IMPLEMENTATION FEATURES OF OPTICAL DIAGNOSTICS ON A HIGH-CURRENT ELECTRON ACCELERATOR KALMAR FOR VACUUM DIODE PLASMA DYNAMICS INVESTIGATION [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.160

1,2,3Kazakov E.D., 1Orlov M.Yu., 1Strizhakov M.G., 4Sunchugashev K.A., 2Voronin A.V.

1NRC "Kurchatov Institute", Kazakov\_ED@nrcki.ru
2National Research University MPEI, KazakovYD@mpei.ru
3Moscow Institute of Physics and Technology (National Research University)
4RUDN University

Despite the fact that the study of plasma behavior in vacuum diodes of high-power high-current accelerators has been carried out for a long time, a number of new results have been obtained in recent years, demonstrating the need for a more detailed study of this issue [1]. In particular, at the Kalmar facility, in a number of regimes, the glow propagates from the center to the periphery at velocities of the order of 100 km/s [2], which may indicate the development of instabilities or the occurrence of secondary breakdowns, which was not previously observed. On installations of this type, studies of the strength properties of modern composite materials are carried out. The behavior of the plasma in the diode gap can affect not only the erosion of near-surface layers, but also the formation of additional pressure, and, consequently, the occurrence of an additional (besides the action of the electron beam) shock wave load.

For a more detailed than earlier [3] study of this process, a new optical scheme was proposed that allows chronographic registration of the anode and cathode plasma expansion in two directions – along and across the axis of the vacuum diode. The registration system, implemented on the basis of two streak-cameras, makes it possible to register the intrinsic emission of the plasma, or laser radiation transmitted through the vacuum diode. When using color filters, it is also possible to combine the glow of the plasma with the shadow image. This scheme also makes it possible to implement the Schlieren-method. For probing, a pulsed laser based on yttrium orthoaluminate with neodymium (λ1=1079 nm) manufactured at the Scientific and Technical Center of the UP RAS is used. The laser operated in the free generation mode with intracavity conversion of λ1 radiation into the second harmonic (λ2=540 nm). The laser has an adjustable pulse duration with the ability to provide a plateau of about 300 µs at an energy of 90 mJ. This made it possible to consider the pulse as quasi-continuous, which greatly simplified its synchronization with plasma processes and the registration system.

The paper presents the first results of the application of this optical scheme on the Kalmar setup. The plasma dynamics in the laser shadow was recorded behind two types of filters - an interference filter at 540 nm and a set of green color filters. In the first case, we observe only the motion of the plasma boundary with an electron density of the order of 1018 cm-3; in the second case, we also observe the residual self-glow of the plasma. This makes it possible to separate the effects associated with the movement of the plasma plume from the anode from the process of its deceleration on the residual gas.

References

1. Ananyev S.S., Bagdasarov G.A., Dan’ko S.A., et al. //Plasma Physics Reports. 2017. Т. 43. № 7. С. 726-732.
2. Ananyev S.S., Dan'Ko S.A., Kazakov E.D., Kalinin Y.G., Kurilo A.A., Strizhakov M.G. // Journal of Physics: Conference Series. 2016. Т. 747. № 1. С. 012003.
3. Kazakov E.D., Kalinin Y.G., Krutikov D.I. et al. //Plasma Physics Reports. 2021. Т. 47. № 8. С. 803-813.
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/FC-Kazakov.docx) [↑](#footnote-ref-1)