International Atomic Energy Agency

The 8th DAE-BRNS Theme Meeting on

EXFOR Compilation of Nuclear Data

Department of Physics, The M.S. University, Vadodara, India

12–16 November 2019

EXFOR Format

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Nuclear Data Section

Department of Nuclear Sciences and Applications

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

सत्यं शिवं सुन्दरम्

राष्ट्र की सेवा में परमाणु

BRNS

ATOMS IN THE SERVICE OF THE NATION

EXFOR Format

1. Experimental Description

2. Numerical Description

Structure of BIB Section

```
        11                                                 66           80
---------+----------+---------+---------+---------+--------+---+---------+
..
AUTHOR     (B.K.Nayak, A.Saxena, D.C.Biswas, E.T.Mirgule,     33023001     6
…
INSTITUTE  (3INDTRM)                                          33023001     9
REFERENCE  (J,PR/C,78,061602,2008)                            33023001    10
...
```

- Coded information is designed for database search.
- Many abbreviations are defined in Dictionary.

<u>Example</u>

3INDBDA: M.S. University of Baroda (Institute code)

PRM: Pramana (Journal code)

,SIG: Cross section (Quantity code)

Experimental Condition of EXFOR 33080.002

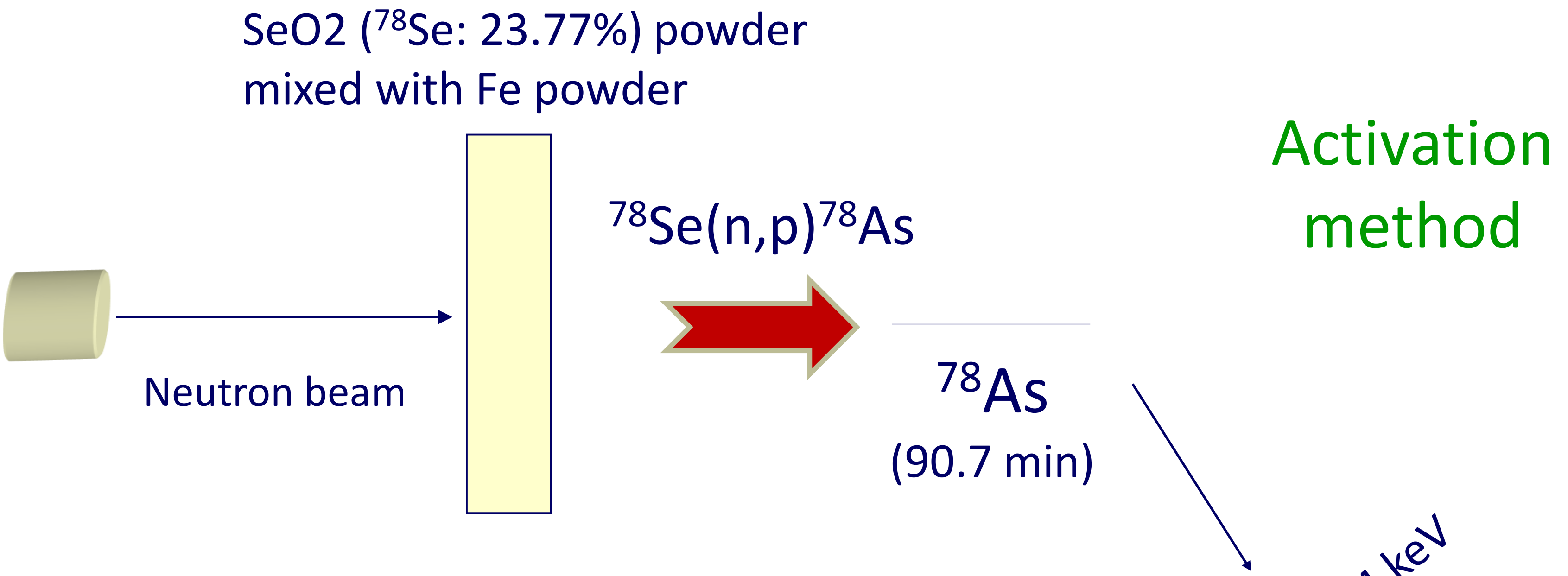
```
SUBENT        33080002   20150107                               3308000200001
BIB                  9          15                              3308000200002
REACTION   (34-SE-78(N,P)33-AS-78,,SIG)                         3308000200003
SAMPLE     (34-SE-78,NAT=0.2377)                                3308000200004
           Natural SeO2 (purity of 99.99%) powder               3308000200005
           (26-FE-56,NAT=0.9175)                                3308000200006
           Natural Fe (purity of 99.99%) powder                 3308000200007
DECAY-DATA (33-AS-78,90.7MIN,DG,614.,0.54)                      3308000200008
MONITOR    (26-FE-56(N,P)25-MN-56,,SIG)                         3308000200009
DECAY-MON  (25-MN-56,2.578HR,DG,847.,0.99)                      3308000200010
MONIT-REF  (41240001,A.A.Filatenkov+,R,RI-252,1999)             3308000200011
METHOD     (ACTIV) Irradiated for 5400 sec., then measured for  3308000200012
            900 sec.                                            3308000200013
           (MOMIX) SeO2 and Fe powder (total weight of ~1 g)    3308000200014
            packed in a polyethylene bag (10 mm x 10 mm)        3308000200015
ERR-ANALYS (MONIT-ERR,2.,3.7) 56Fe(n,p)56Mn cross section (2-3.7%)3308000200016
STATUS     (TABLE) Table II of Phys.Rev.C90(2014)064609         3308000200017
ENDBIB              15           0                              3308000200018
NOCOMMON             0           0                              3308000200019
DATA                 3           5                              3308000200020
EN         DATA        DATA-ERR                                 3308000200021
MEV        MB          MB                                       3308000200022
 13.73      15.6         1.5                                    3308000200023
 14.07      17.          1.6                                    3308000200024
 14.42      18.6         1.6                                    3308000200025
 14.68      20.4         1.7                                    3308000200026
 14.77      22.          1.7                                    3308000200027
ENDDATA              7           0                              3308000200028
ENDSUBENT           27           0                              3308000299999
```

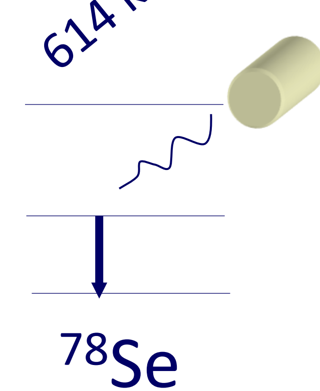
Natural SeO_2 (enrichment=23.7%) powder used.

