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

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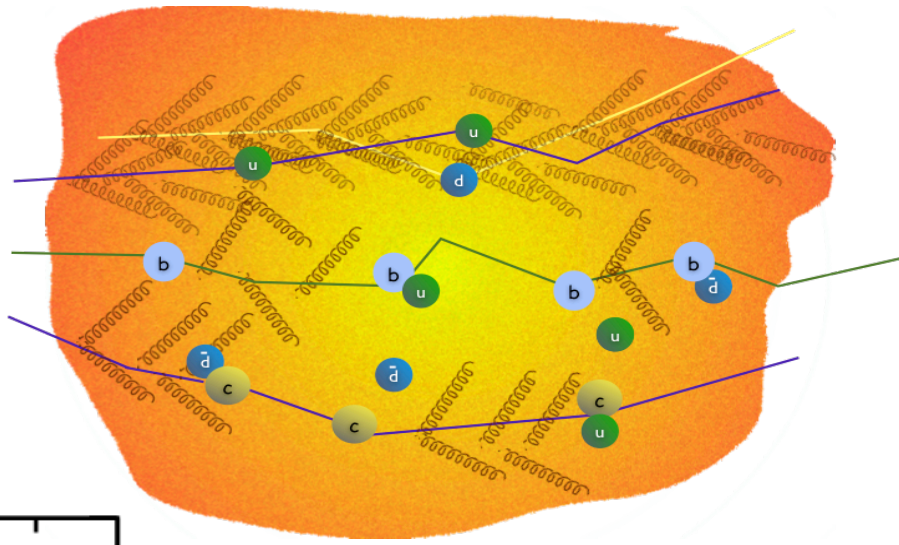
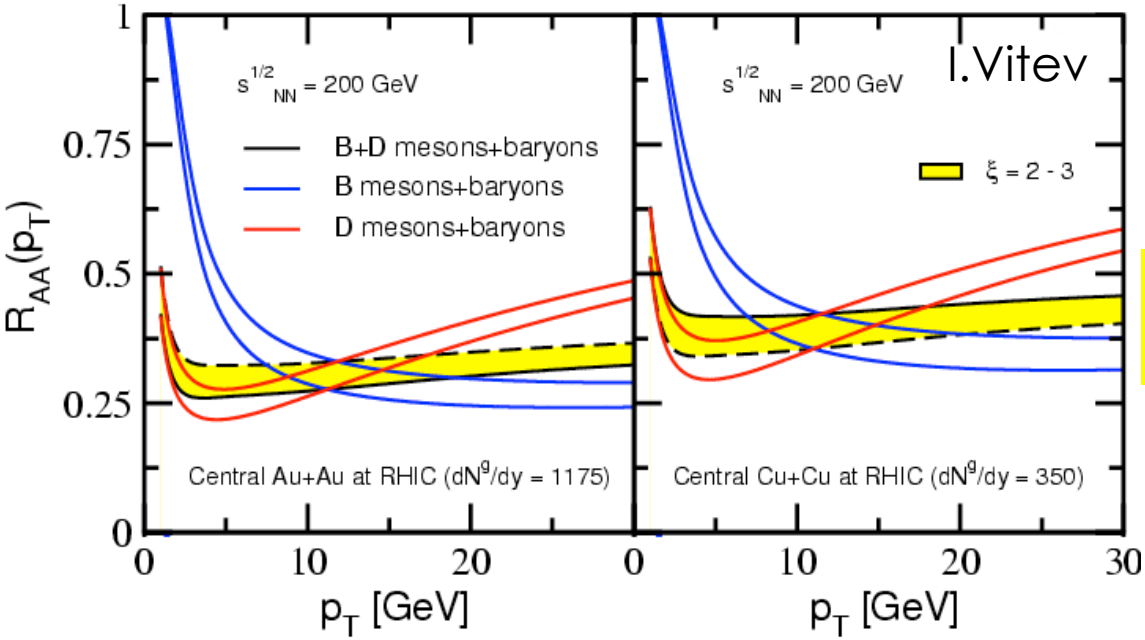
Light, Charm and Bottom Quarks crossing QGP

Energy loss:

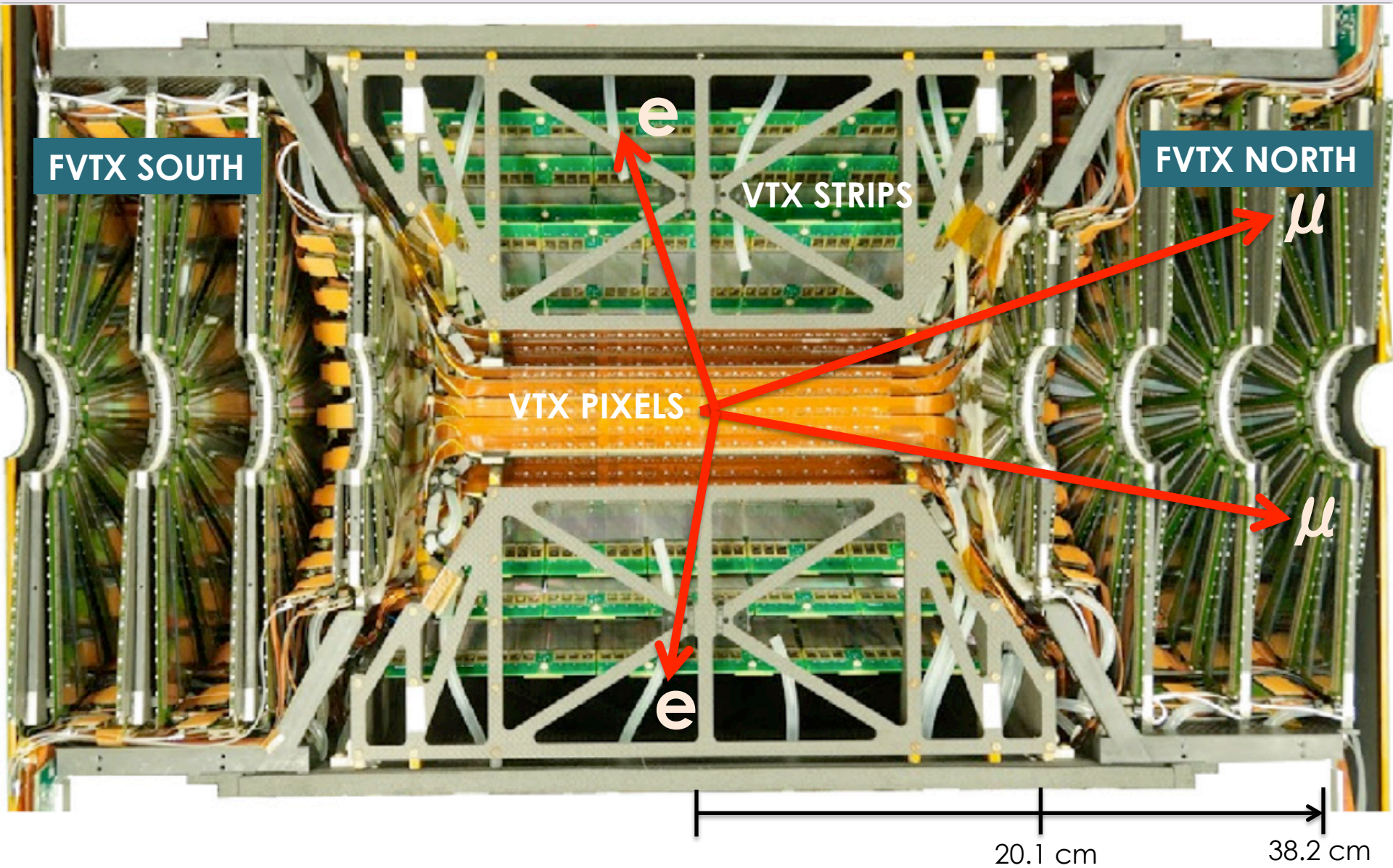
- Gluon radiation
- elastic collisions
- Gluon radiation suppressed for θ <M/E
- Heavy quarks hadronize quickly crossing the medium as mesons or dissociated quarks



