NOISE AND LONG TERM BEHAVIOR OF PROTOTYPE GEM CHAMBER

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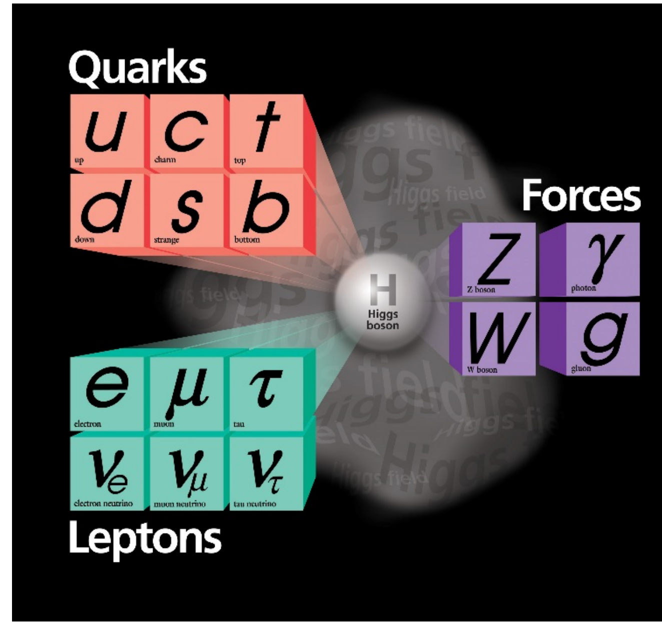
19th January 2014

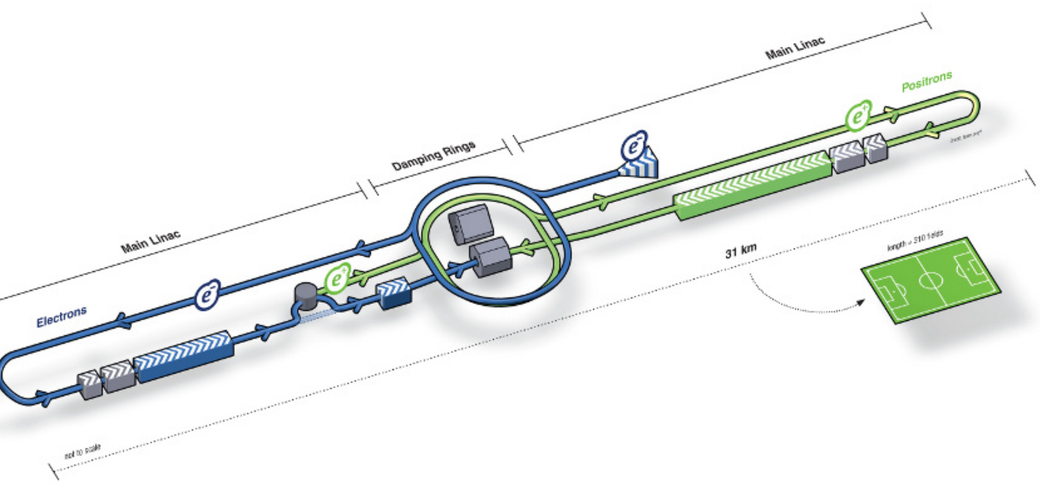
Conference for Undergraduate Women in Physics 2014

Motivation and Introduction

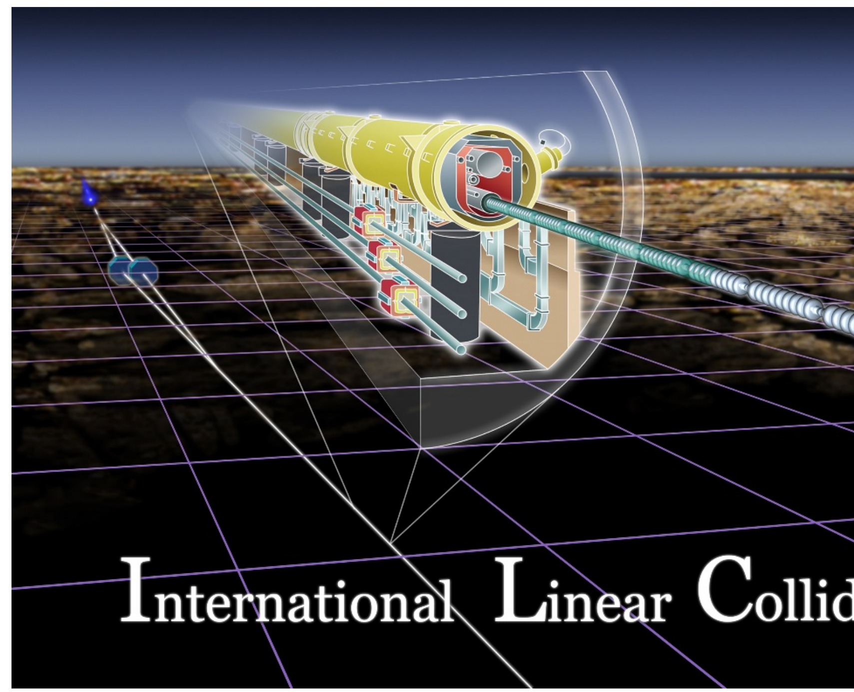
Physics topics in the International Linear Collider(ILC) requires detectors for high precision jet energy measurements.

The Gas Electron Multiplier(GEM) is a good candidate as a active gap detector for the calorimeter by the particle flow approach(PFA).(Yu)





Above: International Linear Collider-Schematics



HAT IS GEM?

ds for Gas Electron Multiplier

t Generation Micro-strip Detector Technology

it:

wer voltage is needed

wer chance of discharge/sparks that may damage the ectronics

cellent Resolution.

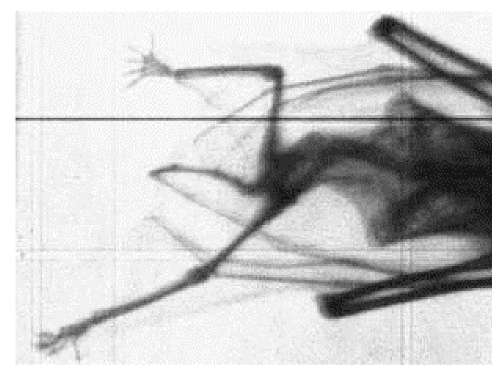
sible application:

rticle and radiation detector in ILC and LHC,

edical Diagnostics and Portal Imaging.

ensifier for CCD camera

ray Polarimeter to study polarization of supernovas d pulsars



8 keV absorption radiography of
mammal. The horizontal image is

Bachmann. *"Development and applications of the gas electron multiplier ", European Organization of Nuclear Science,* Invited paper, Imaging 2000 conference; holm, Sweden, June 28-July 1, 2000

HOW DOES GEM WORK?

cosmic ray passes through chamber it ionizes ArCO2 mixture in the chamber.

