

Test beam results from large pxd6 detectors

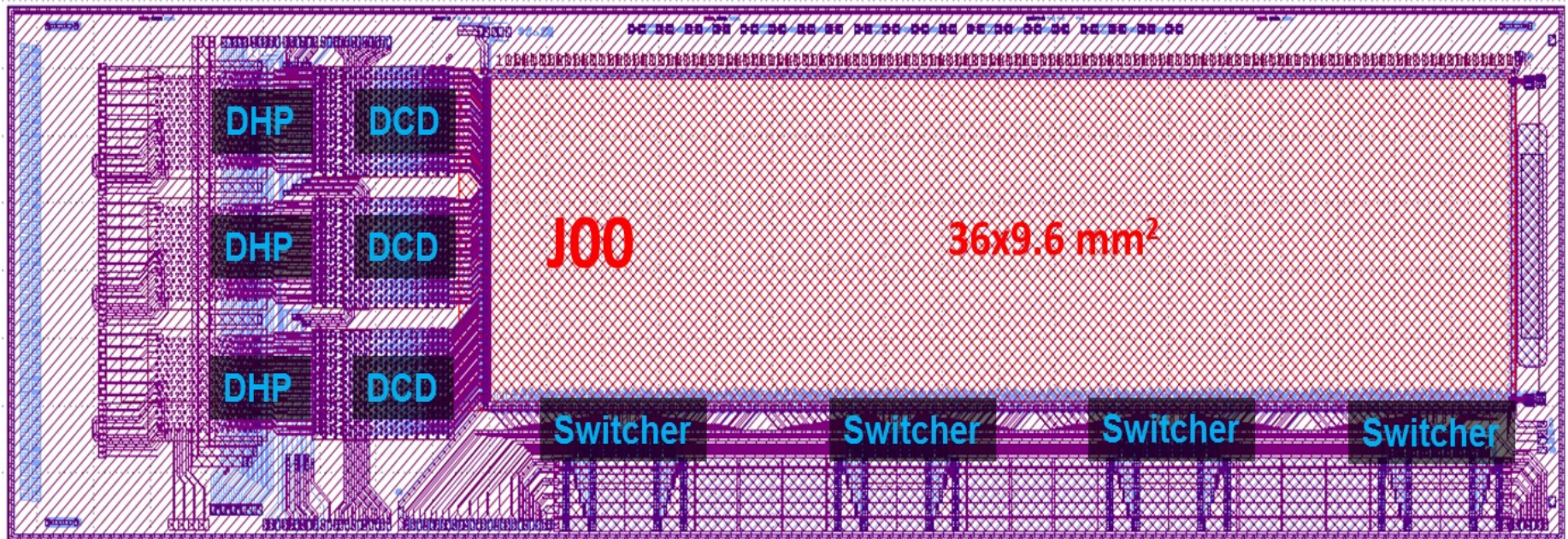
B. Schwenker

For the test beam crew

What can we learn ... ?

- November 2014 test beam at CERN tells us:
 - System understanding → see F. Lütticke's talk
 - Improvement from 2bit DAC (as compared to test beam in Jan. 2014)
 - Get the calibration constants to compare data with PXD6 simulation?
 - El. Noise, Gq , LSB
 - Does our measured signals match with simulation?
 - Landau, residuals, cluster size
 -

The prototype detector



- Pixel pitch: $50 \times 75 \mu\text{m}^2$
- Thickness: 50 μm thick sensor
- 192 physical columns
- 480 physical rows



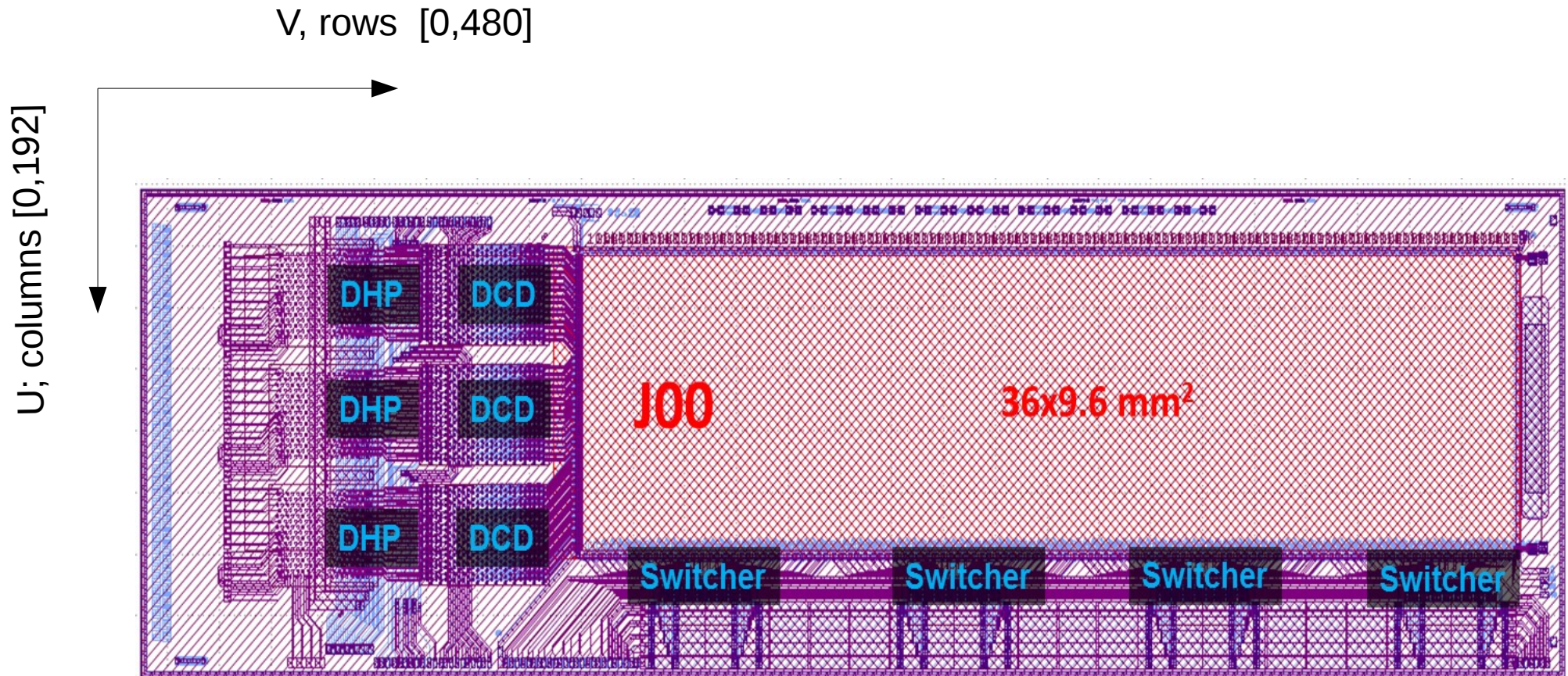
- ASICS: DCDBv2, DHP02, SwitcherB1.8G
- Speed: 250MHz (nominal 320MHz)

- Same detector as in January 2014

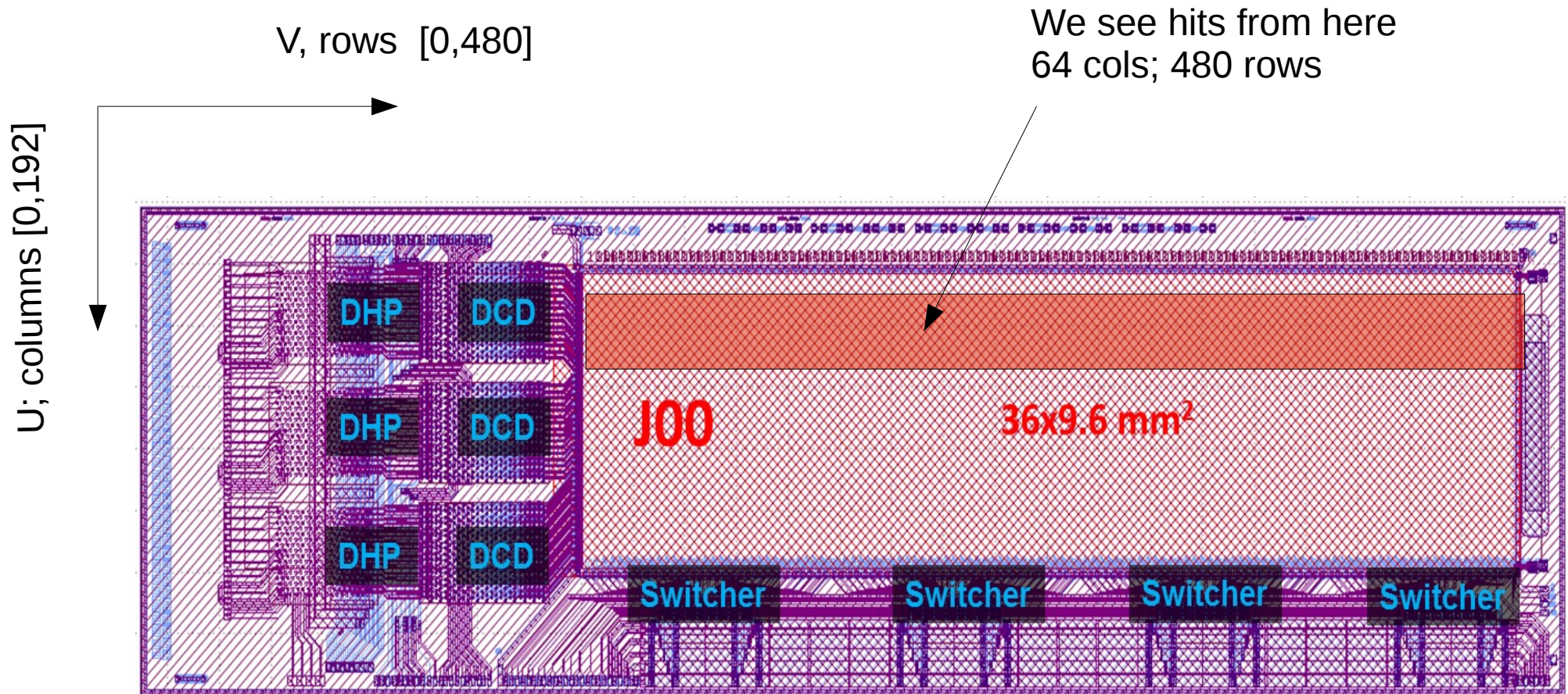
- 2 μm pointing error from telescope
→ in-pixel stat.

