Silicon detector alignment study update

POL analysis meeting

17th November 2004

Catherine Fry

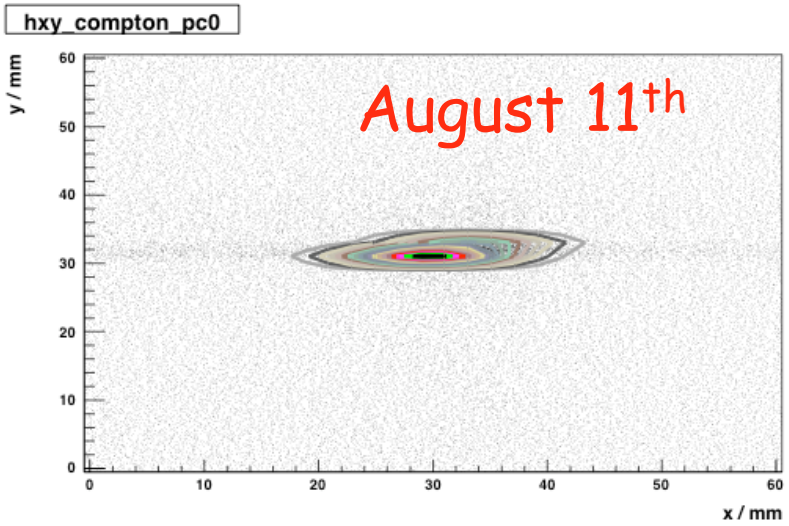
Imperial College London

Outline of studies

- Data studies:
  - check beam tilt from four data sets
  - subtract background and measure x-η slope
- MC studies:
  - use newest version of tpolmc
  - varying silicon angle w.r.t. beam
  - varying silicon AND cal angle TOGETHER w.r.t. beam (i.e. changing beam tilt)
  - varying parameter "DILU" - fraction of light penetrating into opposite cal plate (only up/down)
  - varying cal angle w.r.t. beam - fixed silicon angle
- Compare mc with data:
  - for cal and silicon quantities

Beam tilt measurements

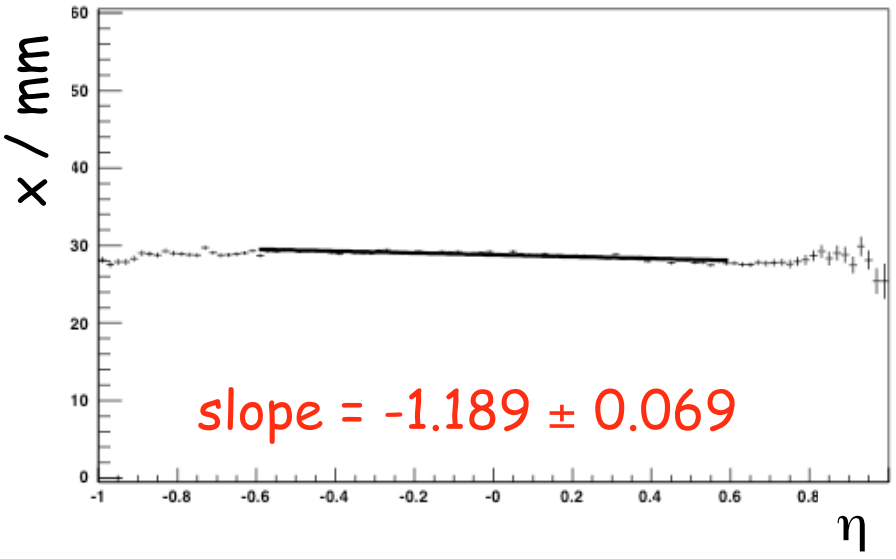
- Use same four data sets as Yongdok
- Subtract background by normalising laser on and laser off data to tail of energy distribution
- Fit 2-D ellipse to silicon y-x plot for pc=0 and 1 and extract beam tilt w.r.t. silicon:
- Seems that the beam tilt varies with time



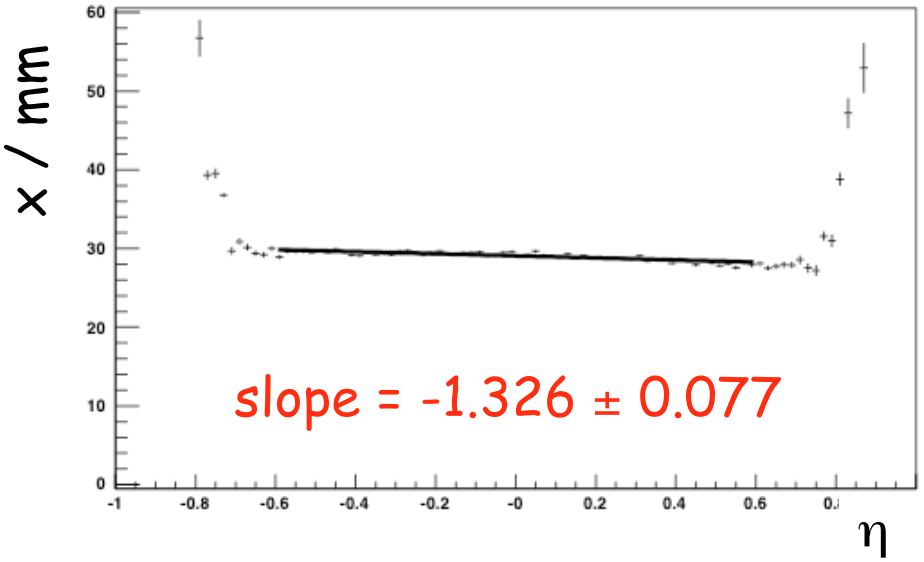
α / °	pc = 0	pc = 1
1st March	6.8 ± 0.3	6.8 ± 0.3
7th March	4.5 ± 0.1	4.7 ± 0.1
24th May	3.1 ± 0.1	2.9 ± 0.1
11th August	3.4 ± 0.2	2.9 ± 0.2

