A brief summary report on selected Indian nuclear data physics activities: A status report submitted to the NRDC Meeting-2008

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IAEA Technical Committee Meeting of International Network of Nuclear Reaction Data Centres (NRDC) from 22 to 25 September 2008 at the Institute of Physics and Power Engineering in Obninsk, Russian Federation

BARC is in the process of initiating the formation of a strong and sustainable Indian nuclear data centre. The nuclear data physics activities have significantly been enlarged in scope in the last 4 years in India. Presently the nuclear data physics activities in India encompass already the following activities:

- *Basic nuclear data physics measurements.*
- *EXFOR compilations.*
- *Nuclear model based calculations.*
- *Processing of evaluated nuclear data files to produce plug-in libraries for discrete ordinates and Monte Carlo codes.*
- *Efforts to digest the status of covariance error methodology in nuclear data and its applications*
- *Preparation of integral Indian experimental criticality benchmarks for integral nuclear data validation studies*

The current status and a document on perceived vision of the Indian nuclear programme (PHWRs, PWRs, FBRs, AHWR etc.,) is described in http://www.dae.gov.in/publ/vision.pdf

Until 2004, both at BARC and IGCAR, the Indian nuclear data activities were confined to processing of ENDF/B files and thus generically encompassed the user-oriented reactor physics approach starting from the basic evaluated nuclear data files available from the IAEA.

All the reactor physics applications oriented nuclear data processing tasks at BARC and IGCAR have been covered in the INDC report presented in the 27th International Nuclear Data Committee (INDC) Meeting, April 21-25, 2008, IAEA, Vienna, Austria, Europe

The EXFOR activity in India got a boost with BARC successfully organizing two EXFOR national training workshops sponsored by the DAE-BRNS (department of Atomic Energy-Board of Research in Nuclear Sciences) mechanism, one in 2006 and another in 2007. In each of these two workshops, more than 40 delegates (experimental nuclear scientists, University faculty, Ph. D. and M.Sc., students) took active part and got a "first time" exposure to a classical nuclear data physics activity of EXFOR compilation culture.

India appreciates the initiative by the IAEA-NDS in deputing Dr. Otto Schwerer during September 4-8, 2006 period and Dr. Ms. Svetlana DUNAEVA during October 29-November 2, 2007 period as faculty in these Indian training workshops on EXFOR.

India offers to collaborate with other network of reaction data centres and help host more such training workshops on international co-ordination of EXFOR compilation activity in the coming years.

India successfully contributed more than 50 EXFOR entries:

•10 new entries in 2006 EXFOR Workshop (Faculty: Otto Schwerer; Manual entries)

•31 new entries in 2007 EXFOR Workshop (Faculty: Svetlana DUNAEVA, EXFOR editor software used)

and many more new EXFOR entries are continuing to be made.

•Thus far, in all more than 50 new Indian EXFOR entries based upon experimental data generated in Indian nuclear physics experiments have been successfully made into the IAEA-EXFOR database.

•The identification for coding into EXFOR of all the suitable Indian articles published in the literature was done by the IAEA-NDS staff.
The details of new Indian EXFOR entries are, for instance, available in "Full EXFOR Compilation Statistics", in the IAEA-NDS site: http://www-nds.iaea.org/exfor-master/x4compil/exfor_input.htm

EXFOR Compilations in India WILL BE SUSTAINED

Presently, BARC plans to continue the EXFOR compilation activity and take up more responsibilities. After the two IAEA-EXFOR training workshops (2006, 2007), a Ph. D. student (Paresh Prajapati from MS University, Vadodara) is continuing to work with us. Thus far, he has made nine new Indian EXFOR entries (Reference: EXFOR entry with no: 33003, D6007, 33011, 33016, 33017, 33018, 33019, G0014 and D6016 and accepted by the IAEA).

Experimental generation of nuclear data

- **Experimental 14 MeV nuclear activation data generation at the University of Pune, Pune, India.**
- **Experimental Studies on fast neutron and bremsstrahlung induced reaction and fission of actinides and preactinides.**
- **Measurements of MeV range (1-4 MeV) neutron activation cross-sections using 14 MV BARC-TIFR Pelletron machine. Li(p,n) based neutron source.**
- **Determination of the ^{233}Pa(n, f) reaction cross-section from 11.5 to 16.5 MeV neutron energy by surrogate ratio method. 14 MV Pelletron Accelarator ^{6}Li(p,n) based neutron source. Li-6 Projectile on Th-232 target.**
- **Data relevant for thorium fuel cycle studies.**

- **After a Letter of Intent was signed by all member teams in the n_TOF Collaboration participating in Phase-1, the CERN management and the n_TOF Collaboration started in 2005 a negotiation for the definition of the Memorandum of Understanding (MoU) for the execution of experiments at the CERN n_TOF facility for Phase-2.**
- **CERN has accepted the LoI signed by the Director of BARC.**
- **Mengoni (IAEA-NDS) visited BARC during May 30 – June 2, 2007**

Soon, in 2008, a formal MOU between BARC and CERN is expected to be signed.

