

# Current Activities of IAEA A+M Unit

B. J. Braams and H.-K. Chung

Atomic and Molecular Data Unit, Nuclear Data Section  
Division of Physical and Chemical Sciences

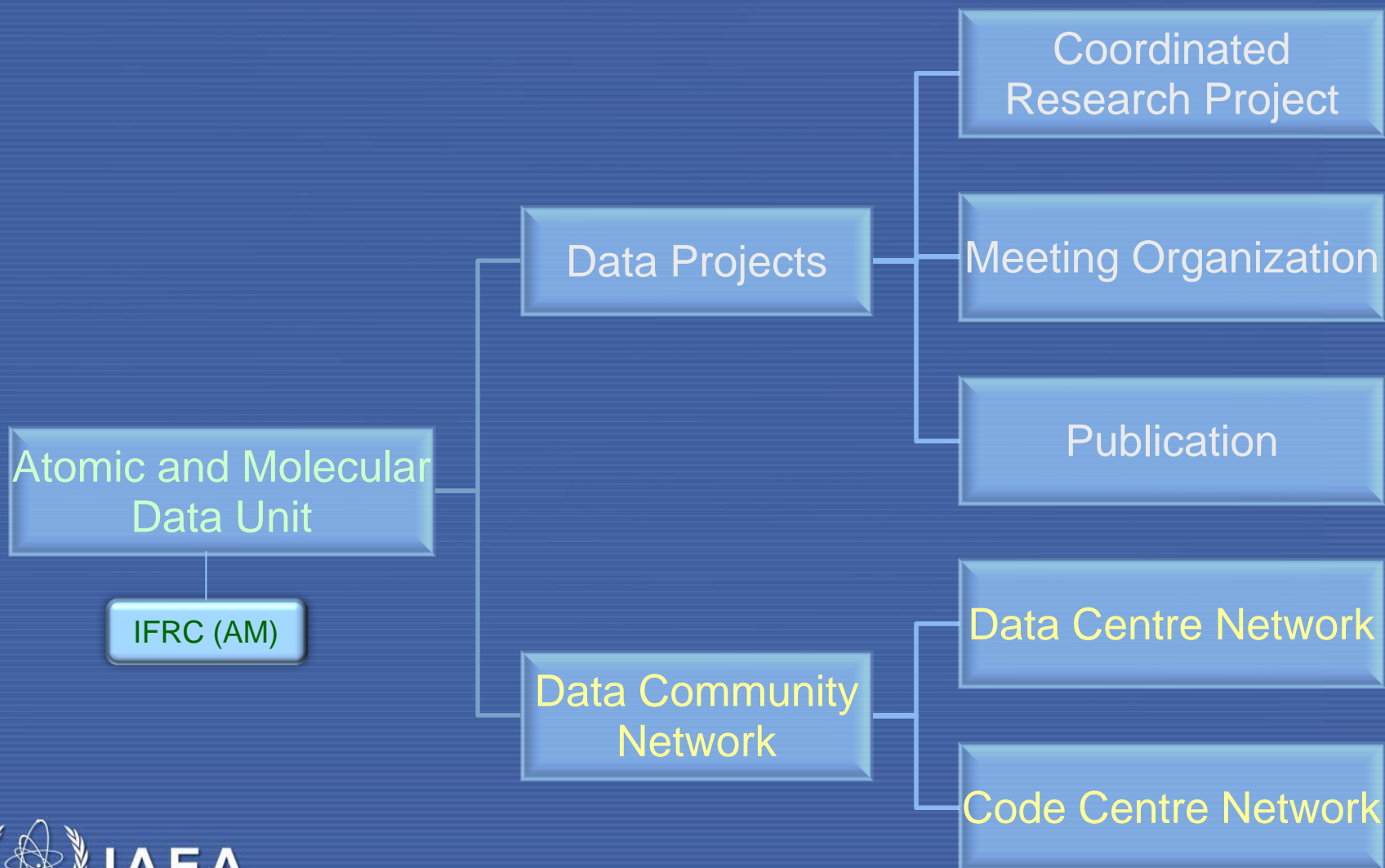
23<sup>rd</sup> Data Centre Network (DCN) Meeting, November 2-4, 2015



**IAEA**

International Atomic Energy Agency

# Atomic and Molecular Data Unit Activities



# Coordinated Research Projects

## Data Generation and Exchange

### CRP: Coordinated Research Project

- Main mechanism by which the AMD Unit encourages new research
- Unique Opportunity for Comprehensive and Synergistic Collaboration

### Joint research on Atomic, Molecular & Plasma Surface Interaction Data for fusion:

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

### Objectives: To define and to coordinate international research on:

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

### Outputs:

- Publications, Meeting Presentations and Reports
- Final Reports in “Atomic and Plasma-Material Interaction Data for Fusion” (APID); more recently in a journal (JPCS, Atoms)
- Data and Results in ALADDIN Numerical Database and Knowledge Base

# Past, Present and Future CRPs

<http://www-amdis.iaea.org/CRP>

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: Data for kinetic modelling of molecules of H and He and their isotopes in fusion plasma

2012-2016: Erosion and Tritium Retention for Beryllium Plasma-Facing Materials

2013-2017: Plasma-Wall Interactions with Irradiated Tungsten and Tungsten Alloys in Fusion Devices

2015-2019: Plasma-wall Interaction with Reduced-activation Steel Surfaces in Fusion Devices

2016-2020: Data for Charge Transfer Processes Related to Neutral Beams in Fusion Plasma



# CRP on Spectroscopic and Collisional Properties of Tungsten from 1 eV to 20 keV (2010-2014)

## Objectives

- Concerned with W in all plasma regions, edge to core
- Theory and experiment are both represented, with overlap among and between the two
- Aim to produce validated database for tungsten in plasma

## Data needs

- Electron-impact, radiative and photon-induced, and heavy particle collision processes
- Cross-sections for kinetic modelling
- Rate coefficients for macroscopic modelling
- Spectroscopic signatures for diagnostics

