# Design, performance and operational experience of ALICE FIT in LHC Run3

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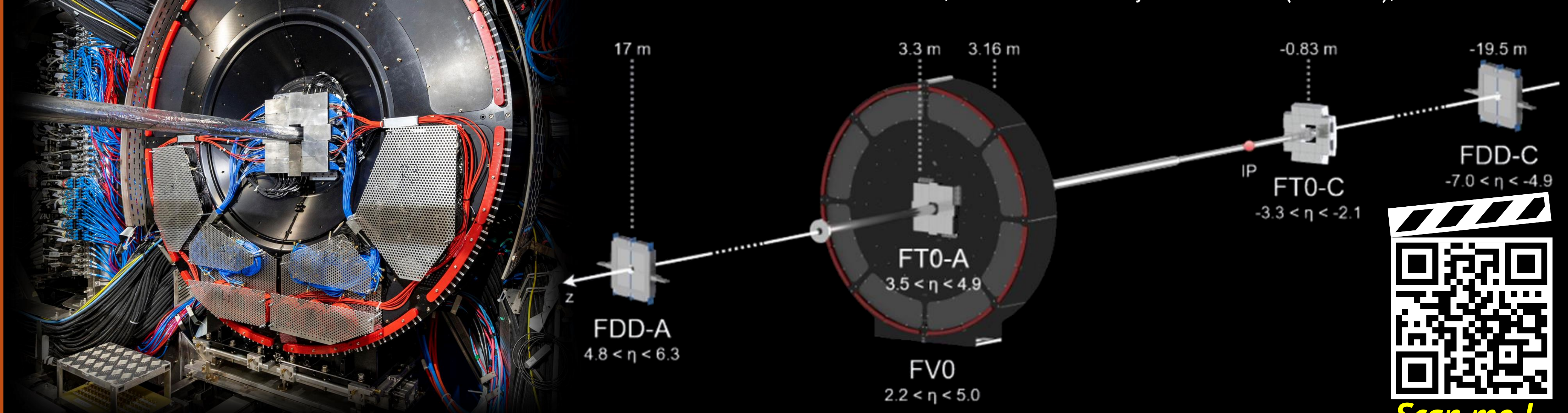


*Scan me !*

**The ALICE experiment** is designed to study quark-gluon plasma produced in ultra-relativistic heavy-ion collisions. For LHC Run3 ALICE experiment underwent significant upgrades during the LHC Long Shutdown 2 (2019–2021), including installation of the new Fast Interaction Trigger (FIT) system. FIT comprises three detectors FT0, FV0 and FDD. Experience with the FIT detector system has shown that FT0 is the primary detector for measuring global event characteristics.

## FIT's vital roles in ALICE

- Fast Interaction Trigger
  - Vertex, minimum bias and centrality triggers
  - Background rejection and tagging
  - Diffractive event tagging and veto for ultra-peripheral collisions
- Collision time → Time-Of-Flight → Particle ID
- Multiplicity → Centrality and event plane
- Luminosity and background monitoring for LHC beam tuning

## FT0 – the FIT Cherenkov detector

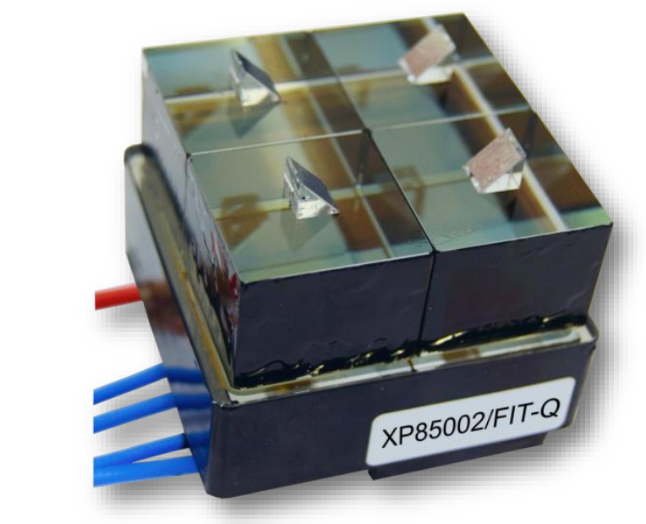
- Two arrays of Cherenkov counters;
- 96+112 quartz radiators coupled to 52 multianode microchannel plate-based PMTs (MCP-PMTs) for the best time resolution;
- **First massive application of the Planacon® MCP-PMTs in HEP;**
- Each channel equipped with individual inputs of the optical monitoring system based on a picosecond laser.

## FV0 – the FIT Scintillator detector

- Circular arrays of plastic scintillator tiles with novel light collection technique;
- Clear plastic fibers in direct optical contact with the scintillator back plane – non-WLS for the better timing;
- Fine-mesh PMTs H6614-70-Y001: B-field immunity.

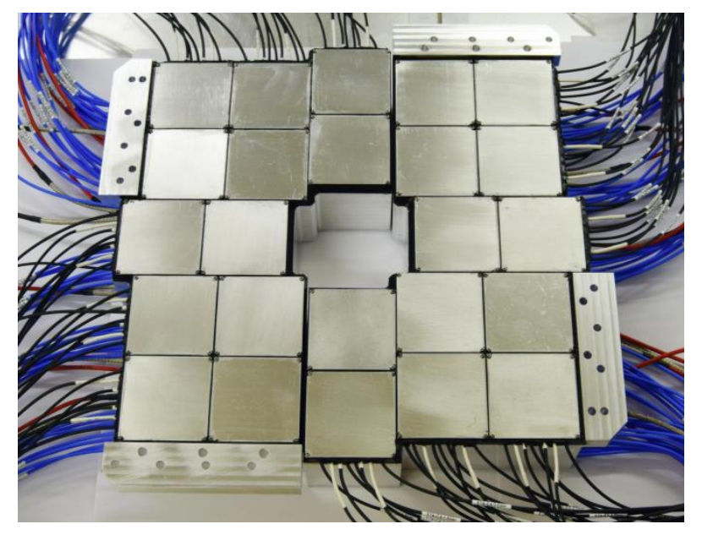
## FDD – the FIT Forward Diffractive Detector

- Double-layered plastic scintillator read out by fine-mesh PMTs through WLS plastic bars and clear fibers (coincidence mode);
- Fine-mesh PMTs H8409-70: B-field immunity, good timing, high signal rate capacity;
- Fast wavelength-shifting bar: 1 ns re-emission time, NOL-38;
- Light transport by clear fiber bundles: Kuraray PSM-Clear.



