Neutral pion and η meson production in ALICE in proton-proton collisions at $\sqrt{s} = 8$ TeV

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on behalf of the ALICE Collaboration

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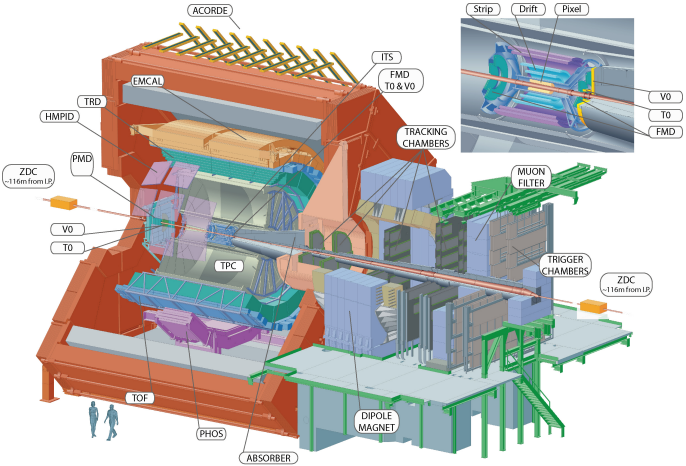
ALICE at the LHC



A Large Ion Collider Experiment (ALICE)

- Detector divided into central barred and forward muon spectrometer
- Red solenoid magnet from L3 (LEP) experiment generates $B = 0.5$ T

Detector systems used:

- V0/T0 detectors: MB trigger + luminometers
- ITS/TPC: excellent tracking + PID
- EMCal/PHOS: electromagnetic calorimeters $\rightarrow$ Triggering capabilities to extend high p_{T} reach

$\rightarrow$ Photon reconstruction possible via three independent methods

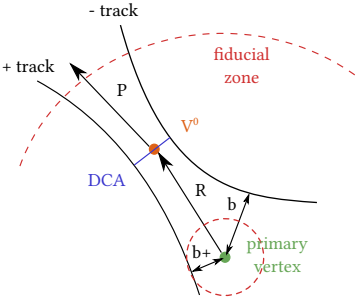
$\rightarrow$ Measurement of neutral mesons via photonic decay: $\pi^0(\eta) \rightarrow \gamma\gamma$

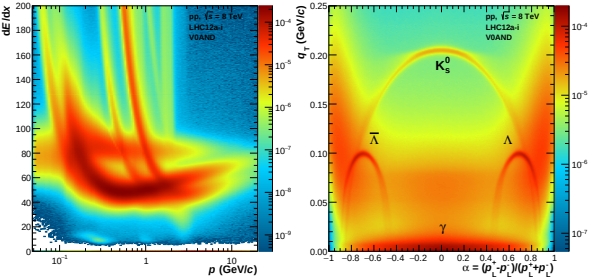
Photon reconstruction in ALICE

The Photon Conversion Method (PCM)

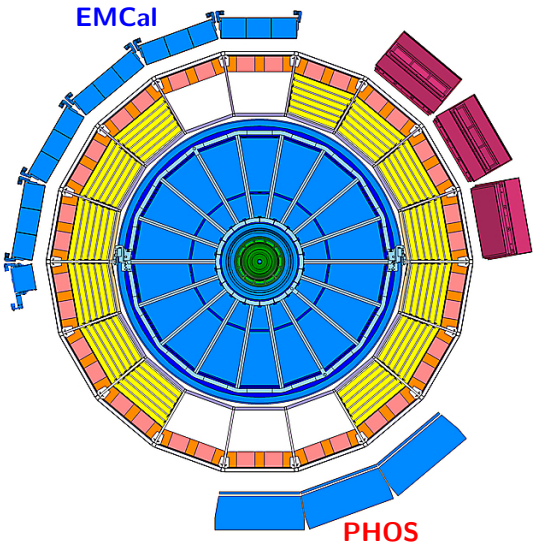
- Charged particle track combination with large impact parameter
  small DCA $\rightarrow$ $V^0(\gamma)$ candidate
- Large combinatorial Background, usage of cuts in analysis to primarily select photon candidates from V^0 sample
  - General criteria (charge, no kinks, ...)
  - PID / electron selection
  - Armenteros-Podolanski
  - Kalman-Filter
  - Cosine of pointing angle
  - ...

