Reaction Yield Divided by Areal Density (14324 in PRELIM.1420)

(N. Otsuka, V. Semkova, 2016-11-30, Memo 4C-3/406)

We believe distinction between the cross section (SIG) and reaction yield (RYL) is critical for EXFOR users dealing with neutron resonances. Recently NNDC has systematically compiled capture yields divided by the areal density from ORELA. If we follow the rules formulated by H. Potters and F. Fröhner in 1973 in 4C-2/36 and 4C-2/40, this quantity must be coded with `,SIG,RAW`. However, we received the following comment from Boris Pritychenko on 24 June:

> *Klaus Guber gave me his final data: energy in eV and cross sections in barns. My understanding was that I deal with regular cross sections when all imaginable corrections were already applied because Klaus would not give you an unfinished product. He is a very accurate man.*

We understand his concern about the modifier `RAW`. Following discussion with the participants of the Consultant's Meeting on "EXFOR Data in Resonance Region and Spectrometers' Response Function" (8-10 October 2013), we came to the following conclusion:

> The ORELA capture yields actually have been <u>corrected for known effects</u> (*e.g.*, dead time, background), and are <u>properly reported</u> capture yields per areal density. Therefore the quantity should be compiled as the capture yield divided by the areal density (say `,RYL,,DAD`) without the `RAW` modifier. It should not be coded as cross sections (`SIG`).

If NNDC still does not agree with the proposal and still wants to compile them as cross sections (`SIG`), we ask NNDC to move 14324.006, 009, 010 and 012 from PRELIM.1420 to [TRANS.PROBLEM] of the NDS open area for further discussion, and finalize the rest part in TRANS.1420 as soon as possible.

During discussion of this subject, Yaron Danon (RPI) informed me that the RAW modifier is not systematically applied in EXFOR entries compiling TOF spectra from RPI. We ask NNDC to check if RAW is really necessary in the following data sets:

14110.010-038; 14112.004-009; 14239.022-050; 14263.014-021.

Peter Schillebeeckx (EC-JRC IRMM) also recommends (1) deletion of the 22921.008.1 data set (gross yield) and (2) deletion of the RAW modifier from 22921.008.2 (net yield). The gross yield could be kept under the heading `MISC` if necessary.

Dictionary 34 (Modifiers)
`DAD`   Divided by areal density

Dictionary 236 (Quantities)
`,RYL,,DAD` Reaction yield divided by areal density

Quantity	Reaction Type	Dimension	Subentry
`,RYL,,DAD`	TOF	B	14324.006,009-010,012

Addition of this quantity code requires retroactive corrections of existing data sets providing the same quantity. Except for three entries (20374, 20555, 41016), all affected entries (*i.e.*, neutron capture and fission data sets coded with `,SIG,,RAW` with `TOF` under the keyword METHOD) are from area 1.

N.B. The current equation defining the reaction yield in LEXFOR "Transmission and Reaction Yield"

$$Y_x(E) = [1 - \exp(-n_T \sigma_T(E))] \frac{\sigma_x(E)}{\sigma_T(E)}$$

misses the multiple scattered neutron contributions, and must be corrected to

$$Y_x(E) = [1 - \exp(-n_T \sigma_T(E))] \frac{\sigma_x(E)}{\sigma_T(E)} + \sum_{i=1}^{\infty} Y_{x,i}(E)$$

as formulated by Potters in Memo 4C-2/36, namely. ($Y_{x,i}$ is the reaction yield from neutrons scattered i times before inducing the reaction x).