§3. Bremsstrahlung Measurement with Tangentially Viewing Cameras in LHD

Shoji, M.,
de la Cal, E., Hidalgo, C. (EURATOM-CIEMAT)

It is concerned that in high density plasmas in ITER, the Bremsstrahlung can contaminate the visible emission by atomic plasma interactions in the plasma periphery. The Large Helical Device (LHD) can produce high density plasma in the core region by repetitive fueling pellet injection. Tangentially viewing standard CCD cameras and a fast framing camera (Photron APX-RS) with an image intensifier can investigate the effect of the Bremsstrahlung on the visible emission in high density plasmas in LHD.

Figure 1 shows observations obtained in a high density plasma discharge. The right figure is the radial profiles of the electron temperature and the plasma density measured with a Thomson scattering system and a FIR interferometer after fueling pellet injection. The upper-left image is a tangential view of the LHD plasma observed with a standard CCD camera (30fps) without interference filters. A bright area with halation was formed in the main plasma confinement region by intense Bremsstrahlung light due to the high density core plasma, which considerably masks the structure of visible emission in the plasma periphery. The lower-left one is an image of the Bremsstrahlung light observed with the tangentially viewing fast framing camera (20kfps) with an interference filter for Bremsstrahlung measurements (central transmission wavelength: λ_0=522.3nm, and FWHM of the transmission wavelength: λ_{FWHM}=2.1nm). It shows that the two-dimensional image of Bremsstrahlung light in the core plasma region can be clearly measured from the tangential port using the appropriate interference filter.

Figure 2 (a) and (b) give experimental results in a high density plasma operation before and after the formation of high density core plasma, respectively. The lower-left images are plasma images observed with the tangentially viewing standard CCD cameras equipped with four different interference filters for CII (λ_0=426.7nm, λ_{FWHM}=1.1nm), CIII (λ_0=464.5nm, λ_{FWHM}=1.2nm), HeI (λ_0=587.6nm, λ_{FWHM}=1.0nm) and H_α (λ_0=656.3nm, λ_{FWHM}=0.8nm) emission measurements.

Before the formation of the high density core plasma, the structure of visible emission in the plasma periphery was clearly identified. After the formation of the high density core plasma, the structures of the emission of CII, CIII and HeI are considerably contaminated by the Bremsstrahlung. On the other hand, the H_α emission can be measured by excluding the effect of the Bremsstrahlung. It shows that measurement of intensity profiles of primary visible emission by carbon and helium whose wavelengths are in the range of less than ~600nm is impossible in the high density discharges in LHD. Meanwhile, intensity profile of H_α emission whose wavelength is more than 600nm can be clearly measured from the tangential port by using the interference filter. The reason for this may be the following two facts: one is naturally strong H_α emission in the plasma periphery during the formation of the high density core plasma, and the second is the negative dependence of the visible Bremsstrahlung emissivity on the wavelength.

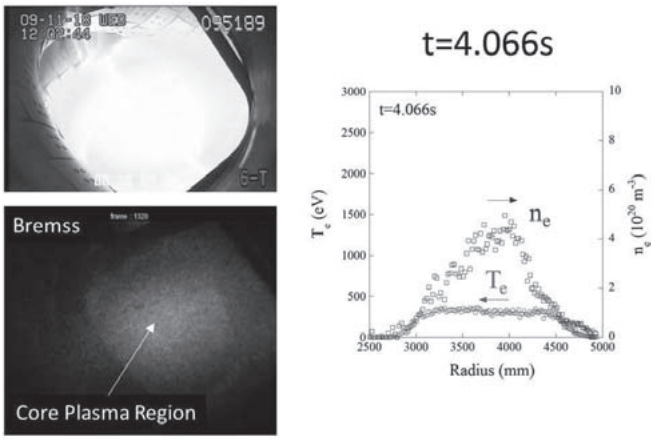

Fig. 1. A tangential view of a LHD plasma observed with a standard CCD camera (upper-left), an image of Bremsstrahlung observed with a fast framing camera (lower-left), and the radial profiles of electron temperature and density in a high density discharge.

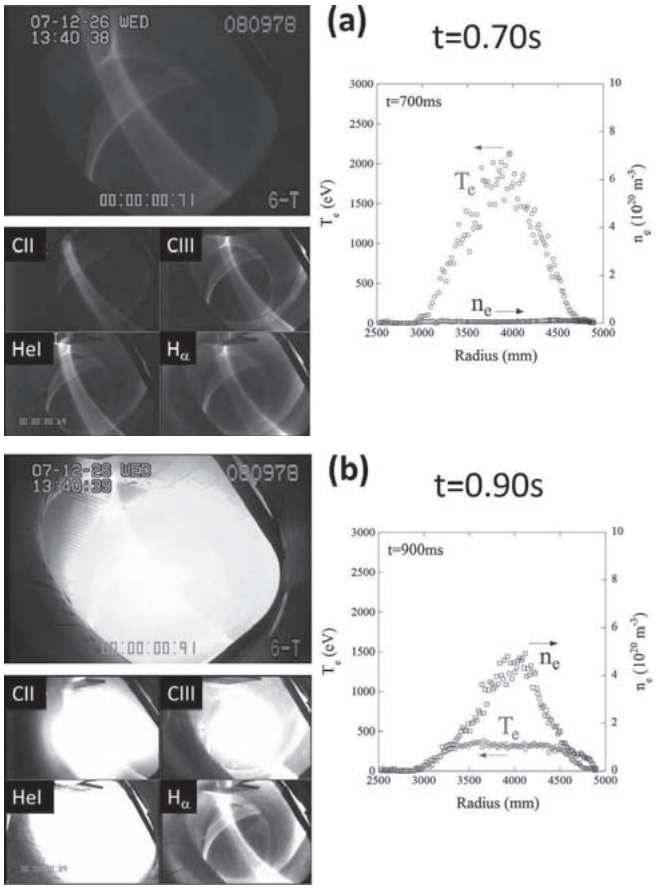

Fig. 2. Tangential plasma images observed with CII, CIII, HeI and H_α interference filters before (a) and after (b) the formation of high density core plasma by pellet injections (lower-left). The other images/figures are same as those in Figure. 1.