# Fitting the TPOL silicon data

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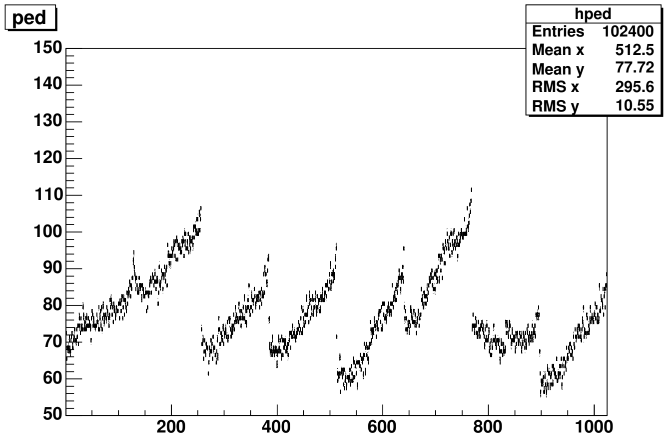
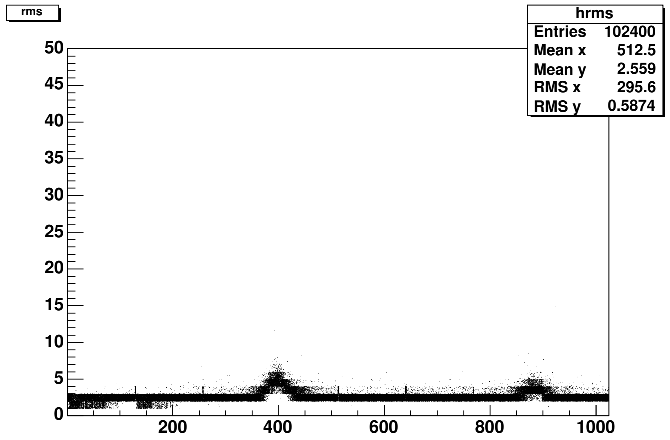
## Contents

# The silicon detector

- Measures position and provides $\eta$-y calibration
- 768 y-strips and 256 x-strips
- Pedestals:



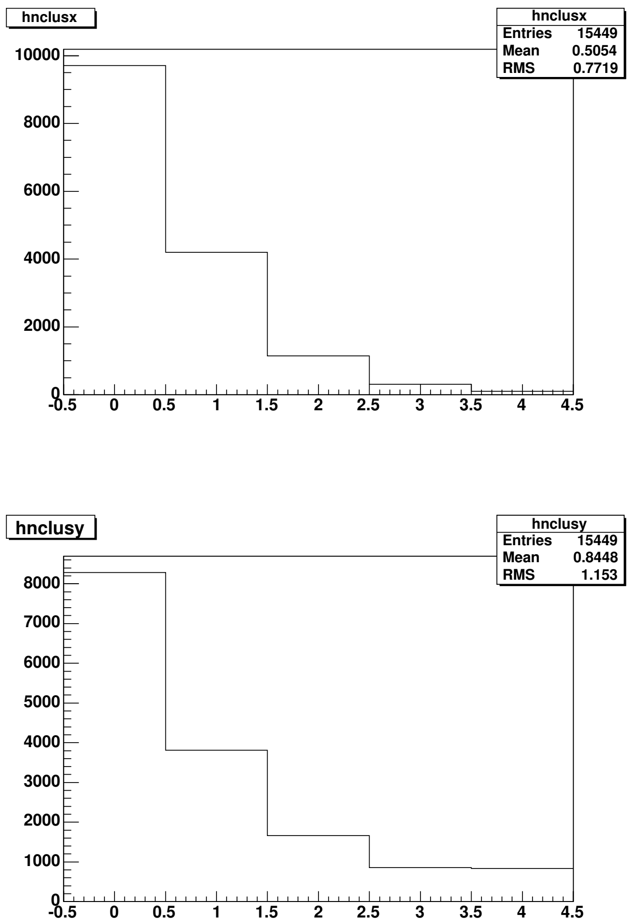

- Noise:



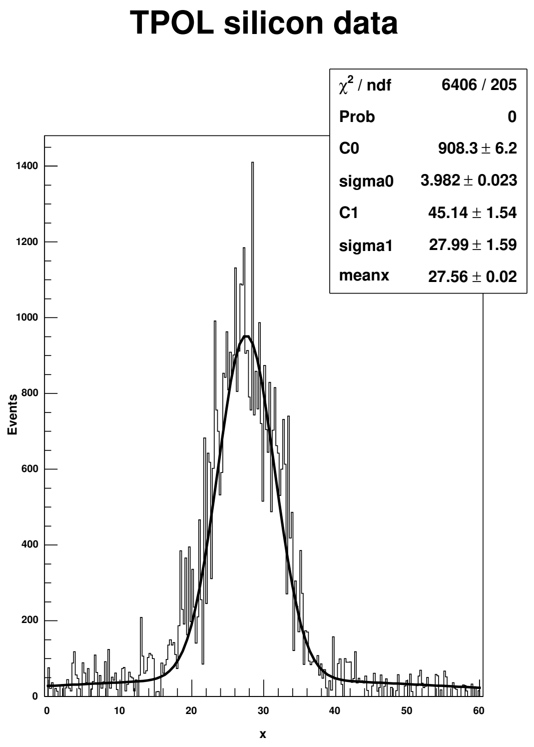

- Common mode calculated per event
- SIGNAL = RAW - PEDEDESTAL - COMMON MODE

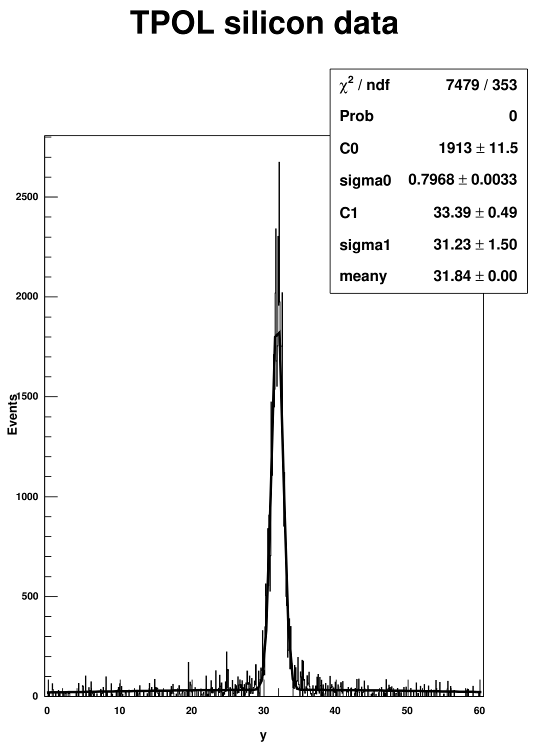
# The clustering algorithm

- Clusters defined with simple *'centre of mass'* style analysis - find centre of 'mass' of signal region
- Strips in cluster must have:
  STRIP SIGNAL $>= 3 \times$ RMS
- The total signal of a cluster must be:
  CLUSTER SIGNAL $>= 5 \times$ RMS
- The algorithm seems to be working fine
- Number of clusters per event in x and y:



# Fitting the beam ellipse I

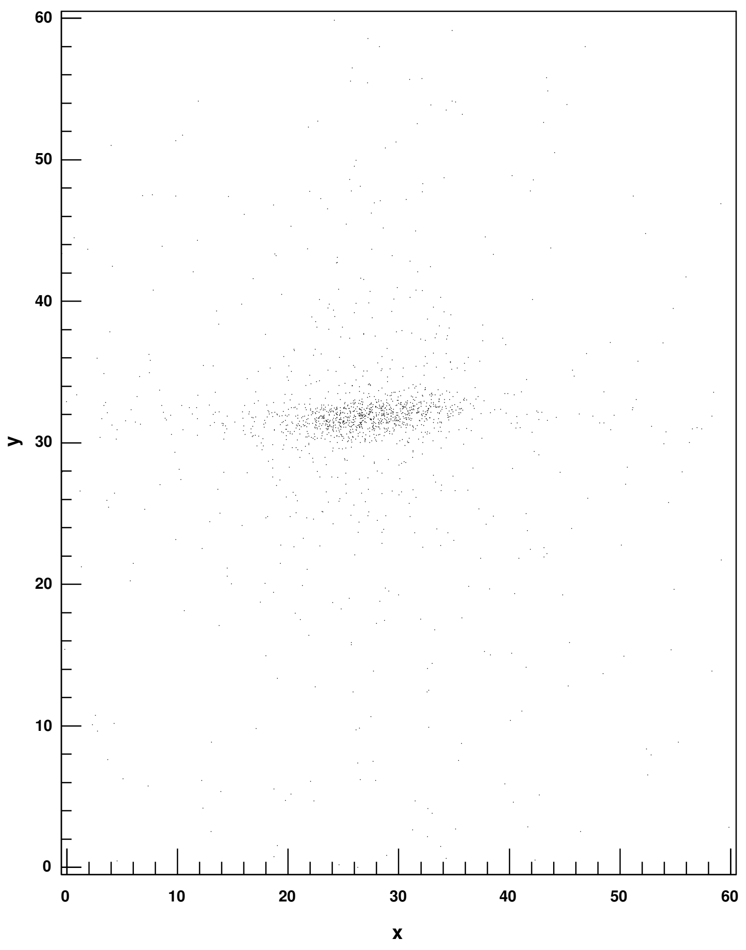



- Plots were made of the charge clusters in x and y
- The plots are from a run of 100,000 events taken on 01/06/04
- A double Gaussian function was fitted, but this did not always describe the data very well
- The mean value from each histogram was used to estimate the x and y positions of the beam centre

# Fitting the beam ellipse II

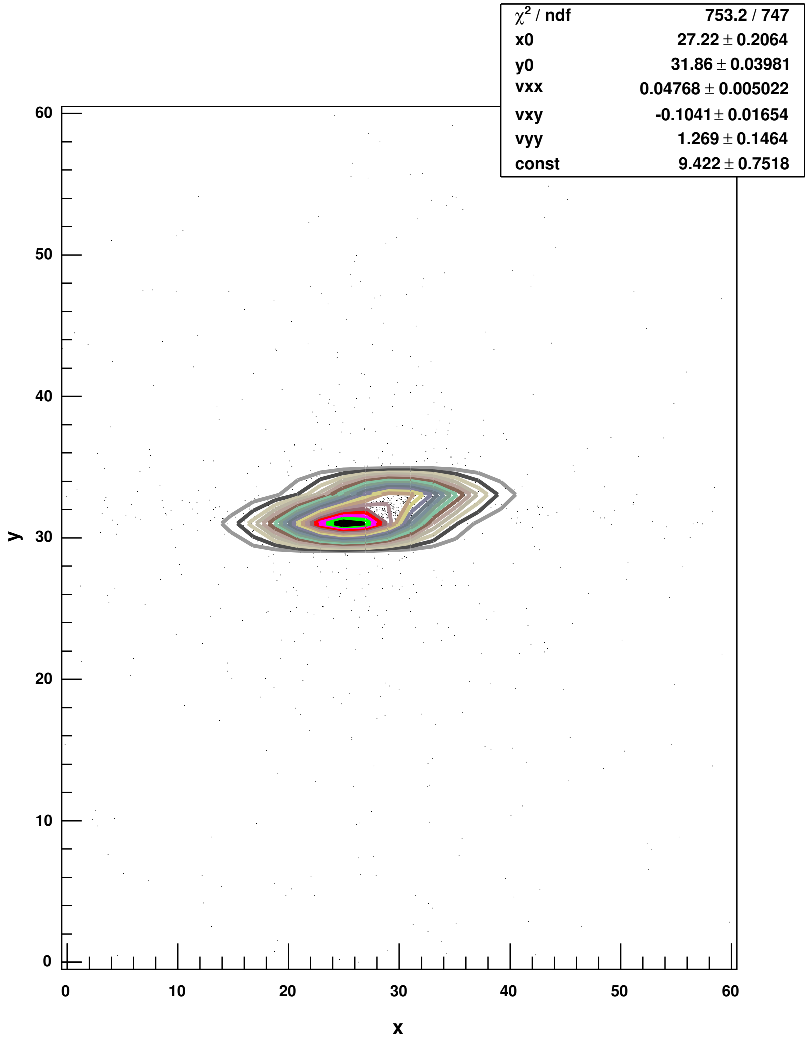
## TPOL silicon data




- Only plot single cluster hits
- Four strips per bin in both x and y to enhance the central peak and aid fitting
- No cut on the charge in a cluster

# Fitting the beam ellipse III

## TPOL silicon data




- A 2D Gaussian was fitted to the data
- $f(x,y) = C \exp[-0.5(v_{xx}(x-x_0)^2 + 2v_{xy}(x-x_0)(y-y_0) + v_{yy}(y-y_0)^2)]$
- $x_0$ and $y_0$ were initialised with the mean values of the clusters in the x and y
- The $\chi^2$/ndf is 1.01 so this function describes the data quite nicely

## Data-taking efficiency

- A run of 100,000 events takes 150 seconds
- From a given run about 1.8$\%$ are useful - i.e. produce single cluster events which are in the energy cut from the calorimeter and can be fitted
- This gives a data rate of about 12 useful events / second

- Runs providing just 50,000 events did not provide sufficient data to accurately fit an ellipse to the beam
- What is the smallest number of events we need for the ellipse fit to work?

