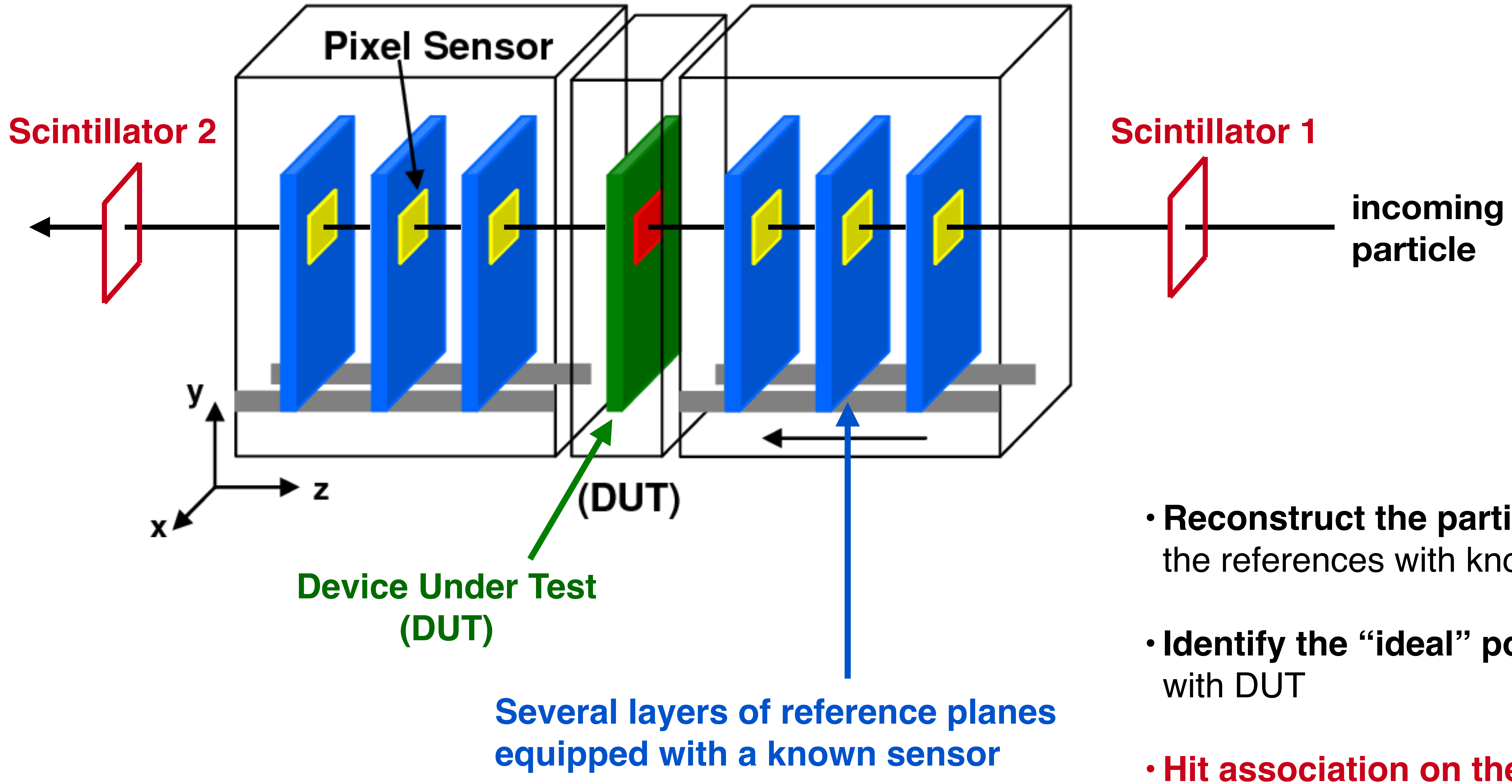
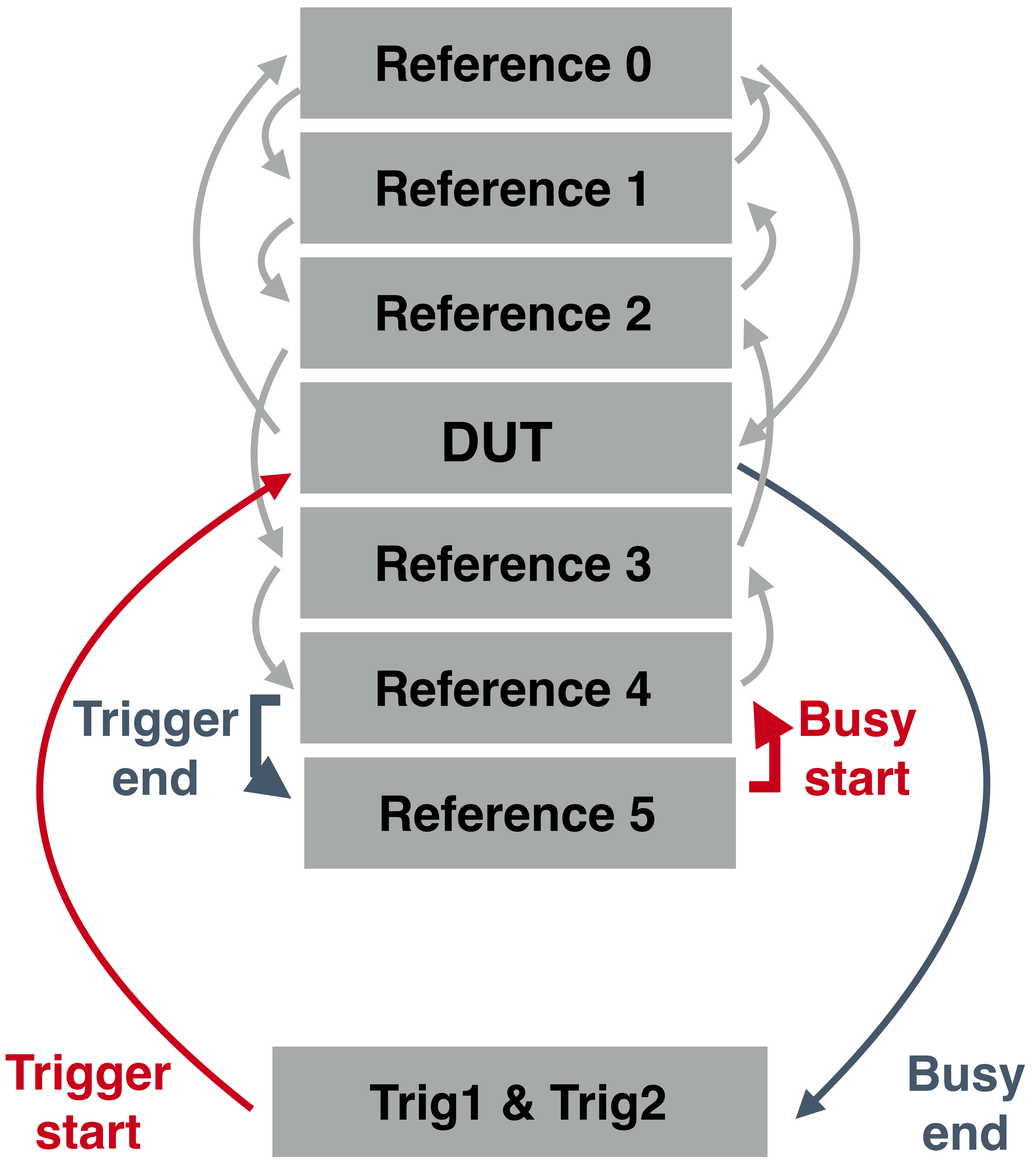
Recent activities at CERN:
test beams with ALPIDE telescope

What is a telescope and how does it work?



- **Reconstruct the particle trajectory** using the references with known resolution
- **Identify the "ideal" point of intersection** with DUT
- **Hit association on the DUT** to estimate the DUT resolution and efficiency

Trigger/busy logic

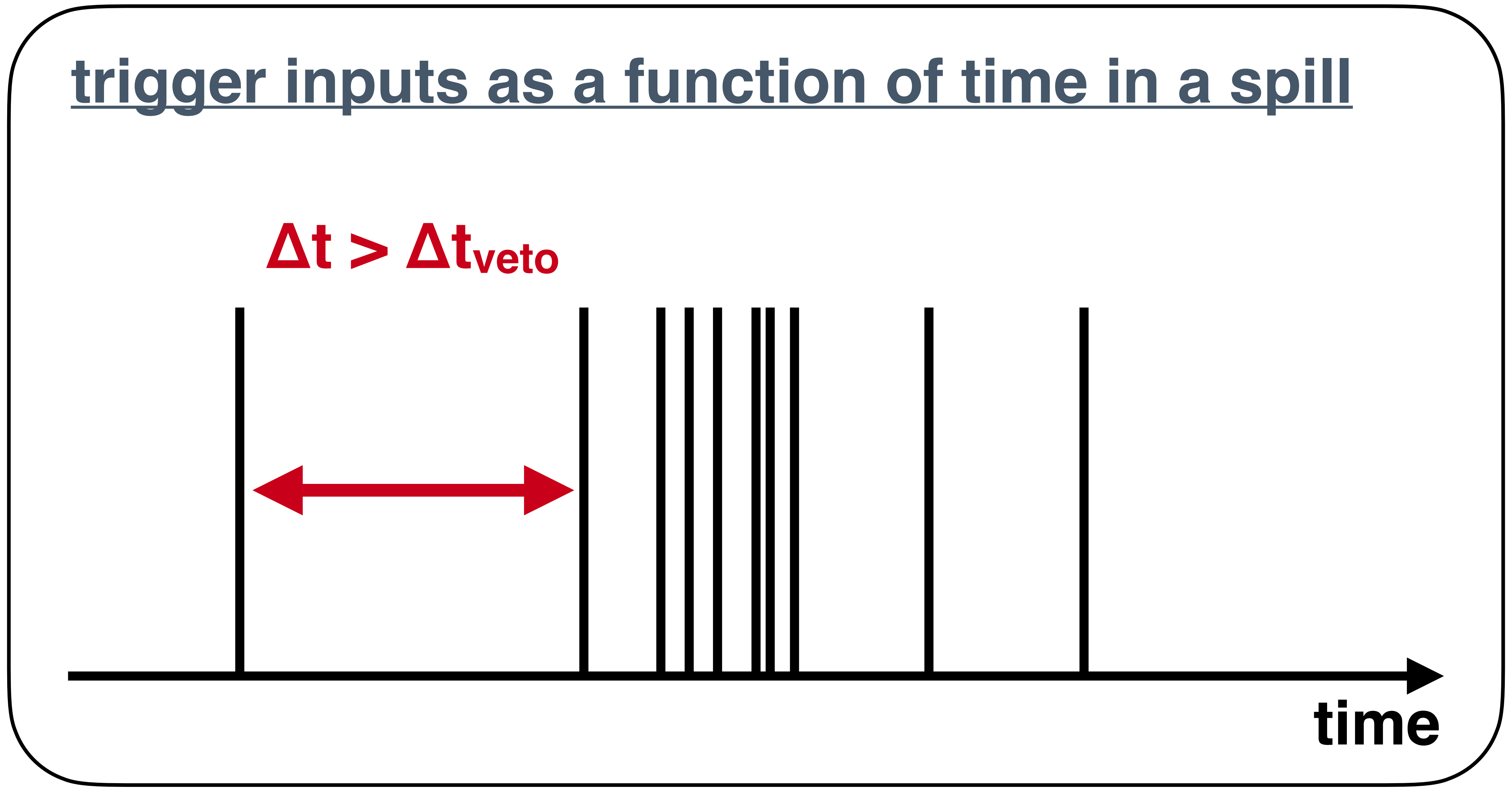


Trigger coincidence (PMT1 AND PMT2):

