Simultaneous measurements of density and potential profile of Internal Transport Barrier plasmas by Heavy Ion Beam Probe in Compact Helical System

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Internal transport barrier (ITB) has been commonly observed in toroidal helical plasmas sustained with electron cyclotron resonance (ECR) heating since the first discovery of ITB in CHS among toroidal helical plasmas. The gradient of electron temperature has been found to sharply increase in the connection layer between electron and ion roots, where the sufficiently strong electric field is created to reduce the fluctuation. On the other hand, a few reports on the electron density profile in the shear layer have been available, suggesting no significant difference of density profile in the layer between the states with and without the ITB within the present precision of the measurements.

Heavy ion beam probe (HIBP) is an excellent diagnostics that can measure the profiles of electrostatic potential and probably density simultaneously. In CHS, we have developed a method to reconstruct density profile from the detected beam intensity that can be expressed as a product of local ionization rate (proportional to local density) and beam attenuation. Actually, the method has been applied on the plasmas with ECR-heated and neutral beam injected (NBI) plasmas of CHS, and successfully reproduce the density profiles for ECR and NBI plasmas, with the condition that the electron temperature profile is known from Thomson scattering.

Utilizing the density reconstruction method, a slight difference between the plasmas with and without the ITB could be distinguished, since the spatial resolution of density profile reconstruction is in principle finer than the width of the shear layer (1-2 cm). Therefore, the resolution of the density reconstruction using HIBP could be sufficient to detect the detailed difference in the density profiles with and without ITB in CHS. In this paper, we will present the details of density reconstruction method using HIBPs, and the result of the density profile reconstruction on the plasmas with and without ITB.