EXFOR data correction system.

EXFOR relational database. X4Lite. Accessing data in C5, XML, JSON.

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Contents

Part I.

EXFOR data correction system

EXFOR data correction system /2009-2015/
(renormalization system)

Goal: To create tools for re-calculation absolute values from EXFOR according to
(a) today's knowledge (new standards, decay data, abundances)
(b) evaluators' experience based on additional information about experiments

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

Initial plan:

2009
1) to define concept and syntax describing data corrections
2) to develop software implementing data corrections according the syntax
3) to develop software to generate automatic corrections using EXFOR information
4) to collect experts' corrections to a database
5) to develop Web system implementing (a) automatic, (b) experts' and (c) user's corrections in optional, semi-automatic and interactive modes

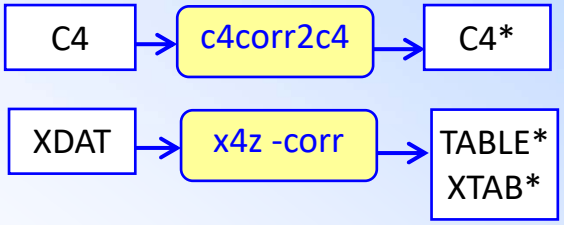
2014
6) to generate and distribute renormalized data for whole EXFOR database

Concept

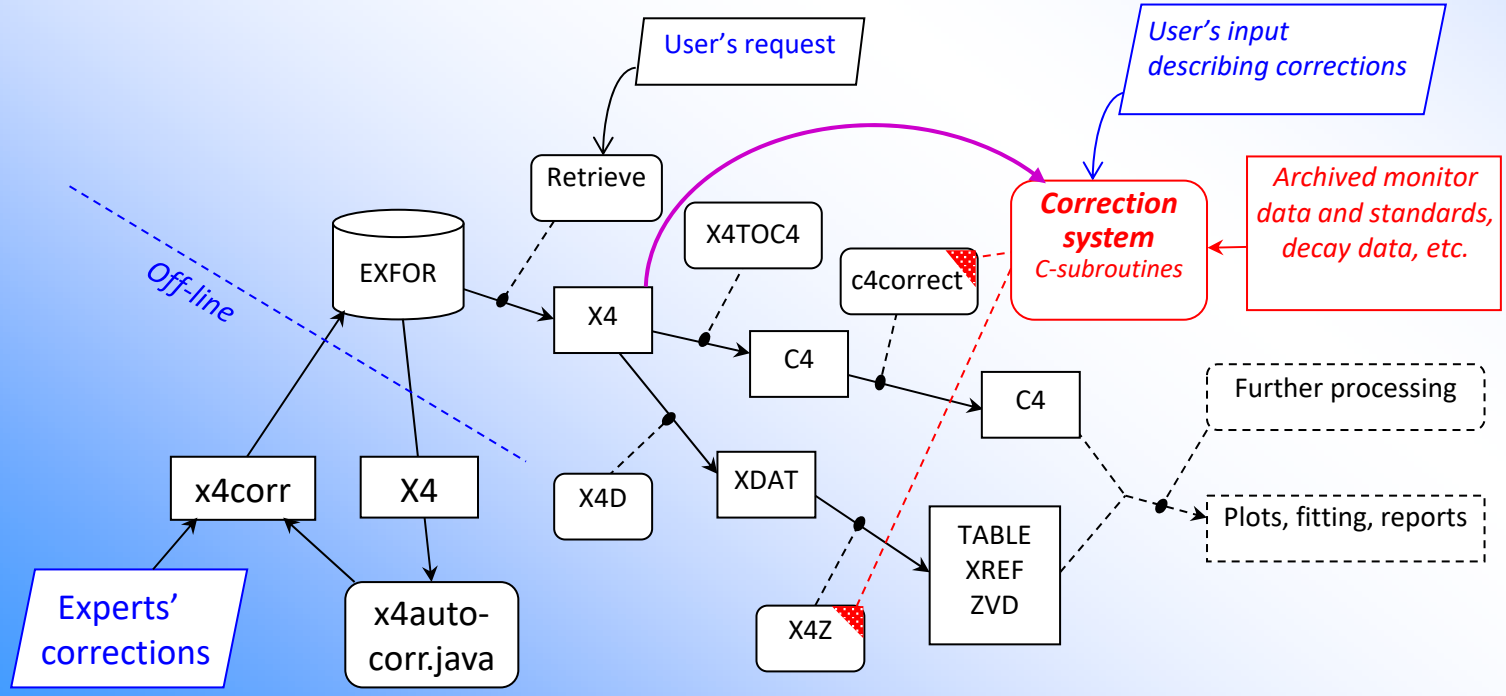
- We DO NOT change data in EXFOR.

  We re-normalize output from EXFOR system:
  - C4 computational format
  - TABLE, XREF (NNDC computational formats)

    Results can be plotted as:
    - Quick plots (TABLE)
    - Advanced plots (C4)
    - + comparison to evaluated data (ENDF)



Software structure and data flow



“Manual” and “automatic” 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.

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

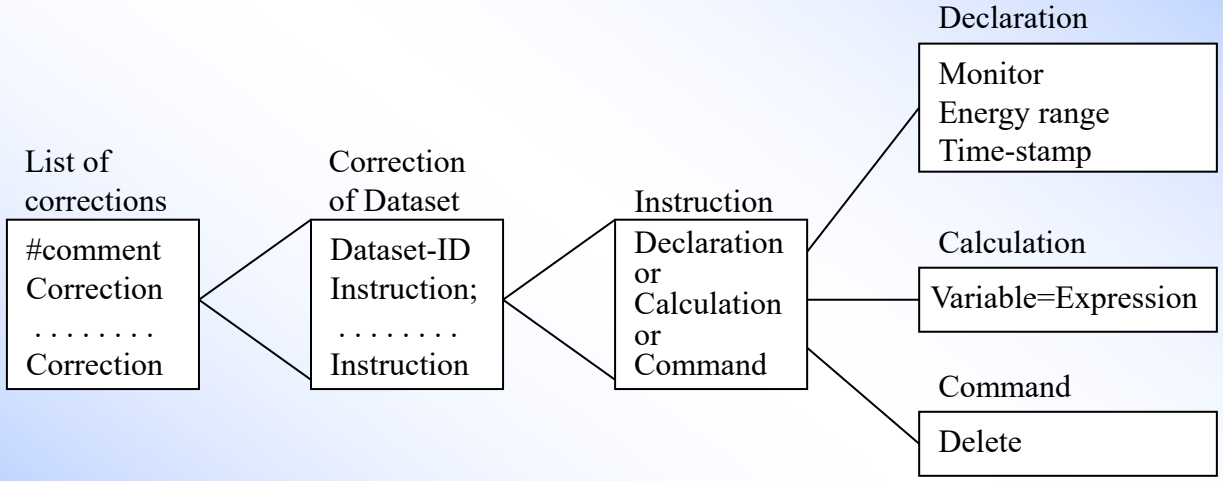
We are going to collect database of experts’ corrections.

Both methods need:

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

Syntax. Structure.

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.

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
//S. Mughabhab: 2009 request for Web system

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.

Syntax. 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.

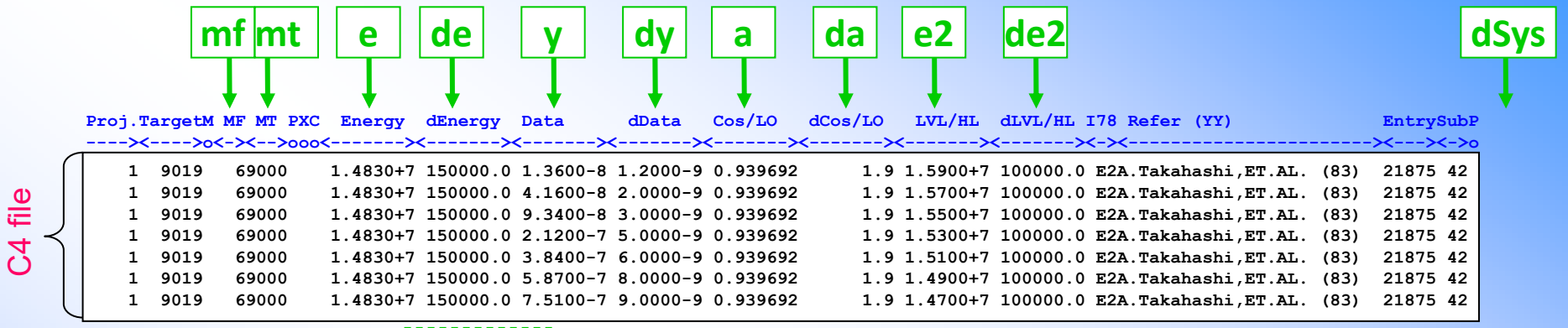
syntax: m0:[EN, MONIT, MONIT-ERR];
to describe column with monitor uncertainties (after that, dm0 will have a value)

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

example: y=y*m1/m0;

After you declare monitor (m0, m1, etc.), you can use variable (m0 , m1, etc.) in your expressions
Example: y=y*m1/m0;
dy=((dy/y)**2 -(dm0/m0)**2 +(dm1/m1)**2)**0.5*y;

Syntax. Mapping variables on C4 file.



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: 1-40, plus additions: 1-999)
16- 19	MT	MT	MT (ENDF conventions 1-999, plus additions: 1-9999)
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	Systematic uncertainty
141-149	dStat	dStat	Statistical uncertainty

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 order of operations

Calculations

syntax: variable=expression;

Traditional for programming languages

Results in 2011: “manual system”

- expert K.Zolotarev (physicist from IPPE, Russia) uses the system to prepare corrections and test the system (2011): 33 dataset for the reaction Zn-64(n,p) were analysed, correction file was prepared
- Zolotarev’s collection of monitors was adopted to archive and tested
- functions of the Web system were extended (precise data checking, uploading user’s monitor, etc.)
- syntax was extended to include parentheses and monitor data errors

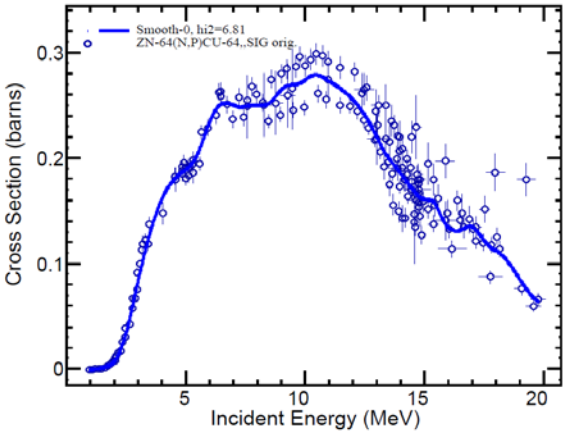
Example of Zolotarev’s corrections:

```
10224003                # 1972 D.C.Santry+
                        #measurements with T(p,n)He3 neutron source
                        #monitor S32(n,p)P32 reaction
a0=0.91582;             #experimental data were renormalized to the integral of
                        #cross-section calculated from experimental data of Mannhart
                        #and Schmidt 2007 in the overlapping energy
                        #range 1.500 - 3.958 MeV, a0=0.91582
a1=0.0115;              #error in b+ mode in Cu64 decay     - 1.15%
a2=0.03;                #error in normalization value       - 3%
a3=0.03;                #error in angular neutron intensity - 3%
m0: [en,monit];         #old cs for S32(n,p)P32 monitor reaction
m1: rrdf10 $ s32np;     #new cs for S32(n,p)P32 monitor reaction
c1=dm1/m1;              #relative error in new cs for S32(n,p)P32 monitor reaction
dy=dy/y;                #relative uncertainty in original cs for Zn64(n,p)Cu64 reaction
fc=m1/m0*a0;            #total correction factor
y=y*fc;                 #correction exp. cs
dy=dy^2+c1^2+a1^2+a2^2+a3^2; #determination the quadrature of new total error
dy=dy^0.5*y;            #determination the absolute error in new Zn64(n,p) cs

12956003                #1975 R.Spangler+
m0: [en,monit];         #old cs for Al27(n,a)Na24 monitor reaction
m1: rrdf10 $ al27na;    #new cs for Al27(n,a)Na24 monitor reaction
a=0.380/0.348;          #correction to new  511 keV gamma-yield per decay Cu-64
fc=m1/m0*a;             #total correction factor
y=y*fc;                 #correction exp. cs
dy=dy*fc;               #correction  abs. uncertainty in renorm. cs
```