FT0 Cherenkov module
(4 channels)

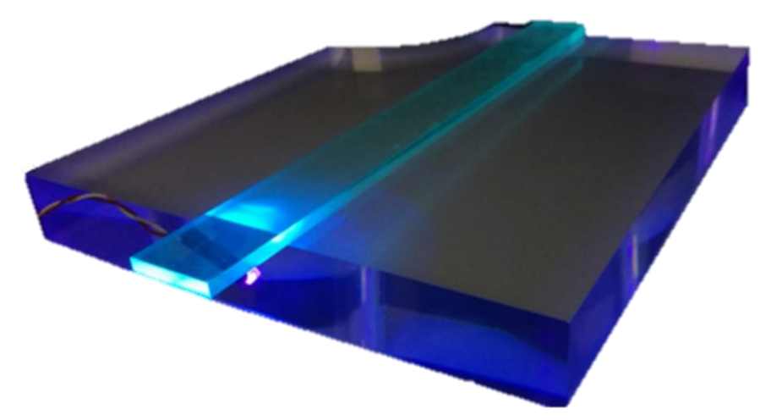
FT0-C half – back view



FT0-A assembled

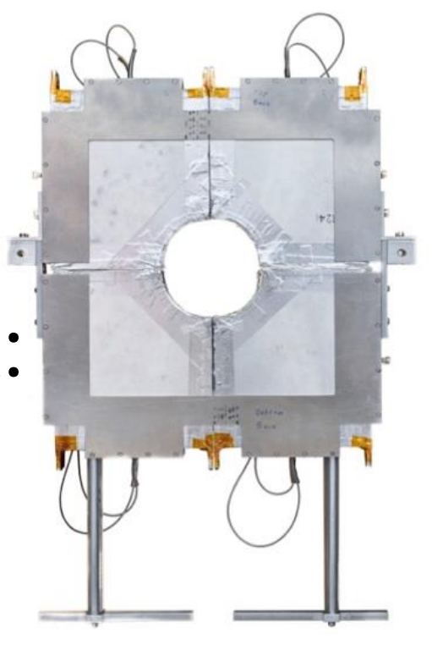
FV0 PMTs and fiber bundles arrangement

Attachment of optical fibers to scintillator

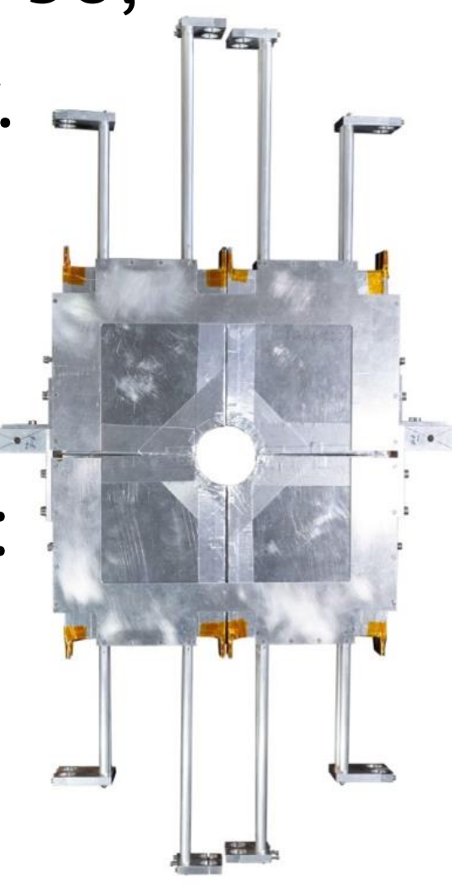


One FDD quadrant: plastic scintillator and WLS bar

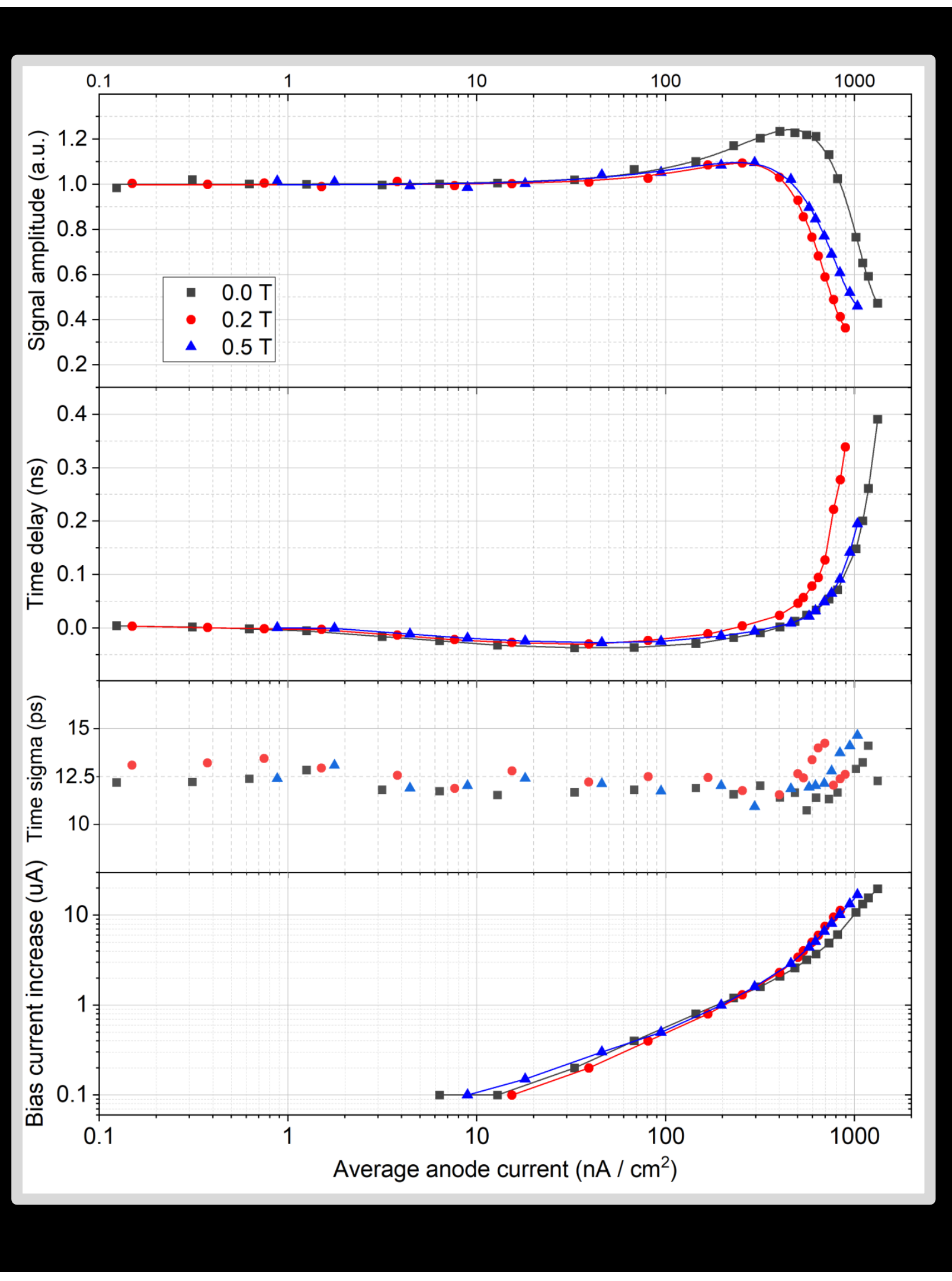
FDD-A:



FDD-C:



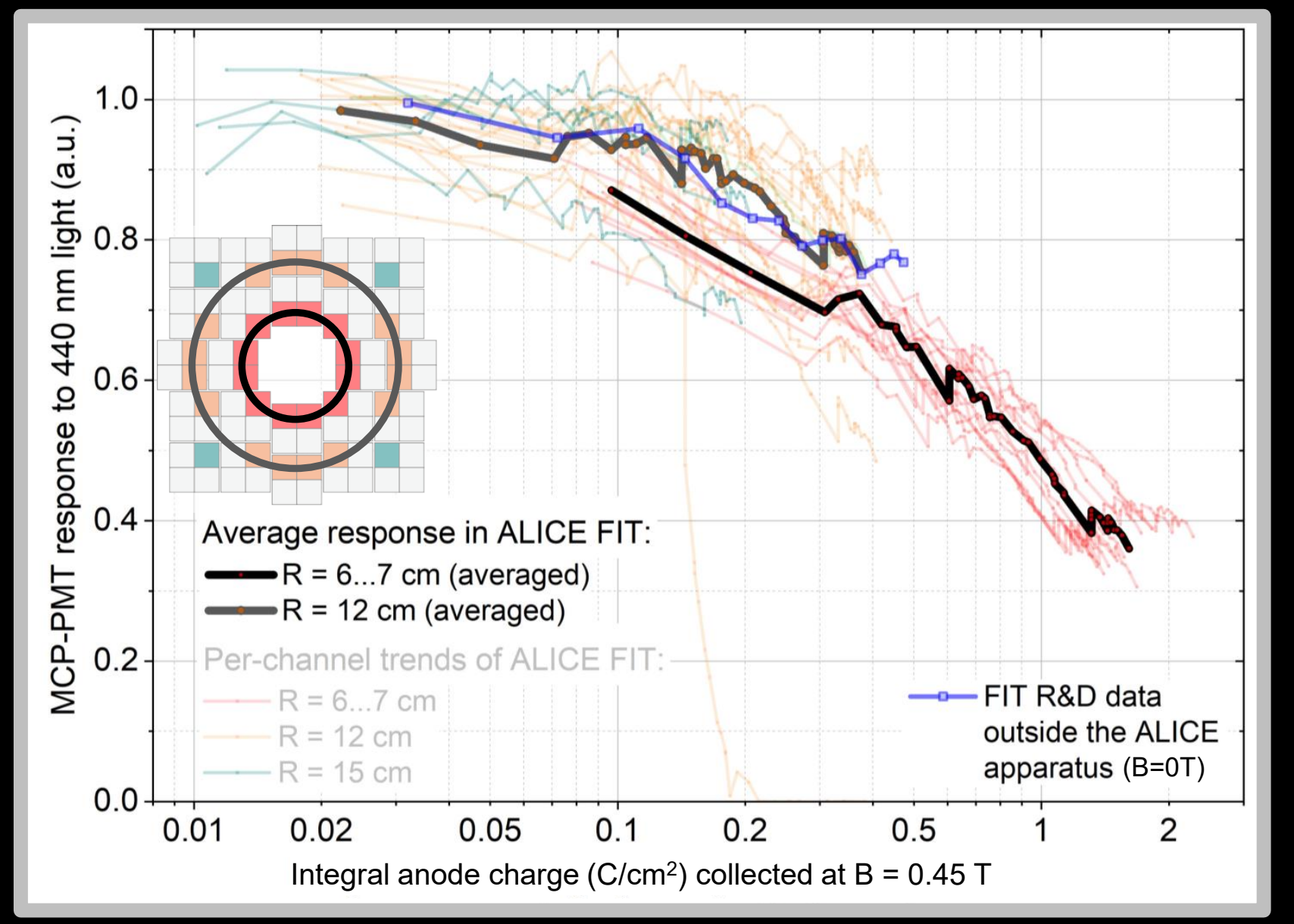
## Average anode current saturation



Rate capability is naturally limited by the MCP RC **~100 nA/cm²** for standard Planacons;
**~800 nA/cm²** for the low-resistance non-ALD Planacons;
(gets further suppressed in 0.5T B-field)

