Evaluation of the Beam Width at CDF

Stan Lai and the Vertexing Group

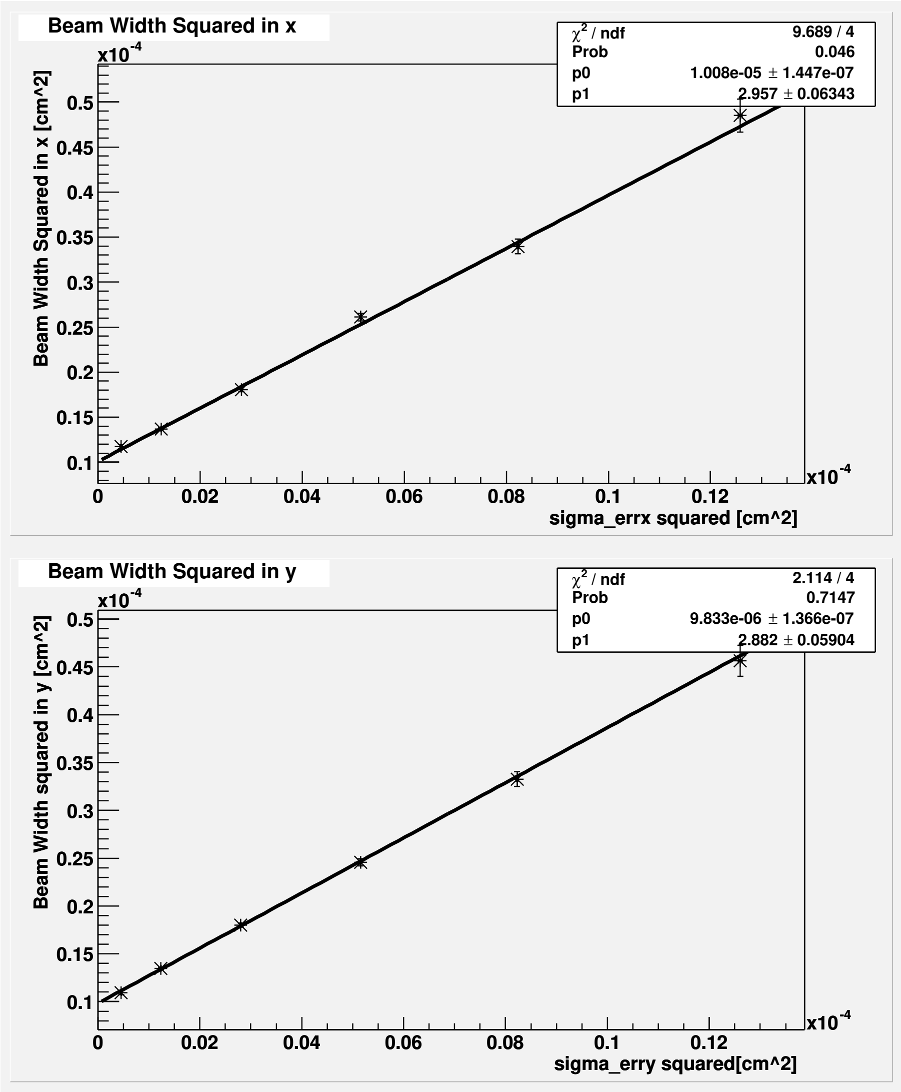
Motivation:

- Beam Width needed for evaluation of $\sigma(L_{xy})$
- Useful to understand the width and feedback to BD
- Side Benefit: Understand vertexing algorithms

Method:

- Use VxPrim to find primary vertex on $gjet08$ data
- $\sigma_{beam} = \sqrt{\sigma_{obs}^2 - \kappa^2 \sigma_{pvtx}^2}$
- Look at the variation of beam width with z
- Functional Form: $\sigma_{beam} = \sqrt{\epsilon \times (\beta^* + (z - z_0)^2/\beta^*)}$

Scale Factor for VxPrim



$$\sigma_{beam} = \sqrt{\sigma_{obs}^2 - \kappa^2 \sigma_{pvtx}^2}$$

Plot σ_{obs} vs. σ_{pvtx}

Slope gives κ^2

y-int gives σ_{beam}^2

Result:

