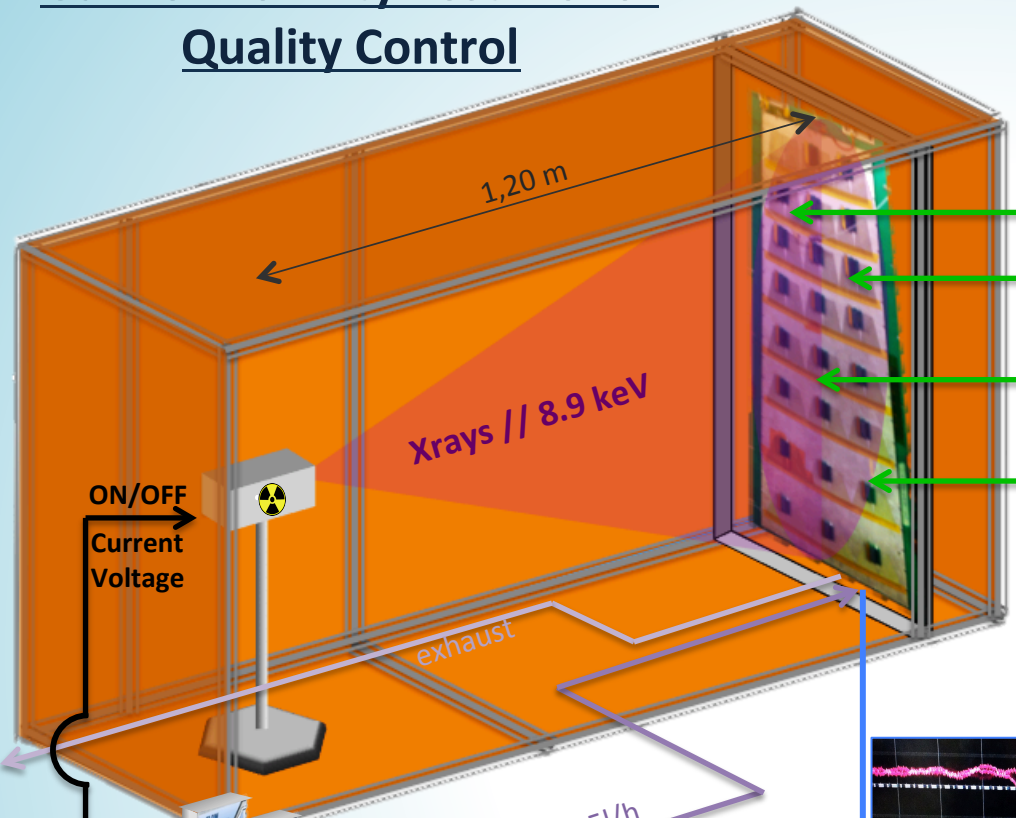
# Quality Control of Full Scale GE1/1 CMS Chambers

(APV+SRS SYSTEM)

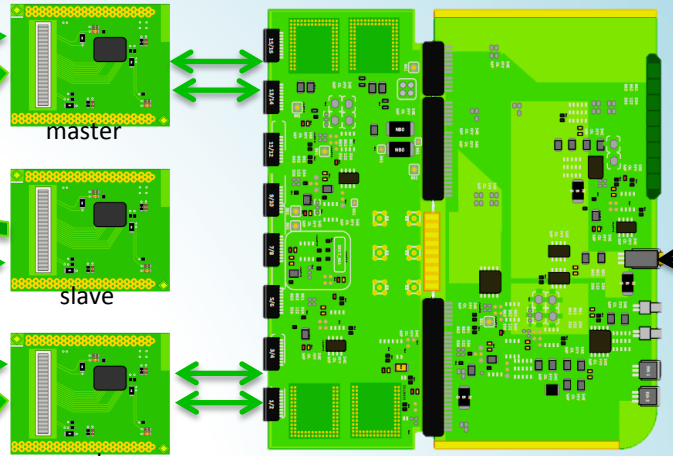
Jeremie Merlin
(IPHC,CERN)

# Gain Uniformity Test 2.0 for Quality Control



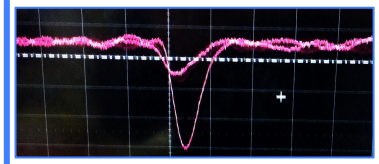

APV

SRS



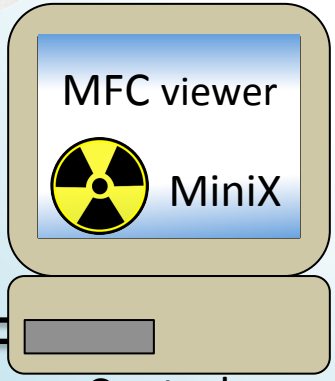

Need two FECs and 24 APVs to scan the entire prototype.

trigger



Pulse from the bottom of the last GEM

Trigger




Control


Amplifier

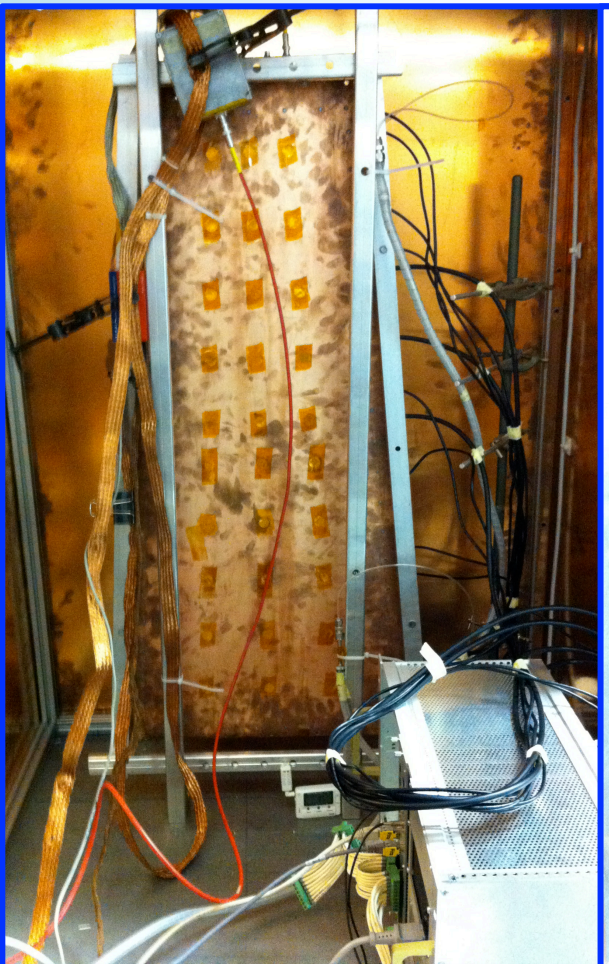
CFD

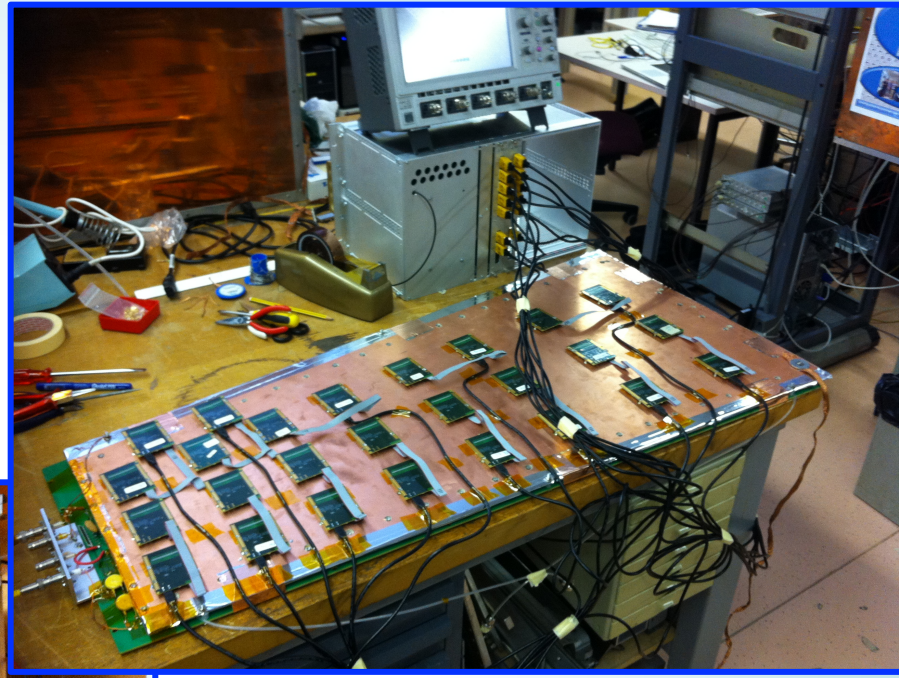

Storage

Latency
Nb of APVs
Internal rate
Veto
Trigger type
DATA

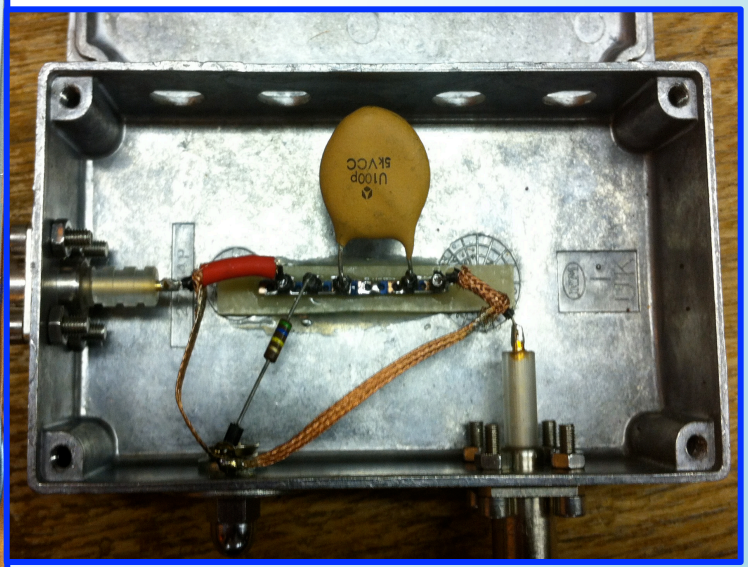
# Gain Uniformity Test 2.0 for Quality Control

The detector inside the copper box





Detector ready for testing




Filter to cut the noise

# Data Transmission

Sectors

SRS FEC_0

SRS FEC_1

Data0

Data1

NETGEAR Mbps Switch

Multi-Fec DATA

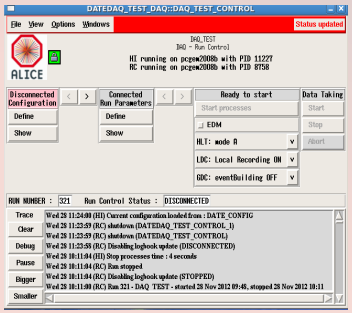
Scientific Linux 5.8

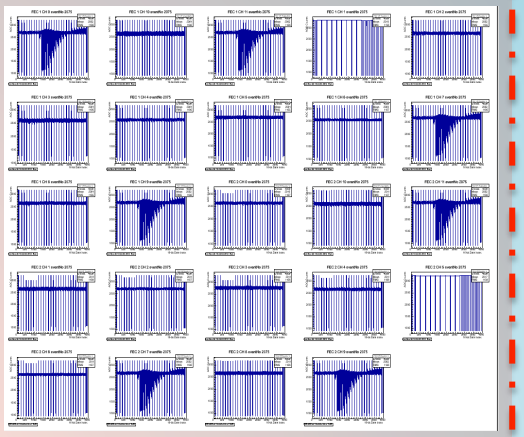
# Acquisition

## SlowControlC
-> Initialization
-> Configuration
-> Trigger Control

## AmoreAgent/Gui
-> Data Reading
-> ONLINE Monitoring

## DATE
-> Data Control
-> Run Type
-> Start/Stop



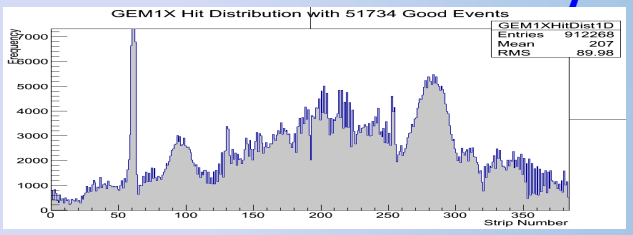



# Analysis

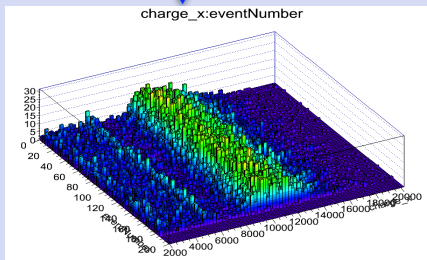
3 APVs = 1 Detector in Amore

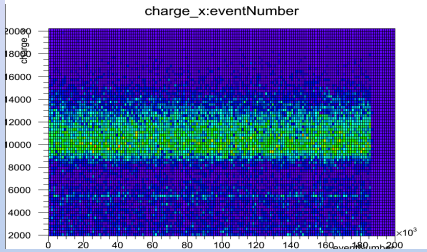
## Amore SRS
-> Pedestal Analysis
-> Zero Suppression
-> Beam Analysis
-> OFFLINE Monitoring

Beam Profile

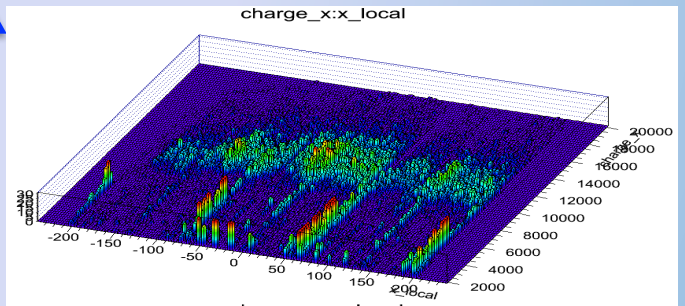


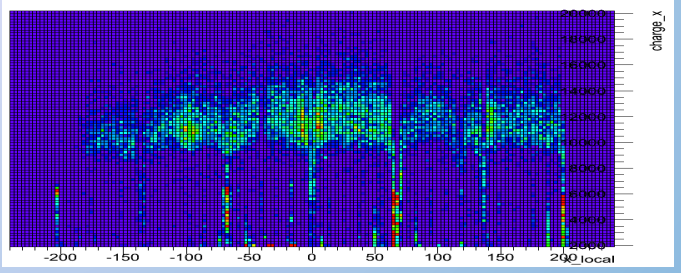

Charge Vs Time



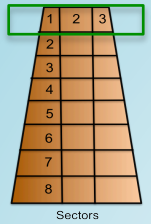




Charge Vs Strips




# Gain Uniformity Test 2.0 for Quality Control




# Gain Uniformity Test 2.0
# Preliminary Results

## Configuration :

**24 APVs // 2 FECs**

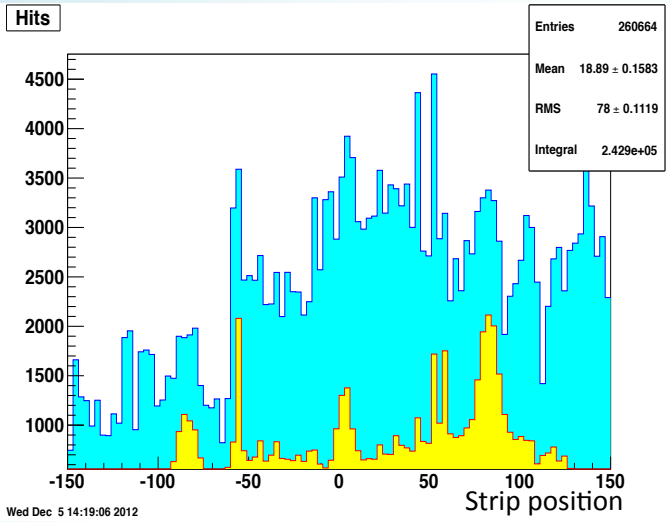
**Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA**

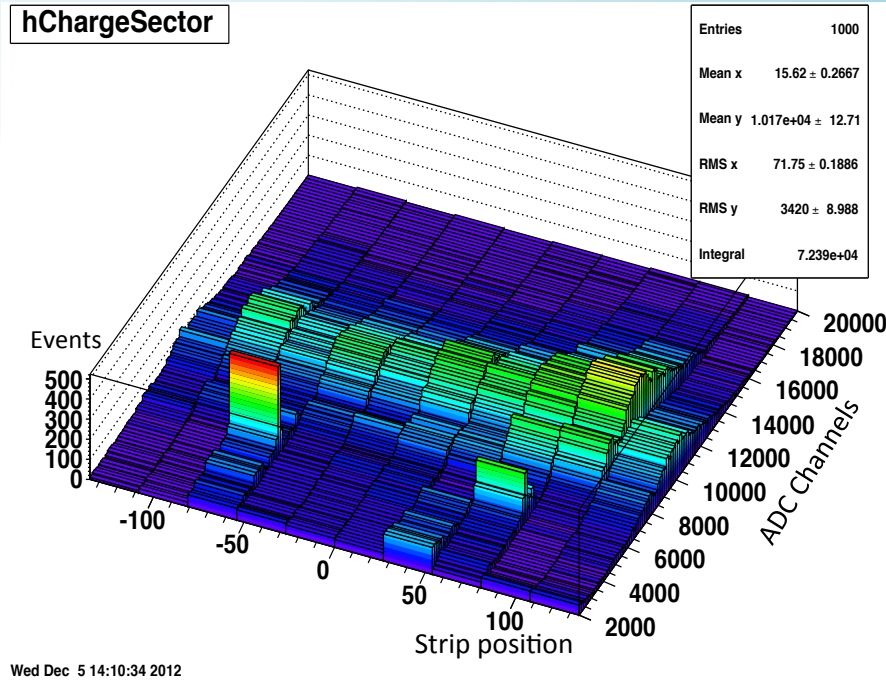
**Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)**

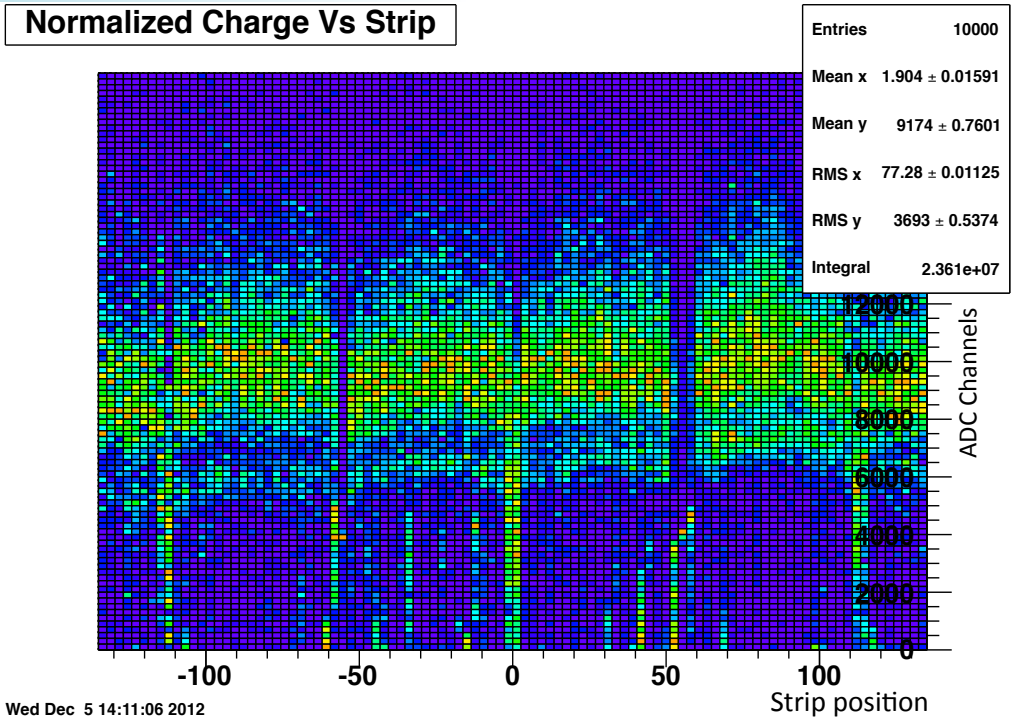
**Copper absorber (few 10s of um)**

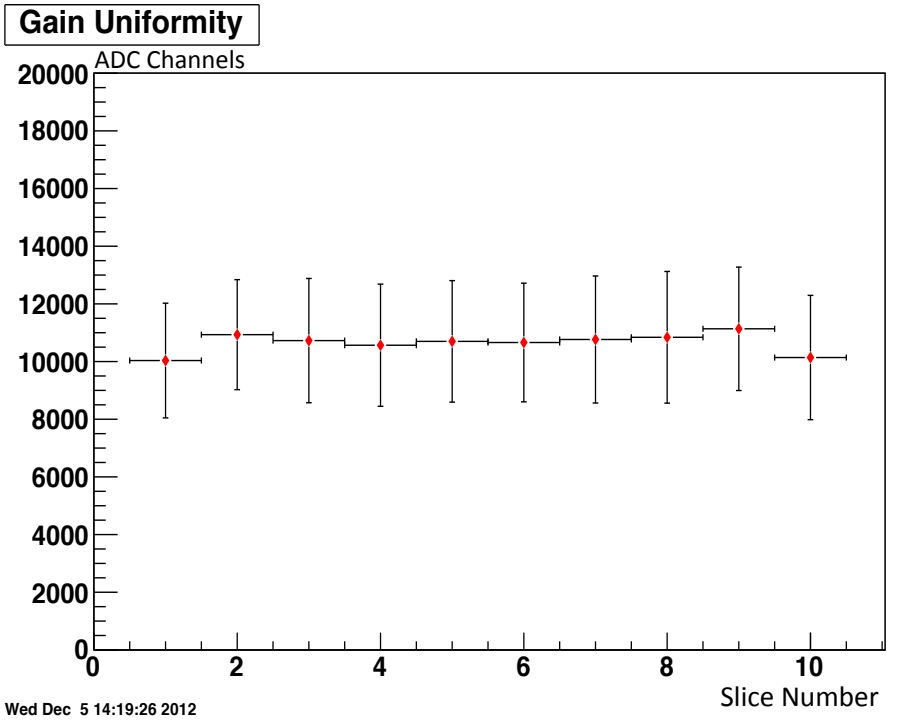
**Holes not filled**

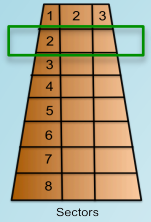
**300 K events**






GEM2

# Gain Uniformity Test 2.0
# Preliminary Results

## Configuration :

24 APVs // 2 FECs

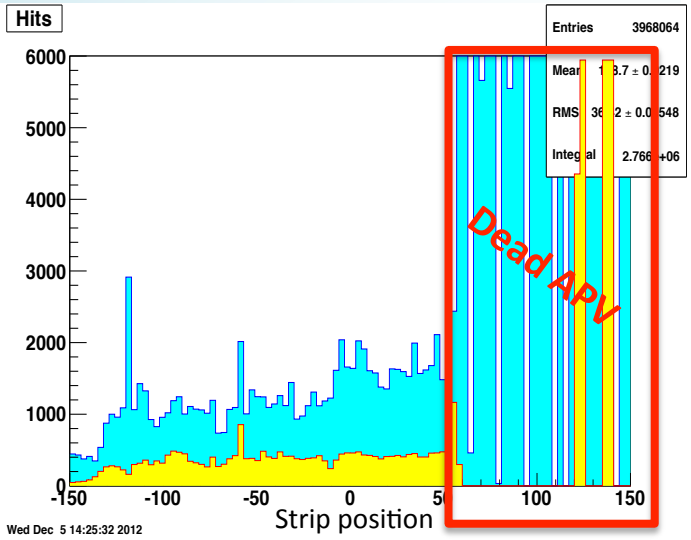
Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA

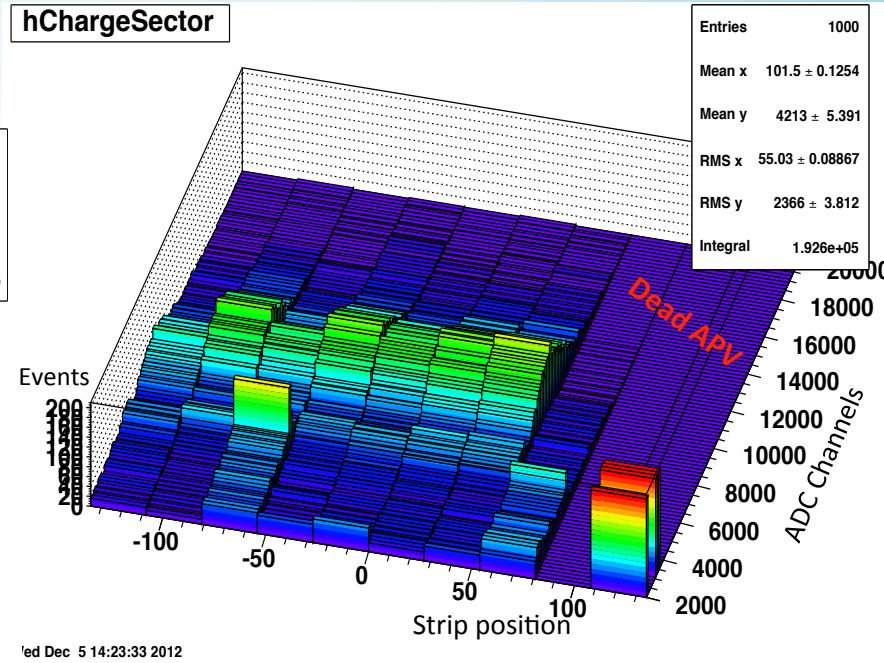
Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)

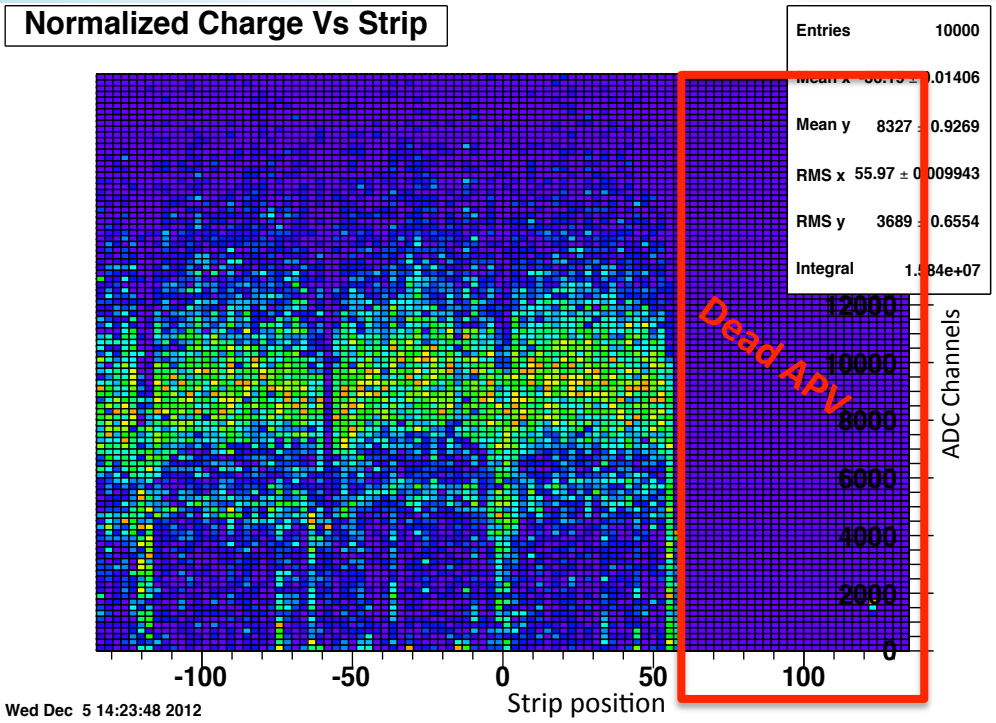
Copper absorber (few 10s of um)

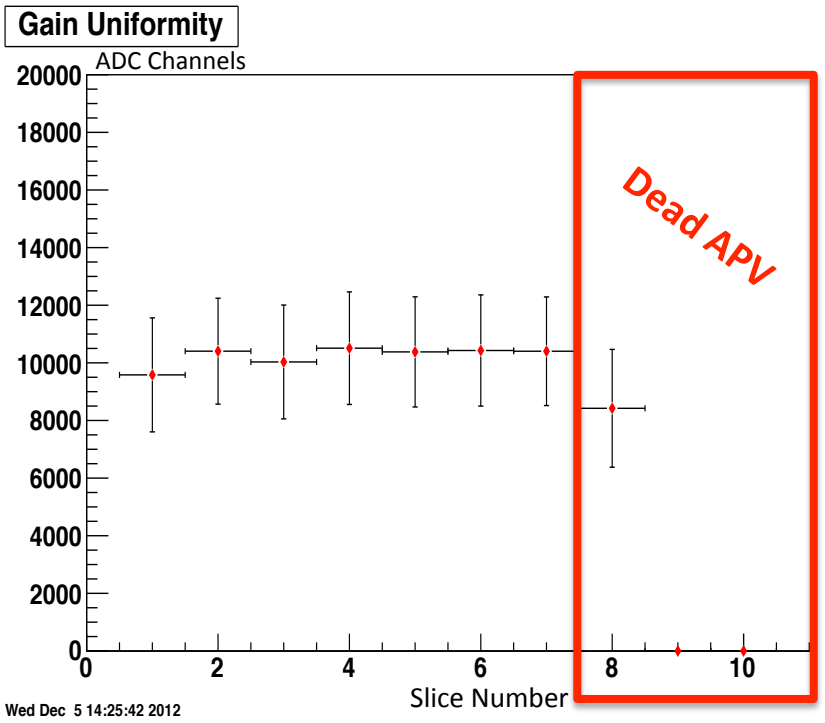
Holes not filled

300 K events

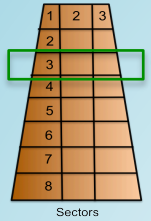


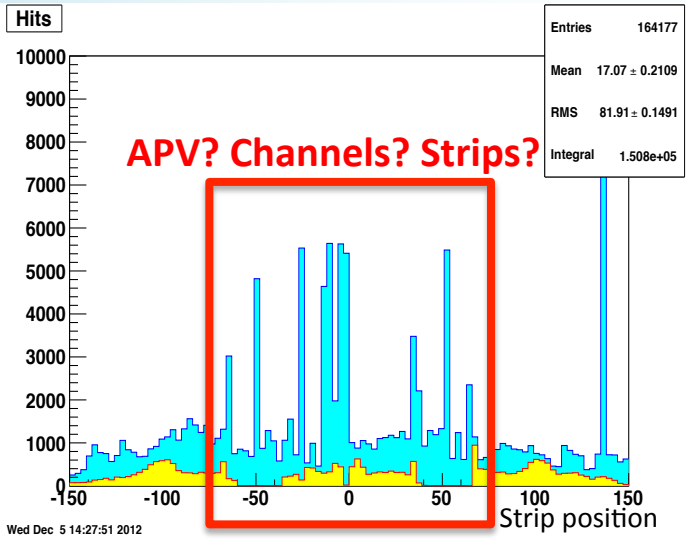
# Gain Uniformity Test 2.0
# Preliminary Results

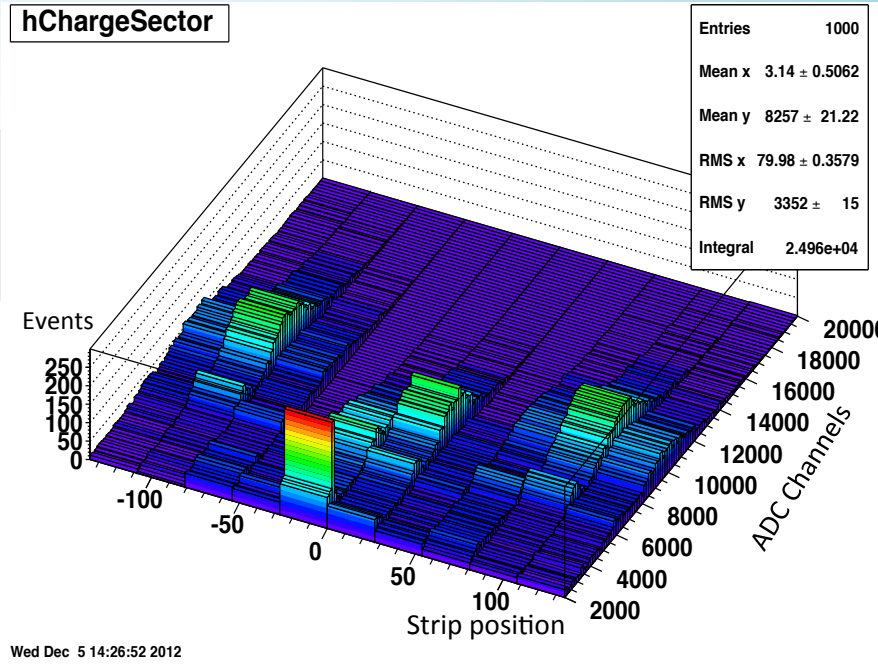


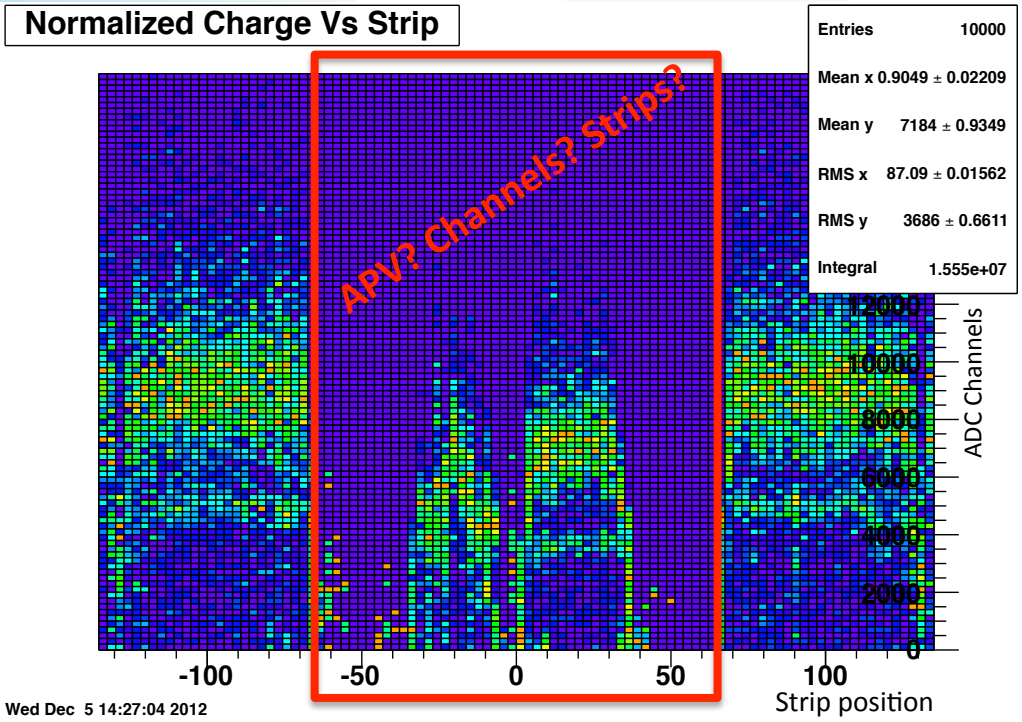

GEM3

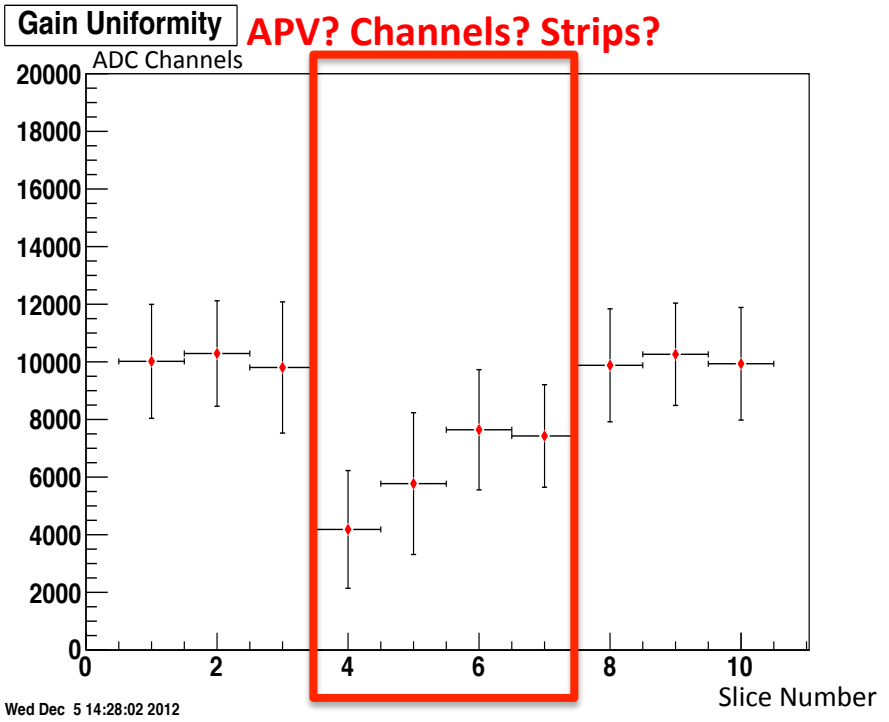
## Configuration :

- 24 APVs // 2 FECs
- Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA
- Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)
- Copper absorber (few 10s of um)
- Holes not filled
- 300 K events

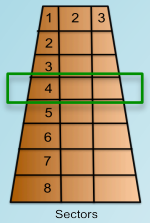


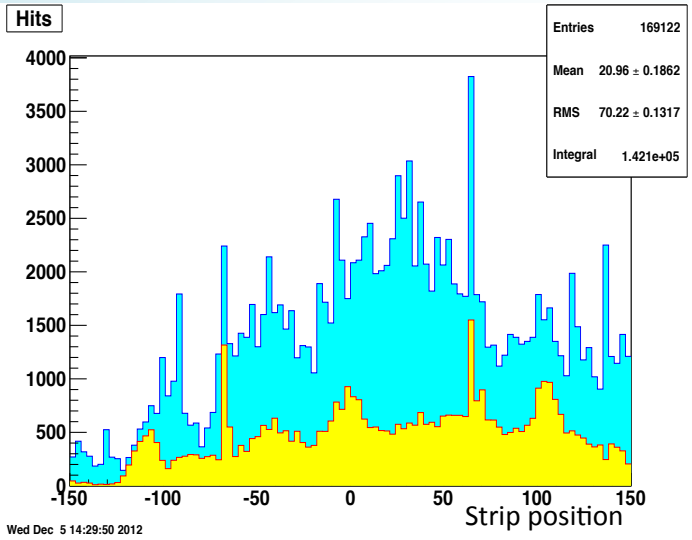
# Gain Uniformity Test 2.0
# Preliminary Results

