔY}5	{ΔY}6	{ΔY}7
Header:	EN	DATA	ERR-TOT	MONIT-ERR	ERR-1	ERR-2	ERR-7	ERR-8	ERR-3
Units:	MeV	mb	per-cent	per-cent	per-cent	per-cent	per-cent	per-cent	per-cent
Type:	Table	Table	Table	Table	Table	Table	Table	Table	Const
Value:									1.2

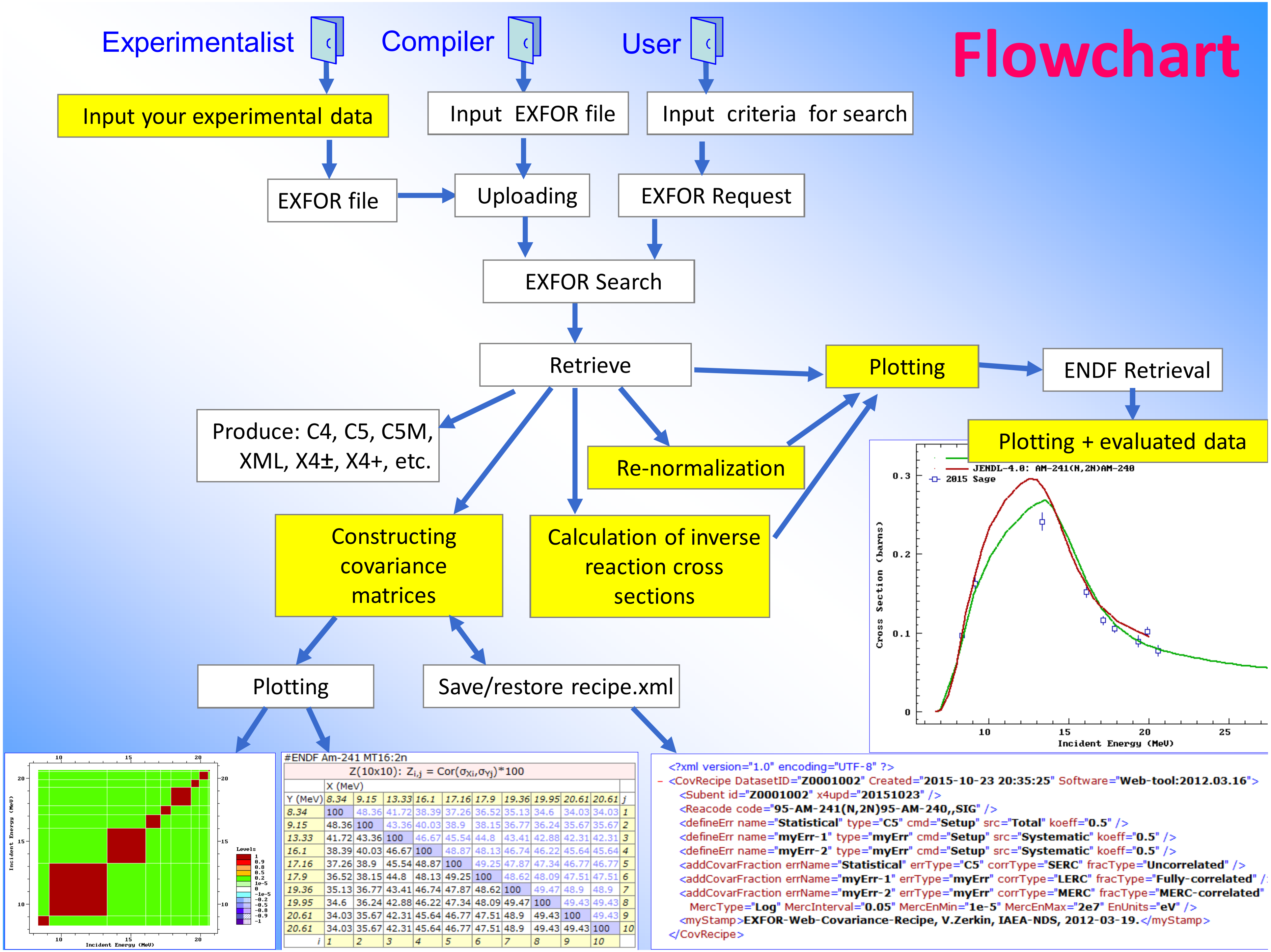
x y Δy . . . input your data below (copy/paste) . . .

