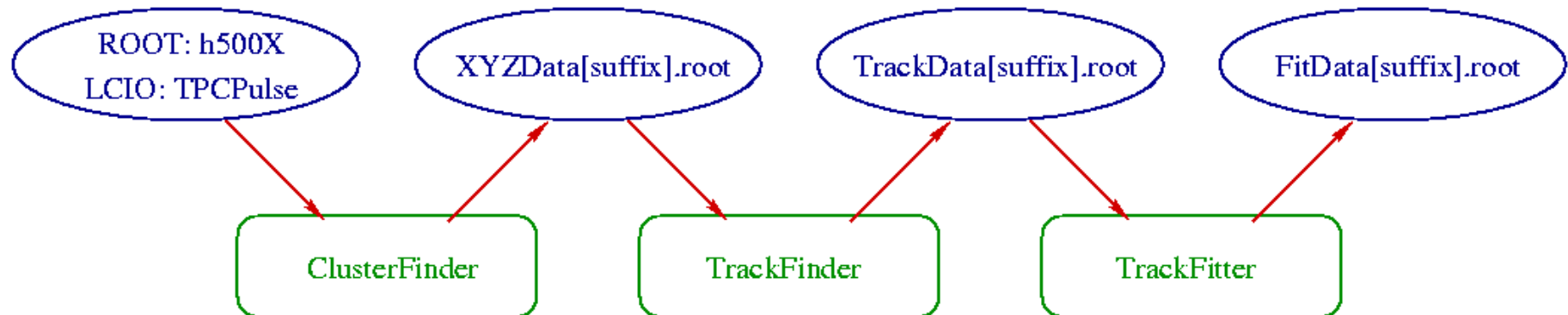


# Reconstruction&Analysis

- Reconstruction Frame Work: MultiFit
  - methods for reconstruction
    - pulse finding
    - hit reconstruction
    - track finding and fitting
  - ansatz for Pad Response Function correction
- Resolution Analysis
  - Geometric Mean Method
  - Triplet Method
- Choice of Pad Layout
  - staggered and
  - non-staggered layout

# MultiFit

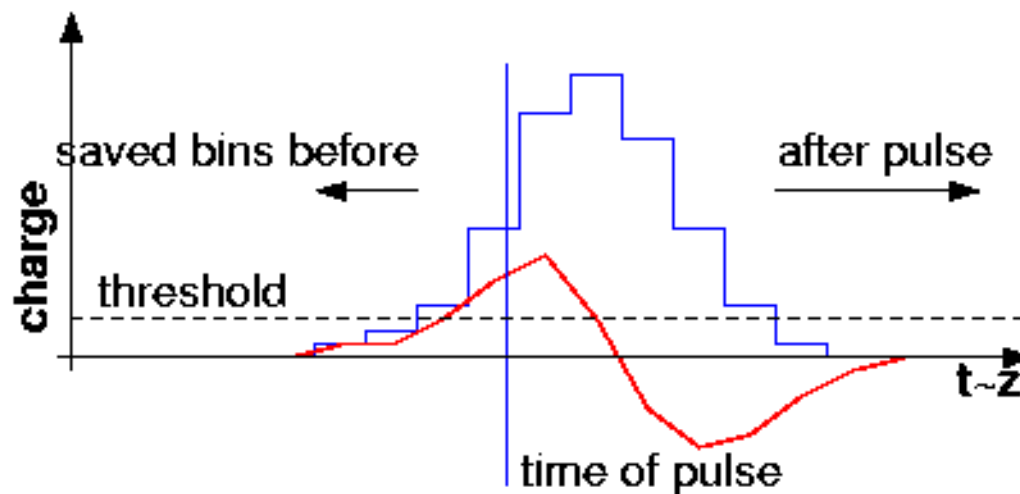
- Reconstruction is done in three steps



- ClusterFinder: reconstruction of 3D space points from the raw data
- TrackFinder: combines the space points to tracks
- TrackFitter: calculates the track parameter and residuals etc.