614 keV γ-ray (I_γ=54%) used.

SeO2 reaction sample powder mixed with Fe monitor powder used.

Experimental Condition of EXFOR 33080.002





EXFOR users should be able to imagine this situation from the BIB section of the EXFOR entry.

Keyword, Code and Free text

- Keyword is given in 1st to 11th columns.
- Code(s) follow an open parenthesis at the **12th** column.
- Free text is given between 12th to 66th column

Example

```
         11          22          33          44          55          66
----------+----------+----------+----------+----------+----------+
TITLE      The 5th DAE-BRNS Theme Meeting on EXFOR Compilation of
           Nuclear Data
AUTHOR     (B.Rudraswamy, B.R.Behera, A.Kumar, A.Saxena)
INSTITUTE  (3INDPUC) Department of Physics
           (3INDTRM) Nuclear Physics Division
```

Free text only

coded information only

coded information + free text

Major Keywords (Bibliography)

Keyword	Contents
TITLE	Title of the experimental work
AUTHOR	Researchers contributes to the work
INSTITUTE	Institutes of authors
REFERENCE	Articles used for compilations

Example

```
          11         22         33         44         55         66
----------+----------+----------+----------+----------+----------+
TITLE      Radiative capture cross-sections of isotopes of Gd, Sm
           and V between 1 and 3 MeV
AUTHOR     (M.Afzal Ansari, R.K.Yasikul Singh, M.L.Sehgal,
            V.K.Mittal, D.K.Avasthi, I.M.Govil)
INSTITUTE  (3INDMUA,3INDPUC)       Aligarh Muslim Univ.+Punjab Univ.
REFERENCE  (J,ANE,11,173,1984)     Ann.Nucl.Energy 11(1984)173
```

Major Keywords (Experimental Description)

Keyword	Contents
FACILITY	Experimental facility (reactor, accelerator etc.)
INC-SOURCE	Source of beam (for neutron and photon beam)
INC-SPECT	Spectrum of beam (for neutron and photon beam)

Example

```
         11         22         33         44         55         66
----------+----------+----------+----------+----------+----------+
FACILITY   (CYCLO,3INDPUC)  Cyclotron at Punjab University
INC-SOURCE (P-T)            3H(p,n)3He neutron source
```

Major Keywords (Experimental Description)

Keyword	Contents
SAMPLE	Sample specification (enrichment etc.)
DETECTOR	Detector used in the experiment
METHOD	Experimental method
ANALYSIS	Experimental data derivation

Example

```
          11         22         33         44         55         66
----------+----------+----------+----------+----------+----------+
SAMPLE     (64-GD-160,ENR=0.981) 48.42 mg/cm2
DETECTOR   (GELI)
METHOD     (ACTIV)
```

^{160}Gd (enrichment 98.1%)

Ge(Li) detector used

Activation technique used

Major Keywords (Parameters)

Keyword	Contents
MONITOR	Standard reaction for normalization
DECAY-DATA	Decay property of reaction product
DECAY-MON	Decay property of standard reaction product
LEVEL-PROP	Level of reaction product (spin, parity)

Example

```
          11         22         33         44         55         66
----------+----------+----------+----------+----------+----------+
MONITOR    (53-I-127(N,G)53-I-128,,SIG)
DECAY-DATA (64-GD-161,3.7MIN,DG,315.,0.229)
DECAY-MON  (53-I-128,24.9MIN,DG,443.,0.160)
```

$^{127}I(n,\gamma)^{128}I$ used as reference reaction

315 keV decay gamma (I_γ=22.9%) from ^{161}Gd measured

443 keV decay gamma (I_γ=16.0%) from ^{128}I measured

Major Keywords (Data Specification)

Keyword	Contents
REACTION	Reaction and quantity in the DATA section

Example

```
          11         22         33         44         55         66
----------+----------+----------+----------+----------+----------+
REACTION   (64-GD-160(N,G)64-GD-161,,SIG)
```

$^{160}Gd(n,\gamma)^{161}$ Gd cross section is given

Major Keywords (Correction and Error)

Keyword	Contents
CORRECTION	Correction applied to the raw data
ERR-ANALYS	Specification of uncertainties (e.g. statistical)
COVARIANCE	Covariance or correlation information

Example

```
         11         22         33         44         55         66
----------+----------+----------+----------+----------+----------+
CORRECTION Corrected for self-absorption of neutrons in the sample
ERR-ANALYS (ERR-T) Total uncertainty
           (ERR-S) Statistical uncertainty
           (ERR-1) Uncertainty in sample mass
COVARIANCE  Uncertainty in sample mass is fully correlated
```

Major Keywords (Bookkeeping)

Keyword	Contents
STATUS	Status of data (source, approval, cross reference)
HISTORY	History of the EXFOR entry

Example

```
          11         22         33         44         55         66
----------+----------+----------+----------+----------+----------+
STATUS     (TABLE) Table 2 of Ann. Nucl. Energy 11(1984)173
           (APRVD) Approved by S.Ganesan (2010-03-30)
HISTORY    (20100321C) Compiled by Paresh M. Prajapati
           (20110411A) Corrected by Megha Bhike
```

EXFOR Formats Manual

All details of EXFOR Formats are described in the EXFOR Formats Manual. A pdf copy is available on NRDC web page

(http://www-nds.iaea.org/nrdc/).

INTERNATIONAL ATOMIC ENERGY AGENCY

IAEA-NDS-207
Rev. 2015/08

NUCLEAR DATA SERVICES

DOCUMENTATION SERIES OF THE IAEA NUCLEAR DATA SECTION

EXFOR Formats Manual

last revision edited by

Otto Schwerer
IAEA Nuclear Data Section, Vienna, Austria

on behalf of the
International Network of Nuclear Reaction Data Centres

August 2015

IAEA Nuclear Data Section, Vienna International Centre, A-1400 Vienna, Austria

Example of EXFOR Formats Manual

DECAY-DATA. Gives the decay data for any nuclide occurring in the reaction measured as assumed or measured by the author for obtaining the data given[1]. See also **LEXFOR, Decay Data**.

1. If the keyword RAD-DET is used, an entry should also be made for DECAY-DATA. Also, if decay flags appear in the data section, they must be linked to an entry under DECAY-DATA, see below. Otherwise, its presence is optional, and free text or coded information, with or without free text, may be given.

   If the keyword DECAY-DATA is present, the keyword HALF-LIFE may not be used. See also **LEXFOR, Half-Lives**.

2. The general format of the coding string consists of three major fields which may be preceded by a decay flag:

   ((flag)nuclide,half-life,radiation).

