P9-01

Measurement and analysis of visible line spectra with inhomogeneous spatial distribution in LHD

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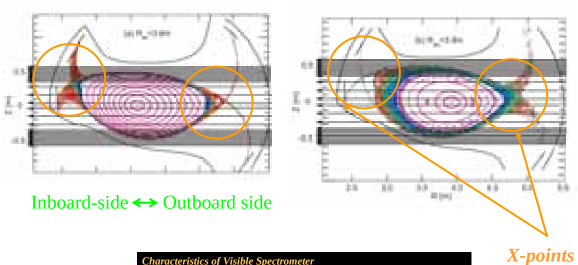
Introduction

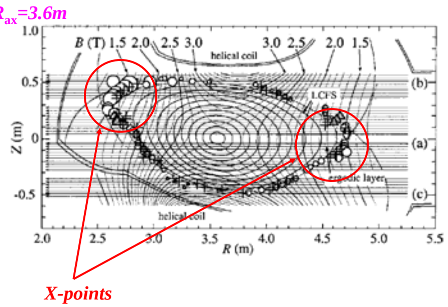
Neutral gas pressure at the plasma edge region affects the plasma confinement performance. In LHD, neutral gas pressure at the plasma edge region is inhomogeneous and it may caused by the complicated three-dimensional structure. Local helium line intensities have been analyzed with using Zeeman splitting. HeI line intensities around the inboard X-point are extremely stronger than those of other places. The line intensity depends on some parameters so it is important to evaluate electron temperature and electron density at the location where the line intensity is strong. It is available for the estimation of electron temperature and electron density to apply the ratios of HeI line intensities. When the magnetic configuration changes, the distribution of ion flux to the divertor plates also changes. We measure the line intensity distribution for different magnetic configurations and investigate its relationship with the ion flux distribution.

26 parallel vertical chords for measurement of visible spectra



Characteristics of Visible Spectrometer
- Grating : 100(g/mm)
- Measurement Region : 300〜800(nm)
- Time Resolution:200(ms)
- Dispersion:0.52(nm/pixel)
- 26ch

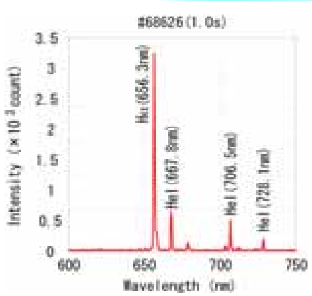
Two-dimentional spatial distribution of HeI spectrum



Local helium line intensities have been analyzed with using Zeeman splitting. HeI line intensity around the inboard X-point is extremely stronger than those of other places.

Symbol size reflects on the strength of line intensity.

Appliance the ratios of HeI line intensities to evaluation of local T_e and n_e



HeI(728.1nm)/HeI(706.5nm)
→mainly depends on T_e

HeI(667.8nm)/HeI(728.1nm)
→mainly depends on n_e

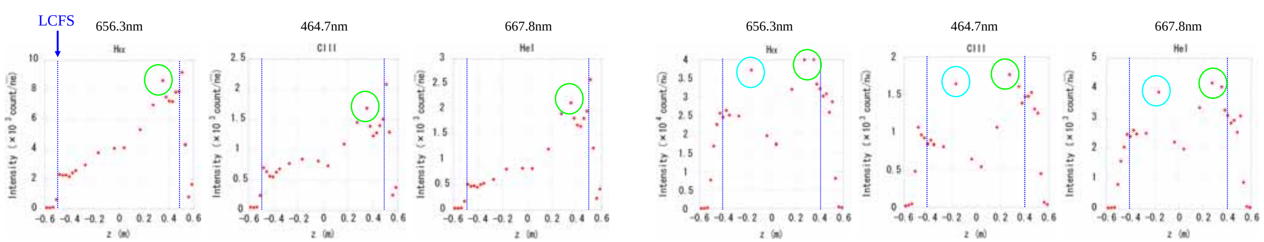
Applying the ratios two of three HeI line intensities to evaluating local T_e and n_e and investigating the relation with non-uniform spatial distributions.

$$I = A(p,q)n_p(n_e,T_e,n_i)$$

Spatial distributions of hydrogen, carbon and helium

#68626 (R_{ax}=3.6m, B=-2.75T, γ=1.254, B_q=100%)

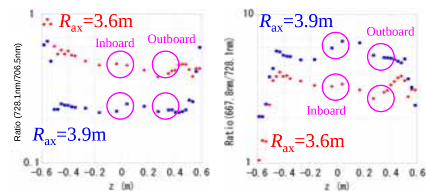
#69346 (R_{ax}=3.9m, B=-2.539T, γ=1.254, B_q=100%)



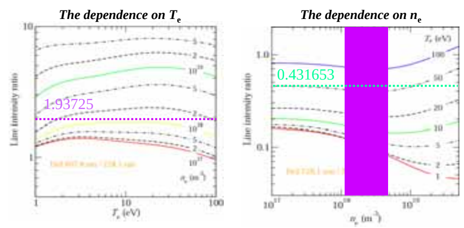
When the magnetic axis is shifted outwardly, the ion flux distribution is drastically changed.

Experimental results

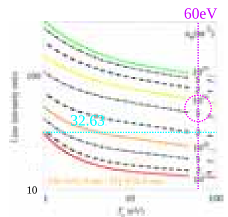
Spatial Distribution of the ratios of HeI



The ratios of HI



The ratios of Hα and Hγ



#68626(R_{ax}=3.6m)

T_e, n_e evaluated from HeI ratios

- Inboard
  T_e : 60 (eV)
  n_e : 1.8×10^18 (m^-3)
- Outboard
  T_e : 50 (eV)
  n_e : 4.2×10^18 (m^-3)
- High Field Side
  T_e : 75 (eV)
  n_e : 5.0×10^18 (m^-3)

n_e evaluated from HI ratios

- Inboard
  n_e : 2.8×10^18 (m^-3)
- Outboard
  n_e : 3.0×10^18 (m^-3)
- High Field Side
  n_e : 5.0×10^18 (m^-3)

#69346(R_{ax}=3.9m)

T_e, n_e evaluated from HeI ratios

- Inboard
  T_e : 23 (eV)
  n_e : 6.0×10^18 (m^-3)
- Outboard
  T_e : 35 (eV)
  n_e : 4.5×10^18 (m^-3)
- High Field Side
  T_e : 50 (eV)
  n_e : 6.5×10^18 (m^-3)

n_e evaluated from HI ratios

- Inboard
  n_e : 2.3×10^18 (m^-3)
- Outboard
  n_e : 2.5×10^18 (m^-3)
- High Field Side
  n_e : 4.8×10^18 (m^-3)

Summary

(1) Spatial distributions are measured in LHD with 26 vertical sightlines. Spatial distributions of Hydrogen, Carbon and Helium are all inhomogeneous. When the magnetic axis is shifted outwardly, the ion flux distribution is drastically changed, so new peak appear around the outboard X-point.

(2) The ratios of Helium and Hydrogen were applied to the analyses of local electron temperature and electron density to investigate the dependence on line intensity. With a configuration of R_{ax}=3.6m, atoms exist around the inboard X-point. With a configuration of R_{ax}=3.9m, the peak around the outboard X-point may be caused by atom density.

(3) T_e and n_e values determined from the ratios of helium lines and hydrogen lines . As a result, a comparison among three sightlines of n_e evaluated from HI ratio denotes the same tendency of n_e evaluated from HeI ratio, but the values are not accord with each other. Within a factor of 2, but it may be caused by the difference between the radial location of Hα and HeI.