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Laser-driven Ion-, electron- and photon-beams from relativistically overdense plasmas B.M. HEGELICH, L. YIN, B. ALBRIGHT, K. BOWERS, C. GAUTIER, LANL, A. HENIG, R. HOERLEIN, LMU, B. DROMEY, QUB, D. JUNG, LANL/LMU, D. KIEFER, LMU, S. LETZRING, LANL, T. TAJIMA, X. YAN, D. HABS, LMU, J. FERNANDEZ, LANL — As one of the main tools for the experimental investigation of relativistic plasmas in the laboratory, ultrahigh intensity lasers have seen rapid growth with ever extremer parameters of energy and pulse duration. At peak powers, already exceeding 10^{22} W/cm^2, in virtually every experiment in relativistic laser physics, the laser pulse interacts with a more or less extended and heated plasma, due to prepulses and ASE. By drastically improving this contrast, we initiated a paradigm shift in relativistic laser-matter interactions, allowing us to interact ultrarelativistic pulses volumetrically with overdense targets, that will turn relativistically transparent during the few 10s – 100s fs of the interaction. Specifically, we increased the contrast of the 200TW Trident laser to better than 2x10^{-12} at 500ps and better than 1^{-7} at 5ps enabling an interaction with overdense targets between 3 to 300nm. This volumetric overdense interaction enables new particle acceleration mechanisms for both electrons and ions, as well as forward directed relativistic surface harmonics. In first experiments we were able to experimentally demonstrate a new ion acceleration mechanisms, the Break-Out Afterburner, reaching carbon energies of >0.5GeV and proton energies >65MeV. This work was supported by the DOE OFES and by the DFG through LMUexcellent.

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