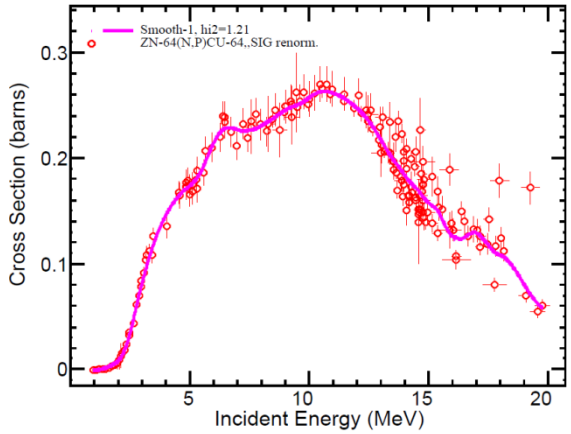
Example of “manual” corrections results

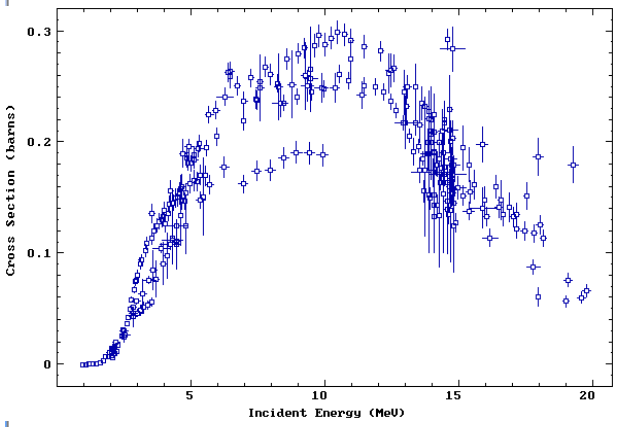
by K.Zolotarev, 2011



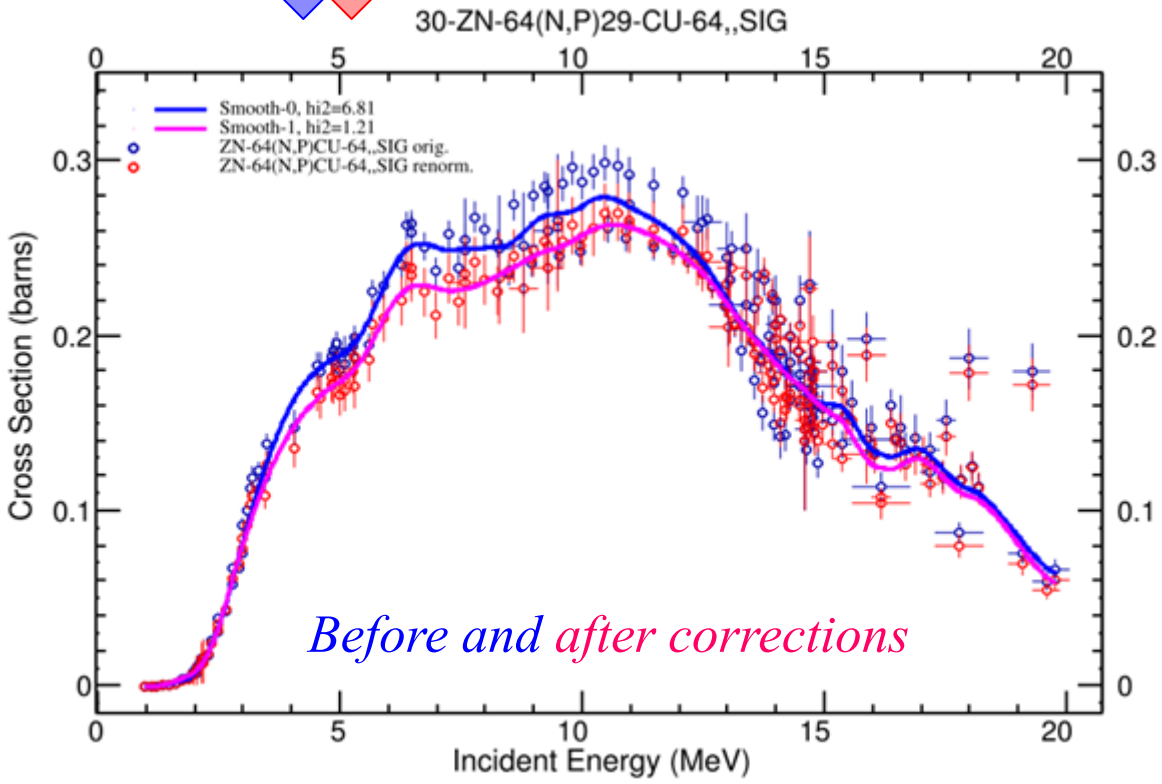
Data selected

Data corrected

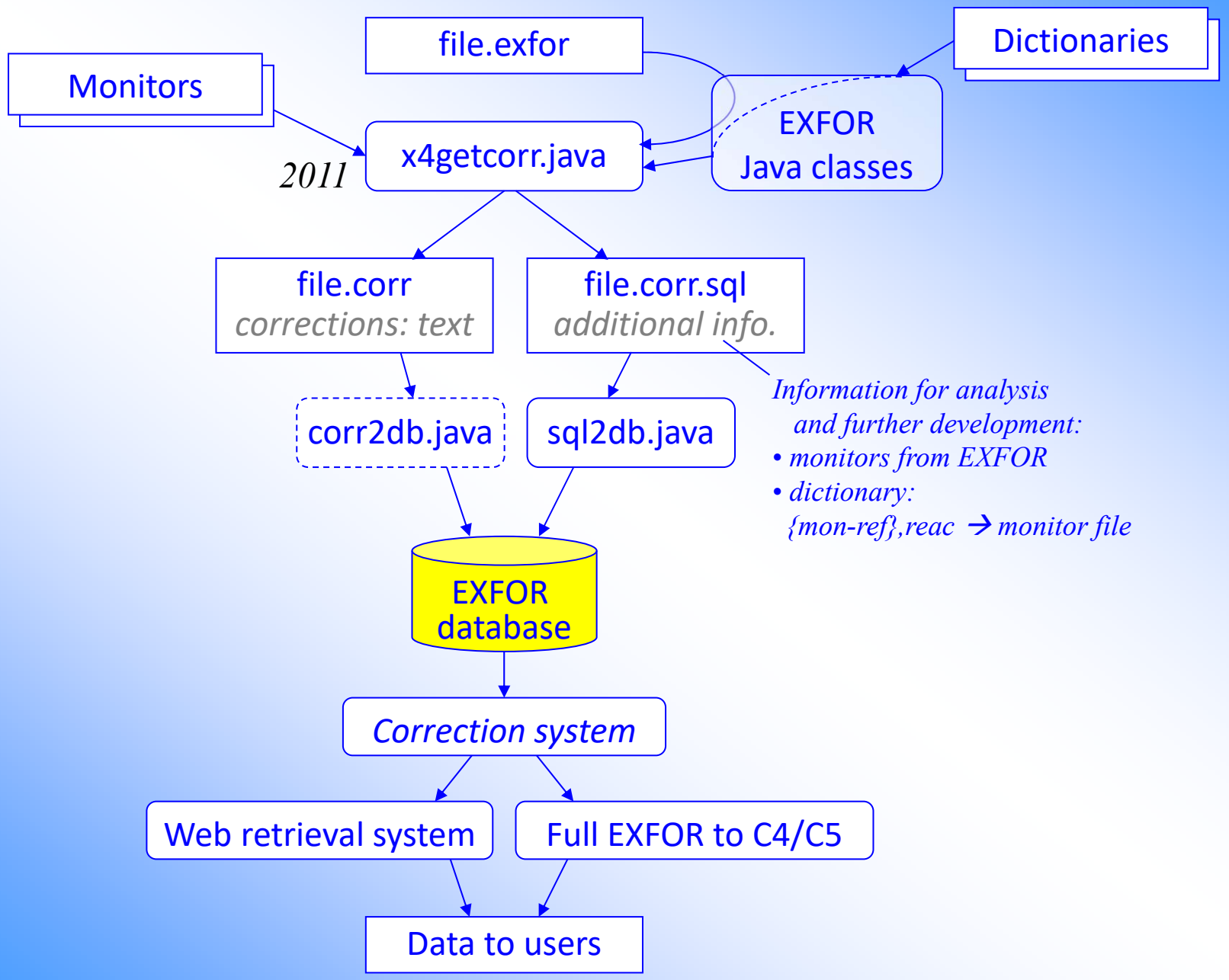




Original EXFOR data



Automatic corrections based on EXFOR information



Available automatic corrections

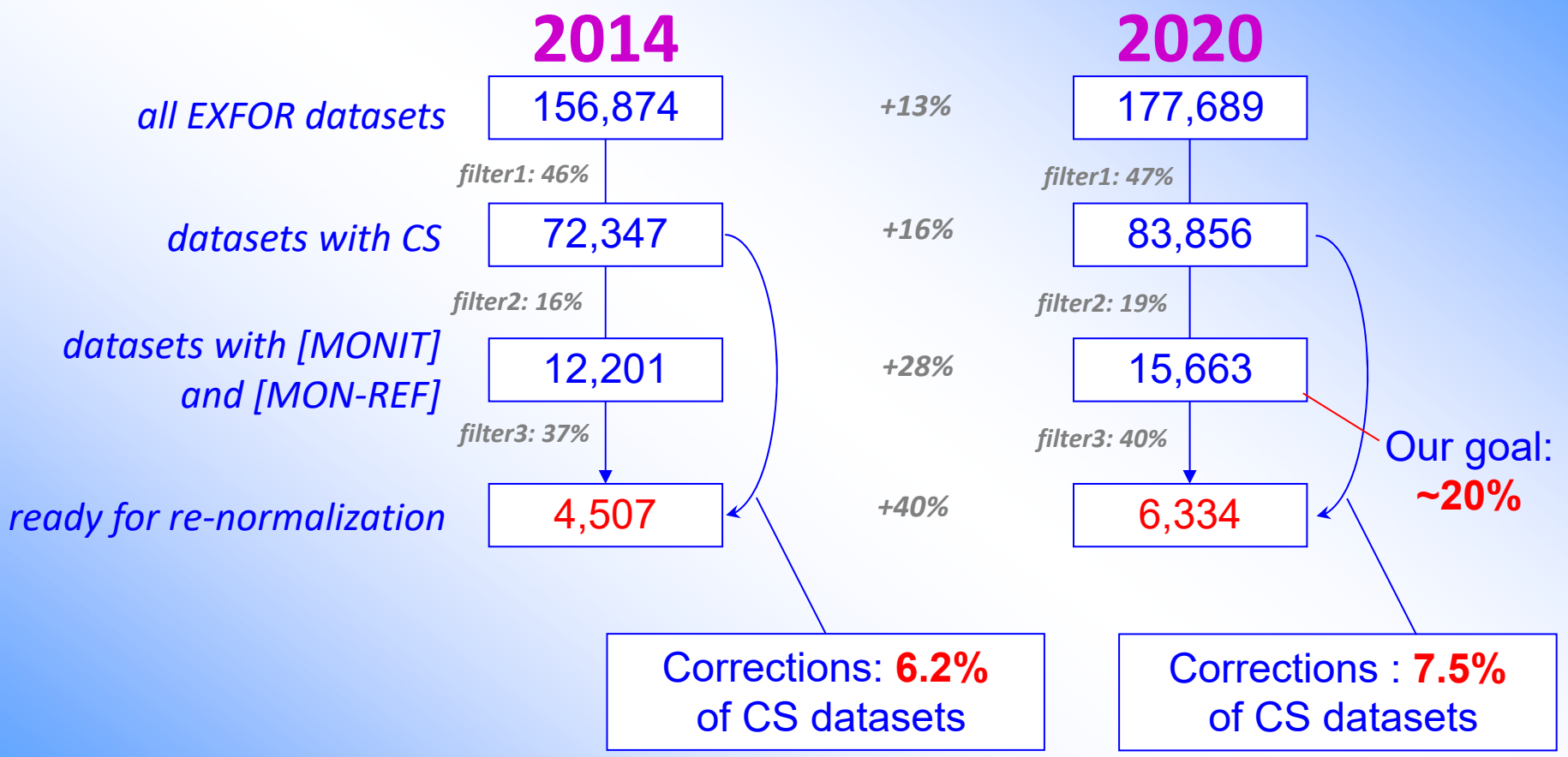


Table Name: x4corr

Columns and Indices | Table Options

Column Name	Datatype	NOT NULL
DatasetID	VARCHAR(9)	✓
author	VARCHAR(40)	✓
itype	VARCHAR(40)	
fileID	INTEGER	✓
fileDate	DATE	
dbDate	DATE	
x4reac	VARCHAR(255)	
x4monreac	VARCHAR(255)	
pts	INTEGER	
enMin	DOUBLE	
enMax	DOUBLE	
m0lib	VARCHAR(255)	
monreac	VARCHAR(255)	
m1lib	VARCHAR(255)	
monfile	VARCHAR(255)	
link2exfor	VARCHAR(255)	
link2endf	VARCHAR(255)	
ratioGiven	INTEGER	
oldMonitorExists	INTEGER	
monitorFileExi...	INTEGER	
ready4correc...	INTEGER	
strcorr	VARCHAR(8192)	

Corrections in EXFOR database

← Table x4corr used for system's extensions

Missing new-monitor-file (neutron induced)

monfile	x4monreac	noNewMonFile
b0nabs	5-B-0(N,ABS),,SIG,,MXW	246
i127ng	53-I-127(N,G)53-I-128,,SIG	222
co59ng	27-CO-59(N,G)27-CO-60,,SIG,,MXW	206
pu239nf	94-PU-239(N,F),,SIG	80
fe56ninl	26-FE-56(N,INL)26-FE-56,,SIG,G	75
mn55ng	25-MN-55(N,G)25-MN-56,,SIG	61
in115ng	49-IN-115(N,G)49-IN-116-M,,SIG	61
v51nel	23-V-51(N,EL)23-V-51,,SIG	46
in0ng	49-IN-0(N,G),,SIG	46
h1ng	1-H-1(N,G)1-H-2,,SIG	44

Missing new-monitor-file (CP and gamma)

monfile	x4monreac	noNewMonFile
al27pn3p	13-AL-27(P,N+3P)11-NA-24,,SIG	290
al27dx	13-AL-27(D,X)11-NA-24,,SIG	223
al27c12x	13-AL-27(6-C-12,X)11-NA-24,,SIG	64
ti0dx	22-TI-0(D,X)23-V-48,,SIG	49
al27gx	13-AL-27(G,X)11-NA-24,,SIG,,BRA	41
al27ax	13-AL-27(A,X)11-NA-24,,SIG	40
al27p3n3p	13-AL-27(P,3N+3P)11-NA-22,,SIG	38
au197af	79-AU-197(A,F),,SIG	37

Corrections database

Experts' correction database

#	Last update	Title	Datasets
1	2014-07-03	K.Zolotarev 2011, Zn64(n,p)Cu64	33
2	2014-07-02	K.Zolotarev 2011, Fe-54(n,p)Mn-54	30
3	2014-07-03	A.Trkov 2012, Mn-55(n,2n)	48
4	2014-07-03	D.Smith and R.Capote 2010	59
5	2016-09-23	R.Capote 2016-09-23, Fe-0(n,2n)	2
6	2018-09-12	H.Sjoestrand 2018, Ni-59(n,*)	10
			182

Automatic correction database

#	Type	Generated	Ready
1	MON-REF	6301	333 (5%)
2	X4DATA (EN)	1905	1345 (70%)
3	X4POINT	7457	4656 (62%)
		15663	6334 (40%)

6. Library: ENDF-B/VI, USA, 1990
6.1. m0: endfb6 $ al27np;
6.2. m0: endfb6 $ al27na;
6.3. m0: endfb6 $ u235nf;
6.4. m0: endfb6 $ u238nf;

7. Library: ENDF-B/V, USA, 1984
7.1. m0: endfb5 $ li6nt;
7.2. m0: endfb5 $ al27np;
7.3. m0: endfb5 $ al27na;
7.4. m0: endfb5 $ fe56np;
7.5. m0: endfb5 $ in115nnm;
7.6. m0: endfb5 $ u235nf;

8. Library: ENDF-B/IV, USA, 1974
8.1. m0: endfb4 $ al27np;
8.2. m0: endfb4 $ al27na;
8.3. m0: endfb4 $ fe56np;
8.4. m0: endfb4 $ ni58np;
8.5. m0: endfb4 $ u235nf;

