A brief progress report on EXFOR compilations by Nuclear Data Physics Centre of India

On behalf of NDPCI

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<u>Abstract</u>

This report summarizes the activities of Nuclear Data Physics Centre of India (NDPCI) for the period 2012-2013, while also describing a brief history of NDPCI and its activities.

I. Brief History of NDPCI and its activities:

As the youngest member, "The NDPCI" joined NRDC as a full member in September, 2008. NDPCI with the help from IAEA-NDS is responsible for all EXFOR compilations in India and is making a steady progress to meet and carry out its objectives for its thrust areas which encompass:

1) Coordinating EXFOR compilation in India with the help of IAEA-NDS through
   i) Projects/funds giving mechanisms to university faculties in collaboration with different DAE units.
   ii) Organizing EXFOR theme meetings/workshops
   iii) Encouraging and using voluntary compilers including young researchers as well as authors of the articles.
2) Basic nuclear data physics measurements using facilities in India and abroad.
3) Nuclear model based calculations using codes such as TALYS and EMPIRE are being continued. Workshops related nuclear data evaluations have also been conducted.
4) Efforts to digest the status of covariance error methodology in nuclear data and its applications.
5) Financially Supporting researchers partly/fully to attend national as well as international conferences.
6) Improved nuclear structure and decay data for nuclear models in the heavy nuclides region.
7) Preparation of integral Indian experimental criticality benchmarks for integral nuclear data validation studies.

NDPCI has conducted five phenomenally successful EXFOR workshops listed below:

1. DAE-BARC theme meeting on EXFOR compilation of nuclear data" at BARC, Mumbai from 4th – 8th September,2006.
2. DAE-BARC theme meeting on EXFOR compilation of nuclear data" at BARC, Mumbai from 29th – 2nd October,2007.
3. The 3rd DAE-BARC theme meeting on EXFOR compilation of nuclear data" at Jaipur University, Jaipur from 3 – 7 November, 2009.
4. The 4th DAE-BARC theme meeting on EXFOR compilation of nuclear data" at Panjab University, Chandigarh, from 4th -8th April, 2011.
5. The 5th DAE-BARC theme meeting on EXFOR compilation of nuclear data" at *Varanasi, Banaras Hindu University, Varanasi, from 18th -22nd February, 2013.*

A *Two Day* National Workshop on Surrogate Reactions and its Applications (Surrogate-2013) has also been held at M.S. University of Baroda from 24-25th January, 2013.

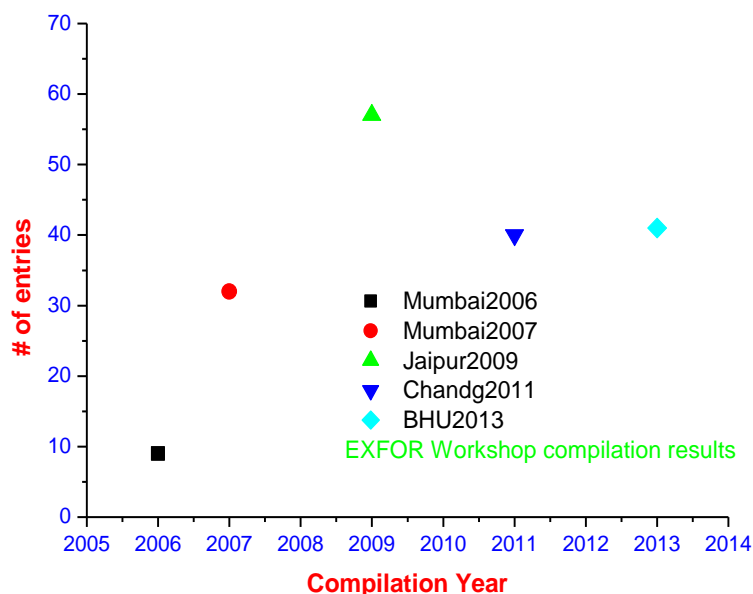Fig.1 shows the number of EXFOR entries compiled in the above workshops.

Fig.1: Number of EXFOR entries in Indian EXFOR workshops.

