Track Resolution Studies for a MPGD TPC

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DESY FLC
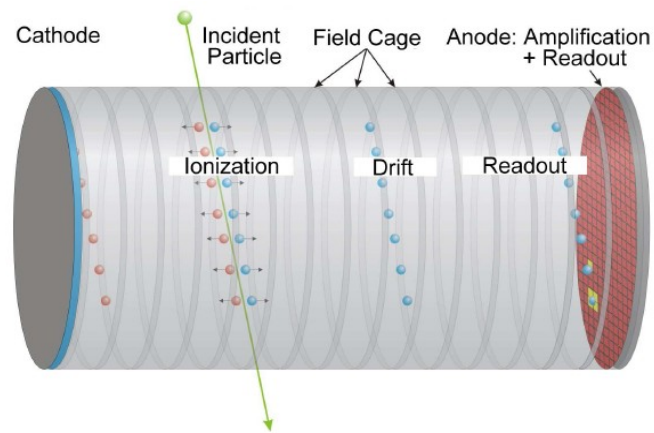
May 31, 2007

LCWS 2007

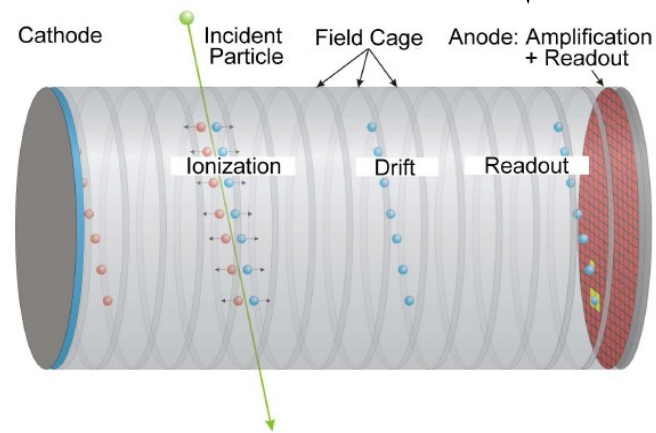# Overview

➢ Time Projection Chamber (TPC)

Overview

➢ Time Projection Chamber (TPC)
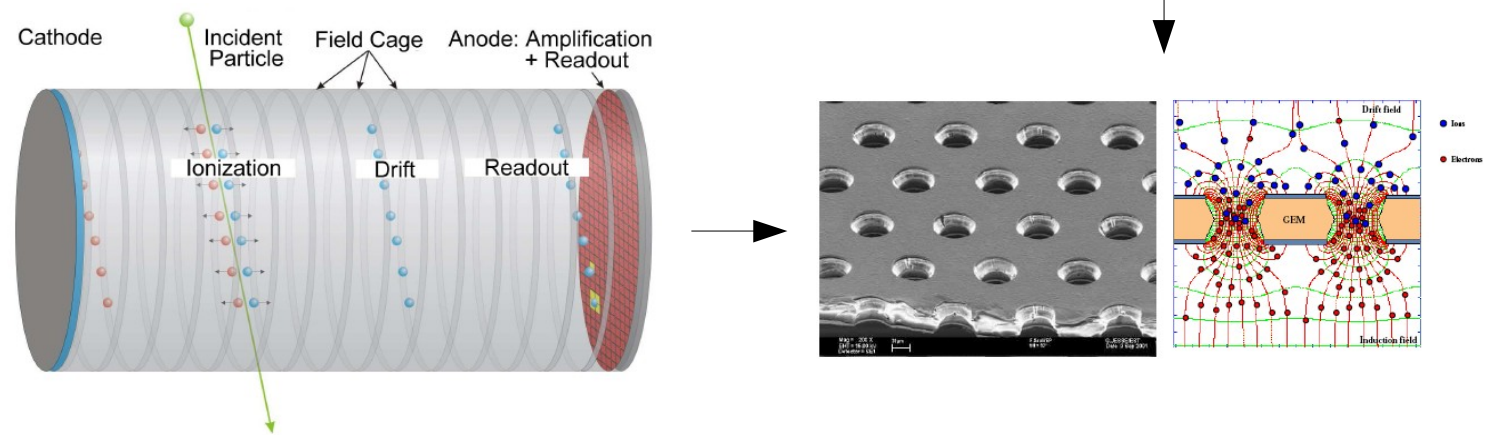
➡ MicroPatternGaseousDetector (MPGD)

Cathode   Incident Particle   Field Cage   Anode: Amplification + Readout

Ionization   Drift   Readout

Klaus Dehmelt
LCWS
Hamburg, May 31, 2007

Overview

➢ Time Projection Chamber (TPC)

➡ MicroPatternGaseousDetector (MPGD)

➡ GasElectronMultiplier (GEM)

