Liverpool HEP meeting 2025

MUonE

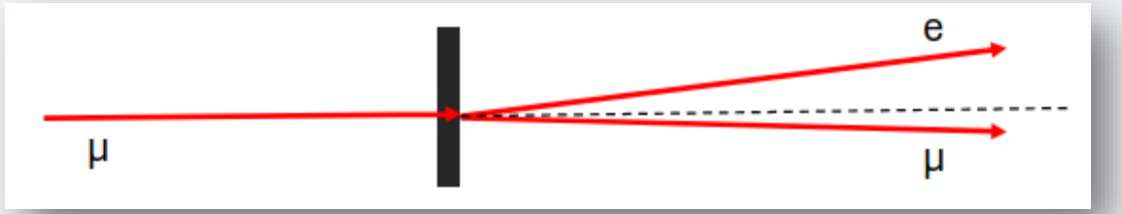
test-run 2025 preparation

Clément Devanne

A bit of context…

MUonE: Roadmap towards a_μ^{HLO}

A high-energy muon beam ~ 160GeV /c is directed onto atomic electrons in a fixed low-Z target to study $\mu^+e^- \rightarrow \mu^+e^-$ elastic scattering



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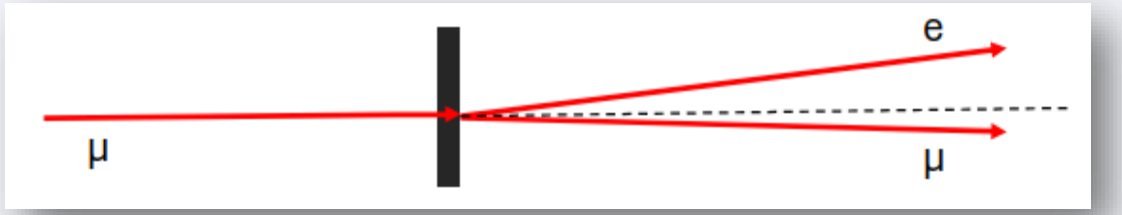

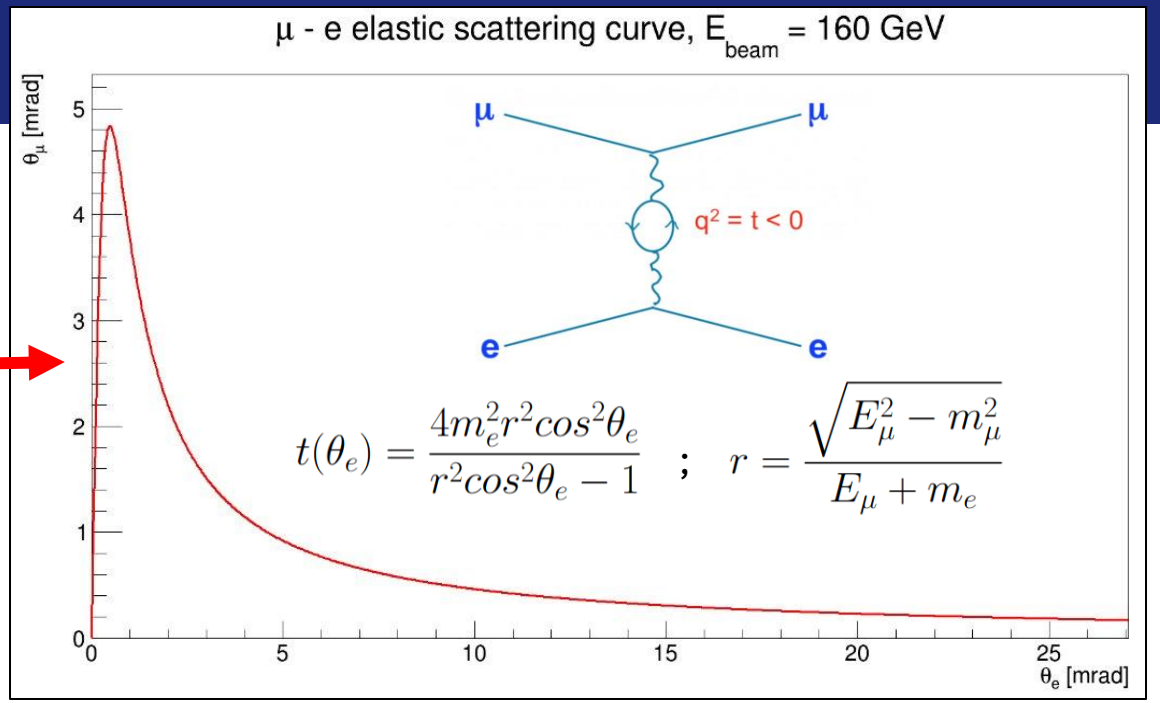

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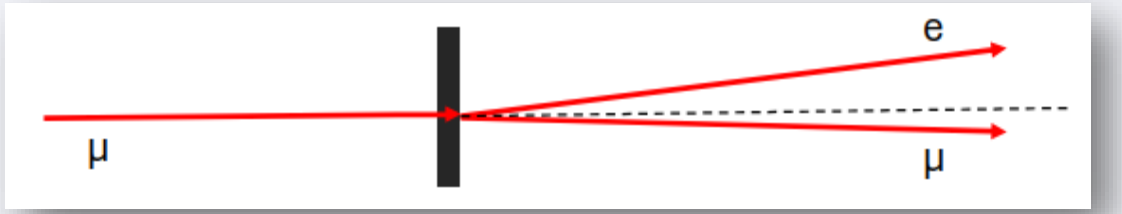

