130th LHCC meeting – Open Session

CERN - 10 May 2017

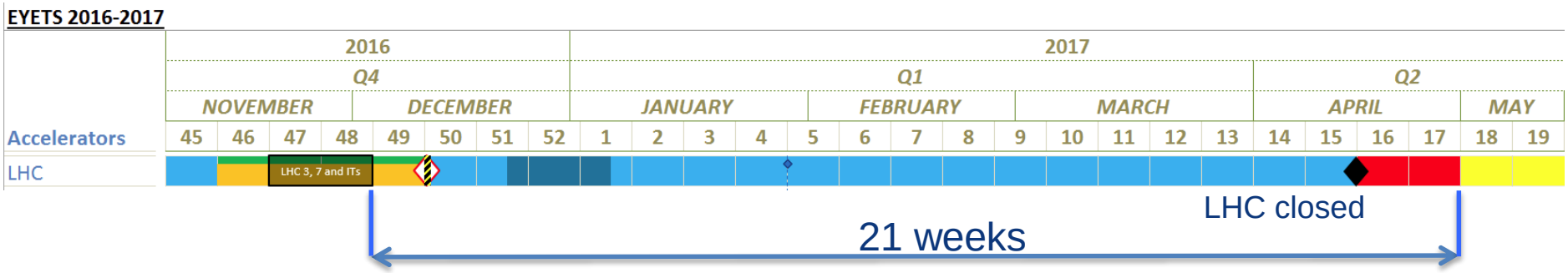
ALICE Status Report

Livio Bianchi

University of Houston

Detector maintenance and running

EYETS



Most detectors profited of this long technical stop for maintenance activities

TRD:

- Xenon recuperation
- Repair broken optical connections
- Wiener PS firmware upgrade campaign

TPC:

- Inspection of TPC inner CO2 volume (guard ring current)
- FEC replacement
- Gas back to neon

TOF:

- Displace TOF7 (DC/DC problem)
- Replace DC/DCs and TRMs on several modules

EMCAL:

- SRU displacement
- Replace several FEC

PHOS:

- Reprogram 5 problematic TRUs, exchange the broken cable for LED and investigate new version of SRU firmware
- Recover 10 FECs in M4

PMD:

- Repair several FEC on CPV side (detector in parking position)

MTG:

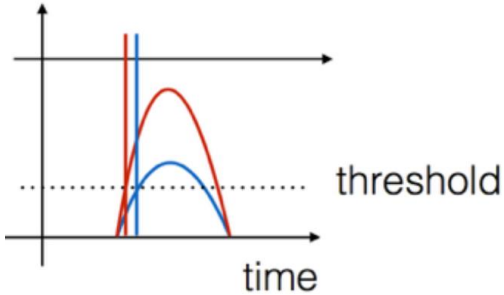
- Change all the 2304 connectors of the FET (Front-End Test) distribution cables on the RPCs

AD:

- Shielding to protect ADA from background
- Replace 3 PMTs
- New coax cables ADC

Optimization: TOF calibration

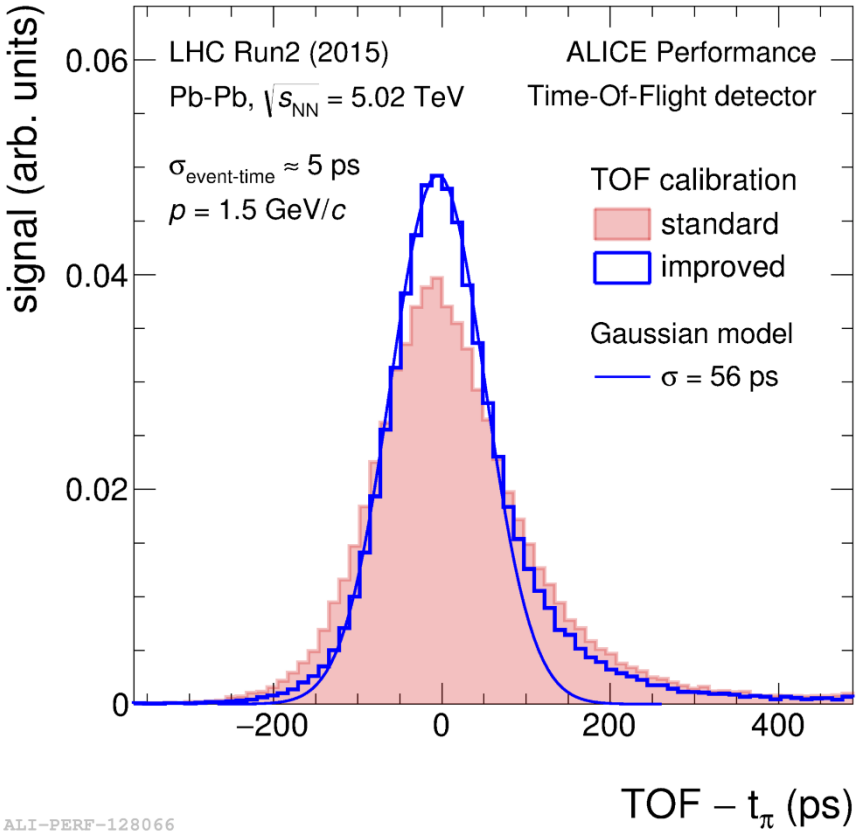
Large/small analogic signals cross FEE threshold at different times
↓
digital signal emitted at different times
↓
time-amplitude correlation (slewing)



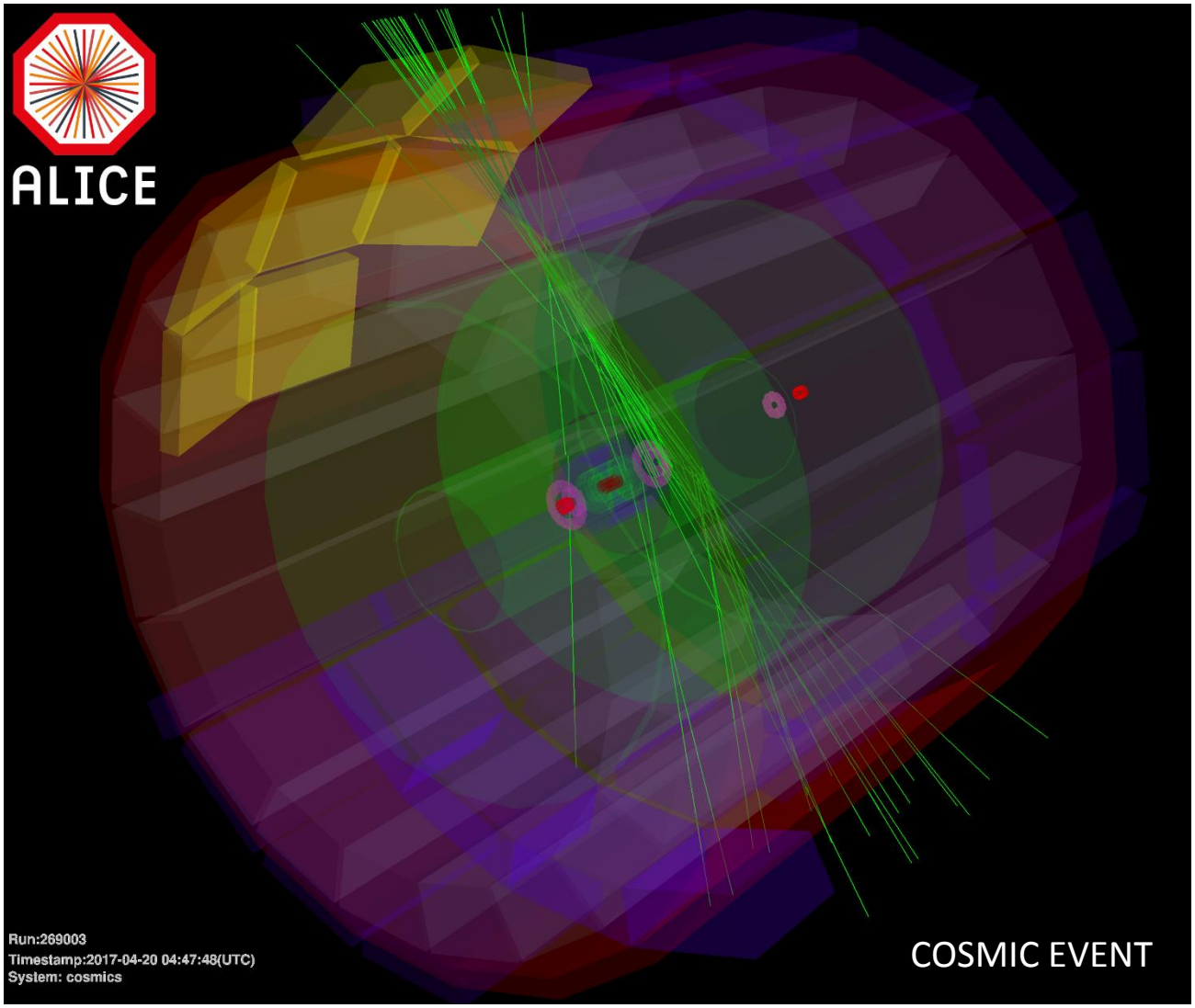
BEFORE
Parametrization of the time-TimeOverThreshold on a single-chip basis (8 channels)

With higher statistics of Run2 data: channel-by channel residuals estimation
NOW

Significant improvement which will lead to smaller systematics!



ALICE detector re-start



Since mid-April: detectors active and ready to take data

Cosmic campaign during LHC re-commissioning phase

Will use cosmic data to align both central detectors and muon spectrometer

ALICE data taking special requests for 2017

- **pp reference run @ 5 TeV**
  - Request: 1000M minimum bias events
    - 128M already collected in 2015
  - Assume 1.5 kHz readout rate
    → 6.7 days in STABLE BEAM
  - + rare triggers (parasitically)

TOP PRIORITY FOR ALICE

Several PbPb and pPb analyses affected by poor 5 TeV pp reference

Supported by LHCC.

ALICE prefers to have it in 2017

- **pp data-taking @ 13 TeV with ZDC**
  - Request: 100M minimum bias events with isolated bunches (μ<0.2-0.3%)
    - ~ 2-3 fills
  - ZDC constraints on half total crossing angle:
    - < +85 μrad (< -32 μrad) for positive (negative) crossing

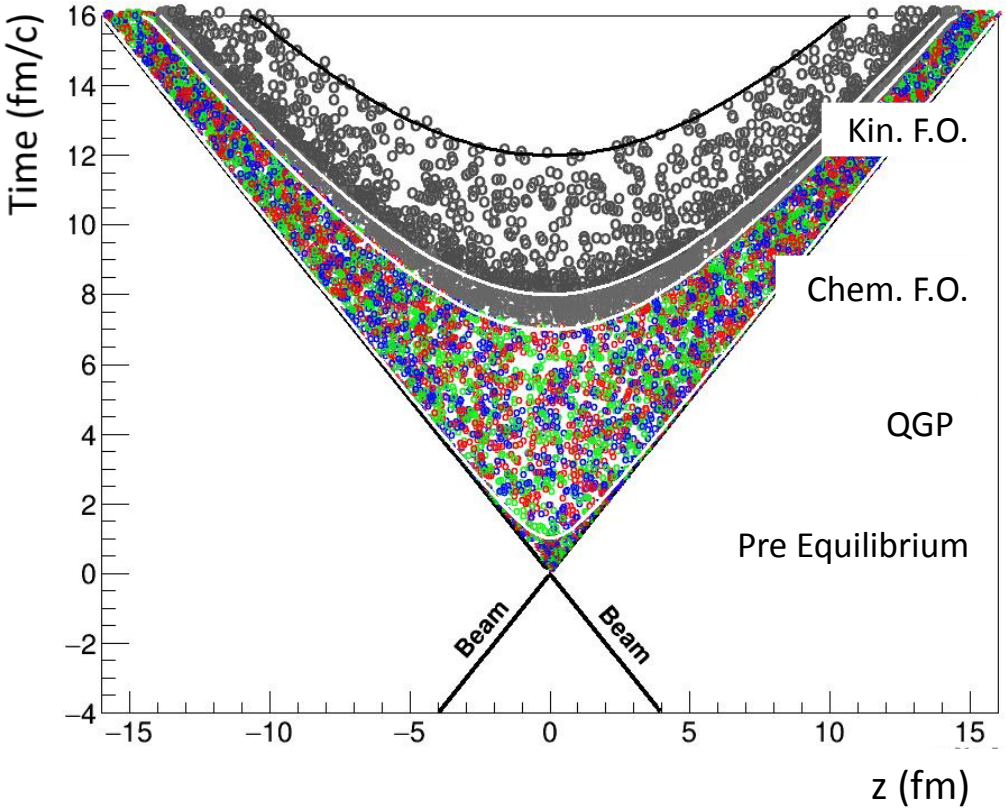
- **pp data-taking @ 13 TeV with reduced B-field (0.2T)**
  - Could be done during the intensity ramp-up phase since solenoid magnetic field has no impact on beam operations
  - ~ 40-45 h data taking

Physics results

- Pb-Pb collisions
- p-Pb collisions
- pp collisions

Resonances in Pb-Pb

Resonances are powerful tools to probe the hadronic phase after chemical freeze-out



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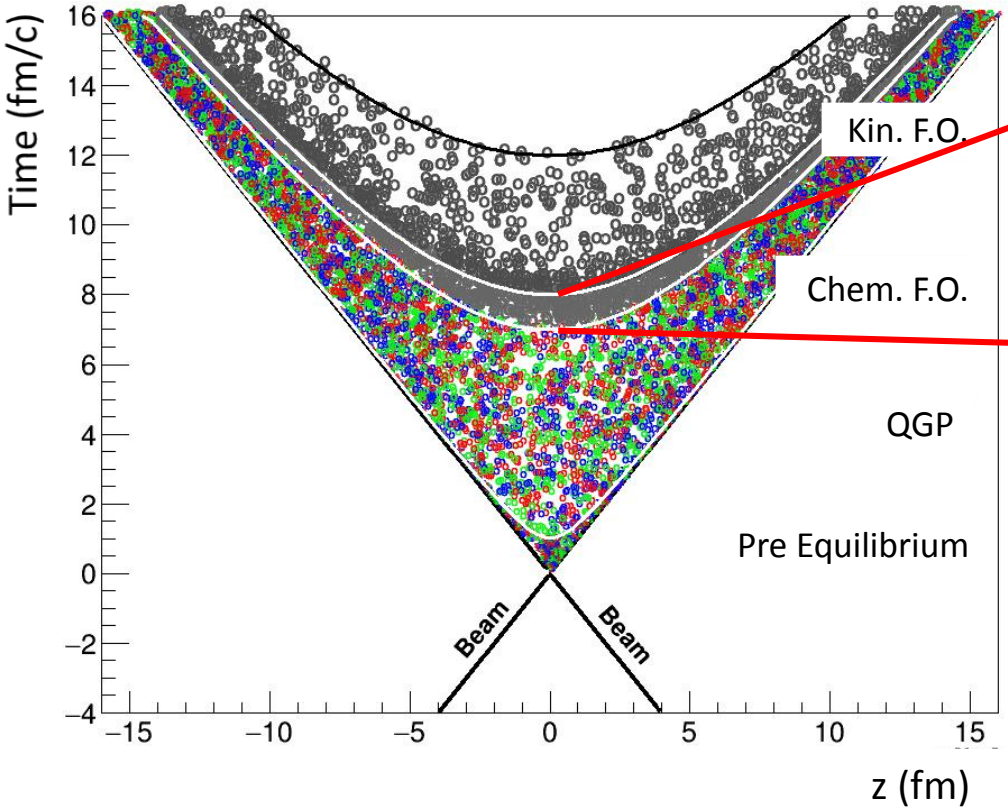

