Imperial College London

Analysis of TPOL silicon detector cosmic-ray muon data

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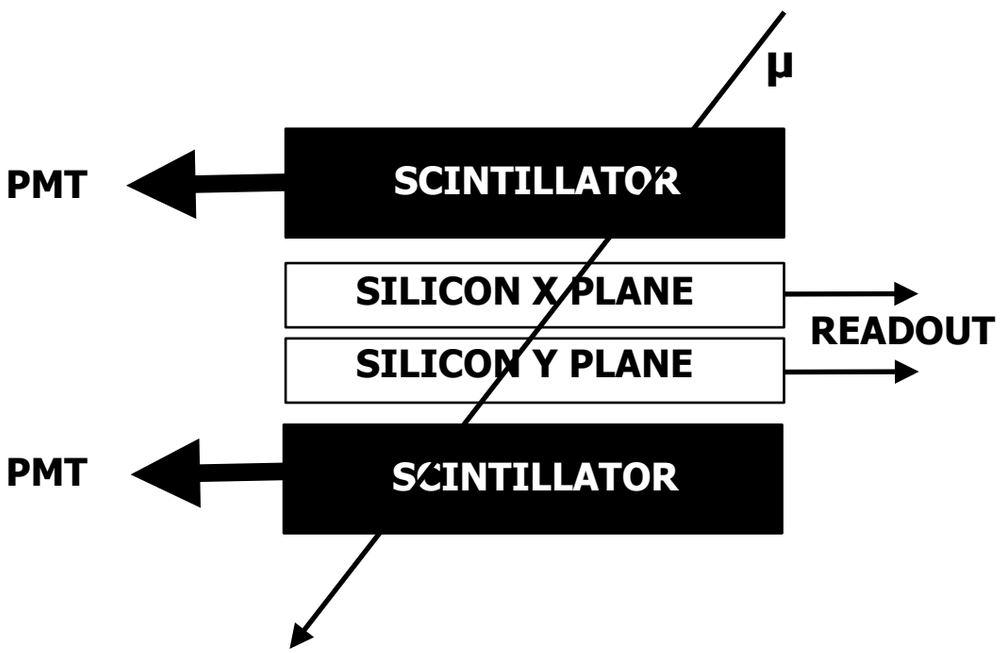
- Cosmic-ray test stand
- Signal reconstruction
- Data analysis
- Conclusions

Cosmic-ray muon test stand



- Test stand set up in London
- Trigger cosmic-ray muons with scintillator coincidence above and below silicon detectors
- Same electronics and settings as HERA tunnel
- Approx. 100 runs of 10K events each taken in 2003 and 2004
- All 4 TPOL silicon detectors used in HERA tunnel were tested

Signal reconstruction

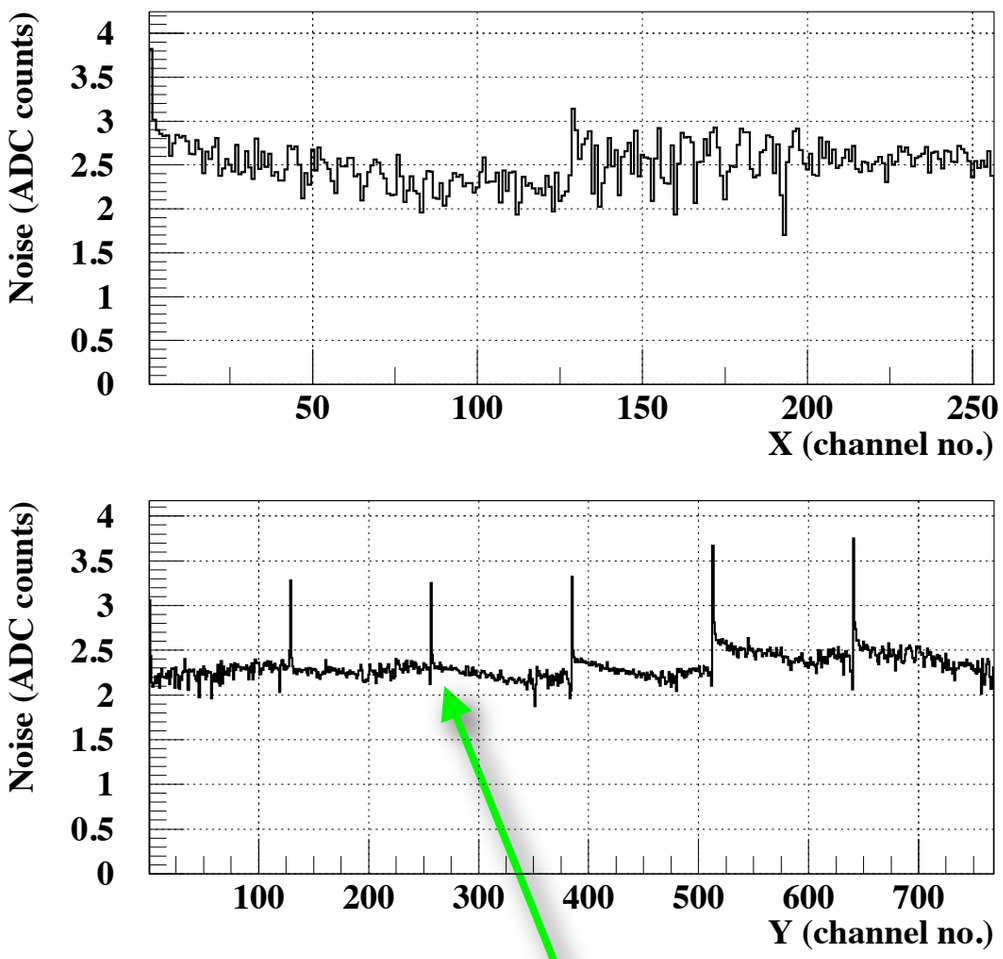
- Procedure as follows:

1. Calculate signal and noise and check data integrity (sync of readout chips and errors in header finding)
2. Calculate pedestal for each channel (excluding signal defined as 3*noise and signal>10 ADC counts from step 1.)
3. Calculate common mode for each readout chip (excluding signal defined as 3*noise and signal>10 ADC counts from step 1.)
4. Signal = raw ADC counts - pedestal - common mode

- Look for noisy and dead channels by eye at this point. Perhaps use an algorithm later to exclude them from clustering