- 2bit pedestal subtraction (DCDB)
→ Largest problem last time

Local coordinate system and channel numbering (TB)



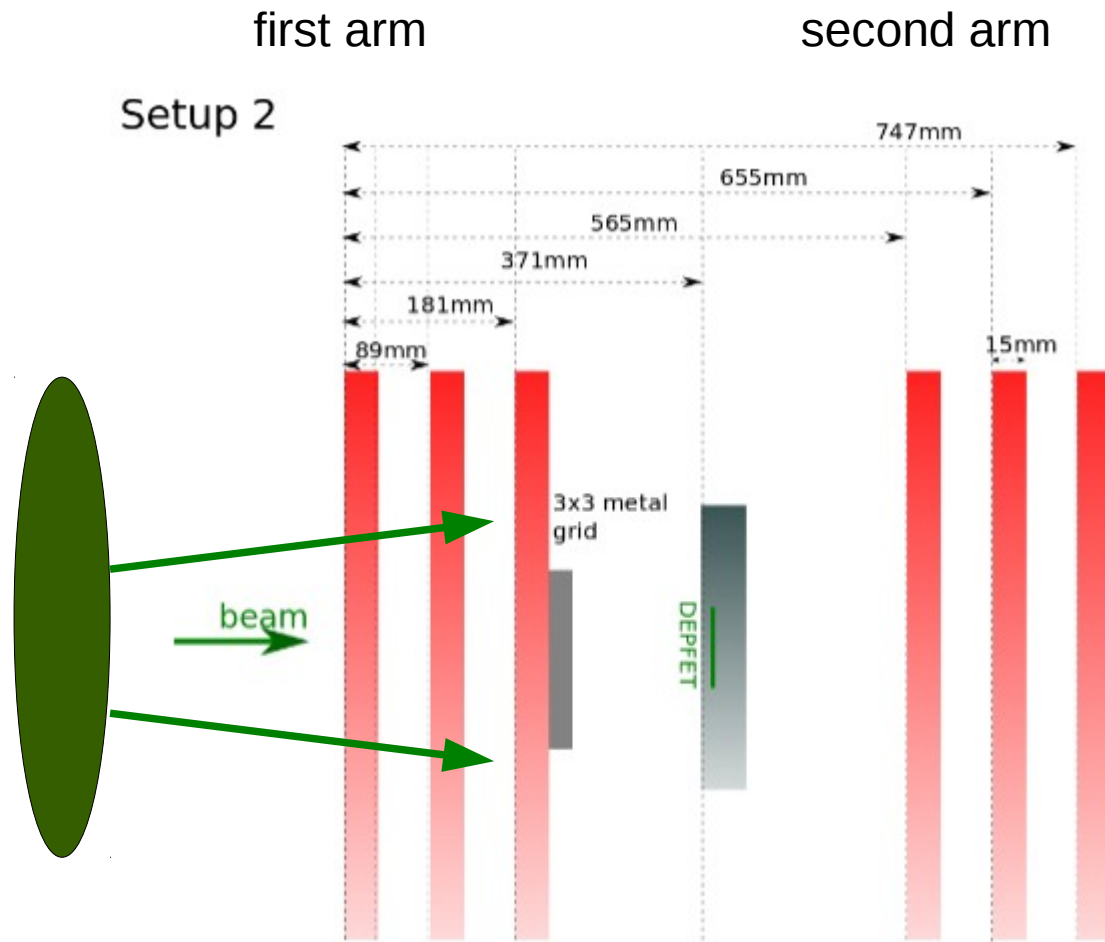
Only one DCD/DHP pair readout



Data sample from CERN

- Many short runs needed for debugging and not usable for validation.
- Runs at perpendicular incidence; 120GeV
 - Runs: 209, 210, 211, 212
 - First DCD/DHP pair used
 - Total of 350k tel. tracks with DEPFET hit
- Runs at 30° tilted sensor
 - Only one long run: Run325
 - Tilt around local horizontal (x) axis
 - Only few tracks (<10k matched tracks)

EUDET Tracking



- 6 eudet layer, $\sim 2\mu\text{m}$ error

- trigger PMT's before and after eudets

- triggered track: 6hit eudet hit(!)

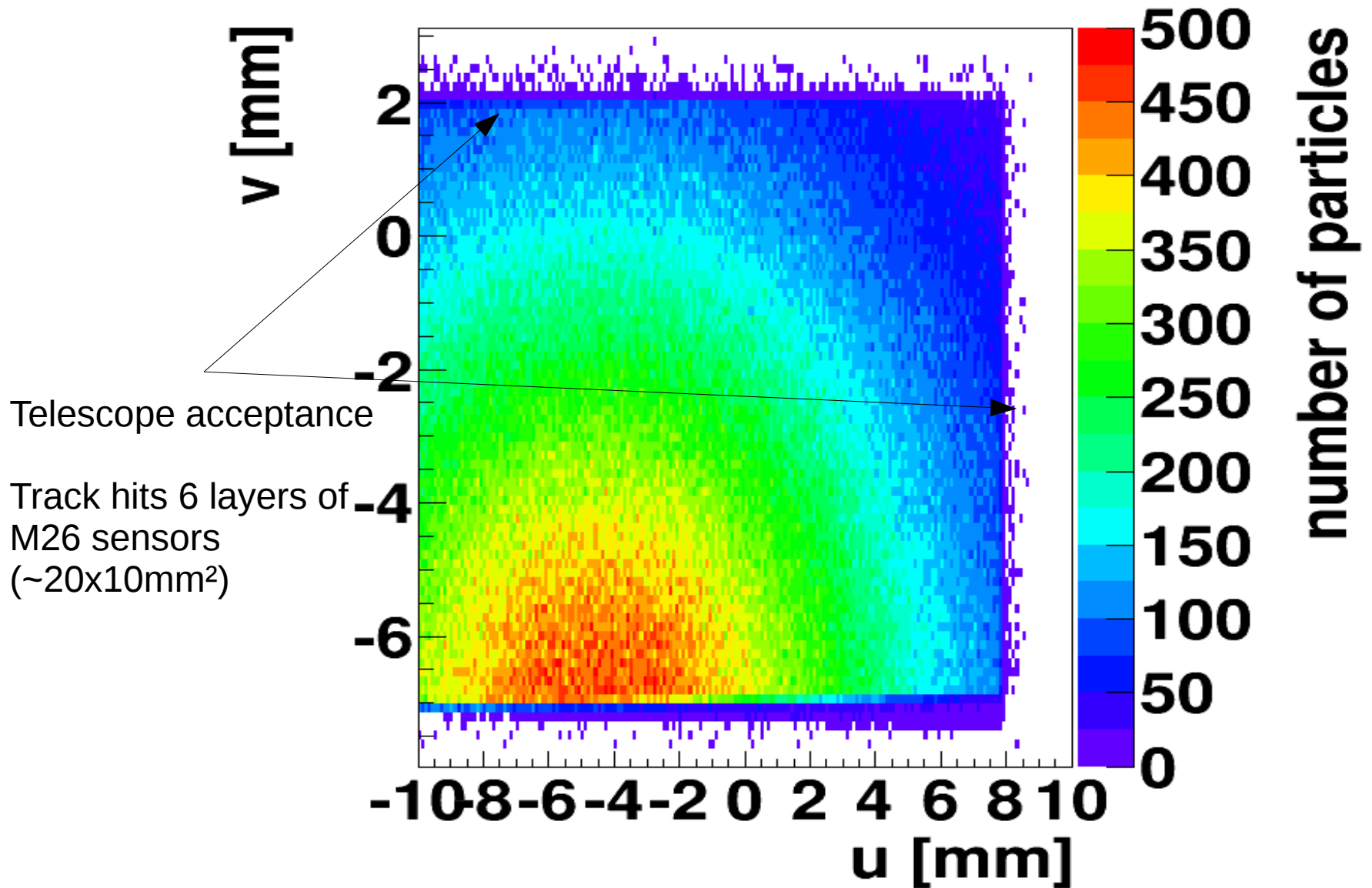
- z axis is aligned to beam axis

- finding/alignment/tracking in ILCSSoft.

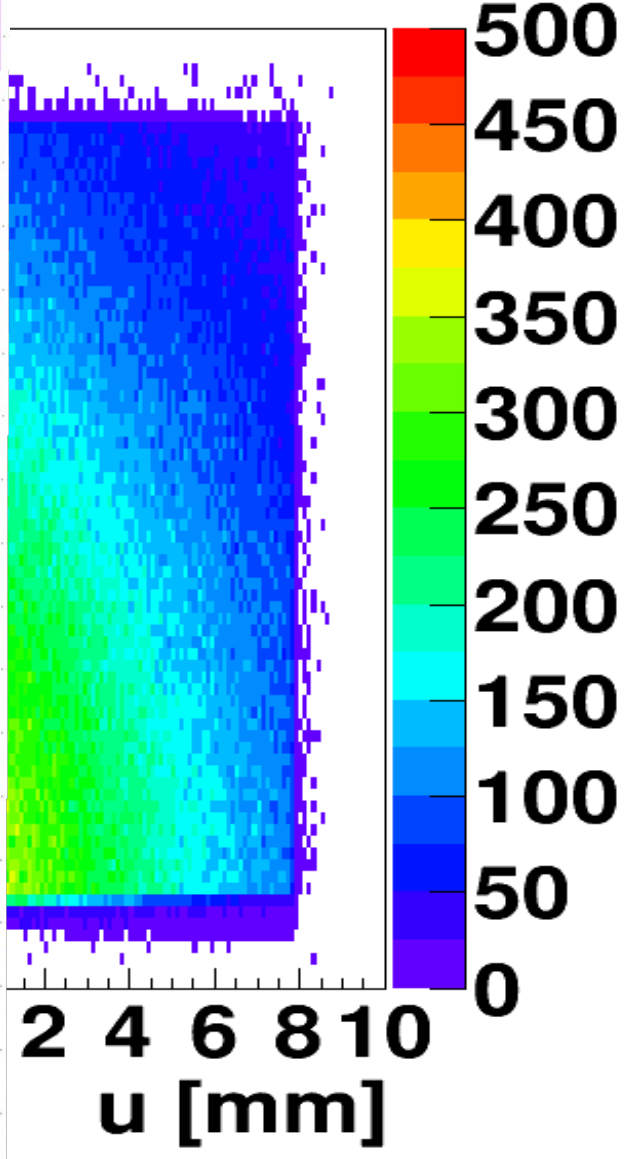
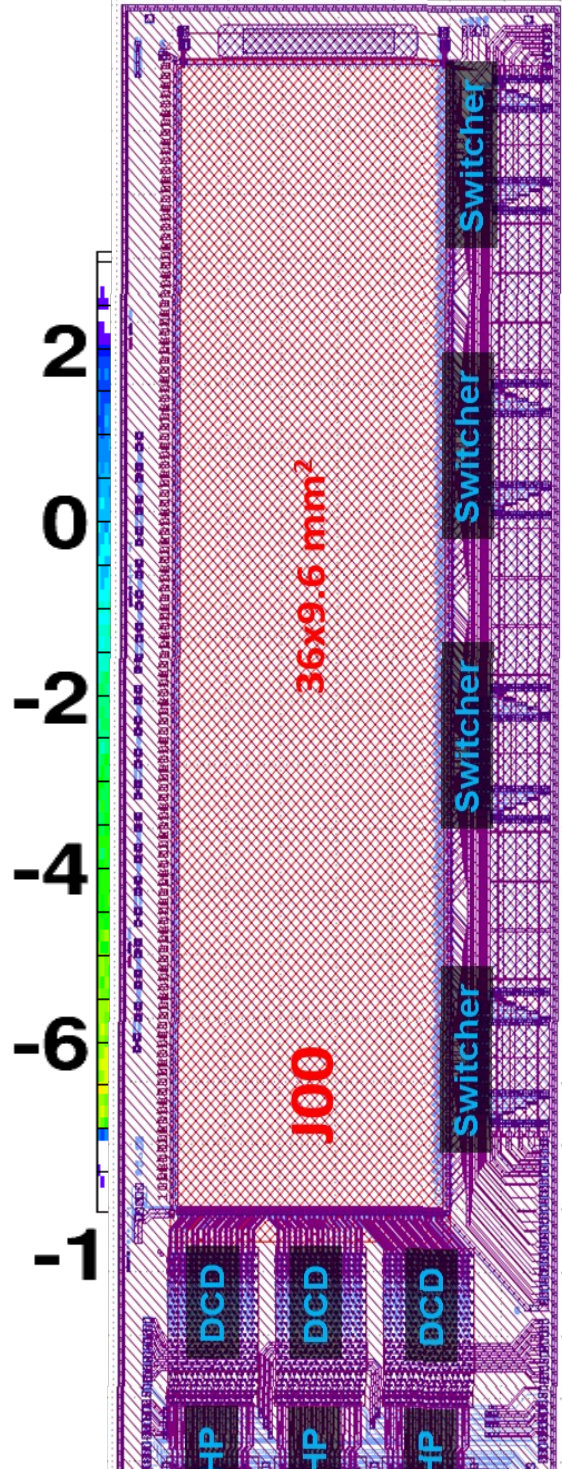
Spot size (rms)
 $\sim 7\text{mm}$

Divergence (rms)
 $\sim 100\mu\text{rad}$

Beam Spot: Tel. Acceptance

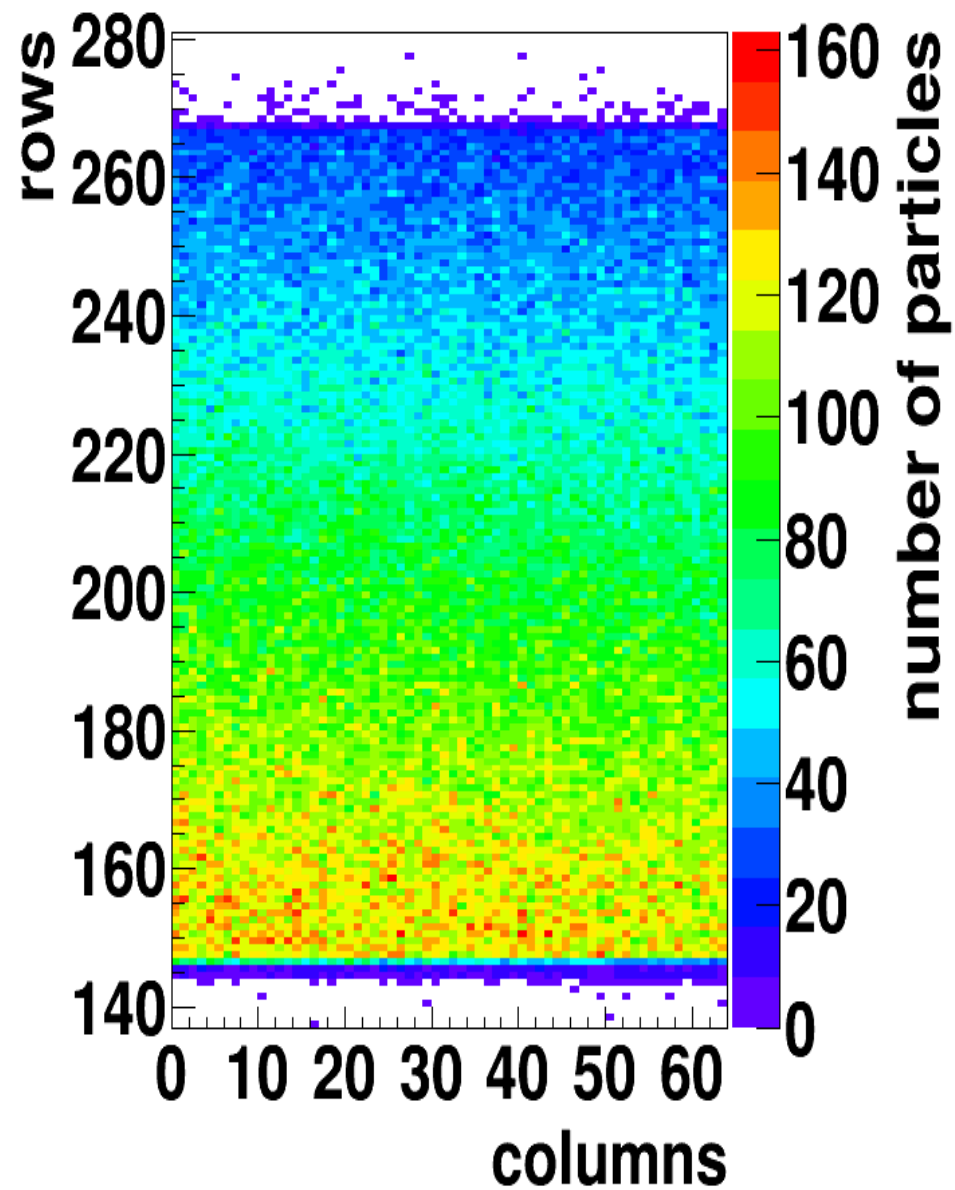
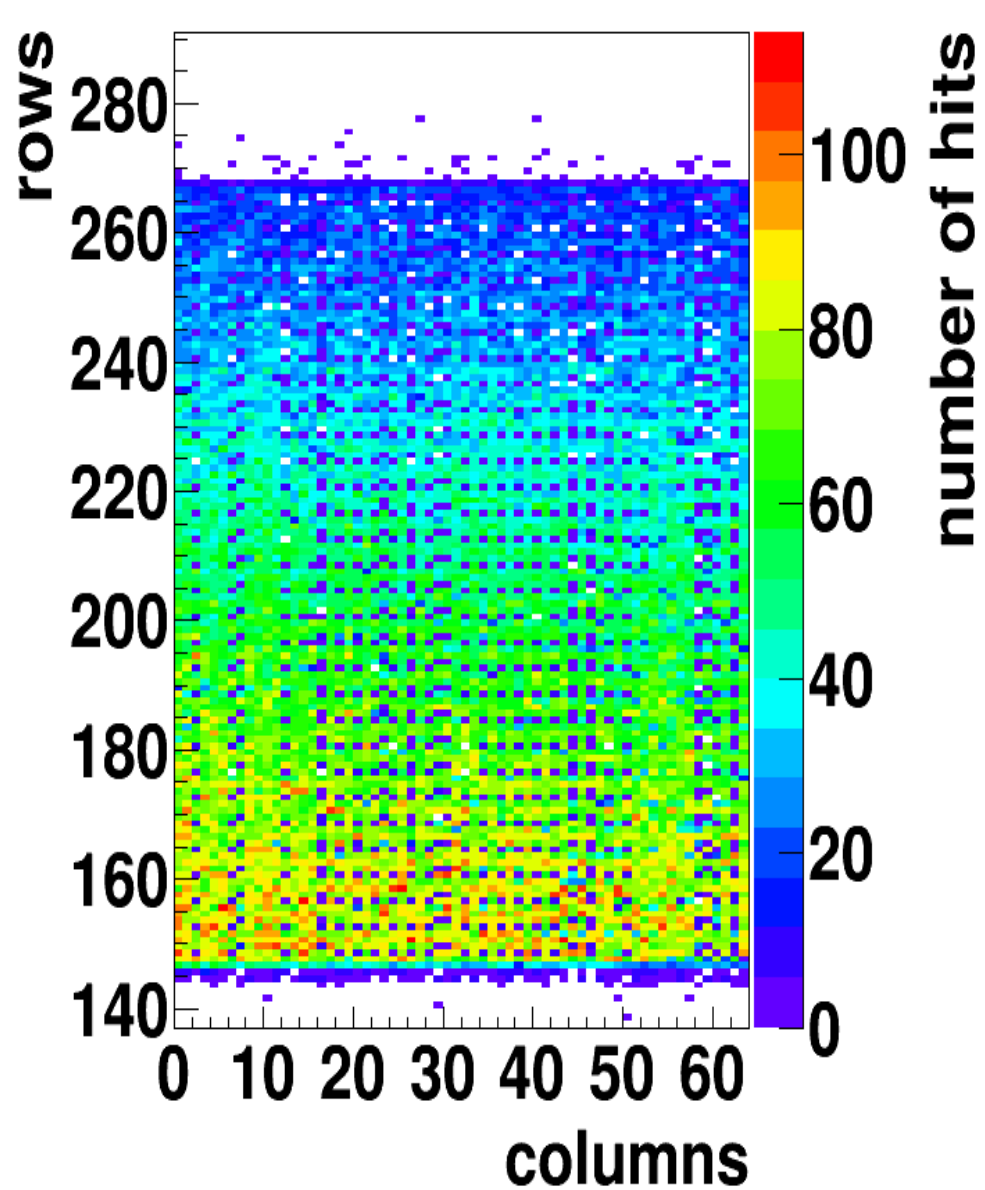


v [mm]

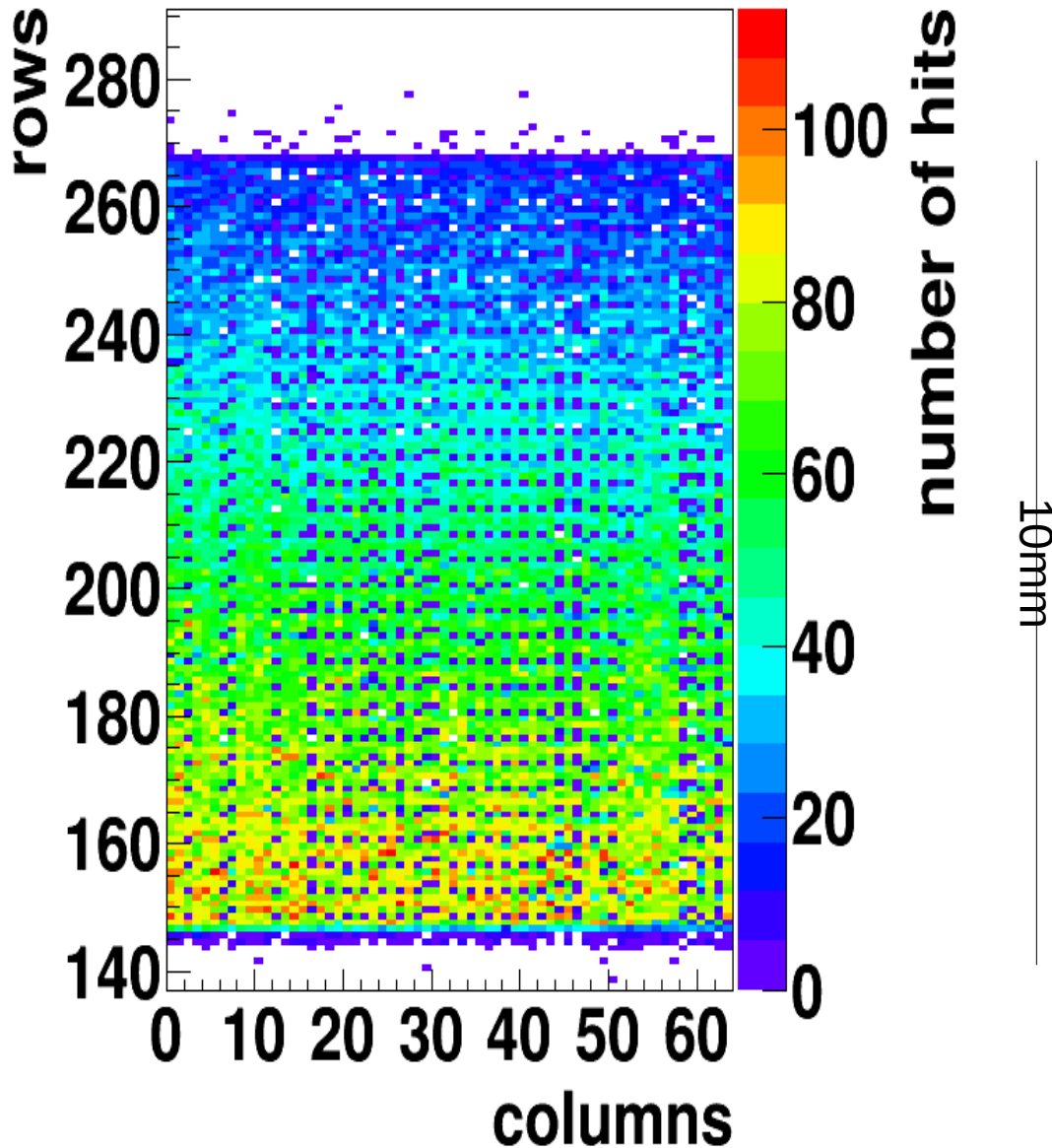


number of particles

DEPFET hits vs. tel. tracks



DEPFET hits vs. tel. tracks



:- Tracks cross rows 140-270

→ telescope acceptance

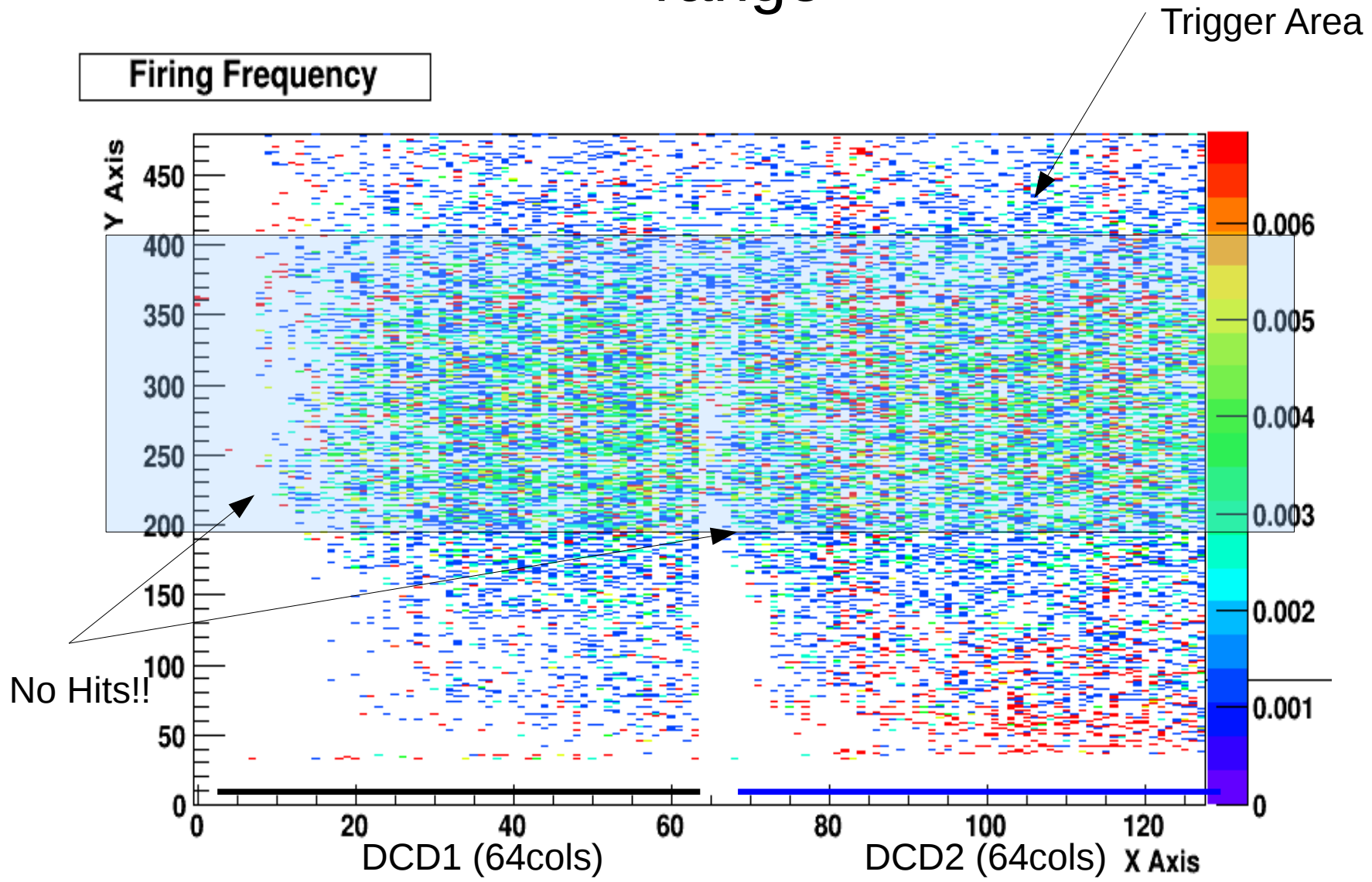
:- many 'dead pixels' (→ no hits)
with period 4 pattern

→ discussion result:
Problem with **drain lines**
(brocken/not connected?)

:- Apart from dead pixels, we see a
smooth section of beam profile.

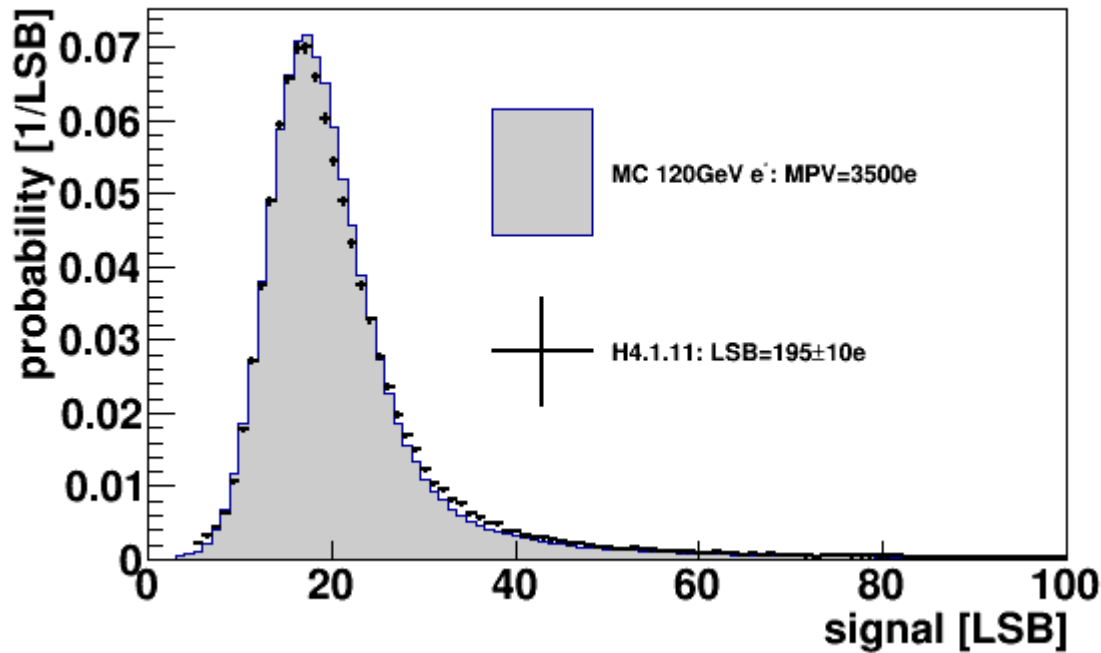
→ thanks to 2bit dac

Remember situation in Jan. 2014:
Many drain currents do not fit into DCDB dynamic range



Landau: H4.1 Measurements

Very good agreement with Digitizer



- DEPFET hits matched to track.

