MAPS 2026 - Operation

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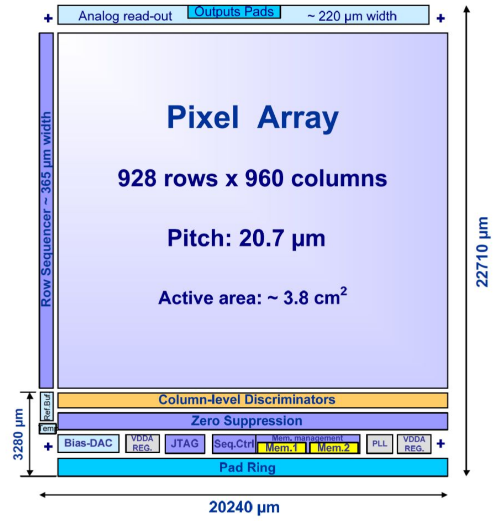
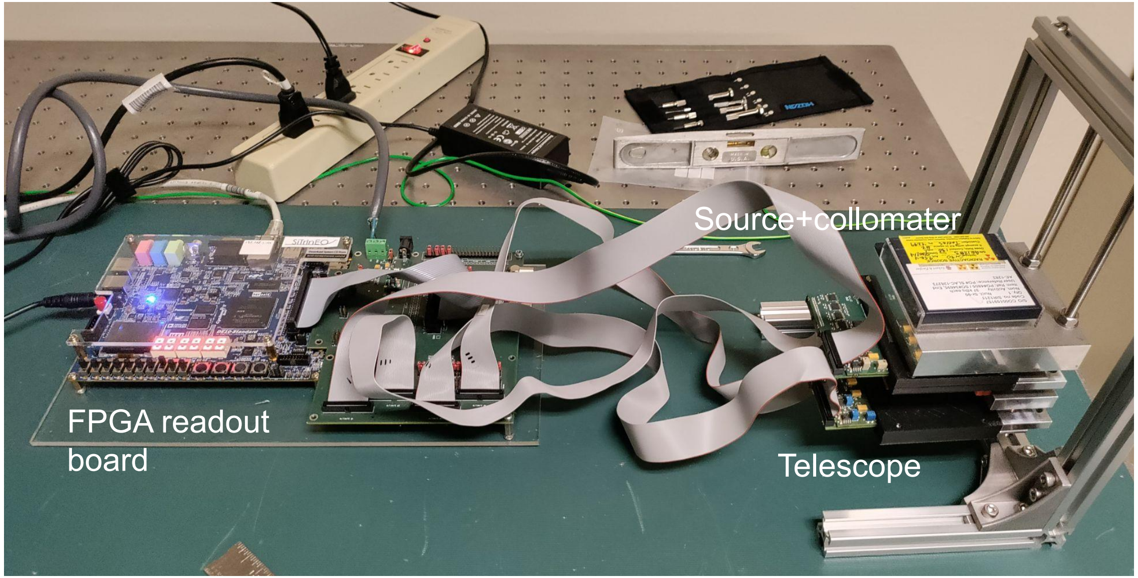
MIMOSA-28 Operation

- Active area of 3.8 cm^2 with 14 μm thick epitaxial layer.
- Total thickness of 50 μm.
- Telescope constructed of 4 planes separated into 2 cassettes with opposite orientation for ease of cabling from carrier card.
- R/O board connected to DE10 FPGA board.

