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RELAXにおける低アスペクト比RFPのMHD不安定性のフィードバック制御
Feedback Control of MHD Instabilities in Low-aspect-ratio RFP Configuration in RELAX

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The reversed field pinch (RFP) is one of the magnetic confinement systems for high-beta plasmas. Relatively weak external magnetic field is enough to confine the plasma, and therefore, the magnetic field outside the plasma is mostly due to the plasma current. Thus engineering beta is quite high, which is a great advantage of the RFP reactor concept. In order to realize good confinement in the RFP, it has been shown that magnetic flux surfaces have to be formed to sustain the RFP configuration. One of the methods is to allow a single dominant mode to grow to a saturation level (quasi-single helical or QSH state) to form nested flux surfaces inside the dominant magnetic island. Low aspect ratio ensures much space around the rational surface of the dominant mode in the core region. Consequently, the mode can grow up to larger amplitude than in standard medium- or high-A RFP configuration.

RELAX is a low-A RFP machine (A=R/a=0.51[m]/a=0.25[m]=2), which aims to confirm experimentally the advantages of low-A RFP. The main theme is focused in active feedback control of magnetic boundary conditions to suppress MHD instabilities in RELAX, Resistive Wall Mode(RWM). Figure 1 shows the result from a 3-D MHD simulation[1] using the 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 time evolution is consistent with experimental results.

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. The mean magnetic flux measured by the sensor coil arrays (m=1/n=2 component) has decreased with feedback control: from 0.42 (a.u.) to 0.11 (with control). It directly indicates the m/n=1/2 mode are suppressed successfully. Figure 2 shows the effect of the feedback control of the m=1/n=2 single mode on plasma performance.

[1] R. Paccagnella: “3-D nonlinear MHD simulation profiles RWM in RELAX” , (2008)

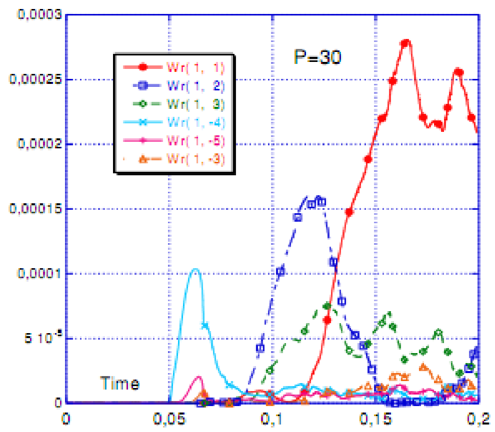

Fig. 1: mode grows in RELAX (**m/n=1/2**)

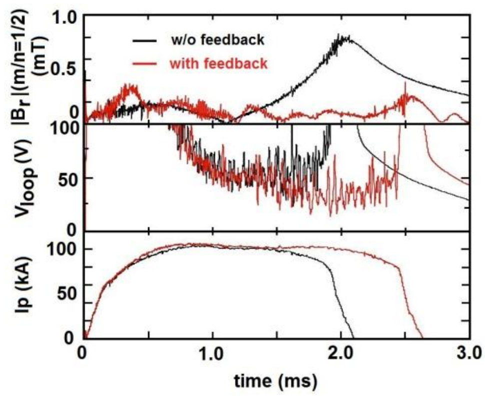

Fig.2: Effect of feedback control of the m=1/n=2 mode on plasma performance.