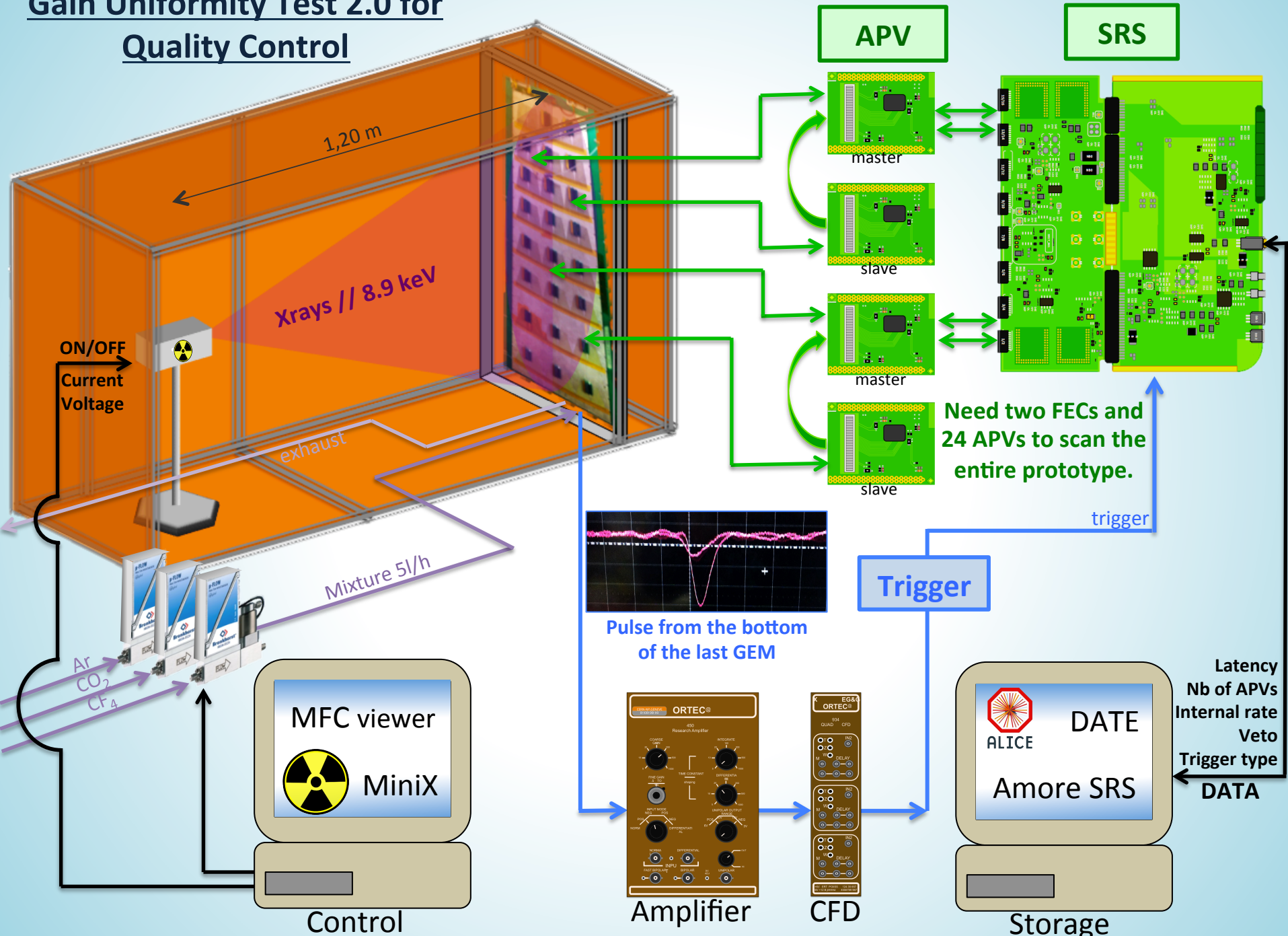


# Quality Control of Full Scale GE1/1 CMS Chambers (APV+SRS SYSTEM)

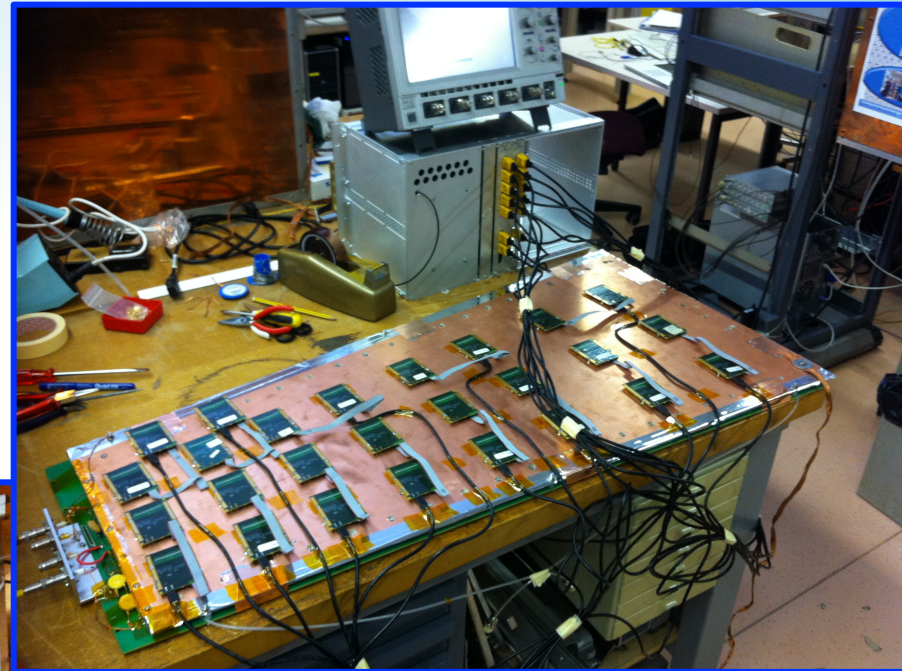
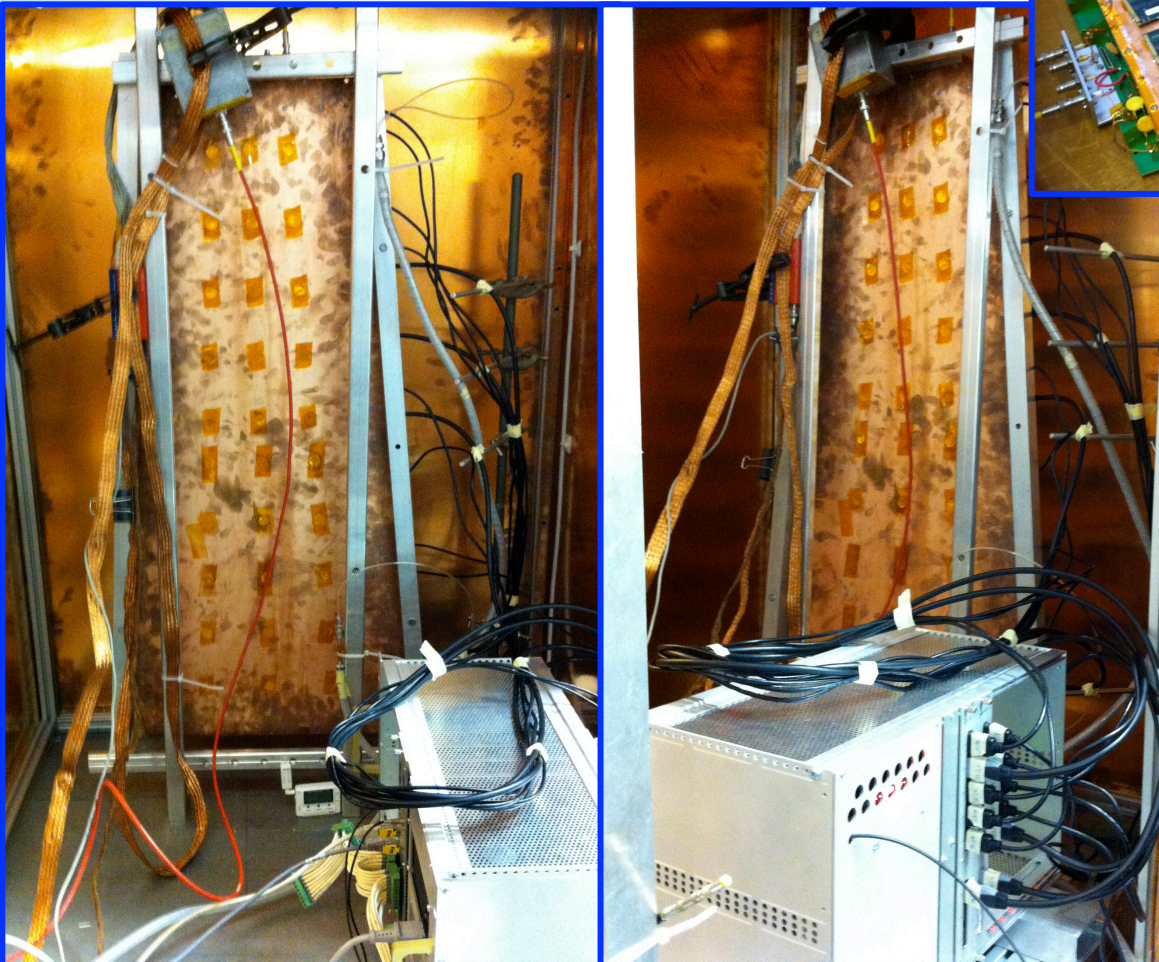
Jeremie Merlin  
(IPHC,CERN)

# Gain Uniformity Test 2.0 for Quality Control

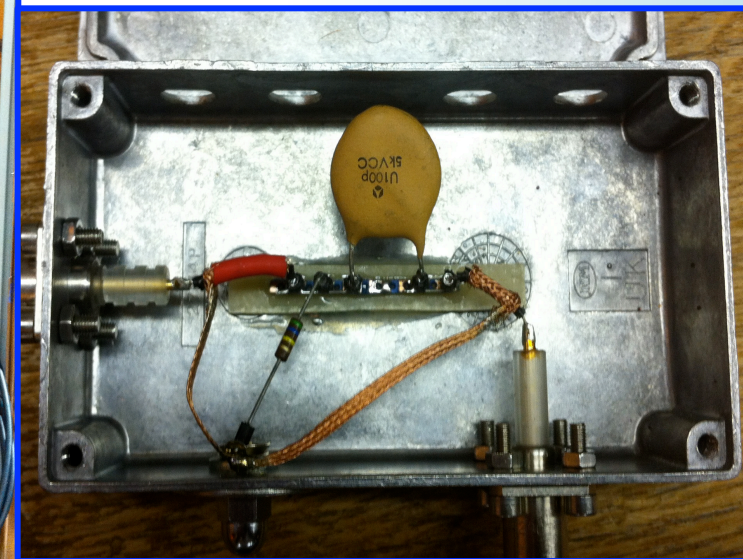


# Gain Uniformity Test 2.0 for Quality Control

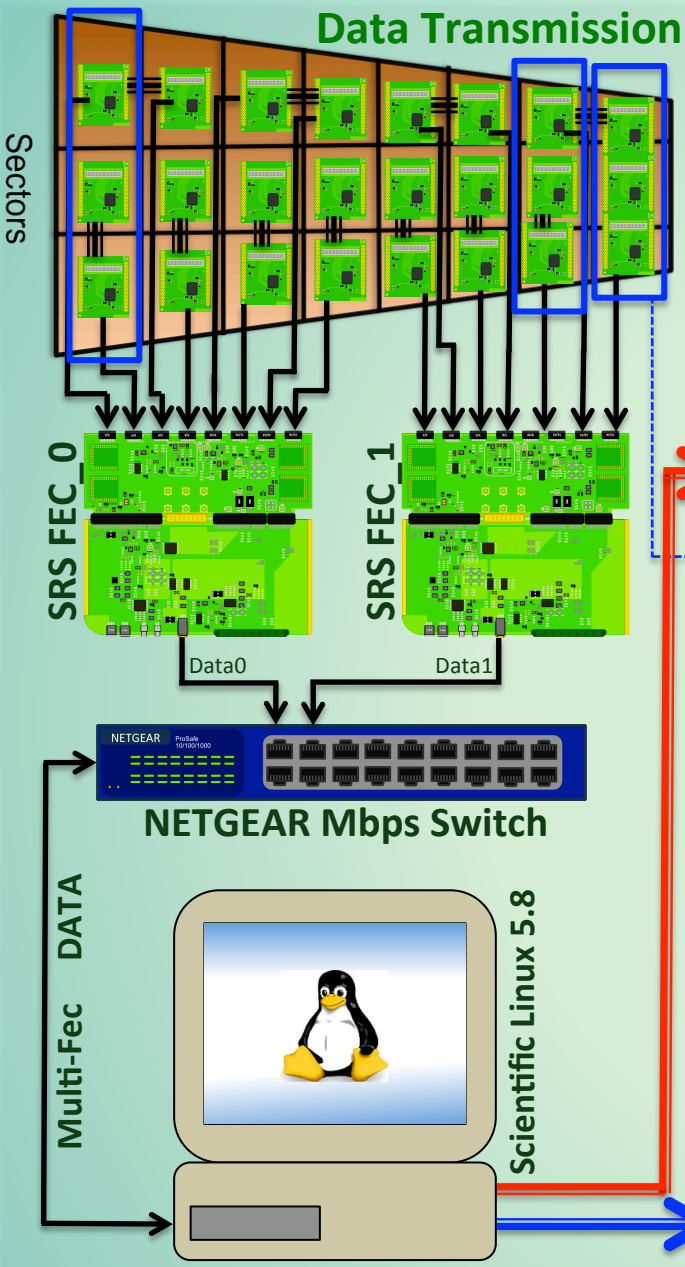
The detector inside the copper box



Detector ready for testing



Filter to cut the noise



### SlowControl

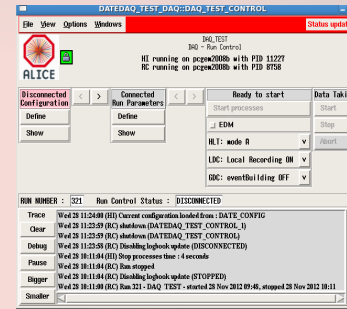
- > Initialization
- > Configuration
- > Trigger Control



