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Outcome of testbeam with CHESS 1 HVCMOS prototype

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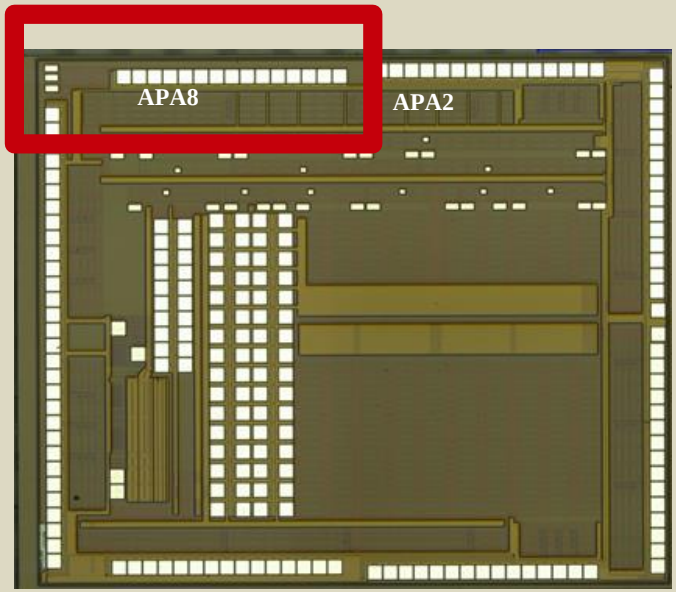
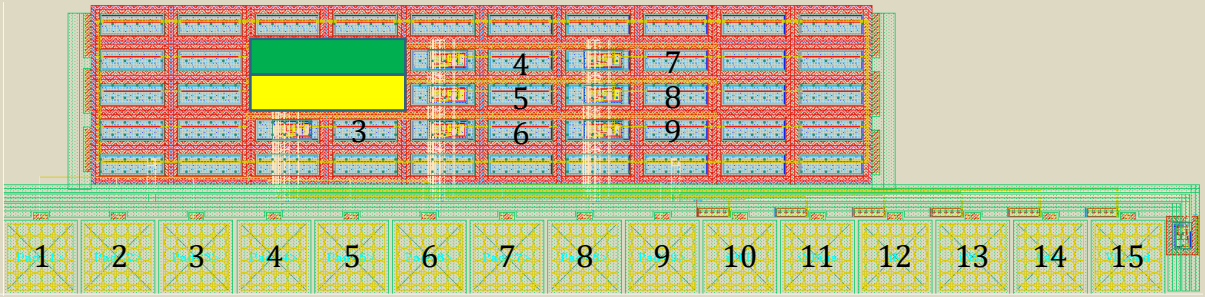
AMS CHESS 1 Sample

