Neutral meson production in pp and Pb-Pb collisions at the LHC measured with ALICE

Haitao Zhang (Wuhan-CCNU) for the ALICE collaboration

Motivation

Identified hadron spectra are considered to be sensitive to transport properties of strongly interacting matter produced in high-energy nucleus-nucleus collisions. They also provide constrains to **pQCD** calculations in pp collisions. In particular, with π^0 and η mesons produced at the LHC energies and colliding systems:

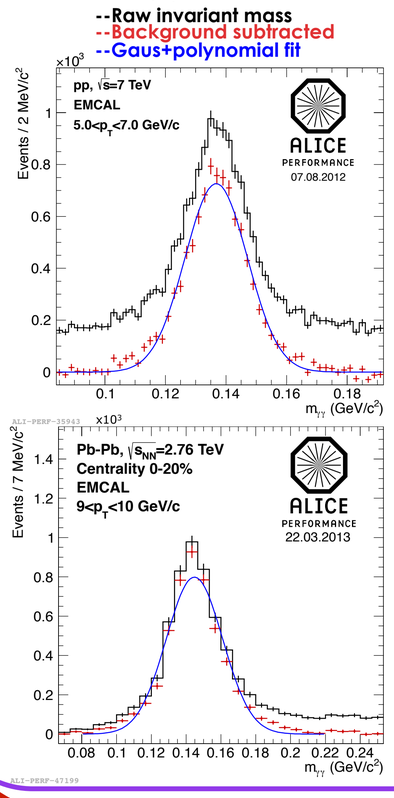
- The *PDF* and *FF* can be probed at lower x and z than at previous colliders, and provide further constraints crucial for **pQCD** predictions.
  - π^0 and η production is dominated by gluon fragmentation at p_T < 100 GeV/c, their measurement puts constraints on gluon *FF*.
  - η meson spectrum measurement imposes constraints on strange quark *FF*.
- Neutral meson spectra in Nucleus-Nucleus collisions, and R_{AA} provide constraints on the energy loss models in the **QGP**.

We present the measurements of π^0 and η mesons at mid-rapidity in a wide transverse momentum range in pp and Pb-Pb collisions (only π^0 for the latter) at LHC energies, measured with the ALICE detector. The mesons are reconstructed via their two-photon decays by two complementary methods, using the electromagnetic calorimeters and the central tracking system for photons converted to electron-positron pairs on the material of the inner ALICE barrel tracking detectors. The three detectors provide complementary methods with different resolution and independent systematic uncertainties.

