ALICE Status Report

Marie Germain

SUBATECH, CNRS-IN2P3

For the ALICE Collaboration

- New published and submitted papers
- Selection of recent physics results
- ALICE commissioning for Run 2
- Run 3 preparation

122nd LHCC meeting, 3 June 2015

Published papers since last LHCC

- Phys. Lett B 746(2015) 1: Measurement of jet suppression in central Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV
- Phys. Rev. C 91 (2015) 024609: $K^*(892)^0$ and $\Phi(1020)$ production in Pb-Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV
- Phys. Rev. C 91 (2015) 034906: Two pion femtoscopy in p-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV
- Eur. Phys. J. C 75 (2015)146: Inclusive photon production at forward rapidities in proton-proton collisions at $\sqrt{s} = 0.9, 2.76, 7$ TeV

Submitted and Accepted papers since last LHCC

Pb-Pb

- Elliptic Flow of identified hadrons in Pb-Pb collisions at $\sqrt{s_{NN}}$ =2.76 TeV
  arXiv:1405.4632 accepted in JHEP

- Inclusive, prompt and non prompt J/ψ production at mid-rapidity in Pb-Pb collisions at $\sqrt{s_{NN}}$ =2.76 TeV
  arXiv:1504.07171 submitted to JHEP

- Coherent ρ^0 production in ultra-peripheral Pb-Pb collisions at $\sqrt{s_{NN}}$ =2.76 TeV
  arXiV:1503.09177 submitted to JHEP

p -Pb

- Measurement of dijet k_T in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV
  arXiv:1503.03050 submitted and accepted in Phys.Lett.B

- Transverse momentum dependence of the inclusive J/ψ nuclear modification factor in p-Pb collisions at LHC at $\sqrt{s_{NN}}$ = 5.02 TeV
  arXiv:1503.07179 accepted in JHEP

- Centrality determination of p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV in the ALICE experiment
  arXiv:1412.6828 accepted in JHEP

Submitted and Accepted papers since last LHCC

proton-proton

- Production of pions, kaons, protons in proton-proton collisions at $\sqrt{s} = 7$ TeV
  arXiv:1504.00024 accepted in Eur. Phys. J. C

- Forward-backward multiplicity correlations in proton-proton collisions at $\sqrt{s} = 0.9$, 2.76 and 7 TeV.
  arXiv:1502.00230 accepted in JHEP

- Charged Jet cross sections and properties in proton-proton collisions at $\sqrt{s}=7$ TeV
  arXiV:1411.4969 accepted in Phys.Rev.D

- Measurement of charm and beauty production at central rapidity versus charged-particle multiplicity in proton-proton collisions at $\sqrt{s} = 7$ TeV
  arXiv:1505.00664 submitted to JHEP

Selection of recent physics results

J/ψ ,quarkonium and beauty interaction in medium

arXiv:1504.07171: Inclusive, prompt and non prompt J/ψ production at mid-rapidity in Pb-Pb collisions at $\sqrt{s_{NN}}$ =2.76 TeV

arXiv:1503.07179: Rapidity and transverse momentum dependence of the inclusive J/ ψ nuclear modification factor in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV

Jet interaction in medium

arXiv:1411.4969 Measurement of dijet k_T in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV

Charm and beauty production in proton-proton

arXiv:1505.00664: Measurement of charm and beauty production as a function of charged particle multiplicity in p-p at $\sqrt{s}$ =7 TeV

proton-proton reference

arXiv:1504.00024: Production of pions, kaons, protons in p-p collisions at $\sqrt{s}$ = 7 TeV

Recent J/ψ results in Pb-Pb and p-Pb collisions

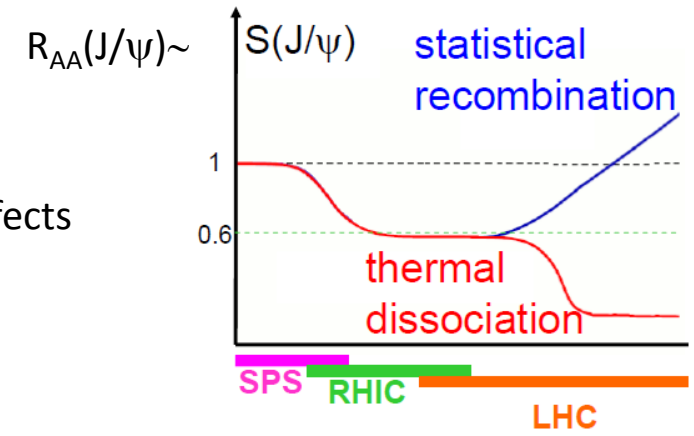
arXiv:1503.07179, arXiv:1504.07151

J/ψ and quarkonium interactions with medium

In presence of QGP:

Suppression was proposed as signature of the QGP (*Matsui and Satz, Phys.Lett.B178(1986)416*)

- Color screening
- Dissociation/regeneration in plasma
- recombination



But charmonium production could be modified by nuclear effects (*Phys.Lett.B207(1988)253)*

Cold Nuclear matter effects :

- Shadowing
- Energy loss (initial/final states, coherent)
- Nuclear absorption

Beauty interactions in medium:

Parton energy loss mechanisms w.r.t. color charge and parton mass:

- J/ψ from beauty hadron decay: **Non-prompt component in J/ψ yield**

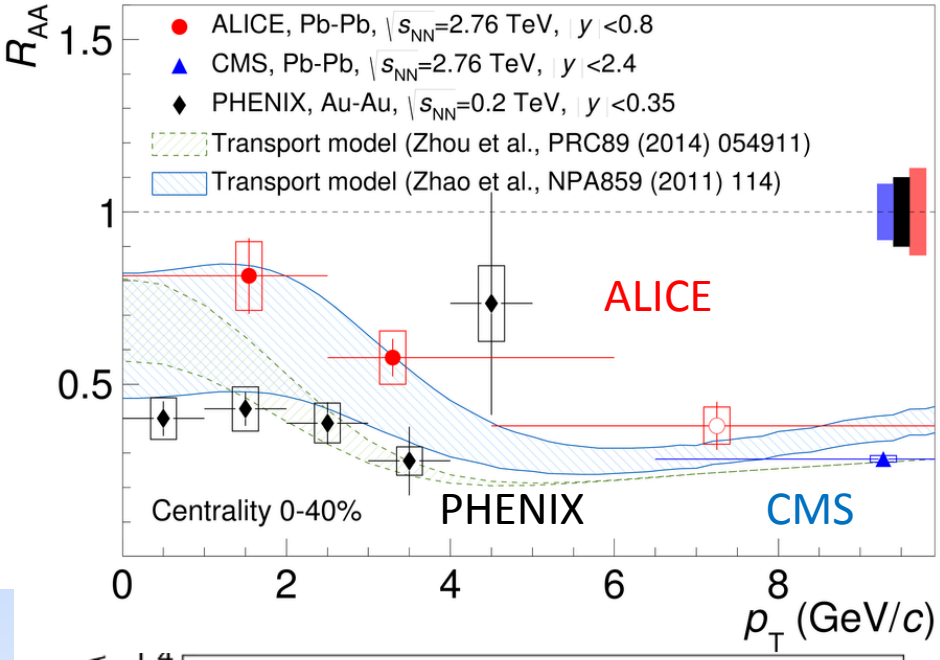
Pb-Pb: R_{AA} Inclusive J/ψ at mid rapidity

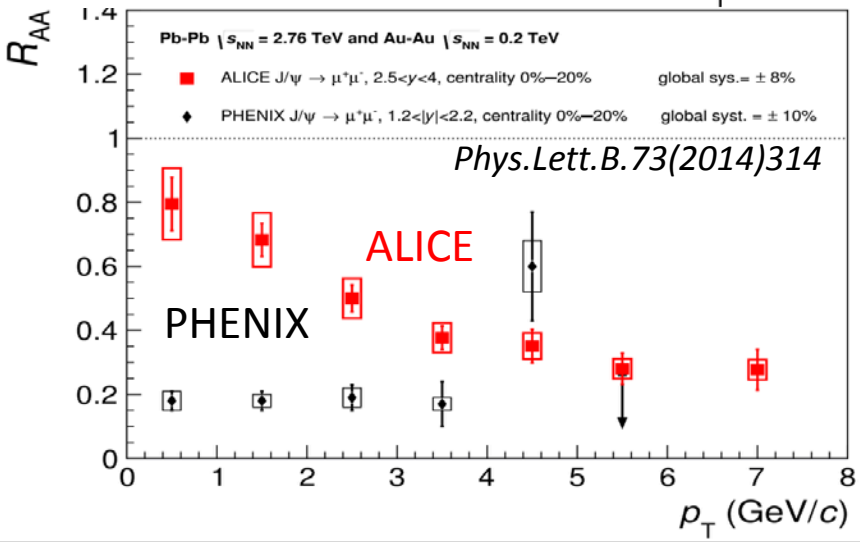
$$R_{AA} = \frac{Y^{J/\psi}_{PbPb}(p_T)}{<N_{coll}> Y^{J/\psi}_{pp}(p_T)}$$

