

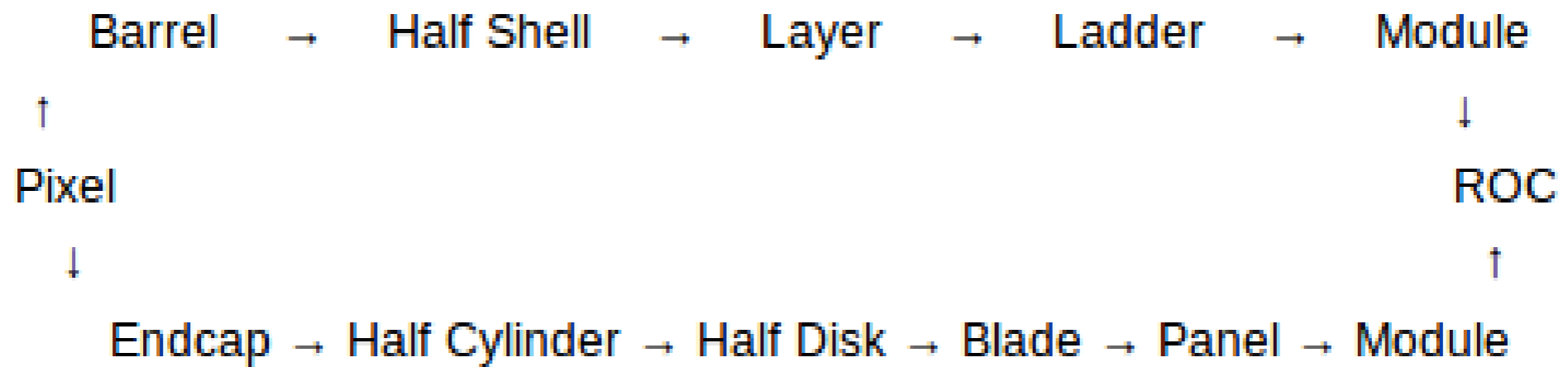
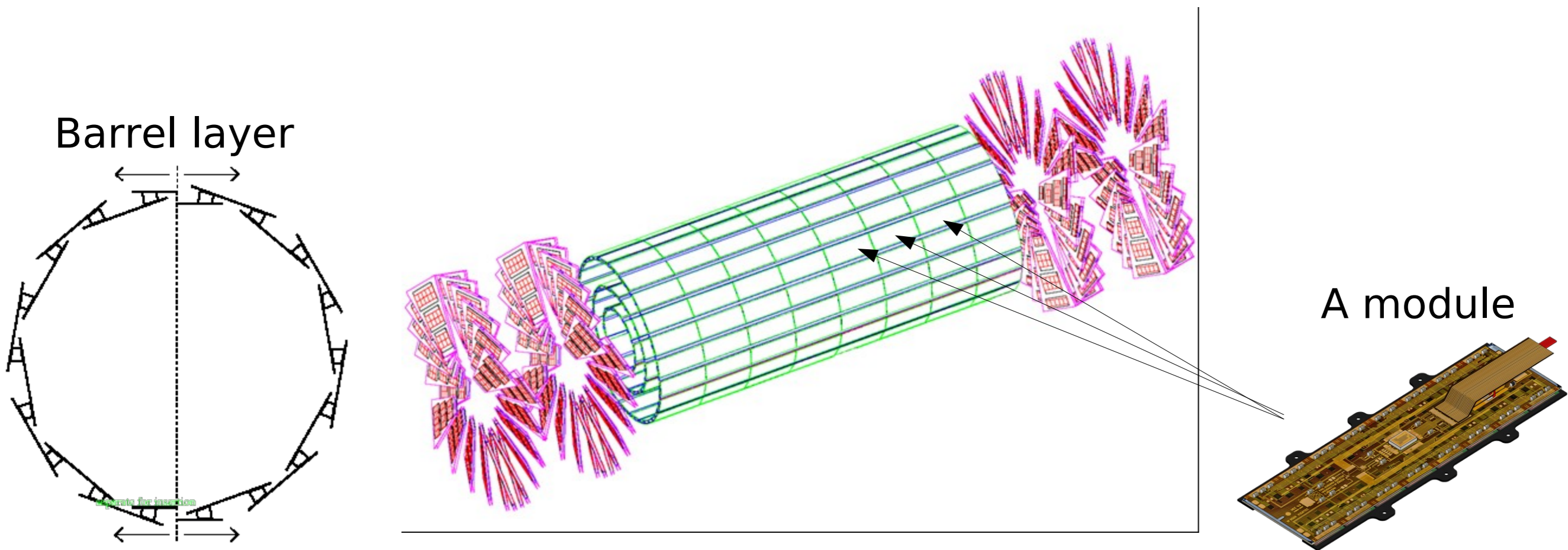


# Cluster charge distributions in Barrel Pixel Read Out Chips

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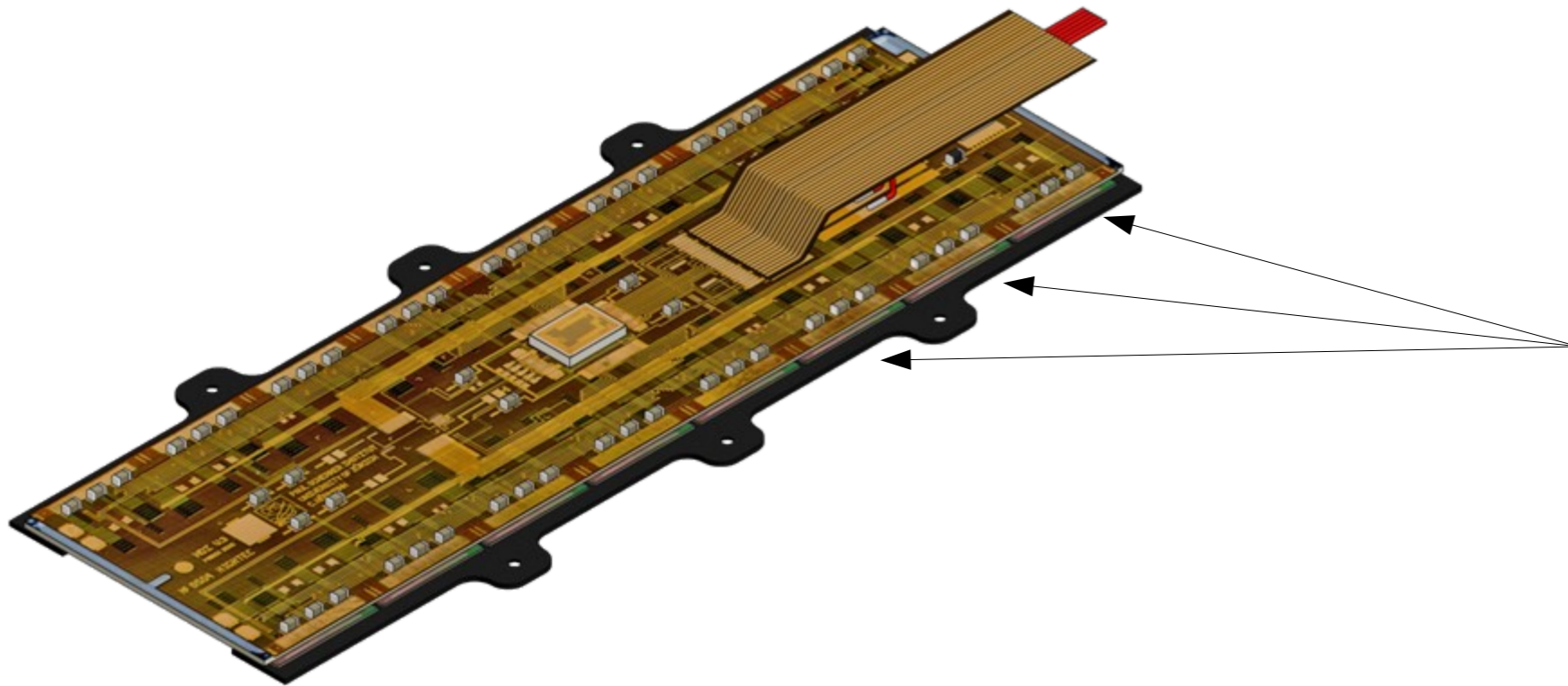
11 April 2011

