JANIS: A New Software for Nuclear Data Services

A. NOURI[1,*], P. NAGEL[1], N. SOPPERA[2], A. AHITE[2], B. TATON[2], J. PATROUIX[2],
F. LECOMPAGNON[2], C. CUNIN[2], O. RIOLAND[2], L. D'EURVEILHER[2]

[1] *OECD Nuclear Energy Agency*

[2] *Aquitaine Electronique Informatique, France*

Janis (Java-based nuclear information software) is a display program designed to facilitate the visualisation and manipulation of nuclear data. Its objective is to allow the user of nuclear data to access numerical and graphical representations without prior knowledge of the storage format. It offers maximum flexibility for the comparison of different nuclear data sets. Features included in the first version are described and foreseen extensions are discussed which will allow the user to directly access centralised databases and to perform on-line processing of the data.

KEYWORDS: Nuclear data, Display software, Java technology

I. Introduction

Nuclear data are fundamental to all applications involving radioactive materials and nuclear fuels. The data concerned cover both the properties of radioactive nuclei and the elementary laws of nuclear interactions. Two important aspects are to be taken into account when providing nuclear data services to the user community:

- The volume of data is quite sizeable (several hundreds of Megabytes for a comprehensive library).
- There is a large variety of applications and end users of these data.

The first requirement calls for the utilisation of efficient means to store and to retrieve the data and for the definition of standardised formats to allow their exchange among users and their treatment with specialised computer codes. For instance, the Evaluated Nuclear Data File (ENDF) format provides a comprehensive way of representing nuclear data. Formats such as these, however, become too complex for a non-specialised user. Furthermore, cross-platform compatibility requires the formats to be based on textual representation of the data. It becomes difficult even for specialised users to check and handle the data contained in large files. Both experienced and non-specialised users would thus benefit from an easy and efficient access to the data without a prior knowledge of the storage format.

II. Background

The OECD Nuclear Energy Agency Data Bank is part of an international network of data centres in charge of the compilation and dissemination of basic nuclear data. Through its activities in the nuclear data field, the NEA plays a role that involves the participation in the production of data and the dissemination of these data through the services provided to nuclear data users. The NEA occupies a middle ground between nuclear data producers and users, providing an essential link between these two communities.

The NEA has accumulated experience in the development of user-friendly means for accessing and manipulating data. Two axes of developments were conducted and will be briefly discussed in this section.

Nuclear data display software installed on desktop computers offers flexibility in terms of the user interface. However, the user does not have access to the latest version of the data. JEF-PC is an example of such software. It was developed by the NEA in the early nineties through a collaboration with the University of Birmingham (UK), the Centre de Spectrométrie Nucléaire et Spectrométrie de Masse (Orsay, France) and the UK nuclear industry. Version 1.0 and 2.0 were released in 1994 and 1998 and were acquitted by more than 500 users. JEF-PC features include the display of evaluated and experimental cross-sections, radioactive decay data and fission yields.

The NEA has been using relational databases since 1993 to provide a centralised repository of data and has used web-based technology to allow interactive retrieval of the data. The NEA web site (www.nea.fr) offers interfaces to the main nuclear databases: EVA for evaluated data, CINDA for bibliographical information and EXFOR for experimental data. This latter also includes on-line plotting capabilities. By accessing centralised information, web users can benefit from up-to-date data, the drawbacks being that the graphical interface is less sophisticated and the user may be limited by the amount of data transferred.

Important feedback has been accumulated from the users of these two kinds of services. Suggestions for further developments of the JEF-PC program in order to add new features (possibilities for plotting angular and energy distributions, etc.) faced the problem of software architecture. In fact, JEF-PC was developed using Borland C++, which implies limitations in terms of compatibility on different operating systems and flexibility of the user interface. The key question was thus to foresee the extension of the services while taking advantage of both solutions: software and web-based services.

Investigations of different programming languages were carried out in 1998 and 1999 taking into account criteria

* Corresponding author, Tel. +33.1.45.24.10.84,
E-mail: nouri@nea.fr *or* janis@nea.fr

such as cross-platform portability, performances in terms of execution time and the possibility of having a dual usage as discussed above (software and web-based). Java technology offered the optimum choice, and a project was launched by the NEA to design a new software called JANIS (JAva Nuclear Information System) which would supersede JEF-PC in terms of features and portability while maintaining comparable performances in terms of execution time. This new software would also offer all the necessary connectivity to web services and centralised databases. The following section will describe the features of the current version of JANIS, which has already implemented the specifications of application-like software with some extensions to display data taken from web servers. The last section of this paper will discuss the foreseen developments, which include allowing to take full advantage of the server by having direct access to large databases and launching data processing that could be displayed locally, with all the flexibility of local applications.