9. Library: IRK-90, H.Vonach, Vienna, 1990
9.1. m0: irk90 $ al27na;
9.2. m0: irk90 $ nb93n2nm;
9.3. m0: irk90 $ au197n2n;
9.4. m0: irk90 $ zr90n2n;

10. Monitors used in the past
10.1. m0: gammel60 $ h01nn;
J.L.Gammel, Fast Neutron Physics, Vol II, p.2185, Interscience Pub., Inc., New York, 1960
10.2. m0: sowerbay73 $ u238nf;
M.G.Sowerby et al. Report AERE-R-7373, 1973
10.3. m0: allen58 $ u235nf;
W.D.Allen, R.Henkel
Fast Neutron on the Isotopes of Thorium, Uranium and Pluttonium.
Progress in Nuclear Energy. Pergamon Press, New York, 1958, series 1, vol.2, pp. 1-50
10.4. m0: smith57 $ u238nf;
R.K.Smith, R.L.Henkel, R.A.Nobles
Neutron-Induced Fission Cross Sections for U233, U235, U238 and Pu241 from 2 To 10 MeV.
Bulletin of the American Physical Society; Vol.2, p.196(K4), 1957
10.5. m0: vonach83 $ al27na;
H.Vonach
The Al-27(n,a)Na-24 Cross Section. Nuclear Data Standards for Nuclear Measurements. Technical Reports Series No.227, IAEA, Vienna, 1983, pp.59-63
10.6. m0: filatenkov96 $ nb93n2nm;
A.A.Filatenkov et al.
Systematic Measurement of Activation Cross Sections et Neutron Energy of 13.4 - 14.9 MeV.
VANT, Ser.:Yadernye Konstanty, v.2, p.8, Moscow, 1996

Libraries: 10, files: 69. Last update: 2015-03-30

Archive of monitors

- Organized in two level structure: library $ monitor ==> directory / file
- Data are stored in 3-col. text files
- Monitor-covariance: not yet
- Total: 69 data files
- Initial source: IRDF-2002 project (K.Zolotarev, IPPE, Russia)
- Last update: 2015-03-30

Example: Energy dependent monitor given in DATA section

```
SUBENT        10421001   20030221
REFERENCE   (J,NSE,57,300,197508)
AUTHOR      (W.P.Poenitz)
TITLE       Measurements of the Neutron Capture Cross Sections of
            Gold-197 and Uranium-238 Between 20 and 3500 keV
SUBENT        10421003   20030221
REACTION    (92-U-238(N,G)92-U-239,,SIG)
MONITOR     (79-AU-197(N,G)79-AU-198,,SIG) Relative standard
DATA                  6         44
EN          EN-RSL      DATA        DATA-ERR    MONIT       MONIT-ERR
KEV         KEV         MB          MB          MB          PER-CENT
 20.          4.          631.         54.         720.         2.
 24.                      550.         47.         655.         2.
 28.                      490.         42.         600.         2.
 32.                      459.         39.         552.         2.
 36.                      434.         37.         518.         2.
 40.                      425.         37.         488.         2.
 44.                      389.         33.         464.         2.
 48.                      353.         30.         446.         2.
 52.                      315.         27.         430.         2.
 56.                      305.         26.         412.         2.
```

Automatically generated by x4getcorr.java

```
10421003  x4u:20030221  #1975 Poenitz
#Reaction: 92-U-238(N,G)92-U-239,,SIG
#Monitor:  79-AU-197(N,G)79-AU-198,,SIG
m0: [EN,MONIT,MONIT-ERR];      #old monitor(energy)
m1: recom$au197ng;             #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 uncertaintie
dy=dy*y;                       #to abs. uncertainties
```

```
-1  En(MeV)=0.02    Y(mb)=631       dY(mb)=54        (8.56%) 10421003  W.P.Poenitz (75)
+1                  Y(mb)=614.184   dY(mb)=52.107    (8.48%) 10421003  *Fc=0.973351
-2  En(MeV)=0.024   Y(mb)=550       dY(mb)=47        (8.55%) 10421003  W.P.Poenitz (75)
+2                  Y(mb)=540.62    dY(mb)=45.7459   (8.46%) 10421003  *Fc=0.982946
-3  En(MeV)=0.028   Y(mb)=490       dY(mb)=42        (8.57%) 10421003  W.P.Poenitz (75)
+3                  Y(mb)=497.788   dY(mb)=42.3081   (8.50%) 10421003  *Fc=1.01589
-4  En(MeV)=0.032   Y(mb)=459       dY(mb)=39        (8.50%) 10421003  W.P.Poenitz (75)
+4                  Y(mb)=478.342   dY(mb)=40.3473   (8.43%) 10421003  *Fc=1.04214
-5  En(MeV)=0.036   Y(mb)=434       dY(mb)=37        (8.53%) 10421003  W.P.Poenitz (75)
+5                  Y(mb)=453.274   dY(mb)=38.4025   (8.47%) 10421003  *Fc=1.04441
-6  En(MeV)=0.04    Y(mb)=425       dY(mb)=37        (8.71%) 10421003  W.P.Poenitz (75)
+6                  Y(mb)=441.328   dY(mb)=38.2229   (8.66%) 10421003  *Fc=1.03842
-7  En(MeV)=0.044   Y(mb)=389       dY(mb)=33        (8.48%) 10421003  W.P.Poenitz (75)
+7                  Y(mb)=396.12    dY(mb)=33.4425   (8.44%) 10421003  *Fc=1.0183
-8  En(MeV)=0.048   Y(mb)=353       dY(mb)=30        (8.50%) 10421003  W.P.Poenitz (75)
+8                  Y(mb)=357.414   dY(mb)=30.2427   (8.46%) 10421003  *Fc=1.0125
-9  En(MeV)=0.052   Y(mb)=315       dY(mb)=27        (8.57%) 10421003  W.P.Poenitz (75)
+9                  Y(mb)=318.742   dY(mb)=27.2133   (8.54%) 10421003  *Fc=1.01188
-10 En(MeV)=0.056   Y(mb)=305       dY(mb)=26        (8.52%) 10421003  W.P.Poenitz (75)
+10                 Y(mb)=310.399   dY(mb)=26.3649   (8.49%) 10421003  *Fc=1.0177
```

Generated by x4-correction system on Web

Example: monitor given in MONIT-REF pointing to ENDF/B-V

```
SUBENT         22325001    20190205    20190424    20190420        2274
BIB                 17          70
TITLE        Activation cross section measurement of reactions
             producing short-lived nuclei at neutron energy
             between 13.4 MeV and 14.9 MeV
AUTHOR      (Y.Kasugai, H.Yamamoto, K.Kawade, Y.Ikeda, Y.Uno,
             H.Maekawa)
REFERENCE   (C,94GATLIN,2,935,1994) Main ref.
MONITOR     (13-AL-27(N,P)12-MG-27,,SIG) Based on the standard
             Al-27(n,a) reaction in ENDF/B-V.
MONIT-REF   (,,3,ENDF/B-V,,1978)
. . . . . .
SUBENT         22325004    20190205    20190424    20190420
REACTION    (26-FE-57(N,P)25-MN-57,,SIG)
DATA                3           6
EN          DATA        ERR-T
MEV         MB          MB
      13.38        63.          7.
      13.70        60.          4.
      14.03        59.          4.
      14.36        59.          4.
      14.66        55.          4.
      14.95        53.          4.
ENDDATA              8
ENDSUBENT           17
```

Automatically generated by x4getcorr.java

```
22325004  x4u:20190205  #1994 Kasugai
#Reaction: 26-FE-57(N,P)25-MN-57,,SIG
#Monitor:  13-AL-27(N,P)12-MG-27,,SIG
#m0: {,,3,ENDF/B-V,,1978} $ al27np;#old monit-ref
m0: endfb5$al27np;          #old monitor(energy) in ENDF
m1: recom$al27np;           #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 uncertaintie
dy=dy*y;                    #to abs. uncertainties
```

```
-1 En(MeV)=13.38   Y(mb)=63        dY(mb)=7         (11.11%)22325004   Y.Kasugai+ (94)
+1                 Y(mb)=64.8167   dY(mb)=7.17063   (11.06%)22325004   *Fc=1.02884
-2 En(MeV)=13.7    Y(mb)=60        dY(mb)=4         (6.67%) 22325004   Y.Kasugai+ (94)
+2                 Y(mb)=60.1809   dY(mb)=3.96481   (6.59%) 22325004   *Fc=1.00302
-3 En(MeV)=14.03   Y(mb)=59        dY(mb)=4         (6.78%) 22325004   Y.Kasugai+ (94)
+3                 Y(mb)=57.7125   dY(mb)=3.86958   (6.70%) 22325004   *Fc=0.978177
-4 En(MeV)=14.36   Y(mb)=59        dY(mb)=4         (6.78%) 22325004   Y.Kasugai+ (94)
+4                 Y(mb)=56.1903   dY(mb)=3.76892   (6.71%) 22325004   *Fc=0.952378
-5 En(MeV)=14.66   Y(mb)=55        dY(mb)=4         (7.27%) 22325004   Y.Kasugai+ (94)
+5                 Y(mb)=51.193    dY(mb)=3.68991   (7.21%) 22325004   *Fc=0.930782
-6 En(MeV)=14.95   Y(mb)=53        dY(mb)=4         (7.55%) 22325004   Y.Kasugai+ (94)
+6                 Y(mb)=48.3388   dY(mb)=3.6192    (7.49%) 22325004   *Fc=0.912052
```

Generated by x4-correction system on Web

Correction protocol

Applied corrections. Datasets: 1

1) EXFOR:#22325004 Ref:Y.Kasugai,ET.AL. (94) Corrected_Points:6 yFactor_Ave:0.96754 yFactor_Min:0.912052 yFactor_Max:1.02884

22325004 X4U:20190205; M0:endfb5$al27np; M1:recom$al27np; dY=dY/Y; Y=Y/M0*M1; tmp0=dY^2-dM0^2+dM1^2; dY=tmp0^0.5; dY=dY*Y;

Example: monitor given in MONIT-REF pointing to EXFOR

```
ENTRY            30581   20090506
REFERENCE   (J,APP/B,11,853,198011) Final
AUTHOR      (E.Zupranska,K.Rusek,J.Turkiewicz,P.Zupranski)
TITLE       Excitation functions for (n,a) reactions in the neutron
            energy range from 13 to 18 MeV.
MONITOR     (26-FE-56(N,P)25-MN-56,,SIG)
MONIT-REF   (20377002,H.LISKIEN+,J,JNE/AB,19,73,196502)
STATUS      (APRVD) Approved with corrections, by M.Herman,81/06/15
SUBENT         30581004   20090506
REACTION    (25-MN-55(N,A)23-V-52,,SIG)
DATA                 4         10
EN          EN-RSL      DATA        ERR-T
MEV         MEV         MB          MB
 1.3000E+01 1.0000E-01 2.1900E+01 2.1000E+00
 1.3300E+01 1.0000E-01 2.1800E+01 1.4000E+00
 1.3900E+01 2.0000E-01 2.4100E+01 1.5000E+00
 1.4500E+01 2.0000E-01 2.7700E+01 1.6000E+00
 1.5100E+01 2.0000E-01 2.9200E+01 1.9000E+00
 1.5500E+01 2.0000E-01 2.4900E+01 1.8000E+00
 1.5900E+01 2.0000E-01 2.3700E+01 2.2000E+00
 1.6600E+01 1.0000E-01 2.3900E+01 2.6000E+00
 1.7400E+01 2.0000E-01 2.1300E+01 2.6000E+00
 1.7800E+01 1.0000E-01 1.8100E+01 2.4000E+00
ENDDATA             12
```

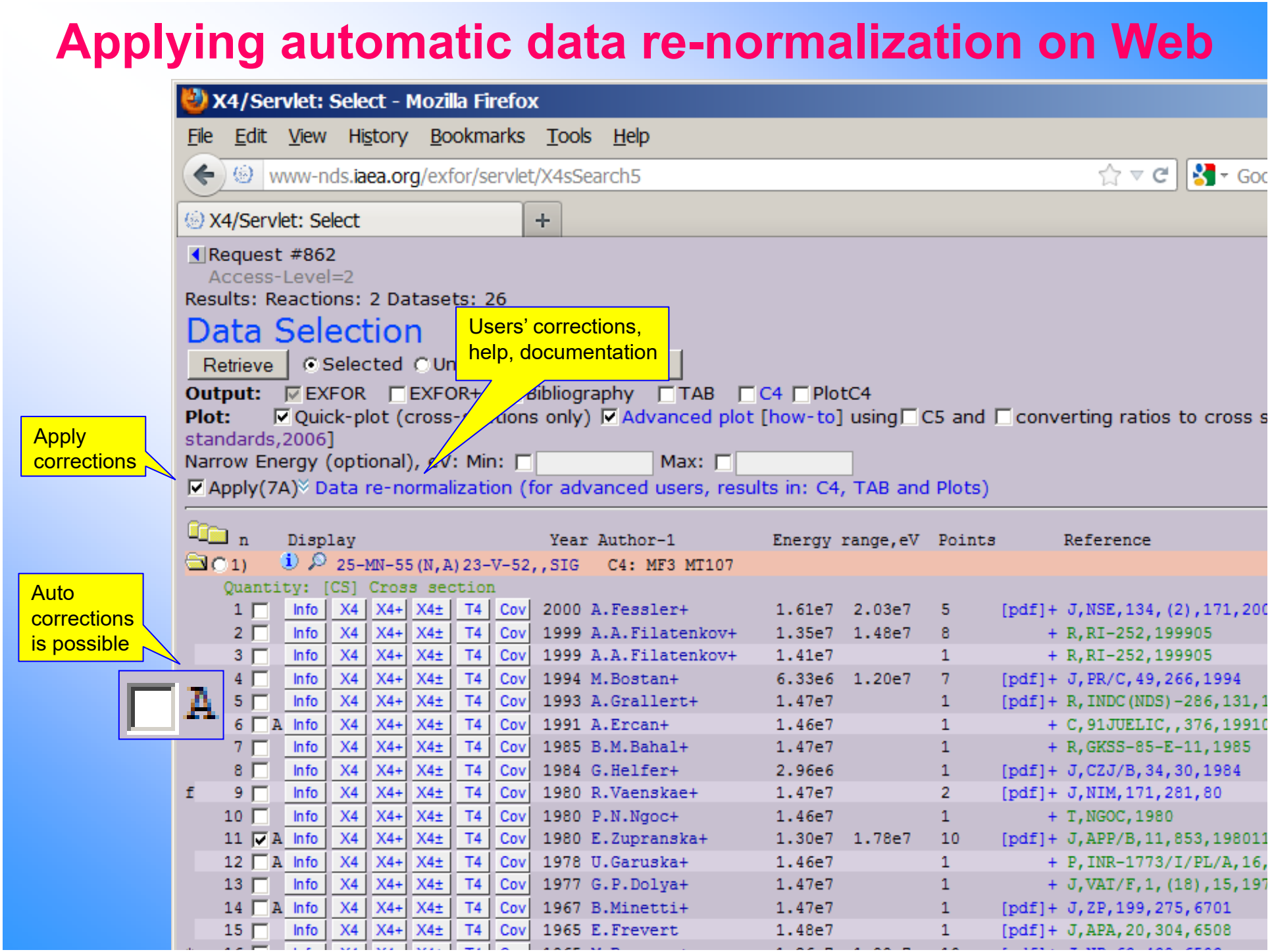
Automatically generated by x4getcorr.java

```
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$20377002_fe56np;     #old monitor(energy)
m1: recom$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
```