R_{AA}= 1: No medium effects
R_{AA} > 1: Enhancement
R_{AA} < 1 : Suppression

- Different p_T dependence than RHIC
- At high p_T ALICE and CMS consistent
- Observed also at forward rapidities
  Phys.Lett.B.73(2014)314

arXiv:1504.07151

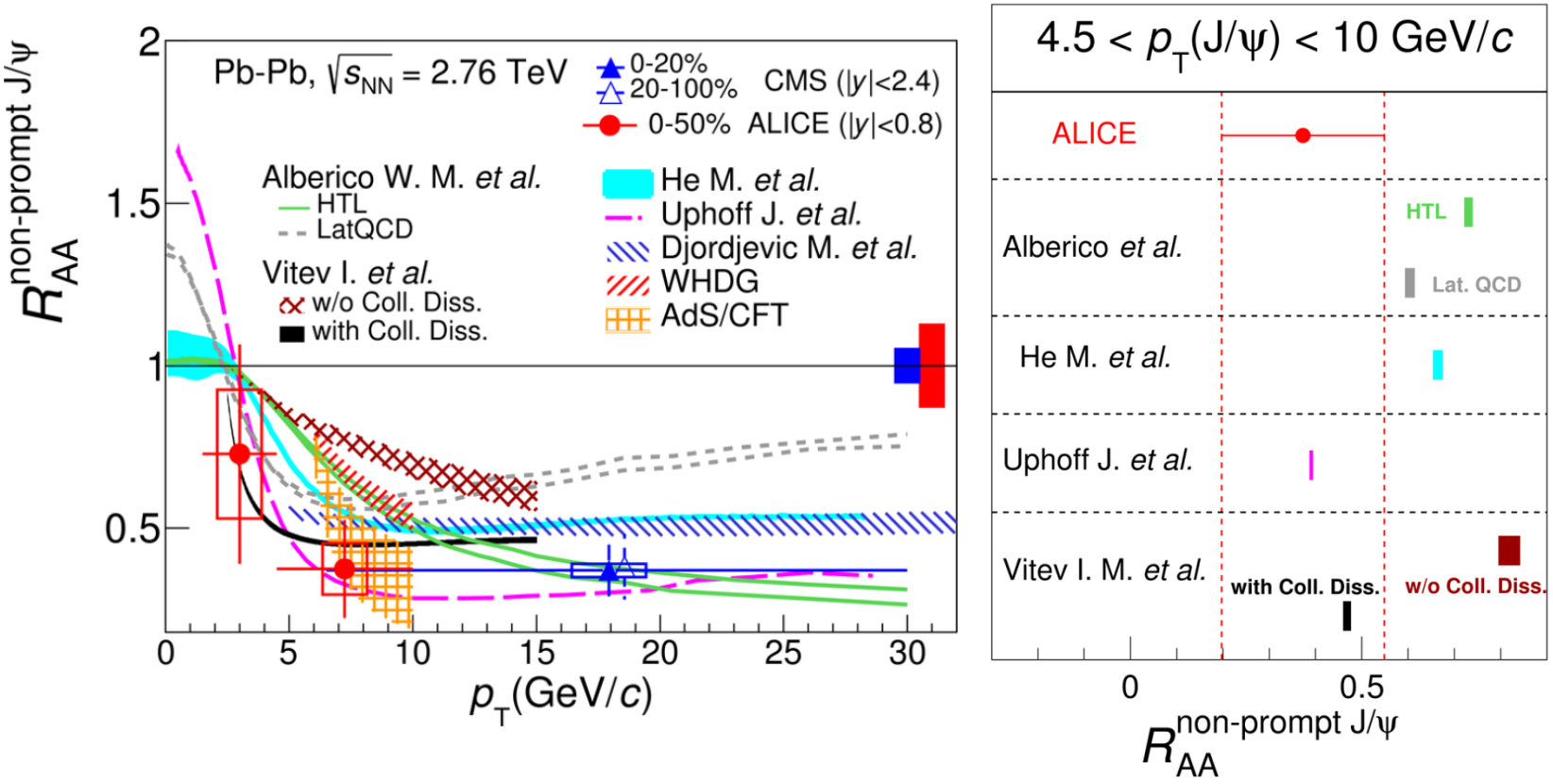




CMS: *JHEP 1205(2012)063, arXiV:1201.5069*
PHENIX: *Phys.Rev.Lett.98(2007)232301*
Phys.Rev.Lett.101(2008)122301

Pb-Pb: R_{AA} J/ψ from beauty decay

arXiv:1504.07151



Run 2 data will help to discriminate the beauty production mechanisms in Pb-Pb

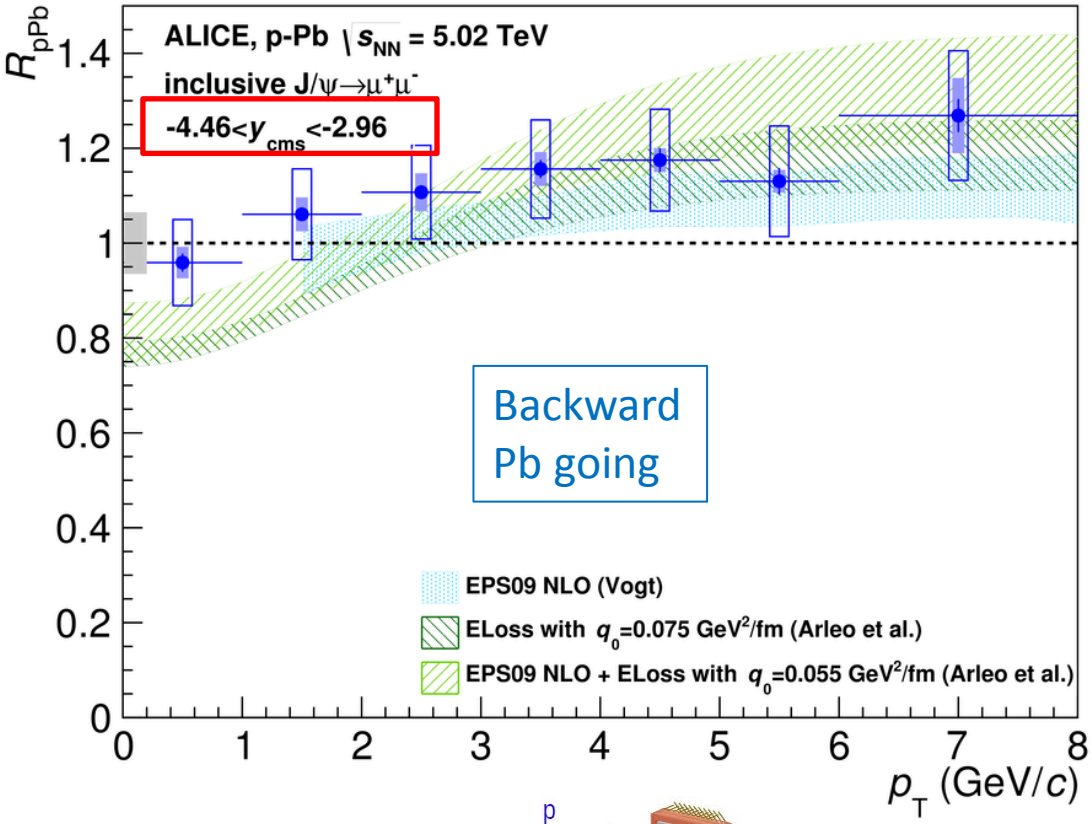
p-Pb: J/ψ nuclear modification factor

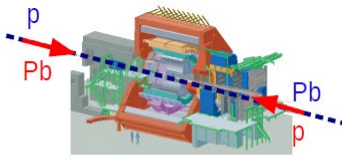
$$R_{\mathrm{pPb}}(y, p_{\mathrm{T}}) = \frac{\mathrm{d}^2\sigma^{\mathrm{J}/\psi}_{\mathrm{pPb}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}{A_{\mathrm{Pb}} \cdot \mathrm{d}^2\sigma^{\mathrm{J}/\psi}_{\mathrm{pp}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}$$

- Backward rapidity: no suppression

arXiv:1503.07179

accepted in JHEP





Pb-p: -4.46<y_{CMS}<-2.96 backward

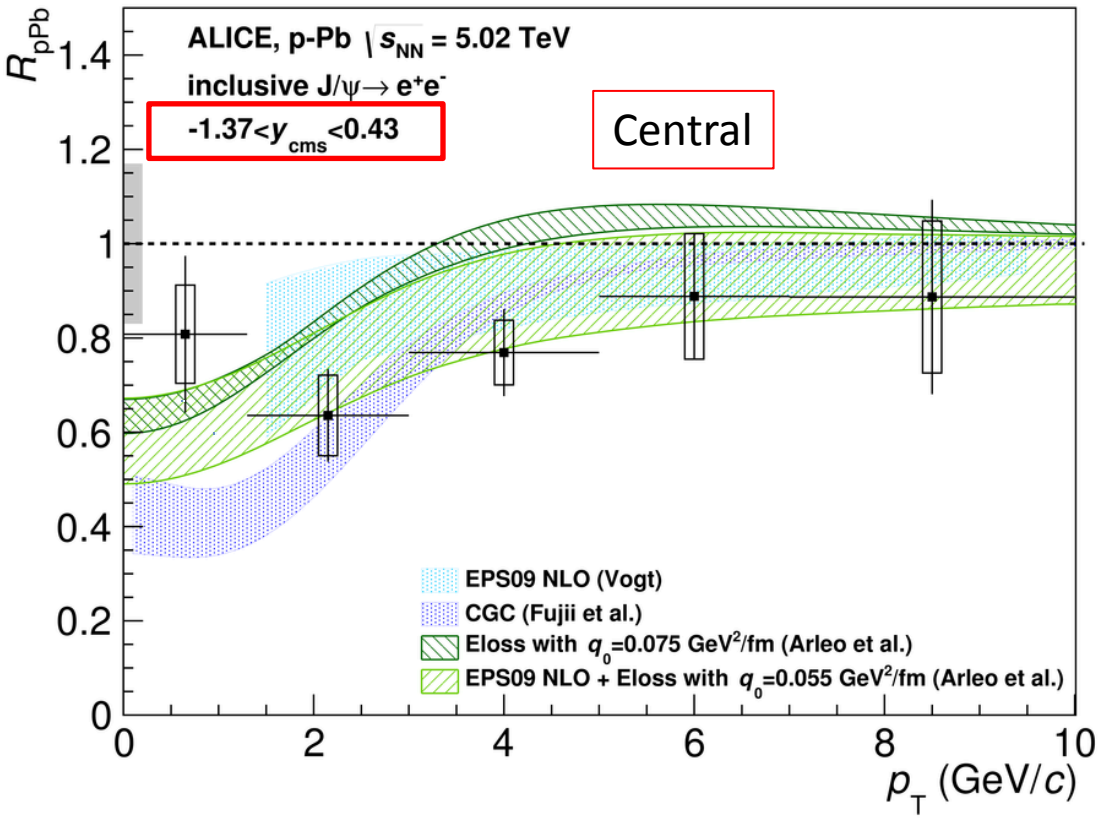
p-Pb: 2.03<y_{CMS}<3.53 forward

p-Pb: J/ψ nuclear modification factor

$$R_{\mathrm{pPb}}(y, p_{\mathrm{T}}) = \frac{\mathrm{d}^2\sigma^{\mathrm{J}/\psi}_{\mathrm{pPb}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}{A_{\mathrm{Pb}} \cdot \mathrm{d}^2\sigma^{\mathrm{J}/\psi}_{\mathrm{pp}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}$$

