Fast ion confinement analysis in Globus-M

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Massive fast ion losses have been observed in Globus-M tokamak earlier in experiments with 18 and 25 keV H and D NBI into D plasmas [1, 2]. Although first orbit losses exceed all other types of losses, sawtooth oscillations decrease confinement of the 25 keV D+ ions significantly. A way to diminish losses of the energetic particles was found. It is plasma column inward shifting, increasing distance between plasma border and the wall at the low field side. Improvement in fast confinement is confirmed both by experiment and modeling and is much more significant for the 25 keV injection. Moreover strong dependence of the ion temperature and neutron yield on the plasma-wall distance was observed [3]. Since fast ion tracking algorithm described in [1] can explain decrease in losses only partially (it lacks several losses mechanisms as sawtooth-induced, slowing-down and losses due to ripple of the magnetic field), it was desirable to make complementary modeling. Interpretation of NPA spectra observed in the experiment was done by simulations using analytical solution of Boltzmann kinetic equation with Landau collision term including velocity diffusion term and particle slowing down [4]. Compared with a simplified Boltzmann kinetic equation solution used in previous approach, latter simulations gave better coincidence of experimentally observed NPA spectra with simulated spectra shape, especially for energies less than critical one. So, it is important to use this function for the discharges with 18 keV NBI.

In Globus-M2 [2] magnetic field and plasma current will be increased 2.5 times, leading to a much better confinement. Modeling shows, that it is possible to use particles with higher energies for NBI heating. In the case of 60 keV D NBI direct losses won’t exceed 20% even if plasma column is not shifted inwards. For 25 keV D injection direct losses decrease more than 10 times as compared with the Globus-M plasma parameters.

References: