Gamma tomography study for non-photonic electron measurements in Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV at STAR

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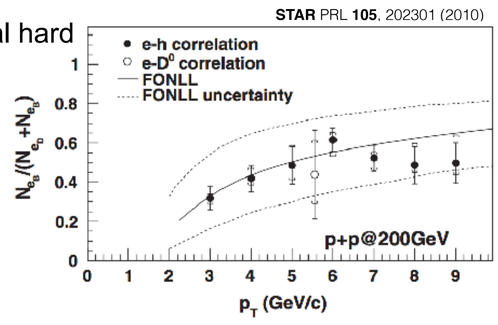
Motivation

★Heavy flavor quarks are primarily produced in initial hard scattering, and are exposed to the evolution of the hot nuclear matter created at RHIC.

★Using the HF as a probe to study properties of the QGP and their dependence on e.g. parton energy loss in medium, system size and collisional energy.



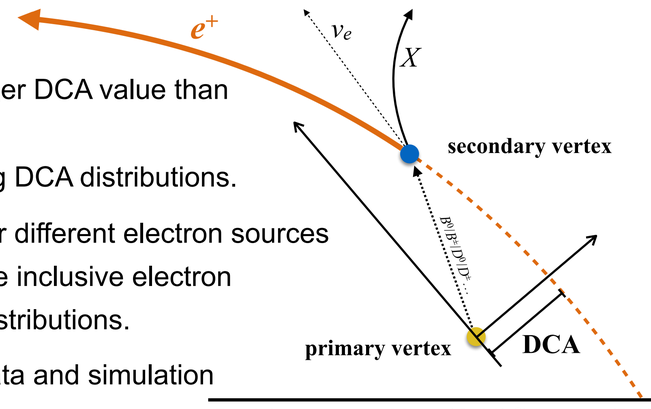
→ Theories predict for ΔE in medium : $\Delta E_g > \Delta E_{light\ quark} > \Delta E_c > \Delta E_b$

→ Precise measurements of charm and bottom quark energy loss separately are crucial for understanding the heavy quark energy loss mechanism.

★STAR published $N_{b\to e}/N_{b,c\to e}$ ratio using e-h and e-D^0 correlation in p+p 200 GeV.

Analysis method

- b hadron decay electrons have larger DCA value than c hadron decay electrons.
  → We can distinguish b and c using DCA distributions.
- We can obtain DCA distributions for different electron sources in data and/or simulation, and fit the inclusive electron DCA distribution in data to these distributions.
  - gamma conversion electrons: data and simulation
  - π^0/η Dalitz decay electrons: data and simulation
  - $D^0/D^*/D^\pm$ ... decay electrons: simulation
  - $B^0/B^\pm$... decay electrons: simulation



Particle	$c\tau$ (μm)	Mass (GeV/c^2)	$X \to e$ (BR)
D^0	123	1.865	0.0653
D^+	312	1.868	0.160
B^0	459	5.279	0.101
B^+	491	5.279	0.108

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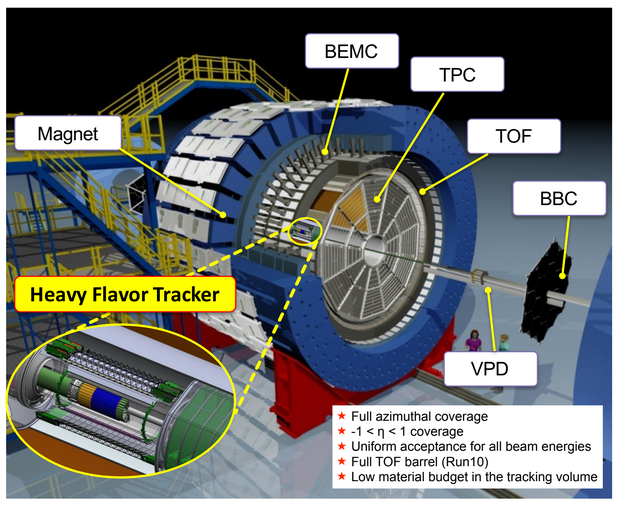
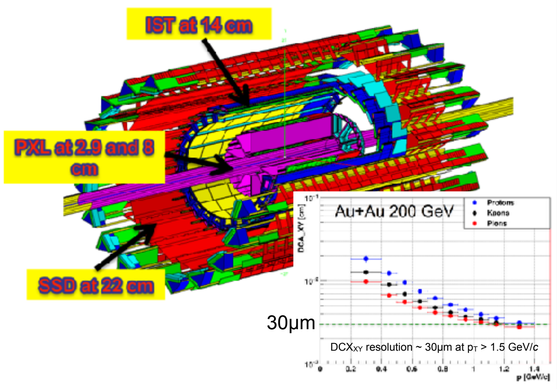
STAR and HFT detector