   Embedded blanks are permitted in the code only at the beginning of a field or subfield. A code string may be broken for continuation onto the next record, but the break must come at the end of a field or subfield, *i.e.*, the comma separating the subfields should be the last character on the line.

   Flag. The general format of the code is (*n*.), where *n* has a numerical value that also appears in the data section under the data heading DECAY-FLAG. The flag may be omitted, in which case its parentheses are also omitted. See also **LEXFOR, Flags**.

Free Text – *Be short and precise*!

Free Text
(See also EXFOR Formats Manual Chapter 3).

Be short and precise!

Lengthy free text information may hide essential free text information. The compiler should *avoid "copy and paste"* and should identify key information to be kept as free text.

Free Text – *Be short and precise*! (cont)

How to make free text more effective?

- **Enter the free text under the keyword and code to which it pertains.**

  (3INDIND,2JPNJPN) Bangalore University and Sapporo University

  →

  (3INDIND) Bangalore University

  (2JPNJPN) Sapporo University

- **Do not expand coded information by free text in general.**

  (3INDBHU) ~~Baranas Hindu Univ.~~

- **Use coded information instead of free text when possible.**

  Decay data were taken from R.B.Firestone et al., Table of Isotopes (1996)

  →

  (N,,B,FIRESTONE,,1996) Decay data given

Free Text – *Be short and precise*! (cont)

(ACTIV,EXTB,STTA,GSPEC,MOSEP)
Excitation function was measured via the activation technique using stacked foil targets. Six stacks were irradiated at 16.0, 20.7 And 26.6 MeV. Irradiation time were between 0.5 and 2 hours, the beam current was 100 to 200 Na. The beam energy was measured directly by measuring the time between the beam bounches in Juelich, and was determined from the extraction radius and the cyclotron frequency in Debrecen. For monitoring the beam Ti and Cu foils were used.

(ACTIV) Irradiated for 0.5 to 2 hours with the beam current was 100 to 200 nA.

The beam energy was measured directly by measuring the time between the beam bounches in juelich, and was determined from the extraction radius and the cyclotron frequency in Debrecen.

(MOSEP) Ti and Cu foils used for monitoring the beam.

(STTA) Six stacks were irradiated at 16.0, 20.7 and 26.6 MeV.

(EXTB,GSPEC)

Free Text – *Be short and precise*! (cont)

(2ITYBAU) Istituto Nazionale di Fisica Nucleare (INFN), Bari, Italy. G.Tagliente, corresponding author, Email = guiseppe.tagliente@ba.infn.it; N.Colonna, S.Marrone, R.Terlizzi

(2ITYTRI) Istituto Nazionale di Fisica Nucleare (INFN), Trieste, Italy. K.Fujii, P.M.Milazzo, U.Abbondanno, F.Belloni, C.Moreau

(2FR SAC) CEA/Saclay-DSM/DAPNIA, Gif-sur-Yvette, France. G.Aerts, S.Andriamonje, E.Berthoumieux, W.Dridi, F.Gunsing, J.Pancin, L.Perrot, A.Plukis

→ **(2ITYBAU,2ITYTRI,2FR SAC)**

Free Text – *Be short and precise*! (cont)

Nuclear data were taken from E. Browne, R.B.Firestone, Table of radioactive isotopes, ed. V.S.Shirley, Wiley, 1986, New York. To calculate the particles energies in the foils Ziegler's stopping table was used. (J.F.Ziegler, the stopping and ranges of ions in matter, vol 3. Pergamon, New York, 1977)

→

(R,,J.F.Ziegler,B,ANDERSEN,3,1977)
Stopping power given

(R,,E.Browne+,B,BROWNE,,1986)
Decay data given

Free Text – *Don't copy and paste full sentence!!!*

Common article …

Copy and paste

II. EXPERIMENT

A. Neutron irradiation

The neutron irradiation work was carried out at the 14 MeV neutron generator laboratory [7], Department of Physics, University of Pune, Pune, India. The 14 MeV neutrons were produced by bombarding deuterium ions of energy 175 keV on an 8 Curie tritium target. On the tritium target, the deuterium beam had a diameter ~4 mm and current ~100 μA.

```
INC-SOURCE (D-T) The 14 MeV neutrons were produced by bombarding  33080  1   37
           deuterium ions of energy 175 keV on an 8 Curie tritium 33080  1   38
           target. On the tritium target, the deuterium beam had  33080  1   39
           a diameter ~4 mm and current ~100 microA.              33080  1   40
```

```
INC-SOURCE (D-T) Deuterium ion beam (175 keV, ~4 mm in diam.,     33080 1   11
            ~100 uA on target) on an 8 Curie tritium target       33080 1   12
```

Extract essential information for free text (like TELEX).

This job is not for secretaries but for physicists!

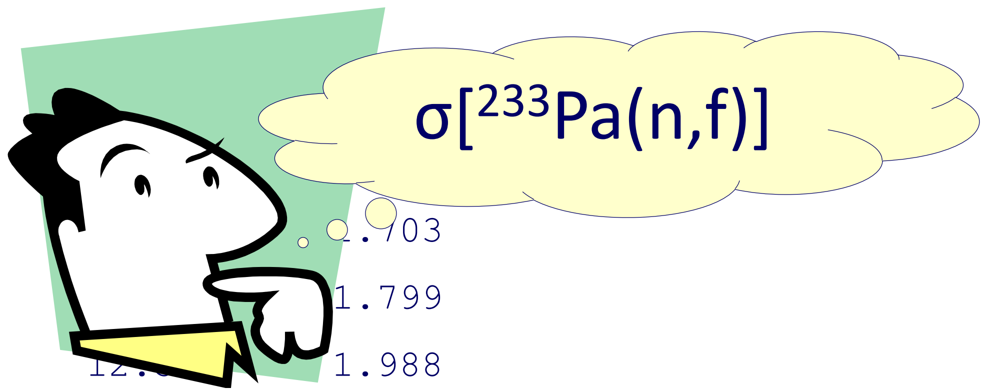
REACTION Code

REACTION code is the most important coded information in EXFOR. It defines quantity (DATA) given in the subentry.

