The Forward Diffractive Detector for ALICE

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Introduction

ALICE (A Large Ion Collider Experiment) is one of the four large detectors at the LHC. Its main goal is the study of strongly interacting matter. During the ongoing Long Shutdown 2 (LS2), ALICE is implementing significant upgrades in detectors and systems [1] to cope with the conditions of the LHC Run 3 and 4.

An increased interaction rate and luminosity are expected, reaching up to about 50 kHz and 6 x 10^{-27} cm^2 s^{-1} for Pb-Pb; and 1 MHz and 10^{-34} cm^{-2} s^{-1} for pp.

To exploit the new LHC scenarios, ALICE will have new detectors, i.e. the Inner Tracking System, Muon Forward Tracker and the Fast Interaction Trigger (FIT), as well as new continuous trigger mode in addition to the traditional trigger scheme at its disposal.

Fast Interaction Trigger (FIT)

The **FIT** detector [2] is composed of three systems: **FV0**, **FT0** and the **Forward Diffractive Detector (FDD)**. FDD was included in 2019 in the FIT project, to be integrated in a **common Front End Electronics** and **Detector Control System**.

FIT is capable of providing:

- Minimum latency interaction trigger.
- Luminosity monitoring.
- Precision collision time and vertex.
- Determination of centrality.
- Determination of the event plane for heavy-ion collisions.

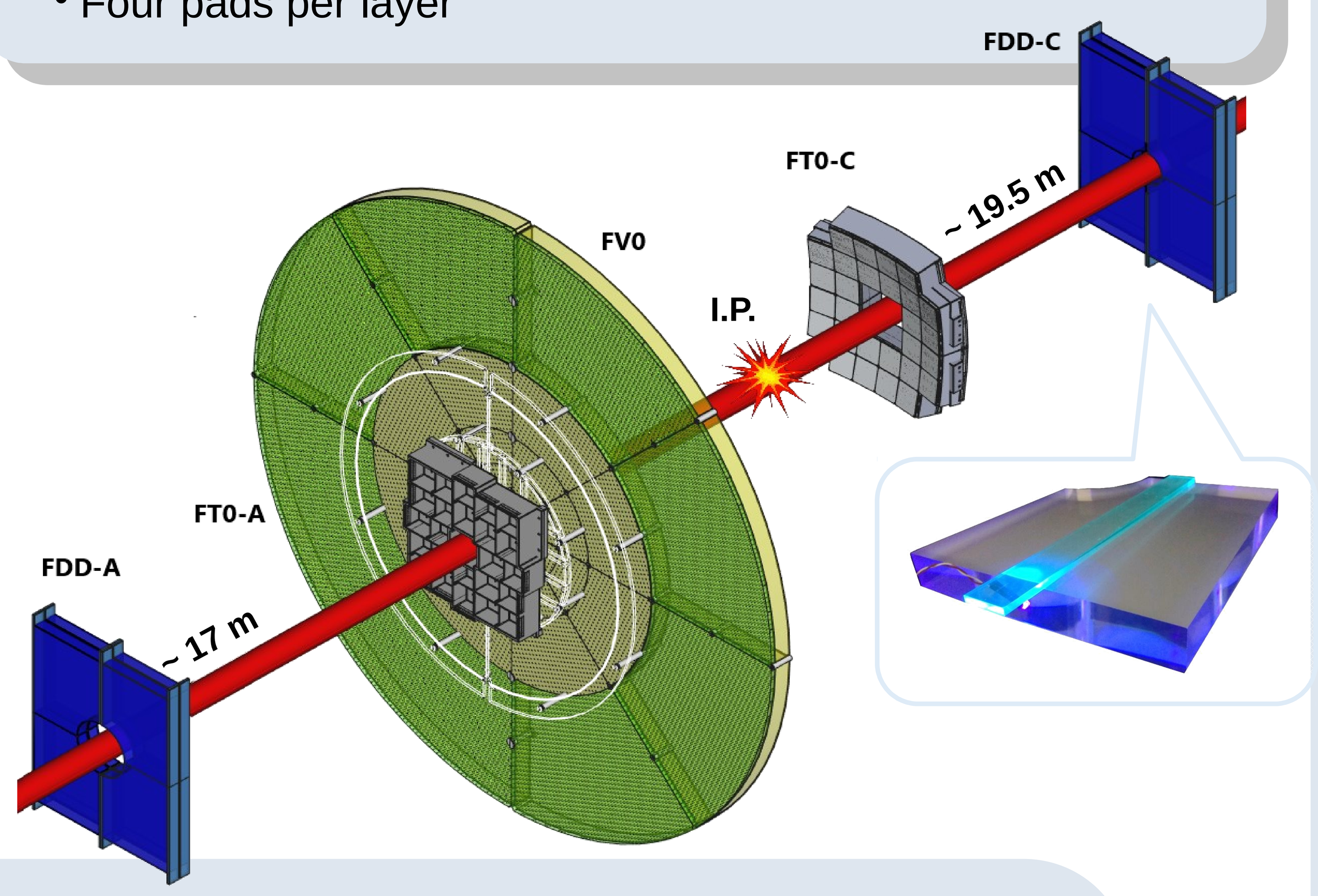
The **FDD** will in addition have other important contributions:

- **Monitoring the LHC background.**
- **Providing vetoes for UPC, electromagnetic and diffractive interactions.**

The FDD concept

FDD is the upgrade of the former **ALICE Diffractive (AD)** detector, keeping the same geometry but with improved materials. FDD consists of:

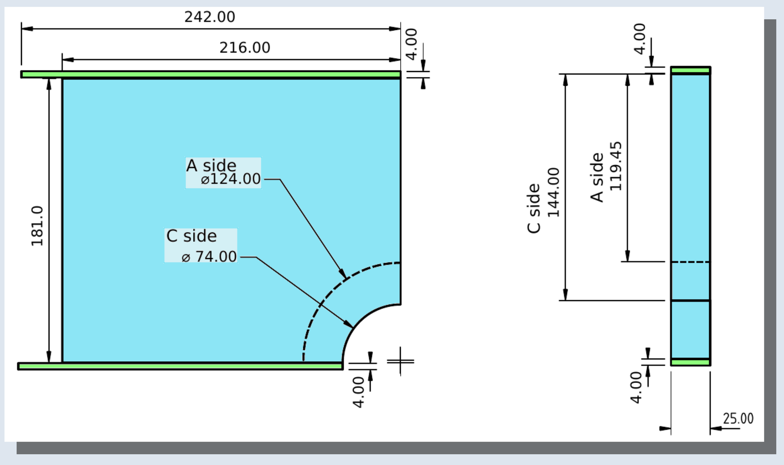
- Two stations **FDD-A** and **FDD-C**.
- Two layers per station.
- Four pads per layer



Geometry

Each pad has two **wavelength shifting (WLS) bars** connected to individual **PMT** via a bundle of **clear optical fibers**.

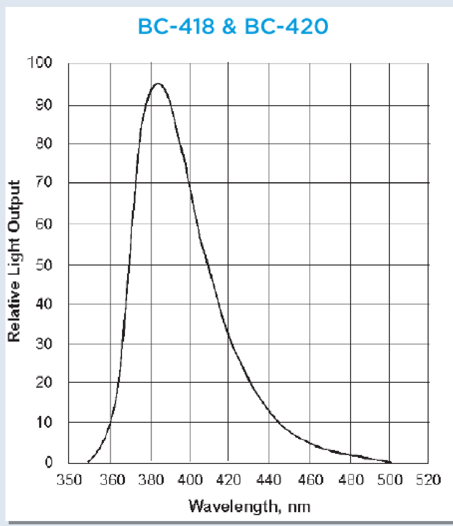
The A- and C-side pads differ only in their corner cuts due to the difference in the beam-pipe radius on their corresponding sides.