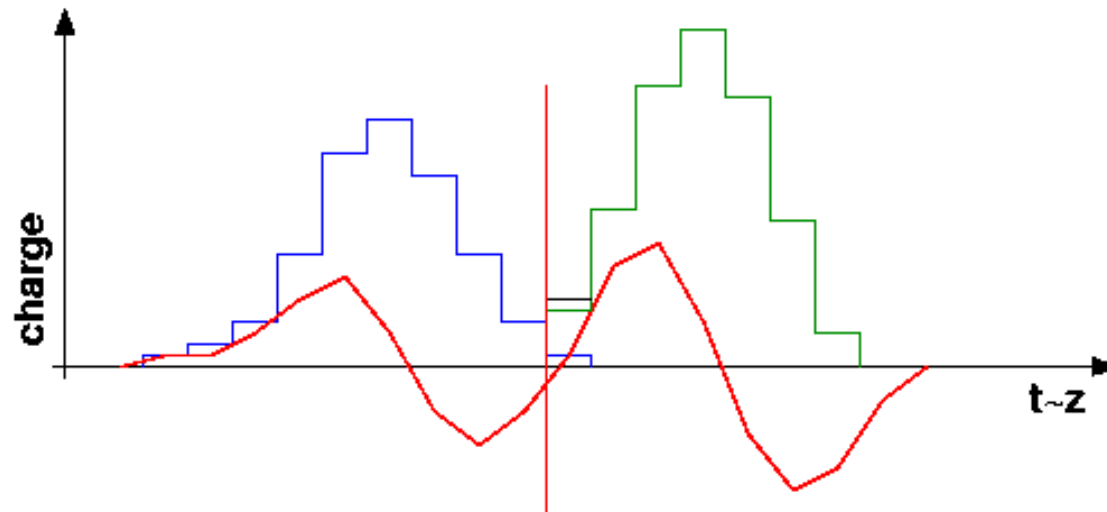
# ClusterFinder: Pulse-Reco

- First, find pulses from raw data
  - detect pulses by threshold (use of different values for beginning and end)
  - save # bins before and after the pulse
  - calculate integrated charge
  - calculate a time information: inflexion point of rising slope (mean of positive derivative)



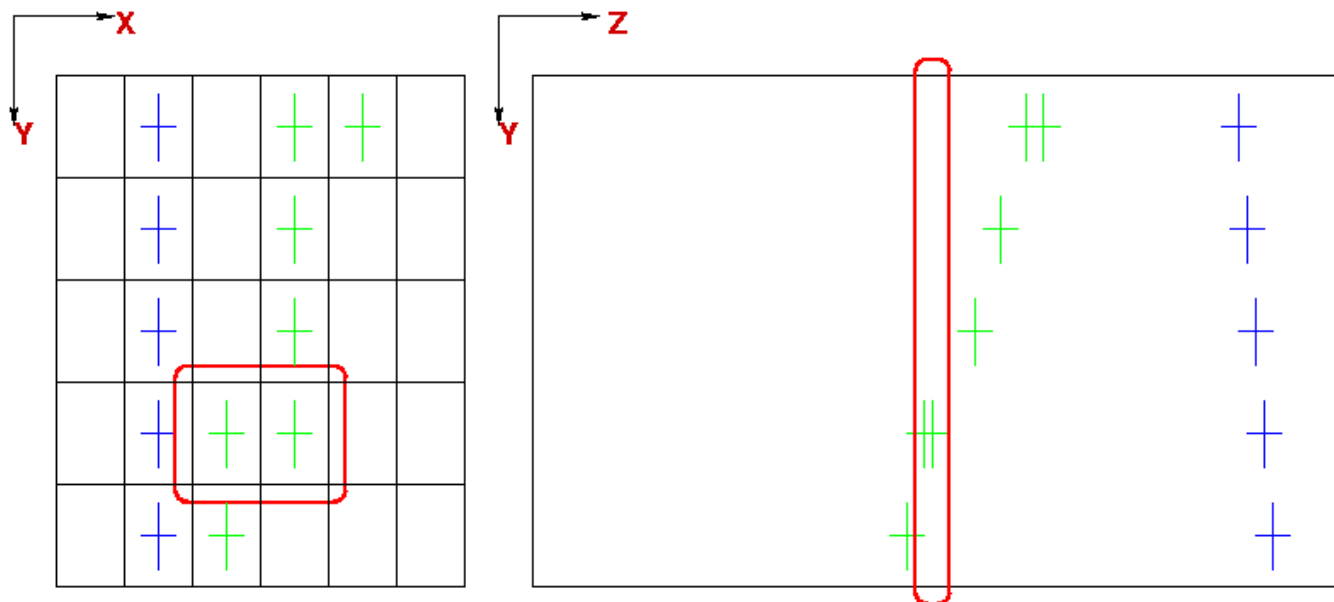
# ClusterFinder: Double-Pulse Separation