…

REACTION (91-PA-233(N,F),,SIG)

…



EN	DATA	ERR-S		
MEV	B	B		
11.83	0.8832	0.076	[illegible]	.703
12.83	0.8754	0.076	[illegible]	1.799
13.84	0.8986	0.066	[illegible]	1.988
14.84	0.9444	0.071	13.51	2.091
15.85	1.1347	0.077	14.52	2.151
16.85	1.4780	0.1	15.52	2.122

Sub Fields (SF) in REACTION Code

(SF1(SF2, SF3) SF4, SF5, SF6, SF7, SF8, SF9)

Reaction field

Quantity field

Example

(30-ZN-67(N,P)29-CU-67,,SIG)

= Cross section of $^{67}Zn(n,p)^{67}Cu$

(SF7,SF8 and SF9 are omitted)

Sub Fields (SF) in REACTION Code (Cont)

More Example

(30-ZN-67(N,P)29-CU-67,,DA)

= (Proton) angular distribution in ^{67}Zn(n,p)^{67}Cu [mb/sr]

(30-ZN-67(N,N+P)29-CU-66,,DA,P)

= Proton angular distribution in ^{67}Zn(n,np+pn)^{66}Cu [mb/sr]

(30-ZN-67(N,P)29-CU-67,PAR,DA)

= (Proton) partial angular distribution in ^{67}Zn(n,p)^{67}Cu [mb/sr]

"*partial*" = data for a specific secondary (level, kinetic) energy

Sub Fields (SF) in REACTION Code (Cont)

More Example

(30-ZN-67(N,X)29-CU-66,,SIG)

= ^{66}Cu production cross section from ^{67}Zn(n,x)^{66}Cu [mb]

(Outgoing particle unknown - n+p? d?)

(30-ZN-67(N,X)1-H-1,,DA/DE)

= Proton double diff. cross section in ^{67}Zn(n,p+x) [mb/sr/MeV]

(30-ZN-67(P,EL)30-ZN-67,,DA,,RTH)

= (Proton) Rutherford ratio in ^{67}Zn(p,p_0)^{67}Zn [no dimension]

Sub Fields (SF) in REACTION Code (Cont)

More Example

(92-U-233(N,F)53-I-131,IND,FY)

= ^{131}I independent fission yield from ^{233}U(n,f) [nuclides/fission]

(*"independent"* = contribution of decay to ^{131}I excluded)

(98-CF-252(0,F),PR,NU)

= Prompt fission neutron multiplicity in ^{252}Cf spontaneous fission [neutrons/fission]

(92-U-235(N,F),PR,NU/DE)

= Prompt fission neutron spectrum in ^{235}U(n,f) [neutrons/fission/MeV]

Sub Fields (SF) in REACTION Code (Cont)

More Example

(95-AM-241(N,G)95-AM-242-M,,SIG)

=Cross section for ^{241}Am(n,γ)^{242m}Am [mb]

(91-PA-233(N,F),,SIG)/(92-U-235(N,F),,SIG)

= Cross section ratio for ^{233}Pa(n,f)/ ^{235}U(n,f) [no dimension]

(91-PA-233(N,G)91-PA-234,,SIG,,MXW)

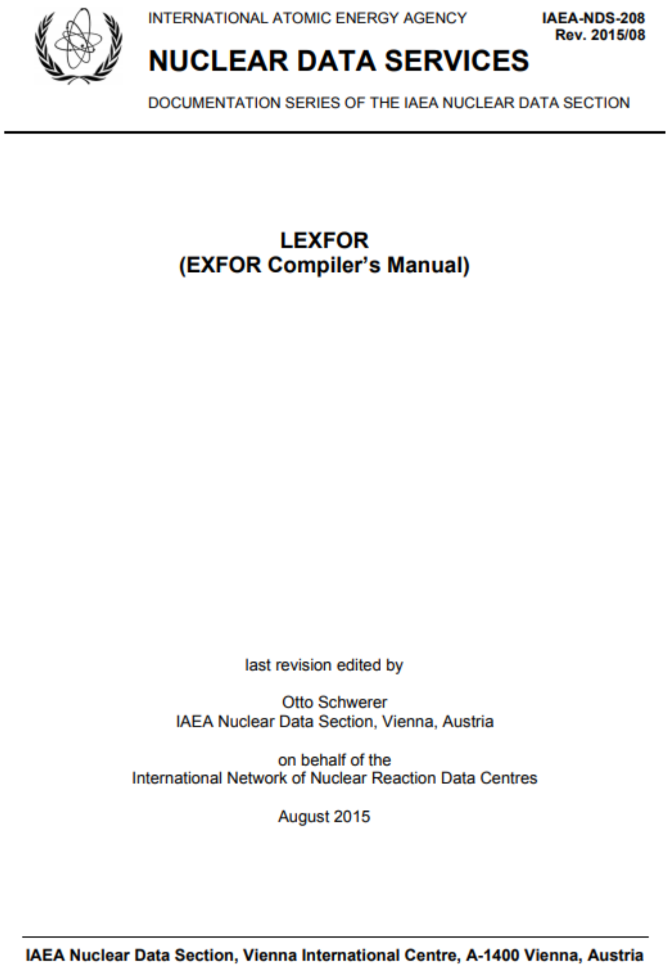
= Cross section for ^{233}Pa(n,γ)^{234}Pa averaged for Maxwellian spectrum [mb]

LEXFOR

- Major quantities defined in the EXFOR Formats are explained in LEXFOR (EXFOR Compiler's Manual) with corresponding REACTION code.

- A pdf copy is available on NRDC web page:

  http://www-nds.iaea.org/nrdc/


INTERNATIONAL ATOMIC ENERGY AGENCY

IAEA-NDS-208
Rev. 2015/08

NUCLEAR DATA SERVICES

DOCUMENTATION SERIES OF THE IAEA NUCLEAR DATA SECTION

LEXFOR
(EXFOR Compiler's Manual)

last revision edited by

Otto Schwerer
IAEA Nuclear Data Section, Vienna, Austria

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August 2015

IAEA Nuclear Data Section, Vienna International Centre, A-1400 Vienna, Austria

Example of LEXFOR

Thermonuclear Reaction Rate

Definition

The thermonuclear reaction rate is defined as cross section times ion velocity averaged over the Maxwellian-Bolzmann distribution of relative ion velocity distribution of the temperature *kT*.

$$\langle \sigma \cdot v \rangle = \frac{\int_0^\infty (\sigma \cdot v) e^{-mv^2/kT} v^2 dv}{\int_0^\infty e^{-mv^2/kT} v^2 dv}$$

← Definition by an equation

The ion with the mass m_2 has the velocity v relative to the target ion of mass m_1. The reduced mass m of the ion pair is $m = m_1 m_2 / (m_1 + m_2)$.