The informal collaboration with the Pohang 100 MeV electron LINAC facility is continuing since 2003 for nuclear data measurements. For instance, Dr. H. Naik, BARC will be visiting Pohang as a visiting scientist for 3 months during the last quarter of 2008 to continue generation experimental data of photo-fission yields and photon induced neutron emission cross sections.

BARC-KOREA COLLABORATION ON NUCLEAR DATA IS CONTINUING:

Bi-209 (gamma,3n) reaction was measured for the first time with 65MeV electron endpoint energy bremstrahhlung
These bremstrahlung gamma ray induced Fission yield also was measured.
A paper was published:
H. Naik, A.V.R. Reddy, S. Ganesan, Devesh Raj, K. Kim, G. Kim,Young Do Oh, Due Khue Pham, Moo-Hyun Cho, In Soo Ko and Won Namkunng, Journal of the Korean Physical Society, Vol 52 (3), 934 (2008).

Coded already by India into EXFOR:
Reference: EXFOR entry no: G0014

The ENSDF evaluation activities are being continued by

- **Ashok Jain (IIT Rourkee),**
- **M. Gupta (Manipal),**
- **Gopal Mukherjee (VECC, Kolkata)**
- **and others.**

For the interested reader, details are available in the INDC report presented in the 27th International Nuclear Data Committee (INDC) Meeting, April 21-25, 2008, IAEA, Vienna, Austria, Europe.

The XnWlup software: The XnWLUP developed at BARC has been designed to view the histogram of 69/172 multi-group cross sections as a function of neutron energy is used by WIMS-D users / thermal reactor physicists extensively around the world. Thiyagarajan et al., successfully developed this software for MS-WINDOWS environment. This program has been designed using Microsoft Visual C++. Microsoft Internet Explorer is required to view the online help topics. The XnWLUP code that has been tested with several WIMSD libraries in 2008 is available:

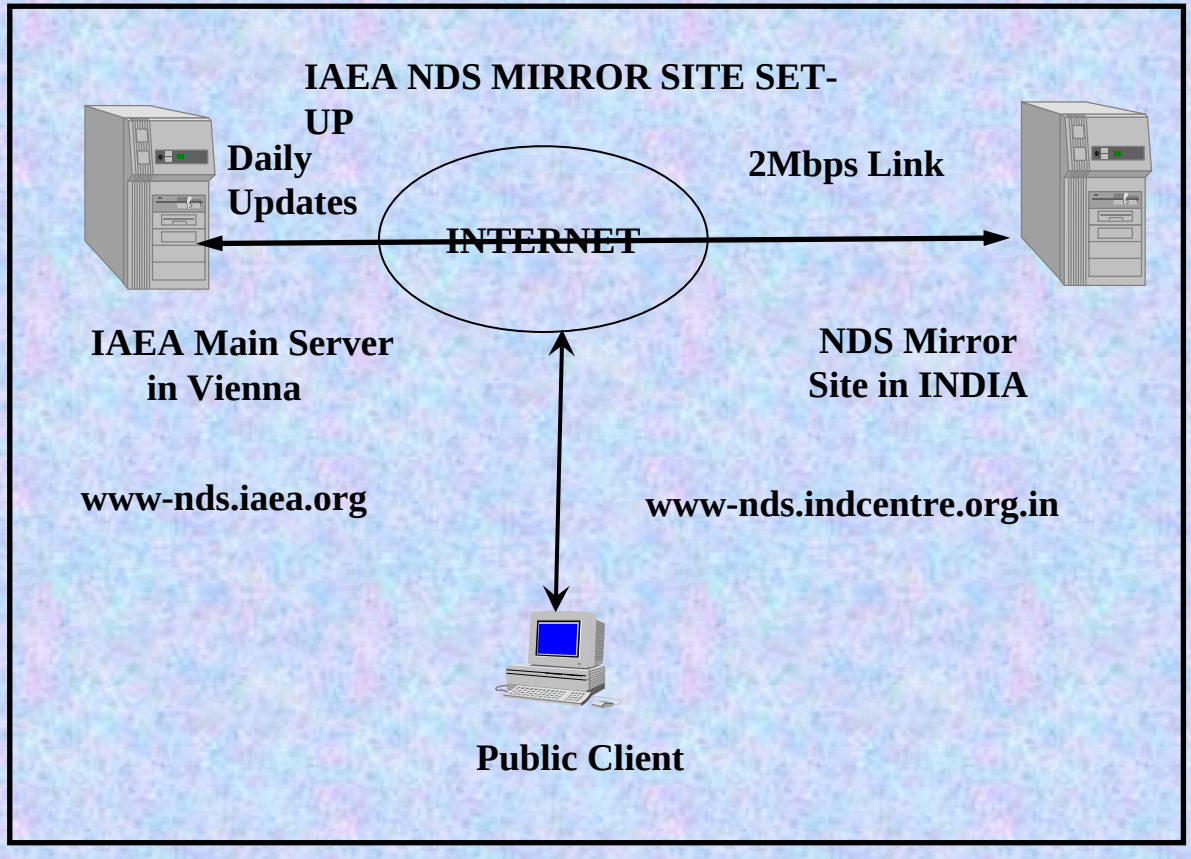
http://www.nds.indcentre.org.in/wimsd/downloads.htm

