Testbeam & Telescope

shan (at) tauex.tau.ac.il

shan.huang (at) desy.de

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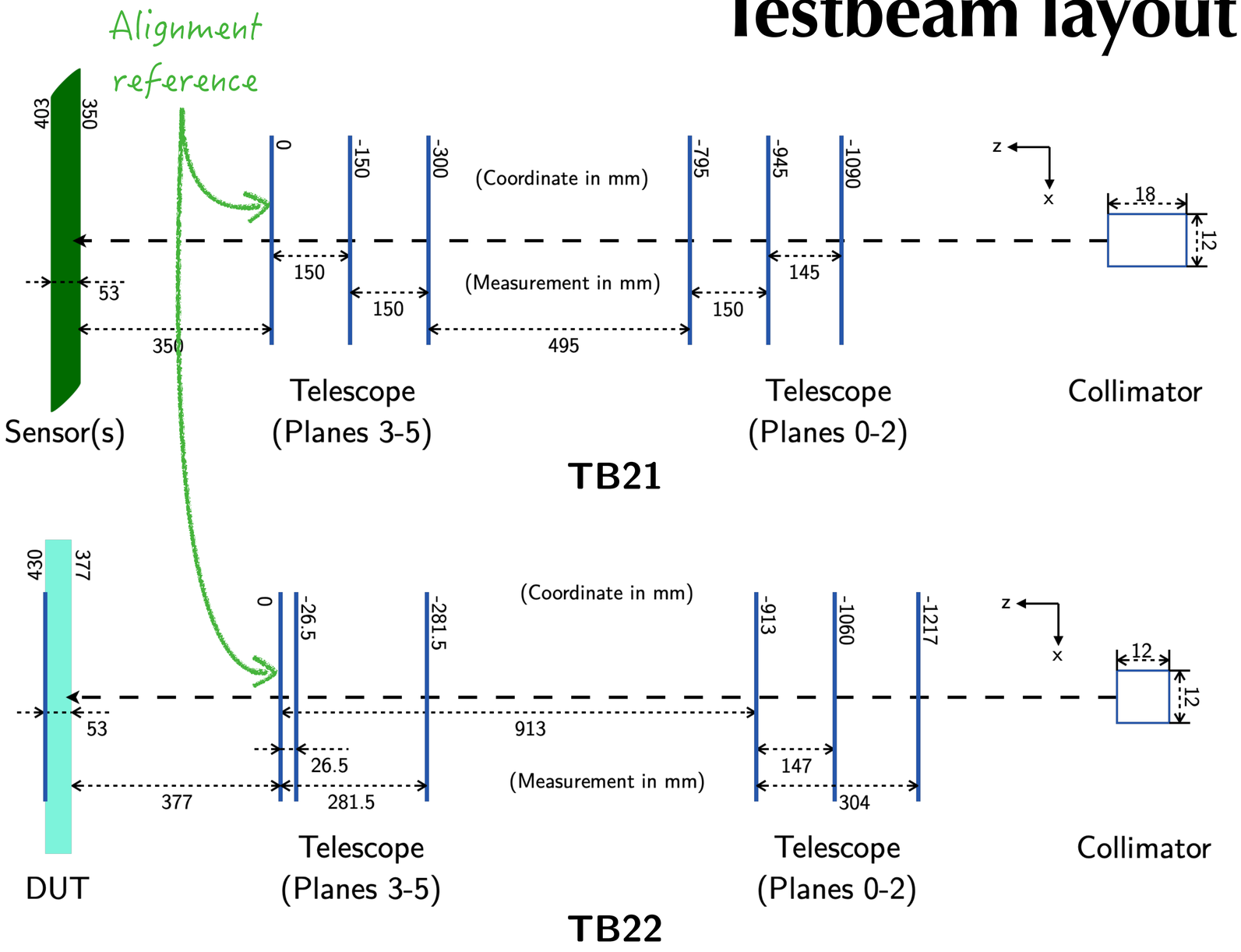
Testbeam layout



- Optimal layout for telescope?
  - TB21: equidistant
  - TB22: two planes close to DUT
- Hardware:
  - 6 Alpide Si sensors (27x29 um2)
  - Mimosa26/Adenium?
- Software:
  - Corryvreckan (since TB20)
    - reads from “raw” data
    - aligns telescope
  - Telescope-sensor sync./align. needs to be done separately