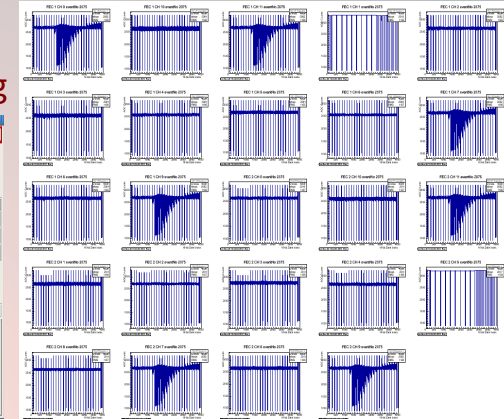
- ### DATE
- > Data Control
  - > Run Type
  - > Start/Stop

### AmoreAgent/Gui

- > Data Reading
- > ONLINE Monitoring



### Acquisition

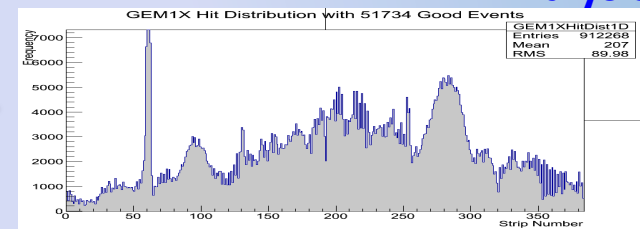


### Amore SRS

- > Pedestal Analysis
- > Zero Suppression
- > Beam Profile
- > OFFLINE Monitoring

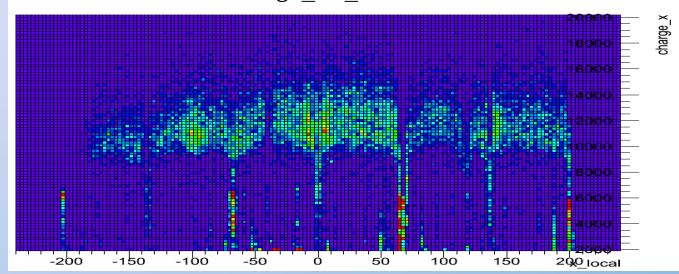
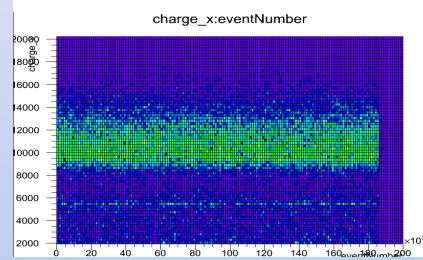
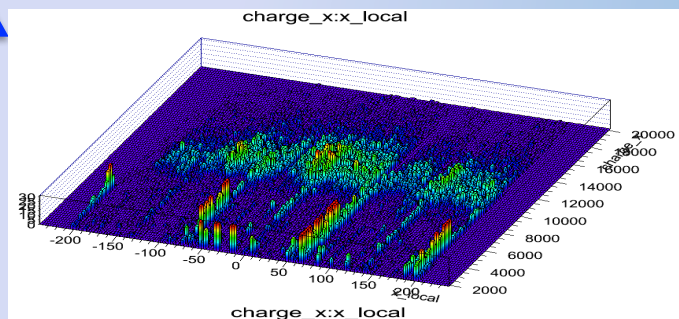
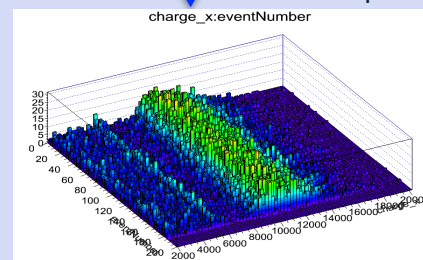
3 APVs = 1 Detector in Amore

### Analysis

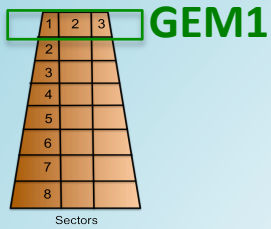


Charge Vs Time

Charge Vs Strips



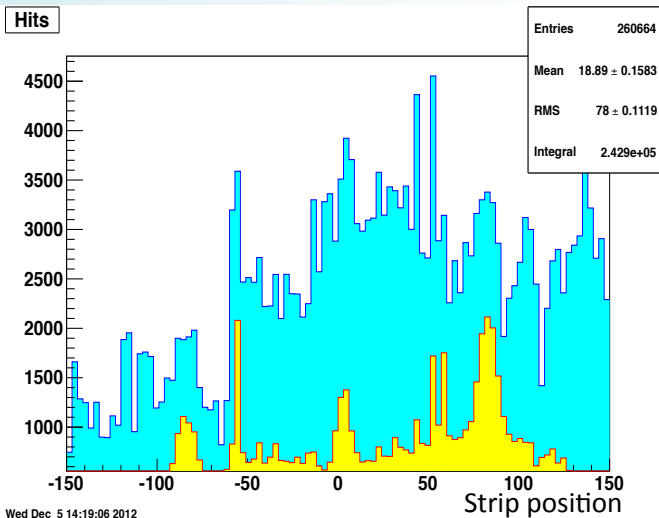
**Gain Uniformity Test 2.0 for Quality Control**



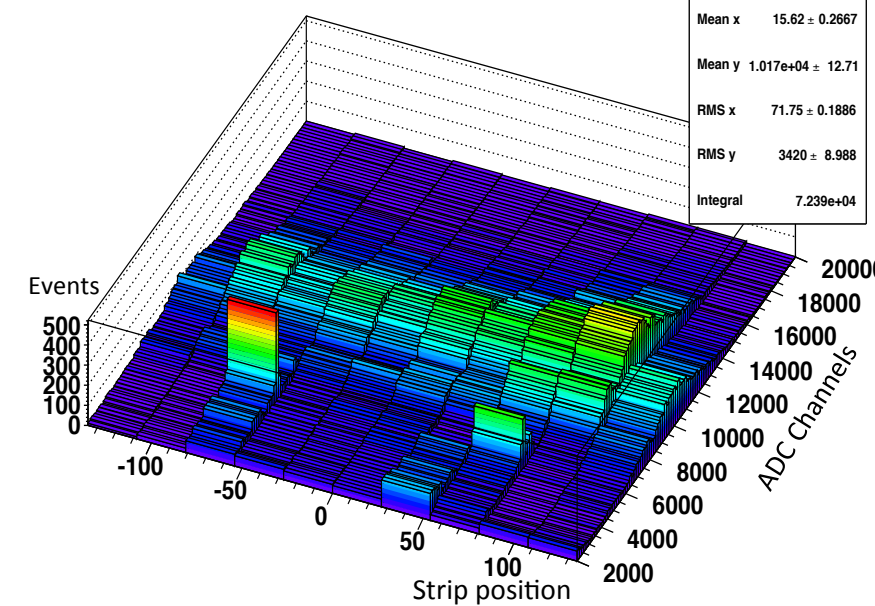
# Gain Uniformity Test 2.0

## Preliminary Results

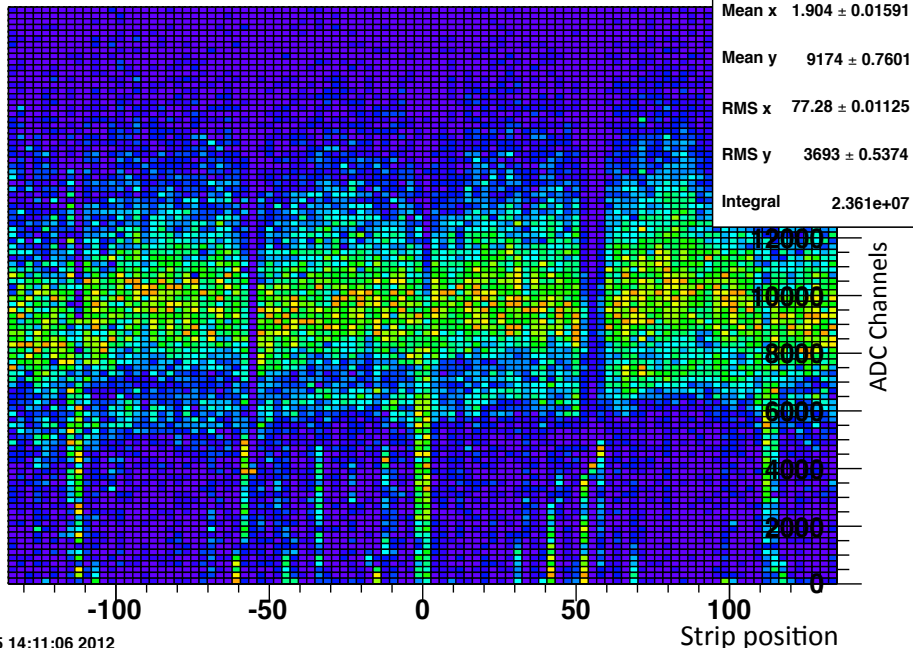
**Configuration :**  
 24 APVs // 2 FECs  
 Prototype GE1/1-NS2 n°3  
 @ 3500 V // 656 uA  
 Xray/Trigger Rate about  
 150 Hz ( 25kV // 20 uA @  
 1.60 m)  
 Copper absorber (few 10s  
 of um)  
 Holes not filled  
 300 K events



