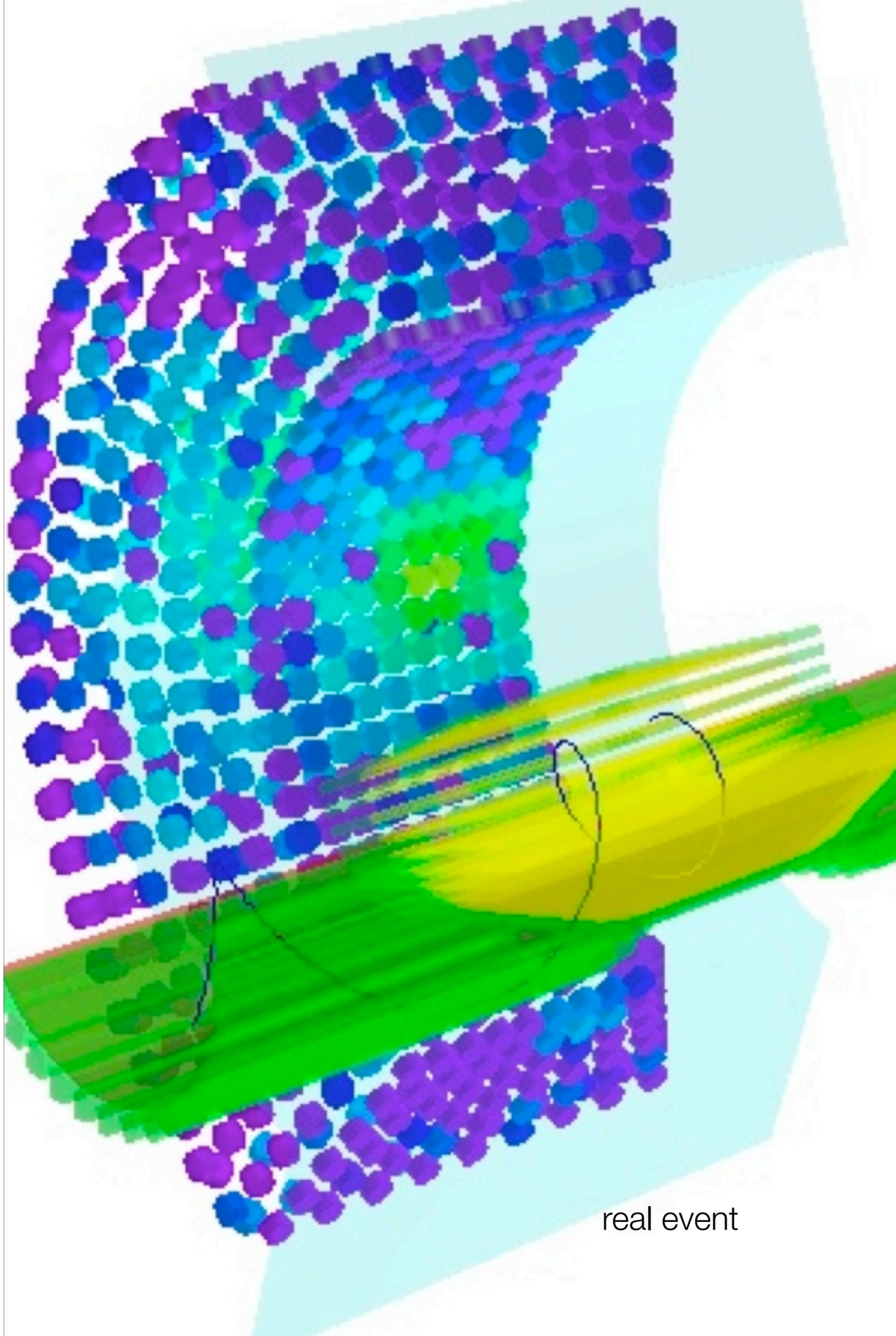
Drift Chamber Analysis - RUN2007

Drift Chamber Group

CONTENTS

- General Remarks
- Hit Reconstruction
- Calibration
  - z / time / x-t
- Tracking
  - Track finding / Track fitting
- Michel Spectrum



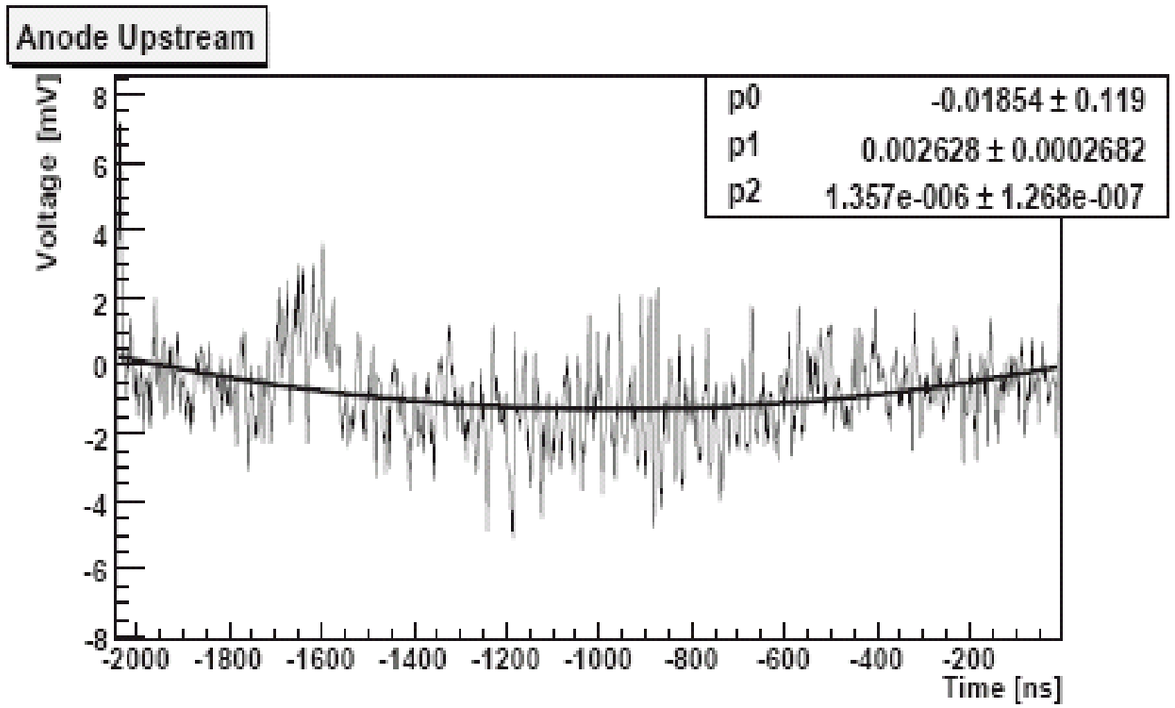
DC Software Development

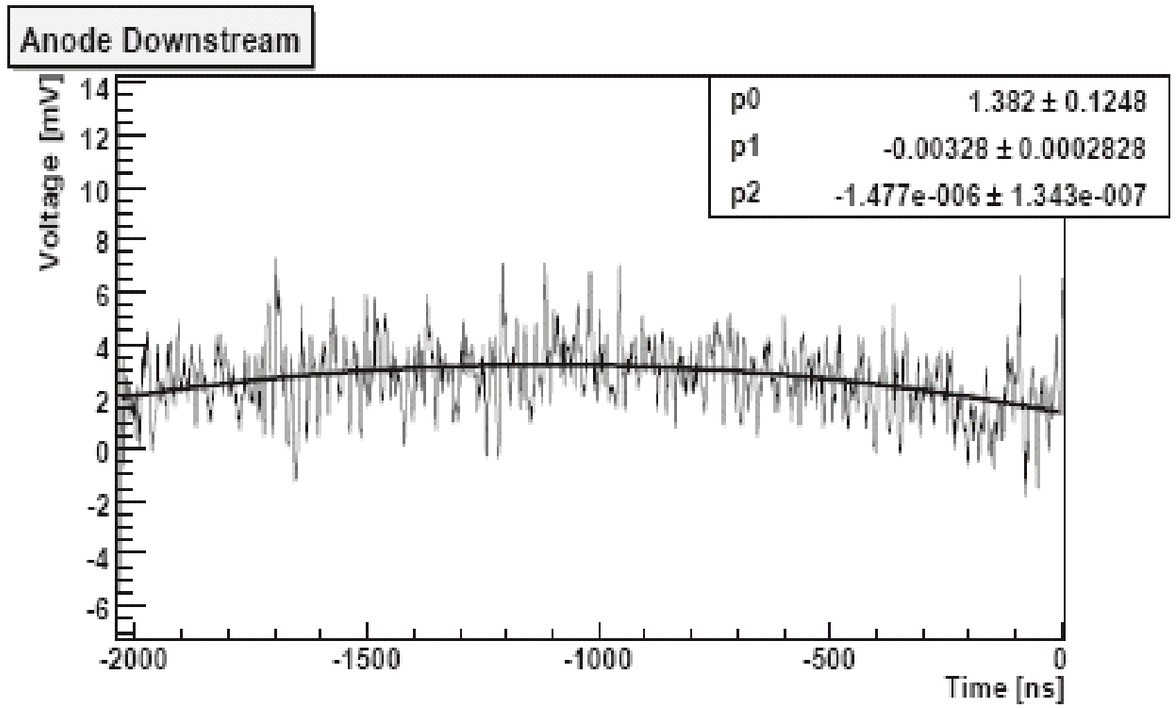
- Multi-stage analysis with two largely independent codes at each stage
  - Roughly equivalent output of each stage – not quite plug compatible
  - Maintaining two code developments has proved valuable
    - Weaknesses in one or the other strategy have been found and improved
    - Very different initial strategies have come closer together
- Calibration of DRS (hardware)
  - Time and charge calibration common to two analyses
  - Shortcomings have been found in current calibration – improved calibration technique (special purpose data) being developed now for next run
- Calibrations in software
  - Z determination – slight differences in principle, poor correlation in some measured parameters (relative gains at two ends of wires), calibration and analysis are strongly correlated.
  - Wire t0 – implemented differently, not yet using timing counter to set event t0
  - Absolute charge – not implemented in either

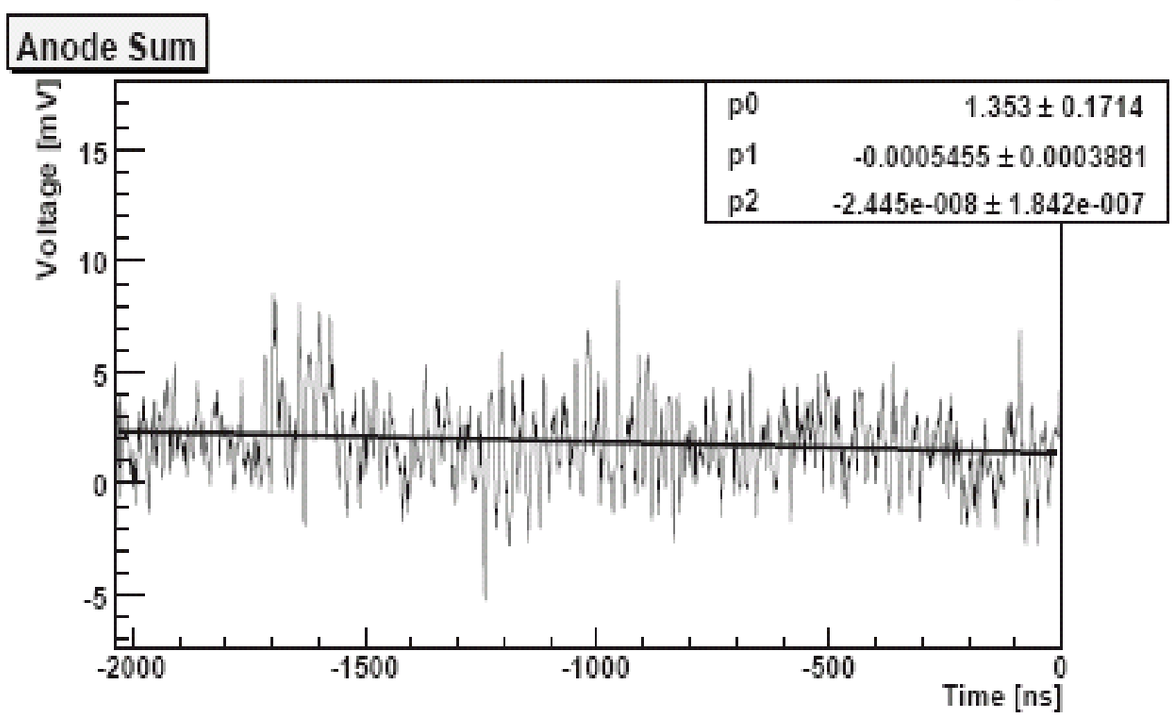
- Hit finding – differences in details, most not tested for relative performance
  - Differences in how baseline (pedestal) is determined
  - Differences in hit time and charge determination algorithm
- Cluster finding – cluster is set of hits in one chamber from one track
  - Similar algorithms, some differences in definition of cluster
  - Handling of pad cycle determination in special cases different
- Track finding – very different initial algorithms have converged, but still significant differences
  - Minimal set of starting clusters (track seed) different
  - Technique for extending track different
  - Handling of hits with ambiguous Z coordinates different
- Track fitting – currently identical Kalman filter code accepts either trackfinder as input
- Calibration data base – some shared, some independent
- Performance measures
  - Reconstruction efficiency – now at the level of scanning to find ways to improve efficiency
  - Resolutions: low level analysis and calibrations not full optimized for resolution, only preliminary results
  - Rate dependence of performance not yet studied

