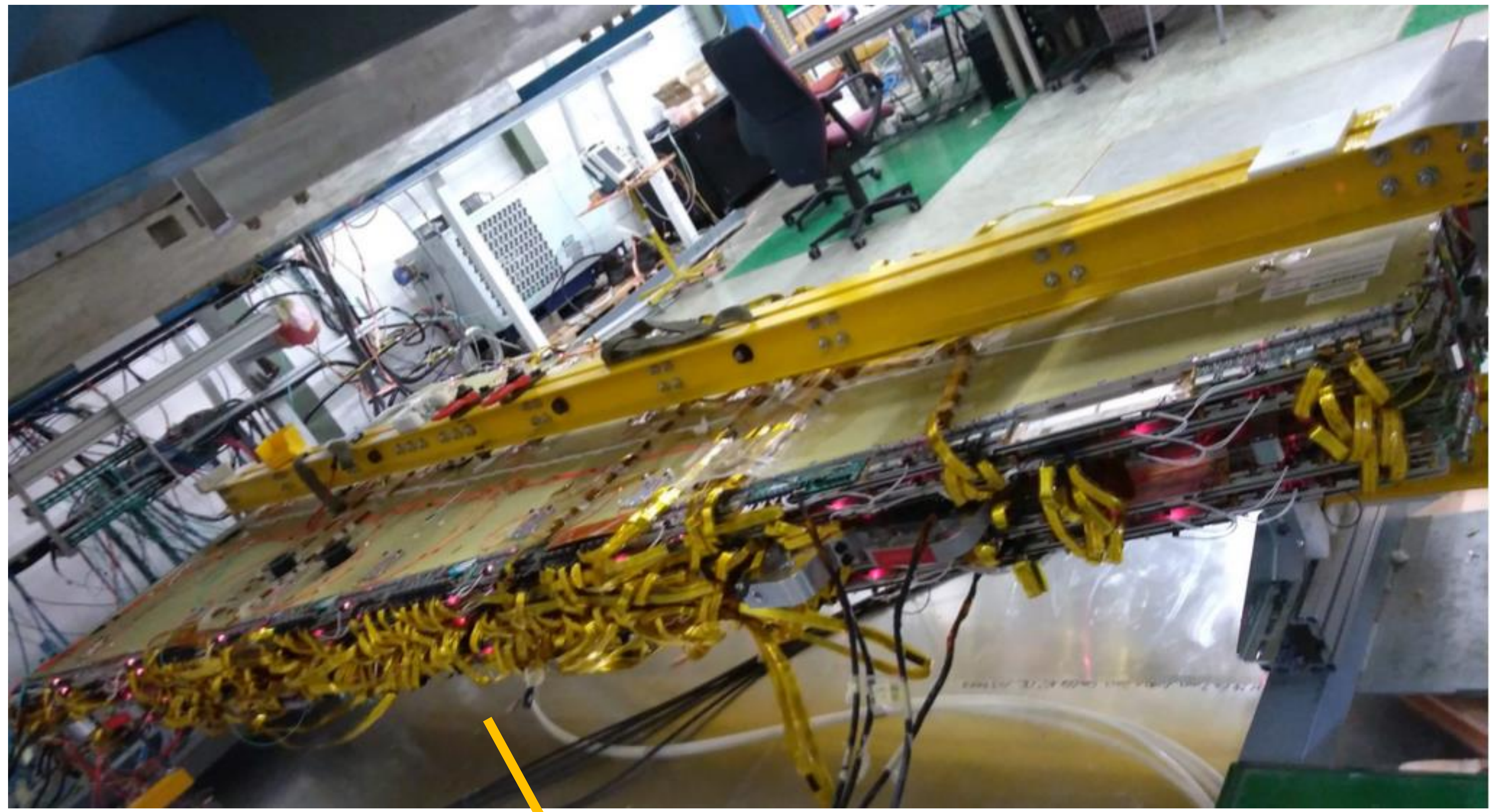
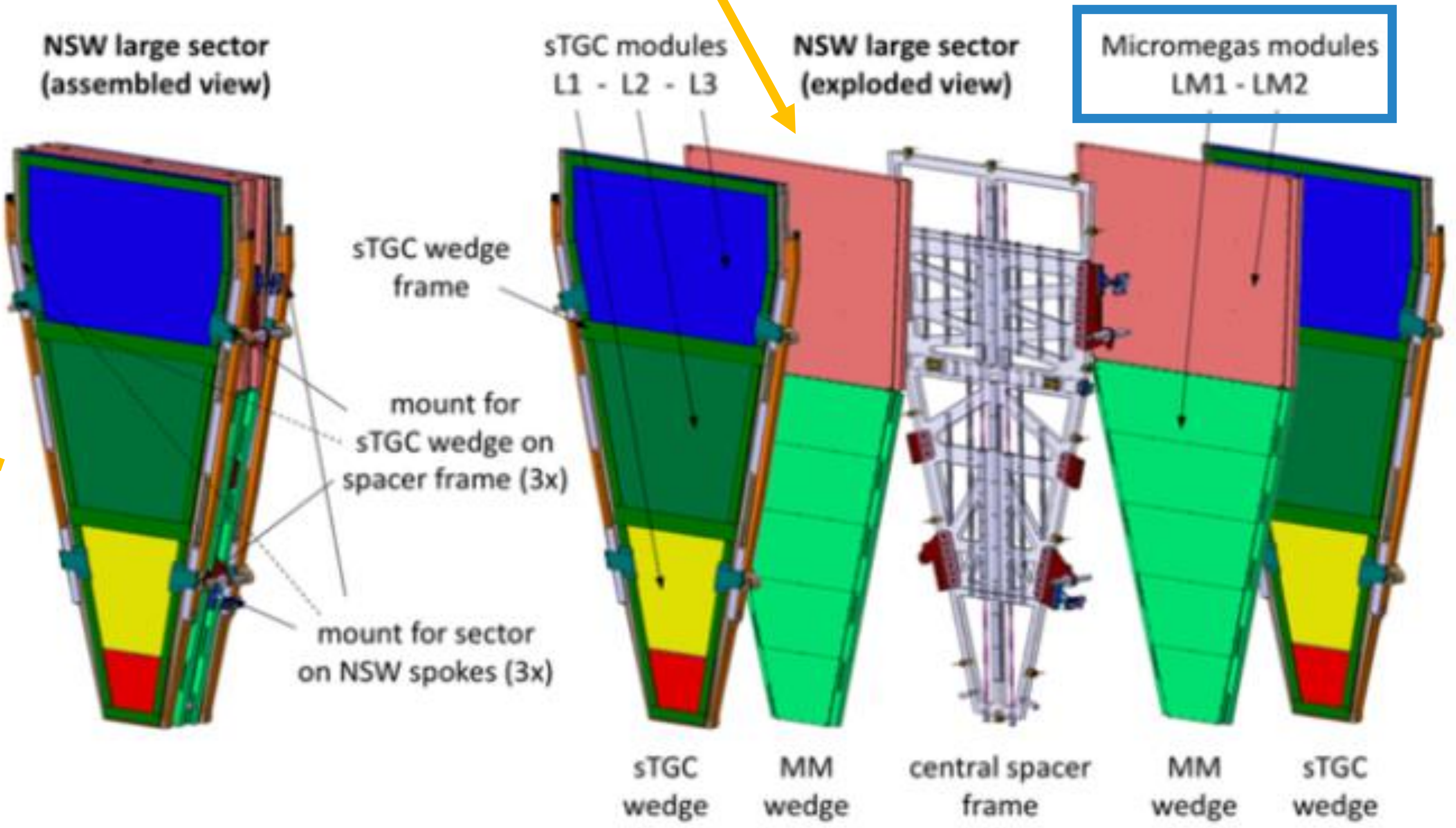
STUDIES ON READOUT CHANNEL THRESHOLDS OF RESISTIVE MICROMEGAS FOR ATLAS MUON SPECTROMETER





