STUDY OF DISRUPTION PREDICTIONS IN TOKAMAK PLASMA USING COnvoluTIONAL NEURAL NETWORKS [[1]](#footnote-1)\*)

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There presents the development of a loopback system for controlling the quenching of a plasma discharge. To start the system for preventing and mitigating a disruption, it is necessary to predict its approach with sufficient time interval in advance [1, 2]. For this, during the entire discharge, it is necessary to generate a disruption probability signal after a certain time interval. When the threshold value of the probability is exceeded, it should be formed a trigger for starting the plasma discharge quenching system.

The development of a massive gas injection system with a movable valve is currently underway, which takes about 4 ms to activate. This requires a prediction of plasma disruption with a lead time of at least 5 ms.

The first preliminary step includes the selection of measured signals and calculated values that will be used in real time to calculate the probability of disruption with a given lead time [3, 4]. Firstly, the diagnostics signals and calculated values which are available for real-time measurement. Then a correlation analysis is performed in order to identify strongly correlated values and leave only one of them in the set being formed.

The next step involves choosing a neural network topology. The report proposes a multilayer architecture consisting of two time-convolutional layers followed by a perceptron. The proposed topology simultaneously provides compression of information and suppression of mismatches on the input layers.

After selecting a set of signals and a neural network topology, a set of training examples is formed. According to the training examples, the parameters of the network and its weights are adjusted. Training takes a long time, but when applying the neural network, the result can be obtained in real time. For additional acceleration of computations, any-time algorithms are used.

The developed software package consists of several modules. One module prepares training examples from archived data. Another module implements the actual neural network of the described topology. The third module provides training and verification of the neural network.

As a result, a method of using a convolutional neural network for solving the problem of predicting the disruption of a plasma discharge is proposed. In addition, the generated disruption probability signal can be used for other purposes, for example, generating trigger signals for other equipment or controlling its position to protect against thermal or ionizing radiation.

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