III. JANIS features through examples

1. General features

JANIS can access data contained in comprehensive databases (typically all materials contained in an evaluation library) or in a single file (typically data for one nuclide either retrieved from centralised databases or obtained from data processing codes). The formats supported are: ENDF-6 (along with the linearised pointwise option PENDF and the groupwise option GENDF) and the computerised format derived from EXFOR. Data originating from the major evaluation files ENDF/B, JEF(F), JENDL, BROND… can be displayed and intercompared.

Various navigation tools are available for helping the user identify the nucleus of interest. **Figure 1** shows the “Chart of Nuclides” and the “Nuclide Explorer”. The properties of the selected nuclide are displayed using textual, graphical or tabular formats. Search capabilities are also included enabling to query the databases and to help the user identify nuclides that have specific characteristics.

2. Radioactive decay data

A summary of the important properties of radioactive nuclides is provided. This includes the masse of the nuclide, its excitation energy, the spin and parity, the half-life, the mean decay energies and decay modes. For each decay mode, the corresponding Q value, branching ratio and nuclide produced are given.

The decay path followed by a particular nuclide toward the stability (also called the decay chain) can be displayed (see **Fig. 2**). The chain is constructed from the data available in the library (half-life, decay modes, branching ratios). The decay path is produced in tabular and graphical format

Discrete and continuous spectra of emitted particles (gamma and X-rays, alpha particles, beta+ and beta-) are represented in JANIS using tabular and graphical formats. The information displayed includes the energy of the emitted particle and the corresponding uncertainty, relative and absolute line intensity and the associated errors.

3. Fission yield data

Fission yields give the proportion of nuclides produced by fission. Data exist as independent yields (yield directly produced by fission prior to delayed neutron, beta decay, etc.) and cumulative yields (which account for all decay branches after fission). JANIS displays these yields using tabular and graphical formats.