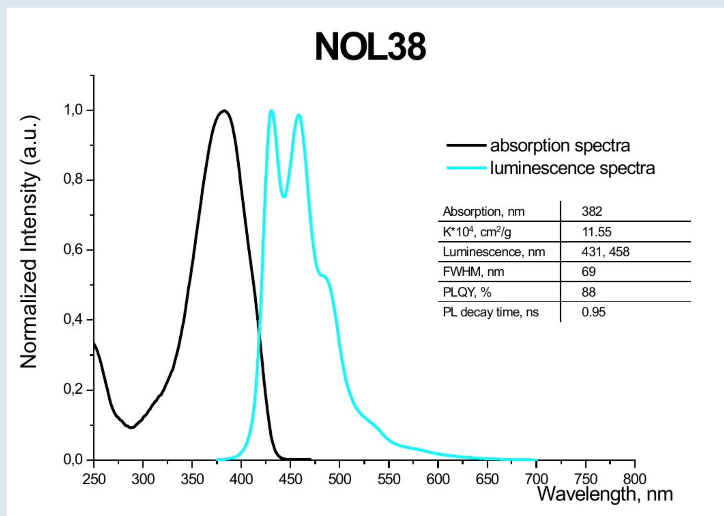


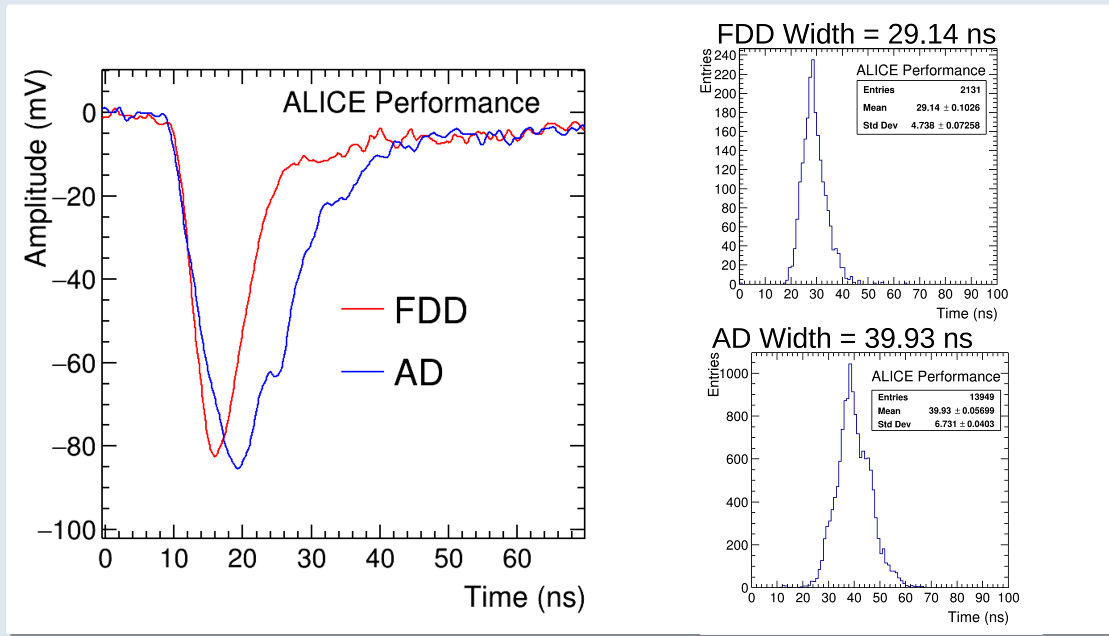
Materials

The reduction of the signal time width of FDD with respect to AD was achieved by using materials with a better timing response in the construction of the pads.

Material	Manufacturer: Model	Timing
Plastic scintillator	Bicron: BC-420	Rise = 0.5 ns, Decay = 1.5 ns
WLS bars	LuminnoTech: NOL-38	Re-emission = 0.9 ns
Optical fibers	Kuraray: PSM-Clear	-
PMT	Hamamatsu: H8409-70	Rise = 2.1 ns, Transit = 7.5 ns

