



Muon Forward Tracker

commissioning



as a part of **ALICE** upgrade

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Bílý potok
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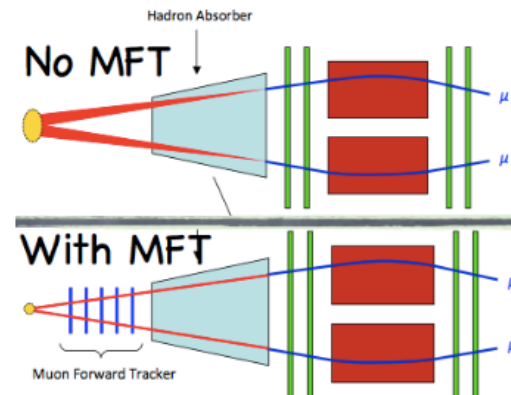
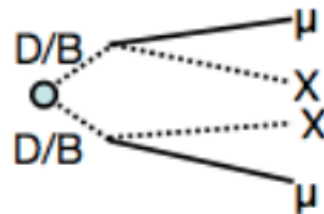
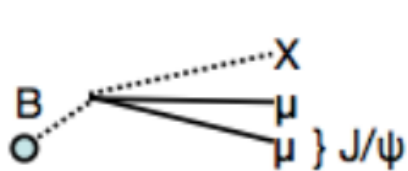
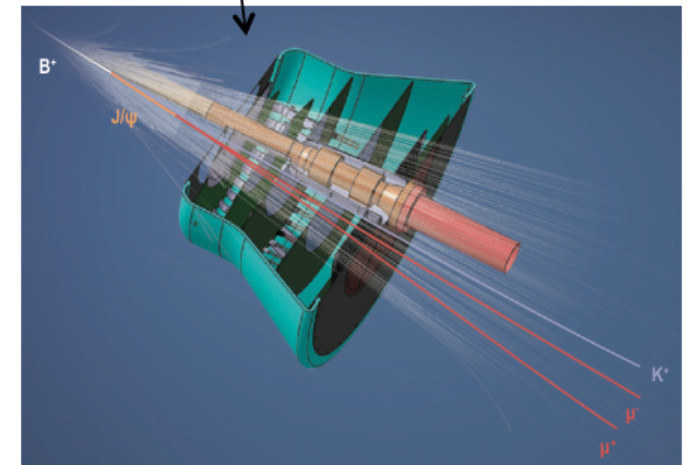
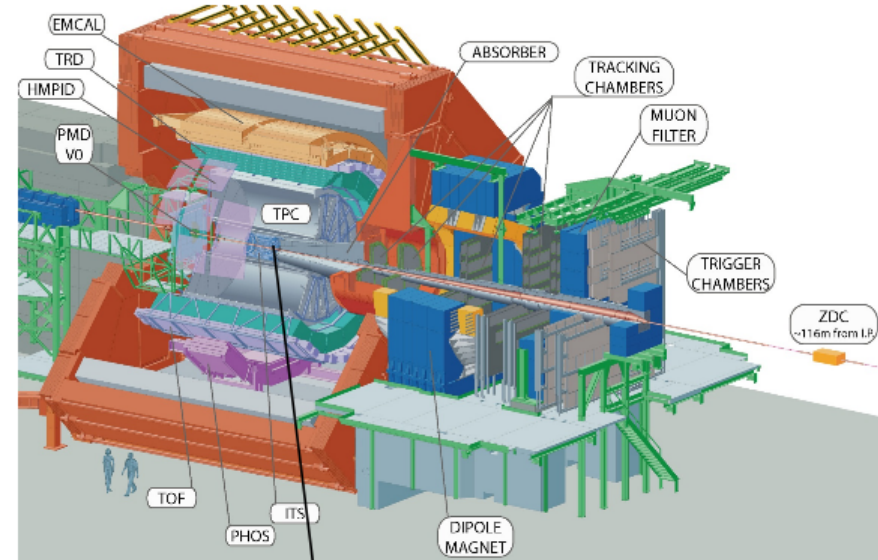


Outline

- MFT layout
- Qualification tests
- Statistics
- Plans for commissioning

Why MFT?

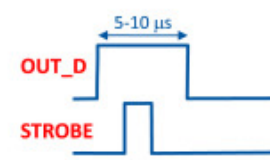
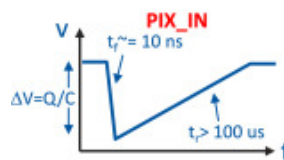
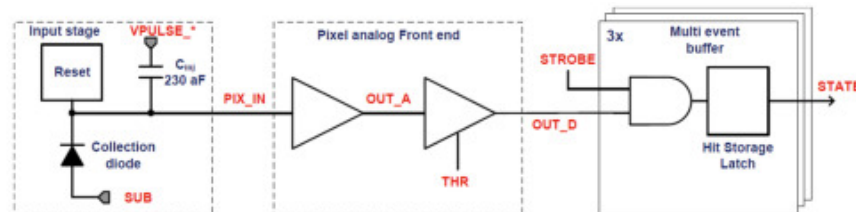
- new Si-tracking detector designed to add vertexing capabilities to the MUON spectrometer
- will allow ALICE to extend the precision measurements of the QGP fundamental properties towards the forward rapidity region
- heavy flavour vertices also at forward rapidity
- enables separation of beauty decay vertices