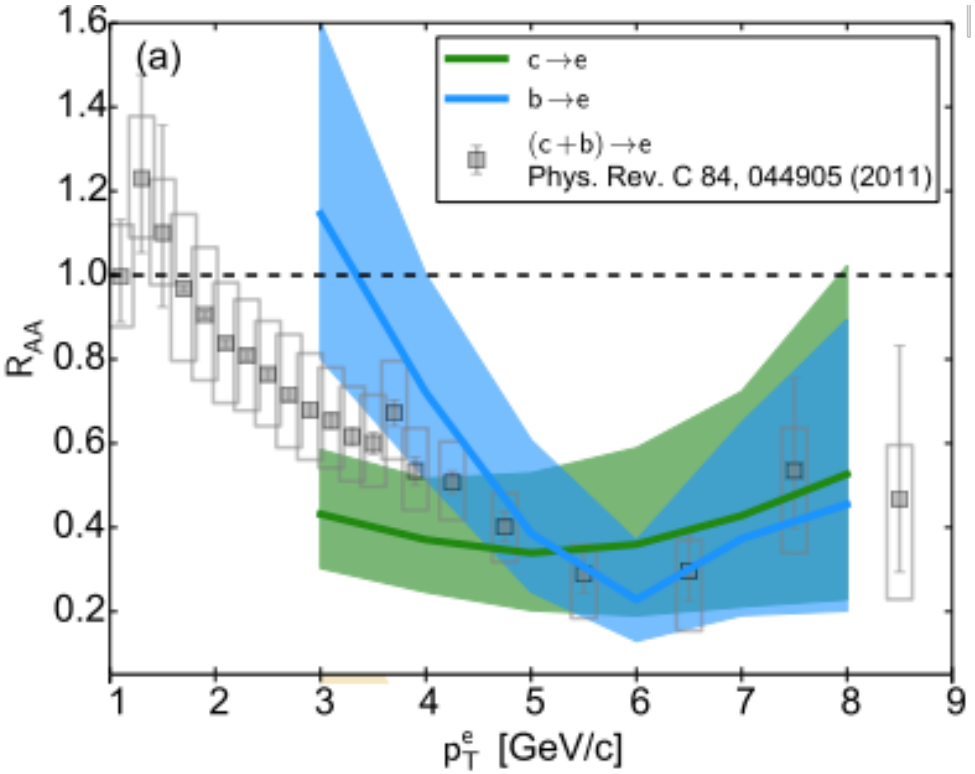


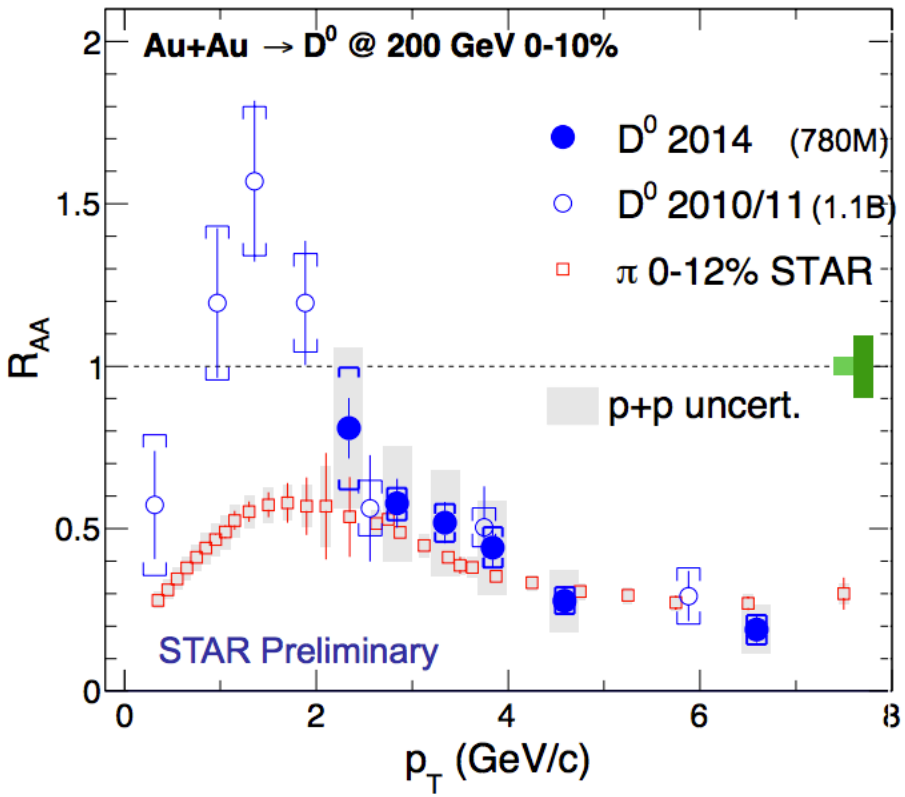
Quark mass dependency more pronounced at small p_T

