Analysis of the DEPFET detector test beam data

taken at SPS in August 2009
with the use of the Ilcsoft Marlin processor package EUTelescope

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DEPFET Colaboration meeting
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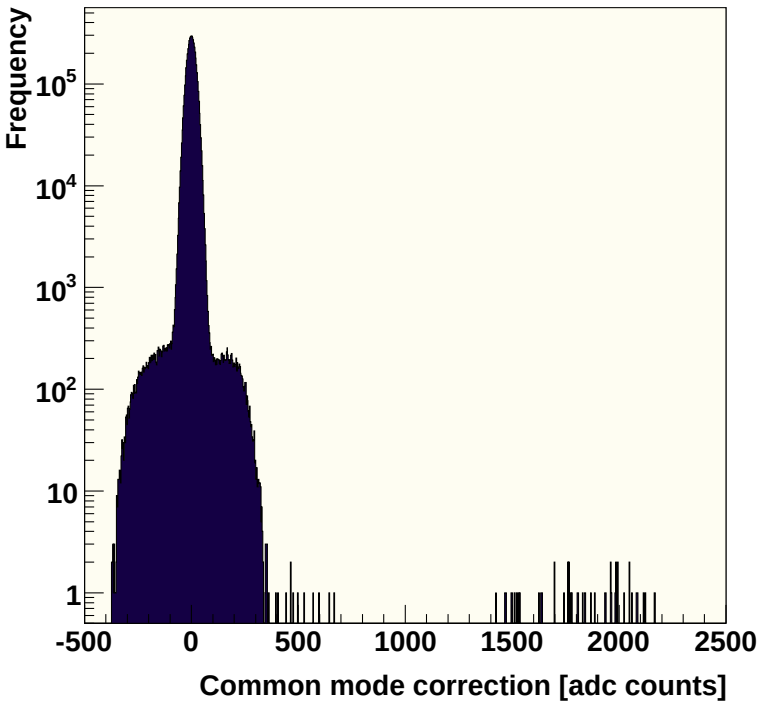
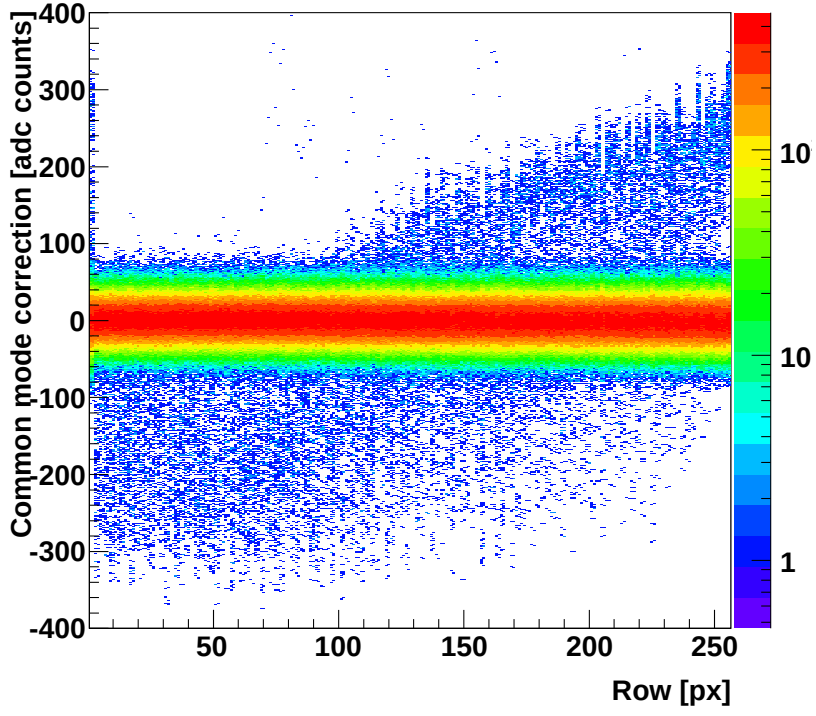
Analysis Chain

1. Readin
2. Pedestal and noise calculation
3. Clustering
4. Filtering
5. Eta function calculation
6. Hit reconstruction
7. Alignment
8. Hit position correction
9. Track reconstruction

Common Mode Noise

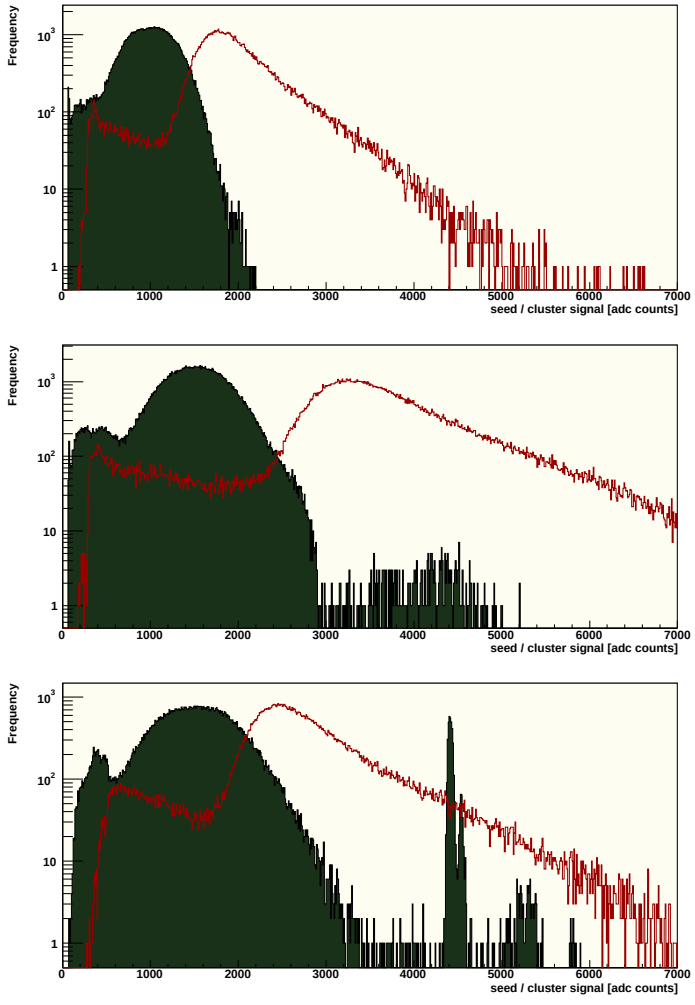


Row wise common mode noise spectrum.

