Measurement of neutral pions in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV in ALICE at LHC

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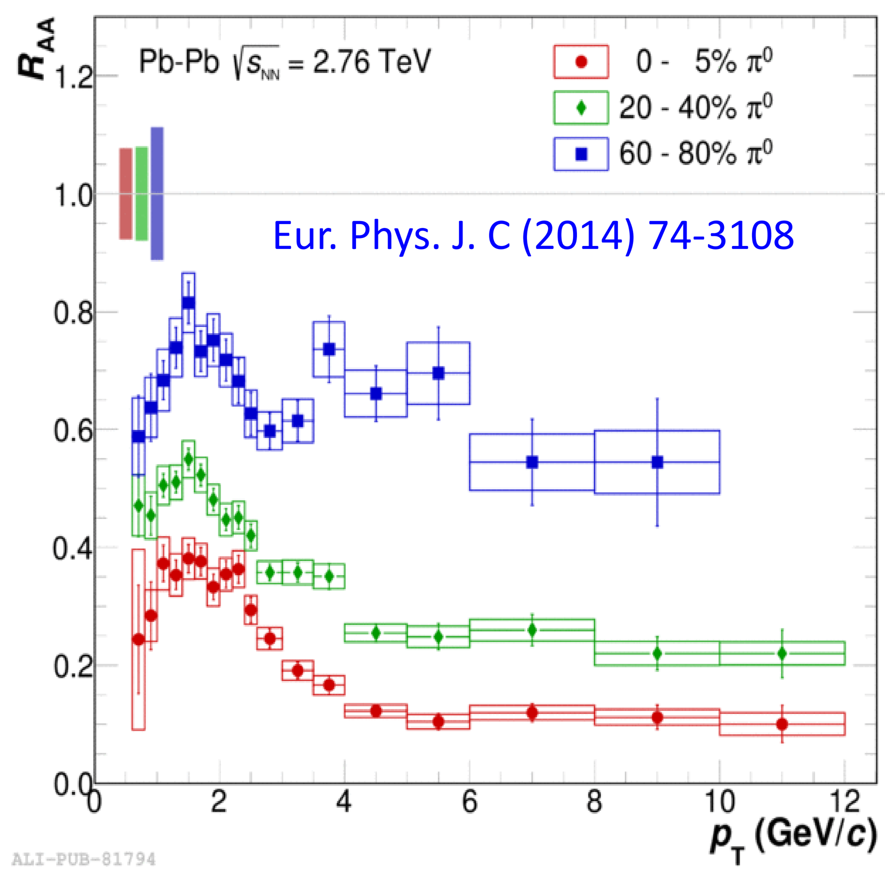
Physics Motivation

The neutral pions measurement is useful to understand particle production and test of pQCD prediction in pp collisions.

In heavy-ion collisions, it helps to study parton energy-loss mechanism that includes the suppression of the hadron spectra. Strong suppression of high- p_T neutral pions has been observed in central Pb-Pb collisions by ALICE. The suppression strength depends on the collision centrality.

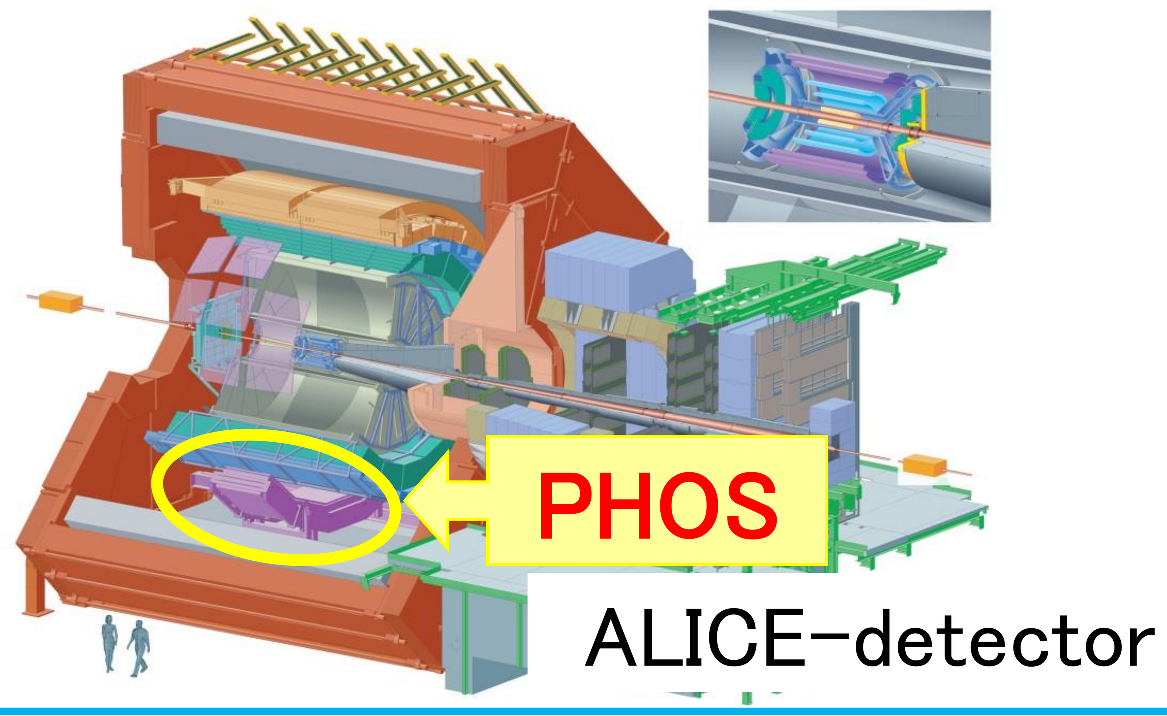
The suppression mechanism can be explained by various processes involving transport properties of the QCD medium and initial-state effects. Studies in p-A collisions are important to disentangle the suppression coming from initial condition of colliding nuclei or final effects in Pb-Pb collisions.



