Experiments on plasma confinement by helical mirror in the linear magnetic trap

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The concept of the dynamic multiple-mirror confinement by the controlled plasma rotation in the helical magnetic mirrors was proposed to improve an energy confinement time and improve fusion gain in future linear magnetic traps [1]. Theory predicts exponential dependence of the plasma flow suppression effectiveness on the helical mirror length, and, therefore, significant rise of the effective mirror ratio [2].

New experimental device SMOLA was constructed in Budker INP to explore this concept [3]. The main part of the device is single 216-cm-long helical plug, which contains 12 periods of the helicity. Helical and axial magnetic field ratio varies arbitrary. Plasma rotation is driven by the controlled profile of the radial electric field and is similar to the vortex confinement system in GDT, thus this system may be used for plasma stabilization. Plasma is confined between the helical plug and plasma gun, which is located in the maximum of the magnetic field. Flow suppression effectiveness may be determined by measuring of the plasma parameters change along the mirror in different regimes of the magnetic and electrical field. Project parameters are as follows: ni ~   
1019 m–3, guide field in helical section up to Bmax = 0.1 – 0.3 T, radial electric field up to Er ~   
100 V/cm, plasma radius r ~ 5 cm, helicity period 18 cm, mean corrugation along the field line Rmean = 1.5 – 2, confinement time τ = 0.1 s [4].

An ability to suppress the plasma outflow was demonstrated previously [5]. New results on the plasma confinement effectiveness dependence at controlled radial profile of the rotational velocity will be presented. Different configurations, including the differential rotation with the rising to the edge angular velocity, are investigated.

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References

1. A.D. Beklemishev. Helicoidal System for Axial Plasma Pumping in Linear Traps // Fusion Science and Technology, V.63, N.1T, May 2013. P. 355
2. A.D. Beklemishev. Radial and axial transport in trap sections with helical corrugation // AIP Conf. Proc. 1771 (2016) 040006, doi: 10.1063/1.4964191.
3. A.V. Sudnikov et al. SMOLA device for helical mirror concept exploration // Fusion Engineering and Design 122C (2017) pp. 86-93, doi: 10.1016/j.fusengdes.2017.09.005.
4. A.V. Sudnikov et al. Helical Mirrors for Active Plasma Flow Suppression in Linear Magnetic Traps // Proceedings of the 42nd EPS Conference on Plasma Physics. P1.178
5. A.V. Sudnikov et al. First Experimental Campaign on SMOLA Helical mirror // Plasma and Fusion Research. In press.