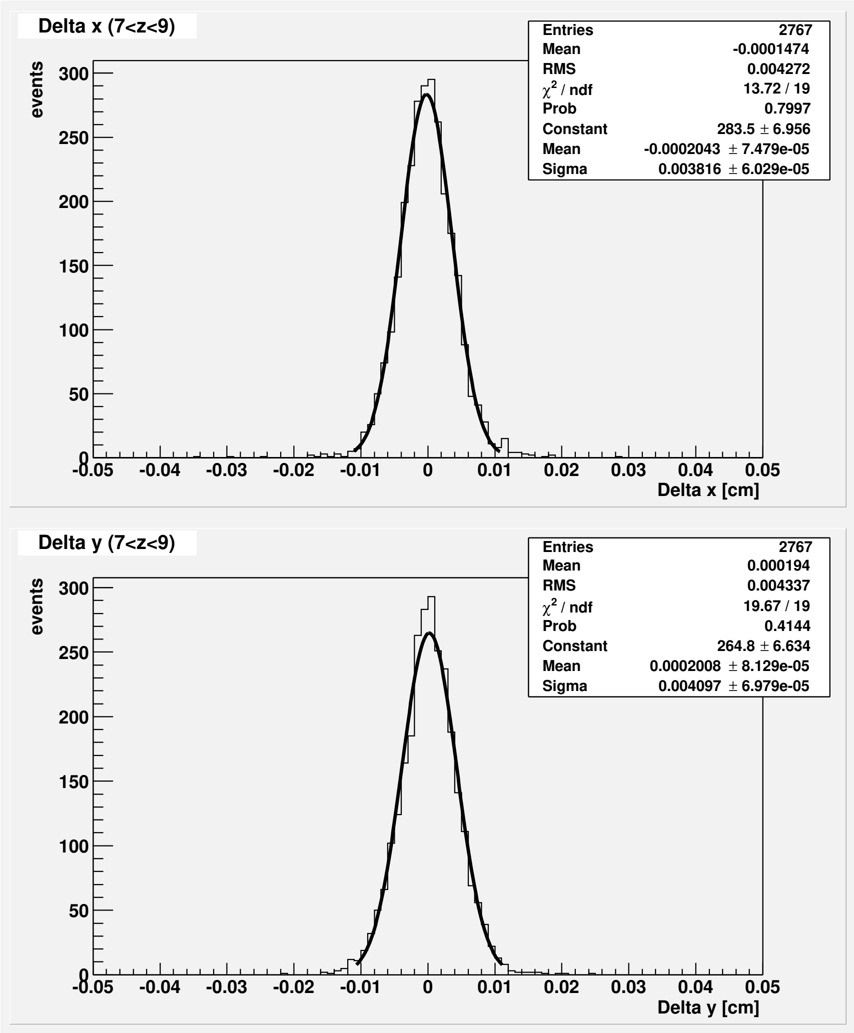
$\kappa_x = 1.72 \pm 0.02,$

$\kappa_y = 1.70 \pm 0.02$

Scale Factors for Certain Runs with Vxprim

Run Number	Date	Lum (nb^{-1})	κ_x	κ_y
153389	Oct 27/02	1066	1.74 ± 0.02	1.75 ± 0.02
153447	Oct 29/02	1077	1.73 ± 0.02	1.75 ± 0.02
154452	Nov 20/02	696	1.75 ± 0.02	1.77 ± 0.02
154654	Nov 26/02	1127	1.72 ± 0.02	1.70 ± 0.02
155130	Dec 7/02	812	1.74 ± 0.02	1.71 ± 0.02
155364	Dec 14/02	579	1.75 ± 0.02	1.72 ± 0.02
155895	Dec 29/02	1072	1.75 ± 0.02	1.72 ± 0.02
Combined			1.74 ± 0.02	1.74 ± 0.02