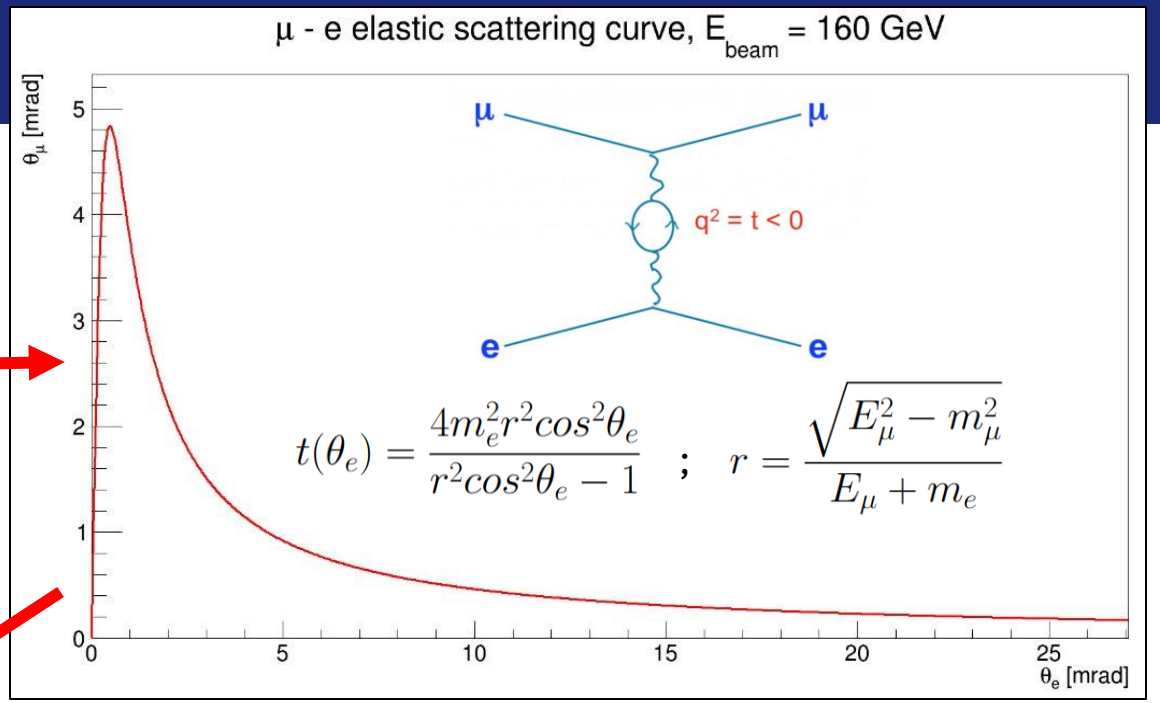

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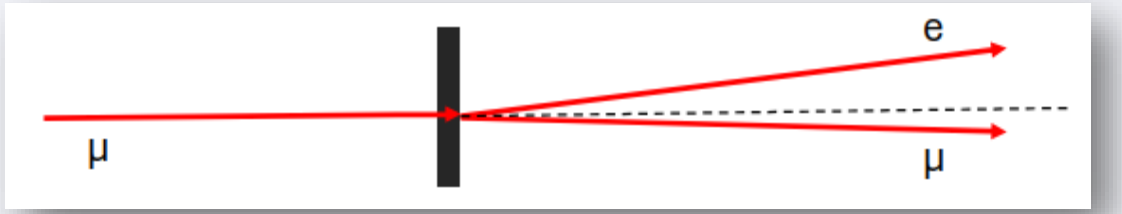

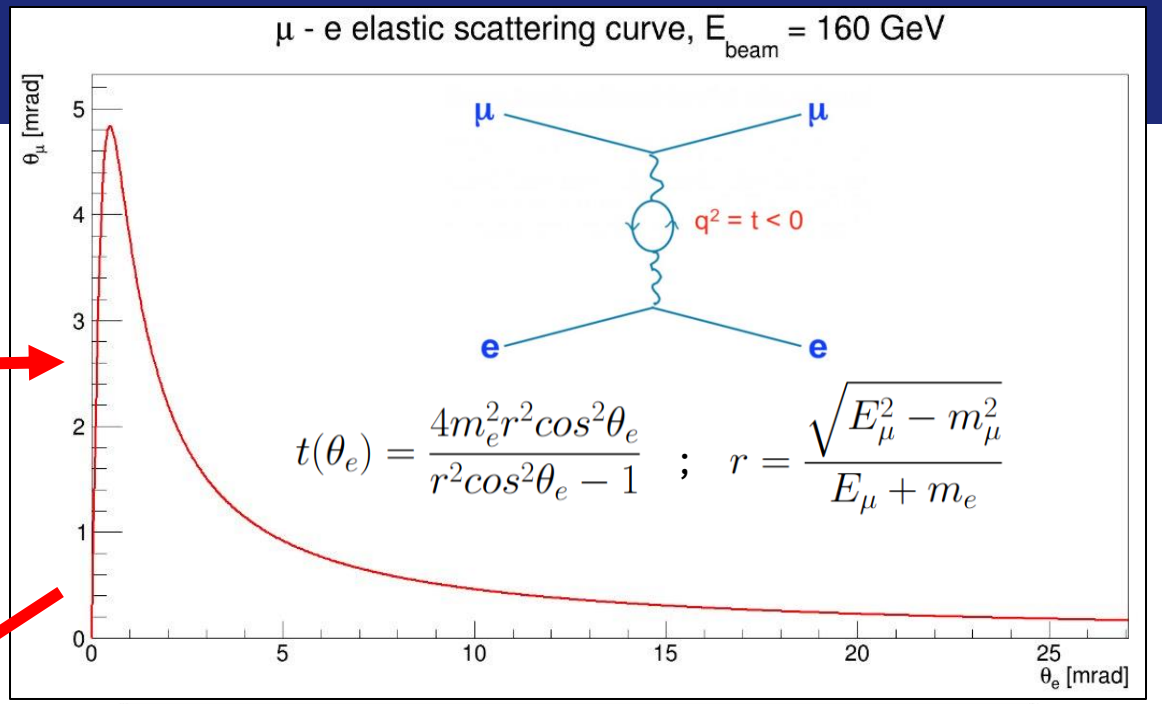

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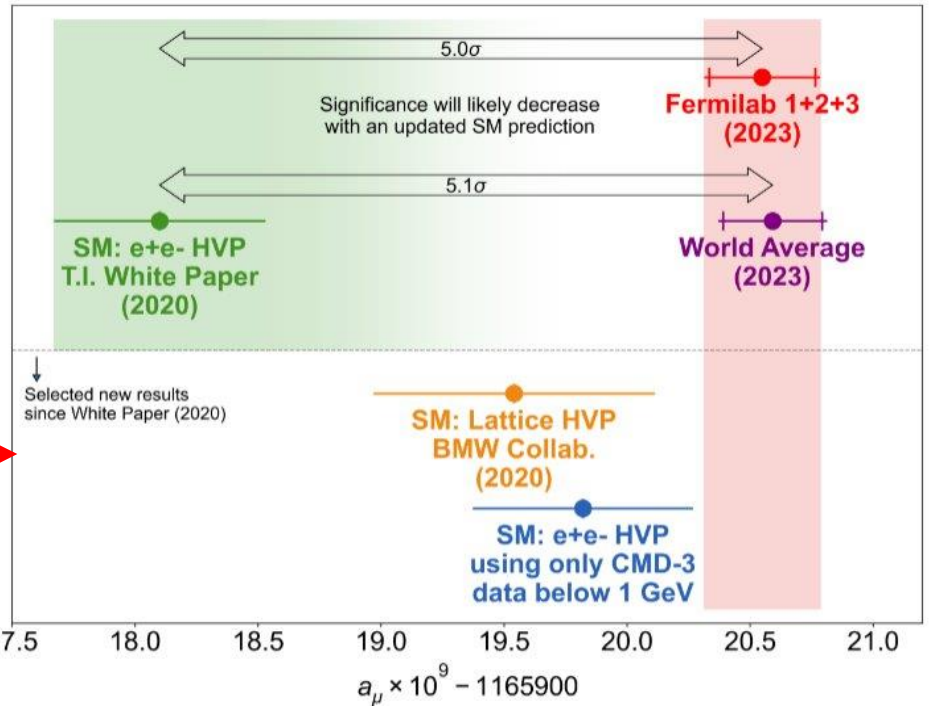

Phase 1: 2025 test-run

Phase 1 will run for ~2 months of data taking starting in June 2025, aim to:

- Validate the full detector setup under operational condition
- Optimize data acquisition and reconstruction techniques
- Studies of systematic uncertainties and background processes

➡ Preliminary measurment the hadronic $\Delta\alpha_{\mathrm{had}}(t)$ with ~20 % statistical uncertainty + similar systematics

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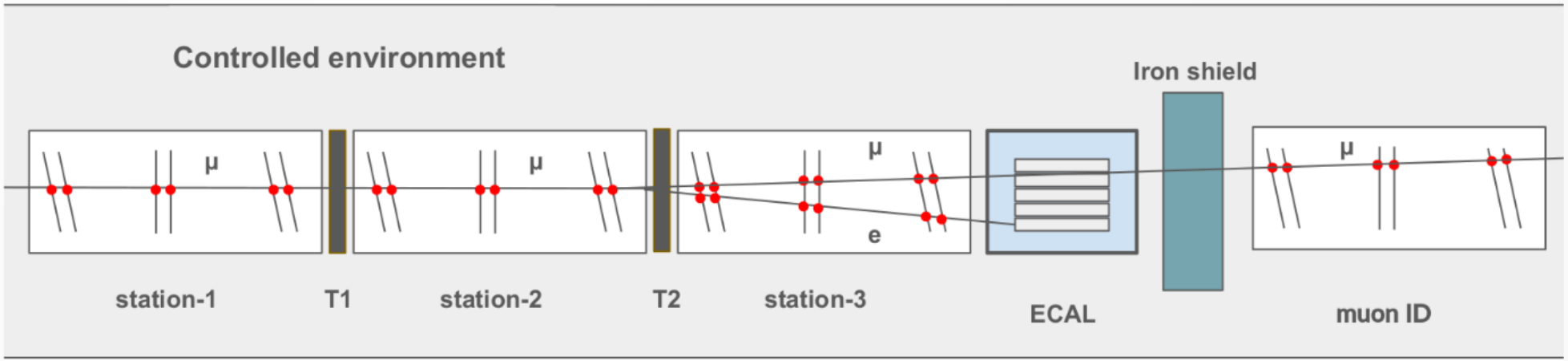

The apparatus:

- A beam Momentum Spectrometer (BMS)
- Three tracking station
- Two 2 cm target
- An electromagnetic calorimeter (ECAL)
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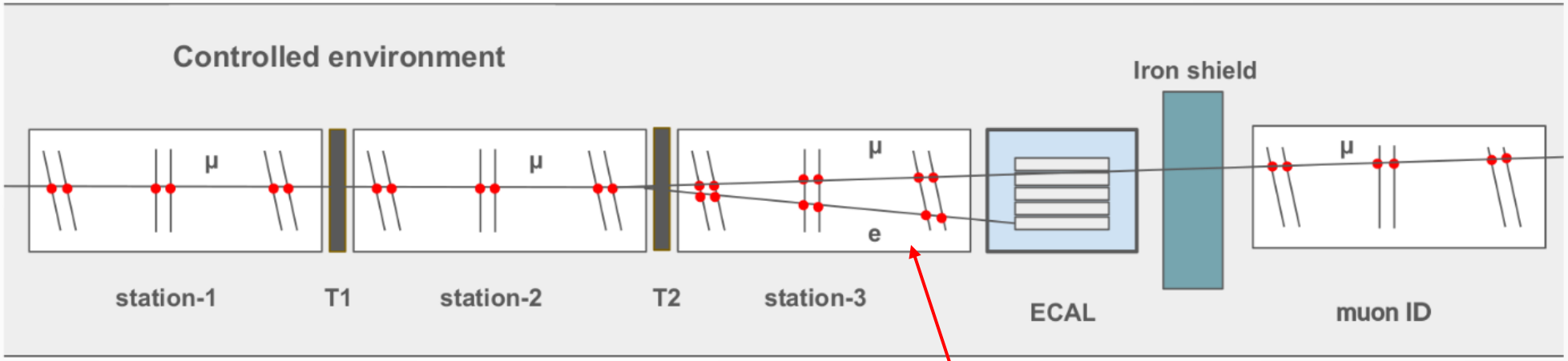

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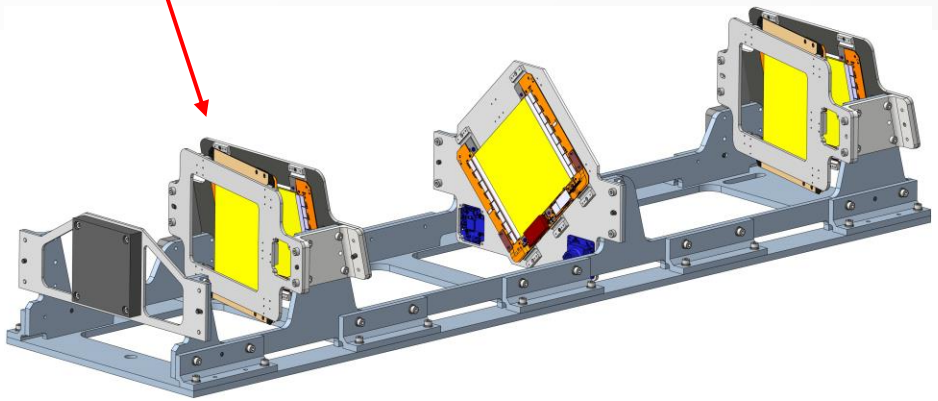

1 station is made of six 2S modules

My work within the MUonE collaboration

- **Tracker integration,** in preparation of the 2025 run

- **Software Development:**
  - Implementation of 2S geometry into the G4 simulation
  - Detector alignment
  - Tracking tools (Kalman Filter)

- **(new) Software Mangement:**
  - Fixing bug
  - Review and merge code ro the master version of the software
  - …

Tracker integration

For the 2025 run

Tracker integration - 2S modules

- Assemble and cable tracker onto the station
- Test power, triggers, DAQ …
- Pedestal, noise, occupancy scans

ready for beam commissioning as one coherent detector

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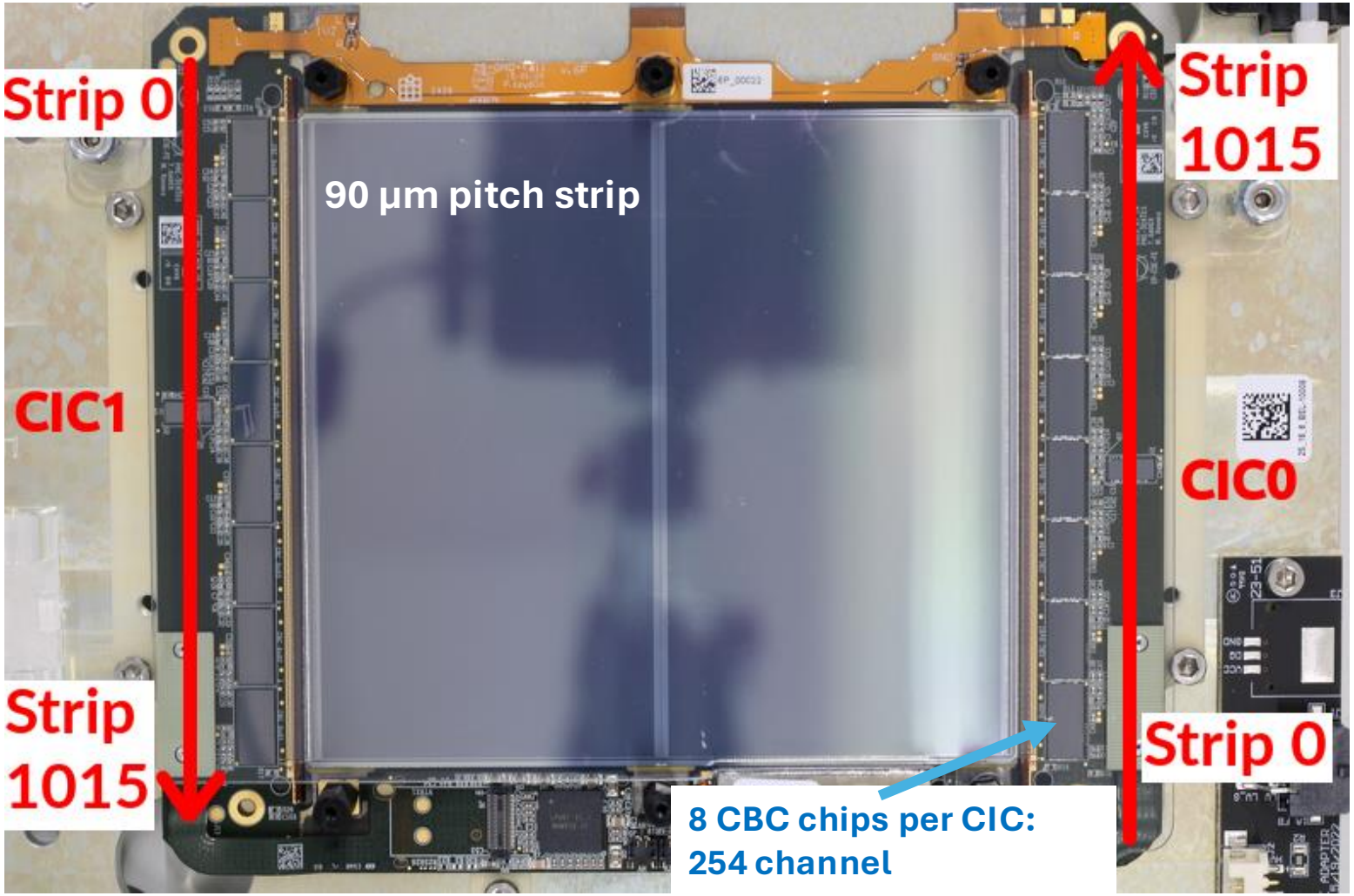

2S modules description:

- 2 close-by Silicon strip sensors with the same orientation
- 2 × 320µm thick sensors
- Gap = 1.8mm
- Total area: 10cm × 10cm
- 2 CIC → 8 CBC each → 254 strips

Tracker integration

Pedestal and noise scan:

- Disable zero-suppression and triggers
- Collect N = 10 000 random events at each threshold setting VC_{th} (1% statistical error)
- Compute the occupancy as function of VC_{th}

Tracker integration – Pedestal and noise scan

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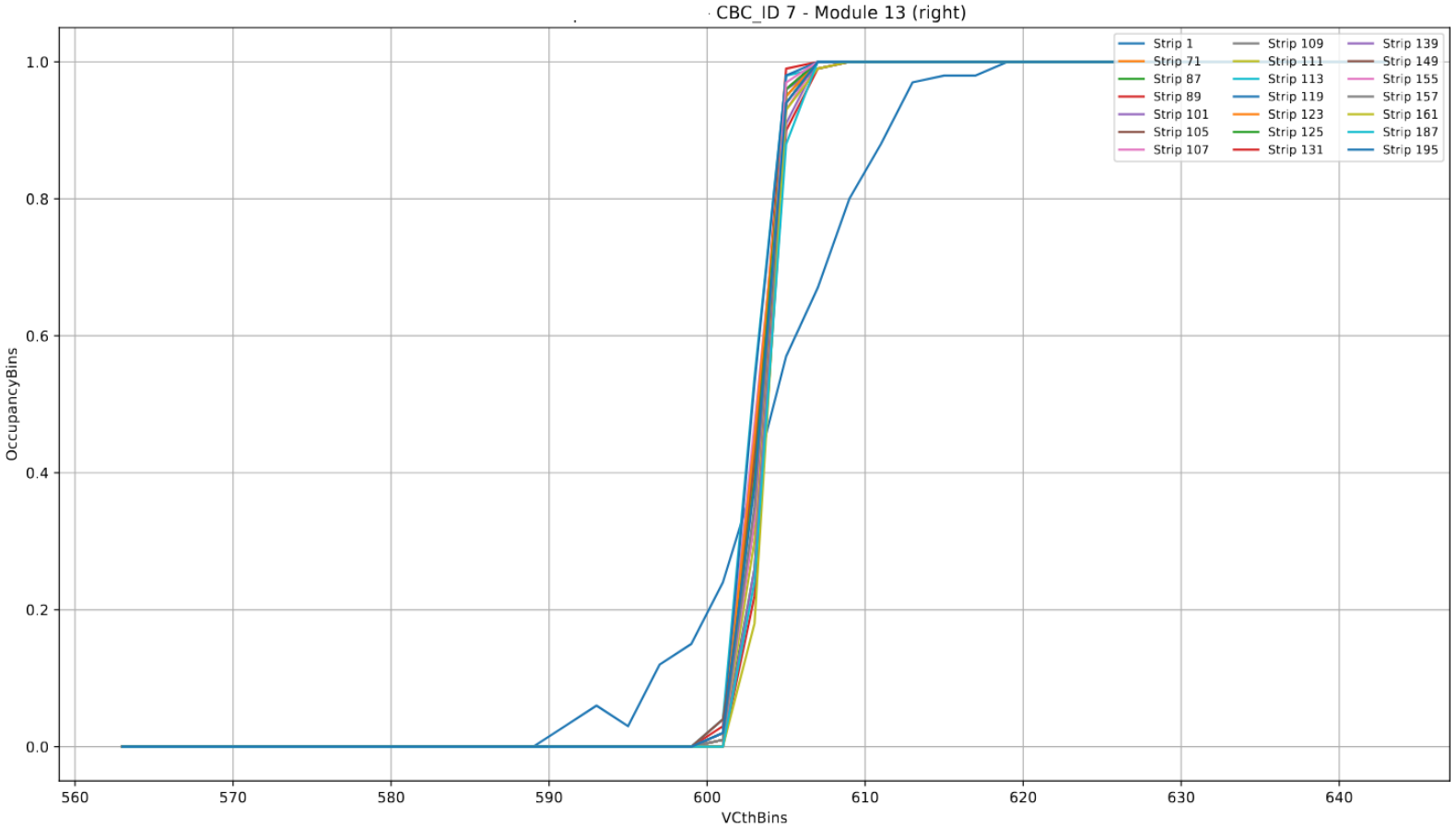
S curve



Pedestal (μ) = $V_{Cth}(50\%)$

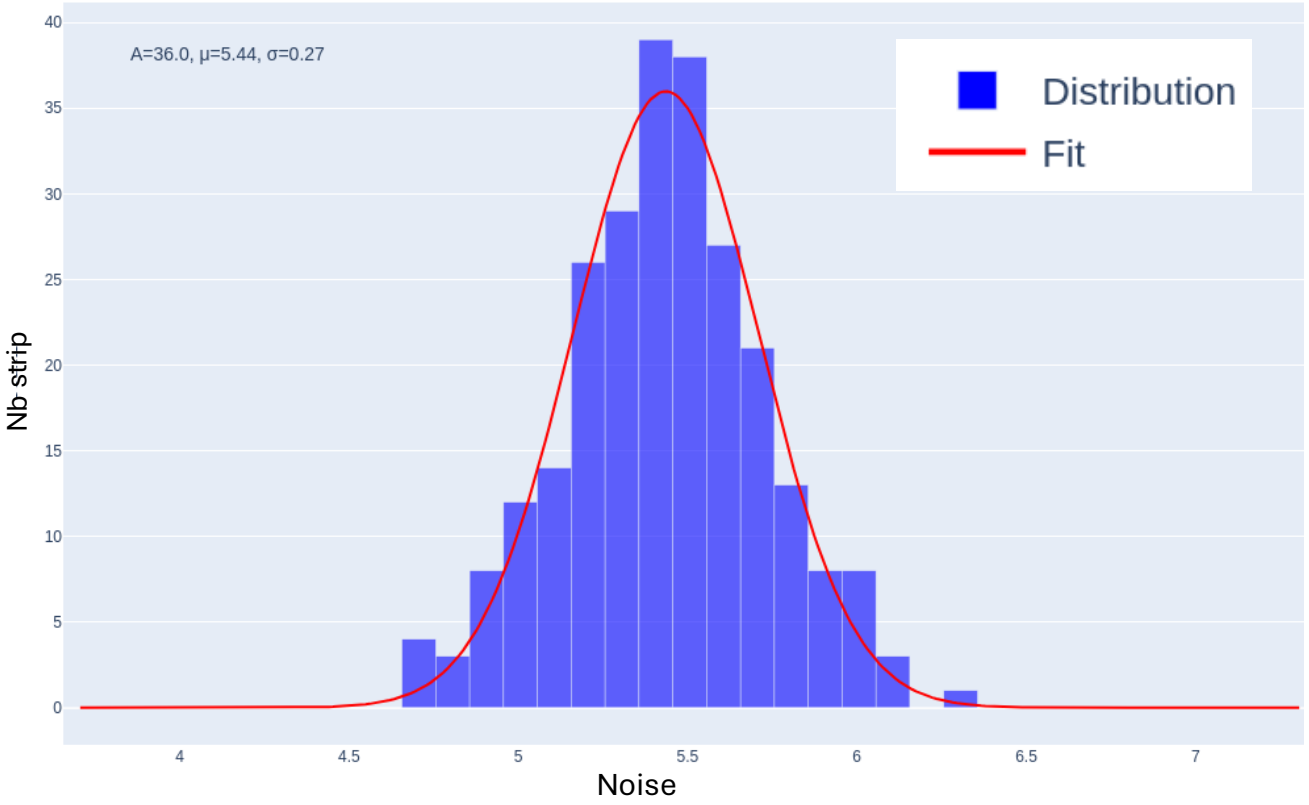
Noise (σ) = $\frac{1}{2}[V_{Cth}(84\%) - V_{Cth}(16\%)]$

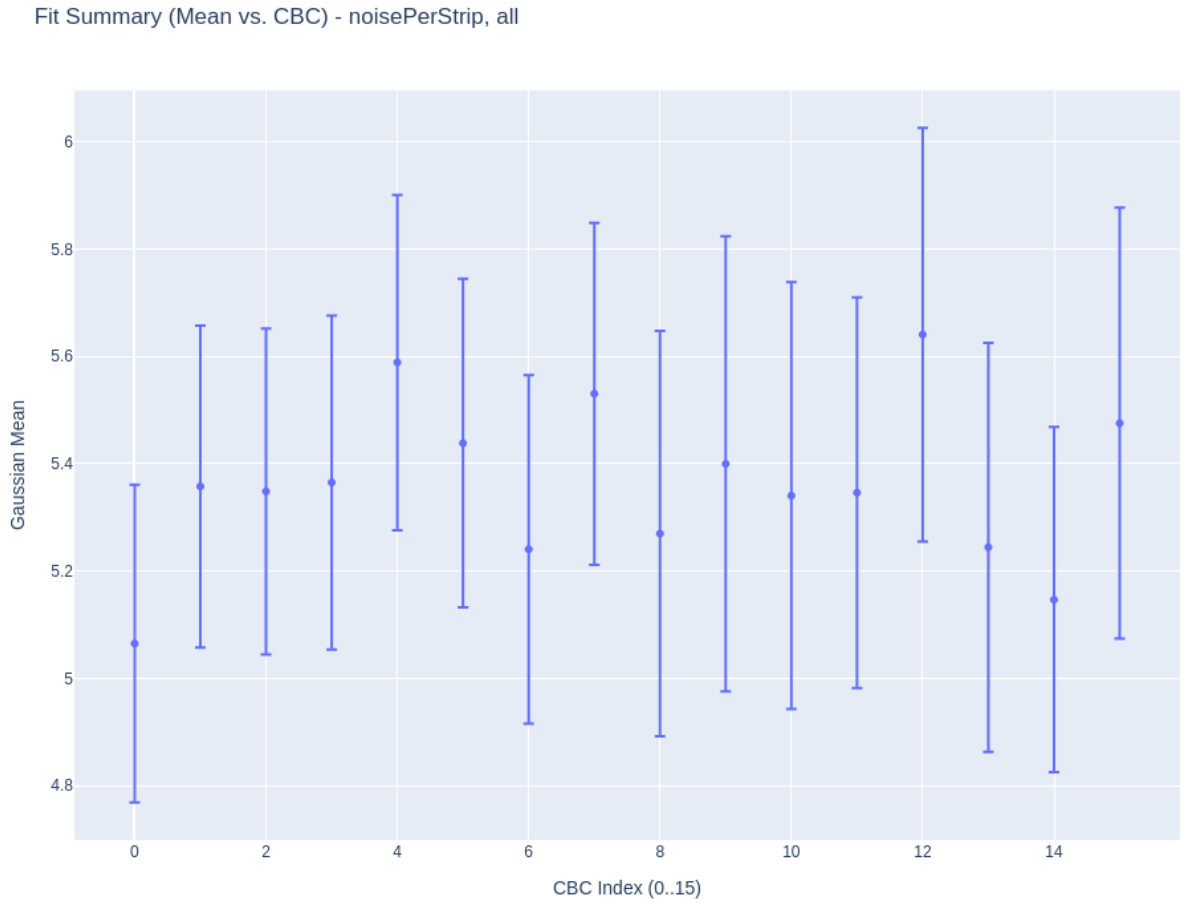
Tracker integration – masking bad strip

Map bad strip:

- For each CBC we plot the distribution of the noises per strip and fit with a gaussian
- We mask strip that are not in the range of the fit above 3 sigma