arXiv:1503.07179

- Backward rapidity: no suppression
- Central rapidity: suppression at low p_T

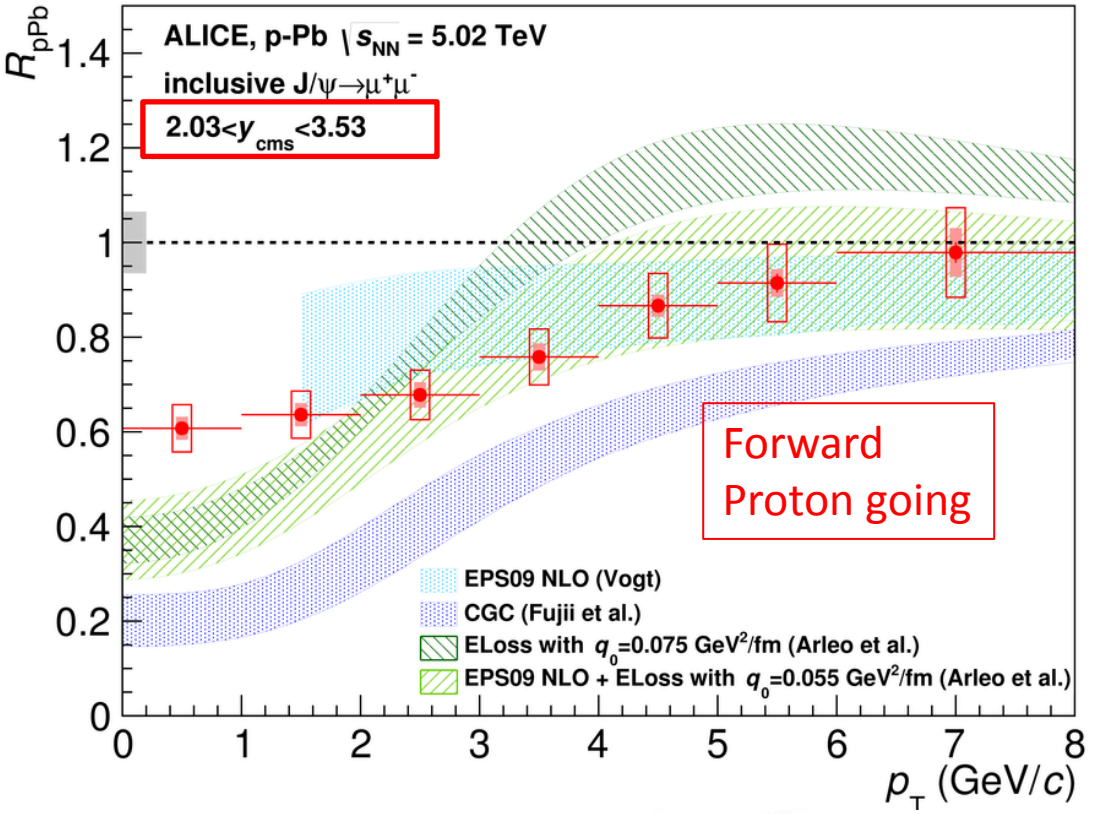


p-Pb: J/ψ nuclear modification factor

$$R_{\mathrm{pPb}}(y, p_{\mathrm{T}}) = \frac{\mathrm{d}^2\sigma^{\mathrm{J}/\psi}_{\mathrm{pPb}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}{A_{\mathrm{Pb}} \cdot \mathrm{d}^2\sigma^{\mathrm{J}/\psi}_{\mathrm{pp}}/\mathrm{d}y\mathrm{d}p_{\mathrm{T}}}$$

arXiv:1503.07179

- Backward rapidity: no suppression
- Central rapidity: suppression at low p_T
- Forward rapidity: suppression at low p_T, vanishing at high p_T



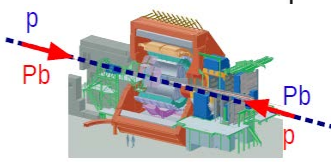
Model predictions:

EPS09: NLO Color evaporation model and EPS09 shadowing parametrisation at NLO
Albacete et al. Int.J.Mod.PhysE22(2013)1330007;

Coherent energy loss: *Arleo et al. JHEP1305(2013)155*

Coherent energy loss +EPS09 shadowing: *Arleo et al. JHEP1305(2013)155*

CGC: Color Glass Condensate *Fuji et al.: Nucl.Phys.A915(2013)1*



Pb-p: -4.46<y_{CMS}<-2.96 backward
p-Pb: 2.03<y_{CMS}<3.53 forward

p-Pb: CNM effects in PbPb

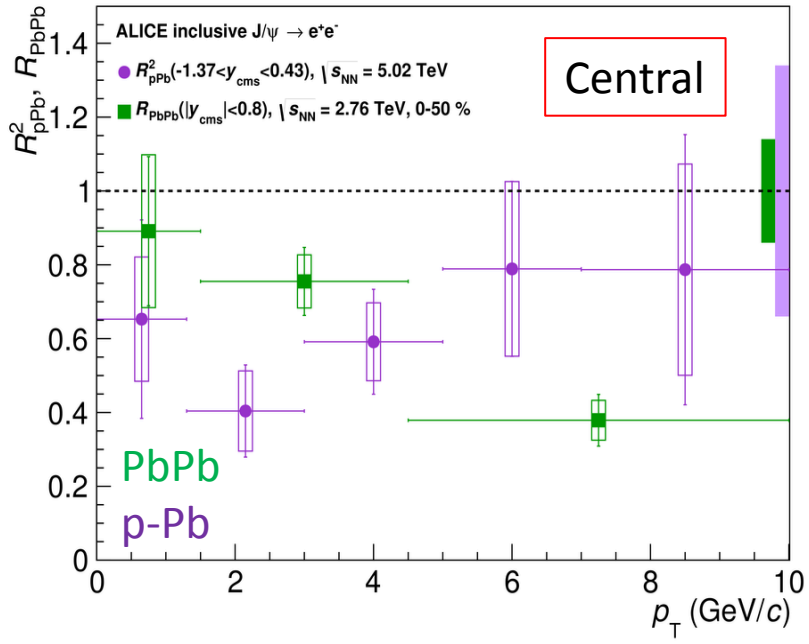
Asumption than CNM are dominated by shadowing

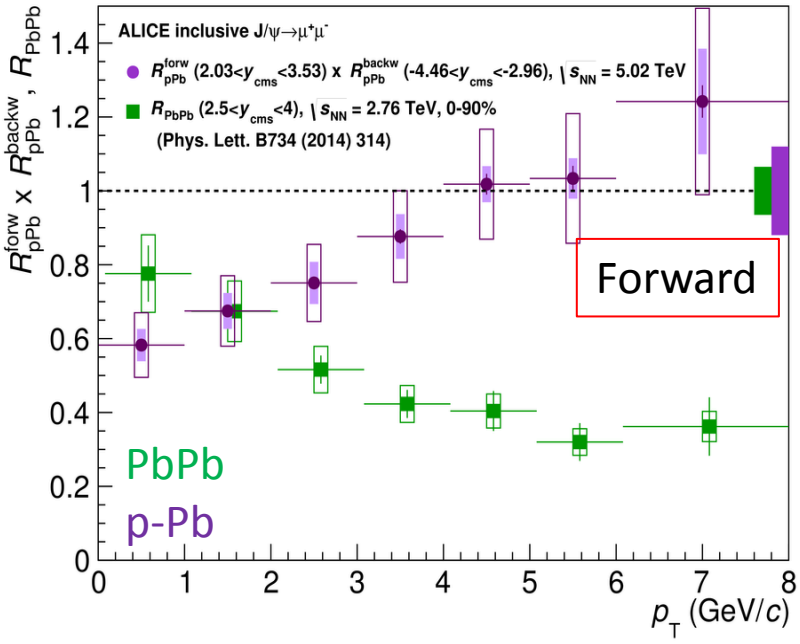
arXiv:1503.07179

$R_{PbPb} \sim R^2_{pPb}$? at central rapidities

$R_{PbPb} \sim R_{pPb}.R_{Pbp}$? at forward rapidities

R_{PbPb} : *Phys.Lett.B734(2014)314-327 and arXiV.1504.07171*





The observed modification of J/ψ in Pb-Pb is not due to incoming wave function

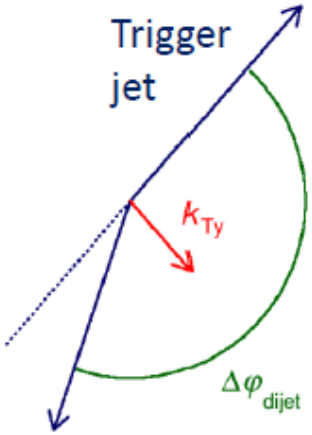
- lower suppression at low p_T consistent with $c\bar{c}$ recombination processes
- higher suppression at high p_T consistent with color screening

Dijet acoplanarity and imbalance

arXiv: 1503.03050

accepted in Phys. Lett. B

$$k_{\mathrm{Ty}} = p_{\mathrm{T,jet}}^{\mathrm{ch+ne}} \sin(\Delta\varphi_{\mathrm{dijet}})$$



In p-p:
2->2 LO scattering processes: balance in transverse momentum and back-to back emission
Small acoplanarity from initial state gluon radiation
At large transfered momentum NLO processes increase : acoplanarity and imbalance increase

In p-Pb:
Multiple scattering of initial and final state partons in nucleus.