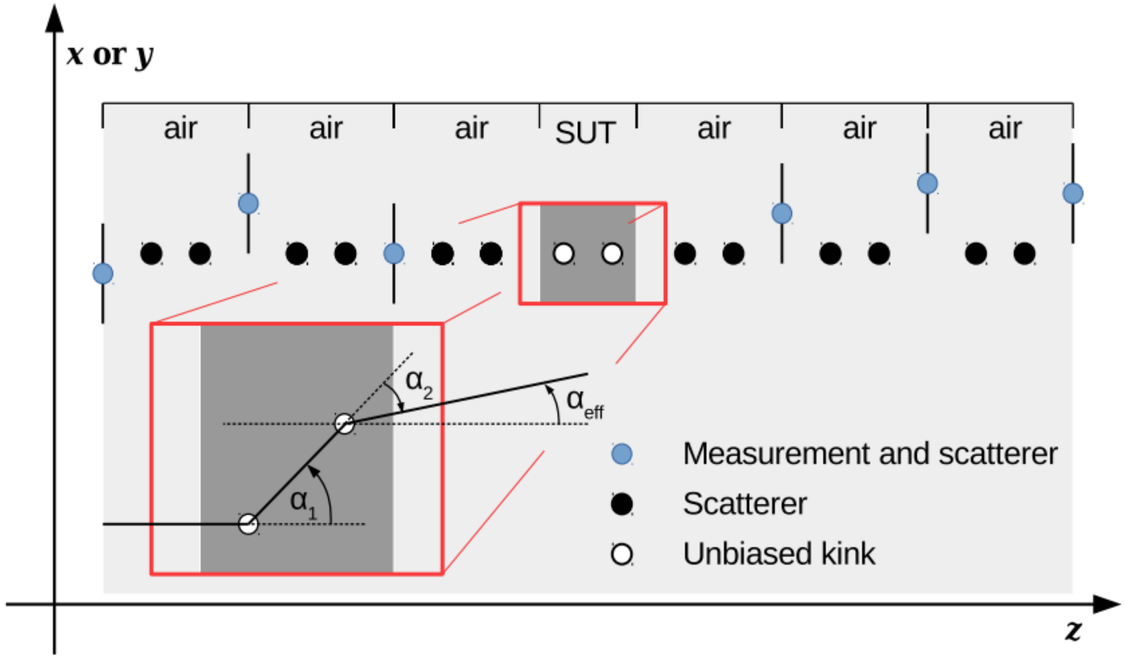
Telescope alignment

- Four-step alignment
  1. Pre-alignment
  2. Alignment on x-y
  3. Alignment on rotation
  4. Alignment on x-y and rotation
- Tracking models:
  - Simple straight line (SSL)
  - General broken line (GBL)

- TB22: alignments finished on GBL
  - 25 alignments for every shift or change of DUT or change of beam energy
  - Reconstruction for every run (~300 runs)

GBL: NIMA **673** 107 (2012)

- Trajectory displacements are allowed
- Displacement uncertainty calculated based on energy and length of air gap



