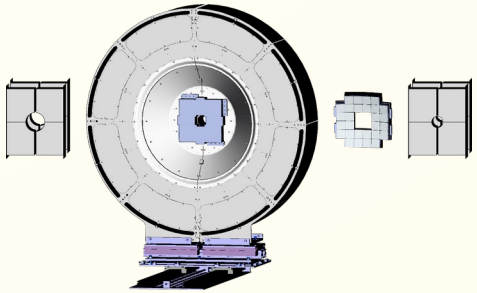
# Status of the Fast Interaction Trigger for ALICE Upgrade

ICHEP2020, 40th International Conference on High Energy Physics
Prague (virtual conference), 28 July – 6 August 2018

Maciej Słupecki **on behalf of the ALICE Collaboration**

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

HELSINKI INSTITUTE OF PHYSICS



# ALICE upgrades

Time Projection Chamber (TPC)

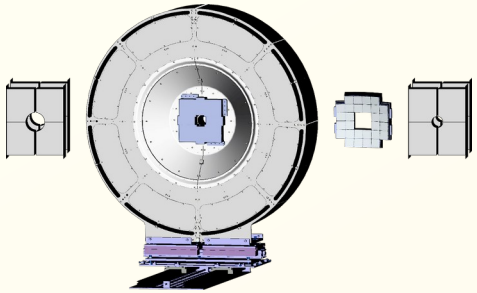
Muon Forward Tracker (MFT)

Inner Tracking System (ITS)

New Online-Offline ($O^2$) computing infrastructure

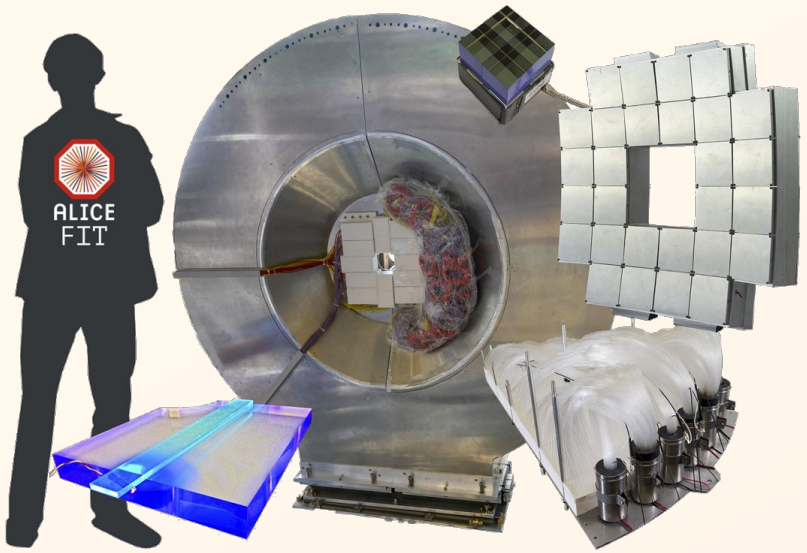
**New Fast Interaction Trigger (FIT)**

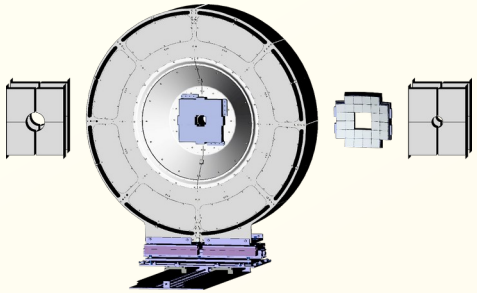
- Cherenkov arrays
- Plastic scintillators



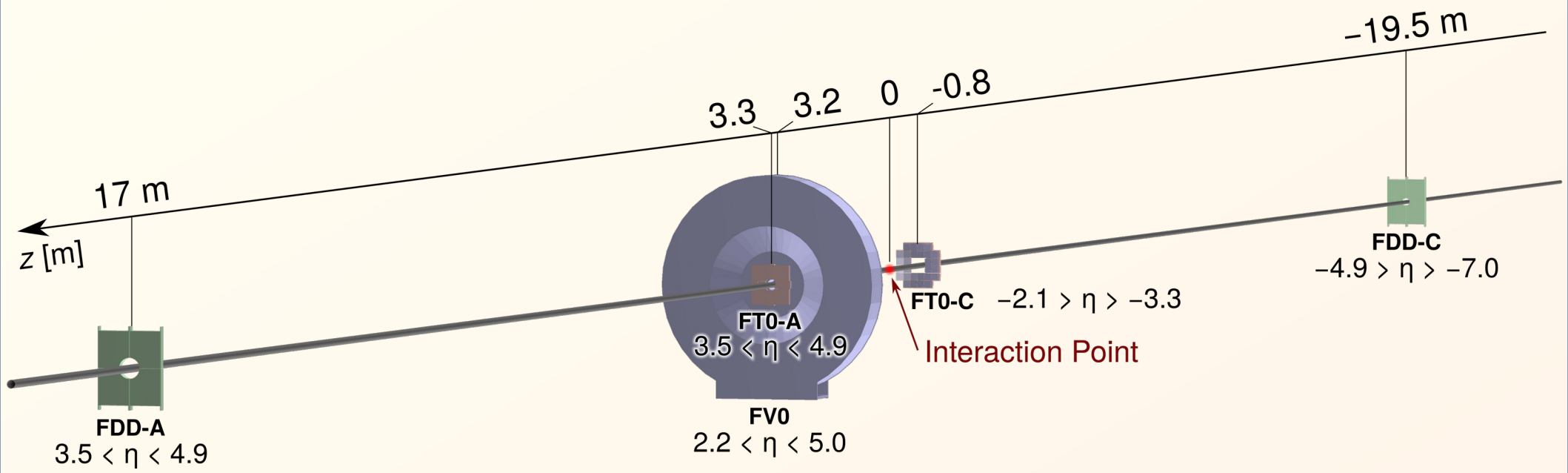
# Why ALICE needs FIT?

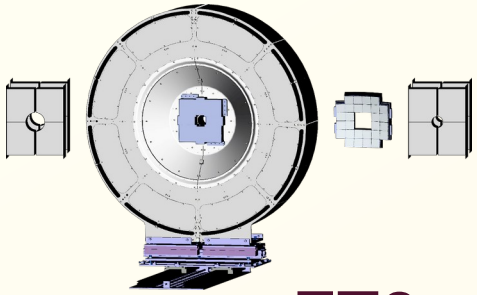
- **Luminosity** monitoring & feedback to LHC
  - Essential for the operation of ALICE
- Fast Interaction **Trigger**
  - Online vertex determination
  - Minimum bias and centrality selection
  - Rejection of beam/gas events
  - Veto for ultraperipheral collisions
- **Multiplicity → centrality** and **event plane**
- **Collision time** for Time-Of-Flight particle ID
- **Diffractive physics**





# FIT layout


−19.5 m
3.3
3.2
0
-0.8
17 m
z [m]
FDD-C
−4.9 > η > −7.0
FT0-C
−2.1 > η > −3.3
FT0-A
3.5 < η < 4.9
Interaction Point
FDD-A
3.5 < η < 4.9
FV0
2.2 < η < 5.0



# FIT subdetectors

## FT0

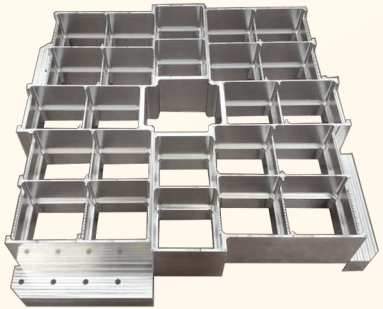
- 2 **Cherenkov** arrays
  → with quartz radiators
- low latency → LM trigger
- time resolution < 20 ps
- background rejection
  → MB trigger, luminosity

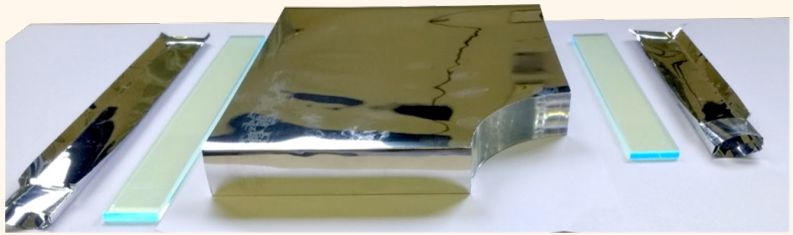
## FV0

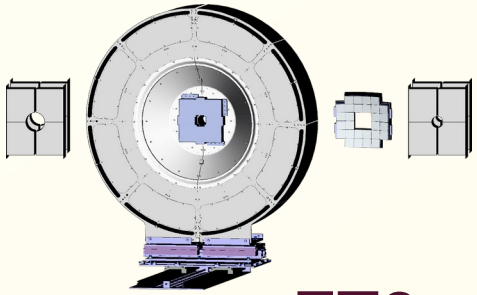
- 5 **scintillator** rings, 8 sectors
- low latency → LM trigger
- time resolution ~ 250 ps
- background monitoring
- large area → multiplicity trigger

## FDD

- 2 **scintillator** arrays,
  2 layers each
- very forward rapidity
  → diffractive physics
- background monitoring







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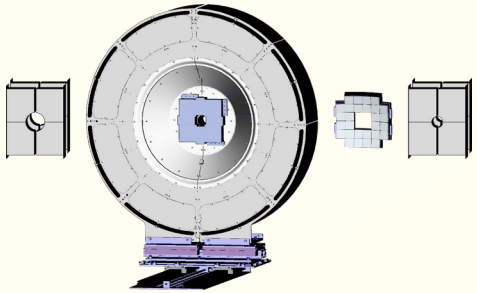
  → diffractive physics
- background monitoring

