

# Muon Forward Tracker

## Status

Raphael TIEULENT – IPN Lyon

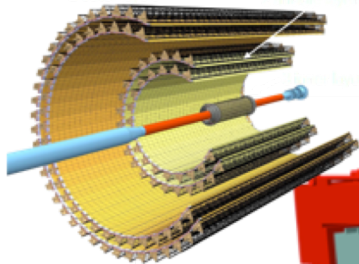
12<sup>th</sup> ITS/MFT/O2/DCS Asia meeting

November 19<sup>th</sup> 2018

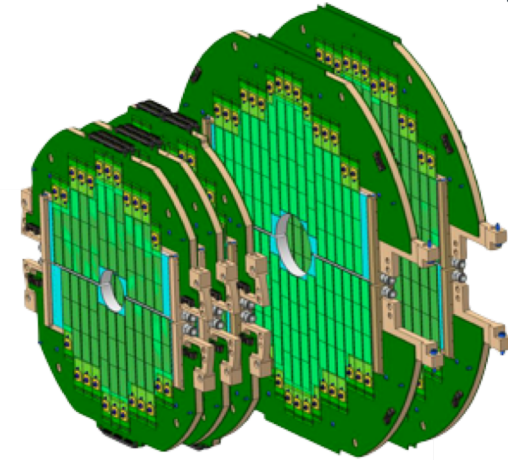


MFT

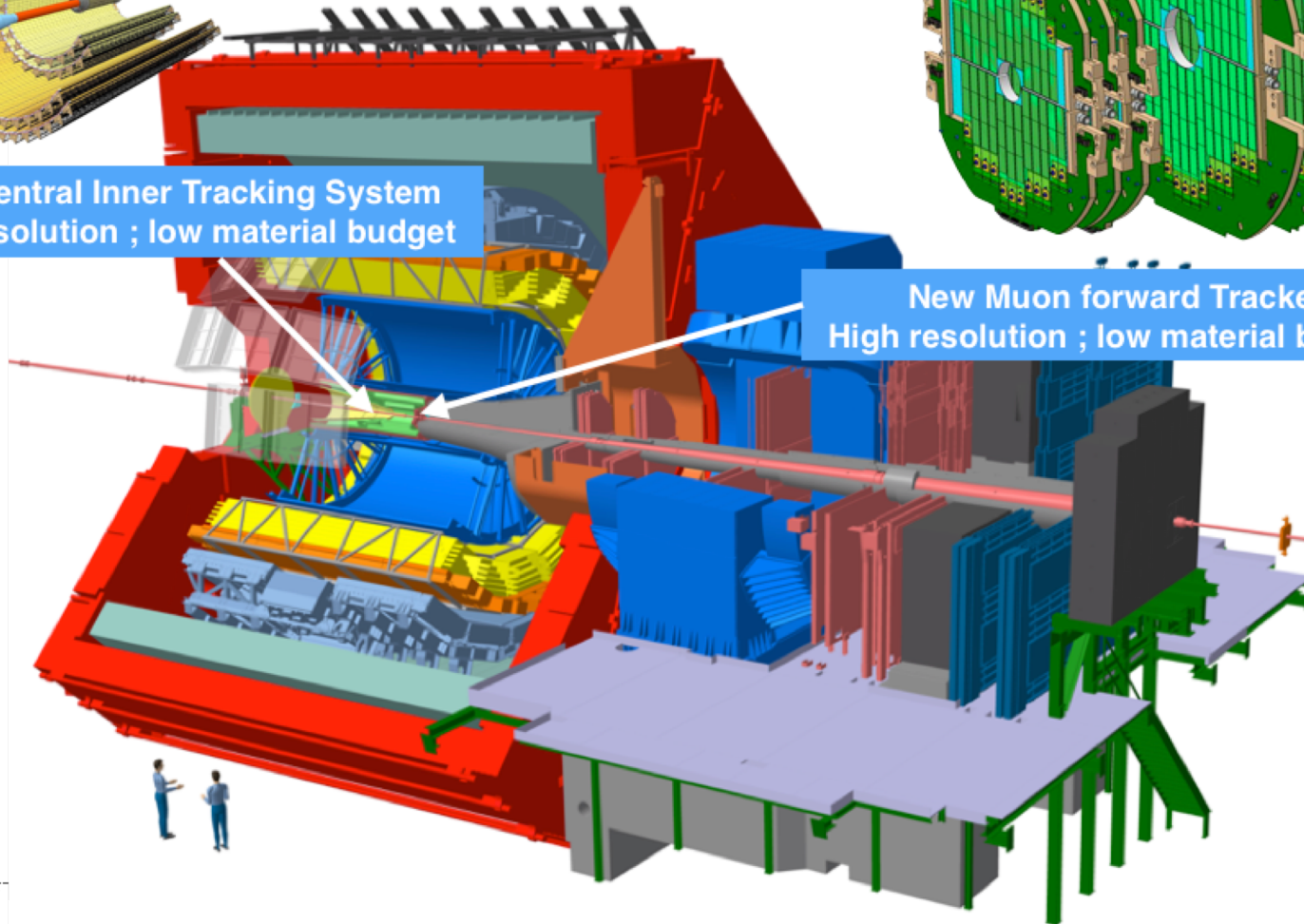
# ALICE Run 3 Silicon Trackers



**New Central Inner Tracking System**  
High resolution ; low material budget

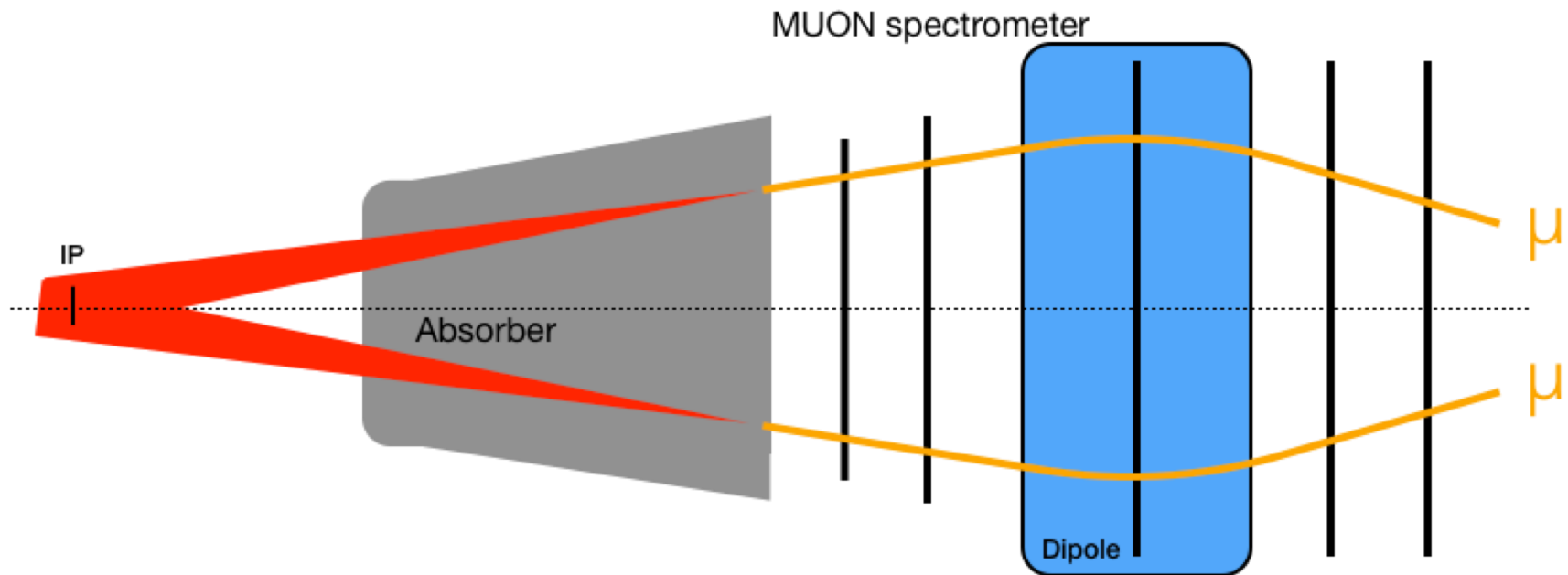


**New Muon forward Tracker**  
High resolution ; low material budget





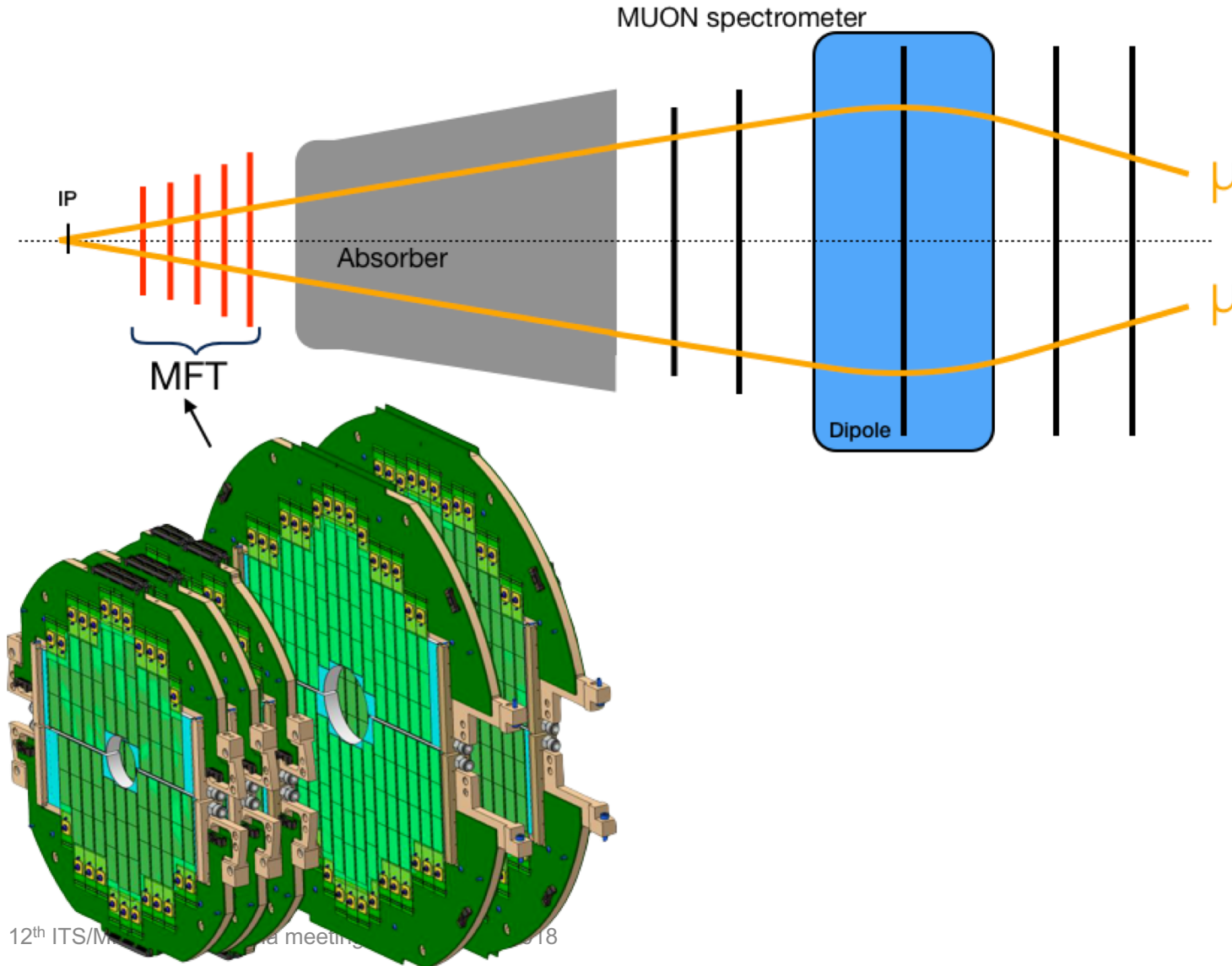
# Present MUON Spectrometer



Present MUON spectrometer blurred in muon track extrapolation

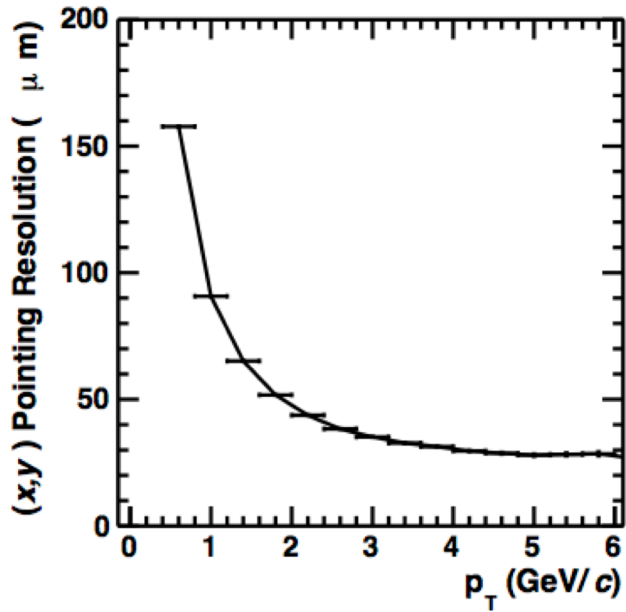
- No constraint in the primary vertex region (no charm/beauty separation)