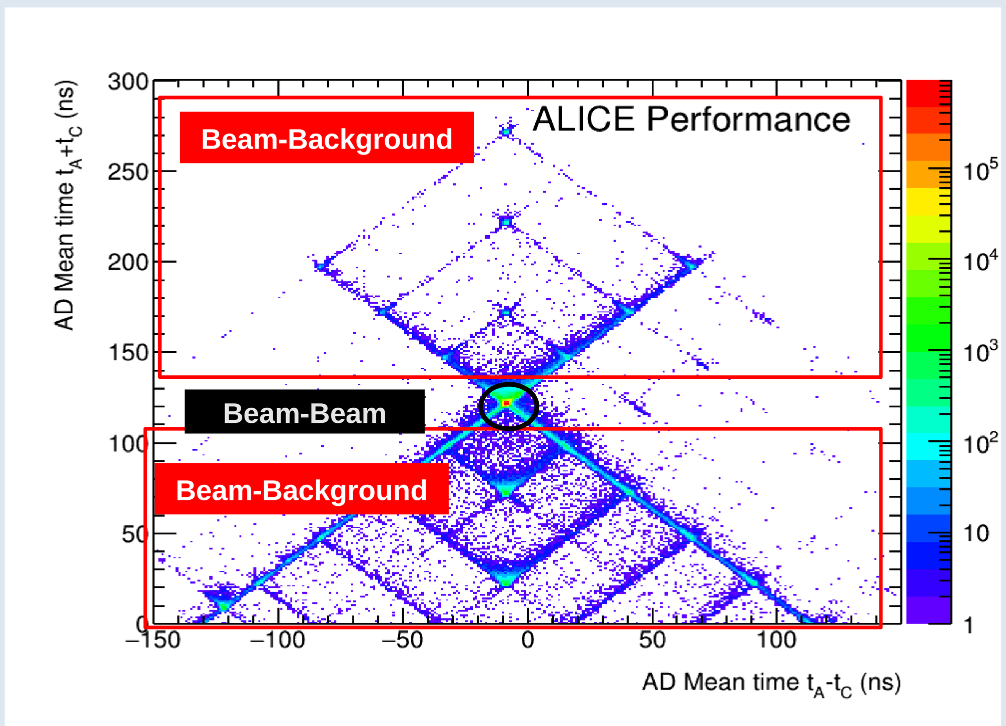






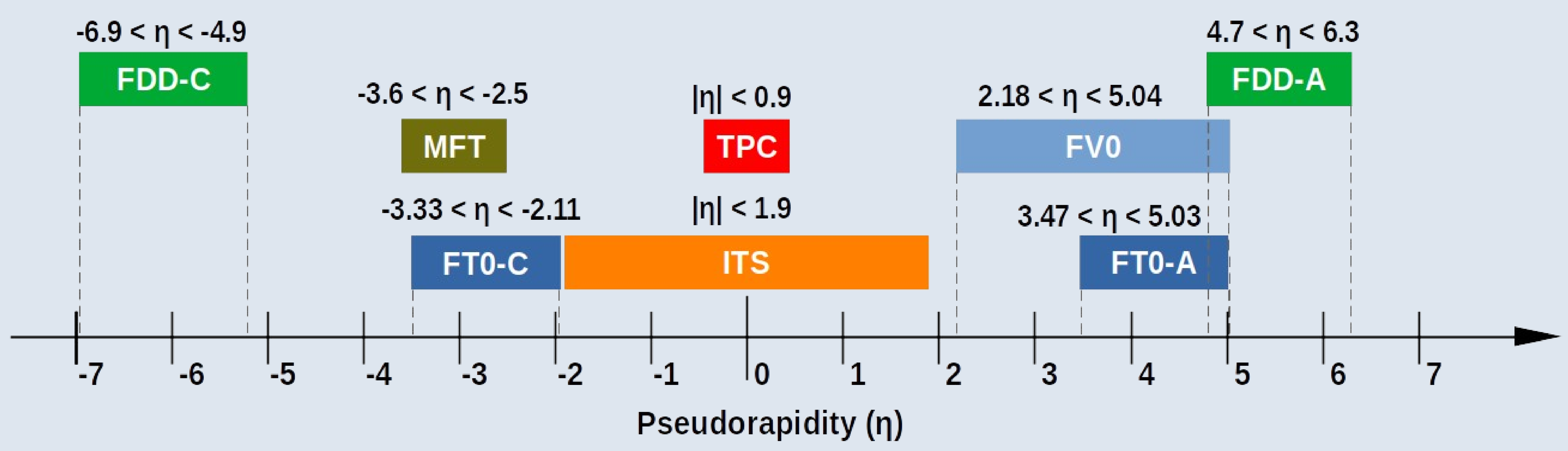
Background monitoring

Since FDD will cover both, the A- and C-sides it is **ideal for beam monitoring and beam-gas rejection** in a similar way as the AD did during the LHC Run 2.