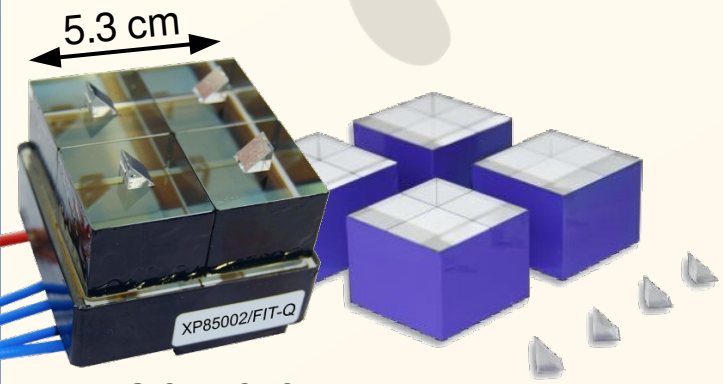
- **Common custom-designed front-end electronics**
  → sustained pp operation at 25 ns bunch crossing, high dynamic range
- **Radiation hard**
  → no active electronics at the detector
  → FIT will survive Run 3 and 4 without major component replacements



# FIT subdetectors – FT0

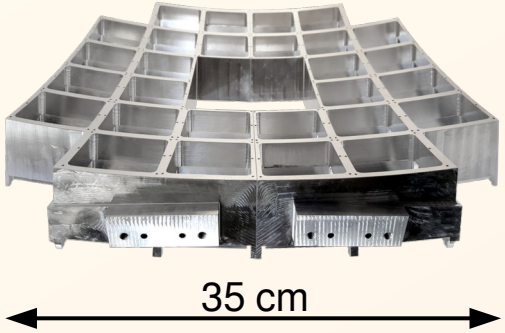
## Detector module

- MCP-PMT PLANACON XP85002/FIT-Q
- 4 quartz radiators & 4 readout channels



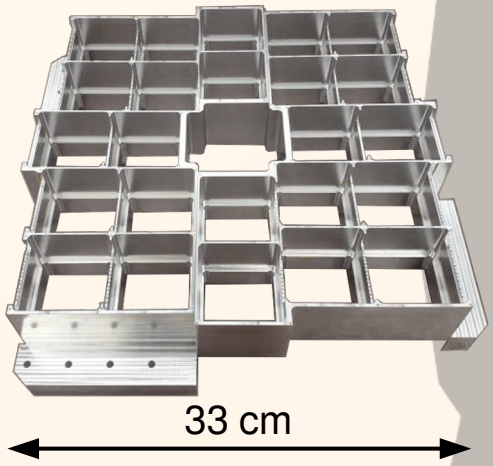

## FT0-C

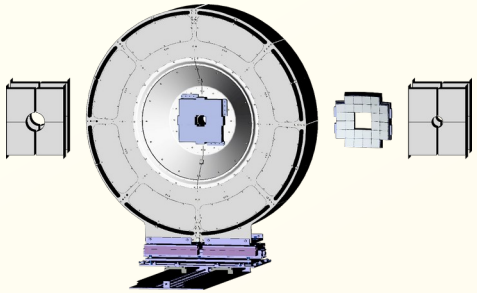
- 28 modules → 112 channels
- concave shape




## FT0-A

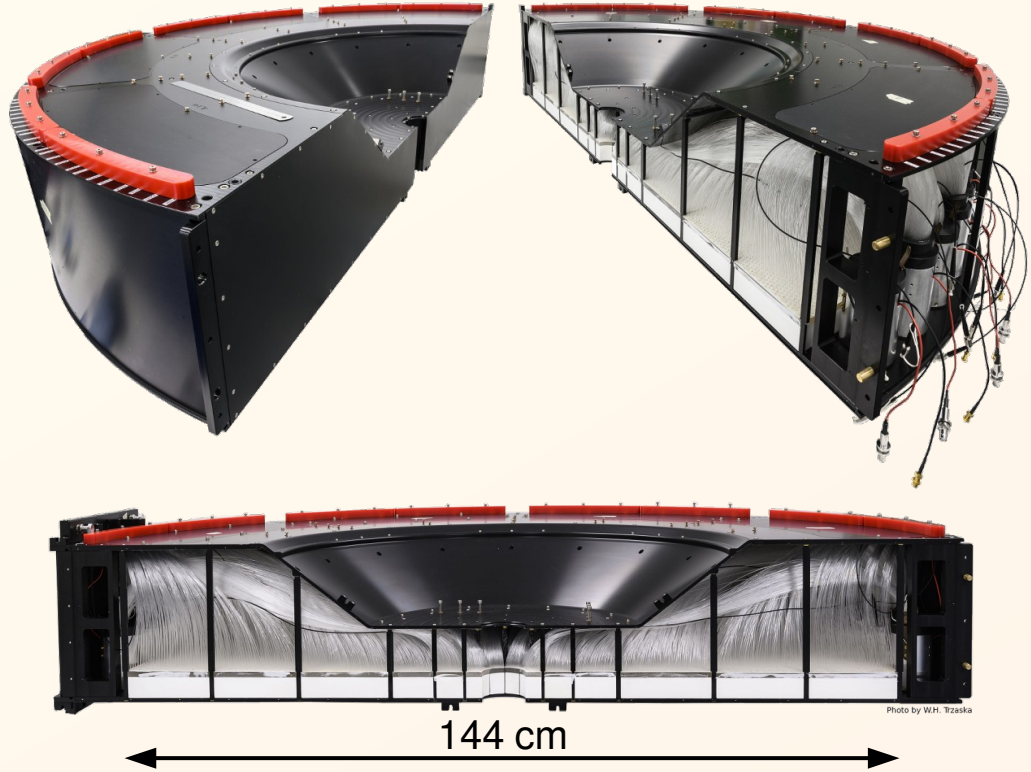
- 24 modules → 96 channels
- planar shape

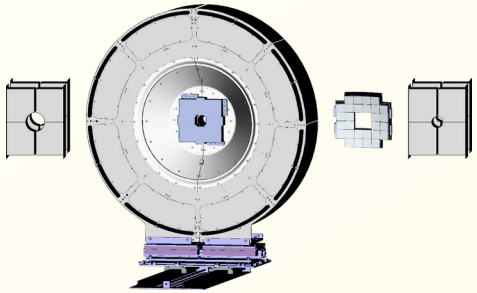




# FIT subdetectors – FV0

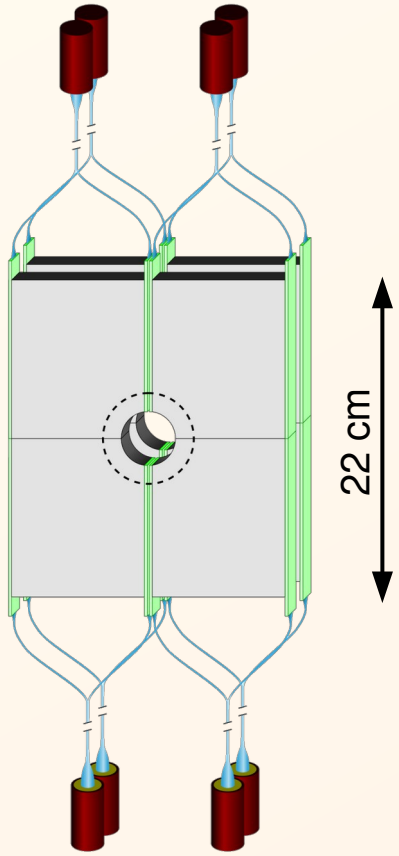
- 40 scintillator cells
- 48 readout channels
  → 2 ch, for every 5$^{th}$-ring-cell
- **novel light-collection system**
  → keep **pulse width** < 25 ns
  → no wavelength-shifting fibers

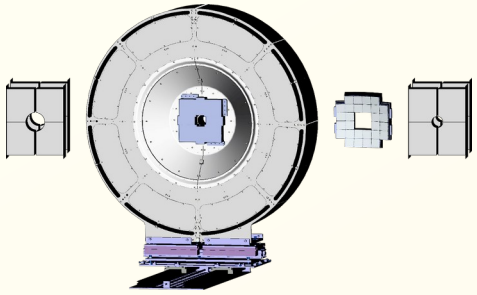




# FIT subdetectors – FDD

- 2 arrays of 2-layered scintillators, 4 cells per layer
  → 16 readout channels in total
- Light is collected through plastic bars doped with very fast wavelength shifter (NOL-38), and transported through clear fiber bundles to PMTs
- Studies diffractive or photon-induced processes
  → tags absence of activity in the forward direction





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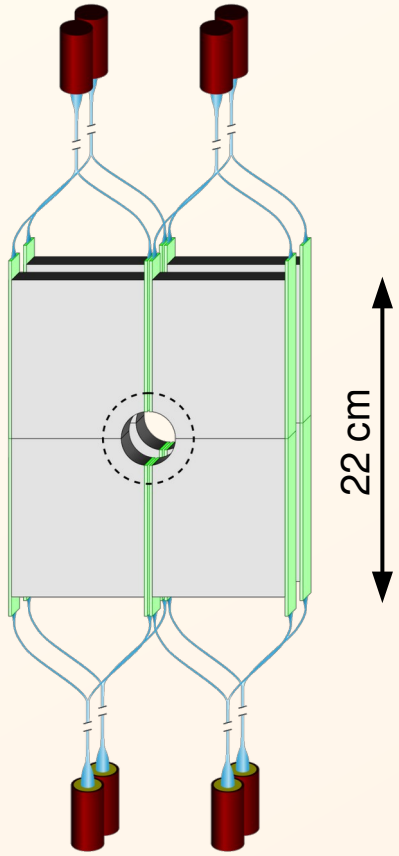
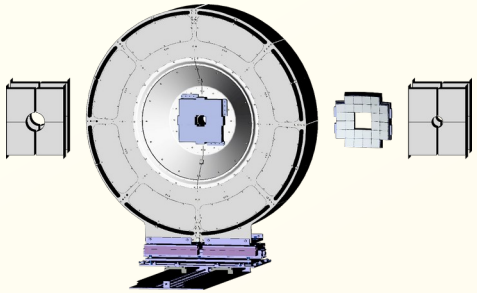
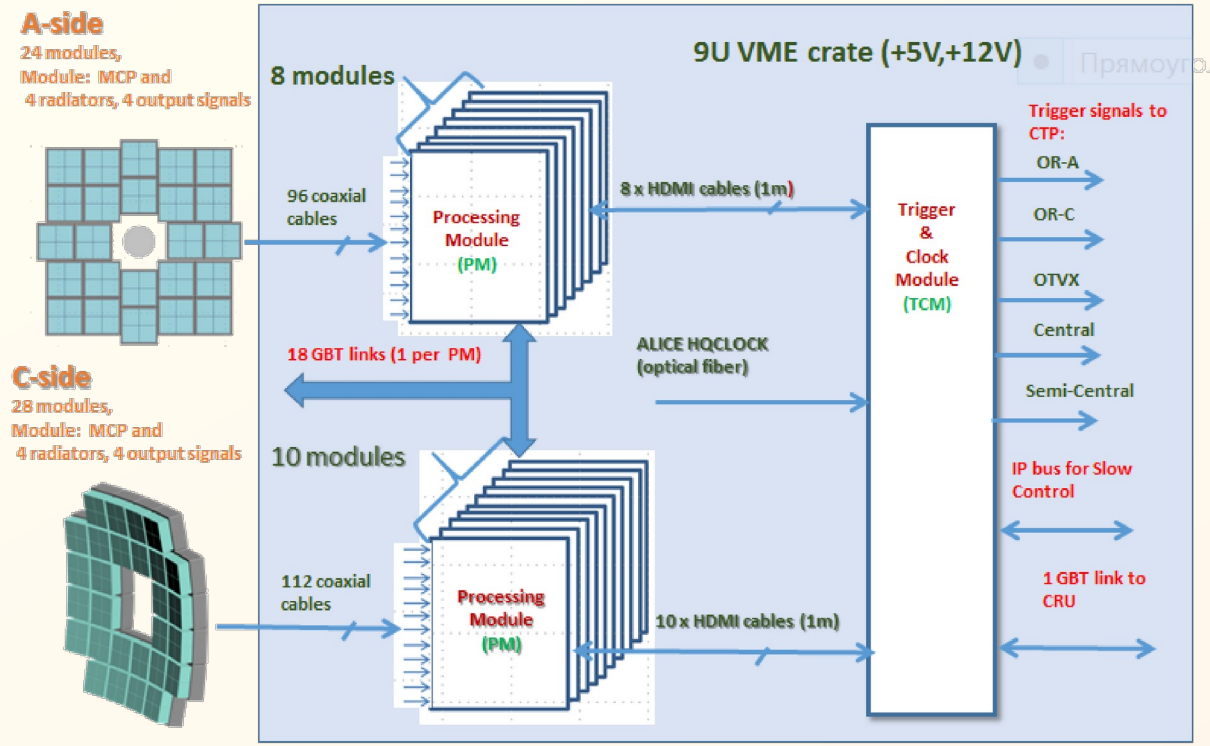
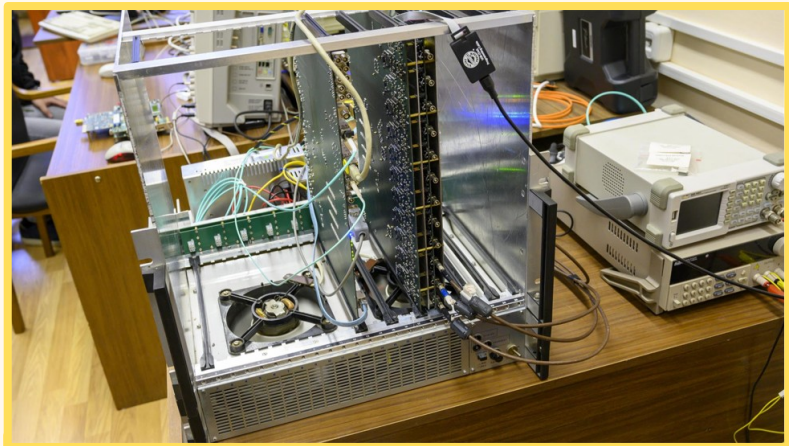


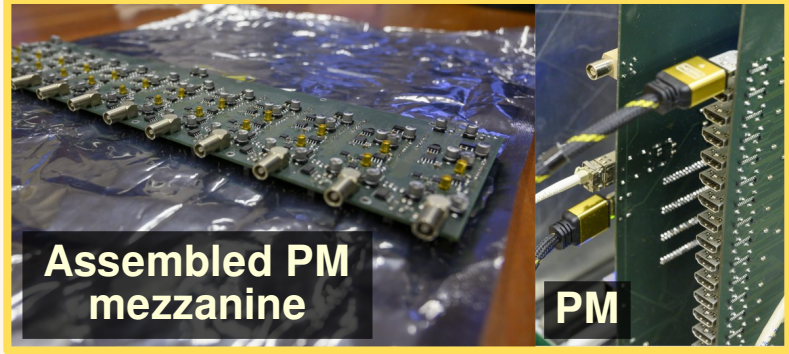

See **poster** on 31 Jul 2020, 13:30 by **Solangel Rojas Torres**:
*The Forward Diffractive Detector for ALICE*

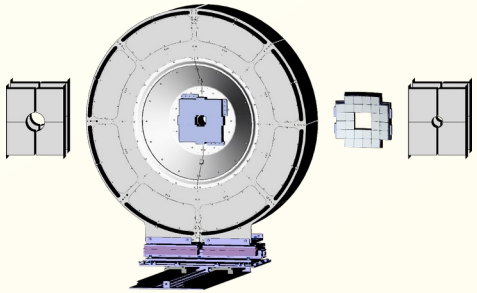


# FIT electronics



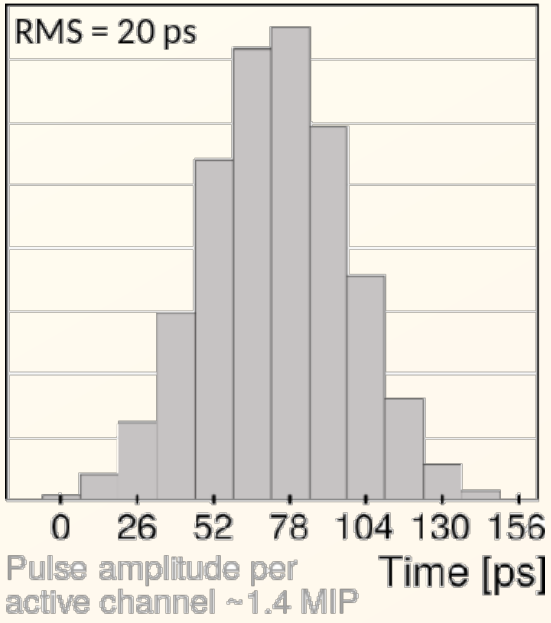





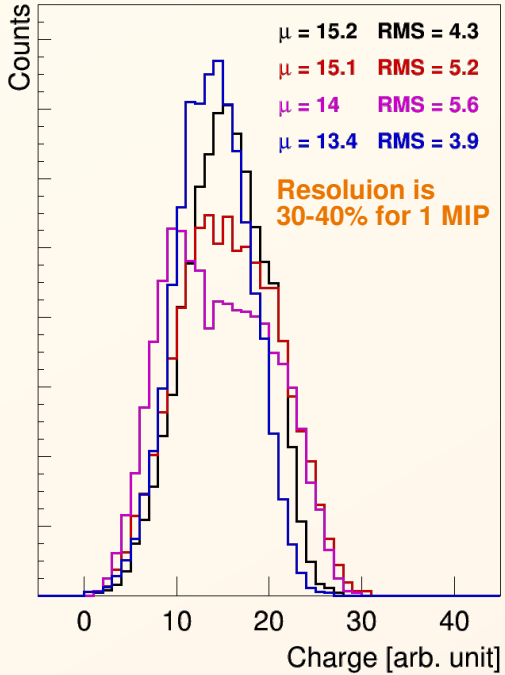


# FIT electronics
## Latest test results

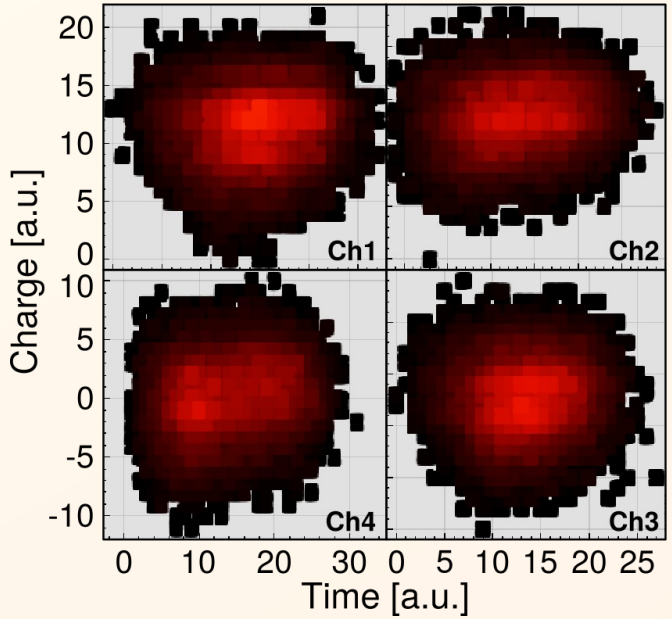
Vertex trigger resolution
at low channel multiplicity (2 & 3)