REACTION Coding: (…, SGV, , MXW)

← EXFOR REACTION code

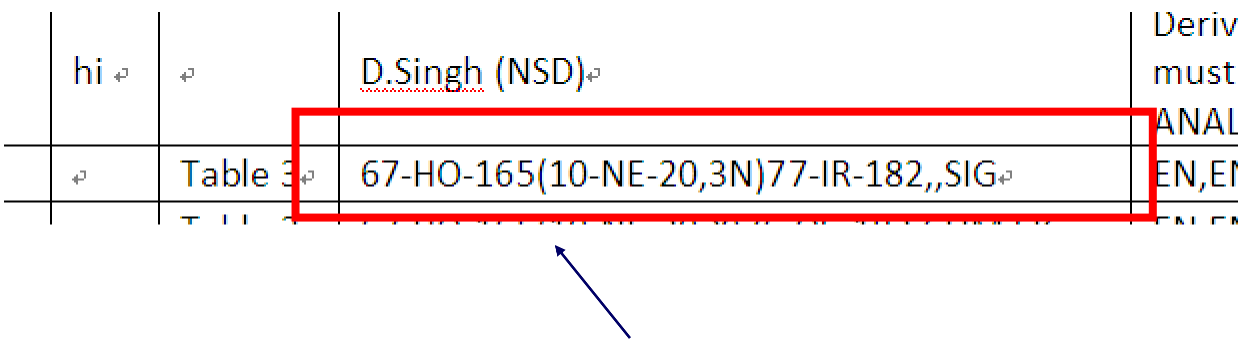
Units: code from Dictionary 25 with the dimension B*V (*e.g.*, CM3/SEC).

Energy Coding: Data are given as function of the Maxwellian temperature (*kT*), which is coded under the data heading KT with units of energy. See **Spectrum Average** for definition of incident spectrum.

In this workshop …

Assignment of the right REACTION code is a most difficult part of EXFOR compilation.

Just copy and paste REACTION code from the article list on the IAEA web site http://www-nds.iaea.org/nrdc/india/ws2015/:



Copy and paste the string to the Editor screen.

Supplemental Numerical Information (Parameters)

$$\sigma = \sigma_M \frac{A \varepsilon_M f_{dM} \lambda}{A_M \varepsilon f_d \lambda_M} \frac{N_M}{N} \frac{(1 - e^{-\lambda_M t_1})}{(1 - e^{-\lambda t_1})} \frac{e^{-\lambda_M t_2}}{e^{-\lambda t_2}} \frac{(1 - e^{-\lambda_M t_3})}{(1 - e^{-\lambda t_3})}, \tag{1}$$

Cross section σ depends on the

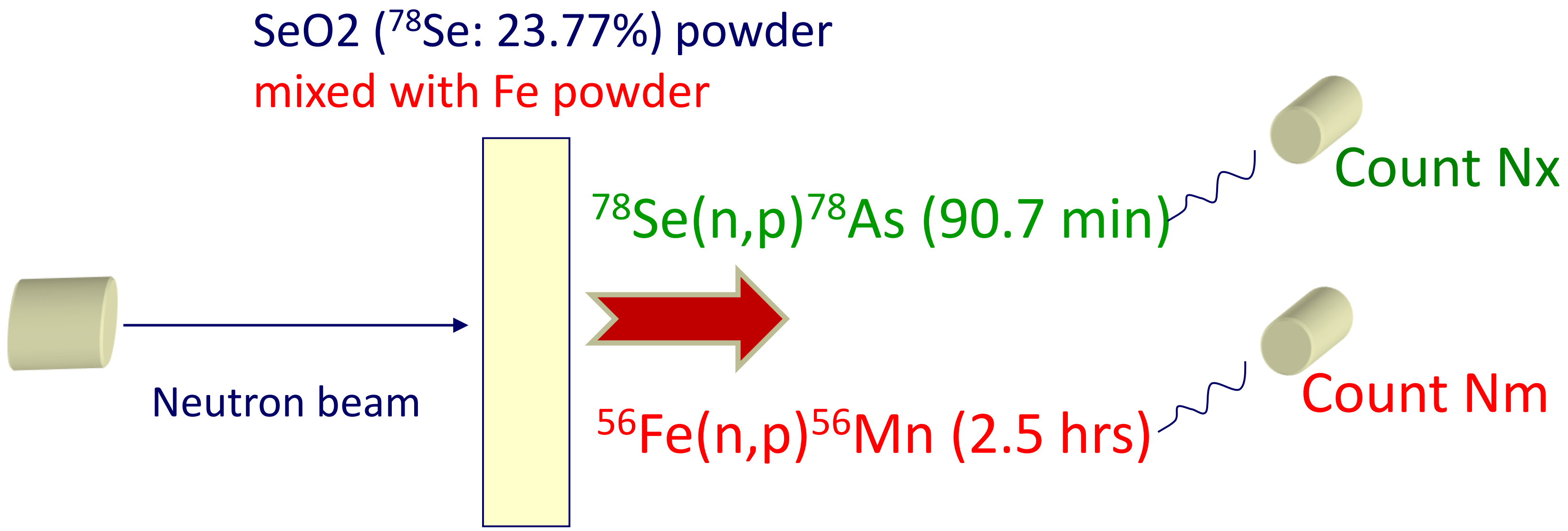
- quantity measured by the authors (count A)

and also depends on values assumed by the authors, for example,

- monitor cross section σ_M
- decay gamma intensity f
- decay constant λ.

These assumed values (parameters) are usually taken from the literature. They must be compiled as supplemental information.

Adopted Monitor Cross Section (EXFOR 33080.002)



Cross section of interest σx = C·(Nx/Nm) σm (monitor cross section)

```
MONITOR     (26-FE-56(N,P)25-MN-56,,SIG)
MONIT-REF   (,A.A.Filatenkov+,R,RI-252,1999)
```

56Fe(n,p)56Mn cross section reported by Filatenkov in 1999 is adopted. Its value is not reported in the 33080 article.

