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Well-controlled near-critical plasmas from supersonic gas jets for enhanced ion acceleration by ultra-intense laser interaction

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Efficient electron heating and enhanced ion acceleration by ultra-intense laser interaction with well-controlled near-critical plasmas were predicted numerically but remained relatively unexplored owing to the difficulty of creating such type of targets. We studied this regime on the CLPU VEGA-2 200TW laser facility (6J, 30fs, at 10^{21} W/cm²) with state-of-the-art pressure-boosted supersonic gas jets from CELIA.

The interest in compact high-repetition rate ion sources with high energy-density at ultra-low emittance stems from many potential applications, including proton radiography, time-resolved probing of ultrafast laser-induced phenomena, fast ignition, nuclear physics and medical applications. Most of these applications require a particle flux which may greatly surpass those attained on standard radio-frequency accelerators.

Our gas jets issue from novel shock nozzles with carefully adapted spatial density profiles that have a high temporal ms-scale stability. Employing different gases, namely N₂, He and mixtures of both, the resulting jets are characterized by a maximum free electron density of $\approx 10^{21}$ /cc after laser-induced ionization.

Such experimental conditions may be prone to driving collisionless electrostatic shocks with PW-level ultra-short laser pulses. We will show first preliminary results already obtained at the 200TW level, regarding the accelerated species detected on radiochromic films, CR-39 and a pair of PIN-diodes.

Choix de session parallèle

4.1 Plasmas et accélérateurs: état de l'art et machines du futur 1

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