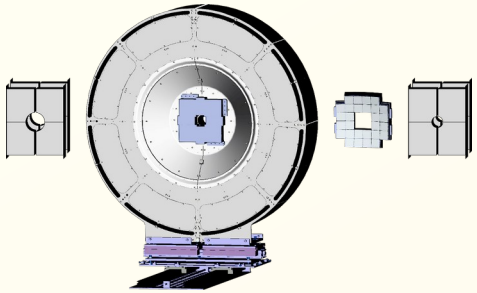



**Charge of 4 random channels from the partly assembled FT0-A detector and final version of FEE using laser**




**Time vs. charge shows no correlation → CFD works correctly**





# Simulated physics performance
## Event-plane resolution

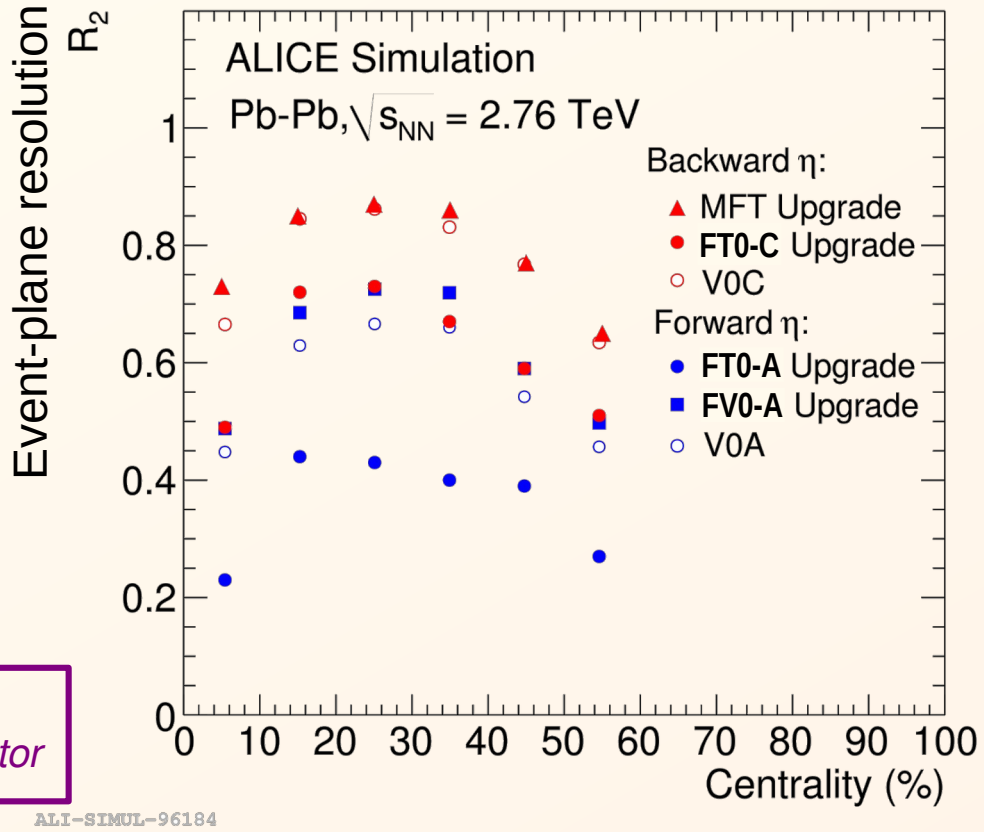
Definition

$$\mathcal{R}_n = \langle \cos\left[n\left(\Psi_n - \Psi_{\mathrm{RP}}\right)\right]\rangle$$

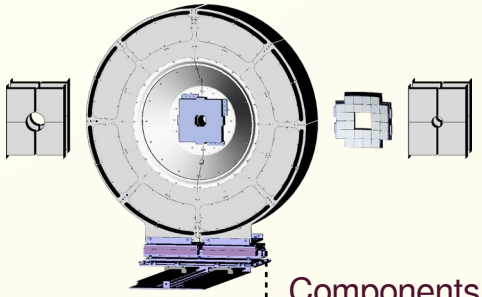
Harmonic number (for elliptic flow $n = 2$)

Measured event plane

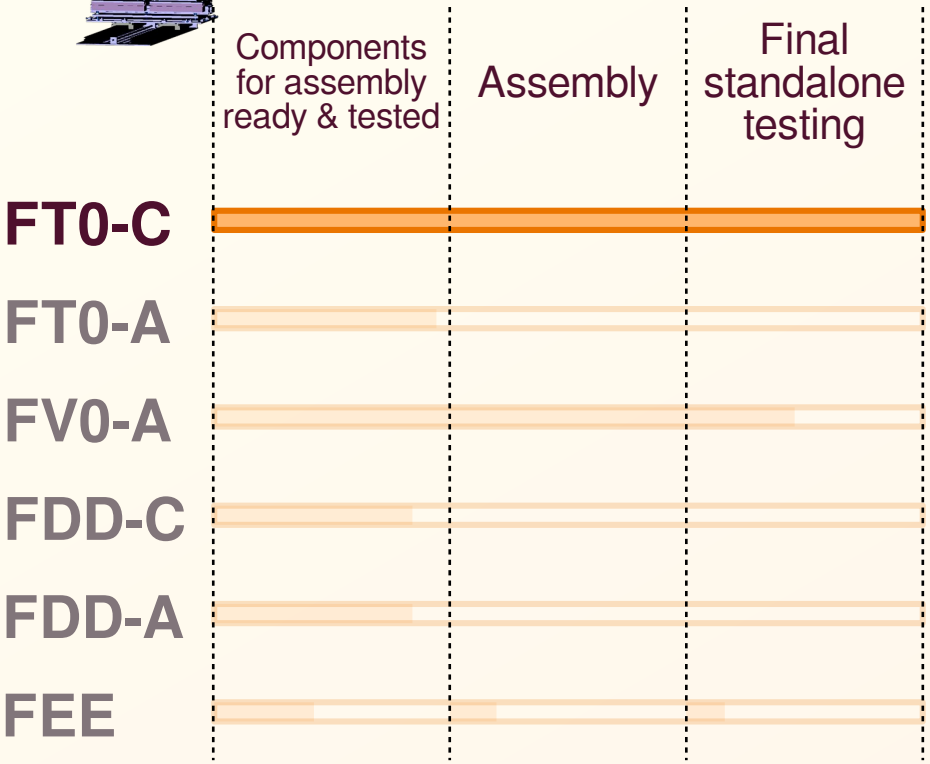
Reference (simulated) plane



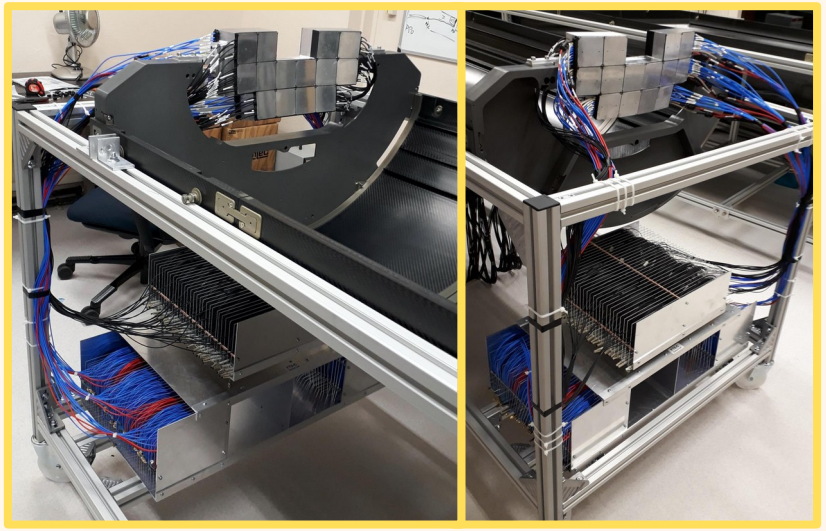

See **poster** on 31 Jul 2020, 13:33 by **Heidi Rytkonen**:
*Event-plane determination with the new ALICE FIT detector*

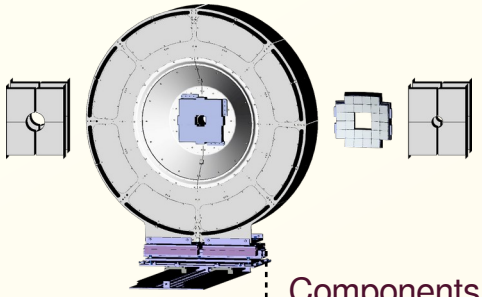


# Status of FIT subsystems




- Assembled, integrated within the common structure with MFT, all connections tested → ready for installation





