Reconstruction and Systematics of Resolution Measurements

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ILC TPC Analysis Jamboree

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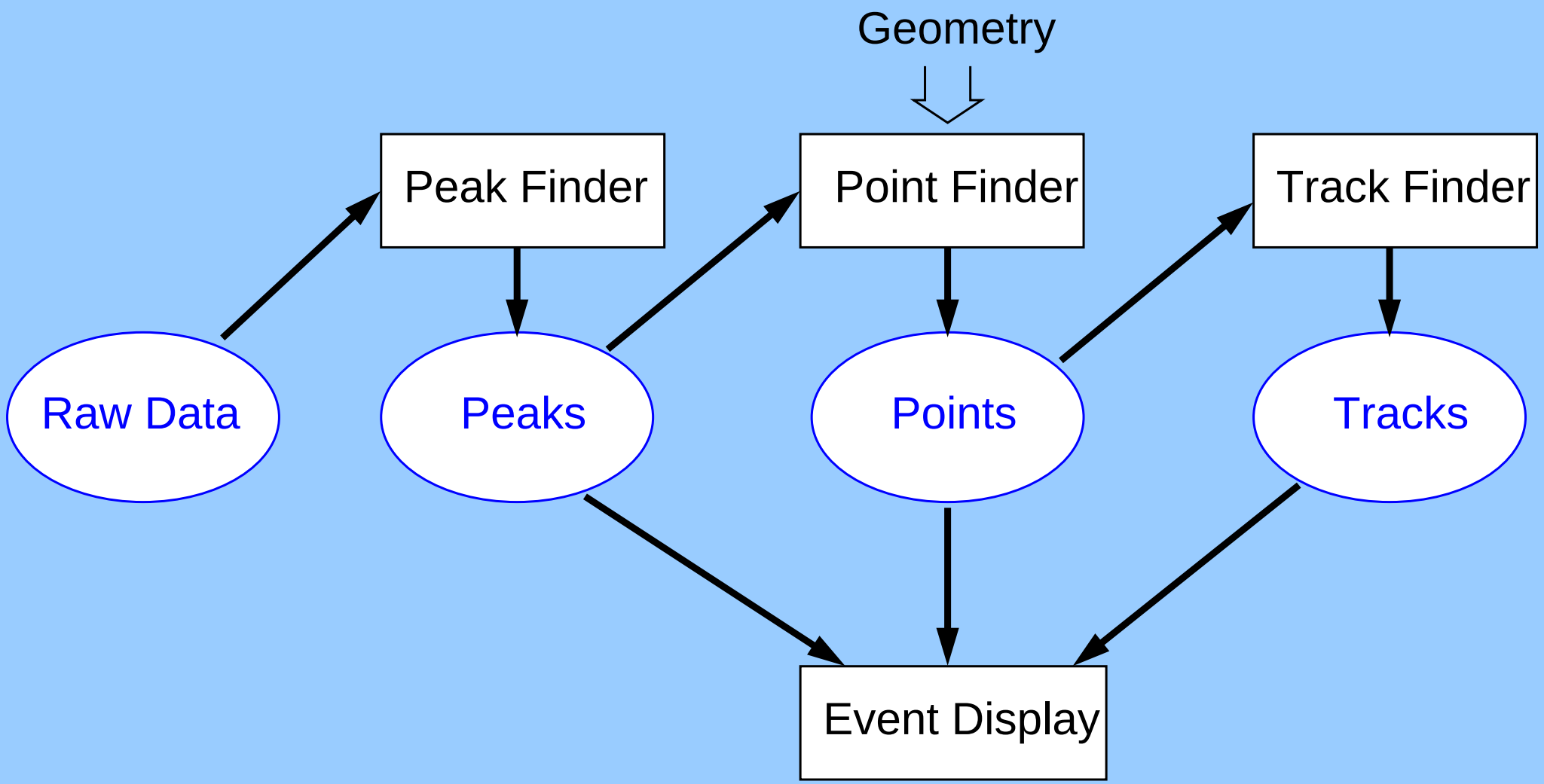
Worldwide Study of the Physics and Detectors for Future Linear e^+e^- Colliders

bmb+f Großgeräte der physikalischen Grundlagenforschung

Overview


Geometry
Peak Finder
Point Finder
Track Finder
Raw Data
Peaks
Points
Tracks
Event Display

