Neutral Pion Measurement in pp collisions at $\sqrt{s}$ = 7 TeV with PHOS Detector in ALICE

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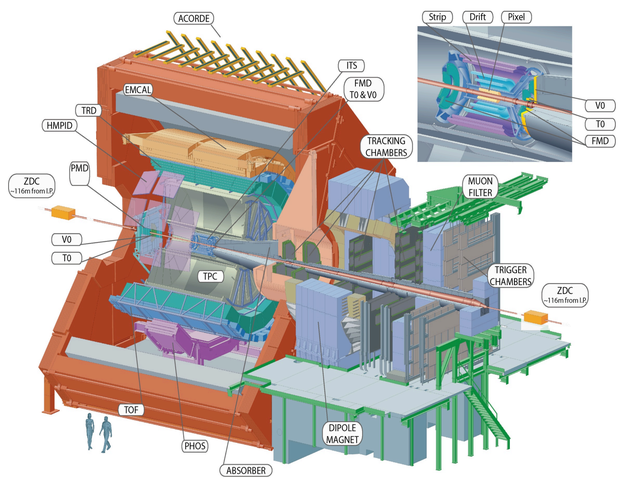
Introduction

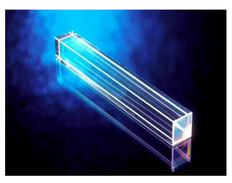
The study of neutral pions in pp collisions in a wide transverse momentum range is important to understand parton dynamics by probing parton density functions and fragmentation function in new energy domains. The π^0 and η transverse momentum spectra are necessary to estimate the decay photon background for direct photon measurements and also provide a reference for heavy-ion collisions. The π^0 and η are measured in a wide p_T range using the PHOS detector at ALICE. The status of analysis for data taken during 2010 with pp collisions at $\sqrt{s}$ = 7 TeV is presented. Recent reconstruction of data improves energy and timing calibration, and doubles the statistics with respect to dataset used for the first result of π^0 and η production in pp collisions at √s = 7 TeV[1]. The neutral pions and η mesons can be measured with PHOS up to p_T < 25 GeV/c and p_T < 20 GeV/c respectively using the minimum bias trigger.

ALICE Detector

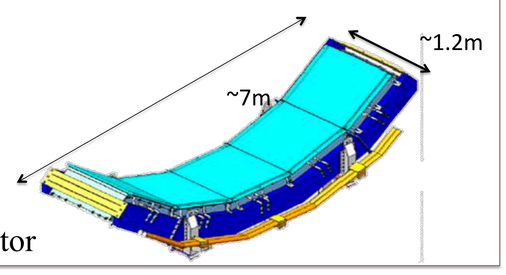


- **PHOS** (PHOton Spectrometer) is an electromagnetic calorimeter designed to measure the energy and hit coordinates of photons and electrons.
- Base element $PbWO_4$ crystals
  - $R_{Moliere}$ = 2.0 cm
  - ρ = 8.28 g/cm^3
  - Size = 2.2×2.2×18 cm^3

$PbWO_4$ crystal



- 3 modules installed at a distance of 4.6 m from ALICE IP.
- 56 × 64 (η × φ) = 3584 cells in each module
- PHOS coverage: |η| < 0.12, Δφ = 60^o
- High granularity (Δη × Δφ = 0.004 × 0.004 rad) to separate photons in high multiplicity.



ALICE PHOS Detector

Time spectrum

Different peaks represent different bunch crossings (BC). The peak at t=0 originates from the main (triggered) BC. PHOS front-end has an integration time ~6 μs after the L0 trigger, so that photons from several consecutive bunch crossing can overlap in one event. Clear peaks are the result of good timing calibration in PHOS, which is essential to suppress out-BC pileup. (~5.5%.)

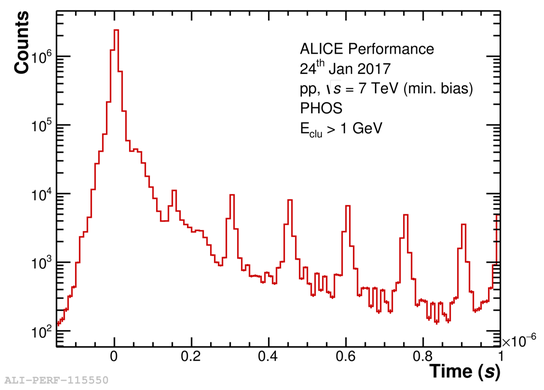
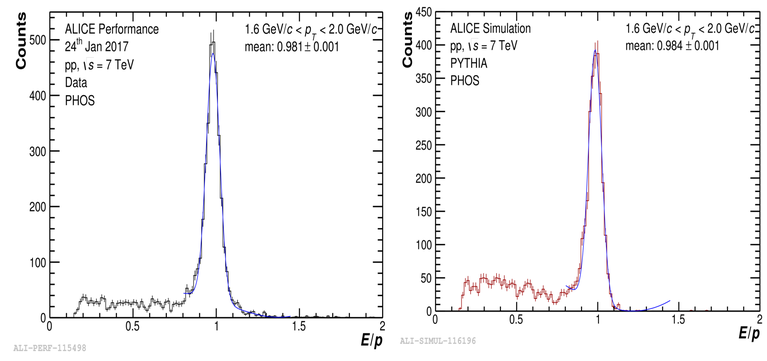