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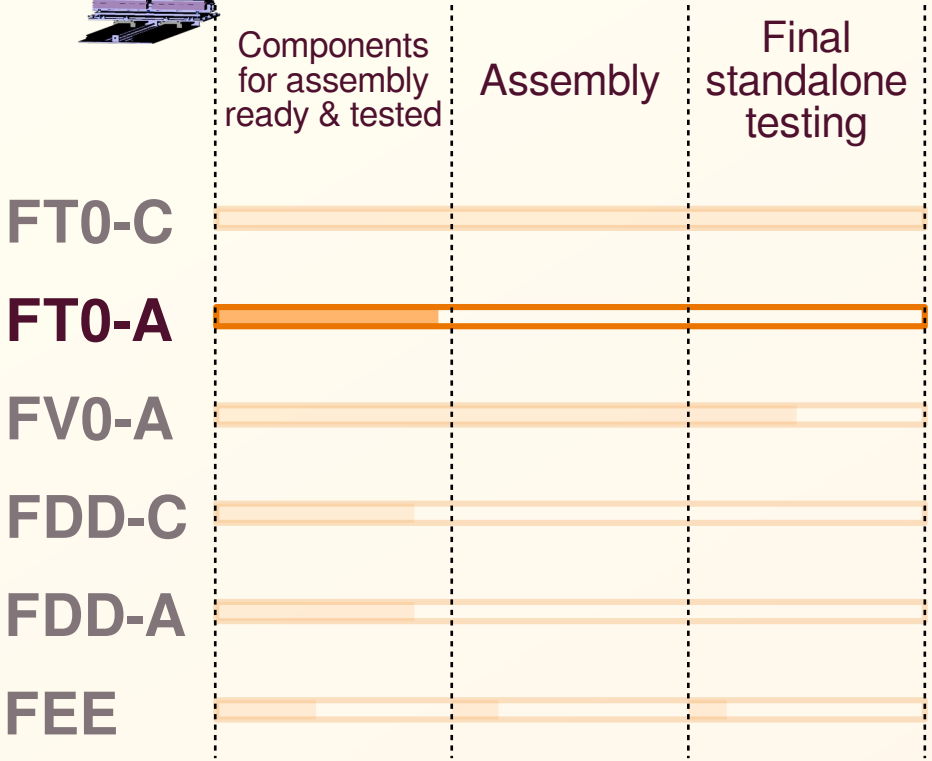
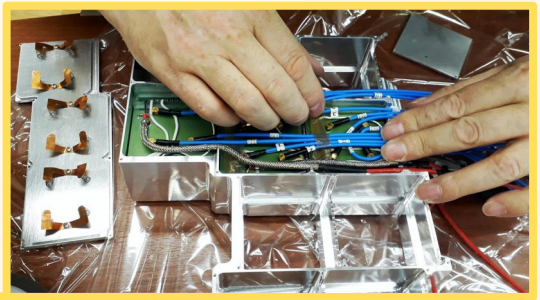
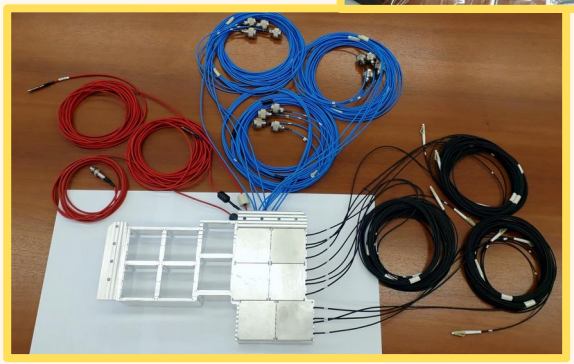
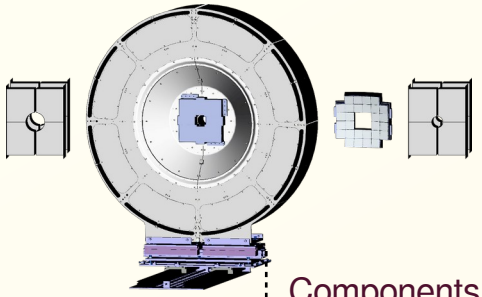



- Used for final FEE tests
- Simple modification of metal structure needed
  → scheduled in 1.5 months
- Expected assembly time: <2 weeks







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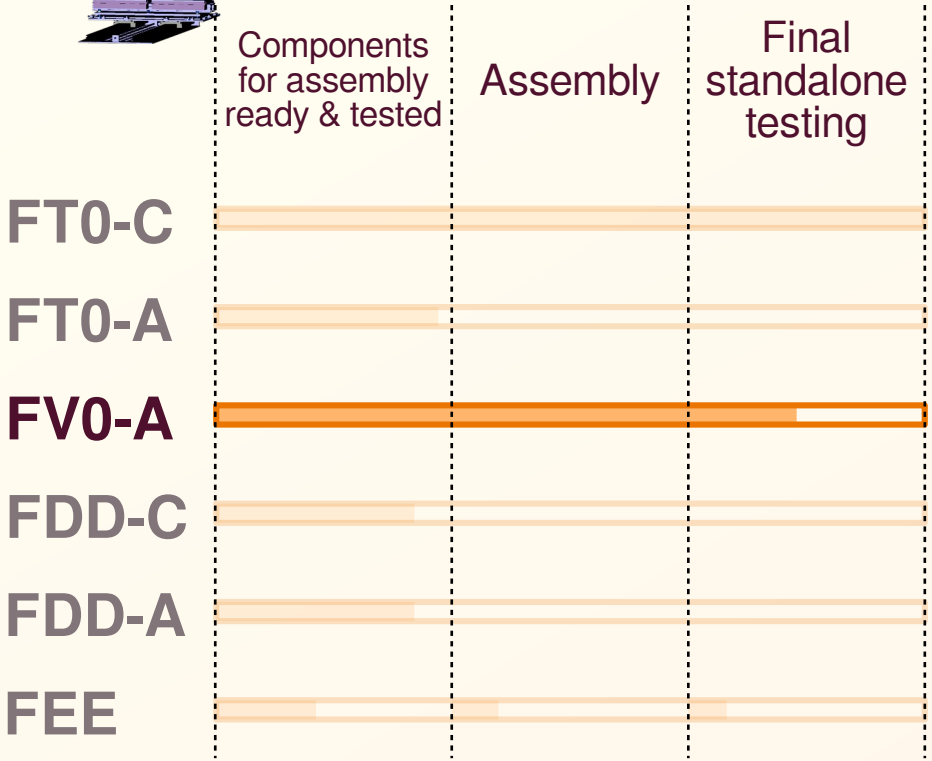
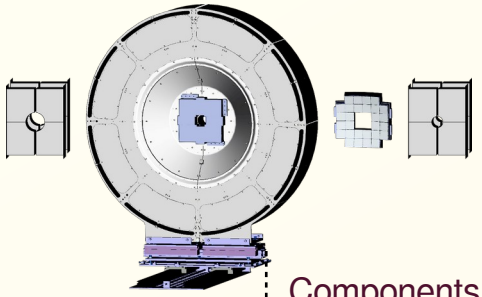



- Measurements to be completed:
  - → pulse-shape verification
  - → tests with final FEE, tuning for FV0
  - → charge measurement with cosmic muons



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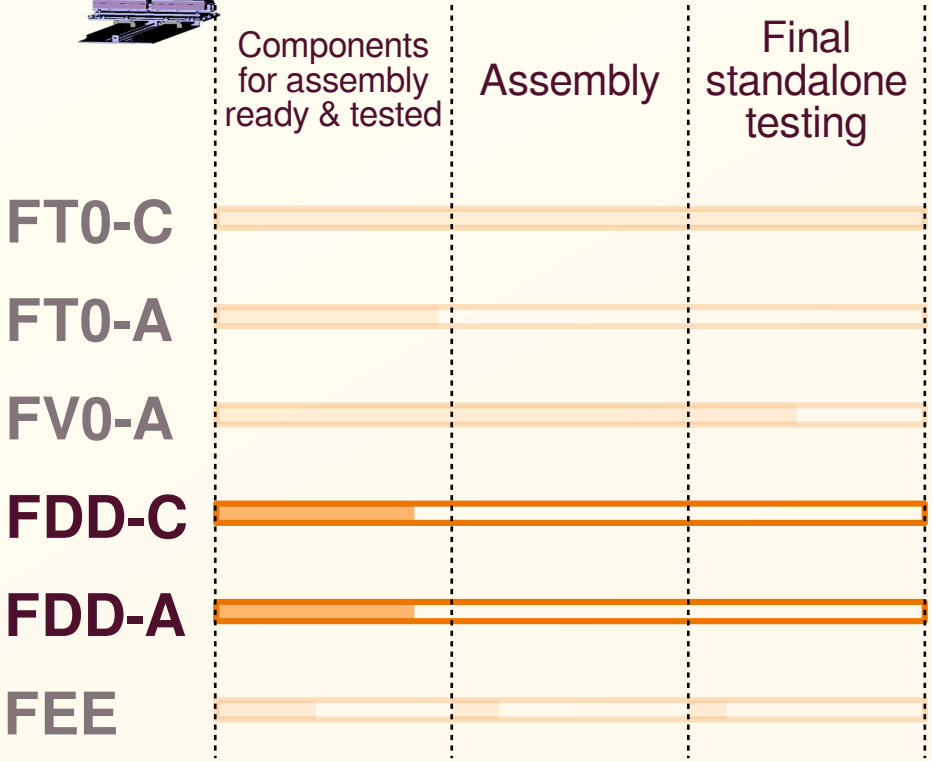
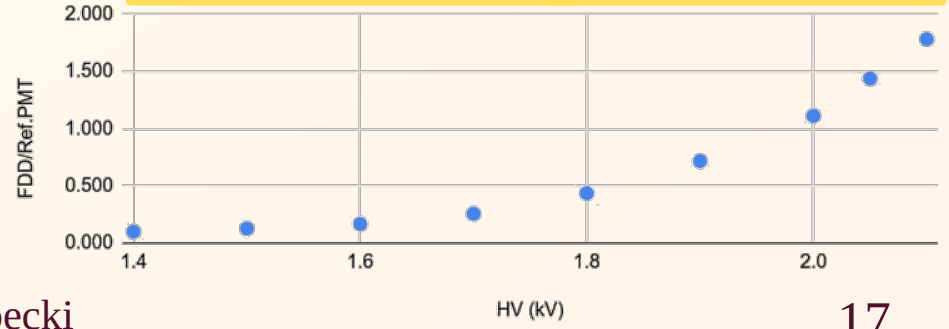
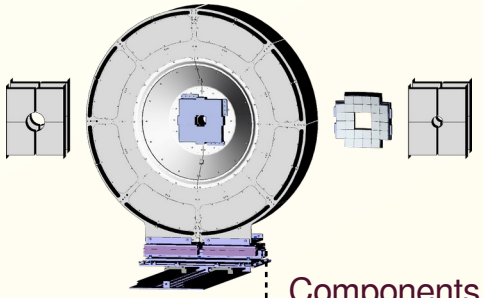