Gaussian Fits to Vxprim Vertices

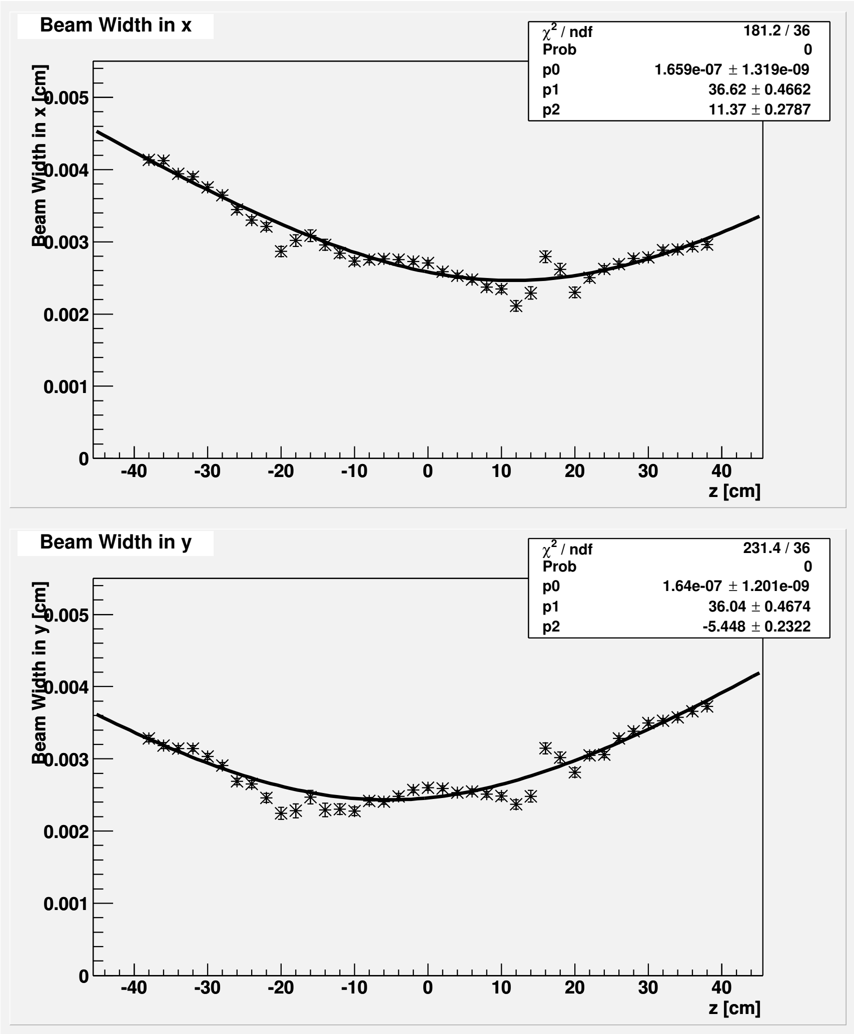


Gaussian fit for vertices

Group vertices in z-bins of 10 cm

Reject vertices at the tails and with $\sigma_{pvtx} > 50\mu$m

Combined Beam Width Fit



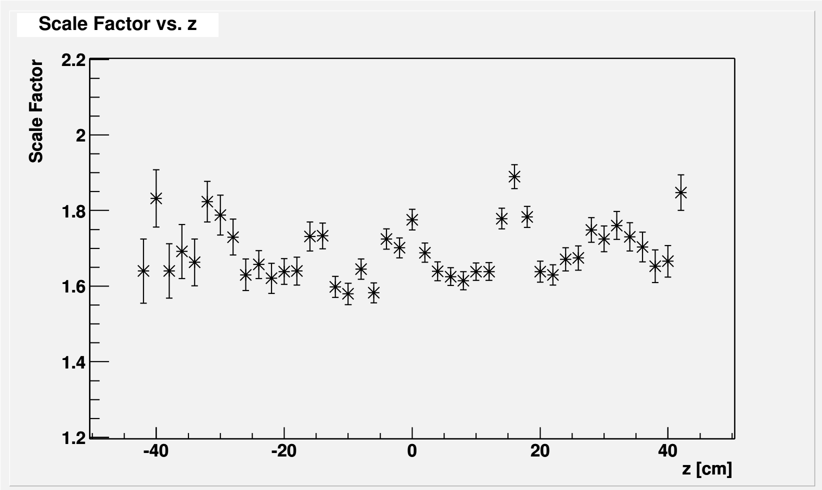
Gaussian Fits to vertex distribution

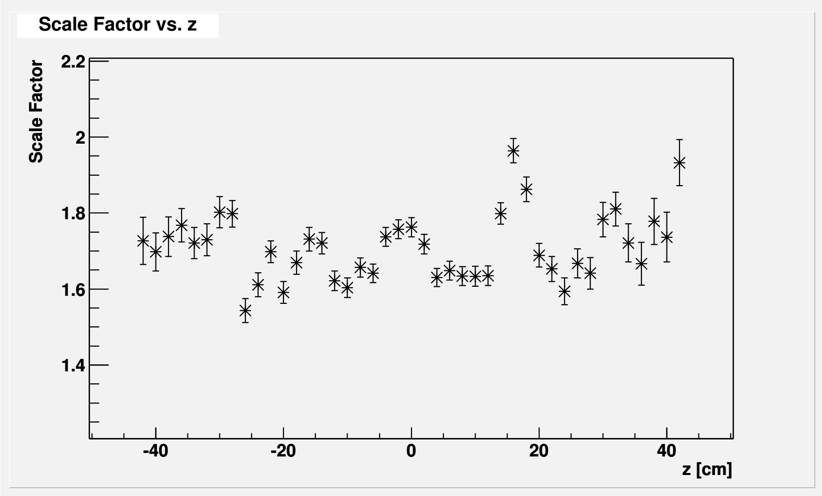
