Globus-M plasma physics research for fusion application and compact neutron source development

N. Bakharev, V.K. Gusev

Ioffe Institute, Saint Petersburg, Russia

Spherical tokamaks (STs) are considered nowadays as a potential candidate for creation of a compact fusion neutron source and fusion-fission hybrid facility based on beam-plasma nuclear reactions. For this purpose development of reliable current drive methods, reduction of fast ion losses and improvement of confinement is vital. This talk presents a review of the following experimental results obtained at Globus-M ST along these lines:

The scheme of non-inductive current drive in spherical tokamak (ST) by launching of LH waves slowed down poloidally proposed and developed at Ioffe institute was for the first time tested experimentally. The LH current drive effect is demonstrated in experiment in agreement with modeling predictions.

Globus-M neutral beam heating experiments helped to distinguish between different types of fast ion (FI) losses and develop recipes for better FI confinement in compact STs. Modeling of FI confinement and neutral beam current drive is performed and compared to experiment. FI confinement optimization resulting in substantial neutron rate growth is predicted on the upgraded Globus-M2 tokamak at higher magnetic field and plasma current.

Alfvèn eigen-mode excitation is investigated in Globus-M experiments with hydrogen and deuterium NB injection. Influence on FI velocity space distribution and confinement is studied.

Isotopic effect on energy confinement is studied at Globus-M. Fundamental importance of such investigation is discussed and experimental dependence $\tau_E \sim M^{0.4}$ is derived similar to the dependence observed in small conventional tokamaks.

The experiments on GAM study in ST Globus-M demonstrate standard electric field ($n = 0, m = 0$) and magnetic field ($n = 0, m = 2$) perturbation structure similar to those in conventional tokamaks. However the GAM frequency is lower in agreement with theory and in density perturbation the mode ($n = 0, m = 0$) dominates.

Experimental data and 2-D numerical modeling was used to identify SOL width dependence, which is a crucial parameter of the edge plasma determining the heat load to the divertor plates. Agreement to the Eich scaling is demonstrated. Divertor materials were tested in conditions modeling tiles damage by ITER-like loads. Their interaction with heat flows demonstrated in-depth loose layer formation.