Data Structure (1)

Peaks:

int ChannelNr

int SumQ [ADC counts]

int MaxQ [ADC counts]

float AvTime [time samples]

int PeakWidth [time samples]

Similar to LCIO::TrackerPulse

Points:

float X [mm]

float Y [mm]

float Z [mm or μs]

int Q [ADC counts]

float SigmaX (RMS or σ)

float SigmaZ (RMS)

int NPads

Similar to LCIO::TrackerHit

Converters to LCIO exist!

Data Structure (2)

Tracks:

float a, b, c, d

int NTrackPoints

float SigmaX

float SigmaZ

array of points in track

Straight line defined by 4 parameters a, b, c, and d (slope and offset in xy and zy projections):

$$x = a \cdot y + b$$

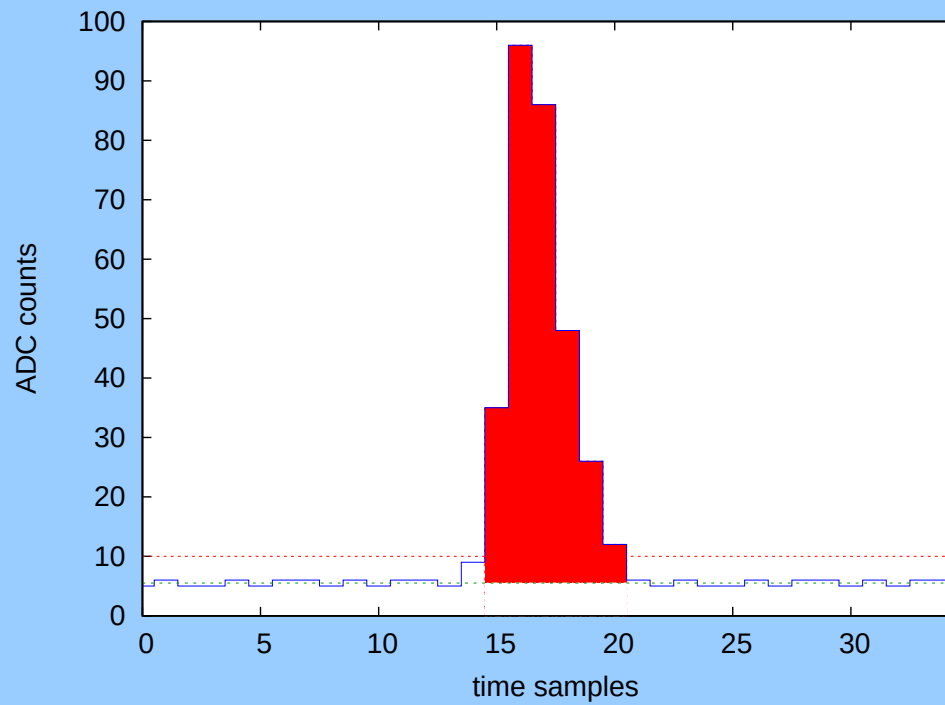
$$z = c \cdot y + d$$

Peak Finder

Find peaks in raw data:

- When signal goes above threshold peak begins
- When signal falls below threshold peak has ended
- Mean Z is center of gravity
- Threshold at 5 σ of pedestal noise
- No pre or post samples

Available as MARLIN processor!



