Test beam results from large pxd6 detectors

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For the test beam crew

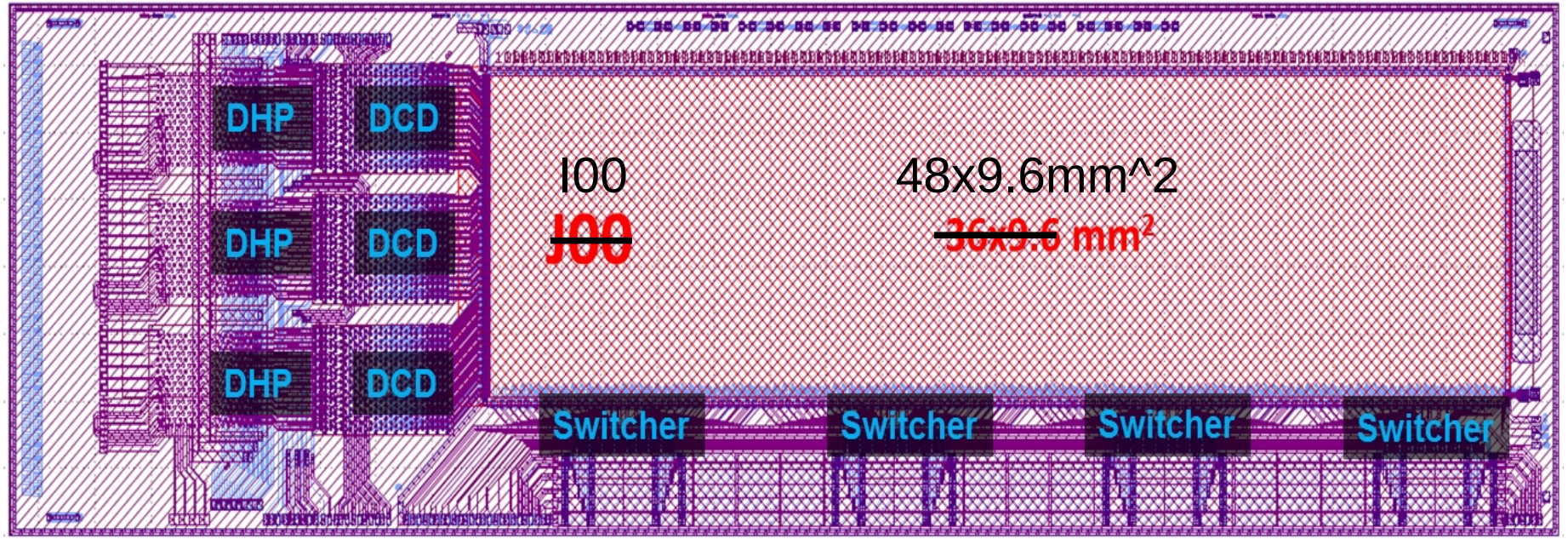
DEPFET Meeting Seoon 2015

Test beam 22-29 March @ DESY

- 3rd beam time with a large PXD6 sensor
- DEPFET integrated into EUDET telescope
- Tests with a 2nd large PXD sensor (I00)
  - No bending of silicon from gluing
  - 2bit pedestal correction used
  - LMU power supply used
  - But: only single DHP/DCD assembled
- Time for more systematic scans
  - Scan of trigger delay settings
  - Scan of hit threshold
  - Collect data from all sensor regions

The prototype detector – I00

(wrong figure, sorry)

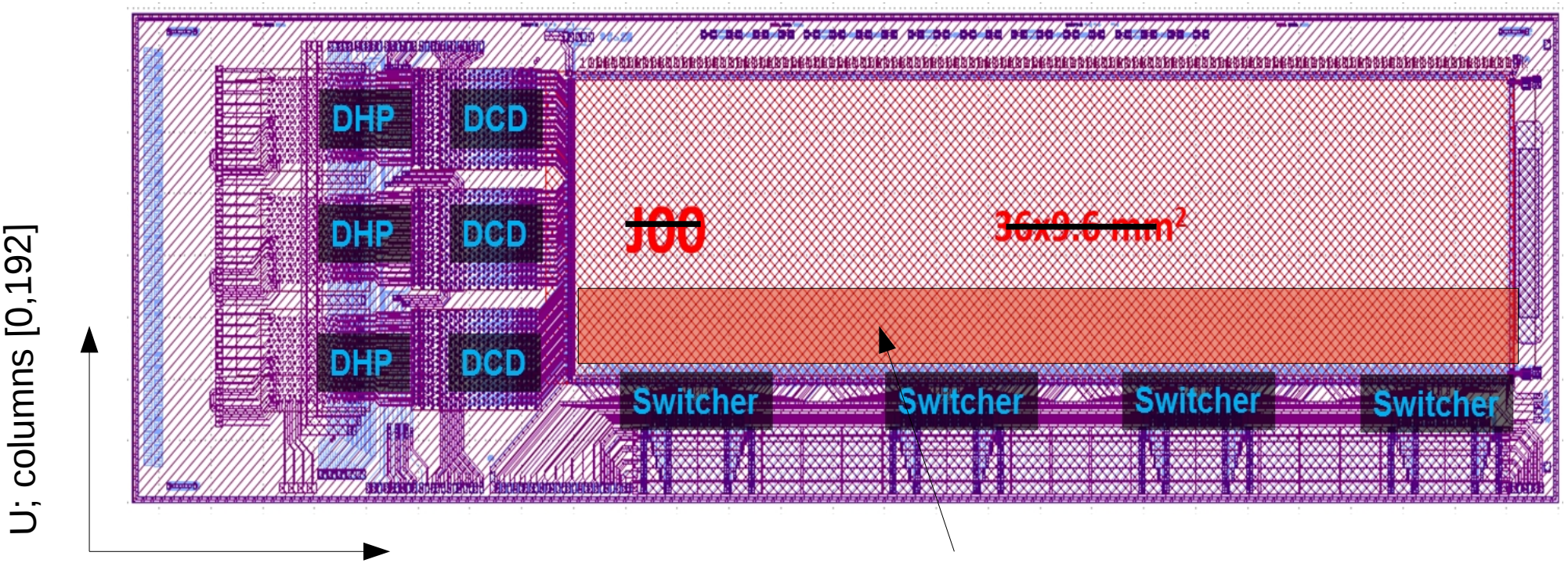


:- 480 rows / 192 columns
:- Pixel pitch: 50x100um²
:- Thickness: 50um
:- Cap. coupled clear gate
:- Only 1x DHP/DCD assembled

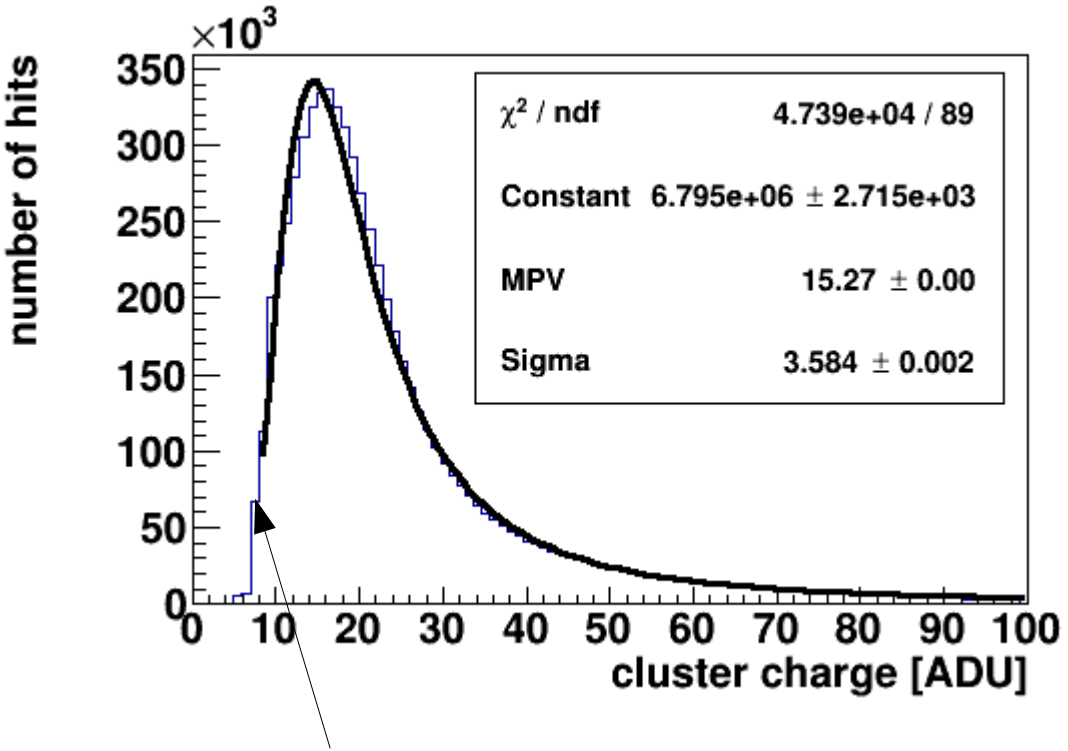
:- ASICS: DCDBv2, DHP02, SwitcherB1.8G
:- Speed: 250MHz (nominal 320MHz)

Local coordinate system and channel numbering (TB)

(wrong figure, sorry)



Large data sample



Edge from hit threhold
(→ cutting into signal)

:- Landau from ~6.6 million matched hits

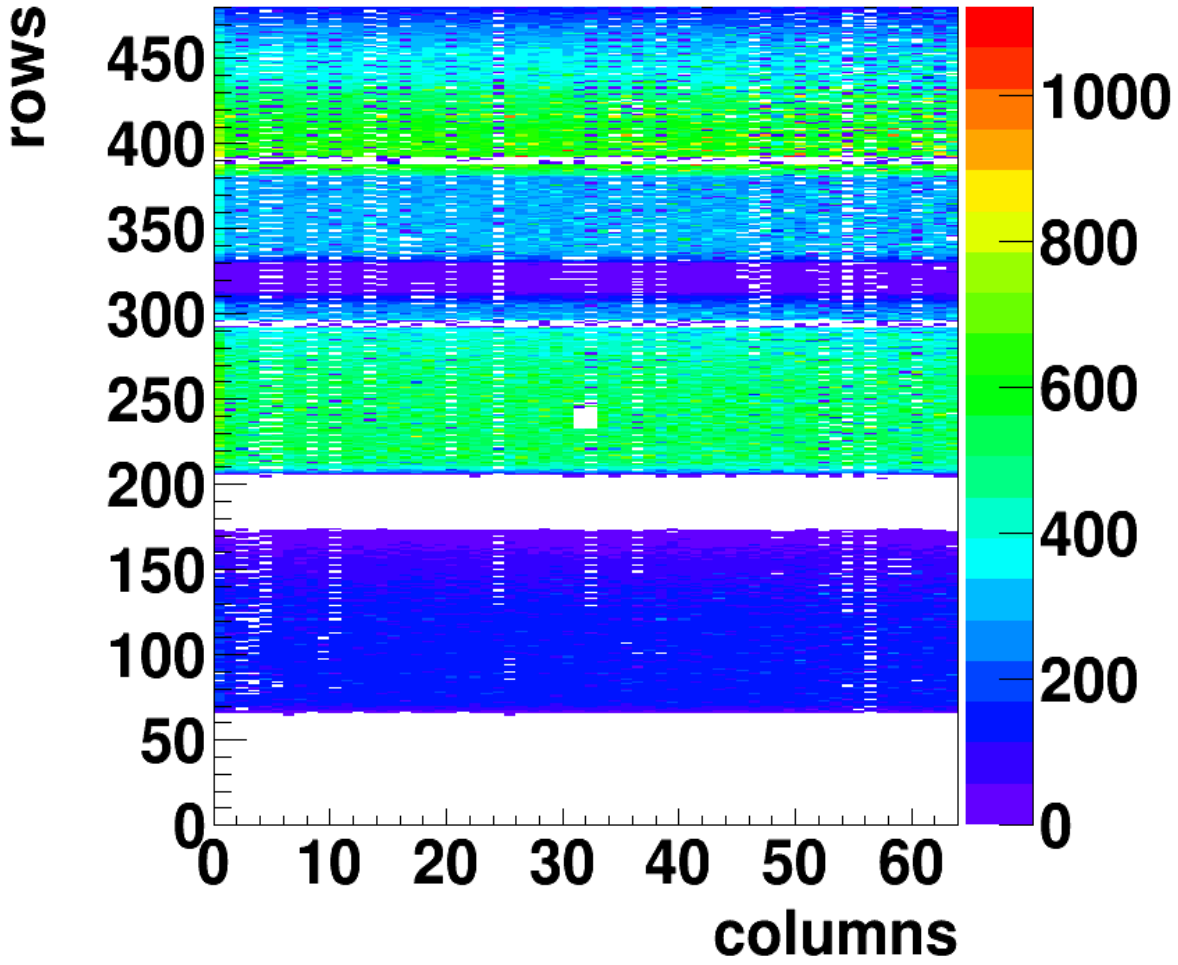
=> intense beam at DESY
=> 2 days data taking

:- Overlay hits from all scans

=> Mostly hit threshold 8LSB

=> Lowest threshold 4LSB
(few runs, rather noisy)

Data from whole sens. area

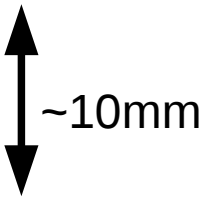


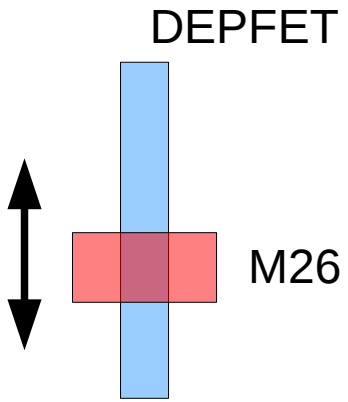
:- >500 hits per pixel in some areas.

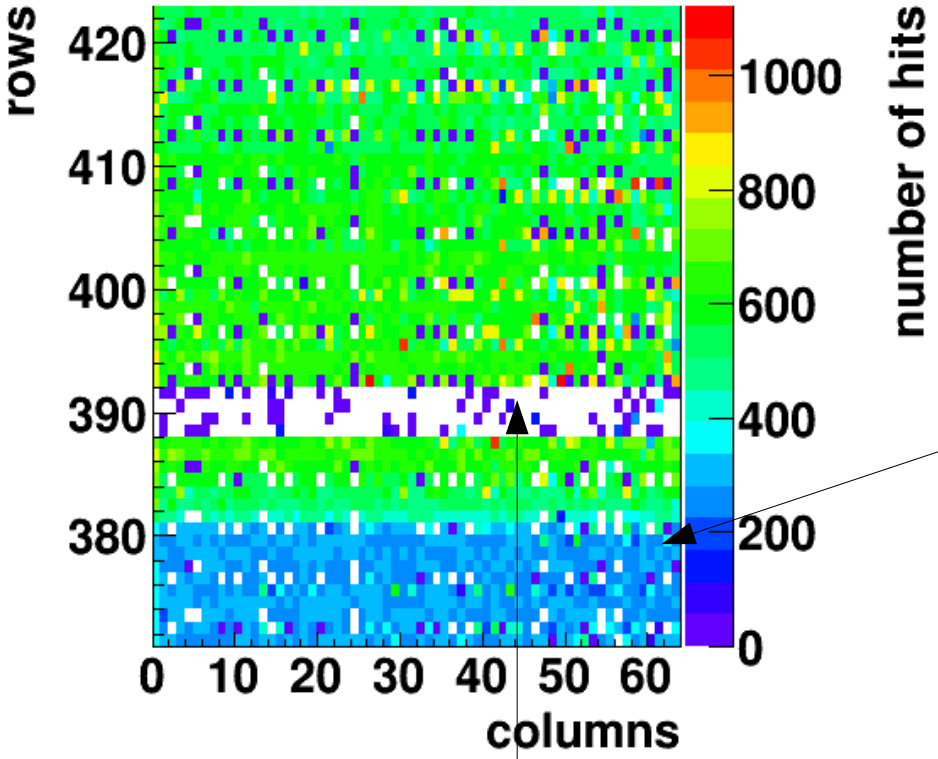
:- moved sensor up/down to get all area

:- illuminate ~100 rows at one Position

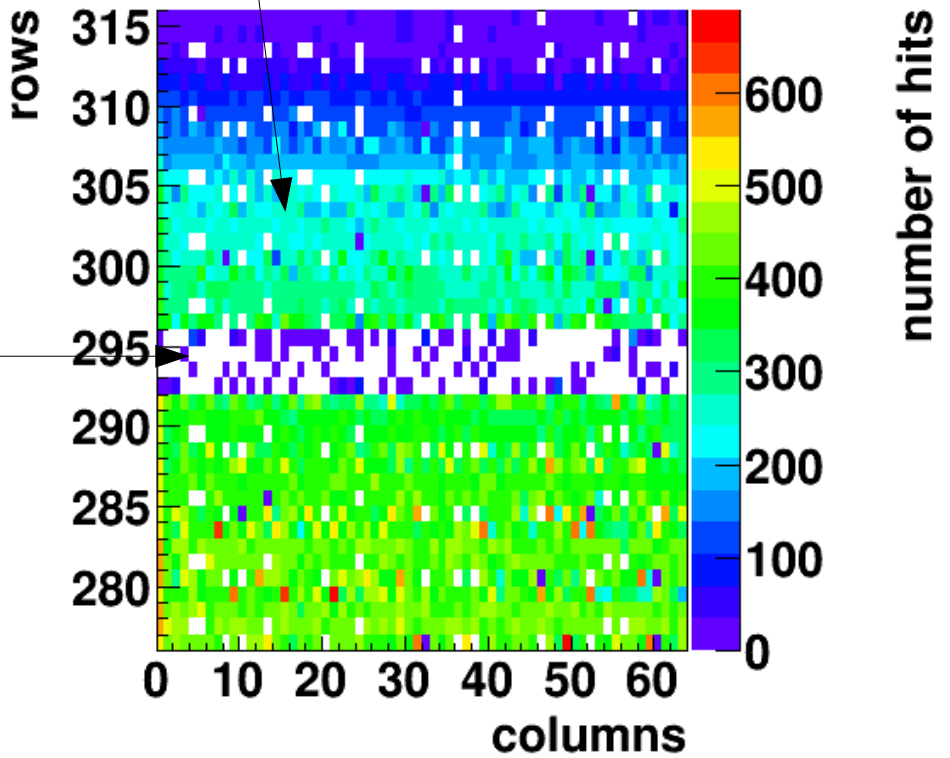
=> small tel. acceptance



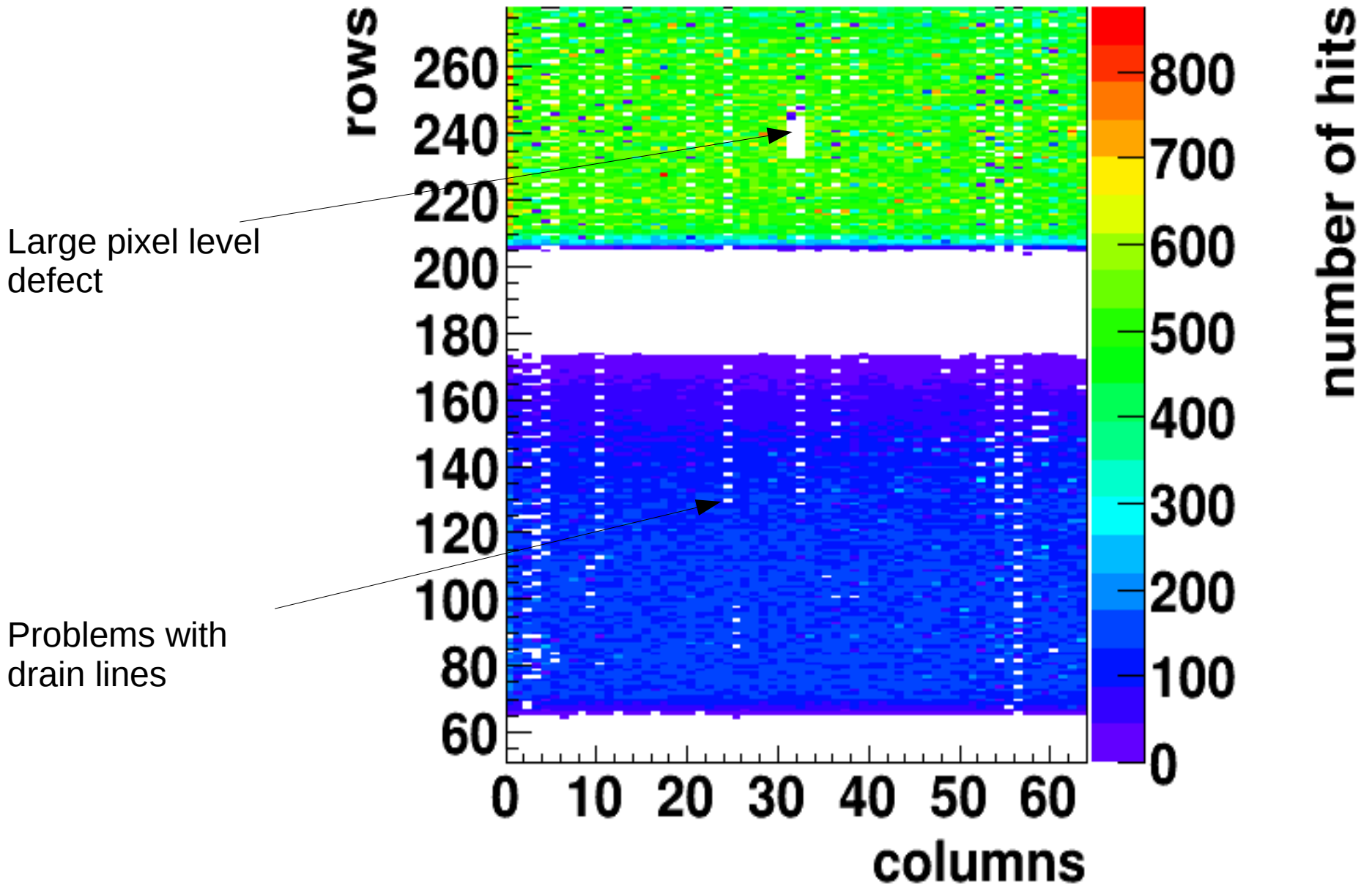




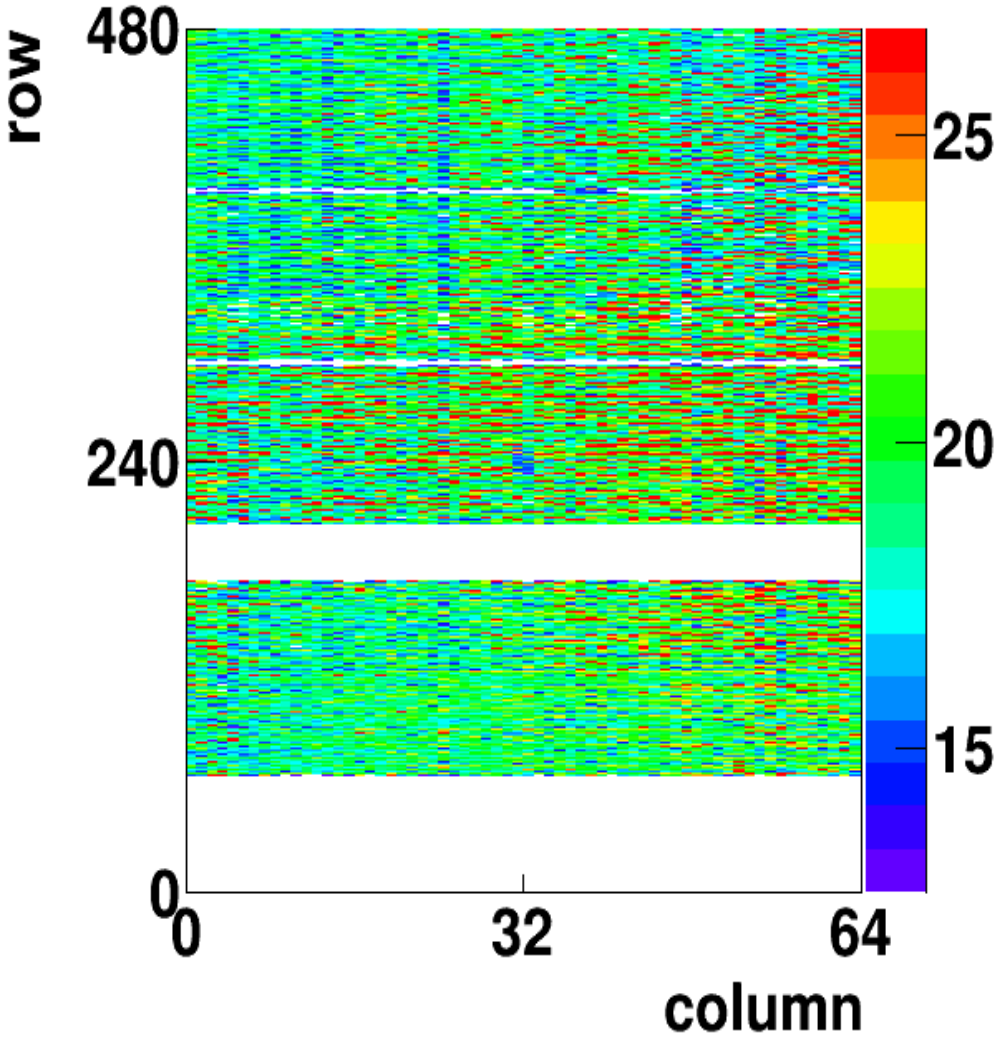
Difference in number of hits
due to illumination time.
→ not a sensor problem



No hits from these two gates
→ probably problem of switcher
→ confirm in lab


Large pixel level defect
Problems with drain lines
rows
260
240
220
200
180
160
140
120
100
80
60
0
10
20
30
40
50
60
columns
800
700
600
500
400
300
200
100
0
number of hits

Study of pixel gains



:- mean seed signal as proxy for pixel gain

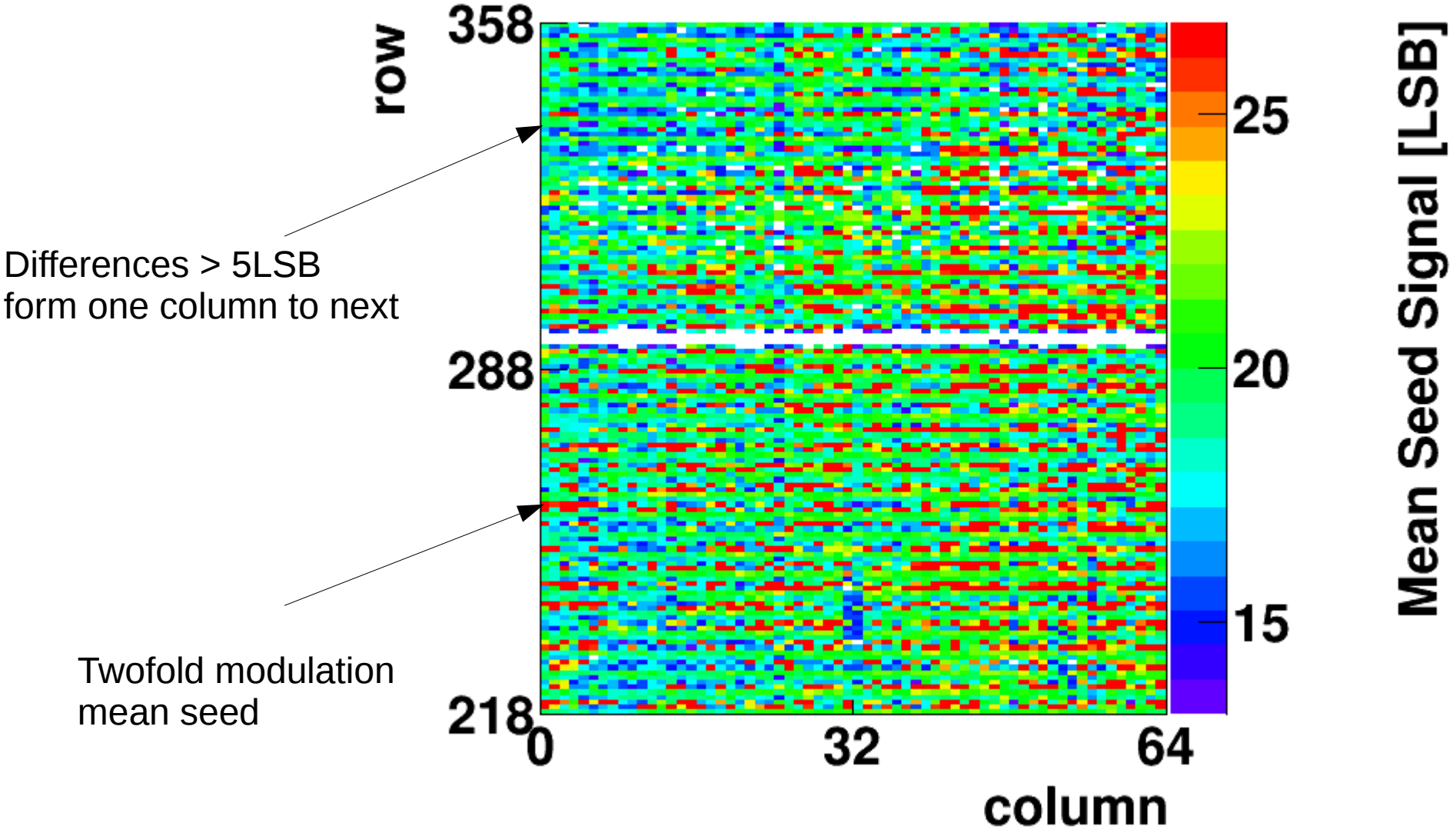
:- cluster attached to pixel hit by the tel. track