## Research Coordination Meetings

**First RCM:** 13-15 December 2010

**Second RCM:** 29-31 August 2012

**Third RCM:** 06-08 October 2014

## Participants

R. SRIVASTAVA	IIT Roorkee
A. MÜLLER	University of Giessen
N. NAKAMURA	University of Electrocommunications
A. RYABTSEV	Russian Academy of Sciences
A. . WYART/	Observatoire de Paris
W. TCHANG-BRILLET	
P. BEIERSDORFER	LLNL
C.-Z. DONG	Northwest Normal University
F. KOIKE	Kitasato University
V. NIKULIN/	St Petersburg Nuclear Physics Institute
M. TRZHASKOVSKAYA	
V. LISITSA,	Kurchatov Institute
N. BADNELL,	University of Strathclyde
J. COLGAN,	Los Alamos National Laboratory
Yu. RALCHENKO,	NIST
D. KWON	KAERI

# CRP on A+M Data for State-Resolved Modelling of H, He and their Isotopes in Fusion Plasma (2011-2015)

## Objectives

- Species H, H<sup>+</sup>, H<sub>2</sub>, H<sub>2</sub><sup>+</sup>, H<sub>3</sub><sup>+</sup>, He, He<sup>+</sup>, He<sub>2</sub><sup>+</sup>, HeH<sup>+</sup>, He<sub>2</sub><sup>+</sup>, H<sup>-</sup> and isotopic variants; isotope effects are important; He is newly important
- Aim to be comprehensive for volume processes among the mentioned species and e<sup>-</sup>, hv
- Predominantly theoretical; some experiment

## Data needs

- State-resolved cross-sections for kinetic modelling
- Electron-impact, radiative and photon-induced, and heavy particle collision processes

## Research Coordination Meetings

**First RCM:** 10-12 August 2011

**Second RCM:** 3-5 July 2013

**Third RCM:** 14-16 March 2016

## Participants

R. CELIBERTO	Polytechnic of Bari, Italy
U. FANTZ	MPI for Plasma Physics, Garching
C. JUNGEN	Laboratoire Aimé Cotton du CNRS
I. SCHNEIDER	Université Le Havre
V. KOKOOLINE	University of Central Florida
P. KRSTIC	Oak Ridge National Laboratory
X. MA	Chinese Academy of Sciences
O. MOTAPON	University of Douala, Cameroon
A. OREL	University of California at Davis
D. REITER	Forschungszentrum Jülich
K. SAWADA	Shinshu University
X. URBAIN	Catholic University of Louvain
J.-S. YOON	National Fusion Research Institute

# CRP on Erosion and Tritium Retention in Beryllium Plasma Facing Components (2012-2016)

## Objectives

The key processes to be studied are physical and chemical sputtering by H, He and Be, which release beryllium impurities into the plasma, trapping and reflection of hydrogen (H, D, T) on beryllium surfaces, the transport of hydrogen in beryllium and means to extract trapped tritium.

## Data needs

- Data for routine interaction of H/He and impurity ions with Be surface, and in transient events (melting, ablation)
- Most important projectiles: H, D, T, He, Be, C, N, O, Ne and Ar
- Data of mixed materials, especially, Be-(H,D,T,He), Be-C, Be-N, Be-O and ternary and higher mixtures

## Participants

R. DOERNER/ D. NISHIJIMA	PISCES Lab, UCSD
D. BORODIN M. PROBST S. IRLE/ H. NAKAMURA	Forschungszentrum Jülich: University of Innsbruck: Nagoya University:
K. NORDLUND/ C. BJÖRKAS	University of Helsinki
Ch. LINSMEIER W. JACOB	Forschungszentrum Jülich IPP, Garching

## Research Coordination Meetings

**First RCM**, 26-28 Sep 2012

**Second RCM**, 18-20 Aug 2014



# CRP on Plasma-Wall Interaction with Irradiated Tungsten and Tungsten Alloys in Fusion Devices

## Objectives

To support assessment of the prospects for tungsten-based plasma-facing materials in a fusion reactor environment

## Data needs

- effects of neutron irradiation and charged particle surrogate irradiation on the microstructure of tungsten-based materials.
- relation between tungsten microstructure after irradiation and plasma-material interaction properties for erosion, tritium retention and tritium migration.
- Synthesize information, extrapolate to fusion neutron fluence, and provide best expert estimates and uncertainties for tritium retention and tritium transport

## Research Coordination Meetings

**First RCM**, 26-28 November 2013

**Second RCM**, 8-11 September 2015



## Participants

G. H. Lu et al., Beihang University, Beijing.  
C. Liu, X. Wu et al., ISSP-CAS, Hefei.  
G. Luo, C. Zhang et al., IPP-CAS, Hefei.  
M. Barthe, C. Becquart et al., CNRS.  
C. Grisolia, B. Rousseau et al., CEA.  
M. Mayer, T. Schwarz-Selinger et al., IPP Garching.  
B. Unterberg, J. Linke, Forschungszentrum Jülich.  
S. Deshpande, P. M. Raole et al., IPR, Gandhinagar.  
A. Hasegawa et al., Tohoku University.  
Y. Hatano, Y. Oya et al., Toyama University.  
M. Sakamoto, H. Watanabe et al., U. of Tsukuba.  
T. Oda, H. Shim et al., Seoul National University.  
Y. Gasparyan, A. Pisarev et al., MEPhI, Moscow.  
B. Khripunov, A. Ryazanov et al., Kurchatov Ins  
S. Markelj et al., Josef Stefan Institute, Ljubljana.  
S. Dudarev et al., CCFE, Abingdon.  
B. D. Wirth et al., U. of Tennessee, Knoxville.  
J. Allain, D. Ruzic et al., University of Illinois.  
M. Shimada, B. Merrill et al., Idaho National Lab.

# CRP on Plasma-wall Interaction with Reduced-activation Steel Surfaces in Fusion Devices

## Background

- Main wall in DEMO or in a reactor will not be beryllium (too high erosion); tungsten is also unattractive (radiation issues). Some kind of low-activation steel looks attractive for the main wall, but more data are needed to assess just where it could be used.
- Special issue with steel: the alloy could be “self-passivating” with respect to erosion.