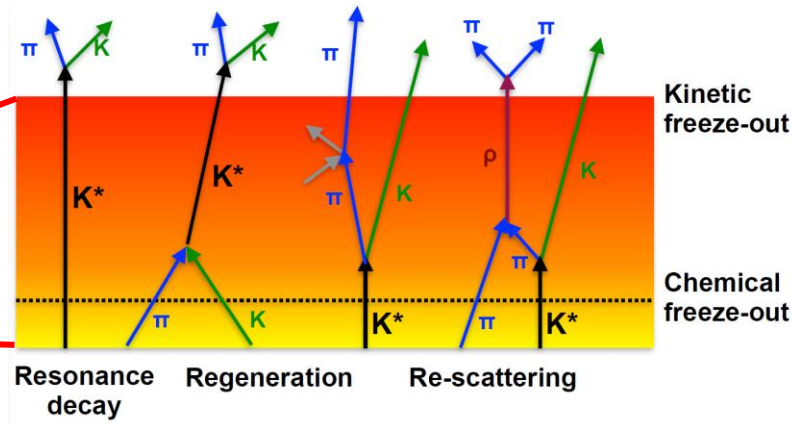

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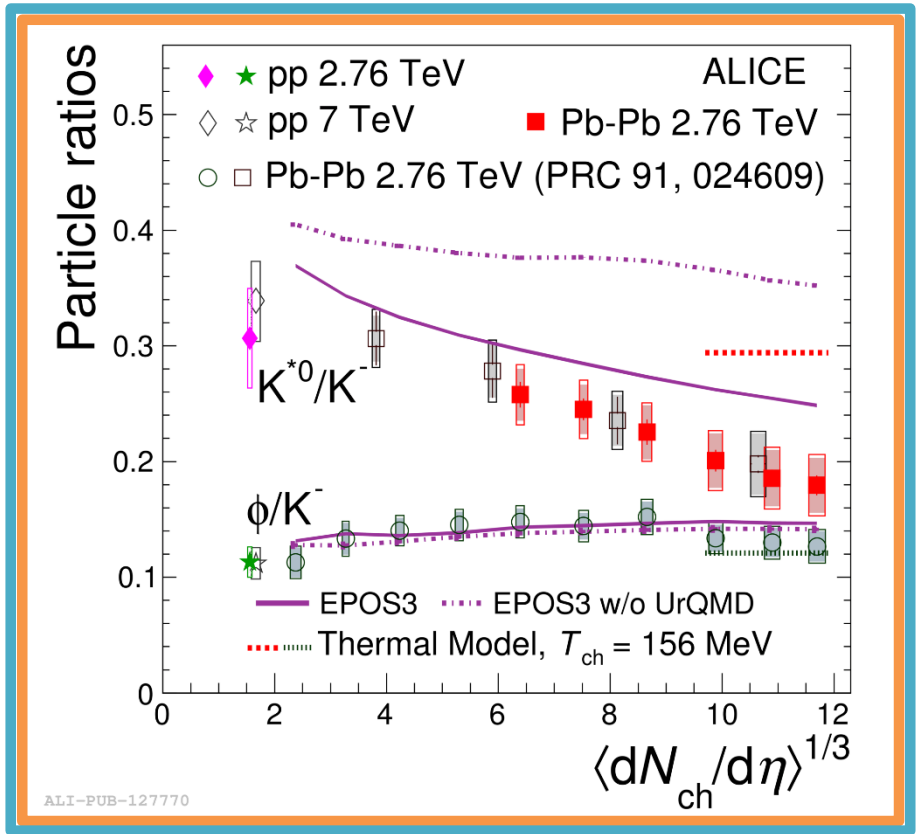

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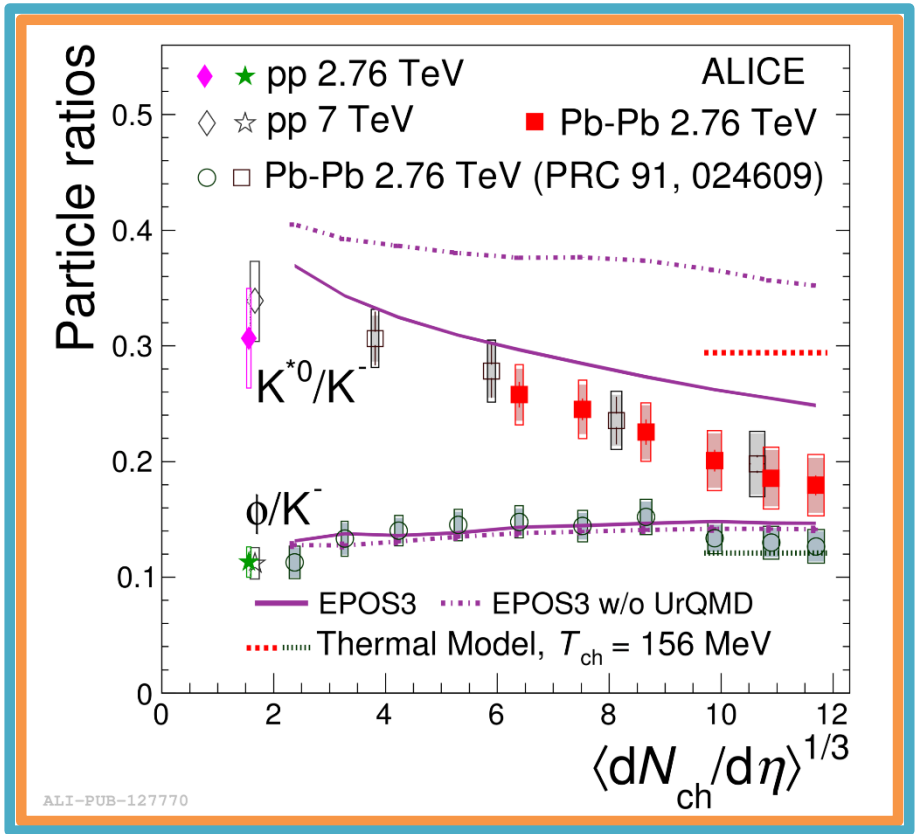

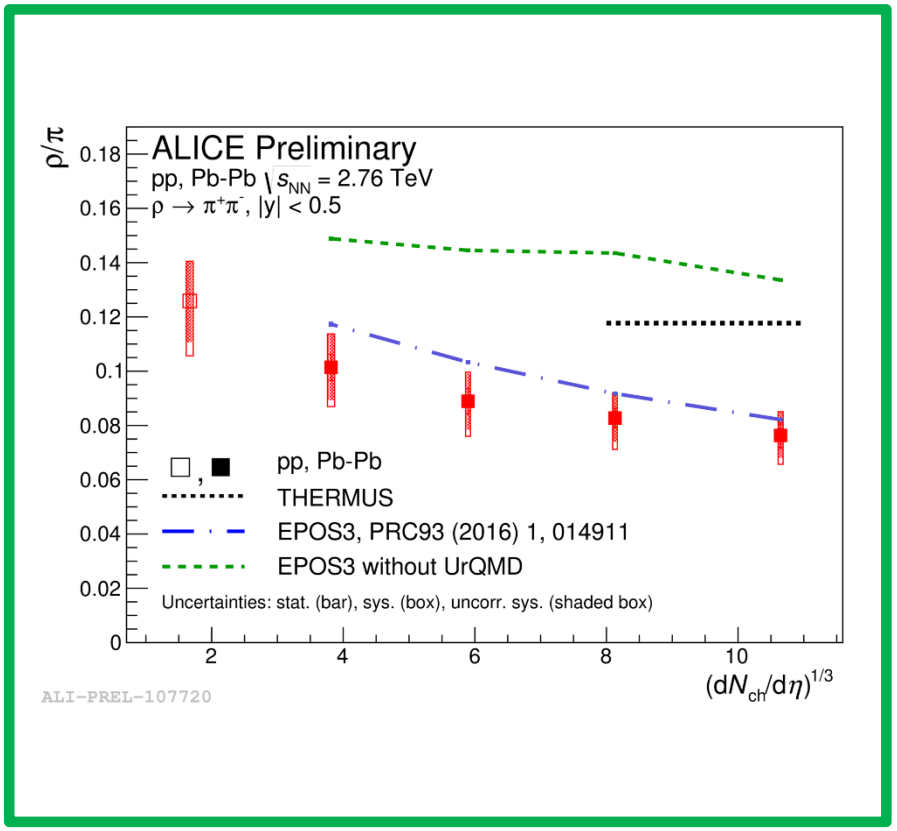

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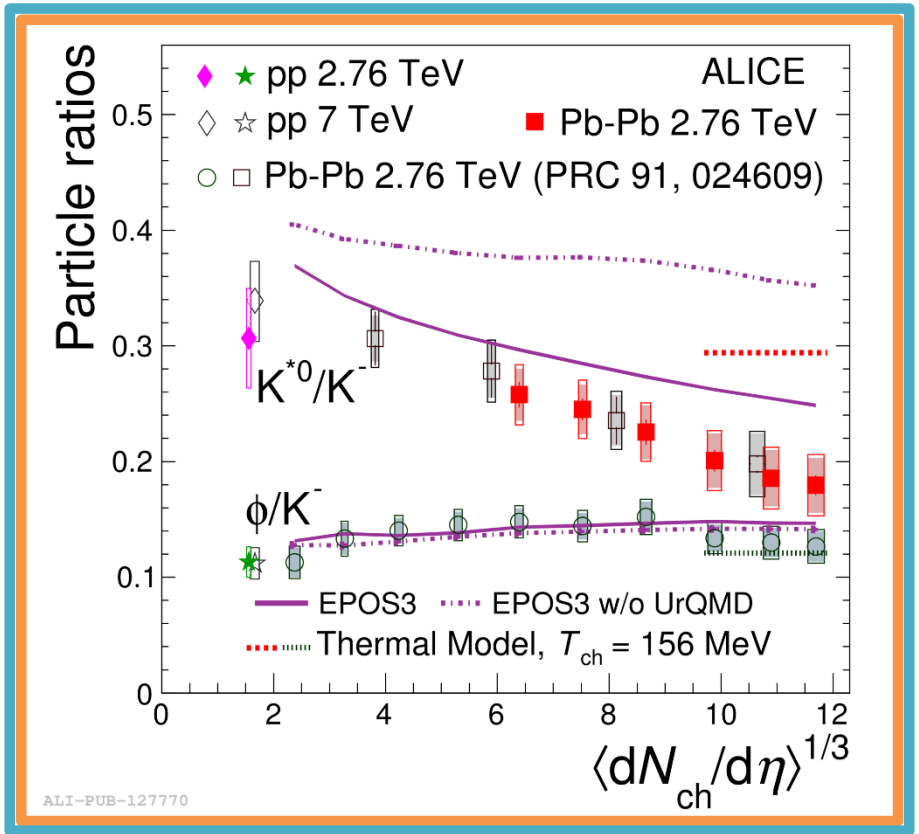

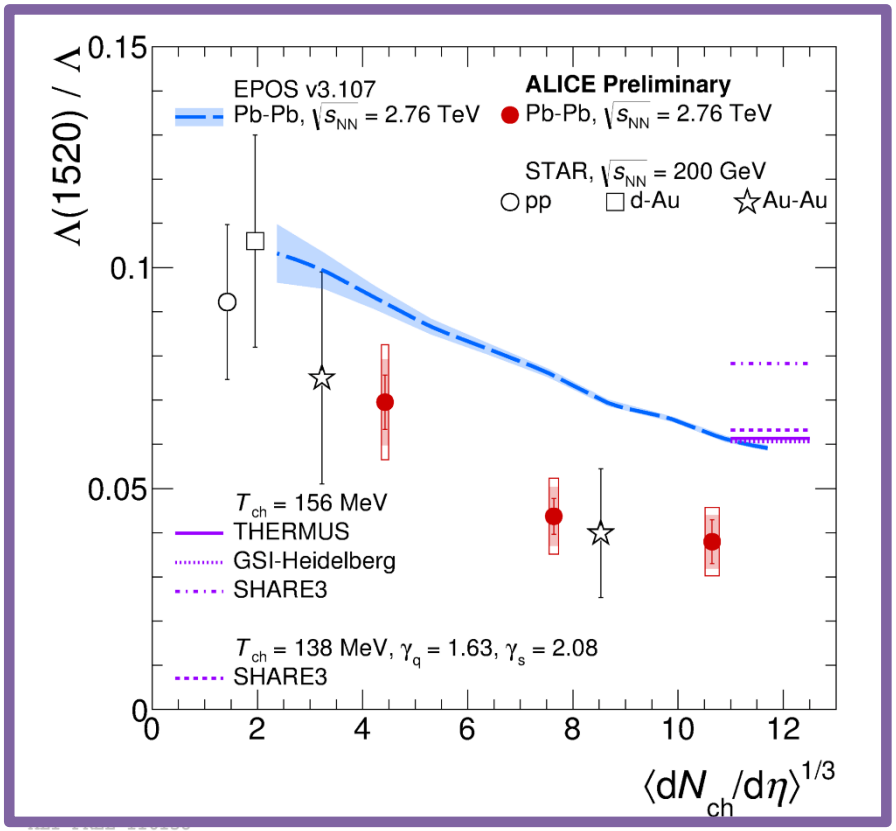

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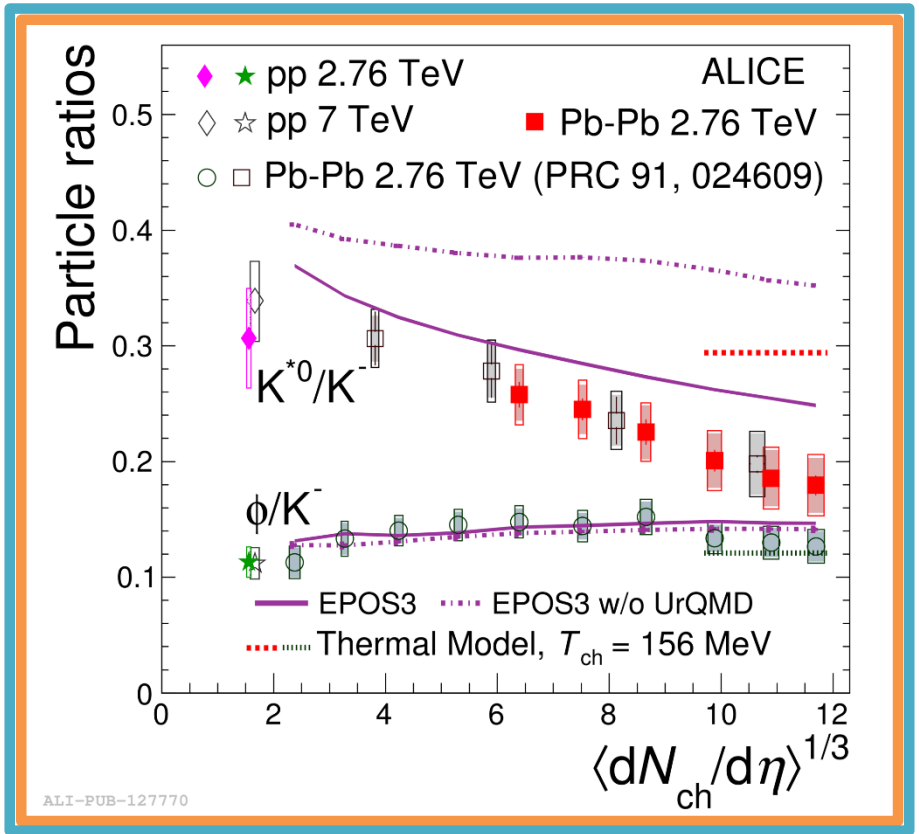

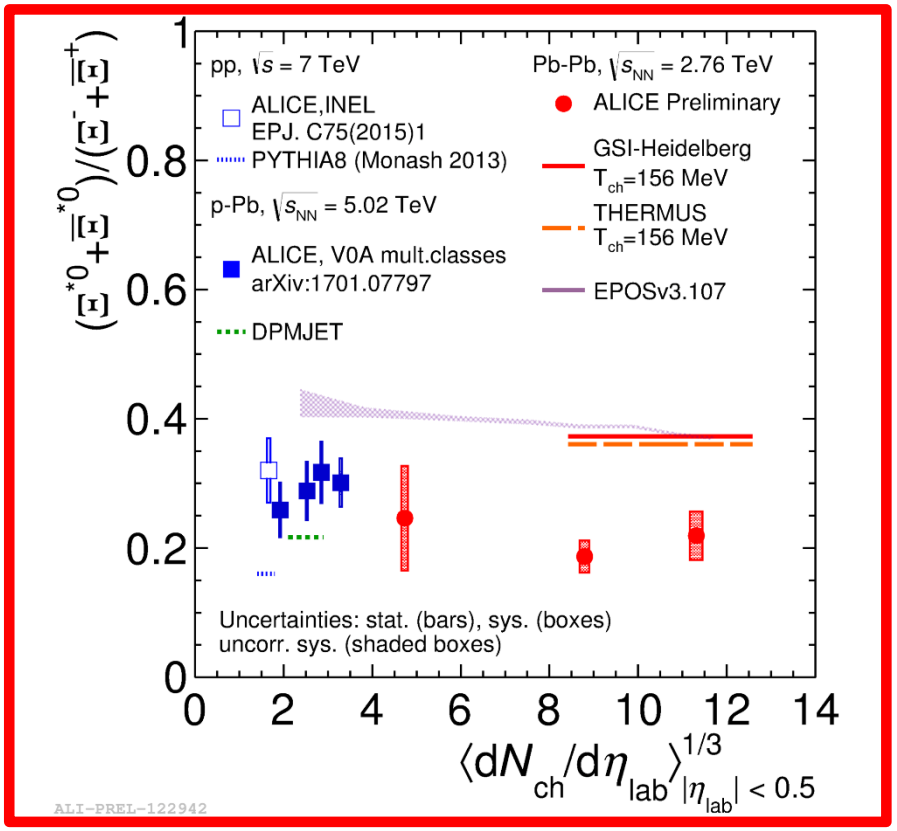

Resonances in Pb-Pb

Resonances are powerful tools to probe the hadronic phase after chemical freeze-out

