Feasibility of pedestal density fluctuation measurement by beam emission spectroscopy on the ITER diagnostic beam

O. Asztalos[1], S. Zoletnik[2], G. Boguszlavszkij[1], M.v. Hellerman[3], M. De Bock[4], G.T.A. Huijsmans[5,6], G.I. Pokol[1]

[1] *Institute of Nuclear Techniques, Budapest University of Technology and Economics, Budapest, Hungary*
[2] *Wigner Research Center for Physics, Budapest, Hungary*
[3] *Institue for Plasma Physics, IEK4 Forschungszentrum Jülich, 52428 Jülich, Germany*
[4] *ITER Organization, Route de Vinon-sur-Verdon, CS 90 046, 13067 St. Paul Lez Durance Cedex, France*
[5] *CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France*
[6] *Eindhoven University of Technology, Eindhoven, The Netherlands*

ITER constitutes a critical milestone on the road to fusion energy production, which requires understanding of the scaling of turbulent density fluctuations and pedestal dynamics to ITER sized machines. This need facilitates the development of various fluctuation diagnostics.

Fluctuation beam emission spectroscopy (BES) is an active plasma diagnostic used for density measurements that has sufficient spatial and temporal resolution for the study of turbulent density fluctuations and associated flows. A high energy neutral beam is shot into the plasma consisting of hydrogen isotopes or light alkali metal atoms, and through various collisional processes with plasma particles the beam atoms get to excited states, and their spontaneous emission is collected by an observation system. In the present contribution, the feasibility of pedestal density fluctuation measurement by BES is discussed that would be proposed to make piggy-back use of the pedestal CXRS periscope viewing the diagnostic neutral beam.

Forward modelling was used to estimate the signal to background (SBR) and signal to noise (SNR) ratios, as well as the spatial resolution. These were evaluated in view of possible applications of the diagnostic. A 10 x 15 channel observation system was put forward that would not interfere with the baseline CXRS diagnostic system using the same periscope. Narrow-band optical filters were optimized for each detector column to eliminate as much as possible of the high continuous background expected on ITER. Resulting SBR of each column was determined using Simulation of Spectra [1], which models the Doppler shifted BES spectrum for each detector channel. The RENATE 3D BES modelling code [2], which handles realistic magnetic geometries and accounts for the spatial effects of the diagnostic, was used to determine the expected photon flux on each detector channel in order to derive the expected SNR. Fluctuation response analysis was performed on the system to determine the extent of the fluctuation sensitive volumes for each detector revealing the amount of expected cross-talk between detector channels and the performance of the diagnostic system.

Applications of turbulence models and non-linear MHD codes, such as JOREK [4], in conjunction with RENATE as a synthetic diagnostic are discussed, as well, to prove the performance of the proposed fluctuation diagnostic.

The views and opinions expressed herein do not necessarily reflect those of the ITER Organization.

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