



## Clusters counting using modified FDC chambers

(particle ID possibilities with full scale prototype )

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Hall D PID upgrade meeting.

September 20 2013.

## PID techniques based on Gas ionization.

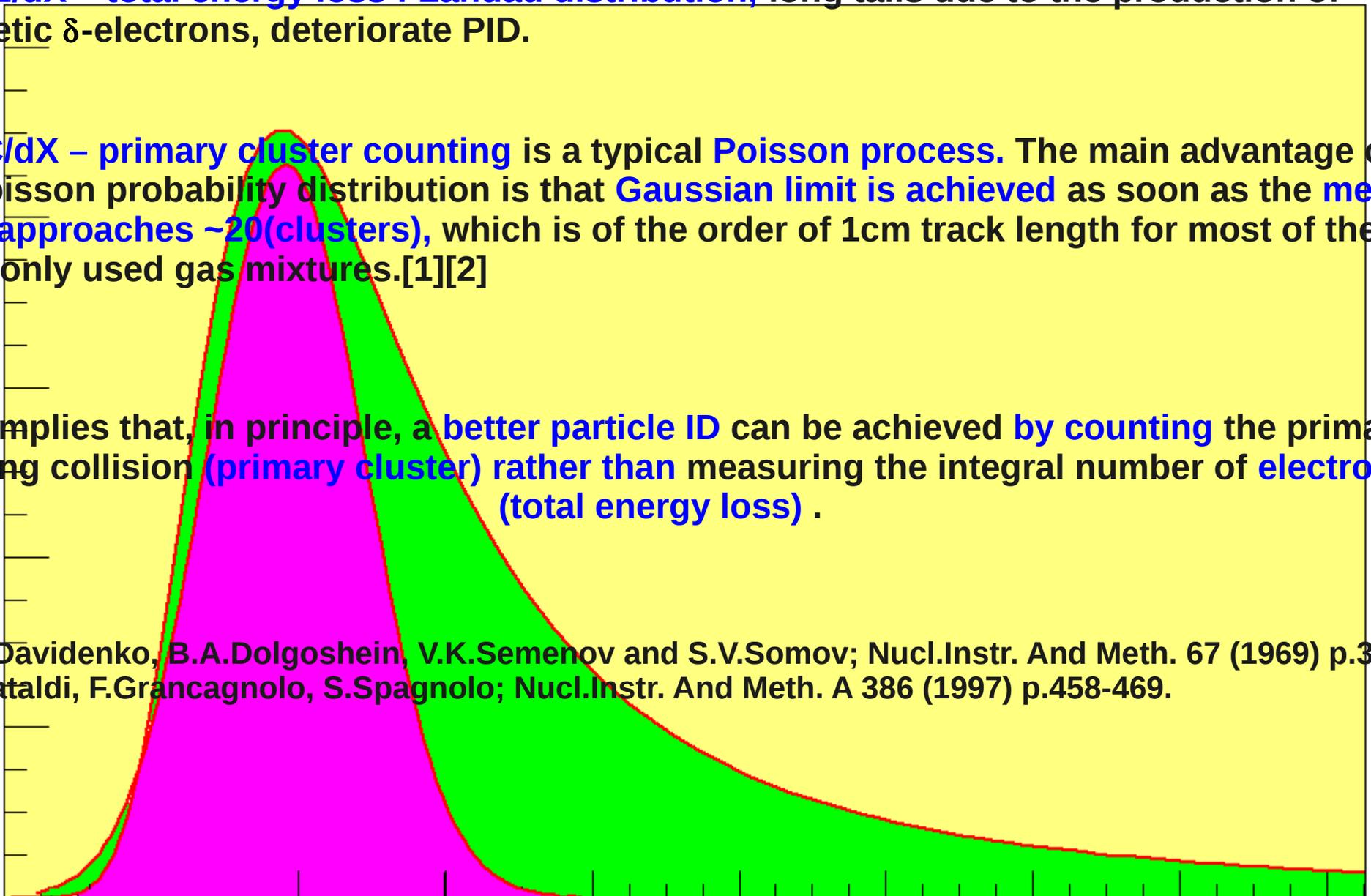
1)  $dE/dX$  – total energy loss : Landau distribution, long tails due to the production of energetic  $\delta$ -electrons, deteriorate PID.

2)  $dC/dX$  – primary cluster counting is a typical Poisson process. The main advantage of the Poisson probability distribution is that Gaussian limit is achieved as soon as the mean value approaches  $\sim 20$ (clusters), which is of the order of 1cm track length for most of the commonly used gas mixtures.[1][2]

