

# Analysis of PCB Irradiation Tests

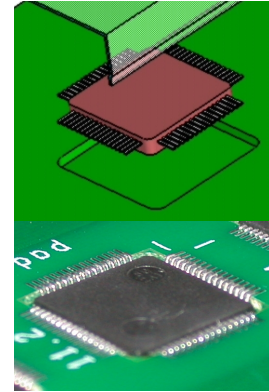
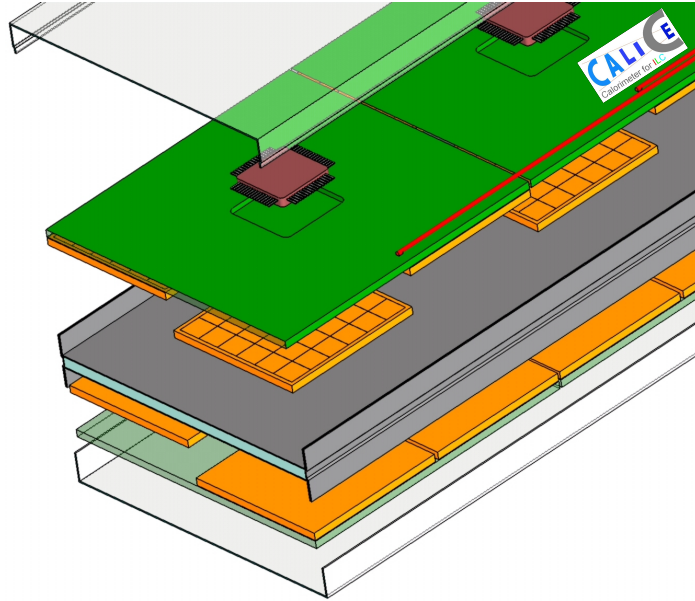
Roman Pöschl  
LAL Orsay

- Motivation
- Experimental Setup
- Data Samples
- Analysis and Results
- Summary, Conclusion and Outlook

Calice Collaboration Meeting Daegu/Korea Feb. 2009

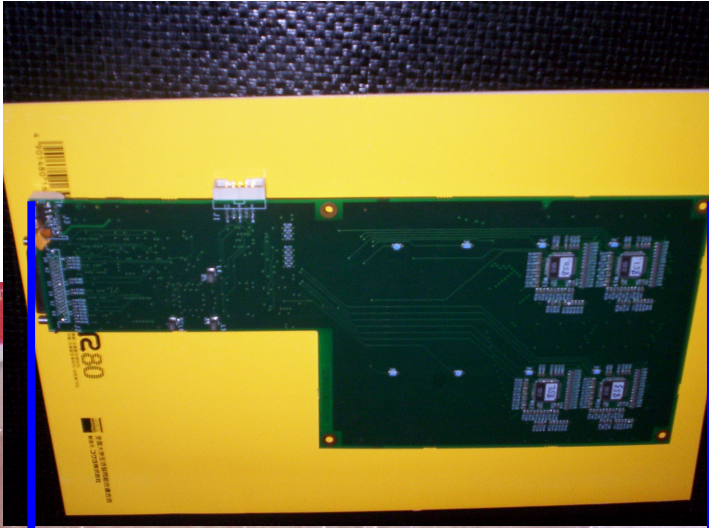
# Introduction

Calorimeter Electronics to be interleaved with layer structure

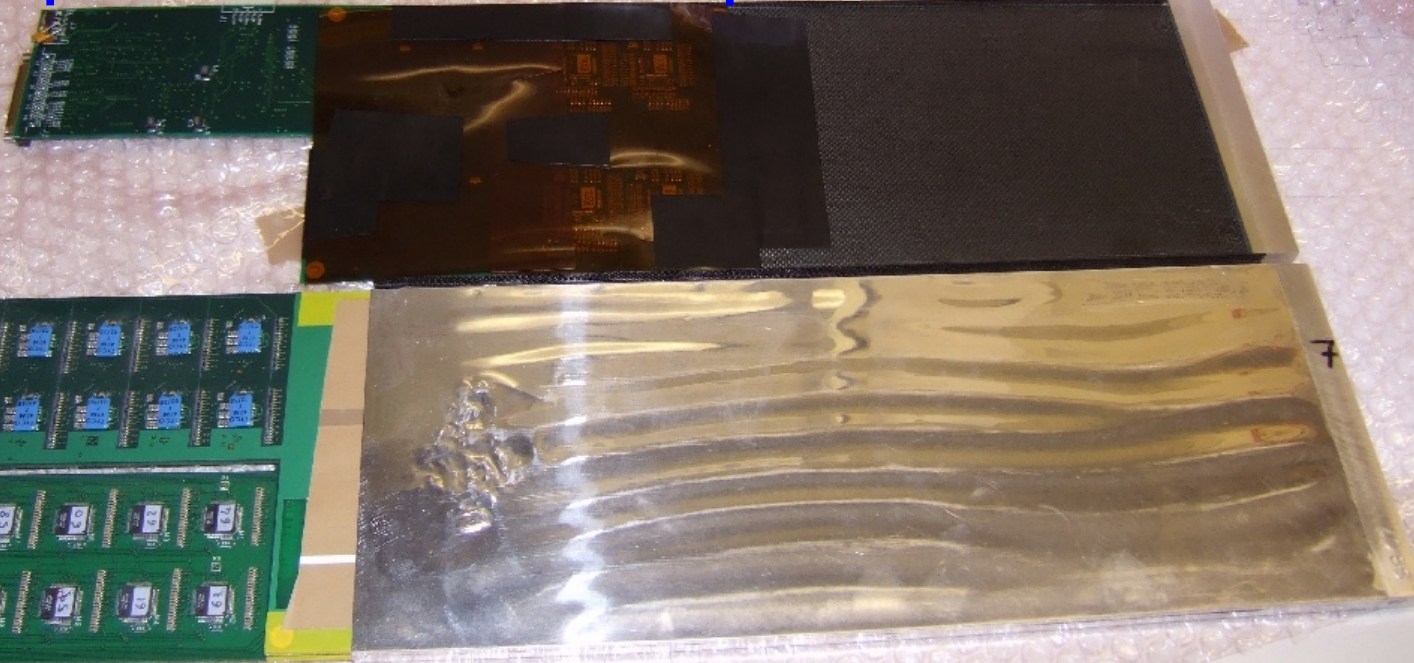


Do high energetic showers create signals directly in electronics ?  
If yes, Rate of faked signals ?

# Special PCB in Ecal Prototype during CERN 07 testbeam – Experimental Setup I



Test PCB  
- equipped with  
PHY3 Chip Set



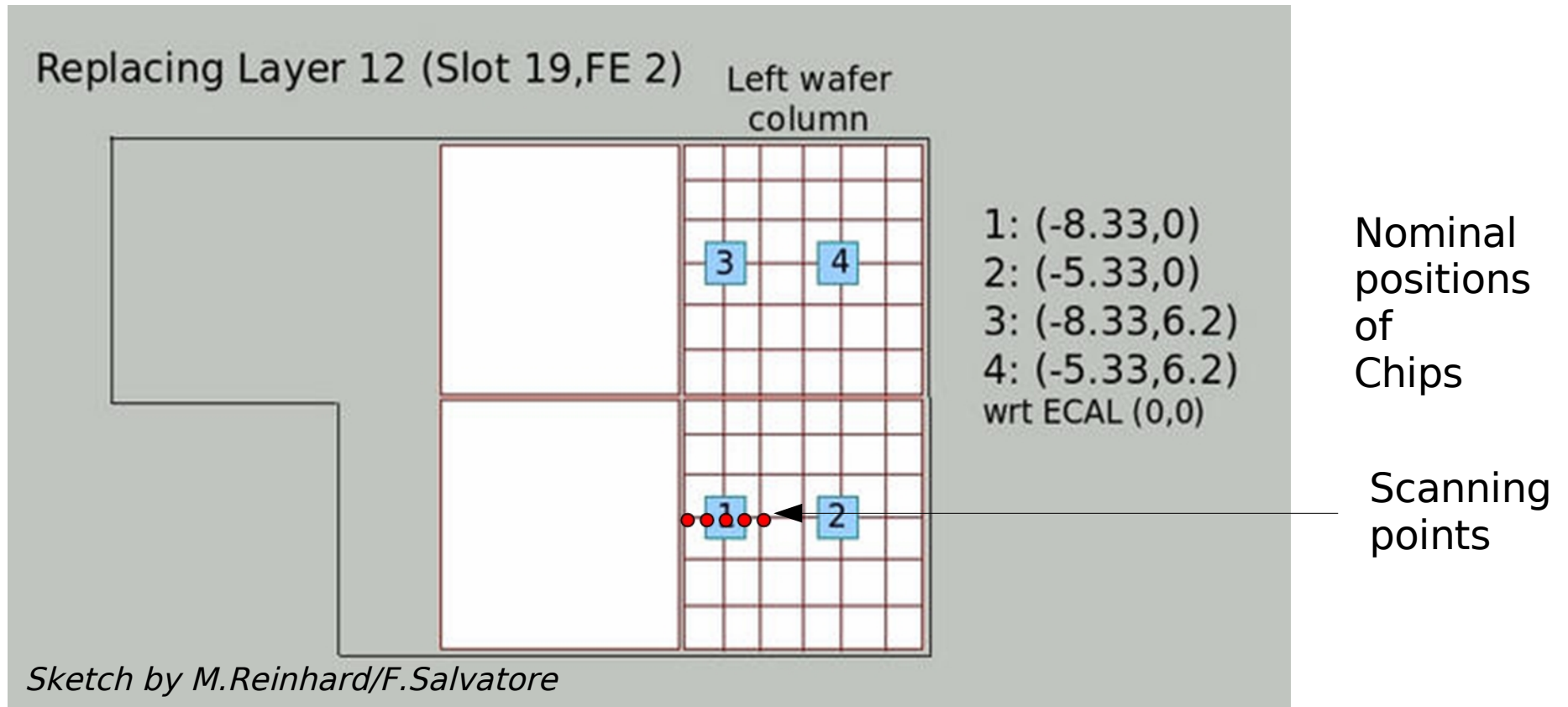
Prepared Slab  
- W dummy  
- capton and paper  
for electrical shielding

Usual Slab



# Special PCB in Ecal Prototype during CERN 07 testbeam – Experimental Setup II

- PCB positioned at place of layer 12 in Ecal ~ shower maximum  
x,y position identical to layer 2
- Schematic view of test PCB - 'Expect' signals from 72 pads, 4x18 = 2 Wafer

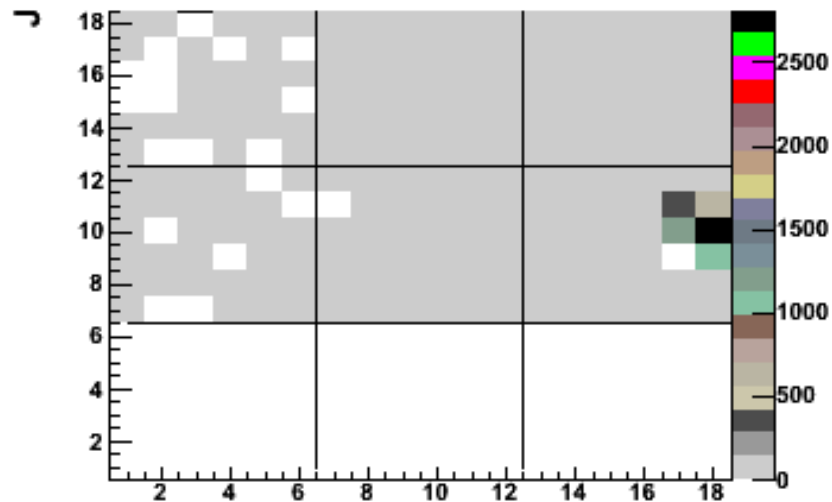


- $2.6 \cdot 10^6$  Events with 90 GeV Electrons (-  $5.8 \cdot 10^5$  with 70 GeV Electrons)  
At least 70 K at each scanning point (Details see later)  
Runs 331462 – 331518  
Today: Analysis of 10k Events per analysed run – **(nearly) Full Statistics**
- First Step: Runs were subject to the same data processing chain as 'usual' runs  
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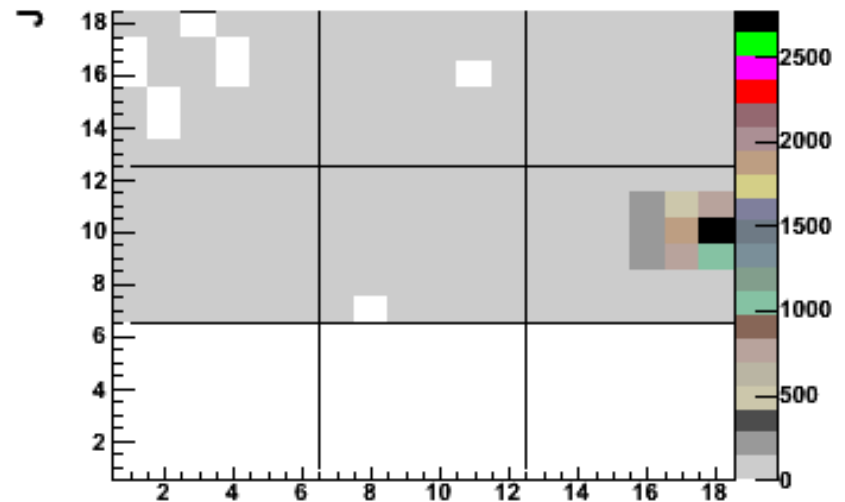
# First Steps of Data Analysis – Alignment Studies