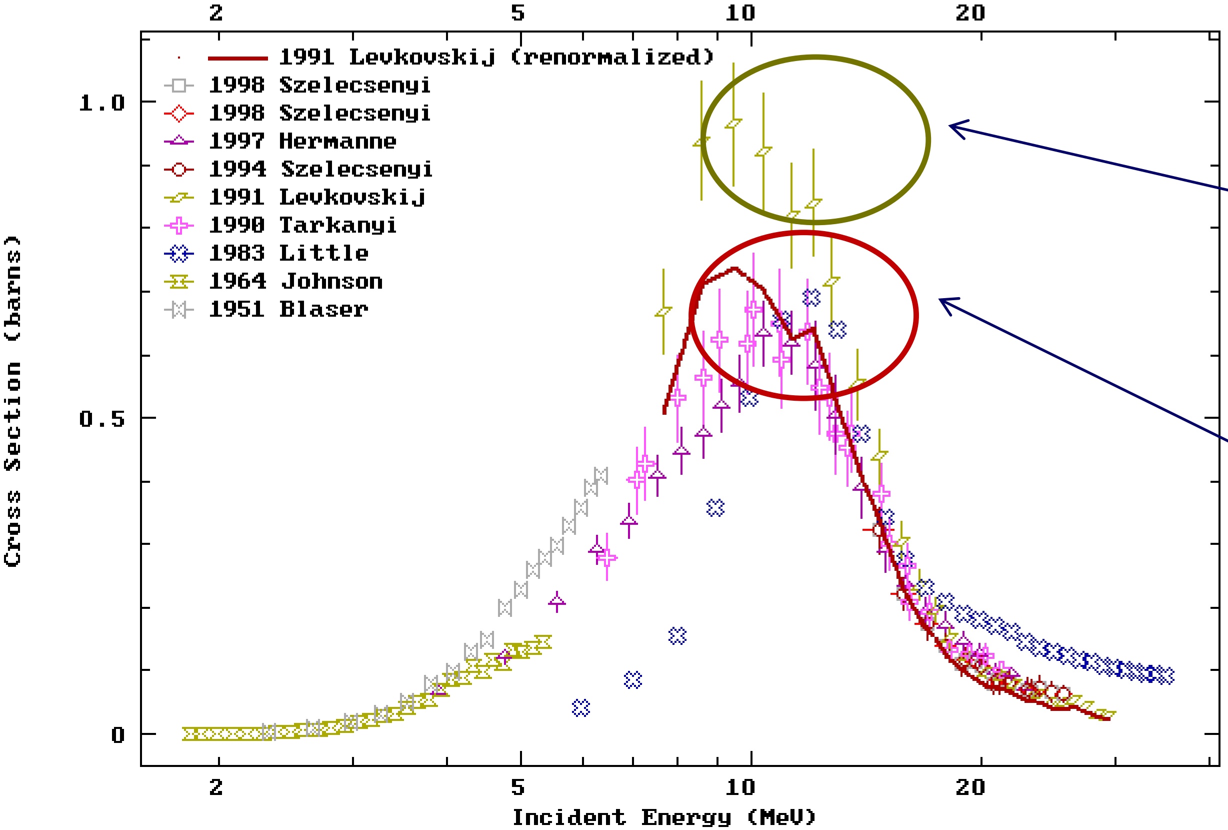
Monitor Cross Section (EXFOR A0510)

```
ENTRY              A0510   20110726                        A0510000     1
SUBENT          A0510001   20110726                        A0510001     1
BIB                   12         35                        A0510001     2
TITLE      Activation cross section nuclides of average    A0510001     3
           masses (A=40-100)by protons and alpha-particles A0510001     4
           with average energies (E=10-50 MeV).            A0510001     5
AUTHOR     (V.N.Levkovskij)                                A0510001     6
...
MONITOR    (42-MO-0(A,X)44-RU-97,,SIG)                     A0510001    29
           ((MONIT)42-MO-0(P,X)43-TC-96,,SIG)              A0510001    30
...
ENDBIB                35                                   A0510001    38
COMMON                 4          3                        A0510001    39
EN-NRM     MONIT       MONIT-ERR  DATA-ERR                 A0510001    40
MEV        MB          MB         PER-CENT                 A0510001    41
30.        250.        10.        10.                      A0510001    42
ENDCOMMON              3                                   A0510001    43
ENDSUBENT             42                                   A051000199999
```

Mo(p,x)^{96}Tc cross section=250 mb at Ep=30 MeV assumed.

Impact of Monitor Cross Section Update

$^{67}Zn(p,n)^{67}Ga$



Levkovskij (original)
σm=250 mb (@ 30 MeV)

Levkovskij (renorm.)
σm=190 mb (@ 30 MeV)

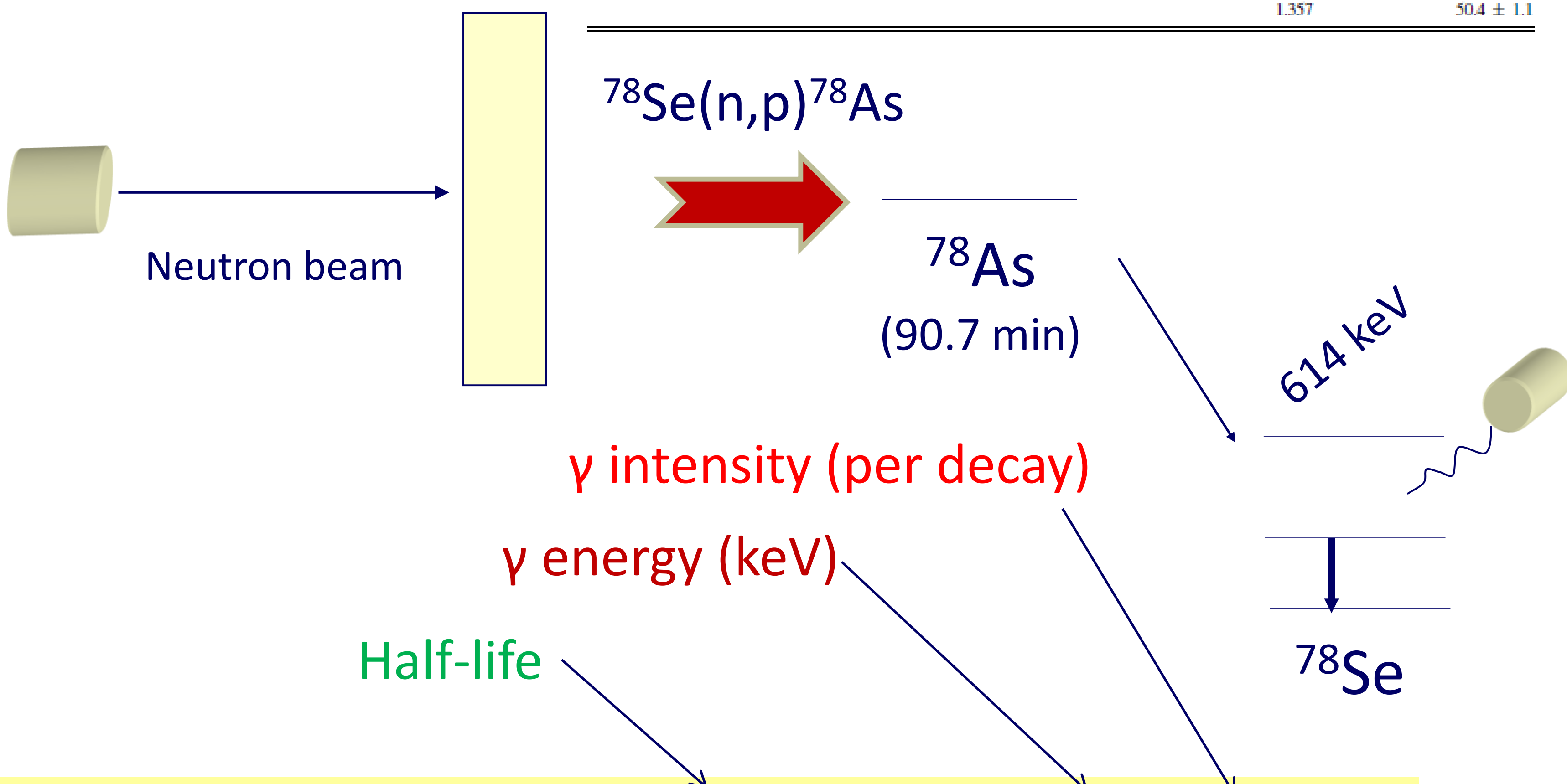
Monitor cross section adopted by Levkovskij (1991) recorded in EXFOR allows us renormalization with a modern monitor value (factor 0.75!!)