$$R_{AA}(p_T) = \frac{d^2N/dp_T dy|_{AA}}{\langle T_{AA}\rangle \times d^2\sigma/dp_T dy|_{pp}}$$

ALICE experiment

The Quark-Gluon Plasma (QGP) which is believed to have existed in the first microseconds after the big-bang, is a high temperature and dense matter. High-energy heavy-ion collisions experiment is the only way to create QGP in the lab. The ALICE experiment is optimized for heavy-ion collisions and intended to explore the properties of QGP. To measure photons, the ALICE has three individual ways, PHOS, EMCal and photon conversion method(PCM). The EMCal is PbSc sandwich calorimeter and has wide acceptance. The PCM reconstructs and identifies photons converted to electron-positron pairs in material of the ALICE inner detector.



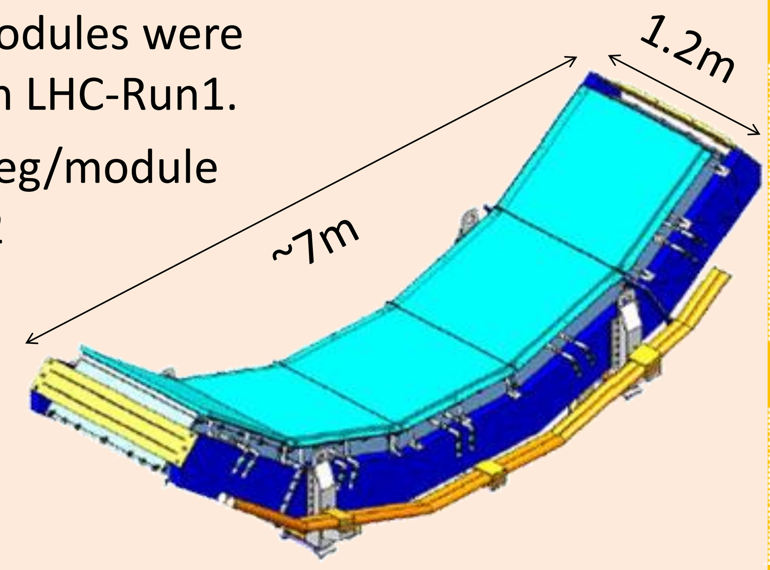
PHOton Spectrometer

The PHOton Spectrometer (PHOS) is a unique electro-magnetic calorimeter designed to measure the energy and hit coordinates of photons and electrons.

PHOS features

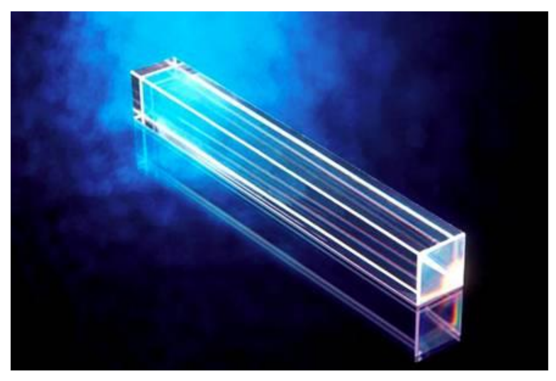
- Distance to interaction point 4.6 m
- $PbWO_4$ crystal and APD readout @ 1 cell
- 3584 cells @ 1 module
- High energy resolution (1 GeV @ 3%)
- Wide dynamic range (5 MeV ~ 80 GeV)
- High granularity allows to separate photons in high-multiplicity environment

