American LC workshop
SLAC 7-10 Jan. 2004

Beam Tests of a GEM-TPC at CERN

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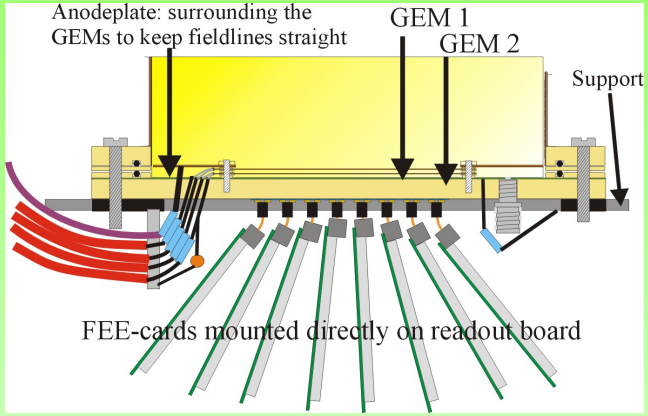
Chamber

<u>dimensions:</u>

length: 25cm

inner diameter: 20cm

flexible readout endcab



<u>pad size:</u>

1.27*12.5mm²

<u>number of pads</u>

8*32

<u>amplification:</u>

GEMs pitch=140µm

outer diameter holes=70µm

inner diameter holes=60µm

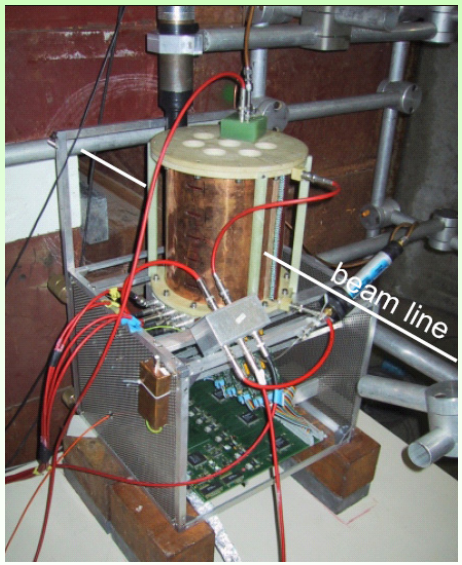
transfer gap: 2mm

induction gap: 2mm

transfer field: 2.5kV/cm

induction field: 3.5kV/cm

Experimental setup at CERN East Hall, T7



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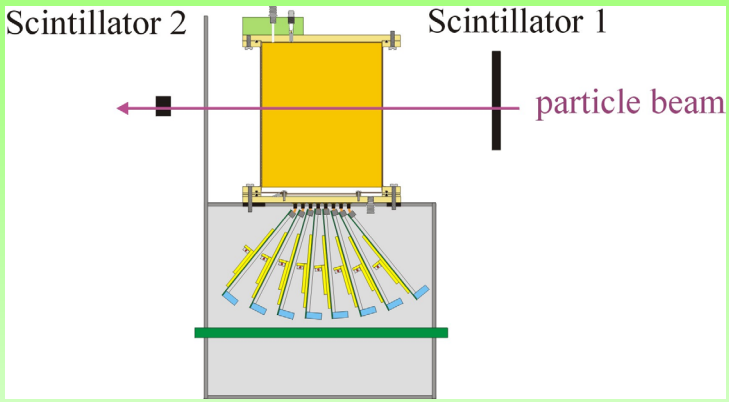
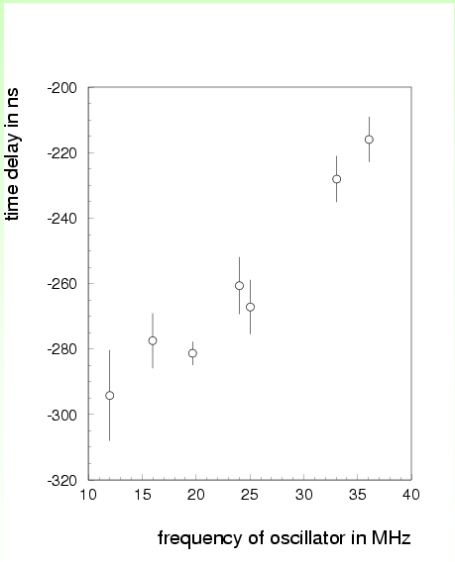
Trigger, DAQ and FEE



scintillator 1: 4.5*19cm² vertical
scintillator 2: 3*7.3cm² horizontal

trigger rate: one event per spill, but 500 time slices read out to see more beam particles



<u>STAR front-end electronics:</u>

Sampling rate: 19.66MHz

Peak time: 150ns

FWHM of pulse width: 180ns

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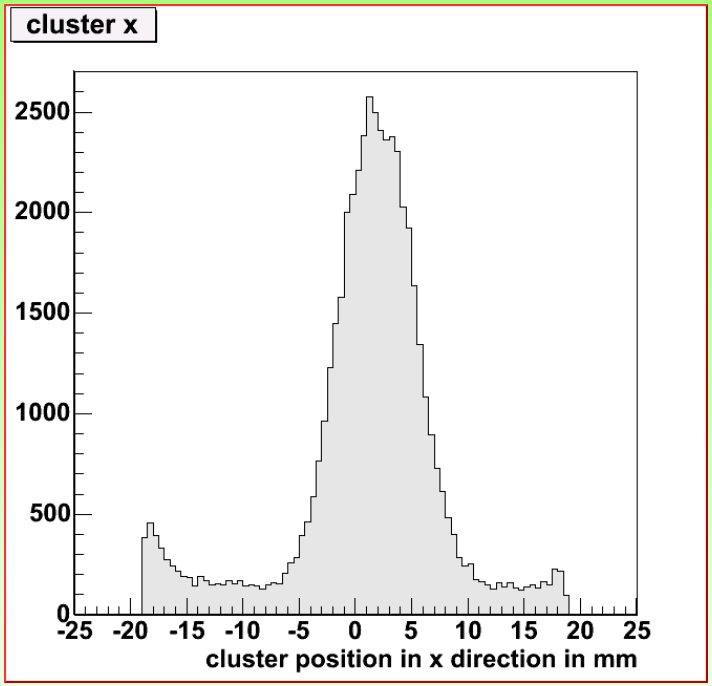
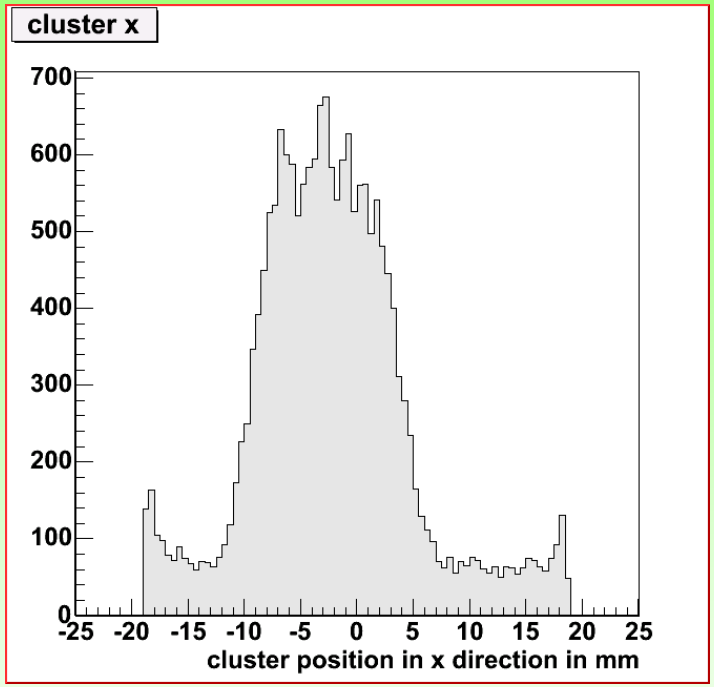
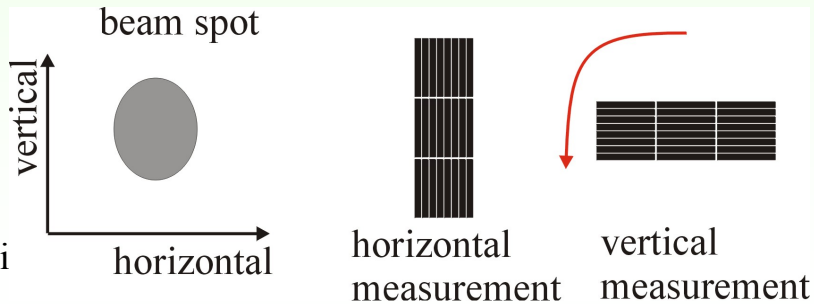
Beam properties - width