Vertex Detectors in PHENIX



Separating charm and bottom





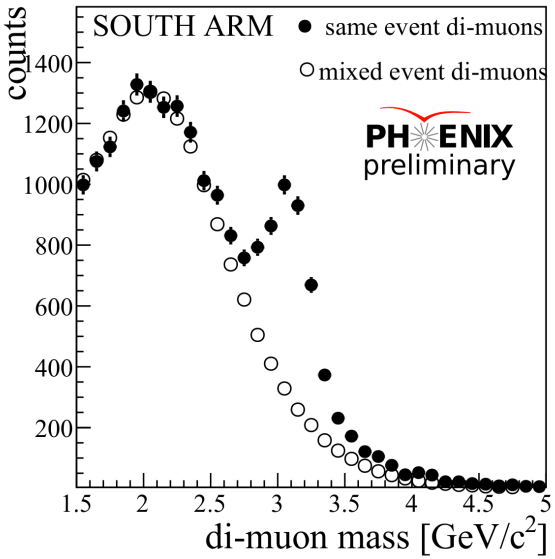
First results at mid-rapidity using

- Displaced vertex of semi-leptonic decays
- Reconstructed D^0

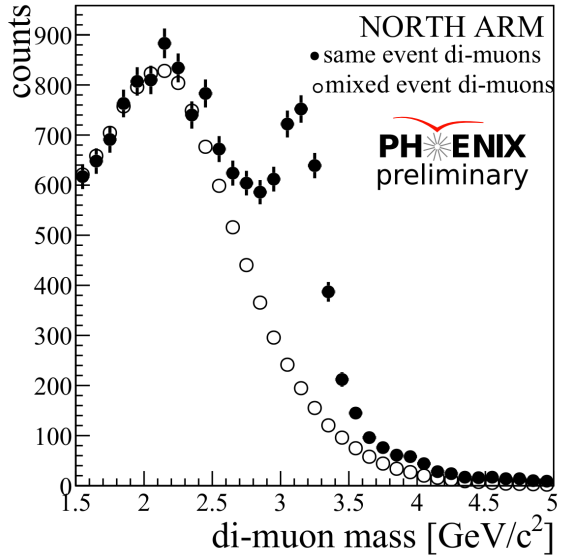
B-mesons at RHIC

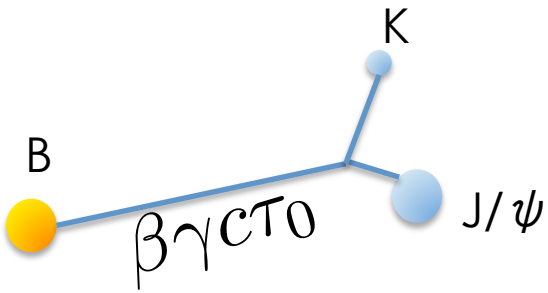
Inclusive J/ψ

-2.2<y<-1.2



1.2<y<2.2



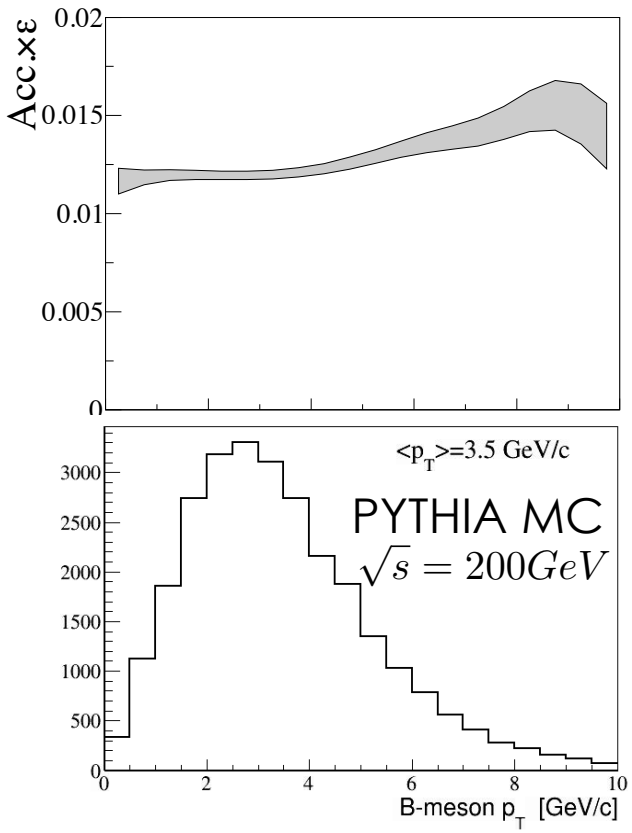


$$c\tau_0 \sim 450\mu m$$

$$\gamma = \frac{\sqrt{p_z^2 + p_T^2 + M^2}}{M}$$

- 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



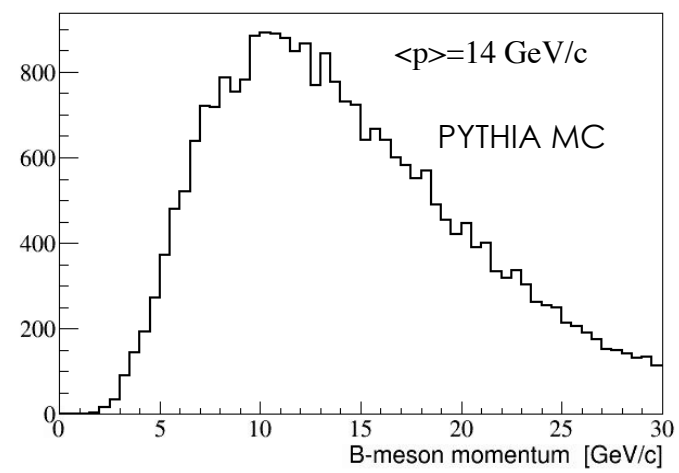
$$B \rightarrow J/\psi \rightarrow \mu$$

Flat detector acceptance in small p_T region.

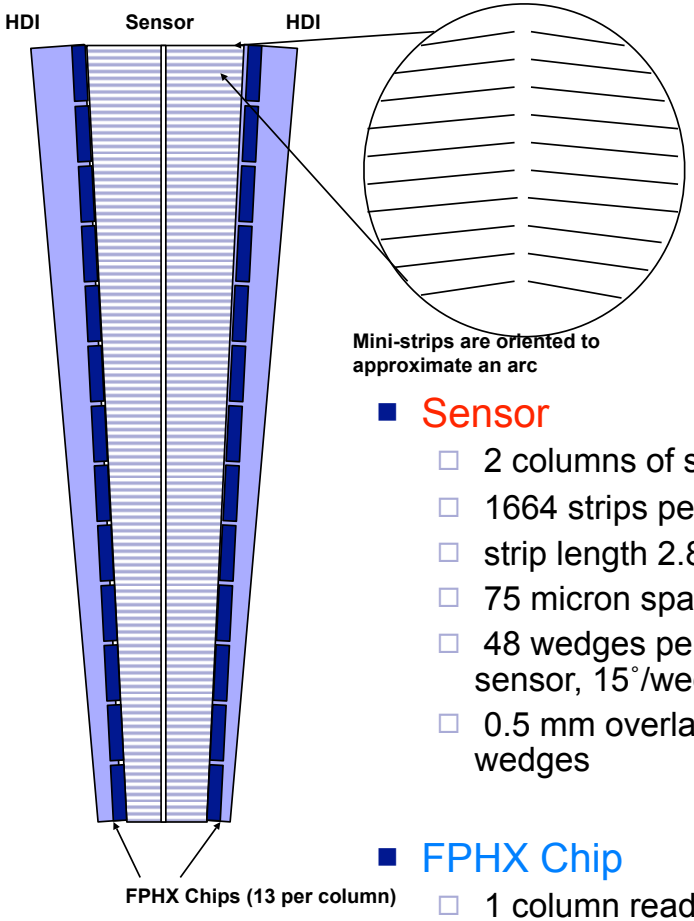
Clean access to small p_T B-mesons.

Boosted B-mesons :

- longer decay length
- may also have physics implications on path length until hadronization

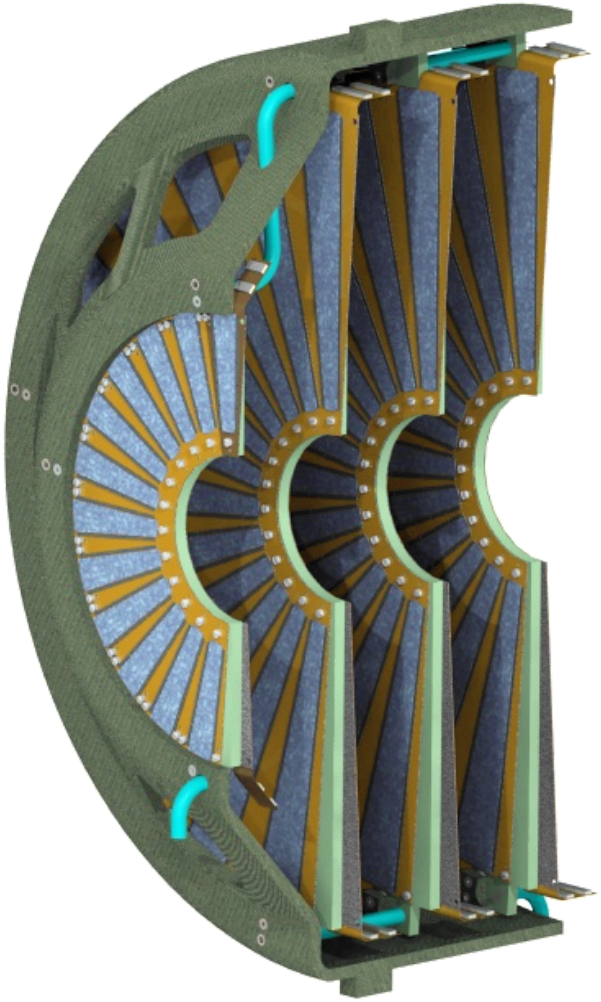


The Forward Vertex Detector (FVTX)