# THE Muon Forward Tracker principle

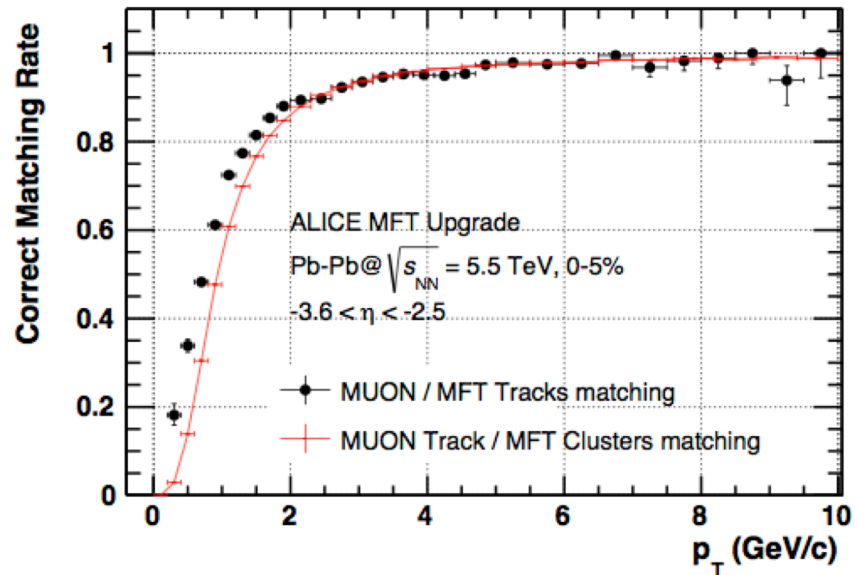


# MFT + MUON tracking capabilities

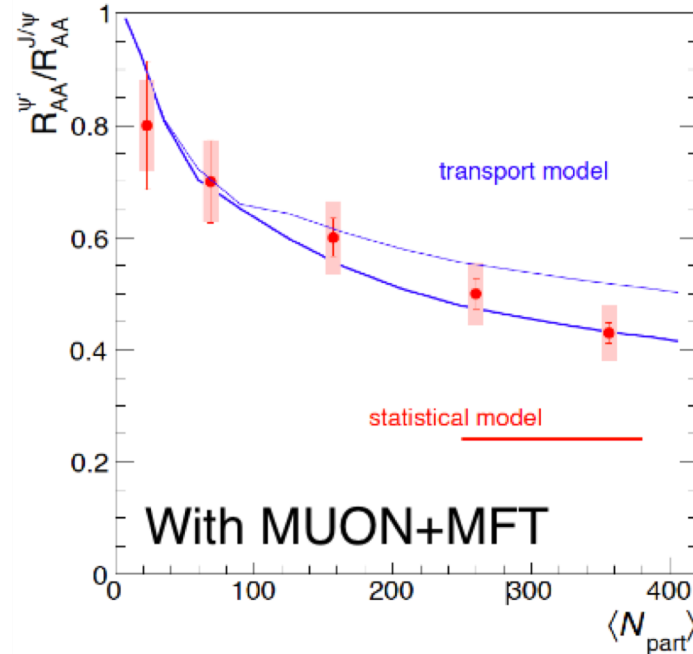
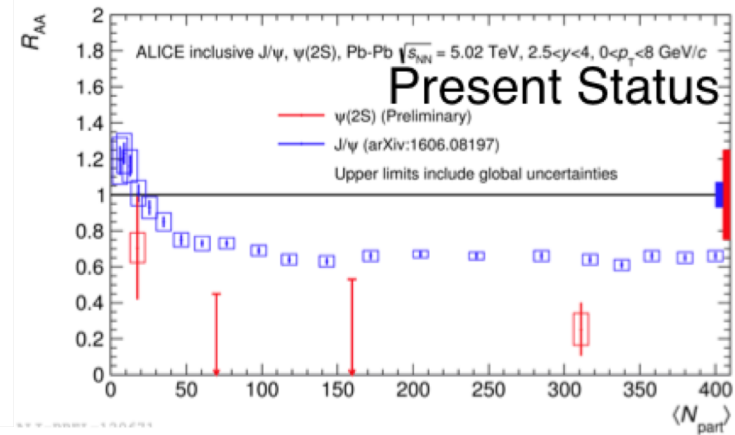
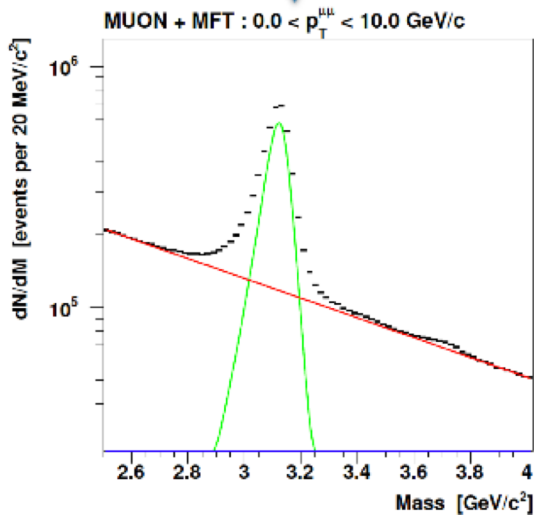
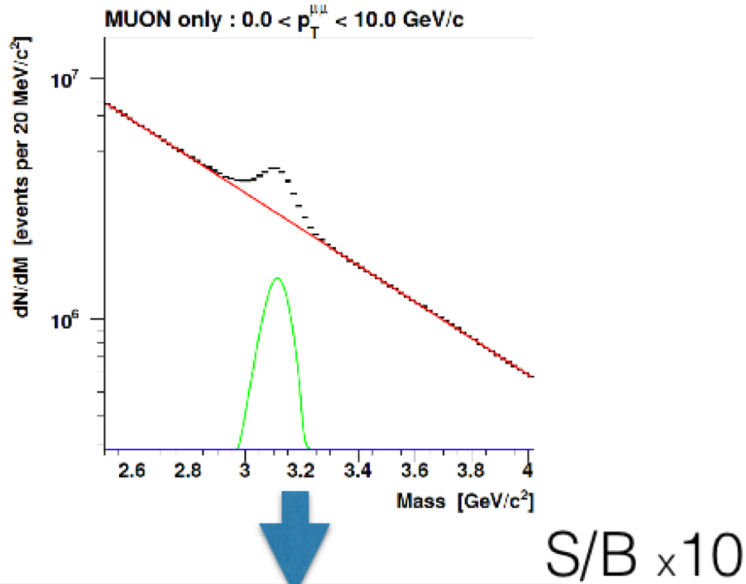
## Transverse pointing resolution



## MUON/MFT Matching rate



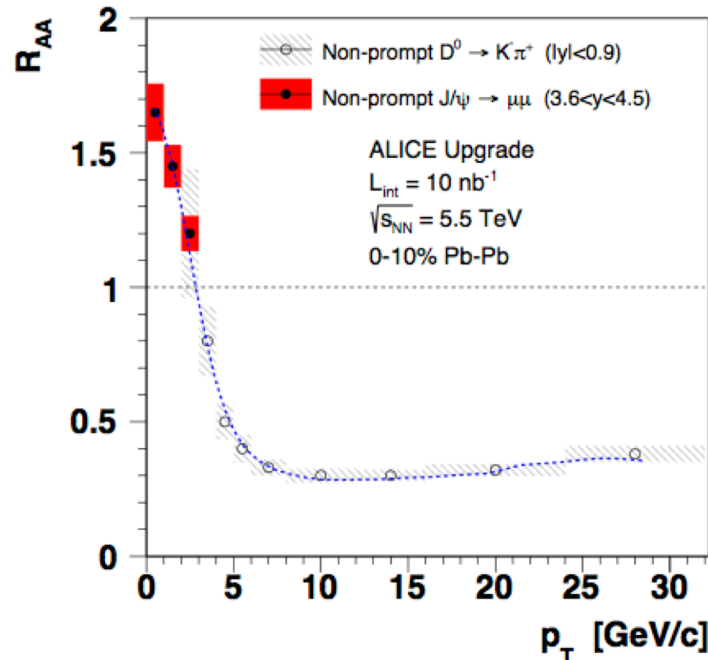
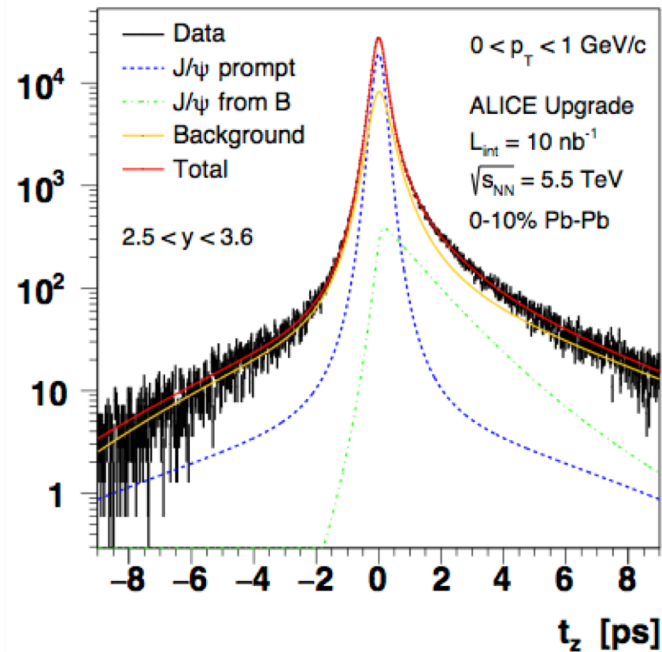
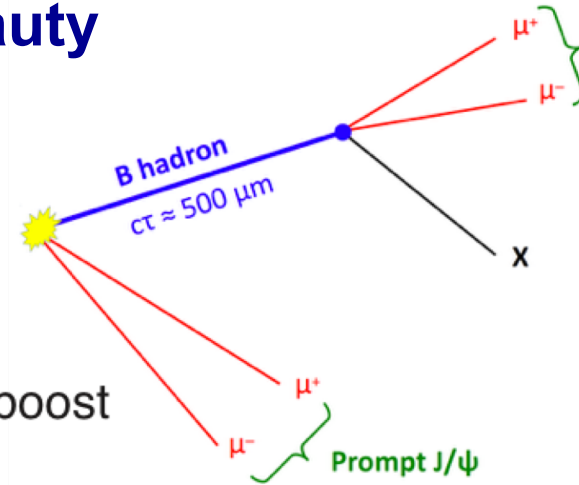
# Physics Capabilities: $\Psi(2S)$



