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NEUTRAL GAS INFLUENCE ON PLASMA HEATING AND CONFINEMENT IN THE MULTISLIT ELECTROMAGNETIC TRAP "JUPITER 2M"*

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INTRODUCTION

The basic idea of electromagnetic traps is cashing character of plasma confinement. The plasma in these traps is kept in the cashing formed by combined electrical and sharp-angle magnetic fields (in the central part of a trap the fields are absent). The plasma cooperates with these fields in a thin superficial layer, and its central part is in powerless, thermally equilibrium condition. Such system of the combined plasma confinement by electrical and magnetic fields has unique properties allowing to struggle successfully with plasma instability of a various type. As against other systems with magnetic plasma confinement width of diffusion layer in an electromagnetic trap is limited by a flow through magnetic slit, which can not be wide because of a condition of ions confinement in a potential well. Really in electromagnetic traps width of diffusion layer makes 20-60 Larmor's radius of electrons, and the question about character of electrons transfer has basic importance for an estimation of prospects of creation thermonuclear reactor based an on electromagnetic trap. Therefore data of density change in volume of plasma confinement during a pulse of injection are necessary for finding - out the character of electrons diffusion.

The influence of neutral gas on plasma heating and confinement in multislit electromagnetic trap is considered in the report.

MULTISLIT ELECTROMAGNETIC TRAP"JUPITER 2M "

The experiments were carried out on installation "Jupiter 2M"[1]. A magnetic field of installation, the fig. 1, has axial symmetric multipole structure with seven ring magnetic slits in the central part and axial holes on the ends. Length of magnetic system between axial fuses makes 1.3 ì, diameter of a ring slit - 0.43 ì, diameter of axial holes - 0.025 m. The maximal strength of a magnetic field in a ring slit B_A=9 kG. Strength of a magnetic field in axial Holes $B_{A0}=2B_A$.

The spatial distribution of a magnetic field in the region of plasma confinement is characterized by a deep magnetic well, so at r ▪ 0.1m, | | 0.25 m takes place $Â/Â_À$ < 5%. All magnetic slits are closed by system of electrodes with high negative potential. The plasma in a trap is created with the help of electrons injection through axial holes.

The experiments have confirmed high efficiency of plasma creation in a multislit electromagnetic trap with the help of electrons injection. At moderate power contribution 10^{-4}J/ñm^3 and weak magnetic field 500 gs on a limiting magnetic surface in "Jupiter 2M" the plasma of density 10^{12} cm^{-3} in volume 50 l is received. The absence of high-frequency plasma activity and monotonous (without failures) growth of its parameters during all time of accumulation are marked.

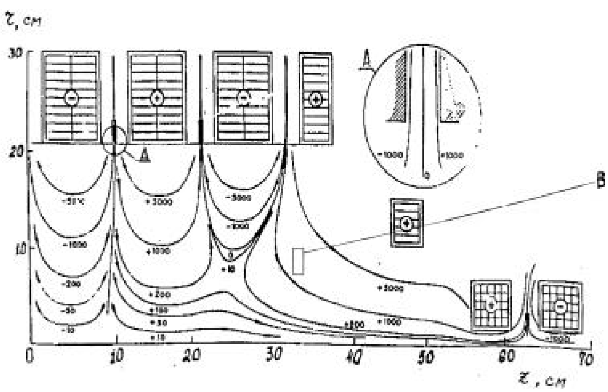

Fig. 1. A configuration of magnetic force lines of a multislit electromagnetic trap«Jupiter2M »
A - magnetic ring slit,
B- arrangement of a probe for measurement of neutral gas density.

EXPERIMENTAL RESULTS

It was experimentally observed, that the pulse of plasma accumulation in a trap is accompanied by increase of neutral gas pressure in the vacuum chamber of installation. In the beginning it was assumed, that the gas is allocated during disintegration of plasma owing to its interaction with walls of the chamber. Later was noticed, that the pressure of gas changes already at an initial stage of plasma accumulation.[2,3] As the neutral gas significantly influences on heating and diffusion of electrons, it is interest to estimate change of its density in volume of plasma confinement during a pulse of injection.

