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High-repetition-rate laser-proton acceleration employing a cryogenic Hydrogen jet as a target

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Applications of laser-accelerated protons demand a stable, high-energy and high-repetition rate particle source. We present the results of our experimental campaign in cooperation with the HED group at SLAC, performed at the 10 Hz Ti:Sa laser Draco of Helmholtz-Zentrum Dresden-Rossendorf (HZDR), employing a cryogenic Hydrogen jet as a renewable target. Draco delivers pulses of 30 fs and 5 J at 800 nm, focussed to a 3 μm spot by a F/2.5 off-axis parabolic mirror. The cylindrical jet has a diameter of 2 μm or 5 μm and a nominal electron density of 30 times the critical density. Preliminary results show a mono-species proton acceleration in a solid angle of at least +/-45° with respect to the incoming laser beam and proton energies exceeding 10 MeV. Radiochromic film stacks in forward direction show signatures of two acceleration mechanisms, one being the conventional TNSA and a second one leading to filament-like structures, possibly stemming from an instability within the plasma. Among other results, an on-shot monitoring of the stability of the jet by means of a temporally synchronized probe beam will be shown in the presentation.

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