PLASMA ELECTRONIC DENSITY MEASUREMENT SYSTEM FOR "MEPhIST" TOKAMAK BASED ON A HETERODY INTERFEROMETER [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2022.49.1.051

Belov A.S., Gubsky K.L., Krat S.A., Alieva A.I., Efimov N.E., Prishvitsyn A.S., Kuznetsov A.P.

National Research Nuclear University "MEPhI", [info@mephi.ru](mailto:info@mephi.ru)

Electron density is one of the main parameters used to control the tokamaks. The insertion of probes into a long-lived high-temperature plasma is not possible; therefore, remote optical methods are used to measure the electron density. A heterodyne interferometer at a wavelength of 10.6 microns has been developed to measure the electron density of plasma on the small spherical tokamak "MEPhIST-0".

After starting in the operating mode, the following plasma parameters are expected in the «MEPhIST-0» tokamak: electron density 1012 ÷ 1014 cm-3, plasma lifetime up to 30 ms [1].

The geometry of the tokamak makes it possible to realize the transmission mode of the interferometer. The length of the diagnostic chord is approximately 45 cm. At a radiation wavelength of 10.6 μm, the phase shift introduced by plasma with a density of 1013 cm-3 is ~ 0.12 radians. The frequency shift in the interferometer is provided by an acousto-optic modulator that shifts the radiation to a frequency of 40 MHz. The signal is detected by a CdHgTe photodiode operating at cryogenic temperatures. The interferometer is mounted on a frame made of non-magnetic materials and is vibration-isolated from the supporting structures of the tokamak.

The tests of a heterodyne interferometer on the "MEPhIST-0" tokamak were carried out at various installation modes: at quiescent state; with starting all the holding coils, but without injection in the working gas, which prevents the formation of plasma; during normal operation of the installation. Tests have shown that the interferometer is insensitive to electromagnetic noise during tokamak operation. According to the results of the first experiments, the maximum measured linear plasma density is 7.9 \* 1013 cm-2, which corresponds to the bulk plasma density of 3 \* 1012 cm-3 with a parabolic profile of the plasma density distribution along the diagnostic chord. The maximum measurement error is 1.3 \* 1013 cm-2 and is mainly due to the noise of the photodetector and the flicker noise of the master oscillator of acousto-optic modulator.

References

1. Gornostaeva O. et al. Two-color CO2/HeNe laser interferometer for C-2 experiment // Review of Scientific Instruments. American Institute of Physics AIP, 2010. Vol. 81, № 10. P. 10D516.
2. Kurnaev V.A. et al. The Project of MEPhIST Tokamak // Physics of Atomic Nuclei, 2019. Vol. 82, № 10. P. 1329–1331

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLIX/Mu/ru/BN-Belov.docx) [↑](#footnote-ref-1)