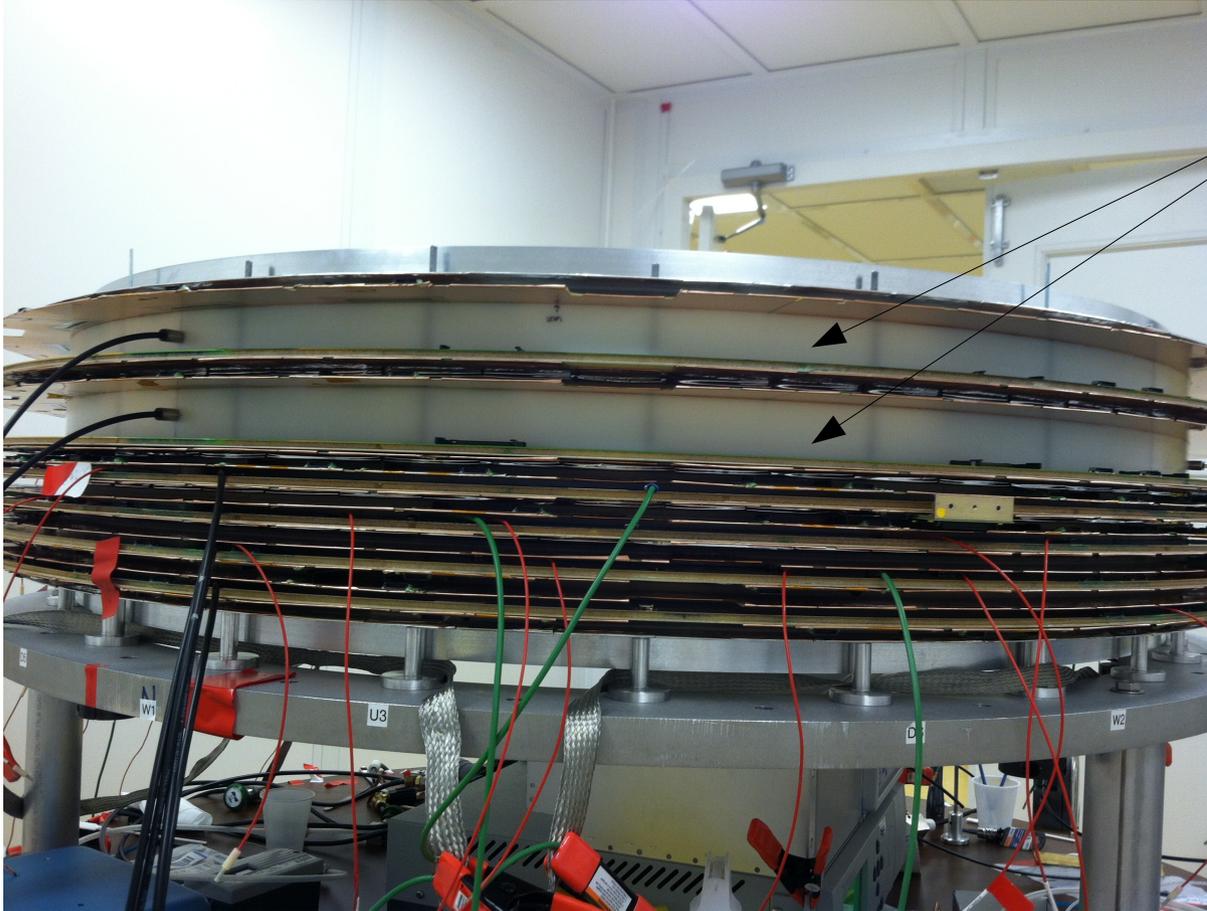
This implies that, in principle, a better particle ID can be achieved by counting the primary ionizing collision (primary cluster) rather than measuring the integral number of electrons (total energy loss) .

[1]V.A.Davidenko, B.A.Dolgoshein, V.K.Semenov and S.V.Somov; Nucl.Instr. And Meth. 67 (1969) p.325.

[2]G.Cataldi, F.Grancagnolo, S.Spagnolo; Nucl.Instr. And Meth. A 386 (1997) p.458-469.



## Modified FDC full scale PID prototype.



The two modified FDC cells :

Replaced 5 mm gas spacer to  
35 mm gas spacer.

Drift velocity is reduced significantly.

