

Measurement of D^0 and D^* production
in p+p collisions at $\sqrt{s} = 200$ GeV
RHIC Run 12

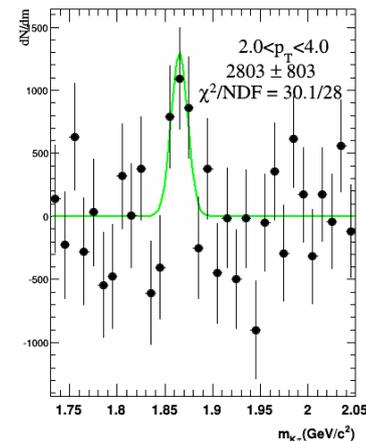
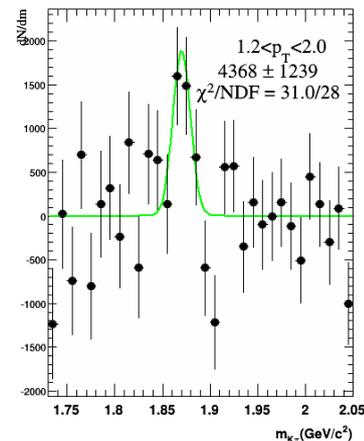
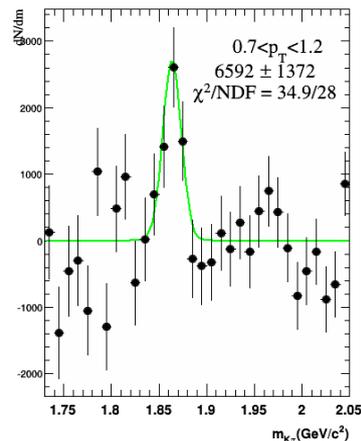
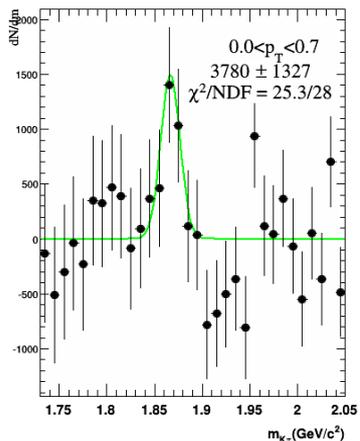
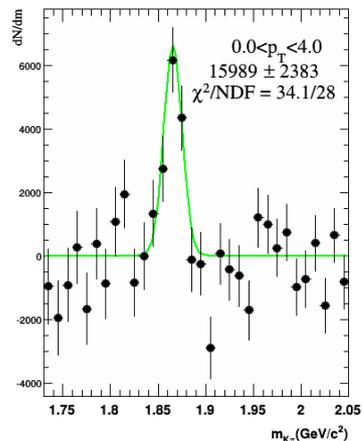
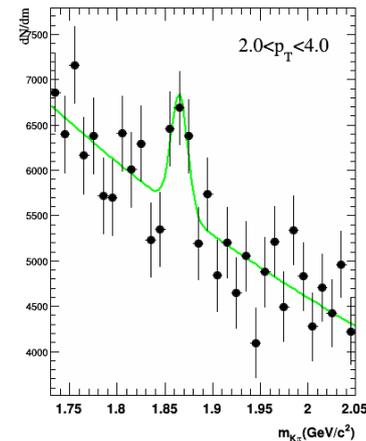
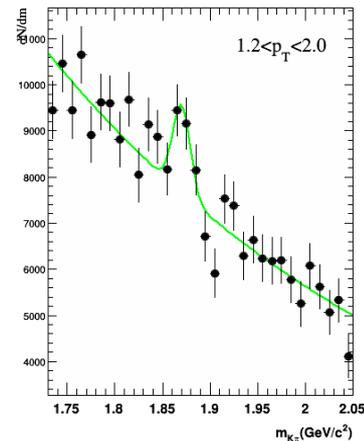
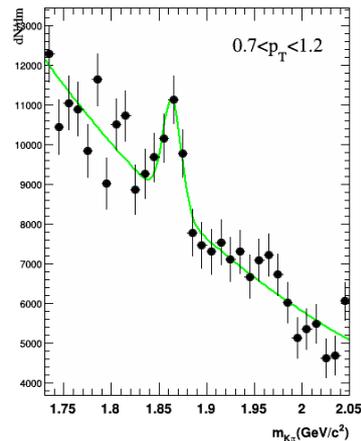
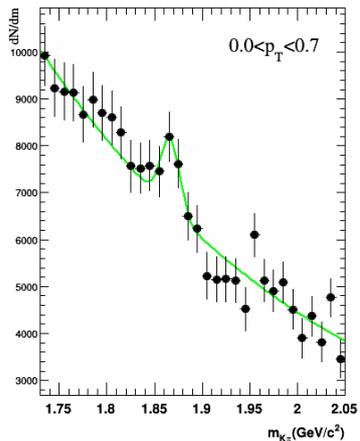
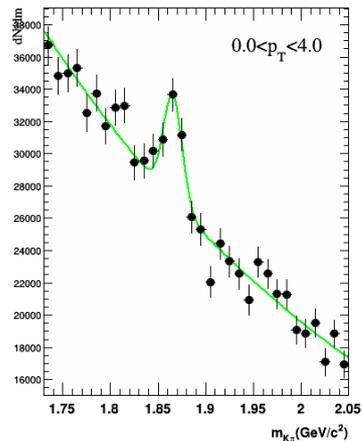
Mustafa Mustafa, Hao Qiu,
Xin Dong

2014 – 05 - 08
HF PWG Group Meeting

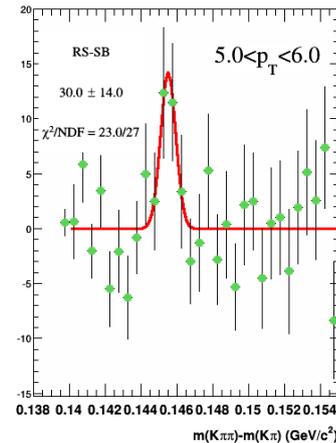
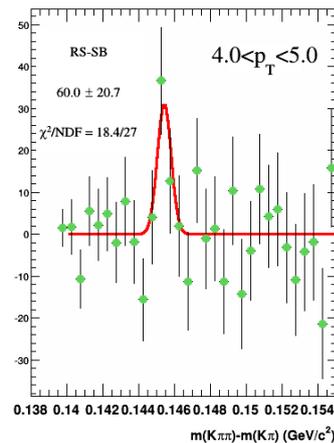
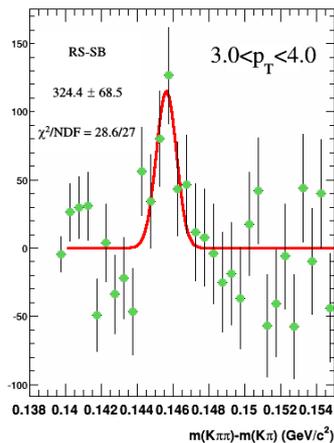
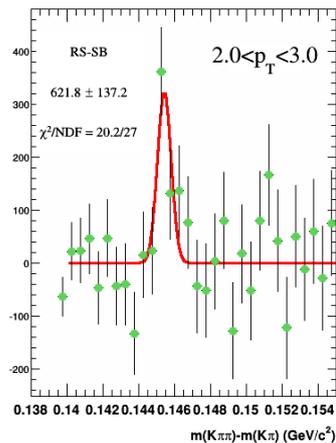
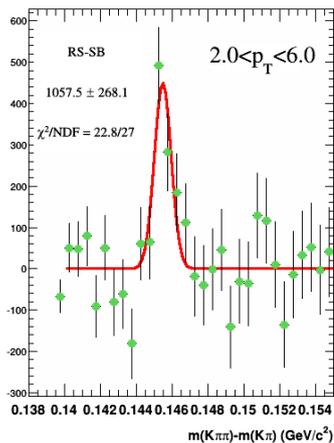
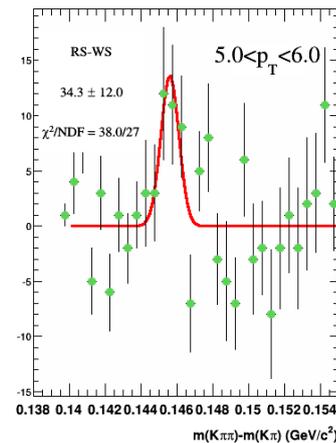
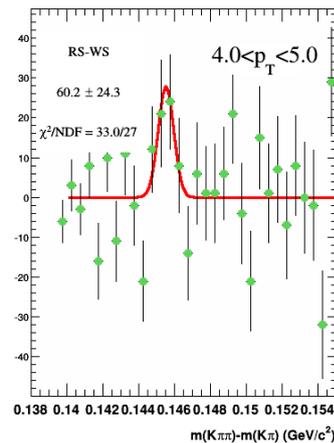
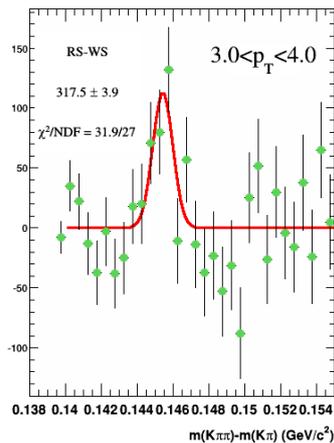
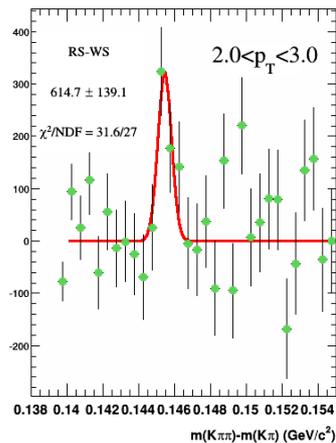
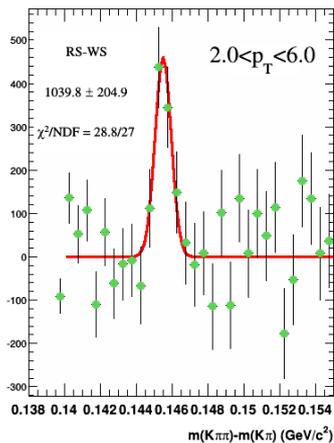
Update:

- Fixed fits.
- p_T corrected for bin shifting.
- Systematics added (bin counting + tracking).
- HT hadrons triggering efficiency from Hao convoluted with tracking efficiency.
- Spectra up to $p_T = 10$ GeV/c.

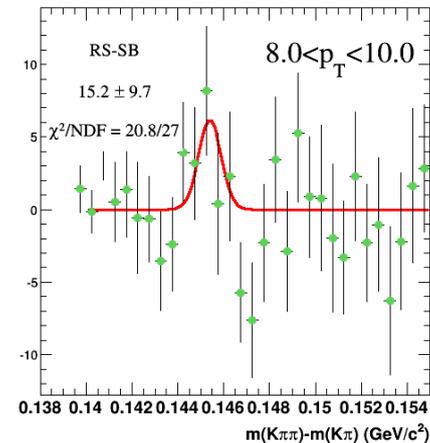
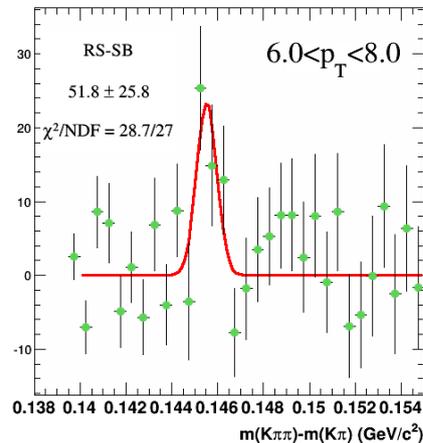
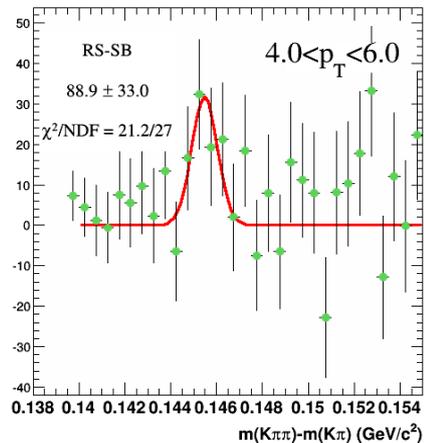
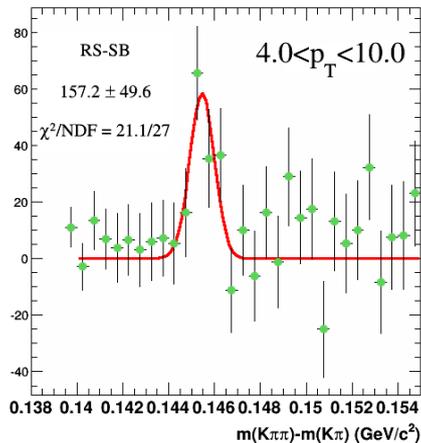
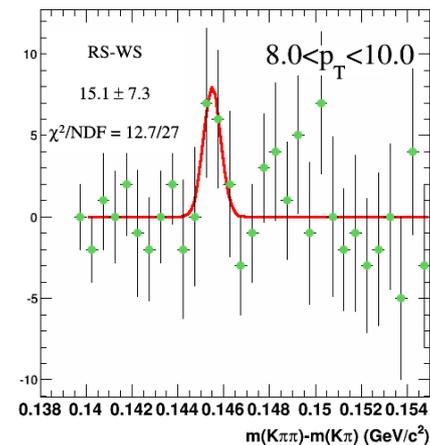
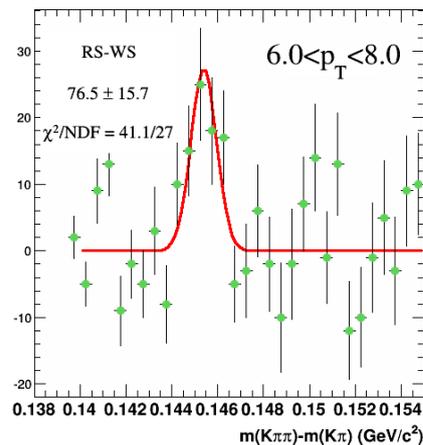
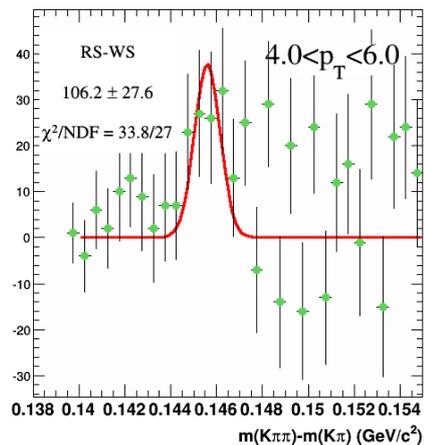
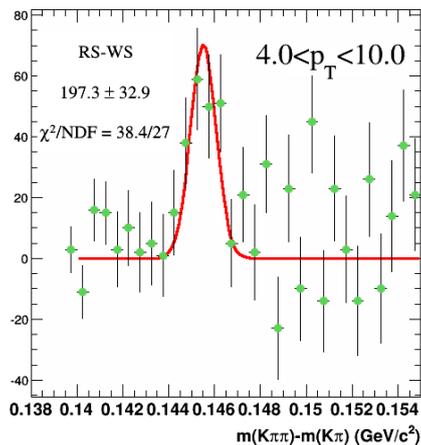
D⁰ reconstruction - MinBias



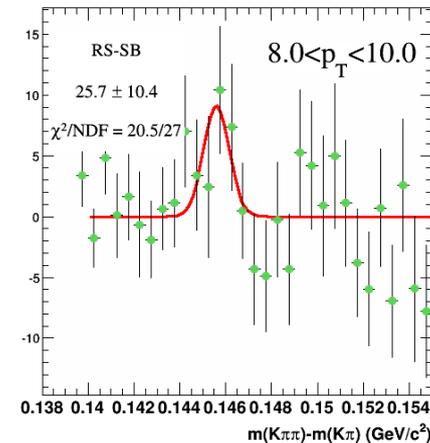
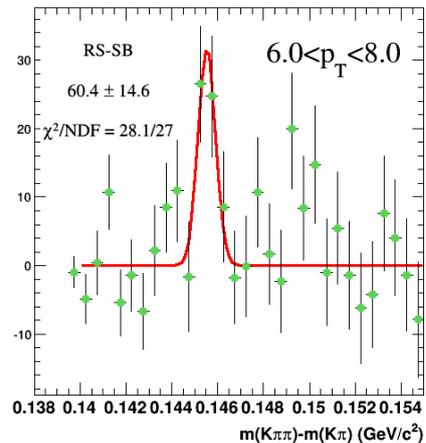
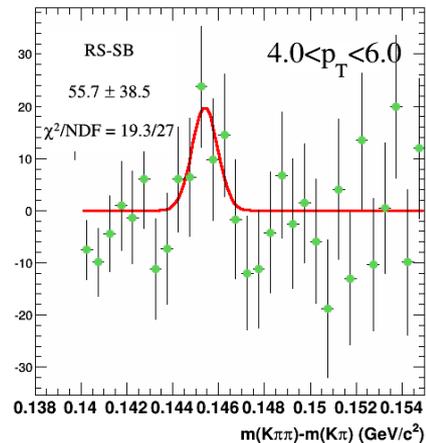
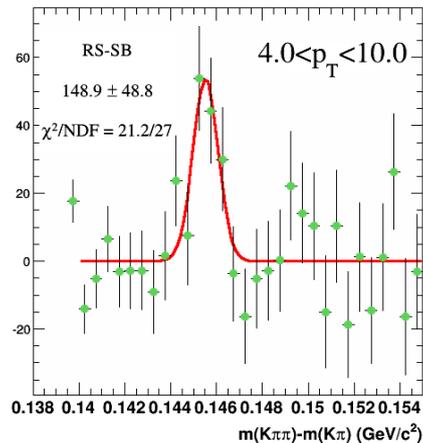
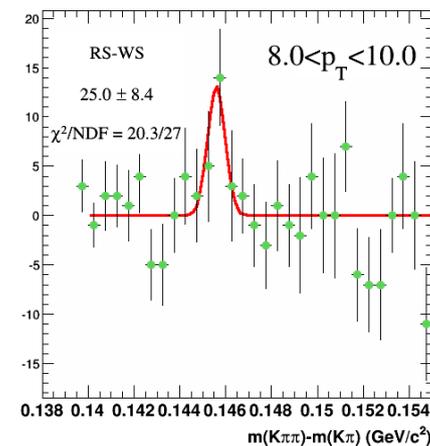
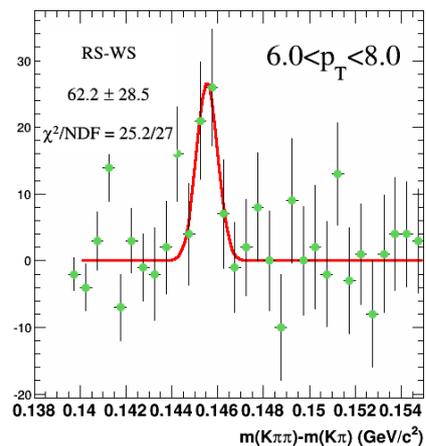
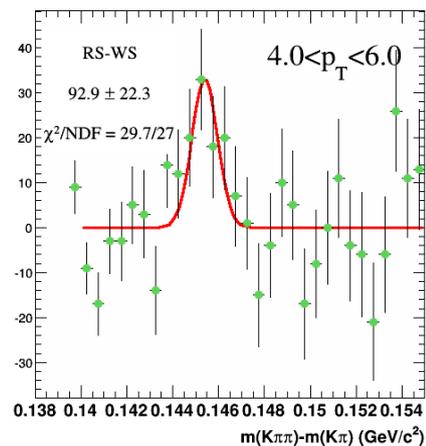
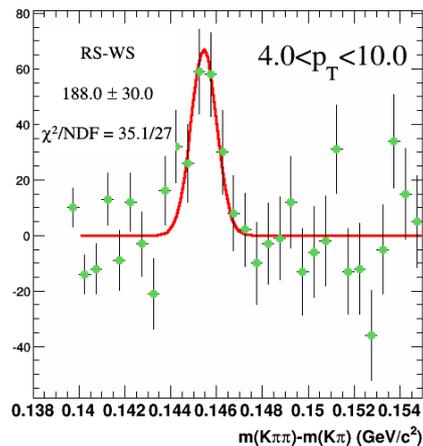
D* reconstruction - MinBias



