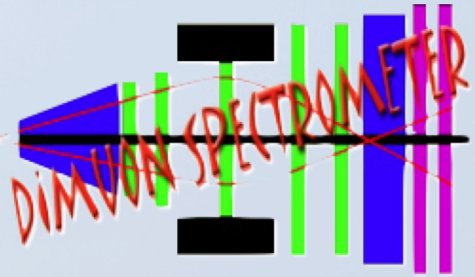


ALICE MUON Project
Studying Quark Gluon Plasma

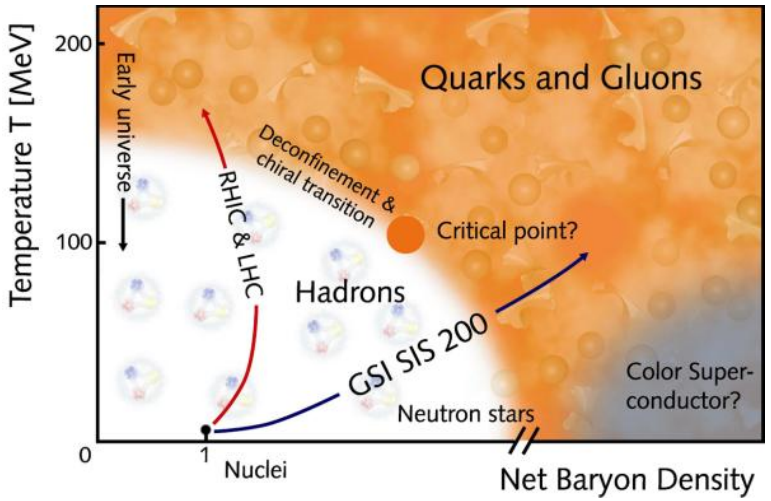
Raphael TIEULENT, IPNL, Lyon (FR)

FJPPL – FKPPL

Jeju Island

May 8th – 10th, 2019

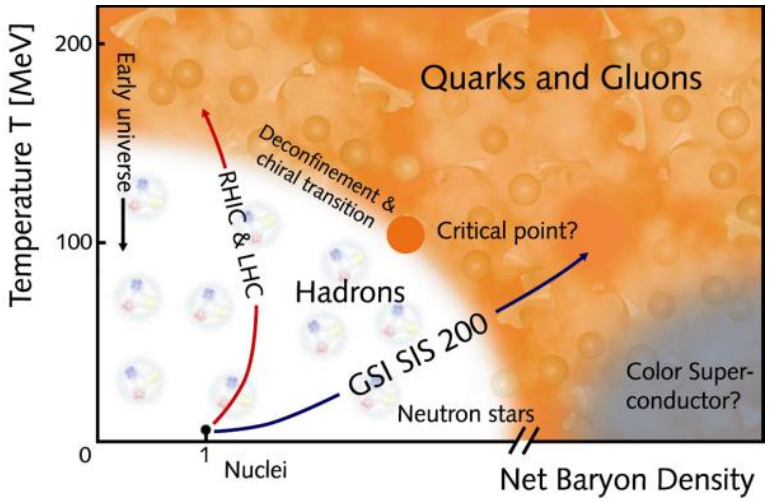
Quark Gluon Plasma (QGP)



QGP = deconfined state of quarks and gluons

- Predicted by QCD
- Studied in high-energy heavy-ion collisions

Quark Gluon Plasma (QGP)



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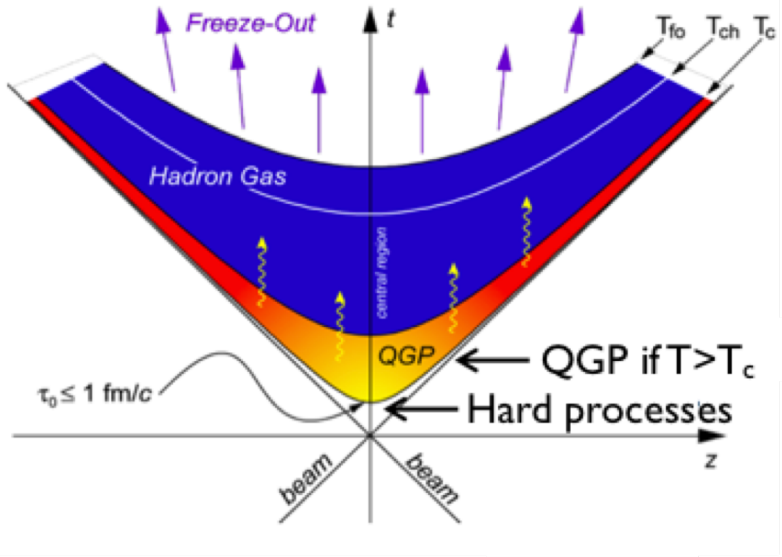


Heavy Quarks (c + b)

Created at the early stage of the collision: 0.1 fm/*c* compared to 10 fm/*c* of QGP lifetime ⇨ Experience full history of collision

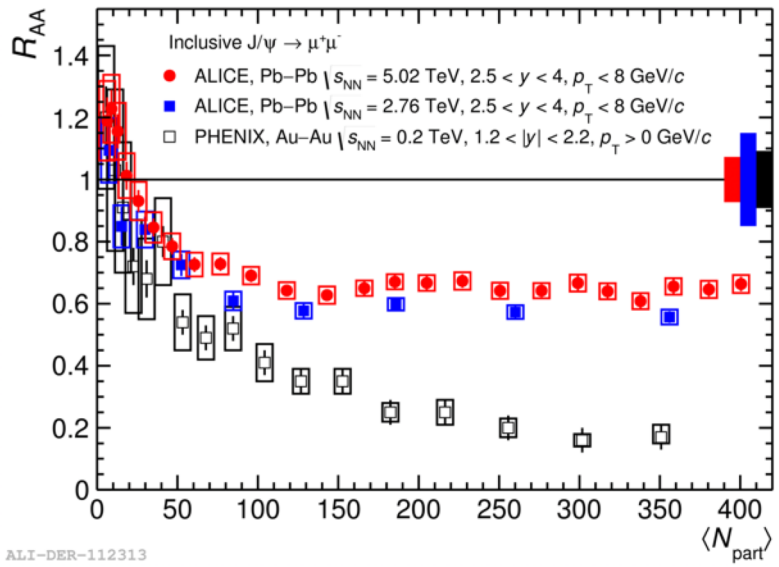
Quarkonia (J/ψ and ϒ families) sensitive to energy density/temperature

⇨ Quarkonia « melted » in the QGP ⇨ decrease of production rate

Energy loss of Heavy Quarks depends on medium density

⇨ Measurement of Open Heavy Flavors (D & B)

Main results from run 1+2 (selection)

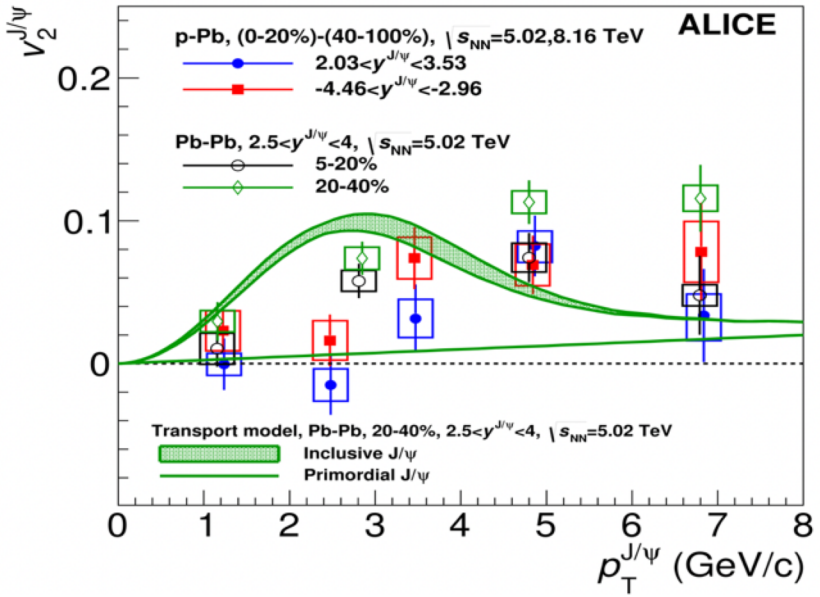


$$R_{AA} = \frac{Y^{PbPb}}{\langle N_{coll} \rangle Y^{pp}}$$

R_{AA} = 1 (PbPb overlap of pp)
$R_{AA} \neq 1$ (PbPb ≠ pp)