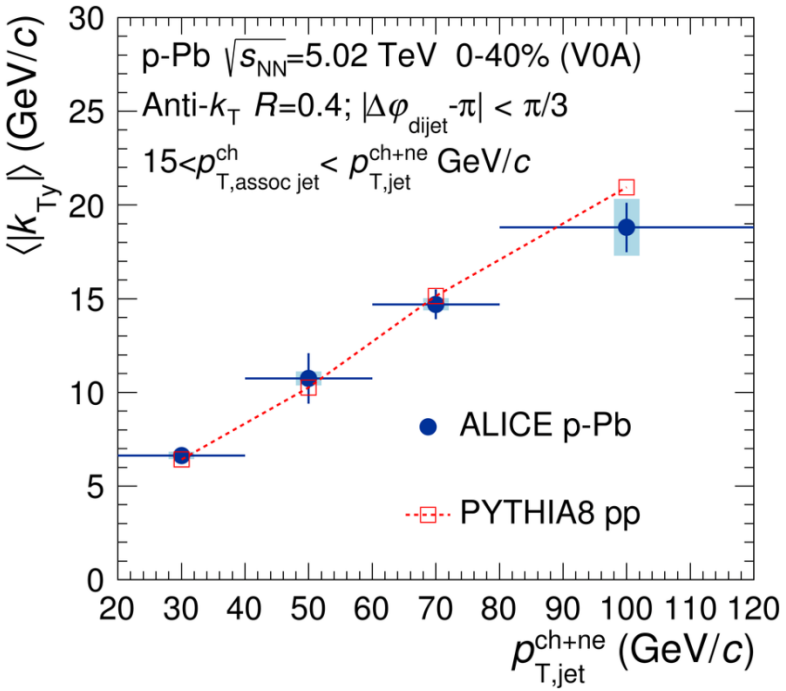
In Pb-Pb:
In medium parton energy loss

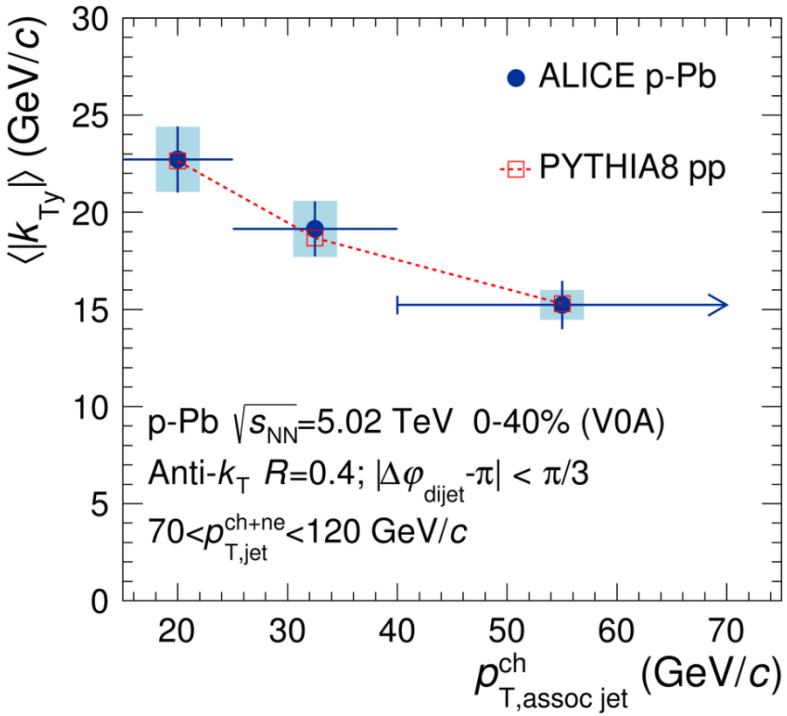
Trigger jet: Full jet (anti k_T with R=0.4); $1.4+R < \varphi_{\mathrm{jet}}^{\mathrm{ch+ne}} < \pi - R$; $|\eta_{\mathrm{jet}}^{\mathrm{ch+ne}}| < 0.7 - R$

Opposite jet: charged jet (anti k_T with R=0.4) $|\eta_{\mathrm{jet}}^{\mathrm{ch}}| < 0.9 - R$; $|\Delta\varphi_{\mathrm{dijet}} - \pi| < \pi/3$

Mean < $|k_{Ty}|$ >

arXiv: 1503.03050

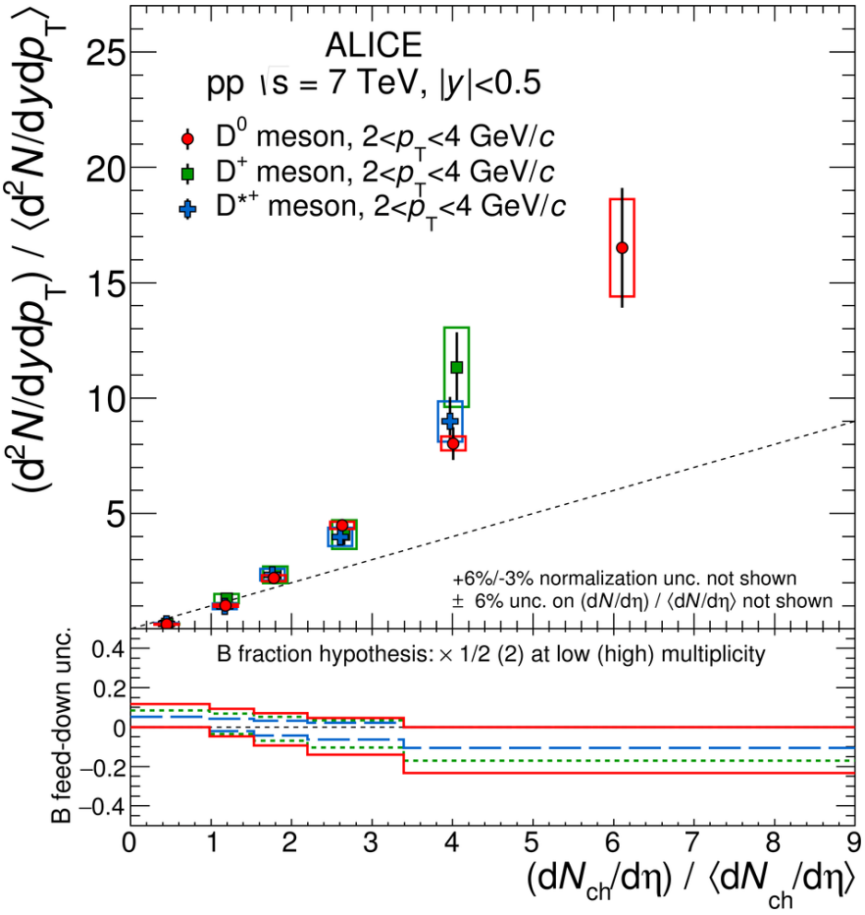




- Nuclear matter effects on k_T are small
- Importance final state of in the dijets asymetries measured in PbPb*

*ATLAS *Phys.Rev.Lett105(2010)252303* and CMS(*Phys.Rev.C(2011)024906)*

Multiplicity dependence of D-meson yields in p-p collisions

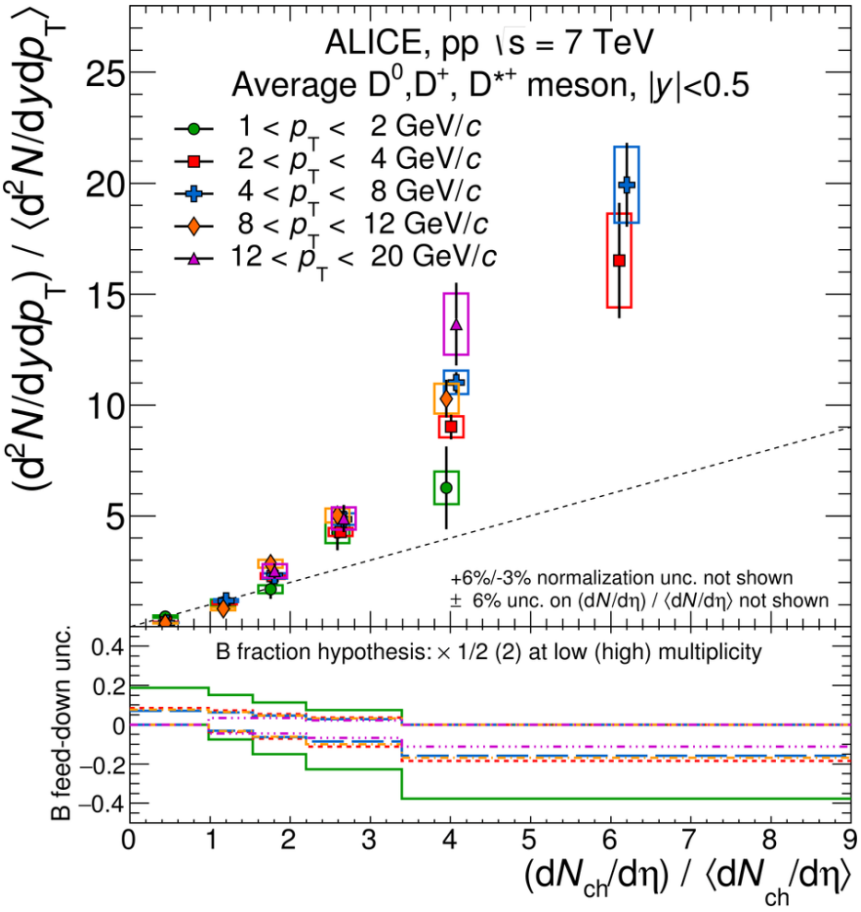


arXiv:1505.00664

Increase of D-meson self-normalized yields :