D* reconstruction - HT1



D* reconstruction - HT2



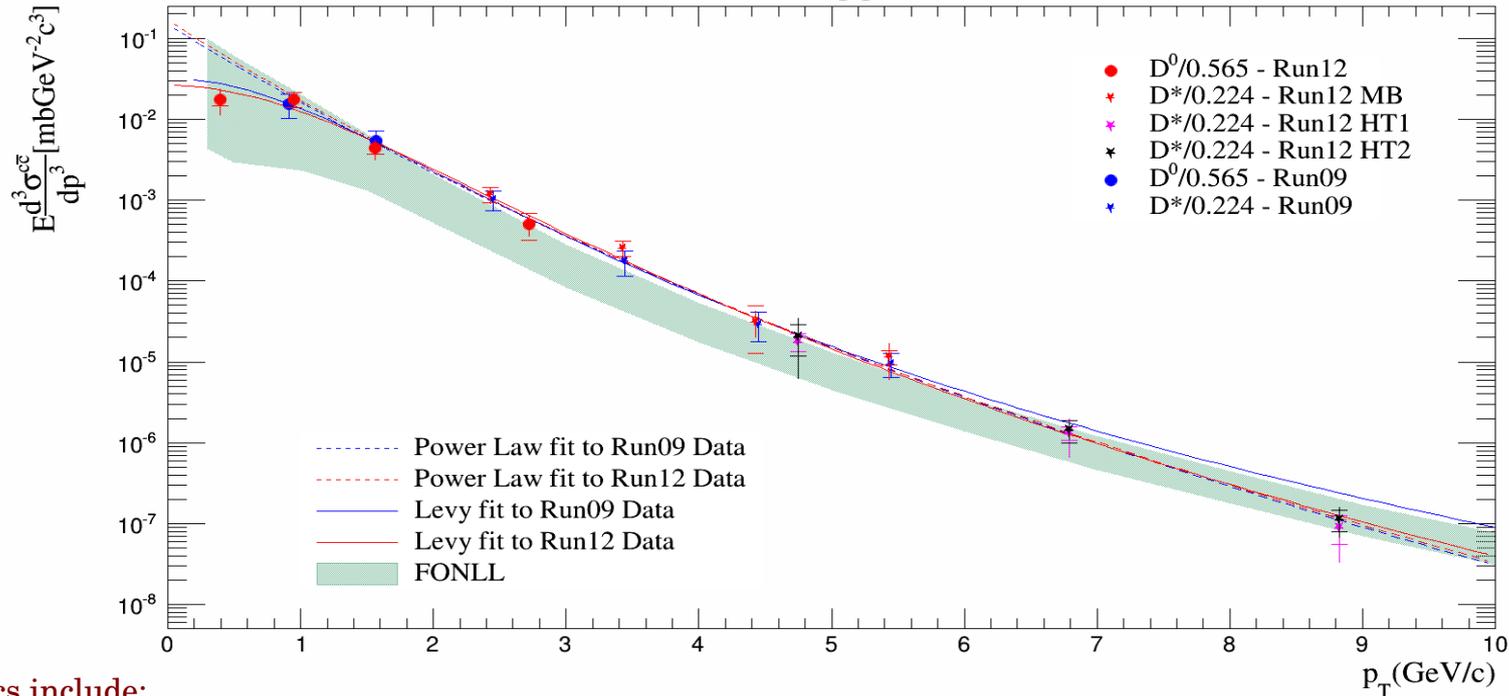
Systematics - bin counting:

p_T	0-0.7	.7-1.2	1.2-2	2-3	3-4	4-5	5-6	6-8	8-10.
D^0	3780± 1327± 263	6592± 1372± 1016	4368± 1239± 282	2803± 803± 937					
D^* MB SB				622 ± 137 ± 7	324 ± 69± 16	60 ± 21± 33	30 ± 14±1		
D^* HT1 SB						89 ± 33±9		52 ± 26±5	15 ± 9±5
D^* HT2 SB						56 ± 38±4		60 ± 15± 15	25 ±10±7

The above table shows counts ± (stat) ± (sys) where the counts are directly from fit and the systematic is the difference between fitting and histogram bin counting.

Cross-section:

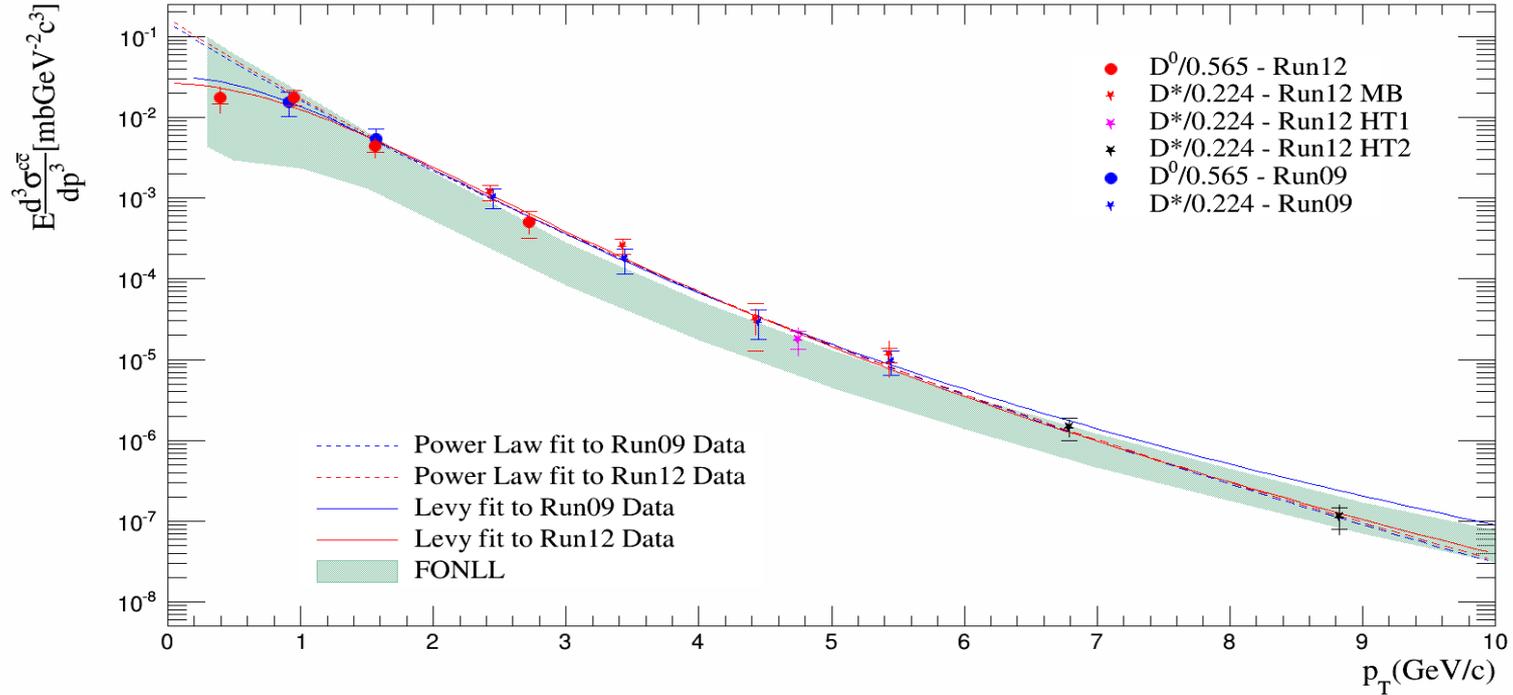
Results from different triggers are consistent.