3 PHOS modules were installed in LHC-Run1.
$\Delta\phi$ = 20 deg/module
$|\eta|$ < 0.12

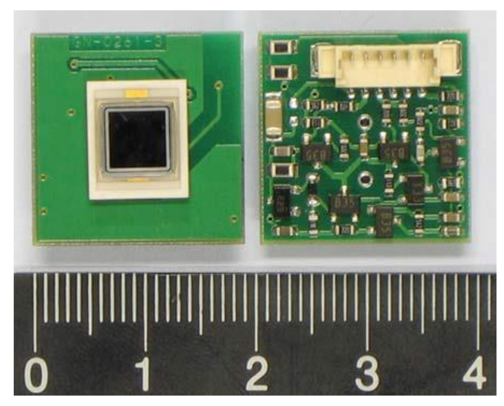


ALICE-PHOS detector

These characteristics provide precise measurement of energy for photons and electrons, and allow the identification of neutral pions with high transverse momentum.



PWO_4 crystal



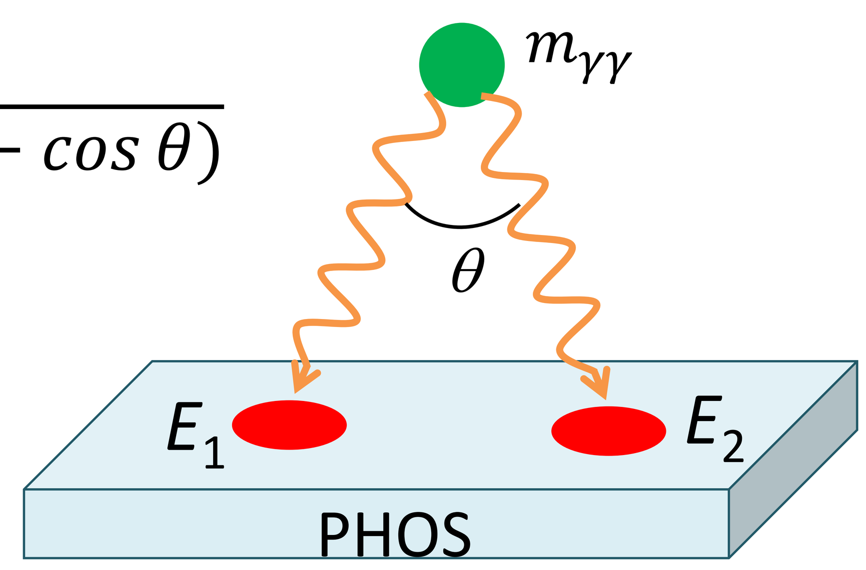
APD & preamplifier

Invariant Mass Analysis

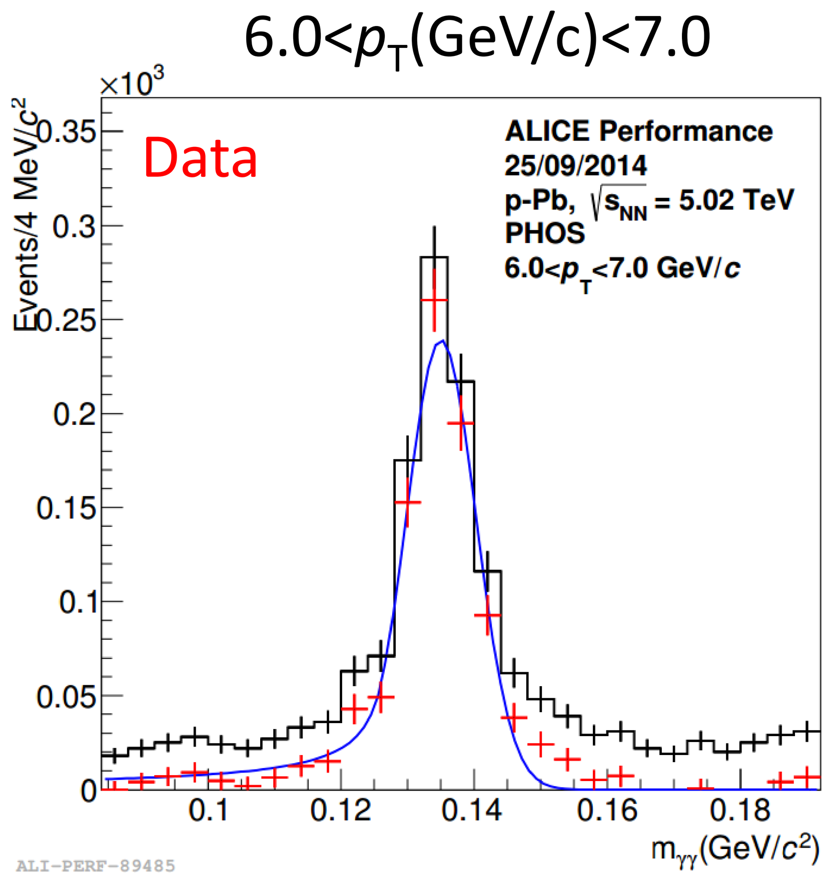
Analysis of p-Pb data triggered events with minimum bias. Invariant mass is reconstructed via two photons detected in PHOS in the same event. We can see the clear mass peak in the neutral pion mass region in both data and simulation. The signal peak is extracted via a Gaussian fit after background subtraction and the number of neutral pions is counted in each p_T. The simulation is analyzed in the same way as in data. The simulation reproduces well the shapes of signal peak and background in data.

