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PROJECT OF ECRH SYSTEM FOR THE GDMT DEVICE *)

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The BINP is developing a project for a new generation open trap – a gas-dynamic multiple-mirror trap (GDMT). The project aims to justify the use of an open trap as a source of thermonuclear neutrons for various applied problems, as well as a thermonuclear reactor. The project envisages the development of a technology for long-term confinement of hot plasma in an open trap, as well as improvement of diagnostic methods and plasma heating in such a configuration [1].

The ion component of plasma in a GDMT consists of two parts: a population of anisotropic high-energy ions and a collisional, relatively cold plasma. The first component is obtained as a result of the capture by the second component of powerful neutral beams injected at an angle to the GDMT axis. Fusion neutrons are obtained as a result of the interaction between the ions of the hot component. The neutron flux and, accordingly, the fusion power are proportional to the braking time of these ions on electrons. In turn, the braking time is proportional to the electron temperature to the power of 3/2. Therefore, to increase the fusion yield and, accordingly, to advance towards the goal of the GDMT project, it is necessary to increase the electron temperature. The main method of heating electrons in the GDMT will be the deceleration of hot ions on them, but this cools the hot ions and reduces the fusion yield. To solve this problem, the GDMT proposes to use heating of electrons with powerful microwave radiation at the electron cyclotron frequency (ECRH). The efficiency of this method in an open trap and the achievement of an electron temperature of ~ 1 keV were demonstrated in the GDT, an open trap of the previous generation [2].

The GDMT project provides two places for placing the ECRH system near the mirrors with a relatively uniform magnetic field of 3 T, which assume transverse injection of radiation. Unlike the GDT, it is proposed to use the absorption of radiation at the second harmonic of the extraordinary wave (X2) or the first harmonic of the ordinary wave (O1). As a radiation source, we expect to use several gyrotrons similar to those manufactured for ITER, with a total power of 2-6 MW, a frequency of 170 GHz for X2 or a frequency of 85 GHz for O1 and a pulse duration of up to 2 s. In this paper, we compare the results of numerical modeling of the propagation and absorption of microwave radiation in the GDMT plasma using various methods: geometric-optical, quasi-optical and full-wave. The plasma parameters that will be obtained in the GDMT are still being discussed, so the modeling was carried out in a wide range of plasma parameters and for different magnetic configurations. Based on these data, an optimal scheme for injection of radiation into the plasma was selected and a system for transporting and introducing radiation into the GDMT was developed.

References

[1]. Skovorodin D.I. et al // Plasma Phys. Reports, 2023, V.49, № 9, P. 1039.
[2]. Bagryansky P.A. et al // Phys. Rev. Lett. 2015, V. 114, P. 205001.

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