

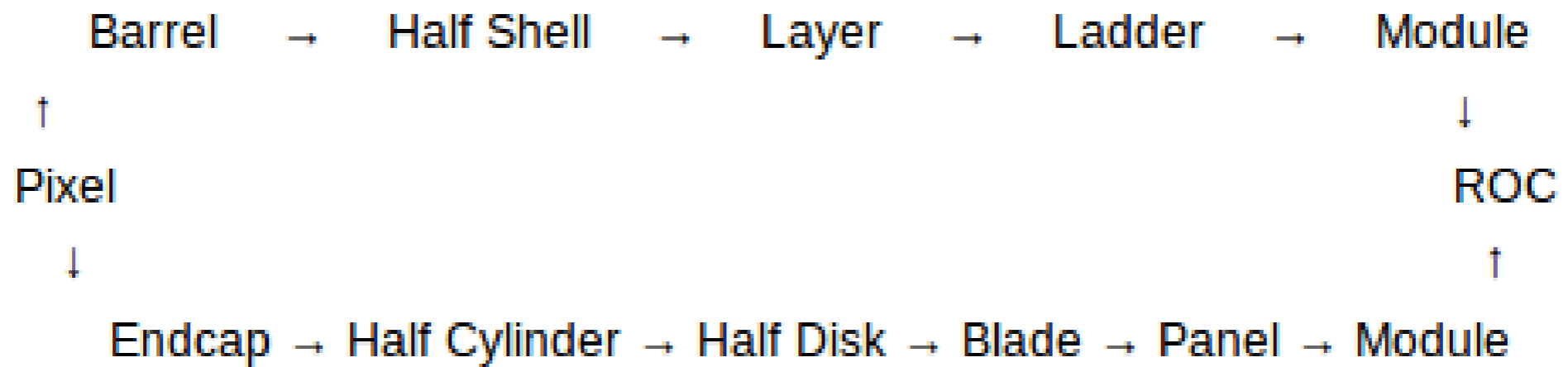
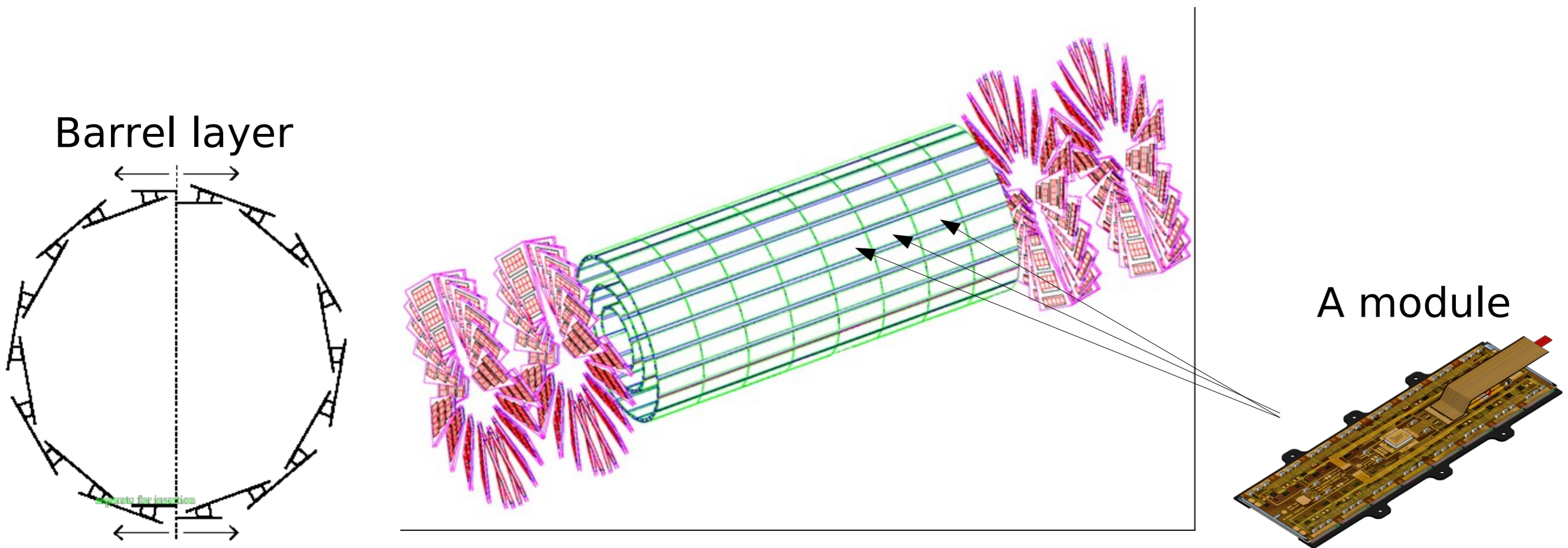


Cluster charge distributions in Barrel Pixel Read Out Chips

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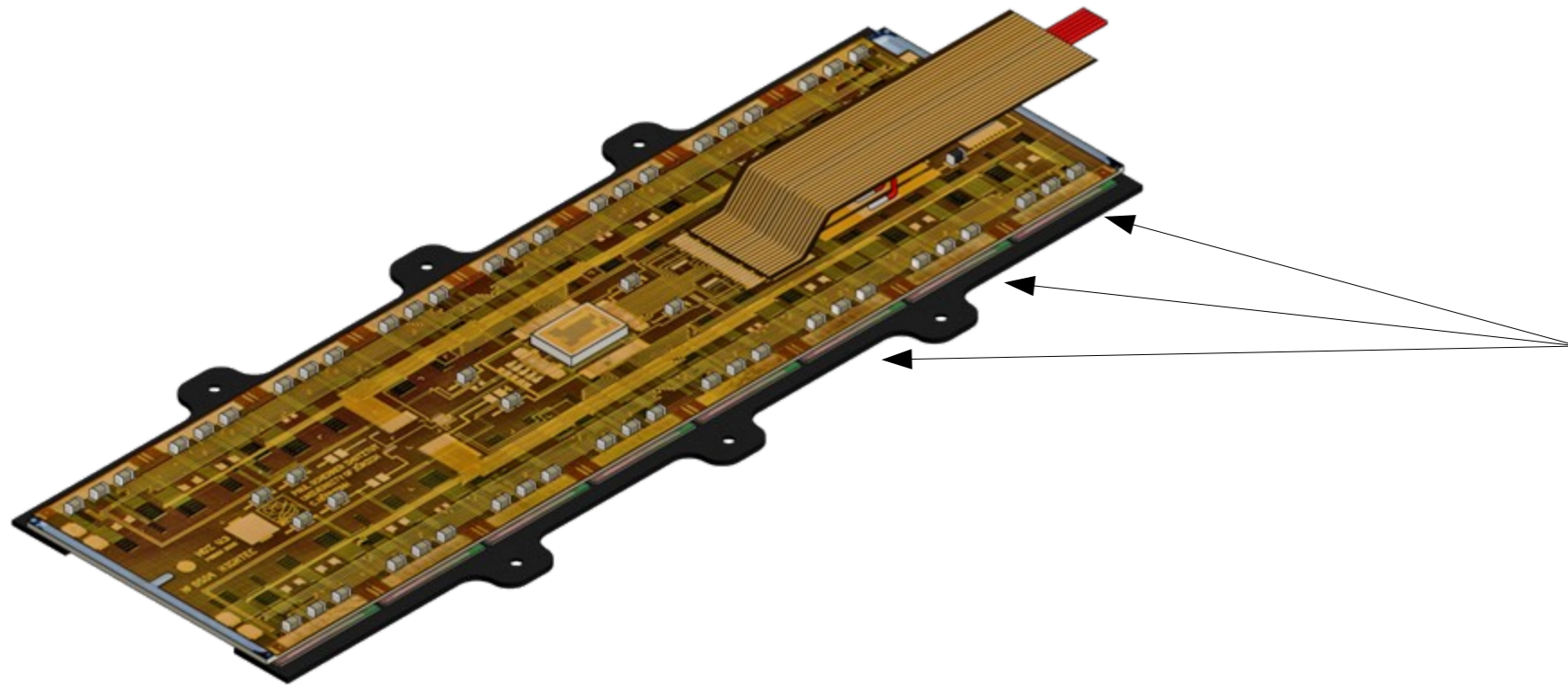
11 April 2011

