FKPPL-ALICE
ALICE Muon Trigger Project

FKPPL-FJPPL workshop (Seoul, June 4-6)

Outline

- Members and activities
- ALICE Muon Spectrometer
- Muon Trigger performance (2012/2013)
- Selected physics results

Outlook

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ALICE Muon Trigger (MTR) Project Members and activities

List of participants

French Group			Korean Group		
Name	**Title**	**Affiliation**	**Name**	**Title**	**Affiliation**
Leader: Dupieux, Pascal	Dr.	LPC-IN2P3	Leader: Baek, yongwook	Dr.	GWNU & LPC-IN2P3
Rosnet, Philippe	Pr.	LPC-IN2P3	Lee, Sungchul	Pr.	GWNU
Crochet, Philippe	Dr.	LPC-IN2P3	Kim, Do-Won	Pr.	GWNU
Lopez, Xavier	Dr.	LPC-IN2P3	Oh, Sunkun	Pr.	Konkuk
Portboeuf, Sarah	Dr.	LPC-IN2P3	Kong, Byungyun	M.S.	Konkuk
Barret, Valerie	Dr.	LPC-IN2P3			

Konkuk new ALICE member in association with GWNU (03/2013)

FKPPL Activities @ CERN:

MTR operation: Common work of run coordination & detector expertise

MTR maintenance: Trigger electronics & detector

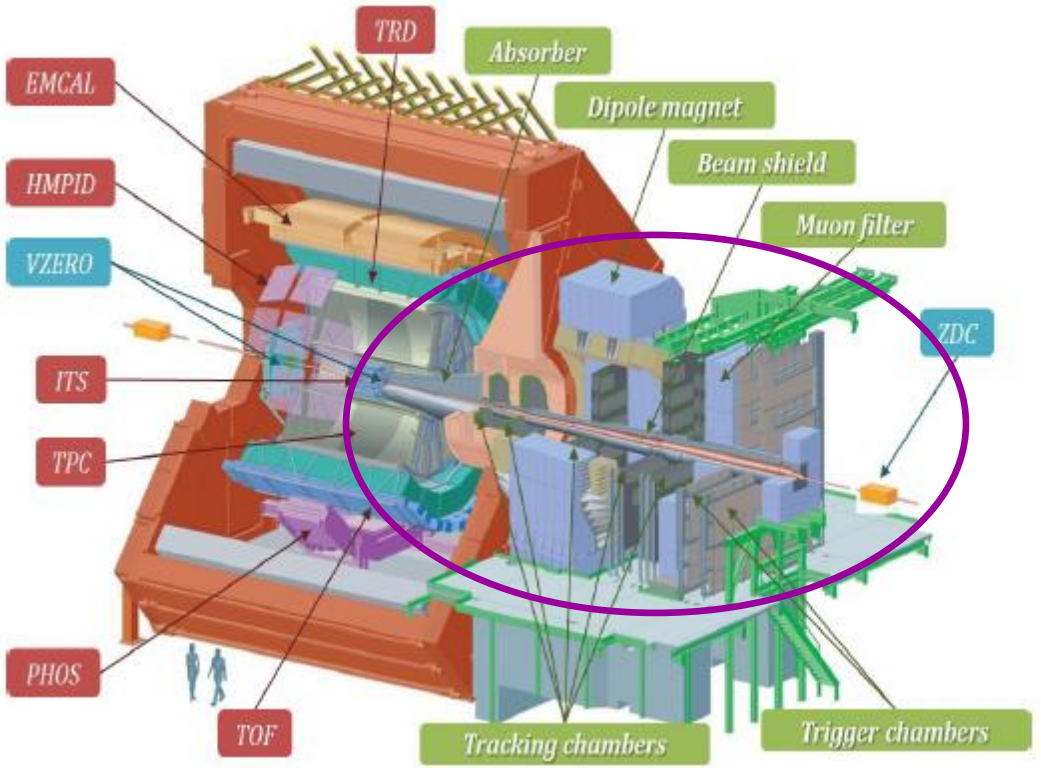
Physics analysis: Upsilon physics

Shift participation: MTR on-call & ALICE General shifts

A Large Ion Collider Experiment

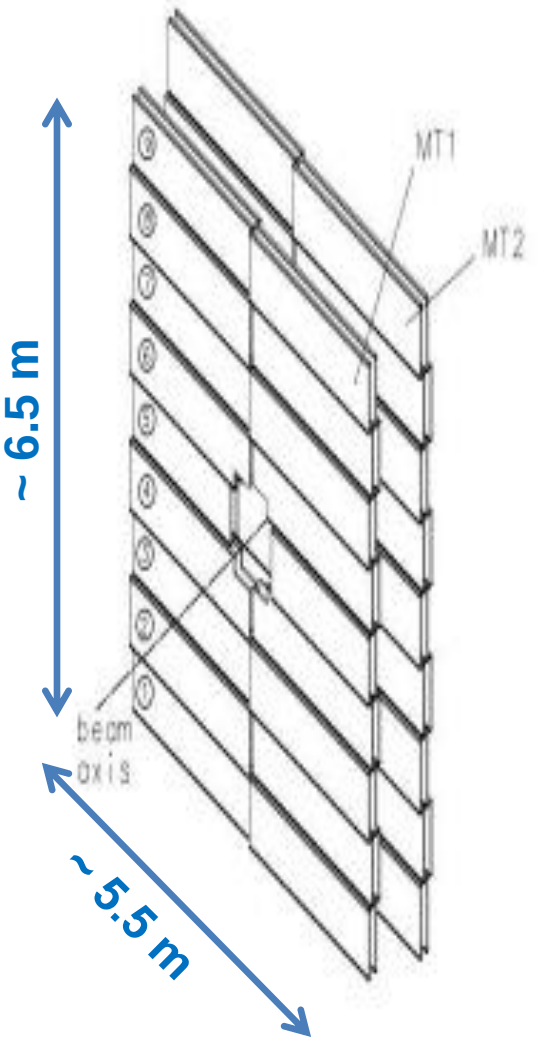
Study of the properties of strongly interacting matter