standard orientation
horizontal beam width



turning of chamber
vertical beam width



<u>Spill length:</u>
550ms

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Software tools

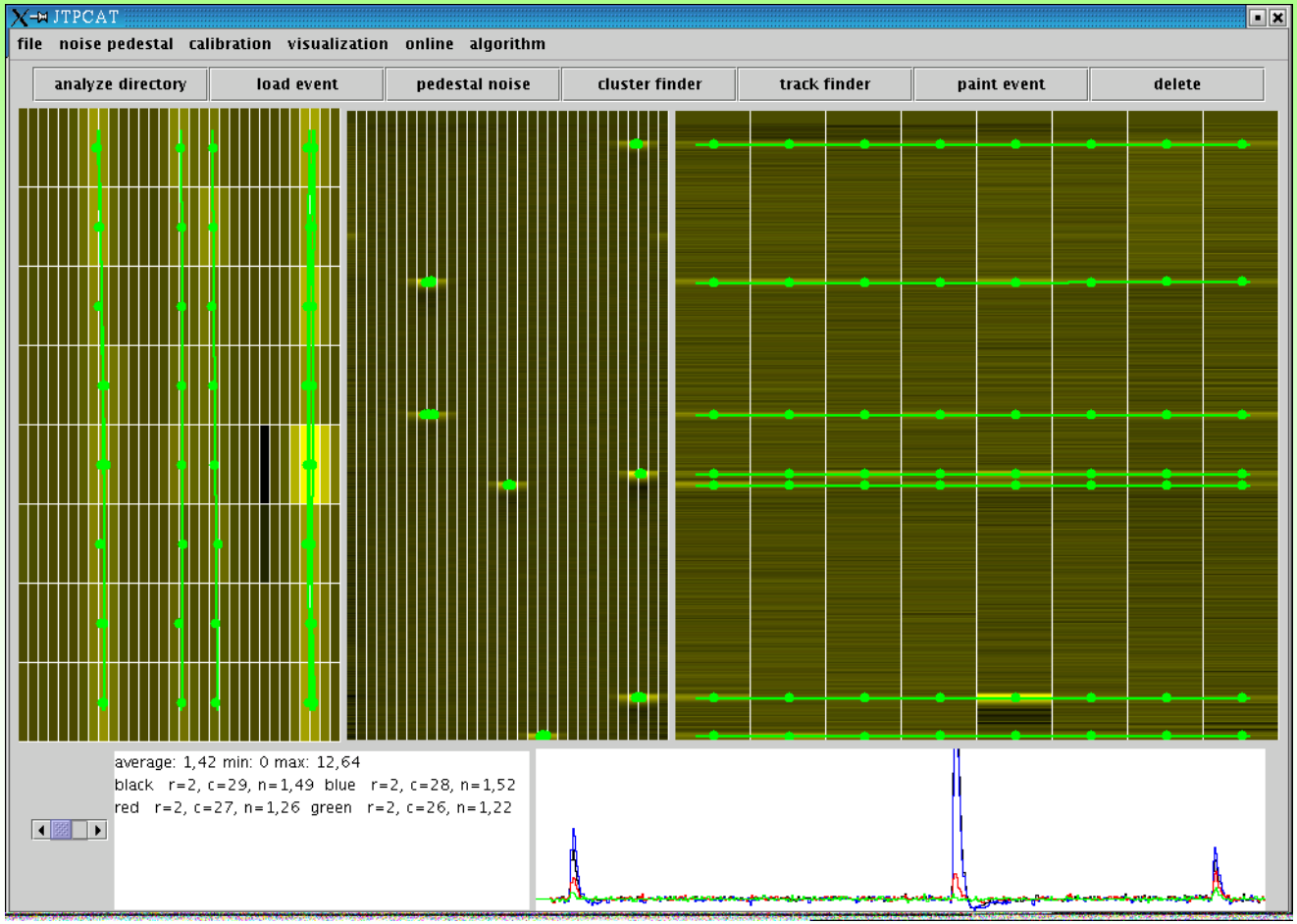
Besides the existing VB-package (s. talk by S. Kappler at Berkeley) a JAVA based analysis tool is being developed.

functionality similar but code developed independently (=> cross check)

New feature: ‘parabolic linear regression’:

$y = A + B*x + C*x^2$

=> a measure of the curvature (C)