Beam Impact at nominal center of Chip 1 (-8.33,0) cm

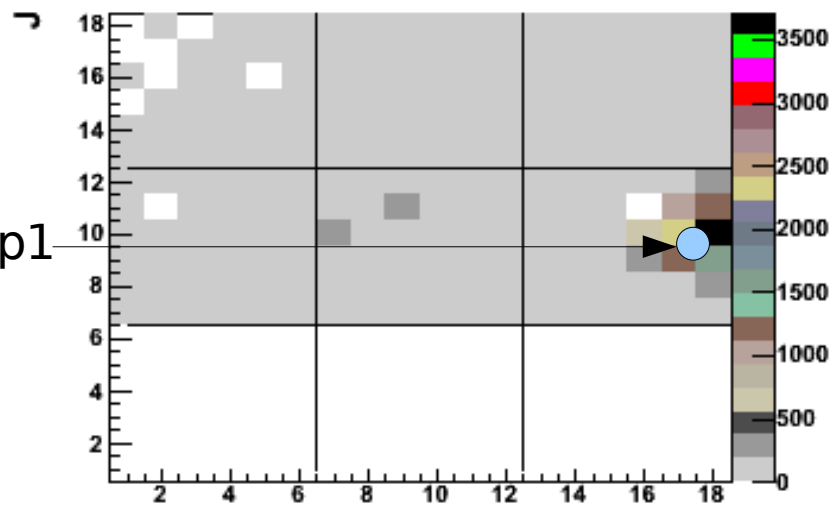
Layer\_0\_hist



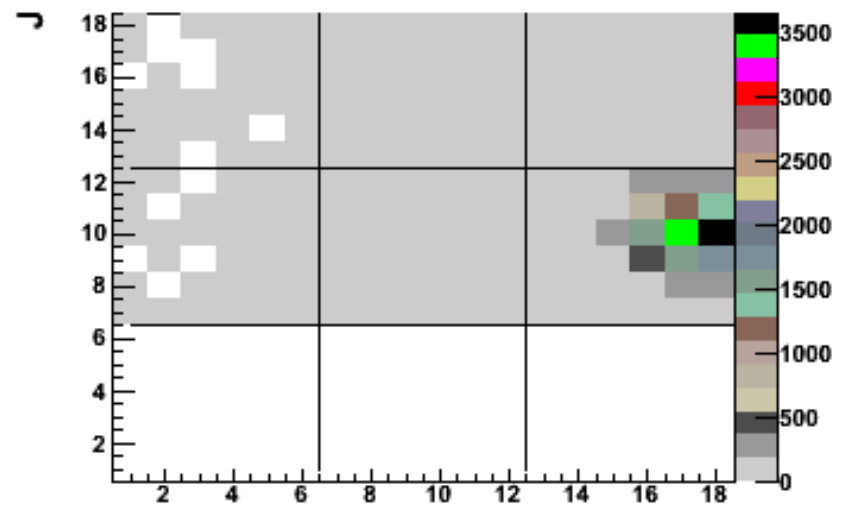
Layer\_1\_hist



Layer\_2\_hist



Layer\_3\_hist

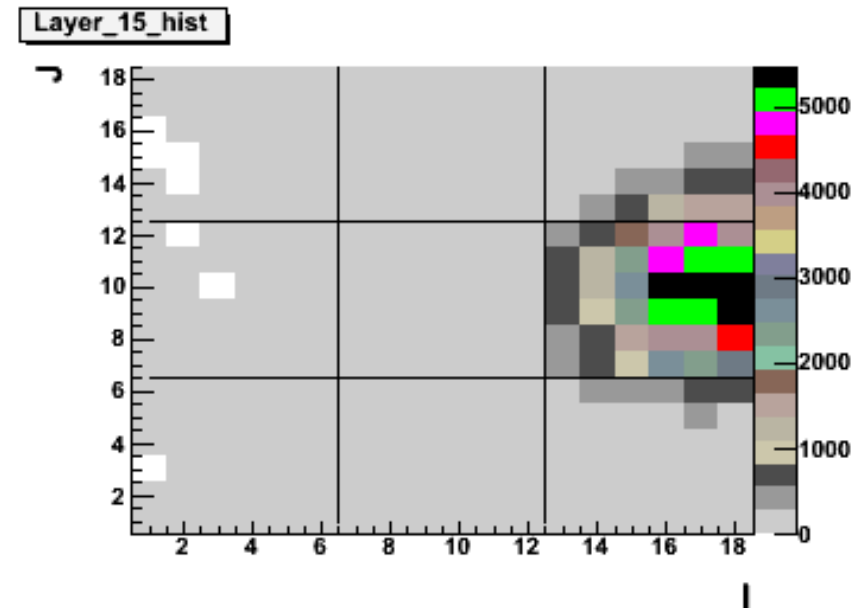
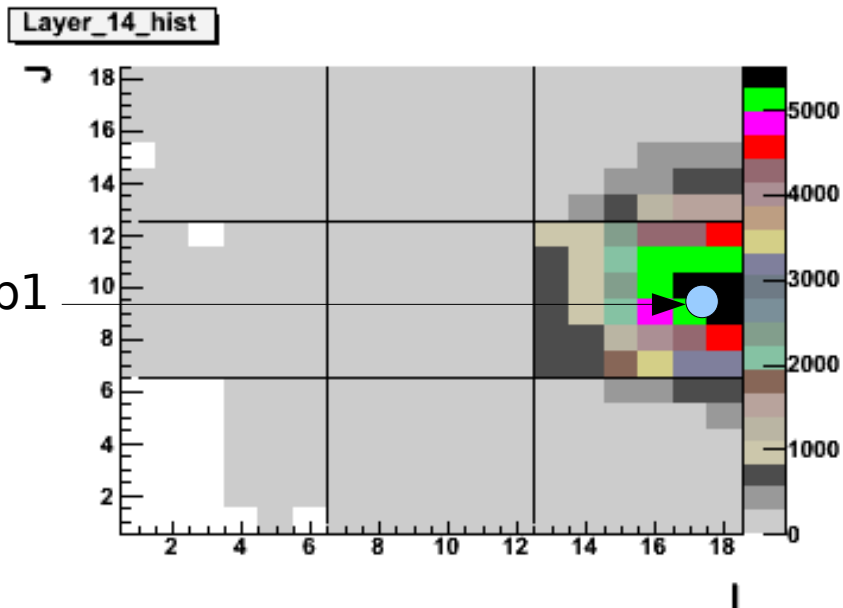
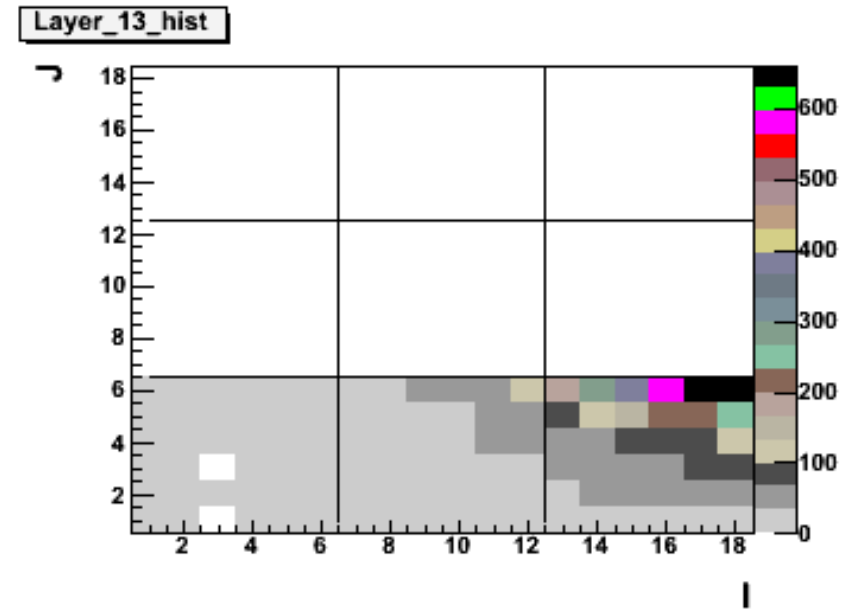
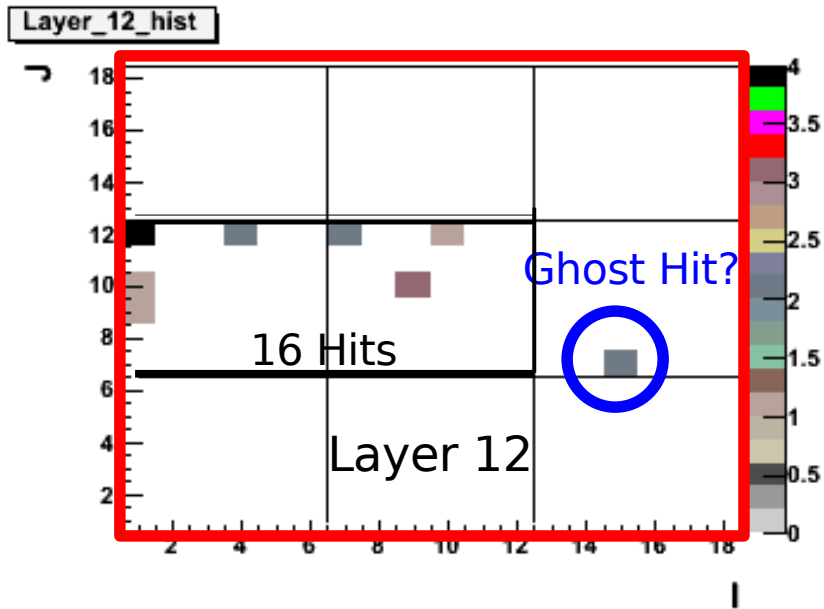


Projection of Center of Chip1 onto layer 2

Looks like we've shot a bit too high and too close to the Ecal Border

# First Steps of Data Analysis – Rough Alignment Studies

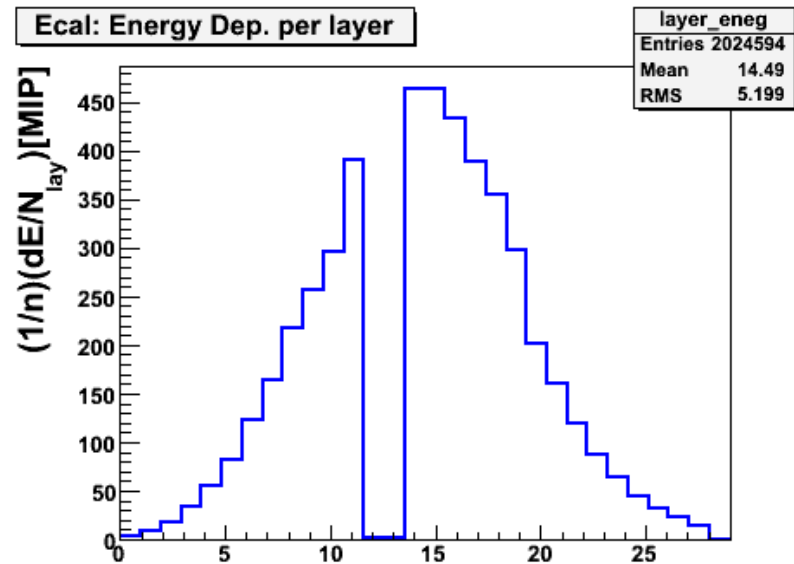
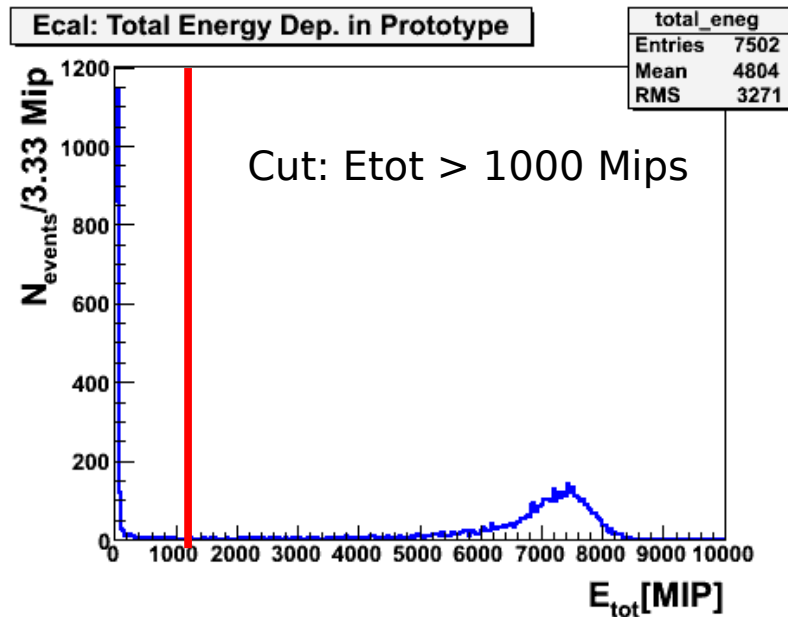
70 GeV e<sup>-</sup> - Beam Impact at nominal center of Chip 1 (-8.33,0) cm



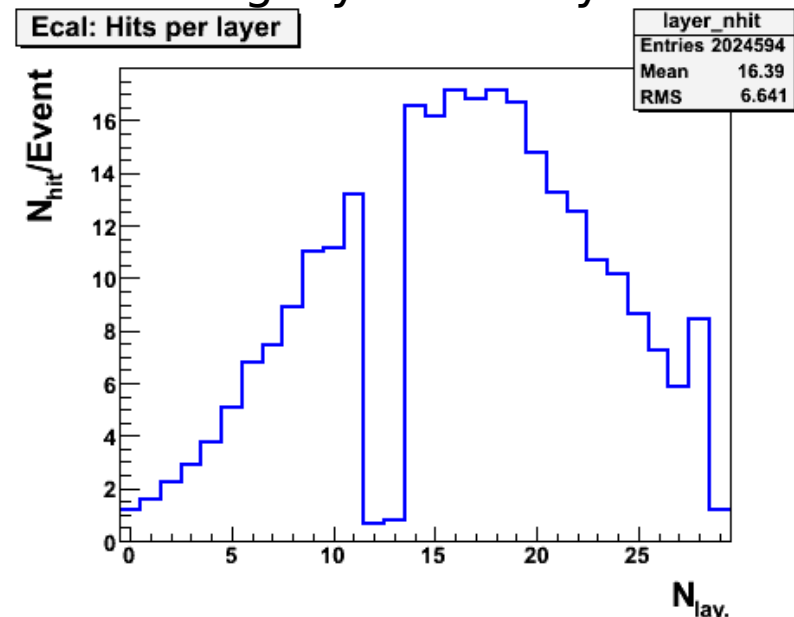
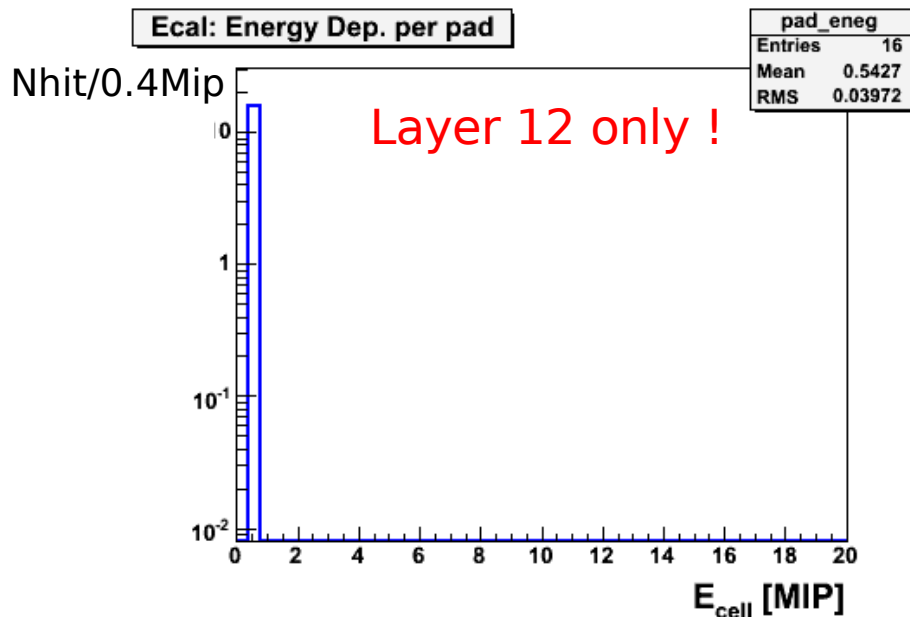
Projection of Center of Chip1 onto layer 14

- Chip 1 well 'touched' by shower maximum
- Small Activity in Layer 12

# Basic Spectra (for 10k Events)



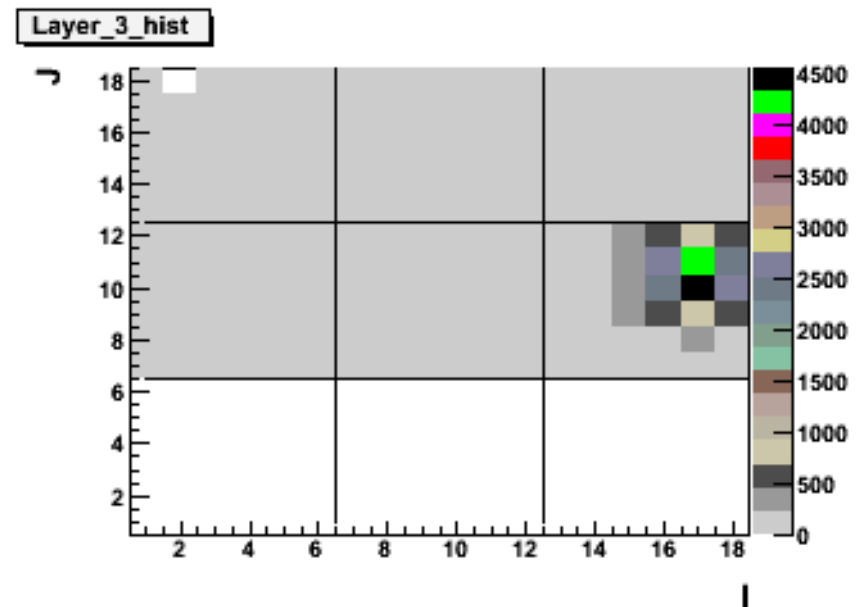
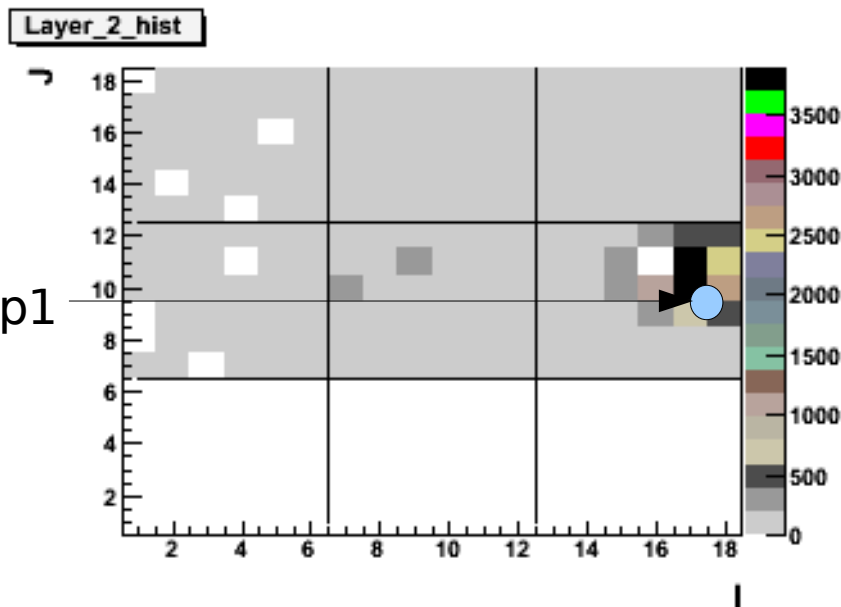
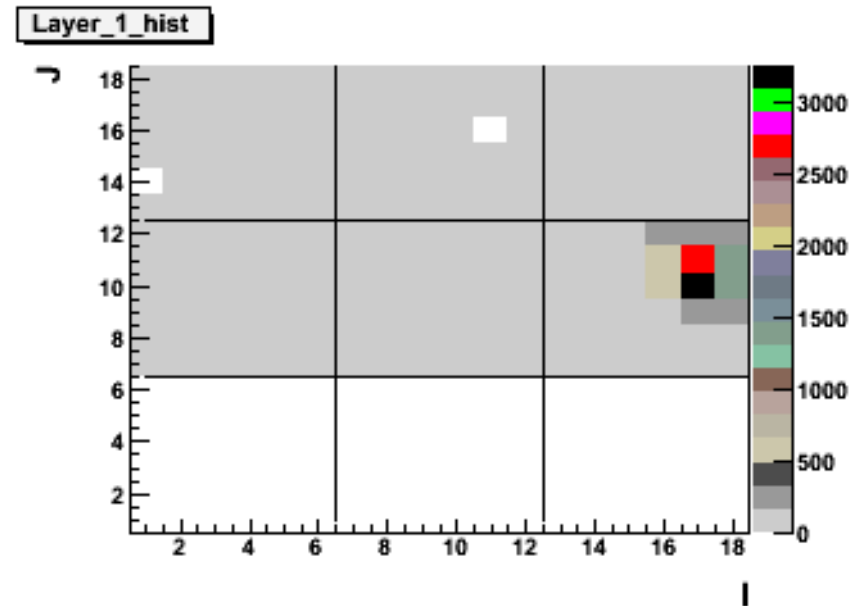
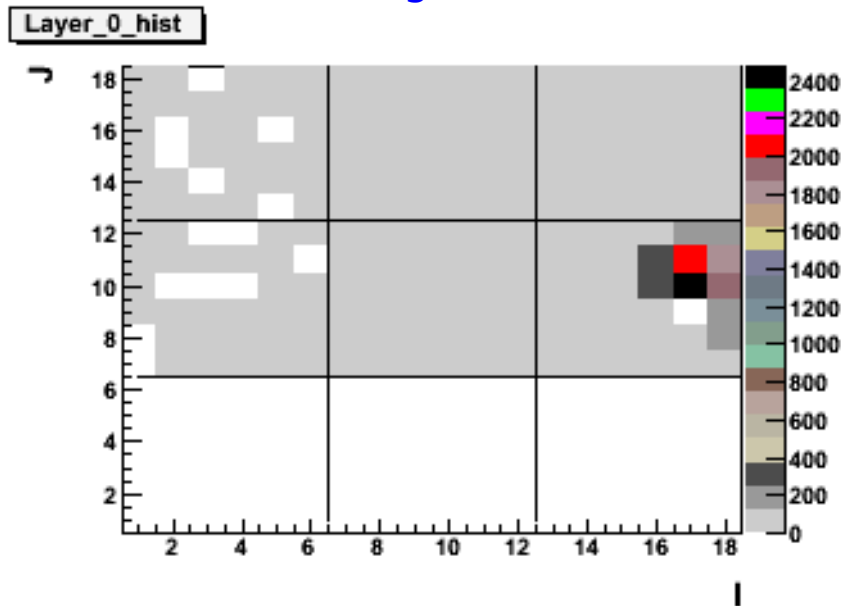
Missing layers clearly visible



