The ALICE Muon Forward Tracker upgrade project

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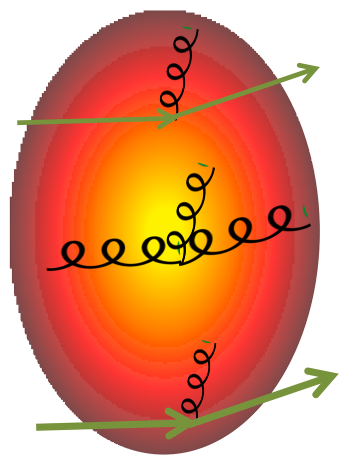
XXIV QUARK MATTER DARMSTADT 2014

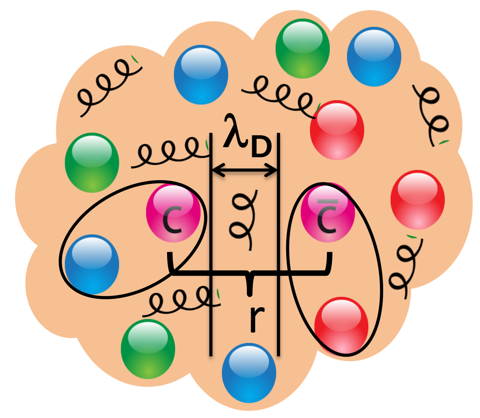
Physics motivations

Heavy-ion collisions at the LHC ➔ Quark Gluon Plasma: deconfined state of quarks and gluons. Studying the Quark Gluon Plasma with (di)leptons:

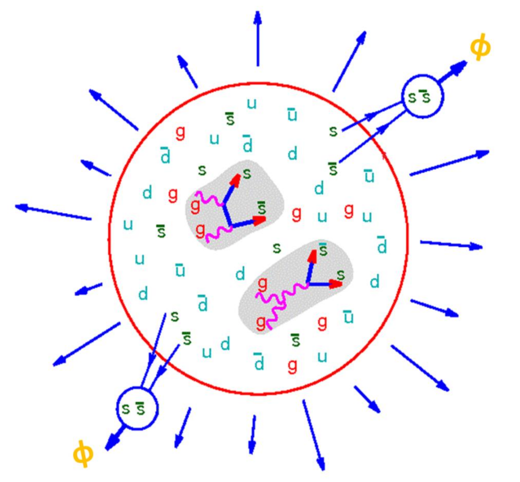


Heavy flavours [1,2,3]:
- Created in the first instants of the collision.
- QCD & dead cone effect ➔ colour-charge and mass dependence of energy loss