Short-lived resonances exhibit suppression.
Suggests elastic scattering dominant mechanism

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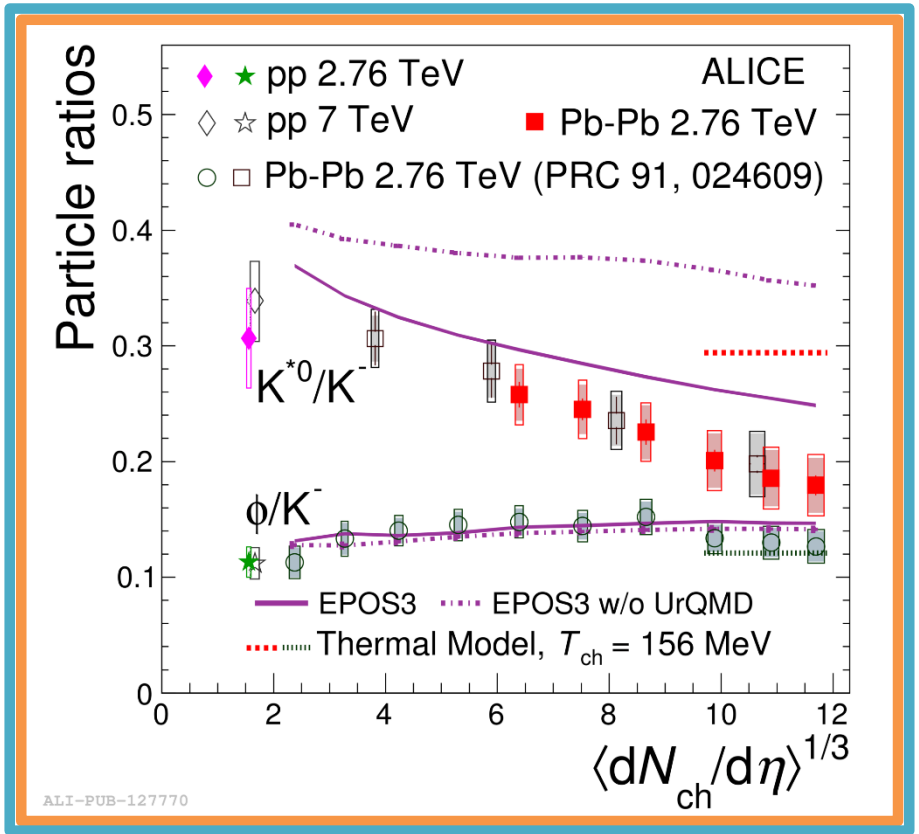

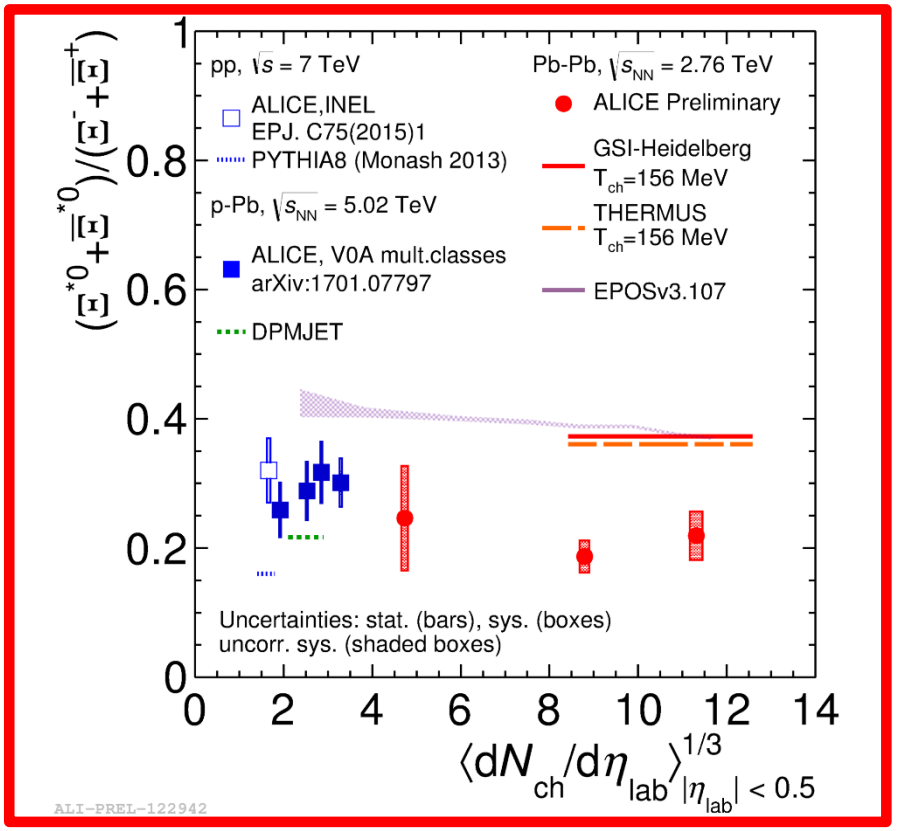

Net particle moments at the LHC

Net particle moments used to measure event-by-event fluctuations on the conserved (on average) charges at the phase boundary:

$$x = p - \overline{p}$$

# of p or $\overline{p}$ in a single event

$$\kappa_1(x) = \langle p - \overline{p} \rangle$$

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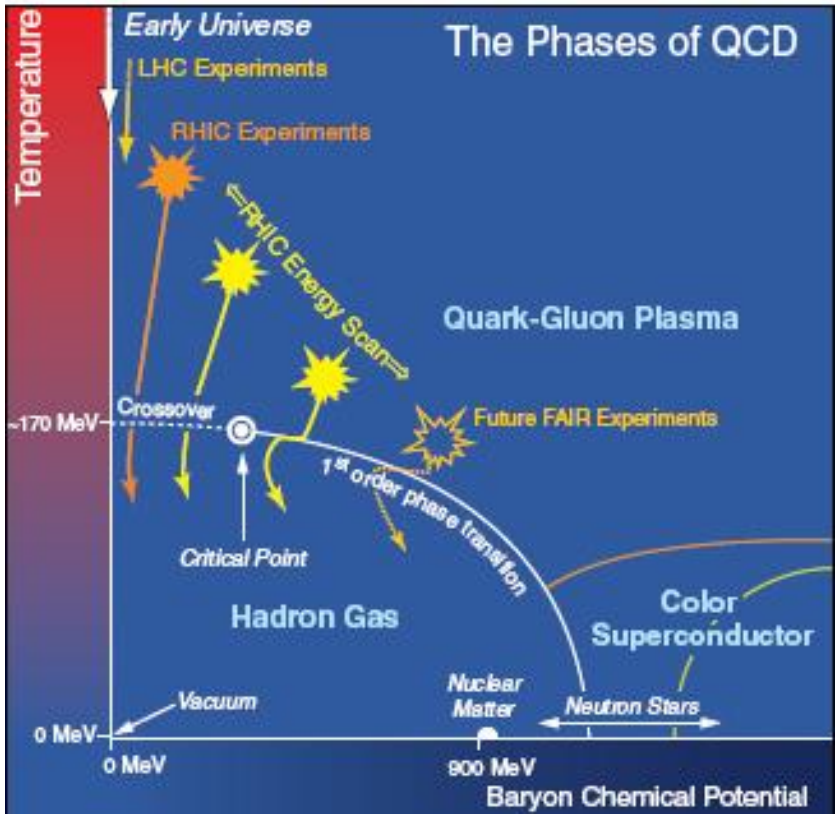
$$= \kappa_2(p) + \kappa_2(\overline{p}) - 2(\langle p\overline{p} \rangle - \langle p \rangle \langle \overline{p} \rangle)$$

$$\kappa_2(Skellam) = \kappa_1(p) + \kappa_1(\overline{p})$$

Difference of two Poisson distributions

Correlation term.
Can come from:

- Resonance decay
- Global charge conservation (baryon number, strangeness, …)



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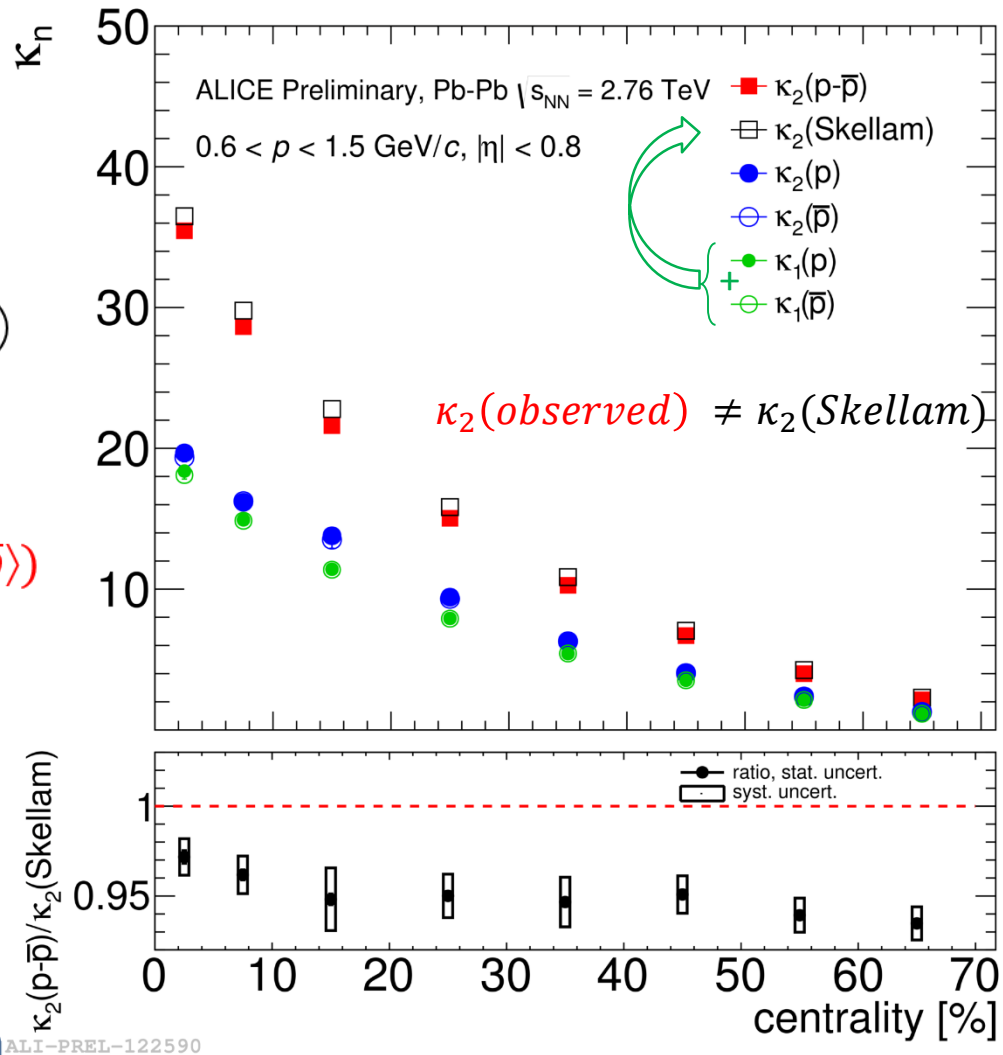

Where does this difference come from?

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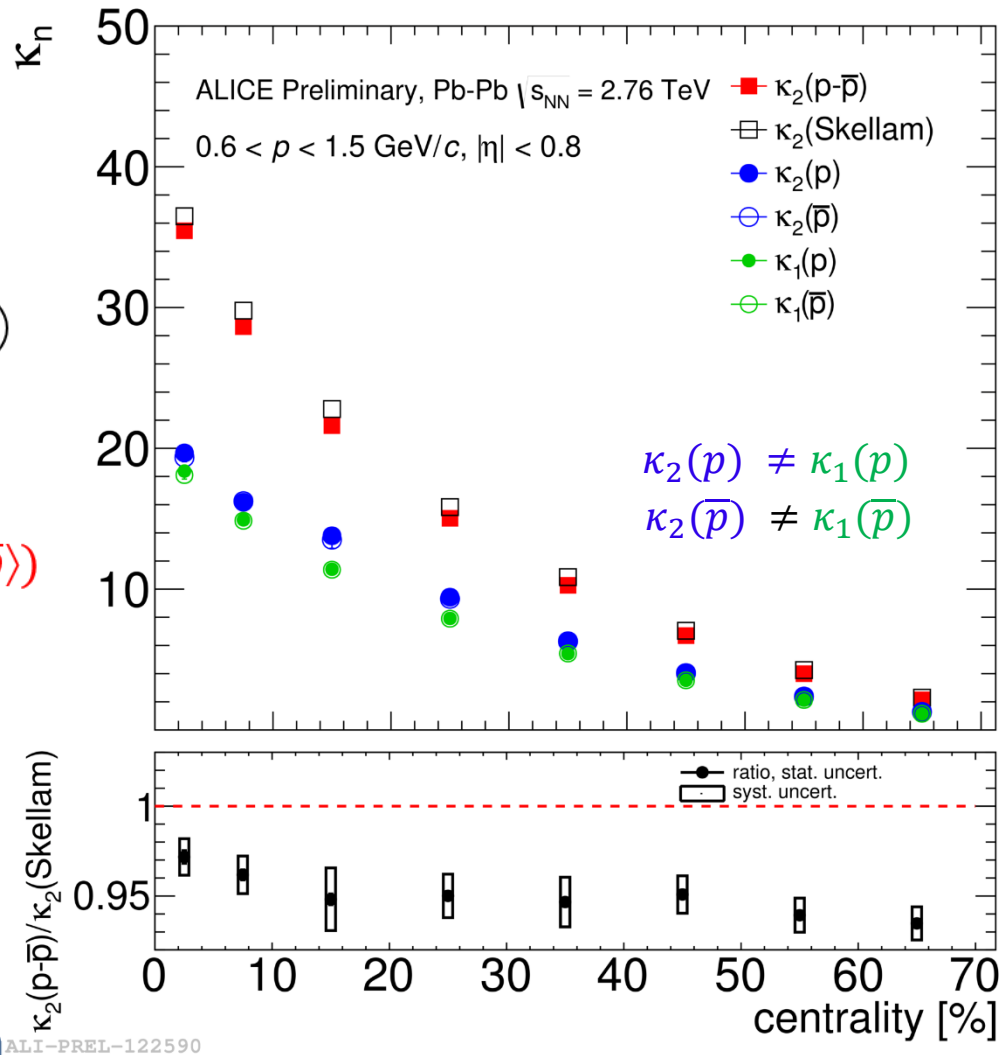

Hint for non-Poissonianity of p and $\overline{p}$?

