APPLICATION OF MACHINE LEARNING FOR DETERMINING THE ELECTRON TEMPERATURE IN TOKAMAK GLOBUS-M2 ACCORDING TO DIAGNOSTICS OF THOMSON SCATTERING AND SOFT X-RAY RADIATION [[1]](#footnote-1)\*)

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An important part of studying high-temperature plasma is the determination of the electron temperature (*Те*) in tokamak experiments. For this purpose in spherical tokamaks we can use diagnostics of Thomson scattering and diagnostics of the intensity of soft x-ray emission (SXR). The first diagnostic provide accurate local electron temperature and density measurements, but its temporal resolution is limited by the repetition rate of the powerful lasers used. Thus, it cannot be used for fast, time-dependent processes. On the other hand, SXR diagnostics has a high temporal resolution, so it can be used to obtain the electron temperature time profile during the entire experiment.

However, there are difficulties in determining the temperature from the intensity of SXR radiation. The X-ray spectrum from plasma includes a continuum of free-free bremsstrahlung and free-bound recombination radiation and of bound-bound line radiation. Only continuum radiation carries information about the electron temperature, so if line radiation gets into the signals, it becomes difficult to determine the temperature from them. Despite the fact that we cut off the part of the spectrum where the line radiation of impurities dominates with metal filters and limitation of the detector’s spectral response, a part of the line spectrum still stays into the detection region. Study shows that the effect of radiation from impurities cannot be neglected [1]. This significantly complicates the problem of obtaining the temperature, forcing to take into account the complex processes of the impurities transport in the plasma.

An alternative approach to finding *Те* evolution from SXR data, without relying on transport models, is to use machine learning (ML). In this case, we can use the local Thomson scattering measurements as labels for supervised ML, so data with any time resolution can be used. In addition, this method makes it possible to use data from other diagnostics that provide information about impurities or the sources of plasma heating. Thus, using the already trained machine learning algorithm, it is possible to obtain the electron temperature evolution with good accuracy.

In this work the result of using ML for obtaining the electron temperature with the combined action of two diagnostics is presented. It is shown, that using machine learning can significantly improve the accuracy of *Te* determination in comparison with the traditional method of processing the intensity of soft x-ray radiation in different spectral ranges [2] without taking into account the effect of impurities on the Globus-M2 tokamak.

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References

1. S. von Goeler et al., 1995 Nucl. Fusion 15 301
2. Delgado-Aparicio L F et al., 2007 J. Appl. Phys. 102 073304

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