Pixel detector components

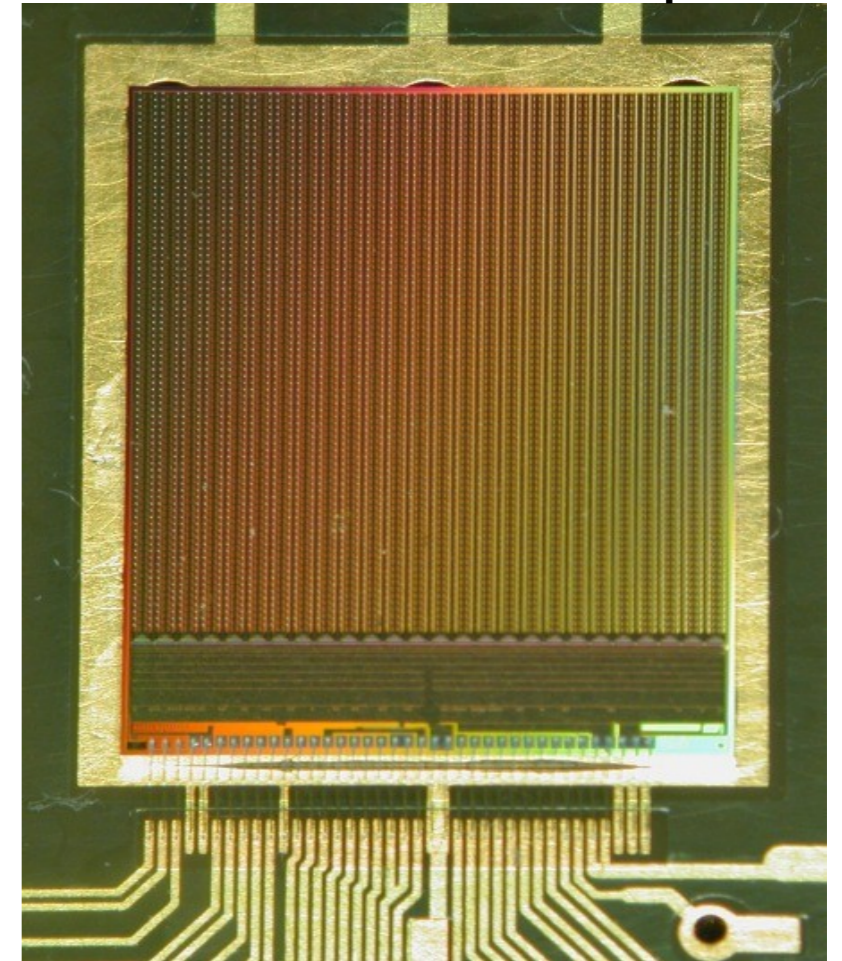


Pixel detector components (Barrel)

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 1×8 (for half-ladders) or 2×8 (for full-ladders) configuration.
- A readout chip (ROC) is an array of 80×52 pixels, each of size $100 \mu\text{m} \times 150 \mu\text{m}$.

Method

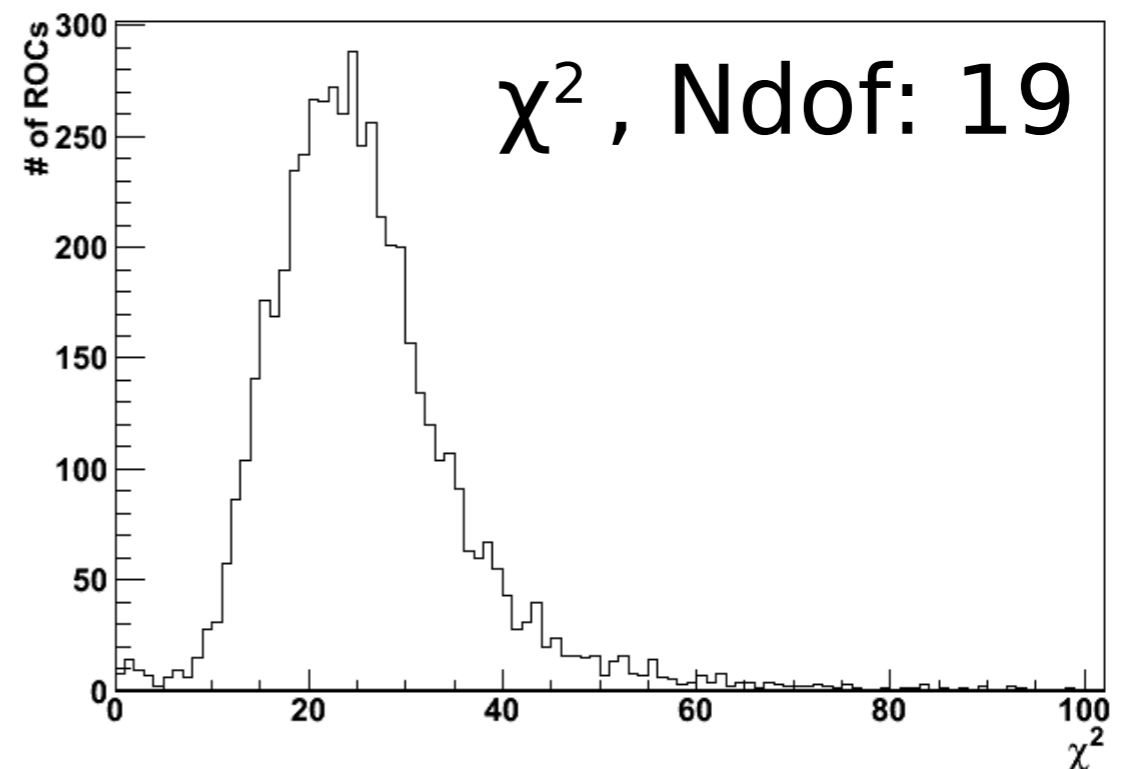
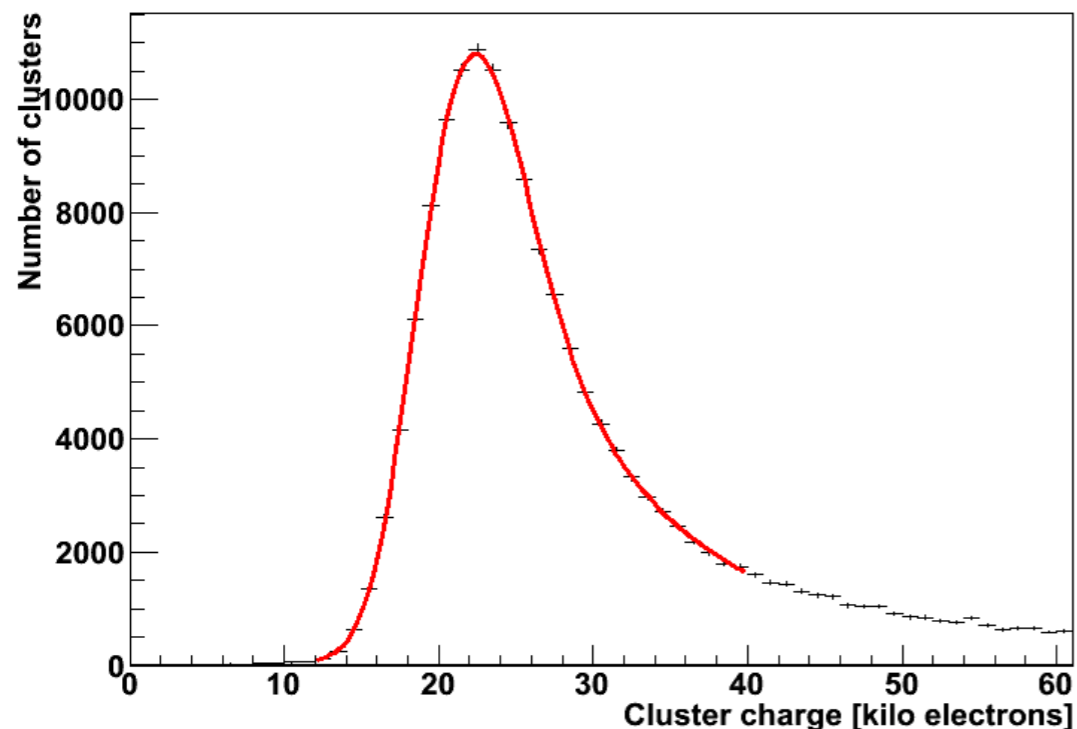
- Ionizing particle creates electron-whole pairs.
- Signal is converted and amplified by the ROCs.
- Hit clusters = overall collection of hit pixels.
- Select hit clusters associated to Reconstructed Trajectory Hits in the Barrel.
- Look at cluster charge distribution per Read Out Chip for these clusters.