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No signal beyond 1 MIP!!!

# First Steps of Data Analysis – Rough Alignment Studies

Moving towards Center of Ecal (-7.8,0) cm



Projection of Center of Chip1 onto layer 2

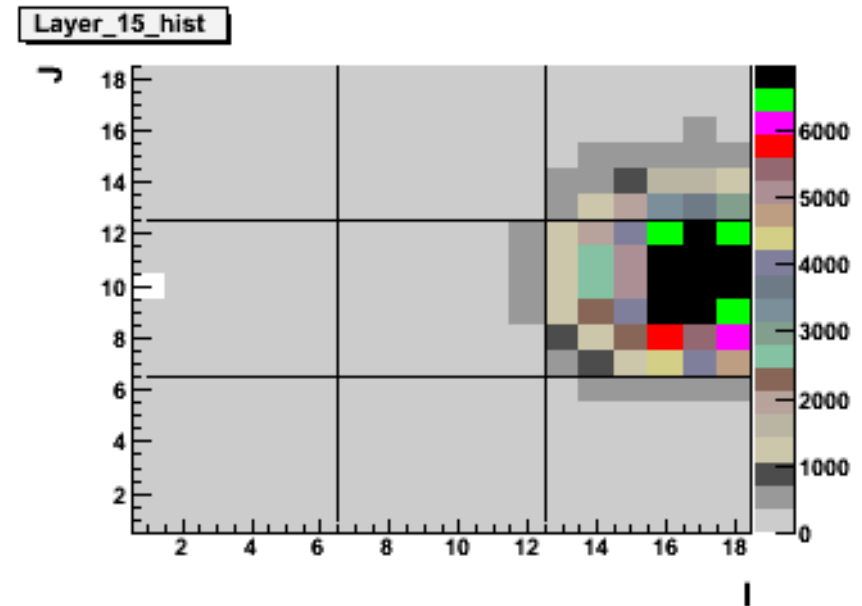
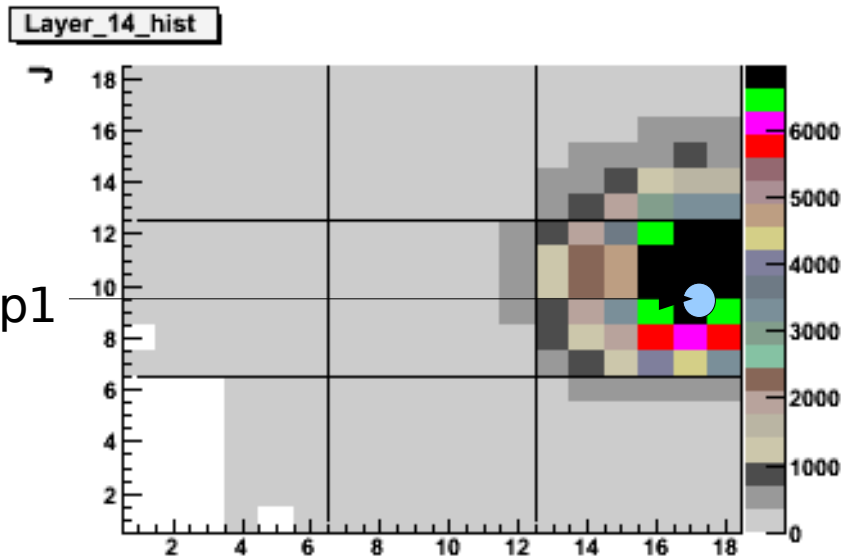
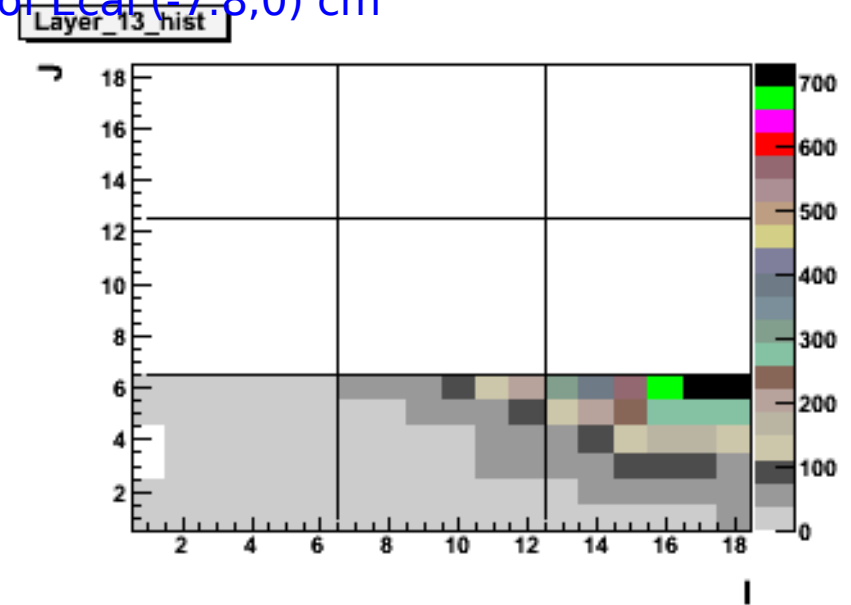
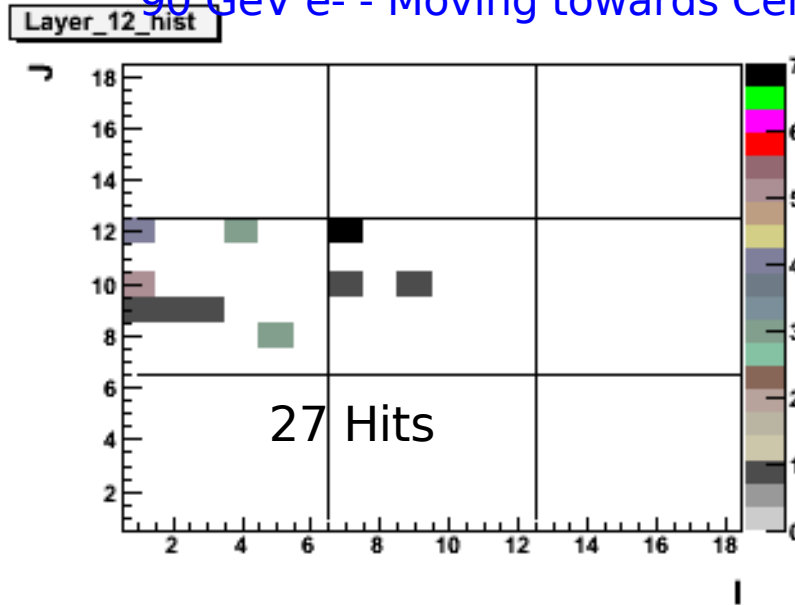
Change in impact position clearly visible

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# First Steps of Data Analysis – Alignment Studies

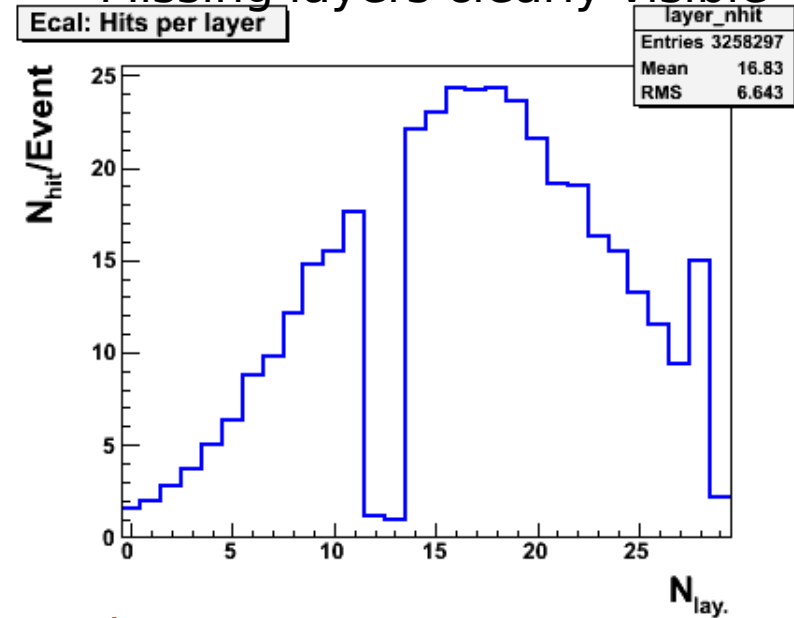
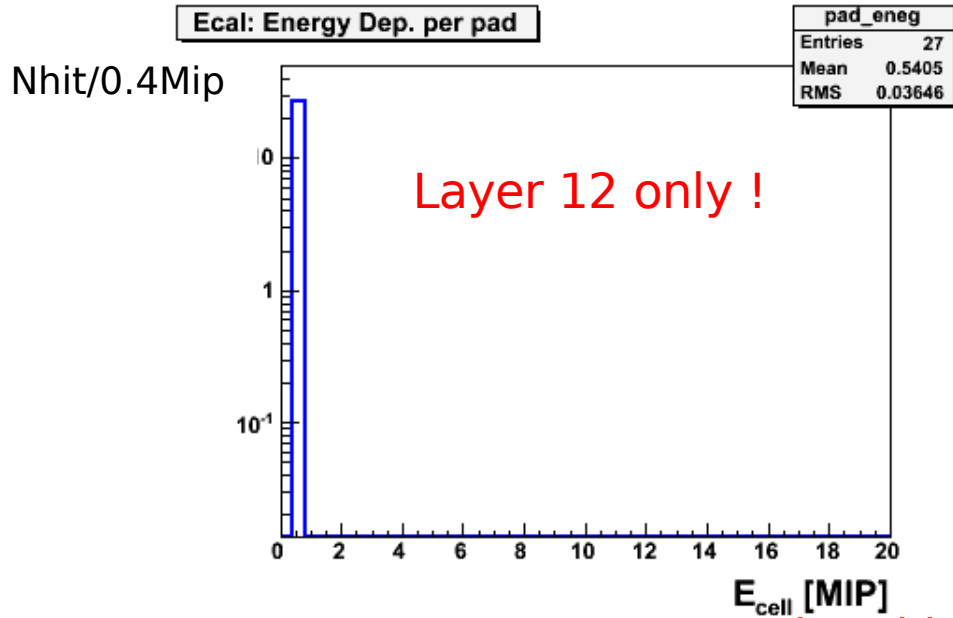
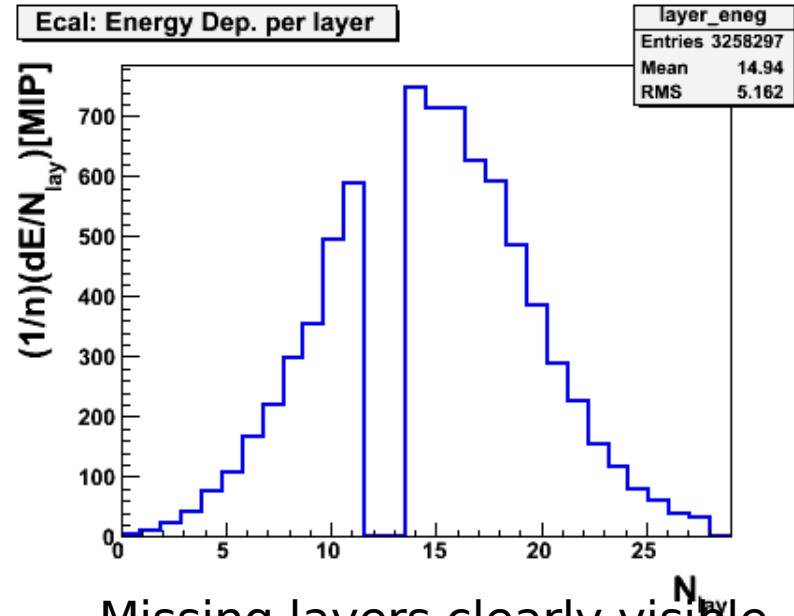
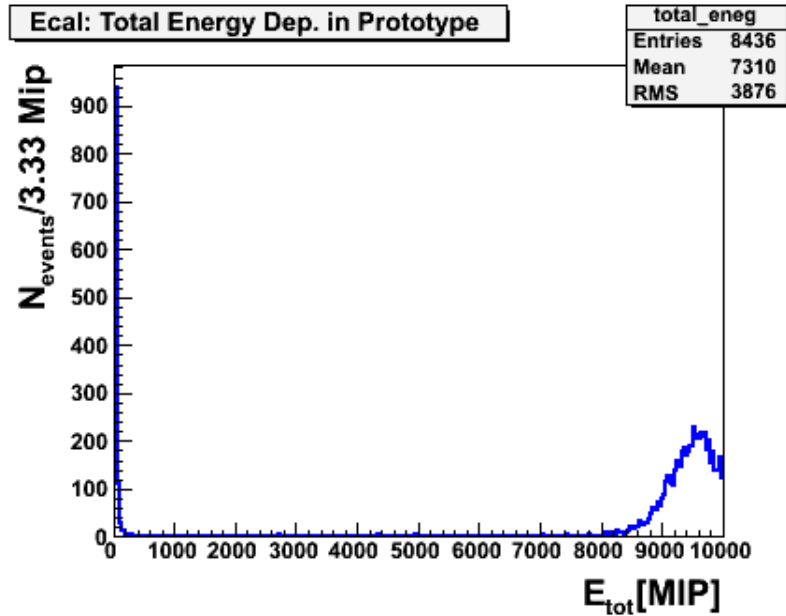
90 GeV e<sup>-</sup> - Moving towards Center of Ecal (-7.8,0) cm



Projection of Center of Chip1 onto layer 2

- Chip 1 well 'touched' by shower core
- Small Activity in Layer 12 (bit larger than for 70 GeV and 'nominal' Center)

# Basic Spectra (10k Events)



Missing layers clearly visible

No signal beyond 1 MIP!!!