★ 2 layers of silicon pixel (MAPS)
- Light material budget : ~0.4% (0.5%) X_0 inner (outer) layer
- Excellent DCA resolution : ~30μm at p_T > 1.5 GeV/c

★ 2 layers of silicon strip detectors:
- Fast readout, bridging TPC and PXL

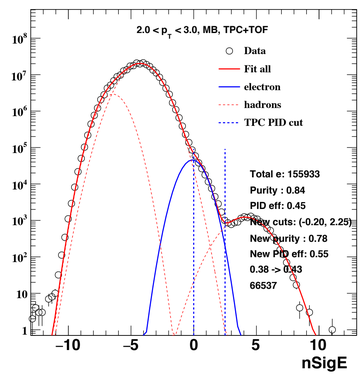
★Heavy Flavor Tracker (HFT) : enhance track DCA resolution, installed in 2014

★Time Projection Chamber (TPC) : particle identification (dE/dx → $n\sigma_e$: modified dE/dx for electron mean is 0 and sigma is 1) and tracking

★Barrel ElectroMagnetic Calorimeter (BEMC) and Barrel Shower Maximum Detector (BSMD) : electron identification (e0 : highest tower energy deposit in the cluster)

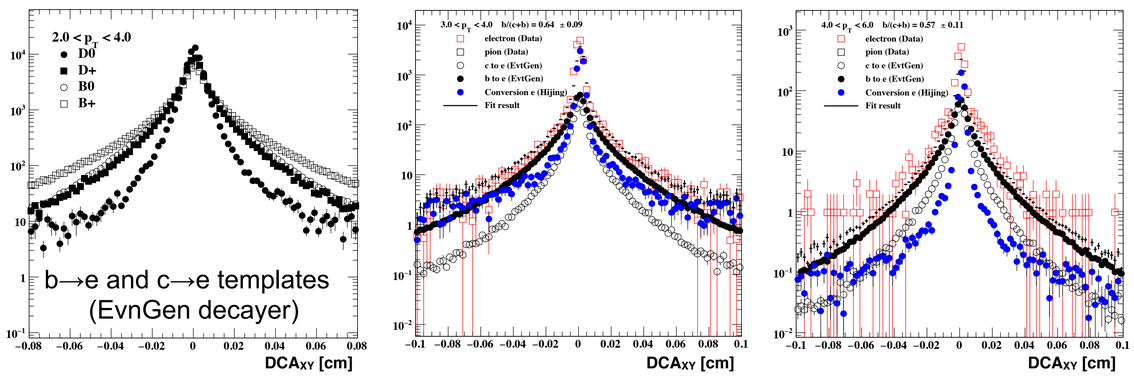
★STAR take ~1.2B Au+Au MinBias and ~0.4 nb^{-1} BEMC triggered data at Run14 with HFT and we expect to increase the Au+Au statistics by a factor of 3 in Run16.

