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Fast neutron generation from laser-driven sources

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High intensity lasers ionise and accelerate mega-ampere currents of electrons within targets to relativistic energies, driving a series of secondary processes as a result. Two mechanisms of note are the generation of energetic photons extending up to 10s-100s MeV in energy, and 10s MeV proton-population driven by electrostatic charges from the escaping electrons. Both these secondary processes in turn provide a mechanism for a bright, prompt, and tunable fast neutron source through (γ,n) and (p,n) reactions.

Each mechanism inherits a common set of characteristics from the driving laser pulse, they are short lived (<ps), emanate from a small source (um-mm), and can be tuned by altering the laser parameters or target conditions. (p,n) reactions have dominated the field utilising a pitcher-catcher style target system where protons are driven into a secondary target of, typically, copper or lithium to generate a pulse of neutrons with fluxes up to 10^{10} N/sr/shot and energies extending up to 35 MeV [1].

Novel high repetition laser facilities, such as the Extreme Photonics Applications Centre (EPAC) at the CLF, are looking to utilise these sources for industrial applications. Herein, we describe this bright and energetic source of neutrons, how we characterise them in laser-plasma experiments and the possible applications we are exploring.

[1] - Kleinschmidt, Annika, et al. "Intense, directed neutron beams from a laser-driven neutron source at PHELIX." *Physics of Plasmas* 25.5 (2018).