

The ALICE Fast Interaction Trigger Upgrade

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ALICE



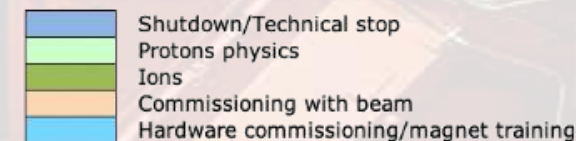
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Run 3 – challenging running conditions

- After LS2, Run 3 will start in the spring of 2022
- 10 times higher luminosity, larger statistics
- Interaction rate: pp at 1 MHz, Pb-Pb at 50 kHz (3 TB/s data readout)
- Cont. readout operation or fast trigger needed for ALICE detectors
- Fast and efficient online event selection important

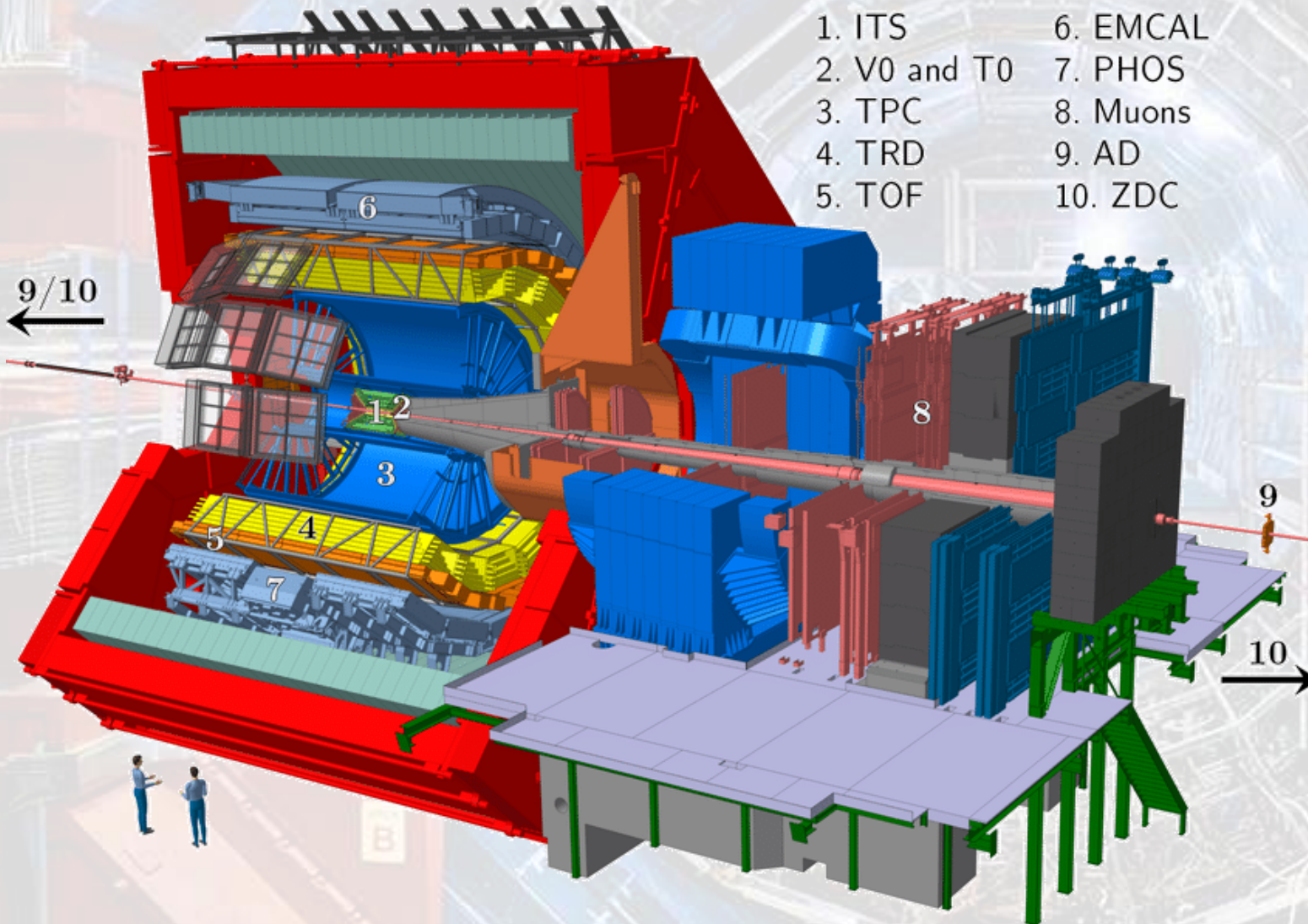