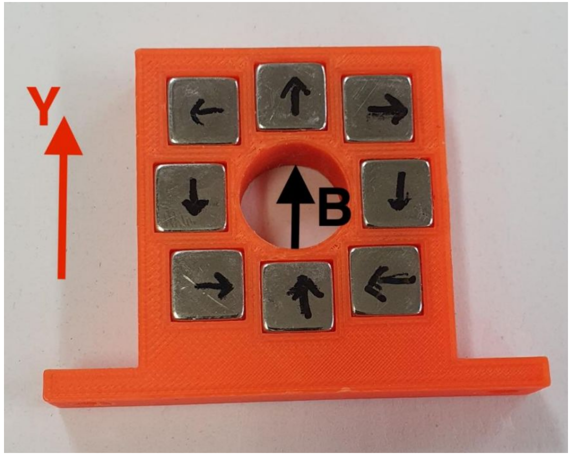




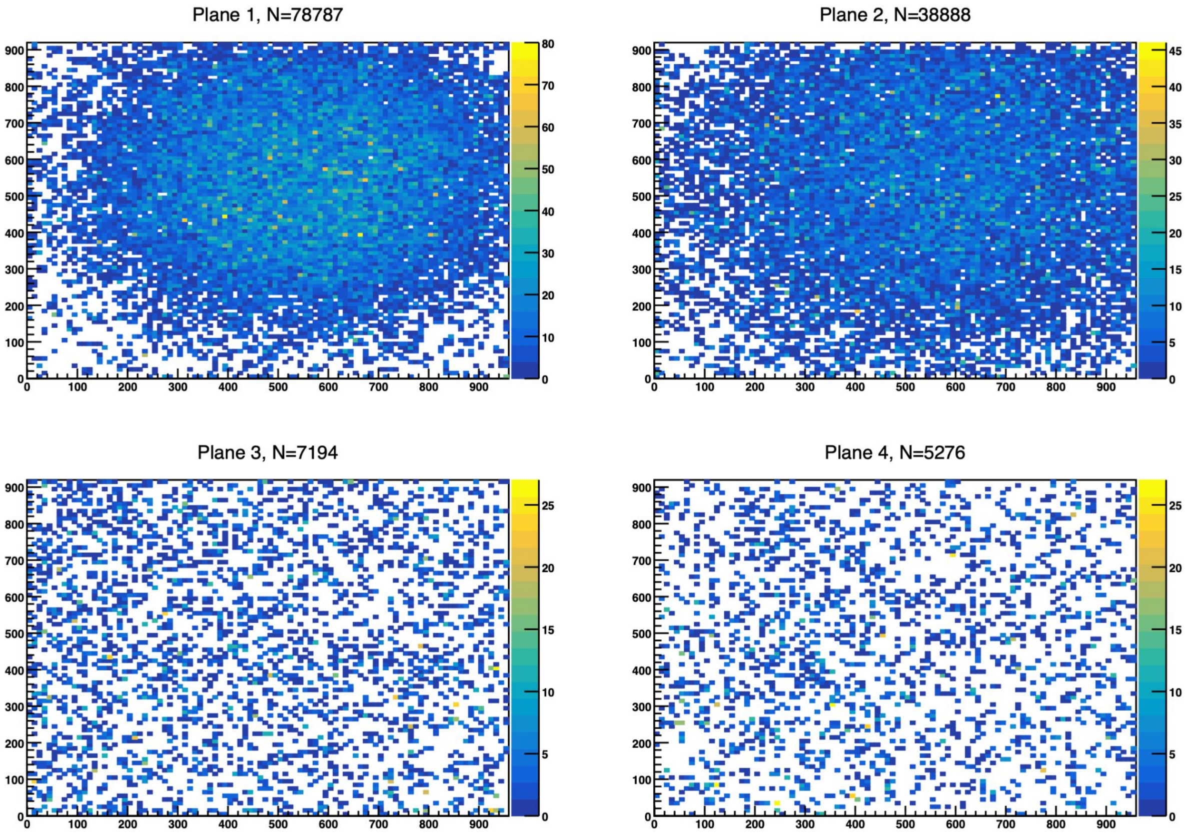
	Mimosa 28
Input & output Frequency	160 Mhz
Read out of 1 line	200 ns
Sensor dimension	20.2 * 22.7 mm
Matrix dimension	19.8 * 19.2 mm
Number of lines	928
Integration time	185.6 µs
Number of Columns	960
Pitch	20.7 µm
Number of pixel	890 k
Memory size	2 * 2048 w32
Max number of data transfert per frame	1850 w32 + 6 w32 (encapsulation)

Experimental setup

- Initial runs were used to characterize the noise level in each of the chip's four sectors.
- The detection thresholds were manually tuned to reduce the noise occupancy to around <10 pixels per sector.
- Any pixels that remained noisy were masked.
- A 37 kBq ^{90}Sr source and collimator was positioned above the telescope.
- Measurements were first taken without the magnet to establish detector alignment and reconstruct straight tracks.
- A 0.3 T Halbach magnet was then placed to deflect the particle tracks in a defined direction.



2D - Hit maps



Summed Hits over 46 runs

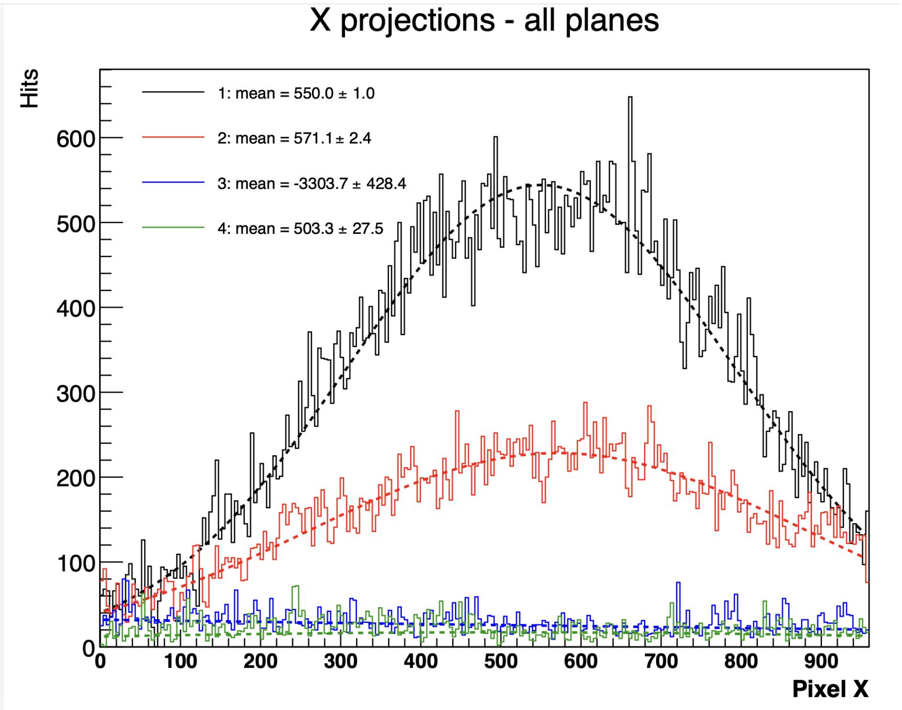
- each run 100k events (~2 min)
- Without magnet
- Source on ~ 1 cm circular opening
- No additional collimator

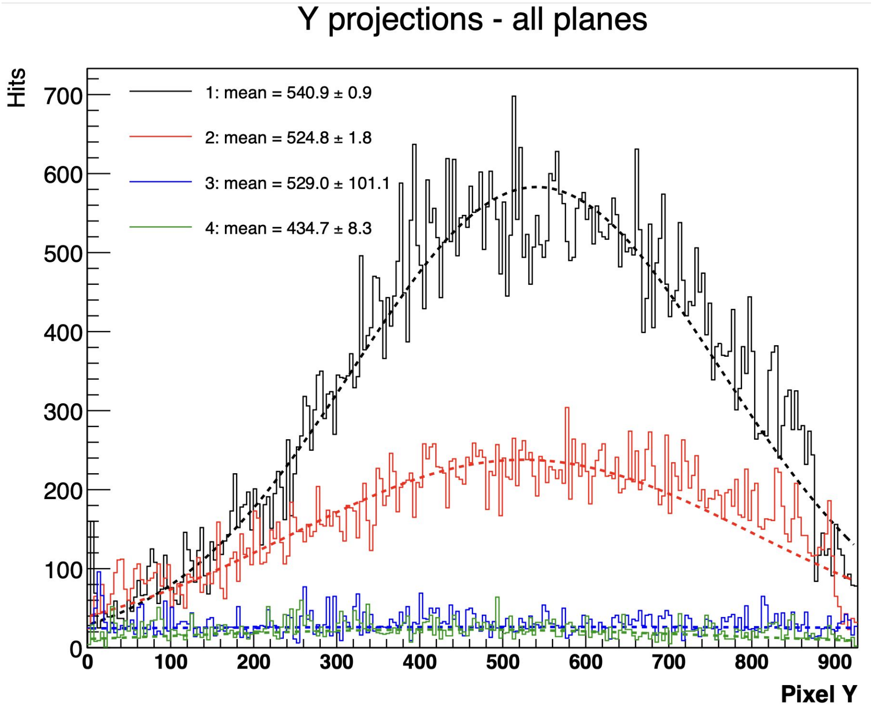
- 79k Hits in Plane 1
- 5k Hits in Plane 4
- Reduction of Hits due to
  - Absorption
  - Scattering

1D - Projections

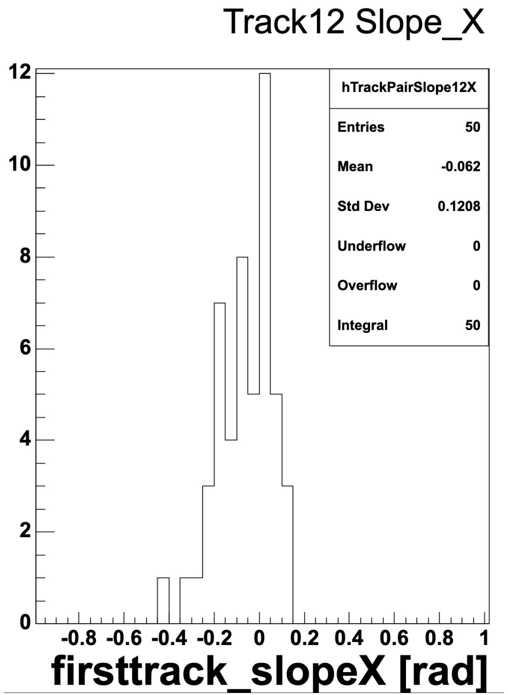
Alignment:

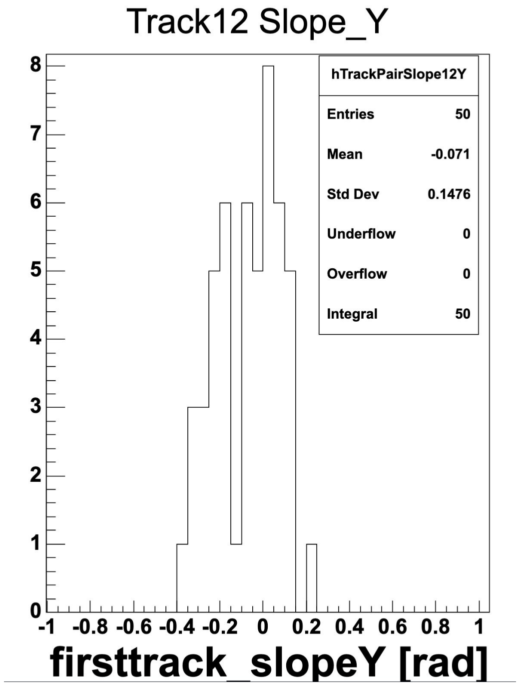
- Plane 1-2 shifted by 20 pixels (410 µm)
- Plane 3 and 4: Flat profile → no alignment possible





Track reconstruction (first 2 planes)





- Fitting routine requires hits in all 4 planes

  → Only 50 reconstructed tracks

- Slope centered around 0 for X and Y direction
- Suggestion: Check independent track fitting without requiring hits in plane 3 and 4

  → Should give thousands of tracks

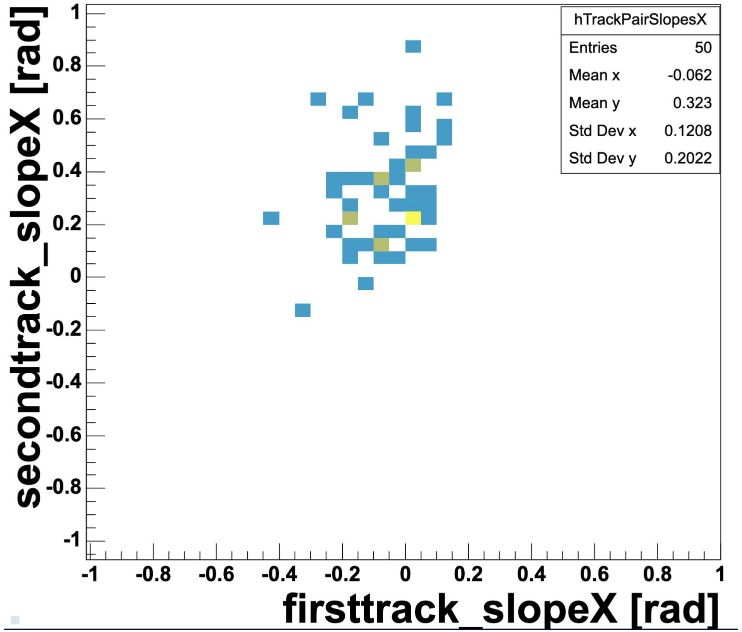
Track slopes

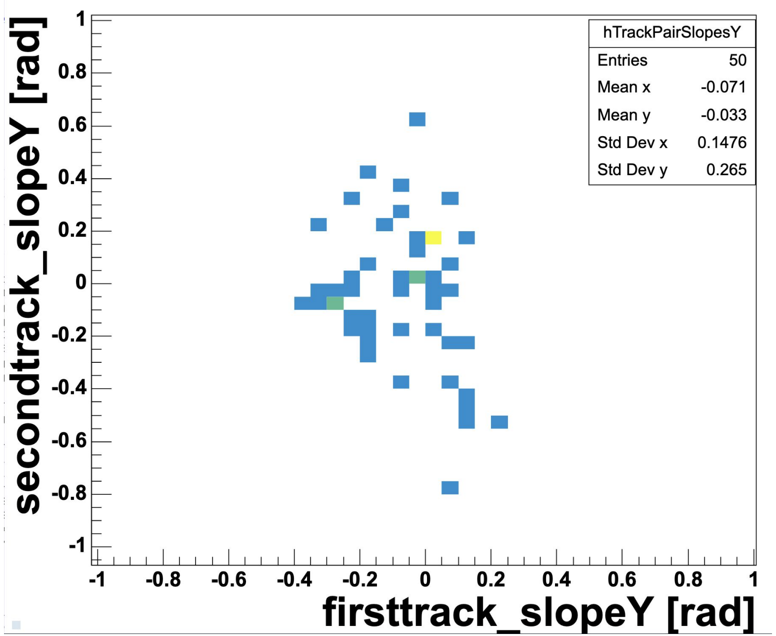
Second track from planes 3 and 4

- Slope_X not centered around 0.
- Data without magnet

→ Recheck tracking with higher stats

- Plane 1+2
- Plane 3+4





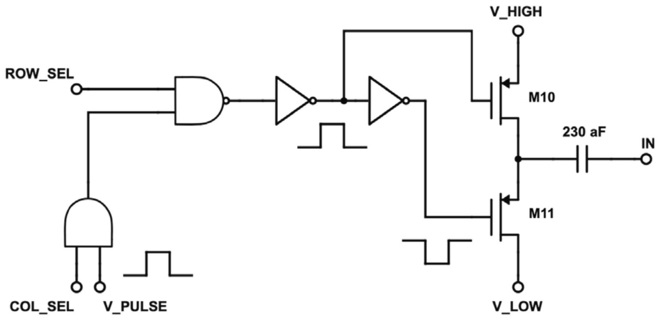
Conclusions

- Pixel planes for the first cassette are well aligned within 400 μm.
- For the second cassette statistics are rather low for full alignment.
- Sensor operation is sensitive to temperature and is encapsulated in plastic without cooling, prolonged operation will influence noise.
- To find threshold setting all registers high and then going region by region is rather slow but is good to understand the orientation of the analysis and for understanding of how the sensor works.

Improved chip capabilities:

- Masking of noisy pixels before measurement→ Do not occupy read-out bandwidth
- Charge injection circuit on chip

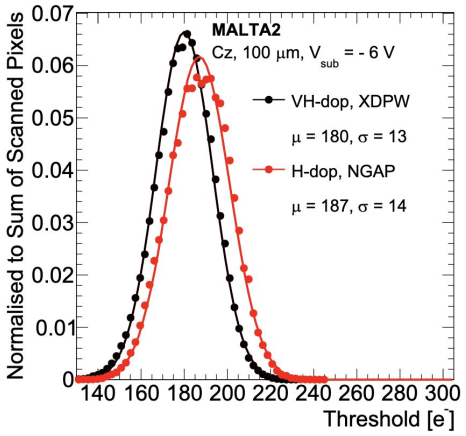
Threshold calibration by charge injection

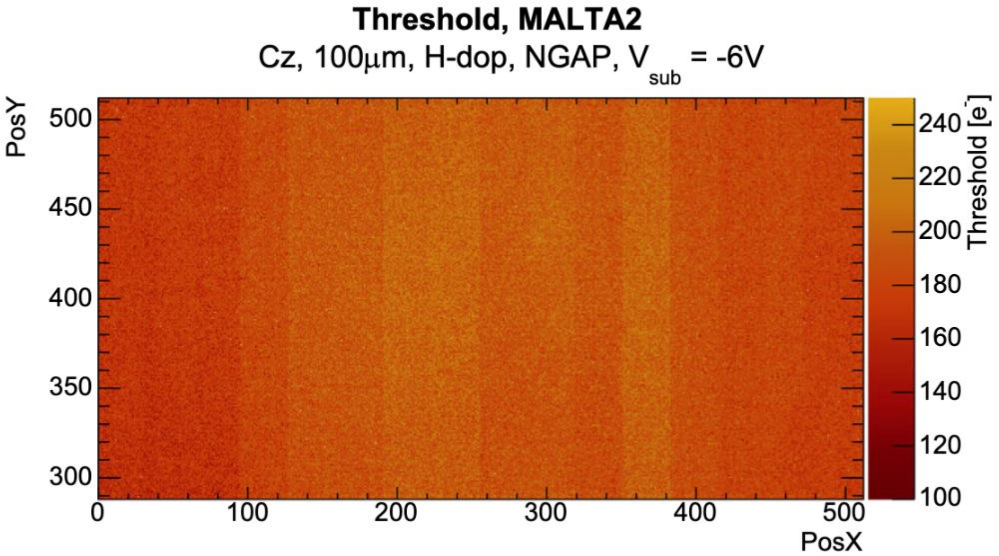


- 230 aF in-pixel capacitor
- Simple design: 2 metal layers
- Scan voltages to charge up capacitor

→ Quantify threshold per pixel

- About 10% threshold dispersion
- 180 e^- corresponds to MIP in ~3 μm silicon

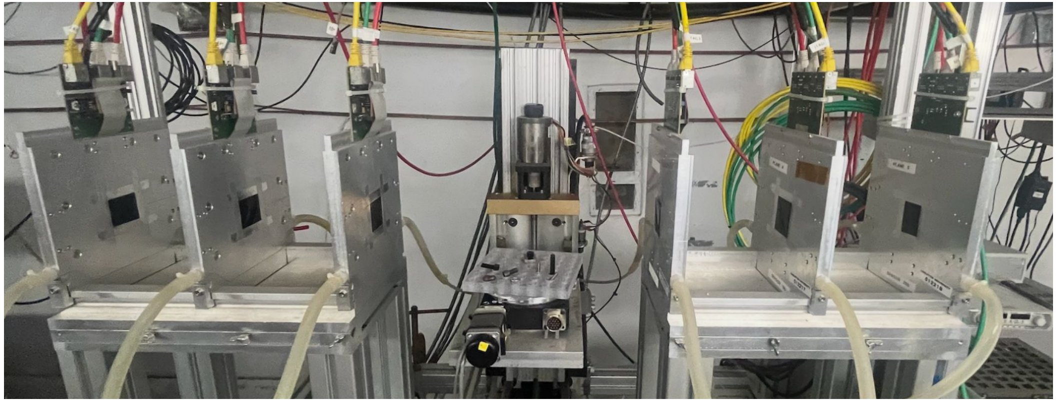


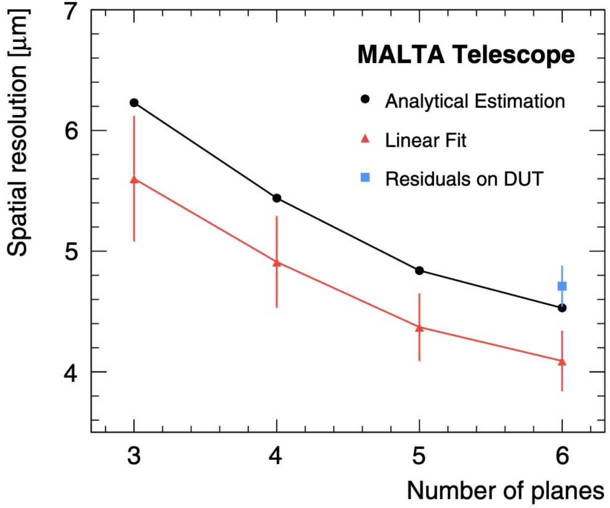


Beam telescopes

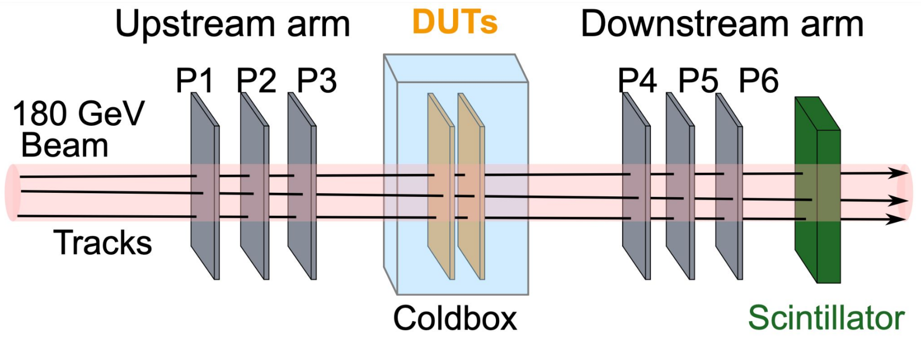
- Similar setup to the 4 tracking planes
- More planes → better resolution (~ 4 um)
- Scintillator for timing resolution (~ 2 ns)

Beam telescope at SLAC

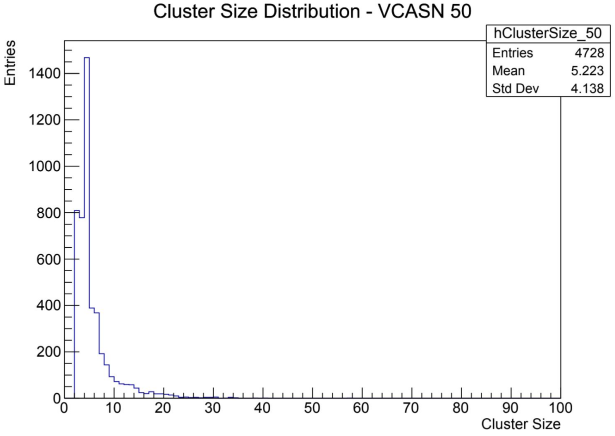


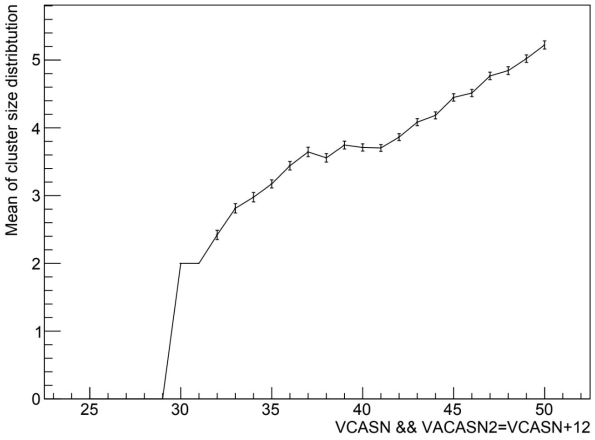


Schematics of telescope at CERN SPS

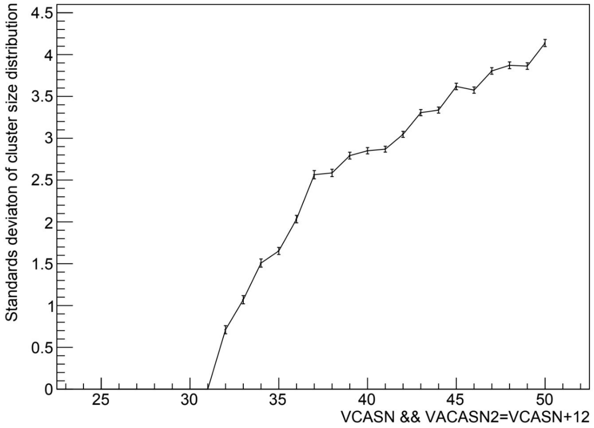


ALPIDE Sr^{90} test on threshold





Ran test with source placed in same place and modified the threshold parameters, same number of triggers taken (1e5) triggers with constant pulser.



Comments for future schools

Operations:

- Compare different size collimators and source strengths
- Add temperature monitoring → measure noise performance
- Split group into Measurement and Analysis
  - Clustering algorithm
  - Spatial correlation of telescope planes
  - Track fitting

General:

- Thanks for the clearly structured tutorials and engaging talks!
- More time for tutorials (2 days per tutorial)
- 1 slide intro per participant at the start

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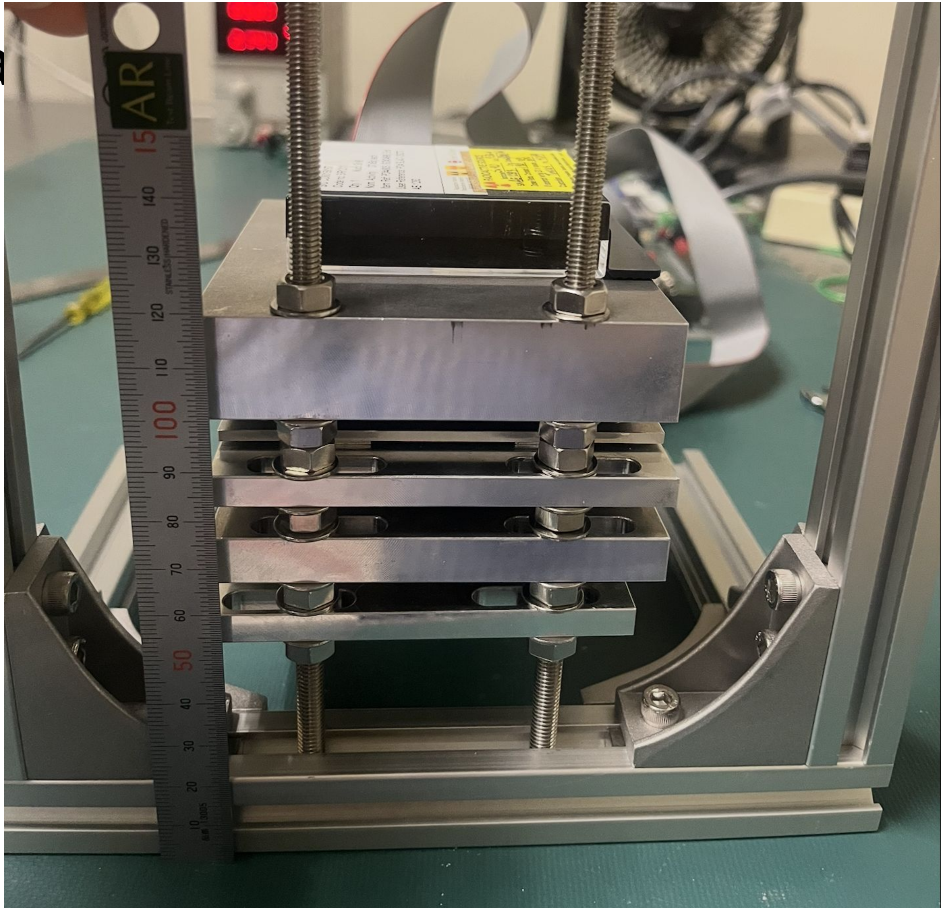
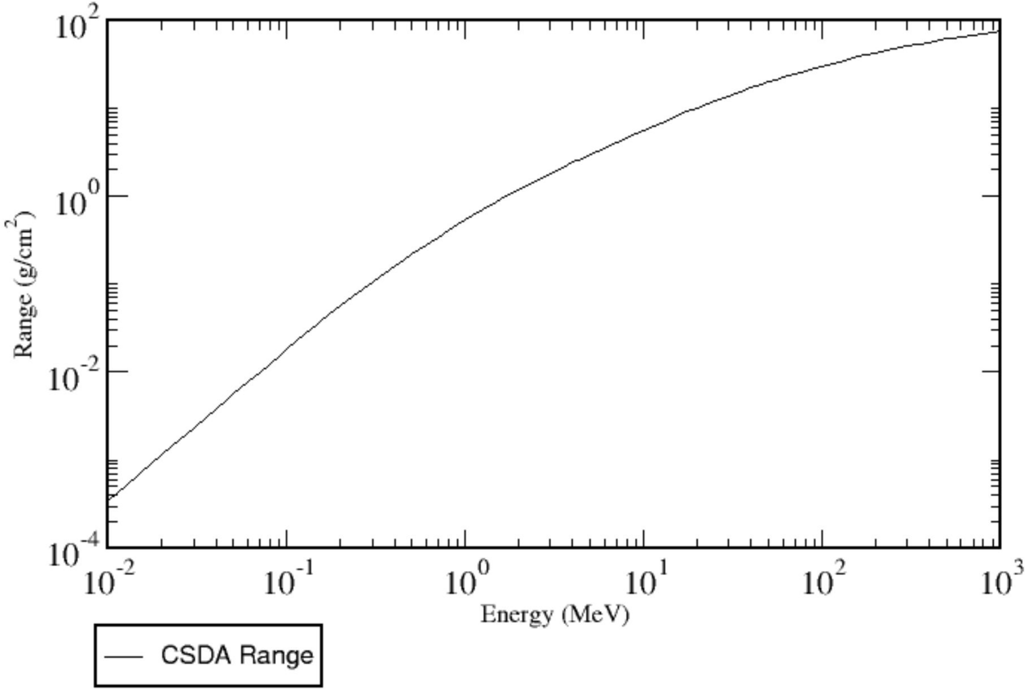


Electron range in silicon

https://physics.nist.gov/cgi-bin/Star/e_table.pl



At 0.5 MeV:

CSDA= 0.22 g/cm^2

rho(Silicon) = 2.33 g/cm^3

CSDA / rho = 0.22/ 2.33 cm = 9 mm