

## §10. Behavior of High-Energy Electrons in ECH Plasma of LHD

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Hard x-ray spectrum up to 200 keV has been successfully observed for the first time with an x-ray-pulse-height analyzer installed on a horizontal diagnostics port of Large Helical Device. The spectrum has been observed in a central chord. As a detector, solid-state germanium detector is used with a data-acquisition system basically working in high counting rate mode. The observed spectrum is obtained from plasma heated by electron cyclotron heating (ECH).

The line averaged temperature and the density of high-energy electrons are estimated from the continuous spectrum in hard x-ray region above 60 keV under assumption that the energy distribution of the electron is maxwellian. The minimum accumulation time necessary to the estimation is approximately 400 msec in a single shot.

Figure 1 shows the time evolution of x-ray intensities. After ECH heating is finished at 650 msec, the bulk plasma continues to radiate soft x-rays for 150 msec approximately. However, hard x-ray suddenly decayed in 10 msec. The confinement time for bulk electrons is quite different from that of high-energy electrons.

Figure 2 shows the estimated temperature of high-energy electron and the energy-distribution index obtained with an assumption that the energy distribution of is polynomial. The infinite temperature is corresponding to 1.5 of polynomial index. Above the value of 1.5 the energy distribution is non-maxwellian. Maximum electron temperature is estimated to be approximately 400 keV. Around 450 msec the distribution is suggested to be non maxwellian.

The estimated density of the high-energy electron is strongly depending on the electron density of the bulk plasma as is shown in Fig.3. The density is remarkably reduced in the case of the higher density of the bulk electrons than  $1.0 \times 10^{12} \text{ cm}^{-3}$ .

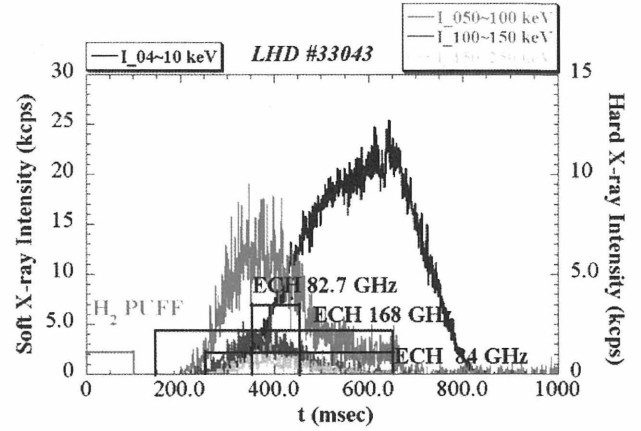


Fig.1. The time evolutions of x-ray intensities. The black line represents the intensity of soft x-rays. The colored lines represent the intensities of hard x-rays.

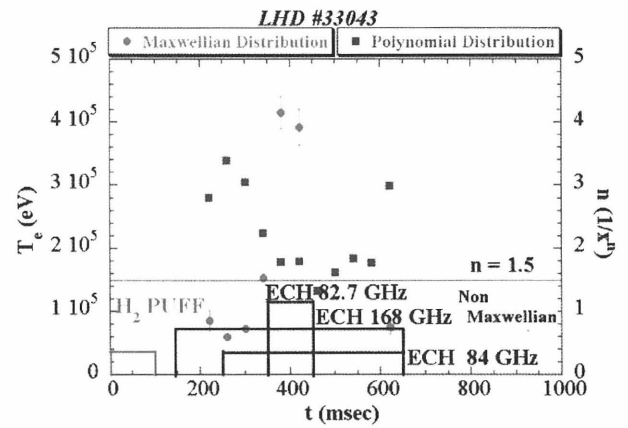


Fig.2. The time evolution of the electron temperature and the polynomial index of the energy distribution. The solid circles represent the electron temperature. The solid squares represent the index of polynomial distribution. The horizontal line means the limit of Maxwellian distribution.

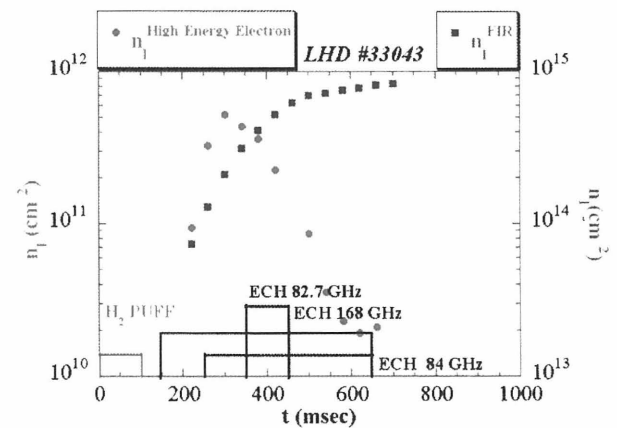


Fig.3. The time evolution of the line averaged electron density. The solid squares represent results from FIR. The solid circles represent the experimental results obtained with the x-ray-pulse-height analyzer.