The SIGACE software: Collaboration between the Institute for Plasma Research, BARC and the IAEA NDS resulted in the successful development of the SIGACE software for use in the Monte Carlo simulations of nuclear systems. In this software, a new recipe has been evolved for generating high-temperature ACE files for use with the MCNP code. The SIGACE code that has been tested with several FENDL/MC files (endorsed for ITER and fusion reactor applications) is available:

http://www-nds.indcentre.org.in/fendl21/downloads/

The online nuclear data services (http://www-nds.indcentre.org.in/) mirror the nuclear data website of the Nuclear Data Section of the International Atomic Energy Agency (IAEA), Vienna (http://www-nds.iaea.org).

The MOU between DAE/BARC and the IAEA is expected to be continued beyond 2010.



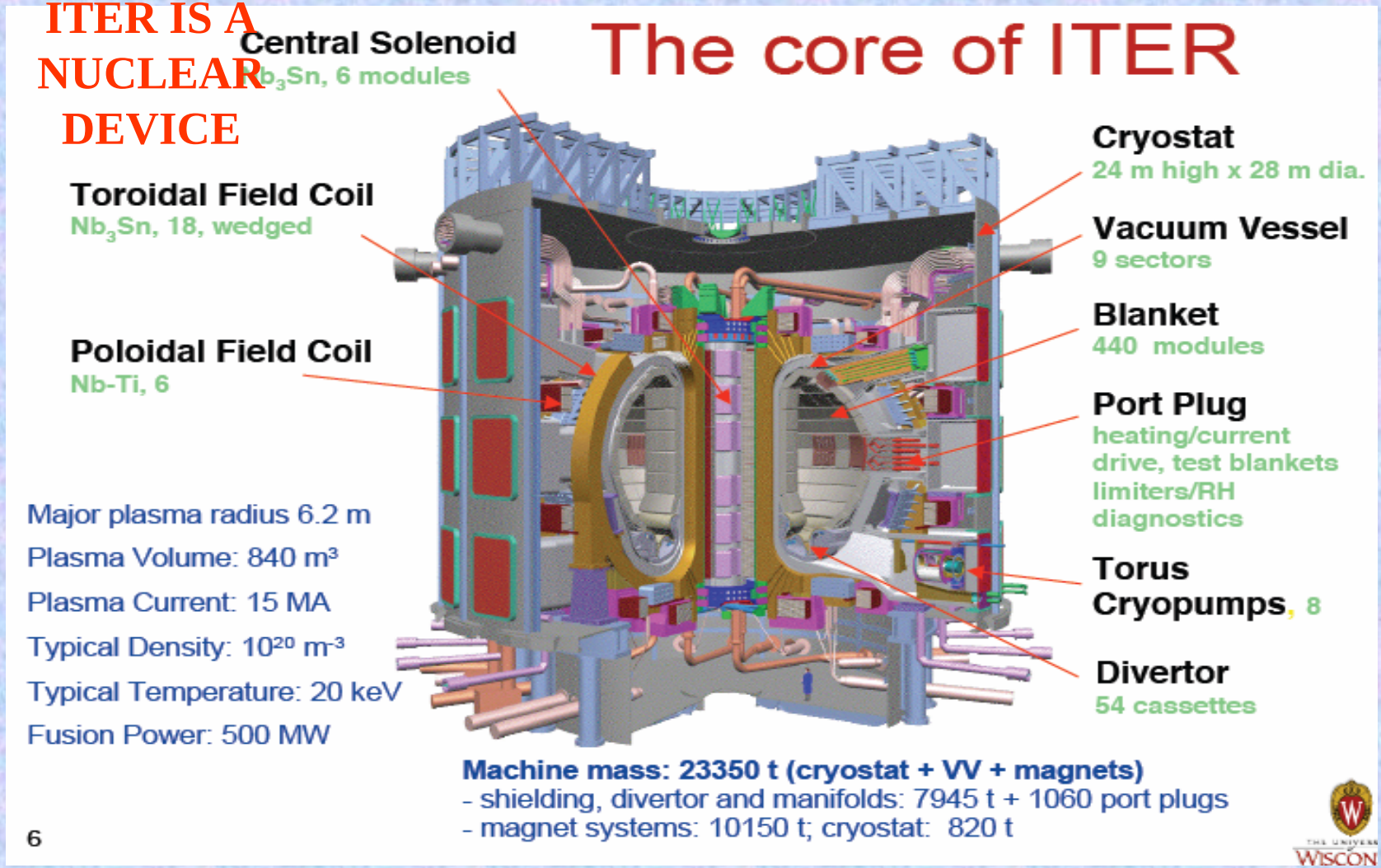
Under this arrangement, online-updating every 12 hours is performed in the mirror with the IAEA website through a 2MB direct link. The server is being maintained by BARC Computer Division - with manpower and machinery. It offers 2-3 times faster downloads in BARC compared to the Vienna site. India offers to collaborate with other network of reaction data centres and help in promoting the online nuclear data services in the coming years.

