Contribution ID: **18** Type: **not specified**

Spectroscopic analysis of plasmas created in high contrast relativistic laser-matter interaction.

Thursday, 22 June 2017 10:10 (20 minutes)

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In this work we present an experimental evidence of a highly ionized plasma state with a near solid electron density obtained due to interaction of the high contrast 45 fs relativistic laser pulse with Ti-foils. Intensity of the second harmonic (400nm) Ti-sapphire laser pulse onto the target reached 1019 W/cm2. Complex diagnostic set-up was used for characterization of the laser-matter interaction by measuring of a characteristic plasma radiation, a bremsstrahlung radiation providing by suprathermal electrons decelerated in the target material, and an energy distribution of energetic run-away electrons escaping the target. Plasma parameters have been evaluated from the characteristic spectra of highly charged Ti-ions measured with a high spectral resolution. Transient plasma effects (dependence of the ion population states on time), role of suprathermal electrons which influence ionization and excitation of electrons with high binding energy, together with a non-collisional ionization of atoms up to higher charge states by means of the laser field have been taken into account in the interpretation of measured spectra. By application of layered targets it was shown, that the thickness of the keV hot dense plasma layer is below 200nm. PIC simulations confirm that at the high contrast laser-matter interaction a substantial part of the laser energy transfers into electrons with energies below 10 keV. By propagation in matter, these electrons are stopped in a very thin target layer. High energy density stored in a small target volume leads to creation of keV hot plasma of solid density diagnosed in the experiment.

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Session Classification: Ultrafast plasma