Charm reconstruction with HFT for STAR

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Introduction

The new detector Heavy Flavor Tracker (HFT) for STAR:

- will improve measurements with heavy flavor hadrons for low p_T
- uses technology of CMOS MAPS
- **main purpose:** carry out systematic study of QGP

Our work:

- investigate simulated data
- survey capabilities of the new design to reconstruct D^+ mesons
- our goal: maximize D^+ signal significance

Physical motivation

Heavy quarks in ultrarelativistic heavy-ion collisions:

- are produced in early stages of the collision
- in later stages of the QGP their amount is not modified
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Important topics to study:

- high p_T hadrons suppression and jet quenching (R_{AA})
- collective expansion and fireball thermalization (v_2)

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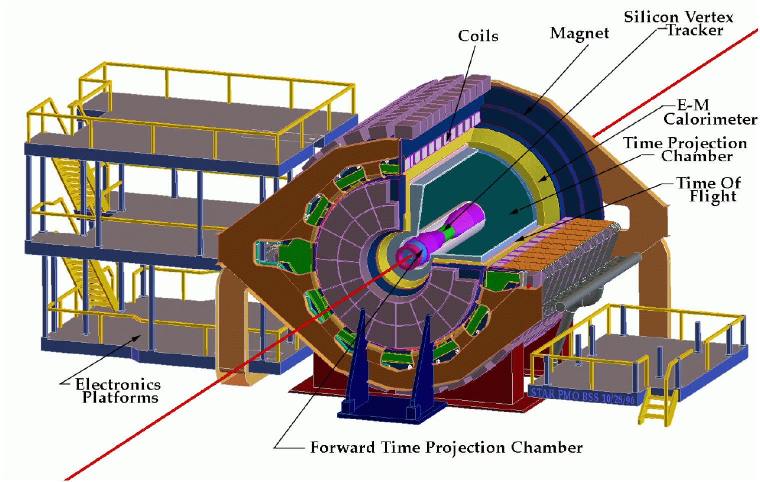
The goal:

- improve precision of the measurement these quantities
- ⇒ do the direct topological reconstruction of heavy flavor hadrons

The STAR detector



Detector design

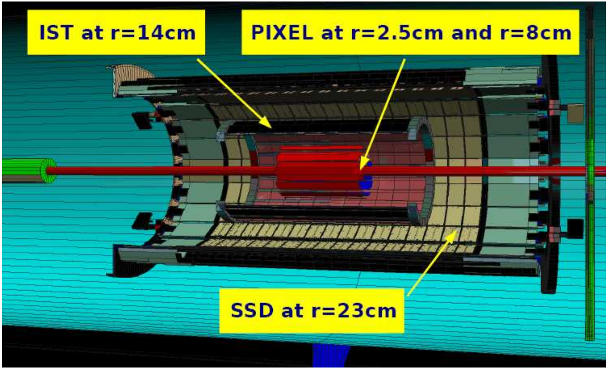
Two detector subsystems of the HFT:

- PIXEL, low mass MAPS, (2 layers, $r_1 = 2.5$ cm, $r_2 = 8$ cm)
- Intermediate Silicon Tracker (IST), fast one-sided strip detector, (1 layer, $r = 14$ cm)

Other detectors of the STAR tracking system:

- Silicon Strip Detector (SSD), (1 layer, $r = 23$ cm)
- Time Projection Chamber (TPC)

Detector design



Geometry of STAR silicon detectors

The data set

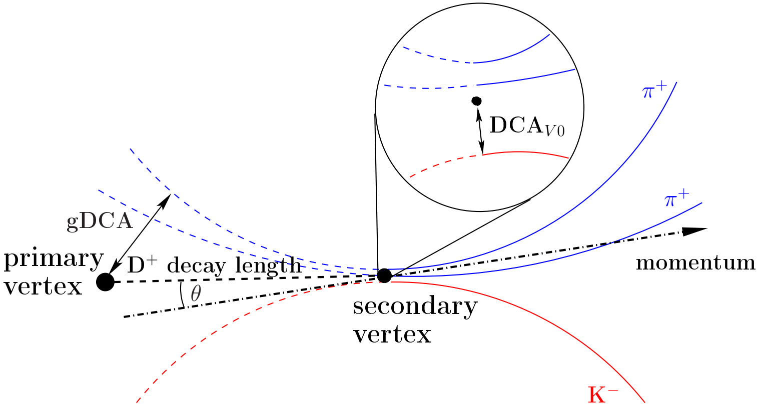
Properties of the simulated data

- 10 000 events
- collisions Au + Au at $\sqrt{s_{\mathrm{NN}}} = 200$ GeV (HIJING)
- 5 embedded D^+ with uniform p_T spectra in each event
- new STAR geometry with the HFT (STAR with HFT upgrade)

