Commissioning of the ALICE MFT detector and measurement of the polarisation of the J/ψ in 5.02 TeV ultra-peripheral Pb-Pb collisions

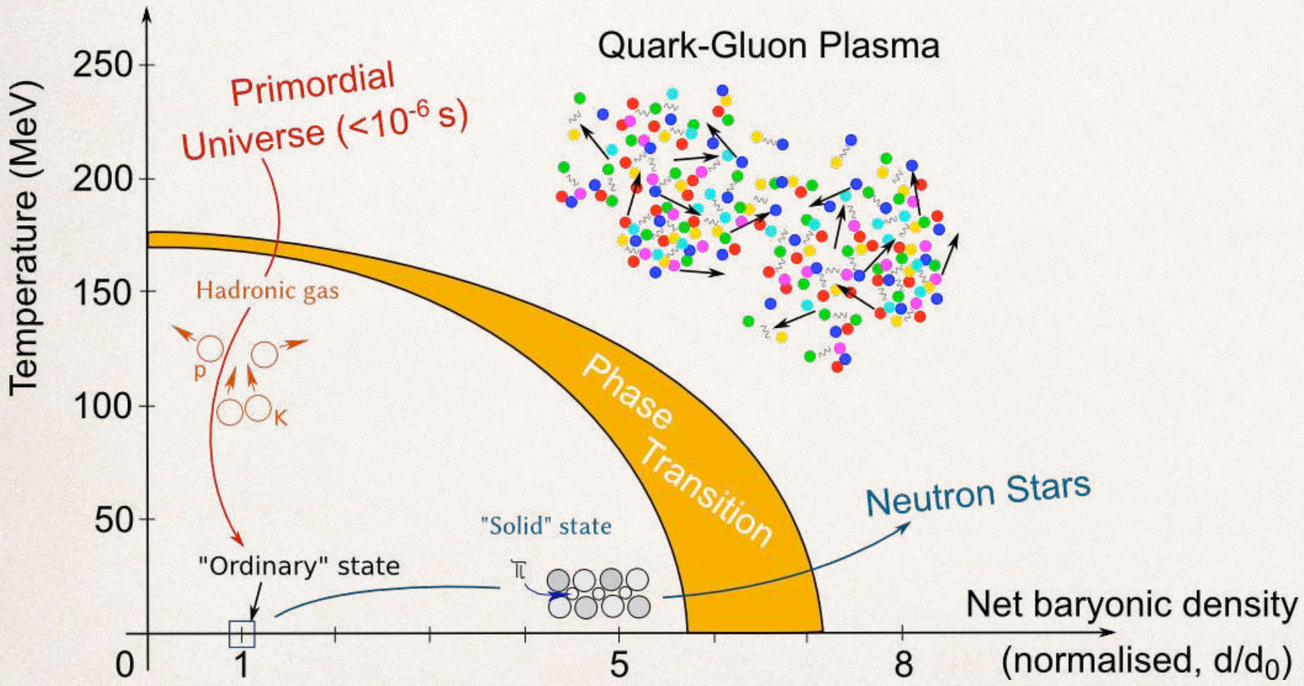
Lucrezia Camilla MIGLIORIN - IP2I Lyon

Journées de Rencontre des Jeunes Chercheurs JRJC 2021 **22/10/2021**

L.C.Migliorin (l.migliorin@cern.ch)

Ultra-peripherical collisions in heavy-ion collisions (1)

Purpose of ultra-relativistic heavy-ion collisions : study of **Quark-Gluon Plasma** (QGP) characteristics produced by **nuclei collisions**.



Important for heavy-ion collision : **distinguish** between **final-state particles** produced **directly** by the nuclei themselves from those **originating from the QGP**.

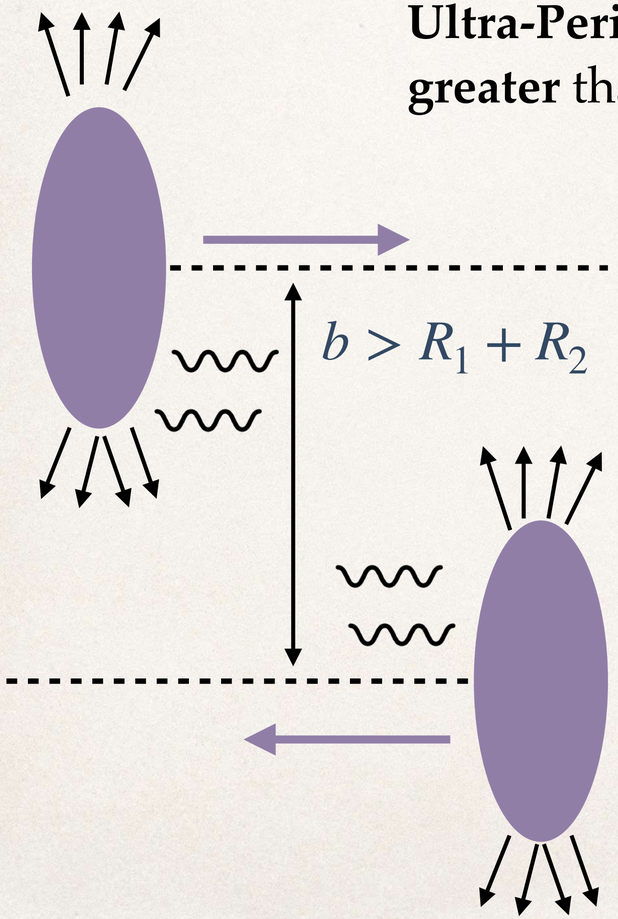
One important characteristic still **unknown** : parton distribution functions (PDFs) show **gluon distributions** are still poorly known.

Parton : Any hadron with 2 or more quarks proposed by R. Feynman.

L.C.Migliorin (l.migliorin@cern.ch)

Ultra-peripherical collisions in heavy-ion collisions (2)

One of interaction types : $\gamma - A$, a **photon** generated by one of the passing nuclei can interact with a **parton** inside a second one producing a wide variety of particles → ***photoproduction***.

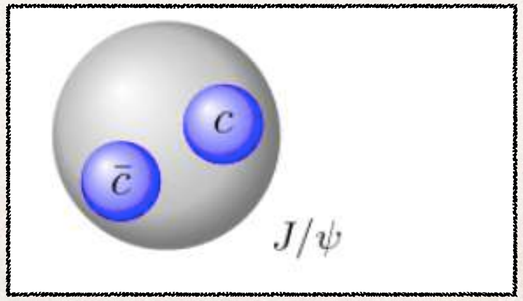


Ultra-Peripheral Collisions (UPC) : two **nuclei** intersect with an **impact parameter (*b*) greater** than the **sum** of their **radii.**

UPC are collisions that do not collide!