- Participates to LHC pp and heavy ion programs
- Central detectors ($|\eta| \leq 0.9$) detection of hadrons, electrons and photons
- Muon spectrometer ($-4 \leq |\eta| \leq -2.5$)
  - length: 17 meters
  - 3 absorbers (front, beam shield, muon filter)
  - min. μ momentum = 4 GeV/c
  - dipole magnet: 3 Tm field int.
  - 10 tracking planes (CPC)
  - 4 trigger planes (RPC)
  - 1 M channels
  - total active area ~ 240 m^2
  - $\sigma(M) \sim 100$ MeV/c^2 at M = 10 GeV/c^2



Muon trigger system

- participates in **L0 trigger decision** (latency < 1.2 μs)
- pt-based muon selection and muon identification
- 4 planes of 18 **single gap RPCs** (2 stations of 2 planes)
- total surface ~ 140 m2
- gas mixture: 89.7% C2H2F4, 10% i-C4H10 0.3% SF6
- **saturated avalanche mode** (streamer mode with same FEE) → no amplification at the FE electronics level
- ~21,000 strips and Front-End channels



Muon Trigger electronics and algorithm

234 Local Trigger boards:

- Estimate of deviation wrt a straight track from IP
- Coincidence of hits from at least 3/4 MTR planes, bending and non- bending separately
- 2 programmable pt cuts (LUT): Low & High pt

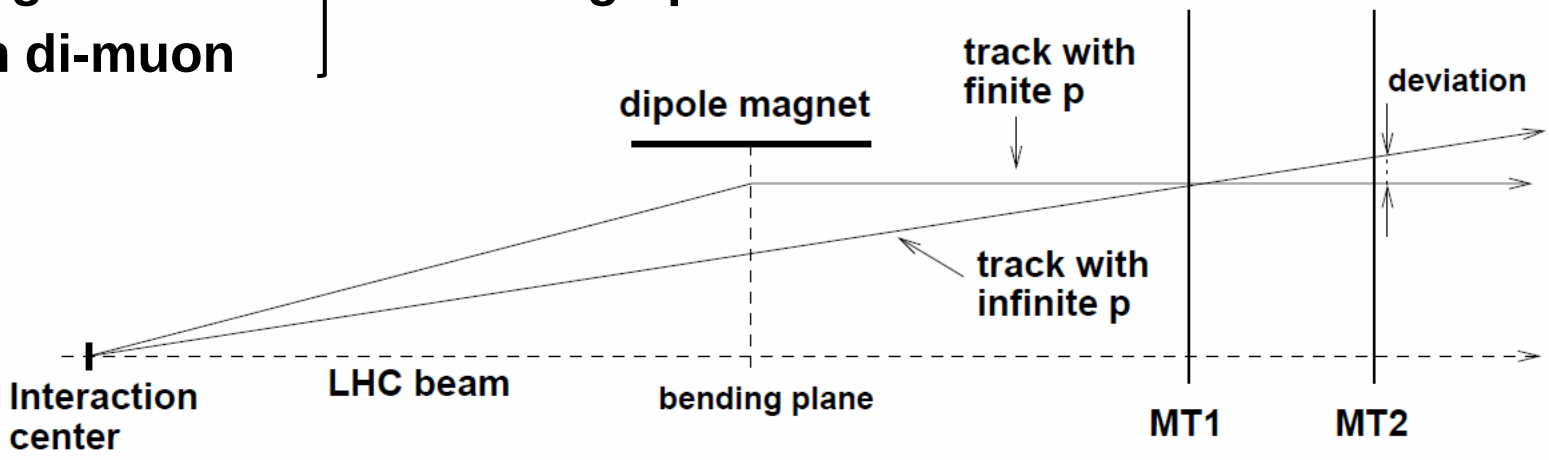
16 Regional Trigger boards:

- Single muon and di-muon

1 Global trigger board: 6 output signals @ 40 MHz

- single muon
- unlike-sign di-muon
- like-sign di-muon

} Low & High pt



Muon Trigger performance (2012-2013)

Running conditions

p-p 8 TeV low rate from April to September 2012

- MTR switched on at MB rate of 300 kHz
- Luminosity < 2 Hz/μb

p-p 8 TeV high rate from October to December 2012

- MTR switched on at MB rate of 700 kHz
- Maximum luminosity: 7 Hz/μb

p-Pb 5.02 TeV January-February 2013

- Maximum luminosity: 100 Hz/mb (MB of 200 kHz)