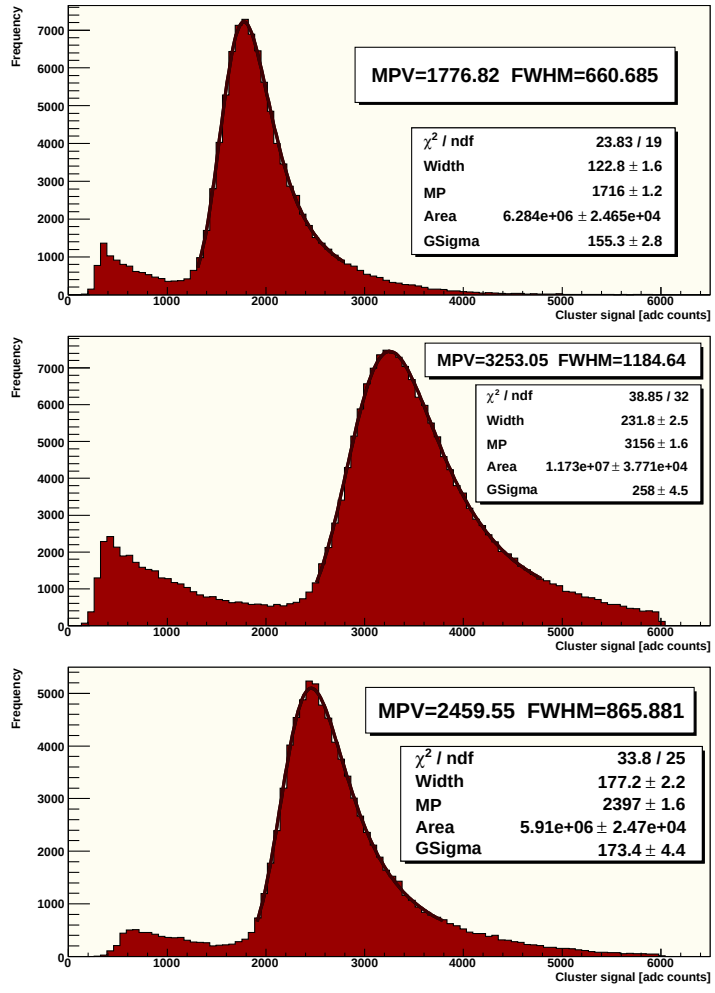


Common mode noise spectrum as function of the sampled row.

Cluster and Seed Signals

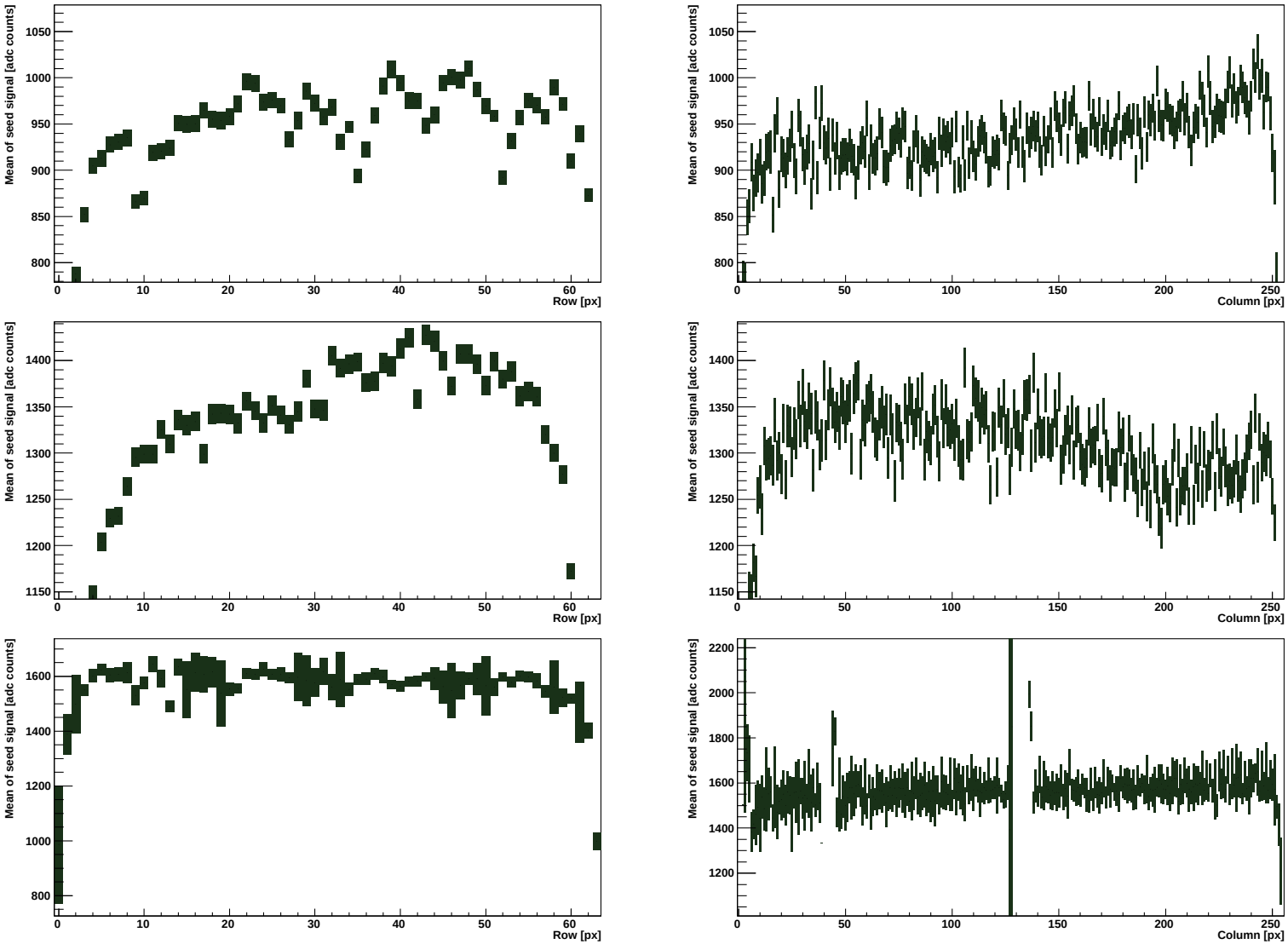


Seed and cluster charge distribution for the DUT H3.0.04, H3.0.07 and H3.0.01 (top to bottom).



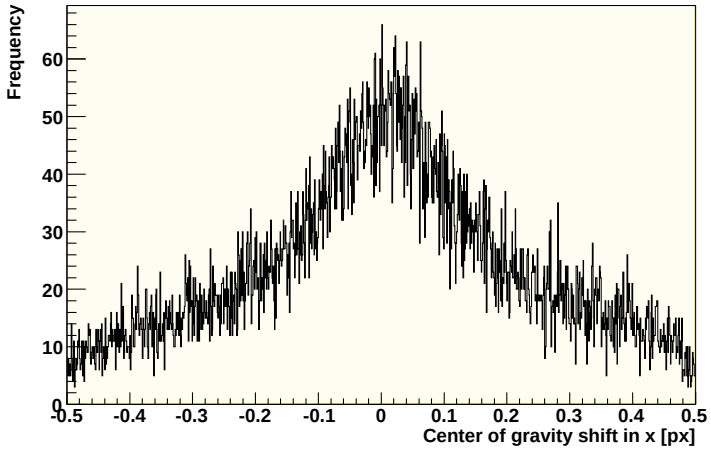
Cluster charge distribution and Landau fit around peak for H3.0.04, H3.0.07 and H3.0.01.