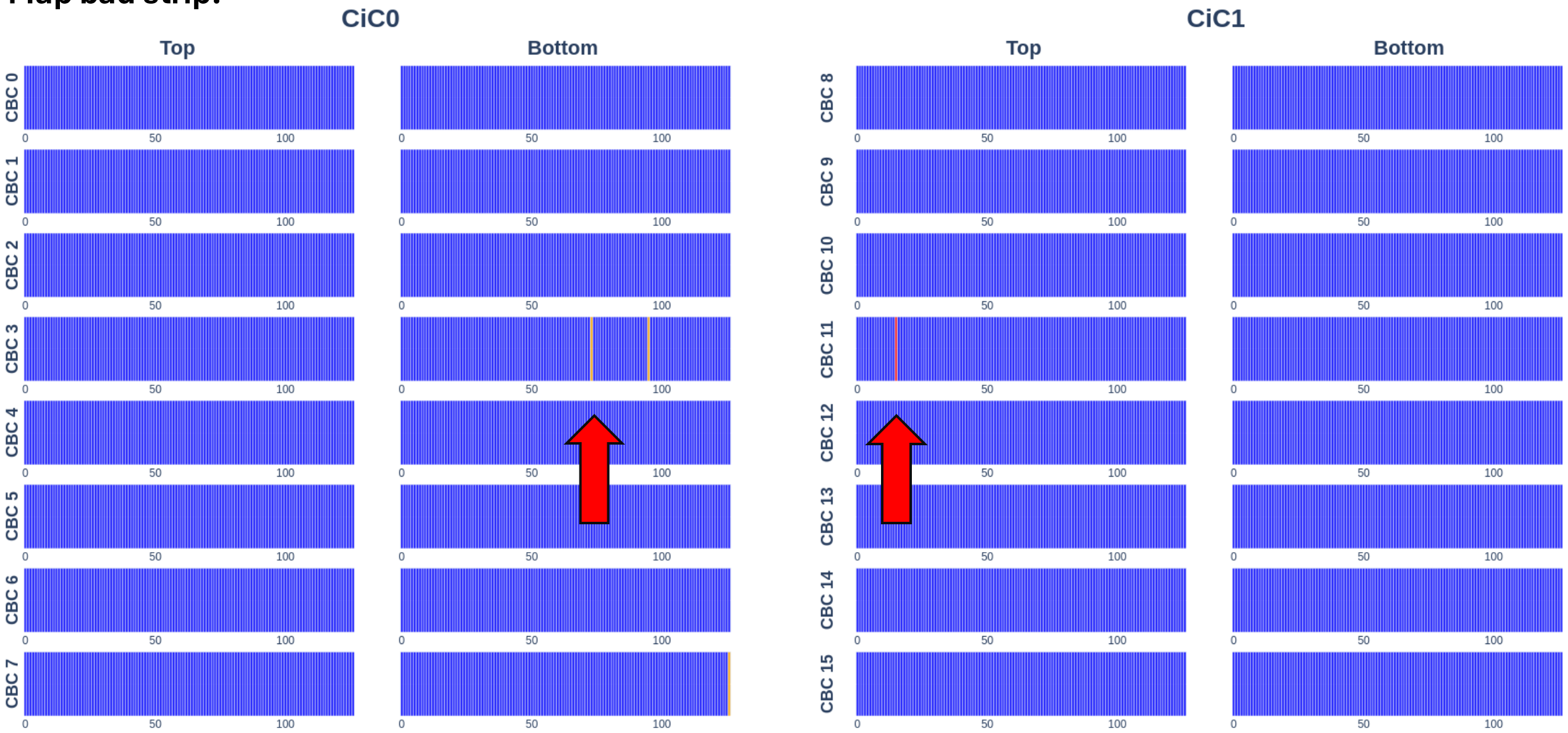
Noise scan – CIC0 - CBC5





Tracker integration – map strip quality

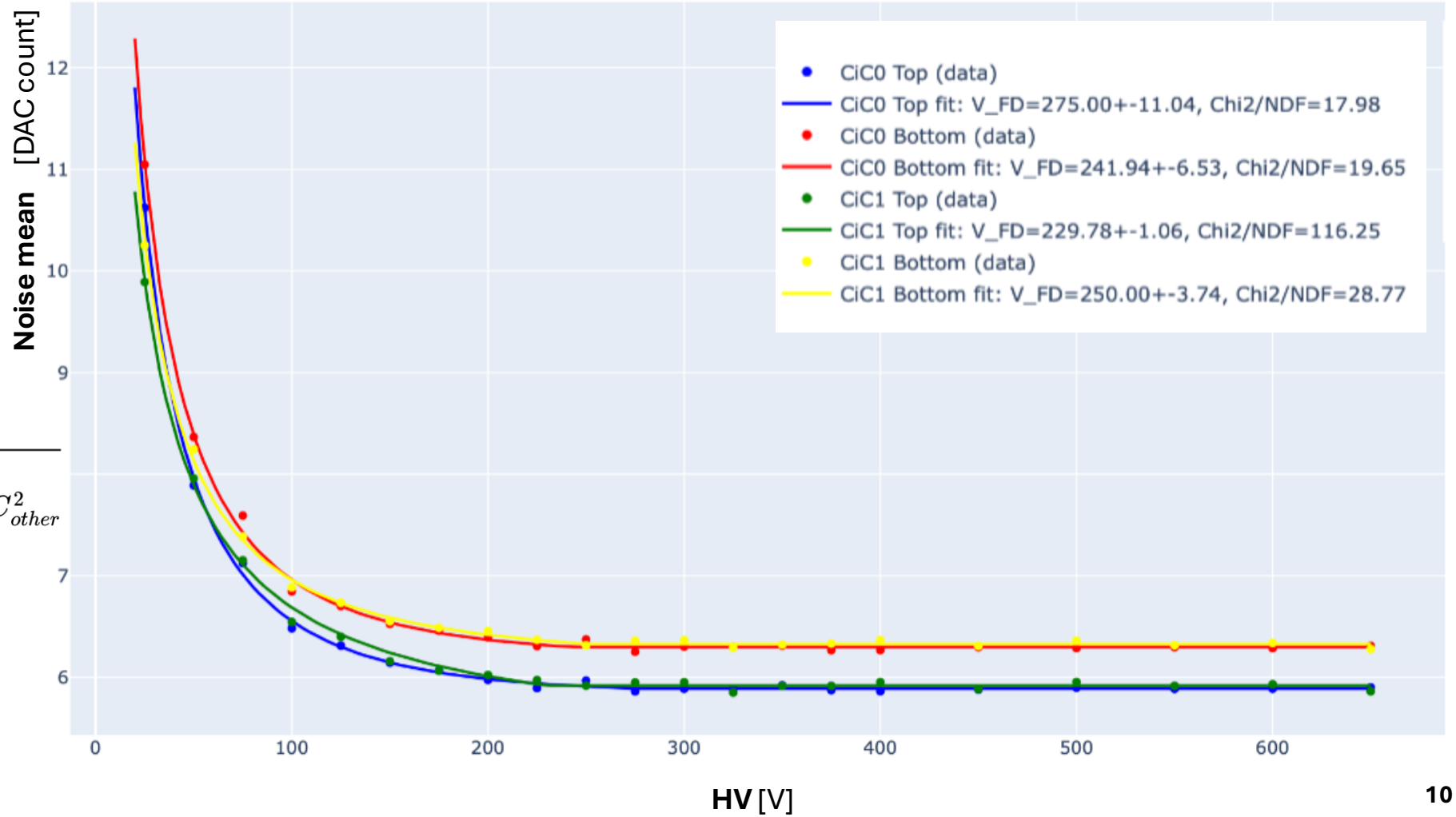
Map bad strip: Legend: dead noisy good



Tracker integration – depletion voltage

HV bias scan

- Estimate depletion voltage for each sensor (V_{FD})
- Noise measurement vs High Voltage



Fit with:

$$N(V) = \sqrt{\left(a + \frac{b}{\sqrt{min(V, V_{\mathrm{FD}})}}\right)^2 + ENC^2_{other}}$$

Tracker integration - conclusion

Some other tests have been performed (but I am short in time) : common noise, noisy strip vs HV etc…

18 modules have been tested (3 station), we have chosen the nicer and they are already installed on the beamline for commissioning

I am/will be involved in:

- Re perform some routine above on the beamline site
- Timing synchronization of all tracker (DLL)
- Efficiency and resolution vs threshold study
- …

Thanks