The development of 6 MeV Heavy Ion Beam Probe system in LHD

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Heavy Ion Beam Probe (HIBP) is a very powerful diagnostic tool for studying physics related to potential in high temperature toroidal plasmas, because it can measure the potential with good spatial/temporal resolution, without giving perturbation to plasma. Moreover, it can measure the density fluctuation simultaneously, so we can evaluate the particle flux caused by the turbulent fluctuation from obtained data. In LHD, a HIBP, of which acceleration voltage is 6 MeV, was installed and has been developed [1,2]. By improving components of this system, such as the ion source, the electro deflector and the beam detector, the signal to noise ratio and the temporal resolution become better. In recent experiments, not only the equilibrium potential profile but also the fluctuation in the central region of plasma was measured [3]. In this presentation, the detail of our HIBP system is shown, and recent results of measurements are reported.

When electron cyclotron heating was applied to the plasma sustained by neutral beams, the negative pulse of potential in the central region was observed in LHD. In this case, the density of plasma was 0.4×10^{19} m^{-3}, the central electron temperature was about 2~3 keV. The potential at the plasma center was about same magnitude of the electron temperature (a few kV). The depth of negative pulse of the potential was a few hundreds volts. The time constant of the potential change in this negative pulse was 100 μs in the drop phase, and 500 μs in the returning phase. In this plasma, the internal transport barrier was observed in the electron temperature profile. It is considered that the negative pulse of potential is related to the collapse of the internal transport barrier. Possible reasons of this phenomenon are the strong gradient of electron temperature or the bifurcation of electric field between two roots, so called electron root and ion root. Detail analysis of this experimental result will be shown in this presentation.

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