Beam test @ DESY (2021 Dec.) data analysis with Corryvreckan

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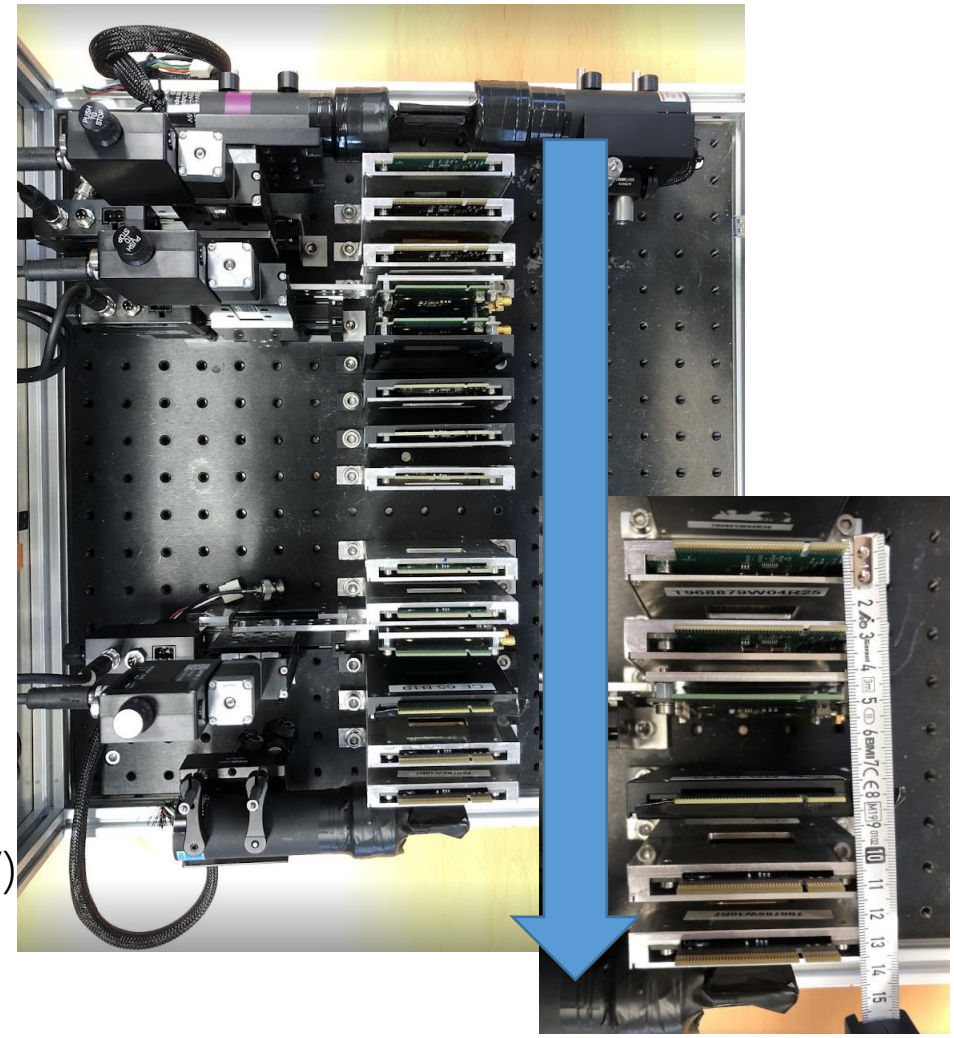
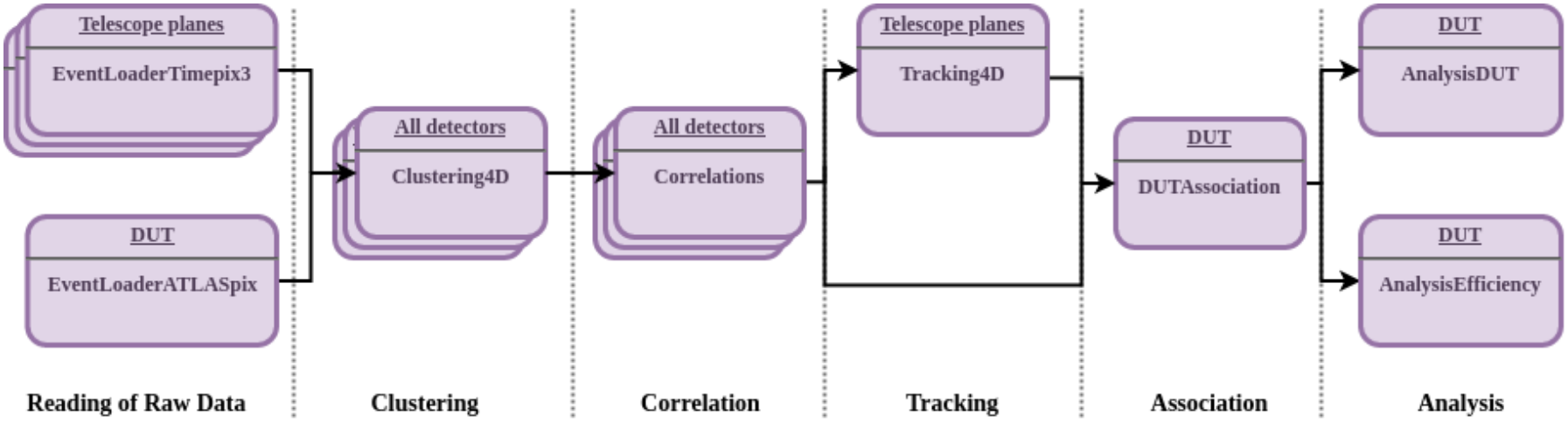
Beam setup

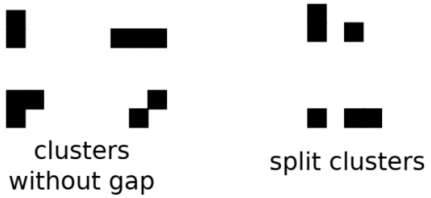
- DESY T22
- Beam
  - Electron 5.4 GeV (or 1 GeV)
- **Telescope**
  - Trigger: Scintillators / **DPTS**
  - 2 REFS + DPTS + CE65 + 2REFS
- Data taking
  - Dec. 2 -4
  - A4: ~66k hits on DUT
  - B4: ~73k (5.4 GeV) + 220k (1 GeV)
  - C4: ~95k hits
  - D4: ~2.5k hits

