113th LHCC meeting: ALICE status report

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University of Padova – INFN Sez. di Padova

113th LHCC meeting Open Session, March 12th - 13th 2013

Outline

✧ Results since the last LHCC (December 2012):

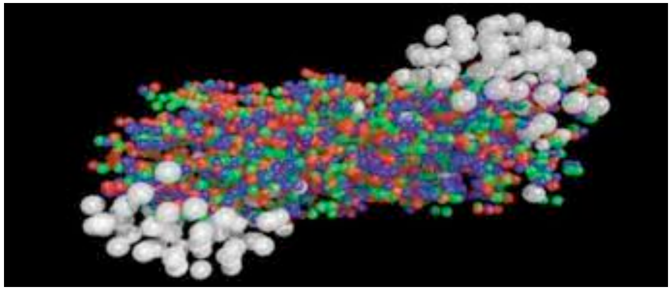
- Pb-Pb
- pp
- p-Pb → "the double-ridge"

✧ p-Pb 2013 run

✧ Performance plots obtained with p-Pb 2013 data.

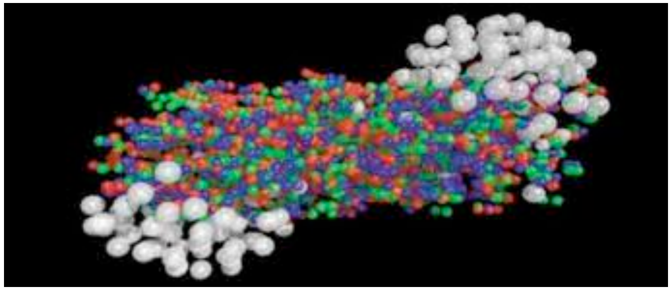
✧ ALICE Plans for Long Shutdown 1

Pb-Pb collisions



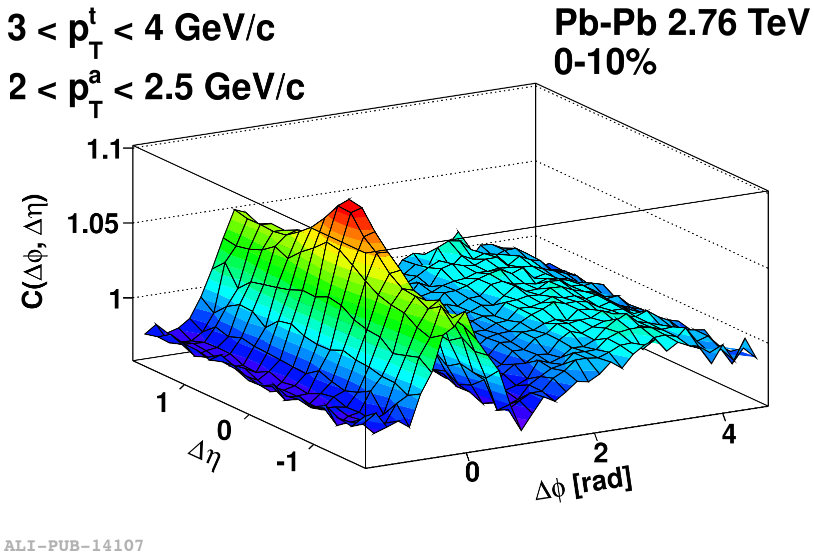
- In ultra-relativistic heavy ion collisions a high density and hot colour deconfined state of nuclear matter is formed

Pb-Pb collisions

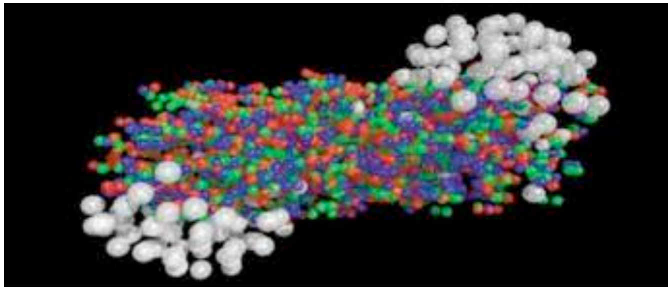


- In ultra-relativistic heavy ion collisions a high density and hot colour deconfined state of nuclear matter is formed

- Final state observables are used to study the properties of the medium formed in these collisions, e.g.:
  - Energy density → Particles multiplicity and spectra
  - Physical properties of the medium → flow, correlations

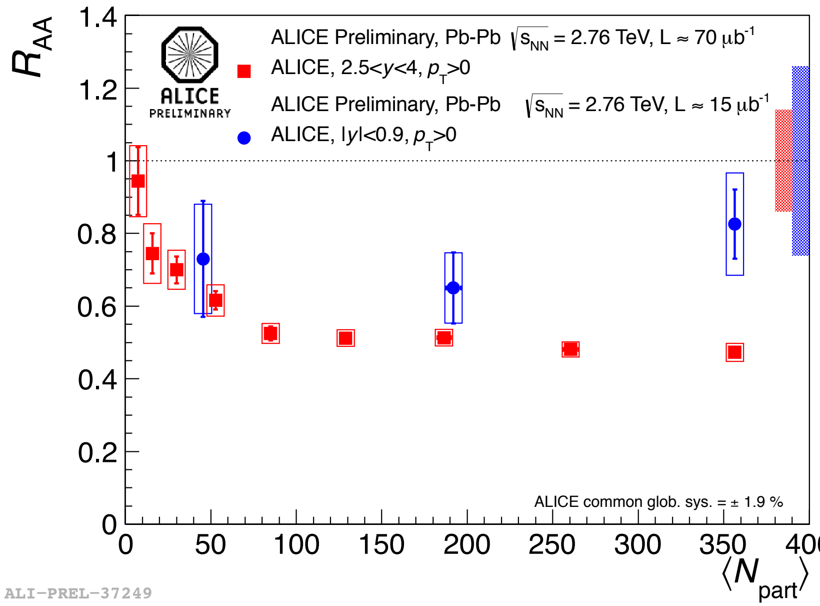


Pb-Pb collisions

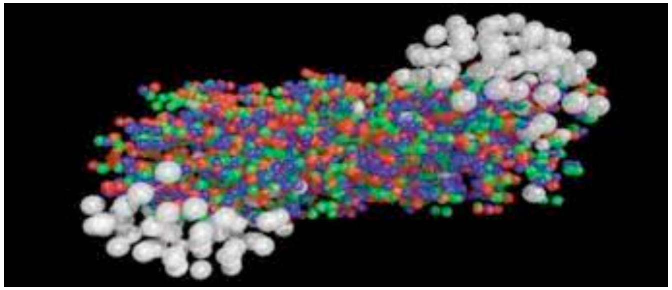


- In ultra-relativistic heavy ion collisions a high density and hot colour deconfined state of nuclear matter is formed

- Final state observables are used to study the properties of the medium formed in these collisions, e.g.:
  - Medium temperature → quarkonia suppression, direct photons, …

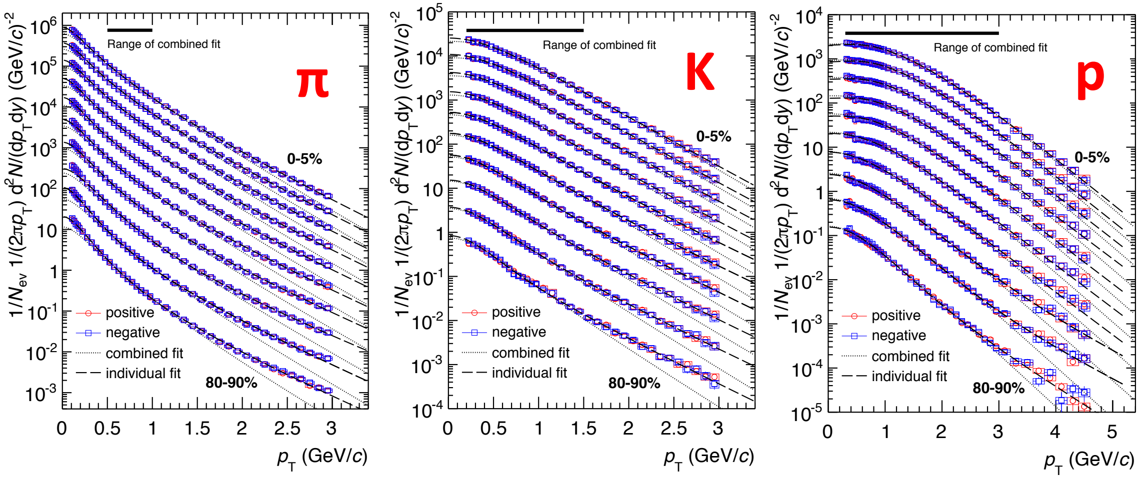


Pb-Pb collisions

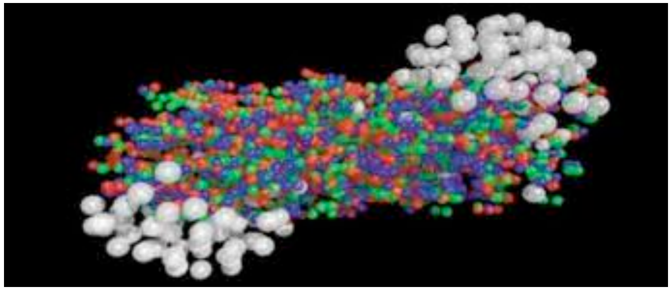


- In ultra-relativistic heavy ion collisions a high density and hot colour deconfined state of nuclear matter is formed

- Final state observables can be used to study the properties of the medium formed in these collisions, e.g.:
  - Chemical freeze-out temperature → Identified particles yields
  - Kinetic freeze-out temperature, expansion velocity → Identified particle p_T spectrum vs centrality

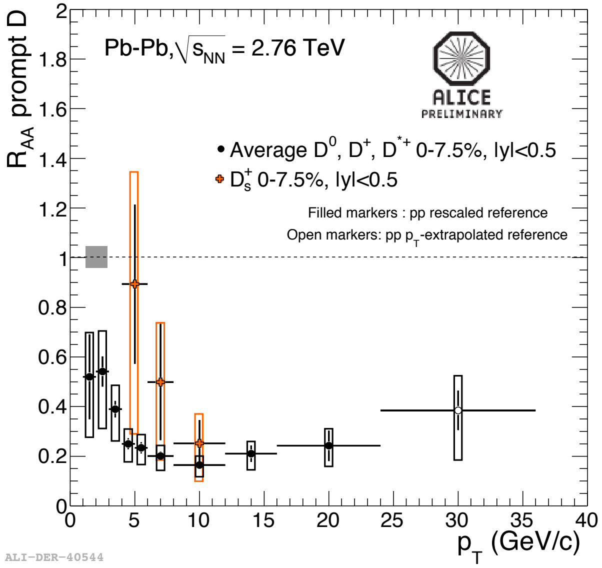


Pb-Pb collisions



- In ultra-relativistic heavy ion collisions a high density and hot colour deconfined state of nuclear matter is formed

- Final state observables can be used to study the properties of the medium formed in these collisions, e.g.:
  - Transport coefficient of the medium → high $p_{T,}$ jets, heavy flavour
  - Different medium interactions for different partons → heavy flavour



Outline

New papers since the last LHCC (December 2012):

Pb-Pb

- "Centrality determination of Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV with ALICE" arXiv:1301.4361
- "Centrality dependence of π, K, p production in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV" arXiv:1303.0737
- "Charge correlations using the balance function in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV" arXiv:1301.3756

pp

- "Measurement of the inclusive differential jet cross section in pp collisions at $\sqrt{s}$ = 2.76 TeV" arXiv:1301.3475
- "Charged kaon femtoscopy correlations in pp collisions at $\sqrt{s}$ = 7 TeV" arXiv:1212.5958

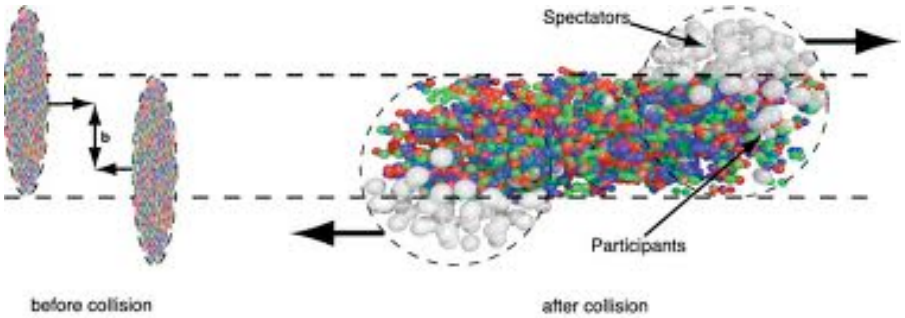
p-Pb

- "Long-range angular correlation on near and away side in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV" arXiv:1212.2001 PLB719 (2013) 29

Centrality determination in Pb-Pb collisions

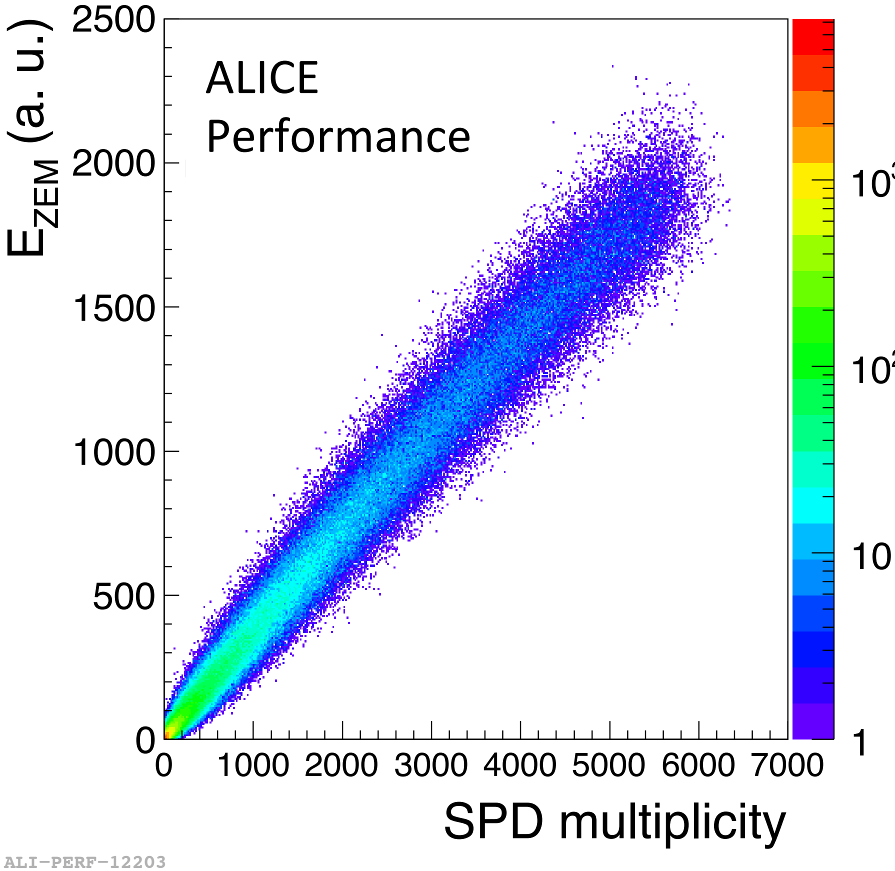
arXiv:1301.4361

Detailed paper on the centrality determination in ALICE, fundamental tool for heavy ion collisions



Correlation between:

- amplitudes of the signals in the forward region detectors:
  - VZERO detector $2.8 < \eta < 5.1$ $-3.7 < \eta < -1.7$
  - Zero Degree Calorimeters
- clusters measured in central rapidity region



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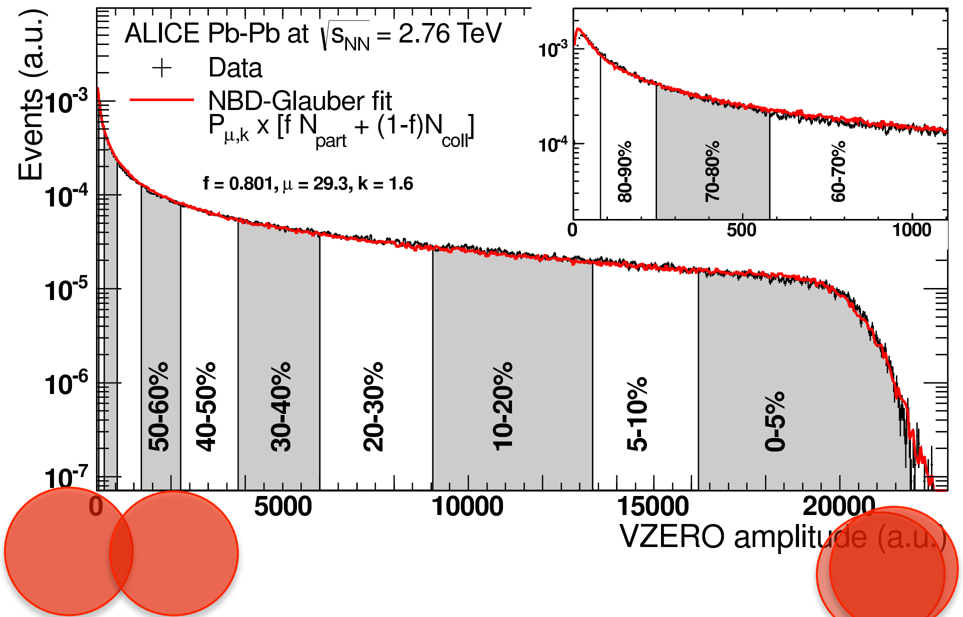
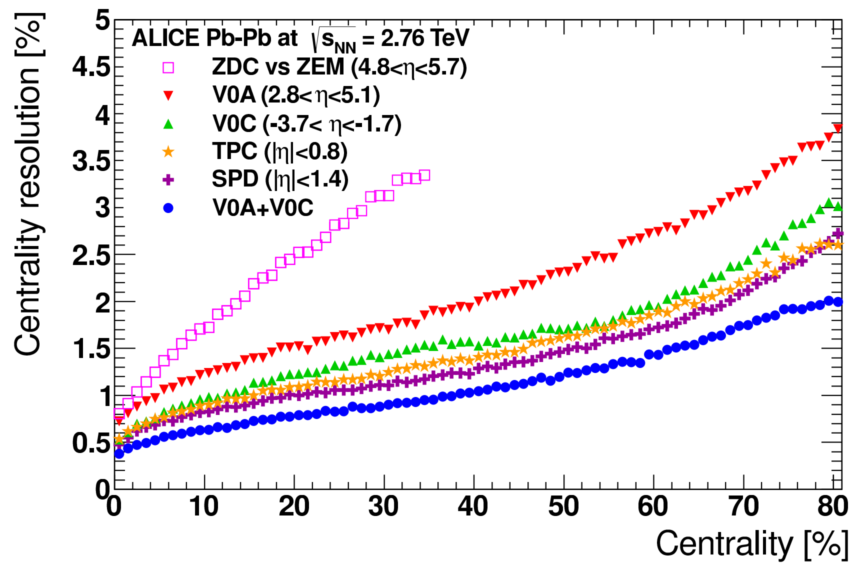


peripheral

central

The distribution of the VZERO amplitude is fitted with the Glauber model.

Centrality resolution estimated using event by event determination with different estimators.

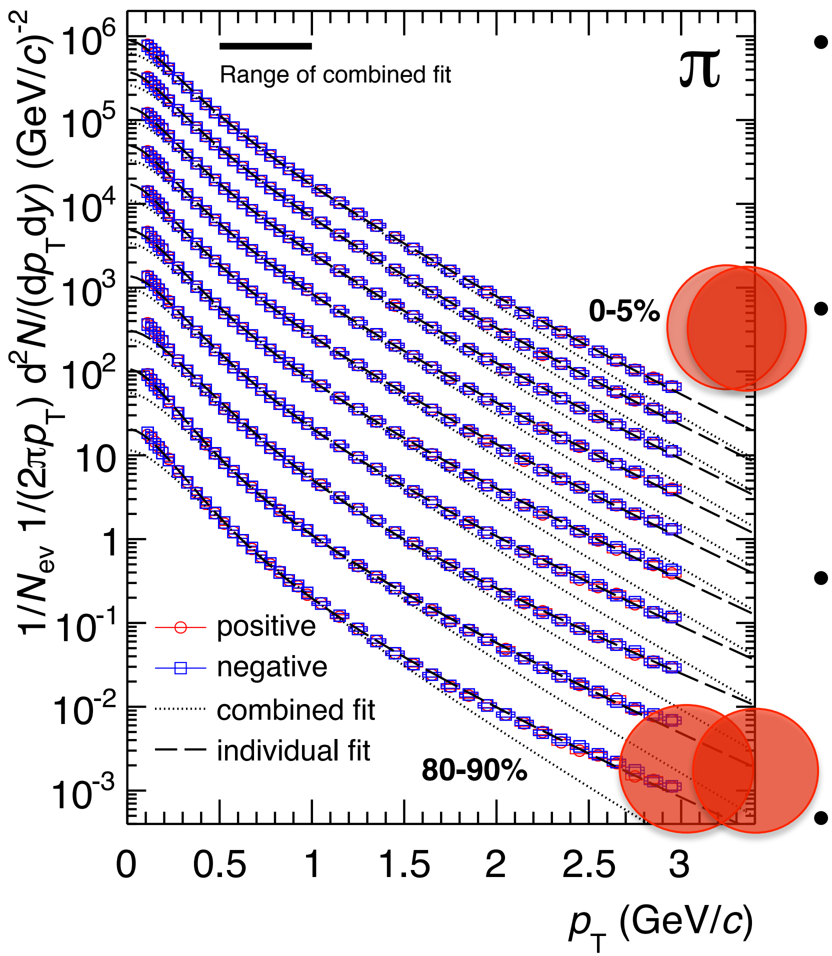


Very good results with different centrality estimators.