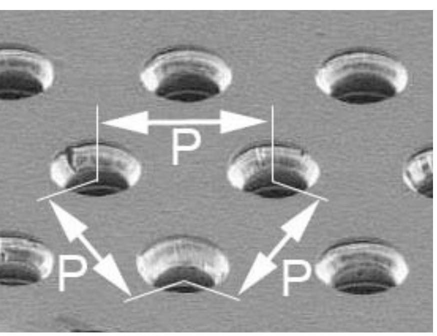
onized electrons travel down by the electric d(drift region:1.3e+4 V/m) , they pass through holes in the 2 layers of GEM foils with a much her electric field.(7e+6 V/m)

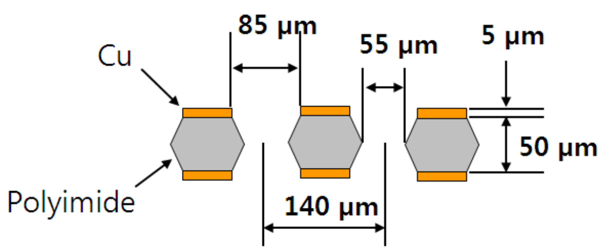
high electric field cause a cascade of ctron to be ionized(Multiplication)

multiplied electrons is read out at the anode rd.

Gain=# of electrons read out on the anode

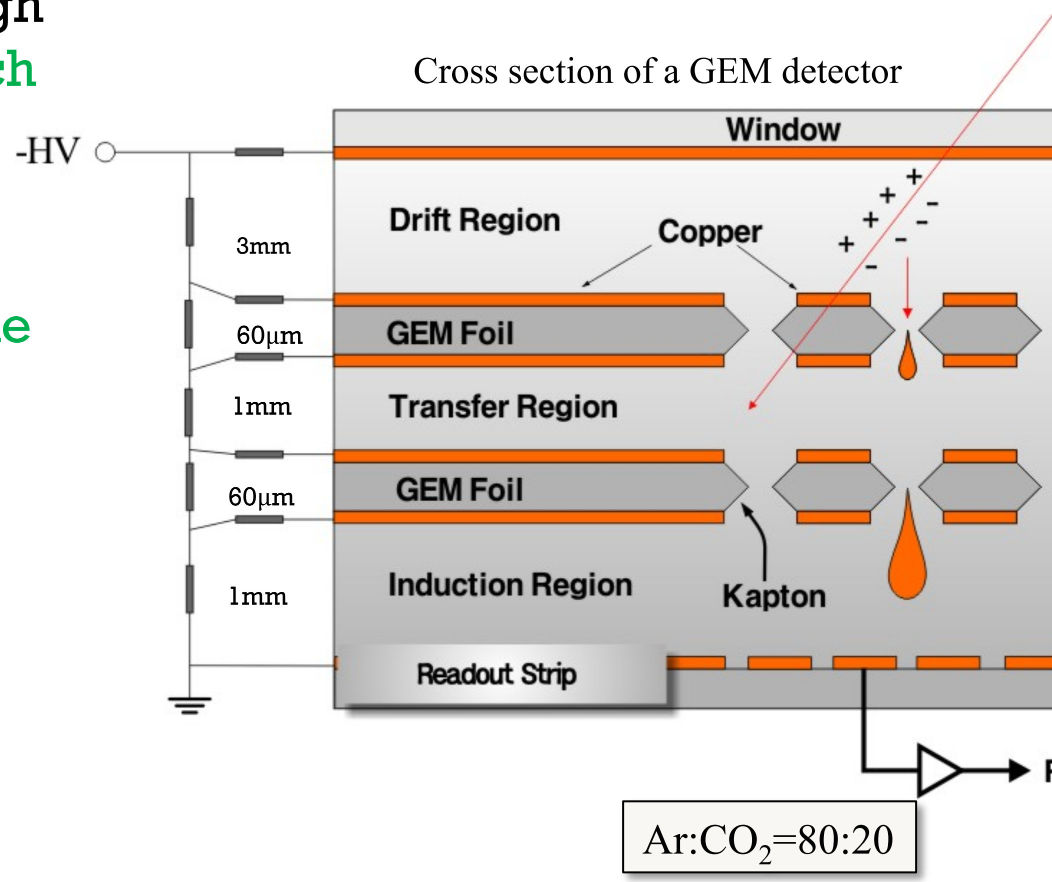
of electrons ionized in the drift region





e up of a standard GEM foil with regular pierced bi-conical holes
-0μm; Diameter of the holes: D(cu):85μm; D(polyimide):55μm

Cross section of a GEM detector



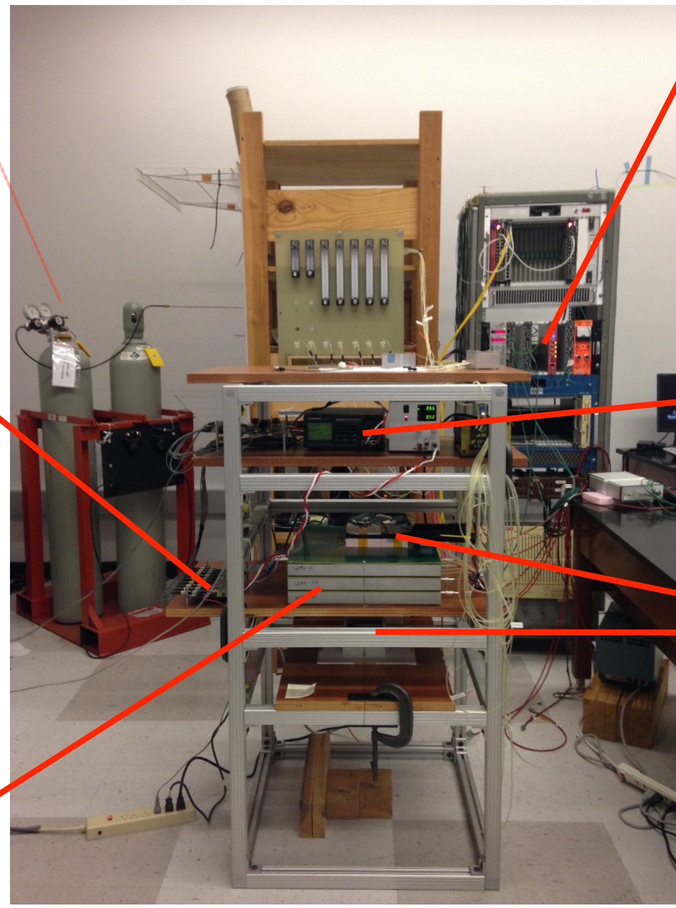
GEM AT UT ARLINGTON

Dr. Andy White proposed to have GEM as an active element of DHCAL in 2002. The
group has been working on the GEM project since then.