M.T. CAMERLINGO ON BEHALF OF ATLAS MUON COLLABORATION FOR THE 9TH ANNUAL LARGE HADRON COLLIDER PHYSICS (LHCP2021) CONFERENCE

The inner parts of the end-caps of ATLAS Muon Spectrometer (Fig. 1) will be replaced with new detector structures, called New Small Wheels (NSW). They are equipped by a combination of small-strip Thin Gap Chambers (sTGC) and resistive Micromegas (MM) detectors (Fig. 2).

The MM readout channels are 8192 floating **copper strips** with different lengths, from 284.0 mm to 1990.0 mm (capacitively coupled with **carbon strips** at few hundreds V), read by VMM ASIC FE electronics .

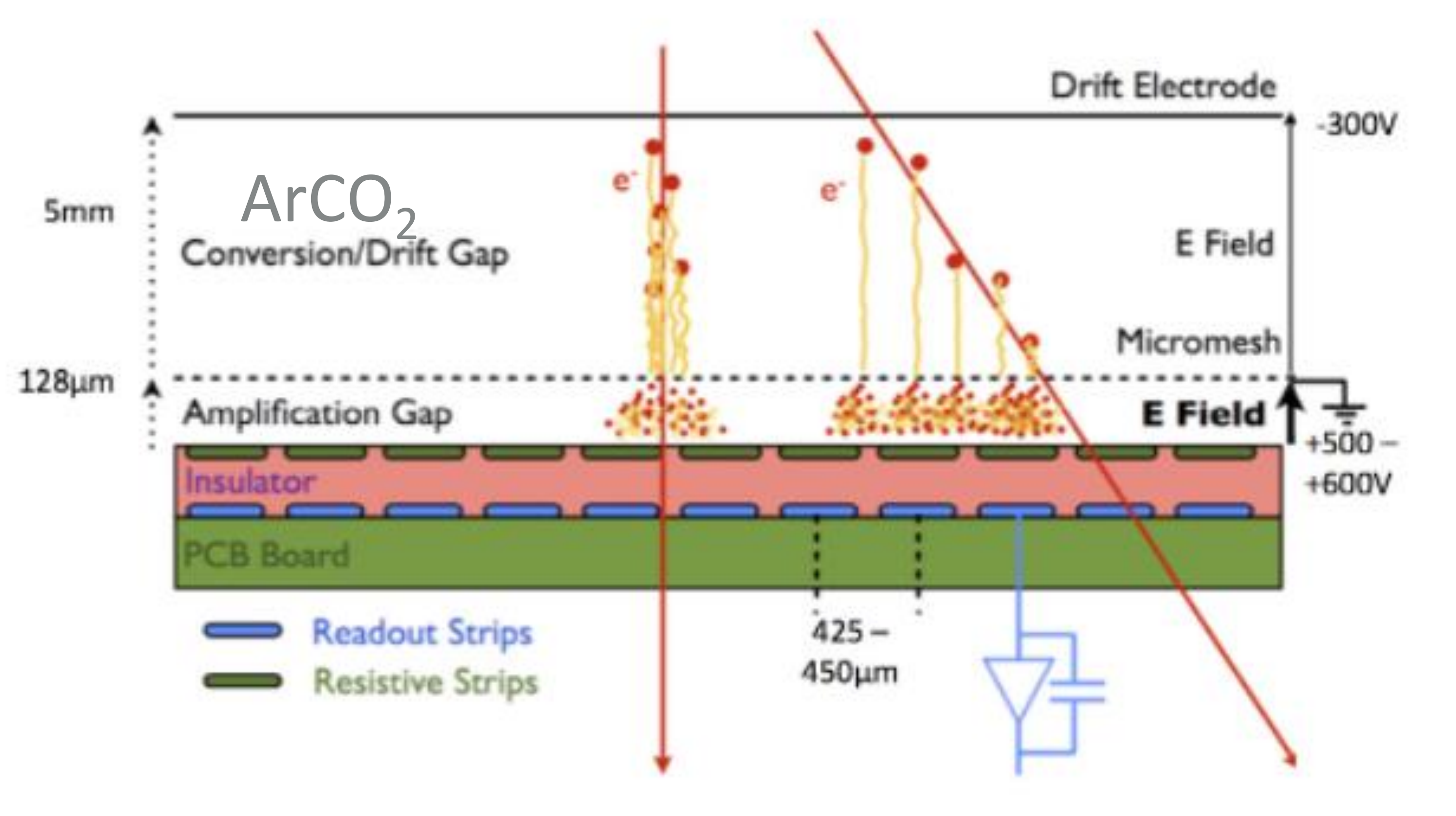
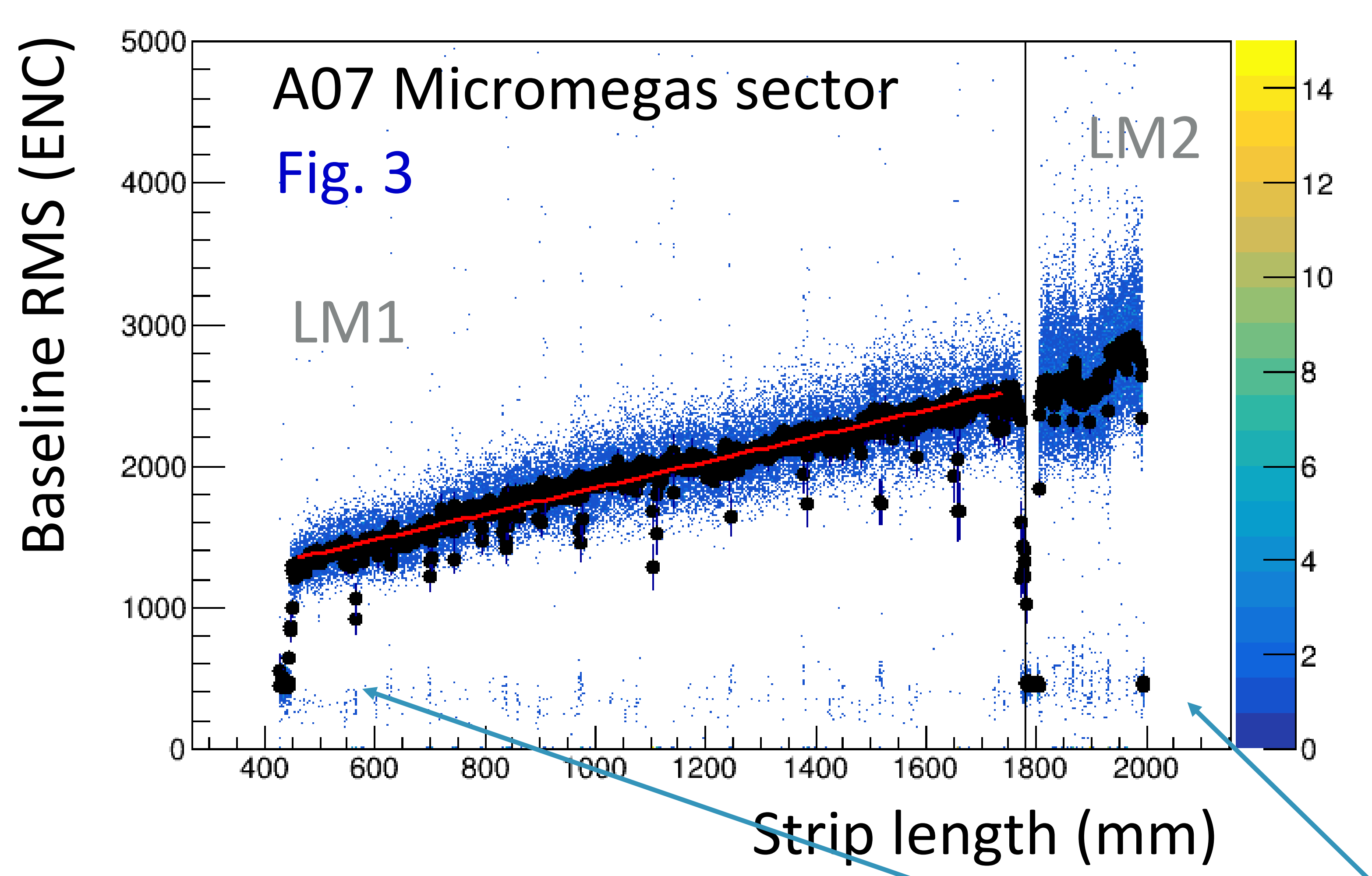
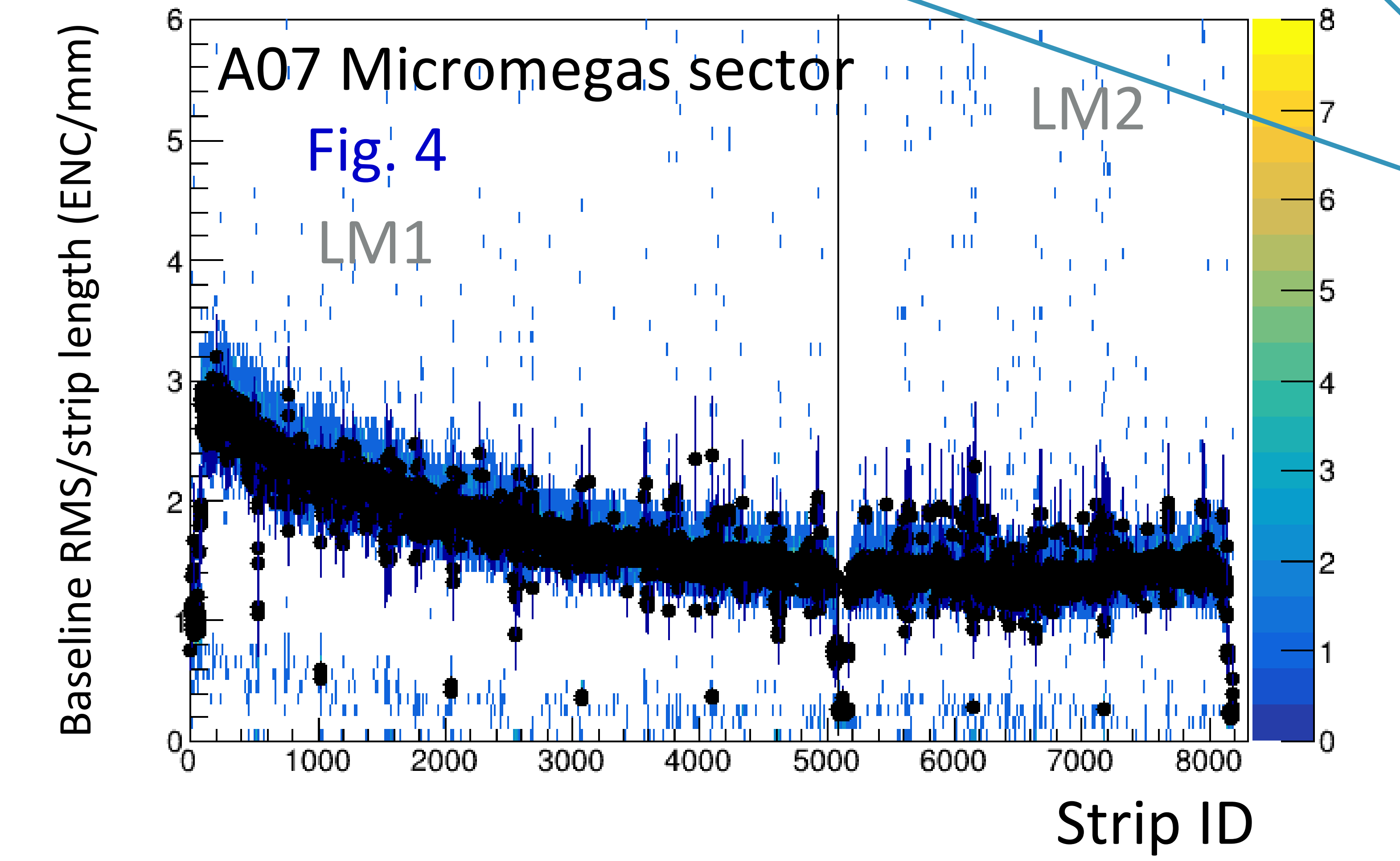


Fig. 2: Sketch of a resistive MM independent Layer

Fig. 3 Baseline RMS of each readout channel of A07 Micromegas sector as a function of strip length (blue markers). Black dots point the mean Baseline RMS of the strips with same length. **Fig. 4** Baseline RMS/strip length of each readout channel of A07 Micromegas sector as a function of Layer strip ID (blue markers). Black dots point the mean ratio of the strips with same strip ID in the different tracking layers.