## CRP Topics and Objectives

- Develop information about the microstructure of steel surfaces exposed to fusion neutrons and energetic plasma particles.
- Develop information about the relation between steel microstructure after irradiation and properties for erosion, tritium migration and ways to extract trapped tritium.
- To synthesize new information and provide best expert estimates and uncertainties for plasma-material interaction properties for steel surfaces in a fusion reactor environment.

## Participants

- Peng Wang, Lanzhou Institute of Chemical Physics
- W. Jacob and T. Schwarz-Selinger, IPP Garching
- Y. Hirooka and N. Ashikawa, NIFS
- A. Golubeva and A. Spitsyn, Kurchatov Institute
- R. Doerner and D. Nishijima, UCSD PISCES Lab
- V. Maklai and I. Garkusha, IPP Kharkov
- D. Terentyev and L. Malerba, SCK-CEN

## Meeting Plan

- **First RCM:** 9-11 December 2015
- **Second RCM:** Apr. Q2, 2017

# CRP on Data for Charge Transfer Processes Related to Neutral Beams in Fusion Plasma

## Planned CRP; tentative title

- Proposal is due in Q2 2016; CRP could start in Q4 2016 or Q1 2017

## Core topics and objectives

- Develop data for collision processes of neutral beams in fusion plasma

## Scope to be better defined

- Heating and diagnostic neutral beams
- H/D/T beams for sure; He, Li beams most likely; maybe other (Ne, Ar, ...)
- Charge transfer processes and related (CXRS) spectroscopy
- Beam excitation and related (BES) spectroscopy
- Motional Stark Effect (MSE) diagnostics
- Processes in the beam generation, negative ion production and neutralization? (Probably not)

## Meeting schedule

- Consultancy meeting to help define the scope in March 2016
- First RCM could be near the end of 2016 or early 2017

# CRP beyond 2016 (very tentative)

## Procedure

- Preliminary proposal or proposals are submitted in the course of 2016
- Definitive proposal about 9 months before the intended start of the CRP
- Instead of a CRP we can choose to organize one or more technical meetings

## Possible topic: Data for plasma interaction with liquid metal surfaces

- Most interest: Li, Ga, Sn
- Interest in plasma contamination and tritium retention
- Possible interest in related spectroscopy

## Possible topic: Codes and data for vapour shielding in fusion plasma

- Relevant for disruptions, other pulsed heat load on walls
- Also relevant for pellet injection (D/T; impurity seeding)
- Classic problem of radiation transport
- Likely involvement from the WDM/HDM/ICF community

# Meetings in 2013

<http://www-amdis.iaea.org/meetings/>

- Final RCM on "Light Element (H, He, Li, Be) Atom, Molecule and Radical Behaviour in the Divertor and Edge Plasma Regions"
  - 20-22 Mar 2013, IAEA Headquarters, Vienna, Austria
- TM on "International Code Centres Network"
  - 6-8 May 2013, IAEA Headquarters, Vienna, Austria
- 2nd RCM on "A & M Data for State-Resolved Modeling of Hydrogen and Helium and Their Isotopes in Fusion Plasma"
  - 3-5 July 2013, IAEA Headquarters, Vienna, Austria
- The 2nd SLSP Code Comparison Workshop
  - 5-9 August 2013, K+K Maria Theresia Hotel, Vienna, Austria
- TM on "Technical Aspects of A & M Data Processing and Exchange 22nd Meeting of the A & M Data Centres Network"
  - 4-6 Sep 2013, IAEA Headquarters, Vienna, Austria
- 1st RCM on "Plasma-Wall Interaction with Irradiated Tungsten and Tungsten Alloys in Fusion Devices"
  - 25-29 Nov 2013, IAEA Headquarters, Vienna, Austria
- CM on "Data Evaluation of N<sub>2</sub> Molecules"
  - 5-6 Dec 2013, IAEA Headquarters, Vienna, Austria

# Meetings in 2014

<http://www-amdis.iaea.org/meetings/>

- TM of the International Fusion Research Council Subcommittee on A & M Data for Fusion
  - 28-29 April 2014, IAEA Headquarters, Vienna, Austria
- Joint IAEA-ITAMP TM on Uncertainty Assessment for Theoretical A & M Scattering Data
  - 7-9 July 2014, Cambridge, MA, USA
- 2nd RCM on "'Data for Erosion and Tritium Retention in Beryllium Plasma Facing Materials"
  - 18-19 Aug 2014, IAEA Headquarters, Vienna, Austria
- CM on "Plasma Interaction with Steel Surfaces"
  - 20 Aug 2014, IAEA Headquarters, Vienna, Austria
- 16th International Conference on Radiative Properties of Hot Dense Matter (RPHDM)
  - Sep 29- Oct 3, 2014, Vienna, Austria
- 3rd RCM on "Spectroscopic and Collisional Data for Tungsten from 1 eV to 20 keV"
  - 6-8 October 2014, IAEA Headquarters, Vienna, Austria
- Joint ICTP-IAEA Conference on Models and Data for PMI in Fusion Devices
  - 3-7 Nov 2014, Trieste, Italy
- IAEA Technical Meeting on A & M and PMI Data for Fusion Science and Technology
  - 15-19 December 2014, Daejeon, Korea

# Meetings in 2015

<http://www-amdis.iaea.org/meetings/>

- The 3rd Spectral Line Shapes in Plasma Workshop
  - 2-6 March 2015, Marseille, France
- Joint ICTP-IAEA Advanced School and Workshop on Modern Methods in Plasma Spectroscopy
  - 16-27 March 2015, Trieste, Italy
- CM on "Guidelines for Uncertainty Quantification of theoretical atomic and molecular data"
  - June 22-23 2015, IAEA Headquarters, Vienna, Austria
- CM on " Evaluation and Uncertainty Assessment for Be, C, Ne Atomic Data"
  - July 13-15 2015, IAEA Headquarters, Vienna, Austria
- TM on "International Code Centres Network on Simulation of PMI Data"
  - July 29-31 2015, IAEA Headquarters, Vienna, Austria
- 2nd RCM on "PWI for Irradiated Tungsten and Tungsten Alloys in Fusion Devices"
  - September 8-11 2015, Seoul National University, Seoul, Korea
- Joint IAEA-KAERI CM on " Recommended Data for Processes of Tungsten Ions"
  - September 14-16 2015, Korea Atomic Energy Research Institute, Daejeon, Korea
- TM on "Technical Aspects of A & M Data Processing and Exchange, 23rd Meeting of the A & M Data Centres Network"
  - November 2-4 2015, IAEA Headquarters, Vienna, Austria
- 1st RCM on "Plasma Interaction with Reduced-Activation Steel Surfaces in Fusion Devices"
  - December 9-11 2015, IAEA Headquarters, Vienna, Austria

