High-repetition-rate targets at the CLPU: liquid, gas, and tape targets

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Laser-driven ion acceleration has been studied in depth in the last decade due to a large potential range of applications, from fundamental science to medicine. Traditionally, high-power laser facilities were only available at low repetition rate and thin metallic solid targets were usually used due to their simple fabrication and ability to produce high-quality ion beams. However, after the interaction the target is destroyed and realignment of a new one is mandatory.

Nowadays, high-power laser operation rates up to 1-10 Hz requires 3600-36000 targets per hour. Thus, laser facilities need to provide the supporting technologies for delivering targets capable to regenerate in situ and operate at high repetition rate (HRR). A large effort of research and development is taking place to understand, test and optimized HRR targets. For example: cryogenic ribbons [1], water droplets [2], liquid crystal films [3], bulk glass targets [4], gas-jet targets [5,6] or even tape targets [7].

We will present three different HRR targets that are under development at the CLPU: a versatile quasi-planar water target, a high-density supersonic-gas-jet target, and a solid tape target.

The water target is made from the collision of two equal diameter and velocity liquid microjets. This target is easy to align by shadowgraphy techniques and is debris-free, the thickness can be controlled (submicron range), and the ablated interaction region refresh in tens of µm. We report proton acceleration up to 4 MeV from the interaction of the HRR VEGA-2 laser with the HRR water sheet target in high-vacuum conditions (10^{-4} mbar). These results are published in [8].

The gas target consists of the generation of a high-density supersonic-gas jet to study alternative acceleration mechanisms at critical density. The advantages of gas targets are continuous refreshment of the target inherently debris-free, and the variety of ion species that can be used.

The tape target is built to work in the petawatt VEGA-3 laser environment. The challenges in laser particle acceleration with solids are mainly fast target refreshing, positioning “on focus” and alignment in real-time. Details will be presented in a future article.

References

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