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Precise T_e and n_e are obtained only with carefully calibrated responsivities of the polychromators which spectral-analyze the scattered light. Because the sensitive area of light-detectors, on which the image of an object (laser beam) is formed, is bounded, the responsivities are dependent on the position and size of the object; if a part of the image is out of the sensitive area the responsivity will drop. Thus it is highly desirable to occasionally monitor the laser beam position and correct it if necessary. For this, we adopted a new method, in which the laser beam position is swept rapidly while observing the scattering signals. In the JIPPT-IIU TS system, the laser beam is guided by five mirrors to traverse vertically the center of the vacuum chamber from the top to the bottom. The directions of the last two mirrors can be controlled dynamically by stepping motors so that the laser beam move transversely and tilt. The status of the laser beam (position and tilt with respect to the array of the detectors) is inferred by sweeping the laser beam position (the second last mirror) while monitoring the scattering signals from a stationary plasma. Figure 1 shows evolutions of the 84 (=28 spatial channels x 3 spectral channels) raw scattered signals, $\{sct_j(t); j=1, 84\}$, and the transverse beam position, $x(t)$. As the beam position changes, the signals grow, reach peaks and then decay. The peak represents the best position for each detector. The time delay, if present, between the peaks at the lower and higher beam positions will indicate that the laser beam tilts slightly. The poor quality data resulting from the shot noise and plasma fluctuation necessitates some statistical approach to deduce the tilt angle and position of the laser beam. For this purpose, we first assume the Gaussian form for the beam-position-dependence of the detector responsivities:

$$R_i(x) = \exp(-x^2/2\sigma_i^2), \quad (1)$$

where σ_i is the width determined by the laser beam profile and the instrumental width of the i-

the detector. Then the tilt angle, α , and the beam position, x_0 are determined so that the summation,

$$S = \sum (C_i \cdot R(x(t_j) - x_0 - \alpha \cdot z_i) - sct_i(t_j))^2 \quad (2)$$

over the scattering position which the i-the detector sees, z_i , and the time of the laser shot, $t_j = 10 j$ [ms], is minimized with respect to α , x_0 and C_i . Here $\{C_i; i=1, 84\}$ are the parameters dependent on n_e and T_e . If n_e , T_e and then $\{C_i\}$ are constant in time, the $\{C_i\}$ which minimize the S for fixed value of α and x_0 are given by setting the partial derivative of Eq.(2) with respect to C_i equal to zero. The contour plot of the $S(\alpha, x_0)$ for Fig. 1 is shown in Fig.2, which gives the best estimate $\alpha_m = 1.2 \pm 0.2$ m-rad and $x_{0m} = 2.2 \pm 0.025$ mm. Then the tilt of the laser beam is corrected by $-\alpha_m$ and the beam position is reset at x_{0m} .

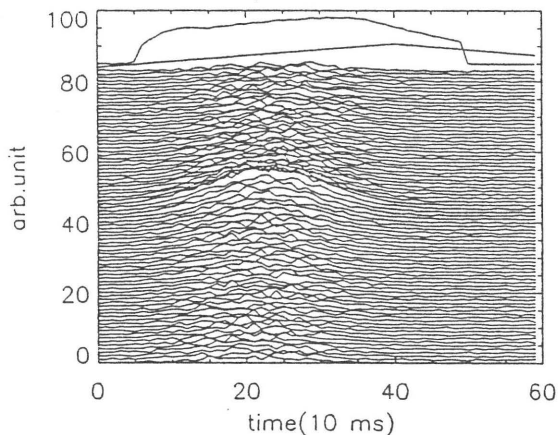


Fig.1. From the bottom: raw scattering signal of ch1, ch2, —, ch84, position of the laser beam and plasma current.

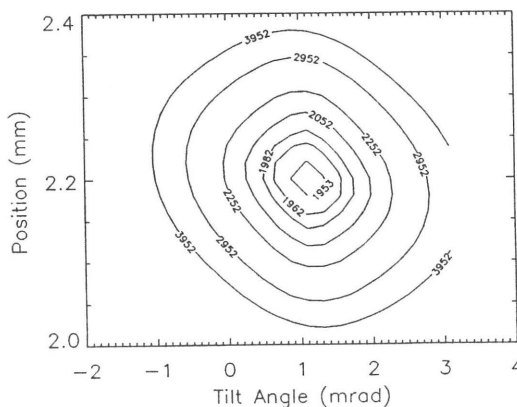


Fig.2. A contour map of the sum of residual squared in the (α, x_0) plane.