EXFOR Evaluating System:
reasons, ideas and proposals to WPEC SG-30

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Problem.

Sometimes evaluators see discrepancies in the EXFOR data, but when they complain to EXFOR compilers they got a reply: EXFOR contains data as they were published and/or received directly from authors, we've checked data: there are no mistakes comparing with original publication; data can be corrected only if author supply new data. This means on practice, that data will not be corrected in EXFOR database (unless author appear to be reachable and is able to send newer data, but this is rare case). So, in this case evaluator can: (1) just ignore the data or (2) introduce some re-calculation procedure correcting data and keep either corrected data or parameters on the procedure. Whenever another evaluator will try to use the same dataset, he (she) will go most likely the same way: surprised by the data, contact EXFOR compiler, get polite reply (data are exactly as it was published), and either reject dataset or introduce re-calculation factors. The problem becomes more and more obvious, when advanced model codes (like, Empire and Talis) can be used for massive evaluations.

Goal.

First evaluator has already come to some conclusion: s/he has some knowledge which is outside of EXFOR contents, and probably can be used by other evaluators. Obviously, evaluators would appreciate each other sharing this information. If some procedure would exist for exchange of this knowledge, evaluators could store and use this information as common attachment to EXFOR database; it could be also used by retrieval/processing/plotting systems developed by Nuclear Data Centres and being offered to an ordinary user.

Organizational matters.

If the goal looks reasonable and being accepted, at first, the process of exchange and storage should be organized:
1) define capabilities of the system - specification of the stored information (what information do we want to keep in the system); this will define further manipulations with EXFOR data
2) agree on format (should be simple and straight in order to be accepted)
3) manpower (programming and maintenance)

Usage.

Then existing software systems can use the system:
a) full EXFOR in C4, modified with flags and corrections
b) options for EXFOR retrieval/processing systems used by evaluator (EndVer/GUI, EXFOR for Applications, Janis, Empire,…)
c) options on Web for computational output and plotting:
   1) [use only "Trusted" datasets];
   2) [do not use "Rejected" datasets];
   3) [correct data by evaluators coefficients];
   4) etc. (text can be softer…)

Questions, other approaches and history of the problem.

1) Where to keep flagging/correction information? Right now EXFOR format allows to have renormalized data (STATUS code RENORM) - it is not widely used. It looks more preferable to keep the information **outside of EXFOR** as associated data, because it is much easy to implement (+other reasons).
2) The ways of keeping data in form of Ratios in EXFOR were proposed by A.Trkov when working in IAEA and discussed within NDS (approx. in 2002-2005). Renormalization using current "standards" is implemented by Andrej in EndVer package.
3) "Quality flagging" was proposed by D.Rochman (NNDC, USA) and discussed on NRDC Meetinng-2005 on the basis of experience working in ENDF/B-II project using Talis and Empire. Proposed system could allow searching "trusted" data only as option of a retrieval system.
See: D. Rochman, "Proposition for a new field in the EXFOR format for "trusted data" (CP-C/363)", September 26, 2005, WP-2005-06, http://www-nds.iaea.org/nrdc/nrdc_2005/working/wp2005-06.doc

NRDC Meeting Action on NDS was formulated:
A14. *Develop an external flagging system to indicate which data sets were adopted by evaluators.* (No further development till now.)

Procedures.

Working with EXFOR data, evaluators:
a) send their notes to the IAEA-NDS as free text; NDS will put information to agreed format and load to the database;
b) put information to agreed format and send to IAEA-NDS; NDS checks information and load to the database.
IAEA provides collected data to Nuclear Data Centres and to all users.

Capabilities.

Again two layers possible:
a) flags: [Trusted]; [Rejected]; [Corrected]; and may be this is already enough for some applications (?)
b) corrections: varieties, e.g. shift Energy; multiply cross-section data; reject Energy interval; increase data Errors by factor…; etc. To cover these cases a linear (polynomial) functions should be sufficient and can be implemented, as following:
one experimental data point: {data(i), i=1,m}
corrected values for every i: $\text{data}(i) := a_0 + a_1 \cdot \text{data}(1) + a_2 \cdot \text{data}(2) + \ldots + a_m \cdot \text{data}(m)$
For example in C4 formatted file,

Energy shift:	$\text{data}(1) := \text{Energy}_0 + \text{data}(1)$
Factor for cross-sections:	$\text{data}(3) := \text{Factor} \cdot \text{data}(3)$
Set Errors as 5% of cross-sections:	$\text{data}(4) := 0.05 \cdot \text{data}(3)$
Increase Data-errors by 3% of data:	$\text{data}(4) := \text{data}(4) + 0.03 \cdot \text{data}(3)$
Set Energy-errors =6KeV:	$\text{data}(2) := 6000$

Specification of cases which have to be implemented and requirements in details should be discussed by SG30 members.

Format.