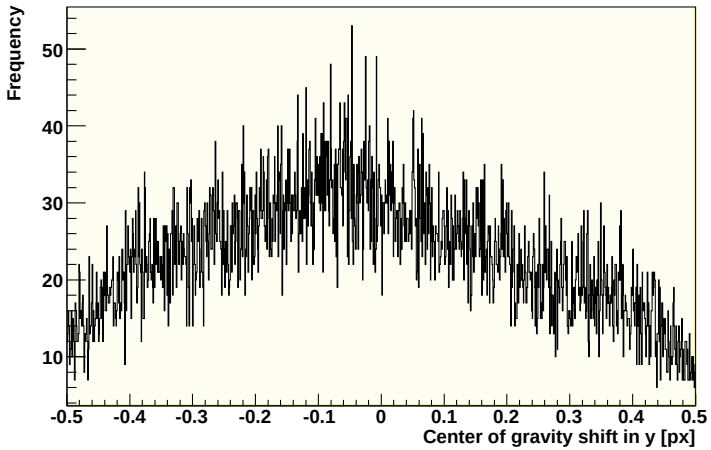
Gainmodulation



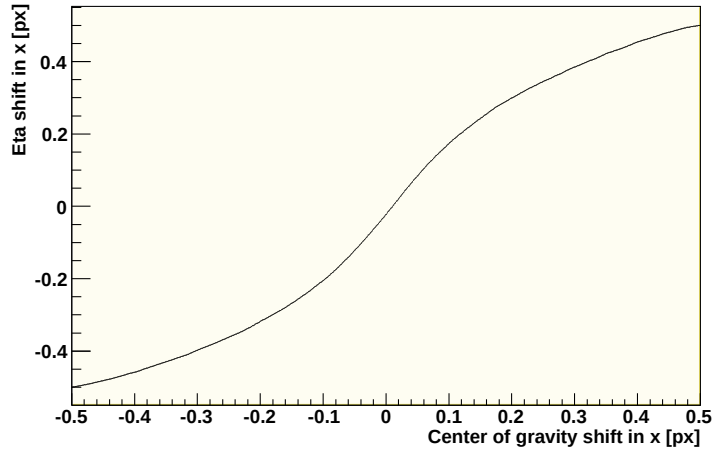
Mean of the row (left) and column (right) wise seed signal distribution for H3.0.04, H3.0.07 and H3.0.01 (top to bottom).

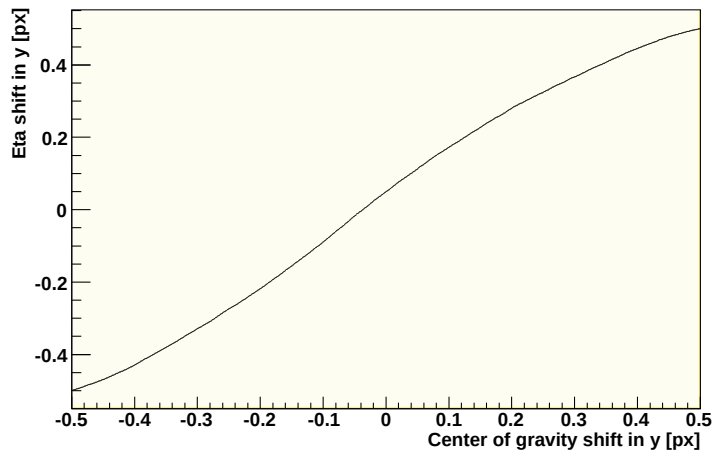
Eta Hit Reconstruction





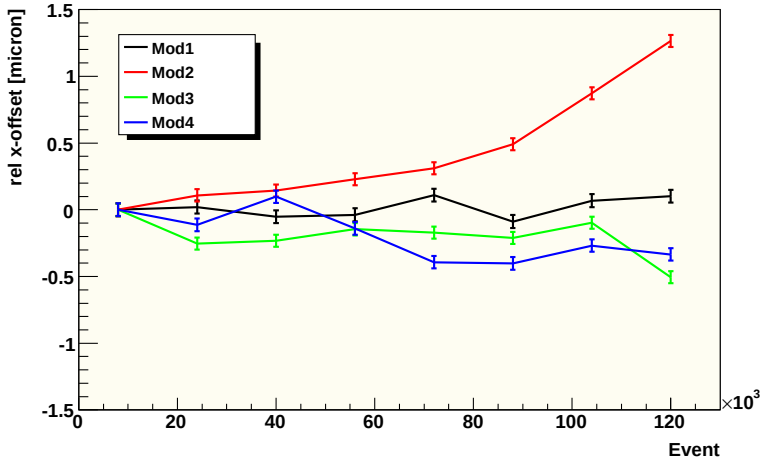
In pixel hit position frequency determined by center of gravity in x (32μm) and y (24μm).

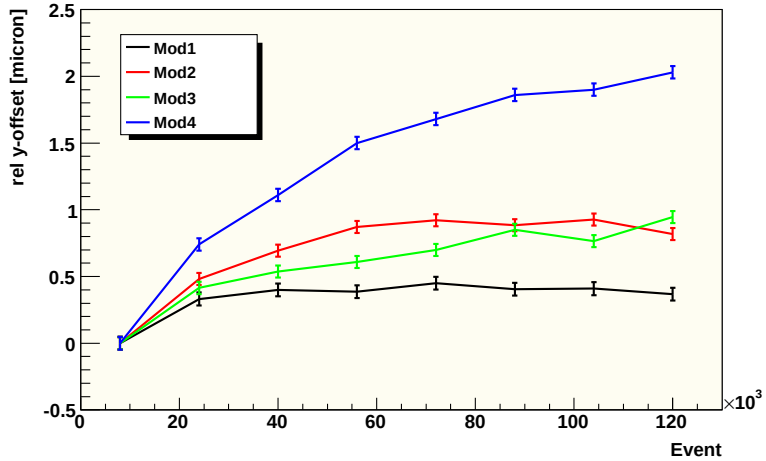


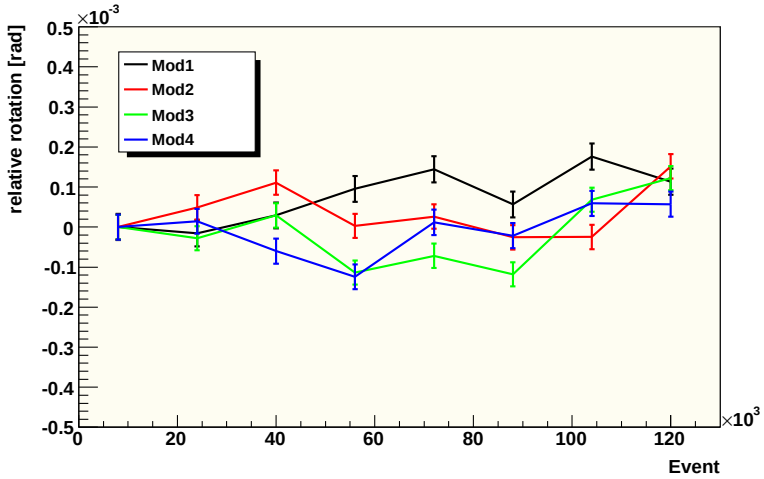


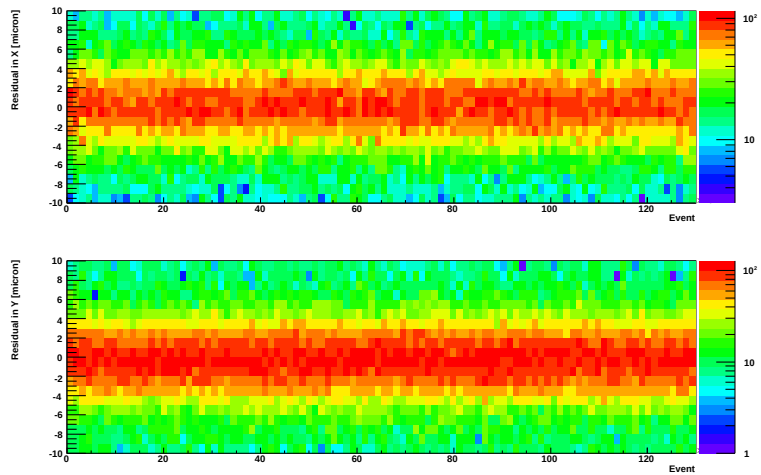
Eta correction function for x and y direction.