# Pixel detector components

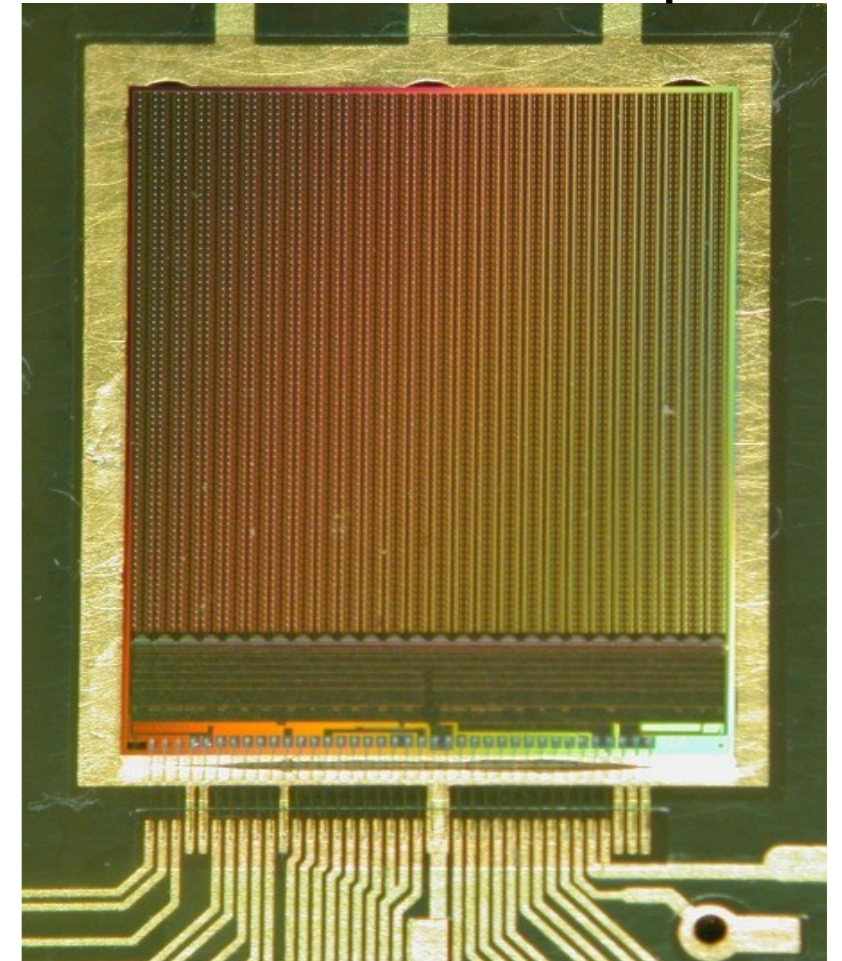


# Pixel detector components (Barrel)

A module with 2x8 ROCs



Read Out Chip



- A ladder consists of 8 modules along the Barrel.
- A module has either 8 or 16 readout chips (ROC) arranged in a  $1 \times 8$  (for half-ladders) or  $2 \times 8$  (for full-ladders) configuration.
- A readout chip (ROC) is an array of  $80 \times 52$  pixels, each of size  $100 \mu\text{m} \times 150 \mu\text{m}$ .

# Method

- Ionizing particle creates electron-whole pairs.
- Signal is converted and amplified by the ROCs.
- Hit clusters = overall collection of hit pixels.
- Select hit clusters associated to Reconstructed Trajectory Hits in the Barrel.
- Look at cluster charge distribution per Read Out Chip for these clusters.

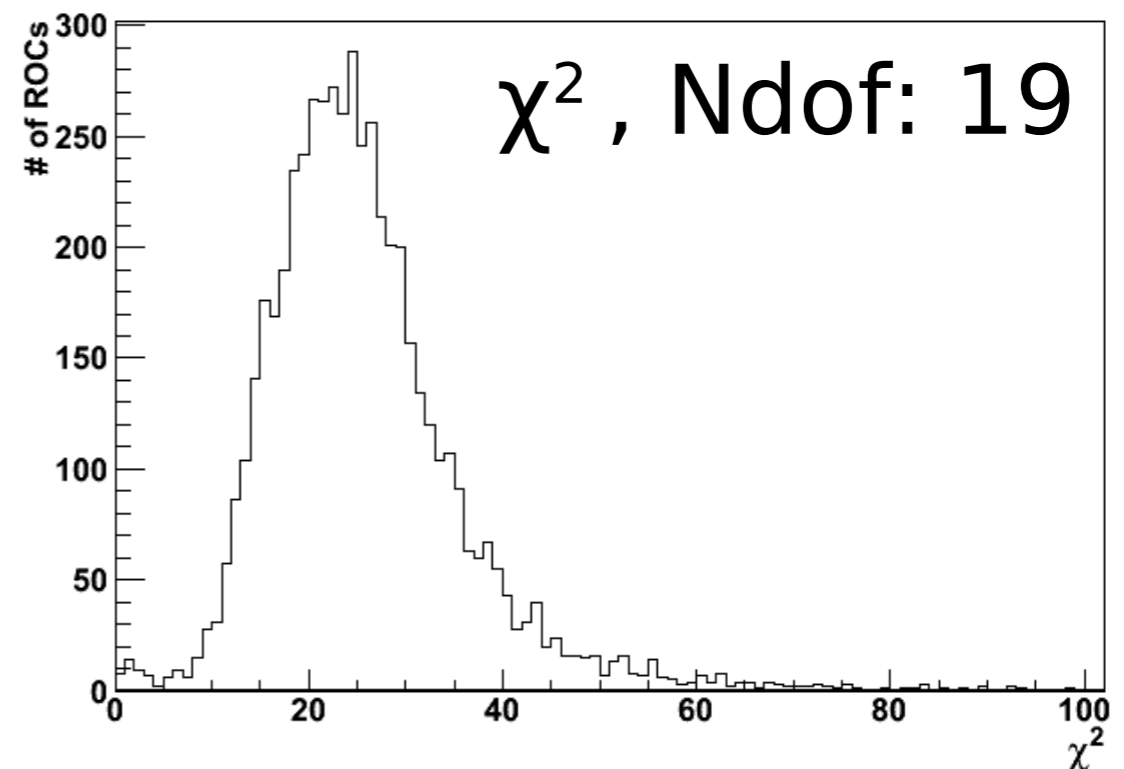
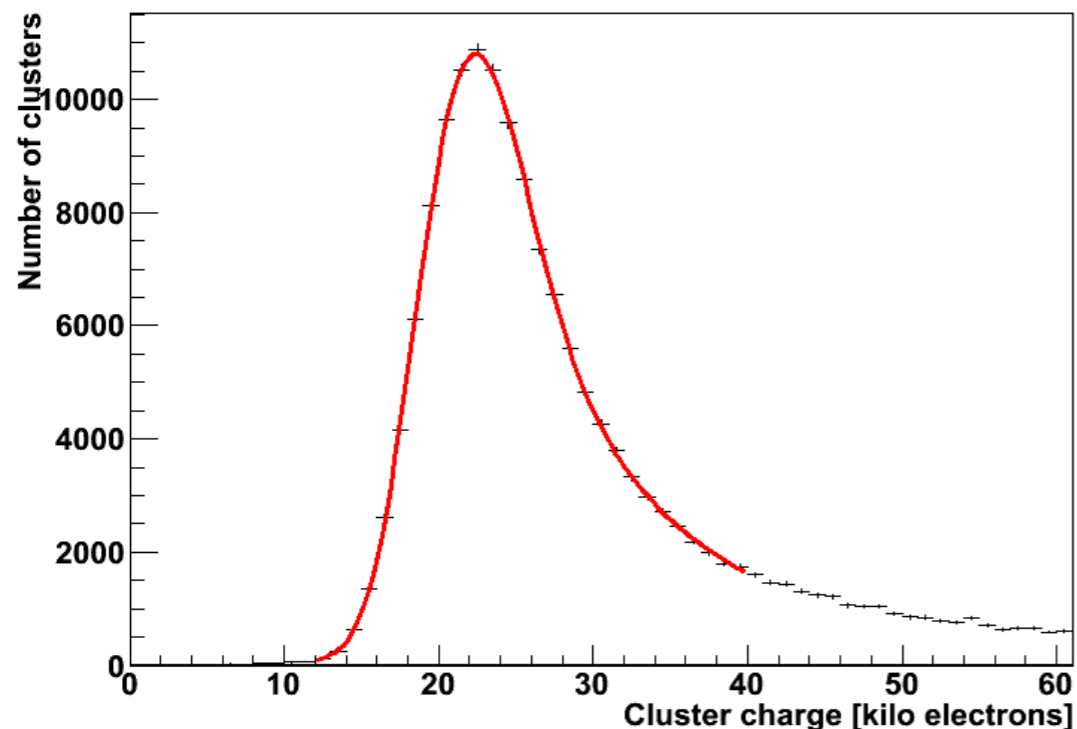
# Dataset

