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Radioisotope production yield using ejectiles generated from high intensity laser simulation

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Radioisotopes for example technetium-99 metastable state (^{99m}Tc) and fluorine-18 (^{18}F) plays an important role in nuclear medicine imaging procedures. With the emergence of theranostic medicine, one can expect the need for synthesis of other radioisotopes, beyond the conventional ones, to increase dramatically. To sustain the future demand especially in the era of theranostic medicine, a reliable and sustainable production facilities is necessary.

The introduction of high-intensity laser [1] offers one such option apart from the more common cyclotron and nuclear reactor facilities. A major advantage offered by the high-intensity laser setup, apart from its relatively small setup, is the simultaneous emission of protons and photons which can be used as incident particles onto a target nucleus.

In this preliminary work, we focus on the production of ^{99m}Tc which is used in regular nuclear medicine imaging procedures. The ^{99}Mo–^{99m}Tc generator is usually produced in nuclear reactors. However, disruption in the supply of ^{99}Mo have spurred scientists to search for alternatives in producing ^{99m}Tc [2].

In common settings, the ^{99m}Tc radioisotope is supplied to medical facilities in the form of ^{99}Mo–^{99m}Tc generator. The ^{99m}Tc radioisotope is then extracted from the generator on a daily basis. Another approach available to medical facilities with in-house cyclotron is to produce ^{99m}Tc directly [3].

In this primary study of ^{99m}Tc production with high-intensity laser, we first simulate the production of protons using particle-in-cell code. Figure (a) shows the simulated proton counts as a function of energy. The outgoing protons are then made incident on various nuclei to produce either ^{99}Mo which decay to ^{99m}Tc, or to ^{99m}Tc directly. The TALYS nuclear reaction code is used for this part of the simulation. Figure (b) shows an example of the production cross-section of ^{99m}Tc via (p,np) reaction. Results from both the particle-in-code and TALYS code simulations are then used to calculate the total production yield of ^{99m}Tc. Figure (c) shows an example of the partial sum of the ^{99m}Tc production yield.

References
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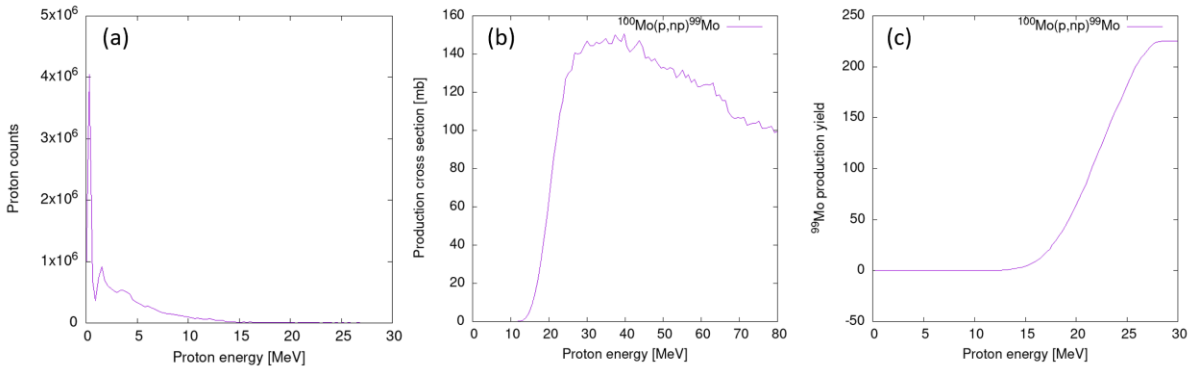

Figure 1: Panel (a) shows the proton counts obtained from the particle-in-cell code while panel (b) shows the production cross section of ^{99m}Tc via (p,np) reaction obtained with the TALYS code. Partial sum of the production yield is shown in panel (c).