Pb-p 5.02 TeV February 2013

- Maximum luminosity: 100 Hz/mb (MB of 200 kHz)

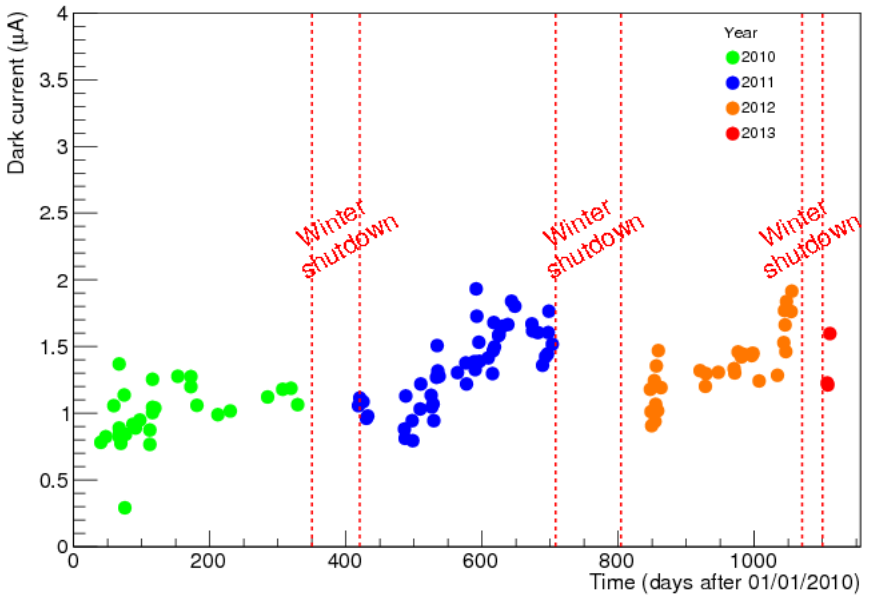
p-p 2.76 TeV low rate February 2013

- Maximum luminosity: 4 Hz/μb (MB of 200 kHz)

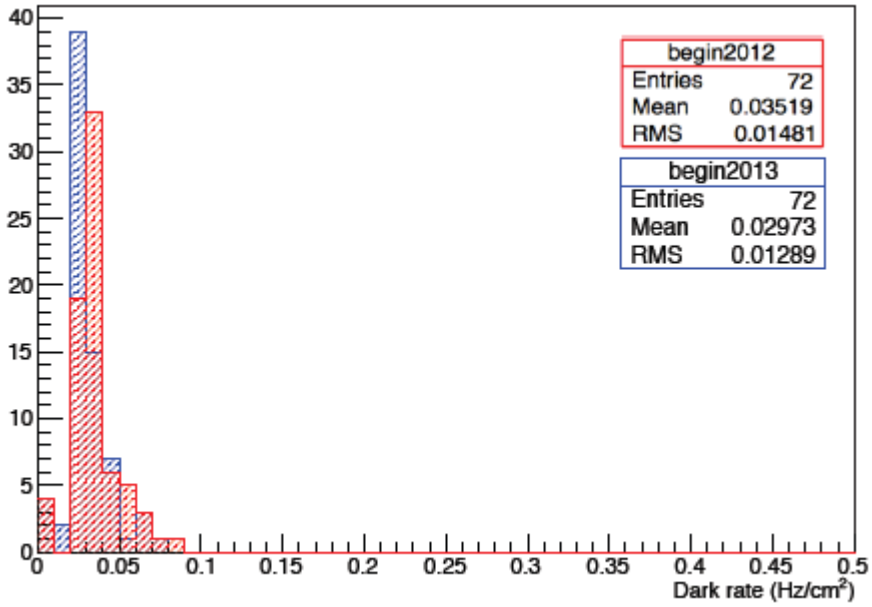
RPC performances: aging

Dark current measured in calibration runs between fills (analysis up to February 2013)

max value after the high luminosity p-p runs at the end of 2012
Slow increase in time and low value (< 2 μA / RPC)



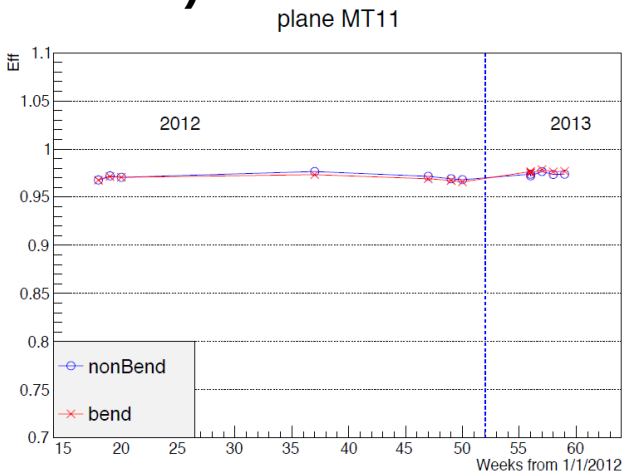
Dark rate distribution: comparison between the beginning of 2012 and 2013