:- tel track resolution ~5mu (at DEPFET plane)

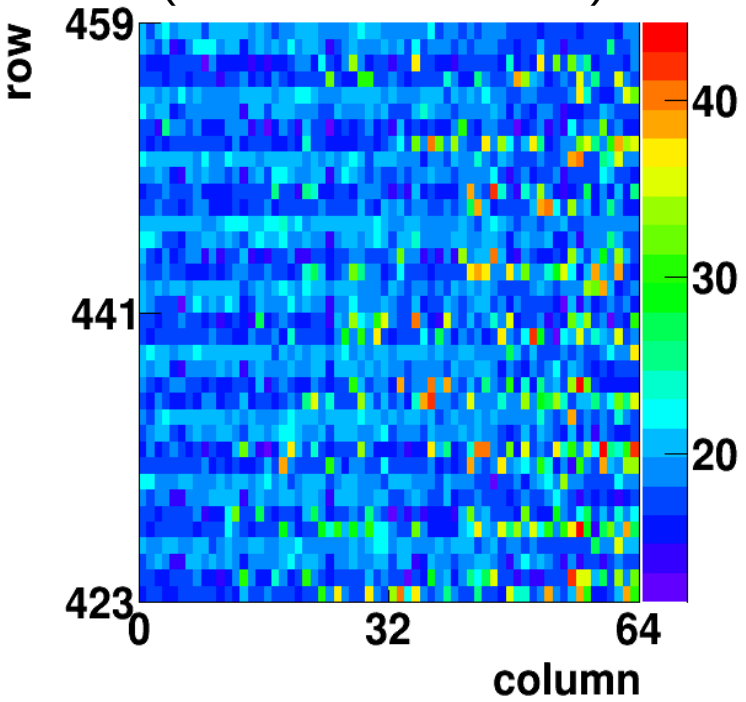
:- Non brocken pixel have

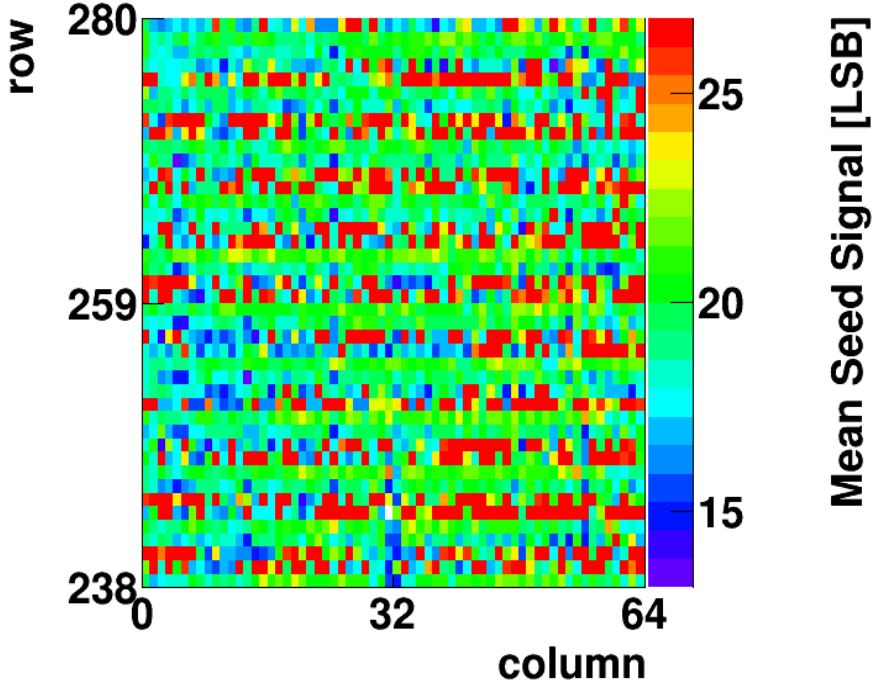
> 200 hits (lower part)
~600 hits (upper part)

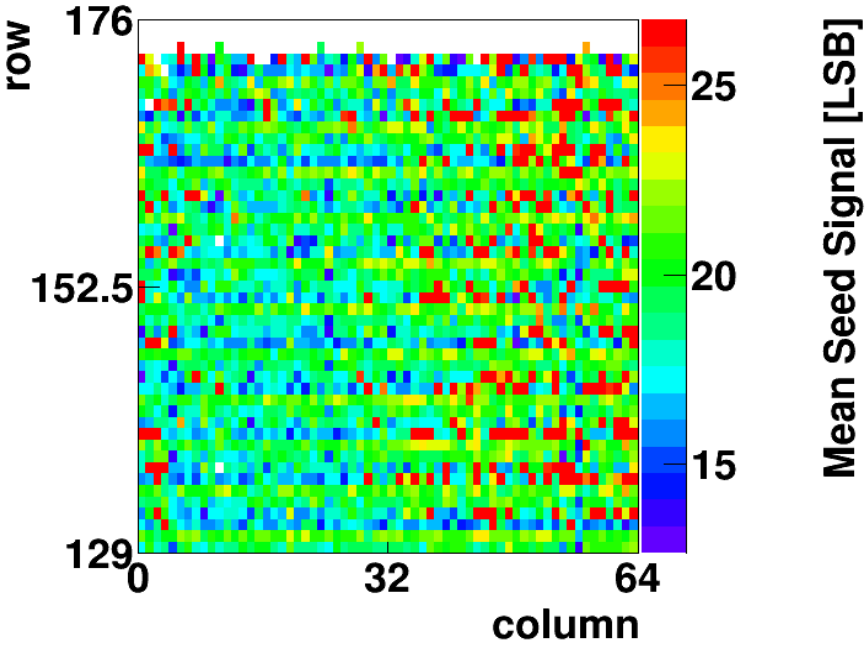
Zoom in to see more details



(different color scale)



