STUDY OF THE SIGNAL-to-NOISE ratio OF REFRACTOMETRY IN ITER TURBULENT PLASMA WITH ACCOUNT FOR HIGH TEMPERATURE EFFECTS AND VERTICAL DISPLACEMENTS OF THE PLASMA COLUMN

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The report studies the signal-to-noise ratio of ITER refractometry. ITER refractometry is part of the high magnetic field side reflectometry (HFSR) system. HFSR is planned to be used for measurement of the electron density profile, as well as for the study of plasma density fluctuations. In addition, it is assumed that the reflectometry in the ITER will also measure the average electron density along the chord, which, in fact, requires a refractometry channel operating in the passage mode, using the ITER plasma transparency window for an extraordinary (X-) wave between the upper and lower cutoff frequencies (~40–100 GHz). At the same time, the transmitting antenna system is located in the Equatorial port 8, just opposite the antenna system of HFSR [1]. In this case, regular antenna of HFSR for the reception of microwave radiation will be used.

The use of the refractometry channel should also significantly improve the quality of measurements of the plasma density profile by the HFS-ITER reflectometer, especially in modes with increased plasma turbulence.

The effect of turbulence on the signal-to-noise ratio of the refractometry is considered, the relativistic effects and the vertical displacement of the plasma cord are also considered in the analysis.

This report presents the results of calculations of radiation propagation in refractometry (in the transmission mode) considering the real geometry of the HFS-ITER reflectometer. The calculations were carried out for the ITER scenario with a current of 15 MA at the stationary stage of discharge with an average density of ne ~ 9⋅1019 m–3, in the plasma transparency window for probing radiation at an X-wave, at 3 fixed frequencies from the frequency range of 40-90 GHz when probing from a weak magnetic field. The aperture of the transmitting antenna in the calculations was taken equal to 120 х 30 mm, of receiving antenna – 18 х 58 mm. The calculations were performed in the package Zemax, specially developed for this purpose .dll files being used, which describes the distribution of refractive index of ITER plasma for X-wave both for the turbulent plasma, and a "quiescent" plasma.

As a result of the calculations, the signal attenuation of the Refractometer in the turbulent ITER plasma was determined. It is concluded that it is possible to measure the average density of turbulent plasma by a Refractometer provided that the plasma is probed in the plasma transparency window with frequencies exceeding the cutoff frequency by 4 GHz or more (operating frequencies for the considered scenario should be in the range of 58-90 GHz).

References

1. A.V. Krasilnikov, Yu.A. Kaschuck, V.A. Vershkov, A.A. Petrov, V.G. Petrov, S.N. Tugarinov. International conference on thermonuclear reactor diagnostics, Varenna, Italy 9–13 September 2013.