

Progress Report (2002-2004)

To the NRDC Meeting (4-7 October 2004, Brookhaven, USA)

ATOMKI NUCLEAR REACTION DATA GROUP

**Institute of Nuclear Research of the Hungarian Academy of Sciences (ATOMKI)
Debrecen, Hungary**

**Tárkányi F., Takács S., Szelecsényi F., Ditrói F., Fenyvesi A., Kovács Z., Szűcs Z.,
Mahunka I., Andó L., Király B., Csikai J.**

Introduction

The main task and profile of the Atomki Nuclear Reaction Data Group is the measurement, compilation, evaluation and application of the low and medium energy charged particle nuclear reaction data. The work is done on the frame of international collaborations. The measurement, compilation and evaluation works are connected to international projects and to the every day applications at the home institute and at institutes of collaborating partners.

Experimental works

Cross sections for production of different residual radionuclides induced by low and medium energy light ion beams are important for a variety of applications and of research studies. The experimental data is the basis for applications demanding accurate data and for model calculations to test the capability of the models and to adjust the optimal parameters. 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).

These experiments were done at the MGC 20E cyclotron and VdG-5 accelerator in Debrecen and at cyclotrons of foreign laboratories in the frame of well established long term collaboration, in:

- the Institute of Nuclear Chemistry (FZ Jülich, Germany),
- the Cyclotron Laboratory of the Free University of Brussels (VUB, Brussels, Belgium),
- the Cyclotron Radioisotope Center of the Tohoku University (CYRIC, Sendai, Japan),
- the Cyclotron Laboratory of the Abo Akademi (Turku, Finland),
- the Division of Advanced Technology for Medical Imaging of the National Institute of Radiological Sciences (Chiba, Japan),
- the Radionuclide Production Laboratory of the Themba Laboratory for Accelerator Based Sciences (Somerset West, South Africa).

The 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 can be obtained in the references.

Main application fields of the new data measurements

Production of medical radioisotopes for diagnostic and for therapy

In the field of the production of diagnostic and the therapeutic radioisotopes the nuclear reaction data are mostly used to optimise the production circumstances (high yield, minimal impurity level, low cost). Recommended database were developed for production of the most widely used radioisotopes in the frame of an IAEA CRP. The recommended data sets, however requires validation and additional measurements in selected energy regions. The cross-section database for the newly introduced positron and gamma emitters is usually very poor. In many cases basic data are missing, therefore new measurements vitally important.

The database in the field of the production of therapeutic radioisotopes with charged particle induced reactions even less developed. In most of cases either no experimental data are available or only contradicting data sets were published, except a few well-measured reactions. To improve the situation a Co-ordinated Research Project were started in 2003 with title "Nuclear data for production of therapeutic radionuclides".

The Debrecen group performs intensive experimental work in both application fields.

Excitation functions of monitor reactions

The importance of the monitor reactions is well known in the field of neutron and charged particle induced reactions. They are broadly used both in irradiations for practical applications and for basic research. We continue our systematic work to extend the list of the charged particle monitor reactions, to validate the existing database for series of reactions with integral measurements and to compare the different monitor reactions.

Activation cross sections for accelerator technology

Several applications make use of nuclear data up to 100 MeV including accelerator technology (shielding, low activation materials, collimators, target backings, secondary neutron sources etc.). With regard to input beam the proton and deuteron induced reaction are most widely used. Recent model intercomparisons underline the importance of the experimental data. The main goal of our investigations is to complete the experimental data base for the not measured, missing elements, and for the production of short half radioisotopes on important elements where the database for longer lived products are well measured.

Compilations and evaluations

EXFOR compilations

During the 2002-2004 period 47 charged particle entries were compiled at ATOMKI with experimental data inputs mostly from Hungary (ATOMKI) and Germany (FZ Jülich).

The compilation activity shows raising tendency. Practically all old missing works from Debrecen and Jülich (about 90%) were compiled. The extensive experimental work in both institutes gives permanent task for further compilation activity. New compilation list will appear soon in connection with the Therapeutic CRP.

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

The Debrecen group is participating in the upgrading of the IAEA recommended cross-section data base for charged particle induced reactions relevant to production of radioisotopes used for medical diagnostic and for related reactions to monitor beam parameters. During 2002-2004 the upgrading of the database for production of PET radioisotopes was completed. Presently the upgrading of the reaction cross section data for production of diagnostic gamma emitters is in progress.