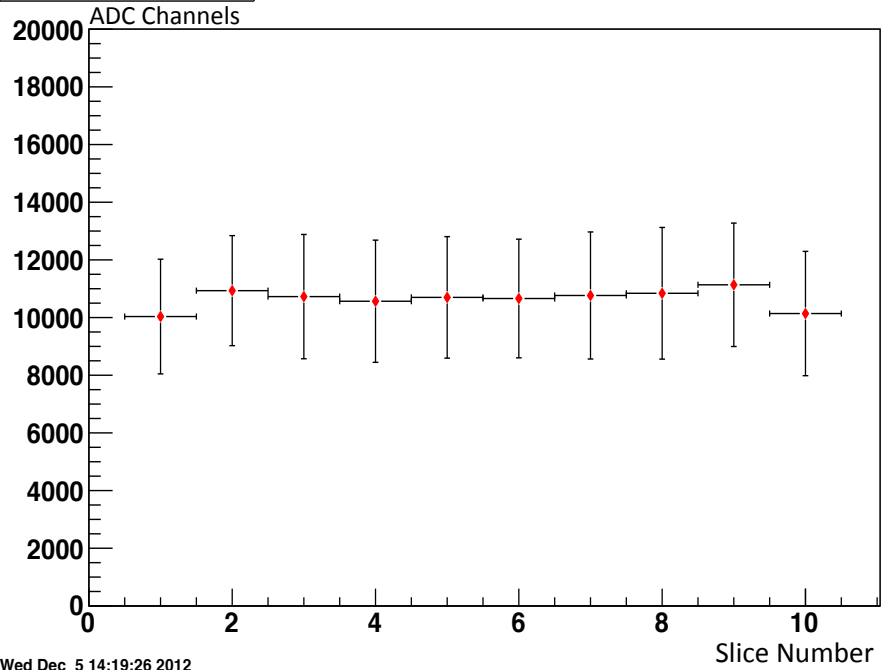
### hChargeSector

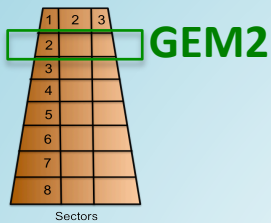


### Normalized Charge Vs Strip



### Gain Uniformity

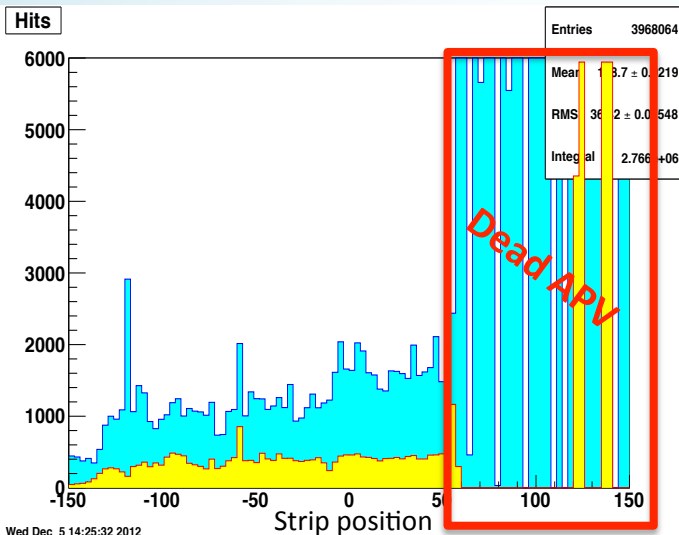




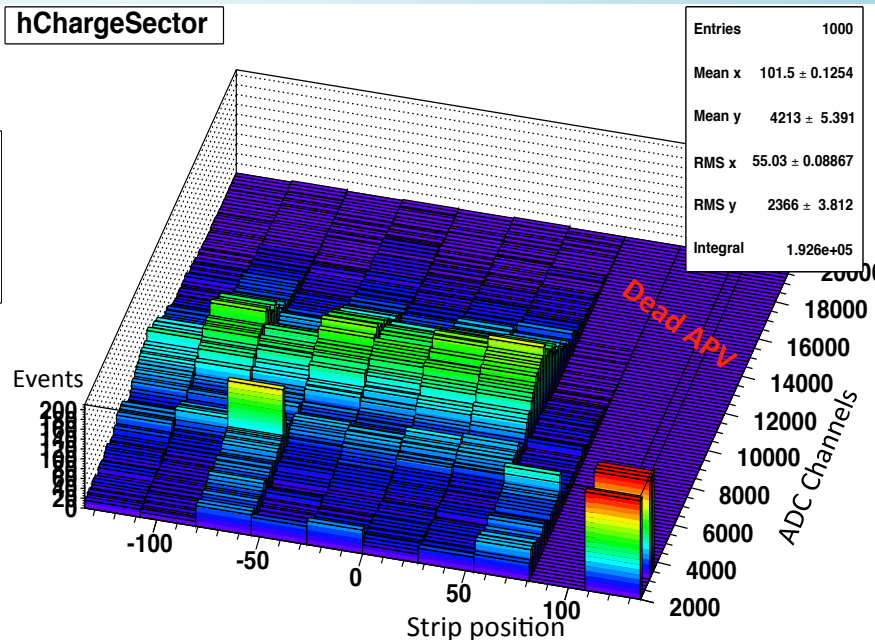
# Gain Uniformity Test 2.0

## Preliminary Results

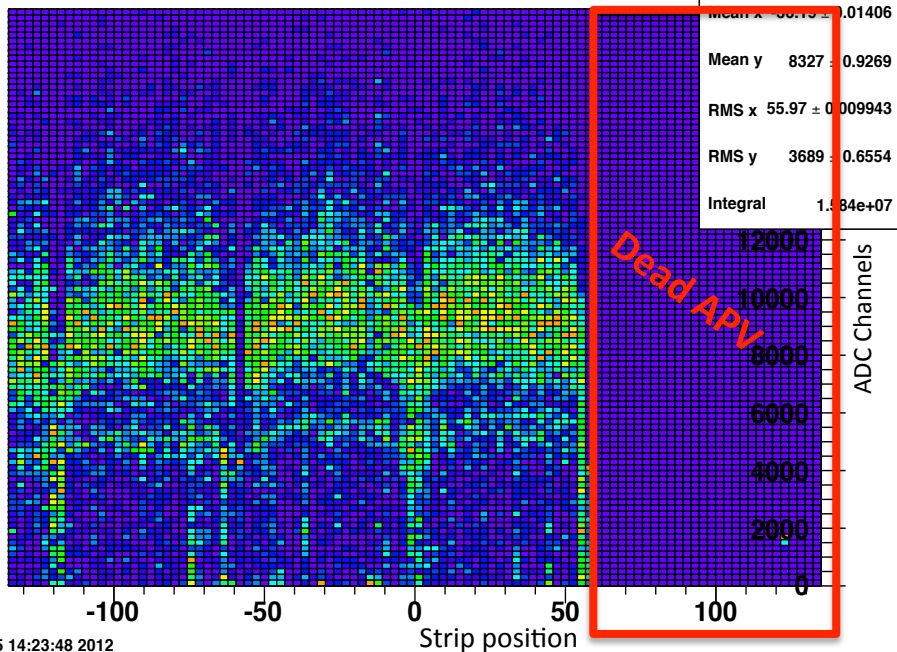
**Configuration :**  
 24 APVs // 2 FECs  
 Prototype GE1/1-NS2 n°3  
 @ 3500 V // 656 uA  
 Xray/Trigger Rate about  
 150 Hz ( 25kV // 20 uA @  
 1.60 m)  
 Copper absorber (few 10s  
 of um)  
 Holes not filled  
 300 K events



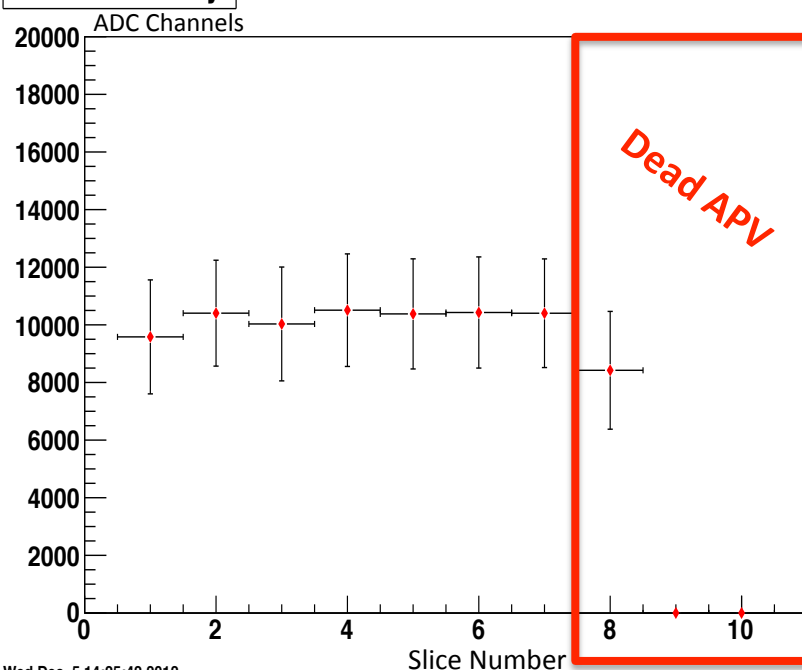
**hChargeSector**



**Normalized Charge Vs Strip**

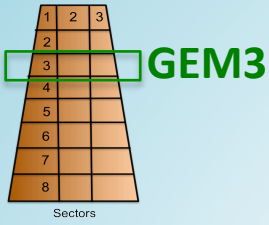


**Gain Uniformity**

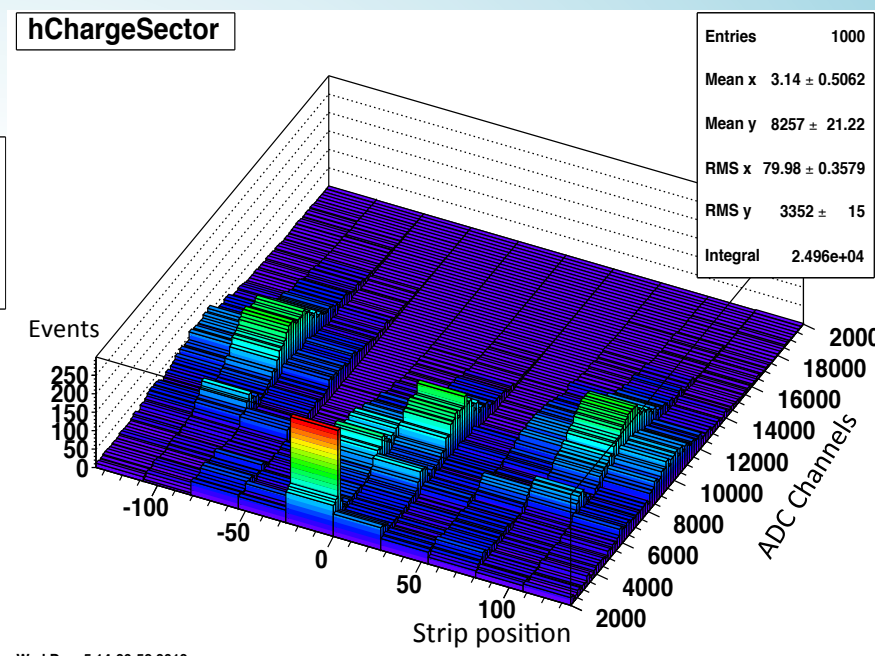
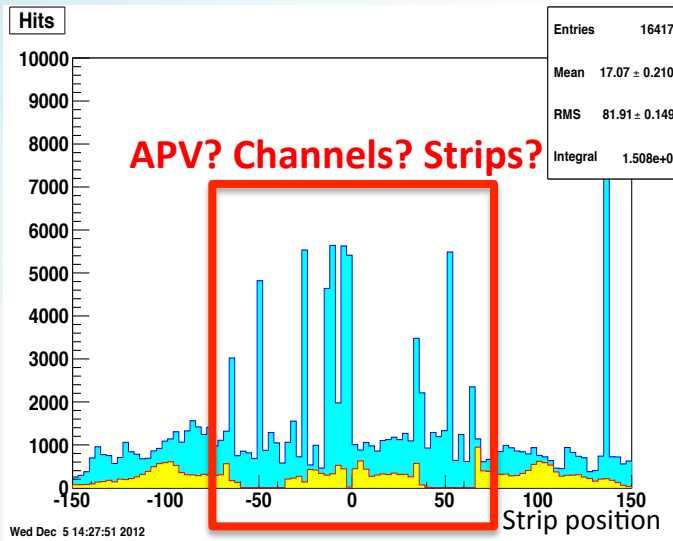