8.34	96.8	6.5	1.9	5	1	.9	.3
9.15	162.9	5.7	1.9	4	1	.6	.3
13.33	241.8	4.6	1.6	2.5	1	.4	.3
16.1	152.4	4.6	2	2.1	1	.6	.3
17.16	116.1	4.4	2	1.5	1	.6	.3
17.9	105.7	4.4	2.2	1.3	.7	.7	.3
19.36	89.5	8.2	3.1	6.3	2	.6	1.3
19.95	102.1	5.8	4.1	1.4	1	.6	1.4
20.61	77.9	8.8	5.4	5.7	1.6	.6	1.4

Submit Reset

☑ Submit in new Window

Flowchart



#ENDF Am-241 MT16:2n

Z(10x10): $Z_{i,j} = Cor(\sigma_{Xi},\sigma_{Yj})*100$

	X (MeV)										
Y (MeV)	8.34	9.15	13.33	16.1	17.16	17.9	19.36	19.95	20.61	20.61	j
8.34	100	48.36	41.72	38.39	37.26	36.52	35.13	34.6	34.03	34.03	1
9.15	48.36	100	43.36	40.03	38.9	38.15	36.77	36.24	35.67	35.67	2
13.33	41.72	43.36	100	46.67	45.54	44.8	43.41	42.88	42.31	42.31	3
16.1	38.39	40.03	46.67	100	48.87	48.13	46.74	46.22	45.64	45.64	4
17.16	37.26	38.9	45.54	48.87	100	49.25	47.87	47.34	46.77	46.77	5
17.9	36.52	38.15	44.8	48.13	49.25	100	48.62	48.09	47.51	47.51	6
19.36	35.13	36.77	43.41	46.74	47.87	48.62	100	49.47	48.9	48.9	7
19.95	34.6	36.24	42.88	46.22	47.34	48.09	49.47	100	49.43	49.43	8
20.61	34.03	35.67	42.31	45.64	46.77	47.51	48.9	49.43	100	49.43	9
20.61	34.03	35.67	42.31	45.64	46.77	47.51	48.9	49.43	49.43	100	10
i	1	2	3	4	5	6	7	8	9	10	


```
<?xml version="1.0" encoding="UTF-8" ?>
- <CovRecipe DatasetID="Z0001002" Created="2015-10-23 20:35:25" Software="Web-tool:2012.03.16">
  <Subent id="Z0001002" x4upd="20151023" />
  <Reacode code="95-AM-241(N,2N)95-AM-240,,SIG" />
  <defineErr name="Statistical" type="C5" cmd="Setup" src="Total" koeff="0.5" />
  <defineErr name="myErr-1" type="myErr" cmd="Setup" src="Systematic" koeff="0.5" />
  <defineErr name="myErr-2" type="myErr" cmd="Setup" src="Systematic" koeff="0.5" />
  <addCovarFraction errName="Statistical" errType="C5" corrType="SERC" fracType="Uncorrelated" />
  <addCovarFraction errName="myErr-1" errType="myErr" corrType="LERC" fracType="Fully-correlated" /
  <addCovarFraction errName="myErr-2" errType="myErr" corrType="MERC" fracType="MERC-correlated"
   MercType="Log" MercInterval="0.05" MercEnMin="1e-5" MercEnMax="2e7" EnUnits="eV" />
  <myStamp>EXFOR-Web-Covariance-Recipe, V.Zerkin, IAEA-NDS, 2012-03-19.</myStamp>
</CovRecipe>
```

Thank you.