Adopted Decay data (EXFOR 33080.002)

c.f. Table I of the 33080 article

TABLE I. The decay data of the radioisotopes produced in neutron induced reactions [9–11].

Nuclear Reaction	Abundance (%)	Half life	E_γ (MeV)	f_d (%)
^{78}Se(n, p)^{78}As	23.77 ± 0.28	90.7 ± 0.2 m	0.614	54 ± 0.6
^{80}Se(n, p)^{80}As	49.61 ± 0.41	15.2 ± 0.2 s	0.666	42 ± 0.5
^{56}Fe(n, p)^{56}Mn	91.75 ± 0.36	2.578 ± 0.0001 hr	0.847	99 ± 0.3
^{19}F(n, p)^{19}O	100	26.91 ± 0.08 s	0.197	96 ± 2.1
			1.357	50.4 ± 1.1



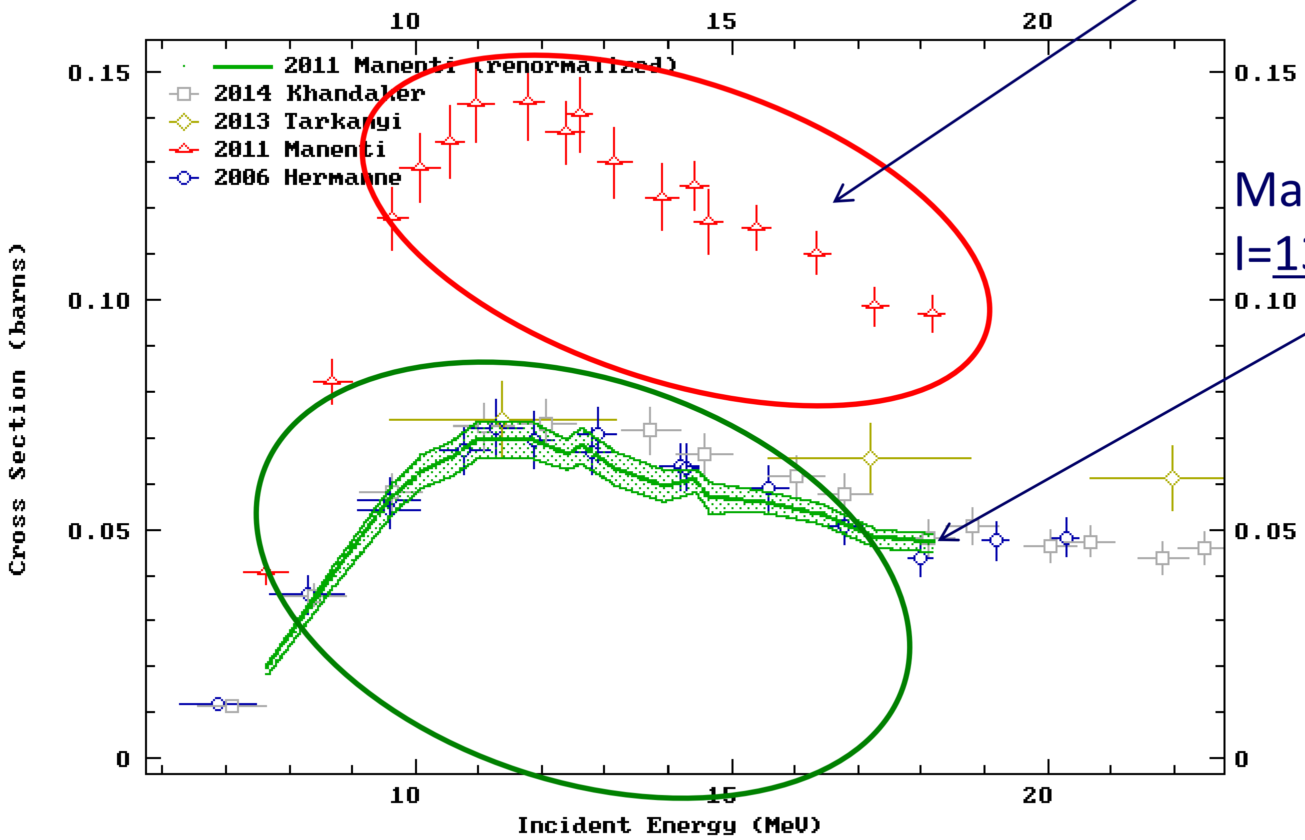
DECAY-DATA (33-AS-78,90.7MIN,DG,614.,0.54)

Impact of Decay Gamma Intensity

Yb(d,x)^{175}Yb

Manenti (original)
I=6.4% (for 396 keV gamma)

Manenti (renormalized)
I=13.1% (for 396 keV gamma)



gamma intensity adopted by Manenti (2011) recorded in EXFOR allows Us renormalization with a modern monitor value (factor 0.49!!)