70 GeV -> 90 GeV Layer 12 outside of shower maximum  
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So far all runs have been reconstruction using usual reco software

Now

Discarding all (Offline) Pedestal Corrections

- **Methodology:**

Subdivision of Runs into BeamTrigger and Pedestal Trigger Events (Oscillator Trigger) interleaved with beam events

Expectation no difference between spectra in the both cases

# Statistics of Analysis

## Scan 3

Run331495: e-?? GeV  
Signal: 314275 Evt.  
Pedestal: 15264 Evt.

Run331498: e- 90 GeV  
Signal: 66655 Evt.  
Pedestal: 4223 Evt.

Run331494: e- 90 GeV  
Signal: 65249 Evt.  
Pedestal: 3602 Evt.

Run331497: e- 90 GeV  
Signal: 214418 Evt.  
Pedestal: 13666 Evt.

Run331474: e- 90 GeV  
Signal: 85884 Evt.  
Pedestal: 4949 Evt.

## Scan 4

Run331513: e- 90 GeV  
Signal: 216877 Evt.  
Pedestal: 38295 Evt.

Run331518: e-90 GeV  
Signal: 90395 Evt.  
Pedestal: 4347 Evt.

Run331511: e-?? GeV  
Signal: 86989 Evt.  
Pedestal: 3909 Evt.

Run331516: e- 90 GeV  
Signal: 228138 Evt.  
Pedestal: 10926 Evt.

Run331512: e- 90 GeV  
Signal: 218519 Evt.  
Pedestal: 9462 Evt.

## Scan 1

Run331473: e- 70 GeV  
Signal: 208885 Evt.  
Pedestal: 38295 Evt.

Run331471: e- 70 GeV  
Signal: 10879 Evt.  
Pedestal: 1950 Evt.

Run331479: e- 90 GeV  
Signal: 85543 Evt.  
Pedestal: 4306 Evt.

Run331472: e- 70 GeV  
Signal: 189966 Evt.  
Pedestal: 37137 Evt.

Run331478: 90 e- GeV  
Signal: 65249 Evt.  
Pedestal: 3602 Evt.

## Scan 2

Run331488: e- 90 GeV  
Signal: 213369 Evt.  
Pedestal: 13719 Evt.

Run331480: e- 90 GeV  
Signal: 85188 Evt.  
Pedestal: 4678 Evt.

Run331491: e- 90 GeV  
Signal: 217711 Evt.  
Pedestal: 11053 Evt.

Run331486: e- 90 GeV  
Signal: 129778 Evt.  
Pedestal: 6146 Evt.

Run331492: e- 90 GeV  
Signal: 89435 Evt.  
Pedestal: 4254 Evt.

## On Run Selection and Observations

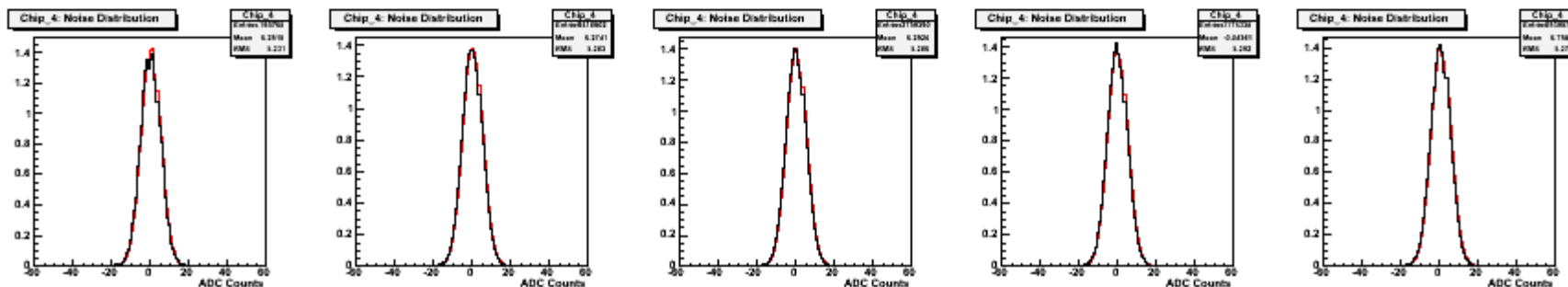
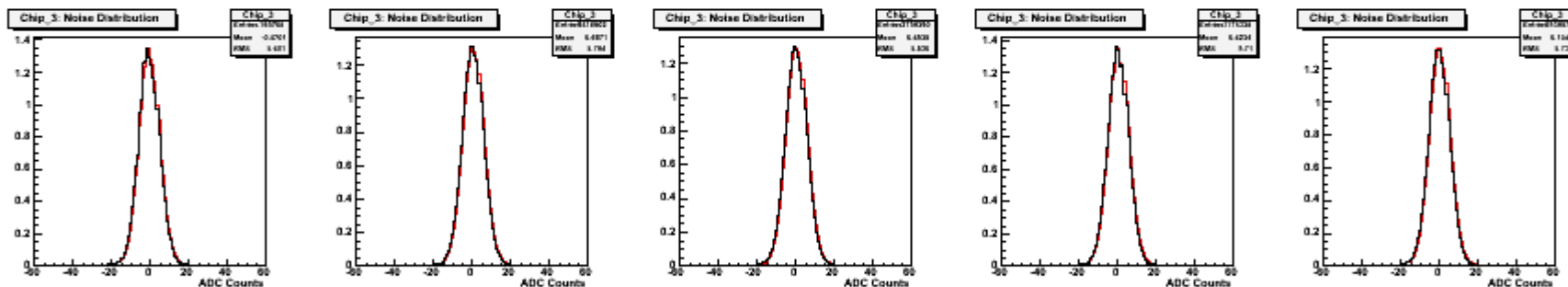
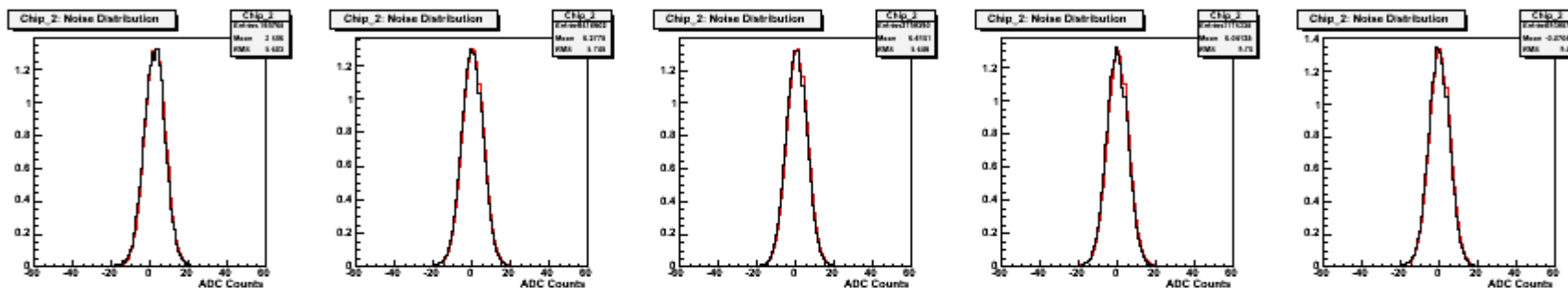
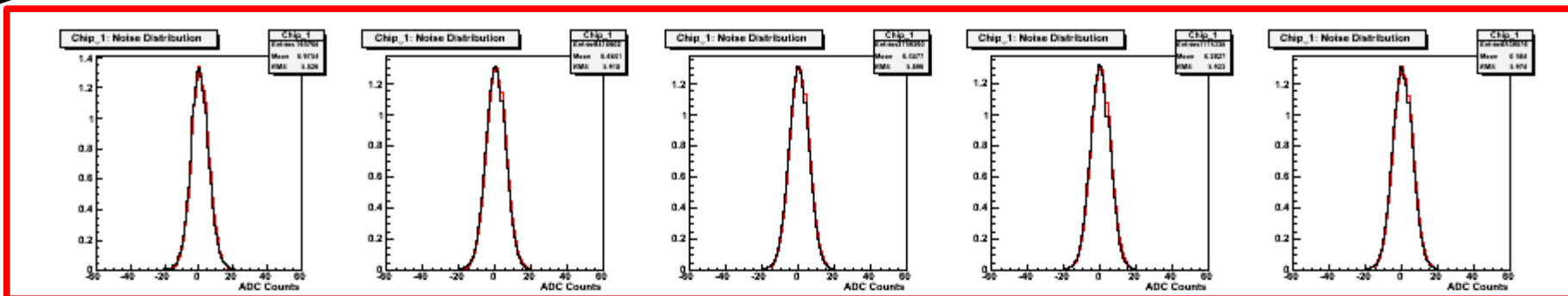
- Run Selected according to entries in the logbook  
No comments on bad quality by Shift Crew
- Switch of energy between Run 331473 and Run 331478
  - Change in Pedestal Rate  
20% of all events -> 5% of all events  
Still at least 3500 of (valuable) pedestal events
- at least 70 at each point
  - ... but Run 331471 poor statistics 10k (can be increased by using 331470)  
very first scanning point
  - mostly 90 kEvents for off center runs
  - > 200k at (nominal) Chip Center

# Noise Spectra Scan 1

**Signal Events**  
**Pedestal Events**

Scan ID

C  
h  
i  
p  
I  
D

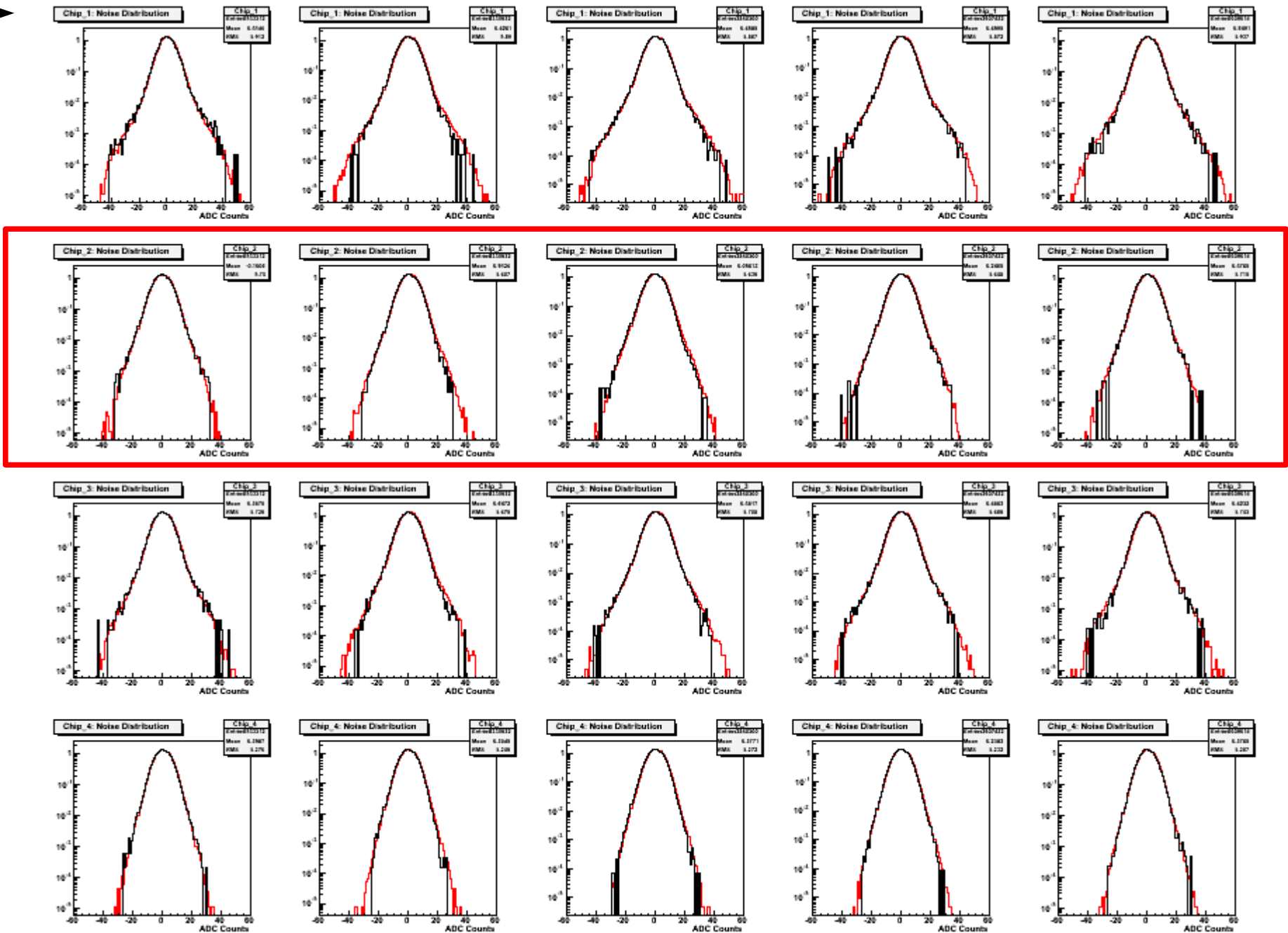




# Noise Spectra Scan 2

# Signal Events Pedestal Events

Scan ID  
Chip ID



## Discussion of Noise Spectra

Disclaimer will show only a selection of plots

- Full set of scan plots in Annex to talk
- First Order: No difference between signal and pedestal events visible
- Signal looks slightly shifted w.r.t pure Pedestal events  
Larger tails  
Number of Hits above MIP threshold  $O(10^{-5})$
- No obvious dependency on scan position
- Next step - Test “gaussianess” of a signal

Expectation: Pedestal events should lead to pure Gaussian noise distribution

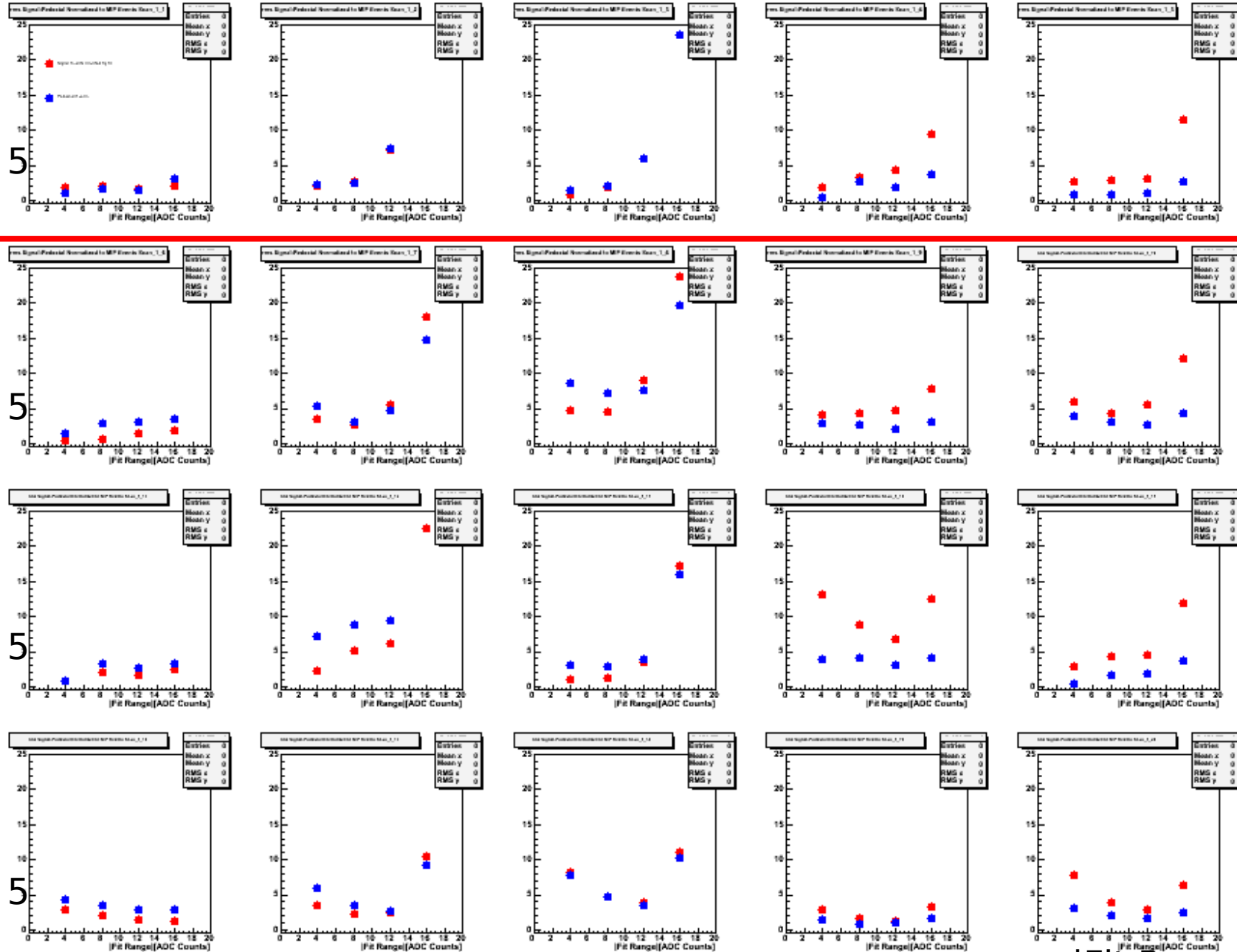
Method: Determine  $\chi^2/ndf$  for different fit ranges

