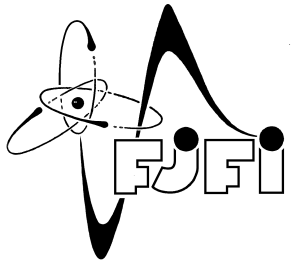


Open charm measurement in p+p $\sqrt{s}$ = 200 GeV collisions at STAR

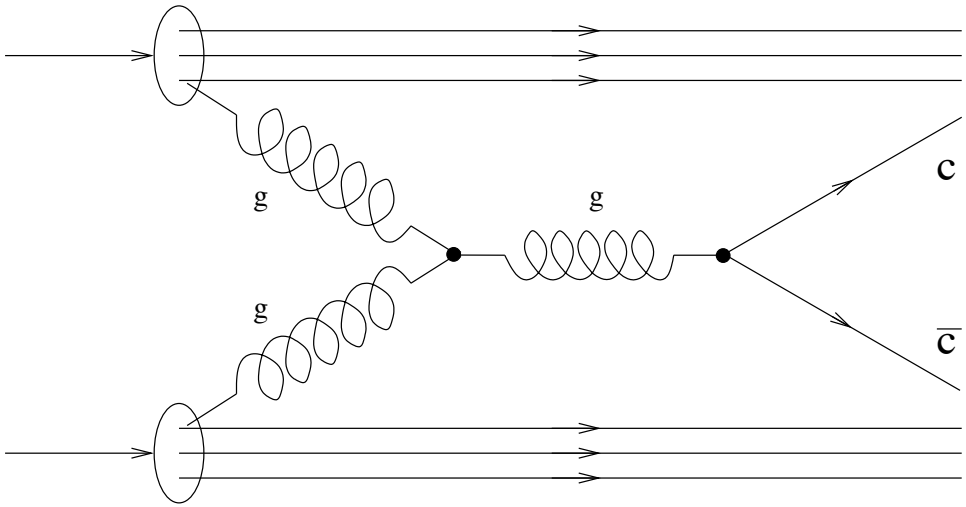
David Tlusty

NPI ASCR

FNSPE CTU Prague

for STAR collaboration

Charm production and Mass



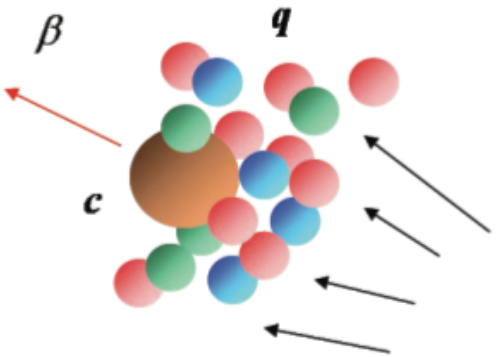
» $gg \rightarrow c\bar{c}$ dominates at initial hard collisions

» good pQCD test at RHIC

» $m_c(\sim 1.5\ \mathrm{GeV}) >> \Lambda_{QCD}(\sim 200\ \mathrm{MeV})$: can be evaluated by perturbative QCD
http://arxiv.org/abs/nucl-ex/0407006v5

» mass given by Electroweak SSB

» QCD chiral symetry breaking doesn't affect charm quark mass
X. Zhu, *et al*, Phys. Lett. **B647**, 366(2007).



» in gluon radiative energy loss mechanism, charm quarks suffer less energy loss while traversing through partonic matter (dead cone eff.) D. Kharzeev et al., Phys. Lett. B 519, 199(2001)

» collective motion or thermalization only if interactions at the partonic level occur at high frequency (excellent probe of QGP)

» cross sec. in AA scaled with N_{bin}

Open Charm measurement

$$\sigma_{c\bar{c}} = \frac{\mathrm{d}N^{pp}_{D^0}}{\mathrm{d}y} \cdot \sigma^{pp}_{\mathrm{inel.}} \cdot \frac{f(\mathrm{mid}\ y \rightarrow \mathrm{full}\ y)}{f(c \rightarrow D^0)}$$

