### **Progress Report**

For the period of October 2004-August 2006 To the NRDC Meeting (25-28 September 2006, IAEA, Vienna, Austria)

#### ATOMKI NUCLEAR REACTION DATA GROUP

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### Introduction

The main task and profile of the Atomki Nuclear Reaction Data Group did not change: measurement, compilation, evaluation and application of low and medium energy charged particle nuclear reaction data. The activity is done in the frame of international collaborations. Measurement, compilation and evaluation are connected to international projects and to the every day applications at the home institute and at institutes of collaborating partners.

### **Experimental works**

. During the last years we have continued the systematic measurement of excitation functions of charged particle reactions for many different applications (see list of references):

- Production of medical radioisotopes for diagnostic and for therapy
- Excitation functions of monitor reactions
- Activation cross sections for accelerator technology (waste transmutation, IFMIF, target technology)
- Activation cross sections for Thin layer Activation (TLA)
- Activation cross sections for charged particle activation analysis

These experiments were done at the MGC 20E cyclotron and in Debrecen and at cyclotrons of foreign laboratories in the frame of well established long term collaboration, in :

- Institute of Nuclear Chemistry (FZ Jülich, Germany)
- Cyclotron Laboratory of the Vrije Universiteit Brussel (VUB, Brussels, Belgium)
- Cyclotron Radioisotope Centre of the Tohoku University (CYRIC, Sendai, Japan)
- Division of Advanced Technology for Medical Imaging of the National Institute of Radiological Sciences (Chiba, Japan)
- Radionuclide Production Laboratory of the iThemba Laboratory for Accelerator Based Sciences (Somerset West, South Africa).

Theoretical calculation of the measured data was done in collaboration with scientist from:

• Institute of Theoretical Physics, IPPE, Obninsk, Russia. The results published in the period covered are in the part: References.

### **Compilations and evaluations**

#### EXFOR compilations

During the June 2004 – August 2006 period 34 charged particle entries were compiled at ATOMKI with experimental data inputs mostly from Hungary (ATOMKI) Belgium (VUB) and Germany (FZ Jülich).

The compilation activity shows constant tendency. Practically all new works from Debrecen, Brussels and Jülich were compiled

# Upgrading the charged particle cross-section database for medical radioisotope production: diagnostic radioisotopes

The Debrecen group is participating in the upgrading process of the IAEA recommended cross-section data base for charged particle induced reactions relevant to production of radioisotopes used for medical diagnostics and the related reactions to monitor beam parameters. During 2002 - 2004 the upgrade of the database for production of SPECT radioisotopes (single photon emitters) was completed. At present the upgrade of the reaction cross section data of charged particle monitor reactions is in progress.

# Development of database for production of therapeutic radionuclides

The IAEA – Coordinated Research Project (CRP) for development of a standard database for production of therapeutic radionuclide is approaching to completion. The main contributions of the Debrecen group to the development of the database are new measurements and compilation of the cross section data of selected charged particle reactions (compilation, critical selection, comparison with integral data).

## Database for activation cross sections of proton and deuteron induced reactions for accelerator technology

In the production process of medical radioisotopes the so-called "targetry" plays very important role. The overwhelming part of the medical radioisotope production is done with proton and deuteron induced reactions. Activation data for target holders, target backing, target chambers and collimator units are very important for safe handling of irradiated parts. Systemic study of low energy activation data on metals are in progress.

Modern accelerators can produce high intensity deuteron beams and the deuteron induced reactions play important role in setting up fast neutron sources (IFMIF) and in thin layer activation technology. The Technical Meeting on Nuclear Data for the International Fusion Irradiation Facility (IFMIF, Karlsruhe 2005) gave high priority to establishing a reliable database for deuteron activation data, in first instance on selected metals. To meet these requirements we started to create an experimental activation database by performing new experiments and systematic survey of deuteron induced activation cross sections up to 50 MeV.

Proton induced nuclear reactions are presently the most widely used in different applications. An important field is the accelerator technology and technology for accelerator based nuclear waste transmutation and energy amplification. The cross section data are in most cases well documented, but reliable experimental data for medium energy reactions on many important material are contradictory or completely missing. During recent years we investigated systematically these missing data up to 80 MeV proton energies.

## Database for emerging positron emitters (secondary PET isotopes)

The great success of positron emission tomography (PET) in medicine requires new tracers and new radioisotopes that provide new possibilities for labelling new molecules and broadens the field of application. At present all routine PET scanner (more than one thousand) use radiotracers labelled exclusively with <sup>18</sup>F, <sup>11</sup>C and <sup>15</sup>O. The short lived and longer-lived  $\beta^+$ -emitters are of interest for investigating metabolic processes via PET. Furthermore, they can be used for quantitation of radiation dosimetry and bio kinetics of  $\gamma$ -emitting radiopharmaceuticals.

No effort was made to compile and evaluate the nuclear reaction data of the most important production routes of these emerging PET radioisotopes. During recent years we investigated systematically (new data measurement and compilation) these missing production data for these radionuclides.

## Charged particle cross-section database for thin layer activation technique

To deduce depth - activity curves either new measurement has to be done on the investigated material or knowledge of the nuclear reaction data and the elemental composition of the irradiated part is required. Unfortunately no evaluated cross section database is available for thin layer activation studies. Therefore an independent database for TLA applications is under development in ATOMKI, using evaluated cross section data. It contains p, d, <sup>3</sup>He and alpha-particle induced reactions up to 40 MeV on the following elements: Al, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Y, Zr, Nb, Mo, Rh, Pd, Ag, Cd, In, Sn, Sb, Er, Tm, Yb, Ta, W, Ir Pt, Au, Pb.

### Nuclear data service

The ATOMKI group continues to distribute compiled or evaluated cross section/thick target yield data for low and medium energy charged particle nuclear reactions mainly for cyclotron applications according to the requirements.

### Staff

The staffs connected to the experimental data measurement consist of six physicists and two chemists. Out of them three physicists are working in part time on data compilation and evaluation. All are engaged in practical application of the ATOMKI cyclotron.

#### **Future plans**

Continuation of the present activity.

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