"Prompt" Summary of oral discussion on Compiling/Storage of Neutron Spectra in EXFOR

1. History

The issue of compilation of the Neutron Spectra in EXFOR was firstly addressed at the IAEA Consultants' Meeting on "Neutron Sources Spectra for EXFOR" (13- 15 April 2011, IAEA), see:

- Summary Report INDC(NDS)-0590
  https://www-nds.iaea.org/publications/indc/indc-nds-0590-rev.pdf
- Presentations: *https://www-nds.iaea.org/index-meeting-crp/CM-2011_web/*

2. Current status of EXFOR

NDS has searched EXFOR to find all Entries with the Neutron and Photon Source Spectra information (energy distributions) collected under the keyword INC-SPECT. These neutron sources were used by authors to measure the Spectrum Averaged cross sections, fission yields and other physical quantities, the latter were compiled in the same Entry as Reaction string.

The results of search are summarised in Tables 1 (with energy spectra) and 2 (without) in INC-SPECT.

Table 1. Entries with the Neutron Source Spectra information coded under keyword INC-SPECT.

INC-SOURC	**Lab First Author**	**n-Source description**	**EXFOR Entries with INC-SPECT having n-Source spectral information**
Reactor facilities			
REAC	AERE, Dhaka M.S. Uddin	TRIGA Mark II LEU fuel, core	31733 http://www-nds.iaea.org/EXFOR/31733.002
REAC	KUR, I. Kimura	^{6}Li-D convertor behind C-column	22214 http://www-nds.iaea.org/EXFOR/22214.007
REAC	TOK, Tokyo H. Harada	YAYOI Reactor, Glory Hole	23075 http://www-nds.iaea.org/EXFOR/23075.002
REAC	INL, Idaho I. Glagolenko	EBR-II, control rods	31686 http://www-nds.iaea.org/EXFOR/31686.002
Radioactive sources			
AM-BE	Bangladesh S. Qaim	Am-Be in polyethylene	31724 http://www-nds.iaea.org/EXFOR/31724.002
Accelerator based sources			
P-LI7	TIT, Tokyo T. Matsumoto	thick ^{7}Li(p,n) E_p = 1.9 – 2.3 MeV	22850 http://www-nds.iaea.org/EXFOR/22850.005
P-LI7	TIT, Tokyo K.Terada	thick ^{7}Li(p,n) E_p = 1.9, ?? MeV	23187 http://www-nds.iaea.org/EXFOR/23187.003

INC-SOURC	**Lab First Author**	**n-Source description**	**EXFOR Entries with INC-SPECT having n-Source spectral information**
P-LI7	TIT, Tokyo T. Wang	thin ^{7}Li(p,n) E_p = 1.9, 2.3 MeV	23103 http://www-nds.iaea.org/EXFOR/23103.002
P-LI7	Manipal H.Naik	thin ^{7}Li(p,n) E_p = 5.6 MeV	33033 http://www-nds.iaea.org/EXFOR/33033.004
P-LI7	KFK, Karlsruhe F. Kaeppeler	thick ^{7}Li(p,n)	O1963 http://www-nds.iaea.org/EXFOR/O1963.002 this source was used to measure many (n,γ) SPA, e.g. http://www-nds.iaea.org/EXFOR/22996.003 (link to O1963 should be included in such Entries ?)
P-LI7	TSL, Uppsala R. Bevilacqua	thin ^{7}Li(p,n) E_p = 179 MeV	23129 http://www-nds.iaea.org/EXFOR/23129.002 (should be compiled as separated p-Li spectrum ?)
P-BE9	WERC, Japan M.S. Uddin	Be(p,xn) E_p = 7.7 MeV	23238 http://www-nds.iaea.org/EXFOR/23238.002 (4 energy groups flux is given)
D-BE9	ANL S. Liskien	thick ^{9}Be(d,xn) E_d = 7 MeV	21857 http://www-nds.iaea.org/EXFOR/21857.002
SPALL	JINR, Dubna C. Bhatia	Pb + U blanket E_d = 1.6 GeV	41529 http://www-nds.iaea.org/EXFOR/41529.002 41565 http://www-nds.iaea.org/EXFOR/41565.002

