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EXPERIMENTAL DEMONSTRATION OF THE PLASMA CONFINEMENT IN MULTIPLE-MIRROR TRAP WITH HELICAL MAGNETIC FIELD *)

[1]Sudnikov A.V., [1]Beklemishev A.D., [1]Inzhevatkina A.A., [2]Kozhevnikov A.V., [1]Burdakov A.V., [1]Postupaev V.V., [1]Tolkachev M.S., [1]Ustyuzhanin V.O., [1]Chernoshtanov I.S.

[1]Budker Institute of Nuclear Physics SB RAS, A.V.Sudnikov@inp.nsk.su
[2]Novosibirsk State University

Multiple-mirror suppression of the axial losses of the thermalized plasma component is one of the possible ways to increase the particle and energy confinement time in the open trap. This technique is proposed to improve plasma confinement in the next-step open trap, GDMT [1] aside with 20 T HTSC mirrors. The momentum transfer from the periodic magnetic field to the plasma can be enhanced if the magnetic mirrors move in the direction opposite to the flow at a velocity comparable to the ion thermal velocity. Recently, it has been proposed to create a moving multiple mirrors by the rotation of the plasma in a helically symmetric magnetic field [2]. The radial and axial flows of the plasma have been calculated using the Lorentz force acting on the radial component of the ion current in a non-uniform magnetic field in [3].

The concept of helical confinement is being tested at the SMOLA device at Budker INP. A detailed description of the device is given in [4]. The possibility of the plasma flow suppression using the helical magnetic mirror has been demonstrated. The experimental scaling matches the theoretical predictions. Significant increase in plasma density in the confinement region has been observed, as reported in references [5, 6]. In the best configurations the density rises more than threefold [7].

Multiple-mirror confinement requires the momentum exchange between the trapped and passing populations. If the frequency of Coulomb scattering is insufficient, then any anomalous scattering of the particles leads to improved confinement. In the helical system the population of the trapped particles, moving at the speed of magnetic perturbations, is an additional source of energy for the oscillations causing scattering itself. In experiments with high enough axial velocity of the magnetic corrugations good axial confinement was observed even at the low plasma density [8, 9].

The use of helical mirrors combined with any other way of axial suppression makes sense if a combination of mirrors can provide a lower level of losses than each method used separately. An increase in overall efficiency when using both straight and helical plug mirrors has been demonstrated in [7].

The report presents the review of the experimental results on helical mirror confinement obtained in SMOLA device. Upgrade of the device is also briefly described. This upgrade aims on the plasma confinement between two symmetric helical mirrors with additional ICR heating. It is planned to achieve dimensionless collisionality typical for GDMT.

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