Development of database for production of therapeutic radionuclides

The main contributions of the Debrecen group to the development of the database are the new measurements and the compilation of the cross section data sets of the dedicated charged particle reaction (compilation, critical selection, comparison with the integral data etc.)

Cross-section database for production of ^{103}Pd from Rh, $^{123,124}\text{I}$ from Te, ^{201}Tl from Tl

In the production process of medical radioisotopes the so-called "targetry" plays a very important role. For standardisation of high intensity solid targets a co-ordinated project was initiated by the IAEA: "Standardised High Current Targets for Production of Diagnostic and Therapeutic Radionuclides". The project deals with all aspects of the production of ^{103}Pd , $^{123,124}\text{I}$ and ^{201}Tl radioisotopes by using Rh, Te and Tl targets. Compilation and evaluation was done by the Debrecen group for the participating stable isotopes of targets and for the backing materials. The database will be published in the near future in the IAEA Technical Report Series.

Charged particle cross-section database for thin layer activation technique

To deduce depth-activity curves either new measurements has to be done on the investigated material or the knowledge of the nuclear reaction

data and of the elemental composition are required. The detailed measurements for each target are very time consuming; therefore in most cases it is more fruitful to obtain the activity distribution with calculation and to perform checking and validation only at few points with more simple experiments. Unfortunately presently no evaluated cross section database exists for thin layer activation studies. Therefore for practical use in the ATOMKI an independent database for TLA is under development by using evaluated cross section data. Presently it contains p, d, ^3He and alpha-particle induced reactions up to 30-40 MeV on the following elements: Al, Ti, Fe, Ni, Cu, Zn, Zr, Nb, Y, Mo, Rh, Pd, Cd, W, Ta, Pt, Ir.

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 induced nuclear reactions mainly connected to cyclotron applications.

Staff

The staffs connected to the experimental data measurement consist of seven 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

References 2002-2004

Hermanne A., Sonck M., Takács S., Tárkányi F., Shubin Yu. N.:

Study on alternative production of ^{103}Pd and characterisation of contaminants in the deuteron irradiation of ^{103}Rh up to 21 MeV.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **187** (2002) 3.

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Ido T., Hermanne A., Ditrói F., Szűcs Z., Mahunka I., Tárkányi F.:

Excitation functions of proton induced nuclear reactions on $^{\text{nat}}\text{Rb}$ from 30 to 70 MeV. Implication for the production of ^{82}Sr and other medically important Rb and Sr radioisotopes.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **194** (2002) 369.

(related project: production of medical radioisotopes: diagnostic isotopes)

Takács S., Tárkányi F., Sonck M., Hermanne A.:

New cross-sections and intercomparison of proton monitor reactions on Ti, Ni and Cu.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **188** (2002) 106.

(related project: production of medical radioisotopes: monitor reactions)

Takács S., Tárkányi F., Sonck M., Hermanne A.:

Investigation of the $^{nat}\text{Mo}(p,x)^{96m}\text{Tc}$ nuclear reaction to monitor proton beams: New measurements and consequences on the earlier reported data.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **198** (2002) 183.

(related project: production of medical radioisotopes: monitor reactions)

Tárkányi F., Ditrói F., Takács S., Al-Abyad M., Mustafa M. G., Shubin Yu. N., Zhuang Y.:

New data and evaluation of ^3He -induced nuclear reactions on Cu.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **196** (2002) 215.

(related project: production of medical radioisotopes: monitor reactions)

Tárkányi F., Ditrói F., Szelecsényi F., Sonck M., Hermanne A.:

Measurement and evaluation of the excitation functions for alpha particle induced nuclear reactions on niobium.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **198** (2002) 11.

(related project: database for thin layer activation)

Hermanne A., Takács S., Tárkányi F., Bolbos R.:

Cross section for the charged particle production of the therapeutic radionuclide Ag-111 and its PET imaging analogue Ag-104g.

Annales Universitatis Turkuensis, Seria D **499** (2002) 14.

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Hermanne A., Sonck M., Takács S., Tárkányi F., Shubin Yu. N.:

Deuteron bombardment of ^{103}Rh : A new promising pathway for the production of ^{103}Pd .