Group vertices in z-bins of 2 cm

Reject vertices at the tails and with $\sigma_{pvtx} > 50\mu$m

Can clearly see effect of bulkheads, and also slight z dependence elsewhere

Use Scale Factor Dependent of z

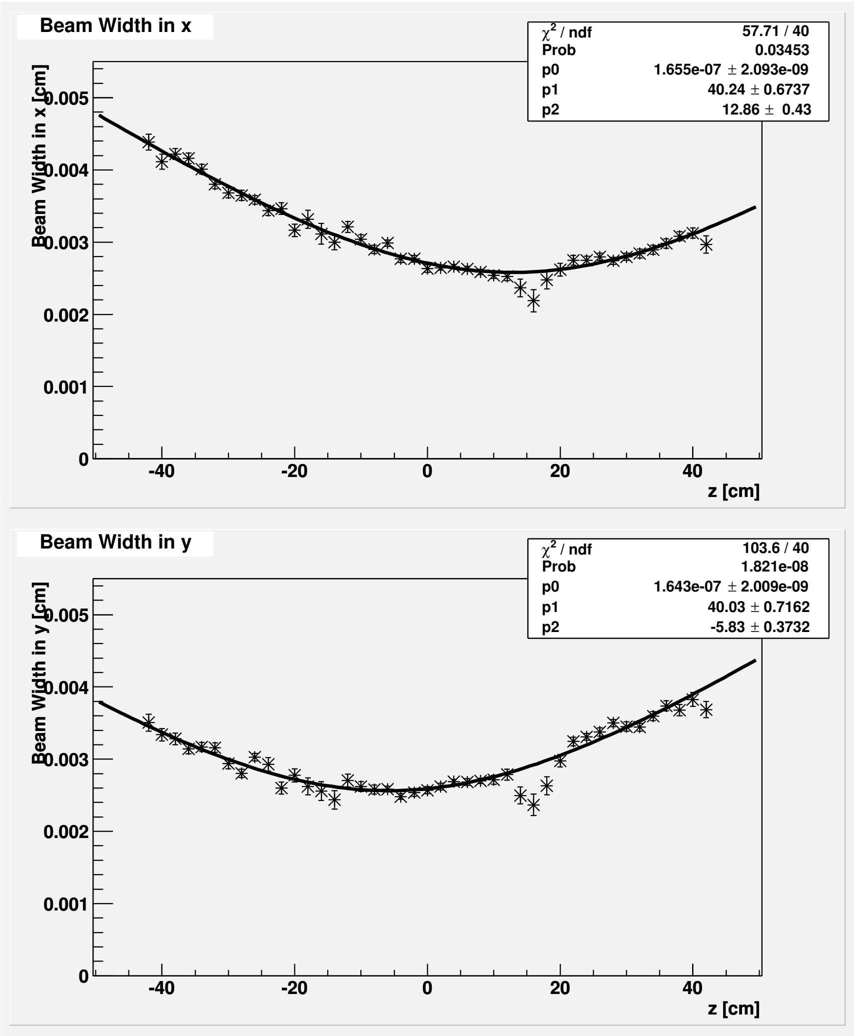




Combined results of 17 runs

Significant variations in z

Beam Width Fit after using z-dependent Scale Factor

