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Ultra-intense neutron source generation from double-layer convertors driven by the PETAL laser

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This work focuses on the experimental characterization of a neutron source driven by the high-energy (between 300 and 600J), short pulse (700 fs) LMJ-PETAL facility. For this purpose, a total of 8 shots were performed in 2023 and 2024 in the 0.38 - 0.86 PW pulse power range. The neutrons were generated through (p,xn) reactions by a target normal sheath accelerated (TNSA) proton beam in a pitcher-catcher configuration [1]. The converters consisted of double-layer targets made of lithium fluoride (LiF) and lead (Pb), the thicknesses of which were varied to optimize the number of emitted neutrons [2]. The properties of both TNSA proton and emitted neutron populations were inferred by a suite of diagnostics, including a radiochromic film (RCF) stack, magnetic particle spectrometers, nuclear activation pellets, bubble dosimeters and neutron time-of-flight (nToF) detectors [1]. The total number of fast neutrons (exceeding 1 MeV and emitted quasi-isotropically) is estimated to be as high as 5×10^{10} per shot, a performance comparable with the state of the art [3]. Such sources could find applications in nuclear physics and astrophysics [4, 5], as well as in radiography of high-energy-density environments or fast neutron material characterization techniques [3, 6].

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