

(論文再録)

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### Proceedings of "International Conference on Nuclear Data for Science and Technology (ND2004)"

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#### Abstract

Two papers based on the talk from Japan Charged-Particle Nuclear Reaction Data Group (JCPRG) and published in the proceedings of "International Conference on Nuclear Data for Science and Technology (ND2004)" are reprinted.

ここに再録された2編の論文は2004年9月26日から10月1日にわたり、アメリカ合衆国ニューメキシコ州サンタフェにおいて開催された「科学技術のための核データ国際会議 (ND2004)」におけるポスター発表を行った内容に基づくものであり、いずれも、JCPRGにおける核データ利用支援ソフトウェアの開発に関するものである。それぞれ本会議の会議録に、

- Shigeyoshi Aoyama, Hiroshi Masui, Michimasa Ohkubo, Koji Arai, Yoshide Ohbayasi, Kiyoshi Kato, Masaki Chiba,  
"Development of Nuclear Reaction Data Retrieval System on IntelligentPad by JCPRG",  
Proceedings of the *International Conference on Nuclear Data for Science and Technology*, p.553-556.
- N. Otuka, M. Aikawa, T. Suda, K. Naito, S. Korennov, K. Arai, H. Noto, A. Ohnishi, K. Katō, T. Nakagawa, T. Fukahori, J. Katakura,  
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# Development of Nuclear Reaction Data Retrieval System on IntelligentPad by JCPRG

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**Abstract.** A newly designed retrieval system of nuclear reaction data is developed on the IntelligentPad architecture, which is called CONTIP. We designed the network-base retrieval system. The relational database is constructed on the UNIX server and the retrieval interface is constructed on the Windows PC. We applied it for NRDF and Exfor compilations as an application example.

## INTRODUCTION

JCPRG (Japan Charged Particle Reaction Group) has compiled the charged-particle nuclear reaction data since 1974, which is called NRDF (Nuclear Reaction Data File) [1]. The policy of accumulating data is that they are produced in Japan. The data are accumulated mainly from the experimental papers (over two thousand by now) with an original format. JCPRG is one of the centers in Nuclear Reaction Data Center Network; its data are exchanged to a so-called Exfor (EXchange FORmat). We have developed retrieval systems of the IntelligentPad version [2] and the CGI version [3]. The recent developments and applications of CGI are reported in ND2004 by Otsuka *et al.* [4]. In this paper, we report on a nuclear reaction data retrieval system on IntelligentPad (IP) architecture, which is called CONTIP. CONTIP is an abbreviation of “Creative, Cooperative and Cultural Objects for Nuclear data and tools on IntelligentPad.” Since needs for the charged-particle nuclear reaction data are increasing in various fields, we need a flexible interface for various types of users.

## INTELLIGENTPAD

The SQL server (the relational database) and the web sever (CGI interface) are constructed on the UNIX computer as schematically shown in Fig. 1. On the client Windows PC, the interface is given by using IntelligentPad (IP), which is explained below. The reason why we do not use the direct access to the SQL server but the CGI one is that we can also easily search for the data from web clients in addition to IP clients.

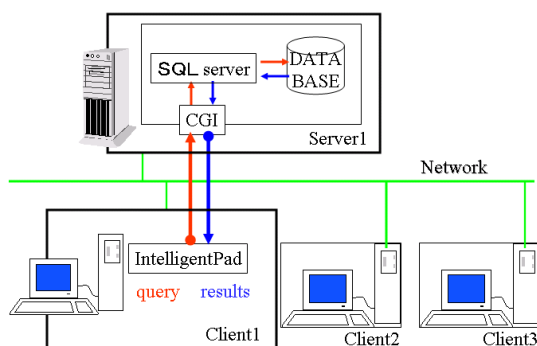


FIGURE 1. System design.

The IP architecture has been proposed by Tanaka [5] and developed at Hokkaido since 1987. In the IP architecture, pads and slots are important concepts. We can see a pile of the pads on the display of PC clients. A view of a pad in the IP resembles “a real paper pad.” And we can connect a pad with other pads with the so-called slots. The functions of slots are restricted so that the users become confused. The image for the pad connection is like the relation between a television (TV) and a video system as shown in Fig. 2. The TV and the video may have several slots and they can be connected with cords. If we do not want to confuse the users who want to connect the TV and the video, we can paint the same color on the slot of the TV and that of the video that should be connected each other. For example, we can paint the visual slot yellow, the left sound slot white, and the right sound slot red.