- Dataset:
  - /MinimumBias/Run2010B-Dec22ReReco
- CMSSW version:
  - CMSSW\_3\_8\_6
- Lumi selection from JSON files:
  - Cert\_136033-149442\_7TeV\_Dec22ReReco\_Collisions10\_JSON.txt



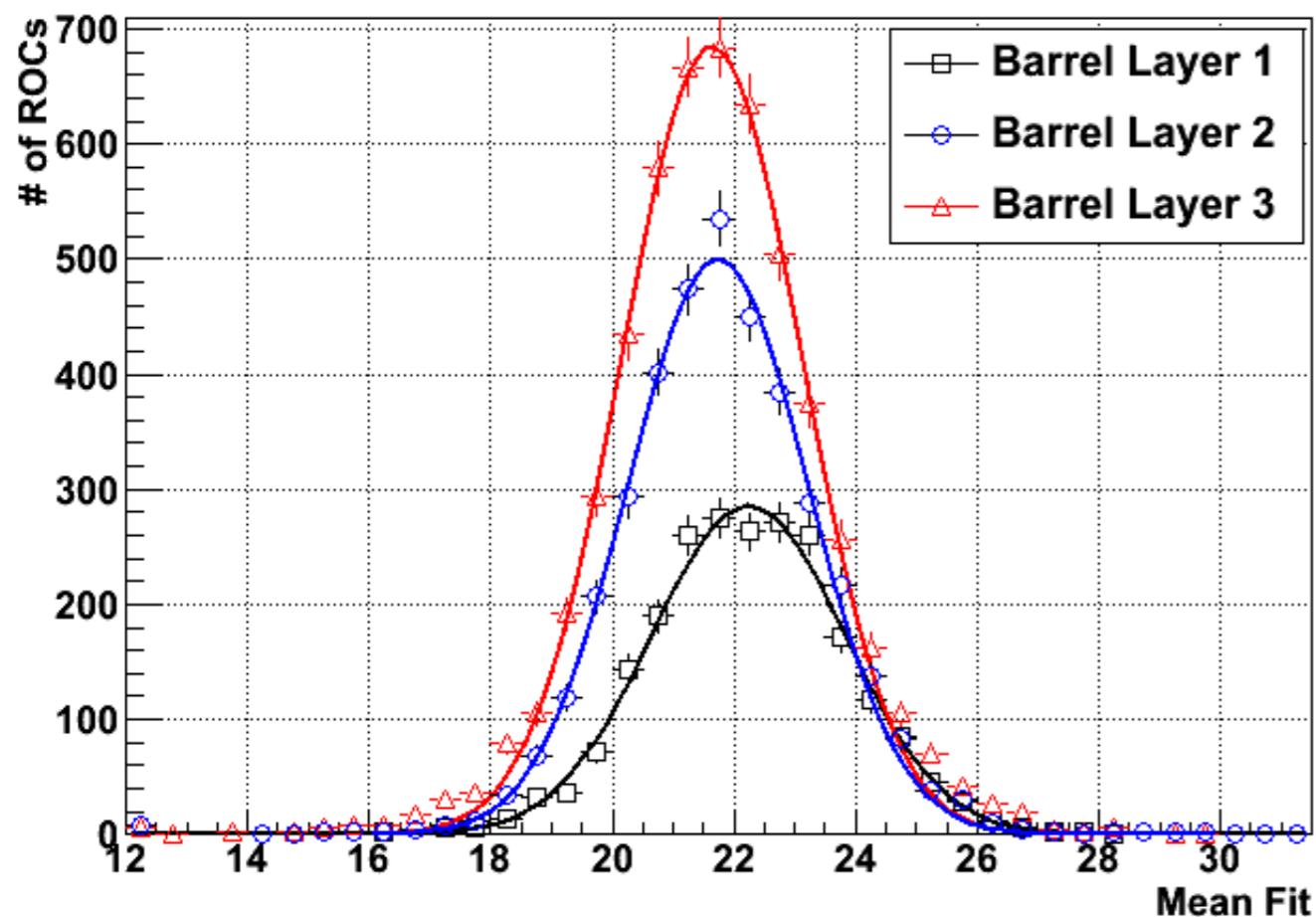
# Fitting per ROC

- Use normalized cluster charge, i.e. cluster charge corrected by the incident angle of the trajectory, so that all tracks appear to enter perpendicularly to the detector.
- The cluster charge distribution is a superposition of smeared Landau distributions.
- Fit with a Landau+Gaussian in two steps:
  - ➔ First: fit with L+G with some reasonable parameters/limits,
  - ➔ Second: constrain the mean of the Gaussian to be within  $\sim 1$  sigma of the Landau MPV fit and fit again.



# Fit results

- In general Gaussian behavior of the Mean fits of ROCs.
- Shift of the Mean average between the Layer 1 and Layer 2,3 is clearly visible in the average of the Mean.
- The width seems to be compatible between the Layers.