- By a factor of 15 for the highest multiplicities
- For all D-meson species

Multiplicity dependence of D-meson yields in p-p collisions



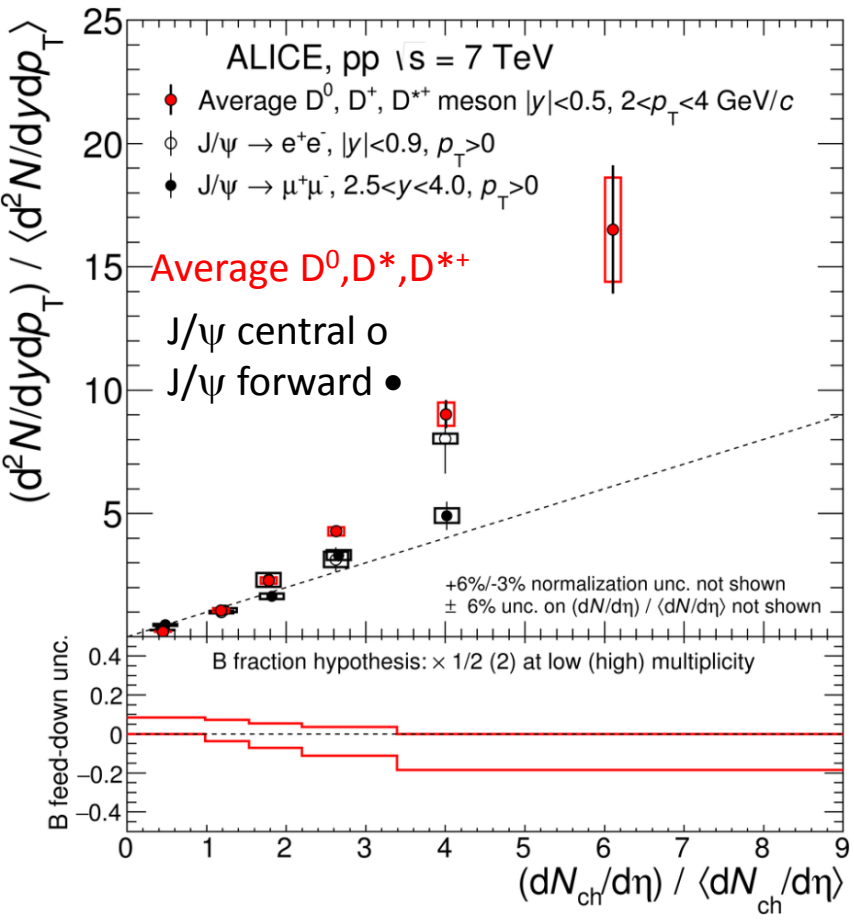
arXiv:1505.00664

Increase of D-meson self-normalized yields :

- By a factor of 15 for the highest multiplicities
- For all D-meson species

- No dependence on D-meson p_T within uncertainties

Multiplicity dependence of D-meson yields in p-p collisions

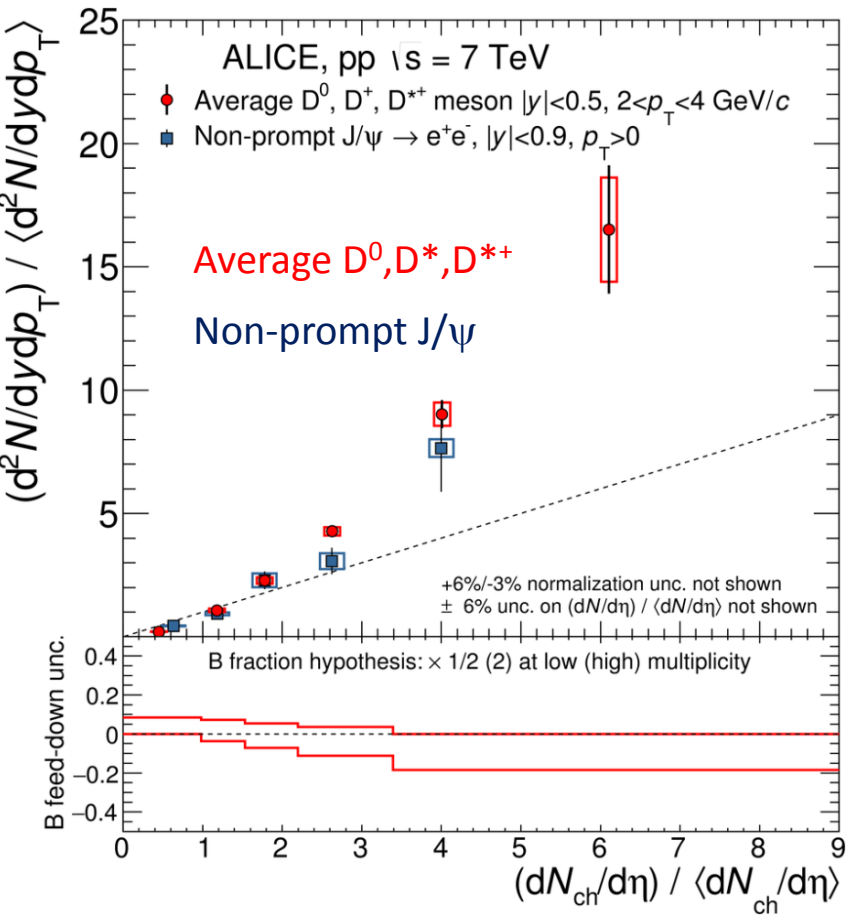


arXiv:1505.00664

Increase of D-meson self-normalized yields :

- by a factor of 15 for the highest multiplicities
- For all D-meson species
- No dependence on D-meson p_T within uncertainties
- Similar to inclusive J/ψ multiplicity dependence at central and forward rapidities *Phys.Lett.B712(2012)165*

Multiplicity dependence of non-prompt J/ψ in p-p



arXiv:1505.00664

Increase of D-meson self-normalized yields :

- By a factor of 15 for the highest multiplicities
- For all D-meson species
- No dependence on D-meson p_T within uncertainties
- Similar to inclusive J/ψ multiplicity dependence at central and forward rapidities *Phys.Lett.B712(2012)165*
- Similar to multiplicity dependence of J/ψ yields from beauty-hadron decays.

Enhancement of heavy-flavour yields with charged-particle multiplicity:

- More likely related to heavy-quark production than to the hadronisation mechanisms
- Qualitatively consistent with Multi Parton Interactions

p-p Recent results: π , kaons, protons

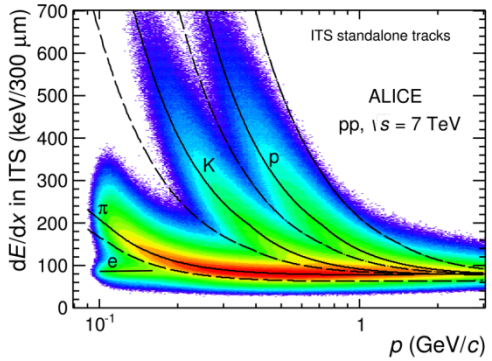
Production of pions, kaons, protons in p-p collisions at $\sqrt{s_{NN}}$ = 7 TeV

arXiV 1504.00024

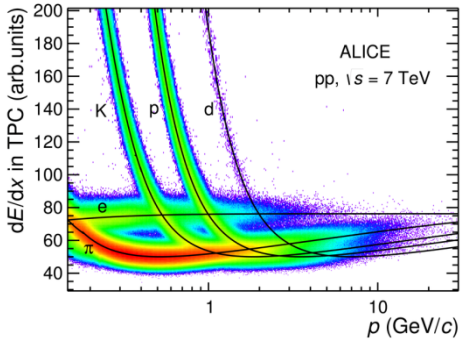
accepted in Eur. Phys. J. C

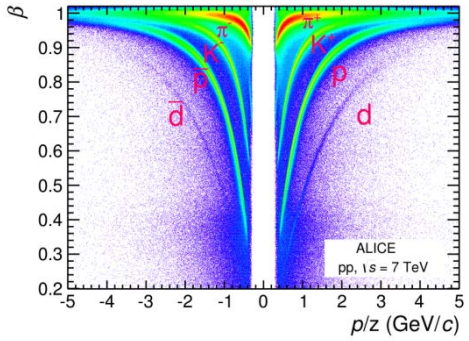
Combination of 5 independent PID techniques