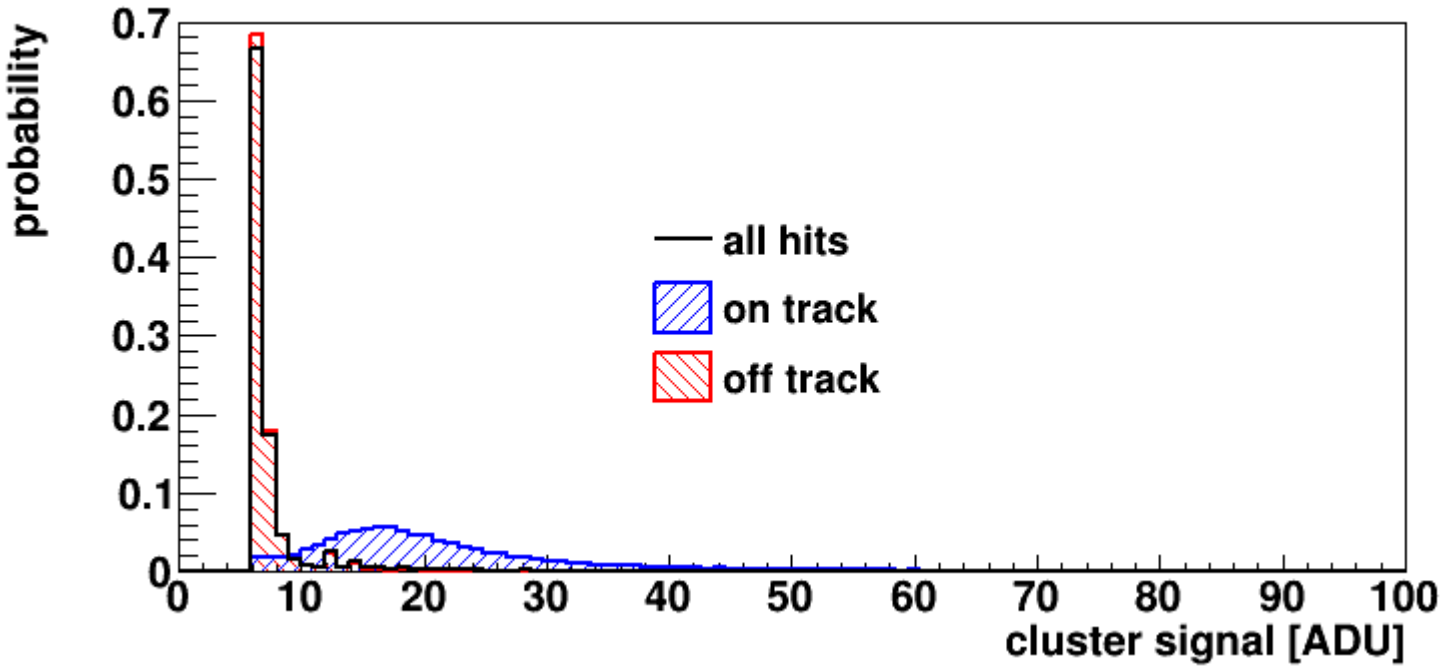




:- rather poor uniformity gains,
but why?

→ clear performance?
→ dynamic range (→ pedestal)?
→ transistor / gq?

“Low” threshold operation



:- tel. tracks to disentengle signal from noise

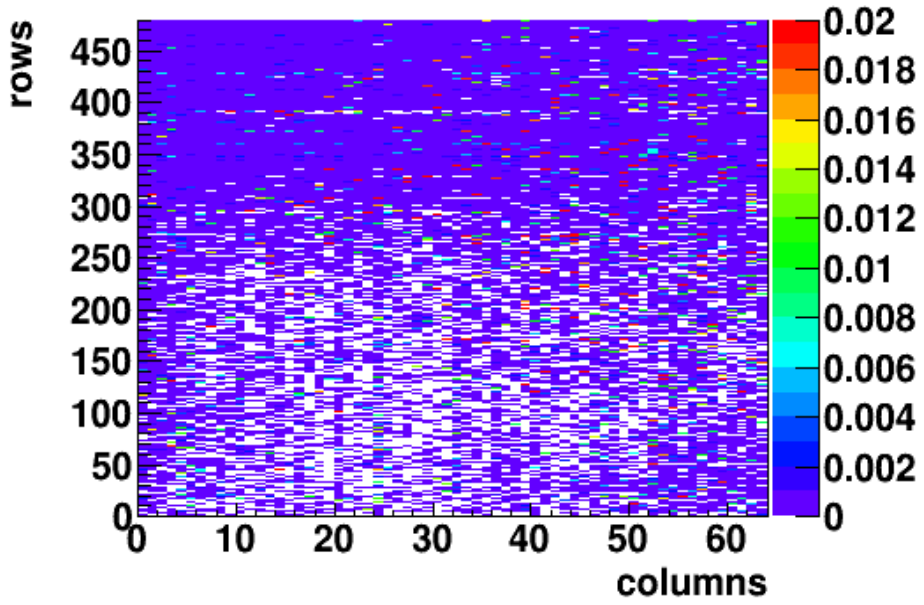
:- hit threshold @DHP set to 6LSB
→ we believe this should be a 10xnoise cut
→ however: noise and signal overlap

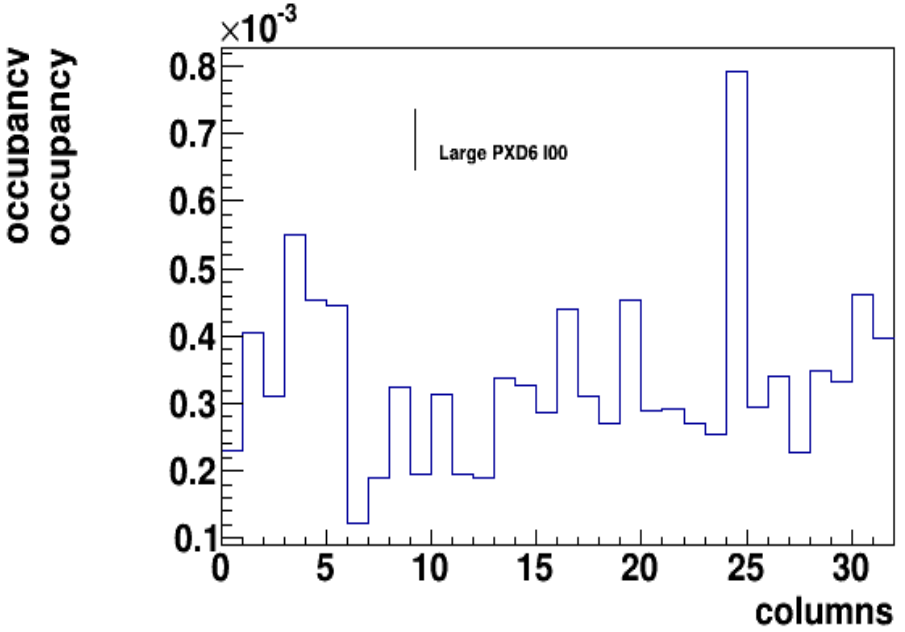
Occupancy Estimation

Occupancy = #noise hits / # triggers

:- DHP02 pedestal and common mode
:- noise hits = hit > 6LSB && far from tel. track