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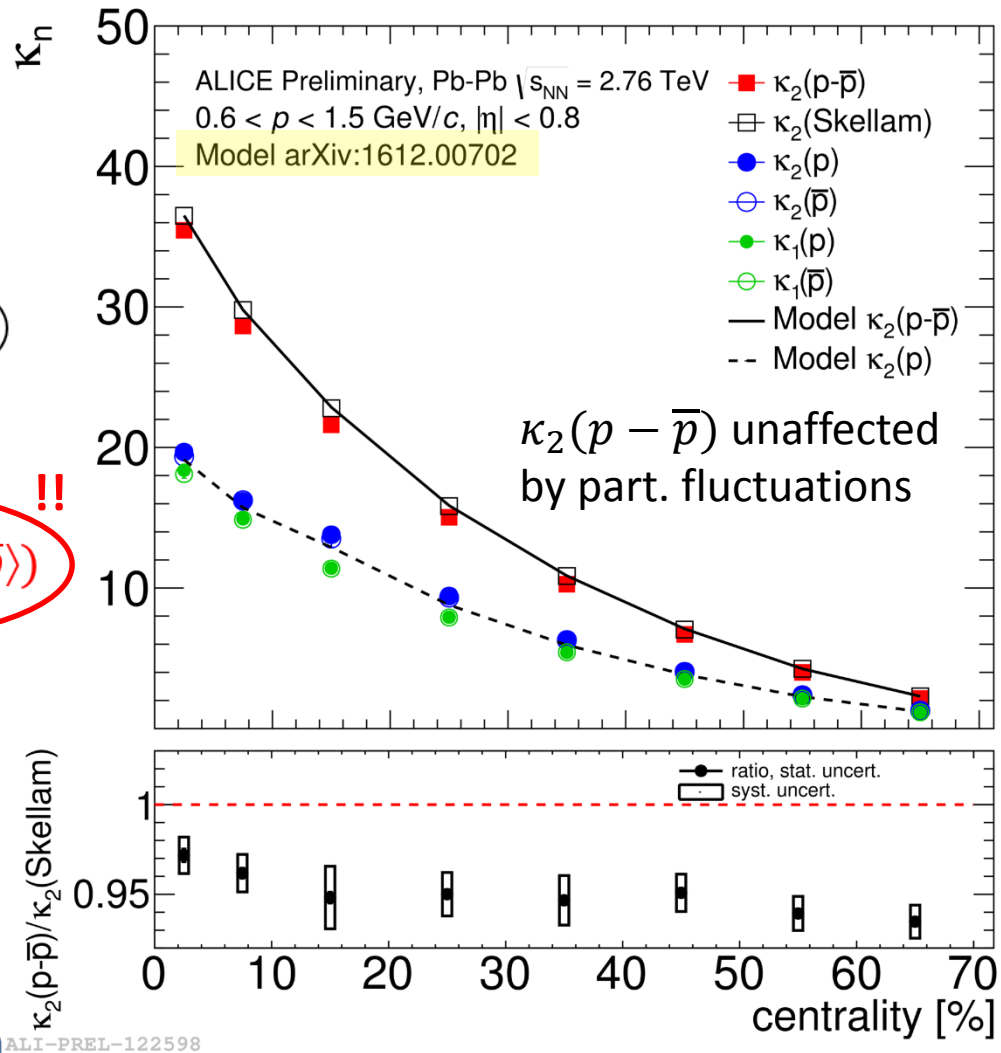

Model: participants fluctuation (with Poisson input) reproduces $\kappa_2(p)$, $\kappa_2(\overline{p})$, $\kappa_2(Skellam)$

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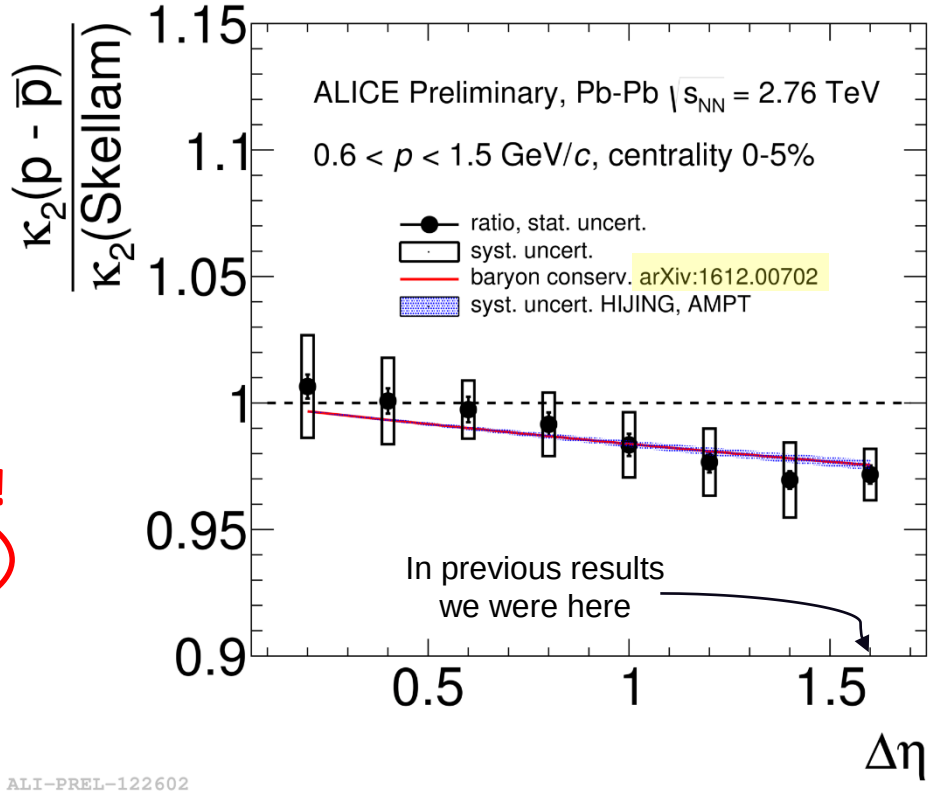
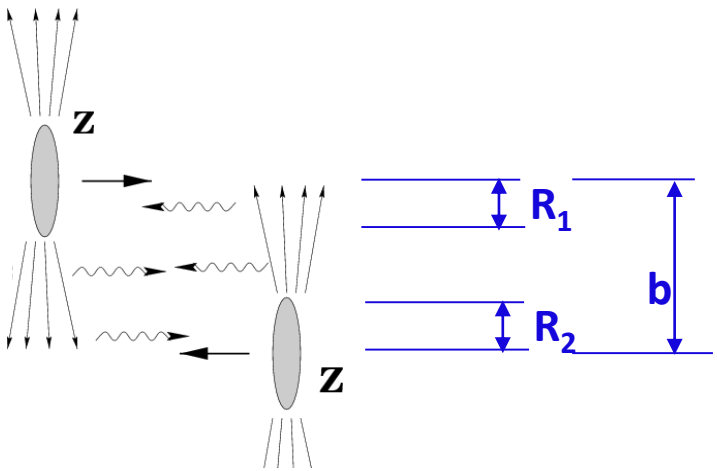


Effect of acceptance restriction on deviation from Skellam due to global baryon number conservation

Correlation observed is due to total baryon conservation

LHC as a γ-Pb and γ-p collider



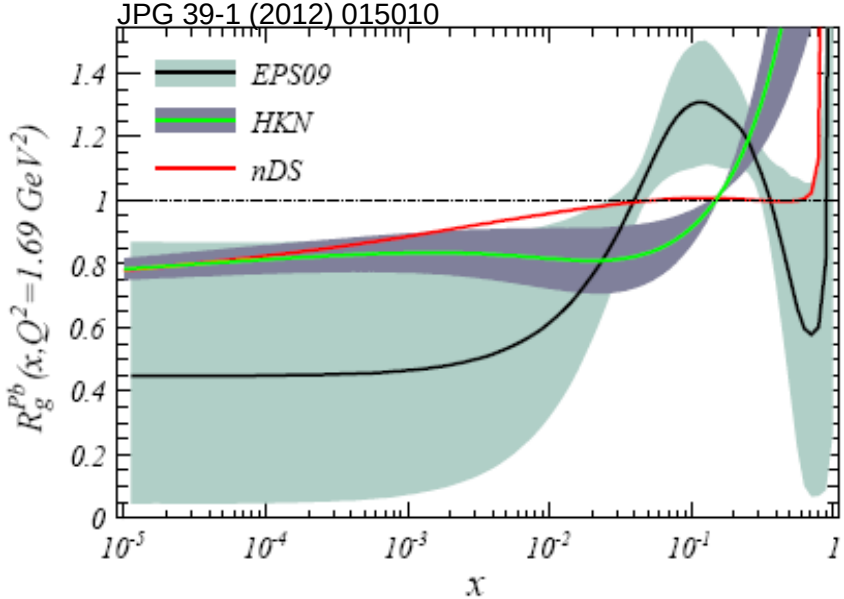
In ultra peripheral collisions (UPC) hadronic interactions strongly suppressed

High photon flux ($\propto Z^2$)

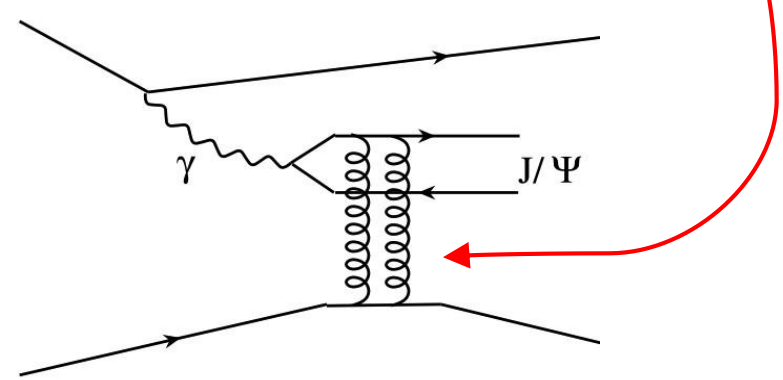
↓

possible to study photo-induced reactions at highest CM energy ever

JPG 39-1 (2012) 015010



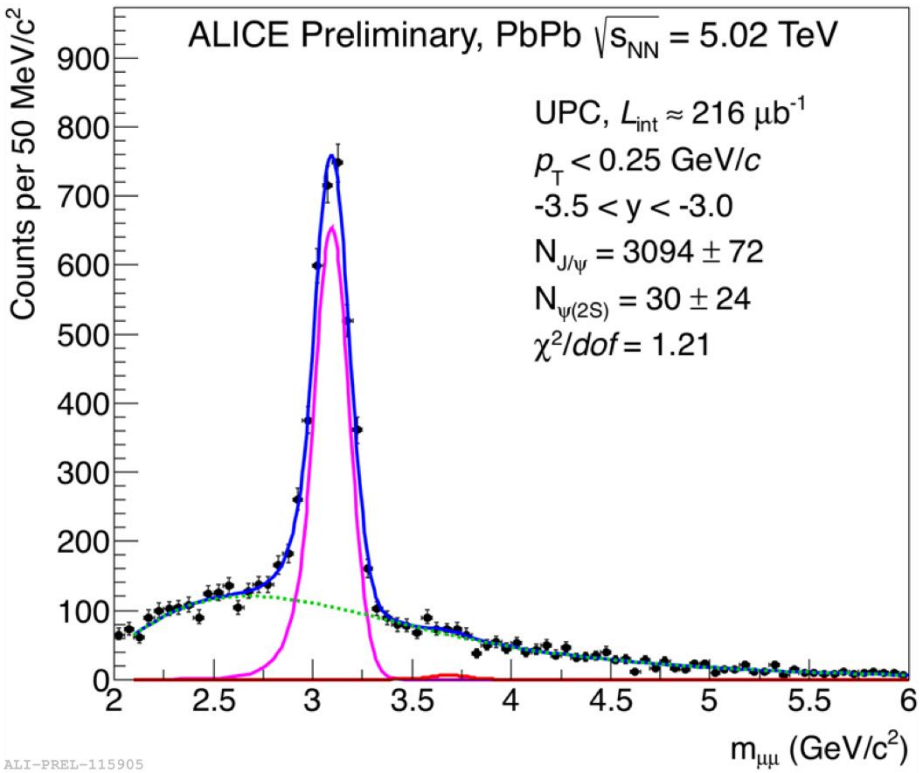
$$\left.\frac{d\sigma_{\gamma A\to J/\psi A}}{dt}\right|_{t=0} = \frac{M^3_{J/\psi}\Gamma_{ee}\pi^3\alpha_s^2(Q^2)}{48\alpha_{em}Q^8}\left[xg_A(x,Q^2)\right]^2$$

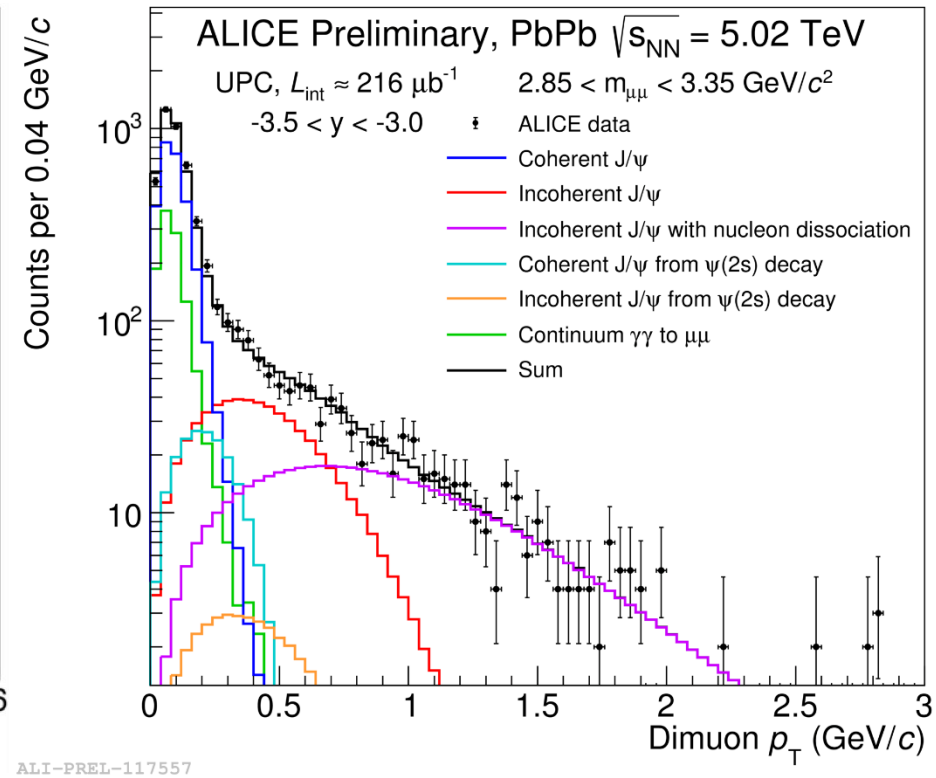


J/ψ cross-section ∝ (gluon density)^2 in the target. If target is Pb → shadowing

UPC: coherent J/ψ production

Forward-rapidity measurement (muon spectrometer)





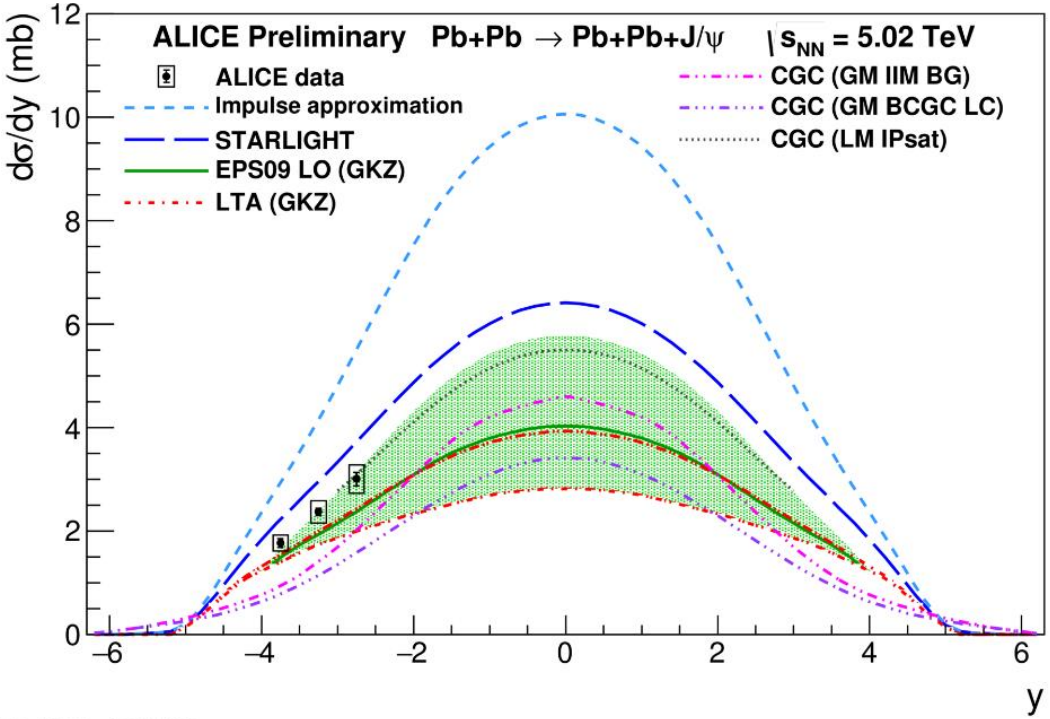
100x more statistics than in Run1

Cross-section extracted in 3 y-bins.