With the full VZERO detector the resolution ranges from 0.5% in central collisions to 2% for peripheral

Centrality dependence of π, K, p production

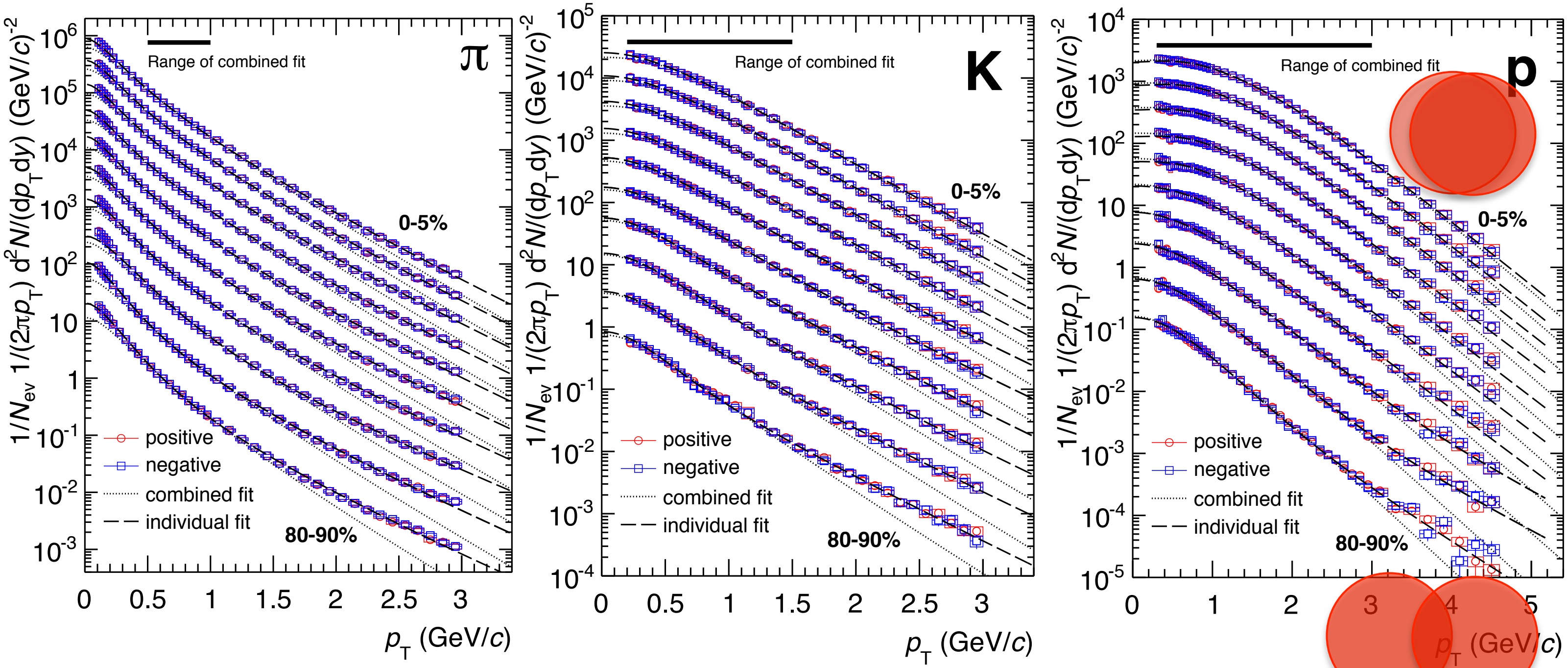
arXiv:1303.0737



- Particle identification with Inner Tracking System, Time Projection Chamber, Time Of Flight.
- Deviation from the power-law tail at high-p_T from peripheral to central collisions.
- Individual fit of the particles spectra allows to extract the particle yields (dotted gray lines).
- Combined fit of all particles species allows to extract kinetic freeze-out parameters of the system. (dashed black line)

Centrality dependence of π, K, p production

arXiv:1303.0737



- Spectra get **harder the more central the events are**
- Flattening of the spectra more pronounced at low p_T and for heavier particles (collective expansion) from central to peripheral collisions.

Blast-wave fits

In order to quantify the collective effect observed with the identified particle spectra we can use a combined blast-wave fit.

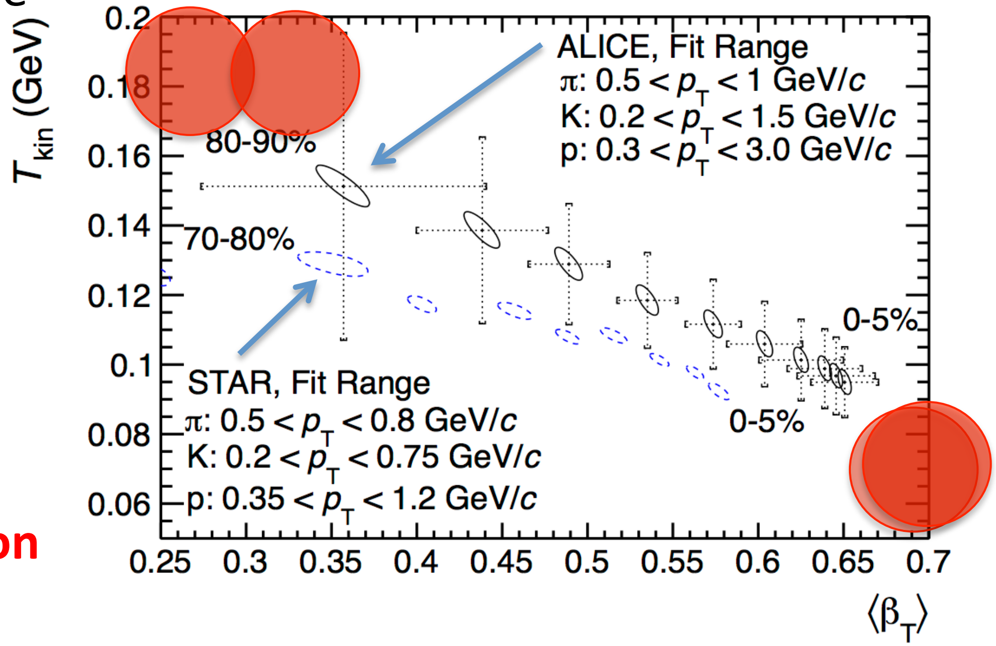
This combined fit allows to extract the freeze-out parameters:

- Average transverse expansion velocity ($<\beta_T>$)
- Kinetic freeze-out temperature (T_{kin})

that quantify the collective particles radial flow

- **Indication of more rapid expansion with increasing centrality**

arXiv:1303.0737



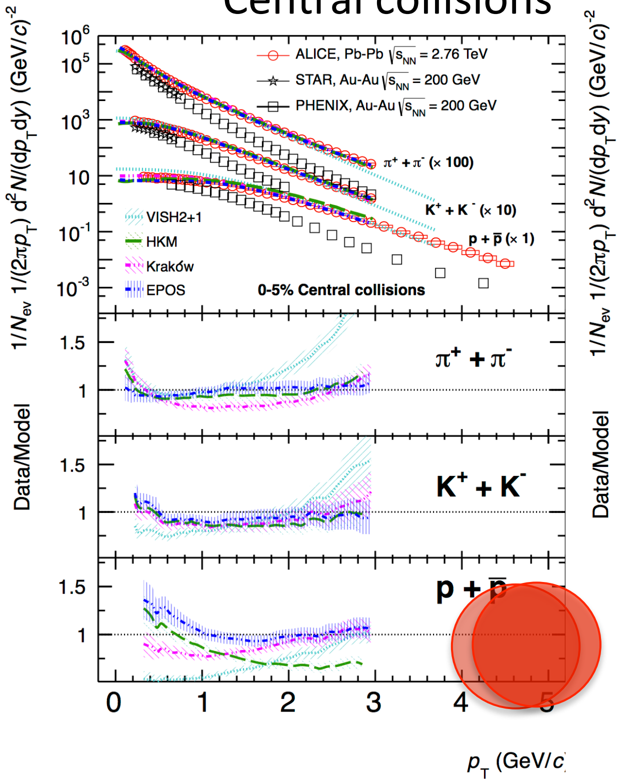
Both parameters increased with respect to lower energy results (RHIC $\sqrt{s_{NN}}$ = 0.2 TeV), **for central collisions at the LHC about 10% stronger radial flow is observed**.

Comparison with hydrodynamical models

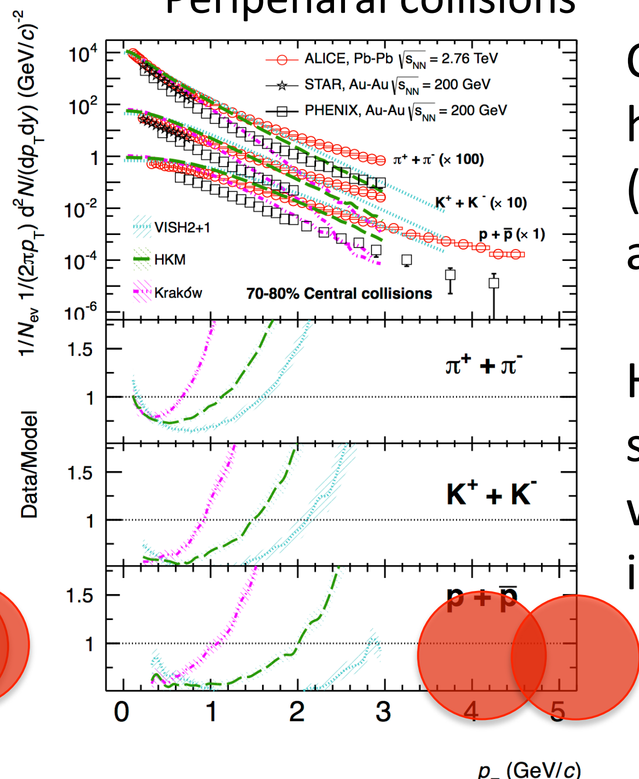
arXiv:1303.0737

ALICE

Central collisions



Peripeharal collisions



Comparison to full hydrodynamical calculation (blast-wave are only an approximation)

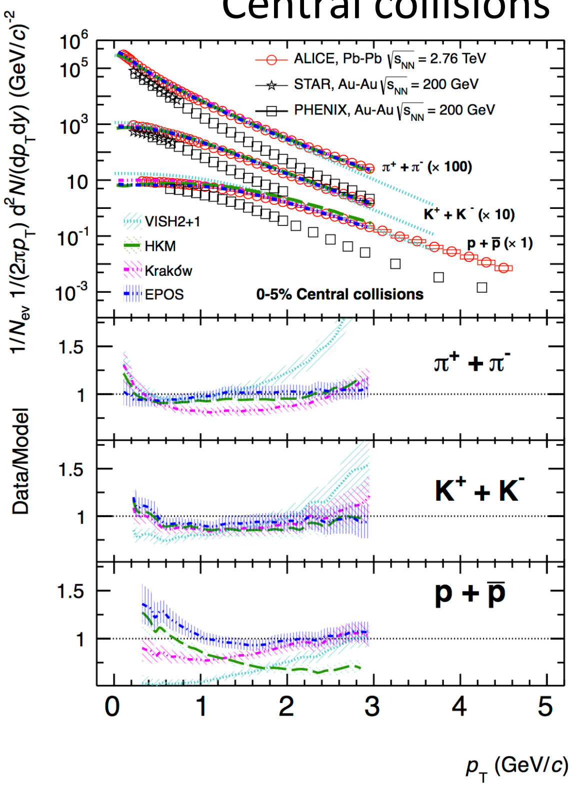
Higher $<p_T>$ for of the spectra at LHC energies with respect to RHIC ones, in particular for protons.

- **For central collisions,** the models describe the experimental data within ~20% → hydrodynamic interpretation of the spectra.
- Hydrodynamical description fails to describe partcles spectra of peripheral events

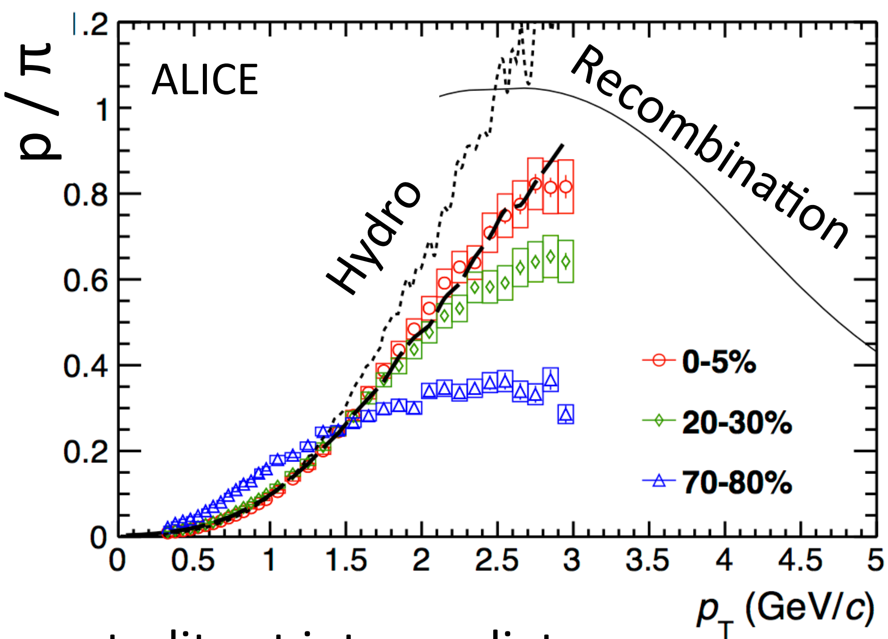
Comparison with recombination models

arXiv:1303.0737

Central collisions



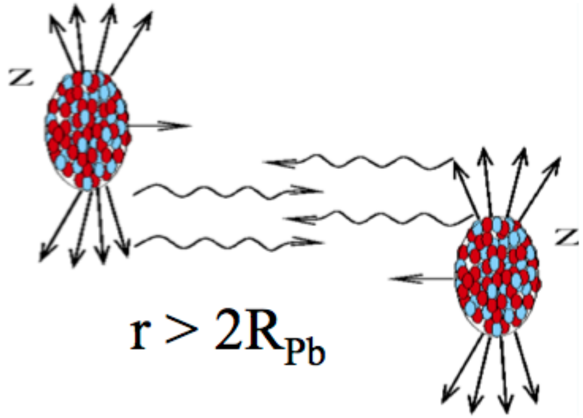
p/π ratio important to understand hadron formation mechanism



- p/π ratio increases with centrality at intermediate p_T:
  - hydrodynamical model: mass ordering induced by radial flow (harder spectra for heavier particles)
  - qualitatively consistent with hadronization via parton recombination (p_T > 3 GeV/c → analysis ongoing)

J/ψ in Ultra Peripheral Collisions (UPC)

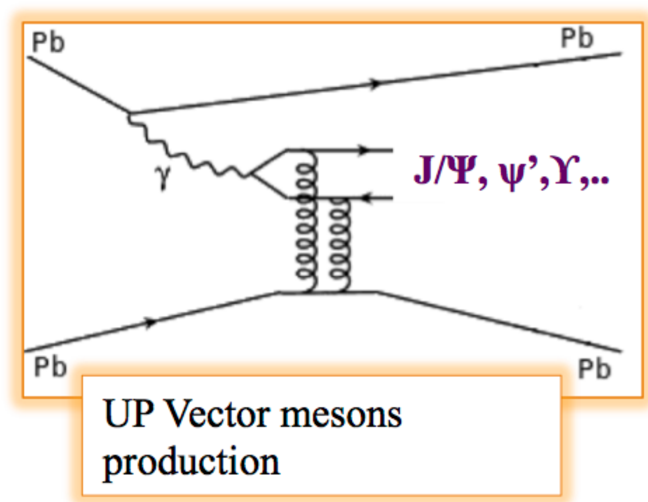
In UPCs, Pb-Pb collide with impact parameter $b > 2R_{Pb}$ → hadronic interactions suppressed.



Vector meson production: scattering of a virtual photon on a nucleus

Exclusive vector meson production in UPC can probe the nuclear gluon distribution at low-x.

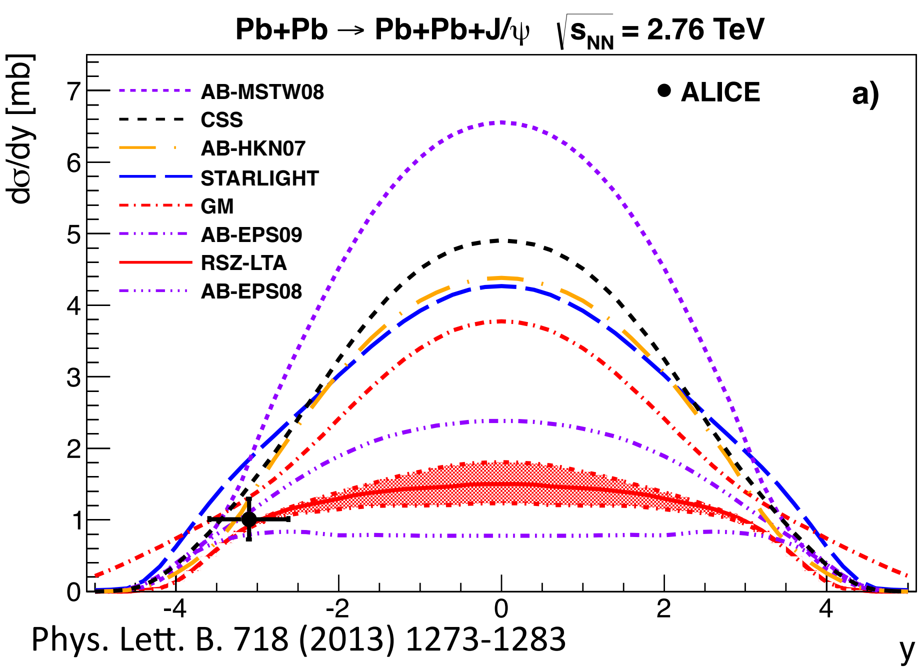
The cross section depends on the nuclear gluon shadowing description in the event generator.



Production of J/ψ in Ultra Peripheral Collisions

UPC J/ψ cross section measurements:

- at forward rapidity in the di-muon channel



Phys. Lett. B. 718 (2013) 1273-1283

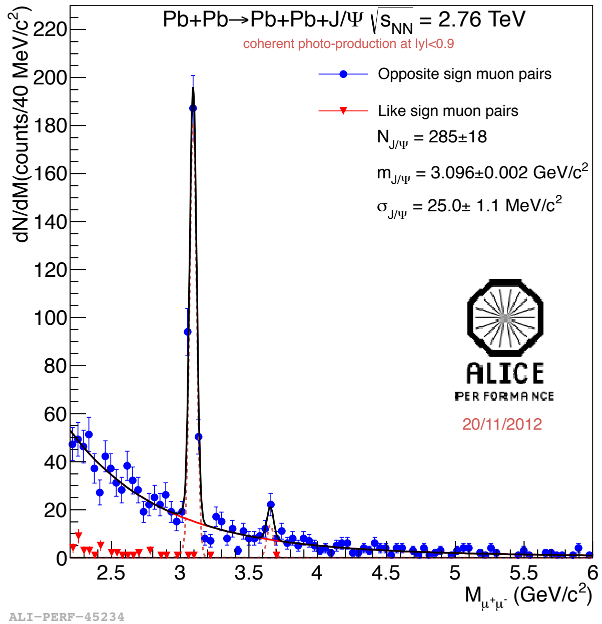
Measured cross section integrated over $-3.6 < y < -2.6$

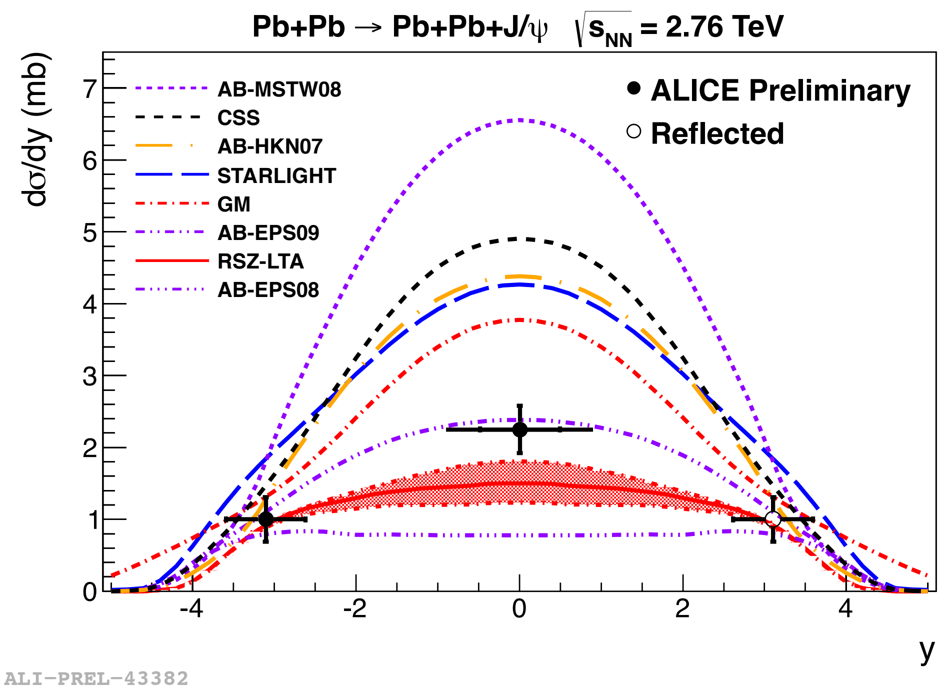
Good agreement with models which include nuclear gluon shadowing

Production of J/ψ in Ultra Peripheral Collisions

UPC J/ψ cross section measurements:

- at forward rapidity in the di-muon channel   Phys. Lett. B. 718 (2013) 1273-1283
- in the central barrel in the di-electron and di-muon channels (preliminary)





Central rapidity: more discriminating measurement!

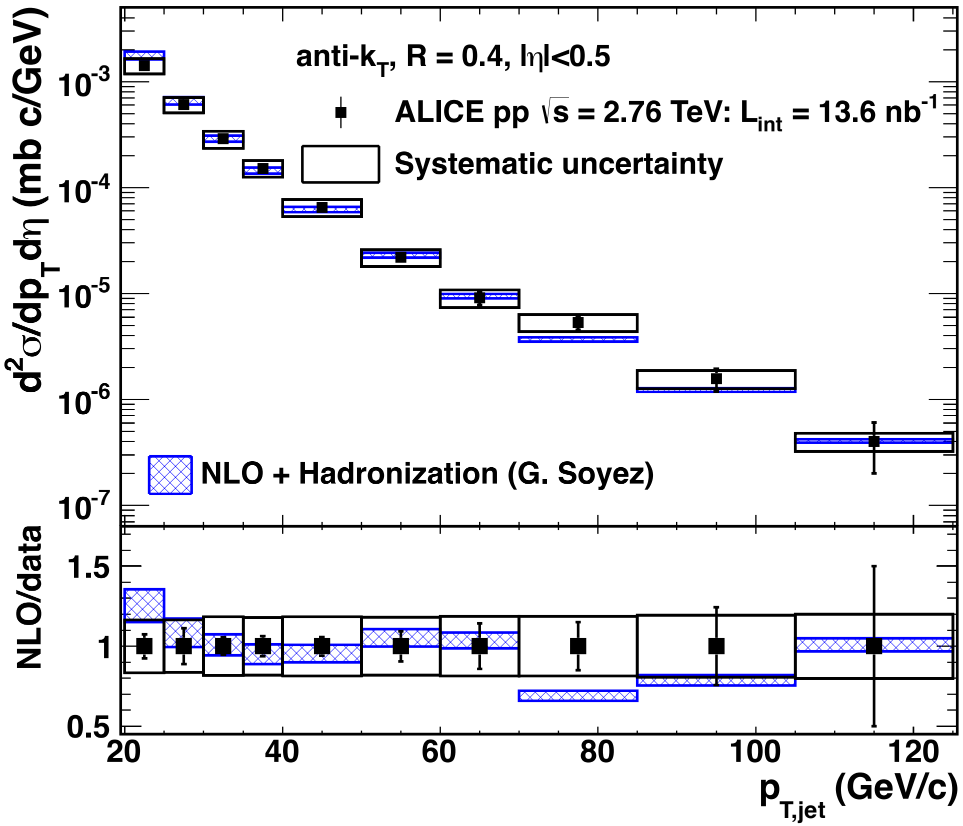
The partonic model with gluon shadowing from EPS09 parametrization (AB-EPS09) seems to be favoured.

Jet differential cross section in pp collisions at $\sqrt{s}$ = 2.76 TeV

arXiv:1301.3475

Important mesurement for:

- reference for the jet measurement in Pb-Pb collisions (jet R_{AA})
- test of the pQCD calculations at this energy



$20 < p_T < 125$ GeV/c

$|\eta| < 0.5$

R = 0.4

NLO + hadronization calculations agree with the data within uncertainties.