$R^{\pi}_{AA} < R^{D}_{AA} < R^{B}_{AA}$

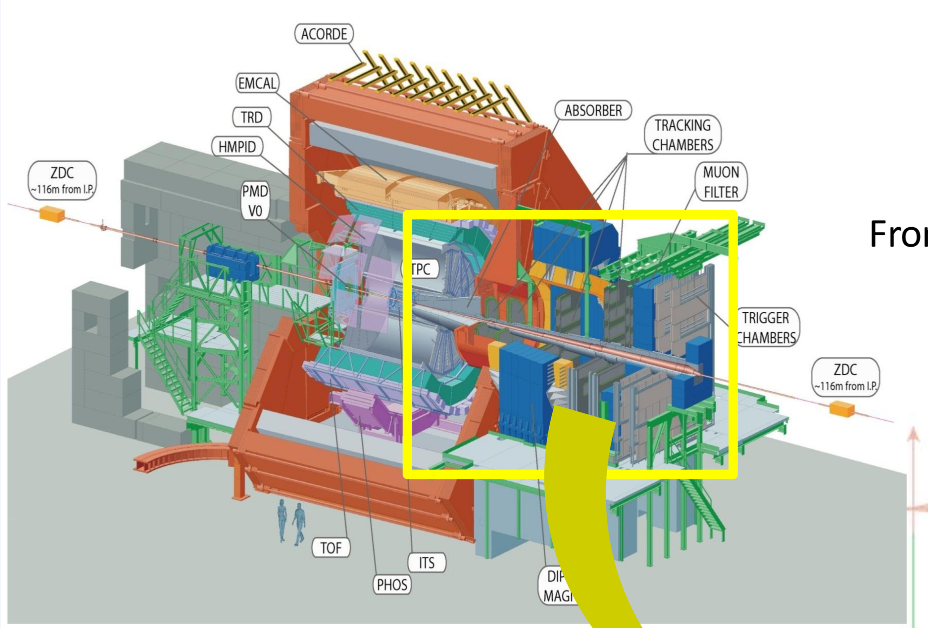


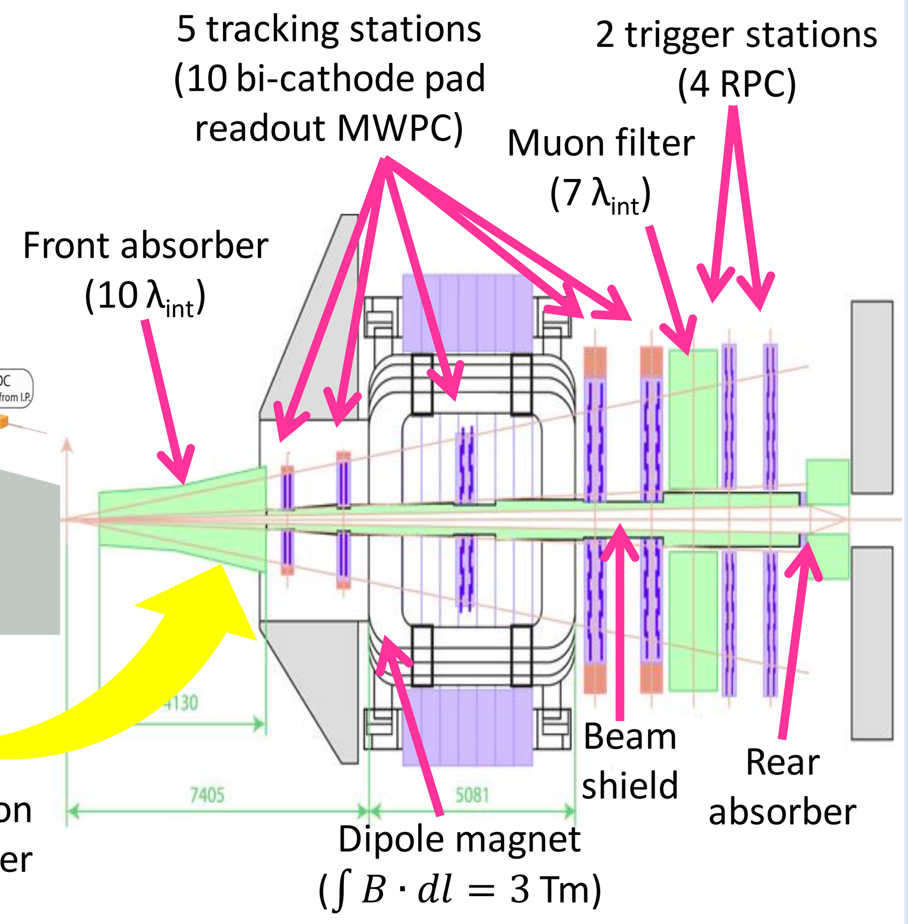
Quarkonia [4,5,6]:
- Suppression due to colour charge screening.
- Sequential suppression of quarkonium states.
- Regeneration by heavy quarks recombination?



Low mass dileptons [7,8]:
- Strangeness enhancement (ϕ).
- In medium modifications of particle properties (ρ) due to partial chiral symmetry restoration.
- Thermal radiation from QGP.