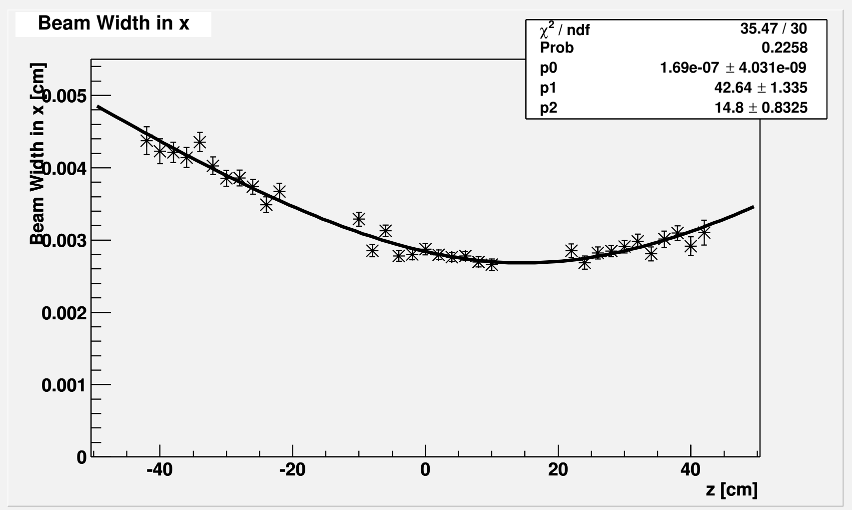


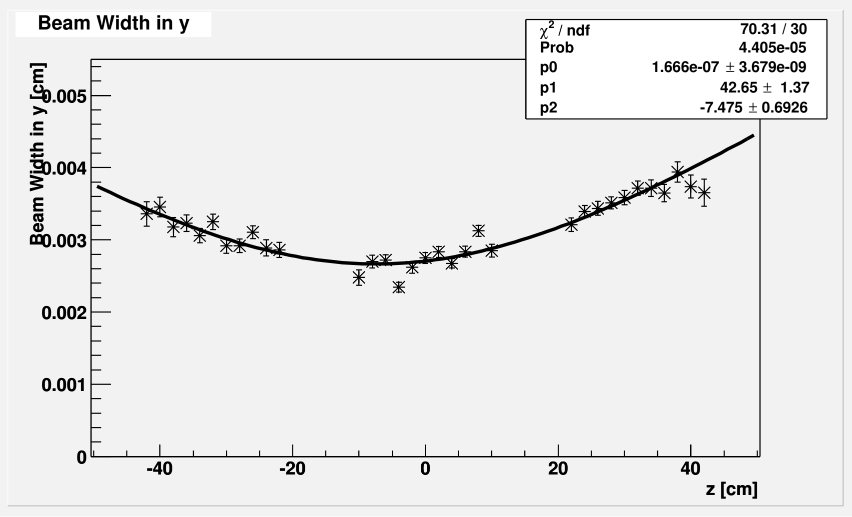
Group vertices in z-bins of 2 cm

Better fit result

Bulkheads still not completely corrected

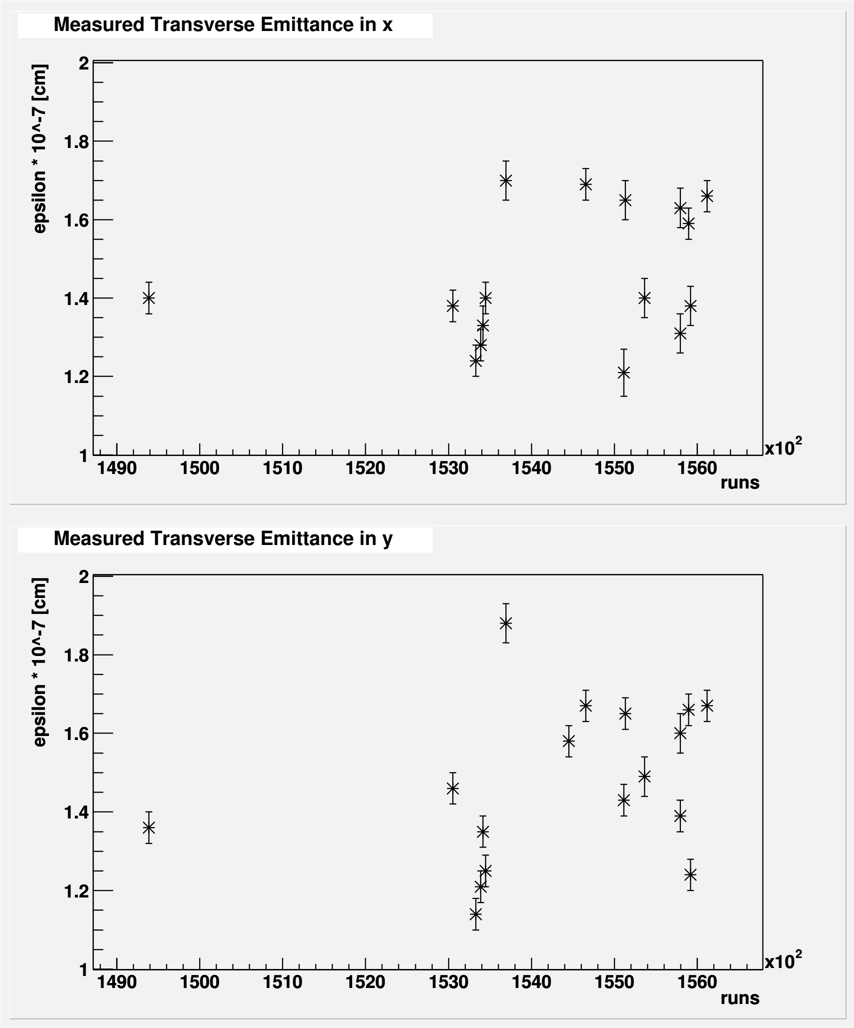
Beam Width Fit - Example Run





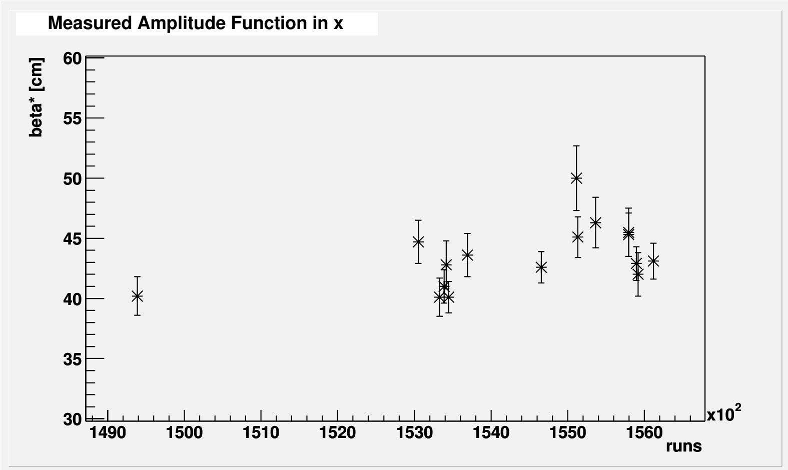
Run 154654

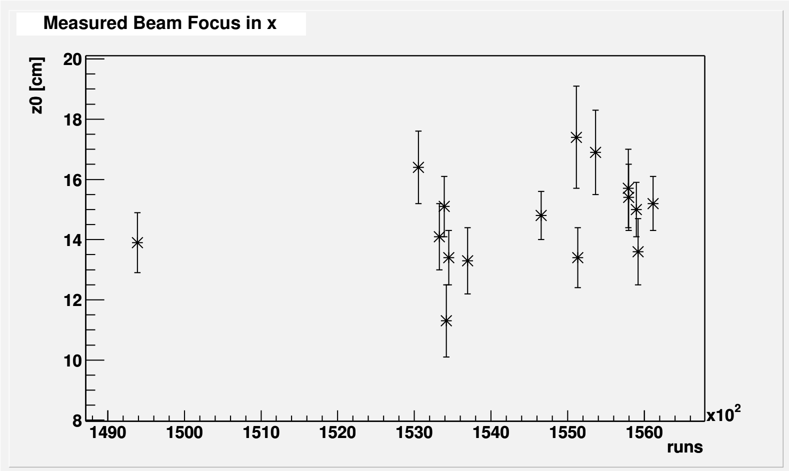
