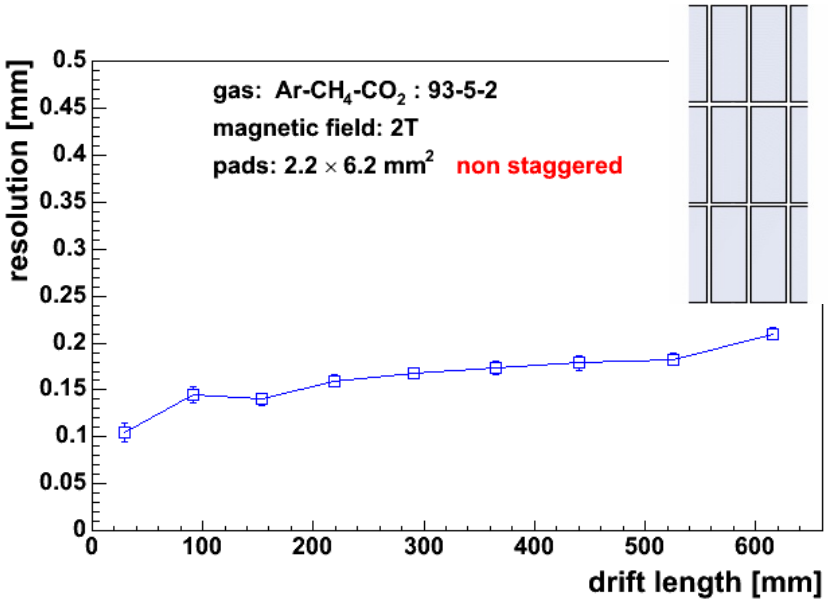
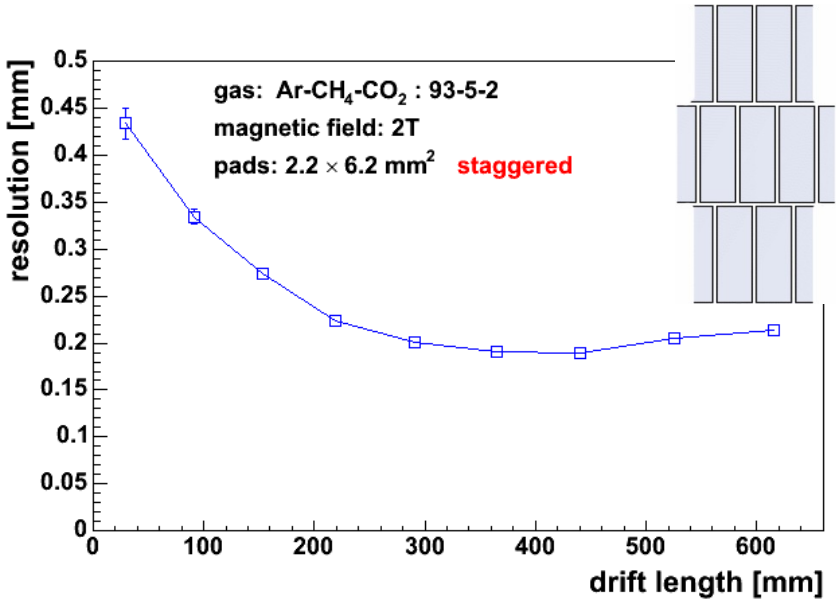
The Pad Response