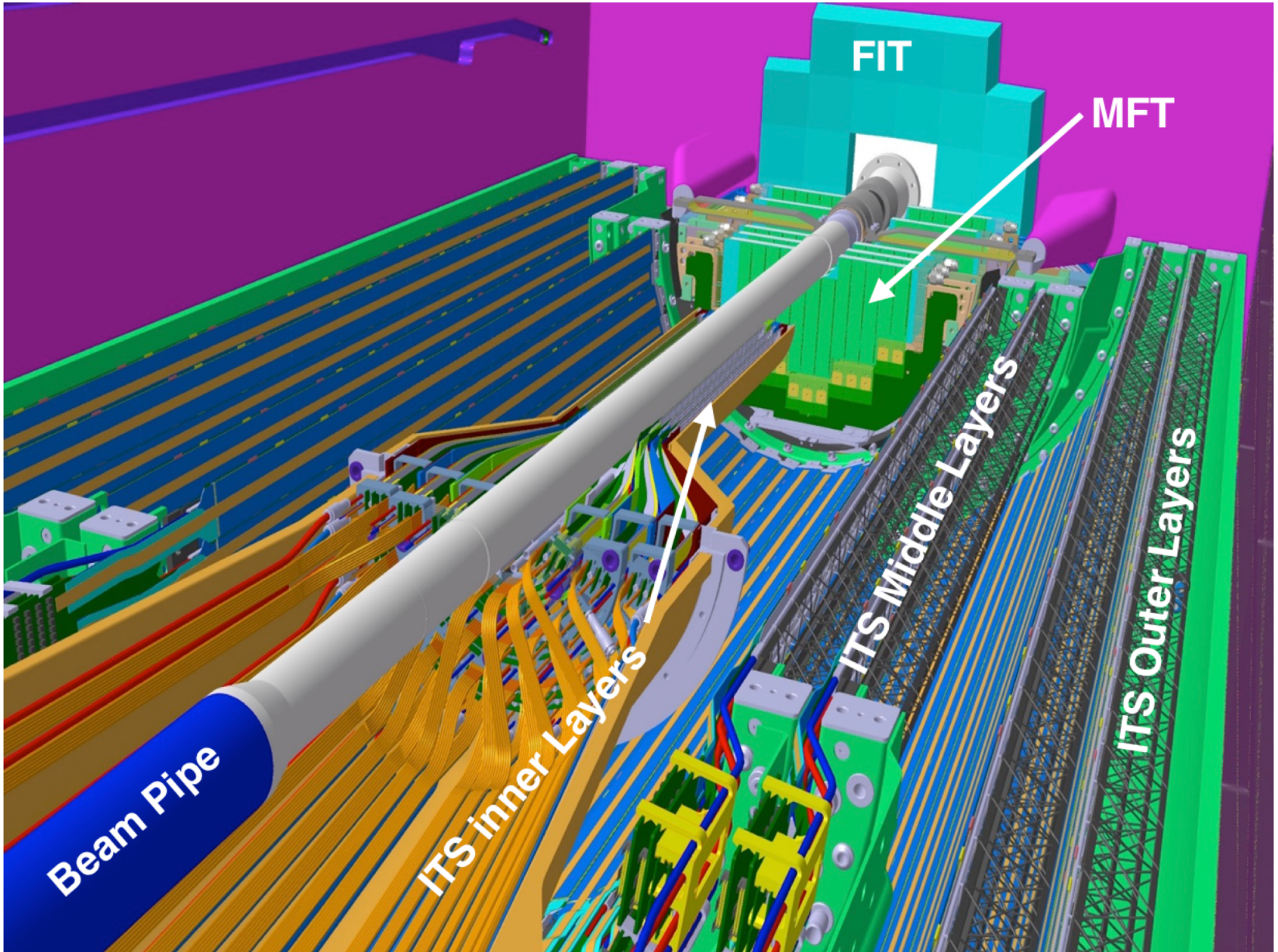
# Physics Capabilities: Beauty

Access beauty down to  $p_T=0$

Displacement ensured by the rapidity boost







# MFT layout

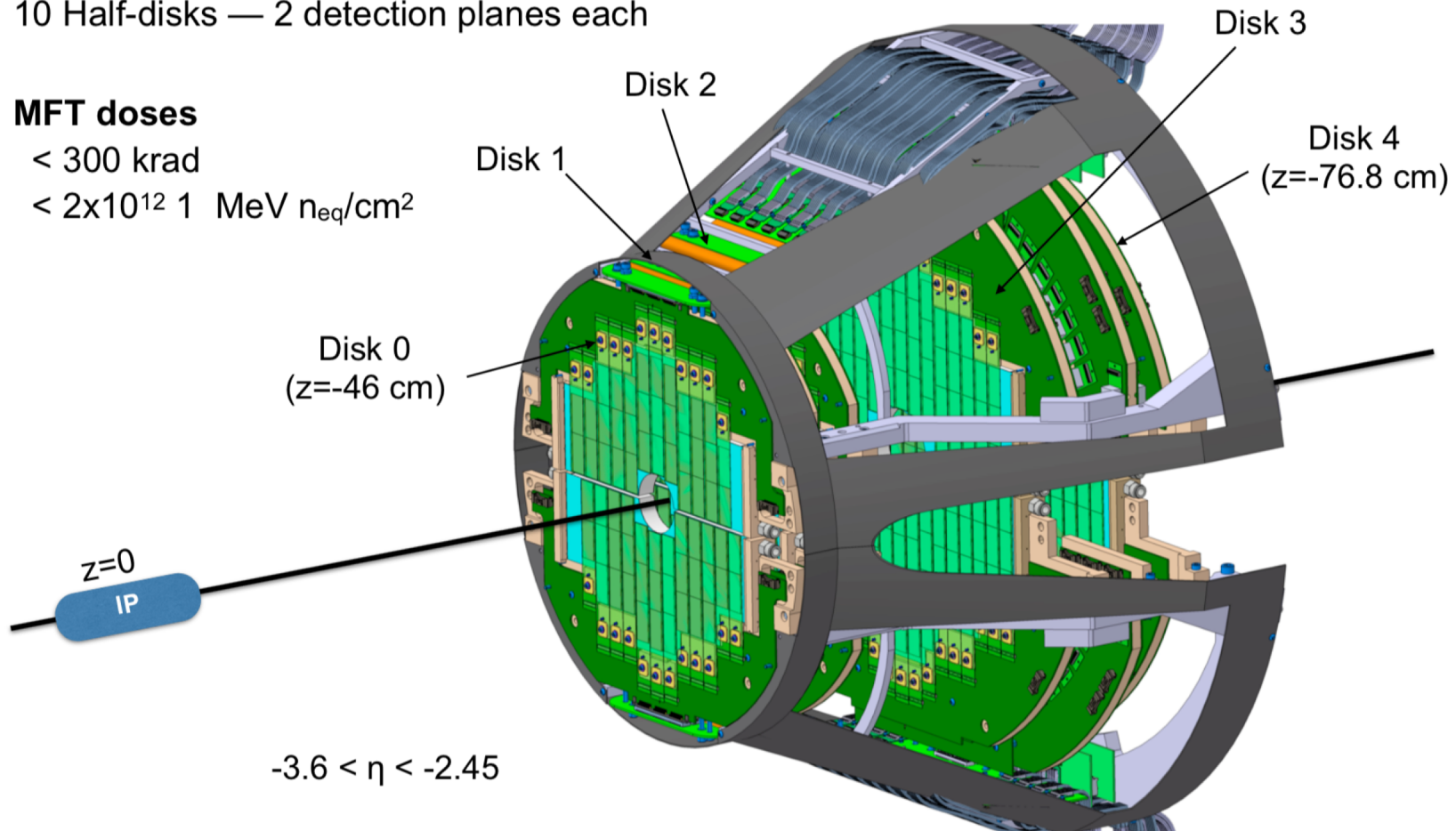
920 silicon pixel sensors ( $0.4 \text{ m}^2$ ) on 280 ladders of 2 to 5 sensors each