Fit Ranges: (-4,4), (-8,8), (-12,12), (-16,16) ADC Counts

# "Gaussianness" in Scan 1

Signal/5 ADC Counts  
Pedestal

$\chi^2/\text{ndf}$

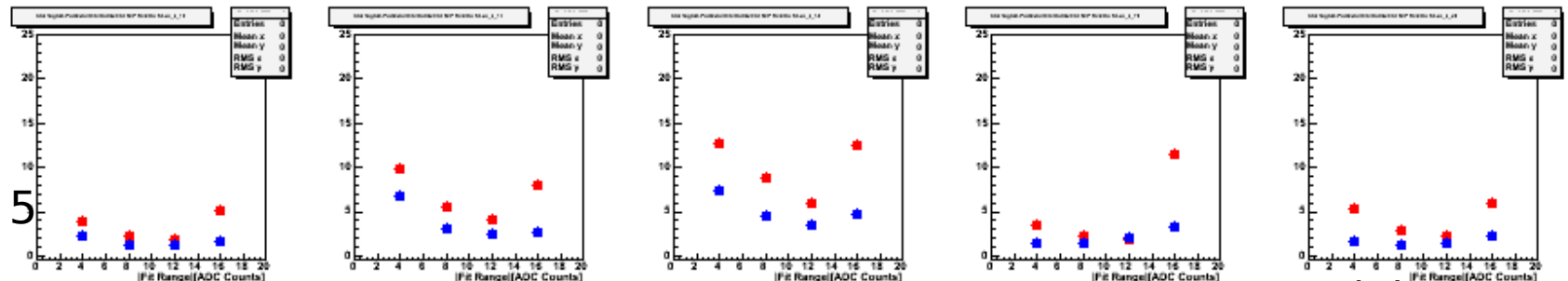
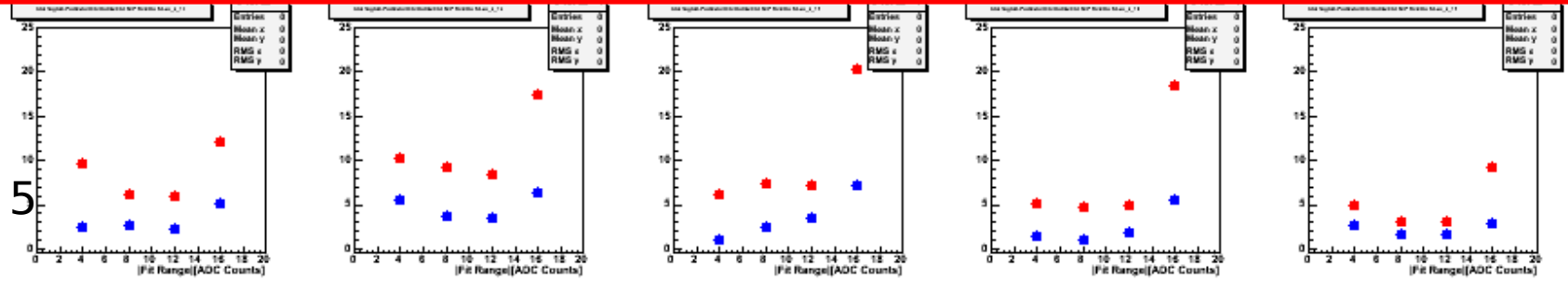
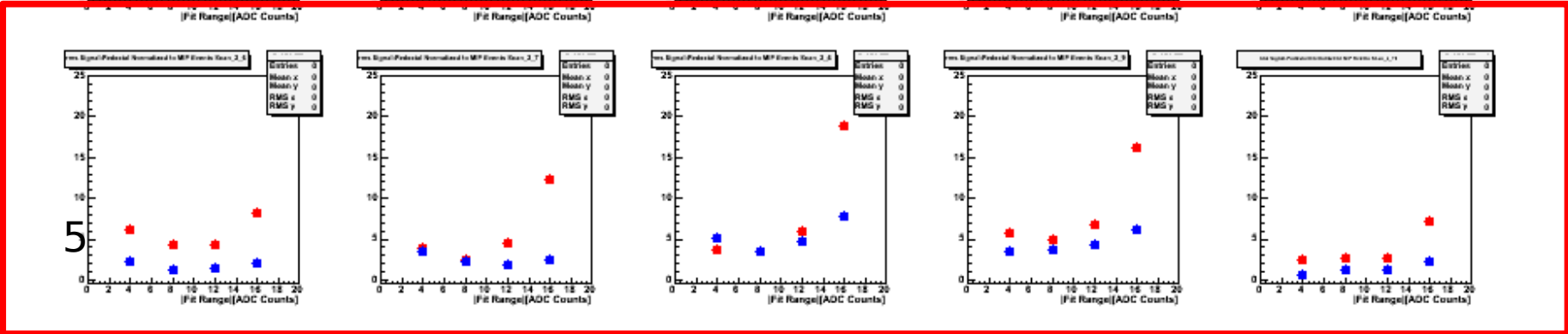
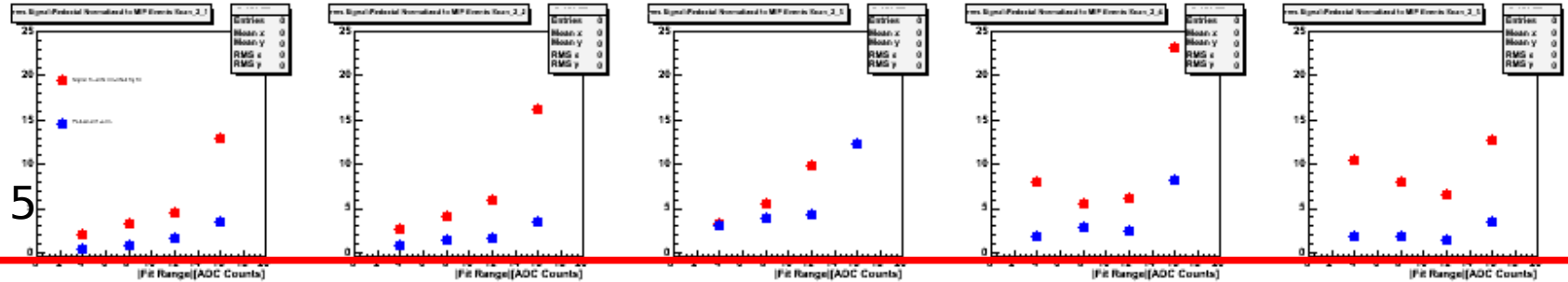


[Fit Range]

# "Gaussianness" in Scan 2

Signal/5 ADC Counts  
Pedestal

$\chi^2/\text{ndf}$

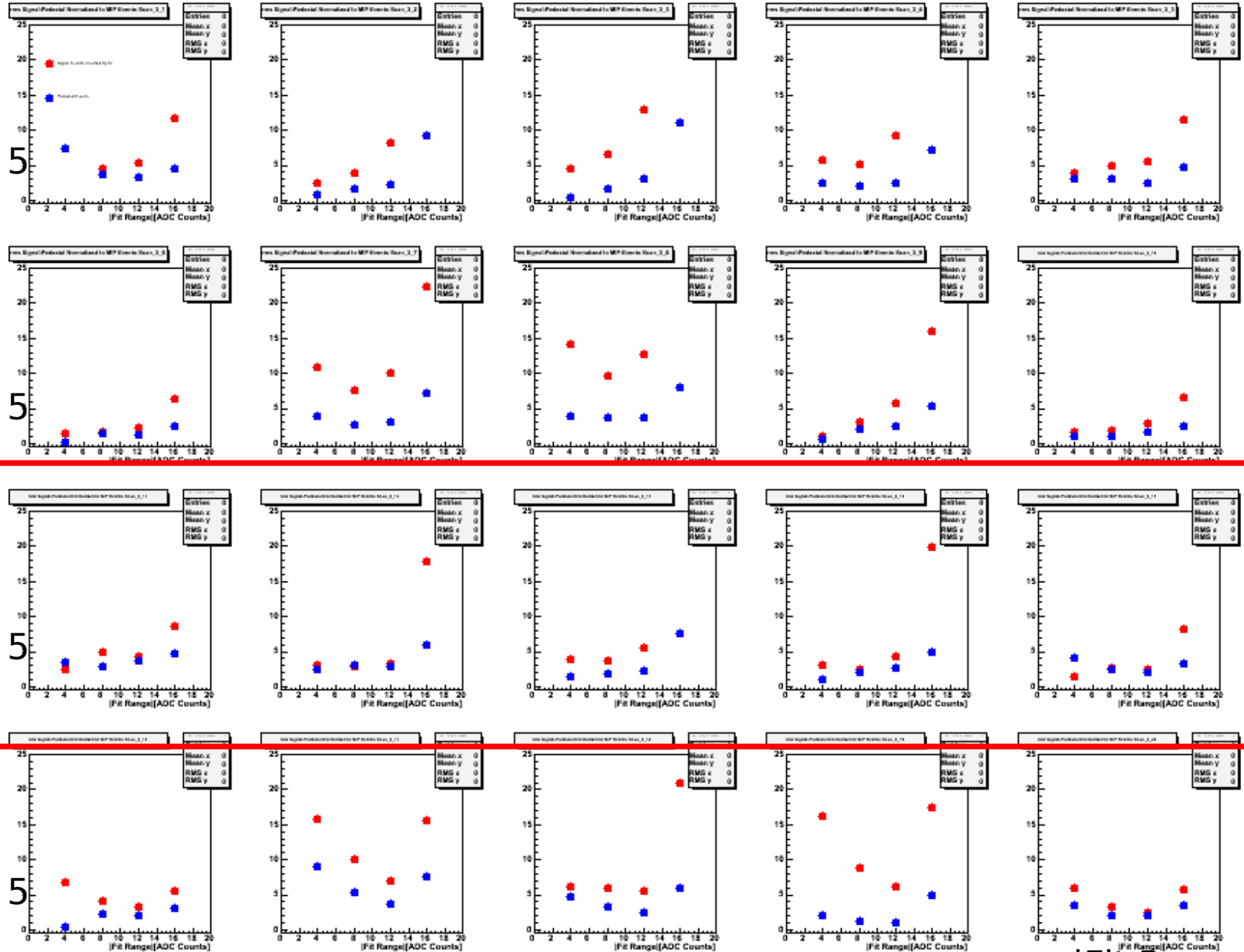


[Fit Range]

# "Gaussianness" in Scan 3

Signal/5 ADC Counts  
Pedestal

$\chi^2/\text{ndf}$

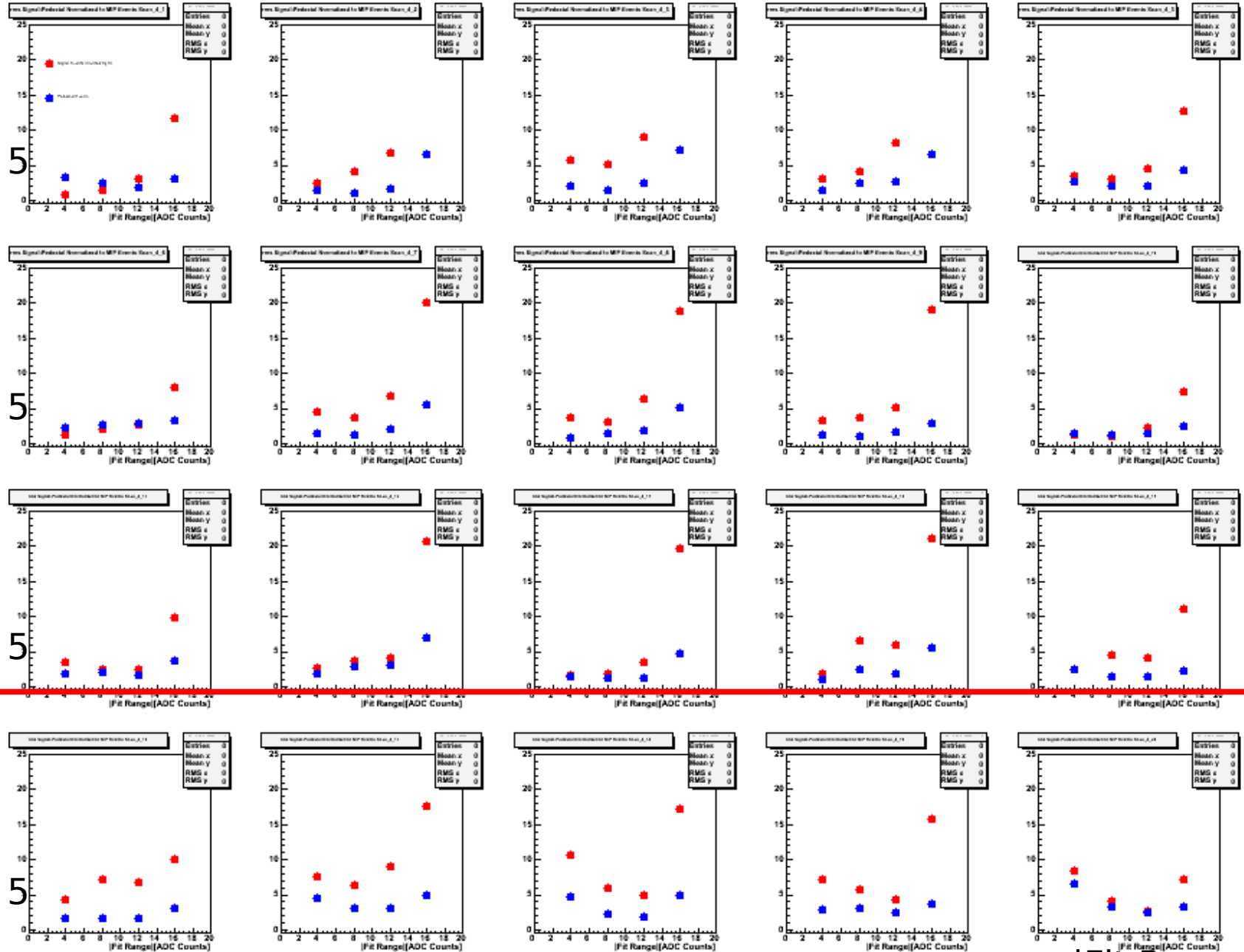


[Fit Range]

# "Gaussianness" in Scan 4

Signal/5 ADC Counts  
Pedestal

$\chi^2/\text{ndf}$



[Fit Range] 20



## Discussion of Gaussian Behaviour of Noise Spectra

- Clear tendency observed

Noise spectra in Layer 12 much less gaussian in Signal Events than in Pedestal events

Average  $\chi^2/\text{ndf}$  in Pedestal events  $\sim 3$

Remember  $\chi^2/\text{ndf}$  for Signal Events has been divided by 5

But ... no dependency on scan position visible!!!

- Chips are obviously sensitive to activity in detector when energy is deposited

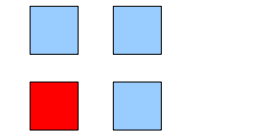
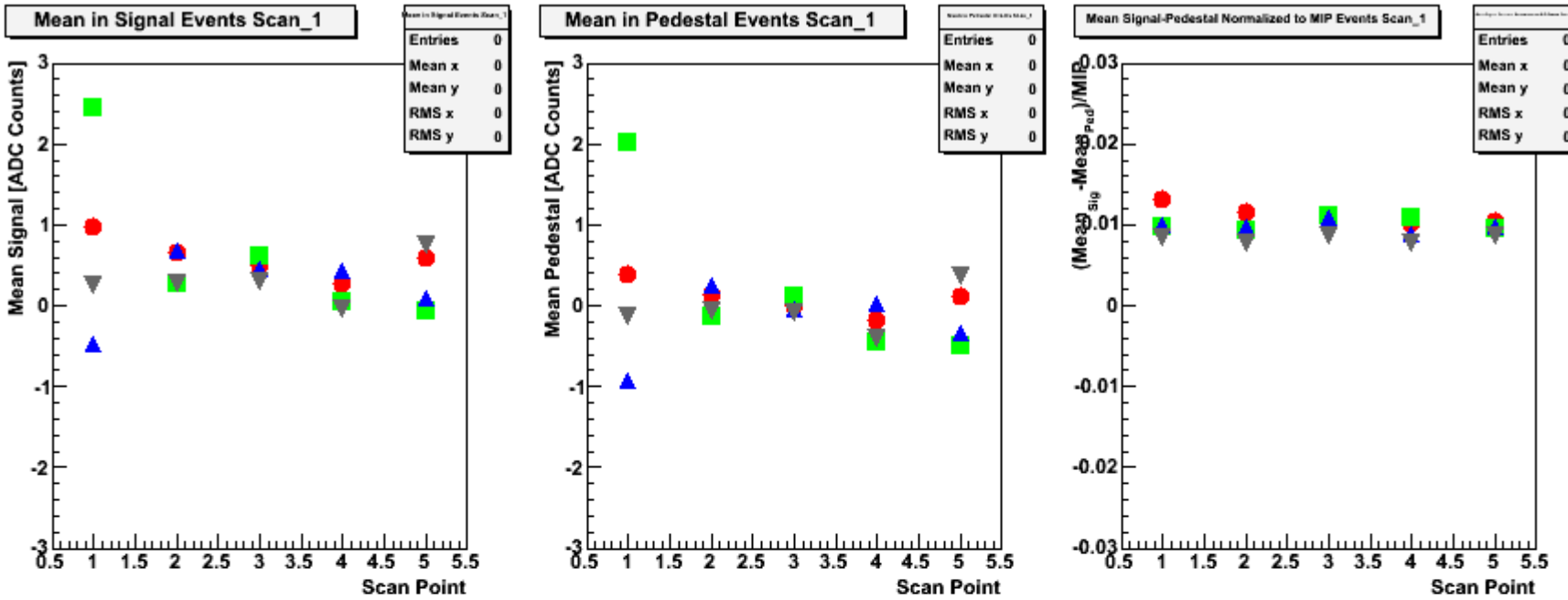
Small Insulation problem?