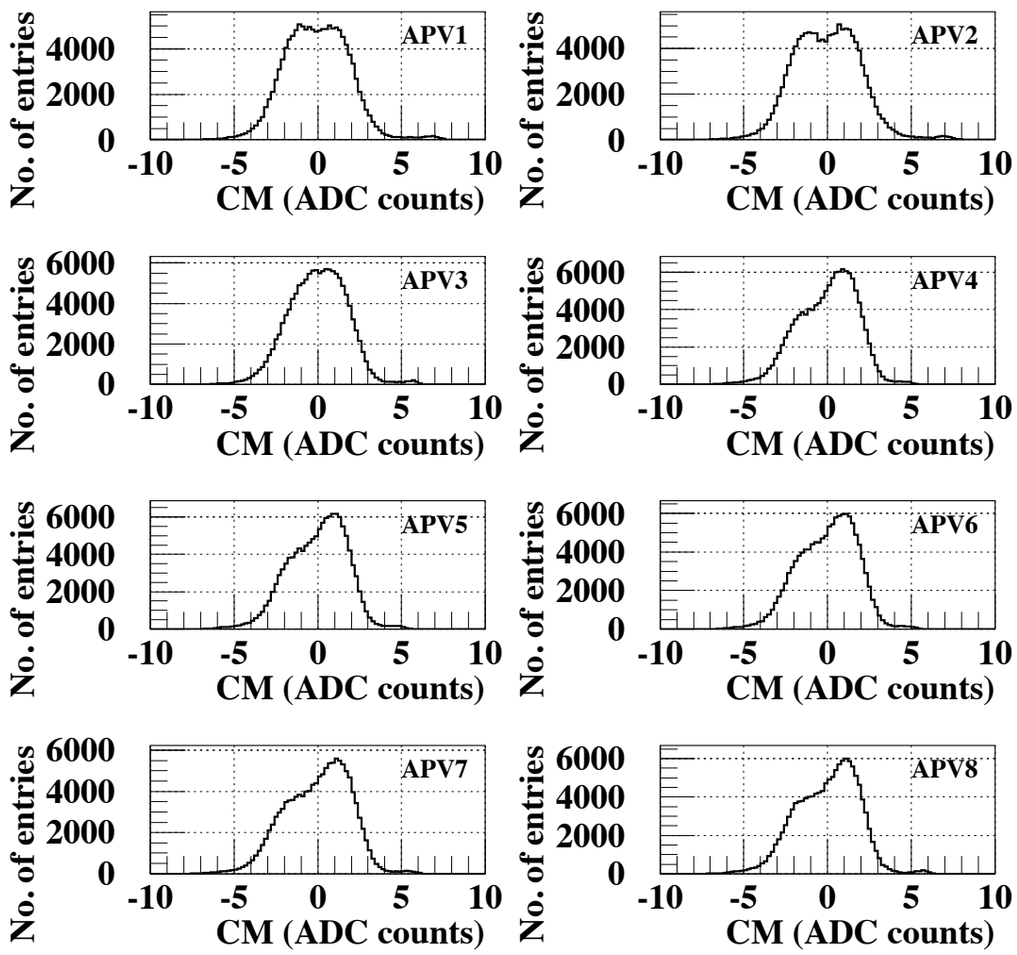
Data analysis

Noise



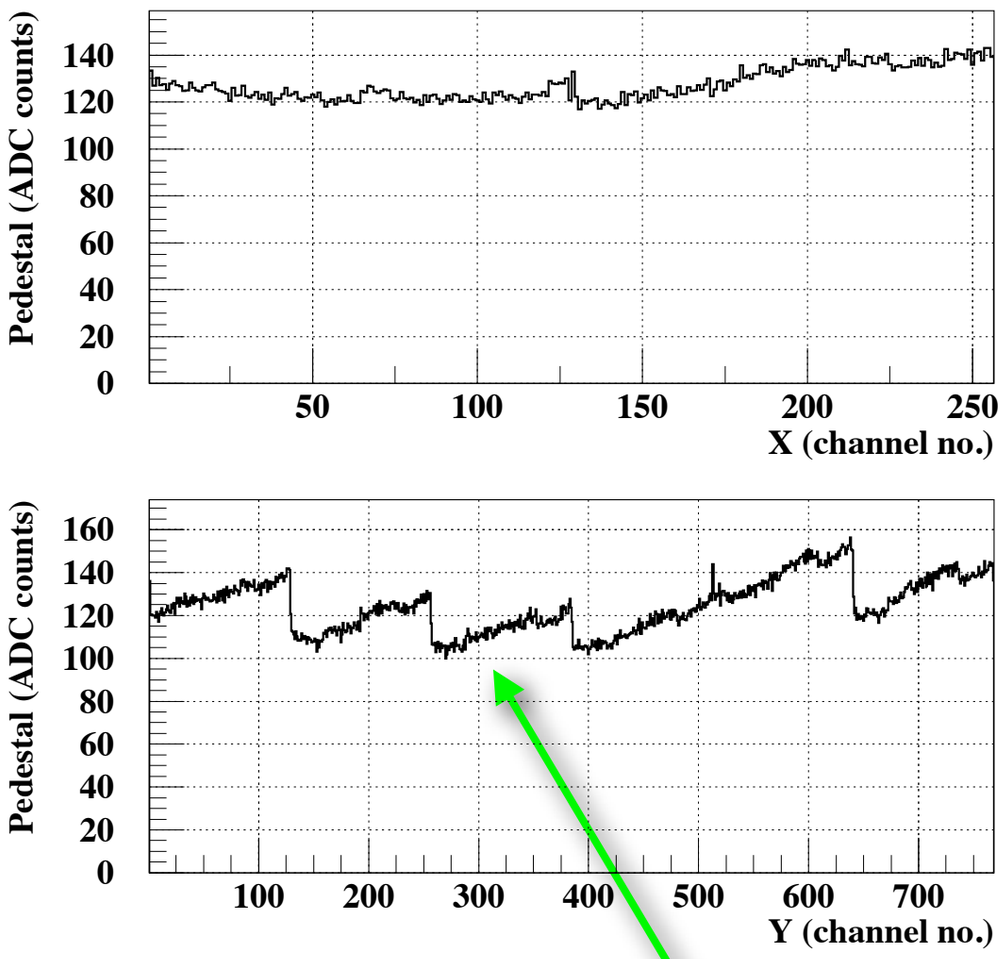
Peaks and drops in noise at end channels not fully understood but very likely from circuit design