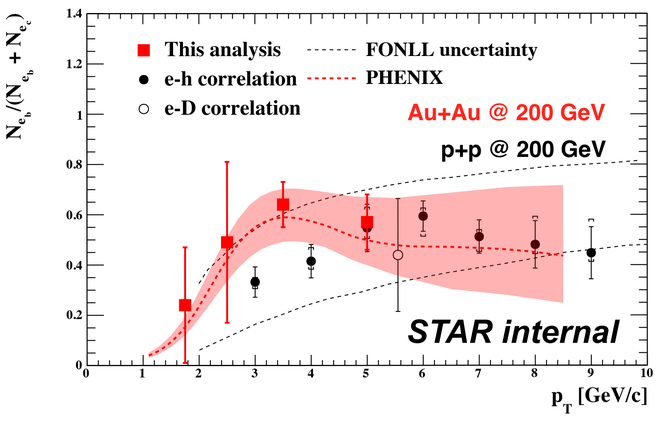
Non-photonic electron analysis



★ Inclusive electron
- TOF + TPC (< 4 GeV/c) or BEMC + TPC (> 4 GeV/c) PID

★ b(→c)→e and c→ e templates
- Data driven fast simulation (Detector effect) + EvnGen (decayer)
- 4 particles (D^0, D^+, B^0, B^+) used to obtain DCA distribution.
  → Ds, D*, Lc will be updated
- Measured D meson (D0, D+) spectra, p+p PYTHIA B meson (B0, B+) spectra weighted

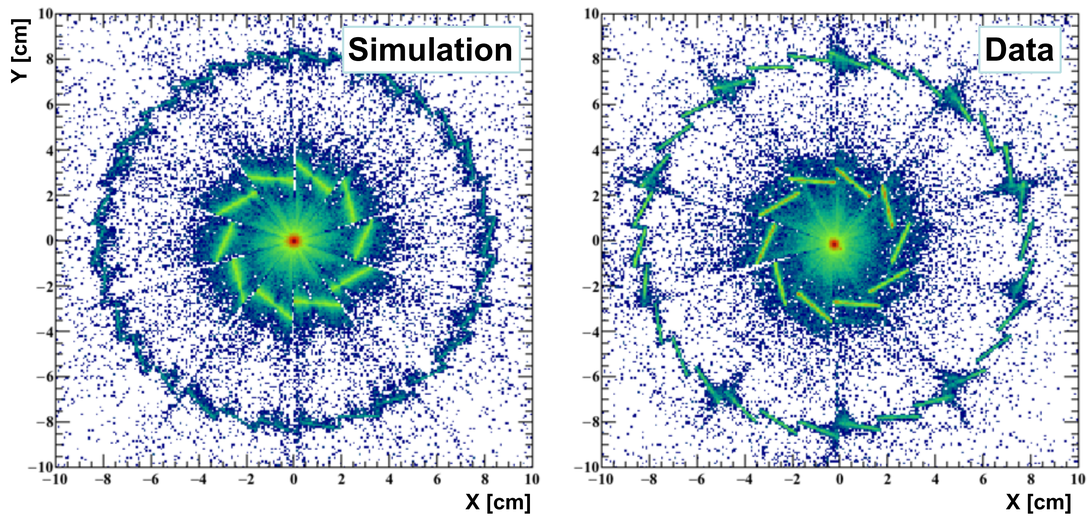


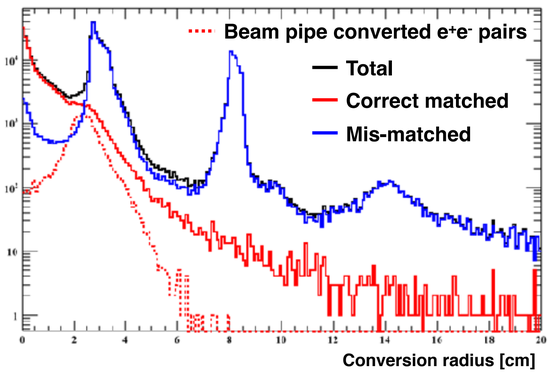


★ Template Fitting
- 4 templates (b→e, c→e, photonic electrons, hadron contaminations)
- TFractionFitter (Likelihood)