- Characterization of photosensors is almost completed
- Assembly of scintillator modules takes 60 h
- Assembly of fiber bundles takes 2-3 weeks





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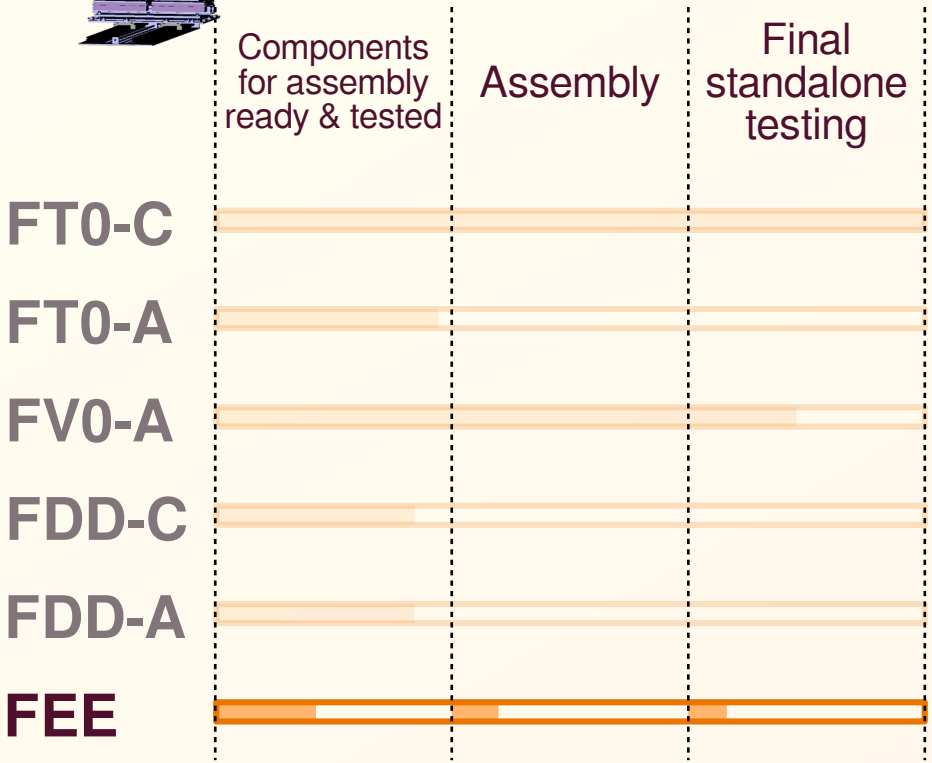
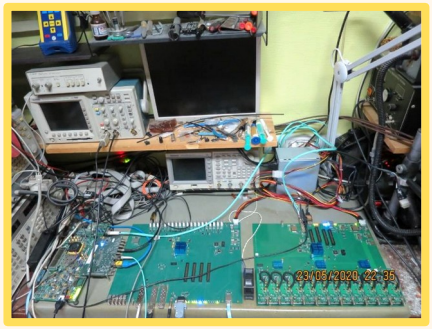
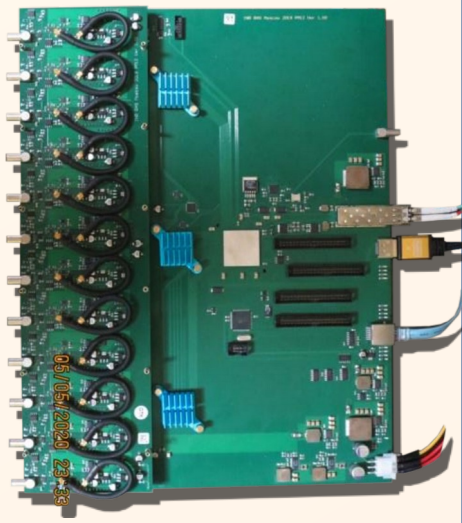
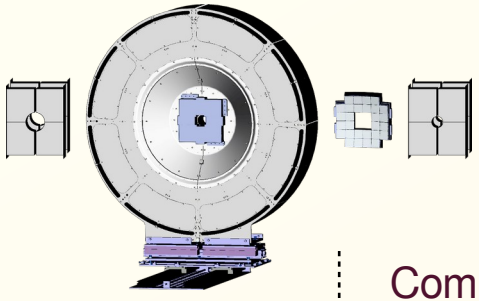



- Components are tested in parallel with assembly
- Electronics designed for FT0
  → need to be tested and tuned for FV0 and FDD
- Mass production will start after all tests are finished
  → within 3 months



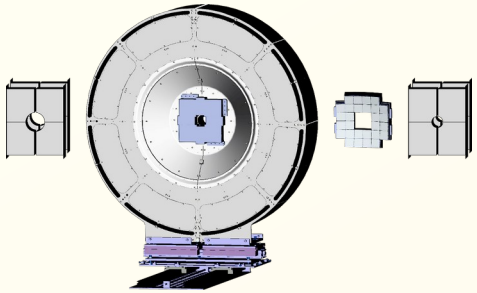




# Status of FIT subsystems

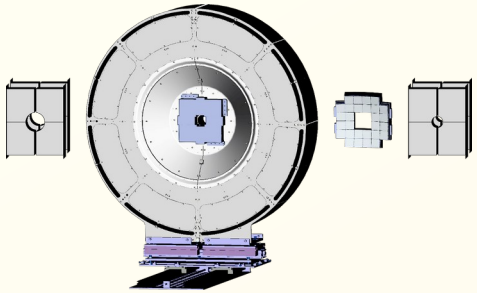
| | Components for assembly ready & tested | Assembly | Final standalone testing | Scheduled for installation at ALICE* | Remaining time |
|---|---|---|---|---|---|
| **FT0-C** | | | | 30.11.2020 – 22.01.2021 | 4 months |
| **FT0-A** | | | | 19 – 23.04.2021 | 8.5 months |
| **FV0-A** | | | | 19 – 23.04.2021 | 8.5 months |
| **FDD-C** | | | | Before 6.11.2020 | **3 months** |
| **FDD-A** | | | | 4-11.01.2021 | 5 months |
| **FEE** | | | | Before 06.2021 (global commissioning) | 10 months |

*According to v41, subject to change, depending on COVID-19 effects



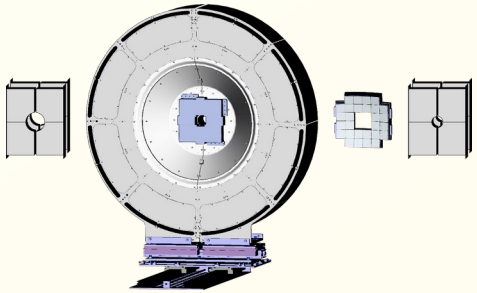
# Summary

- FIT consists of 3 very different subdetectors
- FIT is in the middle of assembly phase and its components are undergoing standalone tests
- In terms of hardware the main focus is on electronics development and testing
- FIT assembly and testing → on time for installation

