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球状 RFP 装置 RELAX における単一 RWM のフィードバック制御実験 －トロイダル非一様性の補正－

Feedback control of single RWM in RELAX spherical RFP -Compensation for toroidal non-uniformity of field penetration time-

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RELAX is a low-A RFP machine (R/a=0.51m/0.25m), which aims to confirm experimentally the advantages of low-A RFP. In RELAX, we use a 4-mm thick SS vacuum vessel which we expect to act as a resistive shell. We have attached saddle coil arrays covering the outer surface of the whole torus for active MHD control. The present report is focused on active feedback control of magnetic boundary conditions to suppress resistive wall mode (RWM) in RELAX.

A 3-D MHD simulation[1] predicts the MHD mode evolution as shown in Fig.1. The simulation has been performed using DEBS code with RELAX plasma parameters. Initial growth of the m/n=(poloidal mode number)/(toroidal mode number)=1/-4 resonant mode is followed by the growth of the non-resonant m=1/n=2 RWM. The result that the most unstable RWM is m/n=1/2 is consistent with the linear calculation of the RWM growth rate[2]. As will become clear, the time evolution of the m/n=1/2 RWM is consistent with experimental results in RELAX.

We set saddle sensor/actuator coils (coils divide each circumference by 8/4 poloidally and toroidally 16/16) right outside the vacuum vessel to control the RWM. As the initial experiment, we have performed feedback control of a single mode by connecting these coils to form m/n=1/2 and the mode are suppressed successfully[2]. Figure 2 shows the effect of the feedback control of the m=1/n=2 single mode on plasma performance. It is clear that growth of the m/n=1/2 magnetic perturbation is suppressed below the preset level when the feedback is applied, where the perturbation otherwise growths with the time scale of the vessel time constant (~1.5 ms)[3].

It should be noted that the loop voltage during the current rise and flat-topped phase has not been improved by the feedback. We suspect it is because of the toroidal non-uniformity of the field penetration time of the vacuum vessel because we apply rapidly changing reversed toroidal field during the current rise phase. We have prepared power supplies for separate control of the m/n=1/2 magnetic perturbations near the poloidal gaps to suppress the local effects on the toroidally averaged perturbation signals which are used as inputs to the feedback system.

REFERENCES

[1] R. Paccagnella:"3-D nonlinear MHD simulation profiles RWM in RELAX", private communication, 2008. [2] S. Masamune et al., 22nd IAEA Fusion Energy Conference, San Diego, 2012.[3] S. Masamune et al., 19th ISHW and 16th IEA-RFP joint WS, SI-3, Padova, 2013.

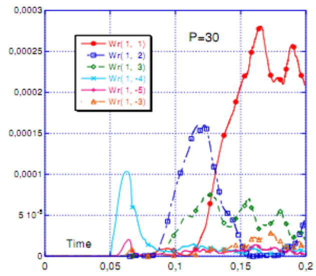

Fig. 1: MHD mode evolution in RELAX (**m/n=1/2**)

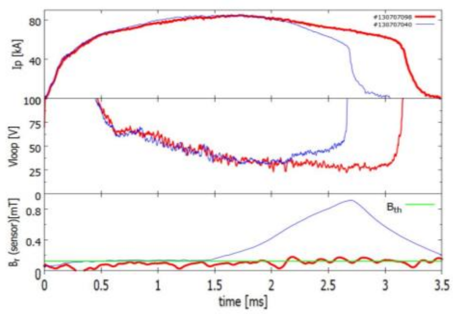

Fig.2: Time evolutions of I_p, V_{loop}, B_r sensor signal, without (blue) and with (red) active control.