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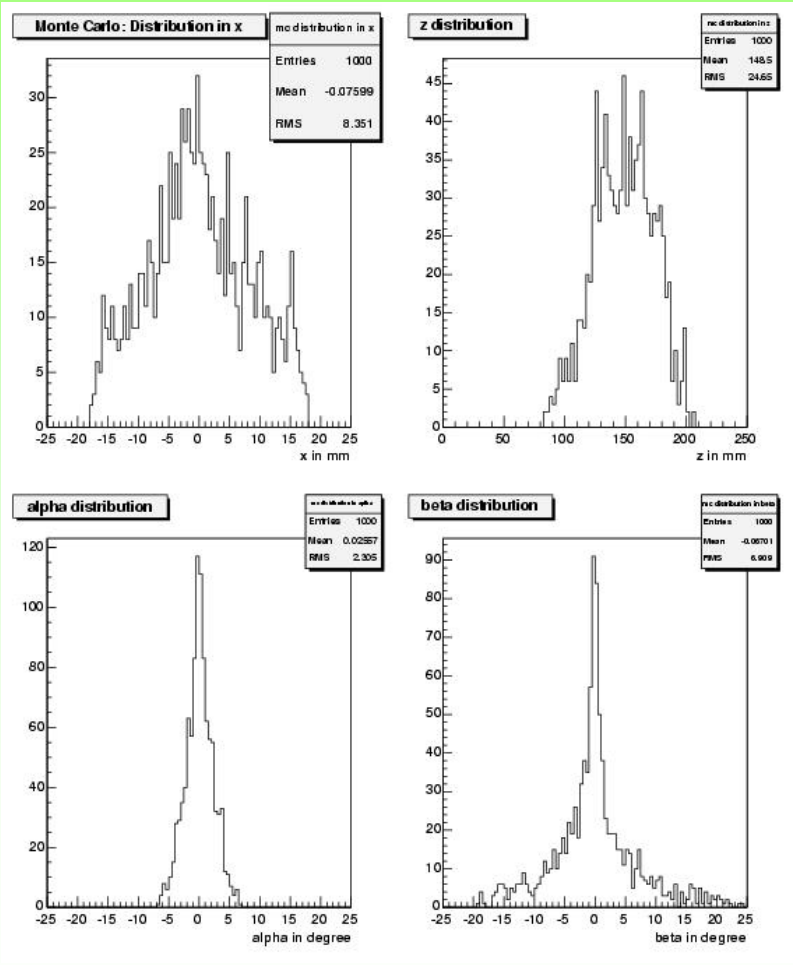
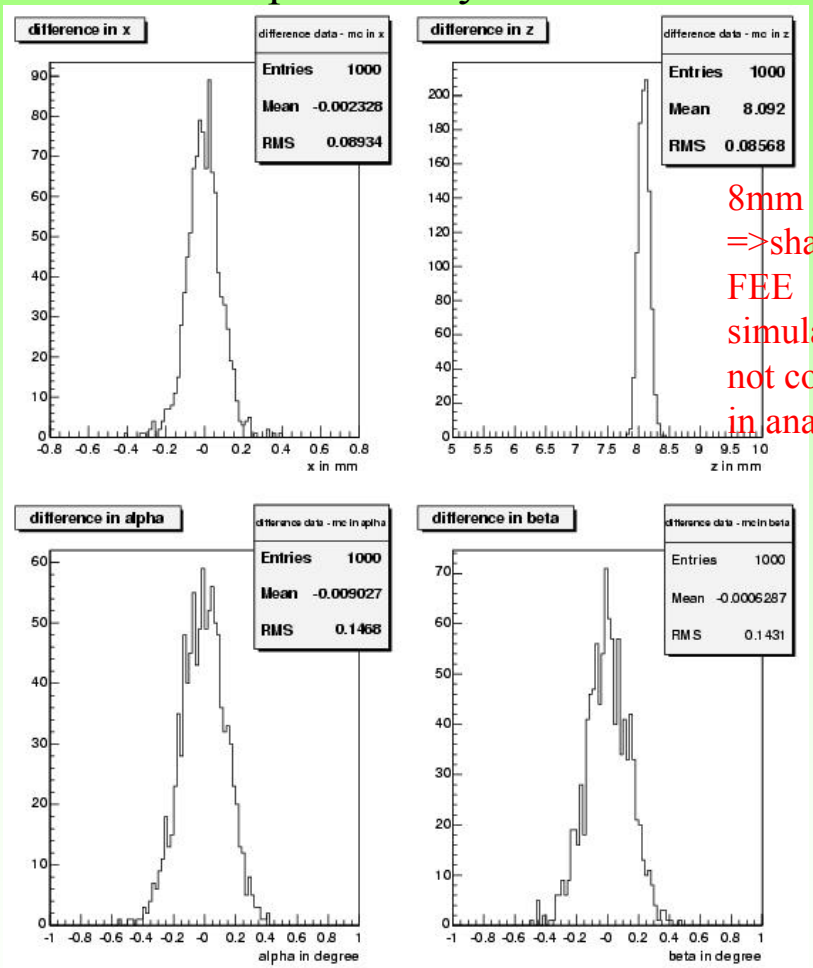
Monte Carlo

Simulation of cosmic muons passing through detector and trigger counter

Input parameter distributions



Difference: input – analysis results



8mm ≅ 150ns =>shaping of FEE simulated, but not corrected in analysis

gas parameters of Ar-CH_4 90:10 given by Magboltz

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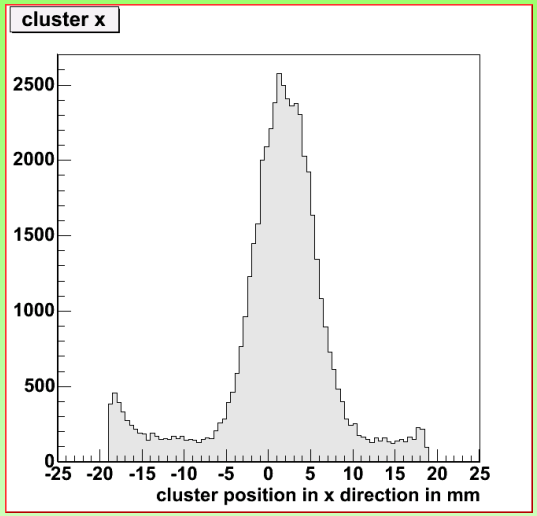
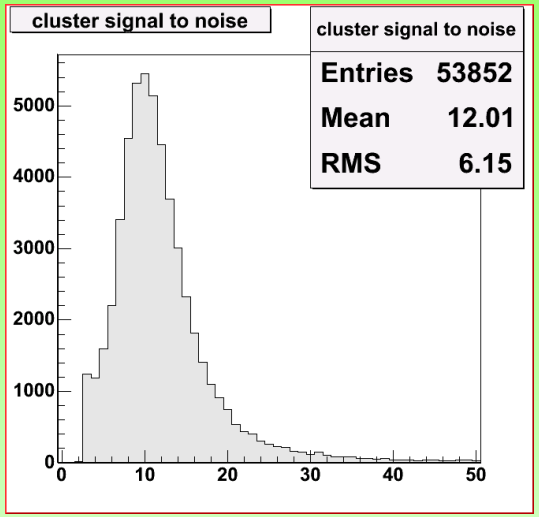
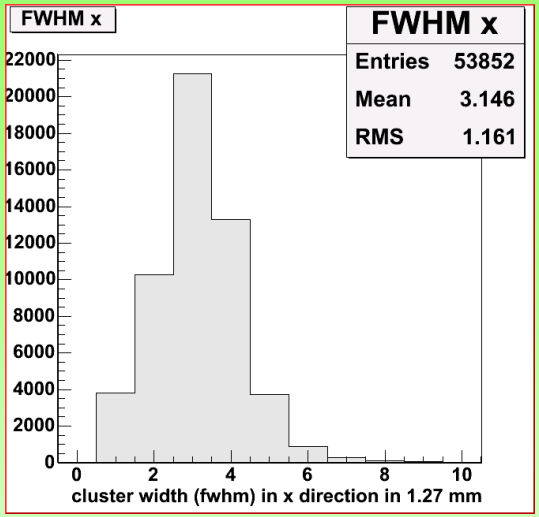
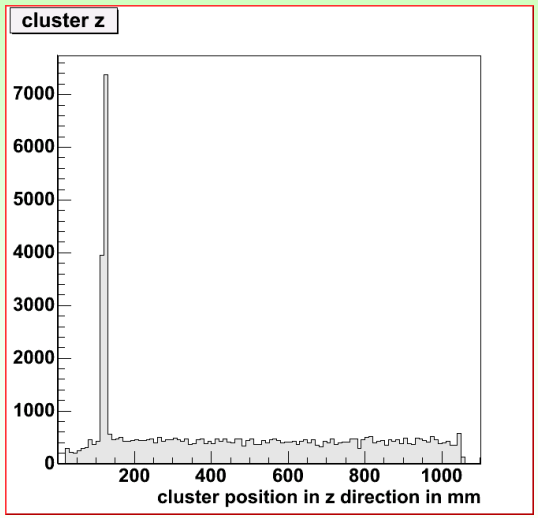
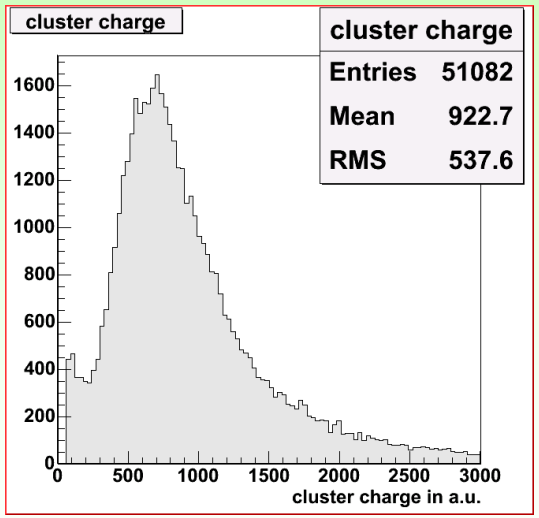
Cluster properties

