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ANALYSIS OF THE STABILITY OF THE NEUTRON PROFILE RECONSTRUCTION ALGORITHM IN CASE OF LOSS OF INDIVIDUAL LINES OF SIGHT OF THE VNC *)

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The Vertical Neutron Camera (VNC) of ITER is a multichannel neutron collimator. It has 11 lines of sight (LOS), at the end of each of which there is a fast neutron detector unit (DU). The DU consists of two fission ionization chambers and two diamond detectors with different sensitivities. VNC is divided into two subsystems: upper and lower. One of the DUs of the lower VNC is used to assess the neutron background. The main goal of VNC is to reconstruct the neutron emissivity profile and fusion power density with spatial and temporal resolution [1].

With prolonged operation of the system under high thermal and radiation conditions, there is a risk of losing some of the detectors and their associated LOS of the VNC. This work demonstrates the results of reconstructing the neutron emissivity profile using a probabilistic approach and neural networks in the absence of individual detectors and LOS. Both solutions also rely on the assumption that neutron source emissivity is constant along magnetic surfaces.

It has been shown that in order to meet accuracy requirements (10%) and measurement time constraints (1 ms) in the ITER baseline plasma scenario (Q = 10, P_{fus} = 500 MW), it is acceptable to lose up to 5 LOS from one subsystem or up to 3 simultaneously directed towards the center or periphery of the plasma. Additionally, the loss of detectors narrows the dynamic range of measured parameters.

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References

[1]. L. Bertalot et al., "Present Status of ITER Neutron Diagnostics Development," Journal of Fusion Energy, vol. 38, no. 3, pp. 283–290, 2019, doi: 10.1007/s10894-019-00220-w.

[2]. R. Rodionov, G. Nemtcev, and A. Krasilnikov, "Fusion neutron emissivity tomography for ITER Vertical Neutron Camera," Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, vol. 1040, p. 167127, Oct. 2022, doi: 10.1016/J.NIMA.2022.167127.

[3]. A. Zharov, G. Nemtsev, R. Rodionov, and T. Kormilitsyn, "Exploring the potential of machine learning for real-time neutron emissivity tomography using the Vertical Neutron Camera of ITER," Fusion Engineering and Design, vol. 204, p. 114519, Jul. 2024, doi: 10.1016/j.fusengdes.2024.114519.

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