Track Reconstruction
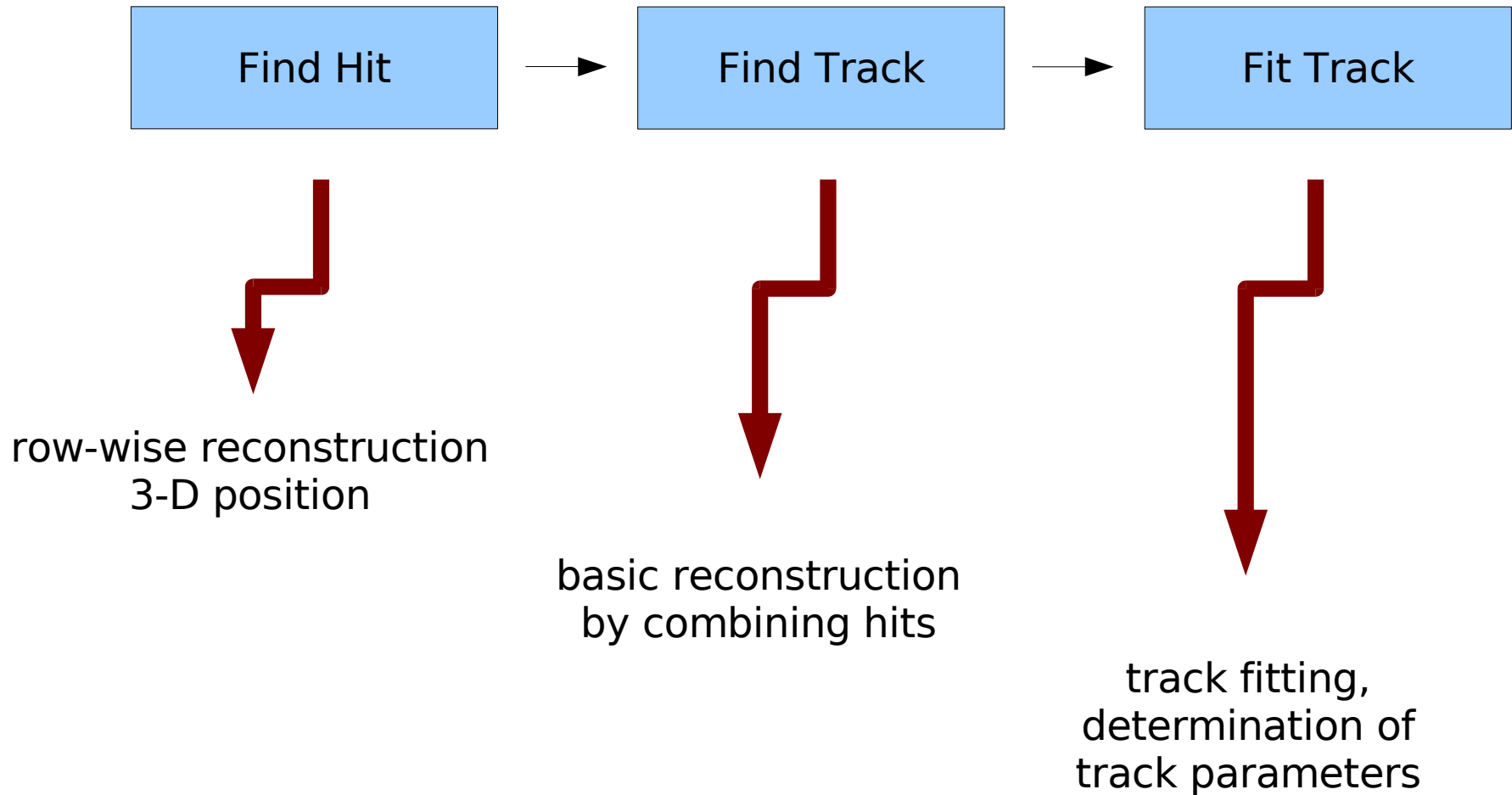
➢ "**MultiFit**" software package

staggered resp.
non-staggered

cosmic muon

sensitive volume

pad plane

TPC
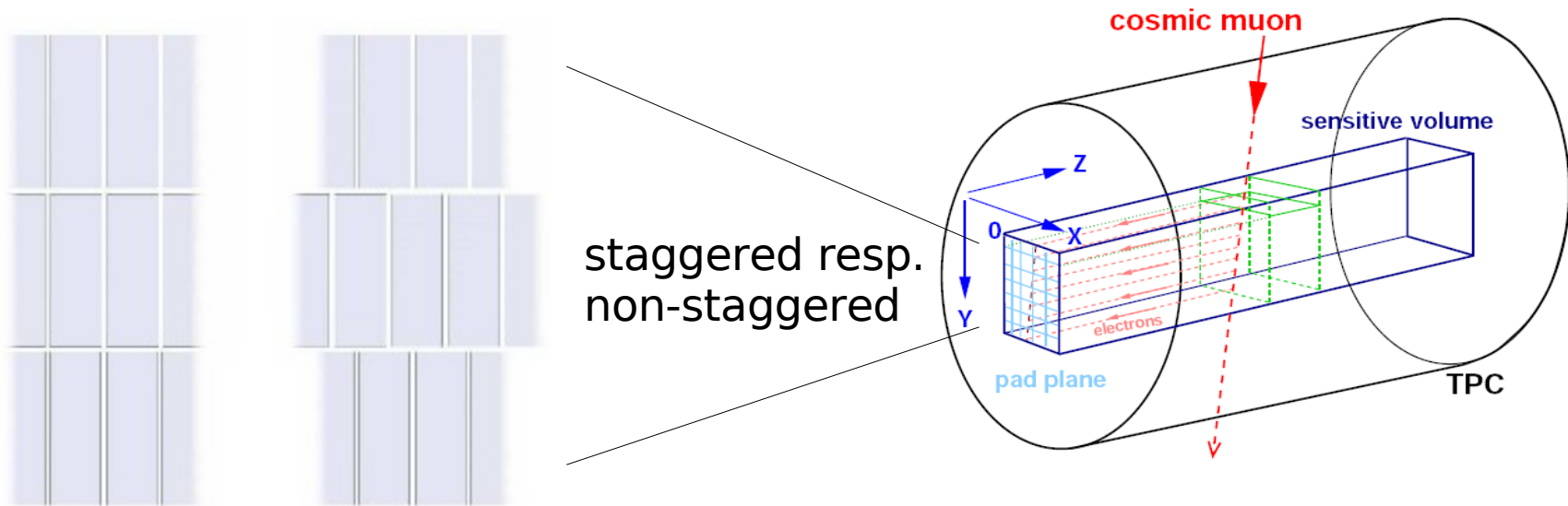
Pad layout:
   24 columns, 8 rows
   pitch 2.2 mm x 6.2 mm

$\rightarrow$ Medi-TPC

Track Reconstruction

Find Hit	→	Find Track	→	Fit Track

row-wise reconstruction
3-D position

basic reconstruction
by combining hits

track fitting,
determination of
track parameters

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Track Fit

> Track Fit methods:

- χ^2 - method

- Global Fit method

For both, straight line and
circular arc tracks

Track Fit

> Track Fit methods:

- χ^2 - method

Adjustment of straight line / circular arc

for hits of x-y projection $\longrightarrow$

χ^2 - minimization

Track Fit

➢ Track Fit methods:

• Global Fit method

Adjustment of straight line(s) for pulses of
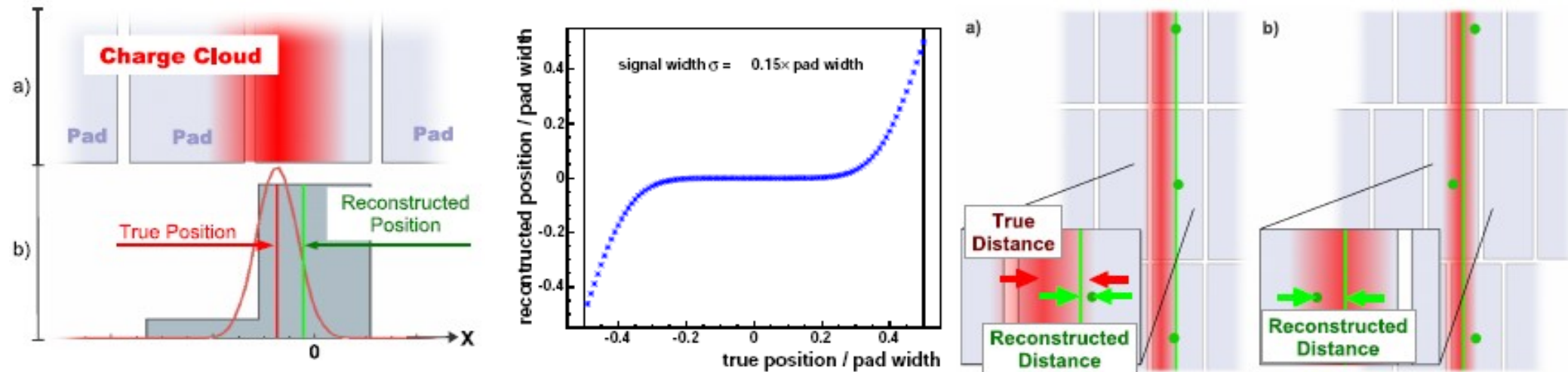
x-y projection →

