Two-dimensional n_e and T_e measurements of the edge plasma turbulence in TJ-II

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Two-Dimensional (2-D) measurement of the edge plasma electron density n_e and temperature T_e has been achieved in TJ-II stellarator recently with turbulence-relevant spatio-temporal scales (4 mm, 10 μs) using an upgraded Spectroscopic Gas Puff Imaging System (SGPI) based on a previous setup [1]. The emission images of 3 characteristic Helium (He) atomic lines recorded with an intensified Fast camera system to deduce the n_e and T_e field using the well-established He line ratio technique [2]. The He injection point has been carefully selected with respect to the camera line of view so as to optimize the spatial resolution. In the present work, the experimental setup is explained and time-averaged radial n_e and T_e profiles in ECRH- and NBI-heated plasmas are described with the typical edge parameters ranges in TJ-II and compared with other diagnostics. After that, the strongly turbulent character of the measured camera emission images will be shown when going to time scales down to the μs scale. Spatially coherent structures of several centimeters appear with relative intensity fluctuations of up to +/- 100% with respect to the average values in accordance with prior Gas Puff Imaging (GPI) studies [3]. However, the link of the raw emission intensity to plasma parameters is not straight forward. A previous work [4] pointed to an unexpected discrepancy between the measured line emission and the deduced n_e distribution. Evidence was found of the plasma turbulence coupling to the neutral atom distribution through local ionization. In this work, thanks to the simultaneous n_e and T_e measurements made possible by the spectroscopic analysis of the 3 atomic lines, allows for further detailed investigation of the phenomena and its characterization is discussed within the limits of the experimental constraints. Finally, the application of advanced turbulence analysis tools [5] to the experimental 2-D measurements will be discussed.

[1] E de la Cal et al 2011 Plasma Phys. Control. Fusion 53 085006. [2] B Schweer et al 1992 J. Nucl. Mater. 196–198 174. [3] S Zweben et al 2017 Rev. Sci. Inst. 88 041101. [4] E de la Cal and TJ-II Team 2016 Nucl. Fusion 56 10603. [5] B van Milligen and R Sanchez 2022 *Analysis of Turbulence in Fusion Plasma* ISBN: 978-0-7503-4856-0