Baseline RMS has a dependence on the strip length (Fig. 3). For the shortest connected strips, it deviates from the linear trend, expected in the approximation of microstrip as ideal parallel capacitor (Fig. 4).





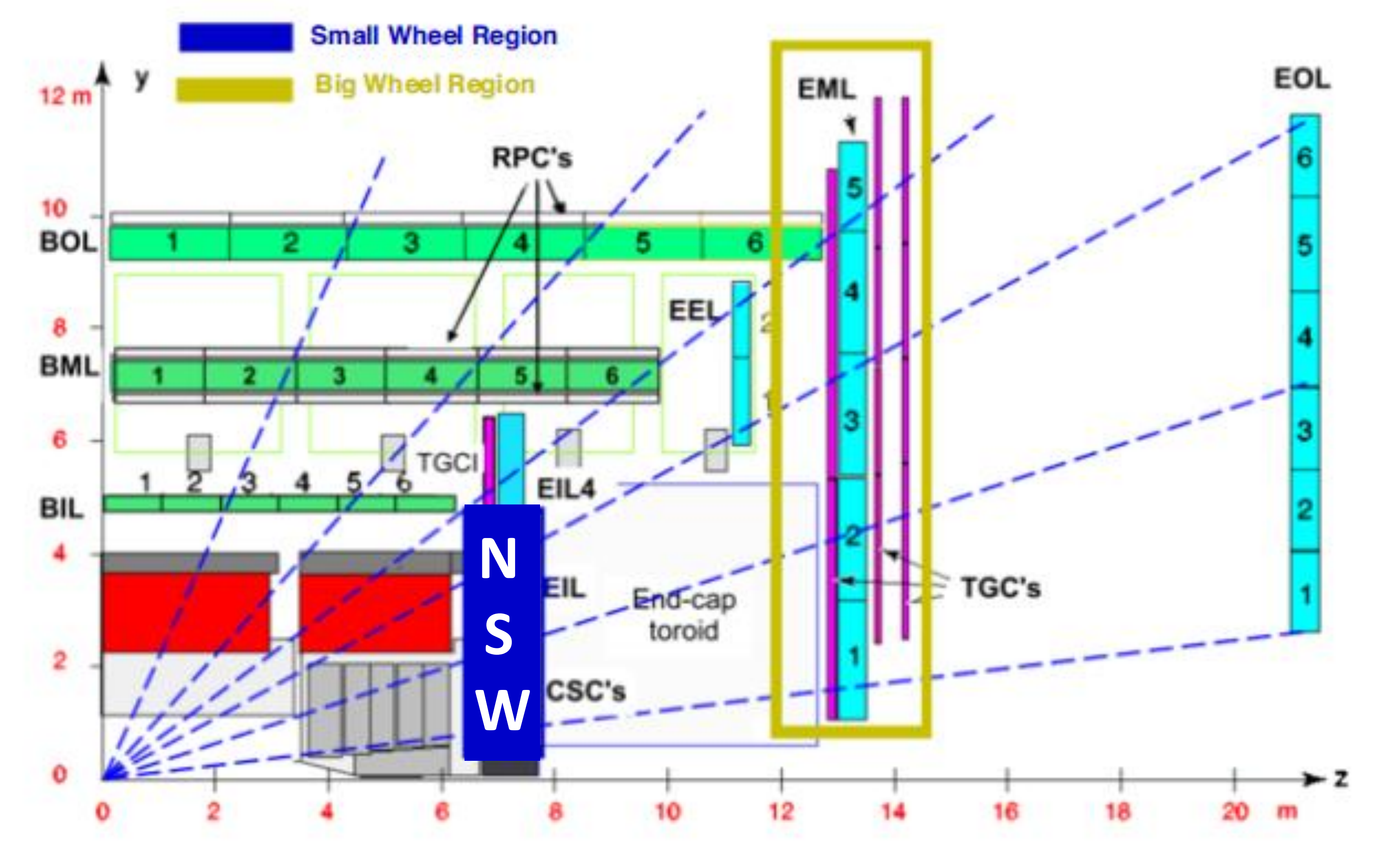


Fig. 1: A quarter z-y view of ATLAS apparatus. In evidence, the three stations of MS in the forward region: the End-cap Inner Large (EIL) in which will be inserted the new detectors, End-cap Middle Large (EML) and End-cap Outer Large (EOL).

By design, some disconnected strips at the edges of modules

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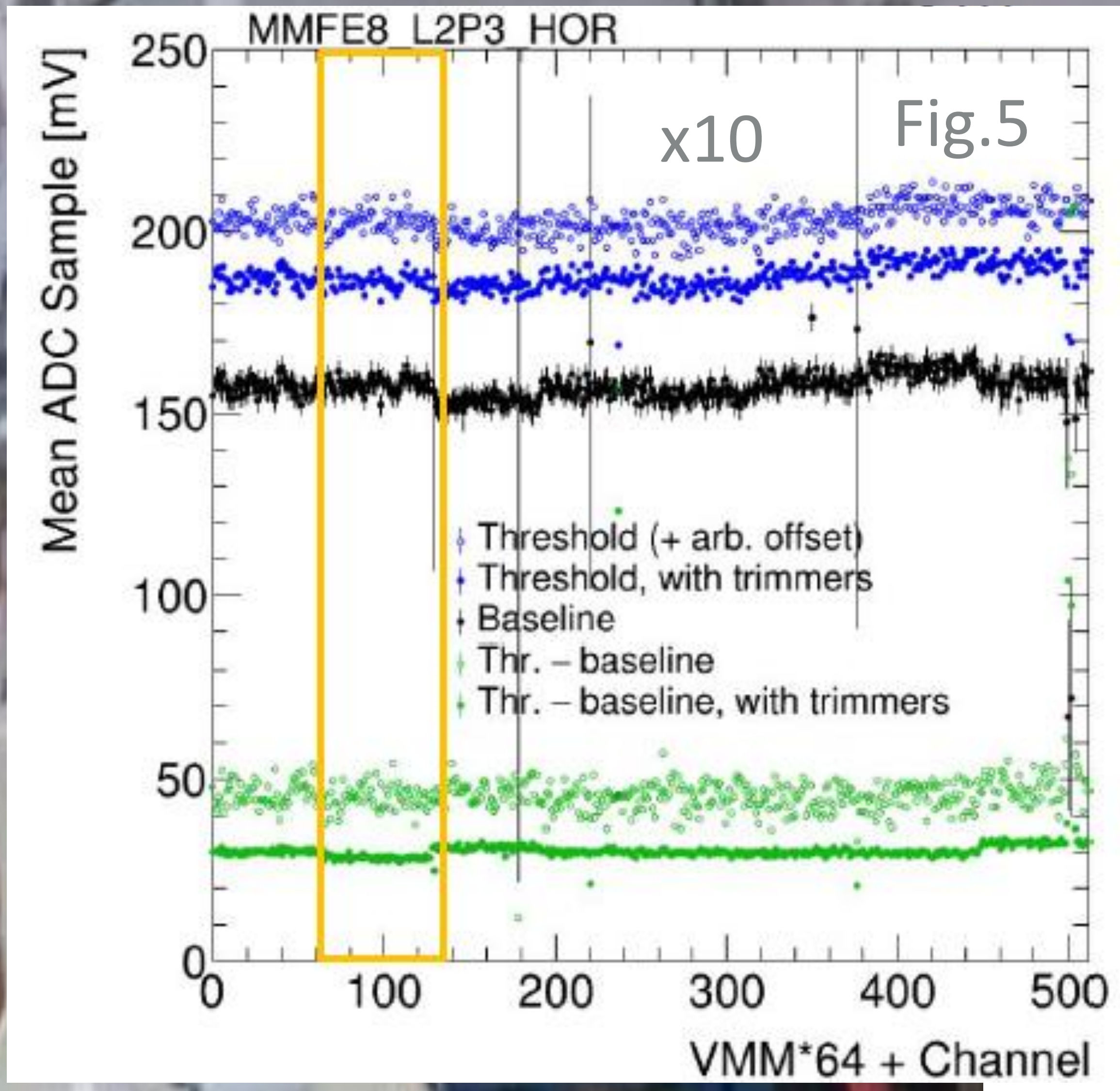