Data: x-η

Laser on



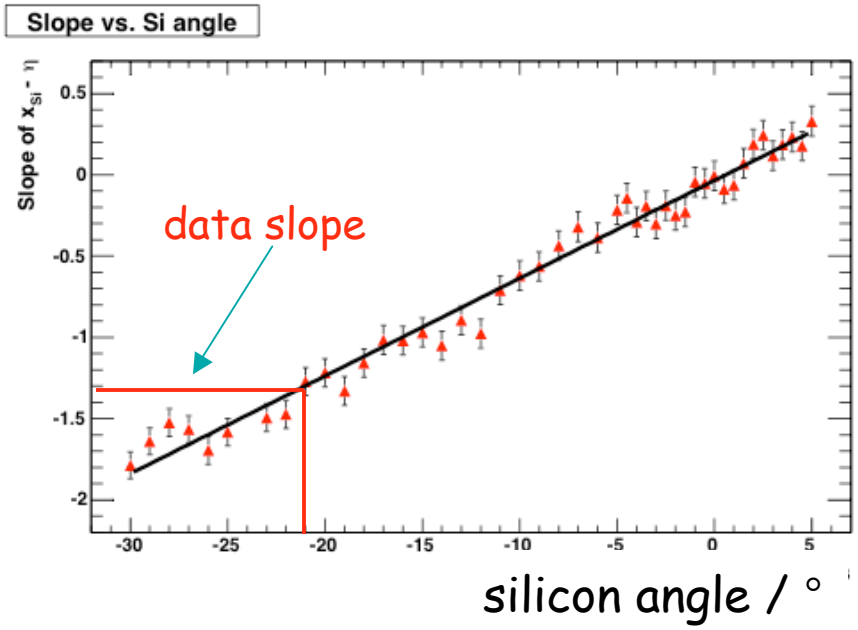
Compton only



- Slope should be zero if no angle between silicon and cal
- Want to compare slope with mc to determine angle
- Why such high x for extreme η in Compton distribution?
- Same thing happens in Compton y-η distribution (i.e. high y values for extreme η bins)
- Could it be due to low stats in extreme η bins and bad background subtraction?

MC: varying silicon angle

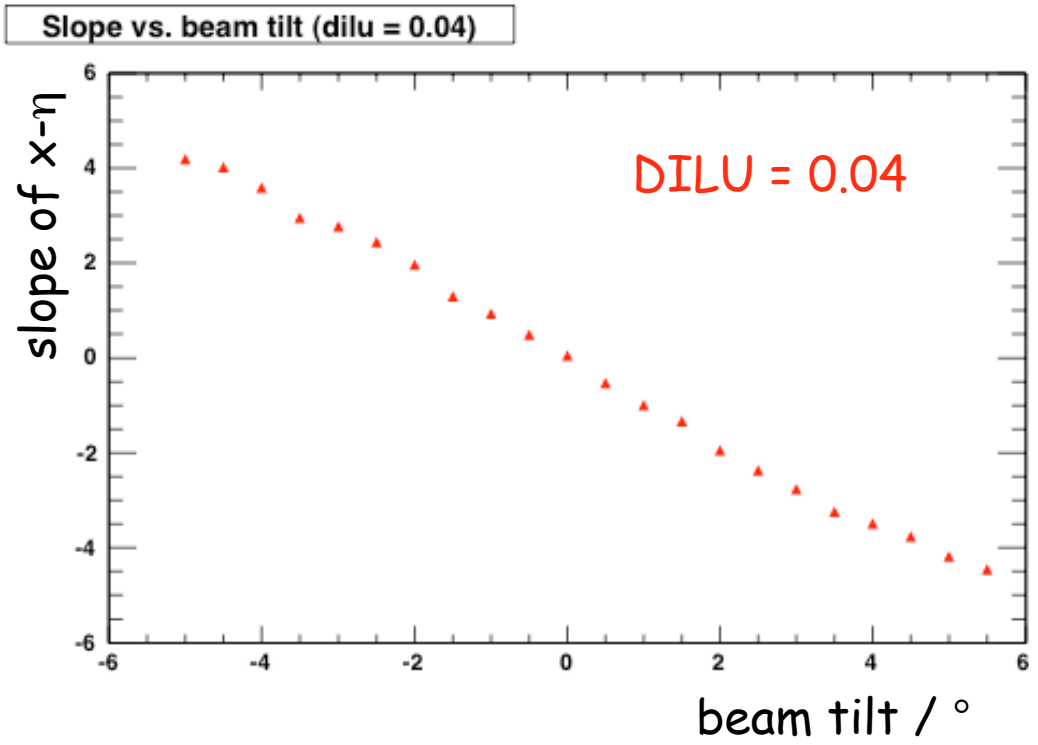
- Same idea as before:
  - rotate silicon angle w.r.t. beam until find x-η slope which matches the slope measured in the background-subtracted data



- Now with newer version of tpolmc, cal angle = 0.06°, DILU=0.04, generate 200k events at many silicon angles from -30.0° to 5.0°
- Find slope that matches that in data gives silicon angle = -21° - still crazy!
- But, have not yet accounted for possible beam tilt…