J/ψ less suppressed at the LHC than the RHIC for higher centrality

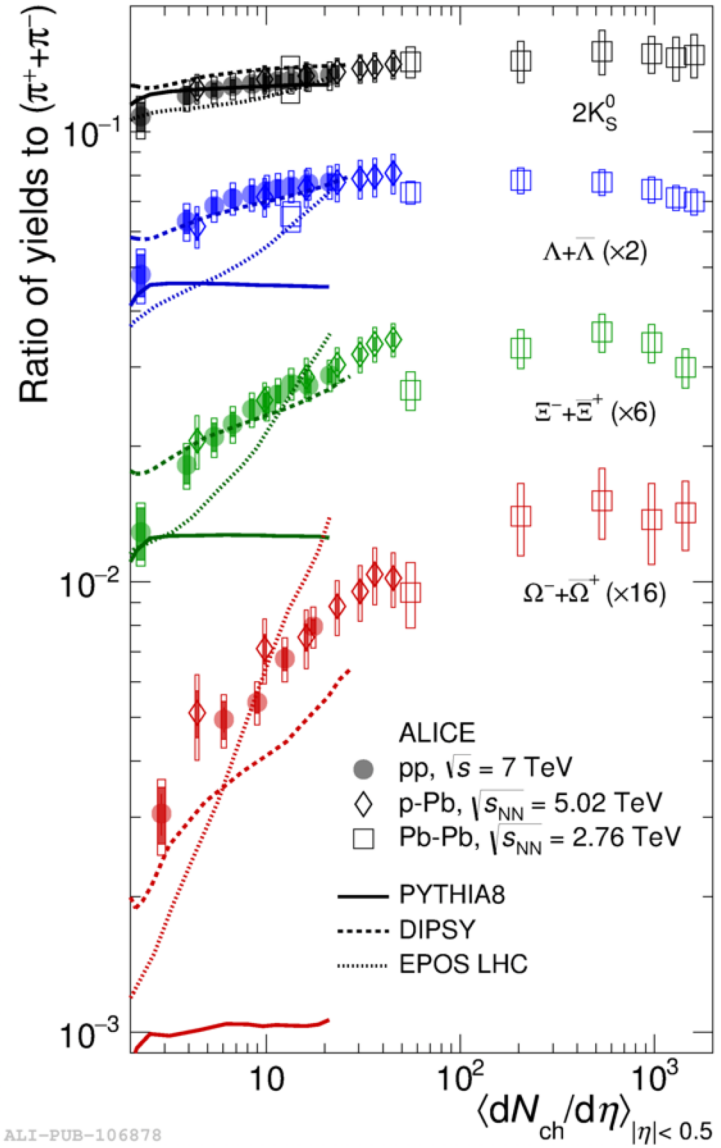
Contribution from J/ψ regeneration at low p_T



$V_2 \simeq$ collectivity

Measurement of J/ψ elliptic flow in p- Pb collisions in two rapidity regions

Main results from run 1+2 (selection)



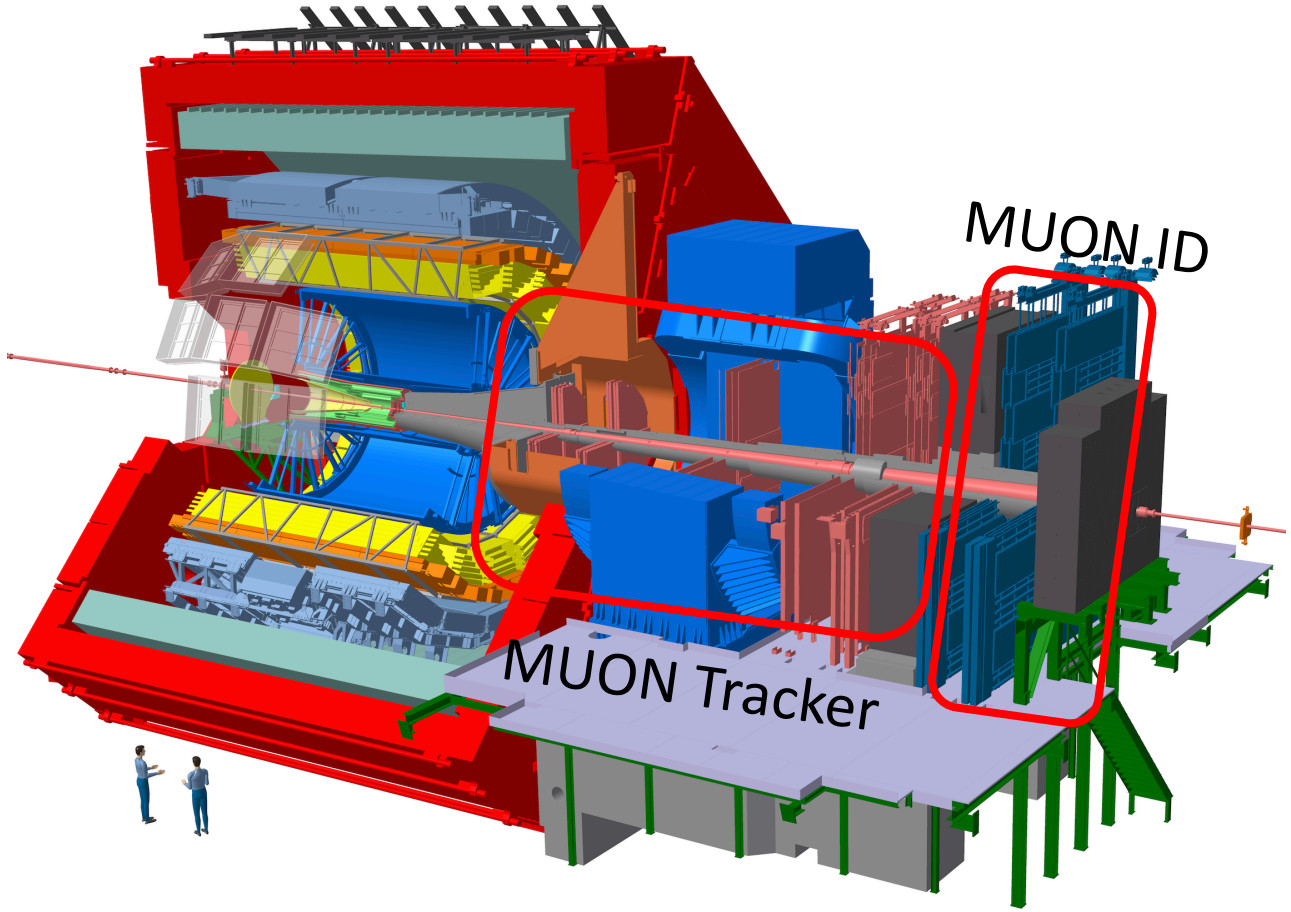
Before LHC era

- Pb-Pb : study of the produced QGP
- p-Pb : no QGP ; study of cold nuclear effects
- p-p : no QGP ; reference for all measurements

LHC revealed unexpected features of high-multiplicity events in small systems

- Questioning our understanding of initial vs. final state and emergence of collectivity
- Muon physics already contributes to this open questions