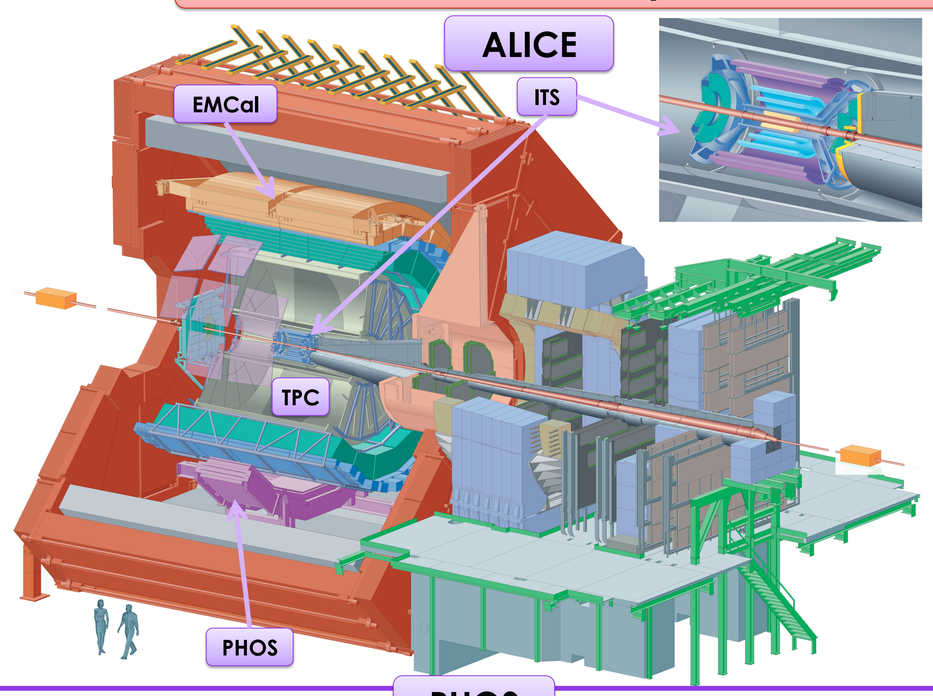
Invariant mass analysis detectors

EMCal

- ElectroMagnetic Calorimeter
- **Active element**: tower of 77 layers, 1.4 mm lead +1.7 mm scintillator, 6×6×25 cm^3
- **Geometry**: 10 modules, 24×48 towers each; distance to IP 450 cm
- **Aperture**: $|\eta|$<0.7, 80°<φ<180°
- **π^0 reconstruction** via invariant mass method: ~1<p_T<~25 GeV/*c*

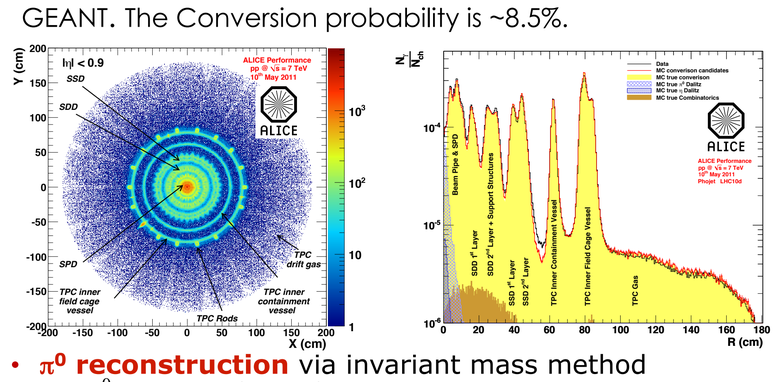


ALICE



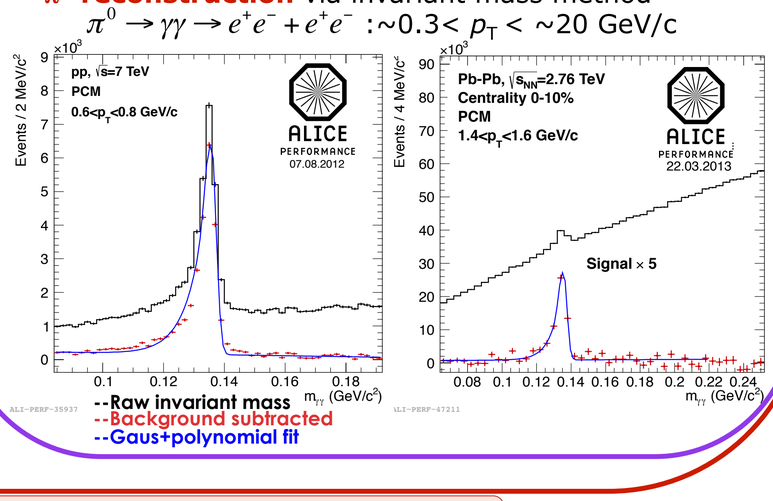
Central Trackers: TPC and ITS

- Time Projection Chamber
- Inner Tracking System: Silicon tracker
- **Aperture**: $|\eta|$<0.9, 0°<φ<360°
- **Principle:** Photons convert in the material of the detectors producing e^-e^+ pairs. Measurement of their production vertex provides a precise tomography of ALICE. Material budget is well described in GEANT. The Conversion probability is ~8.5%.



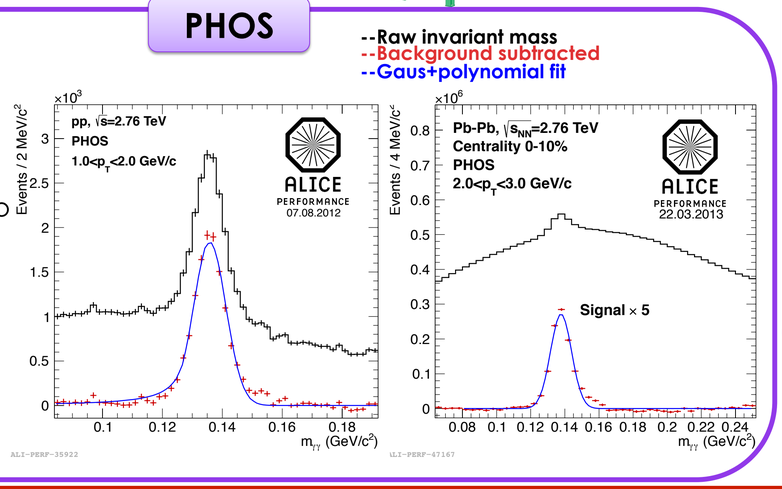
- **π^0 reconstruction** via invariant mass method

