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STUDY OF THE FAST ION POPULATION IN THE GOL-NB FACILITY *)

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The GOL-NB devicefacility is a linear axisymmetric open trap with multimirror sections for plasma confinement. The main goal of the experiments conducted on this facility is to investigate plasma confinement in a multimirror (periodically modulated along the axis) magnetic field. Plasma in the facility is generated by a plasma gun located in the expander at one end of the facility and is heated by the injection of beams of fast hydrogen atoms (25 keV, 1.1 MW).

As the fast atom beams pass through the plasma, they become ionized due to collisions with electrons and ions in the plasma, and the resulting fast ions are captured by the magnetic field of the facility. The captured ions oscillate along the axis of the facility between stopping points (coinciding with injection points) and gradually transfer their energy to the plasma electrons through elastic collisions. Another significant effect leading to the loss of fast ions is charge exchange with neutral gas. The presence of neutral gas in the vacuum chamber and its penetration into the plasma results in losses of fast ions due to resonant charge exchange, which reduces the efficiency of plasma heating.

The primary diagnostic tool for fast ions in the device is a charge exchange neutral analyzer (NPA) located at one of the injection points. The analyzer has 11 energy channels that register neutrals in the range from 5 to 25 keV. The interpretation of the analyzer signals is carried out by comparing the measured signals with expected ones based on a given model distribution function of fast ions and determining the parameters of this distribution function. Additionally, the analyzer allows for direct measurement of ion lifetimes in the plasma by observing the decay of the flux of neutral particles to the NPA after injection is turned off.

Measurements of the dynamics of the fast ion population have shown that a significant portion of captured ions is lost from the plasma without having time to transfer their energy to plasma electrons. The most likely mechanism for ion losses is charge exchange with neutral gas desorbing from the walls of the vacuum chamber, as well as that generated in the injector tract when non-recharged fractions of fast neutral beams hit the wall.

To quantitatively describe plasma heating via a neutral injection system, a model distribution function of fast ions has been proposed, characterized by a single parameter—the ratio of power transferred from ions to plasma electrons to the power lost due to charge exchange. The obtained model aligns well with experimental data and allows for studying the dynamics of effective heating power of plasma by neutral beams during injection. In current experiments, the efficiency of energy transfer from fast ions to plasma does not exceed 20 percent, which limits the achievable plasma temperature.

*) abstracts of this report in Russian