Investigation of the ETG mode turbulence frequency and wave number spectra evolution in dynamic experiments at FT-2 tokamak

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Fine scale component of drift wave turbulence excited by the ETG instability is discussed nowadays as a possible candidate for explanation of the anomalous electron energy transport in tokamak plasmas, in particular in transport barriers. In spite of this the experimental information related to this mode was not detailed. Just recently new experimental techniques based on the microwave scattering effect have been developed to fill in the gap at several tokamaks and first results confirming existence of the ETG mode scale turbulent fluctuations sensitive to electron temperature gradient have been obtained at FT-2, DIII-D and NSTX tokamaks. In particular, two (low and high frequency) small-scale modes identified as TEM and ETG mode were demonstrated in ohmic discharges at FT-2 under conditions when the ETG instability should be above the threshold.

In the present paper we report results of systematic investigations of these small-scale turbulent high and low frequency modes performed in dynamic current ramp up (CRU) experiments at FT-2 tokamak. Both frequency and radial wave number spectra (q-spectra) are measured in the central and gradient discharge region with correlative enhanced scattering (CES) diagnostics in a wide radial wave number domain ($12 > q_r \rho_i > 0.8$). It is shown that q-spectrum of the ETG turbulence component is characterised by pronounced maximum at $q_r \rho_s \approx 9$ corresponding to the scale where the instability growth rate is the largest. Behavior of the ETG component in the CRU experiment is correlated with the ratio of electron temperature and density profile scale lengths determining the ETG mode threshold at the FT-2 conditions, according to the GS2 modeling. Namely, the ETG component is not observable below the threshold and it dominates in the ES frequency spectrum, when the threshold is exceeded by a factor of 2 and more. It is also found that all during the CRU discharge the TEM component possesses a wide exponential q-spectrum. The evolution of the TEM and ETG mode spectra is compared to the behavior of the anomalous electron diffusivity obtained from the experimental parameters using the ASTRA code modeling and to the evolution of the small-scale turbulence spectra at the plasma periphery obtained recently [1].

1. E.Z. Gusakov et al., Proc. 22 FEC 2008, IAEA-CN-165/EX/10-2Rb.