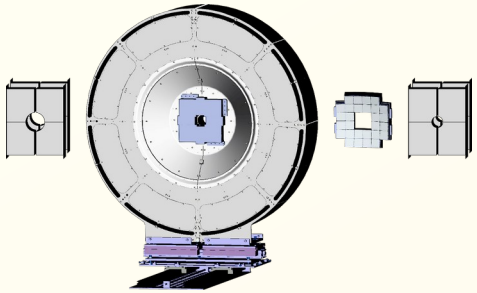


ALICE
A JOURNEY OF DISCOVERY

# Thank you for your attention



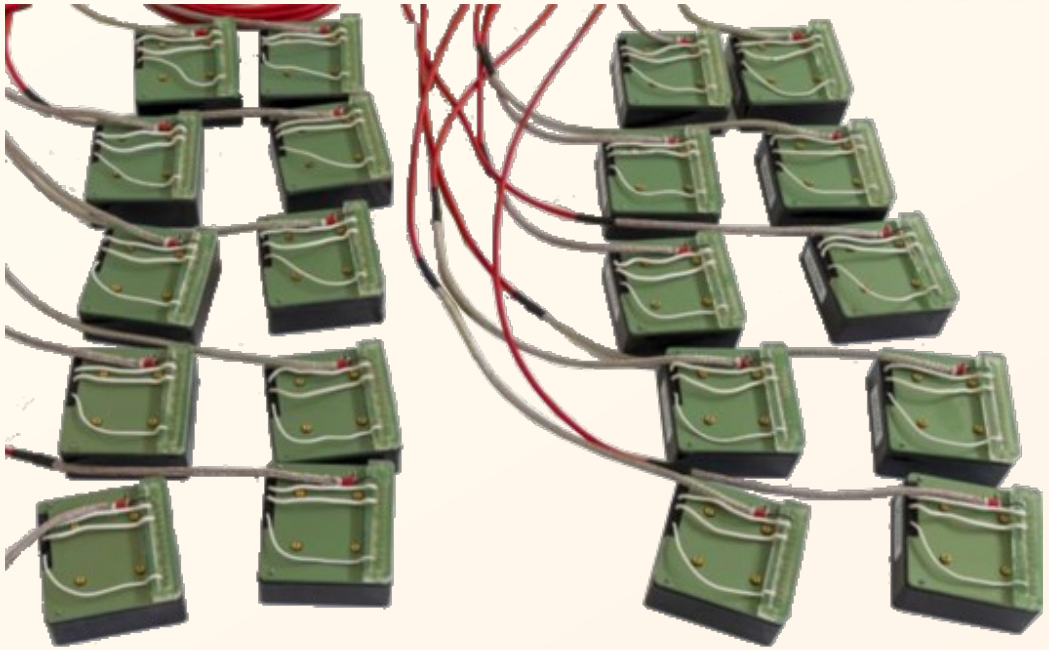
# Backup



# FIT detectors – FT0

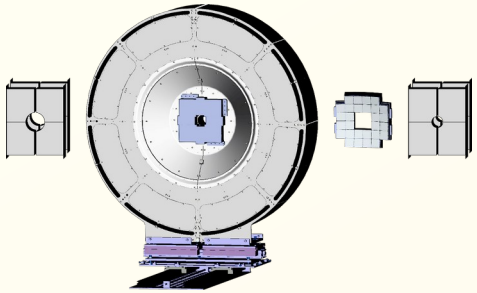
## Comprehensive photosensor acceptance tests

ALICE
A JOURNEY OF DISCOVERY



83 units were tested or retested

- Pulse shape
- Gain scan
- Anode current saturation limit
- Resistance
- Afterpulses and dark count rate
- Long term HV stress-test



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## Comprehensive photosensor acceptance tests

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- **Gain scan**
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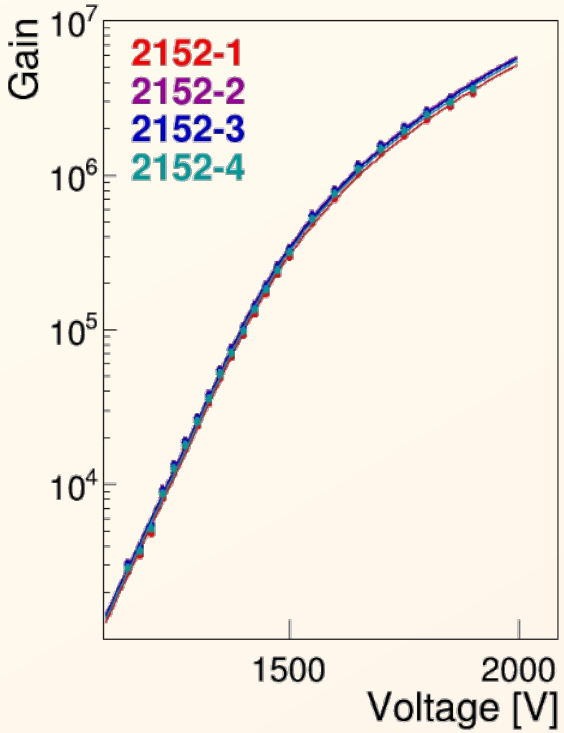


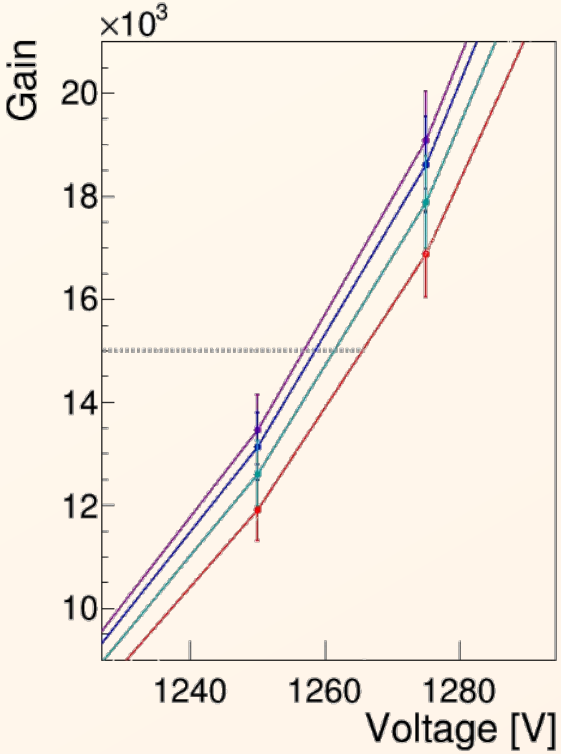

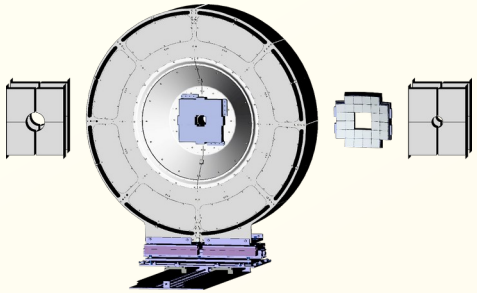

# FIT detectors – FT0

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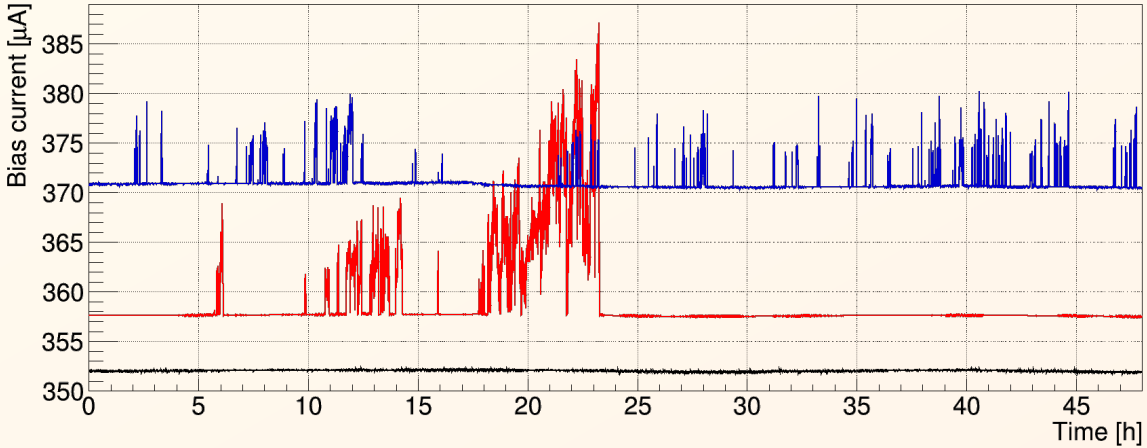

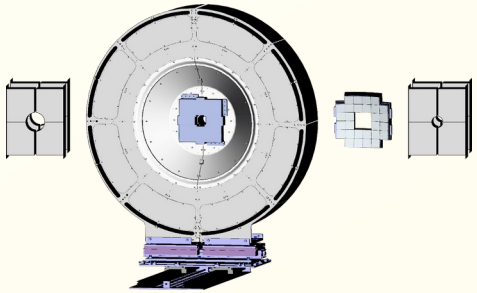

# FIT detectors – FT0

## Comprehensive photosensor acceptance tests

83 units were tested or retested

- Pulse shape
- Gain scan
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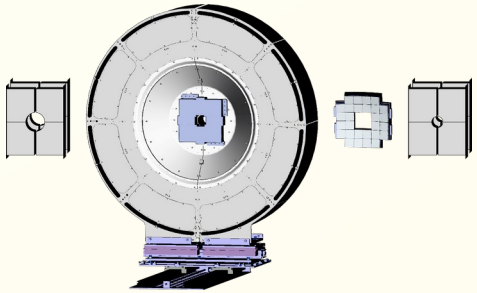
- Resistance
- Afterpulses and dark count rate
- Long term HV stress-test