Systematics include:

- Signal counting.
- Tracking (nfit, dca) ~ 7-10%.
- (Acceptance*efficiency) embedding statistical, HT embedding production is not finished.
- Trigger bias ~ 5.2%
- Other uncertainties:
 - Branching ratio (2-5%),
 - D⁰->c \bar{c} (6%), D*->c \bar{c} (13%)
 - NSD CS (8%)

Cross-section:



Published (Run09):

$$\left. \frac{d\sigma}{dy} \right|_{y=0}^{c\bar{c}} = 170 \pm 45(\text{stat})_{-59}^{+38}(\text{sys}) \mu\text{b.}$$

$$\sigma_{c\bar{c}} = 797 \pm 210(\text{stat})_{-295}^{+208}(\text{sys}) \mu\text{b.}$$

Run12:

$$\frac{d\sigma^{c\bar{c}}}{dy} = 159 \pm 19(\text{stat}) \pm 20(\text{sys}) \mu\text{b.}$$

$$\sigma^{c\bar{c}} = 746 \pm 90(\text{stat}) \pm 146(\text{sys}) \mu\text{b.}$$

Extrapolation to full phase space adds a 15% systematic uncertainty.

Summary:

- We have measured charm differential cross-section down to transverse-momentum 0 GeV/c and up to 10 GeV/c.
- Measurements from minimum-bias, HT1 and HT2 are consistent.

Backup slides

STAR published results

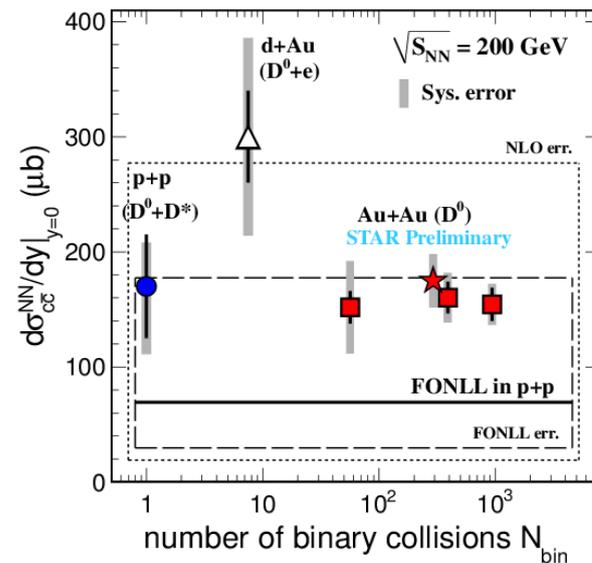
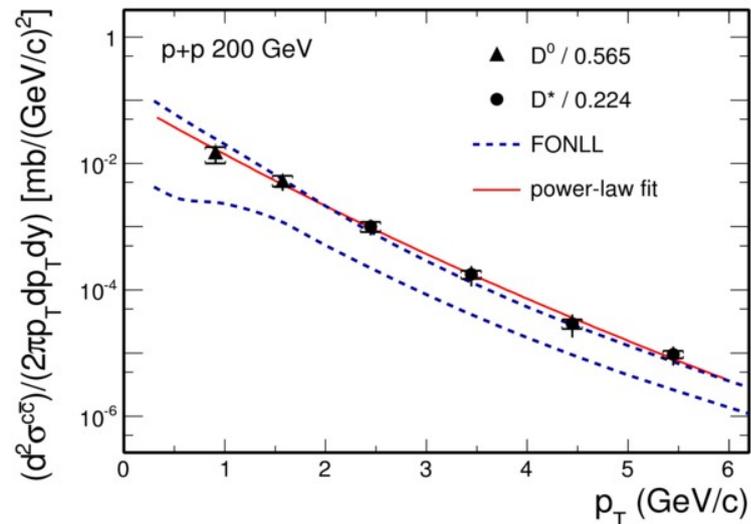
- Used $\sim 100 \times 10^6$ VPDMB events (Run09).
- $\sim 70\%$ of TOF was installed.
- Charm cross-section

$$\left. \frac{d\sigma}{dy} \right|_{y=0}^{c\bar{c}} = 170 \pm 45(\text{stat})_{-59}^{+38}(\text{sys}) \mu\text{b.}$$

$$\sigma_{c\bar{c}} = 797 \pm 210(\text{stat})_{-295}^{+208}(\text{sys}) \mu\text{b.}$$

STAR Run12 events:

Trigger	ID	N_evts before cuts $\times 10^6$	N_evts after cuts $\times 10^6$
VPDMB	370001 370011	688	339
HT1*BBCMB*TOF0	370546	37.8	33.6
HT2*BBCMB	370522	34.0	30.7



Run12 pp200GeV events counts

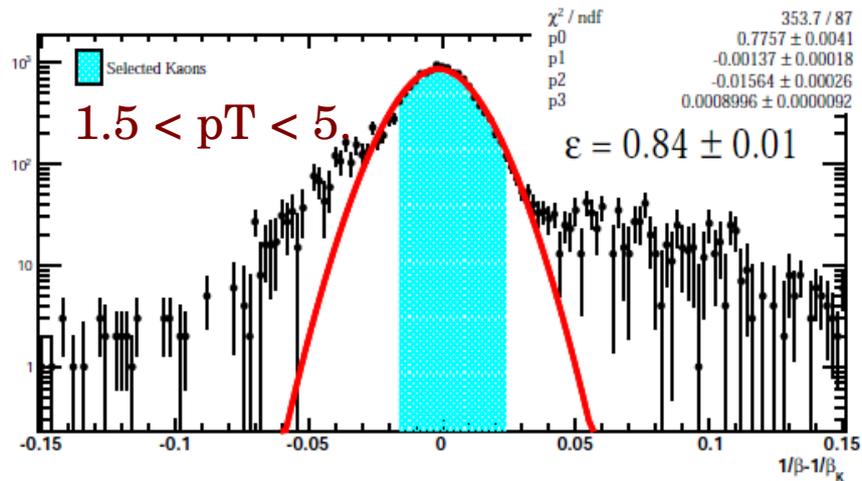
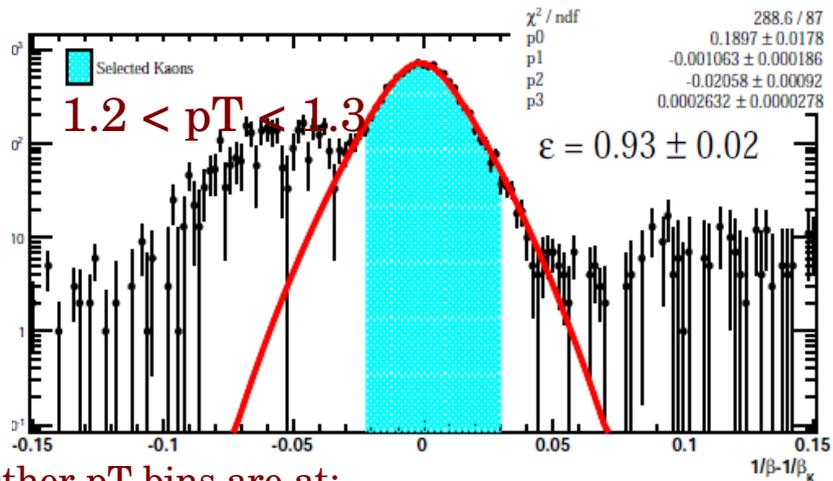
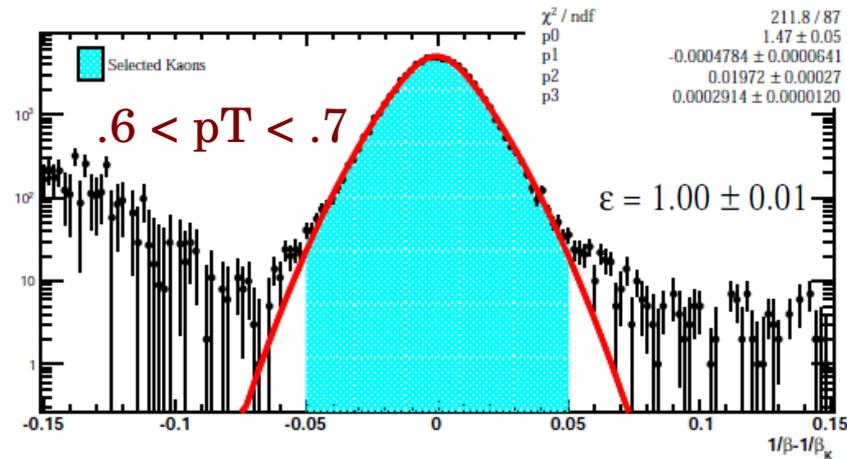
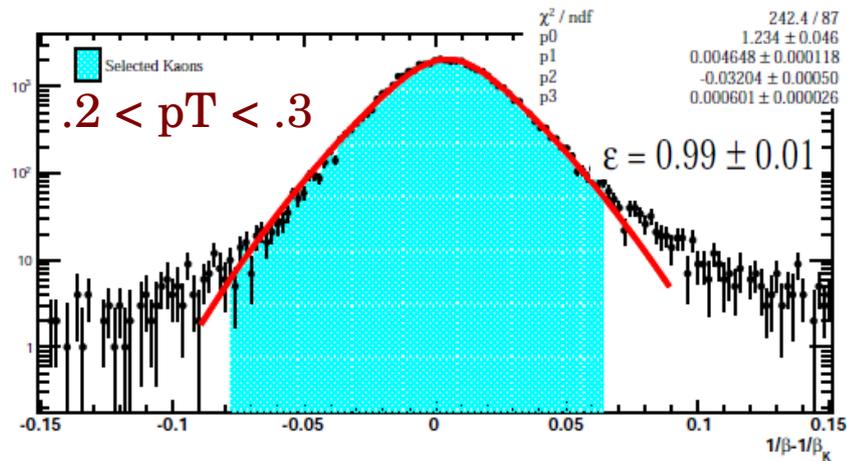
Trigger	ID	L(pb ⁻¹) from Jamie's tables	N_evts before cuts x10 ⁶	N_evts after cuts x10 ⁶	
VPDMB	370001 370011	0.029	677	343	
HT0*BBCMB*TOF0	370542	1.371	35.9	31.8	
HT0*VPDMB	370501	0.398	8.7	8.1	0.1*
HT1*BBCMB*TOF0	370546	9.422	40.0	35.3	
HT1*VPDMB	370511	2.932	9.9	9.3	3.5*
HT2	370531	24.575	46.7	39.5	
HT2*BBCMB	370522	23.550	34.3	30.8	30.8*

