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Cryogenic jet platform for High-Energy-Density experiments at European XFEL

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Jets of cryogenically cooled hydrogen has been fielded just recently in the disciplines of plasma physics and high energy density science in order to explore extreme states of matter as found deep inside planet interiors [1, 2] or in relativistic laser plasma interactions aiming to develop table-top ion accelerators [3, 4, 5]. Latter promise a wide range of potential applications as compact particle source for medical tumor therapy treatments or high flux neutron converter for material radiography. The respective research towards a detailed understanding of the microscopic spatiotemporal evolution of transient laser plasmas is one of the key goals of the high-energy-density (HED) instrument combining brilliant x-ray pulses of the European XFEL facility and ultra-high-power laser drivers of HIBEF*.
This talk will introduce the new standard platform for cryogenic liquid jet delivery, currently developed and soon commissioned at the HED instrument, which aims to provide targets of various types of liquids, shapes (circular, sheets, droplets) and sizes. Compared to solid foil samples, stably free-standing replenishing jets promise continuous 10 Hz repetition rate by mitigating debris, one of the major obstacles in high power laser experiments. The platform integration into the beamline including online target characterization diagnostics will be presented.

*HIBEF - Helmholtz International Beamline for Extreme Fields

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[2] L.B. Fletcher, et al., “High resolution x-ray Thomson scattering measurements from cryogenic hydrogen jets using the Linac Coherent Light Source”, Rev. Sci. Instruments 87, 11E524 (2016)
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[4] M. Gauthier, et al., “High-intensity laser-accelerated ion beam produced from cryogenic micro-jet target”, Rev. Sci. Instruments 87, 11D827 (2016)
[5] L. Obst, et al., ”Efficient laser-driven proton acceleration from cylindrical and planar cryogenic hydrogen jets”, Sci. Reports 7,10248 (2017)

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