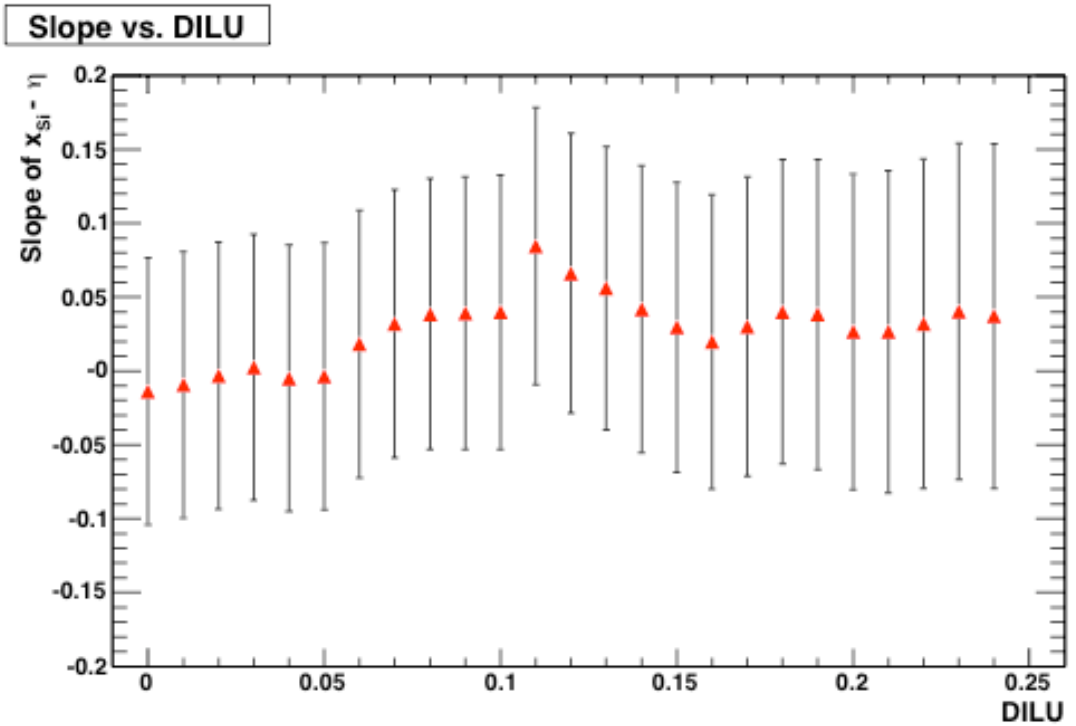
MC: varying beam tilt

- Keep silicon and cal angles w.r.t. beam equal and vary them together to simulate change in beam tilt
- Simulate 200k events at silicon/cal angles (beam tilt) from -5.0° to +5.5°
- Plot x-η slope as function of beam tilt
- Seems simulating beam tilt of few degrees can have relatively large effect on x-η slope (compared to data value of -1.3)



MC: varying DILU - I

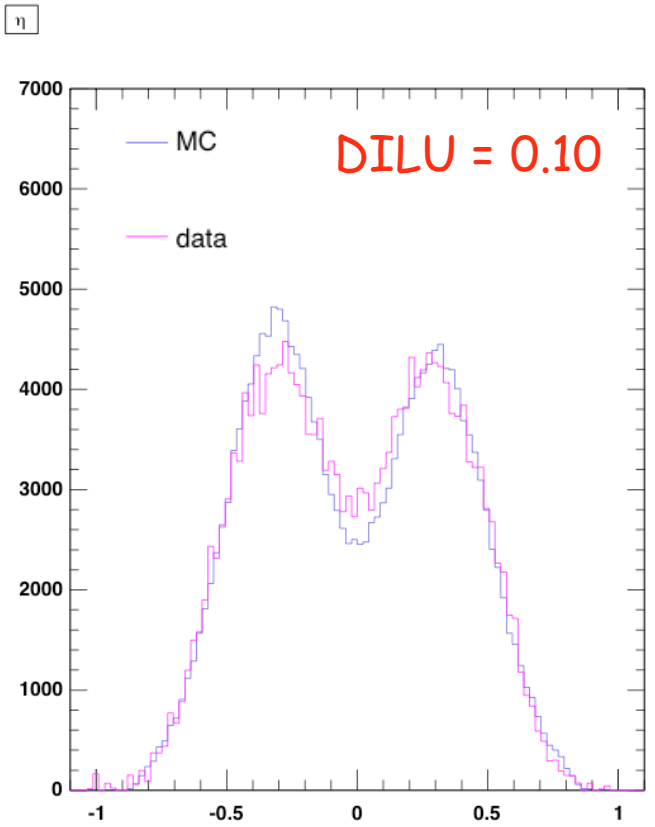
- Want to find what is best value for DILU (fraction of light penetrating into opposite cal plate - up/down)
- Simulate 200k events at silicon angle = 0.0° and cal angle = 0.06° and vary DILU from 0.00 to 0.24
- Find value of DILU doesn't have a huge effect on x-η slope (compared to data value of -1.3)



MC: varying DILU - II

- Compare mc η distributions from different DILU values with background-subtracted data η distribution normalised to the mc (August 11th)
- Subtract data from mc histograms and find which value of DILU gives best match:

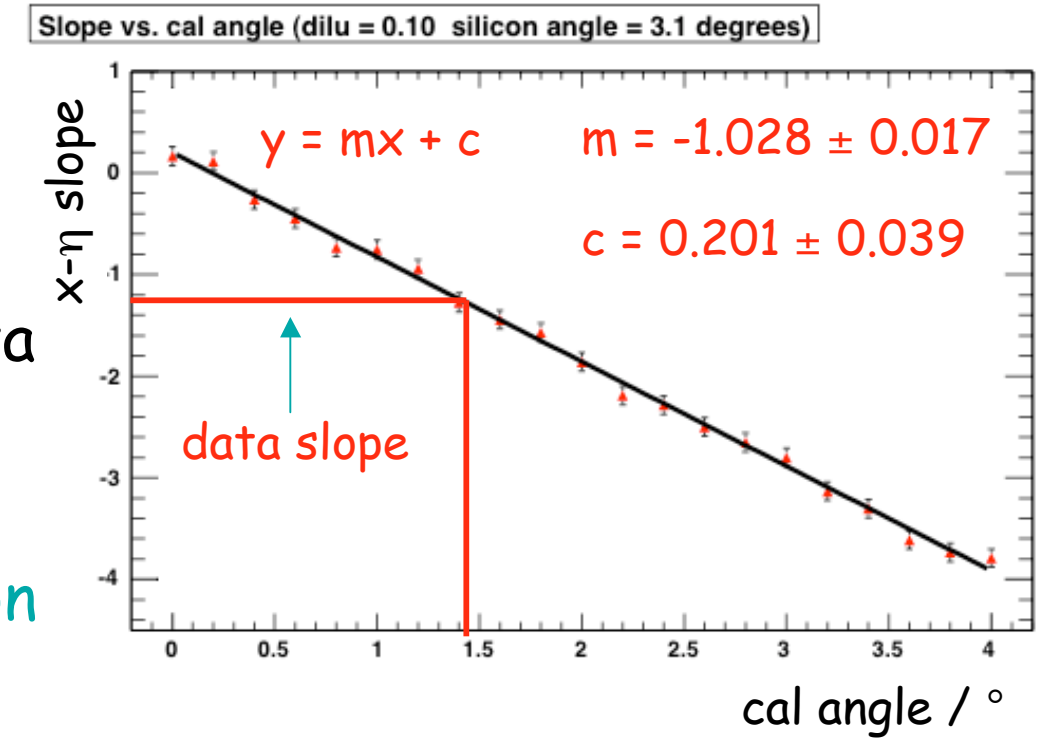
DILU	$\Delta(\eta_{mc} - \eta_{data})$
0.07	24486.6
0.08	20102.8
0.09	17030.5
0.10	**16083.0**
0.11	17865.0
0.12	21049.6
0.13	24842.7



MC: accounting for beam tilt

- Will account for beam tilt by fixing silicon angle = 3.1° (from ellipse fit to data on 11th August), then vary cal angle from 0.0° to 4.0°, with DILU = 0.10