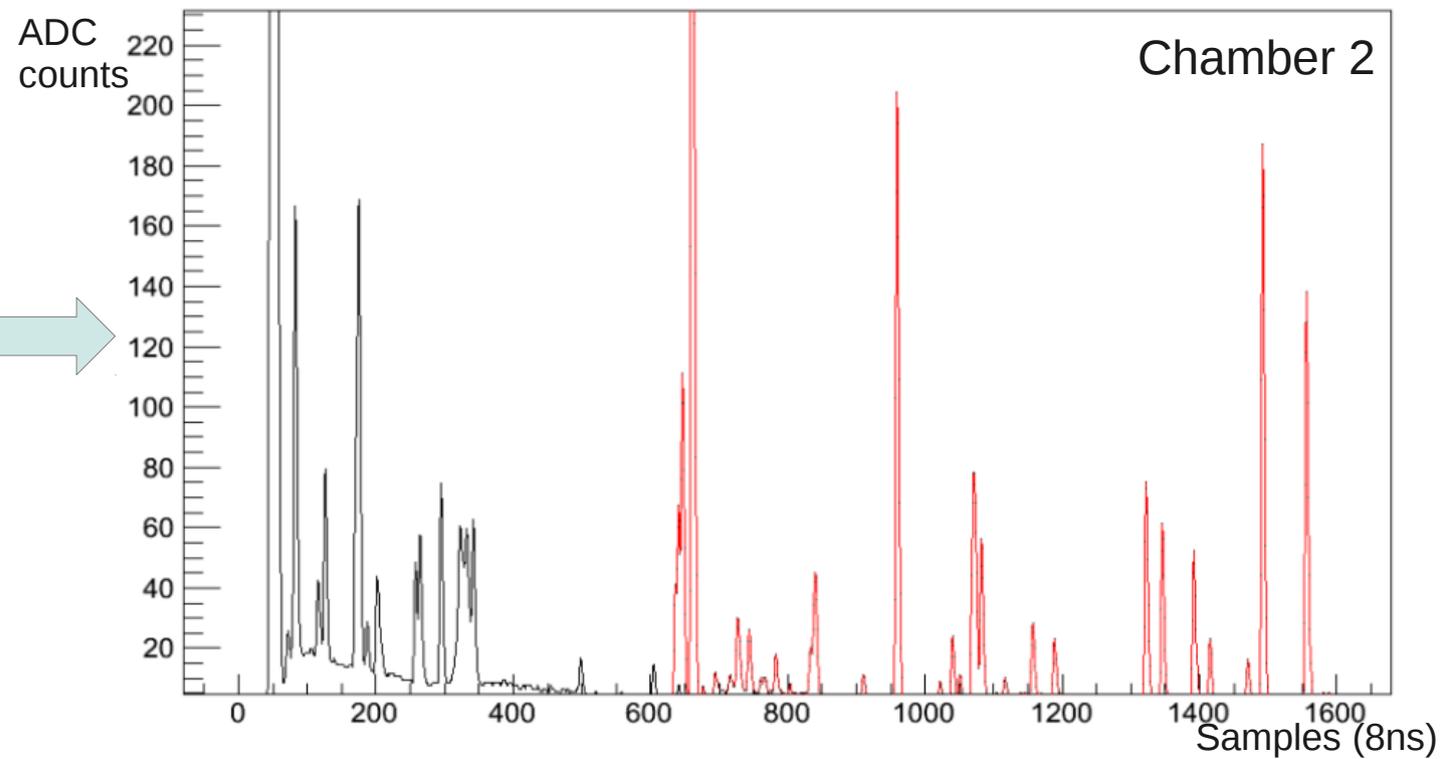
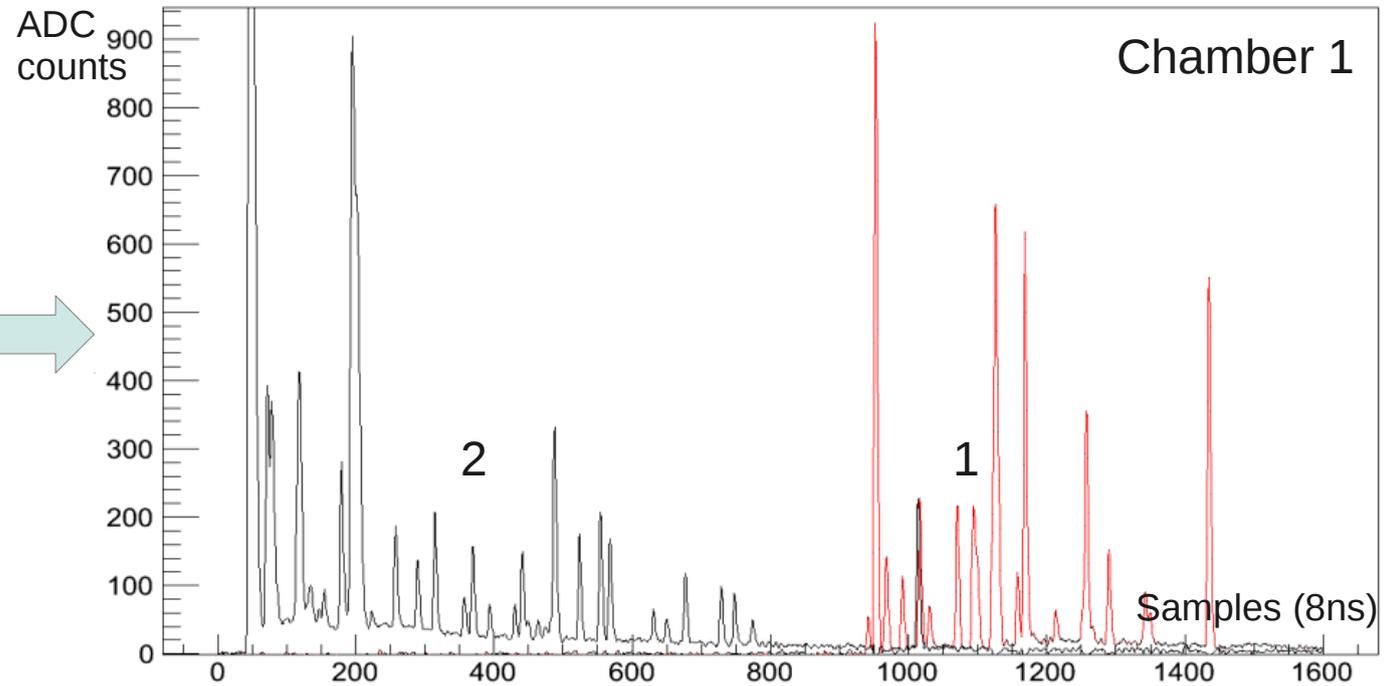
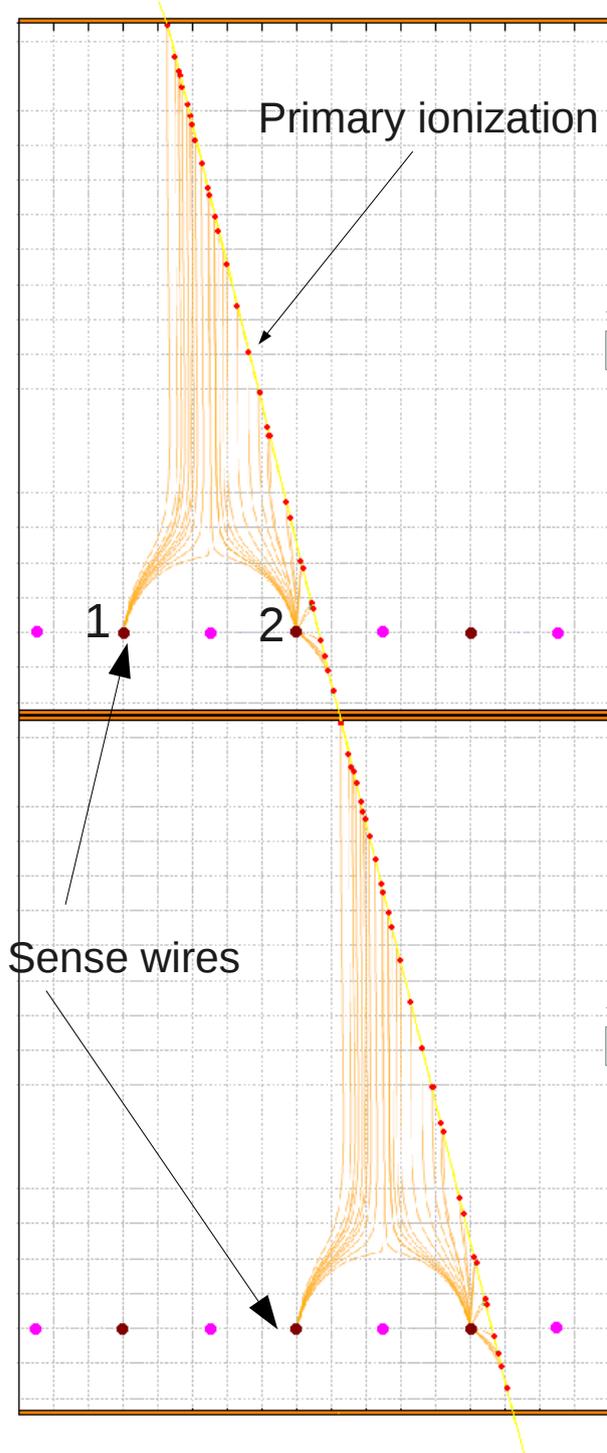
Wire board are same as original  
FDC.