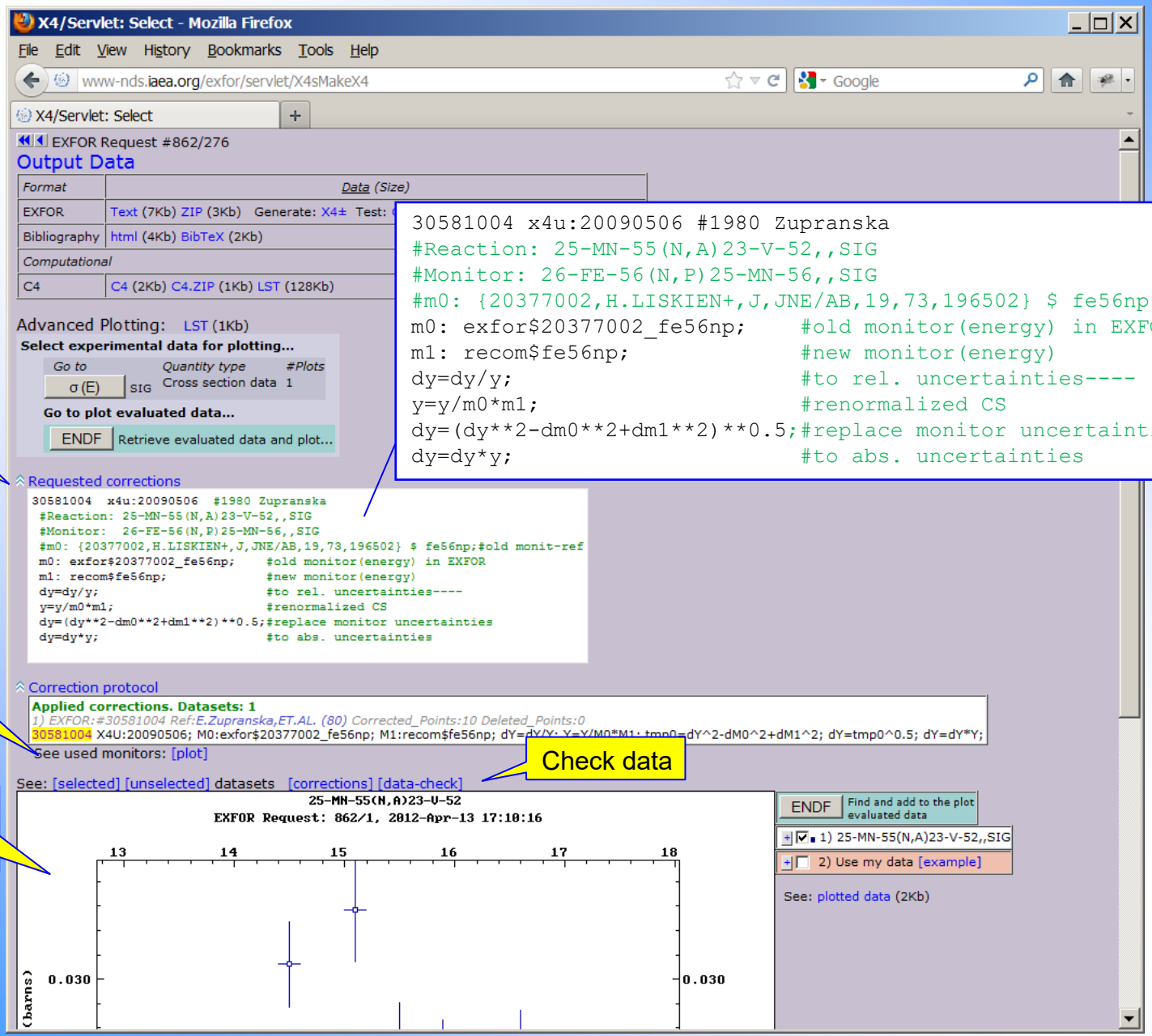
```
-1  En(MeV)=13   Y(mb)=21.9     dY(mb)=2.1      (9.59%) 30581004  E.Zupranska,ET.AL.(80)
+1               Y(mb)=22.258   dY(mb)=2.12897 (9.56%) 30581004  *Fc=1.01635
-2  En(MeV)=13.3 Y(mb)=21.8     dY(mb)=1.4      (6.42%) 30581004  E.Zupranska,ET.AL.(80)
+2               Y(mb)=22.3688  dY(mb)=1.42838 (6.39%) 30581004  *Fc=1.02609
-3  En(MeV)=13.9 Y(mb)=24.1     dY(mb)=1.5      (6.22%) 30581004  E.Zupranska,ET.AL.(80)
+3               Y(mb)=25.8839  dY(mb)=1.60114 (6.19%) 30581004  *Fc=1.07402
-4  En(MeV)=14.5 Y(mb)=27.7     dY(mb)=1.6      (5.78%) 30581004  E.Zupranska,ET.AL.(80)
+4               Y(mb)=30.6262  dY(mb)=1.75976 (5.75%) 30581004  *Fc=1.10564
-5  En(MeV)=15.1 Y(mb)=29.2     dY(mb)=1.9      (6.51%) 30581004  E.Zupranska,ET.AL.(80)
+5               Y(mb)=32.8526  dY(mb)=2.12995 (6.48%) 30581004  *Fc=1.12509
-6  En(MeV)=15.5 Y(mb)=24.9     dY(mb)=1.8      (7.23%) 30581004  E.Zupranska,ET.AL.(80)
+6               Y(mb)=27.1053  dY(mb)=1.95423 (7.21%) 30581004  *Fc=1.08857
-7  En(MeV)=15.9 Y(mb)=23.7     dY(mb)=2.2      (9.28%) 30581004  E.Zupranska,ET.AL.(80)
+7               Y(mb)=25.9568  dY(mb)=2.40631 (9.27%) 30581004  *Fc=1.09522
-8  En(MeV)=16.6 Y(mb)=23.9     dY(mb)=2.6      (10.88%)30581004  E.Zupranska,ET.AL.(80)
+8               Y(mb)=25.9387  dY(mb)=2.82001 (10.87%)30581004  *Fc=1.0853
-9  En(MeV)=17.4 Y(mb)=21.3     dY(mb)=2.6      (12.21%)30581004  E.Zupranska,ET.AL.(80)
+9               Y(mb)=22.7836  dY(mb)=2.77977 (12.20%)30581004  *Fc=1.06965
-10 En(MeV)=17.8 Y(mb)=18.1     dY(mb)=2.4      (13.26%)30581004  E.Zupranska,ET.AL.(80)
+10              Y(mb)=19.3299  dY(mb)=2.56225 (13.26%)30581004  *Fc=1.06795
```

Generated by x4-correction system on Web

Applying automatic data re-normalization on Web



Automatic 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

Plot result of corrections

Check data

Automatic re-normalization: data checking

Old data

Old uncertainty

Final Factor

New data

New uncertainty

Plot old and new monitors

Mozilla Firefox

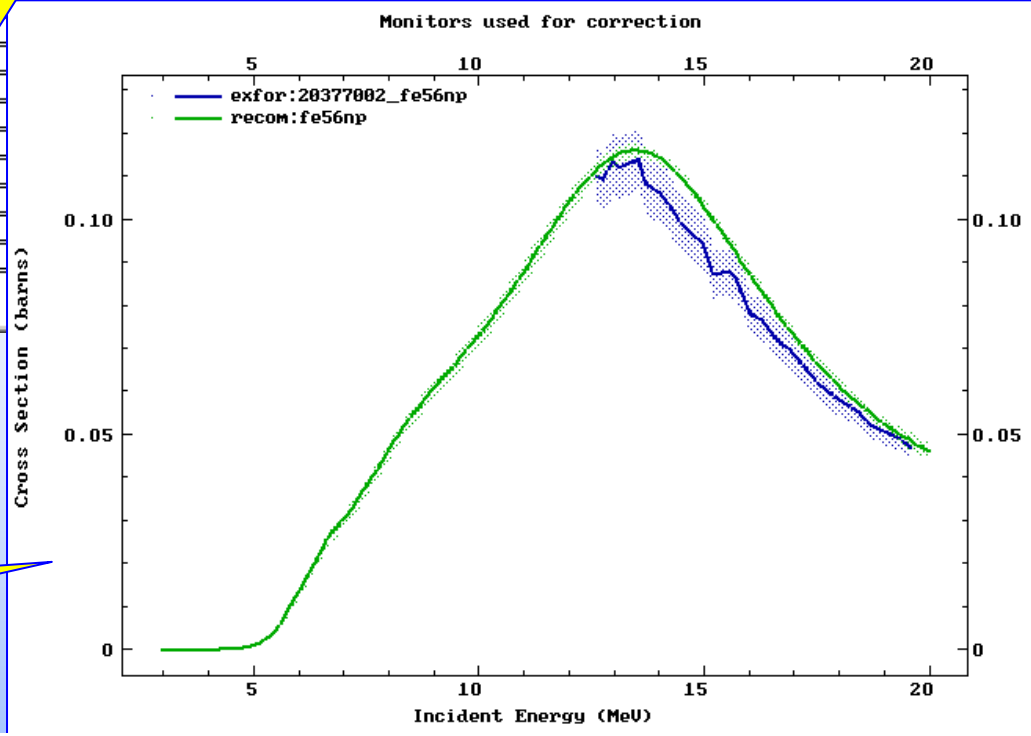
File Edit View History Bookmarks Tools Help

www-nds.iaea.org/exf.../servlet/X4sShowData?db=x4&op=g...x4&req=8

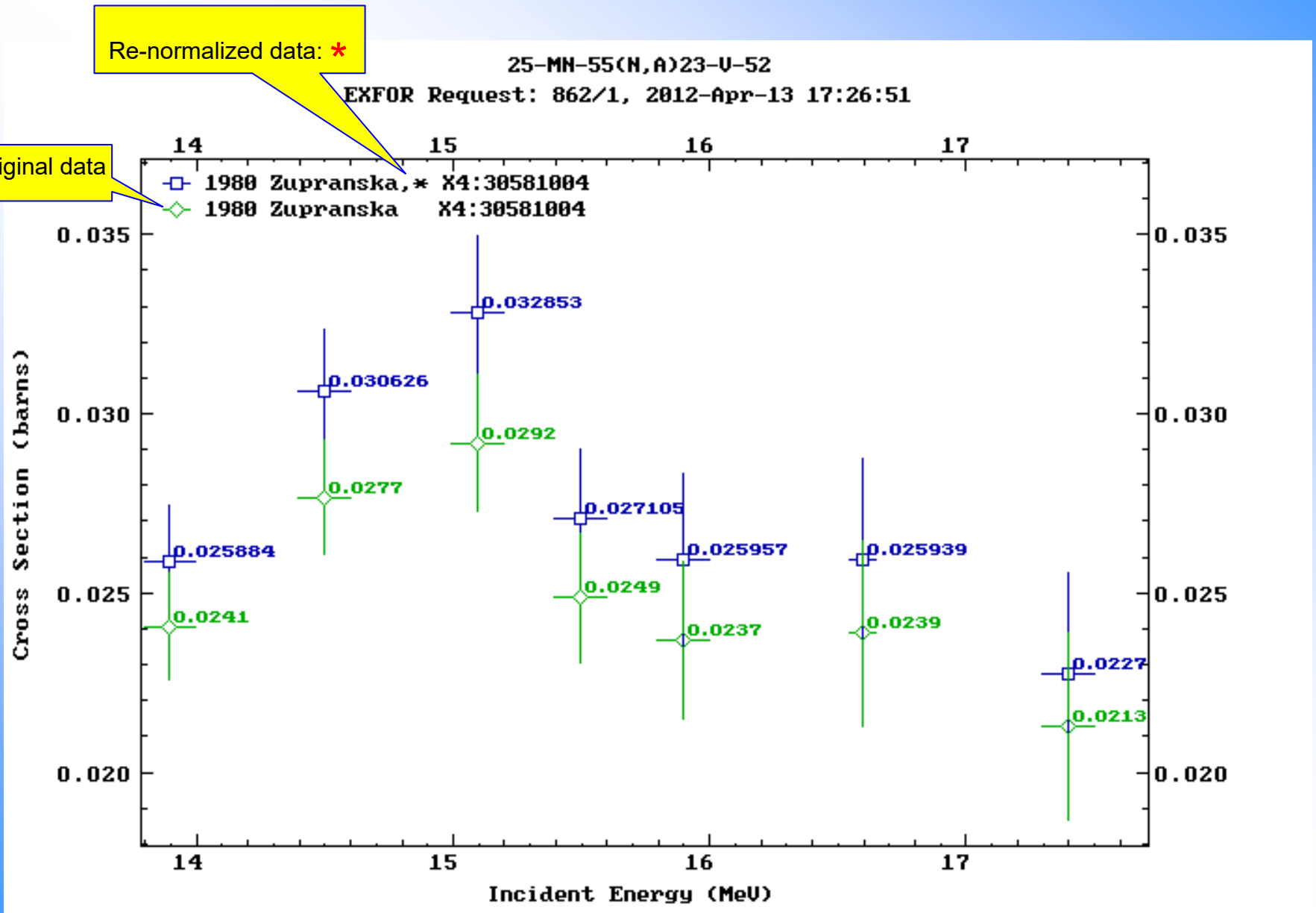
Google

X4/Servlet: Select | http://www-nds...x4.c4.datamod | http://www-nds...2_mon_factors

-1	En(MeV)=13	Y(mb)=21.9	dY(mb)=2.1	(9.59%)	30581004	E.Zupranska,ET.AL. (80)
+1		Y(mb)=22.258	dY(mb)=2.12897	(9.56%)	30581004	*Fc=1.01635
-2	En(MeV)=13.3	Y(mb)=21.8	dY(mb)=1.4	(6.42%)	30581004	E.Zupranska,ET.AL. (80)
+2		Y(mb)=22.3688	dY(mb)=1.42838	(6.39%)	30581004	*Fc=1.02609
-3	En(MeV)=13.9	Y(mb)=24.1	dY(mb)=1.5	(6.22%)	30581004	E.Zupranska,ET.AL. (80)
+3		Y(mb)=25.8839	dY(mb)=1.601...	(6.19%)	30581004	*Fc=1.07402
-4	En(MeV)=14.5	Y(mb)=27.7	dY(mb)=1.6	(5.78%)	30581004	E.Zupranska,ET.AL. (80)
+4		Y(mb)=30.6262	dY(mb)=1.5976	(5.75%)	30581004	*Fc=1.10564
-5	En(MeV)=15.1	Y(mb)=29.2	dY(mb)=1.9	(6.51%)	30581004	E.Zupranska,ET.AL. (80)
+5		Y(mb)=32.8526	dY(mb)=2.12995	(6.48%)	30581004	*Fc=1.12509
-6	En(MeV)=15.5	Y(mb)=24.9	dY(mb)=...			
+6		Y(mb)=27.1053	dY(mb)=...			
-7	En(MeV)=15.9	Y(mb)=23.7	dY(mb)=...			
+7		Y(mb)=25.9568	dY(mb)=...			
-8	En(MeV)=16....	Y(mb)=23.9	dY(mb)=...			
+8		Y(mb)=25.9387	dY(mb)=...			
-9	En(MeV)=1...4	Y(mb)=21.3	dY(mb)=...			
+9		Y(mb)=22.78...	dY(mb)=...			
-10	En(MeV)...8	Y(mb)=18.1	dY(mb)=...			
+10		Y(mb)=19...9	dY(mb)=...			