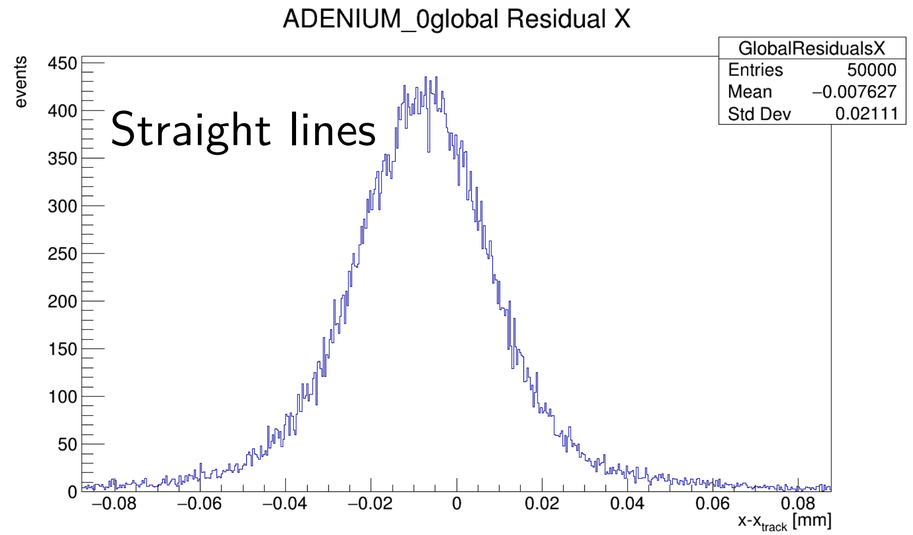
Telescope alignment

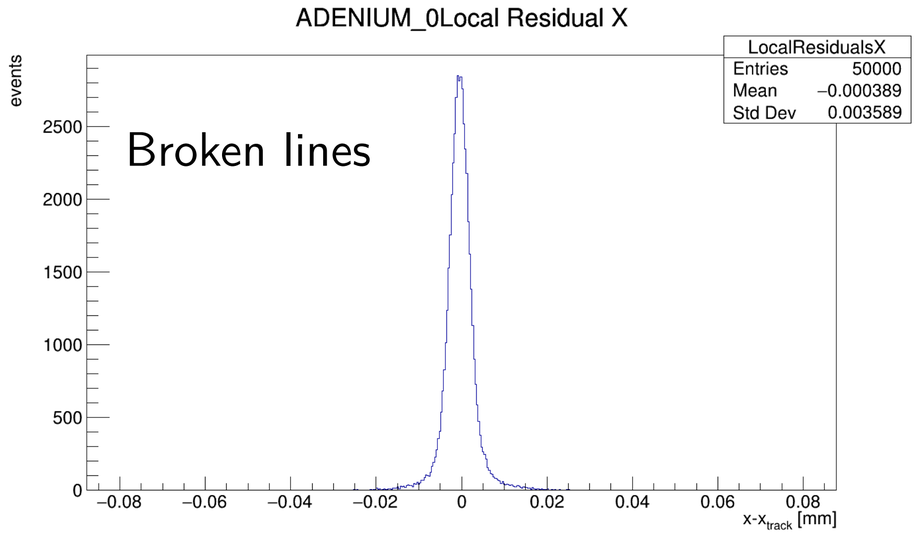
Compare between hardware parameters and
the ones used in alignment and reconstruction

	Telescope sensors		**Software**
	MIMOSA26	**ALPIDE**	**Corryvreckan**
Pixel pitch [um]	18.4×18.4	29.24×26.88	29.24×26.88
Pixel number	1152× 576	1024× 512	1152× 576
Spatial res. [um]	5.3×5.3	8.44×7.76	5.0×5.0
Time res. [us]	115.2	10.0	10.0

Telescope alignment

- Residue comparison between two models
  - local coordinates (does not matter much)
  - after full alignment
  - from the first plane (farthest from the ref.)
  - GBL: 3.6 um; SSL: 21.1 um





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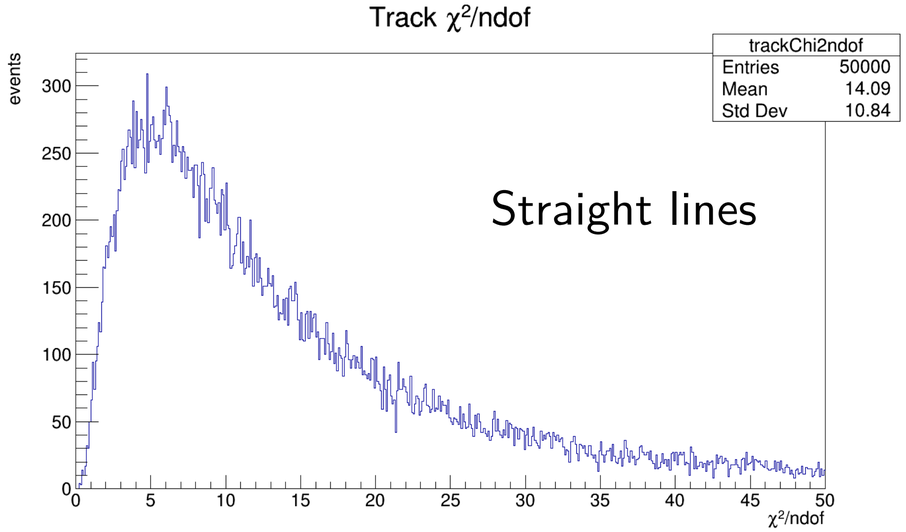
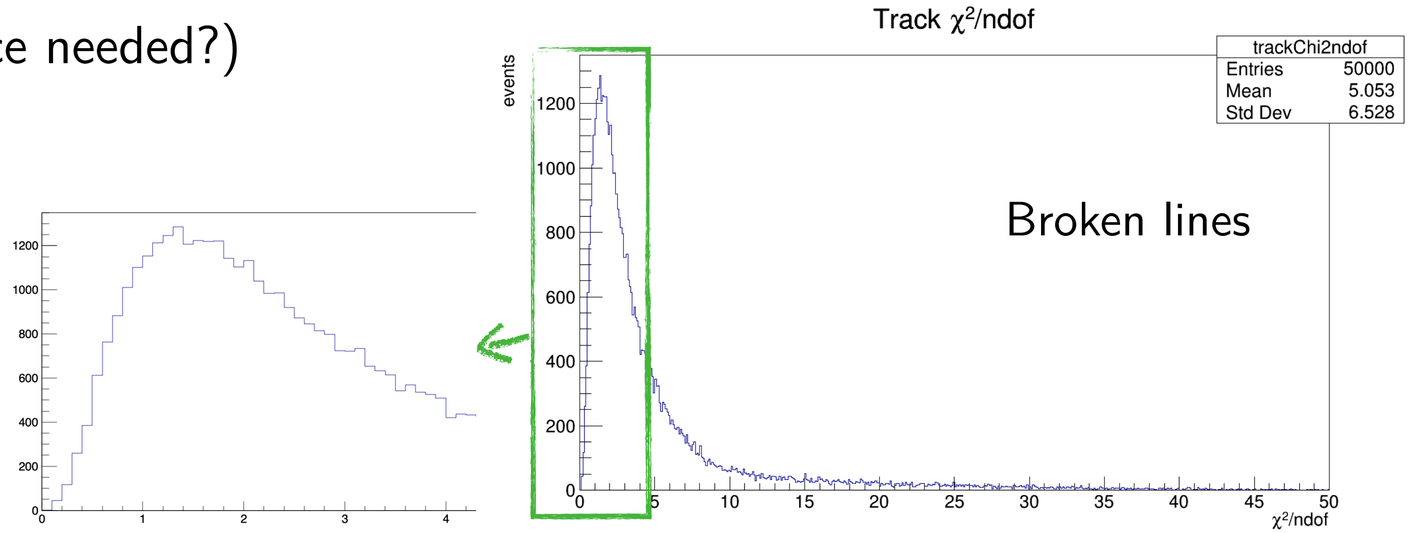
- Chi^2 over n_{dof}:
  - GBL has MPV between 1 to 2
  - Recommended cut at 5 (source needed?)