ALICE and the Muon Spectrometer

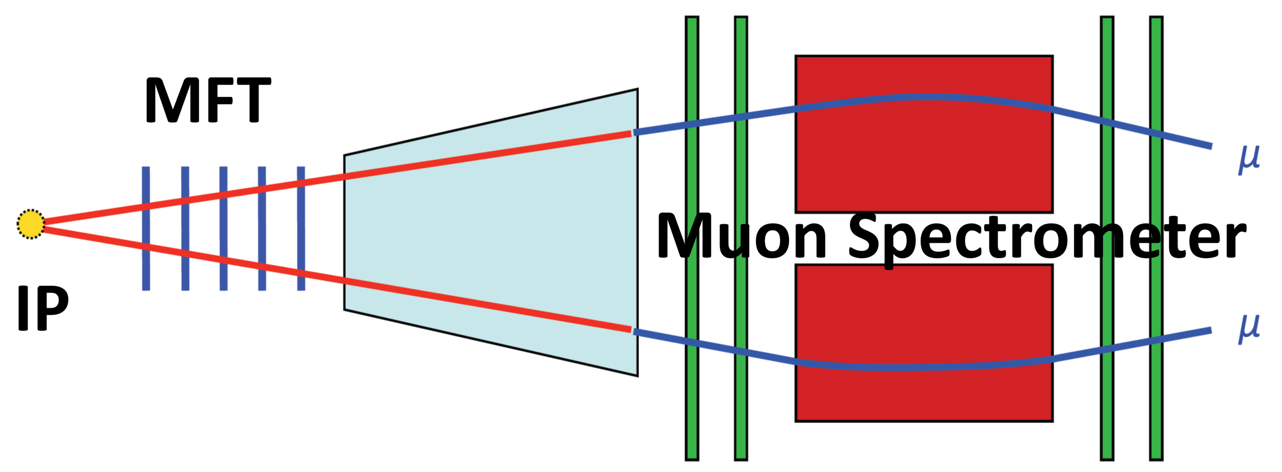




ALICE [9] is the heavy-ion dedicated experiment at the LHC.

Distance of tracking chambers from Interaction Point (IP) + multiple scattering in the front absorber ➔details of the vertex region are smeared out.

Muon Forward Tracker



Located between the IP and the front absorber, the Muon Forward Tracker (MFT) [10], will perform a precise tracking of particles before they reach the front absorber.

MFT will be installed during the Long Shutdown 2 of the LHC (2018-2019). Planes located between 50 and 76 cm from IP, with inner (outer) radius ranging from 2.5 (11) to 3.5 (15.5) cm and covering $-3.6 < \eta < -2.5$

Tracks from the spectrometer will be extrapolated back to the primary vertex and matched with clusters in the MFT.

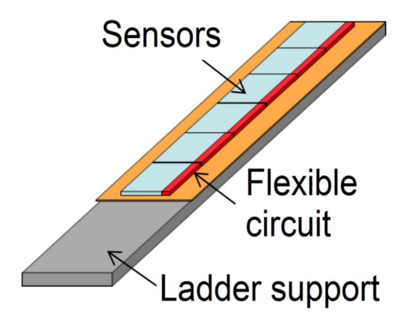
Muon offset: distance between the primary vertex and the extrapolated track in the transverse plane ➔ distinguish between prompt and displaced muons but also reconstruct dimuon secondary vertices.

