



International Atomic Energy Agency

The 9th DAE-BRNS Workshop on

Nuclear Reaction Data and its Compilation for EXFOR Database

Department of Physics, Bharathiar University, Coimbatore India

14–18 November 2023

Introduction to EXFOR

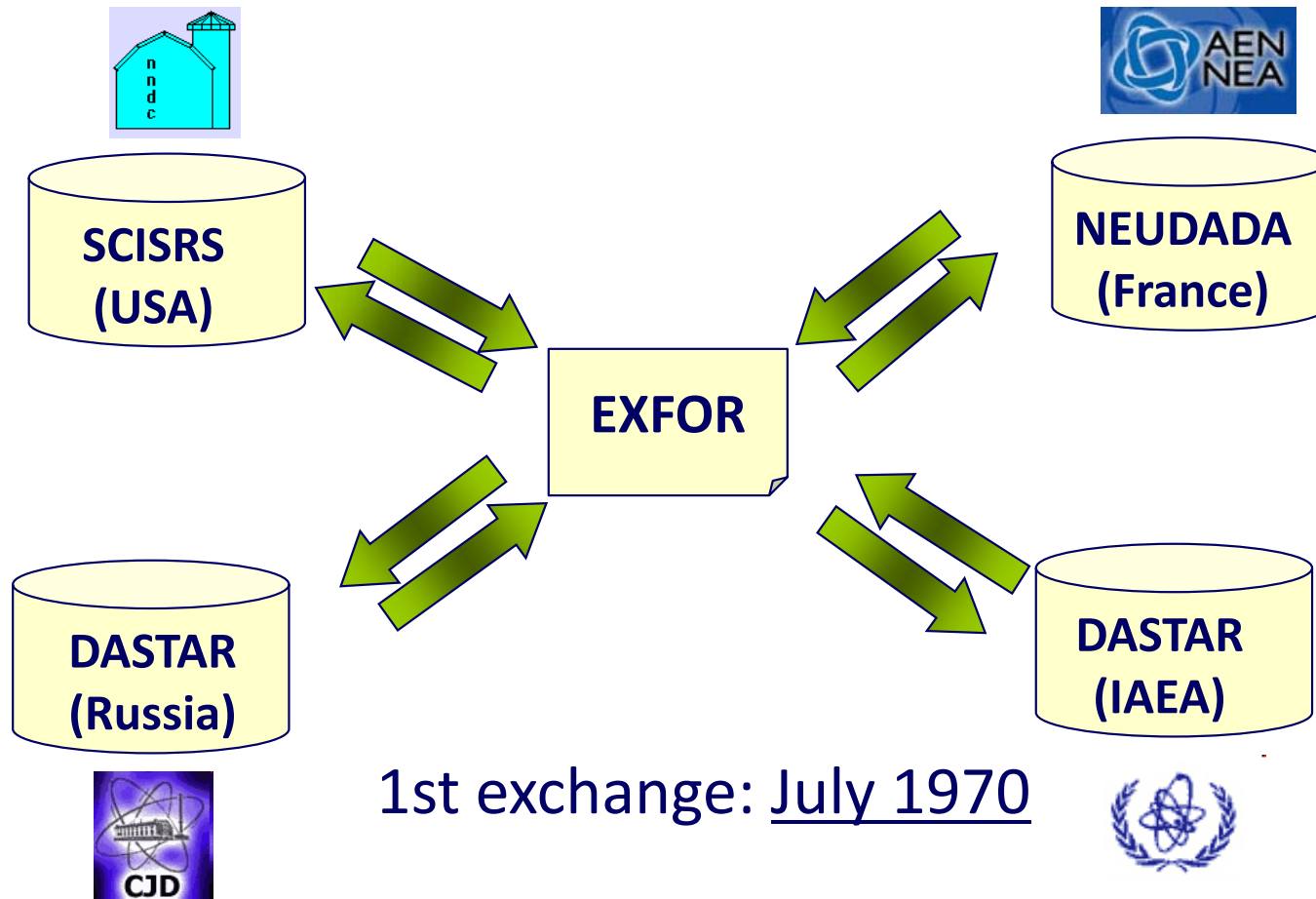
Naohiko OTSUKA

Nuclear Data Section

Department of Nuclear Sciences and Applications



Experimental Data Exchange during Cold War



EXFOR = EXchange FORmat

