§27. Flexibility of CHS-qa Magnetic Configuration

Shimizu, A. (Nagoya Univ.), Okamura, S., Isobe, M., Suzuki, T., Nishimura, S., Matsuoka, K., Watari, T.

For an experimental device, flexibility of magnetic configuration is needed to study several physical properties of confinement plasma. In quasi-axially symmetric system, CHS-qa, this flexibility is achieved by using auxiliary toroidal field coils and poloidal field coils. With current control of modular coils, mirror component is also controlled.

Auxiliary toroidal field coils are used to vary the rotational transform. Its geometry is optimized with NESCOIL code, and the disturbance to other properties (such as shape of magnetic surface, quasi-axial symmetry) by these auxiliary coils is suppressed to be small. With 5 % of main modular coil current at the 1.5 T operation, the rotational transform at the magnetic axis can be swept from 0.3 to 0.4, and at 1.0 T operation it can be controlled more dynamically.

Three pairs of poloidal field coils, which are of the same type as in CHS and LHD, will also be installed to CHS-qa. By using them, we can apply a vertical field to main magnetic configuration and can shift magnetic axis. The rotational transform of vacuum magnetic configuration can be controlled with axis shift control. In the case of inward shift, the rotational transform goes down for the sake of the increase in the toroidal magnetic field. In the case of outward shift the rotational transform goes up. In outward shift case, helical ripple component increases, however quasi-axial symmetry is not deteriorated largely. The vertical field is also applied to high beta plasma and is used to suppress the Shafranov shift.

Quadrupole field can be applied by adjusting the ratio of currents of poloidal field coils. With quadrupole field, shaping control (elongating magnetic surface vertically or horizontally) is possible. In Fig.1, examples of magnetic surface, when quadrupole field is applied, are shown. In horizontally elongated case, the rotational transform goes up and 2/5 islands move to inner region. Therefore magnetic surface shrinks. In vertically elongated case, the rotational transform goes down. In this case, helical residual ripples tend to increase. The structure of residual ripple components is important for transport, MHD stability, max-J criterion, etc. By applying quadrupole field we can change this structure and can investigate the effect of them experimentally.

The current of main modular coils is supplied from 2 electric power sources. Therefore the ratio of modular coil current can be controlled and by which a mirror ripple component can be changed dynamically. Mirror ripple deteriorates quasi-axial symmetry and increases the viscosity in toroidal direction. Poincare plots and magnetic components when current control is applied are shown in Fig.2. In this case, the current of 8 modular coils around the vertical elongated cross section (4 modular coils around $\phi = 0$ degree and 4 modular coils around 180 degree) is reduced to 80 % of other modular coil current. The amount of mirror component is effectively increased, without the significant change of magnetic surface shape and rotational transform.

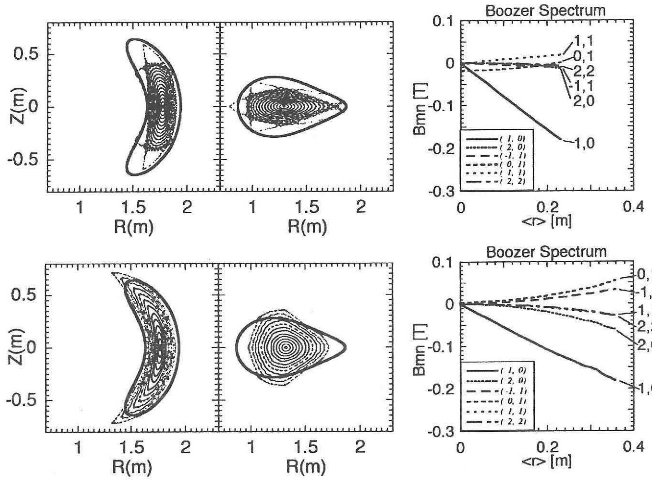
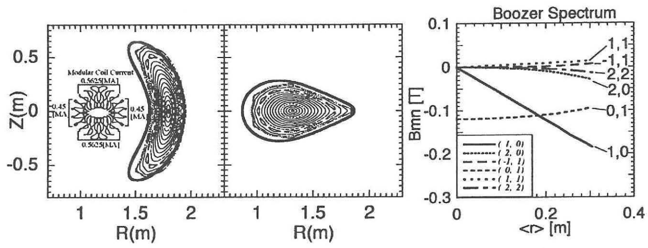


Fig. 1 Examples of shaping control with quadrupole fields. upper: deformation of horizontal elongation, lower: deformation of vertical elongation.



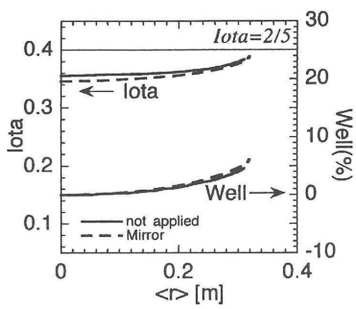


Fig. 2 The Poincare plot of magnetic field when current control of modular coils is applied. The rotational transform and magnetic well are also shown. Mirror ripple is changed largely without significant disturbance of other properties.