# Meetings in 2016 (highlights)

<http://www-amdis.iaea.org/meetings/>

- 3rd RCM on Atomic and Molecular Data for Hydrogen and Helium in Fusion Plasma
  - 14-16 March 2016, IAEA Headquarters, Vienna, Austria
- CM on data evaluation for heavy particle collision processes; CM on processes of neutral beams in fusion plasma
  - 17-18 March 2016, IAEA Headquarters, Vienna, Austria
- 3rd RCM on Data for Erosion and Tritium Retention in Beryllium Plasma-Facing Materials
  - April/May/June 2016, IAEA Headquarters, Vienna, Austria
- Joint ICTP-CAS-IAEA School and Workshop on Plasma-Material Interaction in Fusion Devices
  - 18-22 July 2016, Hefei, China
- ?? TM on Uncertainty Assessment for calculated atomic, molecular and plasma-material interaction data
  - Oct-Nov 2016, IAEA Headquarters, Vienna, Austria
- ?? TM on benchmarking experimental and theoretical A+M collision data
  - Oct-Nov 2016, IAEA Headquarters, Vienna, Austria
- CM on recommended data for hydrogen and helium in fusion plasma
  - Q4 2016, IAEA Headquarters, Vienna, Austria
- CM on Data Exchange (XSAMS, etc.)
  - Q4 2016, IAEA Headquarters, Vienna, Austria
- 1st RCM on Data for Collision Processes related to Neutral Beams in Fusion Plasma
  - Q4 2016, maybe Q1 2017, IAEA Headquarters, Vienna, Austria



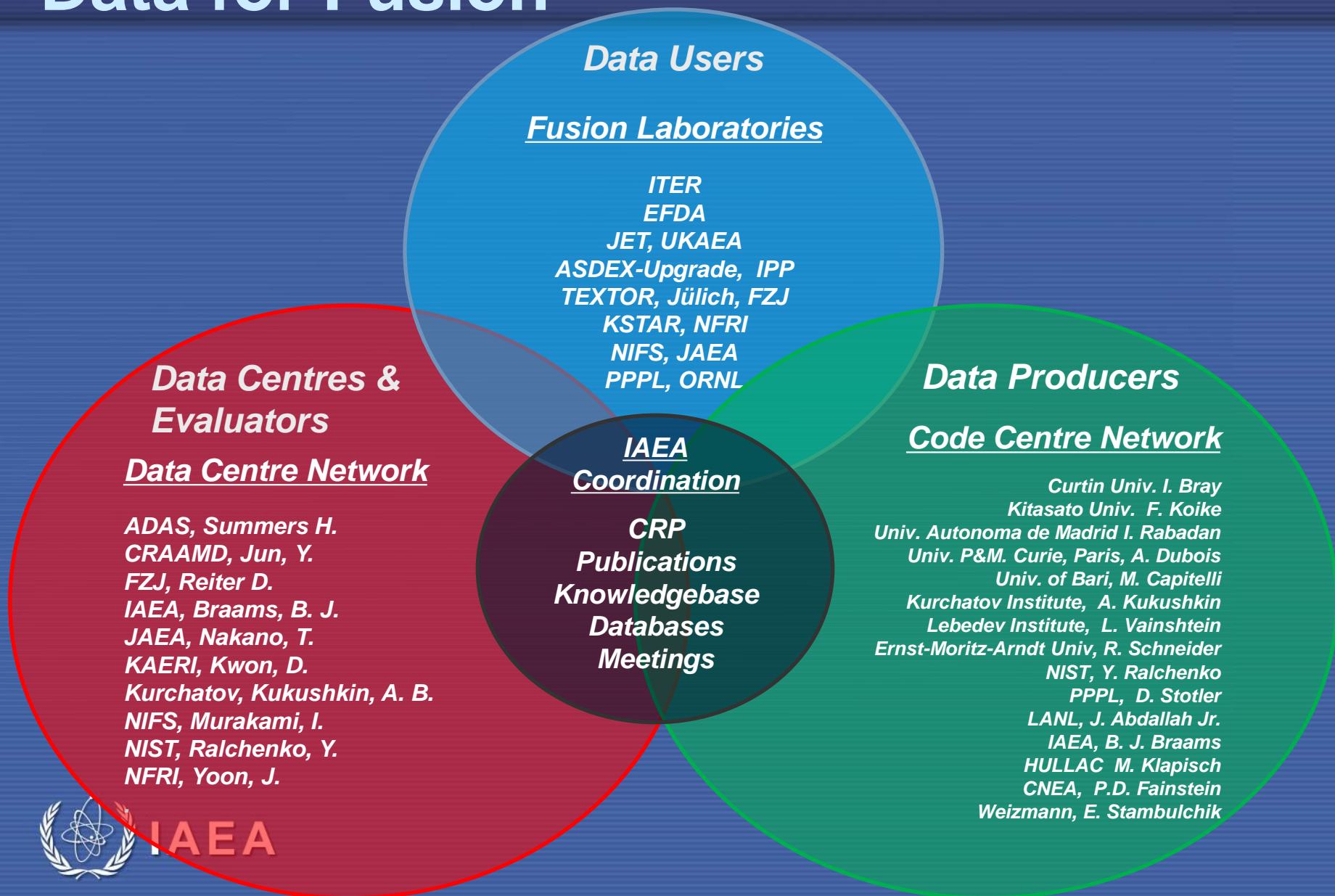
**IAEA**

# Publications

<http://www-amdis.iaea.org/publications/>

- IAEA-INDC(NDS) Reports (<http://www-nds.iaea.org/publications/>)
  - Reports are published for every meeting
- International Bulletin on Atomic and Molecular Data for Fusion
  - Bibliographic Information on Atomic, Molecular and Plasma-Surface Interaction Data
  - No publication since 2013
- Atomic and Plasma-Material Interaction data for Fusion (APID Series)
  - Data and papers related to results produced by CRPs and Consultants groups
  - All volumes are available on-line (<http://www-amdis.iaea.org/publications/APID/>)
  - Edition in preparation
    - Volume 17: CRP on “Atomic Data For Heavy Element Impurities in Fusion Reactors
    - Volume 18: CRP on “Light Element A & M and Radical Behaviour in the Divertor and Edge Plasma Regions”
    - Volume 19: CRP on “Spectroscopic and Collisional Data for Tungsten from 1 eV to 20 keV”
- Special issues at Atoms Journals
  - Critical Assessment of Theoretical Calculations of Atomic Structure and Transition Probabilities (2014)
  - Spectral Line Shapes in Plasmas Print Edition available (March 2014)
  - Atomic Data for Tungsten (July 2015)


