DCA and secondary vertex measurement of electron pairs using PHENIX-VTX

XXIV QUARK MATTER DARMSTADT 2014

Takashi HACHIYA for the PHENIX collaboration
RIKEN NISHINA Center contact : hachiya@rcf.rhic.bnl.gov

Introduction

Heavy quark (charm and bottom) production is a powerful tool to study the property of QGP.

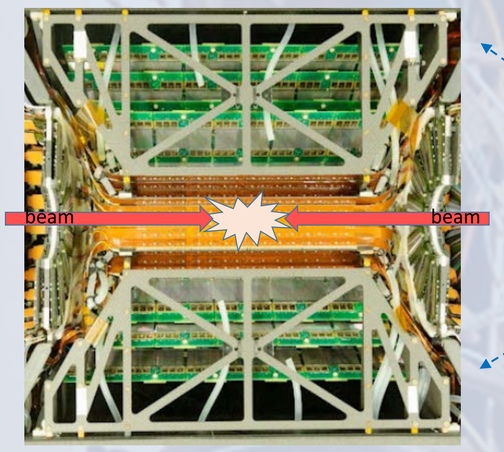
- Calibrated probe :
  - Heavy quark is mainly produced in the initial hard scattering.
  - Heavy quark production is calculable by perturbative QCD
    - their large mass (M_c~1.3GeV/c^2, M_b~4.2GeV/c^2).
- Carrying QGP information :
  - Heavy quarks propagate through the QGP after the production
  - Modification of the yield and angler distribution is directly reflected by the property of QGP.

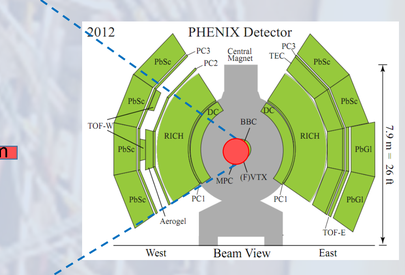
- Bottom and charm separation is important to study QGP in detail.
  - Observed strong suppression of heavy quarks is not well understood.

- Secondary J/ψ as a probe
  - $B \rightarrow J/\psi + X \rightarrow e^+ + e^-$
  - This is a direct measurement of B meson production.
    - Bottom and charm contributions needs to be separated in single electrons from heavy quark decays.
  - It is challenging to extract the signal
    - Branching ratio ($B \rightarrow J/\psi$) is small (~1%)

- Main background is prompt J/ψ that comes from the collision vertex

Silicon Vertex Tracker (VTX)





- Structure : 4 layers of silicon detectors
  2 inner pixel and 2 outer stripixel layers
- Wide acceptance: |ϕ|~2π, |y|<1.2
- Capabilities:
  - A precise tracking around the collision vertex
  - Collision vertex determination

- VTX archives 74μm DCA resolution for single electron measurement
  - Distance of Closest Approach (DCA) from collision vertex.

Secondary Vertex Reconstruction

1. e^+e^- pairs are measured by the central arm + VTX
   - VTX improves momentum resolution
2. Secondary vertex position is reconstructed
   - The position of closest approach for e^+e^- pairs

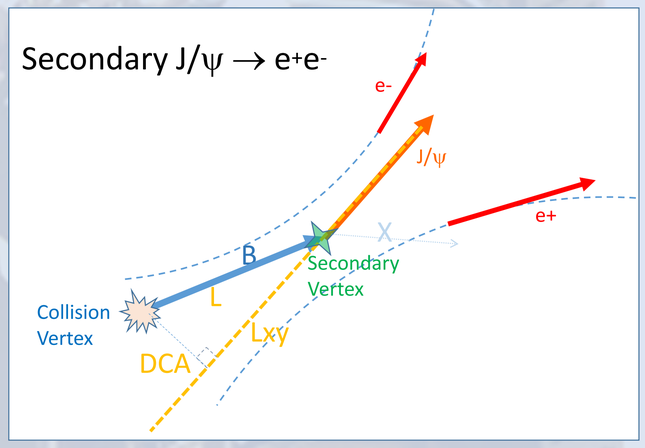
Feasibility test for secondary J/ψ measurement

Pseudo proper time (x)

