TAE-induced Energetic ion TRANSPORT AND LOSSES at Globus-M/M2 [[1]](#footnote-1)\*)

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BakharevN*.*N*.*, BalachenkovI*.*M*.*, ChernyshevF*.*V*.*, GusevV*.*K*.*, IlyasovaM*.*V*.*, KhilkevitchE*.*M*.*, KhromovN*.*A*.*, KiselevE*.*O*.*, KornevV.A*.*, KurskievG*.*S*.*, MelnikA*.*D*.*, MinaevV*.*B*.*, MironovM*.*I*.*, MiroshnikovI*.*V*.*, PetrovYu*.*V*.*, Ponomarenko A.M., SakharovN*.*V*.*, ShchegolevP*.*B*.*, ShevelevA*.*E*.*, SkrekelO*.*M*.*, TelnovaA*.*Yu*.*, TokarevV*.*A*.*, TukhmenevaE*.*A*.*, VarfolomeevV*.*I*.*, YashinA*.*Yu*.*, ZabrodskyV*.*V*.*

Ioffe Institute, St. Petersburg, Russia

The paper presents a review of multidiagnostic studies of energetic ion transport and losses during toroidal Alfvén eigenmodes (TAE) [1] at Globus-M/M2 tokamaks [2]. TAE is a candidate for the role of the most dangerous instability for the fast ion confinement in future thermonuclear machines. Excited by a population of MeV alpha particles, generated in the nuclear reaction of D and T fusion, TAE can lead to catastrophic consequences. The interaction of Alfvén waves with fast particles induce their anomalous transport to the periphery, creating local loads on the tokamak wall and reducing the efficiency of plasma heating and current drive. Experimental studies of TAEs at existing conventional tokamaks require specific discharge conditions. At Globus-M/M2 spherical tokamaks these instabilities appeared in routine experiments with auxiliary heating. They resulted in the loss of up to 30% of high-energy ions [3], the transport of more than half of the fast ion population from the central plasma region [4], as well as significant heating of the first wall.

Globus-M/M2 tokamaks are equipped with a wide range of diagnostics, that allows fast ion study: neutron detectors [5], neutral particle analyzers with central and peripheral line of sight [6], solid-state detectors that register lost particles, a Langmuir probe and a fast infrared camera. The localization and structure of the mode itself can be obtained using Doppler reflectometry diagnostics [7] and a set of high-frequency magnetic probes. The experimental data, obtained with the help of these diagnostics, as well as modeling of the fast ion interaction with a wave, allowed us to investigate the mechanisms of transport; the width of the resonance; the locality of losses in time and space; the features of the mode evolution due to interaction with fast ions and background plasma; the dependence of the fast ion losses on the amplitude of the mode, the toroidal magnetic field and plasma current and features of fast ion confinement during TAE in compact spherical tokamaks. The analysis allows us to give a favorable forecast for future machines.

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References

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