- Next step: Quantify global changes between signal and pedestal events

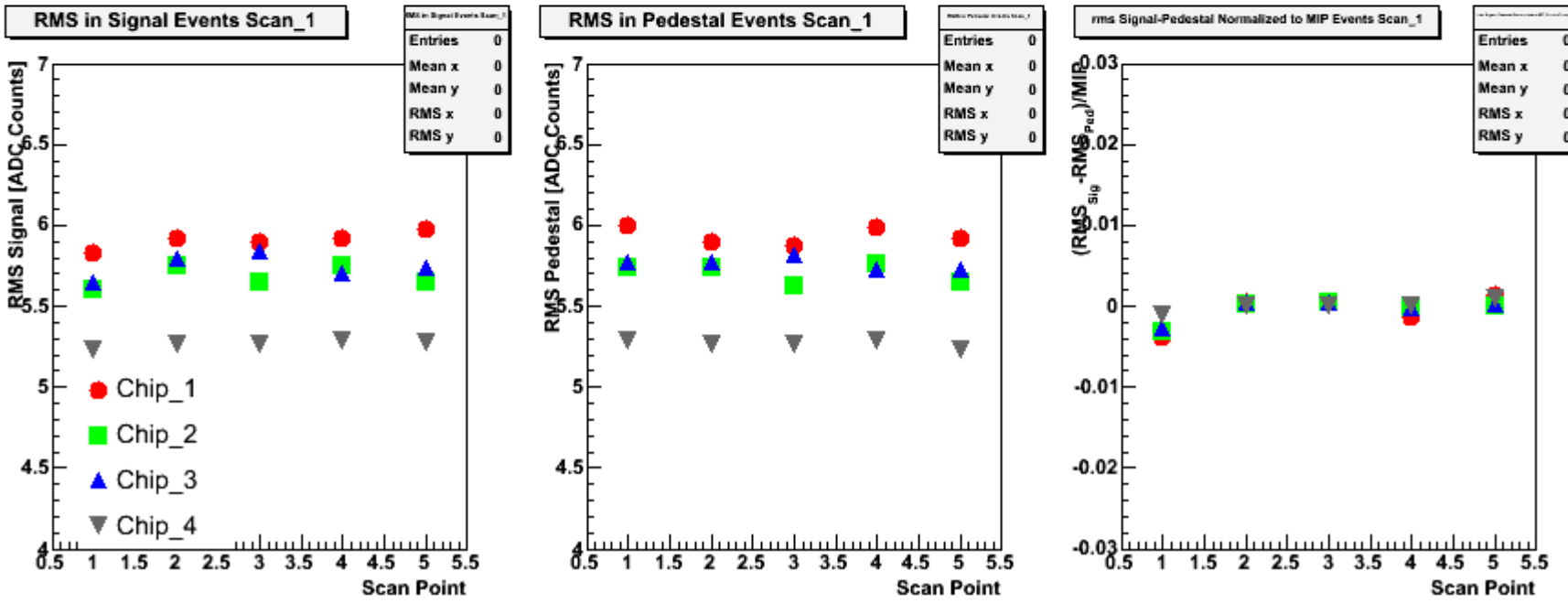
Back to mean and rms

as gaussian is maybe not a meaningful quantity

# Average Mean and RMS for Scan 1



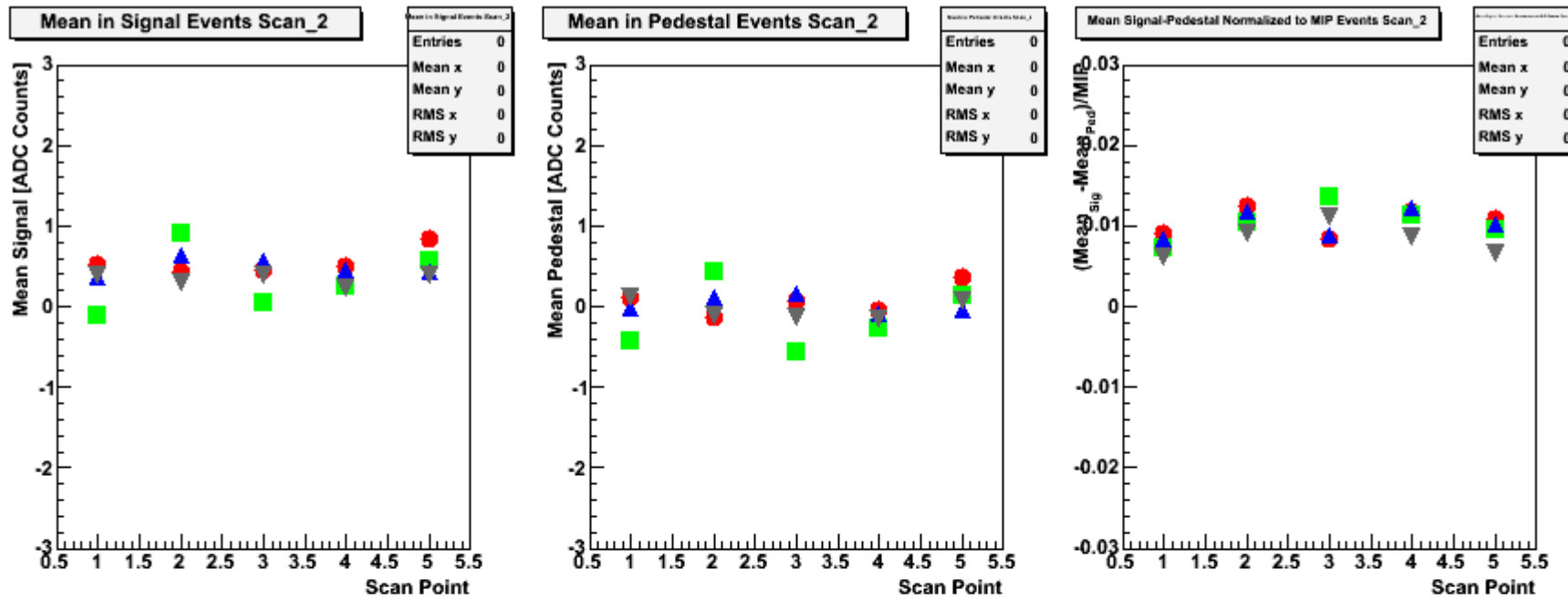
Difference normalized to MIP  
=>  
Global effect 1% of MIP



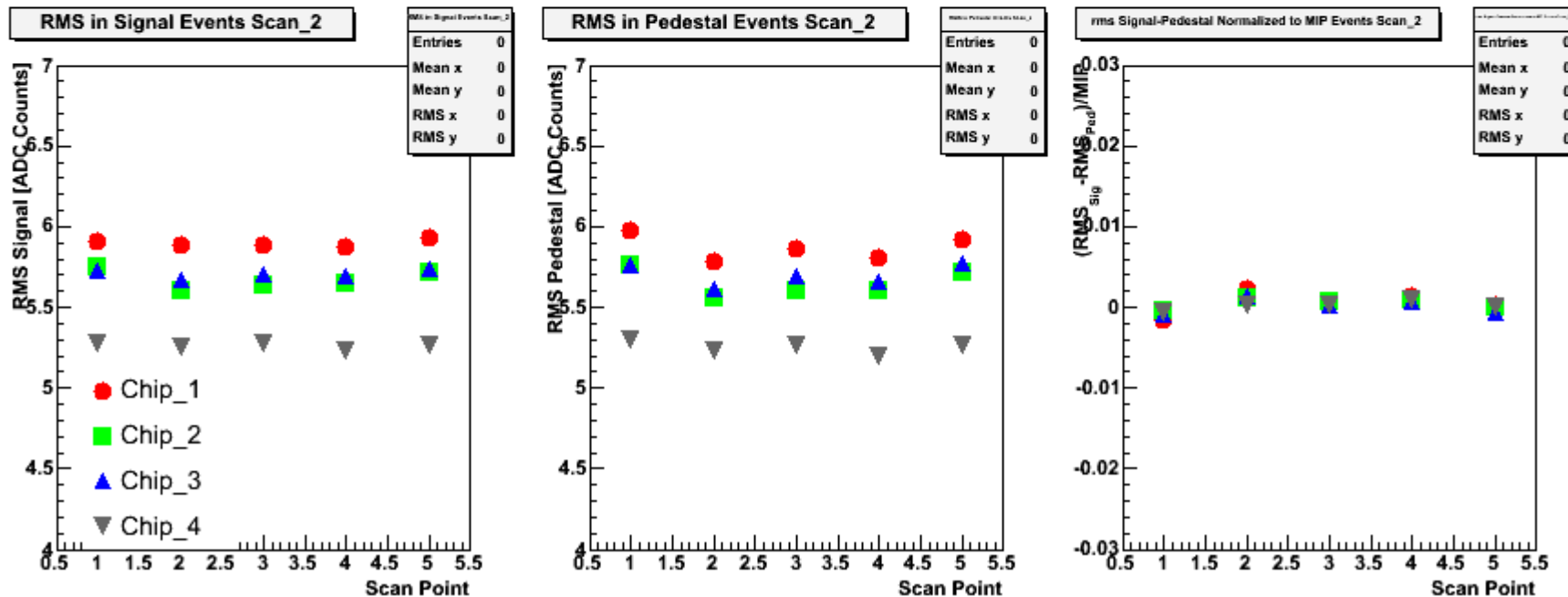
Difference normalized to MIP  
=>  
Global effect <0.5% of MIP