ITS

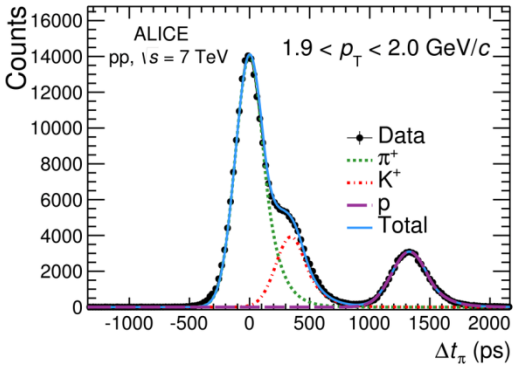


TPC-TOF

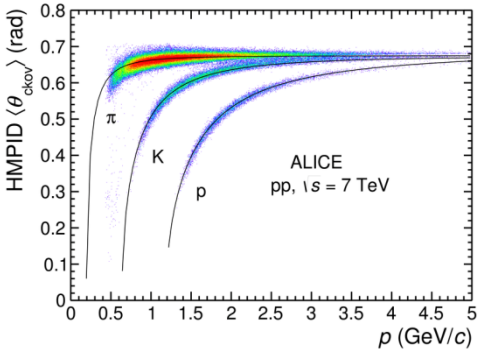




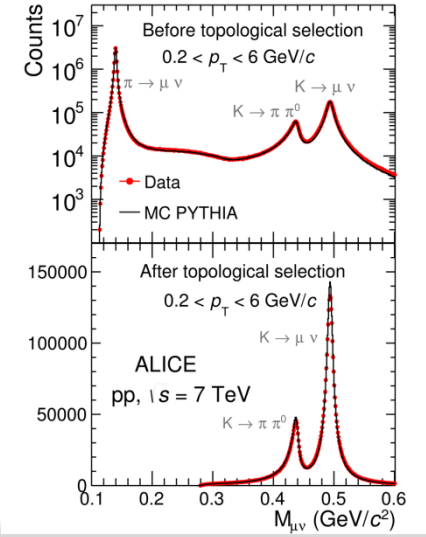
TOF



HMPID

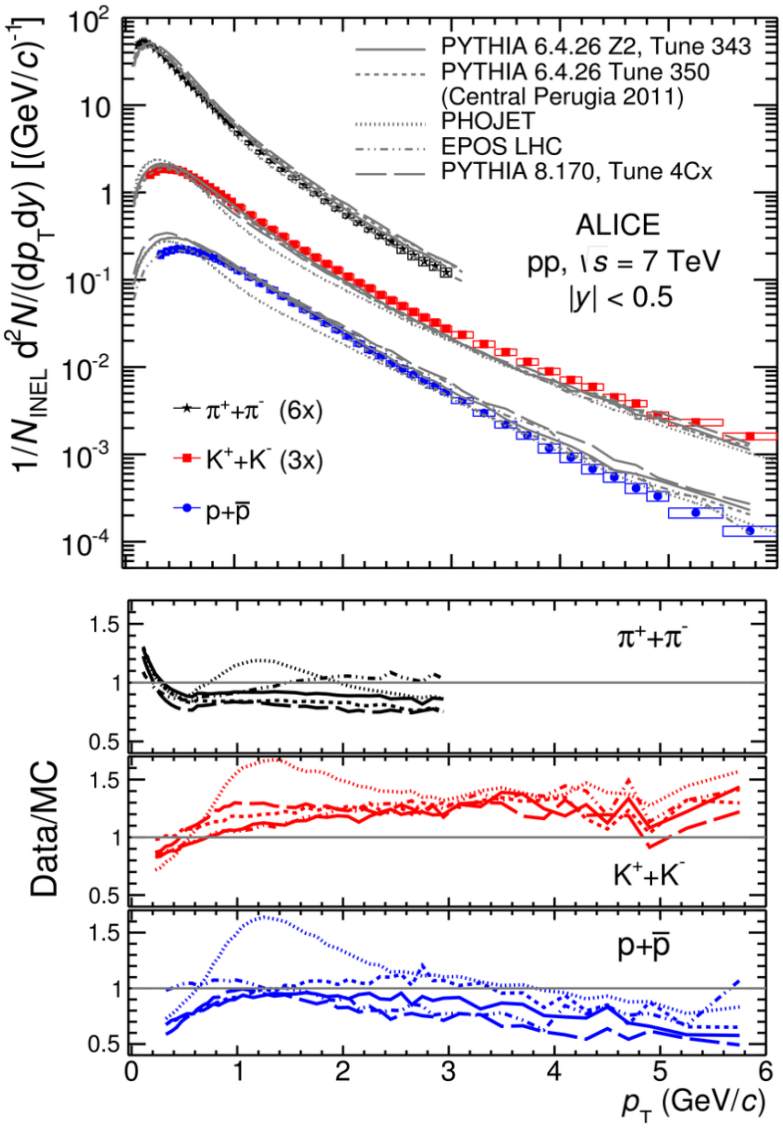


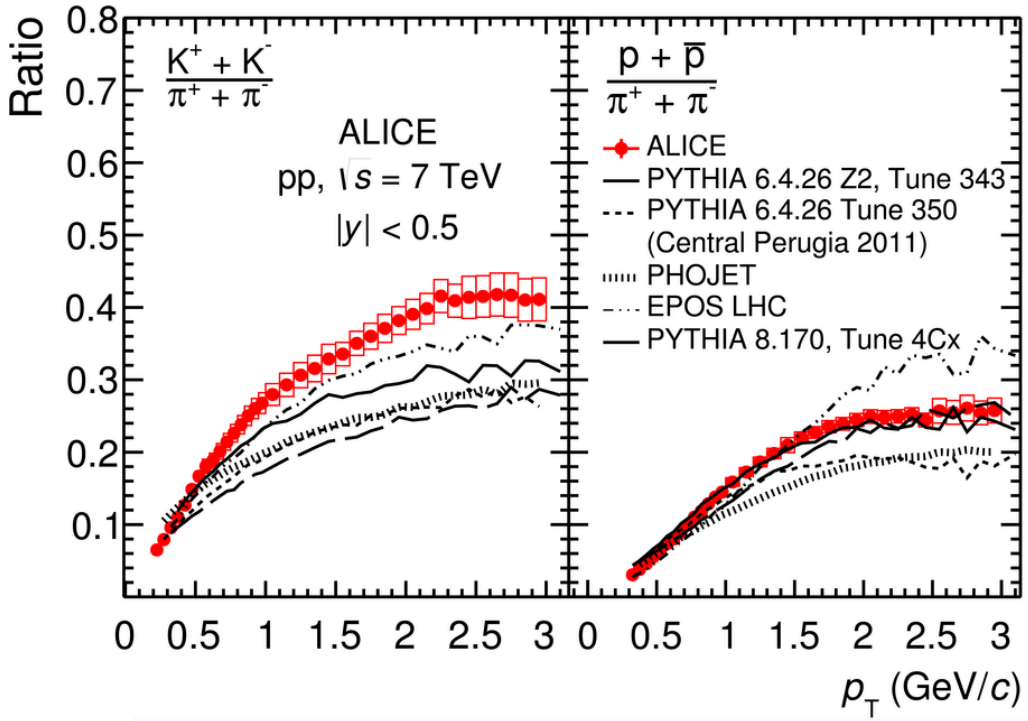
TPC-KINK



K,π, p in p-p: model comparison

arXiV 1504.00024

