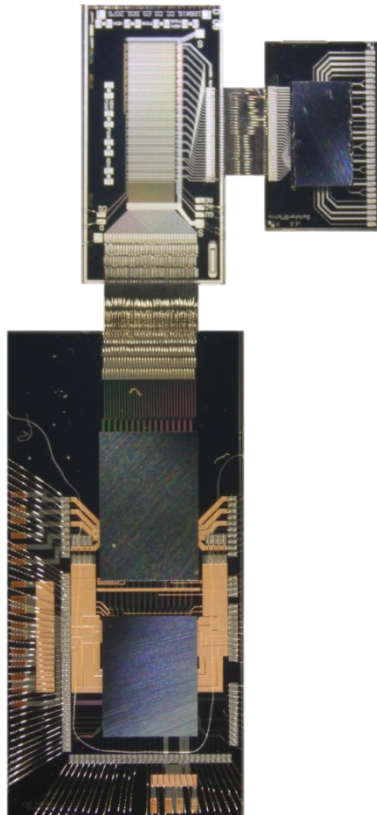# DEPFET test beam november 2015 @DESY

PXD Seevogh meeting 8.12.2015

B. Schwenker

For TB crew

Small PXD9 @ DESY

- DCDBPipeline,DHPT1.0,SwitherB1.8Gated

- PXD9 small Belle II type matrix (50x55 μm2)

- First Belle II PXD9 seen particles on a test beam

- Optimization and testing before going to DESY

  - ASIC optimization

  - EUDET integration

  - First source measurements

Testing results Hybrid 5

All testing results EMCM/Hybrid5 collected here:
http://twiki.hll.mpg.de/bin/view/DepfetInternal/Emcmresults

channel053
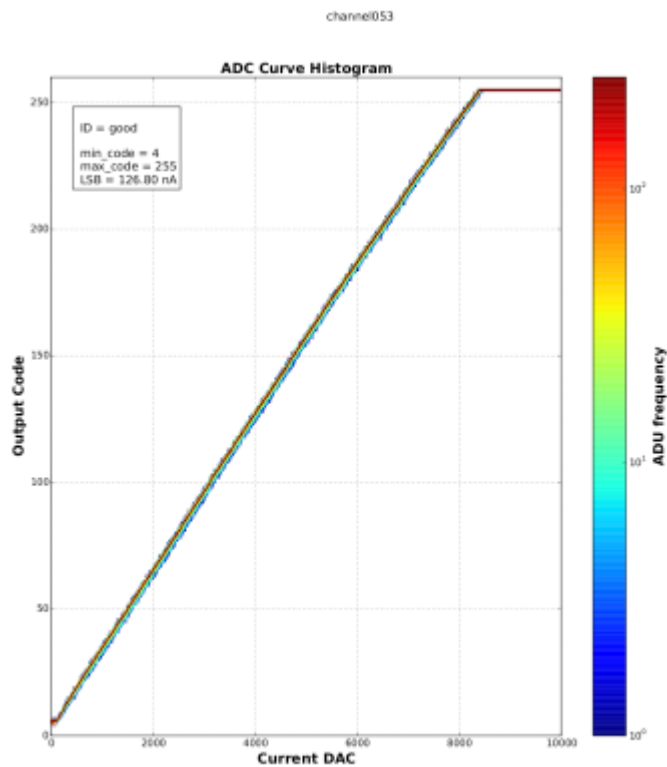
:- ADC curve with DHE current source after optimization
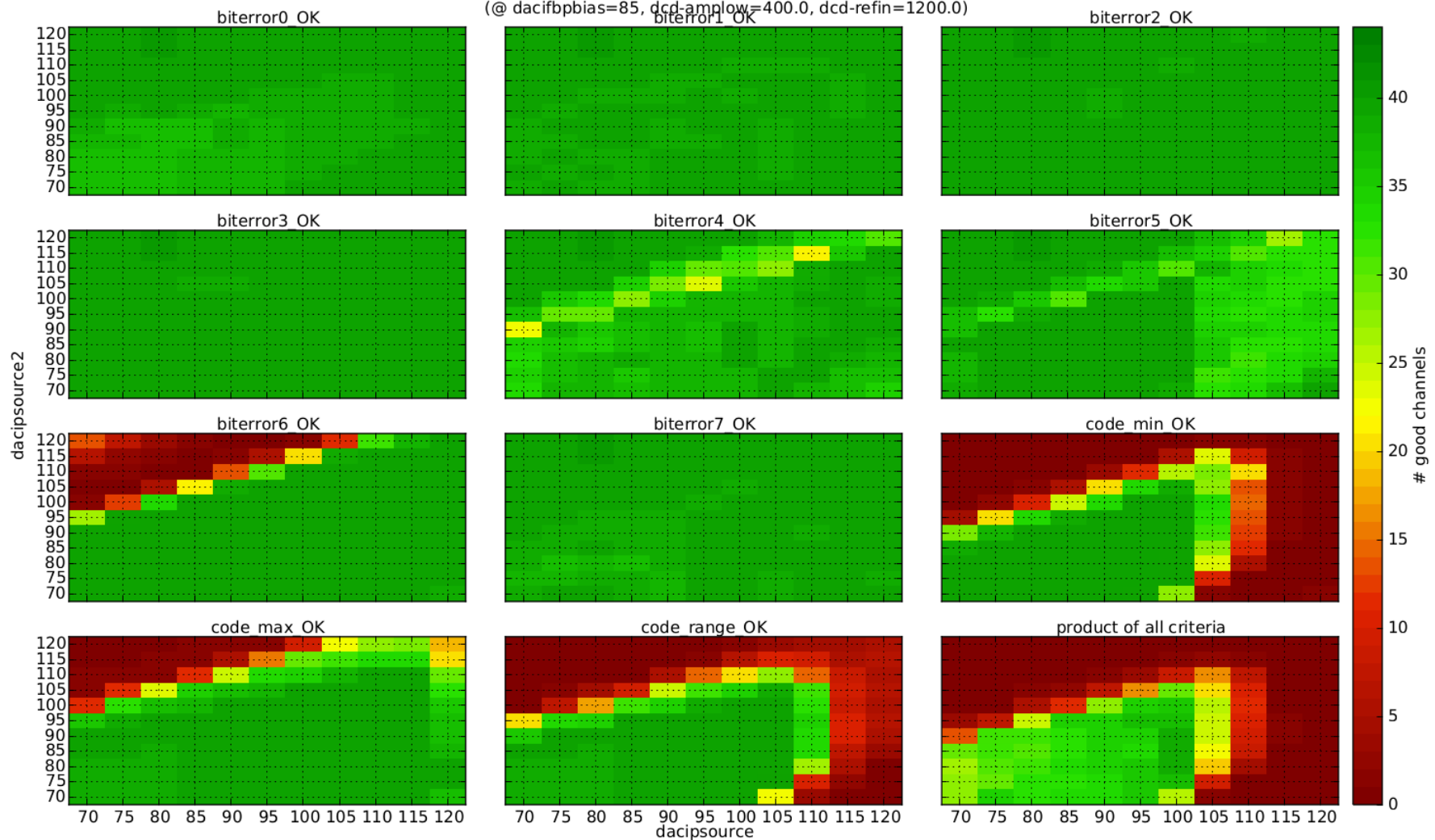
:- large dynanic range: 127nA per ADU

:- low noise noise: ~0.7ADU

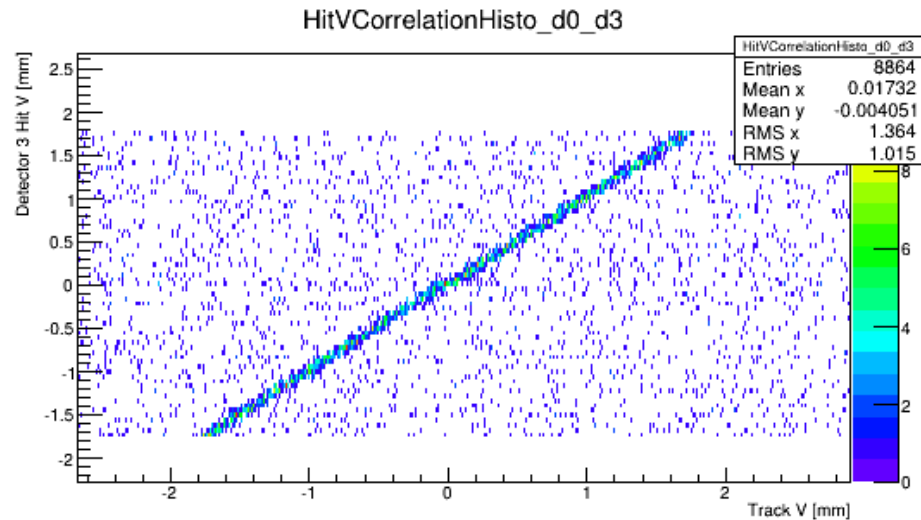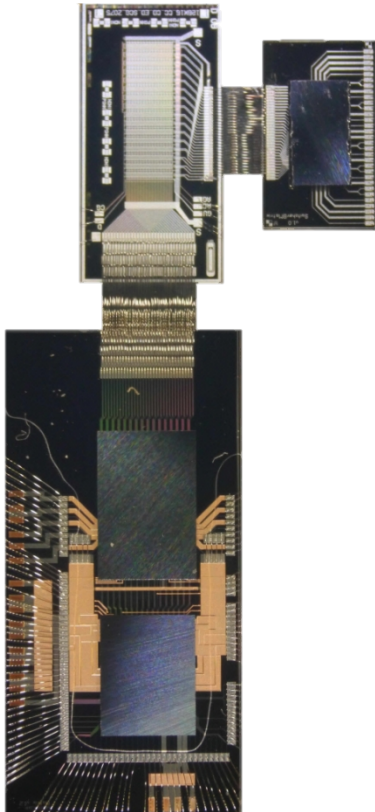:- no missing code / no bit errors

It is easy to select a bad setting ...

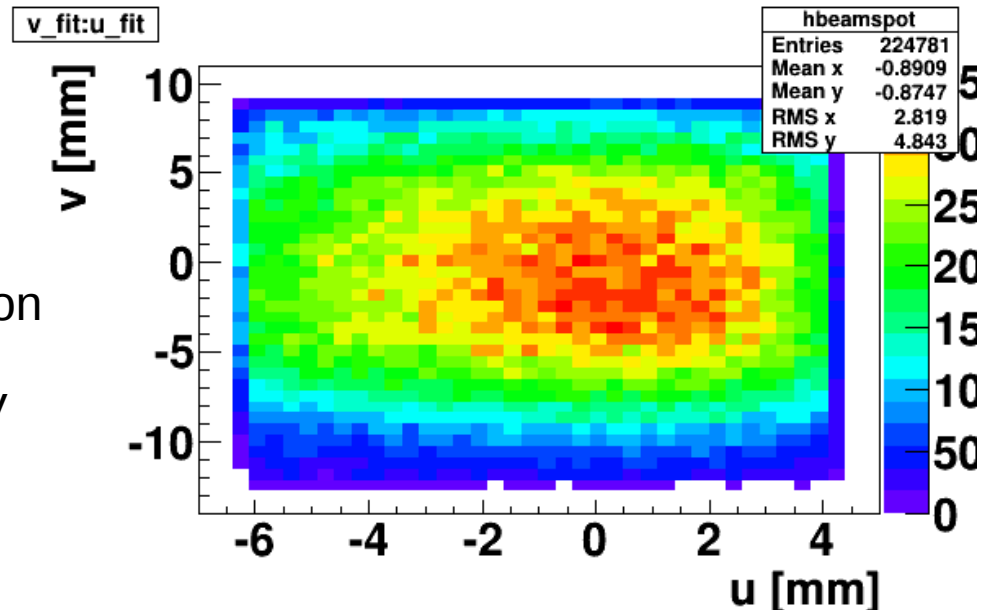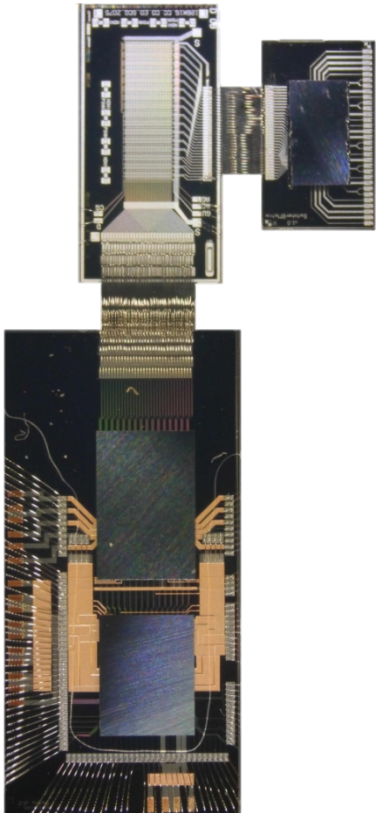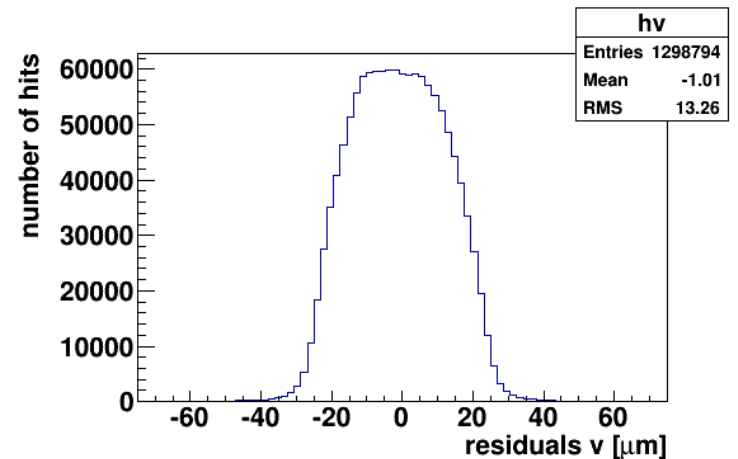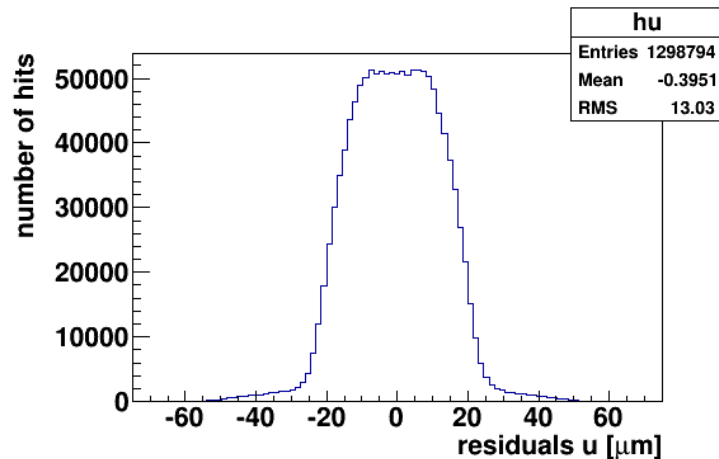# First TB results from Hybrid 5
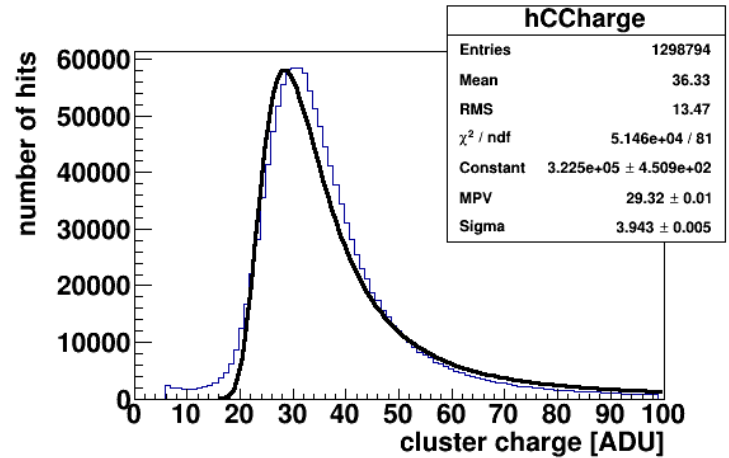

:- correlations with
   Eudet telescope

→   successful integration

:- beam spot with 4GeV
   electrons

Residuals and Landau

:- >10Mio tracks in total

:- 4GeV electrons; 90 degree

:- MPV ~29ADU

:- ~2/3 hits are single pixel

hCCharge	
Entries	1298794
Mean	36.33
RMS	13.47
χ^2 / ndf	5.146e+04 / 81
Constant	3.225e+05 ± 4.509e+02
MPV	29.32 ± 0.01
Sigma	3.943 ± 0.005

hu	
Entries	1298794
Mean	-0.3951
RMS	13.03

hv	
Entries	1298794
Mean	-1.01
RMS	13.26

HV scan and matrix uniformity

Charge Collection Uniformity

:- 90° incidence on PXD9 @4GeV
:- Looking at mean seed signal per pixel

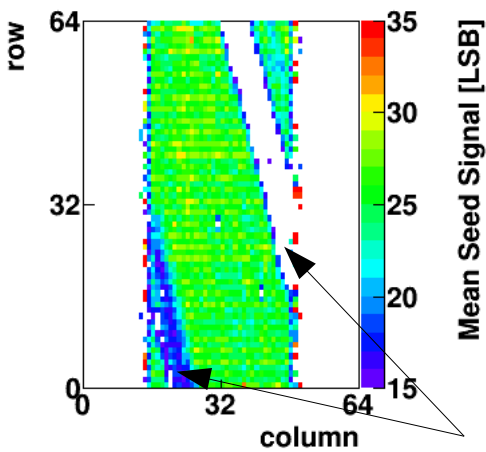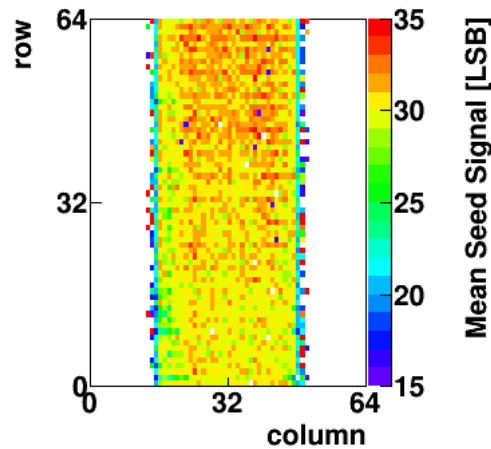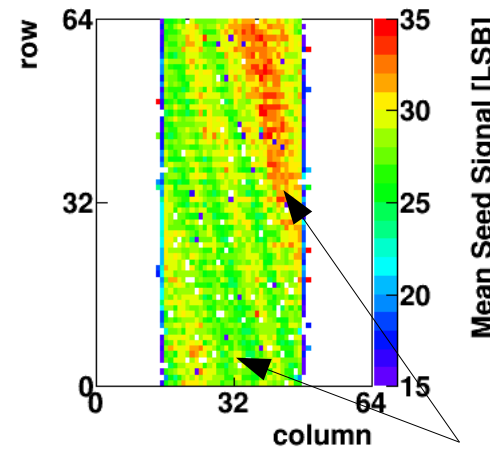HV 60V / Drift 5V   HV 70V / Drift 5V   HV 75V / Drift -5V   HV 80V / Drift 5V

(best)

strips   strips

:- HV 60V too low   :- HV 70V best   :- HV >75V too high
:- Two strips with small collected   :- most uniform charge   :- Strips appear again
   charge.   collection   :- Between strips charge
:- Between strips not all signal   :- highest mean signal   is lost
   collected (mean signal ~25LSB)   >30LSB

Hit occupancy (efficiency)

:- 90° incidence on PXD9 @4GeV
:- number of pxd9 hits matched to tracks
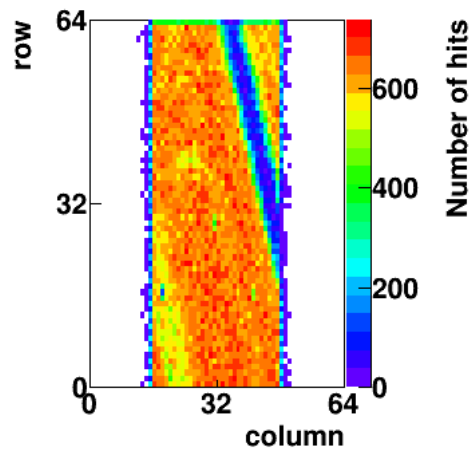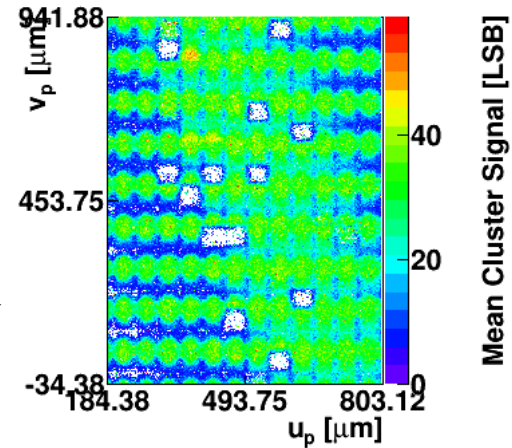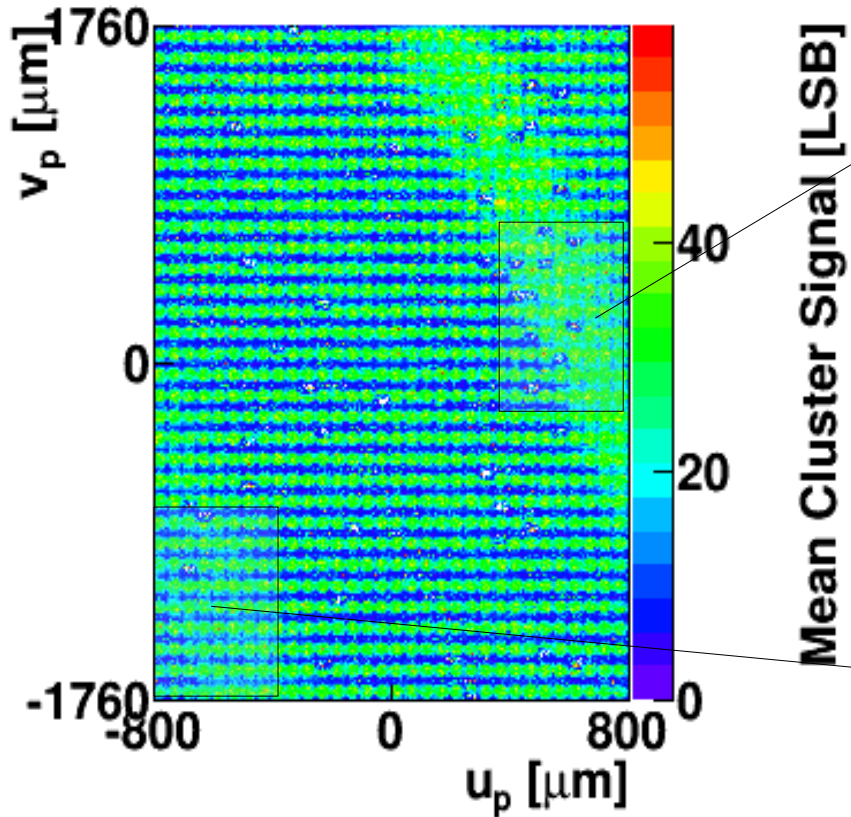→ proxi for hit efficiency!

HV 60V / Drift 5V   HV 70V / Drift 5V   HV 75V / Drift -5V   HV 80V / Drift 5V
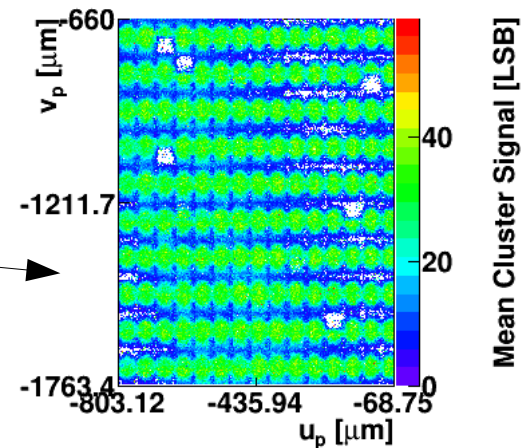
(best)
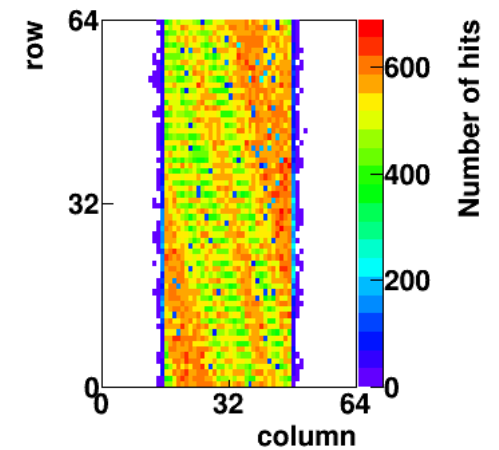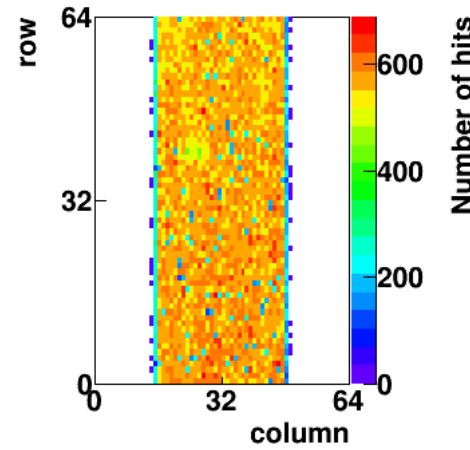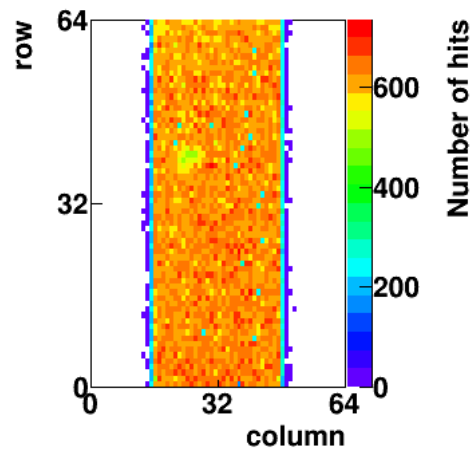
:- similar pattern as before

:- for HV 60V and HV >75V: ineffecient regions observed

H5: HV -80V and Drift -5V

CCE in-pixel resolution for all 32x64 pixels
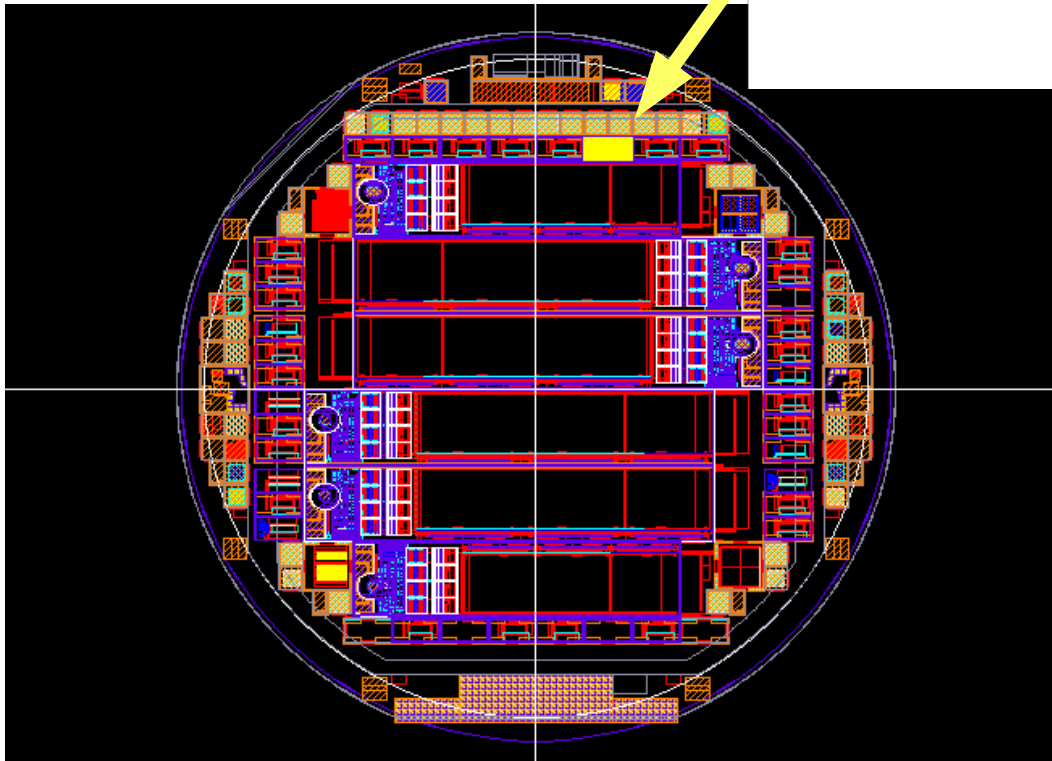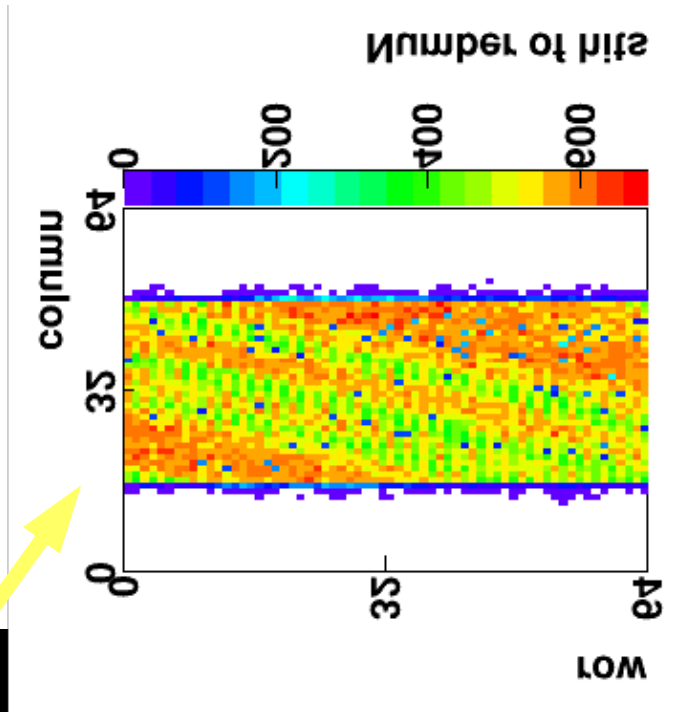(there is a high resolution pdf available)

A) CCE changes over scales ~200um
(->seems we loose drifting electrons)
B) ring pattern quasi periodic

What is the origin?

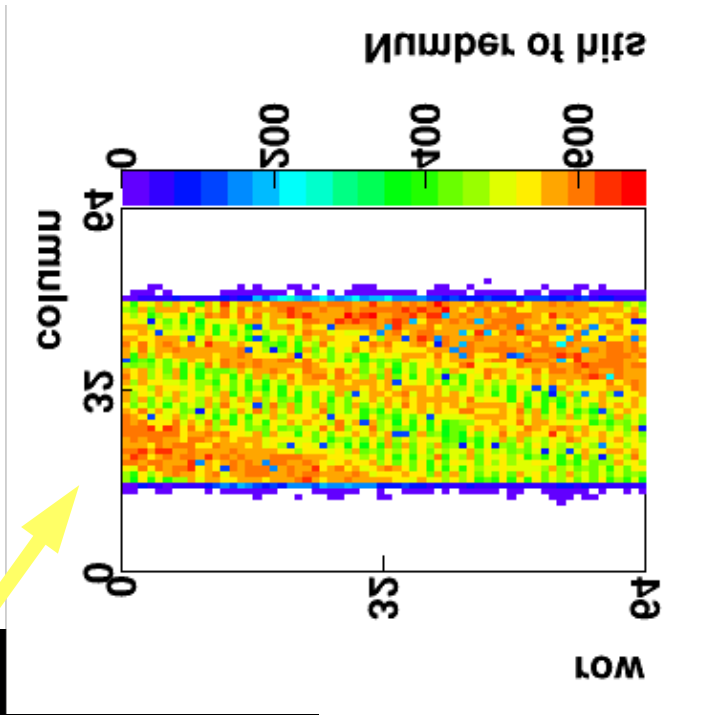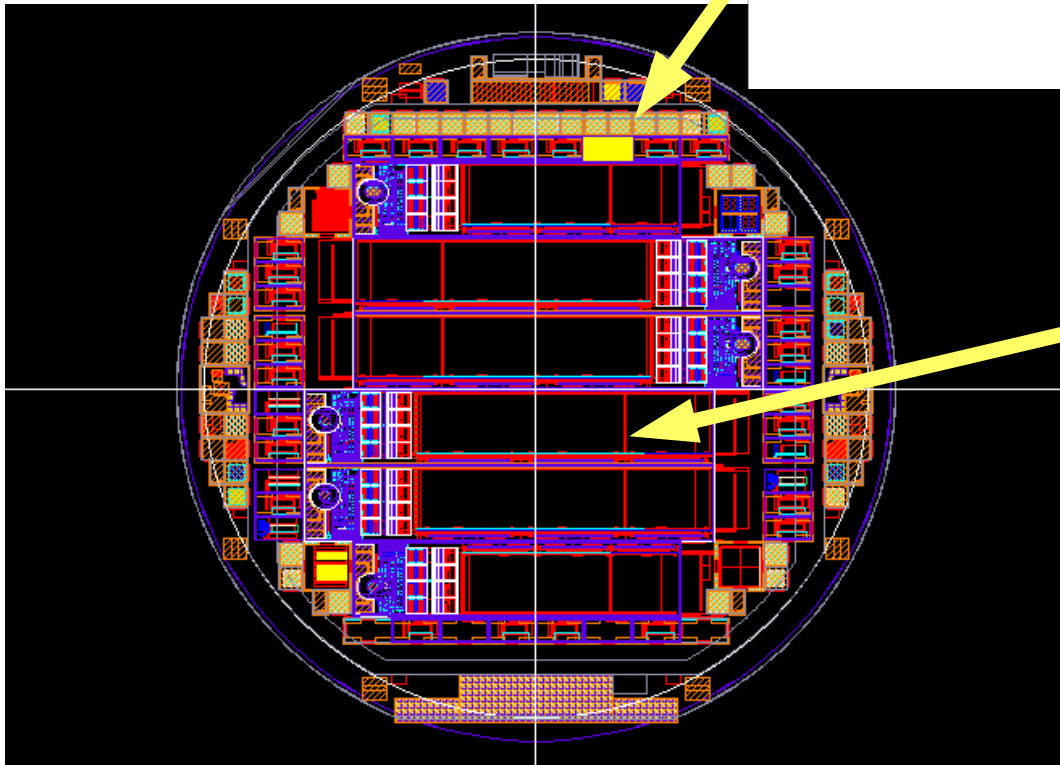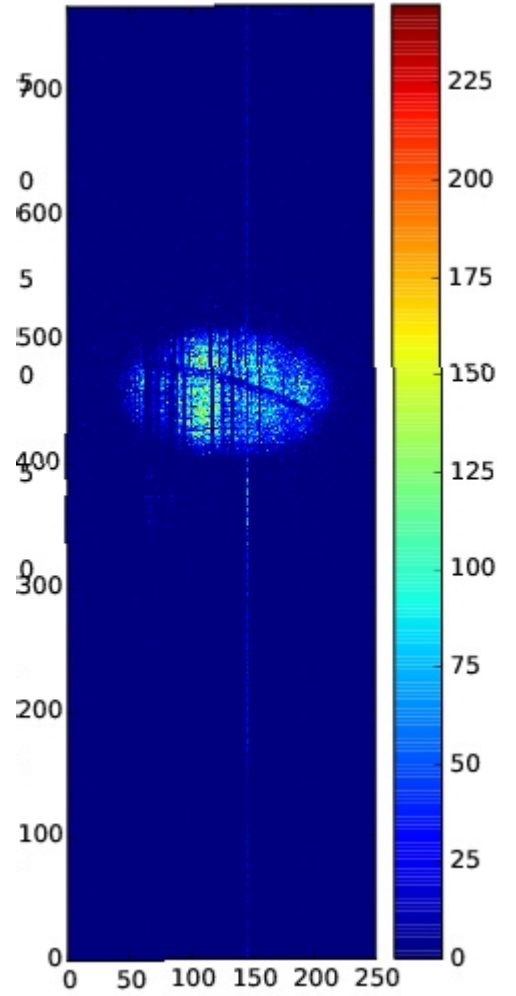(From discussion with rainer)

Chip number: PXD9-6 W30 A05

:- Idea: variation of bulk doping in concentric rings around wafer center

:- yellow area on wafer: tb sensor

:- hit occupancy mirrored to match orientation of chip on wafer.

What is the origin?
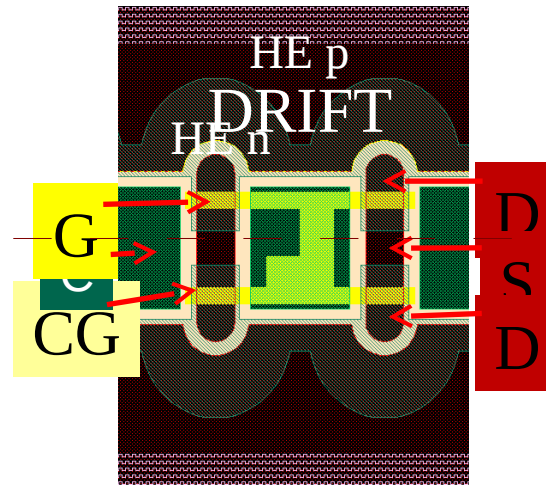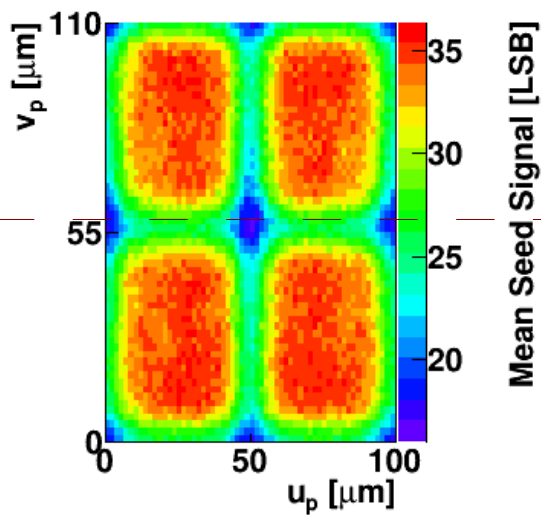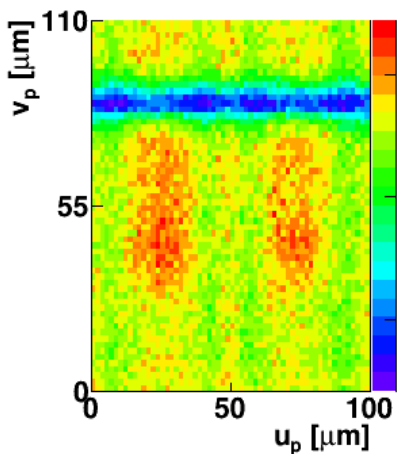
(From discussion with rainer)

