

Complete characterization of the energy spectra of laser-accelerated protons for the production of radioisotopes used in medical imaging.

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Laser-driven ion accelerators may represent a competitive technology for the future production of medical radioisotopes. First experiments on laser-driven proton acceleration in the Target Normal Sheath Acceleration (TNSA) regime were performed at the Laser Laboratory for Acceleration and Applications (L2A2) by focusing a 45 TW, 10 Hz repetition rate femtosecond laser on Al foils of a few micrometer thickness. Typical exponential maxwellian-like proton spectra with a cut-off energy up to 1.65 MeV were measured with a time-of-flight (ToF) detector system. Results have been compared to recently published data, regarding maximum energy, particle number, and distribution temperature in order to infer correlations between these parameters and the laser pulses characteristics. These correlations were used to extrapolate our results to obtain estimations on production activities for various proton- and deuteron-induced nuclear reactions, for optimized experimental parameters. Activity levels of ~32.1 MBq for ^{11}C via $^{11}\text{B}(p,n)^{11}\text{C}$ reaction are estimated for one hour of irradiation at a laser repetition rate of 10 Hz, which are in the range of doses required for preclinical Positron Emission Tomography (PET) imaging. Other radioisotope production reactions are also considered and studied.

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