Density of neutral gas in a trap was measured with the help of the specially made probe, which was placed near to an extreme magnetic surface limiting area of plasma accumulation, in a face part of a trap, fig 1, B. In a fig. 2 the circuit of a probe is shown which works by a

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principle of a ionization lamp in a range of pressure 10^{-3} – 10^{-6} Tor with enough high time thin-bed vertical resolution . The probe is placed

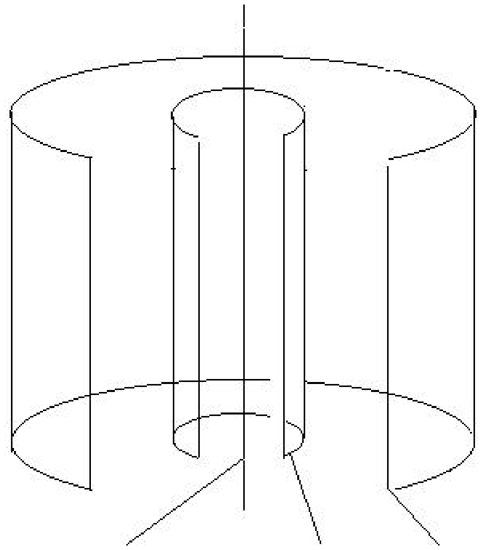

Fig. 2. The circuit of a probe for measurement of temporary dependences of neutral gas pressure.

in the special screen, which prevents hit of the charged particles on its electrodes. The calibration of a probe in a magnetic field of a trap was carried out. The calibration curve is given in a fig. 3.

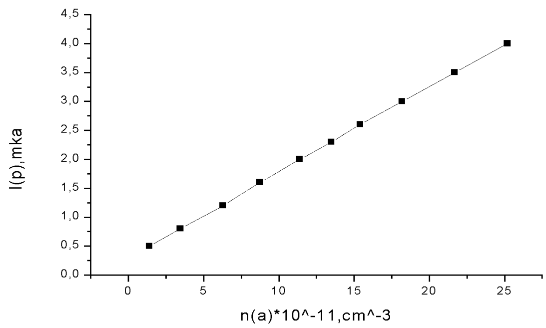

Fig. 3. Calibration curve of a probe.

A change of neutral gas density (bottom curves), strength of magnetic field, current cross electrons transfer are given in a fig. 4, 5. On oscillograms of a magnetic field strength the pulse of electrons injection is imposed on, during which there is a plasma accumulation in a trap.

From oscillograms it is visible, that the increase of neutral gas density occurs at once of a beginning of a pulse of electrons injection and density is increased at 8-20 of time by the end of a pulse of injection depending on mode of operations of installation. The increase of neutral gas density during a pulse of injection is connected with its knockout from surfaces of magnetic

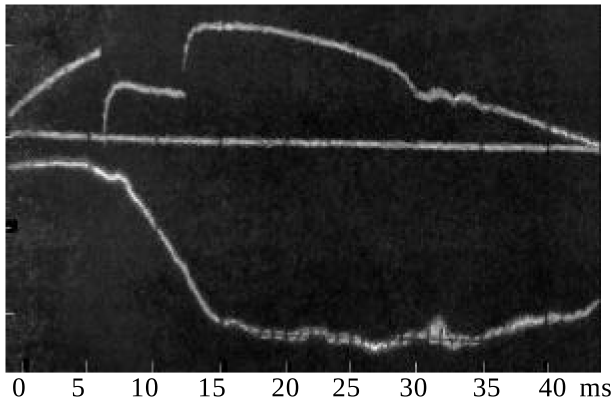

Fig. 4. Oscillograms of a magnetic field strength (top) and density of neutral gas (bottom).

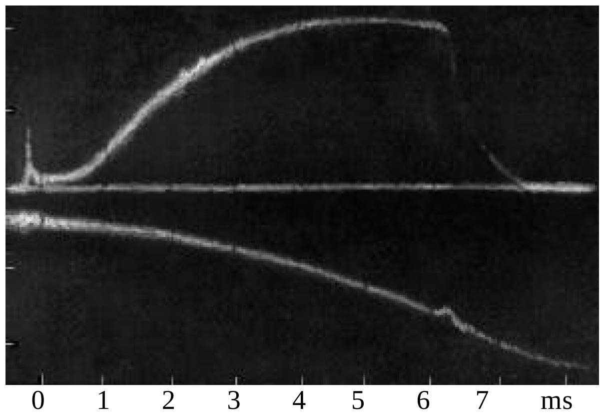

Fig. 5. Oscillograms of cross electrons transfer (top) and neutral gas density (bottom).

and electrostatic systems located near to area of plasma accumulation, charged particles and radiation from plasma. A condition of electrostatic and magnetic systems surfaces significantly influence on neutral gas density increase during pulse of injection, therefore experiments were carried out after their processing by preliminary shots.