- 350 nm, 20 Ω, max. bias voltage 120 V, active pixels

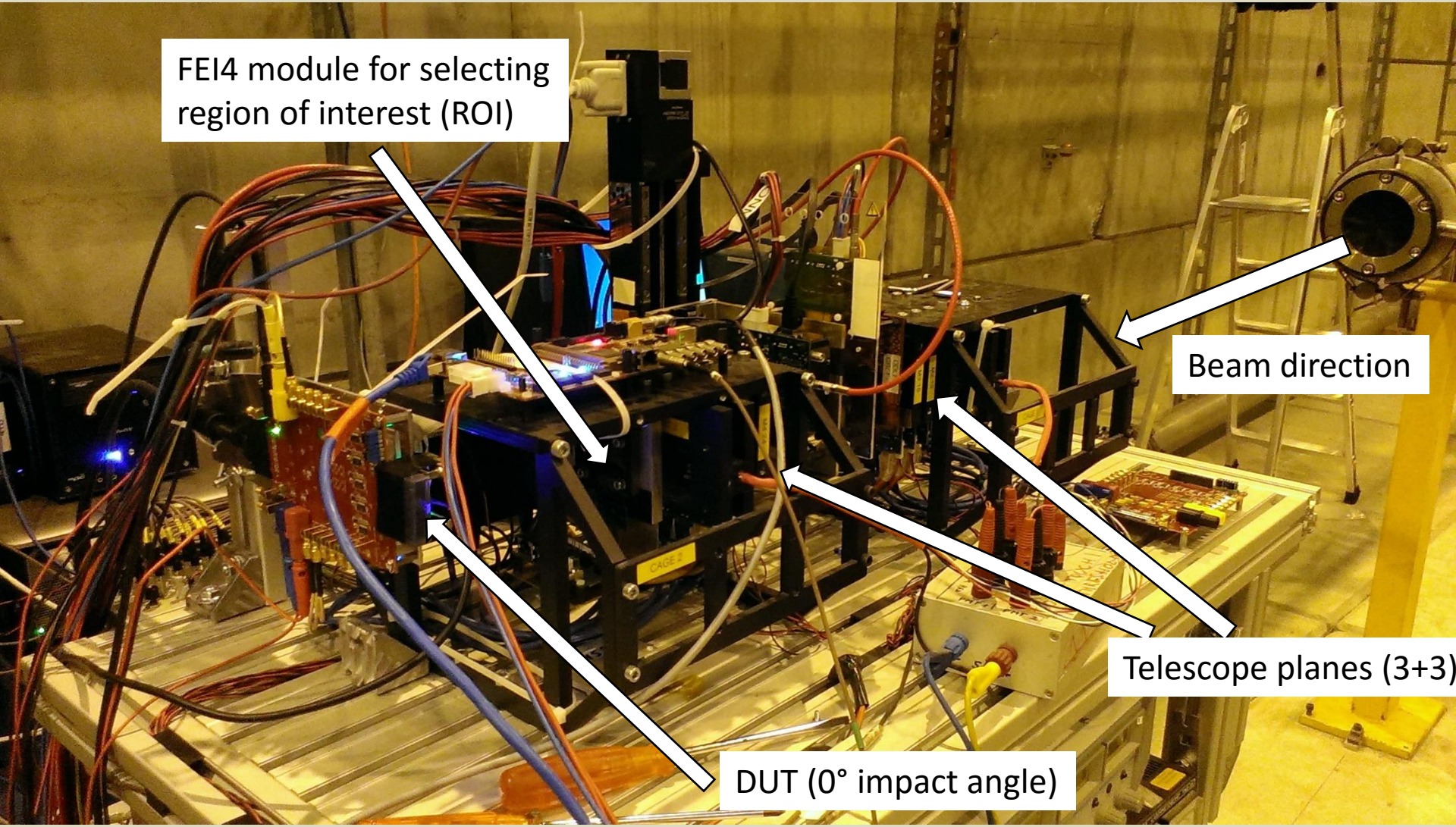
- Testbeam at CERN SPS (150 GeV pions)
  - Joined a RD42 test beam slot
  - Ljubljana beam telescope
  - Unirradiated sample
  - Active pixel array APA08, pixel size 800 x 45 µm^2
  - 2 adjacent pixels read out





exemplary layout of a 3x3 APA (200 x 45 µm^2)

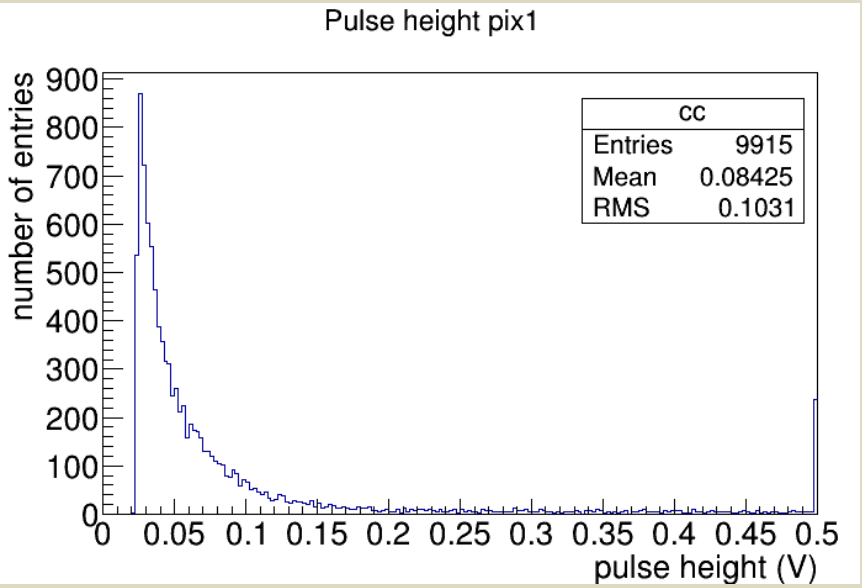
Test beam setup

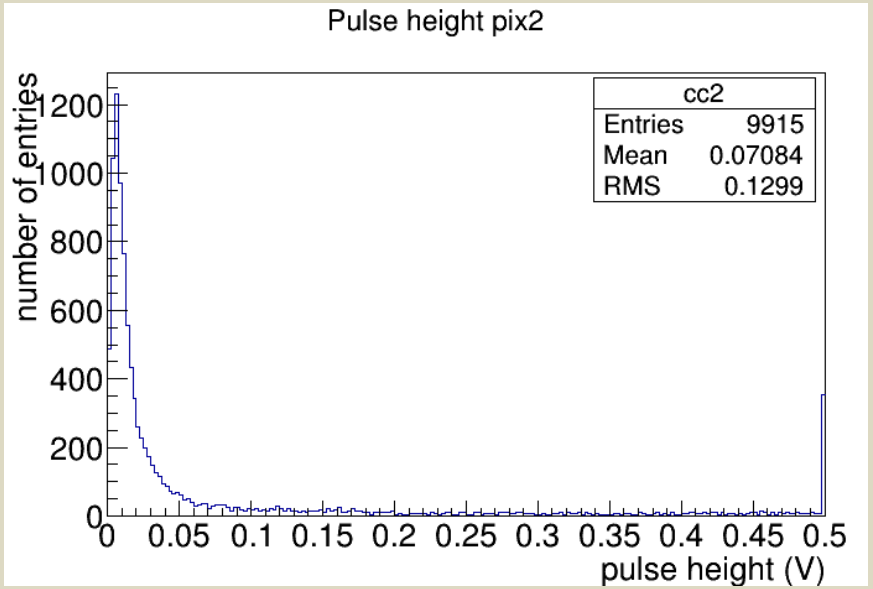


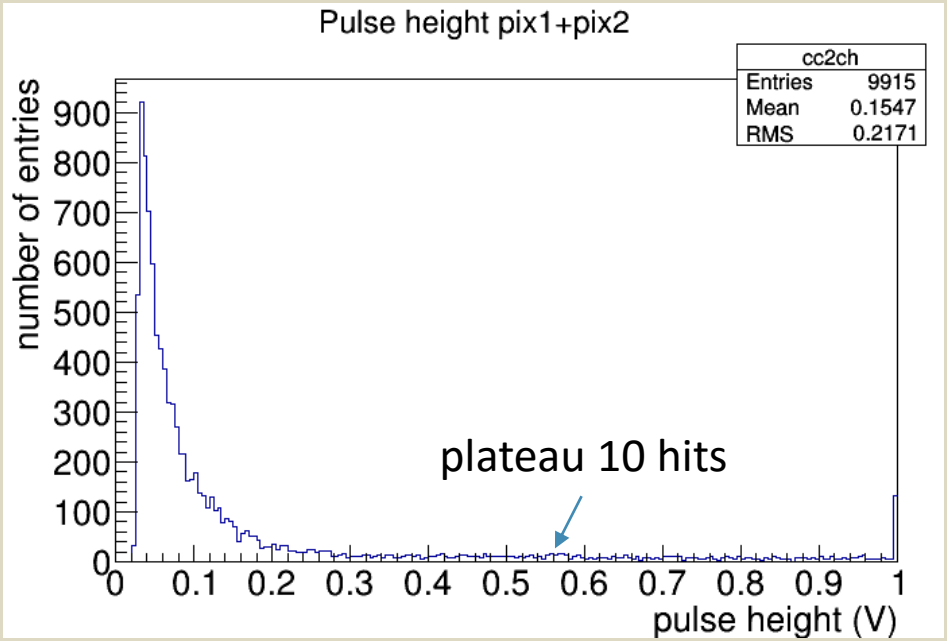
Outcome

- We had a biasing problem, so there was most likely no HV on the chip (shorted wire bonds)
  - In all measurements HV was set to 120 V, but all voltage drop on HV filter
- First measurements done with self triggering on one of the chanels
  - tracking NOT enabled
  - was run for several days, since no impact on the other telescope users
  - obtained signal spectrum
- Then dedicated run with telescope
  - tracking enabled
  - trigger: scintillator coincidence + ROI
  - recorded approx. 100k events

Results – self trigger – spectrum, config 8

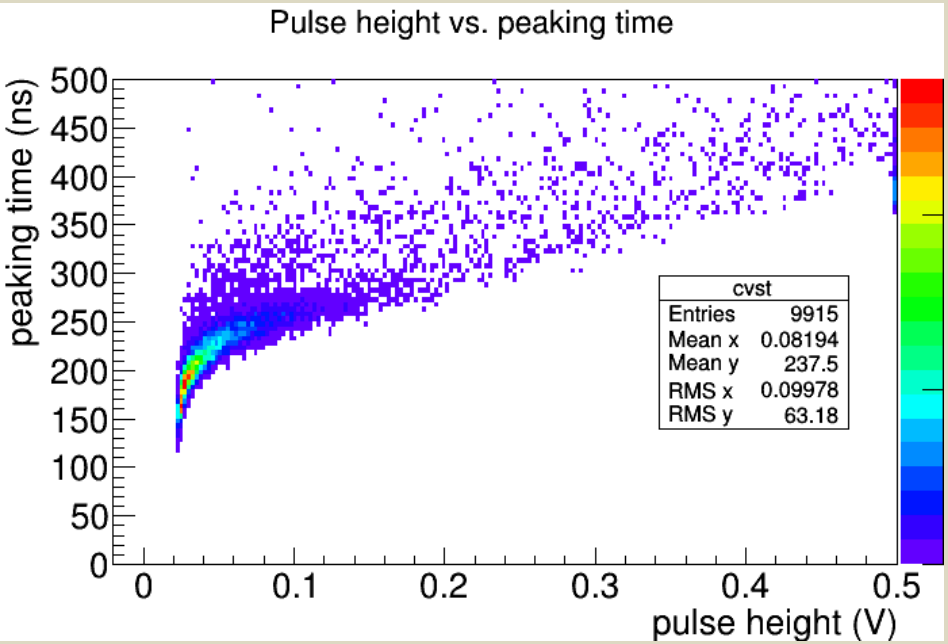


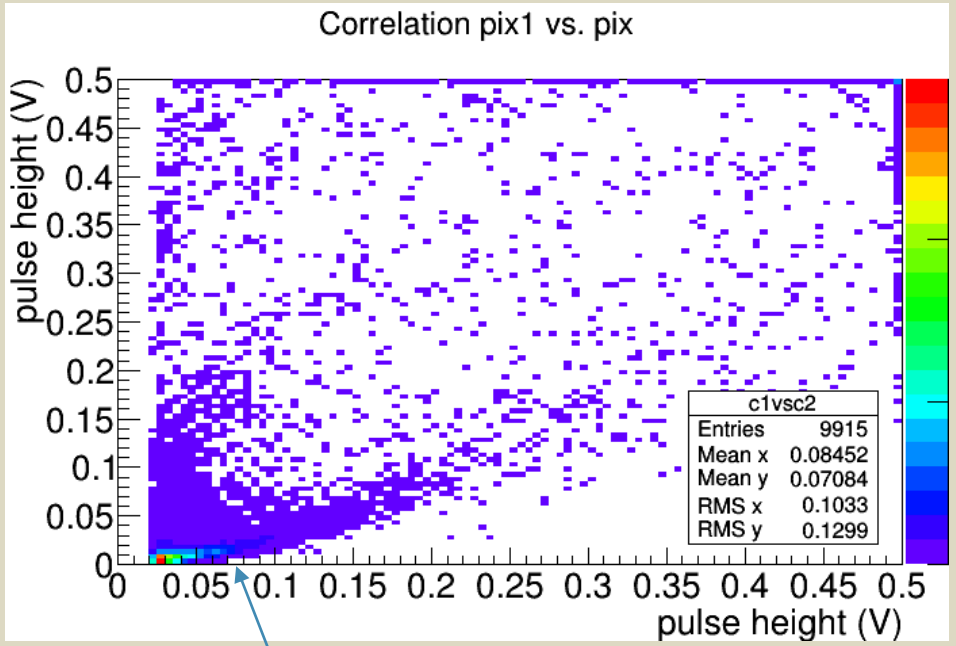




Sum of the charge from both pixels
No peak visible

Results – self trigger – correlations





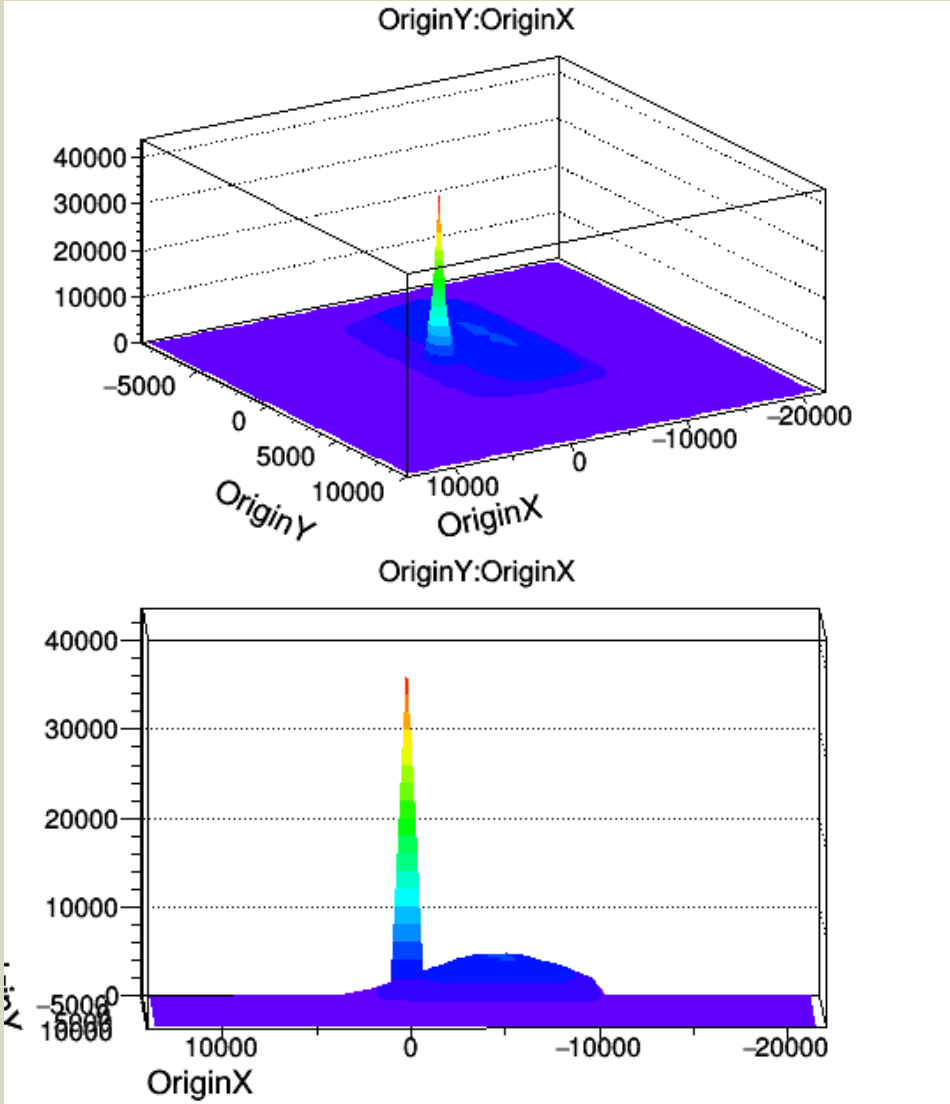
biased because of self trigger (time walk)

correlation between both chanels visible

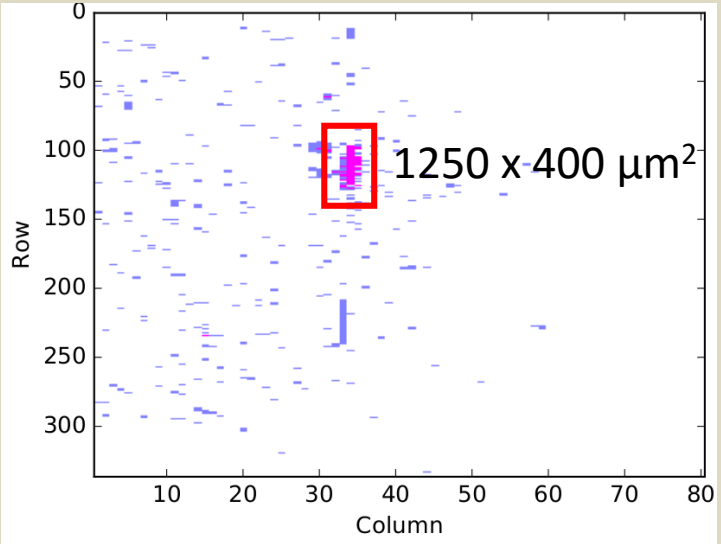
Results – telescope run - ROI

- Region of interest worked OK

Telescope: track origin



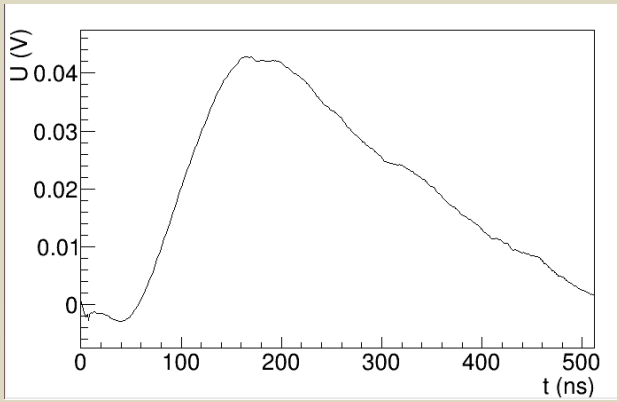
FEI4: selected ROI



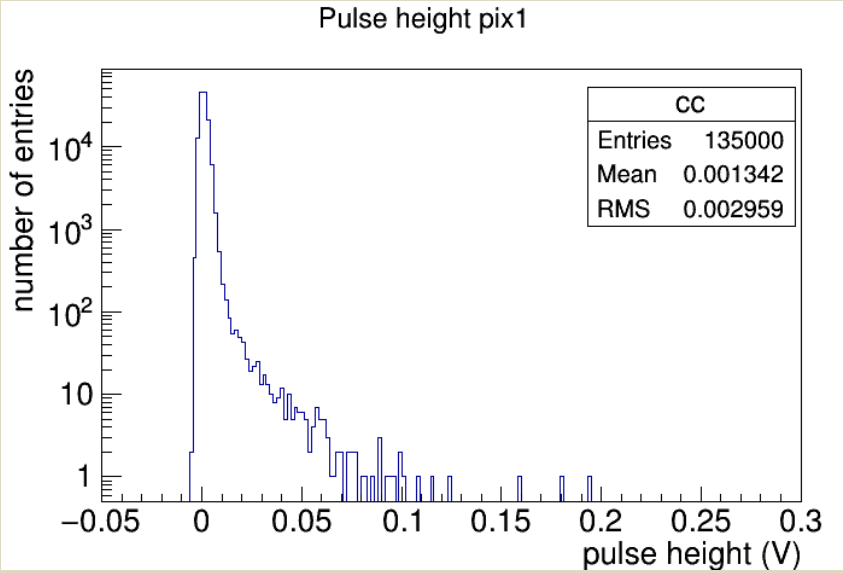
Results – telescope run

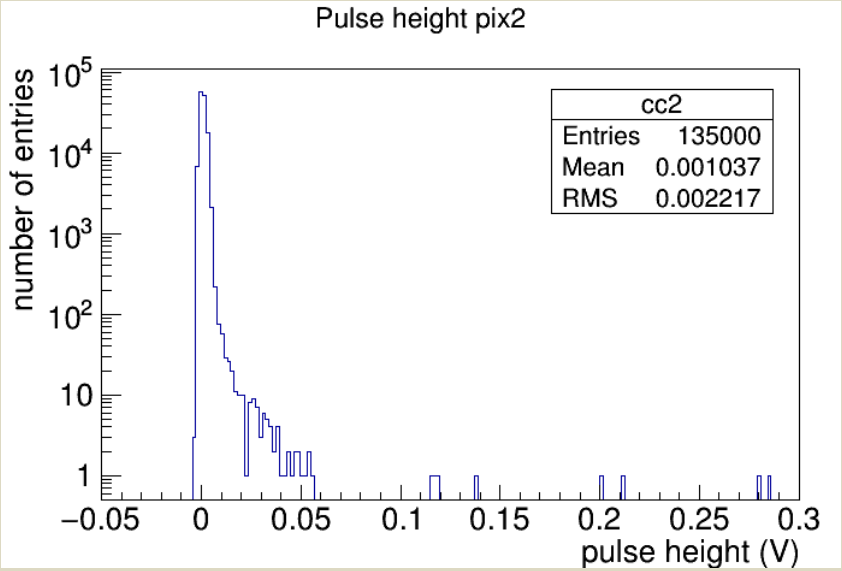
- Number of recorded events differs by 20 % between DUT (DRS 4) and telescope
  - DUT: 135k events
  - telescope: 112k events
- Discrepancies in number of triggers similar within every beam spill
- no successful event synchronization between the DUT and the telescope so far
  → missing triggers are a major problem
- no efficiency maps

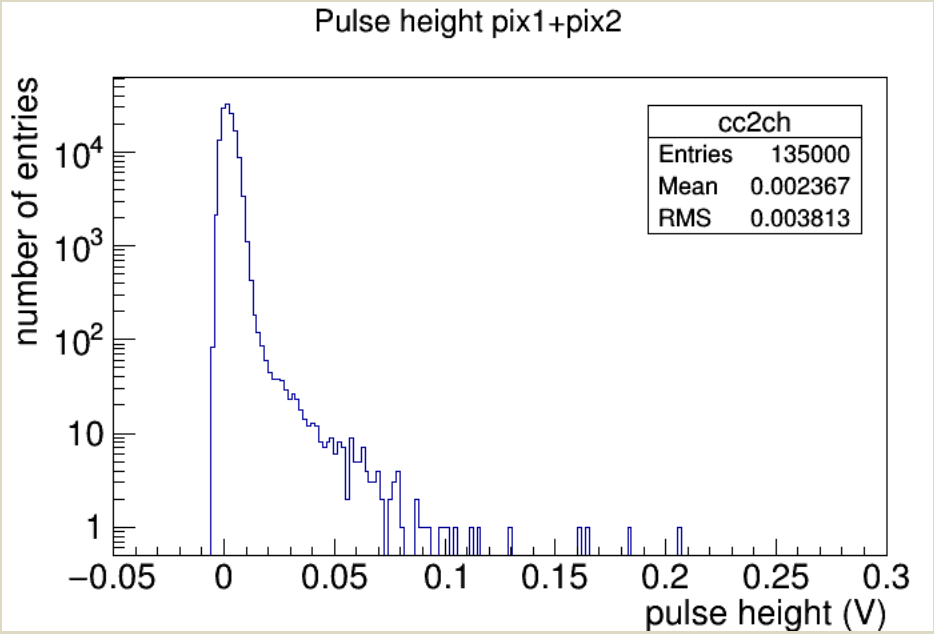
- Other observations:
  - trigger rate approx. 100 times higher than with self trigger
  - ROI 1250 x 400 μm^2 – approx. 7 times larger than pixel surface
  - however, distinctive pulses observed only in about 1 % of waveforms
  - DUT seems to have a very low efficiency