Cathodes are same as original FDC.

Same gas tightness.

The two cells have parallel wires.

# Example of typical cosmic event.

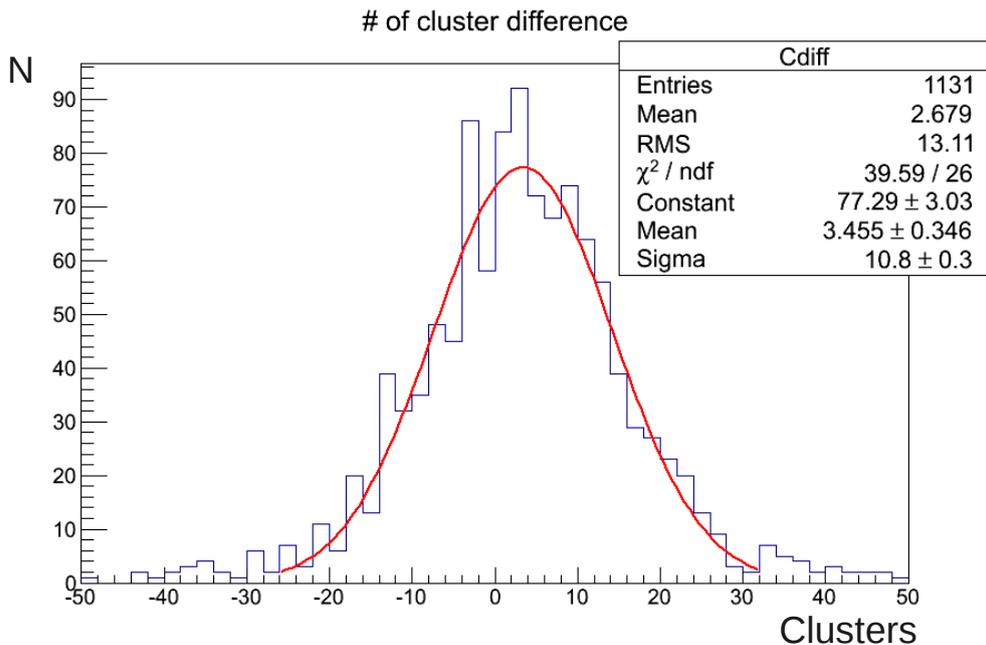
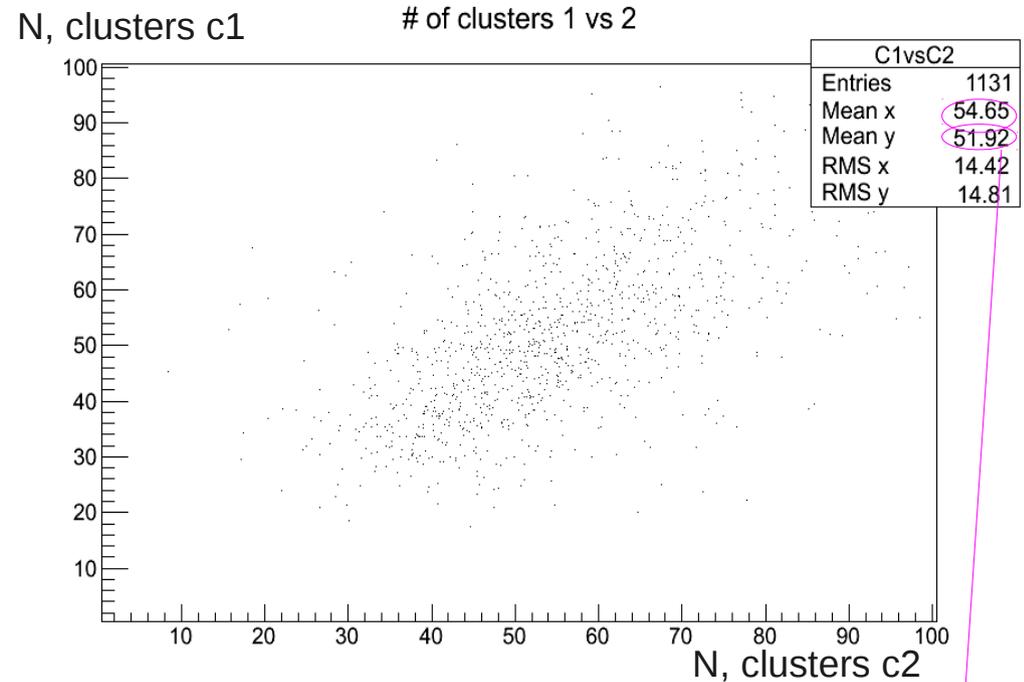
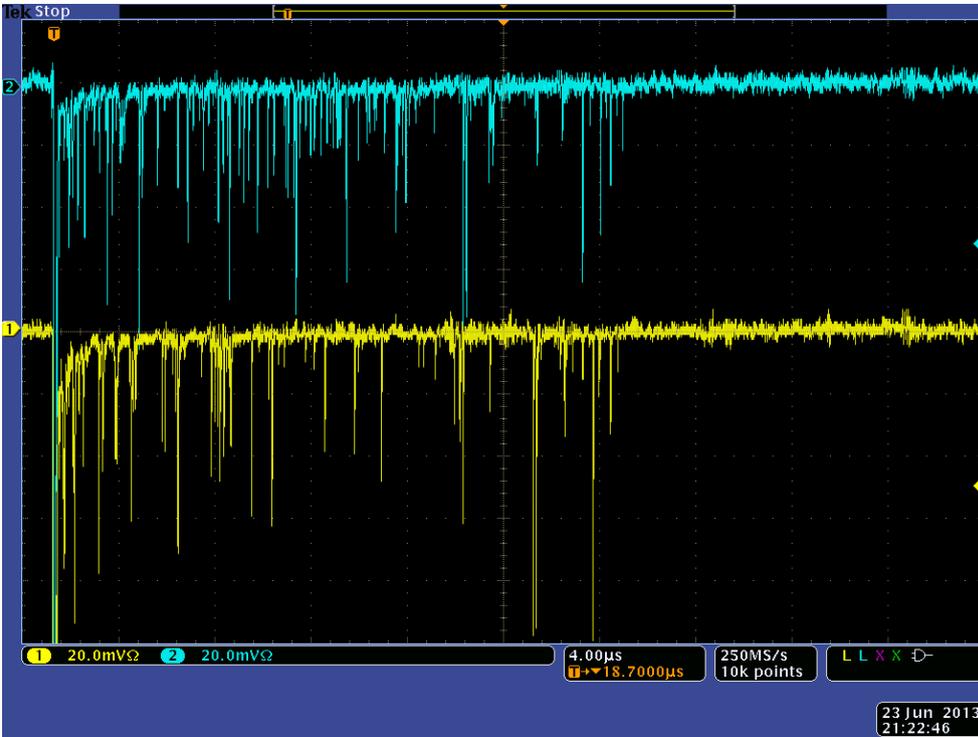