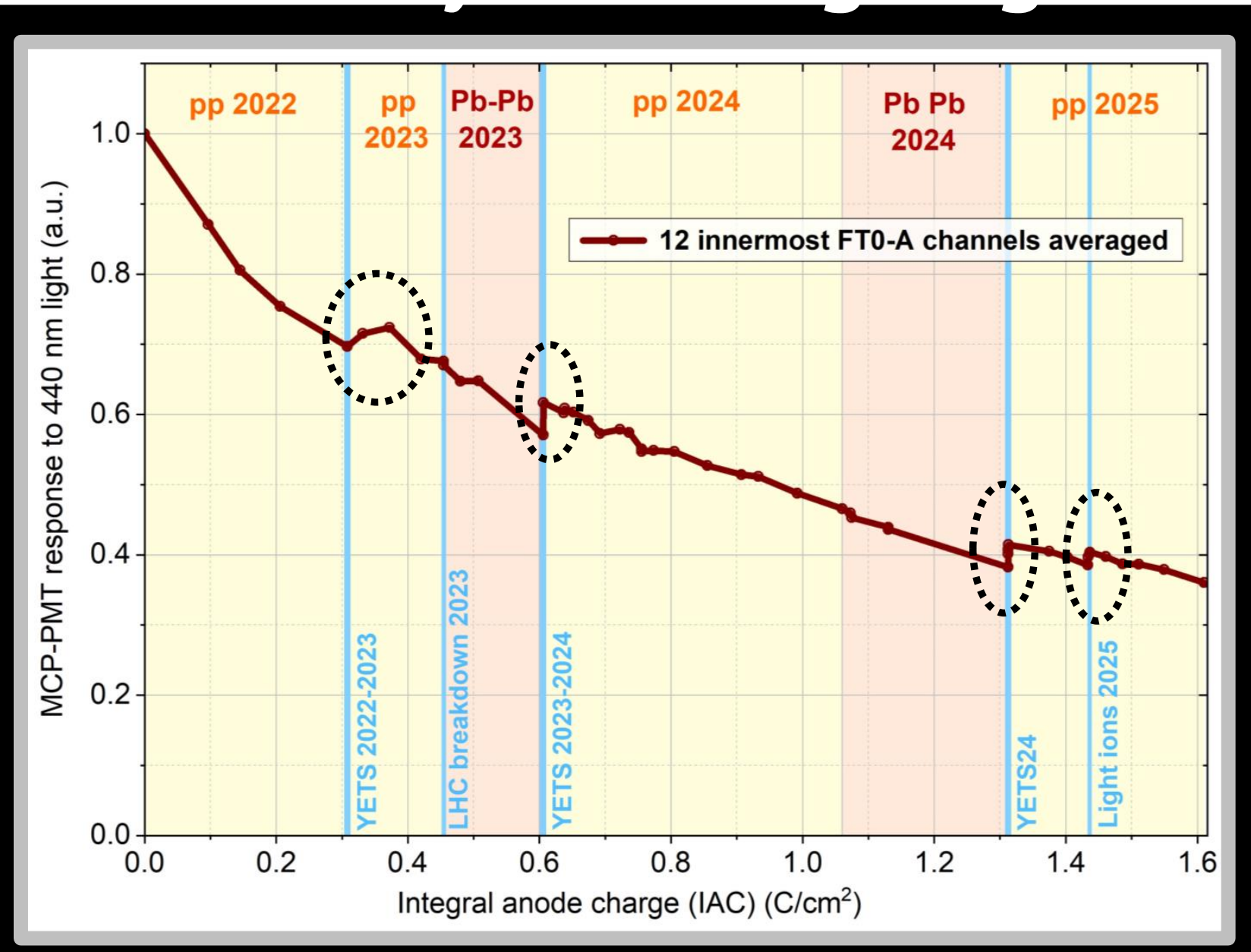
Planacon upgrade for ALICE FIT – NIM A 952 (2020) 161689
Bench testing of the ALICE FIT Planacons – JINST 16 (2021) P12032
Long-term performance of MCP-PMTs
12th International Workshop on Ring Imaging Cherenkov Detectors *(RICH2025)*

## Planacon MCP-PMT ageing



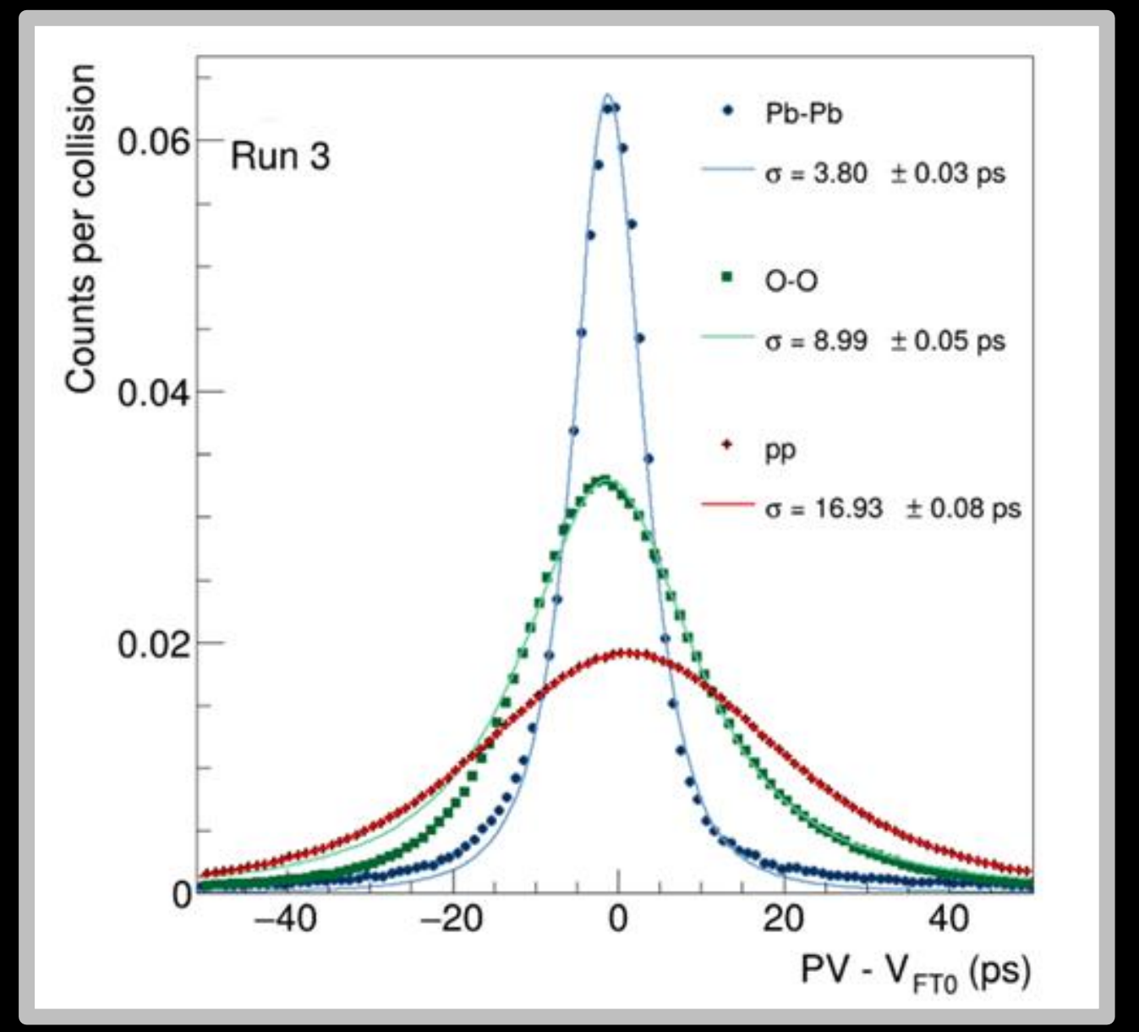
- Trends' shapes ~repeatable across different MCP-PMTs;
- Moderately-loaded Planacons age as fast as in the dedicated ageing test in lab (outside ALICE);

