DISPERSION INTERFEROMETER For PLASMA DENSITY CONTROL IN THE GLOBUS-M2 ToKAMAK

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One of the main goals that modern fusion research is trying to achieve is to ensure continuous operation of a fusion reactor or tokamak-based neutron source. In the Ioffe Institute on the Globus-M2 tokamak after the modernization is planned to achieve a plasma discharge time of 0.7 s [1] in modes with non-inductive current drive. This is only possible with the use of special methods for controlling plasma parameters during discharge.

To implement this method, a system was developed that controls plasma parameters in real time using an automated complex consisting of a dispersion interferometer based on a CO2 laser, a data recording and processing system that calculates the current plasma density in real time using the calculated parameters, and a gas supply system controlled by the calculated parameters..

The most important qualities of the interferometer are its compactness and weak sensitivity to vibrations of optical elements. Thanks to the choice of the optimal wavelength for probing radiation for modern plasma devices, the operation of this interferometer is practically not affected by the refraction and rotation of the polarization plane in a magnetic field. A similar interferometer is used on installations: GDT [2], W-7X [3], LHD [4], and also previously used on TEXTOR [5]. When developing this model of the dispersion interferometer, all disadvantages of the previous models on the GDT and TEXTOR installations were taken into account. In particular, a stabilized laser was installed, additional measures were taken to decouple the laser resonator from the optical circuit, the circuit's sensitivity to transverse displacements of the retro reflector was reduced, and the temperature stability of the optical circuit elements of the interferometer was also increased. The development of a new automated data recording and processing system was based on past developments in this direction, but it uses a fundamentally new plasma density restoration algorithm based on the Fourier transform and the use of CORDIC procedures. The signal recorded by the photodetector is digitized by a high-speed ADC and transmitted to the digital stream processing node to implement the phase recovery algorithm in real time. This node is based on a programmable gate array (FPGA). To provide feedback and control of plasma density, the measurement results are transmitted to the remote module of the digital-to-analog converter embedded in the technological subsystems of the gas supply. An important part of this work is to determine the optimal method for controlling the gas injection into the vacuum chamber under conditions of gas recycling during the discharge from the walls of the vacuum chamber and the injection of high-power neutral beams.

References

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