# The beam parameters I

From the fitted function, the following parameters were extracted:

- $x_0$ and $y_0$ - the coordinates of the beam centre
- $\sigma_x$ and $\sigma_y$ - the width of the beam in the x and y directions
- $\alpha$ - the tilt of the beam with respect to the silicon's x and y axes

$x_0$ and $y_0$ were fitted directly

$\sigma_x$, $\sigma_y$ and $\alpha$ were calculated from the fit parameters with the following expressions:

- $\sigma_x = \sqrt{\frac{v_{yy}}{(v_{xx}v_{yy})-(v_{xy}v_{xy})}}$
- $\sigma_y = \sqrt{\frac{v_{xx}}{(v_{xx}v_{yy})-(v_{xy}v_{xy})}}$
- $\alpha = \frac{1}{2}\arctan(\frac{2v_{xy}}{v_{xx}-v_{yy}})$

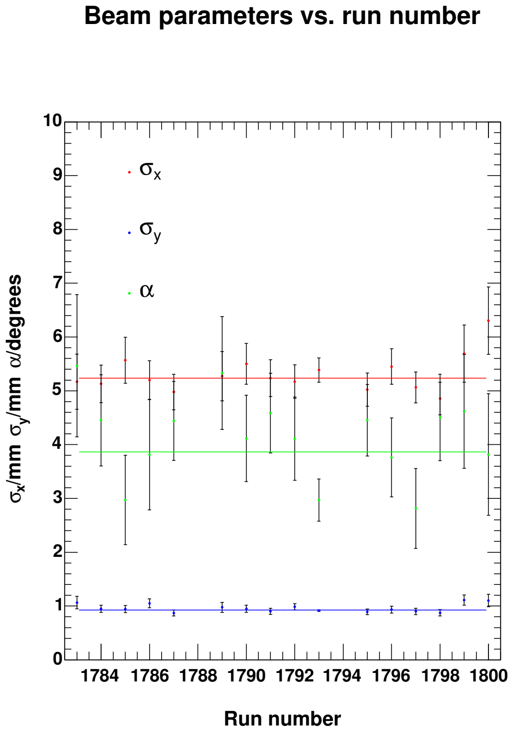
For the fit on slide 7, this gives the following results:

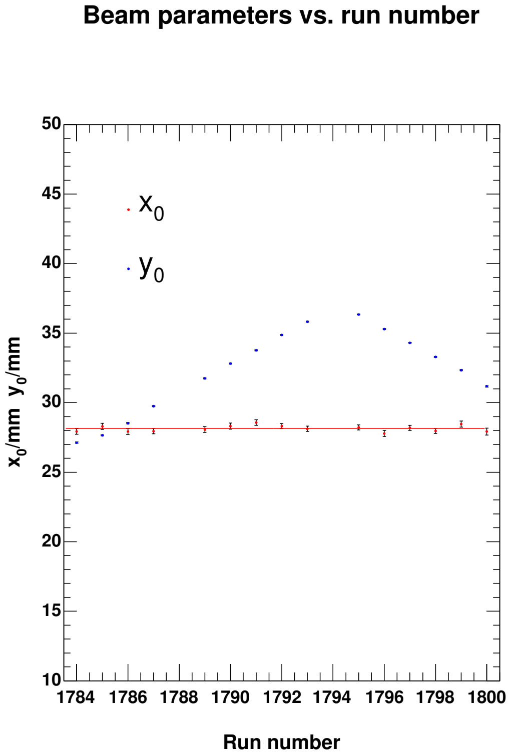
$x_0 = 27.22 \pm 0.21$ mm $\quad \sigma_x = 5.05 \pm 0.37$ mm $\quad \alpha = 4.84 \pm 0.94$ deg

$y_0 = 31.86 \pm 0.04$ mm $\quad \sigma_y = 0.98 \pm 0.08$ mm

# The beam parameters II

To see how well the parameters were estimated, the data from a table scan were analysed.