LHC running schedule



Last updated: June 2021

Upgrades of the ALICE detector system



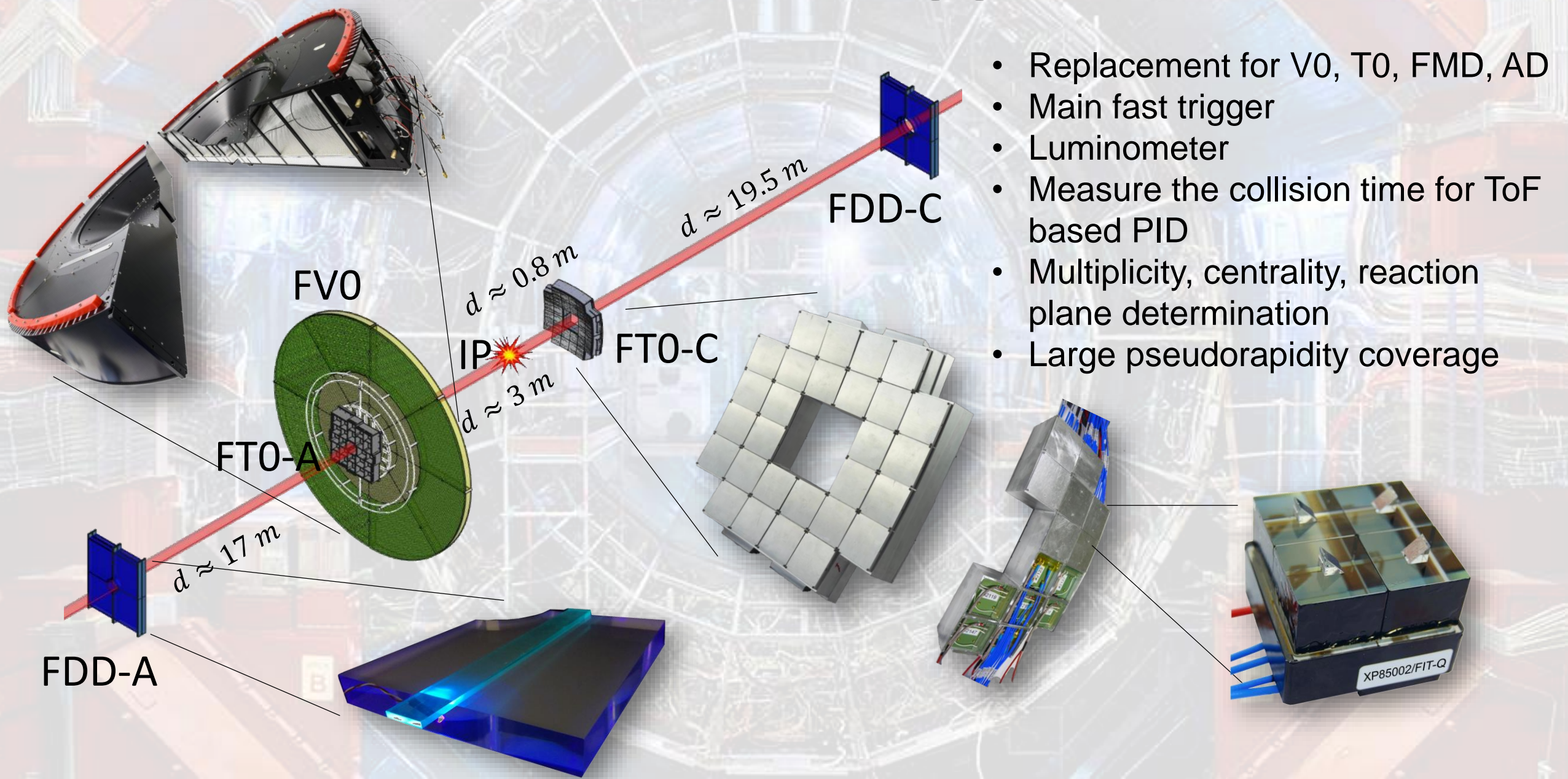
New and upgraded detectors:

- Inner Tracking System (ITS)
- Muon Forward Tracker (MFT)
- TPC: new GEM and readout
- Fast Interaction Trigger (FIT)

Upgraded ALICE detector:

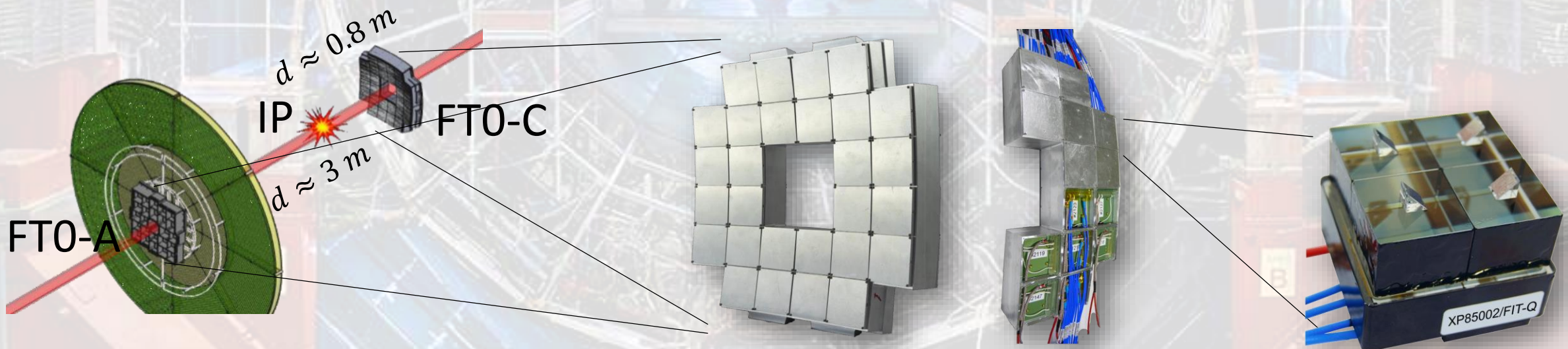
- Record minimum bias Pb-Pb events with the highest rate
- Precise luminosity monitoring, feedback LHC
- Enhanced tracking, centrality and event plane determination
- Reach to low $p_T \approx 0$

