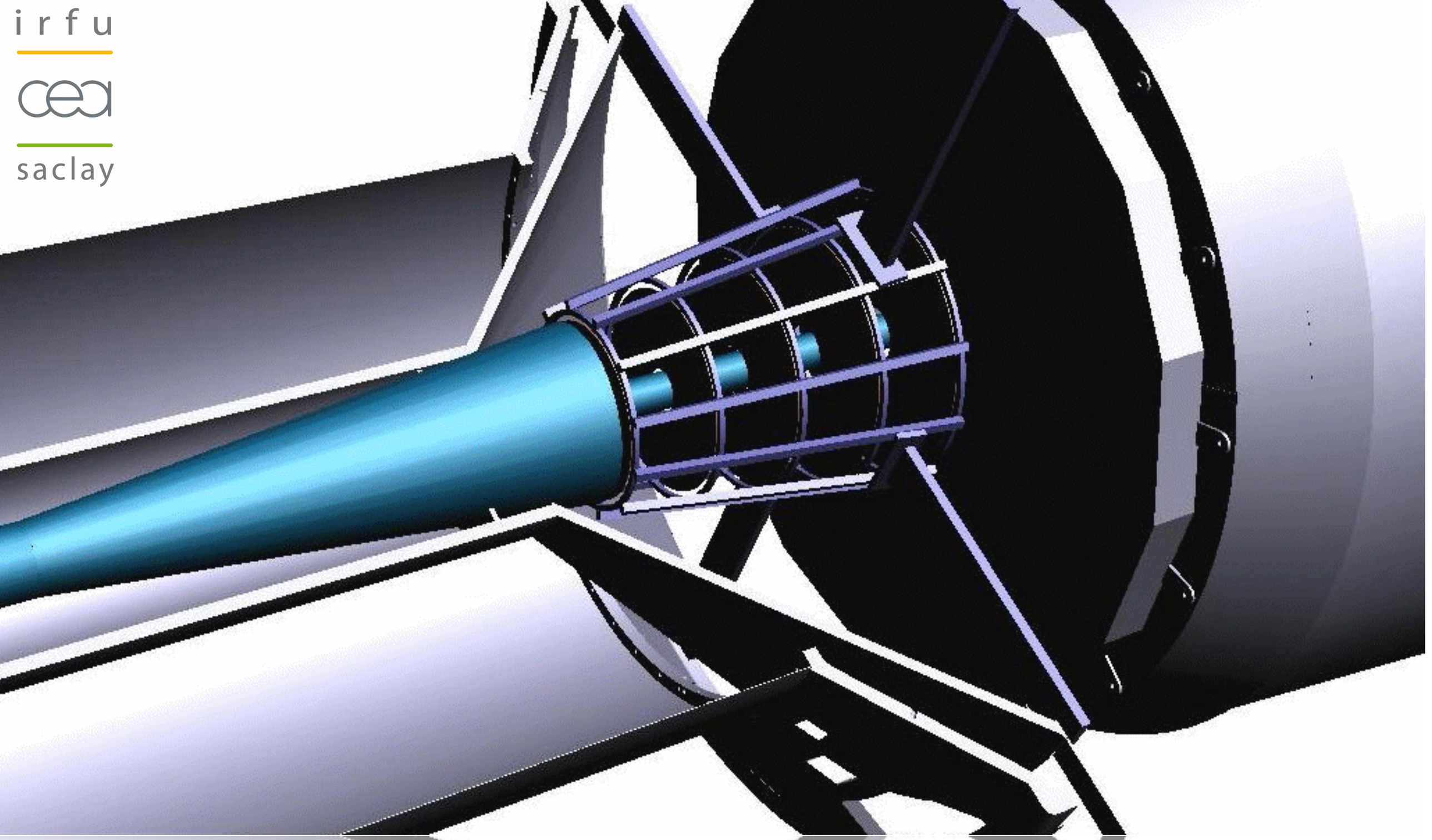
irfu

cea

saclay



ALICE Upgrades

Irfu High Luminosity LHC Day

May 31th 2011

ALICE SPhN group

A. Baldisseri

High luminosity in ALICE

Dedicated Heavy Ion Experiment

- Proton-Proton
  - Normalization Pb-Pb physics, study production mechanism (J/ψ, ...), ...
  - Ideally at the same energy as Pb-Pb (short run @ $\sqrt{s}$ = 2.76 TeV in 2011)
  - Design luminosity: L = 5 10^{30} $cm^{-2}s^{-1}$ (achieved ~2 10^{30} $cm^{-2}s^{-1}$ <=> Rate ~ 100 kHz)
  - Not much (a priori) concerned by an increase of luminosity in p-p (displaced beams, β*)
- Pb-Pb
  - Design luminosity: L = 10^{27} $cm^{-2}s^{-1}$ (achieved ~ 2 10^{25} $cm^{-2}s^{-1}$)
  - Beyond L = 10^{27} $cm^{-2}s^{-1}$: stochastic cooling needed (done at RHIC) => not yet explored @LHC
- p-Pb
  - Study cold nuclear matter effects (run in 2012 ?)
  - Design luminosity: L ~ 10^{29} $cm^{-2}s^{-1}$

Chamonix Workshop, Jan. 2011

The **year 2012** appears to be a **good opportunity for *p*-Pb collisions**, at an ideal centre-of-mass energy [34].

ALICE Plan 2011-2021

2011 - 2013

- 2011
  - PbPb at higher luminosity (~1.4x10^{26} cm^{-2}s^{-1})
    3.5 TeV at intermediate (200ns) or nominal (100ns) bunch spacing
  - Feasibility test for p-Pb running (MD + ?)
- 2012
  - Either pPb/Pbp or further PbPb runnin
- 2013
  - Shutdown, relocation of collimators
  - If dA is to be considered at any point: r has to be formalized

Under discussion with the LHC team
(already obsolete)

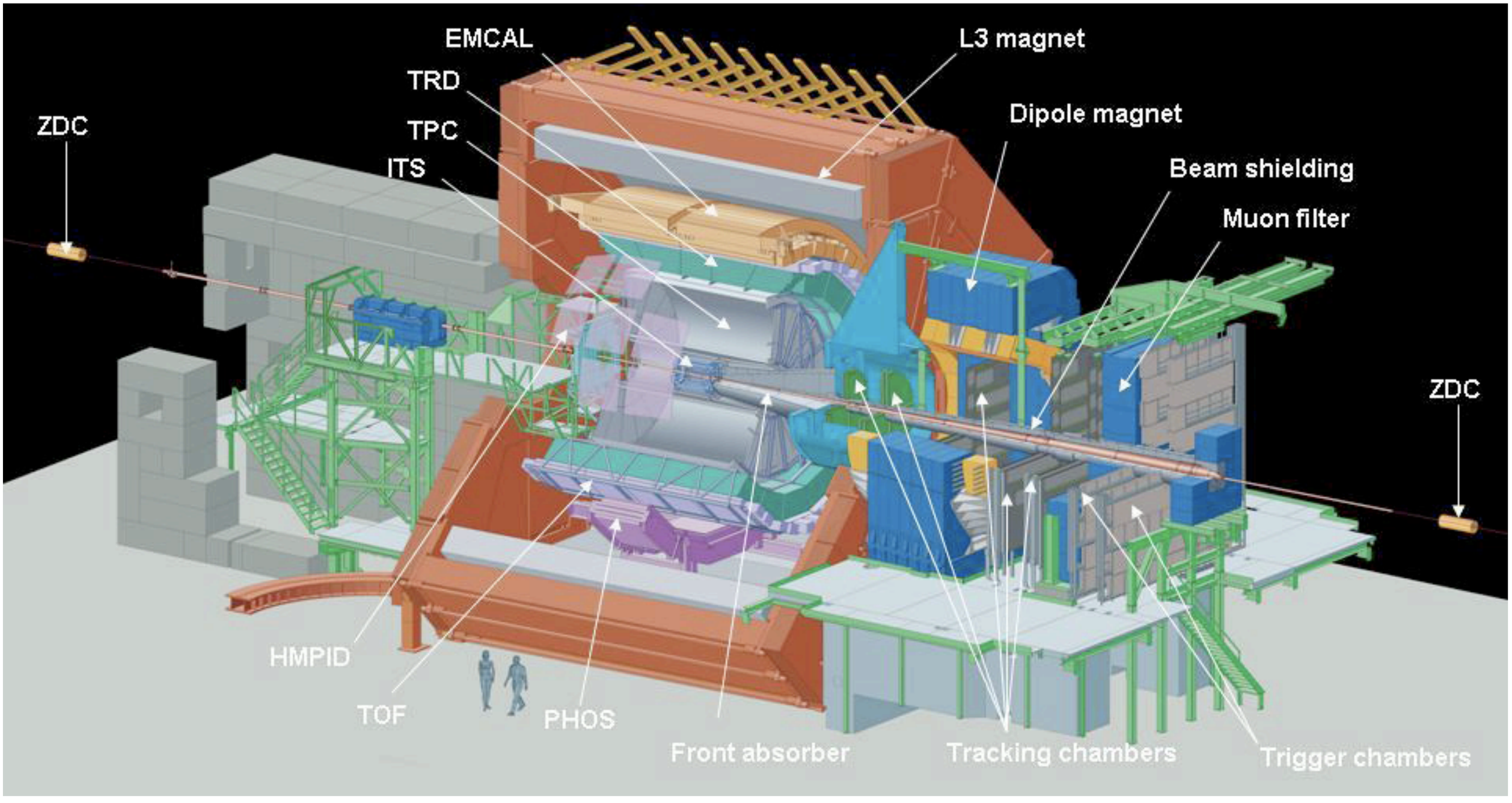
2014 - 2017

- 2014
  - PbPb at luminosity (~5x10^{26} cm^{-2}s^{-1}) at top energy 7 TeV
  - Depending on length of shutdown, long ion run (Ar) for NA61 before Pb run
- 2015
  - Continue PbPb at top energy to get to famous 1 nb^{-1}
- 2016
  - Depending on outcome of runs in 2015, of PbPb or pPb
- 2017
  - Shutdown; installation of dispersion su at IP2 (if not done previously)

