Investigation of pinching effects in intense laser plasma interactions

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Developments in the field of laser plasma accelerators have been pushed by applications like radiation therapy in the past years. Thereby the acceleration of particle to higher energies is one of the key questions for such applications. Probing methods offer the capability for investigating the laser target interaction and thus allow for studying the acceleration process.

In this talk results obtained by optical probing in recent experiments for laser driven proton acceleration with high contrast at the high power laser Draco at HZDR are presented. Draco delivers pulses of 30 fs and 5 J at 800 nm, focused to a 3 µm spot by a F/2.5 off-axis parabolic mirror. We present results of an experimental campaign using a cryogenic hydrogen jet as a renewable debris free target. The hydrogen jet’s nominal electron density is approximately 30 times the critical density for 800 nm and its shape and size can be varied. For instance cylindrical geometries with diameters of 2 µm, 5 µm or 10 µm were used. The laser plasma interaction could be monitored on-shot with two temporally synchronized optical probe beams perpendicular and longitudinal to the Draco laser axis. Recorded probe images taken up to 100 ps after the laser pulse arrived at the target indicate plasma density modulations from pinching effects along the jet axis. A possible driver for those density modulations is a strong surface current which has been studied with 2D-PIC simulations. Such density modulations may modify the shape of the electron sheath and thereby alter the beam profile of the laser accelerated protons.