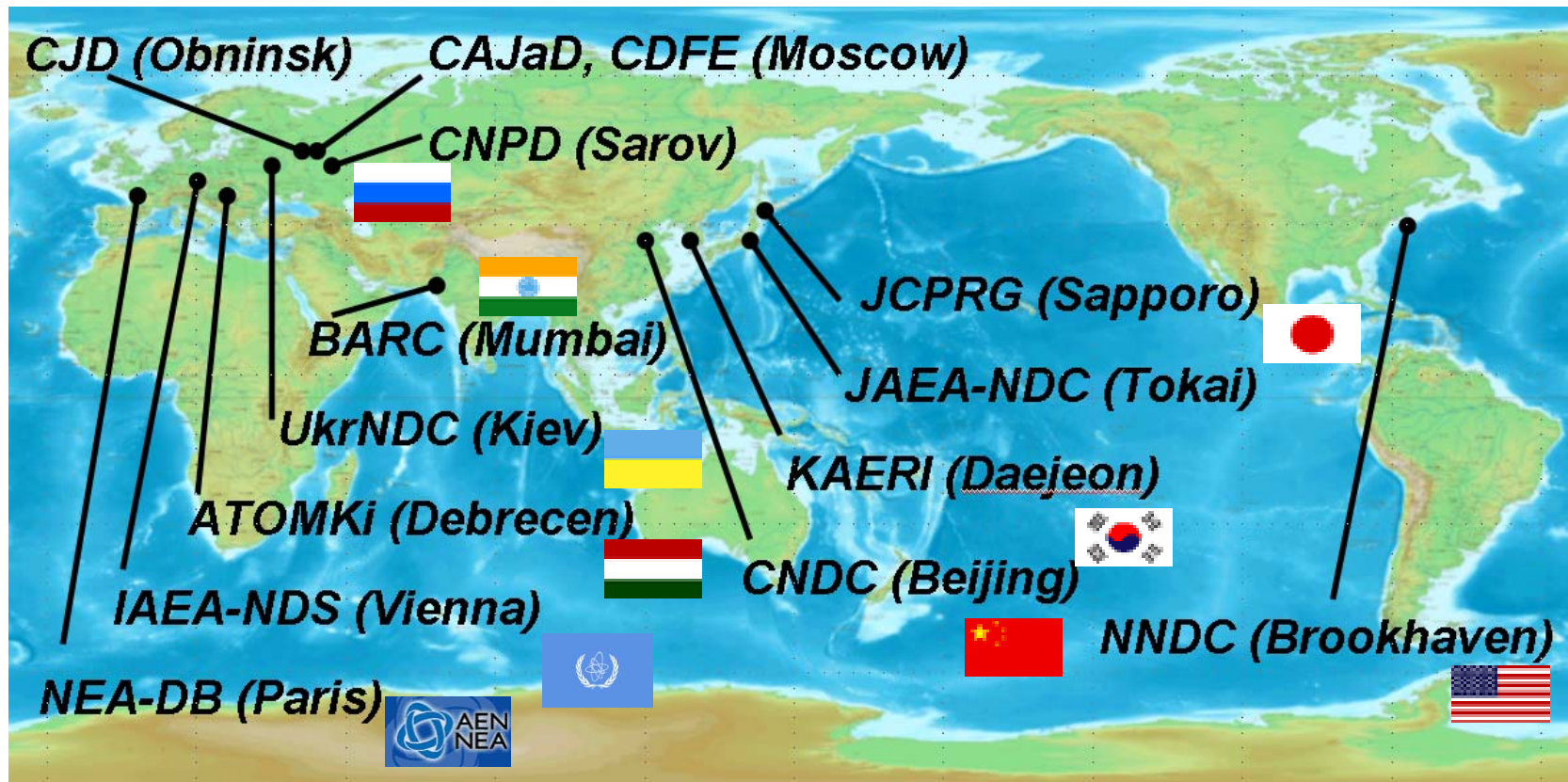


Annual NRDC Meeting (1983)



17-21 October 1983 in Obninsk or Moscow

Nuclear Reaction Data Centres (NRDC)



12 centres from 8 countries and 2 international organisations
(China, Hungary, India, Japan, Korea, Russia, Ukraine, USA, NEA, IAEA)

Collaborating for **EXFOR** compilation under the auspices of IAEA NDS

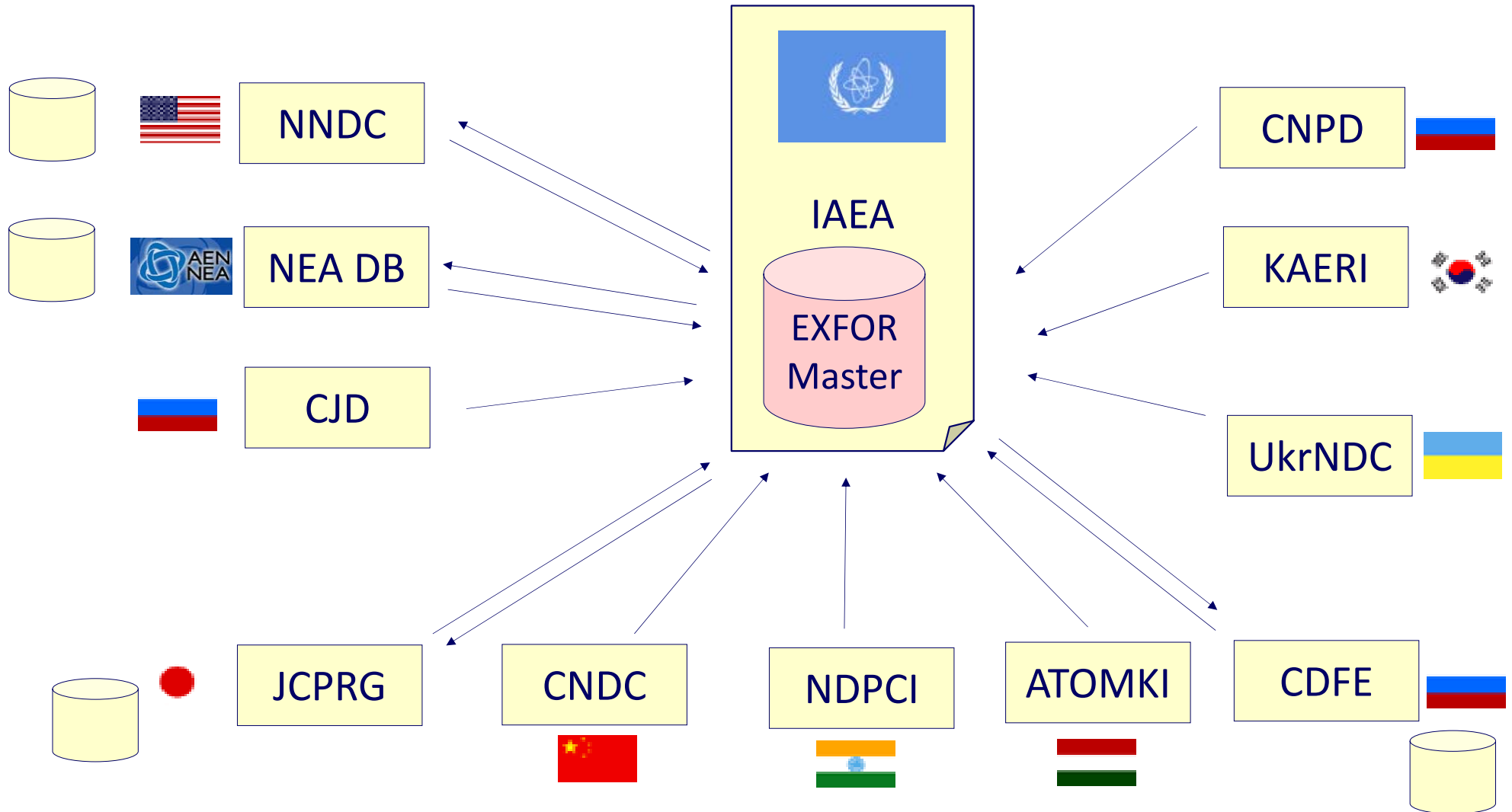
Annual NRDC Meeting (2018)