Measured Transverse Emittances

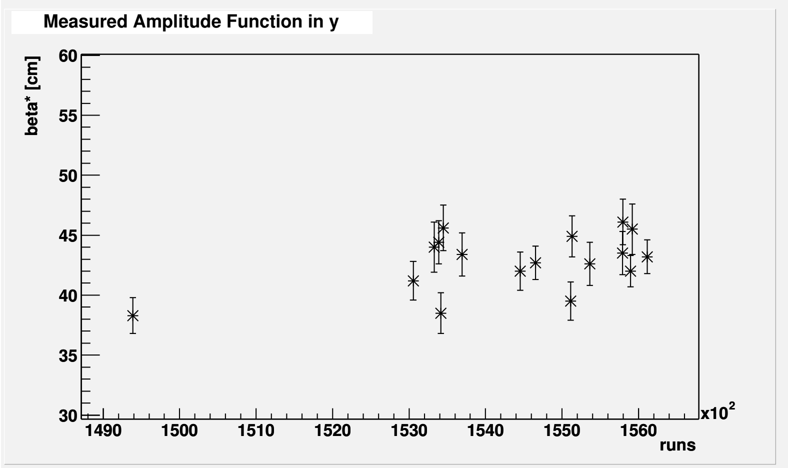


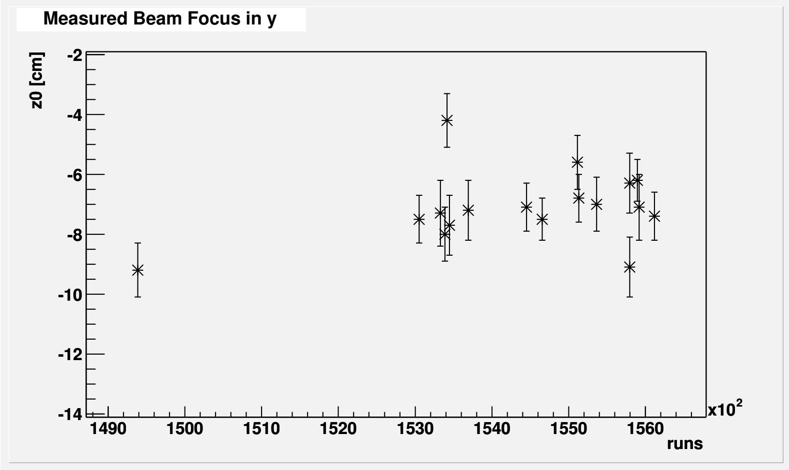
Measured ϵ as a function of Run Number

Measured Amplitude Function and Beam Foci









Average Results

Transverse Emittance:

$\epsilon_x = (1.45 \pm 0.17) \times 10^{-7}$ cm, $\epsilon_y = (1.47 \pm 0.20) \times 10^{-7}$ cm