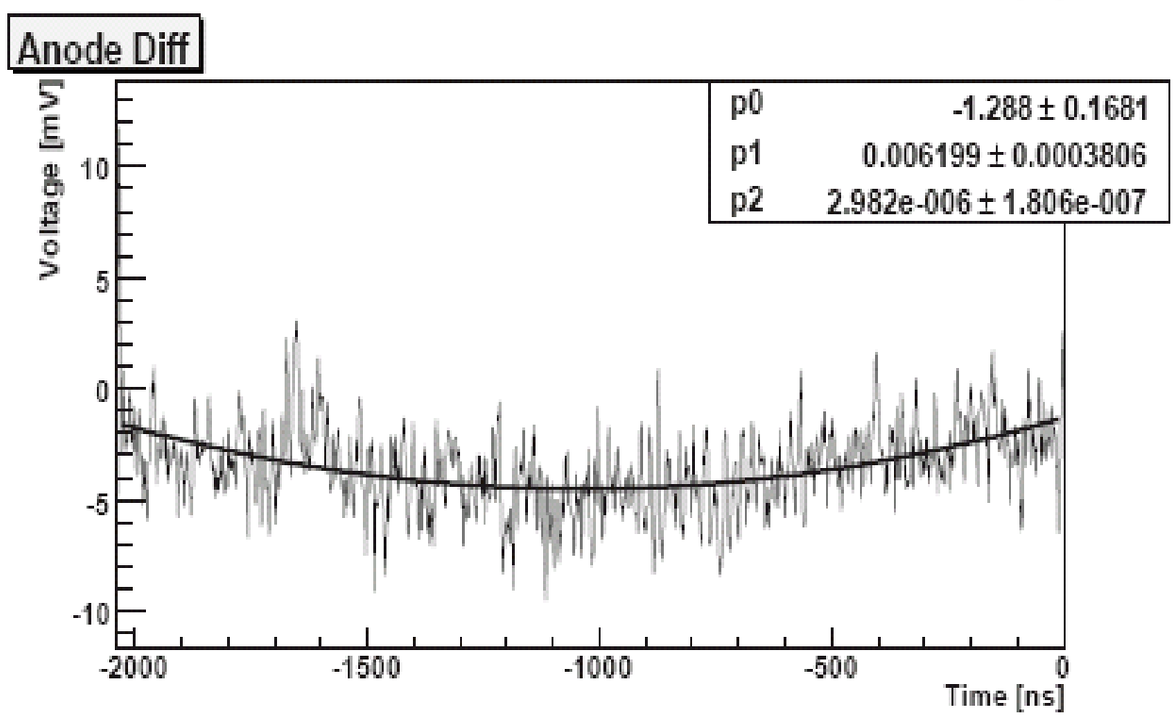
Hit Reconstruction

Low frequency noise; DRS timing calibration; etc



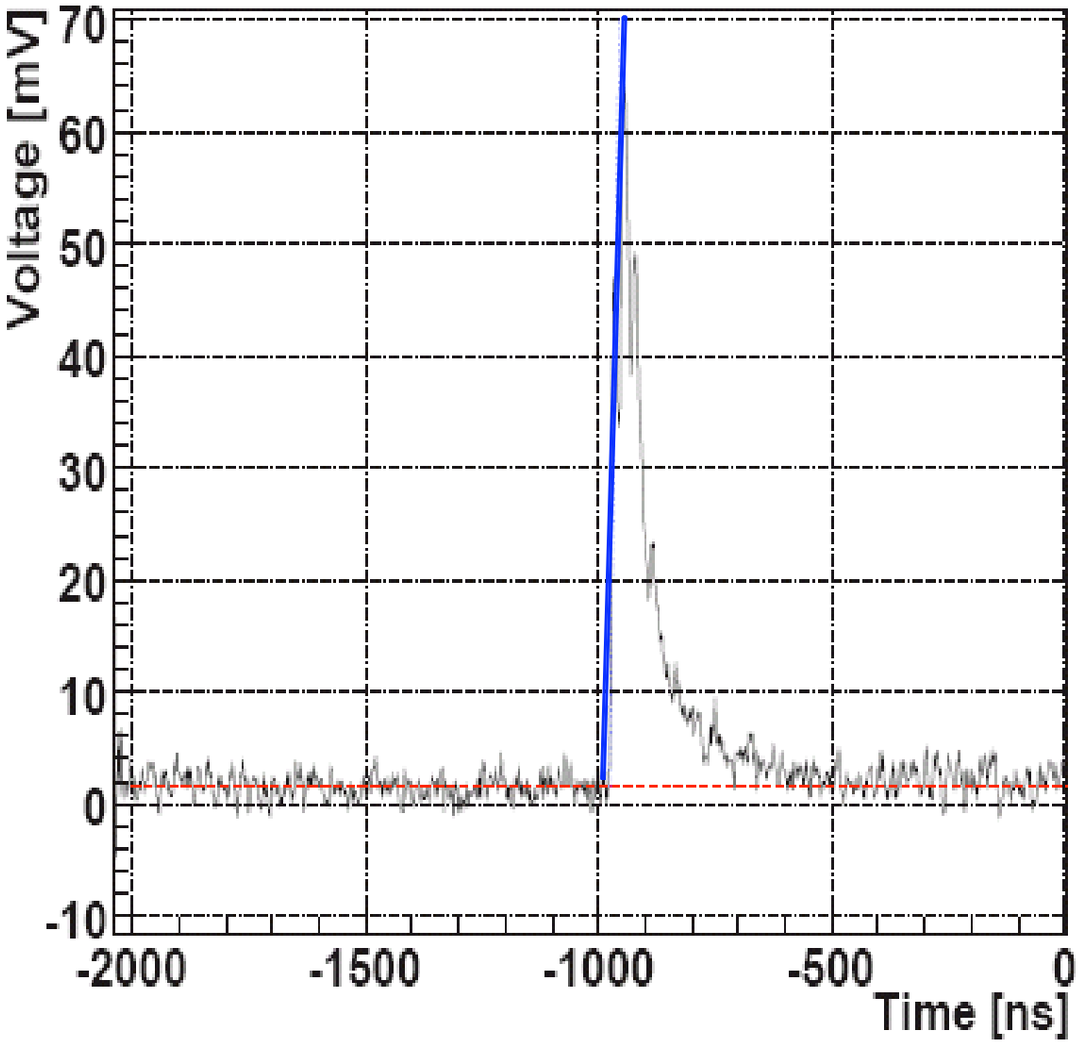


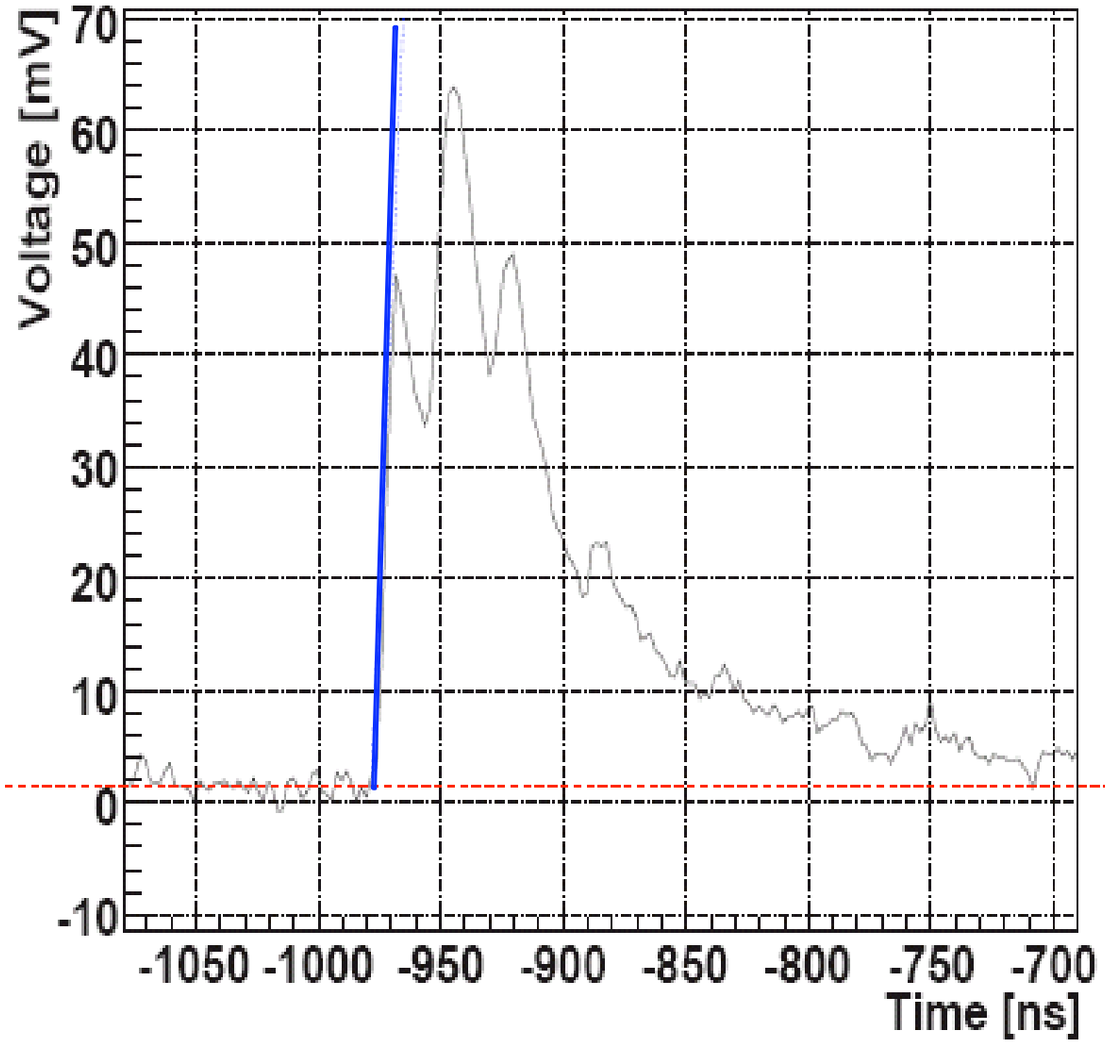




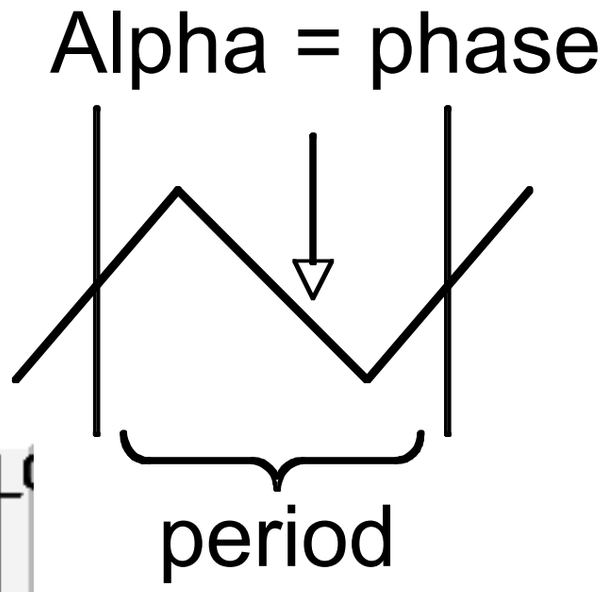
Hit Reconstruction II

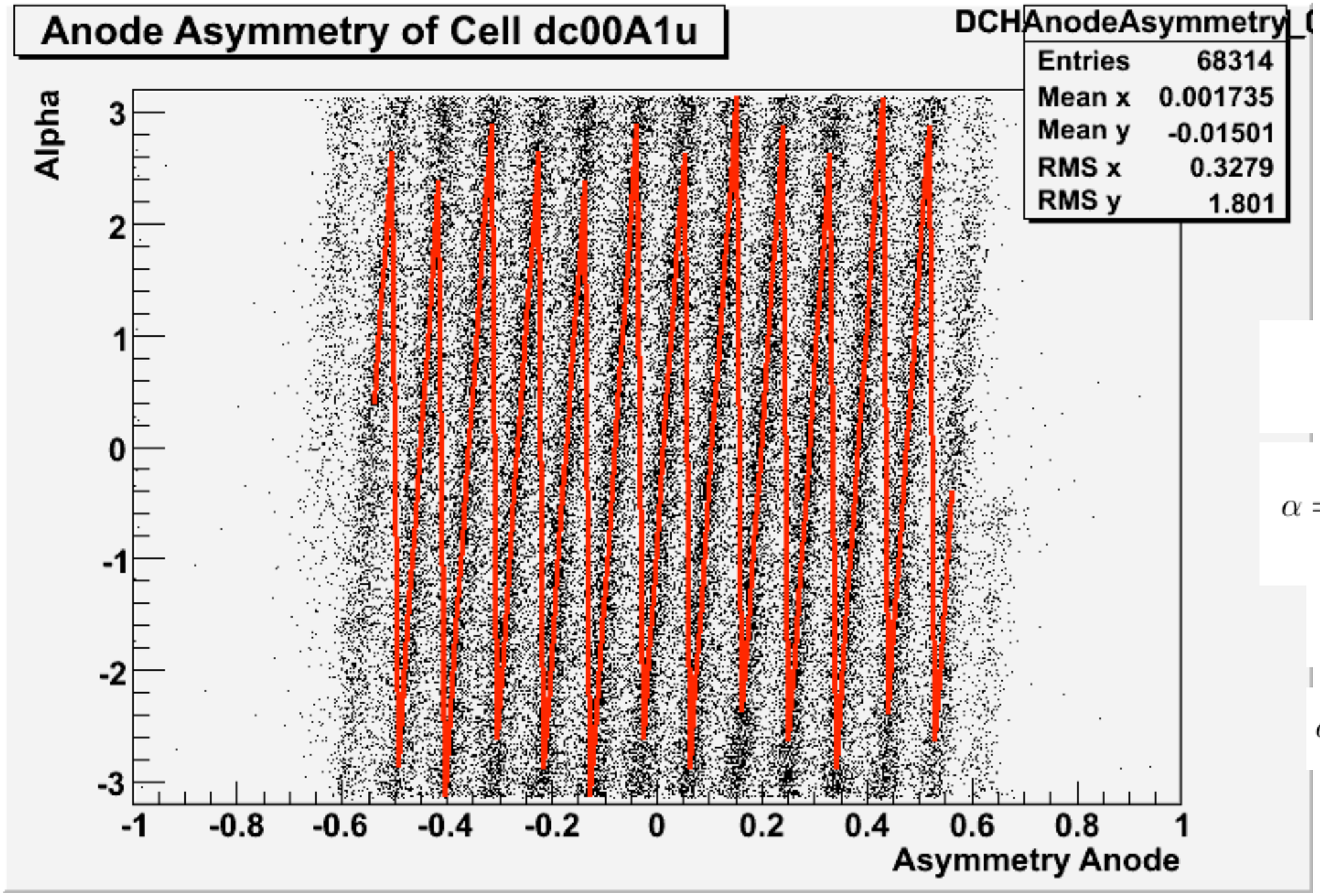
- Baseline : Maximum of the amplitude distribution of points out of the peak region
- T0 : Leading edge fit including different numbers of points on the leading edge
- Charge : Integration with a fixed integration length (50-75nsec)





- All calibrations are done with Michel data
- Fitting "α vs. anode asymmetry" with a polynomial function
- Periods of α give a length scale to anode asymmetry
- Offset at the wire center (α=-π/4) indicates relative gain difference





$$asymA = \frac{Q_d - Q_u}{Q_d + Q_u}$$

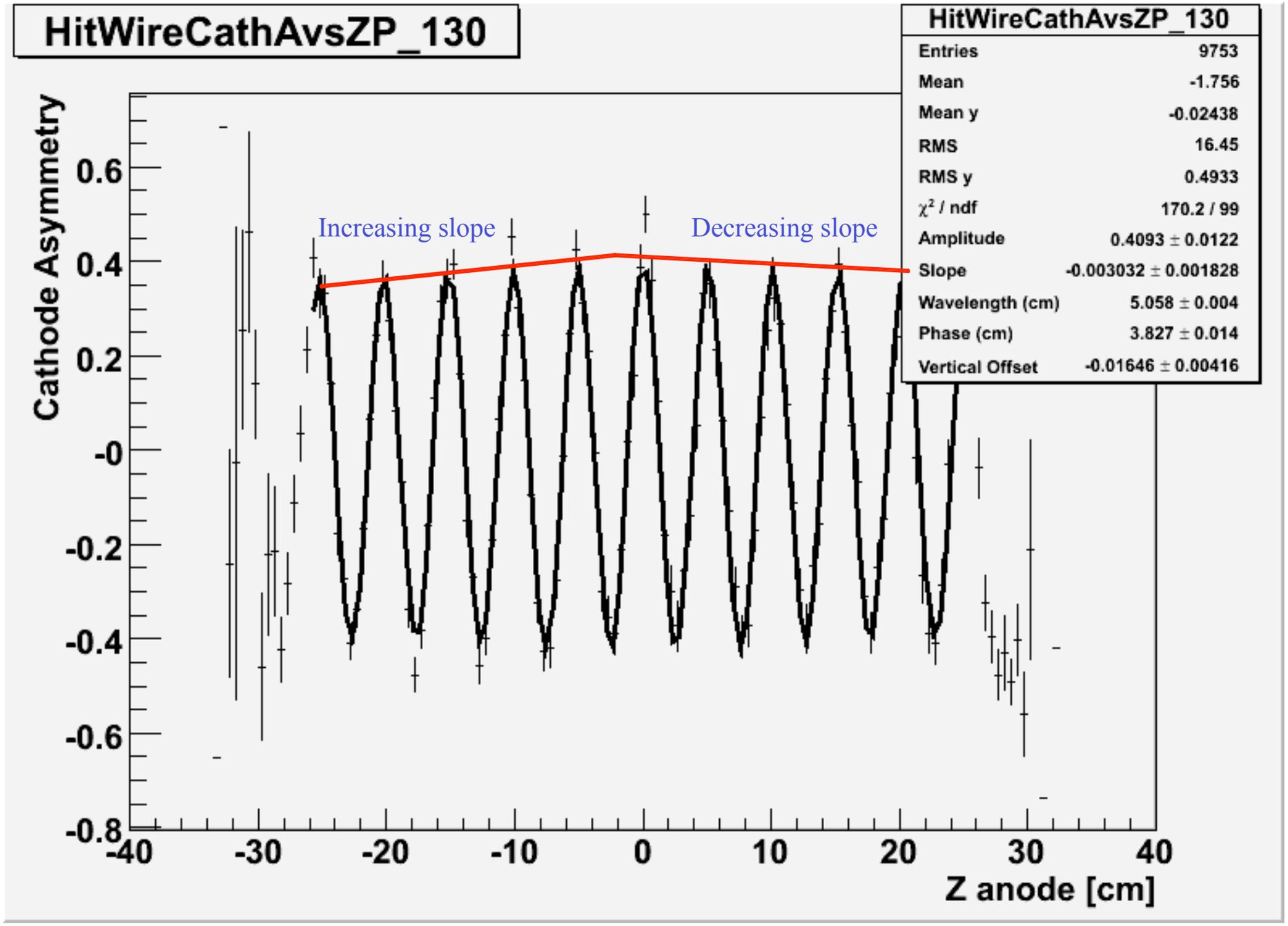
$$\alpha = arctan\left(\frac{cathAsym0}{cathAsym1}\right)$$

$$cathAsym0 = \frac{Q_{uh}-Q_{dh}}{Q_{uh}+Q_{dh}}$$

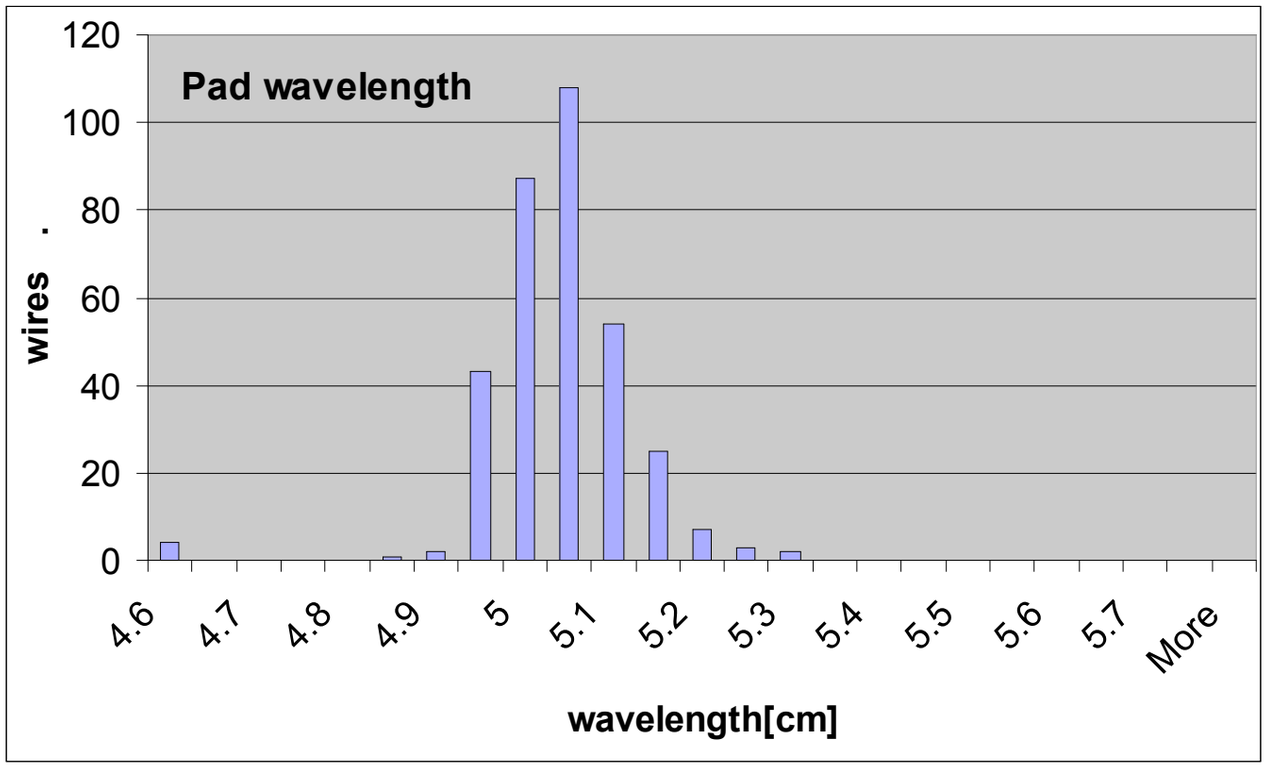
$$cathAsym1 = \frac{Q_{uc}-Q_{dc}}{Q_{uc}+Q_{dc}}$$