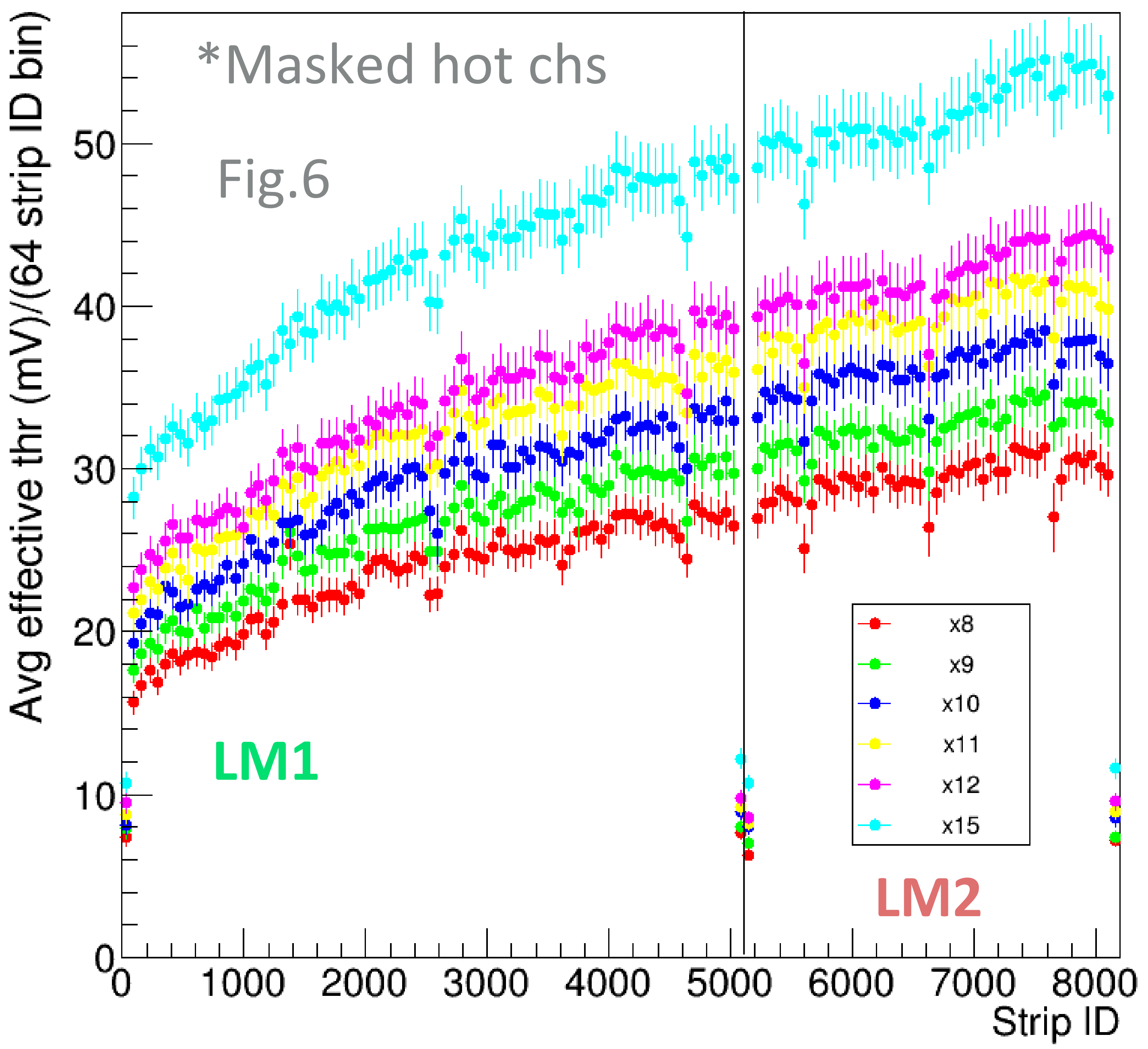
To uniform the **effective threshold** (difference between absolute threshold and baseline in Fig. 5), the absolute threshold is evaluated at VMM-level according to the Eq. 1 + a trimmer can decrease the single channel threshold in a [0, 30] mV range reducing the threshold spread

$$\text{VMM-level threshold} = N \times RMS_{\text{VMM-baseline}} + \text{median}_{\text{VMM-baseline}} \quad \textbf{Eq. 1}$$

