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Exploratory Study of Nuclear Reaction Data Utility Framework of Japan Charged Particle Reaction Data Group (JCPRG)

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Compilation, evaluation and dissemination are essential pieces of work for the nuclear data activities. We, Japan charged particle data group, have researched the utility framework for the nuclear reaction data on the basis of recent progress of computer and network technologies. These technologies will be not only for the data dissemination but for the compilation and evaluation assistance among the many corresponding researchers of all over the world. In this paper, current progress of our research and development is shown.

KEYWORDS: Nuclear reaction data, database retrieval system, NRDC, JCPRG, NRDF, EXFOR, IntelligentPad, SQL, Meme Media, information sharing

I. Introduction

Nuclear data activity is one of the most important bases for the application of nuclear science and engineering. As a result of these continuous activities, the utilization of nuclear data is expanding from nuclear engineering and nuclear physics to wider related fields. For these activities, compilation, evaluation and dissemination are essential pieces of the work. In order to develop these activities, it is necessary to be achieved that experimental and theoretical researchers of nuclear physics and engineering are strongly cooperated. Thus nuclear data centers of the international network have engaged in supporting and promoting these activities.

For every purpose of data use, the amount of data becomes larger year by year, and the contents of data will be more complex. Therefore, it can be said that strong cooperation among the corresponding researchers and effective framework of data management should be taken into account more than before. However, since each researcher actually spreads all over the world, we should solve the problem of actual distance among the researchers. Therefore, with much support of computers and their networks, development of utility systems for nuclear data is an important subject. In recent years, development of computer technologies, infrastructures and software architectures enables us to support and expand utilization of the nuclear data among many researchers. Indeed, the real issue is how to organize the system which extends our research activities.

For the above background, Japan Charged Particle Reaction Data Group (JCPRG)[1)] has researched a nuclear data utility framework. In this paper, a brief introduction of JCPRG and current progress of our research and developments are shown.

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II. JCPRG -Japan Charged Particle Reaction Data Group -

JCPRG has compiled charged particle nuclear reaction data (CPND) for more than 20 years. For the CPND, many kinds of new quantities have been measured along with the progress of experimental techniques and research interests. Thus the description rules of CPND should be adapted to such the new kind of quantities. Therefore, we defined a flexible format for the data description, which is called Nuclear Reaction Data File (NRDF), and has compiled the experimental information from the experimental papers.

For the purpose of international exchange of experimental nuclear reaction data, international nuclear reaction data exchange format (EXFOR) compilation is used as a de facto standard.[2)] JCPRG also belongs to Nuclear Reaction Data Center Network,[3)] and mainly has managed to compile the domestic CPND. Parts of NRDF data are translated into EXFOR, and then we have contributed to EXFOR compilation.[4)]

Although such the compilation is a major objective of JCPRG activity, we also have tried to develop a utility framework for the nuclear data community. There are several issues which motivate us for such the development. For one thing, we would like to mention that recent development of computer technologies has vast potential for the expansion of the effective use of nuclear data. Moreover, the compilation activity is inseparably related to dissemination of data. Thus, we started to develop a data search system for the NRDF. In the following sections, through the brief introduction of our system development, we discuss the issue how we can manage the nuclear data effectively.

III. System Development

Until now, we have researched three major projects: i) data retrieval system, ii) data entry system, and iii) Media-based data utility framework. In this section, the purposes of these projects and current progress are shown.

1. Data Retrieval System Development

We have developed a WWW-based data search system.[5] The present system is implemented by using "Perl" script. Perl script is suitable to develop this kind of system and has portability to other servers, which support a CGI of the Perl script.

For the data retrieval system, data visualization and keyword translation features are useful for the users. Because it is inconvenient to understand the meaning of data by displaying bare nuclear data code directly in order to understand the meaning of data. Some specific keywords may prevent readability, and it may be difficult to understand the numerical data table just by looking at the text style.

The data search system is opened on the following address:

http://nrdf.meme.hokudai.ac.jp/tools/nrdf_search.html

In **Fig. 1**, snapshots of the system are shown. Features of this system are: i) easy operations using friendly interface of a Web browser, ii) graphically data visualization with information about the experiment and x- and y-axes, iii)simpleness in the implementation of the system, and iv) platform-free for users.