Measurement used as reference for R_{AA}

Jet differential cross section in pp collisions at √s = 2.76 TeV

arXiv:1301.3475

ALICE

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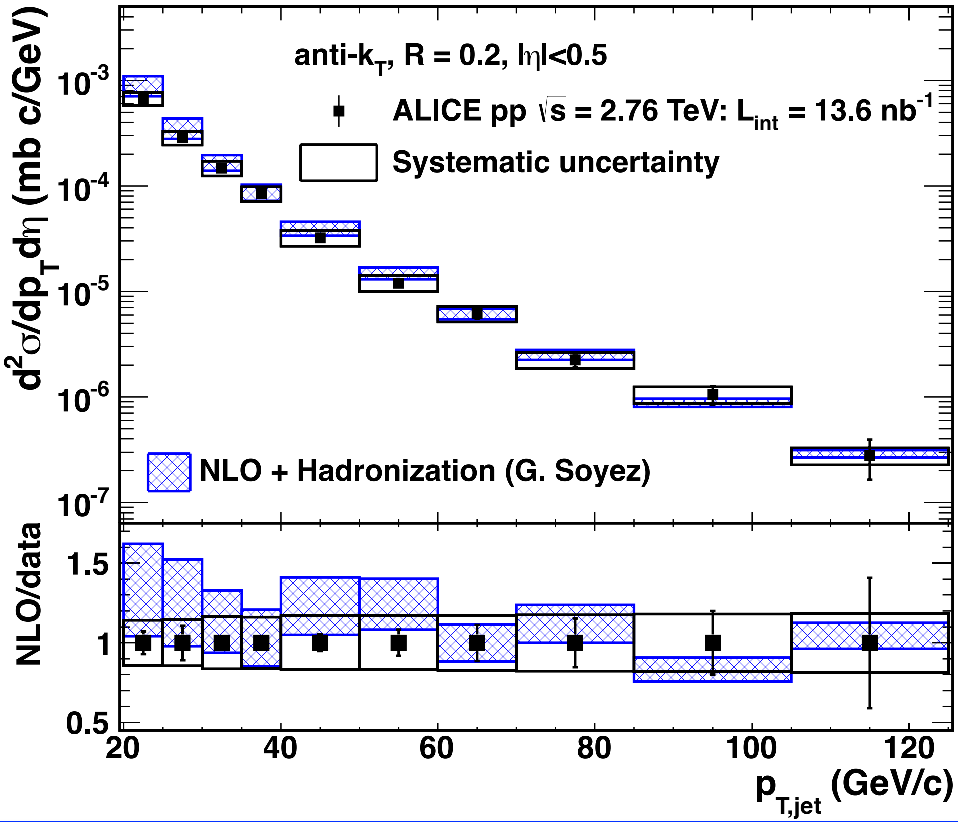

$20 < p_T < 125$ GeV/c

$|\eta| < 0.5$

R = 0.2

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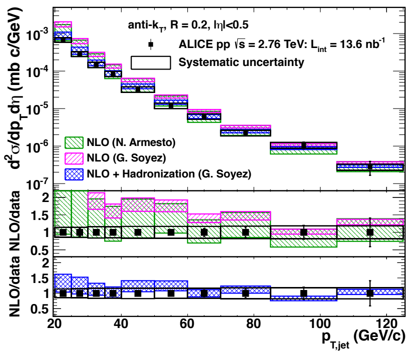
Measurement used as reference for R_{AA}

$$R_{AA} = \frac{dN_{AA}/dp_T}{\langle N_{coll}\rangle \times dN_{pp}/dp_T}$$

Jet differential cross section at √s = 2.76 TeV

The ratio of the jet cross sections measured with two different radii is sensitive to the transverse jet structure

σ(R=0.2)



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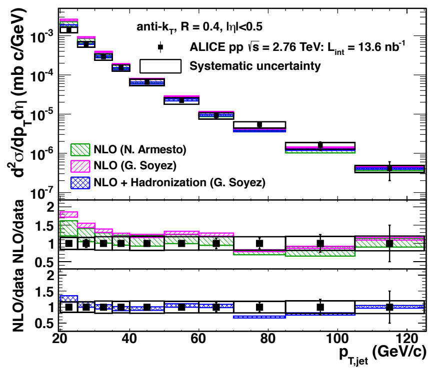
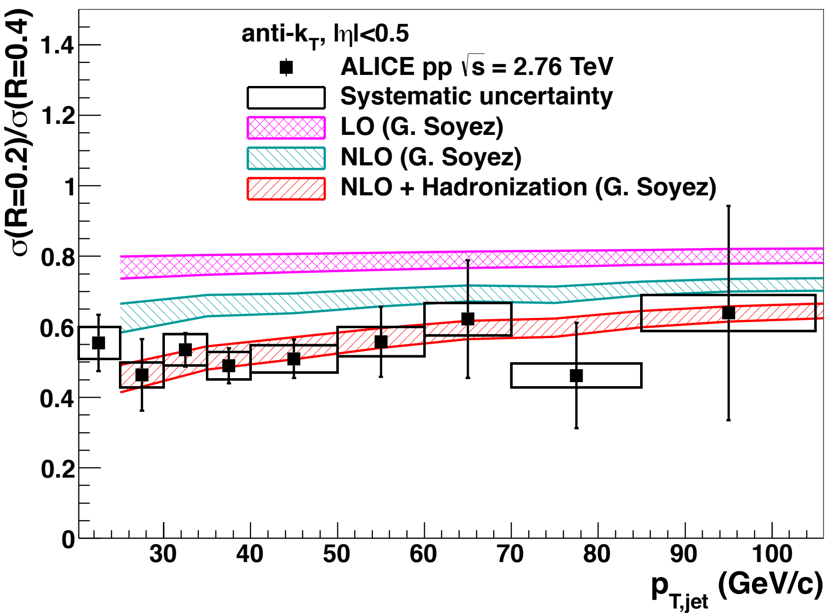


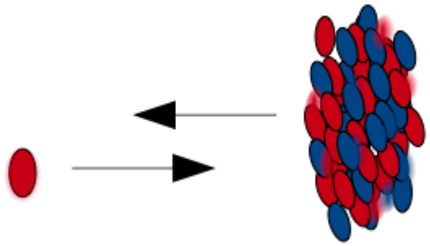


More stringent comparison of data and calculation since systematic uncertainties are common or highly correlated (trigger and tracking efficiency, normalization, …)

The NLO + hadronization calculation of the ratio describe quite well the data.

arXiv:1301.3475

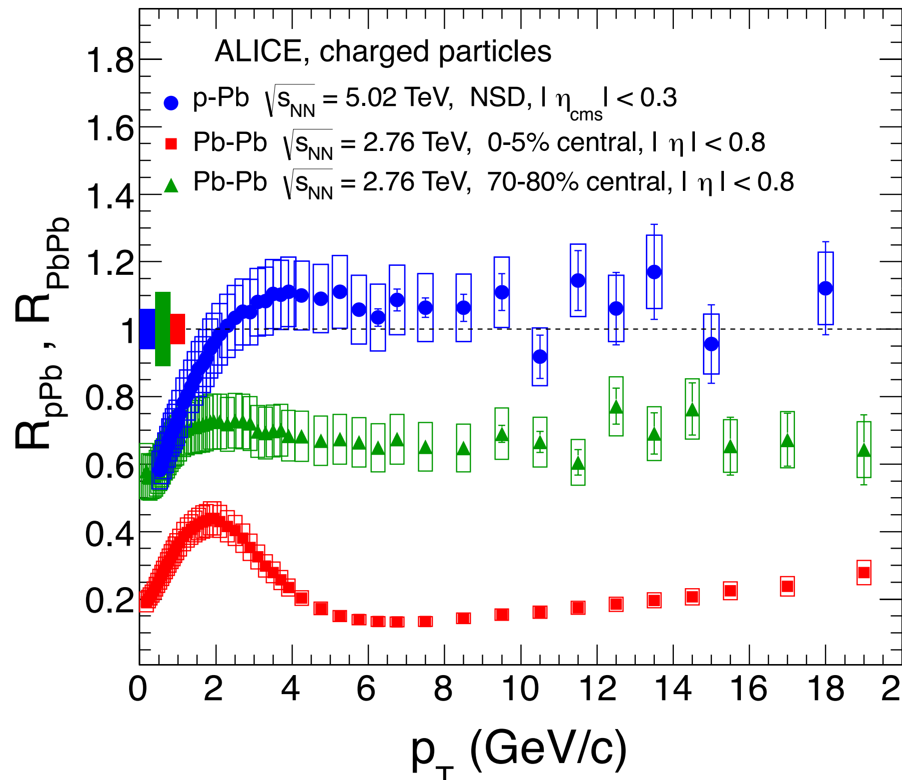
p-Pb collisions



- **Used as control experiment**
  - pp and pA measurement are used as control experiment for the Pb-Pb ones.
  - Use "calibrated probe" to investigate the hot nuclear matter.

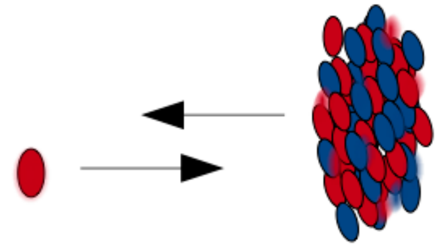
- **No suppression of high-p_T particles is observed in p-Pb collisions**

- **Suppression of high p_T particles in central Pb-Pb collisions has to be attributed to hot QCD matter, not to initial state effects**



ALI-PUB-4… arXiv:1210.4520

p-Pb collisions



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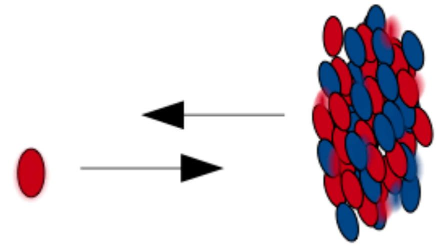
  - Use "calibrated probe" to investigate the hot nuclear matter

- **Study of initial state effects.**
  - Initial state effects can modify the parton distribution function with respect to the free nucleon one. These effects present both in p-Pb and Pb-Pb collisions (Cronin effect, shadowing, gluon saturation).
  - Effects measured in Pb-Pb are a "superposition" of initial state effects and hot nuclear matter effects.

p-Pb collisions



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  - Effects measured in Pb-Pb are a “superposition” of initial state effects and hot nuclear matter effects.

- **“Low-x” physics**
  - Probe nucleus structure in a QCD regime of very small-x
    (gluon saturation, shadowing,…)

Di-hadron correlations

Pilot p-Pb run
September 2012

The ΔηΔϕ di-hadron correlation is built between a trigger and an associated particle in p_T intervals ($p_{T,assoc} < p_{T,trig}$)

$$\frac{1}{N_{trig}} \frac{d^2 N_{assoc}}{d\Delta\varphi\Delta\eta} = \frac{S(\Delta\varphi,\Delta\eta)}{B(\Delta\varphi,\Delta\eta)}$$

Signal distribution **(S)** contains correlation within the same event. Background **(B)** is study using mixed event technique.

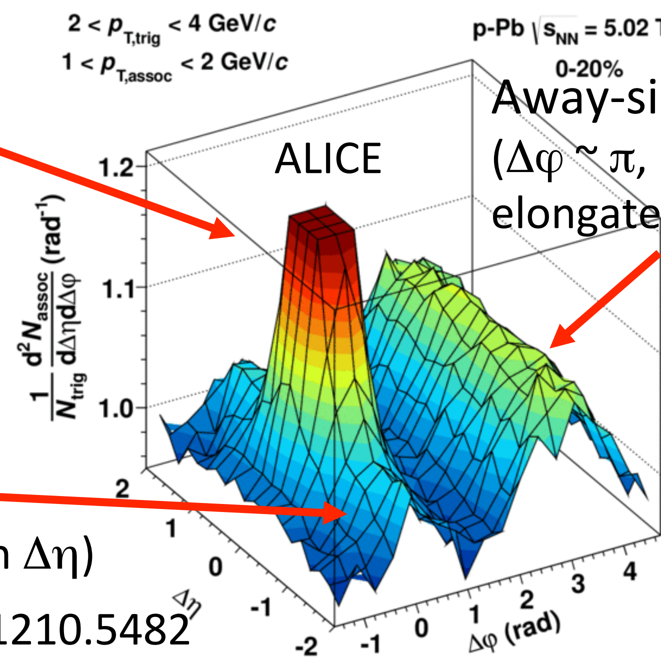
$2 < p_{T,trig} < 4$ GeV/c
$1 < p_{T,assoc} < 2$ GeV/c

20% highest multiplicity events

Near-side jet
($\Delta\varphi \sim 0$, $\Delta\eta \sim 0$)

Away-side jet
($\Delta\varphi \sim \pi$,
elongated in $\Delta\eta$)

Near-side ridge
($\Delta\varphi \sim 0$, elongated in $\Delta\eta$)



First observed by CMS arXiv:1210.5482

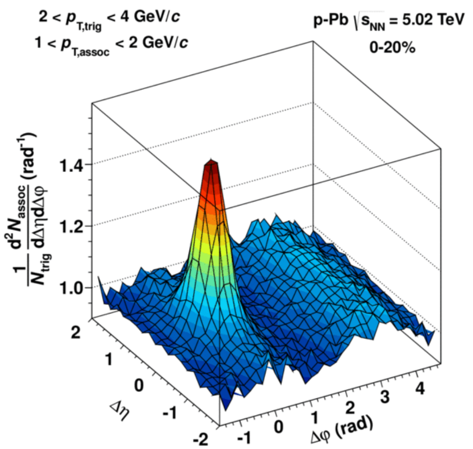
Di-hadron correlations vs multiplicity

We define four multiplicity event classes in multiplicity ranges with a forward scintillator detector (VZERO):

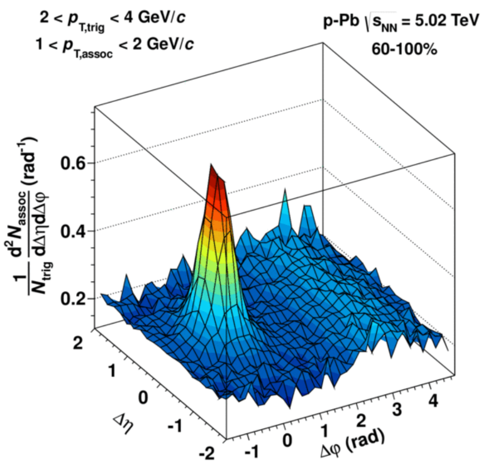
- Denoted by 0-20% (highest multiplicity), 20-40%, 40-60%, 60-100% (lowest multiplicity)

Event class	V0M range (a.u.)	$\langle dN_{ch}/d\eta \rangle \vert_{\vert\eta\vert<0.5}$ $p_T > 0$ GeV/c	$\langle N_{trk} \rangle \vert_{\vert\eta\vert<1.2}$ $p_T > 0.5$ GeV/c
60–100%	< 138	6.6 ± 0.2	6.4 ± 0.2
40–60%	138–216	16.2 ± 0.4	16.9 ± 0.6
20–40%	216–318	23.7 ± 0.5	26.1 ± 0.9
0–20%	> 318	34.9 ± 0.5	42.5 ± 1.5

0-20%



60-100%



- No near-side ridge seen in 60-100%, similar to pp collisions.
- What remains if we subtract 60-100% to 0-20%?

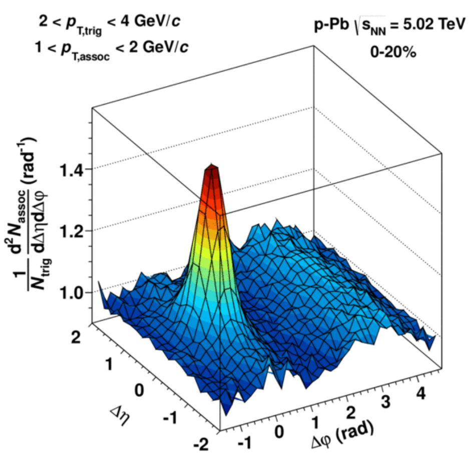
Di-hadron correlations vs multiplicity

We define four multiplicity event classes in multiplicity ranges with a forward scintillator detector (VZERO)

- Denoted by 0-20% (highest multiplicity), 20-40%, 40-60%, 60-100% (lowest multiplicity)
- What remains if we subtract **60-100%** from **0-20%**?

A double ridge!

0-20%



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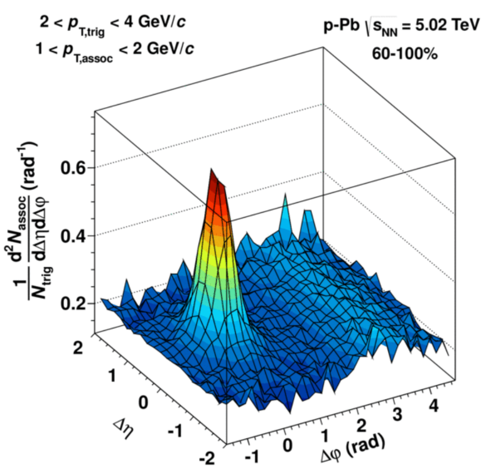
60-100%



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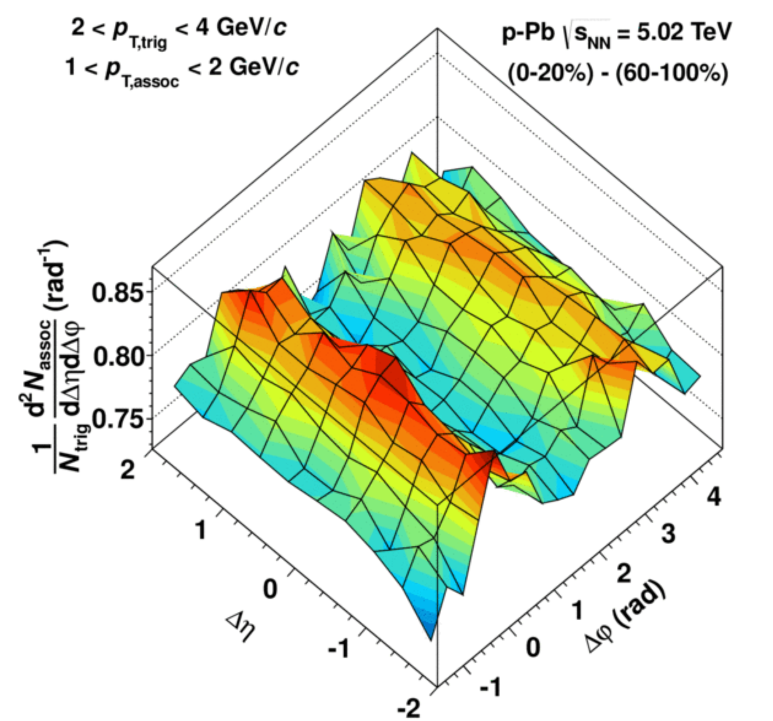
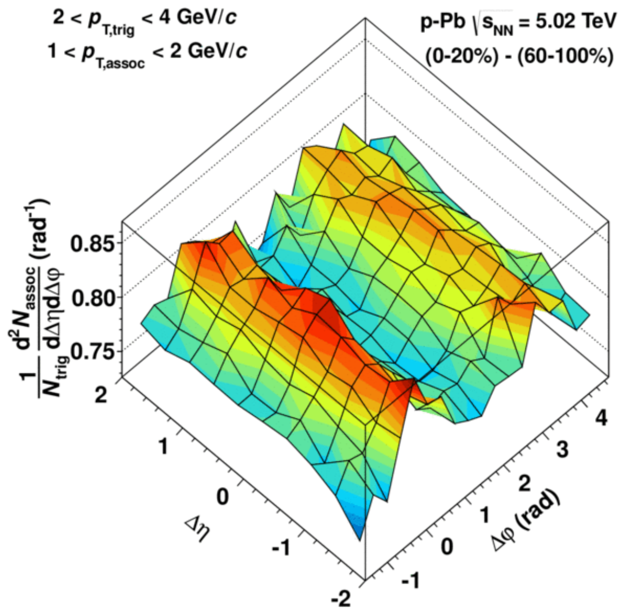
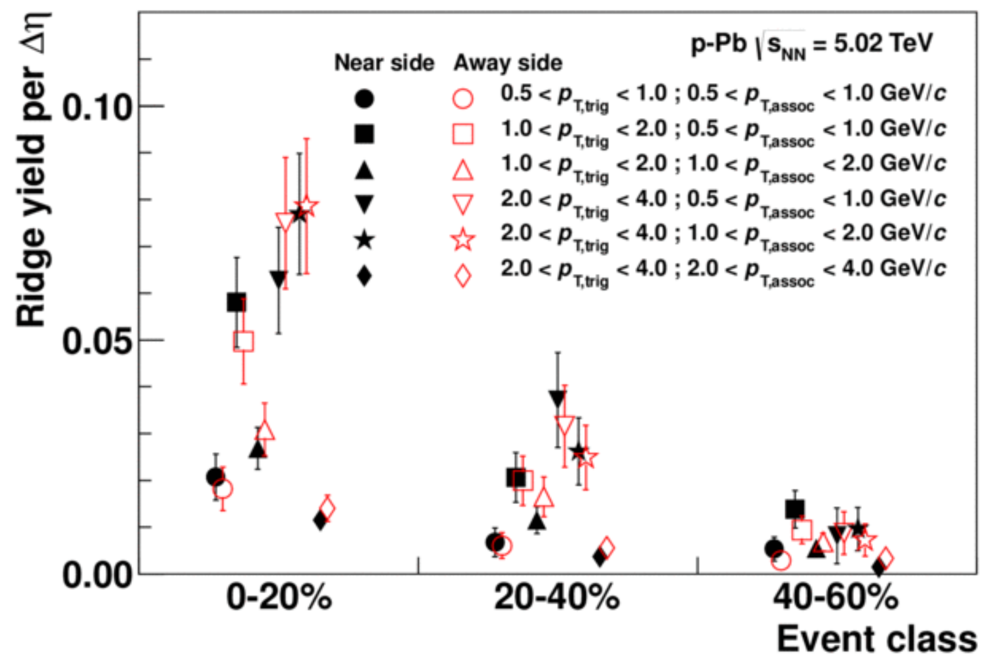


First observed by ALICE (PLB719 (2013) 29)
Confirmed by ATLAS (arXiv:1212.5198)

The double ridge

PLB719 (2013) 29





- Ridges are flat in $|\Delta\eta| < 2$
- Slight excess on the near side around $\Delta\eta \sim 0$ (residual jets?)

