Improved confinement transition in high density deuterium discharges at the FT-2 tokamak accompanied by onset of negative triangularity

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In FT-2 (R = 55 cm, a = 7.9 cm) ohmic-heated discharges with high densities $n_e \leq 10^{20}$ m^{-3} a significant effect of the isotope content on the global energy confinement was discovered recently [1]. At the achieved plasma densities ($\langle n_e \rangle \approx 9\times10^{19}$ m^{-3}), it was shown that the total energy confinement time in deuterium (D) is twice as long as in hydrogen (H) plasma. Such a significant difference was explained by the spontaneous transition to the improved confinement regime, initiated solely by density increase and observed only in D-plasma while the hydrogen plasma remained in L-mode in all comparable discharge scenarios.

In the present paper a detailed analysis of the improved confinement transition in high density D-plasma is performed. Reconstruction of plasma magnetic configuration, based on interferometry measurements, is provided by full-wave code modeling (CUWA code) and ray tracing computations taking into account strong refraction effect due to high density. The reconstruction reveals a grow of the triangularity of the magnetic surfaces above the natural level [4] for the FT-2 tokamak after the transition of D-plasma into improved confinement. Magnetic surfaces of H-plasma in L-mode keep circular shape as natural for the circular cross section of the FT-2 vessel.

The results of the reconstruction were checked with soft X-ray and probe diagnostics. To investigate the influence of the negative triangularity onset on the turbulence, according to [2, 3] leading at TCV and DIII-D to its suppression and confinement improvement, the turbulent modes in FT-2 high density discharges were measured using a set of microwave diagnostics as well as estimated with the linear gyrokinetic GENE code.

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