ALICE - MUON Apparatus for run 3-4

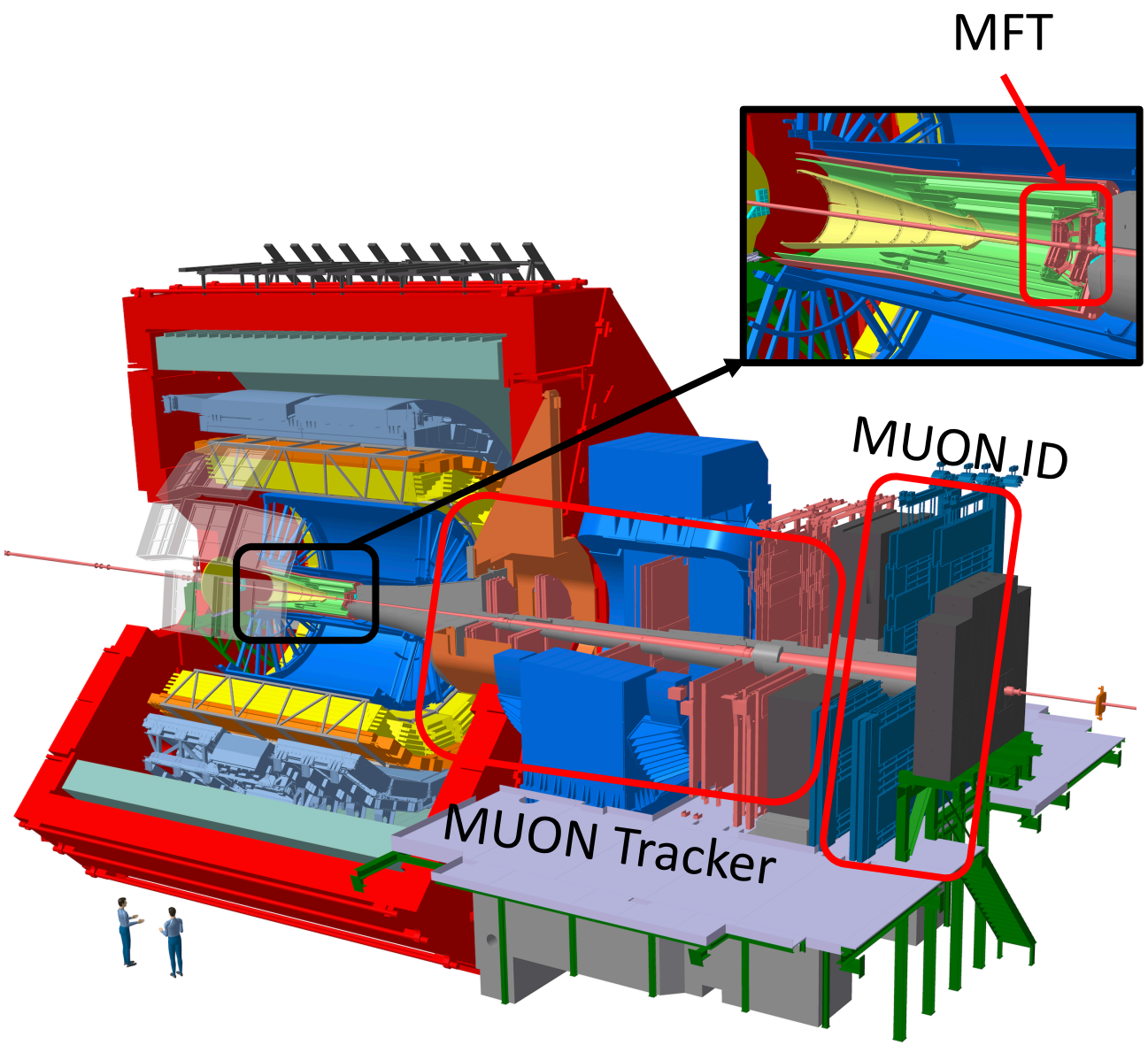


ALICE-MUON upgrade during LS2

- Switching ALICE data taking to continuous readout

⇨ Change FEE of Tracker and MUON ID

ALICE - MUON Apparatus for run 3-4



ALICE-MUON upgrade during LS2

- Switching ALICE data taking to continuous readout

⇨ Change FEE of Tracker and MUON ID

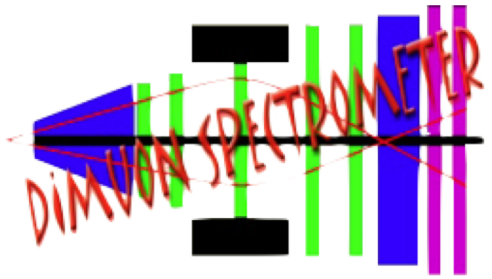
- Adding Vertexer before absorber

⇨ MFT = Muon Forward Tracker

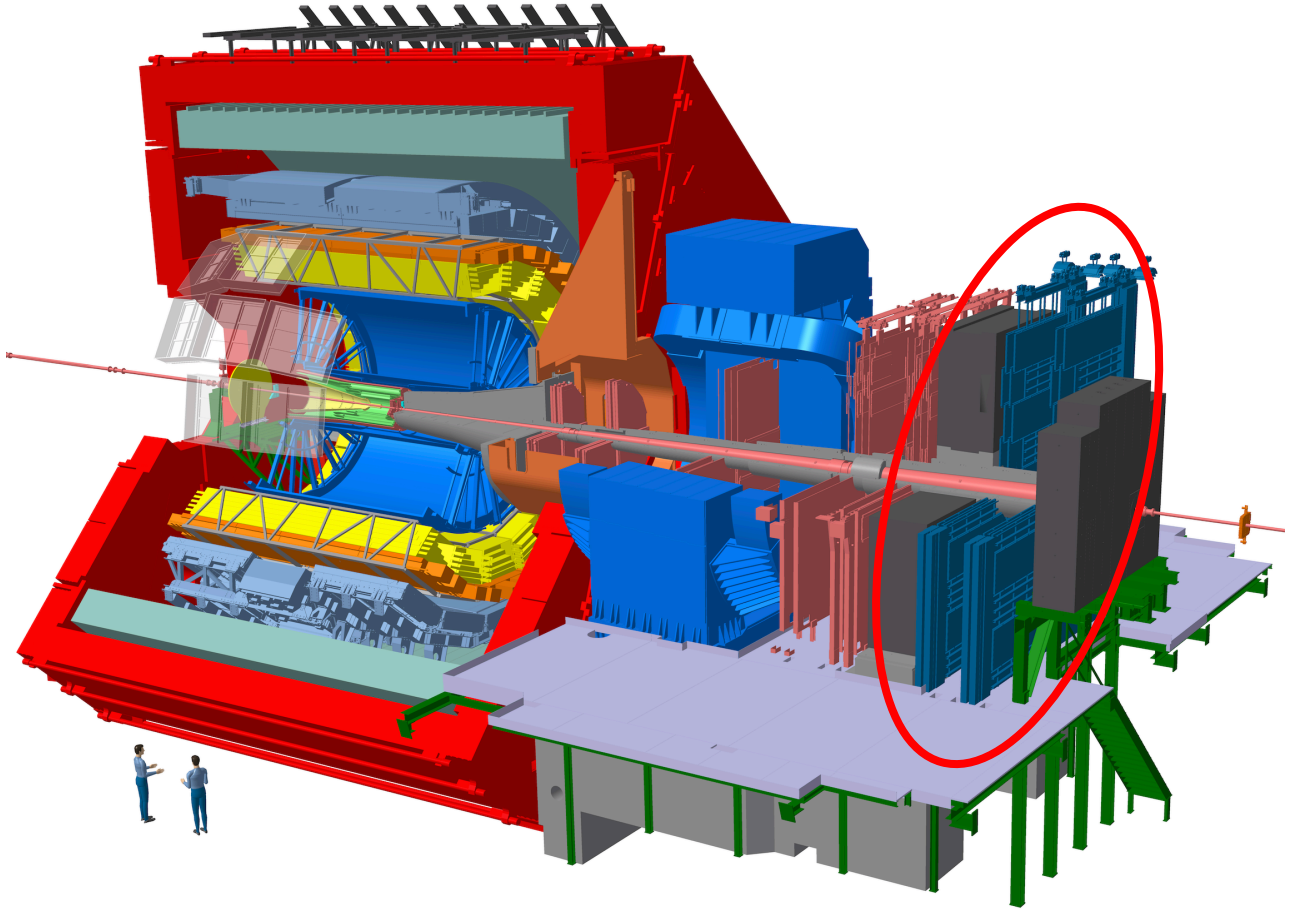
Pixel silicon tracker based on ALPIDE chip from CERN