Format specification depends of procedures and capabilities. Example of exchange file providing flagging, intervals and corrections presented below has following features:

1) Evaluators name and date when the note was created
2) SUBENT (with date) and REACTION lines, copied from EXFOR file
3) Flag with instructions for processing code: Trust, Rejected, Correct
4) Description of corrections: applied for whole dataset, and for every data point (linear)

```
X4EVALUATING     10001    20080522
EVALUATOR  (Herman,20080522)

SUBENT        21926004      850311
REACTION   (13-AL-27(N,TOT),,SIG)          Accepted with "high" priority
Author     (1984,M.Ohkubo)
Flag       (Trust)
/REACTION
/SUBENT

SUBENT        13761007   20010726
Author     (1977,Harvey+)
REACTION   (13-AL-27(N,TOT),,SIG)          Rejected
Flag       (Reject)
/REACTION
/SUBENT

SUBENT        13761006   20010726
Author     (1977,Harvey+)
REACTION   (13-AL-27(N,TOT),,SIG)
Flag       (Correct)

#Ignoring Energy Interval: 0-4 KeV and 8-...KeV
Correct  ALL: Ignore      #EN;EV           Limit data by
Interval D1: 0 : 4e+4                      Energy range
Interval D1: 8e4
/Correct

#     cross section multiply by 0.1 : Data(3) in C4 file
#     within interval Energy:4KeV..8KeV    Renormalize
Correct  D3: Calc         #DATA;B          data in one
Interval D1: 4e4 : 8e+4                    energy range
Linear   (D3)*0.1
/Correct

#recalculate error of cross section:
# add 3% of data value                    Increase data
Correct  D4: Calc         #DATA-ERR;B      errors by 3% of
Linear   (D4)+(D3)*0.03                    data
/Correct

#assume systematic error of data: 2% of data value :
# new column in C4 file: DD1               Introduce
Correct  DD1:   Def   #DATA-ERR;B #systematic error  systematic error
Linear   (D3)*0.02                         (for future usage
/Correct                                   by other codes)

/REACTION
/SUBENT

/X4EVALUATING
```
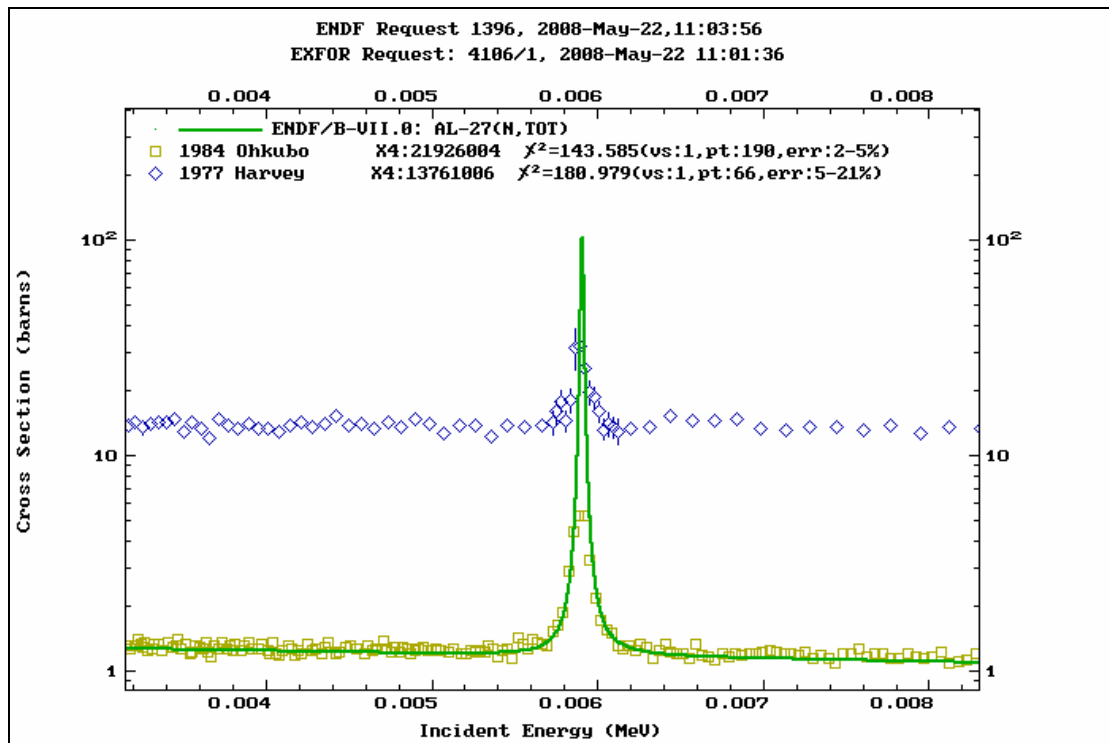
Accepted with corrections

Fig.1 Data for the given Format-example

Possible problems in the future.

Because EXFOR is permanently changing database, it is possible that new data superseding old data do not need corrections anymore (or need another corrections). So, corrections which we have in the database are not valid anymore. In order to deal with such cases, we should foresee options, like [do not use corrections for newer data], and/or EXFOR compilers could be asked by SG30 to use another Subentry numbers in such cases… (Other solutions?)

Conclusion.

If the goal will be accepted by SG30 group, details of format and implementation can be discussed again with evaluating code developers, experienced evaluators, and some EXFOR users outside of SG30. The aim would be to involve them to the process of format development and further data exchange. Finally, IAEA-NDS can then provide: (a) maintenance of the EXFOR Evaluating System, (b) supply C4Evaluated file of full EXFOR in addition to the full C4 file and (c) implement foreseen features in NDS EXFOR-ENDF retrieval systems.