maximization of likelihood function *
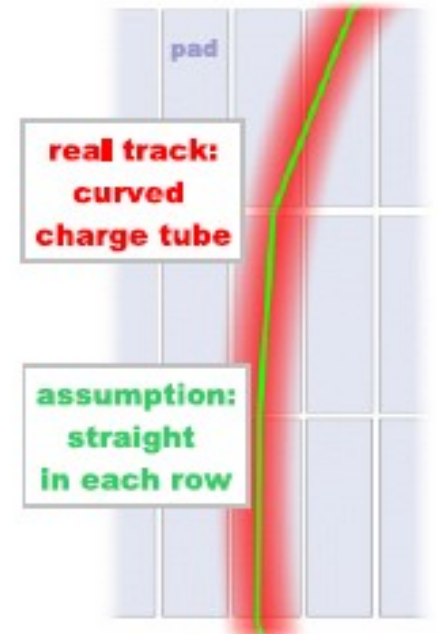
* D. Karlen et al., Nucl.Instrum.Meth. A555 (2005) 80-92

Pad Response

- χ^2 - method needs

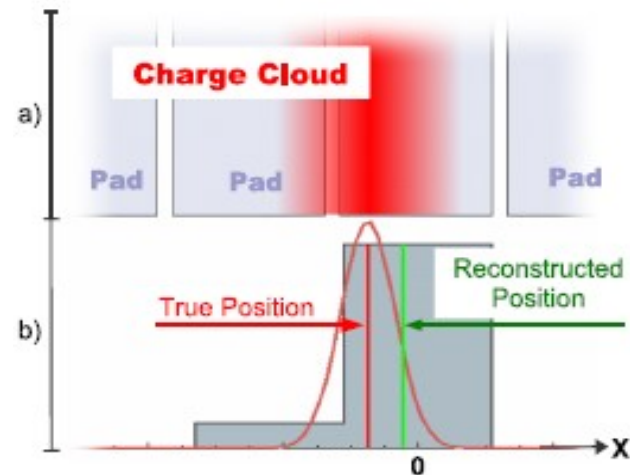Pad Response Correction (PRC)
due to
Pad Response Function (PRF)

$\rightarrow$ COG

Pad Response

- χ^2 - method needs

Pad Response Correction (PRC)
due to
Pad Response Function (PRF)
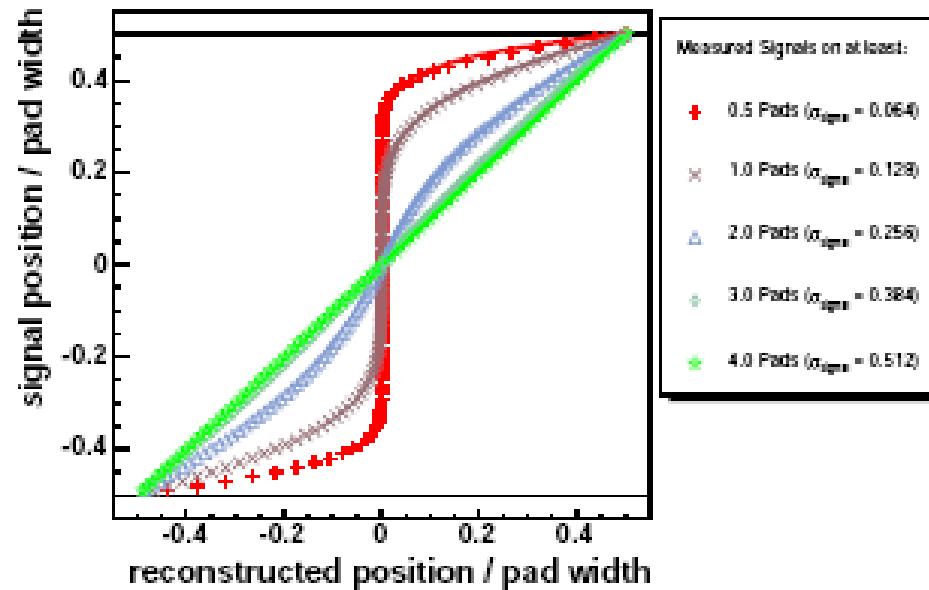
$\rightarrow$ COG
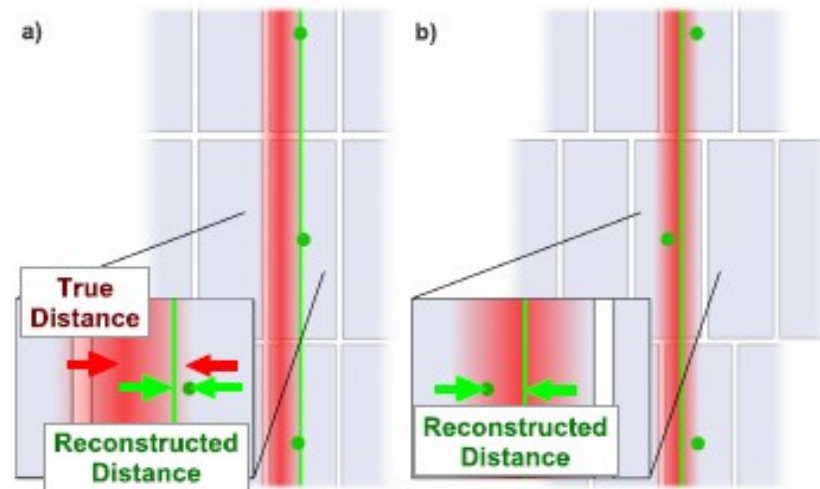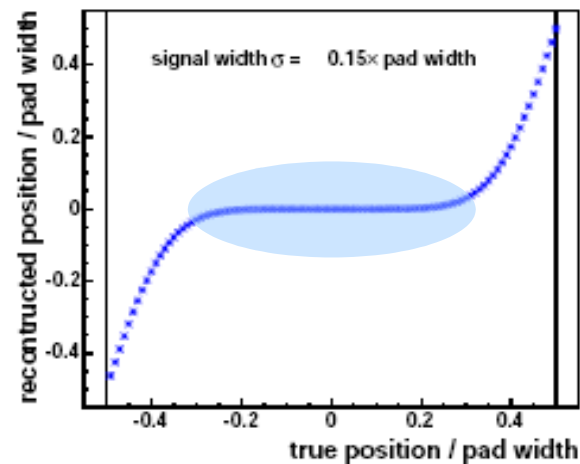
Pad Response