ArCO2 gas Supply
Ar: CO2 ->80:20

Kpix Readout system
ystem that reads out the
from GEM to the computer
system is able to read a
tude of signal->can
ure effective gain and
ncy of the GEM chamber
pixel-> 64 in use

4 GEM chambers
ons and Specifications:
: 310x310 mm^2
ctive area : 280x280 mm^2
as room: 350x350x6 mm^3
ut channels(1x1 cm^2)♪



High Voltage Supply
Across each GEM chamber(19

Low Voltage supply
For the readout electronics(5

2 scintillator
- Sandwiching the GEM cham
- Work as a Hodoscope
- The Kpix system only read o
hit data when both scintillato
detects a signal->Less stress
electronics

MOTIVATION OF THIS STUDY

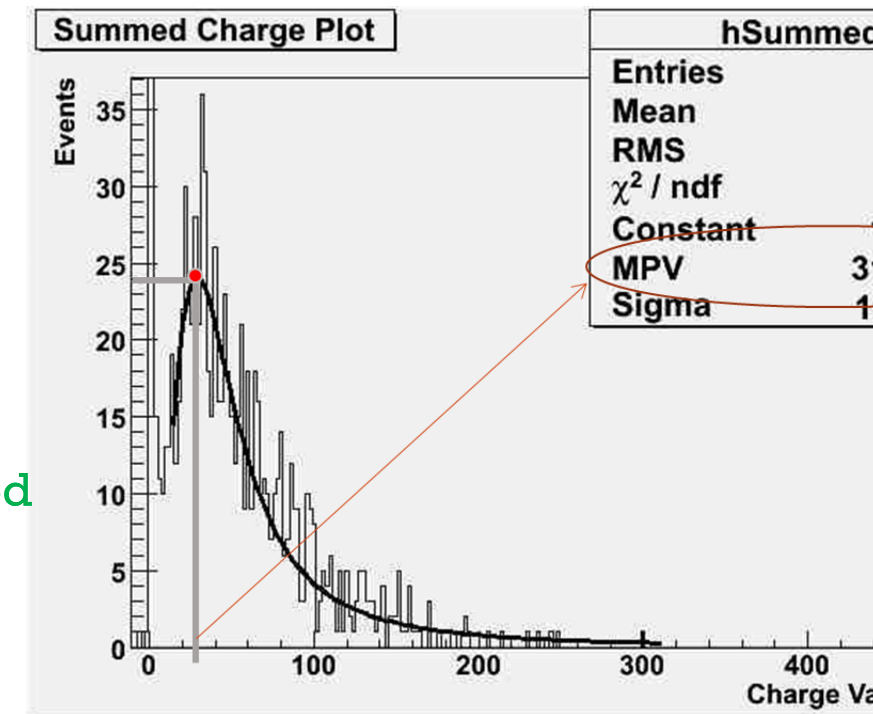
- Effective Gain-> An Important index of how efficient GEM is.
- Stability of GEM chamber over a long period of time
  - The more stable it is the more reliable of an candidate GEM is as a gap detector
  - Investigation of the long term behavior of GEM is therefore important

METHODOLOGY: RESPONSE OF THE GEM CHAMBER

ain=# of Electrons read out on the anode board/# of
onized in the drift region

ead out on the anode board=MPV/Charge of an electron

f the # of electron ionized at the drift region is constant, hen the MPV value of the charge distribution Plot is a good nalogy to the effective gain of the GEM device!



A sample Charge distribution plot of the signal

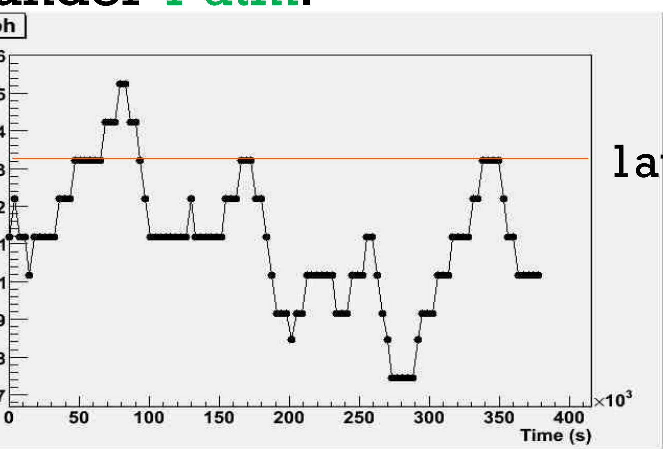
ETHODOLOGY: PRESSURE ORRECTION

ivation:

- The gain process-> pressure dependent
- (GEM is a open air system)

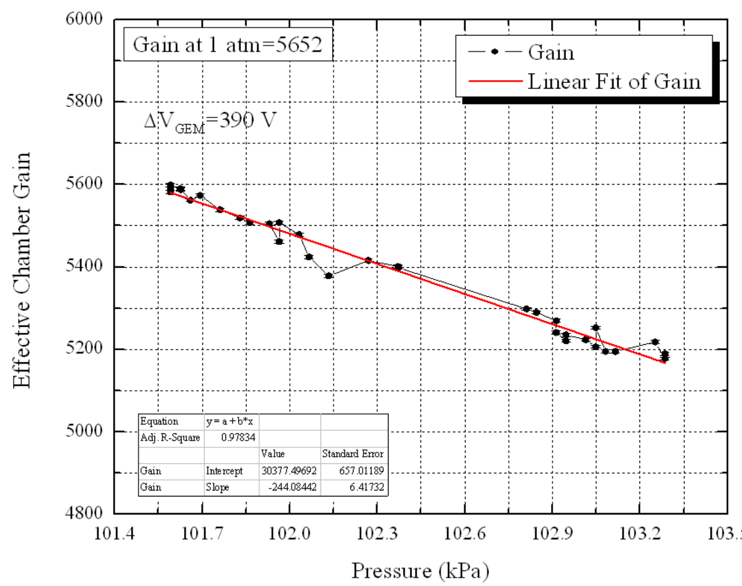
k:

- Pressure correct the cosmic run data to get cosmic ray amplification data that reflects the performance of the detector under 1 atm.

