DEVELOPMENT OF CHARGED PARTICLE CROSS SECTION
CALCULATION METHODS FOR
MEDICAL RADIOISOTOPE PRODUCTION

Yu.N. Shubin, V.P. Lunev, N.V. Kurenkov

Theoretical Division
Institute of Physics and Power Engineering
249020 Obninsk, Russia

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SUMMARY

The activity on the development of charged particle cross section calculation methods for medical radioisotope production was carried out in several directions:

- Compilation of the production cross sections for commonly used medical radioisotopes, in particular I-123, In-111 and Tl-201.
- Development of calculation methods and the study of level density effects on calculated excitation functions for production of Cs, Xe, I, Tl, Pb and Bi.
- Evaluation of experimental and calculation results for the reactions specified at the first CRP Meeting.
- Creation of data files for production cross sections of I-123, Tl-201 and In-111.
- Estimations of the reaction cross sections for the production of other advantageous radioisotopes.

According to the first year programme the following work was performed:

- The calculation, analysis and comparison with experimental data for the reaction cross sections for the production of commonly used medical radioisotopes I-123 and Tl-201 have been performed. The production of I-123 and Tl-201 was considered either directly through nuclear reactions on Te and Hg targets or indirectly through nuclear reactions on I, Xe, Tl, Pb and Bi via the decay of its radioactive precursors Xe-123, Cs-123, Pb-201 and Bi-201. The competing reactions which influence the radioisotope purity were calculated and analyzed also. More than 50 reactions induced by protons,
deuterons and alpha-particles and used for radioisotope production in the regions
Z=51-55 and Z=80-83 were calculated using two versions of the ALICE code. The
comparison with the compiled experimental data and statistical analysis was
performed. It is shown that the new version -ALICE-IPPE- gives a better description
of experimental data in a wide energy region, especially for proton induced reactions.
The paper “Excitation function calculation method analysis for radioisotope production
of Iodine and Thallium” is now in press (Appl. Radiat. Isot.). The version of the
ALICE-IPPE code was installed in INC KFA, Juelich, and in Hannover (Institute of
Radioprotection and Radioecology).
- The calculation methods were developed and level density effects on the calculated
excitation functions for the production of Cs, Xe, I, Tl, Pb and Bi were studied. The
available experimental data were compared with excitation functions calculated in the
energy range up to 100 MeV using two versions of the ALICE code. It was shown that
generalized superfluid model for the level density ensures better description of
- The analysis and evaluation of the excitation functions for the following reactions
was performed using the calculation results and compiled experimental data:
$^{127}$I(p,5n)$^{123}$Xe, $^{111}$Cd(p,n)$^{111}$In, $^{112}$Cd(p,2n)$^{111}$I, $^{nat}$Cd(p,x)$^{111}$In, $^{123}$Te(p,n)$^{123}$I,
$^{124}$Te(p,n)$^{124}$I, $^{203}$Tl(p,3n)$^{201}$Pb, $^{203}$Tl(p, 5n)$^{201}$Pb, $^{63}$Cu(p,2n)$^{62}$Zn, $^{65}$Cu(p,3n)$^{63}$Zn,
$^{65}$Cu(p, n)$^{65}$Zn, $^{65}$Cu(p,4n)$^{62}$Zn.
The numerical data for production of I-123, Tl-201 and its precursors are available for
these reactions. The cross section calculations analysis for the reactions on Ni, Ti and
Al were performed also.

Method of thallium-199 production via the reaction $^{200}$Hg (p, 2n) $^{199}$Tl
induced with protons in the energy range 10-35 MeV was investigated. The excitation
functions for the $^{200}$Hg (p, 2n) $^{199}$Tl reaction and accompanying $^{200}$Hg (p, n) $^{200}$Tl
and $^{200}$Hg (p, 3n) $^{198}$Tl reactions were performed with ALICE-IPPE code. Thick
target yields for thallium-199, thallium-200 and thallium-198 and radionuclidic purity
thallium-199 were calculated using excitation functions obtained.