- Motivation:
  Resolution results for non-staggered and staggered pad layout

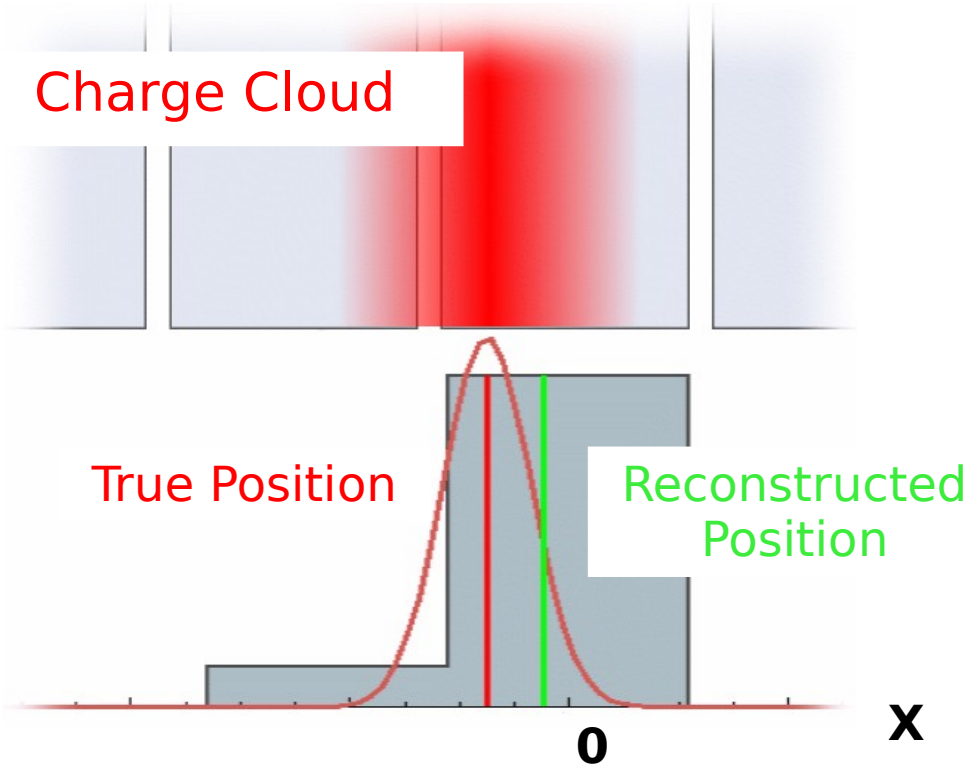


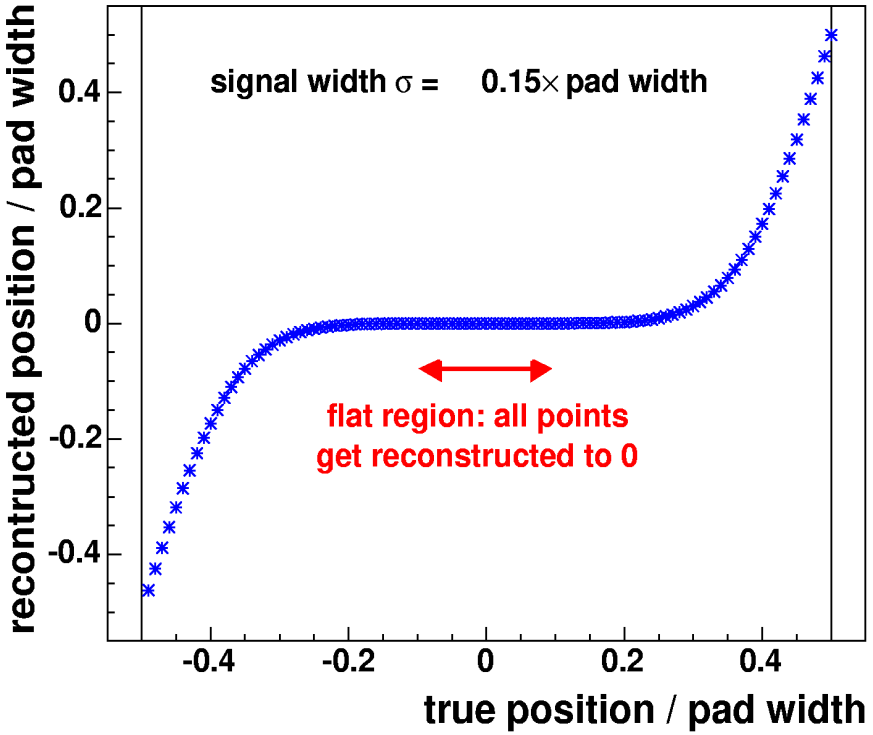


- Non-staggered pad layout:
  - Expected dependence on drift length

- Staggered pad layout:
  - Increasing values at small drift lengths
  - Explanation: not enough charge sharing for correct reconstruction of point positions and residuals (Pad Response)

The Pad Response

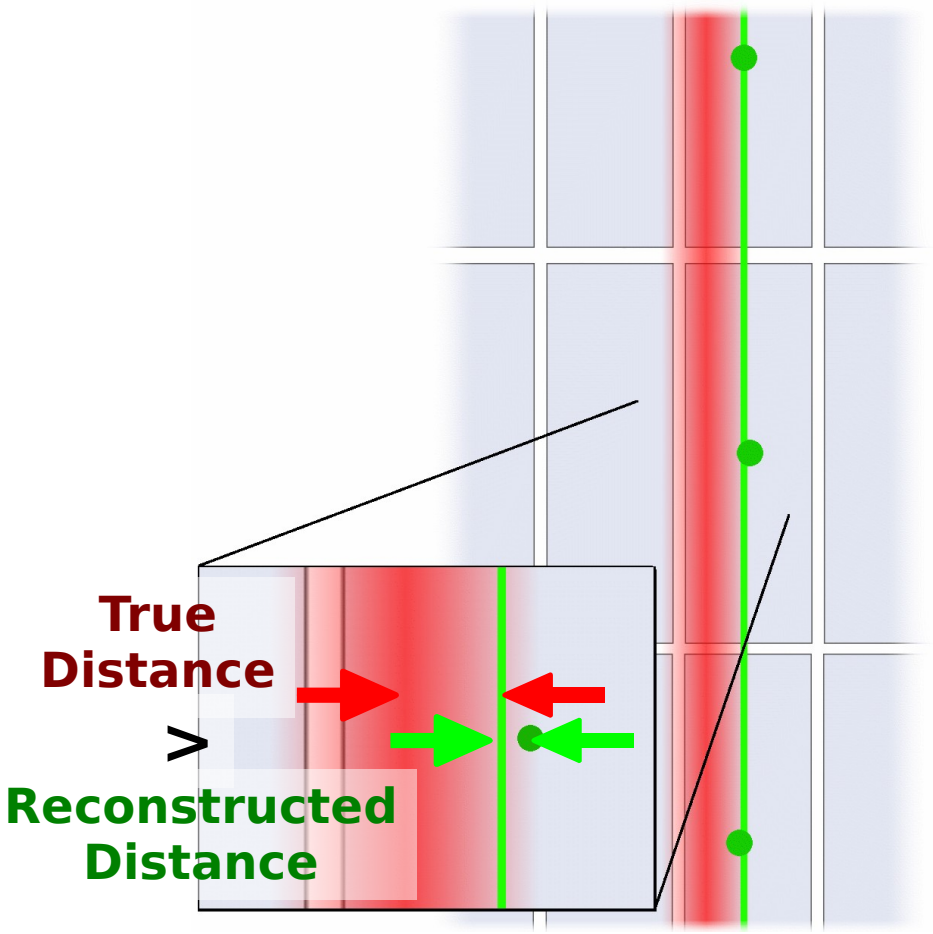




- Not enough charge sharing →
  Instead of at the true position, hits are reconstructed by Center of Gravity method towards the middle of the pad with highest signal

