Dynamics of beam-plasma discharge development in the GDT facility [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.167

1,2Glinskiy V.V., 1,2Timofeev I.V., 1,2Volchok E.P., 1,2Annenkov V.V.

1Budker Institute of Nuclear Physics of Siberian Branch Russian Academy of Sciences
 (BINP SB RAS), Novosibirsk, Russian Federation
2Novosibirsk State University (NSU), Novosibirsk, Russian Federation

A necessary step in any experiment on plasma heating and confinement in open magnetic traps is the creation of an initial plasma that should have a high enough volume and high enough density to capture injected beams of neutral atoms. In our opinion, the simplest and cheapest method of plasma generation is the beam-plasma discharge. In contrast to plasma discharges produced by plasma guns, this method makes it possible to create plasma directly in the working volume without its reflection from the entrance mirror. Besides, unlike the microwave discharge, the beam-plasma one does not require high-technology devices such as gyrotrons.

The possibility of creating a plasma by an electron beam in open traps has been known for more than 60 years, but a distinctive feature of the first experiments was that they were carried out at small devices, which were comparable in sizes to the beam relaxation length. In order to understand how efficiently this method of creating plasma can work in modern fusion facilities, such as the Gas Dynamic Trap (GDT) or GDMT at the INP SB RAS, experiments on injection of an electron beam with a characteristic energy of 20-30 keV and a current of 5 -8 A into neutral gas have been carried out [1]. It was shown that a beam having a diameter of 1 cm in the central section of the setup is capable of creating plasma in the entire volume of the trap (50 cm in diameter). In this case, both the experiments themselves and their numerical simulation by the particle-in-cell method indicated that the beam relaxation region is strongly localized in the input magnetic mirror [2]. As a possible mechanism of plasma ionization in the main volume of the trap, impact ionization by thermal electrons, which receive sufficient energy from the relatively hot region of beam relaxation due to longitudinal electron heat conductivity, was discussed in [2].

In this work on the basis of a numerical model, that calculates the propagation of heat due to classical electron heat conductivity in the nonuniform magnetic field and the production of plasma by thermal electrons due to impact ionization, we study the dynamics of discharge creation in the entire volume of the GDT facility and compare the simulation results with data from interferometric and probe measurements obtained in the above experiments [1].

The work was supported by the Russian Science Foundation (project 22 – 22 - 00514).

References

1. Soldatkina E. I. et al. Electron beam-plasma discharge in GDT mirror trap: experiments on plasma start-up with electron gun //Nuclear Fusion. – 2022. – Т. 62. – №. 6. – С. 066034.
2. Timofeev I. V. et al. Electron beam–plasma discharge in GDT mirror trap: particle-in-cell simulations //Nuclear Fusion. – 2022. – Т. 62. – №. 6. – С. 066033
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/EH-Glinskiy.docx) [↑](#footnote-ref-1)