§15. Development of Measuring Method of Electron Temperature and Its Density Distributions by Intensity Ratio of Helium Lines in GAMMA10

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In the device GAMMA10, Plasma Research Center (PRC), Univ. of Tsukuba, characterization and control of electron density n_e and its temperature T_e in the central/anchor/end cell regions are important from a viewpoint of plasma confinement improvement and the divertor physics. Since monochromator measurements have advantages due to a non-invasive method, we have initiated a development of an estimation of the above electron temperature/density by optical measurements using an intensity ratio method.[1] Particularly we will focus on the multi-view measurements by the use of HeI lines to derive a local emission intensity after inversion techniques, leading to the understanding of the confinement physics.

In the GAMMA10, only one channel measurement is being executed, and thus a multi-channel development is needed. In Tokyo Univ. of Agriculture & Technology (TUAT), using a high-speed camera, a multi-view measurement of high-density helicon plasma[2] has been being developed, whose technique should be applied to the above machine. Incorporating elementary processes, we are advancing a calculation method to derive intensity ratios (e.g., 667.8, 706.5 and 728.1 nm) under the collaborations between TUAT, NIFS and Shinshu Univ. We can also compare the obtained results to another simple code.[3,4]

In order to have full experiments in the GAMMA10, we have first analyzed HeI line intensities taken in the D module region, as shown in Fig. 1. The above lines were taken, using three mirrors, interference filters and monochromators with amplifiers through a fiber optical cable from the D region. Taking into recombination and ionizing processes, we have derived the contour map of n_e and T_e by line intensity ratios using sets of (667.8, 728.1) nm and (728.1, 706.5) nm, respectively (Fig. 2). From this, typical data of $n_e = (5\text{-}10)\times 10^{17}$ m^{-3} and T_e =20-30 eV were obtained, which is consistent with probe results. In addition, we are trying to compare this result with that by a Collisional Radiative (CR) model,[5] taking full elementary processes.

We have also done simulation experiments, using devices in TUAT to produce high-density (up to 10^{13} cm^{-3}) helicon plasmas.[1] Here, there views of optical emission intensities were taken by interference filters and a fast speed camera (Photron: FASTCAM SA-5) through fiber optical cables from argon and/or helium plasmas.

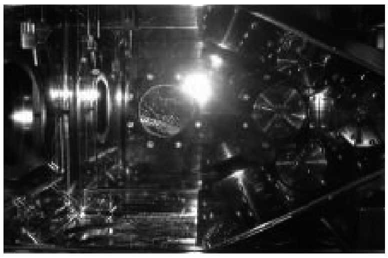

Fig. 1. Inside of D Module in the West region.

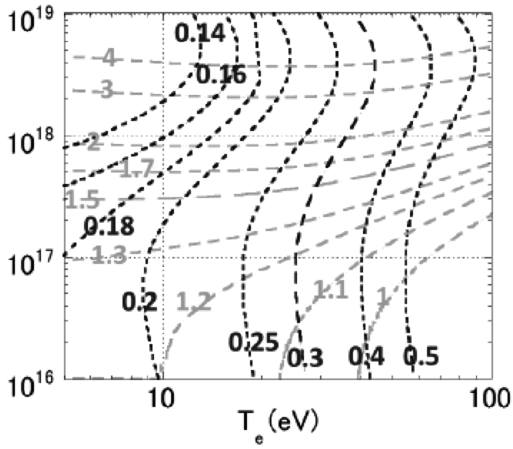

Fig. 2. Contour map of n_e (red lines) and T_e (blue lines) by He line intensity ratios (calculation).

In conclusion, we have initiated the estimation of n_e and T_e by using intensity ratios based on the simple CR model. In parallel, we have developed the full CR code, characterizing high-density helicon discharges in TUAT.

In the near future, it is necessary to increase the view lines to have local plasma parameters of of n_e and T_e, especially in the D region, after suitable inversion techniques, leading to the understanding the D module region in the GAMMA10.

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