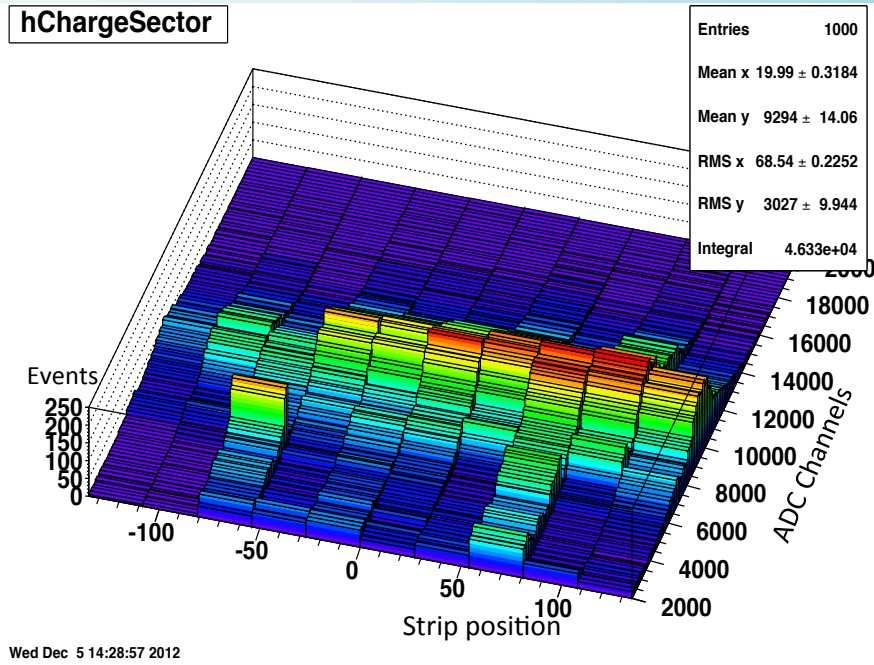


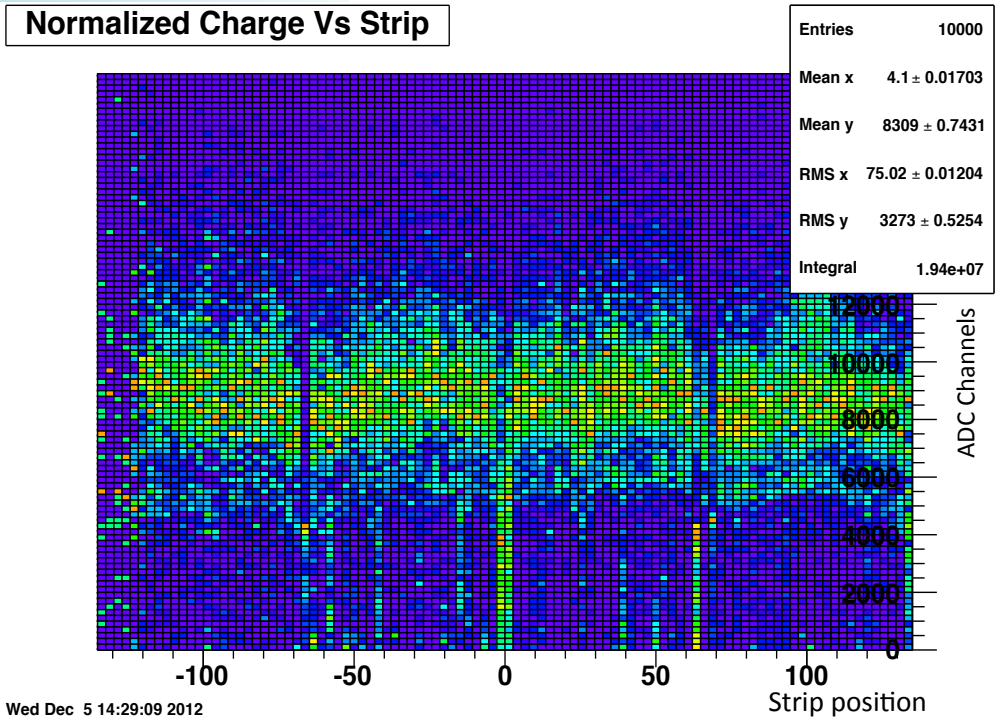

GEM4

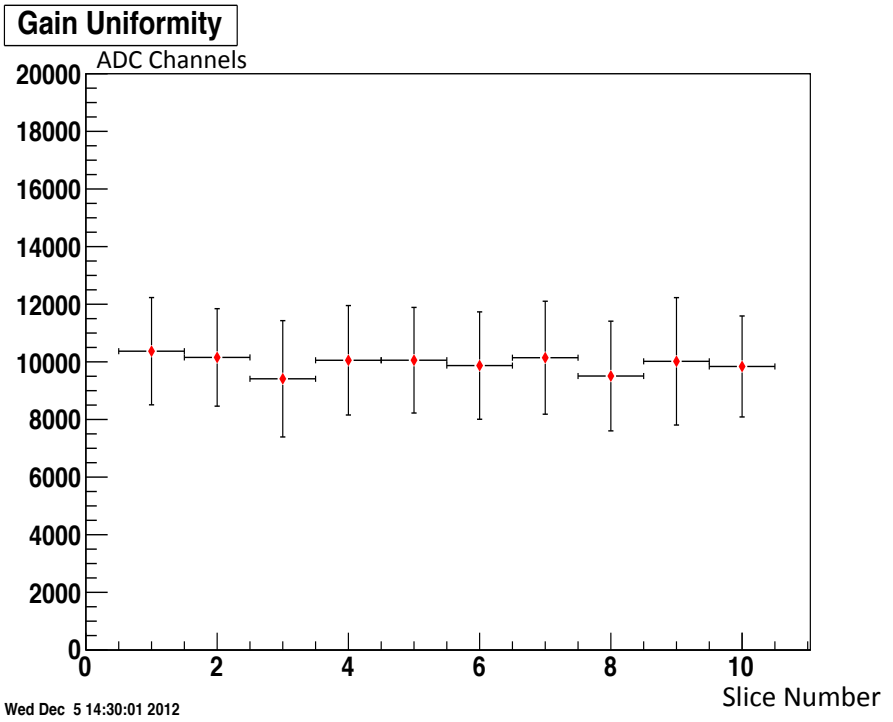
## Configuration :

- 24 APVs // 2 FECs
- Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA
- Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)
- Copper absorber (few 10s of um)
- Holes not filled
- 300 K events

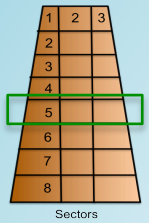


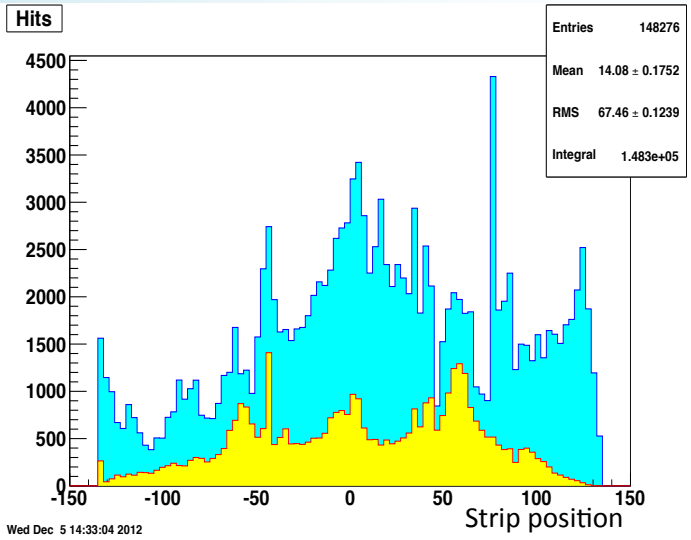
# Gain Uniformity Test 2.0
# Preliminary Results

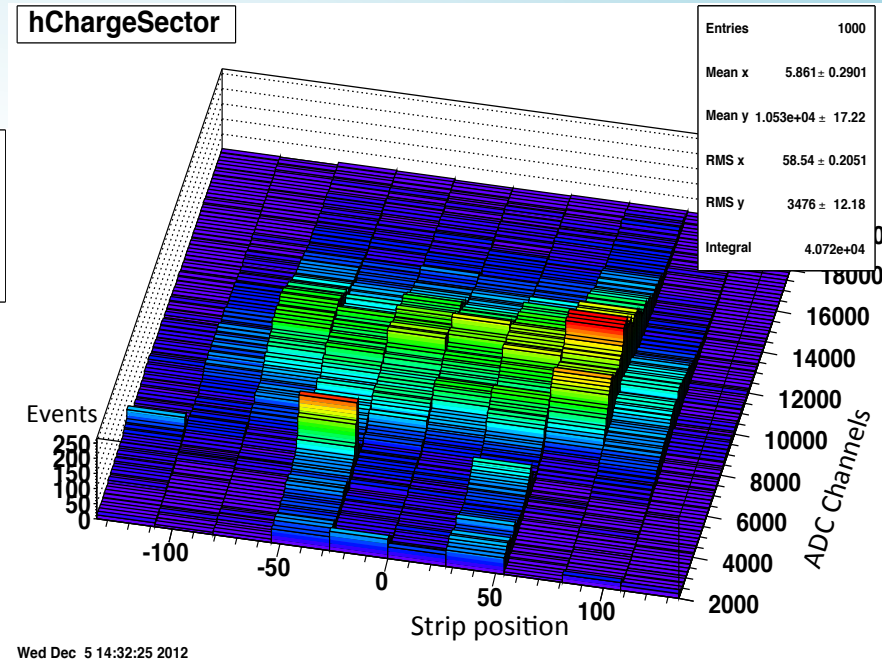


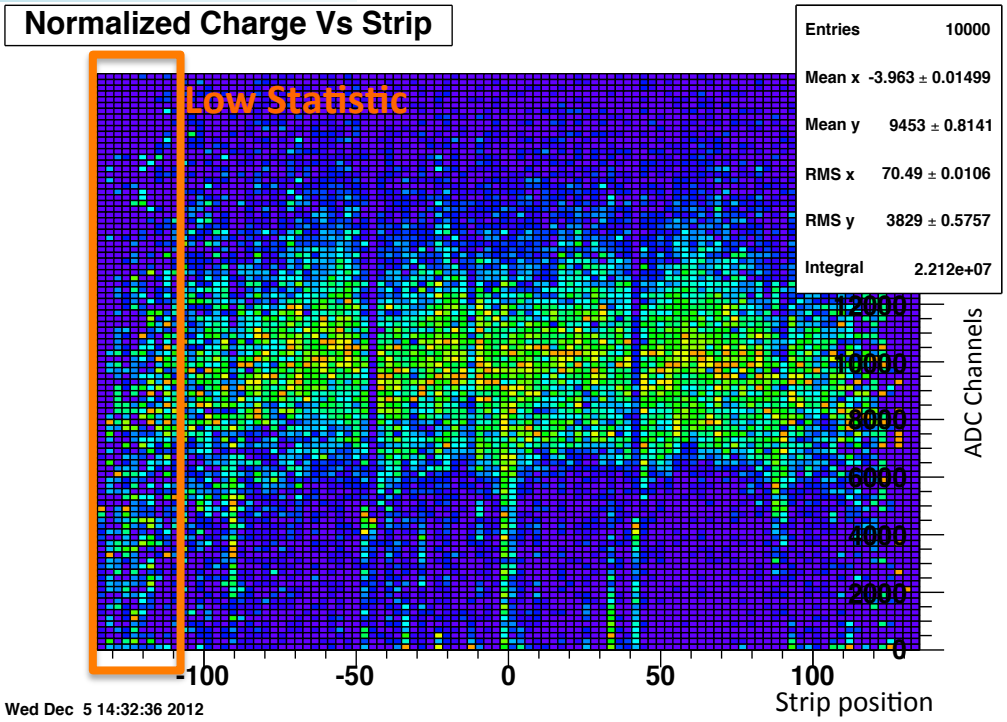

GEM5

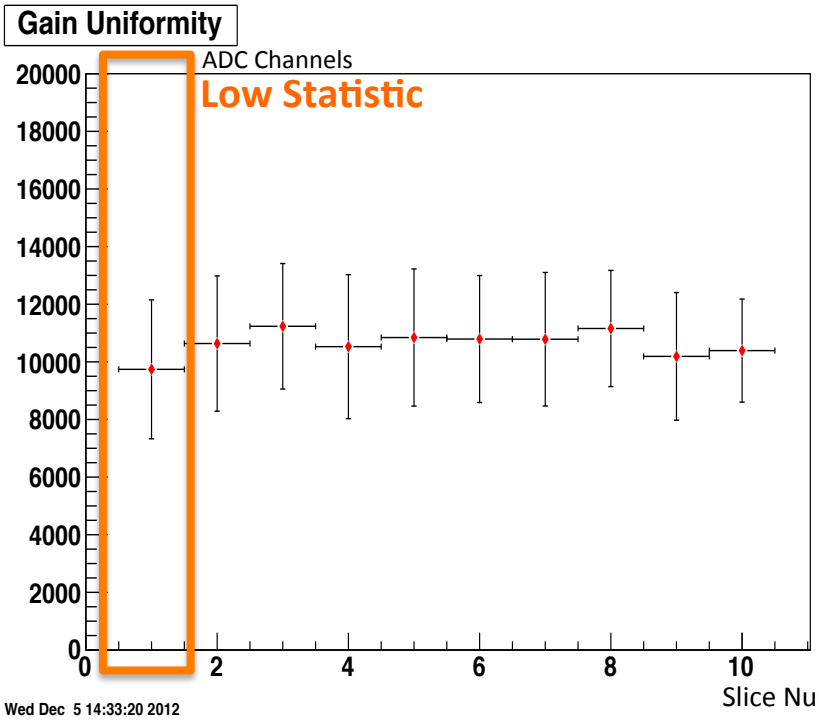
## Configuration :