The Fast Interaction Trigger



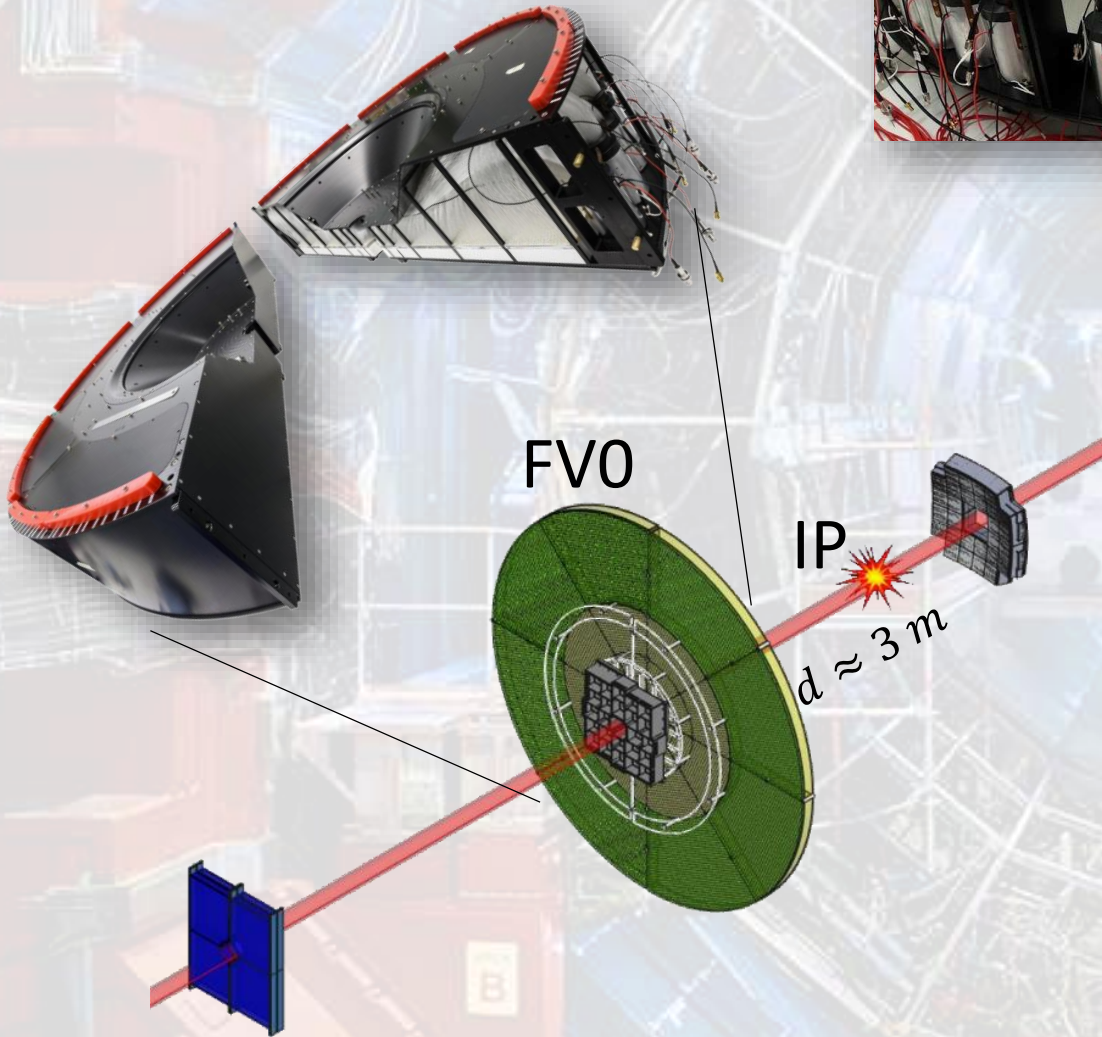
FIT – FT0

- 24 and 28 Cherenkov modules, each with four 2 cm thick radiators
- Asymmetrically placed: ~ 0.8 m and ~ 3 m
- $3.8 < \eta < 5.0$ and $-3.4 < \eta < -2.3$
- Array at ~ 0.8 m is concave to equalize the flightpath
- Time resolution: ~ 33 ps
- Min. Bias trigger, luminometer, online vertex determination
- Collision time for ToF PID