H5

Pilot

In-pixel charge collection

Optimal point: HV -70V / Drift -5V
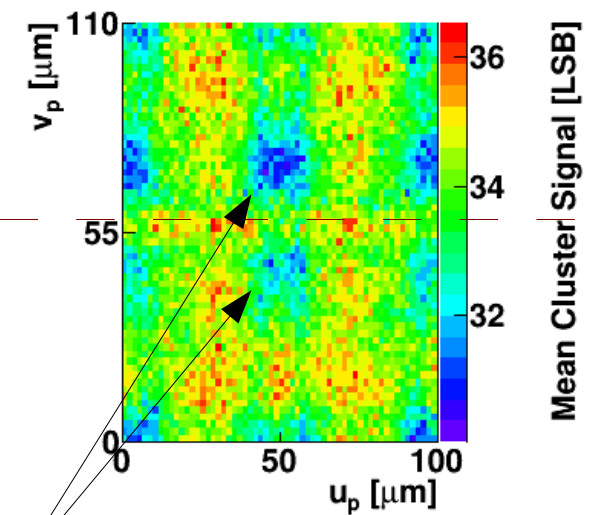
Charge loss

:- 2 double pixle structures (2x2 pixels)
:- charge loss at interface of clear implant and clear gate

Next slide: Scan of HV
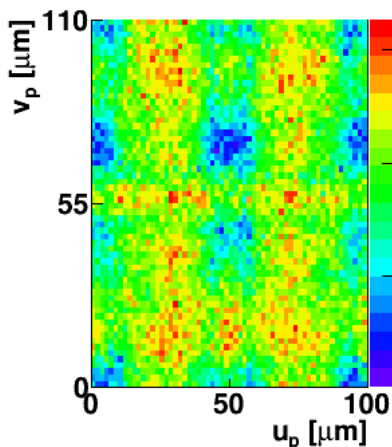
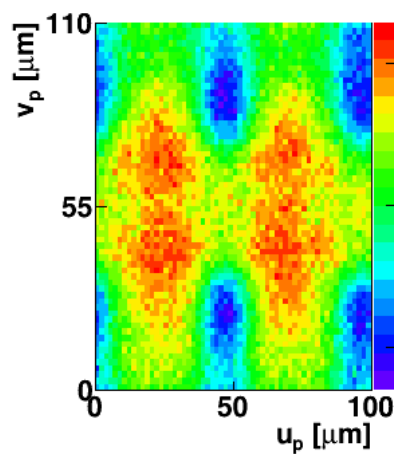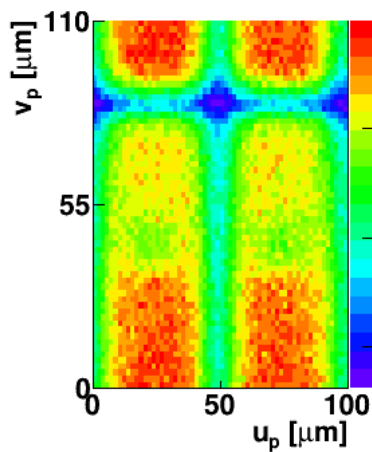# HV -60V / Drift -5V　　HV -70V / Drift -5V　　HV -75V / Drift -5V　　HV -80V / Drift -5V
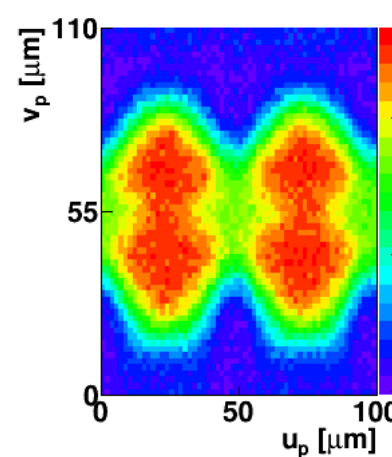
(best)

Cluster Charge

:- Not fully depleted
:- No charge seperation between
　pixels sharing source

:- too much HV
:- electrons lost
　in clear gate

(best)
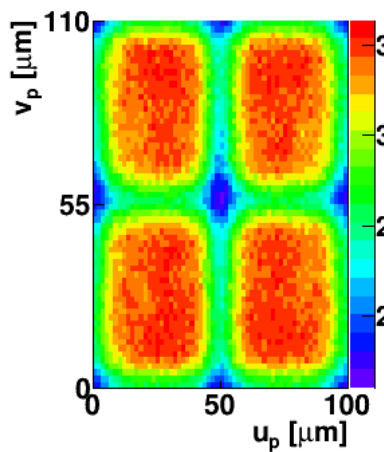
Seed Charge
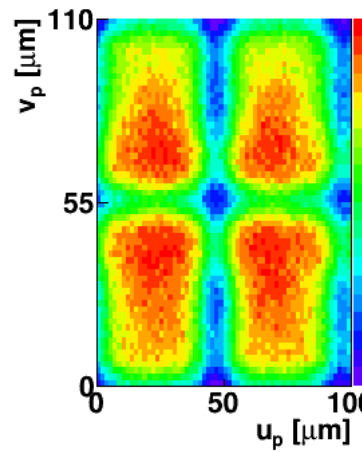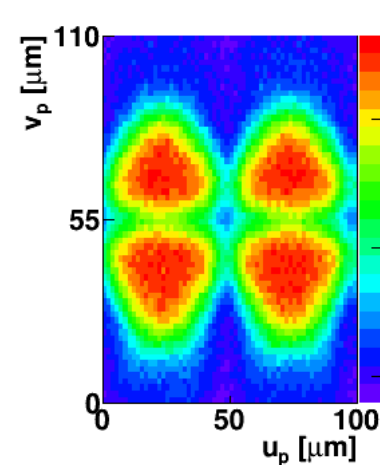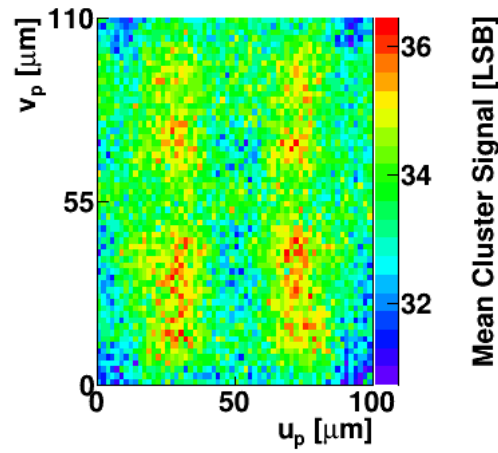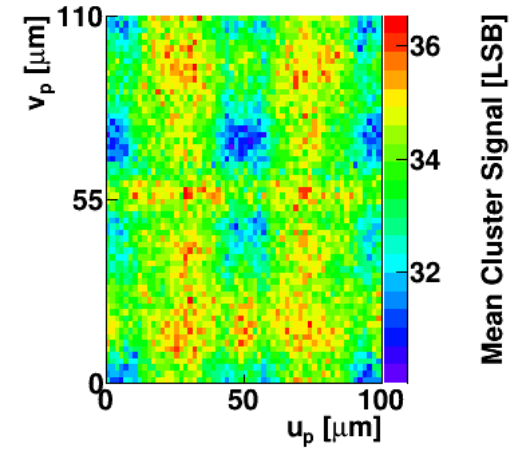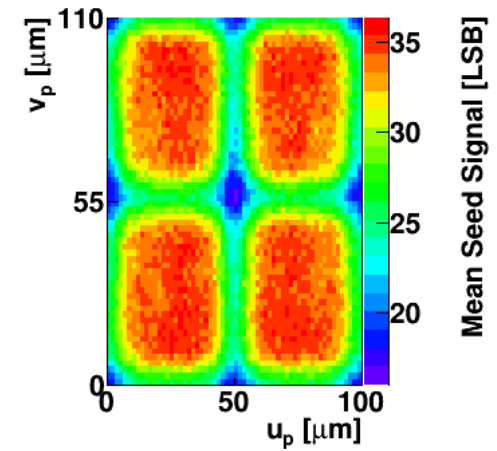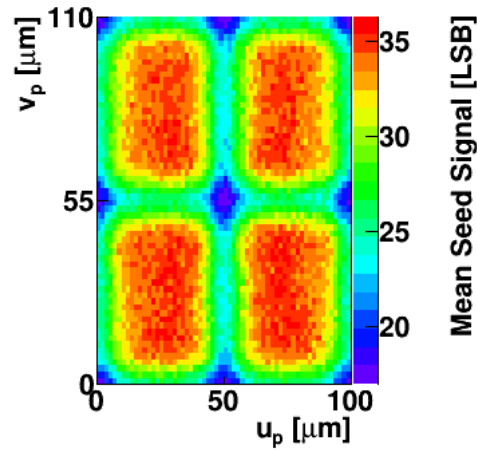
Next slide: Scan of Drift
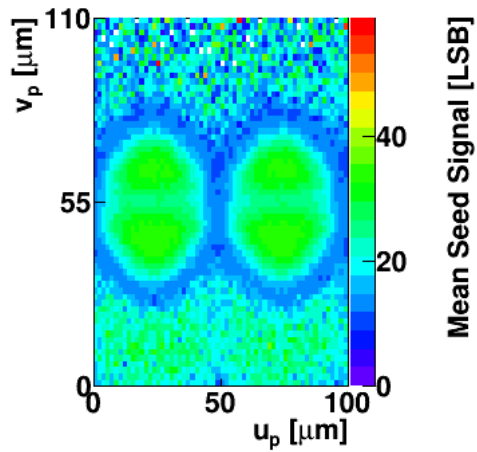
HV -70V / Drift -1V
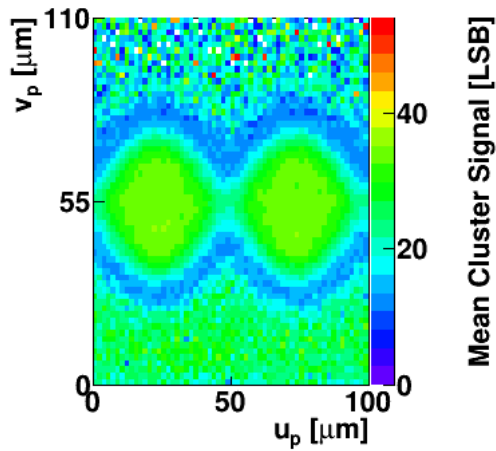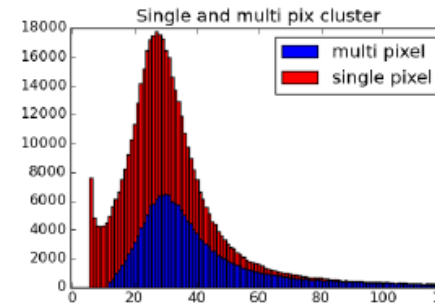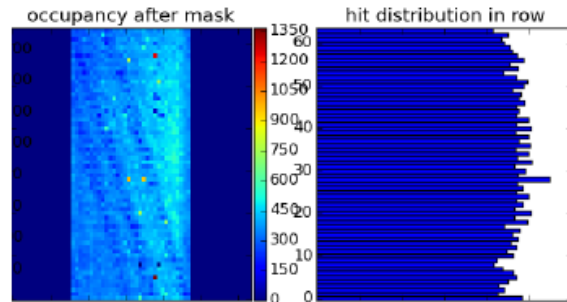
HV -70V / Drift -3V

HV -70V / Drift -5V

:- crift voltage too small
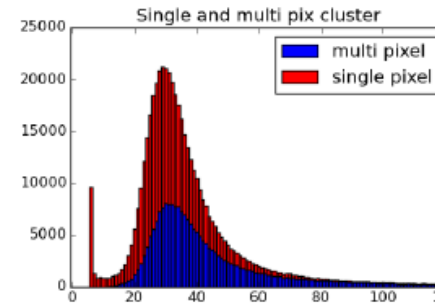:- not all charge from drift region collected
:- charge loss below clear gate

Source measurements in Bonn

HV: -80 V
Drift: -5 V

HV: -76 V
Drift: -5 V

HV: -70 V
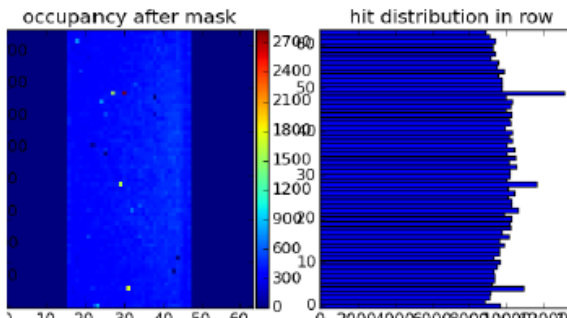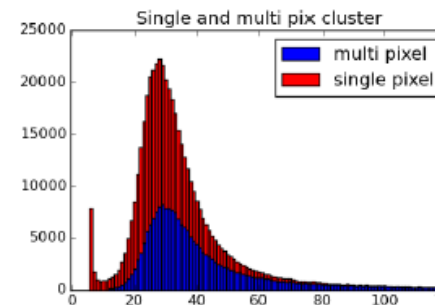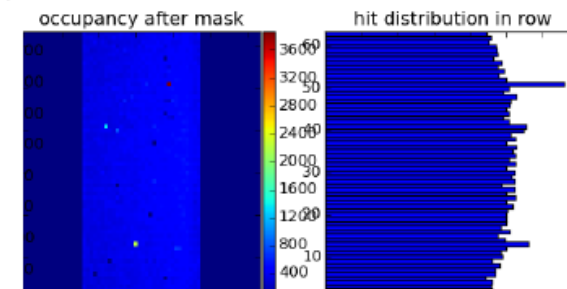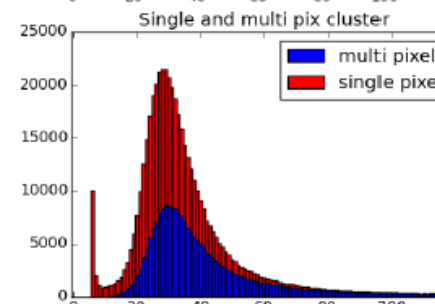Drift: -5 V

HV: -66 V
Drift: -5 V

CCG: -1 V
Clear-low: 3 V
Clear-high: 20 V
Gate-on: -2.5 V
Gate-off: 3 V

Source measurements in Bonn
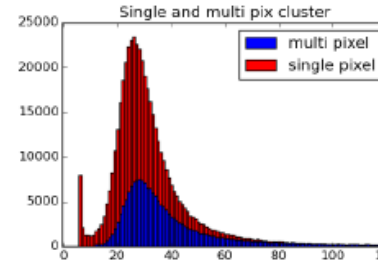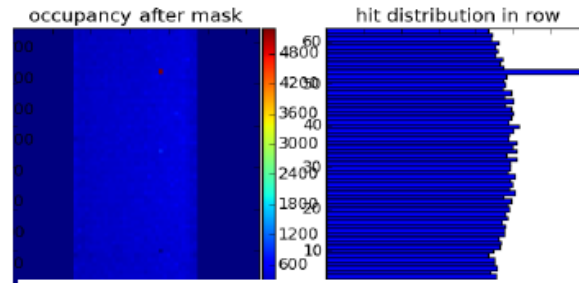
HV: -80 V
Drift: -7 V

