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ANALYSIS OF SAWTOOTH DENSITY FLUCTUATIONS DURING OFF-AXIS ECRH IN TOKAMAK T-15MD *)

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The analysis of density transport during sawtooth oscillations was studied for the first time in the world only in one ohmic mode T-10 [1] (I_p = 200 kA, B_z =1.5 T, $n_e(0) = 2,0^{19}/m^3$) and the density rise between the oscillations was explained by the presence of the neoclassical pinch velocity $V_{p neo}$. Modeling of sawtooth density fluctuations in the ohmic modes of the TM-4 and TUMAN-3 tokamaks [2] made it possible to prove the presence of precisely the neoclassical dependence $V_{p neo} \sim E_z/H_{\theta}$ inside the surface of q=1. These conclusions were expanded in the report [3], where it was shown that with central and non-central ECRH and EC current generation ($P_{ECRH} < 0.7$ MW), the pinch rate velocity in the central part of the column is close to neoclassical. For example, with noncentral EC current generation (PECRH =0.7 MW) with almost suppressed sawtooth oscillations with a period of about 20 ms, the amplitude of the oscillations of the central chordal density was about 1.3%. Note that for q=1, the value of H_{θ} is directly proportional to the value of Hz. But at $P_{ECRH} > 1.5$ MW, n_e profiles become hollow at r/a<0.5 and sawtooth fluctuations in the density of the reverse phase are observed (an increase in the center with a decrease in T_e , a decrease at r/a= +/-0.4). The analysis shows the presence of an outward pinching velocity $V_p \approx 0.3$ m/s.

A microwave interferometer with a wavelength of 0.935 mm probing radiation is used to measure the average plasma density of the tokamak T-15MD [4-5]. The probing is carried out through the center of the vacuum chamber along a vertical chord. The experiments presented in this report were conducted in the autumn campaign of 2024 at Hz = 1.5 T and plasma currents of 400-500 kA. A gyrotron with $P_{ECRH} \approx 1$ MW generated off-axis heating at high field side (see details in [6]). Sawtooth oscillations often occurred at the end of the gyrotron pulse. First of all, sawtooth oscillations and their phase reversal radius were detected by multichannel measurements of SXR [7]. Sawtooth n_e oscillations are sensitive to density rise, and may not be visible at all even with moderate density growth, which limits the number of shots suitable for analysis. For example, in shot 3089, with a period of about 15 ms, the amplitude of the oscillations of the central chord density was about 1.2%. The preliminary results of the analysis currently underway show that the neoclassical pinching rate of $V_{p neo}$ is sufficient to describe the density rise between fluctuations.

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References

- [1]. Vasin N.L., Gorbunov E.P., Neudachin S.V., Pereverzev G.V. 1982 Sov. J. Plasma Ph. P. 244
- [2]. Dnestrovskij Yu.N., Neudachin S.V., Pereverzev G.V. 1984 Sov. J. Plasma Ph. P. 236
- [3]. S.V. Neudatchin, D.A. Shelukhin, A.A. Borshegovskii, S.G. Maltzev, T.B. Myalton, N.A. Mustafin, D.S. Sergeev 2014 Proc. 25th FEC (St. Petersburg, 2014) EX/P1-43
- [4]. Drozd A.S., Sergeev D.S. . et al. // Plasma Physics Reports. 2024. Vol. 50, № 5, P. 568–572.
- [5]. Drozd A.S., Sergeev D.S. // Rev. Sci. Instrum. 2022. Vol. 93, № 6, P. 063501.
- [6]. Kirneva N.A. et al, 2025 52 Int. Zvenigorod Conf. on Pl. Phys. and Contr. Fusion
- [7]. Rogozin K.A. et al, 2024 51 Int. Zvenigorod Conf. on Pl. Phys. and Contr. Fus. Abstr. P.103

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