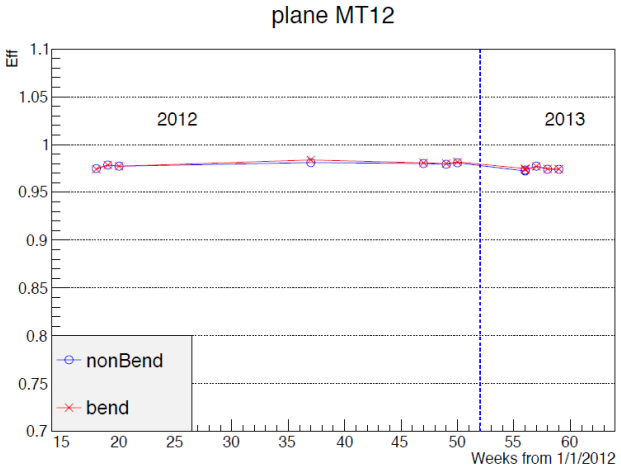


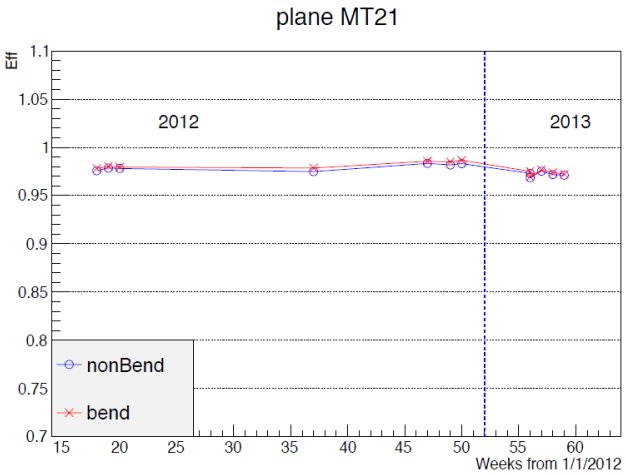
No evidence for performance worsening

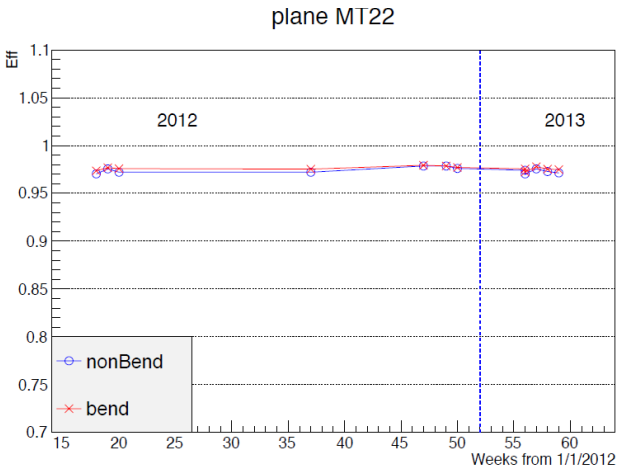
RPC performances: efficiency

- HV scans performed periodically
- Efficiency obtained using redundancy wrt trigger condition (ratio of 44/34 coincidences)



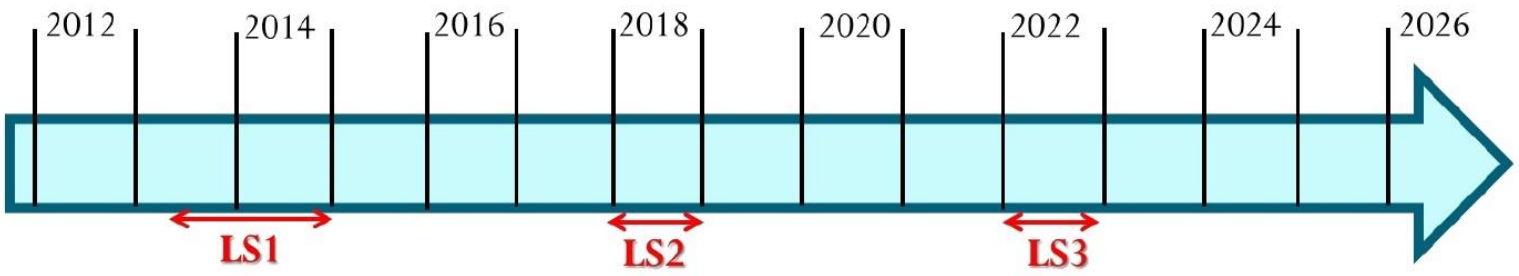






Efficiency stable during the whole period (Eff > 95%)

LS1: Muon Trigger activities



Satisfactory RPC performance and stability throughout RUN I
→ no major intervention needed

Gaz system: proposal by Technical Coordination to upgrade the MTR gas distribution system to a closed-loop system during LS1

Participate in general upgrades as requested by ALICE (Consolidation Task force)

Replacement/Maintenance:

- replacement of a few FE cards
- replacement of two faulty local boards
- replacement of all regional boards (to speed-up configuration)
- maintenance and test of DARC spares

Muon Trigger upgrade

For operating after LS2 in the context of high luminosity at LHC (after 2018):

- larger signal + background rates
- larger trigger rates

2 main upgrades are presently considered:

Front-End Electronics:

- FEE with amplification (avalanche mode) for limiting aging
- R&D started since spring 2012
- before end of LS1: equip 1 RPC in ALICE cavern (pre-production test)
  2015-2016 : production

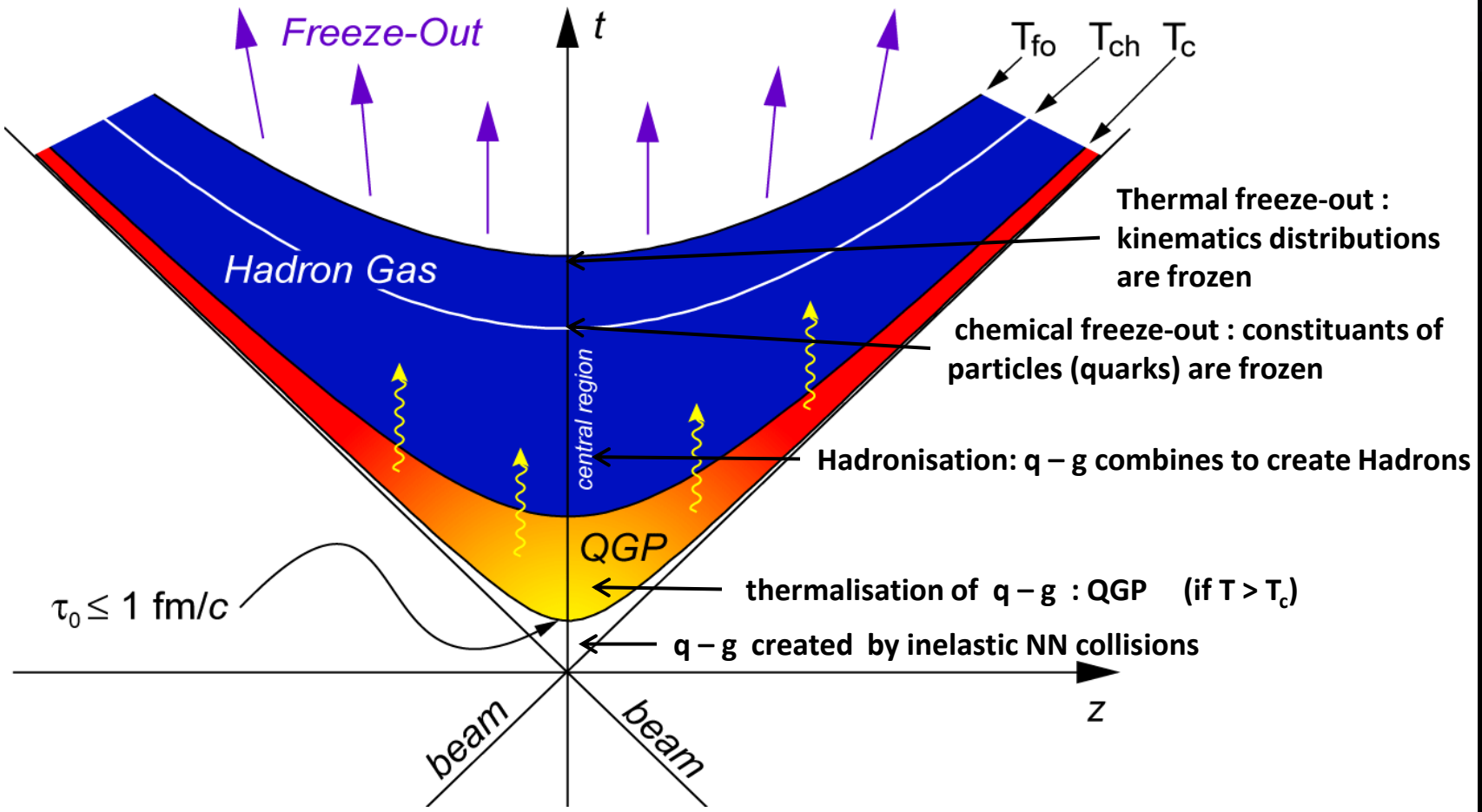
Readout Electronics (Subatech Nantes): dead time free read-out

- need to change the LOCAL cards (234 cards + spares)
  Planning (prel.)
- 2013-2014 : test the DTC e-link
- 2014-2016 : R&D and production of the new LOCAL

FKPPL involved on FEE upgrades of the Muon Trigger Project

Selected physics results: quarkonia measurement

Reminder: time evolution of heavy ion collisions



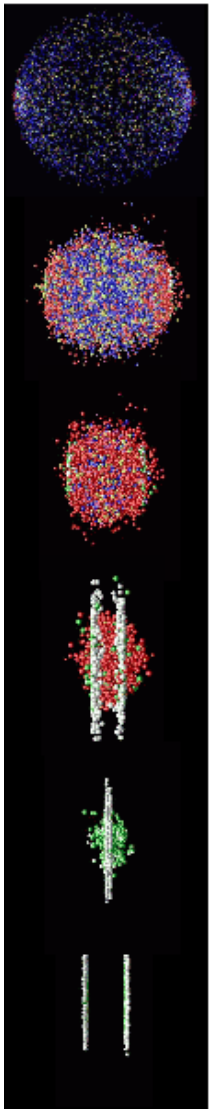
Thermal freeze-out : kinematics distributions are frozen