1. **DAE-BRNS Theme Meeting on "Use of updated multi-group nuclear data libraries for thermal reactor applications" July 28-29, 2004 at BARC, Mumbai.**
2. **Golden Jubilee DAE-BRNS Theme Meeting on "Use of neutron sources for experiments related to nuclear technology and fuel cycles" September 8-10, 2004, North Eastern Hill University, Permanent Campus, Umshing, Shillong, Meghalaya-793022.**
3. **DAE-BRNS National Workshop on Nuclear Data for Reactor Technology and Fuel Cycle, 7-10 March 2005, BARC, Mumbai.**
4. **Supplementary Meeting on Multigroup cross sections, July 18-19, 2005, Training School Hostel, Anushaktinagar.**
5. **DAE-BRNS Theme Meeting on EXFOR Compilation for Indian Scientists during September 4-8, 2006.**
6. **BARC Golden Jubilee DAE-BRNS National Workshop on Nuclear Data for Advanced Nuclear Systems, Nuclear Databases and Applications, 8-11 November 2006, NWND-2006.**
7. **Meeting on Atomic and Nuclear Data for Next Generation Medicine and Technologies, 12-13 November 2006, MAHE, Manipal, Karnataka.**
8. **Supplementary Meeting to the DAE-BRNS Theme Meeting on EXFOR Compilation for Indian Scientists, December 7, 2006.**
9. **DAE-BRNS Theme Meeting on EXFOR Compilation for Indian Scientists during Oct. 29 – Nov. 2, 2007.**
10. **DAE-BRNS Theme Meeting on "Covariance Error Matrix and its Applications in Reactor Fuel Cycle and Technology," February 25 – 28, 2008, Manipal University, Manipal – 576104.**

INDIA IS A PARTICIPANT IN THE ITER PROGRAMME.

The nuclear data needs for fusion applications is one of the areas receiving increased attention in India.

ITER IS A NUCLEAR DEVICE



CREATION OF EXPERIMENTAL NUCLEAR CRITICALITY BENCHMARKS FOR INTEGRAL NUCLEAR DATA VALIDATION STUDIES

2005: India contributed the KAMINI experimental benchmark
(ICSBEP Reference: U233-MET-THERM-001)

2008: India contributed the PURNIMA-II experimental benchmark
(ICSBEP Reference: U233-SOL-THERM-007)

For details, please visit the URL: http://icsbep.inl.gov/

THANK YOU