## Self-recovery of the ageing effect



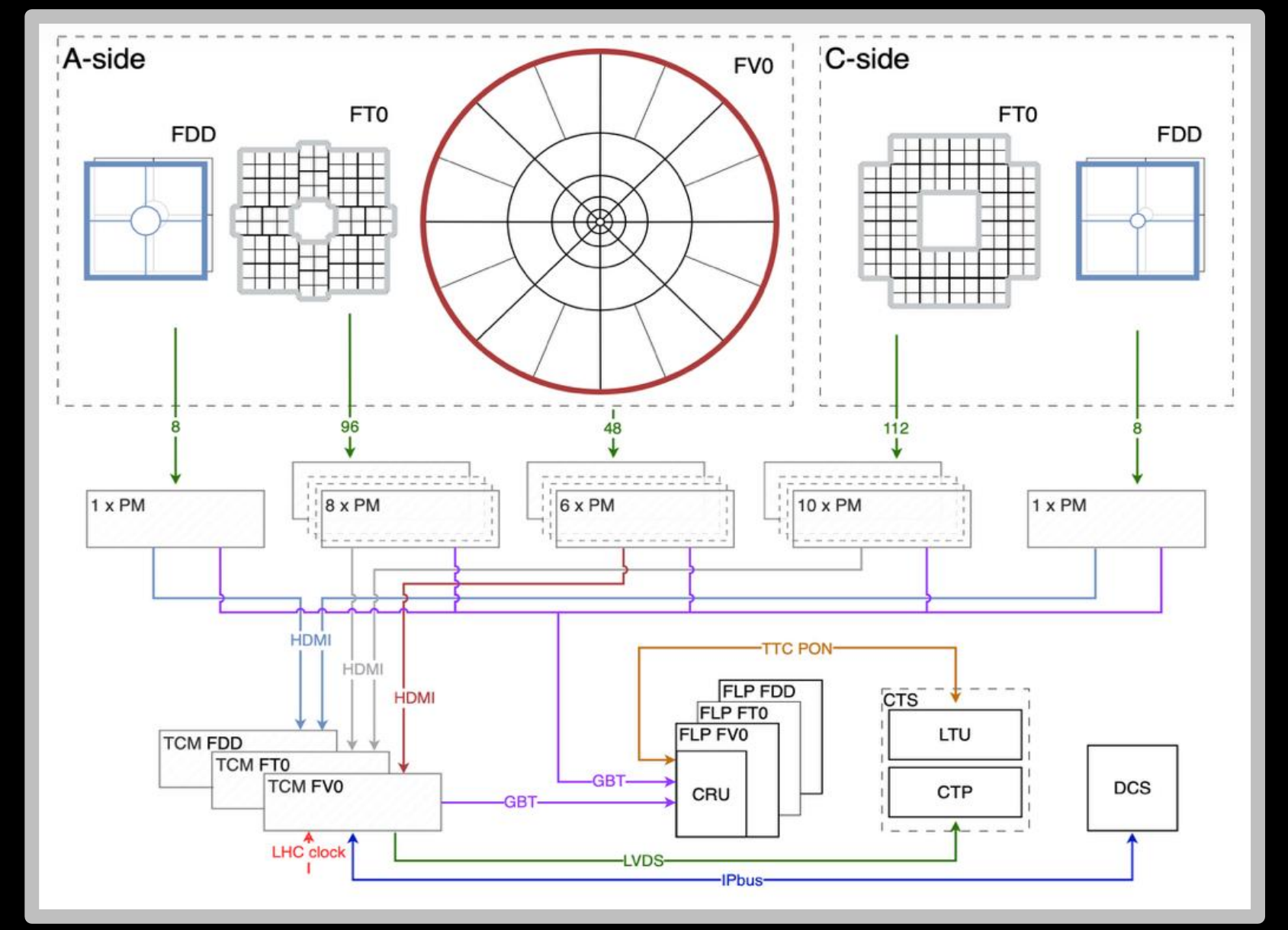
- Heavy-ion running results in faster ageing (x6 proton load) – proportional to IAC;
- Notable self-recovery of the aged MCP-PMTs is observed throughout YETS (at room temperature without beam).

