Dynamic Behavior of Internal Magnetic Field during Disruption in the Small Tokamak HYBTOK-II

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The tokamak disruption, which is accompanied by an intense heat load on the divertor during thermal quench and large electromagnetic force on in-vessel components during current quench, is one of the most crucial issues for the next generation tokamak, like ITER [1]. It is known that an unstable current profile leads to a growth of tearing modes, the current profile is flattened by a nonlinear growth of tearing modes, magnetic islands overlapping brings a dramatic loss of confinement, and the total current quenches. But the physical processes involved in the disruptions are not well understood in detail [2]. The direct measurement inside the plasma during disruption may give a lot of information. However, it would be quite difficult in large tokamak devices. Small tokamaks have an advantage of inserting magnetic probes inside the plasma. It is realized indeed that the internal magnetic field during disruption has been measured by multi-channel magnetic probes (10 channel) inserted into the small tokamak HYBTOK-II.

Disruption has been driven artificially by increasing plasma current so that decreasing the safety factor q_a. The plasma current quench was found to have two stages. A very rapid drop (~10μs << current diffusion time) of the poloidal magnetic field at an inner layer has been observed at just start of current quench, resulting in a flattening of the current density profile. The internal magnetic field starts to increase slowly after the ringing oscillation (200kHz) of poloidal magnetic field following a sudden drop. Concerning the internal magnetic fluctuations before disruption, a 20kHz component has been observed at the edge region, while the high frequency fluctuation of 50~100kHz is superposed to the low frequency magnetic fluctuation.

From the poloidal mode analysis by the poloidaly located external magnetic probe array, the growth of m = 3 mode, with the frequency of 20kHz, was observed to grow quickly just before disruption, together with the growth of m = 1, 2 mode. They may produce a thick stochastic magnetic layer.

In the workshop structural dynamics of poloidal magnetic field including precursor magnetic signals, and some post-disruption phenomena like a current density flattening, a ringing phenomenon and the radial propagation will be presented in detail and its physical origin will be discussed.

[1] ITER Physics Basis, Nuclear Fusion **39** (1999) 12.
[2] J.A. Wesson, Tokamaks 3rd edn, Oxford University Press 2004, Ch. 7.