1-4 May 2018, GCNEP, Bahadurgarh, India

Experimental Data Exchange (Present)

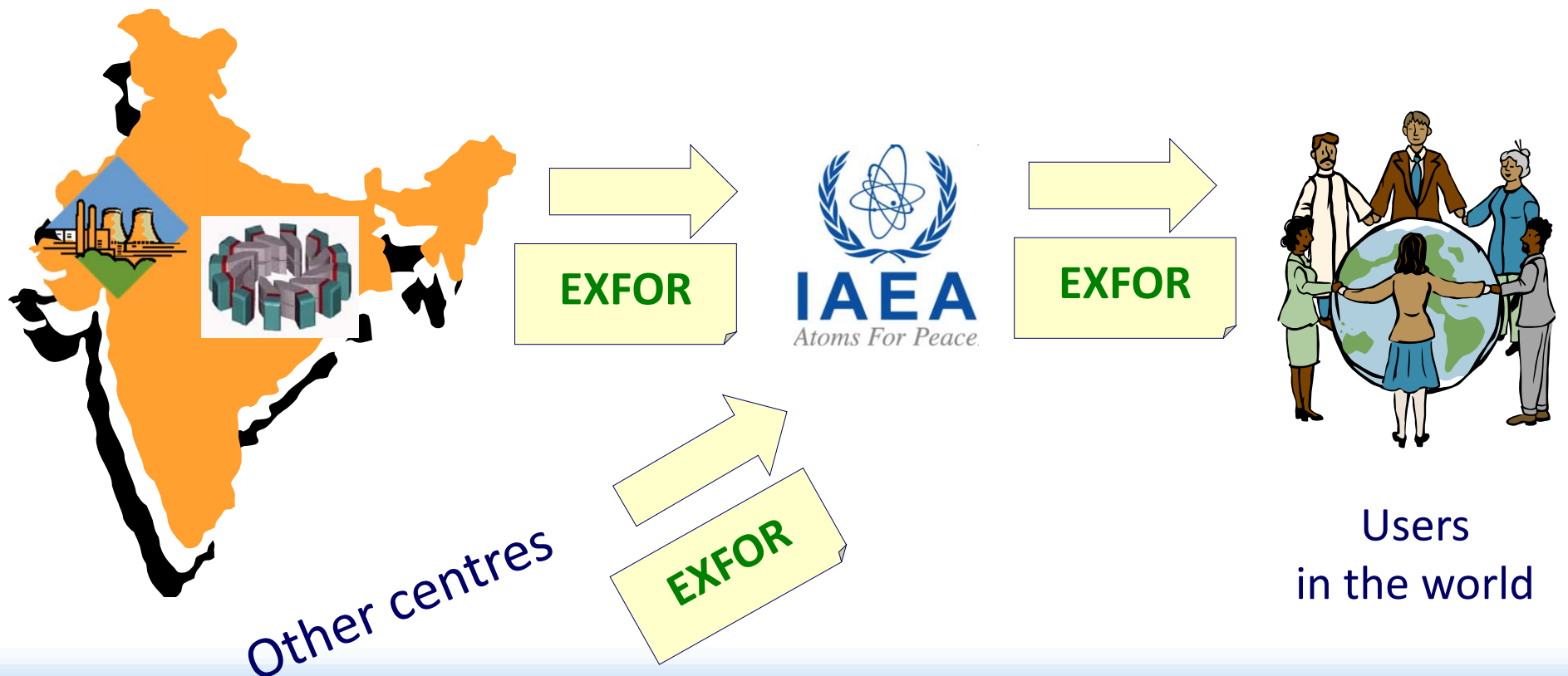
The current exchange structure:



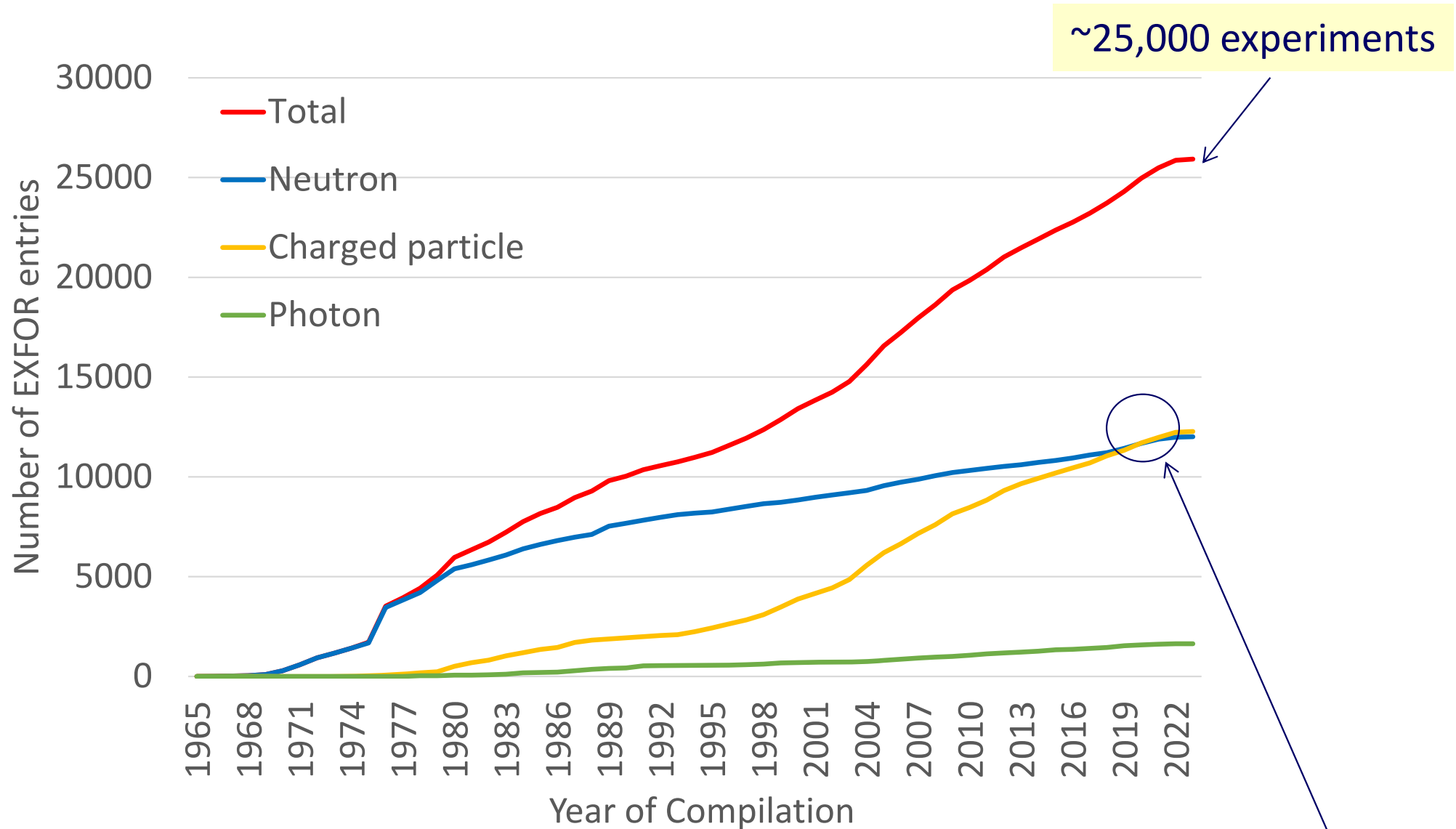
5 centres receive exchanged data and include into their own DB.

Responsibility of Indian Researchers

Indian Centre (NDPCI, coordinated by Devesh Raj, BARC) is responsible to neutron, charged-particle and photonuclear reaction data **measured in India**.