FIT – FV0

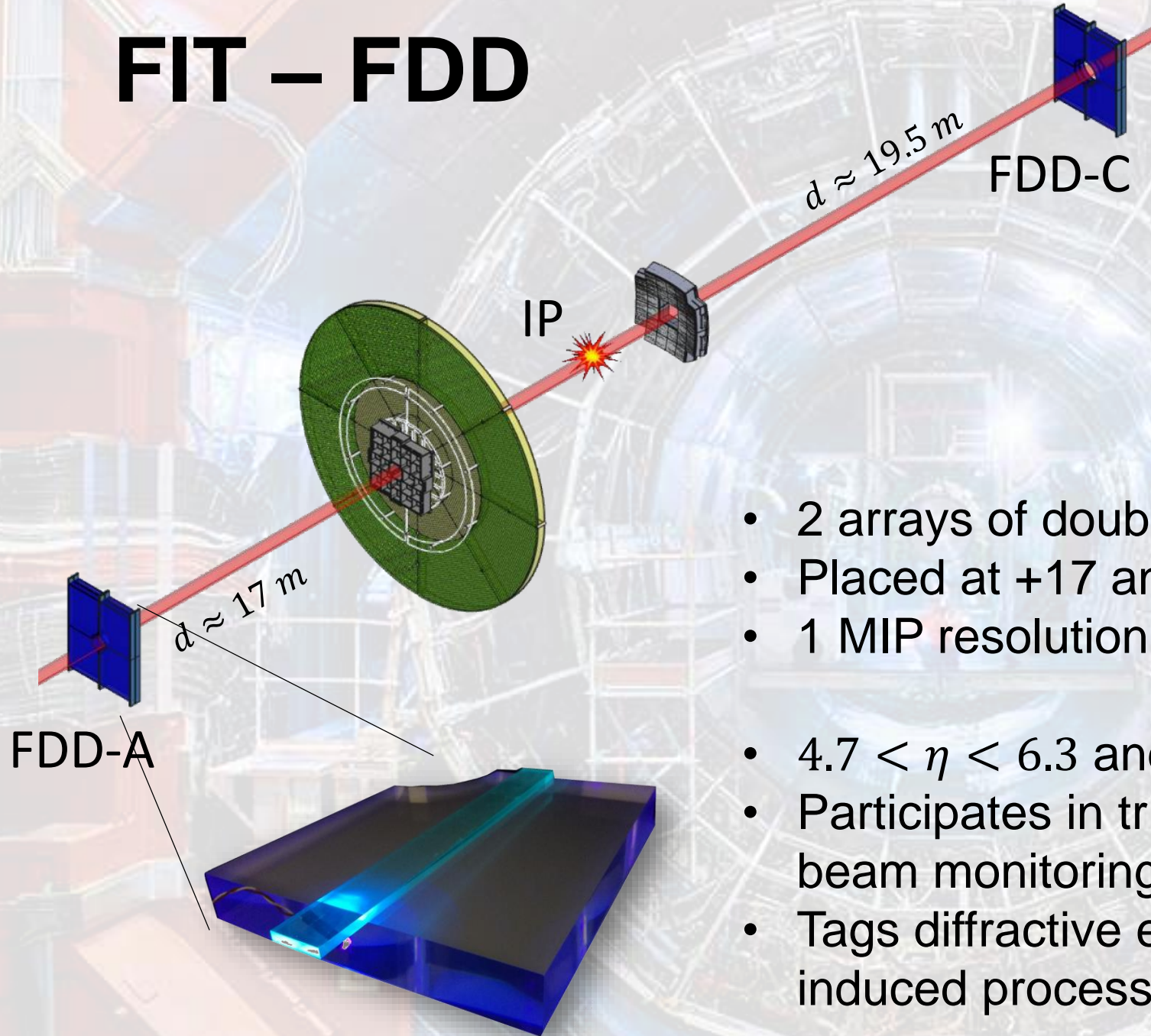
6/15



- Placed $\sim 3\text{m}$ from IP, $\sim 1.5\text{ m}$ diameter
- Divided into 5 rings and 8 segments
- Rings cover equal η ranges in $2.2 < \eta < 5.1$
- 40 plastic scintillators, 4 cm thick
- 48 readout channels
- Large acceptance for event plane and centrality determination
- 1 MIP resolution 150 – 300 ps
- Dynamic range: 1-300 MIP