- during the pulse search: separation of pulses
  - detect the change in slope using the zero-crossing of the derivative
  - ignore variations in the order of noise



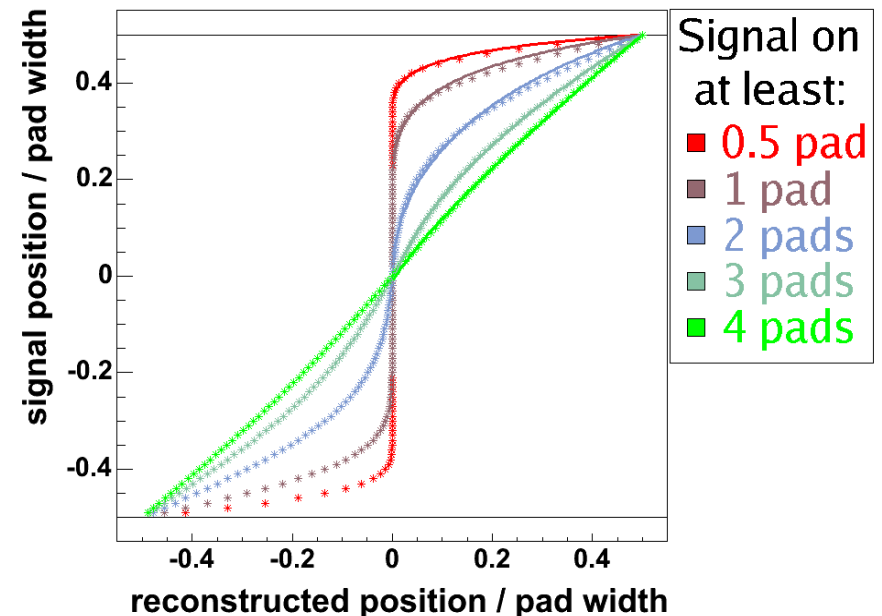
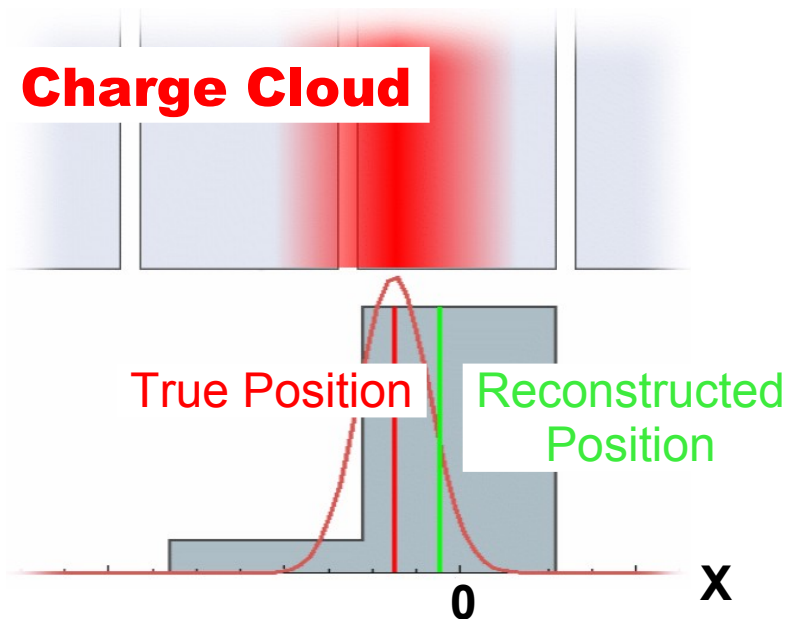
# ClusterFinder: Merge Pulses

