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Laser ion acceleration with low density targets: a new path towards high intensity, high energy and high current ion beams

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Intense research is being conducted on sources of laser-accelerated ions and their applications, motivated by the exceptional properties of these beams: high brightness, high spectral cut-off, high directionality, laminarity, and short duration (~ps at the source). It was recently experimentally shown that a promising way to accelerate ions to higher energies and in a collimated beam is to use under-dense or near-critical density targets instead of solid ones. In this case, volume effects dominate, enhancing the laser-to-proton energy conversion, and allowing reaching high ion energies with a high number of accelerated ions.
The transition between various laser ion acceleration regimes depending on the density gradient length (controlled by the delay between the lasers) was studied at LULI 200 TW and LLNL Titan Facilities using a two-laser setup. A first ns pulse was focused on a thin target to explode it and a second laser was focused on the exploded foil. Protons with energies significantly higher than the ones reached for solid targets were obtained while keeping a good beam quality. These results demonstrate that low-density targets are a promising candidate for an efficient compact proton source.

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