



**International Atomic Energy Agency**

# **Nuclear Data Activities in the IAEA-NDS**

**R.A. Forrest**

**Nuclear Data Section**

**Department of Nuclear Sciences and Applications**

# Outline

- **NRDC**
- **NSDD**
- **EXFOR**
- **International collaboration**
- **CRPs**
- **DDPs**
- **Training**
- **Security**

# NRDC

- International Network of Nuclear Reaction Data Centres (NRDC)
- Aim:
  - ▶ EXFOR
- Core data centres:
  - ▶ NNDC
  - ▶ NEA-DB
  - ▶ IAEA-NDS
  - ▶ CJD
- 10 specialized centres
- Meeting Vienna, April 2013 (Technical), see [http://www-nds.iaea.org/nrdc/nrdc\\_2013/](http://www-nds.iaea.org/nrdc/nrdc_2013/)

# NSDD

- **International Network of Nuclear Structure and Decay Data Evaluators (NSDD)**
- **Aim:**
  - ▶ Provide up-to-date evaluated nuclear structure and decay data
- **Regular meetings since 1974**
- **Last in January 2013 in Kuwait see <http://www-nds.iaea.org/nsdd/>**
- **18 evaluation centres**
- **ENSDF master database at NNDC**



# EXFOR

- **Compiled experimental data**
- **The EXFOR database was established in the 1960s**
- **Originally exclusively neutron-induced reaction data**
- **Now includes charged particle data and higher energies**
- **Since 2003 the EXFOR libraries at the various data centres have been merged**
- **NDS has responsibility for the maintenance of this Master file**



# EXFOR (cont.)

- EXFOR **Compilation Control System** used to coordinate the compilation of the data centres
- During 2012, the average time between publication and compilation steady ~ 6 months
- EXFOR contains data for about **20,000** experiments, web content is updated monthly
- Continuing effort to remove errors and inconsistencies from the database



# EXFOR (cont.)

- To make best use of these data considerable work on various retrieval and **visualisation systems**
- Output formats:
  - ▶ EXFOR+ format
  - ▶ XML and HTML
  - ▶ C4 format - numeric data in simple tables
  - ▶ Standard EXFOR format
- Development of EXFOR-XML and possible unification with ENDF
  - ▶ in frame of SG 38 (2nd Meeting, May 2013)

# DDEP

- **DDEP collaboration established in 1994**
- **Decay data specialists who use a specific evaluation methodology**
- **Publishes decay data through the Bureau International des Poids et Mesures (BIPM) Monographie series**
- **NDS has been a major contributor to DDEP for many years:**
  - ▶ **CRP on x-ray and gamma ray decay data standards**
  - ▶ **CRP on 'Updated Decay Data Library for Actinides' (84 evaluations)**
- **Meeting on Metrology, (19 June) organised by EURAMET EMRP will be attended by DDEP members**



# **JEFF project**

- **NDS staff make technical contributions to the OECD/NEA JEFF Project**
- **Particularly in the field of decay data**
- **Approximately 500 decay scheme evaluations adopted into the latest JEFF Radioactive Decay Data sub-library**
- **IAEA evaluations for reaction data are candidates for inclusion in the next release (JEFF-3.2)**

# CRPs

- **Coordinated Research Projects (CRPs) are an IAEA tool produce outputs such as data libraries by encouraging collaboration between various parties**
- **3 active**
- **3 planned**

# On-going and Planned CRPs

10	Prompt fission neutron spectra for actinides	2009–2013	12 (6)	Capote	On-going
11	Charged-Particle Monitor Reactions and Nuclear Data for Medical Isotope Production	2012–2015	~15 (6)	Capote	On-going
12	Nuclear data for Particle Induced Gamma Ray Emission (PIGE) analysis	2011–2014	11 (6)	Dimitriou	On-going
13	Validation of the International Dosimetry Library IRDFF	2013–2017	-	Simakov Capote	Starting (1st RCM 1-5 July)
14	Beta-delayed Neutron Emission Evaluation	2013–2017	-	Dimitriou	Starting (1st RCM 26-30 August)
15	Primary Radiation Damage Cross Sections	2013-2017	-	Simakov Forrest	Starting (1st RCM 4-8 Nov)



# Prompt Fission Neutron Spectra for Actinides (2009 - 2013), R. Capote

- **Objectives:**

- ▶ Make available existing experimental information on prompt fission neutron spectra (PFNS) relevant to fission reactor applications
- ▶ Incorporate available experimental information on PFNS for major actinides into evaluated nuclear data files
- ▶ Recommend evaluations of PFNS with covariances from thermal to 20 MeV