A Sinusoidal Fitting Function

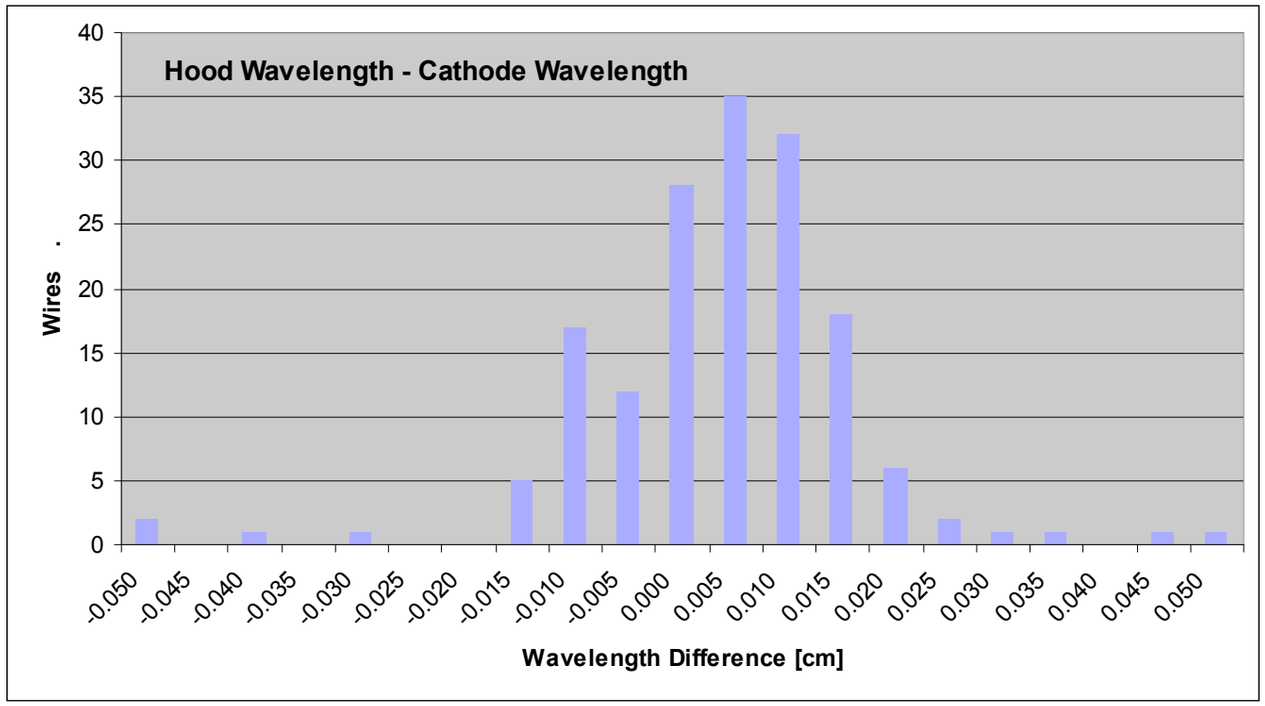
A cathode (hood) asymmetry was fit for each wire:
Asym(z) = A*(1 + slope * z) * sin[2pi / wavelength*(z - phase)] +offset



- Cathode & Hood Wavelength:
  - mean = 5.016 cm
  - σ = 0.059cm

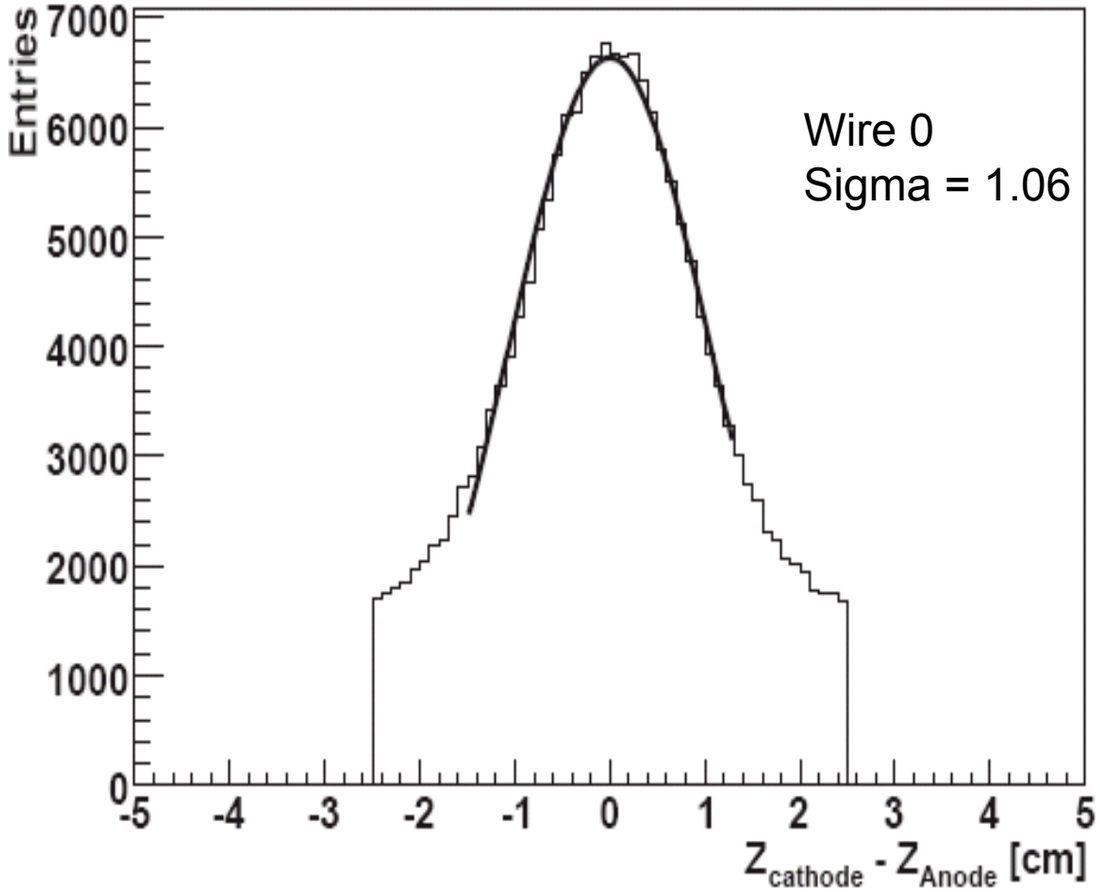


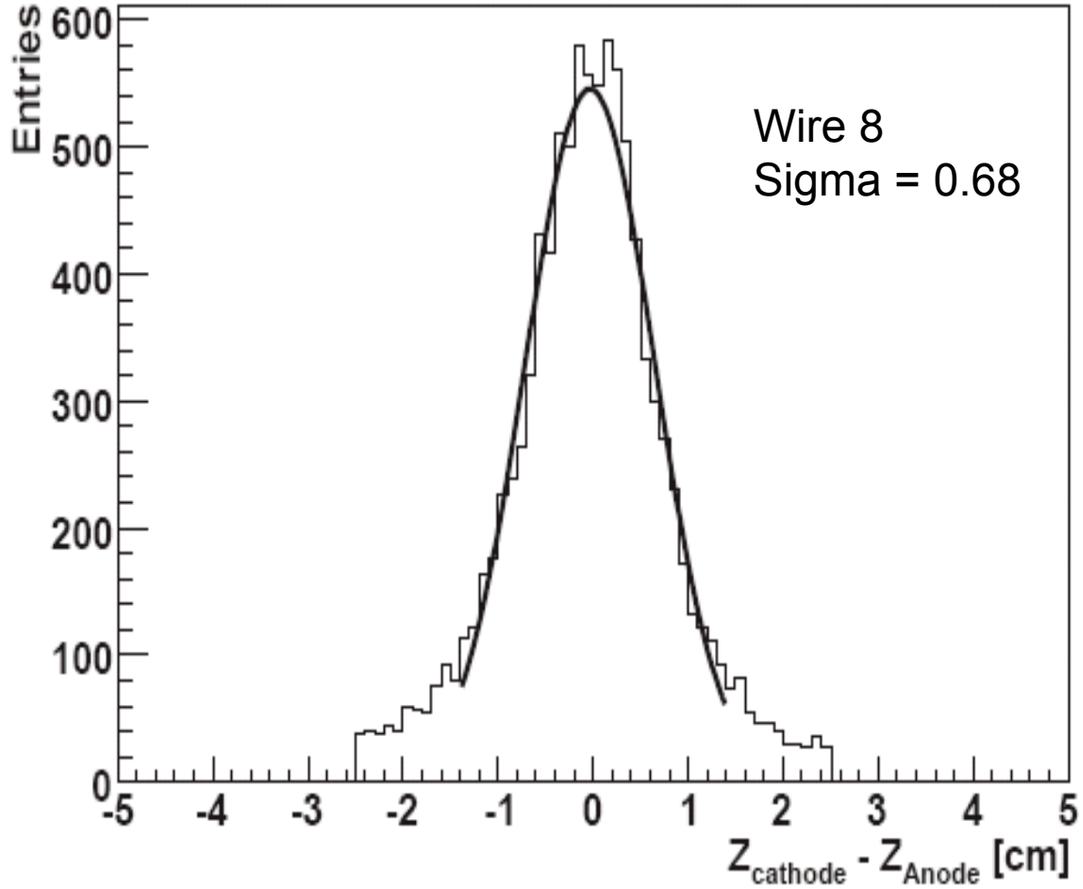
- Hood - Cathode difference:
  - mean difference = 0.005 cm
  - σ = 0.029cm



Anode Z resolution

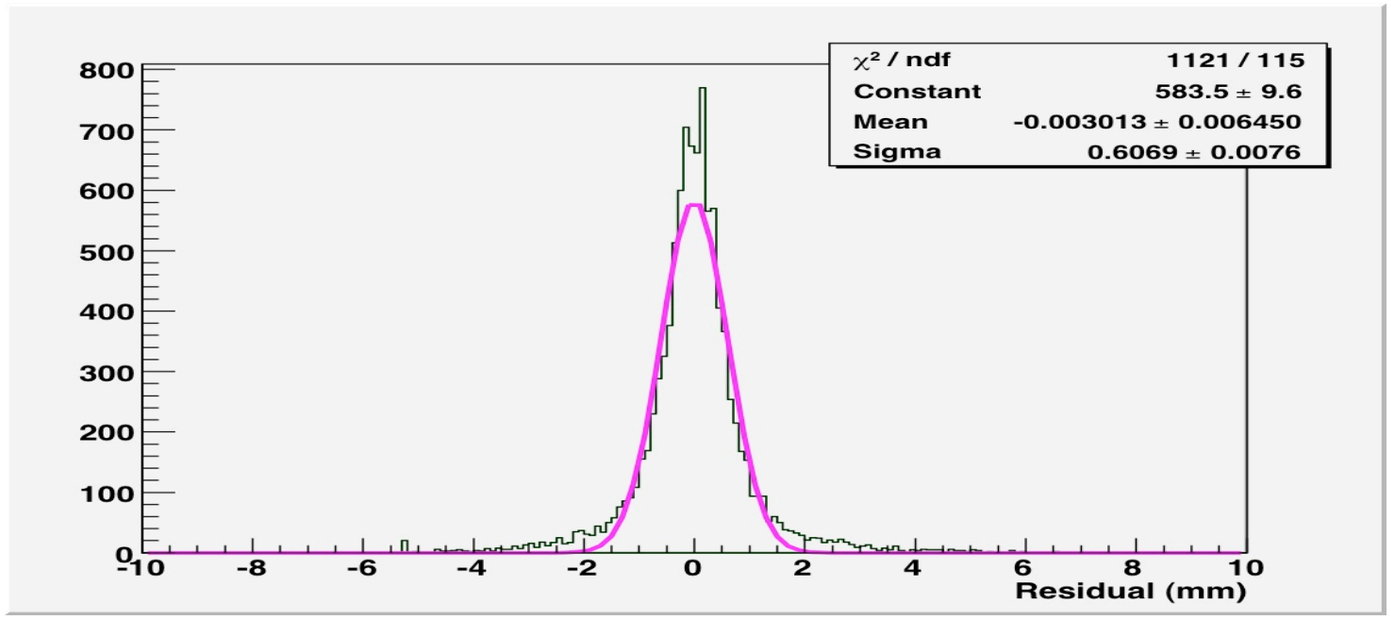
- All wires < 1.06cm
- Only 1% of the hits are in the wrong period.
- On the anode we achieve the designed resolution

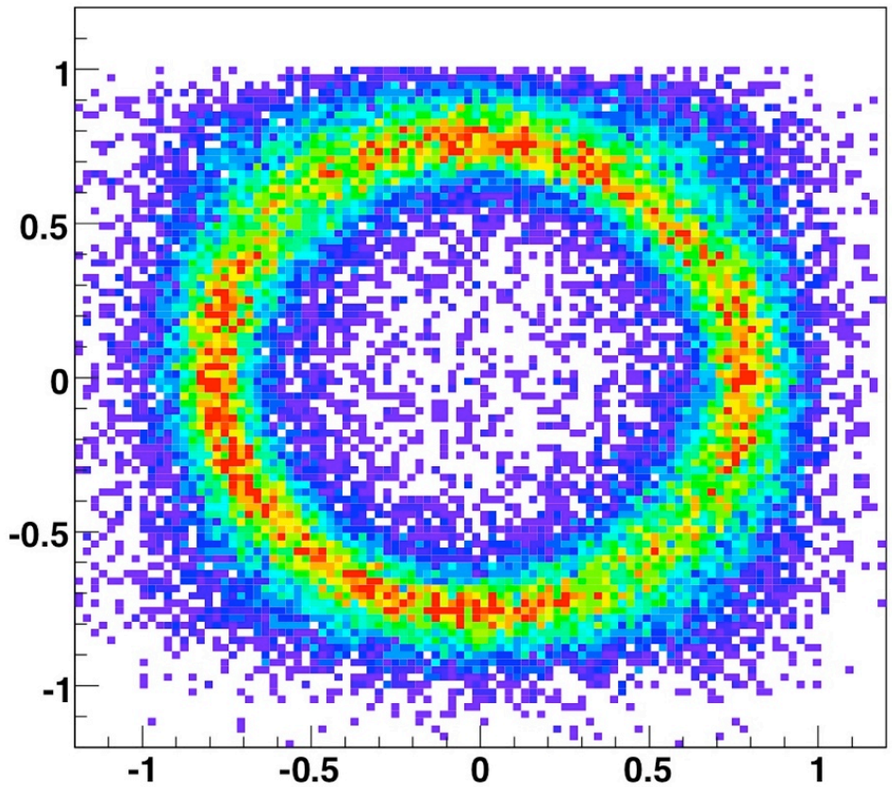


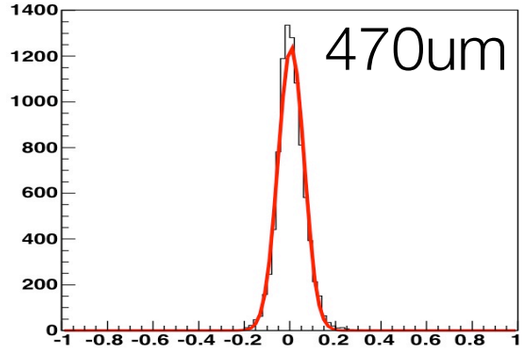


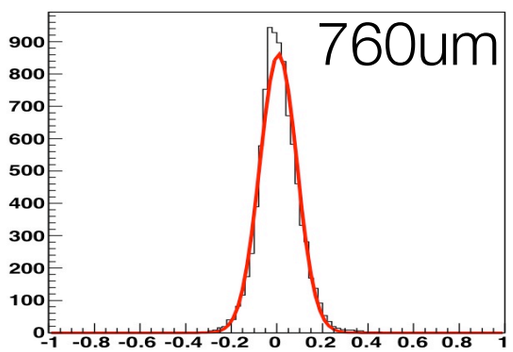
Z Position Resolution

- σ = 600~800 μm for “good” chambers
- The intrinsic resolution indicated by the thickness of the *vernier-circle*.
- The residual distribution is not biased by the reconstruction algorithm.

