T-15MD: MISSION AND RECENT EXPERIMENTAL RESULTS

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T-15MD tokamak is the medium size machine with R=1.5 m, a=0.67 m, elongation up to 1.9 and triangularity up to 0.4 [1]. The machine can operate in hydrogen discharges in the range of toroidal magnetic fields up to B_T=2.0 T. The T-15MD tokamak will be equipped with four auxiliary heating and current drive systems: 8 MW of electron cyclotron heating, 6 MW of ion cyclotron heating, 4 MW of low hybrid heating and 6 MW of neutral beam injection. In accordance with the operational range of toroidal magnetic fields and the value of the aspect ratio (A~2.2) the T-15MD tokamak occupies an intermediate position between conventional and spherical tokamaks. This feature will allow the T-15MD to provide additional information required for the development of reactor relevant physical model of tokamak plasmas.

The scientific program of the device is aimed at solving of the topical issues of tokamak plasma physics, i.e. development of a long-pulse discharge scenario with the non-inductive current drive and improved plasma confinement, physics of turbulence and transport, plasma wall-interaction and divertor physics. Along with this, the following issues will also be addressed at T-15MD: first wall technology, safety assurance, development of additional plasma heating and fueling systems and development of diagnostic methods.

The first plasma in the T-15MD tokamak was produced in March 2023 in conditions with a stainless steel first wall and carbon rail limiter [2]. The central column, lower divertor and partially upper divertor were covered by C tiles before the 2024 experimental campaign. Two poloidal limiters on the central column were also installed instead of the rail limiter. Baking of vacuum vessel and glow discharge in Ar, He or H are routinely used for T-15MD wall conditioning.

Electromagnetic system of the device has so far been tested in the range of magnetic fields up to 1.65 T. Maintenance of a toroidal field of 1 T for 30 s was demonstrated (Fig. 1). Tokamak operational range was extended from the plasma current value of I_p=30 kA in the first experiments to I_p=560 kA in the third experimental campaign (Fig. 2).

Two 1 MW gyrotrons were installed: one gyrotron with frequency f=82.6 GHz and another one with f=105 GHz. Gyrotrons were used for plasma initiation and further heating. ECR breakdown was observed at X2 resonance layer, no breakdown was obtained at X3 resonance layer in experiments with EC power level up to 1 MW. Noninductive current up to 10 kA was observed after EC-power switch-on in dependence of the initial magnetic configuration during the solenoid-free phase. Plasma discharges lasting up to 2 s were obtained. Electron temperature up to 3 keV measured by Thomson scattering was reached with auxiliary heating power up to 1 MW [2].

Discharges with different plasma shape including k>1.5 (Fig. 3) were realized in limiter configuration. First experiments in divertor configuration were carried out at plasma current I_p> 380 kA and k>1.5 (Fig. 4). Plasma performance was consistent to L-mode in both types of discharges.

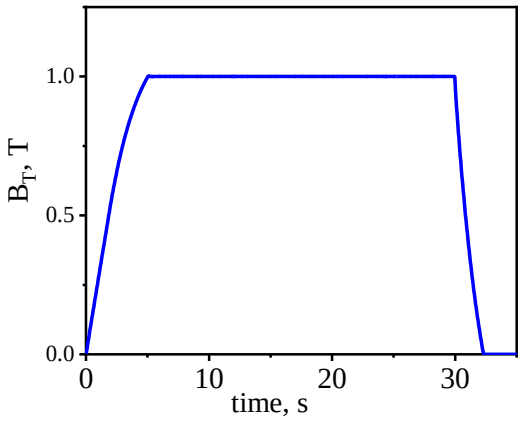

Fig. 1 Shot 371. Record duration of toroidal magnetic field in T-15MD tokamak

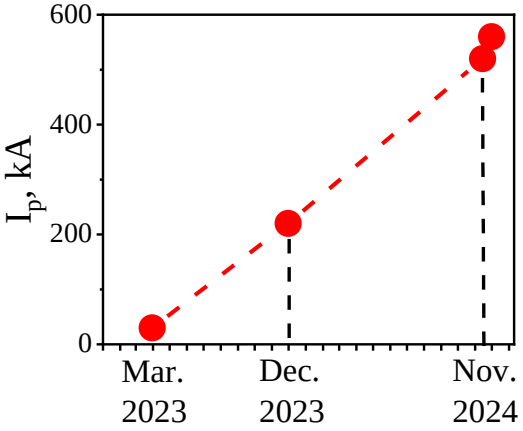

Fig. 2 Increase of plasma current values achieved in T-15MD experimental campaigns

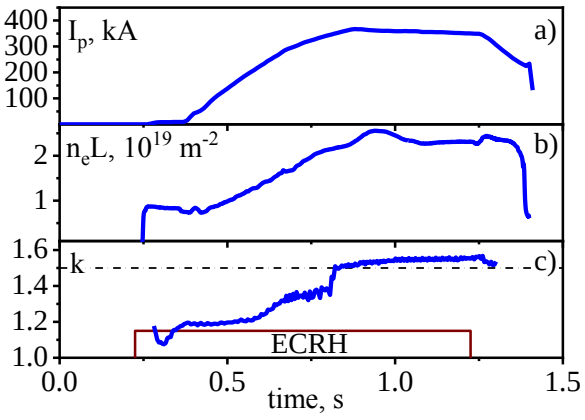

Fig. 3 Shot 3166. Traces of plasma current (a), line averaged density (b) and elongation (c).

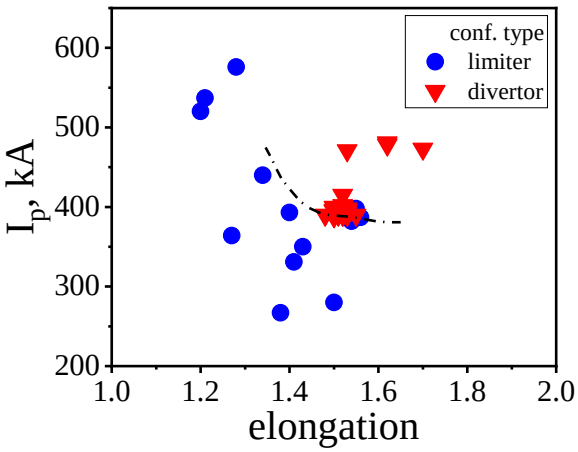

Fig. 4 Parameter range for the first T-15MD diverted discharges.

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REFERENCES

[1] Khvostenko, P.P., Bondarchuk, E.N., Kavin, A.A. et al, Phys. Atom. Nuclei **84** (2021) 1332–1341. https://doi.org/10.1134/S1063778821070061

[2] Velikhov, E.P., Kovalchuk, M.V., Anashkin, I.O. et al, Phys. Atom. Nuclei **87** (Suppl 1) (2024) S1–S9. https://doi.org/10.1134/S1063778824130283