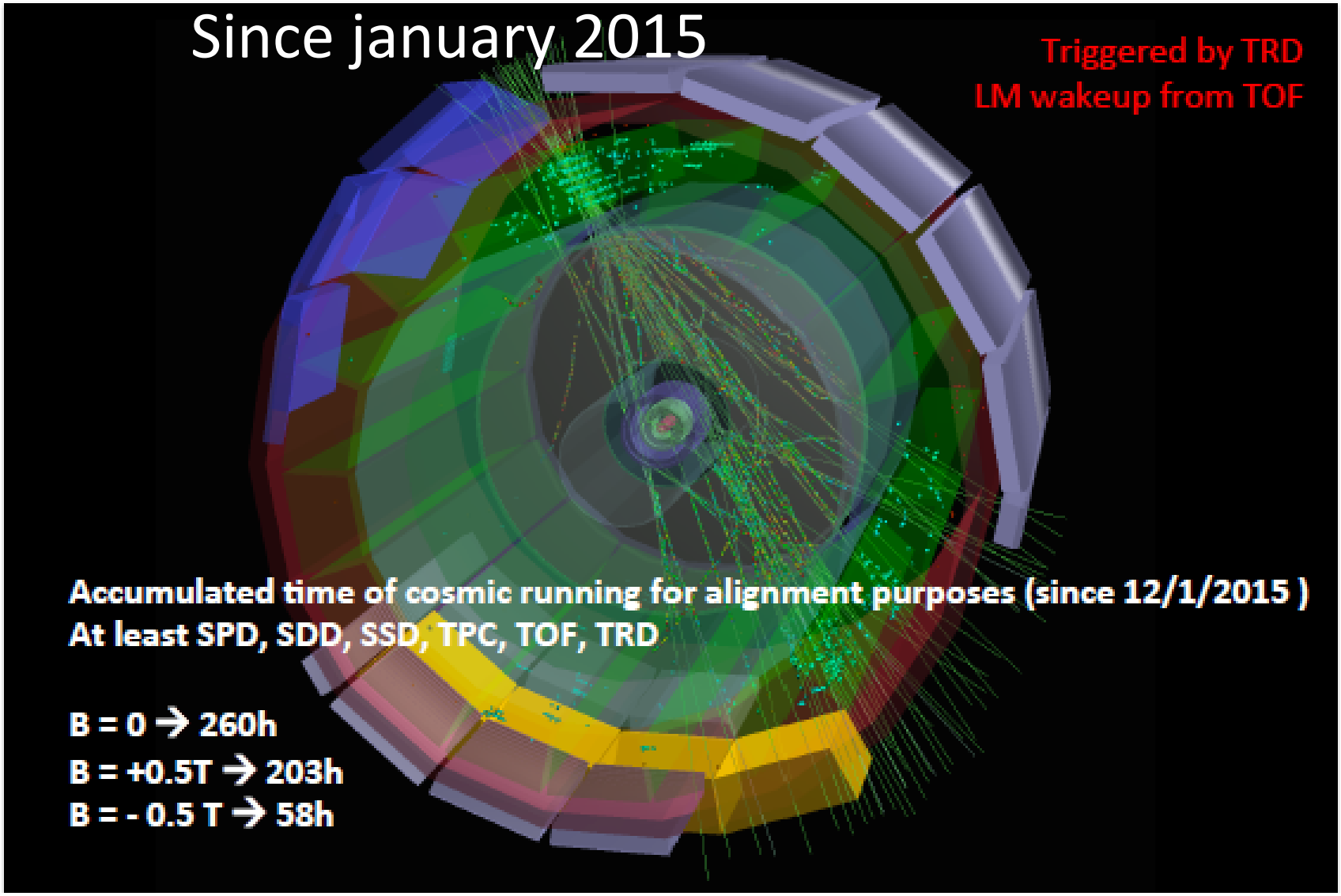




- Shape of spectra fairly well reproduced
- BUT: No simultaneous description of p, K, π

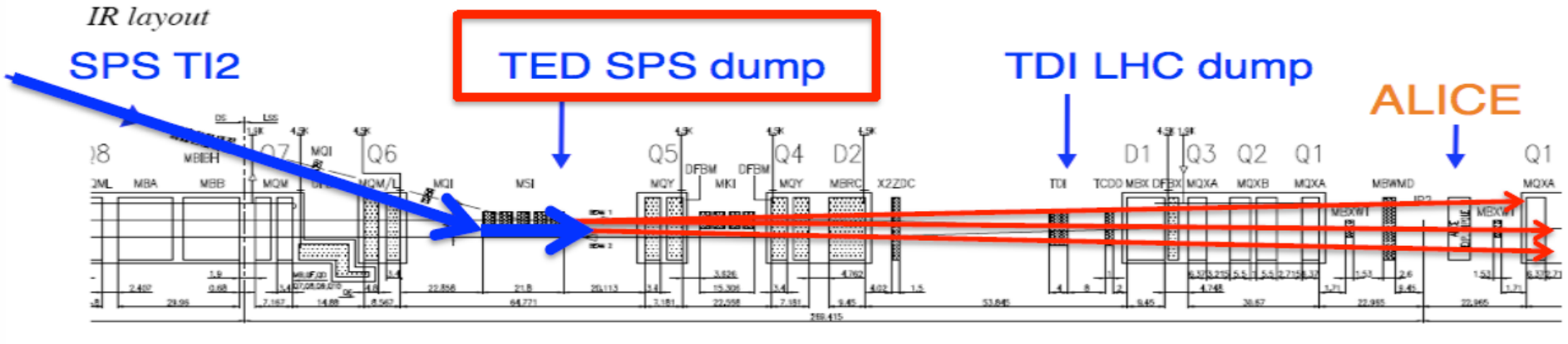
Crucial data to tune MC generators at LHC

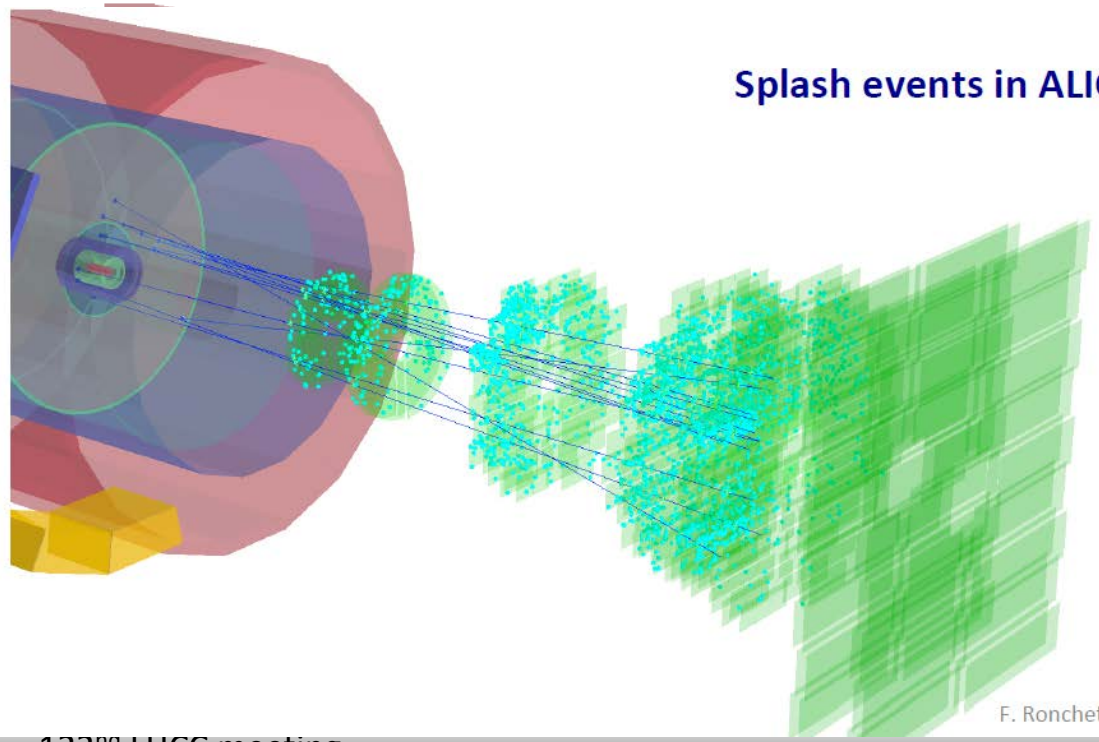
ALICE Run 2: Re-commissioning with cosmics



