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First observations of the transition to the H-mode on the Globus-M2 tokamak using Doppler backscattering

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Recently, a new spherical Globus-M2 tokamak has begun to operate. This tokamak makes it possible to achieve a toroidal magnetic field of 1 T and a plasma current of up to 0.5 MA. The first neutral beam heating experiments on Globus-M2 demonstrated the increase of the thermal energy up to 8 kJ. This is nearly triple as high as in Globus-M. The energy confinement time increased more than two times that is significantly higher than the IPB98(y,2) scaling predicts [1].
These parameters were achieved in the H mode initiated by neutral beam injection (NBI). The transition to the H-mode was studied by Doppler backscattering (DBS). The four frequency Doppler backscattering was implemented to measure the plasma rotation velocity and the turbulence amplitude simultaneously at four radii [2]. The use of four frequencies made it possible to determine the evolution of the plasma rotation velocity shear. DBS operated in the 20-48 GHz band at O-mode propagation so that the detection region covered a considerable radial interval of normalized minor radii ρ = 0.6-1 for typical Globus-M2 discharges.
The transition to the H mode on the Globus-M tokamak was not pronounced and was mainly identified by an increase in the plasma density gradient at the periphery of the discharge [3]. On the contrary, well-pronounced transitions with all the characteristic features of the transition were observed on the Globus-M2 tokamak. This was achieved with the following main discharge parameters: major radius R ≈ 0.36 m, minor radius a ≈ 0.24 m, toroidal magnetic field Bt = 0.7 T, plasma current Ip = 280 kA, averaged electron density <ne> = (3-6)·1019 m-3, electron temperature in the plasma core Te = 0.6 –1.1 keV, elongation k ≈ 1.8, triangularity δ ≤ 0.5. Deuterium plasma was utilized. LH transition was initiated by the deuterium beam injection with particle energy 28 keV and heating power 0.8 MW.
The transition was characterized by the electron density ne increase and by the Dα emission drop (Fig.1 - ne, Dα). The transition to the H-mode leads to the appearance of edge localized modes (ELMs). ELMs can be seen as periodical Dα bursts. The diamagnetic measurements show the plasma thermal energy increasing during H-mode.
The measured by DBS velocity at the normalized minor radius ρ = 0.86 was about 3 km/s in the L-mode and increased to 9 km/s after the transition to the H-mode (Fig.1 - V). Moreover the plasma rotation velocity shear near the periphery doubled after the transition (Fig.1 - ωE). One can also see a sharp decrease of the peripheral turbulence amplitude during the transition to the H-mode (Fig.1 - Aturb). The turbulence amplitude spectrogram shows a decrease in all spectral components (Fig.1 - Spturb). Such an observation corresponds to the well-known paradigm of transition to the H-mode with the suppression of turbulence due to the appearance of a velocity shear [4].
Similar measurements using DBS were carried out over a wider range of discharge parameters. It is planned to perform such studies of the L-H transition with an increase in the toroidal magnetic field to the projected values.
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