* Shared cells are common events.

Event cuts:

- $|V_z| < 100\text{cm}$.
- **Ranking > 0**
- $|V_z - V_{zVPD}| < 6. \text{ cm}$ for VPDMB only.

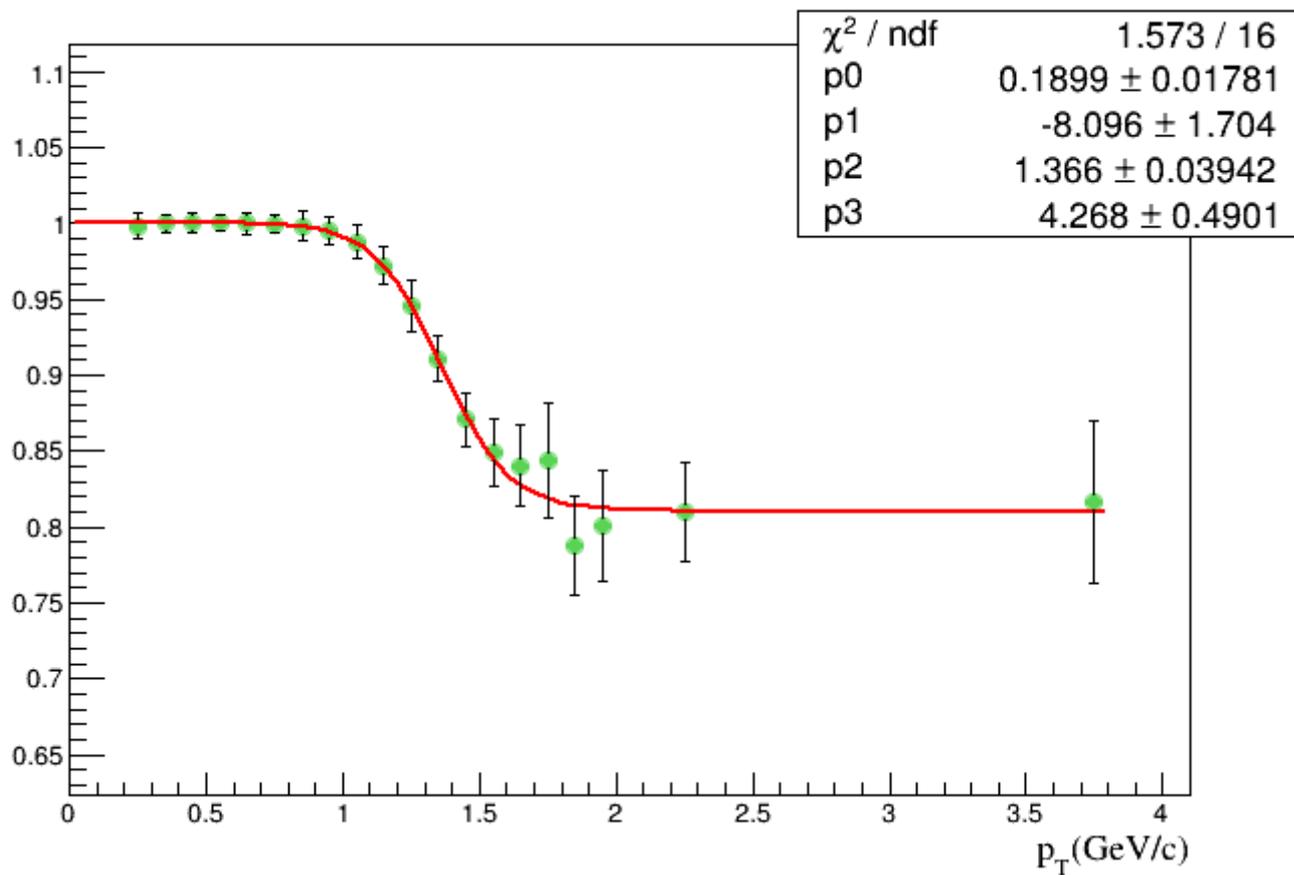
TOF Kaon PID



Other pT bins are at:

http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/TOF-eff/btof_beta_fits.pdf

TOF Kaon PID

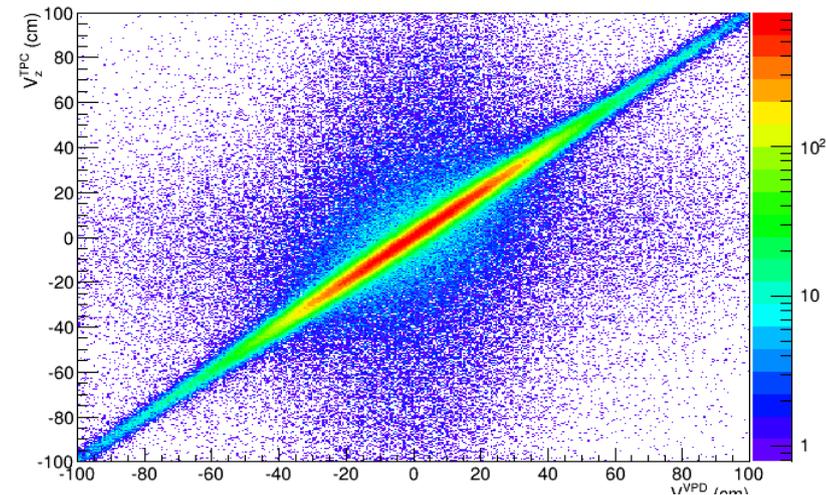


Embedding requests:

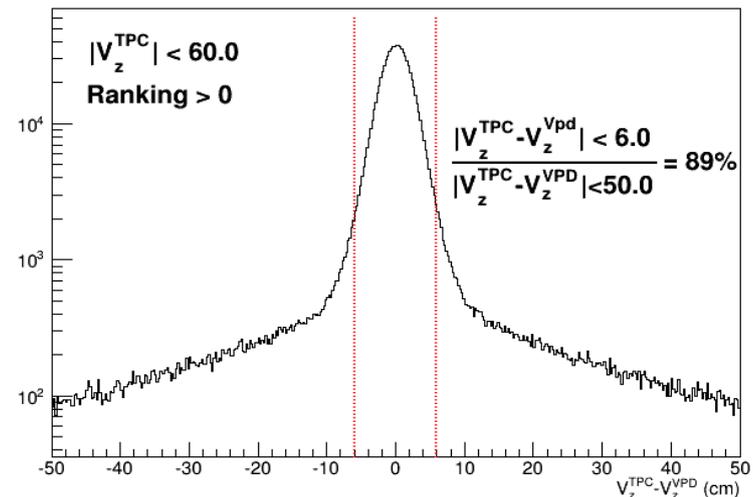
<p>VPDMB D0/D0bar</p> <p>100k each, 2 particles/event.</p> <p>$V_z < 60.$ cm</p> <p>$y < 1.$</p> <p>$0 < p_T < 5.$</p> <p>Triggers: 370001, 370011</p> <p>QA</p>	<p>VPDMB D*+/D*-</p> <p>300k events each, 2 particles/event.</p> <p>$V_z < 60.$</p> <p>$y < 1.$</p> <p>$2. < p_T < 12.$ Flat in $p_T.$</p> <p>Triggers: 370001, 370011</p> <p>QA</p>	<p>HT D*+/D*-</p> <p>500k events each, 2 particles/event.</p> <p>$V_z < 100.$ cm</p> <p>$y < 1.$</p> <p>$4 < p_T < 12.$ Flat in p_T</p> <p>Triggers: 370522, 370511, 370501</p> <p>HT2-eff-pions HT2-eff-kaons</p>
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Events cuts:

- Vertex Rank > 0.
- HT: $|V_z| < 100$. cm.
- MB: $|V_z| < 60$.cm $|V_z - V_z^{VPD}| < 6$. cm.