Uncertainty

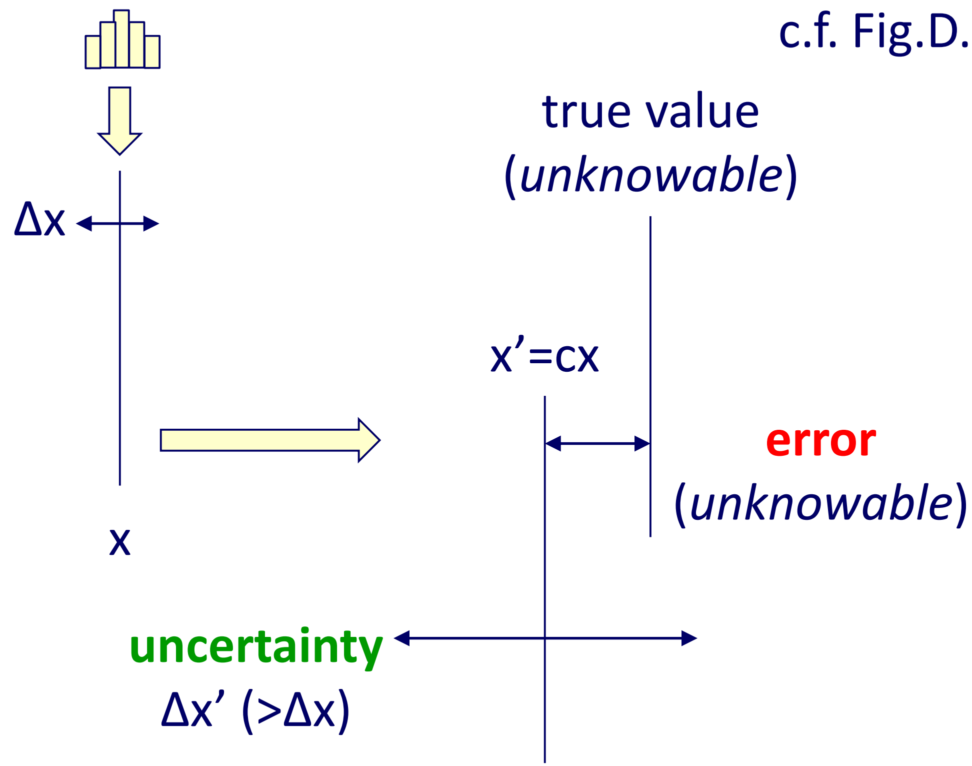
c.f. Fig.D.2 of GUM2008

Measurements

Arithmetic mean
(not very common
In ND experiment)

Correction

Result



The true value is within the uncertainty.
(successful estimation)

Don't mix up "uncertainty" and "error". Experimentalists can report "uncertainty", but cannot report "error" which is unknowable!!

Sources of Uncertainties (Example)

- **Uncertainty independently applied to each data point**
  - Counting statistics

- **Uncertainty commonly applied to each data point (pt)**
  - Unc. due to sample thickness (if the same sample is used for all pts.)
  - Unc. due to gamma intensity (if the same gamma line is used for all pts.)
  - Unc. due to efficiency curve (if the same gamma line is used for all pts.)

ERR-ANALYS (33080)

are negligibly small. The estimated errors in the different parameters are as follows; (i) detector efficiency (~1.5%); (ii) self absorption of γ rays (<14%) [14]; (iii) neutron energy distribution (<1%); (iv) absolute γ-ray intensity (<2.2%); (v) reference cross section of the reaction ^{56}Fe(n, p)^{56}Mn (2–3.7%) [15]; and (vi) reference cross section of ^{19}F(n, p)^{19}O reaction (<5.28%) [16].

Source	Uncertainty
Detector efficiency	1.5%
Gamma self-absorption	<14%
Neutron energy distribution	<1%
Gamma-ray instensity	<2.2%

```
ERR-ANALYS (ERR-1)       Detector efficiency                (~1.5%)     3308000100017
           (ERR-2,,14.) Self absorption of gamma-rays   (<14%)      3308000100018
           (ERR-3,,1. )  Neutron energy distribution      (<1%)     3308000100019
           (ERR-4,,2.2) Absolute gamma-ray intensity  (<2.2%)      3308000100020
…
ENDBIB              19          0                                   3308000100022
COMMON               1          3                                   3308000100023
ERR-1                                                               3308000100024
PER-CENT                                                            3308000100025
 1.5                                                                3308000100026
ENDCOMMON            3          0                                   3308000100027
```

Conclusion

The following keywords are essential for interpretation of numerical data compiled.

REACTION: Definition of the quantity given

DECAY-DATA: Decay parameters adopted by the authors

MONITOR: Reaction adopted by the author for normalization

DECAY-MON: Decay parameters adopted for monitor reaction

MONIT-REF: Reference where the authors find the monitor value

ERR-ANALYS: Definition of total and partial uncertainties

EXFOR Format

1. Experimental Description

2. Numerical Description

COMMON and DATA Section

Headings and units

```
          11                                                      66           80
------+---------+---------+---------+---------+---------+---------+---------+
COMMON                1          3                                 D6213  2   10
E-LVL                                                              D6213  2   11
MEV                                                                D6213  2   12
  0.0                                                              D6213  2   13
ENDCOMMON             3          0                                 D6213  2   14
DATA                  3         22                                 D6213  2   15
ANG-CM     DATA-CM    DATA-ERR                                     D6213  2   16
ADEG       MB/SR      MB/SR                                        D6213  2   17
…
  74.76      0.327      0.023                                      D6213  2   24
  80.18      0.258      0.024                                      D6213  2   25
  85.53      0.171      0.018                                      D6213  2   26
  90.01      0.153      0.016                                      D6213  2   27
…
ENDDATA              24          0                                 D6213  2   40
…
```

COMMON section (constants of the data set)

Headings and units

DATA section (variables of the data set)

DATA Section

```
          11         22         33
---------+----------+----------+----------+----
COMMON                1          3
E-LVL
MEV
 0.0
ENDCOMMON             3          0
DATA                  3         22
ANG-CM     DATA-CM    DATA-ERR                                        D6213   2    16
ADEG       MB/SR      MB/SR                                           D6213   2    17
…
  74.76     0.327      0.023                                          D6213   2    24
  80.18     0.258      0.024                                          D6213   2    25
  85.53     0.171      0.018                                          D6213   2    26
  90.01     0.153      0.016                                          D6213   2    27
…
ENDDATA              24          0                                    D6213   2    40
…
```

E_{level} (MeV)	θcm (deg)	dσ/dΩ (mb/sr)	Δdσ/dΩ (mb/sr)
0.0	74.76	0.327	0.023
	80.18	0.258	0.024
	85.53	0.171	0.018
	90.01	0.153	0.016

Each data field has **11 columns**.

"REACTION" and Heading "DATA"

Measured quantities are always coded under the heading DATA. Its definition is given under the REACTION code.

```
…
REACTION    (91-PA-233(N,F),,SIG)
…
EN          DATA        ERR-S       EN-NRM      MONIT
MEV         B           B           MEV         B
 11.83       0.8832      0.076       10.50       1.703
 12.83       0.8754      0.076       11.50       1.799
 13.84       0.8986      0.066       12.51       1.988
 14.84       0.9444      0.071       13.51       2.091
 15.85       1.1347      0.077       14.52       2.151
 16.85       1.4780      0.1         15.52       2.122
```