- Second, combine the found pulses to hits
  - start with the biggest pulse (charge)
  - define a time window for search
  - use recursive method
    - add the pulse if it is smaller (in a given error band)
    - take care of damaged pads



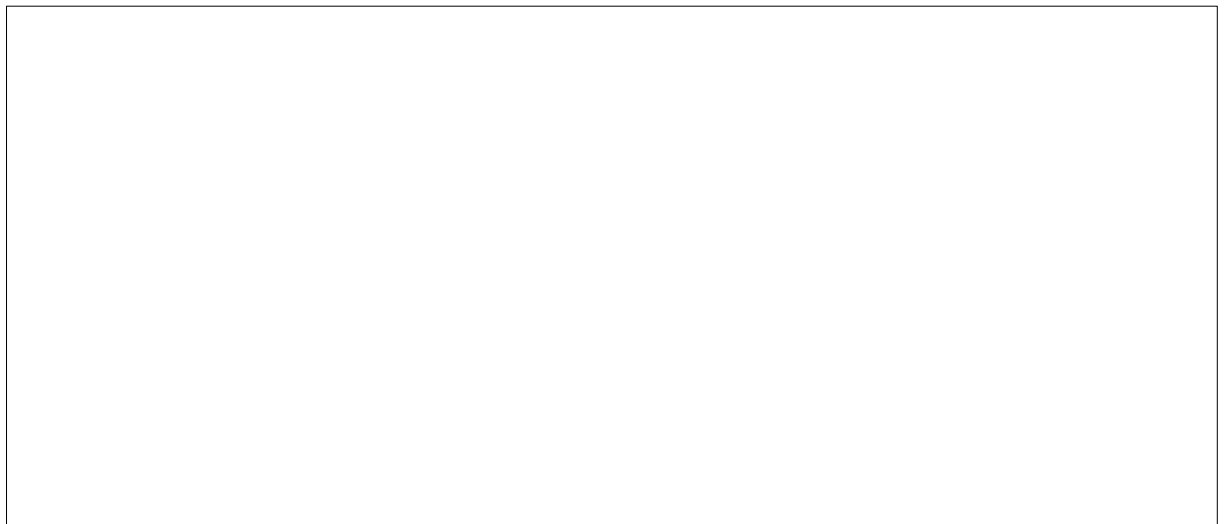
# ClusterFinder: PRF Correction

- Optional: correction of hit coordinate in xy-plane using the Pas Response Function
  - calculate the signal width out of
    - diffusion coefficient
    - defocussing constant (diffusion in amplification region)