Fig. 1: Cluster timing spectrum in PHOS in pp collisions at $\sqrt{s}$ = 7 TeV for all cluster with E >1 GeV.

E/p of electron

Fig. 2: *E/p* of electrons in pp collisions at $\sqrt{s}$ = 7 TeV in data and simulation. *E* is the energy of electron measured in PHOS and *p* is the momentum of track of the electron measured in the ALICE central tracking systems consisting of Inner Tracking System (ITS) and Time Projection Chamber(TPC). Electron identification is based on ionization loss in TPC.



E/p ratio in data and simulation is a tool to adjust the global energy scale for each PHOS module. In the above figures *E/p* = 0.98 for both data and simulation, shows the good energy calibration in the new data reconstruction.

Neutral meson measurement

Raw π^0 and η yields are extracted from two photon invariant mass analysis. In the invariant mass spectra of two photons π^0 and η are visible as peaks at their rest mass, above the combinatorial background. This background is estimated with mixed event technique, and is normalized to the same event background.

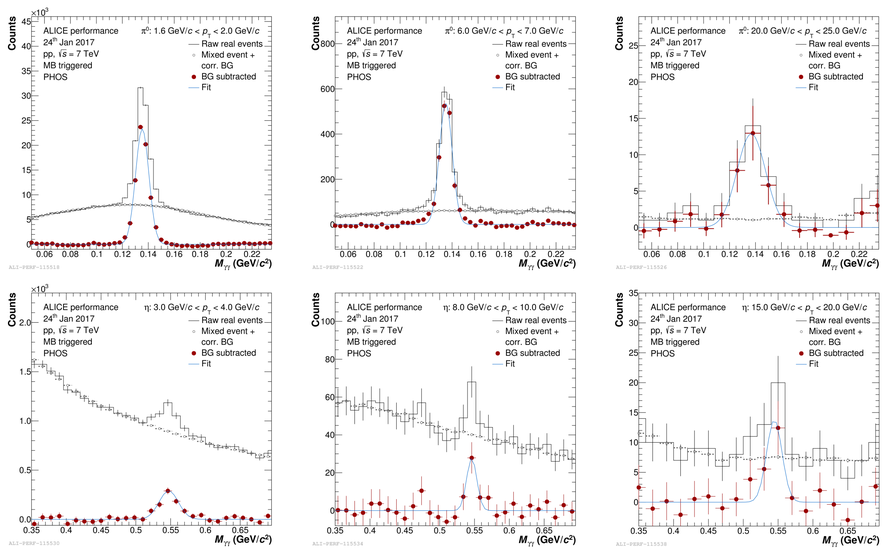


Fig. 3: Invariant mass spectrum of cluster pairs in pp collisions at $\sqrt{s}$ = 7 TeV around the π^0 and η mass at three different p_T bins. The combinatorial background is estimated with mixed event technique. The signal is fitted with a Gaussian function.

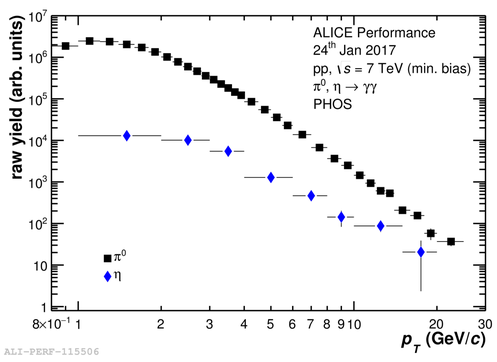


Fig. 4: Uncorrected yield measured in pp collisions at $\sqrt{s}$ = 7 TeV, errors are only statistical.