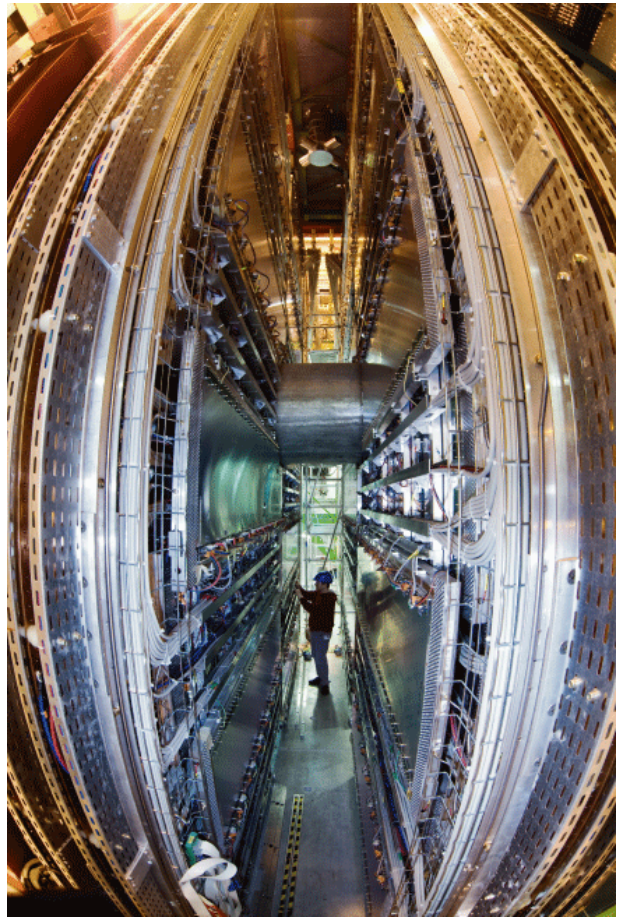
MUON Spectrometer

MUON Trigger → MUON ID

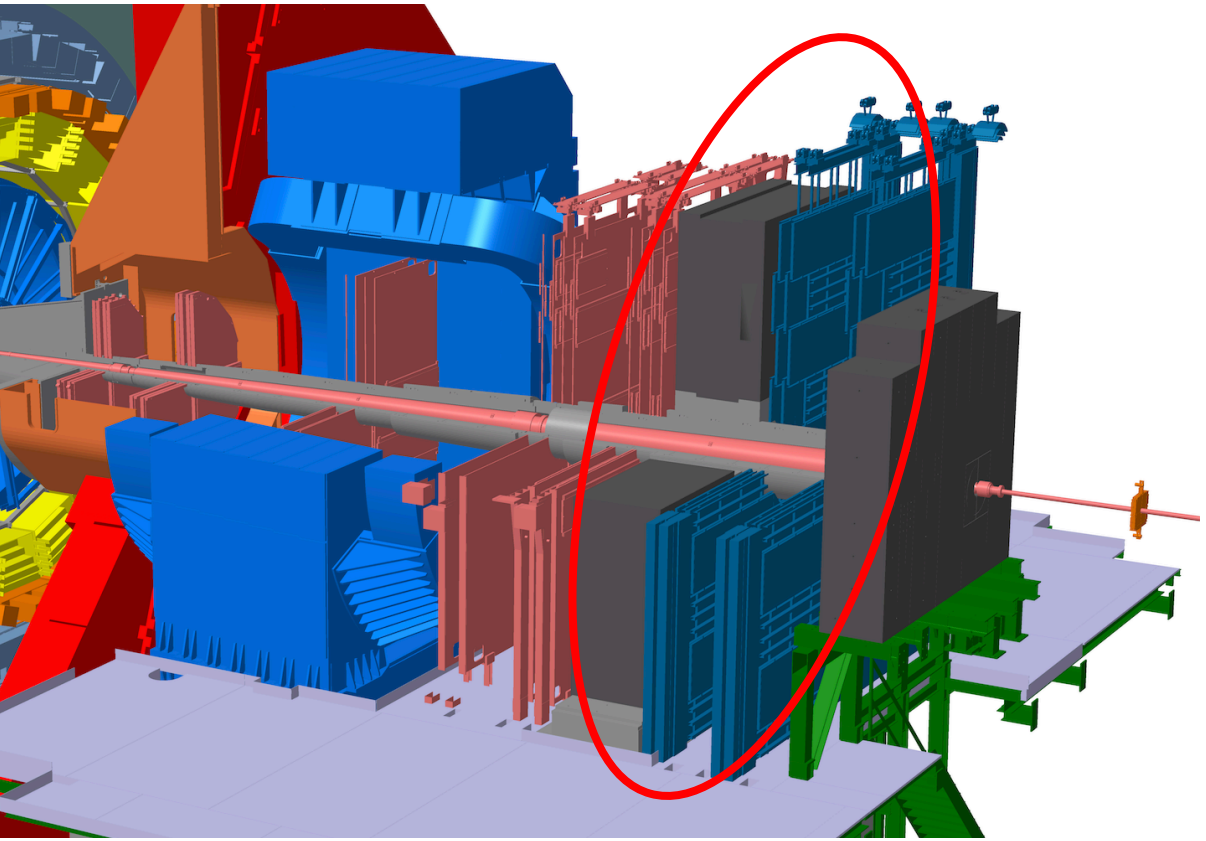


MUON Trigger



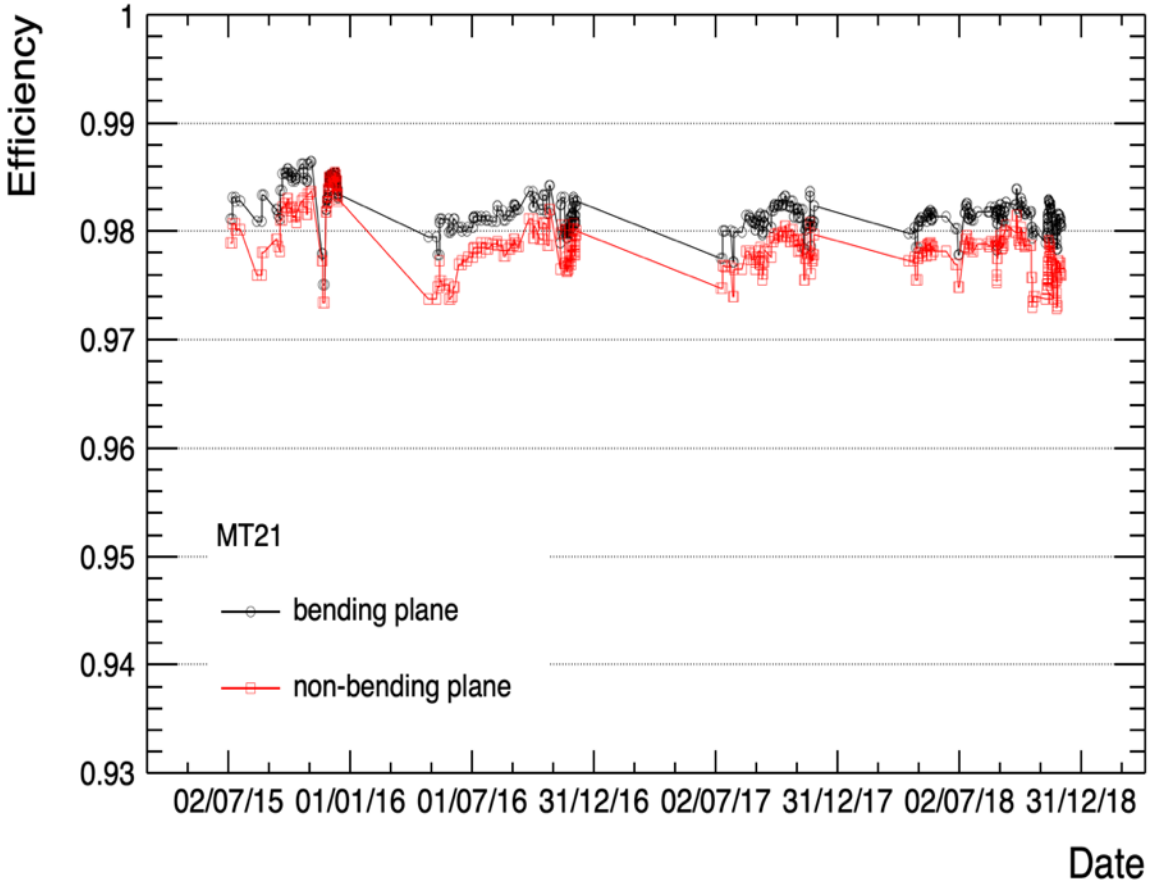


MUON Trigger



- 4 detection planes of 36 m^2 each
- 72 single-gap resistive plate chambers (RPCs) ≈ 21k R/O channels
- Muon identification (behind iron walls)
- Provides single and dimuon Muon Trigger with 2 p_T threshold

MUON Trigger



- 4 detection planes of 36 m^2 each
- 72 single-gap resistive plate chambers (RPCs) ≈ 21k R/O channels
- Muon identification (behind iron walls)
- Provides single and dimuon Muon Trigger with 2 p_T threshold
- Excellent (≈98%) and stable efficiency during all run 2

MUON Trigger → MUON ID

ALICE in continuous read-out mode from Run 3 and 4

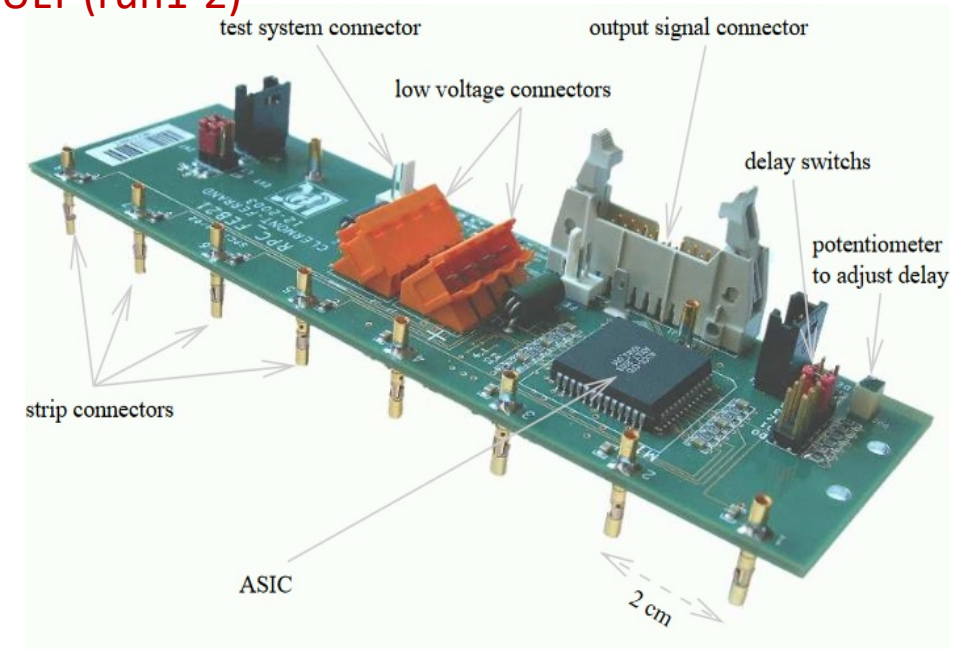
⇨ no more trigger given by muon RPCs

Muon Trigger ⇨ Muon IDentifier

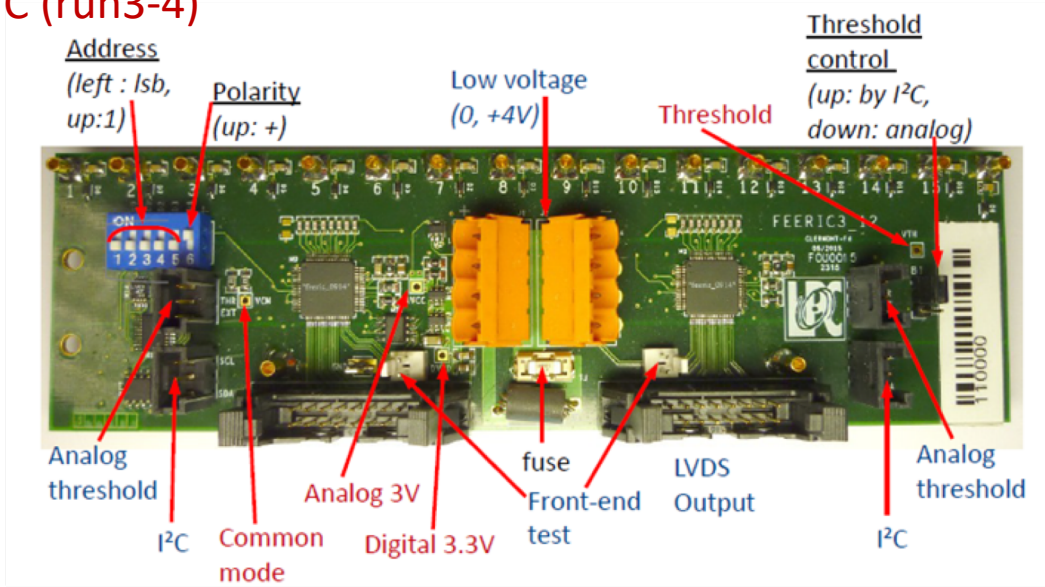
Ageing limitation of RPCs during Run1-2

- Need to decrease HV and add signal amplification to the FEE

ADULT (run1-2)