→ clean hit sample

- LSB ~ 195 electrons

→ $Gq \sim 500 \text{ pA/e}$ (sensor)

→ 1 ADU ~ 100 nA (DCD)

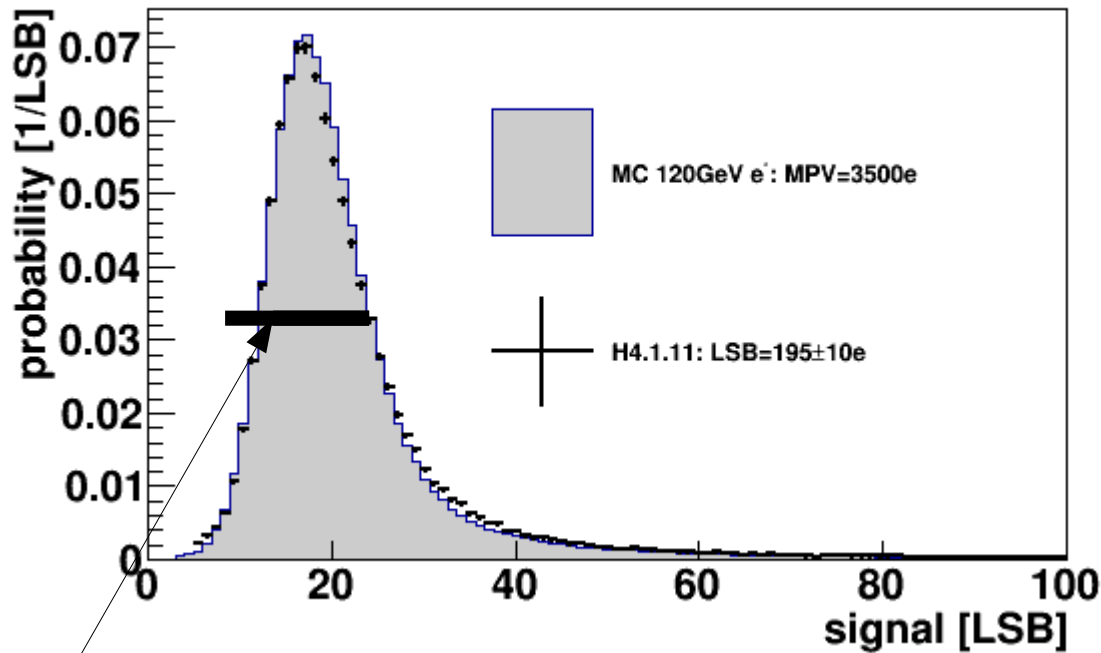
- FWHM ~ 2000e ~ 10 LSB
(Landau fluctuations)

→ we sample noise
(landau fluct.) precisely

→ to me: this makes no sense for Belle II

Landau: H4.1 Measurements

Very good agreement with Digitizer



Landau fluctuations (10~LSB or 2000e)

- We should think about size of LSB in ADC

- proposal: 100nA → 200nA

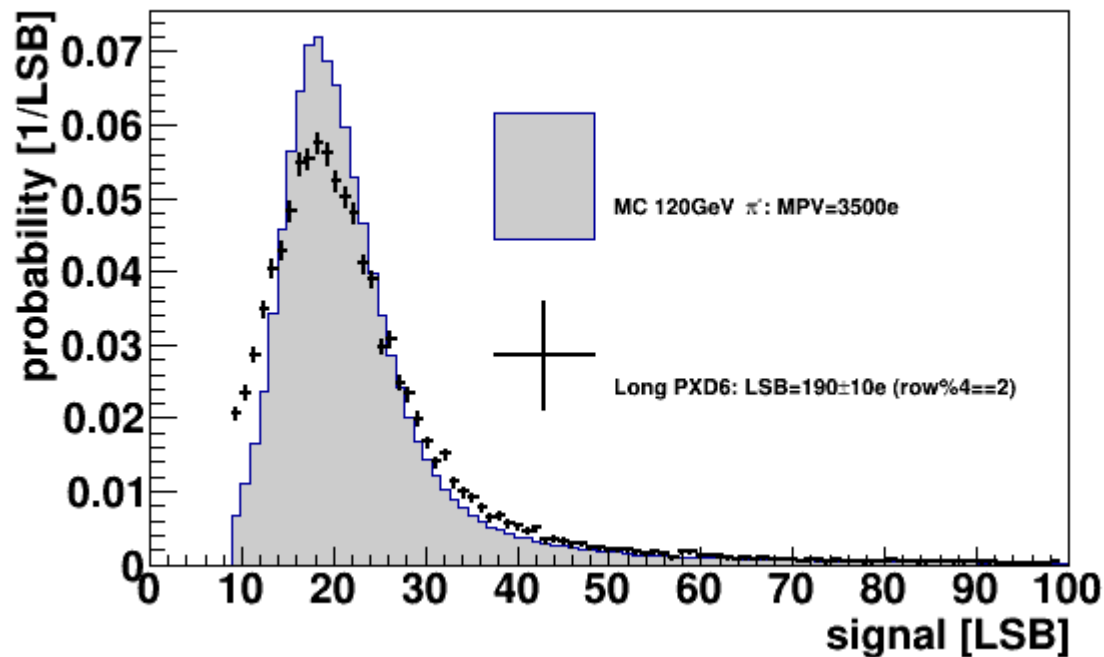
- down: will increase el. noise:

→ no need to be better than landau fluct.

- up: helps to cope with pedestal Variations.

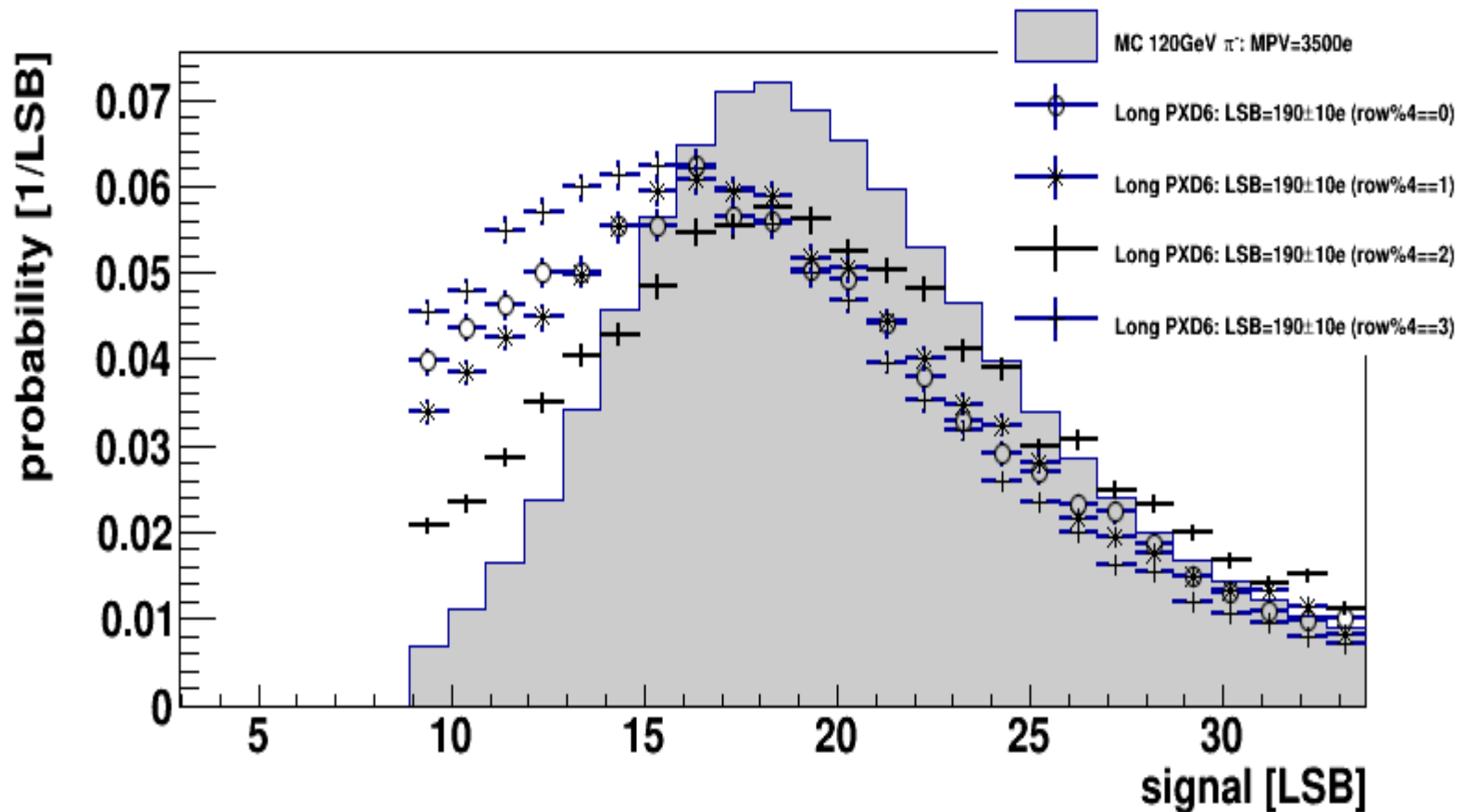
- We should collect arguments and discuss with Ivan.