- 24 APVs // 2 FECs
- Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA
- Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)
- Copper absorber (few 10s of um)
- Holes not filled
- 300 K events

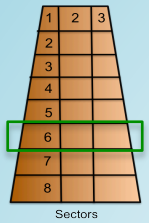


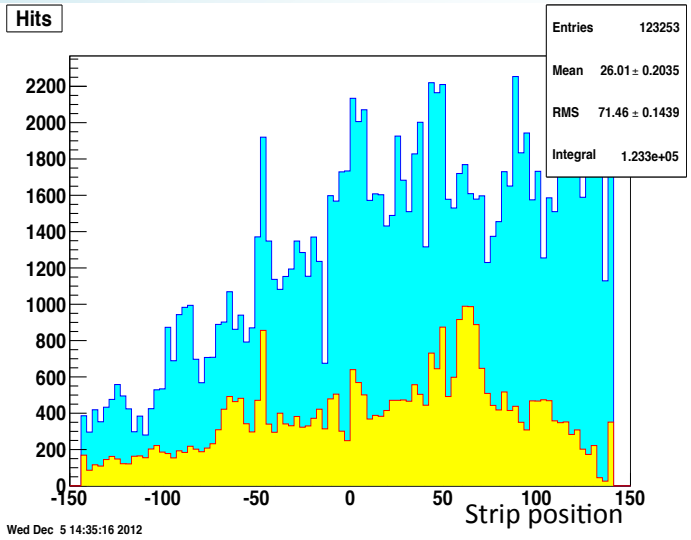
# Gain Uniformity Test 2.0
# Preliminary Results

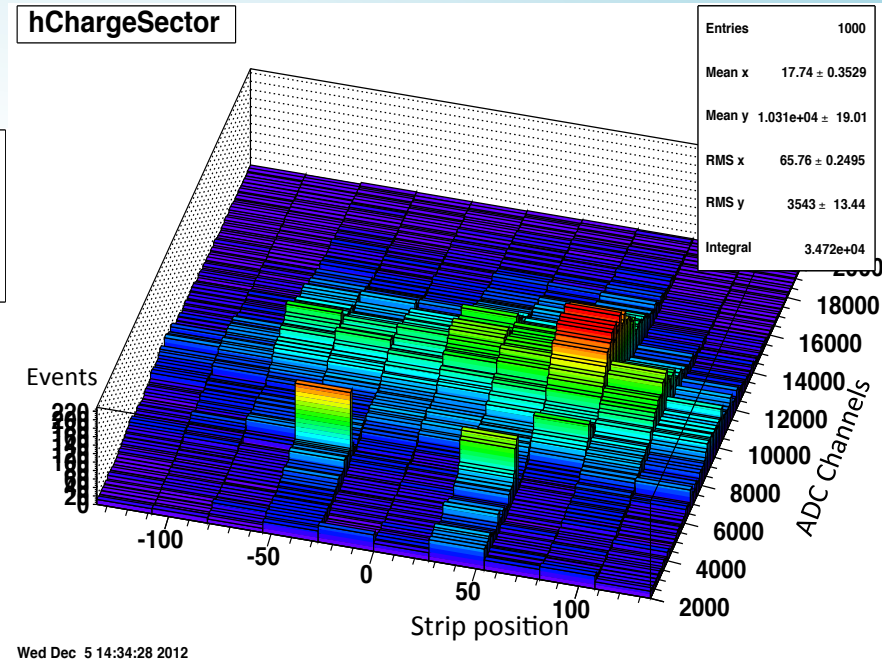


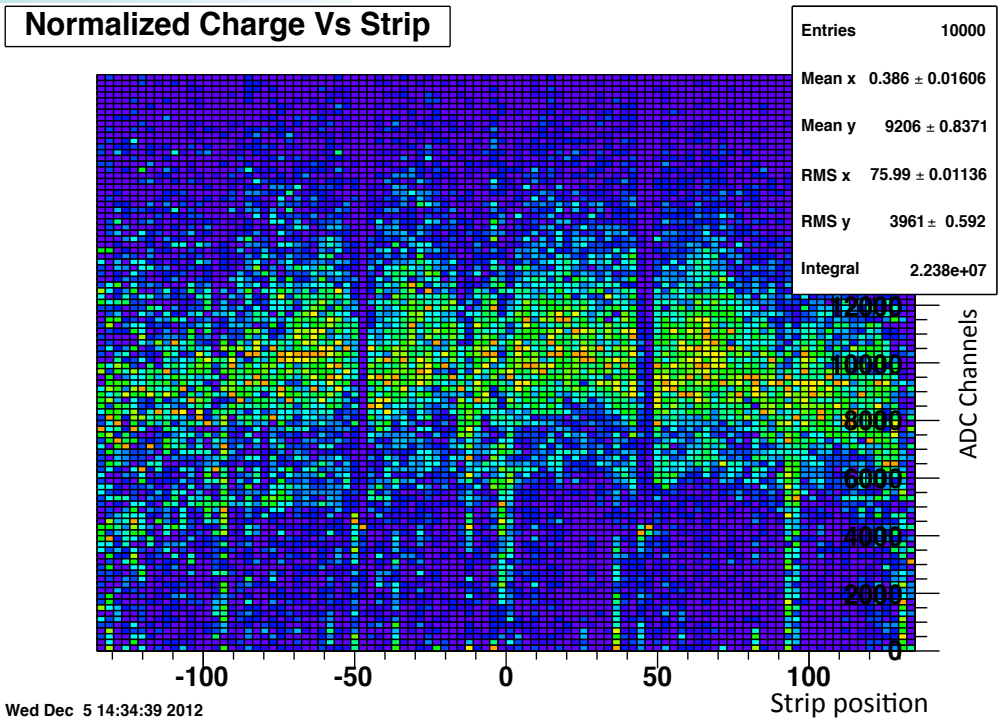

GEM6

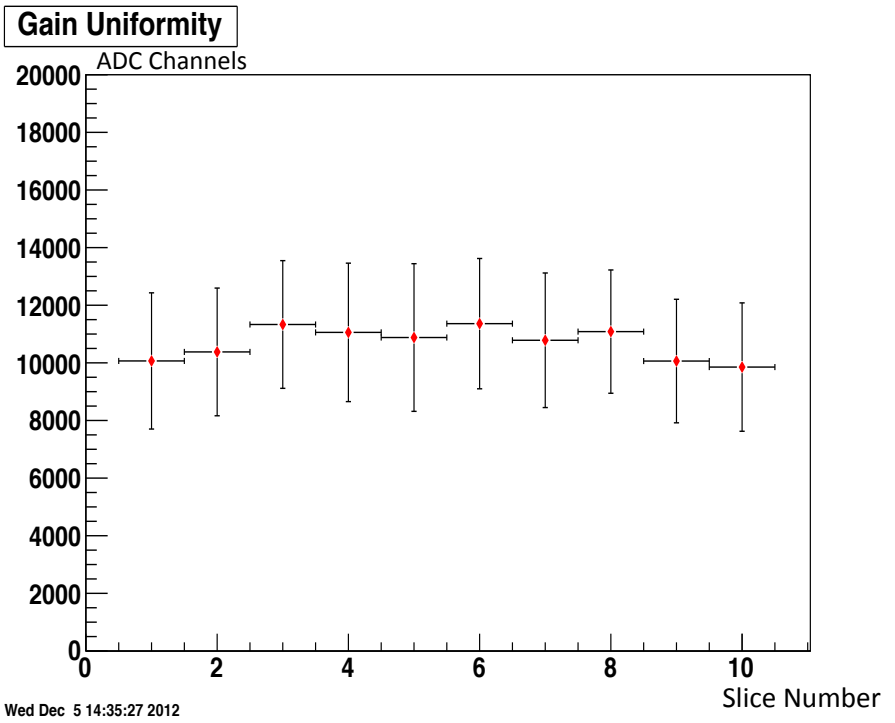
## Configuration :

- 24 APVs // 2 FECs
- Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA
- Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)
- Copper absorber (few 10s of um)
- Holes not filled
- 300 K events

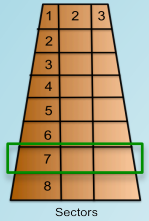


# Gain Uniformity Test 2.0
# Preliminary Results




GEM7

## Configuration :

24 APVs // 2 FECs

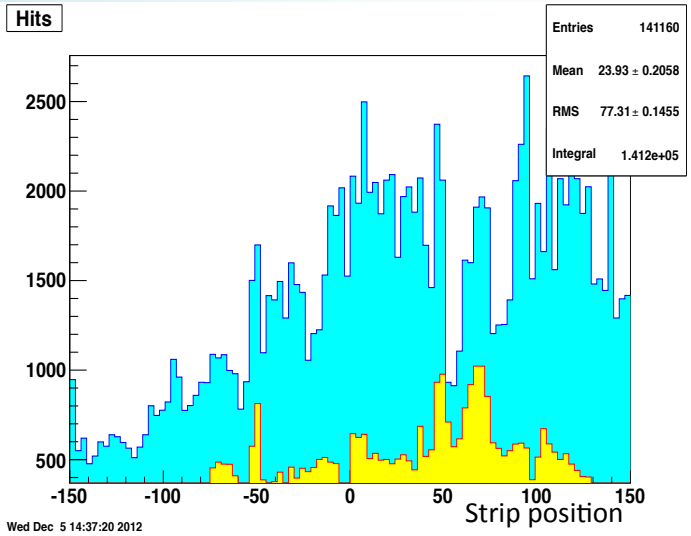
Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA

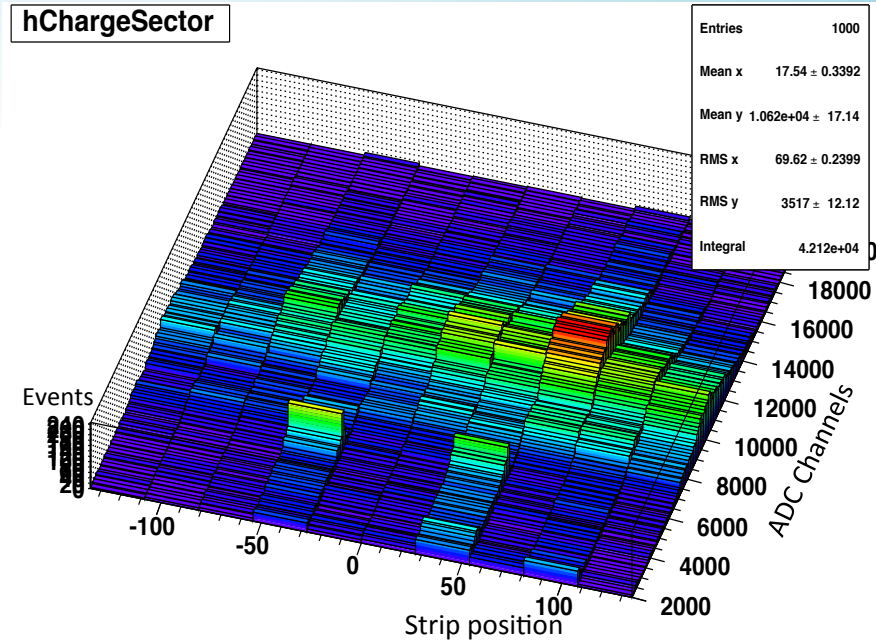
Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)

Copper absorber (few 10s of um)