Dataset

- Dataset:
 - /MinimumBias/Run2010B-Dec22ReReco
- CMSSW version:
 - CMSSW_3_8_6
- Lumi selection from JSON files:
 - Cert_136033-149442_7TeV_Dec22ReReco_Collisions10_JSON.txt

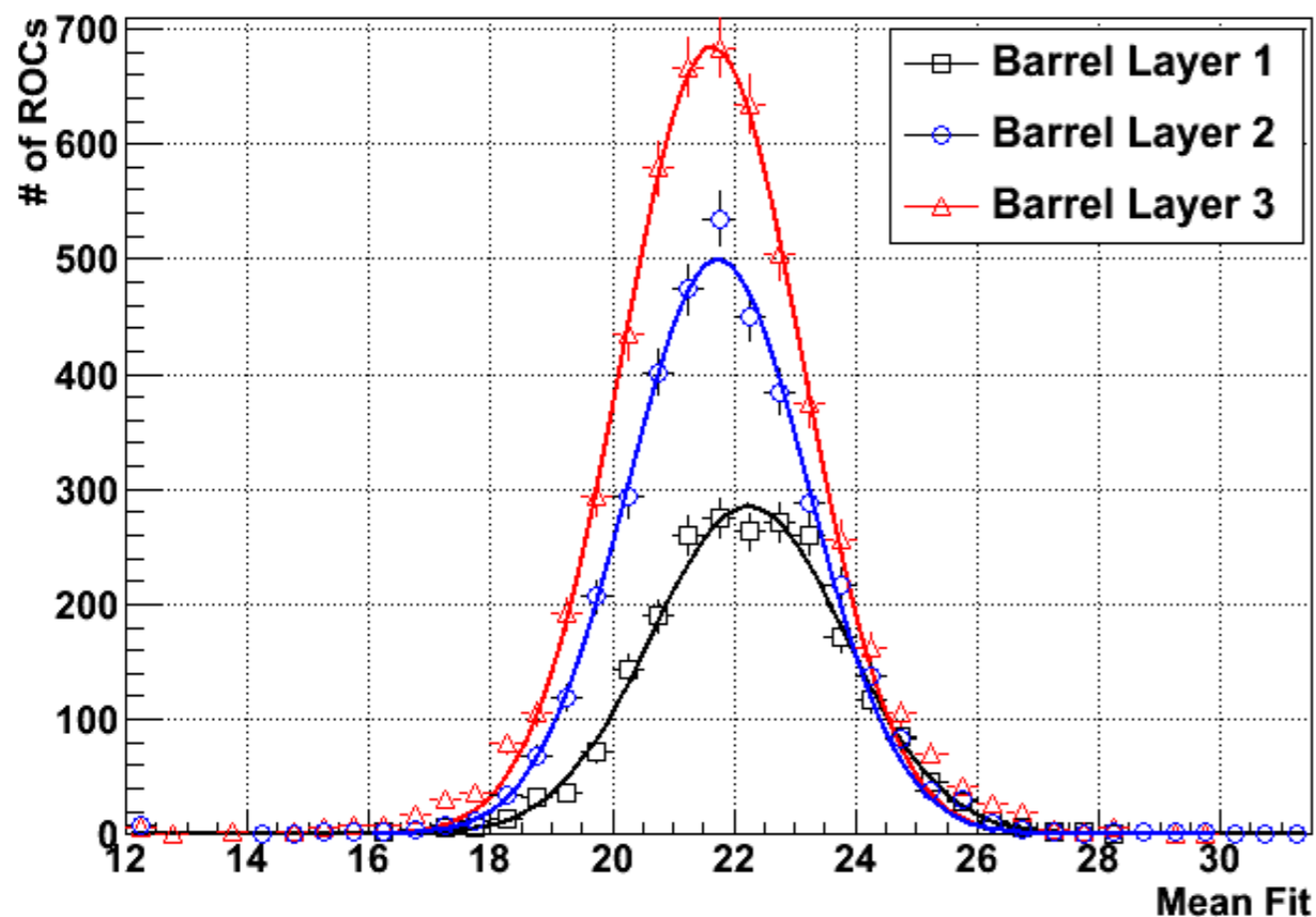
Fitting per ROC

- 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 ~ 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.



