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JT-60SAにおける磁気計測ノイズがプラズマ平衡制御に与える影響の緩和
Mitigation of the impact of the magnetic measurement noise on the plasma equilibrium control in JT-60SA

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The precise control of the plasma equilibrium is essential in safe and stable plasma operation. An MHD equilibrium control simulator (MECS) has been developed in order to study the techniques of plasma equilibrium control for JT-60SA [1]. The MECS consists of modules of plasma simulator, plasma shape reconstruction, plasma controller to simulate a real plasma equilibrium control as shown in Fig. The plasma simulator predicts the self-consistent plasma equilibrium with eddy current induced at the conducting structures such as the vacuum vessel and the stabilizing plate under the given coil currents and plasma internal parameters. The coil currents are determined from the coil voltages within the power supply capability by considering the resistance and inductance. The controller adopts the ISOFLUX scheme for the control of plasma position and shape, and its controller modifies the poloidal field (PF) coil currents to decrease the residuals between poloidal magnetic flux value at the plasma boundary and that at the control points which specify the plasma position and shape [2]. For decreasing the difference between the actual value of plasma current I_P and its reference values, the controller changes the poloidal flux equally at all control points to apply the loop voltage suitable. The MECS adopts the Cauchy Condition Surface (CCS) method for the plasma shape reconstruction. The CCS method, which was developed in JT-60U for real-time feedback control system, estimates the plasma boundary from the magnetic diagnostic signals and provides the residual required for the plasma equilibrium control [3]. By linking these modules, the feedback control of the plasma equilibrium can be simulated within the power supply capability.

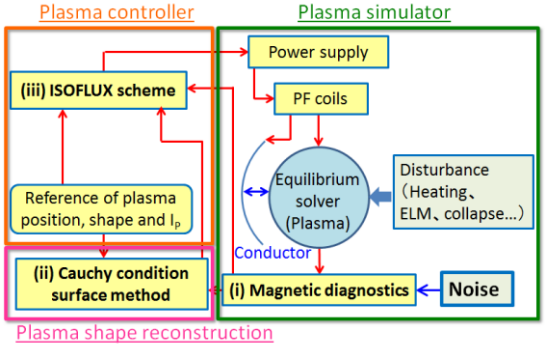

Figure: Schematic view of MECS

It is expected that the noises of magnetic diagnostic signals have an impact on the plasma equilibrium control with the combination of ISOFLUX scheme and CCS method in real tokamak devices. The residual provided by the CCS method fluctuates when the signals of magnetic diagnostics such as the magnetic probes and flux loops fluctuate. Since the high-frequency fluctuation of residual causes the large command values of PF coil voltages, the impacts of noises of magnetic diagnostic signals on the plasma equilibrium control should be mitigated. There are several techniques of mitigating them: (i) Application of digital low-pass filter to magnetic diagnostic signals. (ii) Optimization of setting parameters in CCS method. (iii) Optimization of control point and gain for ISOFLUX scheme. The effectiveness and characteristics of their techniques will be assessed.

1. Yoshiaki MIYATA et al., Plasma Fus. Res. **9**, 3403045 (2014).
2. F. Hofmann et al., Nucl. Fusion **30**, 2013 (1990).
3. K. Kurihara, Fusion Eng. Des. **51-52**, 1049 (2000).