Use of Helical Magnetic Field Sections for Confinement Improvement in Linear Magnetic Traps

Alexey D. Beklemishev[1,2], Vladimir V. Postupaev[1,2] and Anton V. Sudnikov[1,2]
[1]*Budker Institute of Nuclear Physics, 11 Lavrentjev Avenue, 630090 Novosibirsk, Russia*
[2]*Novosibirsk State University, 2 Pirogova st., 630090 Novosibirsk, Russia*

Linear magnetic traps are classical confinement systems that were dwarfed by tokamaks since the abandonment of the MFTF-B project in mid-1980ies. However, a steady progress in modern open traps still keeps these systems as candidates for fusion energy. Currently, the gas-dynamic trap GDT operates with the relative plasma pressure $\beta \approx 60\%$ [1] at mean energy of hot ions of 12 keV and electron temperature up to 0.4 keV [2]. A simple interpolation of currently-achieved GDT parameters to higher NBI injection energy and D-T fuel resulted in a project of GDT-based neutron source with Q = 0.02 that is sufficient for a material test facility with neutron flux of 2 MW/m^2 [3].

Reactor prospects of GDT-type open traps are limited by low achievable Q value. The confinement can be improved if dedicated magnetic sections designed for suppression of plasma flow from the trap are added beyond the magnetic mirrors of the main confinement zone. Historically, a multiple-mirror concept with a corrugated magnetic field was suggested for this purpose; experiments with the multiple-mirror solenoid were carried out in GOL-3 [4]. Recently, a new idea of usage of helicoidal magnetic field in the end sections in combination with a plasma biasing was proposed [5]. With the biasing, the plasma rotates due to $\boldsymbol{E}\times\boldsymbol{B}$ drift. When rotating plasma outflows from the confinement zone, it experiences interaction with the helical magnetic field in the end sections. Depending on the corrugation helicity and sign of the applied potential, the helical sections can either decrease or increase the axial plasma velocity.

In this report, we will further discuss the idea of plasma flow control by combination of sections of helicoidal magnetic field and plasma biasing. Proposal of a simple experimental device intended for study of helicoidal-field influence on plasma flow will be discussed.

[1] T.C. Simonen, et al., *J. Fusion Energy* **29**, 558 (2010)
[2] P.A. Bagryansky, et al., *Nuclear Fusion* **54** (2014) - *in print*
[3] A.A. Ivanov and V.V. Prikhodko, *Plasma Phys. Control. Fusion* **55**, 063001 (2013)
[4] A. Burdakov, et al., *Fusion Sci. Technol.* **51** (No. 2T), 106 (2007)
[5] A. D. Beklemishev, *Fusion Sci. Technol.* **63** (No. 1T), 355 (2013)