TWO-COLOR INTERFEROMETER FOR INVESTIGATING OF DENSE LOW-IONIZED TARGET PLASMA [[1]](#footnote-1)\*)

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The shadow radiography method is based on the conversion of a highly compressed electron beam (with a current of several kiloamperes) into hard X-ray radiation on a target made of a material with a large atomic mass (tantalum) [1, 2]. The size of the focal spot of the beam on the target determines the spatial resolution of the radiographic complex, and to improve it, it is necessary to ensure good focusing of the beam. In this case, a significant energy release density is created in the target, which leads to its partial evaporation and ionization. The formed target plasma can have a detrimental effect on the focusing of the beam through mechanisms such as charge and current beam neutralization; the interaction of the beam and the reverse current flowing through the plasma; various collective instabilities in the plasma cloud. In addition, in the case of a multipulse mode of operation of the radiographic complex, the electron beams of the second and subsequent pulses go through the already prepared gas-plasma cloud, which greatly complicates the problem of their focusing. In order to study the beam – plasma interaction, it is of interest to determine the parameters of the target plasma — the densities of the neutral and electronic components — and their dynamics at times corresponding to the interval between pulses (tens to hundreds of microseconds).

To solve this problem, we developed diagnostics of the target plasma parameters at the LIU setup based on a two-color interferometer. The use of probe radiation of two frequencies is necessary for independent measurement of the linear densities of the neutral and electronic components of the plasma. To reduce the error in determining the polarizability, it is necessary to use frequencies that are possibly farthest from the atomic transitions of tantalum to the lower side. For a more confident distinction between the neutral and electronic components, probing frequencies that are most remote from each other should be used. Based on these requirements, also taking into account the availability of available lasers, the wavelengths 1.064 μm (Nd:YAG laser) and 10.6 μm (CO2 laser) were chosen in the described interferometer. Both rays are combined in space and pass through the studied plasma along the same chord. To calibrate the amplitude and initial phase of the signal, a moving mirror is used, which oscillates according to a harmonic law. Since the plasma under study is strongly inhomogeneous, significant refraction of rays in the plasma is possible. To suppress this refraction, an optical scheme of two mirrors focusing the rays into the region occupied by the plasma is used. For registration, infrared detectors are used. Separately, the power of the object beam transmitted through the plasma is recorded.

Using the developed diagnostics, initial experiments were carried out to determine the parameters of the target plasma at the LIU setup. Parameters of the electron beam: current 1.6 kA, energy 4.6 MeV, pulse duration 100 ns, initial size of the focal spot on the target 1 mm. A plasma corona of the target plume was detected, expanding at a speed of about 4 km/s. The measured the corona material density was ~ 4∙1017 cm-3, the electron density was ~ 4∙1014 cm-3, and the degree of ionization was ~ 0.1%.

References

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2. Merle, E. et al. (2019). High Current and High Energy AIRIX Induction Accelerator Development.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVII/Lt/ru/FU-Danilov.docx) [↑](#footnote-ref-1)