Diagnostics for studies of small-scale plasma density fluctuations in the central region of the l-2m stellarator plasma column

Batanov G.M., Borzosekov V.D., Malakhov D.V., and Stepakhin V.D.

Prokhorov Institute of General Physics, Russian Academy of Sciences, Moscow, Russia, borzosekov@fpl.gpi.ru

Study of high-temperature plasma density fluctuations, as a manifestation of various plasma instabilities and turbulence, in toroidal magnetic confinement devices is still a topical issue. Microwave diagnostics is a classical technique to study density fluctuations. This technique is based on the effect of collective scattering of electromagnetic radiation when scattering geometry satisfies the Bragg’s condition. Diversity of existing today microwave diagnostics [1–3] does impress. However, only at the L-2M stellarator scattering of microwave radiation that is used for electron cyclotron heating (ECH) of plasma is involved in diagnostics. Two gyrotrons are used for ECH at the L-2M stellarator with total microwave power up to 1 MW which yields huge power density value near 4 MW/m3.

In the present study a possibility of new density fluctuations diagnostics construction is considered. The diagnostics is also based on the detection of scattered radiation of microwave heating. The task for the diagnostics is to study plasma density fluctuations with wavenumber *k* = 20 cm–1 in central regions of the plasma column. A two-horn antenna system will be used for detection of scattered radiation. The antenna system will be installed inside the vacuum vessel of the L-2M stellarator through the upper diagnostic port of the ECH cross section. The two-horn system allows one to measure radial correlation and coherence of density fluctuations from two neighboring plasma regions. The scattering volume of each horn is formed by intersection of its radiation pattern of 10° with 4 cm wide microwave heating beam that propagates in the equatorial plane of the stellarator. Automation of experimental data registration and data analysis is considered. This will be accomplished with the help of designed special program modules and with the help of the already existing hardware-software system for data capture and analysis.

First obtained experimental results in direct detection mode of the diagnostics show that obtained signals substantially differ from the background microwave noise at the gyrotron radiation wavelength. This is encouraging relatively to capability of the diagnostics to operate under conditions of high power microwave heating at the L-2M stellarator and relatively to further modification of the diagnostics for homodyne detection of scattered radiation.

This work is partially supported by Russian Federation president’s grant MK-5298.2016.8.

References

1. Rhodes T.L., Peebles W.A., Nguyen X. et al. // Millimeter-wave backscatter diagnostic for the study of short scale length plasma fluctuations // Rev. Sci. Instrum., 2006, V.77, P.10E922 (8pp).
2. Smith D.R., Mazzucato E., Lee W. et al. // A collective scattering system for measuring electron gyroscale fluctuations on the National Spherical Torus Experiment // Rev. Sci. Instrum., 2008, V.79, P.123501.
3. Zhou C., Liu A.D., Zhang X.H. et al. // Microwave Doppler reflectometer system in the Experimental Advanced Superconducting Tokamak // Rev. Sci. Instrum., 2013, V.84, P.103511 (6pp).