- Plot x-η vs. cal angle and fit straight line
- Cal angle which gives same x-η slope as data is 1.5 ± 0.1°
- Implies 1.6 ± 0.2° between cal and silicon (3.1 - 1.5 = 1.6°)



Cal-Si angle from four dates

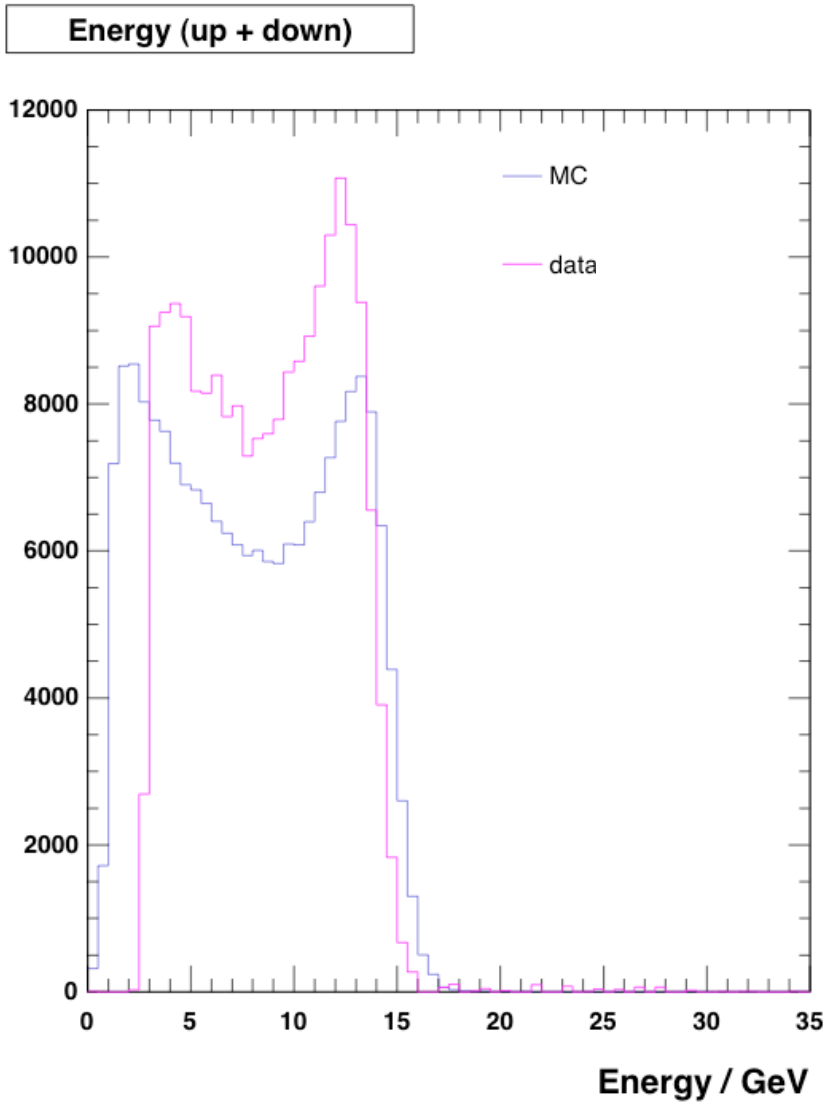
- Compare data: 1st Mar, 7th Mar, 24th May and 11th Aug
- Use the following procedure for all samples:
  - measure x-η slope
  - measure beam tilt from silicon x-y ellipse fit
  - simulate mc samples with silicon angle set to beam tilt and vary cal angle
  - plot mc x-η slope vs. cal angle and find which cal angle matches x-η slope in data

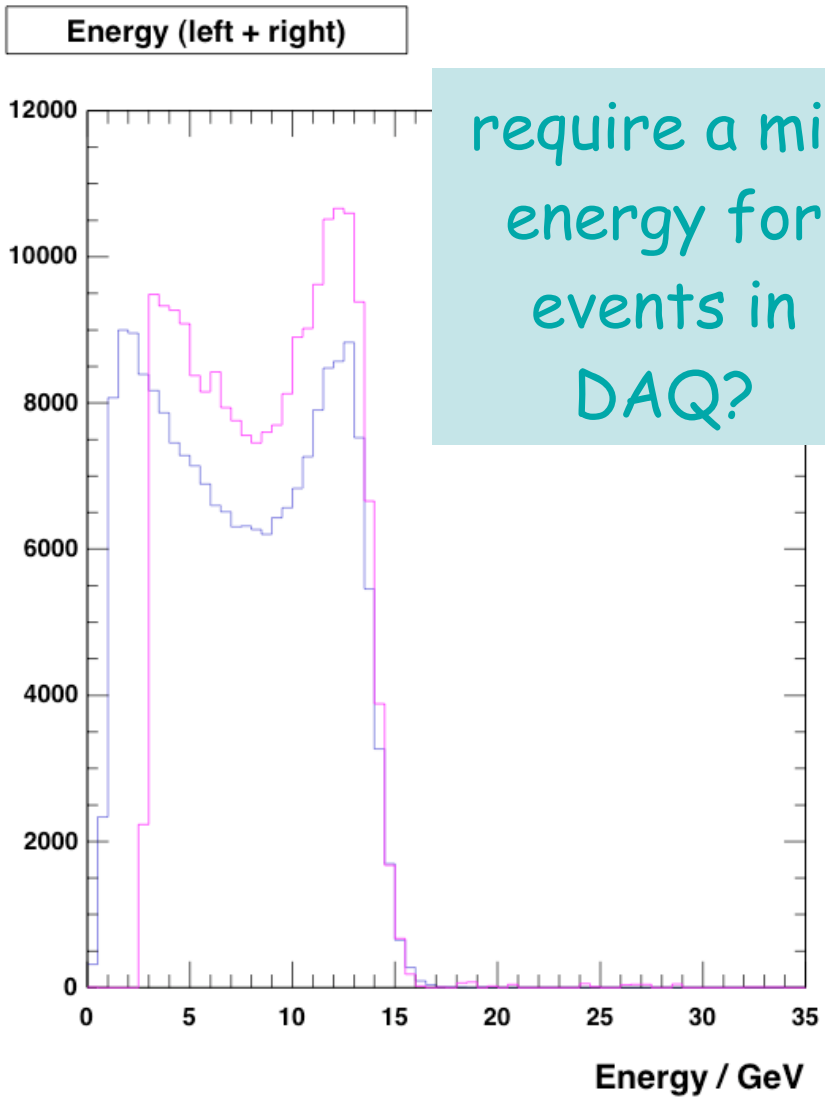
Date	Beam tilt / °	Cal angle / °	Angle between cal and silicon / °
1st Mar	6.8 ± 0.4	1.7 ± 0.2	5.1 ± 0.4
7th Mar	4.6 ± 0.2	1.9 ± 0.1	2.7 ± 0.2
24th May	3.0 ± 0.2	1.4 ± 0.1	1.6 ± 0.2
11th Aug	3.1 ± 0.2	1.5 ± 0.1	1.6 ± 0.2