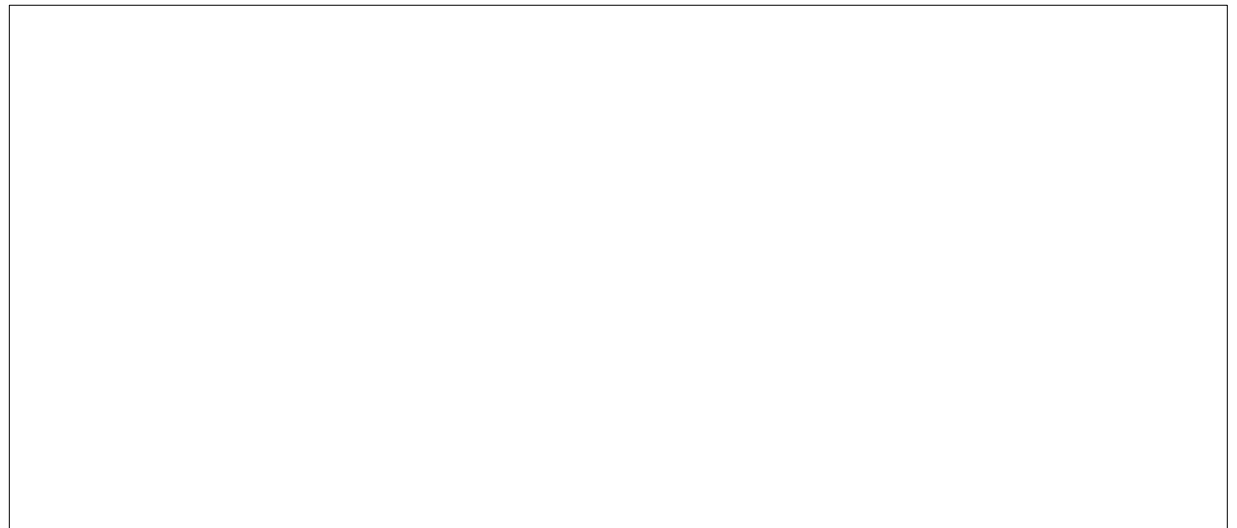
# TrackFinder: Track Following

- Combine the hits to tracks using straight 3D track-following method
  - initialise the track with two hits in different rows with a certain distance
  - calculate probable position for next row
  - add hit in search window, if it is free (if more than one: with the least Chi2)
  - refit track and continue with next row



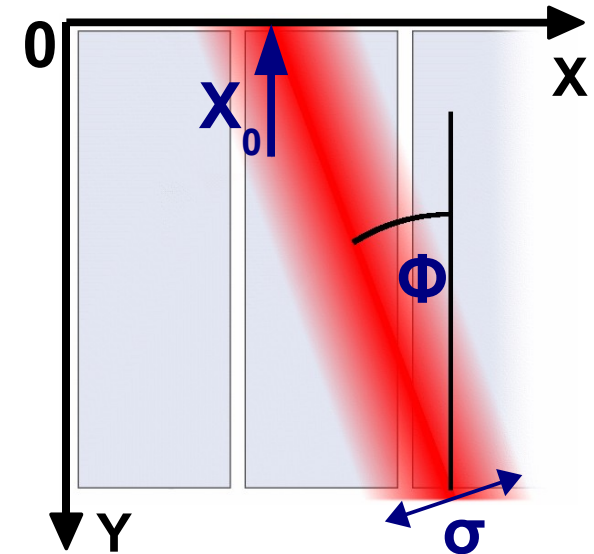
# TrackFinder: False Track

- To avoid false tracks
  - allow only small gaps
  - save tracks
    - with a minimal number of hits
    - a minimal probability  
(dangerous for curved tracks)



# Trackfitter

- Various fitting techniques
  - for the Chi2-based methods
    - errors of the hits as weight
    - otherwise all set to 1
  - for the advanced methods
    - the noise value can be set
- Calculate track parameter
  - in XY:
    - straight: intercept, slope
    - curved: curvature, centre-coordinate
  - in YZ: intercept, slope
- Determine the residuals for the hits
  - including and excluding the corresponding hit during the track-fit

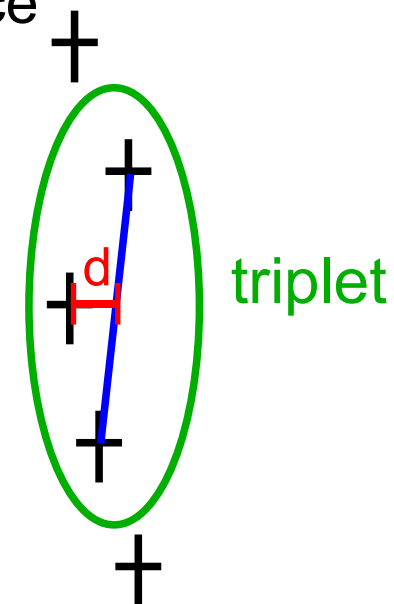


# Determine the Resolution

- Geometric Mean Method
  - Determine width of distribution of residuals for:
    - track with all hits:
    - track without the corresponding hit
  - resolution: geometric mean of both
    - for straight tracks: analytically proven
    - for circular tracks: produces the right result in MC