Point Finder

Calculate 3D points from the peaks:

- All signals on neighbouring pads at the same time coordinate ($\pm$ mean peak width) are grouped to a cluster.
- Center of gravity or Gauss fit in X
- Y is center of the row
- Center of gravity in Z
- 1 empty pad allowed

Track Finder

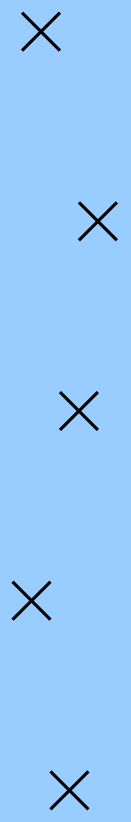
Calculate straight track using linear regression.

Mixture of track road and track following method:

- Use first and last point as seed
- Add points along track and redo regression after each added point
- One missing point allowed
- Minimum 5 points on track

+ simple
+ can handle multiple tracks
– slow with many points and/or tracks

Track following method:



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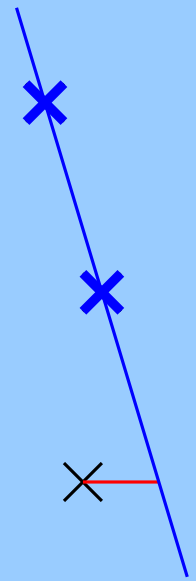

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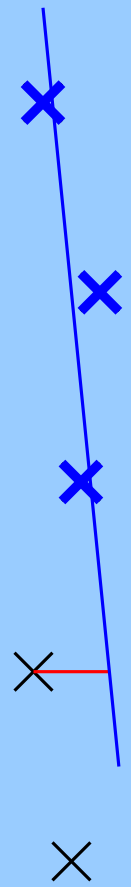

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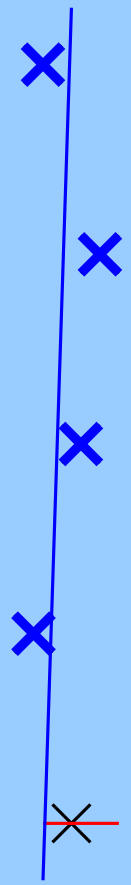

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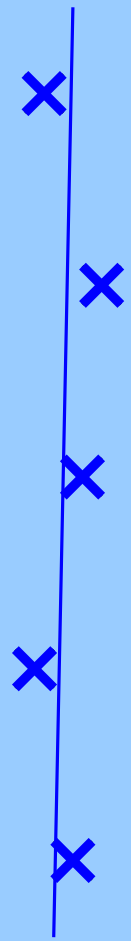

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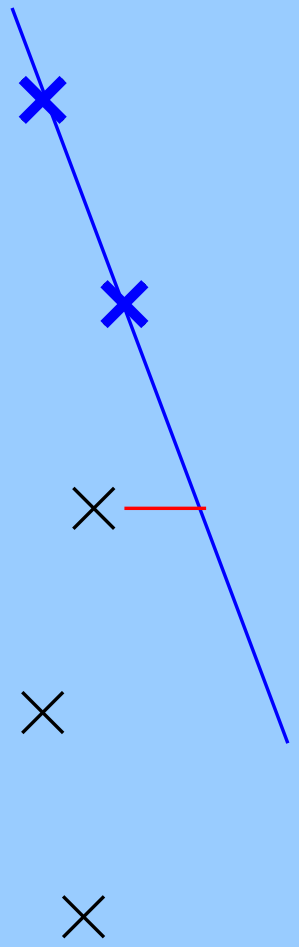

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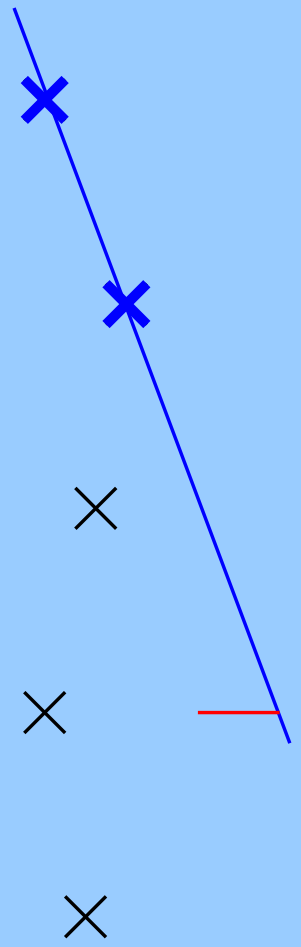