D^+ properties

- D^+ rest mass is 1869 MeV/c^2
- decay channel $D^+ \rightarrow K^- + \pi^+ + \pi^+$
- B.R. = 9.51 %
- $c\tau = 312$ μm

D^+ decay and explanation of cut quantities



D^+ decay

D^+ reconstruction

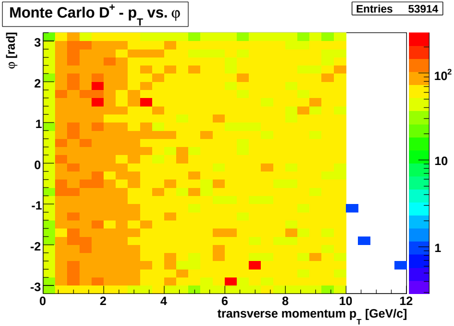
- survey of all possible triplets $K^-\pi^+\pi^+$
- for reduction of number of triplets we use these requirements:

Used cuts

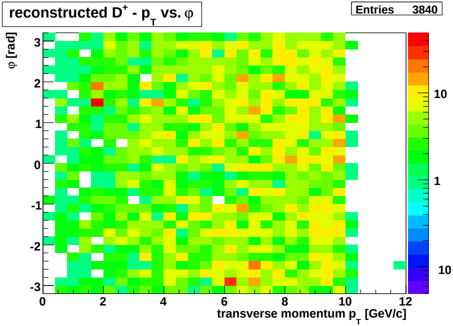
- invariant mass ϵ (1819; 1919) MeV/c^2
- global DCA $>$ 100 μm
- DCA_{V0}/resolution < 2
- cosθ > 0.99
- vertex Z position $\pm$ 5 cm
- 2 reconstucted hits in PIXEL, $\geq$ 15 in TPC

Control plots

Histograms p_T vs. φ



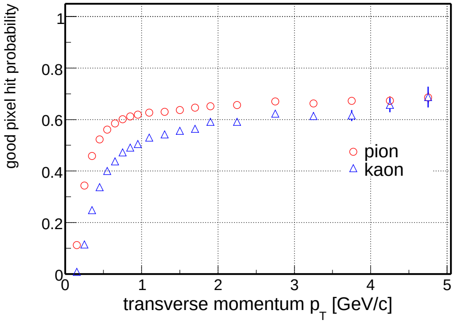
Monte Carlo data



Reconstructed data

Reconstruction efficiency

D^+ decay daughters



Requirements

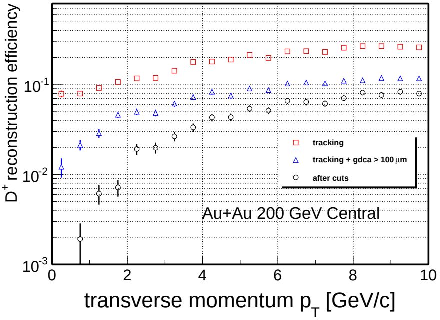
- $|\eta| < 1$
- correctly associated hits in both PIXEL layers
- $\geq$ 15 hits in TPC

Reconstruction efficiency

D^+

Cuts

- $1819 < M_{inv} < 1919$ MeV/c^2
- gDCA > 115 μm
- $\cos\theta > 0.997$
- $DCA_{V0}/resol. < 2$



