Dielectron production in high multiplicity pp collisions at $\sqrt{s} = 13$ TeV

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Introduction

Physics motivation

- Collectivity in small systems has been observed at RHIC and LHC, but no energy loss observed in $R_{AA}$ measurements
- Does the system thermalize or not?
  - Onset of thermal photon production at $dN_{ch}/d\eta \sim 10$?
  - Search for thermal photons in small systems at the LHC energy

Measure direct virtual photon fraction in pp at $\sqrt{s} = 13$ TeV

- Full Run 2 data set
- Analysis in minimum-bias (MB) and high-multiplicity (HM) events
- Factor 3.8 (4.4) in MB (HM) compared to previous publication [1]

Analysis steps

Data analysis

- Identify $e^\pm$ with ALICE Time Projection Chamber and Time of Flight
- Signal (S) extracted using like-sign method:
  \[ S = ULS - LS^* R, \]
  \[ ULS = e^+e^- \text{ from same events} \]
  \[ LS = e^+e^- & e^-e^- \text{ from same events} \]
  \[ R = \text{acceptance correction factor determined with mixed events} \]

Hadronic cocktail simulation

- Expected dielectron yield from known hadron decays
- Light-flavors:
  - ($\pi^0/\eta/\phi$) and $J/\psi \rightarrow$ fit to measured spectra at $\sqrt{s} = 13$ TeV
  - ($\eta^+/\rho/\omega$) $\rightarrow m_T$ scaling
- Heavy-flavors ( $c\bar{c}$ and $b\bar{b}$ ) generated with PYTHIA6

$\pi^0$ and $\eta$ are now measured [1] in the same multiplicity class, not before, which reduced the sys. unc. of the hadronic cocktail!

[1] Poster by A. Mechler and J. König (T14_1 & T14_2)
Data to cocktail comparison

- Data and cocktail are consistent with unity $p_{T,ee} > 1$ GeV/c within uncertainty.

✓ Full mass range is under control
Extract direct photon fraction $r$

Minimum bias

- Cross section/Yield fitted with three-component function
- with $r$ only fit parameter $= (\gamma^*_{\text{dir}}/\gamma^*_{\text{incl}})_{m_{ee}\to 0} = (\gamma_{\text{dir}}/\gamma_{\text{incl}})$
- $f_{\text{dir}}$ approximated by Kroll-Wada formula [1]
- Light-flavor $f_{\text{LF}}$ and virtual photon $f_{\text{dir}}$ template are normalized independently to the data below 40 MeV/$c^2$
- Heavy-flavor function $f_{\text{HF}}$ are fixed to cross section at mid-rapidity

High multiplicity

- Cross section/Yield fitted with three-component function
- with $r$ only fit parameter $= (\gamma^*_{\text{dir}}/\gamma^*_{\text{incl}})_{m_{ee}\to 0} = (\gamma_{\text{dir}}/\gamma_{\text{incl}})$
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Direct photon fraction

Results

- Much smaller statistical and systematic uncertainties compared to previous publication
- Results compatible with pQCD and no significant direct photon fraction in MB
- No sign of increase direct photon fraction in HM