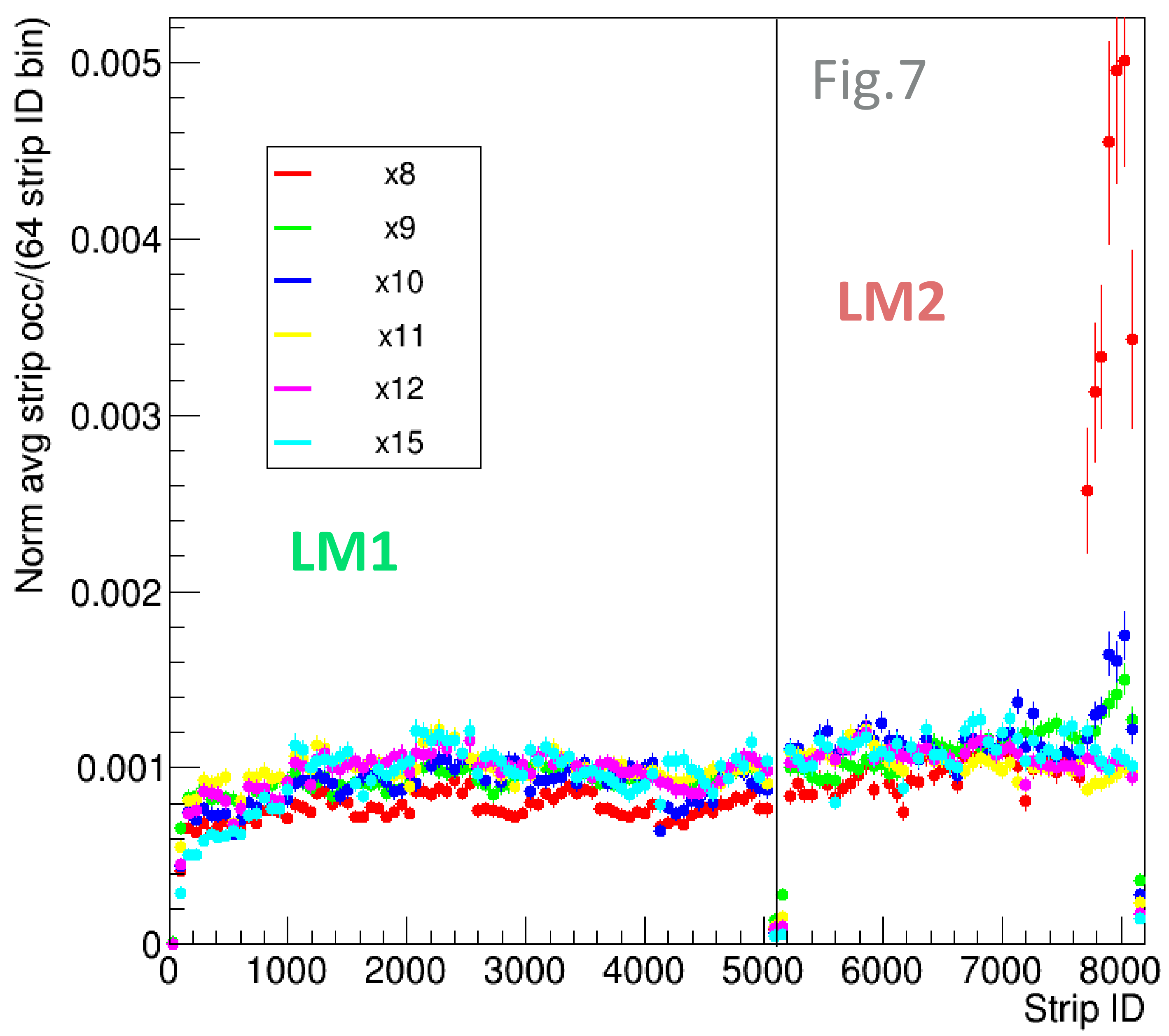
During the characterization study, the N factor was varied {8, 9, 10,11,12,15} to investigate the detector performances when a larger threshold is applied respect to the actual nominal factor x9 to manage possible noise variation after the integration and switching on of the full wheel.

Between the factors x9 and x12, the avg effective threshold increases of ~10 mV (Fig. 6).

Avg threshold among layers at VMM-level



Avg Occupancy (after masking) among layers



From the avg strip occupancy (Fig. 7), it is visible that x9 is the min applicable factor to have an acceptable uniformity of the occupancy on the plane. From x15, starting loss of events on the shortest strips.