- **3<sup>rd</sup> RCM, November 2013, IAEA Vienna**



# Nuclear data for Particle Induced Gamma Ray Emission (PIGE) analysis (2011-2014)

## P. Dimitriou

- **Objectives:**

- ▶ **Identify** the most important nuclear reactions for PIGE
- ▶ Search literature and **convert** relevant data to correct format
- ▶ **Compare data** from sources and **carry out measurements** when necessary
- ▶ **Incorporate** all measured data into **database**

- **2<sup>nd</sup> RCM, 8–12 October 2012, IAEA Vienna**



# Charged Particle Monitor Reactions and Nuclear Data for Medical Isotope Production (2012-2015) R. Capote

## ● Objectives:

- ▶ Update **evaluations of the charged-particle** monitor reaction database
- ▶ Evaluate **decay data, nuclear reaction cross sections and yields for production of heavy alpha emitters and selected long-lived positron emitters**
- ▶ Improve data for **accelerator production** of diagnostic gamma emitters:  $^{123}\text{I}$ ,  $^{99}\text{Tc}$  and  $^{111}\text{In}$
- ▶ Undertake **new measurements and evaluate decay data of:**  $^{66}\text{Ga}$ ,  $^{86}\text{Y}$ ,  $^{103}\text{Pd}$ ,  $^{73}\text{Se}$ ,  $^{94\text{m}}\text{Tc}$ ,  $^{72}\text{As}$ ,  $^{62}\text{Zn}$ ,  $^{76}\text{Br}$ ,  $^{89}\text{Zr}$  and  $^{120}\text{I}$  if possible

## ● 1st RCM, December 2012, IAEA Vienna



# Validation of the International Dosimetry Library (IRDFF) (2013-2017) Simakov-Capote

- A new dosimetry library for fission and fusion applications (IRDFF) has been developed and released in February 2012
- 1<sup>st</sup> RCM to be held 1-5 July 2013 objective is to validate IRDFF
- More information at:  
<http://www-nds.iaea.org/IRDFFtest/>

# Primary Radiation Damage Cross Sections (2013-2017) Simakov-Forrest

- **Bring together Nuclear Data and Radiation Materials Experts**
  - ▶ to revisit NRT-dpa standard and to implement an upgraded one that will account for primary radiation defects (Frankel pairs, clusters ...) that survive after cascade relaxation
  - ▶ improving gas production cross sections
- **1st RCM to be held 4-8 Nov 2013 to coordinate specific tasks (Fe – starting element)**
- **More information at:**  
**<http://www-nds.iaea.org/CRPdpa/dpa.htm>**



# Beta-delayed neutron emission evaluation (2013-2017) P. Dimitriou

- Beta-delayed neutrons are important for energy production, astrophysics and nuclear theory
- 1<sup>st</sup> RCM will be held 26-30 August 2013 in Vienna
- More information at:  
<http://www-nds.iaea.org/beta-delayed-neutron/>

# DDPs

- **Data Development Projects (DDPs) are carried out by the IAEA through:**
  - ▶ Consultancy visits
  - ▶ Service agreements
  - ▶ Work undertaken directly by NDS staff
- **Example:**
  - ▶ Neutron cross section standards (will contribute to CIELO) CM will be held 8-12 July to discuss next steps

# Training

- Provide outreach in the form of training, especially to developing countries
- EXFOR workshop (27-30 August)
- EMPIRE workshop (18-22 Nov)
- Workshops held at **ICTP Trieste** (~ 2 per year)
  - ▶ 2012: Atomic & Molecular
  - ▶ 2012: NSDD related
  - ▶ 2013: Advanced Reactor Systems (30 Sept-4 Oct)
  - ▶ 2013: Analytical Applications (21-25 Oct)



# IT security

- **First web site shutdown – 3<sup>rd</sup> February 2012 (1 week)**
- **Second shutdown - 27<sup>th</sup> April 2012 (2 weeks)**
- **Third shutdown – 30<sup>th</sup> November 2012 - 28<sup>th</sup> January 2013**
- **The servers are now located ‘in the cloud’**
- **Even after 4 months we are missing functionality (scripts)**
- **RIPL and IBANDL sites now functional**