2018 - 2021

- 2018
  - PbPb at luminosity >5x10^{26} cm^{-2}s^{-1} at top energy 7 TeV
  - Depending on length of shutdown, long ion run (Ar) for NA61 before Pb run
- 2019
  - Physics with pPb or dPb, if source and LINAC have been prepared
- 2020
  - Physics with ArAr at very high luminosity (up to 10^{29} cm^{-2}s^{-1})
- 2021
  - Shutdown

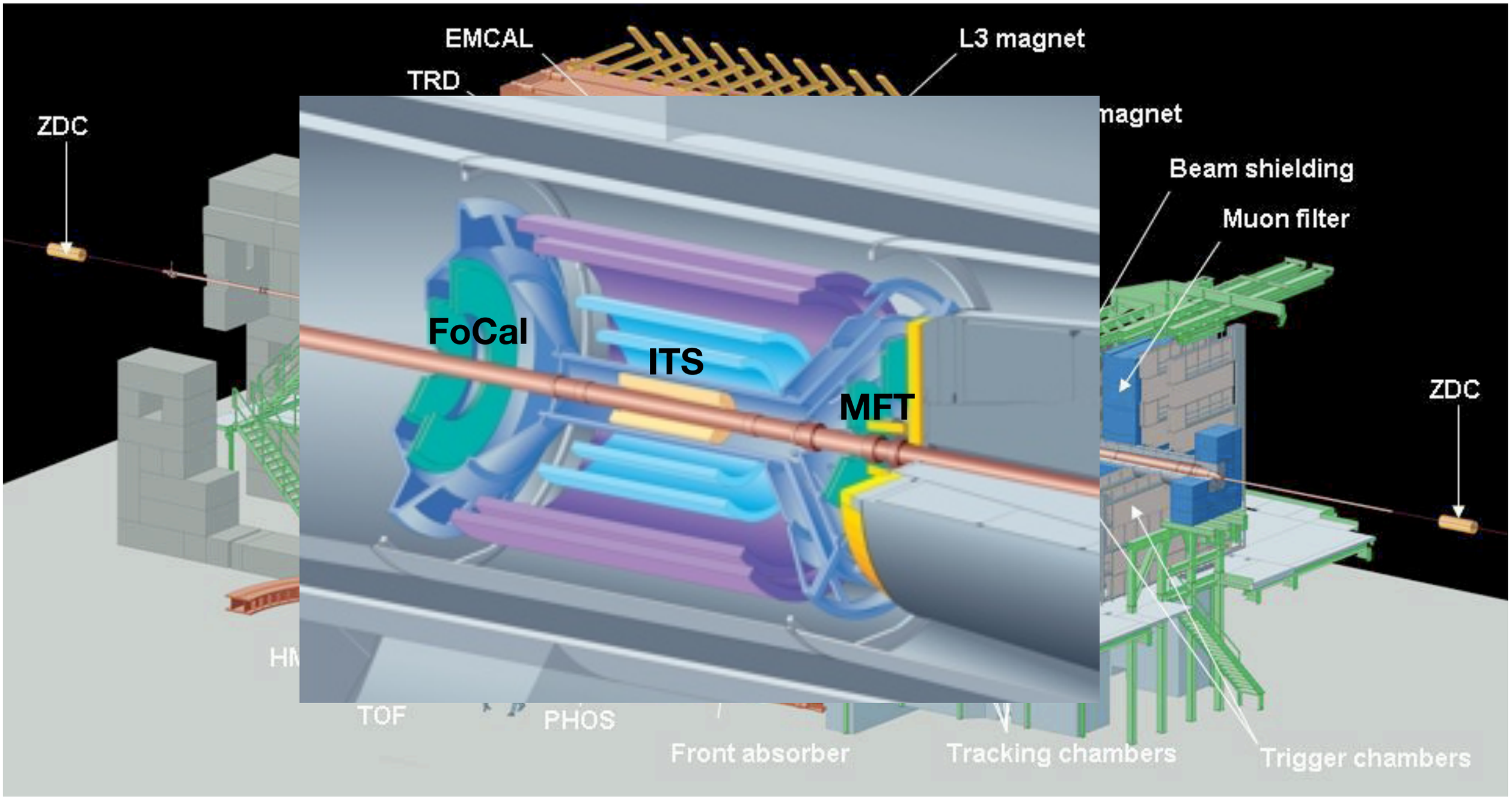
The ALICE Detector



ALICE Upgrades

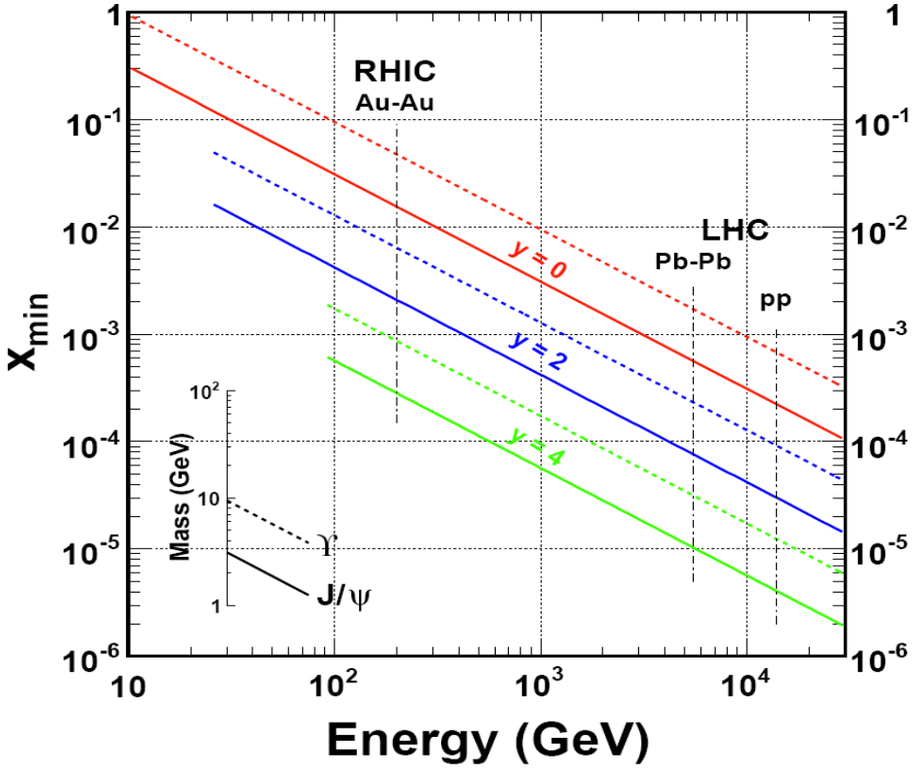
- Upgrade coordinator (since 2 years)
- Kickoff meeting: March 2009
- Very rich program: many projects and ideas
  - Calorimetry: D-Cal (Dijet Calorimeter), **FoCal** (Forward Calorimeter)
  - Tracking: **ITS** (Inner Tracking System), **MFT** (Muon Forward Tracker)
  - TPC: Readout Upgrade (reduce dead time and pileup)
  - PID: VHMPID (Very High Momentum PID)
  - DAQ, Offline, ...
- ALICE Upgrade Workshop 12-13 July 2011: EOIs
- LOIs : end of 2011