Comments: 1) see Qaim's Summary in INDC(NDS)-0590, p. 35

Table 2. Entries which have some numerical information about spectrum
but do not contain energy distributions in INC-SPECT:

INC-SOURC	**Lab First Author**	**n-Source description**	**EXFOR Entries with INC-SPECT having n-Source spectral information**
P-LI7 P-T	IRMM, Geel E. Birgersson	^{7}LiF(p,n), T(p,n) E_p = MeV	23054 http://www-nds.iaea.org/EXFOR/23054.002 (only neutron energy resolution is given …)
D-D	Mexico E. Chavez	D(d,xn) E_d = 3.7 -5.2 MeV	31687 http://www-nds.iaea.org/EXFOR/31687.002 (only dependence of En vs. Angle is given)
REAC	ILL, Grenoble A. Letourneau	High Flux reactor, 2 channels in moder.	22941 http://www-nds.iaea.org/EXFOR/22941.002 (only total and thermal fluxes)
D-BE9	*Julich S. Qaim*	*thick ^{9}Be(d,xn) E_d = 9.7, 14, 30, 53 MeV*	*There are many Entries with S.Qaim's SPA[1] (corresponding n-spectra have to be referred or compiled)*
D-D D-T	*FNG, Frascati M. Pillon*	*solid TiT, gas D, E_d = 0.3 MeV*	*23142 http://www-nds.iaea.org/EXFOR/23142.002 (only Emin, Emax, Emean are given) 23127 http://www-nds.iaea.org/EXFOR/23127.002 (corresponding n-spectra have to be compiled)*
REAC	*IJD, Kyiv O. Gritzay*	*WWR-M filtered n-beam*	*32216 http://www-nds.iaea.org/EXFOR/32216.002 (Emean, Yields of the main and satellite lines) (corresponding n-spectra have to be compiled)*

M0536 – TAGD (Microtron, K.-H. Krause) – Photon tagging Efficiency, polarization

3. Progress work on inclusion of Neutron Spectra in EXFOR

Here are two examples of information on Neutron Spectra received by NDS from Authors but not included in the EXFOR yet:

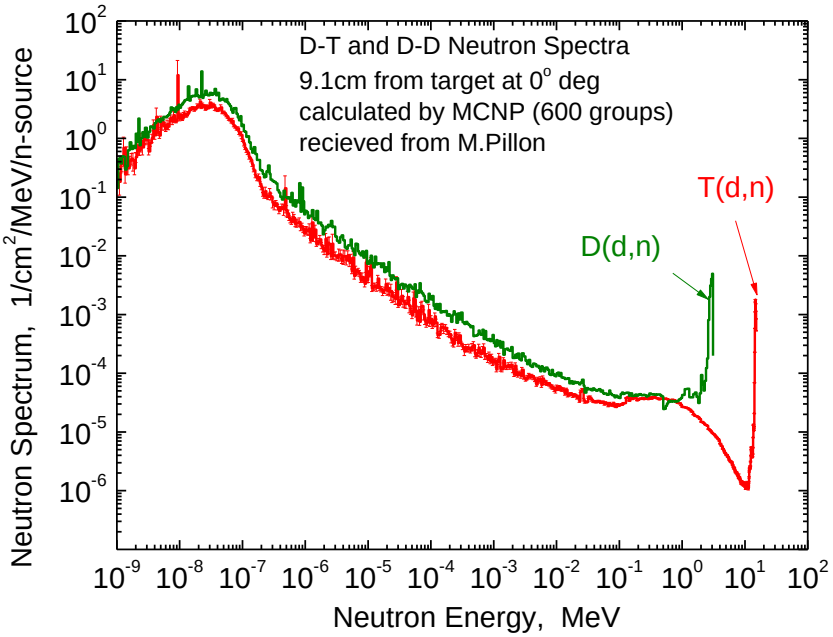

Fig. 1. Neutron Spectra from D-T and D-D Sources from M. Pillon et al. (600 points each).

