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Study of ultra-intense laser propagation in overdense plasmas for fast ignition

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The scheme of fast ignition of fusion energy relies on the ultra-intense laser energy transport into the compressed core plasma. The popular idea is to use a physical reentrant cone to guide the laser beam from the coronal plasma close enough to the core plasma. An alternative idea is to inject the laser pulse directly into the corona plasma. This requires efficient propagation of laser light in the overdense plasma. We study the so called super-penetration mode of ultra-intense laser pulse penetrating into overdense plasmas with the relativistic effect [K. A. Tanaka et al., Phys. Plasmas 7, 2014(2000), R. Kodama et al., Phys. Plasmas 8, 2268(2001)]. We have experimentally observed the laser light penetration through a large preformed plasma with peak density of 10nc and the plasma channel formation, with the channel direction coinciding with the laser axis [A. L. Lei etal., Phys. Rev. E 76, 066403(2007)]. We find that the laser propagation is dependent on the laser focus position via measuring the laser transmittance though the overdense plasmas. The fast electrons generated are pointed along the laser axis and much collimated compared to the laser-solid interactions. To improve the laser propagation quality in overdense plasmas, we propose to use multiple short laser pulses. The physics of multiple pulse penetration will be discussed. This work is supported by the Japan-China JSPS-CAS Core University Program.