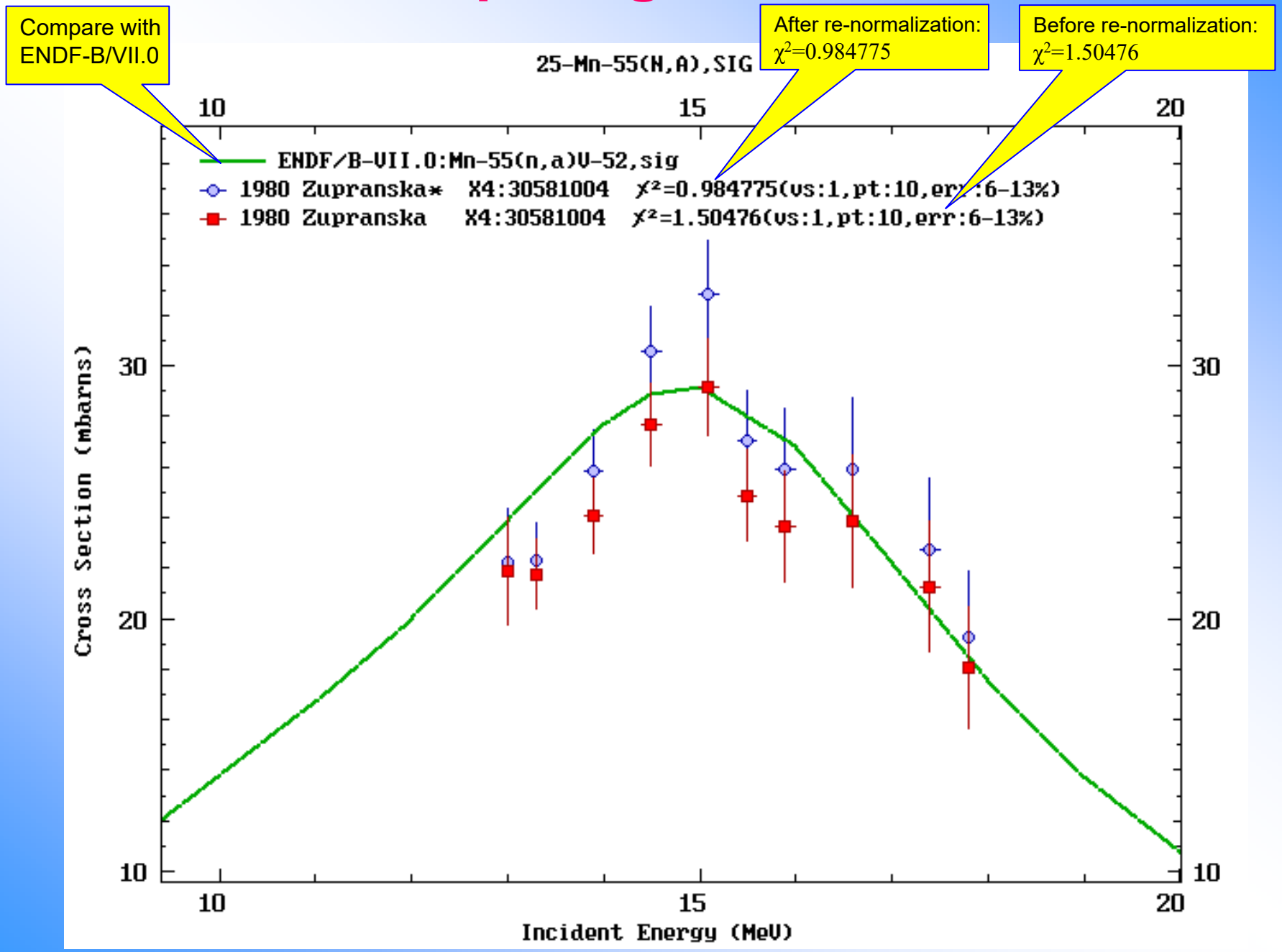


Automatic data re-normalization: common plot



Plotting: Copy/Paste

Comparing to ENDF



Documentation, online help

www-nds.iaea.org

Corrections of experimental data given in computational formats.
V.Zerkin, IAEA-NDS, November 2009 – May 2011
https://www-nds.iaea.org/exfor/x4guide/x4corrections/x4corrections.pdf

EXFOR Correction Coding. Online help.
https://www-nds.iaea.org/exfor/x4js/help_corr.htm

youtube.com

http://www.youtube.com/watch?v=n9P1Z134WYM

Automatic re-normalization of EXFOR data under Web retrieval system using Web-ZVView

308 views Jan 28, 2013 4

Part II.

EXFOR relational database. X4Lite.
Accessing data in C5, XML, JSON.

```
ENTRY            41323   20050902
SUBENT        41323001   20050902
BIB                  7         12
INSTITUTE   (4RUSMIF)
REFERENCE   (J,AE,50,(5),350,198105) M
            (J,SJA,50,325,1981)  ENGLI
AUTHOR      (V.E.ZHITAREV,A.M.MOTORIN,
TITLE       .INTERACTION CROSS SECTION
             WITH COLD NEUTRONS
FACILITY    (REAC)
ERR-ANALYS  (EN-ERR)    WAVE-LENGTH RES
                        TIMES 100 (IN P
HISTORY     (19981121C)  + +  COMPILED
            (20050902A)  . .  Correcte
                        Data-heading
ENDBIB              12
COMMON               3         3
EN-ERR      TEMP        TEMP-ERR
PER-CENT    DEG-C       DEG-C
   3.         22.         3.
ENDCOMMON            3
ENDSUBENT           19
SUBENT        41323002   20050902
BIB                  5         8
REACTION    (13-AL-27(N,TOT),,SIG)
SAMPLE      .ALUMINIUM MONOCRYSTAL, PU
             96 MM, DENSITY 2.70 GRAM/
             MACROCRISTALLINE ALUMINIU
             THICKNESS 50 MM, DENSITY
ERR-ANALYS  (DATA-ERR) NO INFORMATION
STATUS      (TABLE)  DATA ARE TAKEN FR
HISTORY     (19981121T)  + + CONVERTED
ENDBIB               8
NOCOMMON             0         0
DATA                 3         8
WVE-LN      DATA        DATA-ERR
ANGSTROM    B           B
 1.3000E+01 1.9300E+00 1.3000E-01
 1.4000E+01 2.1200E+00 9.0000E-02
 1.5000E+01 2.2500E+00 8.0000E-02
 1.6000E+01 2.3800E+00 7.0000E-02
 1.7000E+01 2.5400E+00 6.0000E-02
 1.8000E+01 2.6100E+00 6.0000E-02
 1.9000E+01 2.8200E+00 8.0000E-02
 2.0000E+01 3.1500E+00 6.0000E-02
ENDDATA             10
ENDSUBENT           23
ENDENTRY             2
```

EXFOR Logic

```
ENTRY            41323   20050902
  SUBENT        41323001   20050902
    BIB                  7         12
      INSTITUTE   (4RUSMIF)
      REFERENCE   (J,AE,50,(5),350,198105) MAIN REFERENCE, DATA ARE GIVEN
                  (J,SJA,50,325,1981)  ENGLISH TRANSLATION
      AUTHOR      (V.E.ZHITAREV,A.M.MOTORIN,S.B.STEPANOV)
      TITLE       .INTERACTION CROSS SECTIONS OF CERTAIN METALS
                   WITH COLD NEUTRONS
      FACILITY    (REAC)
      ERR-ANALYS  (EN-ERR)    WAVE-LENGTH RESOLUTION DELTA-LAMBDA/LAMBDA
                              TIMES 100 (IN PERCENT)
      HISTORY     (19981121C)  + +  COMPILED AT THE CJD + +
                  (20050902A)  . .  Corrected at the CJD + +
                                Data-heading "EN" changed to "WVE-LN"
    ENDBIB              12
    COMMON               3         3
      EN-ERR      TEMP        TEMP-ERR
      PER-CENT    DEG-C       DEG-C
         3.         22.         3.
    ENDCOMMON            3
  ENDSUBENT           19
  SUBENT        41323002   20050902
    BIB                  5         8
      REACTION    (13-AL-27(N,TOT),,SIG)
      SAMPLE      .ALUMINIUM MONOCRYSTAL, PURITY 99.99 PC, THICKNESS
                   96 MM, DENSITY 2.70 GRAM/CM3 AND
                   MACROCRISTALLINE ALUMINIUM, PURITY 99.99 PC,
                   THICKNESS 50 MM, DENSITY 2.70 GRAM/CM3
      ERR-ANALYS  (DATA-ERR) NO INFORMATION GIVEN
      STATUS      (TABLE)  DATA ARE TAKEN FROM TABLE 1 OF MAIN REF.
      HISTORY     (19981121T)  + + CONVERTED FROM SUBENT 88023002
    ENDBIB               8
    NOCOMMON             0         0
    DATA                 3         8
      WVE-LN      DATA        DATA-ERR
      ANGSTROM    B           B
       1.3000E+01 1.9300E+00 1.3000E-01
       1.4000E+01 2.1200E+00 9.0000E-02
       1.5000E+01 2.2500E+00 8.0000E-02
       1.6000E+01 2.3800E+00 7.0000E-02
       1.7000E+01 2.5400E+00 6.0000E-02
       1.8000E+01 2.6100E+00 6.0000E-02
       1.9000E+01 2.8200E+00 8.0000E-02
       2.0000E+01 3.1500E+00 6.0000E-02
    ENDDATA             10
  ENDSUBENT           23
ENDENTRY             2
```

Data formats. EXFOR.

Data formats. EXFOR Interpreted: X4+, XML, X4±

EXFOR data: http://www -
Data retrieved from the EX

```
ENTRY            41323
SUBENT        41323001
BIB                  7
INSTITUTE    (4RUSMIF)
             #(4RUSMIF) Mo
REFERENCE    (J,AE,50,(5),
             (J,SJA,50,32
             # (J,AE,50,(5),
             # (J,SJA,50,325
AUTHOR       (V.E.ZHITAREV
TITLE        .INTERACTION
              WITH COLD NE
FACILITY     (REAC)
             #(REAC) React
ERR-ANALYS   (EN-ERR)    WE
                         TI
HISTORY      (19981121C)
             (20050902A)

ENDBIB              12
COMMON               3
EN-ERR       TEMP       TI
PER-CENT     DEG-C      DE
3.           22.         3.
ENDCOMMON            3
ENDSUBENT           19
SUBENT        41323002
BIB                  5
REACTION     (13-AL-27(N,T
             #(13-AL-27(N,T
             #         Proces
SAMPLE       .ALUMINIUM MO
              96 MM, DENSI
              MACROCRISTAL
              THICKNESS 5(
ERR-ANALYS   (DATA-ERR) NO
STATUS       (TABLE)   DATA
HISTORY      (19981121T)
ENDBIB               8
NOCOMMON             0
DATA                 3
WVE-LN       DATA       DA
ANGSTROM     B          B
13.          1.93       0.
14.          2.12       0.
15.          2.25       0.
16.          2.38       0.
17.          2.54       0.
18.          2.61       0.
19.          2.82       0.
20.          3.15       0.
ENDDATA             10
ENDSUBENT           23
ENDENTRY             2
```

```
<?xml version="1.0" encoding="WINDOWS-1251"?>
<x4files>
 - <x4entry Author="V.E.Zhitarev+" Ref1Year="1981" accnum="41323"
  - <x4subent N2="20050902" subacc="41323001">
   - <bib nKw="12">
    - <keyword subacc="41323001" nCodes="1" kw="INSTITU
     - <kwCode iCode="0" pointer=" ">
      - <x4code type="INSTITUTE">
          <x4code1 expansion="Moscow Inst.of Engine
            dictionary="INSTITUTE">4RUSMIF</x4co
        </x4code>
       </kwCode>
     </keyword>
    - <keyword subacc="41323001" nCodes="2" kw="REFEREN
     - <kwCode iCode="0" pointer=" ">
      - <x4code type="REFERENCE">
          <x4code1 expansion="Jour: Atomnaya Energi
            dictionary="REFERENCE" Year="1981" pag
            Type="J">J,AE,50,(5),350,198105</x4co
        </x4code>
        <Free type="1" ln="1"> MAIN REFERENCE, DATA
       </kwCode>
     - <kwCode iCode="1" pointer=" ">
      - <x4code type="REFERENCE">
          <x4code1 expansion="Jour: Soviet Atomic En
            dictionary="REFERENCE" Year="1981" pag
            Type="J">J,SJA,50,325,1981</x4code1>
        </x4code>
        <Free type="1" ln="1"> ENGLISH TRANSLATION
       </kwCode>
     </keyword>
    - <keyword subacc="41323001" nCodes="1" kw="AUTHOR"
     - <kwCode iCode="0" pointer=" ">
      - <x4code type="AUTHOR">
       - <authors a1ini="V.E." a1="Zhitarev" nn="3">
          <author ii="1">V.E.ZHITAREV</author>
          <author ii="2">A.M.MOTORIN</author>
          <author ii="3">S.B.STEPANOV</author>
         </authors>
        </x4code>
       </kwCode>
     </keyword>
    - <keyword subacc="41323001" nCodes="1" kw="TITLE">
     - <kwCode iCode="0" pointer=" ">
        <Free type="1" ln="2">.INTERACTION CROSS SE
          NEUTRONS</Free>
       </kwCode>
     </keyword>
    - <keyword subacc="41323001" nCodes="1" kw="FACILITY
     - <kwCode iCode="0" pointer=" ">
      - <x4code type="FACILITY">
          <x4code1 expansion="Reactor" dictionary="FA
        </x4code>
       </kwCode>
     </keyword>
    - <keyword subacc="41323001" nCodes="1" kw="ERR-ANA
     - <kwCode iCode="0" pointer=" ">
        <Code type="0">EN-ERR</Code>
        <Free type="1" ln="2"> WAVE-LENGTH RESOLUT
          (IN PERCENT)</Free>
       </kwCode>
```