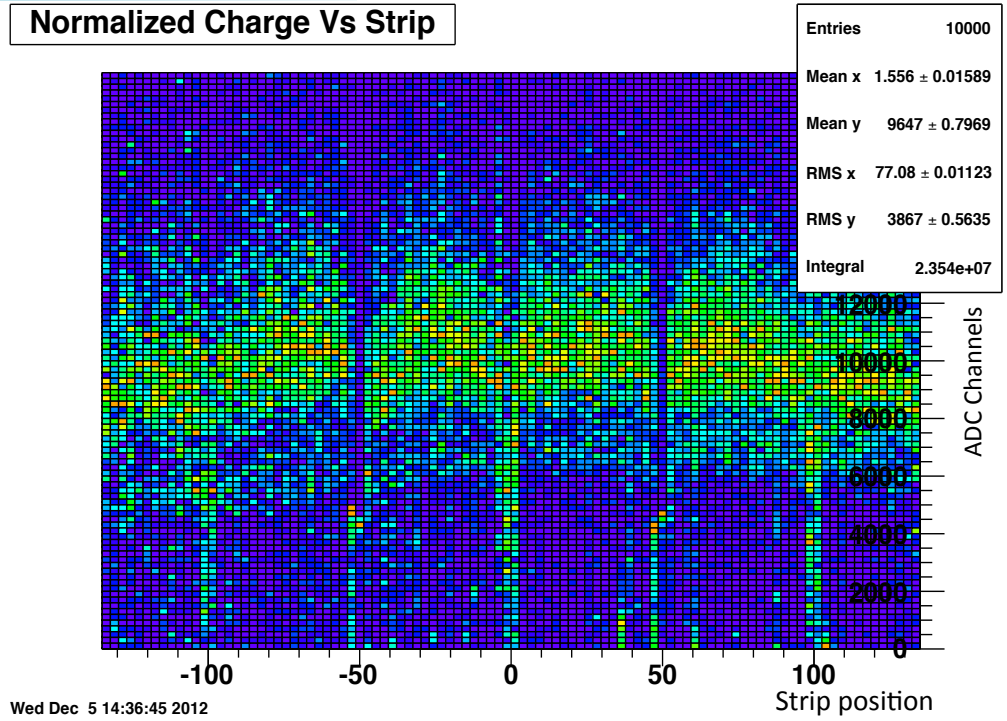
Holes not filled

300 K events

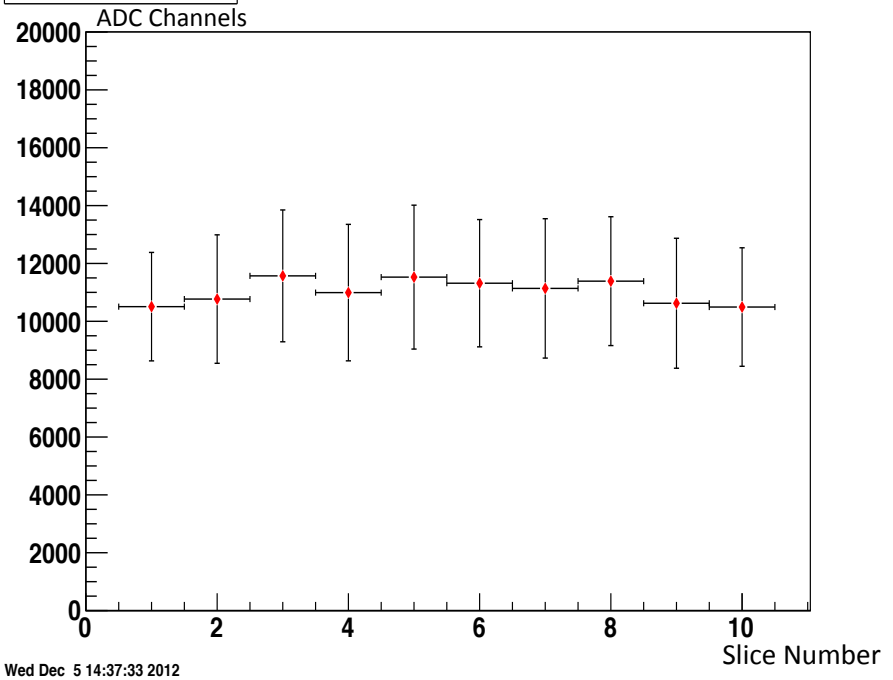


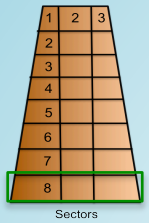

## Normalized Charge Vs Strip




## Gain Uniformity



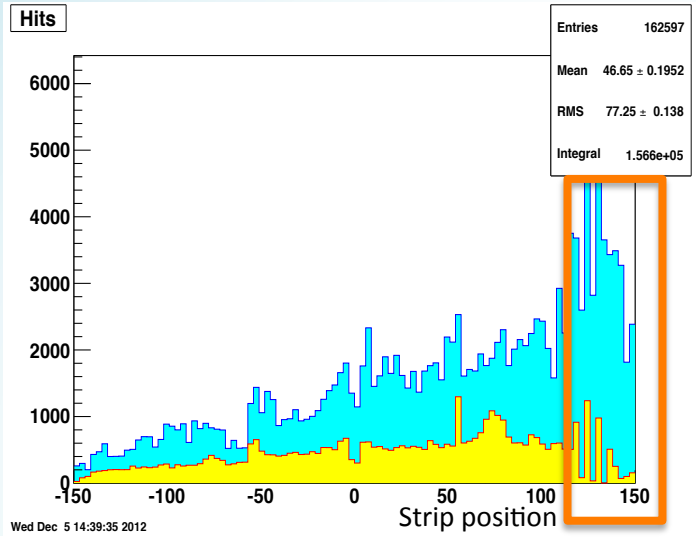
# Gain Uniformity Test 2.0
# Preliminary Results

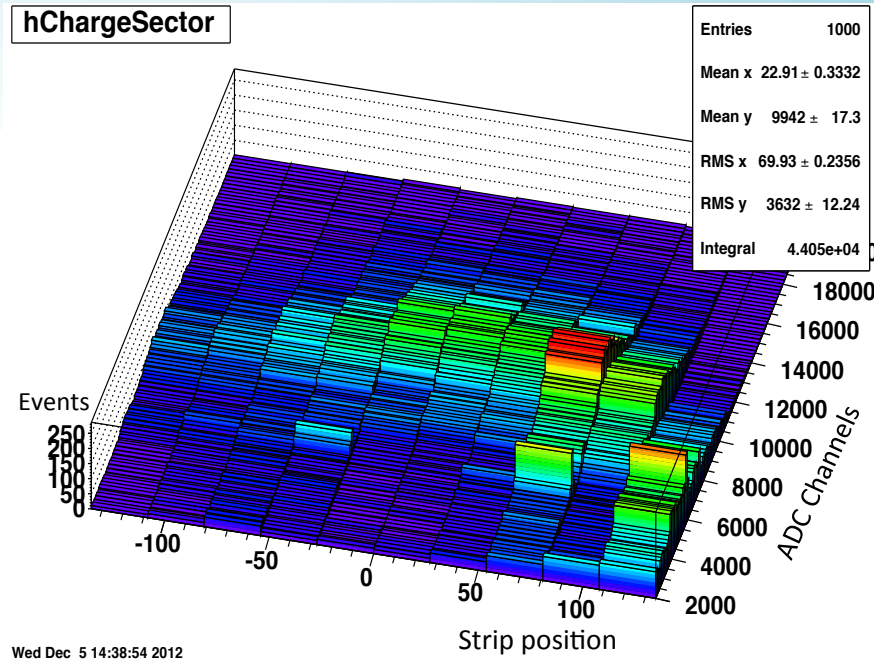



GEM8

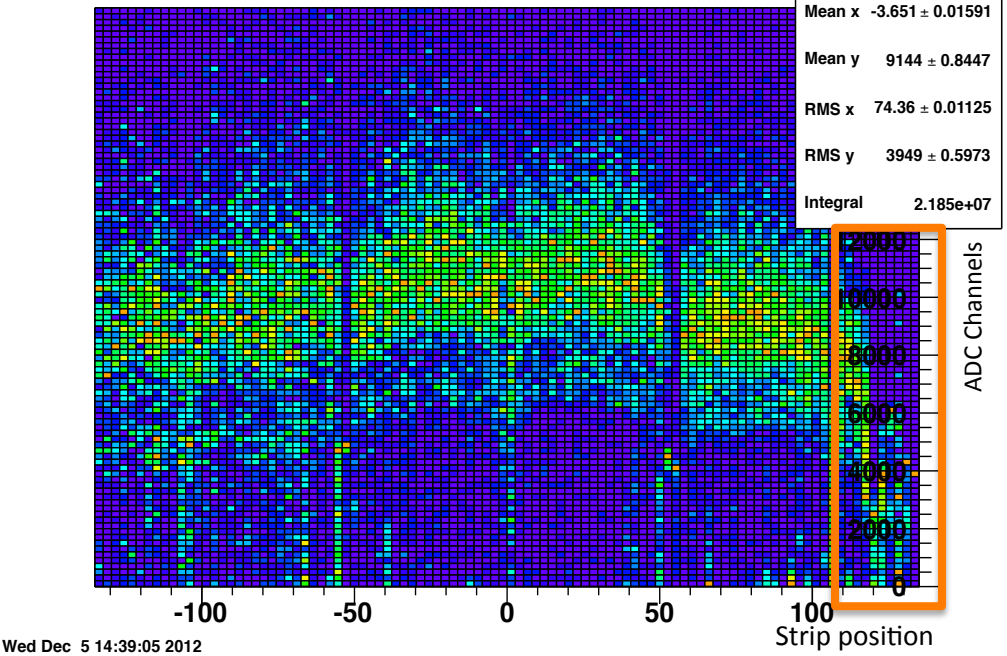
## Configuration :

- 24 APVs // 2 FECs
- Prototype GE1/1-NS2 n°3 @ 3500 V // 656 uA
- Xray/Trigger Rate about 150 Hz ( 25kV // 20 uA @ 1.60 m)
- Copper absorber (few 10s of um)
- Holes not filled
- 300 K events