MFT layout

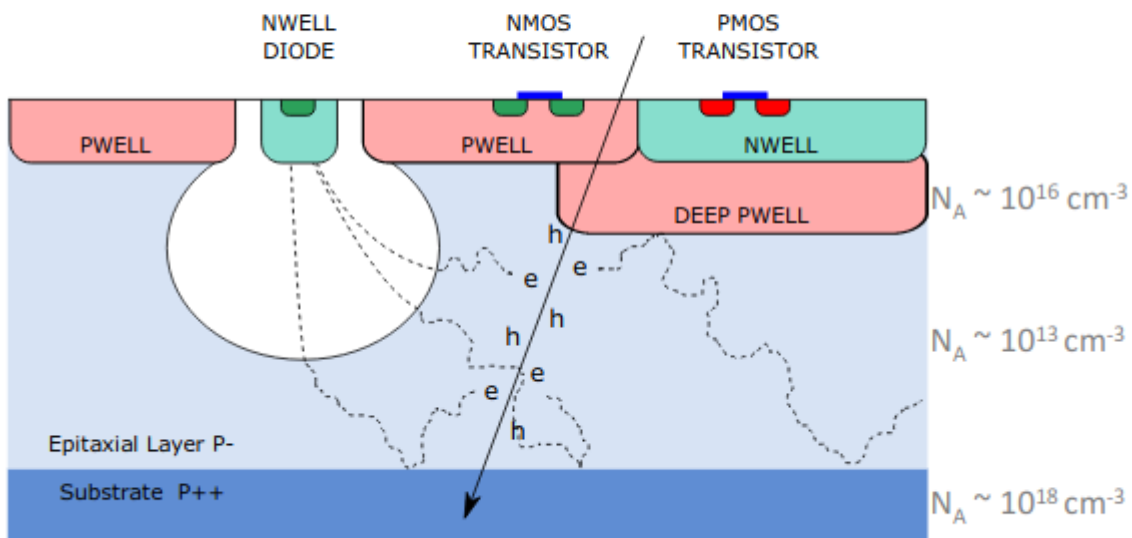
512x1024 pixels, 30x15mm²

- **ALPIDE chips** → ladders → half-disks → half-cones → muon forward tracker

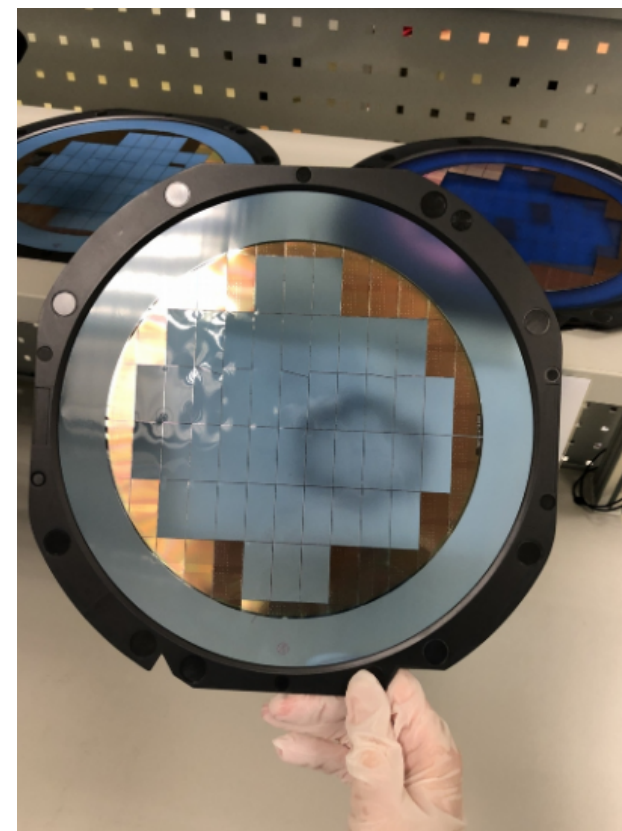


Pixel Sensor CMOS 180 nm Imaging Process (TowerJazz)