# Gain Uniformity Test 2.0

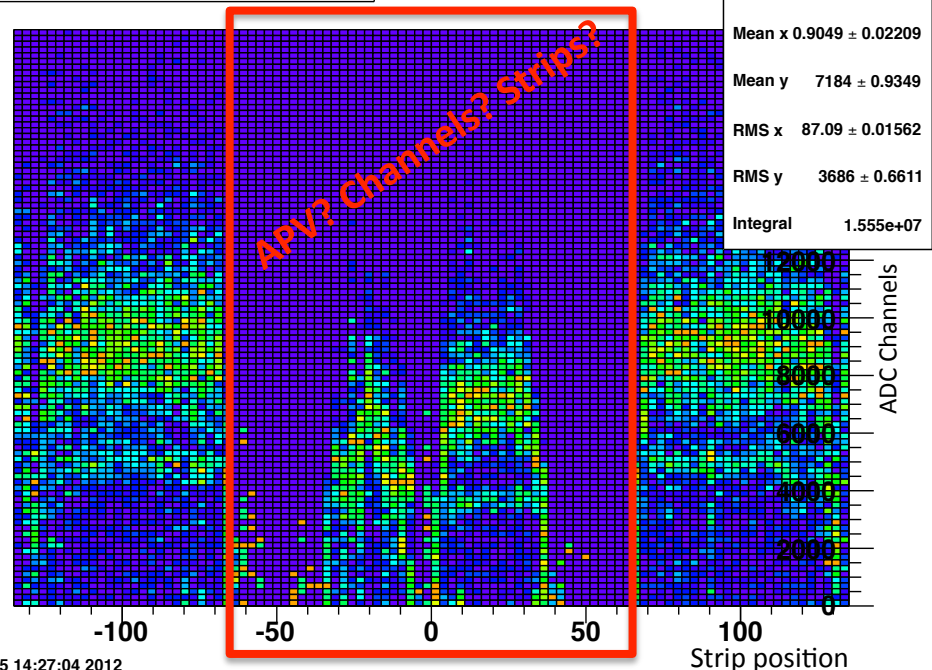
## Preliminary Results



**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

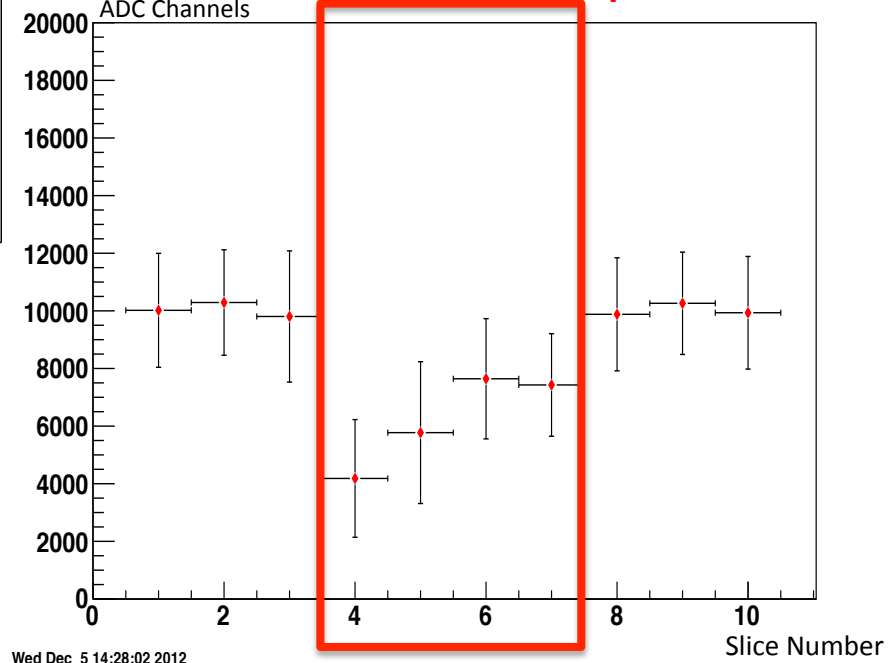


### Normalized Charge Vs Strip



Wed Dec 5 14:26:52 2012

### Gain Uniformity APV? Channels? Strips?

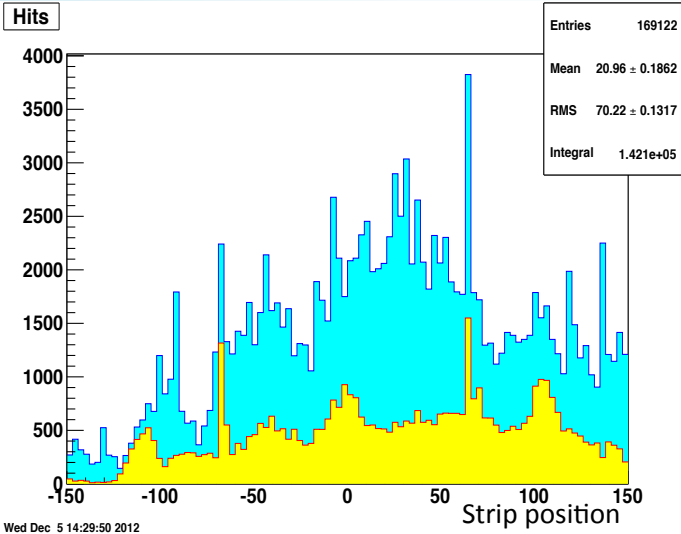
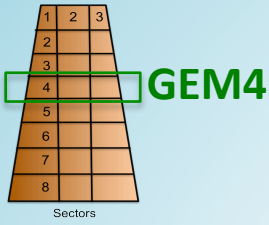


Wed Dec 5 14:27:04 2012

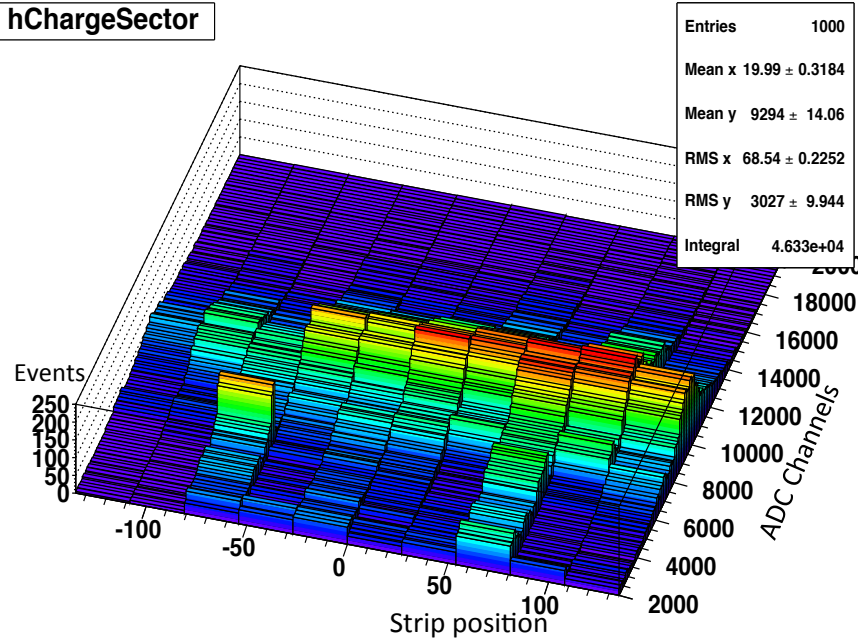
Wed Dec 5 14:28:02 2012

# Gain Uniformity Test 2.0

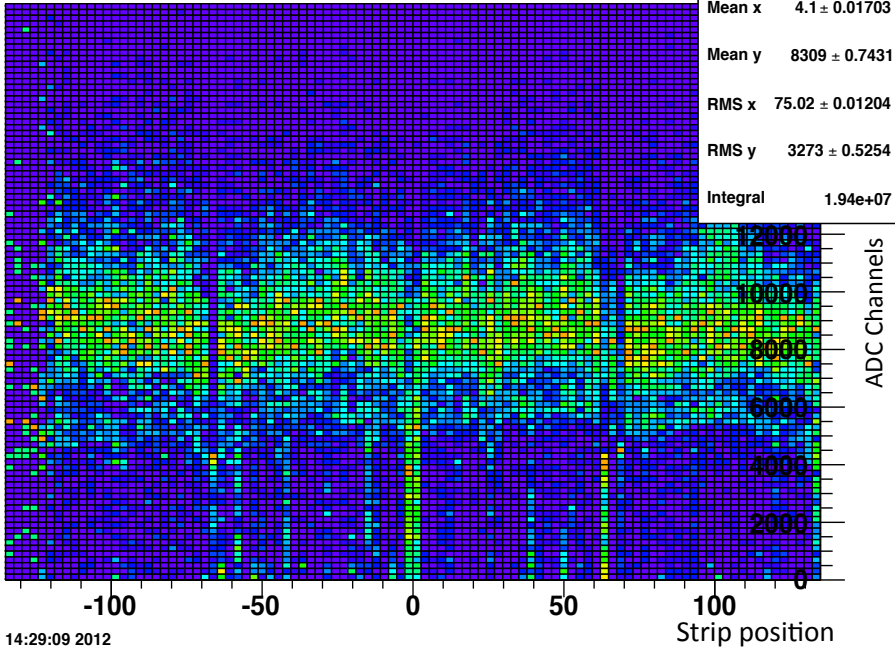
## Preliminary Results



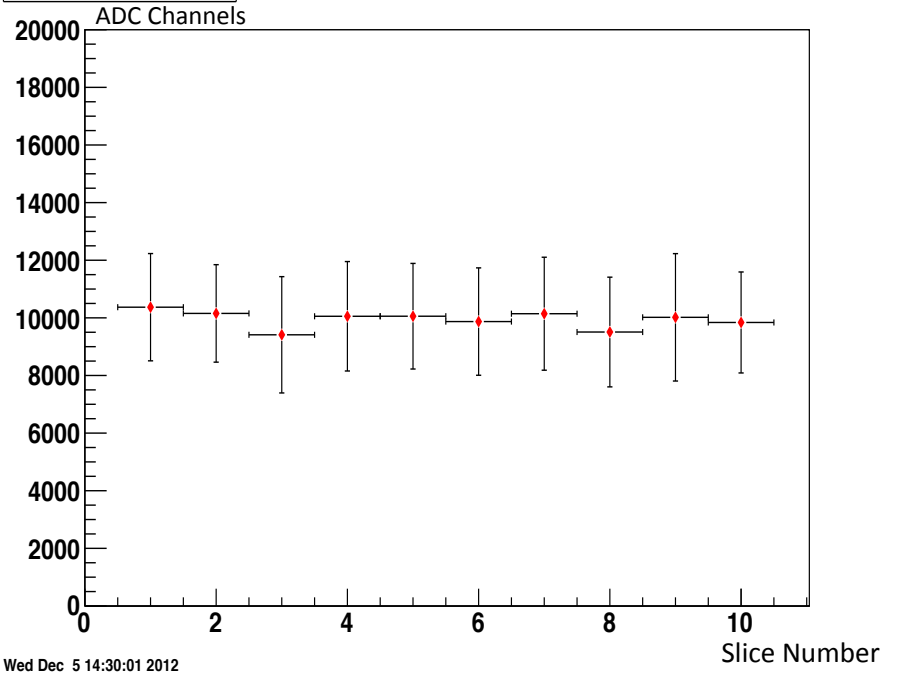
**hChargeSector**



**Normalized Charge Vs Strip**



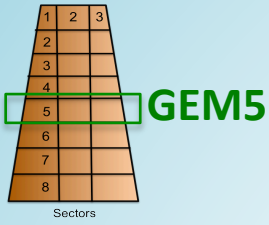
**Gain Uniformity**



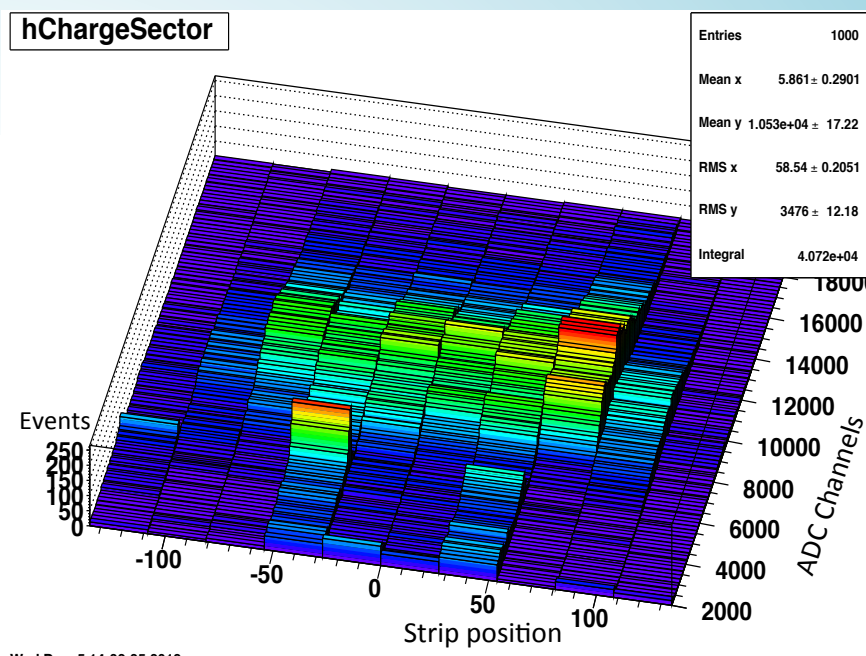
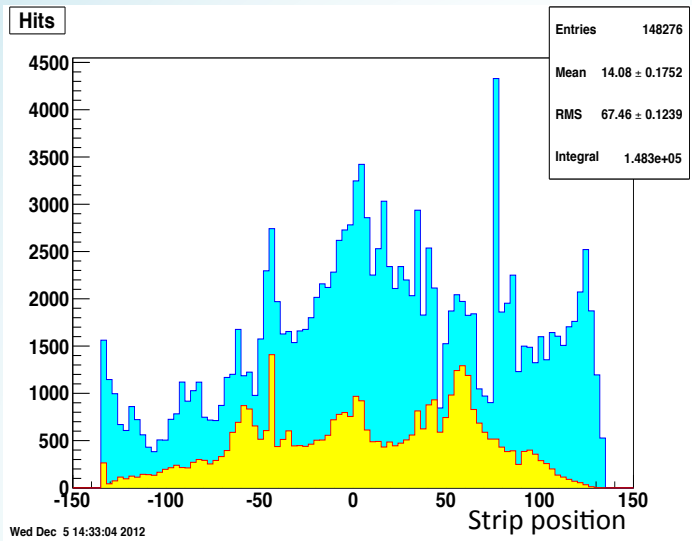