Here, we explain an application example of IP to the nuclear-reaction database. When we retrieve the data from the database, the nuclear-reaction data are represented as a data pad. Although the data pad has some information about the retrieval data, we cannot see any information only from the data pad. If we paste the text pad to the data pad and connect the slots having the keywords that we want to know, we can see the corresponding data. In Fig. 3, we paste three text view pads onto the data pad, and connect three slots; a bibliographical slot, a reaction slot, and a numerical data slot. We can see some bibliographical information from the upper text view pad, reaction information from middle one, and numerical data from the lower one. Furthermore, if we paste the graph view pad on the data pad and connect the numerical data slot, we can see the graphical data.

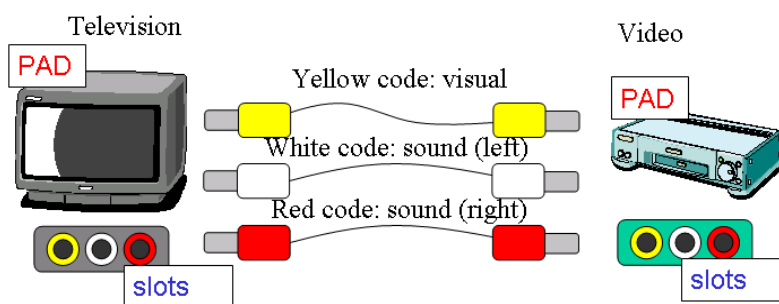


FIGURE 2. Image for pad and slot connections.

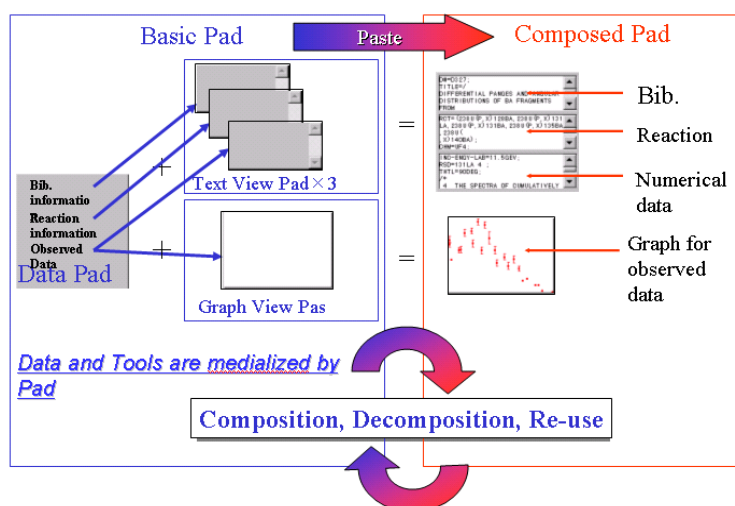


FIGURE 3. Application example of IP to a nuclear-reaction database.

## CONTIP

Here, we explain the CONTIP for NRDF. The NRDF database is composed the data files that are assigned a so-called D-number. In Fig. 4, we show the query pad, which is a composed pad. If we want to search the data for such as a  $^{238}\text{U}(p, X)$  reaction, we first select the NRDF server and input  $^{238}\text{U}$  to a text pad for the target and also  $p$  (for projectile), and push the query button pad. Then we can get the corresponding data, which are identified by D-number and the data number in the list. We then push the get pad button, and we get the data pad, which is explained in the previous section. As mentioned before, we can see some information such as biographical data, reaction data, and numerical data.

If we paste the data pad onto the graph generation pad, we can get a graph pad (the left one in Fig. 5). We can also get another graph pad (the right one in Fig. 5), for another data pad. When we drag the left graph pad and paste it on the graph base pad, we see the graphic data on the graph base pad. Furthermore, when we drag the right graph pad and paste it on the graph base pad, we see the graphs on the same graph basis pad. Then, we can compare the graphic data on the graphic base pad. The procedure of removing the graph is also similar: drag and drop. In this way, we can easily get the data from the database, and visually compare the data by developing the interface of the nuclear reaction database on the IP architecture.