# IBANDL

IBANDL  
Ion Beam Analysis  
Nuclear Data Library



Nuclear  
Data  
Service



IBANDL

## Nucleus

H-1

## Projectile

- p
- d
- $^3\text{He}$
- $\alpha$
- $^6\text{Li}$
- $^7\text{Li}$

## Type of data

- EBS
- NRA
- PIGE
- All

IBANDL

[Summary]

EXFOR

Home

CD version

Updates

Nuclear Data  
Services

This is the **Ion Beam Analysis Nuclear Data Library** developed and formerly maintained by [A.Gurbich](#) under the IAEA auspices. It contains most of the available experimental nuclear cross-sections relevant to Ion Beam Analysis. Excitation functions are presented both as graphs and data files. The numerical data are in the [R33](#) format. All the entries are supplied with a reference to the data source. The data published only in a graphical form were digitized using a precise technique. Where all efforts were made to ensure that the most accurate information was adopted, no guarantee can be given concerning the full validity of the data, and the IAEA accepts no responsibility for usage of IBANDL.

Due to technical reasons the IBANDL Web-interface was relocated and redesigned by [V.Zerkin](#) to whom relevant problems if any should be reported. Every effort was made in order to preserve IBANDL content, look, and functionality. Members of the IBA community are again invited to supply the new data to the library. Data files should be sent to [V.Semkova](#).

The activity of the IBA community in the field of nuclear data is now supported by IAEA through the Coordinated Research Project (CRP) "Development of a Reference Database for Particle-Induced Gamma Ray Emission (PIGE) Spectroscopy. A [summary](#) of the first CRP meeting describes its plans and goals.

Automatic conversion from EXFOR to R33 is now provided. When nucleus and projectile are selected press "EXFOR" button in the left frame and the information available in the [EXFOR data base](#) will be displayed. Details of the conversion algorithm can be found [elsewhere](#).

A complete [CD version](#) of IBANDL updated in December, 2011 is available on request. This new version can be copied from CD to PC.

When citing data retrieved from IBANDL both the original article and the database should be referenced.

*Example:*

A. Scientist et al., Journal..., data retrieved from the IBANDL database, <http://www-nds.iaea.org/ibandl/>

Database Manager (2002-2011): Alexander Gurbich, Institute for Physics and Power Engineering, Obninsk, Russia ([gurbich@ippe.ru](mailto:gurbich@ippe.ru))  
Data Manager: Valentina Semkova, NDS, International Atomic Energy Agency ([V.Semkova@iaea.org](mailto:V.Semkova@iaea.org))  
Web and Database Programming: Viktor Zerkin, NDS, International Atomic Energy Agency ([V.Zerkin@iaea.org](mailto:V.Zerkin@iaea.org)) /2013.03.21/

New Front page



# IBANDL

$^{12}\text{C} + \text{p}$

Extended

Type of data: ALL View:  extended Convert units for plotting:  no  rr->mb/sr  mb/sr->rr Plots: [reset]

No.	Reaction	Angle	Energy(keV)	Reference	File	Plot
1	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	179	380-7100	Evaluated cross-section (SigmaCalc)	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> mb
2	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	179.2°	4000-6600	M. Tosaki et. al. Nucl. Instr. Meth. B168 (2000) 543	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> mb
3	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	178°	490-2500	A.R.Ramos+(2002), Jour. Nucl. Instrum. Methods in Physics Res., Sect.B, Vol.190, p.95	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> rr
4	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	170°	700-2500	E.Rauhala Nucl.Instrum.Methods B12 (1985) 447	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> mb
5	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	170°	290-720	Z.Liu et al. Nucl. Instr. Meth. v.B74 (1993) 439	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> rr
6	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	170°	290-2970	Z.Liu et al. Nucl. Instr. Meth. v.B74 (1993) 439	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> rr
7	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	170°	340-3000	S. Mazzoni et al., Nucl. Instr. Meth. B136-138 (1998) 86	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> mb
8	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	170°	710-2970	Z.Liu et al. Nucl. Instr. Meth. v.B74 (1993) 439	<a href="#">View</a> <a href="#">Save</a>	<input type="checkbox"/> rr