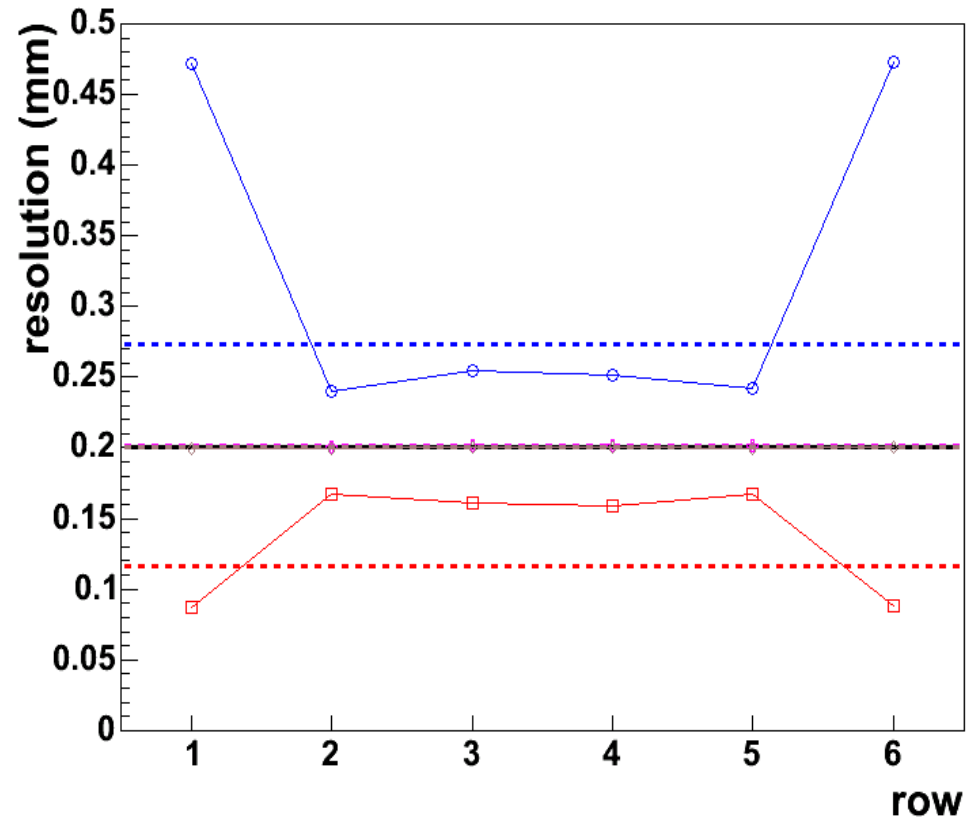
- Triplet Method
  - determine residual only from three adjacent pad rows:
  - draw straight line through outer hits
  - determine distance between straight line and central hit
  - resolution  $\sigma$  assuming same uncertainty for all hits:

$$\sigma = \sigma_d \sqrt{2/3}$$



# MC Test of Analysis Methods

- Circular tracks
  - 500mm < R < 2000mm
  - through the centre
  - no pad effects included
- Geometric mean
  - sensitive to local variations
- Triplet
  - neglect global correlations
- Both methods are complementary