# Cosmic test results with a scope (at Blue Crab) .

Scope time scale : 2 ns samples.

Two parallel wires from 2 chambers connected to the scope.

Scope triggered by coincidence of signals above threshold from 2 wires.

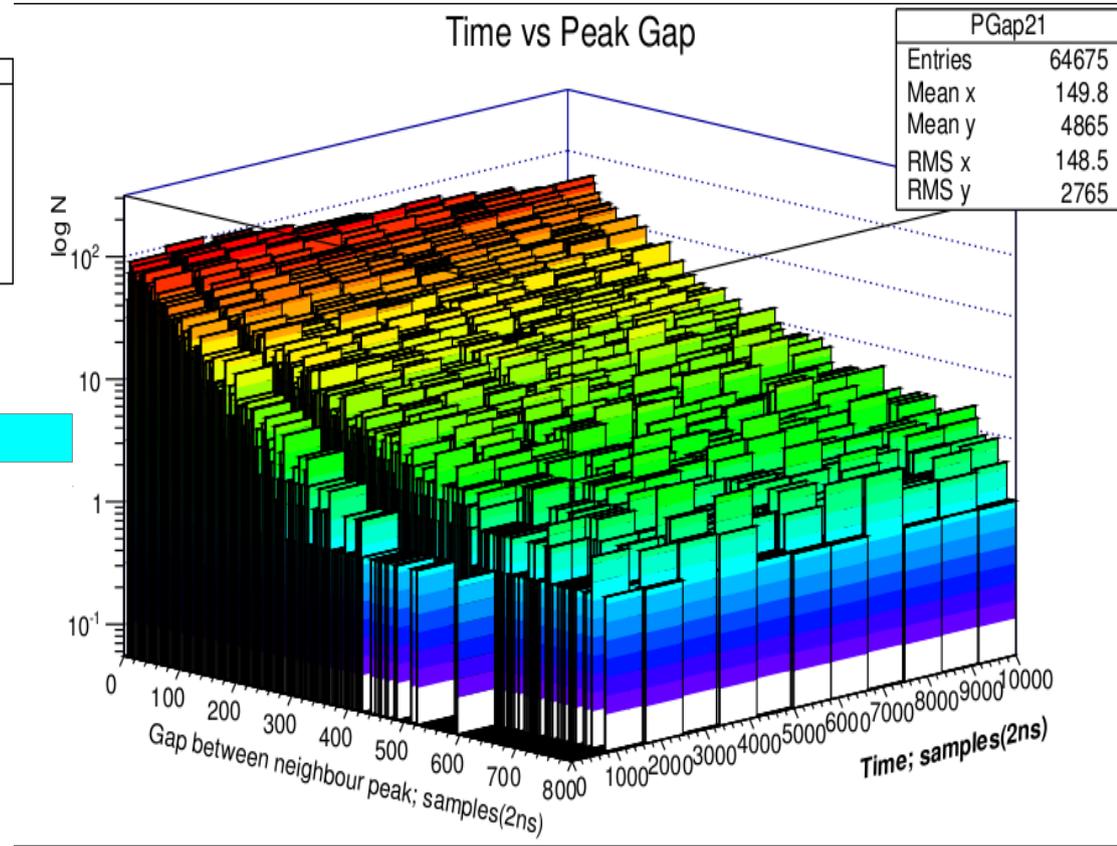
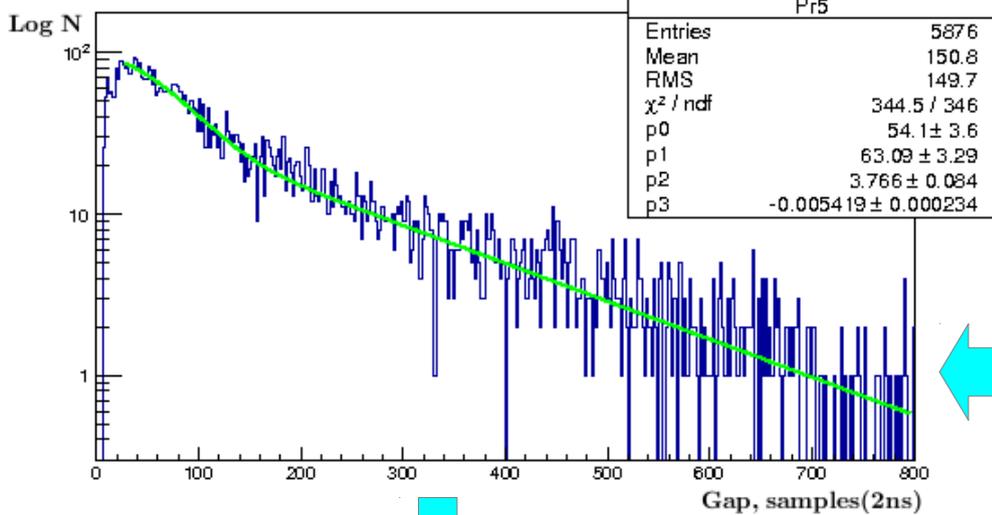


The fact that we can count ~50 clusters from each cell mean that we have a full scale detector which capable to measure number of primary clusters with 10% accuracy.