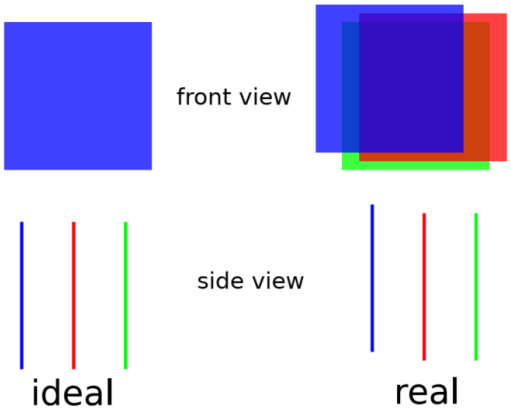


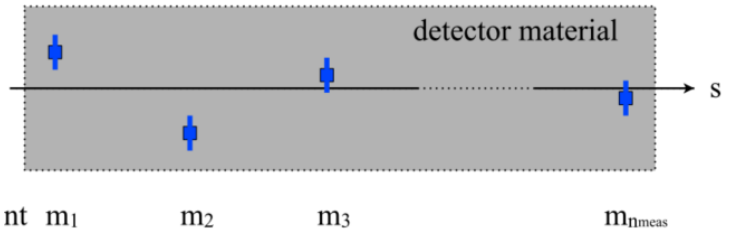
Introduction

- Data analysis – corryvrekan



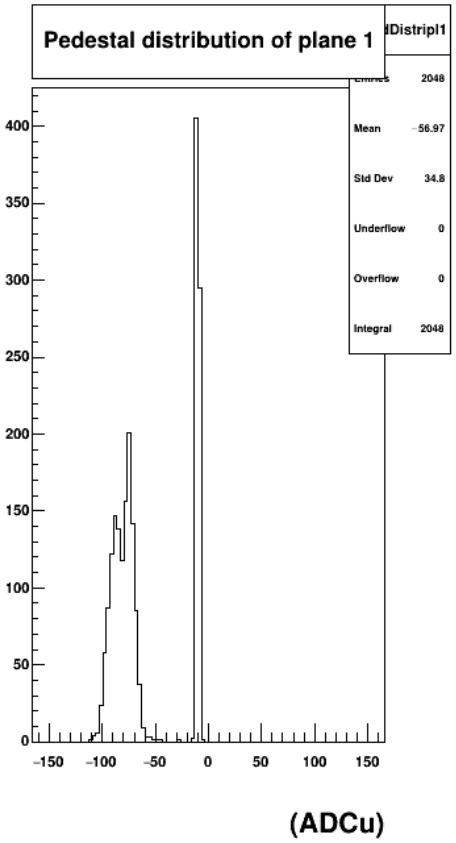


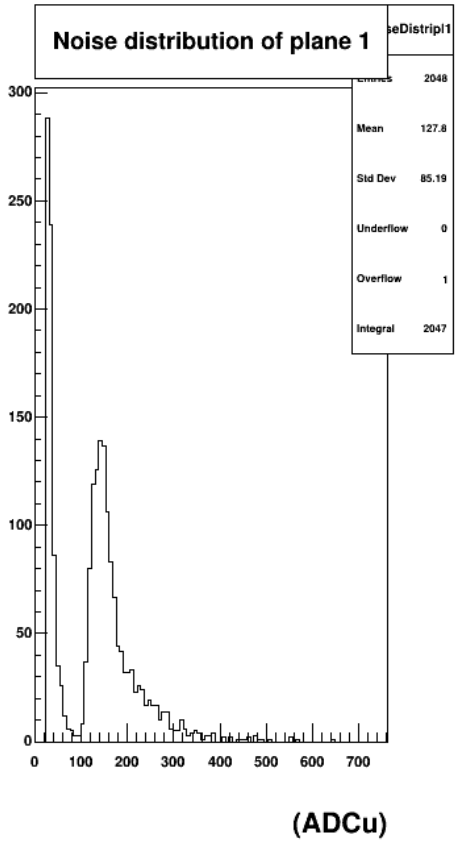


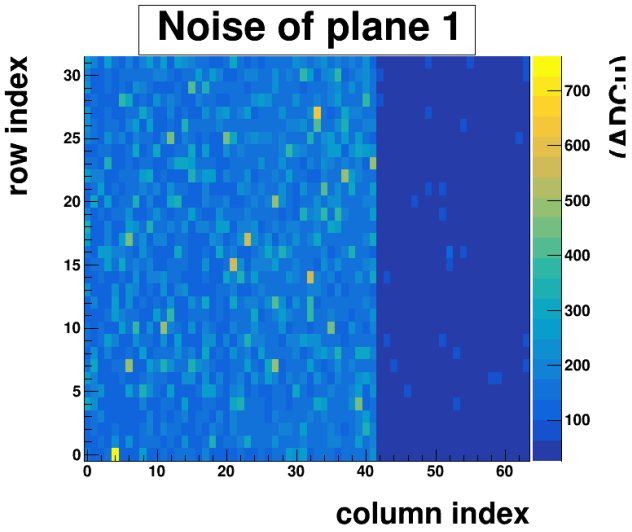


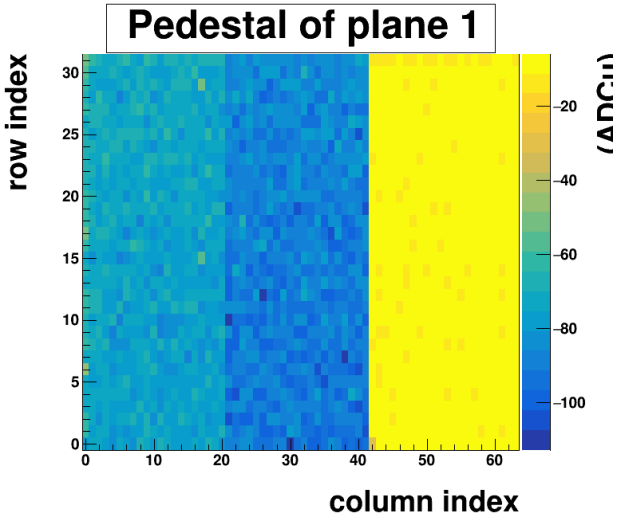
Noise map

- B4 dry-run 483152900
  - InitialNoise: 2500 events



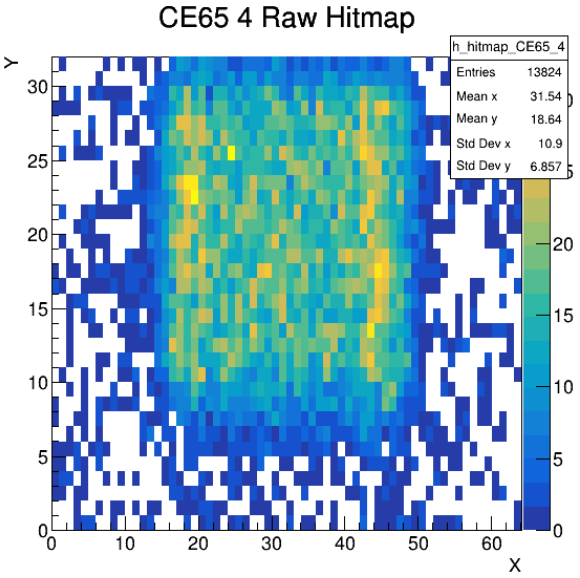


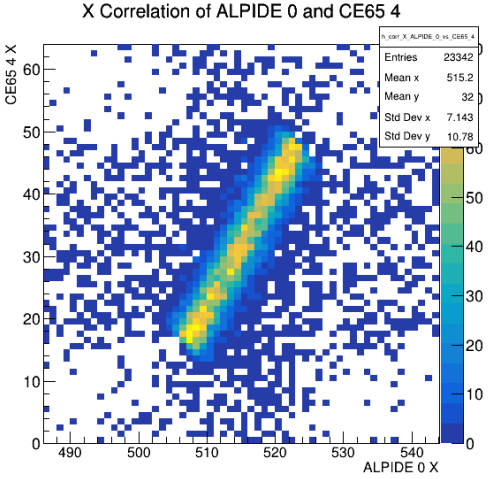


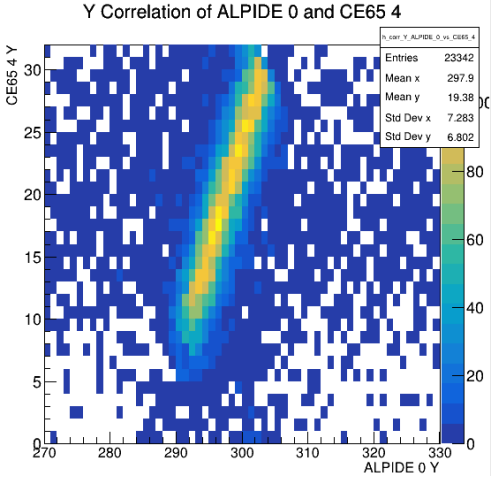


Event monitor

- **Event from EUDAQ2**
  - Same as CE65Event (all frames, raw_amp)
  - RAW event format FIXED after **run485105326**
    - lost 14k hits on B4, but can be integrated from CE65daq
  - Display by EUDAQ2/StdEventMonitor
- **Hits**
  - $Signal\ pulse \equiv |ADC_{last-frame} - ADC_{1st-frame}|$
  - Cut: [1500, 2000, 500] (SNR~10, avg. from dryrun)
  - No charge information,
  - For alignment during beam
- **Example – B4**
  - Run 487192642
  - DPTS trigger
  - 15k events

