Cluster charge distributions in Barrel Pixel Read Out Chips

Balint Radics (KFKI RMKI), Viktor Veszpremi (ATOMKI), Janos Karancsi (ATOMKI)

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NKTH and OTKA MB08-80137, NK81447
Pixel detector components

- Barrel layer
- A module

Barrel → Half Shell → Layer → Ladder → Module

Pixel

Endcap → Half Cylinder → Half Disk → Blade → Panel → Module

http://grid.kfki.hu/twiki/bin/view/CMS/DetectorComponents
- 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 $100 \mu m \times 150 \mu m$. 

**Pixel detector components (Barrel)**

- A module with 2x8 ROCs
Method

- Ionizing particle creates electron-hole 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.

\[ \chi^2, \text{Ndof: 19} \]
• 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.
• ROC quality
Fit results - MPV of Landau

Layer 1

Layer 2

Layer 3
• Fit results - Significance

• Layer 1

• Layer 2

• Layer 3

• Significance: (MPV Fit - MPV Mean) / 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 2

Layer 3

- 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
- ~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