§39. Two Dimensional Ion Temperature and Velocity Measurements by Use of Visible Light Tomography Technique


For the past three years, we have developed one and two dimensional (1-D, 2-D) ion velocity measurements system using two methods: 1) new vector tomography technique for Doppler spectroscopy or 2) combining Doppler measurement with ice pellet injection.

In 2006, we increased the number of optical channel to 72 by adding objective lens, optical fibers, polychromators and ICCD cameras. Though this system still needs another 72 channels for 2-D vector tomography, it was tested using 3-D scholary tomography measurement. Figure 1 shows Hα light emission profile of the oblate FRC, which was reconstructed by 3-D tomography method developed by Balandin etc., together with their corresponding poloidal flux contours. It was clearly observed that the n=1 tilting mode grew for about 20µsec.

As for 2-D velocity profile measurement, the measurement error for the developed reconstruction method was studied by changing the assumed velocity profile. Using the maximum entropy method, we solved the Radon transformation: \( R(\xi)(u, \eta) = -\int_{-\infty}^{\infty} v(\theta)(u', \eta)du' \), by assuming that 2-D plasma velocity profile \( v = \nabla \times \psi + \nabla \phi \) satisfies \( \nabla \cdot v = 0 \). In order to keep the reconstruction error constant, the number of projection channel was found to increase, as the characteristic scale length for the assumed velocity profile was decreased.

Figure 2 shows the typical 2-D vector plot of the reconstructed toroidal plasma flow whose profile has abrupt polarity change at \( r=1m \). As shown in Fig. 3, the reconstruction errors caused by addition of 10% white noise to the line-integrated signals were observed to decrease with increasing the projection number. However, the error for the profile with abrupt change (+ curve) was a few times higher than that with moderate change (• curve). The error in the former case was found to decrease much slower with projection number than that in the latter case. We should increase the projection number when we measure the velocity profile whose characteristic spatial scale is short.

References