# Network Collaboration for AM/PSI Data for Fusion



IAEA

# Atomic Molecular Data Information Services

<http://www-amdis.iaea.org>



International Atomic Energy Agency

## Atomic Molecular Data Services

Provided by the Nuclear Data Section

IAEA.org | NDS Mission | About Us

Search

Databases » AMBDAS | ALADDIN | OPEN-ADAS | GENIE On-line Computing » HEAVY | AAEXCITE | RATES | LANL Codes | FLYCHK | FAC Data

### Home

A&M Data Unit Home

### News

News  
Calendar

### Databases

Overview  
AMBDAS  
ALADDIN  
OPEN-ADAS  
GENIE  
KNOWLEDGE BASE

### On-Line Computing

Overview  
HEAVY  
AAEXCITE  
RATES  
LANL Codes  
FLYCHK  
FAC Data

### Activities

IFRC Subcommittee  
CRP  
Publications  
Meetings  
Workshops  
Data Centre Network  
Code Centre Network  
XSAMS

### Contacts

Links  
Contacts

## Atomic and Molecular Data Unit Activities

The Atomic and Molecular Data Unit operates within the Nuclear Data Section of the International Atomic Energy Agency, Vienna, Austria. The primary objective of the Atomic and Molecular Data Unit is to establish and maintain internationally recommended numerical databases on atomic and molecular collision and radiative processes, atomic and molecular structure characteristics, particle-solid surface interaction processes and physico-chemical and thermo-mechanical material properties for use in fusion energy research and other plasma science and technology applications.

- Databases on Atomic and Molecular Data for Fusion.

Atom, Molecule  
Plasma-Surface  
Data

ALADDIN  
Numerical  
Database

AMBDAS  
Bibliographic  
Database

GENIE  
Atomic Data  
Search Engine

OPEN ADAS  
Database  
Search

Rovibronic  
Energy levels  
Triplet D<sub>2</sub>

FC Factors &  
A-values of  
H<sub>2</sub> & Isotopes

- Online Computing Capabilities

Code  
Centres  
Portal

LANL  
Atomic  
Physics

FLYCHK  
Non-LTE  
Kinetics

Heavy  
Particles  
Collisions

Averaged  
e- Impact  
Cross-section

Effective  
e- Ionization  
Rates


ATOM-AKM  
e- Collision  
Data

- Knowledge Base for Atomic, Molecular and Plasma-Material Interaction Data for Fusion


Our Unit achieves its objectives by coordinating the activities of the International Atomic and Molecular Data Center Network (DCN) and Code Center Network (CCN), initiation and conducting international Coordinated Research Projects (CRP), organization of various types of Expert's Meetings, publication of technical reports on meetings and research activities and using other forms (research contracts, research agreements, consultancies) for stimulation of the generation, collection and critical assessment of the required atomic, molecular (A+M) and plasma-material interaction (PMI) data information.

The activity of Our Unit is supervised and biennially reviewed by the Subcommittee on Atomic and Molecular Data for Fusion of the International Fusion Research Council (IFRC A+M Subcommittee), an advisory body to the Agency's Director General.


#### IAEA Nuclear Data Section




IAEA-NDS  
Mission, Staff  
and more




Nuclear Data  
Services




Meetings  
Workshops




Newsletters




Coordinated  
Research  
Projects




Nuclear Reaction  
Data Center  
Network



Nuclear Structure  
& Decay Data  
Network



Technical Documents  
INDC Reports  
Publications



Computer  
Codes

### IAEA Meetings

Mar. 20-22, 2013  
3rd RCM of CRP on  
"Light Element Atom,  
Molecule and Radical  
Behaviour in the  
Divertor and Edge  
Plasma Regions"  
May 6-8, 2013  
Meeting of the Code  
Centre Network  
Jul 3-5, 2013  
2nd RCM of CRP on  
Atomic and  
Molecular Data for  
State-Resolved  
Modelling of  
Hydrogen and  
Helium and Their  
Isotopes in Fusion  
Plasma  
Sep 4-6, 2013  
22nd Meeting of the  
Atomic and  
Molecular Data  
Centres Network  
Nov, 2013  
1st RCM of CRP on  
Plasma-Wall

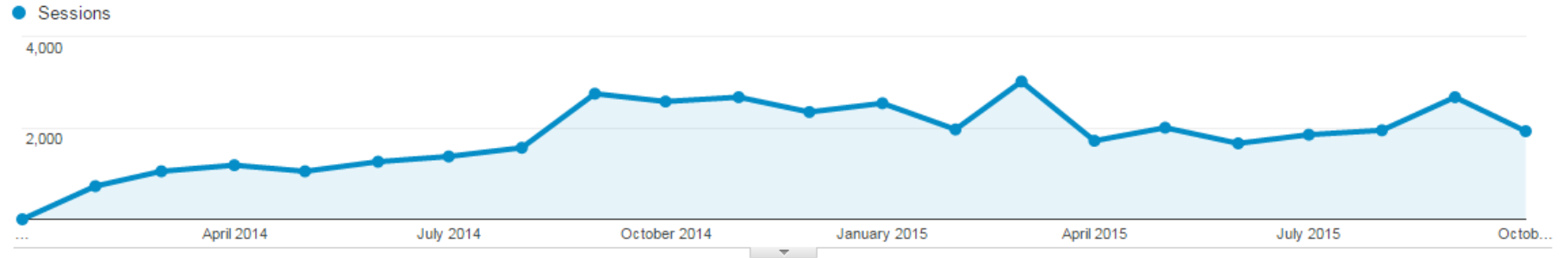
### AMO/PSI Meetings

August 5-9,  
2013: Atomic Spectra  
and Oscillator Strengths  
for Astrophysical and  
Laboratory Plasmas  
(ASOS-11), Mons,  
Belgium  
Sep 30- Oct 4,  
2013: 66th Annual  
Gaseous Electronics  
Conference  
Nov 4- 8, 2013: The 8th  
NLTE Code Comparison  
Workshop

