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RELAXにおける軟X線イメージング計測による2次元電子温度分布測定

2-D Electron Temperature Diagnostic Using Soft-X Ray Imaging Technique in RELAX

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The reversed field pinch (RFP) is one of the magnetic confinement systems for high beta plasmas. The RFP was characterized by MHD relaxation to form and sustain the configuration, and associated MHD activities played important roles in stochastization of the magnetic field lines which is unfavorable to plasma confinement. As a result of recent efforts, two methods have been established to avoid stochastic field lines (magnetic chaos) in the core of the RFP. One is the current profile control to stabilize all the otherwise unstable m=1 tearing modes to suppress magnetic island overlap, and the other is to allow only a single mode to grow in otherwise stochastic core region. The latter configuration is referred to as the Quasi-Single Helicity)QSH) state, and in the extreme case, the island expels the original magnetic axis to form the new helical magnetic axis, which is referred to as the Single Helical Axis (SHAx) state. These states dominated by a single mode is self-organized in an axisymmetric boundary geometry. In low-aspect-ratio RFP configuration, it is shown that we have more space in the core without major m=1 resonant surfaces than in medium- or high- aspect ratio, with adequate choice of the safety factor on axis. RELAX is a low-A RFP machine with circular cross section. The major (minor) radius is 0.5m (0.25) with A=R/a=2. We have observed easy transition to either QSH or SHAx states in RELAX particularly in shallow-reversal regions, where the edge toroidal field is weakly reversed (or almost no toroidal field) its direction with respect to that inside the plasma. We have developed soft-X ray (SXR) imaging diagnostics particularly for the study of mechanism of transition to QSH and helical structures in the core after attaining to the QSH. In the present study, we report initial results from two-dimensional electron temperature profile measurement along with the development of the system.

We have used two pin holes to form two SXR pin-hole images on a single MCP plate, and two thin-foil films with different absorption coefficient are used at each pin hole. In the present system, we have used a 1.0-μm thick aluminum filter and a 0.5-μm thick Polyimide filter. Combination of the SXR imaging and the double-filter techniques provide the chord-averaged 2-D electron temperature profile. The experimental arrangement is shown in Fig.1. We have installed the system to observe the vertical image of the plasma.

Figure 2 shows an example of the experimental images from two different kind of plasmas. The right-hand side figure was taken in a discharge with many m=1 magnetic fluctuations excited (so called multiple helicity (MH) state), where we cannot identify characteristic structure. The electron temperature is the highest in the center, decreasing gradually towards the edge. On the other hand, the left-hand side image, observed in a QSH discharge, shows some structure. Detailed analysis of this structure has suggested that high temperature region is concentrated in the core region, and the structure is deformed. The initial results are consistent with our previous SXR diagnostics. Comparison of the SXR electron temperature with the Thomson temperature will also be discussed.

We have developed a SXR imaging system for 2-D electron temperature measurement, and initial results are reported. The results agrees well with the previous SXR imaging diagnostics and other electron temperature measurements in RELAX.

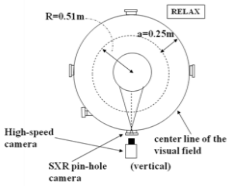

Fig.1 Arrangement of SXR pin-hole camera and high speed camera.

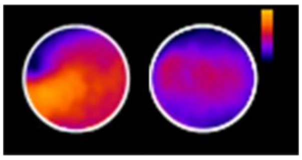

Fig.2 2-D electron temperature image: Right is MH state. Left is QSH state.