	$\sigma$	Mean
<b>L1</b>	1.59	22.2
<b>L2</b>	1.55	21.8
<b>L3</b>	1.64	21.7

	<b>1 <math>\sigma</math> int.</b>	<b>2 <math>\sigma</math> int.</b>	<b>3 <math>\sigma</math> int.</b>
<b>L1</b>	68.4%	94.7%	99.4%
<b>L2</b>	68.6%	94.3%	98.8%
<b>L3</b>	69.4%	93.2%	98.6%

# ROC quality

	<b>Good</b>	<b>OK</b>	<b>Bad</b>
<b><math>\sigma</math> interval</b>	1	2 - 3	> 3
<b><math>\chi^2</math> /Ndof</b>	$\leq 3$	3 - 10	>10
<b>Mean error</b>	< Mean	< Mean	> Mean

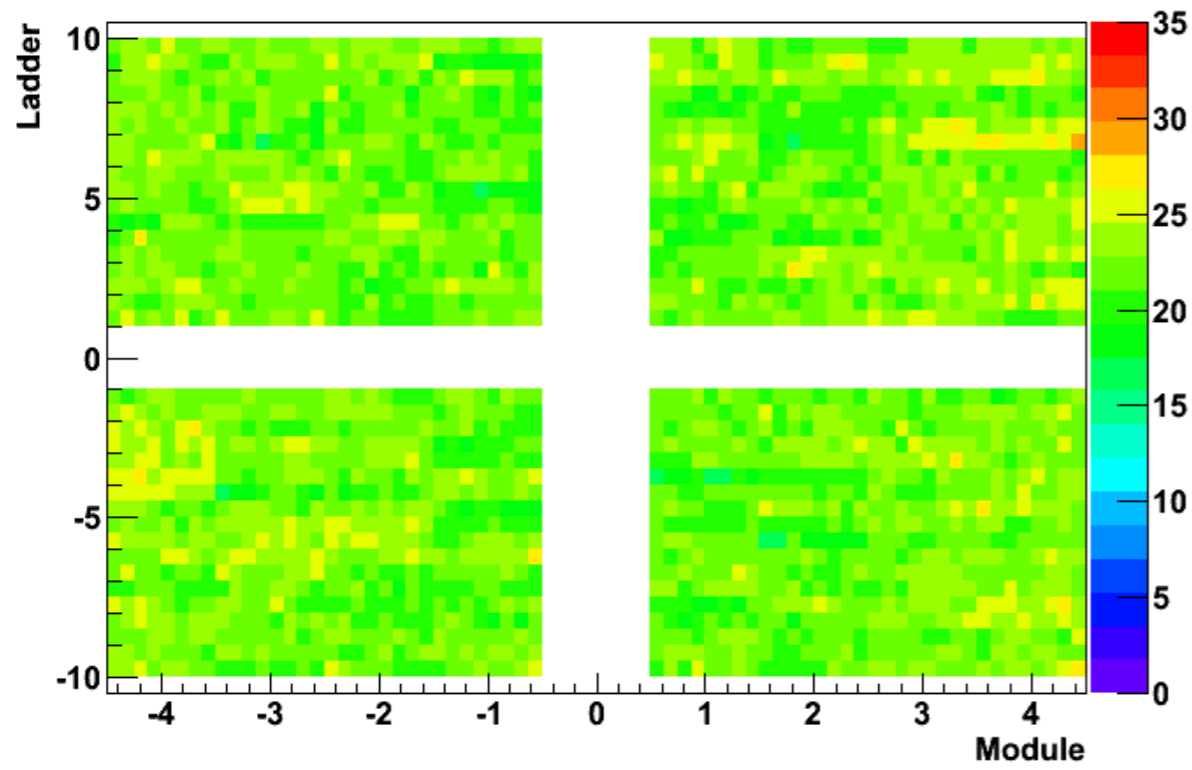
	<b>Good</b>	<b>OK</b>	<b>Bad</b>
<b>L1</b>	96.6%	2.9%	0.5%
<b>L2</b>	97.4%	1.4%	1.2%
<b>L3</b>	97.9%	0.4%	1.7%
<b>All</b>	97.3%	1.6%	1.1%

## Bad ROCs

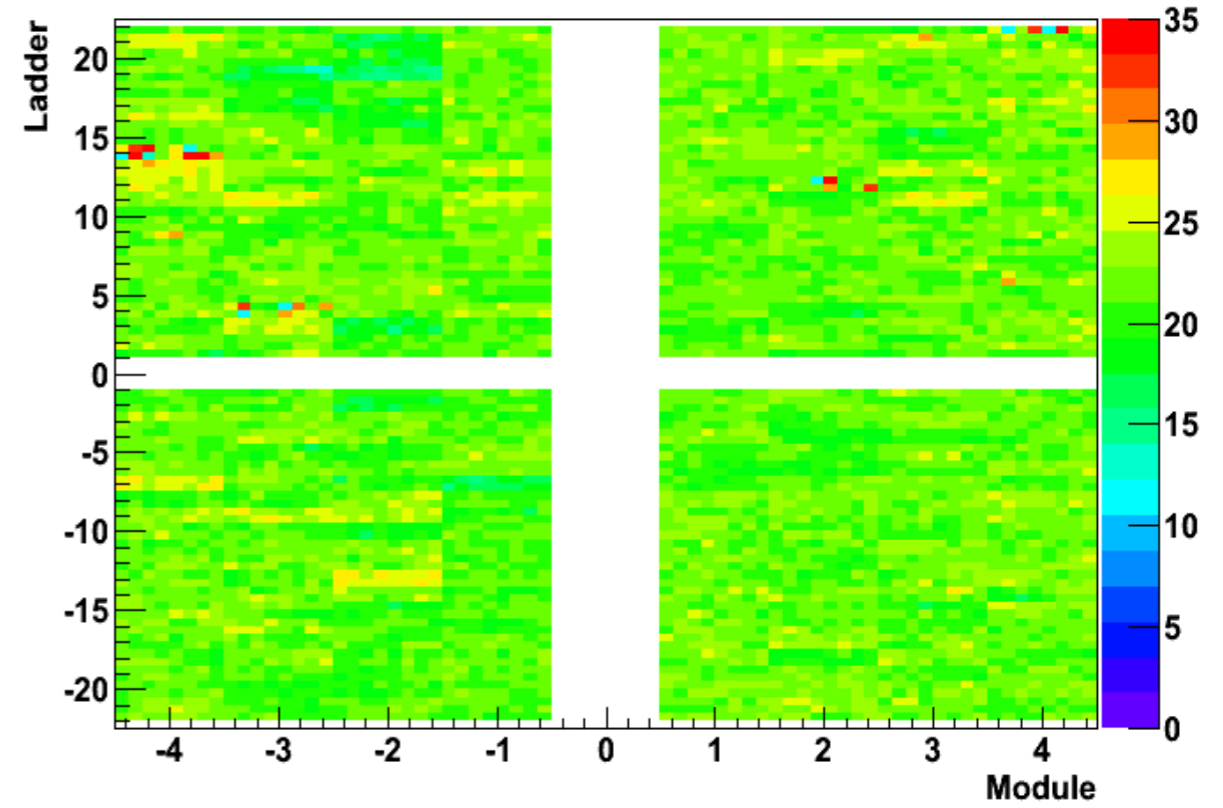
<b>&gt; 3 <math>\sigma</math></b>	<b><math>\chi^2</math> /Ndof &gt; 10</b>	<b>Large error</b>
145	18	12