$$\pi^0 \rightarrow \gamma\gamma \rightarrow e^+e^- + e^+e^- \text{ :~0.3< } p_T \text{ < ~20 GeV/c}$$



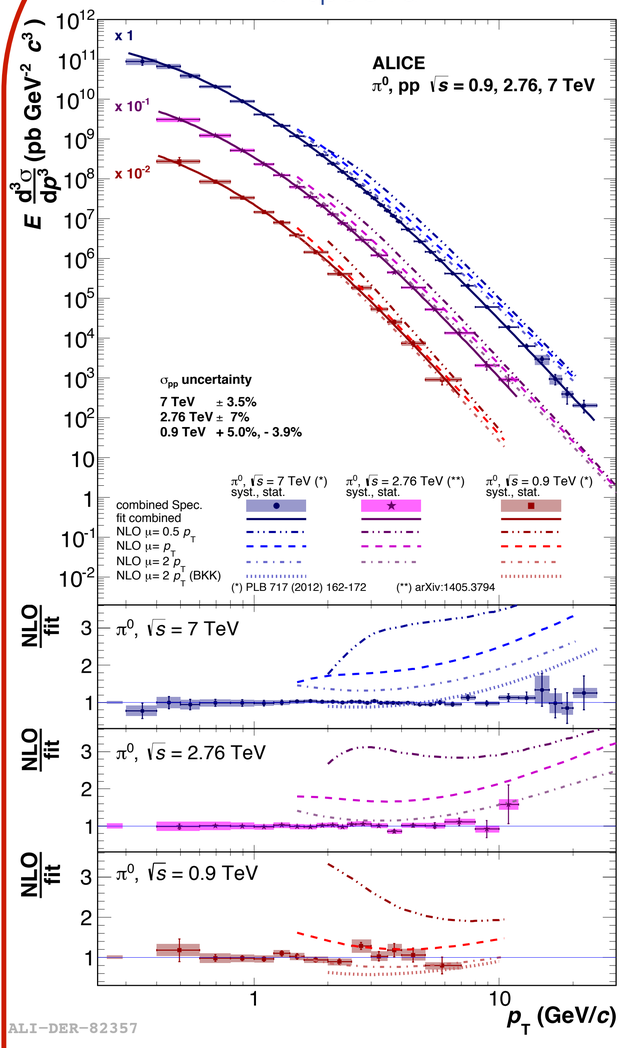
PHOS

- PHOton Spectrometer
- **Active element**: $PbWO_4$ crystal, 2.2×2.2×18 cm^3
- **Geometry**: 3 modules 64×56 crystals distance to IP : 460 cm
- **Aperture**: $|\eta|$<0.13, 260°<φ<320°
- **π^0 reconstruction** via invariant mass method: ~0.5< p_T < ~50 GeV/c