FIT – FDD

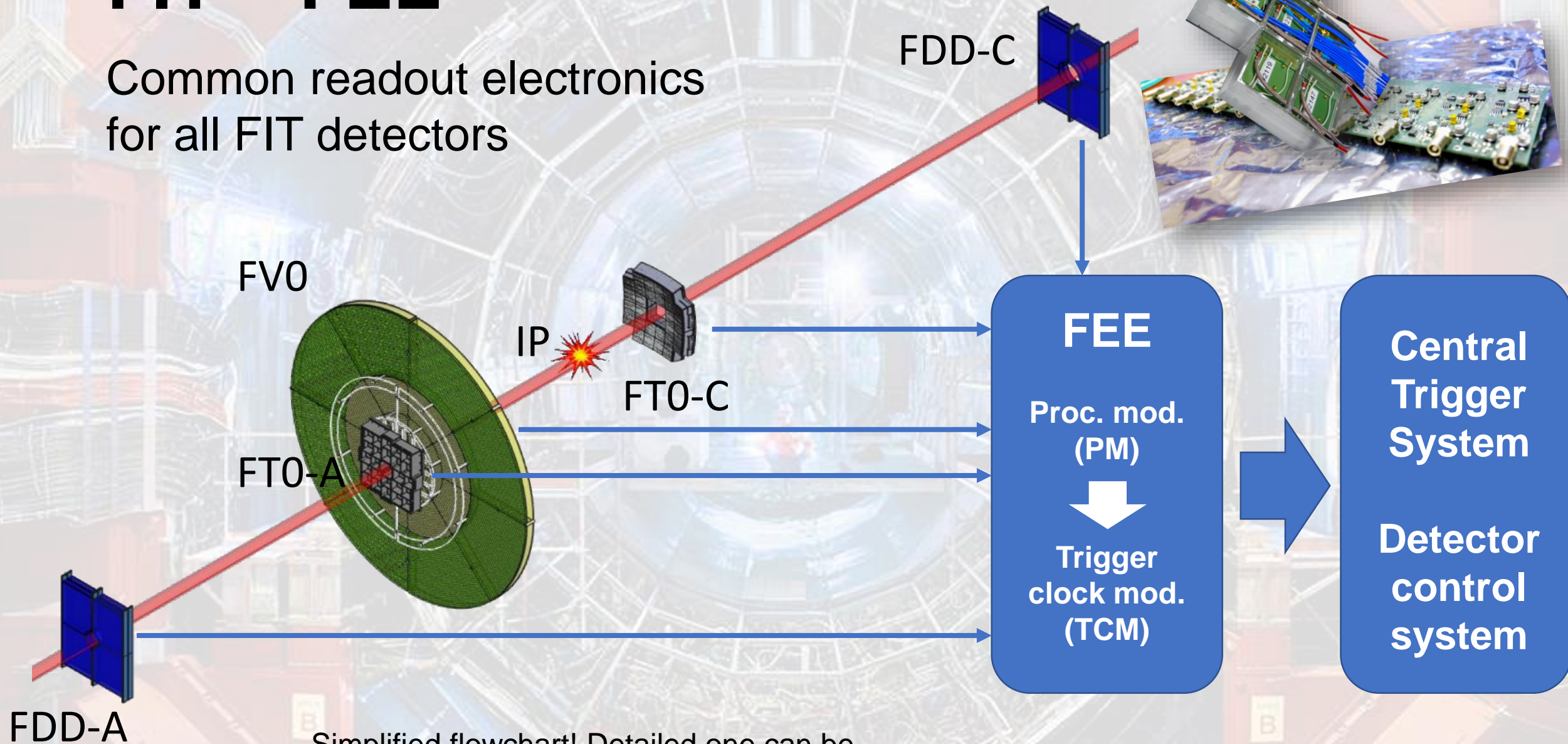
7/15



- 2 arrays of double-layered plastic scintillators
- Placed at +17 and -19.5 m from IP
- 1 MIP resolution 300 – 400 ps
- $4.7 < \eta < 6.3$ and $-4.9 < \eta < -6.9$
- Participates in trigger generation, luminosity and beam monitoring
- Tags diffractive events in pp collisions and photon-induced processes in p-Pb and Pb-Pb interactions

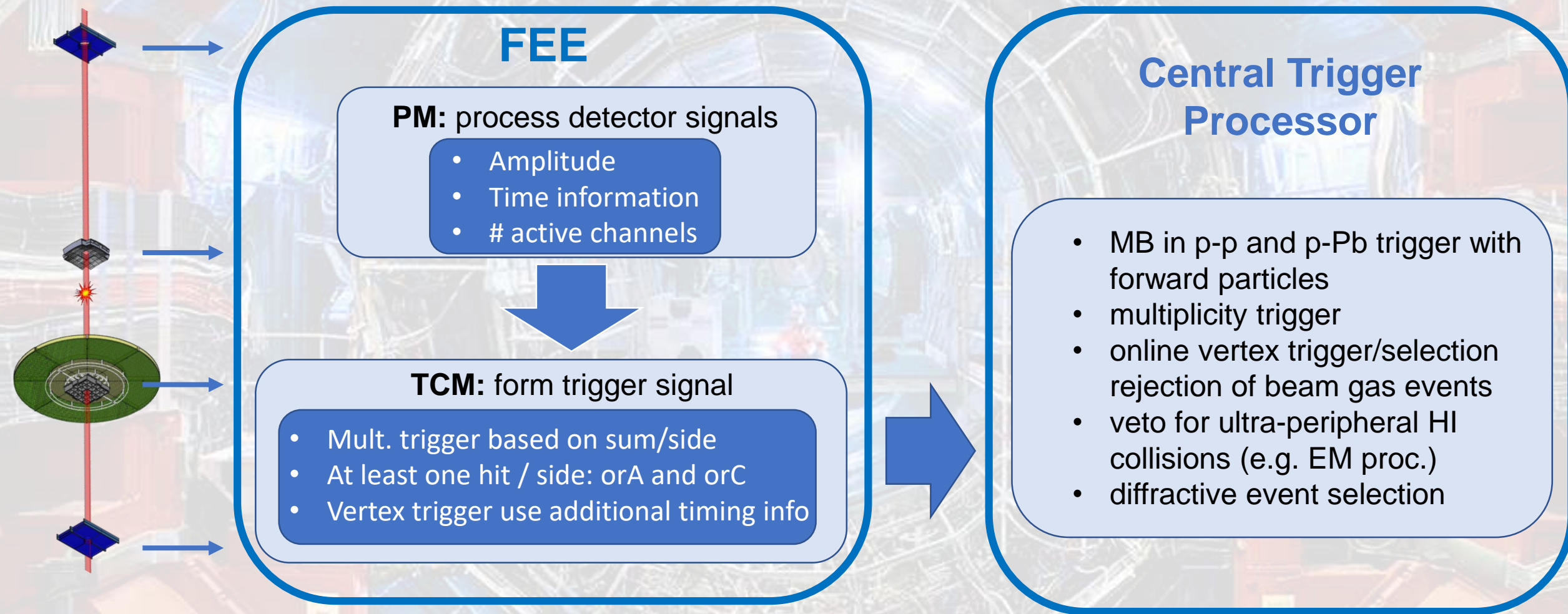
FIT – FEE

Common readout electronics
for all FIT detectors



Simplified flowchart! Detailed one can be
found elsewhere, e.g. [PoS \(LHCP2020\) 251](#)