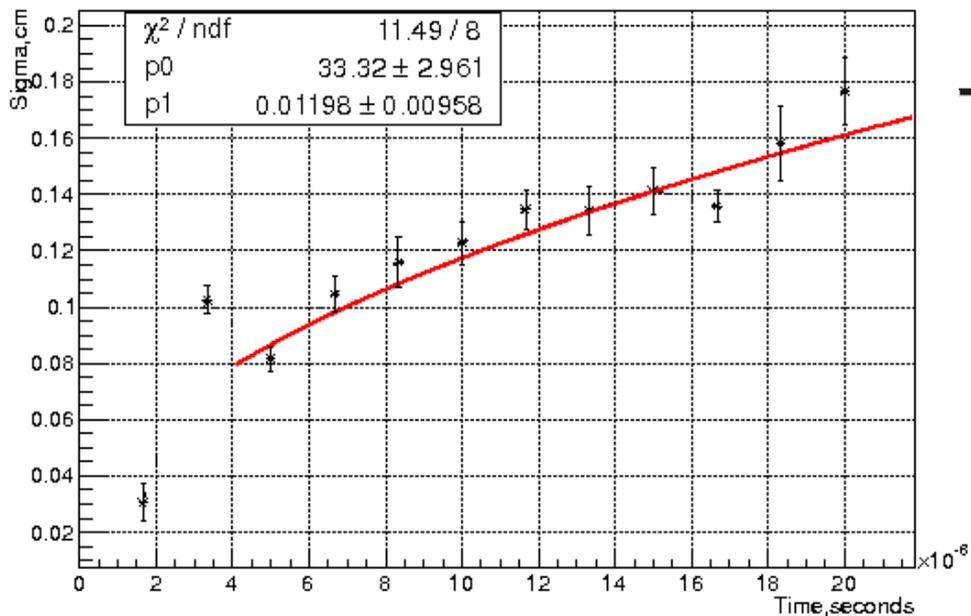
# Diffusion measurements.

fit func :  $f(x)=p0*\exp(-x^2/p1)+\exp(p3+p4*x)$

2DHist(Time vs Gap) Projection X bin N 5



Sigma=sqrt(2\*D\*T) [ fit func f(x)=po\*sqrt(x+p1) ]



Diffusion measurements allow to separate primary clusters peaks from electron diffusion peaks.

$$D_{\text{exp}} = (8.95 \pm 1.61) \text{ cm}^2 / \text{s}$$

$$D_{\text{garfield}} = 15.98 \text{ cm}^2 / \text{s}$$

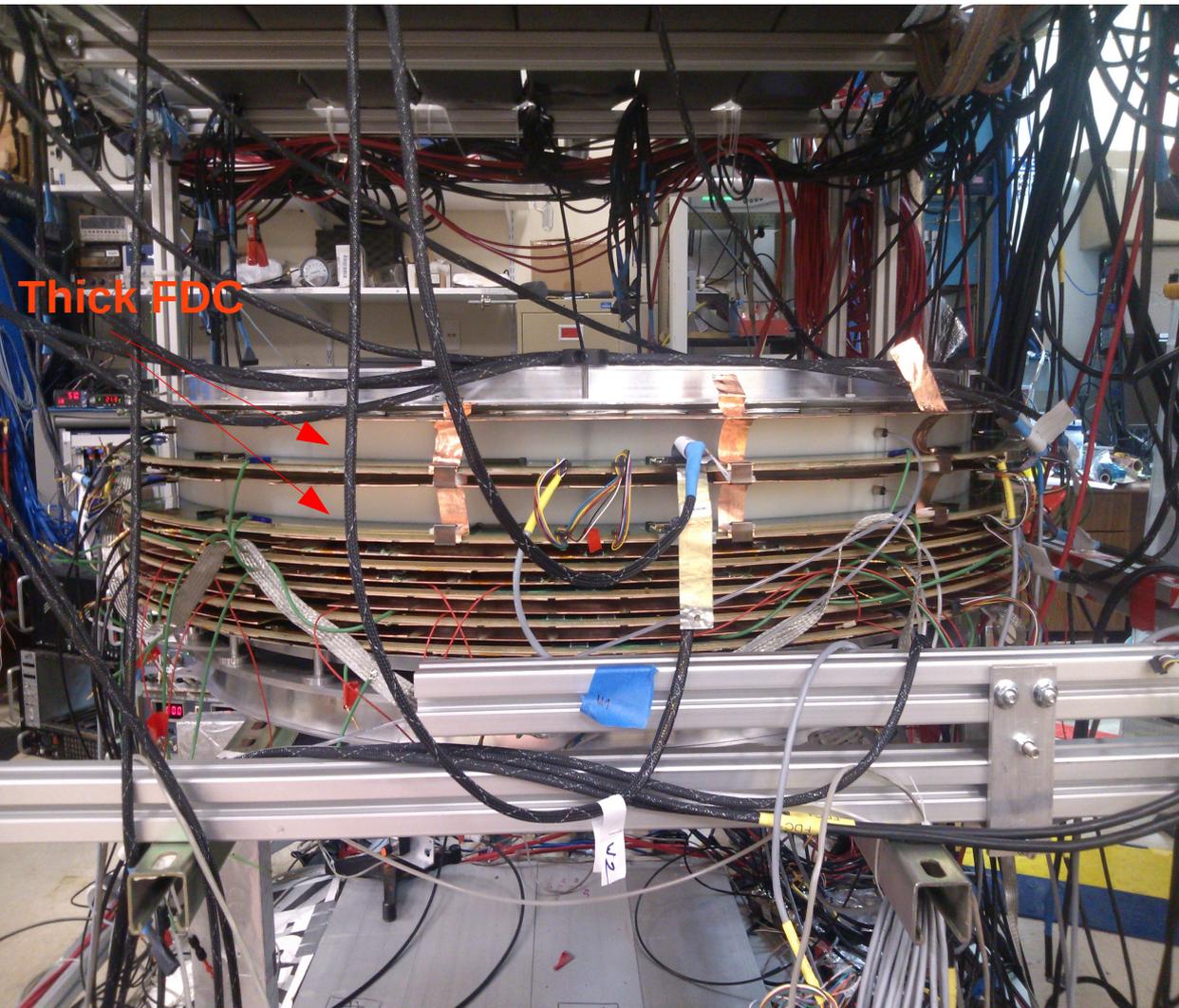
## Experimental setup of the cosmic test with DAQ.