Journal of Nuclear Science and Technology, Supplement 2 (2002) 1286.

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Ido T., Hermanne A., Ditrói F., Szûcs Z., Mahunka I., Tárkányi F.:

Re-measurement of the excitation function of the $^{85}\text{Rb}(p,4n)^{82}\text{Sr}$ nuclear reaction near the threshold: relevance to the production of a $^{82}\text{Sr}(^{82}\text{Rb})$ generator system with a medium energy cyclotron.

Journal of Nuclear Science and Technology, Supplement 2 (2002) 1310.

(related project: production of medical radioisotopes: diagnostic isotopes)

Qaim S. M., Tárkányi F., Oblozinsky P., Gul K., Hermanne A., Mustafa M. G., Nortier M., Scholten B., Shubin Yu. N., Takács S., Zhuang Y.:

Charged-particle cross section database for medical radioisotope production.

Journal of Nuclear Science and Technology, Supplement 2 (2002) 1282.

(related project: production of medical radioisotopes: diagnostic isotopes, monitor reactions)

Scholten B., Hess E., Takács S., Kovács Z., Tárkányi F., Coenen H. H., Qaim S. M.:

Cross section measurements on gas targets relevant to the production of the positron emitting radionuclides ^{14}O , ^{18}F and ^{76}Br .

Journal of Nuclear Science and Technology, Supplement 2 (2002) 1278.

(related project: production of medical radioisotopes: diagnostic isotopes)

Tárkányi F., Takács S., Andó L., Vera-Ruiz H., Shubin Yu. N., Hermanne A.:

Status of the database for production of medical radioisotopes of ^{103}Pd , $^{123,124}\text{I}$, ^{201}Tl by using Rh, Te and Tl targets.

Journal of Nuclear Science and Technology, Supplement 2 (2002) 1318.

(related project: production of medical radioisotopes: diagnostic and therapeutic radioisotopes)

Baglin C. M., Browne E., Norman E. B., Molnár G., Belgya T., Révay Zs., Szelecsényi F.:

^{66}Ga : a standard for high-energy calibration of Ga detectors.

Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment 481 (2002) 365.

(related projects: database for gamma calibration standards)

Szelecsényi F., Suzuki K., Kovács Z., Takei M., Okada K.:

Production possibility of $^{60,61,62}\text{Cu}$ radioisotopes by alpha induced reactions on cobalt for PET studies.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms 187 (2002) 153.

(related project: production of medical radioisotopes: diagnostic isotopes)

Tárkányi F.:

Production and application of therapeutic radioisotopes. Activity on the related nuclear reaction data.

Summary report of the Consultants' Meeting on Nuclear Data for Production of Therapeutic Radioisotopes. Prepared by R.C. Haight and R. Paviotti-Corcuera. Vienna, IAEA (INDC(NDS)-432) 0 (2002) 63.

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Kovács Z., Scholten B., Tárkányi F., Coenen H. H., Qaim S. M.:

Cross section measurements using gas and solid targets for production of the positron-emitting radionuclide O-14.

Radiochimica Acta 91 (2003) 185.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Takács S., Szűcs Z., Tárkányi F., Hermanne A., Sonck M.:

Evaluation of proton induced reactions on ^{100}Mo : New cross sections for production of $^{99\text{m}}\text{Tc}$ and ^{99}Mo .

Journal of Radioanalytical and Nuclear Chemistry 257 (2003) 195.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Takács S., Tárkányi F., Hermanne A., Paviotti de Corcuera R.:

Validation and upgrading of the recommended cross section data of charged particle reactions used for production of PET radioisotopes.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **211** (2003) 169.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Tárkányi F., Ditrói F., Takács S., Szelecsényi F., Hermanne A., Sonck M.:

Activation cross-sections of alpha induced nuclear reactions on iron up to 40 MeV.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **207** (2003) 381.

(related project: database for thin layer activation)

Tárkányi F., Takács S., Hermanne A., Ditrói F., Andó L., Heselius S.-J., Bergman J.:

New experimental data on excitation functions for practical applications of alpha induced nuclear reactions on Ta up to 30 MeV.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **211** (2003) 22.

(related project: database for thin layer activation)

Tárkányi F., Ditrói F., Takács S.:

Excitation functions of ^3He -particle induced nuclear reaction on iron.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **211** (2003) 312.