# Gain Uniformity Test 2.0

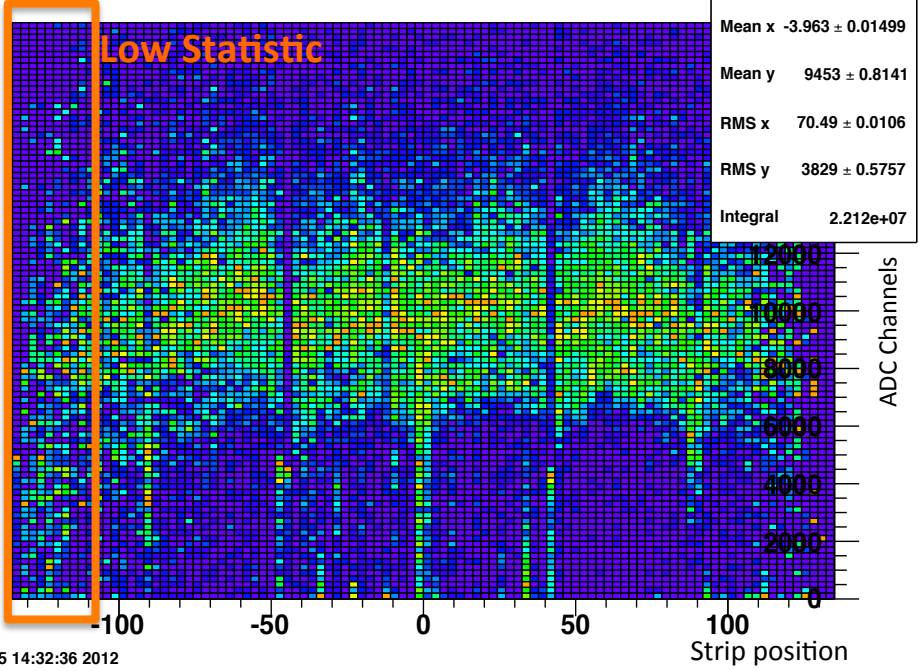
## Preliminary Results



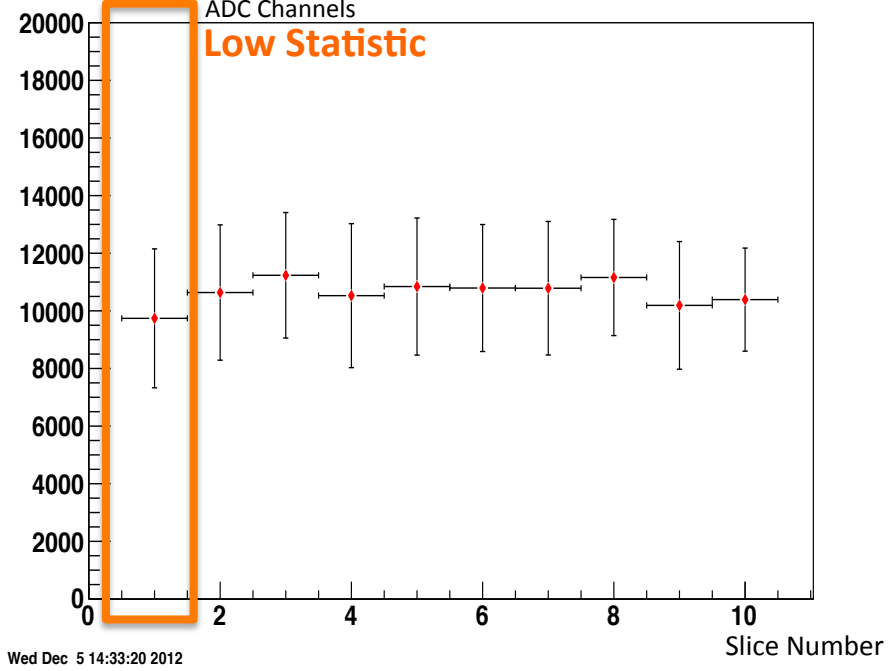
**Configuration :**  
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 @ 3500 V // 656 uA  
 Xray/Trigger Rate about  
 150 Hz ( 25kV // 20 uA @  
 1.60 m)  
 Copper absorber (few 10s  
 of um)  
 Holes not filled  
 300 K events



### Normalized Charge Vs Strip

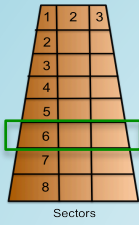


### Gain Uniformity



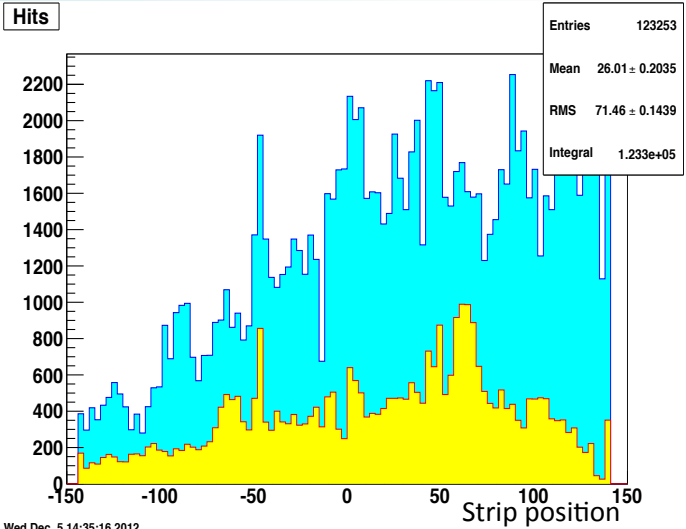
# Gain Uniformity Test 2.0

## Preliminary Results

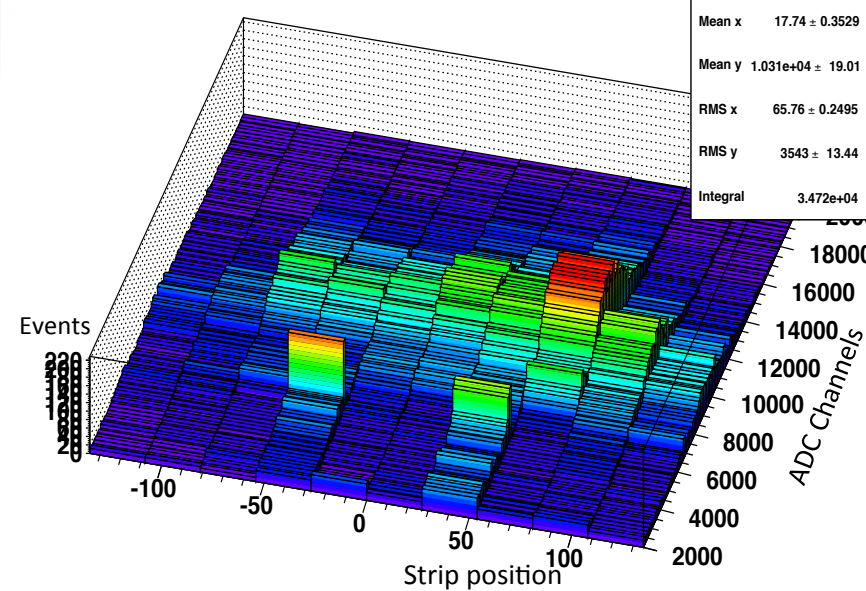


GEM6

**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

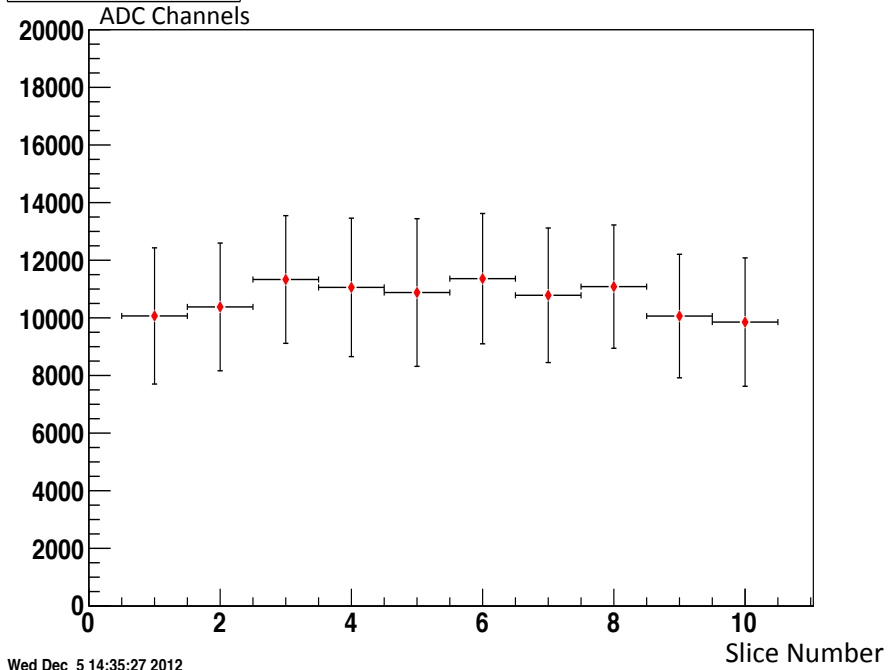


hChargeSector

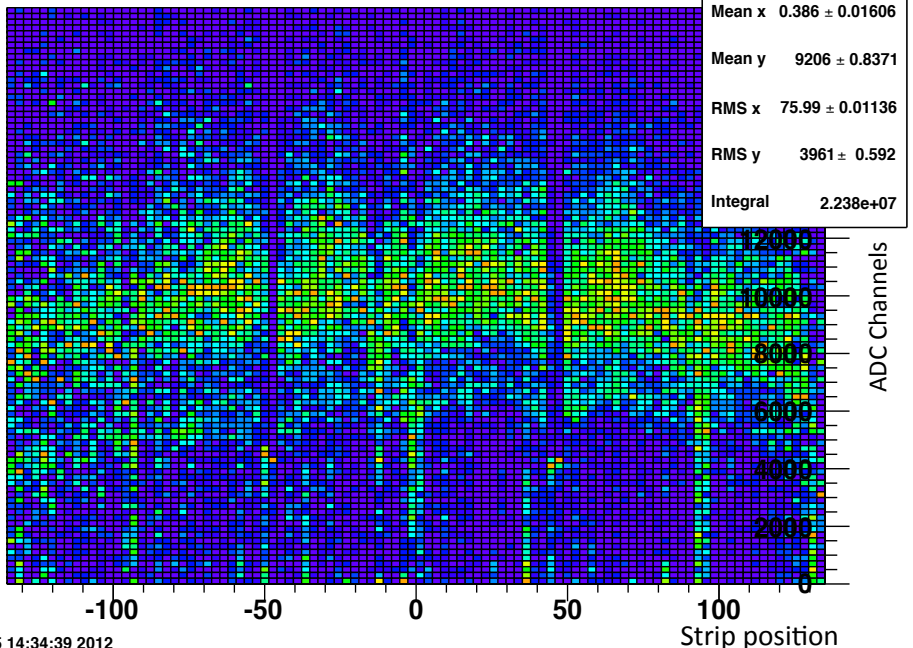


Wed Dec 5 14:34:28 2012

Gain Uniformity

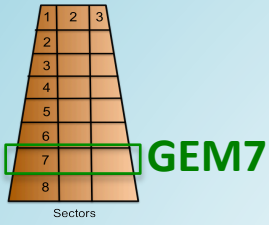


Normalized Charge Vs Strip

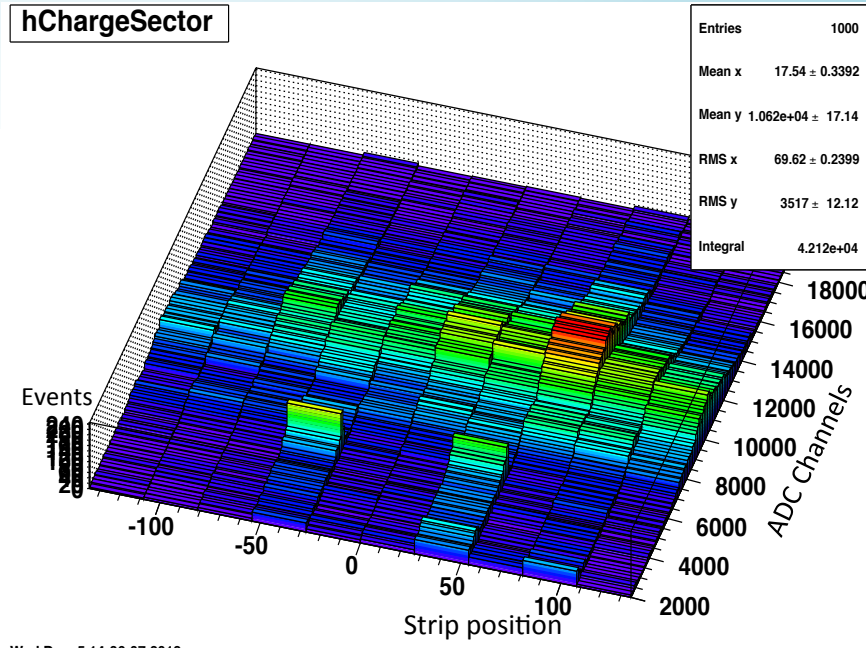
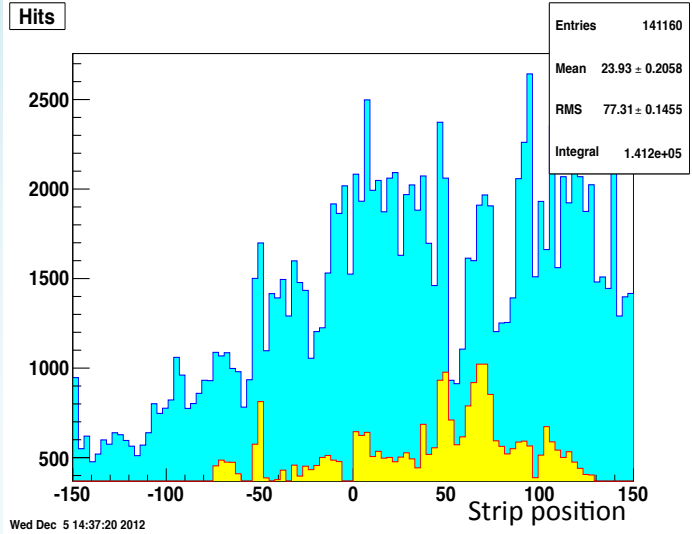


