simulation of the anizotropic distribution function of fast particles in the globus-m2 tokamak using nubeam code

1Kiselev Е.О., 1Bacharev N.N., 1Kurskiev G.S., 1Gusev V.K., 1Telnova A.Yu., 1Tukhemeneva Е.А., 1Khromov N.А., 1Miroshnikov I.V., 1Patrov М.I., 1Petrov Yu.V., 1Sakharov N.V., 1Minaev V.B., 1Schegolev P.B., 1Tokarev V.А., 1Tolstyakov S.Yu., 1Melnik А.D., 2Goncharov P.B.

1Ioffe Physical Technical Institute, Russian Academy of Sciences, Saint Petersburg, Russia,
 nightkeo@gmail.com, kiselev.eo@mail.ioffe.ru
2Peter the Great Saint Petersburg Polytechnic University, Saint Petersburg, Russia

Modeling of fast particles injected into a tokamak by NBI is necessary for calculating characteristics of various plasma processes and for designing reactors of the future.
The fast particle distribution function, in contrast to the distribution function of thermal particles of the main plasma, is anisotropic, which must be taken into account in the simulation. However, many codes traditionally used on classical tokamaks and cannot be used on CTs. The reason is they do not take into account ST’s features – the low value and high gradient of the magnetic field. The report presents the results of numerical simulation of the anisotropic distribution of fast particles in the Globus-M2 tokamak and analysis of its effect on fast particles.

The behavior of fast particles is well studied in classical tokamaks. Recent reports have shown that in most cases, the simulation reproduces the interaction of fast particles with a tokamak plasma, and the calculated distribution function of fast ions in consistent with measured distribution function in the experiment. Most of the current studies on the behavior of fast particles in classical tokamaks are concentrated at supporting the ITER project, as well as future thermonuclear tokamak reactors, but much less data on the behavior of high-energy particles is obtained for spherical tokamaks. But at the same time, only 4 spherical tokamaks were equipped with NBI – Globus-M (M2) (Russia), NSTX (USA), MAST (Great Britain) and START (Great Britain). The behavior of fast particles in spherical tokamaks has some features due to the small size of the tokamak and the relatively low value of the magnetic field with large gradient.

In the Globus-M2 tokamak the toroidal magnetic field and plasma current in comparison with Globus-M are increased to 1 T and 500 kA, which leads to a significant improvement of fast particles losses. The simulation predicts an increasing in direct losses of more than 10 times compared to the tokamak Globus-M.

The Monte-Carlo code NUBEAM [1] is allow to calculate anisotropic fast particle distribution function and losses. The analysis of the effect of this distribution function on the fast particle confinement and on the main plasma is made.

This work was supported by a grant from the Russian Foundation for Basic Research 18-32-20031.

References

1. A. Pankin et al., “The tokamak Monte Carlo fast ion module NUBEAM in the National Transport Code Collaboration library”, Comp. Phys. Comm. 159 (2004) 157.