Noise occupancy<0.1% level

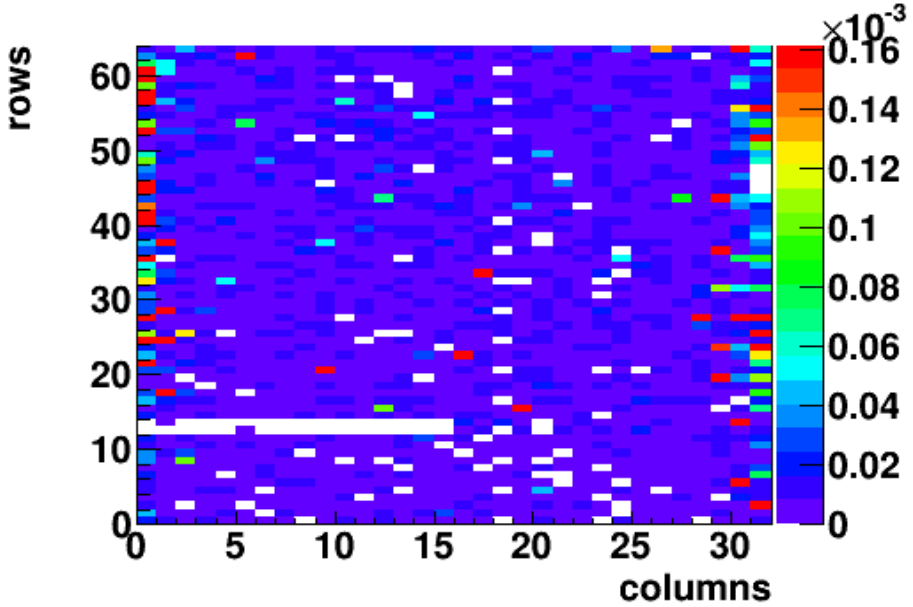




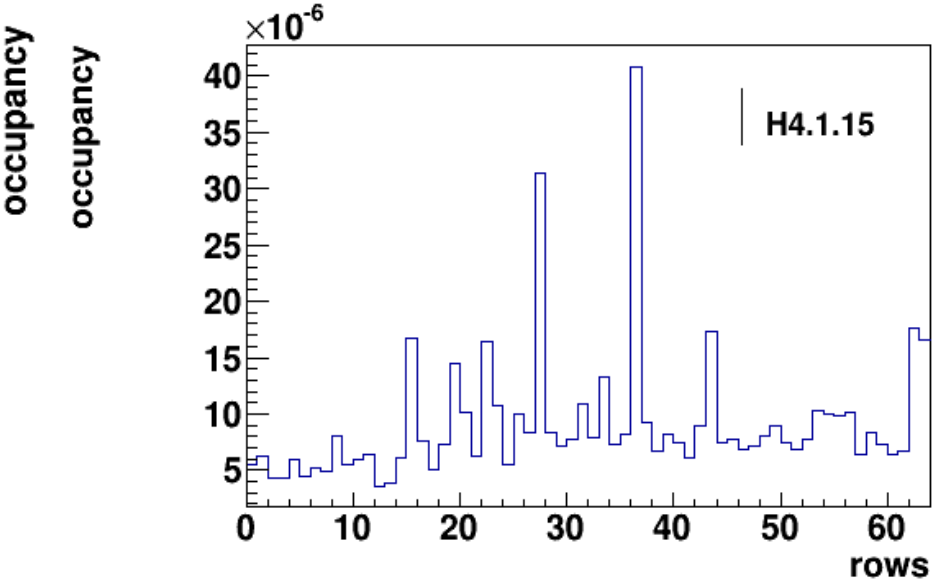
Occupancy Hybrid 4

Occupancy = #noise hits / # triggers

:- noise hits = cluster Threshold > 3LSB) far away from track
:- offline pedestal and common mode

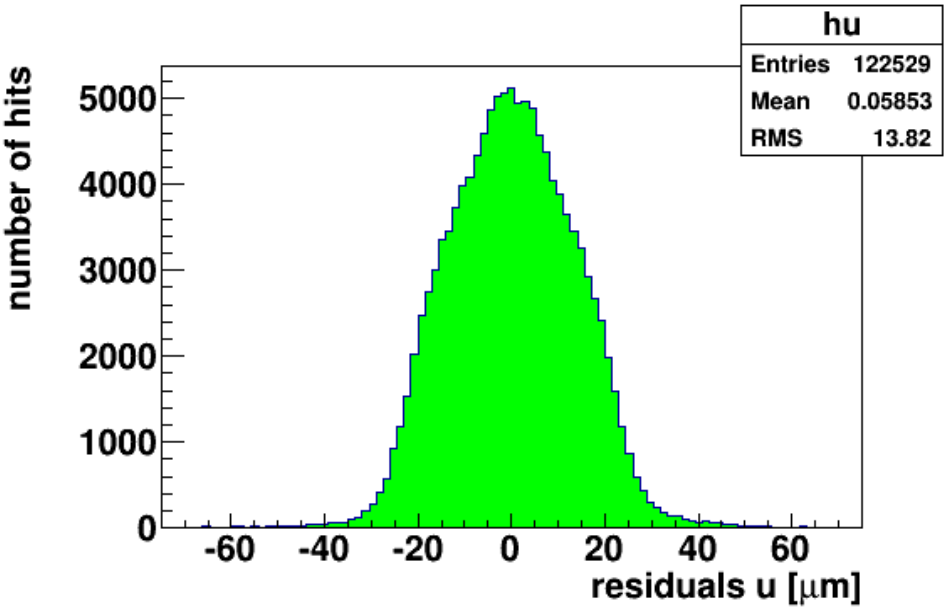


Much less noise @ 2x lower cut



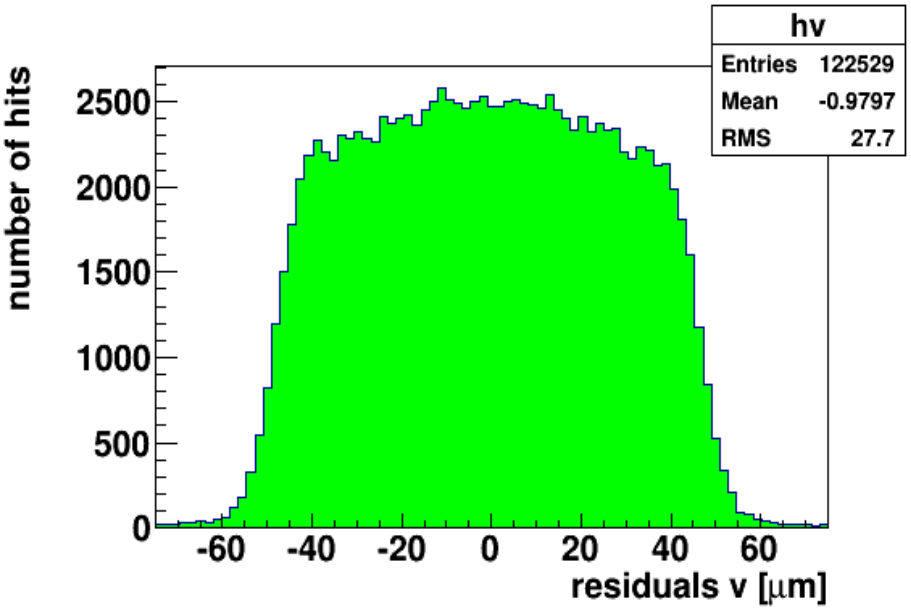
1D residuals (perp. incidence)

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



50um pitch

Profits from charge sharing
(threshold 6LSB)