10 Half-disks — 2 detection planes each

## MFT doses

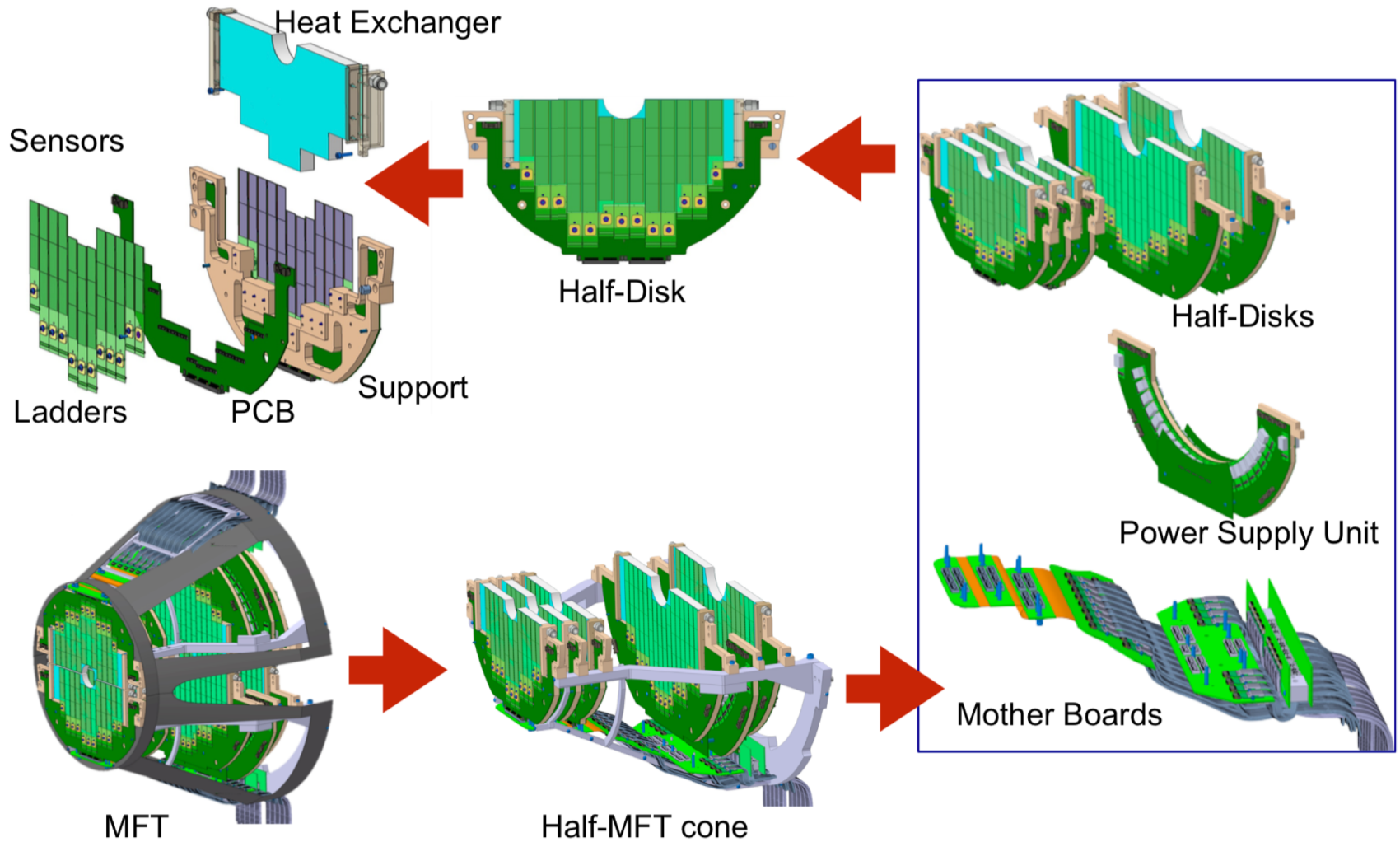
$< 300 \text{ krad}$

$< 2 \times 10^{12} \text{ 1 MeV } n_{\text{eq}}/\text{cm}^2$



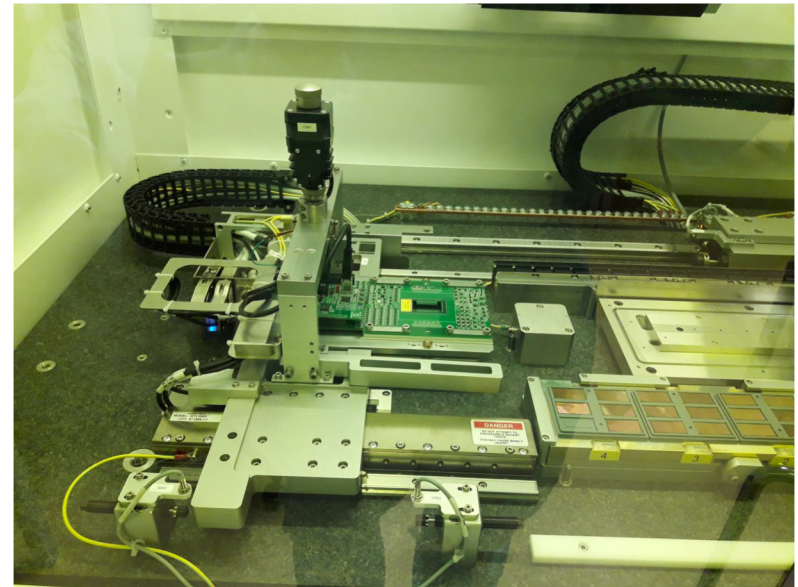
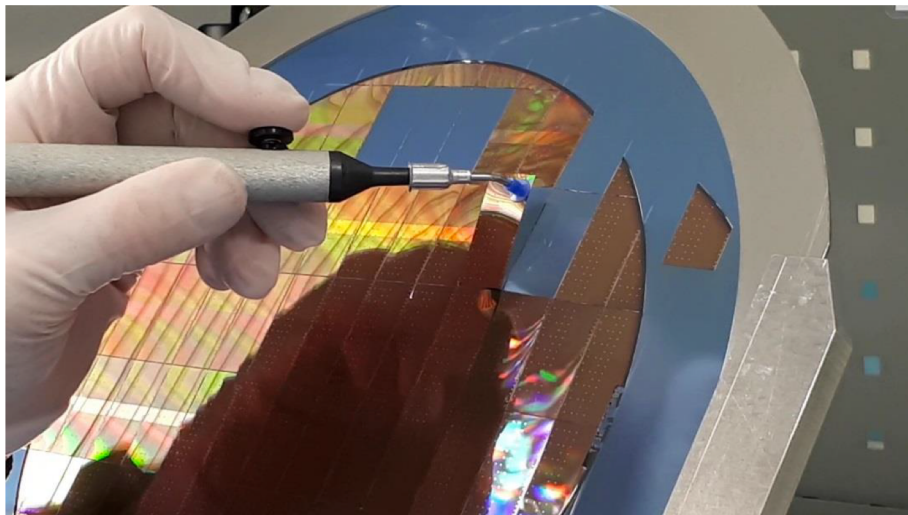


# MFT layout



## MFT – Chip (WP1)

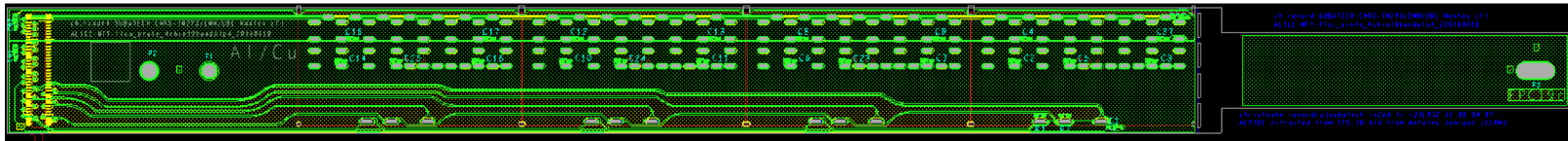
- ALPIDE needs: 100 wafers (production is ongoing)
- MFT team took over for ALPIDE chip picking and testing (at CERN DSF)
  - MFT team member trained for chip picking
  - Probe card installed on ALICIA 7 (MFT MAM)
  - Database connection functional
  - Procedure is fully operational
- Chip testing performed Monday-mornings and Friday-afternoons in order not to interfere with the ladder production



→ See Cyrille presentation

# MFT – Ladder (WP2)

## FPC status



- **FPC production ongoing at CERN** (Rui's lab)
  - 7<sup>th</sup> and 8<sup>th</sup> batches in production, delivery scheduled for end December
  - 6 additional batches need to be produced (3 month delay wrt initial plan)



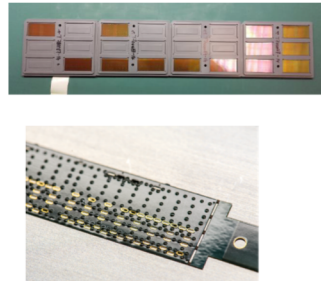
→ See Cyrille presentation



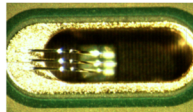
# MFT – Ladder (WP2)

## Ladder production status

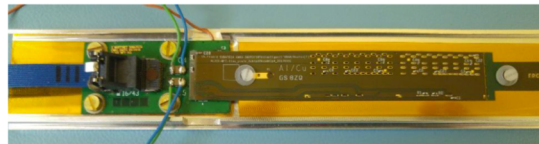
- Ladder production just resumed after a 3-week break due to
  - MAM gripper replacement (silicate balls contamination as ITS)
  - Probe card installation and and MAM configuration for chip testing



Chip alignment/gluing with ALICIA7 machine



Wire Bonding



- Ladder transport boxes produced and delivered to CERN
- Ladder/Disk qualification test benches operational at CERN, Lyon, Nantes

→ See Cyrille presentation

# MFT – Disk (WP3)

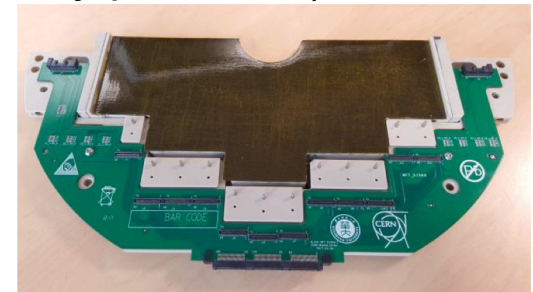
- Pre-prod disk exchanger tested with cooling plant at CERN – OK (i.e. 5 bar pressure test, pressure drop,...)
- HE production is ongoing (4 HE01 already produced)
- Disk supports also in production (3 supports type 01 already produced)



Heat Exchanger



Disk Support



Disk mechanical assembly

| Oct 18             | Nov 18             | Dec 18              | Jan 19             | Feb 19             | Mar 19             | Apr 19             | May 19             | Jun 19  |
|--------------------|--------------------|---------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------|
| 1 Disk01<br>(done) | 3 Disk01<br>(done) | 3 Disk01<br>1 Disk4 | 1 Disk2<br>1 Disk3 | 1 Disk2<br>1 Disk4 | 1 Disk3<br>1 Disk2 | 1 Disk4<br>1 Disk3 | 1 Disk2<br>1 Disk4 | 1 Disk3 |

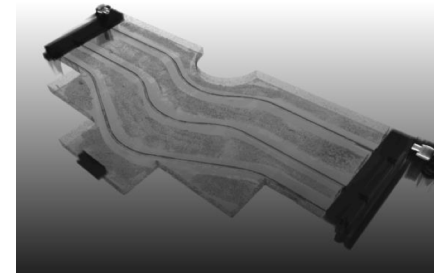
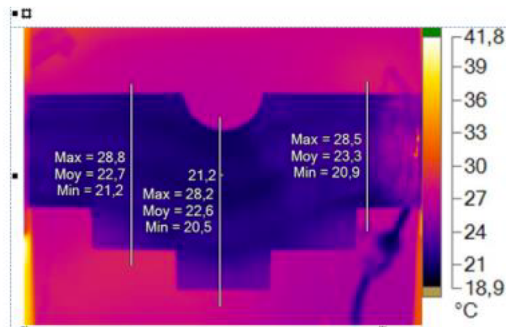
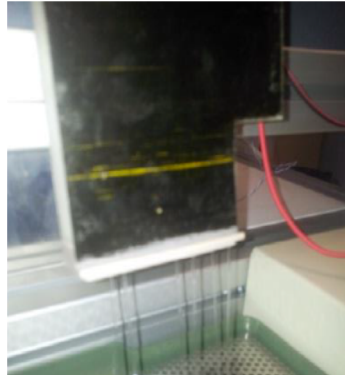
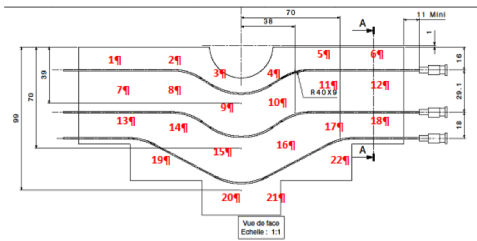
- Disk transport boxes produced and delivered

→ See Stéphane presentation



# MFT – Disk (WP3)

- Disk mechanics qualification procedure fully operational



Dimensional survey



Flow rate check

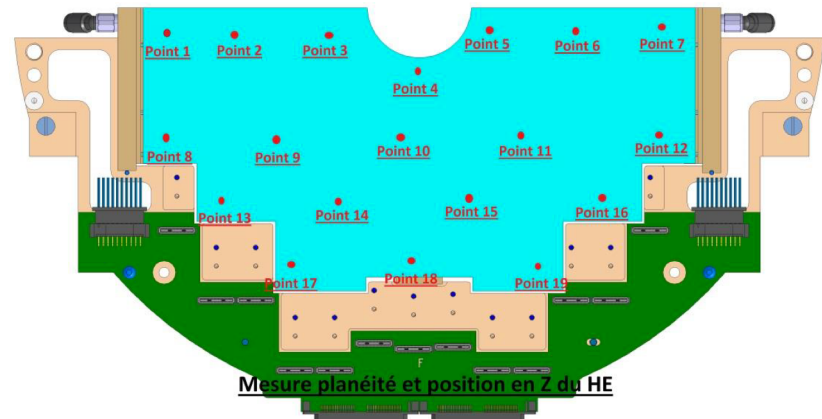


Thermal test



Tomography

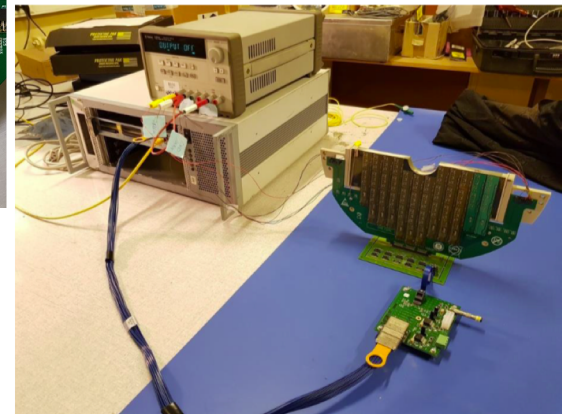
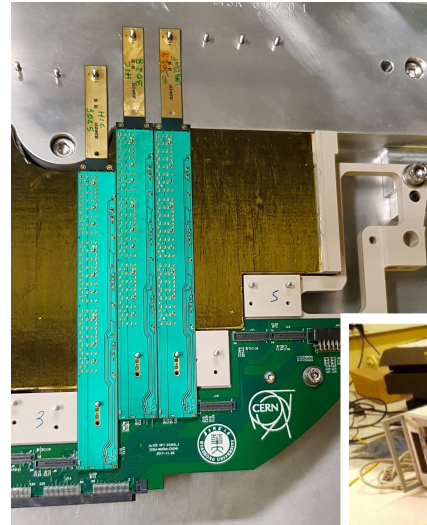
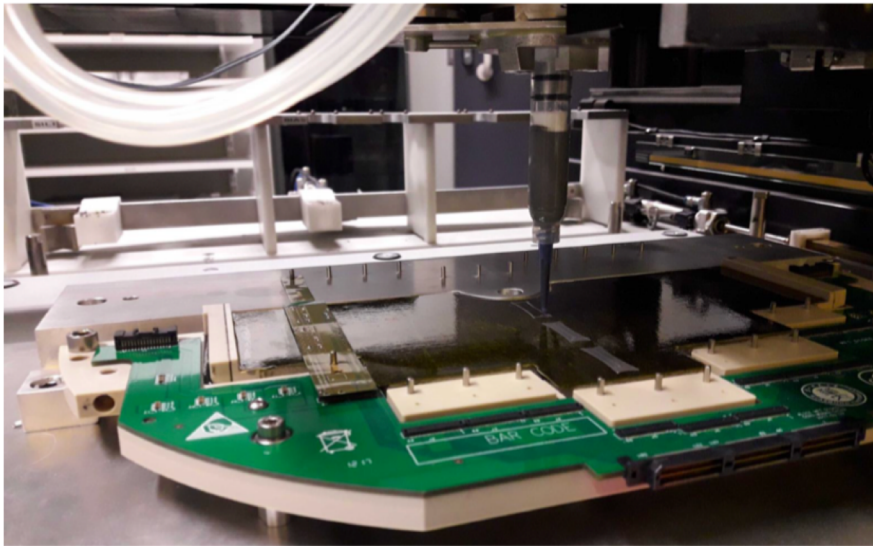
Final Dimensional survey (HE position, pin positions, ladder connector positions)