Mechanical Stability



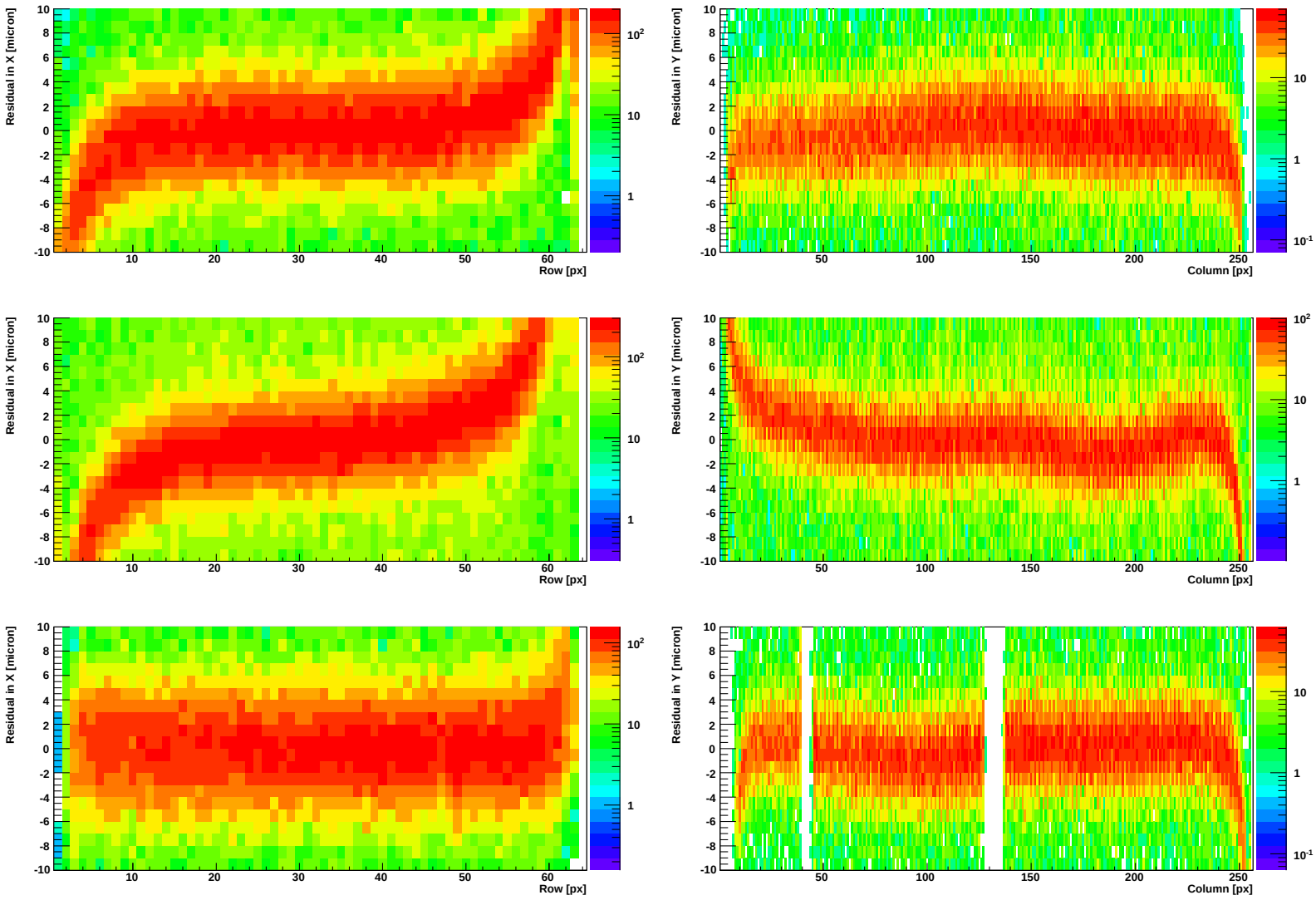






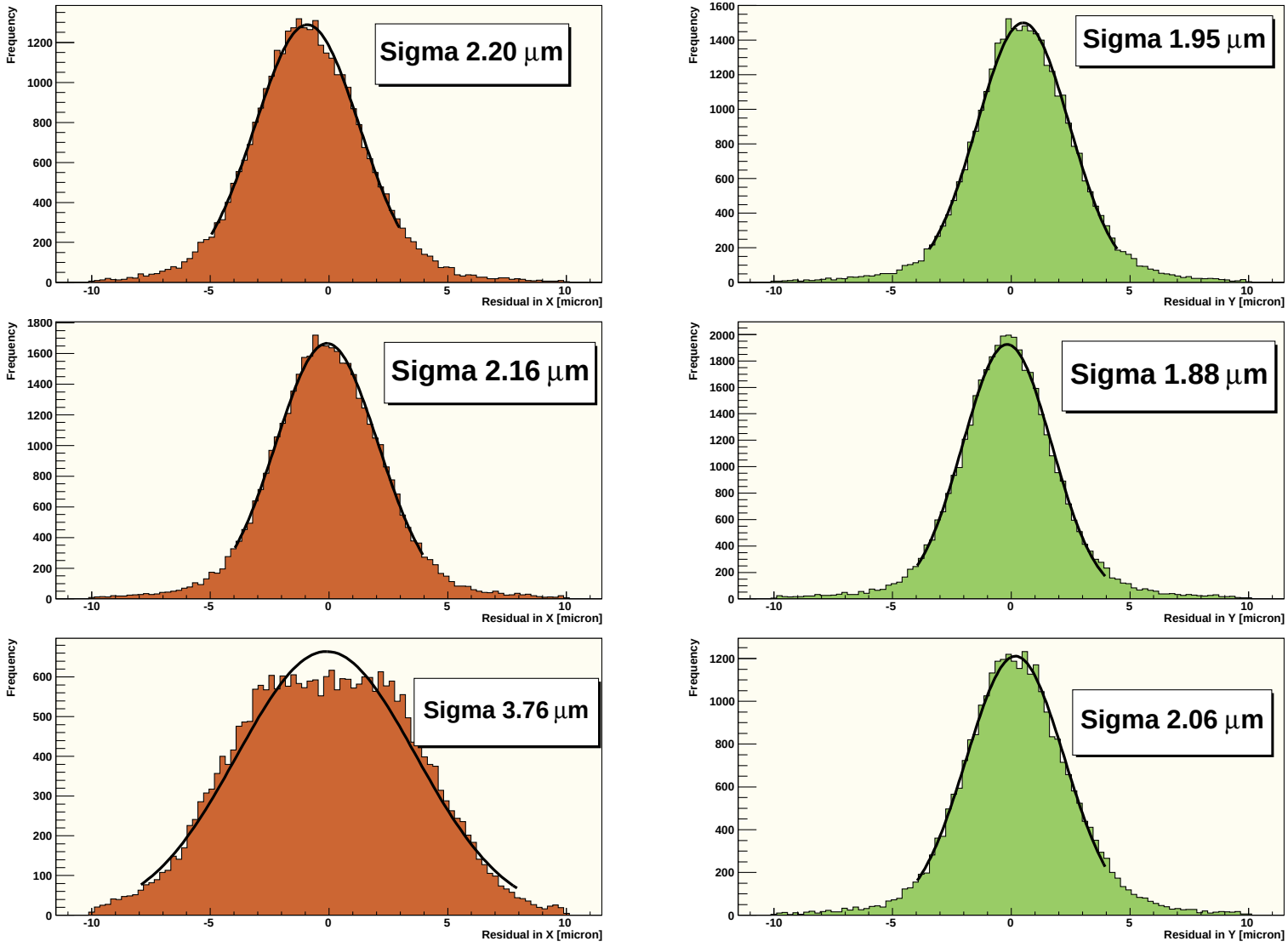
Relative change of alignment constants x, y and φ_z as a funciton of event number. The frame of reference is spanned by first (mod 0) and last module (mod 5).