Coherent contribution extracted in p_T<0.25 GeV/c.

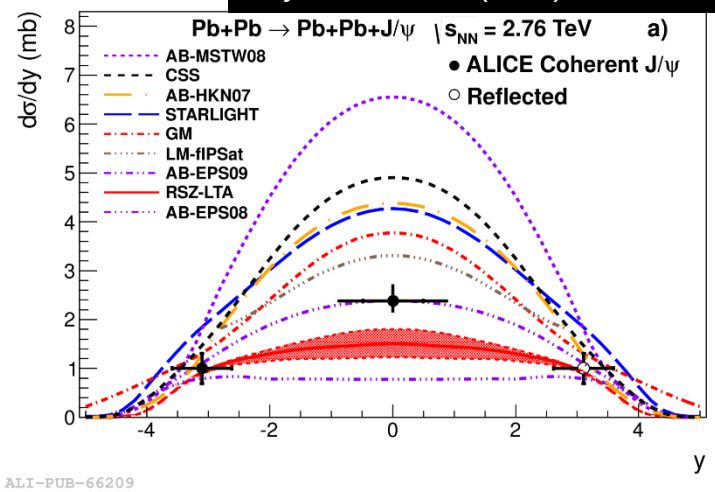
Correction for incoherent part estimated with templates from STARLIGHT

UPC: coherent J/ψ production



Run1 result:

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



Stringent constraint on the models

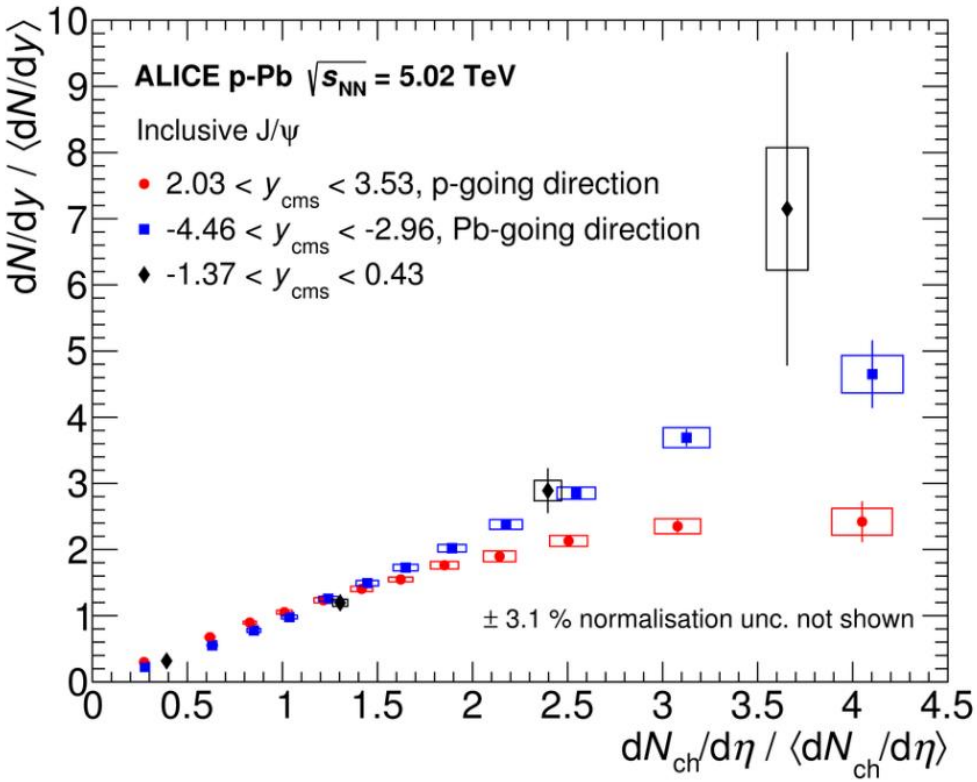
Will extend this study:

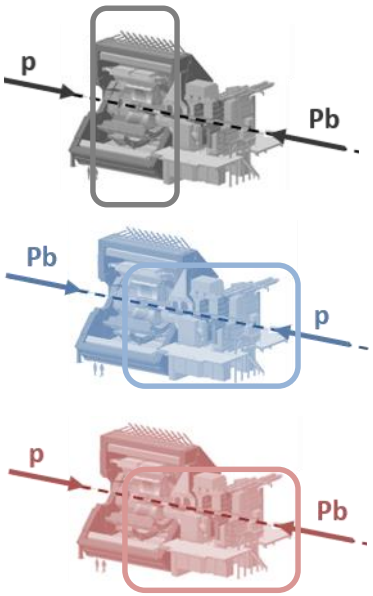
- at central rapidity
- Measuring J/ψ polarization

Physics results

- Pb-Pb collisions
- p-Pb collisions
- pp collisions

J/ψ VS multiplicity - p-Pb at 5.02 TeV

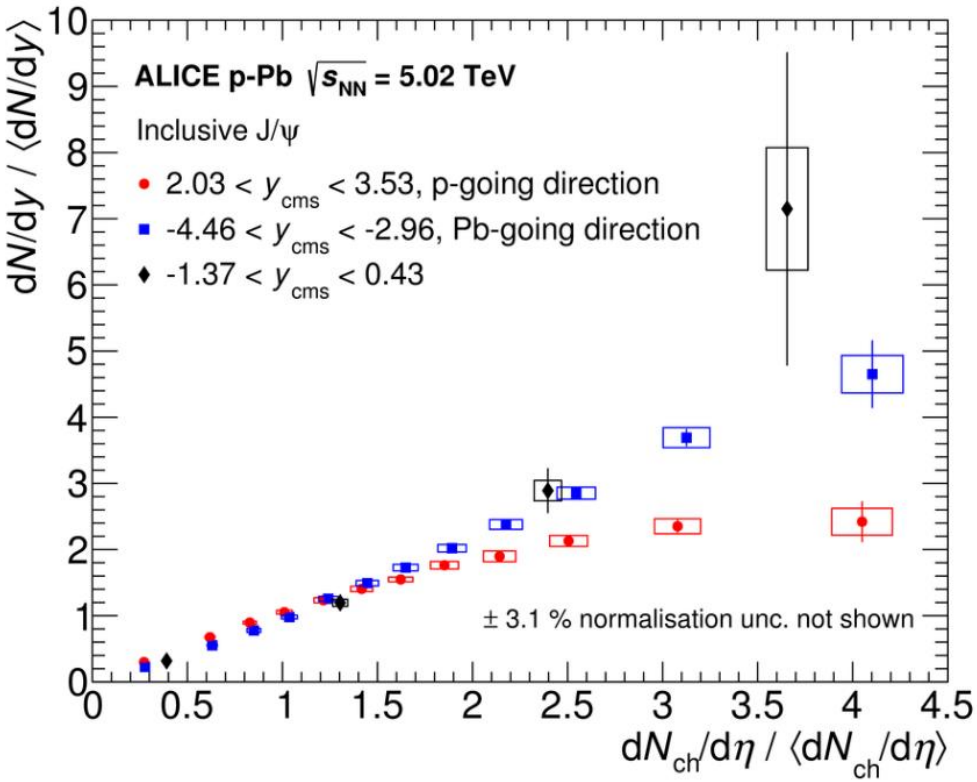




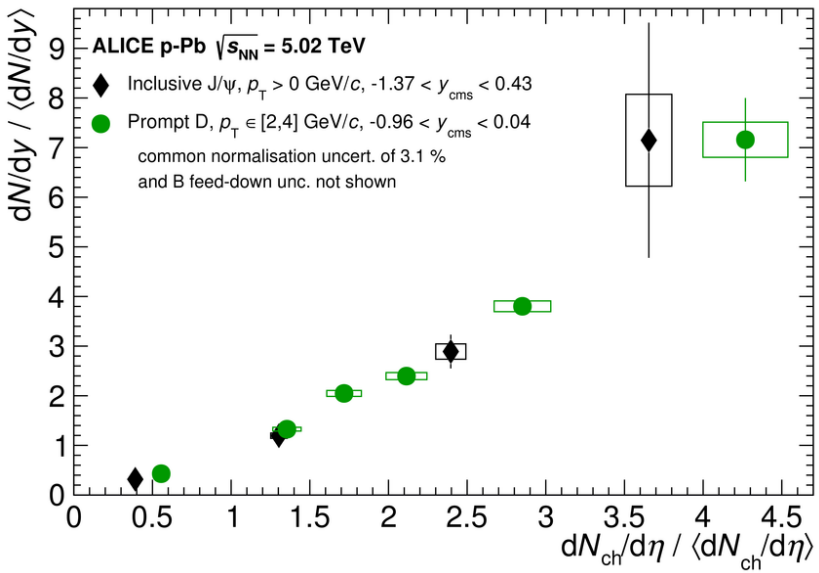
Increase different when going from forward to backward rapidity

arXiv:1704.00274

J/ψ VS multiplicity - p-Pb at 5.02 TeV



At central rapidity the trend is similar to the one measured for D mesons:



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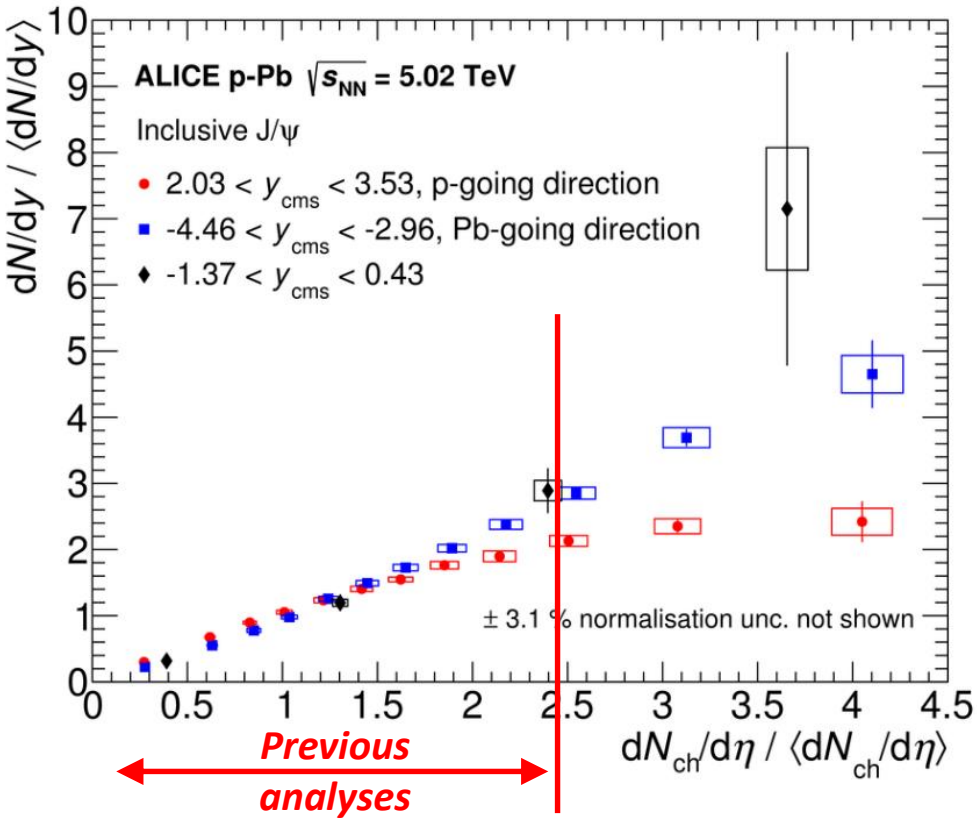

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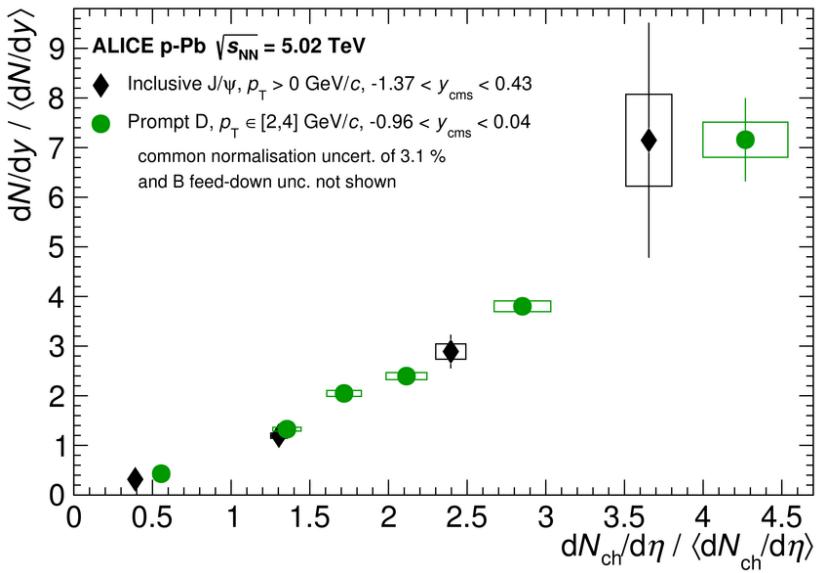


Increase different when going from forward to backward rapidity

Theoretical models can now be tested across a very wide $dN_{ch}/d\eta$ regime

The precision of this measurement will improve significantly making use of Run-2 data!

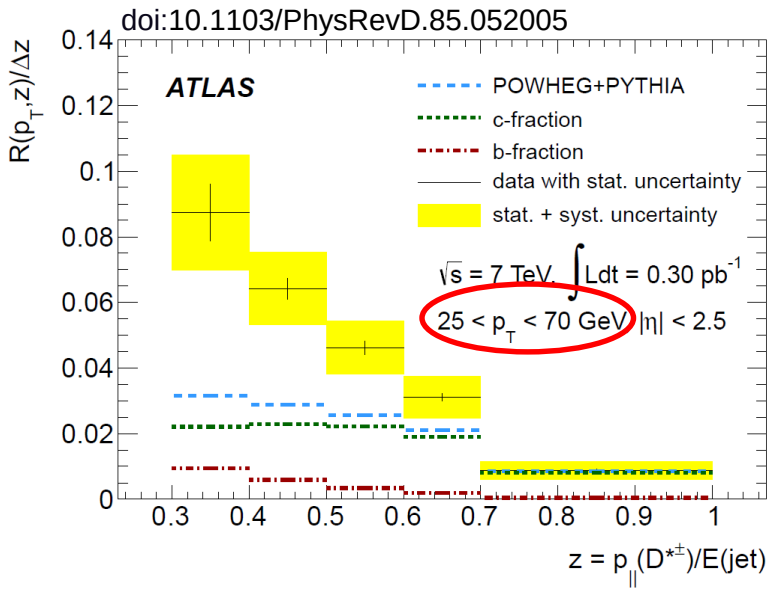
arXiv:1704.00274

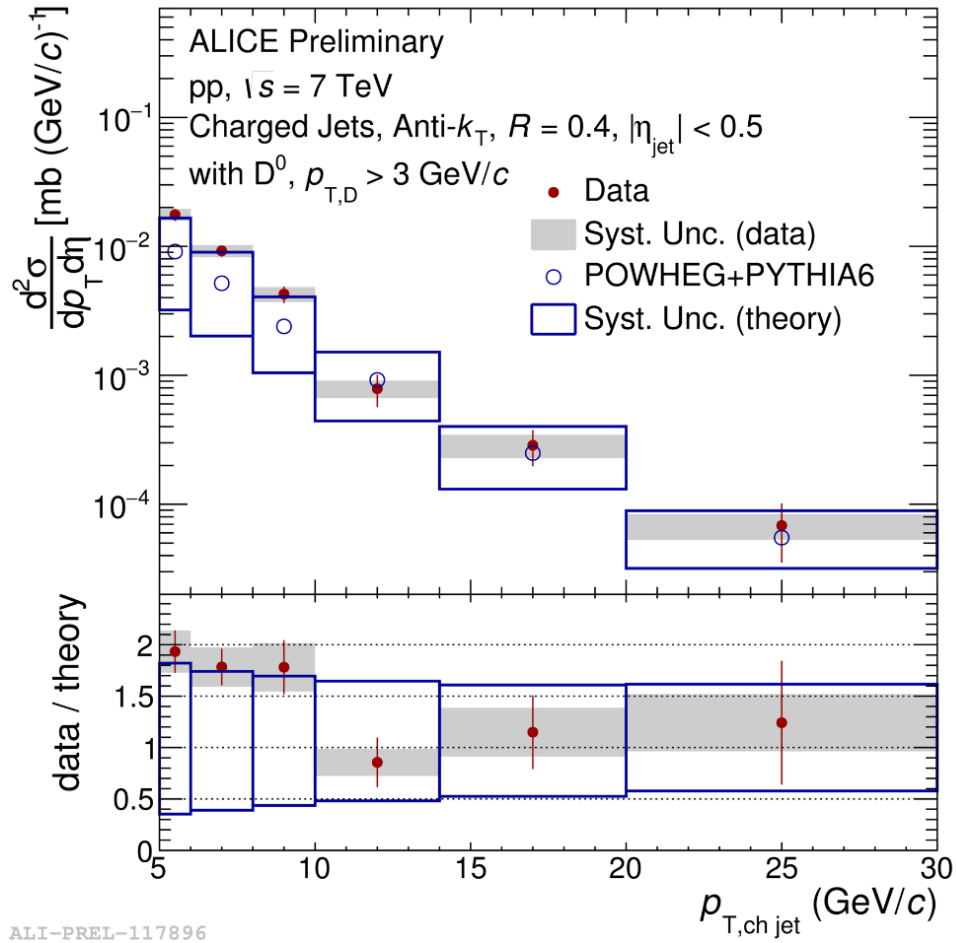
Physics results

- Pb-Pb collisions
- p-Pb collisions
- pp collisions

D-jets cross section in pp @ 7 TeV

Study of D-tagged jets in pp collisions: useful to constrain QCD-based models for charm production.

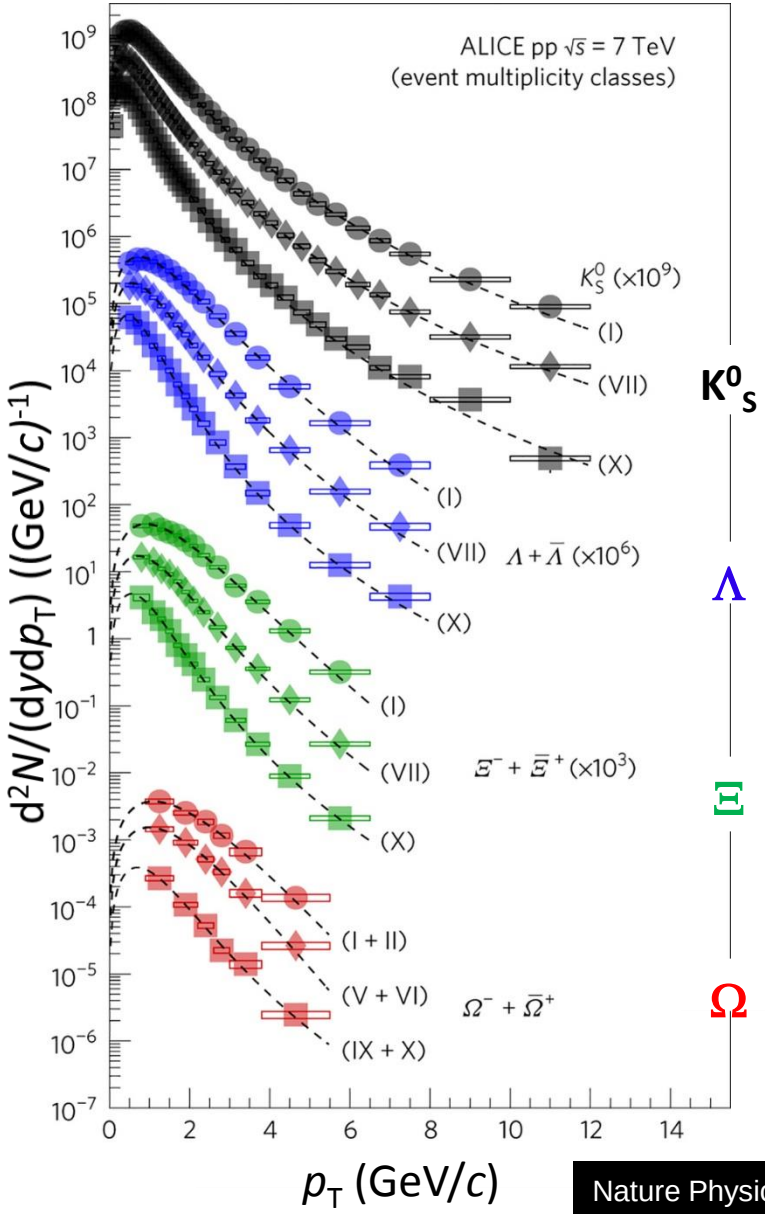




Important for ongoing measurements in p-Pb and Pb-Pb

Data are described by POWHEG+PYTHIA within uncertainties

Strangeness production in pp



Nature Physics (2017) doi:10.1038/nphys4111

Transverse momentum spectra of K^0_s, Λ, Ξ and Ω measured in pp at 7 TeV as a function of charged particle multiplicity at central rapidity

Total yields:

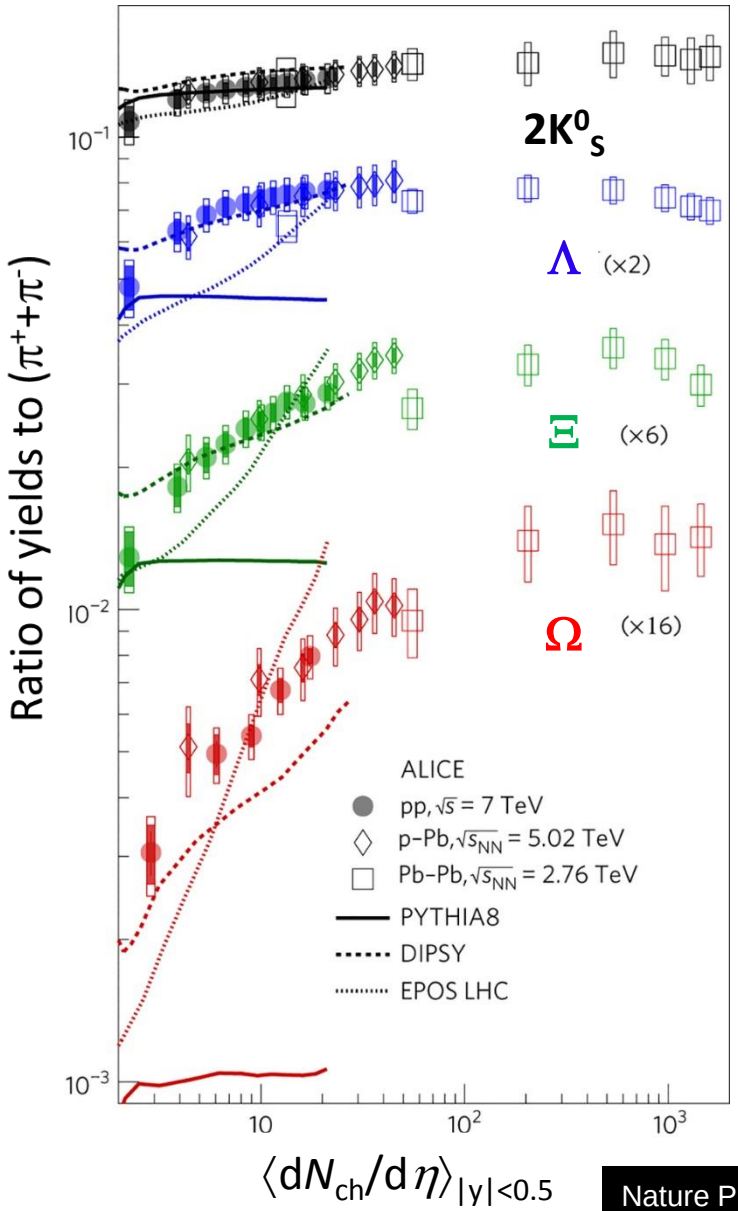
integrate measured spectra

+

add extrapolation to $p_T = 0$

↓

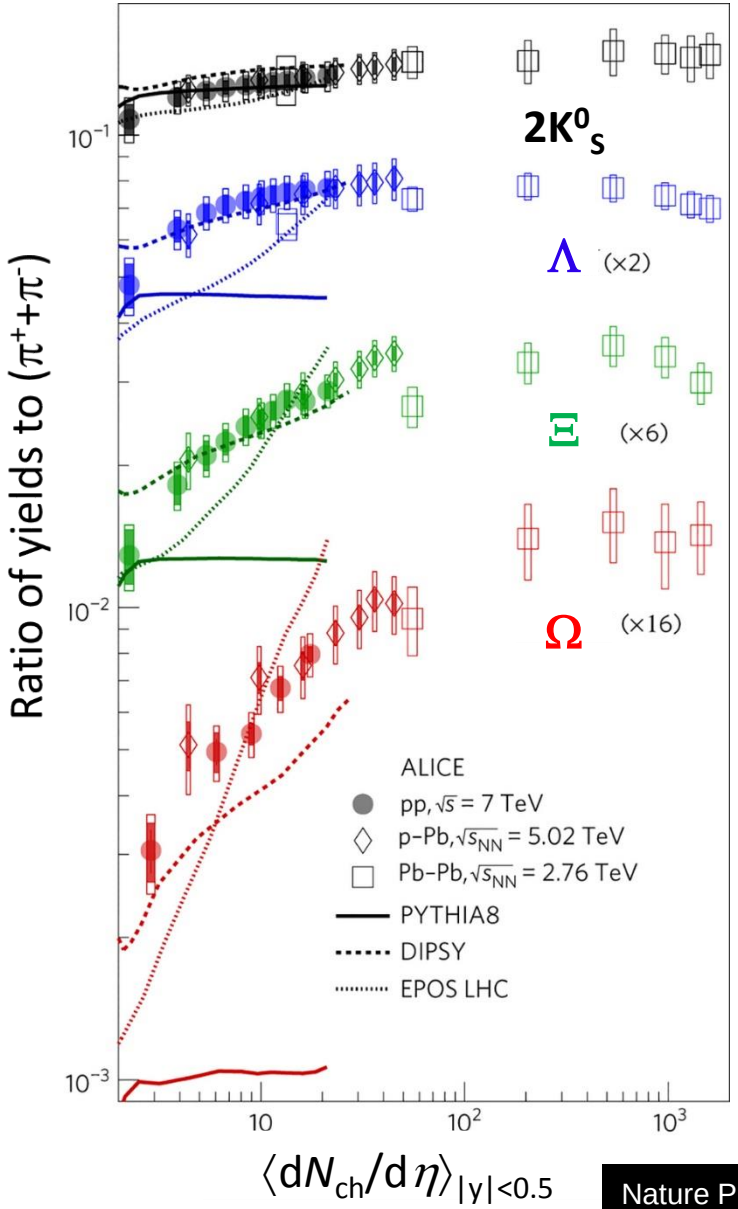
Strangeness enhancement in pp



Strangeness enhancement
in high multiplicity pp collisions

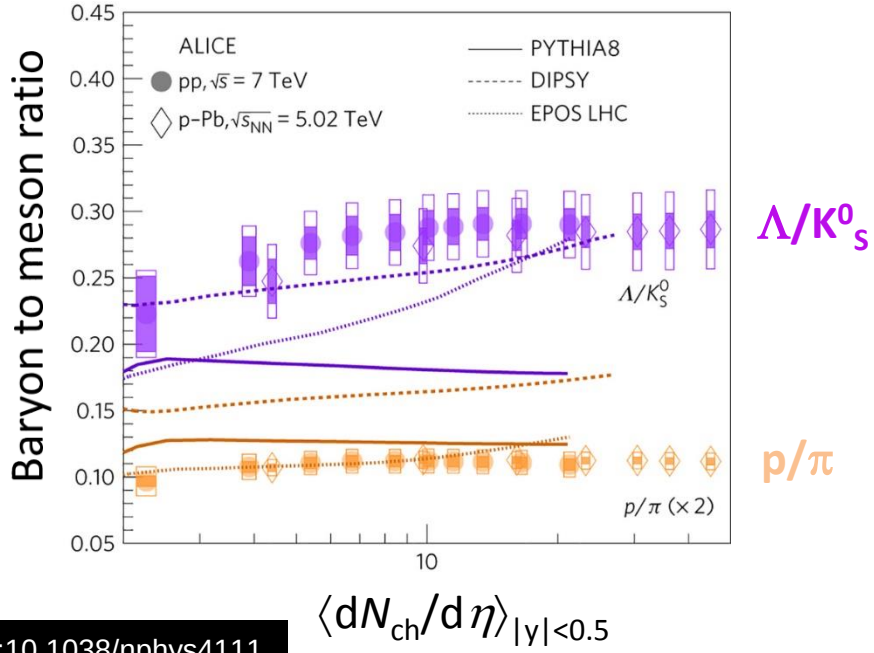
Nature Physics (2017) doi:10.1038/nphys4111

Strangeness enhancement in pp



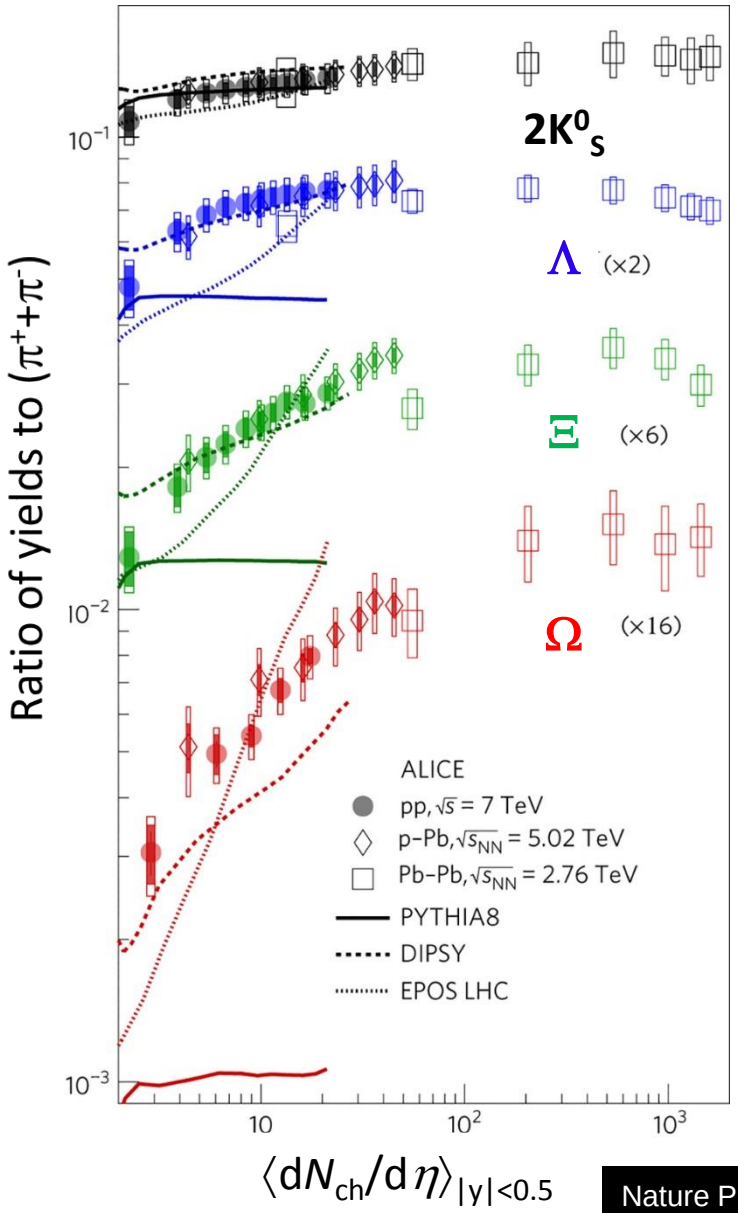
Strangeness enhancement in high multiplicity pp collisions