Trigger – some ALICE detectors need a trigger



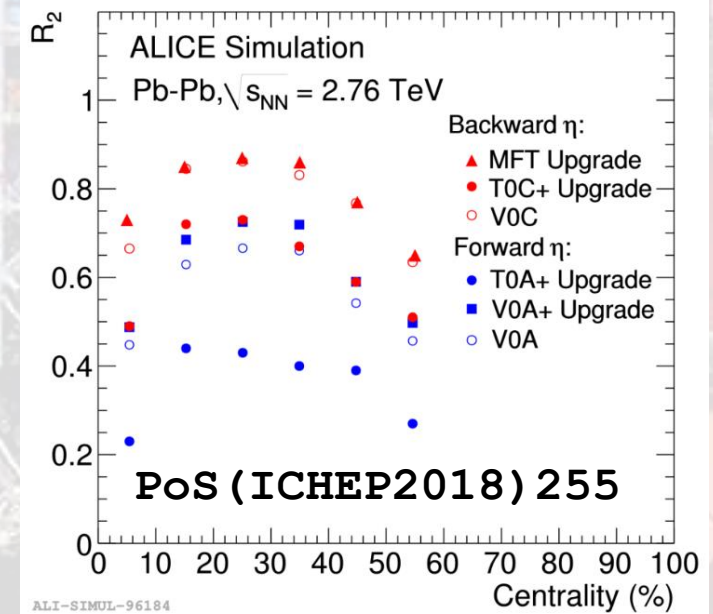
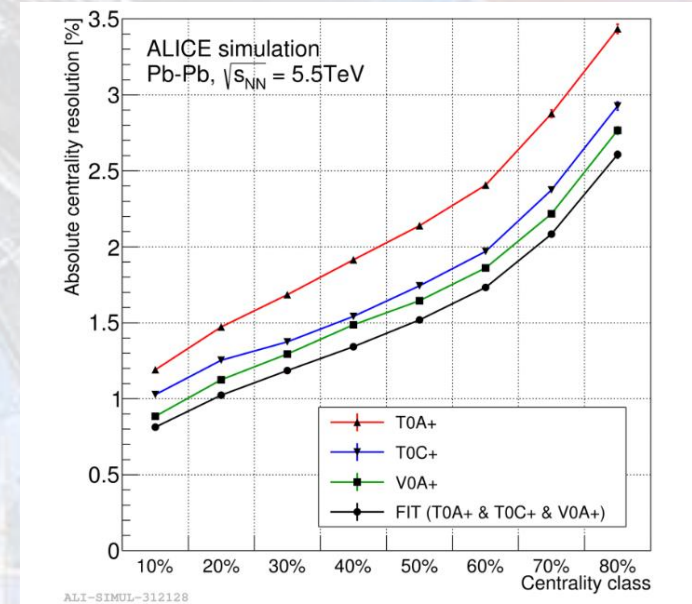
Simplified flowchart! Details can be found elsewhere, e.g. [NIM 952, 2020, 161920](#)

Centrality and event plane determination

- ALICE used N_{ch} in V0, SPD and TPC for cent. det.
- In Run3 V0 will be replaced by FV0
- FV0 has a larger acceptance but no sensors on the other side of IP
- FV0&FT0 together have $< 3\%$ resolution

- Ψ_{RP} determination with final state particles

$$\vec{Q}_2 = \left(\sum_i \cos(2\phi_i), \sum_i \sin(2\phi_i) \right) \rightarrow \Psi_2 = \frac{1}{2} \arctan \left(\frac{Q_{2,x}}{Q_{2,y}} \right)$$
- Influenced by finite multiplicity, detector effects, secondary particles, ...
- Event plane resolution: $R_2 = \langle \cos(2(\Psi_2 - \Psi_{RP})) \rangle$



