Study of longitudinal plasma confinement in the gas-dynamic trap

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A longitudinal confinement of plasma in open mirror trap is an important problem for physics of the open magnetic confinement. Particular this problem is under extremal interest for gas dynamic trap, where axial loses dominant in comparison with transverse losses in stable confinement scenarios. Most part of open magnetic systems has the device for the expansion of the plasma stream flowing out of the trap. Using of such a magnetic nozzle (expander) allows solving a series of physical and technical challenges: to reduce the thermal load on the end wall, to carry out direct recuperation of plasma energy into electricity, and so on. In addition, expanding magnetic field can also suppress the electron heat flow between the central part of the trap and plasma absorber.

GDT expander physics studied experimentally earlier [1], but at much lower plasma parameters than todays. In recent experiments on the GDT the relative pressure of plasma β = 0.6 and the electron temperature up to 1 keV were reached [2]. Thus, more precise investigations of electron longitudinal confinement physics in an open trap is important in terms of future applications like a neutron source and future fusion reactor projects.

For realization of mentioned tasks a series of experiments were carried out on the GDT device. Measurements of potential, the average energy of the electrons and its density in the expander as a function of position along the magnetic field line at high electron temperature in the center of the trap were carried out. The minimum degree of expansion which is necessary for the electron heat conductivity suppression from the open trap was defined. The expansion ratio was varied using a movable central section of the end wall. It should be noted that the physics of the expander for the different types of open traps is quite similar, so the studies carried out on GDT can be useful for a wide range of other projects.

References

1. A.V. Anikeev et al. Longitudinal confinement of particles and energy in a gas-dynamic trap. Plasma Physics Reports, Vol. 25; Issue. 10, p. 775-782 (1999).
2. P.A. Bagryansky, et al. Recent progress of plasma confinement and heating studies in the gas dynamic trap. AIP Conf. Proc. 1771, 020003 (2016); doi: 10.1063/1.4964156.