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 worldwide 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].
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 $^{12}\text{C}(p,\text{inel})$ 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...
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.

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 $^{233}\text{U}(\text{n,tot})$ and $^{233}\text{U}(\text{n,el})$ are shown. Links to tabulated
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.

**REFERENCES**