ALICE Detector

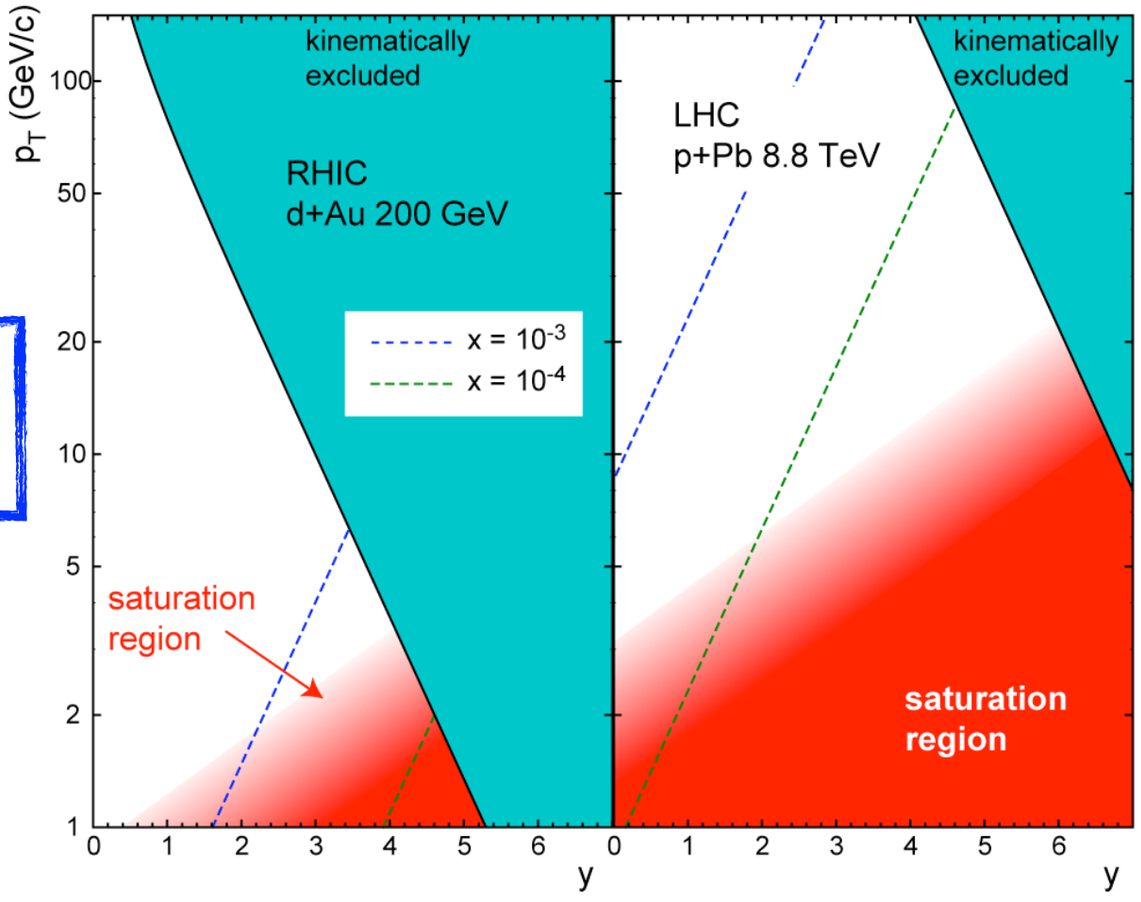


Focal: Physics Motivations

- Physics motivations:
  - Small x physics (= large rapidity): Gluon PDF, from high density to gluon saturation (CGC) in pA
  - Nuclear dependence of saturation scale



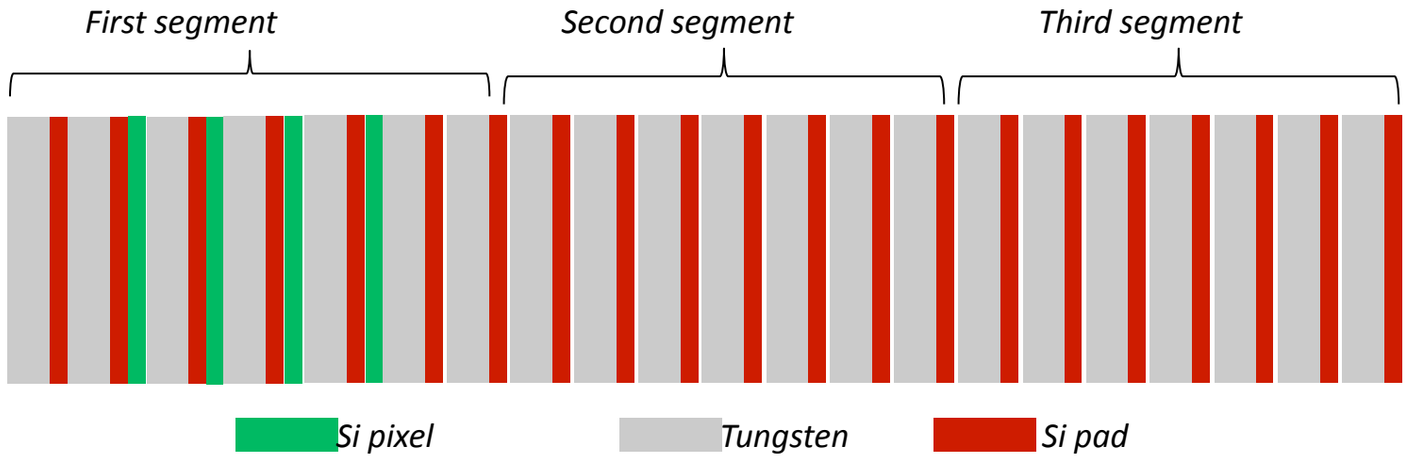
X
$3 * 10^{-6}$ in pp
$1 * 10^{-5}$ in PbPb



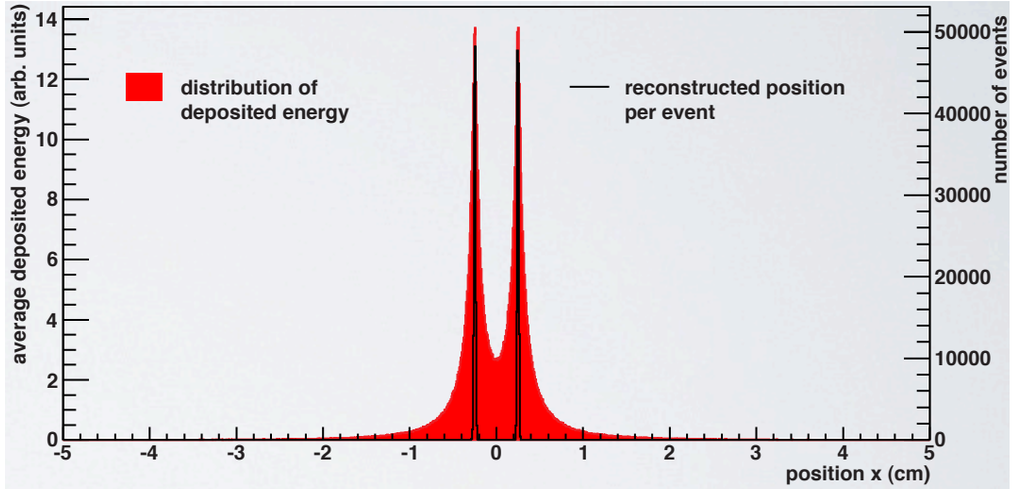
- Elliptic flow (in AA)
- Long range rapidity correlations: ridge (in AA)
- PID for η > 3
  - With EM calo for γ, π^0, jets.. => needs high granularity: gamma separation for π^0… (in lateral and longitudinal)

Focal: Detector

- Proposed detector (inspired from PHENIX FOCAL)
  - Si-W (silicon-tungsten) calorimeter : small Moliere radius (9 mm) and X0 = 3.5 mm

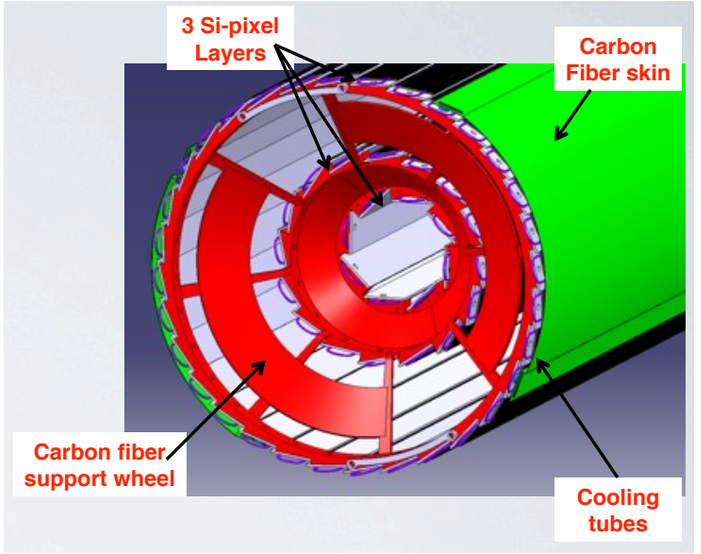


  - Design issue: max particle density tolerable ?
    - OK in pp and pA
    - to which centrality in Pb-Pb ?
    - Beam pipe to be modified: Be up to calorimeter
  - Location: ~ 3,5 – 4,5 m from IP
  - Installation:
    - Phase I : inside magnet η < 4.5 (2017?) (imposed by LHC stops)
    - Phase II: outside magnet η > 4.5 (2020?) (imposed by LHC stops)
    - Proto-collaboration: Japan (Tokyo, Yonsei), India (Kolkata, Mumbai, Jammu), Holland (Utrecht, Amsterdam), Jyvaskyla, Prague……
  - EoI ready; LoI by end of 2011



ITS Upgrade

- Physics motivation
  - D, B mesons: Λ_c -> p+K+π; Λ_b ->Λ_c+π ; Λ_b ->Λ_c+e+X
- Needs
  - Improve impact parameter by factor ~3 (at 1 – 0.5 GeV)
  - High standalone tracking efficiency: x factor 10
  - Low material budget
  - Trigger capability