- EXFOR file
  - ENTRY 41323 1981, V.E.Zhitarev+ last-updated: 2005-09-02
    - SUBENT 41323001 last-updated: 2005-09-02
      - BIB #bibliographic and descriptive information
        - INSTITUTE
          - (4RUSMIF) #Moscow Inst.of Engineering Physics, Moscow, Russia
        - REFERENCE
          - (J,AE,50,(5),350,198105) #Jour: Atomnaya Energiya, Vol.50, Issue.5, p.350 (1981), Russia
            MAIN REFERENCE, DATA ARE GIVEN
          - (J,SJA,50,325,1981) #Jour: Soviet Atomic Energy, Vol.50, p.325 (1981), USA
            ENGLISH TRANSLATION
        - AUTHOR
          - (V.E.ZHITAREV, A.M.MOTORIN, S.B.STEPANOV)
        - TITLE
          - .INTERACTION CROSS SECTIONS OF CERTAIN METALS WITH COLD NEUTRONS
        - FACILITY
        - ERR-ANALYS
        - HISTORY
      - COMMON 3x1 #Constant parameters
        - Legend

EN-ERR	Uncertainty in incident projectile energy	PER-CENT	per-cent
TEMP	Sample temperature	DEG-C	degrees Celsius, Centigrad
TEMP-ERR	Error in sample temperature	DEG-C	degrees Celsius, Centigrad

        - Data

EN-ERR	TEMP	TEMP-ERR
PER-CENT	DEG-C	DEG-C
3.0	22.0	3.0

    - SUBENT 41323002 last-updated: 2005-09-02
      - BIB #bibliographic and descriptive information
        - REACTION
          - (13-AL-27(N,TOT),,SIG)
            #Target:AL-27 #Projectile:N #Reaction:N,TOT #Process:TOT:Total #Quantity:,SIG:CS:
        - SAMPLE
          - .ALUMINIUM MONOCRYSTAL, PURITY 99.99 PC, THICKNESS 96 MM, DENSITY 2.70 GRAM/CM3 AND MACROCRISTALLINE ALUMINIUM, PURITY 99.99 PC, THICKNESS 50 MM, DENSITY 2.70 GRAM/CM3
        - ERR-ANALYS
        - STATUS
        - HISTORY
      - NOCOMMON
      - DATA 3x8
        - Legend

WVE-LN	Wave length of incident particle	ANGSTROM	Angstroms
DATA	Cross section 13-AL-27(N,TOT),,SIG	B	barns
DATA-ERR	Error in value of quantity, defined under ERR-ANALYS	B	barns

        - Data

WVE-LN	DATA	DATA-ERR
ANGSTROM	B	B
13.0	1.93	0.13
14.0	2.12	0.09
15.0	2.25	0.08
16.0	2.38	0.07

Data formats overview

X4+ EXFOR-Interpreted; **X4±** Interactive Tree

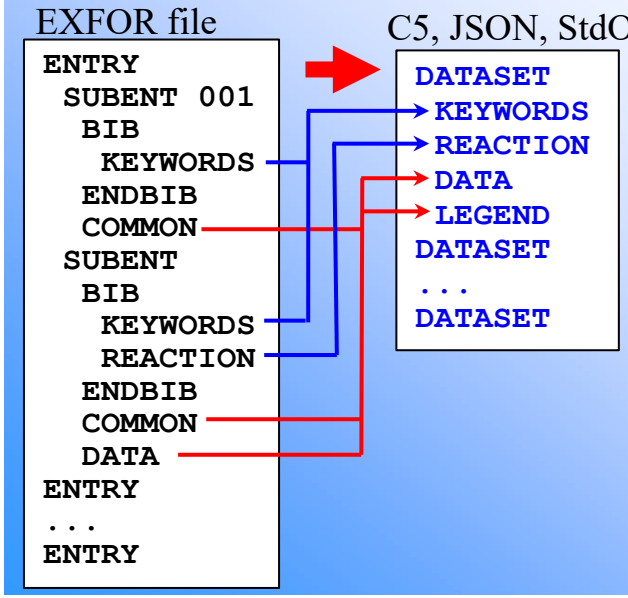
1. Presents EXFOR as it is + extra lines with information from Dictionaries, NSR, etc.
2. Numbers in traditional style
3. No limit on the number of values per line

XML

1. Repeats structure of EXFOR file using nested <elements>; includes information from EXFOR Dictionaries explaining codes
2. Numbers are presented in traditional style (no more E-less Fortran format for numbers)

C5, JSON, JSON_FY, Std_out

1. File contains Datasets; no text blocks for ENTRY, SUBENT, BIB; no Pointers
2. Dataset is identified by DatasetID (SUBENT + Pointer); includes all information related to one reaction: Reaction-code, selected/all Keywords from SUBENT-1 and current SUBENT, Data-section and Legend
3. Data are presented as function Y=Y(X1,X2,…), columns are sorted (fixed order according to Dictionary)
4. Data-section: all data from DATA and COMMON from EXFOR SUBENT-1 and current SUBENT
5. Legend and Keywords contain EXFOR codes and their interpretation (e.g. basic-units and conversion factors)
6. C5 and JSON_FY contain computational data values; StdOut, XML and JSON (as of now) – only original values



Comparison of formats: summary

Nucl. data format	Numbers' format /Language	Sequence (main block)	Meta data	Interpret. from Dictionaries	Orig. data	Computa-tional data
EXFOR	Fixed-length, E-less	ENTRY	yes	no	yes	no
C4	Fixed-fmt lines	SUBENT	no	no	no	yes
C5	Fixed-fmt lines	Datasets	yes	yes	no	yes
X4+	Flex. fields /HTML	ENTRY	yes	yes	yes	no
XML	Flex. fields /XML	ENTRY	yes	yes	yes	no
JSON	Flex. fields /JSON	Datasets	yes	yes	yes	no
JSON_FY	Flex. fields / JSON	Datasets	yes	yes	no	yes
JSON_X4	Flex. fields / JSON	Datasets	yes	yes	yes	yes

C5 versus C4

	Columns	Name	Meaning
C4 Line	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 (ENDF conventions: 1-40, plus additions: 1-999)
	16-19	MT	MT (ENDF conventions 1-999, plus additions: 1-9999)
	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	Projectile incident energy
	32- 40	dEnergy	Projectile incident energy uncertainty
	41- 49	Data	Data, e.g., cross section, angular distribution, etc.
	50- 58	dData	Data uncertainty
	59- 67	Cos/LO	Cosine or legendre order
	68- 76	dCos/LO	Cosine uncertainty
	77- 85	LVL/HL	Identified by columns 95-97 (e.g.,level E, half-life)
	86- 94	dLVL/HL	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)
C5 Line	132-140	dSys	**Systematic uncertainty**
	141-149	dStat	**Statistical uncertainty**
	150-158	dOther	**Other partial uncertainty**
	159-167	dTot	**Total uncertainty given in EXFOR file**
	168-176	dSys%	**Systematic uncertainty, relative in per-cent**
	177-185	dStat%	**Statistical uncertainty, relative in per-cent**
	186-194	dOther%	**Other partial uncertainty, relative in per-cent**
	195-203	dTot%	**Total uncertainty given in EXFOR file, relative in per-cent**
C5 optional	204-212	M0	Old Monitor value
	213-221	dM0	Old Monitor uncertainty, relative in per-cent
	222-230	M1	New Monitor value
	231-239	dM1	New Monitor uncertainty, relative in per-cent

C5 is C4 extended by
- new data columns (after 132)
- meta data (lines started #)

#C5 →
C4 →

Programming language:
C4: by Fortran code//1980's
C5: by Java code //2011-2020

Reactions dictionary:
C4: EXFOR14A.DAT
C5: EXFOR14A.DAT +
Extended table
SF2-SF7 ::: MF-MF-LR
(V.Pronyaev, 2010)

EXFOR coverage:
C4: ~65%
C5: ~75%

C5:
More detailed uncertainties
Correct processing –CM (DA)
Correct processing compounds

C5 options:
Converting RR-B/SR
C5M: include correlation
matrix (Web default-2)

EXFOR database: structure and content

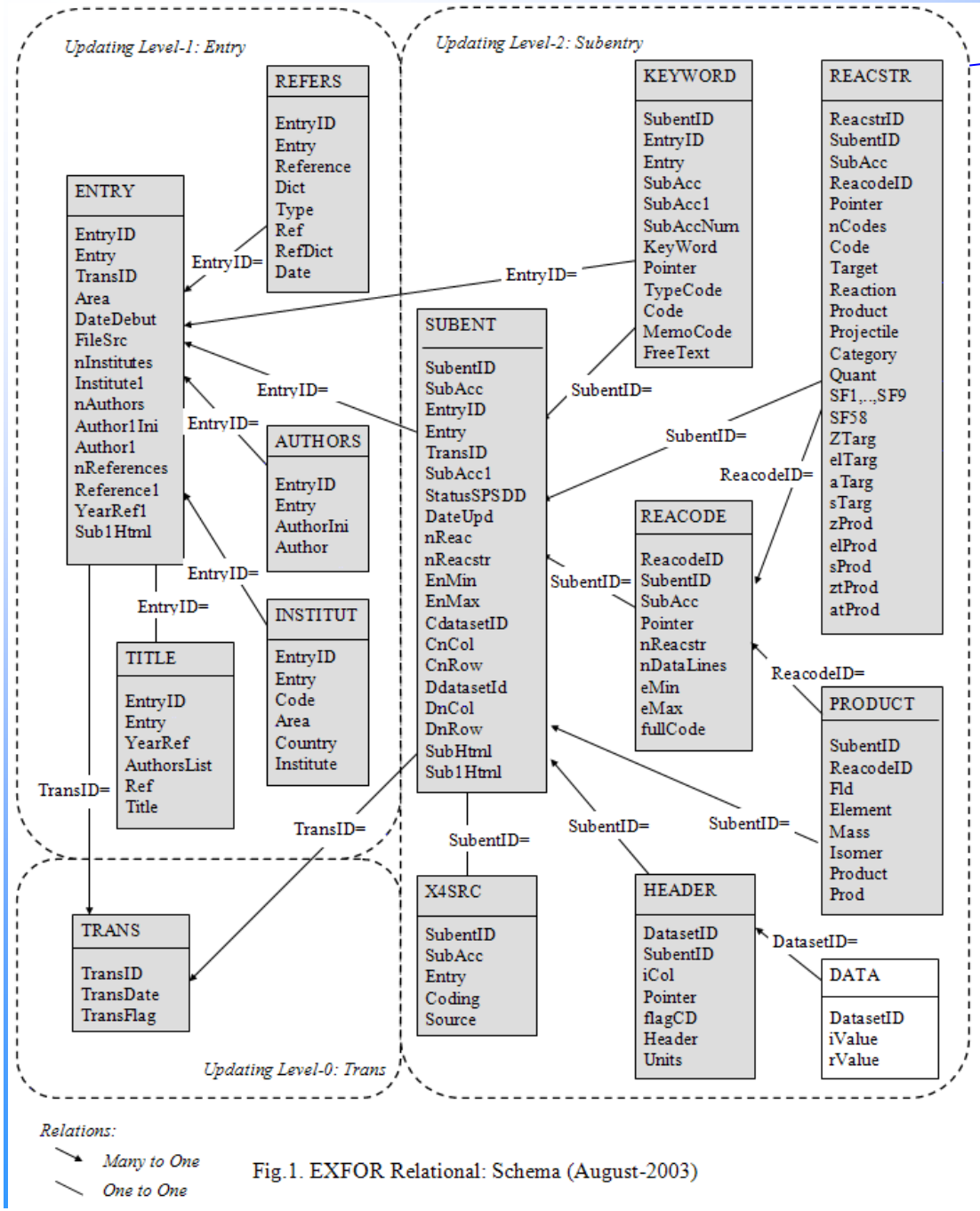


Fig.1. EXFOR Relational: Schema (August-2003)

Initial database:
EXFOR + Dictionaries

Database extensions:

Corrections

Created: 2010
Updated: 2020-09-10
Records: 15,663
Size: 9.2 Mb

Automatic and experts' corrections. Available online via C4, TAB, Plots.

X4-NSR PDF

Created: 2012
Updated: 2020-09-04
Records: 218,210
Size: 180 Gb

PDF files of published materials of EXFOR and NSR databases. Full contents available online for authorized users.