Common mode

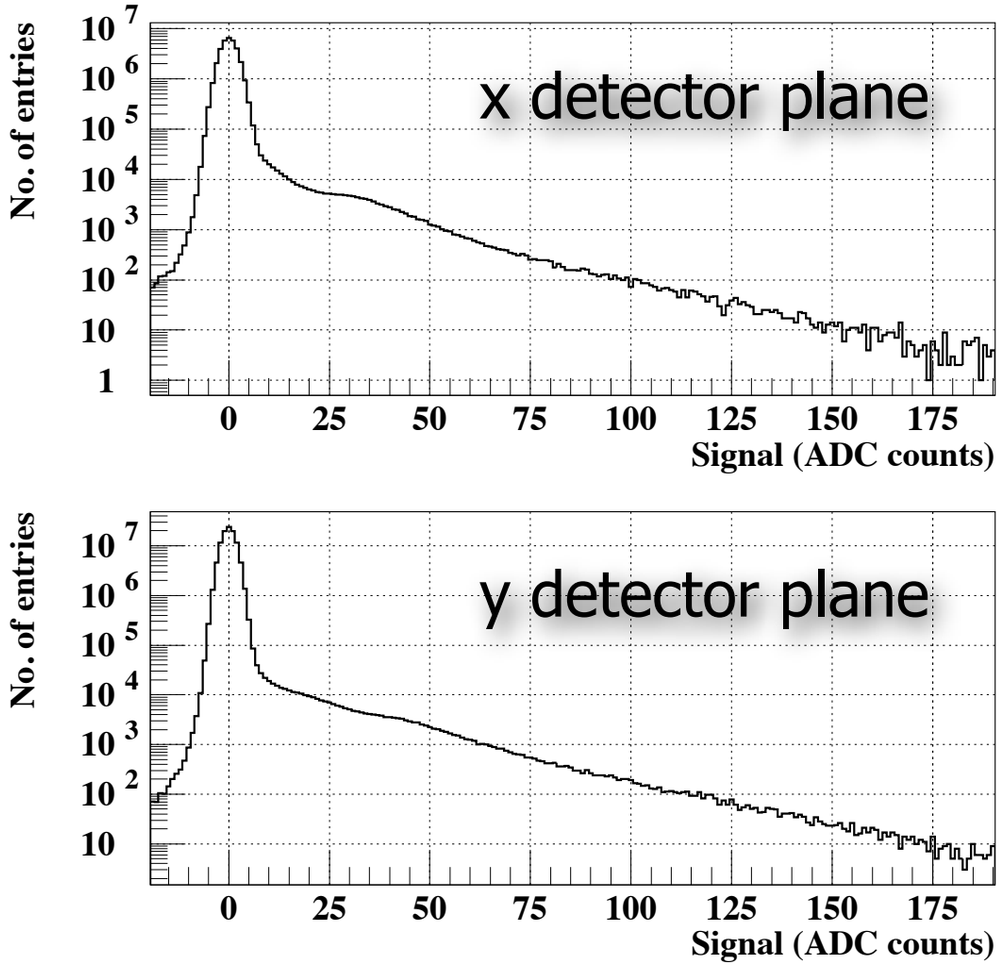


Data analysis

Pedestal



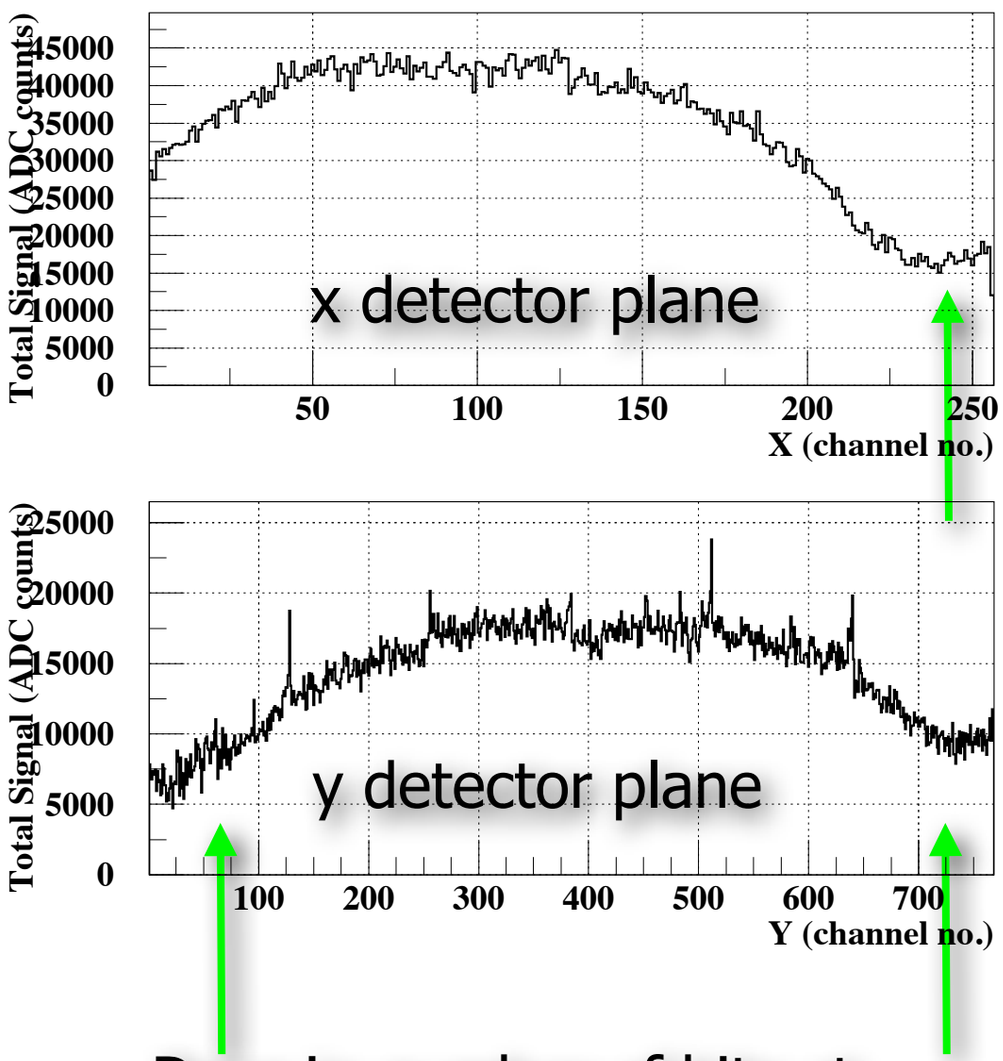
Signal



Saw-tooth shape expected

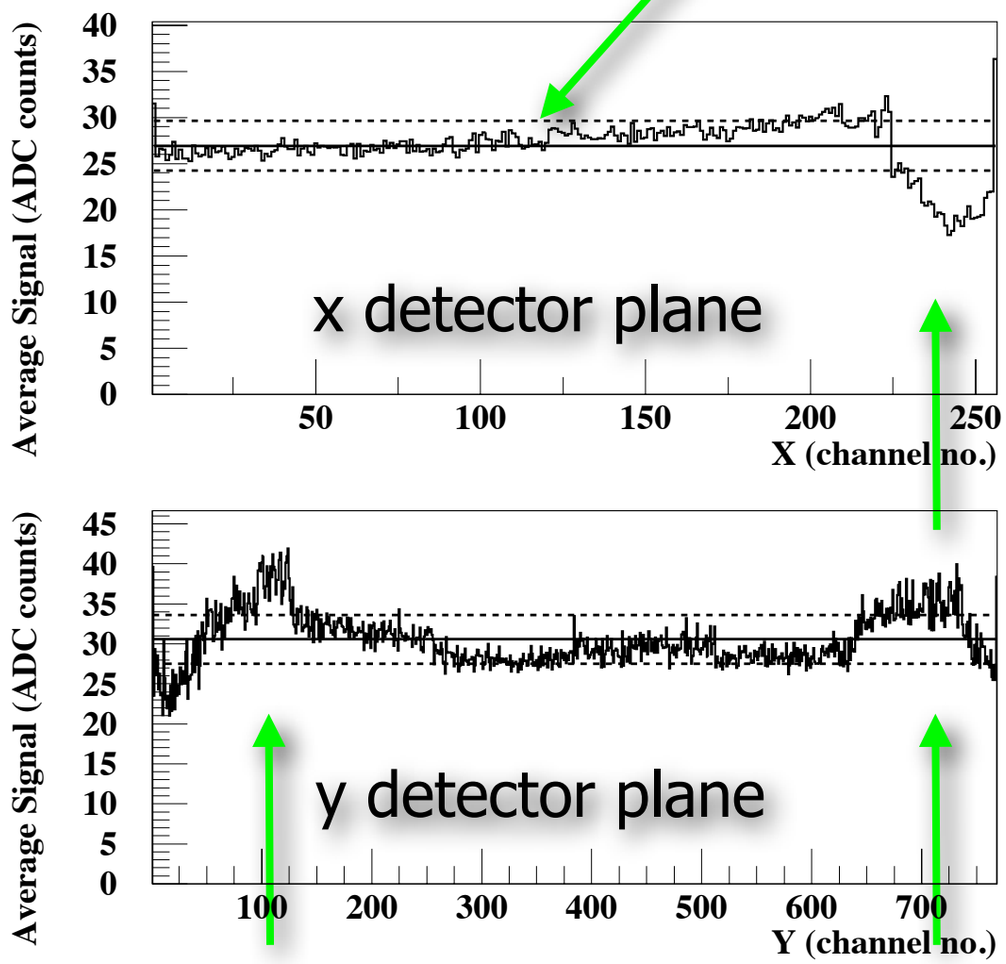
Data analysis

Average from signal > 3*noise and > 10 ADC counts



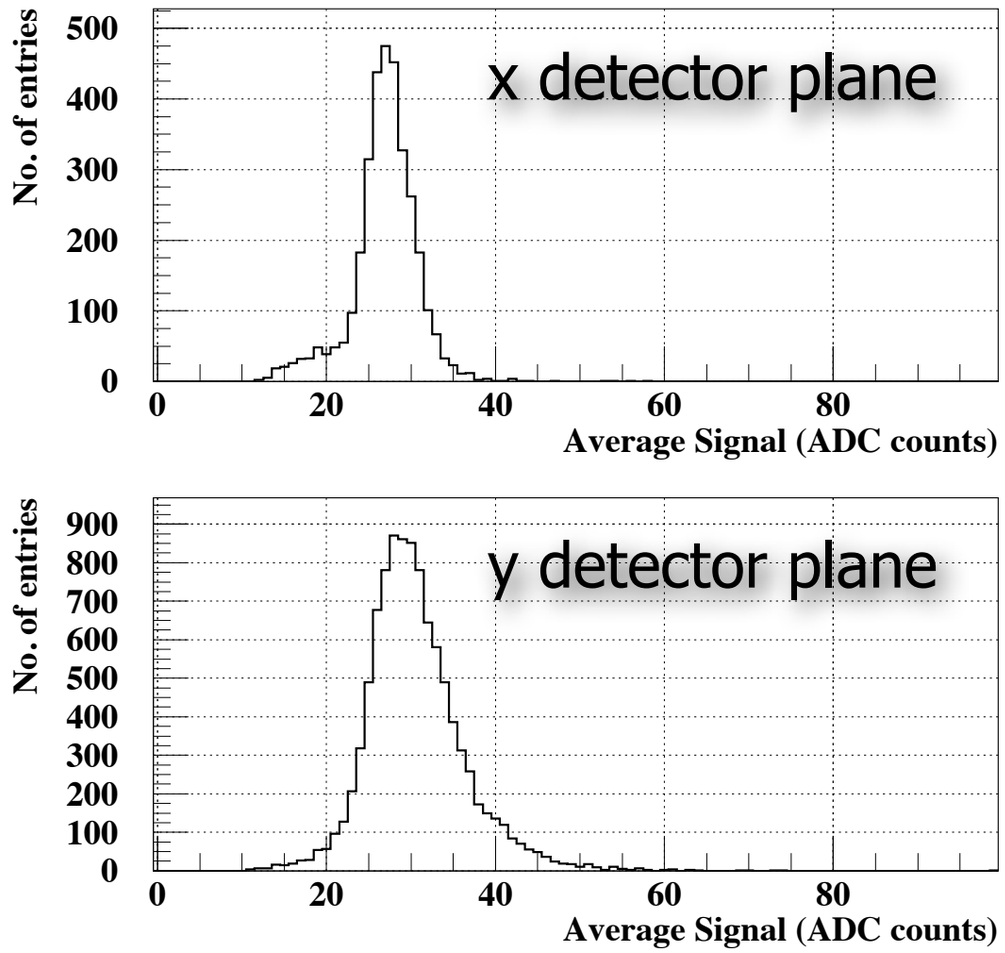