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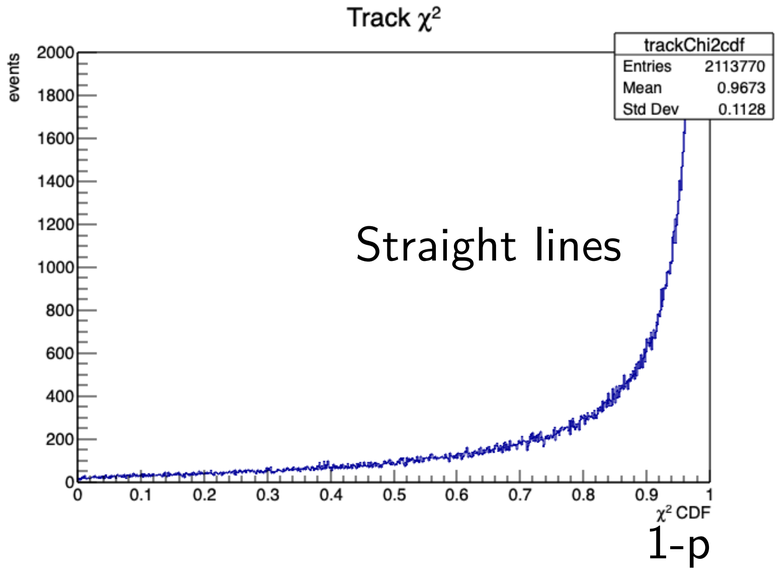
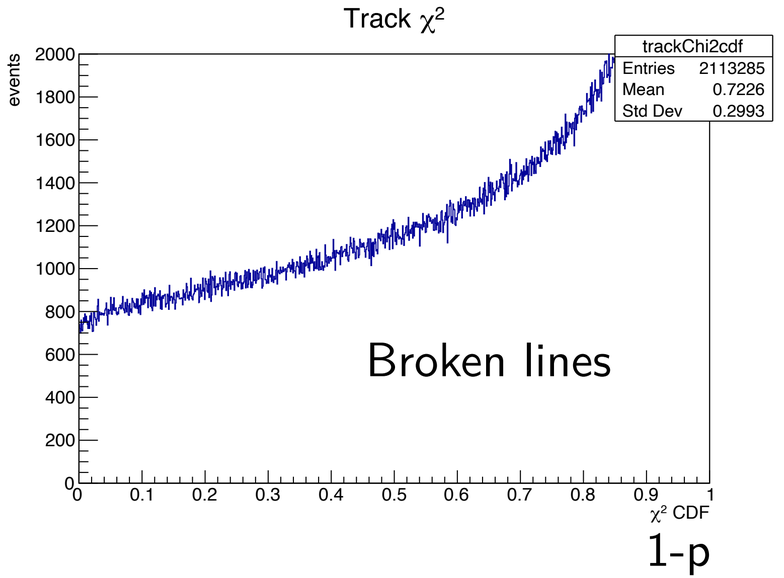
- P-value distribution
  - Both are not flat enough





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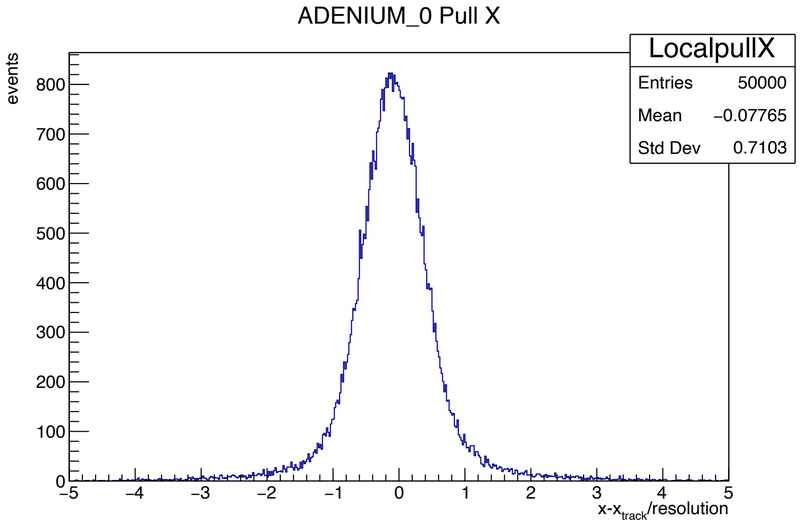
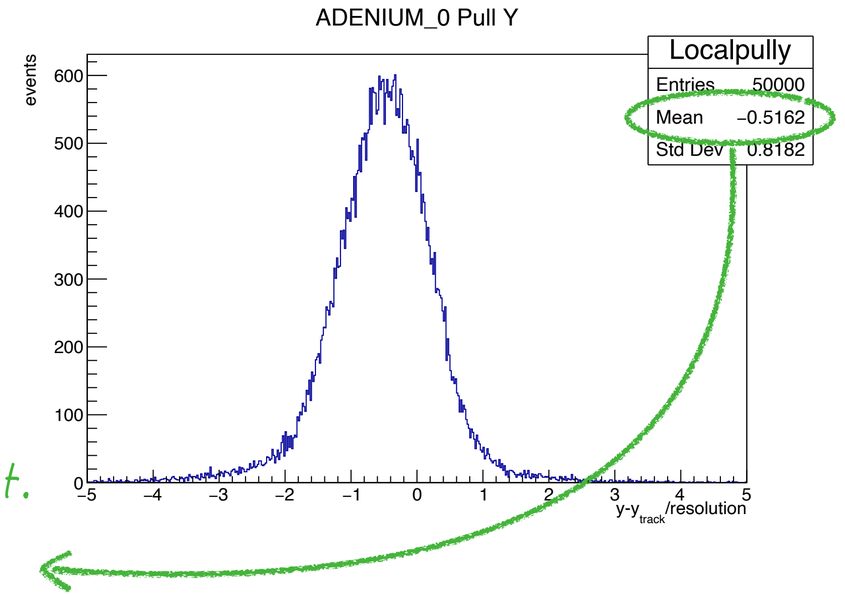
- Chi^2 over n_{dof}:
  - GBL has MPV between 1 to 2
  - Recommended cut at 5 (source needed?)
- P-value distribution
  - Both are not flat enough
- Asymmetric on x-y direction
  - Planes 4-5 sunk due to unbalanced load (TB22 only)