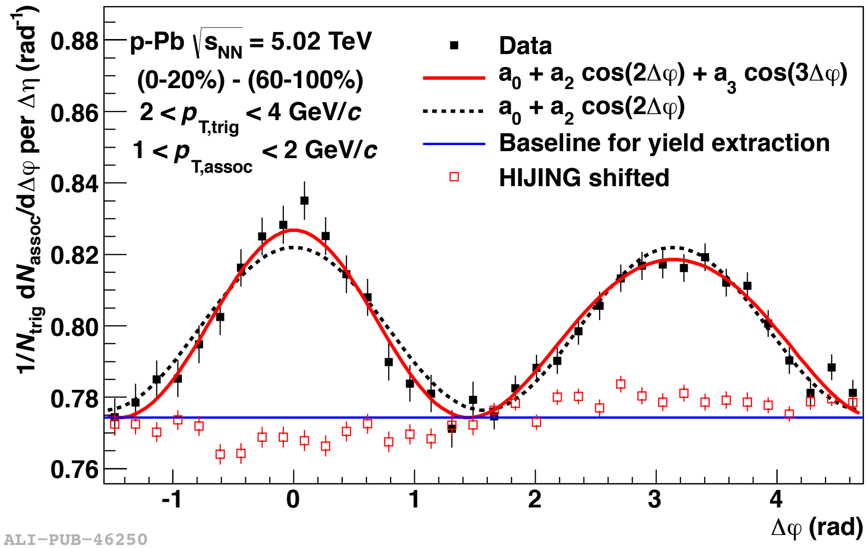
- **The complete correlation signal is composed of di-jets and double ridge-structure.**

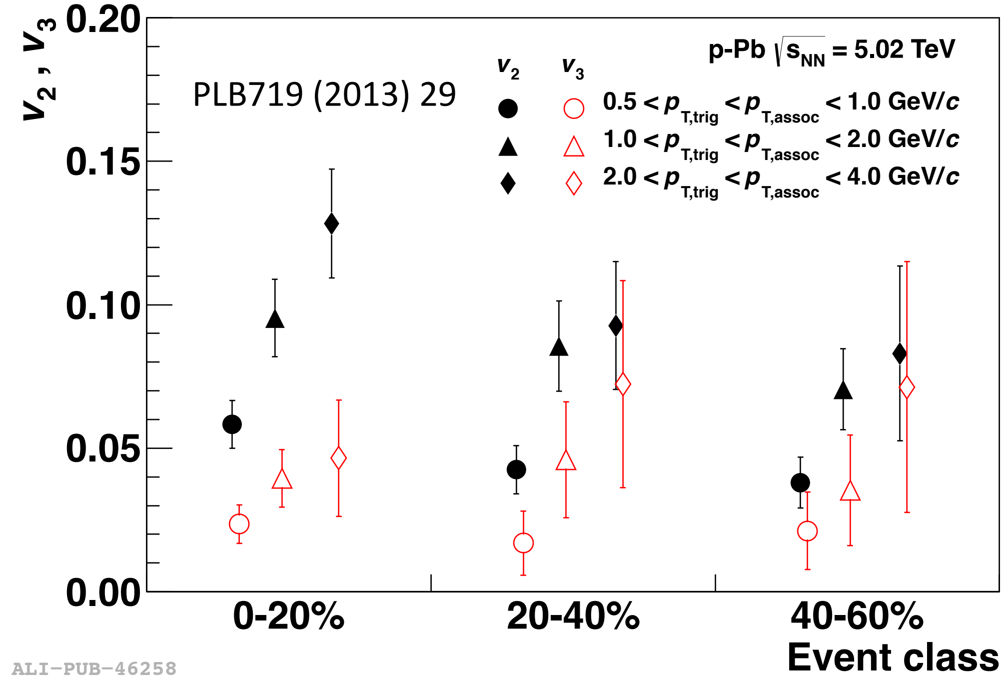
- Integrating near side and away side above baseline allows to extract ridge yields

- **Same ridge yield near and away side for all classes of p_T trigger and multiplicity suggest a common underlying process**

The double ridge

Similar observations in Pb-Pb are ascribed to collective effects.



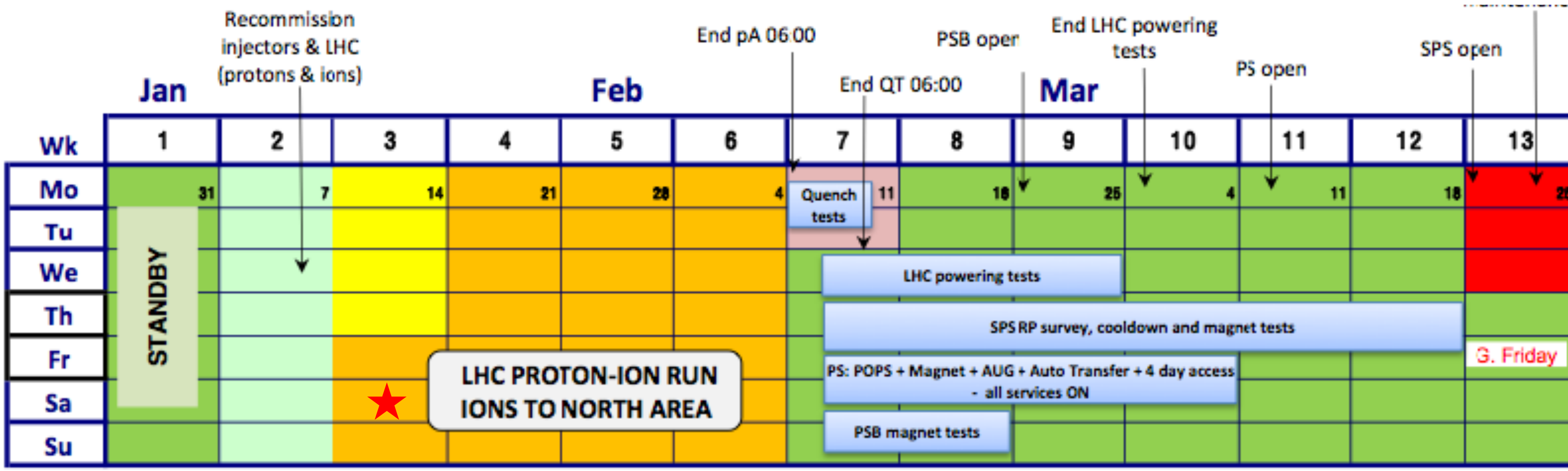


- Remaining correlation described by finite amplitudes of second and third Fourier component.
- Modulation mostly of cos $2\Delta\varphi$ type (v_2).
- Small but significant cos $3\Delta\varphi$ term needed (v_3)

v_2 and **v_3** as a function of p_T for different event classes (each 60-100% subtracted)

- **v_2: Strong increase with p_T**
  Mild increase with multiplicity
- **v_3: Increase with p_T within large uncertainties**

p-Pb 2013 run



Goal:

- 10^8 minimum bias events ✔
- $30 nb^{-1}$ integrated luminosity ✔
- p-Pb – Pb-p switchover ✔
- magnet polarity change for p-Pb and Pb-p ✔

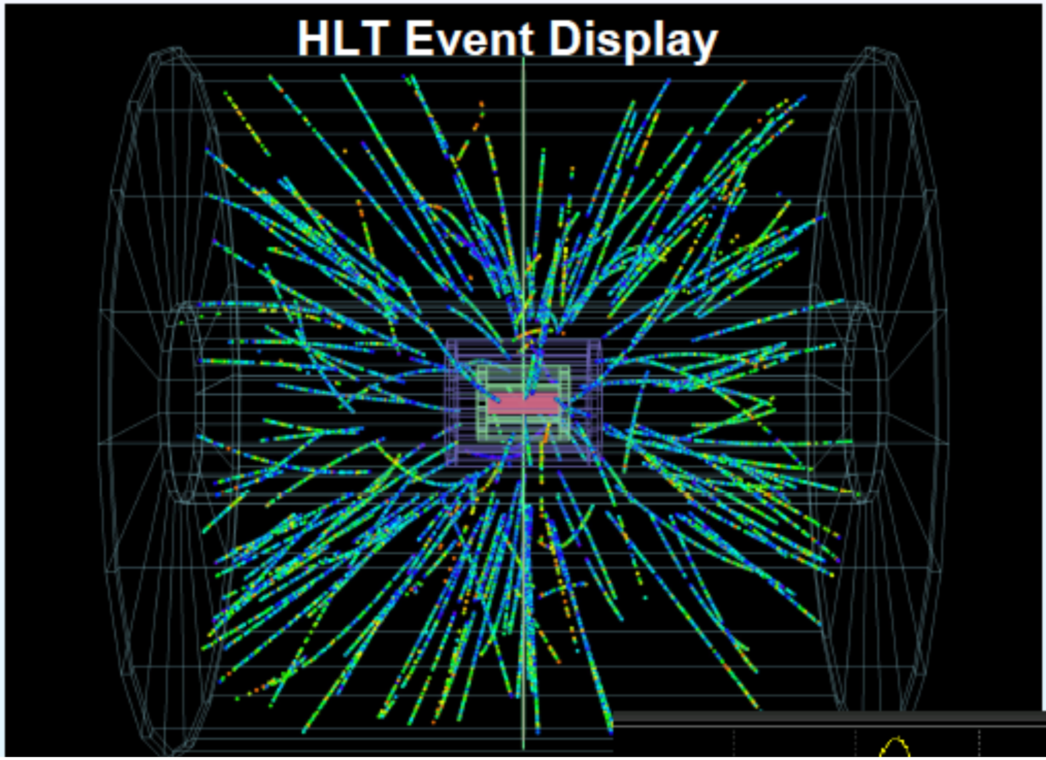
★ First p-Pb 2013 collision with stable beam

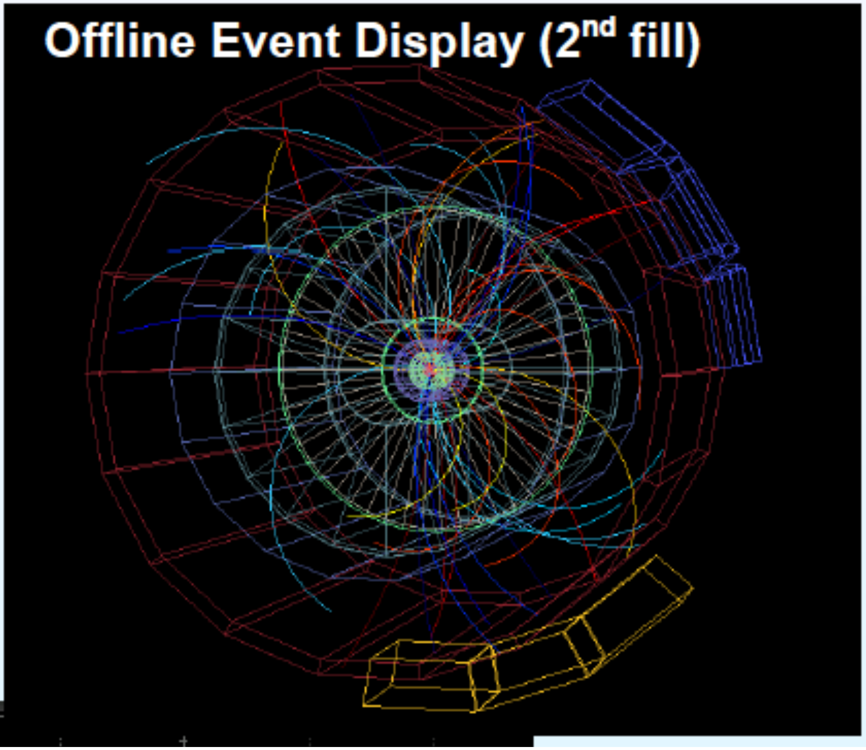
Impressive performance of the LHC !!! Thanks and congratulations!!

p-Pb 2013 run: first collisions

20.1. 15:05 o'clock First "Stable Beams"

Single_13b_8_8_8_pPb

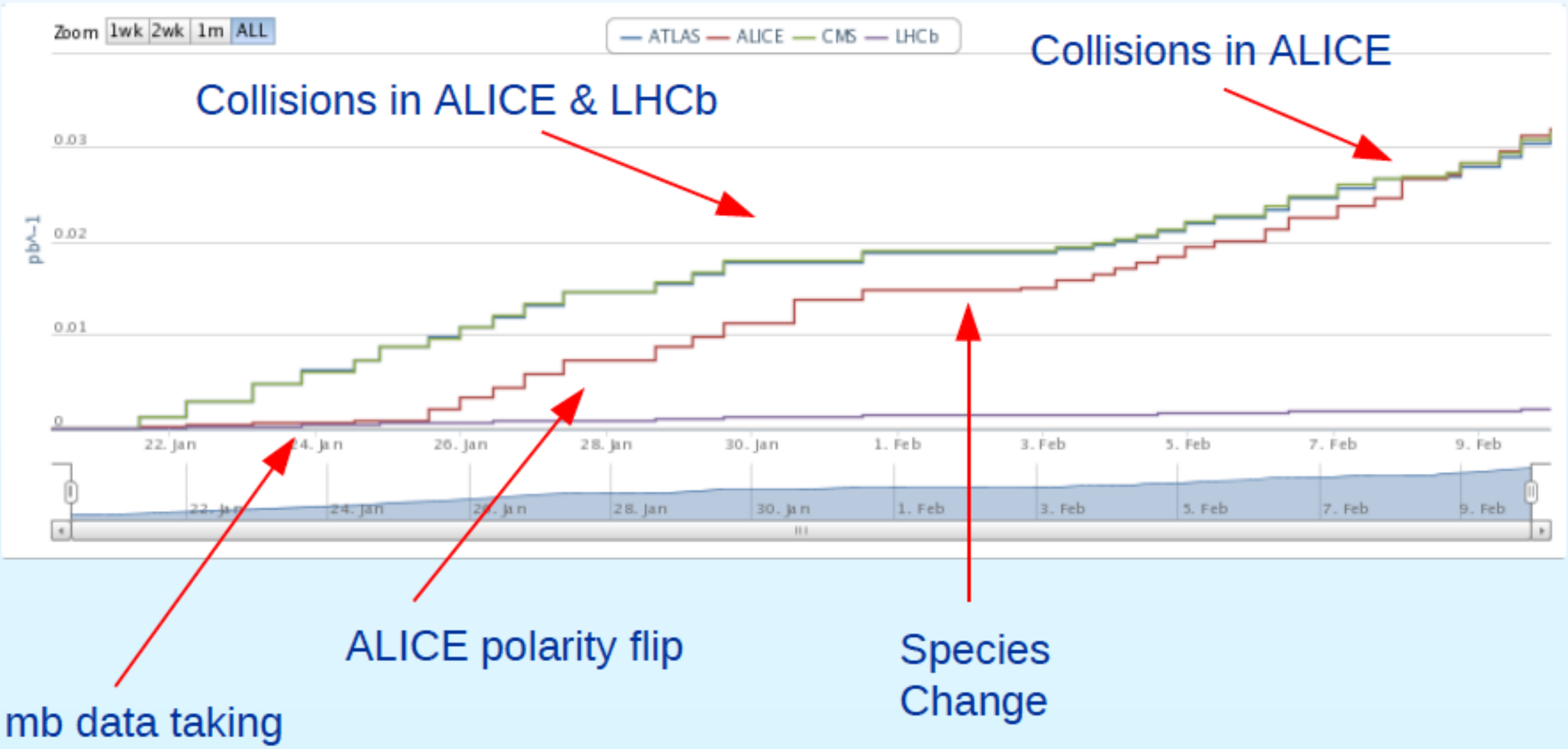




Impressive performance of the LHC !!! Thanks and congratulations!!

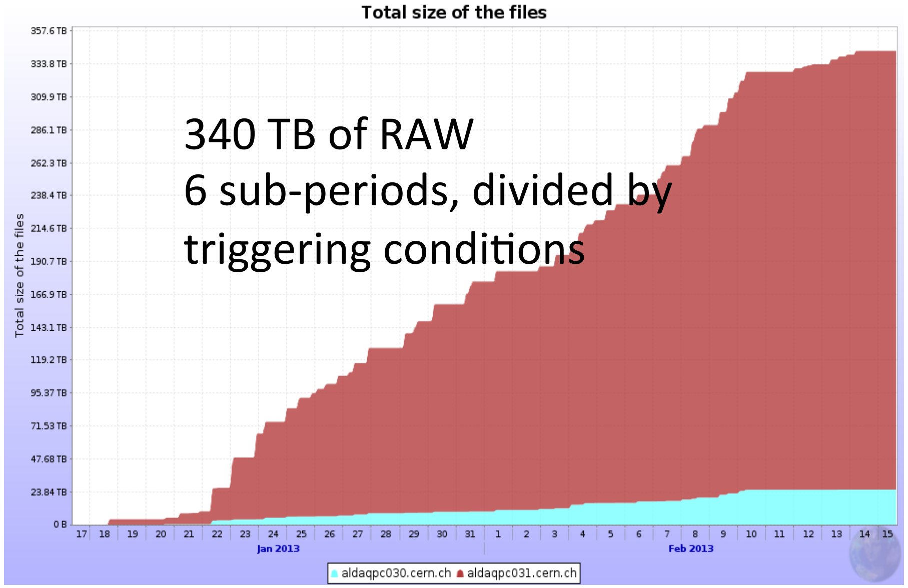
p-Pb 2013 run

ALICE 31.94 nb^{-1} **ATLAS 31.14 nb^{-1}** **CMS 31.67 nb^{-1}** **LHCb 2.12 nb^{-1}**

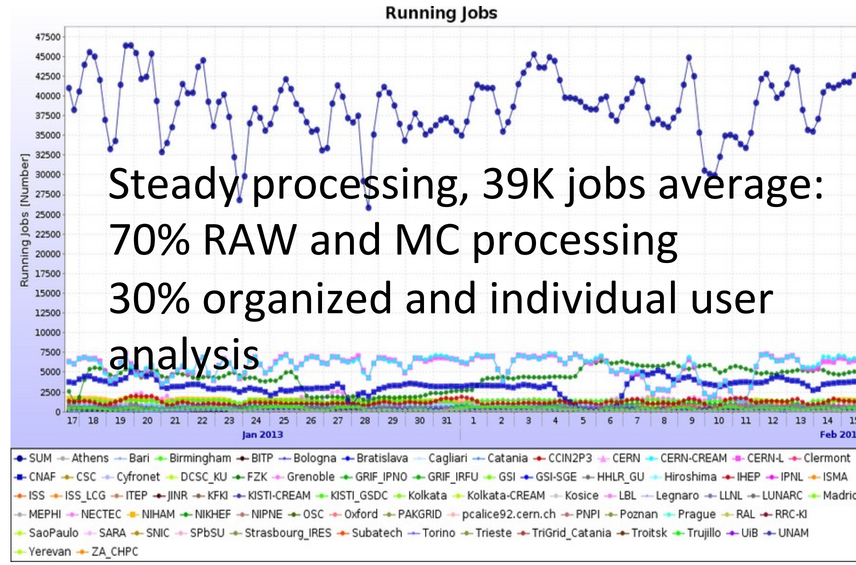


Impressive performance of the LHC !!! Thanks and congratulations!!

Offline performance in p-Pb 2013 run



340 TB of RAW
6 sub-periods, divided by triggering conditions



Steady processing, 39K jobs average:
70% RAW and MC processing
30% organized and individual user analysis

LHC13e_muon_pass2	LHC period LHC13e - reco for Muon (pass2)	Running	196089 - 196311	18	34,449	26.51 TB	34,225	99%	362.8 GB	1%	14,365,603
LHC13d_muon_pass2	LHC period LHC13d - reco for Muon (pass2)	Running	195725 - 195873	16	36,488	29.28 TB	35,767	98%	448.9 GB	1%	17,279,163
LHC period LHC13c - Full production pass 1	LHC period LHC13c - Full production pass 1	Completed	195529 - 195677	15	73,572	64.06 TB	53,583	72%	19.53 TB	41%	73,118,366
LHC period LHC13g - CPass1 (reconstruction)	LHC period LHC13g - CPass1 (reconstruction)	Running	197470 - 197692	25	28,721	15.38 TB	24,259	84%	1.761 TB	13%	18,584,659
LHC period LHC13g - CPass0 (reconstruction)	LHC period LHC13g - CPass0 (reconstruction)	Completed	197470 - 197692	25	28,721	15.38 TB	25,745	89%	140.2 GB	0%	16,037,484
LHC13g_muon_calo	LHC period LHC13g - reco for Muon + Calorimeters	Completed	197470 - 197692	25	28,721	15.38 TB	28,549	99%	736.4 GB	4%	31,025,276

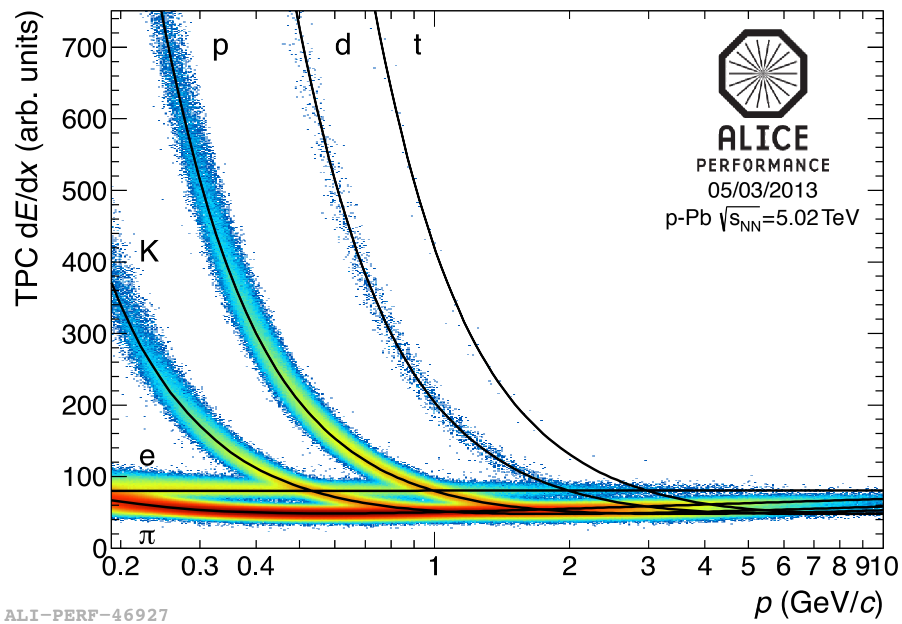
37 RAW processing cycles, including offline calibration and QA
All data is processed fully in Pass1, some sub-periods with Pass2

Performance plots with 2013 p-Pb data… Particle ID

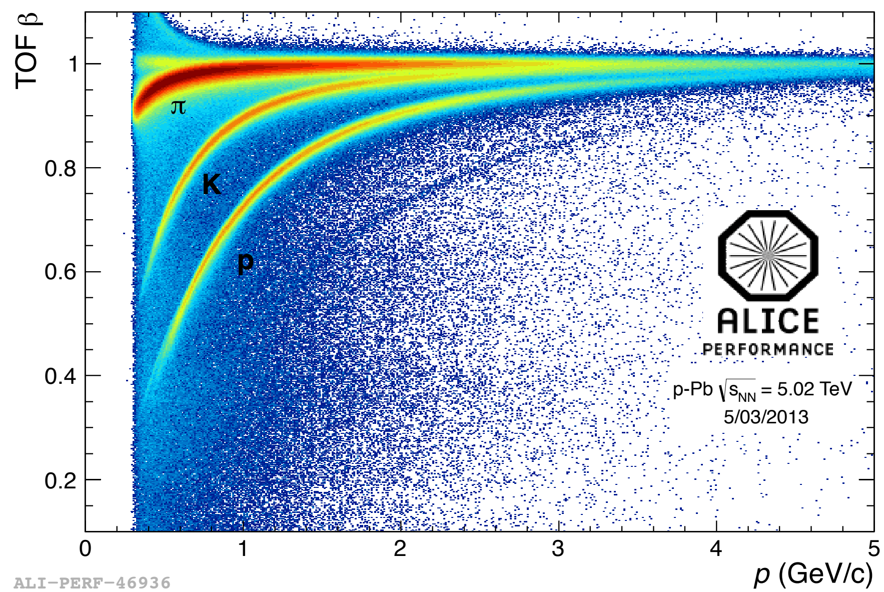
Possible collective effects are being further investigated with other measurements.

Ex: Mass dependence → identified particle spectra.