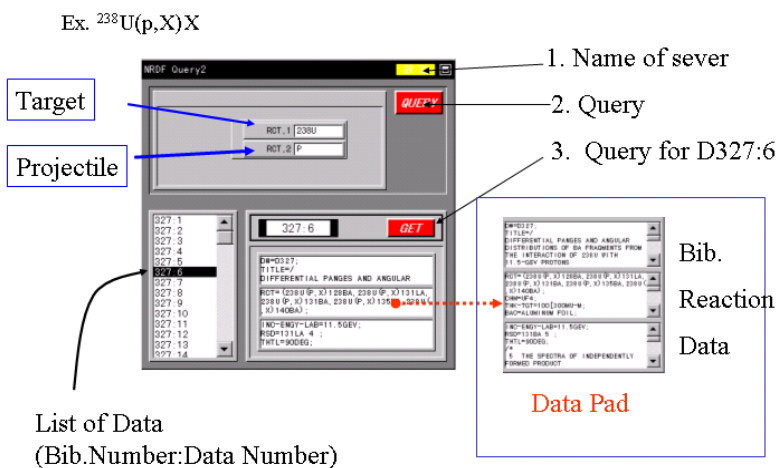


FIGURE 4. Query pad.

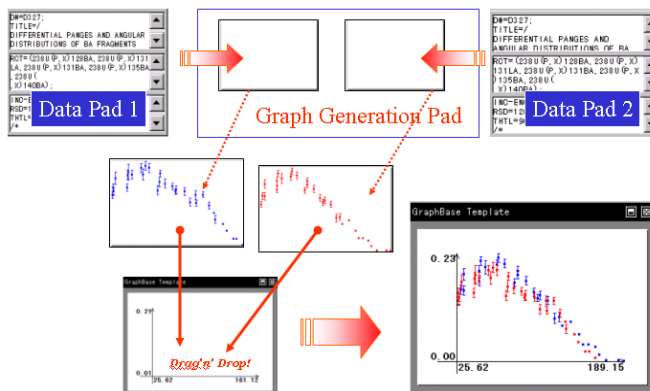


FIGURE 5. Graph base pad.

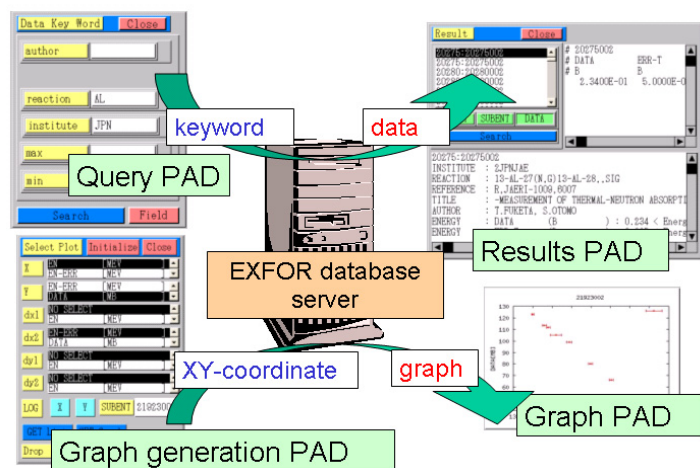


FIGURE 6. Overview of CONTIP for Exfor.

In Fig. 6, we show an overview of the CONTIP for EXFOR. The Exfor database is constructed on a UNIX server, which has tables corresponding to the entry section and the subentry section in the data file in the exchange format. Furthermore, we designed it having the intermediate table for keywords in order to shorten the retrieving time, e.g., reaction, author, etc. The left upper composite pad is a query pad. By using this, we can search the nuclear reaction data in the EXFOR database. The right upper composite pad is a results pad. And we can see some information about the retrieved data. Lower pads are a graph generation pad and a graph pad. We can see the numerical data by using these pads. We mentioned that several minor modifications are carried out from the NRDF one.

## SUMMARY

We have developed the retrieval system of nuclear-reaction data by using the IntelligentPad architecture, which is called CONTIP. We designed the network-base retrieval system. The relational database is constructed on the UNIX server and the retrieval interface is constructed on the Windows PC. We applied it for NRDF and Exfor compilations as an application example. We understand that the IP architecture works well for the nuclear reaction database. Then, we would like to suggest it for an interface of the nuclear-reaction database.

## ACKNOWLEDGMENTS

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# Web-Based Search and Plot System for Nuclear Reaction Data

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**Abstract.** A web-based search and plot system for nuclear reaction data has been developed, covering experimental data in EXFOR format and evaluated data in ENDF format. The system is implemented for Linux OS, with Perl and MySQL used for CGI scripts and the database manager, respectively. Two prototypes for experimental and evaluated data are presented.