© Copyright 2007-2013, International Atomic Energy Agency - Nuclear Data Section.  
Vienna International Centre, P.O. Box 100, A-1400 Vienna, Austria  
Telephone (+431) 2600-0. Facsimile (+431) 2600-7. E-mail: [online@iaeaand.iaea.org](mailto:online@iaeaand.iaea.org). Read our [Disclaimer](#)

Last Updated: 19-Jul-2013

# More than 2000 sessions per month after migration to cloud servers



Primary Dimension: Page path level 1

Plot Rows

Secondary dimension

Sort Type:

Default



advanced



	Page path level 1 ?	Sessions ?	Users ?	Pageviews ?	Pages / Session ?	Avg. Time on Page ?	Avg. Session Duration ?
		39,806 % of Total: 0.84% (4,759,971)	26,080 % of Total: 0.92% (2,838,814)	76,373 % of Total: 0.53% (14,343,912)	1.92 Avg for View: 3.01 (-36.33%)	00:02:04 Avg for View: 00:01:25 (45.71%)	00:01:56 Avg for View: 00:02:51 (-32.60%)
<input type="checkbox"/>	1. /w/	14,718 (36.97%)	12,087 (35.40%)	21,352 (27.96%)	1.45	00:02:43	00:01:19
<input type="checkbox"/>	2. /Workshops/	8,331 (20.93%)	5,338 (15.64%)	13,059 (17.10%)	1.57	00:03:04	00:01:39
<input type="checkbox"/>	3. /ALADDIN/	2,688 (6.75%)	1,964 (5.75%)	7,874 (10.31%)	2.93	00:01:26	00:02:42
<input type="checkbox"/>	4. /index.html	2,440 (6.13%)	2,307 (6.76%)	4,290 (5.62%)	1.76	00:01:12	00:03:38
<input type="checkbox"/>	5. /meetings/	2,173 (5.46%)	1,601 (4.69%)	4,766 (6.24%)	2.19	00:02:48	00:02:39
<input type="checkbox"/>	6. /CRP/	2,021 (5.08%)	1,697 (4.97%)	3,679 (4.82%)	1.82	00:02:44	00:02:05
<input type="checkbox"/>	7. /FLYCHK/	1,868 (4.69%)	1,449 (4.24%)	3,984 (5.22%)	2.13	00:01:49	00:02:12
<input type="checkbox"/>	8. /GENIE/	1,144 (2.87%)	972 (2.85%)	2,993 (3.92%)	2.62	00:02:11	00:03:13
<input type="checkbox"/>	9. /FAC/	1,049 (2.64%)	896 (2.62%)	3,298 (4.32%)	3.14	00:01:42	00:03:42
<input type="checkbox"/>	10. /AMBDAS/	686 (1.72%)	934 (2.74%)	1,735 (2.27%)	2.53	00:01:40	00:01:51

# Data Centre Network (DCN) Activities

<http://www-amdis.iaea.org/DCN>

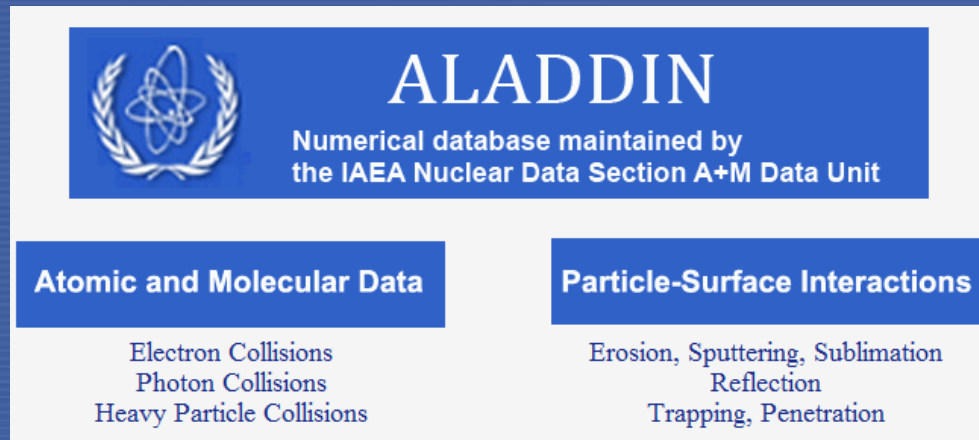
**Domain** : atomic and molecular (A+M), particle surface interaction (PSI) and bulk material properties (plasma-material interaction - PMI) data for fusion and other applications.

**Established Program**: Collection, Dissemination, Critical assessment (evaluation) and generation of A+M, PSI (PMI) data

- ALADDIN: Numerical database
- AMBDAS: Bibliographic database
- Dust Particle database
- GENIE: Search Engine
- XSAMS: XML Schema for A+M/PSI Data

# ALADDIN: Numerical Database

**Data Dissemination** <http://www-amdis.iaea.org/ALADDIN>



- Originally designed to host “evaluated and recommended” data only
- Currently a mix of evaluated data with CRP participants’ data
- Will host evaluated and recommended data
  - CM on " Evaluation and Uncertainty Assessment for Be, C, Ne Atomic Data"
  - Joint IAEA-KAERI CM on " Recommended Data for Processes of Tungsten Ions
- New Interface using GOOGLE free search forms is under development