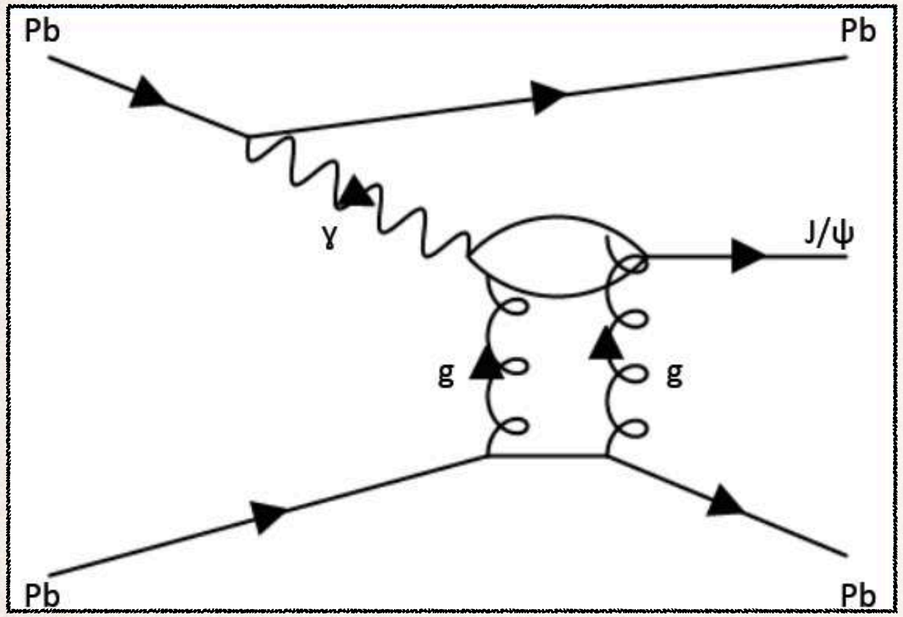
Due to their electric field, they exchange a **very energetic photon**.

A photonuclear interaction that has attracted a lot of interest is **exclusive vector meson production** as J/ψ mesons!

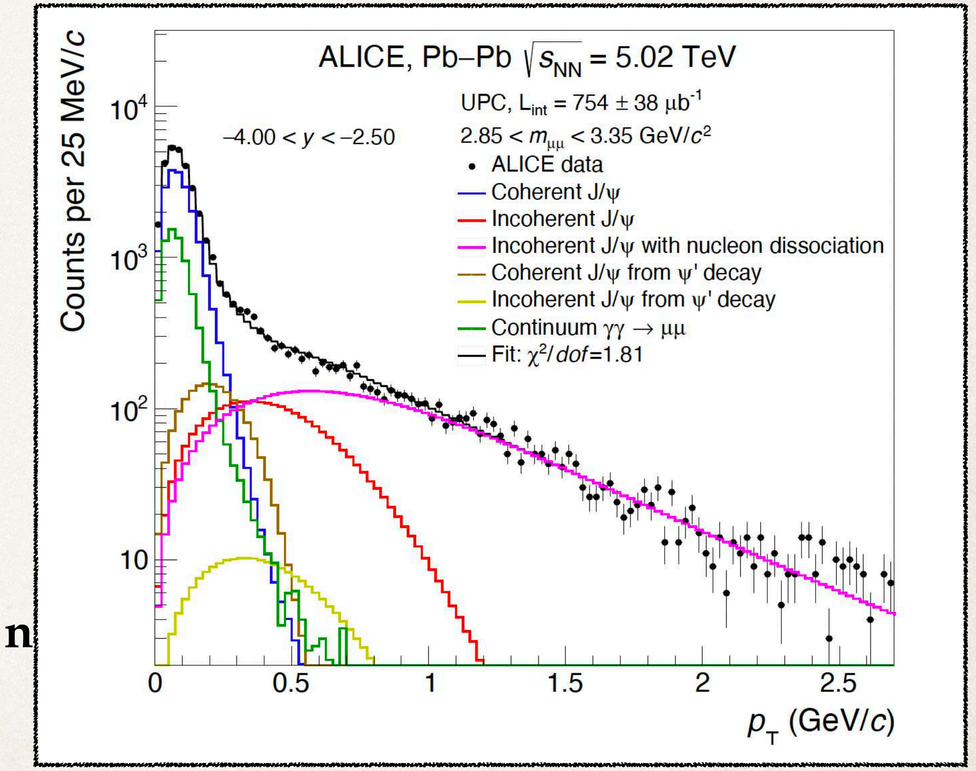


L.C.Migliorin (l.migliorin@cern.ch)

Ultra-peripherical collisions in heavy-ion collisions (3)



I'm working on this hadronic reaction described by this Feynman diagram!



