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Demonstrating MeVs protons acceleration in near critical imploding gas target

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The interaction between relativistic intensity laser pulses and near-critical density targets has been sought after to increase the efficiency of laser-plasma energy coupling, particularly for proton acceleration. To achieve this density regime for high repetition rate applications, one approach is to use gas targets, provided that stringent target density profile requirements are met, including reaching the critical plasma density while maintaining micron-scale density gradients.
In this work, I'll present a novel scheme for achieving the necessary requirements using a tens of mJ optical laser pulses to shape the gas by colliding shock wave in planar geometry or by generating a cylindrical implosion. Utilizing this approach, we experimentally demonstrated stable proton acceleration and achieved up to ~ 5 MeV in a mono-energetic distribution and particle numbers above 10^8 /Sr/MeV using a 1-2 Joule laser system. The presented results open the door for future work in controlling gas targets and optimizing the acceleration process for multi-PW laser system.

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