# AMBDAS: Bibliographic database

**Data Dissemination** <http://www-amdis.iaea.org/AMBDAS>

- Data Sources
  - AM/PSI Data entries relevant to fusion
  - Spectroscopic data from NIST (A. Kramida & J. Fuhr)
  - NFRI, KAERI and IAEA collaboration for electron collisional data
  - Consultancies for plasma-material interaction data
- Data in the “International Bulletin on A & M Data for Fusion” available through AMBDAS
- New environment for bibliographical data collection
  - Web of Science
  - The SAO/NASA Astrophysics Data System

# Planned Databases: Dust particles

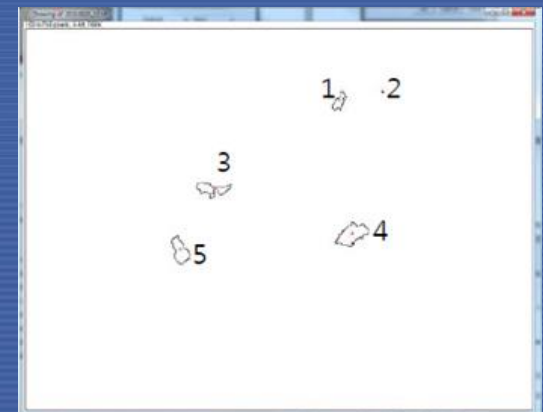
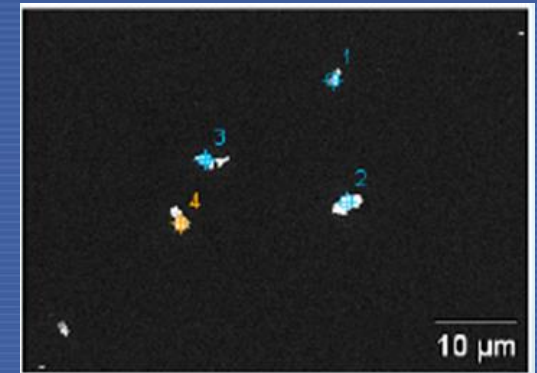
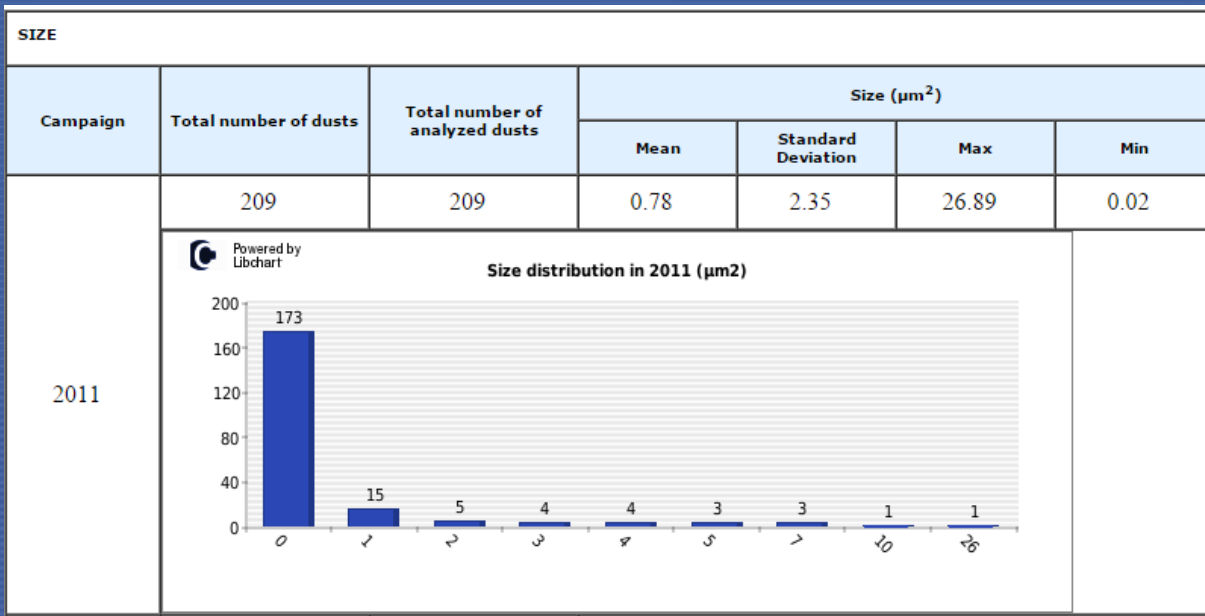
in collaboration with IPP-Garching and NFRI (Hong)

## Why dust database is important ?

- Radioactivity (ITER: 50 mSv =350 Kg W dusts)
- Chemical activity (hot surface)
- Fuel retention (ITER: 700g T in-vessel)
- Uncontrolled „pellet“ injection.
- Damage of in-vessel components

## Standardization

- Collection method
- Characterization method and settings
- Analysis tools and methods
- File upload and maintenance strategy



# GENIE: Web search engine for atomic data

**Data Exchange & Dissemination** <http://www-amdis.iaea.org/GENIE>

Radiative properties – search on 9 databases

Collisional databases – search on 6 databases

Will work on the GENIE statistics outputs for collaborators

## GENIE


A General Internet Search Engine for Atomic Data

### Transition Probabilities Wavelengths Energy Levels

Ion:

Enter wavelength in Å:  
From  to

<a href="#">NIST Atomic Spectra Database</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">Kurucz's CD-ROM 23</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">Atomic Line List v.2.04</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">TOPbase (Opacity Project)</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">Kelly Atomic Line Database</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">MCHF/MCDHF Collection</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">KAERI AMODS Spectral Lines</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">CAMBD Atomic Spectra</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">Spectr-W3</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>



### Electron Impact Cross Sections and/or Rate Coefficients

Ion:

☒ Excitation  
☐ Ionization  
☐ Dielectronic recombination

?