Apart from EXFOR entries made in the above workshops, there are few voluntary Indian individual compilers who dedicated their efforts to EXFOR compilations since 2006, and the statistics of such non-workshop entries are given in Fig.2.
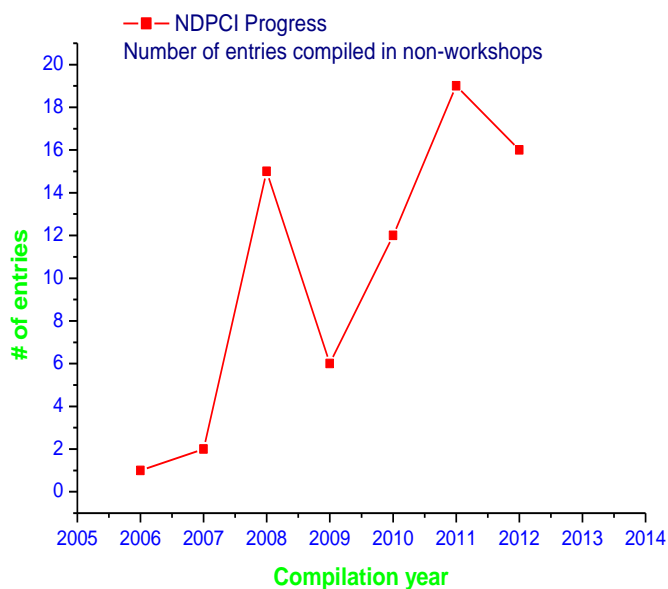

Fig.2: Yearly Non-workshop EXFOR entries from NDPCI

As a result of such efforts, both from the workshops and individual compilers, NDPCI has made significant contributions to the EXFOR compilations and currently at par with many older data centres across the world which is clearly visible in Fig.3. Such activities increase the visibility of

Indian contributions to the basic nuclear data physics experiments generating nuclear data for various applications. These EXFOR compilation efforts have also enhanced BARC/DAE/India's image highly positively in NRDC network.
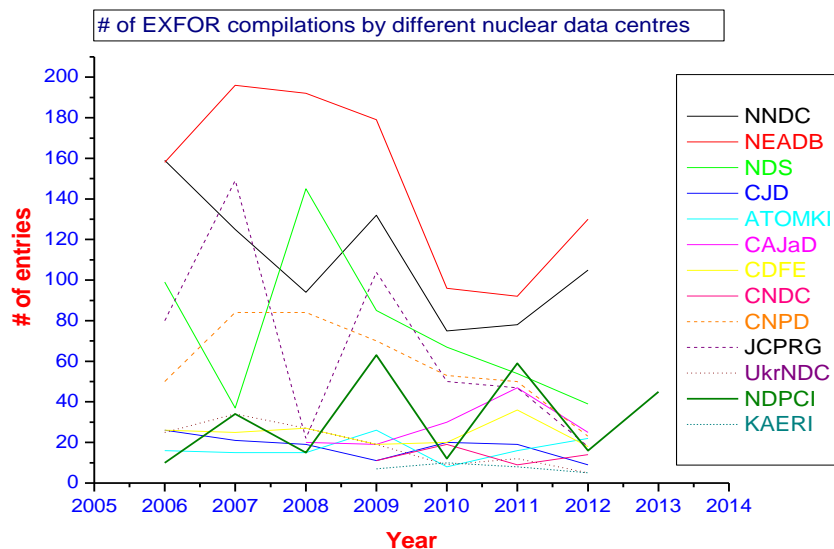

Fig.3: Number of EXFOR entries made by different data centres taken from http://www-nds.iaea.org/exfor-master/x4compil/exfor_input.htm

II. Brief progress report on the activities of NDPCI during 2012-2013:

- EXFOR compilation on a regular basis has been started since 2012 through funds given by NDPCI to Universities.

- There are few voluntary compilers who have been doing compilations since 2006 in their respective laboratories.

- Table.1 list the current EXFOR projects awarded to Universities by NDPCI.

Table.1: NDPCI Projects on EXFOR:

Sl. No	Title of the Project	PI/CI (and Institute)	PCs	Amount (Rupees)	Period	Staff
1	EXFOR compilation of nuclear Data	B.Jyrwa (NEHU)	S.Ganesan, A.Saxena, H.Naik (BARC)	8.15 lakhs	2011-2013	R. Ghosh S.Badwar (Project Assistant)
2	EXFOR Compilation of Nuclear Reaction Data	S.N.Roy (Vishva-Bharati University)	G.Mukherjee (VECC), A.Saxena (BARC)	9.11 lakhs	2012-2014	U.S.Ghosh K.Mondal (Project Assistant)
3	Measurements, EXFOR compilation and theoretical study of nuclear data	B.Lalremruata H.H.Thanga (Mizoram University)	S.V.Suryanarayana, A.Saxena, H.Naik (BARC)	24.69 Lakhs	2012-2015	L.Punte(JRF) Postdoc position yet to be filled

II.1. EXFOR Compilation Procedure:

All the EXFOR compilations carried out under the NDPCI is in consultation with the IAEA-NDS staff, and we followed the procedure prepared by N. Otsuka, NDS, IAEA, Vienna.

