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Radioisotope production using a high-repetition-rate, laser-based proton source

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The level of maturity of laser-based ion accelerators is opening the path for their use in real-life applications. Particularly promising is the in-situ production of short-lived radionuclides for medical imaging, with techniques such as Positron-Emission-Tomography (PET). However, the large activities required (>10MBq for pre-clinical, >200MBq for clinical) are well-above those achievable from a single irradiation using commercial high-power lasers.
In this context, we have developed a novel multi-shot target system capable of operating for thousands of irradiations at rates of up to 10Hz. In particular, the system is based on a rotating wheel with automatised target pre-characterisation, avoiding the need for re-alignment between shots and allowing for rapid changeovers. With this system, stable ion acceleration ($\sigma_{E_{max}}$~15%) has been demonstrated for >1000shots under operation at 10Hz.
In a proof-of-principle experiment, this target system has been deployed at a campaign at CLPU aiming to produce ^{11}C. Using the 100TW laser operating at 0.1Hz, activities >12kBq/shot and total activities >230kBq from bursts were demonstrated. These results indicate that pre-clinical activities are already achievable under the current conditions with extended irradiation times. Furthermore, we demonstrate that multi-Hertz tabletop systems, typically producing lower-energy ion beams, can reach clinical activities thanks to the increased repetition rate.

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