§2. Control of MHD Instabilities in LHD

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It is one of the objectives of the present research to accumulate basic data on MHD instabilities in LHD type magnetic configuration with a view to active control of the instabilities with emphasis on interaction with external magnetic fields.

We have obtained the following data on MHD instabilities in LHD; we have obtained the relationship between amplitudes of the modes and edge magnetic fluctuations near the stability boundary conditions of low-order (i.e., low-(m/n)) modes which are resonant near the edge. Furthermore, we have made clear quantitatively the effect of the edge modes on confinement properties of the LHD plasmas.

The experiments for FY2012 we planned make clear the effect of resonant external magnetic perturbations on the behavior of the low-order edge modes. In particular, emphasis was put on the quantitative study about influence of plasma response to confinement properties in a variety of LHD configurations. The experiments would have provided useful data for active MHD control in LHD. Furthermore, we could have obtained useful database to compare the pressure driven modes with current driven modes in the RFP configuration. We should note that radial profiles of the rotational transform in LHD is similar to those in the RFP, except that the value of rotational transform itself is much lower in LHD than in RFP. Dependence of the mode growth rate on magnetic Reynolds number, penetration of the external magnetic perturbation into the plasma, and plasma response of MHD instabilities to the external perturbation, are examples of issues for comparative studies with RFP configuration.

In the experiments up to 2011, we had performed the following experiments associated with plasma response to perturbation magnetic field in LHD; static magnetic perturbation with m/n=1/1 was applied using the LID (local island divertor) coil. Both the m/n=1/1 magnetic fluctuation level and amplitude of the m/n=1/1 edge resonant mode (estimated from SXR emissivity profiles) decreased as the magnetic perturbation was increased, and complete stabilization of the mode could become possible by resonant magnetic perturbation. Plasmea flow measurement was performed near the resonant furface of the low-order edge modes if penetration of the external magnetic perturbation is affected by plasma flow. The results are summarized in Fig.1. Since we could not observe change in plasma flow associated with external magnetic perturbation beyond the S/N ratio, no conclusive results have been obtained to date. We proposed plasma flow measurements with simultaneous ECE measurements (i.e., 1.5-T, reversed polarity of the magnetic field) as one of MHD-related experiment for FY2012.

Figure 2(a) and (b) shows that threshold amplitude of LID for the stabilization of the low-order edge mode depends on the magnetic field configuration and field intensity (or collisionality). Based on these results, we also proposed experiments for systematically studying the threshold for complete stabilization of the mode.

The proposed experiments have not been carried out for FY2012 because of the limited time of the experimental campaign. We will propose the similar experiments for FY2013 to accumulate basic data on interaction between low-order edge mode and external resonant magnetic perturbation. On the basis of such data set, we will be able to propose possible control scheme of the low-order MHD instabilities.

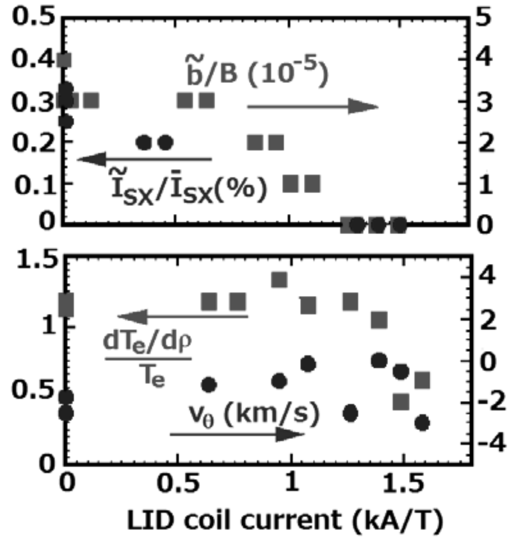

Fig.1. Response of plasma flow to LID.

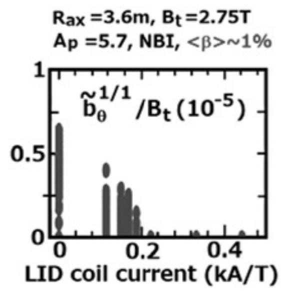

Fig.2(a). Dependence of magnetic fluctuation level on LID current at Bt=2.75T..

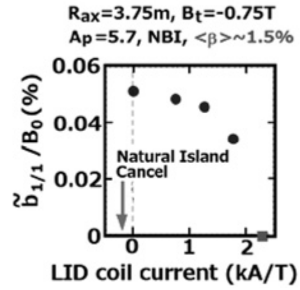

Fig.2(b). Dependence of magnetic fluctuation level on LID current at Bt=0.75T.