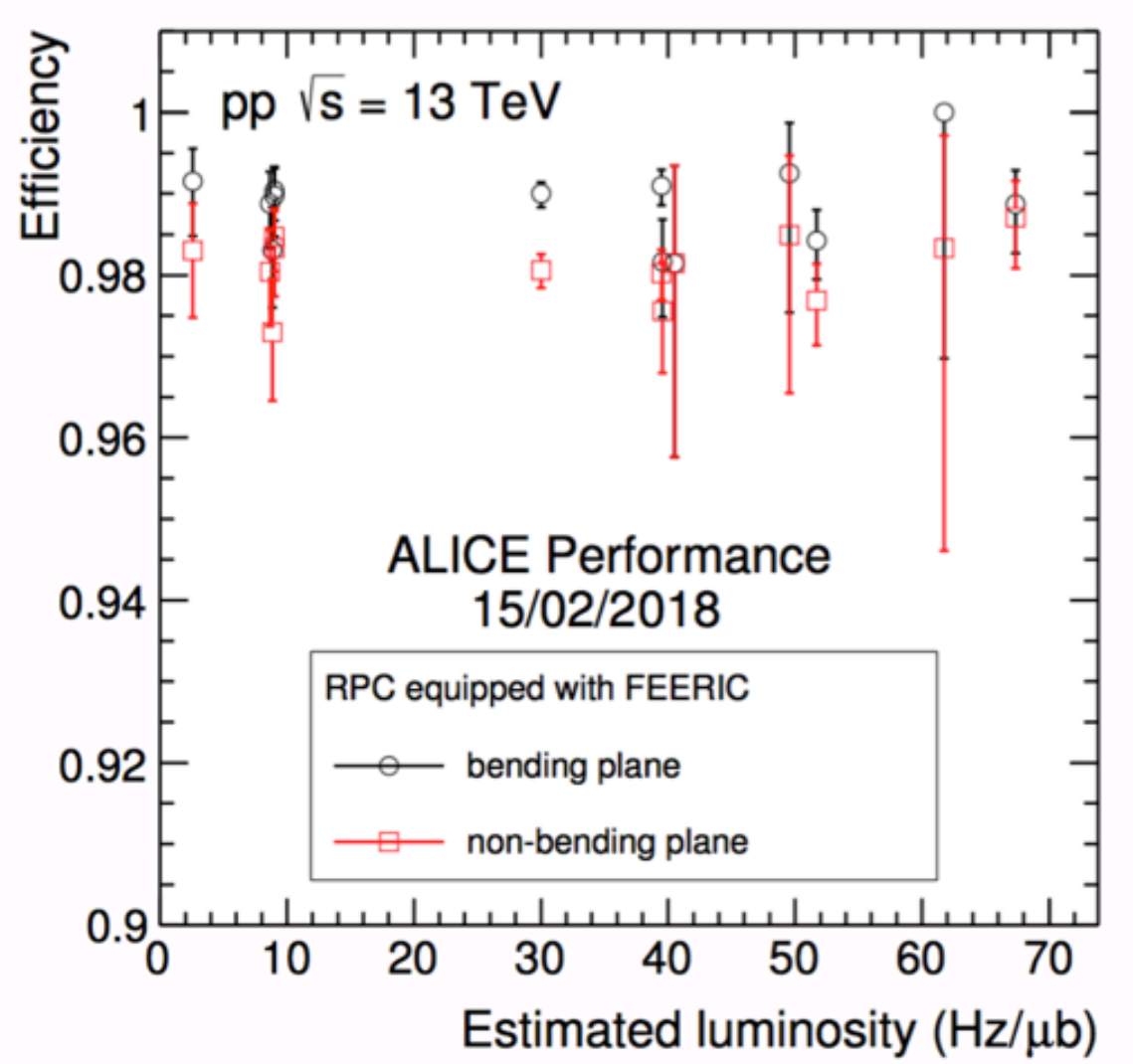
FEERIC (run3-4)