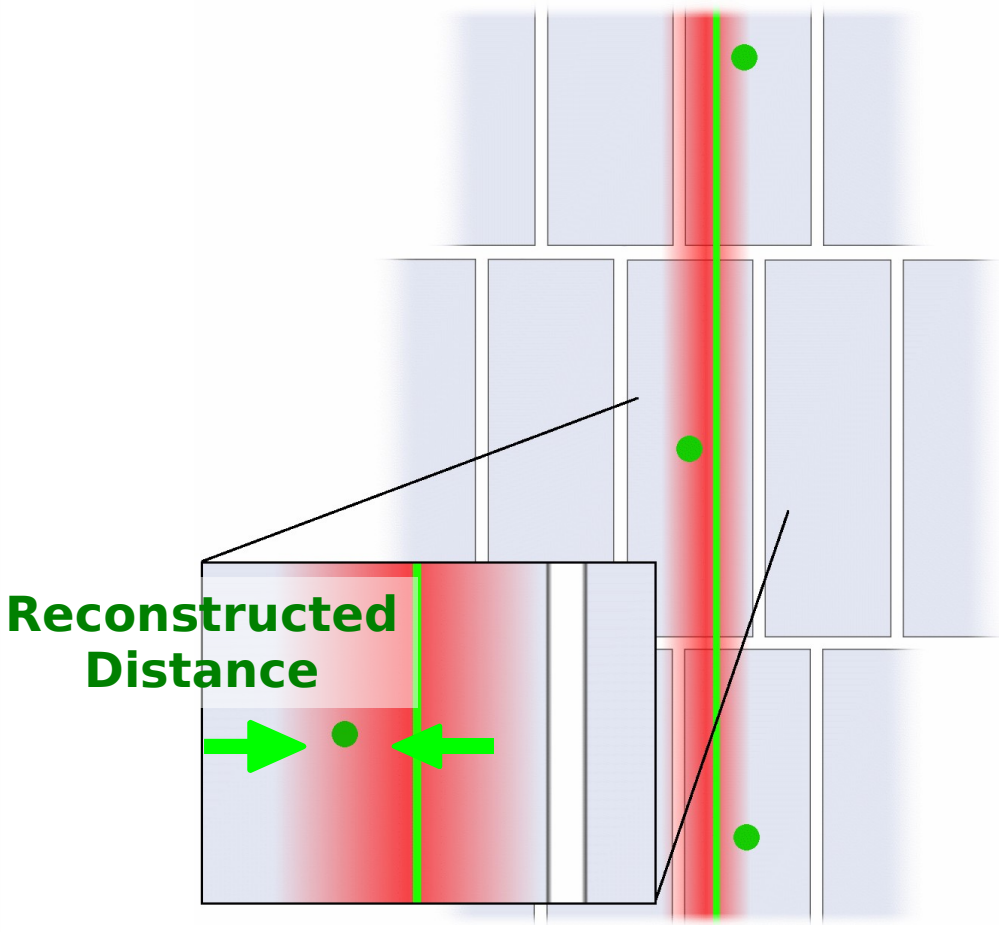
Effect on the Resolution

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



Staggered Pads:
points (Hits) get
reconstructed
too far from track

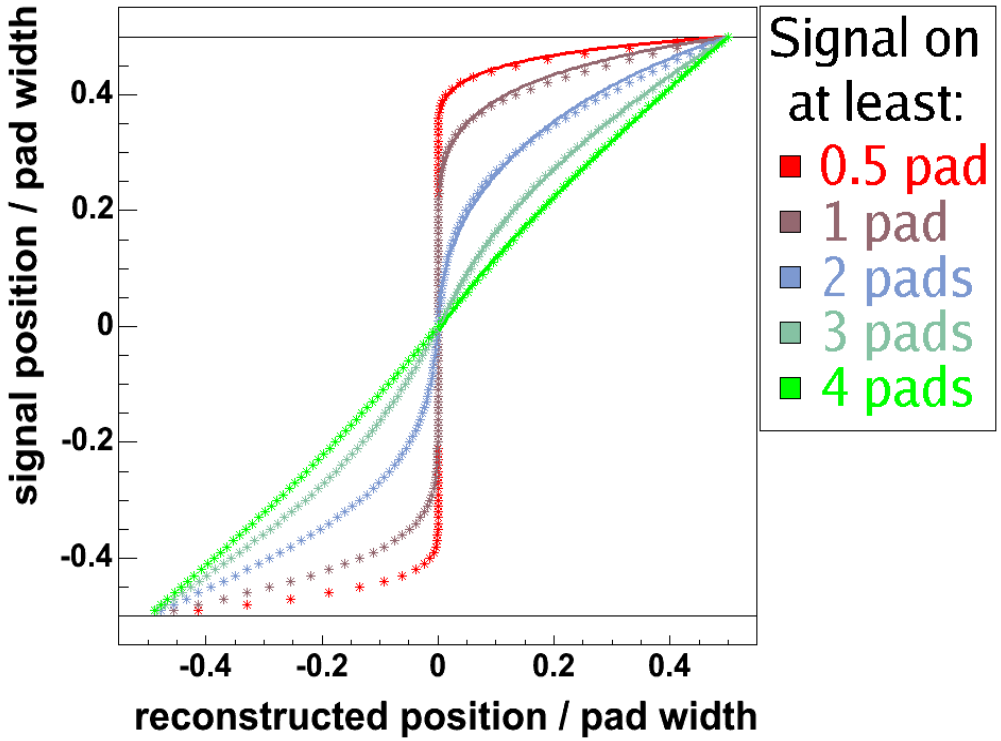
calculated residuals
too big

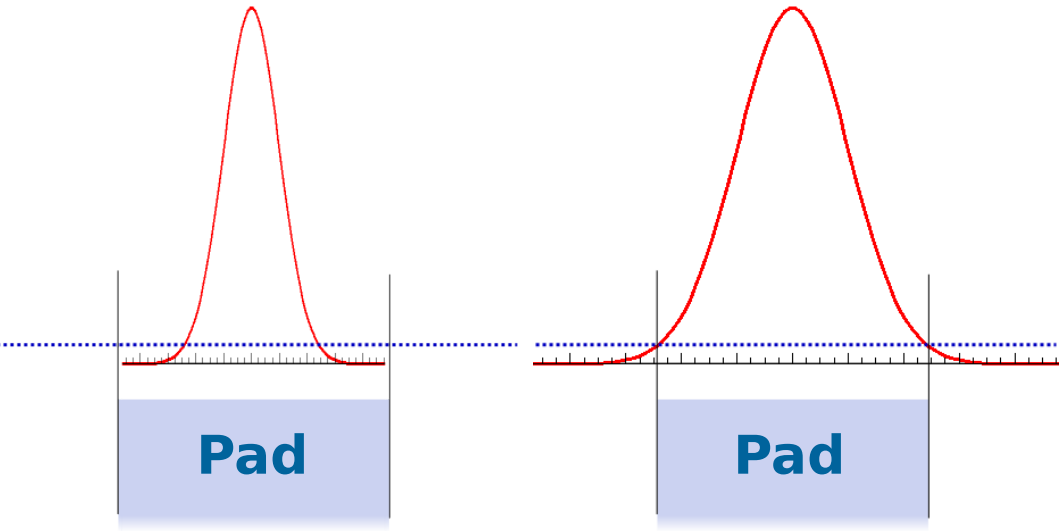


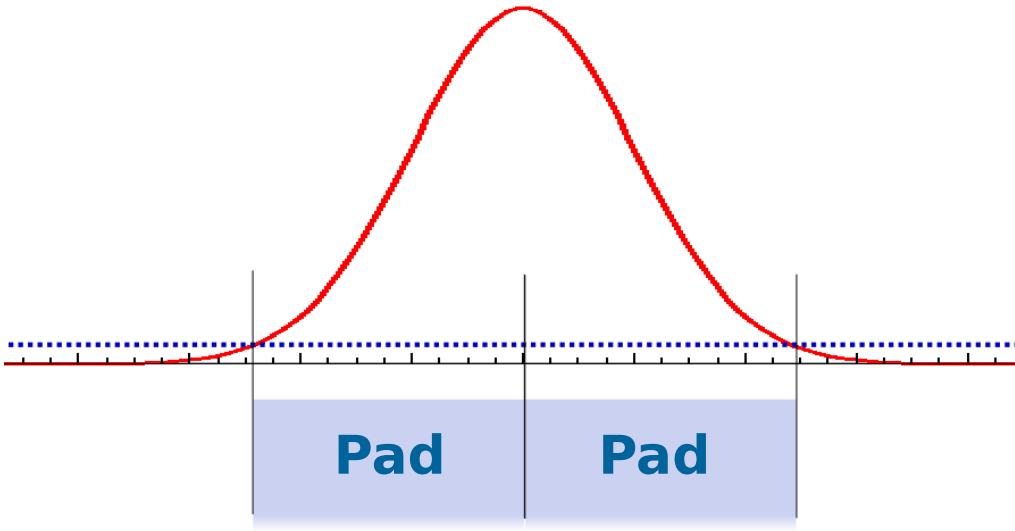
Pad Response Correction

- Pad Response Function
  Simulate signal of a Gaussian charge cloud on your pads
- $$Q_{pad}(y) = \int_{-\infty}^{+\infty} \left(\Theta(\psi - \frac{\Delta}{2}) * \Theta(-\psi + \frac{\Delta}{2}) \right) \times \left(\frac{Q_{max}}{\sqrt{2\pi}\sigma_S} * \exp\left[\frac{-(y-\psi)^2}{2\sigma_S^2} \right] \right) d\psi$$

  with cutoff at noise value (threshold)
- Apply center of gravity method to get pad response







Pad Response Correction

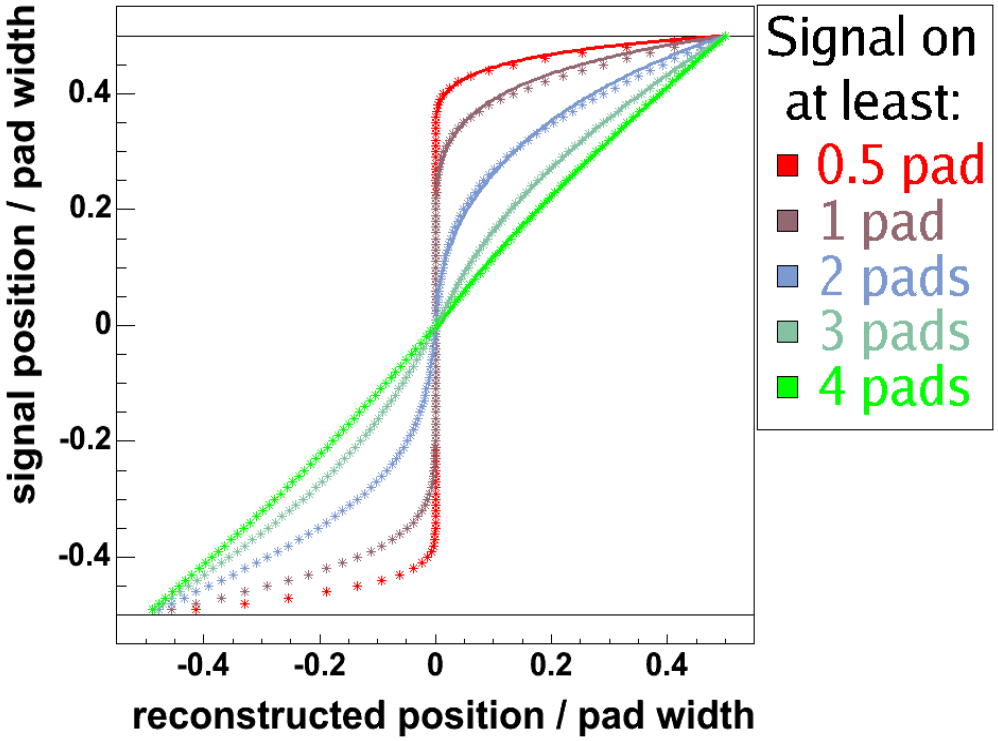
- Pad Response Functions:

$$F_{noflat} = P_1 x + P_2 \sqrt{x} + \left(\frac{1 - P_1}{2} - \frac{P_2}{\sqrt{2}} \right) \cdot \sqrt[3]{2x}$$

$$F_{flat} = P_0 + P_2 \sqrt{x} + \left(\frac{1 - 2P_0}{2} - \frac{P_2}{\sqrt{2}} \right) \cdot \sqrt[3]{2x}$$