Landau from large PXD6 (50um Si)



- DEPFET hits matched to track.
 - clean hit sample
- LSB \sim 190 electrons
 - similar to H4.1.
- Only use 4th row to avoid dead channels.
- Measured FWHM too large
 - add. Noise source \sim 5LSB (could be common mode)

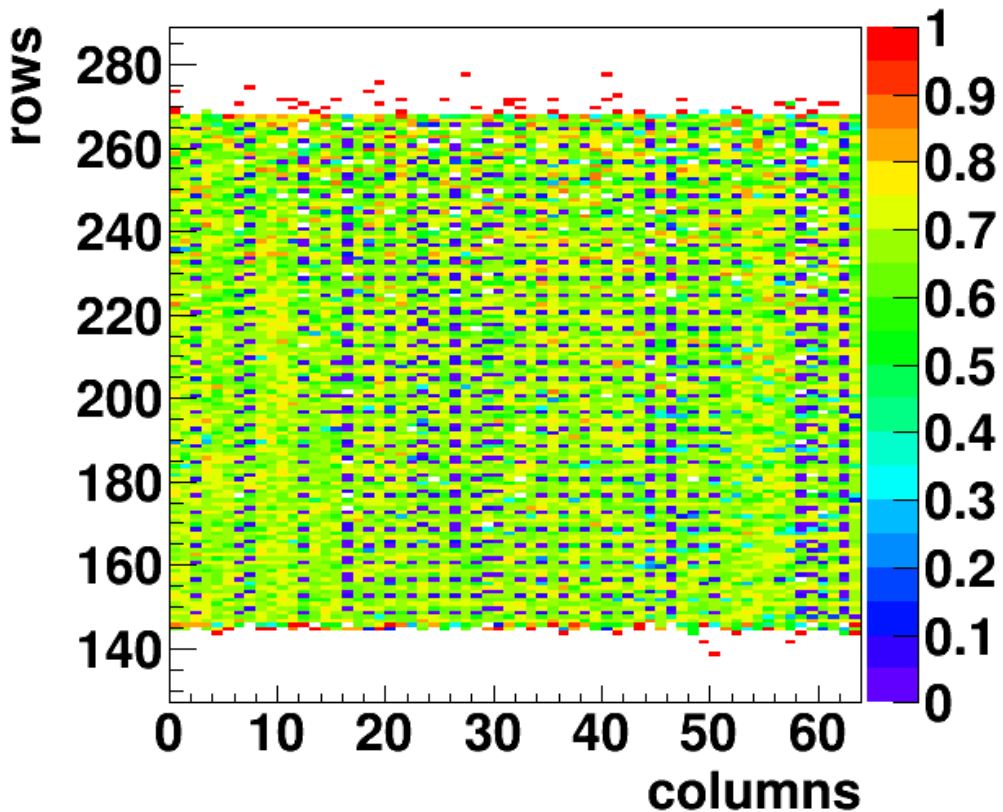
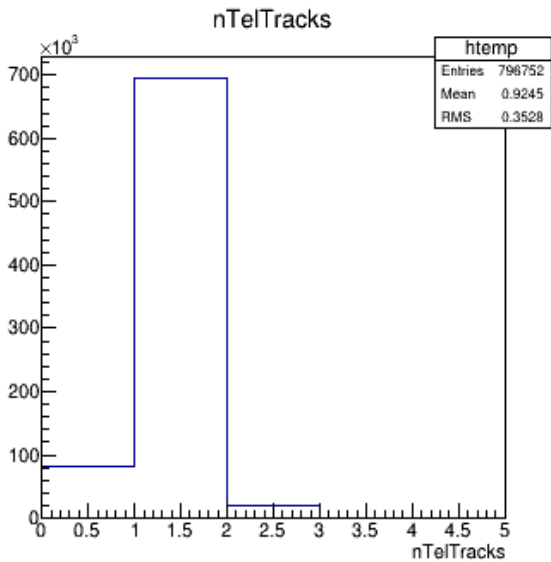
Looking at different rows ...



Efficiency Study

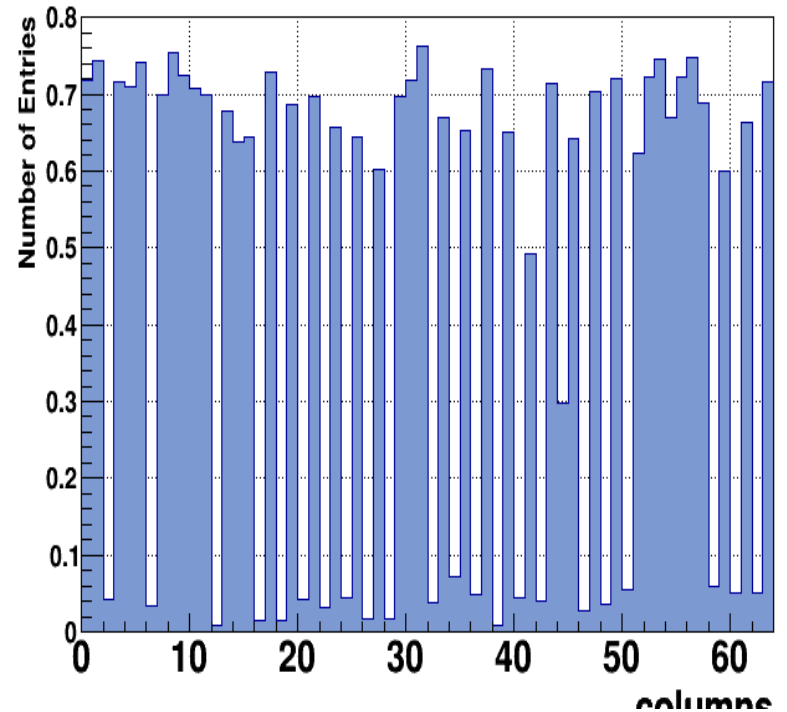
Track with 6 eudet hits used to tag DEPFET hit

