STUDY OF DISRUPTIONS IN THE PLASMA OF GLOBUS-M / M2 TOKAMAK USING NEURAL NETWORKS

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Modern devices for magnetic plasma confinement are becoming more and more complex and place ever more stringent requirements for the automation of experiments. The operability of future reactor- scale devices will depend on real-time plasma monitoring systems. However, some of the data that can be used to create such systems cannot be measured directly during the experiment, and real-time modeling is often impossible due to the complexity of the processes occurring in the plasma. The monitoring of disruptions in tokamak plasma belongs to this type of problem.

Disruptions are potentially dangerous events for a reactor-scale tokamak, so it is necessary to either reduce the frequency of disruptions or mitigate the consequences of disruptions that cannot be avoided by other means. To mitigate the consequences of the breakdown, it is necessary to form a trigger of this event ahead with time sufficient to activate the controlled discharge extinguishing system. To solve this problem, methods of deep machine learning were used.

In this work, a correlation analysis of the signals of the Globus-M2 tokamak available in real time was carried out in order to select the minimum sufficient set of input parameters for training a neural network. The set of input parameters is obtained by analyzing the cross-correlation matrix of the original set of signals.

The topology of the neural network model with convolutional and fully connected layers is selected. Using convolutional layers allows the model to find and respond to stall precursors in the original data. Fully connected layers determine the limits of the operating parameters of the plasma for the normal operating modes of the installation.

The neural network model trained on training data was tested on real charges that were not involved in training. The system shows comparable results with similar systems for JET and ASDEX-U units. The false alarms are 14% and the missed alarms are 7%.