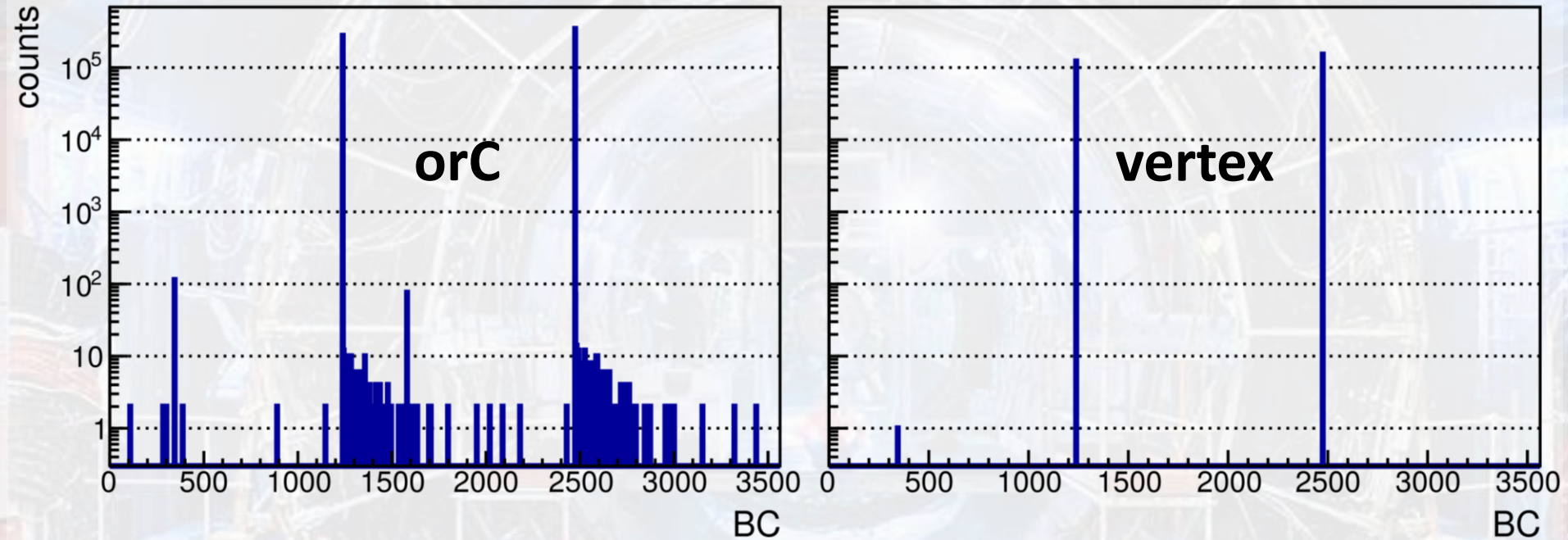
FIT as luminometer

- Real time monitoring, direct feed back to LHC and to ALICE
- Use the same technique as V0 and T0 in Run 2
- With a given trigger condition, the visible cross section can be calculated
- Luminosity then given

$$\mathcal{L} = \frac{\mathcal{R}_{trig}}{\sigma_{vis}} = \frac{\mathcal{R}_{trig}}{\varepsilon \sigma_{inel}}$$

- \mathcal{R}_{trig} the trigger rate, ε detector efficiency
- Vertex triggers can be used as measure for luminosity

FIT pilot beam results – FT0 trigger



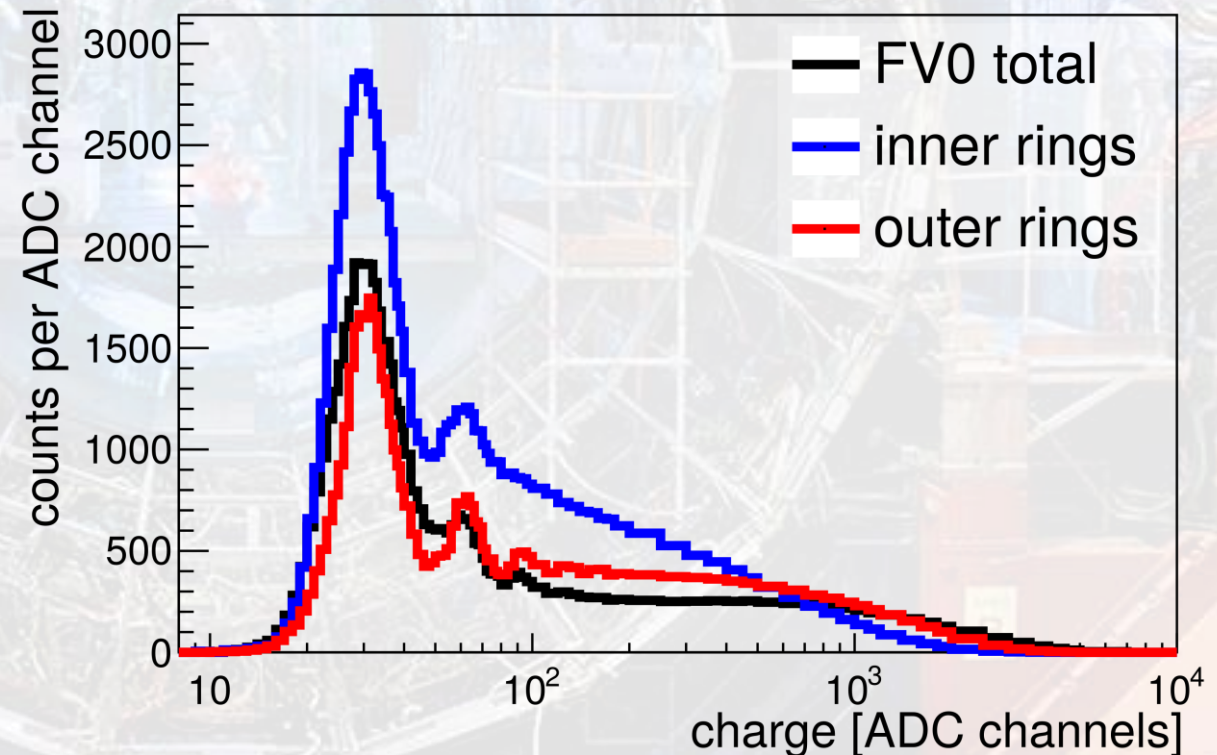
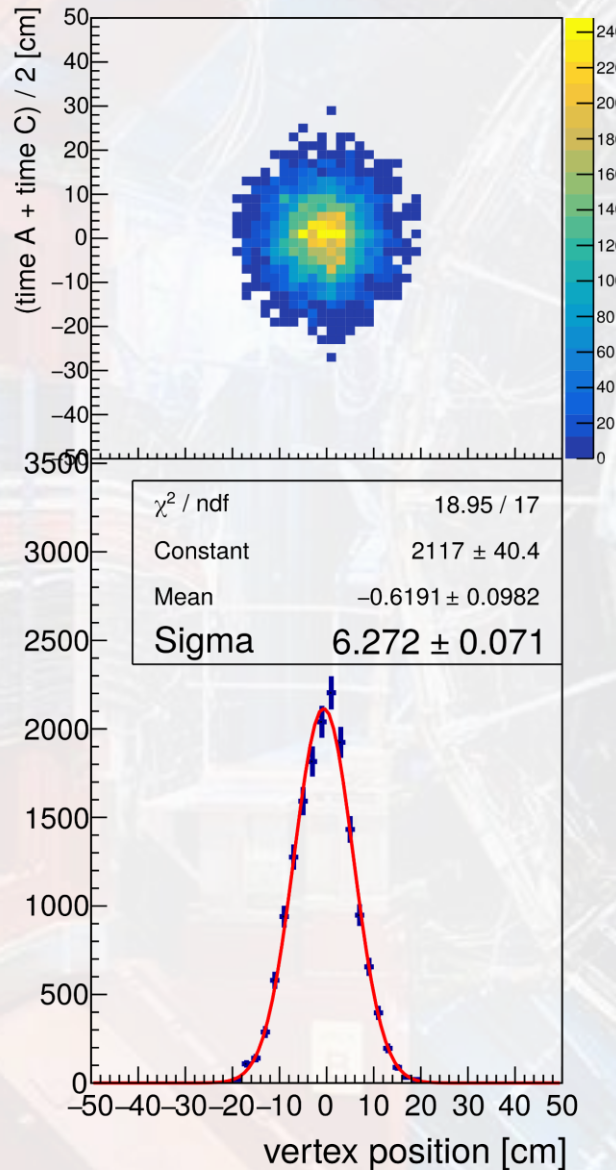
orC: at least one hit on side C