# Gain Uniformity Test 2.0

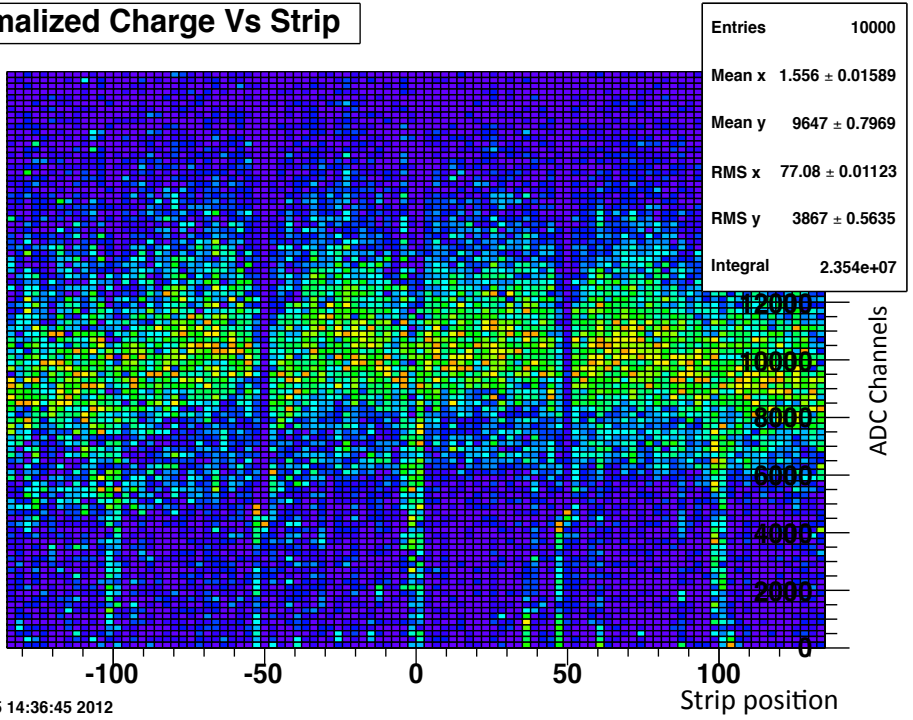
## Preliminary Results



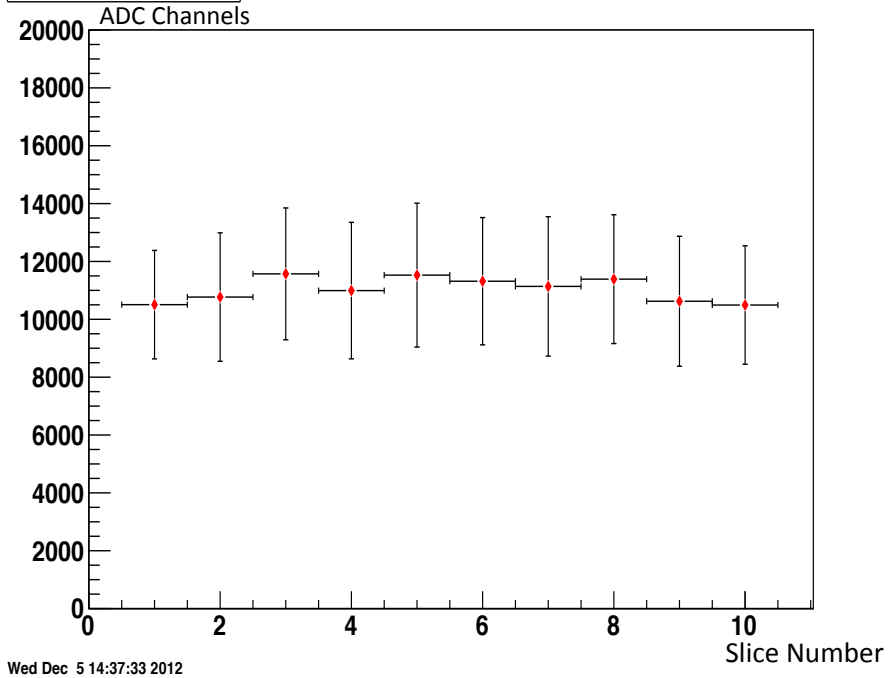
**Configuration :**  
 24 APVs // 2 FECs  
 Prototype GE1/1-NS2 n°3  
 @ 3500 V // 656 uA  
 Xray/Trigger Rate about  
 150 Hz ( 25kV // 20 uA @  
 1.60 m)  
 Copper absorber (few 10s  
 of um)  
 Holes not filled  
 300 K events



**Normalized Charge Vs Strip**

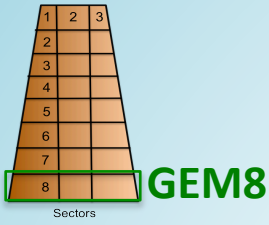


**Gain Uniformity**

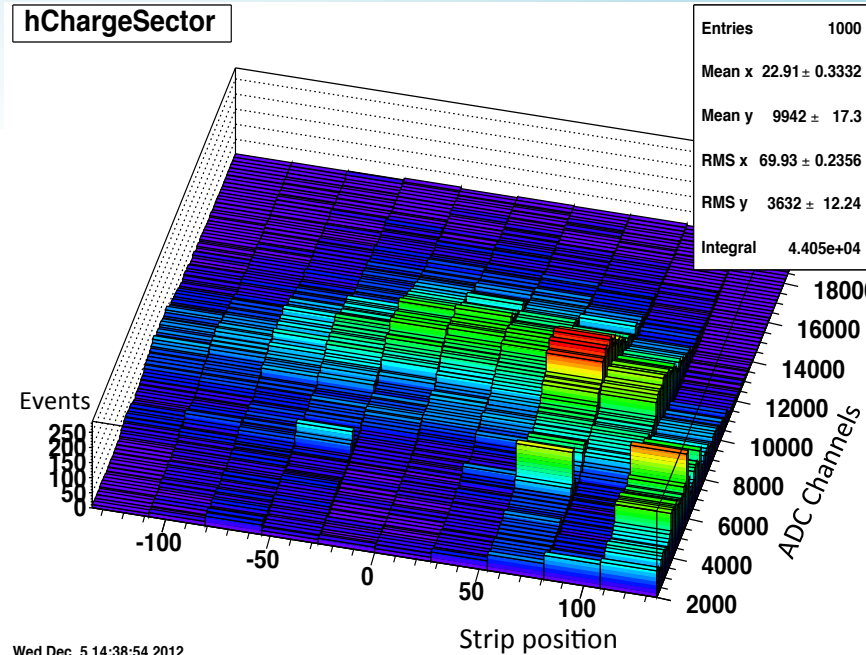
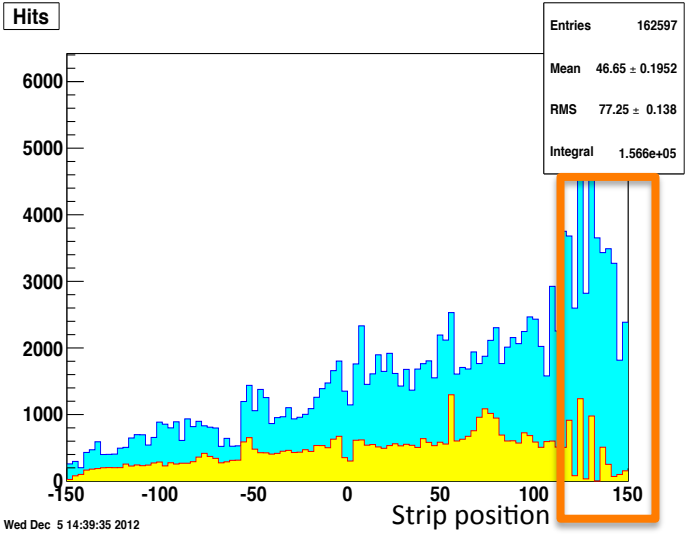


# Gain Uniformity Test 2.0

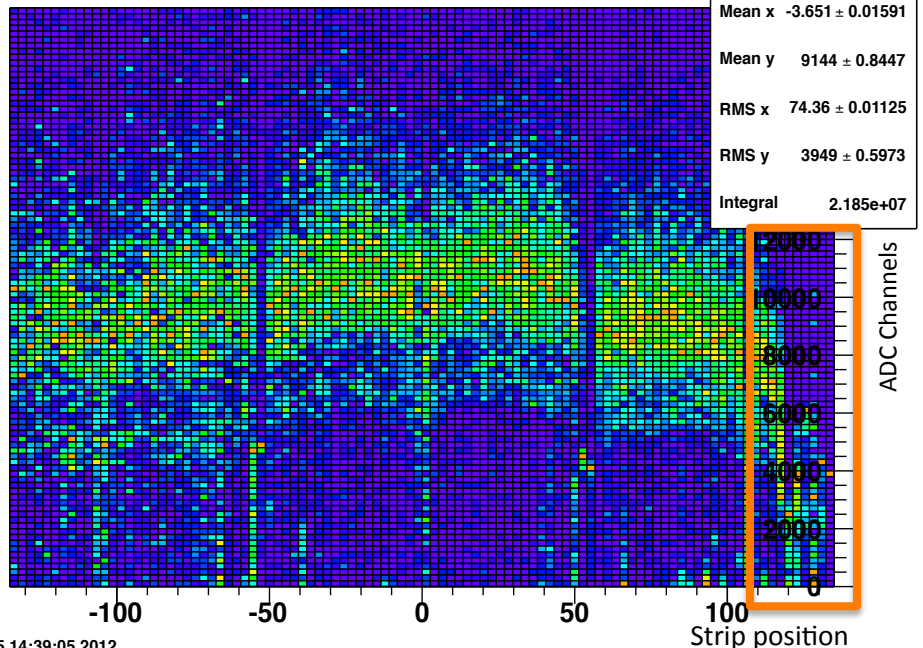
## Preliminary Results



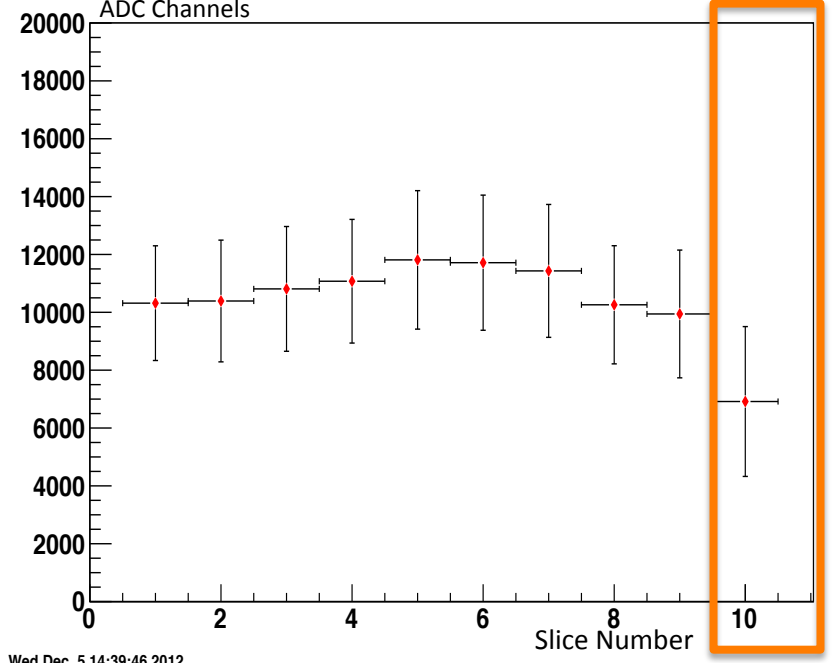
**Configuration :**  
 24 APVs // 2 FECs  
 Prototype GE1/1-NS2 n°3  
 @ 3500 V // 656 uA  
 Xray/Trigger Rate about  
 150 Hz ( 25kV // 20 uA @  
 1.60 m)  
 Copper absorber (few 10s  
 of um)  
 Holes not filled  
 300 K events



### Normalized Charge Vs Strip



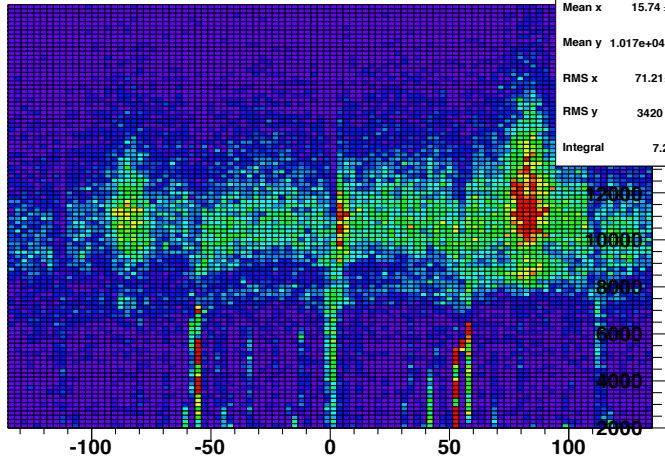
### Gain Uniformity



# Gain Uniformity Test 2.0

## Some Other Information

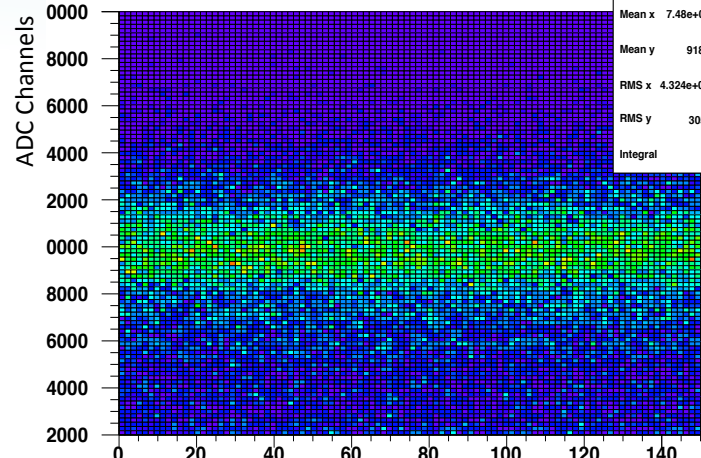
Charge Vs Strip



Entries	76435
Mean x	15.74 ± 0.2647
Mean y	1.017e+04 ± 12.71
RMS x	71.21 ± 0.1871
RMS y	3420 ± 8.987
Integral	7.239e+04