- Strangeness-related: p/π and Λ/K^0_s unaffected
- Commonly-used event generators at LHC do not reproduce the observed behavior (strangeness increase ↔ p/π increase)



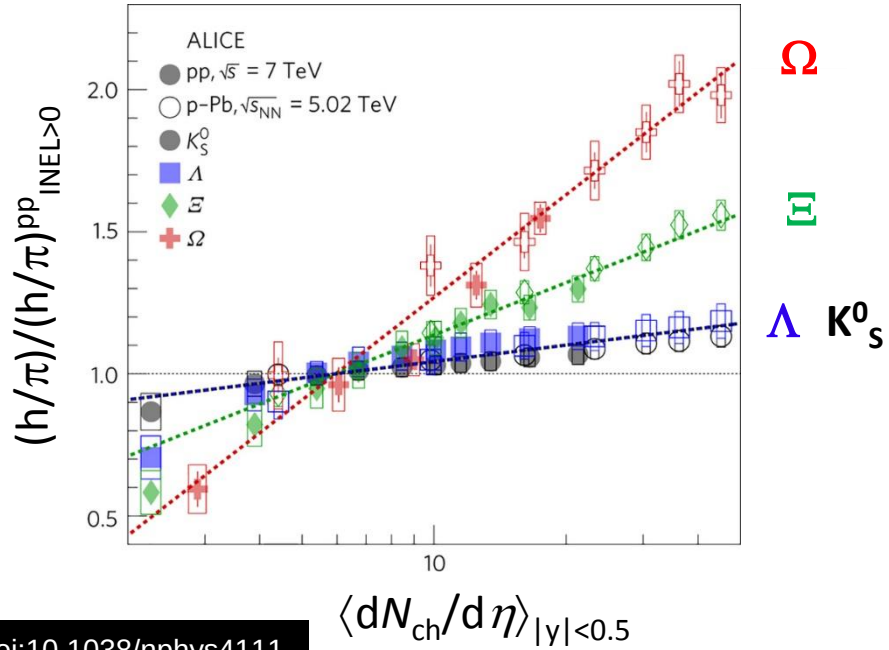
Nature Physics (2017) doi:10.1038/nphys4111

Strangeness enhancement in pp



Strangeness enhancement in high multiplicity pp collisions

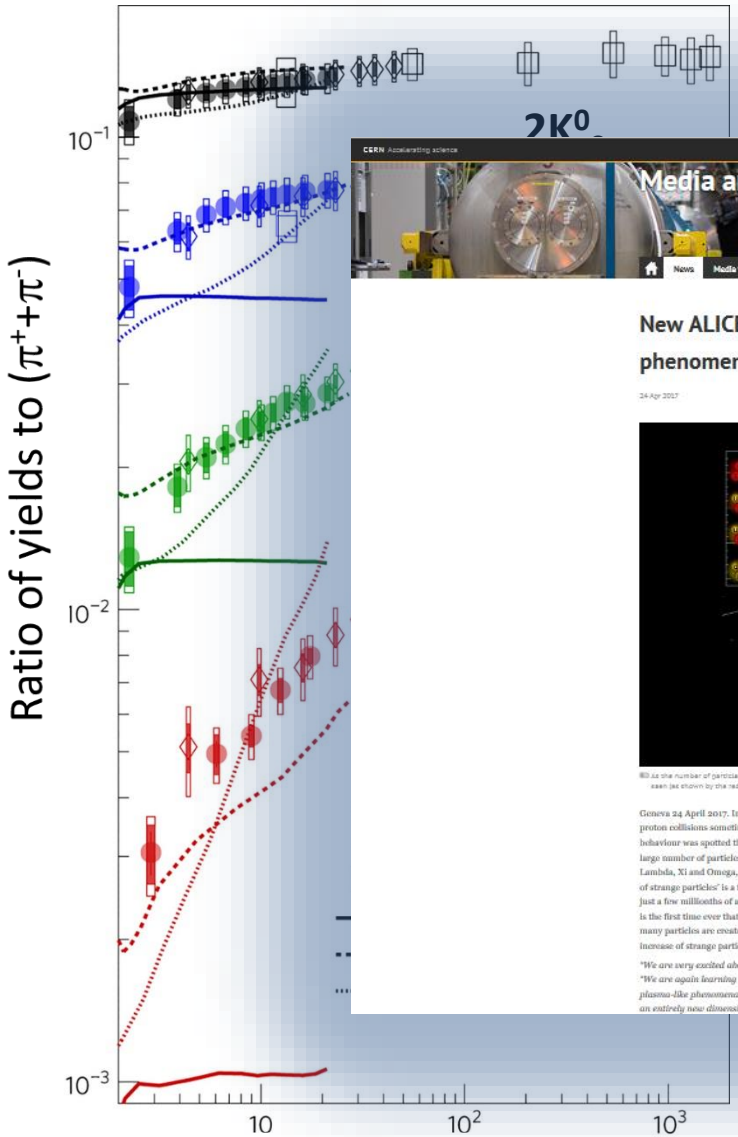
- Strangeness-related: p/π and Λ/K^0_s unaffected
- Commonly-used event generators at LHC do not reproduce the observed behavior
- Increase $\propto$ to s-content. Hint of QGP in high multiplicity pp and p-Pb collisions?

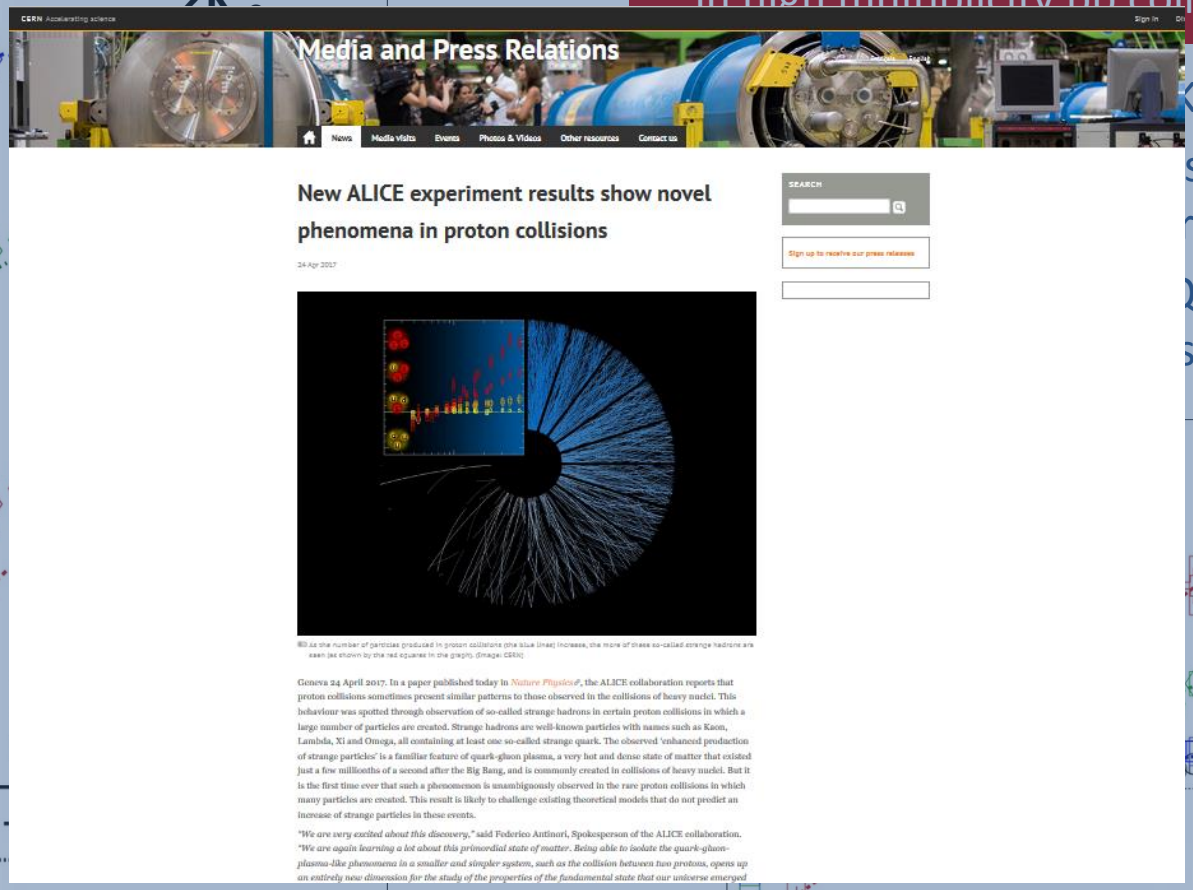


Nature Physics (2017) doi:10.1038/nphys4111

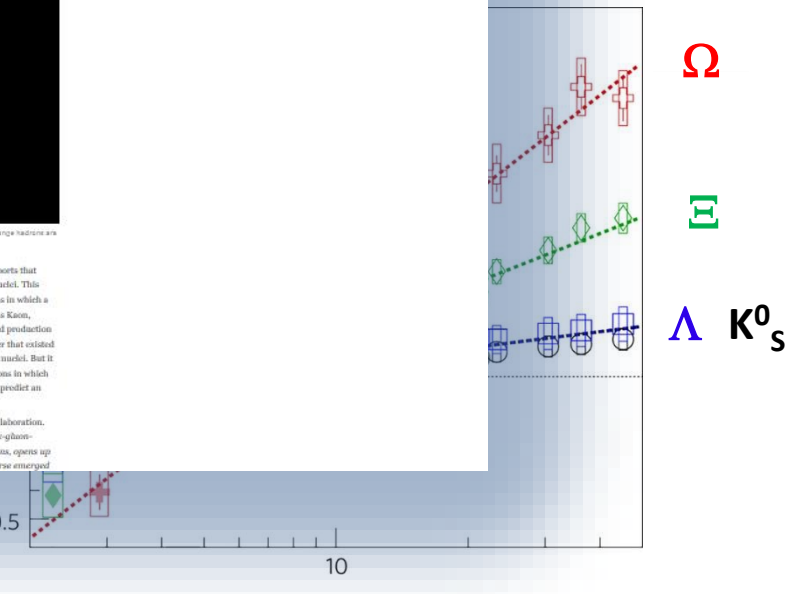
Strangeness enhancement in pp

Strangeness enhancement in high multiplicity pp collisions



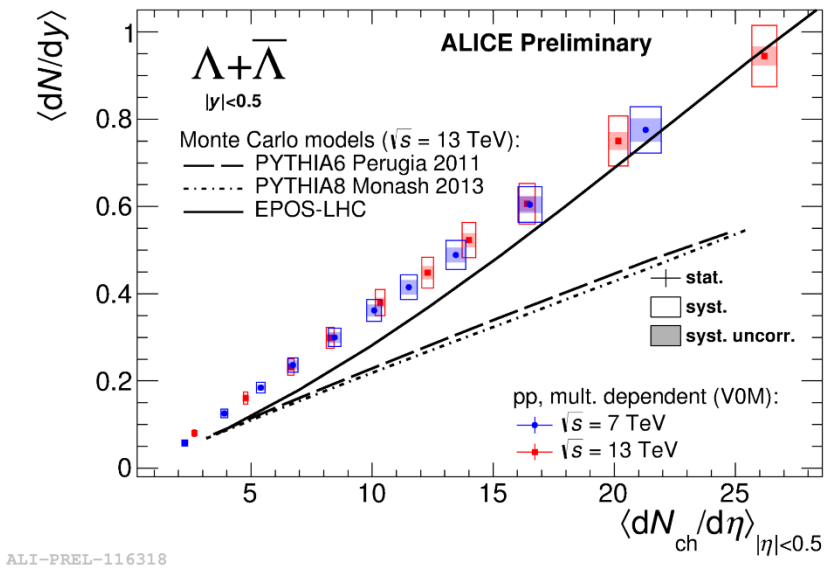


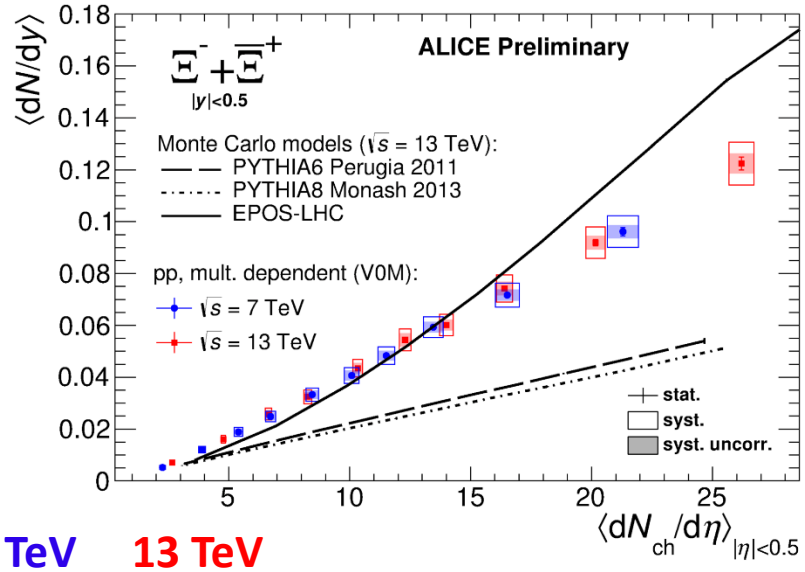
K^0_s unaffected
s at LHC do not
r
QGP in high
s?



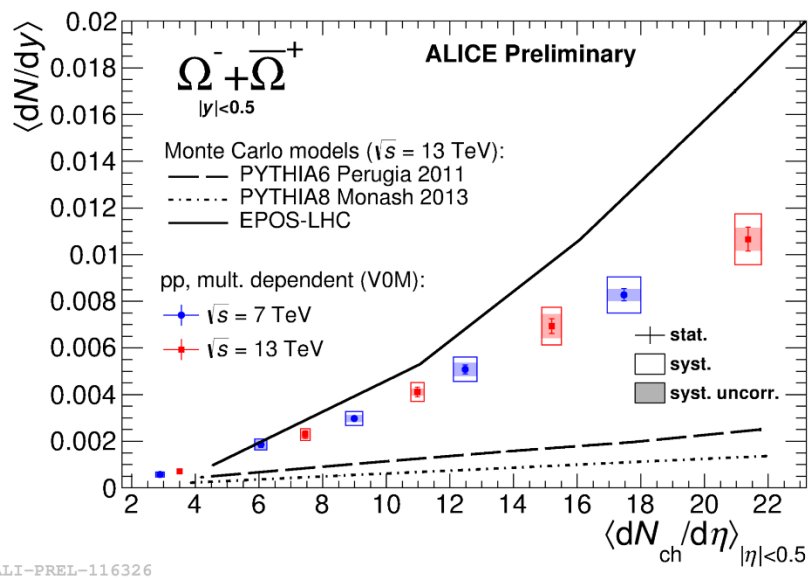
Nature Physics (2017) doi:10.1038/nphys4111

Strangeness enhancement: energy dependence?





