Measurement of low-mass dielectrons in pp collisions at $\sqrt{s} = 13$ TeV with ALICE

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Motivation

Low-mass dielectrons – penetrating probe to study the system created in high-energy heavy-ion collisions
- Produced during all stages of collisions
- Unaffected by strong interactions
- Approximate mass ordering of production time
Proton-proton collisions

Heavy flavour contribution:

New (or heavy-ion like) phenomena in high-multiplicity pp events?
- Production / destruction of $\rho$ mesons, direct photons, …
- Idea: produce a ratio of dielectron spectra in high-multiplicity (HM) over min. bias (MB) triggered events

Experimental Setup

Central barrel detectors (2π coverage, $|\eta| < 0.8$)
- Inner Tracking System
  - Collision vertex reconstruction
  - Tracking
  - Particle Identification
- Time Projector Chamber
- Tracking
- Particle Identification
- Time Of Flight
- Particle Identification

V0 scintillators
- V0A: $2.8 < \eta < 6.1$, V0C: $-3.7 < \eta < -1.7$
- MB trigger: coincidence of V0A & V0C signals
- HM trigger: coincidence of V0A & V0C signals, threshold on V0M amplitude

Pair Analysis

Raw signal normalised by number of events (left), signal / background ratio (middle) and statistical significance (right) in two event classes (HM and MB)
- Clear signs of vector mesons ($\omega$, $\phi$, $J/\psi$)
- Naive expectation: signal is proportional to $N_{ch}$, combinatorial background grows like $N_{ch}^2$
- Signal / background ratio is lower for high-multiplicity events
- Statistical significance is comparable in background-dominated mass region

Cocktail Calculations

Cocktail calculations based on preliminary ALICE $p_T$ measurements
- $m_T$ scaling for other hadrons (with asymptotic values fixed to 7 TeV if avail.)
- Include observed modification of $p_T$ spectrum in events with higher charged-particle multiplicities [1]
  - Red curve – lower limit ($\sim 3\times$ in $\langle N_{ch} \rangle$)
  - Red / blue – upper limit ($\sim 6\times$ in $\langle N_{ch} \rangle$)
  - Take into account also $p_T$-dependent electron efficiency

Heavy flavour contribution:
- PYTHIA simulation of open charm production
- Multiplicity dependent production of D mesons in pp at 7 TeV [2]
  - At $N_{ch}$ ($N_{ch} < 4$ for $2p_{T} > 4$ GeV/c the relative yield increases to $N_{ch} / \langle N_{ch} \rangle = 9.02 \pm 0.57$ (stat) $\pm 0.47$ (syst) $\pm 1.47$ $\pm 0.5$ (feed-down)

$\rightarrow$ Expect $N_{ch}(HM)/N_{ch}(MB) \approx 1 - 2.5$

Results

Ratio of dielectron spectra in high multiplicity over minimum bias events (right - zoomed in low mass region)
- Scaled with multiplicity factor $N_{ch}(HM)/N_{ch}(MB) = 4.36$

In agreement with cocktail expectations everywhere
- $m_T$ mass region: ratio $> 1$ due to change of hadron $p_T$ spectrum [1]
- Low mass region: more data are needed to investigate the spectrum modification in detail
- Intermediate mass: in agreement with D-meson results at 7 TeV [2]
- Outlook: $>5\times$ more pp data from 2016 will be analysed

References


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