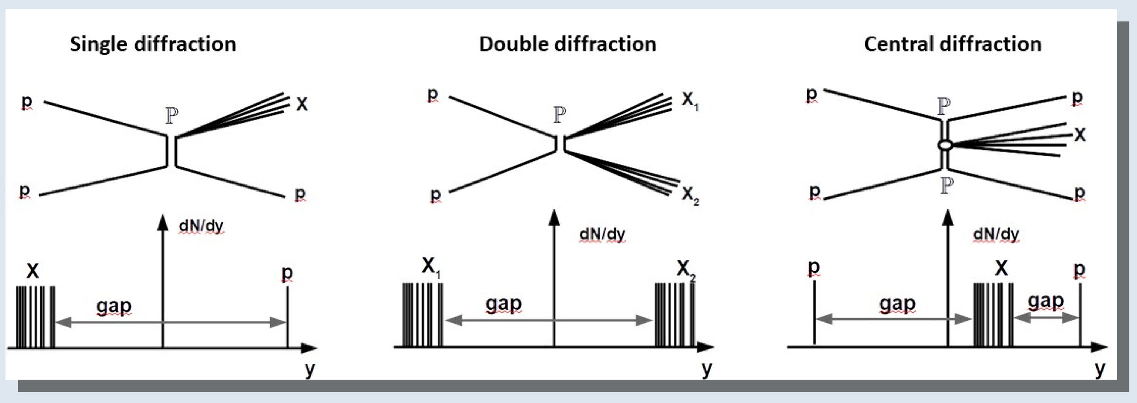
Pseudorapidity coverage

FIT will cover the forward rapidity, where **FDD will be crucial in the most forward region**. FDD-A and FDD-C will cover the pseudorapidity ranges of **4.7<η<6.3** and **-6.9<η<-4.9**, respectively.