## INTRODUCTION

Nuclear reaction data are characterized by sets of various independent variables. When a data set is requested, quantity type, incoming particle, target nucleus, incident energy, outgoing channel must be specified at least, and additional independent variables (e.g. excitation energy, angle) should be given for differential quantities, some of which are not given in traditional information exchange such as scientific papers in printed media due to the space limitation. This makes the electronic dissemination of the nuclear reaction data a very important part of the world-wide scientific research and technical progress.

In Japan, a study group “Information Processing in Nuclear Physics” has been formed in 1974. It had developed a system of compilation and utilization, named NRDF (Nuclear Reaction Data File), for charged-particle induced nuclear reaction data, which has more variety than the neutron data has. The successor of this group, JCPRG (Japan Charged-Particle Nuclear Reaction Data Group), has been working for the development of database system as well as of data compilation.

On the basis of experience obtained in the activity of the group, we are working for a project to develop a new retrieval and plot system for experimental and evaluated nuclear data libraries, which will be a part of an integral nuclear-data utilization system [1] as a part of the project “Fundamental Research and Development on Nuclear Data for Innovative Reactors using Advanced

Radiation Measurement Technology” [2] conducted by the Ministry of Education, Culture, Sports, Science and Technology of Japan. Similar efforts are now in progress at other centers [3].

In this paper, we first briefly introduce the NRDF system – the basis of our research and development, – then explain two prototypes developed in the current project, and finally outline the future of this project.

## NRDF SYSTEM AND DARPE

JCPRG, a member of Nuclear Reaction Data Center network [7] organized by IAEA, has compiled the charged-particle induced nuclear reaction data into NRDF format and converted them to EXFOR format [4]. So far we have compiled more than 1500 publications in NRDF format, over 300 of them have been converted to EXFOR format.

The first NRDF database has been developed on a medium scale computer in collaboration with Hokkaido University Computing Center since 1980 [5]. It was released in 1983, with various functions, e.g. grammatical check, dictionary manager, graph digitization, added later. In addition, NTX, an NRDF-to-EXFOR translation system, was developed [6] to fulfill the responsibility of JCPRG as a member center of NRDC.

As computer technologies and network environment progressed, this system with its architecture went out of date. JCPRG planned to replace the mainframe of NRDF system, and has developed various new systems for retrieving and plotting NRDF data in the second half of 1990s [8].

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**FIGURE 1.** DARPE: Front page to submit keywords (available from JCPRG home page <http://www.jcprg.org/>.)

One of the new systems is a stand-alone utility without a network connection, named CONTIP [10]. It is implemented on IntelligentPad architecture, which is an object-oriented system construction toolkit with an excellent Graphical User Interface (GUI) environment, and has been developed by Meme Media Laboratory of Hokkaido University [9]. Construction of nuclear data utilities based on IntelligentPad is now in progress [11].

Another, web-based, type of tools has been developed since 1996 [12, 13], and in 2003 DARPE (Data Retrieving and Plotting Engine) [14] was released (Fig. 1). This system enables us to retrieve Japanese charged-particle reaction data stored into NRDF system by the following keywords: projectile, target, incident energy, quantity, author, journal and publication year. The system searches for data by using index files which are text files extracted from NRDF source files. These index files are sequentially scanned by a Perl script; there is no database manager as such. DARPE lists the query results in a table: the data ID is followed by bibliography, reaction and physical quantity. Several data sets selected from the table can be superimposed in one plot as long as selected data sets have common data headings applicable to x- and y-axes.

JCPRG aims to convert Japanese charged-particle reaction data to EXFOR, but some data can be distributed

only by NRDF because: i) NRDF has a very flexible format and can cover a wider range of nuclear reaction data; ii) some old data are still in the process of conversion; iii) a part of new data, which are converted to EXFOR files from NRDF files, are being reviewed by the members of NRDC network (i.e. not entered into various EXFOR systems maintained by centers). Therefore it is worth to maintain both NRDF and EXFOR files for world-wide service of Japanese experimental data.

## PROTOTYPES OF THE NEW SYSTEM

Having gained some experience with web-based NRDF, we have started to develop a new utility system in 2002. It processes both evaluated and experimental data, thus some new aspects should be considered: i) the new system is designed to cover both experimental data in EXFOR format and evaluated data in ENDF-6 format [15] in a unified way, with both code schemes accepted; ii) EXFOR is much richer (about 3 million records) than NRDF (about 0.03 million records), and therefore a database manager (e.g. MySQL, PostgreSQL) is deemed to be necessary for the search of EXFOR data; iii) special features of evaluated data library, e.g. various notations of same quantity (tabulated data and fitting coefficient etc.), interpolation technique and so on have to be accounted for.