PRF:
$$Q_{Pad}(y) = \int_{-\infty}^{+\infty} \theta(\psi - \frac{\delta}{2}) \cdot \theta(-\psi + \frac{\delta}{2}) \times$$
$$\frac{Q_{max}}{\sqrt{2\pi}\sigma_s} \cdot \exp\left|\frac{-(y-\psi)^2}{2\sigma_s^2}\right| d\psi$$

PRC:
$$F_A = P_1 x + P_2 \sqrt{x} + \left(\frac{1-P_1}{2} - \frac{P_2}{\sqrt{2}}\right)\sqrt[3]{2x}$$
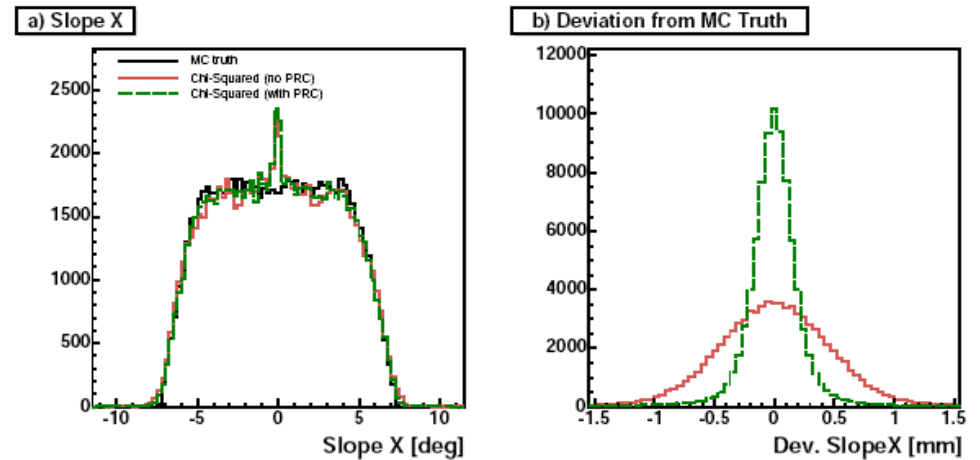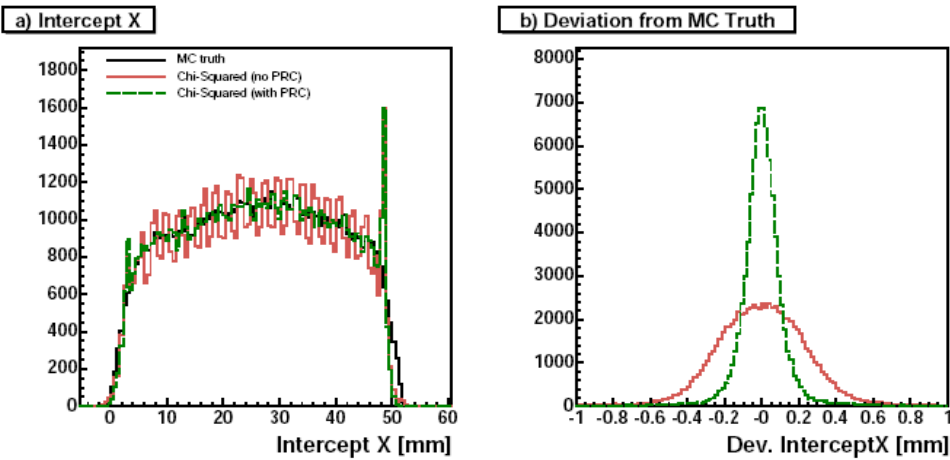$$F_B = P_0 + P_2 \sqrt{x} + \left(\frac{1-2P_0}{2} - \frac{P_2}{\sqrt{2}}\right)\sqrt[3]{2x}$$
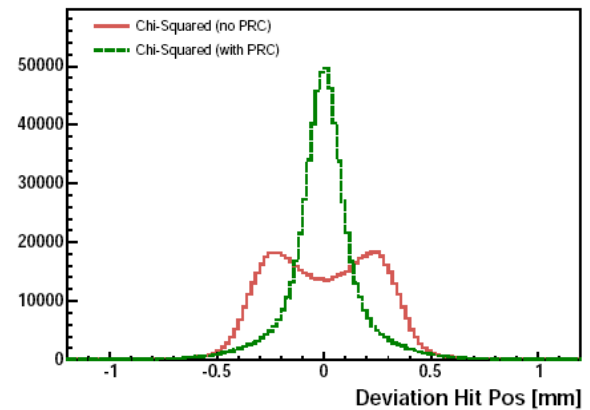
Pad Response

