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Laser driven proton acceleration from imploded gas targets

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Advances in short-pulse near-infrared laser technology have significantly expanded access to the relativistic regime of laser–plasma interactions, enabling new approaches for compact, high-energy proton acceleration. A primary objective is to produce stable, high-charge proton beams suitable for applications such as proton radiography, hadron therapy, and medical isotope generation. Proton acceleration with near-critical density (NCD) gas targets offer promising energy scaling and operation at high repetition rate.

In this work, we present experimental results demonstrating efficient proton acceleration using optically tailored hydrogen gas targets. Femtosecond laser pulses are used in distinct, implosion geometries in order to attain a transient, near-critical density region. By tailoring the gas density profile and optimizing the focal geometry, we achieved stable proton beam generation. Our findings exemplify the role of laser-shaped density gradients in achieving proton acceleration and provide a robust platform for exploring NCD-driven acceleration mechanisms under well-controlled experimental conditions.

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