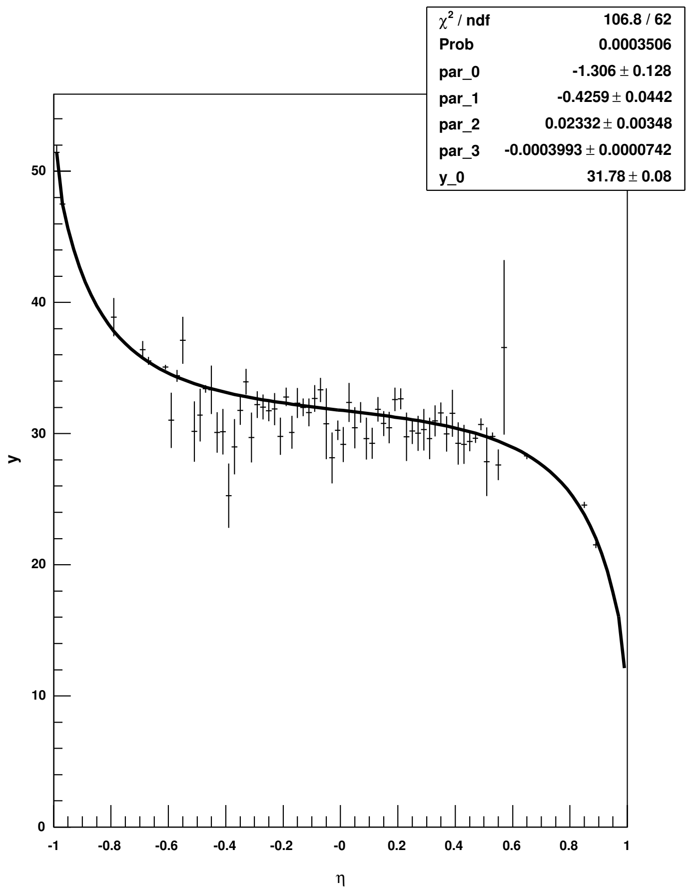

- 100,000 events/run
- A constant was fitted to each parameter
- All parameters had good $\chi^2$/ndf
- Unable to fit 2D Gaussian to 2/17 runs

| Parameter | $\sigma_x$ | $\sigma_y$ | $\alpha$ | $x_0$ |
|---|---|---|---|---|
| Fitted constant | 5.24 | 0.93 | 3.86 | 28.15 |
| $\chi^2$/ndf | 0.59 | 0.96 | 1.07 | 1.29 |

# Fitting $y(\eta)$

$$y(\eta) = y_0 + \ln\frac{1+\eta}{1-\eta} \times (P_0 + P_1(\ln\frac{1+\eta}{1-\eta})^2 + P_2(\ln\frac{1+\eta}{1-\eta})^4 + P_3(\ln\frac{1+\eta}{1-\eta})^6)$$

**TPOL silicon data**




- Fit over whole $\eta$ range; $y_0$ initialised with mean y cluster value
- The fitted parameters are:
  - $P_0 = -1.31 \pm 0.13$
  - $P_1 = -0.43 \pm 0.04$
  - $P_2 = 0.02 \pm 0.00$
  - $P_3 = -0.00 \pm 0.00$
  - $y_0 = 31.78 \pm 0.08$
- $\chi^2$/ndf = 1.72
- Fitted value of $y_0$ consitent with that from the beam ellipse fit

# Summary and future plans

- Silicon detector and clustering algorithm seem to be performing OK
- Fitting a 2D Gaussian to the beam profile works well for 100,000 events; $\chi^2$/ndf = 1.01
- On 01/06/04: $x_0$ = 27.22 $\pm$ 0.21 mm ; $y_0$ = 31.86 $\pm$ 0.04 mm ; $\sigma_x$ = 5.05 $\pm$ 0.37 mm ; $\sigma_y$ = 0.98 $\pm$ 0.08 mm ; $\alpha$ = 4.84 $\pm$ 0.94 deg
- 1.8$\%$ of the data is useful; collected at a rate of 12 useful events / second
- A run of 50,000 events is not sufficient to fit a 2D Gaussian
- Extracted beam parameters are constant within errors over consecutive runs
- What is minimum run size required?
- Subtract laser off from laser on to remove the Compton photons
- Take a RAW run to check pedestal subtraction
- Improve fitting of y-$\eta$ curve; check fit range and constancy of fit parameters