Drop in number of hits at edges due to scintillator size and alignment

±10%



Effects towards the edge of the detectors not understood

Data analysis



x plane: mean = 26.9 ADC counts

y plane: mean = 30.6 ADC counts

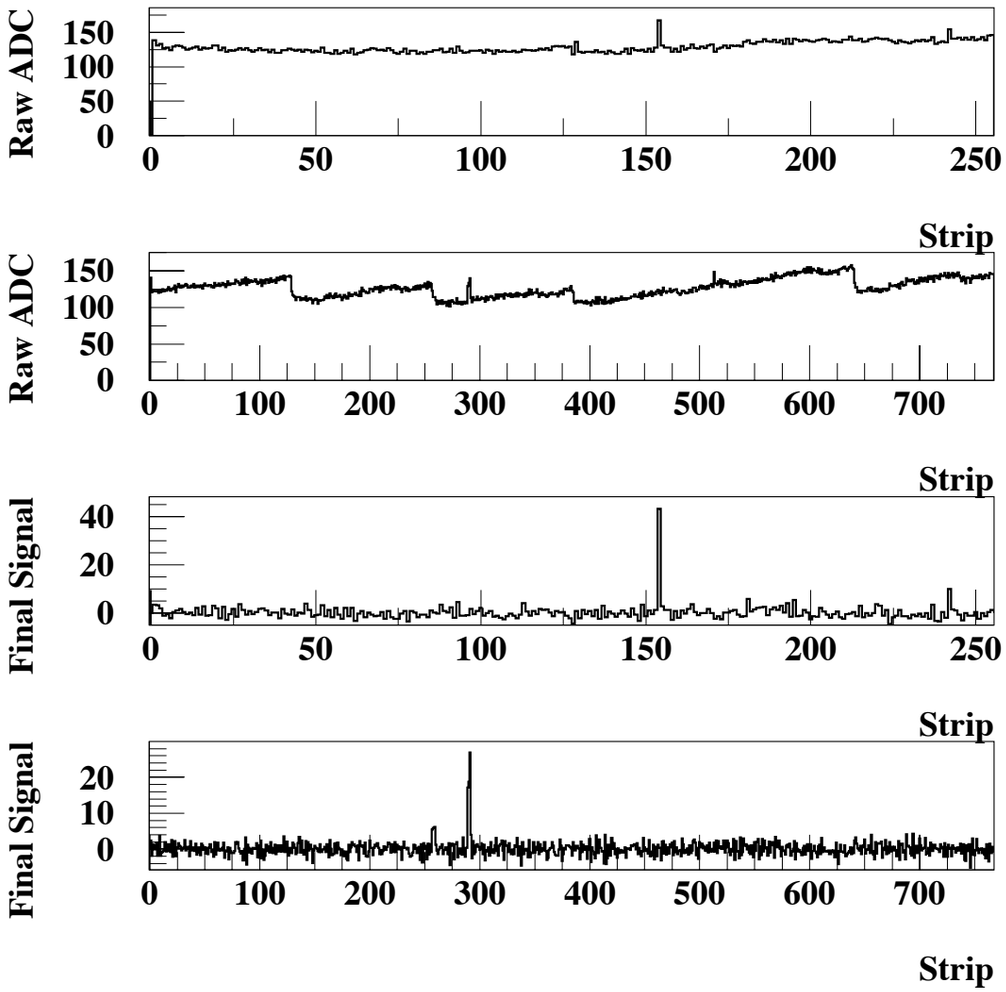
Clustering

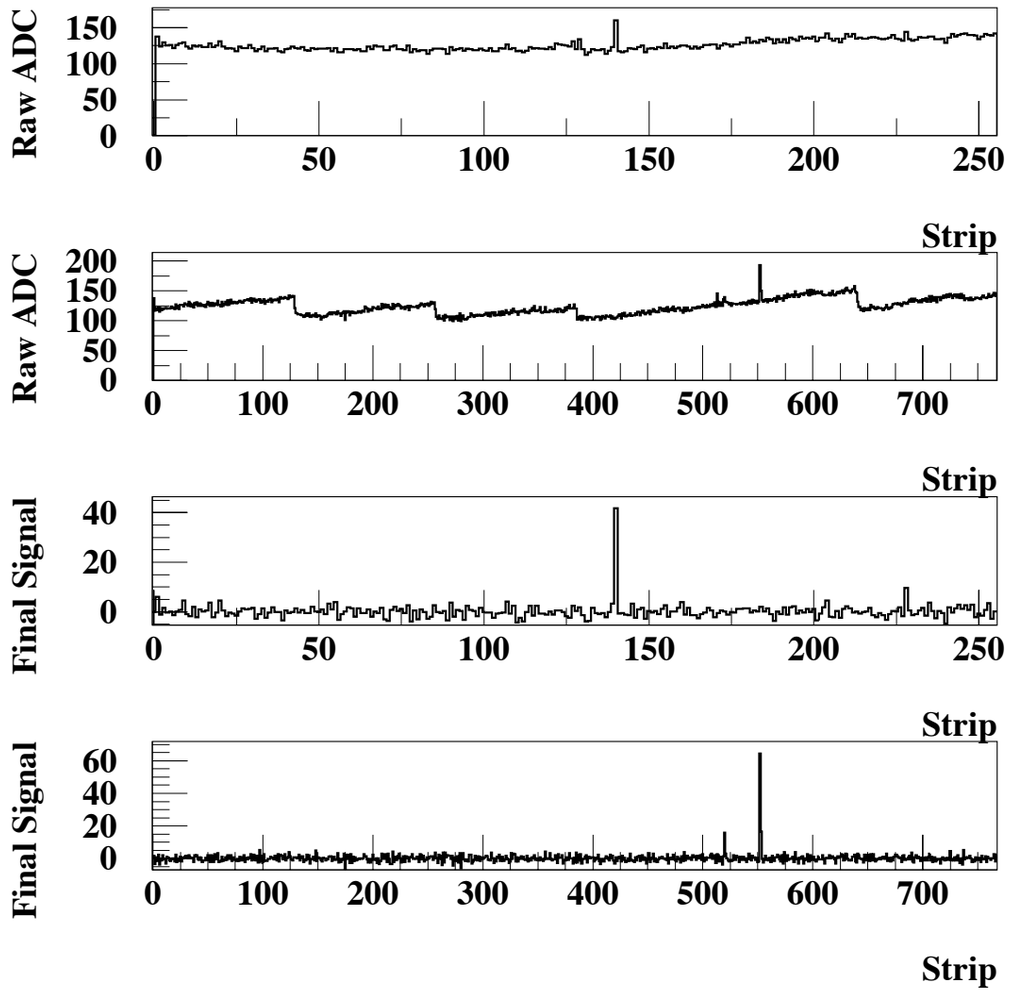
- Procedure as follows (similar to TPOL online):