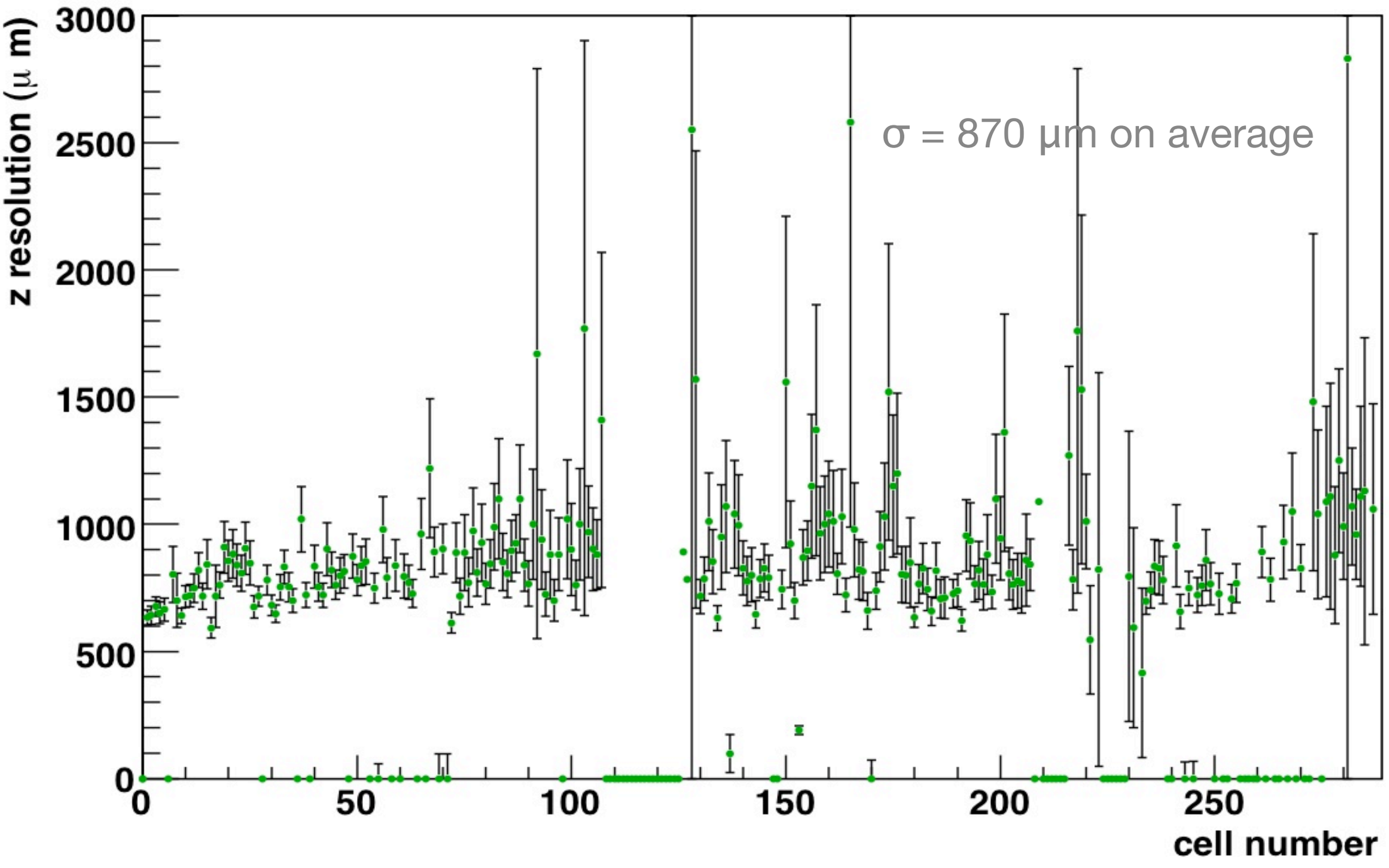








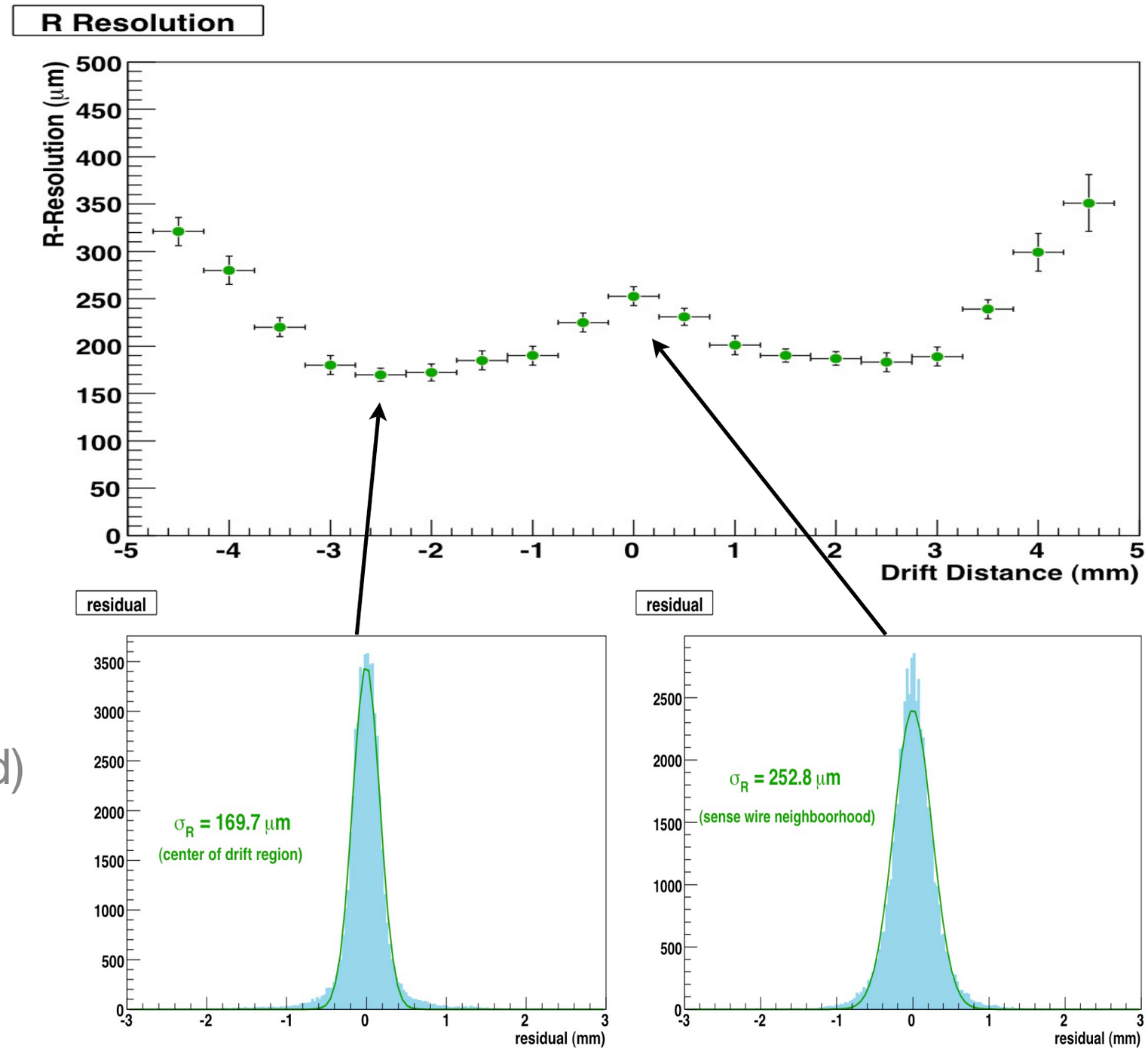
Z resolution as a function of cell-numbers



R Position Resolution

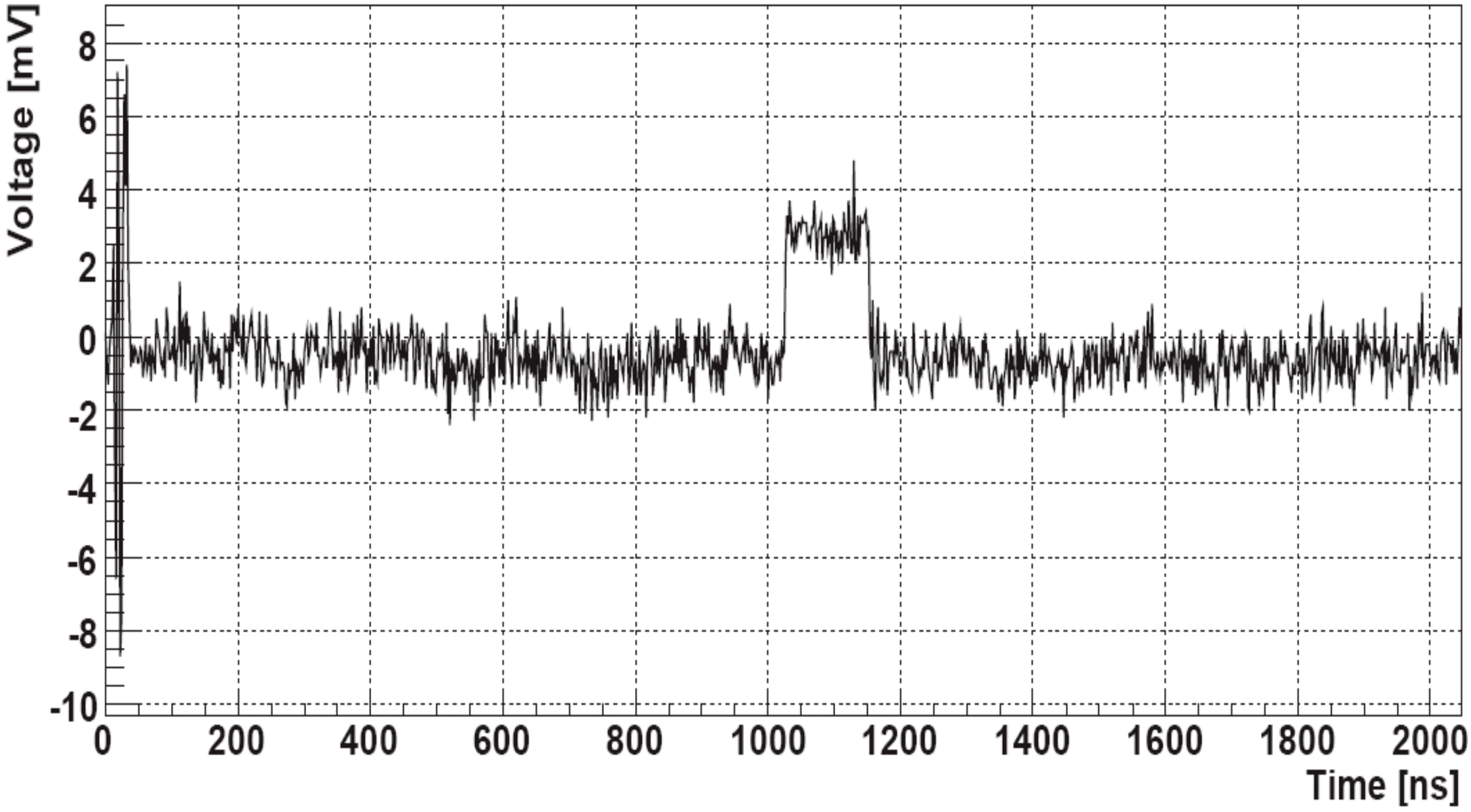
- σ = 170~350 μm for "good" chambers
- overall σ~230 μm

  (effects of multiple scattering not subtracted)



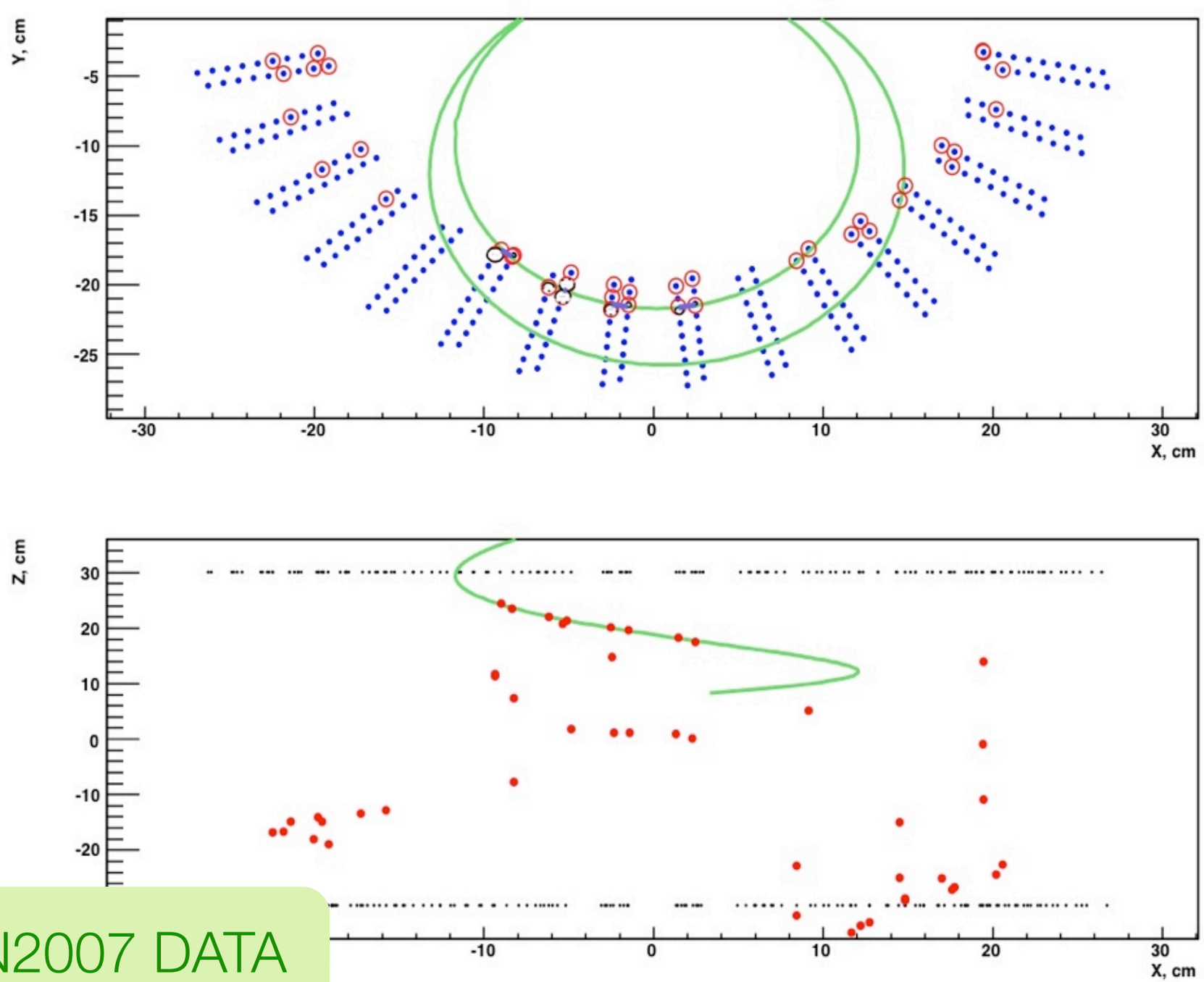
Main Problem

- **Fake hits on DRS2 chip** ==> gone with DRS4
- DRS calibration improvement
- low/high frequency noises



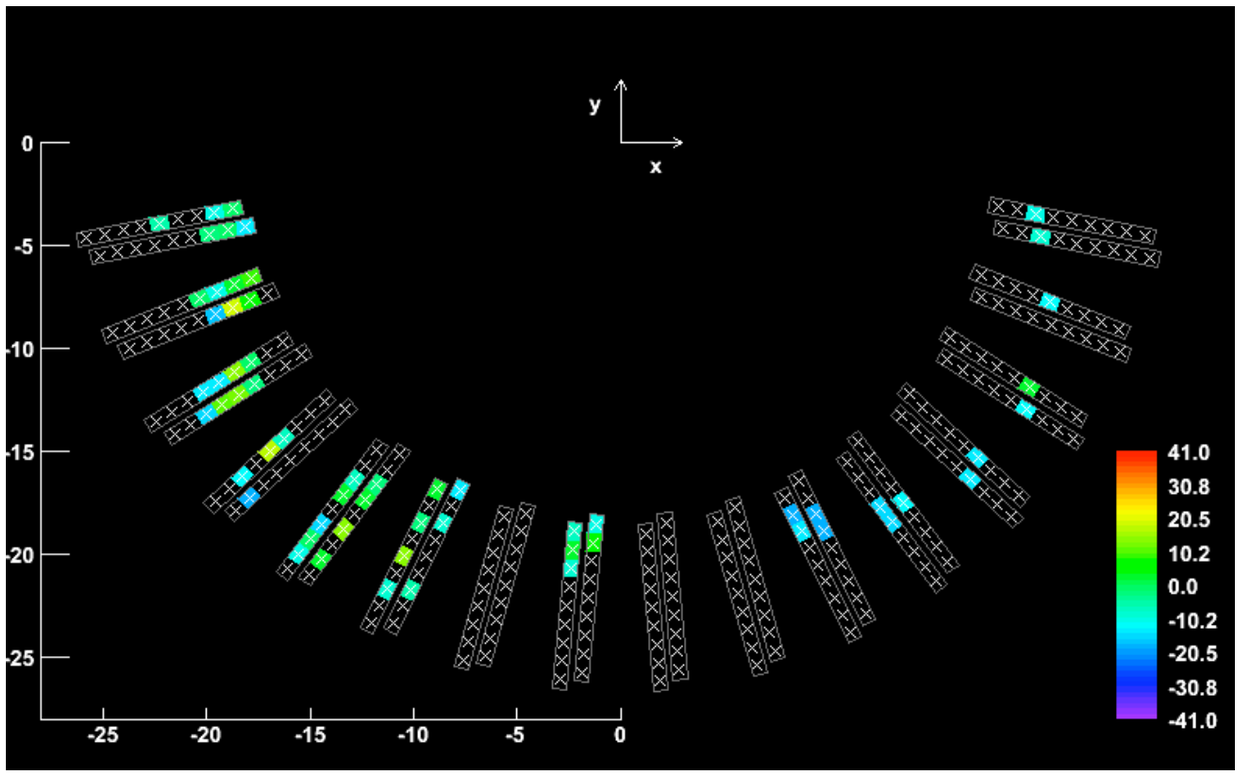
Track Reconstruction

- Two independent tracking algorithms
- Tracking software is still being developed. Many things still have to be done ASAP.
- It works fine for good events in RUN2007 data.

