

Database Developments and Coordinated Research Projects at the IAEA on Plasma-Material Interaction and Neutron-Induced Processes

B. J. Braams, R. A. Forrest and H.-K. Chung
IAEA Nuclear Data Section

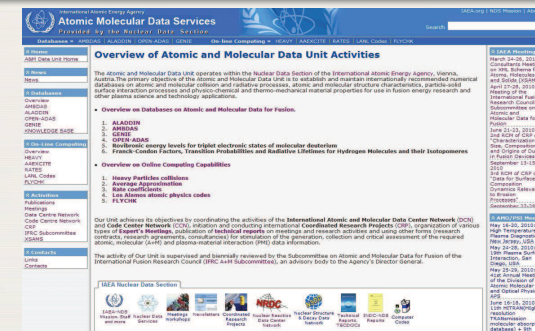


International Atomic Energy Agency

- Founded in 1957 in Vienna
- 151 Member States (As of December 2009)
- 6 Departments & 2200 Staff
- assists its Member States, in the context of social and economic goals, in planning for and using nuclear science and technology for various peaceful purposes, including the generation of electricity, and
- facilitates the transfer of such technology and knowledge in a sustainable manner to developing Member States;



Overview of A+M Data Unit Activities See: <http://www-amdis.iaea.org/>



A+M Data Centres Network (DCN)

- The DCN includes 12 national data centres:
Terms of Reference:
Domain : atomic and molecular (A+M), particle surface interaction (PSI) and bulk material properties (plasma-material interaction - PMI) data for fusion and other applications.
Established Program: Collection, Dissemination, Critical assessment (evaluation) and generation of A+M, PSI (PMI) data
- The DCN activities are coordinated by the IAEA A+M Data Unit and periodically reviewed (every two years) by IFRC A+M Subcommittee.
- The A+M/PMI Data Centre Network represents one of the main instruments by which the international fusion related A+M/PMI data collection and evaluation programmes are implemented.



Main Nuclear Data Projects

- See <http://www-nds.iaea.org/>
- EXFOR: Experimental Nuclear Reaction Data
 - ENDF: Evaluated Nuclear Reaction Libraries
 - ENSDF: Evaluated Nuclear Structure and Decay Data
 - NSR: Nuclear Science References
 - FENDL: Fusion Evaluated Nuclear Data Library
- Activities coordinated by IAEA



CRP: Coordinated Research Project

Joint research on Nuclear or A+M/PMI topic:

- Representatives from 10 to 15 institutes world-wide
- Duration 3-4 years; 3 Research Coordination Meetings

Objectives:

- Generation, compilation and evaluation of data
- Establishment of databases
- Development of new techniques

Data and results:

- Journal publications
- Comprehensive final report
- Numerical data in IAEA Database
- Looking forward to results in Knowledge Base



CRP on Fusion Evaluated Nuclear Data Library FENDL 3.0

- Extension of FENDL-2.1 towards higher energies (150 MeV) and charged particle (p, d) reactions
- Support fusion materials studies
- Support ITER and IFMIF
- Meetings 02-05 Dec 2008, 23-26 Mar 2010, 06-09 Dec 2011



FENDL 3.0 Participants

- M. SAWAN – UW, Madison, WI, USA
- Y. WATANABE – Kyushu University, Fukuoka, Japan
- S. KUNIEDA – JAEA, Tokai-mura, Japan
- A. TRKOV – JSI, Ljubljana, Slovenia
- U. FISCHER, P. PERESLAVSTEV – KIT, Karlsruhe, Germany
- L. LEAL – ORNL, Oak Ridge, TN, USA
- J-C. SUBLET – CCFE, Abingdon, UK
- A. KONING and J. KOPECKY – NRG and JUKO, the Netherlands
- M. AVRIGEANU – IFIN HH, Bucharest, Romania
- T. KAWANO – LANL, Los Alamos, NM, USA
- A. IGNATYUK – Institute of Physics and Power Engineering, Obninsk, RF
- F. TARKANYI – Academy of Science, Debrecen, Hungary