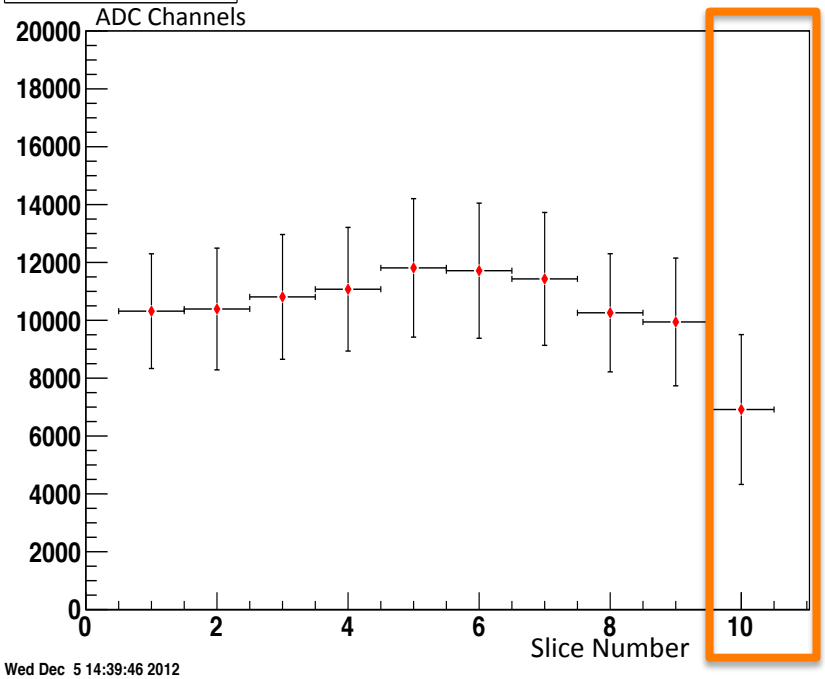


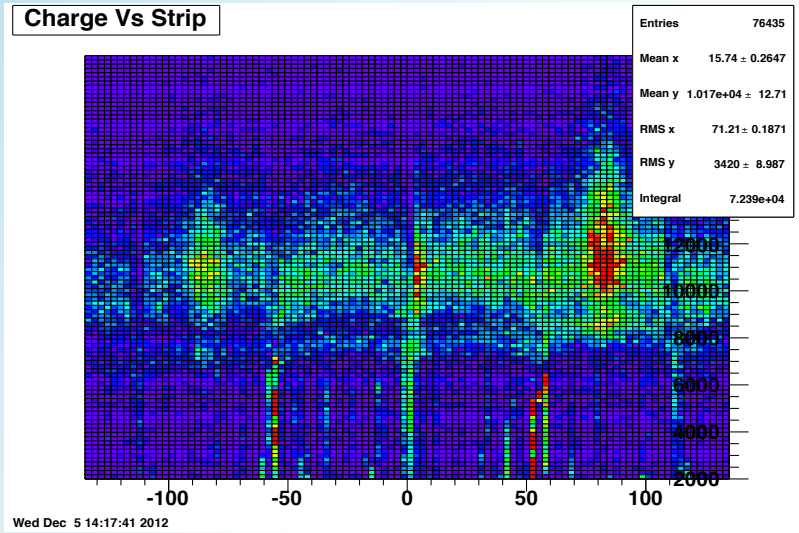

## Normalized Charge Vs Strip

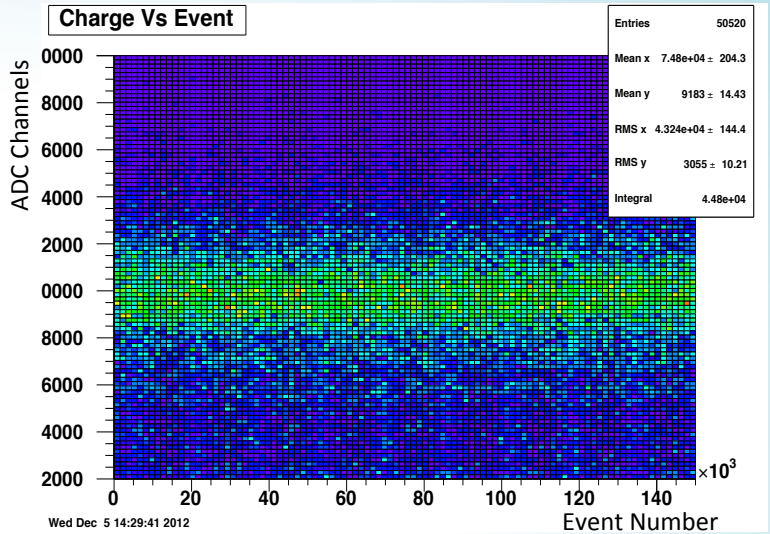


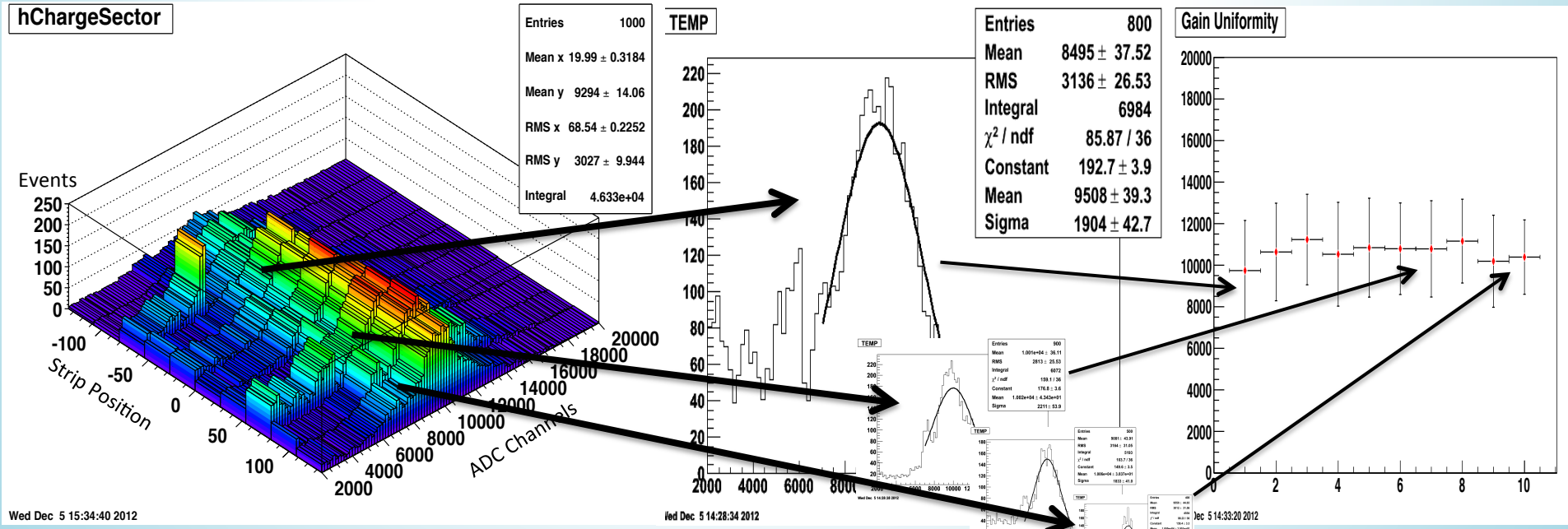

## Gain Uniformity



# Gain Uniformity Test 2.0
# Some Other Information

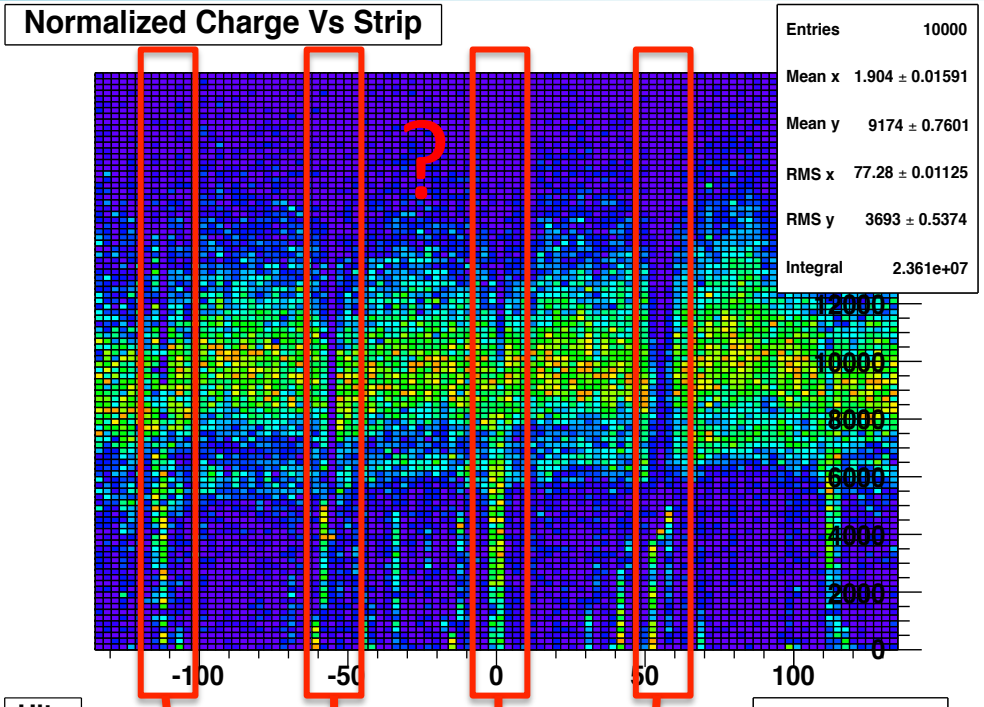


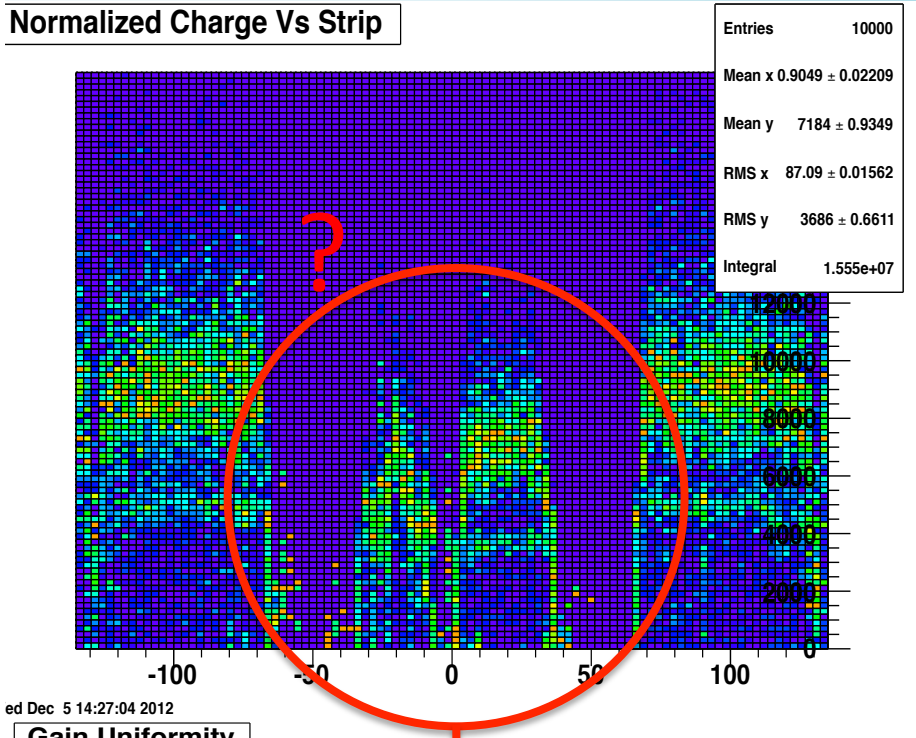



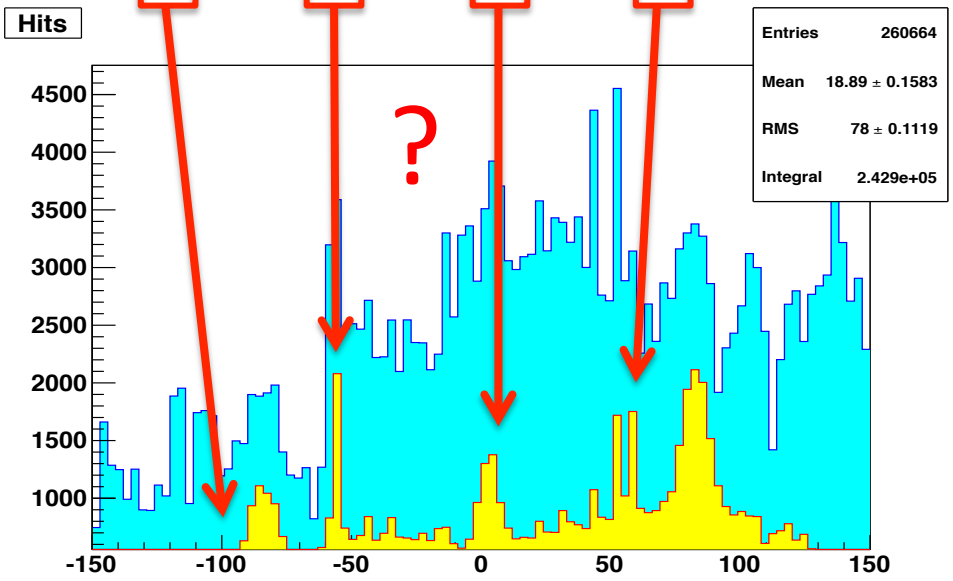



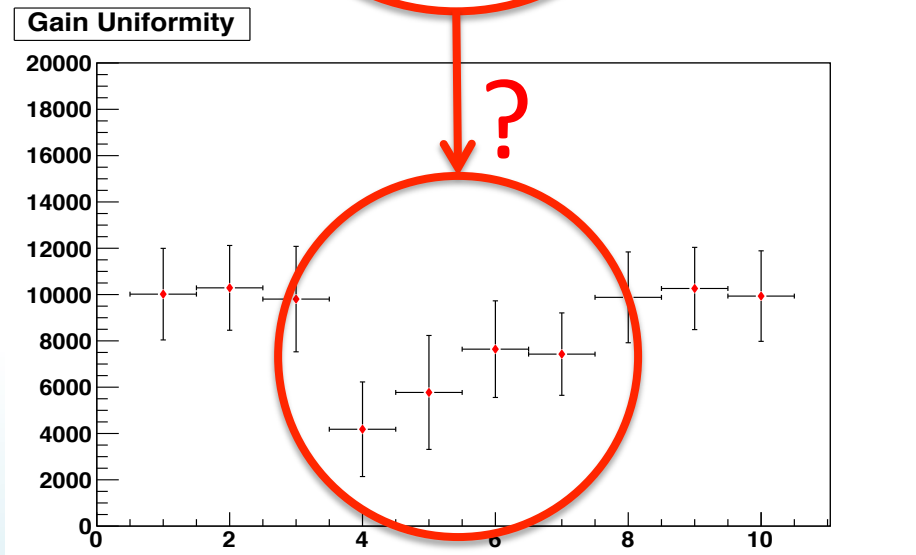
# Gain Uniformity Test 2.0

## HAS TO BE UNDERSTOOD



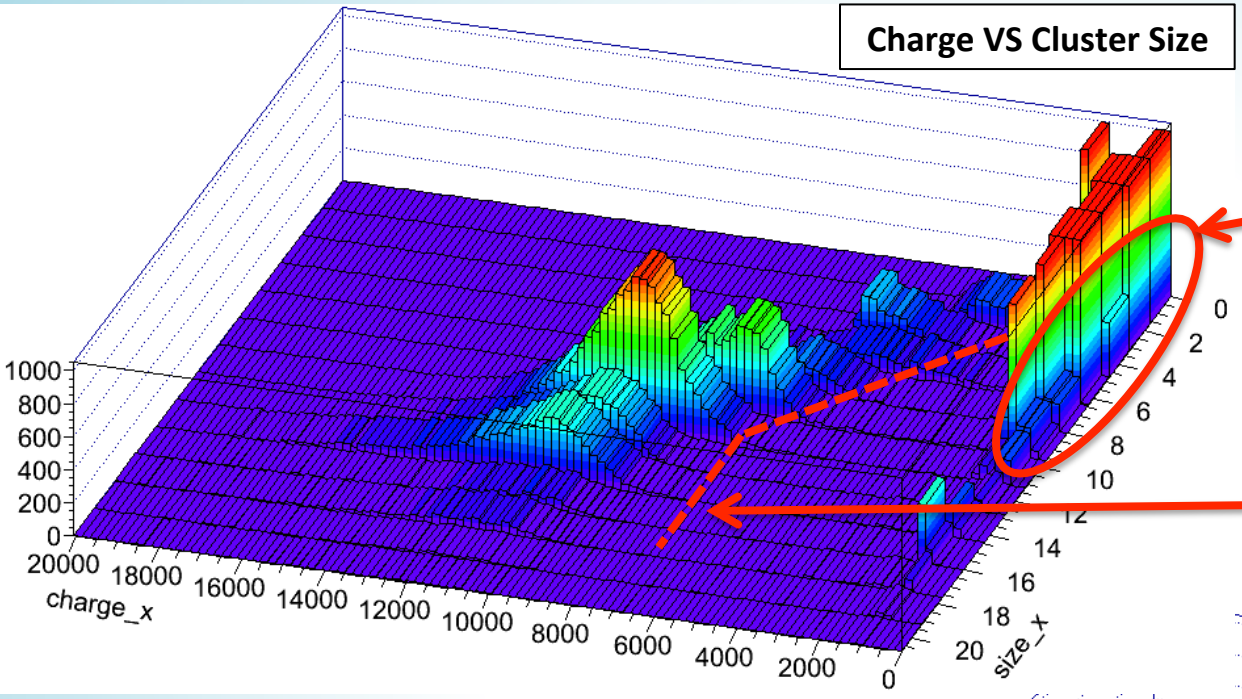



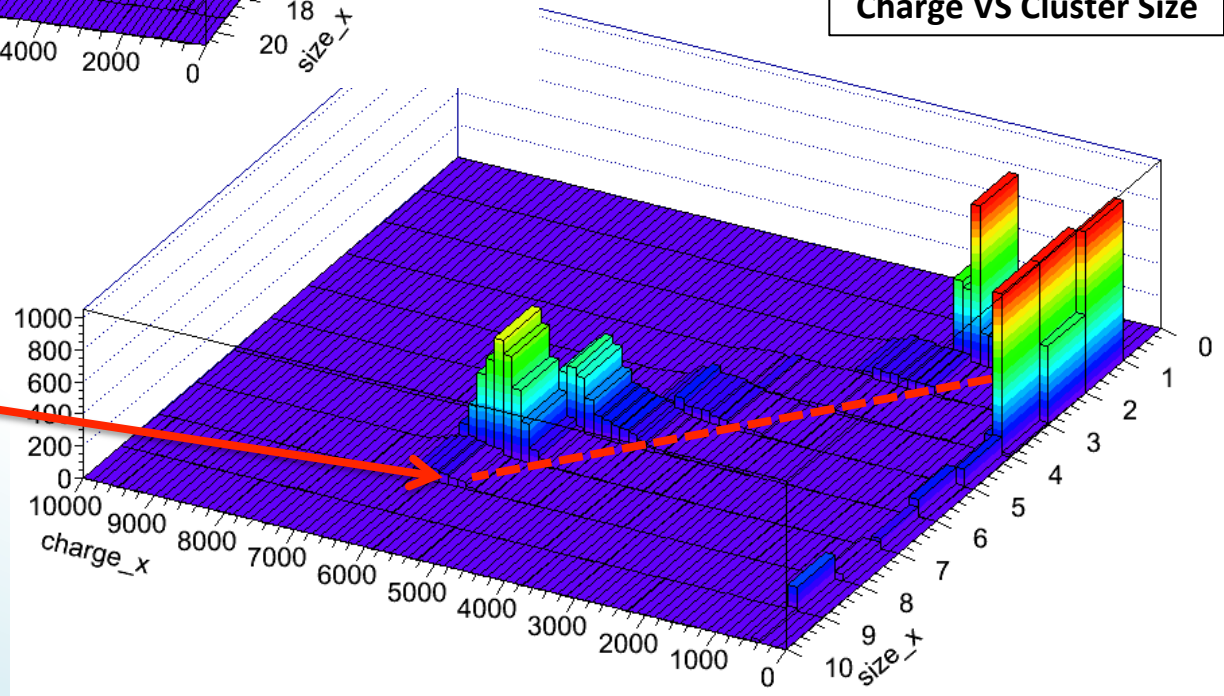
# Gain Uniformity Test 2.0

## HAS TO BE UNDERSTOOD




Noise ? Cosmics ?

Saturation effects ?
Gain : 2000
(very big cluster size)




Saturation ?
Gain : 1000
Reduced noise

# Gain Uniformity Test 2.0

## HAS TO BE UNDERSTOOD

**APV needs :**

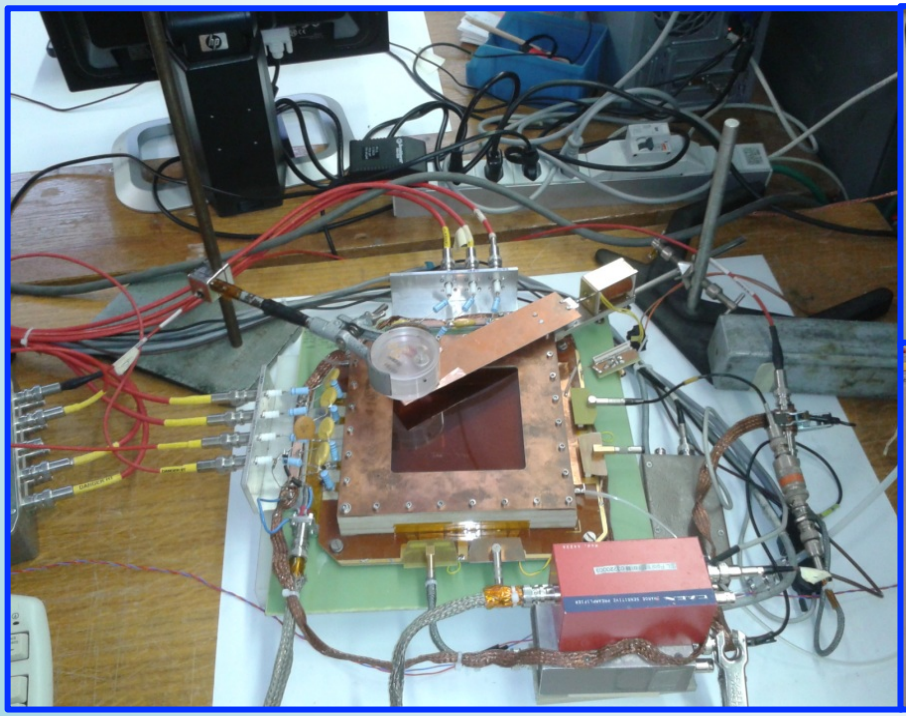
- Low amount of charges on the readout (saturation) → lower Gain
- Good external trigger signal (good energy spectrum) → higher Gain

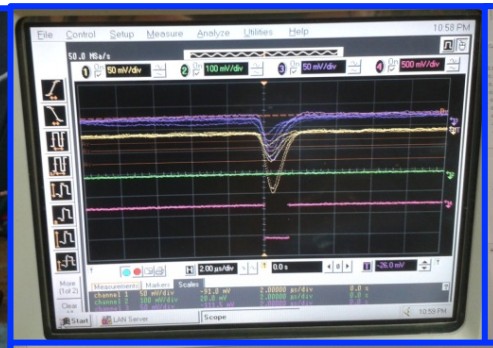
**Changing the induction field we expect:**

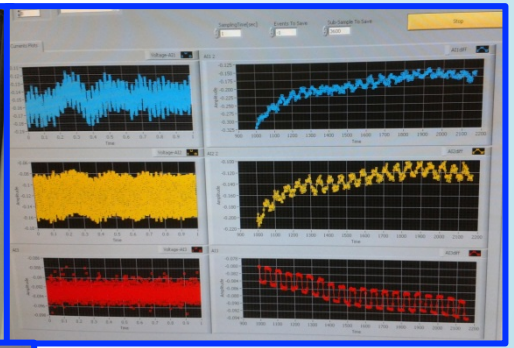
- Lower the charge collected on the readout.

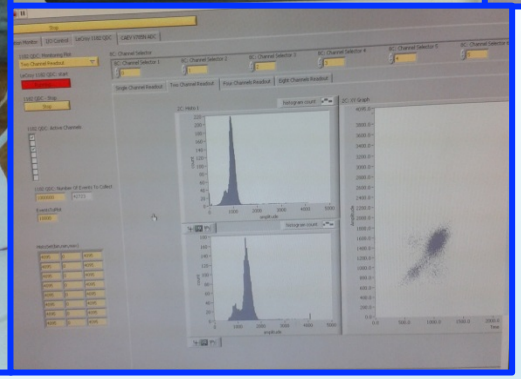
AND

- Increase the signal on the bottom of the last GEM.





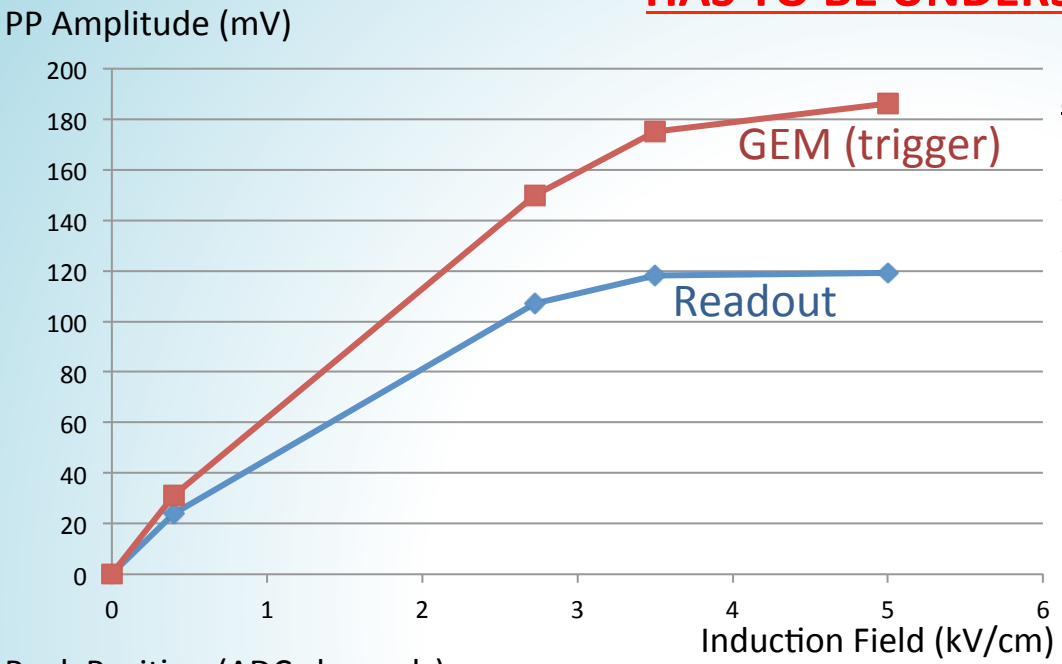




- 10x10 triple GEM