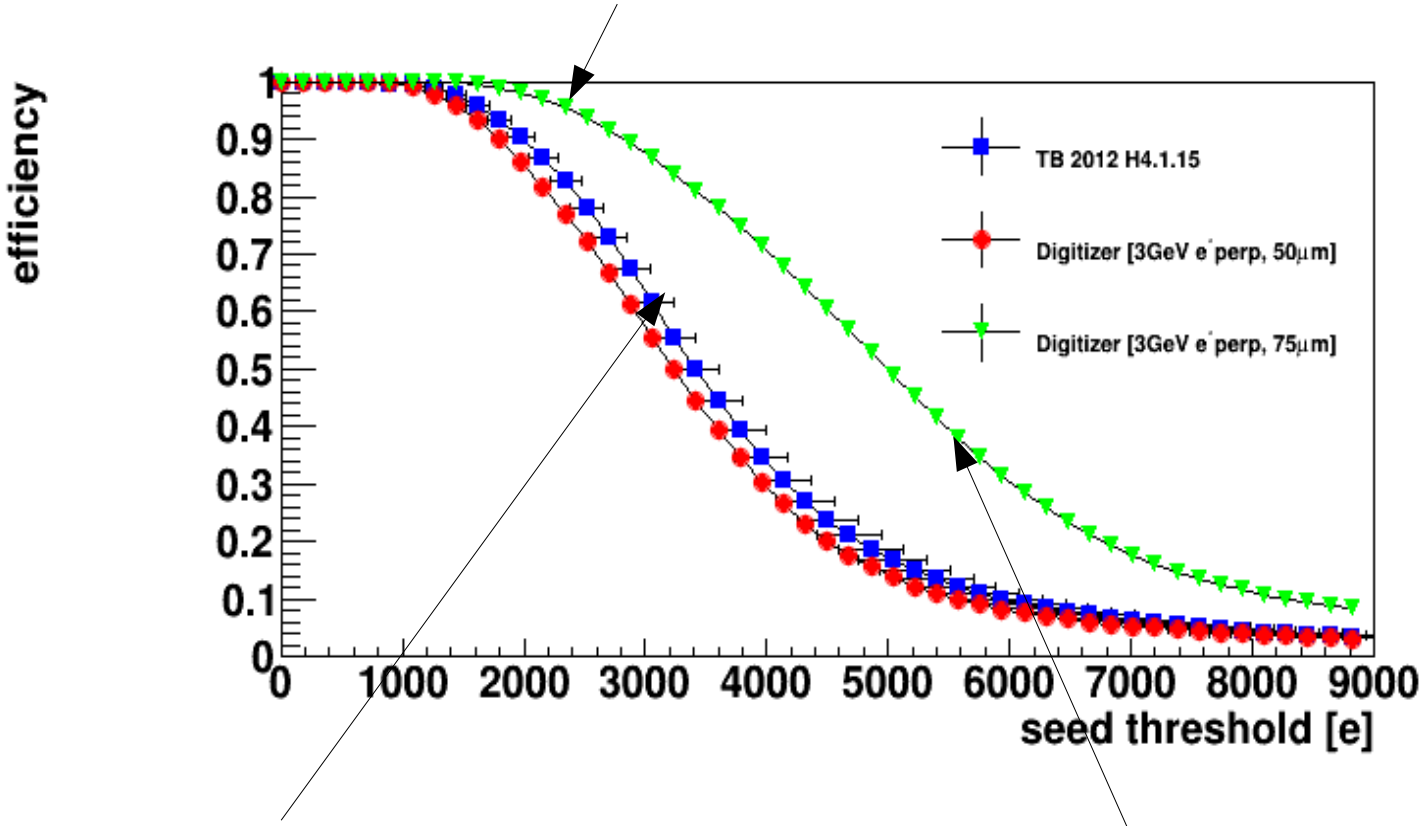


100um pitch

Shows perfect P/sqrt(12)

Efficiency vs seed charge threshold

PXD9: threshold of 2000e still ok.



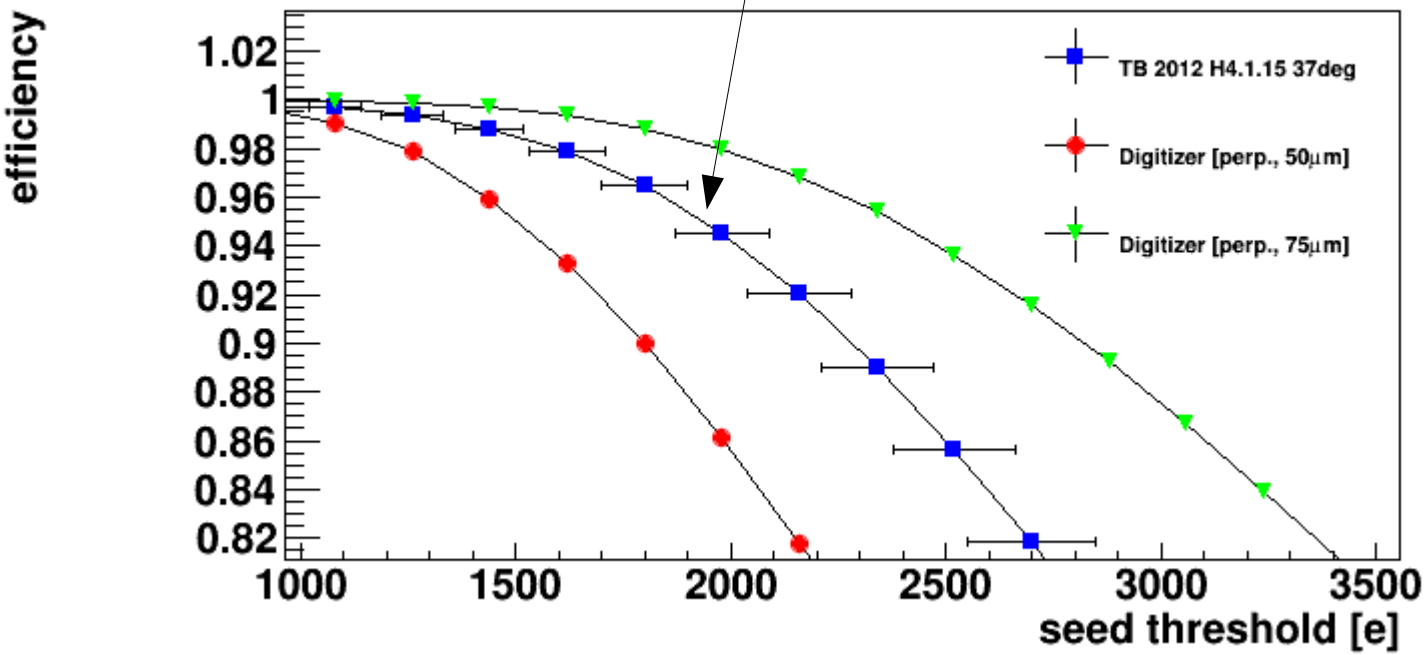
Good agreement with simulation
for Hybrid 4 (50 micron thick)

Extrapolation for PXD9
(75 micron thick)

Now, change angle of incidence

H4.1.15 beam data @ 37° tilt of sensor

→ on average more signal per seed than perp.
→ allows to go to higher thresholds



For reasonable aspect ratio, perp. incidence gives smallest signal per pixel and defines a lower bound for hit threshold.

Summary

- Used the beam time to collect high statistic data sample.
  - Response from all parts of sensor
- As expected: many sensor defects observed, mostly related to metal system.
  - Gains uniformity is poor, needs to be understood
- Some benchmark numbers
  - Landau MPV: 15.5LSB
  - Noise occupancy: ~0.1% (@6LSB threshold)
  - Efficiency: please do not ask
- Setting the hit threshold for PXD9
  - For PXD6 on H4: 1200e threshold was efficient
    - Still, this number should be confirmed with large sensor.
  - For PXD9 on MC: 2000e threshod can be efficient (larger signal)

Thanks