No.	Reaction	Angle	Energy(keV)	Pts	Update	X4	Reference
1	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	179	380-7100	348	2013-03-11		Evaluated cross-section (SigmaCalc)
2	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	179.2°	4000-6600	55	2006-06-23		M. Tosaki et. al. Nucl. Instr. Meth. B168 (2000) 543 »
3	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	178°	490-2500	61	2011-09-02	X4	A.R.Ramos+(2002), Jour. Nucl. Instrum. Methods in Physics Res., Sect.B, Vol.190, p.95 »
4	$^{12}\text{C}(\text{p},\text{p}_0)^{12}\text{C}$	170°	700-2500	29	2006-06-23		E.Rauhala Nucl.Instrum.Methods B12 (1985) 447 »



# IBANDL

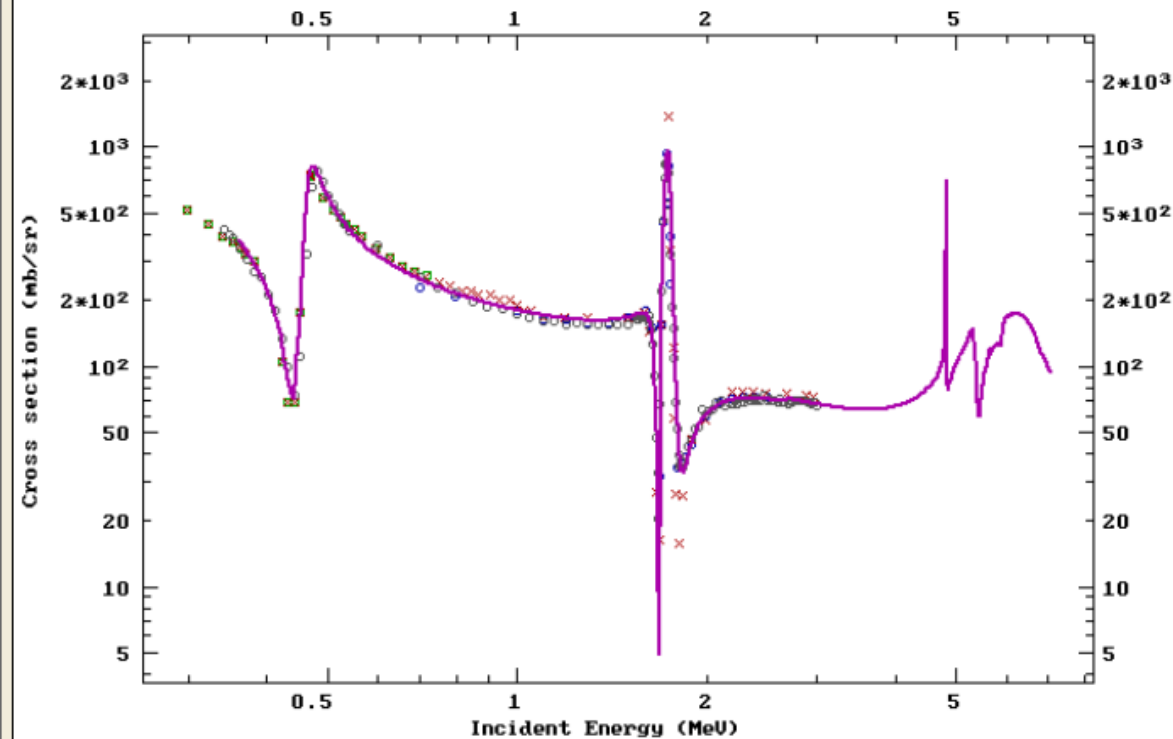
## Welcome to Web-ZVView!

Interactive plotting of IBANDL and SigmaCalc data

- 1)  $\theta=170^\circ$  E.Rauhala Nucl.Instrum.Methods B12 (1985) 447
- 2)  $\theta=170^\circ$  Z.Liu et al. Nucl. Instr. Meth. v.B74 (1993) 439
- 3)  $\theta=170^\circ$  Z.Liu et al. Nucl. Instr. Meth. v.B74 (1993) 439
- 4)  $\theta=170^\circ$  S. Mazzoni et al., Nucl. Instr. Meth. B136-138 (1998) 86
- 5)  $\theta=170.0^\circ$  generated by SigmaCalc version 1.6. C-12(pp) at 170.0 deg.

$^{12}\text{C}(p,p_0)^{12}\text{C}$  170.0deg.

SigmaCalc-1.6, C-12(p,p) 170.0deg.



Use of ZVView  
New Features  
No Security issues

Log:  X  Y Lin:  X  Y Auto-range:  X  Y Page:   Zoom:   Grid:  V  H Pts:  Txt  Box  PL



# Thank you!