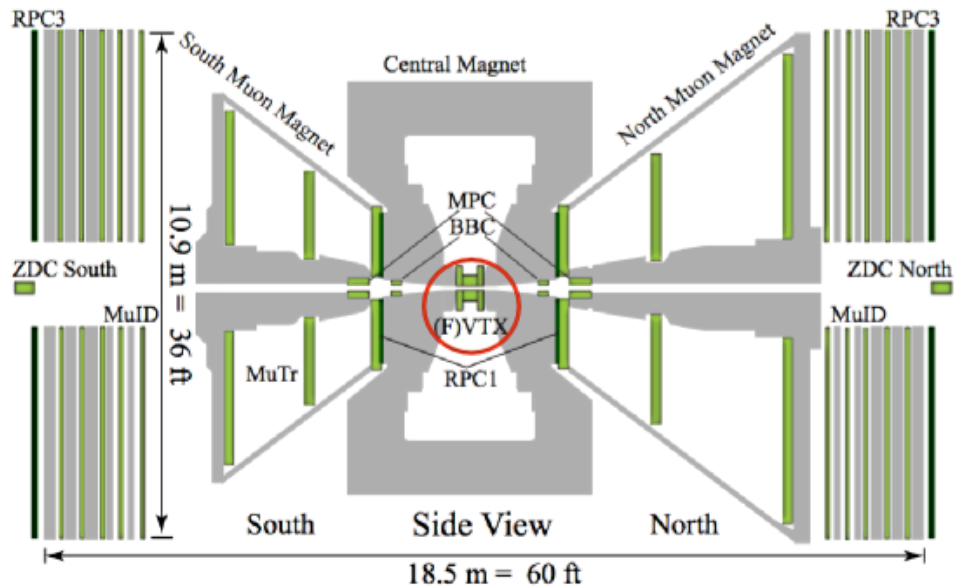
75 μm radial segmentation

- 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

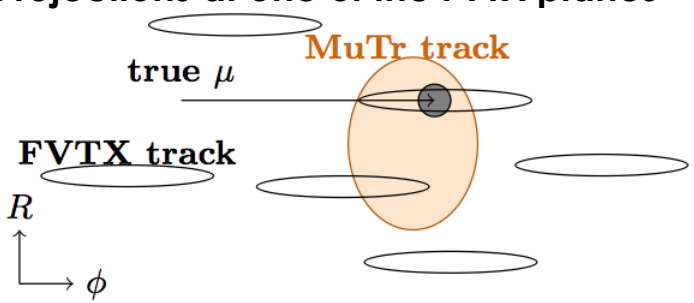


Muon Reconstruction

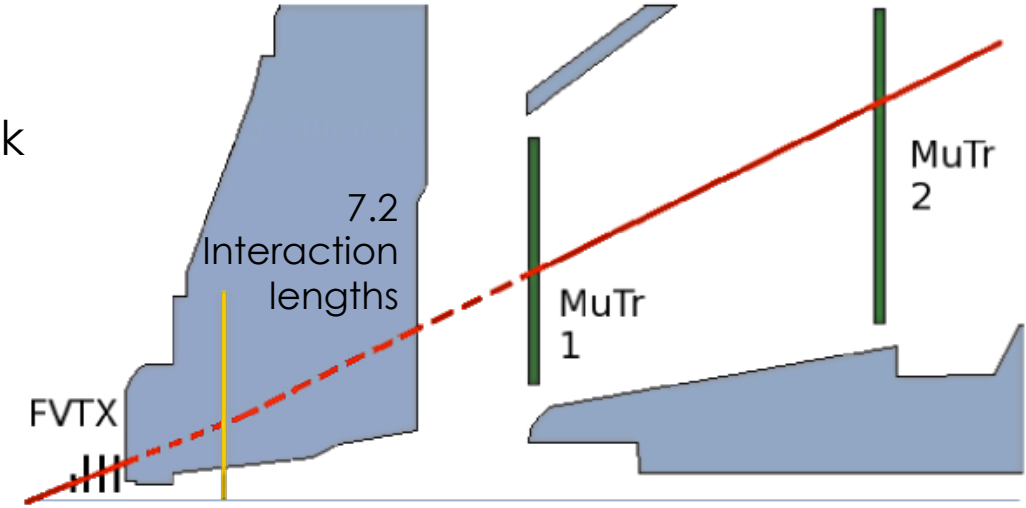
1.2<|y|<2.2
2π azimuthal coverage



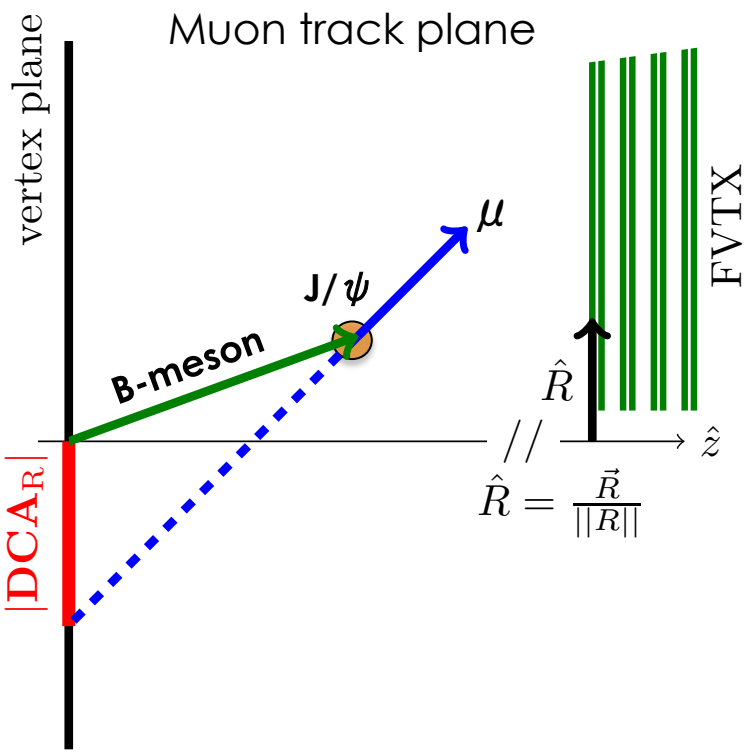
Projections at one of the FVTX planes



- 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



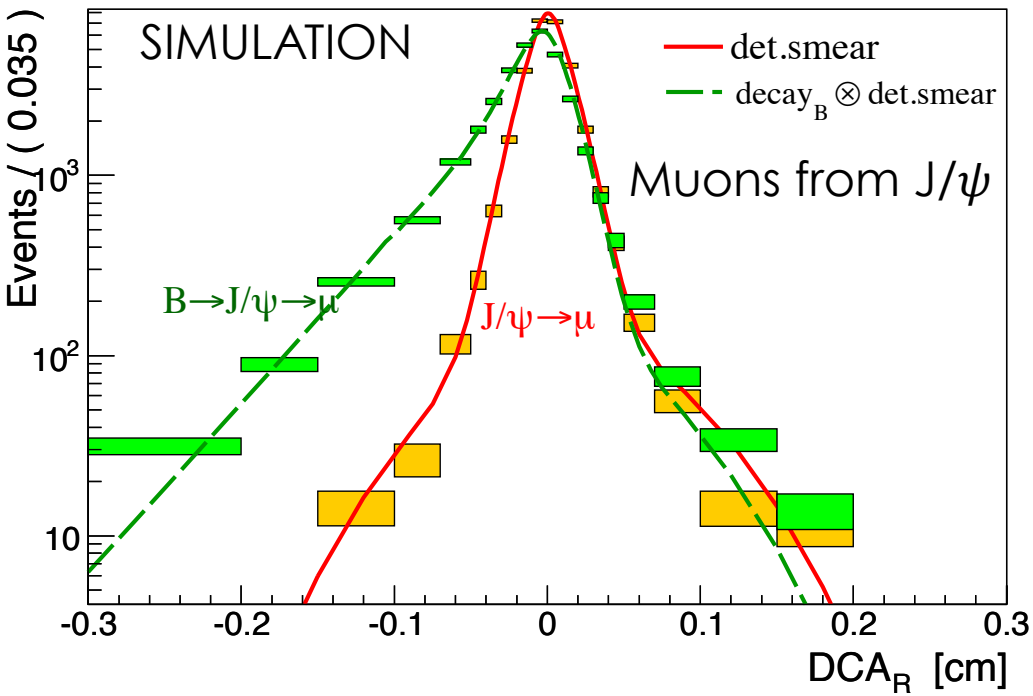
Identifying B-meson decays



Decays from HF produce additional asymmetric tails.

Positive DCA_R tail suppressed because of FVTX acceptance.