chemical freeze-out : constituants of particles (quarks) are frozen

Hadronisation: q – g combines to create Hadrons

thermalisation of q – g : QGP (if $T > T_c$)

q – g created by inelastic NN collisions



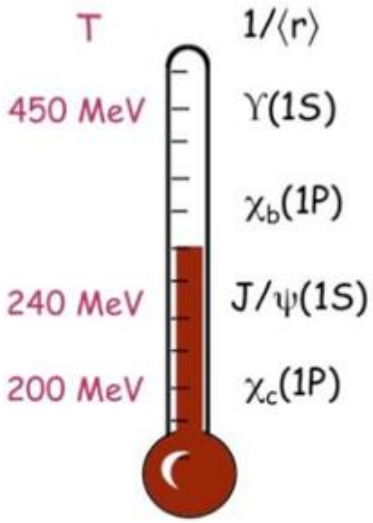
Heavy flavor and quarkonia measurement

- in pp collisions:
  - baseline for pA and AA collisions
  - test NLO pQCD in a new energy regime

- in pA collisions:
  - shadowing and anti-shadowing
  - parton k_t broadening
  - color glass condensate

- in AA collisions, tomography of QCD medium:

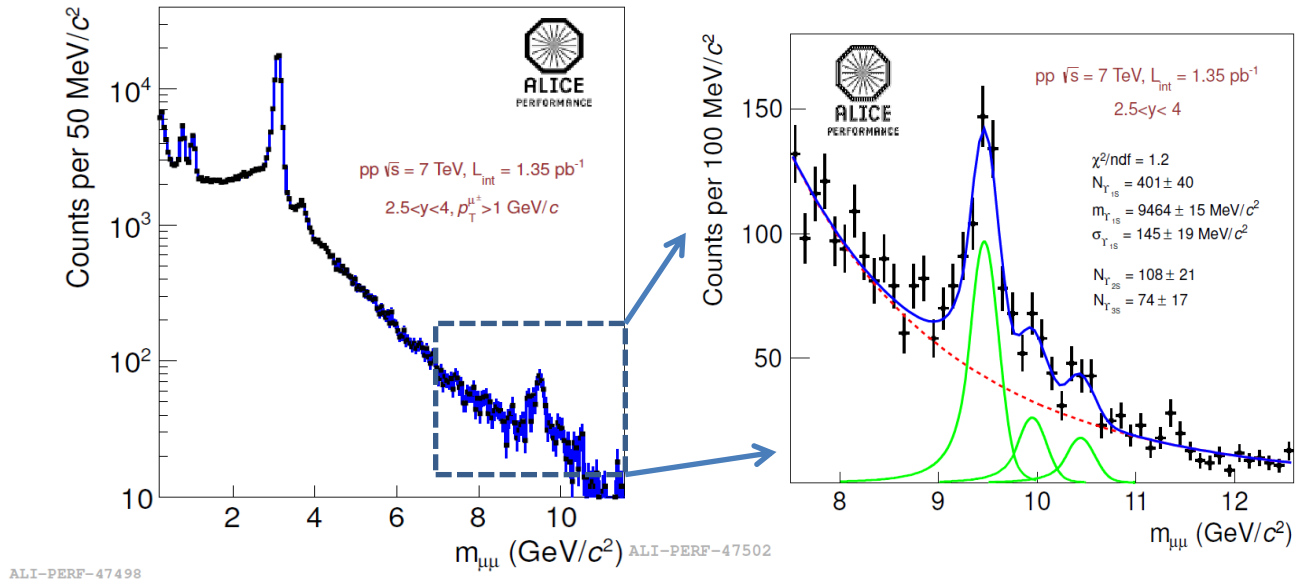
- energy losses of open heavy flavors provide information on the density of the medium
- dissociation rate of resonances provides information on the temperature of the medium
- collective flow study of heavy flavors provides information on the thermalisation of QGP



$$R_{AA}(p_t) = \frac{1}{\langle Ncoll \rangle} \times \frac{dN_{AA}/dp_t}{dN_{pp}/dp_t}$$