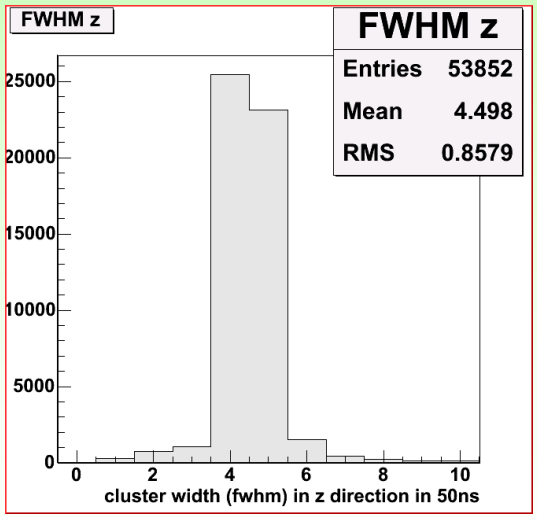












hadronic beam of 9GeV-particles at CERN gas:Ar:CH_4 95:5

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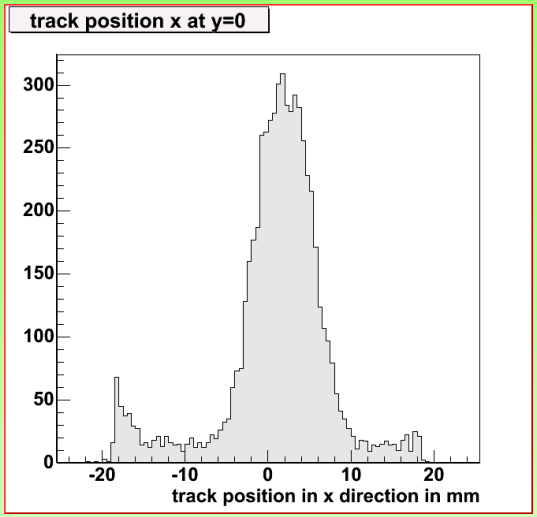
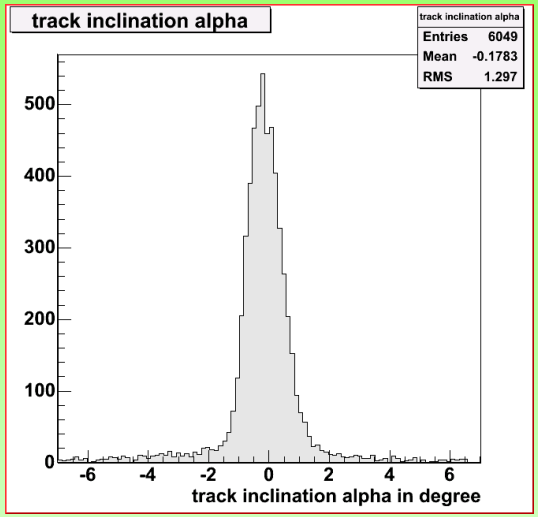
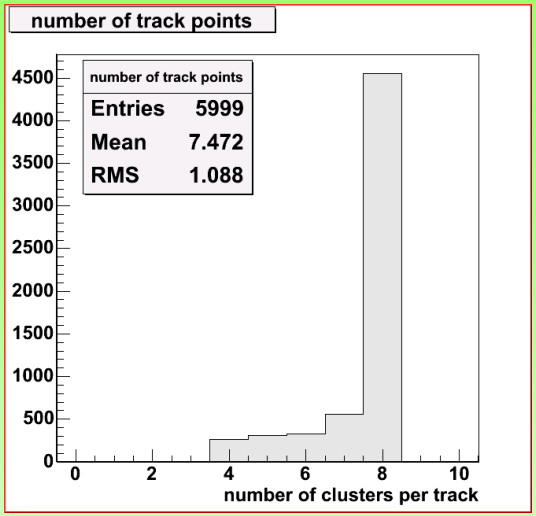
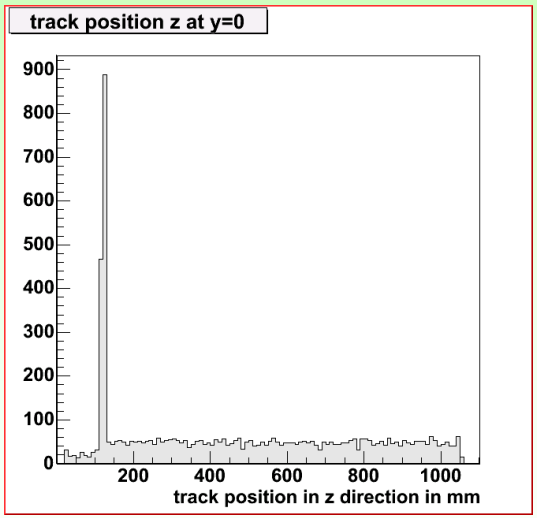
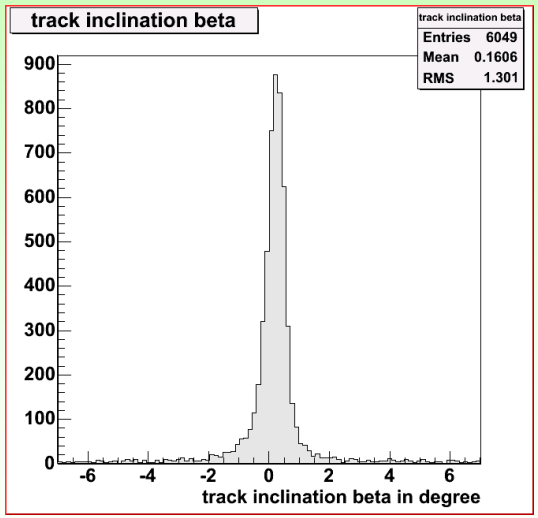
Track properties