  $\rightarrow$ High purities ($> 99\%$ in pp)
- $|\eta| < 0.9$, $0 < \phi < 2\pi$
- Excellent resolution, but $P_{conv} \sim 8.5\%$
  $\rightarrow$ small reconstruction efficiency





Photon reconstruction in ALICE



The Electromagnetic Calorimeter (EMCal)

- $|\eta| < 0.67$, $\Delta\phi = 100°$
- Shashlik calorimeter (lead/scintillator)
- Cell dimensions $\Delta\eta \times \Delta\phi = 0.0143 \times 0.0143$

The Photon Spectrometer (PHOS)

- $|\eta| < 0.13$, $\Delta\phi = 60°$ $\rightarrow$ smallest acceptance
- Lead tungstate crystals $\rightarrow$ very good resolution
- Cell dimensions $\Delta\eta \times \Delta\phi = 0.004 \times 0.004$

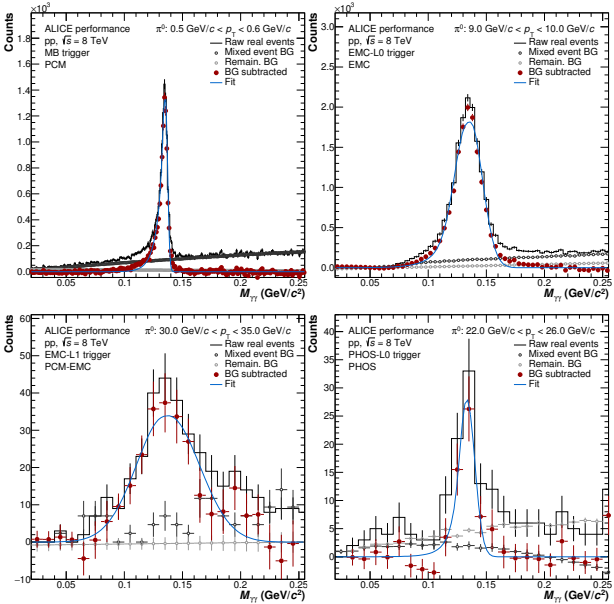
◇ Cells with deposited energy are grouped in clusters $\rightarrow$ photon candidates, example selection criteria:

- Min. energy/ N_{cells} per cluster / Shower shape
- Charged particle veto
- Opening angle
- ...

◇ Trigger capabilities $\rightarrow$ select events with energy deposited above a threshold

Meson reconstruction

- Calculation of invariant mass of two photon candidates:
  $M_{\gamma\gamma} = \sqrt{2E_{\gamma_1}E_{\gamma_2}(1-\cos\theta_{\gamma_1\gamma_2})}$
- Event mixing for uncorrelated background
- Fit with exponential + Gaussian + linear
  → mass position, width
  → bin counting to obtain raw yields
- Combination of two photons from PCM, PHOS or EMCal during reconstruction + "hybrid" methods
  → PCM + calorimeter (PCM-EMC)
  → combines advantages from both methods



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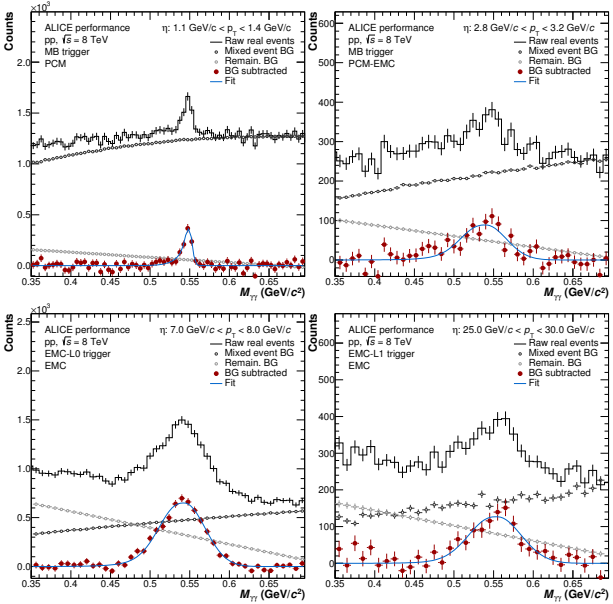
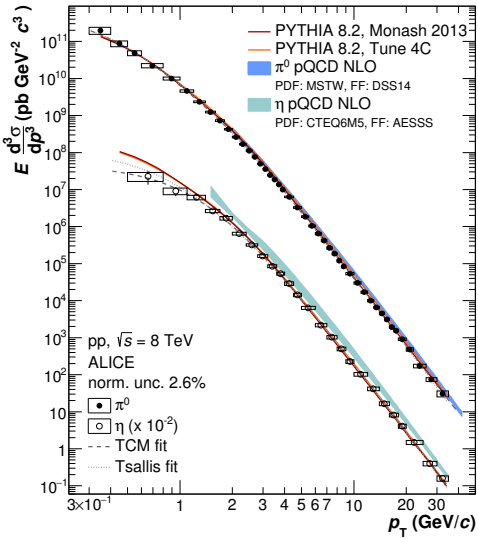
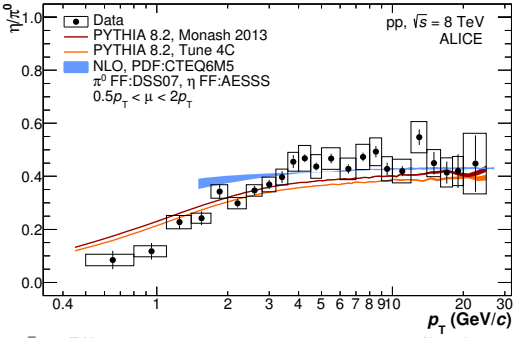