Preparation of Run 3

New FEERIC card installed on 1 RPC during run 2

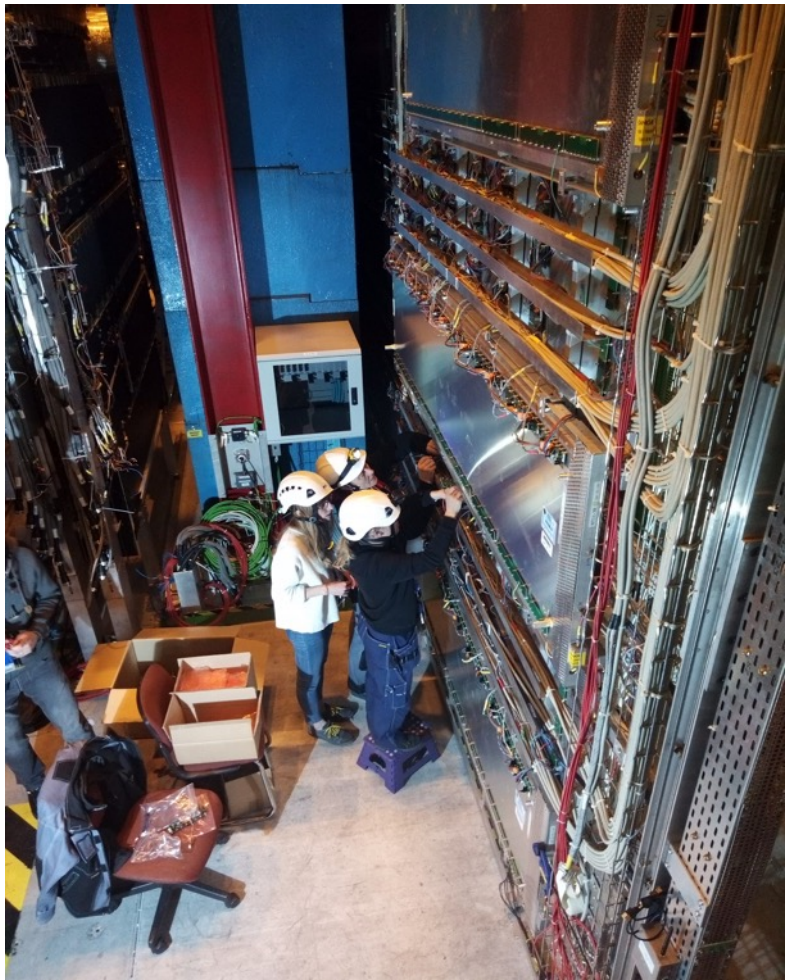
- Very good efficiency at lower HV

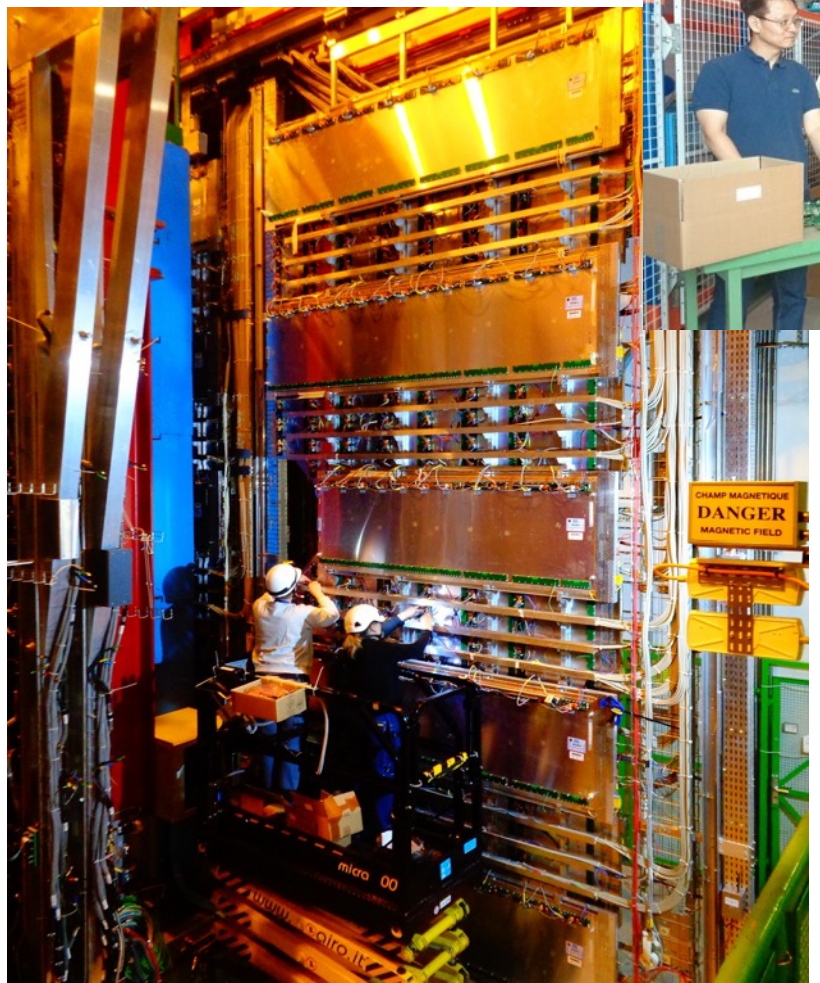


LS2 Activities

FEERIC boards production finished

Installation of 2384 boards on-going



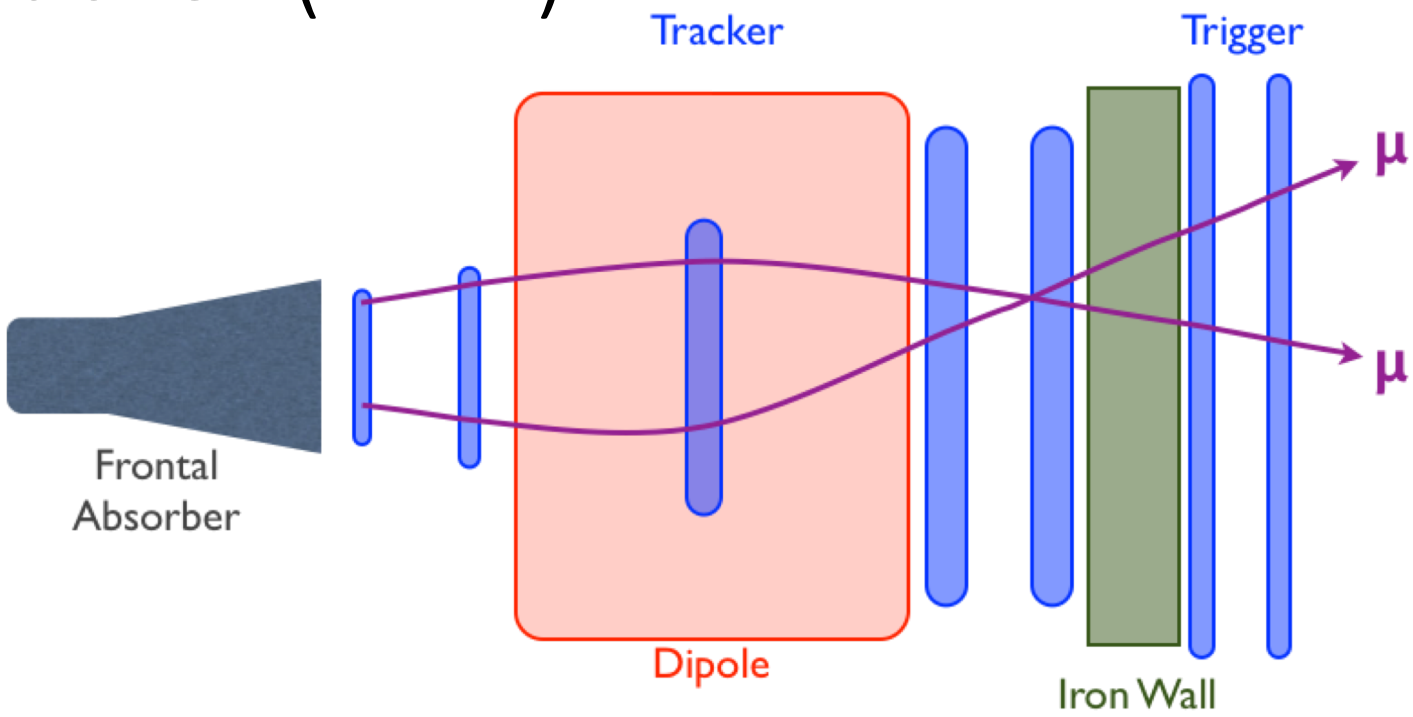


Installation preparation, FEERIC conditionning

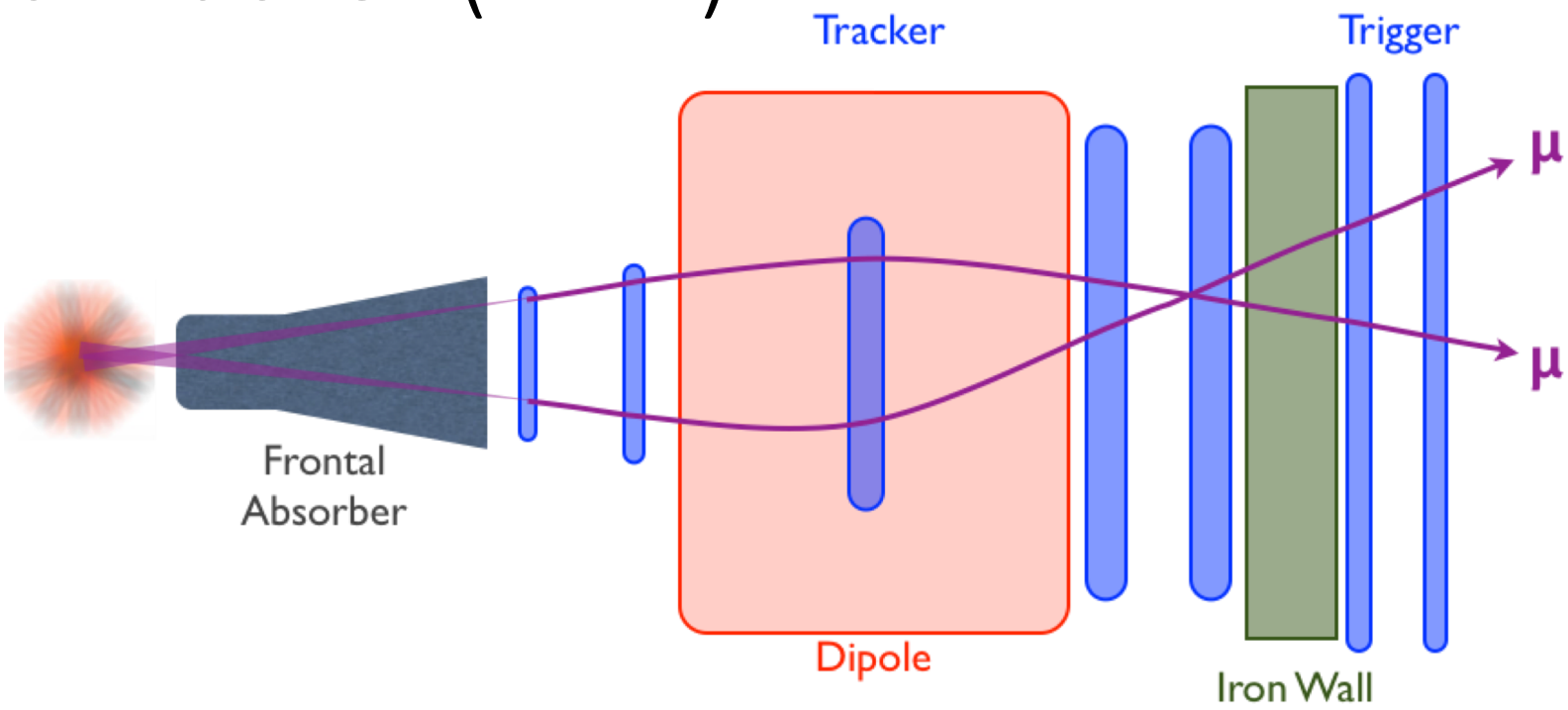
Muon Forward Tracker

Adding vertexing to the MUON spectrometer

Muon Forward Tracker (MFT)



Muon Forward Tracker (MFT)