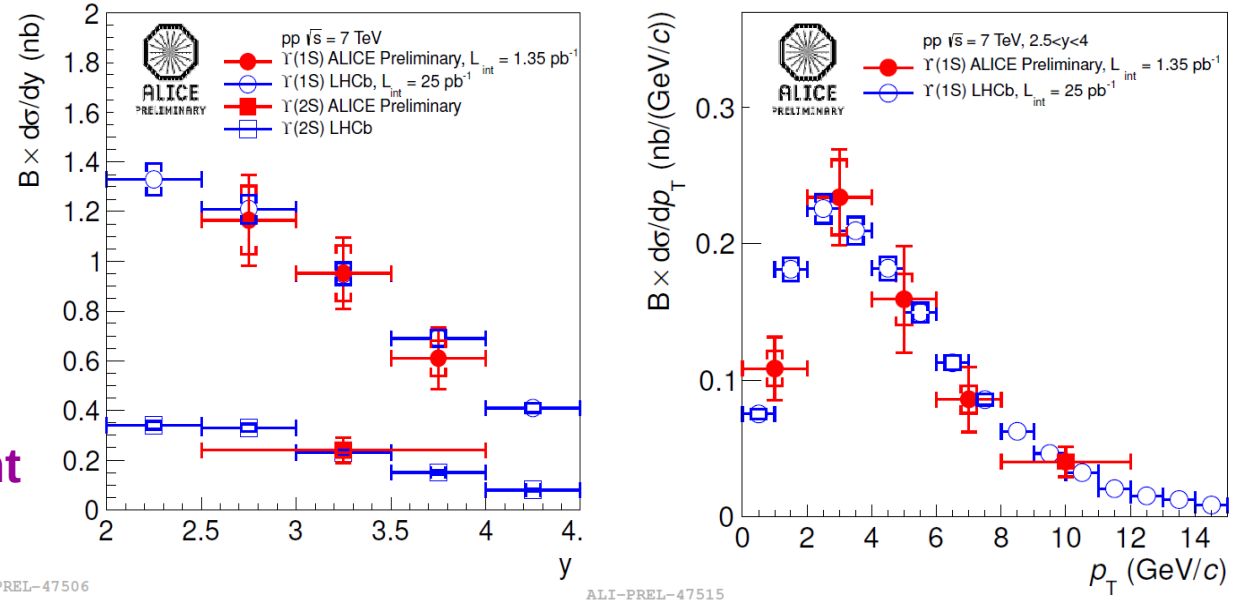
Upsilon measurement in pp at 7 TeV

Dimuon invariant mass spectra & Upsilon states measurement



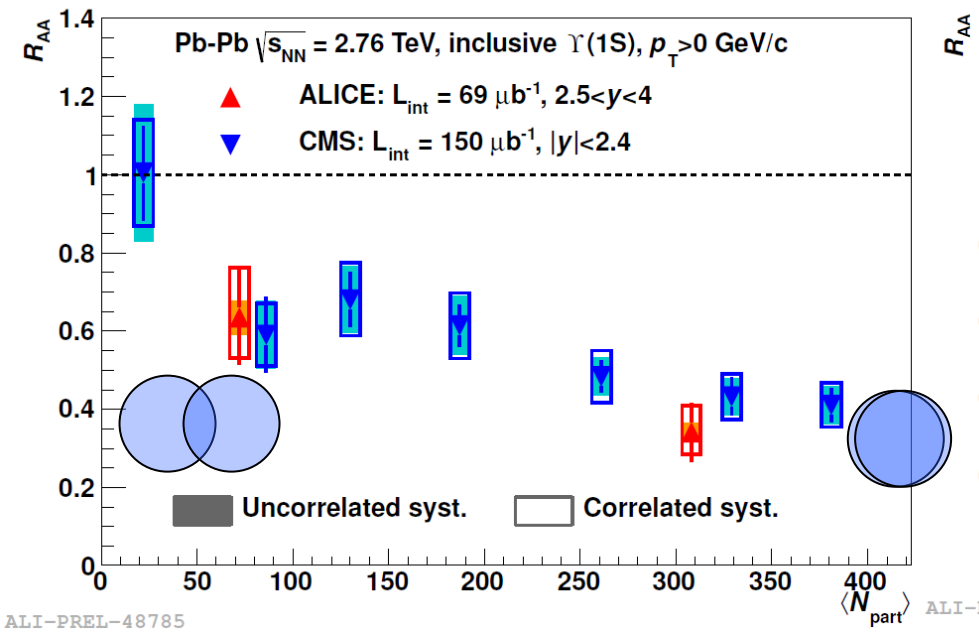
Upsilon diff. production cross section as function of rapidity and pt

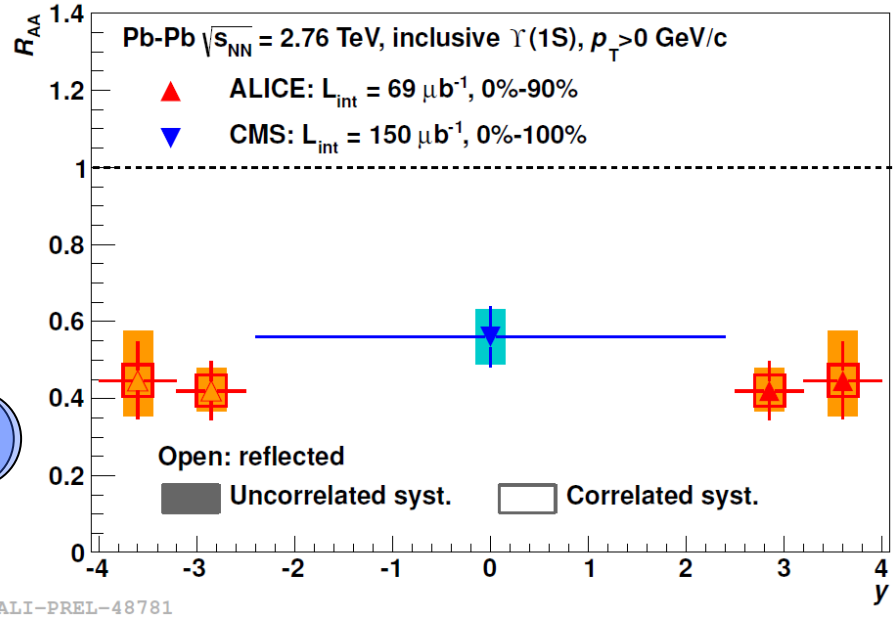
Good agreement with LHCb measurement



Upsilon measurement in PbPb at 2.76 TeV

Comparison between R_{AA} of Y measured by ALICE (2.5<y<4) and CMS (|y|<2)