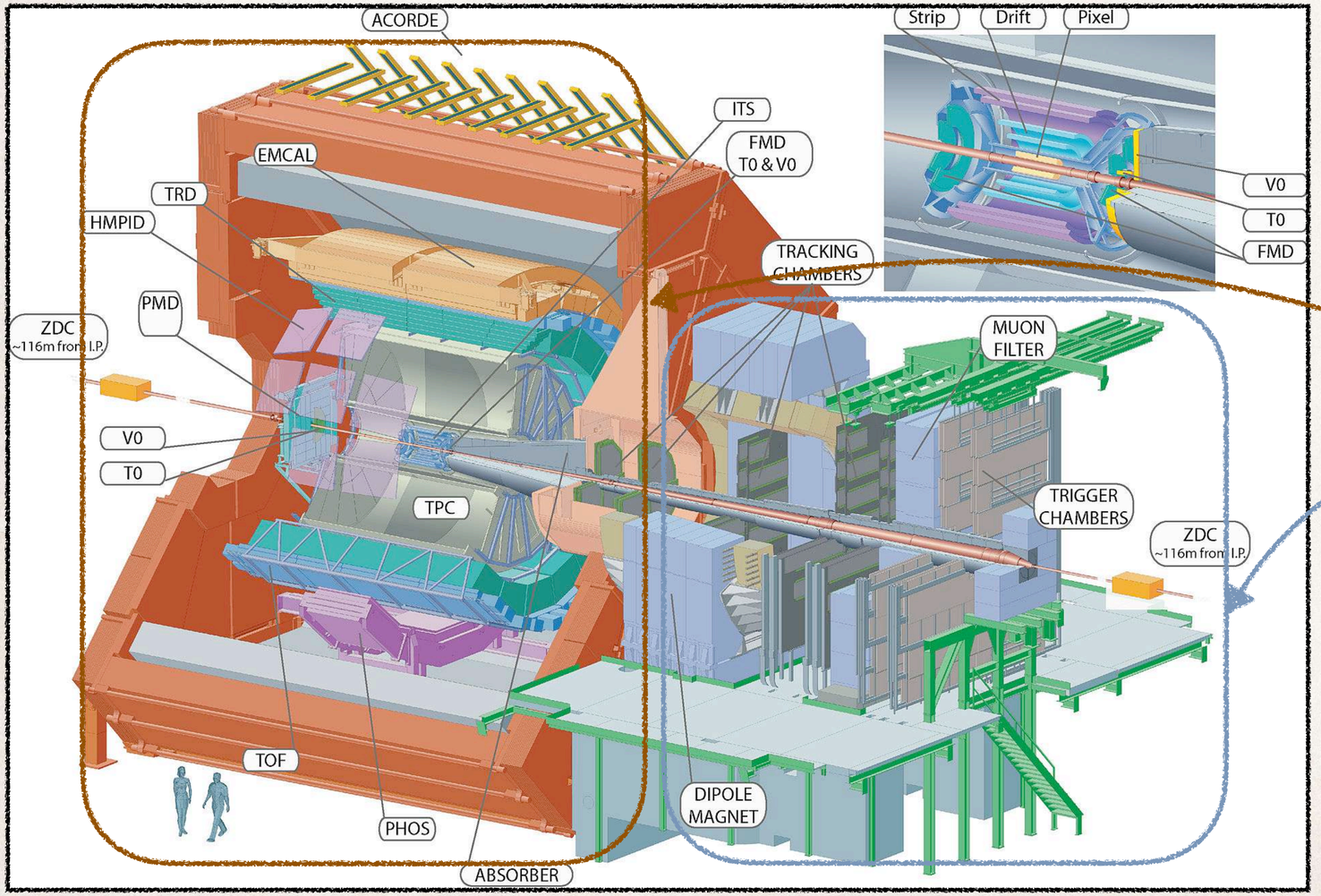
Several different physics processes in UPC events :

- **Coherent photoproduction** : photon emitted couples to the **target n as a whole**;
- **Incoherent photoproduction** : photon couples to an **individual nucleon** within the nucleus.

arXiv:1904.06272v2

L.C.Migliorin (l.migliorin@cern.ch)

ALICE experiment



ALICE (A Large Ion Collider Experiment) is one of the four big experiments at LHC-CERN.

Two main parts of the detector :

- Central part around the point of interaction;
- Front spectrometer for muon measurement.

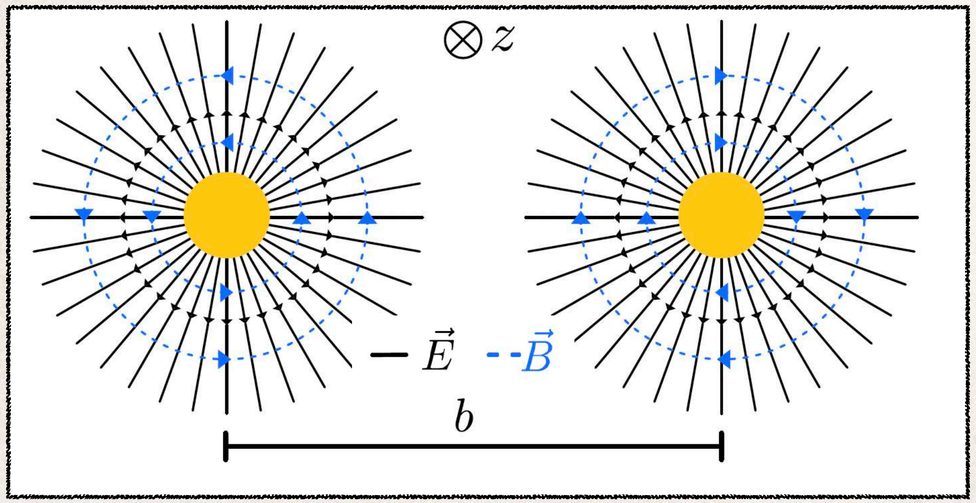
I'm analysing the data Pb-Pb 2018 at $\sqrt{^{s}\mathrm{NN}} = 5.02$ TeV at forward rapidity (collected by the muon spectrometer).

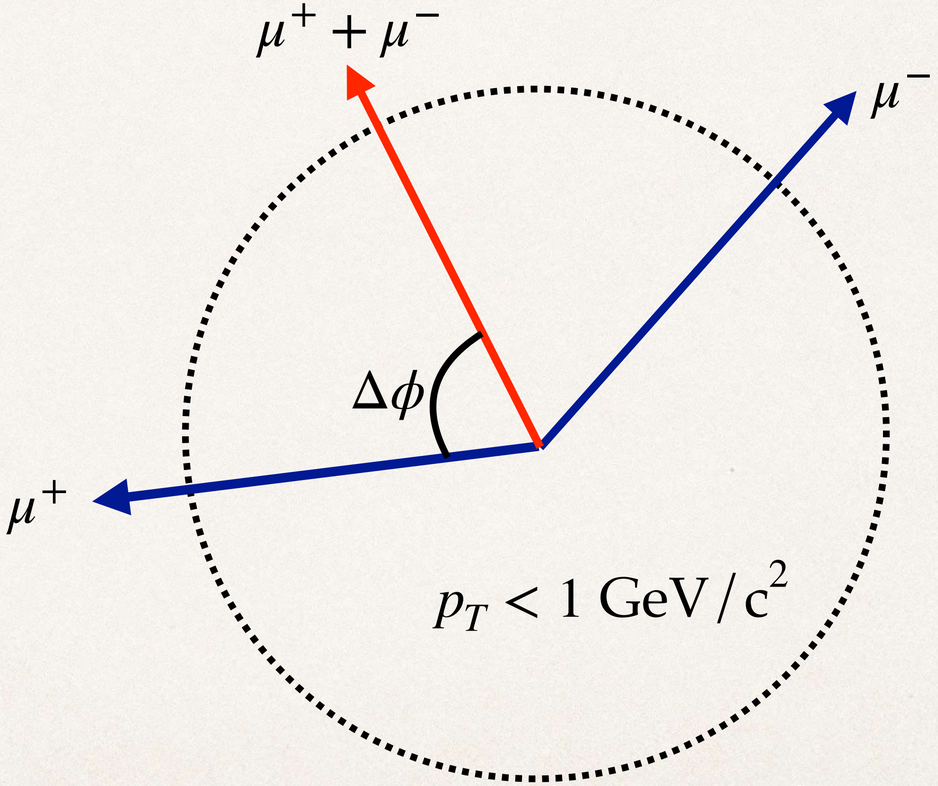
L.C.Migliorin (l.migliorin@cern.ch)

Which is the purpose of my analysis?