Comparing mc with data

- Use mc sample:
  - 200k events
  - silicon angle = 0.0°
  - calo angle = 0.06°
  - DILU = 0.10
- Subtract background from data and normalise to mc distributions

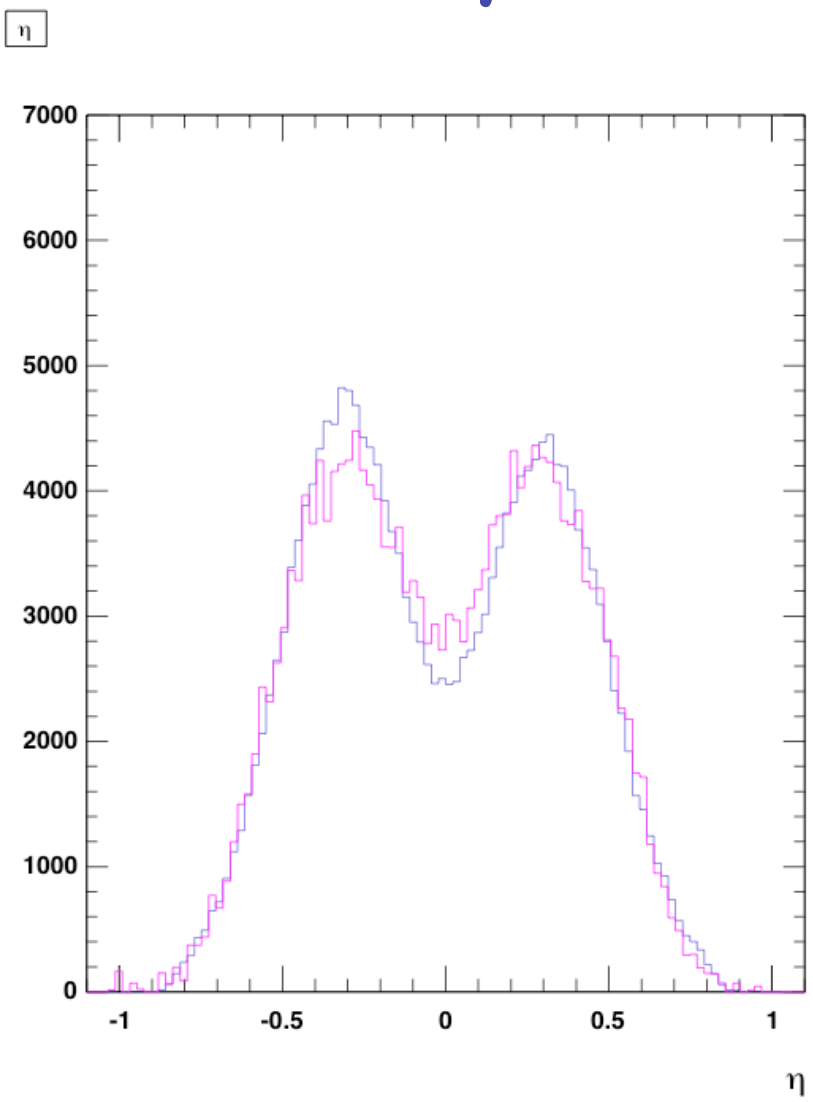
Energy: u/d and l/r

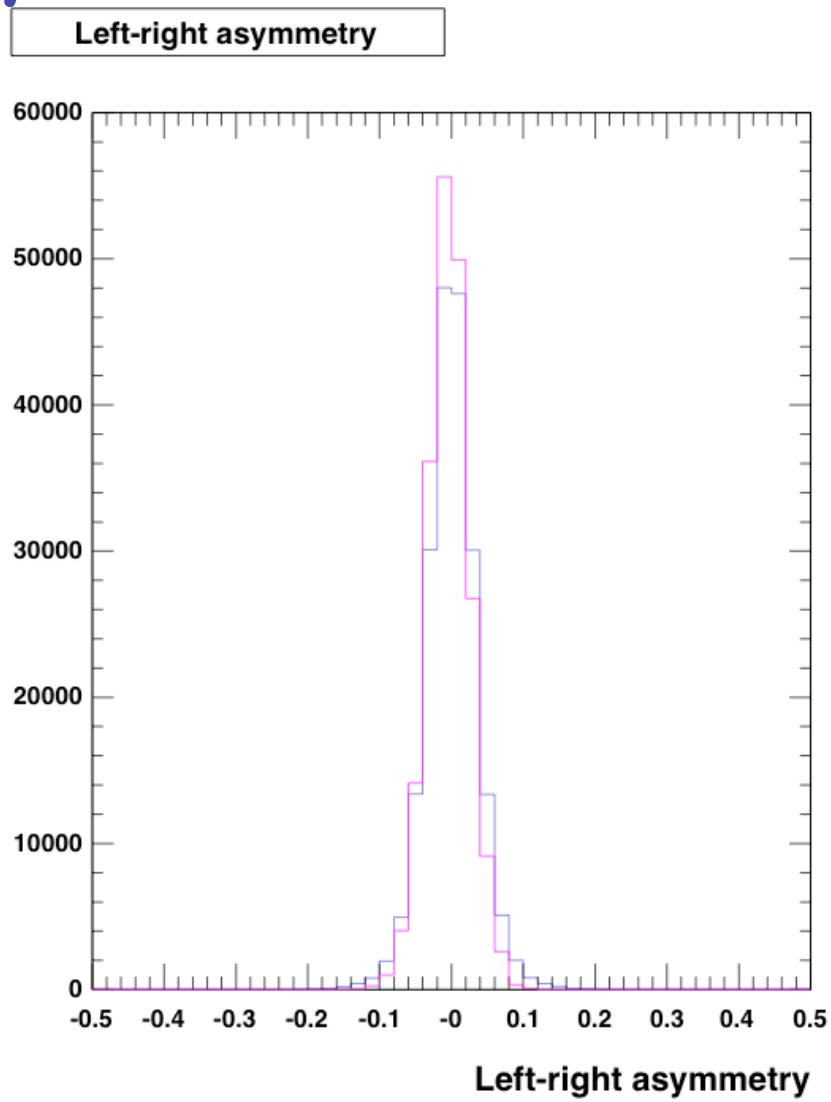




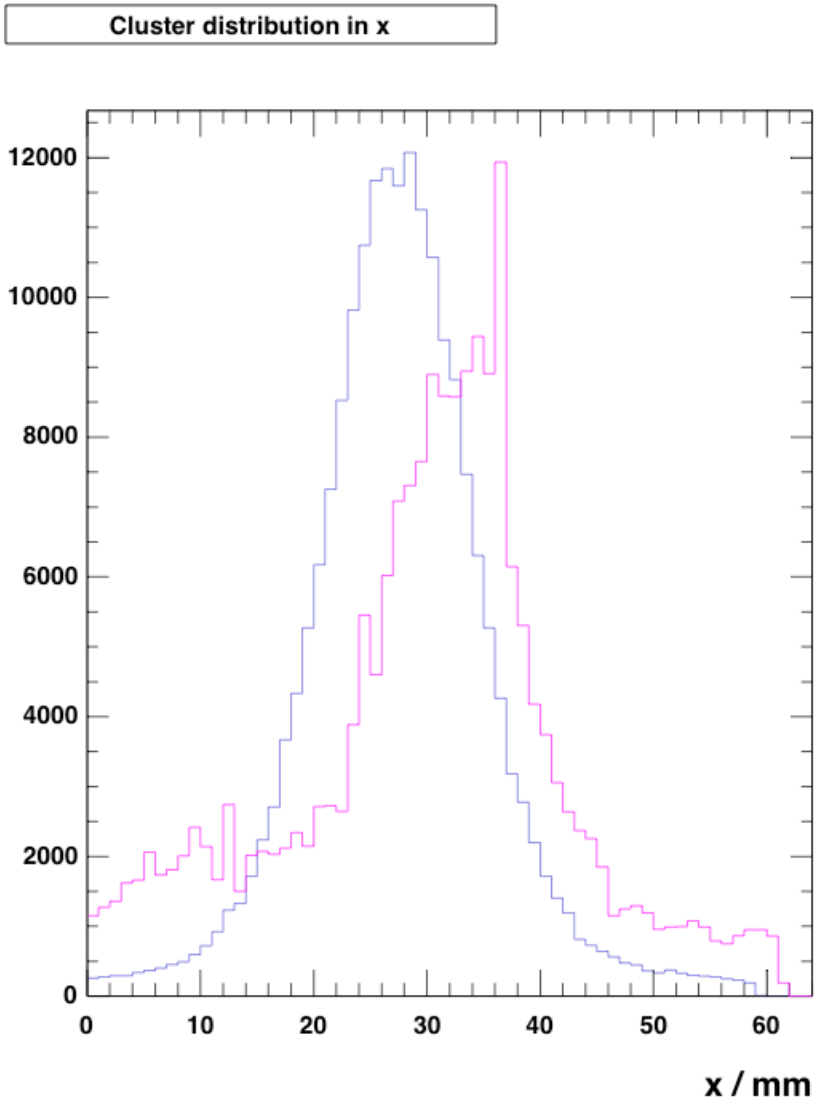
require a min energy for events in DAQ?