Test search

Created: 2014
Updated: 2020-09-10
Records: 1,440,084
Size: 184 Mb

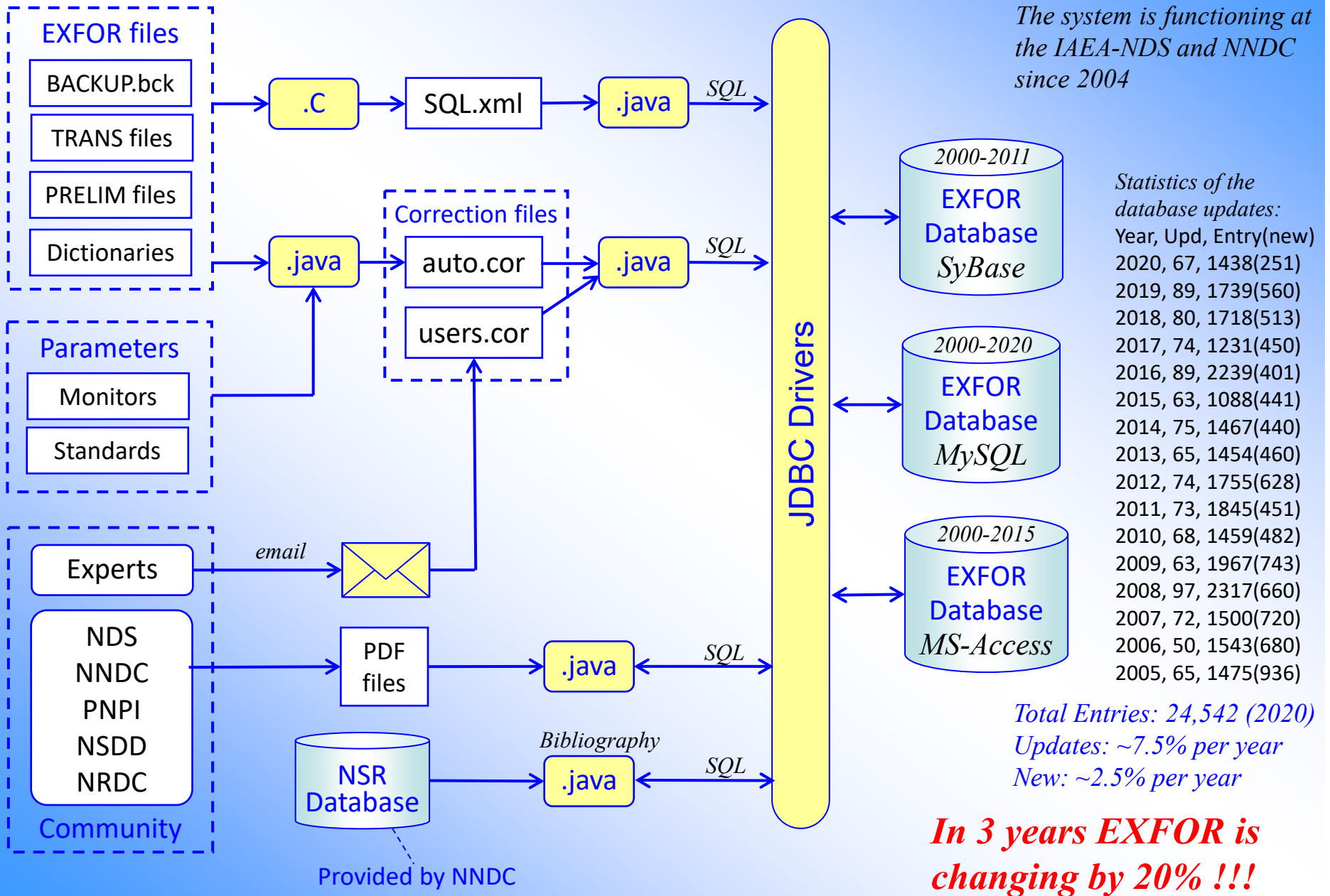
Google-like search in interpreted EXFOR, incl. free text, keywords, codes and their interpretation from dictionaries.

EXFOR Archive

Created: 2014
Updated: 2020-09-10
Entries: 99,381
Subent: 783,183
Size: 0.9 Gb

Contains current and all previous versions of every SUBENT. Available online for EXFOR compilers.

EXFOR relational database



The system is functioning at the IAEA-NDS and NNDC since 2004

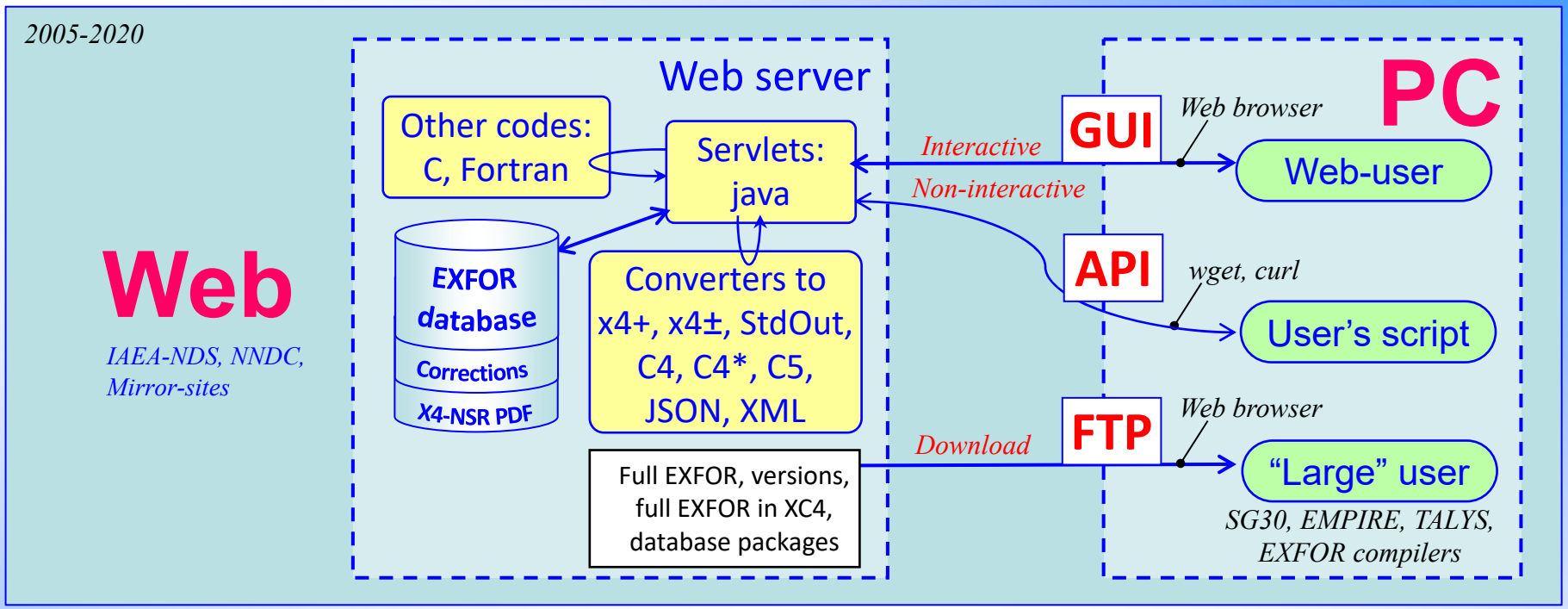
Statistics of the database updates:

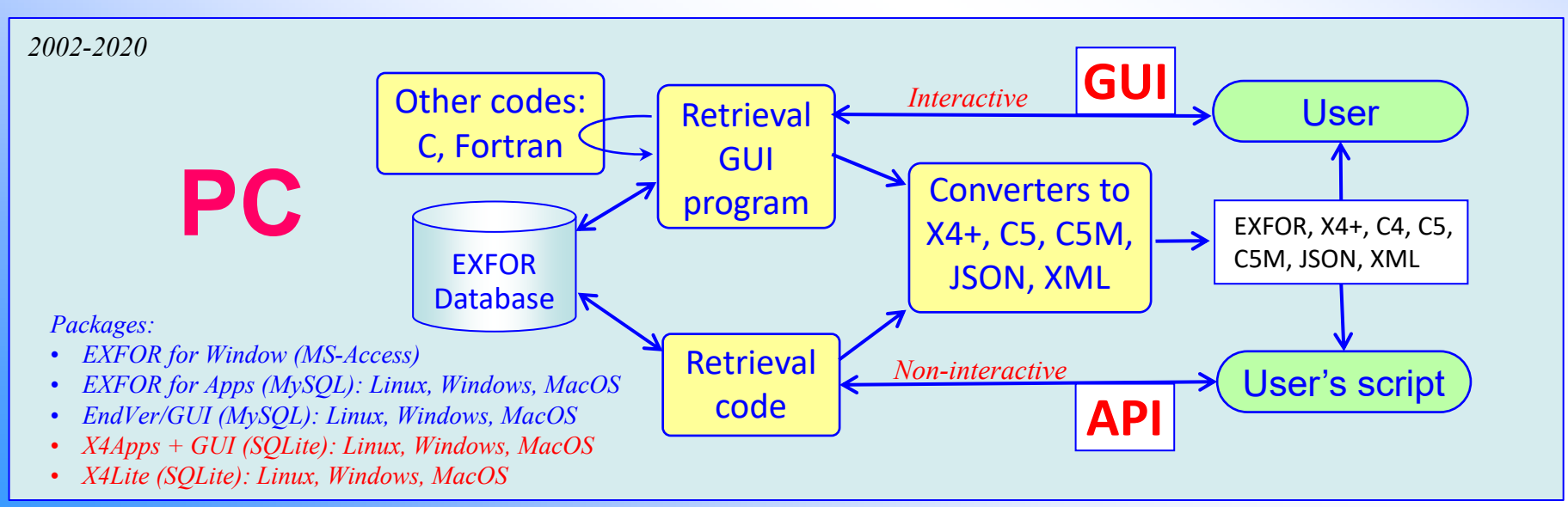
Year	Upd	Entry(new)
2020	67	1438(251)
2019	89	1739(560)
2018	80	1718(513)
2017	74	1231(450)
2016	89	2239(401)
2015	63	1088(441)
2014	75	1467(440)
2013	65	1454(460)
2012	74	1755(628)
2011	73	1845(451)
2010	68	1459(482)
2009	63	1967(743)
2008	97	2317(660)
2007	72	1500(720)
2006	50	1543(680)
2005	65	1475(936)

Total Entries: 24,542 (2020)
Updates: ~7.5% per year
New: ~2.5% per year

In 3 years EXFOR is changing by 20% !!!

Access to EXFOR on Web and PC: GUI, API, FTP





Access to EXFOR data: Web API examples

#Get list of DatasetID's for: Target: Pb-204 Reaction: n,g Quantity: cross section in text form:

https://www-nds.iaea.org/exfor/servlet/X4sSearch5?Target=Pb-204&Reaction=n,g&Quantity=SIG&api=1

#Get list of DatasetID's for: Target: Pb-204 Reaction: n,g Quantity: cross section in JSON form:

https://www-nds.iaea.org/exfor/servlet/X4sSearch5?Target=PB-204&Reaction=n,g&Quantity=SIG&json


```
{"format":"WebExforDatasetsList-0.1" ,"now":"2020-09-11T14:09:52.000Z"
 ,"program":"X4sSearch5, by V.Zerkin, IAEA-NDS, ver.2020-02-03"
 ,"req":2139,"x4Datasets": [
  {"id":"22945010","RC":"82-PB-204(N,G)82-PB-205,,RYL,,MSC","npts":1011,"enMax":4.71e5
    ,"A1":"2007,C.Domingo-Pardo+"
    ,"ref":"Jour: Physical Review, Part C, Nuclear Physics, Vol.75, p.015806 (2007)"}
  ,{"id":"10243003","RC":"82-PB-204(N,G)82-PB-205,,SIG","npts":1,"A1":"1971,R.C.Greenwood+"
    ,"ref":"Jour: Physical Review, Part C, Nuclear Physics, Vol.4, p.2249 (1971)"}
```



```
10243003
11133009
11507099
11679024
12210002
12237002
12758006
22945004
22945005
22945006
22945007
22945008
22945009
22945010
V0102481
V0102482
V10025241
V1002526
```


#Get Dataset by DatasetID in C4 format:

https://www-nds.iaea.org/exfor/servlet/X4sGetDataset?DatasetID=11420003&op=x4toc4


```
    1 25055   3 102    970000.0 100000.0 2.8000-3 2.2000-4        H.O.MENLOVE,ET.AL. (67)  11420  3
    1 25055   3 102    1560000. 120000.0 1.9400-3 1.5000-4        H.O.MENLOVE,ET.AL. (67)  11420  3
```


#Get Dataset in C5:

https://www-nds.iaea.org/exfor/servlet/X4sGetDataset?DatasetID=A1495003&op=x4toc5

#Get Dataset in JSON:

https://www-nds.iaea.org/exfor/servlet/X4sGetDataset?DatasetID=11679024&op=x4json2

#Get Dataset in JSON_FY (JSON format for fission yield data developed together with NNDC)

https://www-nds.iaea.org/exfor/servlet/X4sGetDataset?DatasetID=12729002&op=x4jsfy

#Get JSON_FY & filter products

https://www-nds.iaea.org/exfor/servlet/X4sGetDataset?DatasetID=12729002&op=x4jsfy&prod=s*

https://www-nds.iaea.org/exfor/servlet/X4sGetDataset?DatasetID=12729002&op=x4jsfy&prod=*-G;*-m1

Access to local EXFOR database: API examples

Search and retrieve original EXFOR data from database

```
java -cp x4retr2.jar:sqlite-jdbc-3.30.1.jar x4retr2 -x4pro:x4.pro -o:aa1.x4 -ind:4 \
  -target:"Fe-*" -quant:"cs;da;dae;de;ri;sp" -React:"n,*" -a:"Smith;Whalen"
#Result: aa1.x4 aa1.x4p
```

```
REQUEST          1001   20200713     173040   20200708          3    0  0     0
ENTRY           10238   20110727   20111215   20111113       137410238000     1
SUBENT        10238001   20110727   20111215   20111113       137410238001     1
BIB                 12         53                               10238001     2
INSTITUTE   (1USAANL)                                          10238001     3
REFERENCE   (J,NSE,58,314,197511)
            (R,ANL-NDM-10,197501)
            (R,ANL-NDM-13,197506)
            (J,ANS,16,312,197306) Data superseded
AUTHOR      (D.L.Smith,J.W.Meadows)
TITLE       Cross-section measurement of (n,p) reactions for
             46,47,48Ti, 54,56Fe, 58Ni, 59Co, and 64Zn from
             threshold to 10 MeV
FACILITY    (DYNAM,1USAANL) Fast neutron generator
METHOD      (ACTIV) Activation
```