STAR collaboration discovered a transverse angular modulation for the UPCs (Daniel Brandenburg Slides) :

Extreme Lorentz contraction of EM fields
→ Quasi-real photons should be linearly polarised in transverse plane
$(\vec{E} \perp \vec{B} \perp \vec{k})$





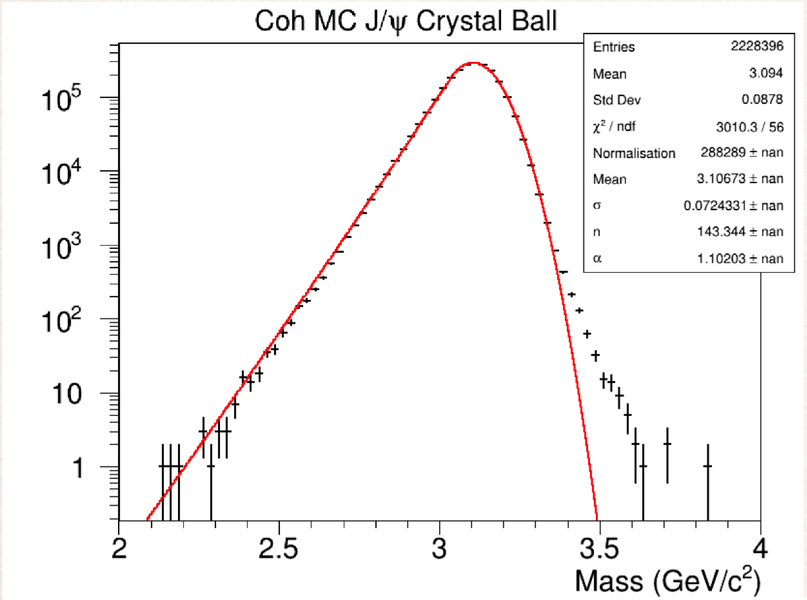
$\Delta\phi = \Delta\phi[(\mu^+ + \mu^-), (\mu^+ - \mu^-)]$
$\sim \Delta\phi[(\mu^+ + \mu^-), \mu^+]$ at small p_T

C. Li, J. Zhou, Y.-j. Zhou, Phys. Lett. B 795, 576 (2019)

L.C.Migliorin (l.migliorin@cern.ch)

Some teeny-tiny results (1)

Fitted the MC production anchored to the Pb-Pb 2018 data using two different functions for J/ψ.

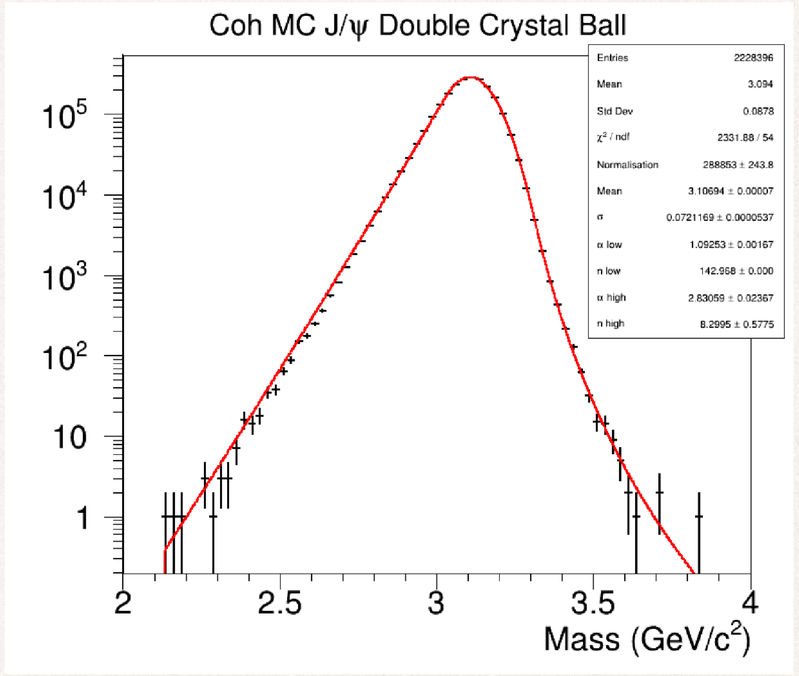


$$f(x;\alpha,n,\bar{x},\sigma) = N \cdot \begin{cases} \exp(-\frac{(x-\bar{x})^2}{2\sigma^2}), & \text{for } \frac{x-\bar{x}}{\sigma} > -\alpha \\ A \cdot (B - \frac{x-\bar{x}}{\sigma})^{-n}, & \text{for } \frac{x-\bar{x}}{\sigma} \leqslant -\alpha \end{cases}$$

where

$$A = \left(\frac{n}{|\alpha|}\right)^n \cdot \exp\left(-\frac{|\alpha|^2}{2}\right), \quad B = \frac{n}{|\alpha|} - |\alpha|,$$