(no physical background, just functions that fit the curves)

- Parameters P_0, $P_{1 \text{ and}}$ P_2 depend on the width of the signal σ



Pad Response Correction

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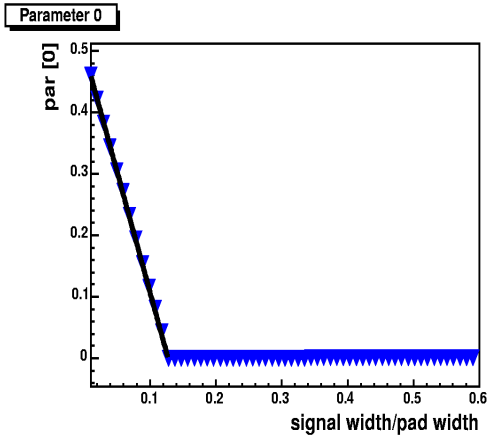
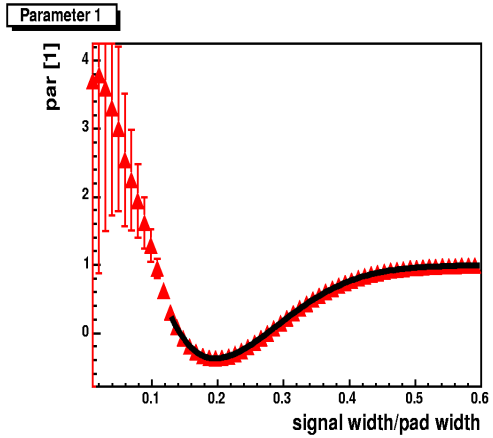
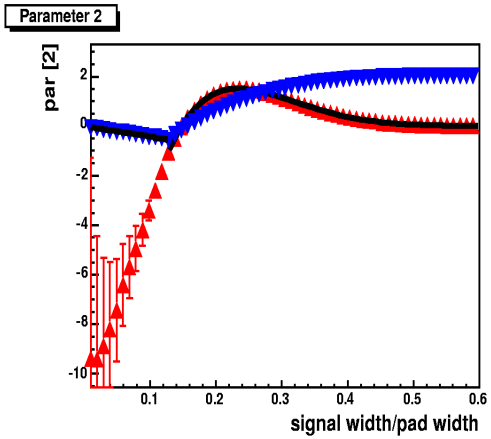
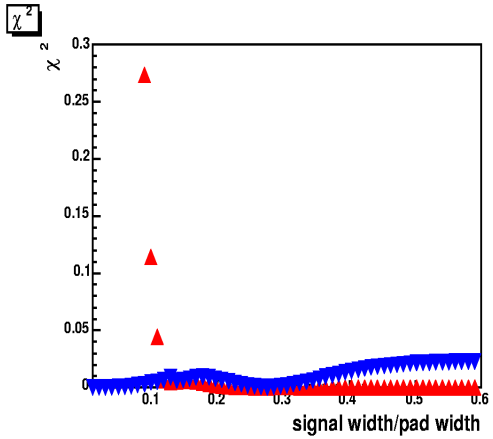




- Parameters:
  dependent on width σ
  Fit F-functions to PRF
  functions for many widths
  to get P_i for many widths





→ fit appropriate polynomials
to the parameter curves

$$P_{0,flat}(\sigma) = a_{01} \cdot \left((1 - \sigma)/a_{00} \right)$$

$$P_{1,noflat}(\sigma) = a_{15}\sigma^5 + a_{14}\sigma^4 + a_{13}\sigma^3 + a_{12}\sigma^2 + a_{11}\sigma + a_{10}$$

$$P_{2,flat}(\sigma) = a_{26}\sigma$$

$$P_{2,noflat}(\sigma) = a_{25}\sigma^5 + a_{24}\sigma^4 + a_{23}\sigma^3 + a_{22}\sigma^2 + a_{21}\sigma + a_{20}$$

→ polynomials implemented in Software; needed input:
diffusion and defocussing coefficients to calculate width for given Z

Pad Response Correction

- To apply correction:

- Calculate width of hit **on the pad plane** from Z position (by using values from Magboltz):

$$\sigma = \sqrt{D\,z + \sigma_0}$$

	P5		TDR	
B (T)	D (mm) 10^{-4}	σ_0 (mm^2)	D (mm) 10^{-4}	σ_0 (mm^2)
0	571	0.288	202	0.180
1	24.05	0.227	34.1	0.142
2	7.24	0.190	11.5	0.110
4	1.92	0.140	3.00	0.070

- Use this width to calculate the parameters P_0, $P_{1 \text{ and }} P_2$ (and decide which function to use: *“flat”* or *“noflat”*)