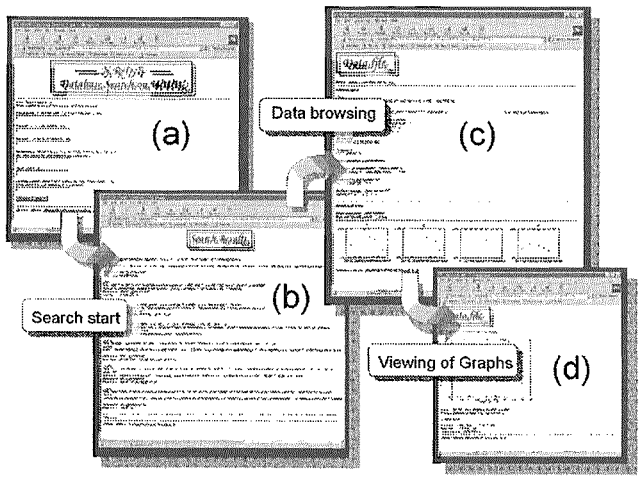

Fig. 1 Snapshots of NRDF data search on the Web.

2. Data Entry System -Data Compilation Assistance -

At present stage, we have accumulated charged-particle nuclear reaction data from published papers, and this compilation has been done by reading the papers. However, such a process of the compilation may cause some mistakes due to misreading of the compiler. As concerns these compilation activities, there are some difficulties to keep relationship closer between data compilers and experimentalists. It is ideal that numerical experimental data are directly given from experimentalists to compilers. However, it is not straightforward to obtain them, and actually the compilers have often read data from the figures of papers. Something new system of the compilers-experimentalists communication is strongly necessary for the effective compilation activities. Therefore, we have developed a new data entry system on the Web which enables us to accumulate the nuclear reaction data directly from the researcher of the experiment with the assistance of Internet.

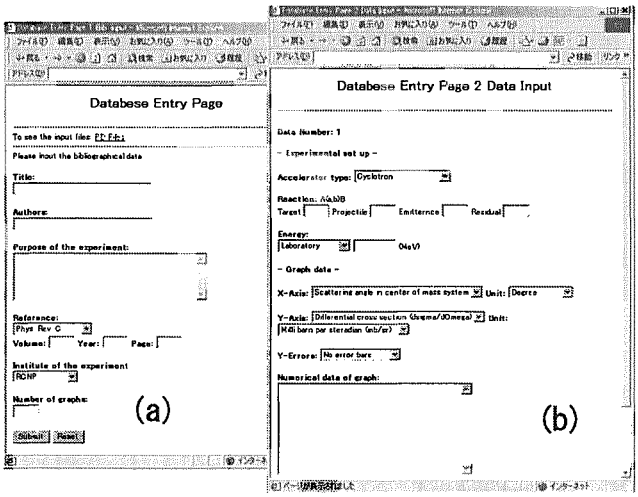

Fig. 2 Snapshots of a trial data entry utility on the Web.

Here, we have shown a trial version of the data entry system.[5] First of all, the title, the authors and the purpose of the experiment is to be input as a free text, as shown in **Fig. 2 (a)**. Next, to avoid careless mistakes concerned the reference and the institute of the experiments, they are chosen from each pull-down menu. Finally, we count the number of graphs to be compiled and input it. According to the number of graphs input, the graph-data input form will be provided, as shown in **Fig. 2 (b)**. In this form, we input the information of the experiment, i.e. an accelerator type, a reaction type, an incident energy, attributes of x- and y-axes, and numerical values of the graph, using pull-down menus and free text-boxes. The NRDF formatted cord is automatically generated, and the input data is linked to the data-browsing page, hence we can see and confirm the input data with graphical views.

3. CONTIP - Media Based Nuclear Data Utility Framework -

We have developed a new type of nuclear data retrieval system, in which NRDF is applied as an example. To get benefits from recent computer and network technologies, we adopt the IntelligentPad architecture[6] as a framework of the present system. This software architecture has many useful features for handling multimedia, media-based system construction, and graphical user interface. We call the present system CONTIP, which is an abbreviation of "Creative, Cooperative and Cultural Objects for Nuclear data and Tools on IntelligentPad". For the practical use, development of the system is in pursuit.[7,8]

The IntelligentPad architecture has been proposed and developed at Hokkaido University since 1987.[6] The development was started as making somewhat object-oriented system construction toolkit that is based on the graphical user inter-

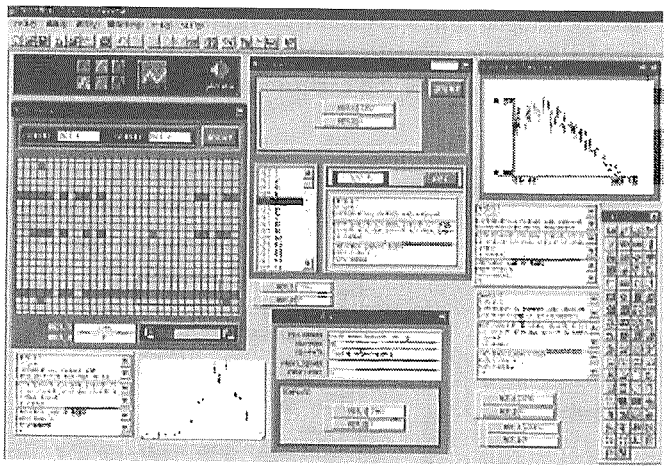

Fig. 3 Overview of CONTIP.