$f(\mathrm{mid}\ y \rightarrow \mathrm{full}\ y) = 4.7$ Pythia

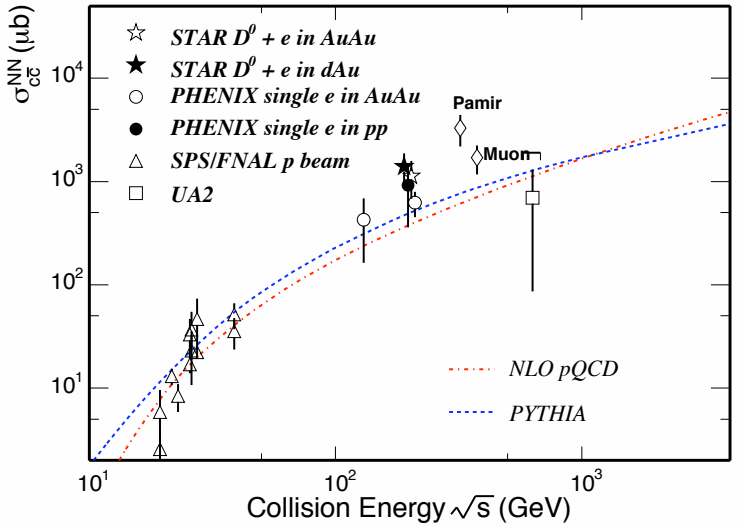
$f(c \rightarrow D^0) = 0.56$ PDG

$$D^{*\pm} \xrightarrow{\Gamma/\Gamma_i=0.677} D^0(\overline{D^0})\pi^{\pm}$$

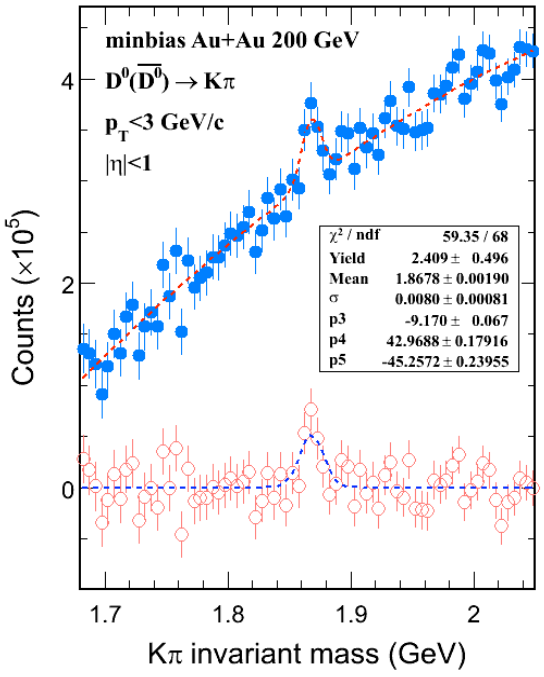
$$D^0(\overline{D^0}) \xrightarrow{\Gamma/\Gamma_i=0.038} K^{\mp}\pi^{\pm}$$

$\frac{\mathrm{d}N^{pp}_{D^0}}{\mathrm{d}y}$ obtained from Kπ pair invariant mass subtracted by combinatorial background

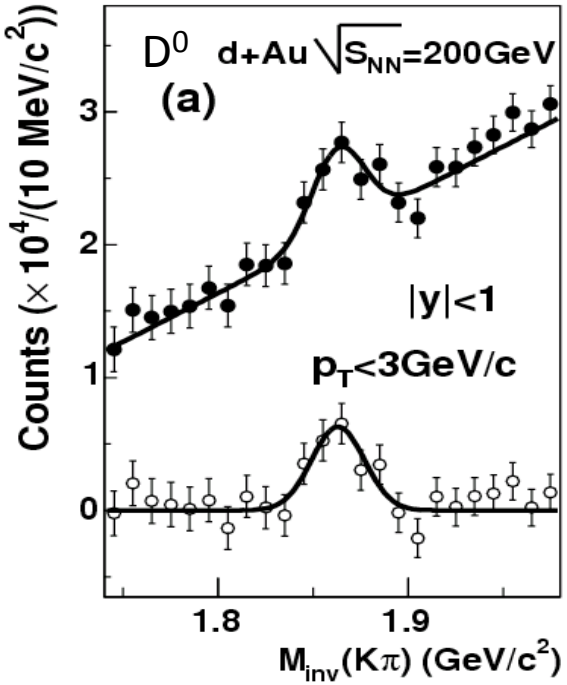
We hadn't obtained direct D^0 signal from p+p collisions yet