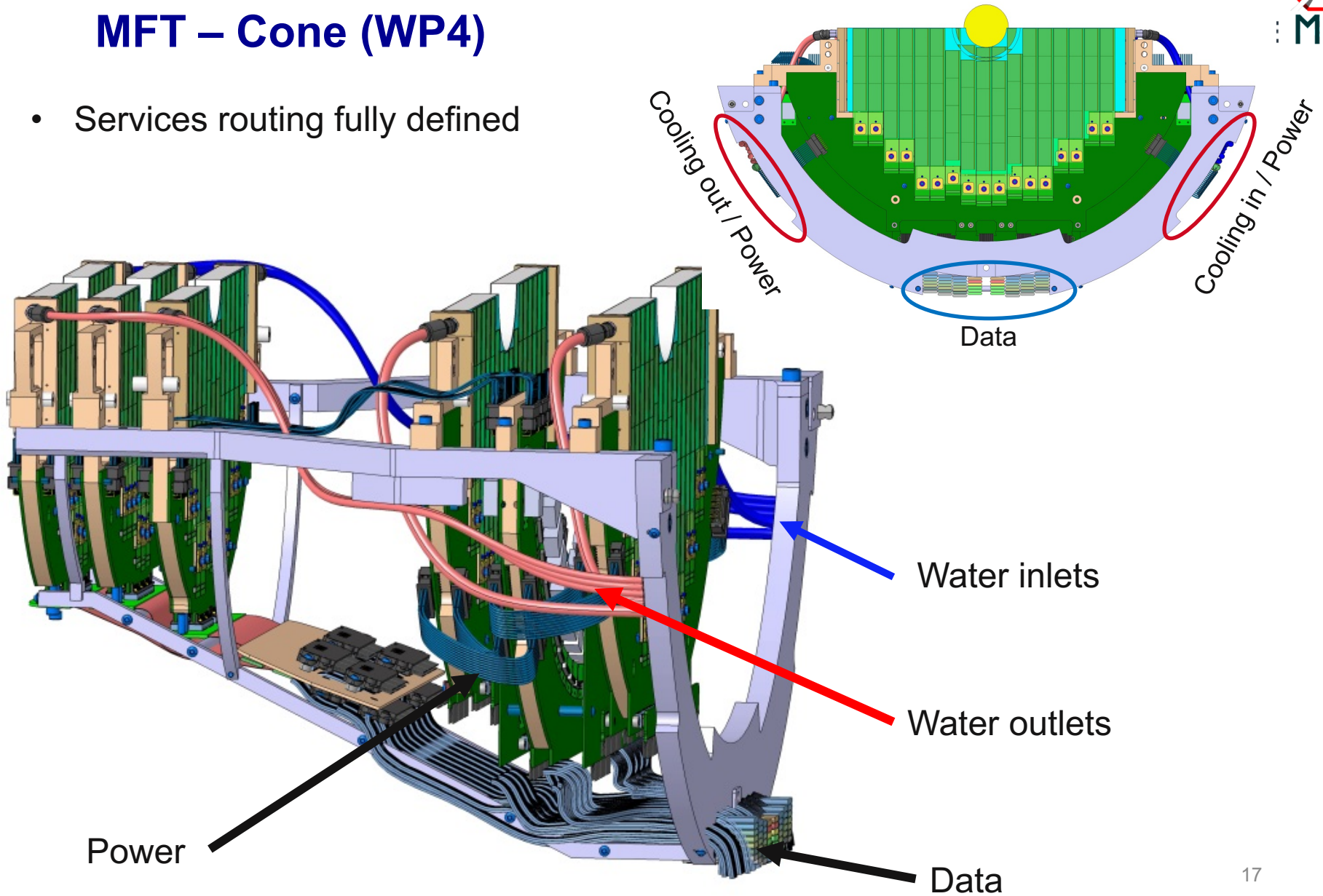
## MFT – Disk (WP3)

- Assembly procedure fully operational using automatic glue dispenser (IPNL)
- One disk (pre-series) equipped and a second partially equipped (test beam)
- Ladder performances measured before and after gluing on disk: no change!



# MFT – Cone (WP4)

- Services routing fully defined

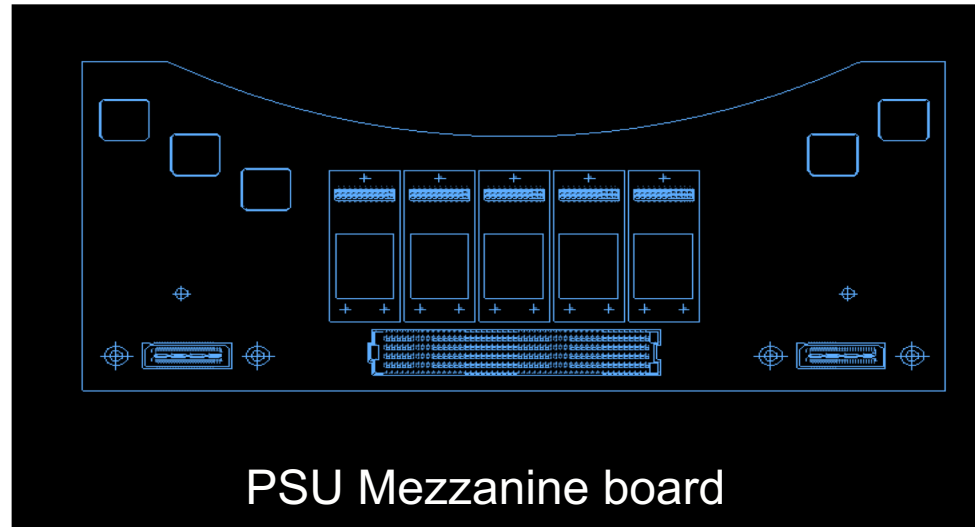
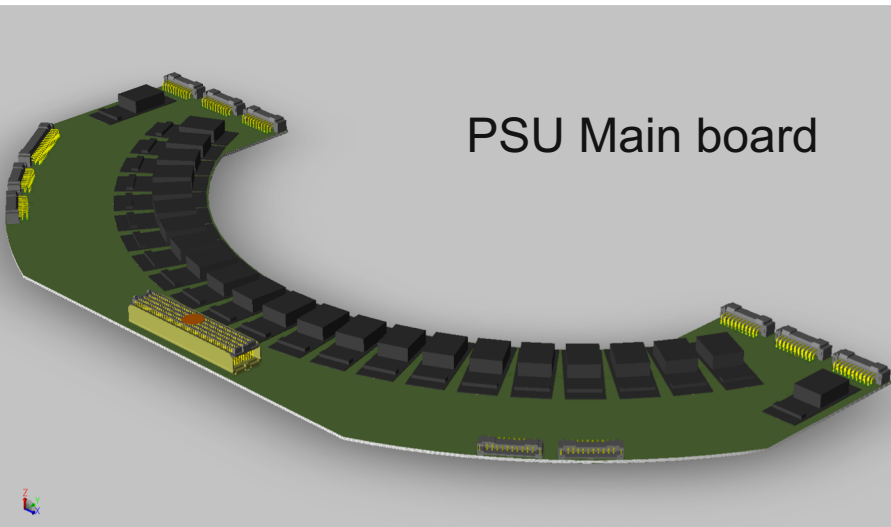
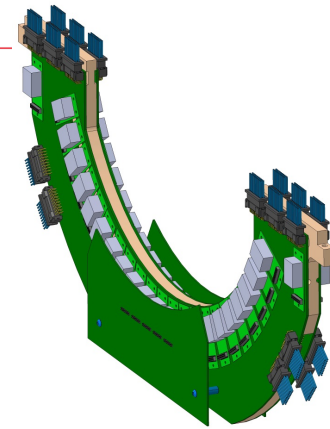




## MFT – Cone (WP4)

### Power Supply Unit

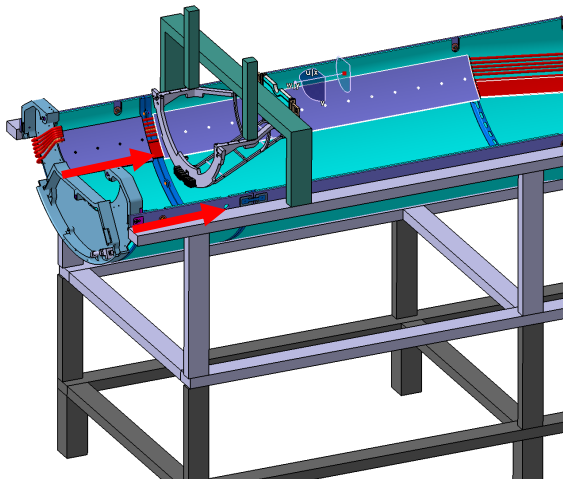
- Mechanical design finalized
- Schematics finalized ; layout on-going
- New feature added: system to shut-down analog or digital line in case of DCDC failure of digital or analog line in the same zone
- All DCDC converters produced and delivered



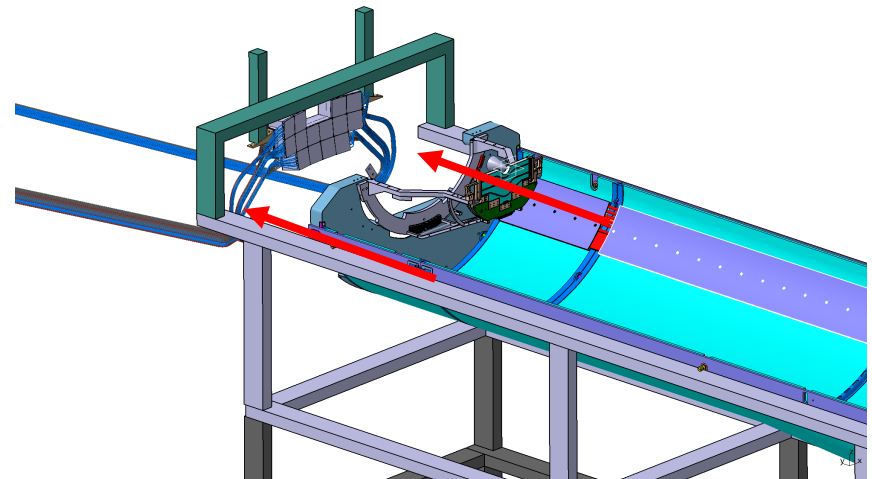
→ See Massimiliano presentation

## MFT – Barrel / Patch Panel (WP5)

- Barrel
  - Production started in October
  - Delivery scheduled for January 2019 (dry test inside ITS cage)
- Patch Panel
  - Pre-series produced in Porto Alegre, delivered to CERN in July. Metrology within specs
  - Final production on-going
  - Delivery scheduled January 2019
- FIT / MFT Assembly procedure defined, handling tools under design