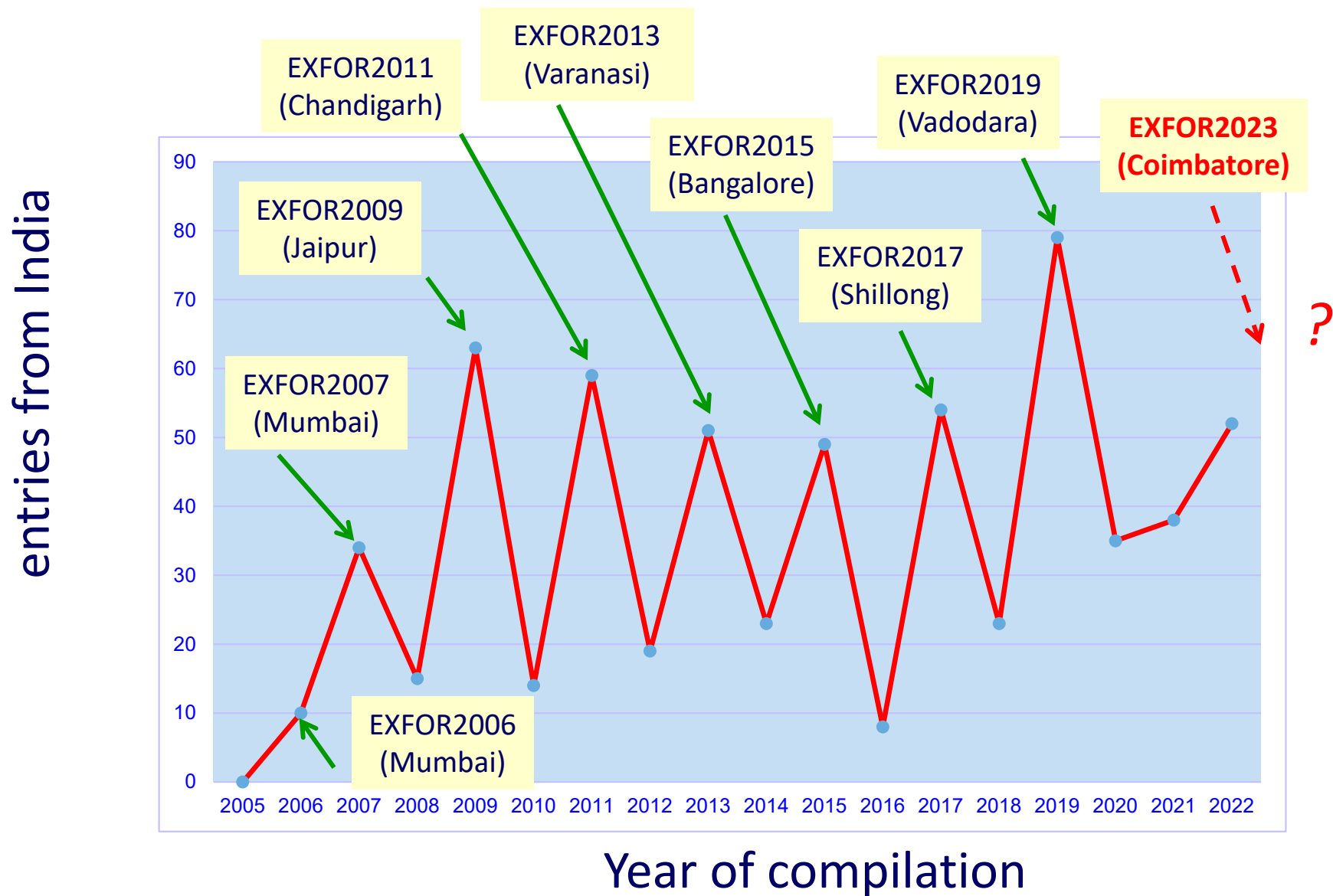
How Many Experiments in EXFOR?



charged particle > neutron entries since ~2020

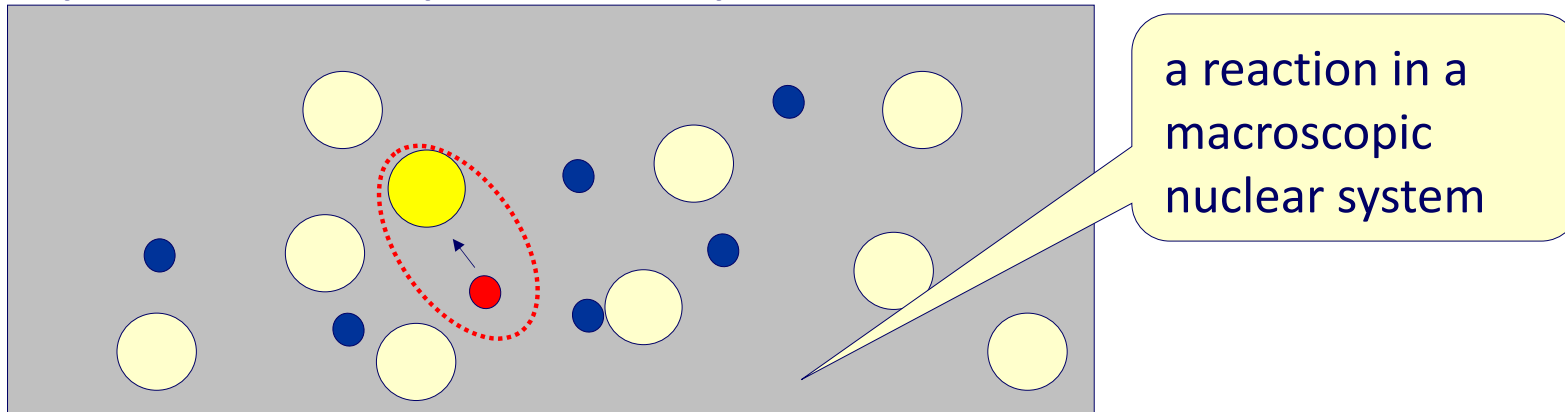


Contribution from India to EXFOR



Scope of EXFOR

- EXFOR is a **general purpose** experimental data library.
(c.f. ENDF – evaluated nuclear data libraries – are designed for fission and fusion energy systems. $E_n < 20$ MeV)
- Data describing a **microscopic** nuclear reaction are considered (c.f. “per incident particle” “per reaction”).