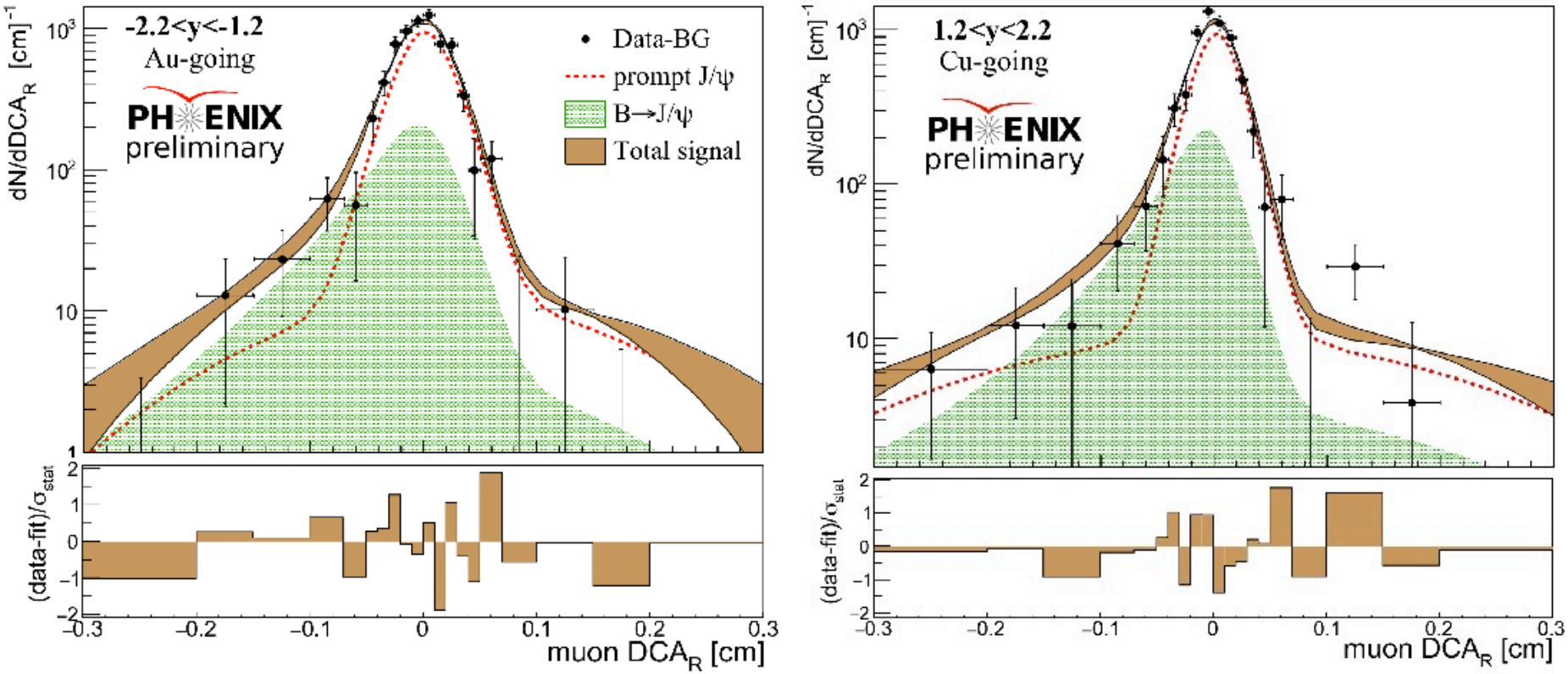
Detector smearing obtained from large and clean sample of prompt pions and kaons.



B→J/Ψ decays

Cu+Au @ 200 GeV

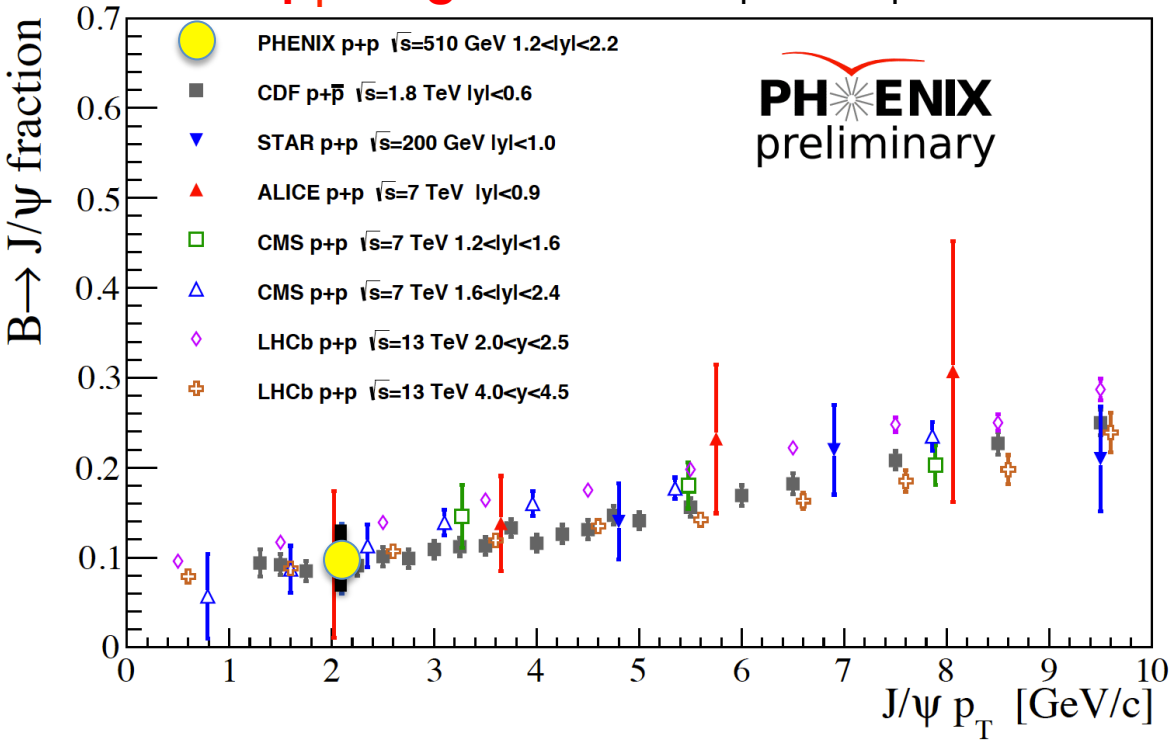
Integrated Centrality and p_T.



Di-muon combinatorial and FVTX-MuTr mismatch backgrounds not shown for clarity, but considered in the likelihood fit.

B→J/Ψ fraction results

PHENIX results are **p_T integrated**. Data points placed at average J/ψ p_T.