Trigger	ID	N_evts before cuts $\times 10^6$	N_evts after cuts $\times 10^6$
VPDMB	370001 370011	688	339
HT1*BBCMB*TOF0	370546	37.8	33.6
HT2*BBCMB	370522	34.0	30.7



Tracks selection:

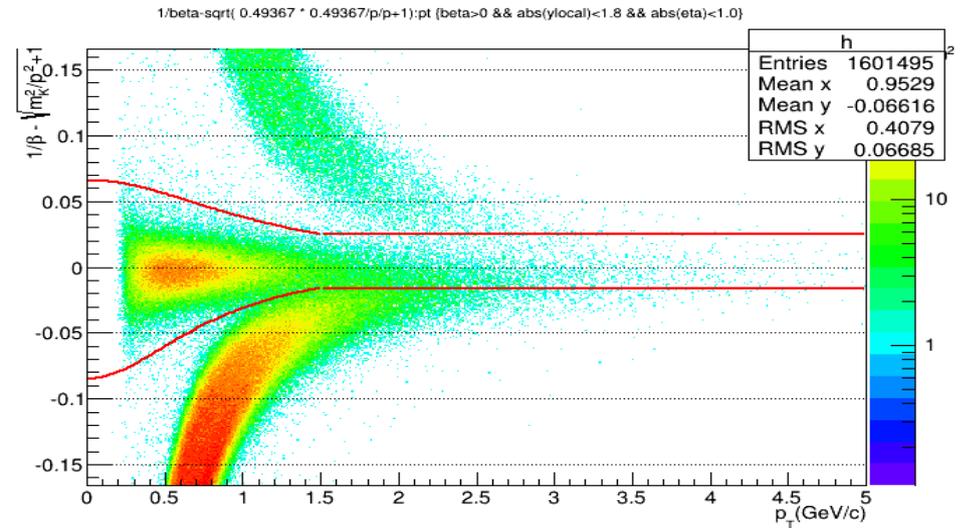
- $n\text{HitsFit} > 15$ && $n\text{HitsFit}/n\text{HitsMax} > 0.52$
- $g\text{DCA} < 2$. cm.
- $p_T > 0.2$, > 0.15 for soft pions.
- $|\eta| < 1$.
- No Eta cut on soft pions.

PID:

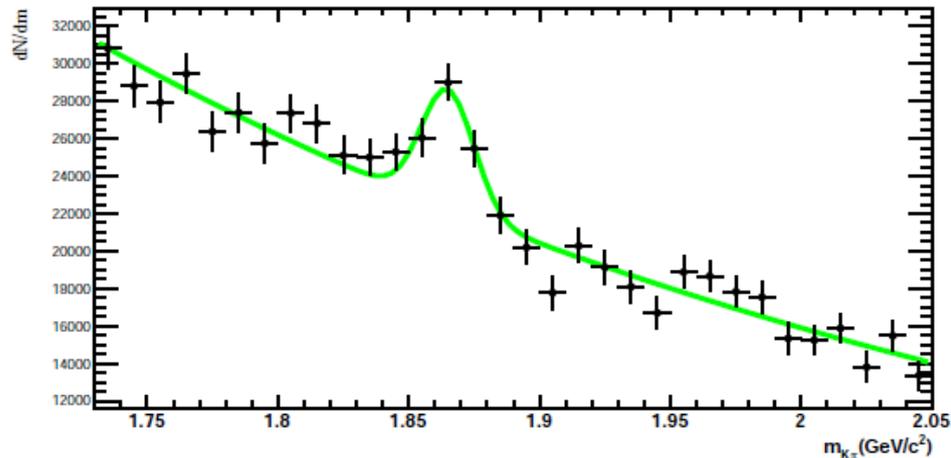
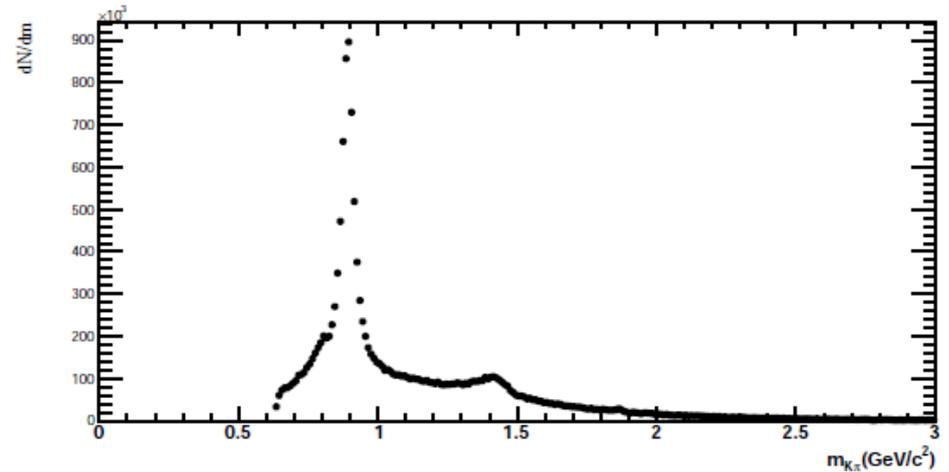
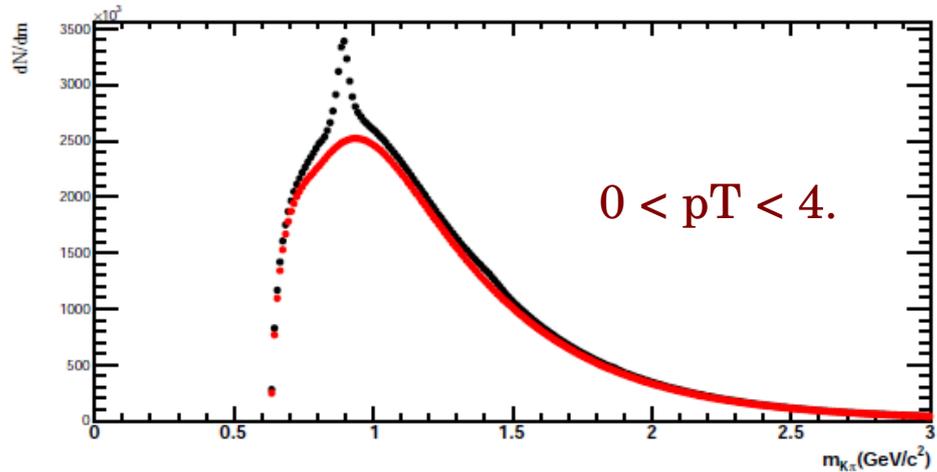
- $|\ln\text{SigmaPion}| < 3$.
- $|\ln\text{SigmaKaon}| < 3$.

Kaons TOF cut:

- $|y_{\text{Local}}| < 1.8$ cm.
- $\beta > 0$.
- Asymmetric p_T dependent cut on $1/\beta$ to reject pions and protons.