Cross sections ☒  
Rate coefficients ☒

<a href="#">IAEA ALADDIN Database</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">NIFS AMDIS Database</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">CAMBD Collisional Processes</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">NIST Atomic Cross Sections</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">OPEN-ADAS</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>
<a href="#">Spectr-W3</a>	<input checked="" type="checkbox"/>	<input style="background-color: yellow;" type="button" value="?"/>

# XSAMS: XML Schema for A+M/PSI Data

Data Exchange <http://www-amdis.iaea.org/xsams>

- Sep 2009: First release version 0.1 of the schema
- Mar 2010: XSAMS Meeting in NIFS, Japan
- Nov 2010: XSAMS Meeting at IAEA
- Jan 2011: Version 0.1.1 (bug fixes)  
Source forge project <http://sourceforge.net/projects/xsams/>
- Oct 2011: XSAMS Meeting at NIST
- Feb 2012: XSAMS Meeting with VAMDC, University of Vienna

VAMDC continues to develop XSAMS.

*Technical Discussions on XSAMS for DCN databases*

# Code Centre Network (CCN)

<http://www-amdis.iaea.org/CCN>

Joint effort to gather and provide access to any information relevant for modellers in fusion plasma science

## Purpose

To provide solutions to anyone willing AM/PSI data which can not be easily accessed on the web or which simply do not exist.

## Tools

- Online computing

- Downloadable codes

- Direct contacts with the CCN for any expertise

## IAEA Activities

- Organization of meetings and workshops for code developers

- Dissemination of community available codes and code results

- Online computing capabilities



# Code Centre Network (CCN) Meetings

<http://www-amdis.iaea.org/CCN>

- The 3<sup>rd</sup> CCN Meeting in May 2013:
  - Uncertainty estimates of theoretical atomic and molecular data
  - General approach to establish guidelines of uncertainty estimates
- The 4<sup>th</sup> CCN Meeting in July 2015:
  - Uncertainty estimates of plasma-material interaction data
  - Review the status of PMI codes :DFT, MD, KMC, Multi-scale modeling codes
- Code comparison workshops
  - Spectral Line Shapes in Plasmas Code Comparison Workshops (2012, 2013,2015)
  - Joint IAEA-ITAMP TM on Uncertainty Assessment for Theoretical Atomic and Molecular Scattering Data (July 2014)
  - Joint ICTP-IAEA Conference on Models and Data for Plasma-Material Interaction in Fusion Devices (November 2014)
  - Workshop on Uncertainty Quantification in Physics and Chemistry (May, 2015)

# IAEA Online Codes and Code Results

- **Average Approximation** <http://www-amdis.iaea.org/AAEXCITE/>
  - Electron impact excitation cross sections for any ion and configuration
- **Heavy particle collisions** <http://www-amdis.iaea.org/HEAVY/>
  - Excitation, ionization and charge exchange for bare nucleus on hydrogenic target
- **Effective Ionization/Recombination Rates** <http://www-amdis.iaea.org/RATES/>
  - Level population distributions and radiative power rates from CR modeling
- **LANL atomic data from CRP** <http://www-amdis.iaea.org/LANL/>
  - Si, Cl, Ar ions (~ 2 GB)
- **FAC atomic physics codes and atomic data** <http://www-amdis.iaea.org/FAC/>
  - He – Si atoms (~ 30 GB)
- **GRASP2K code distribution** <https://int-amdis.iaea.org/GRASP2K>
- **FLYCHK Collisional-Radiative code results** <http://www-amdis.iaea.org/FLYCHK>
  - Charge state distributions and radiative loss rates for  $Z=1-79$  for  $T_e=0.5$  eV- 100 keV

# Knowledge Base: Inputs only from IAEA

[page](#)[discussion](#)[view source](#)[history](#)

## Main Page

### Knowledge Base for Atomic, Molecular and Plasma-Material Interaction Data For Fusion

#### knowledge base

- [Main Page](#)
- [Data Needs](#)
- [Data Sources](#)
- [Data Exchange](#)
- [Special Topics](#)
- [Fusion Research](#)

#### navigation

- [IAEA AMD WEB](#)
- [IAEA CRP](#)
- [Community Forum](#)
- [Current events](#)
- [Recent changes](#)
- [Random page](#)
- [Help](#)

#### search

#### toolbox

- [What links here](#)
- [Related changes](#)
- [Special pages](#)
- [Printable version](#)
- [Permanent link](#)

## Introduction

Atomic, molecular and plasma-material interaction processes play an important role in the energy balance, confinement and stability of a thermonuclear plasma. The primary goal of this Knowledge base is to identify the **needs** in the atomic, molecular and plasma-surface interaction data sets for fusion research, both **magnetic** and **inertial confinement fusion studies**, to provide a direct link to the relevant **data sources** and present more information on the available data sets.

## Data Needs

### Magnetic Confinement Fusion

- [Introduction](#)
- [Spectroscopic Data](#)
- [Collisional Data for Edge Studies](#)
- [Collisional Data for Neutral-Beam Heating](#)
- [Radiative Plasma Cooling](#)
- [Plasma-Wall Interaction](#)
- [Material Properties](#)

#### Contents [\[hide\]](#)

- 1 [Introduction](#)
- 2 [Data Needs](#)
  - 2.1 [Magnetic Confinement Fusion](#)
  - 2.2 [Inertial Confinement Fusion](#)
  - 2.3 [Atomic Data](#)
  - 2.4 [Molecular Data](#)
  - 2.5 [Plasma-Material Interaction Data](#)
- 3 [Data Sources](#)
  - 3.1 [Online Databases](#)
  - 3.2 [Data Centers](#)
  - 3.3 [Code Centers](#)
- 4 [Data Exchange](#)
  - 4.1 [Data Producers Directory](#)
  - 4.2 [Data Requests](#)
  - 4.3 [Data Exchange Forum](#)
- 5 [Special Topics](#)
  - 5.1 [IAEA Coordinated Research Projects \(CRP\)](#)
  - 5.2 [IAEA Workshops](#)
  - 5.3 [NLTE Kinetics Code Comparison Workshops](#)
  - 5.4 [ITPA Diagnostics Group](#)
  - 5.5 [European Fusion Development Agreement \(EFDA\)](#)
- 6 [Fusion Research](#)
  - 6.1 [Magnetic Confinement Fusion Research](#)
  - 6.2 [Inertial Confinement Fusion Research](#)

# Issues for Technical Discussions

- Data Evaluation Activities
- Maintenance of Bibliographical Data on Collisional Processes
- Implementation of XSAMS and VAMDC node software
- Priority List of A+M/PSI data for Fusion
- Database development