Indian EXFOR Compilation Procedure
Prepared by Naohiko Otsuka (IAEA-NDS, 2012-03-19 Rev.)

List of article for EXFOR compilation
Central EXFOR CoCoS (EXFOR Compilation Control System)
http://www-nds.iaea.org/exfor-master/x4compil/progress_India.htm
Indian EXFOR CoCoS (EXFOR Compilation Control System)
http://www-nds.iaea.org/nrdc/india/

EXFOR software
NRDC Software (editor, digitizer, checking code etc.)
http://www-nds.iaea.org/nrdc/nrdc_sft/

ORDER+CHEX on WEB
http://www.jcprg.org/exfor/tool/

E-mail address (to be included in all communications)
ganesan555@gmail.com
aloks279@gmail.com
marema08@gmail.com
n.otsuka@iaea.org

	Who	What
1	Compiler	Ask Naohiko a new article.
2	Naohiko	Send a new article with its entry number to the compiler. (Normally figures and tables for compilation are also provided with their REACTION codes.)
3	Compiler	Send authors a request of numerical data.
4	Compiler	Compile the article. Indicate the request of data by `(UNOBT) Request sent to A.B.Author by e-mail (2012-03-15)` under the keyword STATUS. This will be deleted when the compiler receive numerical data.
5	Compiler	Send two files (ordered EXFOR draft and its CHEX output) to Rema when the entry is made.
6	Rema	Check - if BIB information (Title, Author, Institute, Reference) is coded as given in the article. - if CHEX error messages are removed as much as possible. (Ask Naohiko if these messages are not understandable.)
7	Rema	Make correction with the compiler when necessary.
8	Rema	Send the corrected file to Naohiko.
9	Naohiko	Do further checking and correct the file with Rema when necessary.
10	Naohiko	Notify Rema and Compiler when the compilation is completed.

Therefore, under such compilation procedure, we have completed entries listed below as of today.

Serial No.	ENTRY #	COMPILER	STATUS	DATE of FINALIZATION
1	33034	MZU	Finalized	20120311
2	D6136	Ranjita Mandal(IIT-Kharagpur)	Finalized	20120430
3	D6127	Ranjita Mandal(IIT-Kharagpur)	Finalized	20120502
4	D6149	NEHU Team	Finalized	20120511
5	D6083	NEHU Team	Finalized	20120606
6	D6130	Ranjita Mandal(IIT-Kharagpur)	Finalized	20120703
7	D6154	Ranjita Mandal(IIT-Kharagpur)	Finalized	20120704
8	D6129	NEHU Team	Finalized	20120712
9	D6133	NEHU Team	Finalized	20120713
10	33037	Paresh Prajapati	Finalized	20120723
11	D6144	Ranjita Mandal(IIT-Kharagpur)	Finalized	20130109
12	D6158	NEHU Team	Finalized	20120921
13	D6152	NEHU Team	Finalized	20121024
14	D6156	NEHU Team	Finalized	20121127
15	D6157	NEHU Team	Finalized	20121022
16	D6164	NEHU Team	Finalized	20120606
17	D6169	NEHU Team	Finalized	20121204
18	D6143	VECC team	Finalized	20120925
19	D6161	VECC team	Finalized	20130109
20	33041	VECC team	Finalized	20120829
21	D6132	NEHU Team	Finalized	20130404
22	D6165	NEHU Team	Finalized	20130404
23	D6207	NEHU Team	Pending	
24	D6208	NEHU Team	Pending	

During 2012, on behalf of NDPCI, the following international meetings were attended:

1. The AASPP Workshop ,The 3rd Asian Nuclear Reaction Database Development Workshop, Pohang Accelerator Laboratory, Pohang, Korea, 27-29 August, 2012".

Participants: B. Lalremruata(Mizoram University), P.D.Krishnani (BARC), R.Ghosh and S.Badwar(NEHU).

2. Benchmarking of Digitization Software, (Consultants' Meeting, 12 to 14 November 2012, IAEA Headquarters, Vienna, Austria)

Participant: B. Lalremruata.