ALICE Run 2: Re-commissioning with beam

March 2015

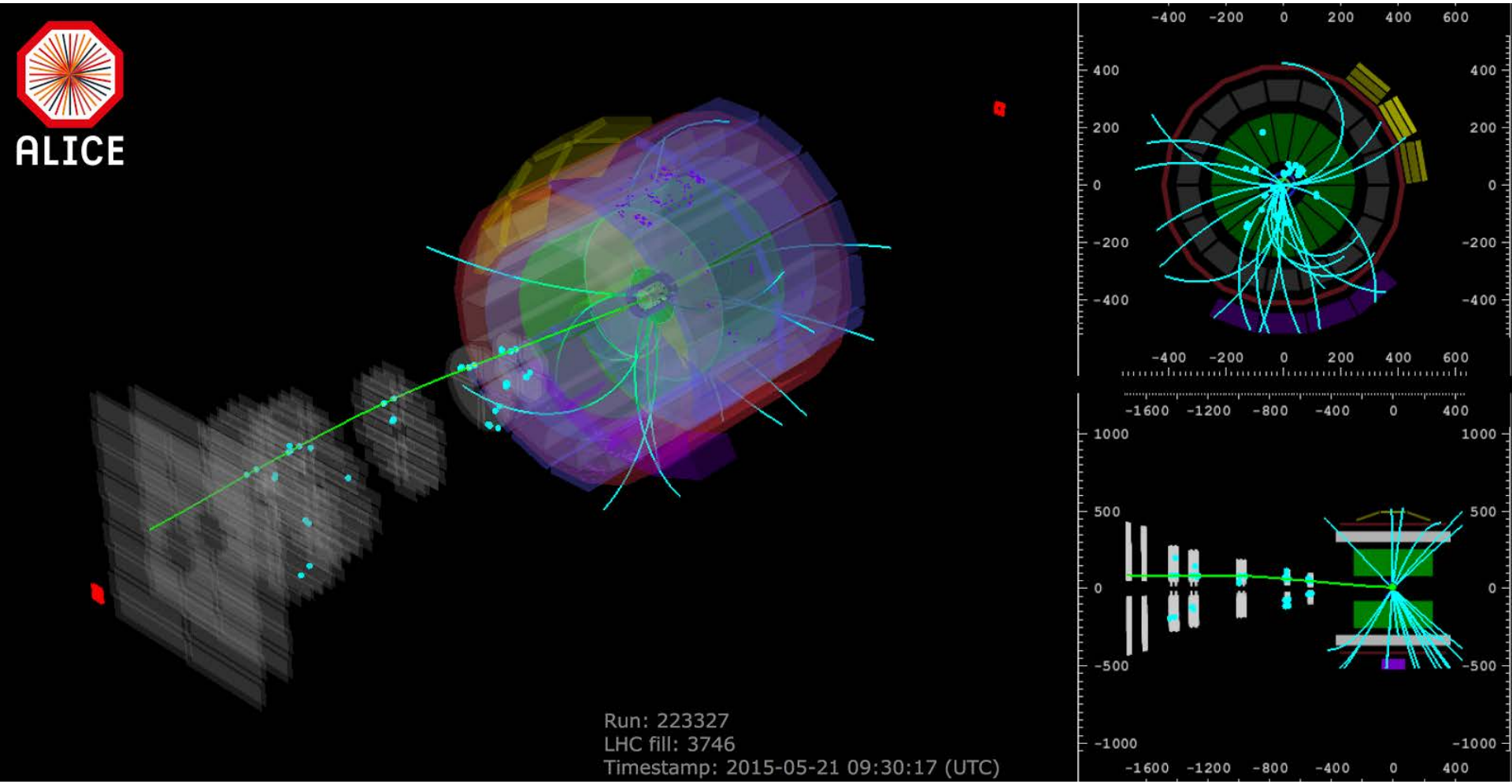




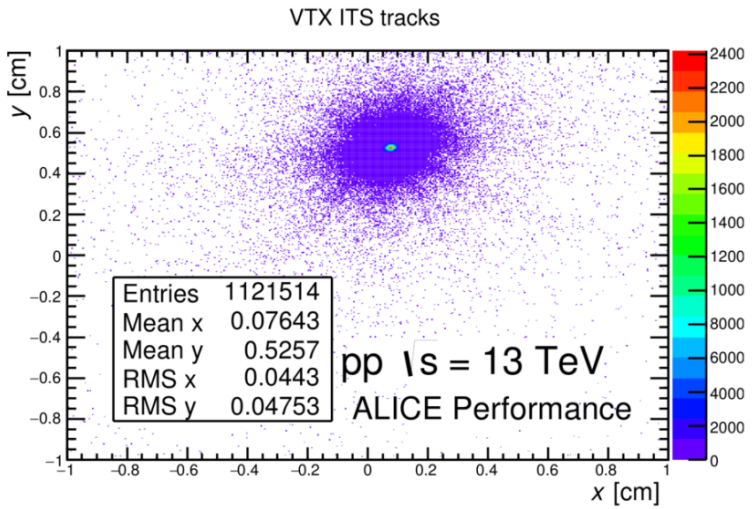
F. Ronchetti - LHCC Referees

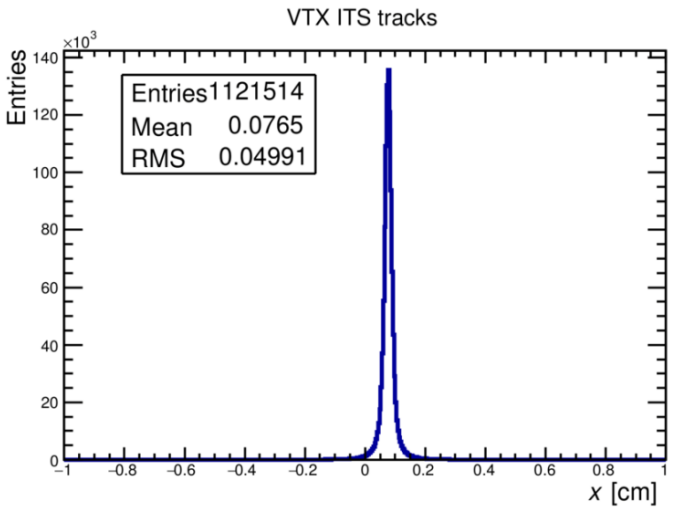
Run 2: Quiet p-p collisions at 13 TeV

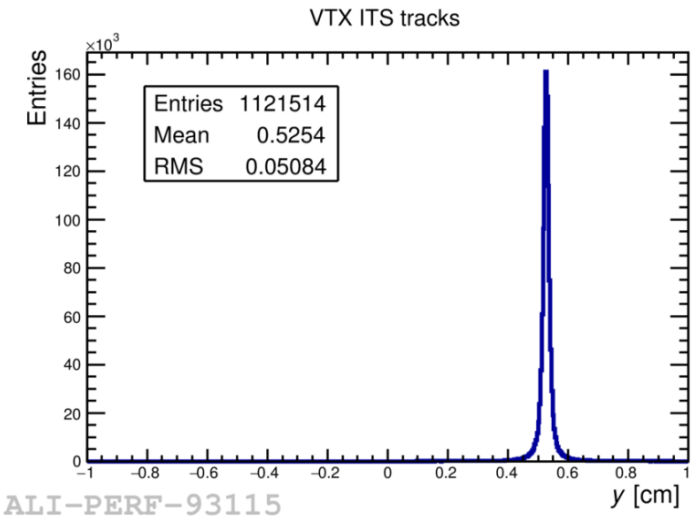
14 ALICE sub-detectors took beam data for several hours (others out because beam not fully stable)

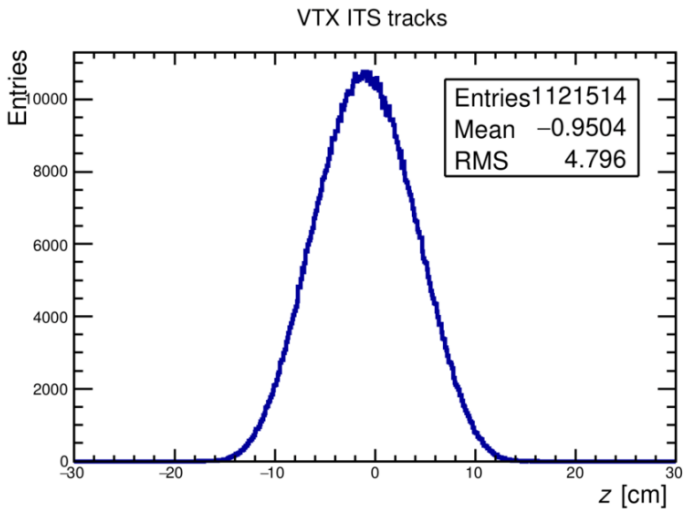


Run 2: first data in p-p collisions at 13 TeV







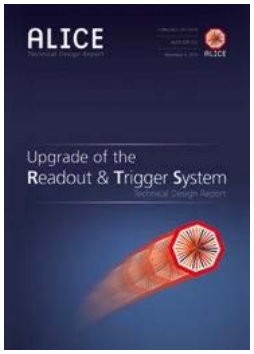


ALI-PERF-93115

RUN 3: LS2 Upgrades

LS2 upgrades in 5 TDRs

ITS



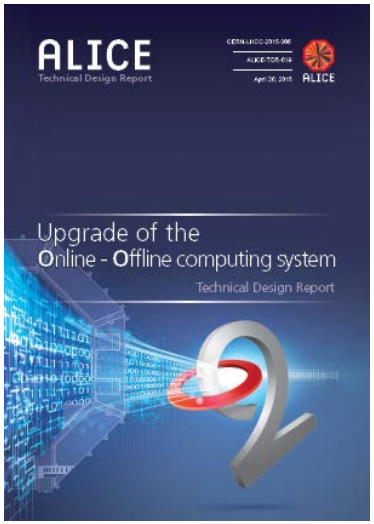
Readout and Trigger system

TPC

Muon Forward Tracker

Online and Offline system: O^2 TDR submitted April 20, 2015
https://cds.cern.ch/record/2011297/files/ALICE-TDR-019.pdf
Discussed this week

O2 general overview



Online - Offline Computing system:

Data of all interactions shipped from detector to online farm in continuous mode

More than 8000 optical links

1.1 TByte/s ⇩

Data volume reduction by an average factor 14 (factor 20 for the TPC data)
All the events go to data storage

- Read-out farm: 250 servers with FPGA acceleration
- Processing farm: 1500 servers with GPU acceleration

90 GByte/s ⇩

Data Storage needs: 1 year of compressed data

- Bandwidth: Write 90GB/s Read 90GB/s
- Capacity: 60PB

1 storage array of 4U in 2019

- 1PB with redundancy
- 7GB/s Bandwidth
- 68 units needed with 34 data servers

⇩ ⇧

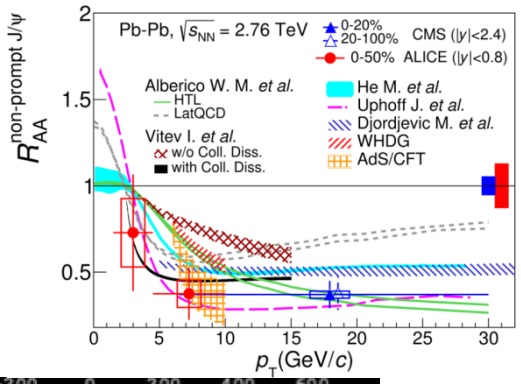
Asynchronous event reconstruction with a delay of few hours.

Summary

ALICE continues analysis of RUN 1 results:

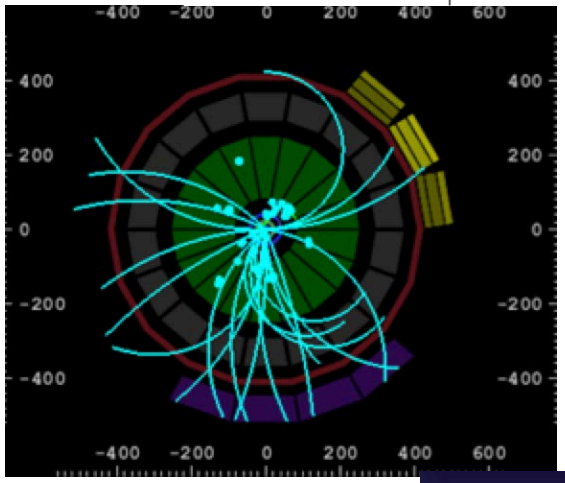
14 new published and submitted papers

- J/ψ, quarkonium, beauty, jet interaction in medium
- Charm and beauty production mechanism in proton-proton
- Proton-proton reference
- And others results not shown here



ALICE ready and waiting for RUN 2

- New detectors installed (end of nov 2014)
- Commissioning with cosmic, beam, collisions since january



ALICE preparing for RUN 3

- Last TDR (Online-Offline Computing) sumitted on april
- All cost review documents submitted, either approved or in final discussion