MFT Cone installation in Barrel

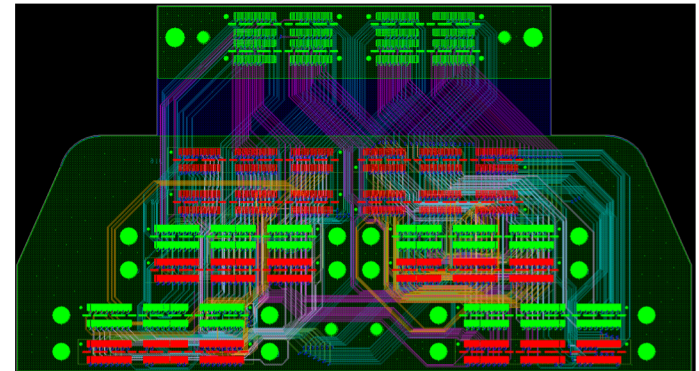
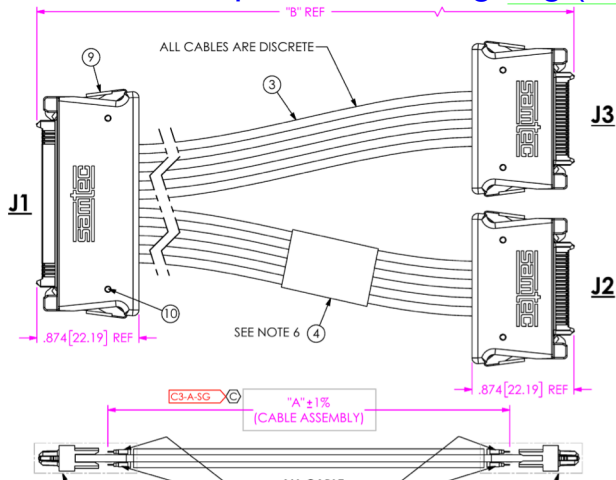
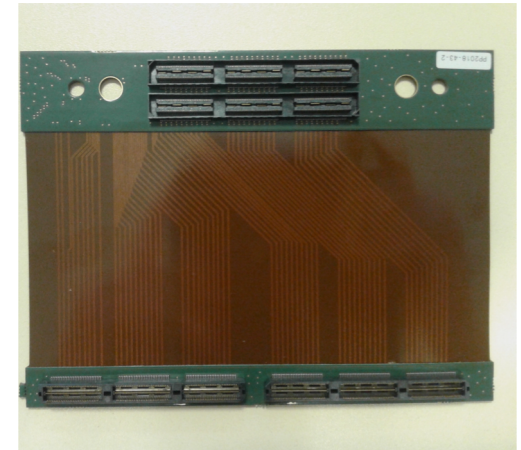
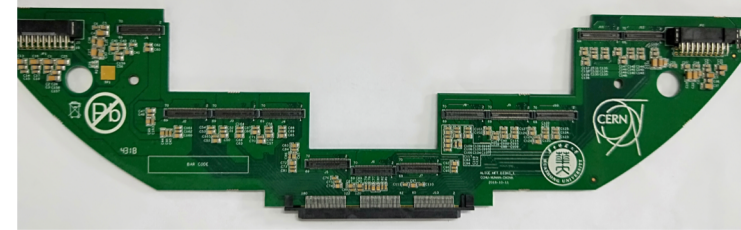


FIT installation on MFT

# MFT – Readout (WP6)

## PCB, MB and cables

- Disk01 PCB pre-production finalized
  - New capacitor strategy, tests on-going
- Mother Boards
  - MB01 produced ; Mechanical and electrical test on-going
  - MB2 layout finalized ; final check before production
- Cables
  - Pinout/wrapping finalized with SAMTEC
  - Pre-production on-going (delivery beginning of December)

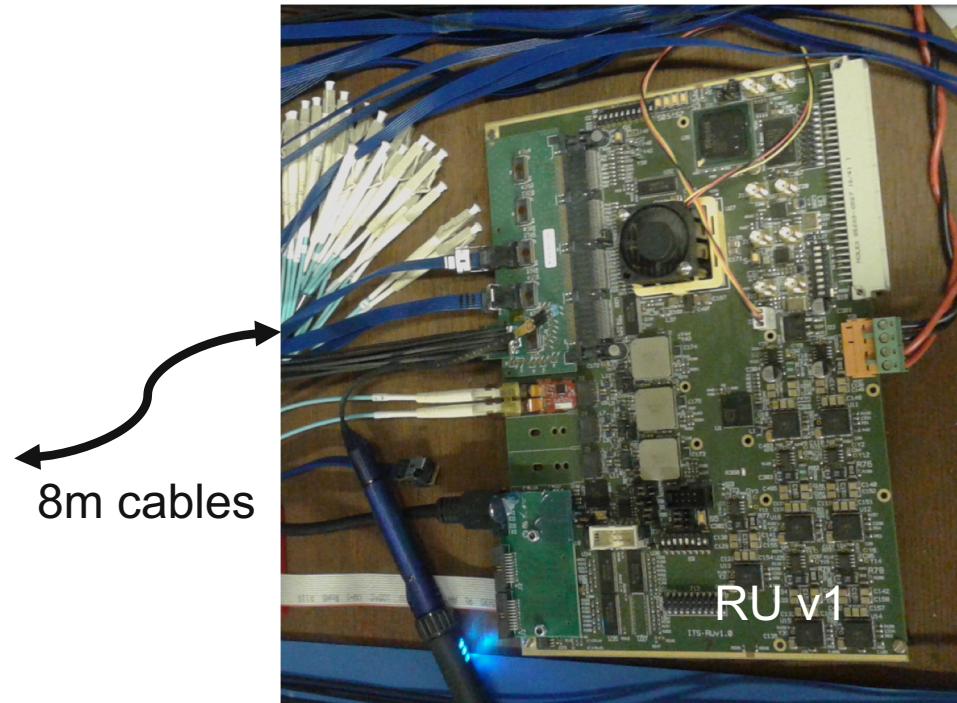
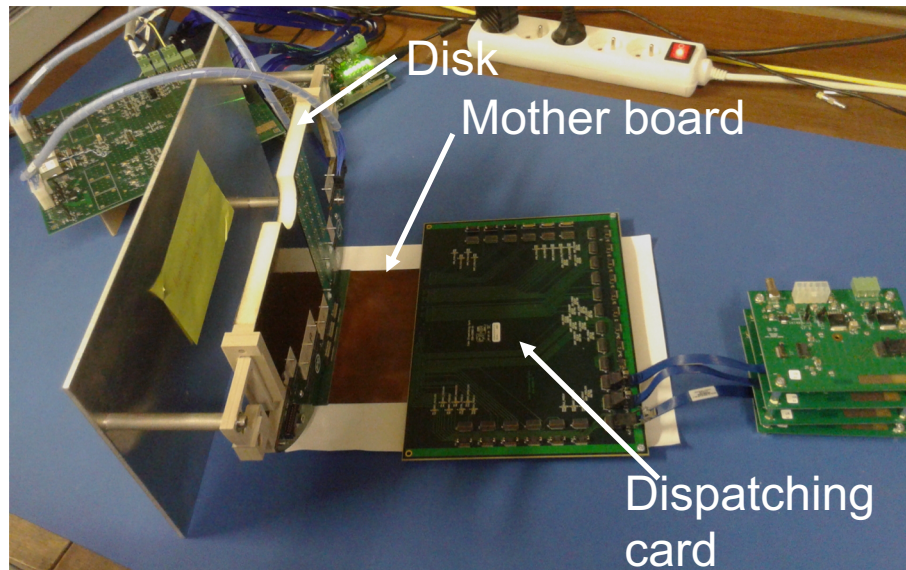


→ See Massimiliano and Ni presentations

# MFT – Readout (WP6)

## System tests

- Full scale setup (with most of pre-prod elements)
  - Ladders on disk, PCB, Mother Board, 8 m long SAMTEC Cable, RU
  - Intermediate boards and connectors equivalent to final setup
- BER measurement on-going with one chip in PRBS mode at 1.2 Gbs and all others with activity
- Readout PRR Scheduled Nov 29th

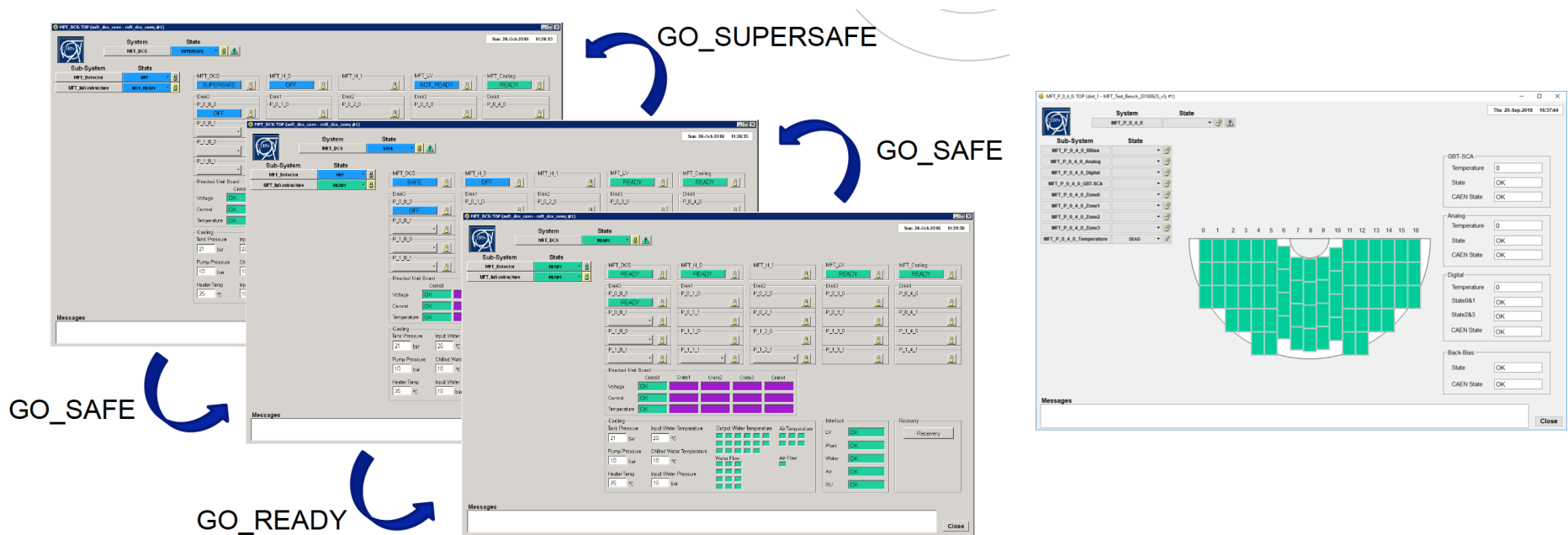


→ See Massimiliano presentation



# MFT – Services (WP7)

- DCS development very advanced
  - Development of all panels almost finalized
  - Definition of operation procedures on-going (SUPERSAFE, SAFE, ...)
- Detector control using GBT-SCA (on PSU) through CRU
  - Development on-going using CRU/FLP/ALF/FRED/WinCC chain
  - Test bench to be set up at CERN and then sent to Hiroshima



The image displays three screenshots of the MFT DCS control panels, illustrating the state transitions between different operational modes:

- GO\_SUPERSAFE:** The top screenshot shows the system in the SUPERSAFE state. The 'System' state is 'SUPERSAFE', and the 'Sub-System' state is 'MFT\_READY'. The 'MFT\_Ready' indicator is green.
- GO\_SAFE:** The middle screenshot shows the system in the SAFE state. The 'System' state is 'SAFE', and the 'Sub-System' state is 'MFT\_READY'. The 'MFT\_Ready' indicator is green.
- GO\_READY:** The bottom screenshot shows the system in the READY state. The 'System' state is 'READY', and the 'Sub-System' state is 'MFT\_READY'. The 'MFT\_Ready' indicator is green.