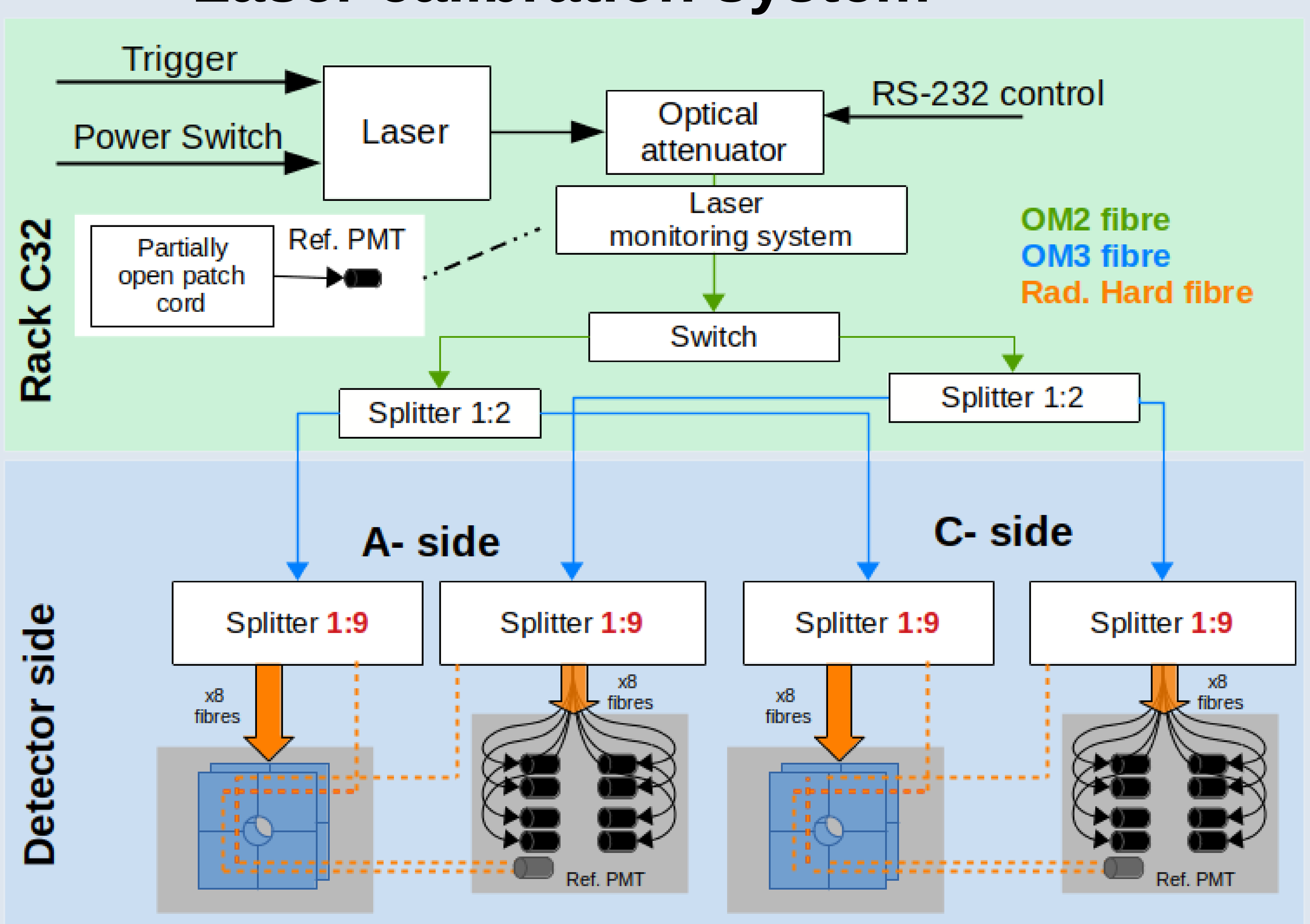


This increased coverage allows ALICE to:

- **Select diffractive events** down to diffractive masses of a few GeV/c^2.
- **Veto particle production** in the forward regions to obtain clean samples of ultra-peripheral and diffraction events.



Laser calibration system



Comments and outlook

Based on the experience of working with the AD detector and its performance, we expect to successfully construct and commission the FDD at the end of 2020 and the beginning of 2021. With the actual scheme of forward detectors, FDD will make an essential contribution in beam monitoring tasks [3], in addition to the contributions to the diffraction [4] and ultra-peripheral [5] interaction studies in ALICE.

The new materials used for the construction show a significant improvement with respect to the AD. The full characterization and construction are in progress, including the tuning of the Front End Electronics and Detector Control System. The laser calibration system will allow for the monitoring of the detector to adjust parameters to guarantee the best performance.

References

[1] Upgrade of the ALICE Experiment: Letter of Intent, ALICE Collaboration (2012). DOI 10.1088/0954-3899/41/8/087001

[2] New Fast Interaction Trigger for ALICE, Wladyslaw HenrykTrzaska et.al. (2016). DOI doi.org/10.1016/j.nima.2016.06.029

[3] Beam-Gas Background Observations at LHC, Gibson, Stephen et.al. (2017). DOI 10.18429/JACoW-IPAC2017-TUPVA032

[4]Measurement of inelastic, single- and double-diffraction cross sections in proton–proton collisions at the LHC with ALICE. Eur. Phys. J., vol. 73, 2013. ARXIV:1208.4968.

[5] Coherent J/ photoproduction at forward rapidity in ultra-peripheral Pb–Pb collisions at sNN=5.02 TeV. Physics Letters B, vol. 798, ALICE Collaboration (2019). doi.org/10.1016/j.physletb.2019.134926