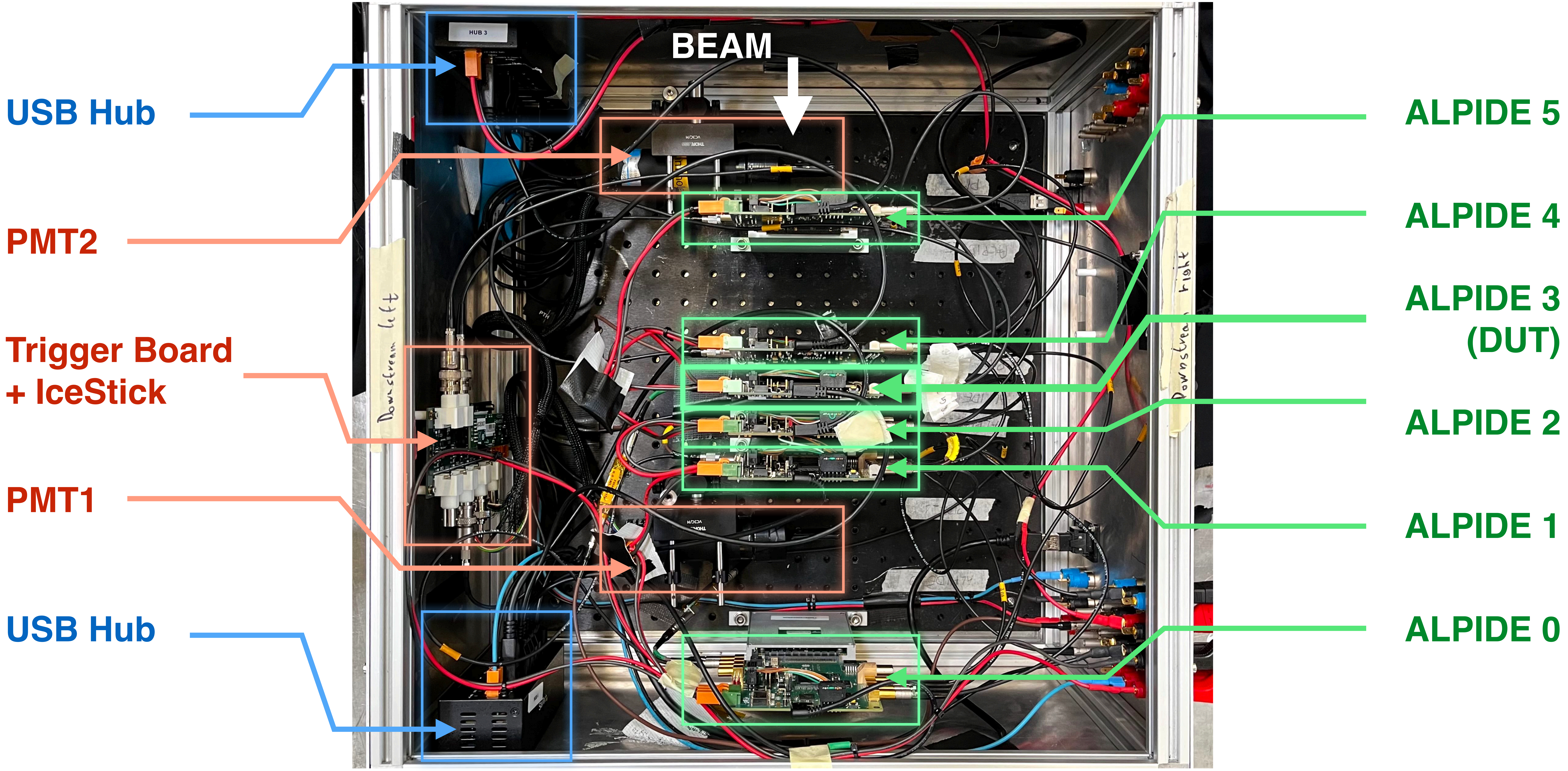
- logic end between the signals coming from the two PMTs

Trigger veto to mitigate pileup:

- accept a trigger only if no trigger input were received was received in a given time windows



Telescope setup



Telescope calibration, alignment and operation (summary)

Telescope installation at PS test-beam

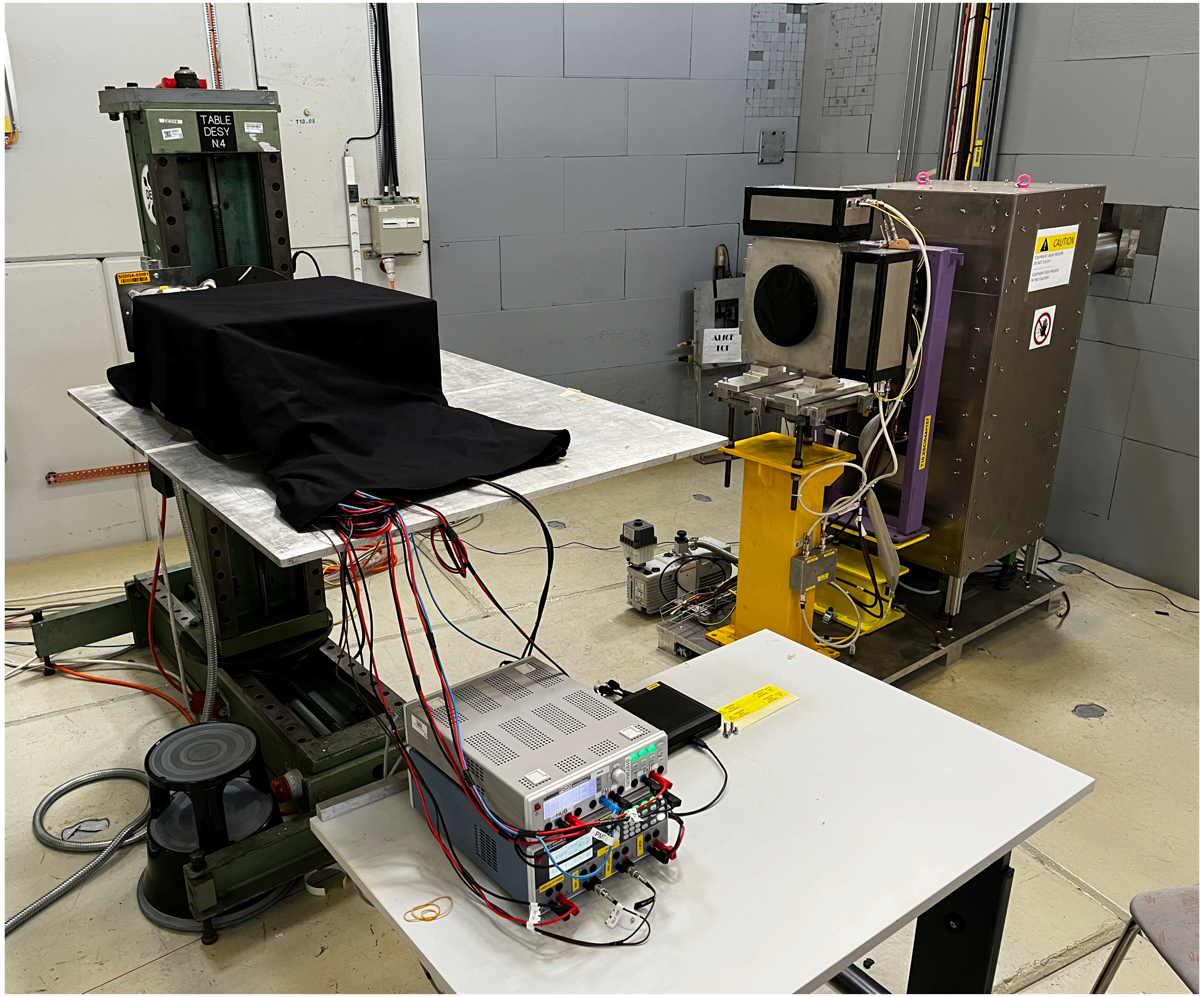
- First “manual” alignment with a laser
- Connect power, connect to the PC
- Refine alignment with beam + eudaq hit display

Calibration of the PMTs

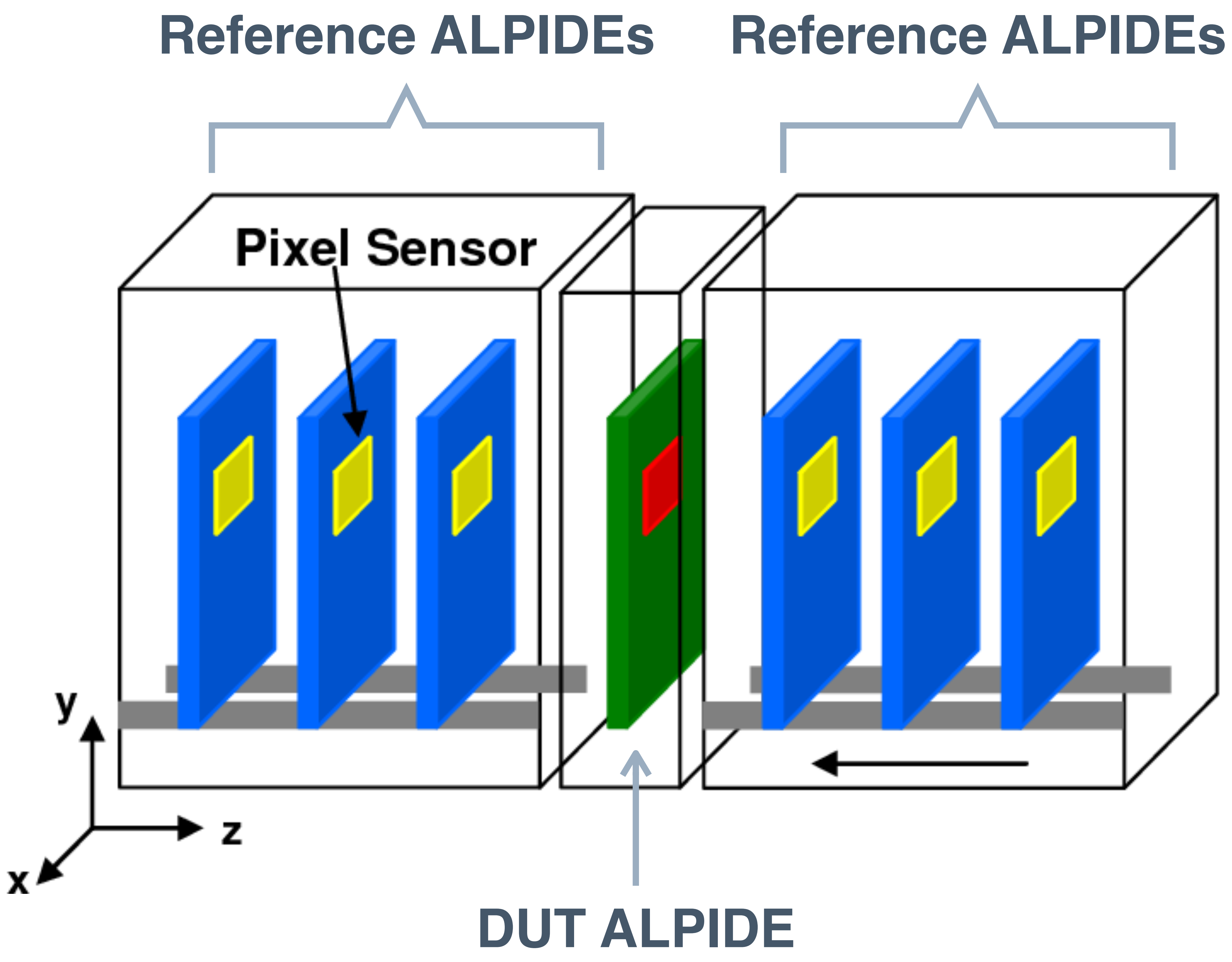
- Gain and threshold adjustment

Optimization of the veto time

- Improve rate of data taking
- Reduce pile-up in the reference + DUT planes



Data analysis: primary goals



1) ALPIDE VCASN scans (internal threshold)

- Data for range of VCASN values with vbb at 3V and 0V

2) ALPIDE data with vbb = 0V

- New data! ALPIDEs have not been characterized with this bias

3) Experiment and optimize process for MOSS test-beam

- Prepare for MOSS telescope
- Establish data collection and analysis pipeline

Overview of the data taking strategy

During Run: Checks with EUDAQ2

- Hit maps → Is telescope aligned to beam?
- Correlations → Are DUT + references working together?
- Hits per event → Reasonable? Pileup issues?

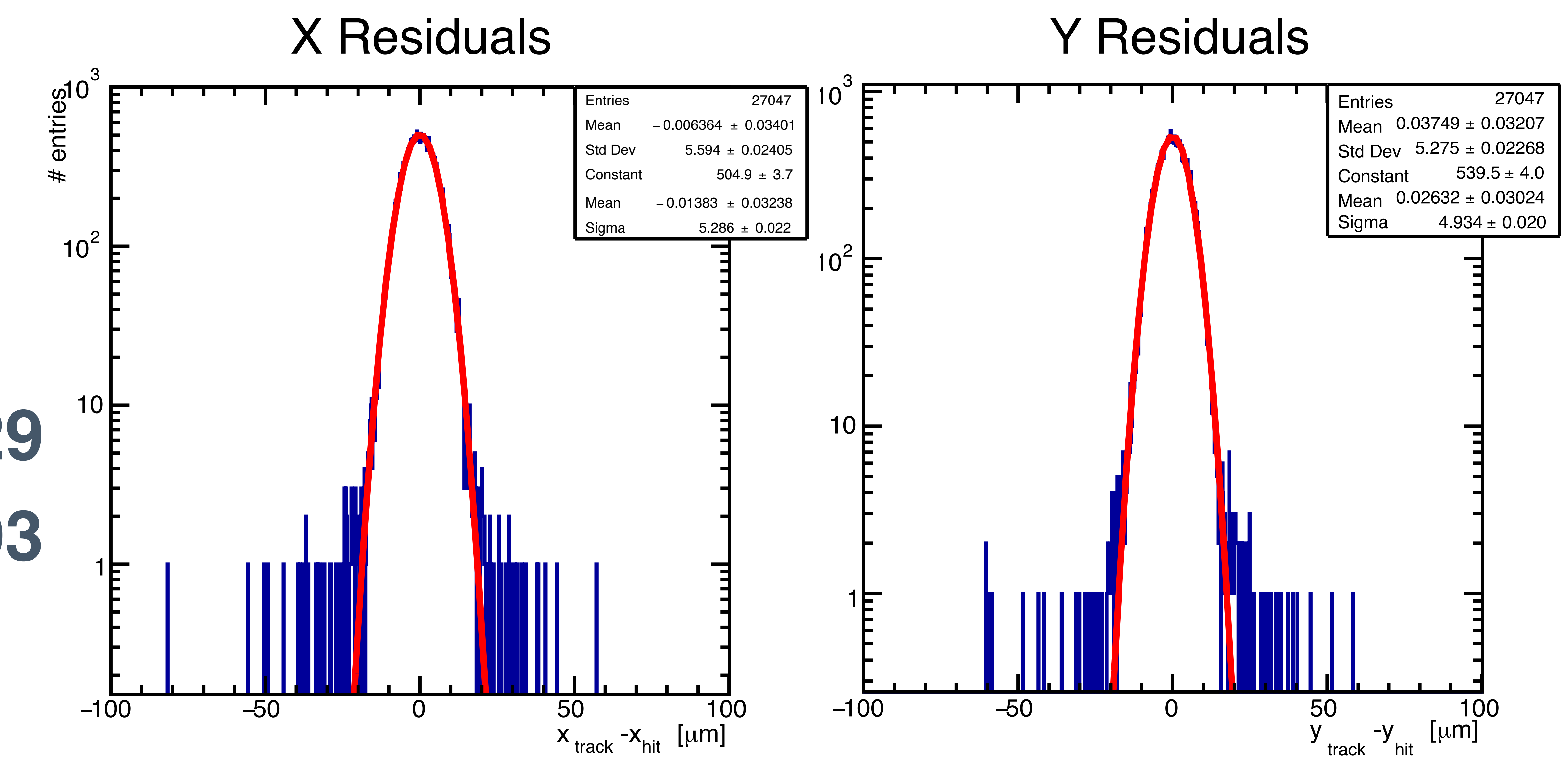
After Run: Analysis with Corryvreckan

- Align DUT ALPIDE with reference ALPIDE
- Ensure usable tracks with data
- Residuals → Alignment between refs & DUT
- Clusters, cluster sizes → DUT performance, noise

3V

x: 5.29

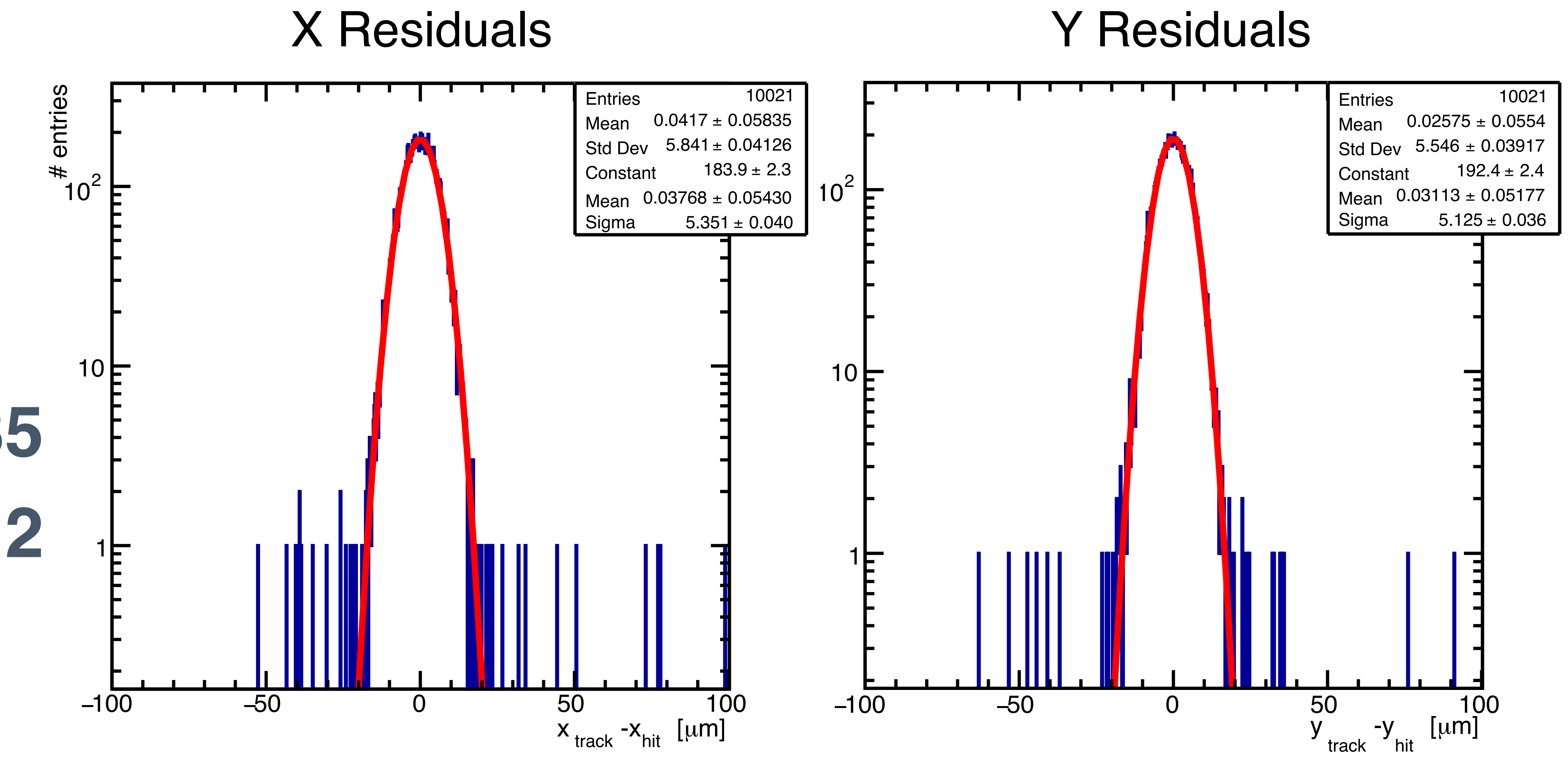
y: 4.93



0V

x: 5.35

y: 5.12



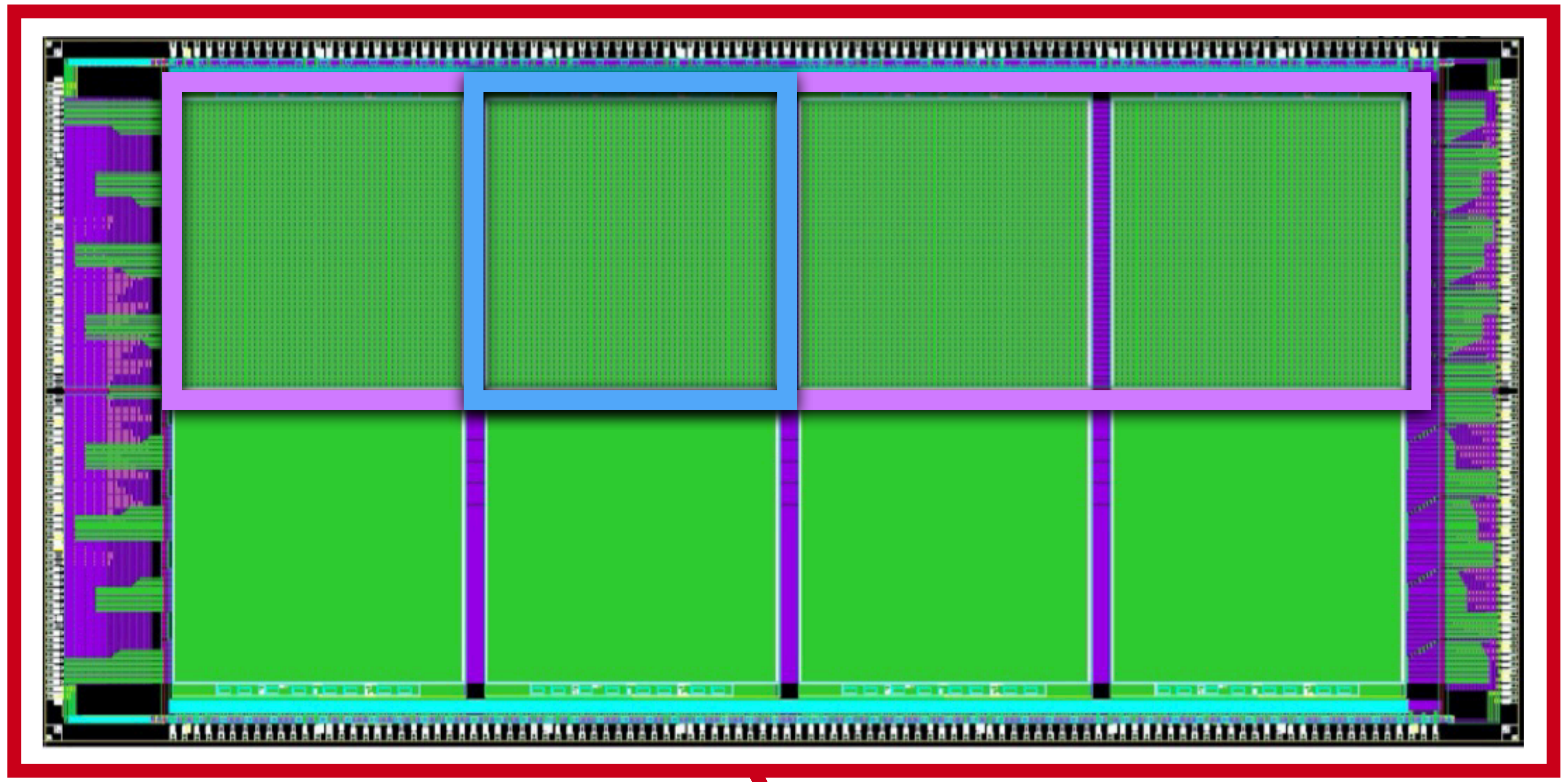
Recent activities at CERN:

first test beams with the MOSS!

Overview of the MOSS

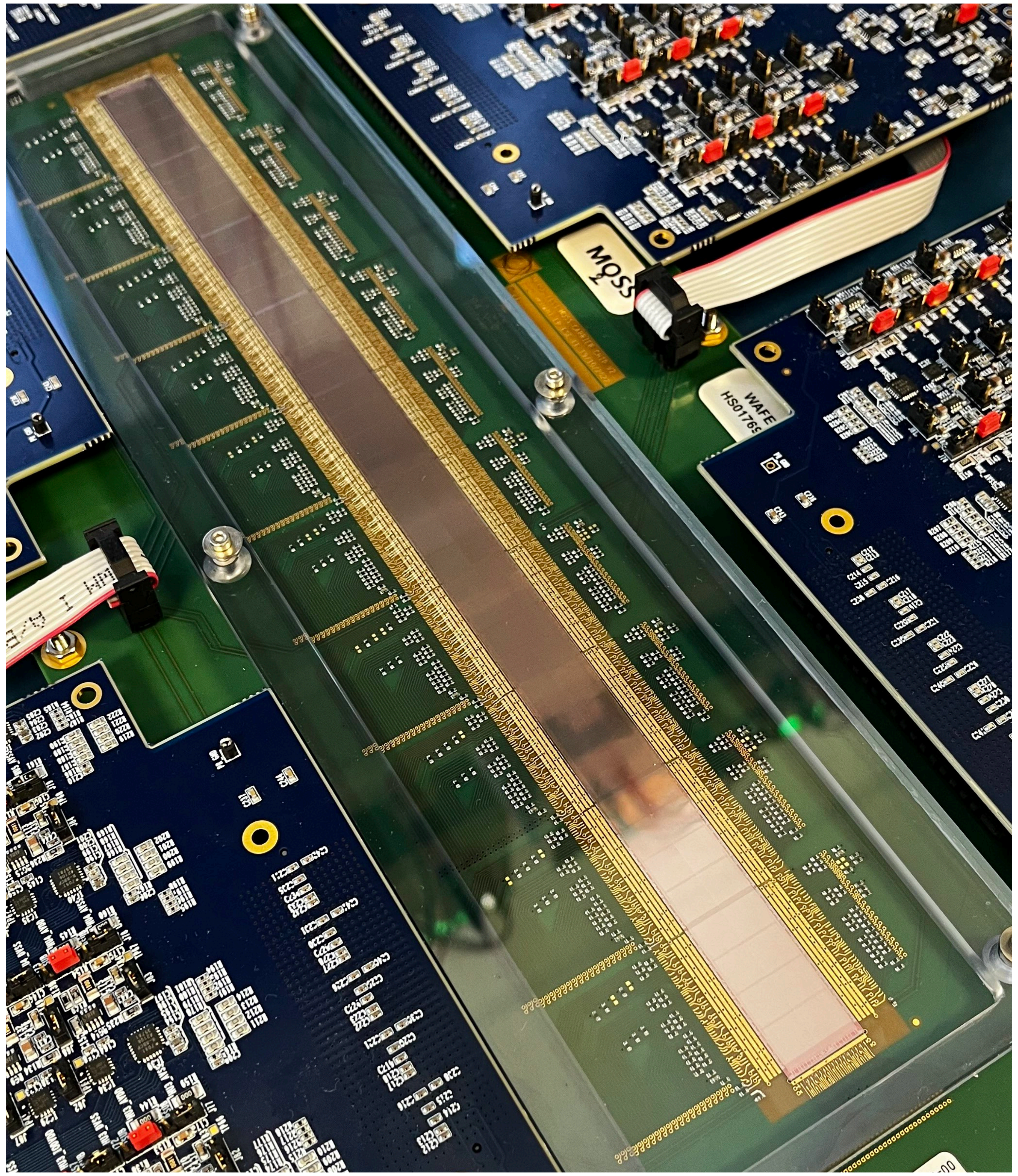
(**Mo**nolithic **S**titched **S**ensor)

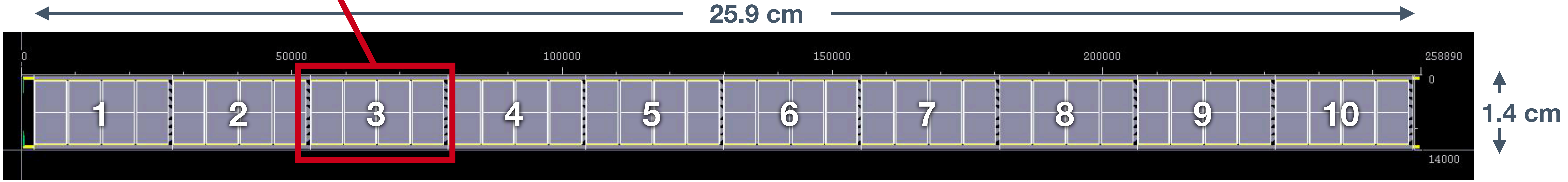
10 Repeated Sensor Units (RSU)
↳ **2 Half-Units (HU)** per RSU (top & bottom have diff. pitch)
↳ **4 Regions** per HU (each with diff. transistors)



Top:
256 x 256 pixels
Pitch: 22.5 µm

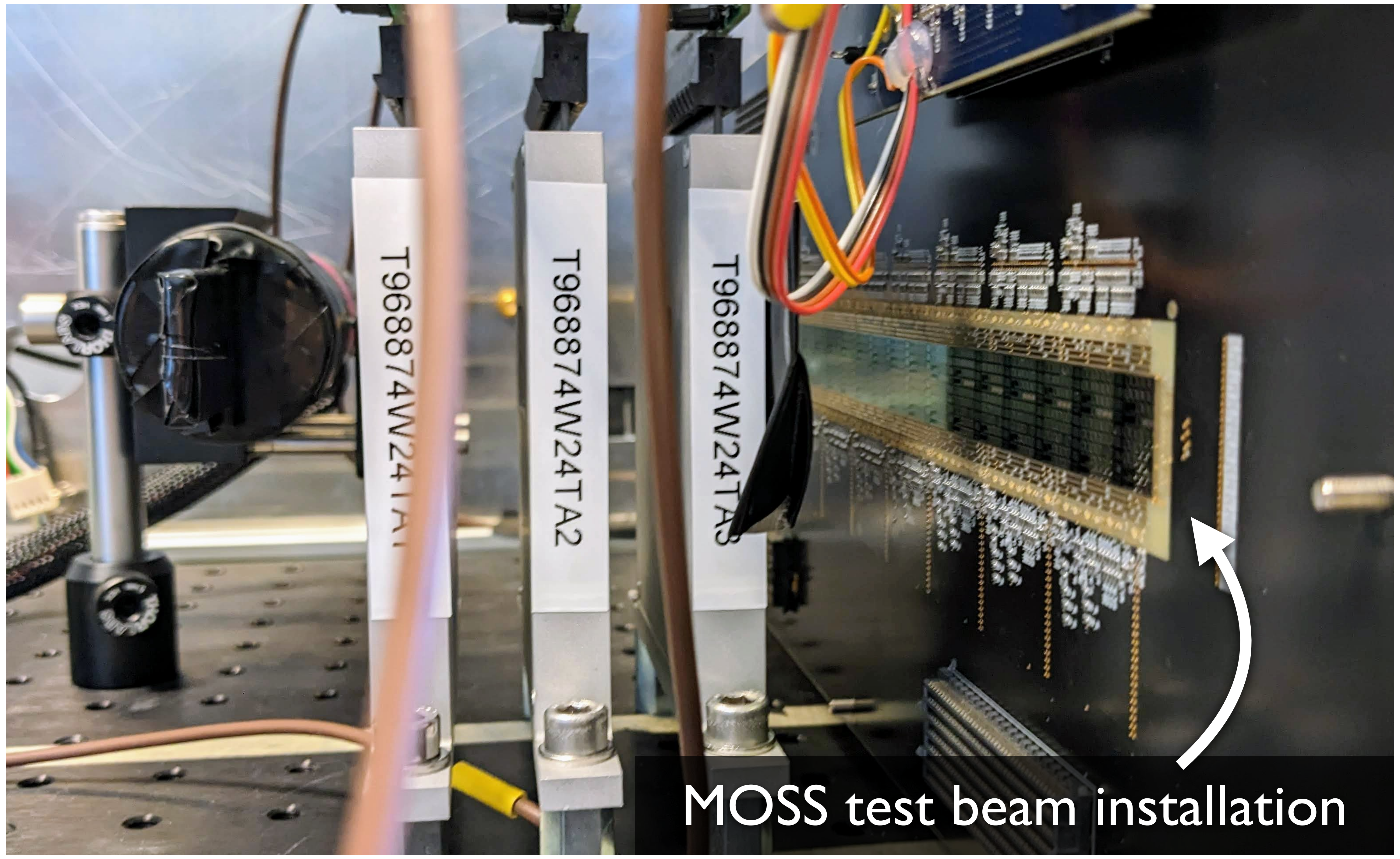
Bottom:
320 x 320 pixels
Pitch: 18 µm



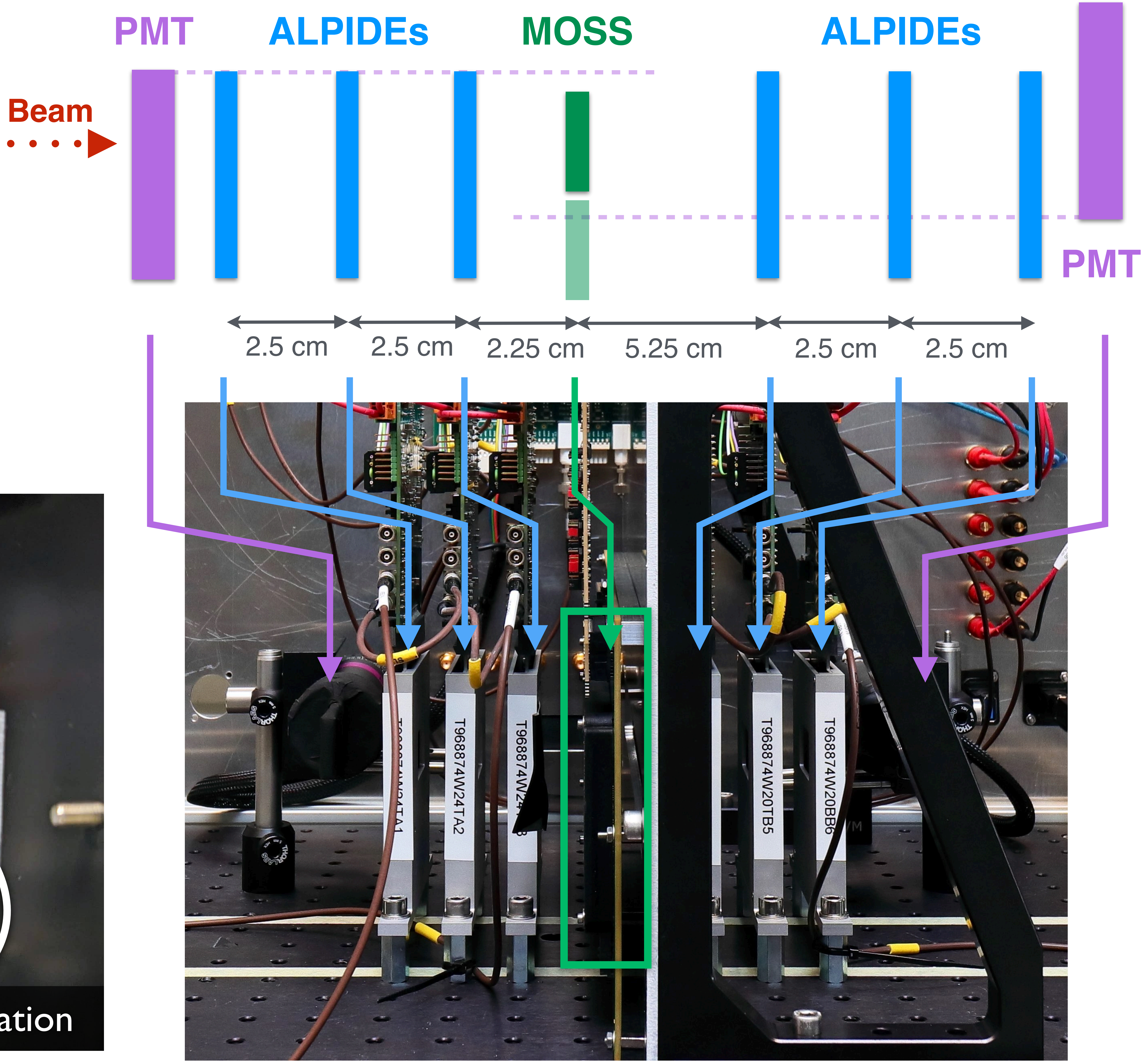


MOSS telescope setup

- **6x ALPIDE reference planes**
- Trigger: **2 PMTs in coincidence**
- **1 MOSS as DUT**



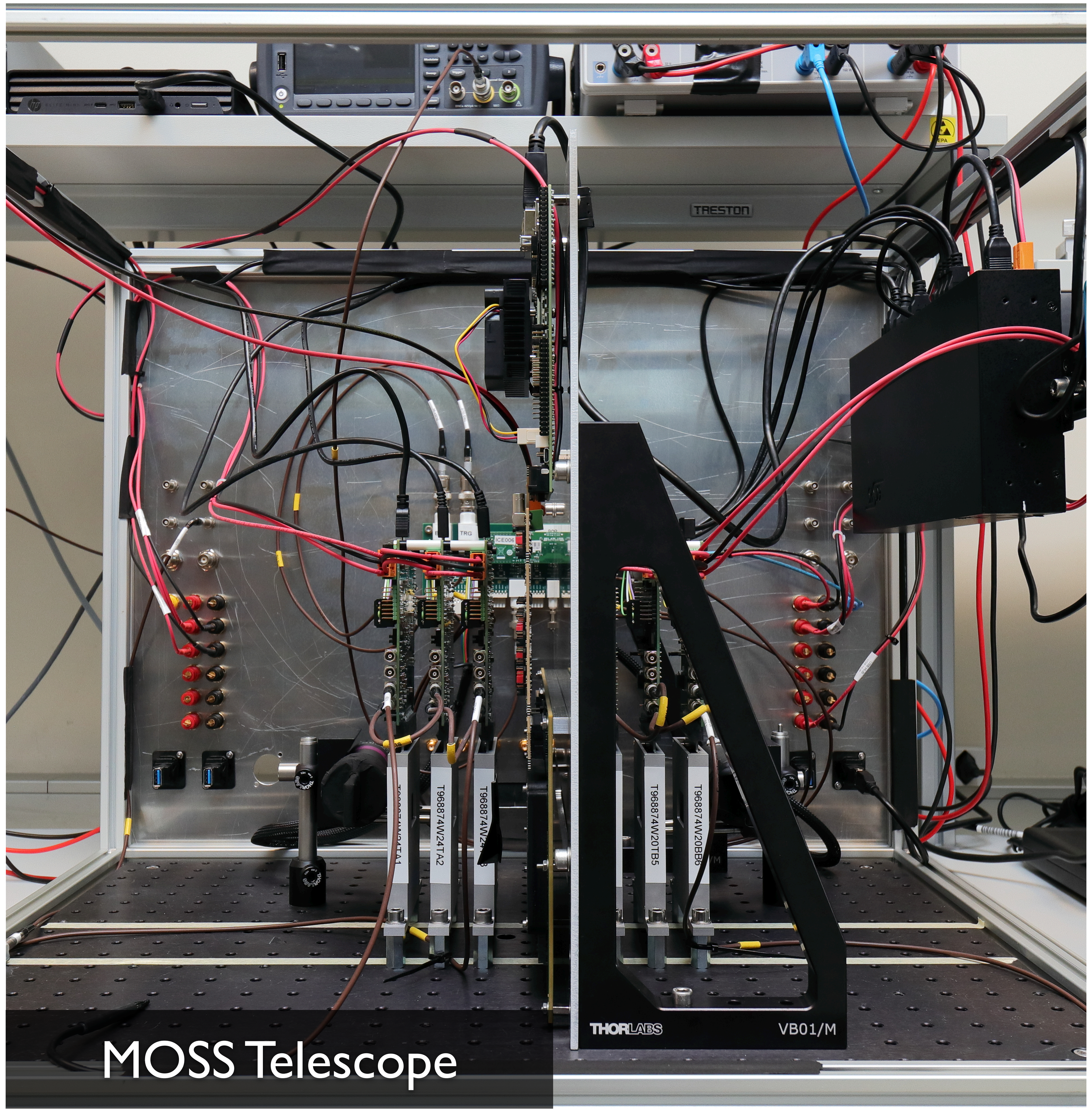
MOSS test beam installation



Test beam at the PS: plan and schedule

Timetable:
- PS test beam 5 - 19 July
- MOSS in beam since 14 July
- Just 5 weeks after the bonded MOSS arrived at CERN!

Beam configuration:
- T10@PS: **10 GeV negative hadrons**
- both low-intensity and high-intensity runs

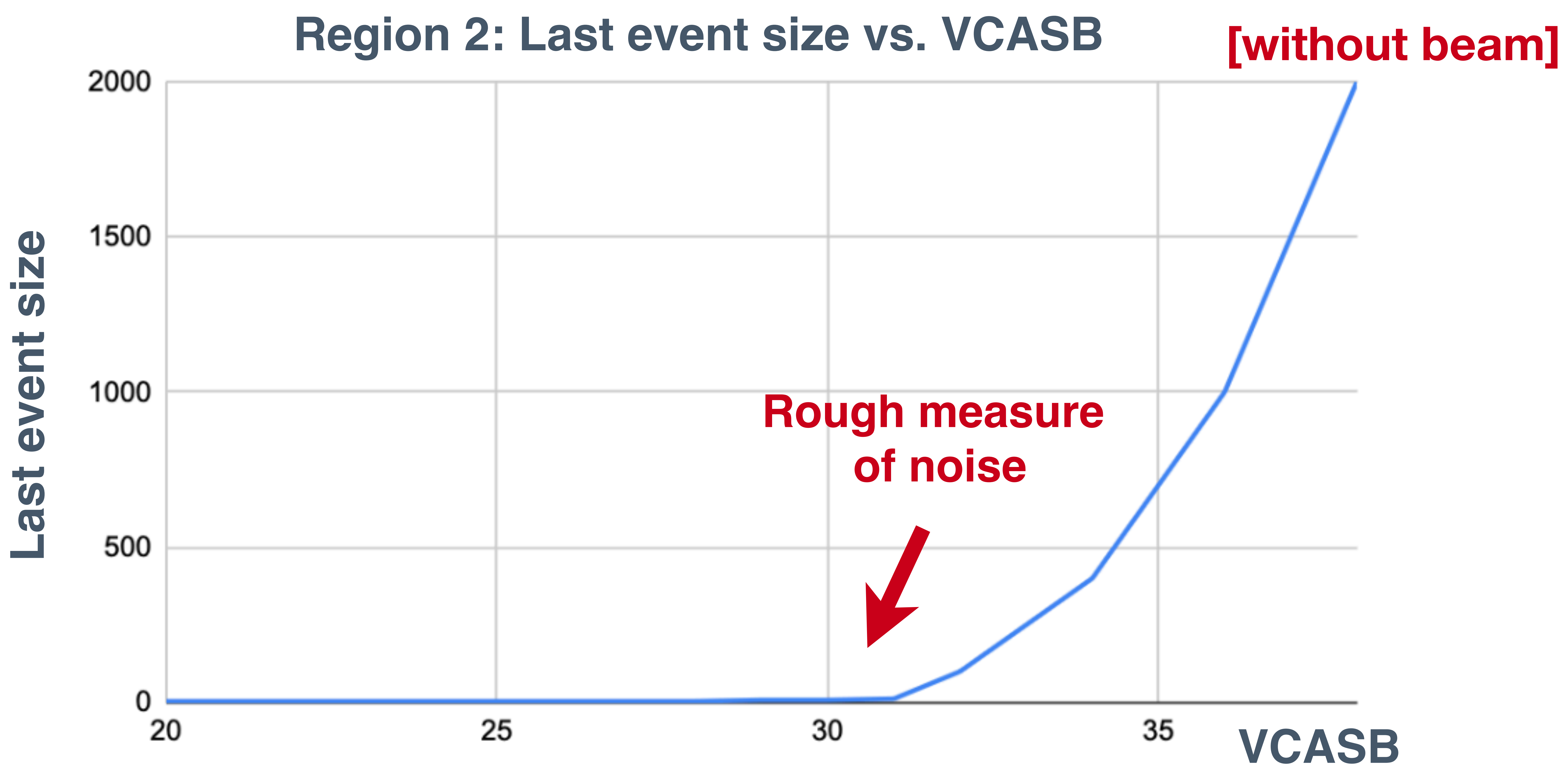


Goals of the test:
- Observe and characterize the very first signals in the MOSS
- Characterize efficiency and resolution as a function of tension VCASB **(see next slide)**

MOSS 'Word scan' vs VCASB → noise level

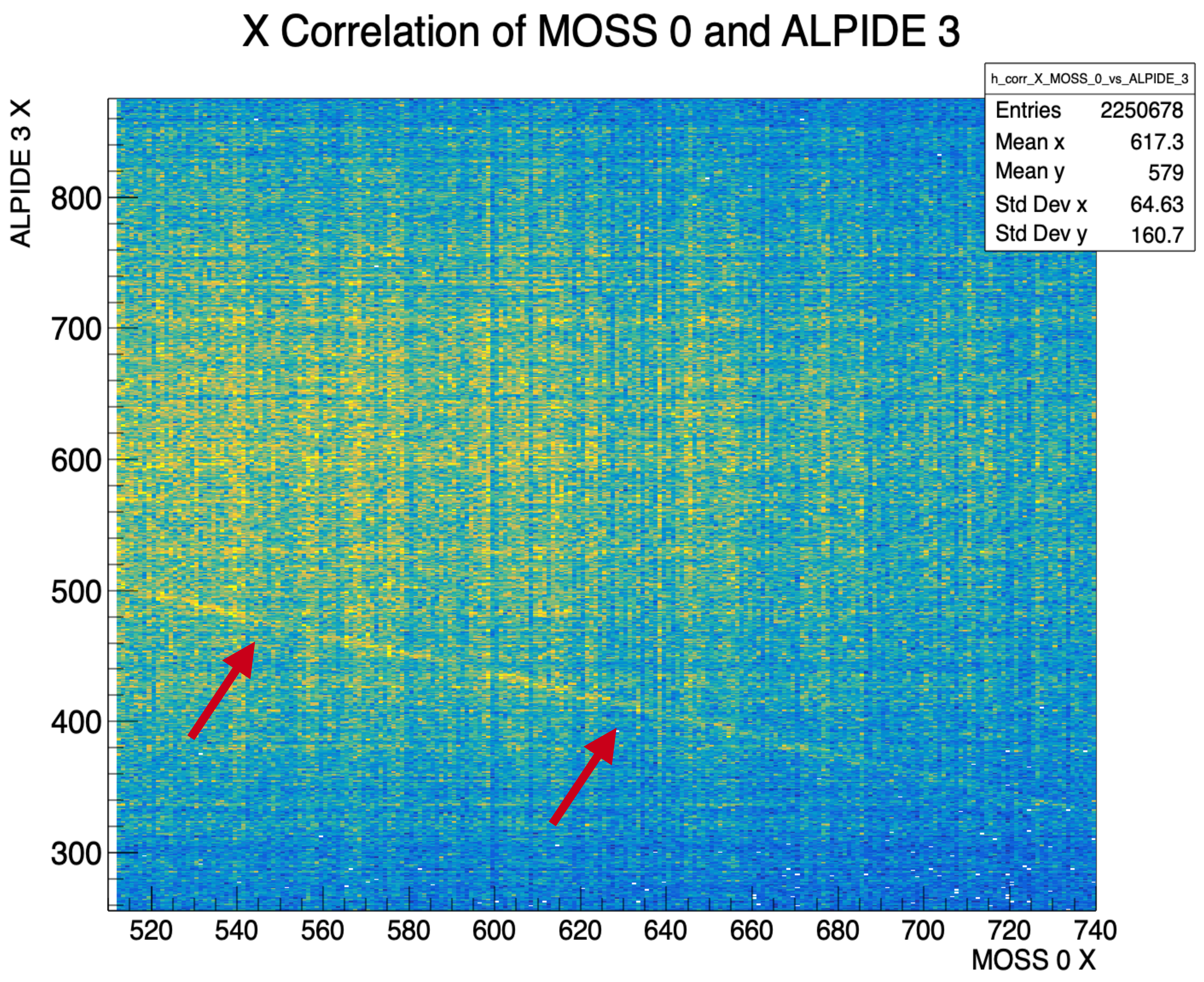
Number of words of the last event recorded by the online DAQ system **(4 words = empty event)**
→ rough estimation of the noise level of the MOSS

VCASNB	Last event size (n. of words)
36	~ 1000
34	~ 400
32	~ 100
31	12
30	8
29	8
28	4
26	4
24	4
22	4
20	4

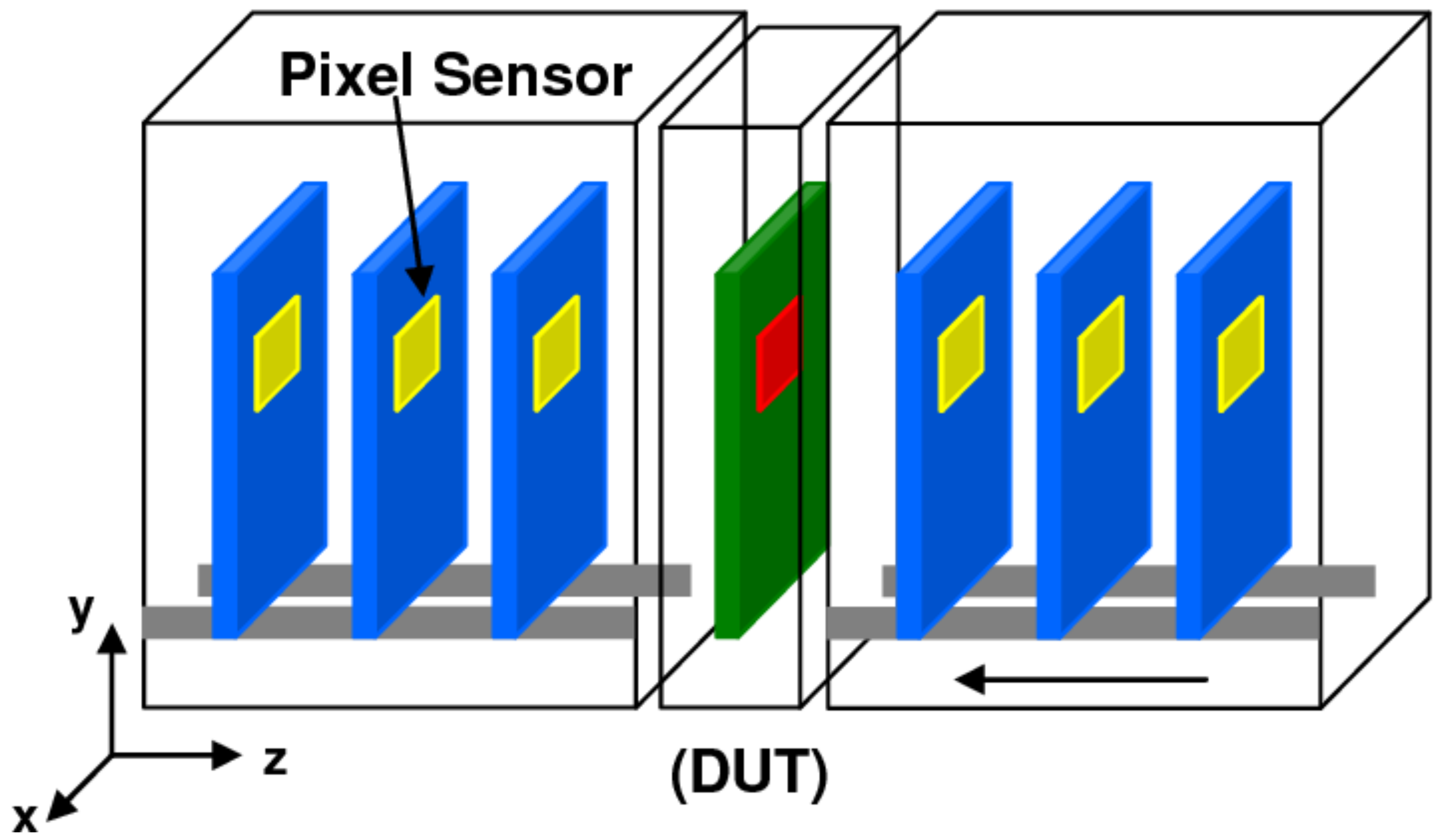


First correlation seen on ALPIDE(s)-MOSS!

(with high-intensity beam)



Region 2, VCASB=26



Correlation between the MOSS signal and the one in <u>any</u> of the ALPIDE reference planes:

- both ALPIDEs and MOSS are “seeing” the passage of the same particle trajectory

Data taking strategy and collected samples

Large datasets collected in low-intensity mode:

- Low-intensity runs → collimators ± 3.0 cm
  - Cleaner and higher-luminosity samples (milder trigger veto)
- 20k trigger events per VCASB level
  - ~1 MOSS hit per event
  - ~18k ALPIDE tracks per set → ~10% through MOSS

	good set		good set	
REGION	**0**	**1**	**2**	**3**
VCASB steps	[3,25] in steps of 2	[7,23] in steps of 2	[4,30] in steps of 2	-
Statistics	12 x 20k	9 x 20k	13 x 20k	-
Beam Intensity	low	high*	low	

**Different beam settings - data is not reliable*

MOSS analysis: masking noisy pixels

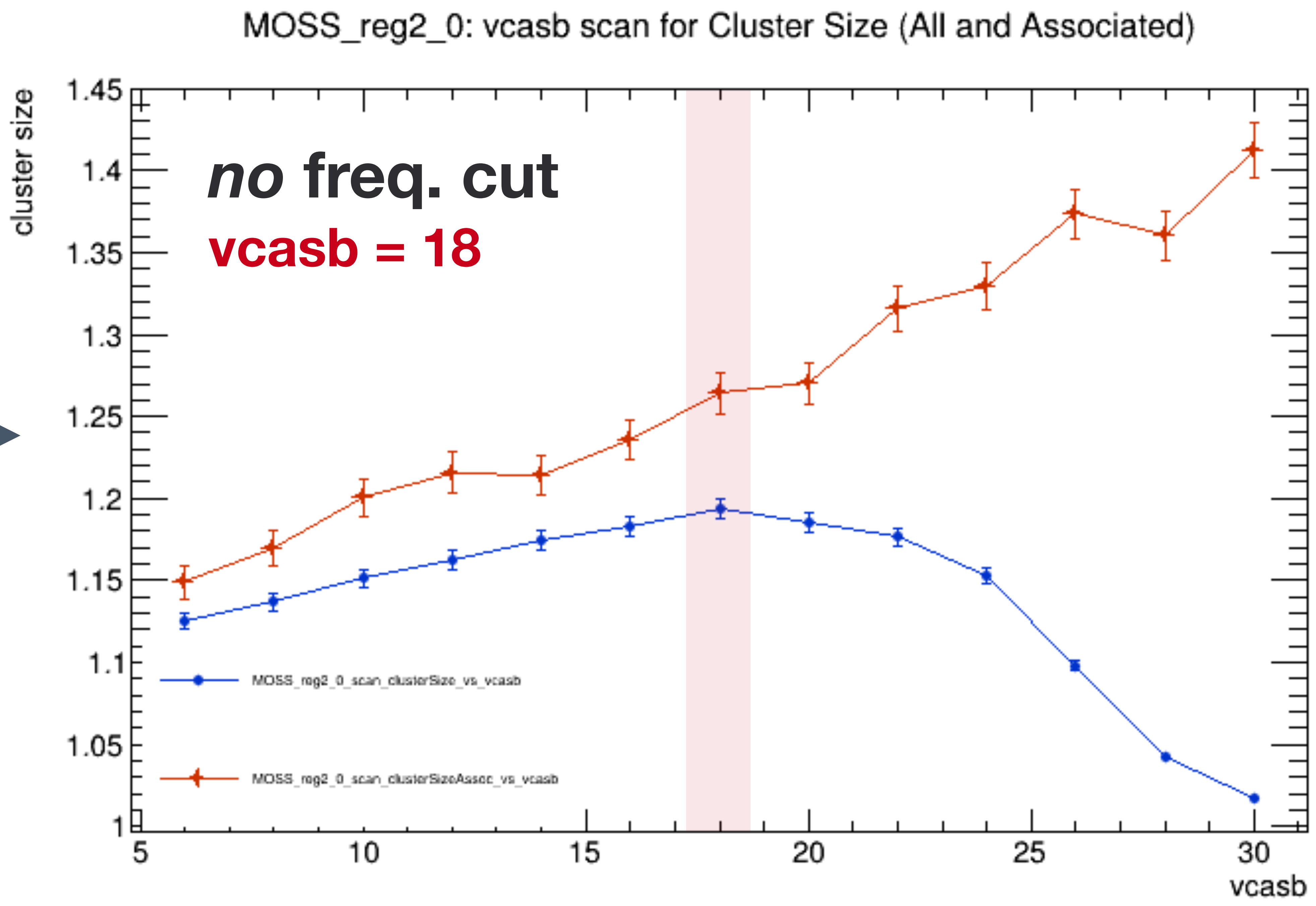
Apply frequency cut to automatically mask

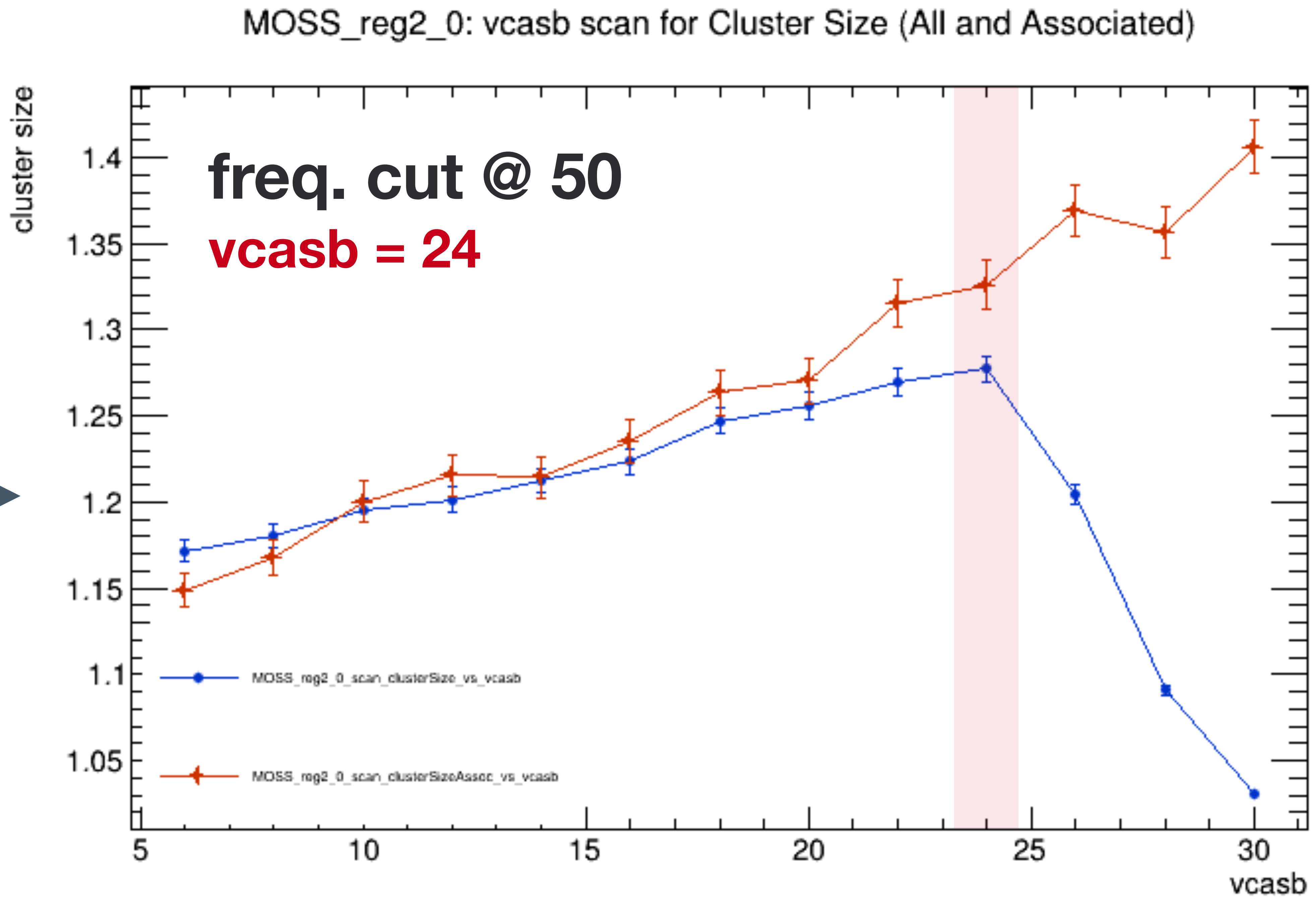
- Pixel is masked if it satisfies:

  [#hits] ≥ [freq] x [avg. hits per event]

- Peak cluster size **without cuts** is at vcasb = 18
  - Much lower than expect, **but…**
- For frequency ≥ 50, **peak shifts to vcasb = 26**
  - **This is close to "manual scan" results!**

	Manual	No Cut	Cut @ 50
Region 2	**~26**	**18**	**24**
Region 0	~16	13	13





MOSS analysis: alignment process

- Set MOSS at origin in Z
- Use ALPIDE 2 as "reference" (stays ~fixed, closest to MOSS)
- Time cuts with MOSS are set to 1e99 or turned off

Corryvreckan Steps

1. Masking

Mask with:

`frequency_cut=-1`

2. Prealignment

Broader settings:

`max_rms=15mm`

`range_abs=20mm`

3. Alignment 1

Excludes DUT, aligns ALPIDEs only (Tracking4D & AlignementMillipede)

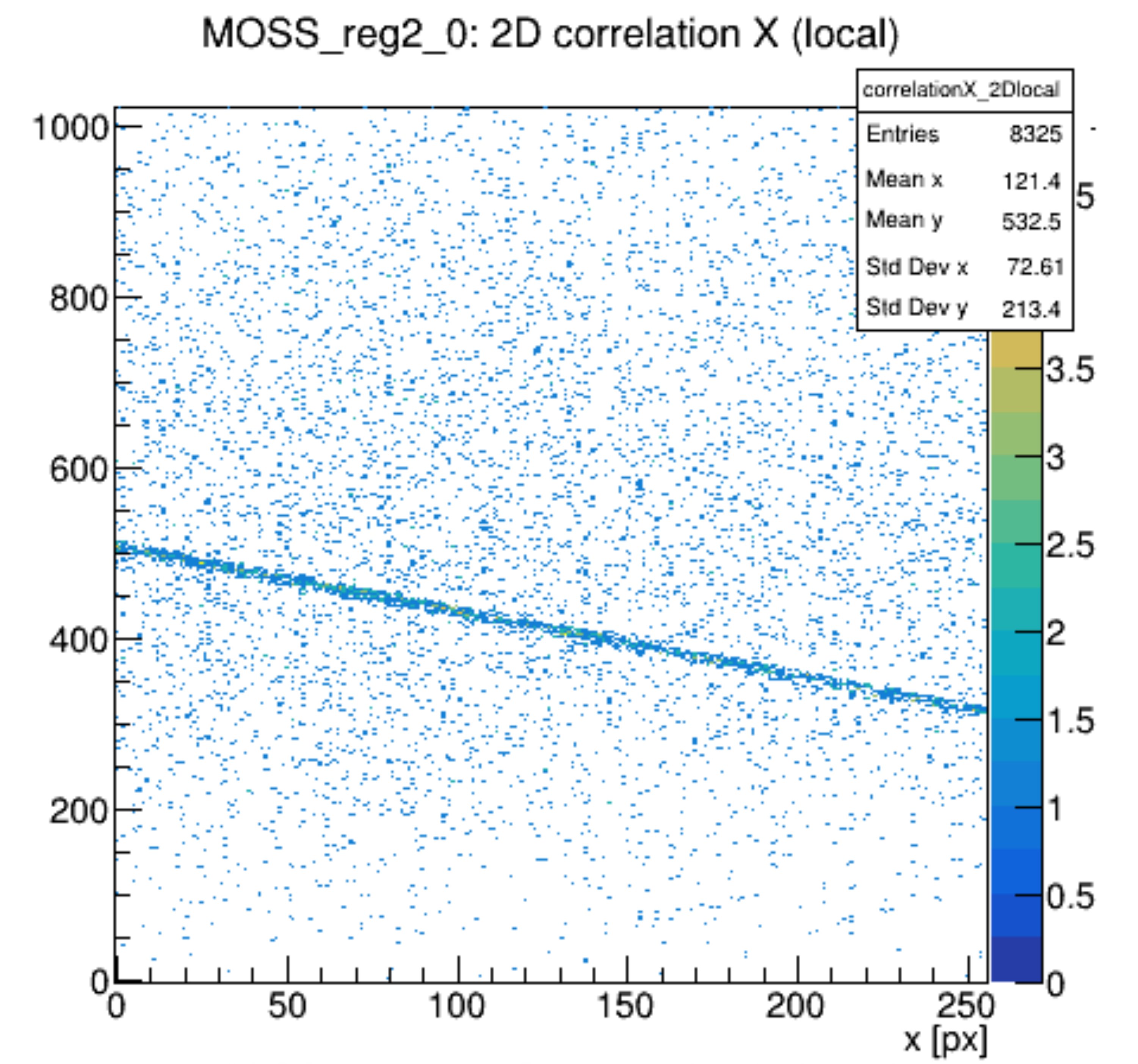
4. Alignment 2

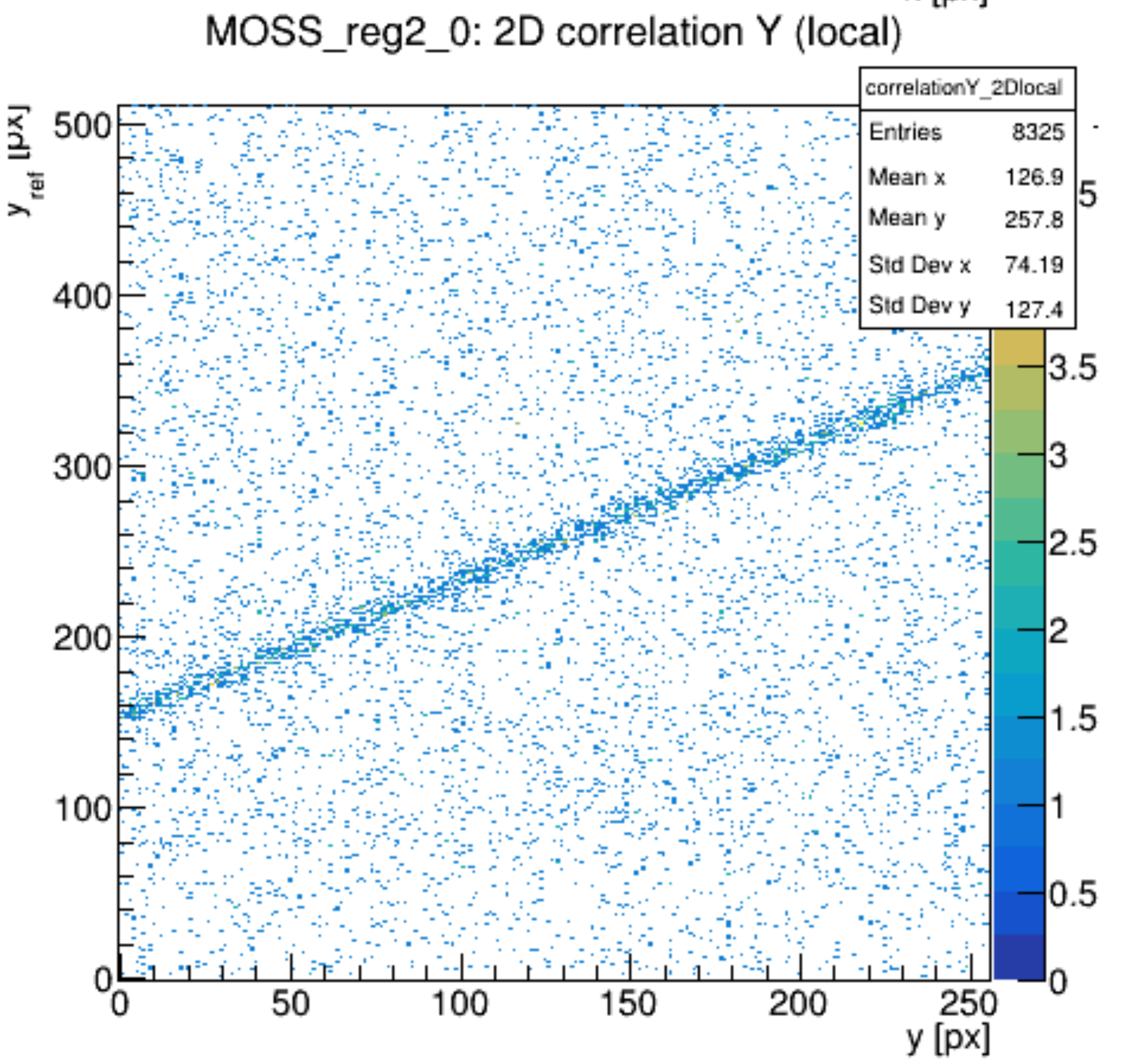
Includes DUT, aligns MOSS with ALPIDEs (Tracking4D & AlignementMillipede)

5. Analysis

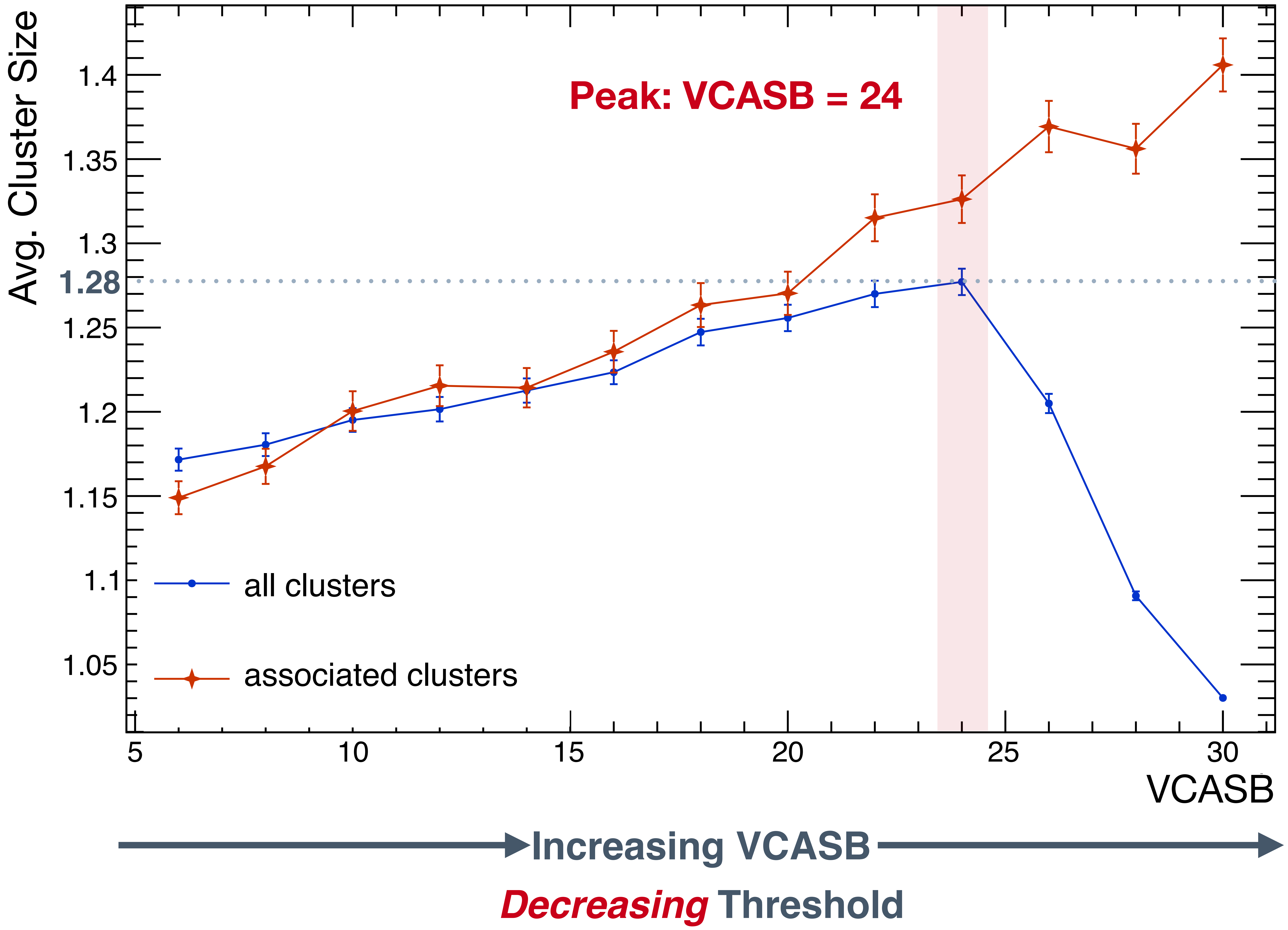
No major changes

Two Alignment Steps





Region 2: ⟨Cluster size⟩ vs VCASB



VCASB is
inversely proportional
to threshold

Why the peak?

- Associated cluster size increases as threshold decreases (charge on neighboring pixels)
- At a point, pixels become noisy and 1-pixel cluster noise dominates

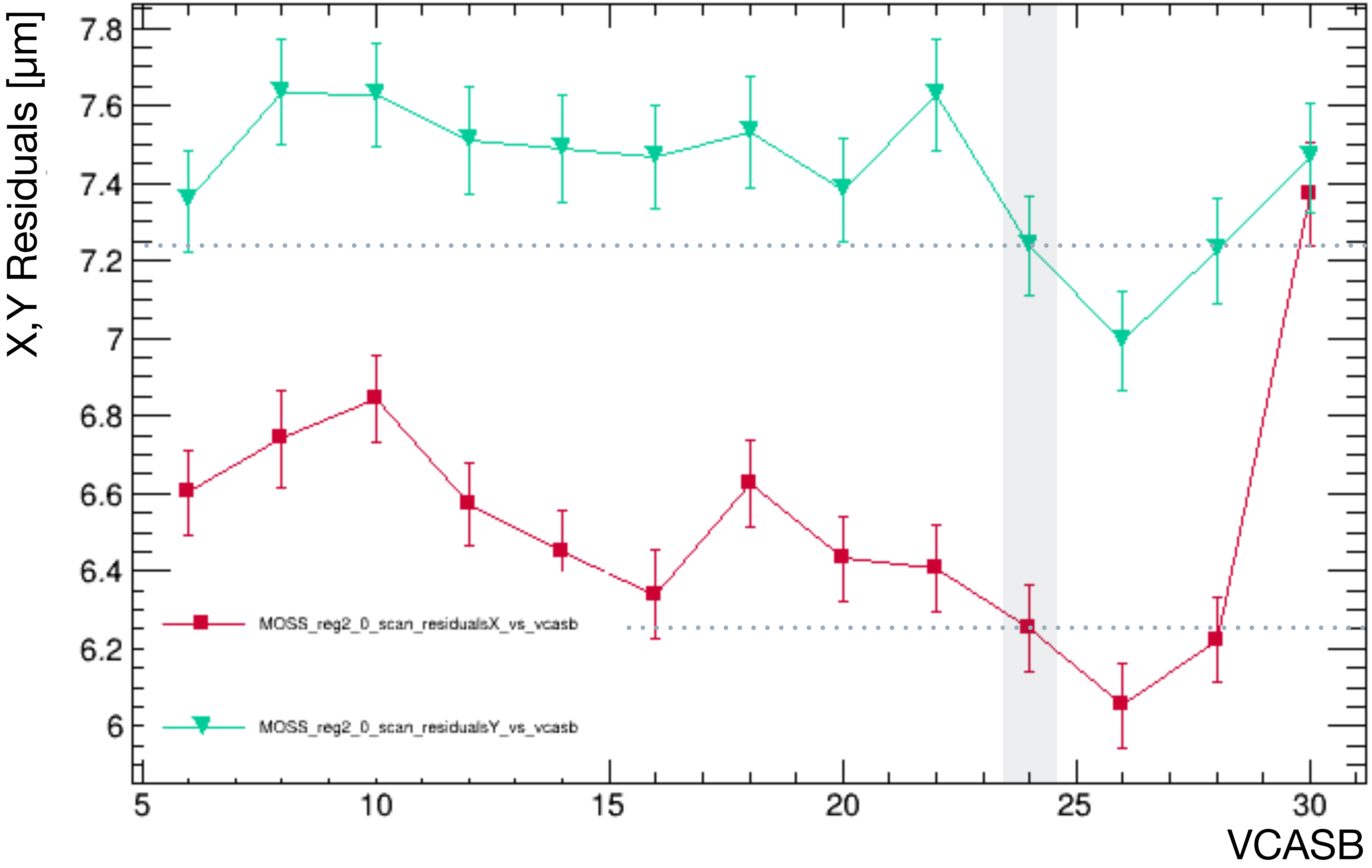
MOSS Alignment: Region 2 Residuals

Region 2 (for VCASB = 24)

- X Residuals: **6.25 µm**
- Y Residuals: **7.25 µm**

Significant asymmetry between X & Y

- Expected cause: ALPIDE pixels have difference X, Y pitch
- Still need to subtract telescope residuals



Summary and next steps

- **Major contribution to the R&D, construction, installation and commissioning of the SVT innermost layers**

→ ITS3 as the technological baseline, but with a lot of additional challenges!

- **MIT will profit from a CERN-based laboratory to maximize the knowledge transfer from ALICEITS3 to ePIC SVT**

- **Good plan from the near to the far future, with several aspects are still being optimized/finalized.**

→ any feedback/suggestion is very welcome

- **Already delivering good results!**

→ Our CERN team is providing major contributions to the MOSS first test beam

→ Ramping up the activities at Bates for the mechanical design and R&D

→ A lot of opportunities for students and postdocs to have an impact on the project!

BACKUP slides