	σ	Mean
L1	1.59	22.2
L2	1.55	21.8
L3	1.64	21.7

	1 σ int.	2 σ int.	3 σ int.
L1	68.4%	94.7%	99.4%
L2	68.6%	94.3%	98.8%
L3	69.4%	93.2%	98.6%

ROC quality

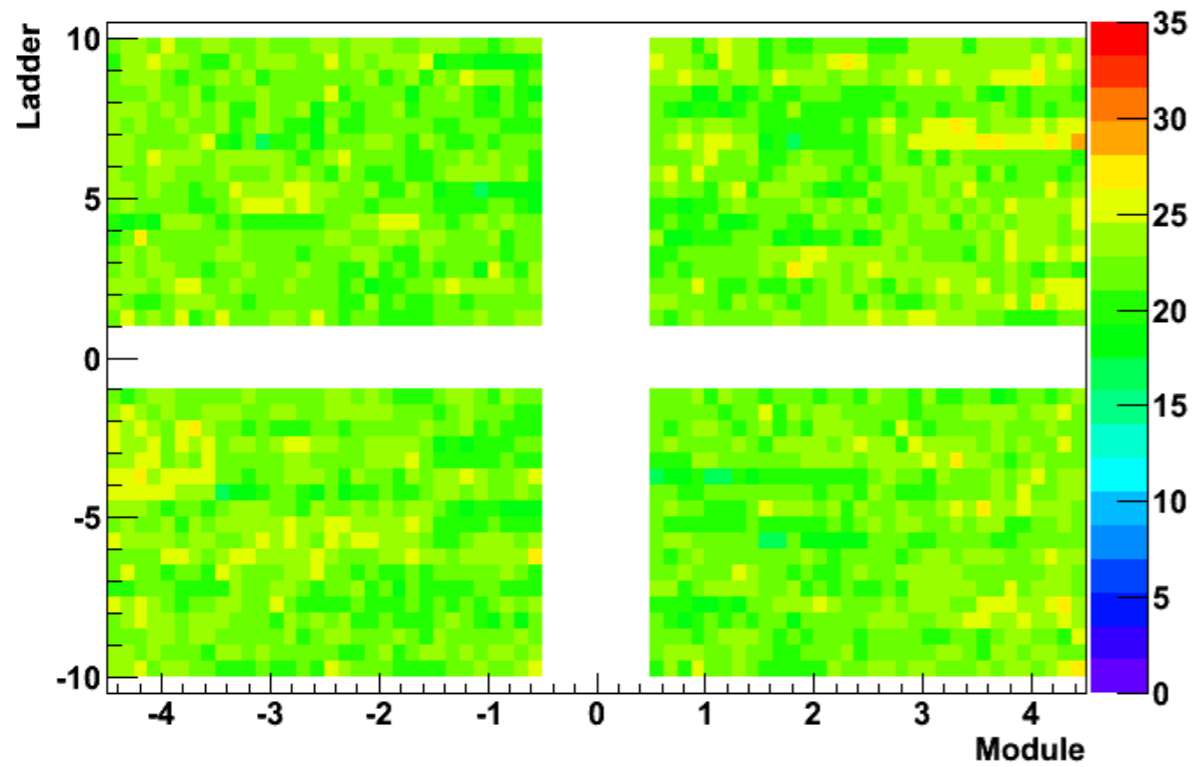
	Good	OK	Bad
σ interval	1	2 - 3	> 3
χ^2 /Ndof	≤ 3	3 - 10	>10
Mean error	< Mean	< Mean	> Mean

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

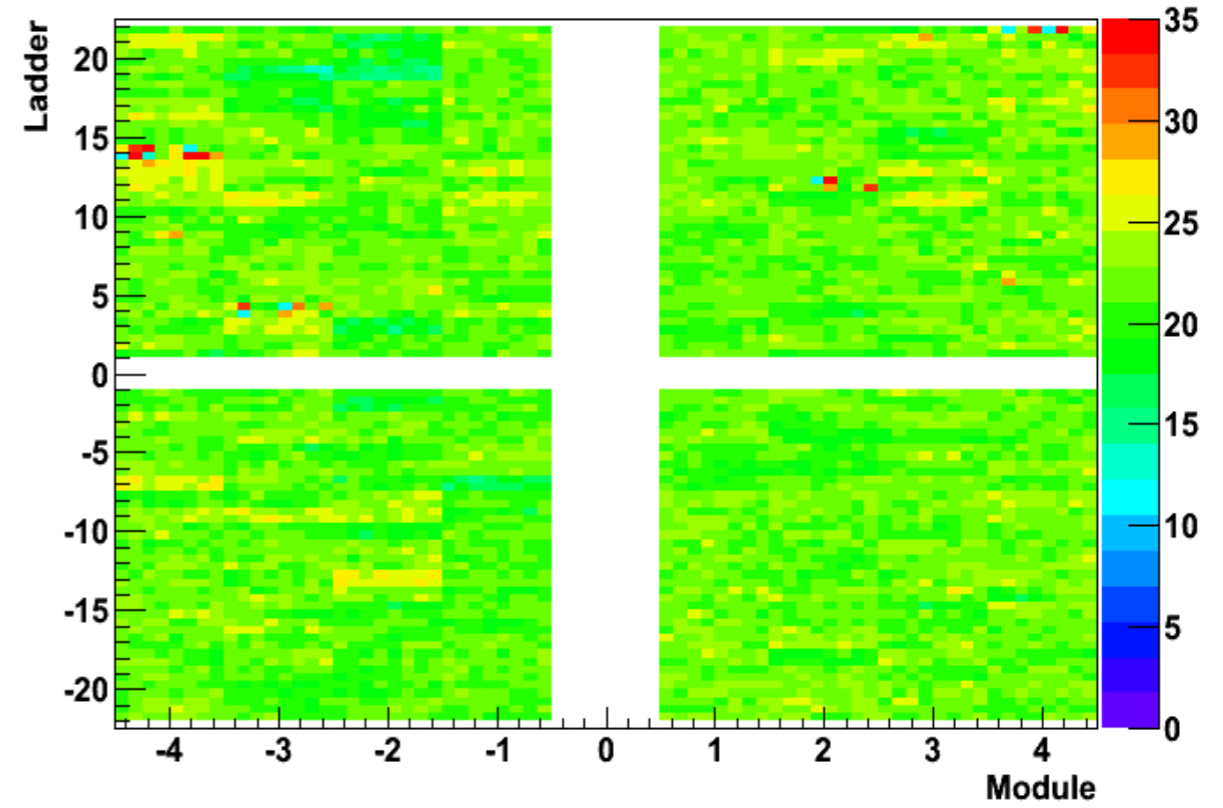
Bad ROCs		
> 3 σ	χ^2 /Ndof > 10	Large error
145	18	12