Time Projection Chamber dE/dx PID

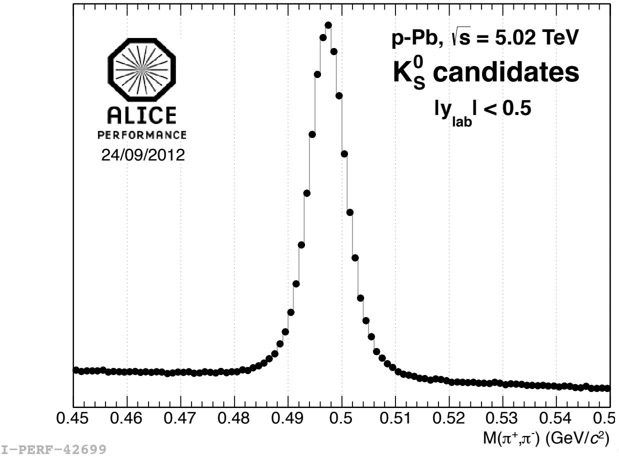


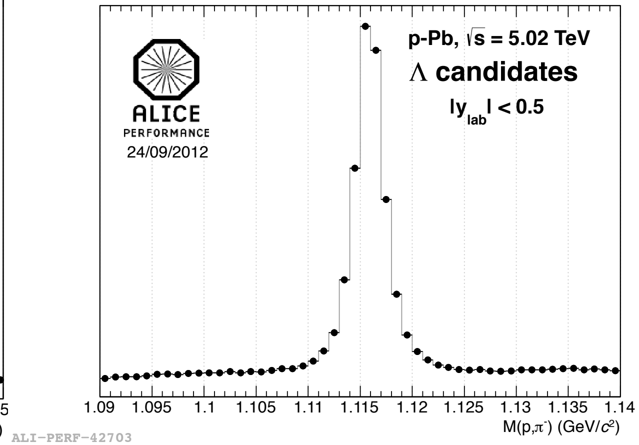
Time Of Flight PID

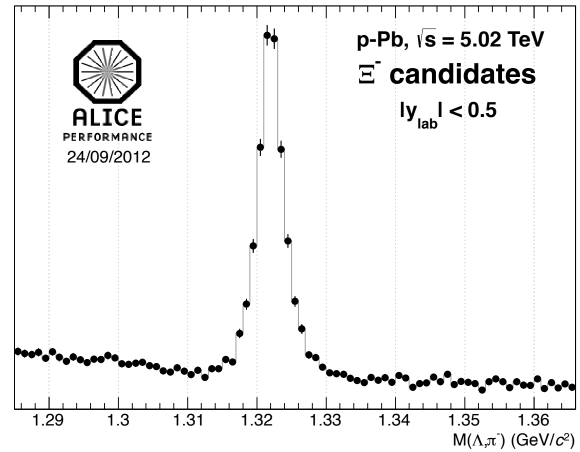


Good calibration of the detector provide already very good PID performances

Performance plots with 2013 p-Pb data... K^0_s and hyperons

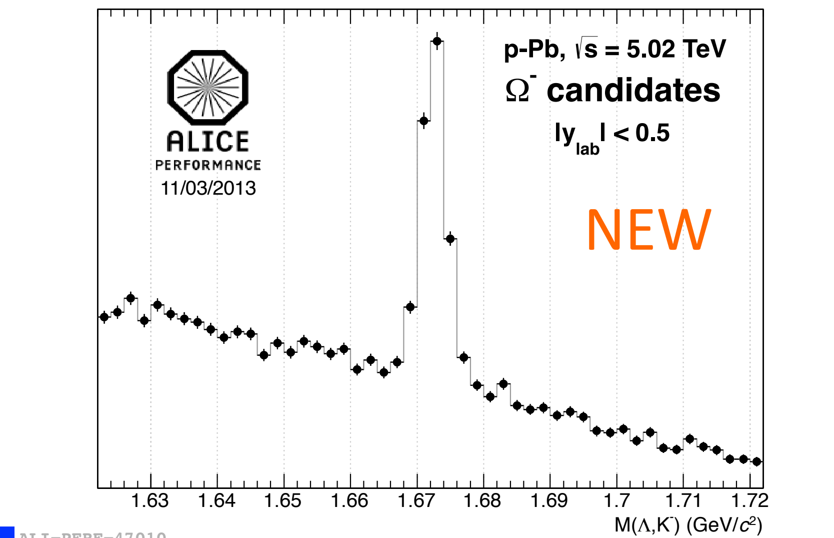






K^0_S, Λ, Ξ already shown with p-Pb pilot run in Semptember 2012.

Ω signal with partial statistics of MB sample collected in 2013



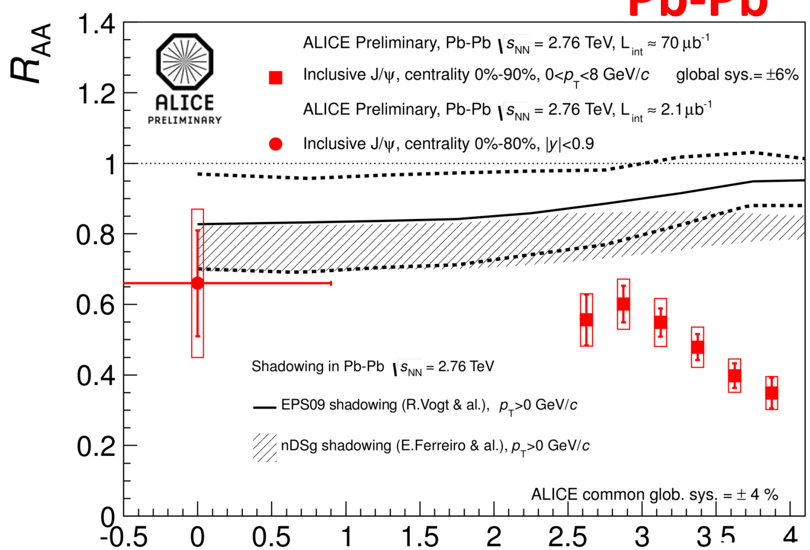
Charmonium

Interesting behaviour of low p_T J/ψ suppression in Pb-Pb collisions at LHC with respect to RHIC energy → new effects at the LHC?

Shadowing can play an important role at LHC energies for the J/ψ suppression.

Several theoretical models are available with prediction for p-Pb and Pb-Pb collisions
Different treatments of the J/ψ productions, initial state effects, interactions, …

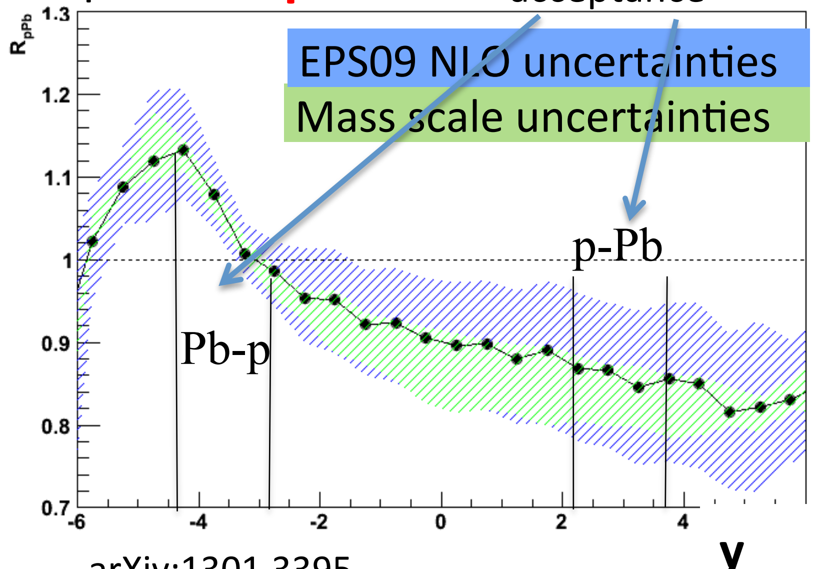
Pb-Pb



Phys. Rev. C 81, 044903 (2010),
Nucl. Phys. A855, 327 (2011).

$p_T > 0$ **p-Pb**

Di muons ALICE acceptance

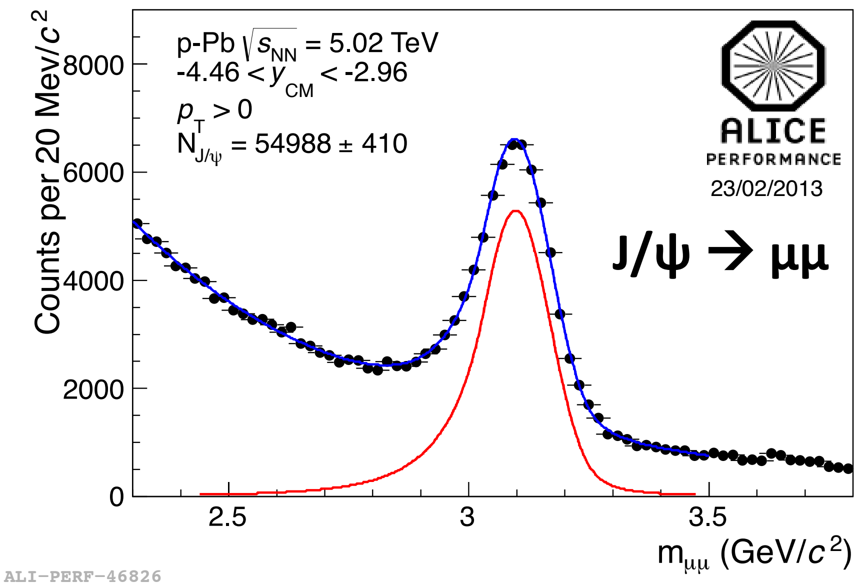


arXiv:1301.3395

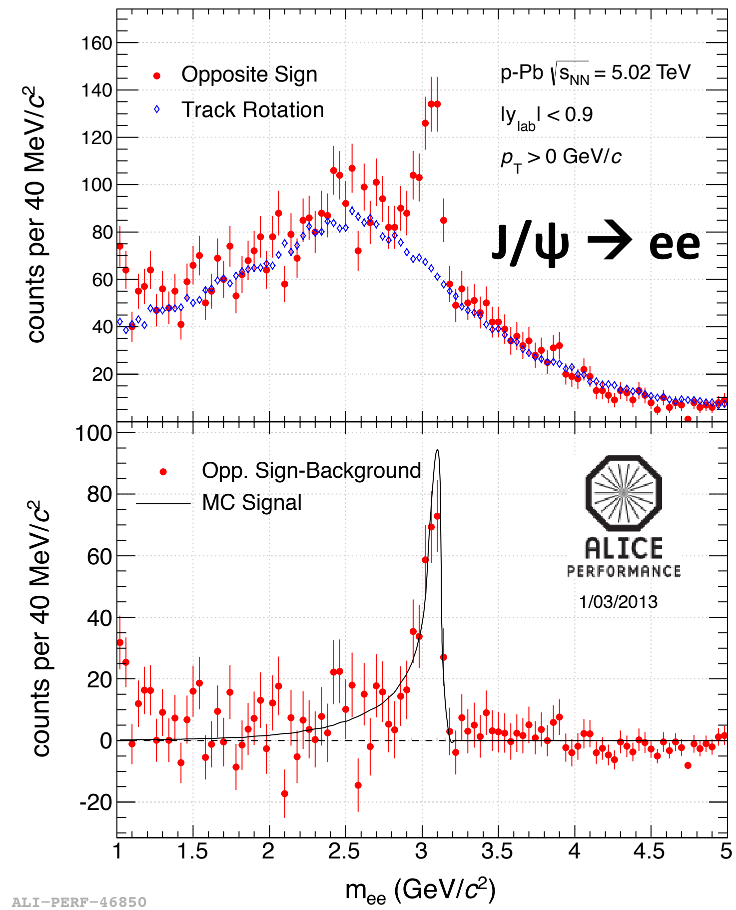
Performance plots with 2013 p-Pb data... J/ψ

ALICE J/ψ reconstructed from $p_T = 0$

forward rapidity region



central rapidity region



J/ψ signals

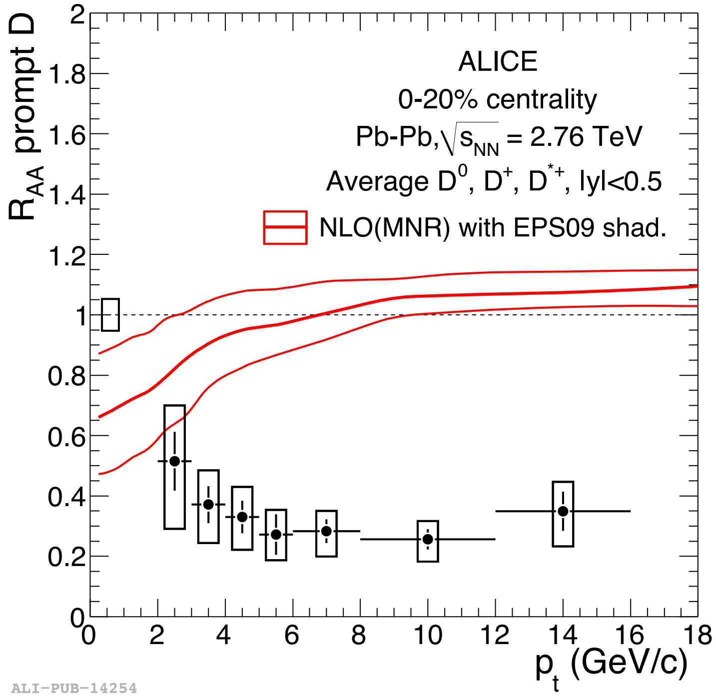
- in the di-muon channels in forward region ($-4.46 < y_{CM} < -2.95$)
- in the di-electrons channel in the central barrel ($|y_{lab}| < 0.9$)

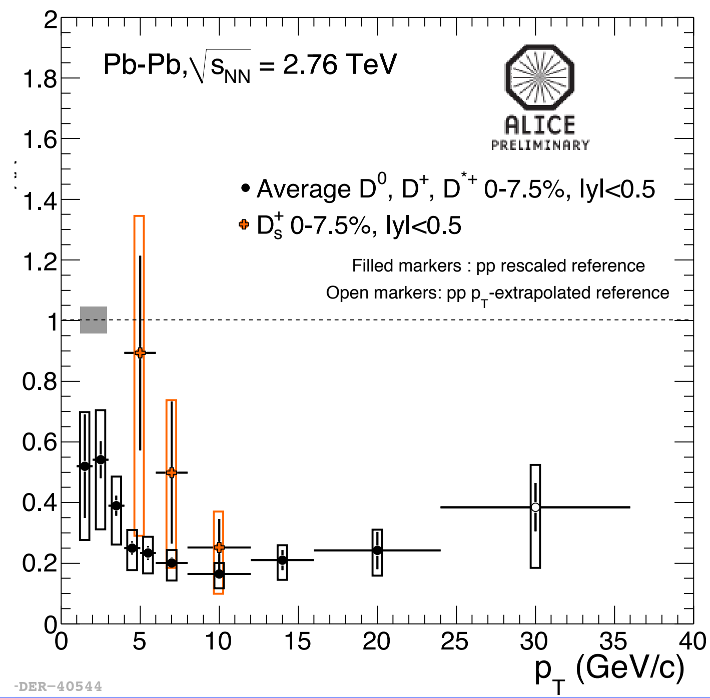
Open Heavy Flavour production and nPDF in p-Pb

R_{pPb} for heavy flavour particles important measurement to quantify the relevance of initial-state effects, which may be strong at low pT .

First measurement of D_s in heavy ion collisions. What about p-Pb?

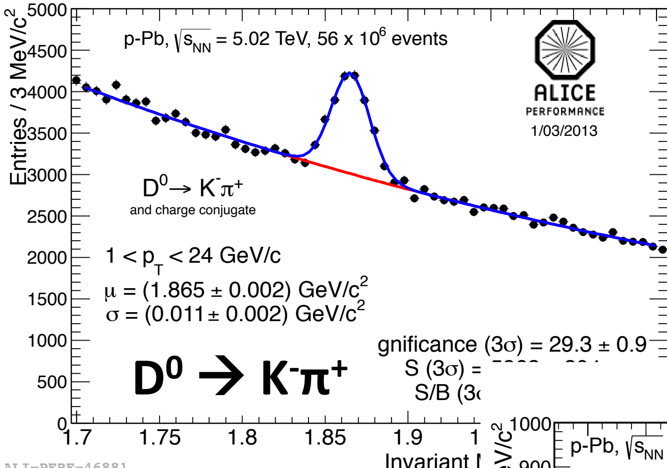
JHEP 1209 (2012) 112

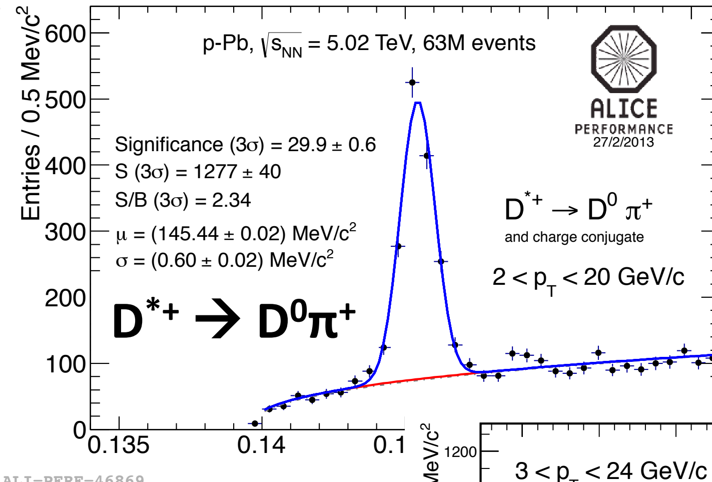




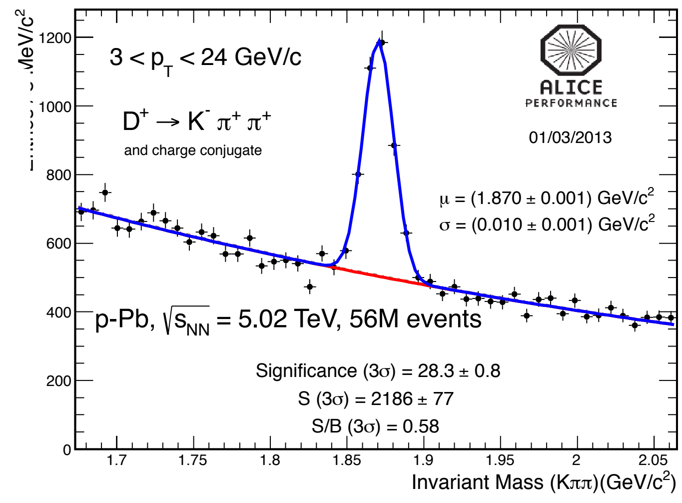
Performance plots with 2013 p-Pb data… heavy flavour

D^0, D^+, D^{*+}, D_S signals with part of 2013 MB statistics.



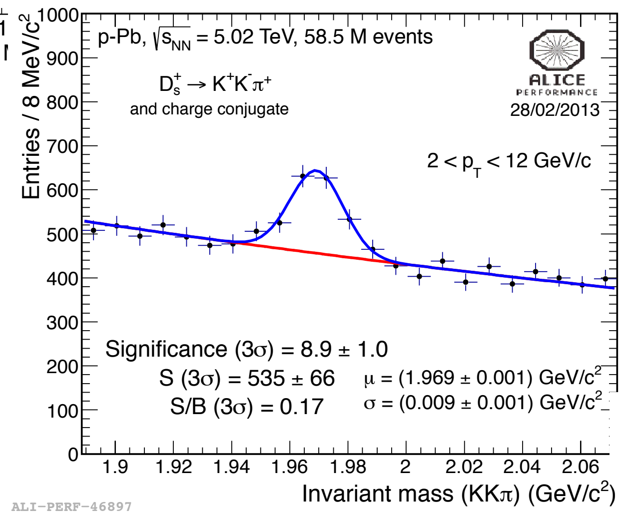


$D^+ \rightarrow K^+ \pi^- \pi^+$



p_T > 1-2 GeV/c for the four D mesons

+ HF electrons and HF muons



$D^+_s \rightarrow K^+ K^- \pi^+$

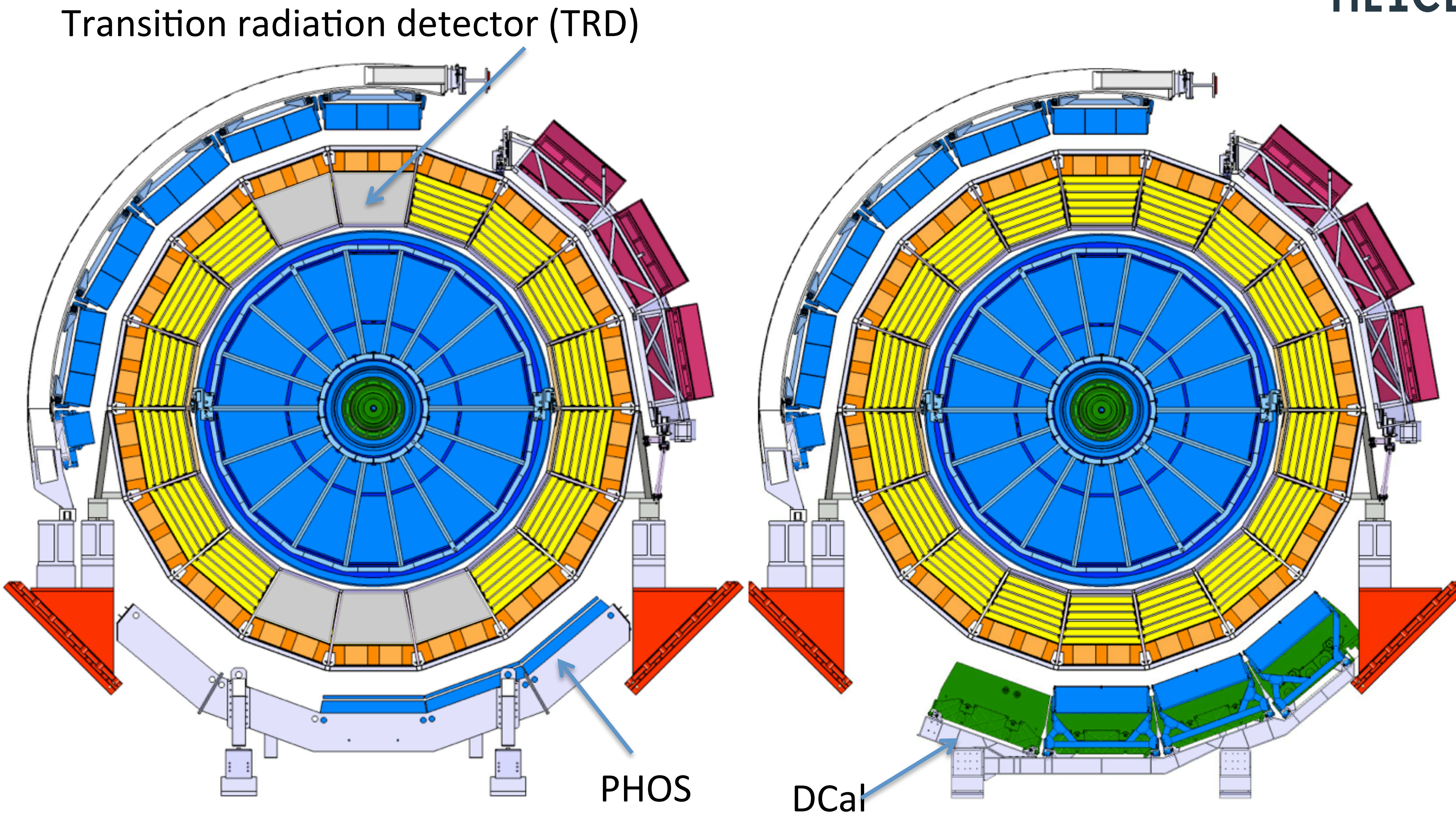
Plans for the LS1

- **Baseline sequence:**
  - Complete TRD detector (+5 Supermodules)
  - Install Di-jet calorimeter (DCal) (8 Supermodules). Including support structure and support beams
  - Install 1 PHOS Supermodule
  - Numerous detector consolidation efforts

