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Enhanced proton and neutron production using the ultra-short (24 fs) and high-power (2 PW) Apollon laser facility

Friday 6 June 2025 09:30 (30 minutes)

We will review interesting advances we have been able to perform in the domain of laser-driven generation of proton and neutron beams, using the new ultra-high power Apollon laser facility (France) [BUR]. Thanks to the ability to tailor the ultra-short timescales of the temporal pedestal of the laser pulse, we have notably been able to accelerate protons in a "lighthouse"fashion, whereby the highest-energy component of the beam is emitted in a narrow cone, well separated from the lower-energy components. As a result, the spectrum of the output protons can be easily adjusted by collecting them along a specific direction, therefore removing a major roadblock of these beams, which are otherwise spectrally broadband. This approach offers the advantages of leveraging a robust sheath acceleration process in standard micron-thick targets and being optically controllable. We have also demonstrated that, when enhancing the temporal contrast by using plasma mirrors, we could enhance the laser-to-target coupling and the proton energy, as well as reduce the angular divergence of the proton beams. Last, we will review the high flux neutrons that can be produced using these beams when using (p,n) reactions in Li [LEL]. The measured high fluxes that can be obtained using Apollon open perspectives for getting insight into nucleosynthesis of elements [HOR].

Footnotes

[BUR] K. Burdonov et al., , Characterization and performance of the Apollon short-focal-area facility following its commissioning at 1 PW level, Matter and Radiation at Extremes 6, 064402 (2021)
[HOR] V. Horny et al., Quantitative feasibility study of sequential neutron captures using intense lasers,Phys. Rev. C 109, 025802 (2024).
[LEL] R. Lelièvre et al., A Comprehensive Characterization of the Neutron Fields Produced by the Apollon Petawatt Laser, http://arxiv.org/abs/2311.12653

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