- Present ITS

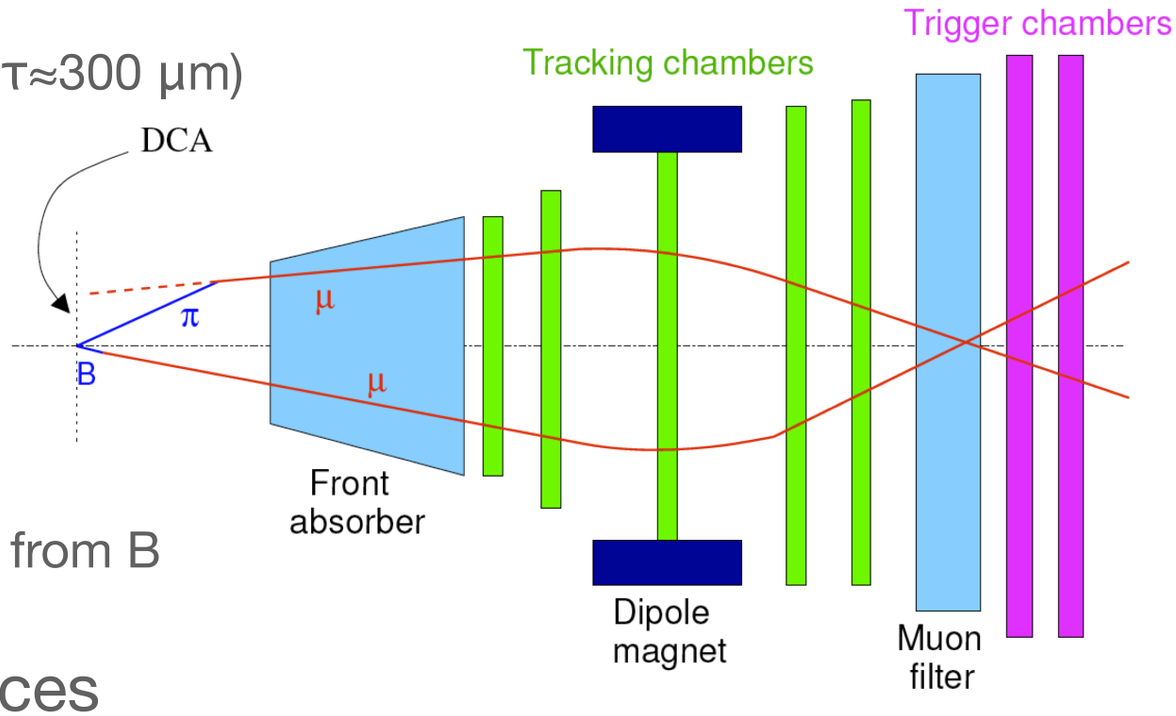
	SPD	SDD	SSD
# of layers	2	2	2
radius (cm)	3.9 & 7.6	15 & 24	38 & 43
spatial precision (μm)	rφ =12 μm z = 100 μm	rφ =35 μm z = 25 μm	rφ =20 μm z = 830 μm
readout time (μs)	≈300	≈1023÷2110	≈300
readout	digital	analog	analog

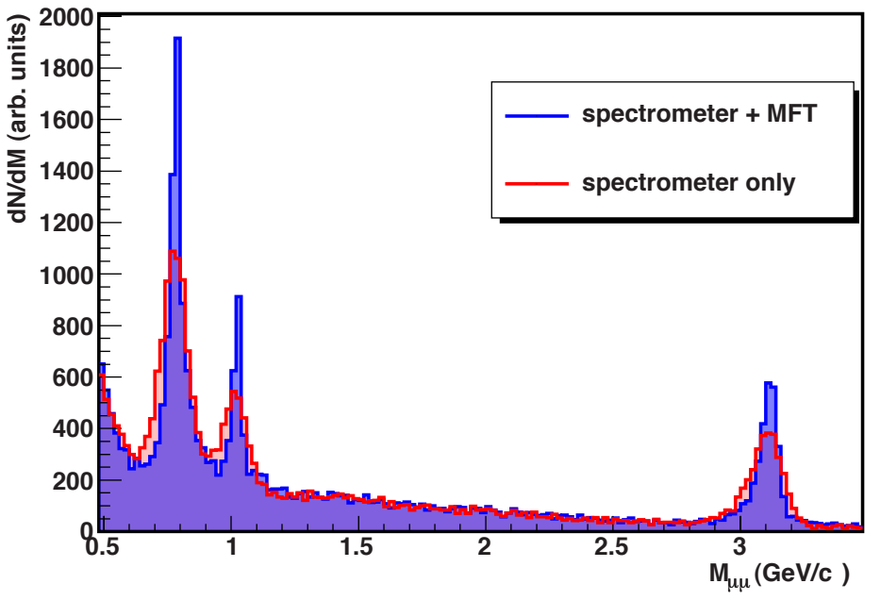
- New ITS
  - Additional pixel layer at ~ 2 cm radius (L = 28 cm)
  - Under study: 3 Si-Pixel layers + 4 Si-Strips
  - Need to modify beam pipe: from 29 mm to 20-22 mm radius
  - Monolithic pixel detectors or hybrid pixel detectors
  - Installation: 2017-2018 (long LHC shutdown)

MFT: Physics Motivation

forward region
$2.5 < \eta < 4$

- Open Charm and Beauty
  - Semileptonic decays of D ($c\tau \approx 150$ μm) and B ($c\tau \approx 300$ μm)
  - Normalization for J/ψ and ϒ families
  - Input for models (recombination, ...)
- Direct production of J/ψ and ψ'
  - Disentangle from secondary production coming from B
- Improve the detection of heavy resonances
  - Increase S/B (killing secondaries μ from π)
  - Improves invariant mass resolution
- Low vector mesons (ρ, ω, Φ) in the dimuon channel
  - Chiral symmetry restoration
- Direct multiplicity measurement





MFT Setup

Preliminary Simulations

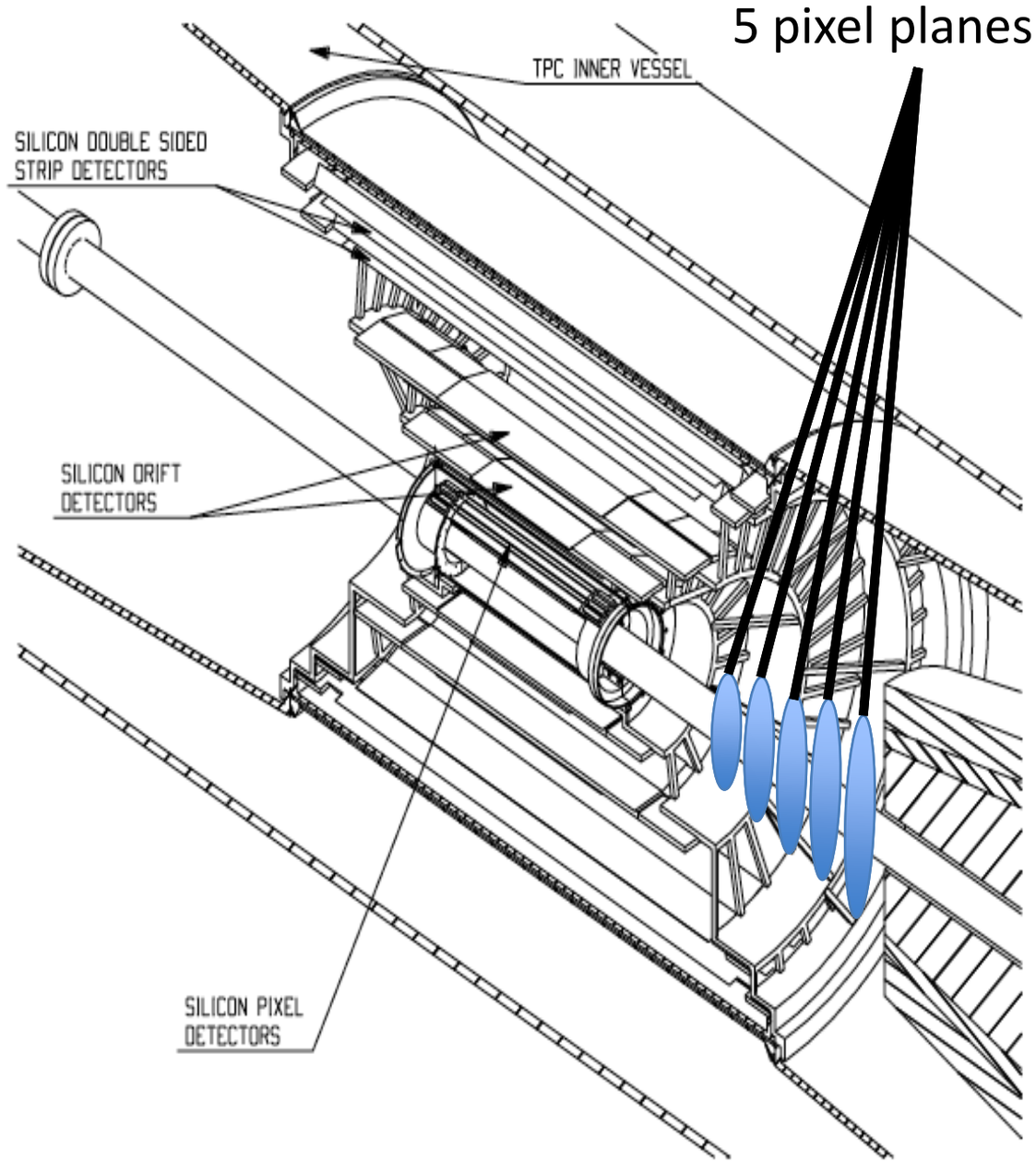
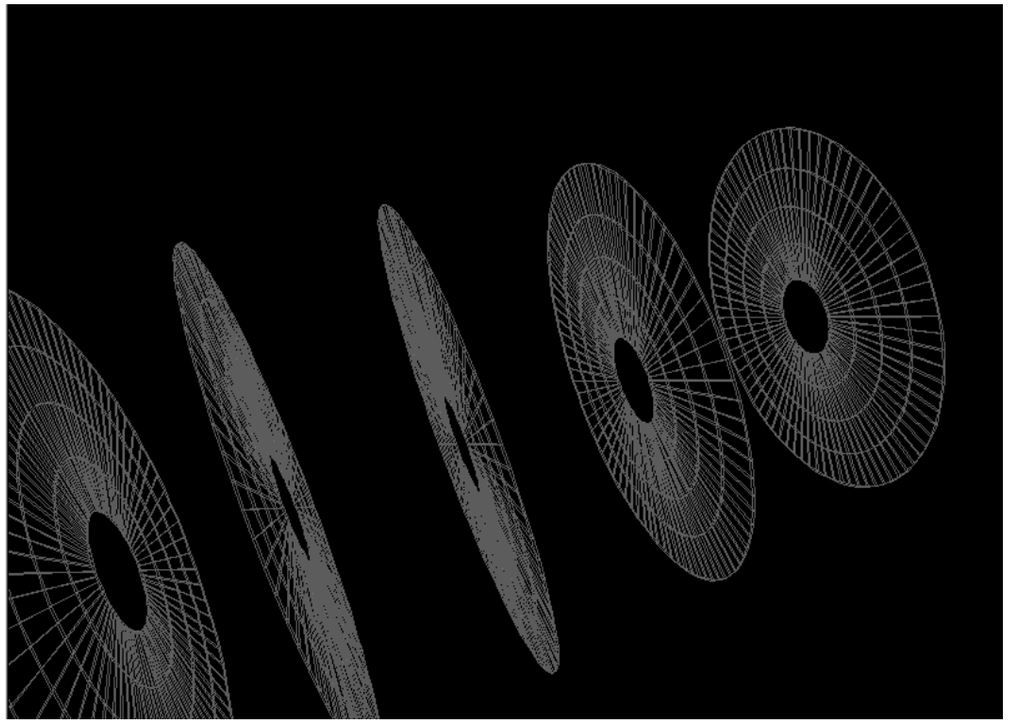