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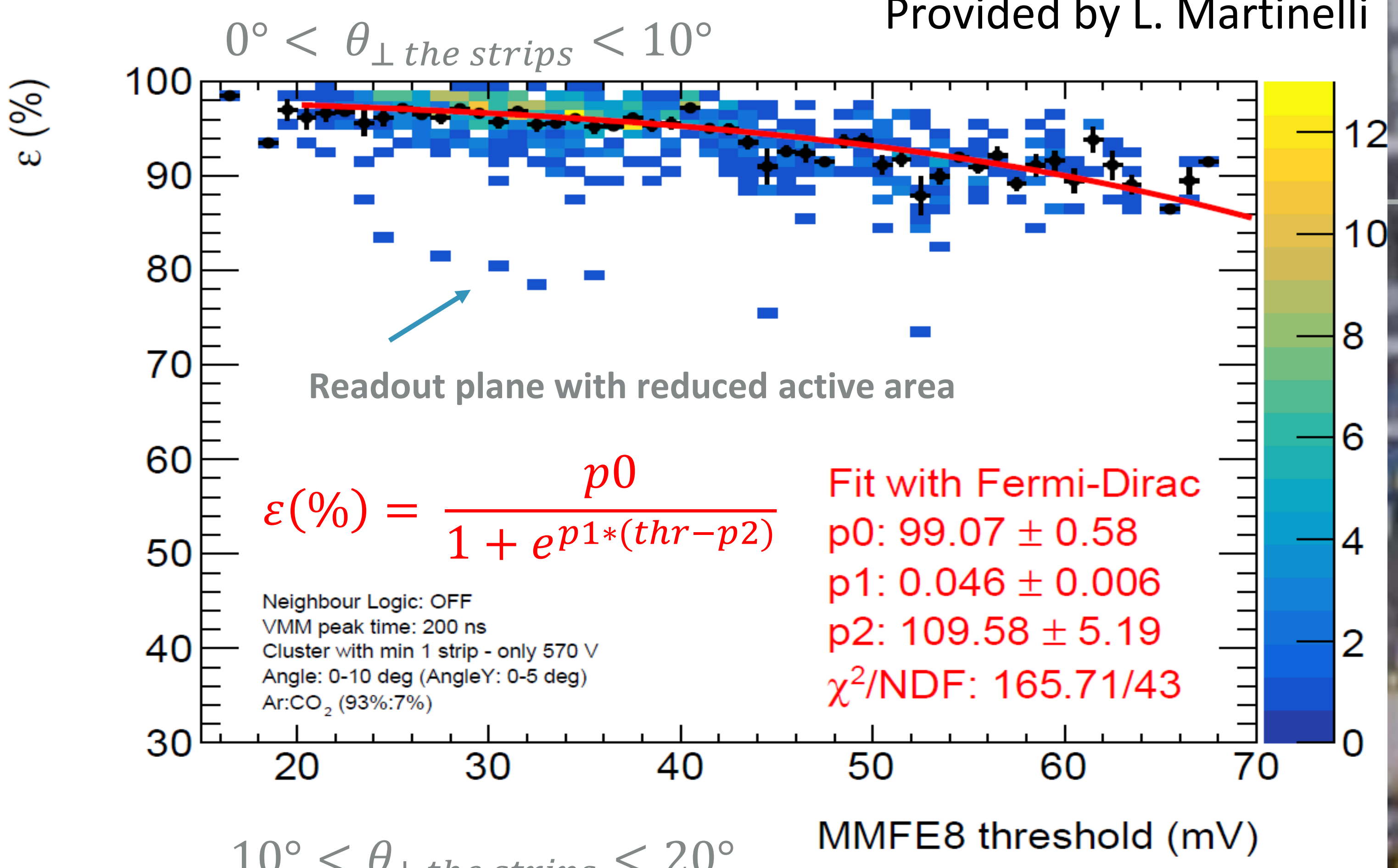
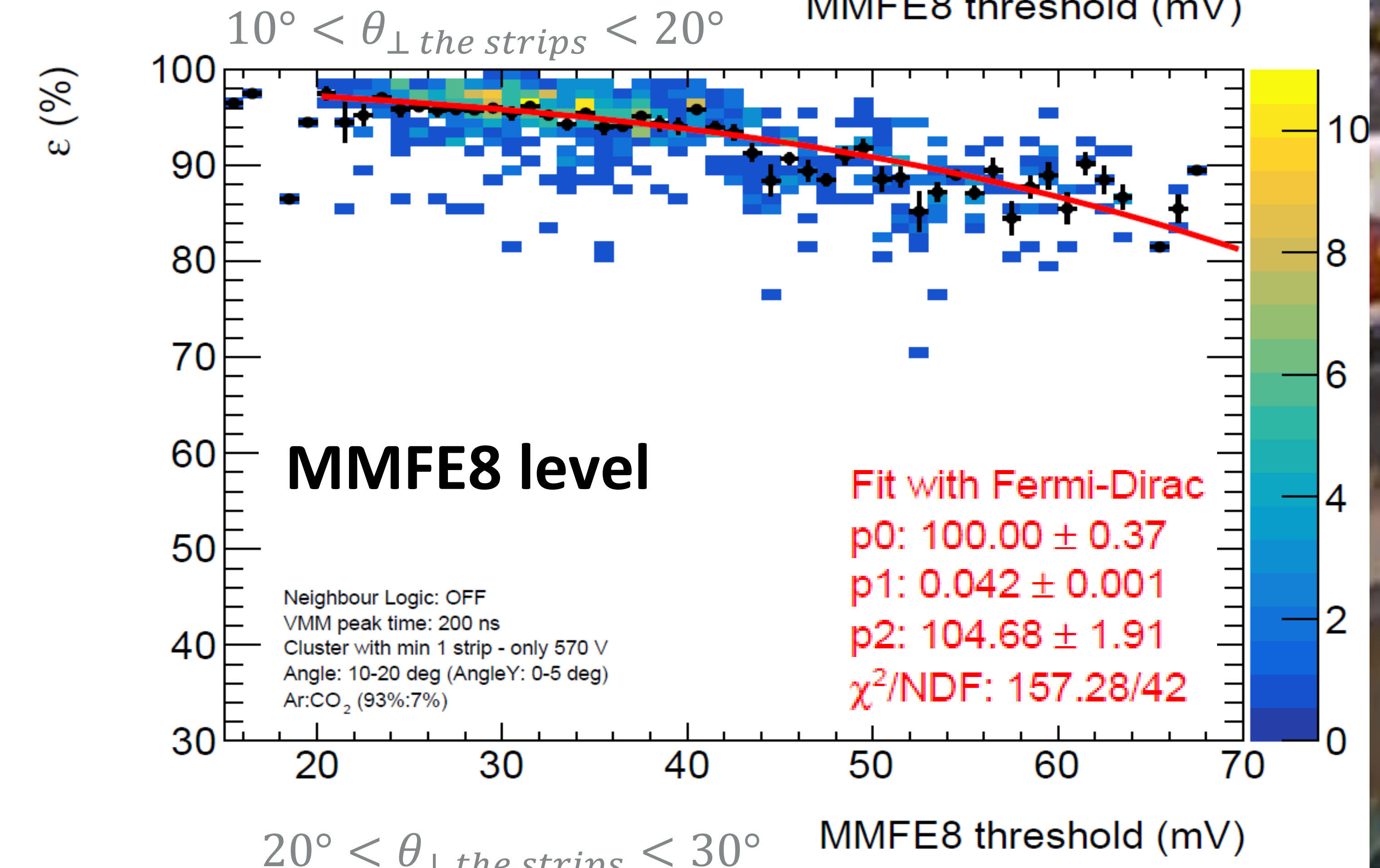
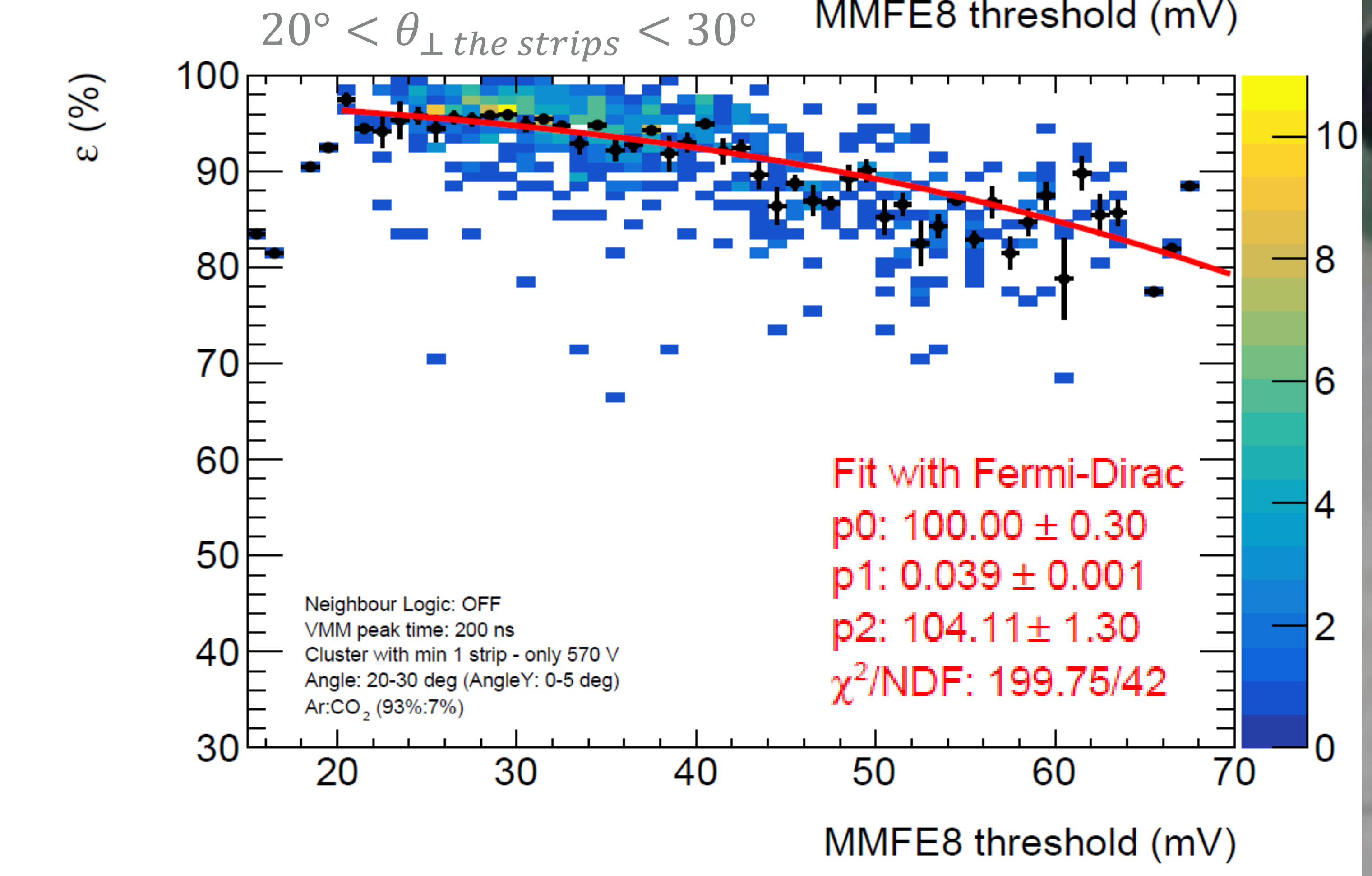
Provided by L. Martinelli





