Measurement of low-mass dielectrons in p-Pb collisions with ALICE

Theo Bröker
Outline

• Introduction
• The ALICE detector
• Electron identification
• Signal extraction
• Hadronic cocktail
• Results
• Summary
Studies in different collision systems

pp collisions:
- vacuum reference

Pb-Pb collisions:
- medium modifications of light mesons
- thermal radiation from hot medium
- heavy-flavor modification in the medium

p-Pb collisions:
- modifications from cold nuclear matter effects
  - initial state suppression of charm production
  - final state effects, energy loss
- thermal radiation in (high multiplicity) p-Pb?
Cold nuclear matter effects

- charm suppression expected in p-Pb at low \( p_T \) by different models
- no strong conclusion from present D meson results
- open heavy-flavor dielectron results provide complementary measurement of charm suppression at low \( p_T \) due to sensitivity for very soft dielectrons (\( p_T^e > 0.2 \text{ GeV/c} \))

The ALICE detector

- Inner Tracking System (ITS)
  - tracking & vertexing
  - PID (dE/dx)

- Time Projection Chamber (TPC)
  - tracking
  - PID (dE/dx)

- Time Of Flight (TOF)
  - PID (hadron rejection)

- p-Pb: ≈ 106 million min. bias events at 5.02 TeV
Electron identification

- **ITS**
  - select electrons

- **TPC**
  - select electrons
  - reject pions

- **TOF**
  - reject hadrons, if TOF signal available
Signal extraction

- calculate all possible unlike-sign (ULS) pairs
  - ULS contains real signal, combinatorial and correlated background
- background estimation by like-sign (LS)
  - LS describes combinatorial and correlated background
- signal subtraction:
  - \( S = ULS - LS \times R \)
- \( R \): Acceptance correction factor for LS
  - \( R \) calculated from mixed events

![Graph](attachment:image.png)

ALICE Preliminary
p-Pb NSD \( s_{NN} = 5.02 \) TeV
\( p_T^e > 0.2 \) GeV/c
\( |\eta^e| < 0.8 \)

- Unlike-sign distribution
- Like-sign distribution
Signal extraction

- signal to background ratio smaller in p-Pb than in pp

challenging analysis
**Hadronic cocktail**

known hadronic dielectron sources:

- $\pi^0$ contribution based on charged pion ALICE measurement in p-Pb
  

- $\eta$, $\eta'$, $\omega$, $\phi$, $\rho$ from $m_T$-scaling

- J/$\psi$ based on pp calculations scaled to p-Pb measurements
  
  dx.doi.org/10.1016/j.nuclphysa.2014.09.062

- open heavy flavor based on pp expectations at 2.76 & 7 TeV scaled by $\langle N_{\text{coll}} \rangle = 6.9$
Heavy flavor contribution

- heavy-flavor cocktail contribution based on measured cross section
- large uncertainty of ALICE result
- additional uncertainty from scaling to p-Pb energy
Invariant mass spectrum

- data comparison to known hadronic sources
- agreement of cocktail and data within uncertainties
- no hint for thermal contribution
- maybe hint for suppression in charm dominated mass region
- cocktail uncertainties do not allow for strong conclusion on CNM effects
- more checks in MC needed
Pair $p_T$ spectrum in $0 < m_{ee} < 0.14$ GeV/c$^2$

- pair $p_T$ spectrum dominated by $\pi^0$ contribution
- data in agreement with cocktail expectations
Pair $p_T$ spectrum in $0.14 < m_{ee} < 0.75$ GeV/c$^2$

- mass region dominated by $\eta$-meson and open charm contribution
- no thermal enhancement at low $p_T$
Pair $p_T$ spectrum in $0.75 < m_{ee} < 1.1$ GeV/$c^2$

- mass region of $\omega$, $\phi$ dominated by open charm contribution
- data in agreement within cocktail uncertainties
Pair $p_T$ spectrum in $1.1 < m_{ee} < 3$ GeV/$c^2$

- intermediate mass region dominated by open heavy flavor contribution
- data in agreement within cocktail uncertainties
Summary

• dielectrons are good probe to study CNM effects in p-Pb at low $p_T$

• p-Pb measurement in agreement with cocktail calculations within uncertainties

• no conclusion on possible charm suppression due to large uncertainties

Outlook

• attempt to reduce uncertainties on cocktail

• alternatively data-driven approach by comparing p-Pb with scaled pp reference $R_{pPb}(m_{ee})$

• search for thermal radiation in high multiplicity p-Pb events

• possible charm suppression due to CNM effects would have important impact on Pb-Pb measurement