Crystal Ball



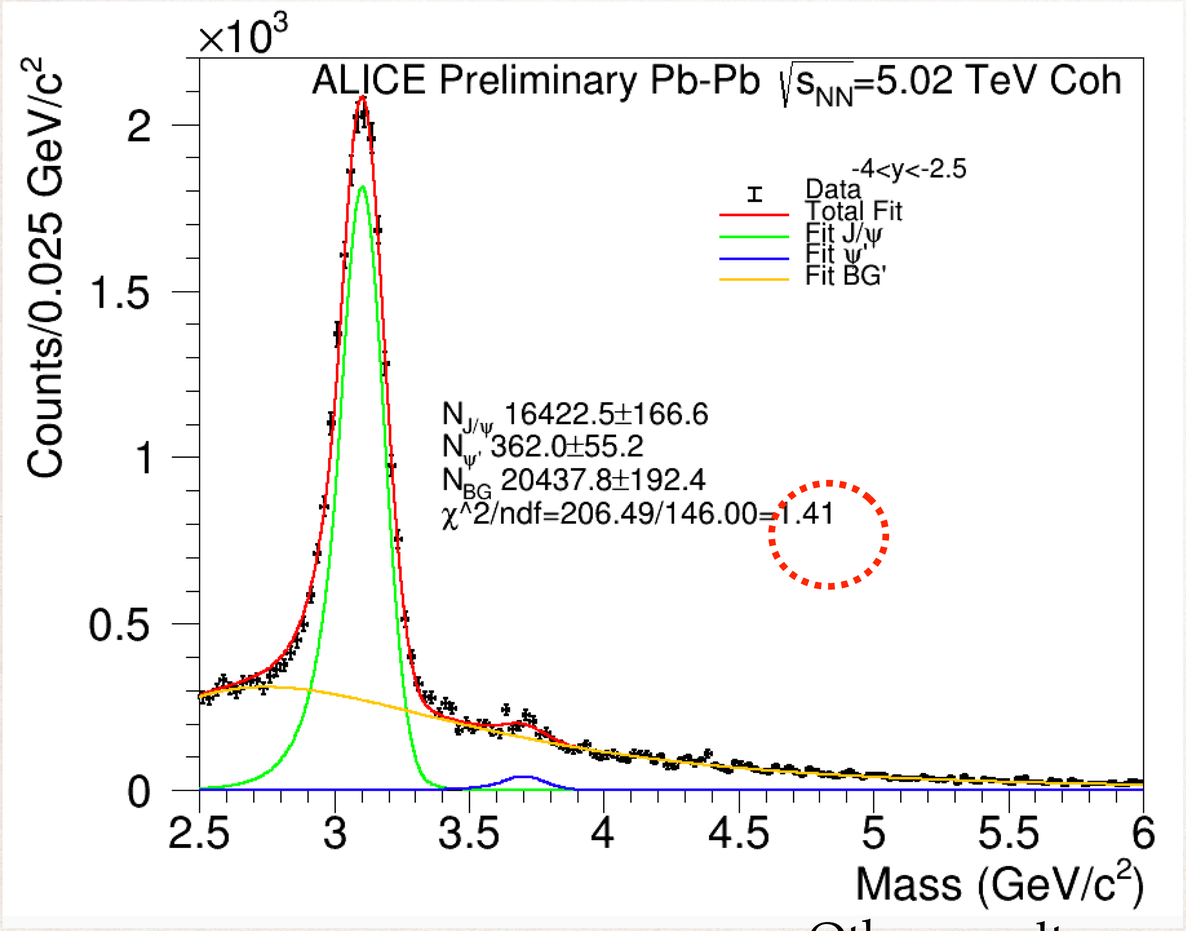
$$N \cdot \begin{cases} e^{-t^2/2} & \text{if } -\alpha_{Low} \geq t \geq \alpha_{High} \\ \dfrac{e^{-0.5\alpha_{Low}^2}}{\left[\frac{\alpha_{Low}}{n_{Low}}\left(\frac{n_{Low}}{\alpha_{Low}} - \alpha_{Low} - t\right)\right]^{n_{Low}}} & \text{if } t < -t = \Delta m_X/\sigma_{CB},\ \Delta m_X = m_X - \mu_{CB} \\ \dfrac{e^{-0.5\alpha_{High}^2}}{\left[\frac{\alpha_{High}}{n_{High}}\left(\frac{n_{High}}{\alpha_{High}} - \alpha_{High} + t\right)\right]^{n_{High}}} & \text{if } t > \alpha_{High}, \end{cases}$$

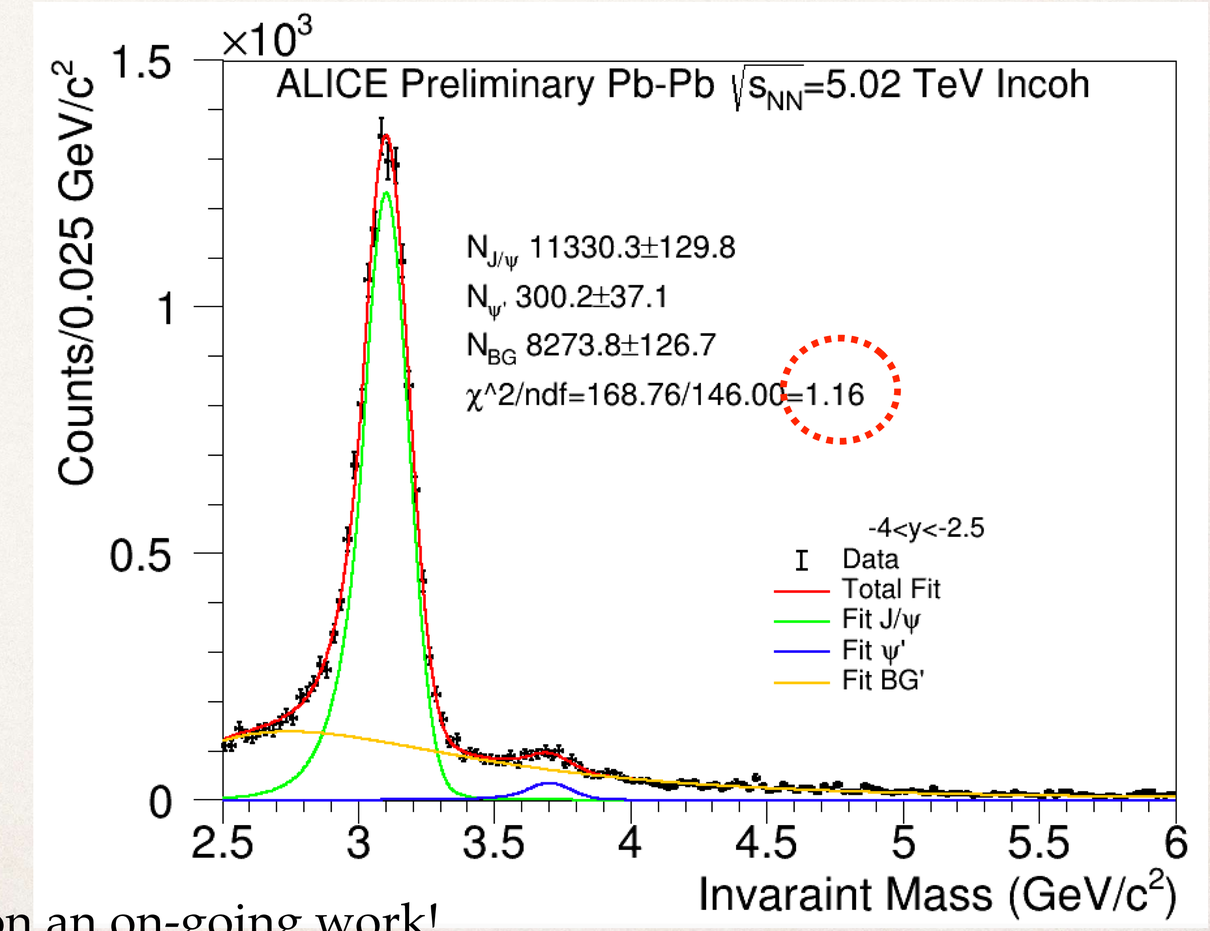
Double Crystal Ball

L.C.Migliorin (l.migliorin@cern.ch)

Some teeny-tiny results (2)

χ^2/ndf ~ 1, fit works !

