STUDY OF Disruption Prediction in Tokamak Plasma using Neural Networks [[1]](#footnote-1)\*)

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Kapralov V.G., Bogdanov A.M., Novokhadskaya O.E., Svintsov M.V., Totrov D.R.

SPbPU, Saint-Petersburg, RF, [v.kapralov@spbstu.ru](mailto:v.kapralov@spbstu.ru)

The development of plasma systems and diagnostics increases the requirements for control systems and experimental data processing. Automation of measurement and control processes often requires real-time calculations and simulations of physical processes, including situations where it is impossible or difficult to directly measure the required values.

An example of such a task is the control of a system for disruptions mitigation and quenching of a plasma discharge [1,2]. In order to get sufficient time to activate the discharge quenching system, it is necessary to form a disruption precursor, i.e. during the discharge, calculate the probability of disruption on a certain period of time in future and, when the threshold value of probability is exceeded, form a trigger for launching the discharge quenching system [3]. In addition, the same signal can control the position of the discharge quenching system relative to the edge of the plasma edge, which is important for systems with long discharges and a large neutron output, because allows you to temporarily divert equipment to a region of lower neutron load.

The report discusses the physical problem of forming a trigger of system to prevent plasma disruption [1,2]. The system consists of a massive gas injection device and/or pellet-injector, as well as a disruption prediction module. Even before training the neural network, it is necessary to determine the set of input parameters of the discharge, which can be used in real time [3,4]. To do this, a correlation matrix of diagnostics signals that are available in real time is built and basic signals are selected that will be used to model and prepare training examples. In this case, it is possible to solve the problem using real-time simulation using other measured parameters. To provide real-time calculations, the numerical solution of differential equations describing the physical process is replaced by a solution to the problem using a neural network. Acceleration of calculations is achieved by performing a long process of training the neural network in advance, before application during a plasma discharge. In this case, the use of a neural network allows you to calculate the result of the next simulation step in the allowed time for one iteration of the control cycle with acceptable accuracy.

At the application stage, the current values ​​of the selected measured plasma input parameters are fed to the input of the neural network [3]. The network performs simulation of transport processes in real time ahead of schedule. At the output of the neural network, the predicted values ​​of the parameters necessary for the operation of the disruption prediction module are formed. Based on the obtained set of model data, the disruption prediction module generates a signal about the movement of the injection system closer to or further from the plasma, and taking into account the current plasma parameters, a signal is generated to start the injection and quench the discharge.

Литература

1. Kapralov V.G. et al., Journal of Physics: Conf. Series, 2017, **907**, 1, 012010.
2. Dremin M M et al., Problems of Atomic Science and Tech., Ser. Th. Fusion, 2012 , **4**, 58.
3. Kapralov V.G. et al., Journal of Physics: Conf. Series, 2017, **907**, 1, 012027.
4. Gusev V.R. et. al., Proc of the 21st IAEA FEC. 2006, **16**, 21

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