Fit results - MPV of Landau

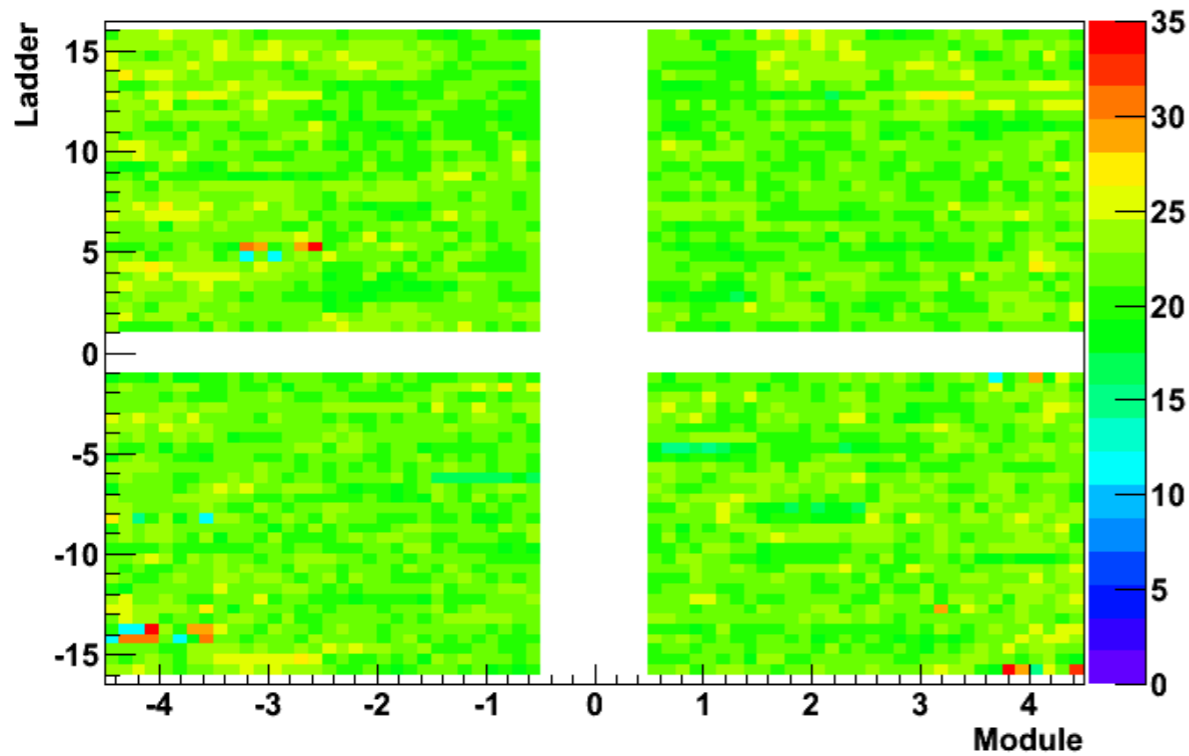
Layer 1



Layer 3

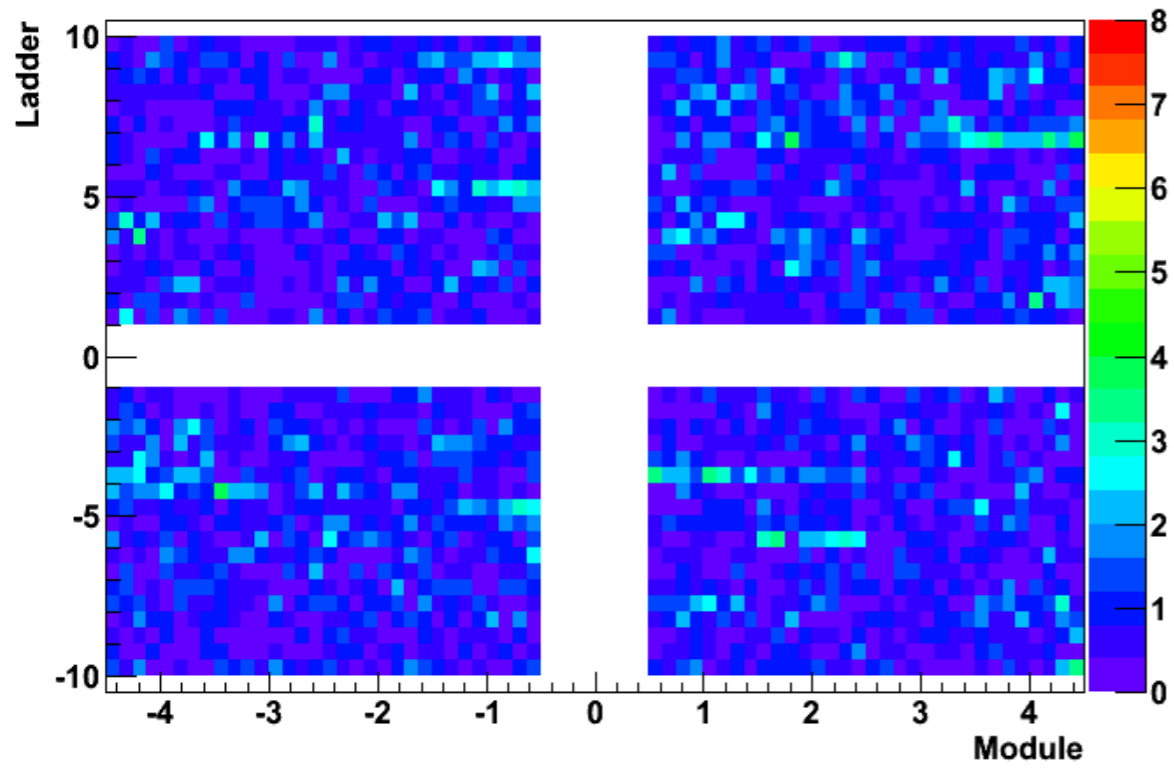


Layer 2