## FT0 time resolution

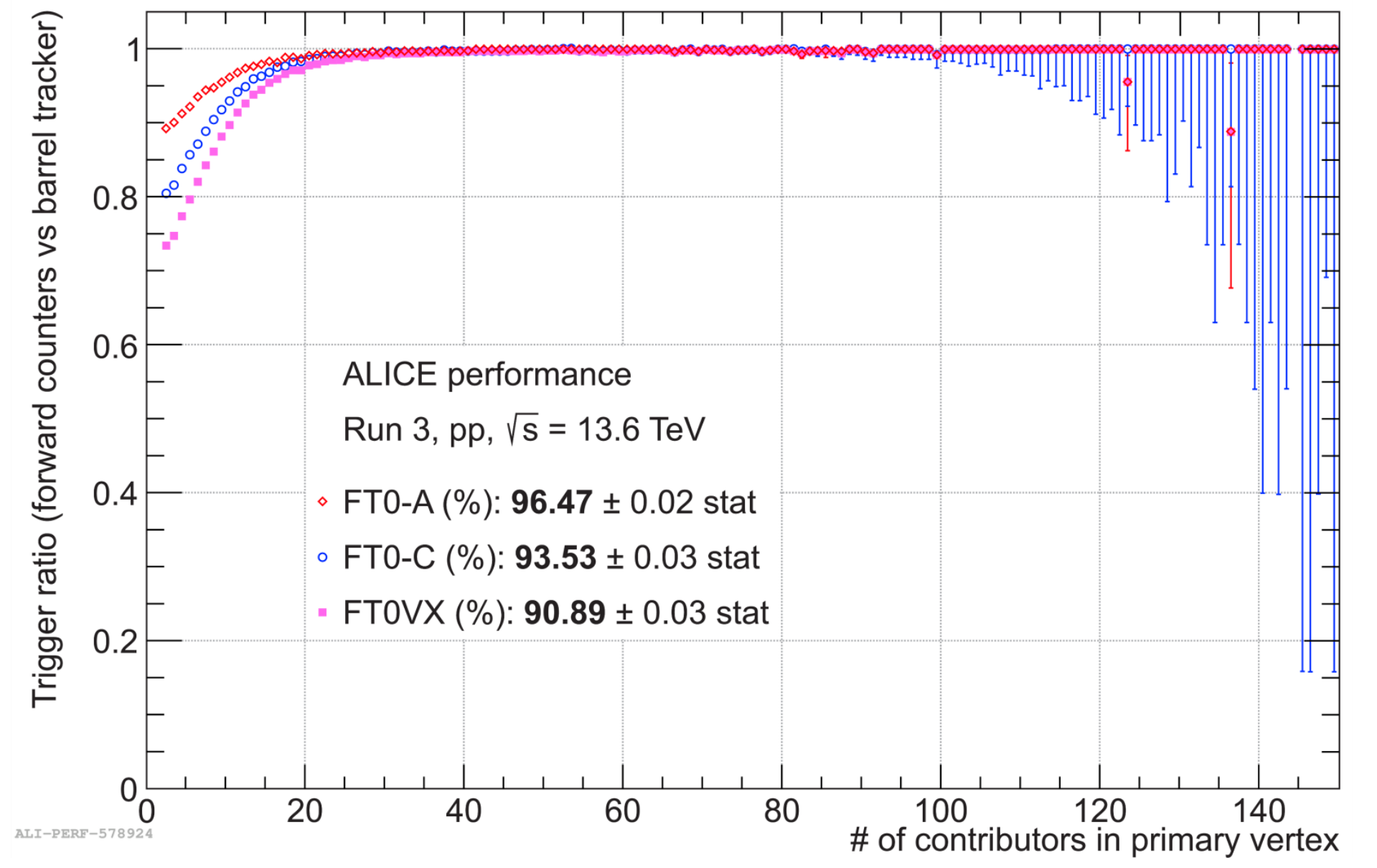


Typical collision time resolutions are:
$\sigma_{pp}$ ≈ **17 ps** ($\sqrt{s}$=13.6 TeV),
$\sigma_{O\text{-}O}$ ≈ **9 ps** ($\sqrt{s_{NN}}$=5.36 TeV),
$\sigma_{Pb\text{-}Pb}$ ≈ **4 ps** ($\sqrt{s_{NN}}$=5.36 TeV).
Single-MIP time resolution is σ ≈ **40 ps**.