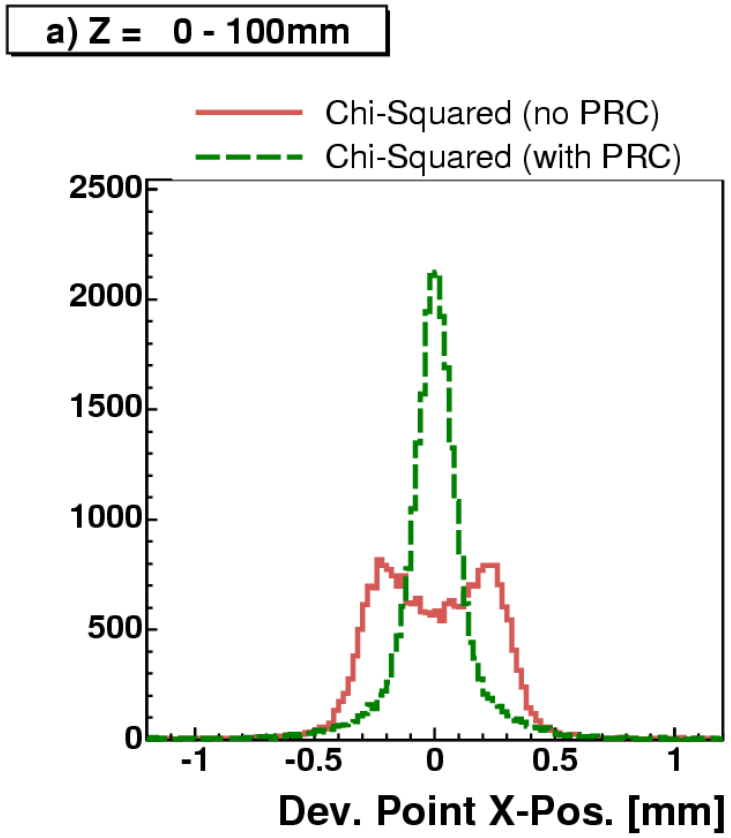
- Use the pad response to correction function to calculate the “real” position from the measured position (from Center of Gravity method)

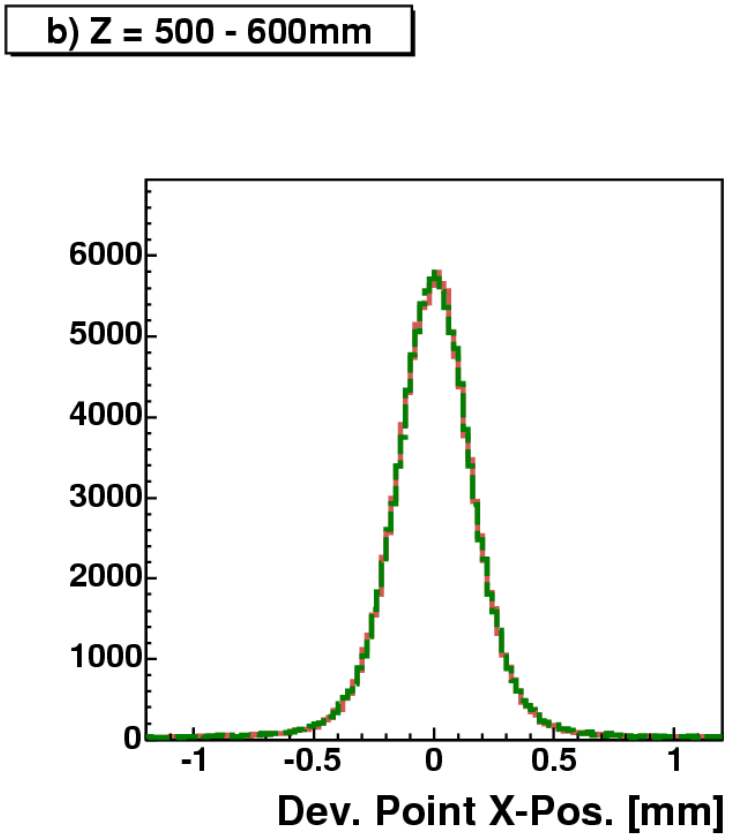
- If the signal is only on one pad or in the flat region: no correction possible, Hit gets assigned the coordinate of the center of the pad

Performance of Correction

- Use of Pad Response Correction in the point (Hit) reconstruction leads to a significant improvement