1. Search for cluster seeds: signal>5*noise and signal>10 ADC counts
2. If clusters are <6 strips apart then merge them
3. Add adjacent ±6 strips to the seed if signal>3*noise and signal>10 ADC counts

- No treatment of dead/hot strips necessary
- Select events with only one cluster for further analysis
  - ➡ Clean cosmic-muon sample

Example events

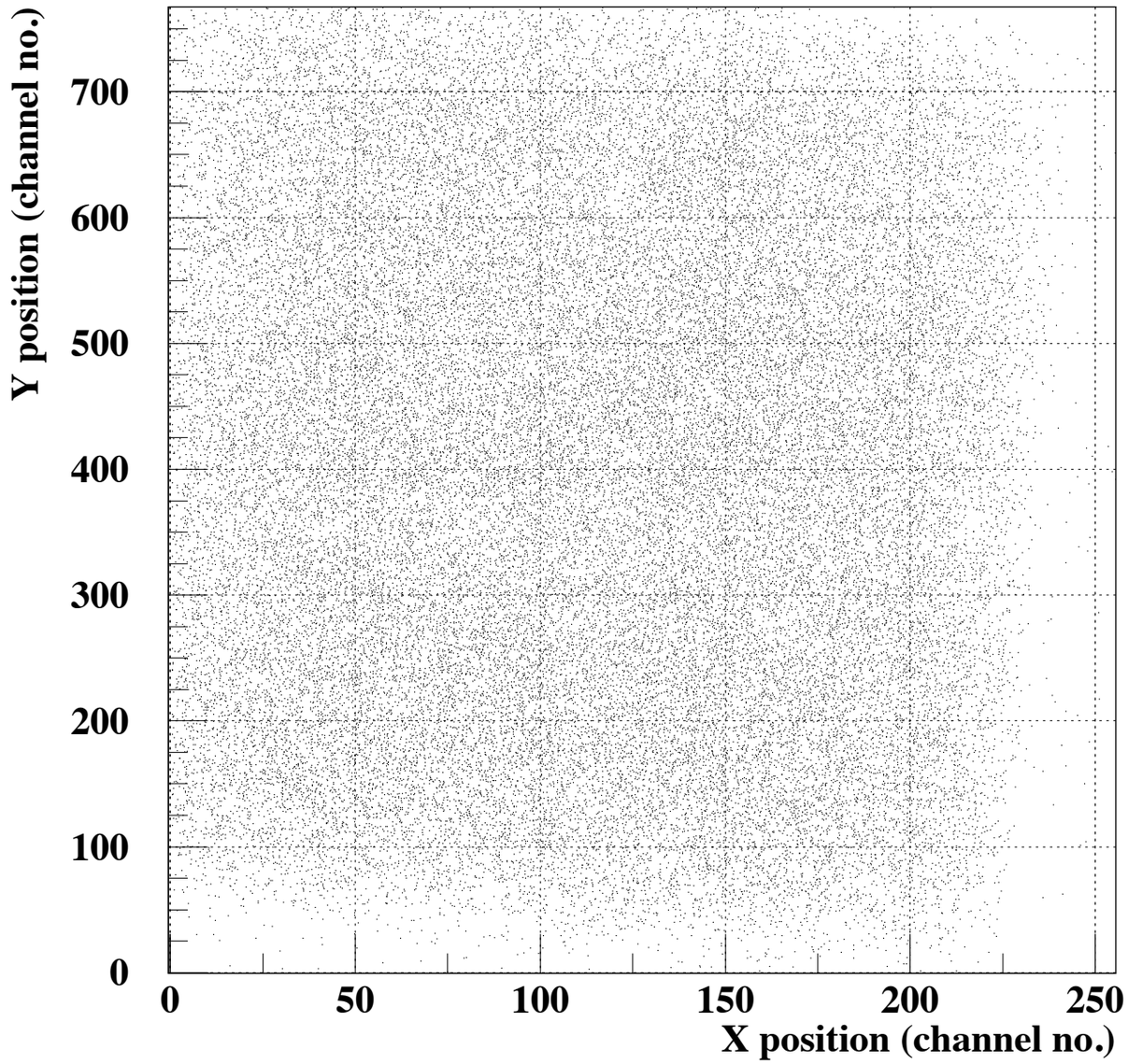




Signal reconstruction all looks okay

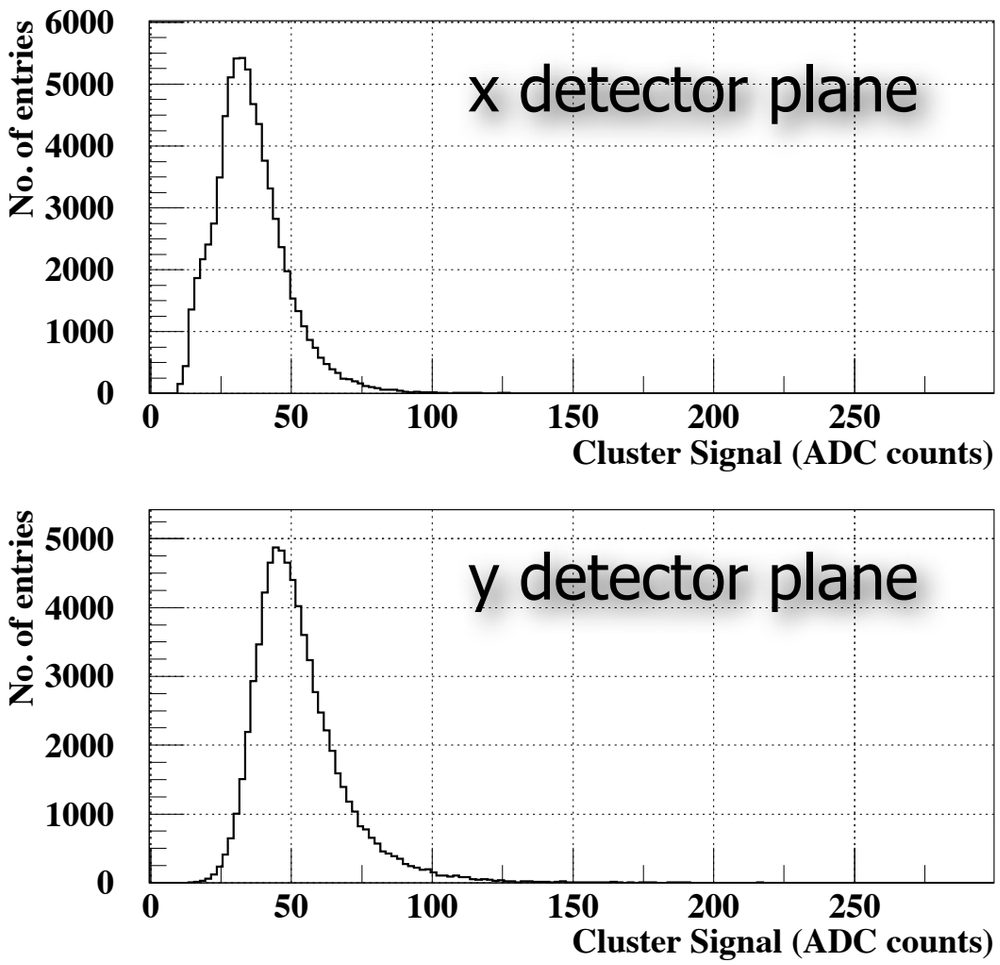
Data analysis

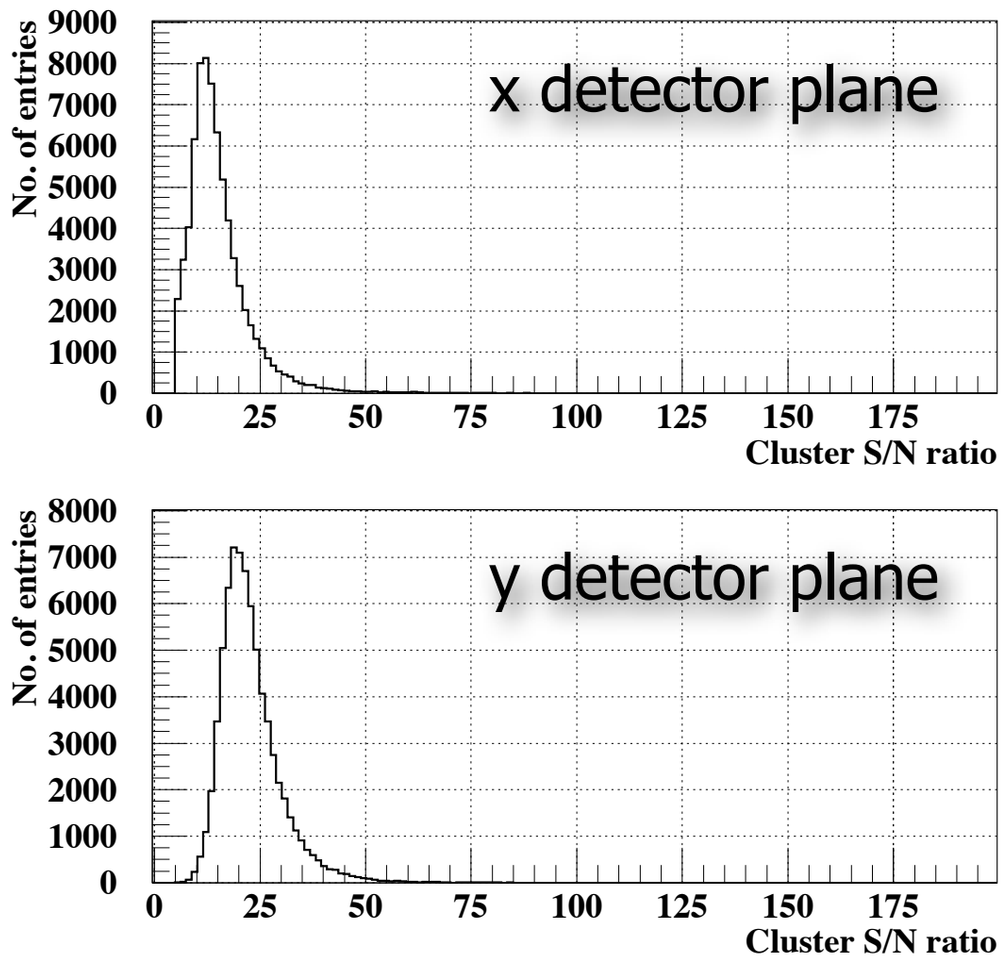
Cluster position shows rotation and size of scintillator