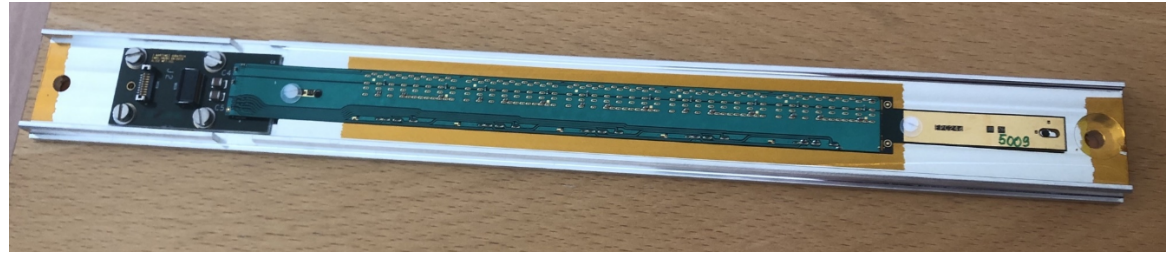
3 nm thin gate oxide, 6 metal layers



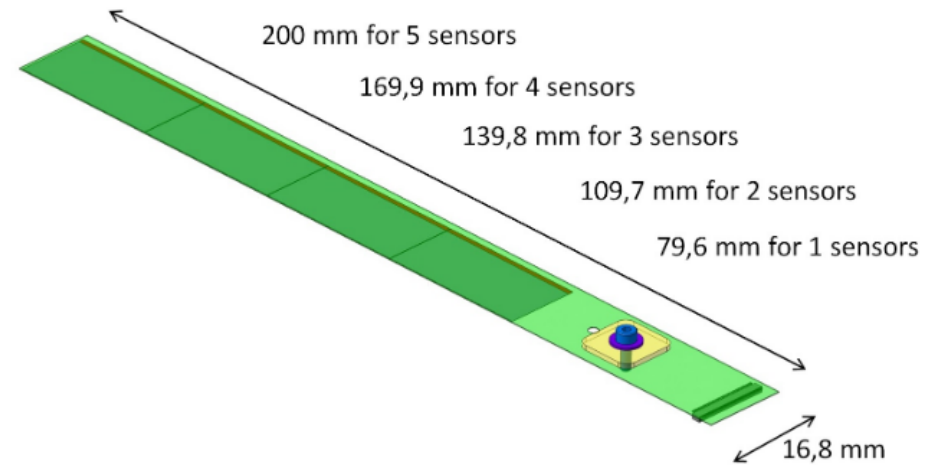
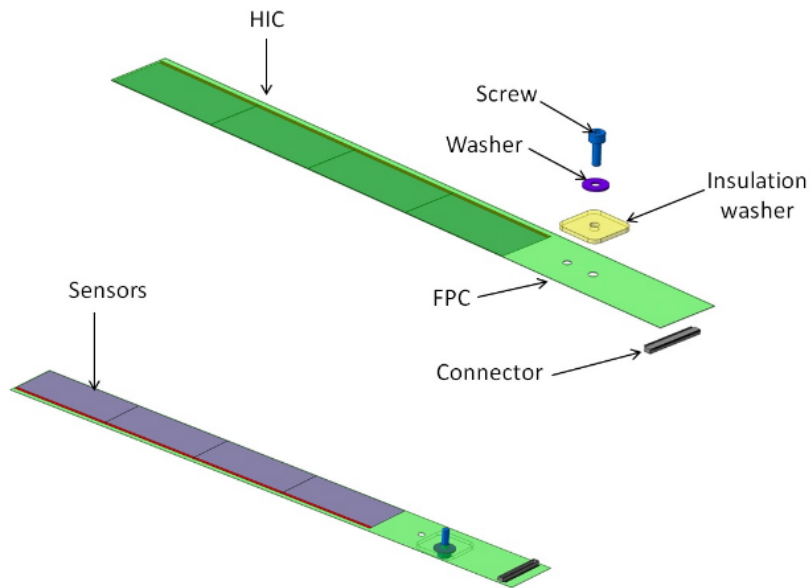
Not to scale



MFT layout

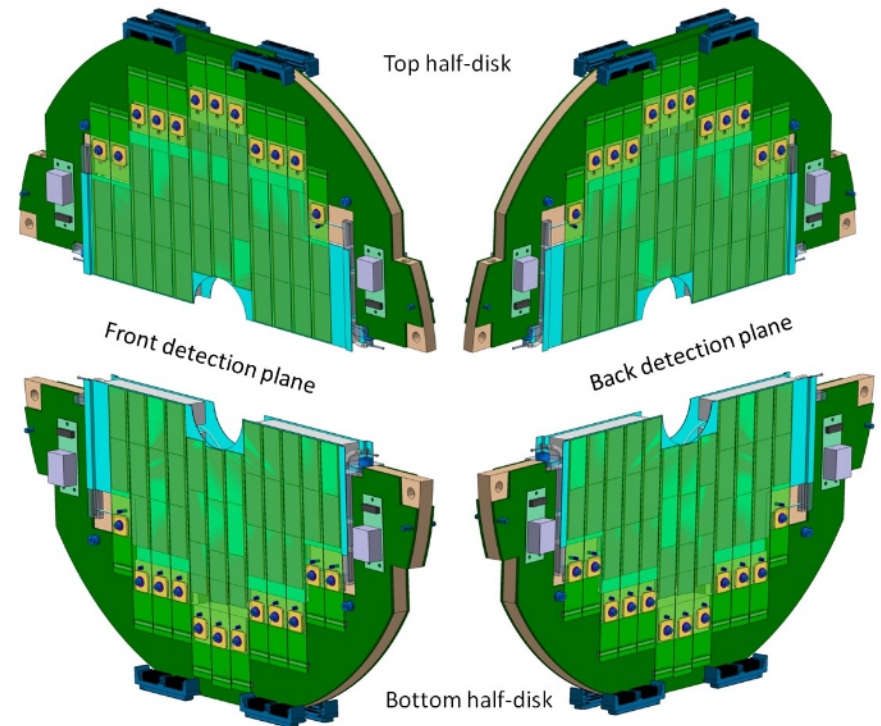
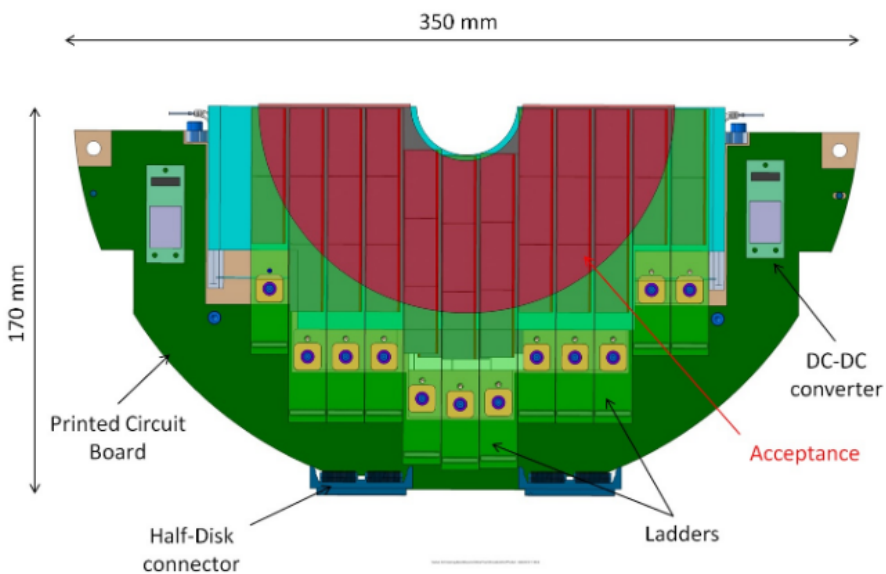


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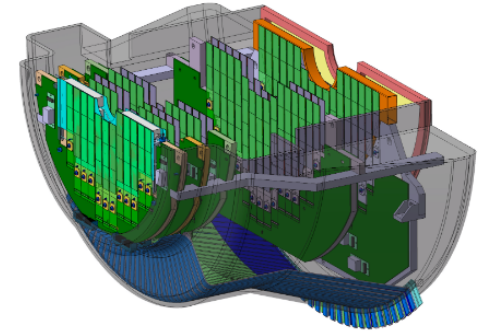


MFT layout

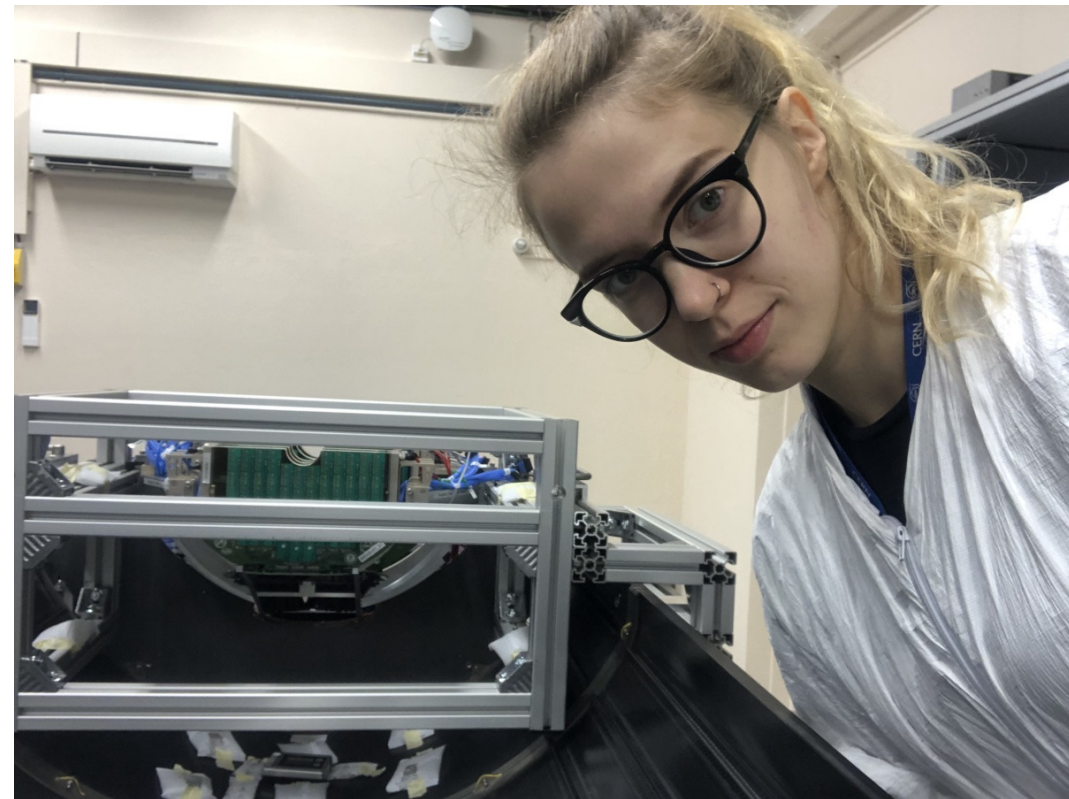
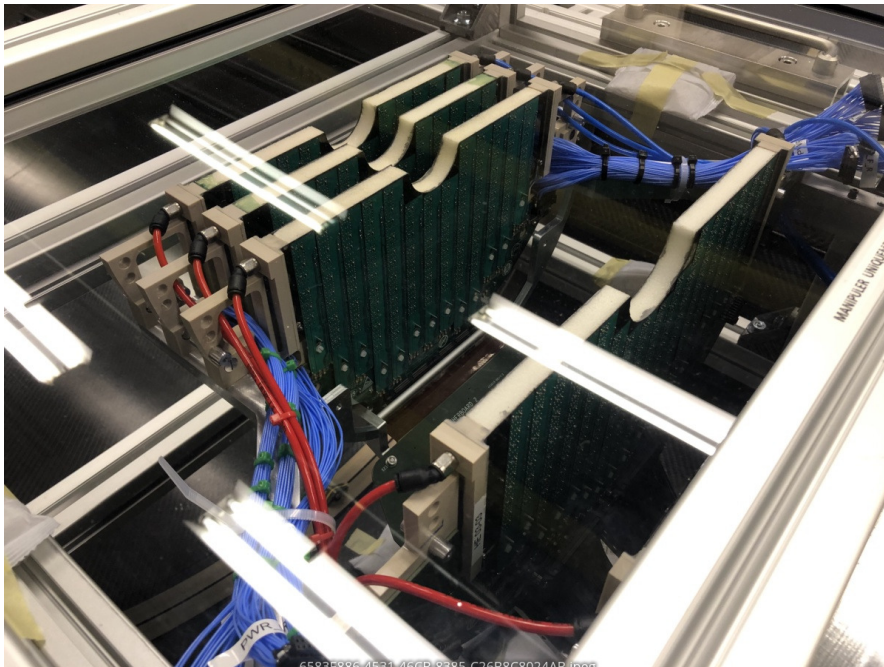
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MFT layout

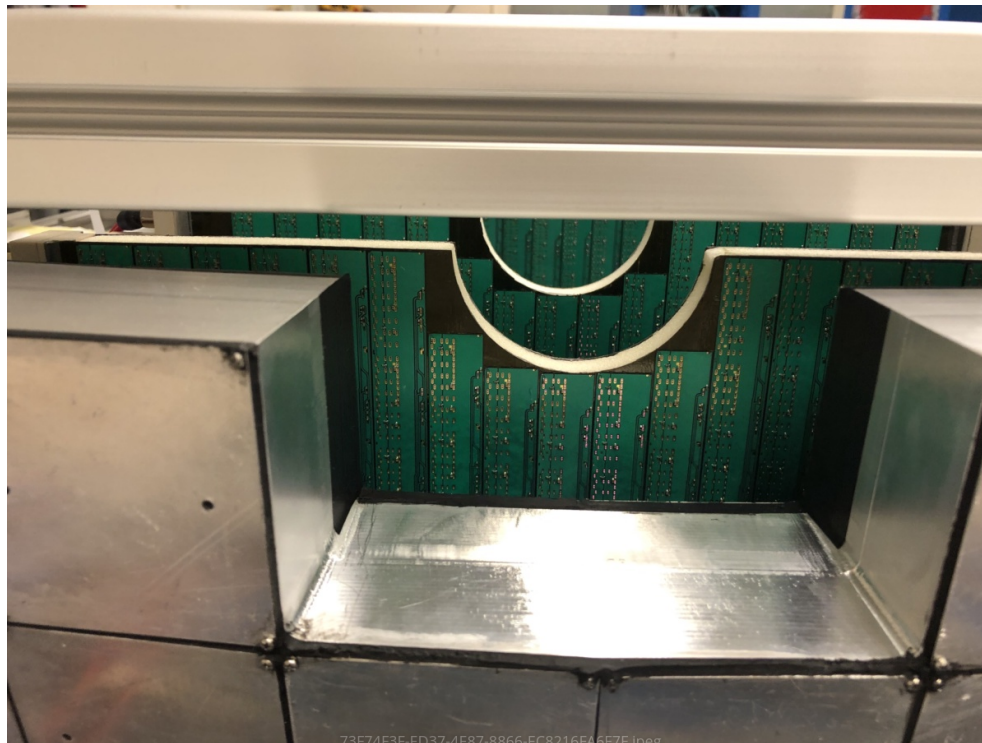


- ALPIDE chips → ladders → half-disks → **half-cones** → muon forward tracker

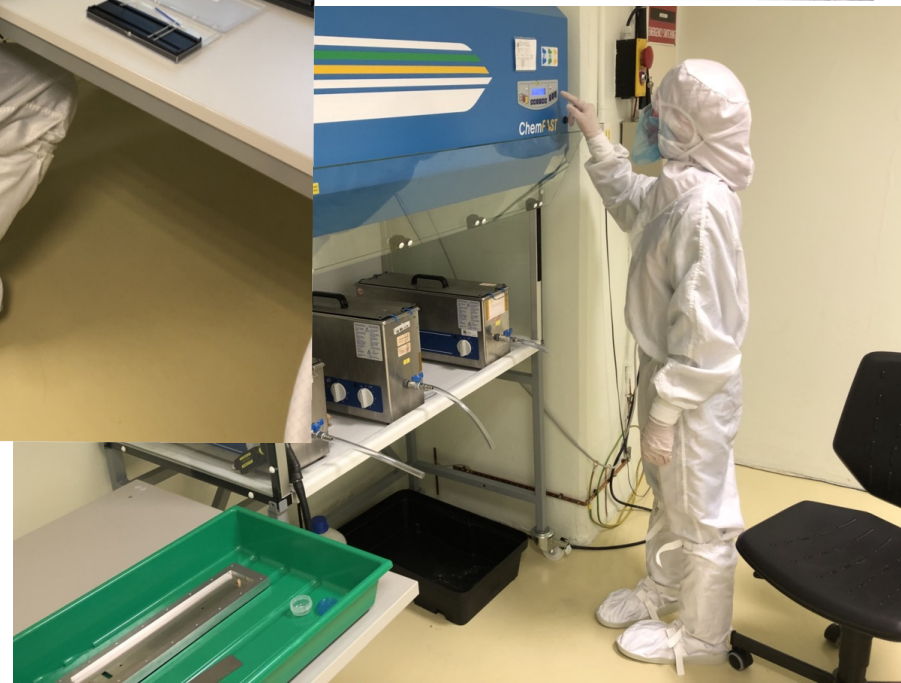
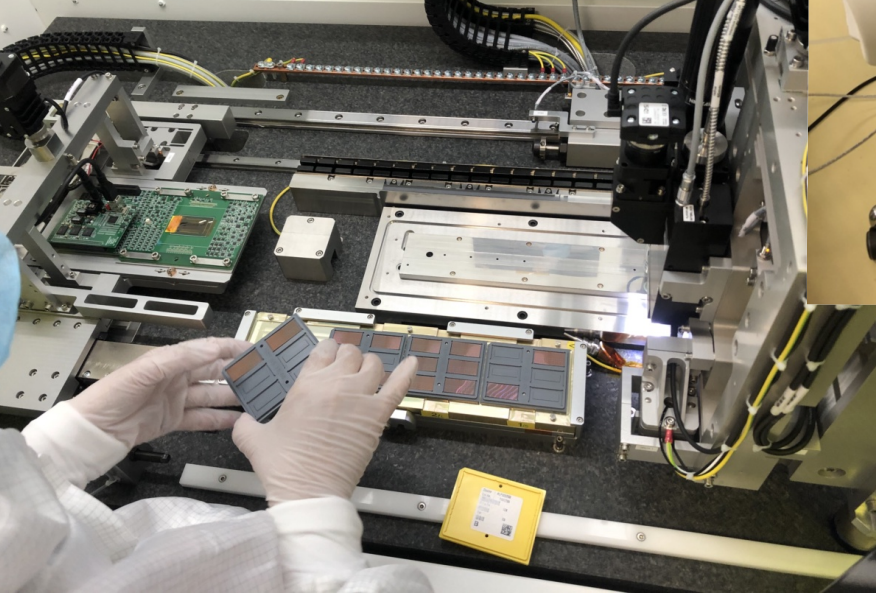


MFT layout

- ALPIDE chips → ladders → half-disks → half-cones → **muon forward tracker**



Ladders assembly

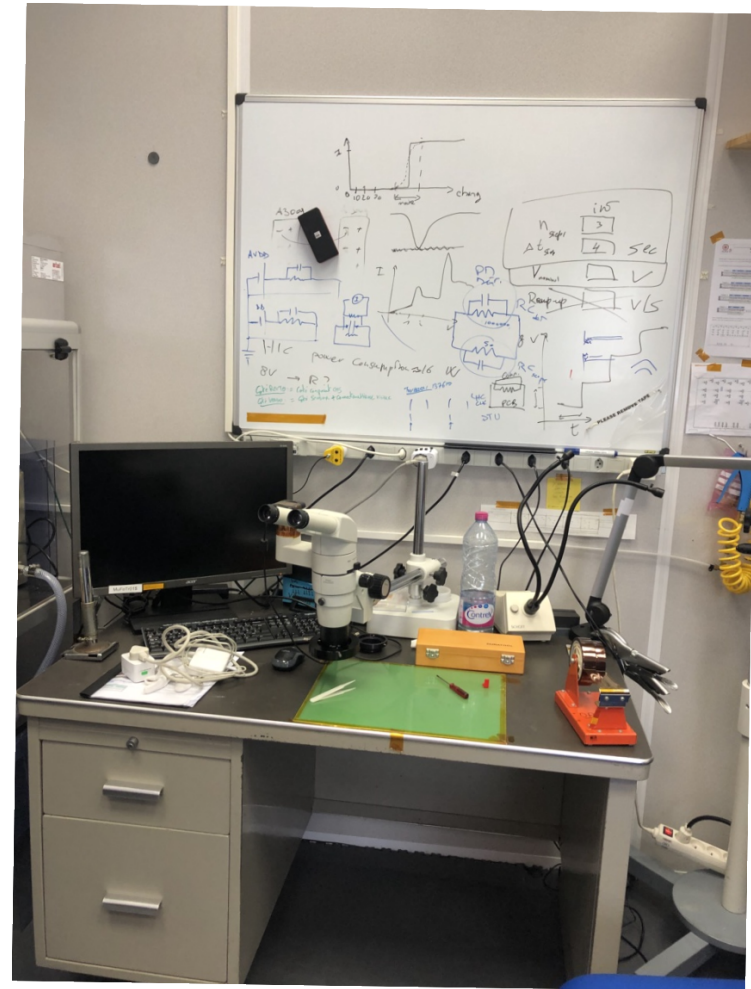


Qualification tests

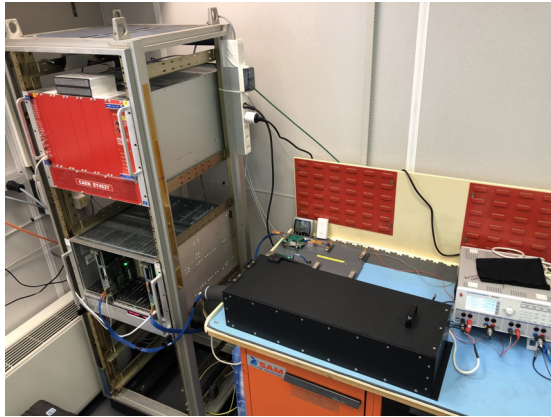
- smoke test

both with and without back-bias (-3 V):

- FIFO scan
- digital scan
- threshold tests
- noise occupancy
- eye diagram



Smoke test



Ladder Smoke Test

Day: 19, Month: 9, Year: 2019, Hour: 15, Minute: 59, Second: 59

RESET

Ladder ID: 3170
Examiner: diana

Analog

t_steps: 3 sec OK
V_finess: 100 mV OK
V_max: 1.8 V OK

Advanced Settings Set

Digital

Duplicate Analog

t_steps: 3 sec OK
V_finess: 100 mV OK
V_max: 1.8 V OK

Advanced Settings Set

Back Bias

t_steps: 3 sec OK
V_finess: 100 mV OK
V_max: 3 V OK

Advanced Settings Set

Loop Setting

Enable Loop times: 0 Stable time: 0 min Disable
Disable Loop interval: 0 min Apply

Test

Start

Voltage [V] Zoom

Analog/channel000 1.83
Digital/channel001 1.81

Current [A] Zoom

Analog/channel000 0.04
Digital/channel001 0.03

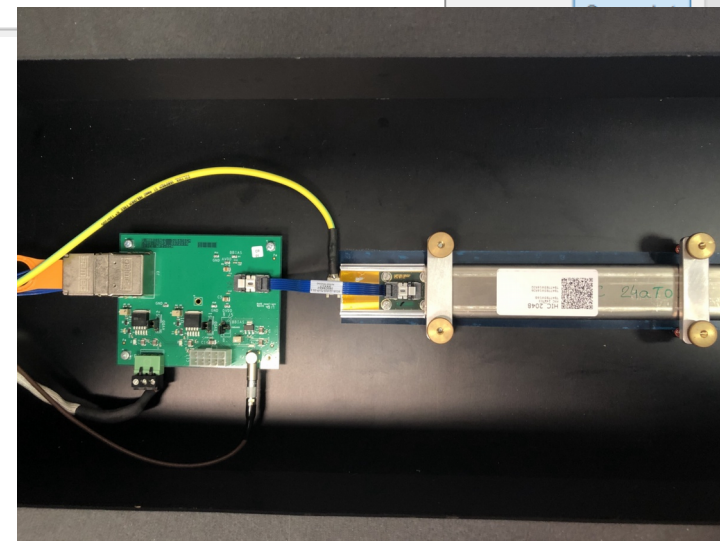
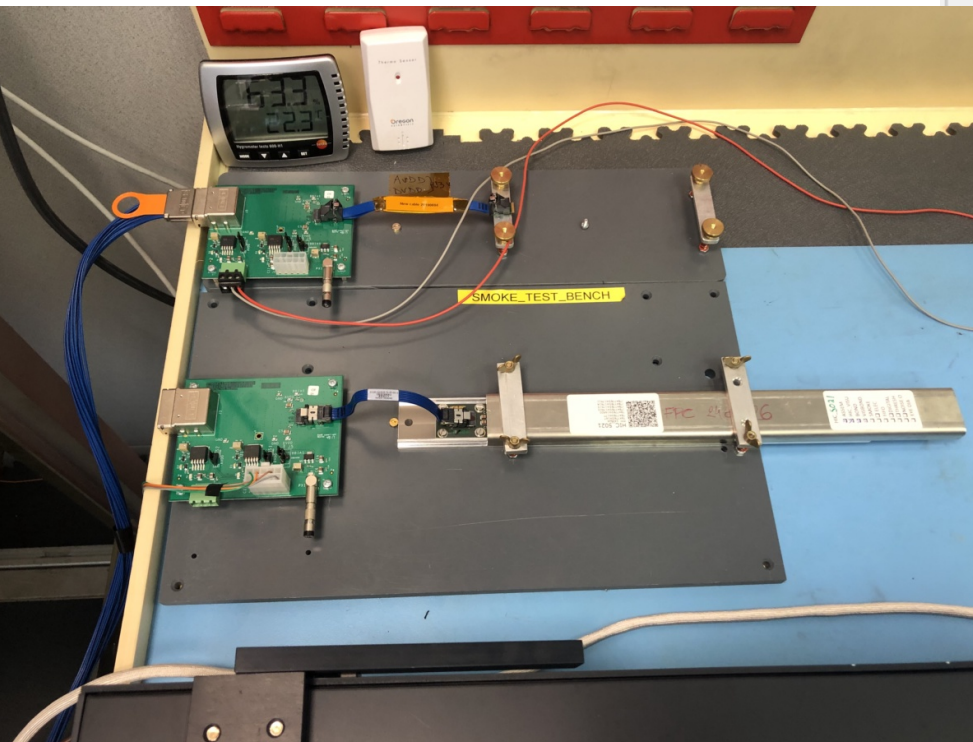
Voltage [-V] Zoom

Back Bias/channel002 3.01

Current [A] Zoom

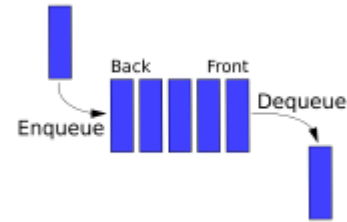
Back Bias/channel002 0.000

Export Close



FIFO scan

first in, first out



GOLD/RED

- the oldest entry – head of the queue – is processed first
- MOSAIC sets register in the memory of each pixel and it reads them back, comparing writing and reading



Digital scan

digital circuitry tests

GOLD/SILVER/BRONZE/RED

- consumption reaches its maximum
- inspection of the full matrix
- detection of dead, inefficient and noisy pixels
- each pixel is pulsed 50 times

$n_{\text{replies received}}$	Result of pixel quality
0	Dead pixel
1÷49	Inefficient pixel
50	Good pixel
≥51	Noisy pixel

n_{bad}	Result of Digital Scan
0≤50	GOLD
50≤2100	SILVER
2100≤5243	BRONZE
≥5243	RED

Threshold scan

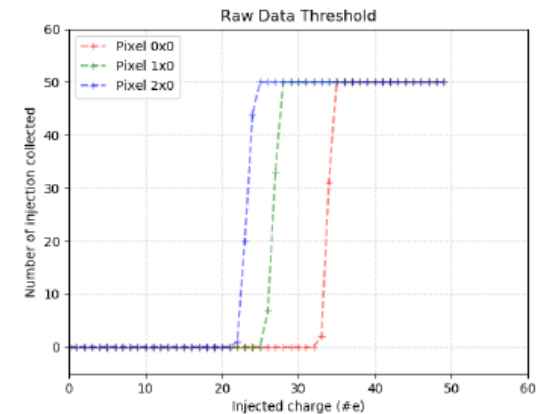
analog circuitry tests and threshold equalization