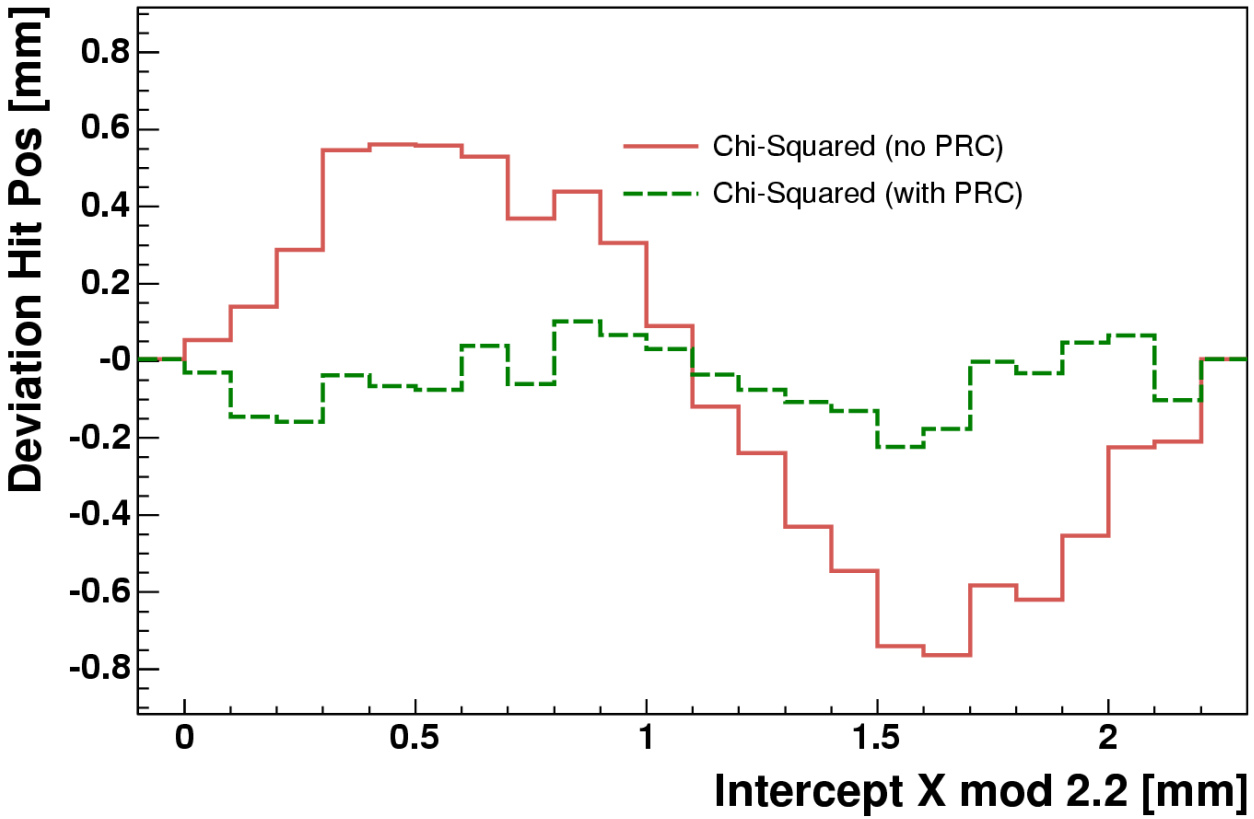
Deviation: hit position ↔ Monte Carlo track
Monte Carlo Data: 2T, P5 gas, staggered pad layout





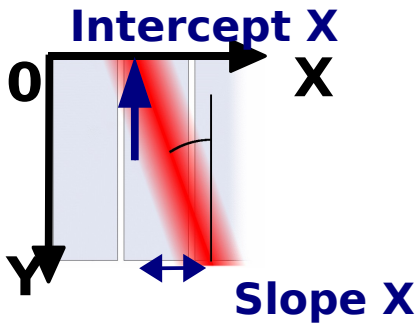
Performance of the Correction

- Deviation of the reconstructed Hit position from the Monte Carlo track position
- Plotted in dependency on the location of the Monte Carlo track on the pad

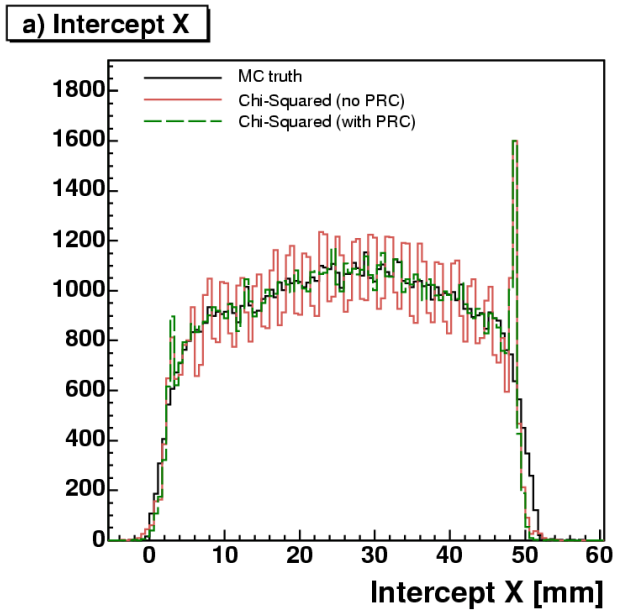


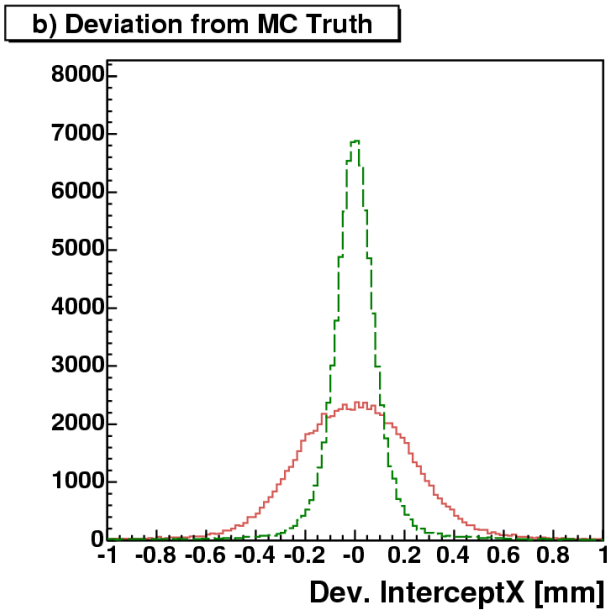
Performance of Correction

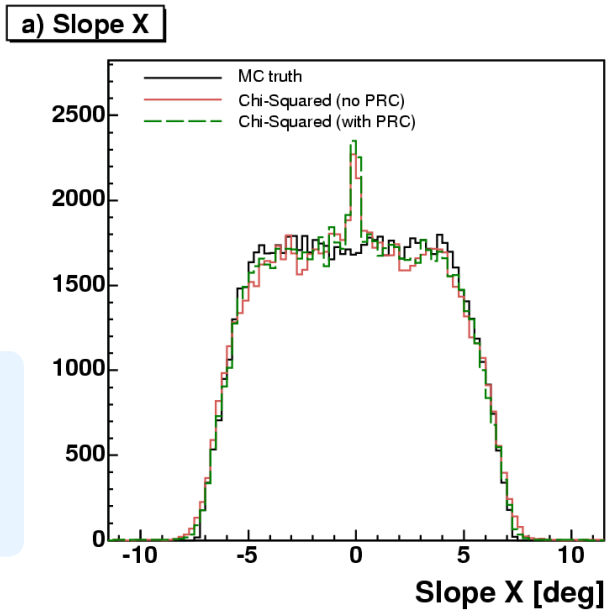
- Improvement of the reconstructed track parameters