Results - π^0 and η in pp, $\sqrt{s} = 8$ TeV

- Published results: arXiv:1708.08745

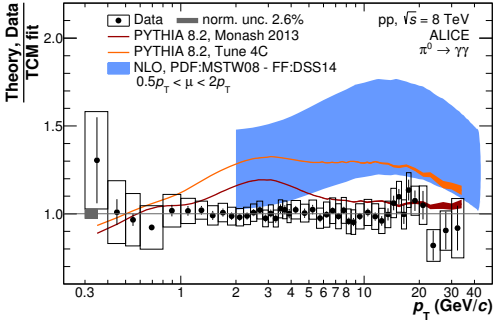


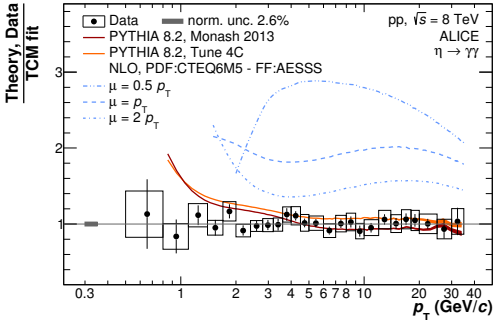
- Combination of 4 methods with 4 different triggers
  $\rightarrow$ high momentum reach for π^0 and η
  - PCM, EMCal, PCM-EMCal, PHOS (π^0)
  - MB + Calorimeter triggers:
    $\rightarrow$ EMCal ($\sim$ 2 and $\sim$ 8 GeV) and PHOS ($\sim$ 4 GeV)
- Precise reference data for LHC Run 2 p-Pb @ 8 TeV; total uncertainties (at $\sim$ 3 GeV/c):
  $\rightarrow \sim$ 5% for π^0 $\rightarrow \sim$ 10% for η

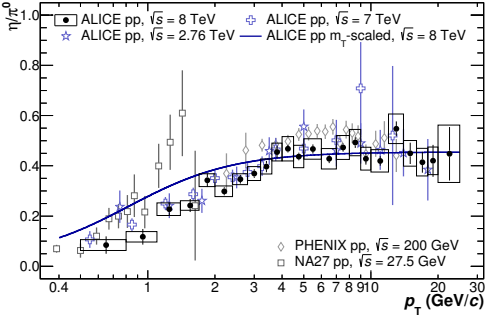


Results - π^0 and η in pp, $\sqrt{s} = 8$ TeV

- Comparison of TCM (Tsallis) fit of data to:
  - PYTHIA8.2 Monash2013 + Tune4C
  - pQCD NLO calculations (FF:DSS14 /AESSS)
- Observation of m_T scaling violation with significance of 6.2σ below 3.5 GeV/c
- Universality of η/π^0 ratio
  - NA27, PHENIX, ALICE within uncertainties







Summary and Outlook

- ALICE neutral meson measurements in pp collisions at $\sqrt{s} = 8$ TeV
  $\rightarrow$ publication August 2017: arXiv:1708.08745
- Incorporation of minimum bias and triggered data for wide p_{T} reach
- Interesting future possibilities:
  - Comparison to pPb collisions @ 8 TeV
  - Application of spectra for direct photon measurements