:- despite long m26 integration time, multiplicity low

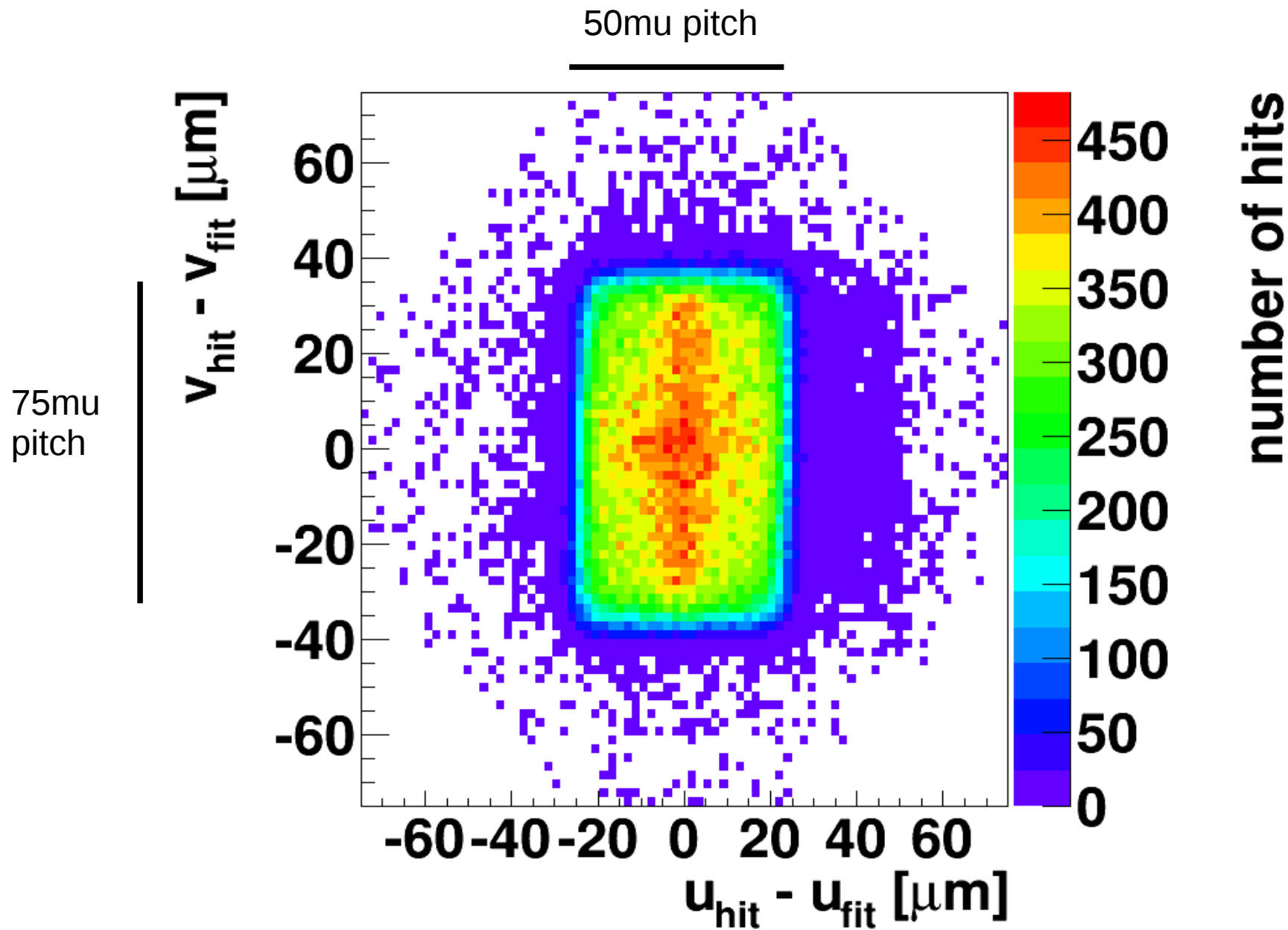


efficiency

ProjectionX of biny=161

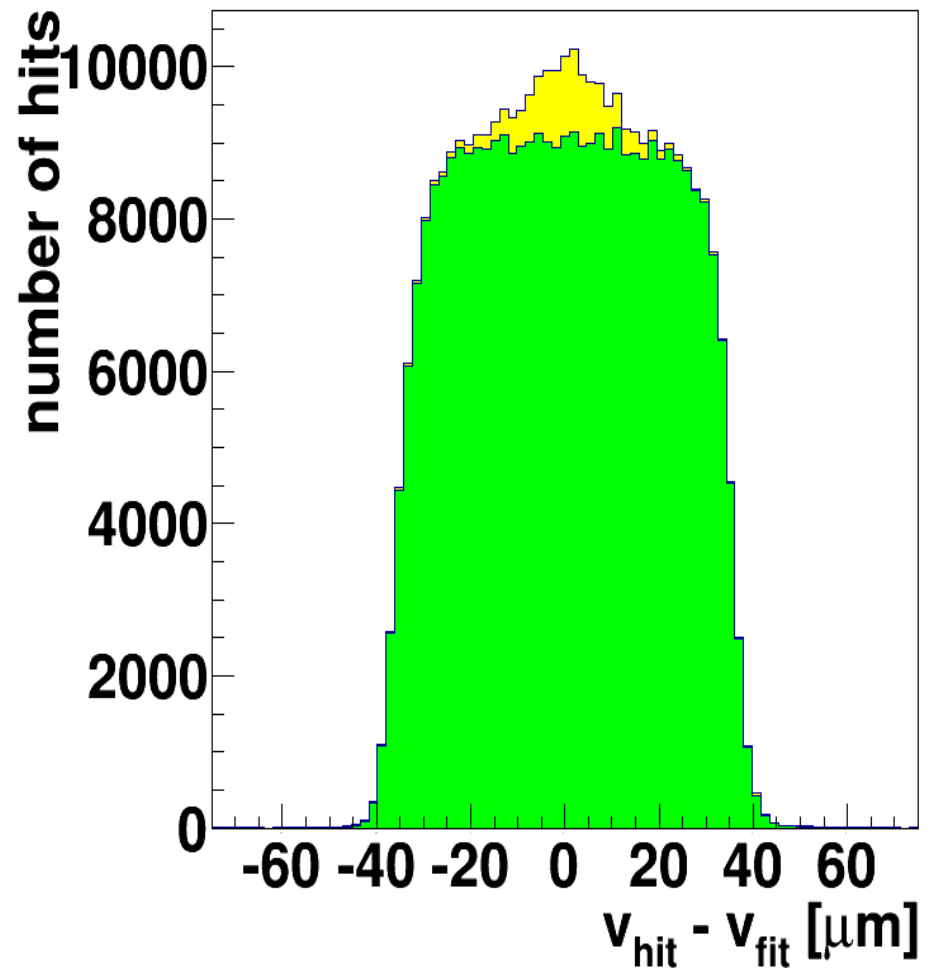
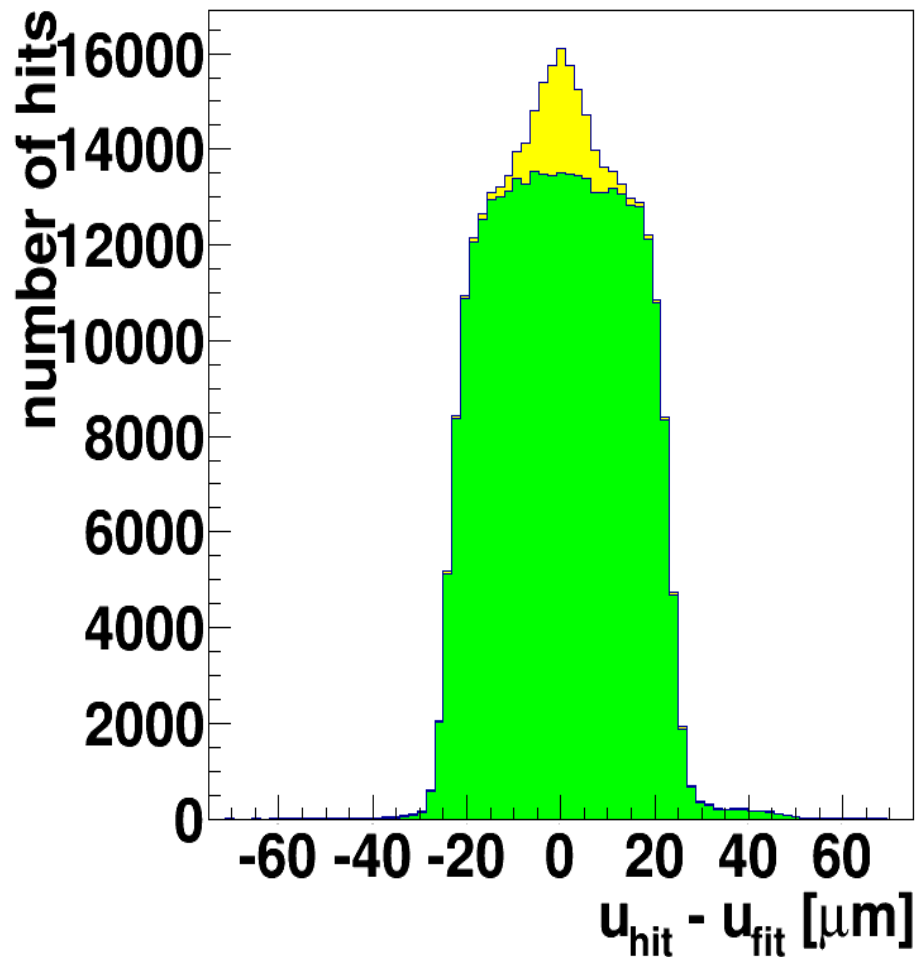


2D Residuals (perp. incidence)

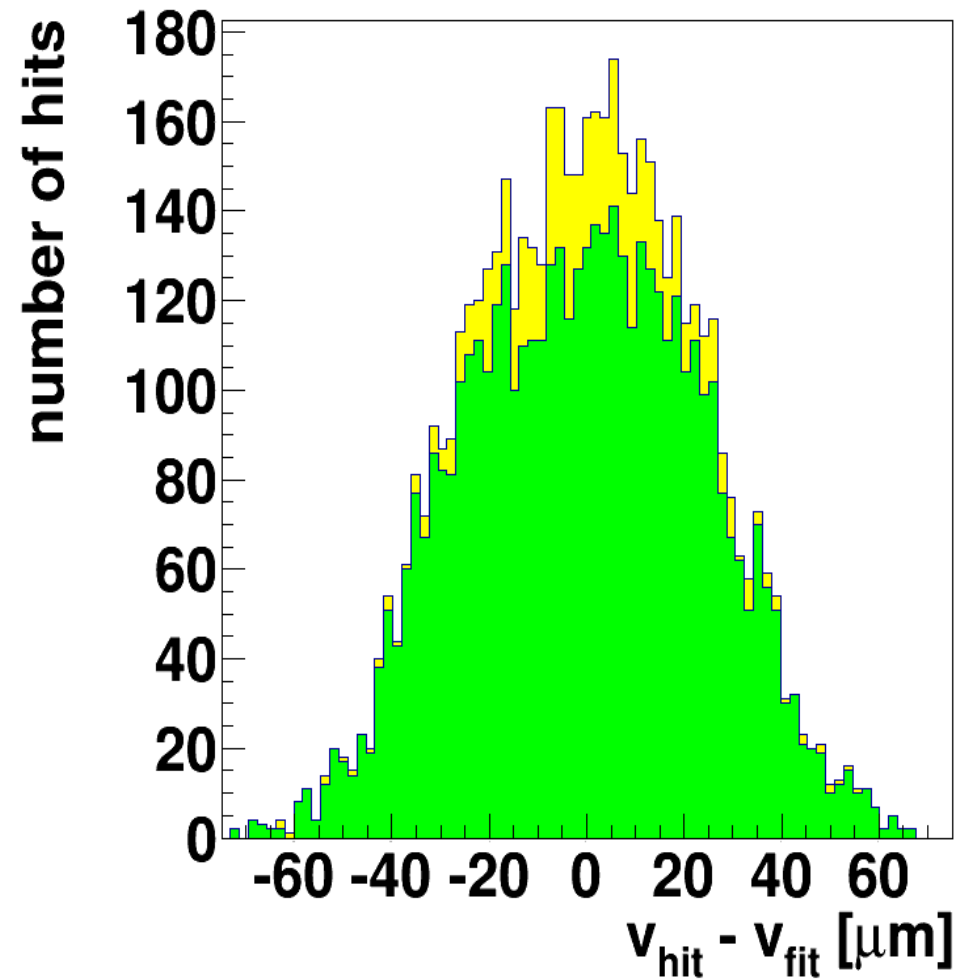
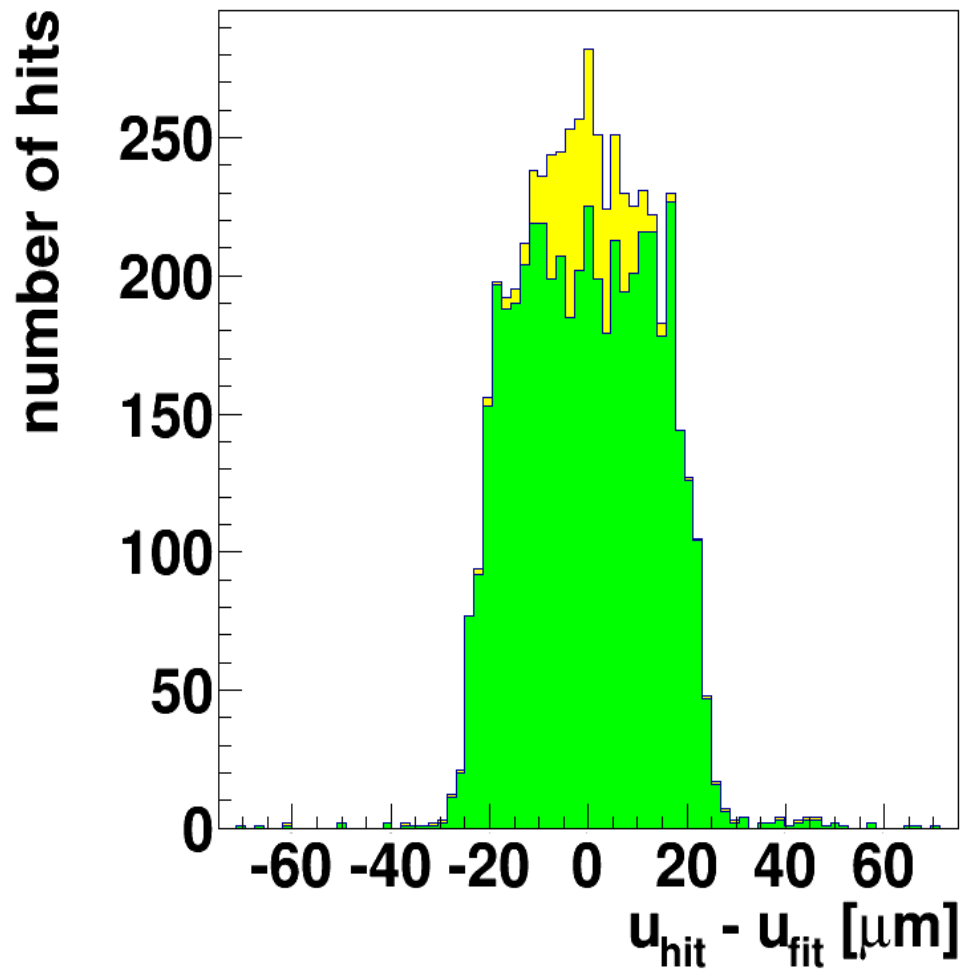


