Generation and acceleration of steady-state plasma in PLM-M device for testing of fusion materials

Fedorovich S.D., Dedov A.V., Budaev V.P., Kavyrshin D.I., Lukashevsky M.V., Peregudov D.V., Gubkin M.K., Chan K.V., Rogozin K.A.

National Research University "MPEI"

Email: fedorovichsd@mail.ru

Testing of in-vessel plasma-facing materials in modern tokamaks, experimental testing of in-vessel components of the ITER tokamak reactor revealed a number of significant problems of fusion materials under the powerful plasma, beam, and thermal loads expected in a fusion reactor [1]. It is necessary to test materials and components with high heat loads up to 10 MW in plasma devices to predict their operation in the reactor, see [2]. For this purpose, steady-state plasma devices with auxiliary heating and plasma acceleration should be developed and constructed.

The generation and acceleration of steady-state plasma for testing fusion materials is being conducted at the PLM-M [3] device at the National Research University MPEI. The PLM-M magnetic system consists of two solenoids and the eight-pole multicusp system. The magnetic field reaches a value of 0,035 T in the center of the cylindrical plasma discharge and up to 0.2 T in the cusp zone on the periphery. In the main volume of magnetic confinement, the hot zone of the cylindrical plasma discharge has a diameter of 3.5 cm. A cooled helicon antenna is used for steady-state RF heating of the plasma and aceleration. Water cooling is used to ensure the steady-state operation of the helicon antenna, plasma heating system, vacuum chamber and device systems. The parameters of the steady-state plasma of the PLM-M were measured using probe and optical methods. To estimate the electron temperature, a spectral method was used to determine the intensity ratios of the most intense lines in the ultraviolet, visible, and near-infrared wavelength ranges: the He II line with the length of 468.5 nm and the He I line with the length of 471.3 nm with known electronic excitation functions. In experiments with additional RF plasma heating using the helicon antenna, the electron density is ~10^{19} m^{-3}, the electron temperature is ~10 eV, depending on the plasma current, Fig. 1,2.

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REFERENCES

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[3]. V.P. Budaev, S.D. Fedorovich, A.V. Dedov, and others. Issues of Atomic Science and Technology. Ser. Thermonuclear Fusion, 2024, vol. 47, issue 2, pp. 49-57.

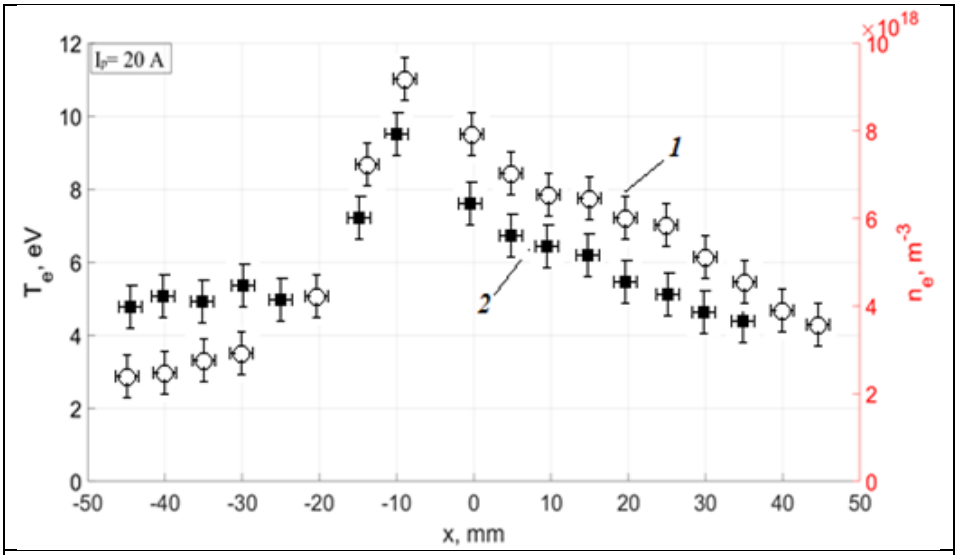

Fig.1. (1)- Radial distribution of electron temperature T_e and
(2) - electron concentration n_e, plasma current of 20 A

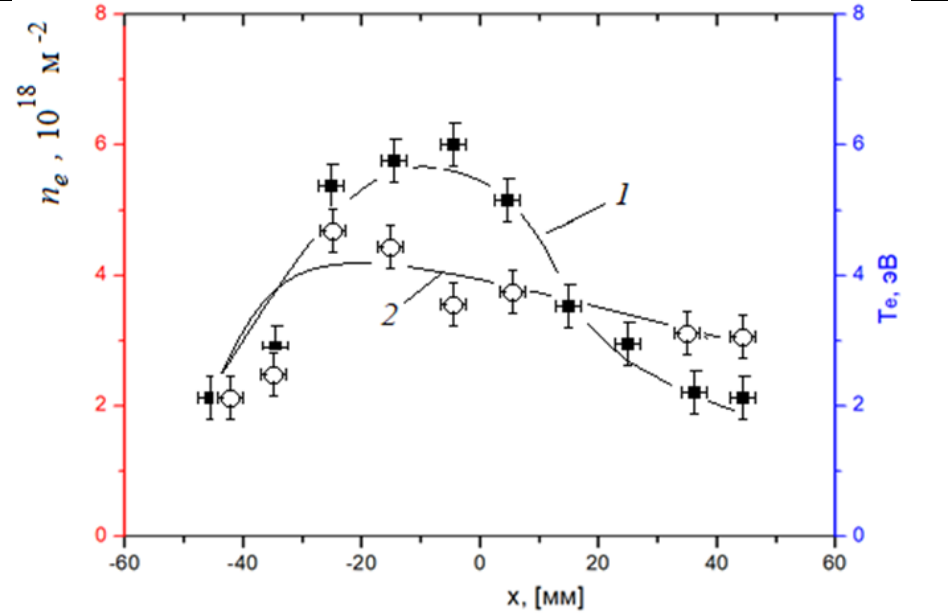

Fig.2. (1)- Radial distribution of electron temperature T_e and
(2) - electron concentration n_e, plasma current of 8 A