Phys.Rev.Lett.94:062301,2005



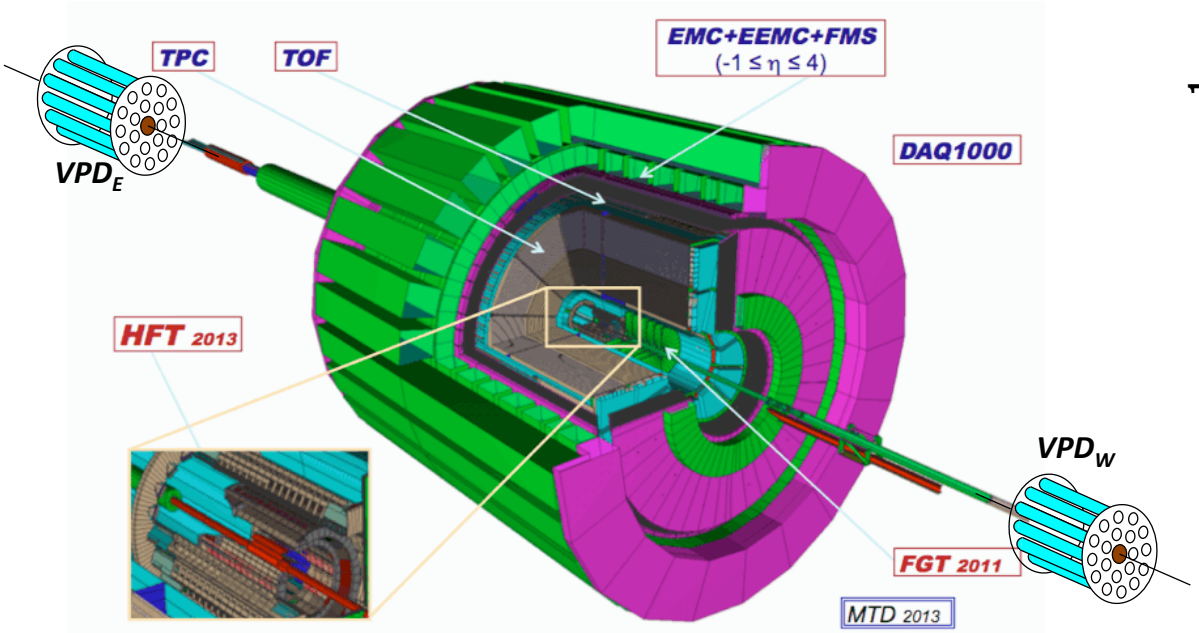
arXiv:0805.0364v2



PRL. 94 (2005) 62301

The STAR detector and PID

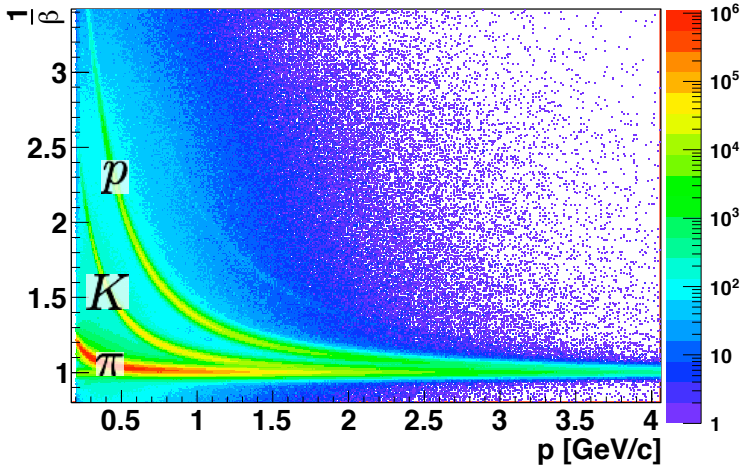
Large acceptance: $|\eta| < 1,\ 0 < \phi < 2\pi$

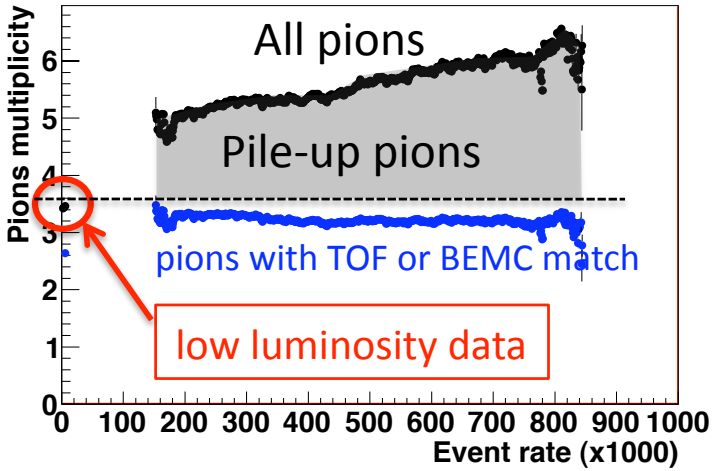


- VPD EW coincidence: minbias trigger, TOF start time
- TPC : PID, tracking $(\mathrm{d}E/\mathrm{d}x,\ \vec{p})$
- TOF : PID (β, time resolution = 110 ps)
- BEMC : remove pile-up tracks, E_T triggers

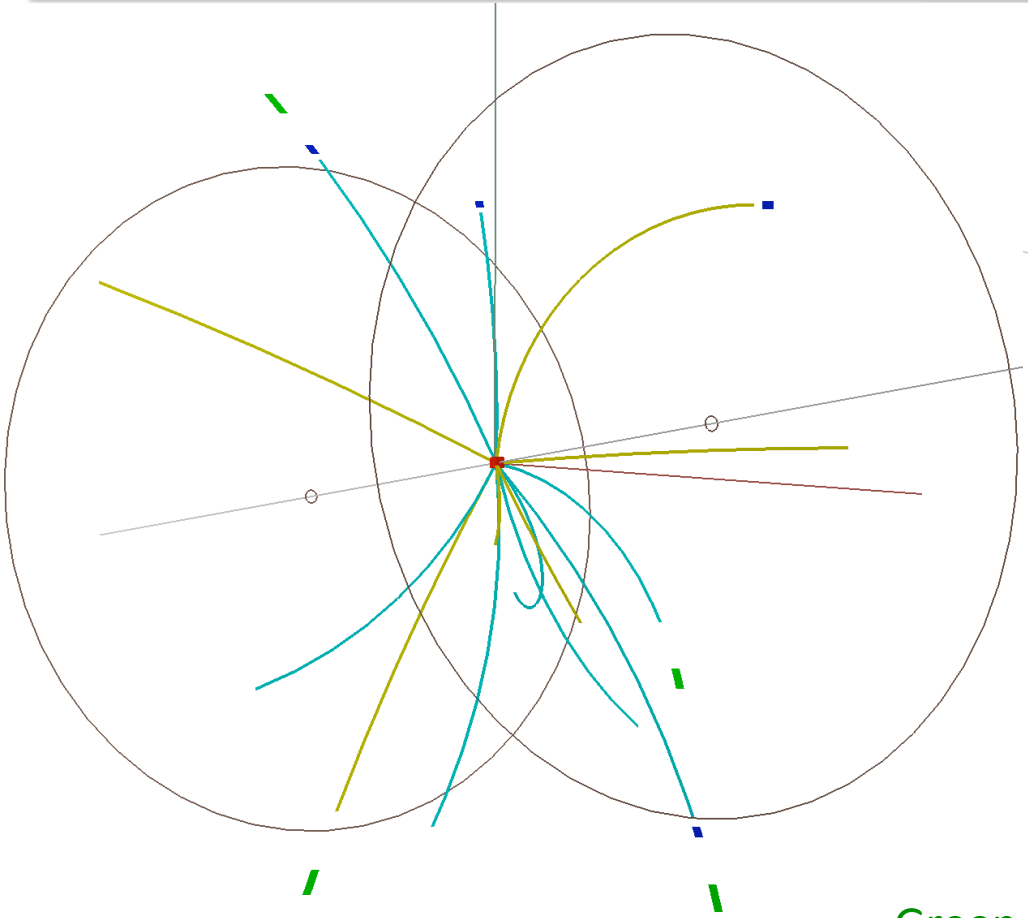
Run 9 p+p 200 GeV 107.7 M minbias events

