Laser-made tailored plasma targets for Laser Wakefield Acceleration

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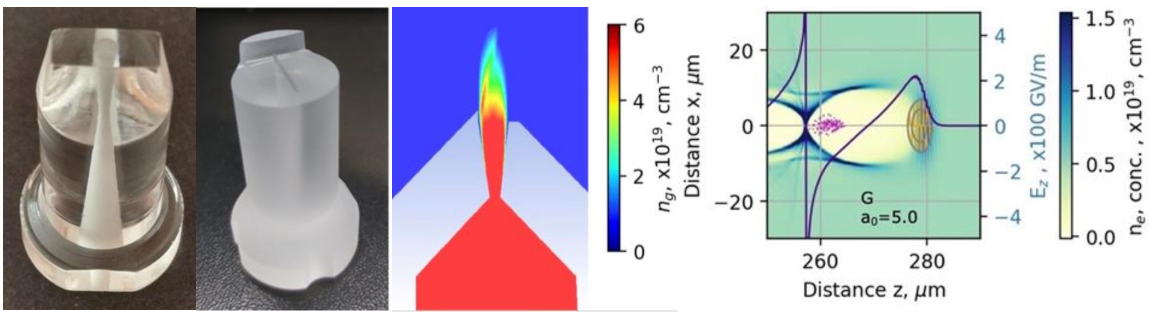
Laser wakefield accelerators are a promising alternative to huge radiofrequency accelerators, enabling the production of electrons with GeV energy in just a few centimetres. Acceleration takes place by interacting an extremely intense laser beam with a target. Emerging multi-terawatt high-repetition rate lasers open new opportunities for developing more compact and cost-efficient energetic beams for various applications, including radiotherapy. Solid and liquid targets are not well suited to this kind of laser, and near-critical density compressed gas targets with tailored density distributions are in demand.

We utilise a combined laser micromachining technology with ultrashort-pulse burst-mode lasers to manufacture complex gas nozzles in fused silica [1,2]. The process includes supersonic flow dynamic simulation, mechanical design of the nozzles adapted to the laser beam and Fourier-Bessel Particle-In-Cell (FBPIC) simulation of electron acceleration in a plasma wake, generated inside the gas target [3] before the real manufacturing.

A stable operation with electron energy around 3 MeV was demonstrated at a 1 kHz repetition rate with a low pulse energy utilising converging one-side-shock nozzles [4]. Research on more complex-shaped gas targets is ongoing. Flexibility in the 3D shaping of plasma targets, tailored to particular beam profiles of ultra-high intensity lasers, is a way to achieve high energy of accelerated electrons with low energy spread and divergence required for high-energy research and practical applications.



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