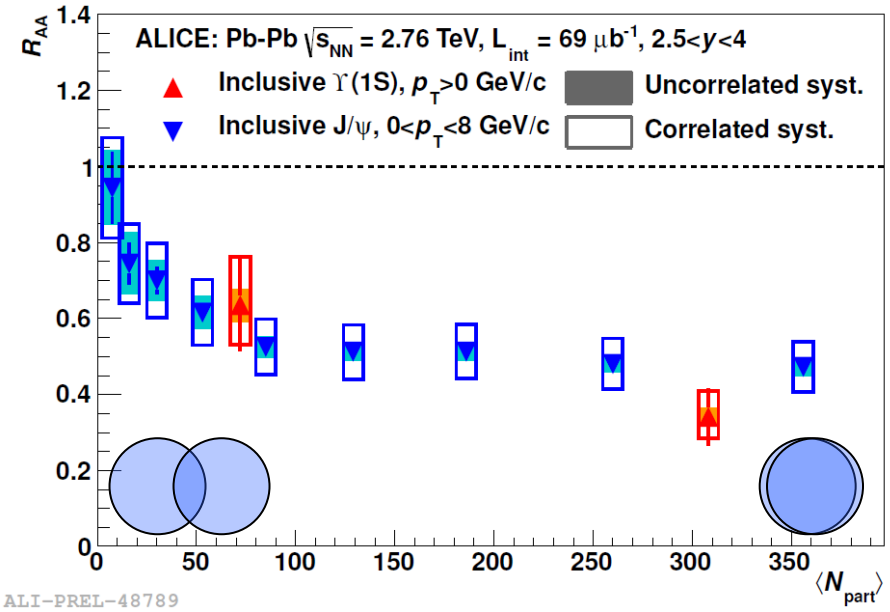


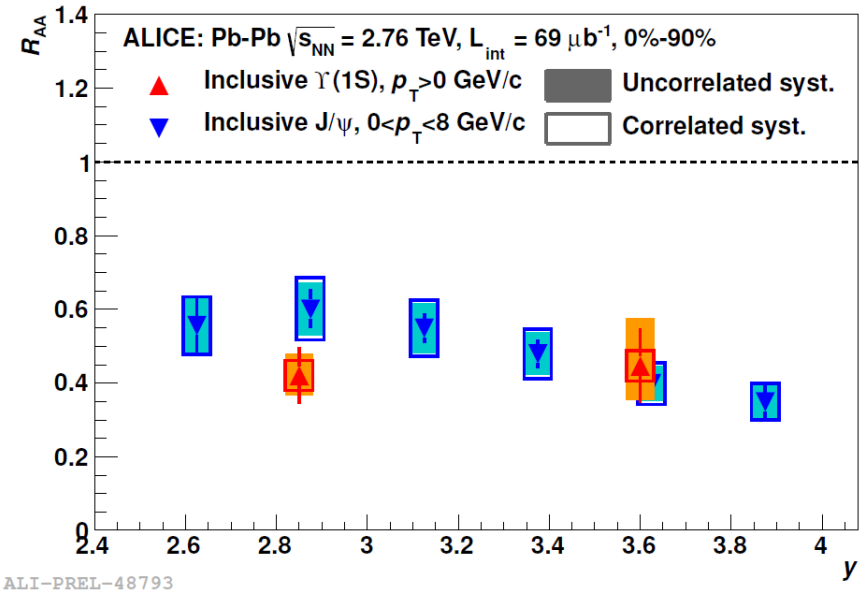
The centrality dependence of the CMS and ALICE Υ(1S) nuclear modification factors are compatible while the acceptance are different

The observed suppression factor (about 2) remains rather constant in the large rapidity range covered by ALICE and CMS

Upsilon measurement in PbPb at 2.76 TeV

Comparison between R_{AA} of J/Ψ ($c\bar{c}$) and Υ ($b\bar{b}$)





Large suppression (×2) observed for both quarkonia

Similar suppression for J/ψ and Υ(1S) observed as a function of centrality and as a function of rapidity

Interplay of various competing mechanisms is to be considered

Conclusion/Outlook

ALICE Muon Trigger system fully operational since start of LHC program

- **electronics robust and stable**
- **RPC Efficiency > 95%**
- **stable dark current and dark rate**
- **no significant aging effect**
- **successful data taking campaigns in pp, PbPb and p-Pb/Pb-p**

2012-2013 data taking conditions

- **pp: $\sqrt{s}$ = 8 TeV**
- **pA (Ap): $\sqrt{s}$ = 5.02 TeV**
- **Analysis of the data ongoing**

Several publications ongoing (Upsilon) and good visibility of the Muon community in ALICE collaboration

FKPPL perspectives:

- **Master student (B. Kong)**
- **MTR maintenance and shifts**
- **MTR upgrade**

BACKUP