Edge Effect



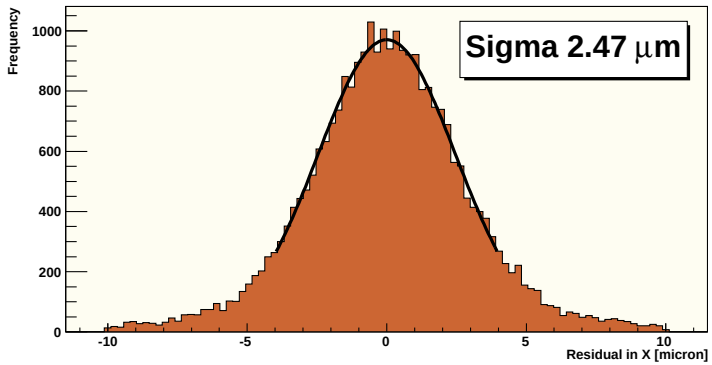
Residual in dependence on matrix position. Residual in x vs. row (left). Residual in y vs. column (right). From top to bottom H3.0.04, H3.0.07 and H3.0.01.

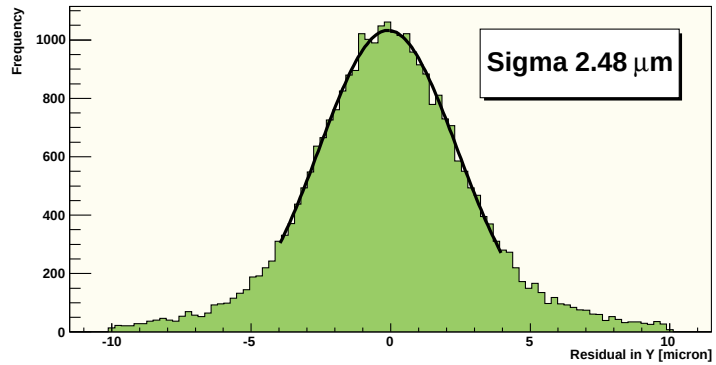
Center of Gravity Residuals

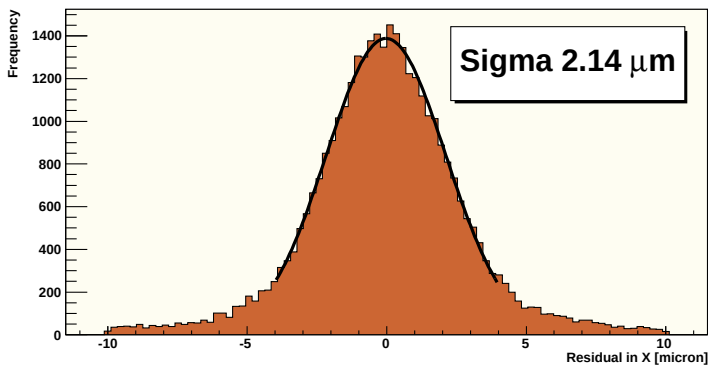


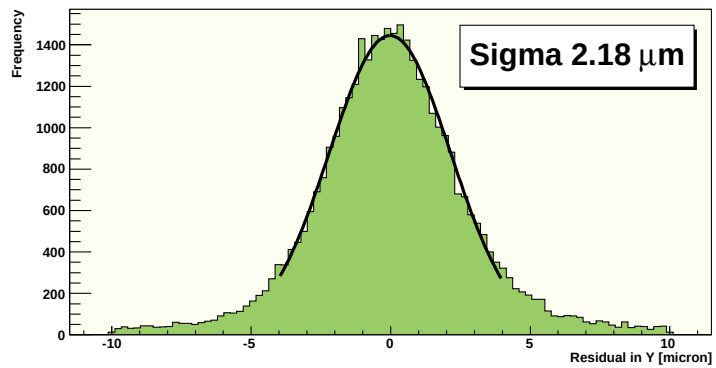
Residuals in x and y of H3.0.04, H3.0.07 and H3.0.01. Telescope and DUT hits reconstructed as center of gravity.