# Fit results - MPV of Landau

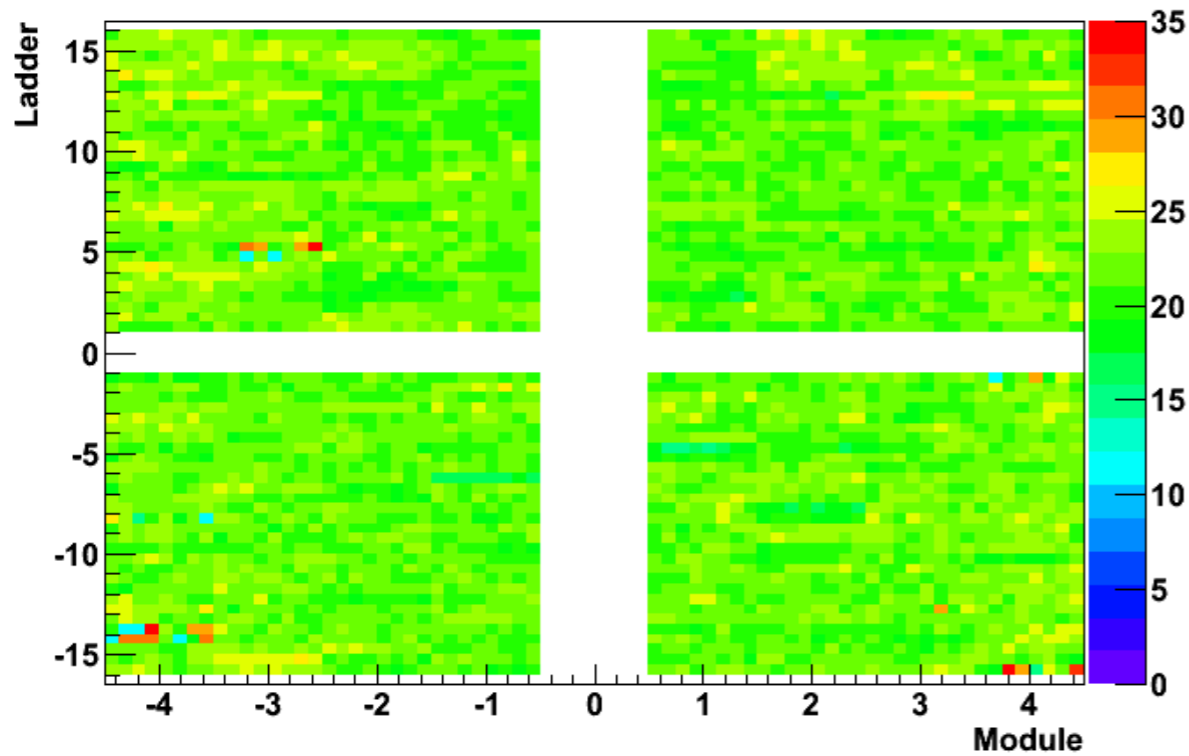
Layer 1



Layer 3



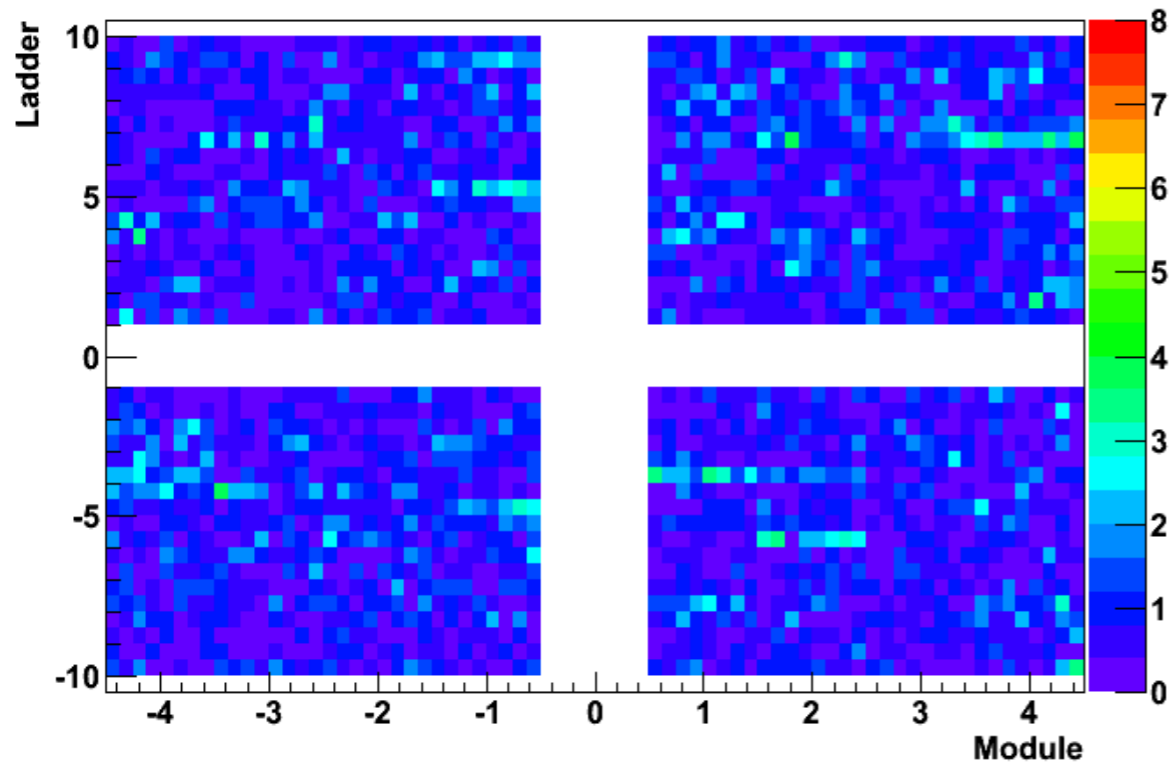
Layer 2



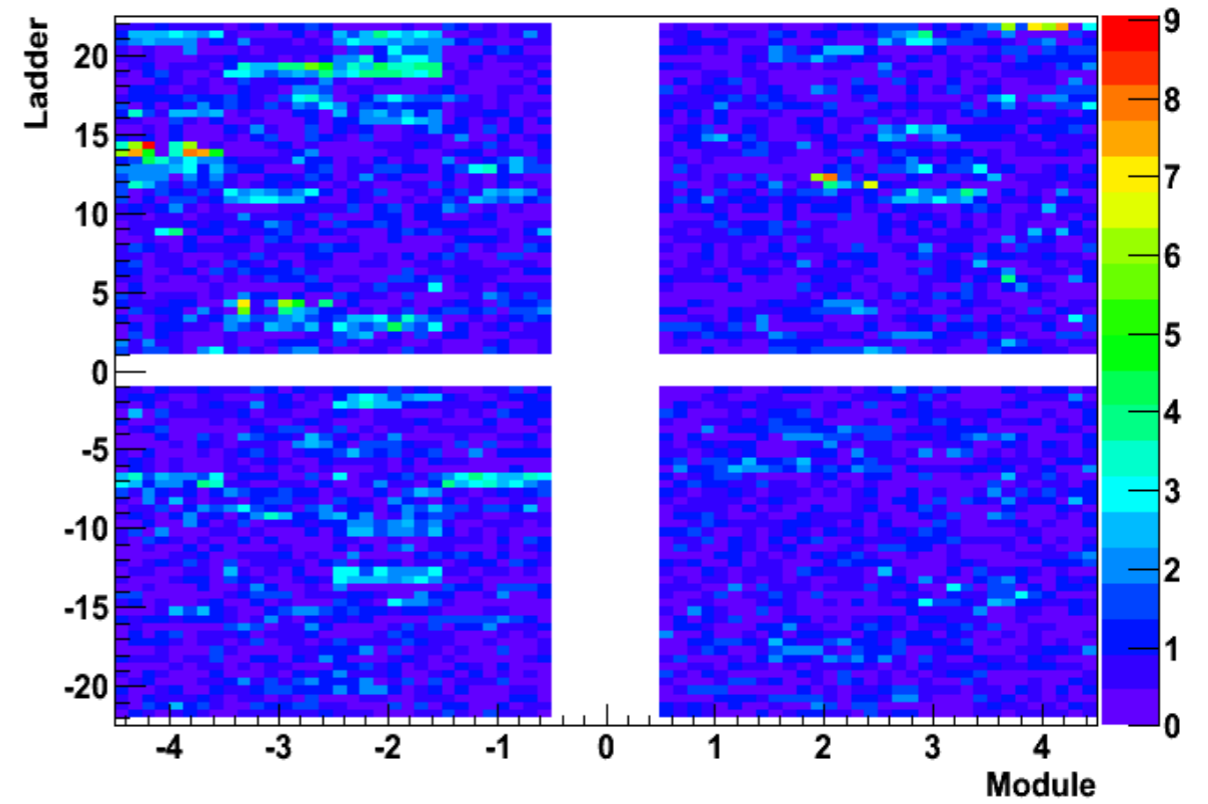


# Fit results - Significance

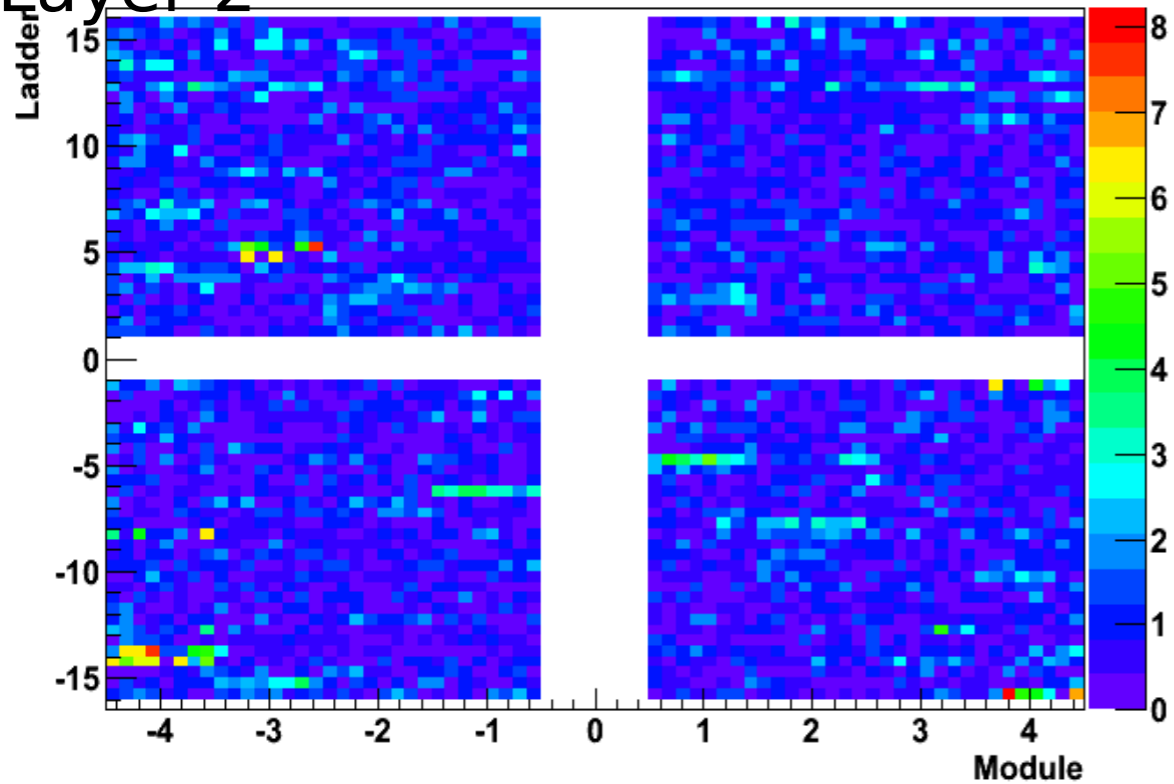