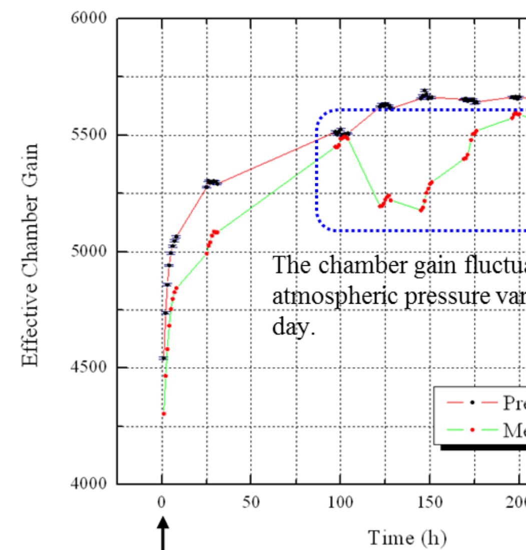


ple pressure data of a cosmic run

Effective Gain=# of Electrons read out at the anod board/# of Electrons ionized at the drift region



[*1]



HV=on

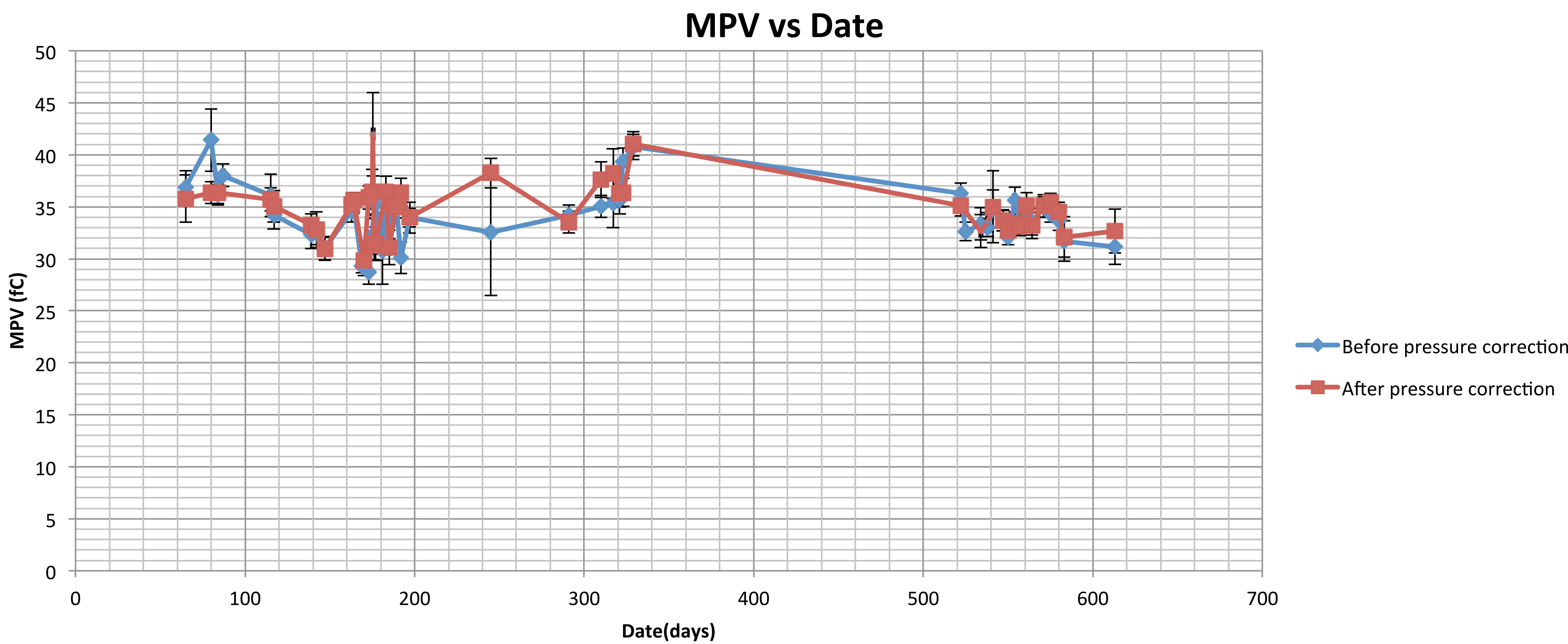
$$Gain = -303.9Pressure(in\ Pascal) + 35509 \quad [*2]$$

[*1] Park, Seongtae PhD. *"Hadron Calorimeter with GEMs", Powerpoint,* CALICE Worksho

[*2]: Baldelomar, Edward (Unpublished).