(related project: database for thin layer activation)

Tárkányi F., Takács S., Szelecsényi F., Ditrói F., Hermanne A., Sonck M.:

Excitation functions of deuteron induced nuclear reactions on natural tungsten up to 50 MeV.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **211** (2003) 319.

(related project: database for thin layer activation, database for accelerator technology)

Kovács Z., Tárkányi F., Scholten B., Coenen H. H., Qaim S. M.:

Cross sections of proton induced reactions on nitrogen: Determination of ^{14}O and ^{13}N contaminants in ^{11}C production.

Journal of Labelled Compounds and Radiopharmaceuticals, Supplement **46** (2003) 267.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Szelecsényi F., Kovács Z., Van der Walt T. N., Steyn G. F., Suzuki K., Okada K.:

Investigation of the $^{\text{nat}}\text{Zn}(p,x)^{62}\text{Zn}$ nuclear process up to 70 MeV: a new $^{62}\text{Zn}/^{62}\text{Cu}$ generator.

Applied Radiation and Isotopes **58** (2003) 377

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Fukumura T., Okada K., Szelecsényi F., Kovács Z., Suzuki K.:

Practical production of ^{61}Cu via $^{\text{nat}}\text{Co}(\alpha,2n)^{61}\text{Cu}$ reaction and preparation of ^{61}Cu -ATSM.

Journal of Labelled Compounds and Radiopharmaceuticals, Supplement 46 (2003) 286.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Suzuki K., Yoshida Y., Ogawa M., Kovács Z., Szelecsényi F.:

A new production method of $^{11}\text{C}/\text{CH}_3\text{I}$ using a loop technique.

Journal of Labelled Compounds and Radiopharmaceuticals. Supplement 46 (2003) 241.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Szelecsényi F., Kovács Z., Suzuki K., Takei M., Okada K.:

Investigation of direct production of ^{62}Cu radioisotope at low energy multiparticle accelerator for PET studies.

International Symposium on Utilization of Accelerators. Sao Paulo, Brazil, 26-30 Nov., 2001. Proceedings. Vienna, IAEA (IAEA Conference and Symposium Papers 16/CD, IAEA-SM/366-217P) 0 (2003) 1.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Tárkányi F., Takács S., Hermanne A.:

Nuclear reaction data for accelerator-produced therapeutic radioisotopes. Status report on the activity at Atomki in Debrecen.

Nuclear Data for Production of Therapeutic Radionuclides. Vienna, IAEA. INDC(NDS)-444 0 (2003) 65.

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Fenyvesi A., Tárkányi F., Heselius S.-J.:

Excitation functions of nuclear reactions induced by ^3He -particles on cobalt.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms 222 (2004) 355.

(related project: database for thin layer activation, production of medical radioisotopes: diagnostic radioisotopes)

Hermanne A., Takács S., Tárkányi F., Bolbos R.:

Experimental cross sections for charged particle production of the therapeutic radionuclide ^{111}Ag and its PET imaging analogue $^{104\text{m,g}}\text{Ag}$.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms 217 (2004) 193.

(related project: production of medical radioisotopes: therapeutic and diagnostic radioisotopes)

Hermanne A., Takács S., Tárkányi F., Bolbos R.:

Cross section measurements of proton and deuteron induced formation of ^{103}Ag in natural palladium.

Radiochimica Acta 92 (2004) 215.

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Scholten B., Takács S., Tárkányi F., Coenen H. H., Qaim S. M.:
Excitation functions of deuteron induced nuclear reactions on enriched ^{78}Kr with particular relevance to the production of ^{76}Br .
Radiochimica Acta **92** (2004) 203.
(related project: production of medical radioisotopes: diagnostic radioisotopes)

Tárkányi F., Hermanne A., Takács S., Ditrói F., Dityuk A. I., Shubin Yu. N.:
Excitation functions for production of radioisotopes of niobium, zirconium and yttrium by irradiation of zirconium with deuterons.
Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **217** (2004) 373.
(related projects: database for thin layer activation, database for accelerator technology)

Tárkányi F., Takács S., Ditrói F., Hermanne A., Sonck M., Shubin Yu. N.:
Excitation functions of deuteron induced nuclear reactions on natural zinc up to 50 MeV.
Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **217** (2004) 531.
(related projects: database for thin layer activation, database for accelerator technology)