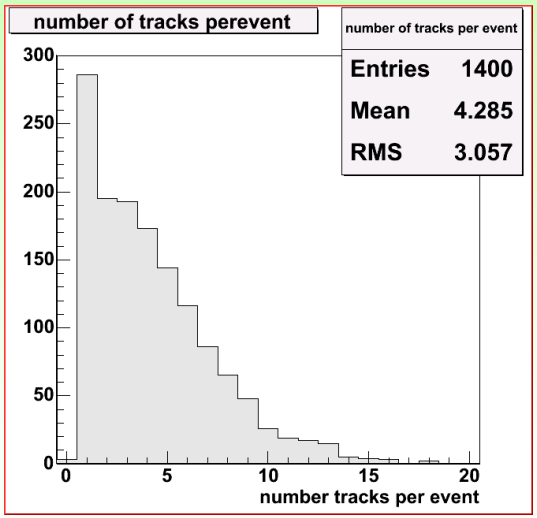












hadronic beam of 9GeV-particles at CERN gas:Ar:CH_4 95:5

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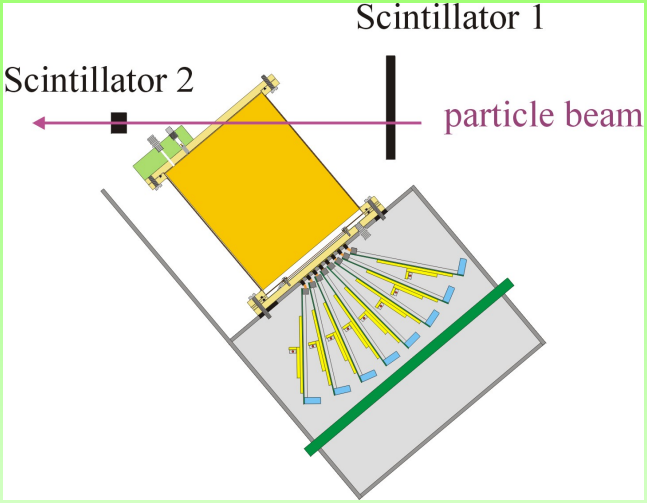
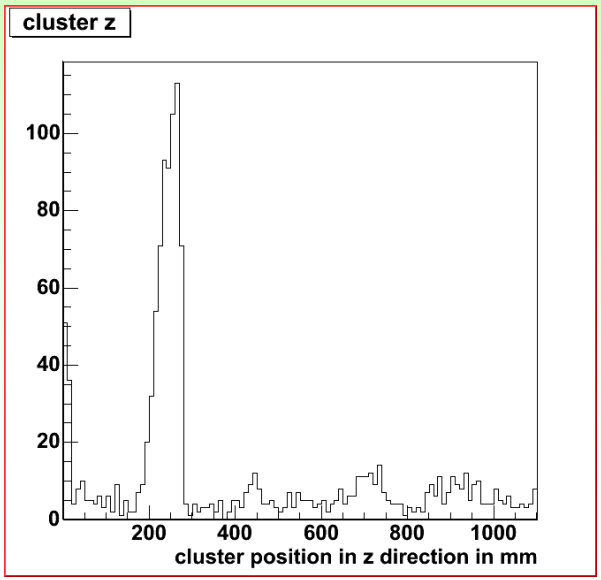
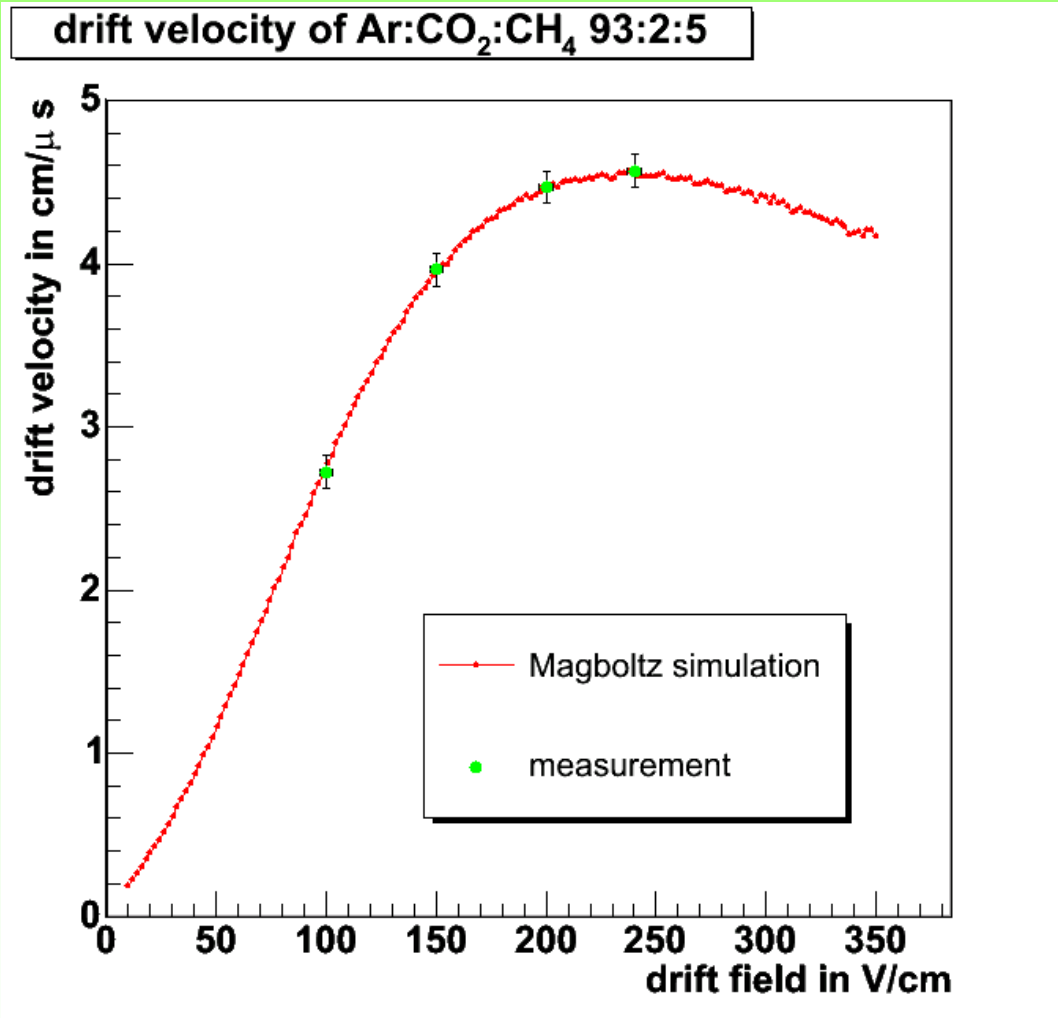
drift velocity in $Ar:CO_2:CH_4$ 93:2:5