HV: -76 V
Drift: -7 V

HV: -70 V
Drift: -7 V

HV: -66 V
Drift: -7 V

CCG: -1 V
Clear-low: 3 V
Clear-high: 20 V
Gate-on: -2.5 V
Gate-off: 3 V
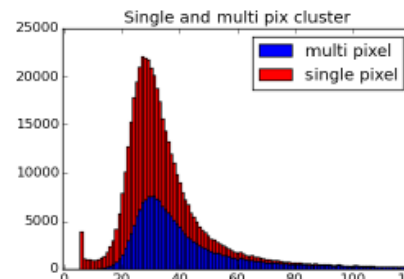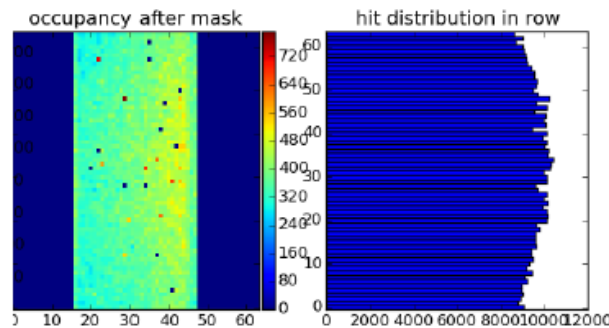
Summary
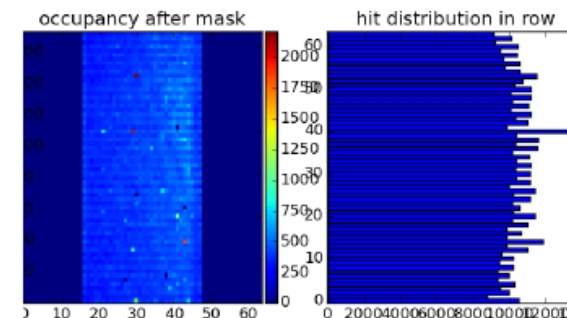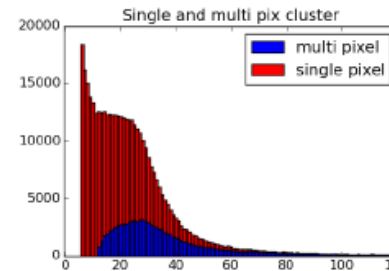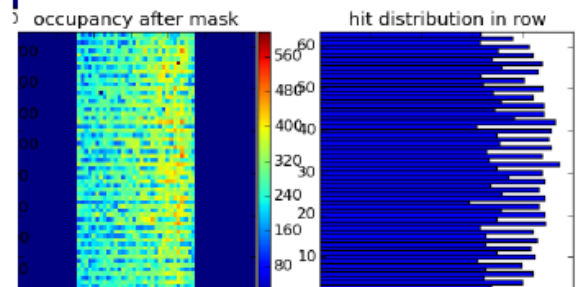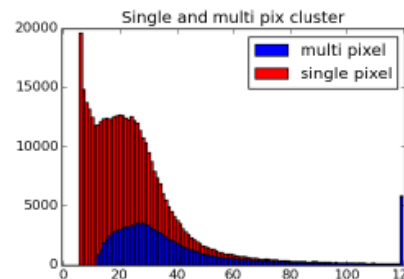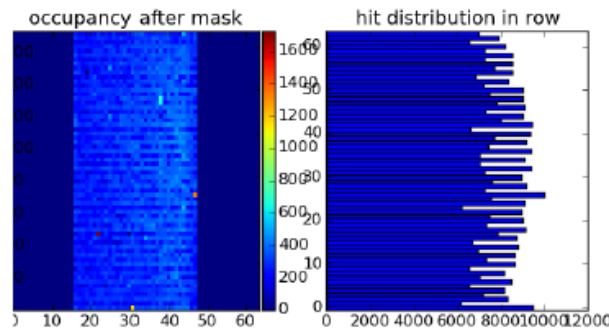
- First time to see MIPS with PXD9 sensors ;)

- Thanks to well trained team: we managed to carry out systematic studies and obtain huge statistic.

- Results are mostly as expected:

  - Cluster size ok

  - Residuals ok

  - Landau ok   (caveat: gq calibration; low energy tail)

- Uniformity and in-pixel charge collection studies revealed "rings"

  - Optimal settings for HV / Drift under discussion

  - Underlying reason not fully understood (bulk doping)

Outlook

- Gq and pixel gain studies

- Sampling point and GateOn scans

- Angular scan up to 60 degrees

- Many more results from Hybrid 6 to come

    - First large sensor operated successfully

Looking at large PXD6 (Hybrid 6)

HV -16V / Drift -1V
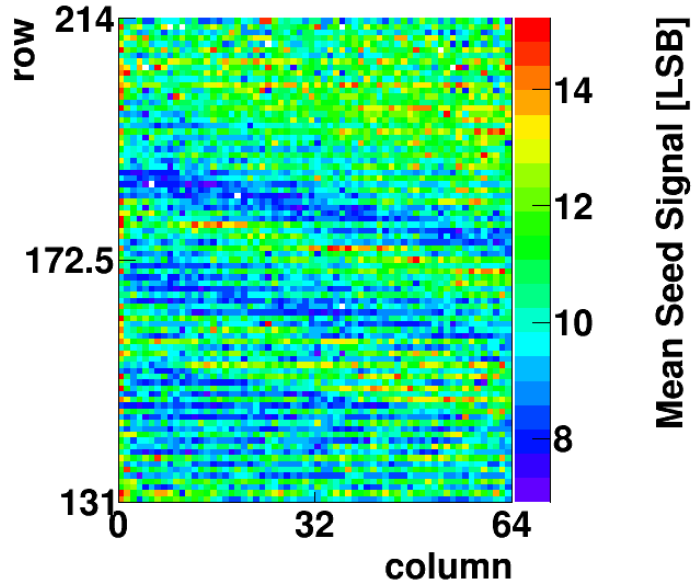
HV -20V / Drift -1V

In the HV range -16V to -20V: no sign of rings for Drift -3V or -5V

→ rings depend on balance HV / Drift
→ also present in PXD6
→ bulk doping variation possible root cause

H5 voltages during TB

- CCG: -1V

- Clear-low: 5V

- Clear-high: 20V

- Gate-on: -2.5V

- Gate-off: 3V

- HV: scanned from -60V to -80V

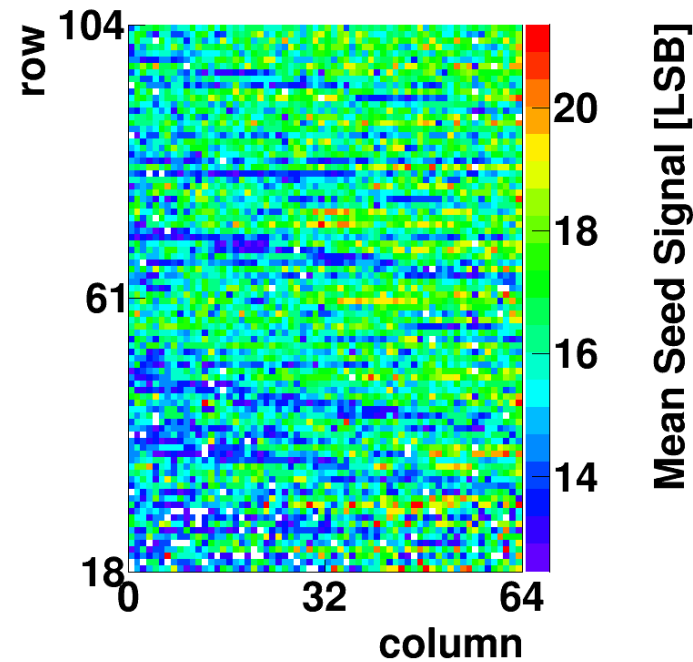- Drift: scanned from -1V to -5V