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FIRST RESULTS OF EXPERIMENTS BY THE NEW METHOD OF ECR PLASMA HEATING ON THE GDT *)

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A gas dynamic trap (GDT) is a prototype of a fusion neutron source for materials science, afterburning of radioactive waste, and a hybrid fusion-fission reactor [1]. Neutrons in the GDT are produced as a result of fusion reactions during collisions in a population of hot ions that are formed during the capture of powerful neutral beams by the target plasma. The neutron flux is proportional to the square of the lifetime of hot ions in the plasma. One of the main mechanisms determining the lifetime of hot ions is their interaction with electrons. Moreover, the lower the electron temperature, the faster the hot ions lose their energy during collisions with electrons. To increase the electron temperature and, accordingly, the lifetime of hot ions at the GDT, additional electron cyclotron resonance (ECR) heating is used at the first harmonic of the extraordinary wave [2]. This method has been shown to be effective in increasing electron temperature, hot ion density, and neutron flux [3].

However, the use of this ECR heating method is associated with a number of difficulties that impose restrictions on the plasma parameters and the magnetic configuration of the device. To solve some of these problems, ECR heating at the second harmonic of the extraordinary wave was proposed at the GDT. Simulations using a geometric-optical numerical code give, at an electron temperature on the axis of 200 eV, absorption from 0 to 90% of the injected power, depending on the plasma density and injection angle. Energy release occurs in a wide region of the plasma, which should not lead to the occurrence of MHD plasma instabilities.

To implement this method, one of the two microwave systems for ECR heating at the first harmonic was redone. The old gyrotron with a power of 400 kW was replaced with a new one with a power of 800 kW and a frequency of 54.5 GHz. The cryogenic system was also upgraded. The flooded cryostat was replaced with a dry cryomagnet. The new gyrotron is more powerful than the old one and is equipped with a recuperation system, so a new, more powerful power supply system with a larger energy reserve was assembled for it. The cyclotron resonance at the second harmonic is located in a different place in the installation, so the waveguide line and the quasi-optical system for introducing radiation into the plasma were redone. The new system allows injection of a focused microwave beam into a plasma in a region with a magnetic field of 0.973 T, which corresponds to the second harmonic of electron cyclotron resonance at a frequency of 54.5 GHz. In this case, the input system allows you to change the injection angle in the range of 74^0-84^0 to the axis and -5^0-5^0 in the perpendicular plane. Changing the angle allows you to change the area of energy release in the plasma, as well as compensate for the refraction of radiation in a dense plasma.

References

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