1D residuals (perp. incidence)

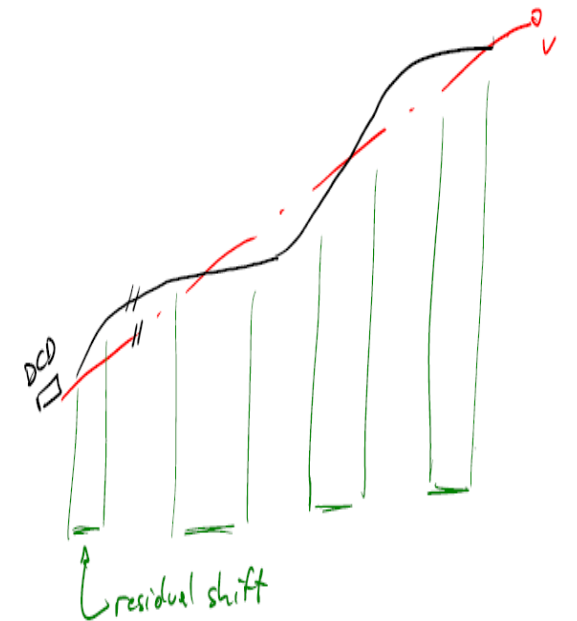
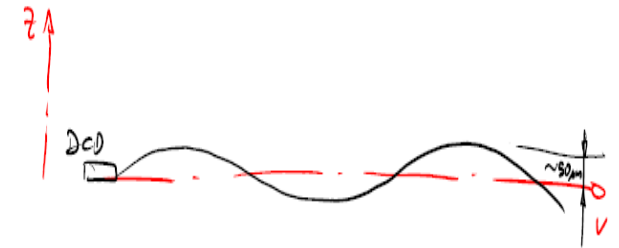
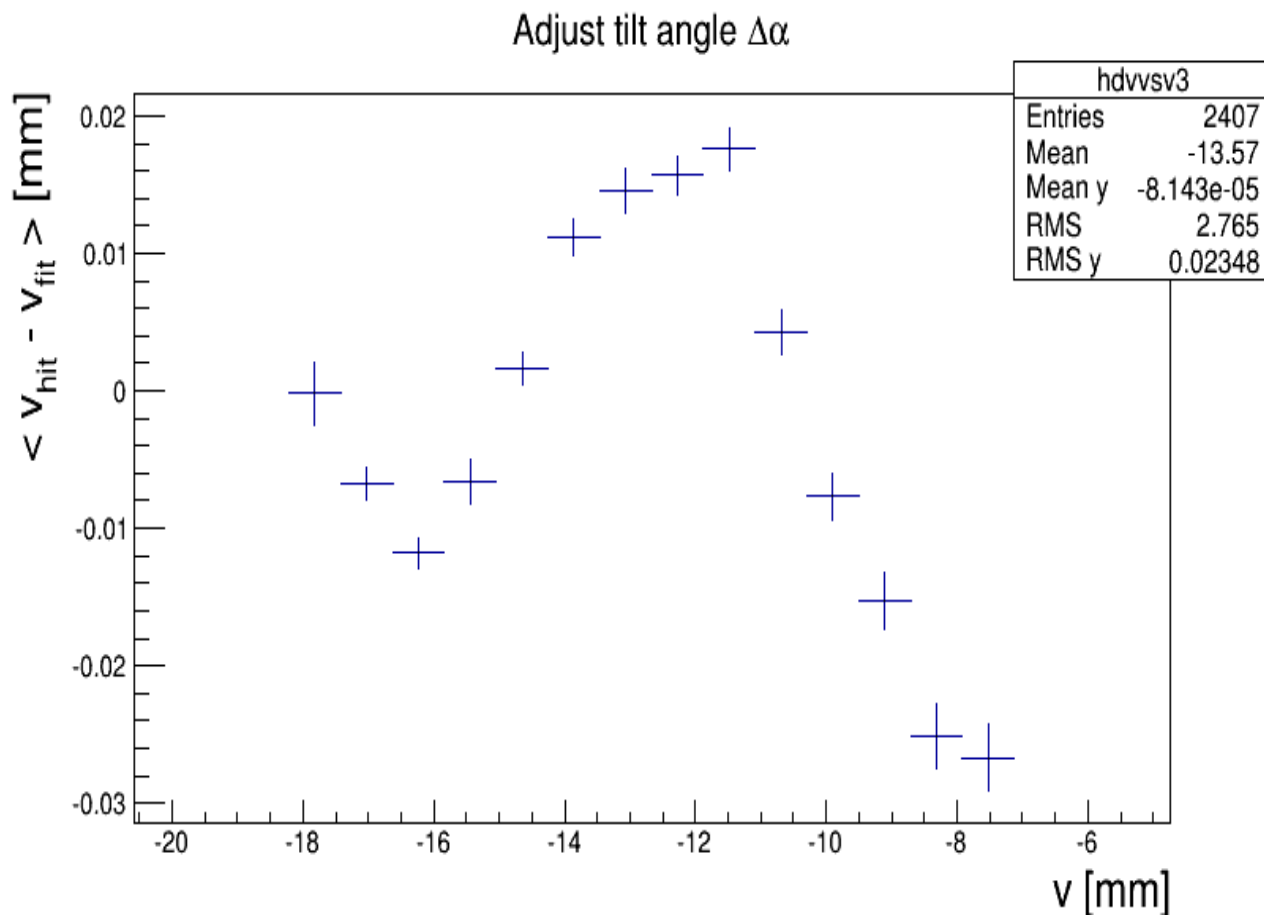
Mostly 1px clusters, few two pixels when track hits pixel edge
(having much better resolution)



1D residuals (30° tilted)



Warped sensor \rightarrow residual shifts

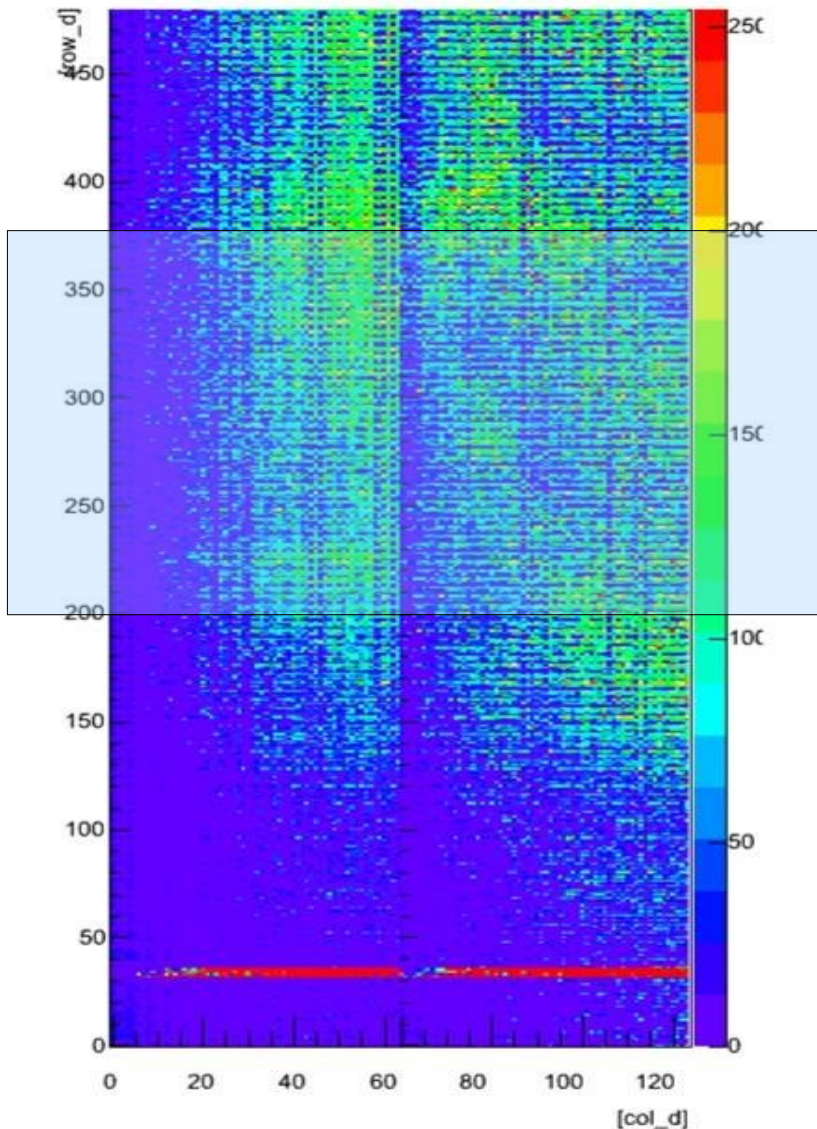


Summary

- 2bit pedestal subtraction is clear improvement compared to Jan. 2014
 - however not enough; still many dead pixels
 - Clear hardware topic
- We measure landaus, clusters and residuals as expected for high threshold operation.
 - Thresholds are $8xLSB \sim 1500e$
 - Spatial resolution (to lesser extent: pxd hit effi) degrades significantly for such high thresholds.

Thanks

Pedestals and Dynamic Range



- Same coordinates as before

- Zero pedestal: out of DCD range!!

- Pedestal variation too strong to operate all sensor

- There is also a row wise patten in Pedestals.

- Questions:

A) How much can 2bit pedestal dac help (not used in tb)?

B) How much of pedestal is due to Mechanic stress/ bad optimization?