Observation of fast-ion distribution function using FIDA DIAGNOSTIC during NEUTRAL INJECTION in THE TUMAN-3M TOKAMAK [[1]](#footnote-1)\*)

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Shuvalova L.K., Abdullina G.I., Askinazi L.G., Belokurov A.A., Zhubr N.A., Kiselev E.O., Kornev V.A., Lebedev S.V., Razumenko D.V., Smirnov A.I., Tukachinsky A.S.

Ioffe Institute, St.Petersburg, Russian Federation, [shuvalova-lyuba@mail.ru](mailto:shuvalova-lyuba@mail.ru)

A fast-ion diagnostic FIDA relies on metering and analysis of emission spectrum. Spectrum is formed as a result of charge-exchange between injected neutral atoms and energetic hydrogen or deuterium ions. It can be measured from different angles towards to the direction of injection and the localization of fast ions and make it possible to obtain a fast-ion distribution function. There were distortions of the emission spectra in some of the first FIDA experiments on TUMAN-3M tokamak associated with the presence of fast atoms and ions in the plasma. However, an unambiguous interpretation of these spectra is difficult due to the weakness of the signals and the influence of stronger radiation due to the other processes, for example, the emission of the injected atoms. In addition, it is required to consider the specific observation geometry in each experiment.

FIDASIM code which implements the Monte Carlo method was used for the quantitative interpretation of the metered spectra. FIDASIM allows to obtain the fast-ion distribution function by modeling the spectrum recorded from real observation lines. It can be possible with achievement of the best agreement modeled spectrum with the experimentally observed spectrum by selecting the parameters of the distribution function of fast ions and the coefficients describing their deceleration and losses.

FIDASIM requires plasma parameters (temperature, density, effective charge profiles, magnetic fields), parameters of atomic and ion beams. Some of the parameters are available from the experiment, and the rest are obtained by modeling the discharge using ASTRA and NUBEAM codes jointly. FIDASIM is complex program that need amount of special type input data. It led to developing an interface between these two codes and FIDASIM. First of all, a connection was established between the ASTRA transport code and the associated NUBEAM module using an additional tool for processing input parameters to the NUBEAM spatial grid, including plasma profiles, magnetic surfaces, neutral injection geometry, and information about the beam composition. The distribution function of fast ions was obtained as a result of the codes interaction. Subsequently, a connection was established between the current data set with the FIDASIM code through a subroutine for reading and converting parameters to a new spatial grid from the files created during the output from ASTRA and NUBEAM. In addition, the real geometry of spectral diagnostics was added. After a complete description of the required input parameters and search for optimal simulation settings, such as the number of test particles for Monte Carlo simulation, synthetic FIDA emission spectra were obtained and compared with experimental spectra. In addition, the effect of electric fields in the tokamak plasma on the confinement of fast ions was studied.

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Mu/ru/AR-Shuvalova.docx) [↑](#footnote-ref-1)