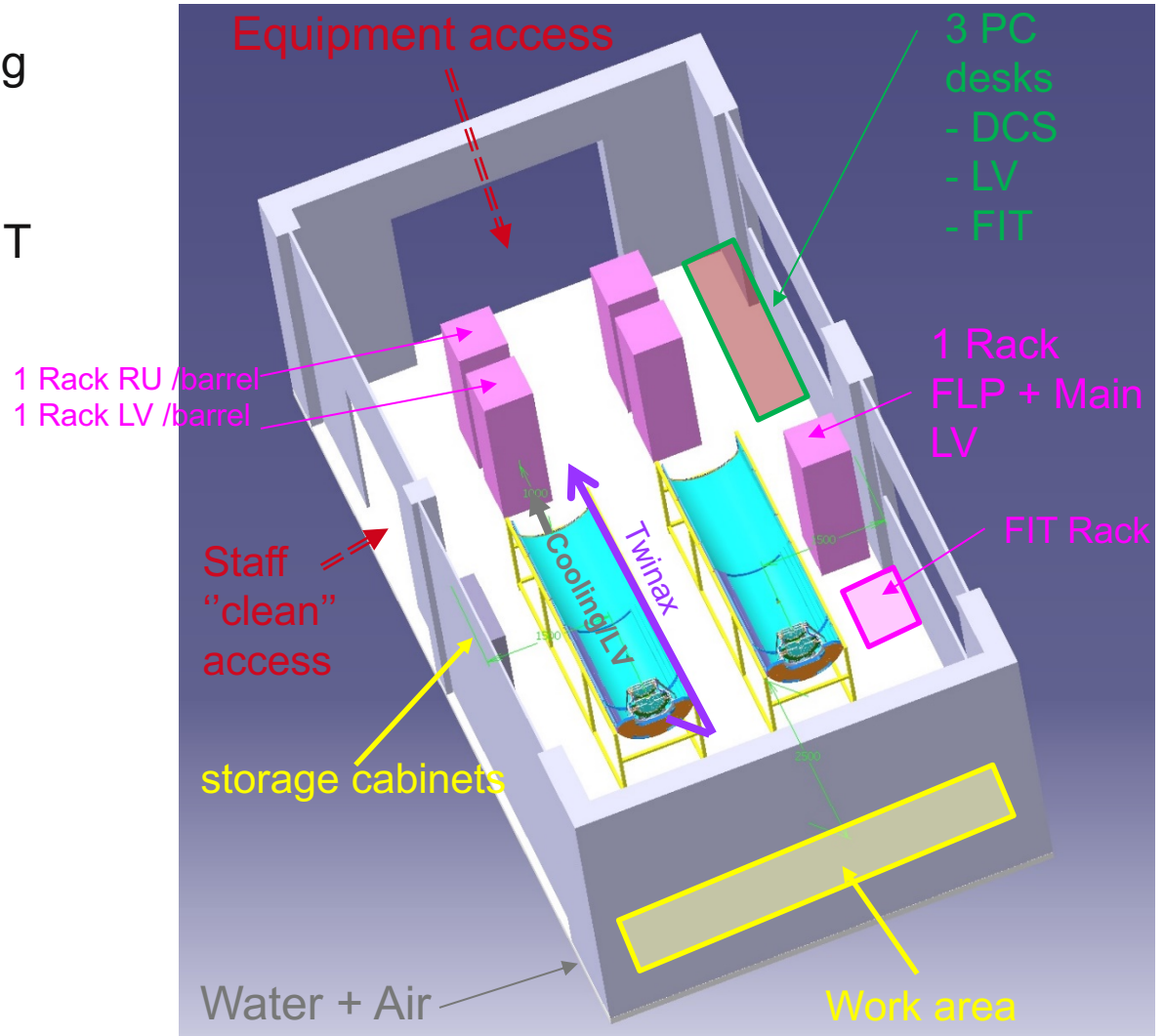
Blue arrows indicate the transitions between these states: GO\_SUPERSAFE (top to middle), GO\_SAFE (middle to bottom), and GO\_READY (bottom to middle).

→ See Motomi presentation



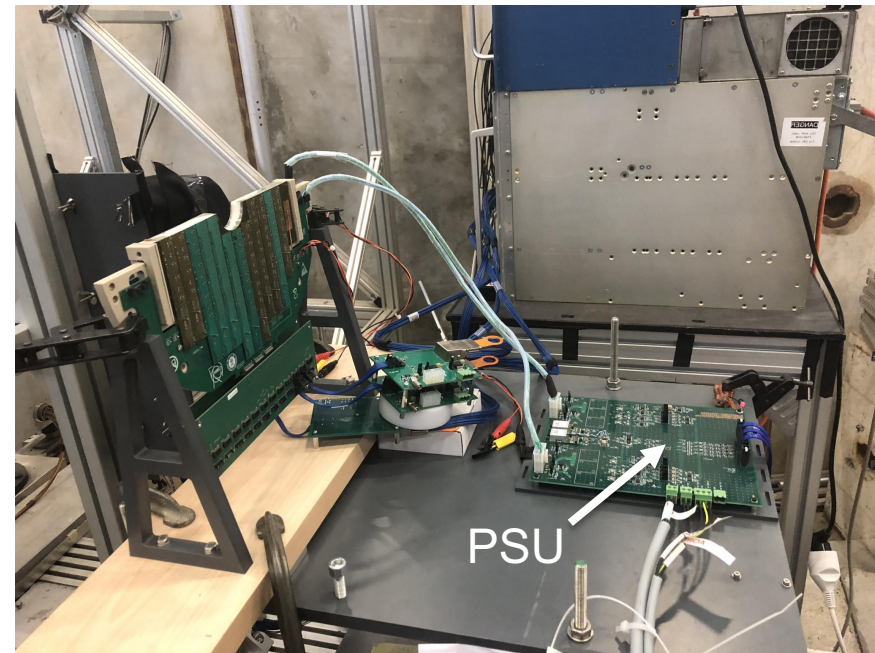
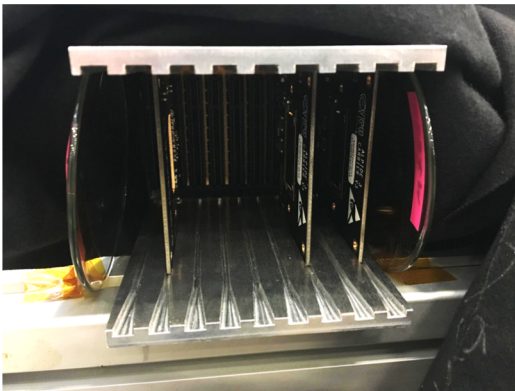
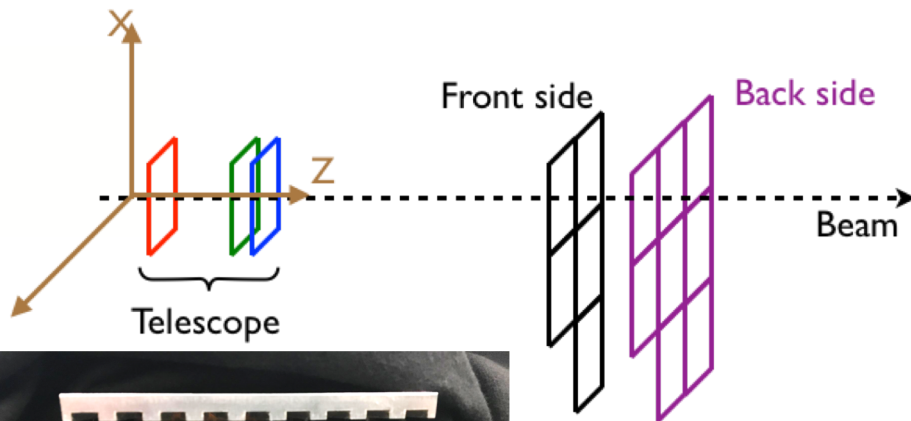
# MFT – Commissioning (WP8)

- Definition of commissioning room equipment on-going
- Including both MFT and FIT needs
- Structural work needed
  - Floor refurbishment
  - Air conditioning
  - Window UV filters
  - Electrical grounding



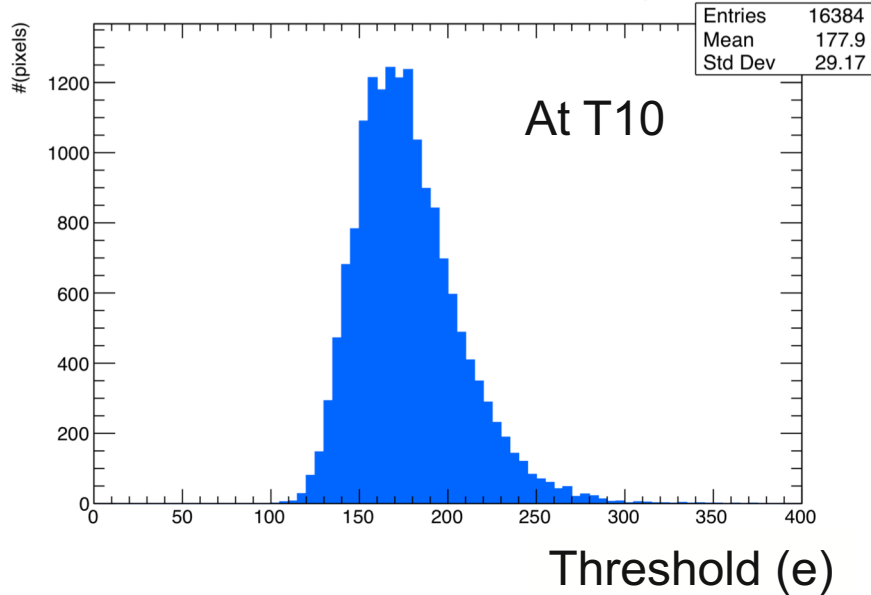
## MFT – Commissioning (WP8)

- Test beam from 20/06 to 09/07 at CERN PS (T10):  $\pi$  - 6 GeV
- Good grounding scheme (low noise), stable system (PSU), high sensitivity to ambient light