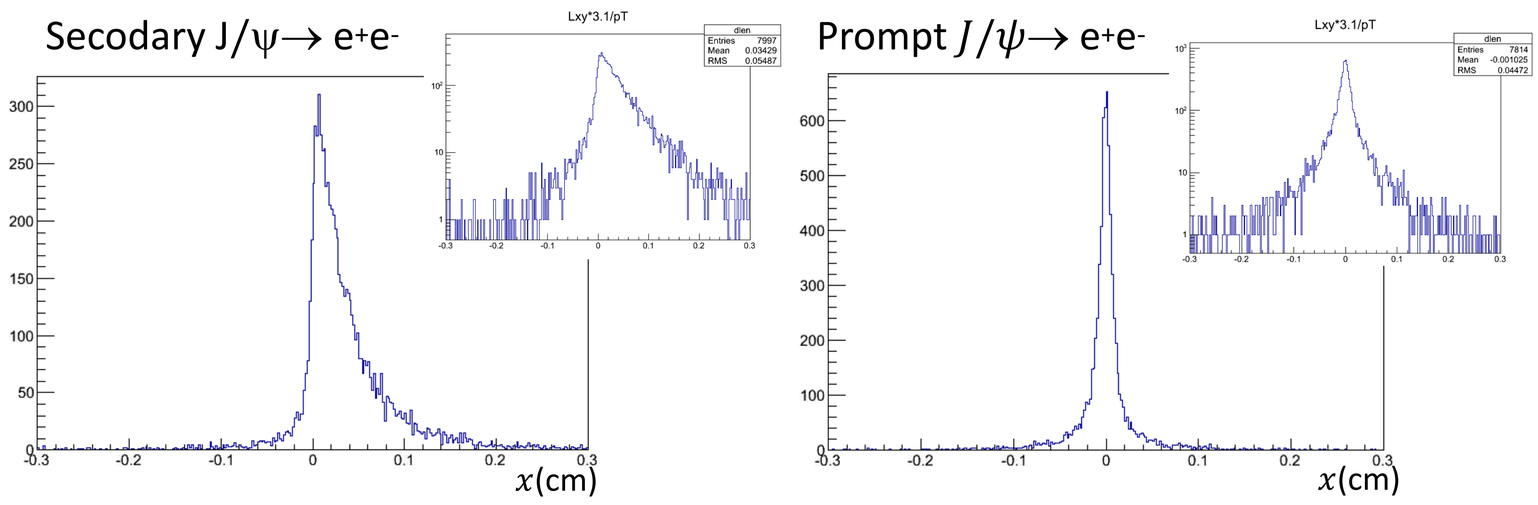
the decay length ($c\tau$) of B using the J/ψ

$$x = \frac{Lxy \cdot M_{J/\Psi}}{p_{T(J/\Psi)}} \sim c\tau(B)$$

L : decay length of B meson
Lxy: projected length of L to J/ψ vector
p_T : transverse momentum of J/ψ
M : J/ψ mass



Pseudo proper time distribution in simulation



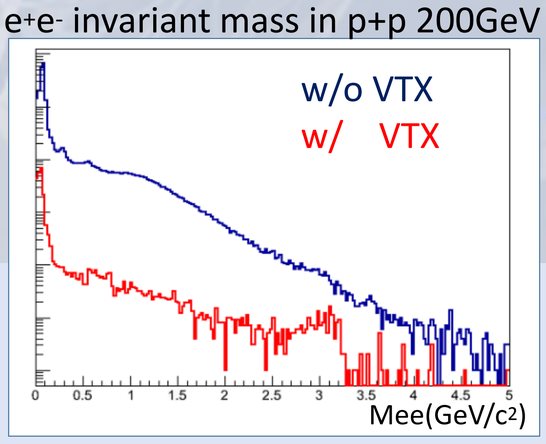
Pseudo proper time (χ) is studied using simulation (PYTHIA + GEANT).
x distribution is different for secondary and primary J/ψ

- Secondary J/ψ is **asymmetric** and enhancement in positive side
  - ✓ cτ (=500μm) + detector resolution
- Prompt J/ψ is symmetric
  - ✓ (cτ = 0 μm) only detector resolution

Secondary J/ψ can be extracted using pseudo proper time!

Data analysis

e^+e^- invariant mass in p+p 200GeV



- The invariant mass of e^+e^- pairs with and w/o VTX. J/ψ peak is appeared when e^+e^- pairs are confirmed by VTX. VTX reduces the combinatorial background significantly.

Summary & Outlook

- Secondary J/ψ measurement via e^+e^- pairs is feasible
- Data analysis for p+p and Au+Au 200 GeV is in progress.
  - VTX reduces combinatorial background and improves the J/ψ yield measurement
- High statistics Au+Au data is coming in run2014
  - Run2014 is going smoothly and the integrated luminosity will be twice than the plan.

- Expected yield of secondary J/ψ
  - Number of J/ψ is 10000 @ 10 billion minimum bias data in Au+Au 200GeV
  - J/ψ yield in p+p 200GeV
    - Secondary J/ψ : $\sigma_{b\rightarrow J/\Psi\rightarrow e^+e^-}$ = 1.2nb (PRL.103.082002 PHENIX)
    - Prompt J/ψ: $\sigma_{J/\Psi\rightarrow e^+e^-}$ = 45 nb (PRL. 98, 232002 PHENIX)
    - Production ratio : 2.6% in p+p, 5.2% in Au+Au
      - Prompt J/psi yield in Au+Au is suppressed 50%
  - The expected secondary J/ψ is 100~200 in Au+Au 200GeV (including VTX efficiency)