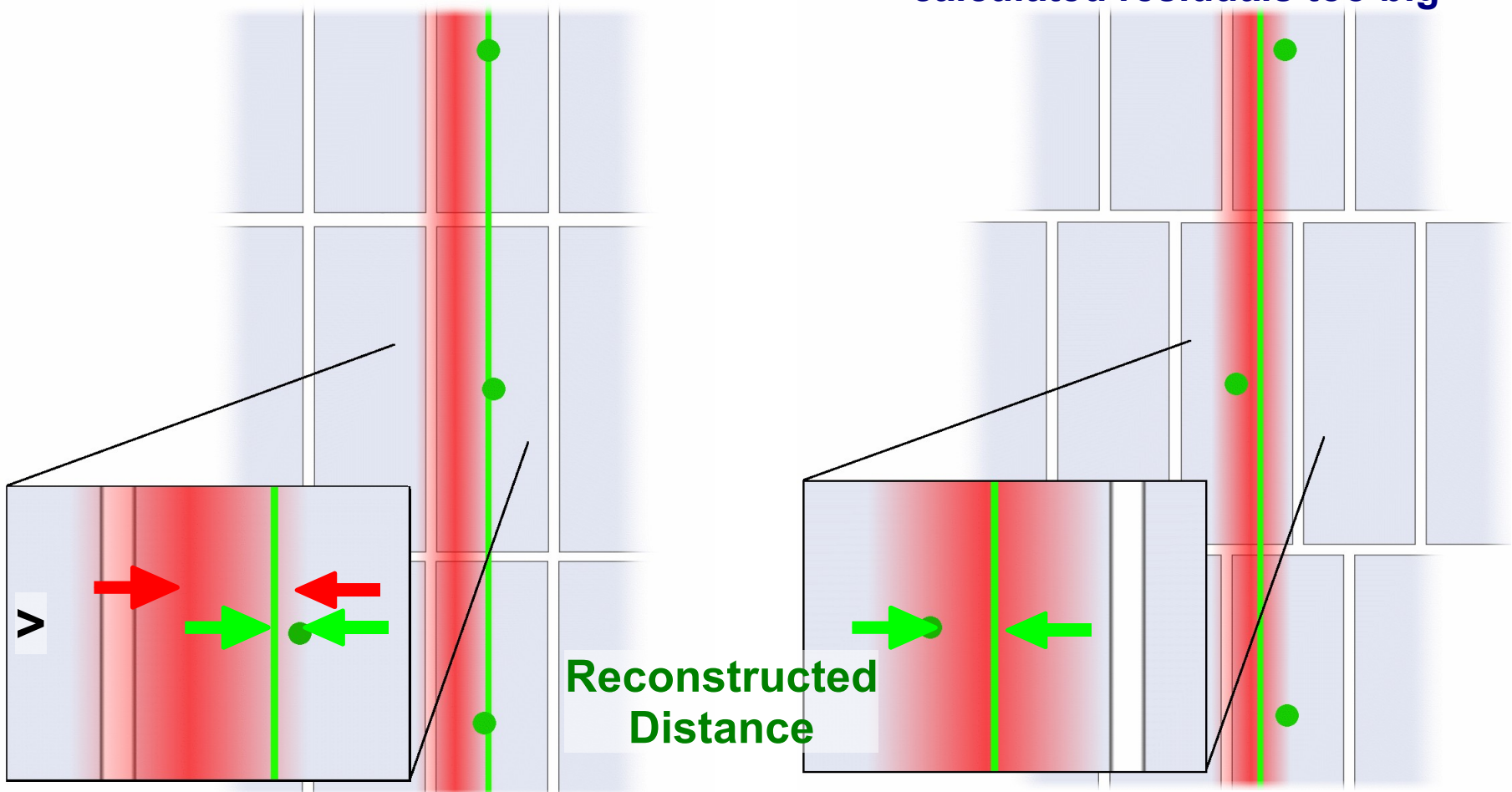


—○— residual without hit      —◇— geometric mean  
—□— residual with hit      —+— triplet      — MC truth

