§13. Radiation Enhancement in Ne or Kr Seeded Plasmas Measured with an Infrared Imaging Video Bolometer in the Large Helical Device

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Reduction of heat and particle loads to the divertor is one of the important issue to realize a fusion reactor. Divertor detachment is a favorable operation mode for this purpose. To achieve divertor detachment, it is necessary to reduce the T_e in the scrape-off-layer (SOL). One of the effective methods for the reduction of T_e is radiation enhancement in the SOL plasma using impurity seeding. In 18th experimental campaign, krypton (Kr) seeding was carried out to expand the T_e region of the radiation. Kr has higher emissivity at T_e > 100 eV compared with neon (Ne) which has been applied the last campaign.

Radiation imaging was carried out using an InfraRed imaging Video Bolometer (IRVB) at 6.5-U port.[1)] The field of view is shown in Figure 1. Figure 2 and 3 indicate normalized radiation enhancement in the Ne and Kr seeded plasma, respectively. The fraction between the total radiated power and the heating power, $P_{rad}/P_{heating}$ ~ 30% in both figures. In the Ne seeded plasma, the radiation was enhanced around the helical divertor X-points (HDXs) and the inboard side. In the Kr seeded plasma, the response of the radiation enhancement was slower than the Ne seeded plasma and the enhanced area was along the HDXs just after the seeding. After that, the area was moved to the toroidal pixel number 0 – 10 and the poloidal pixel number 5 – 20 in Figure 3. This area is around the horizontally elongated cross section and not included the HDXs. Therefore, the radiation enhancement was from the plasma core region in the Kr seeded plasma. From the results of resistive bolometer array at 6.5-L port and SOXMOS at 7-O port, the tendencies of the higher ion stages (Kr^{24+} and Kr^{25+}) were similar to the behavior of the plasma radiation from the core region. These results indicate that the highly charged states of Kr ions which radiated at the core plasma are dominant radiators in the Kr seeded plasma.

We plan to carry out experiments in the future combining Ne and Kr to attempt further radiation enhancement. This advanced operation of the impurity seeding condition should be investigated and optimized to realize an 80-90% radiation power fraction for DEMO reactors.

1) Mukai, K. et al.: Proc. 25th IAEA Fusion Energy Conference (St. Petersburg, 2014) EX/P6-25.

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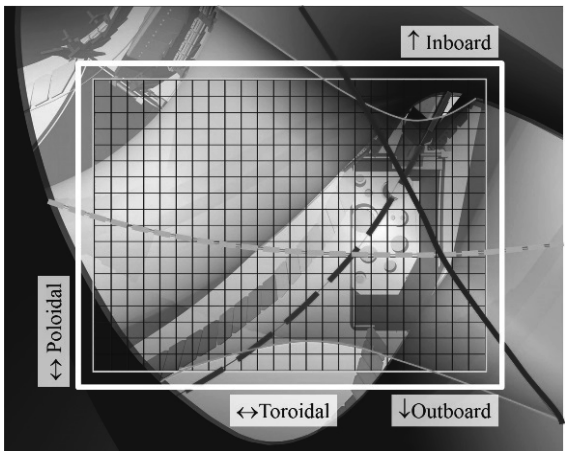

Fig. 1. CAD image of IRVB FoV at 6.5-U port (white rectangular). Solid and dashed lines indicate upper and lower HDXs, respectively. Short dashed line shows magnetic axis. Thin lines indicate LCFS.

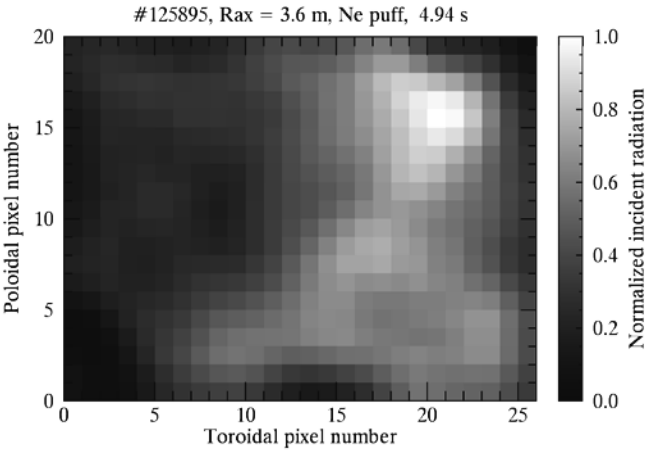

Fig. 2. Normalized radiation enhancement in the Ne seeded plasma (#125895).

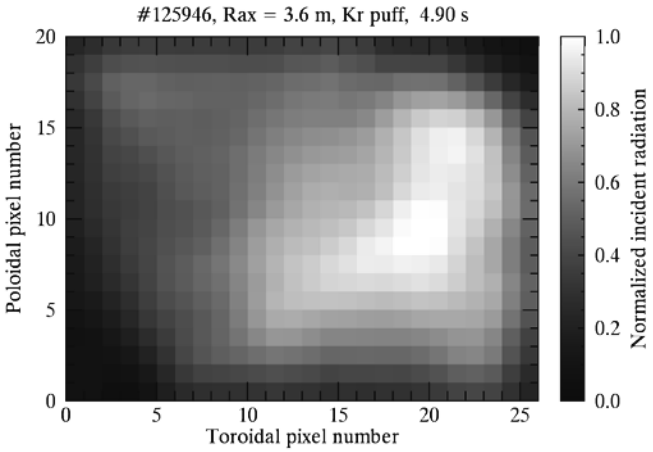

Fig. 3. Normalized radiation enhancement in the Kr seeded plasma (#125946).