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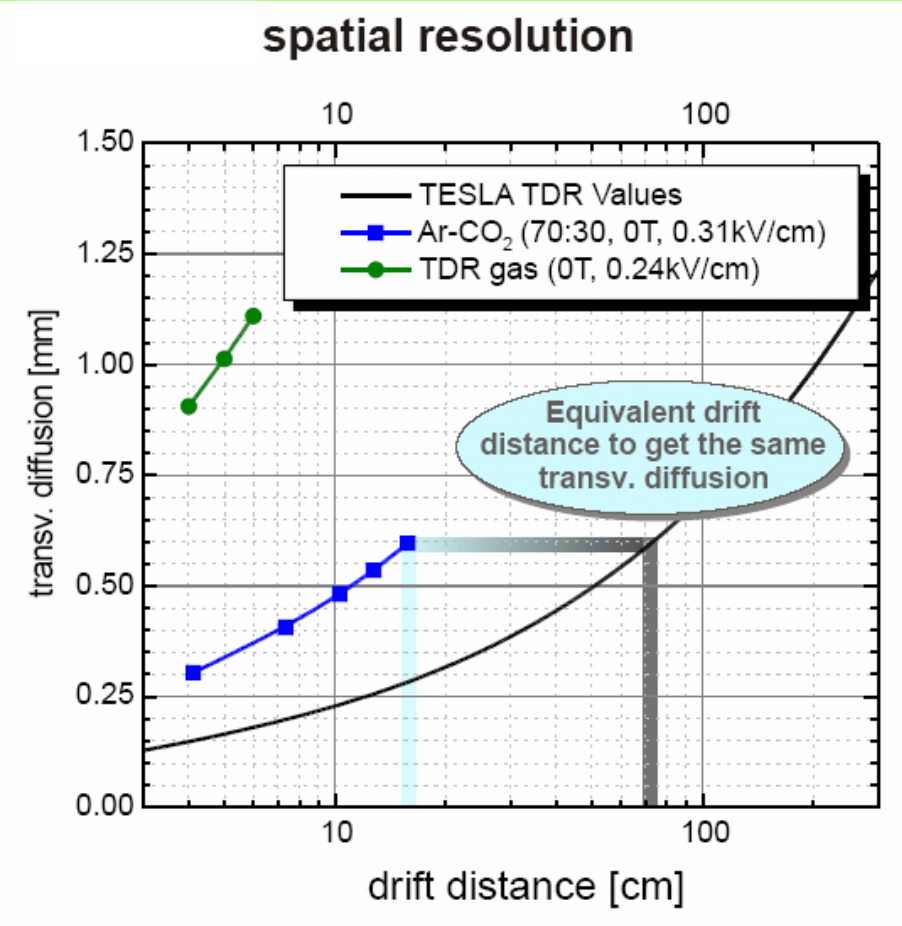
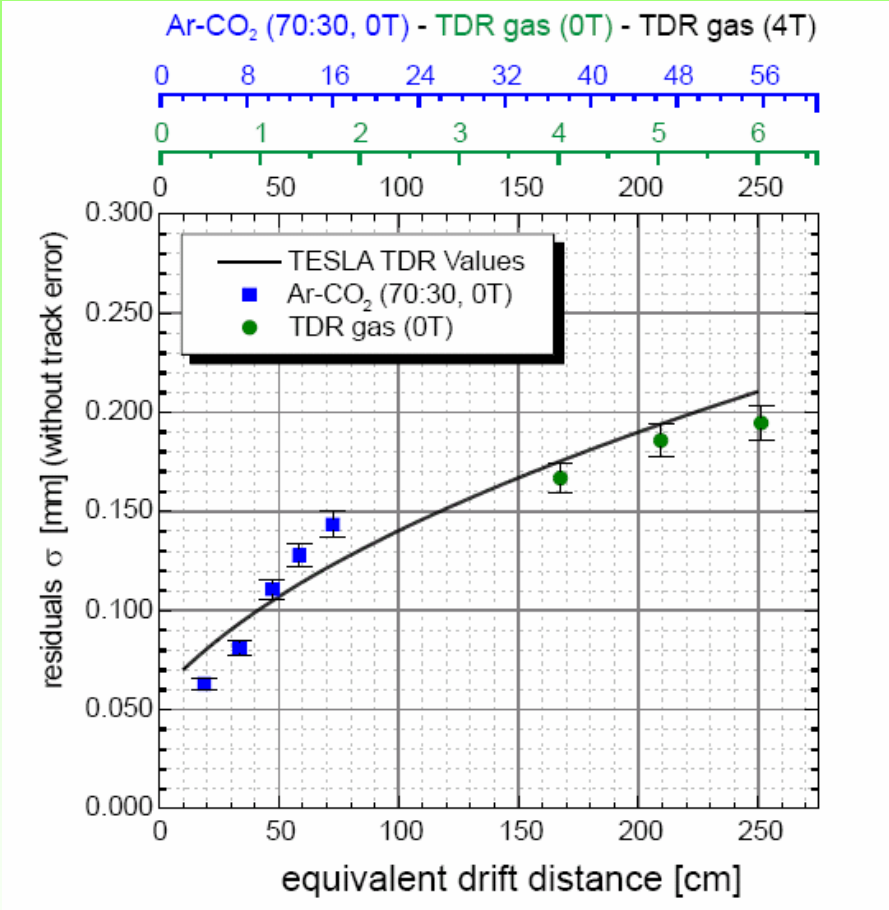
Spatial resolution





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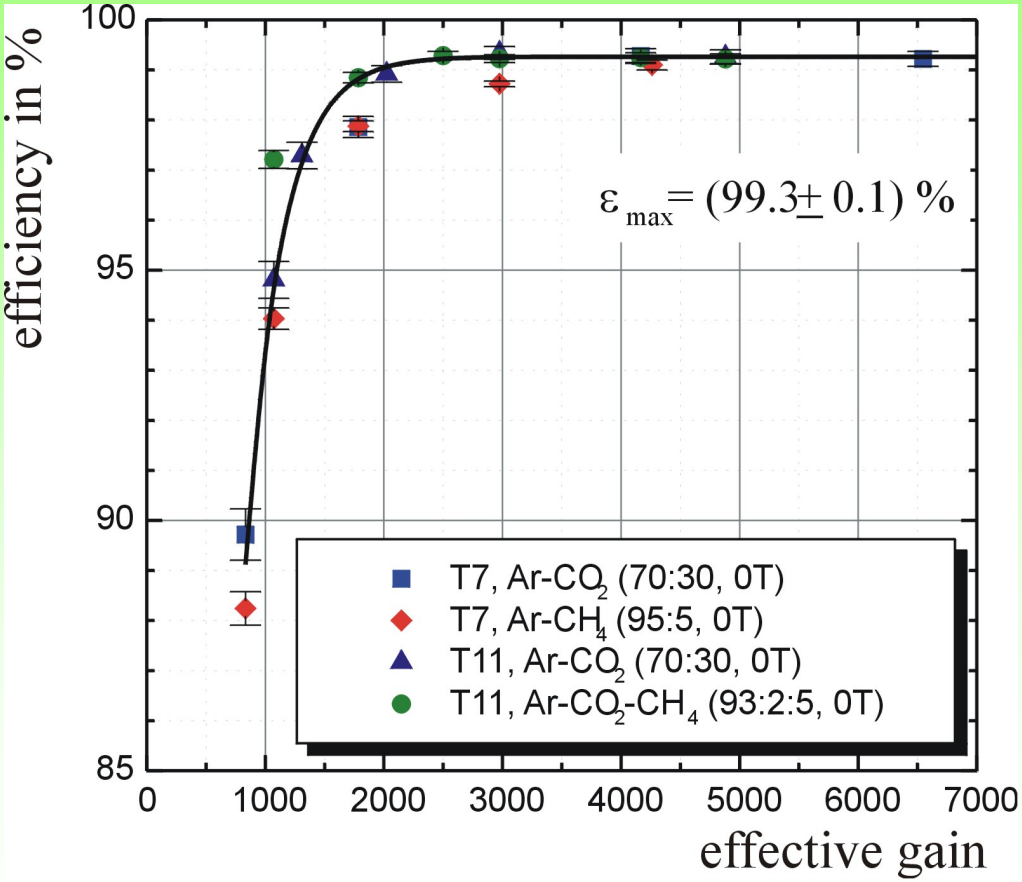
Intrinsic single-pad-row efficiency



Improved algorithm
Isolation criterion ensures:
- no crossing tracks
- effect of delta electrons removed