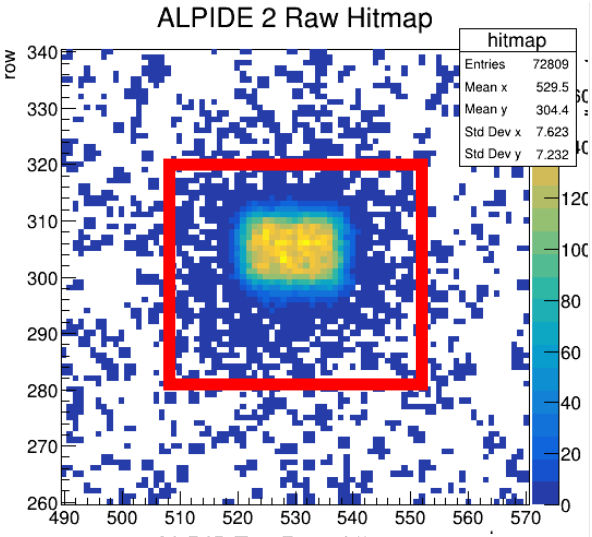


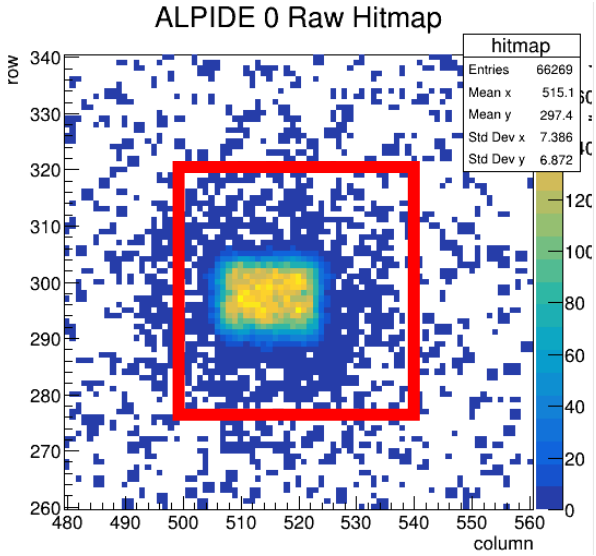


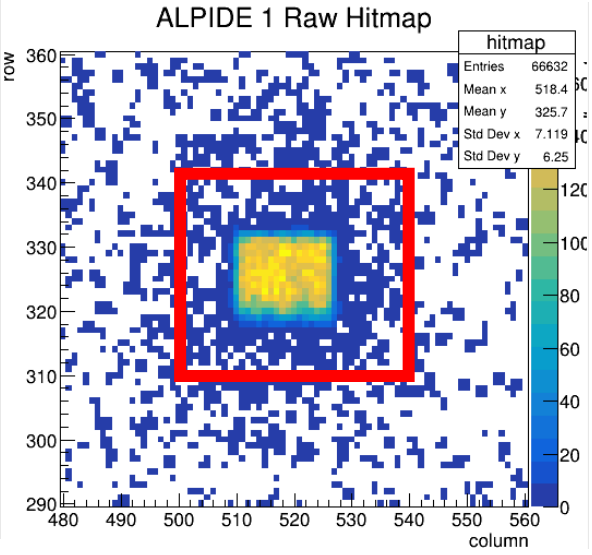


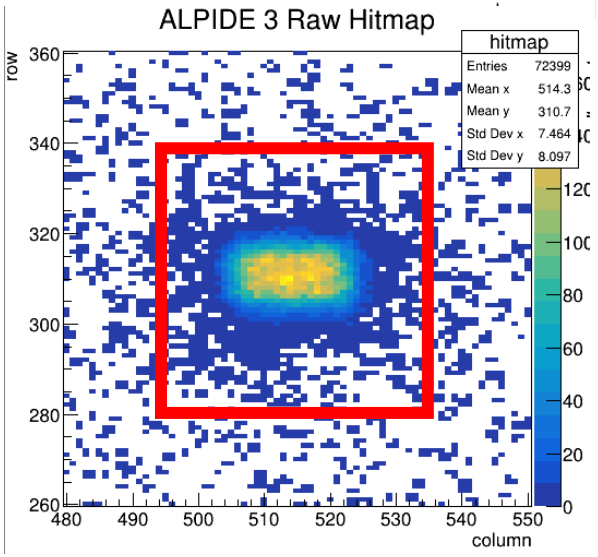
Telescope

- Alignment for references (ALPIDE)
  - ROI selection (~40x40, smaller?)
    - 0 - [500, 280], [540, 320]
    - 1 - [500, 310], [540, 340]
    - 2 - [510, 280], [550, 320]
    - 3 - [495, 280], [535, 340]
  - Fake trigger rejection



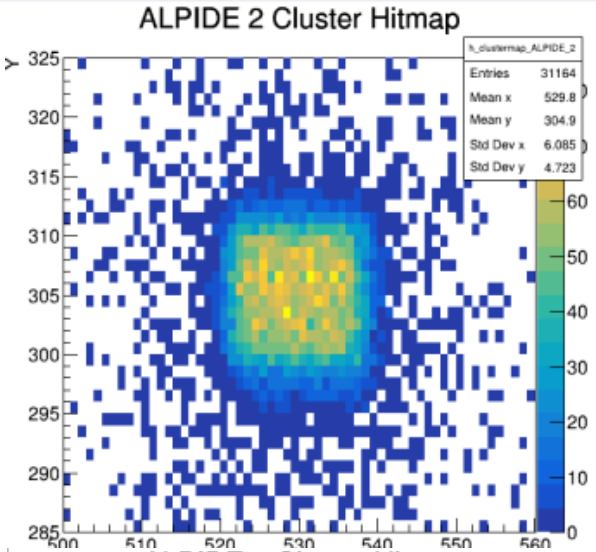


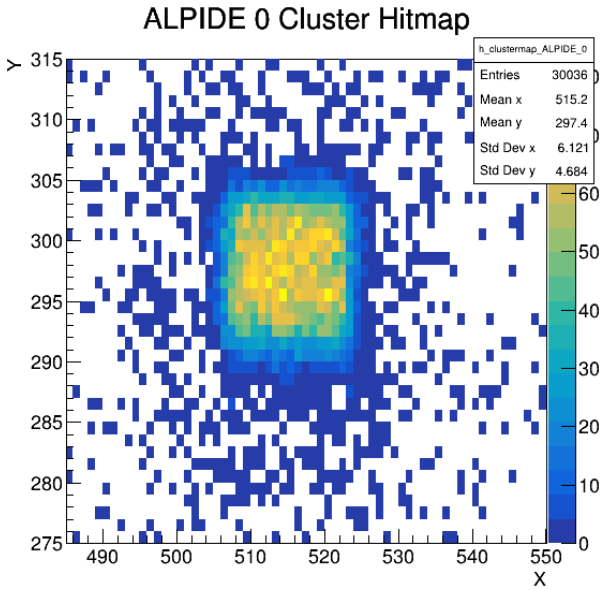


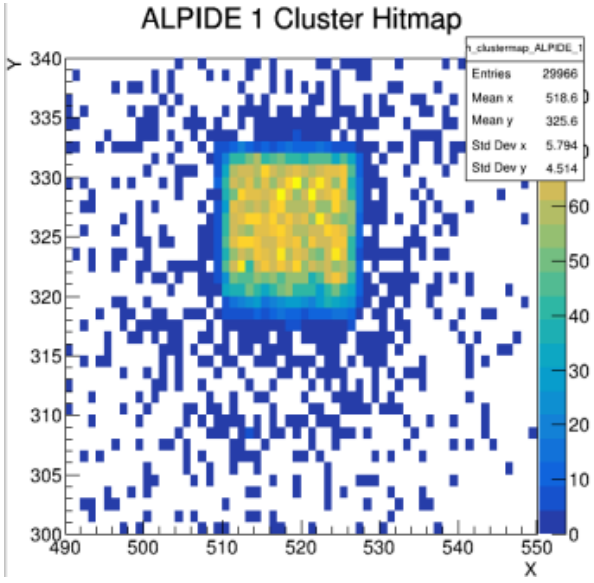


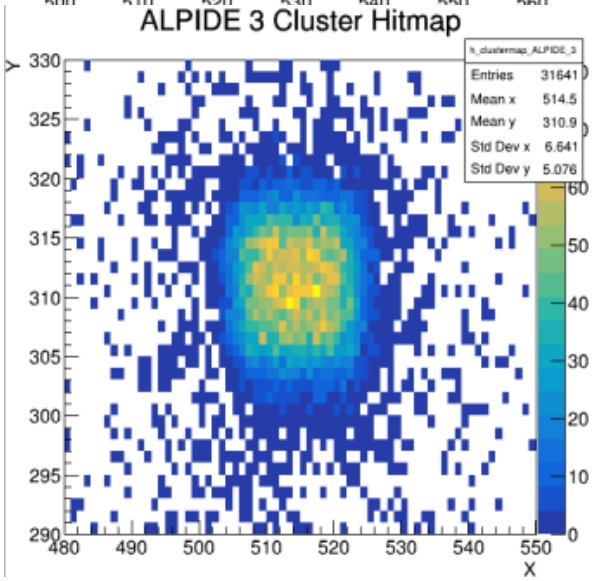
Telescope

- Alignment for references (ALPIDE)
  - After clustering by EUDAQ2





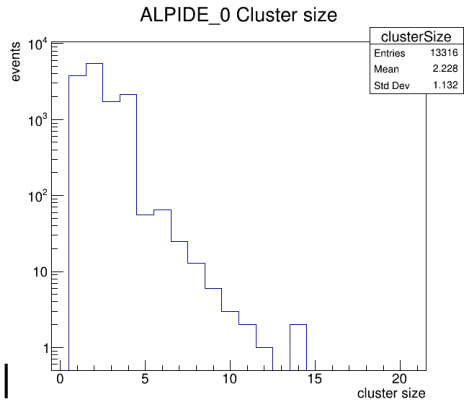


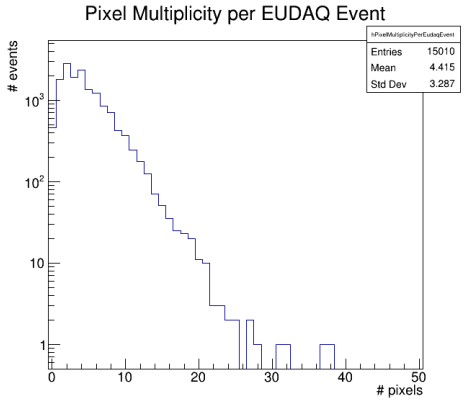


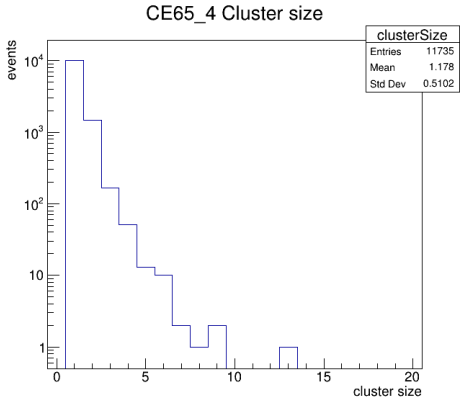
Telescope

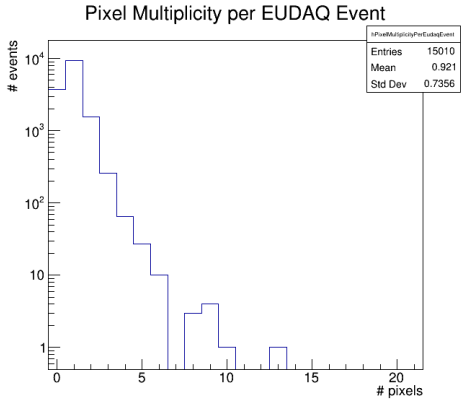
- Alignment for references (ALPIDE)
  - Clustering by Corryvreckan – touching neighbors method
  - CE65 with simple cut (SNR~10)
    -> fire seeding pixel
    -> lost small neighbors

- TODO
  - Input noise map to EUDAQ2
    - Better Amp cut with SNR by pixel
  - NEW Clustering module
    - Corry::ClusteringAnalog
    - Seeding + neighbor
    - Search window - 3x3 matrix?