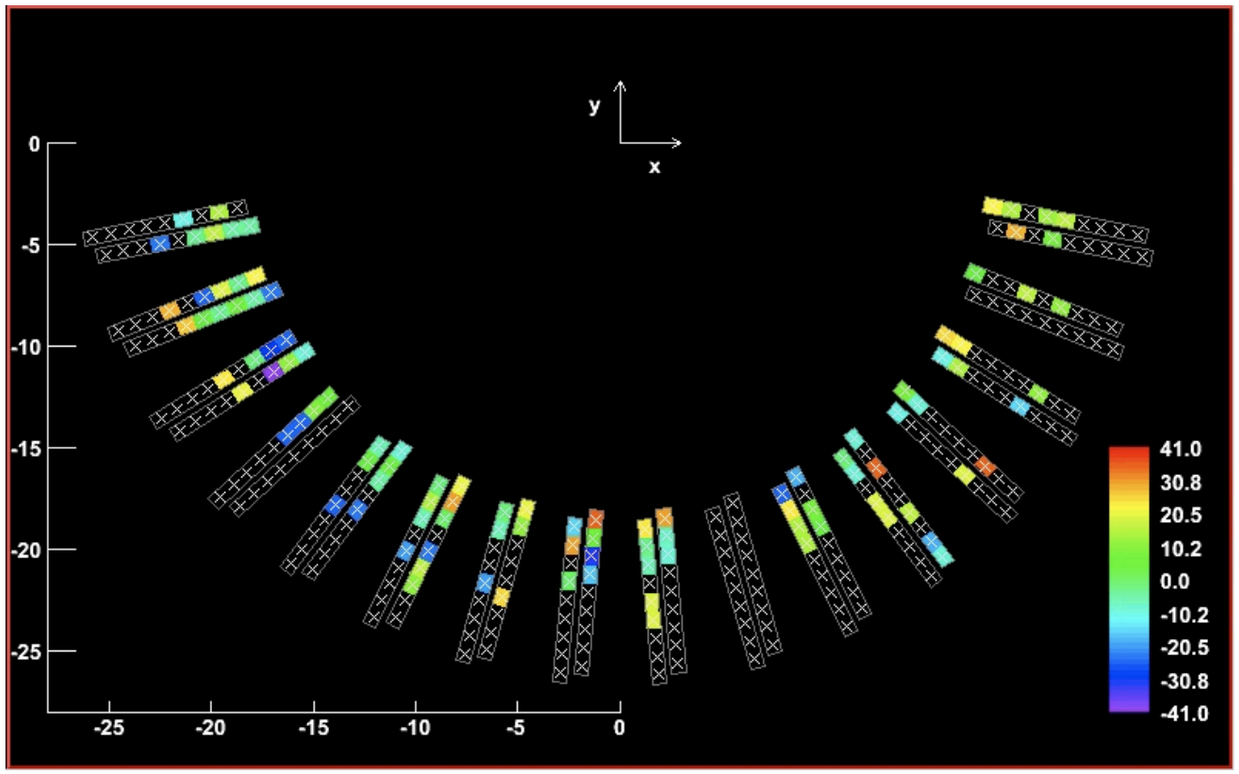


RUN2007 DATA

DC event display

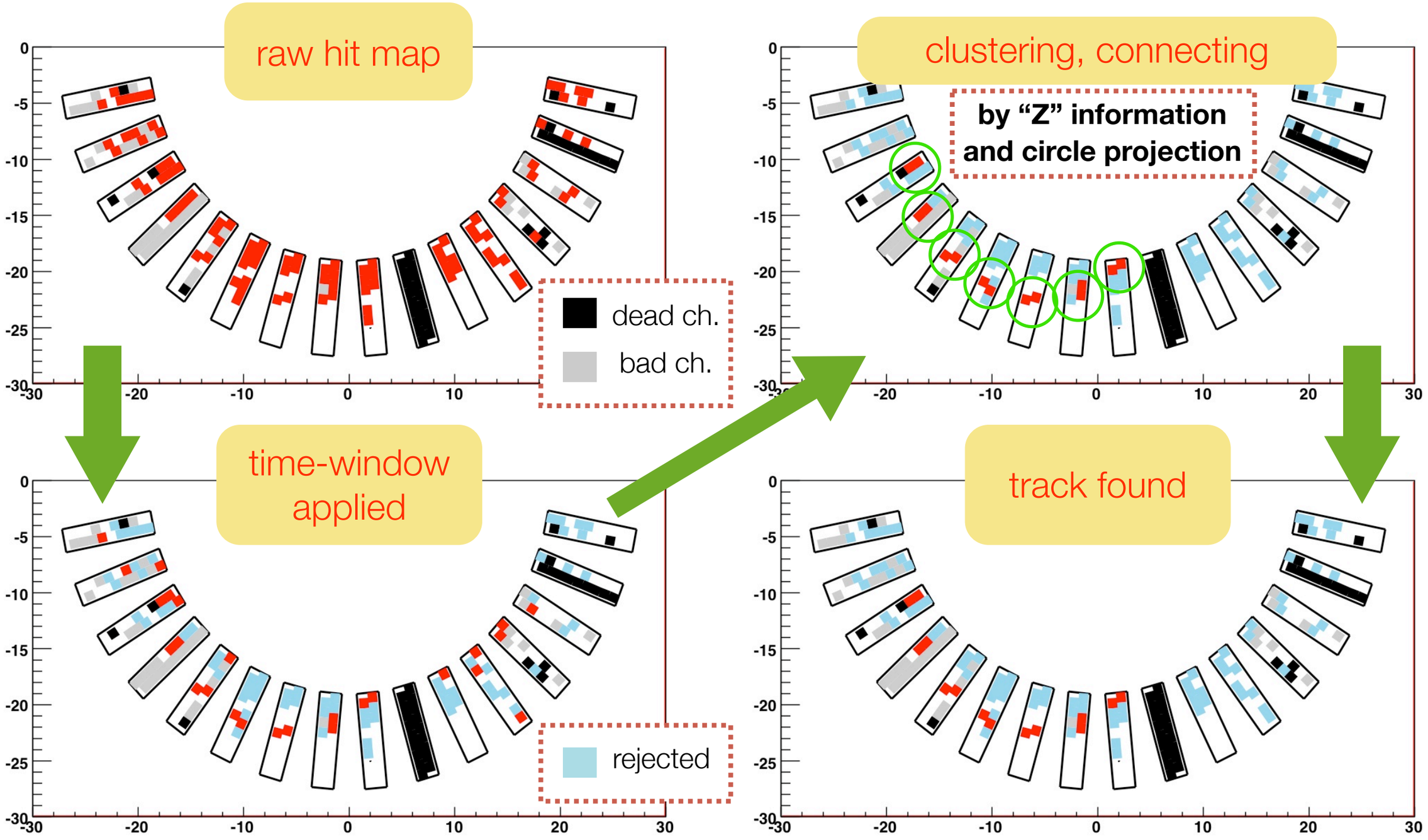


$5x10^6$ /sec muon intensity



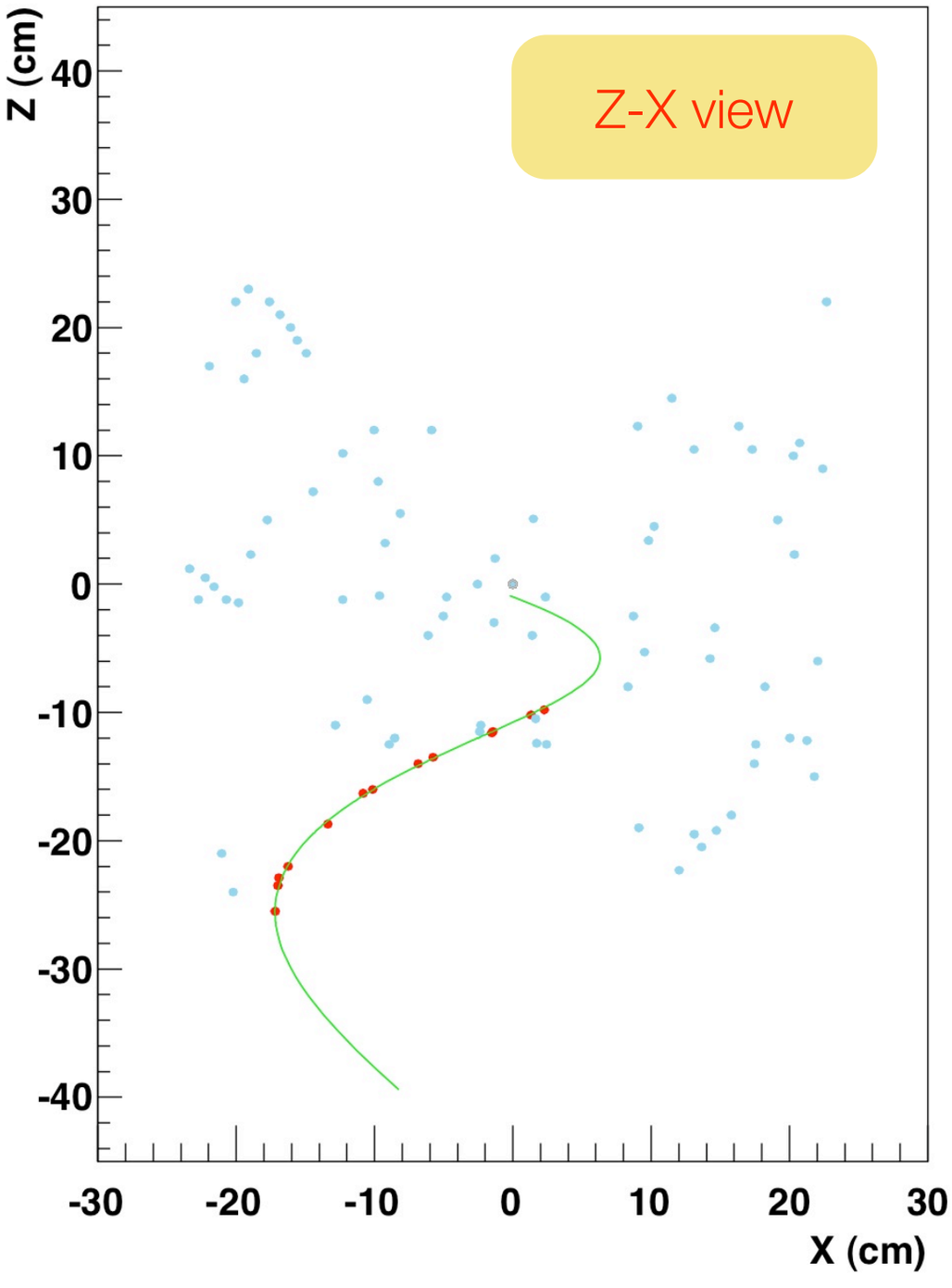
$3x10^7$ /sec muon intensity

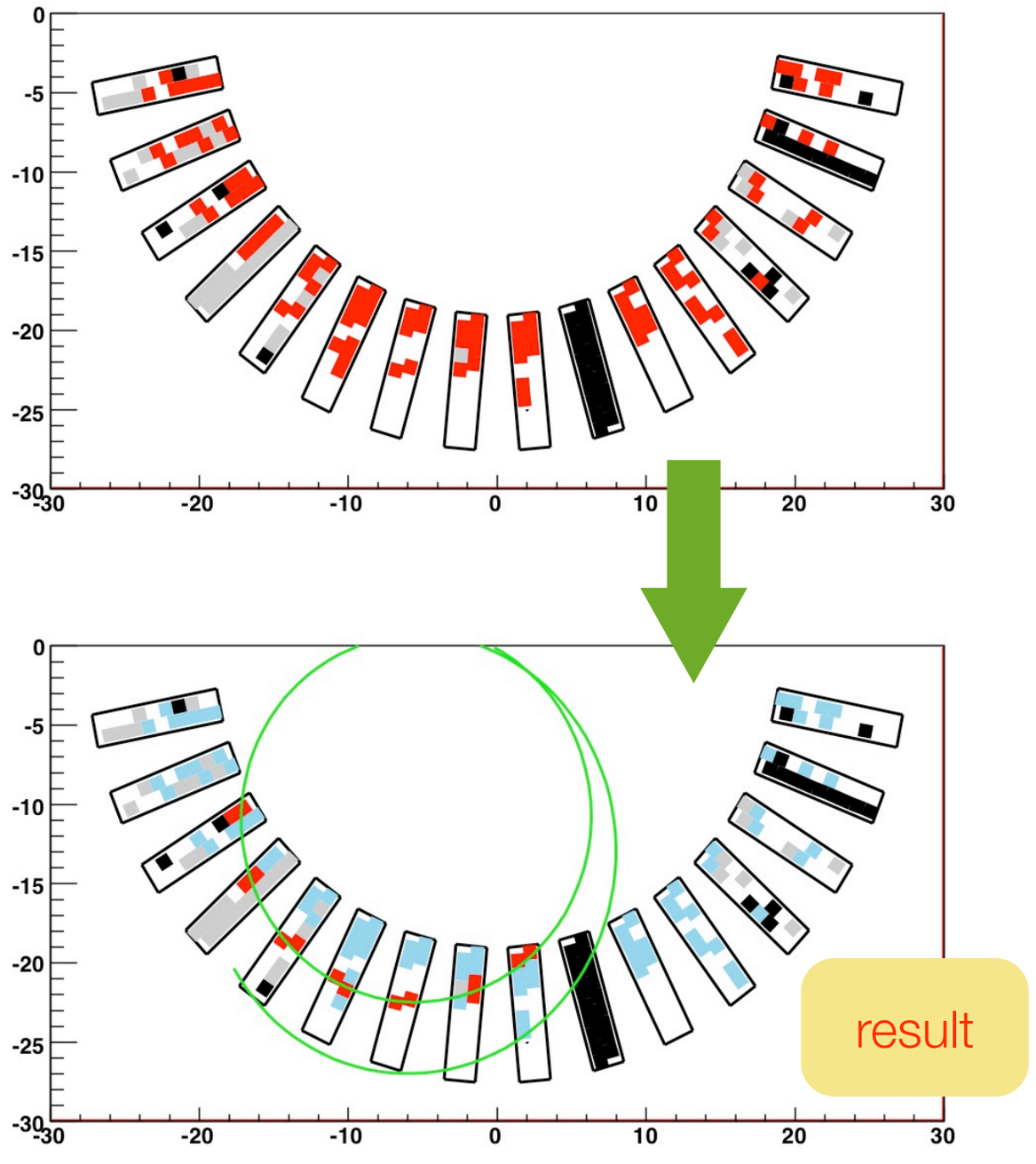
Track Finding (3x10^7 /sec muon intensity, typical event)



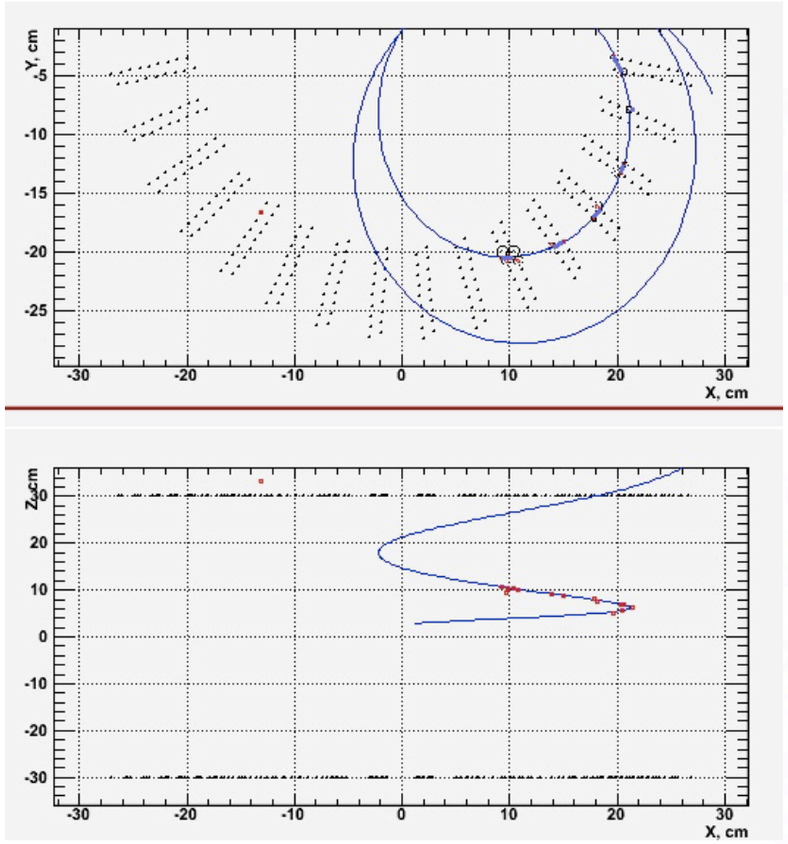
one of the two tracking algorithms shown

Track Finding (3x10^7 /sec muon intensity, typical event)