- TPC dE/dx vs p : pions PID
- TOF 1/β vs p : kaons PID

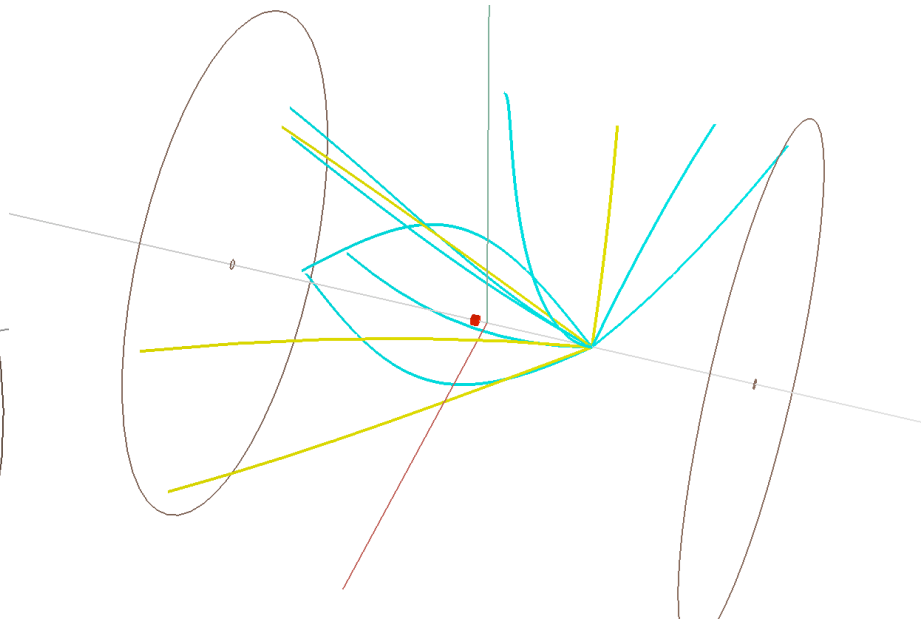




Event Display



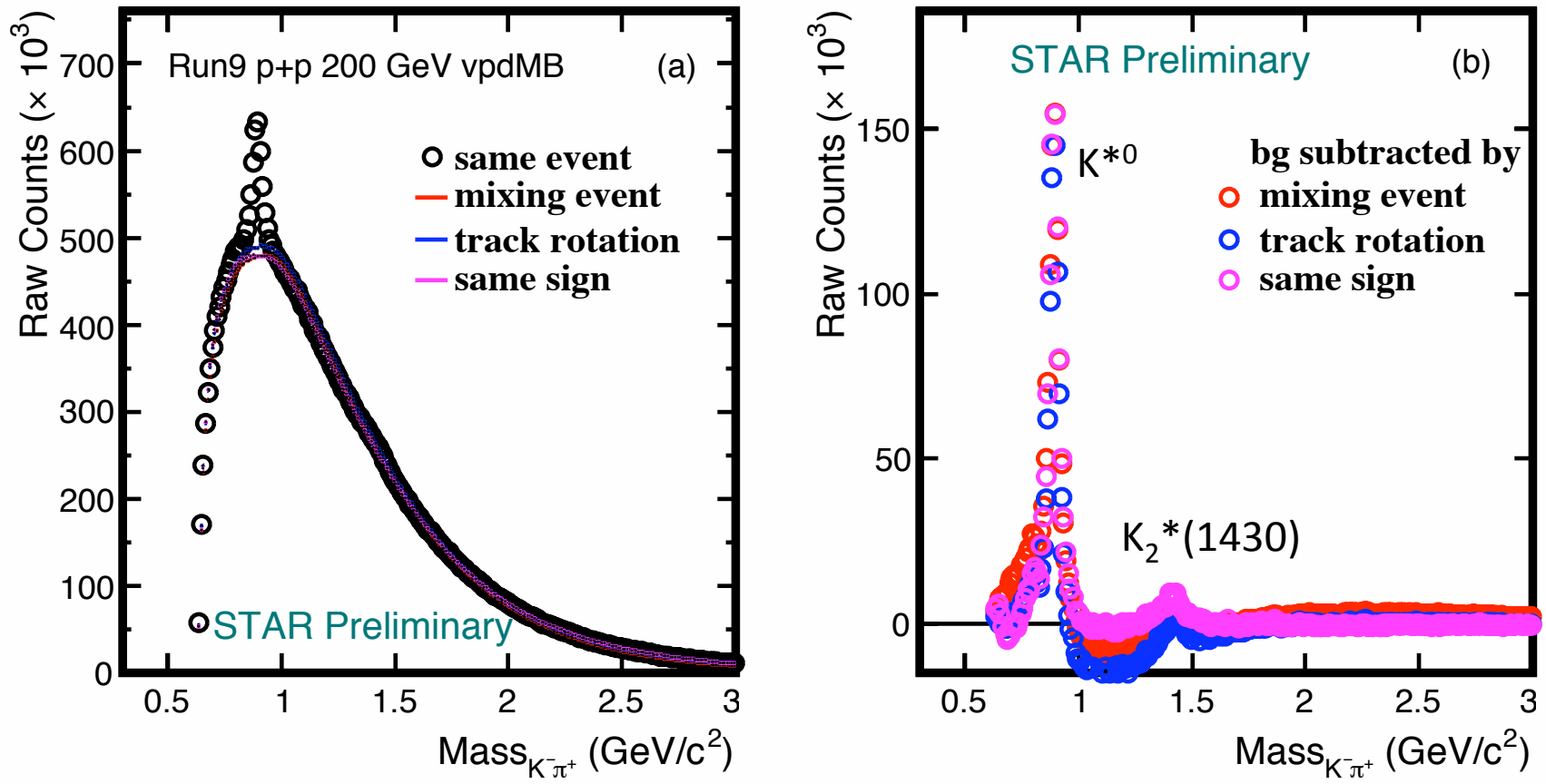
Good event



Pile up

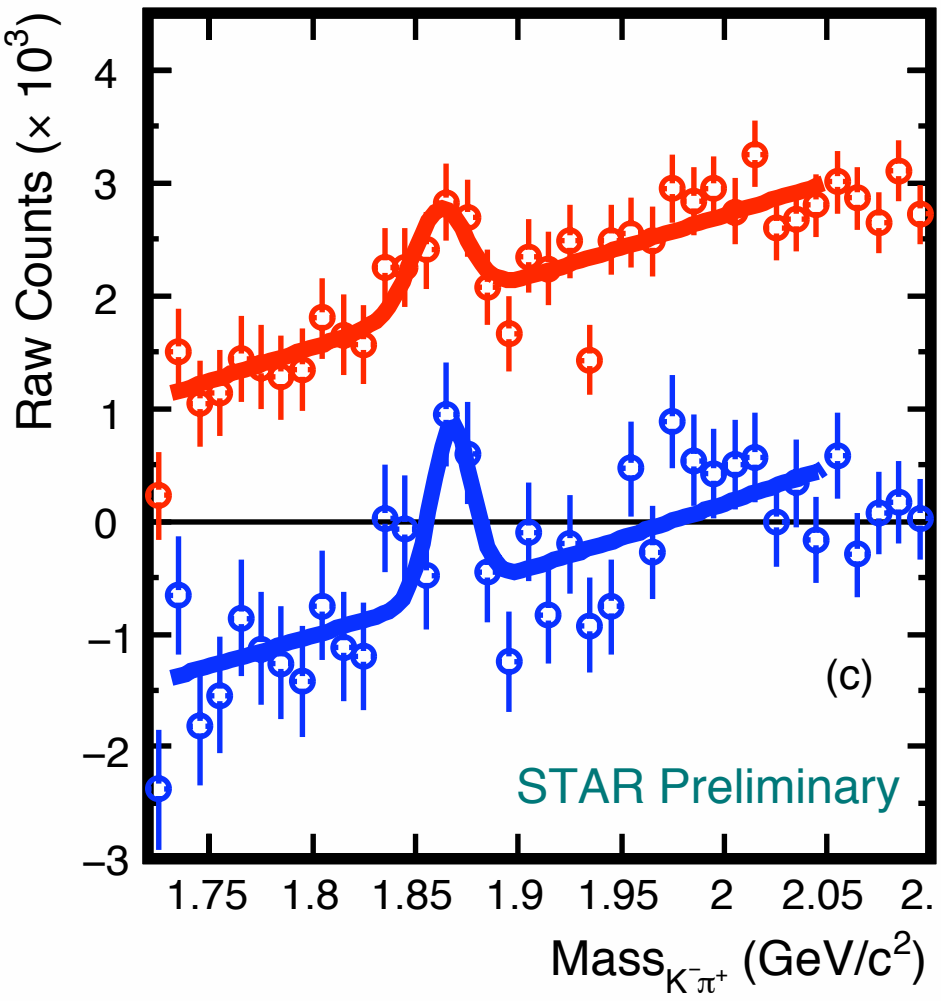
Green boxes – BEMC match points
Blue boxes – TOF match points
Red box – z-position of the vertex from VPD

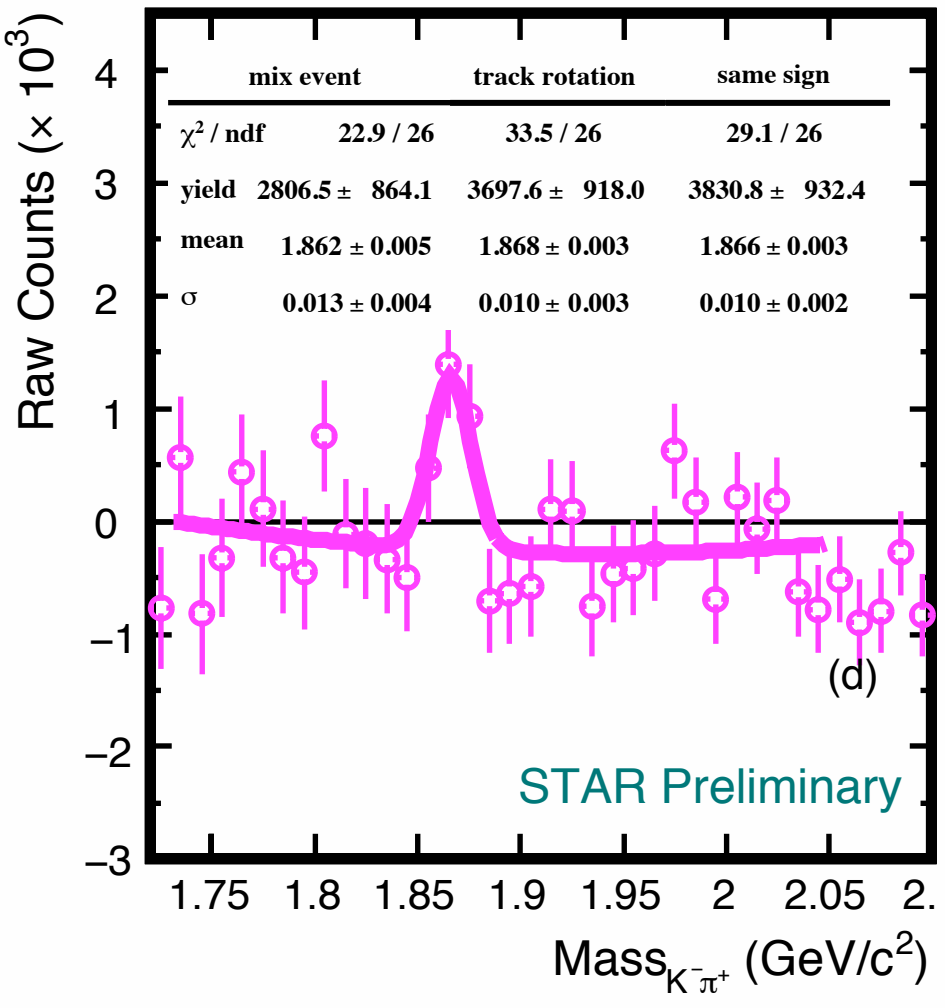
Invariant mass of all K,π pairs



- Mixed event: A pion from an event is paired with all kaons in buffer events. Event buffer is filled randomly (within the z-vertex window)
- Rotated kaon momentum: Each pion is paired with kaon with reversed 3-momenta
- Like Sign: pions are paired with same charged kaons (within current event only). The geometric mean is calculated by $2\sqrt{N_{\pi^+K^+}N_{\pi^-K^-}}$