Gas mixture : Ar/CO<sub>2</sub> {40/60} and {60/40}

HV : central 20 sense and 20 field wires  
in each chamber(2 central HV sectors) .

2 upstream scint. pads & Trigger  
2 downstream scint. pads  
Pads are parallel to the wires

External particle tracker (drift chambers).



Data was collected using  
125 fADC`s

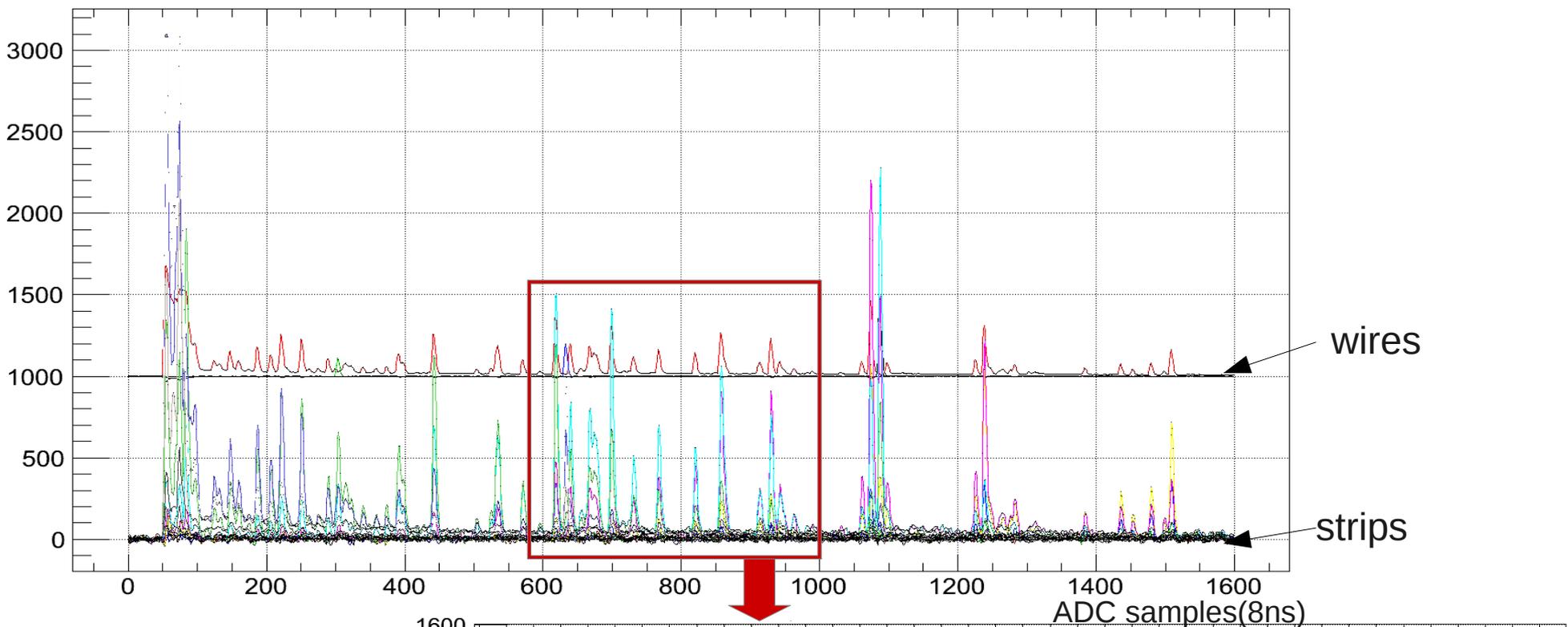
Front end readout:

2 Anode Pre-Amp`s  
13 Cathode Pre-Amp`s  
each preamp has 24 ch

Wires from cell 1 are parallel to  
cell 2 wires.

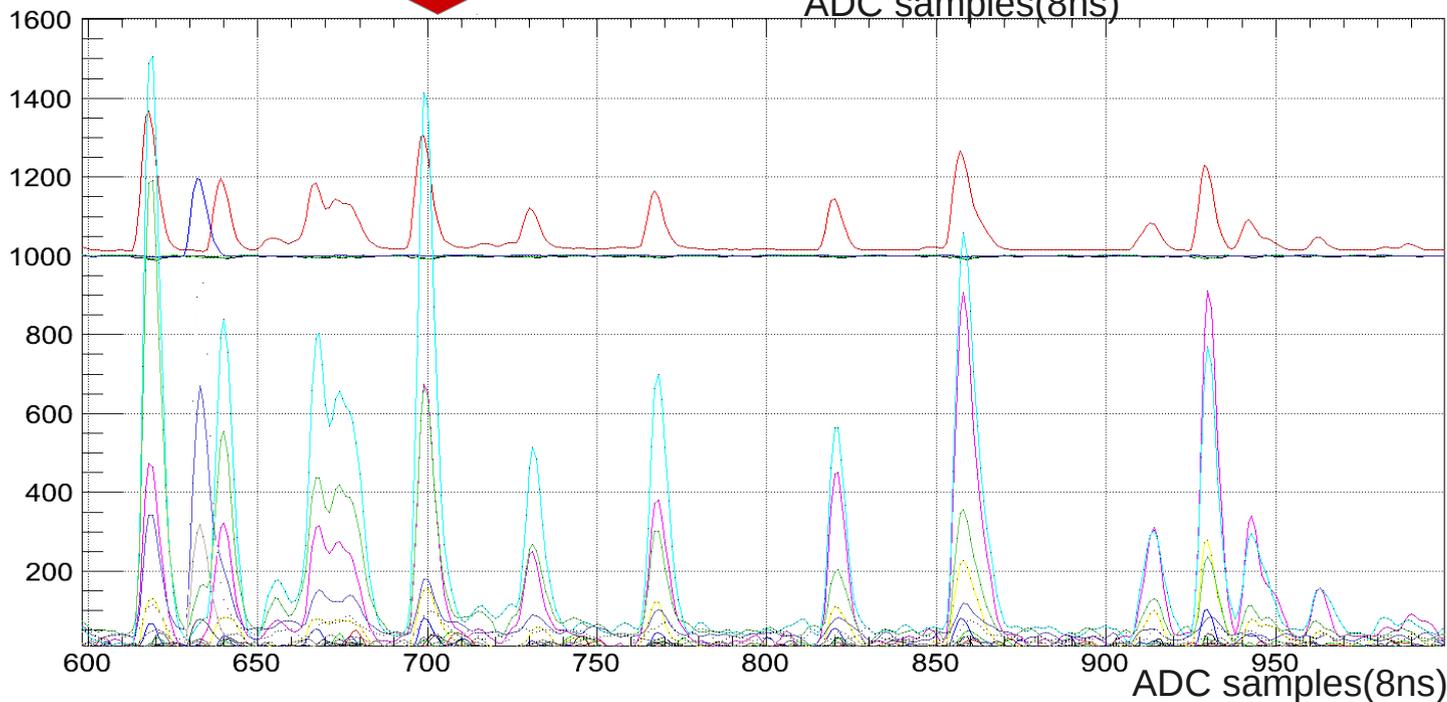
Read out channels(each chamber) :  
-24 wires (central area)  
-144 strips