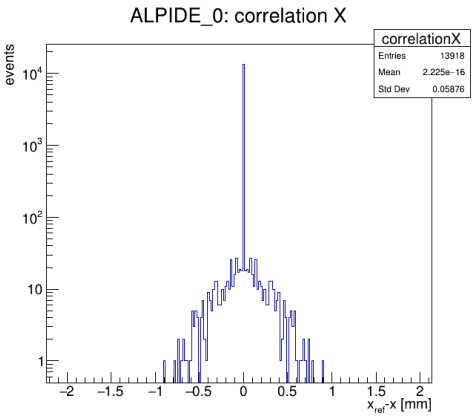


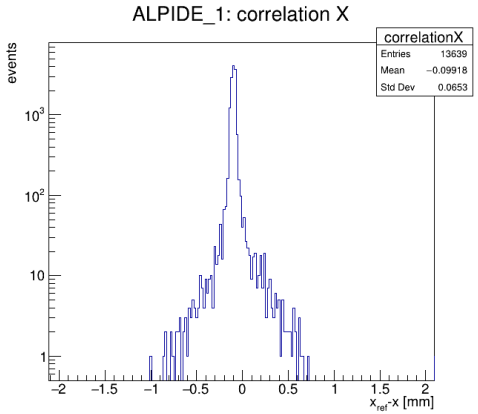


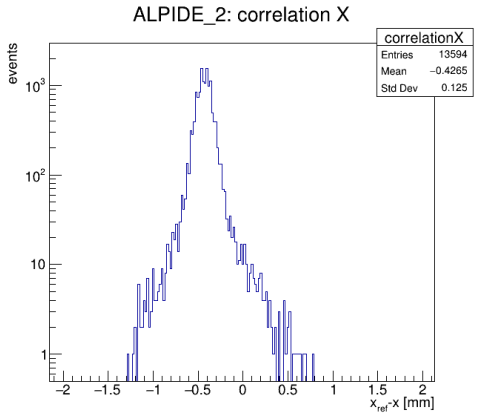


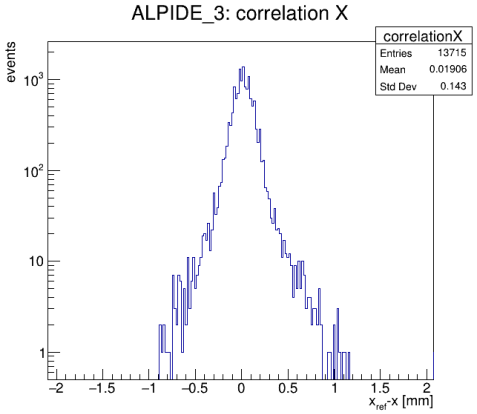
Telescope

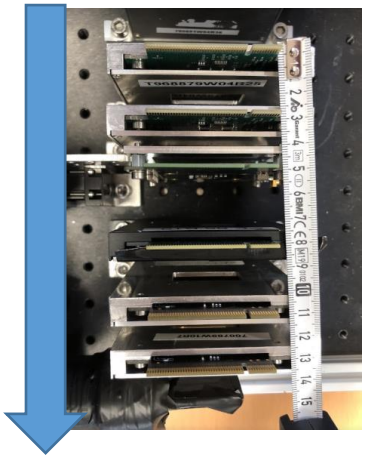
- Alignment for references (ALPIDE)
  - Pre-alignment by fitting hit correlation in X/Y
  - Method: gaus_fit & shift by μ

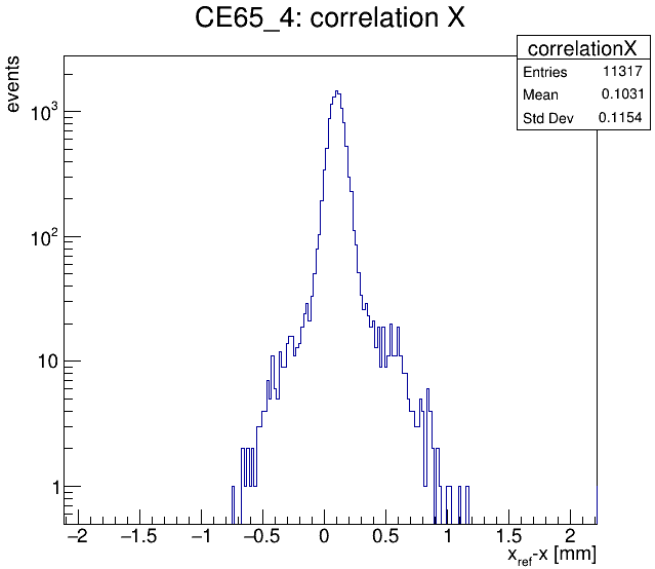












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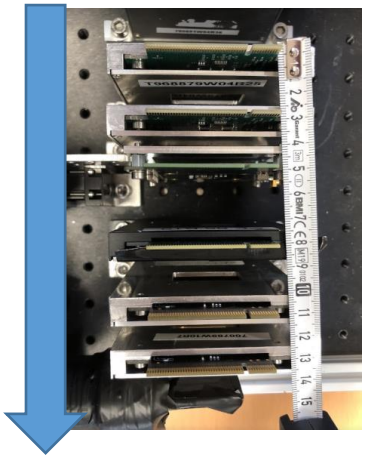
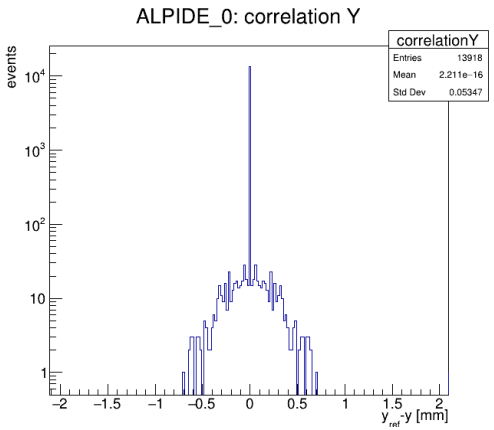
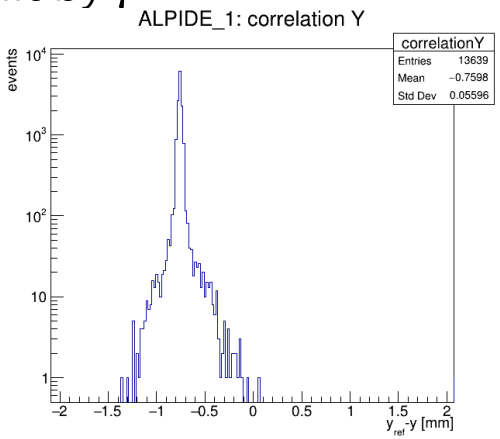
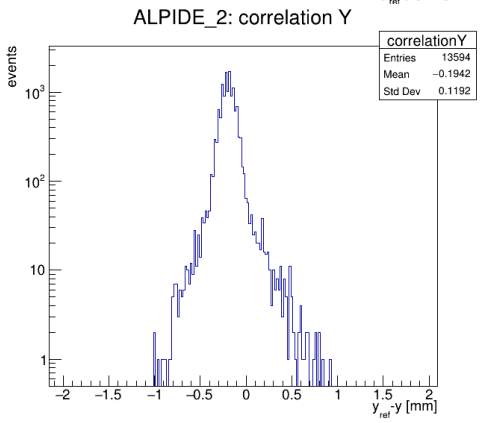
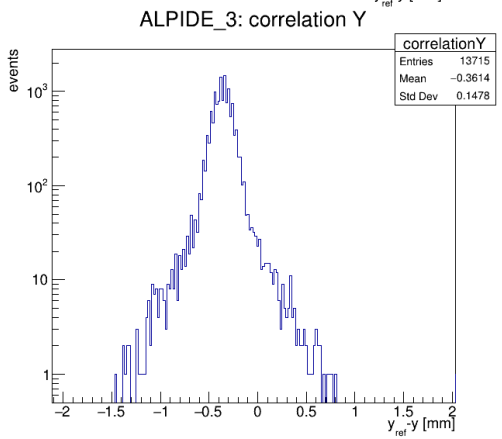
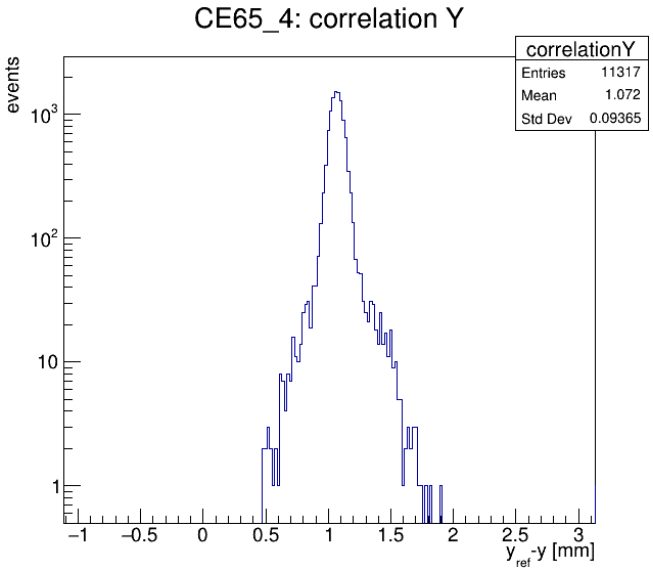






