§2. Measurement of q-Profile with Motional Stark Effect Polarimeter in Current Ramp-Up Discharges

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Information about the radial profile of the poloidal magnetic field or the safety factor is critically important to study stability and transport of a tokamak plasma. Various types of methods are developed for its direct measurement. One of the most promising methods is the motional stark effect (MSE) polarimetry. In JIPP T-IIU a 15-channel MSE polarimeter has been developed and applied to the current ramp-up experiment[1].

Figure 1 shows the experimental arrangement of the MSE polarimeter and a hydrogen heating beam. The optical system consists of four polarizers tilted by 0°, 45°, 90° and 135° with respect to the horizontal direction, respectively. To avoid additional Faraday rotation by the polarizer itself and a glass window of the port, the thickness of the polarizer is as thin as about 1mm and all polarizers are mounted inside the vacuum vessel. Fifteen optical fibers are attached behind each polarizer to obtain the radial profile of the poloidal field. The spectra are recorded by an one-meter spectrometer equipped with a two-dimensional CCD detector, where the intensity integration time is 20 ms. The measurement region of the beam emission mainly covers a core plasma region of the major radius R=83 cm to 109 cm. Figure 2 shows typical MSE spectra of the Balmer α line of beam emission obtained in the current ramp-up discharge. We have analyzed the spectra, using only σ components, because spectral asymmetry in π components is brought about by the fairly large beam divergence of the injected neutral beam[1]. In Fig.3 we show the time evolution of the pitch angle (α_p-) profile and poloidal magnetic field(B_θ) in the current ramp-up discharge, where $B_\theta = B_t \tan\alpha_p$ for a low beta tokamak plasma with a circular cross-section. The slope of B_θ at the magnetic axis increases with time, where the plasma current of ~100 kA is ramped up at 205 ms and reaches ~200 kA at ~230 ms[2]. This means the safety factor at the axis decreases continuously during the discharge and reaches well below unity, i.e., 0.7-0.8 [1]. This suggests that only partial reconnection of magnetic field line takes place at the sawtooth crash.

[1] J. Xu et al., NIFS-419 (1996).

[2] K. Toi et al., this issue.

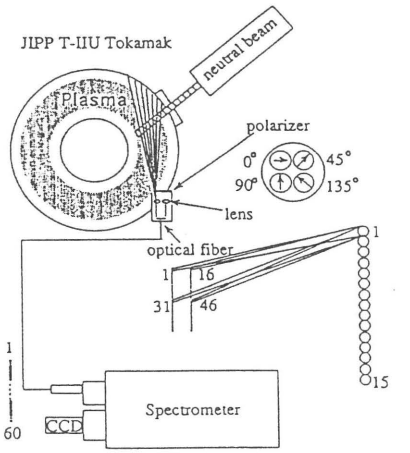

Fig.1 The schematic of the optical system of the MSE polarimeter and hydrogen beam injector.

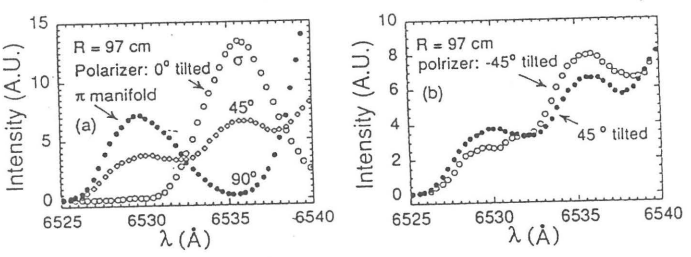

Fig.2 The measured motional Stark spectra of the hydrogen beam emission experimentally obtained from 0°, 45°, 90° and 135° tilted polarizers. (a): σ and π manifolds from 0° and 90° tilted polarizers, and (b) the spectra of the full energy beam emission from 45° and 135° tilted polarizers.

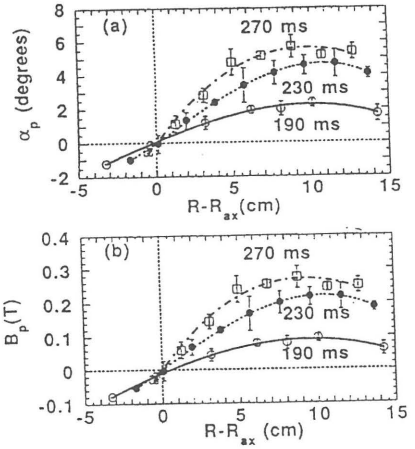

Fig.3 Radial profiles of the pitch angle of the magnetic field line of force and the poloidal magnetic field in the current ramp up discharge.