★ $N_{b\to e}$ / N_{NPE} Ratio
- First attempt to obtain $N_{b\to e}$ / N_{NPE} ratio in Au+Au collisions

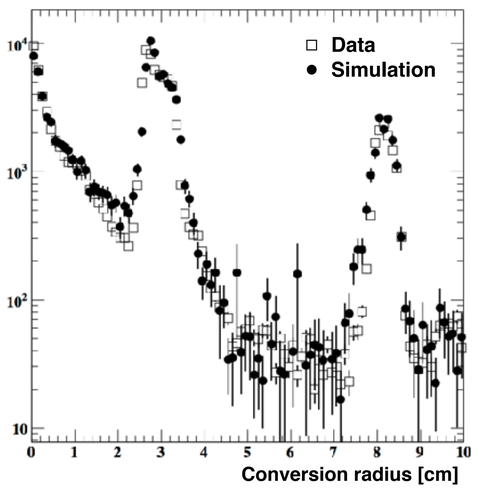
Gamma tomography



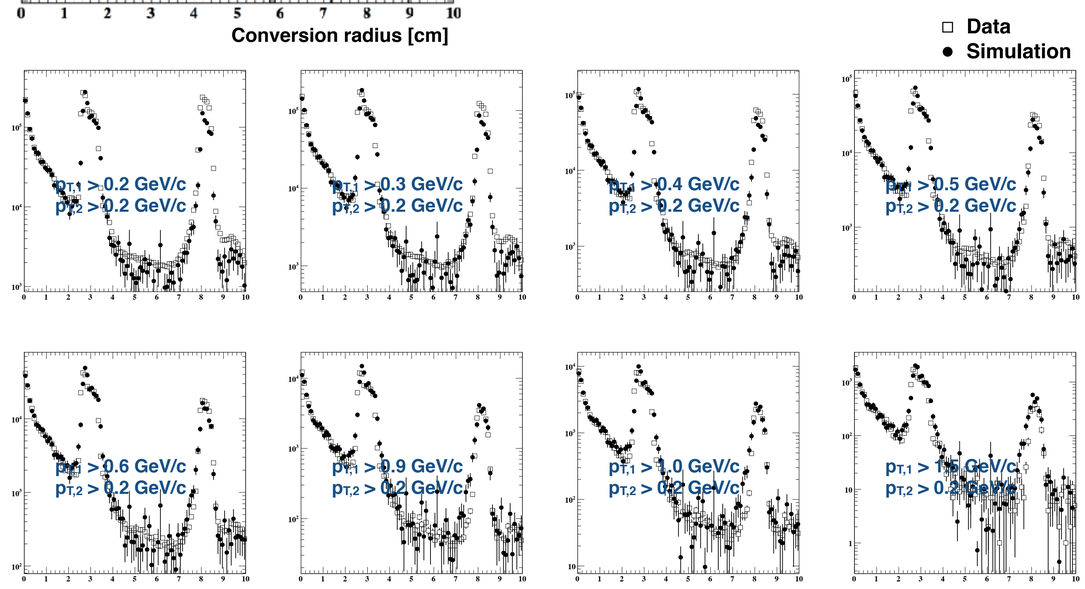


★ HIJING simulation with STAR detector
- Fast simulation for PXL response
- Pixelization effect

★ Beam pipe in conversion radius distribution
- Mis-matching from conversion e
- we cannot distinguish beam pipe because too small opening angle of electron pairs from conversion.



★ Simulation describe data very well
- A good understanding of the detector material budget is crucial for NPE measurements.
- The best track reconstruction performance and understanding of it for all the other measurements that utilize decay topological information by the HFT.



Summary and outlook

★ With the newly installed HFT, STAR can separately measure charm and bottom quark productions through semi-leptonic channels.

★ Run16(+14): x4 Au+Au statistics than QM15, inner PXL 0.5→0.4%X_0 with Al cables

★ Upgraded HFT+ in 2020+: HFT+ with faster MAPS sensors will allow precise measurements of bottom quark to electron production at RHIC.