Wed Dec 5 14:17:41 2012

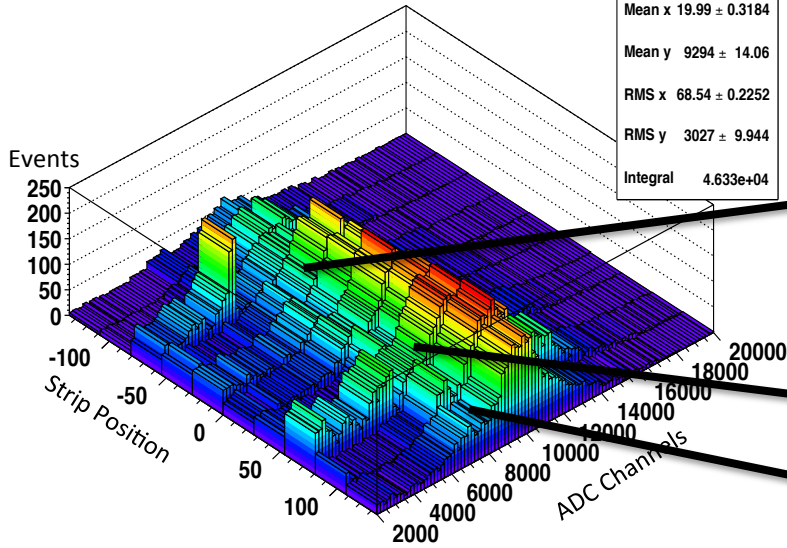
Charge Vs Event



Entries	50520
Mean x	7.48e+04 ± 204.3
Mean y	9183 ± 14.43
RMS x	4.324e+04 ± 144.4
RMS y	3055 ± 10.21
Integral	4.48e+04

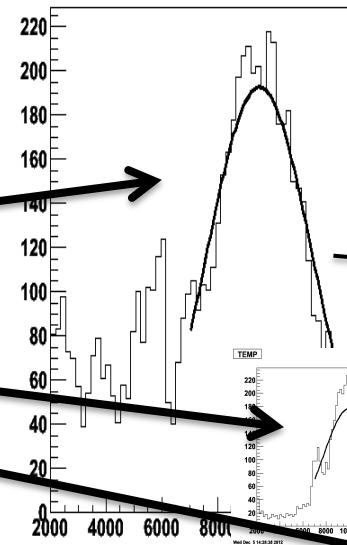
Wed Dec 5 14:29:41 2012

hChargeSector



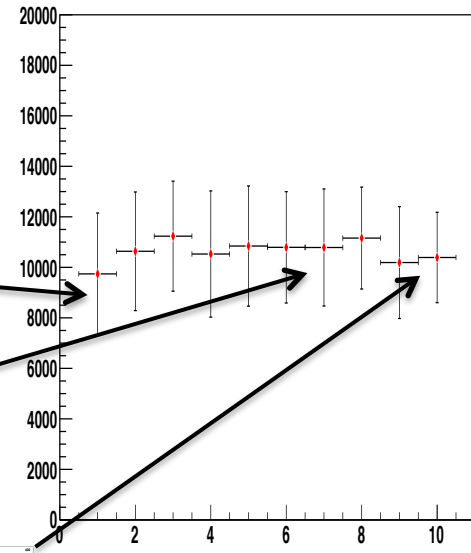
Entries	1000
Mean x	19.99 ± 0.3184
Mean y	9294 ± 14.06
RMS x	68.54 ± 0.2252
RMS y	3027 ± 9.944
Integral	4.633e+04

TEMP



Entries	800
Mean	8495 ± 37.52
RMS	3136 ± 26.53
Integral	6984
$\chi^2 / \text{n df}$	85.87 / 36
Constant	192.7 ± 3.9
Mean	9508 ± 39.3
Sigma	1904 ± 42.7

Gain Uniformity



Wed Dec 5 15:34:40 2012

Wed Dec 5 14:28:34 2012

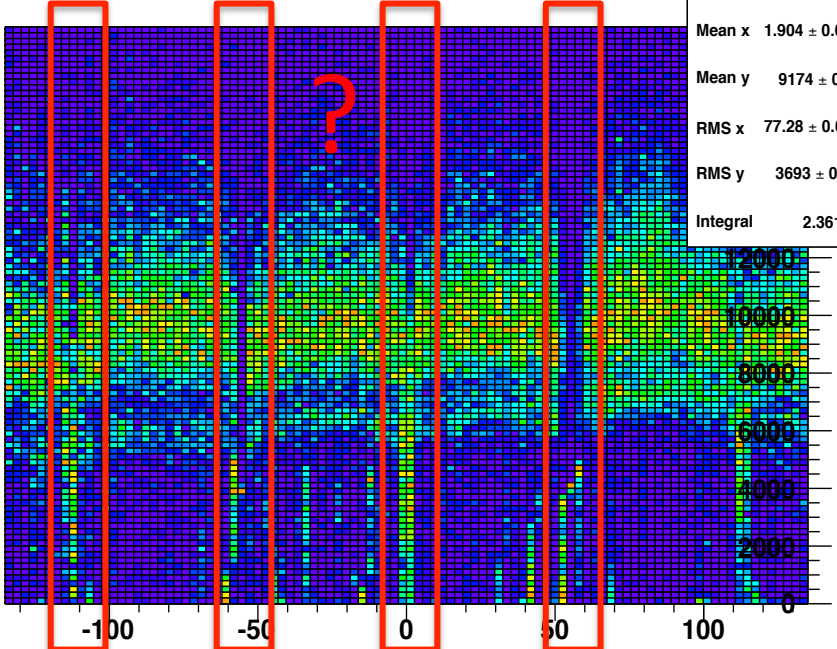
Wed Dec 5 14:33:20 2012

# Gain Uniformity Test 2.0

## HAS TO BE UNDERSTOOD

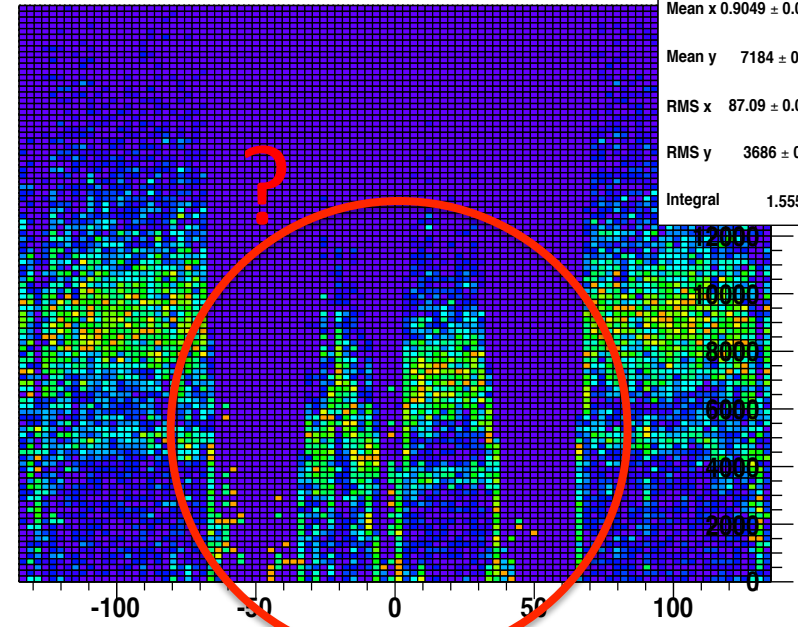
Normalized Charge Vs Strip

Entries	10000
Mean x	1.904 ± 0.01591
Mean y	9174 ± 0.7601
RMS x	77.28 ± 0.01125
RMS y	3693 ± 0.5374
Integral	2.361e+07



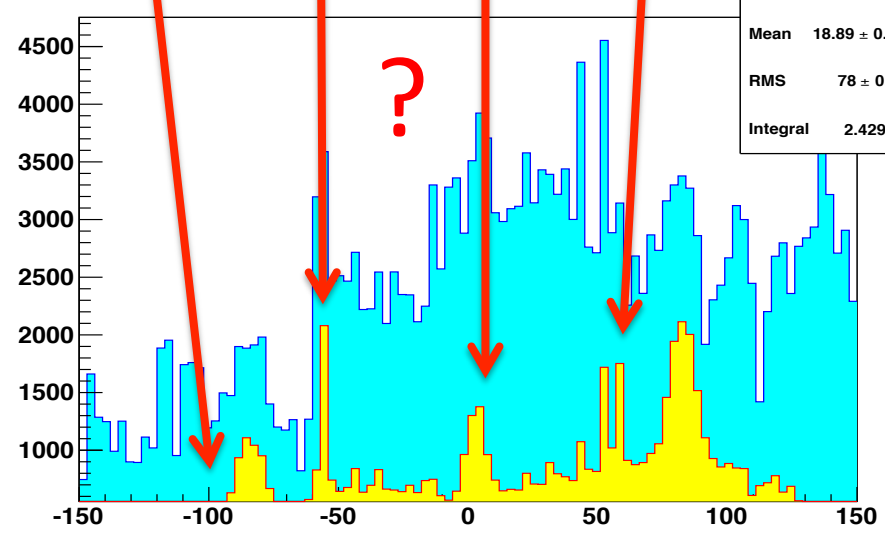
Normalized Charge Vs Strip

Entries	10000
Mean x	0.9049 ± 0.02209
Mean y	7184 ± 0.9349
RMS x	87.09 ± 0.01562
RMS y	3686 ± 0.6611
Integral	1.555e+07