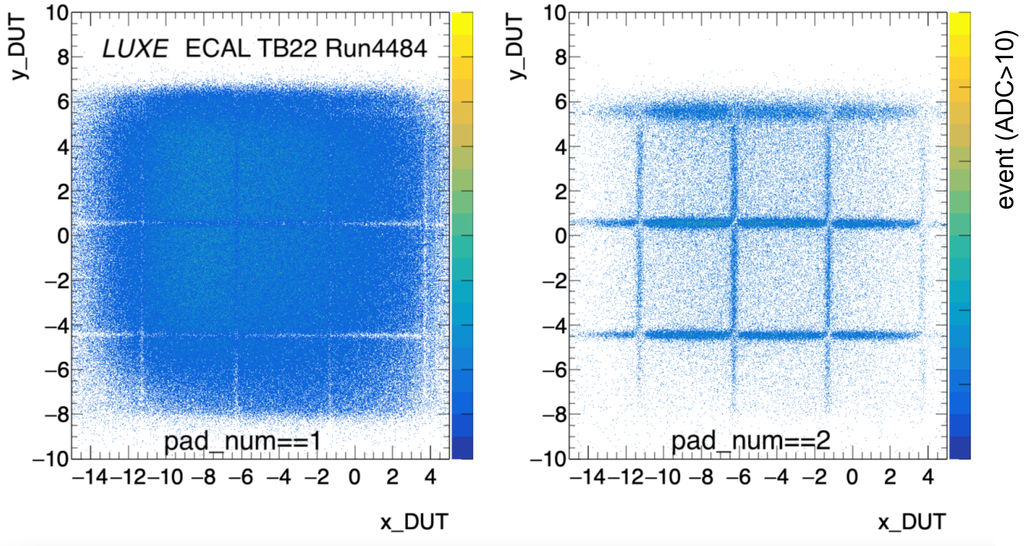


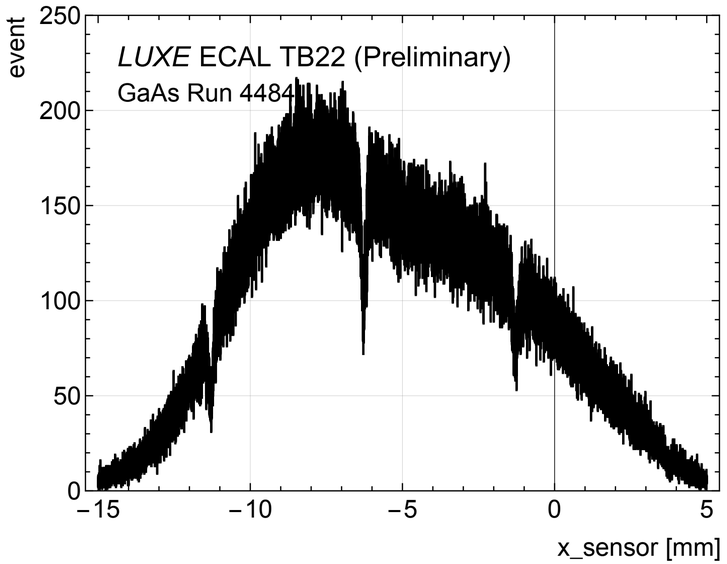


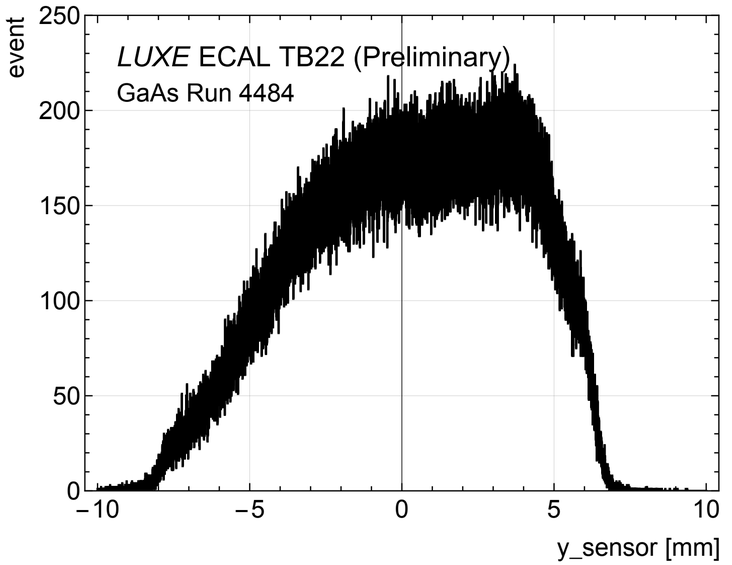
"Pull" function should be a normal dist. with $\mu = 0$ and $\sigma = 1$