Staggered Pad Layout

Intercept   ### Slope
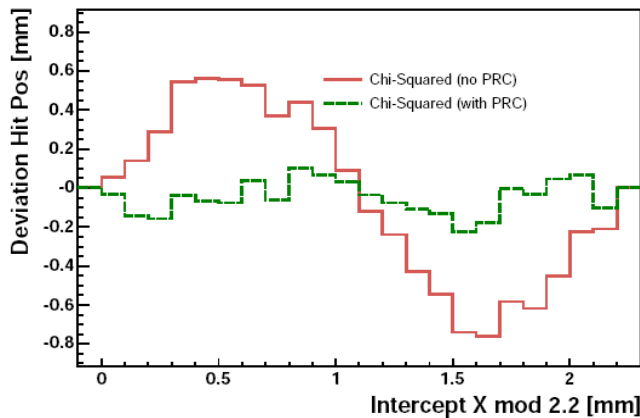
Hit Position

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Track Fit Methods

Track Slope
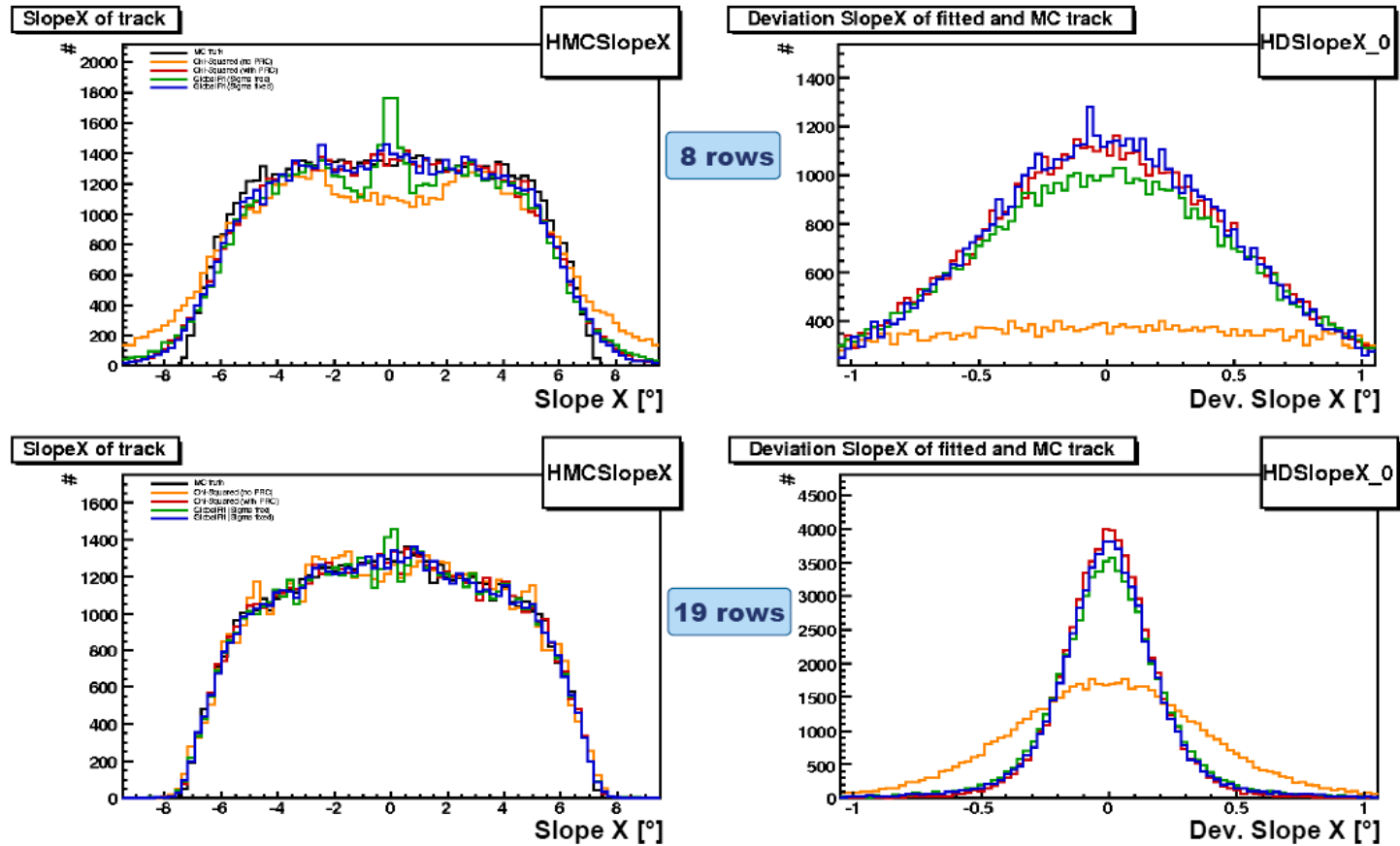
Track Fit Methods

Track Intercept
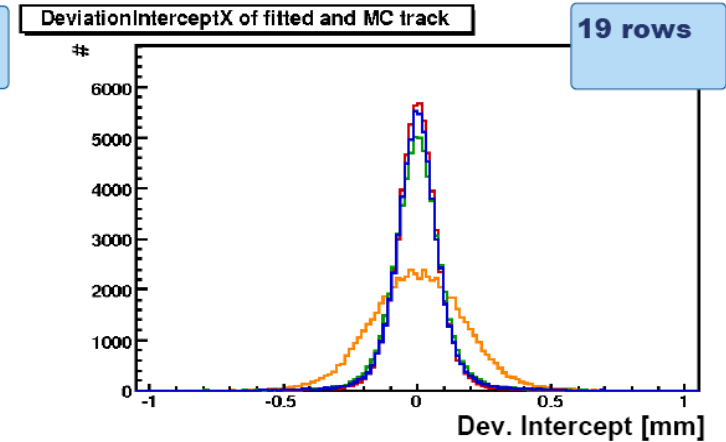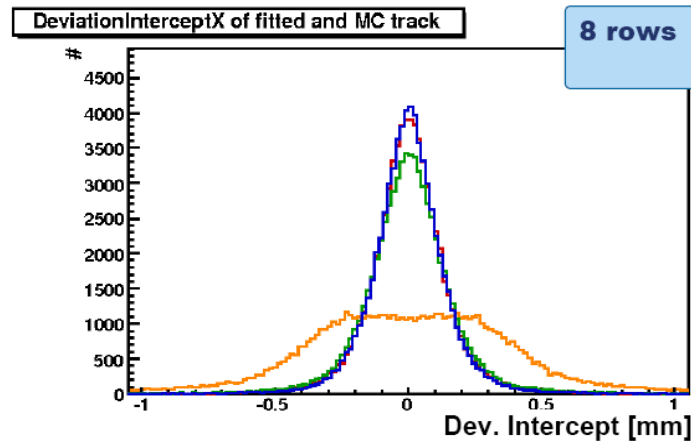
Track Point Resolution