Data analysis

Cluster signal and S/N



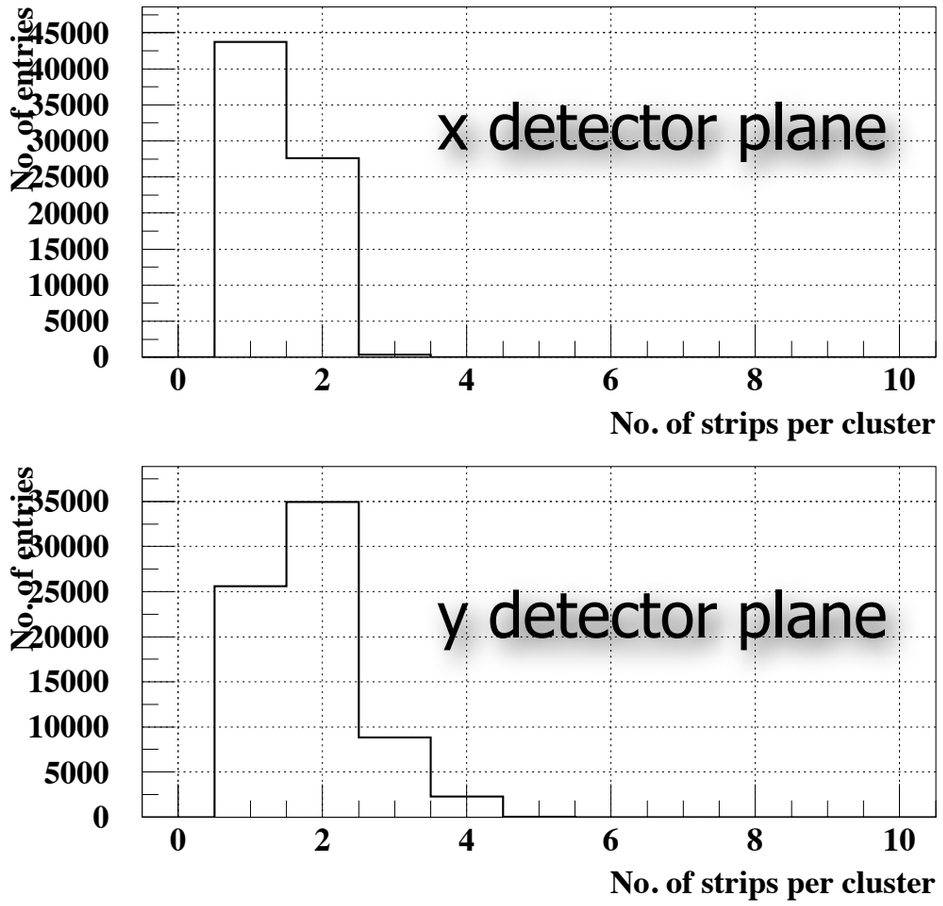


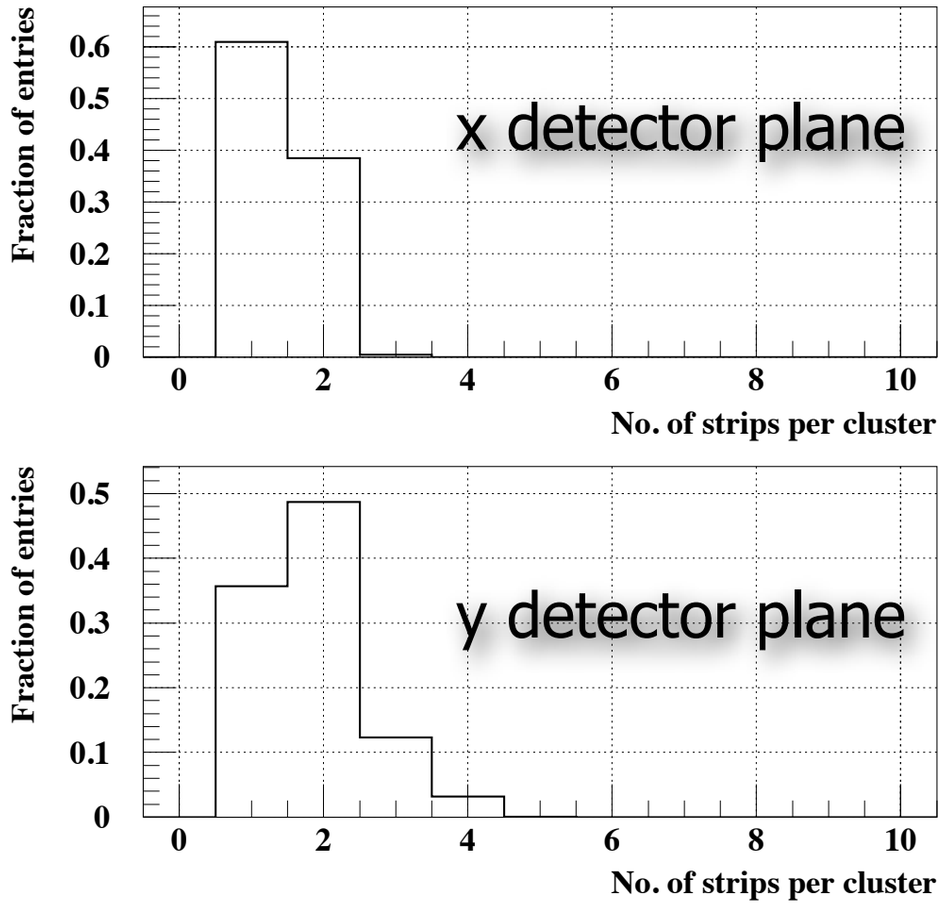
x plane: 32.0 ± 0.1 ADC counts

y plane: 45.5 ± 0.3 ADC counts

Data analysis

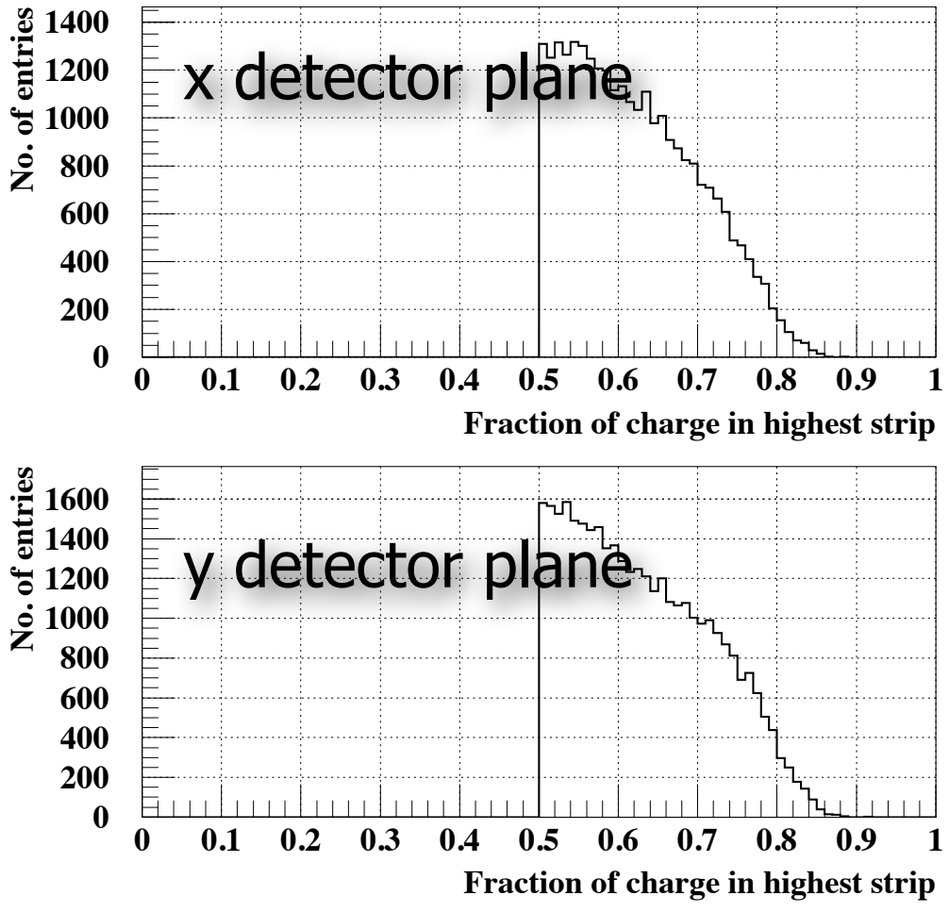
Number of strips per cluster

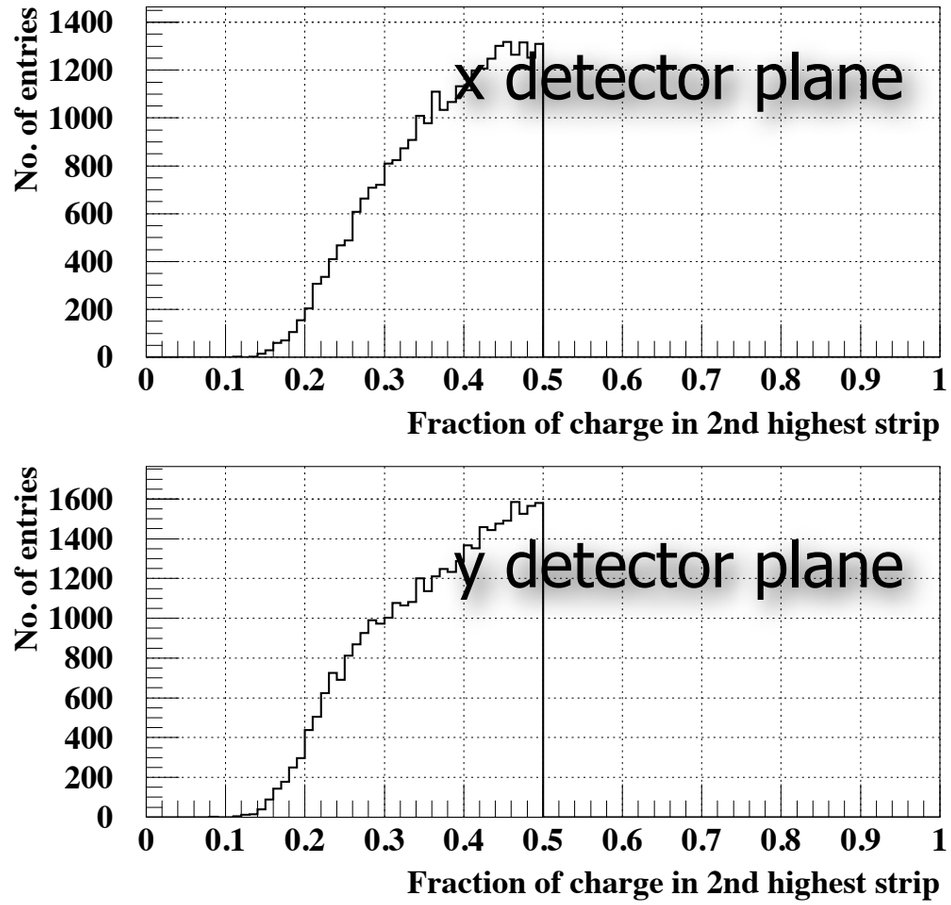




Only n ≤ 3 strips → covers > 95% of clusters

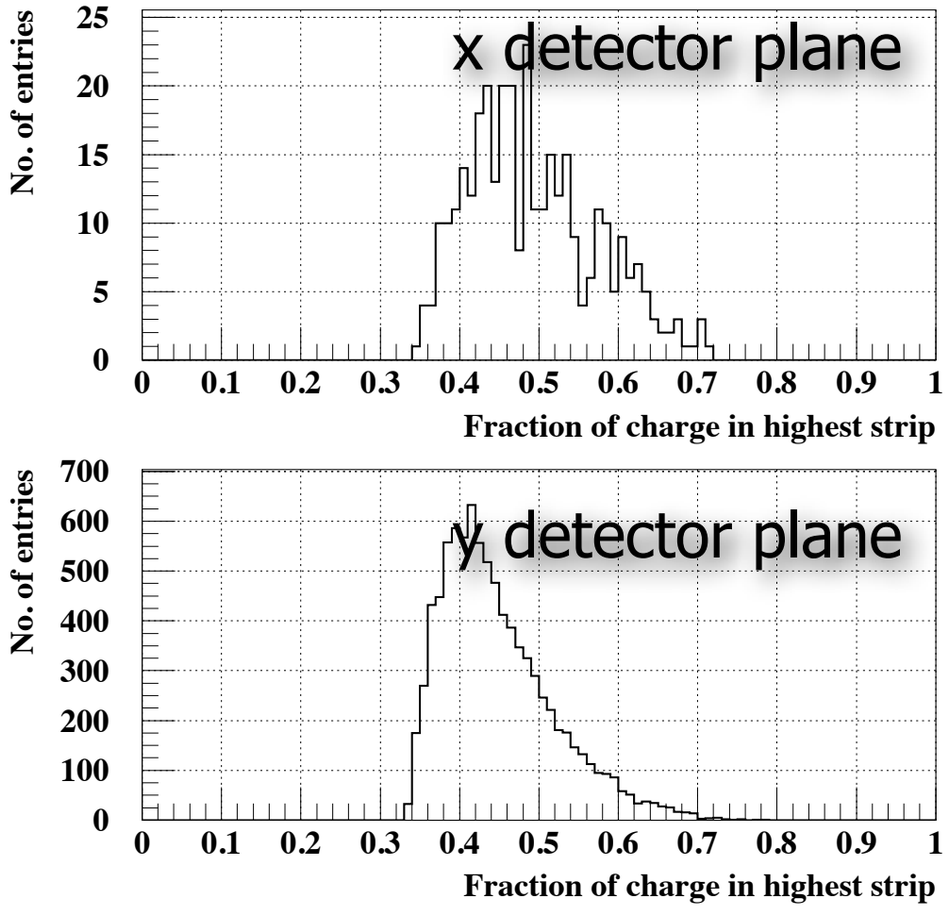
Data analysis

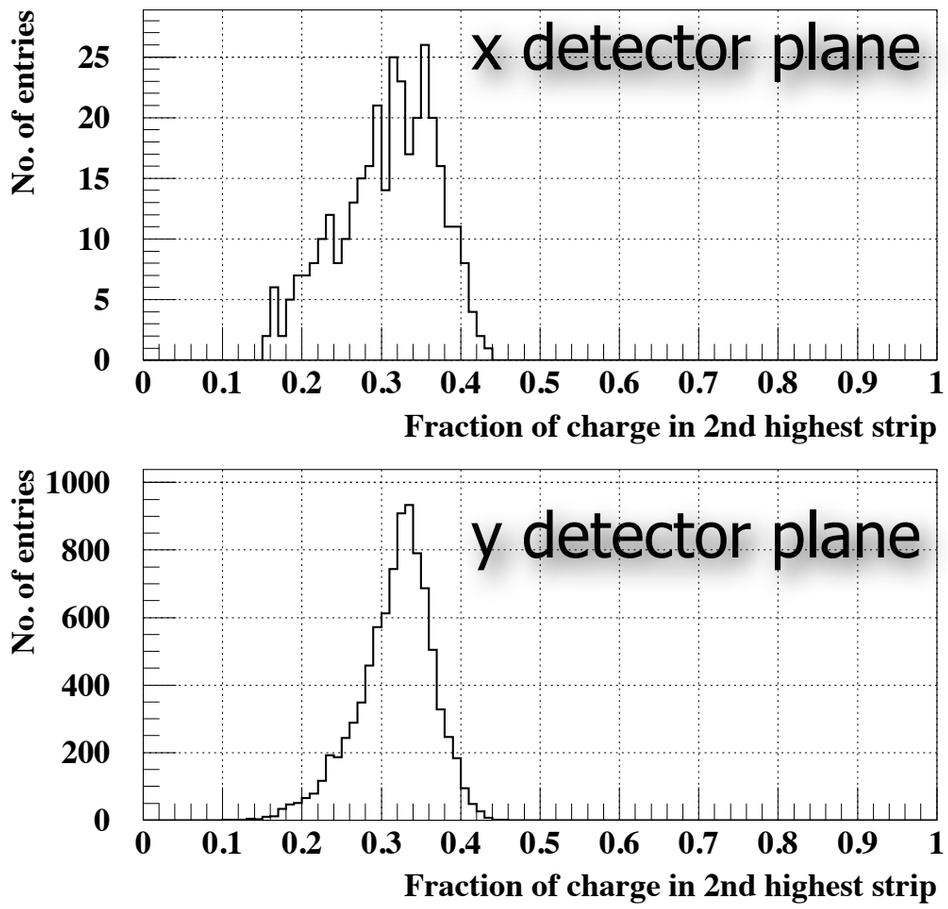