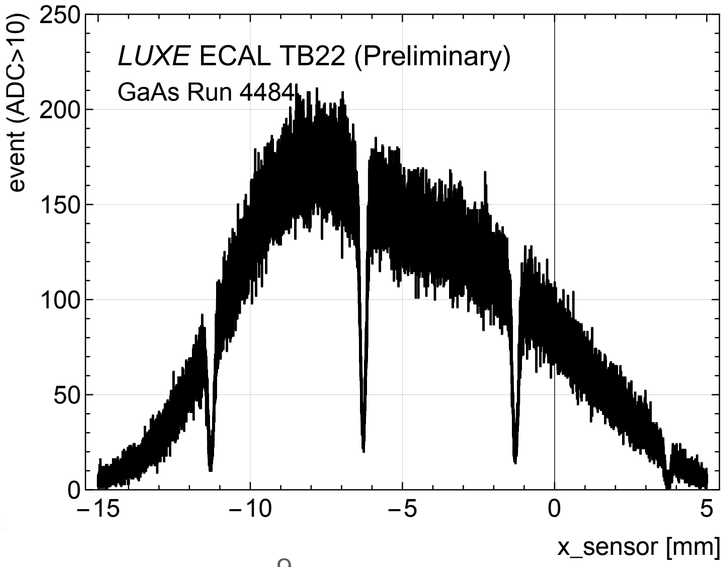
Telescope & Sensor

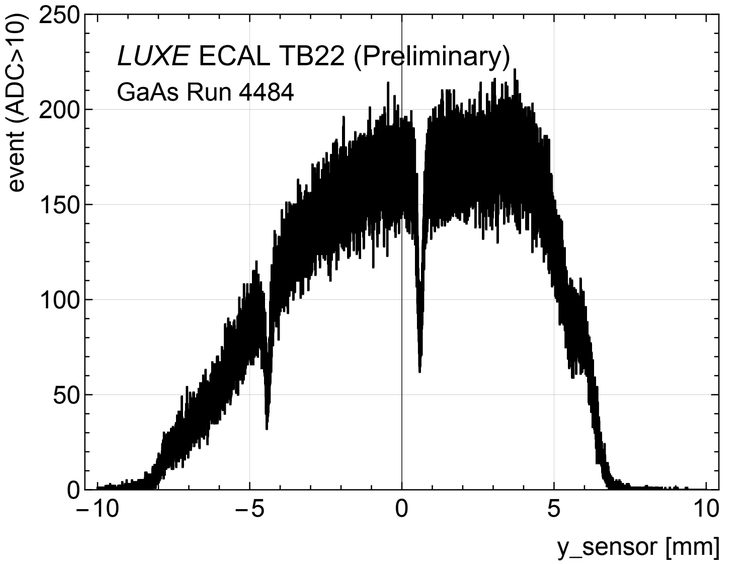
- Gap of event between sensor channels
- The gaps are used to manually align telescope and sensor