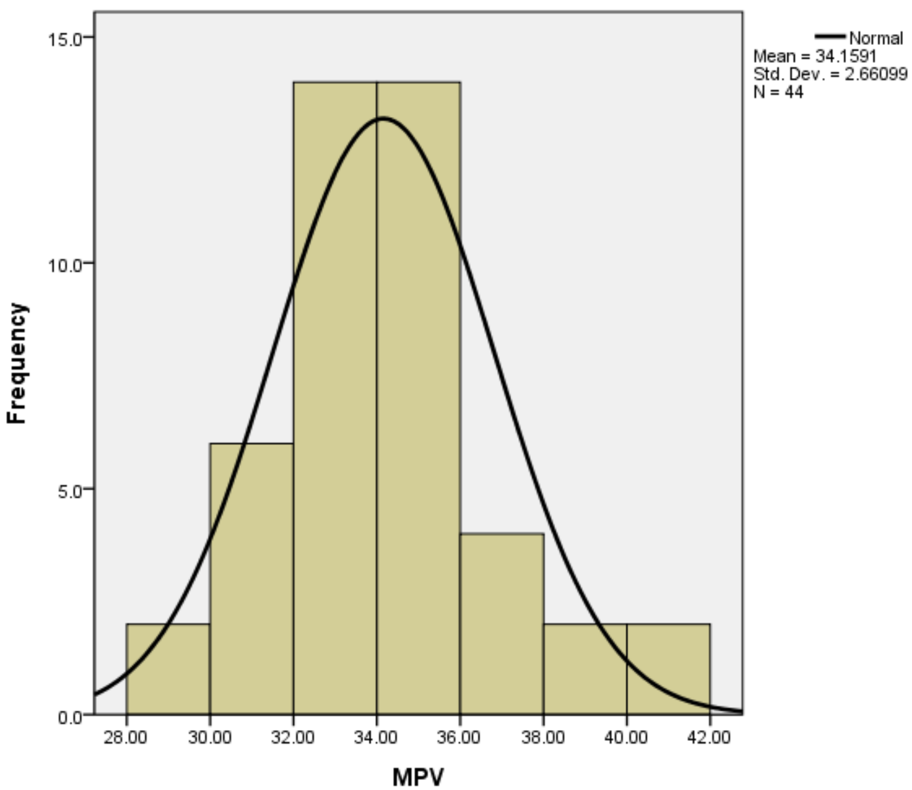
LONG TERM BEHAVIOR OF GEM ANALYSIS BY KPIX

- Long term behavior of the MPV of the charge value at the anode read-out pads



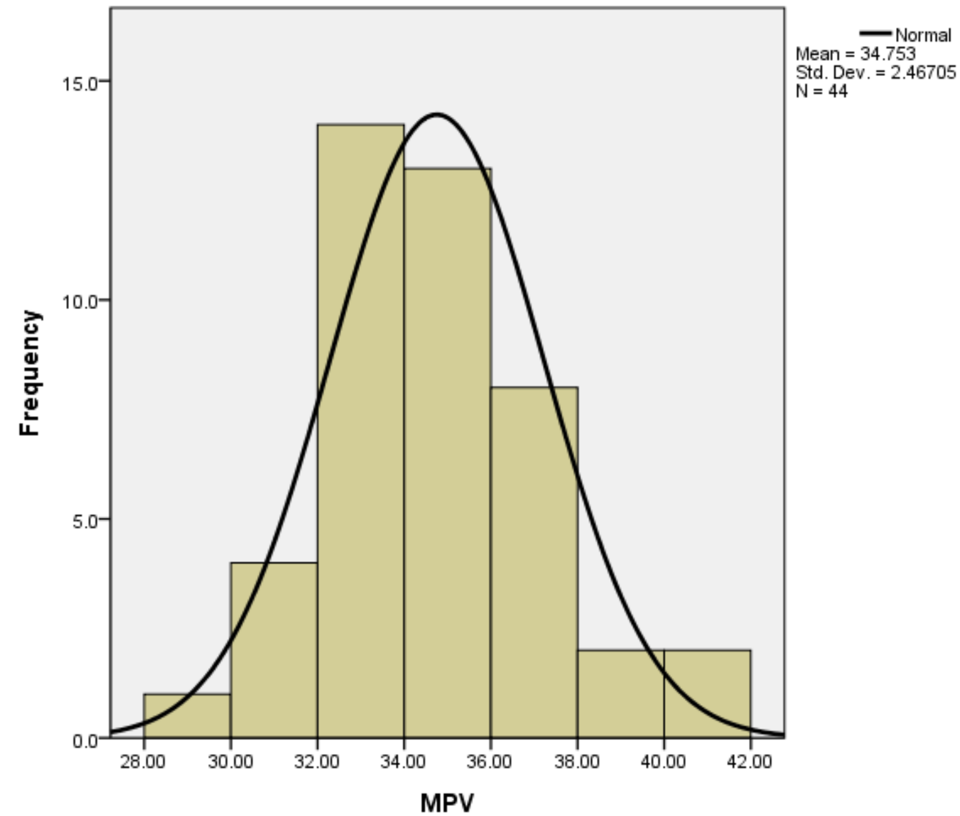
MPV DISTRIBUTION

MPV Distribution Before pressure correction



<Q>=33.12+-0.40 fC

MPV Distribution After pressure correction



<Q>=34.75+-0.37 fC

OISE STUDY- ACKGROUND

hallenge:

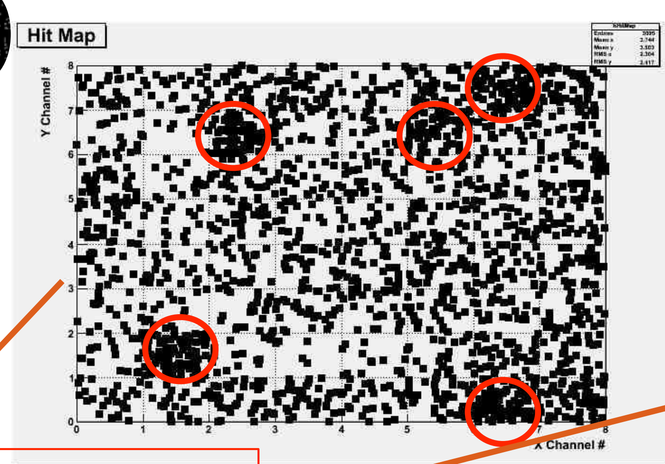
- Aging readout KPiX chip.
- Some channels are performing worse than he rest.

udy:

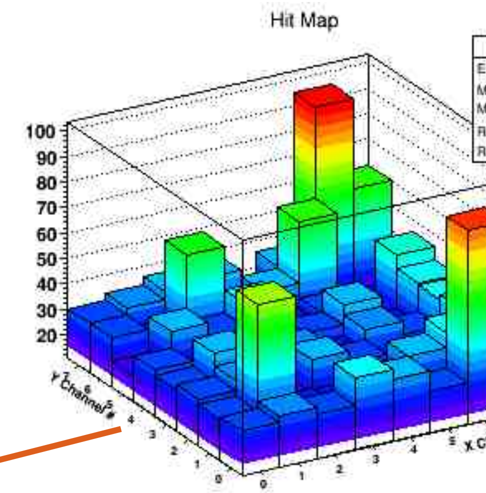
- solating the bad channels

ssible solution:

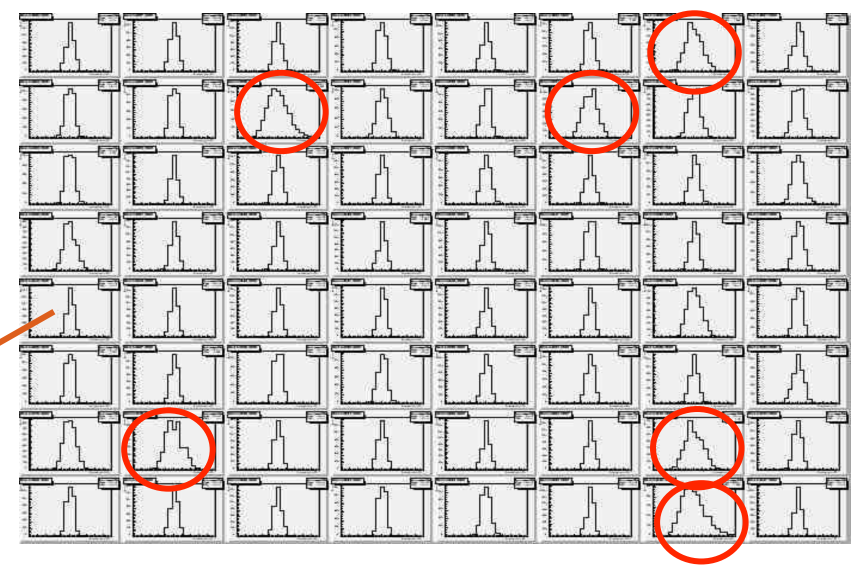
- Raising the threshold
- Masking the channel



Cluster of hits in some channels



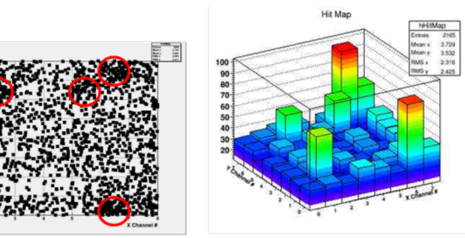
Cosmic ray Hit Map: 2013_09_20_12_43_28



High RMS value for some channels in pedestal data

Pedestal run: 2013_09_24_20_09_44

ating bad Channels: By normalized hit count in cosmic ray run



Cosmic ray Hit Map: 2013_09_20_12_43_28

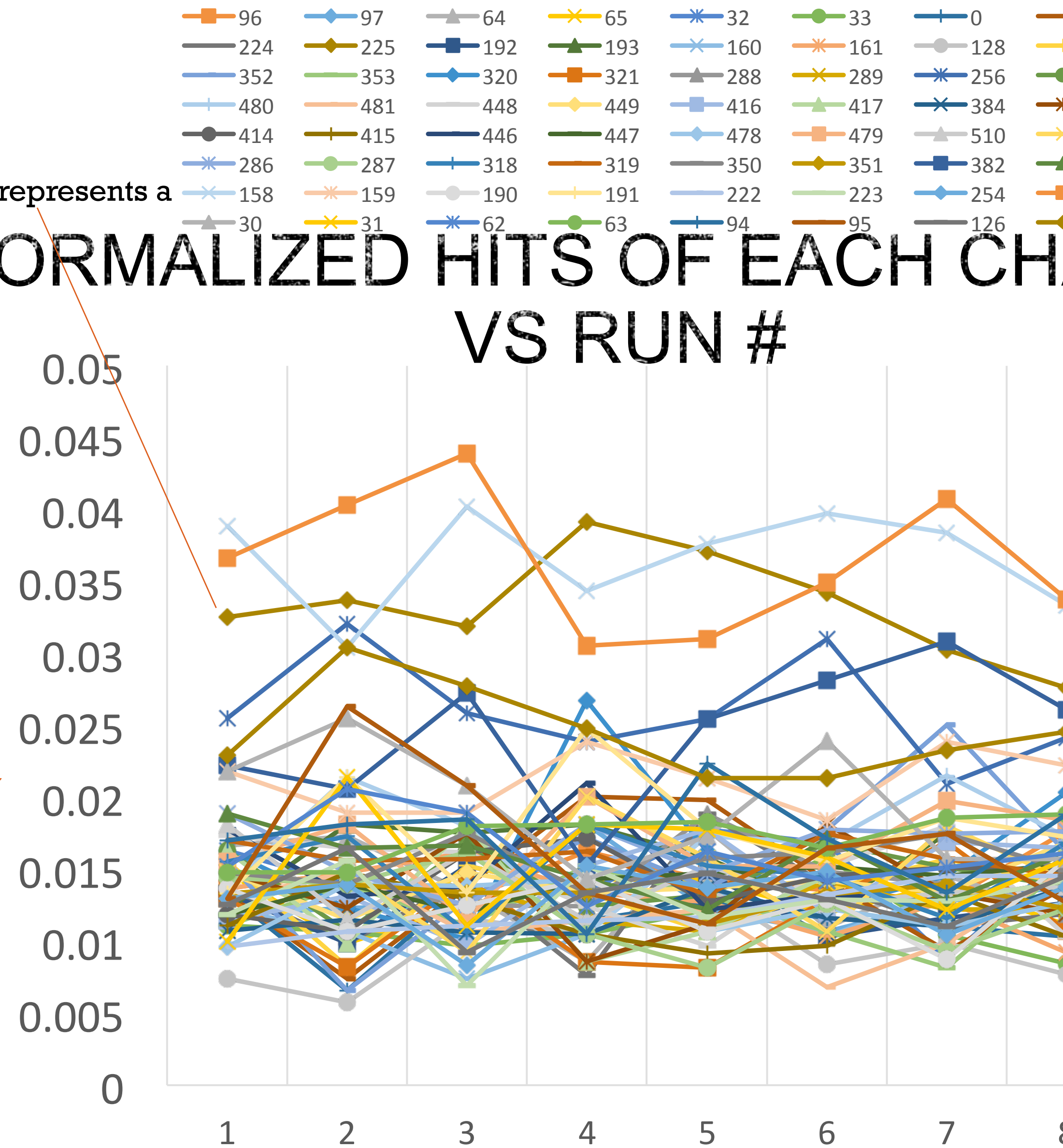
X9 cosmic ray runs done over 2 months

Normalization of the hit count of each channel

Creating a Normalized hits of each channel vs runs graph

Finding a list of channels with a the highest average normalized hit value

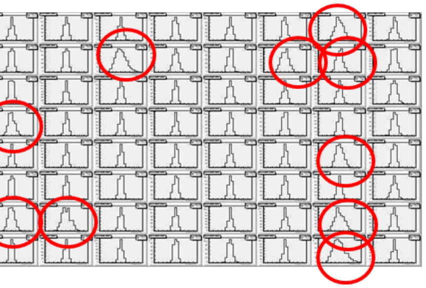
Each line represents a channel



ocating bad channels: by the RMS value of the pedestal data

MS value of the pedestal data is a reflection to the condition of the electronics.