Figure 2.1: General view of the Inner Tracking System.



Plane number	Z(cm)	Rmin (cm)	Rmax (cm)
Plane 1	-50	1.8	8
Plane 2	-58	2	9.25
Plane 3	-66	2.3	10.4
Plane 4	-74	2.5	11.7
Plane 5	-82	2.8	12.9

Track density

An Example: Pb-Pb

J/psi $\rightarrow \mu^-$ at z = 0.0 cm

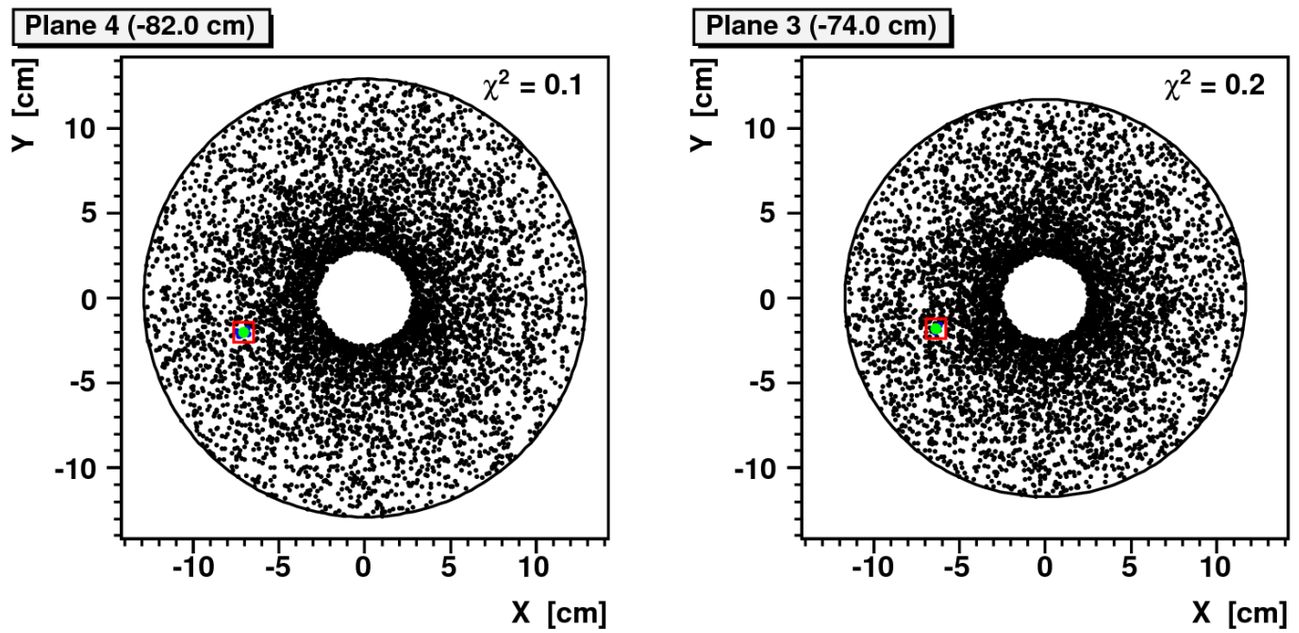
$N_{FinalCandidates}$ = 1

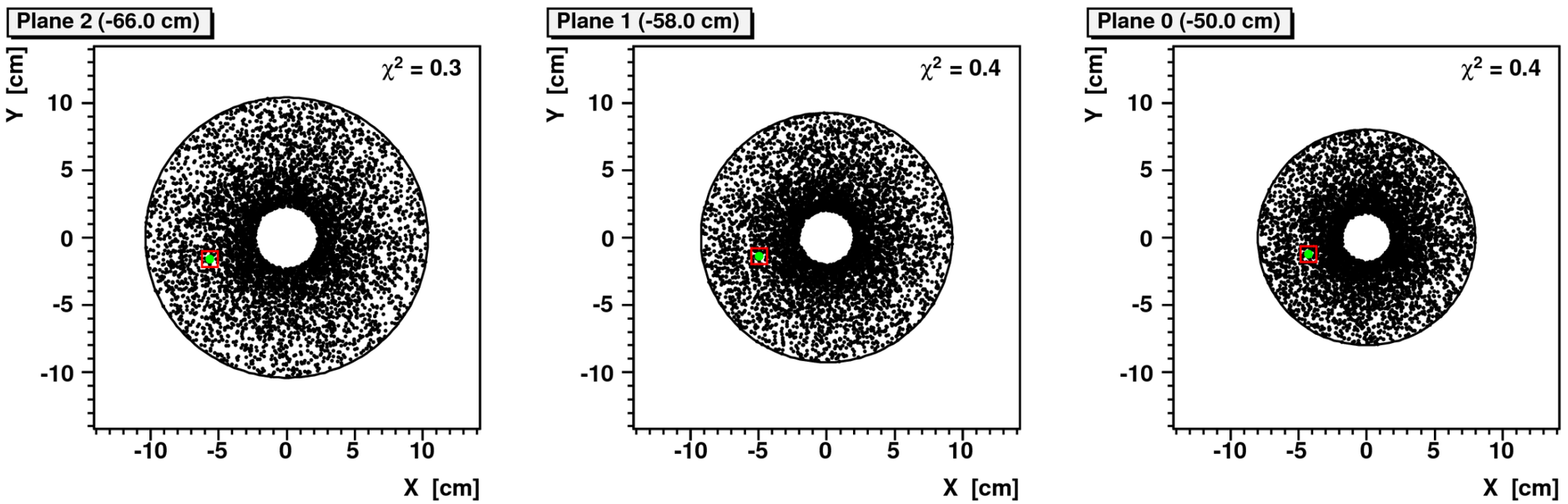
Best Candidate:

$N_{GoodClusters}$ = 5

χ^2_{final} = 0.4

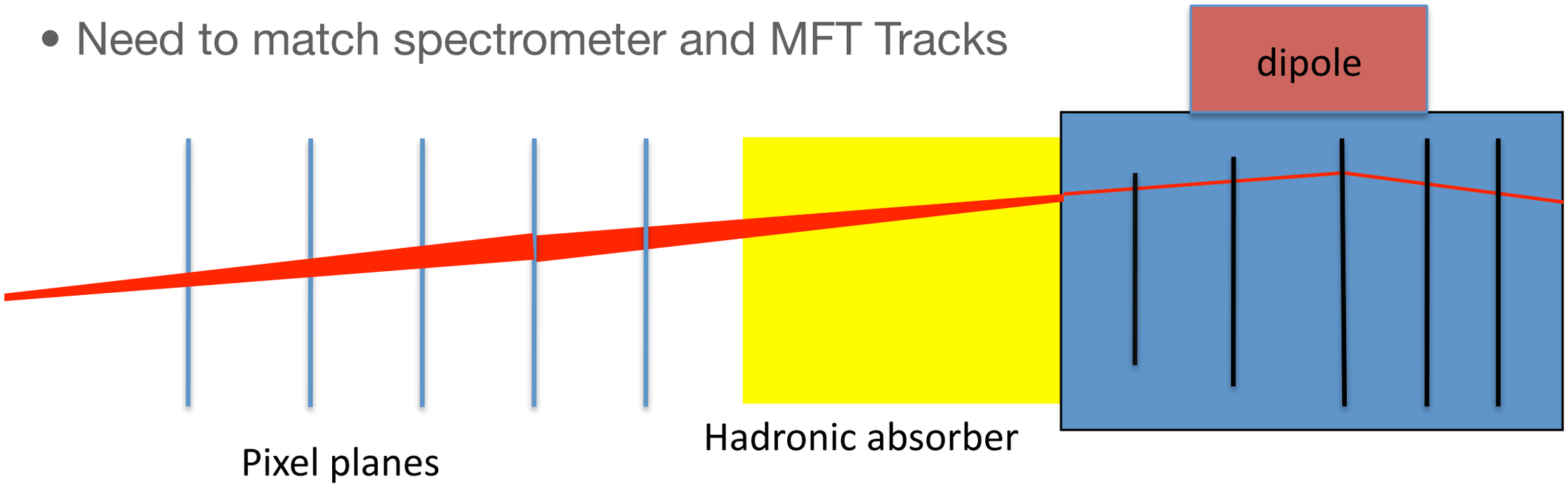
- All Clusters
- Clusters involved in the research
- MC good clusters
- Clusters of the best candidate





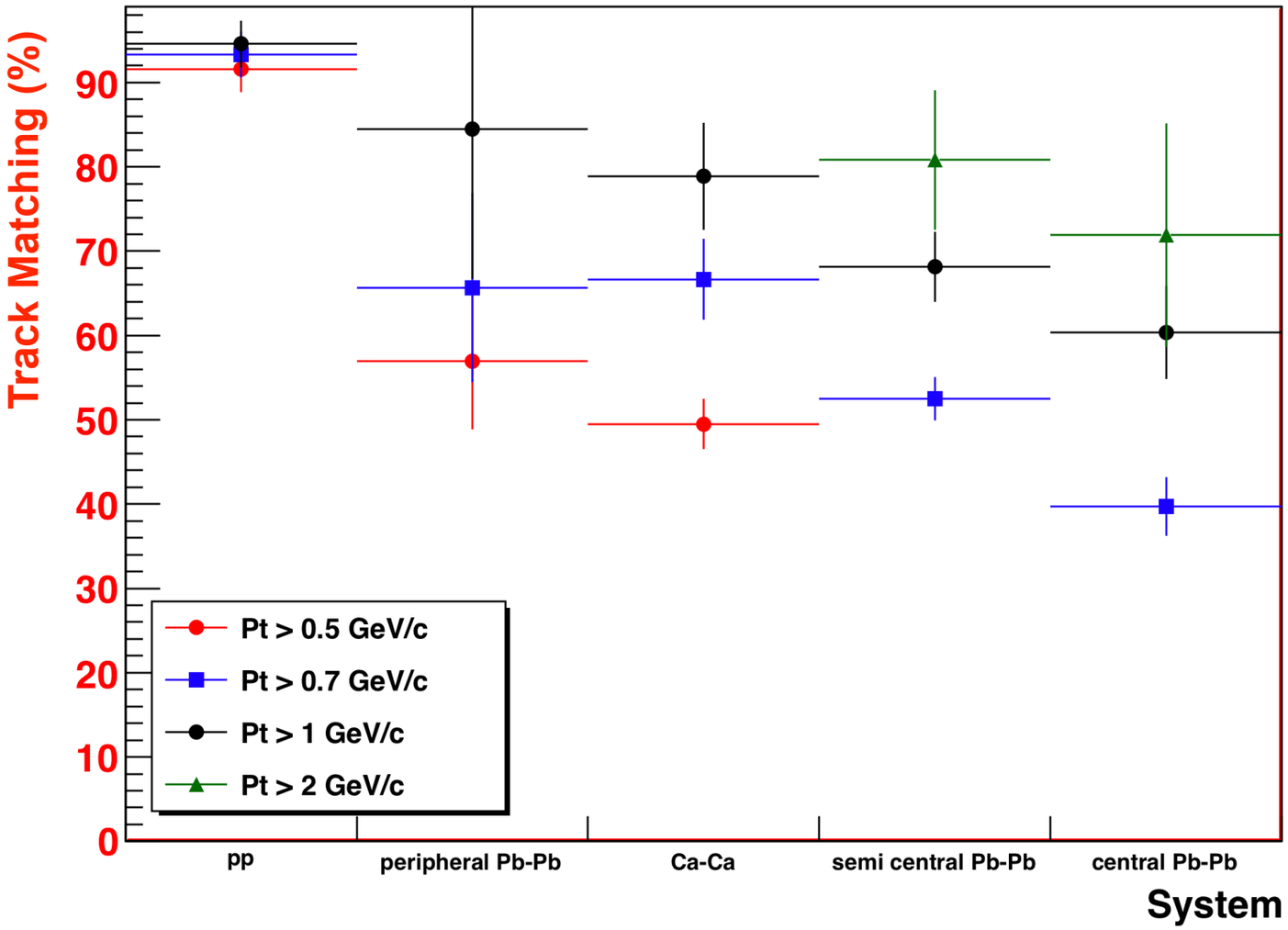
MFT: Track Matching

- Track Momentum measured in the spectrometer (∫Bdl = 3 Tm)
- Track angles and vertex measured in the MFT
- Need to match spectrometer and MFT Tracks



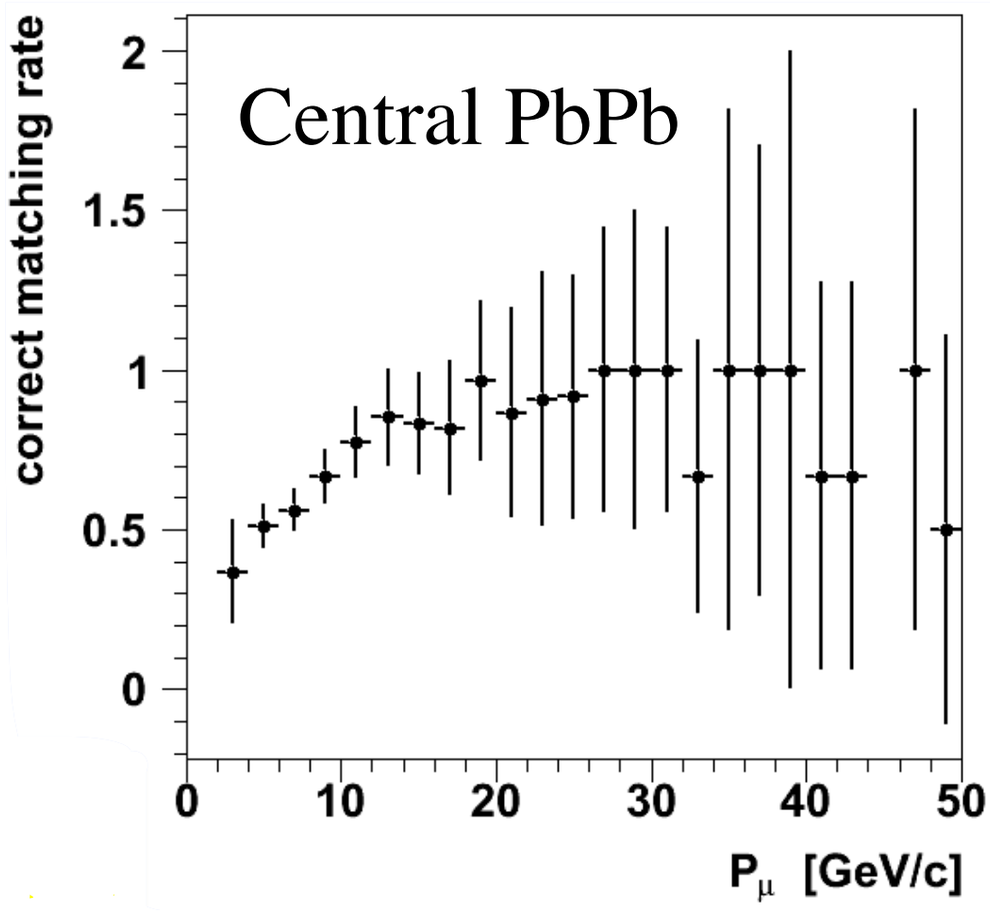
- But...
  - Multiple scattering in the front absorber
    (4m long, 10 λ_{int}, ~60 X_0)
  - Very high track density in central Pb-Pb: dN/dy ~ 1500 (at y = 0)

