

Progress Report

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 Charged Particle Nuclear Data Group, ATOMKI, Debrecen
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General

The Debrecen Nuclear Data Group is working in the Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI) in Debrecen (Hungary). Main field of the activity is the measurement, compilation and application of the low and medium energy charged particle induced nuclear reaction cross section data. The group is dealing with the all aspects of the CP cross section data i. e. measurement, compilation, evaluation and practical application. Direct experiences collected during the applications help in selection of the important tasks and complex investigation of the problems. The measurements and the compilations are carried out in broad range of international collaborations with cyclotron laboratories in Germany (INC, FZ Jülich), in Belgium (VUB Brussels), in Finland (Turku PET Center), in Japan (Tohoku University) and with theoretical groups in Russia (IPPE, Obninsk), China (CNDC, Beijing) to obtain recommended data.

Reference Charged Particle Cross Section Data Base for Medical Radioisotope Production

In the last period most of the nuclear data activity was connected to preparation of the Reference Data Base for medical isotope production. The data base contains 22 monitor reactions to monitor beam parameters of light bombarding particles, 16 reactions to produce single gamma diagnostic radioisotopes and 10 reactions for production of most commonly used PET isotopes. The Debrecen group took a significant part in the CRP, regarding the compilation of the nuclear data, the connected new experiments (see list of references), and finally the preparation of the technical document and in the electronic version of the database on the IAEA Web server.

A significant part of the results of the new measurements is already have been published (see references) or under publication. From our point of view the following conclusions and remarks can be deduced on the whole program, on the present status and on the future improvement of the data base:

- There are already numerous request for the data base, which underline the importance of the work.
- According to our knowledge it was the first attempt to produce a CP cross section data base for medical applications, which resulted in slower evaluating procedure.
- There was a fairly good collaboration between different contributors.
- It was repeatedly stated, that the status of the experimental data base of the charged particle induced reactions is poor.
- It was found, that a significant part of the experimental data still not compiled into the EXFOR.
- A very significant effort was done to produce the database, but the “quality” of the result is still far from the ideal one (and from the possibilities).

- The program, and the number of the evaluated reactions were too ambitious for the available limited time.
- It was practically impossible to use the results of the model codes to produce recommended data.
- In case of several reactions no recommended data can be given without new experiments.

For the future work the following recommendations can be given on the basis of the collected experiences and conclusions:

- Further experimental data are necessary in case of several important reactions.
- The quality of the database can be significantly improved by continuation of the evaluation process with fewer contributors.
- According to our opinion the evaluation process need to be continue immediately, because on the basis of the present results better quality data can be obtained , even with moderate additional effort. After one or two year nobody can remember the details, and the original data files can be cleared. Finally, due to the improved performance, better and more uniform evaluation can be done.
- The correction process requires about one- or two year works from one experimental and one theoretical group.
- The missing works have to be compiled into the EXFOR base.

Activity for development of other CP nuclear data base

Nearly thousand CP accelerators are working on different applications using activation method. On the basis of the broad range application of the cyclotron on industrial and medical field - in agreement with other groups- we came to the conclusion, that there are several other, non energy related, application fields, where the direct or indirect application of CP cross section data are important. It seems to be worthwhile to develop new dedicated CP data bases and to improve the existing ones:

- Extension and improvement of the database to monitor beam parameters is needed, and to put into WEB as separate database would be necessary.
- Extension and improvement of the existing data base for production of diagnostic radioisotopes (SPECT, PET), and putting into WEB as separate data base together with therapeutic radioisotopes(see next).
- Development of new data base for production of therapeutic radioisotopes and putting into WEB in common file with diagnostic radioisotopes. The application of the radioisotopes for radiation therapy is becoming more and more important. According to the last prognoses it will be one of the most prosperous field of the application of the radioisotopes in nuclear medicine. No attempt was made to compile and to evaluate the existing experimental data base, to see the status of the data, to propose new measurements and to produce recommended data base.
- Development of a new data base for standard cross section, and activation curve for wear, erosion and corrosion measurement using Thin Layer Activation technique(TLA). The data base can accelerate and make more easier and economic the calibration process. From other side it can help significantly in the planing phase for optimization of the irradiation circumstances. The list of the possible nuclear reaction is very numerous, but in the practice only limited nuclear reaction are used. Taking into account, that the most widely used

equipments are based on metals and on plastics, out of them the metals can be easily labeled with radioisotopes of acceptable half life. The status of the cross section data on metals are not so bad, therefore both the necessity, and the possibility underline the real development of the data base. Some preliminary attempts already was made to develop standard data on this field as a part a IAEA CRP, but the published results contain contradictory data with other earlier experimental results

- The existing data base for production of diagnostic radioisotopes contains the main production reaction, and the disturbing reactions on the same target isotope. No compilation and recommendation exist for the disturbing reactions on other stable isotopes of the same element. This side reactions are especially important when the target element is not mono-isotopic and/or the enrichment of the target is not satisfactory. The price of the enriched isotopes is strongly depended on the enrichment and on the real composition of the target material. The reliable cross sections allows to calculate with high accuracy of the yields both for the main reaction and for the unnecessary side reactions. Therefore the extension of the existing data base for production of medical radioisotopes with the contributing reactions on other stable isotopes of the same target element is also very important.

Regarding the above mentioned fields the compilation of the existing data has been started, in spite of the well known fact, that they are projects for more manpower and for broader cooperation.

Activity to prepare a “user guide” for measurement and application of integral charged particle cross section data

There is a broad range of the methods for measurement and application of charged particle cross section data in practice. The methods of measurements and the possible error sources are published mainly in old volumes of journals of basic sciences, usually unavailable for the users. The precise descriptions of a method of applications of cross section data are even in worst situation, because the definition of the quantities is not so strict, and different groups have different “habits” for application of the nuclear data. It was recognized during the preparation of the TECDOC of the Medical Isotope Production File, that there is disagreement even between the contributing compilers, in the question of the type of data to propose. The long list of reactions and the limited time did not allow us to prepare a user guide for the field of medical isotope production and CP beam monitoring. Our group has made already some steps in this direction. We have started drafting such a guide in the field of isotope production for medicine, CP activation analysis and Thin Layer Activation corrosion studies, but the task is not simple.

New measurements to complete CP data bases

In collaboration with other international laboratories we are participating in a systematic study of low and medium energy range cross sections in the field of:

- Production of radioisotopes for medical diagnostic.
- Production of radioisotopes for therapy.
- Commonly used reactions for thin layer activation technique.

- Commonly used monitor reactions and intercomparisons.
- Confirmation of experimental data base measured by Levkovski.

The list of the investigated reactions is based on the requirement of every day practice of the collaborating institutes, and on the problems obtained during compilations and data evaluations. The most of the new data are published in international journals (see references).

Compilation in EXFOR

The Debrecen CP Nuclear Data Group are collecting and compiling the CP cross section data measured in Debrecen and Jülich. In the last year this activity was temporary suspended, due to the overload by the evaluation program. With finishing the “first version” of the Medical Isotope Data base, the compilation process was restarted in this May. We hope that the missing work from Debrecen and Jülich will be compiled to the end of this year.

Nuclear data services

The Group continue to distribute compiled experimental charged particle data at low a medium energies for special request, needed mainly on non-energy related applications (medical isotope production, TLA, etc).

Staff

The staff consist of six “professional” physicist, working in different applications at the Debrecen cyclotron, and only in-part time (and with different intensities) on data compilations and other data oriented work. The main problem is, the lack of programmer and/or technician support, to put and to check the compiled data.

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Publications on nuclear data in the last three year

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