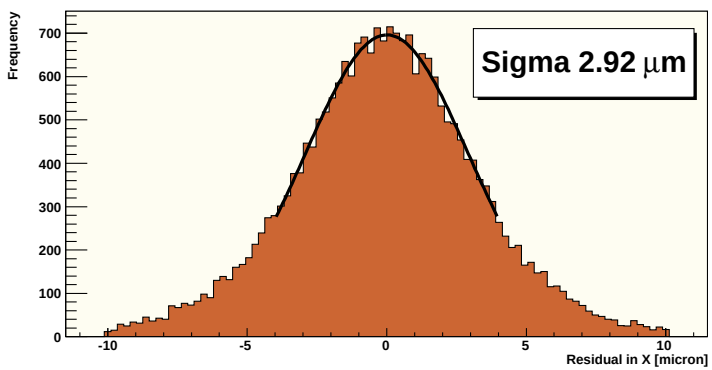
Eta Residuals

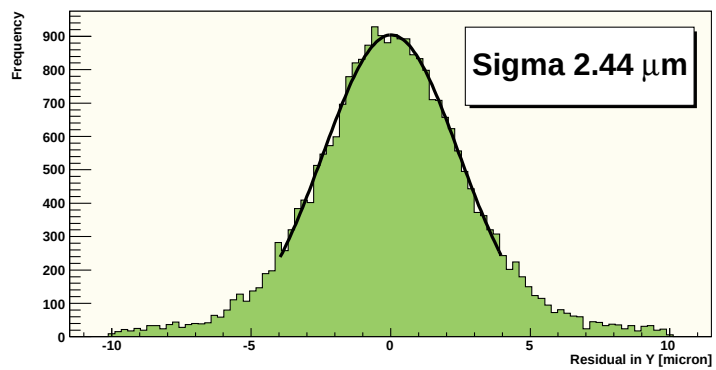






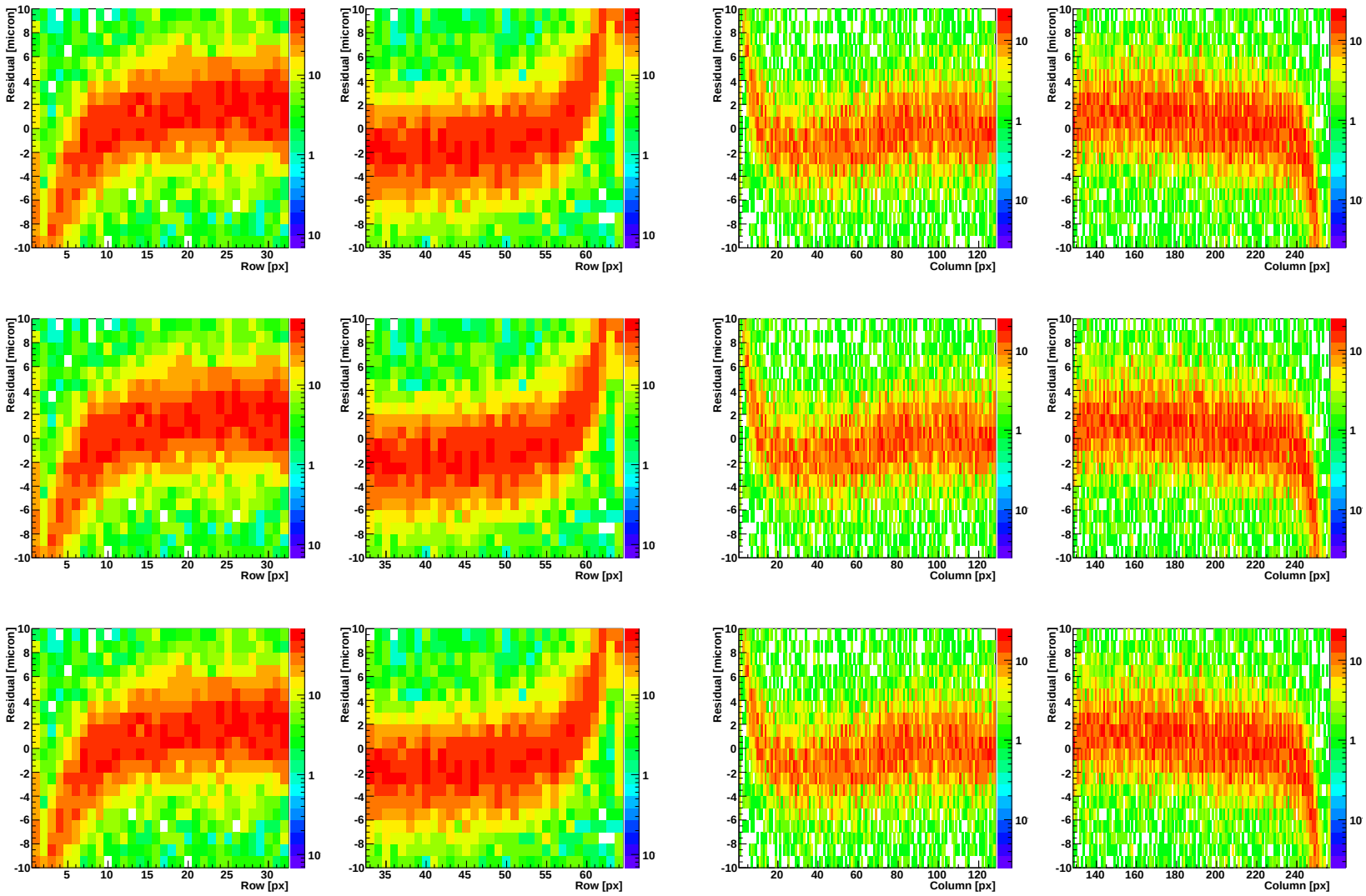






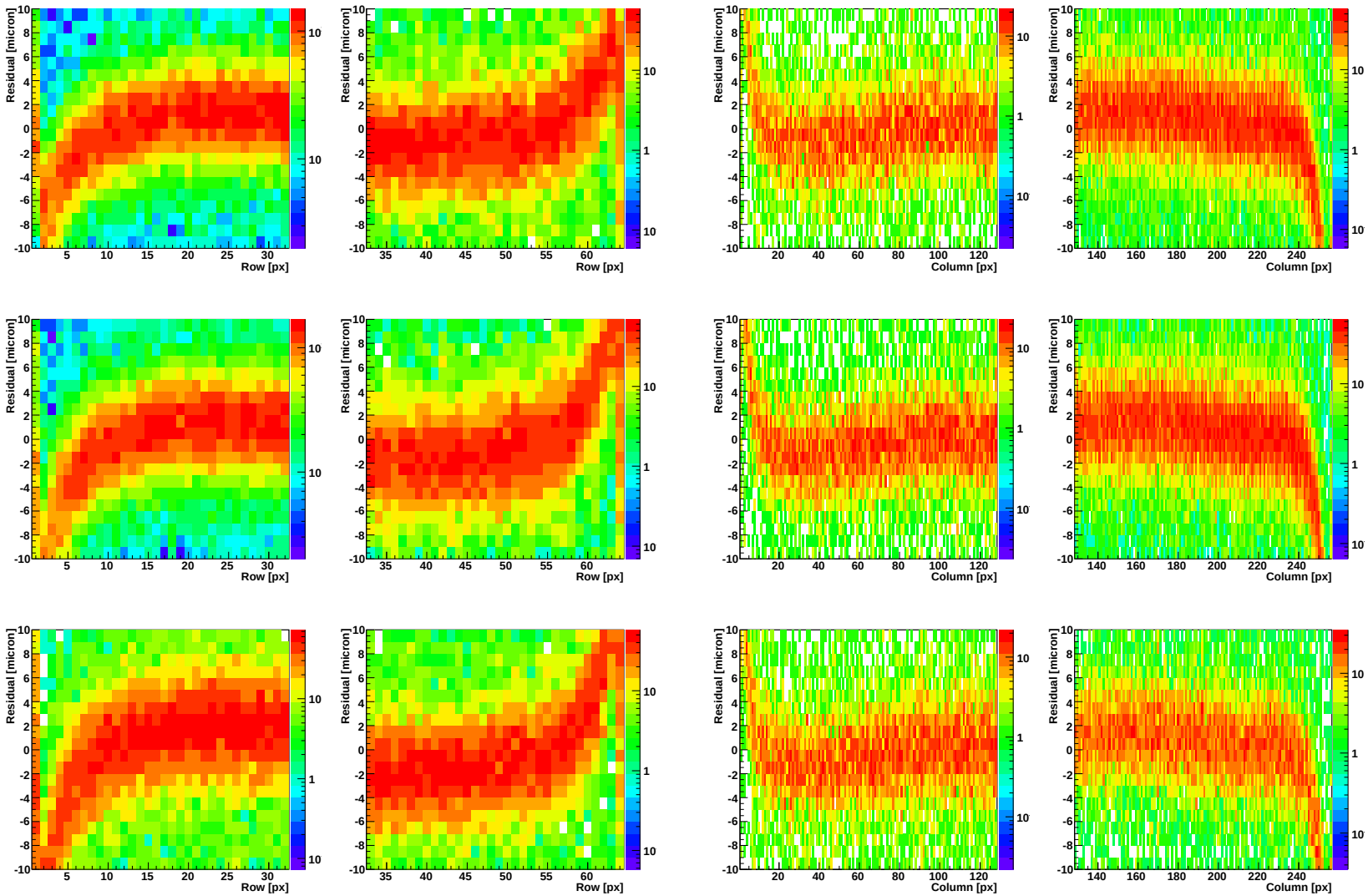
Residuals in x and y of H3.0.04, H3.0.07 and H3.0.01. Telescope and DUT hits reconstructed with eta algorithm.

Edge Voltage Scan



Residuals vs. hit position with reference edge voltage (top to bottom) 0, 0 and 0 Volts on DUT 3.0.04.

Edge Voltage Scan



Residuals vs. hit position with edge voltage (top to bottom) -10, -5 and -3 Volts on DUT 3.0.04.

Analysis Chain in Detail

1. Readin
   - Joining subrun files to large single file
   - Using Marlin processor "DEPFETReader" developed by Julia Furletova to convert daq raw data to lcio standard
2. Pedestal and noise calculation
   - Using "EUTelPedestalNoiseProcessor"
   - Pedestal and noise is calculated within 2 loops over 20k events.
   - In each loop the common mode noise is calculated as the median of adc values of a single row.
   - The first loop delivers pedestal and noise estimates. With these estimates it is possible to reject hits ($I_{px} - I_{ped} > 7 \cdot I_{noise}$) before final pedestal and noise calculation.
3. Clustering
   - Using "EUTelCalibrateEventProcessor"
   - Pedestal subtraction and median rowwise common mode correction for raw event calibration
   - Using "EUTelClusteringProcessor"
   - A seed is defined as the highest signal above $5 \cdot I_{noise}$
   - The cluster is a square of 5×5 pixel with the seed in the center. A cluster pixel can contain positive and negative adc values.
   - The cluster search is iterated, leaving out pixel belonging to a cluster, till no more seed can be found.