MFT: Track Matching

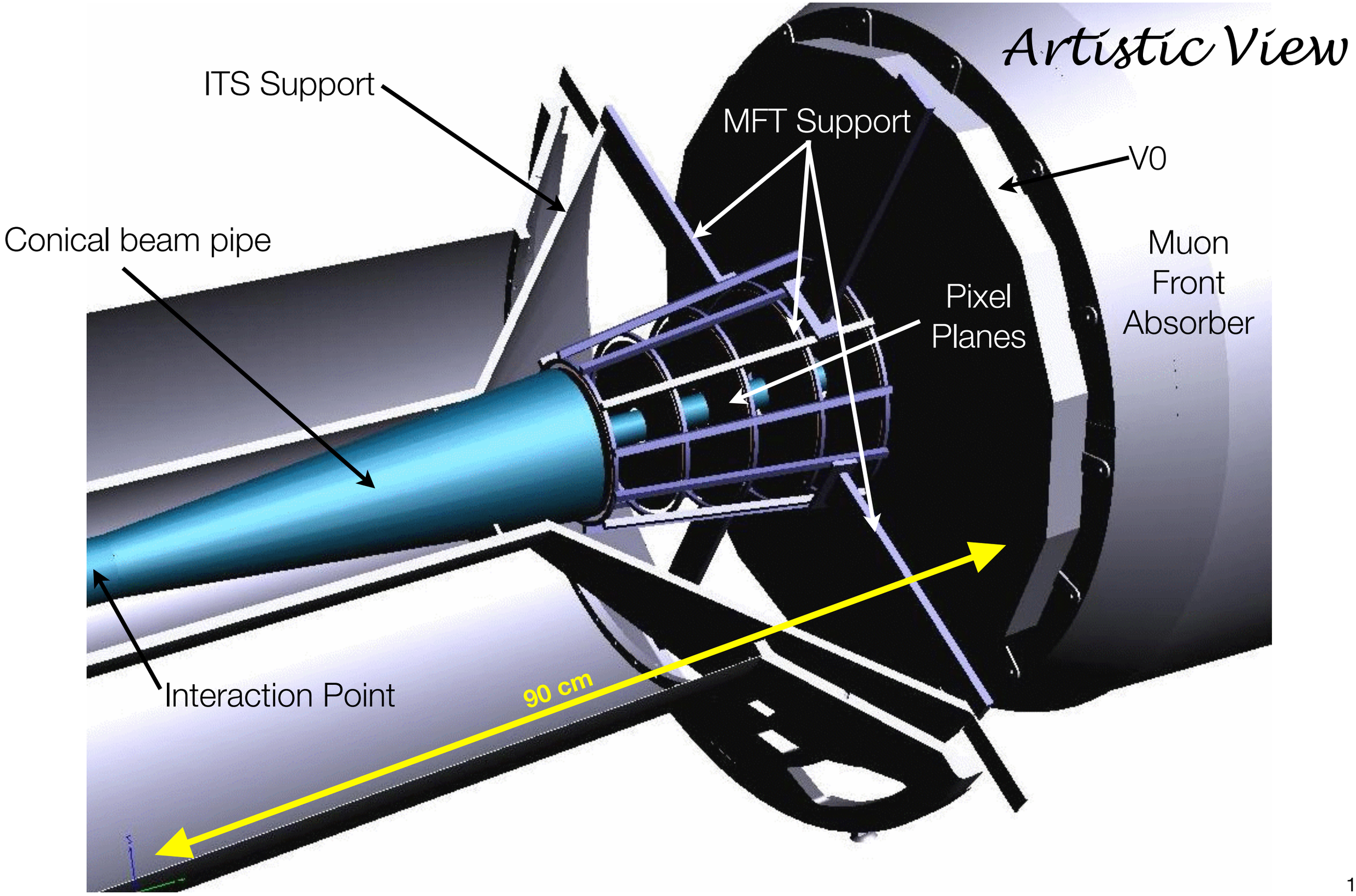


Very preliminary

(10μm x 10μm pixels)

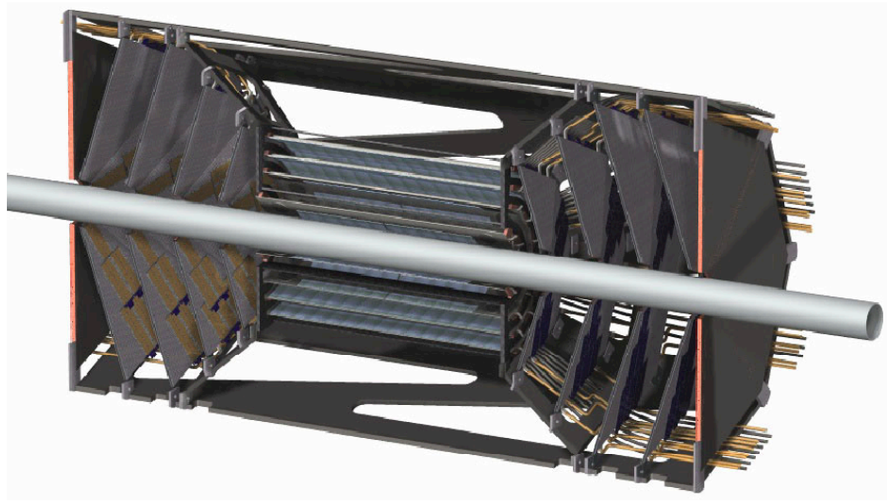


MFT Integration



The MFT timeline

- Early interest in the Saclay ALICE/PHENIX group for PHENIX FVTX



- First simulations done by L. Massacrier (IPN Lyon)
- EOI submitted (March 2011)

Expression of Interest

A Muon Forward Tracker (MFT) for the muon spectrometer

The ALICE Upgrade Collaboration

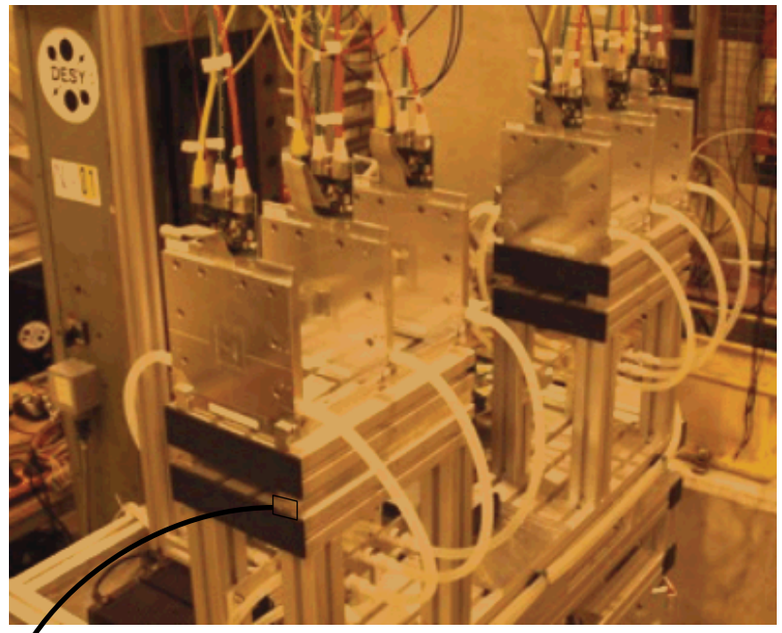
March 10, 2011

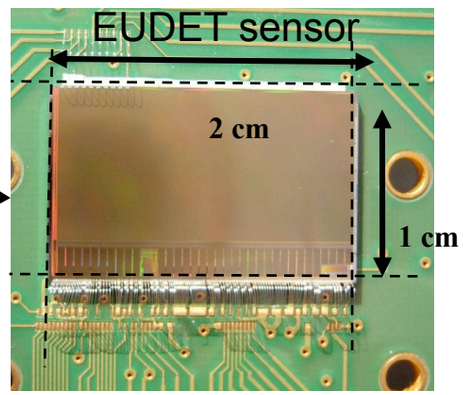
- Implementation in the official Offline code (AliRoot) under way
- Part of Working Groups (common to FoCal and ITS upgrade)
- LoI end of 2011: «Cahier des charges»
- Installation: Long LHC shutdown in (2017 ?)

Tasks sharing

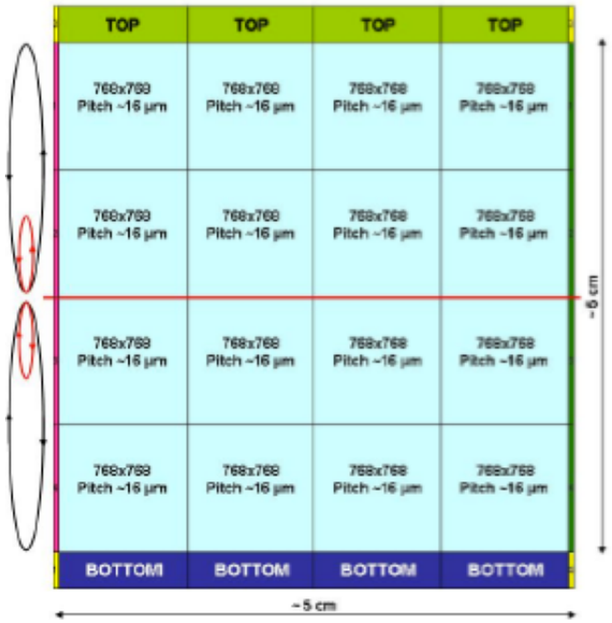
- Nothing decided yet (very preliminary discussions)
  - Sensor conception (monolithic pixels?),...
  - Sensor DAQ
  - Readout
  - Interface to ALICE DAQ
  - Mechanics, cooling,...
  - Integration
  - ....
- IRFU Technical participation
  - Silicon Sensors ?
    - Link to EUDET expertise with monolithic pixels
    - Pursued with AIDA-WP9.3: Precision Pixels Detectors
  - Flex cable ?
  - Thermo mechanical design of sensor supports ?
  - tbd

EUDET Telescope





- One possible solution for the Pixels: CMOS
  - High resolution (≤ 4 µm)
  - Low material budget (~50 µm Si)
  - Large detection area ≥ 5×5 cm^2
  - 2 sided r/o of ~1250 rows in ~ 250 µs
  - Radiation tolerance: 1 Mrad ; ~10^{12} n_{eq}/cm^2



- Participation in the CMOS Pixel R&D (AIDA WP 9.3)
  - IRFU Group: SEDI / SIS / SPhN
  - Deliverables: versatile modular high precision pixels telescope (macroscopic detector),
  - Off beam platform (integration, cooling studies, supports deformation studies, ...)

