10th International Conference and School on Plasma Physics and Controlled Fusion

Alushta (Crimea), Ukraine, September 13-18, 2004

Book of Abstracts

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STATUS OF MODERN MIRROR STUDIES IN NOVOSIBIRSK

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Mirrors have a number of advantages in comparison with the closed magnetic systems like tokamak, stellarator, etc. The most important are the following. The effects of disruptions are not appeared in mirrors. There are no divertor problems in them. Plasma pressure in a mirror device can be comparable with magnetic field pressure. As to the multi-mirror system, in this case, the β value can be even significantly higher than unity (the so called «wall confinement»). At last, mirrors are convenient for direct conversion of energy of charged particles leaving out the ends. This circumstance can turn out to be especially important in future «low neutron» schemes of fusion reactors.

In principle, mirrors are very attractive from the engineering point of view, if the plasma confined in axisymmetric magnetic systems would be MHD stable. At present, the problem of MHD stability has already been solved for all axisymmetric traps designed in Novosibirsk. At least, the value $\beta \cong 0.4$ was obtained in these traps without any indications of macroscopic instability development.

At present, in the Budker Institute of Nuclear Physics there is in operation the most complete set of modern mirror machines based on different principles of plasma confinement. This set includes the multi-mirror system GOL-3 for confinement of dense plasma heated by relativistic electron beam, the gas dynamic trap (GDT) for confinement of collisional plasma and anisotropic fast ions, and the ambipolar trap AMBAL-M.

Important results were obtained recently in the GOL-3 experiments. A specific mechanism of reduction of longitudinal electron thermal conductivity was detected. As a consequence of this effect the electron temperature increased up to 2 keV. Recently, the magnetic system of the GOL-3 device was reconstructed into multi-mirror configuration. In this geometry, a new mechanism of fast ion heating was observed. As a result, the ion temperature was increased from a few eV up to 2 keV and the confinement time significantly increased (up to 1ms). These results were obtained for plasma density of $10^{21}m^{-3}$.

The experiments on the GDT device are directed to the solution of the problem of creation of a 14 MeV high power neutron source. At present, new powerful neutral beam injectors for this device are under construction. After installing these neutral beams at GDT, the electron temperature of plasma should increase up to 300 eV. It means that calculated neutron flux for the case of D-T reaction will be about 0.5 MW/m^2. If this value will be obtained, it will be immediately possible to begin the design of final stage of high power neutron source.

In the paper, the status of all mirror traps in Novosibirsk is presented and description of the main experiments is given.

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PLASMA HEATING AND CONFINEMENT IN THE GOL-3 MULTIPLE MIRROR TRAP

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Experiments on plasma confinement in a multiple mirror configuration are carried out at GOL-3 facility in Novosibirsk [1]. Plasma is confined in a 12-meter-long solenoid which consists of 55 cells with H_{max}/H_{min}=5.2/3.2 T. Collective plasma heating by ~120 kJ (~8 μs) relativistic electron beam results in T_e~2 keV at ~10^{21} m^{-3} density. High T_e exists for ~10 μs. To this time T_i reaches ~1 keV. Then electron temperature rapidly decreases to below 100 eV. Ion temperature keeps at the high level. Energy confinement time in this configuration is ~1 ms and generation of DD neutrons lasts for ~1.5 ms.

Large ion temperature fundamentally differs the regime with multimirror configuration from previously studied plasma heating by the beam in a uniform magnetic field [1]. New physical mechanism of effective heating of plasma ions, substantially dependent on the corrugation of the magnetic field, was suggested in [2]. Main features are: a) nonuniform plasma heating (which depends on the n_b/n_p ratio, i.e. on the local magnetic field); b) suppression of heat transport during the beam injection [3] that enables buildup of large pressure gradients; c) collective acceleration of plasma flows from the high-field part of corrugation cells to cell's 'bottom'; d) thermalization of opposite ion flows.

A set of special experiments was carried out at GOL-3 facility in order to study this mechanism of heating of ions. A Thomson scattering system (10 J, 1.06 μm) was used in order to measure 13-point radial distribution of the plasma density. Shot-to-shot spread of plasma density is below 10% during several first microseconds of the beam injection. Then density spread becomes larger, up to $\partial n / n_0$ □ 30% and such large spread exists for sub-millisecond time. There is no neutron flux during the initial (steady) stage of the plasma heating. Then approximately at the moment of emergence of large density fluctuations intensive neutron flash appears which is followed by a steady neutron emission for 1-1.5 ms. Observed plasma behavior confirms in general the suggested mechanism of fast collective heating of ions in a beam-plasma system in a corrugated magnetic field.

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1. M. A. Agafonov, et al., Plasma Phys. Control. Fusion, **38** (12A), A93 (1996).
2. R. Yu. Akentjev, et al., Proc. 29th EPS Fusion Conf., paper P5_057 (2002).
3. A. V. Arzhannikov, et al., JETP Letters **77** (7), 358 (2003).

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