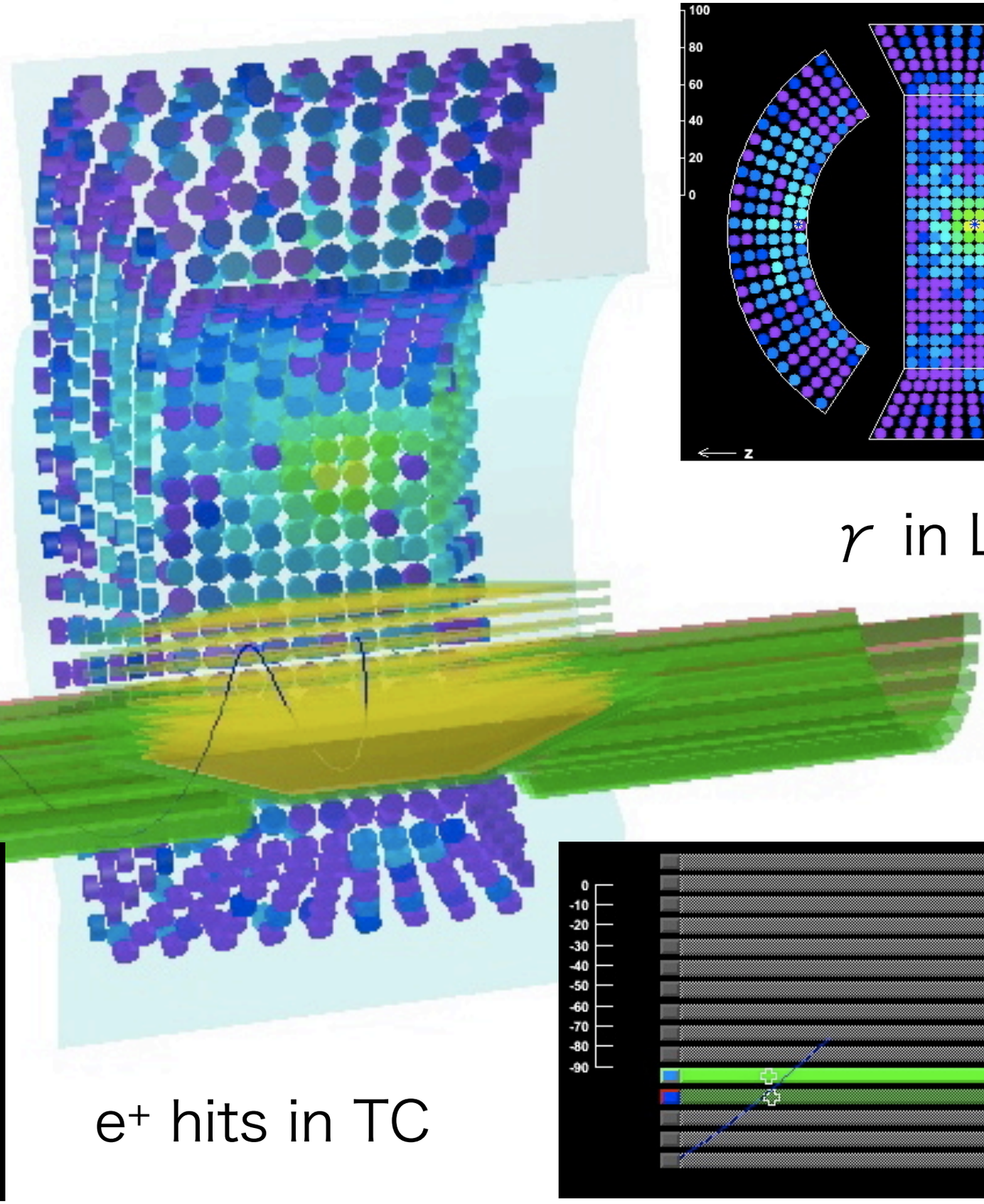




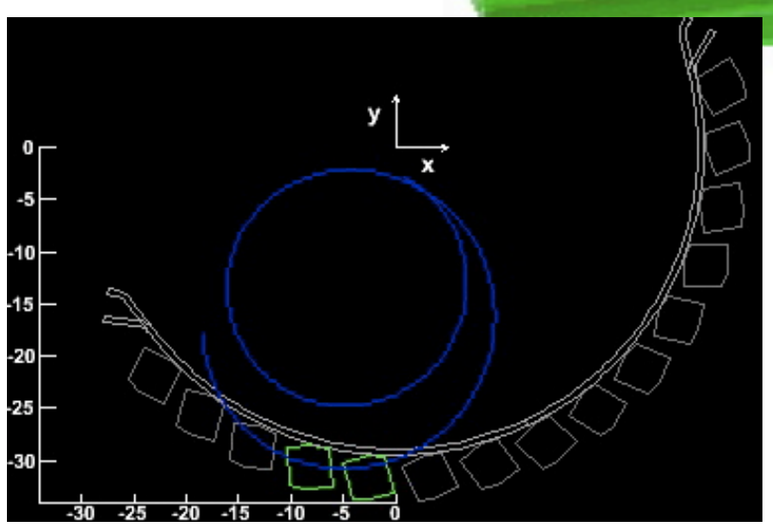
Radiative Event



e^+ Tracks in DC



γ in LXe



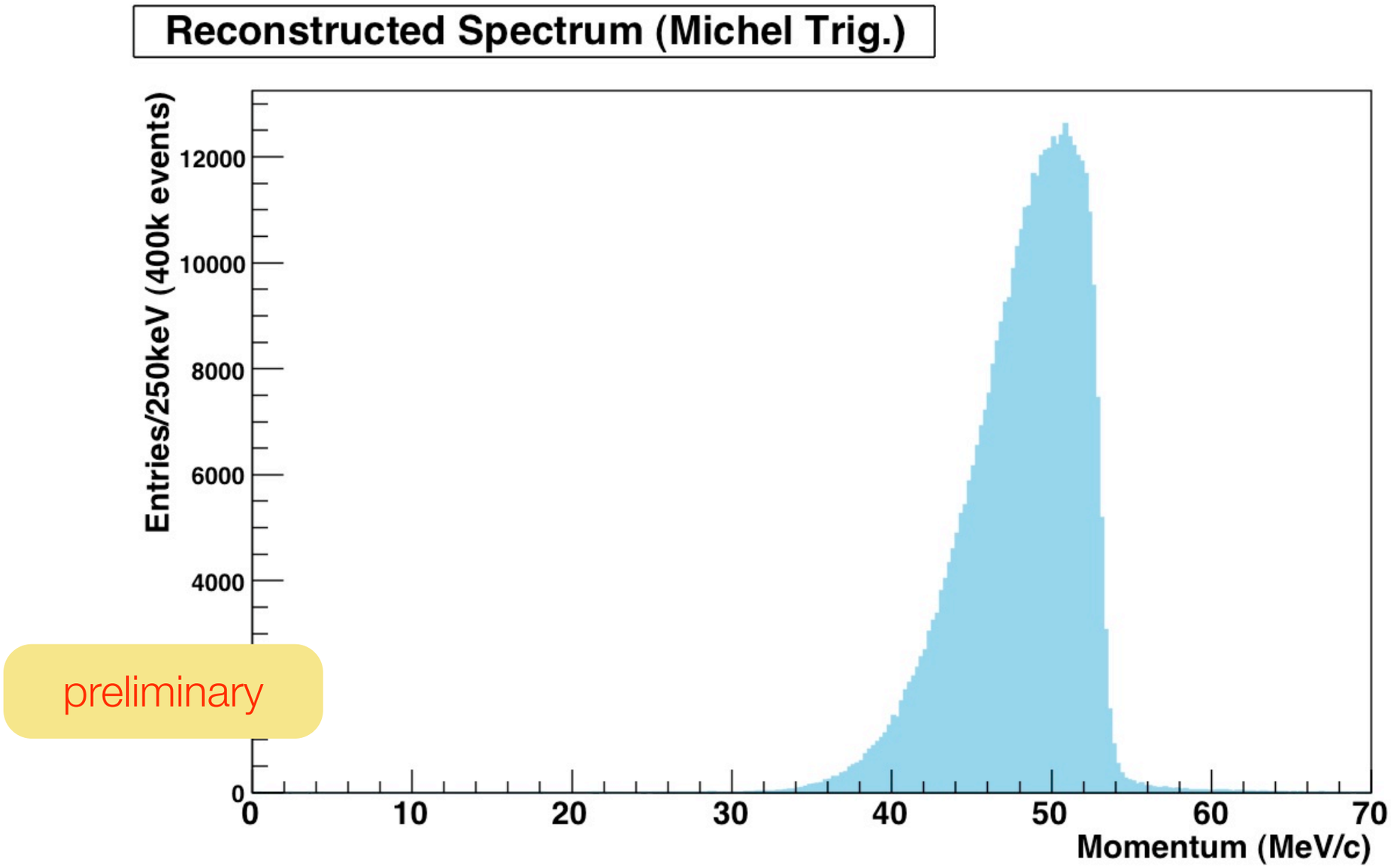
e^+ hits in TC

Tracking Efficiency

	track finding eff.	good tracking eff.
RUN2007 Michel	43%	33%
MC (52.8MeV)	99%	97.5%

- At the ultra-low rate - but the rate dependence seems small.
- Needs optimization for tracking with the dead/bad chambers.
- Efficiencies for Michel spectrum tracks should be worse than monochromatic 52.8 MeV tracks.
- A crude, preliminary evaluation of the effects of the dead/bad chambers gives a “good tracking” efficiency of ~79%.

Reconstructed Momentum Spectrum



preliminary

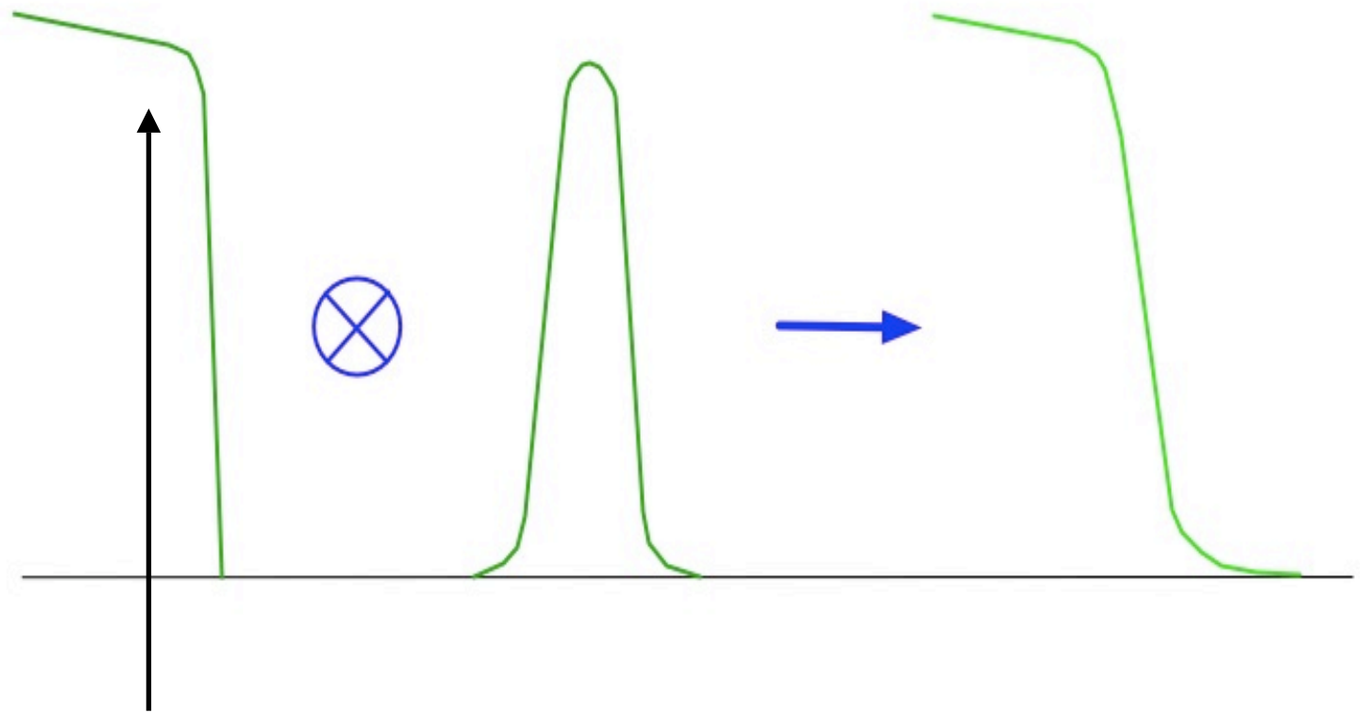
Momentum Resolution Estimation

- The measured spectrum is fitted to the MC spectrum smeared by a Gaussian resolution function with 3 free parameters; "E_{edge}", "σ_p" and "Normalization"

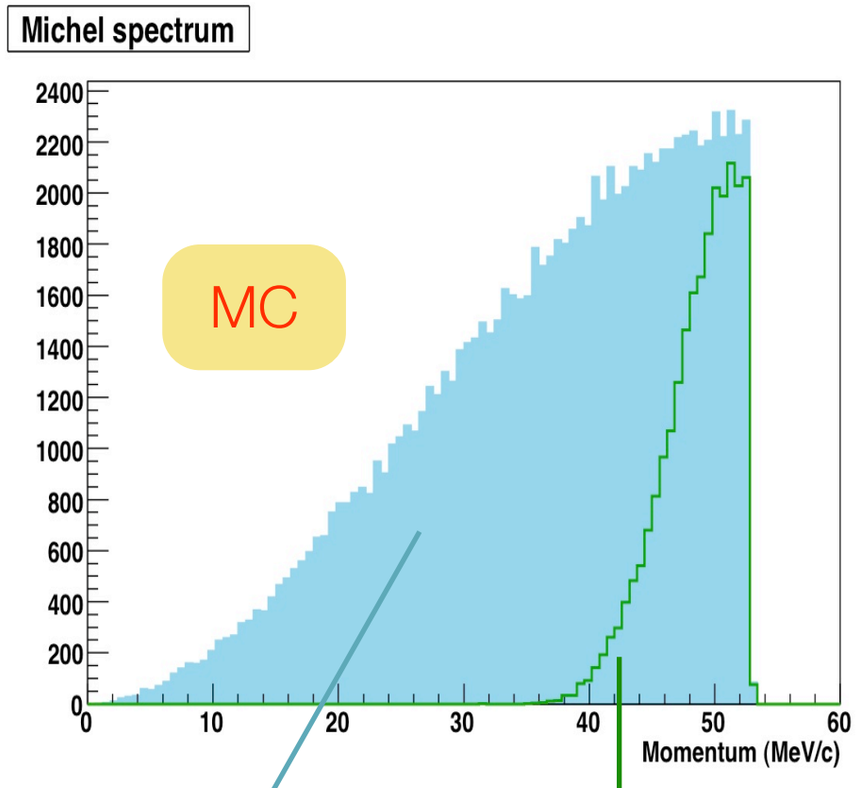
MC Spectrum

Gaussian (resolution)

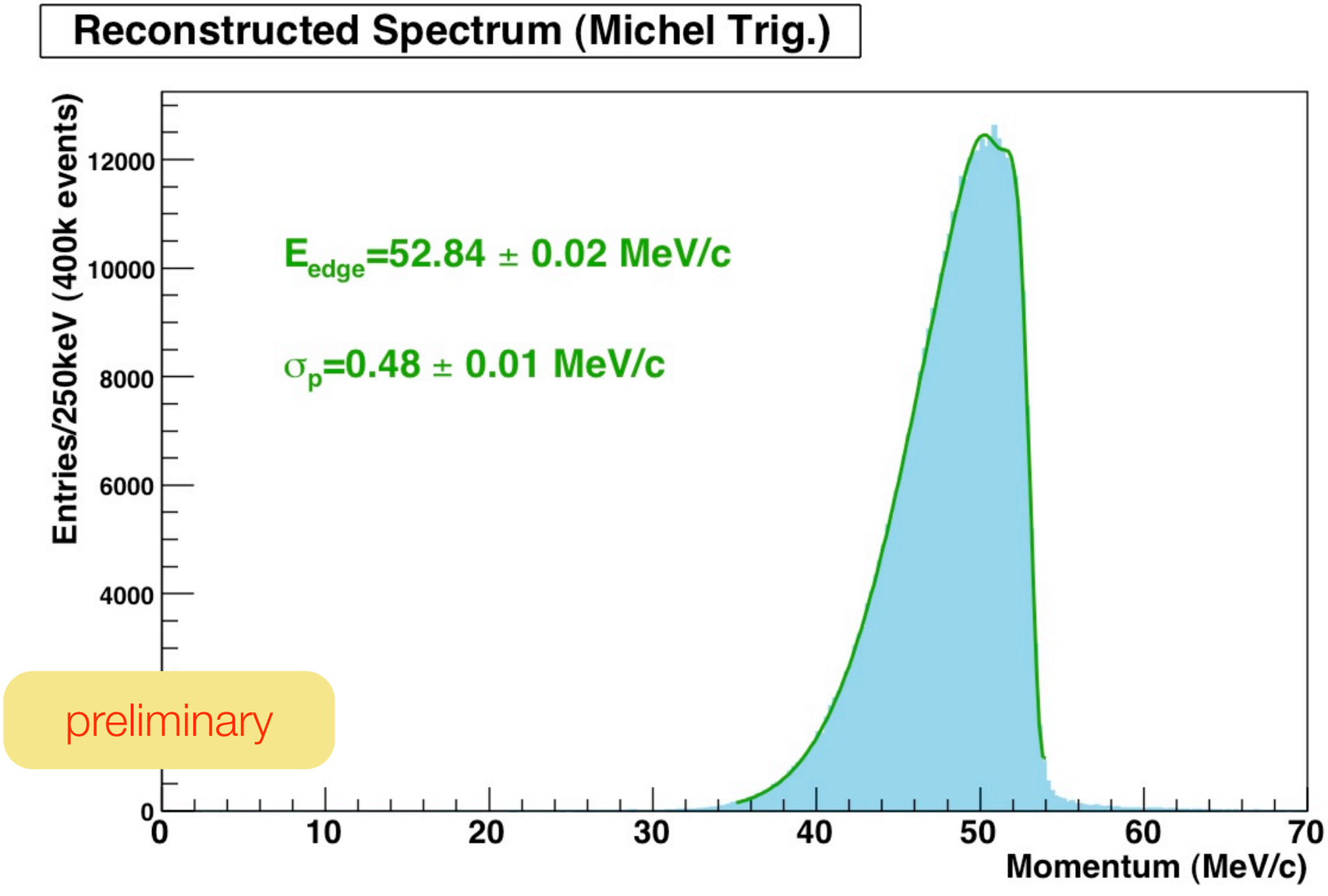
Fitting Function



Edge is smeared by radiative correction and missing DC (trigger condition)