**No dependency on scan position visible**

# Average Mean and RMS for Scan 2

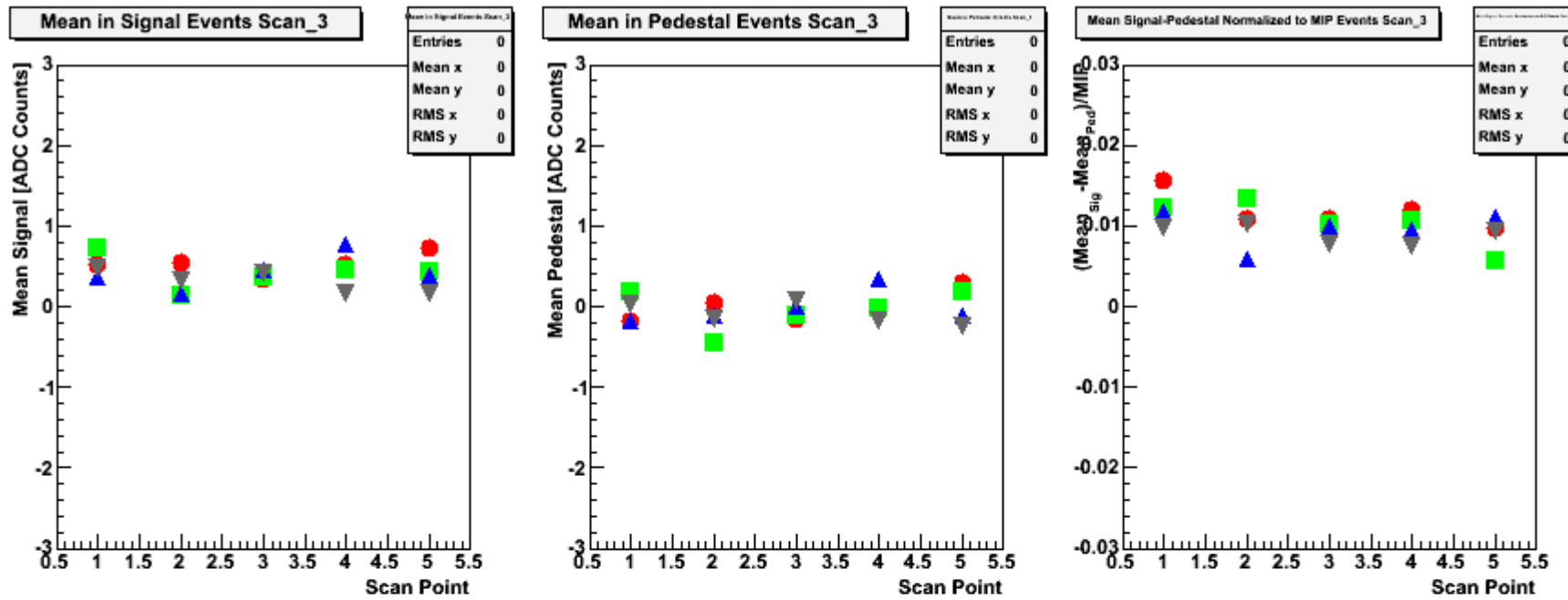


■ ■  
■ ■  
 Difference normalized to MIP  
 =>  
 Global effect  
 1% of MIP

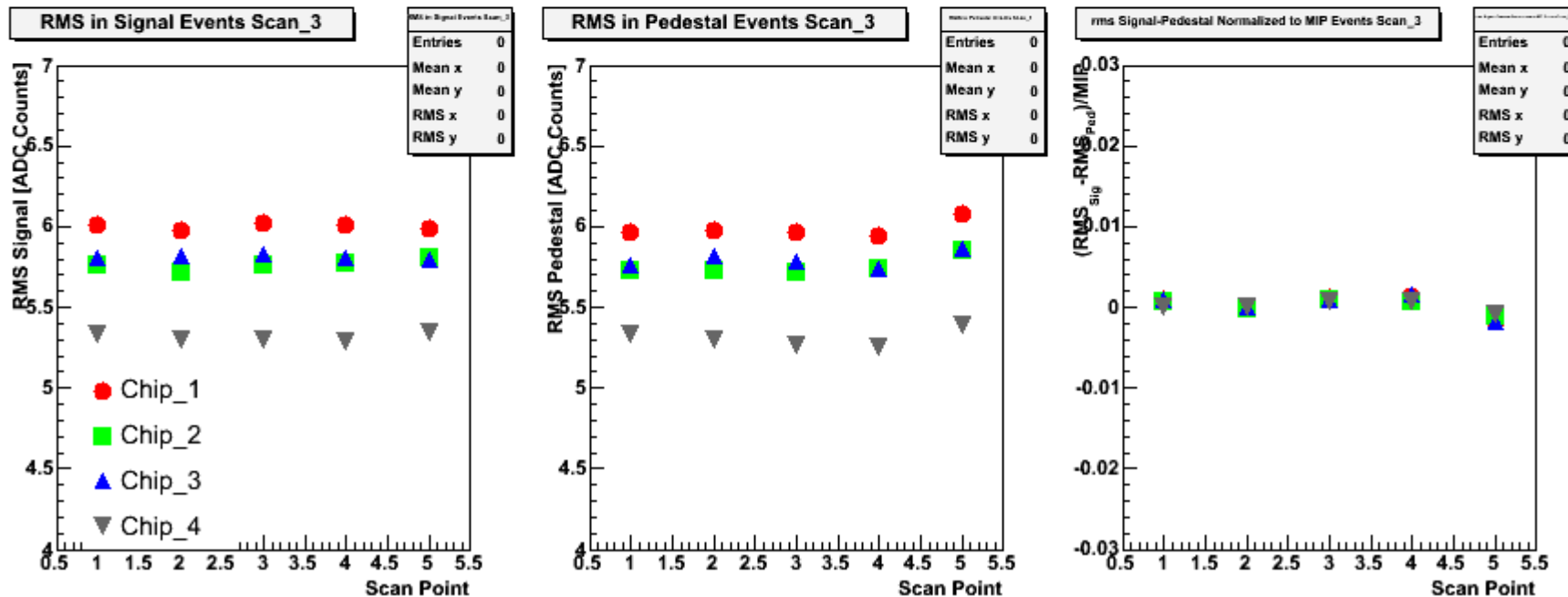


■ ■  
■ ■  
 Difference normalized to MIP  
 =>  
 Global effect  
 <0.5% of MIP

# Average Mean and RMS for Scan 3



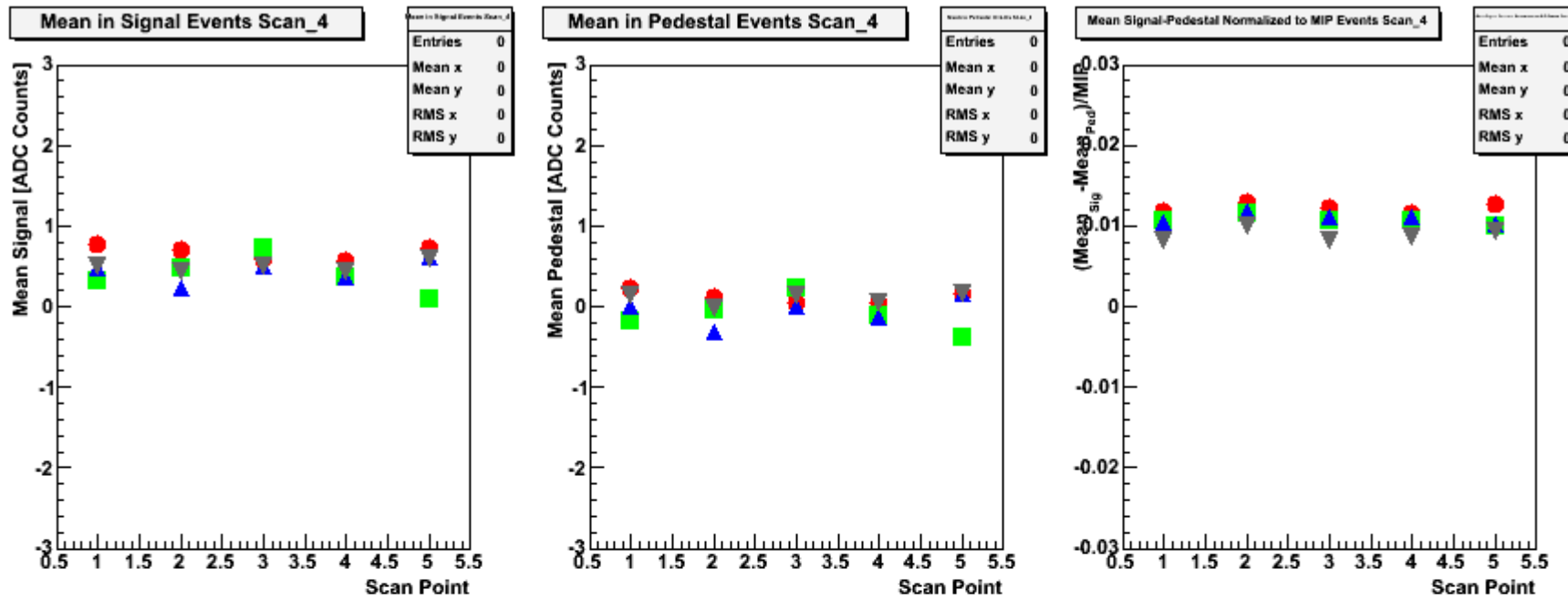
■ ■  
■ ■  
 Difference normalized to MIP  
 =>  
 Global effect 1% of MIP



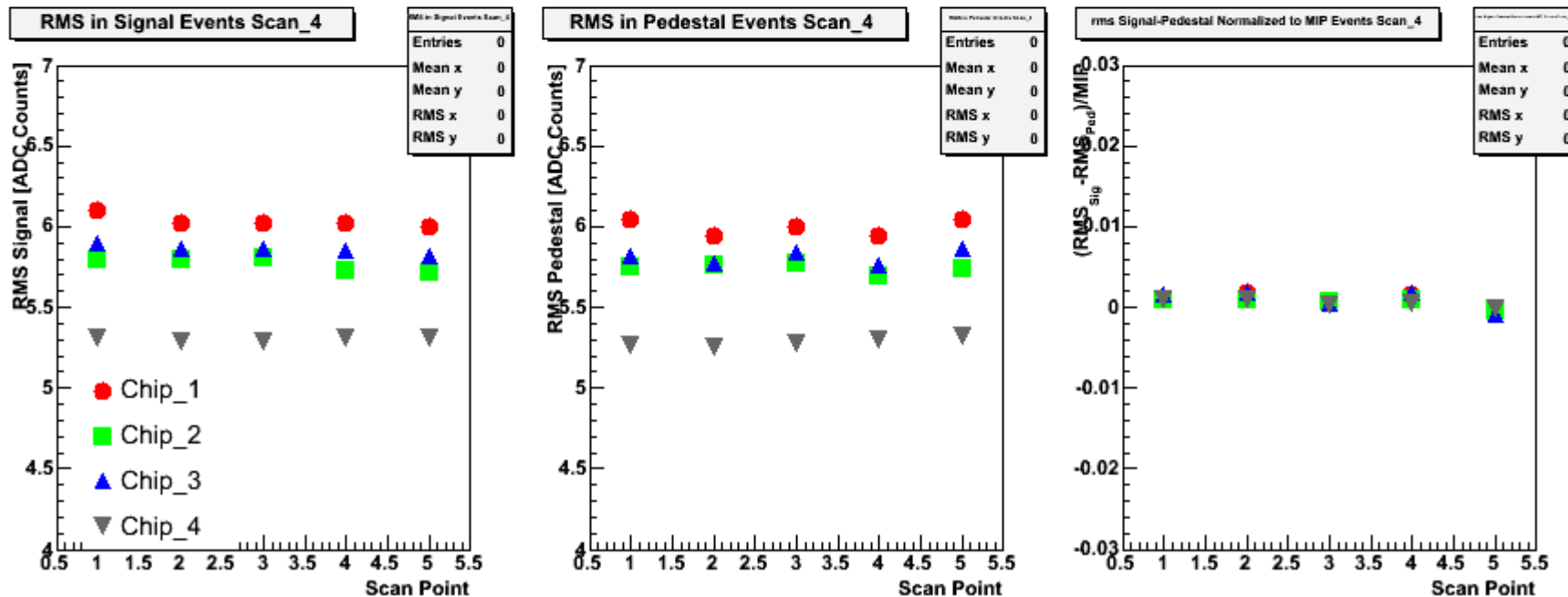
Difference normalized to MIP  
 =>  
 Global effect <0.5% of MIP

**No dependency on scan position visible**

# Average Mean and RMS for Scan 4



■ ■  
■ ■  
 Difference normalized to MIP  
 =>  
 Global effect  
 1% of MIP



Difference normalized to MIP  
 =>  
 Global effect  
 <0.5% of MIP

## Summary, Conclusion and Outlook

- Analysis of PCB Irradiation test extended to (nearly) full statistics
- #Events beyond 1 MIP appear at  $O(10^{-5})$

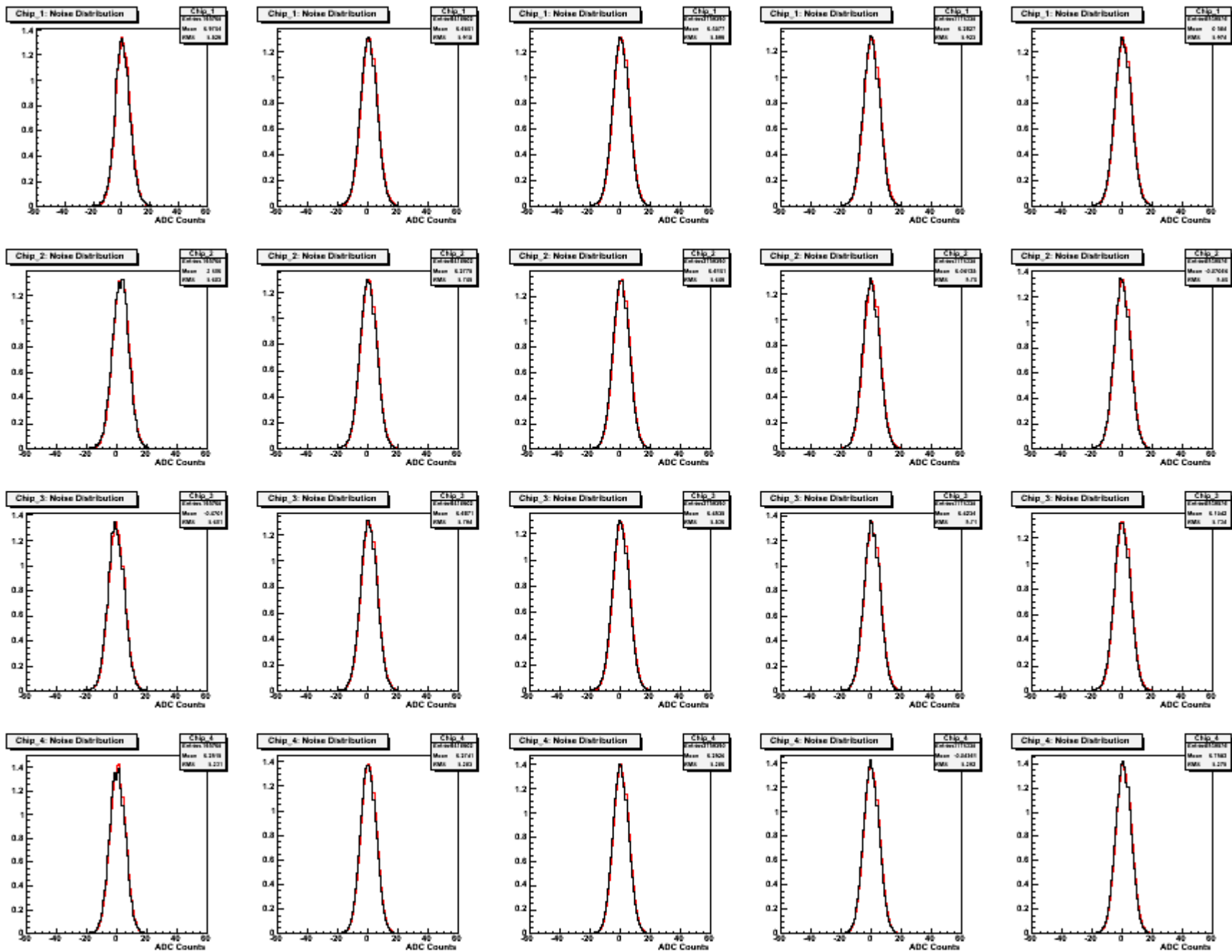
### **No evidence that shower particles create fake hits in detector**

- Energy deposit in detector distorts the gaussian noise spectrum
  - Small sensitivity to detector load, Floating currents etc.
  - Let usual noise very rarely fluctuate above MIP threshold (45 ADC Counts)
- Global effect of parasitic signals (wherever they come from) is  $O(1\%$  of a MIP) on the average signal and not measurable in the width i.e. rms of the detector noise  
(Which is also good news for all other SiW Ecal Analyses)
- **All observed effects seem to be independent of scan position**
- Plan to report presented results as contributed paper to TIPPO9
- Paper for NIM should be accompanied by a simulation study  
First ideas exchanged with Christoph