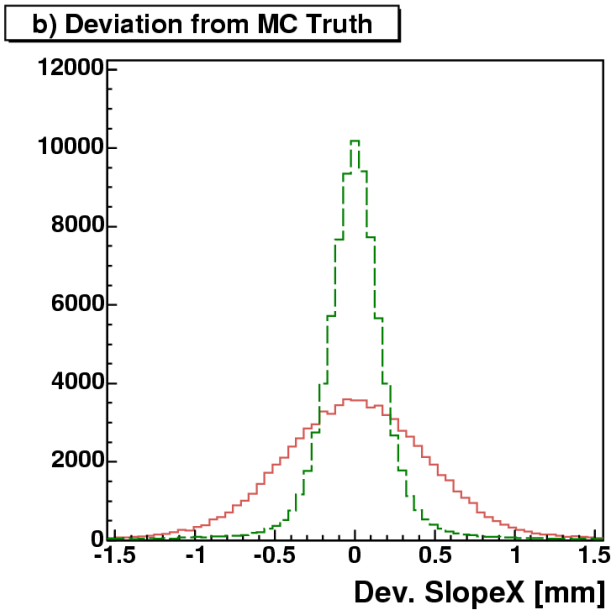


Monte Carlo Data:
4T, P5, staggered pad layout



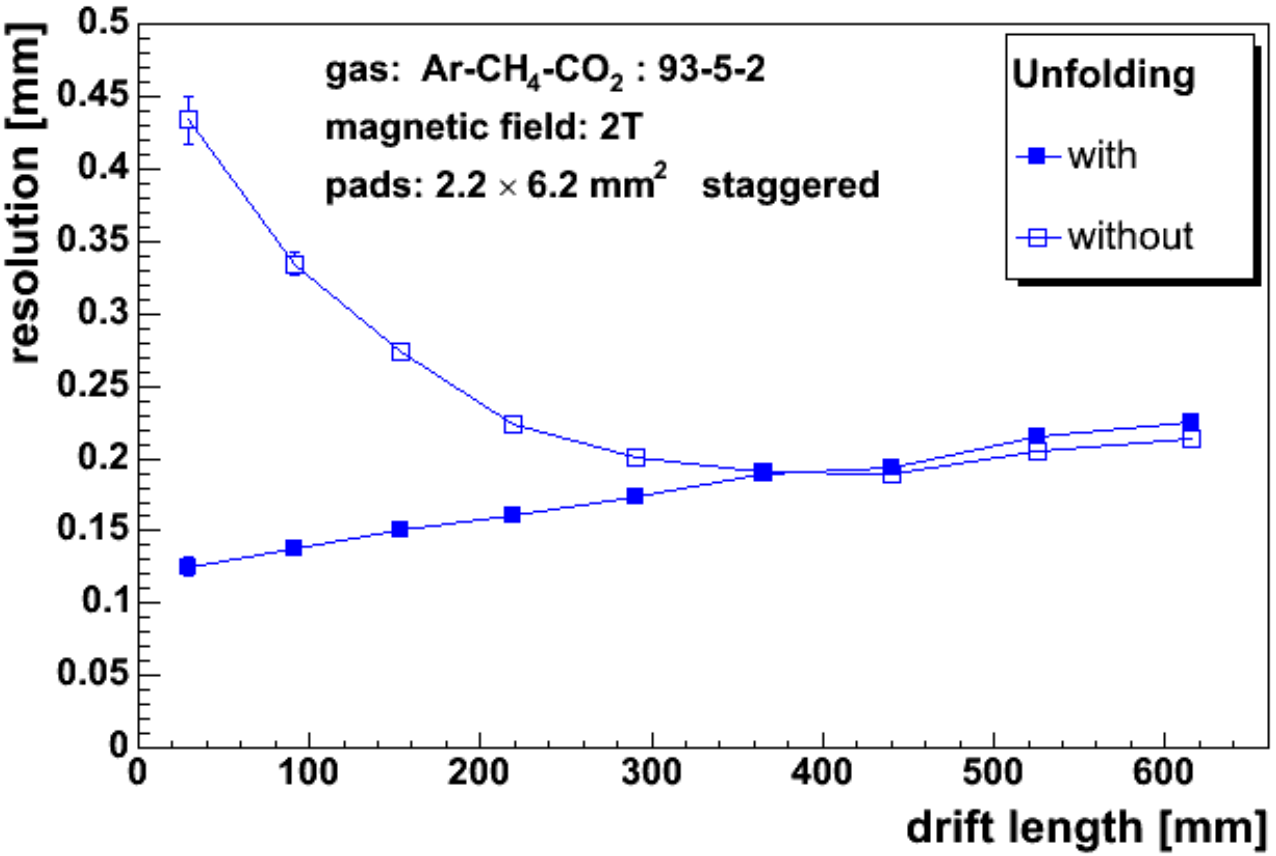






Resolution with Correction

- Use of Pad Response Correction leads to a significant improvement of the point resolution calculation for a staggered pad layout



Point Resolution for staggered pad layout with and without PRC

Remarks

- Angle dependency not included; effect is small for small angles and usually then a significant improvement is reached by applying the PRC, although results are not “exact”
- The noise value you use to cut of the Gaussian distribution of the charge signal is a very important input.
  When changing this input value, the Pad Response Functions will change significantly
- The Global Fit method incorporates the Pad Response in its fit functions including the angle dependency