World Academy of Science, Engineering and Technology
International Journal of Nuclear and Quantum Engineering
Vol:10, No:06, 2016

Laser-Hole Boring into Overdense Targets: A Detailed Study on Laser and Target Properties

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Abstract : Understanding the interaction of ultra-intense laser pulses with overcritical targets is of major interest for many applications such as laser-driven ion acceleration, fast ignition in the frame of inertial confinement fusion or high harmonic generation and the creation of attosecond pulses. One particular aspect of this interaction is the shift of the critical surface, where the laser pulse is stopped and the absorption is at maximum, due to the radiation pressure induced by the laser pulse, also referred to as laser hole boring. We investigate laser-hole boring experimentally by measuring the backscattered spectrum which is doppler-broadened because of the movement of the reflecting surface. Using the high-power, high-energy laser system PHELIX in Darmstadt, we gathered an extensive set of data for different laser intensities ranging from 10^18 W/cm2 to 10^21 W/cm2, two different levels of the nanosecond temporal contrast (10^6 vs. 10^11), elliptical and linear polarization and varying target configurations. In this contribution we discuss how the maximum velocity of the critical surface depends on these parameters. In particular we show that by increasing the temporal contrast the maximum hole boring velocity is decreased by more than a factor of three. Our experimental findings are backed by a basic analytical model based on momentum and mass conservation as well as particle in cell simulations. These results are of particular importance for fast ignition since they contribute to a better understanding of the transport of the ignitor pulse into the overdense region.

Keywords : laser-hole boring, interaction of ultra-intense lasers with overcritical targets, fast ignition, relativistic laser motter interaction
Conference Title : ICHED 2016 : International Conference on High Energy Density
Conference Location : San Francisco, United States
Conference Dates : June 09-10, 2016