Layer 1



Layer 3



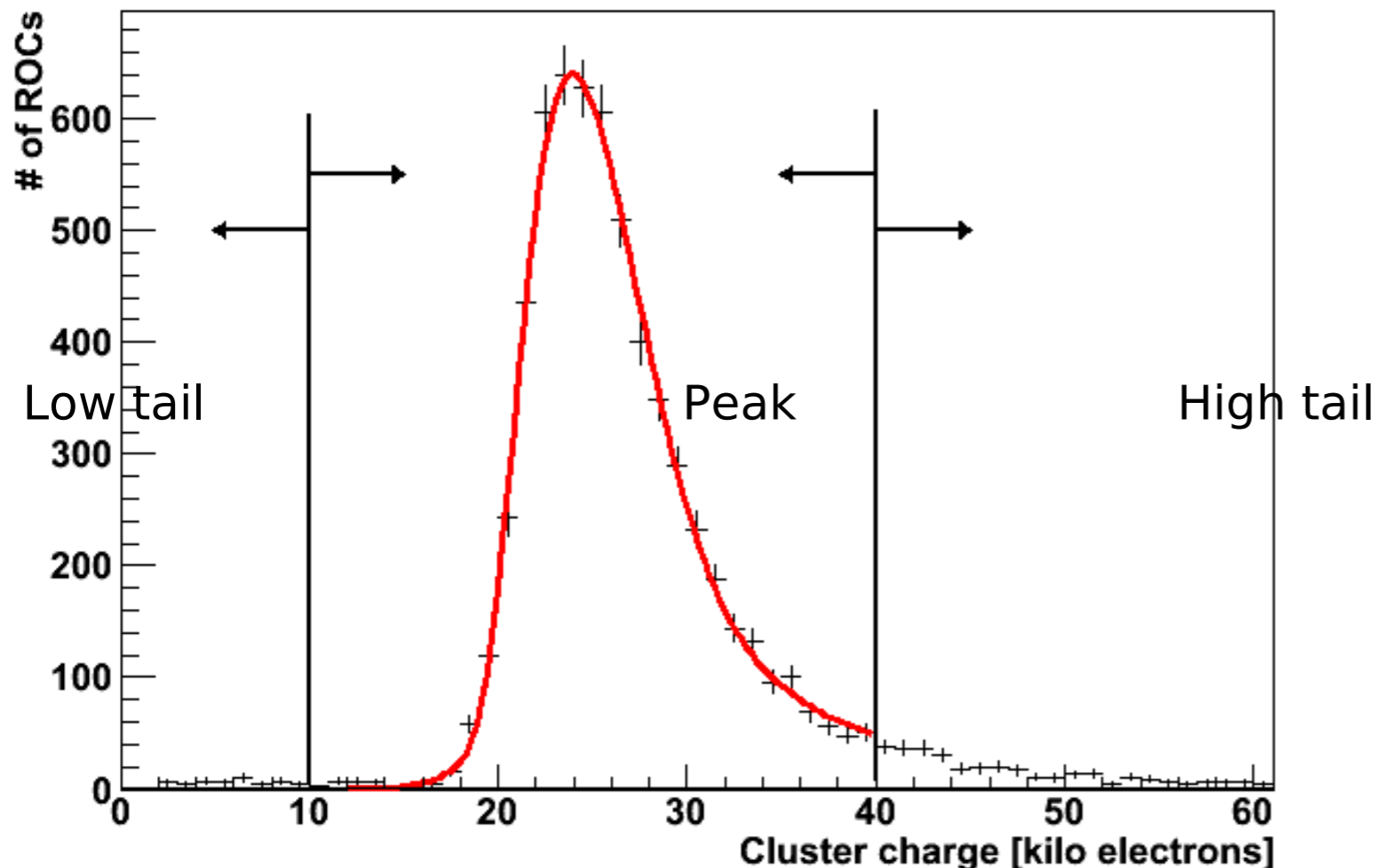
Layer 2



- Significance:  
 $|(\text{MPV Fit} - \text{MPV Mean})|/\text{Sigma}$

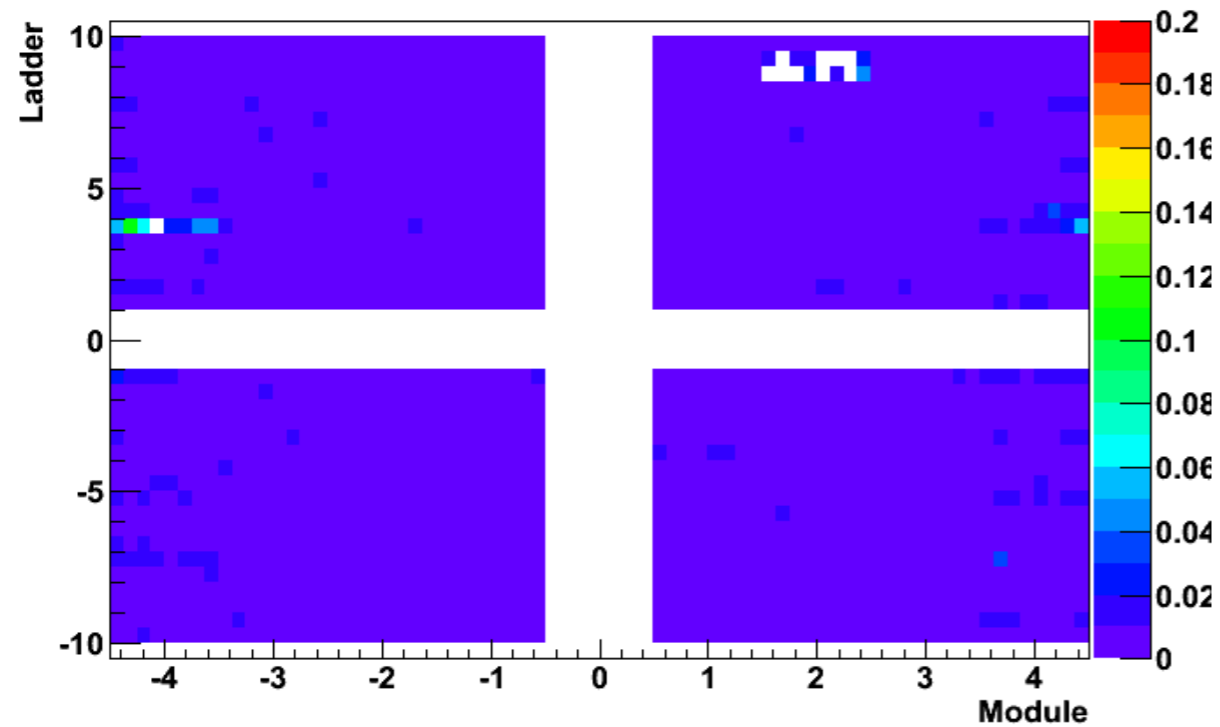
# Tail of the cluster charge distributions

- Observation: bad ROCs have something going on in the tails
- Look at the tail of the cluster charge distribution
- Plot the **fraction of the charge in the tails** w.r.t. the total charge per ROC