Past, Present and Planned CRPs of the A+M Data Unit

- 2002-2006: Tritium Inventory in Fusion Reactors
- 2004-2008: Atomic and Molecular Data for Plasma Modelling
- 2005-2009: Atomic Data for Heavy Element Impurities in Fusion Reactors
- 2007-2011: Data for Surface Composition Dynamics Relevant to Erosion Processes
- 2008-2012: Characterization of Size, Composition and Origins of Dust in Fusion Devices
- 2009-2013: Light Element Atom, Molecule and Radical Behaviour in the Divertor and Edge Plasma Regions
- 2010-2014: Spectroscopic and Collisional Data for W from 1 eV to 20 keV
- 2011-2015 (planned): Data for State-Resolved Modelling of Molecules of H and He and their Isotopes in Fusion Plasma
- 2012-2016 (planned): Erosion and Tritium Retention for Plasma Interaction with Beryllium Surfaces
- 2013-2017 (tentative): Plasma Interaction with Irradiated Tungsten and Tungsten Alloys in Fusion Devices



CRP on Data for Surface Composition Dynamics Relevant to Erosion Processes (2007-2011)

Participants

Karl Krieger MPI für Plasmaphysik, Garching, Germany
 Jungling Chen Chinese Academy of Sciences, Heiji, China
 Alain Allouche University of Provence, Marseille, France
 James Davies University of Toronto, Canada
 Yury Martynenko Kurchatov Institute, Moscow, Russia
 Daiji Kato National Institute for Fusion Science, Toki-City, Japan
 Predrag Krstic Oak Ridge National Laboratory, USA
 Kai Nordlund University of Helsinki, Finland
 Russel Doerner University of California at San Diego, USA
 Rinad Zalavutdinov Russian Academy of Science, Moscow, Russia

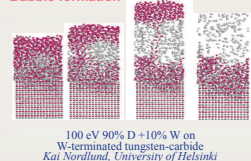


CRP on Data for Surface Composition Dynamics Relevant to Erosion Processes (2007-2011)

Overall objective

- To better understand erosion processes and to find new methods to control erosion
- To collect and generate new data relevant to erosion dynamics in fusion reactors
- Investigated materials mainly the ones foreseen for ITER: C, W, Be

Bubble formation



100 eV 90% D + 10% W on W-terminated tungsten-carbide
 Kai Nordlund, University of Helsinki

First outputs and outcomes

- Some new data included in ALADDIN
- New ALADDIN web interface for PSI

First RCM, 17-19 October 2007

Second RCM, 11-13 March 2009

Final RCM, 13-15 September 2010



CRP on Size, Composition and Origin of Dust in Tokomaks (2008-2012)

Participants

Phil Sharpe Idaho National Laboratory, Idaho Falls, ID, USA
 Charles Skinner PPPL, Princeton, NJ, USA
 Christian Grisolia CEA, Cadarache, France
 Anna Widdowson UKAEA, Abingdon, UK
 Volker Rohde IPP Garching, Germany
 Leonid Khimchenko Kurchatov Institute, Moscow, Russia
 Jörg Winter Ruhr Universität, Bochum, Germany
 Carmine Castaldo ENEA, Roma, Italy
 Naoko Ashikawa NIFS, Toki-City, Japan
 Suk-Ho Hong NFRI, Korea (to be formalized)

Observer

Sergio Ciattaglia ITER, Cadarache, France



CRP on Size, Composition and Origin of Dust in Tokomaks (2008-2012)

Objectives

- To determine the size, composition and origin of dust in tokamaks
- Understand dust transport
- Improve dust estimates
- Understand tritium retention in dust
- Investigate dust removal techniques
- Focus on dust from C, W and Be

First RCM: 10-12 December 2008

Second RCM: 21-23 June 2010

Third RCM: 30 Nov - 02 Dec 2011

Plans for a real dust database! (Effort centred at IPP Garching; based on automated analysis of 10s of thousands of individual dust images.)



Flaking of co-deposited layer on lower part of limiter, TFTR, Nov 1998



Planned CRP on Erosion and Tritium Retention in Beryllium Plasma Facing Components

- Strongly recommended by the IFRC subcommittee on A+M data as our first CRP for the 2012-2013 programme
- Timely for input from JET ILW and for planning for ITER
- Interested in routine interaction of H/He and impurity ions with Be surface, and in transient events (melting, ablation)
- Mix of experiment and modelling
- Tentative schedule: small preparatory meeting in Q2 2011, internal proposal in Q3 2011, first RCM in Q2 2012



Possible CRP on plasma interaction with irradiated tungsten and tungsten alloys

- Strongly recommended by the IFRC subcommittee on A+M data as our second CRP for the 2012-2013 programme
- Tungsten alloys are foreseen for next step beyond ITER
- In any case, W transmutes to W-Re-Os
- Neutron irradiation causes voids and dislocations; changes PMI properties in ways that have not been much studied
- CRP on irradiated tungsten and tungsten alloys in 2013-2017 will support planning for DEMO