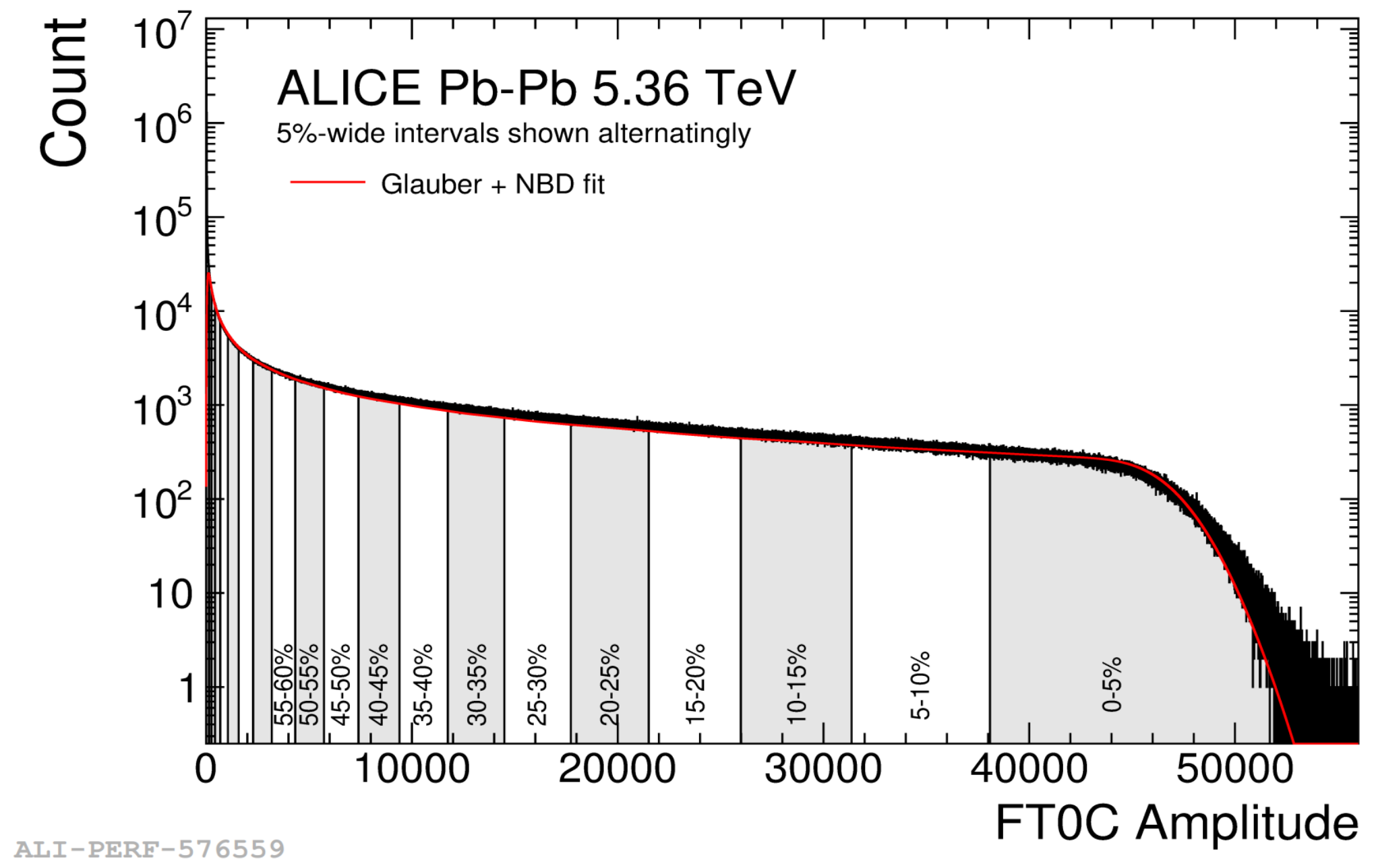
## FIT Electronics



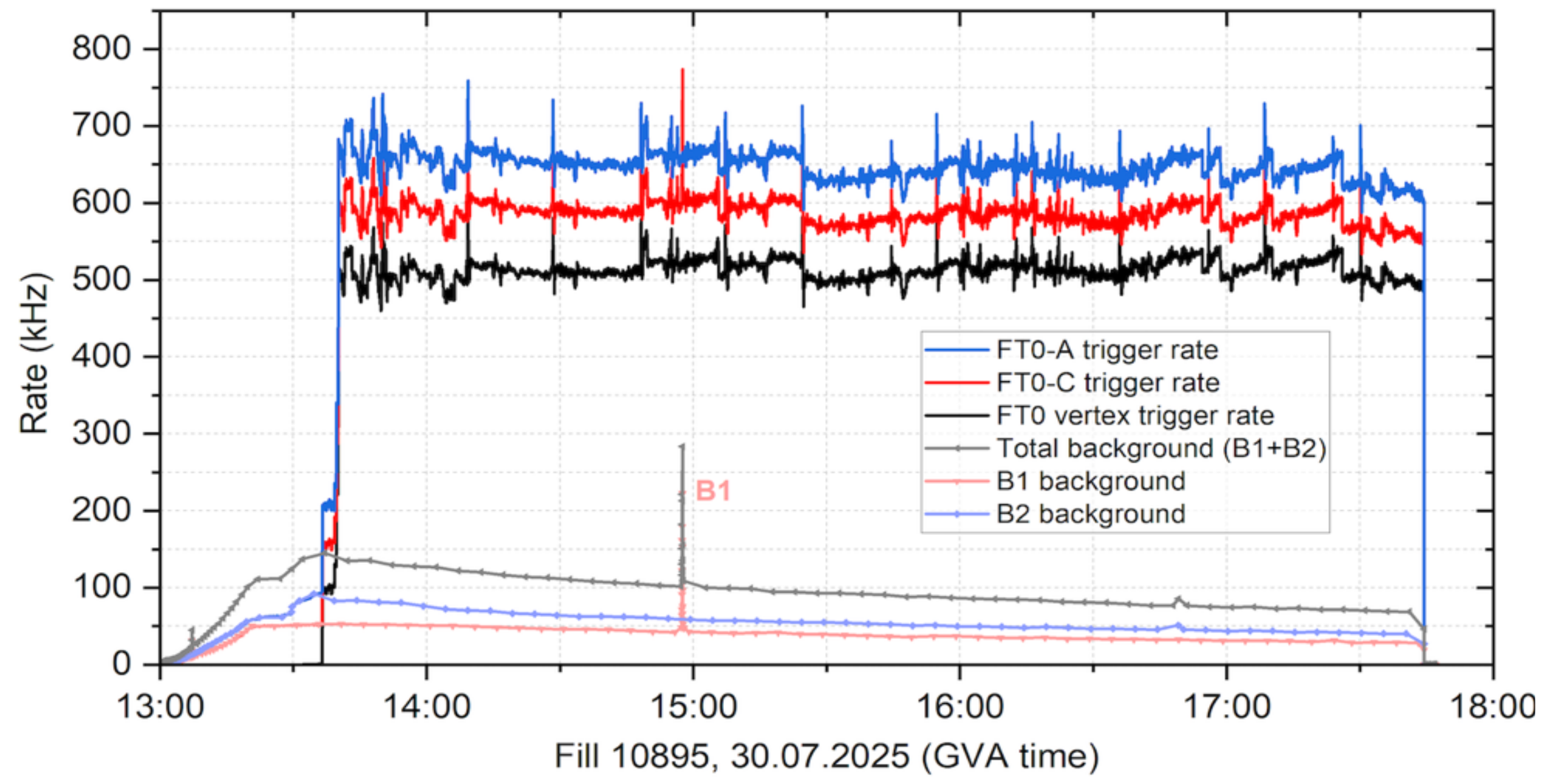
The main design challenge in FIT electronics is to process signals deadtime-free within the 25 ns bunch-crossing period, generate the trigger in under 200 ns. The readout electronics have two key components, both custom-designed: a Processing Module (PM) and a Trigger and Clock Module (TCM).



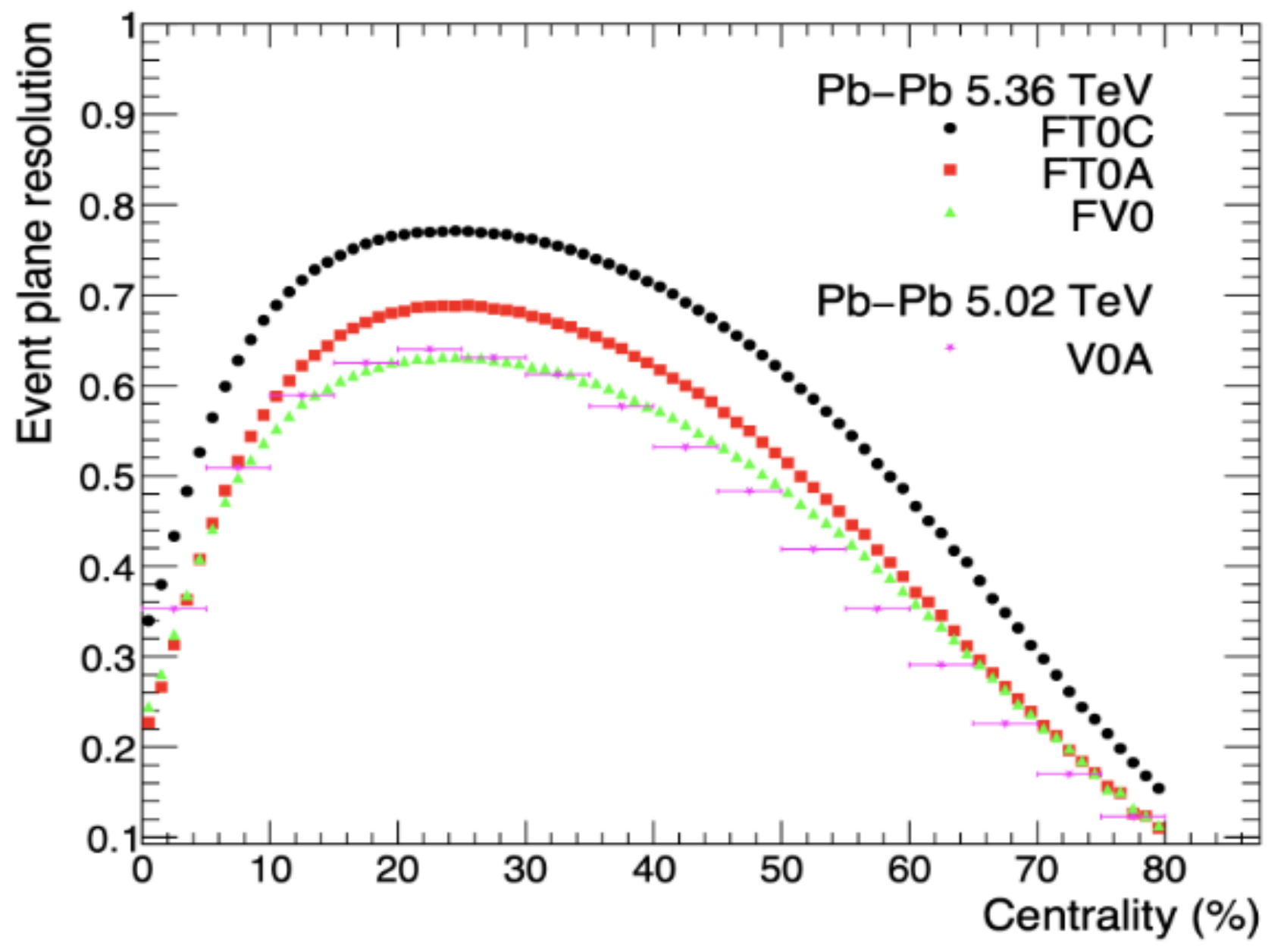
FT0 triggering efficiency expressed as a ratio of events firing FT0 to the number of events reconstructed by the ITS operating in a trigger-less mode and plotted versus the number of contributors in the primary vertex



