§5. Comparison between Magnetic Configuration and Rotational Transform Profile during ETB formation on CHS

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As is previously reported[1], formation condition for edge transport barrier depends on the magnetic configuration, which is changed by the shift of the magnetic axis. There is a hypothesis to explain the reason for the dependence: the ETB formation relates to the existence of ι=1 surface in the plasma . To investigate this hypothesis, the VMEC calculation[2] is performed for the ETB plasma on the different locations of the magnetic axes. The pressure profile is derived from the YAG Thomson scattering measurement. We assumed that the current profile shape is

$$I_p(\rho) \propto T_e(\rho)^{1.5}. \quad (1)$$

The results of the VMEC code calculations are shown in Fig.1. The calculation is performed for the typical ETB plasma on the magnetic axes of 94.9 cm, 92.1 cm, and 89.9 cm. The typical plasma on 88.8 cm without the ETB is also calculated for comparison.

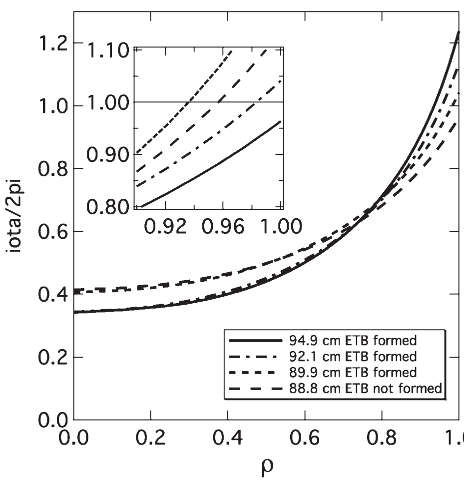

Fig. 1: Rotational transform profiles derived from VMEC calculation on different magnetic axis location.

The calculations show that the ι=1 rational surface always exists near the plasma edge when the ETB is formed, while no ι=1 surface exists in the plasma of 88.8 cm cases, in which no ETB was observed during the whole discharge. Because the ι=1 surface moves to the outward plasma by the inward shift of the magnetic axis, the limit of ETB formation have an accordance with the limit of the existence of the ι=1 rational surface in the plasma. Since the ETB appears to be located around ρ ~ 0.95±0.05 on R_{ax} =92.1 cm cases[1], this location might correspond to the location of the ι=1 surface.

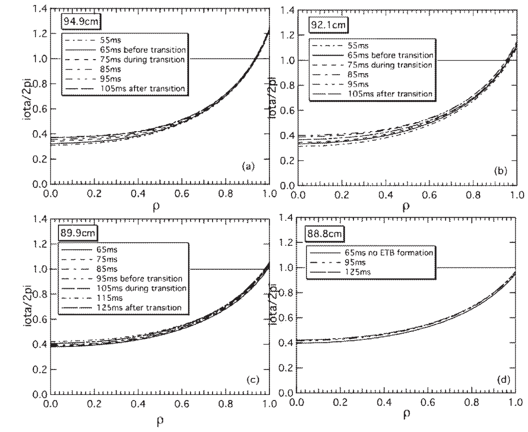

Fig. 2: Time evolutions of rotational transform profiles derived from VMEC calculation on different location of magnetic axes. (a)94.9cm, (b)92.1cm, (c)89.9cm, (d)88.8cm

Figure 2 shows time evolutions of the ι profiles for the plasma of 94.9cm, 92.1cm, 89.9cm and 88.8cm. The calculation show that the changes of the ι profiles in edge region are small during the NBI injection for all cases. It is difficult to explain the ETB formation only by the current profile scenario: the ETB is triggered by the ι=1 rational surface production due to the increase of the plasma current, because the ι=1 surface exists in the plasma from the start to the end of the NB injection. However, the present calculation has an ambiguity of the ι=1 surface location due to the ambiguity of the several parameters: the plasma pressure and current profiles have the ambiguity, because an accurate measurement is difficult for these parameter in the peripheral region. The langmuir probe measurement shows the possibility that the plasma pressure does not equal zero at the LCFS . Accordingly, the large delay of the ETB formation in the R_{ax} =89.9 cm case might be explained by this scenario. Because the ι exists very close to the LCFS in R_{ax} =89.9 cm case on the present calculation, there is possibility that ι=1 surface moved from the outside to the inside of the plasma. The peripheral measurements are required for the further investigation.

References

[1] T.minami, et.al., Plasma and Fusion Research Vol.1, **032** (2006)

[2] S.P.Hirshman, J.C.Whitson, Phys, Fluids **26** (1983), p 3553