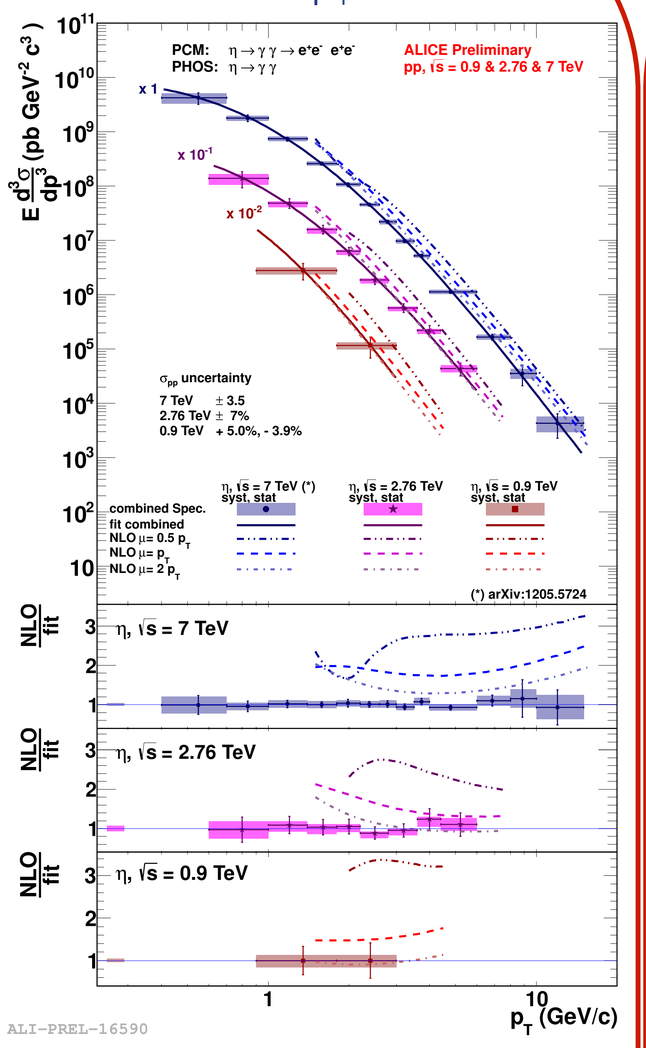


pp collisions at √ s = 0.9,2.76 and 7 TeV

π^0 spectra



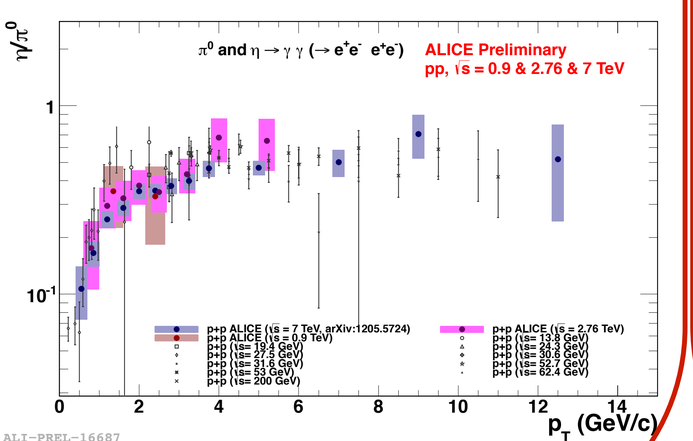
η spectra



pQCD NLO calculations [*] reproduce data at √s = 0.9 TeV, but overestimate π^0 and η spectra at √s = 2.76 and 7 TeV.

- [*] P. Aurenche et al., Eur. Phys. J. C13, 347-355 309 (2000).

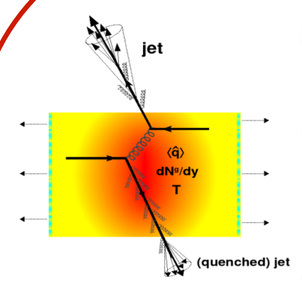
ALICE measurement of the η/π^0 ratio is consistent with world results in pp collisions at all energies and it is well reproduced by pQCD, η/π^0 ~ 0.4 for p_T > 2 GeV/c.



√s = 0.9 and 7 TeV π^0 and η data are published in Physics Letters B 717 (2012), pp. 162-172, CERN-PH-EP-2012-001, arXiv: 1205.5724

√s = 2.76 TeV π^0 data published in Eur. Phys. J. C (2014) 74-3108, CERN-PH-EP-2014-091, arXiv:1405.3794

