§34. Preliminary Results of Neutral Particle Measurements in LHD

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The development of high energy neutral particle measurement system for ion temperature measurements and high energy particle confinement analysis during neutral beam injection and ion cyclotron resonance frequency heating experiments in the Large Helical Device (LHD) is described. The control, data acquisition systems and the horizontal movable stage are prepared to investigate pitch angle distribution and loss cone for a long discharge in LHD. The preliminary results in plasma experiments including long discharges are described. The neutral flux and ion temperature increase extremely during ICRH phase. An ion temperature increase of 300 eV is observed although the stored energy increases only 70 kJ in this shot. The temperature of 2.5 keV is observed. The power dependence between the absorbed ICH power and the ion temperature increase. The ion temperature and the stored energy are increased by the ICH power. The fact indicates that the ion cyclotron heating performs efficiently to the ion energy deposit.

In the ion resonance mode on ICH plasma, the high energy tail above 200 keV is observed (Fig.1). This behavior is remarkable at the low density plasma, and the high energy tail decreases by the density increase. The same result can be obtained by the diamond detector. The angular distribution of the high energy tail is not so large than we expected according to the horizontal scan.

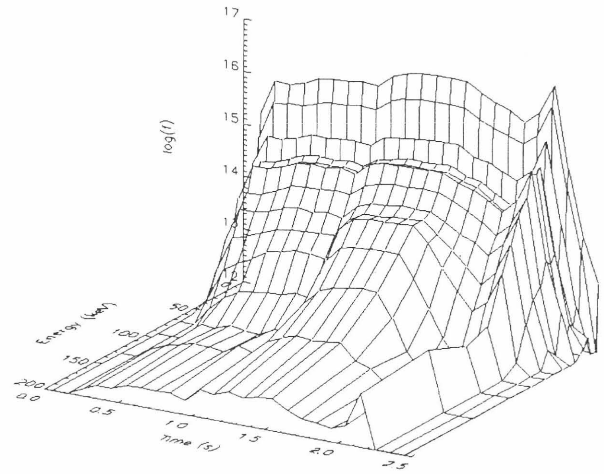

Fig.1. High Energy Tail in ICH plasma.
The high energy tail can be observed during ICH.

We try the horizontal scanning of the neutral particle measurement in the NBI plasma in order to investigate the high energy particle confinement and the loss cone analysis as shown in figure 2 (beam energy of 135 keV). Now we are studying and comparing the simulation results. The spectrum variations above 40 keV come from the amounts of particles with different pitch angles at the NBI deposition. The significant loss cone can not be found because each spectrum agrees with each other up to the energy of several times the electron temperature.

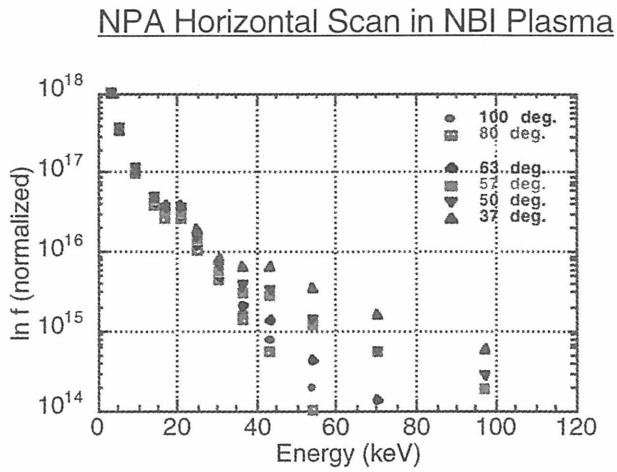

Fig.2. Horizontal Scan in NBI plasma.
The values are normalized at the lowest energy.

In the third cycle, we could succeed a 80-second discharge by NBI or ICH. The helium plasma (hydrogen minority) is produced by the initiation by ECH and additional heating of ICH from 0.5 second to 68.8 second. The radiation slightly increases during discharge. The breathing was not observed in spite of the high density (1x10-19 m-3) because the diverter was covered with graphite tiles. The ion temperature was kept 1.4 keV. We had measured the ratio of helium to hydrogen by accumulating many signals. The ratio of fluxes around 10 keV was equal to the ratio of the gas abundance. We have to keep in mind that this ratio is near the plasma edge because the helium neutral particle is mainly generated there. The long discharge enables us to obtain the ratio in one shot. Sometimes by the increase in the ICH power the density decreased.

In NBI plasma, a 80-second discharge could be succeeded. The ion temperature was about 1 keV during the discharge. The plasma was very stable and quiet similar to the ICH plasma.

Reference
1) Ozaki,T. et al., Rev. Sci. Instrum. **72**, 7 (2000).
2) Ozaki,T., et al., J.Res. Plasma and Fusion (to be publshed).