Output:
EXFOR file,
list of Datasets

```
102380311 1975,D.L.Smith       26-FE-54(N,P)25-MN-54,,SIG
102380321 1975,D.L.Smith       26-FE-54(N,P)25-MN-54,,SIG
102380331 1975,D.L.Smith       26-FE-54(N,P)25-MN-54,,SIG
102380341 1975,D.L.Smith       26-FE-56(N,P)25-MN-56,,SIG
102380351 1975,D.L.Smith       26-FE-56(N,P)25-MN-56,,SIG
102380361 1975,D.L.Smith       26-FE-56(N,P)25-MN-56,,SIG
10886002  1980,A.Smith          26-FE-0(N,EL)26-FE-0,,DA
11511009  1966,R.L.Becker      26-FE-0(N,EL),,DA
11707002  1965,E.E.Carroll Jr  26-FE-54(N,P)25-MN-54,,SIG
11707003  1965,E.E.Carroll Jr  26-FE-54(N,P)25-MN-54,,SIG
12144002  1966,A.B.Smith       26-FE-0(N,EL)26-FE-0,,SIG
```

Convert EXFOR file to computational format C5

```
java -Xmx400M -cp x4tool.jar x4toc5 aa1.x4 -ds:aa1.x4p -dz:x4dict.bin
#Result: aa1.x4.c5
```

Convert EXFOR file X4JSON file

```
java -Xmx400M -cp x4tool.jar x4to1json aa1.x4 -ds:aa1.x4p -a -j -b:2 -o:aa1.x4.json -dz:x4dict.bin
#Result: aa1.x4.json
```

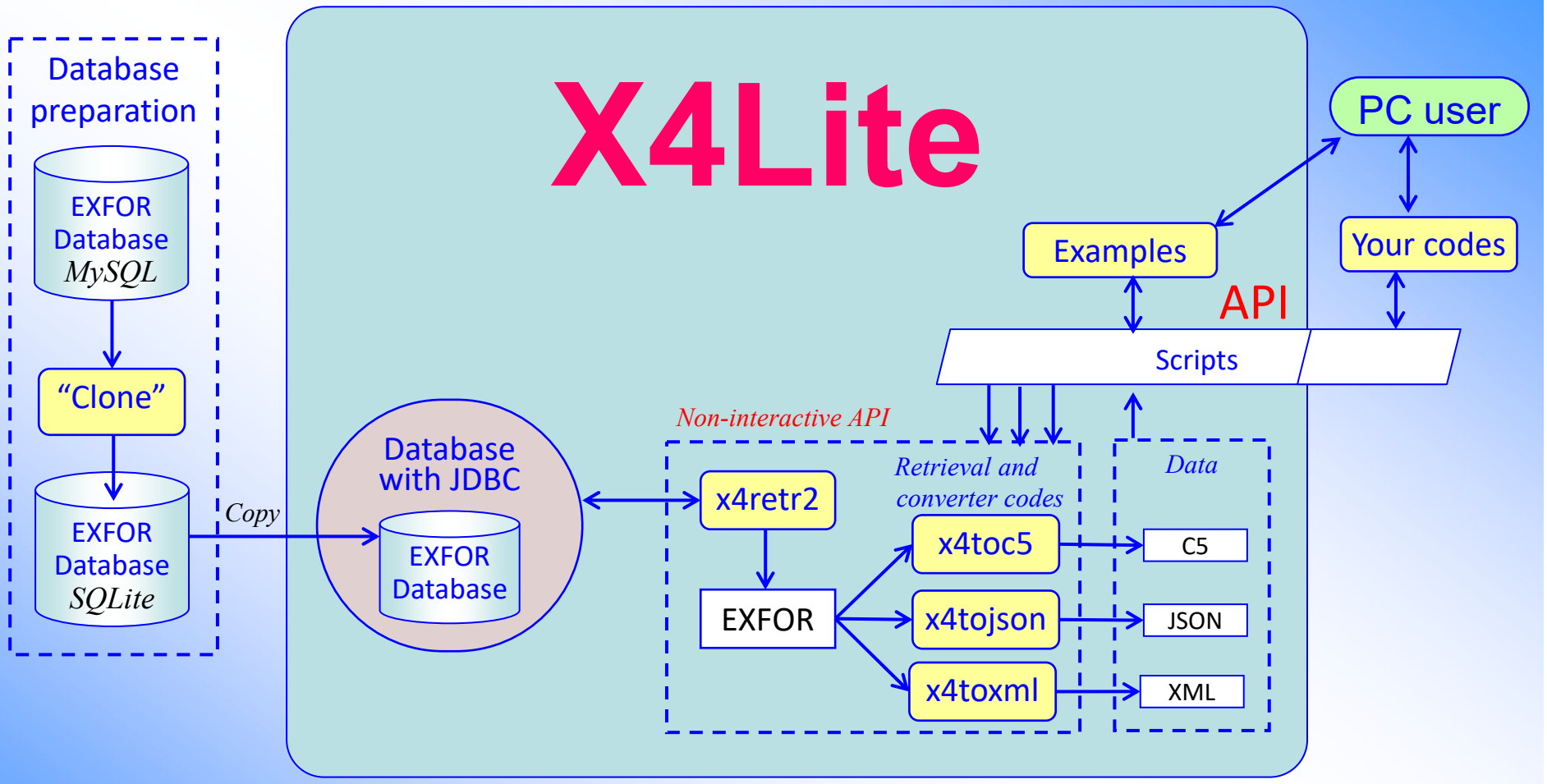
Convert EXFOR file to interpreted X4+

```
java -Xmx400M -cp x4tool.jar x4tox4plus aa1.x4 -o:aa1.x4.x4plus.htm -dz:x4dict.bin
#Result: aa1.x4.x4plus.htm
```

Convert EXFOR file to XML

```
java -Xmx400M -cp x4tool.jar x4read2xml aa1.x4 -o:aa1.x4.xml -dz:x4dict.bin
#Result: aa1.x4.xml
```

X4Lite: database, retrieval and converter codes

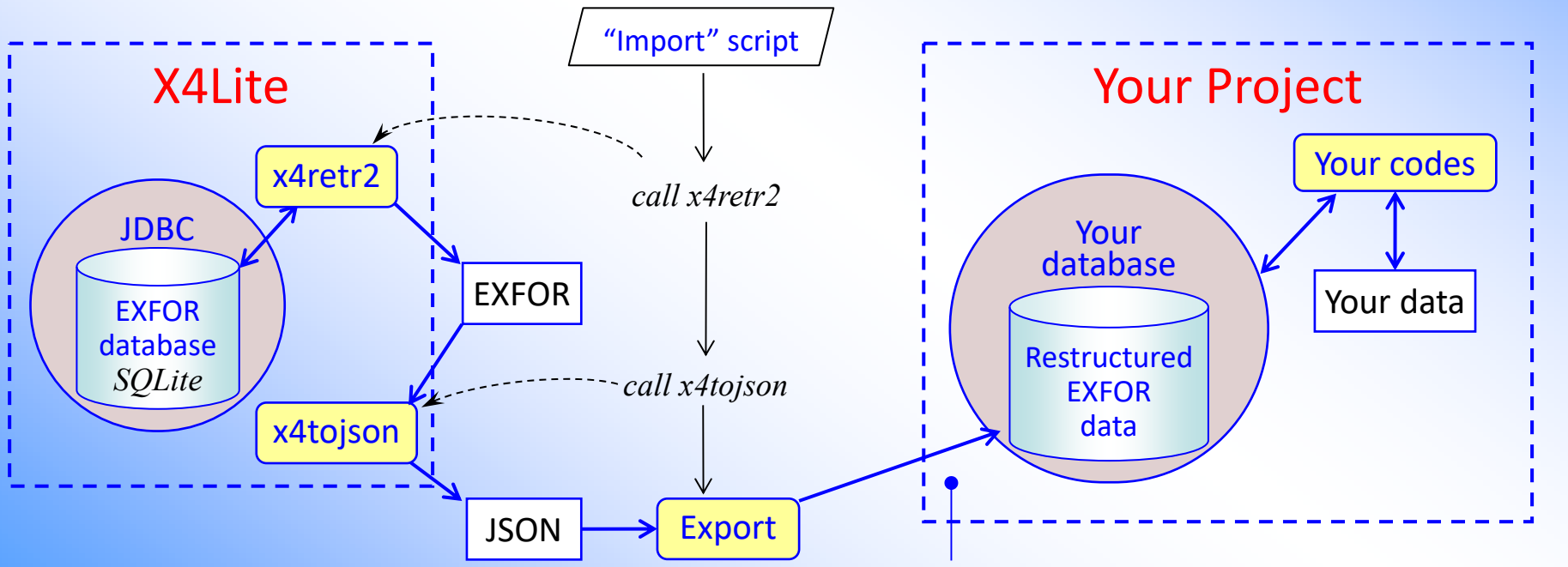


X4Lite preparation is fully automatic. Can be done on regular basis by the IAEA-NDS.

X4Lite. Specialized system for usage under other software packages and containing only
1) EXFOR relational database in SQLite: one file for Linux, Windows, MacOS
2) retrieval code producing list of datasets and/or EXFOR file
3) codes converting EXFOR file to X4+, C5, C5M, JSON, XML

Planning your database for your project?

- *Select data format (e.g. JSON or C5 or XML)*
- *Prepare your "import" script doing:*
  - *Search and retrieve EXFOR data needed in your project*
  - *[Make a loop on the list of found datasets if necessary]*
  - *Call converter from EXFOR file to selected format*
  - *Store dataset into your data structure or SQL/noSQL database*
- *Download X4Lite and run "import" script*

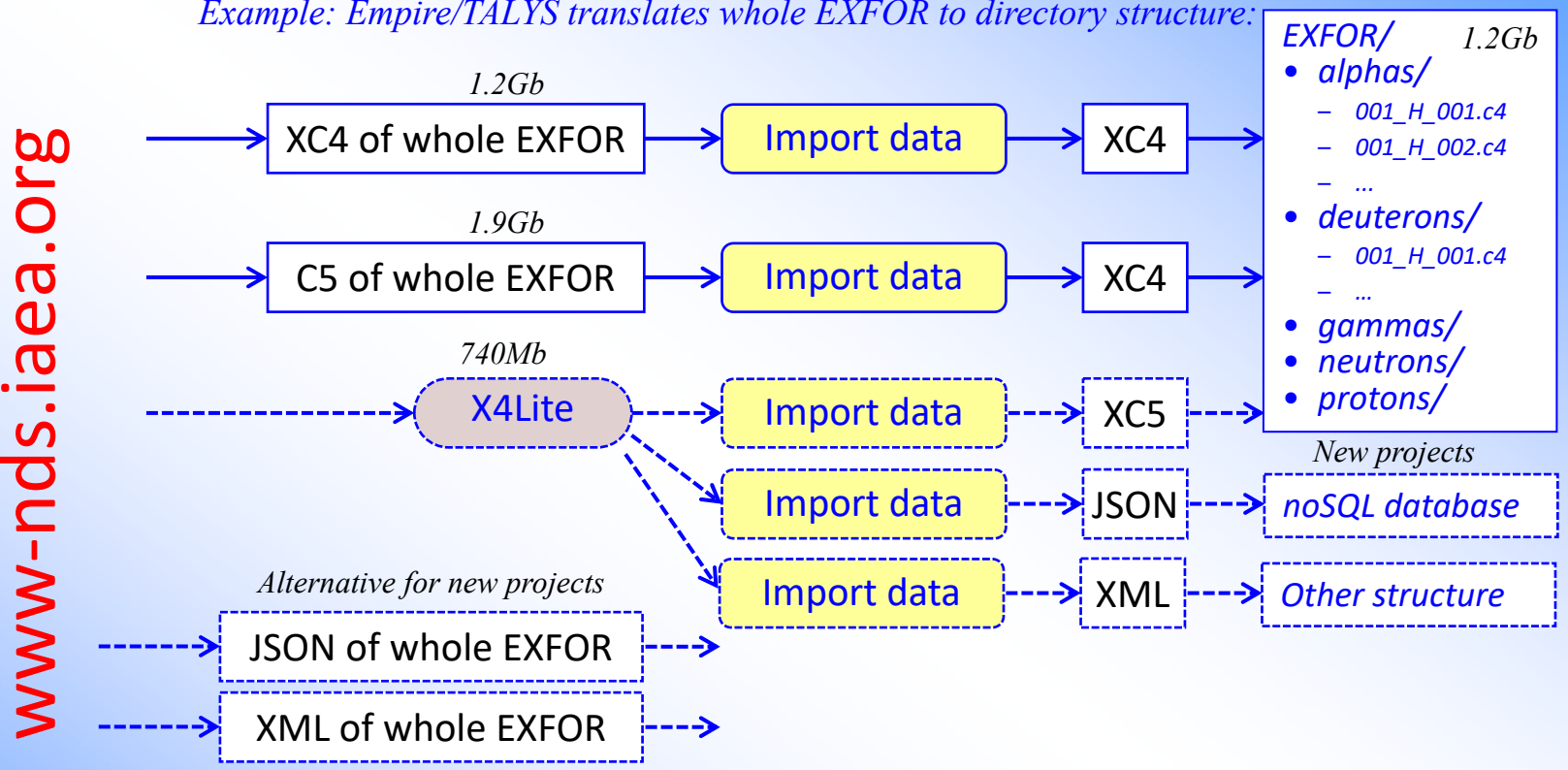


Project/team can build different databases, e.g.:

- *XC4, C5: Empire, TALYS*
- *C5M: GANDR*
- *JSON: SG50 (?)*

X4Lite: pro & con. Alternatives.

Example: Empire/TALYS translates whole EXFOR to directory structure:



What is difference?

- *More rational maintenance (at the IAEA-NDS)*
- *Freedom for user to use formats C4/C5, JSON, XML; easy to use modern tools and languages*
- *Translation from EXFOR C4: 65%, to C5: 75%, to JSON: 98%, to XML: 100%*
- *Easy programming access to all data/information from EXFOR and Dictionaries (name:value)*
- *Easier to filter out and store only data needed for a project*
- *Options to make re-calculations and include/exclude data columns: CM-Lab, RR-B/SR, inverse reactions and kinematics, dictionary information, perhaps monitor data and/or automatic renormalization*
- *Other advantages/disadvantages will be discovered during exploitation*

Concluding remarks

1. EXFOR data correction system is successfully functioning on Web at the IAEA-NDS and NNDC cites working with C4 and TABLE files. Current system can be revised, expanded or rewritten in a short term.

2. Current versions of EXFOR output to C5, X4JSON, XML have a great potential and should be propagated to users' community for practical usage in applications, for feedback and improvements.

3. X4Lite is computational EXFOR for professional nuclear data users.

Thank you.