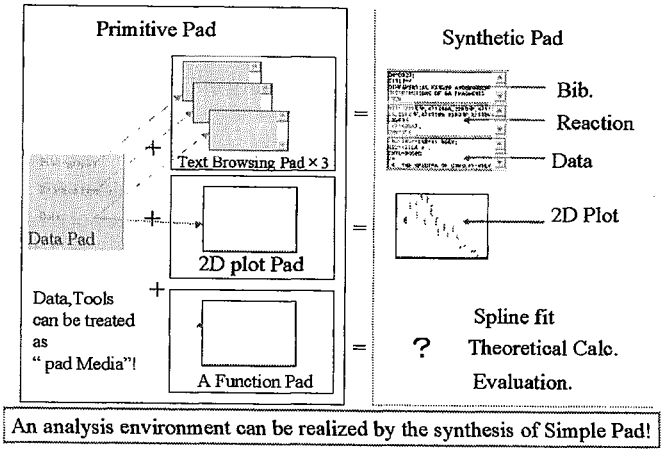

Fig. 4 Synthetic feature of IntelligentPad.

face (GUI). A pad in the IntelligentPad can be treated as an object of GUI, like a view of "real paper pad", and each pad has functions such as data control programs, input/output devices between other pads, and so on. On this environment, programming of tools can be carried out by intuitively operation of pads. In addition, through the research and the development of the IntelligentPad, fundamental prospect and directivity of this architecture is being clarified: the IntelligentPad is not only a specific software package, but also the fundamental environment architecture to support the effective utilization of academic resources. It is called the Meme media architecture.

We have constructed this CONTIP client on the MS-Windows-based IntelligentPad. **Fig. 3** shows the overall appearance of CONTIP for the NRDF data retrieval system. On this system, each utility component is constructed as a composition of primitive pads. For example, database proxy pad is used for the connection to the database server. We construct "Data navigation pad" and "Data retrieval pad" composing the database proxy pad and other primitive pads(See **Fig. 4**). For example, through the data retrieval operations, the data pad holds the code of data, and shows it using a text-browsing pad. Data pads are also used for visualization as shown in **Fig. 5**. Once you drag a data pad into a 2D data plot pad, you can see the graph representation of the data. Data comparison is also achieved by just a drag and drop operation of data plot pads into the graph base pad. The other functions which had experimentally developed are shown in Ref 7).

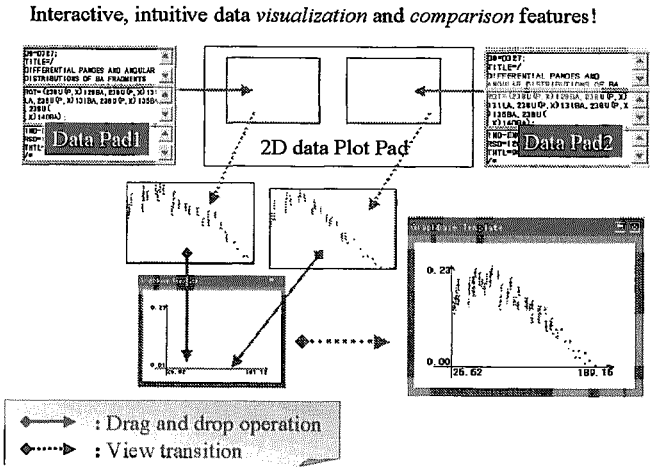

Fig. 5 Data visualization is done by drag and drop operations.

IV. Nuclear Data Market Framework

As shown in the previous section, we have researched and developed several types of utilities for nuclear reaction data. On the other hand, it can be said that it is the most important issue of our research to clarify effective application of utility framework for nuclear data activities. For the effective utilization of nuclear data, seamless linkages between measured experimental data and its application is important. Considering these linkages, it is essential to link accumulation, evaluation and distribution on the same framework. In addition, there are interdependences among them: evaluation of accumulated data, distribution of evaluated data, and re-accumulation of evaluated data. Therefore, we should consider constructing the framework to achieve this continuous cycle. We discuss the key concepts for our research and development.