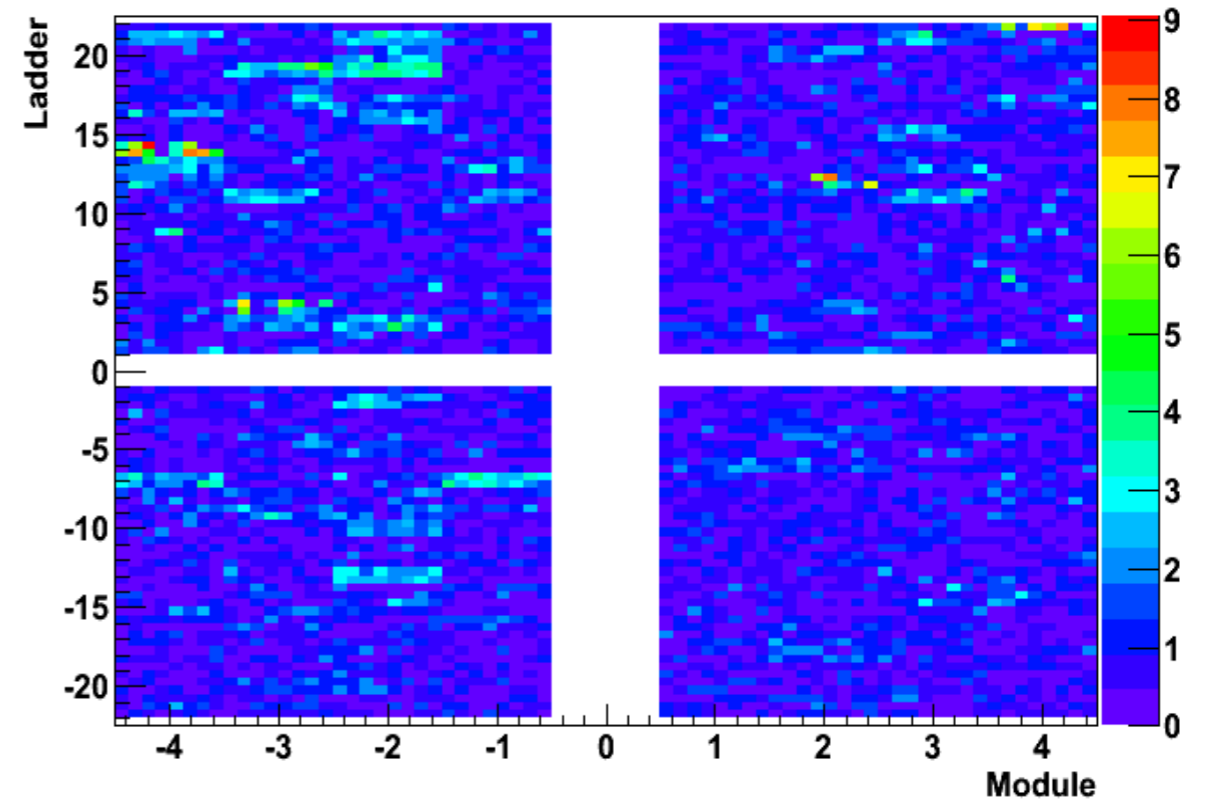


Fit results - Significance

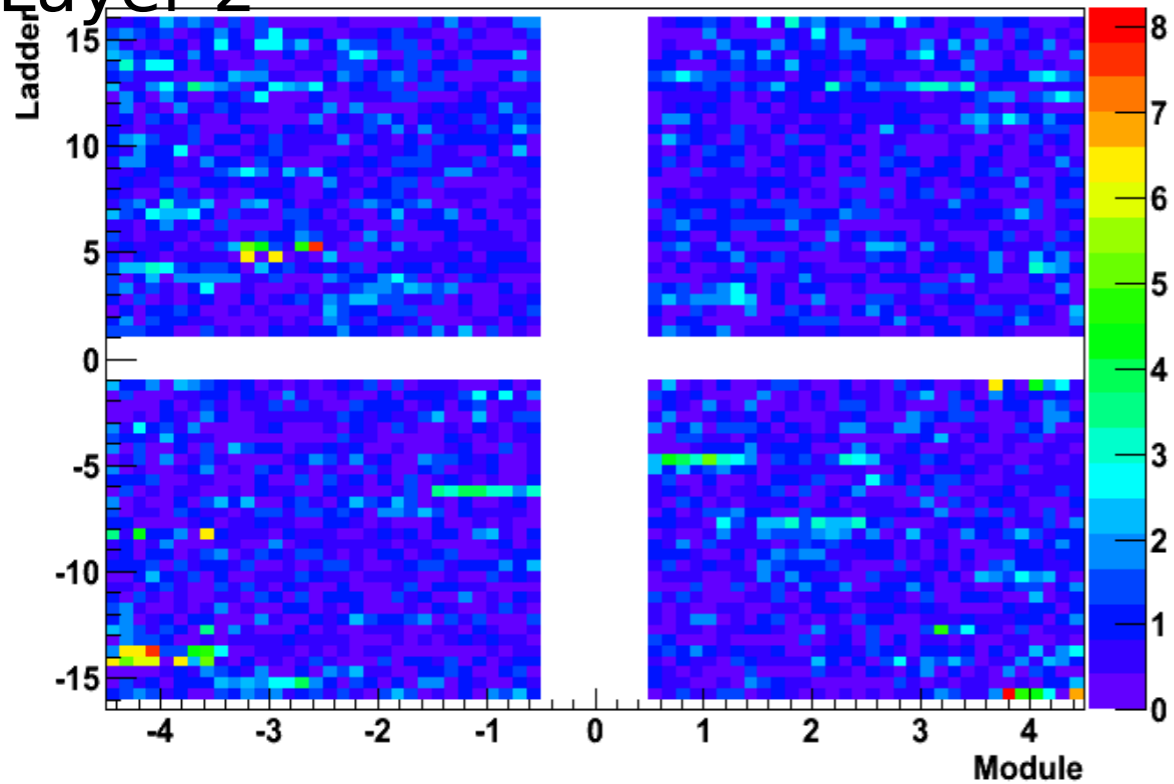
Layer 1



Layer 3



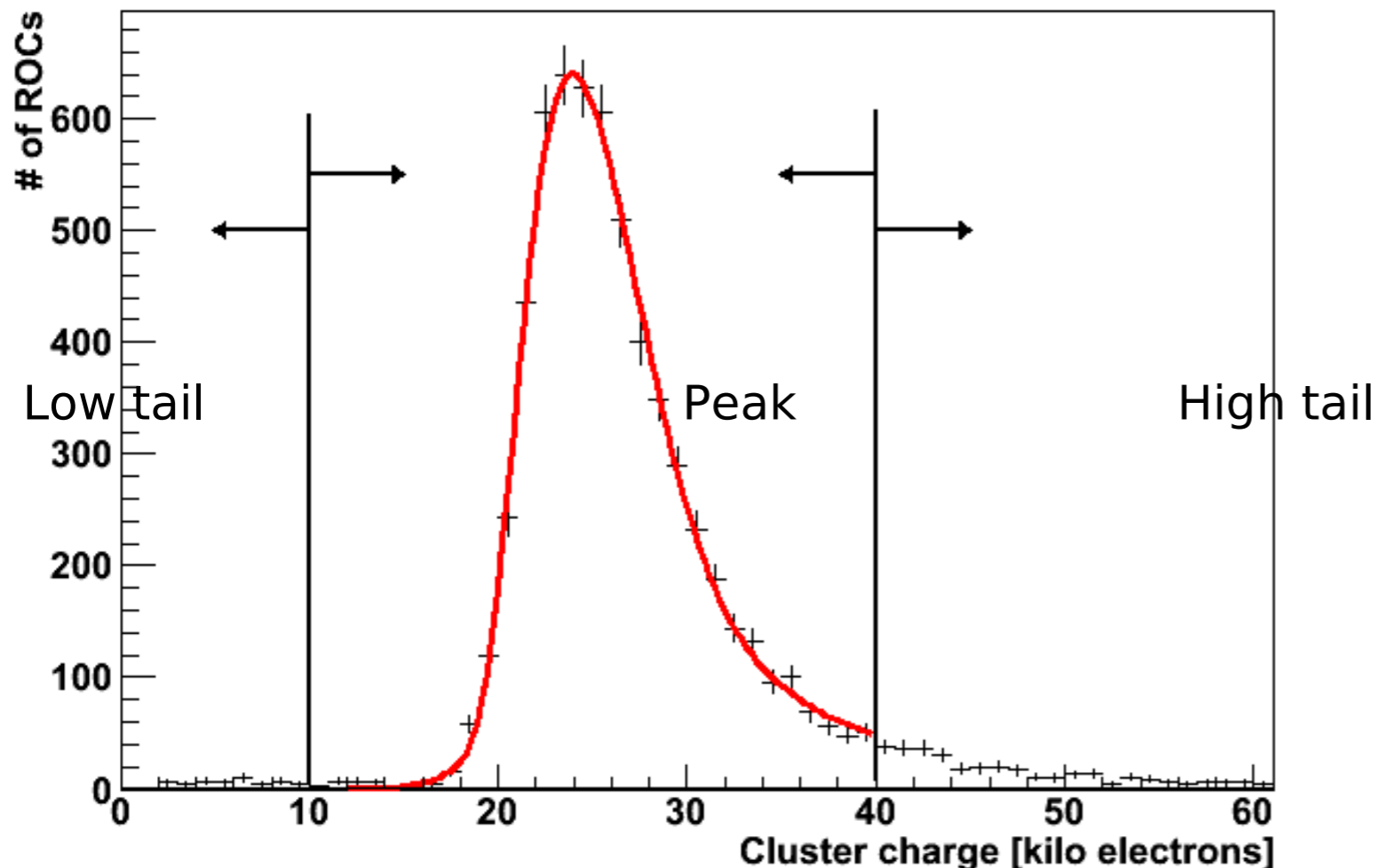