Signal spectrum – telescope run, config 7



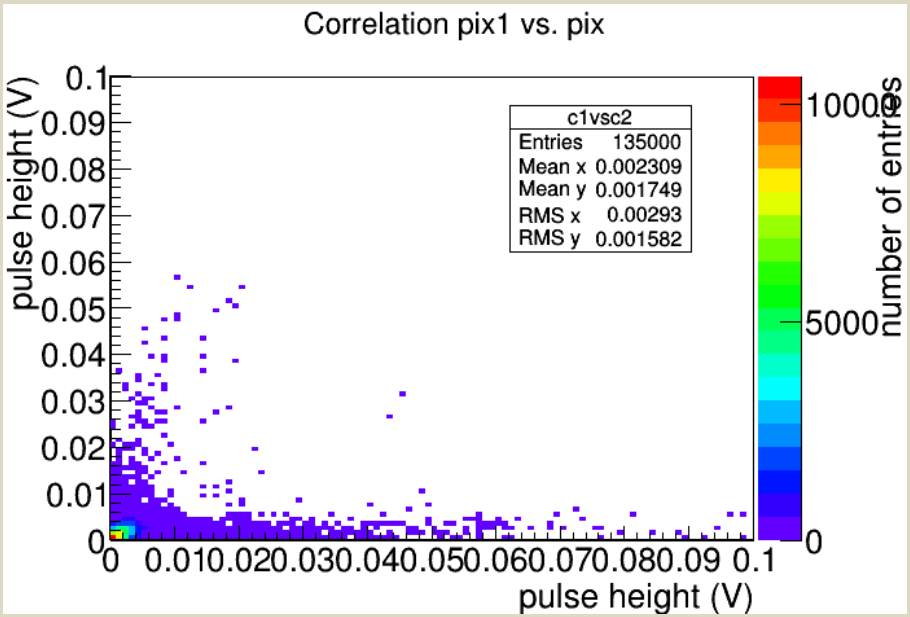




no Landau peak observed

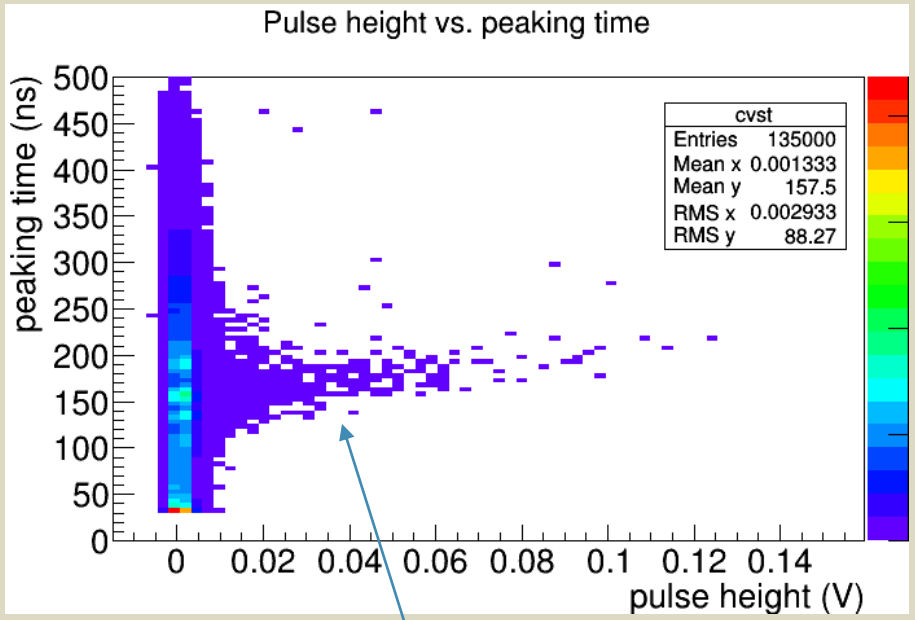
Correlations

pixel to pixel correlation



no correlations observed

pulse height vs. peaking time



events with pulses

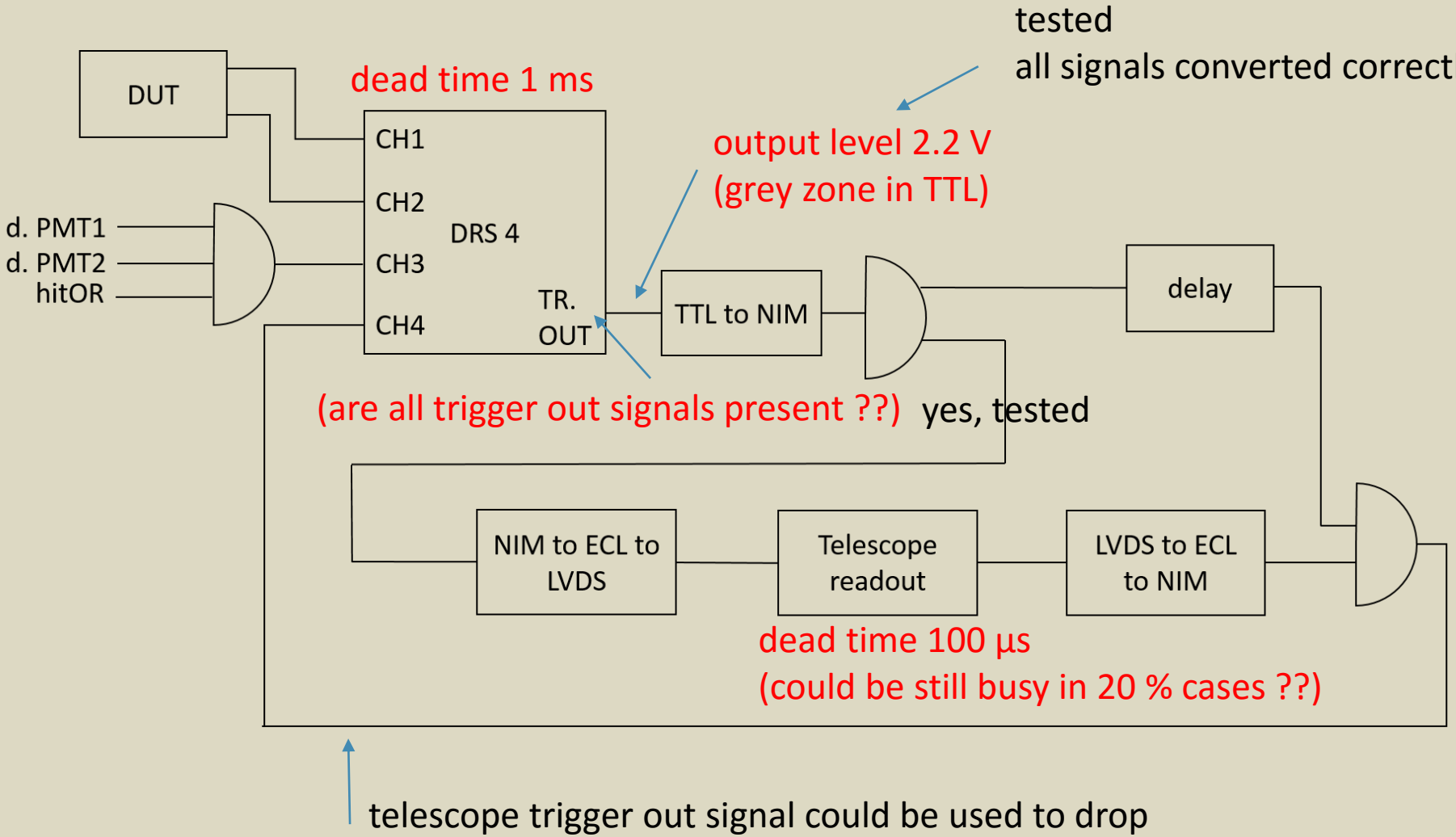
Conclusion

- Identified problems:
  - DUT: cannot apply bias – removed disrupting wire bond, now looks a bit better
  - DUT: low efficiency – require telescope run for further analysis
  - Telescope: missing triggers
    - could be several reasons, try to find a fix for each possible cause
    - it is crucial for the analysis that this is solved

- Next steps:
  - Another test beam slot at CERN SPS 8th - 22nd June
  - try to fix the issues by then
  - try measuring irradiated DUTs ?

BACKUP

Possible weak points causing missing triggers



DRS trigger out