Cut optimization

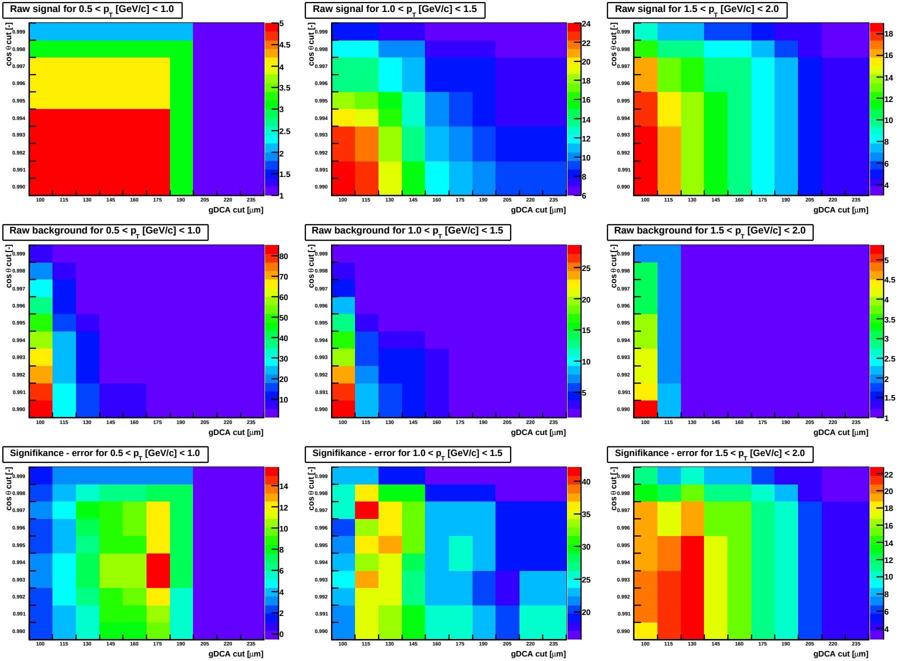
Fixed cuts

- $1854 < M_{inv} < 1884$ MeV/c^2
- $DCA_{V0}/resol. < 2$
- good PID (i.e. $p_{T\,\pi\,K} < 1.6$ GeV/c)

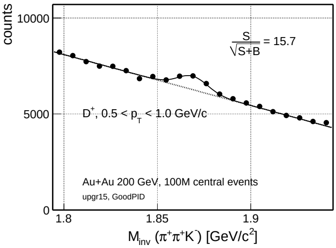
Tuned cuts

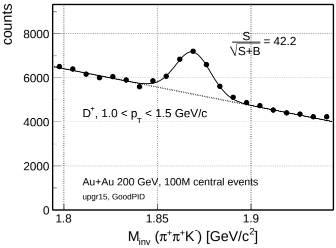
- $100 <$ gDCA < 235 µm
- $0.990 < \cos\theta < 0.999$

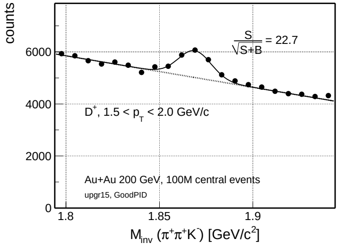
- for $0.0 < p_T < 0.5$ GeV/c we get too low signal (10 k events)
- charm reconstruction for $p_T < 2$ GeV/c in unique for STAR HFT upgrade


Raw signal for 0.5 < p_T [GeV/c] < 1.0
Raw signal for 1.0 < p_T [GeV/c] < 1.5
Raw signal for 1.5 < p_T [GeV/c] < 2.0
Raw background for 0.5 < p_T [GeV/c] < 1.0
Raw background for 1.0 < p_T [GeV/c] < 1.5
Raw background for 1.5 < p_T [GeV/c] < 2.0
Signifikance - error for 0.5 < p_T [GeV/c] < 1.0
Signifikance - error for 1.0 < p_T [GeV/c] < 1.5
Signifikance - error for 1.5 < p_T [GeV/c] < 2.0
cos θ cut [-]
gDCA cut [μm]

Expected D^+ signal for 100M central Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV







Summary and Conclusions

- HFT uses low mass MAPS and fast strip detectors
- HFT will extend STAR capabilities to measure:
  - partonic energy loss
  - charm collectivity
  - baryon/meson ratios
- ⇒ systematic study of QGP at RHIC-II

p_T [GeV/c]	signal significance
0.5 - 1.0	16
1.0 - 1.5	42
1.5 - 2.0	23

The results for 100M central Au+Au collisions