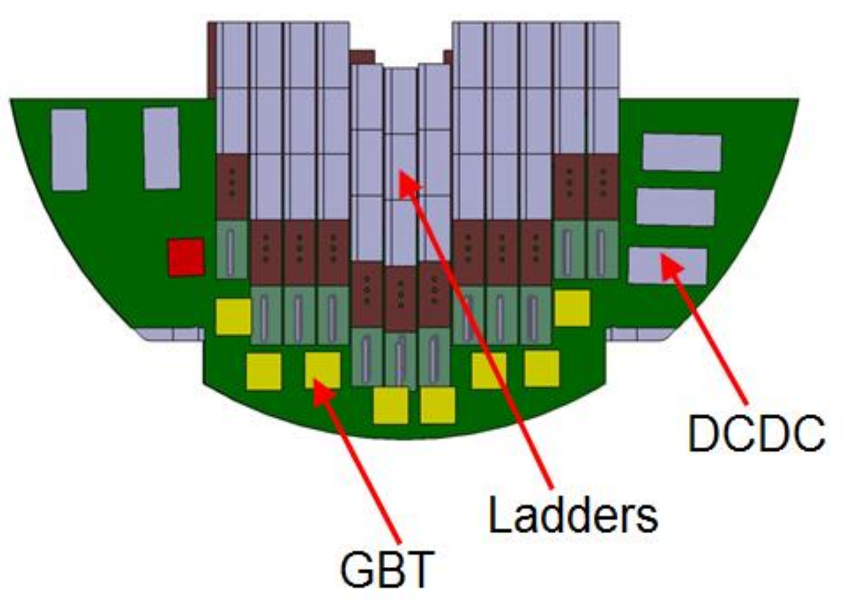
Detector general layout

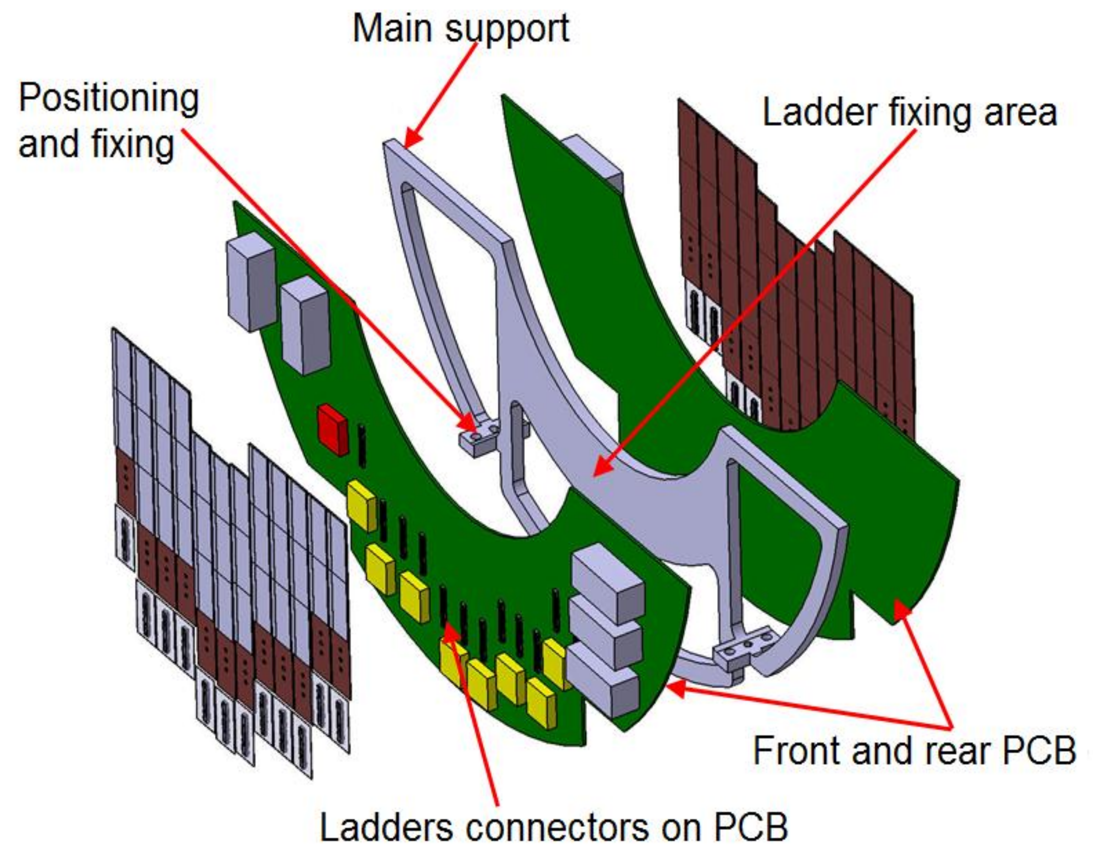
The MFT consists of CMOS Monolithic Active Pixels sensors, with pixel pitch of 25 x 25 μm², 50 μm thick and 0.4% X/X_0 material budget per plane.

