§24. Measurement of Poloidal Magnetic Field Profile with Zeeman Polarimeter

Kuramoto, H., Hiraki, N. (Kyusyu Inst. Tech.)
Toi, K., Sato, K., JIPP T-IIU Group

We have developed a single-channel Zeeman polarimeter and measured the poloidal magnetic field in JIPP T-IIU. The poloidal magnetic field is deduced from polarization analysis of a HeII 4686Å spectral lines emitted from a He-doped deuterium plasma. The polarization modulation is estimated as a ratio of the difference between left-hand and right-hand circular polarized line profiles to the sum of them, from which the magnetic field strength along the line of sight is directly estimated.

Figure 1 shows a schematic of the polarimeter designed for JIPP T-IIU. The output signals from the system have been analyzed through the procedure based on FFT technique as shown in Fig.2. The magnetic field strength averaged along the line of sight is derived as follows,

$$\hat{B}_\theta(z) = C \times \frac{Max(I_L - I_R)}{I_0} \times \Delta\lambda \qquad (1)$$

where I_L, I_R and I_0 denote the left- and right-hand circularly polarized line profiles and the maximum intensity of a profile respectively and z is a tangency radius of a line of sight. A local poloidal field is estimated through Abel inversion from the above field expressed by eq.(1)

$$B_\theta(r) = -\frac{r}{\pi\varepsilon(r)} \int_r^a \frac{d}{dz}\left(\frac{\hat{B}_\theta(z)\hat{I}(z)}{z}\right) \frac{dz}{\sqrt{z^2 - r^2}} \qquad (2)$$

where a is the plasma minor radius, $\hat{I}(z)$ is a measured line brightness, and $\varepsilon(r)$ is a local emissivity obtained from Abel inversion of $\hat{I}(z)$. The poloidal field profile is shown in Fig.3, where open circles denote experimentally obtained data and two curves correspond to the poloidal field profiles for the current density profile assumed as

$$j_\varphi(r) = j_0 \times \left[1 - \left(\frac{r}{a}\right)^m\right]^n. \qquad (3)$$

We have performed calibration of an absolute value, measuring the toloidal magnetic field and poloidal field at the plasma surface. This system has achieved good time resolusion of ~1.5 ms in He-doped plasmas(n_{He}/n_e>10%) with a newly developed fast scanning Fabry-Perot interferometer.

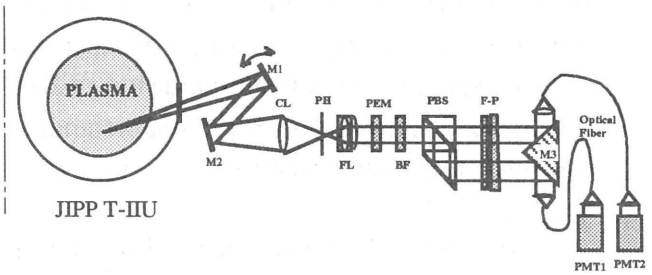

Fig.1. Schematic of a polarimeter on JIPP T-IIU. CL:condenser lense,PH:pinhole,FL:field lense, PEM:photoelastic modulator,BF:bandpass filter, PBS:polarized beam splitter,F-P:the scanning Fabry-Perot interferometer,PMT:photomultipliers

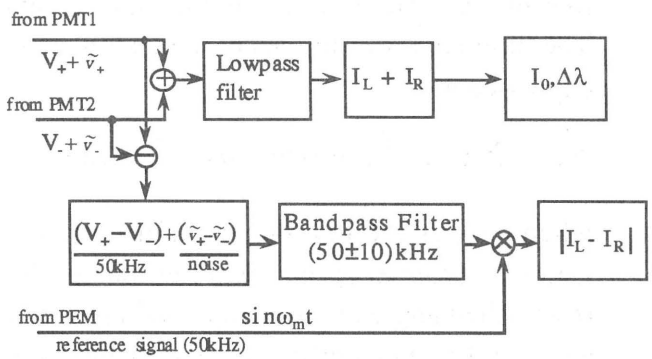

Fig. 2. Block diagram of data analysis sequence

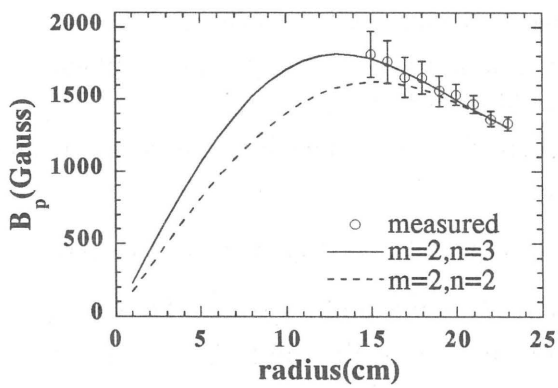

Fig.3. Poloidal field profile measued with the polarimeter in the JIPP T-IIU plasmas, where B_T=2.6T, I_p=150kA, and q(a)=6.0.