Point Resolution: TDR gas, 4T, 8 rows

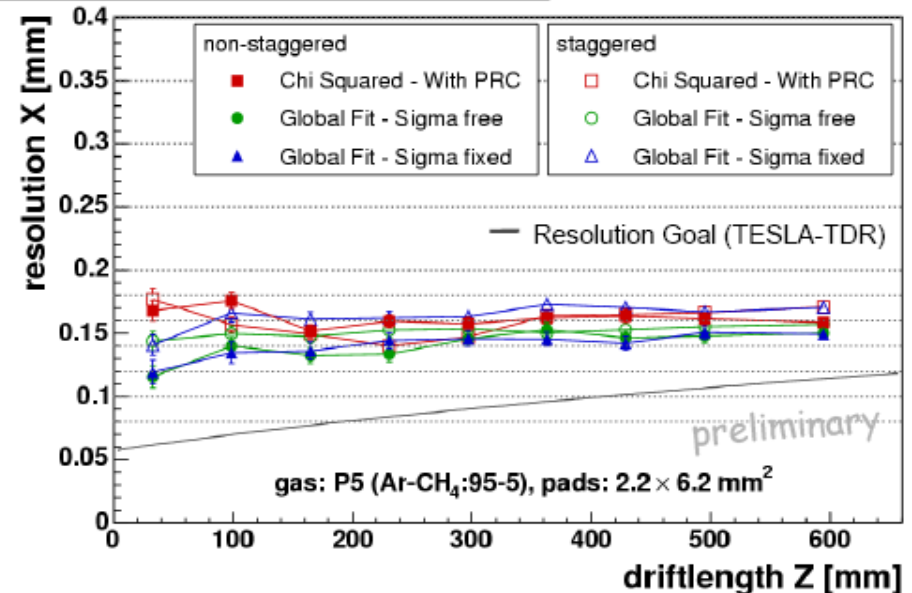gas: TDR (Ar-CH$_4$-CO$_2$:93-5-2), pads: 2.2×6.2 mm^2
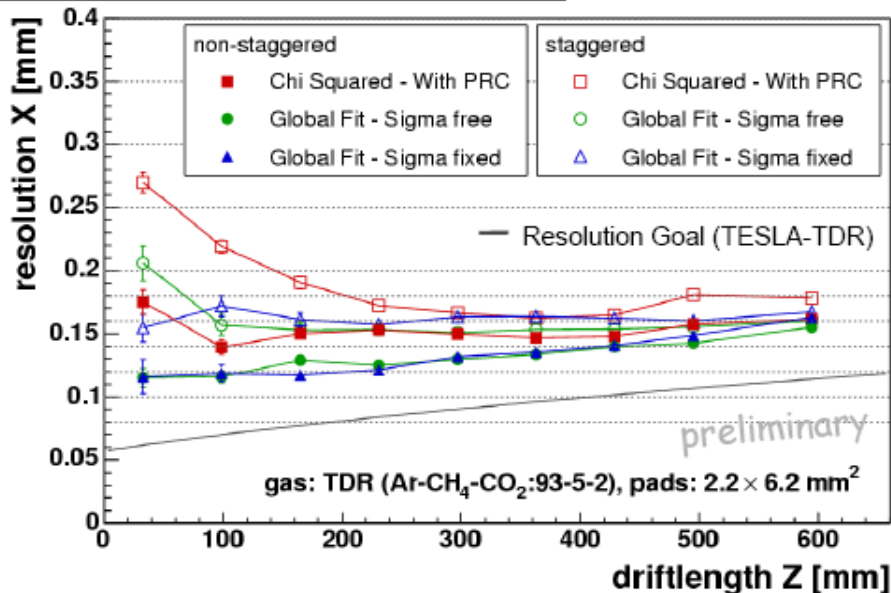
Cosmic Muon tracks
Pad layout:
    24 columns, 8 rows
    pitch 2.2 mm x 6.2 mm
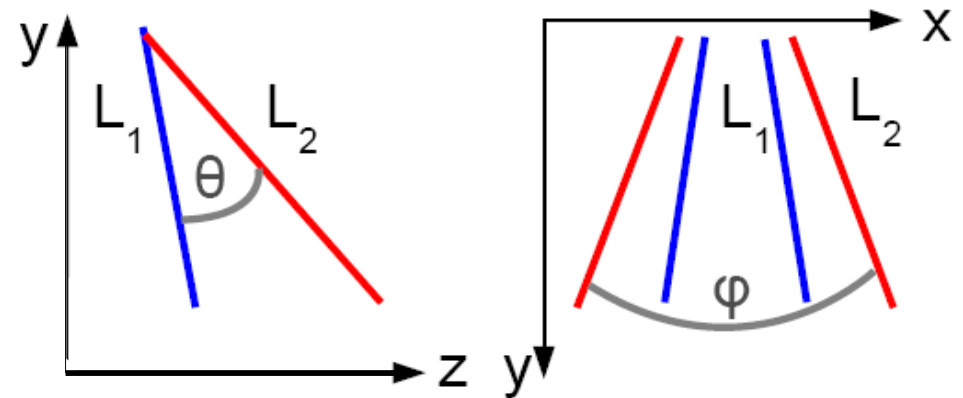
Resolution between

120 μm and 180 μm
    for drift distances
    $\leq$ 600 mm

Point Resolution: P5 gas, 4T, 8 rows

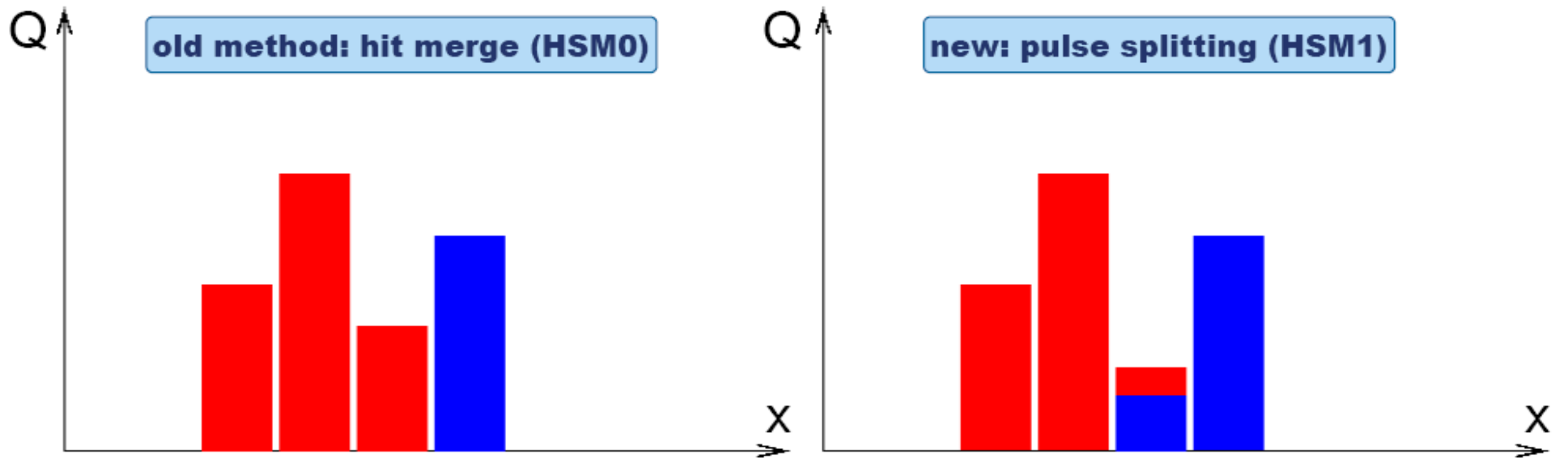gas: P5 (Ar-CH$_4$:95-5), pads: 2.2×6.2 mm^2