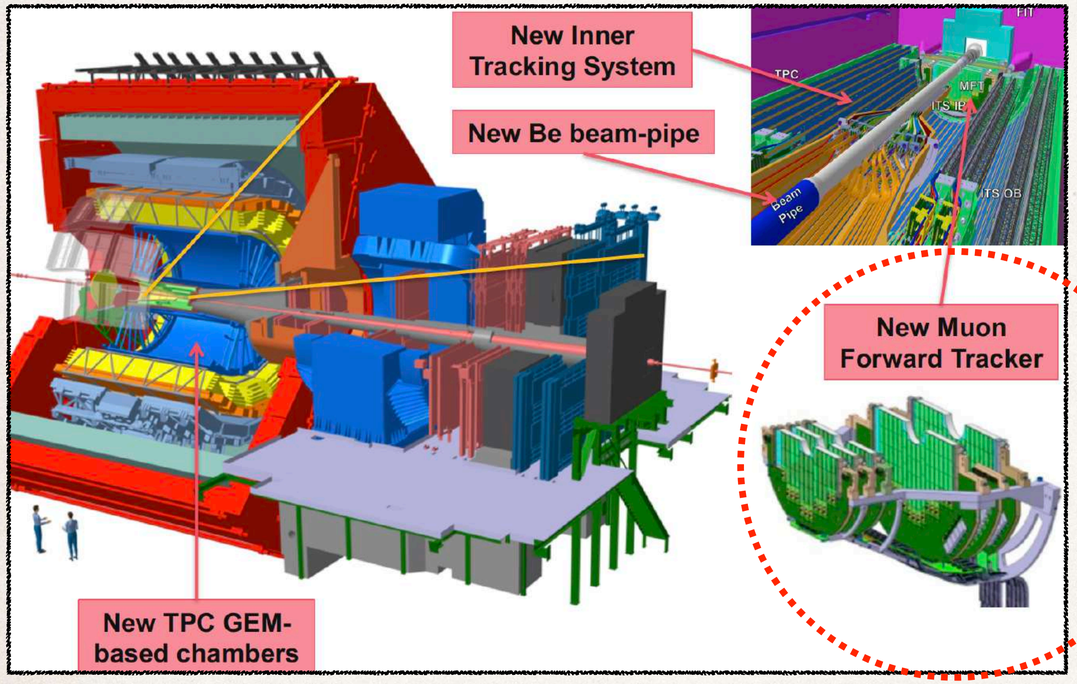




Other results are still on an on-going work!

L.C.Migliorin (l.migliorin@cern.ch)

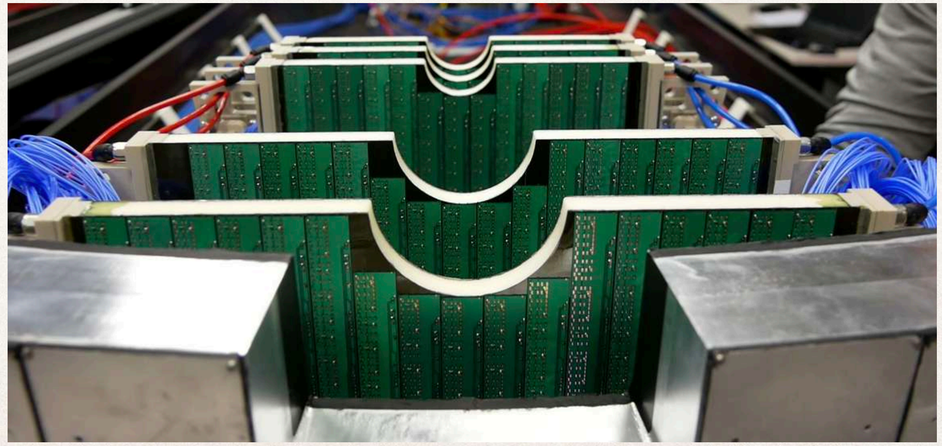
The future of ALICE experiment



LHC Energy and Luminosity = more data produced

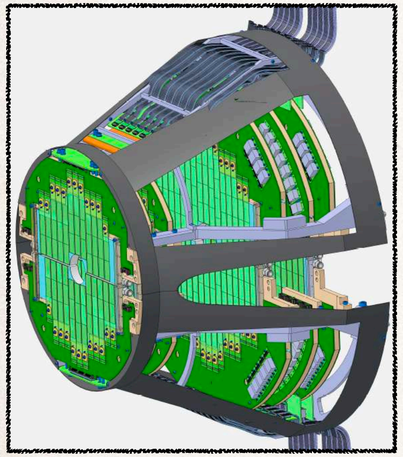
Need more performing detectors and a faster acquisition system

The Muon Forward Tracker (MFT) detector is designed for LHC RUN3 and RUN4



L.C.Migliorin (l.migliorin@cern.ch)

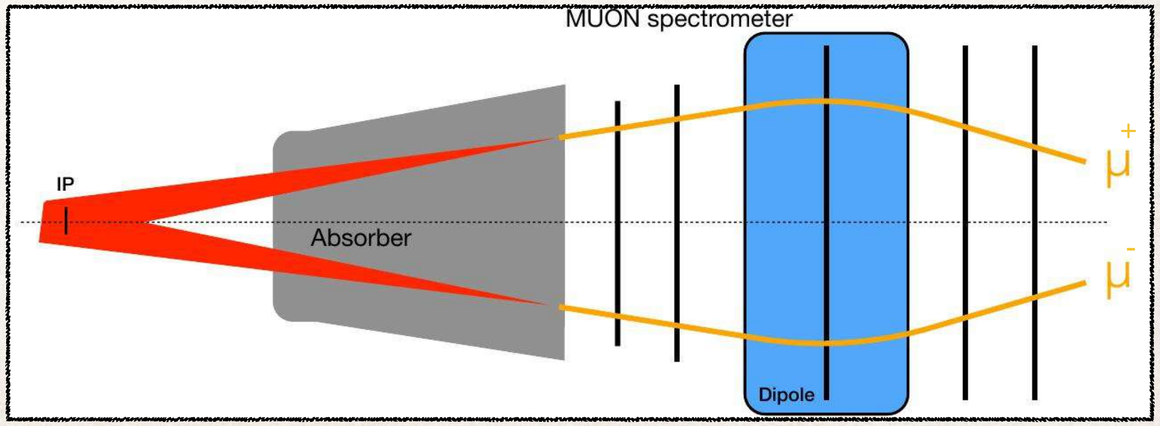
MFT and its commissioning (1)



Type of detector: internal all-silicon-pixel tracker which will give a precise determination of the muon production vertex.