# One event example. Wire and strip signals from 1 cell .

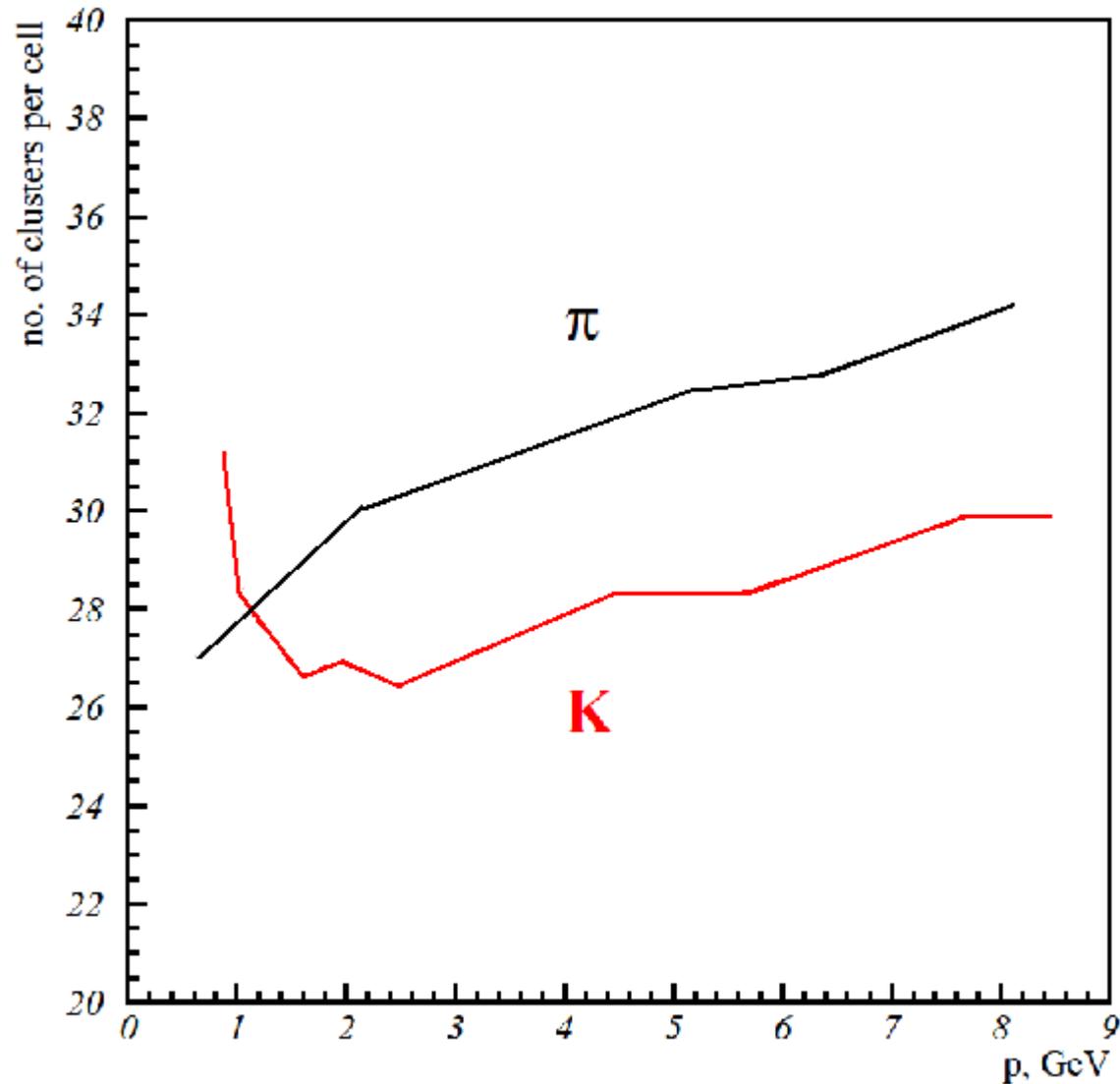


Good coincidence  
between wires and  
strips signals

Single electrons  
can be collected  
with high efficiency



## Clusters amount per cell vs momentum.



-Garfield calculation for He gas mixture.

-Argon calculations will be done soon but according to the literature Pi to K ratio is the same (10-15 %) for  $p > 2$  GeV.

## Summary.

- 1) Test with full scale prototype (modified FDC) with scope & DAQ for several gas mixtures were performed.
- 2) DAQ allowed to collect data with length up to 20 microseconds. (Thanks to Beni).
- 3) Analysis is in progress will take time.
- 4) Future cluster count algorithm which will be taking strips signals into account is being developed.
- 5) External drift chamber tracker plus future algorithm will allow to reconstruct the cosmic tracks.
- 6) HEED (within Garfield) predicts 10-15% separation between pions from kaons.
- 7) With only two chambers we can achieve 10% resolution .