Density of neutral gas during a pulse of injection grows with increase of a current and energy of injection, but decreases with growth of a magnetic field strength. The dependences of neutral gas density at the end of a pulse of injection from strength of a magnetic field for currents of injection 150 and 220 mA are given on fig 6. Thus initial neutral gas density makes 1.4 $10^{11}cm^{-3}$.

In the same figure the dependences of plasma density in a trap is given under the same conditions. Density of plasma was measured by 8 mm interferometer.

The increasing of neutral gas density with increasing of magnetic field strength at small magnetic field value is connected with boundary magnetic field, at which Larmor radius of injected electrons is smaller than magnetic slit width and effective accumulation of plasma is started.

Decrease of neutral gas density with the further increasing of magnetic field strength is connected with decrease of Larmor radius and with decrease of the surface from which neutral gas is knocking out.

The dependence of neutral gas and plasma density from magnetic field strength explains early received

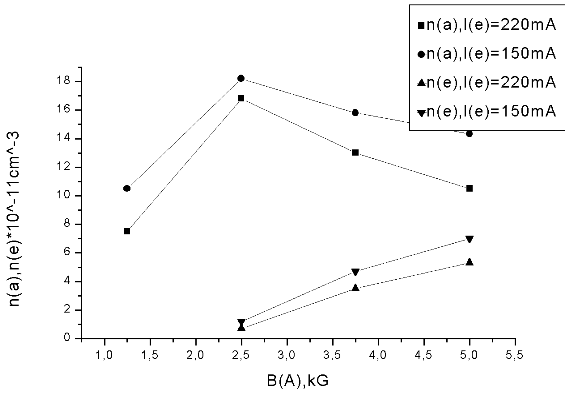

Fig. 6. The neutral gas n(a) and plasma n(e) density at finish pulse of injection dependencies from magnetic field strength in magnetic slit.

dependences of relation of experimental measured and theoretically estimated currents of electrons under assumption of classical diffusion cross magnetic field from plasma density, fig. 7[2].

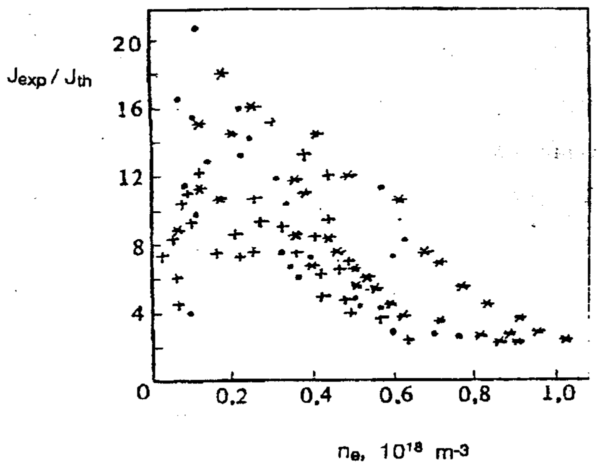

Fig 7. Dependence of experimental and theoretical ratio of electrons cross field transfer from plasma density. B_{A} = 3.75 kG(·); 5.0 kG(+); 6.25 kG (*)

On figure 7 the relation of experimental currents of cross electrons diffusion to theoretical for various currents and energy of injection are given at intensity of a magnetic field in a magnetic slit Â$_A$ = 3.75 (·), 5.0 (+), 6.25 (*) êGs. It is visible from figure, that with growth of plasma density the relation of experimental currents to theoretical one decreases and for density of plasma n_e =10^{12} ñì$^{-3}$ does not exceed 2-3. From comparison of results of neutral gas and plasma density measured dependences from magnetic field strength (the fig. 6) and from relation of experimental and theoretical currents of cross electrons diffusion it is possible to note, that change of neutral gas pressure during impulse of injection is determinative in increasing of cross electron transfer as the result of their diffusion on neutral particles.

The results of these researches allow to make a conclusion about classical character of cross electrons transfer in a multislit electromagnetic trap "Jupiter 2Ì ". These results will be used for updating mathematical model of plasma accumulation, heating and confinement in a multislit electromagnetic trap.

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