D^0 reconstruction

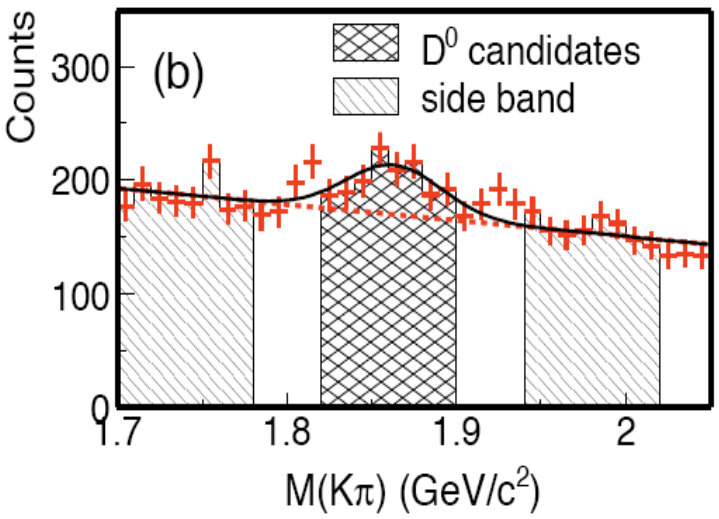




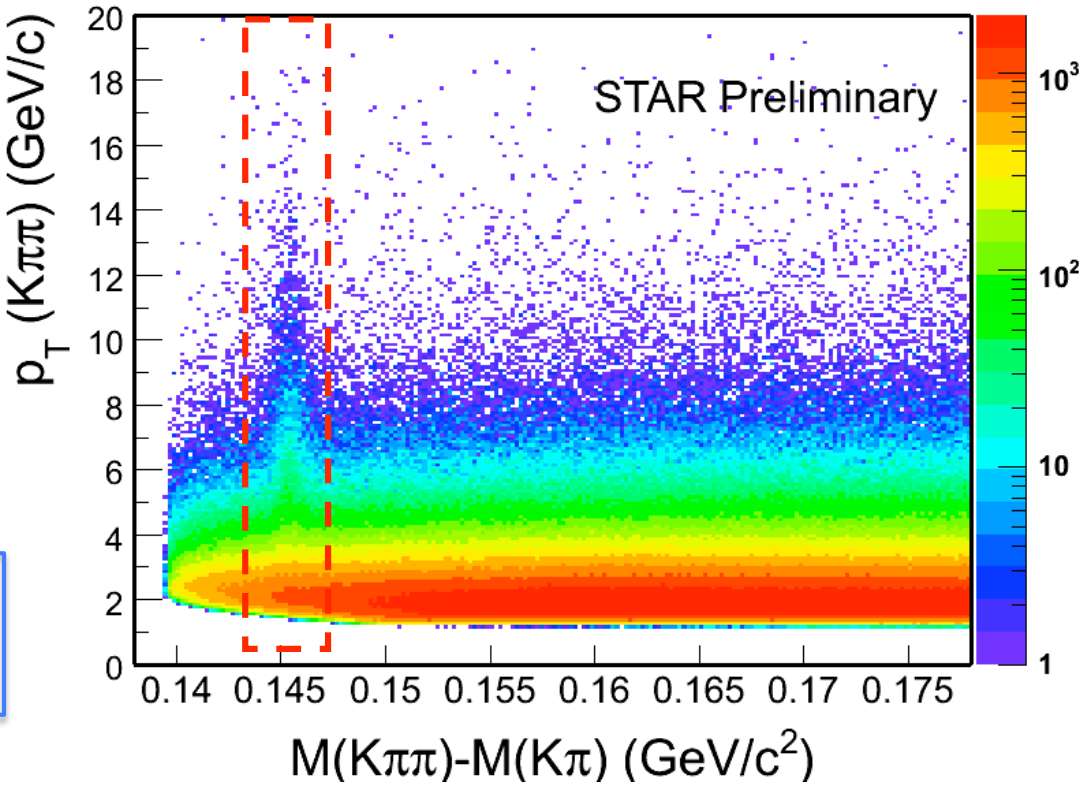
Zoom in mass window (1.72 – 2.1 GeV/c^2)

~ 4σ signal observed.

D* reconstruction



$$D^{*+}\,(D^{*-}) \rightarrow D^{0}(\overline{D^{0}}) + \pi_{s}^{\pm}$$



Background combinations:

Wrong sign:

D^0 and π^-, $\overline{D^0}$ and π^+

Side band:

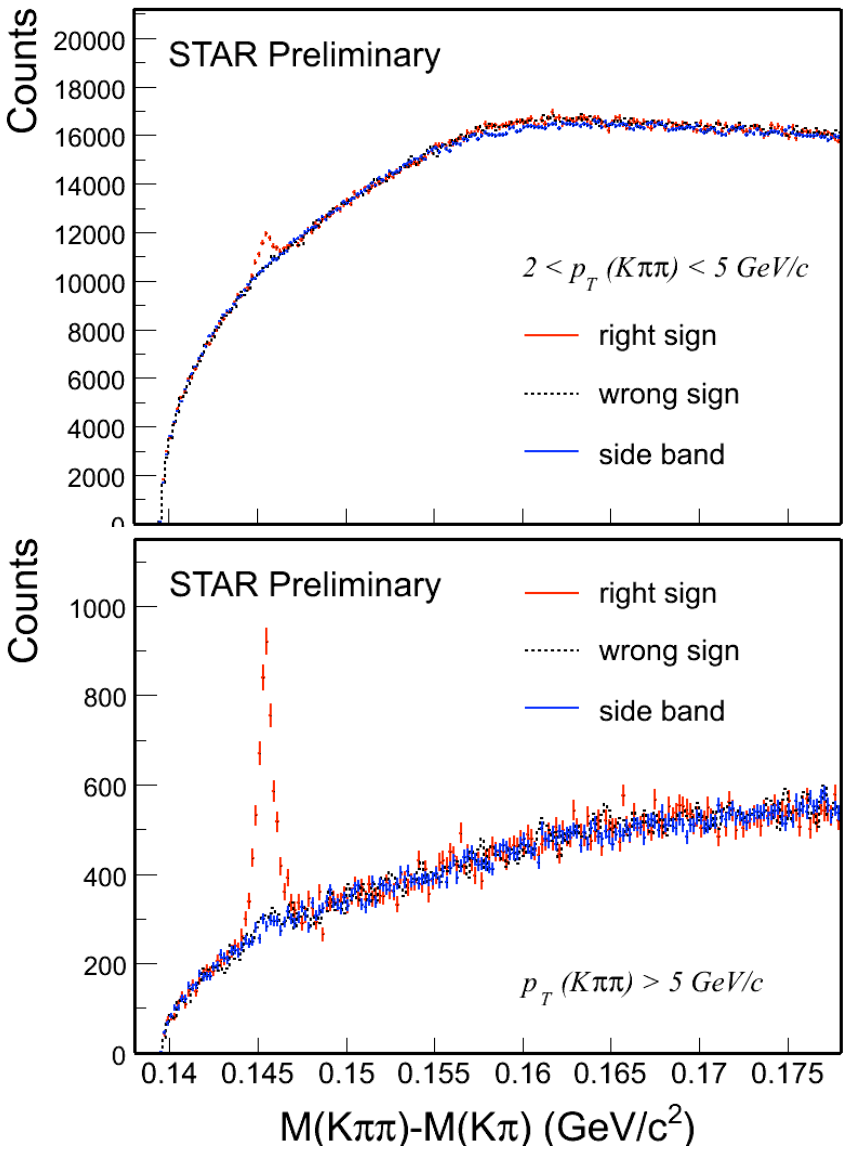
1.72< M(Kπ) < 1.80 or

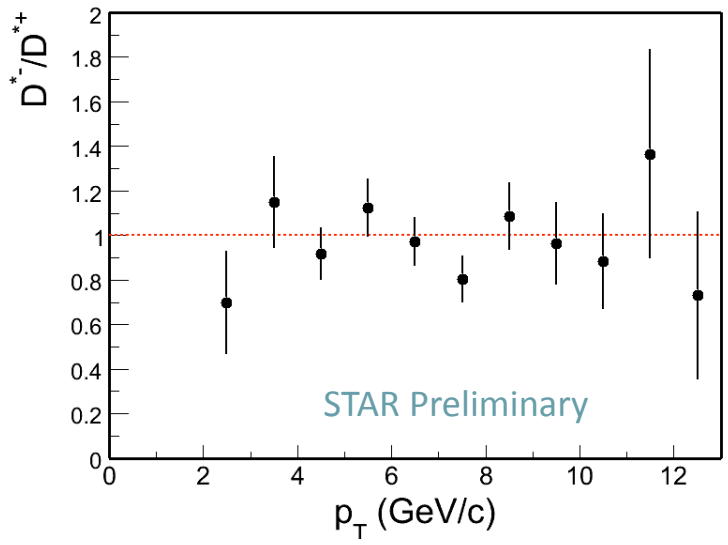
1.92 < M(Kπ) < 2.0 GeV/c²

All triggers included.

More than 4σ signal at low p_T and very significant at high p_T - mostly from EMC-based high neutral energy triggers.

D* reconstruction





No significant charge asymmetry is observed

All triggers included.
More than 4σ signal at low p_T and very significant at high p_T - mostly from EMC-based high neutral energy triggers.

Wrong sign and side-band method reproduce background well.

Summary and outlook

- 4σ raw D^0 signal observed in p+p 200 GeV collisions
- more significant D* signal at high p_T is observed
- excellent method to constrain charm cross section
- Cross section is coming soon!

Backup slides

How to extract charm cross section from D0 raw yield

$$\sigma_{c\bar{c}}^{NN} = f \cdot \frac{d\sigma_{c\bar{c}}^{NN}}{dy} = f \cdot \frac{N_{c\bar{c}}}{N_{D^0}} \sigma_{\text{inel.}}^{pp} \cdot \epsilon_{\text{trig.}} \int_{p_\perp} \frac{d^2N}{dp_\perp dy} dp_\perp$$

$$\frac{d^2N}{p_\perp dp_\perp dy} = \frac{S(p_\perp, dp_\perp)}{N_0 \frac{\Gamma_i}{\Gamma} \epsilon(p_\perp, dp_\perp)} \frac{1}{p_\perp dp_\perp dy}$$