Double Tracks

Laser Setup for
Double Tracks

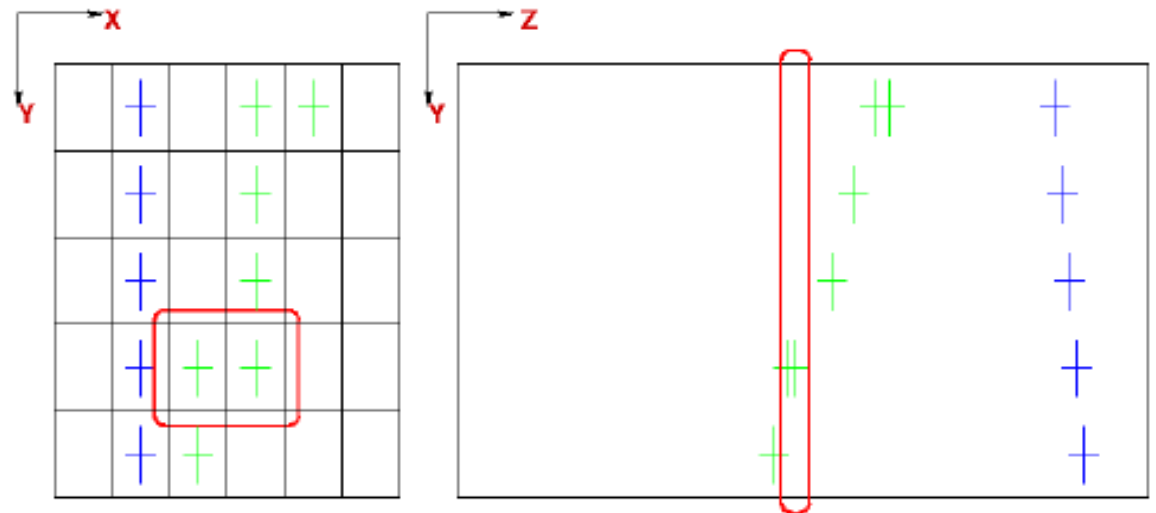$$\Delta x \approx \alpha \cdot L$$

Double Tracks

old method: hit merge (HSM0)