r RMS-> Better electronics condition

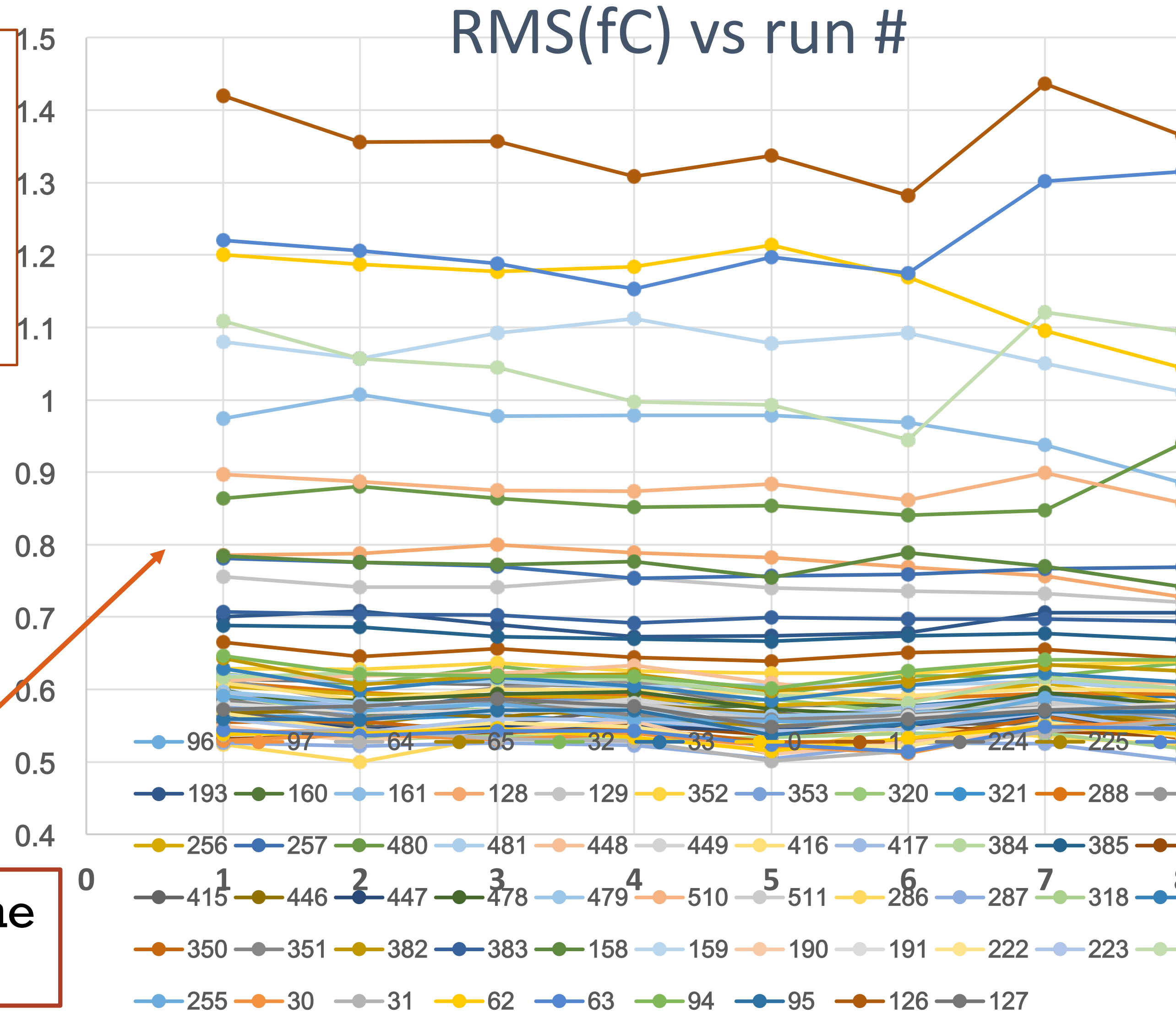


X9
Pedestal
ray runs
done over
2 months

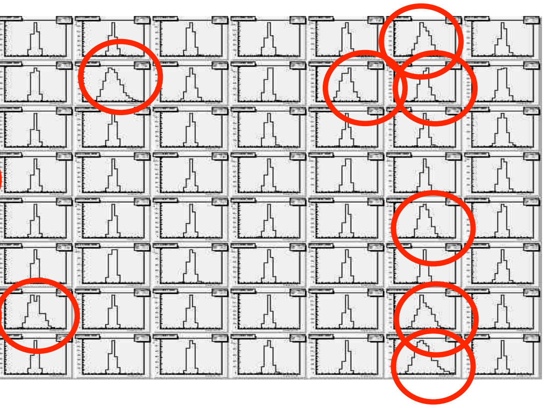
Finding the RMS value of the pedestal data

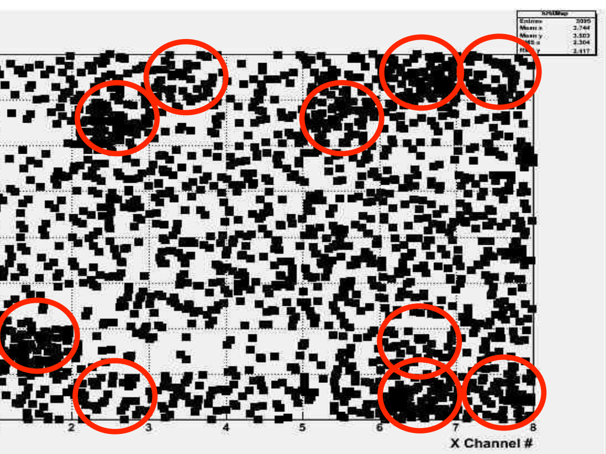
Creating RMS value over time graph of every channels

Finding a list of channels with a the highest average RMS value



BAD CHANNEL LOCATION RESULT:





Noise run top 10 highest RMS

Channel#:	Average RMS value (femtoCoulomb)
126	1.357756
192	1.219496
0	1.15875
159	1.071566
254	1.04514
161	0.963316
510	0.879144
490	0.867683
128	0.774578
158	0.770403

Cosmic Run top 10 Norma

126	0.039
0	0.034
159	0.034
192	0.031
161	0.02
127	0.02
1	0.021
254	0.018
65	0.018
62	0.017

CONCLUSION

- ✓ Pressure Correction:
  - ➢ Found the gain of the chamber at 1 atm.
- ✓ The Noise Channels Studies:
  - ➢ Some channels need to be masked or the threshold need to be raised.
- ✓ The Long Term Behavior:
  - ➢ GEM is capable of giving us a stable long term behavior
  - ➢ Chamber is Characterized by:

    ~35 fC MPV for cosmic ray MIPs

    ~0.5 fC of KPiX noise,

    A few fC of Chamber noise

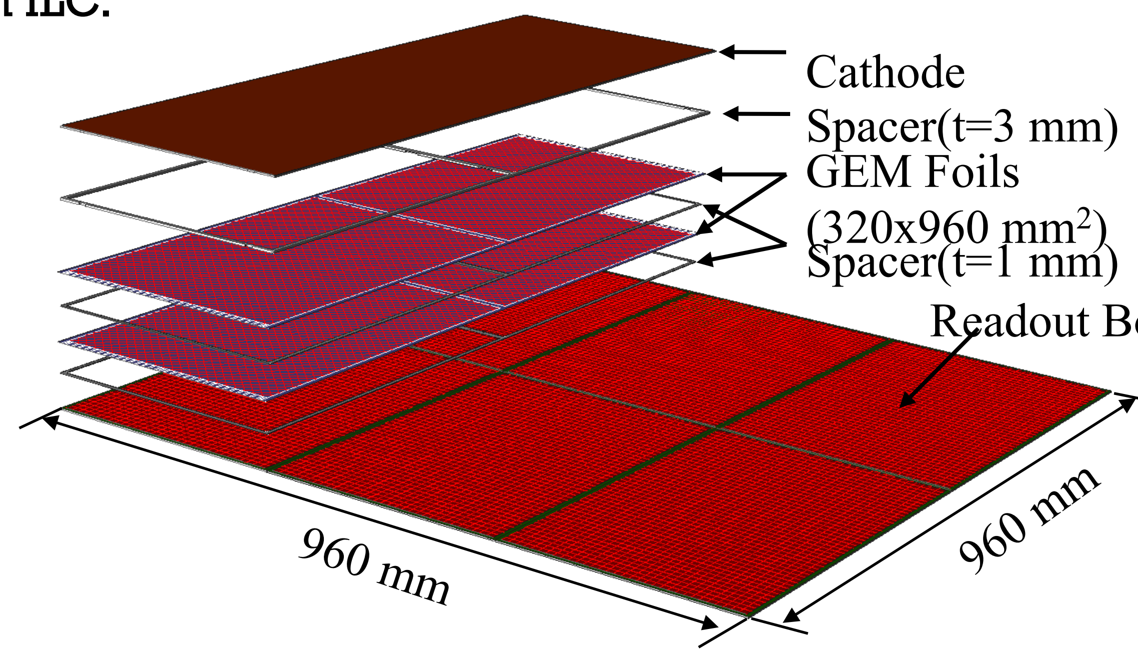
We conclude that GEM-based active layer should work well for a digital calorimet

FUTURE WORK

UTA has worked on the GEM system for over 10 years:

- Different chambers have been used: 10cm x 10cm, 1 inch x 1 inch, 30cm x 30 cm

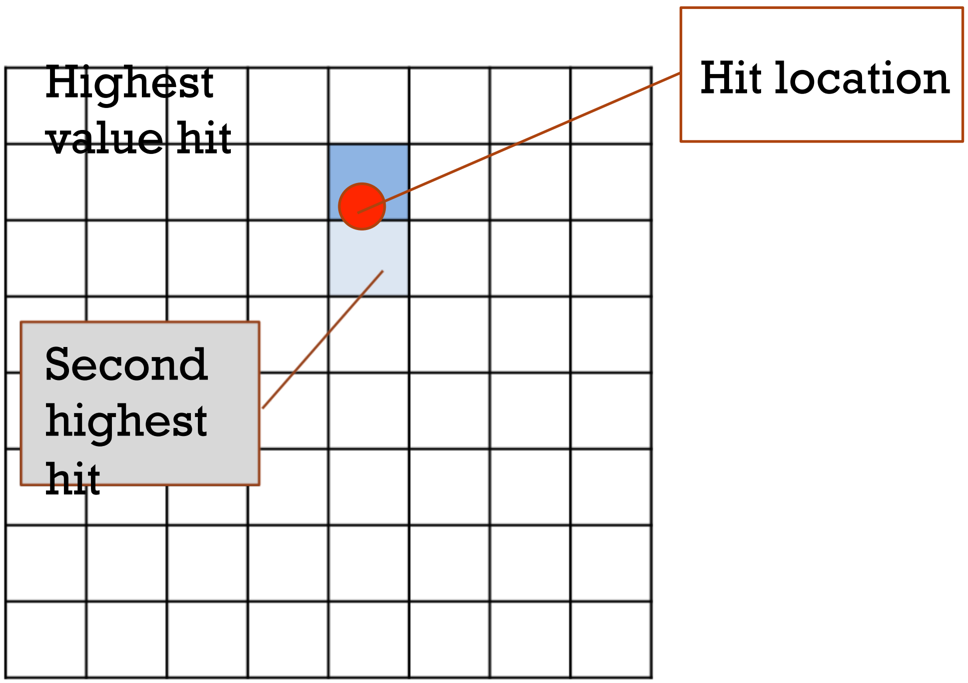
The 30x30 prototype chamber has shown a stable behavior over the past 2 years. A new prototy chamber 1m x 1m LGEM is under construction right now for us to understand the technology be as a potential gap detector for the project in ILC.



[*] Park, Seongtae PhD. *"Hadron Calorimeter with GEMs", Powerpoint,* CALICE Workshop, March 2010

BACKUP SLIDES

MECHANISM BEHIND SUMMED CHARGE VALUE:



(Above): Kpix read-out pad, made out of 64 small individual pads, stimulation of a hit

Adding the highest and second highest value together for a summed charge value
->Enable detecting of charge signal that fall between 2 readout pads