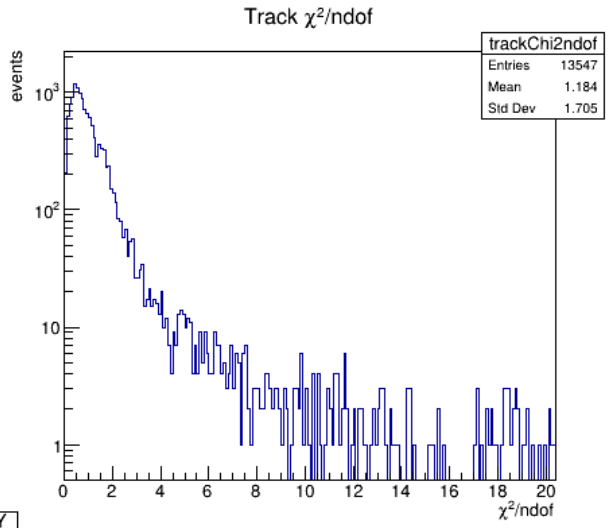


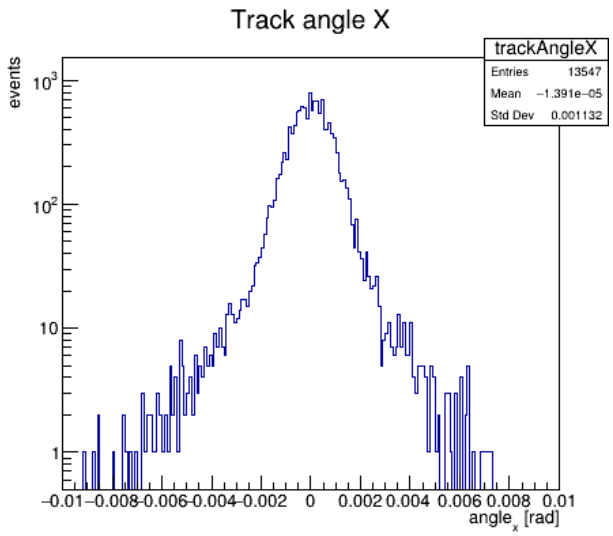


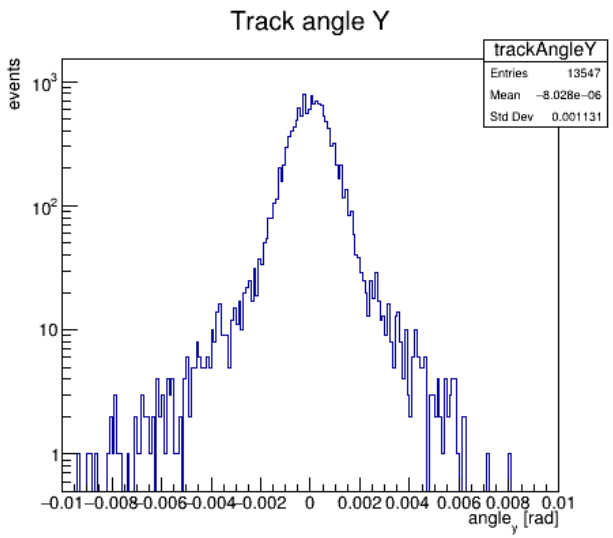


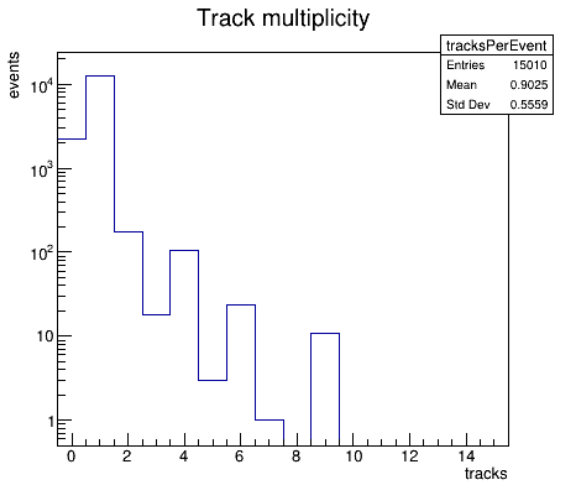
Telescope

- Tracking & Alignment
  - Method: straight line
  - Min hits on track: 4
  - Spatial cut: 1mm, 1mm









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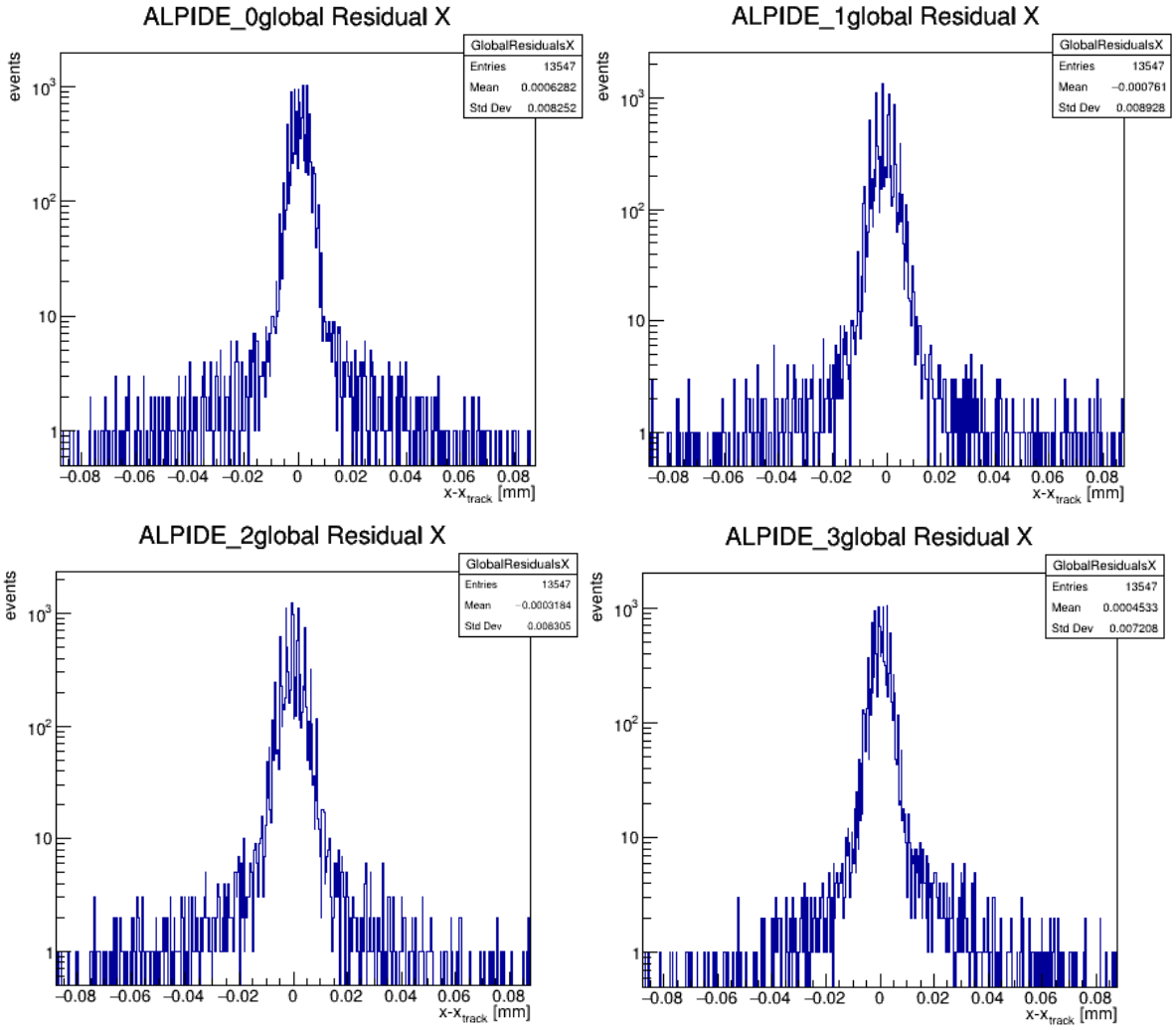

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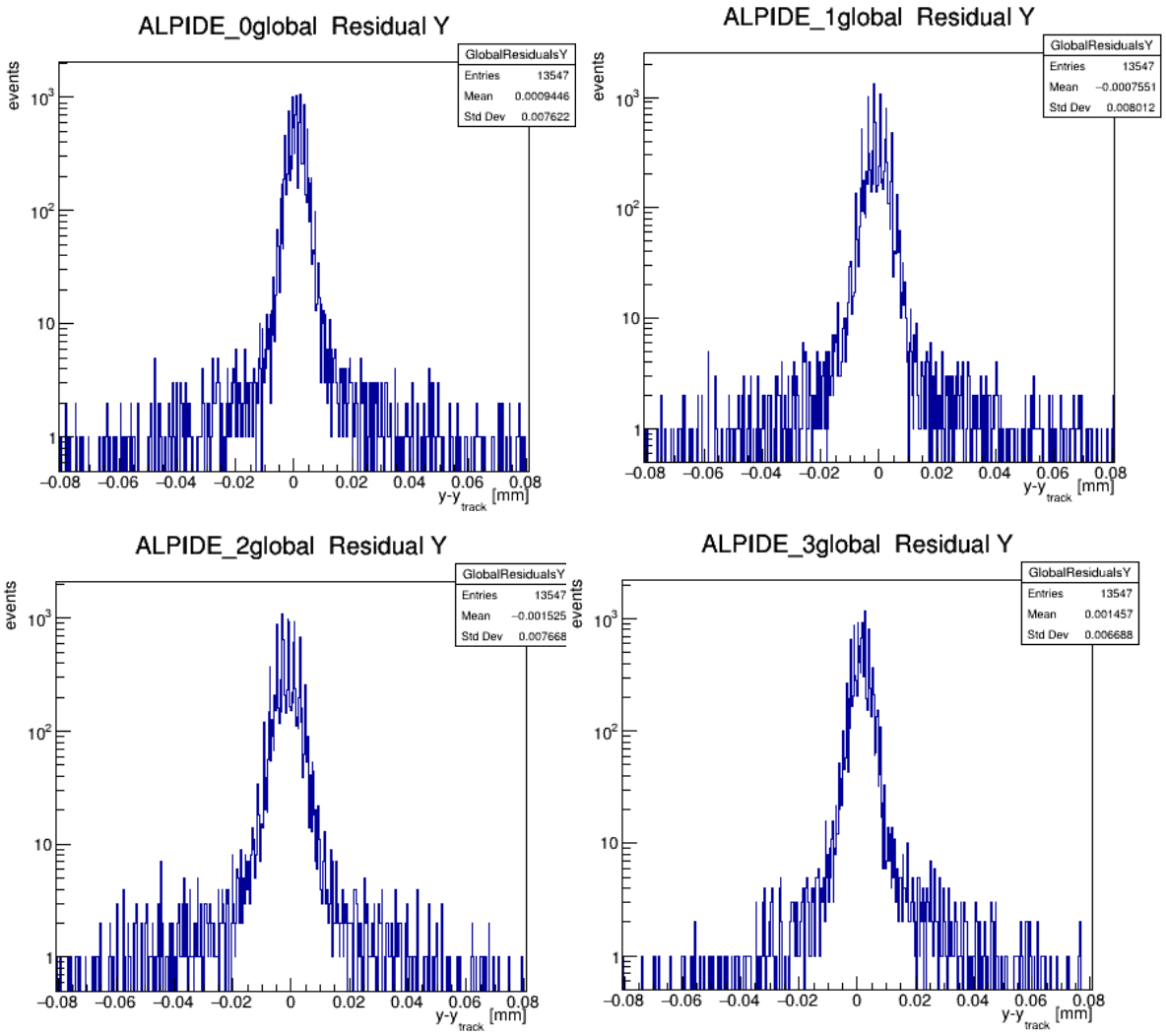