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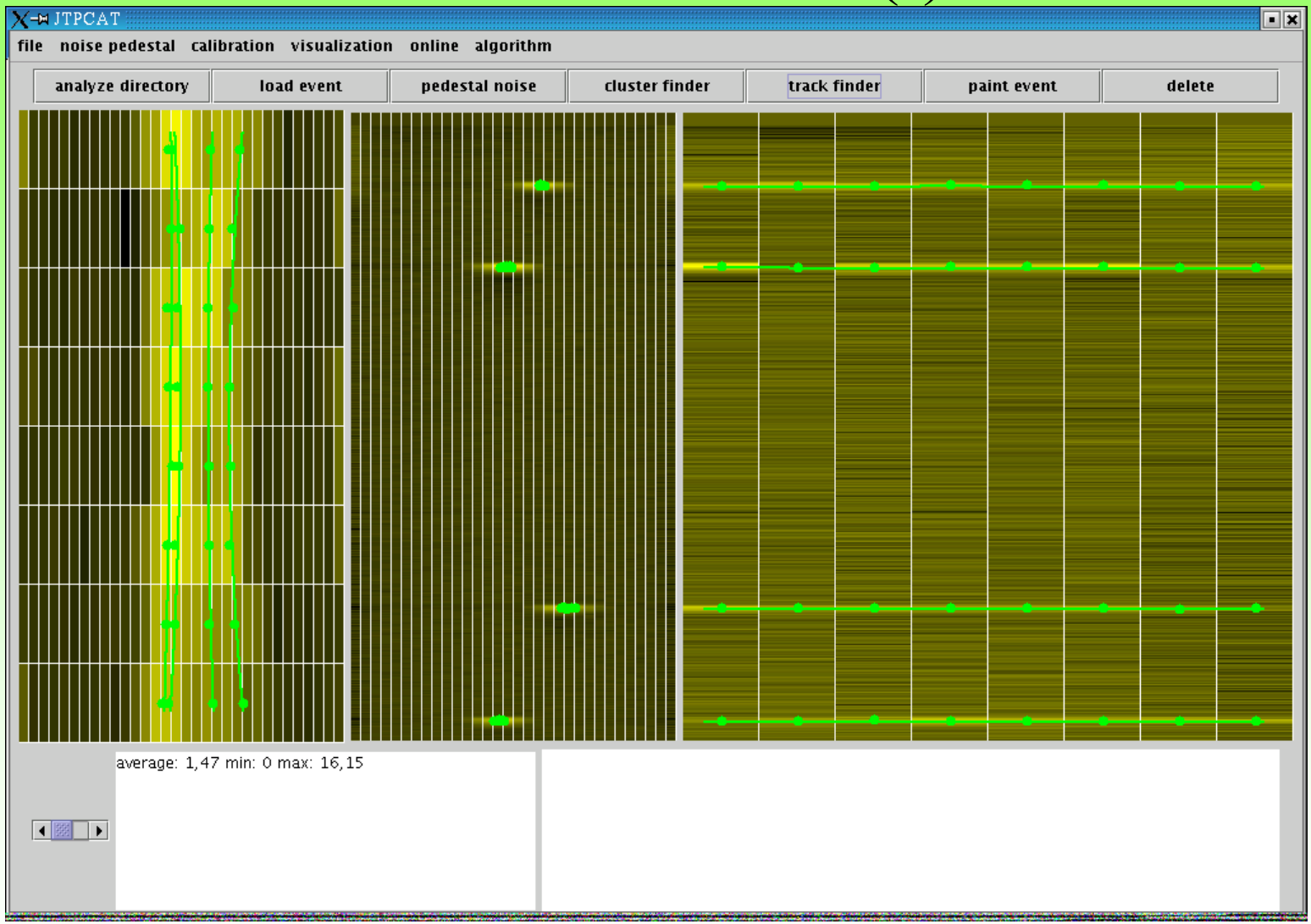
Track distortions (I)



hadronic beam of 9GeV-particles at CERN gas:Ar:CH_4 95:5

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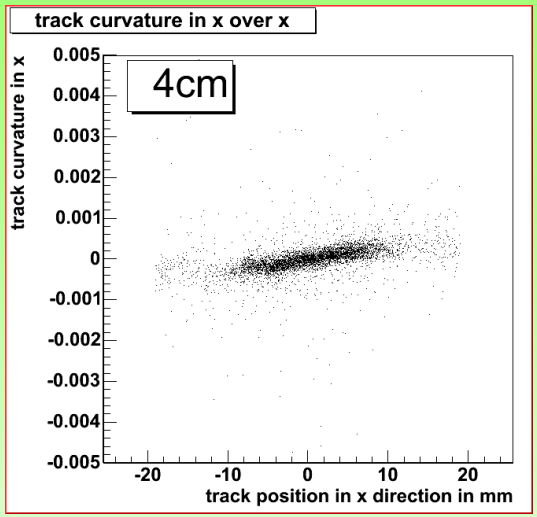
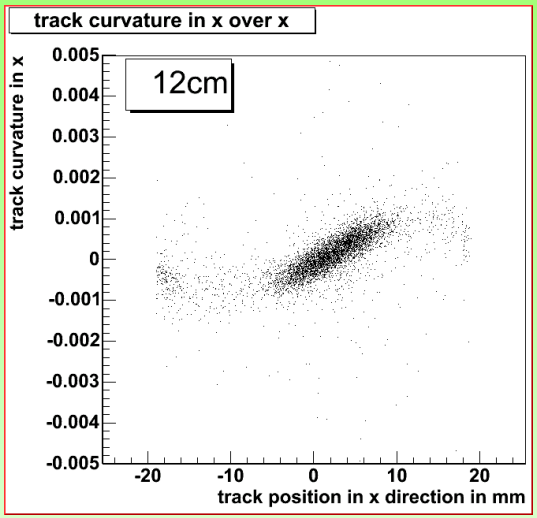
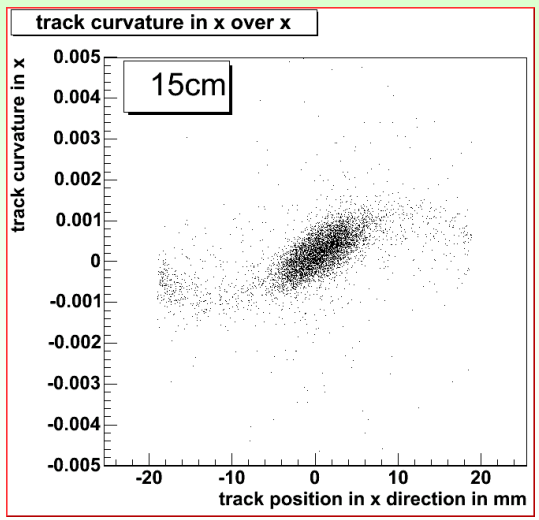
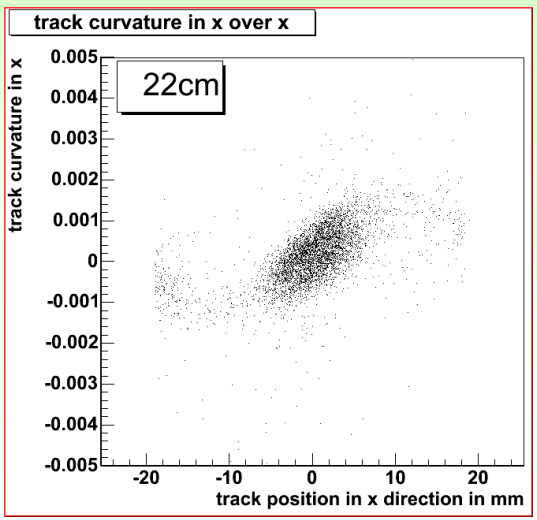
Track distortions (II)





Curvature C is plotted vs. x position of track cluster in top row (= track position)