- For 2 strip clusters

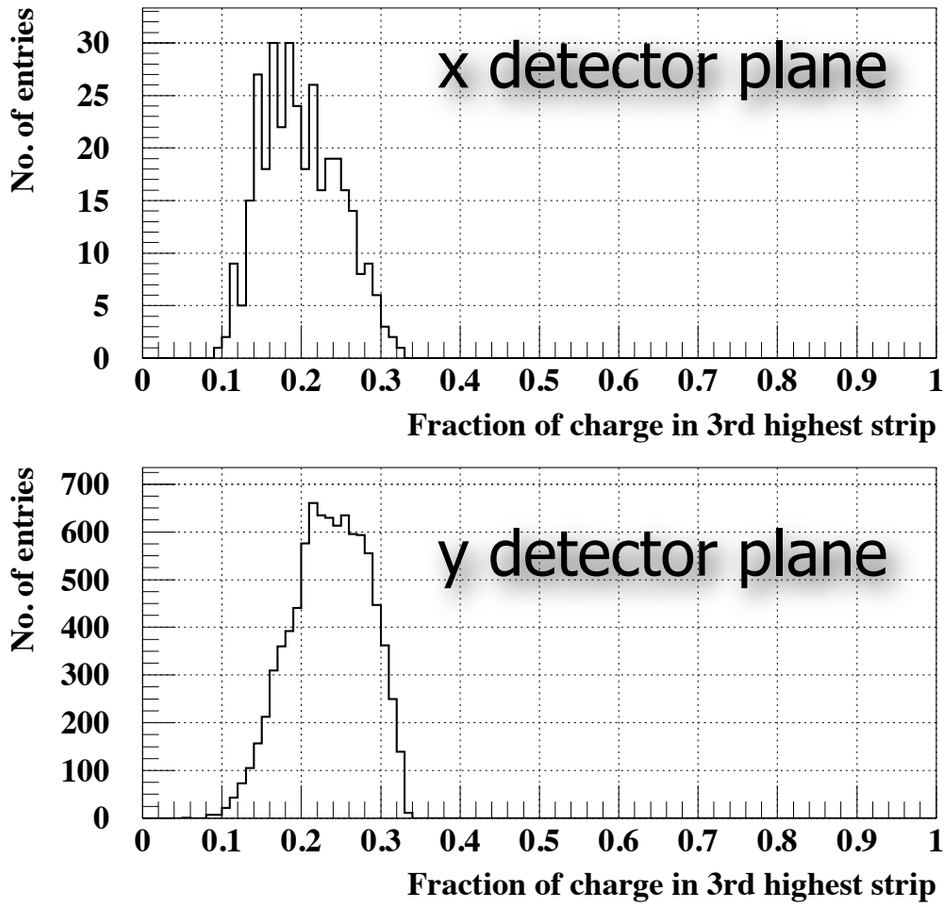
Data analysis





- For 3 strip clusters

Data analysis



- For 3 strip clusters

Data analysis

	Number of strips in cluster					
	x detector			y detector		
	1	2	3	1	2	3
Fraction of clusters	0.61	0.39	0.01	0.36	0.49	0.12
Fraction of charge in highest charge strip	1.0	0.5	0.49	1.0	0.5	0.45
Fraction of charge in 2nd highest charge strip		0.5	0.31		0.5	0.32
Fraction of charge in 3rd highest charge strip			0.20			0.24

Value is approximate peak position

Conclusion

- Analysis of cosmic-ray muon data from TPOL silicon test stand
  - Negligible dead and hot channels

- Detector response uniform to within
  - 10% in centre of detectors (±30 cm)
  - 20% at edges

- MIP signal gives:
  - x plane: 32.0 ± 0.1 ADC counts
  - y plane: 45.5 ± 0.3 ADC counts

- Charge sharing characterised for single-cluster cosmic muons
  - histograms at http://www.hep.ph.imperial.ac.uk/~tapper/tpol.html