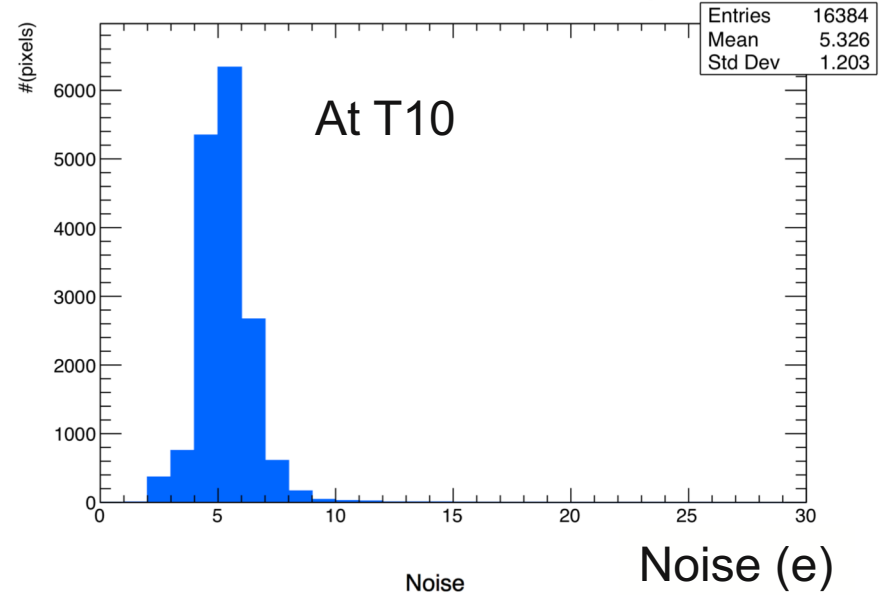


# Noise performances @ T10

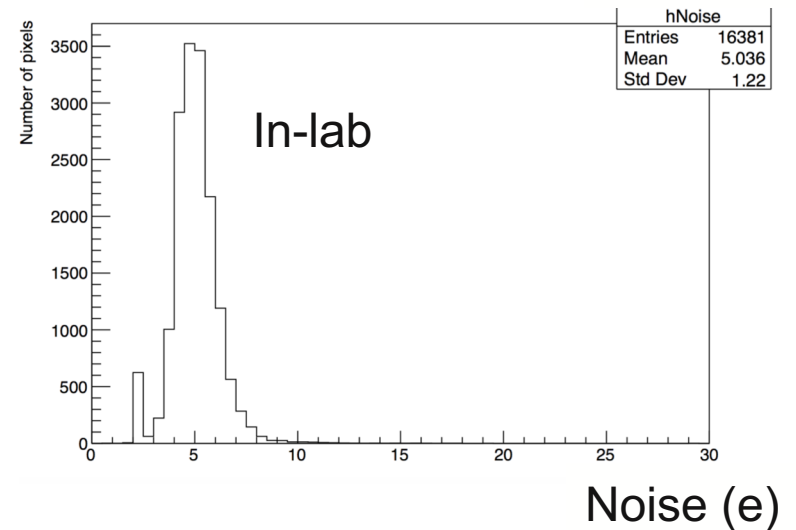
Board 0 Ladder 3010 RCV 3 Chip 8



Board 0 Ladder 3010 RCV 3 Chip 8

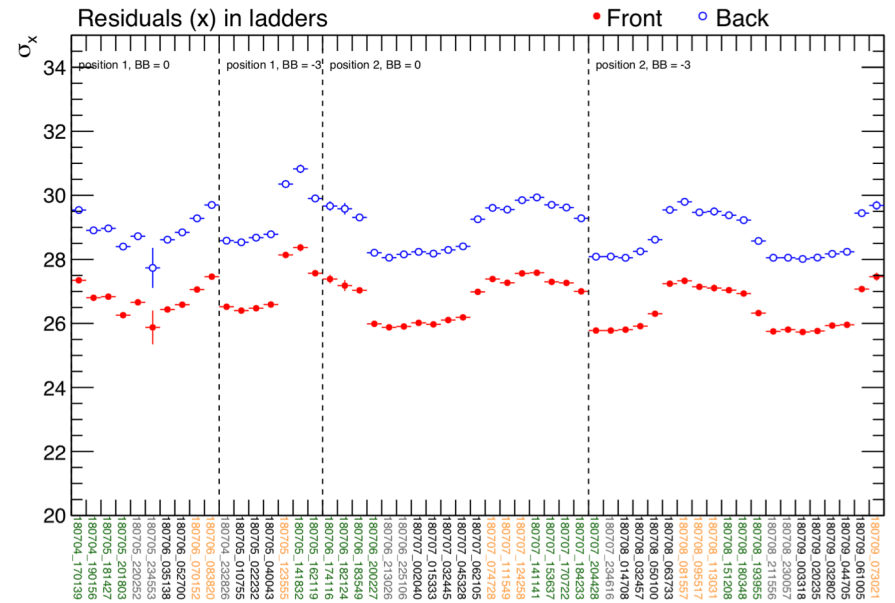
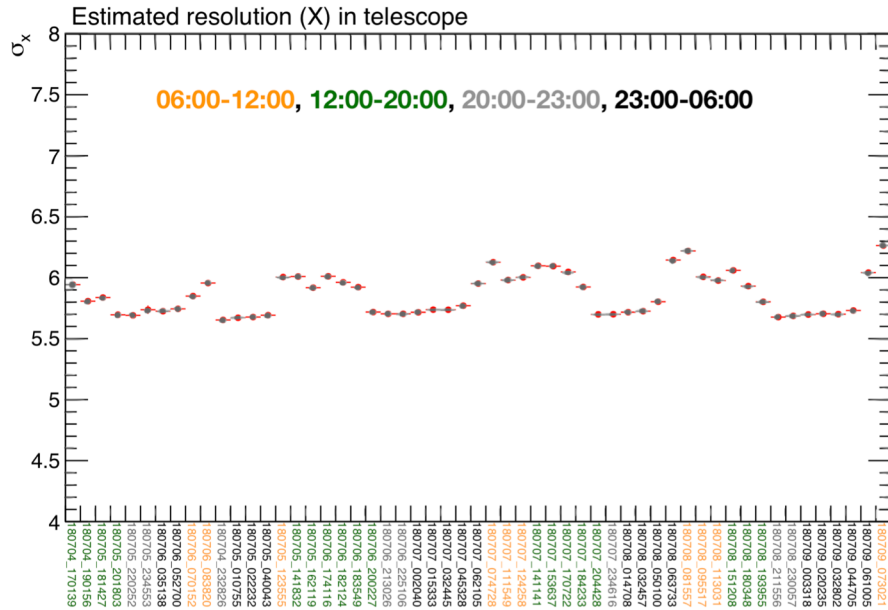


Very good performances in T10 environment  
(as good as during in-lab tests)



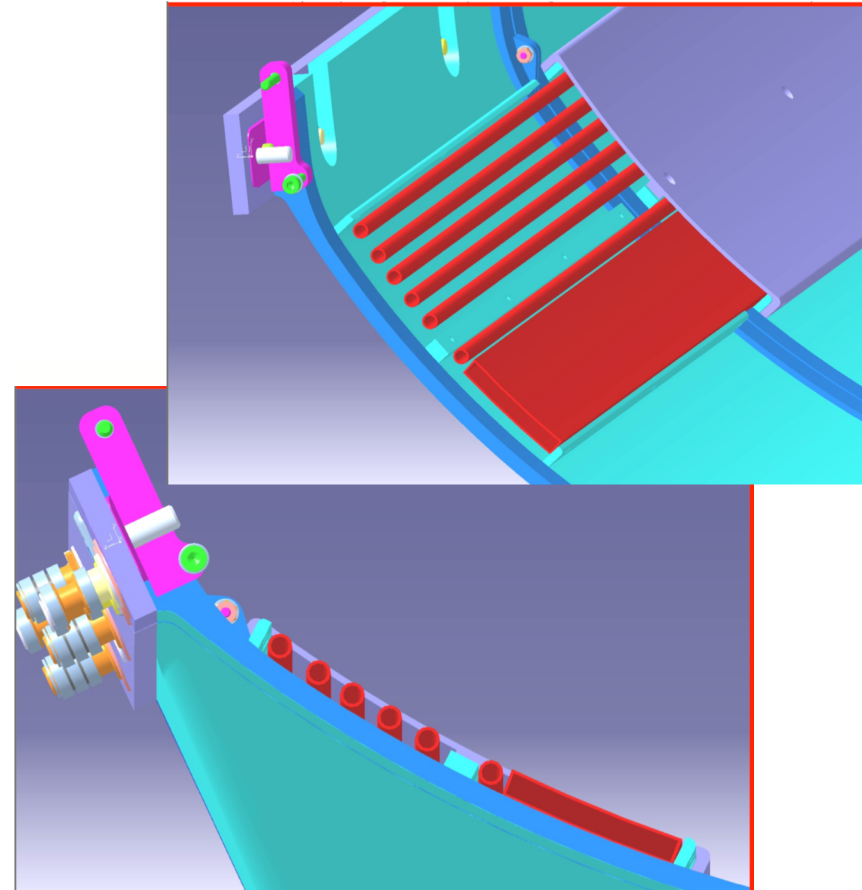
# Beam Test Analysis

- Analysis is advancing well
  - Extraction of Cluster characteristics w/ and w/o BackBais (# of pixels, shapes, spreads)
  - Extraction of MFT ladder resolution and efficiency



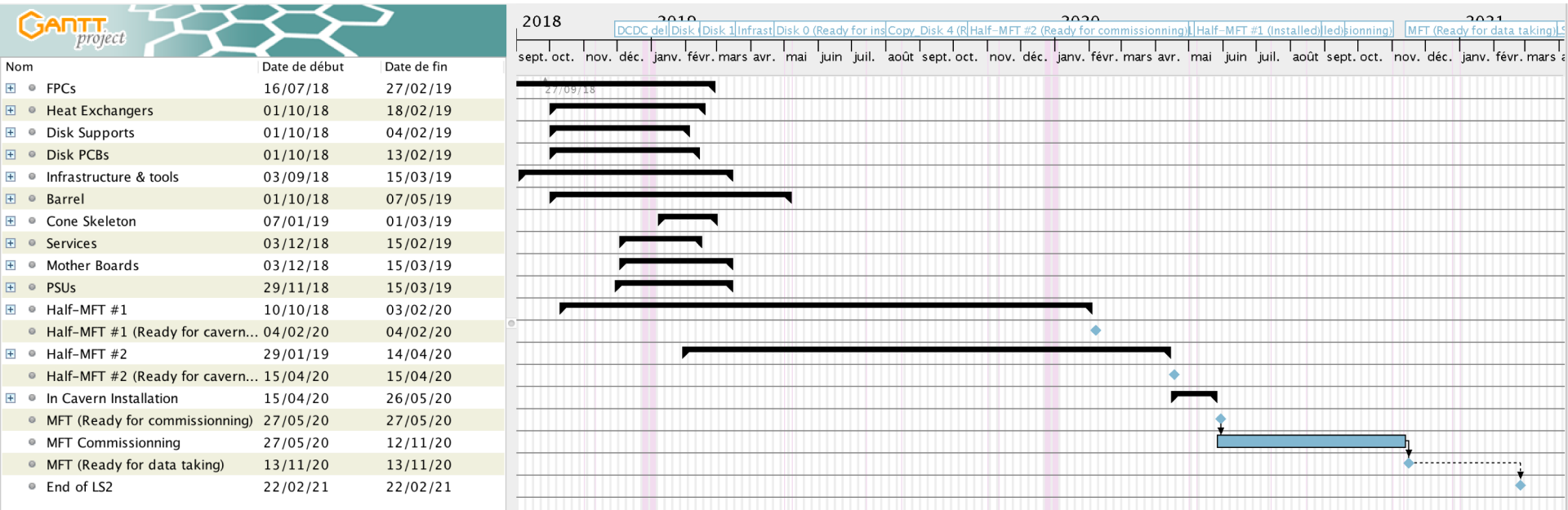
## MFT – Physics (WP9)

- Detector geometry fully implemented, working on out-acceptance details
- Data reconstruction using AliceO2 DPL
  - Digitalization done
  - Clustering almost finalized
  - Standalone tracking ongoing
- Chip positioning / detector alignment
  - Alignment framework done in AliceO2
- Internal MFT training to DPL framework
  - Scheduled in January
  - Goal: increase the number of trained person to the DPL framework



→ See Rafael presentation

# Updated planning





# Updated milestones

| Oct-18  | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|------|------|------|------|------|------|
| Ladder EDR (30/9/16)                          |      | 😊    |      |      |      |      |
| Ladder PRR (18/10/17)                         |      |      | 😊    |      |      |      |
| FPC production end (03/18)                    |      |      |      |      | 😊    |      |
| Ladder prod. end (7/19)                       |      |      |      | ▶️   |      | 😊    |
| Disk EDR (1/2/17)                             |      |      | 😊    |      |      |      |
| Disk PRR (30/1/18)                            |      |      |      | 😊    |      |      |
| Disk prod., assembly, metrology (4/19)        |      |      |      | ▶️   |      | 😊    |
| Cone and barrel EDR (20/6/17)                 |      |      | 😊    |      |      |      |
| Cone and barrel PRR (23/5/18)                 |      |      |      | 😊    |      |      |
| Cone assembly and <u>qualific.</u> end (4/19) |      |      |      | ▶️   |      | 😊    |
| Barrel structure construction end (01/19)     |      |      |      |      | 😊    |      |
| Cone integrated inside barrel (5/19)          |      |      |      |      | 😊    |      |
| RO EDR (13/7/17)                              |      |      | 😊    |      |      |      |
| RO PRR (29/11/18)                             |      |      |      | 😊    |      |      |
| MFT commissioned on surface (11/19)           |      |      |      |      | 😊    |      |
| MFT installation during LS2 (3/20)            |      |      |      |      |      | ▶️   |

5 months contingency



# Backups