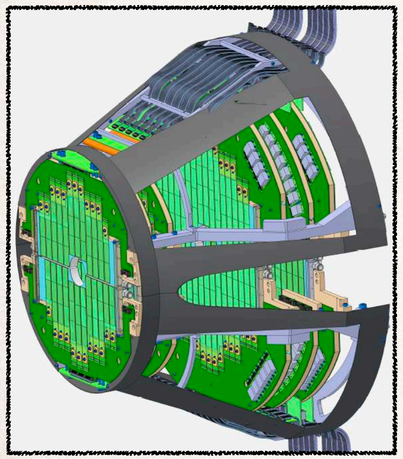
Main objectives of the MFT:

- measure the trajectory of muons before they pass through the absorber;
- discriminate between “prompt” and “not-prompt” J/ψ mesons.



L.C.Migliorin (l.migliorin@cern.ch)

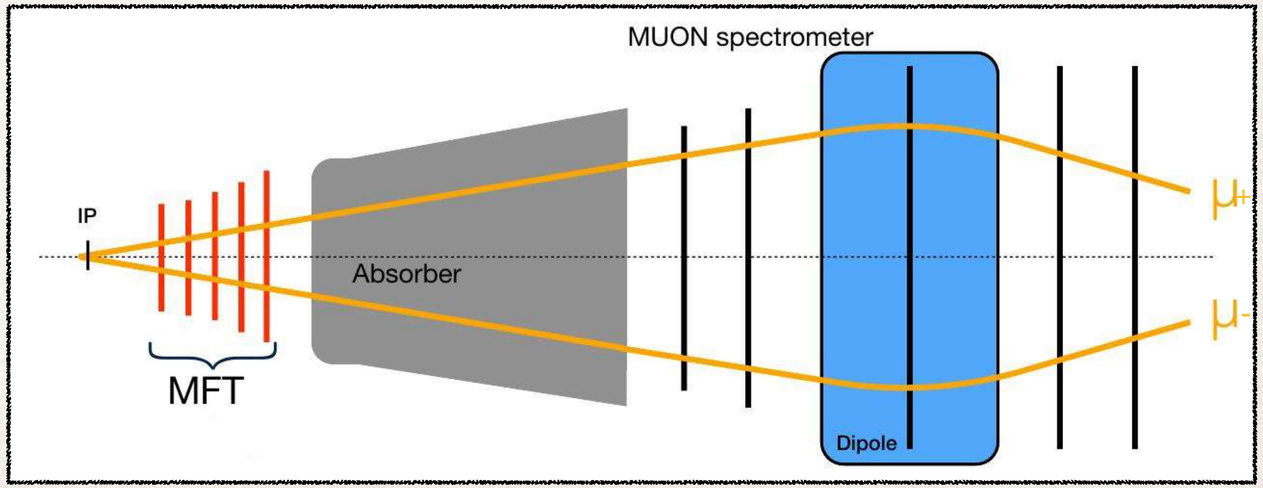
MFT and its commissioning (1)



Type of detector: internal all-silicon-pixel tracker which will give a precise determination of the muon production vertex.

Main objectives of the MFT:

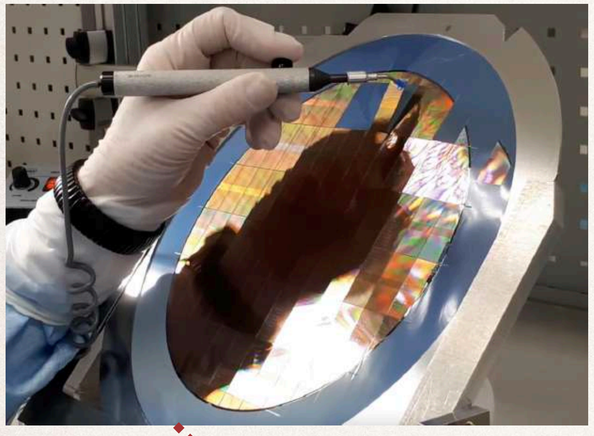
- measure the trajectory of muons before they pass through the absorber;
- discriminate between “prompt” and “not-prompt” J/ψ mesons.



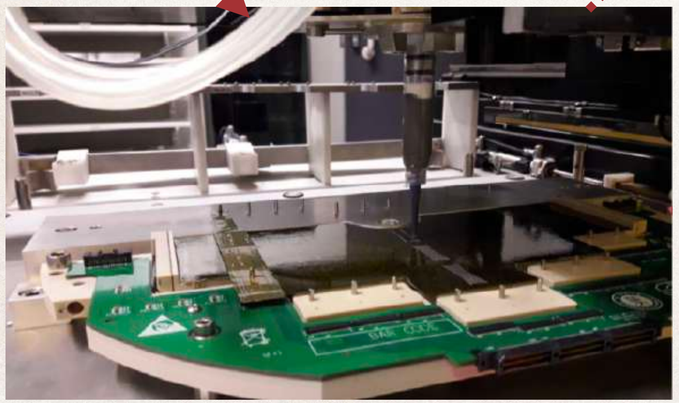
L.C.Migliorin (l.migliorin@cern.ch)

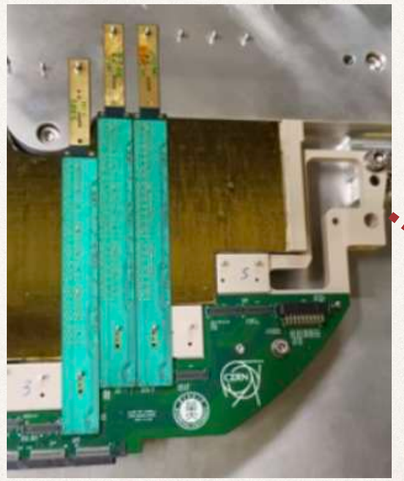
MFT and its commissioning (2)

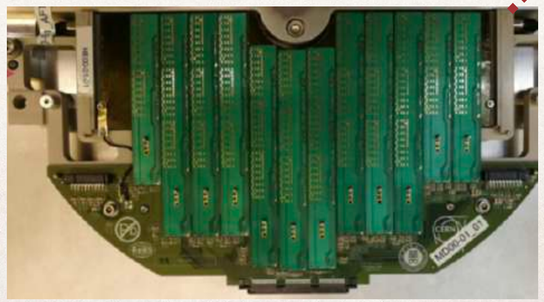
MFT is composed of **936** ALPIDE sensors distributed on **5 disks**. Each sensor is made up of 1024x512 silicon pixels of size 28 μm x 28 μm.