D⁰ reconstruction

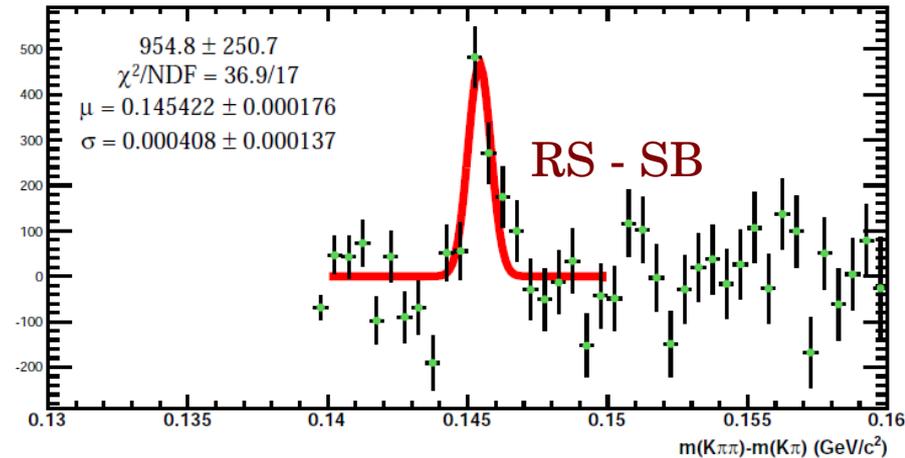
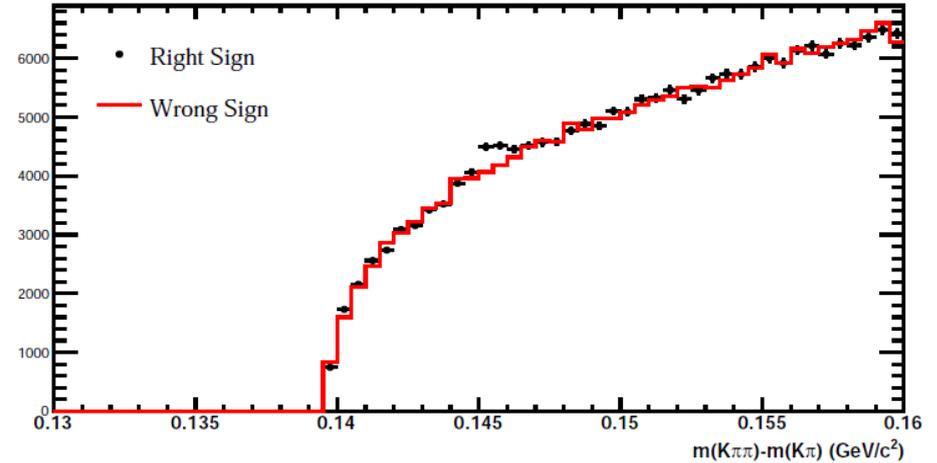
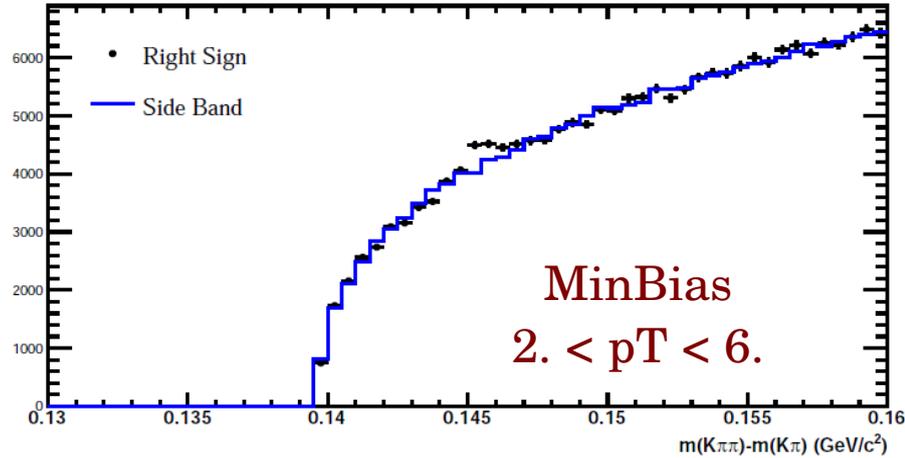


- D⁰ → K⁻ π⁺ (BR. 3.88%)
- TOF Kaons.
- Like sign background. (No scaling).
- Free fits: Exp+Gaus.
- 1.83 < m(D⁰) < 1.89
- |y(D⁰)| < 1.0

All plots are at

http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/invariant-mass/dzero_mb.pdf

D* reconstruction



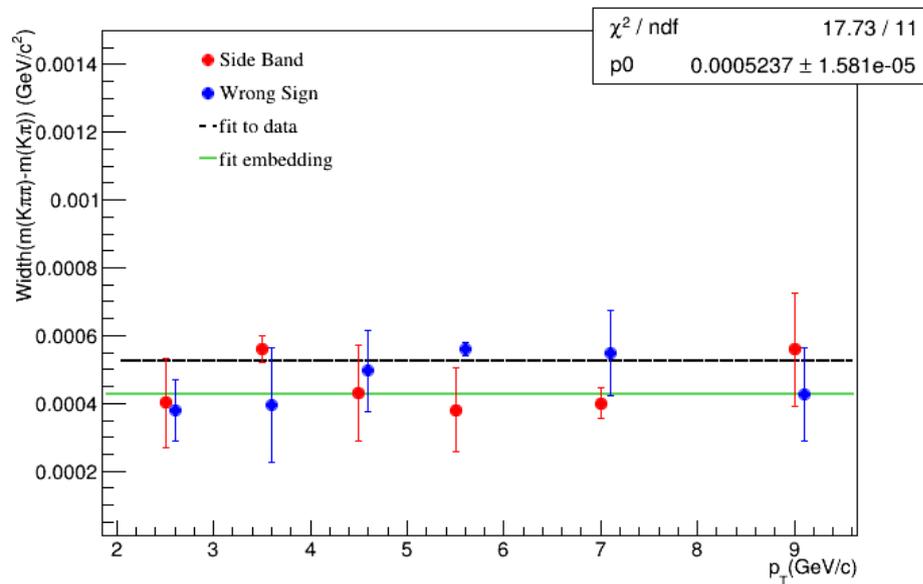
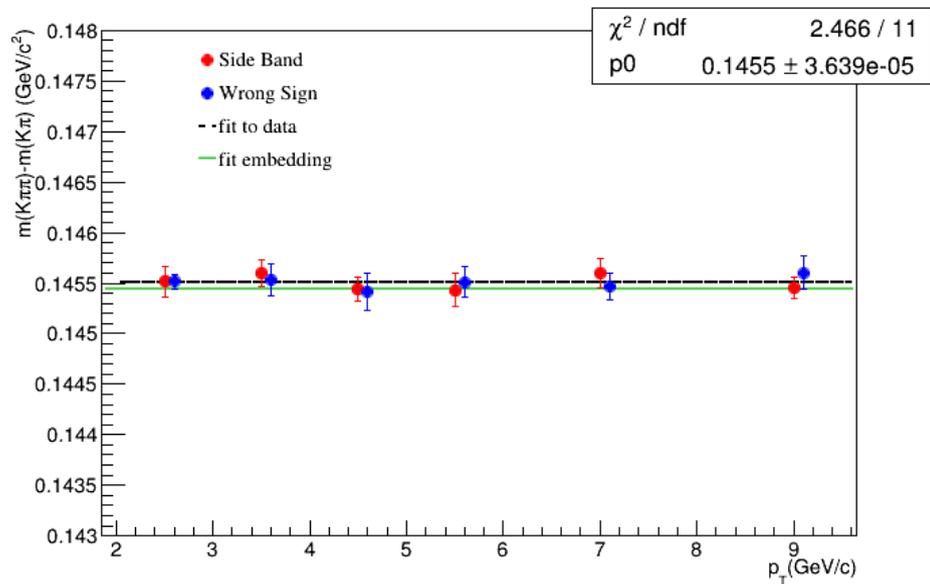
- $D^{*+} \rightarrow D^0 \pi^+ \rightarrow K^- \pi^+ \pi^+$ (BR 67.7% * 3.88%)
- TPC only.
- $1.83 < m(D^0) < 1.9$
- No η on soft pion.
- $7. < pT(D^0)/pT(\text{softPion}) < 20$.
- SB $m(D^0)$: (1.72,1.8) || (1.92,2.)
- Fit: Gaus.
- $0.144 < m(D^*) - m(D^0) < 0.147$

All plots are at <http://portal.nersc.gov/project/star/mustafa/p200Run12Dmesons/invariant-mass/>

- In HT, D* Kaon or Pion to fire trigger. 20

D* mean and width:

- Mean and width extracted from free fits to all D* data. The mean and width were used to constrain the fits to individual triggered data.