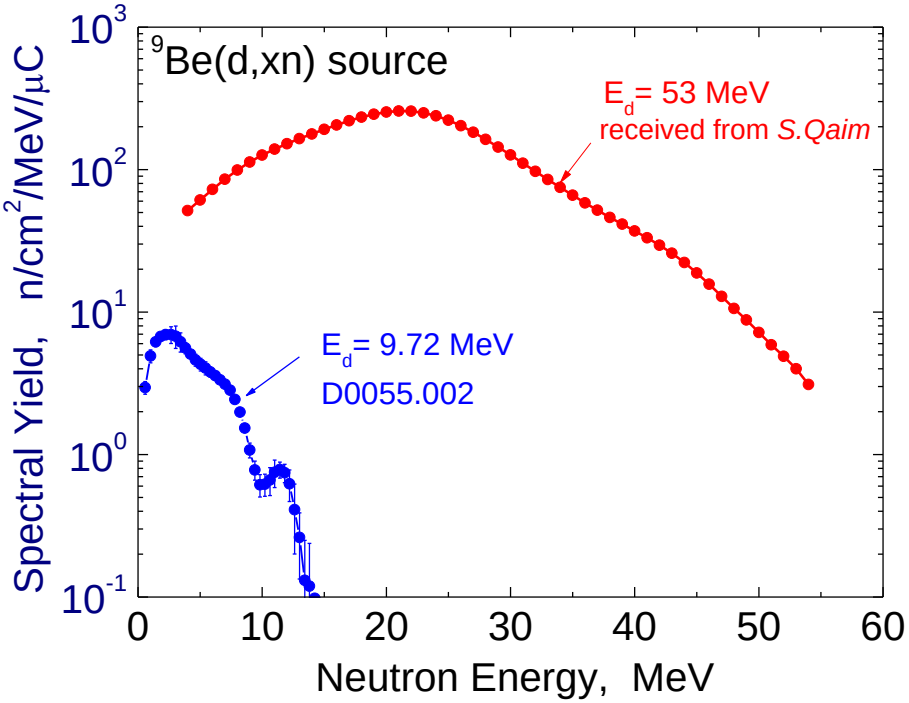

Fig. 2. Neutron Spectra from D-Be Sources from S. Qaim et al. at 53 MeV (51 points)

4. Summary of oral discussions at Workshop "EXFOR Compilation" (6-10 Oct 2014).

Following Alternatives for the Neutron source compilations were considered.

(i). First Alternative: use the REACTION string for incident spectrum

Create the new special SubEntry to code the incident Spectrum as Reaction string:

REACTION (U-238-SRC(0,0),,DE,,SPD)

which will specify Spectrum for already existing SubEntry with reaction SPA cross section coded by proper spectrum code SF8 = MXA, EPI, FIS, FSR, BRA, SPA in:

REACTION (6-C-12(N,TOT) , , , ,SPA

(ii). Second Alternative: continue to use INC–SPECT for incident spectrum

Put spectrum information (reference, or link to file with spectrum) in INC–SPECT:

INC-SPECT ***[or extended version INC-SPECT(DE,…) for searching, plotting etc. ?]***
as free text description of spectrum and how it was obtained

E	Sp
eV	1/eV
10000.	.0001
……	……
19999	.0009

or (E, Sp, Npoints) to read by retrieving system

or ***link to file or text explaining where data could be found, e.g.:***
- ***to File with Spectrum*** *if spectrum array is rather long*
- ***to IRDFF-2002 research reactor Spectra database***
  (https://www-nds.iaea.org/irdf2002/data/irdf2002_spectra.dat):
  for ISNF spectrum from G.P.Lamaze 13153, B.M.Oliver 13752
  for Sig-Sig spectrum from A.Fabry 20948, A.Hannan 20950, I.Garlea 30452, 30568
  for CFRMF spectrum - Y.Harker 10218, E.P.Lippincott 13756
  for YAYOI spectrum - K.Kobayashi 21589, K.Kobayashi 20693
- ***to ENDF or Standards for the case of Cf, U(n,f) source***
- ***to ICSBEP(*** *https://www.oecd-nea.org/science/wpncs/icsbep/):*
  e.g.. to Benchmark FUND-IPPE-FR-MULT-RRR-001 from A. Zvonarev 41068