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WIDE-RANGE X-RAY DIAGNOSTICS OF RELATIVISTIC FEMTOSECOND LASER PLASMA *)

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Accurate measurement and evaluation of the key properties of plasma (mechanisms of energy absorption, heat transfer processes, plasma expansion and other phenomena) is of great importance in the studies of laser-plasma interaction. In this paper, the X-ray plasma spectra in the range from hundreds of eV to hundreds of keV are experimentally studied with the use of wide range diagnostics. The spectral emission properties of plasma are investigated in dependence on the parameters of laser radiation (intensity, contrast, etc.)

In our experiments a 50 fs pulse from the TiSa system is focused to an intensity 10^{16}-10^{18} W/cm^2 on the surface of a molybdenum target. The picosecond pedestal contrast of the pulse varied and was $5x10^7$ and 10^9. This parameter determines the length of the preplasma layer by the moment of arrival of the pulse peak and determines mainly the absorption of radiation as well as the efficiency of hot electron generation.

Investigating the temperature of hot electrons at moderate contrast ($5x10^7$) of the most energetic plasma component, it was found that as the laser intensity increases from ~$2x10^{16}$ to $3x10^{18}$ W/cm^2, the measured value increases from ~30 keV to more than 200 keV and can be attributed to resonant absorption. However, at higher intensities, a transition to ponderomotive acceleration is observed. Nevertheless, the long preplasma prevents efficient energy transfer to electrons in the dense region. This effect appears to be suppressed for the high-contrast pulse (10^9). Thus, the temperature of hot electrons increases significantly in the relativistic intensity region and reaches 300 keV.

At the same time, in the low energy region (thermal component of the electron spectrum) the intensity dependence is not so significant. Temperatures are at the level of hundreds of eV and, to all appearances, are determined by inverse absorption absorption and heating by inverse currents. The temperature increase at higher contrast is also noted, which may be related to a denser plasma near the target boundary.

In addition to the electronic components of the plasma, the generation efficiency of K-αpha radiation has been experimentally investigated. The relation between the flux of quanta and the temperature of hot electrons is shown. The maximum flux of line quanta reaches 4x109 photons per shot.

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