DUT

- Tracking association
  - 15010 events, 13824 hits in CE65
  - Good tracks: **11934** / 13477
    - Cuts: chi2, DUT region, ⋯
  - Efficiency: **9875**/11934 (~82%)

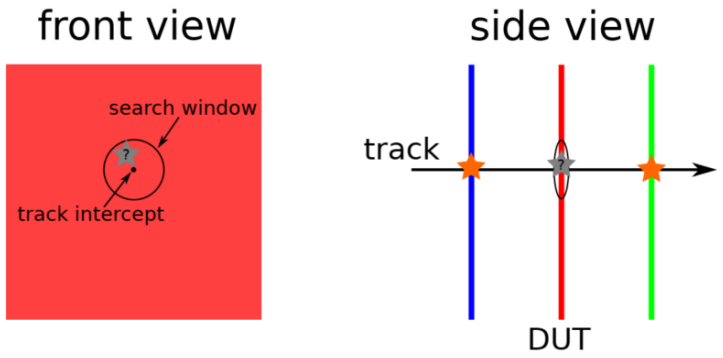
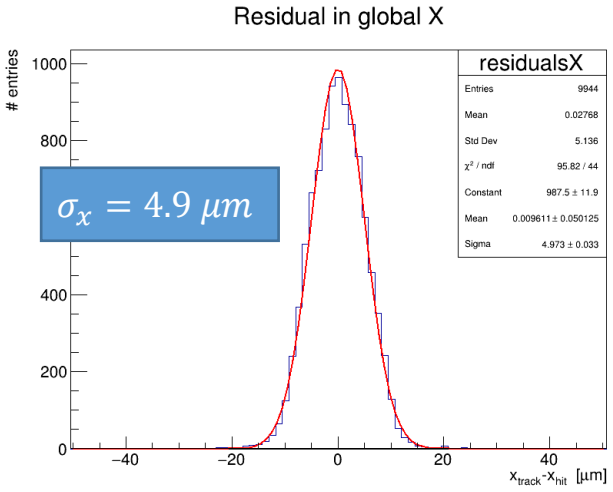
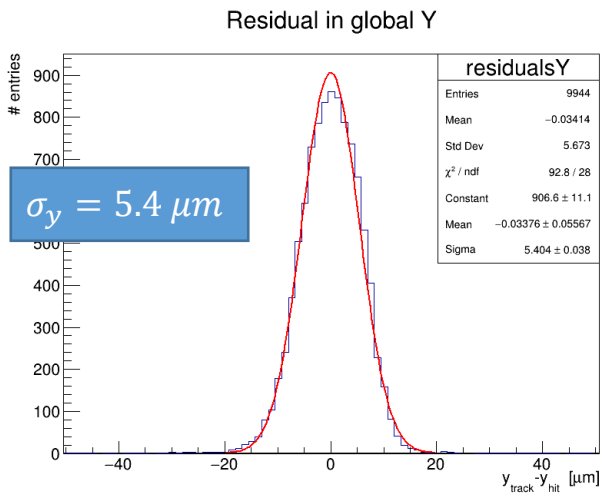
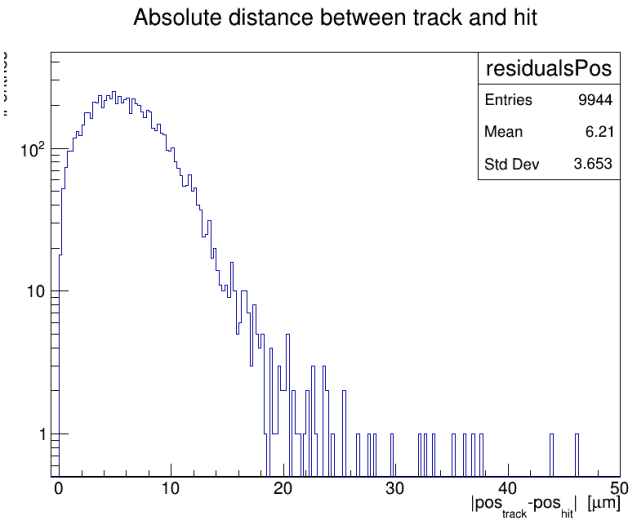


Figure 17: Illustration of the DUT association.







Next

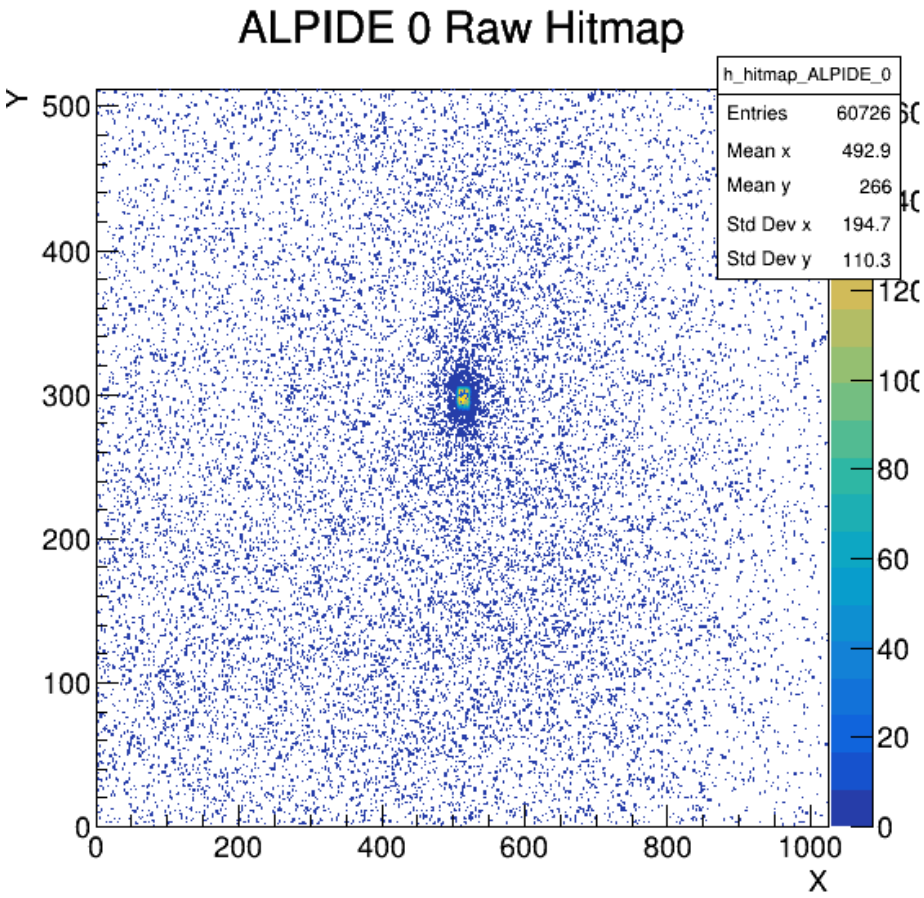
- CE65
  - Noise map to EUDAQ2
- Corryvreckan
  - Seeding & clustering method