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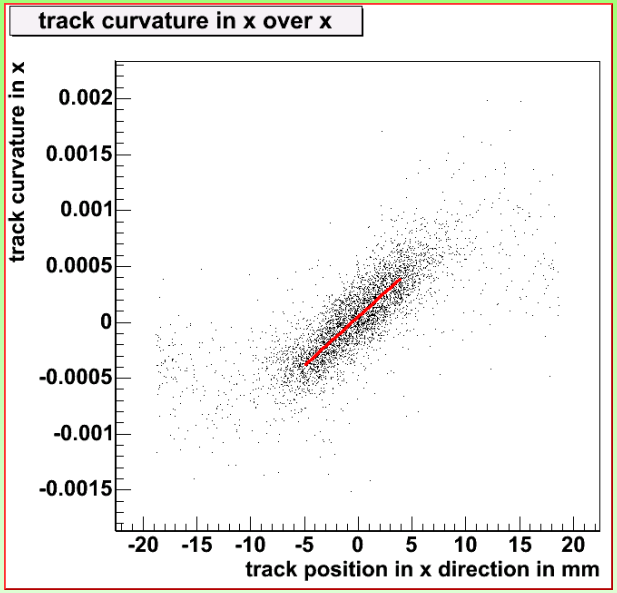
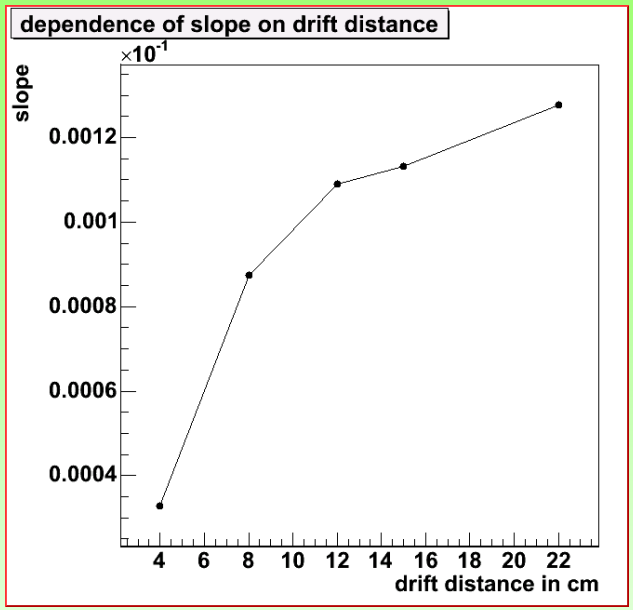
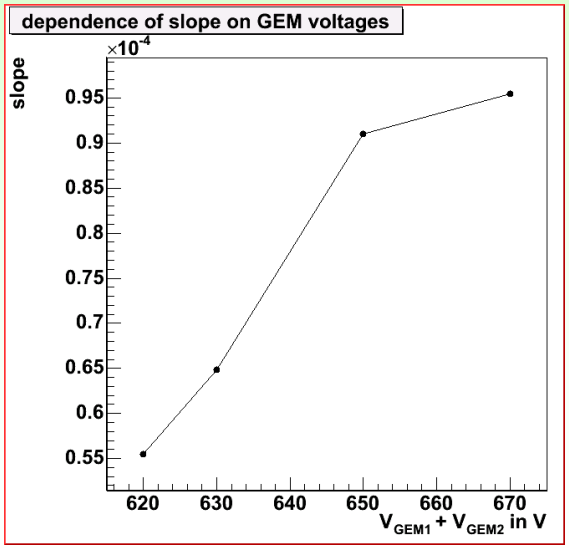
Track distortions (III)



Slope dependence on drift distance



Slope dependence on GEM voltages



middle axis of 'galaxy' is fitted with linear fit => slope taken as measure of distortions

Theoretical interpretation is being developed

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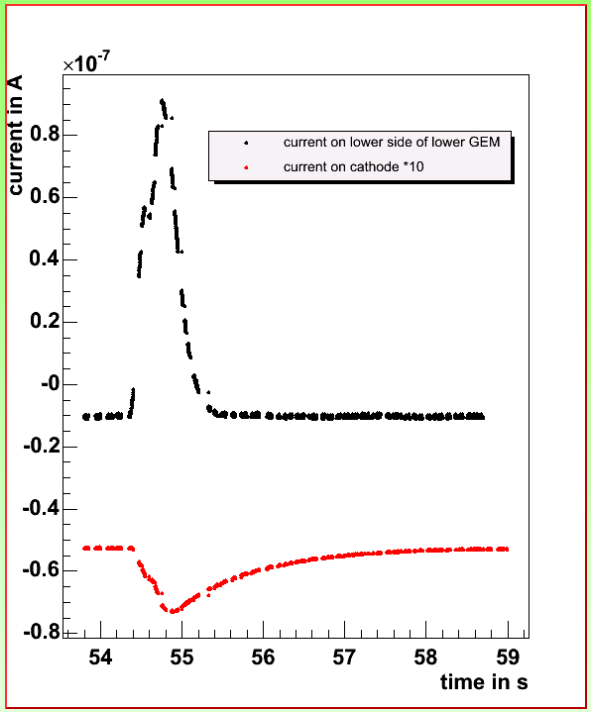
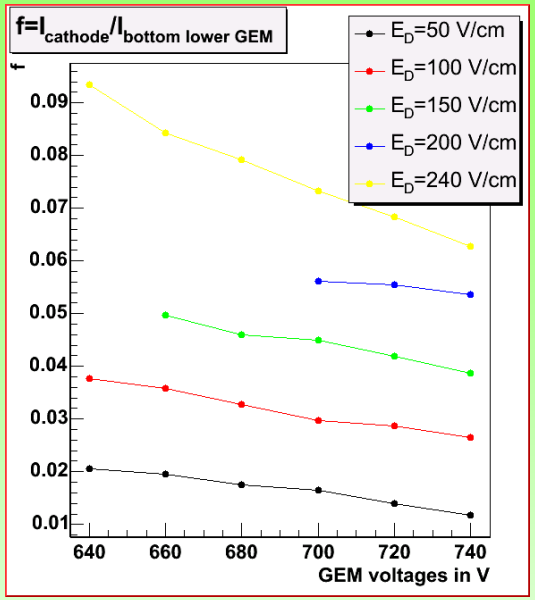
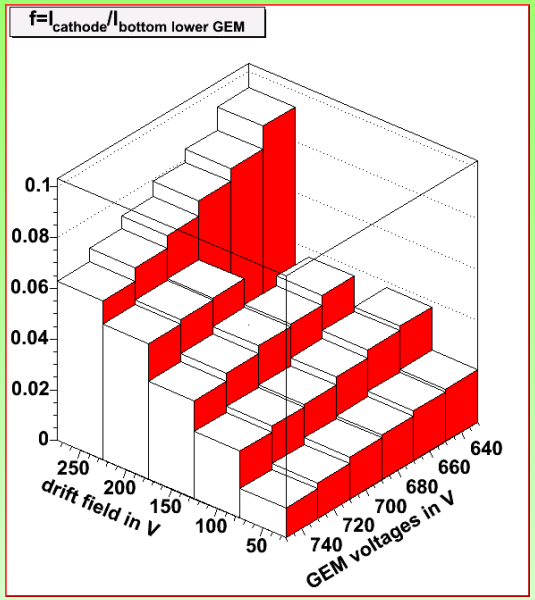
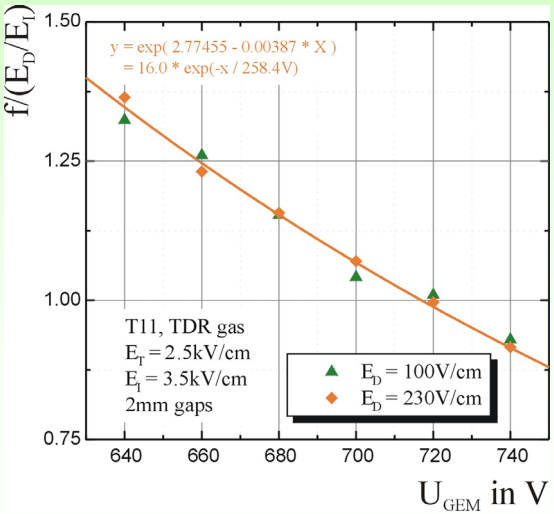
Current measurements









Observations:

1.) Current pulse reflects beam time structure.
2.) Nearly 10% feedback at low GEM voltages.
3.) Larger feedback at higher drift fields.
4.) Dependence on E_D and V_{GEM}

$$f = E_D/E_I * 16.0 * \exp(-U_{GEM}/258.4V)$$

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Conclusion

Detector was tested in a high rate hadronic beam
=> no problems were observed

Intrinsic single-pad-row efficiency plateau of (99.3+/-0.1)%
was reached for all gases.

Efficiency plateau starting at effective gains of 2500.

Spatial resolution were between
63μm in Ar:CO_2 (4cm drift) corresp. to 10cm drift in TDR gas (4T)
190μm in TDR gas (6cm drift,0T) corresp. to 250cm in 4T

Track distortions due to space charges inside the drift volume observed
and under study.

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