§ 16. Measurement of Energy Spectrum of Electrons Using Photon Counting Soft X-ray CCD Camera

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Existence of high energy electrons with the large velocity perpendicular to the magnetic field can be important for the transition from ion root to electron root in the low density plasma with electron cyclotron heating (ECH). The photon counting soft X-ray CCD camera has been installed in CHS to study the high energy electrons excited by ECH as shown in Fig.1. Although the photon counting CCD detector has good energy and spatial resolution[1], the frame rate of the CCD camera is poor (in a order of 10 second). In order to obtain the spatial and time resolution, a slit parallel to the direction of major radius, R, is installed between the pinhole and CCD detector and kinetic mode is used as a operation mode of CCD detector. Then the time resolution is obtained in the vertical direction of the CCD detector, while the spatial resolution is obtained in the horizontal direction. This is the contrast to the normal imaging mode where the vertical direction corresponds to the toroidal direction ϕ.

Figure 2 shows a example of the measurements of high energy electrons near the magnetic axis of the plasma where the ECH resonance exist. When the electron density is high enough ($1x10^{19}m^{-3}$), the energy distribution of electrons nearly is Maxwellian (1 keV) and the electron temperature measured with SX-CCD camera is consistent with that measured with YAG Thomson scattering. However, the high energy electrons is observed in the energy range of > 2keV, when the electron density is below critical values ($0.5x10^{19}m^{-3}$ in this experiment). The effective energy of high energy electrons is 4 – 5 keV, which is much higher than the temperature of bulk electrons measure with YAG Thomson scattering.

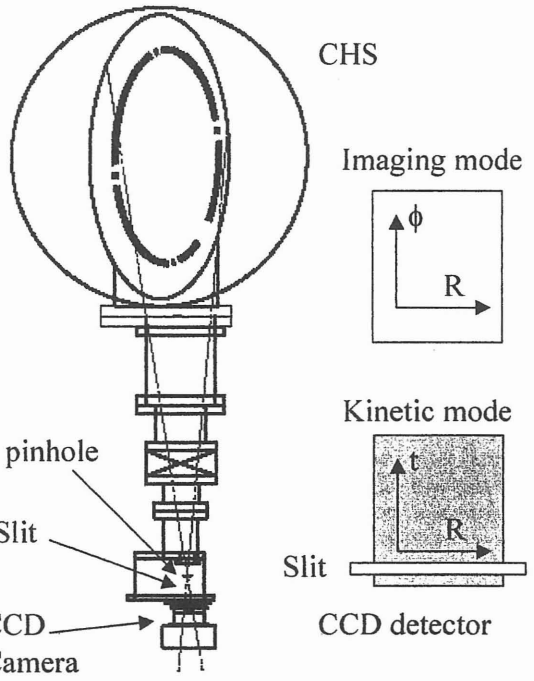

Fig. 1 Experimental setup of photon counting SX-CCD camera for the measurements of energy spectrum of electrons in CHS.

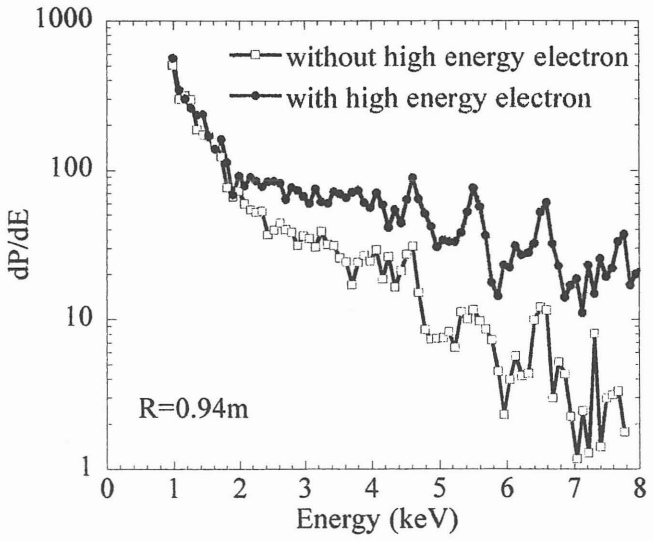

Fig. 2 Energy spectrum measured with SX-CCD camera for the plasma with and without high energy electrons.

Reference

[1] K.Ida and Y.Liang, J. Plasma Fusion Res 79 (2003) 345.