vertex: in a predef. vertex range & orA & orC

vertex trigger is stricter → better performance

FIT pilot beam results – performance

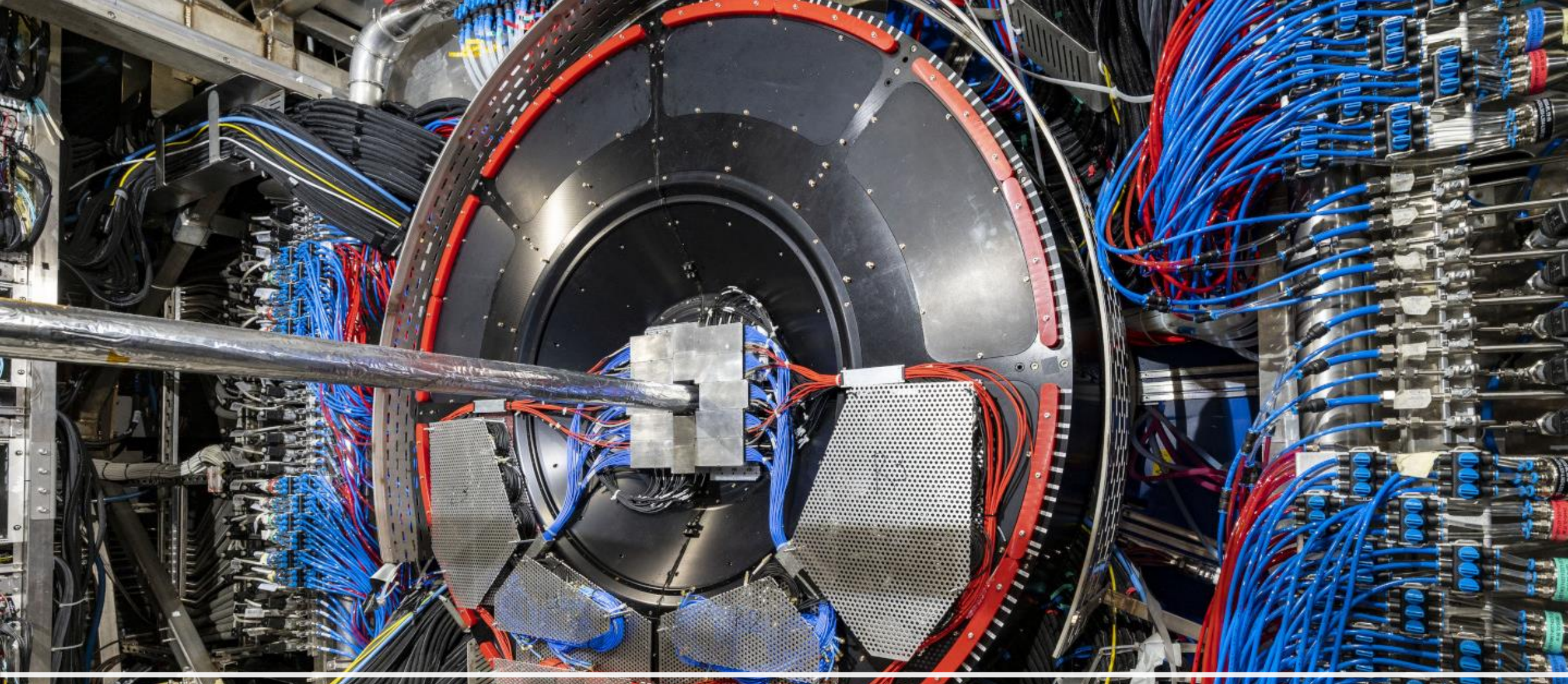
- FT0 vertex position and time determined during the pilot beam
- FV0 total, inner- and outer-ring charge amplitudes



Summary

- Challenging Run 3 conditions
 - Major upgrade of ALICE
 - Four new detectors: FIT, TPC, ITS, MFT
- Pilot beam results: FIT works as expected
 - FIT role in trigger, monitoring and physics analysis
 - Preparations for Run 3 continue, busy months ahead





Thank you for your attention!