- **Improvement and consolidation of infrastructure and services**:
  - EN-EL: UPS replacement and electrical infrastructure consolidation (UPS power increased from 160kVA to 800kVA)
  - EN-CV: P2 chilled water upgrade (+60% cooling power)
  - EN-CV: L3 ventilation upgrade (+60% flow)

ALICE now

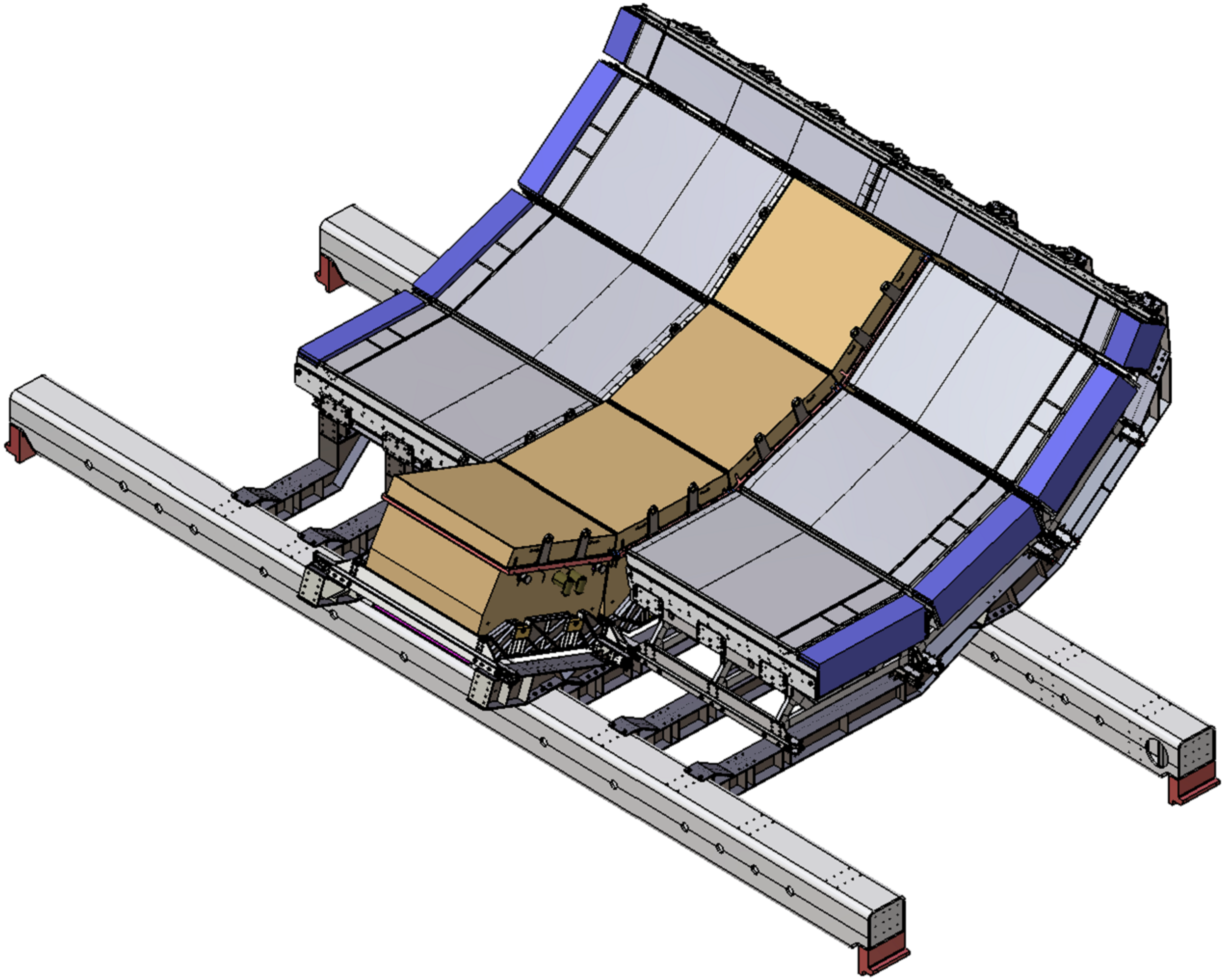
ALICE after LS1



DCal and PHOS

Final configuration:

- 4 PHOS SM
- 8 DCal SM



Poster session

- "Quarkonium measurements with the ALICE Muon Spectrometer."
  Lizardo Valencia Palomo
- "Multi-strange baryon production in Pb-Pb collisions at the LHC with ALICE"
  Domenico Colella
- "Transverse momentum distribution of pions, kaons and protons in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV and p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV in ALICE"
  Jonas Anielski
- "Measurement of D meson azimuthal anisotropy in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV with ALICE"
  Andrea Festanti
- "Azimuithal angular correlation between heavy-flavour decay electrons and charged hadrons in pp collisons at $\sqrt{s}$ = 2.76 TeV in ALICE"
  Deepa Thomas
- "(Anti-)matter and hyper-matter production at the LHC with ALICE"
  Nicole Alice Martin

Poster session

- "Photoproduction in Pb-Pb collisions with the ALICE experiment at the LHC"
  Andrea Agostinelli
- "Measurement of J/ψ → e+e- production in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV in ALICE at the LHC"
  Julien Book
- "Full reconstuction of B mesons with the ALICE Inner Tracker Upgrade"
  Johannes Hendrik Stiller
- "Reference cross section measurement in pp and Pb-Pb collisions at the LHC with the ALICE detector"
  Emilia Leogrande
- "Measurement of full jet p_T spectra in 2.76 TeV pp and Pb-Pb collisions with the ALICE detector"
  Salvatore Aiola
- "A GEM-based readout for the ALICE TPC"
  Andreas Honle

Conclusion and outlook…

- Since the last LHCC we submitted 6 papers:
  3 Pb-Pb, 2 pp, 1 p-Pb

- First observation of double ridge structure in p-Pb collisions:
  - Puzzling observation!
    New effects? Collective Phenomena? Something else?
  - Further analyses ongoing to understand the effect
    (identified particles, hyperons, …)

- Good performance of the ALICE detector during the 2013 p-Pb run

- Many more measurements in p-Pb collisions on the way
  (quarkonia, heavy flavour, jets, …)

BACK UP SLIDES

Outline

New publication since the last LHCC (December 2012):

Pb-Pb

- “Centrality determination of Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV with ALICE” arXiv:1301.4361
- “Centrality dependence of π, K, p production in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV” arXiv:1303.0737
- “Charge correlations using the balance function in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV” arXiv:1301.3756

pp

- “Measurement of the inclusive differential jet cross section in pp collisions at $\sqrt{s}$ = 2.76 TeV” arXiv:1301.3475
- “Charged kaon femtoscopy correlations in pp collisions at $\sqrt{s}$ = 7 TeV” arXiv:1212.5958

pPb

- “Long-range angular correlation on near and away side in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV” arXiv:1212.2001 PLB719 (2013) 29

+ performance on 2013 pPb run!

Charge correlation using balance function

arXiv:1301.3756

$\Delta\eta\Delta\phi$ correlation between emitted particles can be used as a probe of the charge creation mechanism within the medium.

The balance function describes the probability that a **particle in a range of momenta space will be "balanced" by a particle of opposite charge within the same momentum range**.

Particles production stage, collective motion during the expansion and rescattering after hadronization might affect this correlation.

Charge correlation using balance function

arXiv:1301.3756

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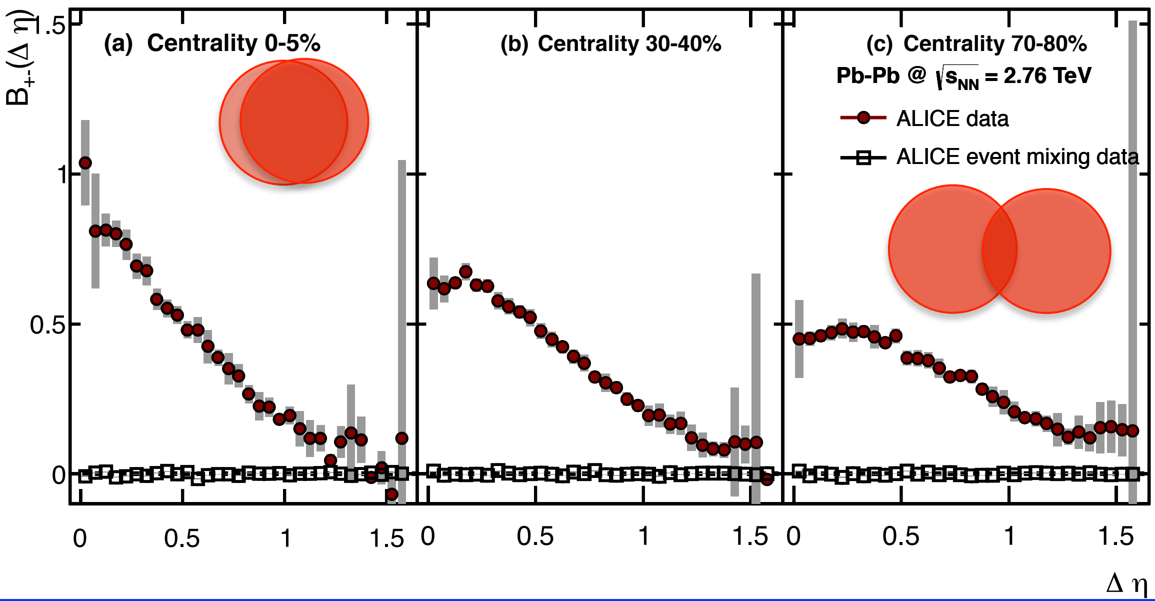
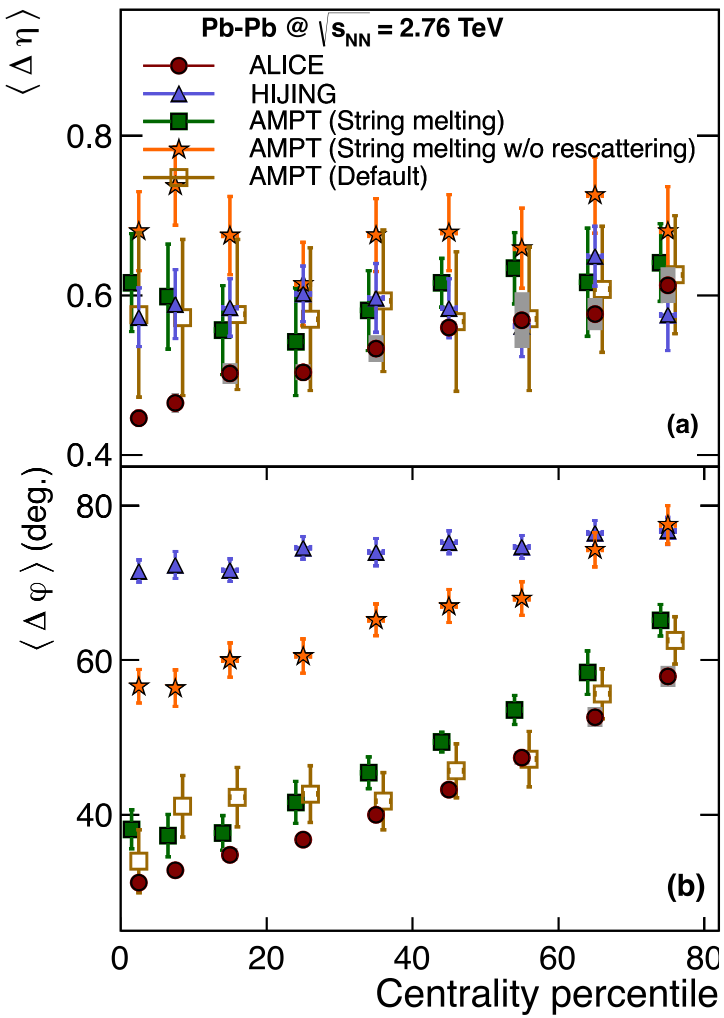
Particles production stage, collective motion during the expansion and rescattering after hadronization might affect this correlation.

Δη projection of the balance functions shows a narrowing trend from peripheral to central collisions.



Charge correlation using balance function

arXiv:1301.3756



The widths of the balance functions <Δη>, <Δϕ> increases from central to peripheral collisions:

- system shows larger radial flow in central collisions
- balancing charges are created at a later stage of the collisions.

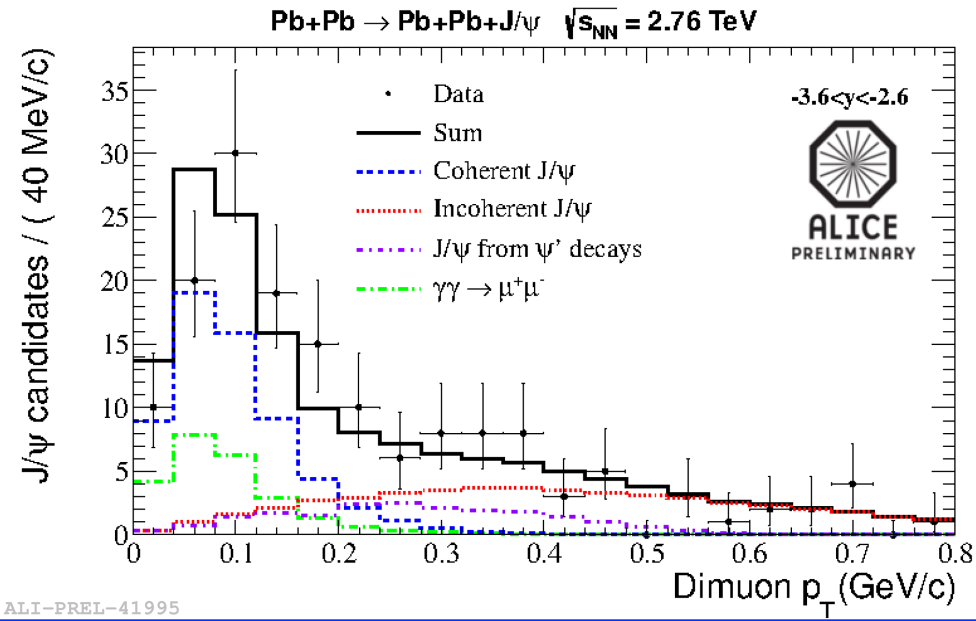
Charge correlation for more central collisions dominated by hadronization products created in a later stage of the collisions

- AMPT tuned to describe the v_2 measured by ALICE seems to agree with the centrality dependence observe in <Δϕ> but not in <Δη>

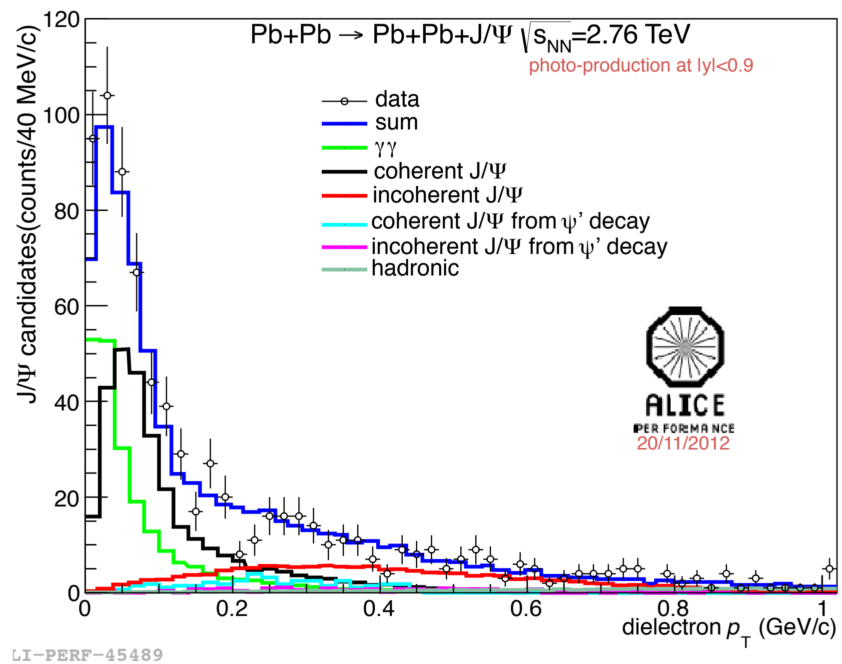
J/ψ in Ultra Peripheral Collisions

J/ψ candidates distribution is fitted summing six different Monte Carlo templates:
VM photoproduction
feed down contributions
di-lepton photoproduction
peripheral events

Forward rapidity region J/ψ→ μμ



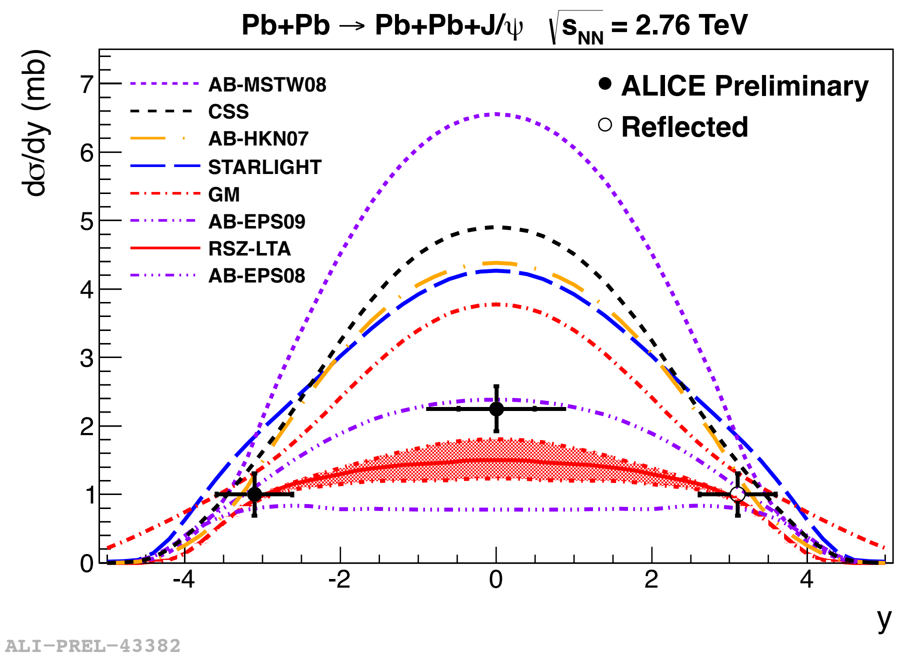
Central rapidity region J/ψ→ee



J/ψ in Ultra Peripheral Collisions

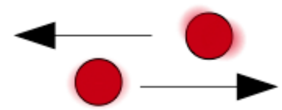
Three classes of model predictions, depending on the treatment of the **nuclear shadowing and Glauber approach**

- those that include **no nuclear effects** (AB-MSTW08). In this approach, all nucleons contribute to the scattering, and the forward scattering differential cross section scales with the number of nucleons squared, A^2.



- models that use a **Glauber approach** to calculate the number of nucleons contributing to the scattering (STARLIGHT, **GM,** and **CSS).** The reduction in the calculated cross section depends on the total J/ψ nucleon cross section
- **partonic models,** where the cross section is proportional to the nuclear gluon distribution squared (AB-EPS08, **AB-EPS09, AB-HKN07,** and **RSZ-LTA)**

pp collisions



- Measurement of particles production in the new LHC energy regime and comparison with theoretical calculations.
- Reference for binary scaling studies ($R_{AA,}$ R_{pA}).

$$R_{AA} = \frac{dN_{AA} / dp_T}{\langle N_{coll} \rangle \times dN_{pp} / dp_T}$$

Charged kaon femptoscopy at $\sqrt{s}$ = 7 TeV

Bose-Einstein correlations of identical particles are used to study the hydrodynamic collective expansion of the fireball in Pb-Pb collisions.

Event multiplicities reached in pp at $\sqrt{s}$ = 7 TeV is comparable with those measured in peripheral A+A collisions at RHIC energies → collectivity in pp?

Kaon femptoscopy allows to:

- study the transverse mass dependence of the correlation radii
- get a clearer signal than pions, since kaons are less affected by resonance decays.

The analysis has been performed in three multiplicity classes

arXiv:1212.5958

Charged kaon femptoscopy at √s = 7 TeV

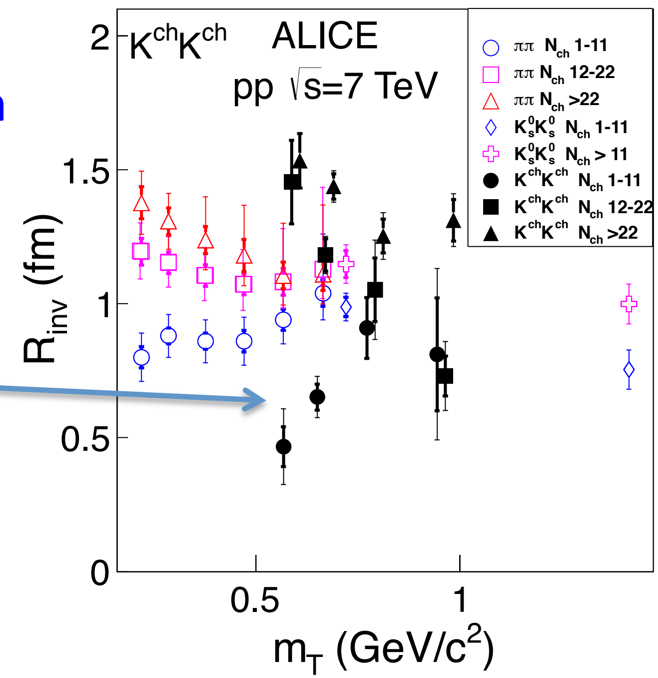
arXiv:1212.5958 ALICE

The fit of the correlation function with a single gaussian allows to extract the size of the source (R_{INV}) and the correlation strength.

R_{INV} increases with the event multiplicity and decreases with the pair transverse mass (m_T).

Same trend is observed with π and K^0_S correlation in pp at √s = 0.9 and 7 TeV and in Pb-Pb collisions

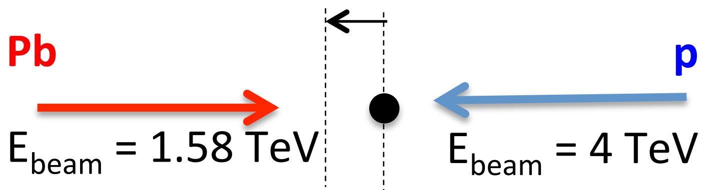
Hint of increases R_{INV} with m_T in the low multiplicity bin.

