Nuclear Modification of B-mesons in Cu+Au collisions at 200 GeV Measured Through B->J/ψ decay by the PHENIX Experiment

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Light, Charm and Bottom Quarks crossing QGP

Energy loss:
- Gluon radiation
- Elastic collisions
- Gluon radiation suppressed for $\theta < M/E$
- Heavy quarks hadronize quickly crossing the medium as mesons or dissociated quarks

Quark mass dependency more pronounced at small $p_T$
Vertex Detectors in PHENIX

VTX PIXELS

FVTX SOUTH

FVTX NORTH

e

VTX STRIPS

\(\mu\)

20.1 cm

38.2 cm

9/20/16

Nuclear Modification of B-mesons in CuAu collisions
Separating charm and bottom

First results at mid-rapidity using
• Displaced vertex of semi-leptonic decays
• Reconstructed $D^0$
Look for non-prompt J/psi using the new forward vertex detector (FVTX)

Decay length is boosted at large rapidities \((p_z >> 0)\) allowing to identify non-prompt particles down to \(p_t = 0\)
B-mesons Acceptance

\[ B \rightarrow J/\psi \rightarrow \mu \]

Flat detector acceptance in small \( p_T \) region.

Clean access to small \( p_T \) B-mesons.

Boosted B-mesons:
- longer decay length
- may also have physics implications on path length until hadronization
The Forward Vertex Detector (FVTX)

Sensor
- 2 columns of strips
- 1664 strips per column
- strip length 2.8 to 11.2 mm
- 75 micron spacing
- 48 wedges per disk (7.5°/sensor, 15°/wedge)
- 0.5 mm overlap with adjacent wedges

FPHX Chip
- 1 column readout
- 128 channels
- ~ 70 microns channel spacing
- Dimensions –9mm x 1.2 mm

Mini-strips are oriented to approximate an arc
Muon Reconstruction

1.2 < |y| < 2.2
2π azimuthal coverage

Projections at one of the FVTX planes

- MuTr track can match >1 FVTX track because of multiple scattering projection
- Analysis use all 3σ matchings and statistically subtract mismatches using event mixing technique
Identifying B-meson decays

Decays from HF produce additional asymmetric tails.

Positive DCA$_R$ tail suppressed because of FVTX acceptance.

Detector smearing obtained from large and clean sample of prompt pions and kaons.
Di-muon combinatorial and FVTX-MuTr mismatch backgrounds not shown for clarity, but considered in the likelihood fit.
Despite expected reduction of $b\bar{b}/c\bar{c}$ ratio at 510 GeV, fraction of B-meson decays in inclusive $J/\psi$ yield is consistent with higher energy results.

- Larger fraction in PHENIX rapidity range? (as observed by CMS and LHCb)
- Compensation from larger $(J/\psi)/c\bar{c}$ at higher energies?
B→J/Ψ fraction results

PHENIX results are $p_T$ and centrality integrated. Data points placed at average J/ψ $p_T$. Cu+Au 200 GeV $1.2 < |y| < 2.2$

B-fraction in Cu+Au data enhanced compared to p+p data at the same average $p_T$.

B-meson is less suppressed than prompt J/ψ in Cu+Au collisions.

200 GeV data from STAR mid-rapidity $p_T > 5$ GeV/c also follow word trend.
No pp reference at 200 GeV in the same $p_T$ and rapidity at this moment.

Assuming $F_{B/J_\psi}(pp)=0.1$ from world $p+p$ data at $J/\psi$ $p_T=1.5$ GeV/c.

In this assumption, $R_{AA}$ from Cu- and Au-going data consistent to binary scaling of B-mesons: no B-meson destruction, no thermal production in the QGP.
Charm and Bottom from inclusive single muons

- Provides high statistics but needs to deal with many sources in DCA$_R$ distribution.
- Very careful analysis underway with Cu+Au and p+p data sets to minimize systematics.

Opportunity in many data samples for $R_{AA}$ and flow measurements.
• Forward B→J/ψ at PHENIX can access B-mesons at small $p_T$, where quark mass is relevant for energy loss.

• B-meson fraction in p+p 510 GeV consistent with higher energy world data.

• Assuming that B-meson fraction in p+p 200 GeV is also consistent with world trend, B-meson $R_{AA}$ in Cu+Au collisions consistent with no nuclear modification.

• Single muon DCA analysis will bring more statistics to the D- and B-meson measurement allowing $R_{AA}$ vs. $p_T$ in Cu+Au

• Very large data set from run14+run16 coming up will provide more insights on the energy loss mechanism in QGP
2017 Jets and heavy flavor workshop

- Second in a series of workshops to bring the NP and HEP communities working on jets and heavy flavor, with emphasis on QCD and SCET

Workshop topics:
- Jets and jet substructure in hadronic and nuclear collisions
- Heavy flavor production in p+p, p+A and A+A
- Perturbative QCD and SCET
- New theoretical developments
- Recent experimental results from RHIC and LHC

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