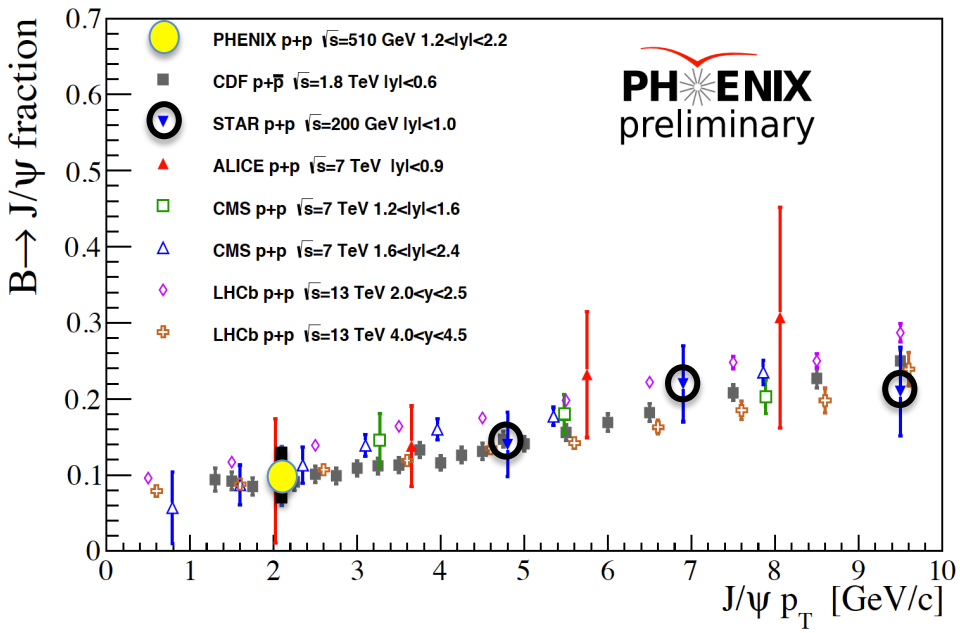


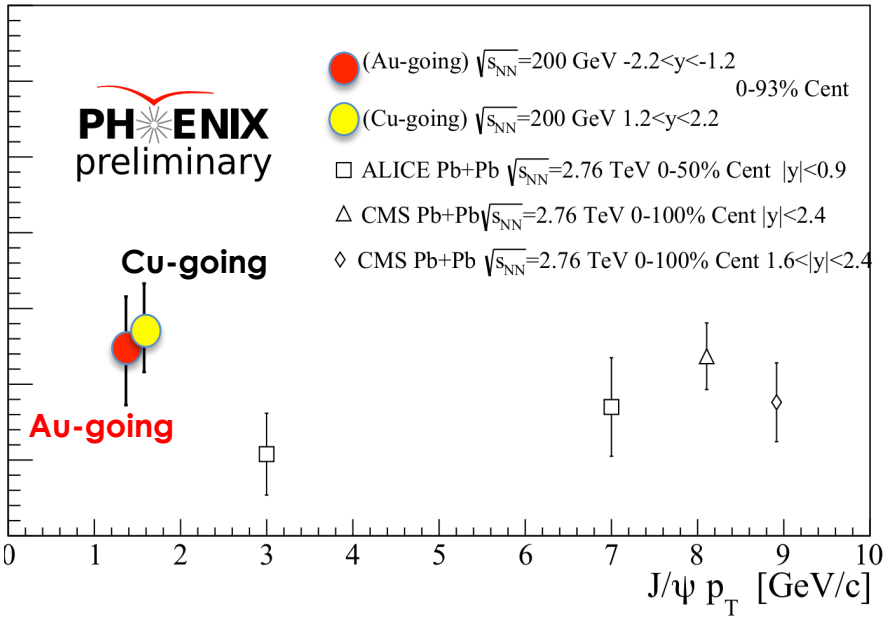
- Despite expected reduction of $b\bar{b}/c\bar{c}$ ratio at 510 GeV, fraction of B-meson decays in inclusive J/ψ yield is consistent with higher energy results
  - Larger fraction in PHENIX rapidity range ? (as observed by CMS and LHCb)
  - Compensation from larger (J/ψ)/$c\bar{c}$ at higher energies ?

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.

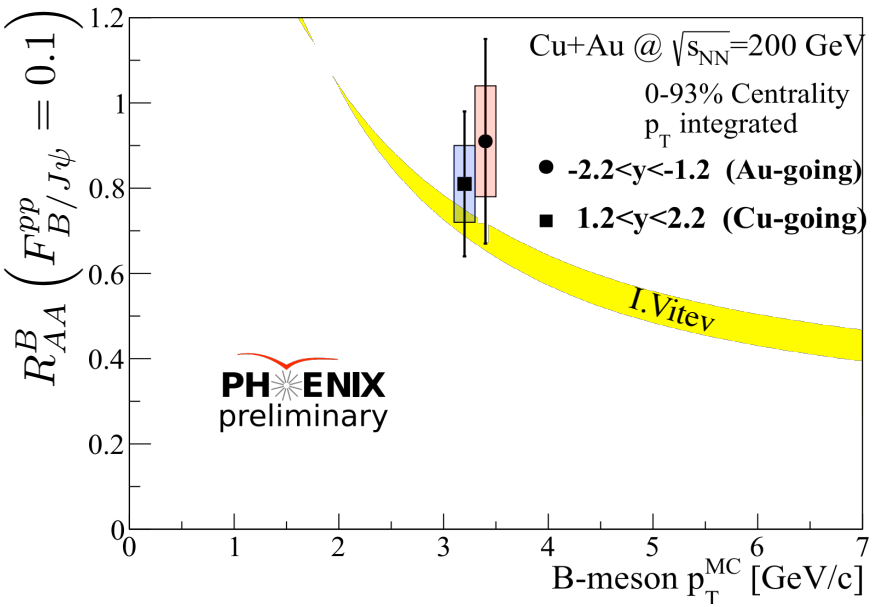
B-meson is less suppressed than prompt J/ψ in Cu+Au collisions.