Concerning the compilation assistance utilities, even if the nuclear database literacy is complicated and difficult to learn for beginners, the development is promising for a help of the database coding operation. Furthermore, if it will be easy to do such the operation by the experimentalists, it is expected that the current compilers works will expand with many supports of experimentalists. Therefore, this development is important to keep strong relationship between compilers and experimentalists.

If we assume that the efficient compilation is achieved by using the above utilities, elementally experimental data is successfully stored into a kind of "elementary" database. Then it will be possible to extract evaluated data from that database, which is something like an "Information Pool". Neverthe-

less, no such useful framework is sufficiently established in the nuclear data community. In order to advocate an ideal framework for such the purposes, such as in **Fig. 6**, we have developed a utility system by using the Meme Media architecture[2].

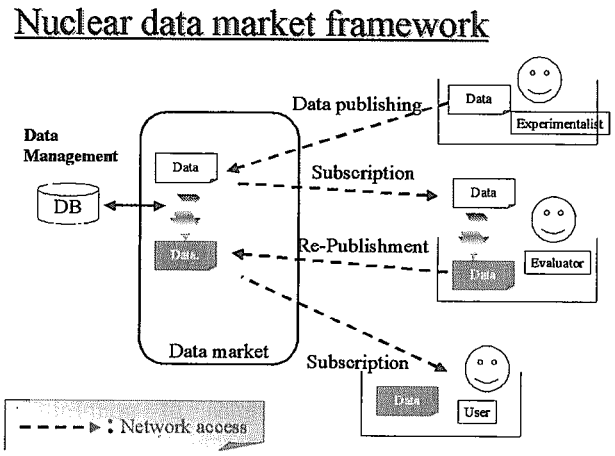

Fig. 6 A conceptual figure for the seamless linkage among the nuclear data activities..

In addition, it is natural that we have necessity which we should discuss or evaluate some nuclear data for an application via the network. Once the description of each data is unified among whole users, e.g., we adopt the basis of pad description for data and tool; each pad can be distributed via the net with holding the ability of editing. For example, the PIAZZA technology[9], as shown in **Fig. 7**, gives a sharing environment of the pads via the network. By using this kind of framework, it is expected that we can construct the so-called "interactive information sharing field" among the nuclear data community(**Fig. 6**).

Lastly, in the management of nuclear data, it is important not only the numerical data but also the information which is concerned with the experiment. In order to handle many kinds of dynamic information, e.g., how the evaluation is derived and what kind of data is used for it, we would like to mention the importance of extending data description format. It seems an ideal way that we can trace such the dynamic use of nuclear data with a help of data description. Thus the development will be placed as an important issue of our research.

V. Summary and Future Issues

In this paper, we have shown our current development, and discussed the effective utilities for nuclear data. And actually we consider the important concepts such as i) medialization of nuclear data and tools, ii) access architecture, and iii) developing data description frameworks.

Development of Web-based data-retrieval and data-entry system is under way to the practical use. Concerning the CONTIP, current IntelligentPad for Windows trial package is available freely via IntelligentPad Consortium.[9] We are going to release "mile-stone" package for the nuclear reaction data retrieval system by using the above IntelligentPad, which includes EXFOR data in the future.

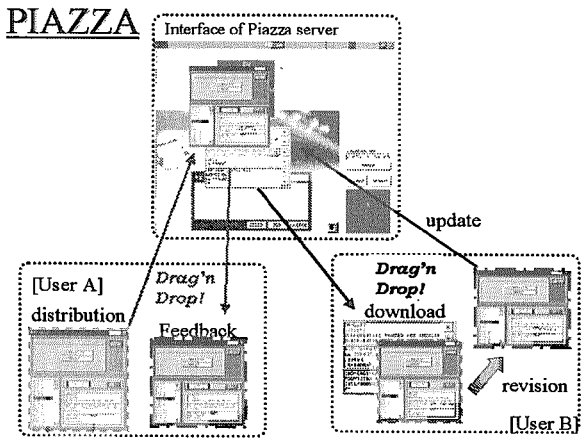

Fig. 7 Piazza: users can access to the space and cooperate to edit contents of the space via network.

For the further development, recently, so-called semi-structure description of data likes HTML is familiar to describe for a publication. For example, XML[10] is a recent development of such description format, and by using such format; unified description of nuclear data from author level to end-user level is expected to be available. We will consider the semi-structure description format of nuclear reaction data.

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