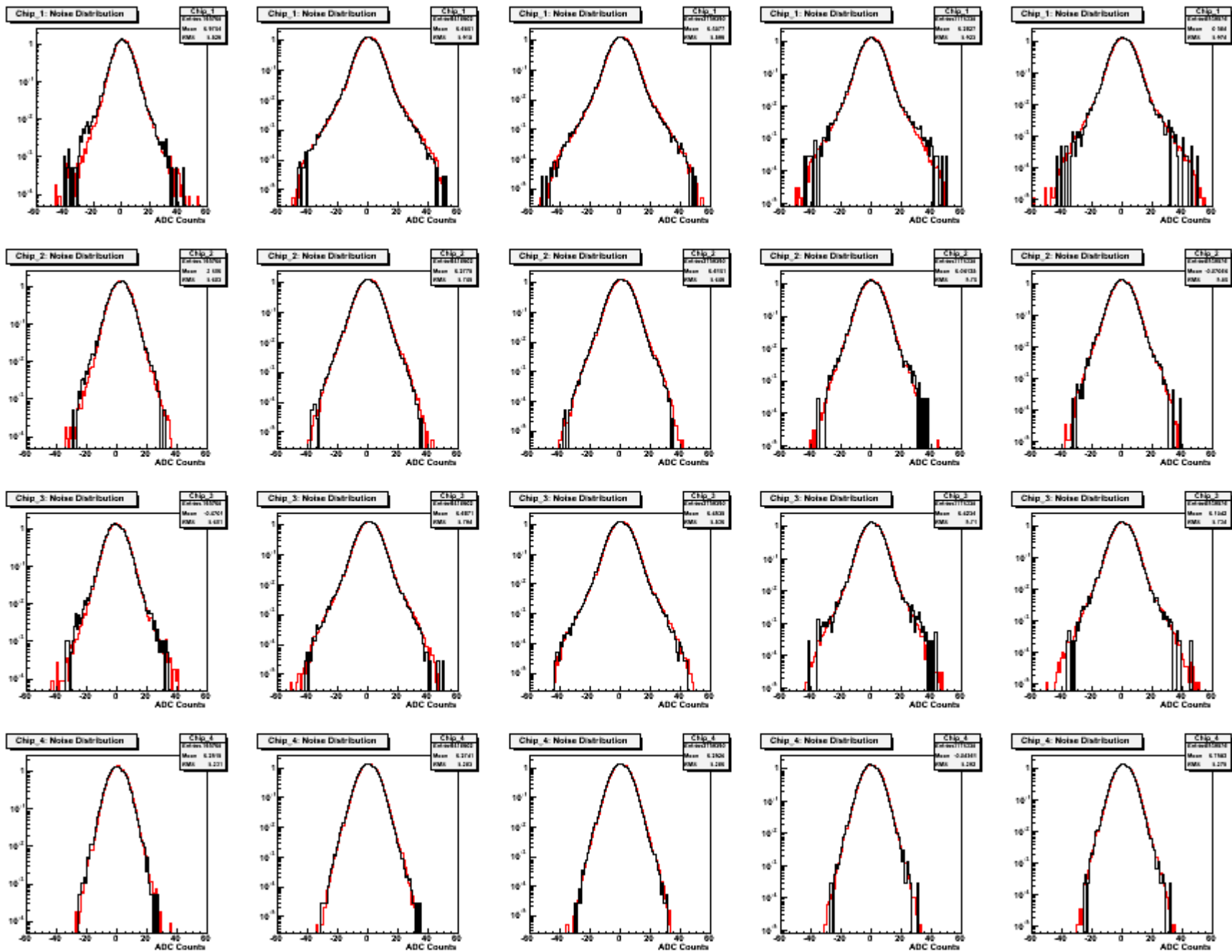


## Annex: Noise Spectra

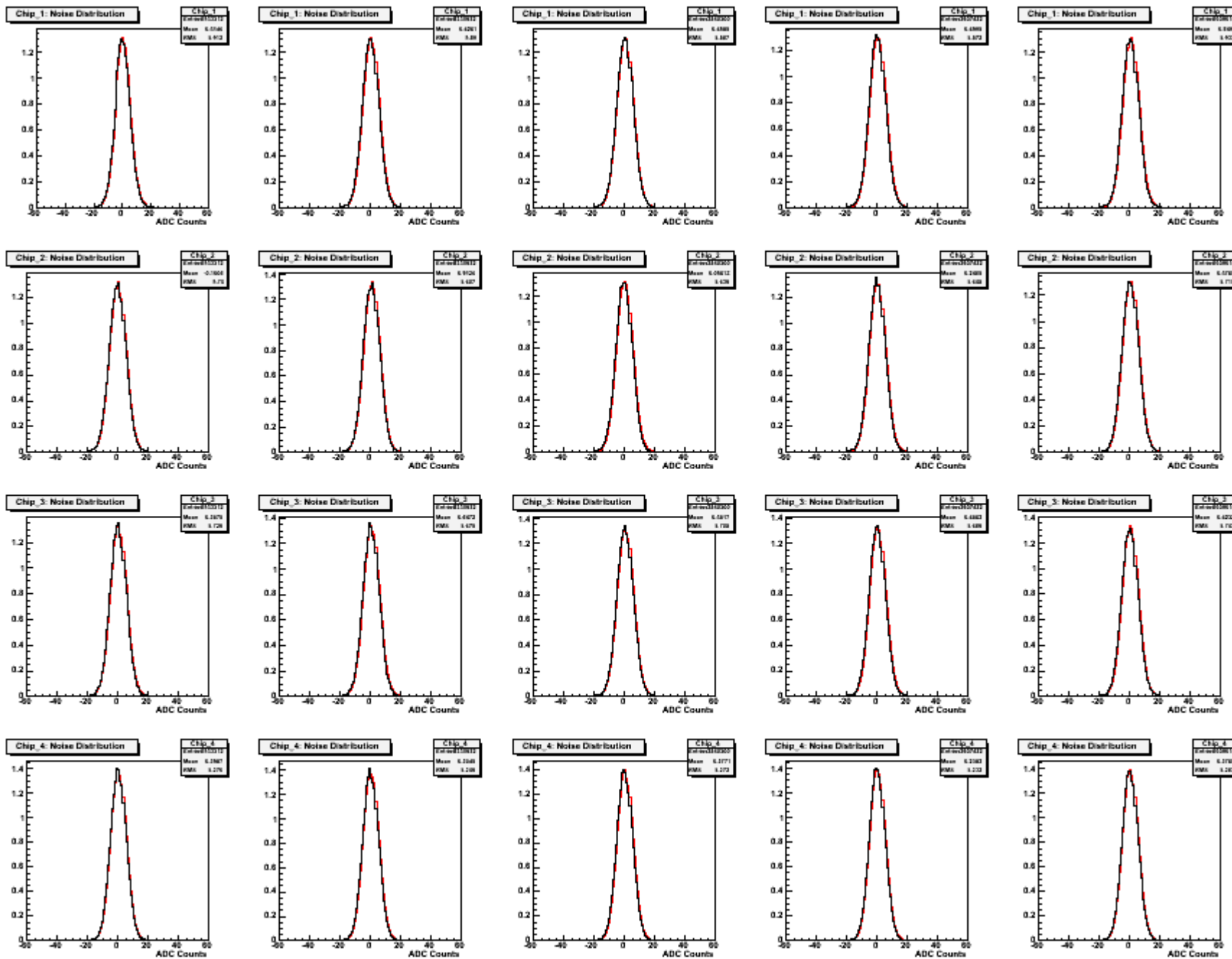
# Scan 1



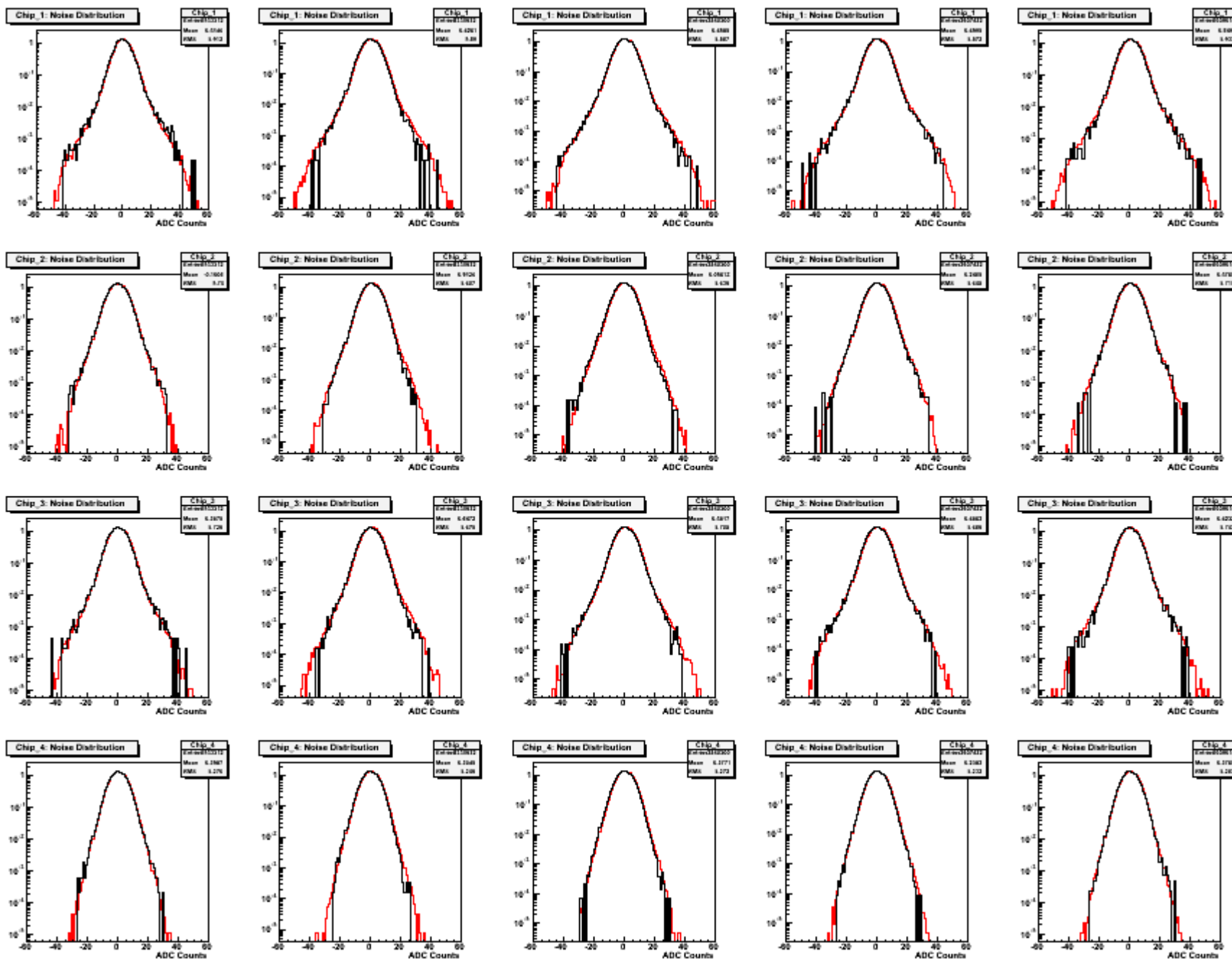
# Scan 1



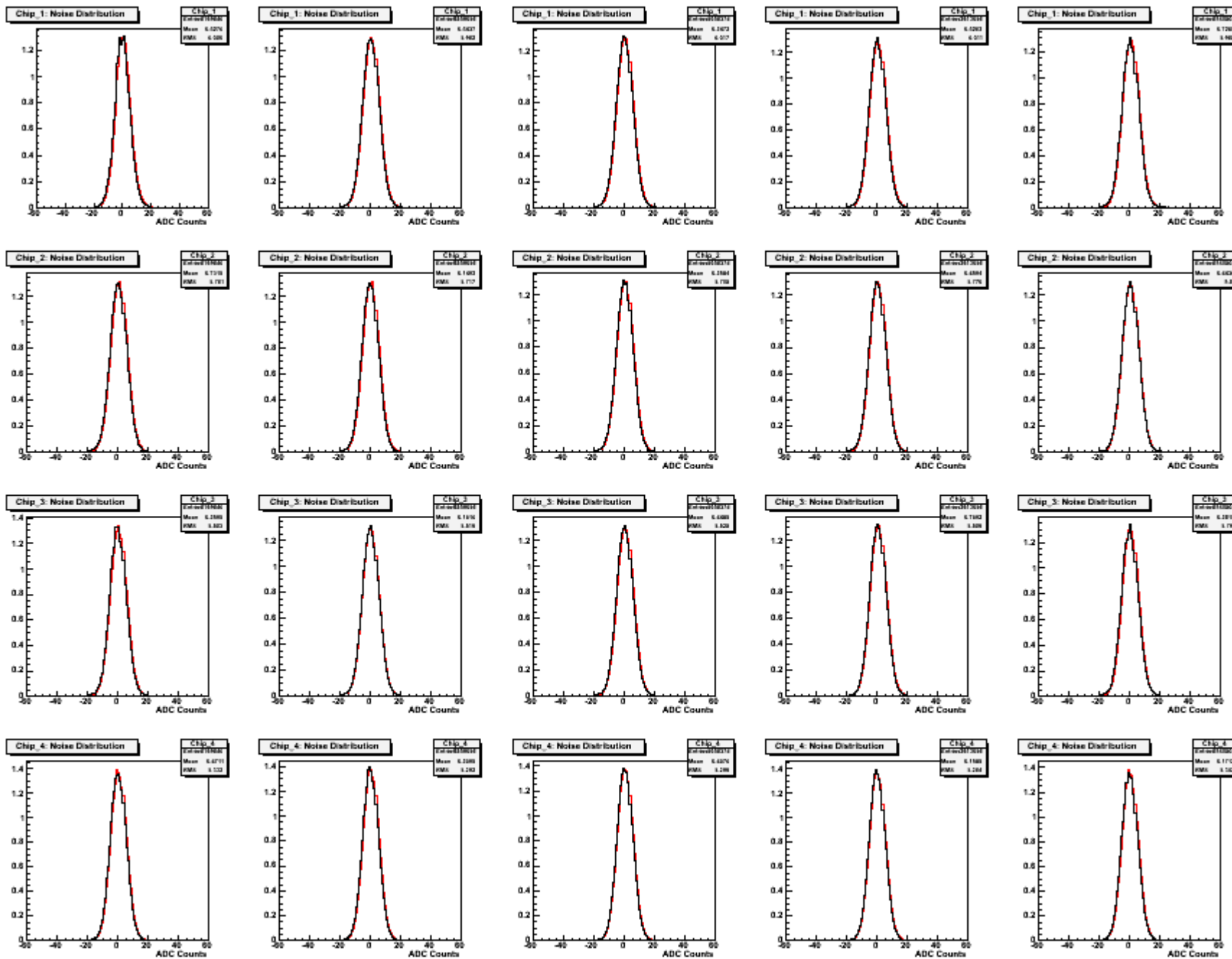
# Scan 2



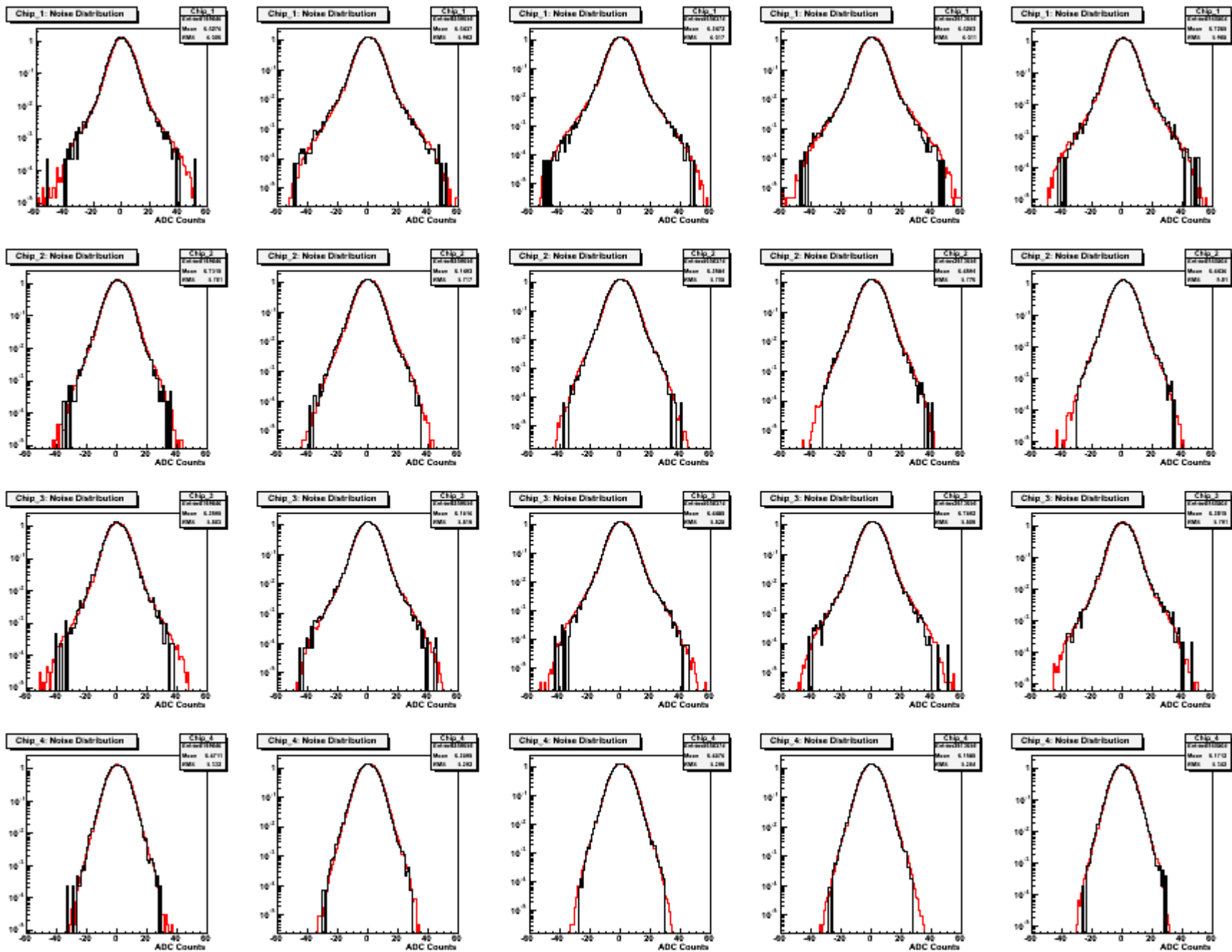
# Scan 2



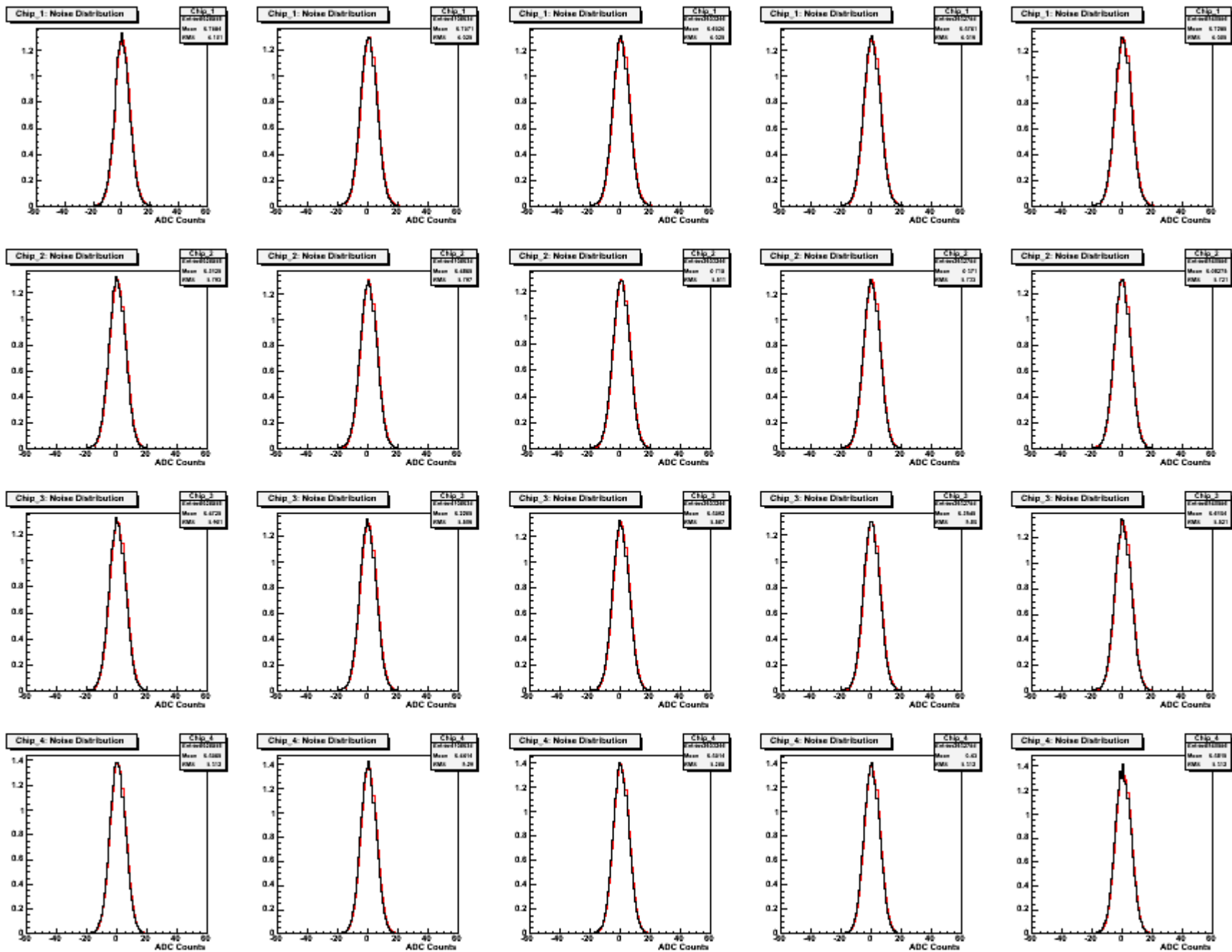
# Scan 3



# Scan 3



# Scan 4





# Scan 4