Tárkányi F., Hermanne A., Takács S., Shubin Yu. N., Dityuk A. I.:
Cross sections for production of the therapeutic radioisotopes ^{198}Au and ^{199}Au in proton and deuteron induced reactions on ^{198}Pt .
Radiochimica Acta **92** (2004) 223.
(related project: production of medical radioisotopes: therapeutic radioisotopes)

Uddin M. S., Hagiwara M., Tárkányi F., Ditrói F., Baba M.:
Experimental studies on the proton-induced activation reactions of molybdenum in the energy range 22-67 MeV.
Applied Radiation and Isotopes **60** (2004) 911.
(related projects: database for thin layer activation, database for accelerator technology)

Uddin M. S., Hagiwara M., Kawata N., Itoga T., Hirabayashi N., Baba M., Tárkányi F., Ditrói F., Csikai Gy.:
Measurement of excitation functions of the proton-induced activation reactions on tantalum in the energy range 28-70 MeV.
Journal of Nuclear Science and Technology, Supplement **4** (2004) 160.
(related projects: database for thin layer activation, database for accelerator technology)

Fukumura T., Okada K., Szelecsényi F., Kovács Z., Suzuki K.:
Practical production of ^{61}Cu using natural Co target and its simple purification with a chelating resin for ^{61}Cu -ATSM.
Radiochimica Acta **92** (2004) 209.
(related project: production of medical radioisotopes: diagnostic radioisotopes)

Szelecsényi F., Kovács Z., Suzuki K., Okada K., Fukumura T., Mukai K.:
Formation of ^{60}Cu and via $\text{Co}+^3\text{He}$ reactions up to 70 MeV: production possibility of ^{60}Cu for PET studies.
Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms **222** (2004) 364.
(related project: production of medical radioisotopes: diagnostic radioisotopes)

Tárkányi F., Takács S., Hermanne A., Van den Winkel P., Van der Zwart R.:

Investigation of the production of the therapeutic radioisotope ^{114m}In through proton and deuteron induced nuclear reactions on cadmium

In: Schriften des Forschungszentrums Jülich, General and Interdisciplinary, Vol. 3 (eds. Qaim S. M., Coenen H.), FZ Jülich, Jülich 2004, p.325.

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Szelecsényi F., Kovács Z., Suzuki K., Fukumura T., Okada K., Mukai K.:

Production possibility of copper radioisotopes from cobalt target for PET studies.

In: Schriften des Forschungszentrums Jülich, General and Interdisciplinary, Vol. 3 (eds. Qaim S. M., Coenen H.), FZ Jülich, Jülich 2004, p.313.

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Tárkányi F., Ditrói F., Csikai J., Uddin M. S., Hagiwara M., Baba M., Shubin Yu. N., Dityuk A. I.:

Activation cross sections of longer lived products of proton induced nuclear reactions on zinc.

Applied Radiation and Isotopes (in press).

(related projects: database for thin layer activation, database for accelerator technology)

Tárkányi F., Ditrói F., Takács S., Csikai J., Hermanne A., Uddin M. S., Hagiwara M., Baba M., Shubin Yu. N., Dityuk A. I.:

Activation cross-sections of light ion induced nuclear reactions on platinum: proton induced reactions.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms (in press).

(related projects: database for thin layer activation, database for accelerator technology)

Tárkányi F., Takács S., Ditrói F., A. Hermanne A., Shubin Yu. N., Dityuk A. I.:

Activation cross-sections of light ion induced nuclear reactions on platinum: deuteron induced reactions.

Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms (in press).

(related projects: database for thin layer activation, database for accelerator technology)

Uddin M. S., Hagiwara M., Baba M., Tárkányi F., Ditrói F.:

Experimental studies on excitation functions of the proton-induced activation reactions on silver.

Applied Radiation and Isotopes (submitted).

(related projects: database for thin layer activation, database for accelerator technology)

Hermanne A., Tárkányi F., Takács S., Szűcs Z., Shubin Yu. N., Dityuk A. I.:

Experimental study of the cross sections of α -particle induced reactions on ^{209}Bi .

Applied Radiation and Isotopes (submitted).

