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

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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, together with the super SINET data transfer.

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 scholar 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 titling 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: $R\{\zeta\}(u,\eta) = -\int_{-\infty}^{u} \mathbf{v}\{\theta\}(u',\eta)du$, by assuming that 2-D plasma velocity profile $\mathbf{v} = \nabla \times \psi + \nabla \phi$ satisfies $\nabla \bullet \mathbf{v} = 0$. 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 have to increase the projection number when we measure the velocity profile whose characteristic spatial scale is short.

References

[1] E. Kawamori, Y.Ono et al., , Rev. Sci. Inst. 77, (2006), 094503-1.

[2] A.Balandin et al., Comp. Phys. Com. to be published,

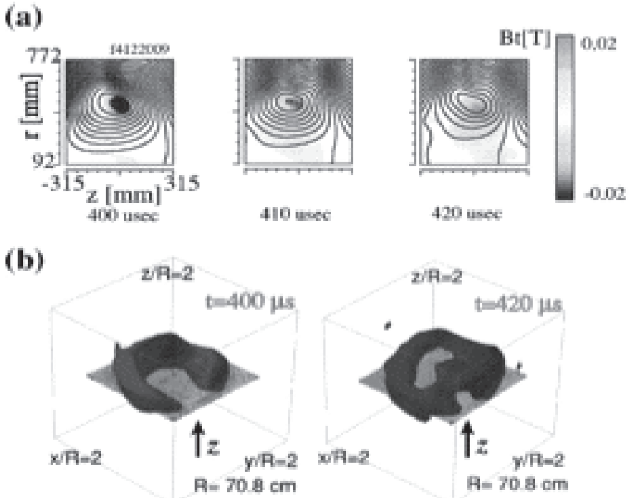

Fig. 1 Hα light emission profile of an oblate FRC shich was reconstructed by 3-D tomography method and their corresponding poloidal flux contours.

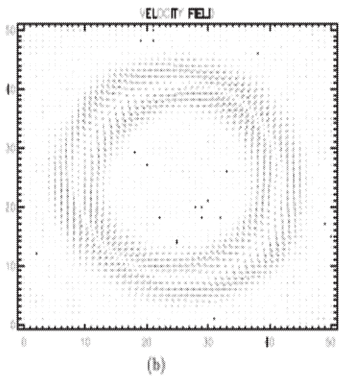

Fig. 2 2-D vector plots of plasma flow with abrupt polarity change at r=1m.

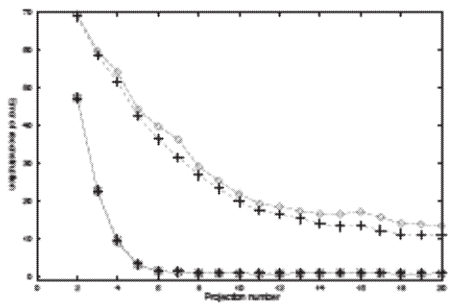

FIG. 3 Reconstruction errors caused by addition of 10% white noise to the line-integrated signals for two flow profiles with abrupt and moderate changes (top and bottom), as a function of projection number.