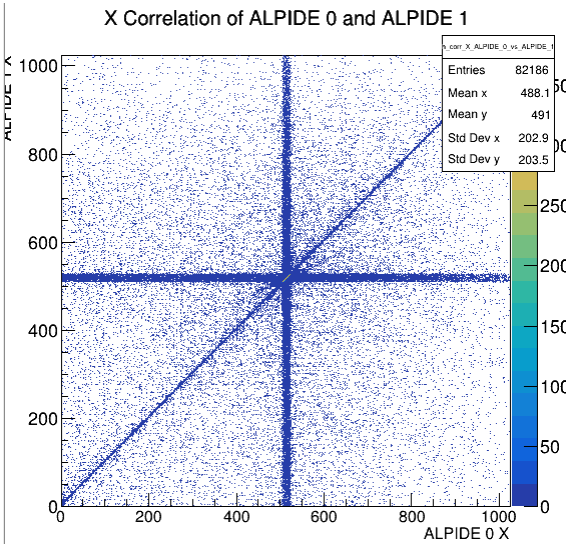
-> Analysis

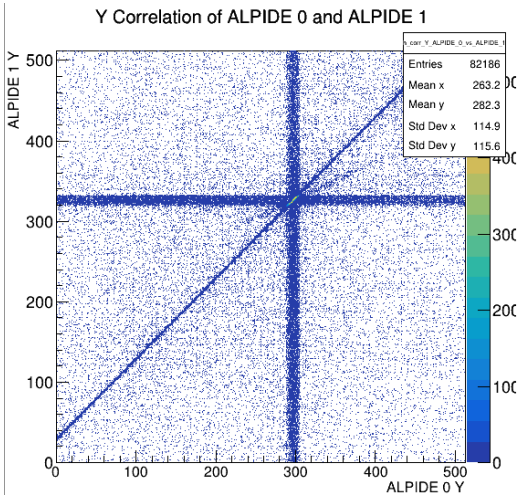
- Cluster size, charge distribution, ···
- Efficiency check

Telescope

- Full Scale HitMap







Corry

- Input Conf

prealign_ce65.conf

```
[ClusteringSpatial]
use_trigger_timestamp=false
charge_weighting=true
reject_by_roi=true

[Correlations]

[Prealignment]
damping_factor=1
max_correlation_rms=6mm
method=gauss_fit
fit_range_rel=100
time_cut_abs=10s
```

align_ce65.conf

```
[Tracking4D]
track_model="straightline"
require_detectors=ALPIDE_0,ALPIDE_1,ALPIDE_2,ALPIDE_3
min_hits_on_track=4
time_cut_abs=10s
momentum=5.4GeV
exclude_dut = true
spatial_cut_abs=1mm,1mm
reject_by_roi=true

[AlignmentMillepede]
residual_cut = 0.05mm
residual_cut_init = 1mm
iterations = 3
dofs = true, true, false, false, false, true
sigmas = 50um, 50um, 50um, 0.005rad, 0.005rad, 0.005rad
exclude_dut = true
number_of_stddev = 0
convergence = 10e-5
```

Corry

- Input Conf

analyse_ce65.conf

```
[CE65_4]
mask_file = "/home/yitao/its-corryvreckan-tools/masks/ce65.txt"
material_budget = 0.0005
number_of_pixels = 64, 32
orientation = 0deg,0deg,0deg
orientation_mode = "xyz"
pixel_pitch = 15um,15um
position = 99.512um,1.06765mm,75mm
role = "dut"
spatial_resolution = 5um,5um
time_resolution = 2us
type = "ce65raw"
```

```
[ClusteringSpatial]
use_trigger_timestamp=false
charge_weighting=true
reject_by_roi=false

[Tracking4D]
track_model="straightline"
require_detectors=ALPIDE_0,ALPIDE_1,ALPIDE_2,ALPIDE_3
time_cut_abs=1e99
spatial_cut_abs=1mm,1mm
min_hits_on_track=4
exclude_dut=true
momentum = 5.4GeV
volume_scattering = false
volume_radiation_length = 304.2m
reject_by_roi=true

[DUTAssociation]
spatial_cut_abs=100um,100um
time_cut_abs=1e99

[AnalysisDUT]
time_cut_frameedge=20ns
chi2ndof_cut=3
use_closest_cluster=true
n_time_bins = 200

[AnalysisEfficiency]
time_cut_frameedge=20ns
chi2ndof_cut=3
inpixel_bin_size=1um
```

Next

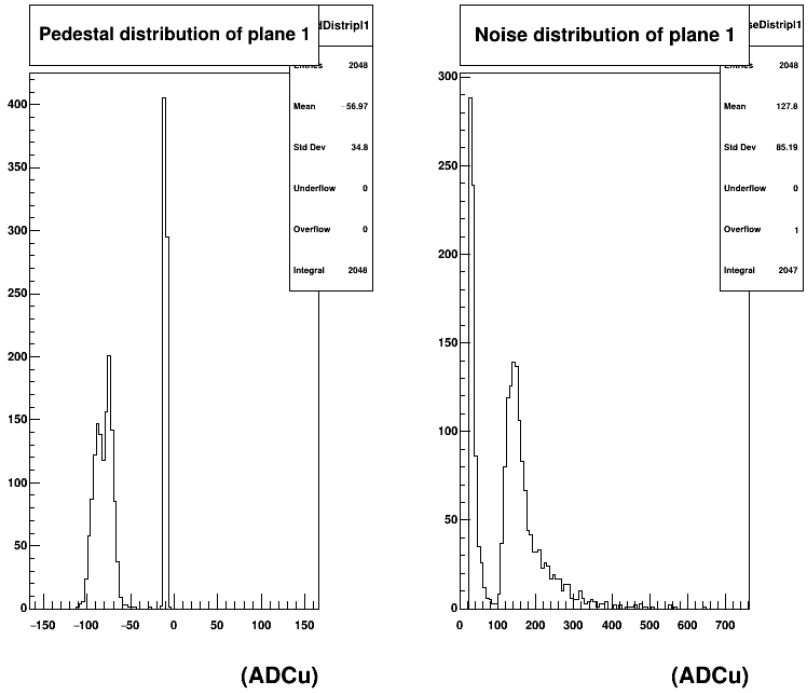
- Track association
  - Output from corry

```
|21:04:40.982|    (INFO) [F:EventLoaderEUDAQ2:ALPIDE_0] Found 66269 hits in the data.
|21:04:41.294|    (INFO) [F:EventLoaderEUDAQ2:ALPIDE_1] Found 66632 hits in the data.
|21:04:41.598|    (INFO) [F:EventLoaderEUDAQ2:CE65_4] Found 13824 hits in the data.
|21:04:41.842|    (INFO) [F:EventLoaderEUDAQ2:ALPIDE_2] Found 72809 hits in the data.
|21:04:42.100|    (INFO) [F:EventLoaderEUDAQ2:ALPIDE_3] Found 72399 hits in the data.
|21:04:42.648|  (STATUS) [F:DUTAssociation:CE65_4] In total, 10743 clusters are associated to 10666 tracks.
|21:04:42.648|    (INFO) [F:DUTAssociation:CE65_4] Number of tracks with at least one associated cluster: 10666 vs total
 number of tracks: 13477
|21:04:43.545|  (STATUS) [F:AnalysisEfficiency:CE65_4] Track selection flow:       13477
                                                       * rejected by chi2          -1199
                                                       * track outside ROI         -0
                                                       * track outside DUT         -335
                                                       * track close to masked px  -0
                                                       * track close to frame edge -0
                                                       * track without an associated cluster on required detector - 0
                                                       Accepted tracks:            11943
|21:04:43.545|  (STATUS) [F:AnalysisEfficiency:CE65_4] Total efficiency of detector CE65_4: 82.6844(+0.347866 -0.35341)%
, measured with 9875/11943 matched/total tracks
```

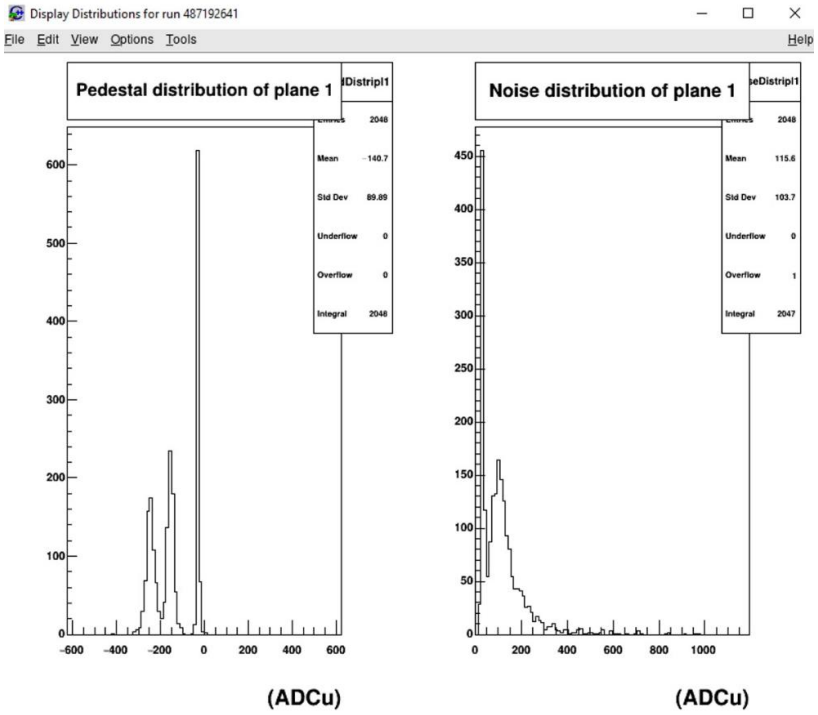
Noise map

- Comparison of dry-run & beam run

B4 dry-run 483152900
InitialNoise: 2500 events



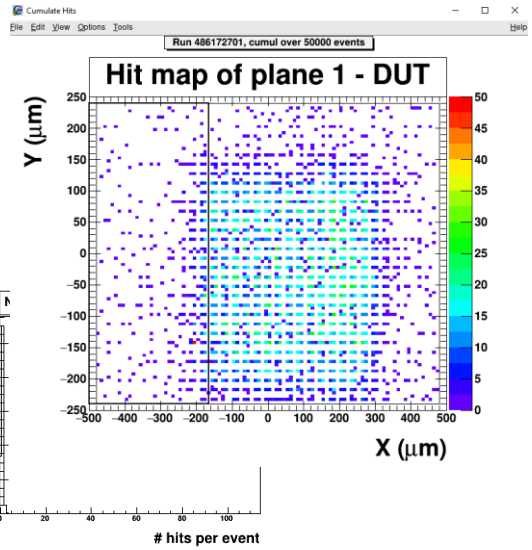
B4 - run 486172701
15k events, DPTS trigger
~13k hits (~0.8 hits/ev.)