Example of Quantities in EXFOR

- Cross section
- Differential cross section (angular, energy, double, triple, ...)
- Resonance parameter
- Fission quantity (fission yield, fission neutron multiplicity, ...)
- Polarization quantity (analyzing power, ...)
- Thick target yield

etc.



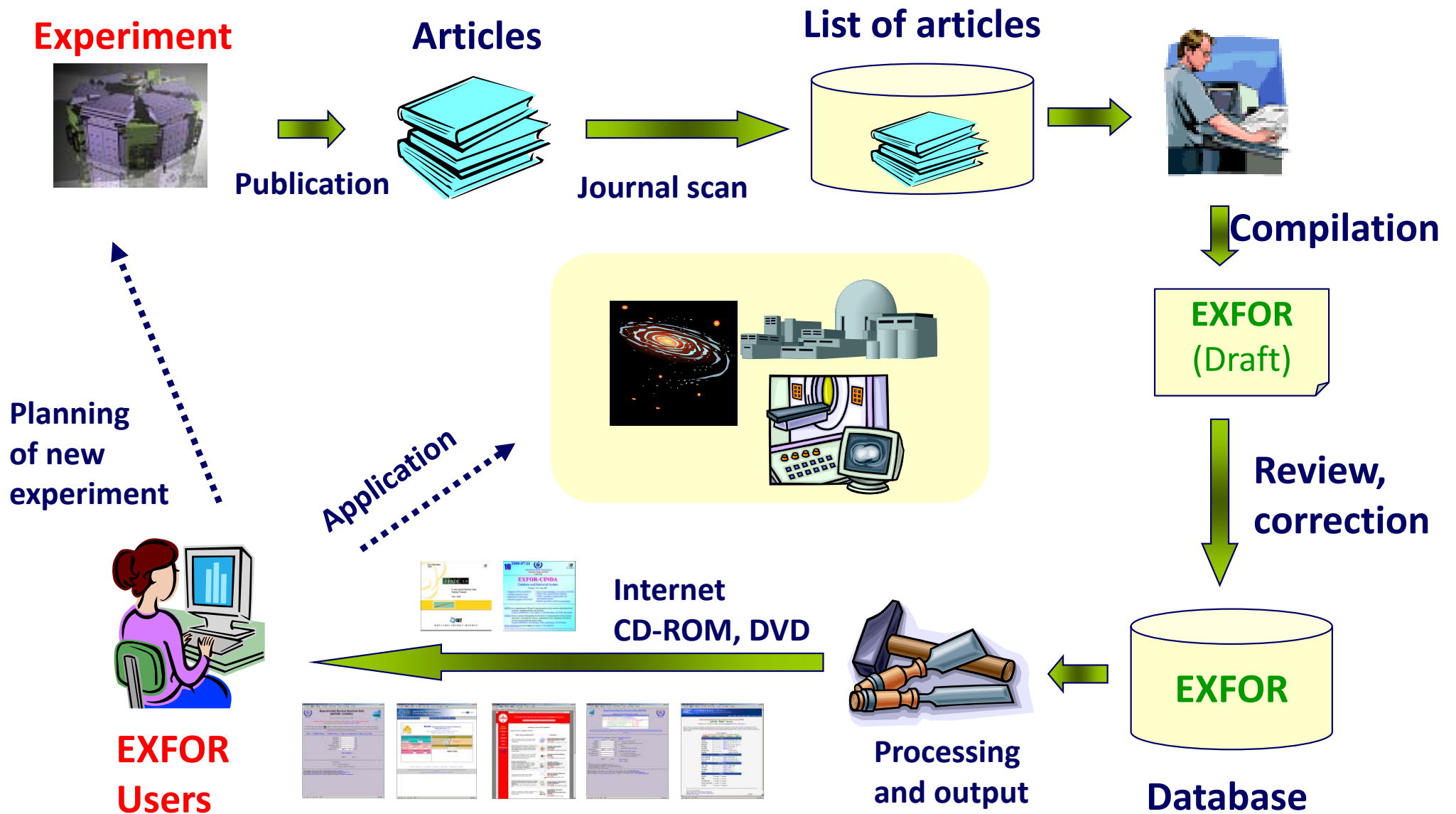
Example of EXFOR Entry – 13597.005

```
SUBENT      13597001      950822
BIB          15          27
...
AUTHOR      (S.K.GHORAI,P.M.SYLVA,J.R.WILLIAMS,W.L.ALFORD)
TITLE      Partial neutron cross sections for 64Zn, 66Zn, 67Zn
           and 68Zn between 14.2 and 18.2 MeV
FACILITY    (DYNAM)
INC-SOURCE  (D-T) deuterons on titanium tritide.
SAMPLE      Natural zinc sample.
METHOD      (ACTIV,MOMIX)
...
ENDSUBENT   34
SUBENT      13597005      950217
BIB          2           2
REACTION    (30-ZN-67(N,P)29-CU-67,,SIG)
DECAY-DATA  (29-CU-67,62.01HR,DG,185.,0.470)
ENDBIB      2
NOCOMMON    0           0
DATA        5           5
EN          DATA      DATA-ERR  MONIT      MONIT-ERR
MEV         MB         MB         MB         MB
14.2        82.        5.        122.0      0.65
15.2        106.       6.        108.0      1.96
16.2        125.       8.        90.0       1.75
17.2        141.       21.       72.0       1.41
18.2        230.       30.       59.5       1.26
ENDDATA     7
ENDSUBENT   14
```

80-columns
ASCII file



Data From Experimentalists to EXFOR Users



Entry Number

- Each EXFOR Entry is identified by **Entry number** (ID for each experimental *work*).
- Entry number has one area character and 4 digits number.

