Contribution ID: **64** Type: **Poster**

Accelerator-based Alternative Tc-99m production: EMPIRE 3.1 theoretical simulations of cross sections for Mo(p,X) reactions and comparison with literature experimental data

Wednesday 19 September 2012 18:00 (1h 50m)

Technetium 99 metastable is the most important and widely used radionuclide in nuclear medicine for over 80% of all diagnostic procedures. Recent shortage of this isotope prompted the international scientific community to ask for investigations on new possible production routes. As possible alternatives to the current reactor-based ²³⁵U(n,f)⁹⁹Mo⟶^{99m}Tc scheme, accelerator-based methods have been considered. In this work, a feasibility study for the production of ^{99m}Tc from irradiation with protons on natural and highly enriched molybdenum targets has been performed. In the framework of INFN LARAMED (LAboratory of RAdionuclide for MEDicine) project currently under way at Legnaro labs, theoretical simulations of excitation functions and yields have, in particular been studied for ^{nat}Mo(p,X)and ¹⁰⁰Mo(p,X) reactions in the 5-35 MeV proton energy range. In addition, a review of all existing experimental data has been collected and compared with the simulations. Theoretical calculations were carried out using the new EMPIRE 3.1 (Rivoli Release) nuclear code, a modular system of nuclear models whose new features permit to evaluate the population probability of isomer states. Preliminary results of simulations have shown good agreement with experimental data. Estimation for the production of other radioactive and stable nuclides together with ^{99m}Tc has been calculated and considered an important discriminator for the feasibility of the production route since the presence of other harmful nuclides in the final product could affect the diagnostic outcome and radiation dosimetry in human studies.

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Session Classification: Poster Session

Track Classification: Nuclear Chemistry, Radionuclide Production, High-Power Targetry