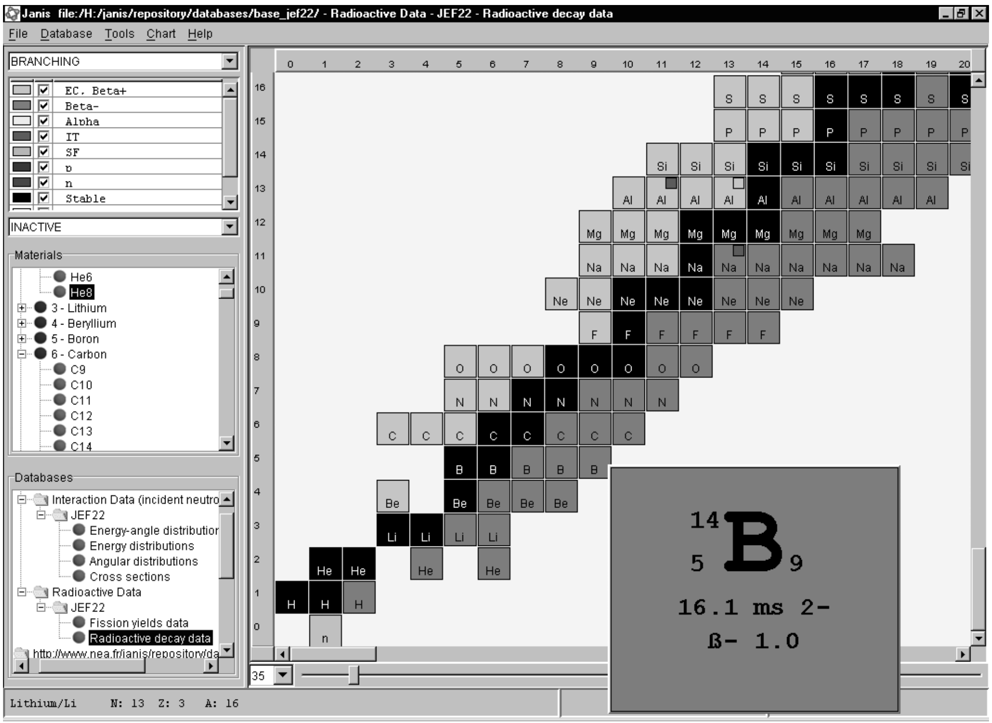

Fig. 1 Navigation tools

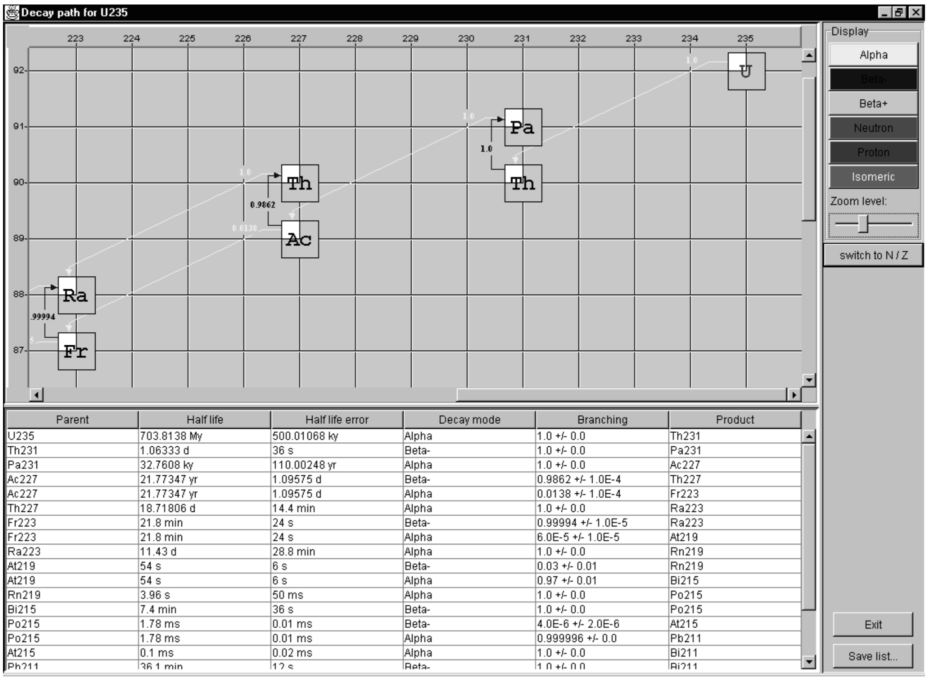

Fig. 2 Radioactive decay path

Fission yields depend on the energy of the neutron causing fission. Independent and cumulative yields are thus given for typical neutron spectra (thermal neutron-induced, fast neutron-induced and high-energy neutron-induced fission). Spontaneous fission yields are provided as well. An example of independent fission yields graph is given in **Fig. 3**.

Graphical examples are given in the figures included in this paper. JANIS was specially designed to offer flexibility for the comparison of different data sets. Various tools enabling data manipulation are provided, including simple operations with cross-sections (linear combination, product, and ratio), flux weighting…

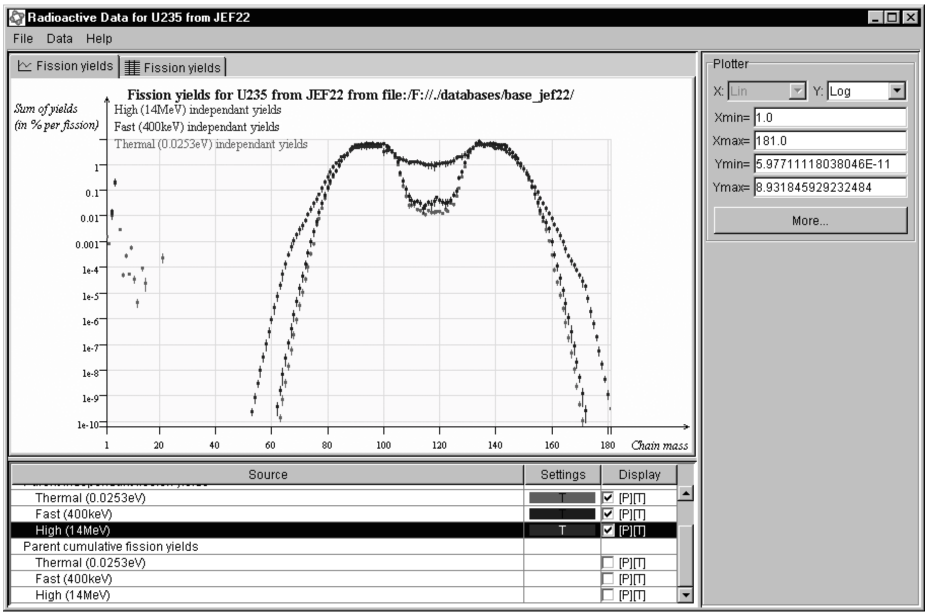

Fig. 3 Fission yield data

4. Interaction data

Data displayed in this category include cross-sections (pointwise and multi-group forms, see **Fig. 4**) and associated uncertainties, resonance parameters, energy distributions, angular distributions and correlated energy-angle distributions.