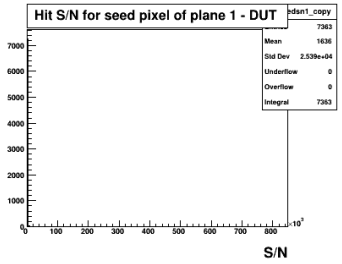


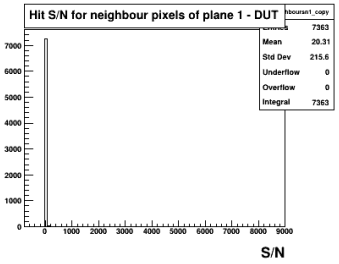
Hit map

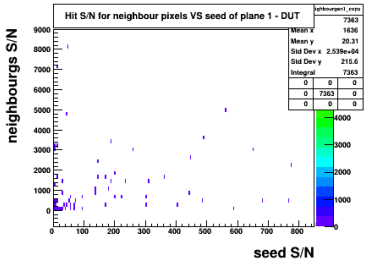
- B4 - run 486172701
  - 15k events, DPTS trigger
  - ~13k hits (~0.8 hits/ev.)

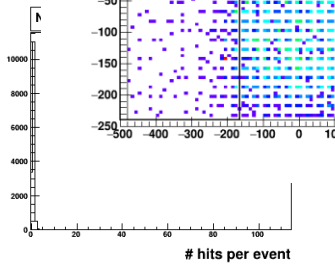
TAF on sub 1

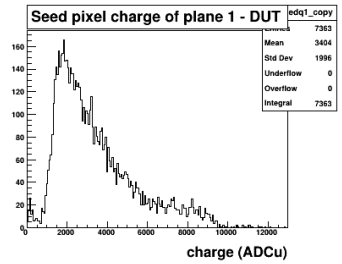


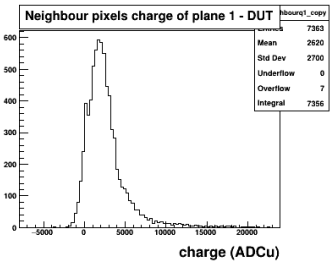


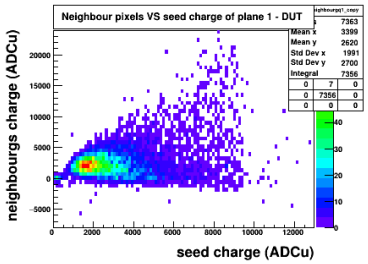


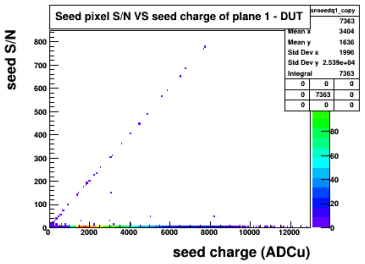


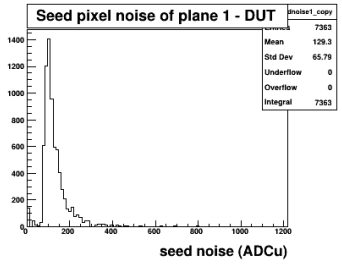


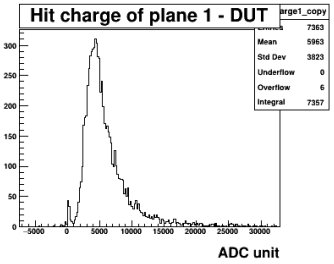


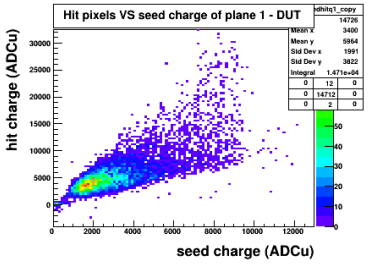


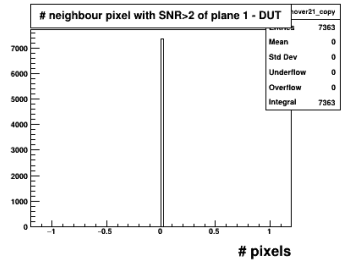






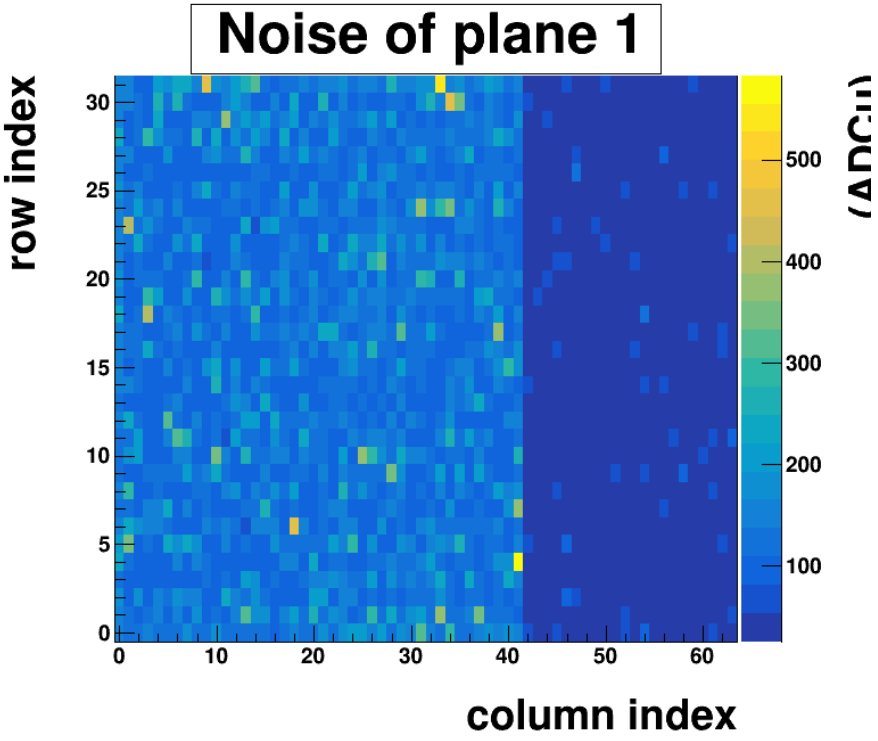


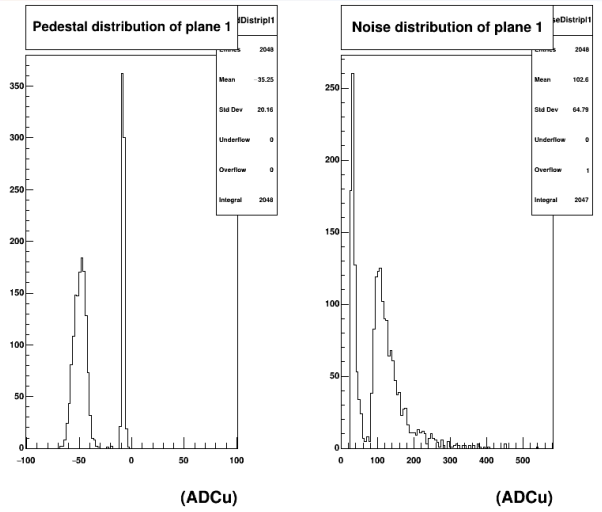


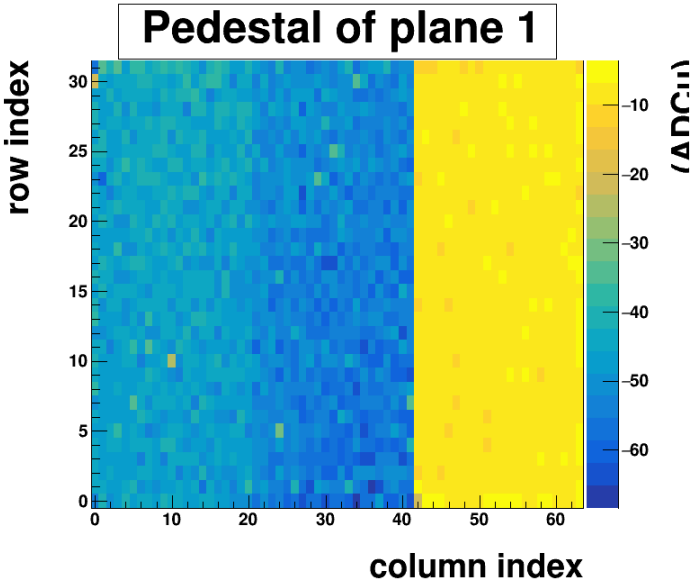


Noise map

- A4-3 beam-run 486122612
  - InitialNoise: 2500 events
  - Trigger: Scin. coin. ~1% eff.







Noise map

- D4-17 dryrun 487221431 (ce65d_mod.cfg)
  - InitialNoise: 100 events