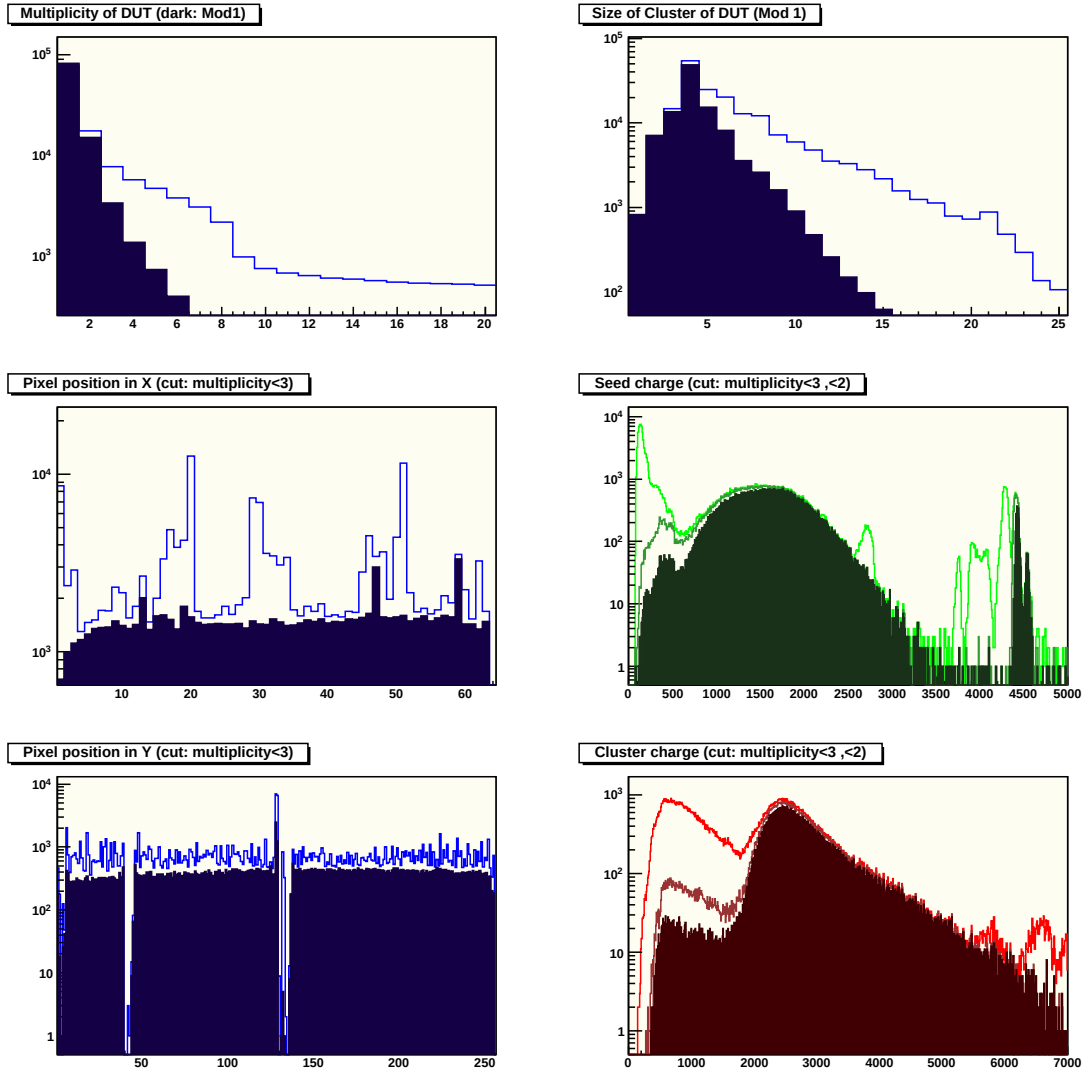
Analysis Chain in Detail

4. Filtering
   - Using "EUTelClusterFilter"
   - Filtering for ROI clusters in the center of the matrix
   - Filtering for events with exactly one cluster on each plane
5. Eta function calculation
   - Using "EUTelCalculateEtaProcessor"
   - Using the filtered ensemble of high quality hits for eta calculation
   - The eta correction function corrects the center of gravity position and accounts for non linearities in charge sharing
   - The center of gravity is calculated using the full signal of a 5×5 cluster
   - Method still flawed and the straigh center of gravity algorithm gives better results !
6. Hit reconstruction
   - Using "EUTelHitMaker"
   - Center of gravity hits are produced from the 5×5 full frame cluster
   - Low and high quality clusters are processed
   - From the Center of gravity position can be refined using the eta correction

Analysis Chain in Detail

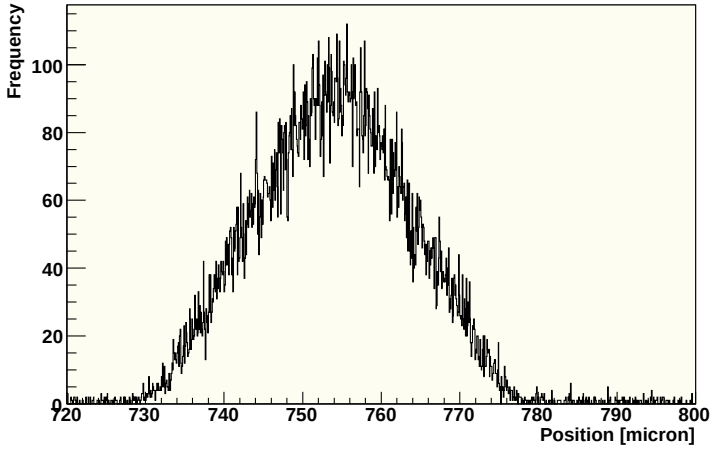
7. Alignment
   - Using "EUTelMille"
   - Eta corrected high quality hits are used for alignment with Millepede II
   - Alignment constants are: x-offset, y-offset and rotation around z
   - The limiting factor in the alignment is the mechanical stability of the setup
8. Hit position correction
   - Using "EUTelApplyAlignmentProcessor"
9. Track reconstruction
   - Using "EUTelMultiLineFit"
   - Fits multiple 6 parameter straight lines through telescope planes of one event
   - Writes all cluster, hit and track parameters to root tuple