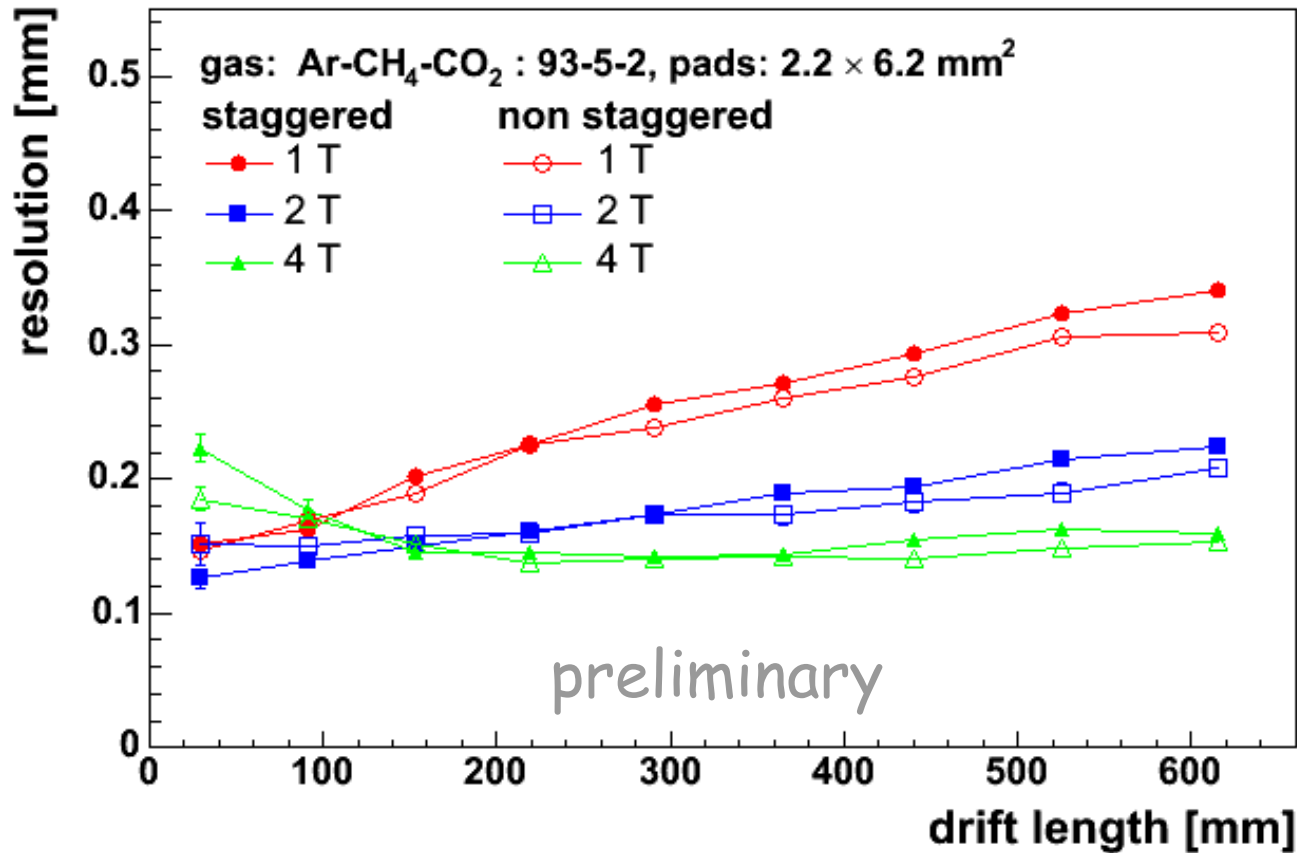
# Staggered vs. Non Staggered

Non-staggered Pads:  
reconstructed track “gets drawn”  
towards the reconstructed points  
**calculated residuals too small**

Staggered Pads:  
points get reconstructed  
too far from track  
**calculated residuals too big**



# Point Resolution with Pad Response Function



- Staggered and non-staggered measurements get comparable
- Bigger values for small drift lengths in 4T (2T) data still indicate not enough charge sharing

# Summery&Outlook

- MultiFit is a reconstruction tool for small TPC-prototypes
  - modular (3-step reconstruction)
  - stand alone program
  - use ROOT for IO
  - read ROOT and LCIO based input data
  - analysis with ROOT scripts
- MaTRIX: Marlin based Track Reconstruction for ILC Experiments will be the Successor
  - embedded in the Marlin analysis framework
  - use LCIO for IO and
  - GEAR as geometry interface
  - LCCD allows handling of conditions data
  - better encapsulation of the modules