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PLASMA THERMAL ENERGY CONFINEMENT IN THE GLOBUS-M2 SPHERICAL TOKAMAK HEATED BY HIGH-ENERGY ATOMIC BEAMS *)

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A review of the of plasma heating and thermal energy confinement study in regime with neutral beam injection on the Globus-M2 spherical tokamak [1] for the period 2018-2023 is presented. The first experiments were carried out at plasma current I_p = 0.25-0.3 MA and toroidal magnetic field B_T=0.7-0.8 T. When injecting a 0.8 MW deuterium beam with a particle energy of 28 keV, a more than twofold increase in the total stored plasma energy was observed compared to the results obtained on Globus-M at the same heating power. Experiments and simulations have shown that the scalings previously obtained at the Globus-M, MAST and NSTX tokamaks and assuming a strong dependence of the energy confinement time on the magnetic field and a moderate dependence on the plasma current ($\tau_E^{GLB} \sim I_p^{0.43} B_T^{1.19}$) are fulfilled for a spherical tokamak and in the region of higher magnetic field values B_T up to 0.8 Tesla. The commissioning of the second injector and a new Thomson scattering diagnostic made it possible to significantly expand the field of research on plasma heating by atomic beams. In the spherical tokamak Globus-M2 with a toroidal magnetic field of 0.8-0.9 T and a plasma current of 0.35-0.4 MA the injection of neutral particles with an energy of up to 45 keV and a beam power of 0.75 MW, doubles electron temperature in comparison with pure ohmic heating regime. The additional inclusion of a second beam with a particle energy of up to 30 keV and a power of 0.5 MW made it possible to obtain a hot ion mode in the range of average plasma densities of $1.6 \div 10\ 10^{19}$ m^{-3}. According to active spectroscopy and neutral particle analyzer, the ion temperature reached 4 keV at a plasma density of $8 \cdot 10^{19}$ m^{-3} in the hot zone, exceeding the electron temperature by more than 2.5 times [2,3].

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References

[1]. Minaev V.B. et al., 2017 Nucl. Fusion 57 066047
[2]. Kurskiev G.S. et al., 2022 Nucl. Fusion 62 104002
[3]. Kurskiev G.S. et.al., 2023, Plasma Physics Reports, 49 (4), pp. 403-418

*) abstracts of this report in Russian