Magnetized Rayleigh-Taylor instability driving particle acceleration

J. Capitaine\textsuperscript{1}, A. Ciardi\textsuperscript{2}, B. Khiar\textsuperscript{2}, G. Revet\textsuperscript{2}, P. Savoini\textsuperscript{3}, J. Fuchs\textsuperscript{3}

\textsuperscript{1} Sorbonne Université and Observatoire de Paris, LERMA, CNRS, France
\textsuperscript{2} Flash Center for Computational Science, University of Chicago, USA
\textsuperscript{3} LULI, CNRS, Ecole Polytechnique, CEA, Université Paris-Saclay, Sorbonne Univ., France

Mega-Gauss-level magnetic fields applied to laser produced plasmas are opening the door to a range of new studies in inertial confinement fusion and laboratory astrophysics. Our experiments and related theoretical work have addressed the physics of magnetized accretion flows \cite{1}, jet collimation \cite{2,3} and variability \cite{4}, and more recently, ion-driven streaming instabilities and particle acceleration.

In this paper we shall discuss the acceleration of charged particles in colliding plasma flows generated by irradiating with a ns-laser, two oppositely facing solid targets. The expanding plumes are collimated into jets by an externally imposed 20 T magnetic field and the collision of the two jets generates a region of strong shocks and turbulence. Measurements using a Thomson parabola indicate particles with energies up to \(~1\text{MeV}\).

To understand the mechanisms leading to the acceleration of the particles, simulations are performed with the 3D resistive MHD code GORGON coupled with a test-particles solver. The dynamics of the plasma and how the particles get their energy will be presented. Notably we find that the magnetized Rayleigh-Taylor instability can drive expanding plasma spikes that energize particles by a Fermi-type acceleration mechanism. Possible implications for astrophysical systems will be discussed.

References

\cite{1} Revet et al., Science Advances, Vol. 3, no. 11, e1700982 (2017)
\cite{2} Ciardi et al., Physical Review Letters, 110, 025002 (2013)
\cite{3} Albertazzi et al., Science, Vol. 346, Issue 6207, pp. 325-328 (2014)
\cite{4} Higginson et al., Physical Review Letters, 119, 255002 (2007)