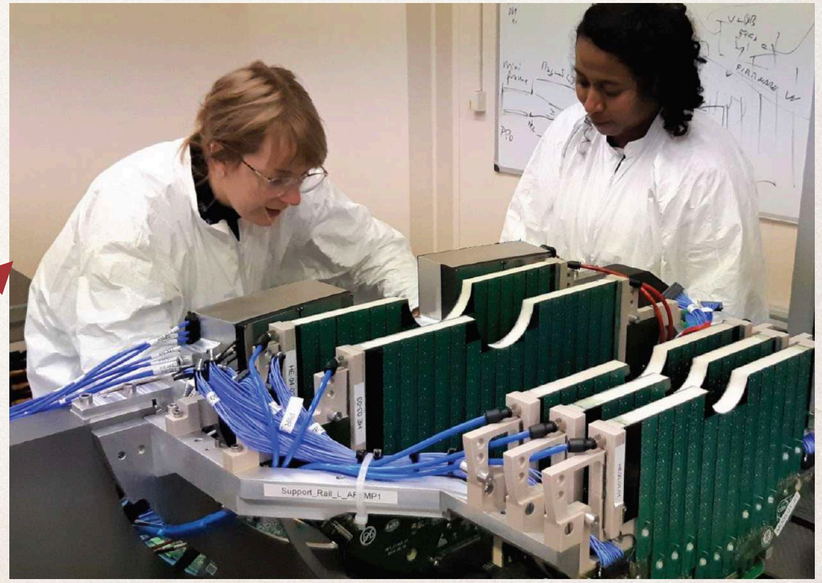


The sensors are glued on Flexible Printed Circuit (FPC) and connected by electronic micro-bridging creating structures called ladders.





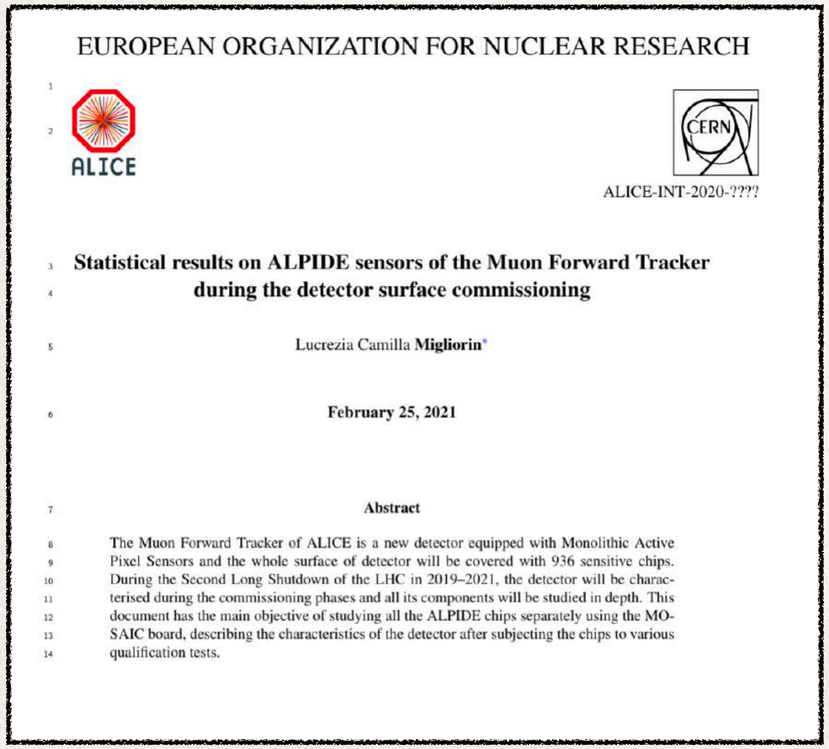




L.C.Migliorin (l.migliorin@cern.ch)

MFT and its commissioning (3)

- Qualification work on disks and ladders;
- Simulation of the MFT detector with the calculation of the acceptance reduction due to defective sensors;
- Development of code for readout and decoding of raw data;
- Writing of an internal note on the qualification of the records.



EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

ALICE

CERN

ALICE-INT-2020-????

Statistical results on ALPIDE sensors of the Muon Forward Tracker during the detector surface commissioning

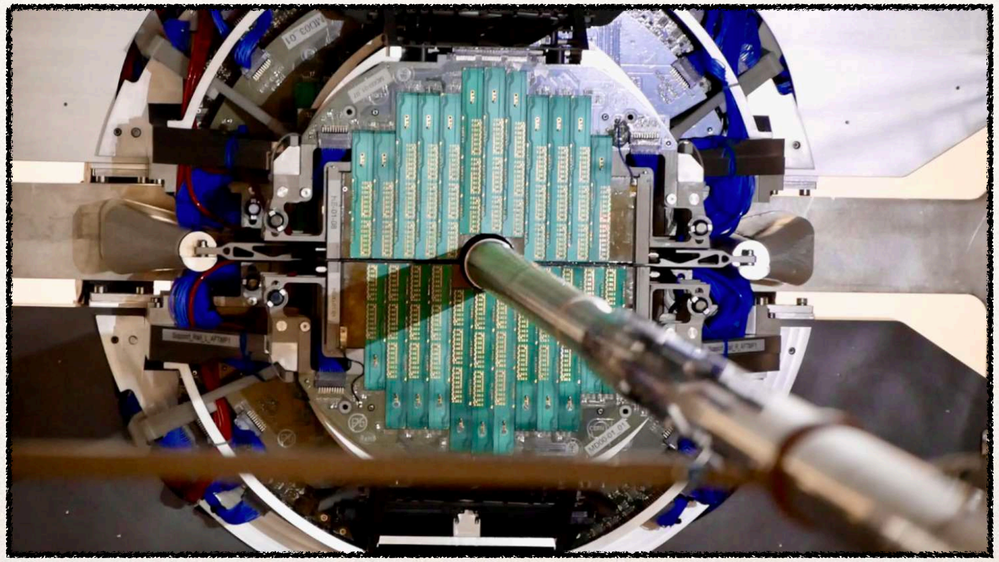
Lucrezia Camilla **Migliorin***

February 25, 2021

Abstract

The Muon Forward Tracker of ALICE is a new detector equipped with Monolithic Active Pixel Sensors and the whole surface of detector will be covered with 936 sensitive chips. During the Second Long Shutdown of the LHC in 2019–2021, the detector will be characterised during the commissioning phases and all its components will be studied in depth. This document has the main objective of studying all the ALPIDE chips separately using the MOSAIC board, describing the characteristics of the detector after subjecting the chips to various qualification tests.

MFT is in ALICE Cavern (ALICE Website) !



KEEP ALEEEERT!

THANKS FOR YOUR ATTENTION

ANY QUESTIONS?