At this stage, two different systems for experimental data and for evaluated data are being developed separately. In the following section we report the current status of these systems.

### Prototype for EXFOR Format - SPES

SPES (Search and Plot Executive System) is a prototype of search and plot system for experimental data library, EXFOR. In this system EXFOR records are reformatted to Comma Separated Value (CSV) files by system identifiers (title, author, etc.), then the CSV files are loaded into the database tables managed by MySQL (this takes several minutes). Once the MySQL database is updated, EXFOR data can be rapidly accessed. MySQL architecture makes it possible to use any EXFOR code as a search keyword. At present, some typical keyword with respect to reaction, quantity, bibliography are selected as search keys. Front page of SPES is shown in Fig. 2.

An example of search result for  $^{12}\text{C}(p,inel)$  is shown in Fig. 3, where subentry number, reaction, first author and reference listed for each data set are tabulated. Data sets can be selected for plotting by marking the checkboxes. We obtain the plot in image files and find links to the graph in other formats (postscript, pdf) as shown in

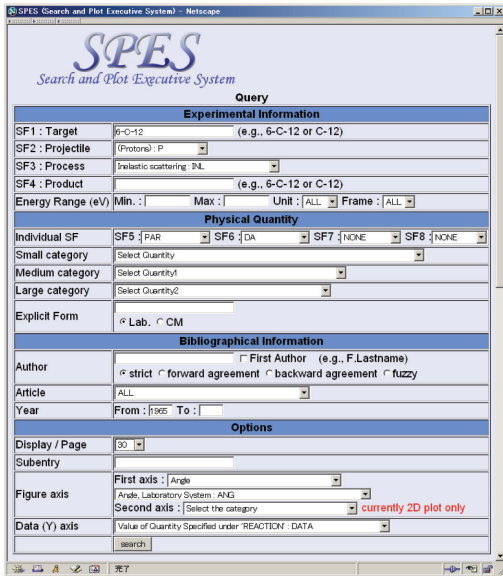


FIGURE 2. SPES: Front page to submit keywords.

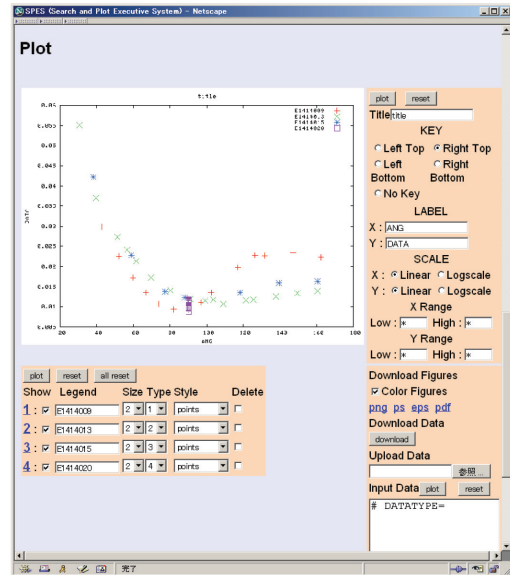


FIGURE 4. SPES: An example of data plot.

Fig. 4. Forms at the right and bottom side on this page are for further customizations (e.g. range, label, line type). The user's data can also be superimposed with the obtained EXFOR data. The SQL format is useful for other purposes as well; for example, validity of "keyword-value" pairs for all entries in EXFOR can be checked in a short time.

The screenshot shows the SPES search result page. It displays a table of search results with the following columns: subentry, reaction, first author, and reference. The table contains 20 rows of results, each with a checkbox in the subentry column.