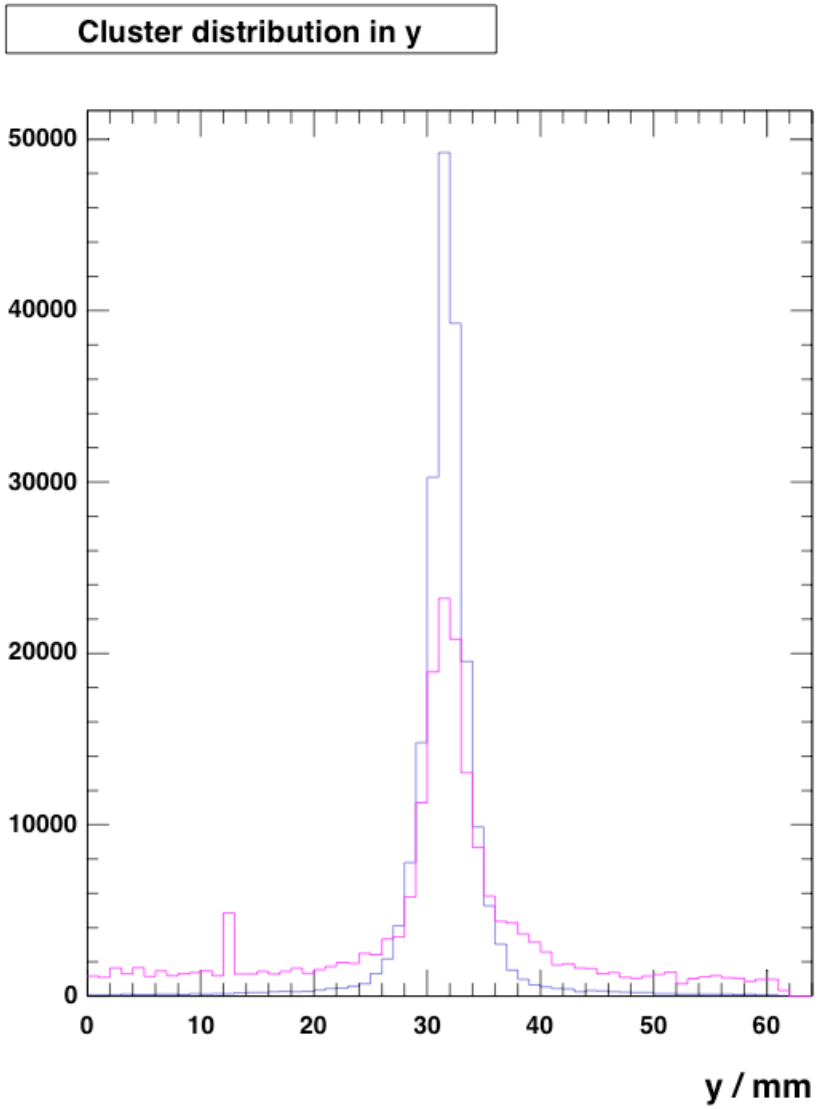
Cal asymmetry: u/d and l/r



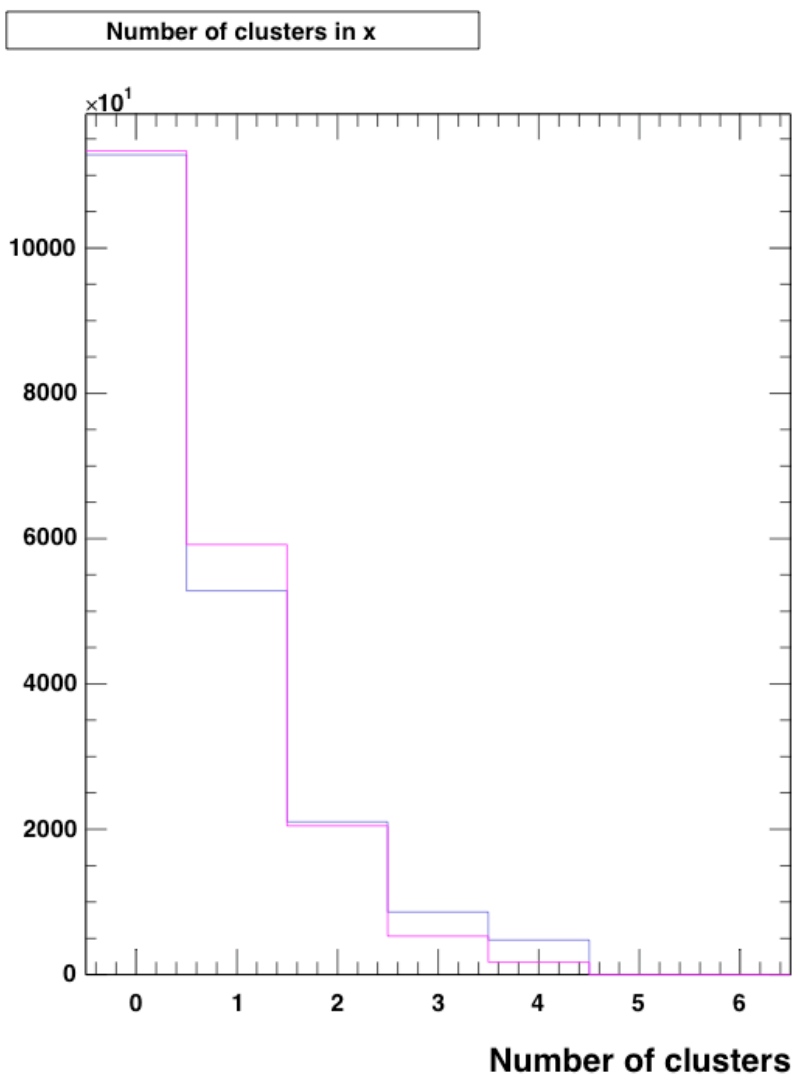


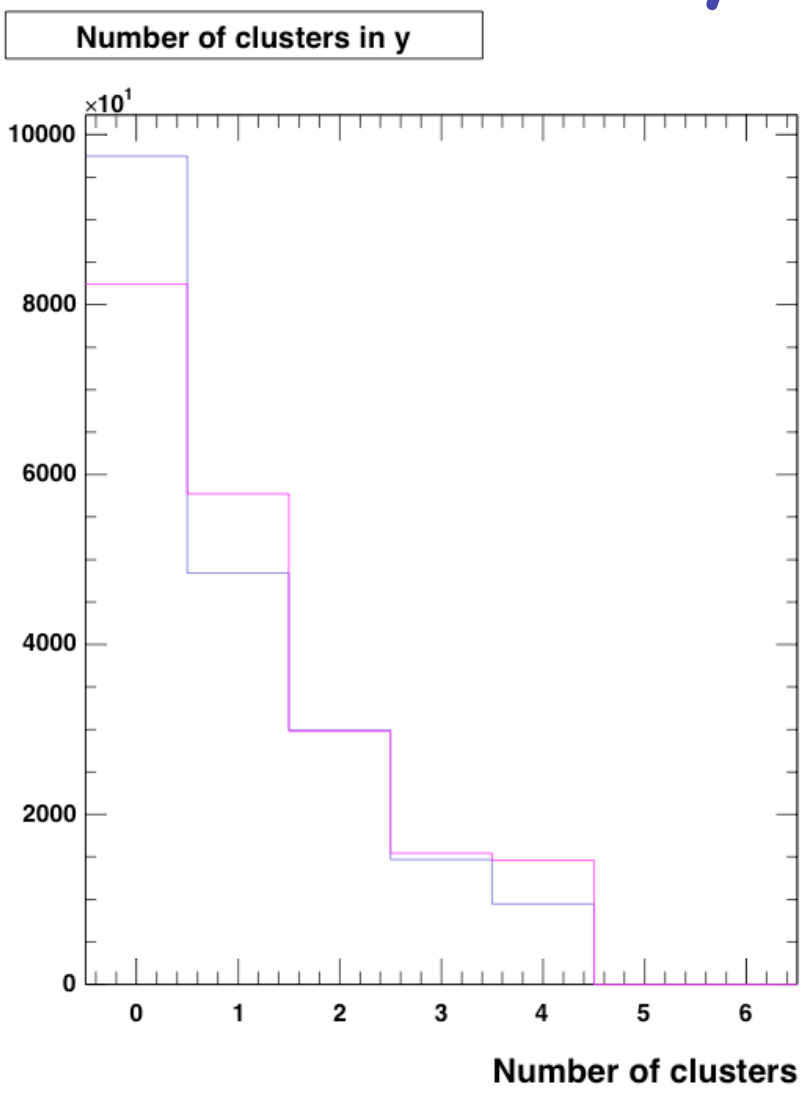
Si cluster position: x and y



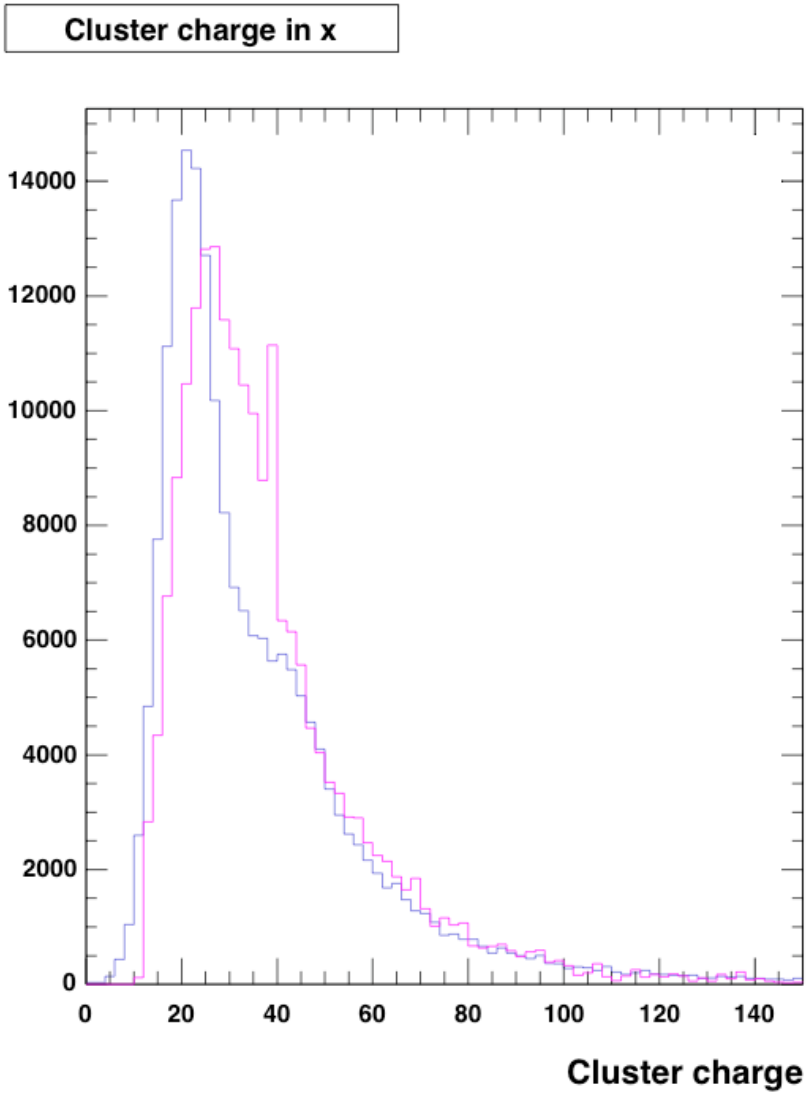


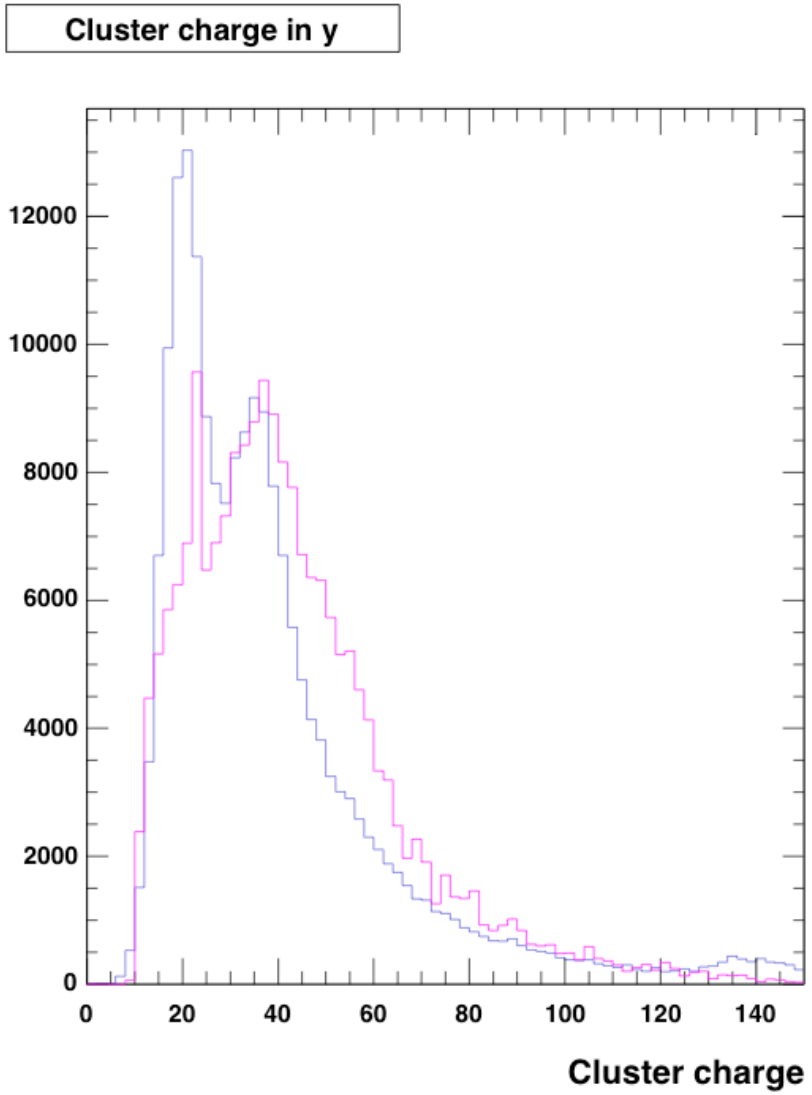
Si number clusters: x and y





Si cluster chg: x and y





Summary

- In silicon data beam tilt seems to vary over time
- Measure a slope in x-η distribution ➔ some angle between cal and silicon
- Just varying silicon angle in the mc and keeping cal fixed to 0.06° ➔ -21° between silicon and cal! Crazy…
- Investigate beam tilt effects by varying cal and silicon angles together in mc by few degrees ➔ produces large change in x-η slope
- Varying DILU has small effect on x-η slope
- DILU = 0.10 gives η distribution which best matches data
- Accounting for beam tilt in mc ➔ 1.6 to 5.1° between silicon and cal from four data samples
- See some differences in both cal and silicon quantities between mc and data

Future plans

- Think about silicon background subtraction in extreme η regions
- Estimate additional error on cal-Si angle from the error on beam tilt by changing beam tilt angle in mc by small amounts
- Try to understand differences between mc and data and repeat comparison with more 'realistic' angles for silicon and cal in mc