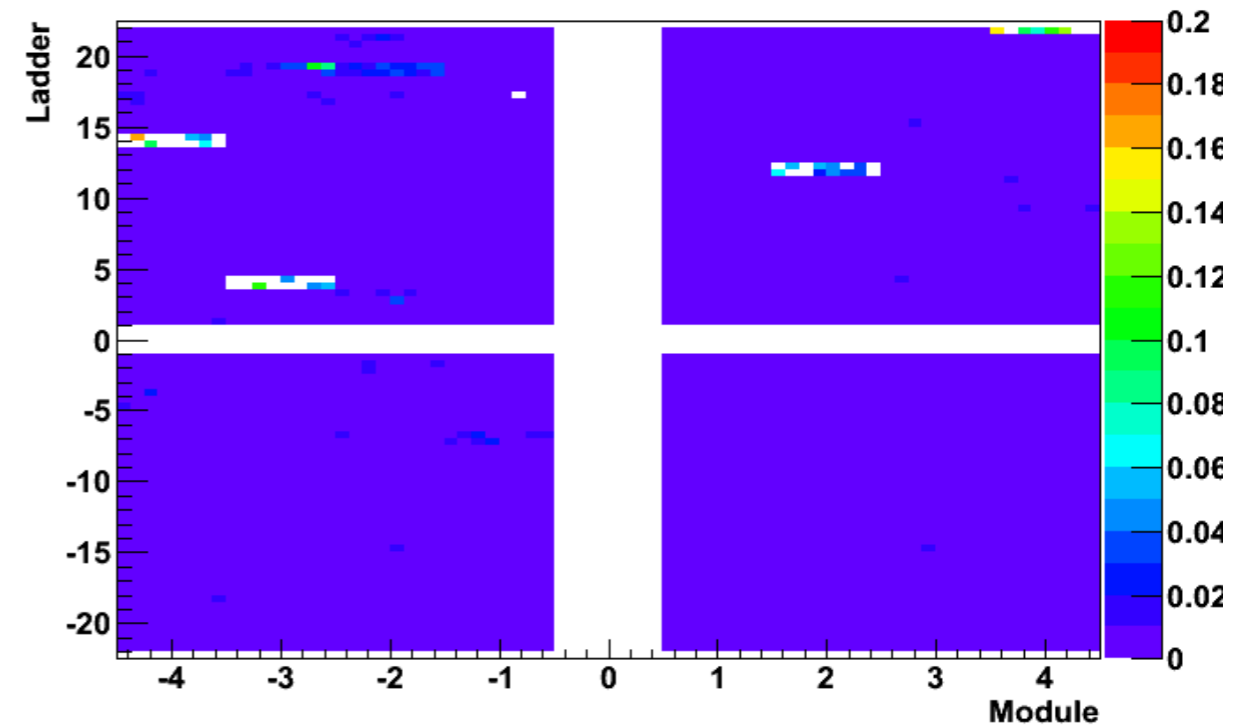


# Fraction of entries in lower tail of the cluster charge distributions

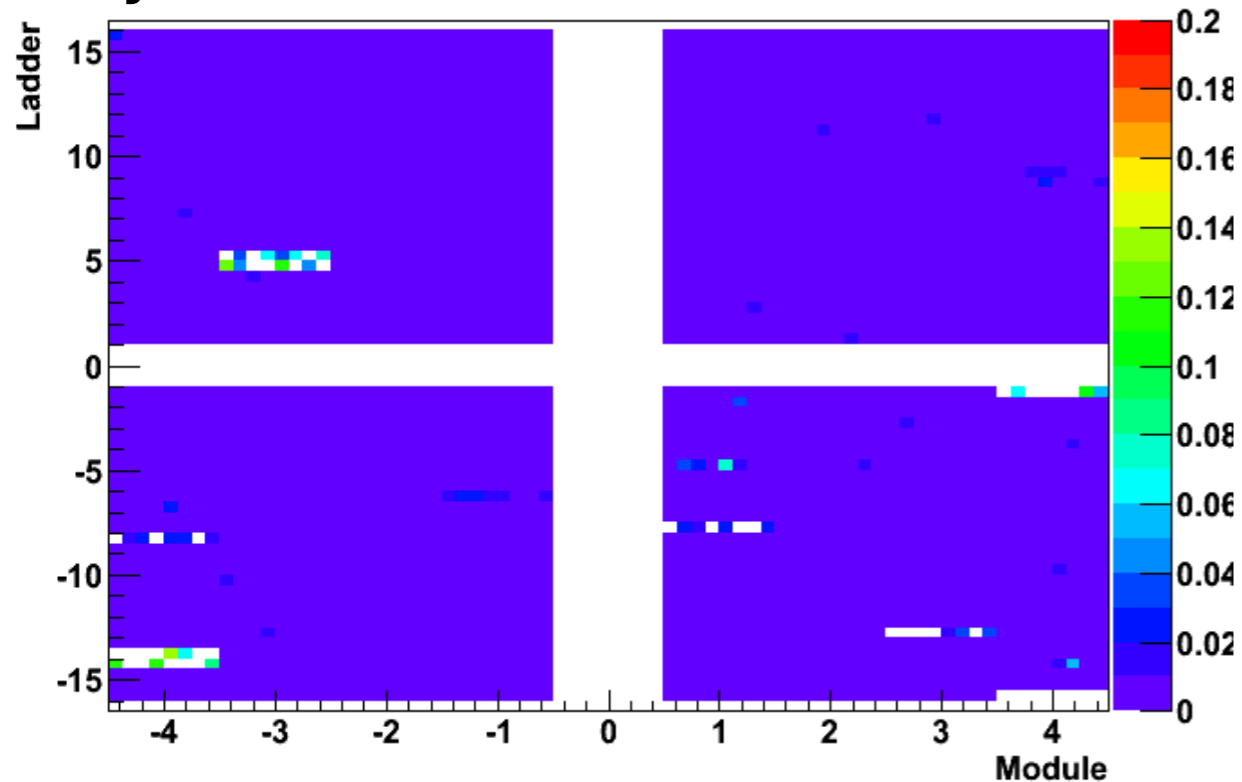
Layer 1



Layer 3



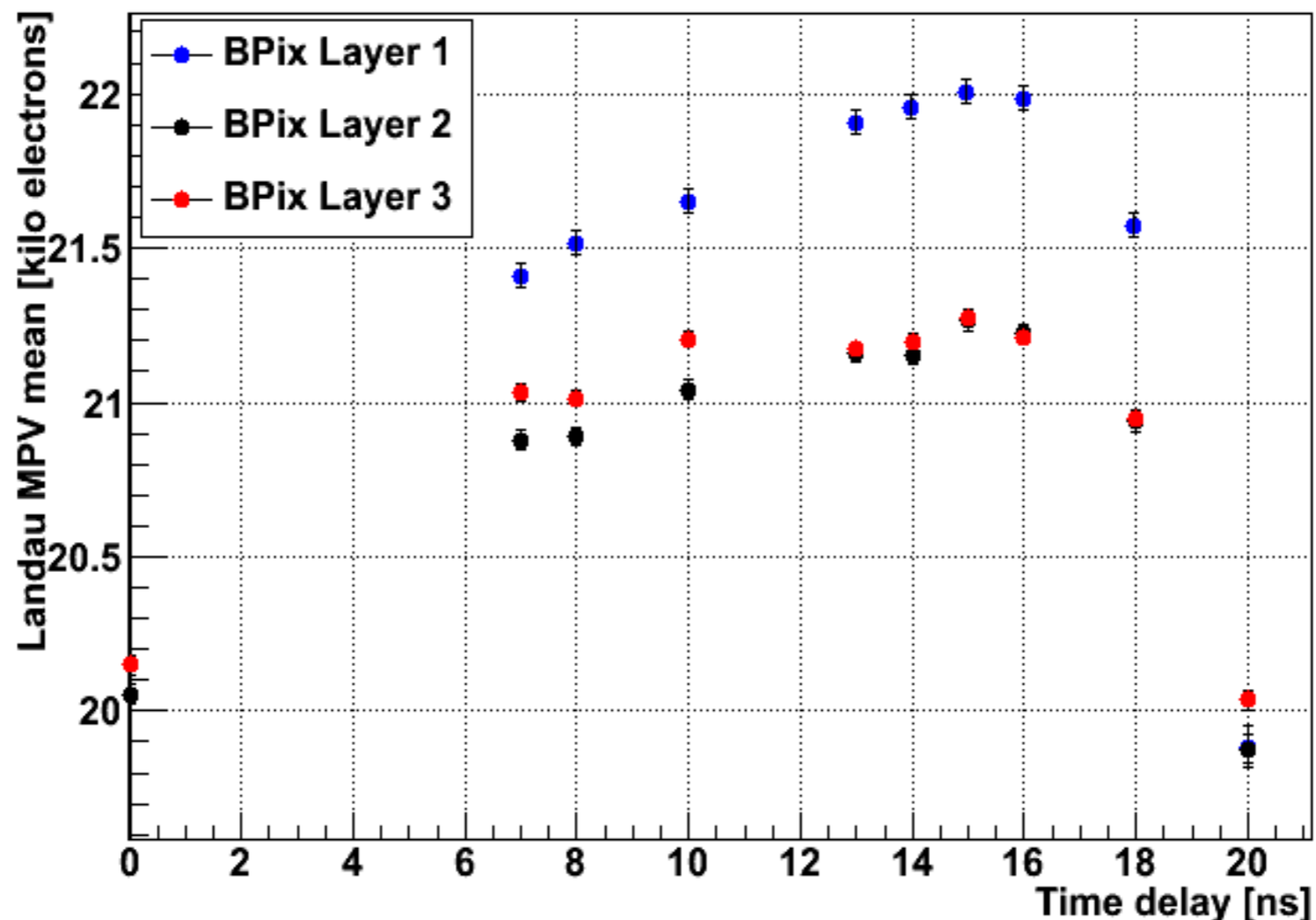
Layer 2



- The modules became visible
- But some full or half modules are pronounced in Layers 2 and 3

# Impact of Time Delay on Landau MPV mean (2011 MinBias Run)

- Using the mean MPV of all ROCs per BPix layer.
- At the correct timing the average cluster charge MPV is expected to be at maximum.
- Timing of all 3 layers consistent with each other.
- Uncertainties are the standard errors on the MPV mean fits.



# Conclusions

- ROC quality monitoring in Barrel Pixel
- Fit cluster charge distribution from multi-pixel Rechits associated to track segments per ROC
- Mainly Gaussian distribution of cluster charge mean
- $\sim 1\%$  Bad ROCs, dominated by  $> 3$  sigma cases
- Tasks:
  - Impact of HV bias on cluster charge distribution
  - Bad ROC into prompt calibration loop
  - FED error propagation