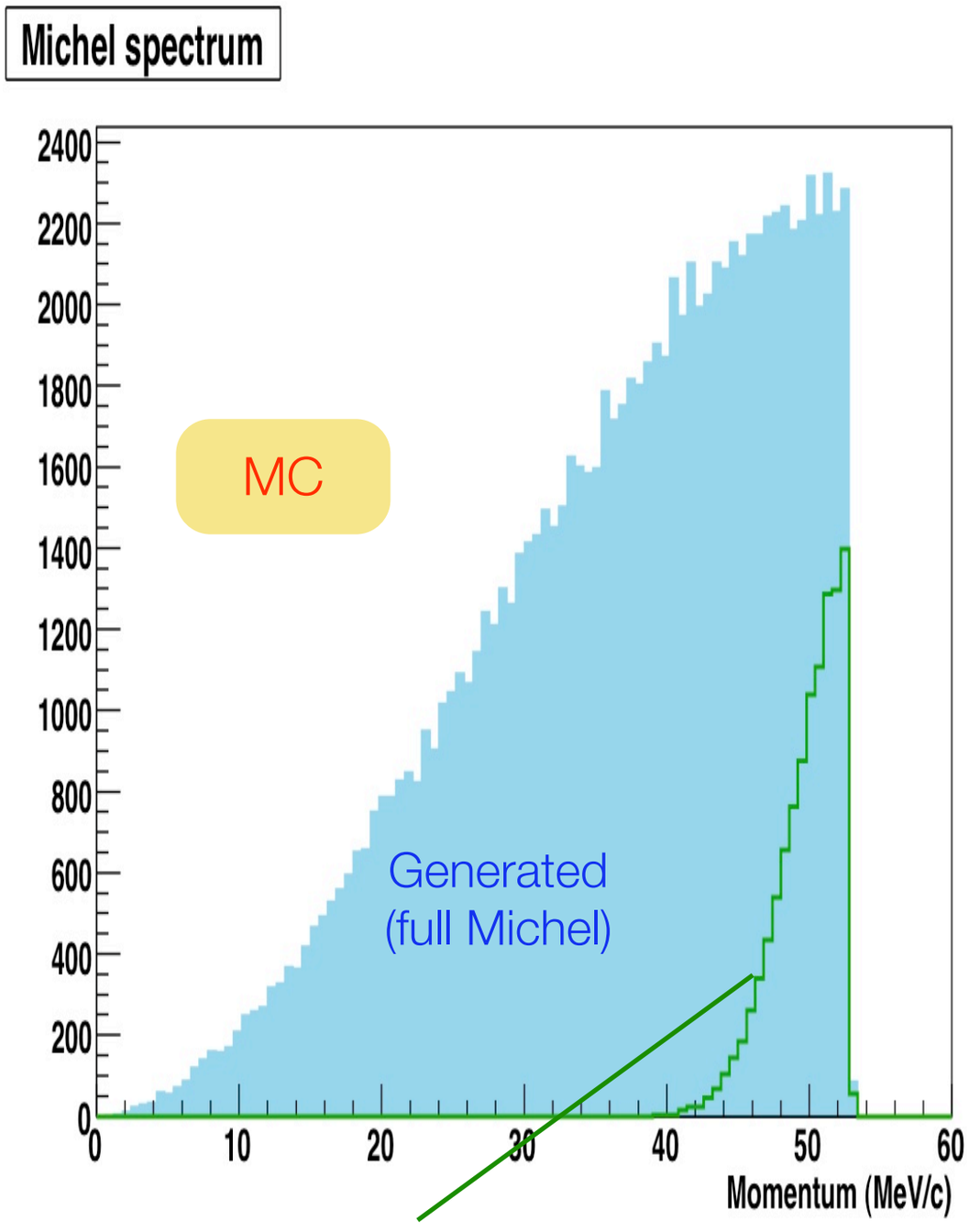


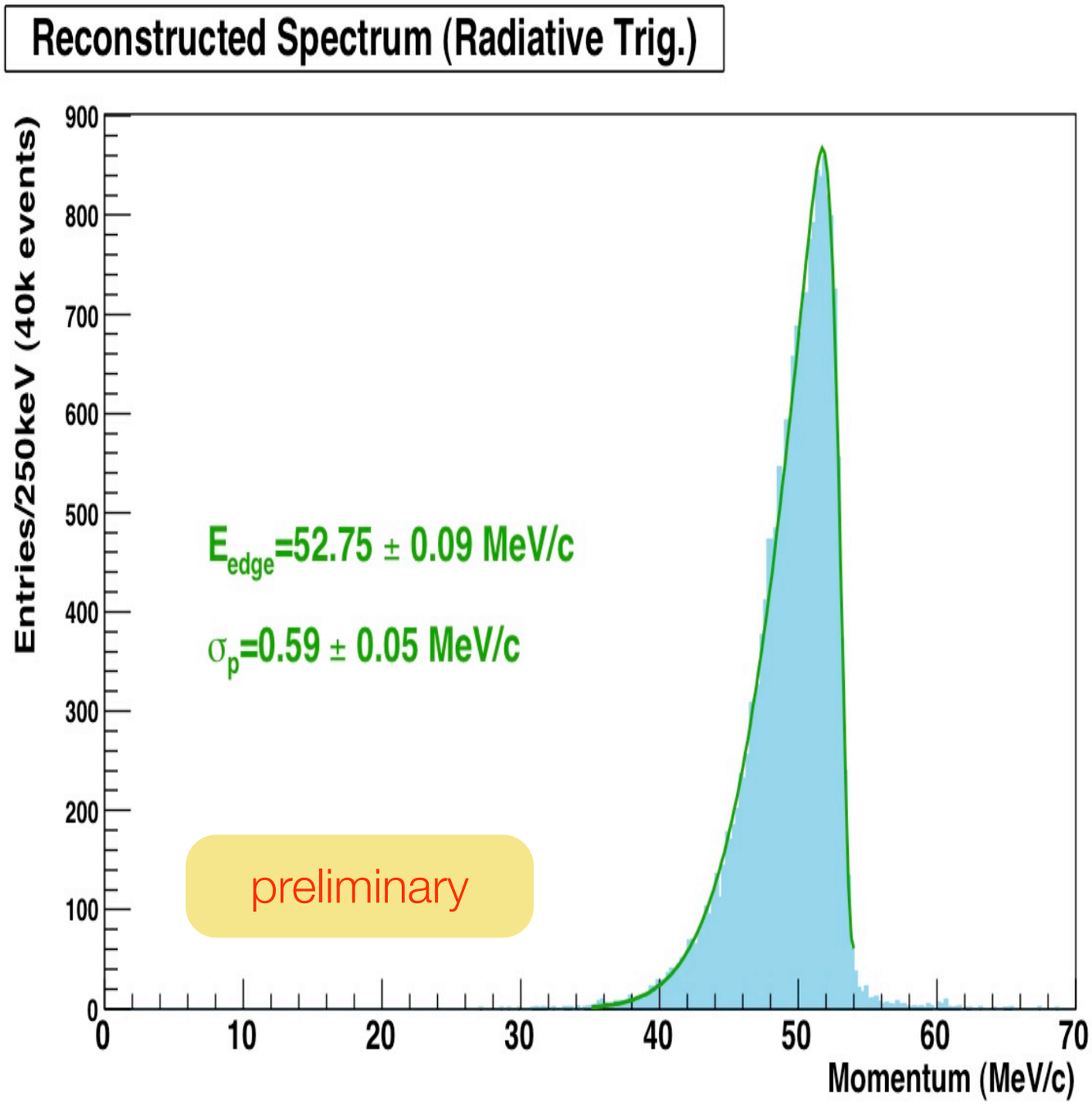
Momentum Resolution



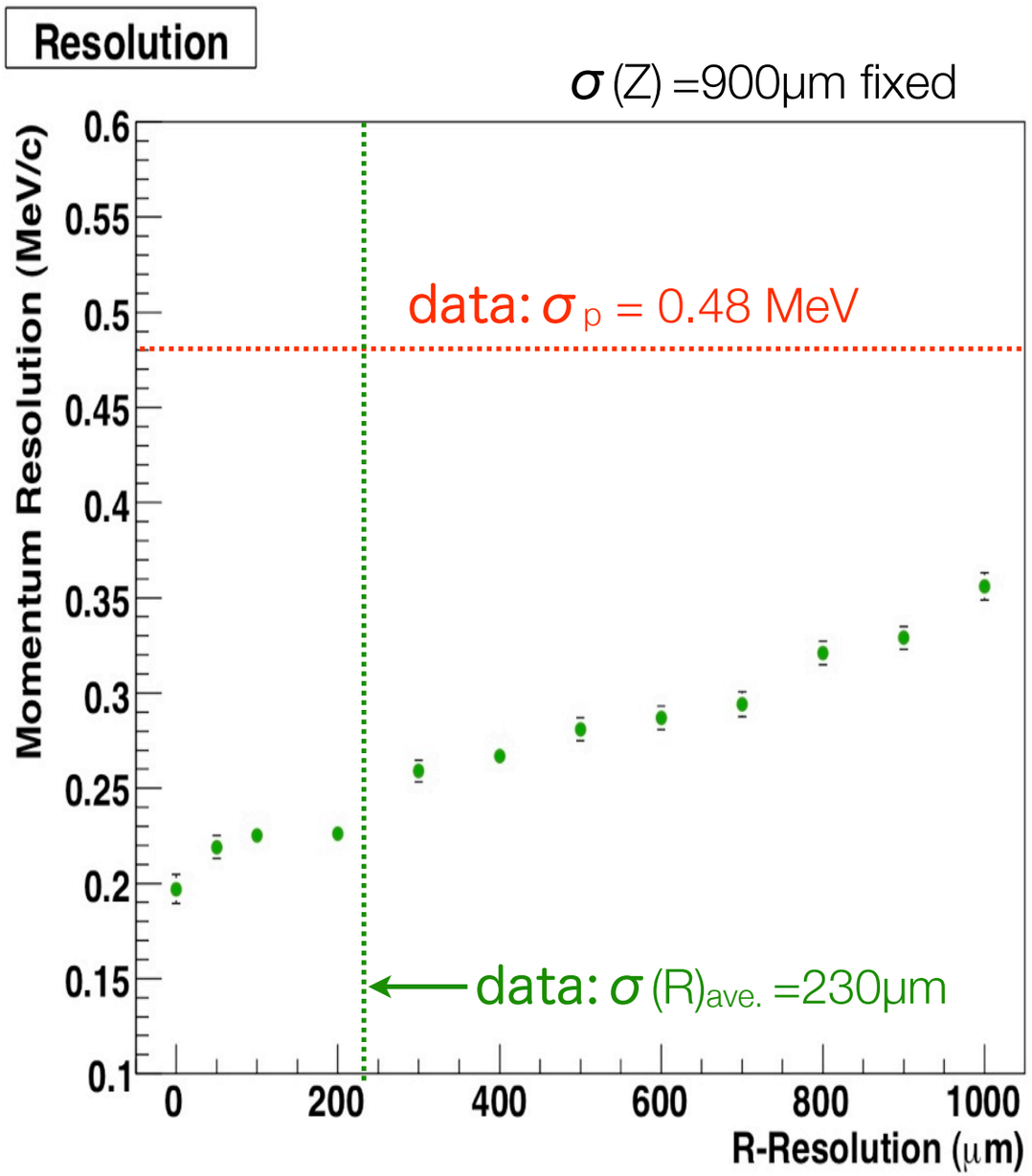
- σ_p =480 keV (=0.9 %)
- only chi2 cut, no other event selection
- angular dependence should be studied

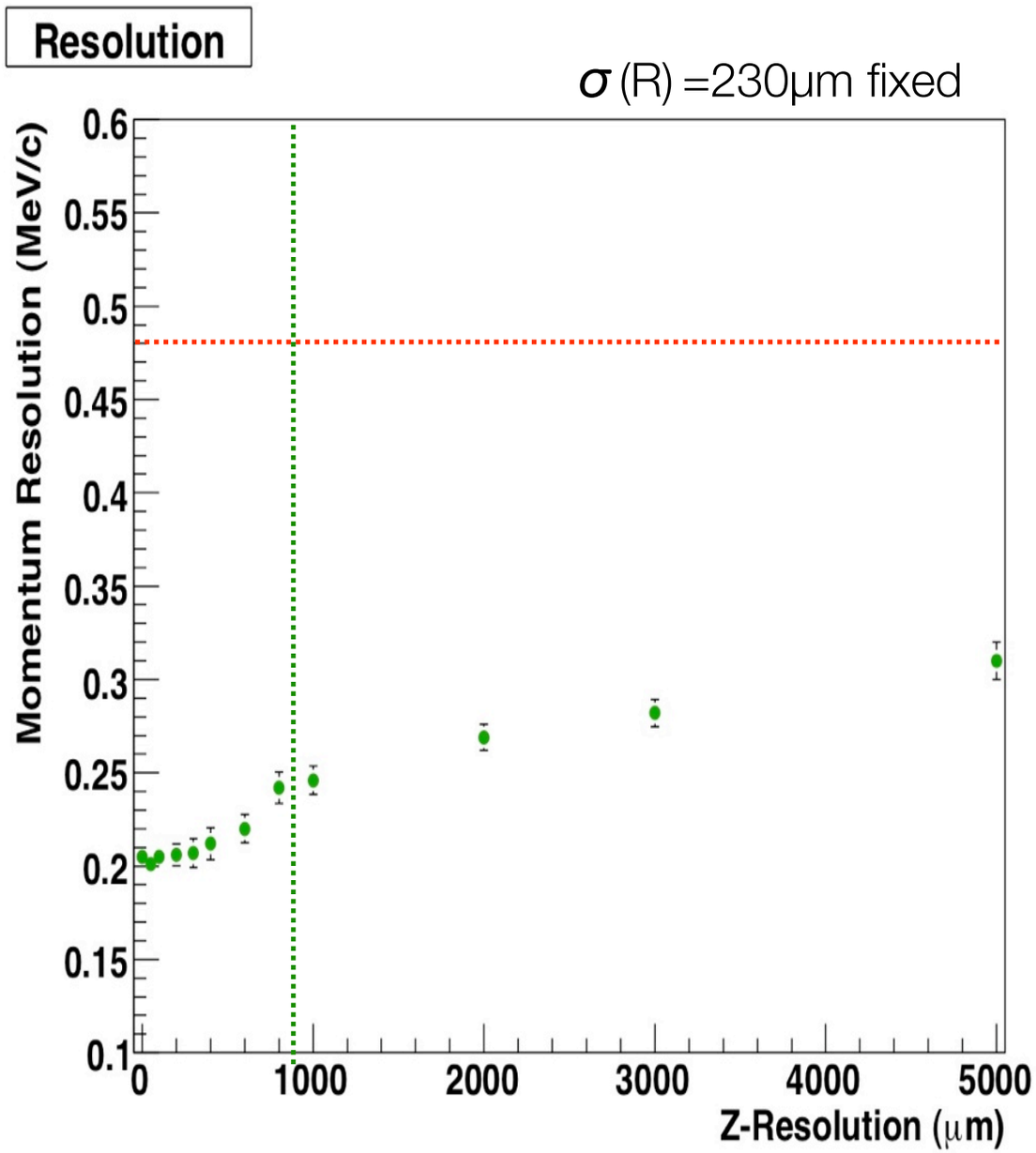
Momentum spectrum (Radiative Trig. = DC*TC)



