§21. Density Profile Measurements by 6 Channel HCN Laser Interferometer

Ejiri, A., Kawahata, K., Okajima, S. (Chubu Univ.)
Tanaka, K.

In the JIPP T-IIU tokamak, an HCN laser (λ=0.337mm) interferometer[1] are used to measure electron density. It measures 6 chords, and has a beat frequency of 50kHz. After the modification of the JIPP TII-U tokamak, the interferometer has suffered from fringe jumps. The main reason is spikes in the beat signal of the reference channel, and correlated spikes are seen in the ECE measurements. The spikes can not be reduced by 1~2 cm thick lead shields. In order to avoid fringe jumps, a narrow band frequency filter has been added to the reference channel. With this filter, the occurrence of fringe jumps is greatly reduced, so that we can calculate density profiles.

Preliminary density profiles are reconstructed from the line integrated density (NL) measured by the interferometer. Usually the reconstruction process requires the information about the plasma position and its minor radius, (R_{maj}, Δv and a_p in Fig.1), which are measured from equilibrium magnetic probes. The quantities are, however, not measured accurately in JIPP TII-U. Thus, Δv and a_p are speculated from the NL profile. For the major radius (R_{maj}), the data from equilibrium magnetic probes is used, because it is difficult to speculate R_{maj} from the NL profile.

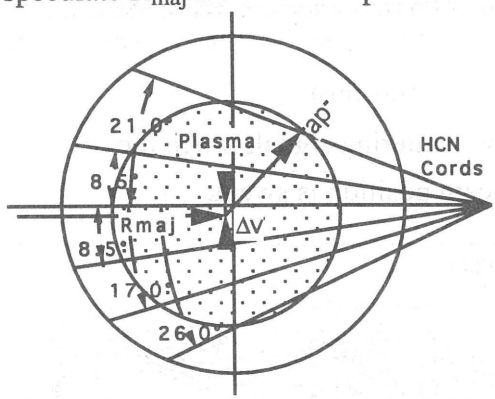

Fig.1. Plasma and chords of the HCN laser.

Δv is determined by the condition that the NL profile looks smoothest (Fig.2(a)). The NL profile is fitted to the following function

$$NL(\rho) = a_1 + a_2\rho^2 + a_3\rho^3 + a_4\rho^4 ,$$

where ρ is the chord distance of the laser chord. In the fitting, higher weights are put on the outer two chords, so that the fitting function is almost linearly extrapolated to hit the x-axis. The intersection with the x-axis yields the minor radius a_p. Assuming that the equi-density surfaces are concentric circles, an analytic Abel inversion can be applied. Figure 2(b) shows the calculated profile. Figure 3 shows the contour plot of the time evolution of the density profile for a NBI heated (from t=170-290msec) plasma. The density increases until the end of NBI, and then the density at the outer region decreases, while the center continues to increase.

The multi channel laser interferometers is a powerful and reliable diagnostics. However, the process to reconstruct density profiles requires special attention and optimization.

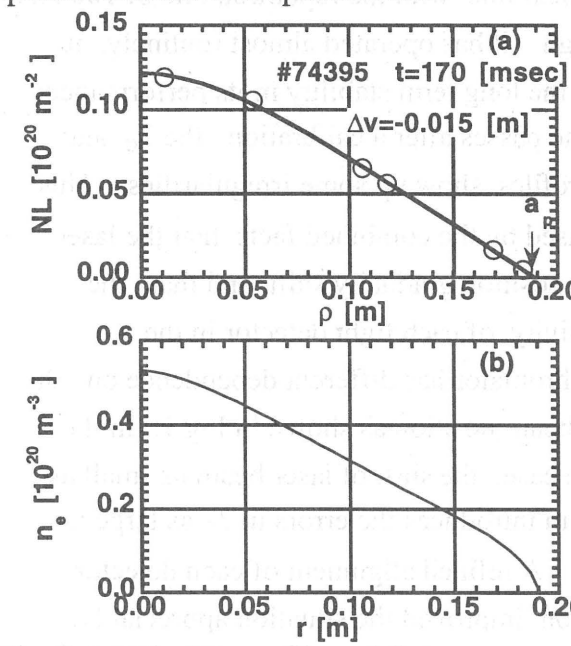

Fig. 2. (a) The NL profile and fitting to a polynomial function. (b) The density profile calculated by an Abel inversion.

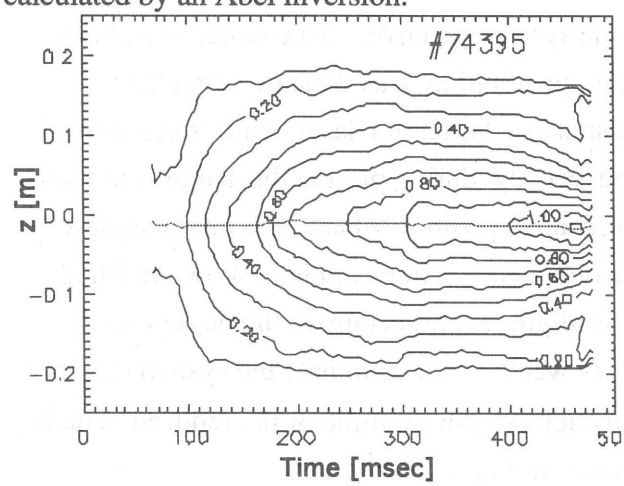

Fig. 3. Contour plot of the time evolution of the density profile. The dotted line shows the vertical displacement of the plasma.

References

1)Kawahata,K., et al., Rev. Sci. Instrum. 60 (1989), 3734.