- Fe55 source (shutter)
- Monitoring :
  - Readout current
  - GEM current
  - Signals amplitude
  - Energy spectra

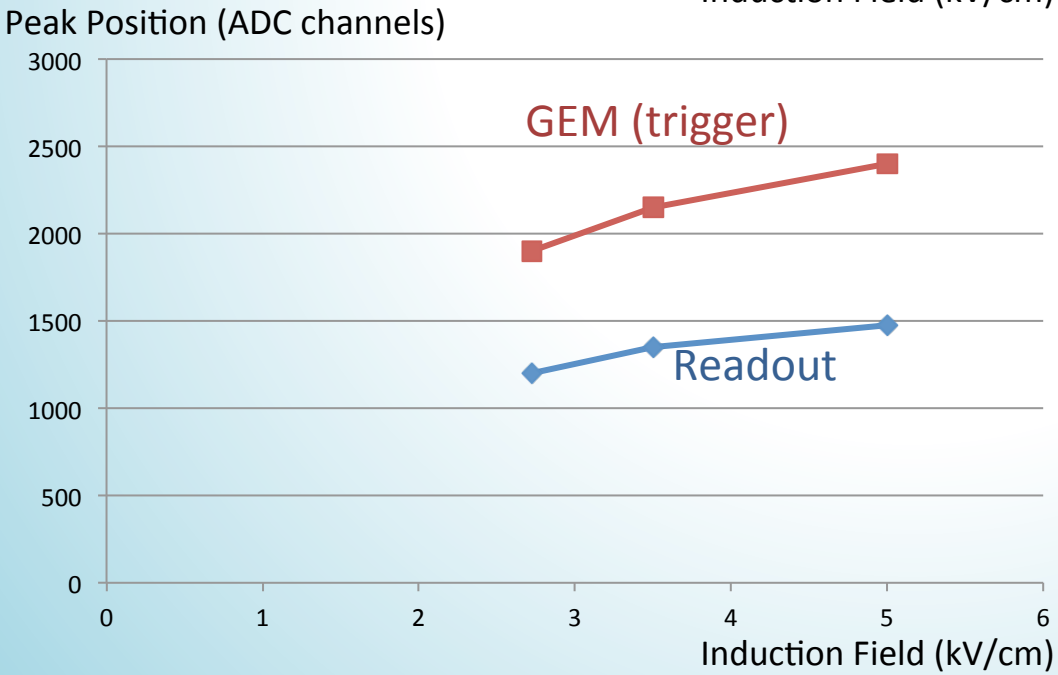
# Gain Uniformity Test 2.0

## HAS TO BE UNDERSTOOD




**Signal Amplitude VS Induction Field :**

- **Higher signal on the bottom of the GEM**
- **Same behaviour changing the field**




**$Fe^{55}$ Main Peak Position VS Induction Field :**

- **Can distinguish the Peak only at 3kV/cm**
- **GEM and Readout follow the same shape**

**As a conclusion (?) :**

**The signal on the GEM is quite complex and does not behave as expected…**

**→ Cannot realy improve the setup**

# Gain Uniformity Test 2.0
# Conclusion

## Good/Bad Points :

- Uniform Measurement ( No effects from external parameters fluctuations )
- Provides a precise map of the large detector ( in terms of gain, energy resolution)
- Gives the gain variation versus time ( and external parameters)
- Fast ( 1 day taking data // 1 day analysing )

- Complex setup which needs time and/or experience
- Needs good knowledge of DATE/Amore computer system
- Needs half/full day to prepare a large detector
- AMOUNT OF DATA :
  Common trigger for all the chips -> only few good events recorded by each APV
  No Zero-Suppression in the current firmware -> 300K events is about 50 Gb
- Saturation effects ?

## Thank you