(related project: production of medical radioisotopes: therapeutic radioisotopes)

Ditrói F., Takács S., Tárkányi F.:

Evaluation of reaction cross section data used for thin layer activation technique.

Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).

(related projects: database for thin layer activation)

Tárkányi F., Ditrói F., Takács D., Mahunka I., Csikai J., Uddin M. S., Hagiwara M., Baba M., Ido T., Hermanne A., Shubin Yu. N., Dityuk A. I.:

Excitation functions of proton induced reactions on ^{nat}Sn and ^{nat}Cd : relevance to the production of ^{111}In and ^{114m}In for medical applications.

Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).

(related project: production of medical radioisotopes: diagnostic- and therapeutic radioisotopes)

Tárkányi F., Takács S., Ditrói F., Csikai J., Hermanne A., Uddin M. S., Hagiwara M., Baba M., Shubin Yu. N., Dityuk A. I.:

Measurement of activation cross sections of the proton-, deuteron- and alpha particle induced nuclear reactions on platinum.

Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).

(related projects: database for thin layer activation, database for accelerator technology)

Tárkányi F., Ditrói F., Takács S., Király B., Hermanne A., Uddin M. S., Hagiwara M., Baba M., Shubin Yu. N., Dityuk A. I.:

Cross sections of the proton induced nuclear reactions on iridium.

Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).

(related projects: database for thin layer activation, database for accelerator technology)

Tárkányi F., Ditrói F., Takács S., Csikai J., Mahunka I., Uddin M. S., Hagiwara M., Baba M., Ido T., Hermanne A., Sonck M., Shubin Yu. N., Dityuk A. I.:

Excitation functions for production of ^{88}Zr and ^{88}Y by proton and deuteron irradiation of Mo, Nb, Zr and Y.

Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).

(related project: production of medical radioisotopes: diagnostic radioisotopes)

Ditrói F., Tárkányi F., Csikai J., Uddin M. S., Hagiwara M., Baba M.:

Investigation of activation cross-sections of the proton induced nuclear reactions on natural iron at medium energies.

Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).

(related projects: database for thin layer activation, database for accelerator technology)

Hermanne A, Tárkányi F., Takács S., Shubin Yu. N.:

Experimental determination of cross section of d-induced reactions on ^{nat}Pd .
Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 2, Santa Fe, USA (submitted).
(related projects: database for thin layer activation)

Hermanne A., Tárkányi F., Takács S., Szűcs Z., Shubin Yu. N., Dityuk A. I.:

Experimental study of the cross sections of α -particle induced reactions on ^{209}Bi .
Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).
(related project: production of medical radioisotopes: therapeutic radioisotopes)

Vermeulen C., Steyn G. F., Nortier F. M., Van der Walt T. N., Szelecsényi F., Kovács Z., Qaim S. M.:

Excitation functions and production rates of radionuclides produced in the proton bombardment of ^{nat}Pr and ^{nat}La .
Proceedings of the International Conference on Nuclear Data for Science and Applications, September 27-October 1, Santa Fe, USA (submitted).
(related project: production of medical radioisotopes: diagnostic radioisotopes)

Szelecsényi F., Steyn G. F., Kovács Z., Van der Walt T. N., Suzuki K., Okada K., Mukai K.:

New cross-section data for the $^{66}\text{Zn}(p,n)^{66}\text{Ga}$, $^{68}\text{Zn}(p,3n)^{66}\text{Ga}$, $^{nat}\text{Zn}(p,xn)^{66}\text{Ga}$, $^{68}\text{Zn}(p,2n)^{67}\text{Ga}$ and $^{nat}\text{Zn}(p,xn)^{67}\text{Ga}$ nuclear reactions up to 100 MeV.
Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms (submitted).
(related project: production of medical radioisotopes: diagnostic radioisotopes)

Szelecsényi F., Steyn, G. F., Kovács Z., Vermeulen, Van der Meulen N. P., Van der Walt T. N., Suzuki K., Okada K., Mukai K.:

Investigation of the $^{66}\text{Zn}(p,2pn)^{64}\text{Cu}$ and $^{68}\text{Zn}(p,x)^{64}\text{Cu}$ nuclear processes up to 100 MeV: production of ^{64}Cu .
Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms (in press).
(related project: production of medical radioisotopes: diagnostic and therapeutic radioisotopes)