II.2: The 5th DAE-BARC theme meeting on EXFOR compilation of nuclear data" 2013 (Varanasi, Banaras Hindu University(BHU), Feb 18-22):

Another important event in 2013 is the 5th DAE-BARC theme meeting on EXFOR compilation of nuclear data" held at, Banaras Hindu University, Varanasi, from Feb 18-22, 2013.

Details about the BHU EXFOR workshop:
Local Convenes:
Ajay Tyagi(BHU),
Technical Convener:
Alok Saxena(BARC)
Faculty:
N. Otsuka(IAEA-NDS, Austria),
S. Dunaeva(Center of Nuclear- Physics Data RFNC-VNIIEF, Russia)
Vidya Thakur(Hokkaido University, Japan)
B. Lalremruata(Mizoram University, India)

Number of participants: ~ 51 (Graduate students+Research Scolars + Faculties from universities and scientists from Research Centres)

Number of articles compiled: 41
***   We concentrated on articles published since 2010.
***   4 neutron induced, 2 photonuclear articles, and 35 charged particle induced articles.

       In the BHU EXFOR workshop, the identification for coding into EXFOR of all the suitable Indian articles published in the literature was done in consultation with and by the IAEA-NDS staff(N.Otsuka), and one remarkable experienced is, out of 41 articles, 20 articles reported cross sections in Figures, and require digitization, but except for the entries D6188(Data no longer available with author), G0504(data never arrived although author promised to send), ***we could receive numerical data of all the articles well in advance of the workshop from the authors.***

       Many experimentalists participated in the workshop, and they compiled their own paper into EXFOR. As a result of workshop like this, we encourage authors who gained experienced in EXFOR compilation during the workshop, to compile their own results (in which case the numerical data is entered) even from their own laboratories. Also Young researchers are motivated in nuclear data physics, and even encourage doing compilation of their own work or sending their numerical data to NDPCI for EXFOR compilation. The young researchers got the opportunity to perform literature survey by reading papers for which EXFOR entries were made. This also gave a motivation to understand new technical terms including on detectors in nuclear physics. In a unique way, experimentalists, students, theoreticians, radio-chemists, health physicists, University researchers all converged and exchanged ideas and gained EXFOR coding experience. A sound appreciation of EXFOR coding by users of EXFOR who otherwise were not aware of the voluminous efforts and technical activity going into making EXFOR system in place for ready use took place.

Photograph-1: N.Otuka, A.Saxena, B.Rudraswamy, S.Dunaeva, A.Tyagi, B.Lalremruata

       Around 50 delegates worked from 9:30 AM to 7:00 PM every day. The Theme meeting was very unique, phenomenally successful and was not in the nature of an usual seminar or conference. The morning session starts with Lectures on EXFOR basics, rules etc (covering each and every section of EXFOR compilation) by N. Otsuka and S.Dunaeva, followed by practical sessions in the afternoon when participants work on EXFOR compilation for the articles assigned to them.

During the practical sessions, discussions over some doubts on the EXFOR coding as   well as on the physics with experts took place. After the compilation is completed, every participant checked their respective EXFOR entries with the help of website (www.oecd-nea.org/janisweb). These entries were submitted to S. Dunaeva for further checking and corrections along with explanations were done on the spot.

S. Dunaeva spent about a week, as a visiting scientist, at BARC, Mumbai after the BHU theme meeting to finalize the entries before they can be sent for approval from authors,   and at this stage, she sent the corrections to be made to the participants, and the updated   entries   were   then submitted back to her. She then submitted the entries to IAEA-NDS.

One very positive outcome of the workshop is, even after the workshop, we received many requests from the participants for articles to be compiled into EXFOR. The EXFOR workshop provided a unique forum to identify possible future EXFOR compilers /EXFOR leaders for the NDPCI. The workshop also provided a valuable forum to discuss with new faculty members on possibility of nucleation of new EXFOR projects in Universities where EXFOR project is yet to be nucleated.

Photograph-2: Group Photo of participants in the 5th DAE-BRNS theme meeting on EXFOR compilation, BHU, Varanasi, India, from 18-22 Feb'2013.