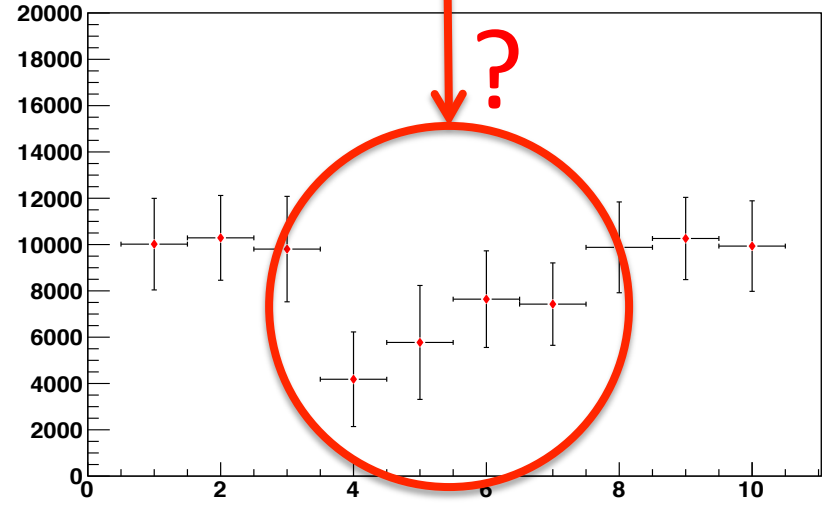
Hits

Entries	260664
Mean	18.89 ± 0.1583
RMS	78 ± 0.1119
Integral	2.429e+05



ed Dec 5 14:27:04 2012

Gain Uniformity



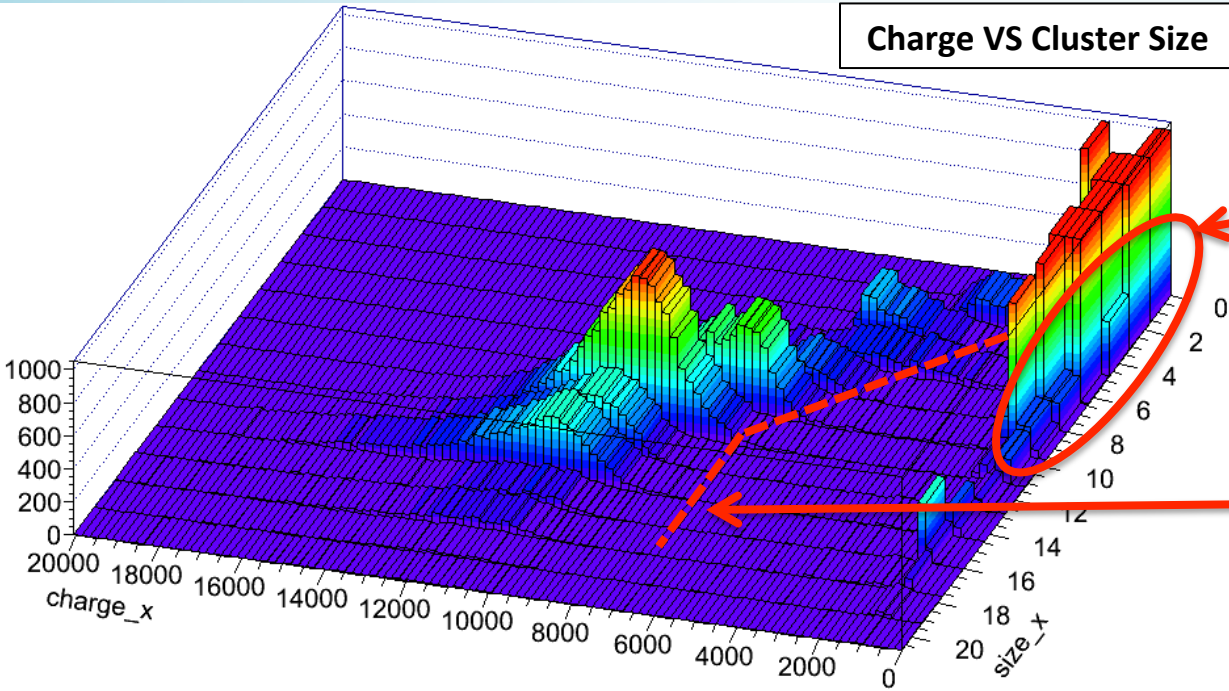
Wed Dec 5 14:28:02 2012

Wed Dec 5 14:19:06 2012

# Gain Uniformity Test 2.0

## HAS TO BE UNDERSTOOD

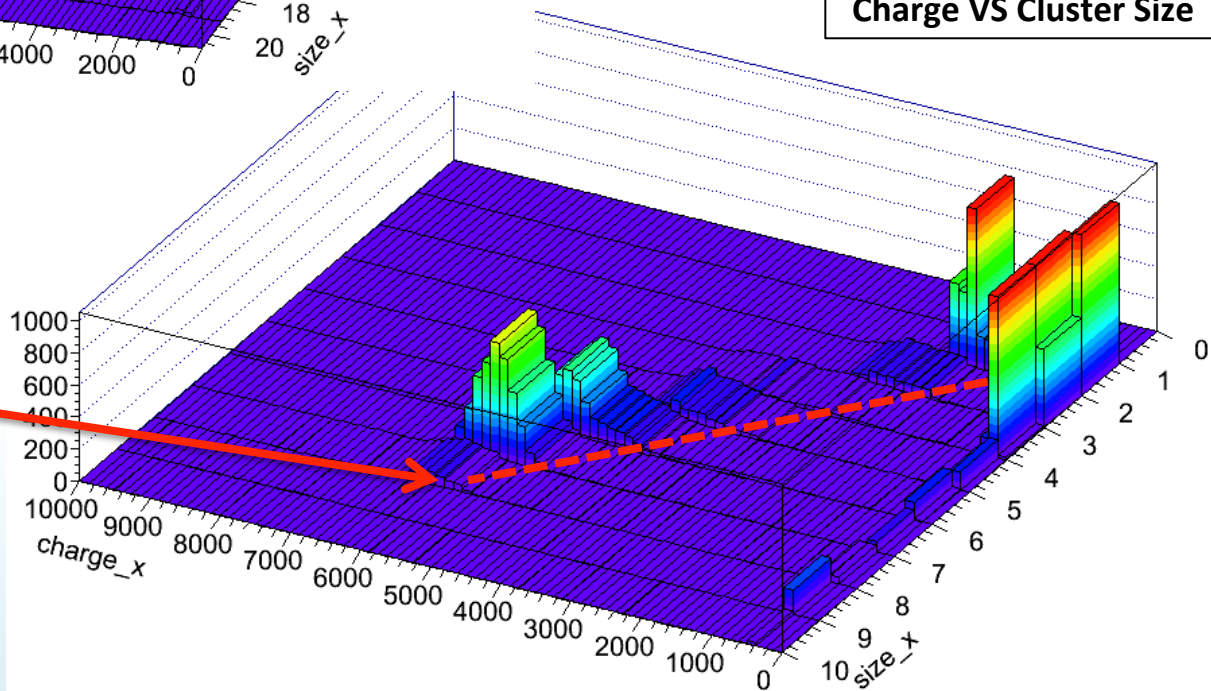
Charge VS Cluster Size



Noise ? Cosmics ?

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

Charge VS Cluster Size



Saturation ?  
Gain : 1000  
Reduced noise

# Gain Uniformity Test 2.0 HAS TO BE UNDERSTOOD

## APV needs :

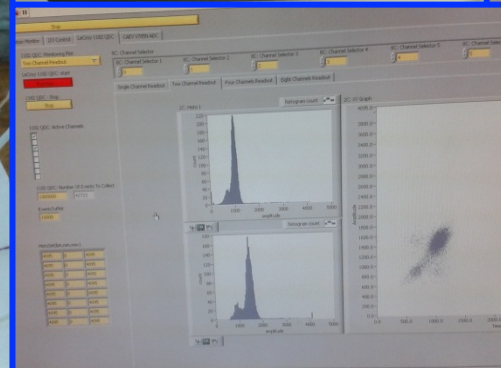
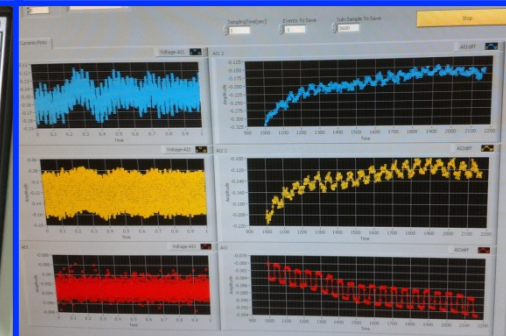
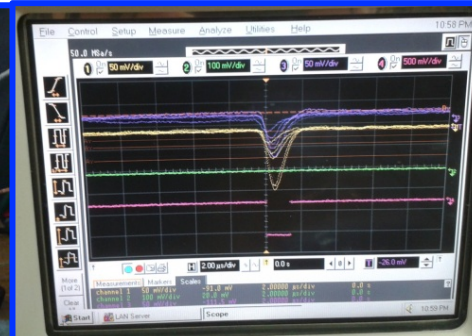
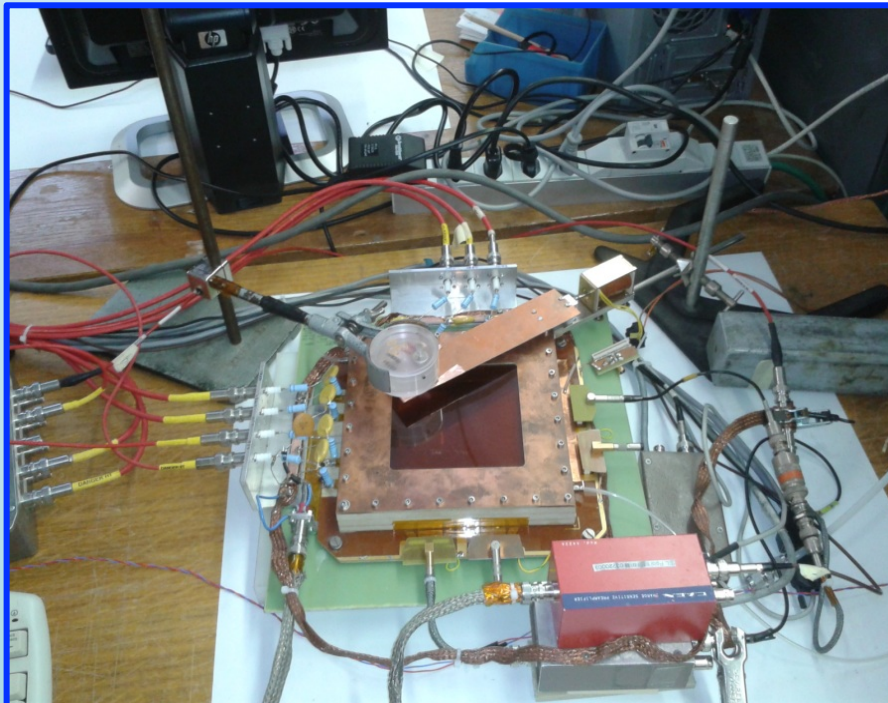
- Low amount of charges on the readout (saturation) → lower Gain
- Good external trigger signal (good energy spectrum) → higher Gain

## Changing the induction field we expect:

- Lower the charge collected on the readout.

## AND

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



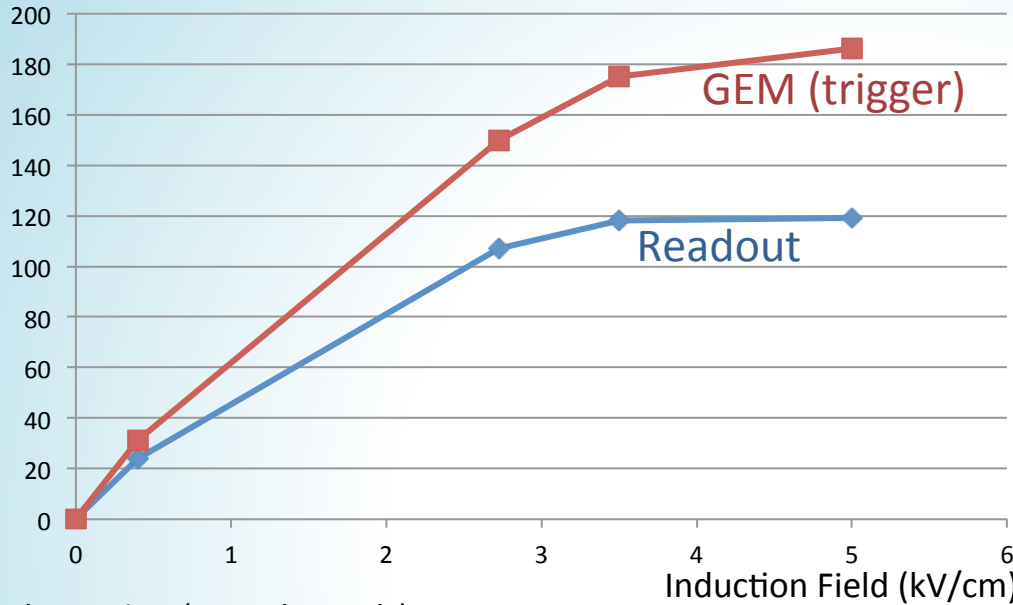
- 10x10 triple GEM
- Fe55 source (shutter)
- Monitoring :
  - Readout current
  - GEM current
  - Signals amplitude
  - Energy spectra



# Gain Uniformity Test 2.0

## HAS TO BE UNDERSTOOD

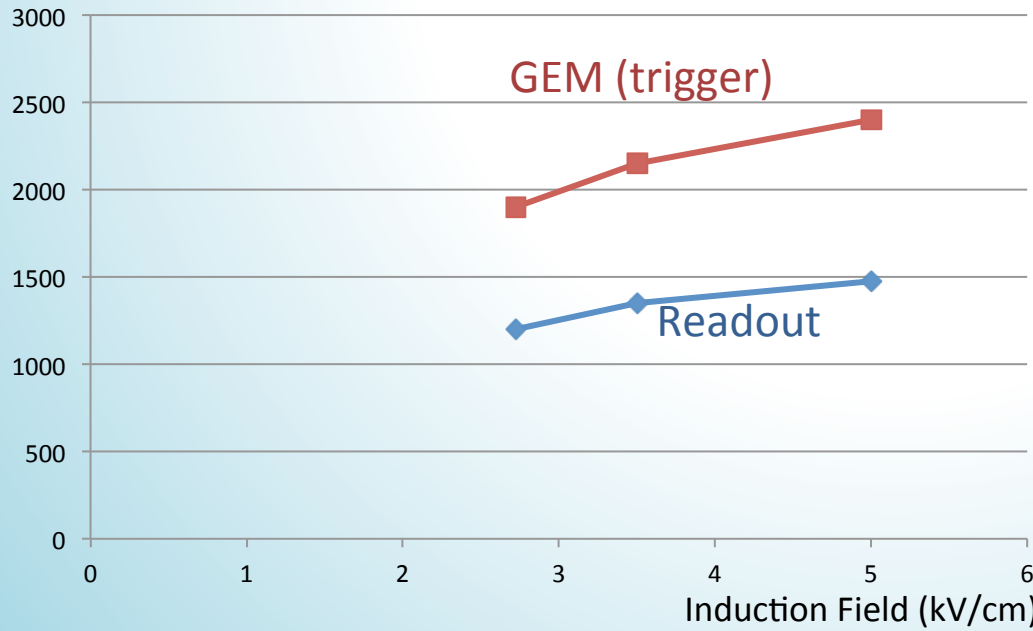
PP Amplitude (mV)



Signal Amplitude VS Induction Field :

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

Peak Position (ADC channels)



Fe<sup>55</sup> 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 really 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