- **Operation within magnetic field**

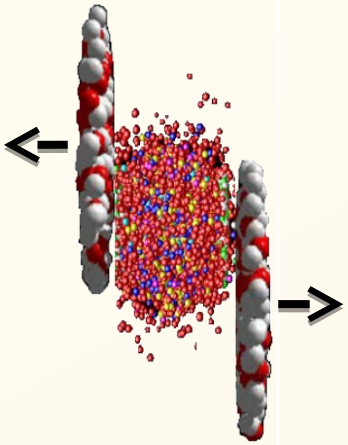
**See the following publications:**

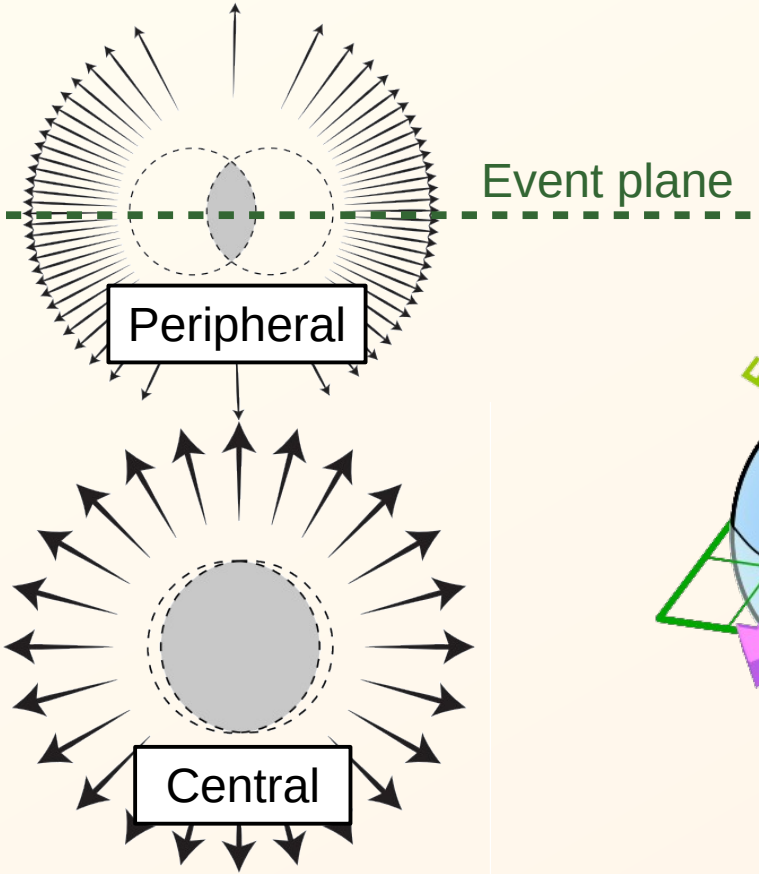

[1] https://arxiv.org/pdf/1807.03804.pdf

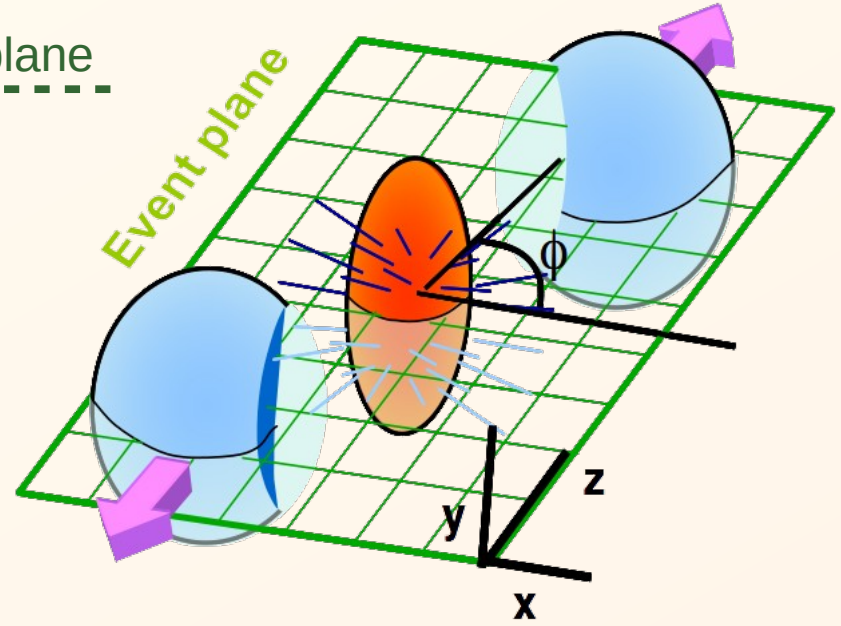
[2] Yu.A. Melikyan, Performance of the cost-effective Planacon® MCP-PMTs in strong magnetic fields, in final review stage in NIMA

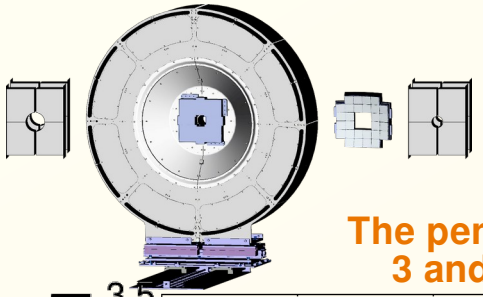


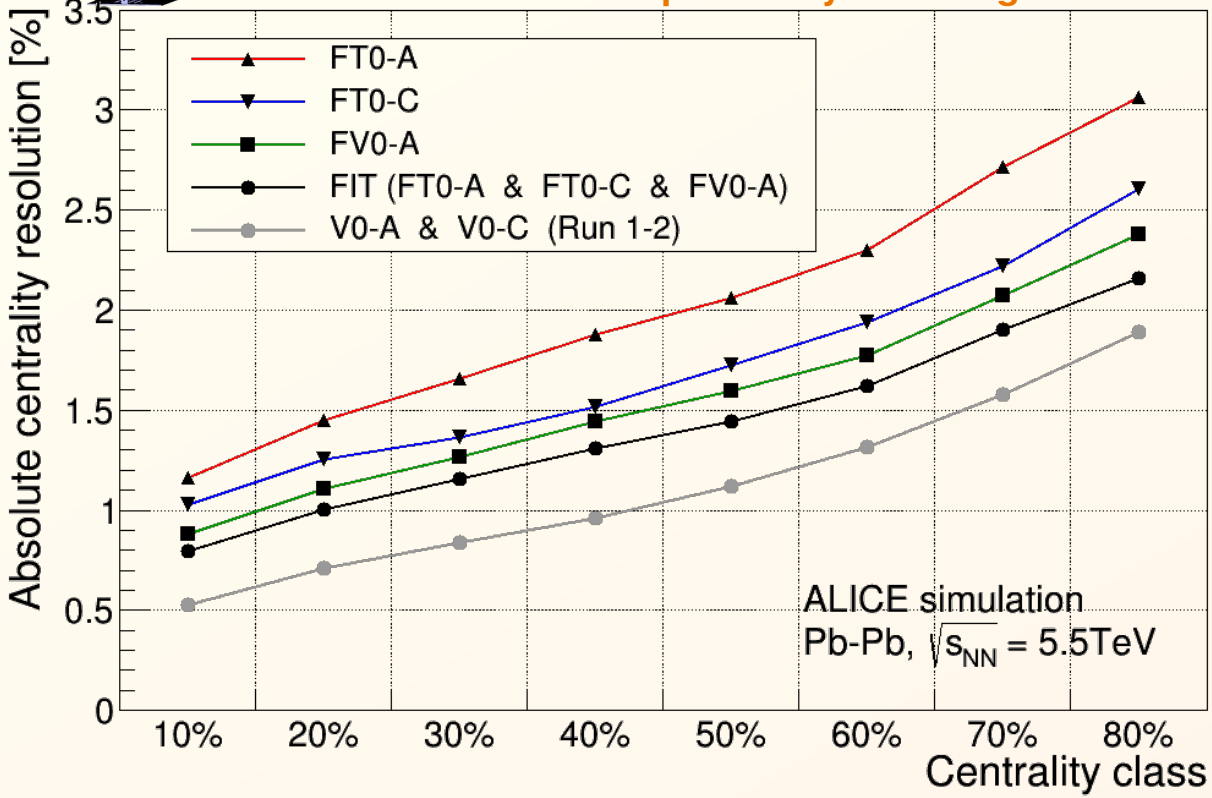
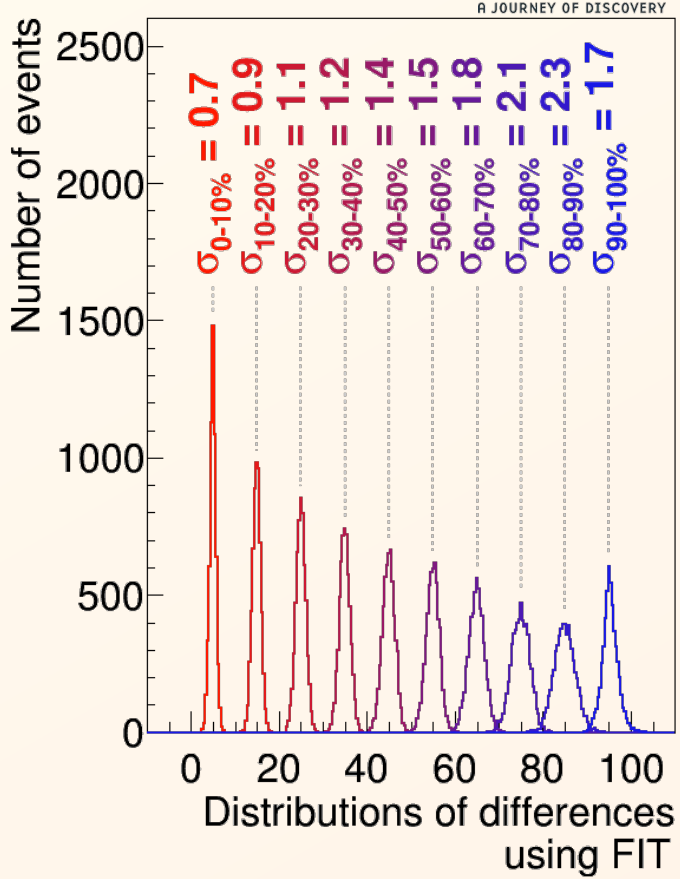
# Centrality and event plane







# Simulated physics performance
# Centrality resolution

**The performance for the whole ALICE in in Run 3 and 4 will be improved by including MFT**