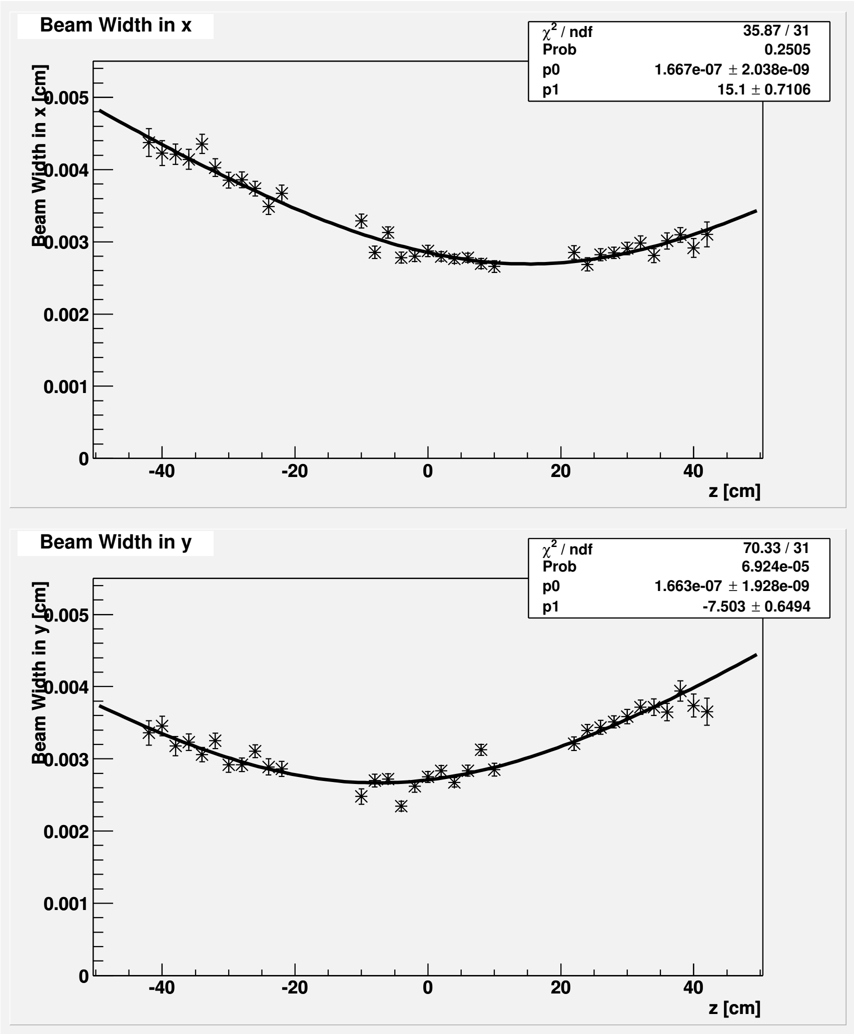
Amplitude Function:

$\beta_x^* = 43.5 \pm 2.7$ cm, $\beta_x^* = 42.8 \pm 2.3$ cm

Beam Foci:

$z_0^x = 14.7 \pm 1.5$ cm, $z_0^y = -7.1 \pm 1.2$ cm

Beam Width Fit - Fixed β^*

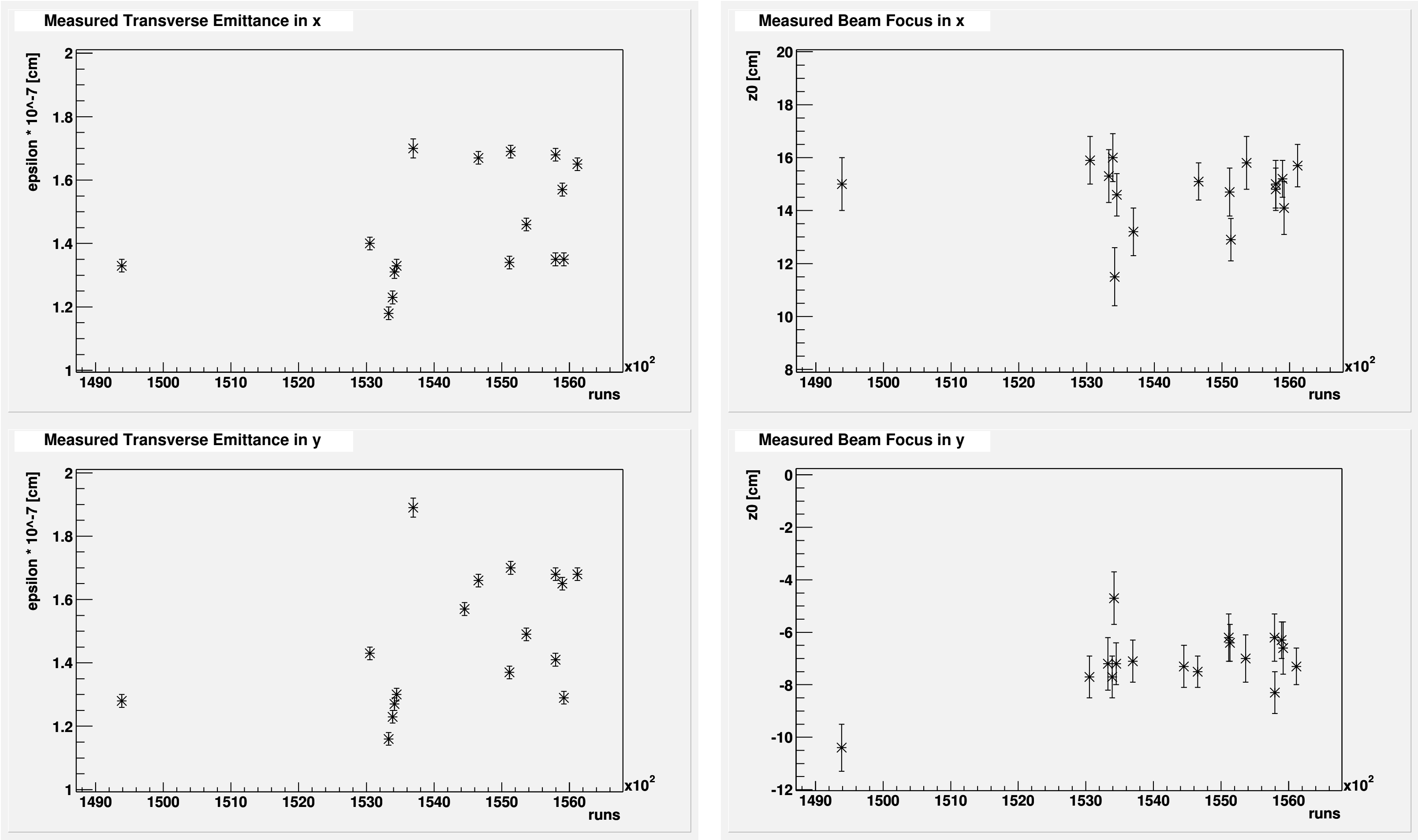


Run 154654

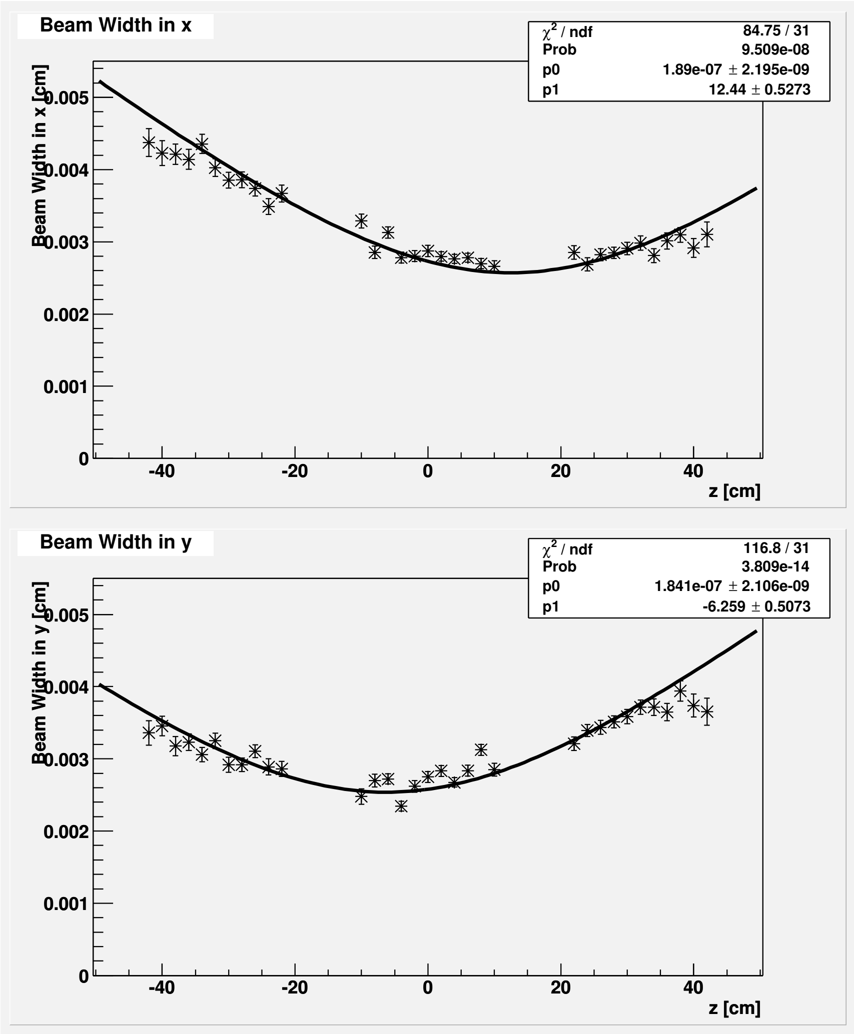
Fixed β^* to avg value

$\beta_x^* = 43.5$ cm, $\beta_y^* = 42.8$ cm

Measured Emittances and Beam Foci (fixed β^*)



Beam Width Fit - Fixed β^*



Run 154654

Fixed β^* to nominal value

$\beta_x^* = 35$ cm, $\beta_y^* = 35$ cm

Average Results with Fixed β^*

Using $\beta_x^* = 43.5$ cm, $\beta_y^* = 42.8$ cm:

Transverse Emittance: $\epsilon_x = (1.45 \pm 0.18) \times 10^{-7}$ cm, $\epsilon_y = (1.47 \pm 0.21) \times 10^{-7}$ cm

Beam Foci: $z_0^x = 14.7 \pm 1.2$ cm, $z_0^y - 7.1 \pm 1.2$ cm

Using $\beta_x^* = 35$ cm, $\beta_y^* = 35$ cm:

Transverse Emittance: $\epsilon_x = (1.65 \pm 0.20) \times 10^{-7}$ cm, $\epsilon_y = (1.64 \pm 0.23) \times 10^{-7}$ cm

Beam Foci: $z_0^x = 12.1 \pm 1.0$ cm, $z_0^y = -5.9 \pm 1.0$ cm