List of Entries Compiled during the BHU workshop are given below:

Sl.No	Entry #	Reference	Lab.	Compiler
1	33039	J,JRN,292,745,2012	3INDTRM	V.K.Mulik
2	33042	J,ANE,47,160,2012	3INDTRM	S.S. Manian
3	33043	J,JRN,293,469,2012	3INDTRM	V.K.Mulik
4	33044	J,PRM,79,249,2012	3INDTRM	Arindam Chakraborty
5	D6171	J,CHP,49,884,2011	3INDVEC	R.Ghosh
6	D6172	J,EPJ/A,47,118,2011	3INDTRM	S.S.Manian
7	D6173	J,EPJ/A,47,156,2011	3INDNSD	S.Badwar
8	D6174	J,EPJ/CS,17,03004,2011	3INDTRM	N.P.Sathik
9	D6175	J,EPJ/CS,17,03006,2011	3INDNSD	Hranghmingthanga
10	D6176	J,EPJ/CS,21,10009,2012	3INDNSD	B.Jyrwa
11	D6177	J,IMP/E,20,645,2011	3INDNSD	U.S.Ghosh
12	D6178	J,IMP/E,20,2119,2011	3INDVEC	M.M.Musthafa
13	D6179	J,IMP/E,20,2305,2011	3INDTRM?	B. Lalremruata
14	D6180	J,NP/A,874,14,2012	3INDTRM	Vidya Thakur
15	D6181	J,NP/A,879,107,2012	3INDVEC	Kalyan Mondal
16	D6182	J,NP/A,882,62,2012	3INDTRM	Najmunnisa
17	D6183	J,PR/C,81,044610,2010	3INDNSD	B.Satheesh
18	D6184	J,PR/C,83,034616,2011	3INDTRM	B.Satheesh
19	D6185	J,PR/C,83,054604,2011	3INDVEC	Najmunnisa
20	D6186	J,PR/C,83,064606,2011	3INDTRM	Arindam Chakraborty
21	D6187	J,PR/C,83,067601,2011	3INDTRM	B.Satheesh
22	D6188	J,PR/C,84,011602,2011	3INDTRM	S.Badwar
23	D6189	J,PR/C,84,014612,2011	3INDNSD	Bhavin Trivedi
24	D6190	J,PR/C,84,024614,2011	3INDNSD	R.Ghosh
23	D6189	J,PR/C,84,014612,2011	3INDNSD	Bhavin Trivedi
24	D6190	J,PR/C,84,024614,2011	3INDNSD	R.Ghosh
25	D6191	J,PR/C,84,031603,2011	3INDTRM	H.B.Sachhidananda
26	D6192	J,PR/C,84,044615,2011	3INDTRM	B.Satheesh
27	D6193	J,PR/C,84,067601,2011	3INDTRM	Munish Gupta
28	D6194	J,PR/C,85,014612,2012	3INDTRM	Parveen Kumari
29	D6195	J,PR/C,85,034606,2012	3INDNSD	H.B.Sachhidananda
30	D6196	J,PR/C,85,034614,2012	3INDNSD	Abhijit Bhattacharya
31	D6197	J,PR/C,85,064607,2012	3INDTRM	Lalrinmawia Punte
32	D6198	J,PR/C,86,014609,2012	3INDNSD	Amit Kumar
33	D6199	J,PR/C,86,014615,2012	3INDTRM	Abhijit Bhattacharya
34	D6200	J,PR/C,86,024607,2012	3INDTRM	S.S. Manian
35	D6201	J,RCA,99,359,2011	3INDTRM	B.S.Shivashankar
36	D6202	J,RCA,99,527,2011	3INDTRM	M.M.Musthafa
37	D6203	J,PR/C,87,014604,2013	3INDNSD	B.S.Shivashankar
38	D6204	J,IMP/E,21,1250059,2012	3INDVEC	B.Satheesh
39	D6205	J,PR/C,81,024603,2010	3INDTRM	B.Rudraswamy
40	G0504	J.IMP/E,20,2361,2011	3INDMNG	B.Satheesh
41	G0505	J,JRN,290,367,2011	3INDTRM	B.Rudraswamy

III. NDPCI future plans:

*** To identify and nurture potential young researchers for our future ventures into EXFOR Compilation and for various activities of NDPCI.

*** To continue supporting researchers through funds giving mechanisms to generate basic nuclear data for various applications. (for eg. Measurement of prompt neutron spectra for 232Th(n,f), neutron induced cross section measurements using Li(p,n), D-T neutron sources etc)

*** Procurement of gamma spectrometry system for dedicated use byNDPCI at 40 lakhs in 2013 is foreseen.

*** Web-design for NDPCI is under construction.

*** The 6th DAE-BRNS theme meeting on EXFOR compilation is planned for in Jan. 2015 at Bangalore University. It is under informal discussions. Application for funding will be made.