- Milestones/deliverables
  - Kickoff meeting: 16-18th Feb. 2011

Del. no.	Deliverable name	WP no.	Nature	Dissemination level	Delivery date
D9.3.1	First phase Telescope arm (demonstrator)	9	O	PU	M19
D9.3.2	Infrastructure for thermo-mechanical measurements	9	O	PU	M31
D9.3.3	Fully integrated Telescope arm	9	O	PU	M37

- AIDA Collaboration:

DESY, CSIC, IPHC, CEA, UOXF, CERN, WUPPERTAL, UNIBONN, UNILIV, UNIGLA, UNIVBRIS, FOM, UNIGE

Interested labs.

- MUON Arm Labs
  - France: Clermont, Lyon, Nantes, Saclay
  - Italy: Calgiari, Torino
  - Others: Russia (Gatchina), India (Kolkata), South Africa (Cape Town), Yerevan (Armenia)
- Other ALICE labs
  - ???

Conclusion

- The upgrade program of ALICE is under way
- MFT: rich physics program

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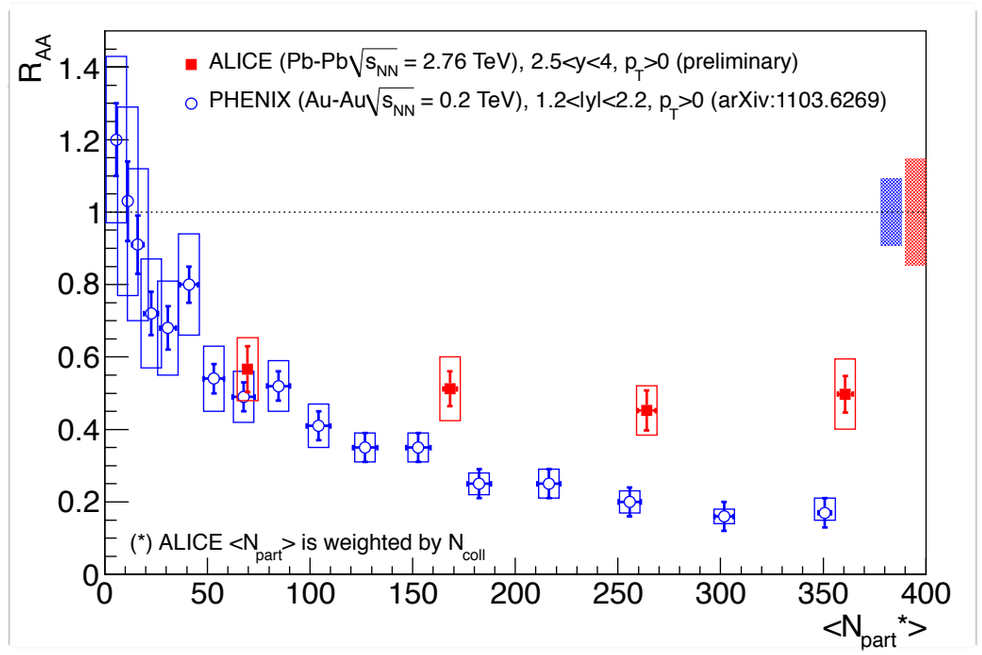
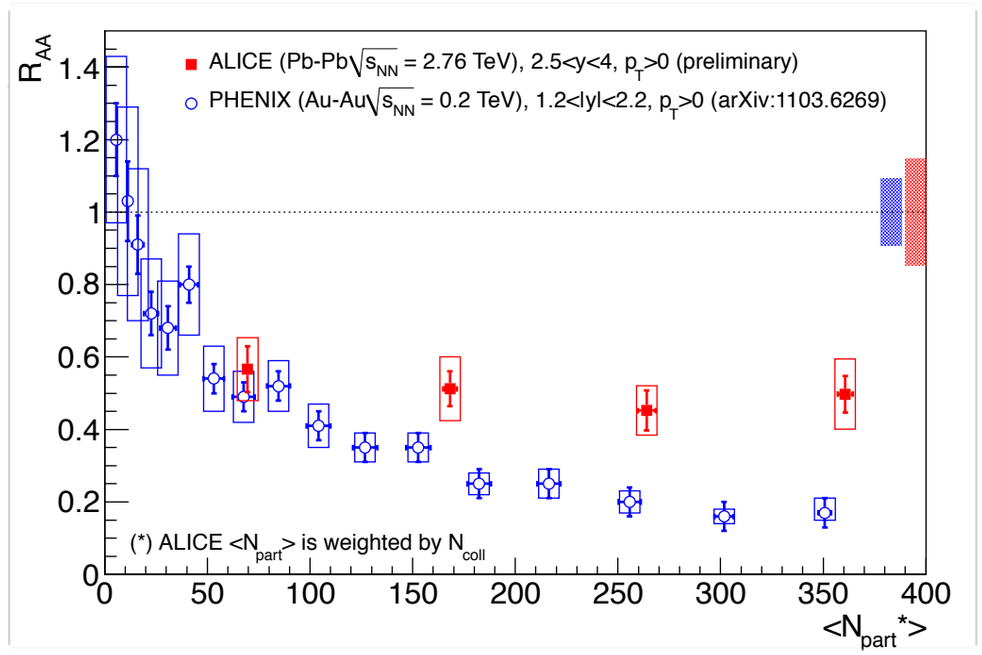
- MFT: rich physics program
  - Complete the J/Psi physics (at low p_T) => QM2011 results

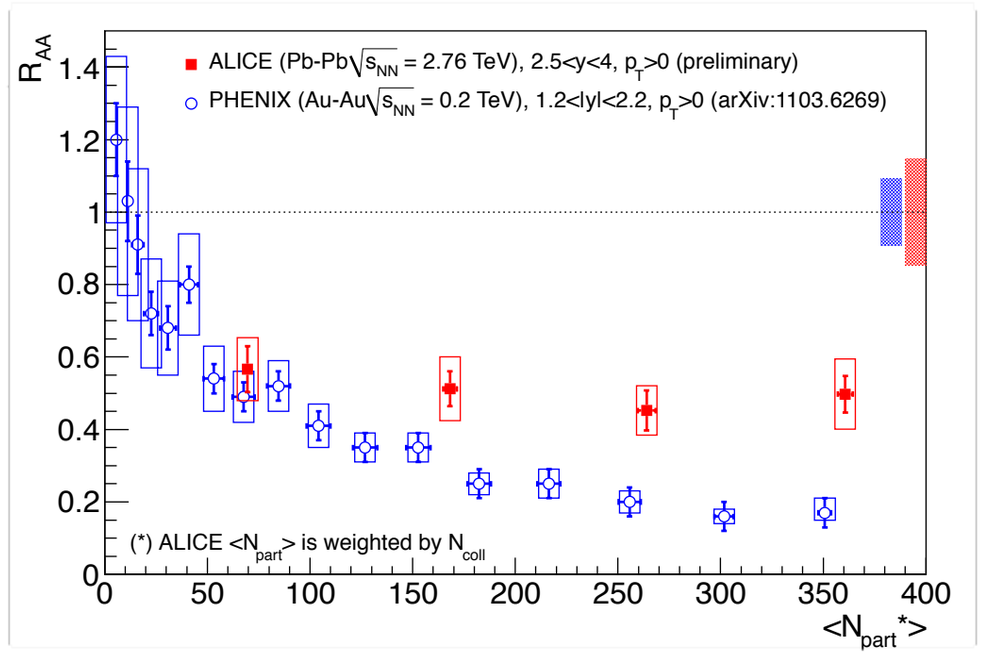


Conclusion

- The upgrade program of ALICE is under way
- MFT: rich physics program
  - Complete the J/Psi physics (at low p_T) => QM2011 results
  - Open heavy flavors direct measurement (2.4<y<4)
  - Unique opportunity for low mass resonances in the forward region (even at low p_T)
  - General improvement of the spectrometer: Mass resolution, S/B



Conclusion



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  - Open heavy flavors direct measurement (2.4<y<4)
  - Unique opportunity for low mass resonances in the forward region (even at low p_T)
  - General improvement of the spectrometer: Mass resolution, S/B
- The MFT is progressing (low manpower up to recently, more interested labs.)
- Milestones
  - Detailed evaluation of the physics case
  - Definition of «cahier des charges»
  - LoI by the end of the year