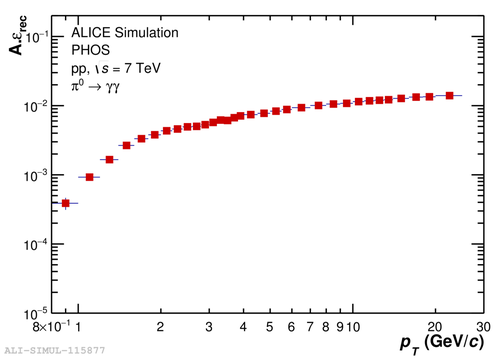


Fig. 5: π^0 reconstruction efficiency for PHOS in pp collisions at $\sqrt{s}$ = 7 TeV,.

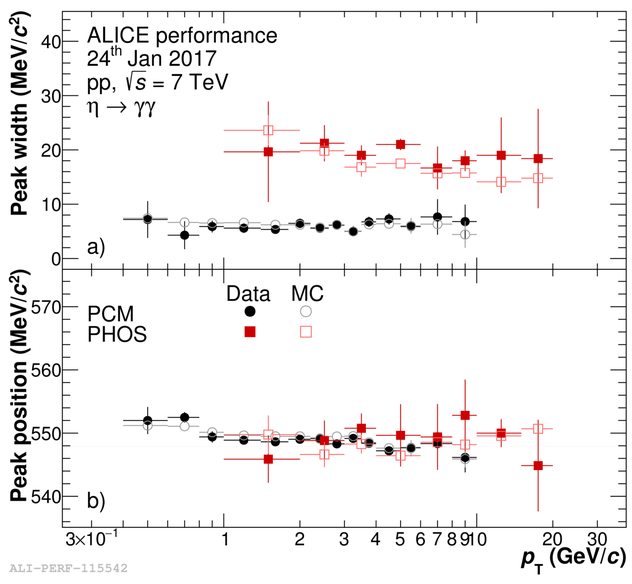


Fig. 6: Dependence of η peak position and width on p_T in pp collisions at √s = 7 TeV. Here, PCM is the "Photon Conversion Method", another way of measuring photons in ALICE via their conversion in e^+e^- pairs, which are measured in the ALICE tracking systems TPC and ITS (|η|<0.9).

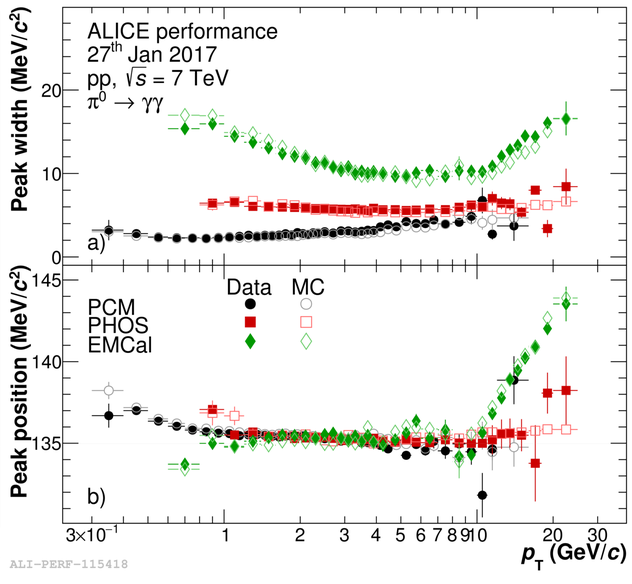


Fig. 7: Dependence of π^0 peak position and width on p_T in pp collisions at √s = 7 TeV. Here, EMCal is another complementary method for neutral meson measurements in ALICE. EMCal is a calorimeter with coarser granularity than PHOS (cell size 0.0143 × 0.0143 rad or 6 × 6 cm) but larger acceptance (|η|<0.7).

- Acceptance and efficiency was calculated in the single π^0 simulation and normalized to the unit rapidity range |y| < 0.5 and full azimuthal angle Δφ < 2π

$$A.\varepsilon_{rec} = \frac{Reconstructed\ \pi^0\ by\ PHOS}{Generated\ \pi^0\ (\Delta\varphi{=}2\pi, |y|{<}0.5)}$$

- Neutral π^0 and η peak position and width vs. p_T are in agreement with MC and other systems. It shows good calibration of the detector.
- The integrated luminosity in present analysis is ~ 7.9 nb^{-1} whereas in previous analysis it was 4 nb^{-1}.
- We expect better statistical significance and improved systematic uncertainties with recent dataset.

Reference:
[1] B. Abelev, et al., ALICE Collaboration, Phys. Lett. B, 717 (2012), p. 162 arXiv:1205.5724 [hep-ex]