$$m_{\gamma\gamma} = \sqrt{2E_1 * E_2 * (1 - \cos\theta)}$$

E_1, E_2 : photon energy
θ : opening angle



6.0<p_T(GeV/c)<7.0



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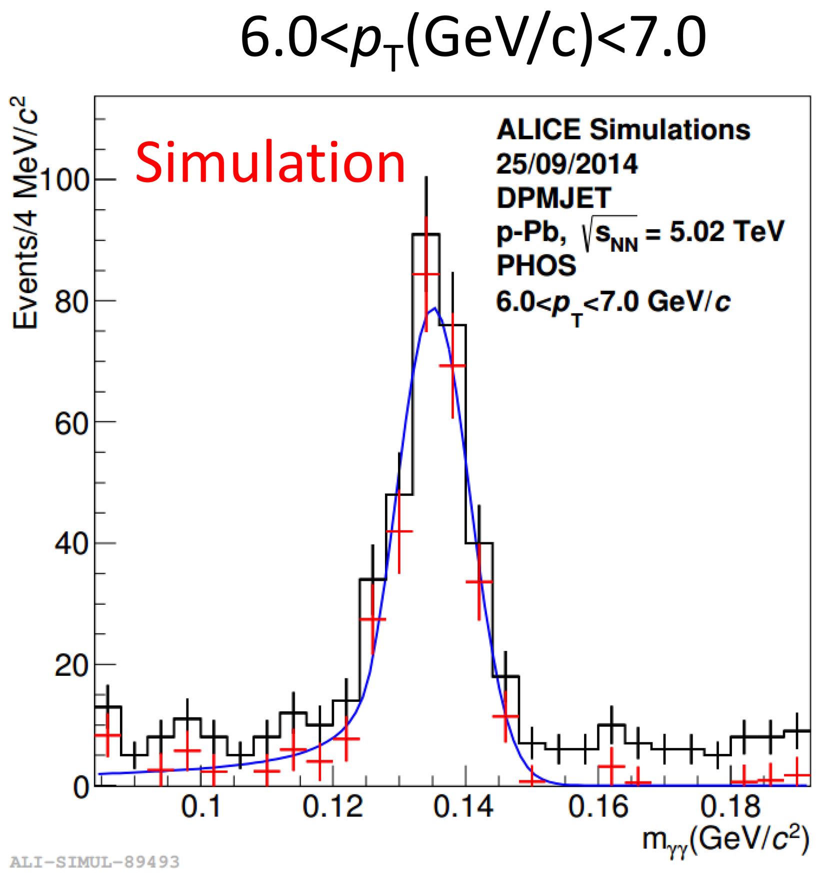
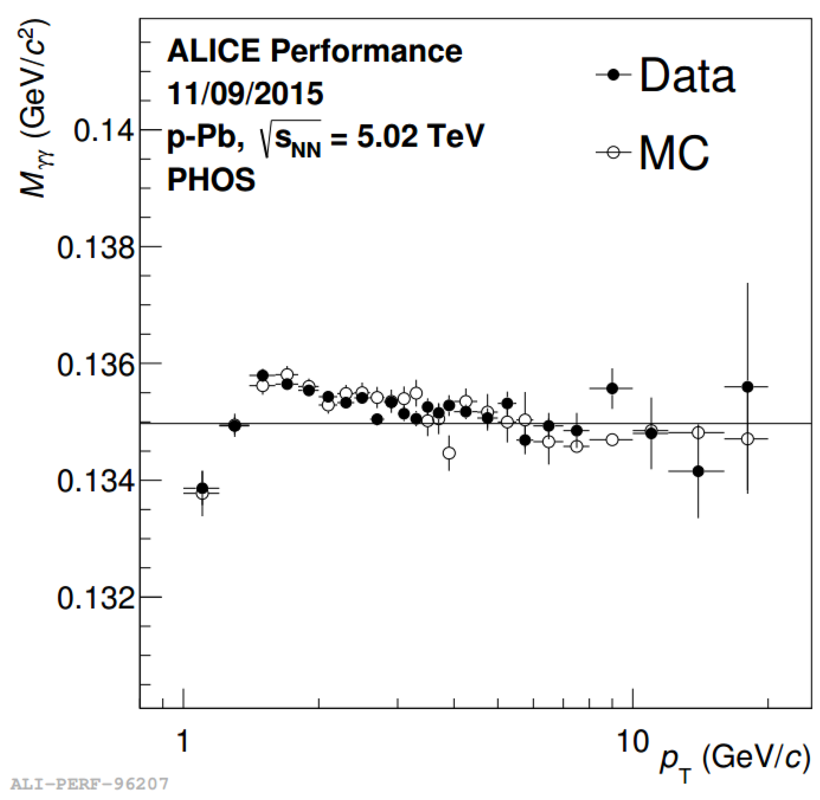
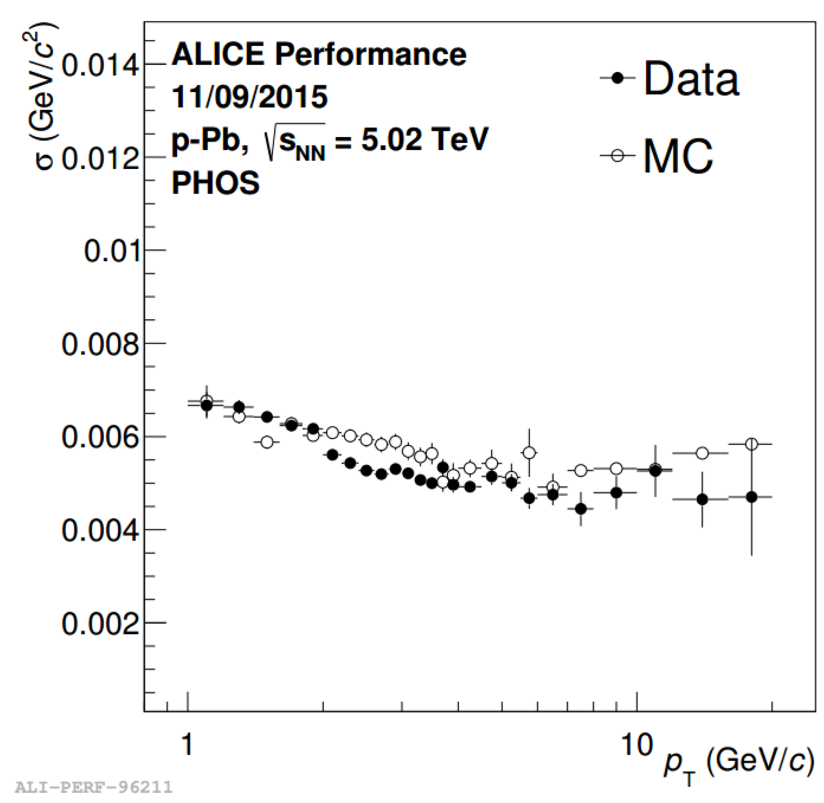


Black solid line: signal before background subtraction
Red filled point: signal after background subtraction
Blue line: signal peak fit





- The neutral pion mass peak position and width are in good agreement between data and simulation.
- The width becomes smaller at high p_T due to the good PHOS resolution in this region.

Summary & Outlook

- The neutral pion measurement is essential for understanding particle production mechanism at LHC colliding system. In p-Pb collisions, it is important to disentangle initial and final state effect in Pb-Pb collisions.
- The invariant mass was reconstructed via two-photon analysis with PHOS in p-Pb collisions with minimum bias events.
  → Signal peak was clearly seen in both data and simulation
- The neutral pion mass peak position and width were compared to simulation as a function of p_T.
  → Simulation reproduces reasonably well the behavior in data.
- The invariant spectrum will be studied soon.