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APPLICATION OF THE MICROWAVE BACKSCATTERING TECHNIQUE FOR INVESTIGATION OF LOWER HYBRID WAVES SPECTRA IN THE FT-2 TOKAMAK *)

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Problems with the development and application of current drive systems using lower-hybrid (LH) waves are largely related to the limitations of diagnostic methods for the parameters of radio frequency (RF) waves. The difficulties with their observation are associated with the relatively small level of the resulting density fluctuations $\delta n/n < 10^{-3}$, their spatial localization and narrow spectrum in terms of propagation angles. Previously, LH waves were studied using complex techniques with high access requirements to tokamak ports: collective laser scattering [1] and time-of-flight enhanced scattering [2]. A new microwave diagnostic – the Doppler backscattering (BS) on LH waves with frequency f_{RF} = 922 MHz, has been developed and applied in the FT-2 tokamak. In this diagnostic, probing is carried out from the low field side by O-mode waves in the Ka-range (f_i = 26-40 GHz) in the presence of a cutoff surface in the plasma. The probing power is increased to 50-100 W to compensate for the decrease in the scattering signal, compared to traditional fluctuation reflectometry. Both single-frequency homodyne scheme, which is promising for implementation of correlative measurements, and double-frequency superheterodyne scheme, allowing for detection of scattering signal on an arbitrary intermediate frequency different from f_{RF}, were tested. In both schemes it was possible to select either "red" ($f_s = f_i - f_{RF}$) or "blue" ($f_s = f_i + f_{RF}$) RF scattering satellites, characterized by opposite directions of LH wave phase velocity. A horn antenna, located either on the equator or shifted upward or downward in the vertical direction, was used for probing in a cross-section toroidally shifted from the RF grill antenna by 90°. The RF power level was 80 kW.

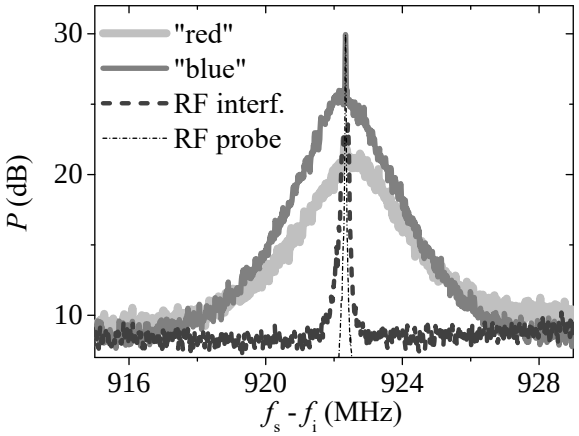

Fig. 1. *Spectra of the BS by LH waves and the RF probe*

An example of the scattering spectra for the upper antenna for each of the RF satellites are shown in figure 1, together with the spectrum of the RF probe and the spectrum of the diagnostic signal in a situation where RF power does not enter the plasma (RF interference). A distinctive feature of presented RF scattering spectra is their significant width against the background of narrow spectral lines of the RF probe and RF interference, indicating multiple and effective scattering of the LH wave on density fluctuations. Differences in the magnitude of the "blue" and "red" satellites were found only for the upper antenna. This may be evidence of BS on the primary LH wave that propagated upward from the RF grill antenna to the diagnostic cross-section along the magnetic field line with an inclination angle of 1.7°.

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References

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*) abstracts of this report in Russian