Pixels are integrated on a support by using a flexible printed circuit to form ladders.

Ladders are fixed onto a support and perpendicular to the half cone structure inner border.







Two planes formed by one support and its ladder on the outside, located on a half-crown shaped PCB. Flexible Printed Circuits (FPC) are connected to this PCB that is used as readout board.

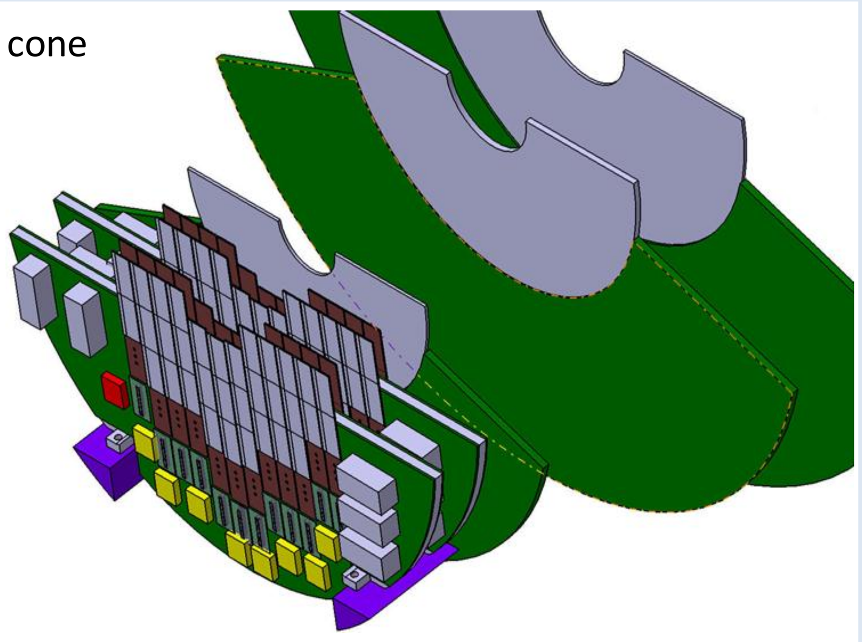
The MFT data flow will be sent out from the CMOS sensors using e-links on FPCs and GigaBit Transceiver (GBT) concentrators located on PCBs up to the Common Readout Unit (CRU) of ALICE.