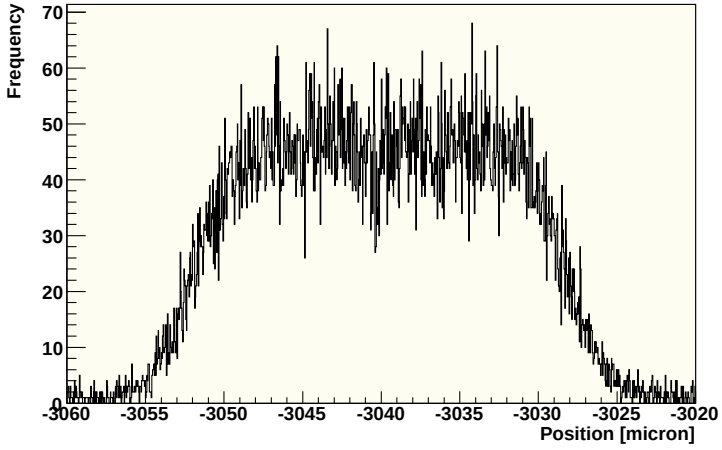
Features of DUT 3.0.01



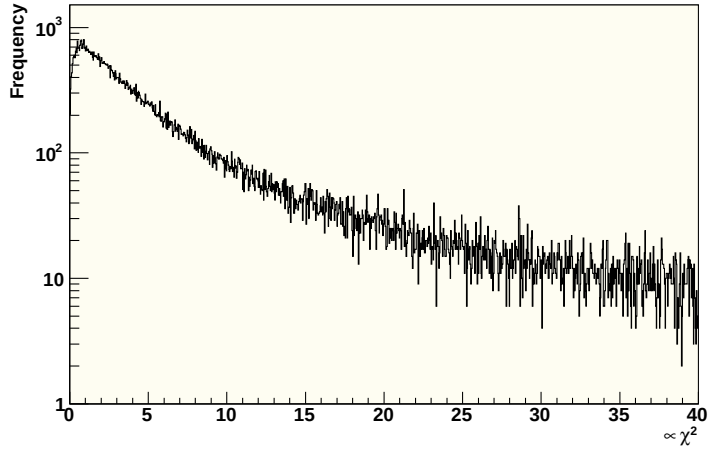
Multiplicity and cluster size of DUT 3.0.01 vs. standard telescope module (top). Seed and cluster charge dependence on hit multiplicity (bottom).

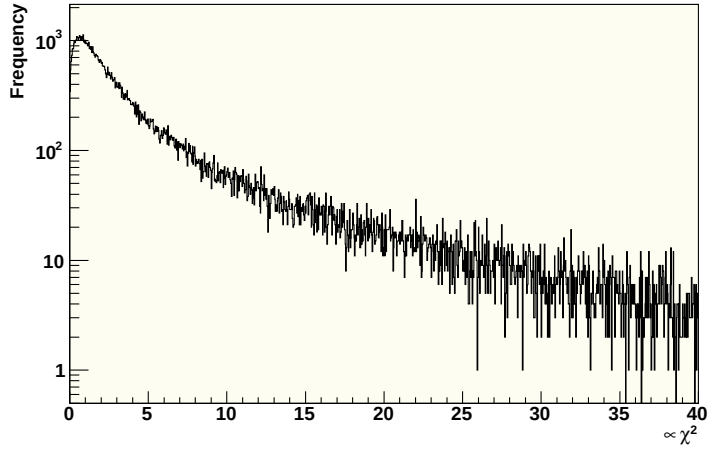
Binary Hit & Chi Squared





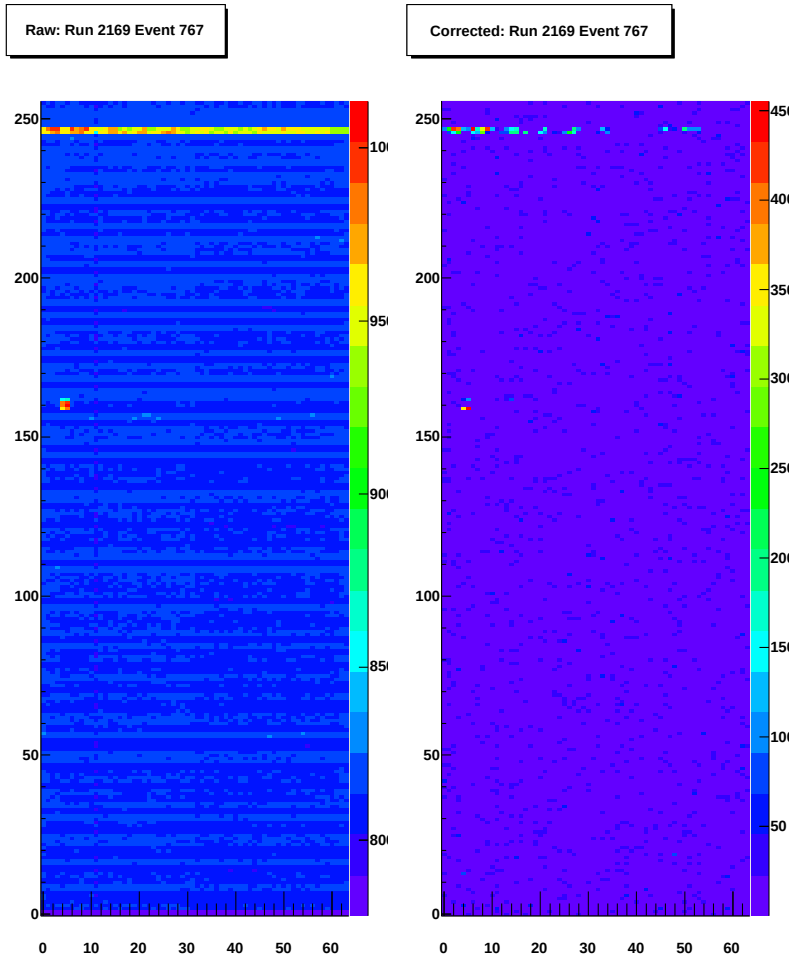
Residal reconstructed from seed position in x and y (top and bottom).



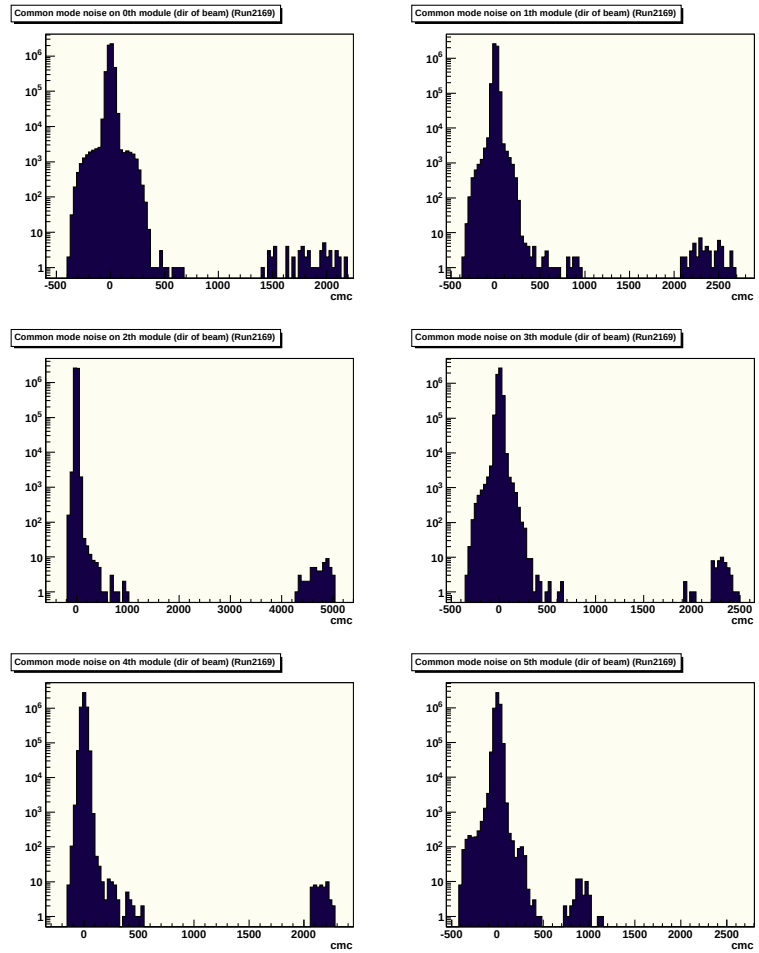


Chi squared distribution from track-fit x and y (top and bottom).

Displays



Example for a high common mode noise event frame.



Common mode noise distribution for telescope and DUT 3.0.04.