new: pulse splitting (HSM1)
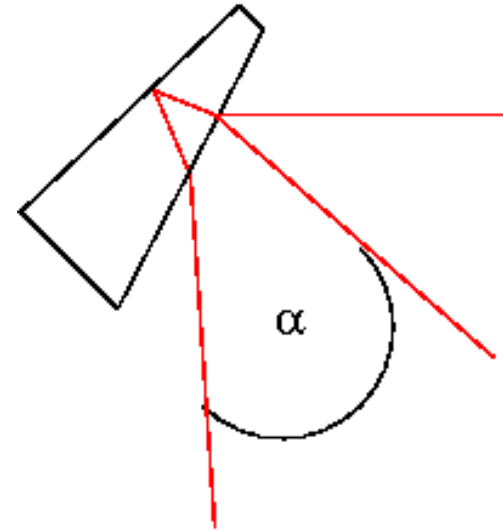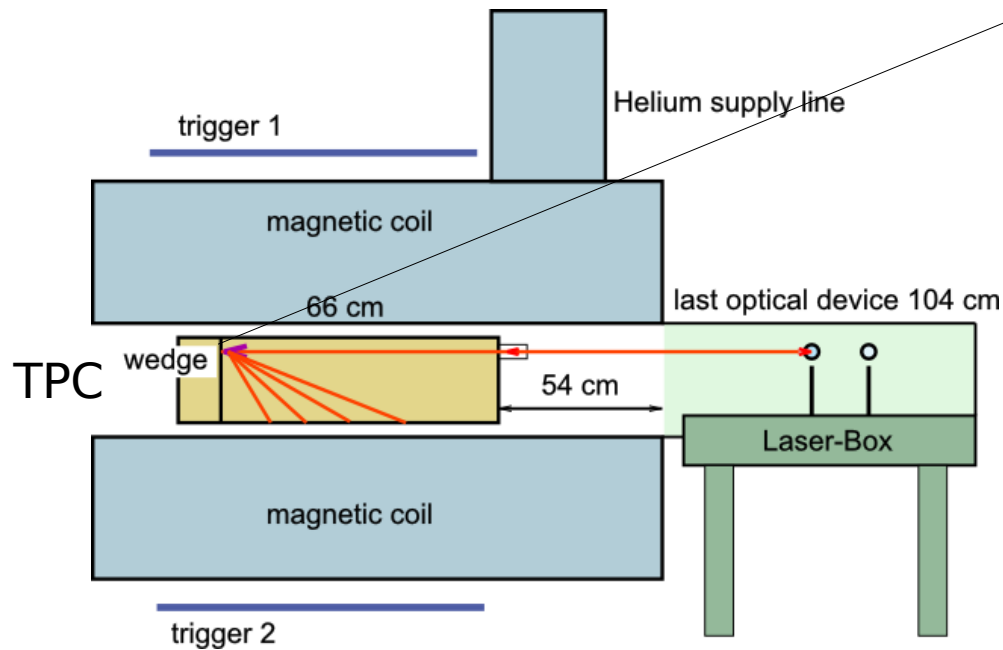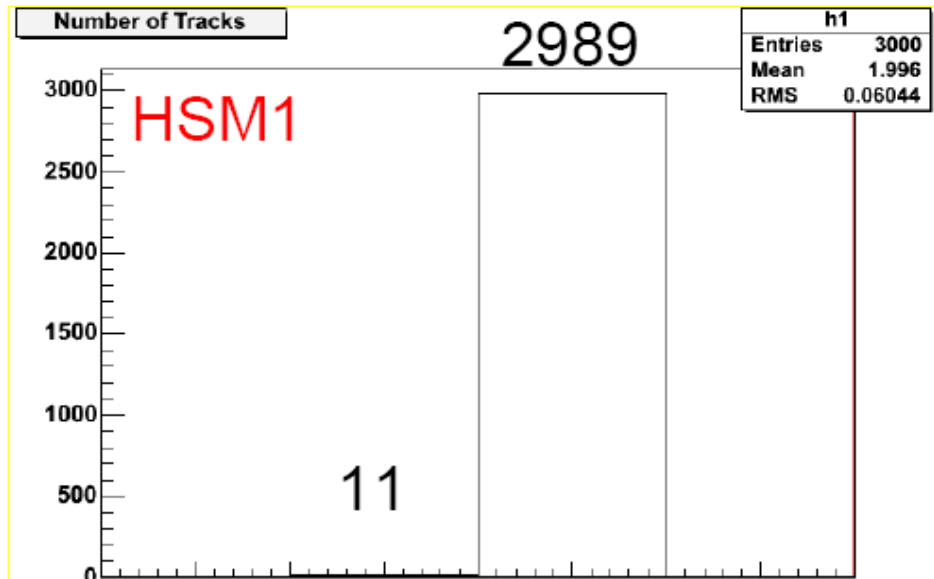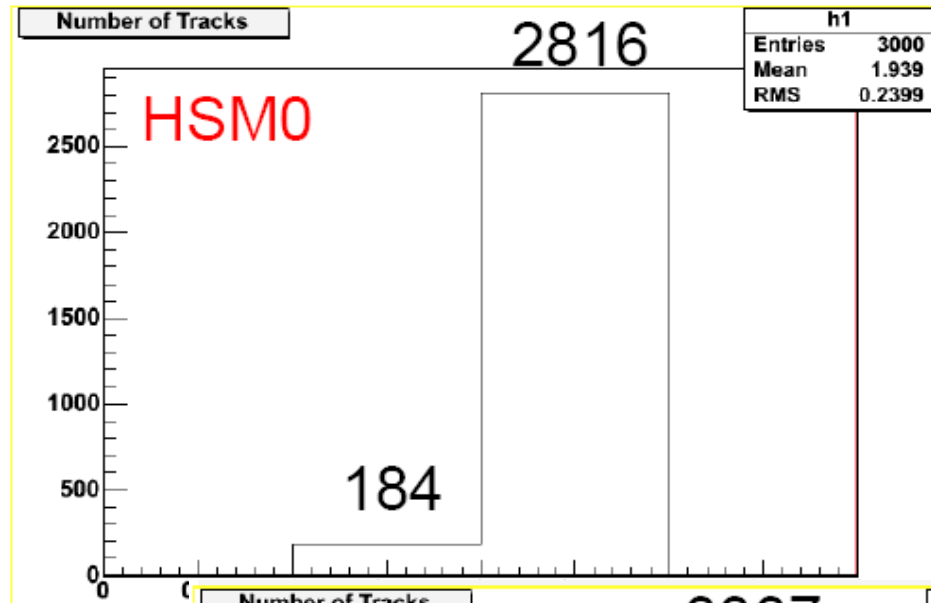
Hit separation:
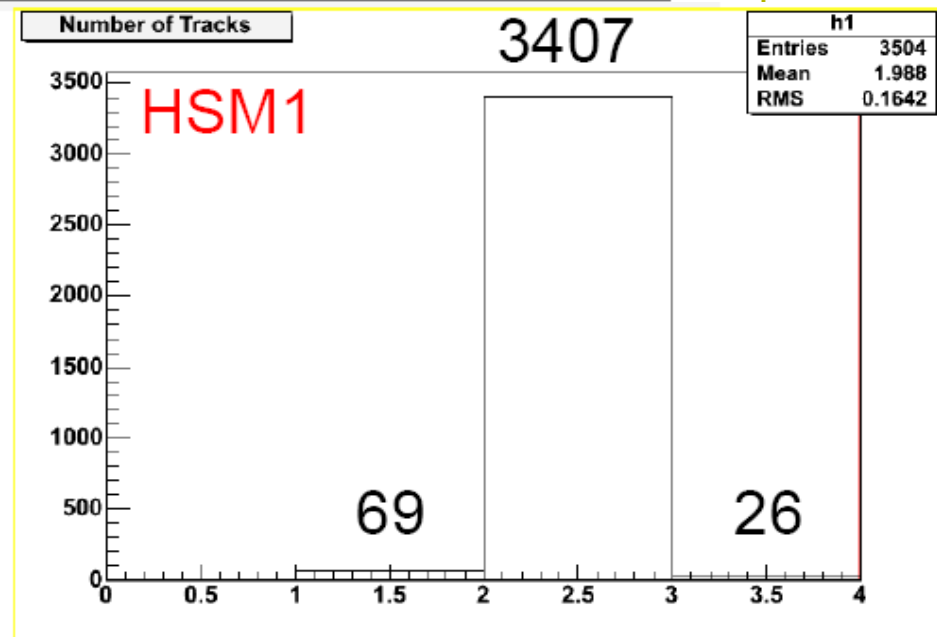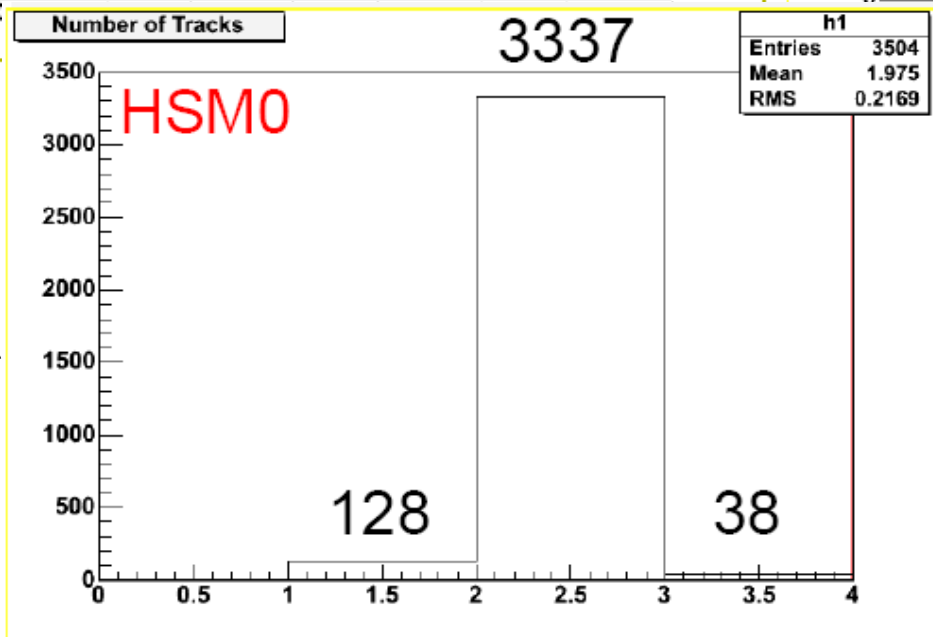
1. Local minimum

2. Weight $x = Q_1/(Q_1+Q_2)$

3. Two pulse collection

Double Tracks

Conclusion & Outlook

- Established tools for track reconstruction

- Two Track Separation

  $\rightarrow$ Separation distance

  $\rightarrow$ Reconstruction efficiency

  $\rightarrow$ Influence of two nearby tracks on fit and single point resolution

Conclusion & Outlook

Track Separation: what is feasible ?