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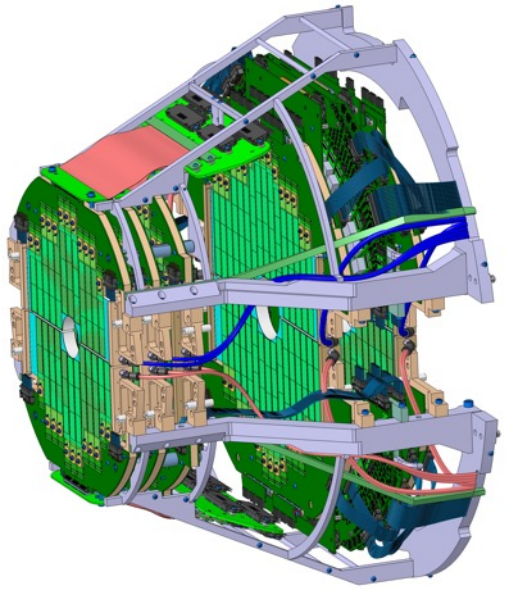
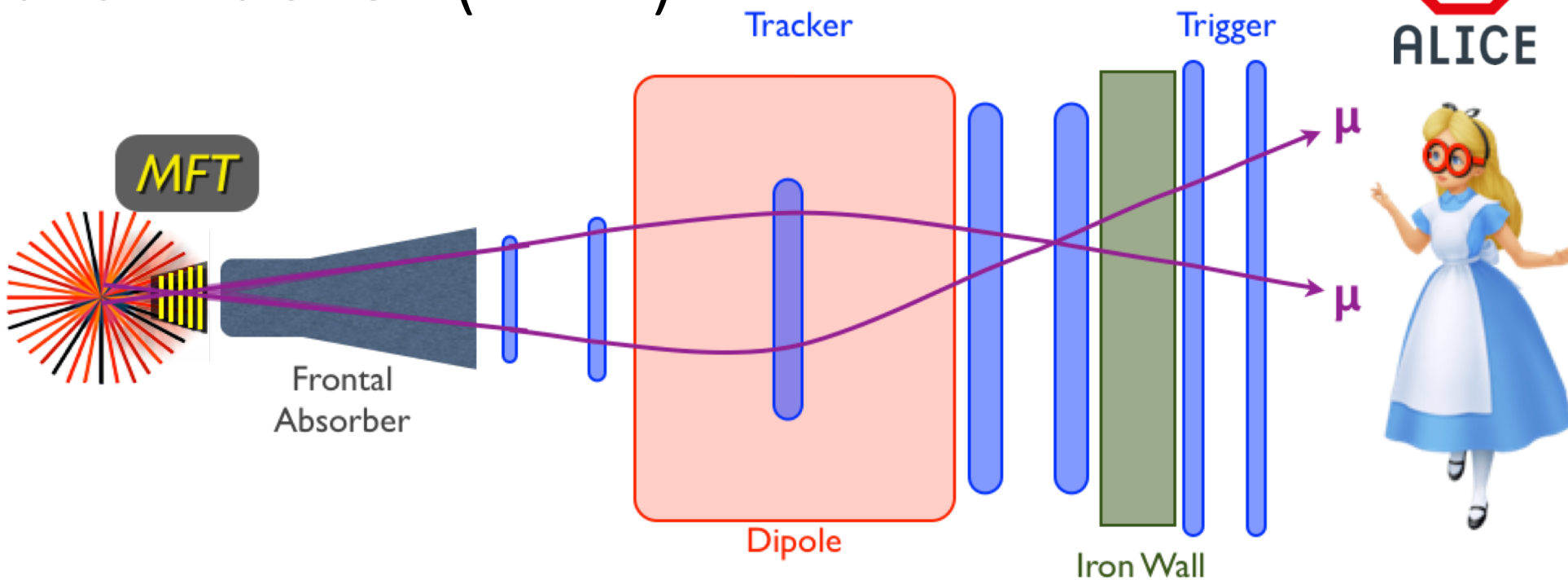
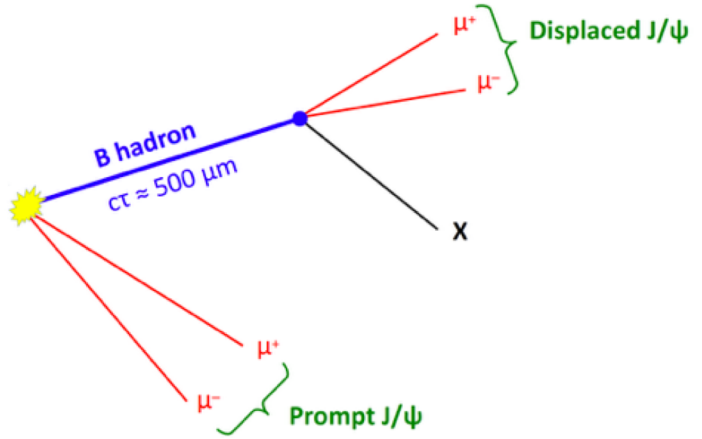




Silicon pixel telescope in front of the absorber

- Track matching MUON - MFT
- Improvement of pointing accuracy at Interaction Point (≃100μm)

- Separation of displaced vertices from Beauty/Charm
- Presently, inclusive measurement of J/Ψ (B feed-down)



The MFT in a nutshell

936 ALPIDE Silicon pixel sensors (0.4 m^2) on 280 ladders of 2 to 5 sensors

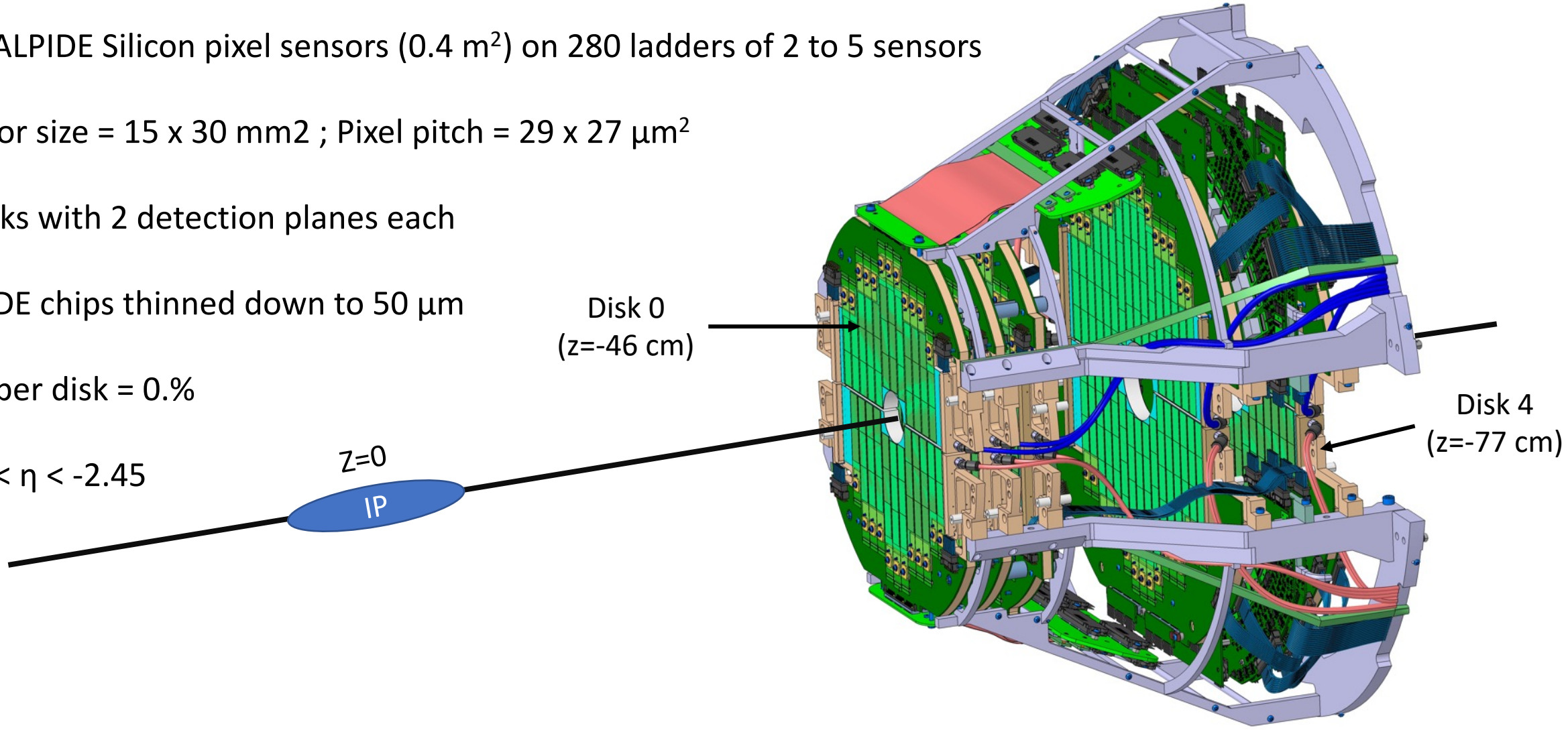
Sensor size = 15 x 30 mm2 ; Pixel pitch = 29 x 27 μm^2

