



## Securing A Better Future For All **Nuclear Techniques for Global Development and Environmental Protection**

### Nuclear and Atomic Data

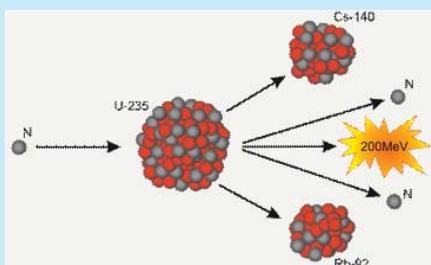
#### Providing Values for Science

The IAEA supports nuclear research activities in Member States by providing essential nuclear data and serving as the central agency for the collection and dissemination of data from laboratories worldwide. The EXFOR database contains a compilation of experimental reaction data from all around the world, and this effort — led by the IAEA — has been very well received, as it provides invaluable data for nuclear calculations and evaluations to researchers in Member States. ENSDF is a collection of evaluated data on the structure and decay properties of radioactive nuclides collected worldwide through a network coordinated by the IAEA.

The IAEA has also developed tools to allow users to visualize data, since visual presentation of data in the form of a plot makes them easier to understand and appreciate. Two important applications are available from the Nuclear Data Services web site: LiveChart interactively presents nuclide properties, and ZVView plots reaction cross-sections, both from evaluated files and from EXFOR, as 2-D or 3-D plots.

Concerted efforts by the IAEA include coordination of activities in Member States, such as EXFOR and ENSDF, coordinated research project (CRP) implementation, and also staff efforts, which have resulted in data libraries of immense value.

IBANDL and RIPL-3 are examples of two databases resulting from CRPs. IBANDL is a database of experimental and evaluated nuclear cross-sections relevant to ion beam analysis. RIPL-3 is a library of reference input parameters which are essential ingredients of theoretical modelling codes. By providing a complete set of verified parameters, it is ensured that evaluations carried out around the world are compatible and can be produced easily and efficiently.



Neutron induced fission reaction.

*“Nuclear data are fundamental to all nuclear research and innovation.”*

**Daud Mohamad**

Deputy Director General  
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All matter is made of atoms, meaning ‘indivisible’ in Greek. However, discoveries in physics have shown that each atom consists of a tiny but massive nucleus surrounded by electrons. While chemistry and atomic physics deal with electrons and changes in their states, nuclear physics deals with changes to the nucleus.

The nucleus contains neutrons and protons existing together in a dynamic equilibrium, and by impacting the nucleus with a particle such as a neutron, many types of reaction can be induced, leading to the formation of new nuclei and the fission or the emission of other particles. Often, the resulting nuclei are radioactive; such nuclear reactions are the basis for production of the artificial radionuclides which are used in nuclear applications.

Accurate nuclear data are essential for many technologies and applications, the most important being the production of nuclear energy: both nuclear fission, which is well established, as well as nuclear fusion, which is still in the research and development stage.

## Atomic Data: Supporting Fusion Technology

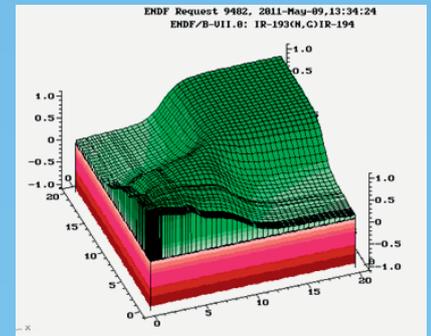
Fusion programmes all over the world rely heavily on atomic and molecular data, and although at present these data support research, with the construction of ITER the focus will switch towards the use of this technology for energy production. The same approach is followed for these data as for nuclear data, namely, the development of high quality data through CRPs and dissemination through web pages.

ALADDIN is the main database for numerical data covering collisions of electrons and heavy particles with atoms, ions and molecules, as well as for particle–surface interactions. The search engine GENIE provides a common query interface to many distinct databases for atomic processes. Bibliographic information for atomic processes can be found in the AMBDAS database.

The scope of atomic and molecular data is so large that an exciting new way of describing it has been implemented through the Knowledge Base for Atomic, Molecular and Plasma Material Interaction Data for Fusion, which is a ‘wiki’ based page that users can directly add to.

## Quick Facts

- The Medical Portal provides a unified view of medical applications, including databases, documents, libraries and ongoing projects. Links to diagnostic and therapeutic radioisotope production, heavy charged particle interactions and phase–space databases are only a mouse click away.
- Nuclear Data for Safeguards provides a handbook of relevant data, both as a downloadable report and in the form of individual data tables. In addition, a specially customized LiveChart application provides safeguards data interactively.
- Evaluated nuclear data libraries in ENDF format have been produced by many data centres throughout the world. Twenty-six of these libraries can be interrogated and cross-section data plotted. Experimental data from EXFOR can then be added to provide evaluation validation.
- Covariance data enable uncertainties in quantities to be calculated. When a physical quantity depends on several variables, then correlations between these variables are needed to provide an accurate estimate of uncertainty. The figure above right shows a typical 3-D plot.
- The EXFOR database covers about 19 000 experiments and contains about 11.5 million data points. Data have been compiled since 1935 and cover reactions induced by neutrons, charged particles and photons.
- Nuclear data are available by directly downloading or by requesting documents or other media such as DVDs and CDs.



A 3-D plot illustrating the correlations that exist between the various quantities involved in the description of a nuclear reaction. Such data are needed to provide uncertainty estimates in derived quantities.

## Nuclear Data: Fundamental for applications

Nuclear and atomic data are essential for many applications such as:

- Nuclear power (fission)
- Research reactors
- Nuclear fusion
- Medicine
- Non-destructive testing
- Environmental monitoring

## Database Glossary:

ALADDIN – Database of numerical atomic and molecular data

AMBDAS – Database of bibliographic references to atomic and molecular papers

ENDF – Format of evaluated nuclear data libraries, also the name of a set of evaluated data files

ENSDF – Database of nuclear structure and decay properties

EXFOR – Database of measured nuclear reaction data

IBANDL – Database of nuclear reaction data for ion beam analyses

RIPL – Database of parameters used in theoretical calculations

GENIE – Search engine for numerical data about atoms in plasma



The interactive LiveChart application that enables users to find the properties of nuclides, both stable and radioactive, is based on information from the ENSDF database.