7 TeV **13 TeV**



Strangeness enhancement does not depend on √s

Will complement this with high multiplicity triggers at 13 TeV (should reach ~ $dN_{ch}/d\eta$ = 50)

Detector upgrade

The Upgrade project

Very ambitious upgrade program for Run 3+4

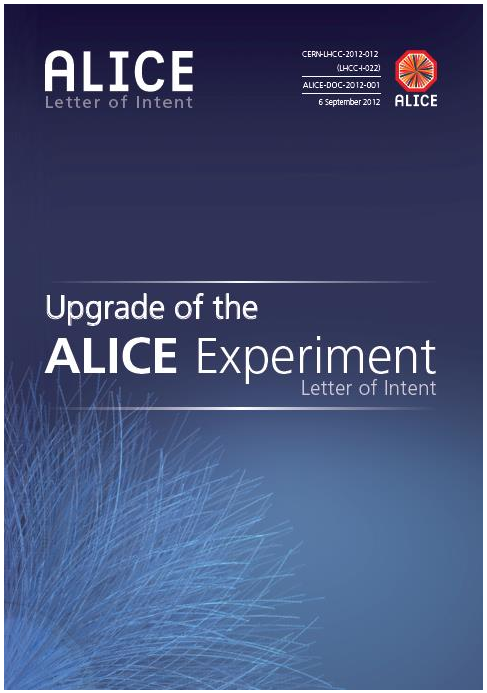
High precision measurements of rare probes:

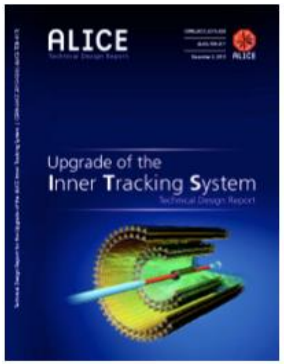
Heavy flavour and quarkonia
Low mass dileptons
Jets
Heavy nuclear states

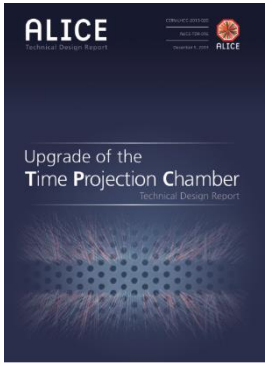
Target **Pb-Pb luminosity**:
13 nb^{-1} (10x increase in luminosity)

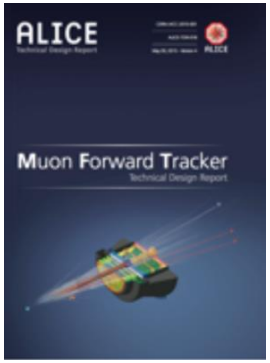
Continuous read-out of all minimum bias Pb-Pb interactions at a **rate of 50 kHz**

Online data **reconstruction** and compression

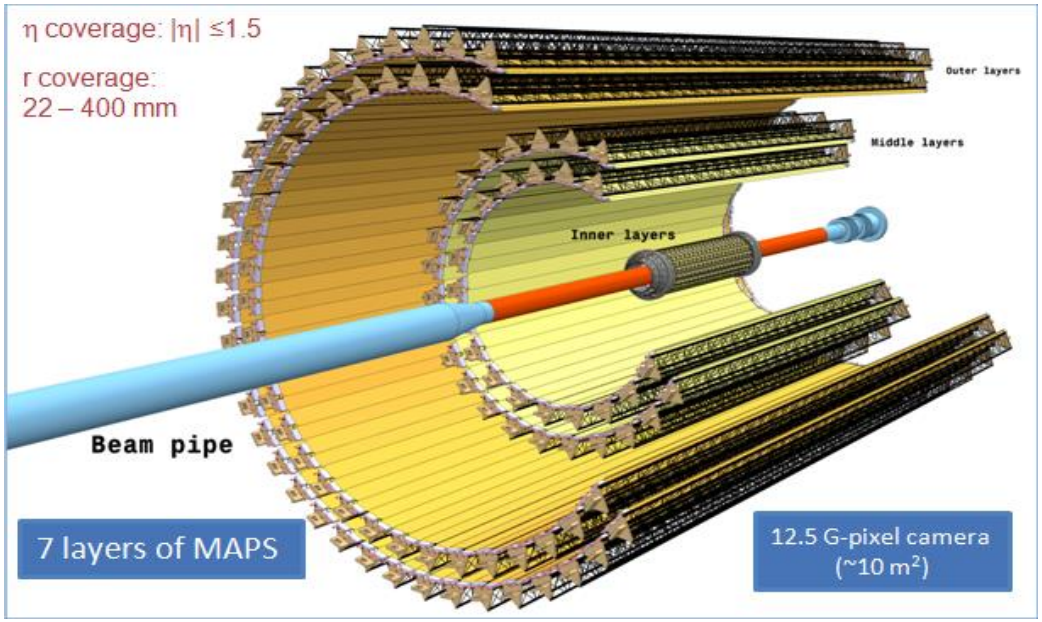








ITS upgrade



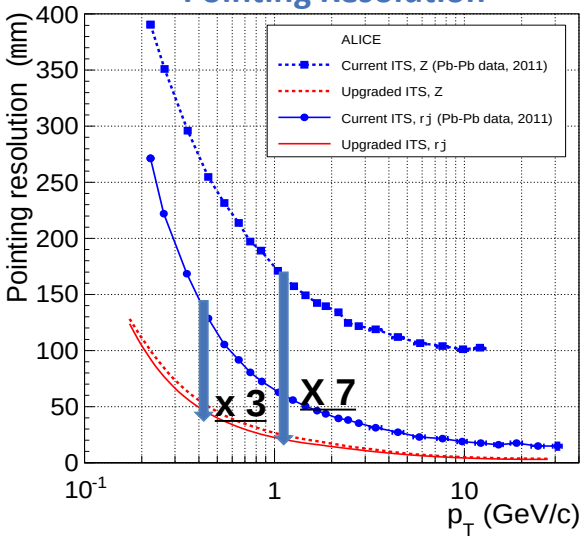
Pixel Sensor Chips:

- Mass production started
- PRR Nov.2016
- Production: Jan.2017-Jan.2018

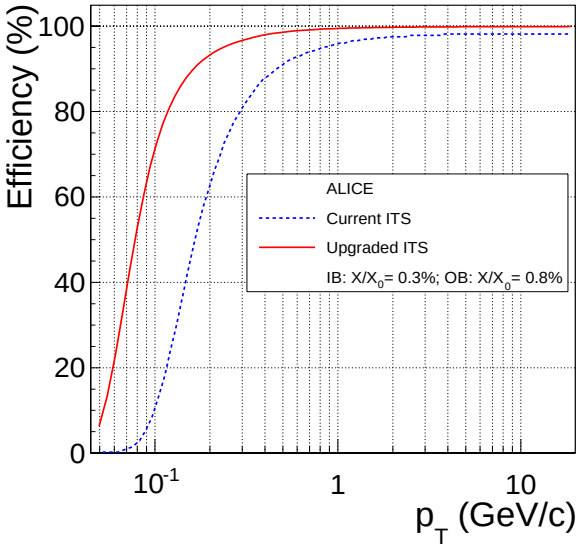
HIC/Stave:

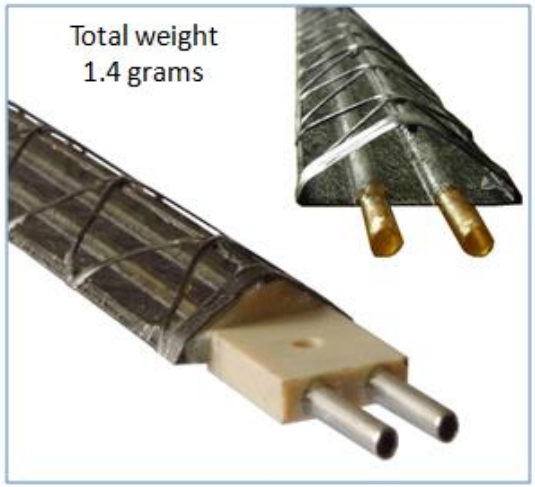
- Series production about to start
- PRR: 27 Apr 2017
- Production: Jun.2017 – Aug.2018

Pointing Resolution



Tracking efficiency





TPC upgrade with GEMs

Operate at the 50 kHz rate

⇓

no gating grid

⇓

need to minimize Ion Back Flow to keep space charge distortions at a tolerable level

⇓

Replace wire-chambers with GEMs

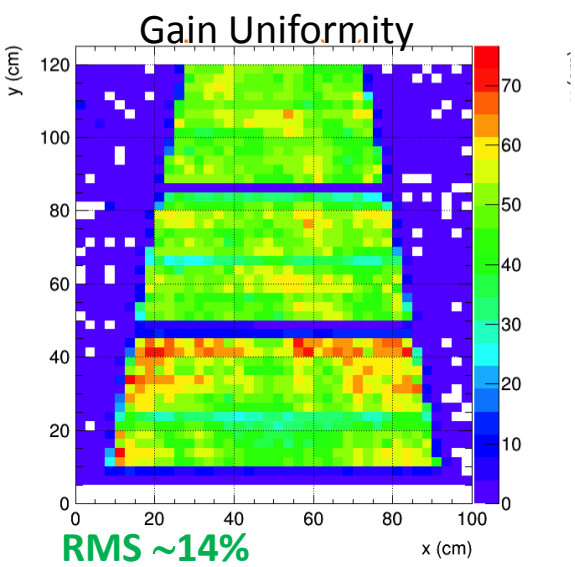
⇓

New readout electronics

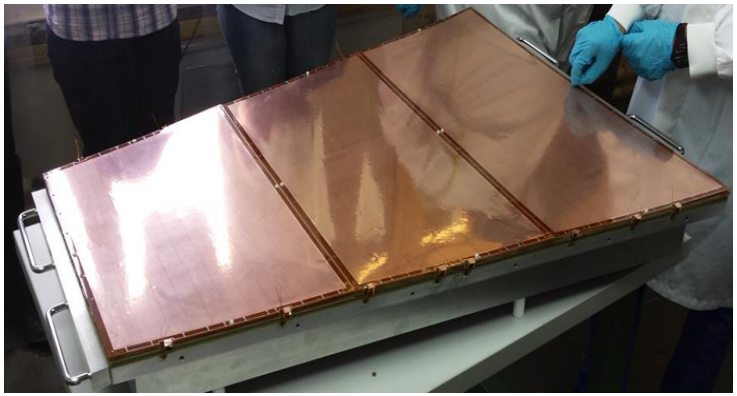
ROC + GEM PRR on March 10, 2017:

- Full qualification of pre-production ROCs
- Performance within design specifications
- All production sites ready
- Mass production of 40+40 ROCs started

SAMPA + FEC performance tests ongoing



RMS ~14%



Summary

Conclusions and Outlook

ALICE is delivering very **high quality physics** results using Run-1 and Run-2 data. Many **new results** in preparation **for summer conferences**

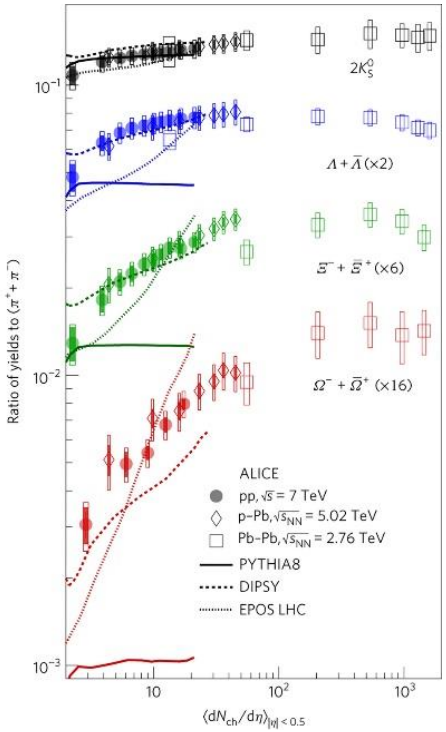
The **detector** is **back running**. A cosmic campaign is ongoing while waiting for beam.

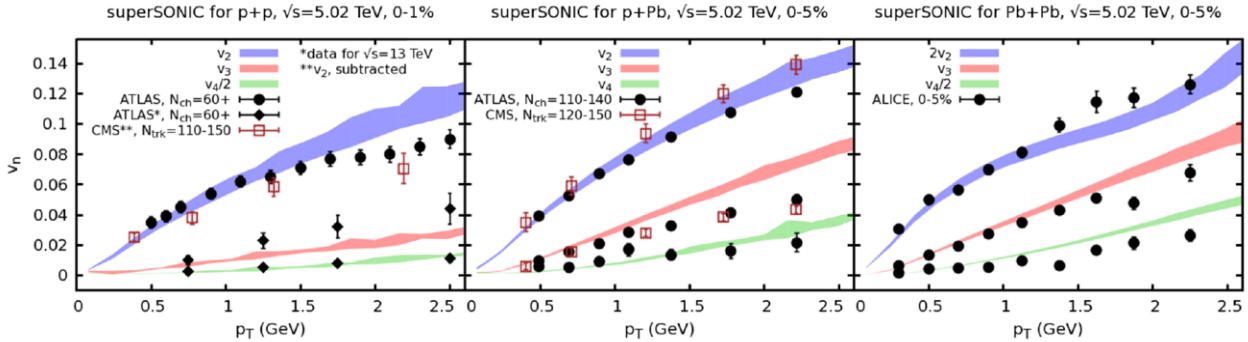
The very ambitious **upgrade program** for Run 3+4 is **on track** and is passing important milestones

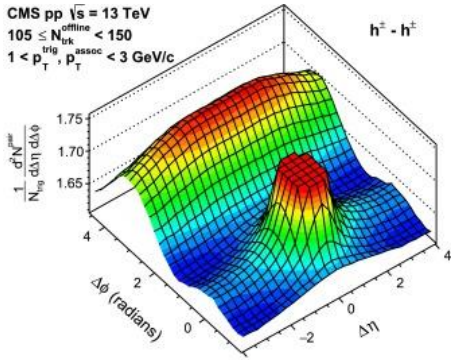
Backup

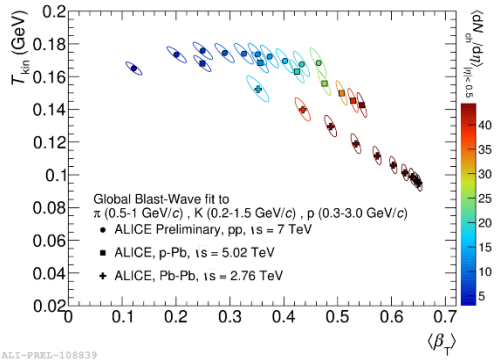
Hints for QGP in small systems

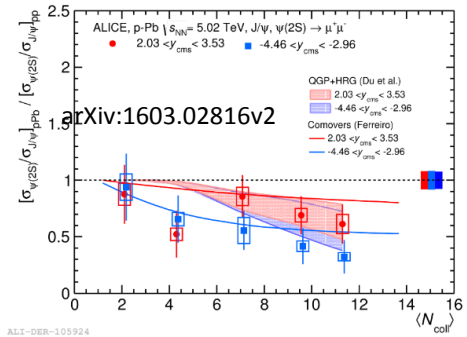
Livio Bianchi
LHCC Meeting
CERN 10 May 17

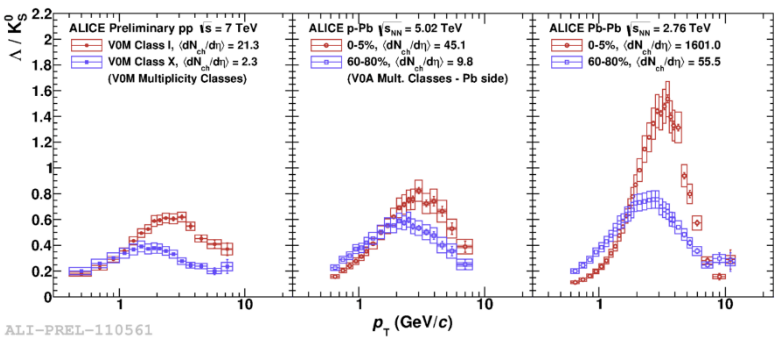




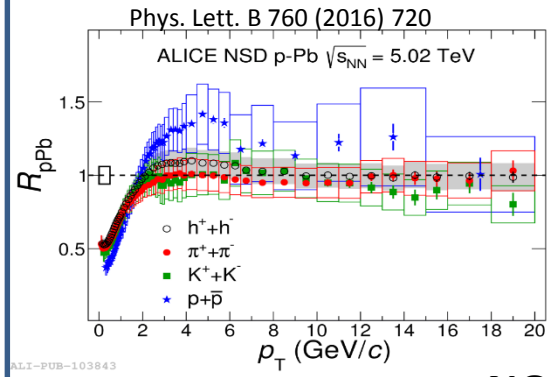




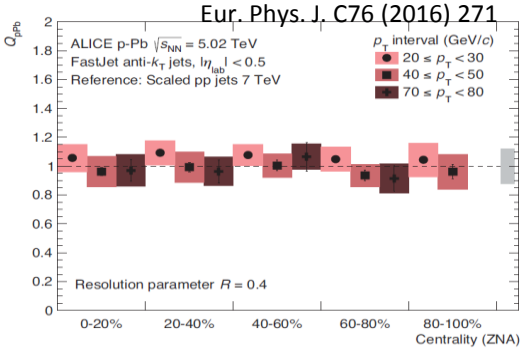




Phys. Lett. B 760 (2016) 720



Eur. Phys. J. C76 (2016) 271



NO HINT