Layer 2



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

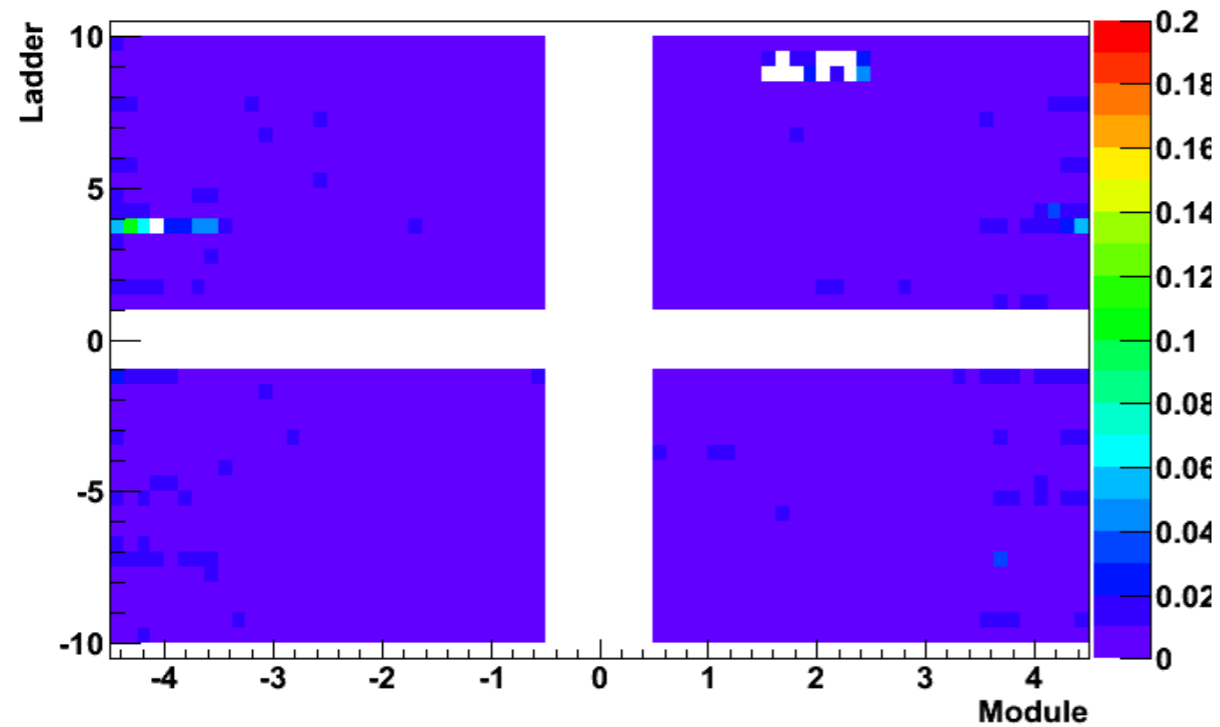
Tail of the cluster charge distributions

