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Proton beam divergence measurements from radiation pressure driven shock acceleration

Laser-plasma ion acceleration is a well established field of research, with several mechanisms being exploited to produce high energy, short particle beams.

Scaling laws show that both the laser's vector potential, and the critical density scale favorably with laser wavelength. Hence the long wavelength (9.2μm) CO_2 laser at the Brookhaven National Laboratories is the ideal choice for exploring radiation pressure acceleration using gaseous targets.

The work carried out by the Imperial group at BNL has demonstrated steady ion production in the scenario where the laser interacts with the gas-jet from a supersonic nozzle.

Significant gains in the ion energies were obtained when employing the laser's pre-pulse to shape the target and form blast waves. This approach produced low divergence, $\sim$1MeV mono-energetic ion beams. The results are backed by PIC simulations which give insights on the acceleration dynamics.

Thanks to a short-pulse probe beam it was possible to accurately image the laser-target interaction using interferometry. An innovative proton spatial diagnostic, which allowed us to quantify the divergence of the ion beams, was also fielded.

Measuring particle divergence is a crucial first step towards optimising the coupling between beams and transport lines, which is essential for all applications of ion acceleration.

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