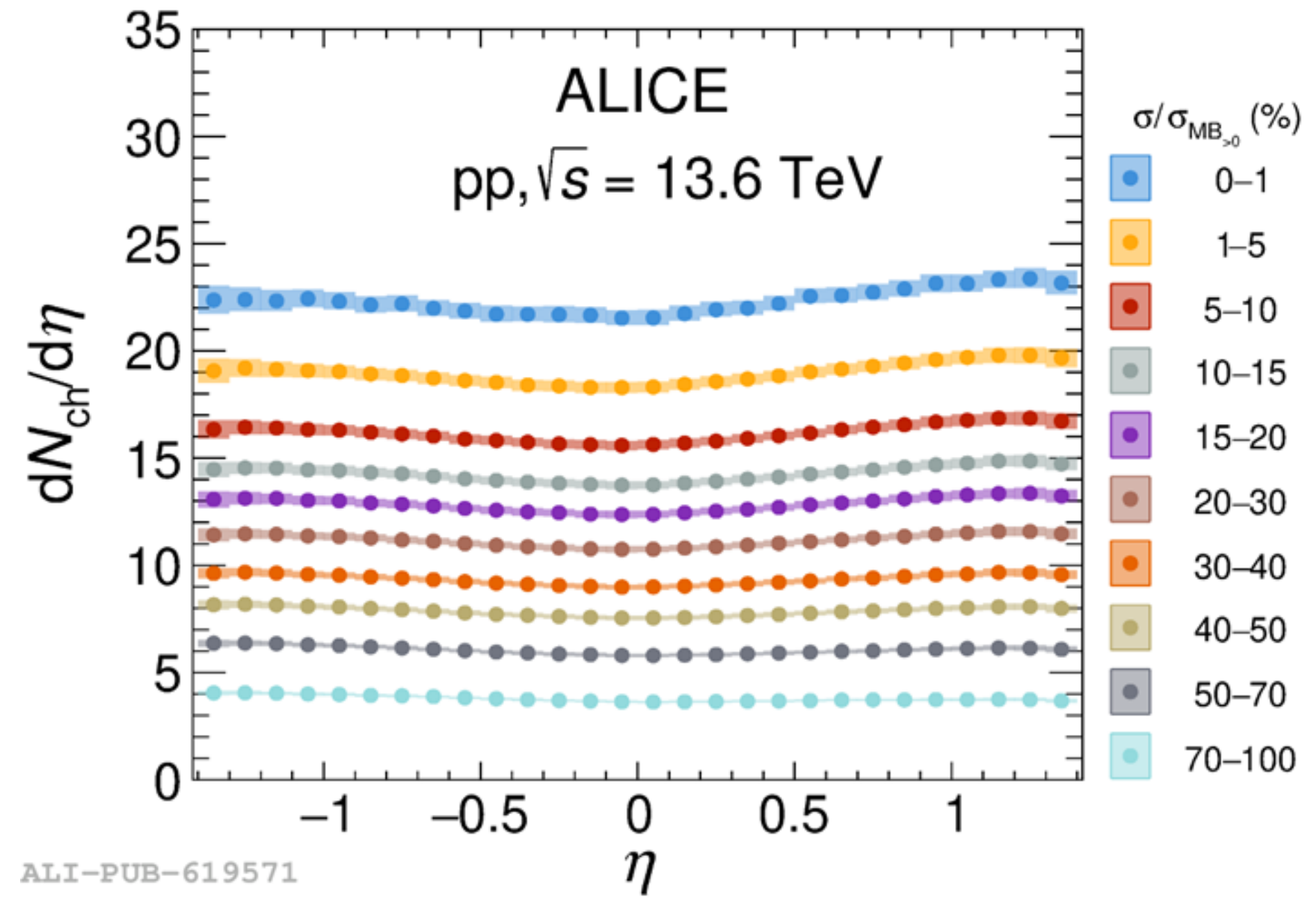
The distribution of FT0C amplitude (black histogram) in Pb−Pb collisions at $\sqrt{s_{NN}}$= 5.36 TeV. The red curve represents a negative binomial distribution combined with a Glauber model fit.



FT0 provides online background monitoring using current LHC fill information. Example of a background spike caused by a vacuum system issue is shown.



Event plane resolution as a function of centrality obtained for FT0C, FT0A and FV0



Charged-particle pseudorapidity density as a function of η with the forward multiplicity estimator FT0, illustrating the dependence of particle production on forward event activity