Fig. 5 presents a graphical display of $\eta = (\nu\, \sigma_f/\sigma_a)$ obtained from individual components in the ENDF file. Experimental data can be plotted as well, with advanced search options combining reaction identifiers, projectile energy range, laboratory and experiment date.

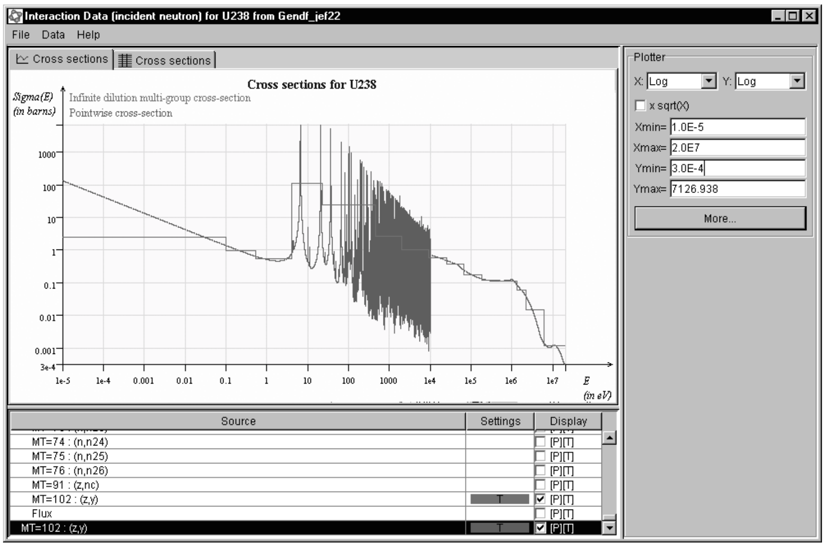

Fig. 4 Comparison of pointwise and multi-group cross-sections

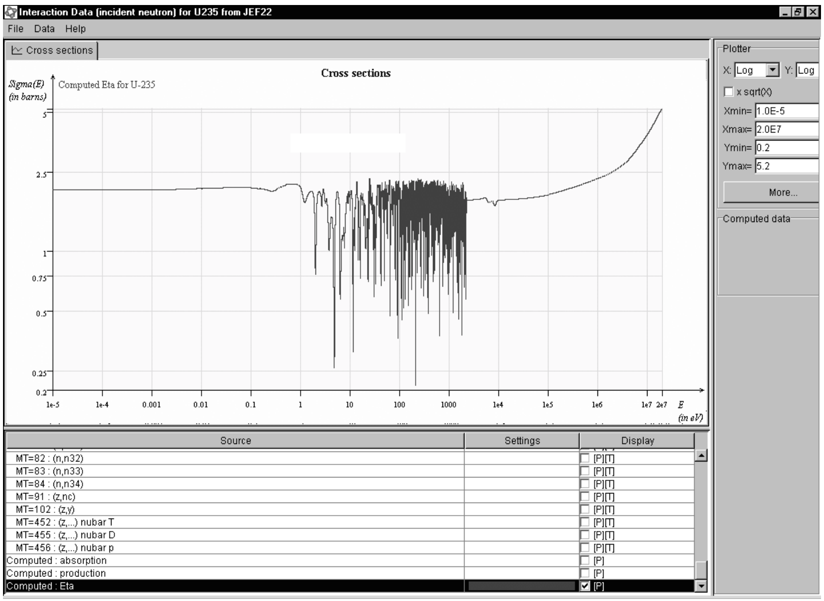

Fig. 5 Example of cross-section manipulation $\eta = (\nu\ \sigma_f/\sigma_a)$

IV. Future developments

The current version of JANIS can access data from local or network drives and from the web. Developments are ongoing for full linkage of JANIS with the relational databases available on the NEA web server using distributed computing technology. The same technology can be extended to provide the user with a package of services in integrated client/server architecture. For instance, the server side can be used for data retrieval and processing at the desired temperature and accuracy using the latest version of well-established tools. The user can then choose the information to be transferred on his local computer. Various options are under study aiming at optimising the amount and format of data to be transferred through the Internet. The client side will finally be used for the display and manipulation of data sets.

V. Conclusions

JANIS is meant to provide both specialised and non-specialised users with an easy and efficient access to nuclear data. The software is free of charge and can be downloaded directly from the NEA web site at the address: http://www.nea.fr/janis. Feedback can be posted on the web and updates automatically downloaded through the live-update feature.

The software runs on almost all operating systems and will enable users to access the latest versions of the data and associated tools through its integrated client/server architecture.

Prior to the official release, JANIS has been tested by more than one hundred users originating from more than 20 different countries who provided valuable feedback.