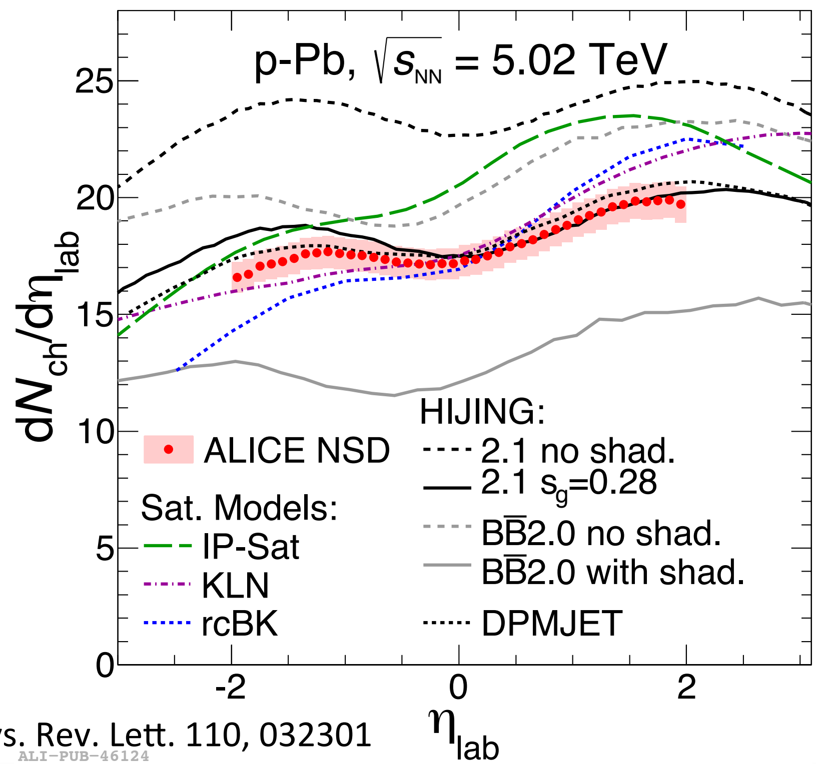


p-Pb first results

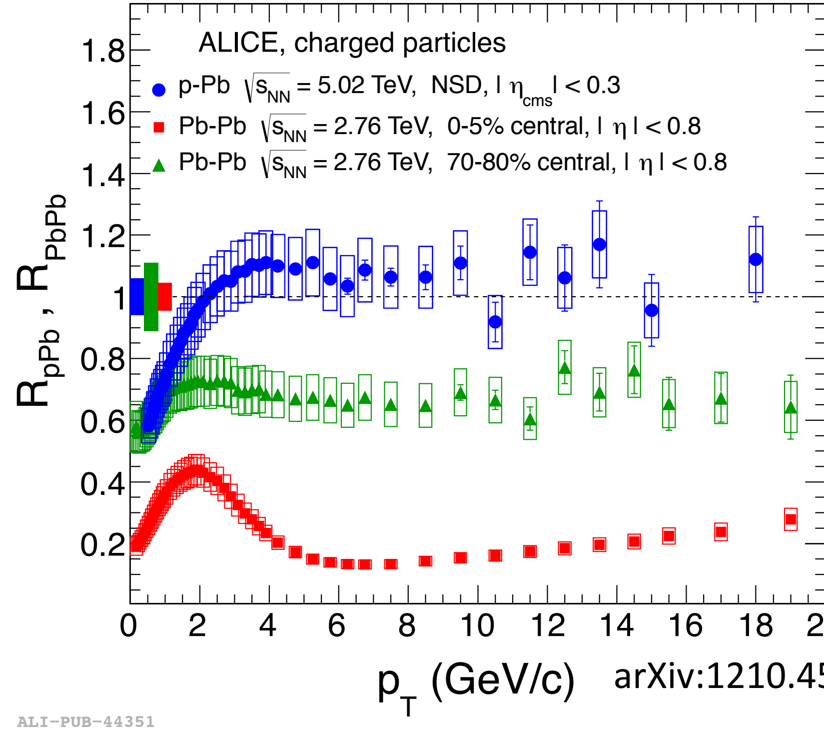
Pilot run pA
September 2012

center-of-mass system
moved by $\Delta y_{NN} = 0.465$





Phys. Rev. Lett. 110, 032301



arXiv:1210.4520

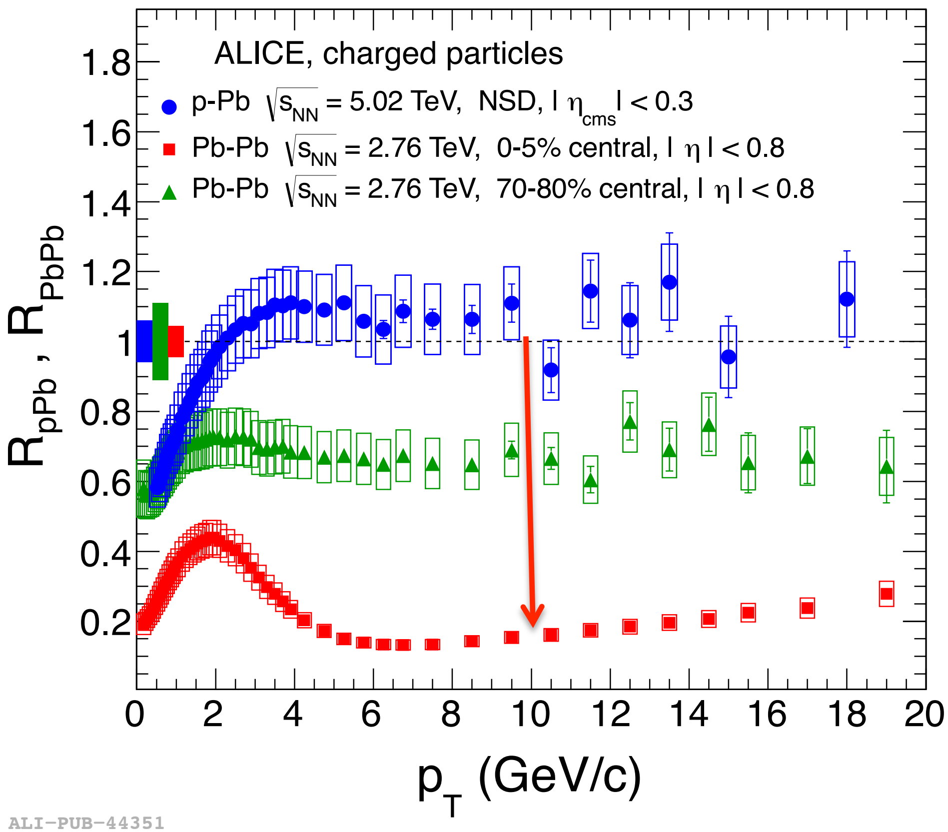
- **Less eta asymmetry than predicted by saturation models**
- **Suppression of high p_T particles in central Pb-Pb collisions has to be attributed to hot QCD matter, not to initial state effects**

p-Pb first results: R_{pPb} (p_T)

Pilot run pA
September 2012

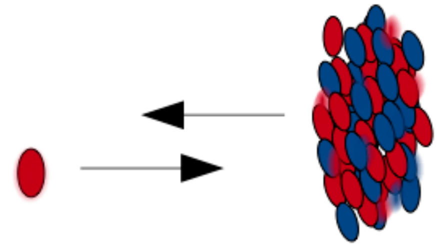
$$R_{pPb}(p_T) = \frac{d^2N_{ch}^{pPb}/d\eta dp_T}{\langle N_{coll}\rangle d^2N_{ch}^{pp}/d\eta dp_T} = \frac{d^2N_{ch}^{pPb}/d\eta dp_T}{\langle T_{pPb}\rangle d^2\sigma_{ch}^{pp}/d\eta dp_T}$$

Event selection: NSD interactions with at least one of the binary nucleon-nucleon collisions is NSD



- Indication of a softening of the spectrum with increasing η for p-Pb.
- R_{pPb} compatible with unity for high p_T
- **Suppression af high p_T particles in central Pb-Pb collisions has to be attributed to hot QCD matter, not to initial state effects**
- No strong sign of Cronin effect

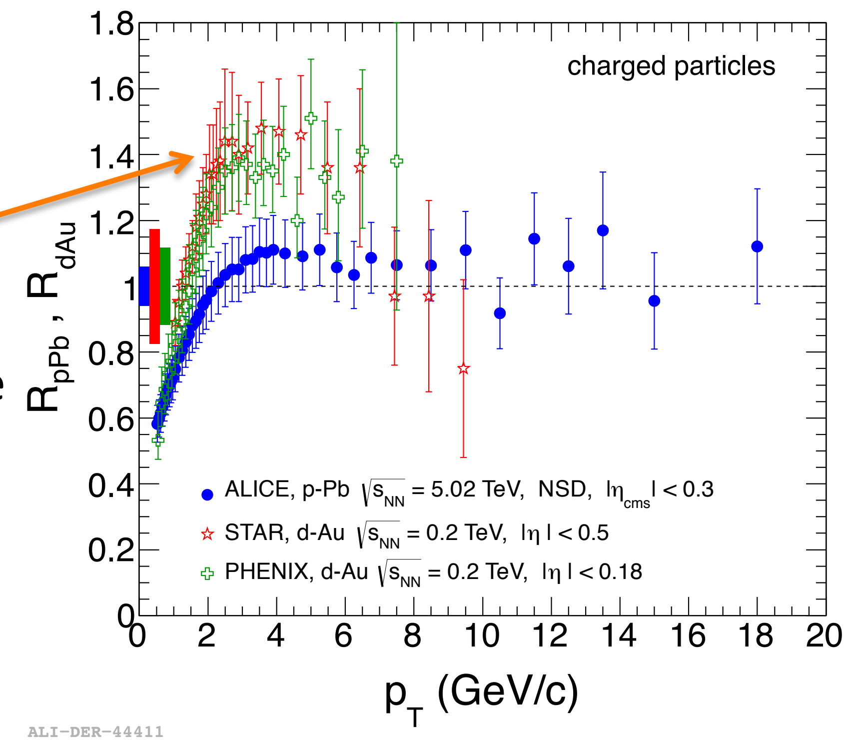
p-Pb collisions



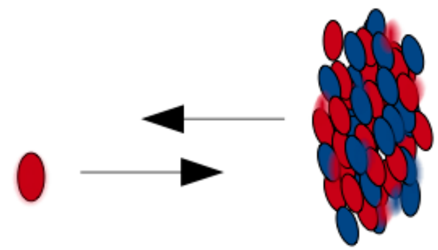
- **Study of initial state effects.**
  - Initial state effects can modify the parton distribution function with respect to the free nucleon one.
  - Effects present both in p-Pb and Pb-Pb collisions.
  - Effects measured in Pb-Pb are a "superimposition" of initial state effects and hot nuclear matter effects.

Cronin Effect (experimental observation)

- Projectile partons might increase their momentum, via multiple collisions with target partons, before the hard scattering which will produce the measured hadrons
- nPDF modification at RHIC energies (anti-shadowing)



p-Pb collisions



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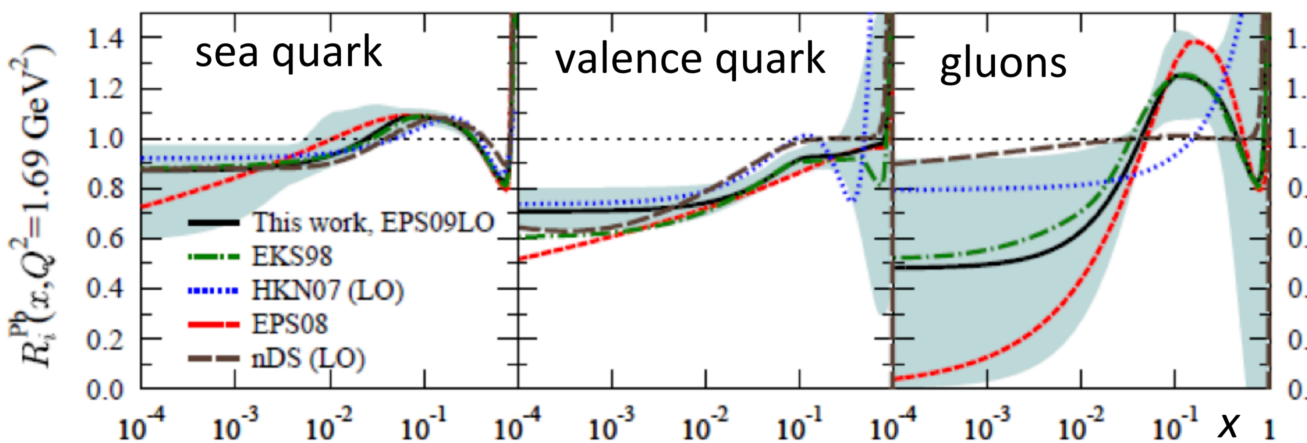
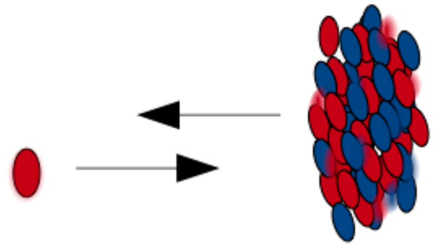
Shadowing
Parton distributions functions (PDF) in nuclei modified
with respect to those in a free nucleon depending on the Bjorken x.

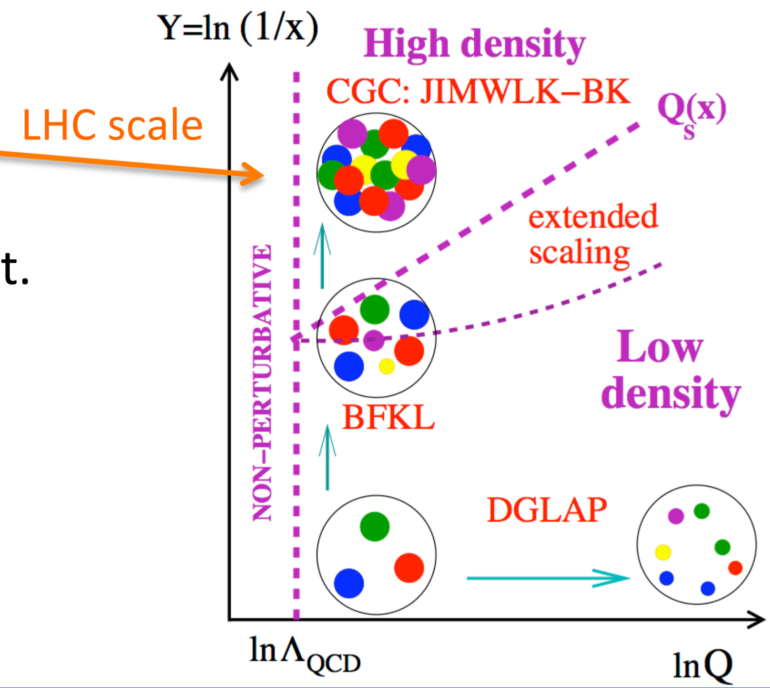


p-Pb collisions



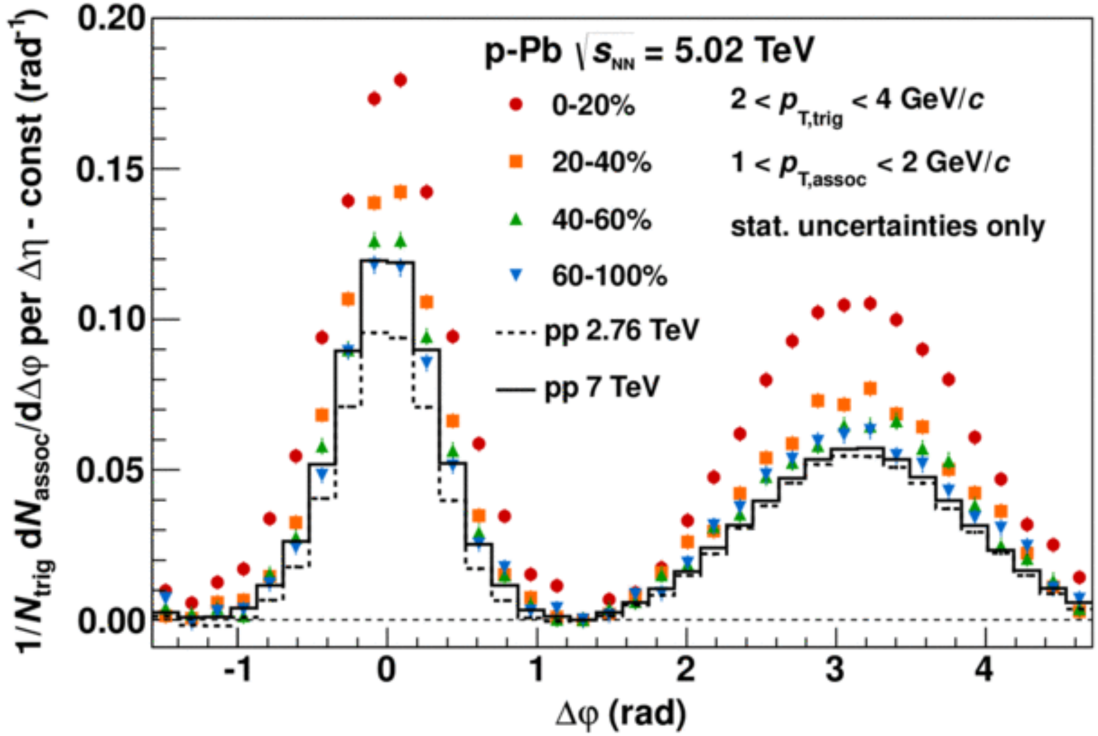
- **Study of initial state effects.**
  - Initial state effects can modify the parton distribution function with respect to the free nucleon one.
  - Effects present both in p-Pb and Pb-Pb collisions.
  - Effects measured in Pb-Pb are a "superimposition" of initial state effects and hot nuclear matter effects.

Gluon saturation:
High parton density at very small x.
Gluon "fusion" might be possible.
Non-linear evolution → saturation effect.



The ridge

Multiplicity classes:
0-20%
20-40%
40-60%
60-100%



Shifted to same baseline by subtracting the value at

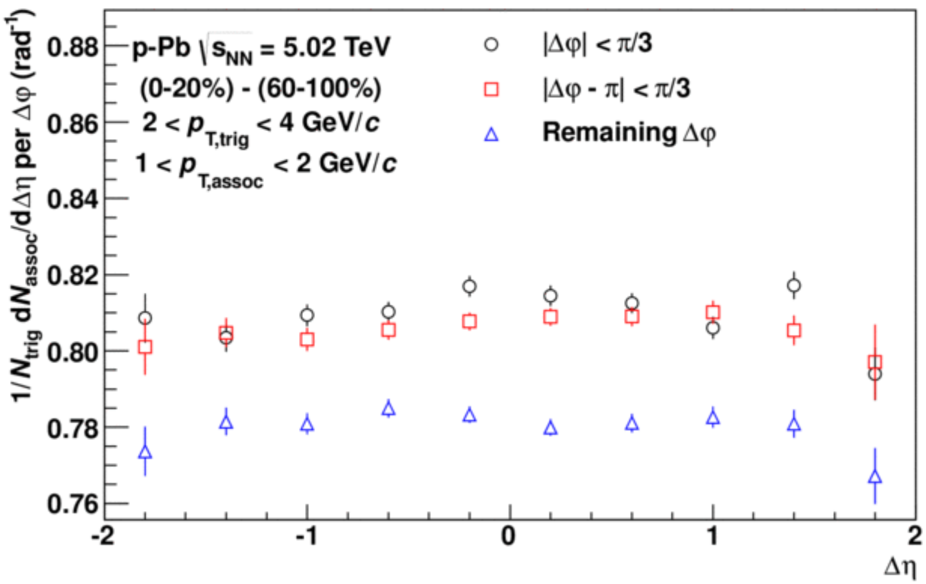
$\Delta\varphi = 1.3$

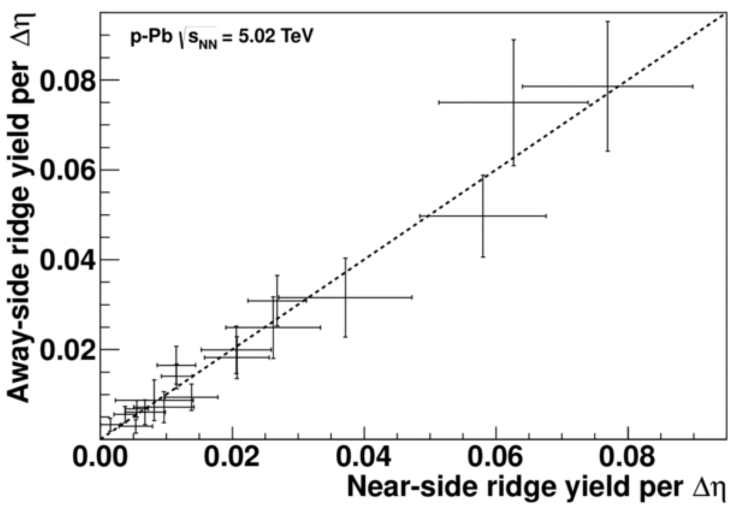
Low multiplicity class agrees with results from pp collisions

Increase of the yield on the near-side and away-side towards higher event multiplicity classes

Ridge yields

- Integrating near side and away side above baseline allows to extract ridge yields
- Increase with p_T and multiplicity



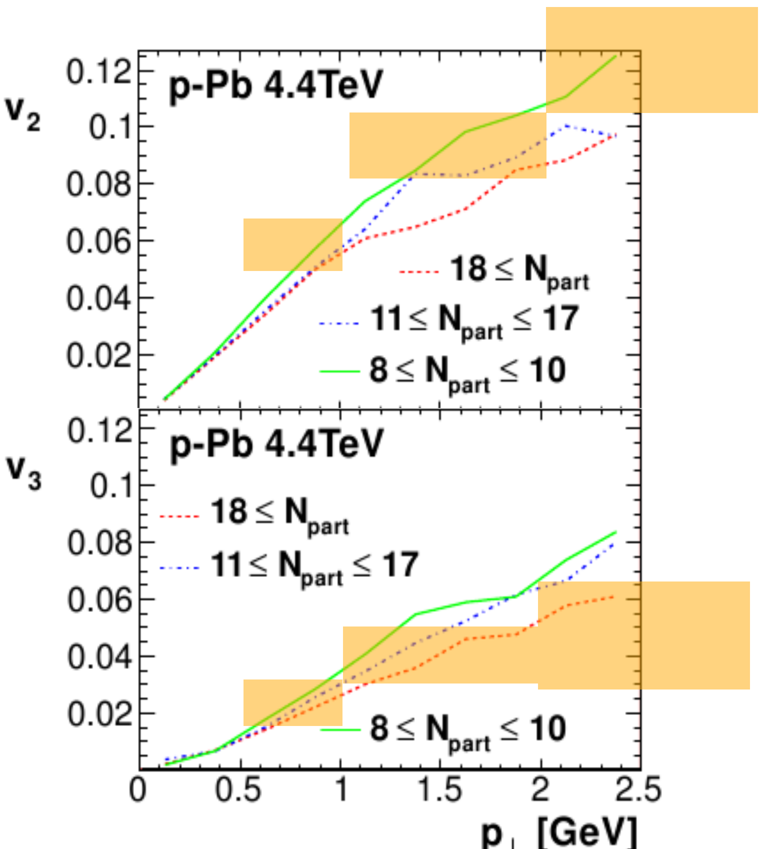


- Despite significant change in absolute values, remarkable agreement of near side and away side ridge yields.