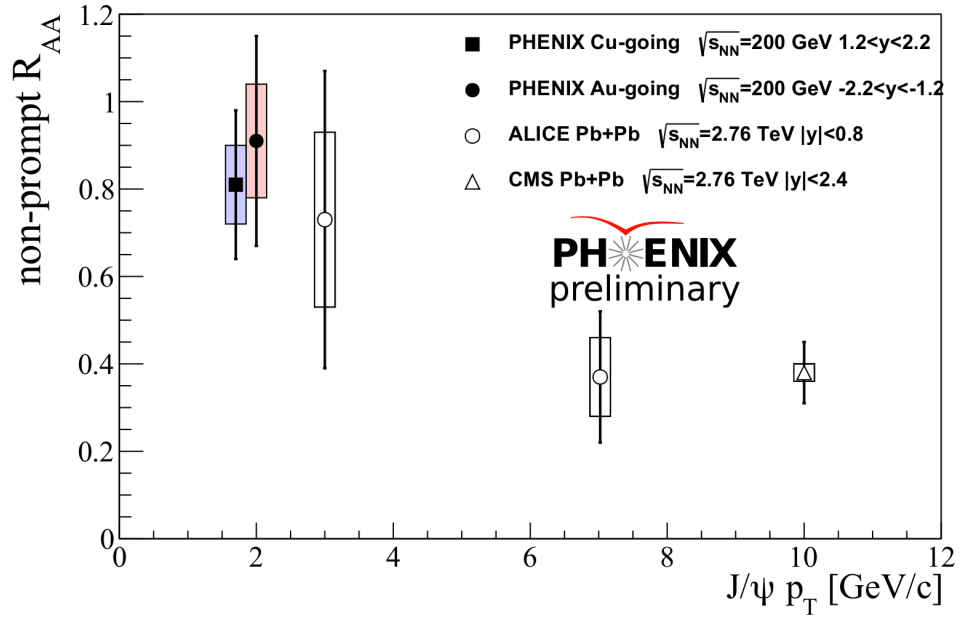
200 GeV data from STAR mid-rapidity p_T>5 GeV/c also follow word trend.

B-meson R_{AA}

Cu+Au 200 GeV 1.2<|y|<2.2

$$R_{AA}(B-meson) = \frac{F^{CuAu}_{B/J\psi}}{F^{pp}_{B/J\psi} = 0.1} R_{AA}(incl.J/\psi)$$



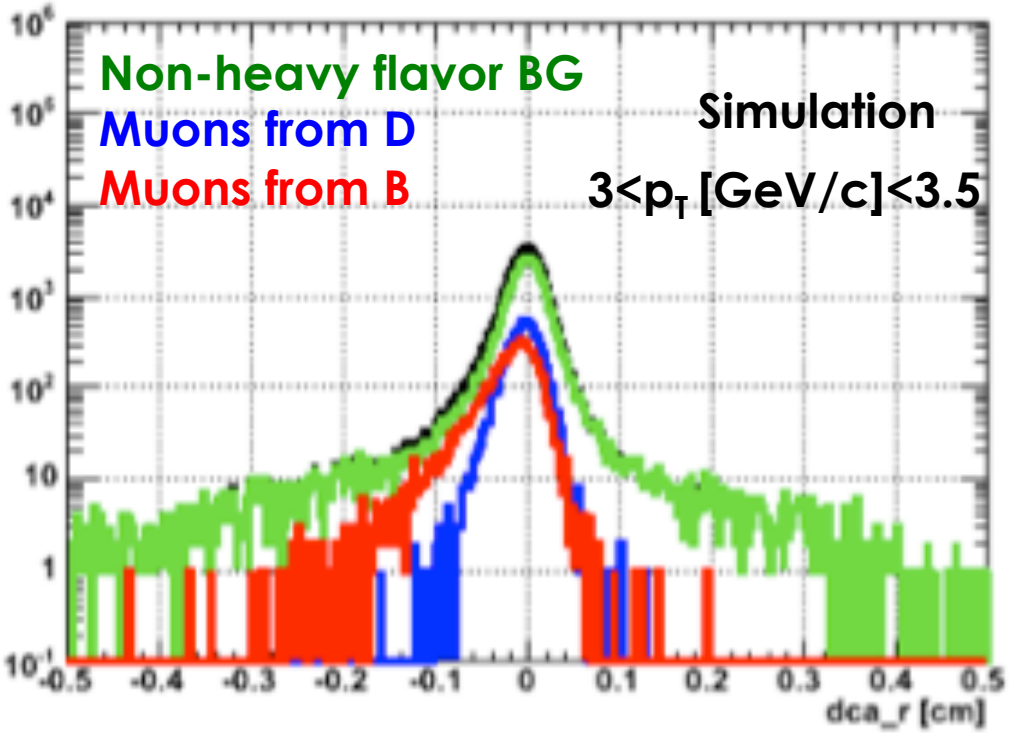


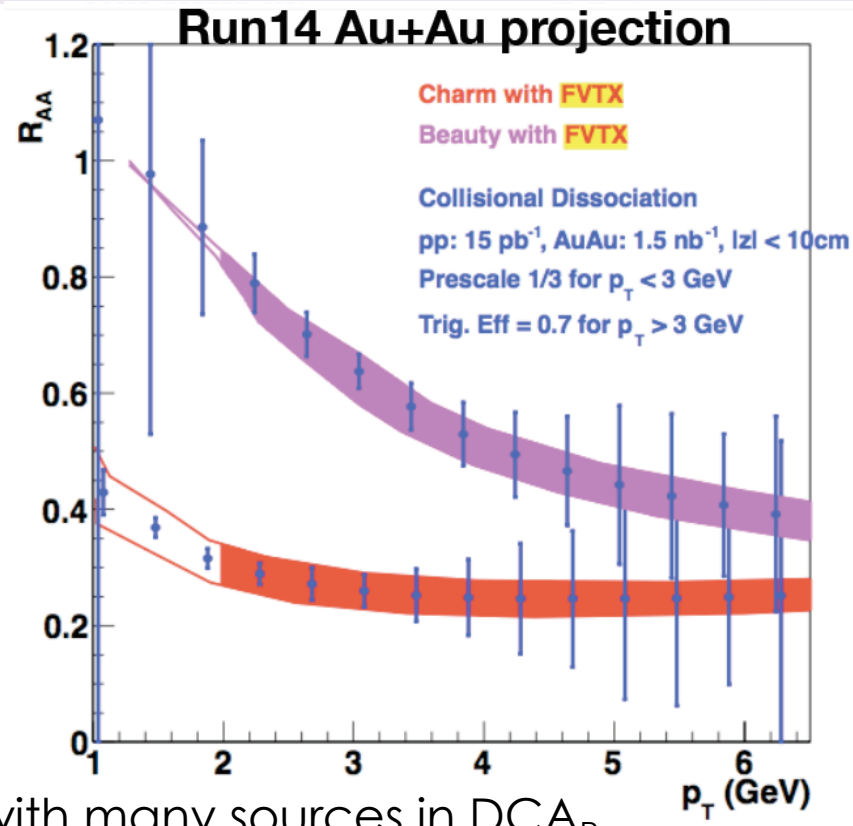
No pp reference at 200 GeV in the same p_T and rapidity at this moment.

Assuming $F_{B/J\psi}$ (pp)=0.1 from world p+p data at J/ψ 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.

Summary

- 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