subentry	reaction	first author	reference
<input type="checkbox"/> E1414009	(6-C-12)(P,INL)6-C-12,PAR,DA	S.KOBAYASHI	J,JP,J,29,1,1970
<input type="checkbox"/> E1414011	(6-C-12)(P,INL)6-C-12,PAR,DA	S.KOBAYASHI	J,JP,J,29,1,1970
<input type="checkbox"/> E1414013	(6-C-12)(P,INL)6-C-12,PAR,DA	S.KOBAYASHI	J,JP,J,29,1,1970
<input type="checkbox"/> E1414015	(6-C-12)(P,INL)6-C-12,PAR,DA	S.KOBAYASHI	J,JP,J,29,1,1970
<input type="checkbox"/> E1414017	(6-C-12)(P,INL)6-C-12,PAR,DA	S.KOBAYASHI	J,JP,J,29,1,1970
<input type="checkbox"/> E1414020	(6-C-12)(P,INL)6-C-12,PAR,DA	S.KOBAYASHI	J,JP,J,29,1,1970
<input type="checkbox"/> E1414022	(6-C-12)(P,INL)6-C-12,PAR,DA	S.KOBAYASHI	J,JP,J,29,1,1970
<input type="checkbox"/> A0191005	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	C.ROLFS	J,NP,A,227,291,1974
<input type="checkbox"/> Q0210004	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	J.MCCLIMMERSON	J,NP,77,305,66
<input type="checkbox"/> Q0210006	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	J.MCCLIMMERSON	J,NP,77,305,66
<input type="checkbox"/> Q0210008	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	J.MCCLIMMERSON	J,NP,77,305,66
<input type="checkbox"/> Q0210010	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	J.MCCLIMMERSON	J,NP,77,305,66
<input type="checkbox"/> Q0215025	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65
<input type="checkbox"/> Q0215026	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65
<input type="checkbox"/> Q0215027	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65
<input type="checkbox"/> Q0215028	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65
<input type="checkbox"/> Q0215029	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65
<input type="checkbox"/> Q0215030	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65
<input type="checkbox"/> Q0215031	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65
<input type="checkbox"/> Q0215032	(6-C-12)(P,INL)6-C-12,PAR,DA...EXP	D.HASSELGREN	J,NP,69,81,65

FIGURE 3. SPES: An example of search result.

### Prototype for ENDF-6 Format - SPES-J

SPES-J (Search and Plot Executive System for JENDL) is a prototype of search and plot system for evaluated data libraries. JENDL-3.3 [16] is stored to this prototype as an example of evaluated data. The front page of SPES-J is shown in Fig. 5. We can search the evaluated data with specified target, reaction and quantity, for which resonance parameter, reaction cross section and angular distribution are in the present scope of this prototype. Implementation of other quantities such as energy distribution and angle-energy distribution is in progress. Evaluated data are stored in the form of text files. The system retrieves the requested data by sequential scanning these text files directly. Fig. 6 gives an example of results, where cross sections of  $^{233}\text{U}(n,\text{tot})$  and  $^{233}\text{U}(n,\text{el})$  are shown. Links to tabulated



FIGURE 5. SPES-J: Front page to submit keywords.

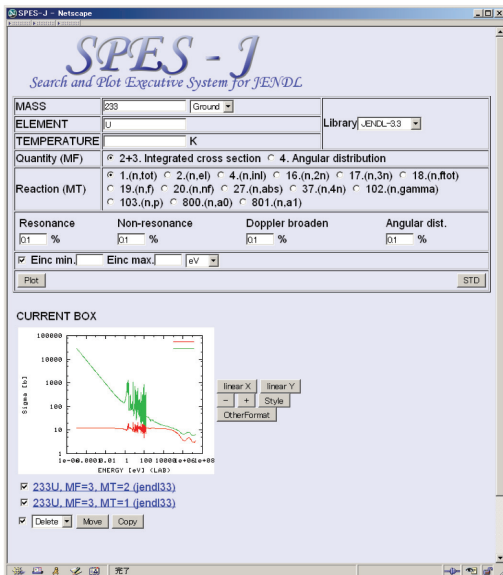


FIGURE 6. SPES-J: An example of data plot.

data files in two columns format are also available. After getting one plot, we can add or delete reactions and plot again. In future, in addition to the extension of quantity types mentioned above, we will add some options for data procession (e.g. Doppler correction for finite temperature, allowable errors for interpolation) by installing ENDF/B pre-processing codes like PREPRO 2002 [17].

Although now this system works only for JENDL-3.3, other libraries in ENDF-6 format can be added easily.

## SUMMARY

We have developed two prototypes of search and plotting systems, SPES and SPES-J for experimental data library (EXFOR) and evaluated library (JENDL-3.3) on the basis of NRDF retrieval and plotter system, DARPE. These two systems will be unified to make it possible to search and plot both experimental and evaluated data simultaneously and from a single web page. This project will be completed in March 2006.

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