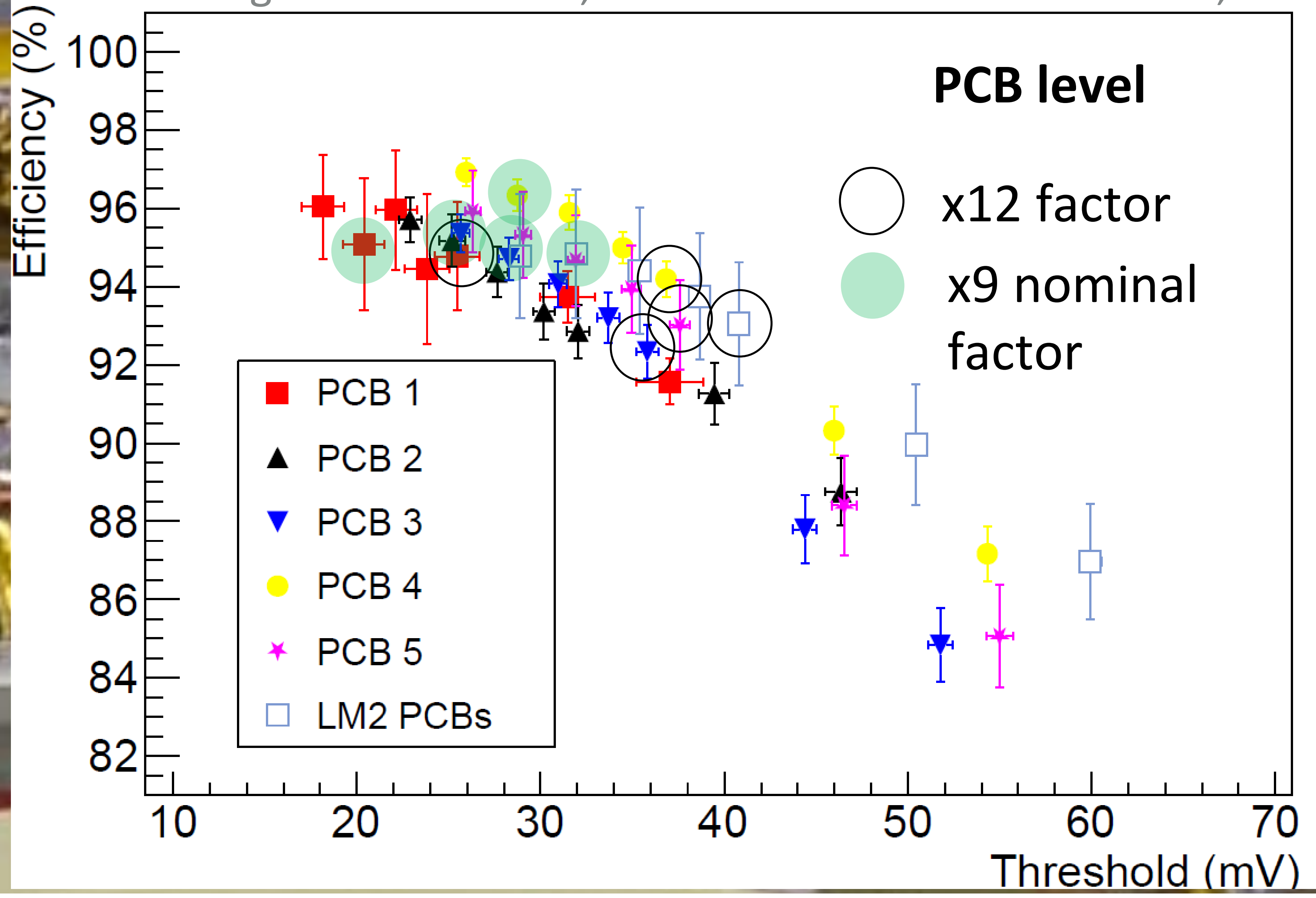


TRACKING EFFICIENCY AS FUNCTION OF EFFECTIVE THRESHOLD

Tracking requirements on least 5 layers with a cluster with:
no restriction on cluster multiplicity;
0.4 fC as min strip charge (1.2 fC as min strip charge for the strip with max charge);
Max number of cluster in an event < 30; Max number of cluster in a layer < 10

The study was performed at different average level (VMM = 64 strips, MMFE8 = 8 VMM, PCB = 2 MMFE8). Here, a summary of the results are reported for the **HV sector at the nominal 570 V amplification voltage in Ar-C0$_2$(93%:7%)** as gas mixture.
The results at MMFE8 level in restricted angular ranges (in Left Figg.) and at PCB level (in Right Fig.) are reported here, efficiency does not significantly decrease up to 40 mV as effective thresholds and it is still greater than 80% up to 60 mV.

No angular restrictions, there are results relative to x18, too



CONCLUSIONS:
No significant occupancy and efficiency losses were observed increasing the thresholds of ~10 mV respect to the nominal values. Specifically, the average PCB efficiency drop at the nominal amplification voltage is around 2% from the x9 nominal factor to x12 factor.

ACKNOWLEDGES: T. Alexopoulos, F. Anulli, P. Iengo and L. Martinelli

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