DOI: 10.34854/ICPAF.51.2024.1.1.235

APPLICATION OF A NEURAL NETWORK TO RESTORE LINE AVERAGED ELECTRON DENSITY IN ITER REFRACTOMETRY DIAGNOSTICS *)

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One of the main diagnostic tasks facing the ITER High Field Reflectometry system (55.F9) is the assessment of the line averaged electron density. To solve this problem, an additional refractometry channel was added to the diagnostics, located in the equatorial port (EP#08) opposite the reflectometer antenna systems on the high-field side [1]. Refractometry is designed to operate during major ITER discharge scenarios. The basic physical principle of refractometry is similar to reflectometry [2], probing will be carried out using an extraordinary wave (X-wave) in the transparency region between the lower cut-off frequencies of the X-wave and the cyclotron frequency. The proximity of the operating frequencies to the boundaries of the transparency region does not allow us to resort to the well-known expression in interferometry that connects the phase incursion of the transmitted wave with the line averaged electron density.

In this work, an algorithm for reconstructing the line averaged electron density for refractometric diagnostics of ITER was developed, taking into account the technical and engineering solutions used in the development of this diagnostic. For this purpose, calculations of the measured parameters were used using synthetic diagnostics based on the expected scenarios of ITER discharges with a toroidal field of 5.3 T [3,4]. Based on the measured parameters, a database was built and a neural network was trained. Since the task was to estimate the integral parameter based on the same integral data, the neural network approach confidently achieves the accuracy required by the IO ITER.

It is shown that for target discharges the maximum and root-mean-square errors do not exceed 1% at the quasi-stationary stage of the discharge (at the current shelf in the region of 90% of the maximum plasma current in the discharge). The average operating time of the algorithm is 150 ns, which significantly exceeds the required 1 ms, which allows diagnostics to operate in real time. In addition, neural networks have the advantage of being able to be further improved by training with real data obtained during plant discharges, which increases their adaptability and accuracy. The developed approaches can be used to solve problems associated with refractometric diagnostics on new generation installations.

This work has been carried out within the framework of activity under State Contracts № H.4a.241.19.23.1014 and 17706413348230000070/12-23/01. All works on ITER HFSR diagnostic has been commissioned by RosAtom.

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