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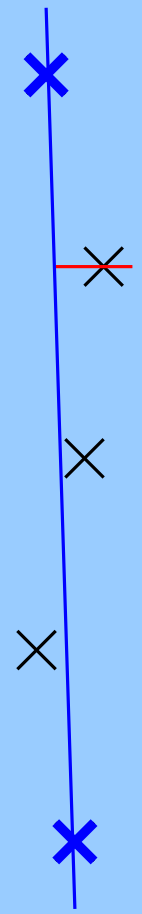
Our algorithm



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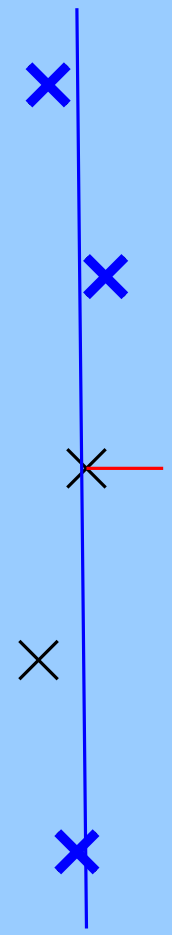

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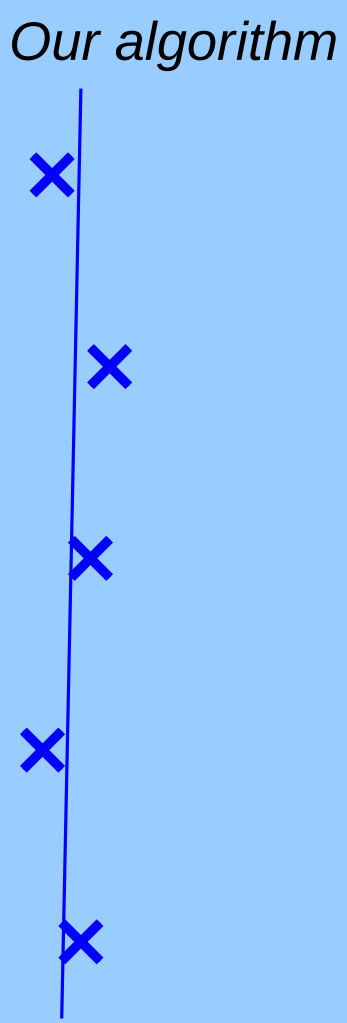

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Resolution of TPC

$$\sigma_X = \sqrt{\frac{\sum \Delta X_i^2}{n-2}} \qquad \sigma_Z = \sqrt{\frac{\sum \Delta Z_i^2}{n-2}}$$

ΔX_i is distance from measured point to reconstructed track:

$$\Delta X_i = X_i - (a \cdot Y_i + b)$$

Resolution with hodoscope:

ΔX_i is distance from measured point in TPC to track in hodoscope:

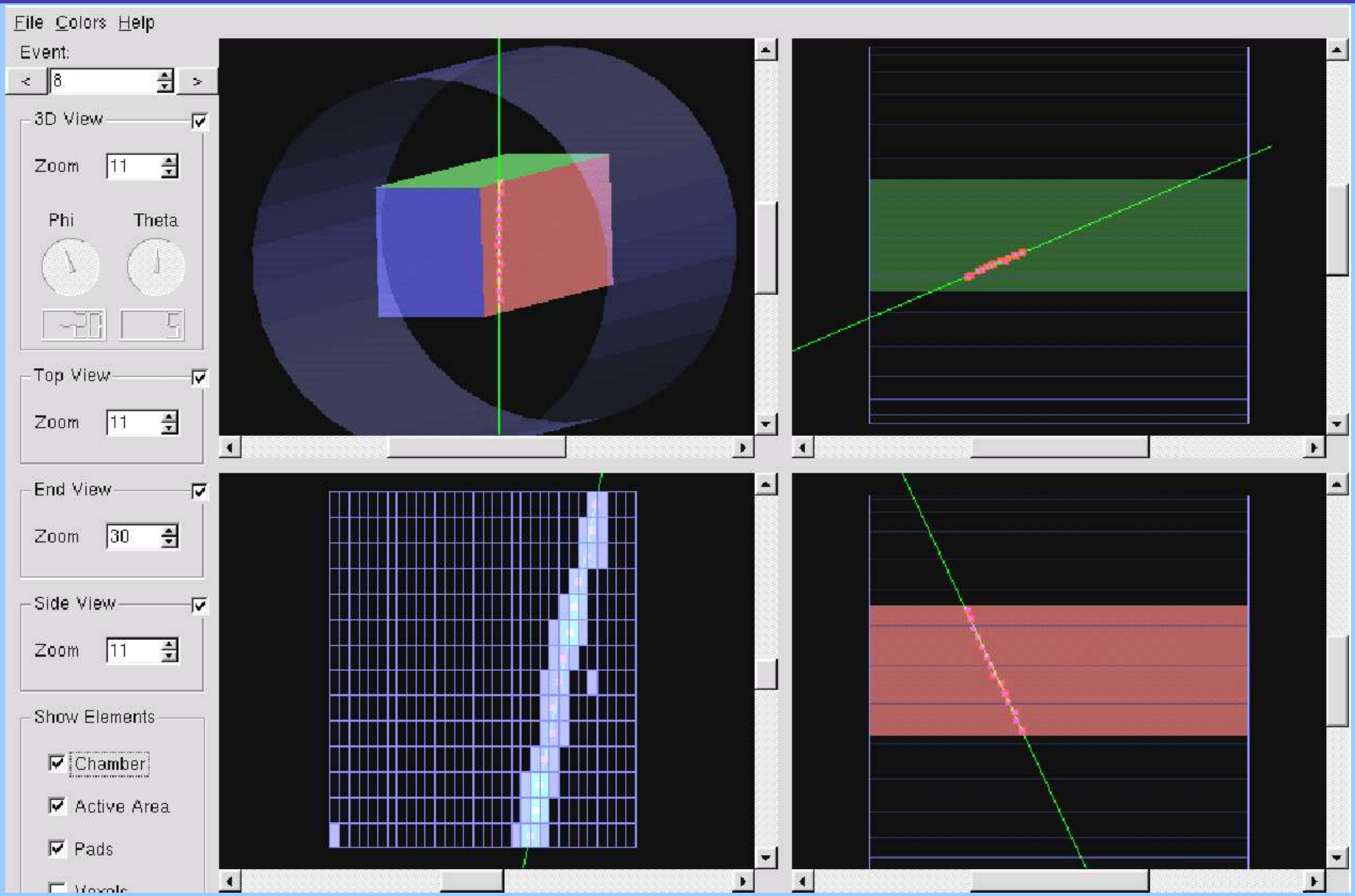
$$\begin{aligned} \Delta X_i &= X_i - X_{hod}(Y_i) \\ &= X_i - (a_{hod} \cdot Y_i + b_{hod}) \end{aligned}$$

- Fill all ΔX_i into histogram
- Resolution is RMS of histogram

Fitting a Gaussian to center of the peak gives “better” resolution, but does not take tracks in tails into account.

But these tracks are there!

Event Display



Analyse Test Beam Data

Resolution in dependence on:

- Gas mixture (TDR, Ar/CH_4 95/5 and 90/10, Ar/CO_2 98/2)
- Angle (0 to 4 degrees)
- Drift distance (0 to 26 cm)
- Particle energy (1 to 6 GeV positrons)
- Magnetic fi eld (4 T, TDR gas only)

No results yet!

Summary

Module	Properties	LCIO/MARLIN
Peak Finder	CoG	Yes
Point Finder	CoG or Gauss fi t	No
Track Finder	Straight line only Linear regression	Yes
Event Display	3D + projections • Pads • Points • Tracks	No