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EX/P4-24: Direct Observation of Soft-X Ray Filament Structure and High Current Operation in Low-Aspect-Ratio RFP

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An equilibrium analysis has shown that the aspect ratio A (=R/a) is an important parameter for optimization of the RFP configuration because the q profile is closely connected to A in the self-organized state. Furthermore, some theories show that the pressure-driven bootstrap current increases as A is lowered to less than 2. RELAX is a RFP machine (R=0.5m/a=0.25m: A=R/a=2) to explore the plasma characteristics in low-A regime. In shallow reversal plasmas, the discharge tends to transit to the QSH state, or helical Ohmic equilibrium state. Experimental internal field profiles showed good agreement with the theoretical helical Ohmic equilibrium state. Recent progress in high-speed soft-X ray (SXR) imaging diagnostic has made it possible to identify a simple helical SXR filament structure. The helically deformed core with higher SXR emissivity is rotating at a speed of ˜1.6×104 rad/s, the same as that of the dominant m=1/n=4 mode. A Poincare plot of the reconstructed magnetic field lines in a poloidal cross section during the QSH phase has shown the helically deformed nested flux surfaces in the core region. These results are consistent with our previous SXR emissivity profile measurement which suggested improved confinement in the helically deformed core. The easier access to the helical state in RELAX may result from the characterictic q profile in low-A RFP where wider space without major resonance allows the island to grow without interacting neighboring mode. The MHD behavior of RELAX plasmas has been studied in detail in the current region from 40 kA to 80kA, where two possible improved confinement regions were suggested: QSH-dominated shallow-reversal region and deep-reversal region with low magnetic fluctuation level. In both regions, further improvement of plasma performance can be expected with higher S because quality of the QSH is improved more at higher S, and magnetic fluctuation level decreases with increasing S in the RFP. In order to improve plasma performance we have started optimization of higher current operation. Optimized 100kA discharge has shown that the discharge resistance decreases with increasing the plasma current. It indicates the possibilities of improved performance of low-A RFP plasma at higher current regions.

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