Integration

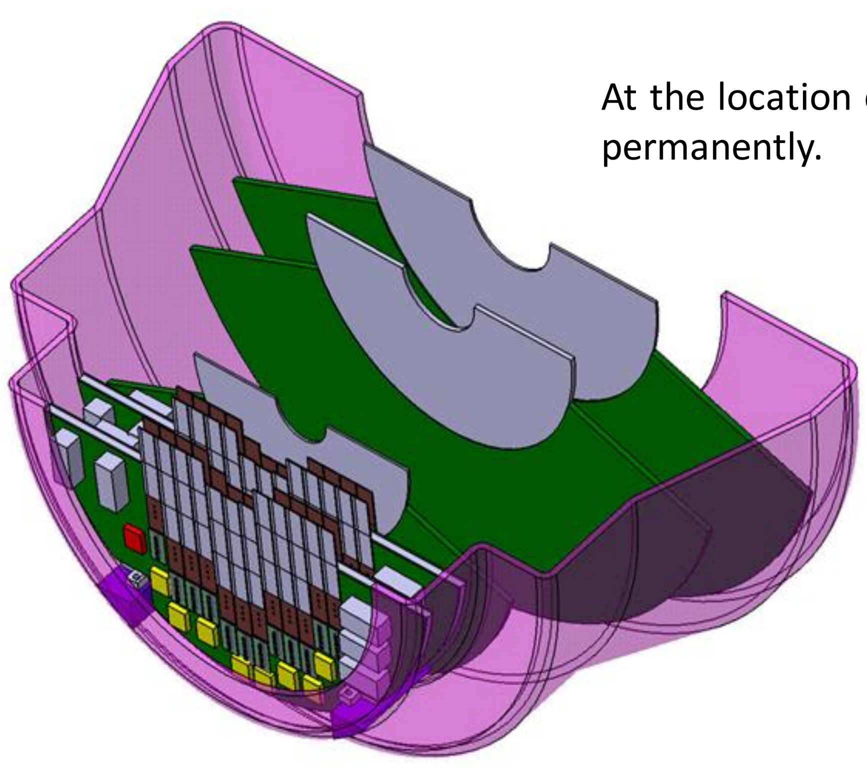
The five half disks are installed into a half cone made of carbon fibre.

Each half cone is hermetically closed by kapton films around the structure and a carbon fibre cover around the beam pipe support.

Thermal simulations show that air cooling is enough to extract heat from planes and to maintain the detector temperature at 35 °C.



Required services: electrical power for sensors and front end electronics, optical fibers for the slow control and the data transfer to DAQ and finally the air flow for cooling.



At the location of the MFT, the beam pipe should be hold permanently.

The two halves of the MFT cone are fixed on two cages in order to be inserted, positioned and fixed to the beam pipe support cage.

The half cages are inserted from the A side and positioned by sliding wheels. This cage will also help to bring the remaining services to the MFT.