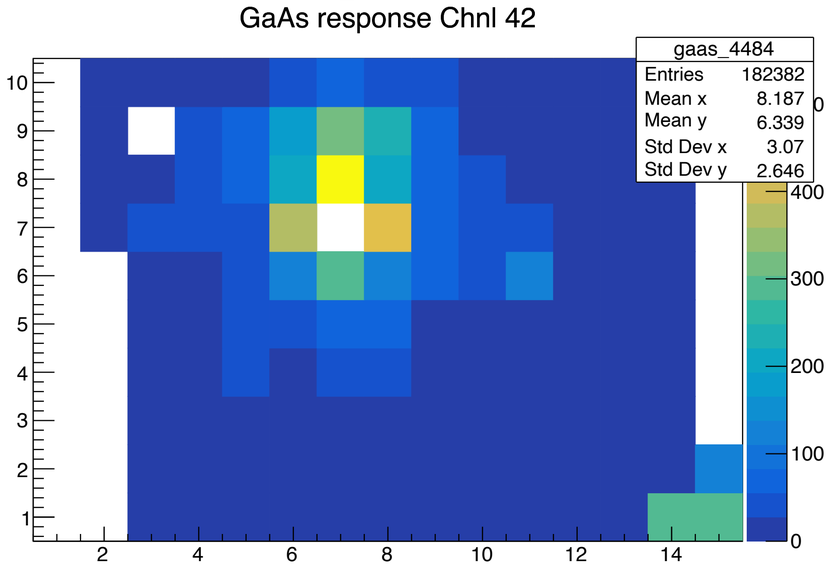


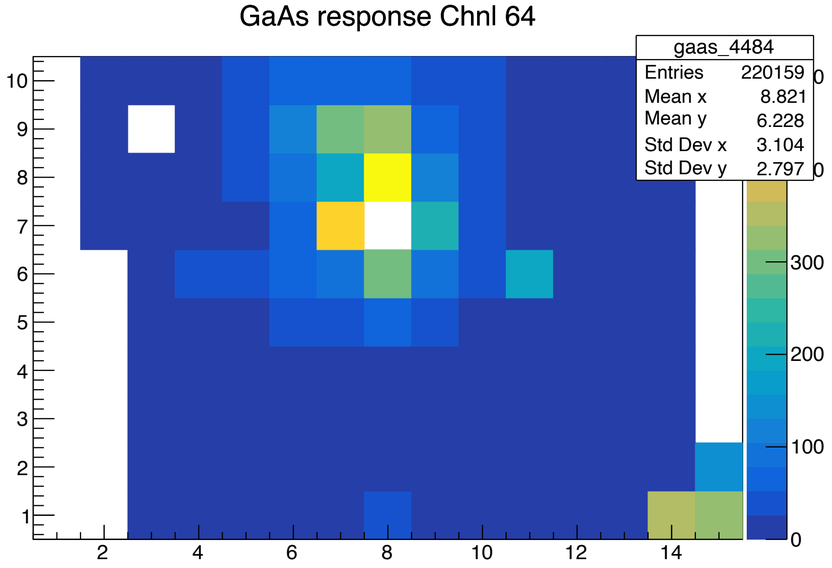


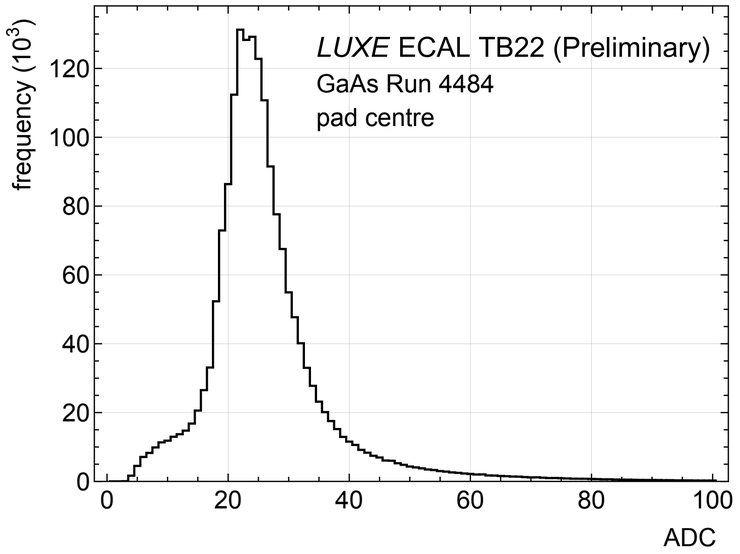


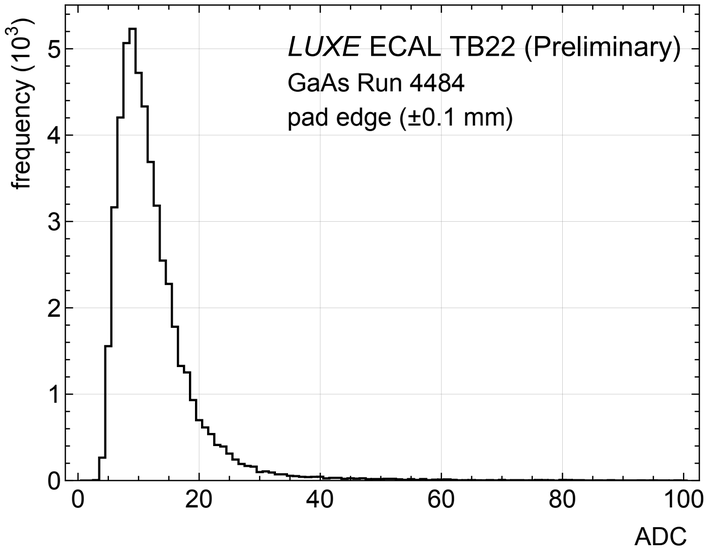
Telescope & Sensor

- Gap of event between sensor channels
- The gaps are used to manually align telescope and sensor
- Different ADC distribution when shooting electron to the centre and to the edge
- When shooting to the edge, puzzling pattern of sensor response appears









Conclusion & Outlook

- Telescope alignment has almost finished, needs fine tune
  - Multiple scattering considered (general-broken-line model)
  - Residue $<$ 5 um; σ_{pull} better than 1; chi2/ndof has MPV in 1 to 2
    - unbiased on x direction; biased on y direction (unbalanced load in TB22)
- Uncertainty from telescope benchmark:
  - intercept uncertainty ~residue $=$ 5 um
  - slope uncertainty ~2*residue/$\text{length}_{\text{telescope}}$ $=$ 5.0 x 10^{-6}
  - Additional uncertainty from scattering at the last layer (~30 um)
- Alignment between sensor & telescope
  - Manually done by looking into the “dead”-area dip
  - (Possible) automatic alignment by maximising events in 5x5 square