- 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

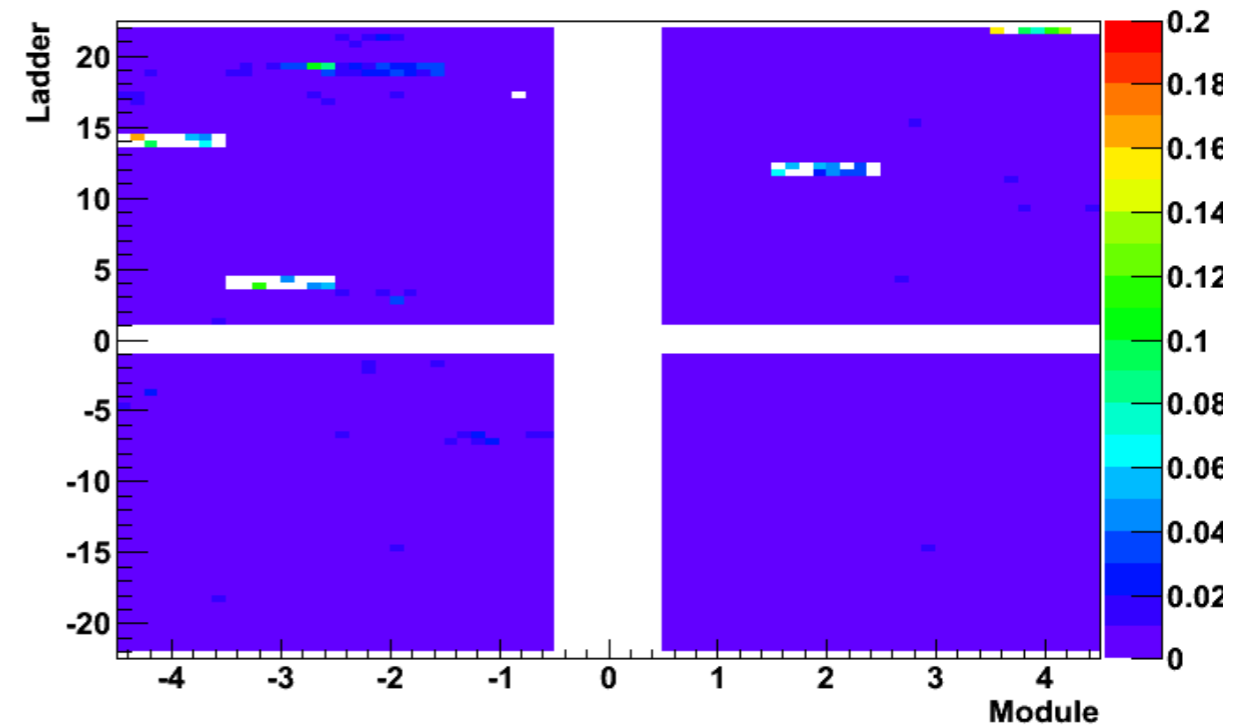


Fraction of entries in lower tail of the cluster charge distributions

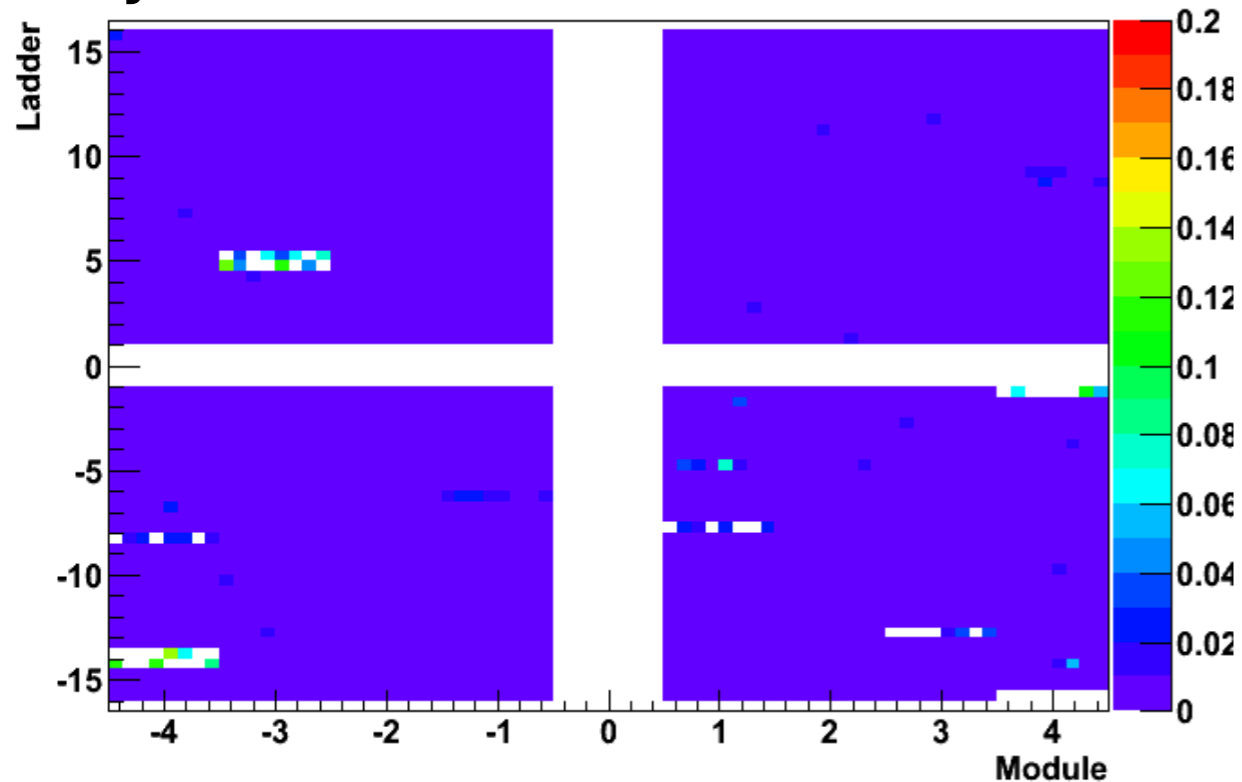
Layer 1



Layer 3



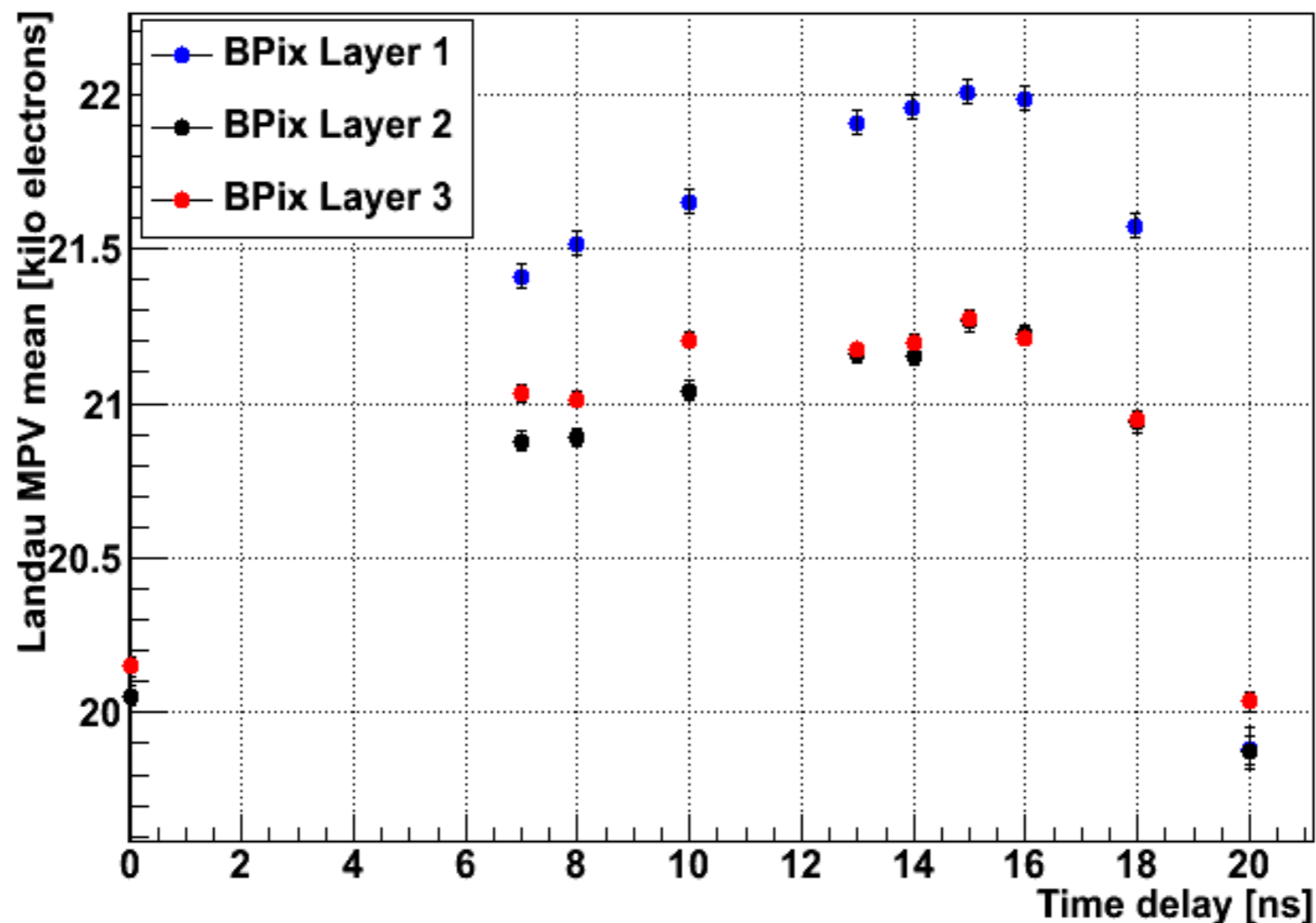
Layer 2



- 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
- (ToDo: Forward Pixel)



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