5 Disks with 2 detection planes each

ALPIDE chips thinned down to 50 µm

x/x_0 per disk = 0.%

$-3.6 < \eta < -2.45$

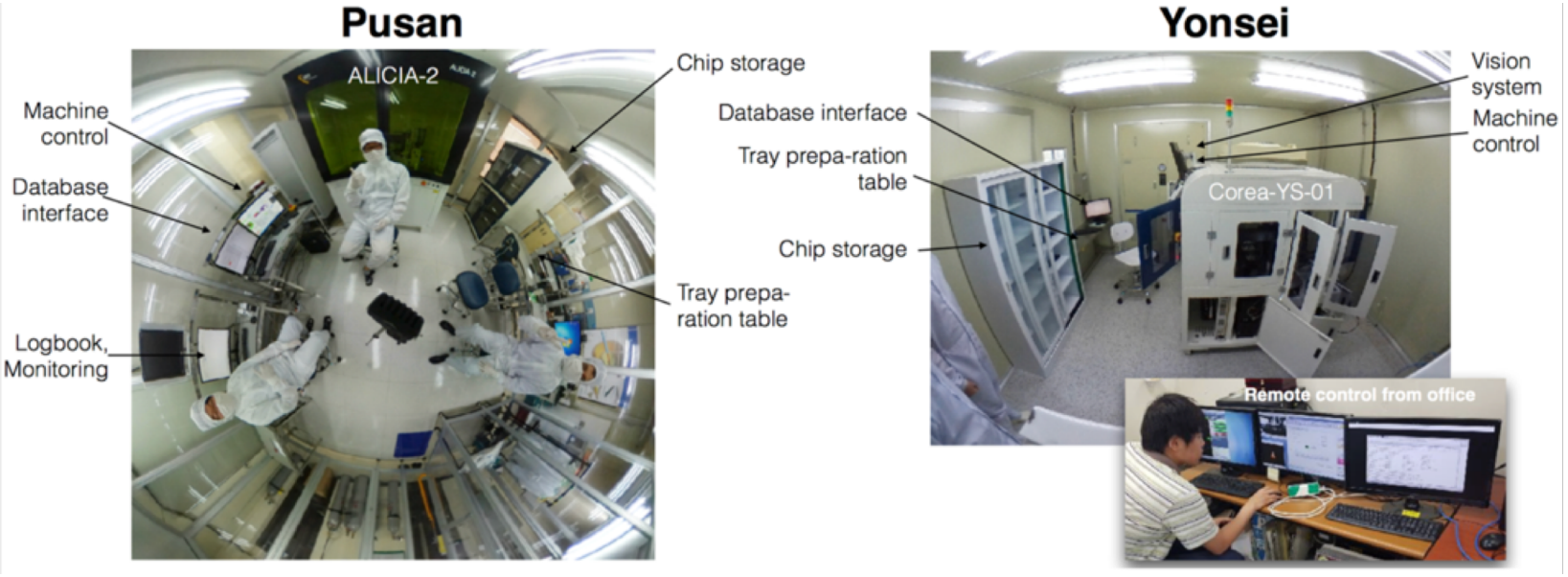


ALPIDE tests and ladder production

Production of probe cards used to test ALPIDE chips

ALPIDE wafers production is finished ; Finalization of Thinning (50µm) and dicing in Korea

Mass production series test both in Korea and at CERN

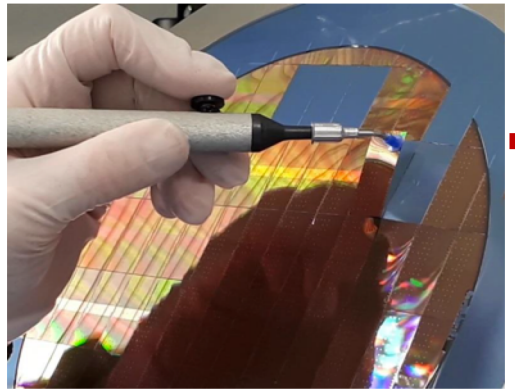


CERN

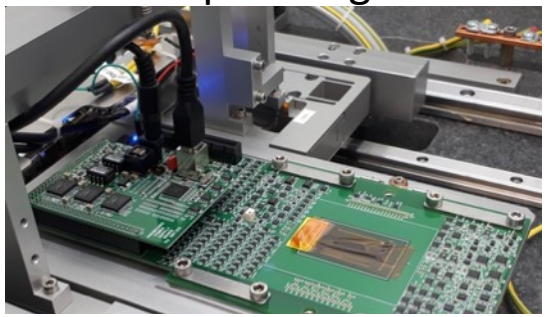
Contribution from Yong Wook Baek to ladder production

MFT production in a nutshell

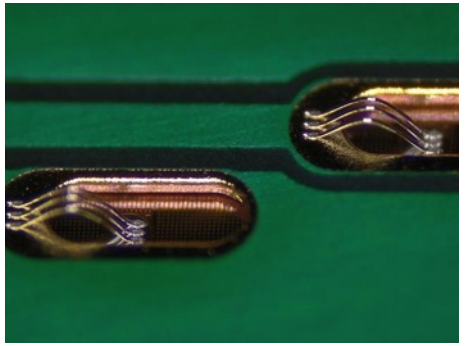
Chip Picking



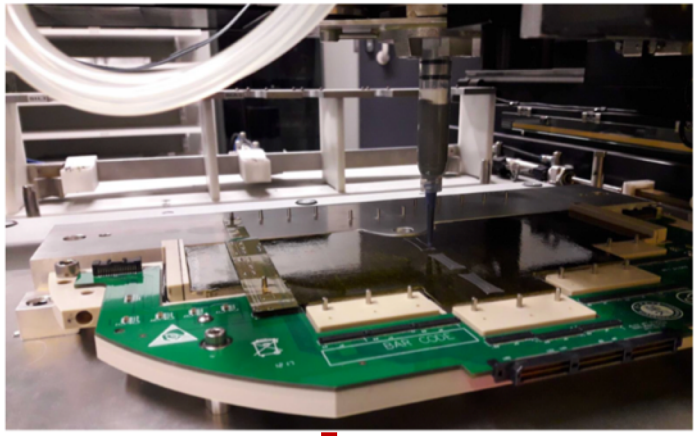
Chip testing



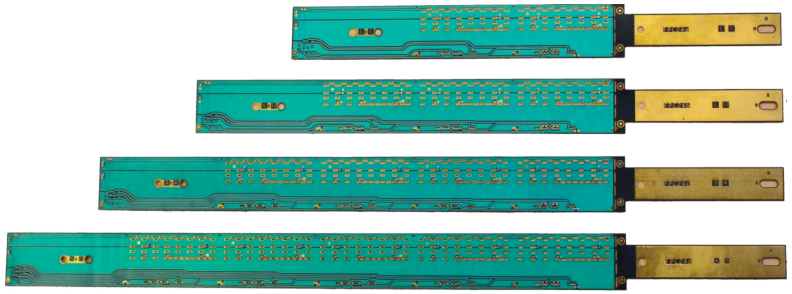
Wire Bonding



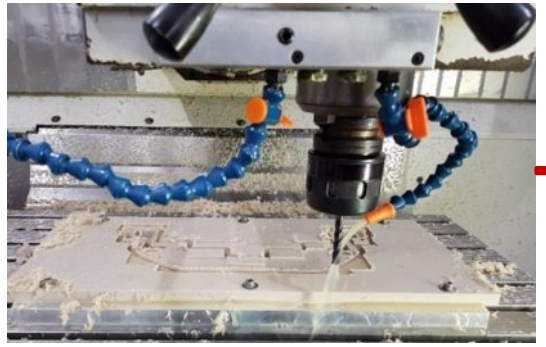
Ladder gluing on the disk



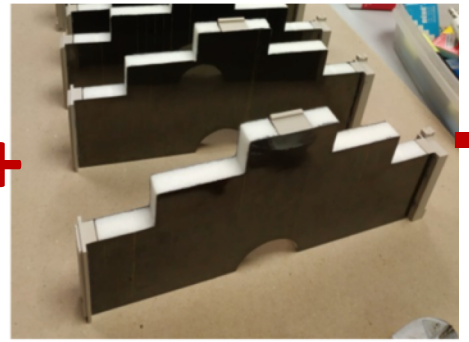
Flexible Printed Circuits



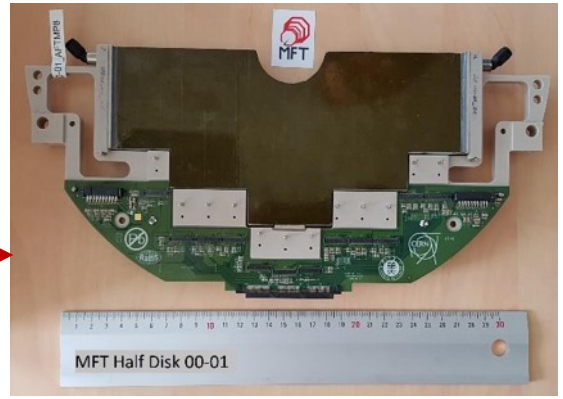
Disk support machining



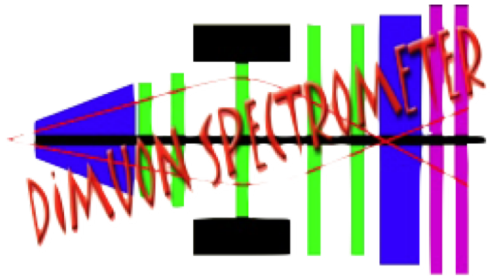
Heat Exchanger



Mechanical disk



FKPPL contribution to ALICE MUON



Korean Post-doc (Y.-W. Baek) based at CERN

very valuable for the Muon-Trigger operations on-site

Run coordination for Muon (SRC) & detector expertise

Important contribution to the MUON ID FEE installation and up-coming commissioning

Participation of French Researcher to bi-annual ITS-MFT-O2 Asia Workshops

- Hiroshima, Japan June ’18 (https://indico.cern.ch/event/687364/)
- Incheon, Korea Republic Nov ’18 (https://indico.cern.ch/event/756081/)

South Korea in charge of the series tests of the ALPIDE

Contribution to set-up the MFT assembly machine at CERN

Inha, Yonsei and Pusan National Universities full member of MFT

どうもありがとうございます

고맙습니다

Merci beaucoup