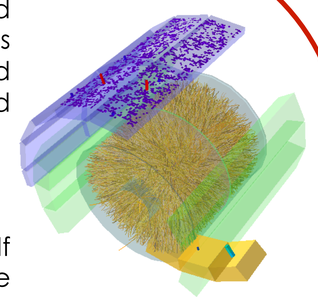
Pb-Pb collisions at √ s_{NN} = 2.76 TeV

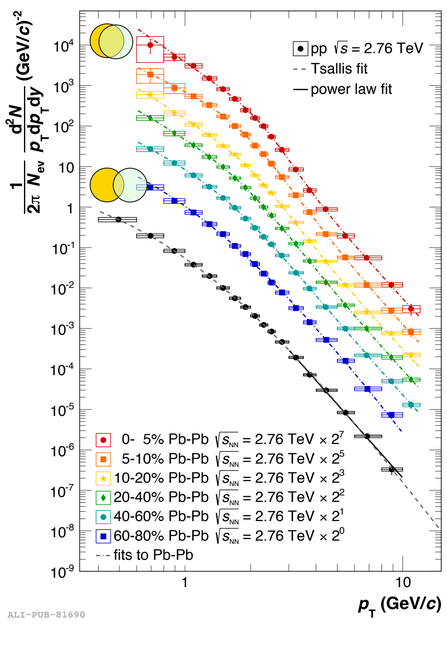


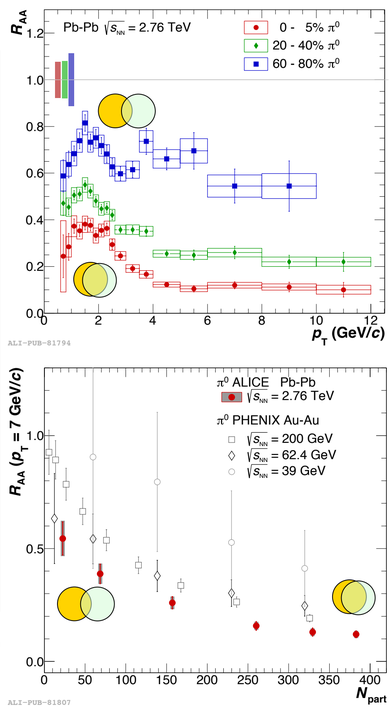
Partons lose energy traversing the **QGP** created in the heavy-ion collisions at LHC, which implies suppression of high energy particles compared to pp collisions. This effect can be quantified measuring the nuclear modification factor,

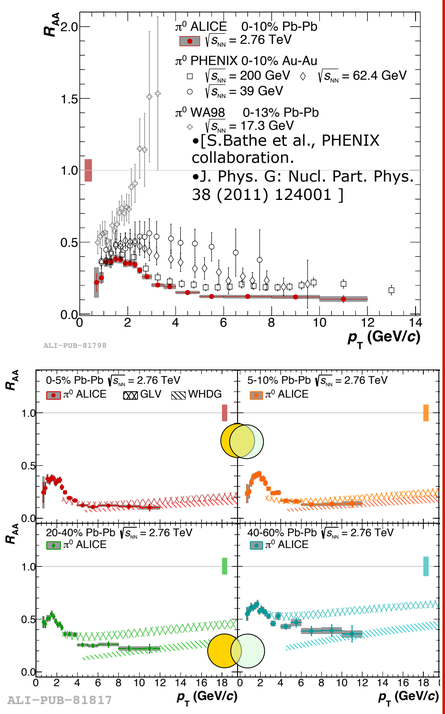
$$R_{AA}(p_T) = \frac{(1/N_{evt}^{AA})\, d^2N_{ch}^{AA}/d\eta dp_T}{\langle N_{coll}\rangle\, (1/N_{evt}^{pp})\, d^2N_{ch}^{pp}/d\eta dp_T}$$

where N_{coll} is the number of binary collisions. If R_{AA}< 1 there is particle suppression in the Nucleus-Nucleus collision.









The suppression of π^0 in central Pb-Pb collisions at $\sqrt{s_{NN}}$=2.76 TeV is of the order of 10, R_{AA}~0.1 at the minimum. It agrees with ALICE charged pion R_{AA} (not shown) within errors.

The suppression follows the energy dependence seen at RHIC energies, being stronger at LHC. The matter created at LHC is denser and hotter.

Theoretical models predictions reproduce the ratio within the errors:

- WHDG model reproduces both strength and centrality dependence
  - W. A. Horowitz. Int.J.Mod.Phys. **E16** (2007) 2193–2199, arXiv:nucl-th/0702084 [NUCL-TH].
- GLV model agrees with data in central collisions.
  - R. Sharma, I. Vitev, and B.-W. Zhang. Phys.Rev. **C80** (2009) 054902, arXiv:0904.0032[hep-ph].

Data published in Eur. Phys. J. C (2014) 74-3108, CERN-PH-EP-2014-091, arXiv:1405.3794