Example

Entry **41123**: 1123th EXFOR entry from area 4

Entry **C0453**: 453th EXFOR entry from area C

- area 4: Neutron data from former USSR

- area C: charged-particle data from US+Canada



Subentry Number

- One Entry is a set of Subentries.
- Each subentry is characterized by subentry number (subaccession number).
- Subentry 001 is a set of common information applicable to all subentries (e.g., title, authors, institute, experimental facility, detector)
- Subentry 002, 003,... are assigned to data sets.



Subentry Number (cont)

Example:

An Indian neutron EXFOR entry (EXFOR 33023)

(B.K. Nayak et al., Phys.Rev.C78(2008)061602)

33023.001:

Common information (title,author,...)

33023.002:

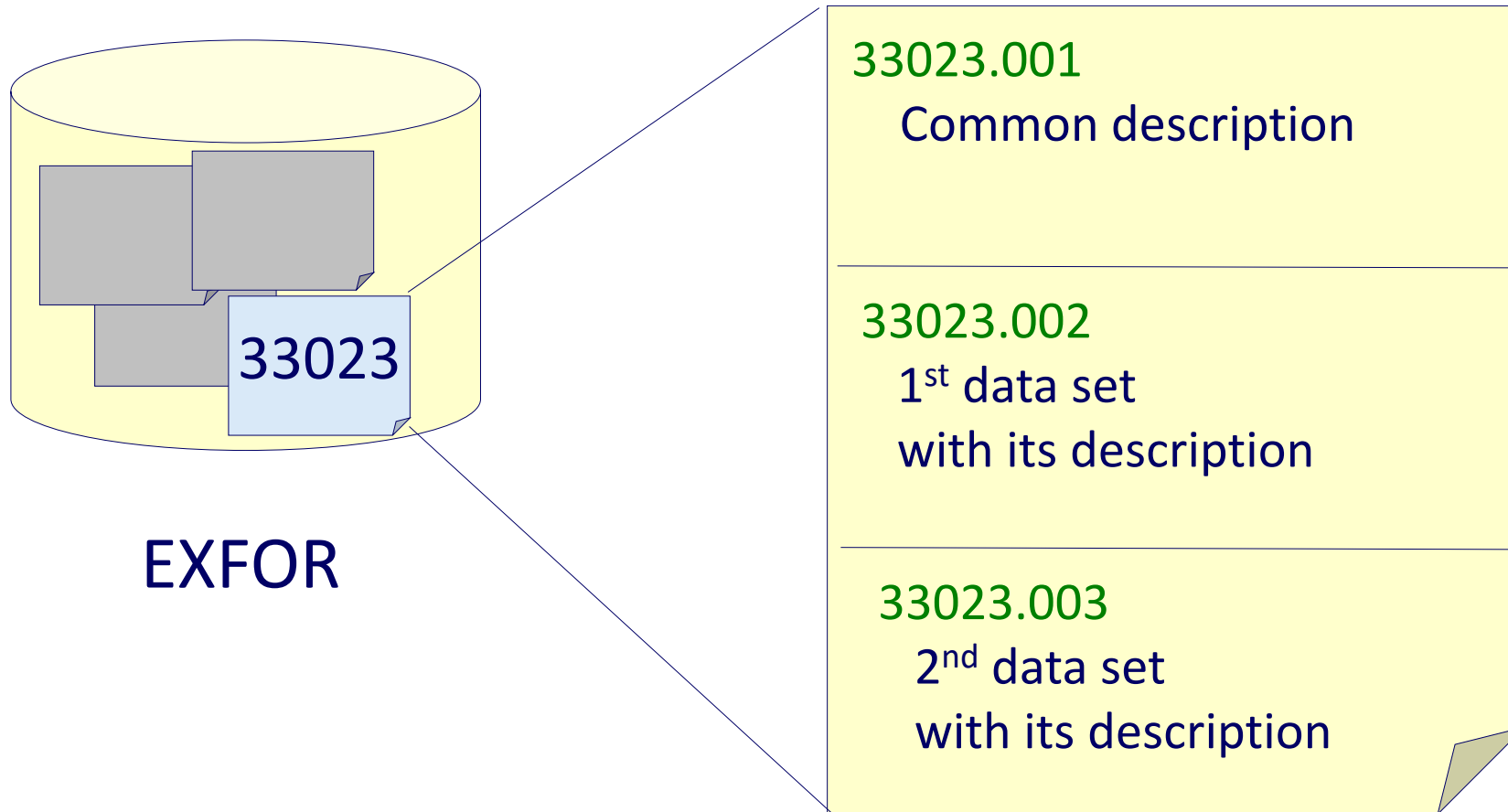
Data set for $^{233}\text{Pa}(n,f)/^{235}\text{U}(n,f)$ x-section ratio

33023.003:

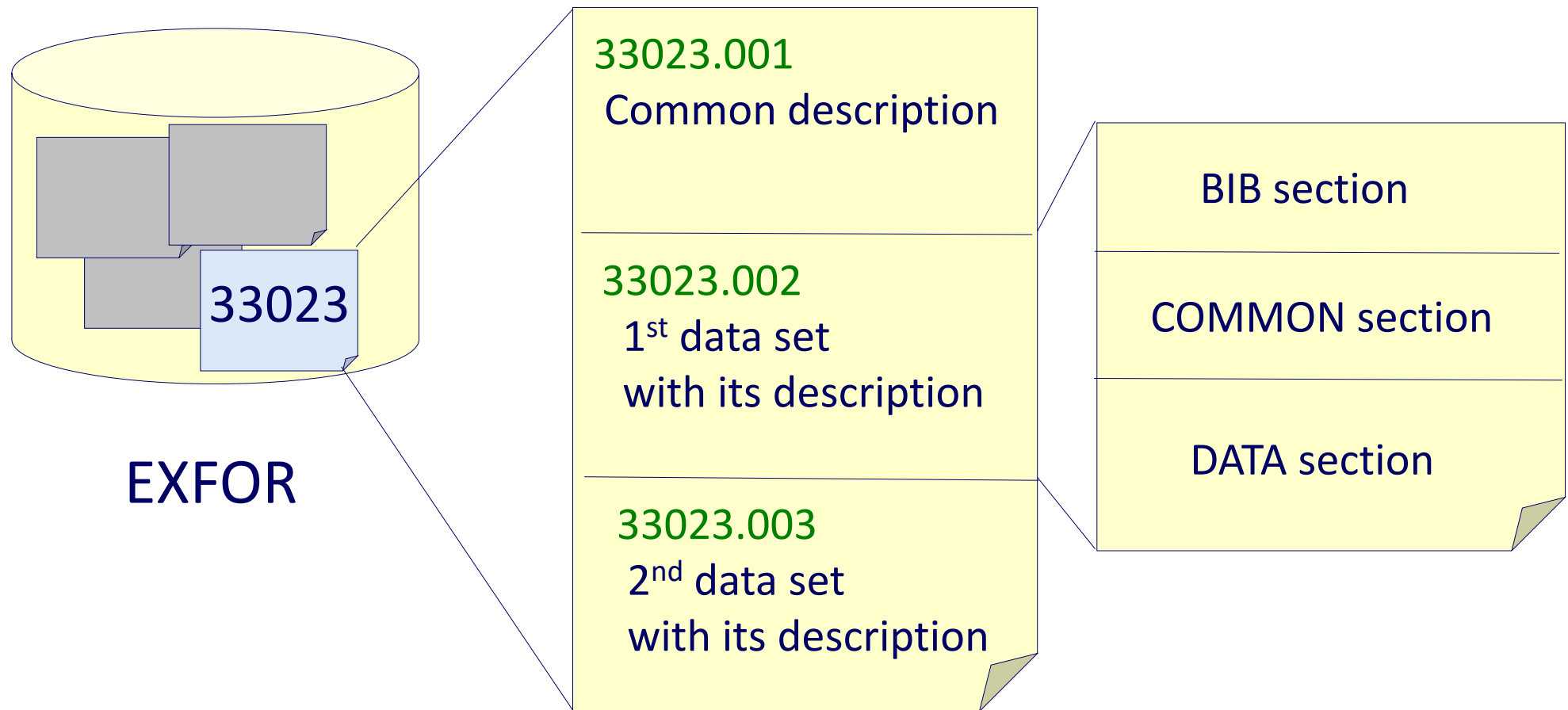
Data set for $^{233}\text{Pa}(n,f)$ x-section



Subentry Number (cont)



BIB, COMMON and DATA Section



Example of BIB Section

	11	66	80
TITLE	Systematic study of (n, p) reaction cross sections	33034001	3
..			
AUTHOR	(B.Lalremruata, N.Otuka, G.J.Tambave, V.K.Mulik,	33034001	5
...			
INSTITUTE	(3INDIND) Mizoram University, Aizawl	33034001	8
...			
REFERENCE	(J,PR/C,85,024624,2012)	33034001	10
FACILITY	(CCW,3INDPOO)	33034001	12
...			
STATUS	(TABLE) Table V of Phys.Rev.C85(2012)024624	33034001	57
	(APRVD) B.Lalremruata (2012-03-15)	33034001	58
HISTORY	(20110516C) Ranjita Mandal	33034001	59
...			

Keyword

Description

- Parenthesized coded information
- Free text information



Example of COMMON and DATA Section

11			66			80		
COMMON	1	3	E_{level} (MeV)	θ_{cm} (deg)	$d\sigma/d\Omega$ (mb/sr)	$\Delta d\sigma/d\Omega$ (mb/sr)		
E-LVL			0.0	74.76	0.327	0.023		
MEV				80.18	0.258	0.024		
0.0				85.53	0.171	0.018		
ENDCOMMON	3	0		90.01	0.153	0.016		
DATA	3	22						
ANG-CM	DATA-CM	DATA-ERR						
ADEG	MB/SR	MB/SR						
...								
74.76	0.327	0.023					D6213	2 17
80.18	0.258	0.024					D6213	2 24
85.53	0.171	0.018					D6213	2 25
90.01	0.153	0.016					D6213	2 26
...							D6213	2 27
ENDDATA	24	0					D6213	2 40
...								