1. injection of pulse into the pixel

2. read the value in pixel's memory

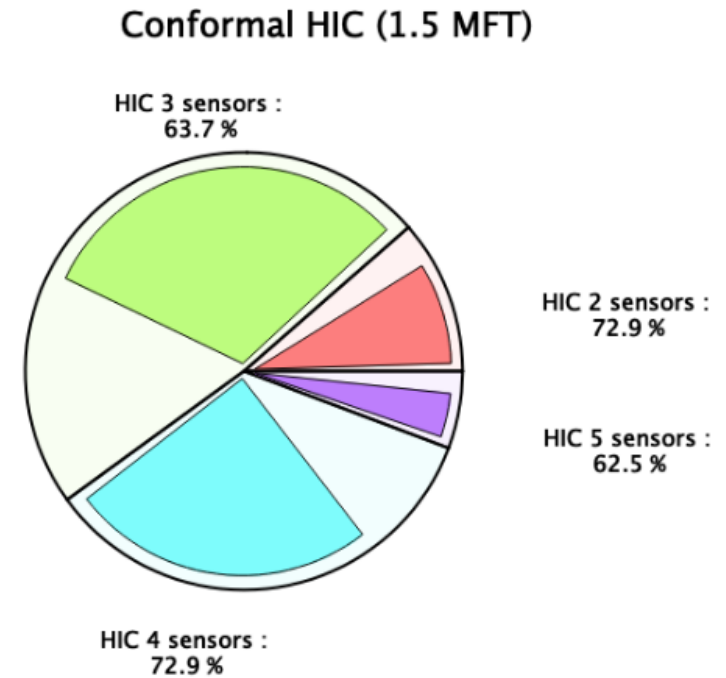
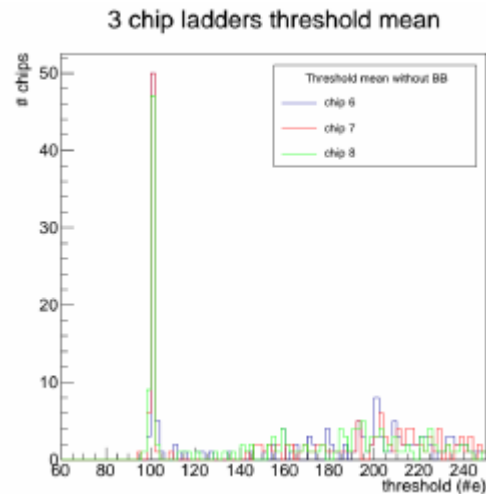
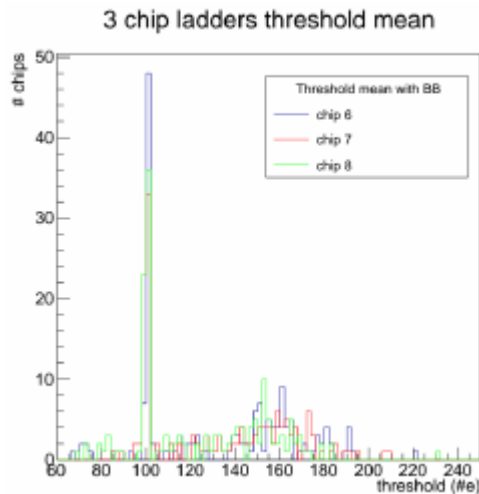
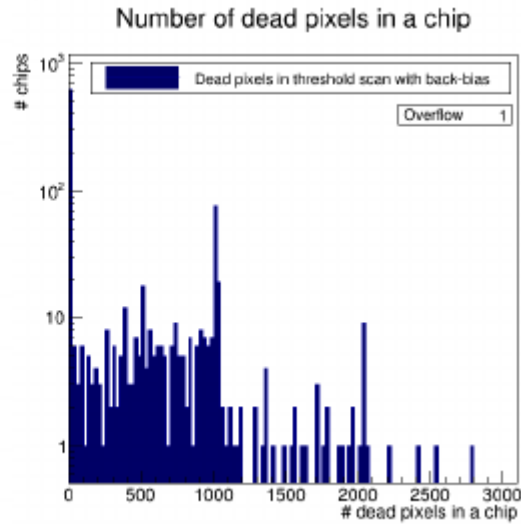
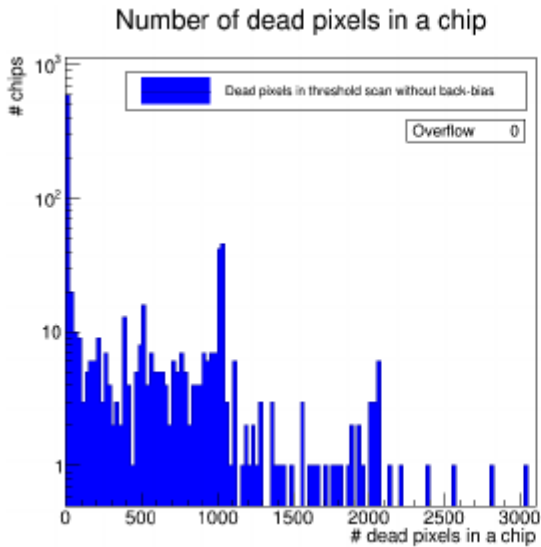
- **threshold:** *the x -th number of electrons at which the efficiency reaches 50%*
- in an ideal situation, we want the threshold to be a steady value which is perfectly determined
- decreased threshold increases the detection efficiency but increases noise



Noise occupancy scan

- large number of random triggers delivered by the MOSAIC board
- probability of registering a hit not due by a passage of particle
- occupancy = average number of pixels firing without any external source per number of pixels in the chip

Statistics for all the tested ladders



Plans

- Power consumption statistics
- Surface commissioning September 2019 – May 2020
- Services installation, Readout installation
- Detector installation May 2020 – July 2020
- Standalone commissioning, continuous operation July 2020 – October 2020
- Global commissioning
- LHC will restart in May 2021