Common underlying physical origin for near side and away side ridge?

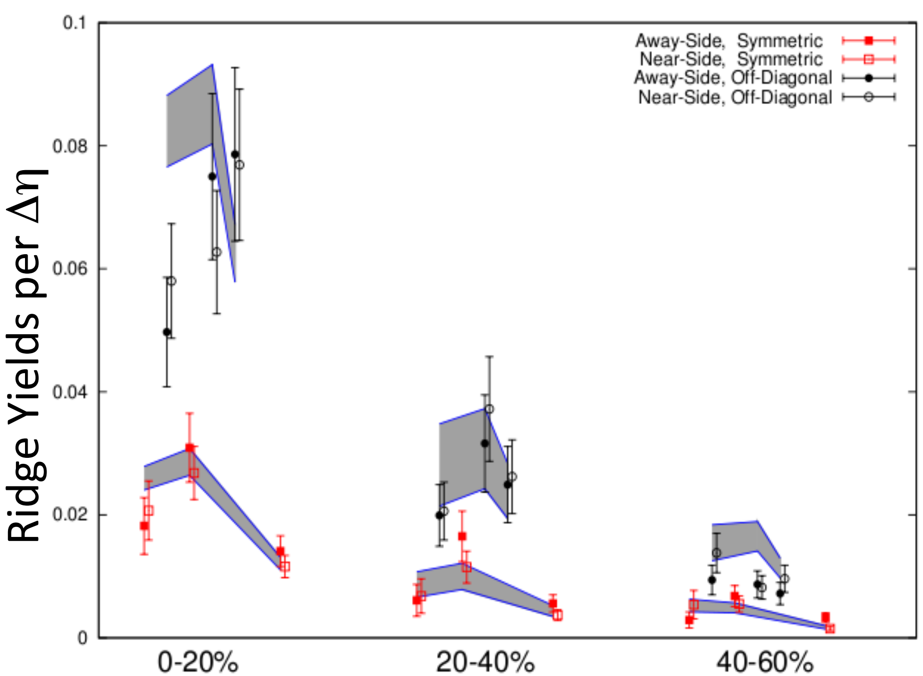
Comparison to models

3+1 viscous hydro in p-Pb collisions (arXiv:1112.0915)



Boxes: our values for 0-20%

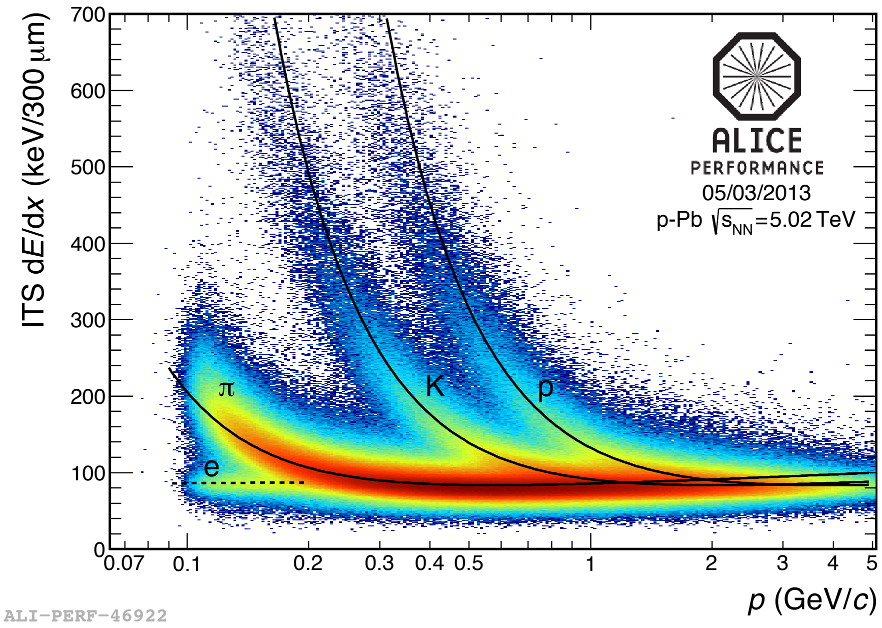
Color glass condensate (arXiv:1302.7018)



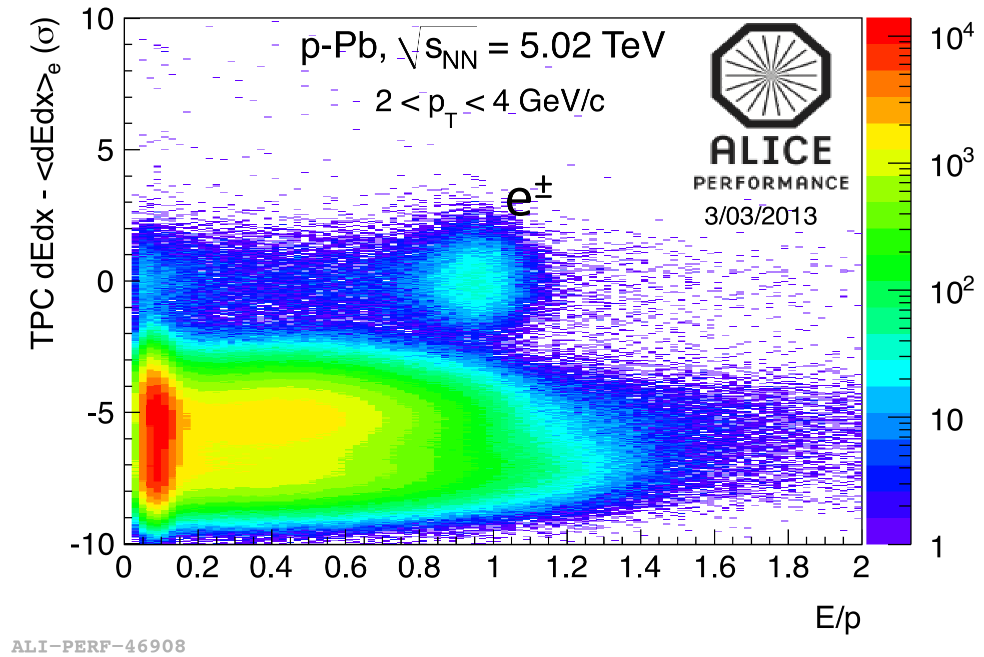
First look at 2013 pA data... Particle ID

Possible collective effects will be further investigated with other measurements...

Silicon Tracker dE/dx for very low p_T PID



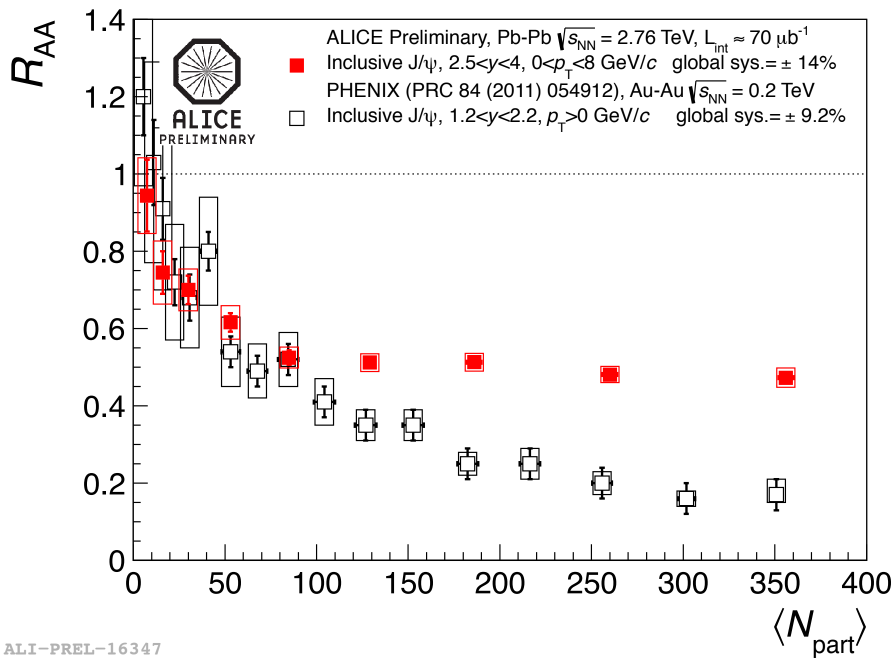
EMCAL + TPC for electron PID

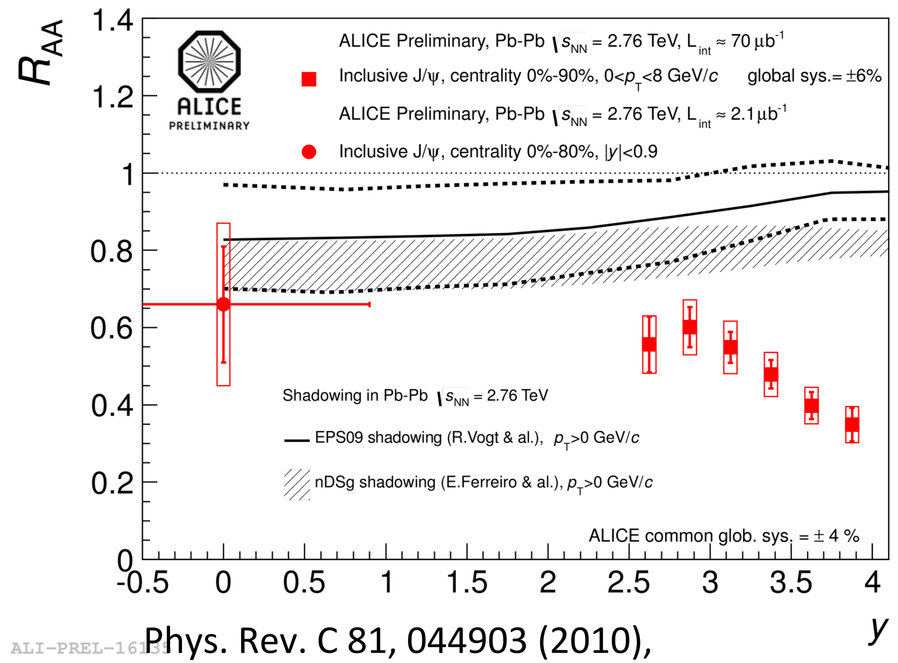


Charmonium

Interesting behaviour of low p_T J/ψ suppression in Pb-Pb collisions at LHC with respect to RHIC energy → new effects at the LHC?

Shadowing can play an important role at LHC energies for the J/ψ suppression.





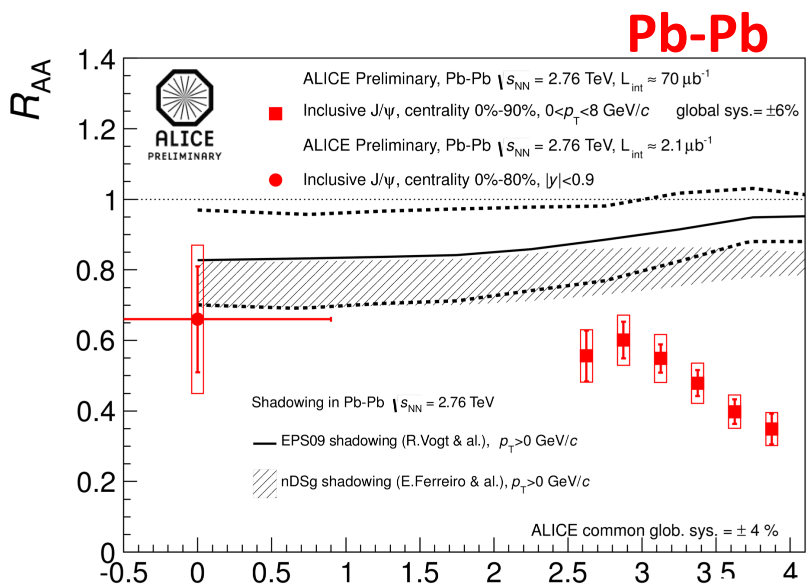
Phys. Rev. C 81, 044903 (2010), Nucl. Phys. A855, 327 (2011).

Charmonium

Several theoretical calculations available for p-Pb:
R. Vogt et al. (arXiv:1301.3395)
F. Arleo, S. Peigné (arXiv:1212.0434)
E. Ferreiro et al. (arXiv:1101.5295)

Different treatments of the J/ψ productions, initial state effects, interactions, …

and Pb-Pb R. Vogt et al.
E. Ferreiro et al.



Phys. Rev. C 81, 044903 (2010),
Nucl. Phys. A855, 327 (2011).

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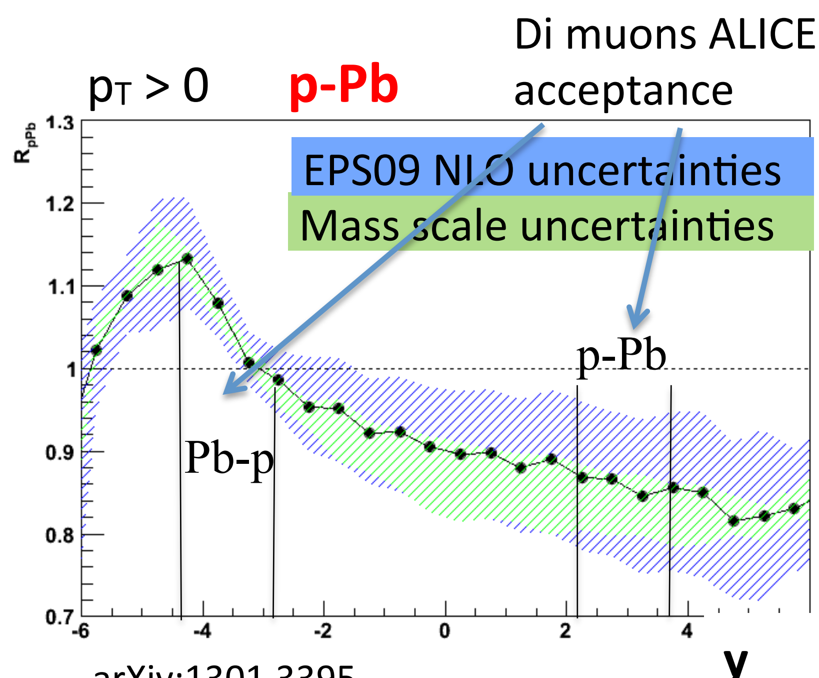
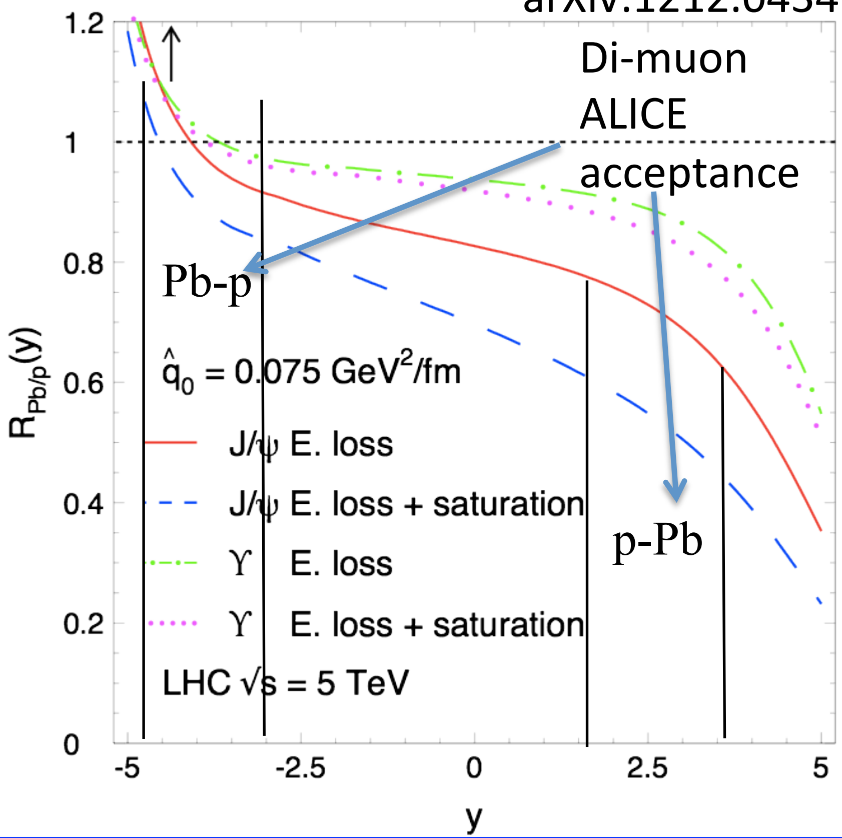


arXiv:1301.3395

Charmonium

Initial state effects can induce a J/ψ suppression not due to hot nuclear matter
Different theoretical calculations available "on the market".

arXiv:1212.0434



F. Arleo, S. Peigné (arXiv:1212.0434)
World data parametrization for the production cross section

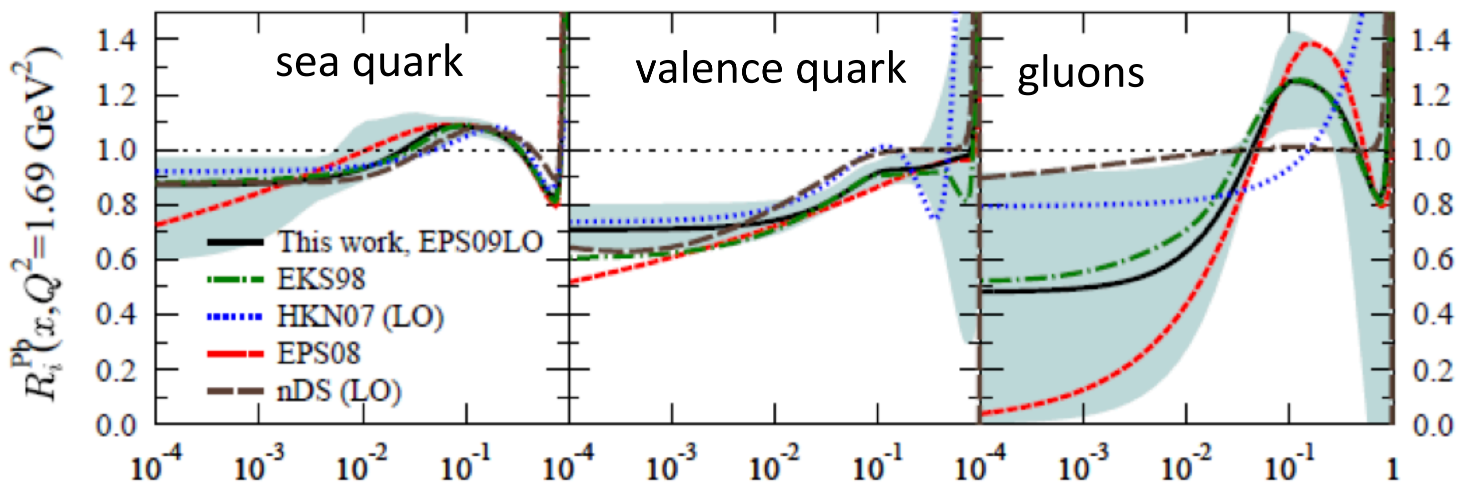
Included parton energy loss

Calculation with and without saturation effects

E. Ferreiro et al. (arXiv:1101.5295)
Color singlet model, EKS98, nuclear absorption

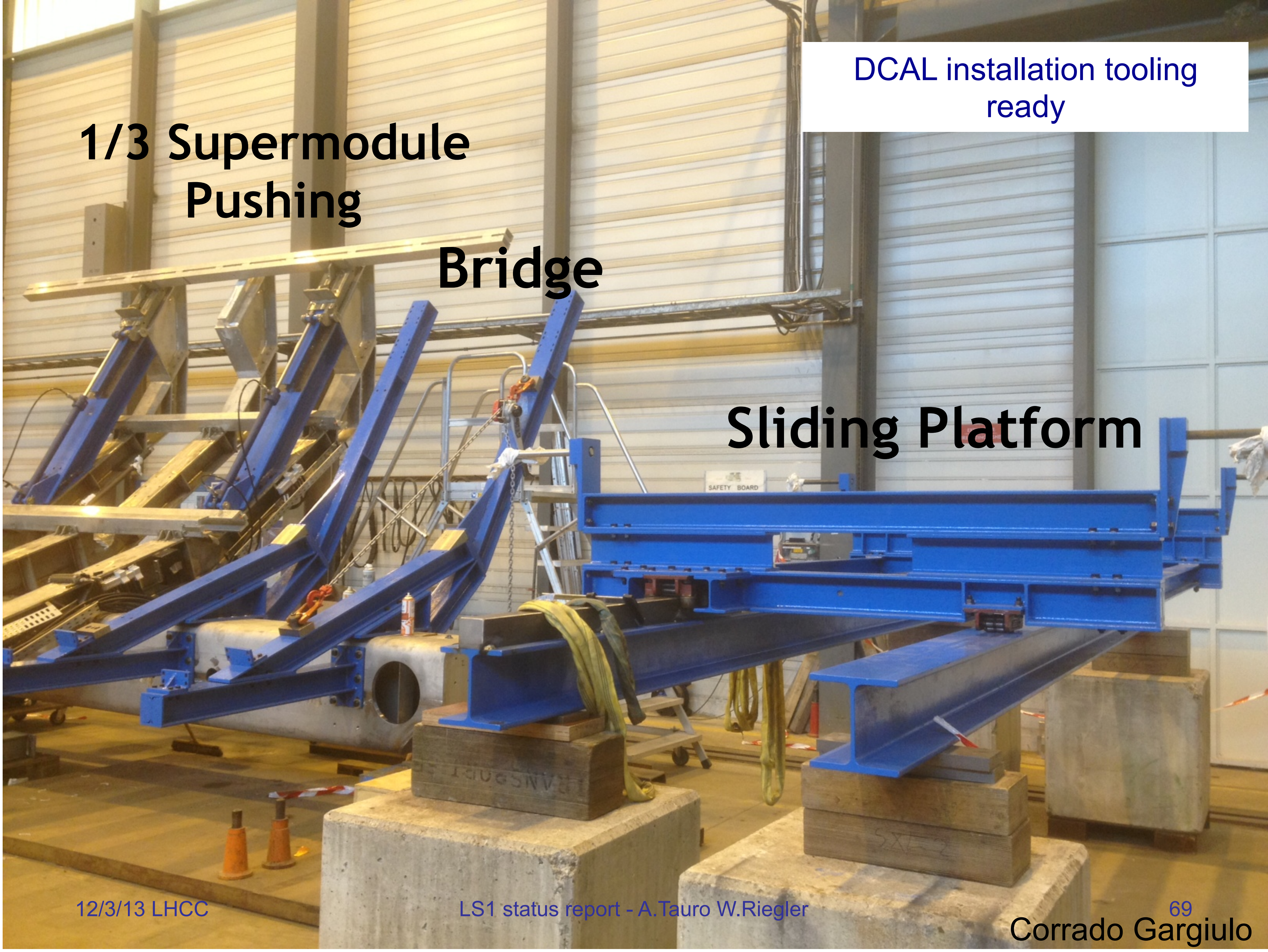
Open Heavy Flavour production and nPDF in p-Pb

nPDF functions are modifed in a small-x energy regime.



R_{pPb} for heavy flavour particles important measurement to quantify the relevance of initial-state effects, which may be strong at low pT.

DCAL installation tooling ready



DCal insertion tool (delivered to P2)