NPA synthetic signal calculations using FIDASIM at globus-m2 spherical tokamak [[1]](#footnote-1)\*)

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Kiselev E.O., Balachenkov I.M., Bakharev N.N., Chernyshev F.V., Varfolomeev V.I., Gusev V.K., Khromov N.A., Kurskiev G.S., Melnik A.D., Minaev V.B., Miroshnikov I.V., Patrov M.I., Petrov Yu.V., Sakharov N.V., Shchegolev P.B., Skrekel O.M., Telnova A.Yu., Tokarev V.A., Tukhmeneva E.A., Zhiltsov N.S.

Ioffe Institute, St. Petersburg, Russia

The injection of neutral particles is an important part of the future thermonuclear neutron source. At the same time, NBI fast particles induced instabilities, which may cause additional heating losses. Validation of fast particles simulation is used to determine the additional power heating. In the presence of instabilities, the classical calculations without instabilities gives overestimated absorbed power. An additional coefficient of anomalous diffusion can be used in fast particles slowing down calculations. The validation can be carried out by comparing the measurements of the NPA and the synthetic signal obtained using the FIDASIM [1] and NUBEAM [2] codes.

Calculation of fast particle distribution function was performed with Monte-Carlo code NUBEAM with Larmor radius corrections. Due to the relatively low magnetic field and compact geometry of the Globus-M tokamak, all types of fast ion losses, are significant for this machine, direct losses, i.e. first orbit (FO) and shine-through losses, charge exchange (CX) losses during slowing down and MHD-induced losses, are observed experimentally.

The FIDASIM code is used to obtain the synthetic signal of the recharge atom analyzer. The first stage of the simulation is the calculation of the density of neutral particles coming from the injector, as well as the calculation of halo atoms. The second stage is the calculation of NPA flux by the Monte Carlo method. NUBEAM distribution function is used to generate particles colliding with the NPA detector. Both the charge-exchange probability, attenuation of the NPA flux are taken into account.

The paper presents the results of NPA calculations for four Globus-M/M2 tokamak shots. Two experiments without instabilities are well described by the classical slowing down of fast particles. In the presence of instabilities, the introduction of a heuristic coefficient of anomalous diffusion is required. It is shown that for 2 shots, the synthetic NPA signal coincides with the experimental one with the additional anomalous diffusion. At the same time, the absorbed injection power drops by 30-40%.

References

1. Benedikt Geiger et al 2020 Plasma Physics and Controlled Fusion 62
2. N.N. Bakharev et al 2015 Nucl. Fusion 55 043023 1421
1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/CE-Kiselev.docx) [↑](#footnote-ref-1)