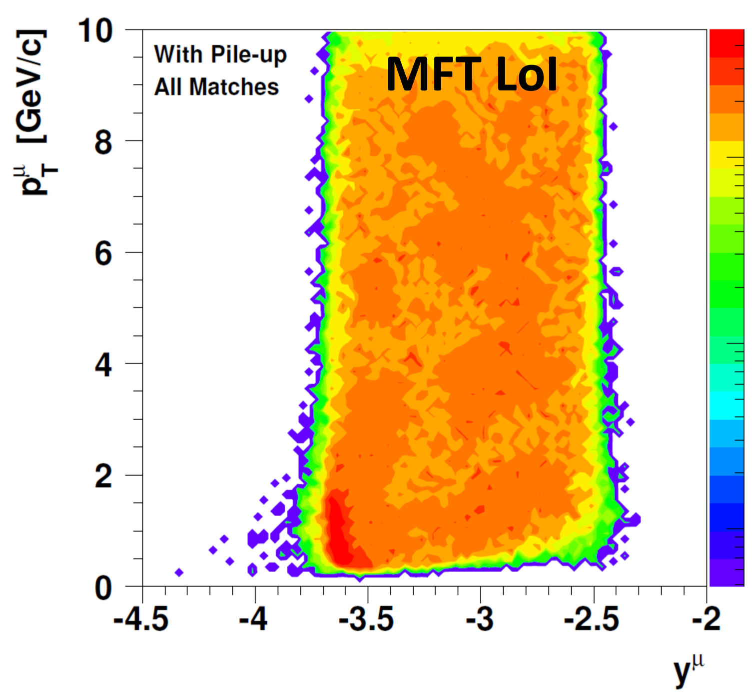
Muon track reconstruction performance

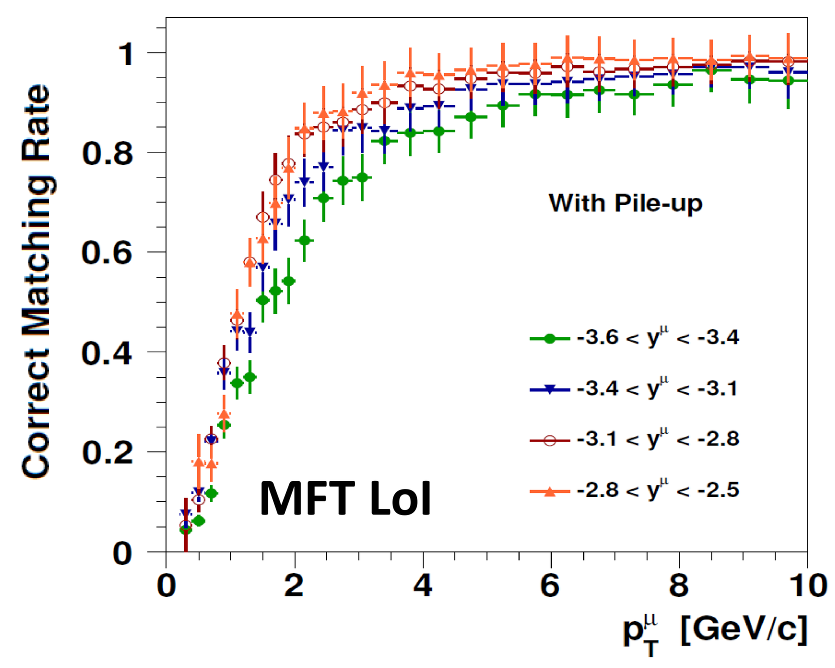
The MFT performance presented here has been evaluated by considering central Pb-Pb collisions with HIJING at $\sqrt{s_{NN}}$ = 5.5 TeV. A pile-up scenario of two central Pb-Pb interactions within the recorded event is also taken into account.

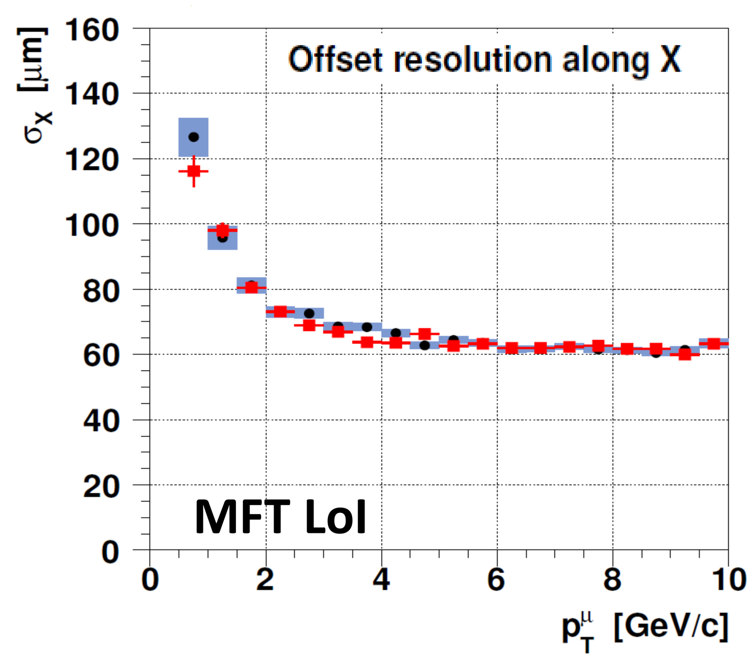
A two dimentional y-p_T plot, at the single muon level, indicates the available phase space of muons reconstructed from the Muon Spectrometer (MS) and the MFT.

Correct matching between MS and MFT tracks increases with p_T and rapidity. Correct matching falls below 50% for p_T < 1 GeV/c. Correct matching improves with no pile-up scenario: cluster density in MFT decreases.

Offset resolution along X (σ_x): 130 μm for p_T = 0.5 GeV/c and saturates at 60 μm for p_T > 4 GeV/c. Blue and red points represent tracks with $\eta < -3.2$ and $\eta > -3.2$, respectively.







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