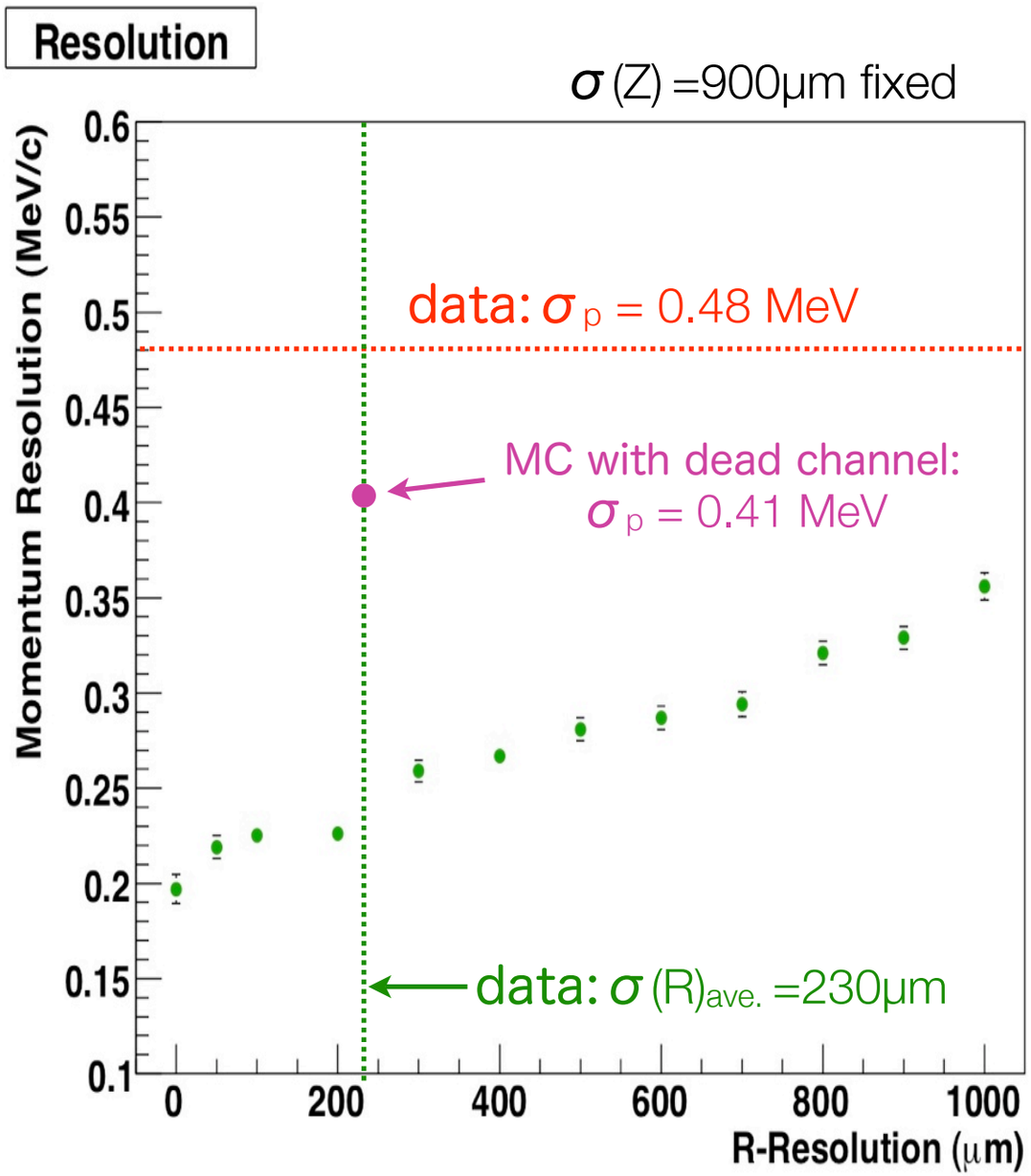


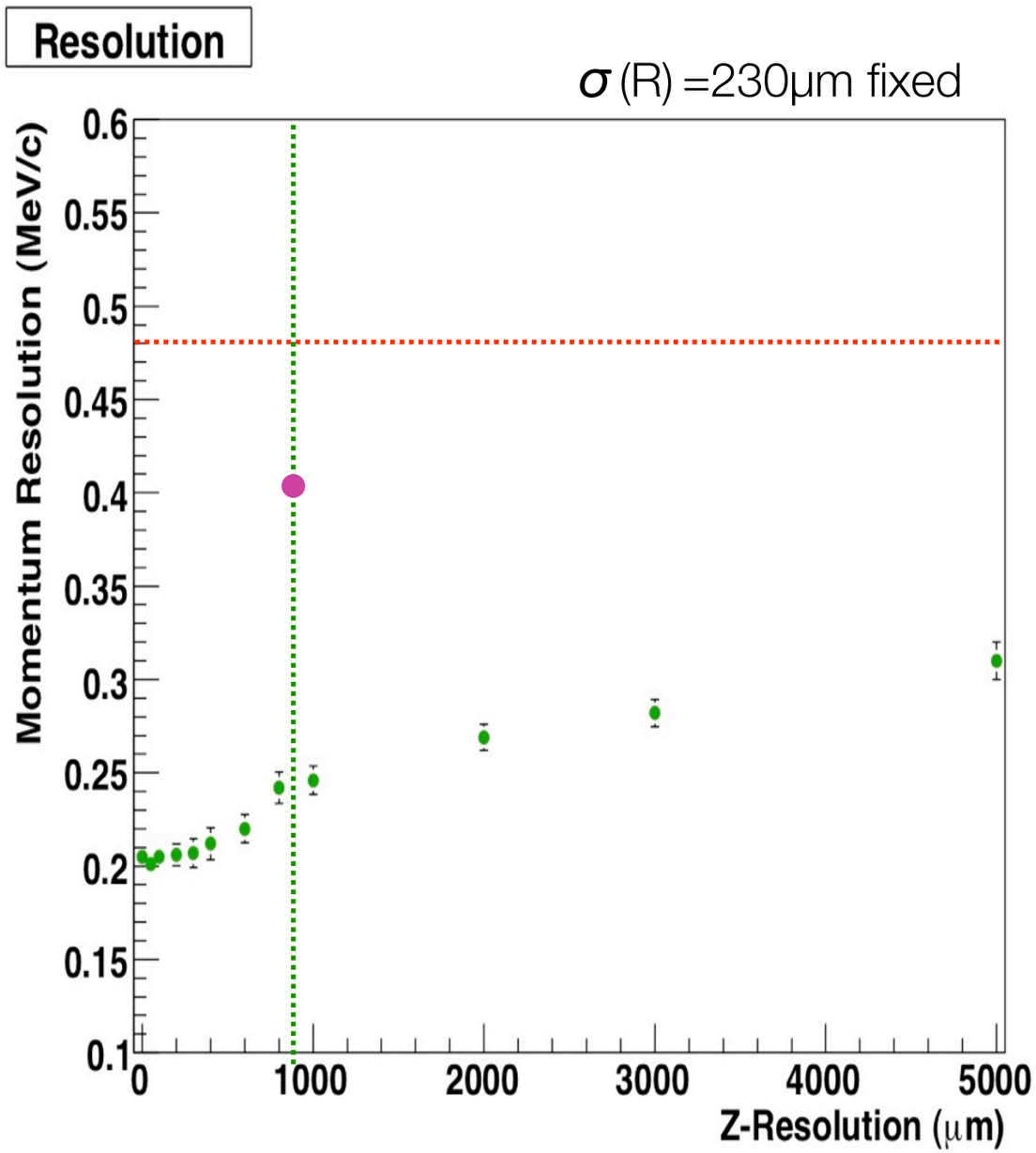
A Comparison to MC Expectation





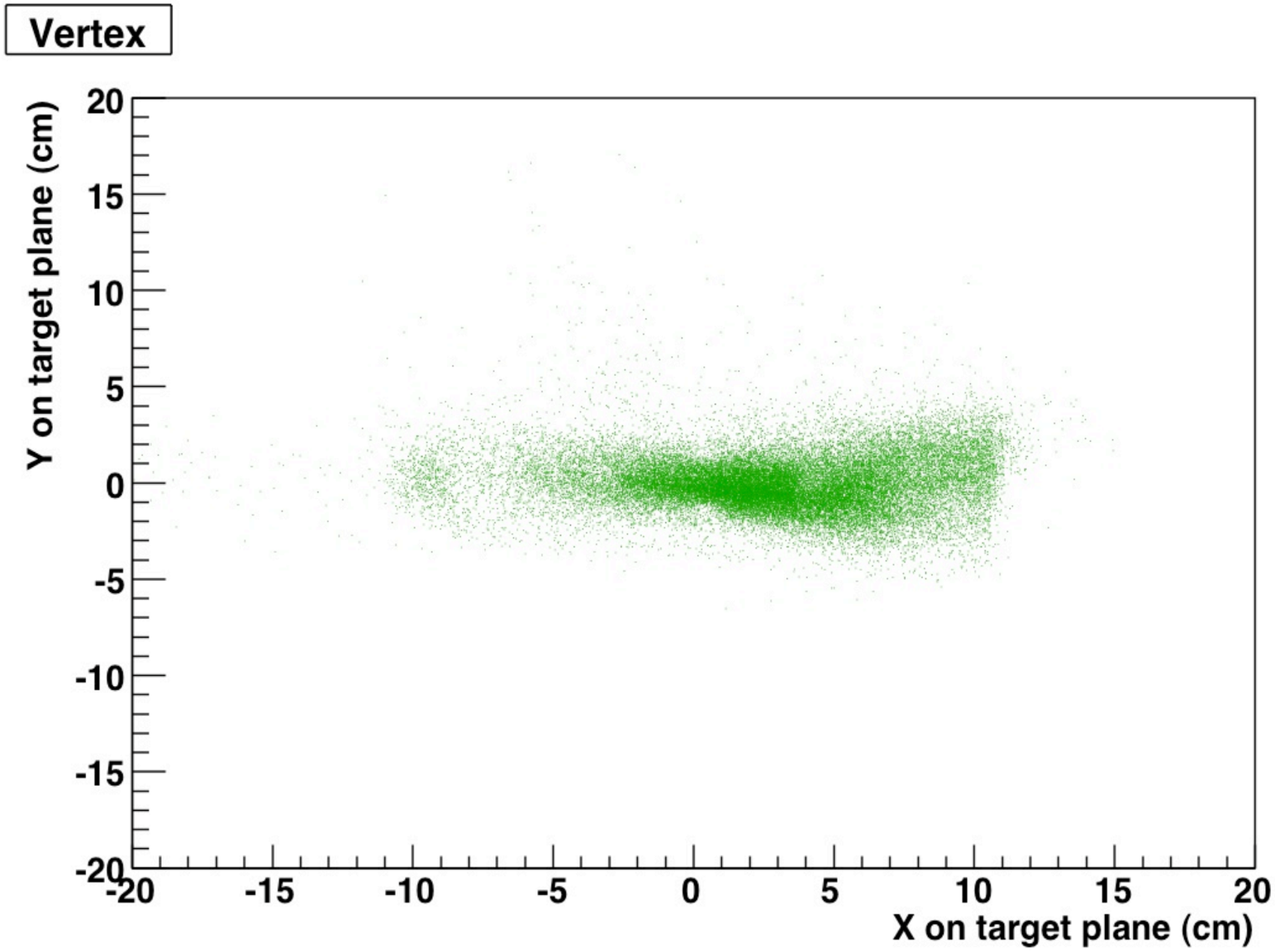
A Comparison to MC Expectation

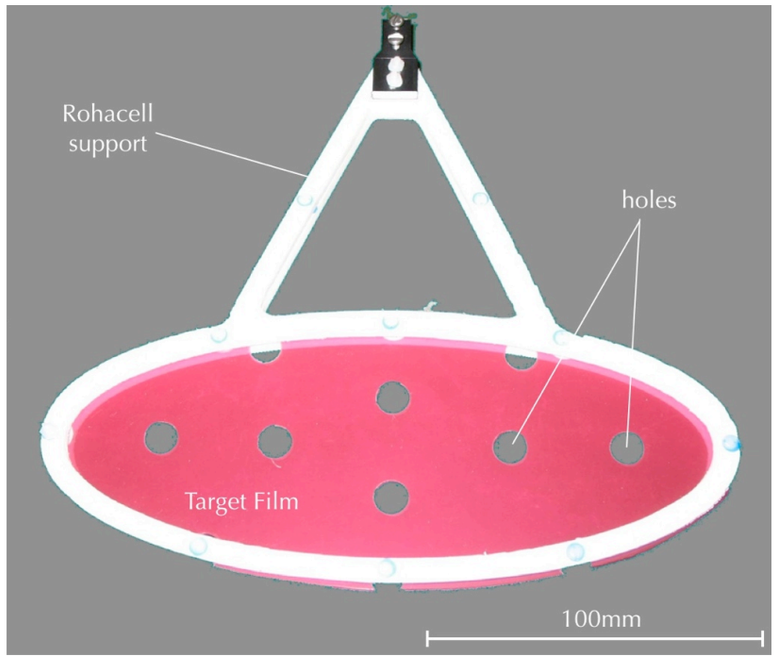




A crude evaluation of effects of dead/bad channels (very preliminary)

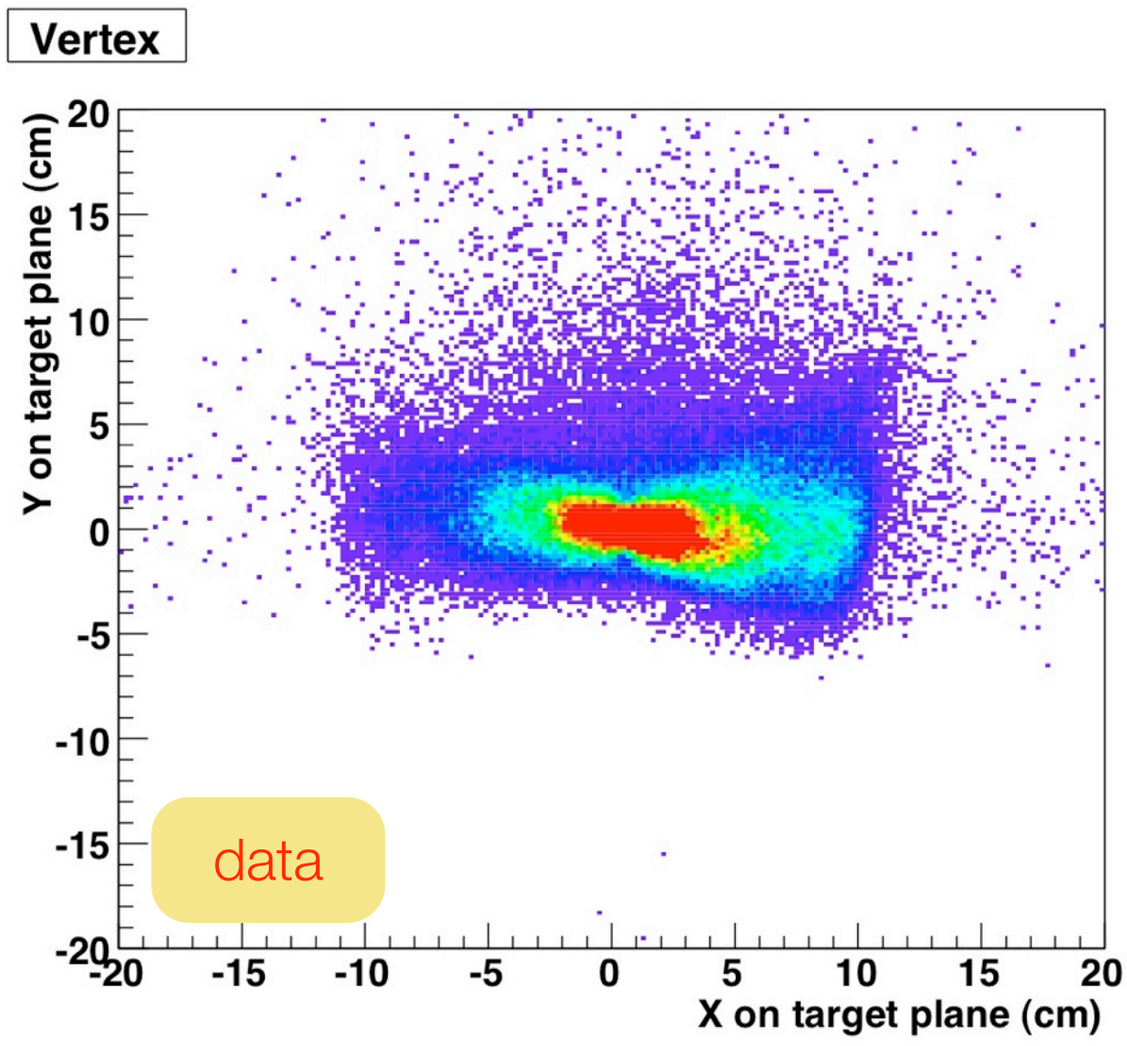
Reconstructed Vertex

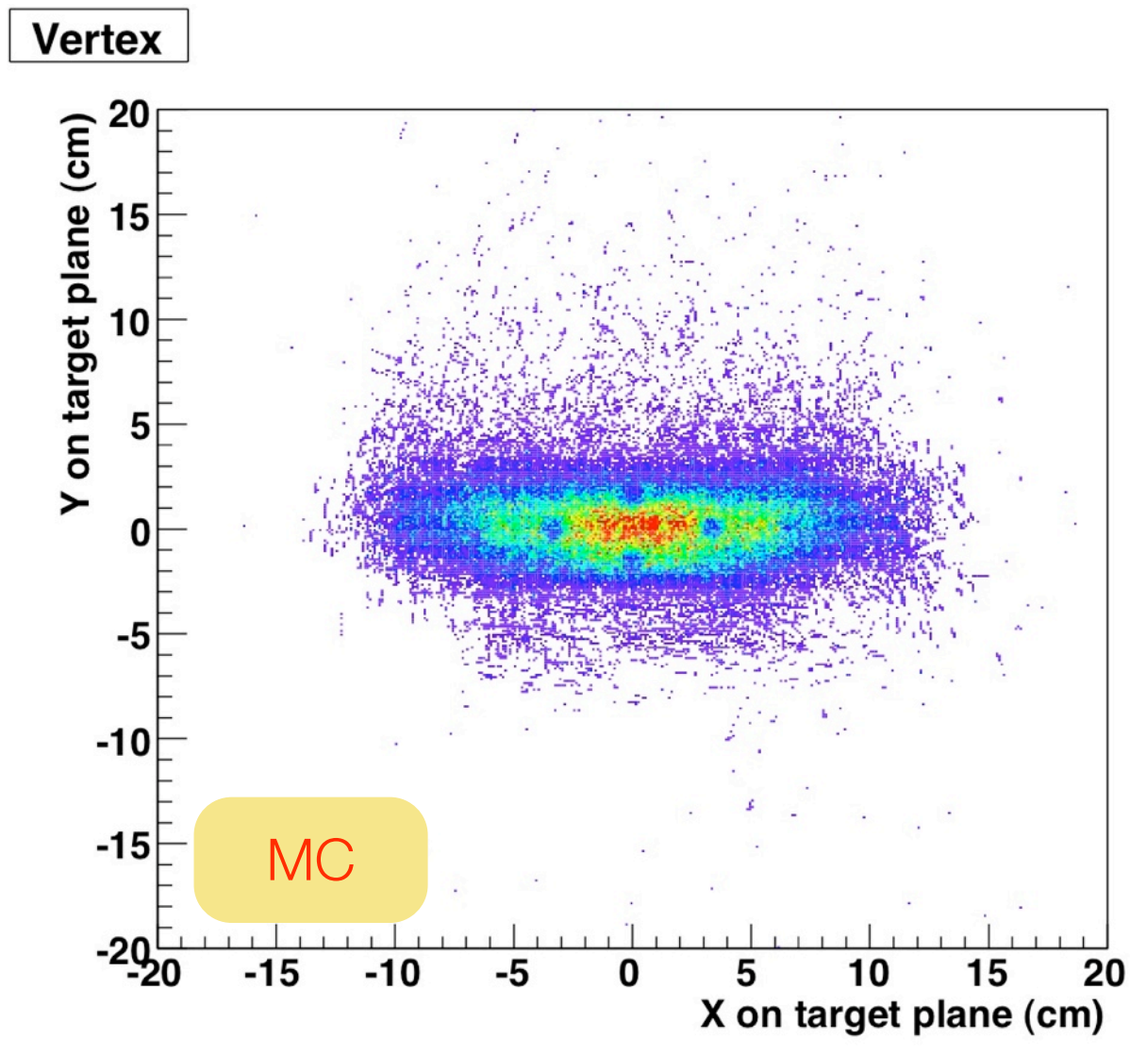




- Projected onto the target plane: only tracks perpendicular to the plane within ±10deg. and high momentum (>45MeV/c) are selected

Reconstructed Vertex (MC comparison)

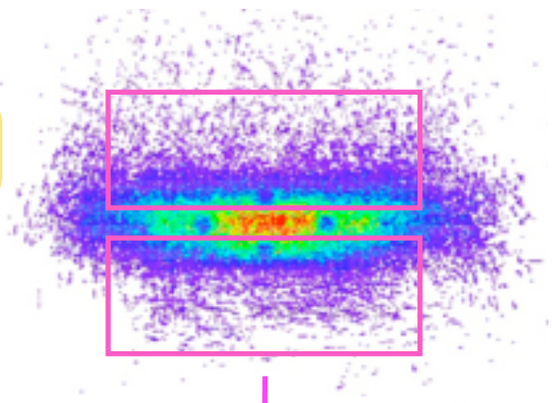




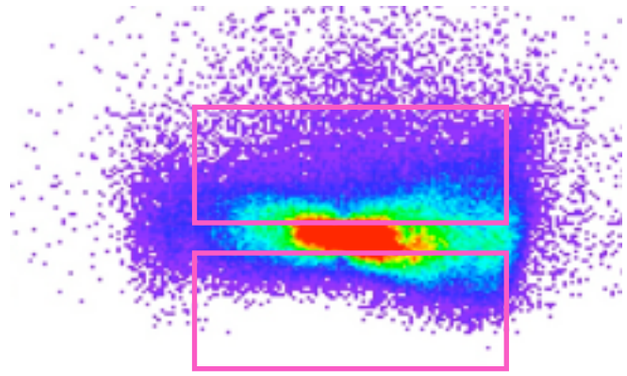
- data : projected onto target plane, perpendicular events (within ±15deg.) and high momentum (>50MeV/c) are selected
- MC : projected onto target plane, perpendicular events (within ±15deg.) (but monochromatic e^+(=52.8MeV/c) is generated)

Slice-view of reconstructed vertex (MC)

MC

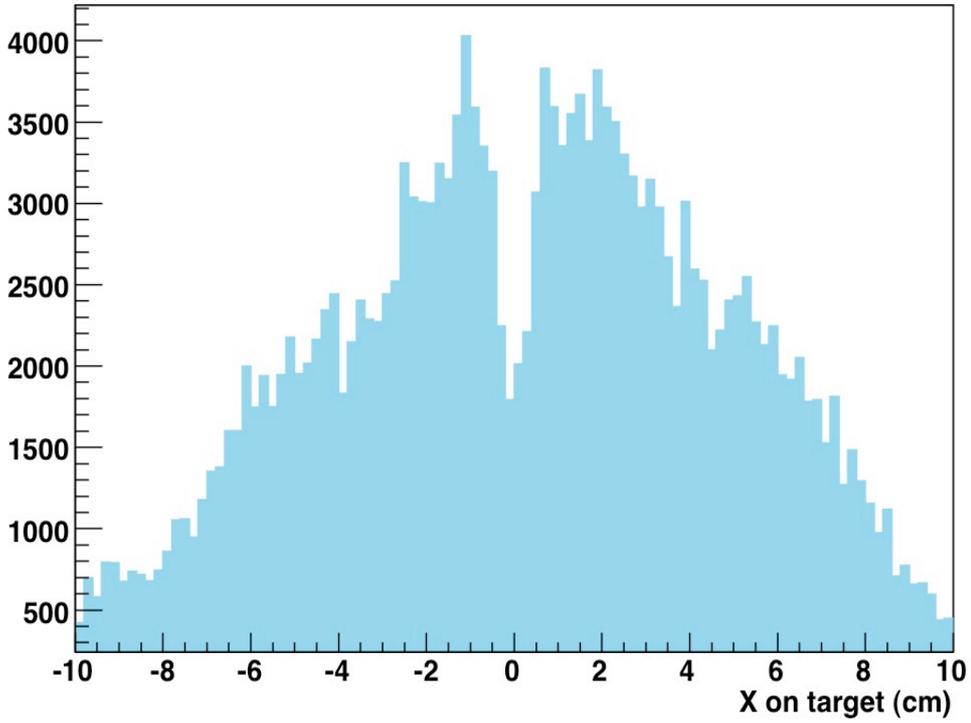


data

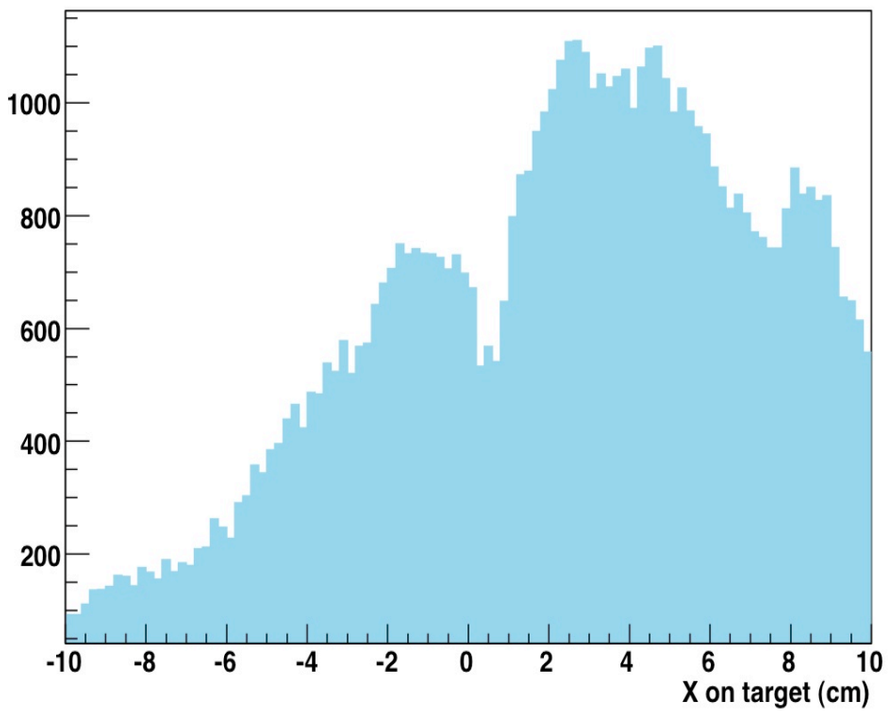


a 1D projection of the selected regions

Y Slice



Y Slice



- ~1 mm vertex resolution with tails.
- An angular resolution guestimated from fitting errors is ~7 mrad.