# Optical shaping of high-pressure gas-jet targets for proton acceleration experiments in the near-critical density regime

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Laser-induced proton acceleration is a subject of great interest due to its numerous potential applications, among others in energy production through Inertial Confinement Fusion (ICF), or in medical applications such as hadron therapy. Extreme pressure gas-jet targets, able to reach the near-critical density regime, can be used as high repetition rate (HRR), debris-free proton sources. In the near-critical regime, Magnetic Vortex Acceleration (MVA) is one of the most promising proton acceleration mechanisms. While state-of-the-art simulations predict hundreds of MeV of protons by super-intense, short wavelength, femtosecond laser pulses, MVA remains experimentally challenging due to the extremely steep density gradient plasma profiles required as implied by simulations. Here, we present Magnetohydrodynamic (MHD) simulation results on the capability of delivering optically shaped targets through the interaction of nanosecond laser pulses with high-density gas-jet profiles. Multiple laser-generated Blastwave schemes capable to compress the gas target into near-critical steep density gradient slabs of few microns thickness are reported. In addition, experimental findings of the optically shaped gas-jet targets, delivered by a solenoid valve along with an air-driven hydrogen gas booster, able to support 1000 bar of backing pressure are presented [1]. Additionally, the capability of proton acceleration by the interaction of the compressed, steep gradient, near-critical density developed targets, with the fs laser pulse of the ZEUS 45TW laser system of IPPL, is demonstrated by 3D Particle-In-Cell (PIC) simulations.

[1] Clark, E. L., et al. High Power Laser Sci. Eng., (2021), pp. 1–28., DOI: 10.1017/hpl.2021.38