power law

Embedding

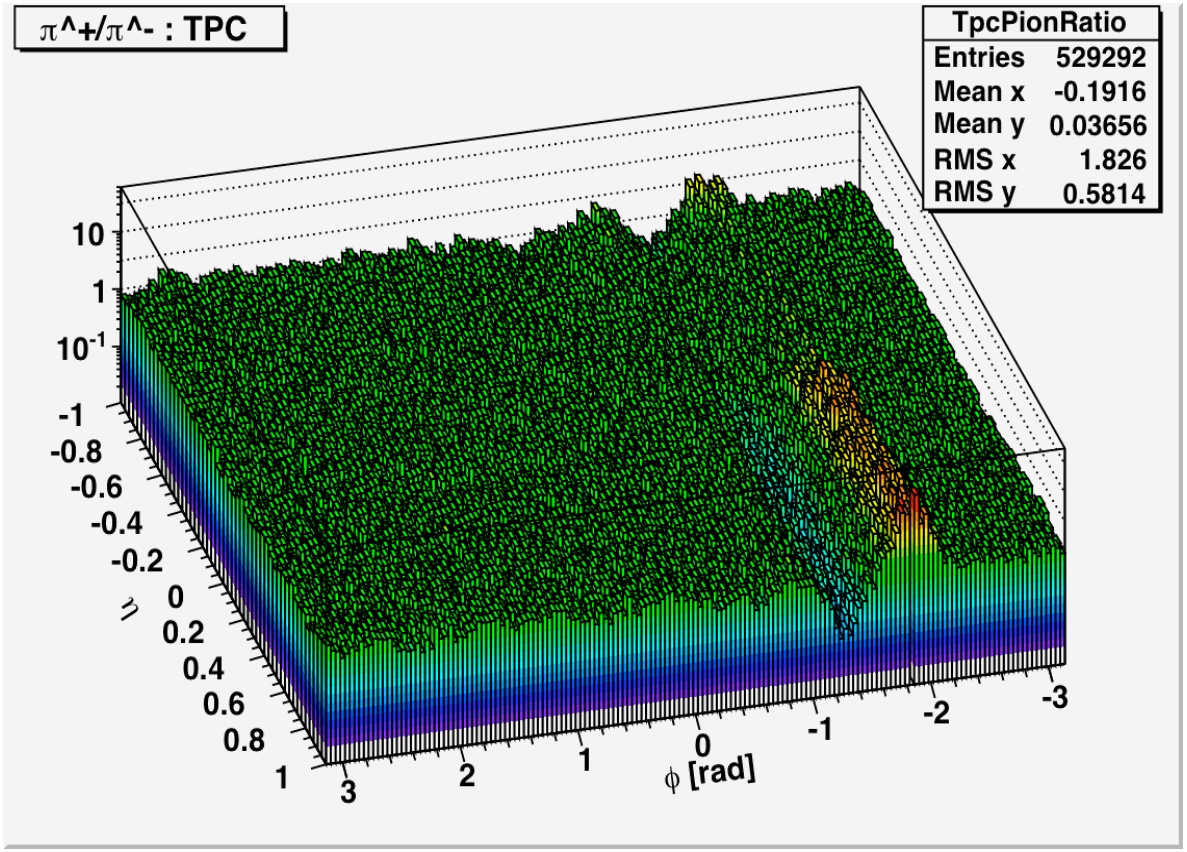
$$\frac{dN}{dp_\perp} = 4 \frac{(n-1)(n-2)}{\langle p_\perp \rangle^2 (n-3)^2} \left(1 + \frac{2p_\perp}{\langle p_\perp \rangle (n-3)}\right)^{-n} p_\perp$$

Track selection

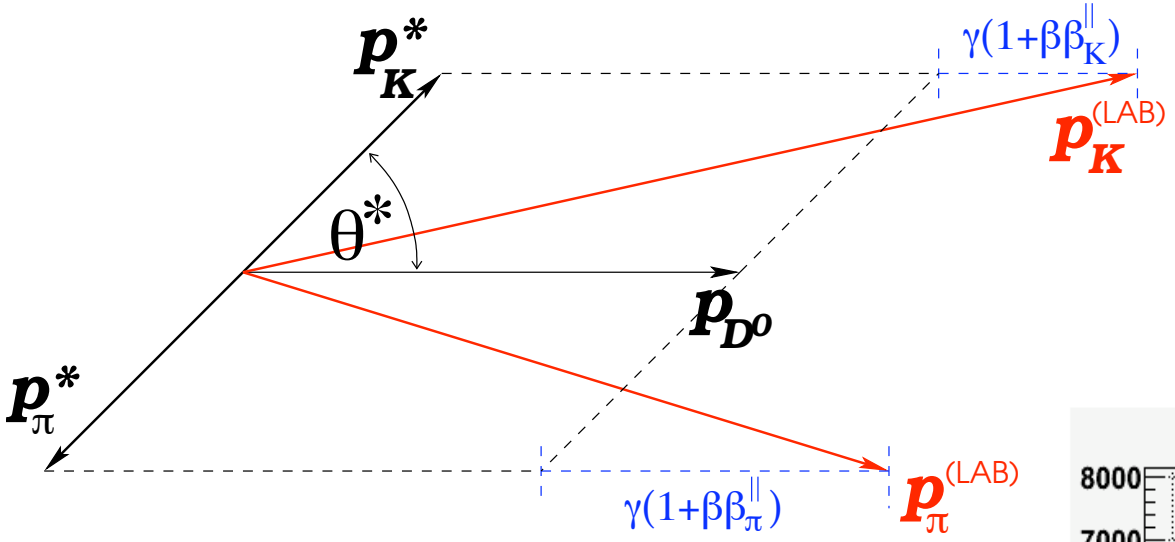
- primary tracks
- 0<flag<1000,
- nHitsFit>15,
- nHitsFit/nMax>0.52
- |dca| < 2 cm
- $p_T > 0.2$
- |Eta| < 1
- remove tracks with first

or last point in TPC sectors 5,6 and 20 for FullField data

- Bemc or TOF match



cos(θ*) < 0.8



In higher p_T , jets are important contribution to combinatorial background.