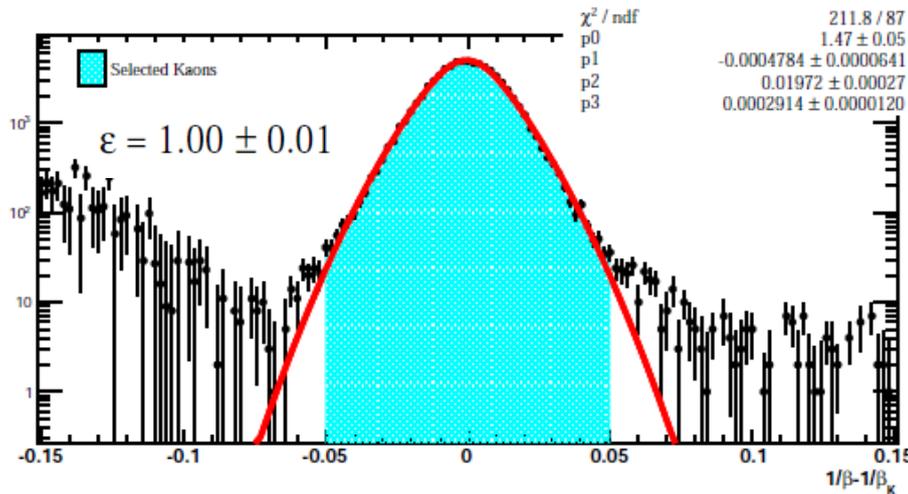
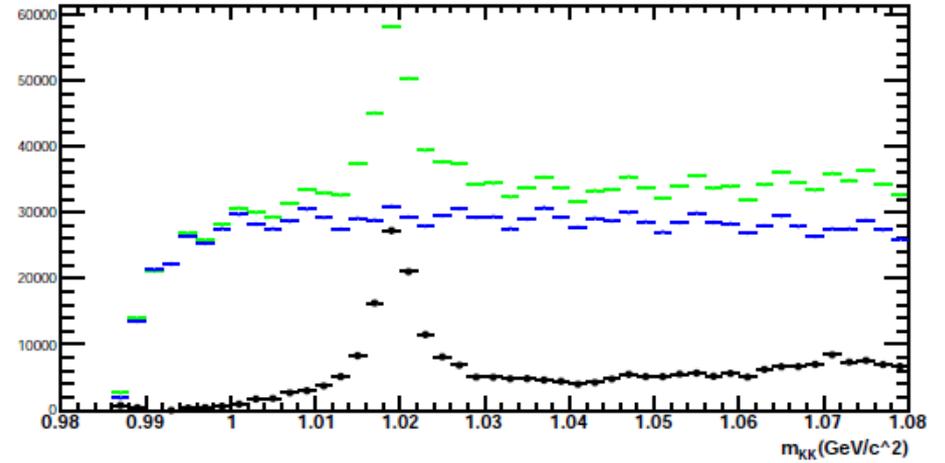
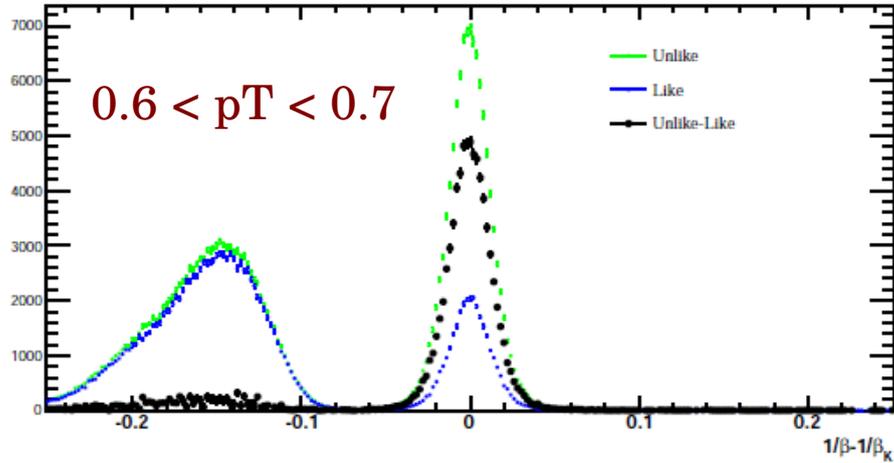
Summary of signal counts:

- Minbias data used to extract $\sim 16\text{k}$ D^0 counts for $0 < p_T < 4$.
- D^* signal extracted from MB, HT1 and HT2 can extend charm p_T to 10 GeV/c.
- a good baseline for next year HFT run.

Not Updated

p_T	0-0.7	0.7-1.2	1.2-2	2-3	3-4	4-5	5-6	6-8	8-10.
D^0	3223±870	6618±992	4372±889	2805±572					
D^* MB									
SB				583 ± 99	333 ± 50	61 ± 16	30 ± 11		
RS				578 ± 100	324 ± 51	62 ± 18	32 ± 9		
D^* HT1									
SB						70 ± 31	48 ± 21	13 ± 8	
RS						94 ± 21	76 ± 13	15 ± 6	
D^* HT2									
SB						54 ± 35	55 ± 11	27 ± 9	
RS						94 ± 18	51 ± 12	29 ± 14	

TOF Kaon PID

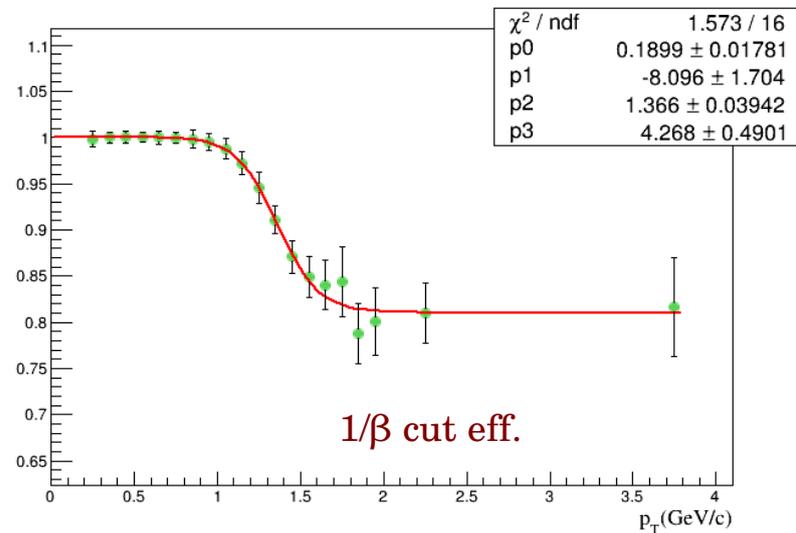
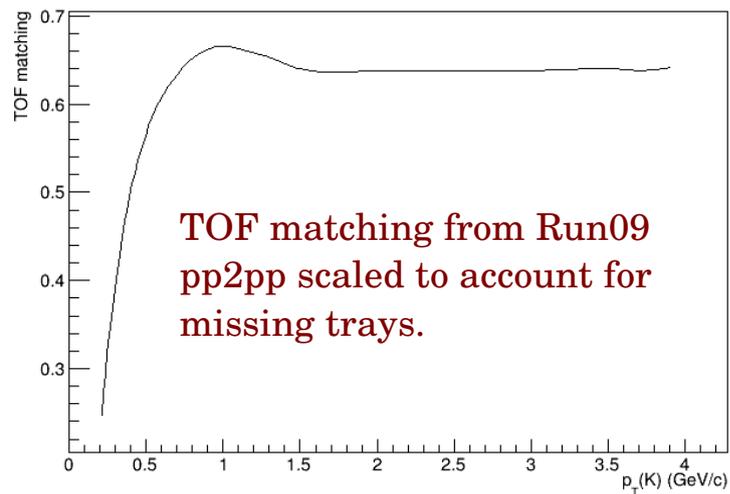


- φ is used to select a pure K sample.
- Asymmetric p_T dependent cut on $1/\beta$ is used to reject pions and protons.
- $\text{Gaus}(\mu, \sigma) / ((x - \mu)^2 + c)$ is used to fit the signal.

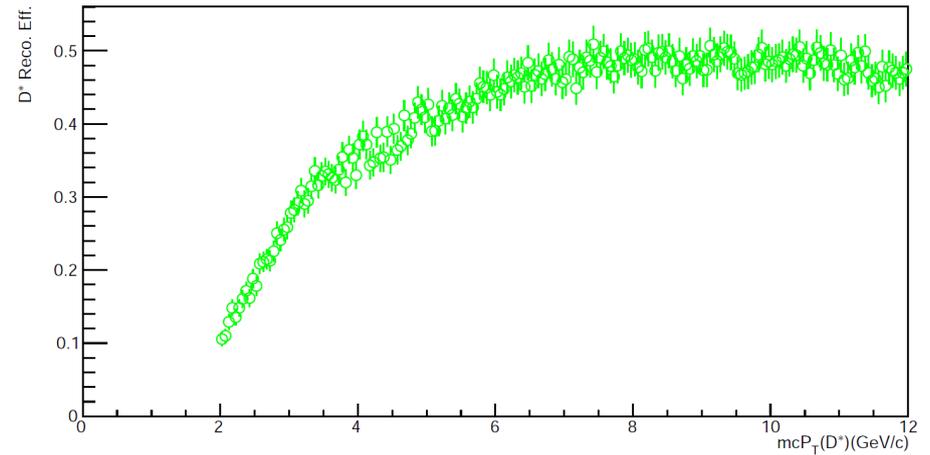
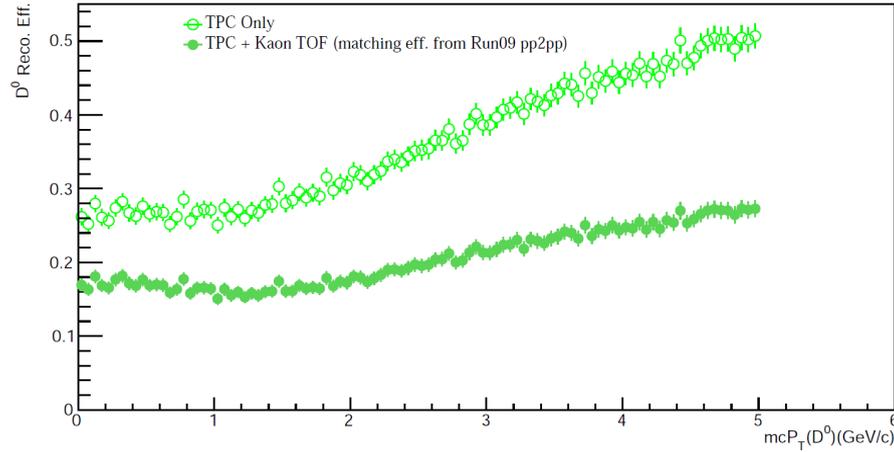
All plots are at:

http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/tof-eff/btof_beta_fits.pdf

Reconstruction efficiency:

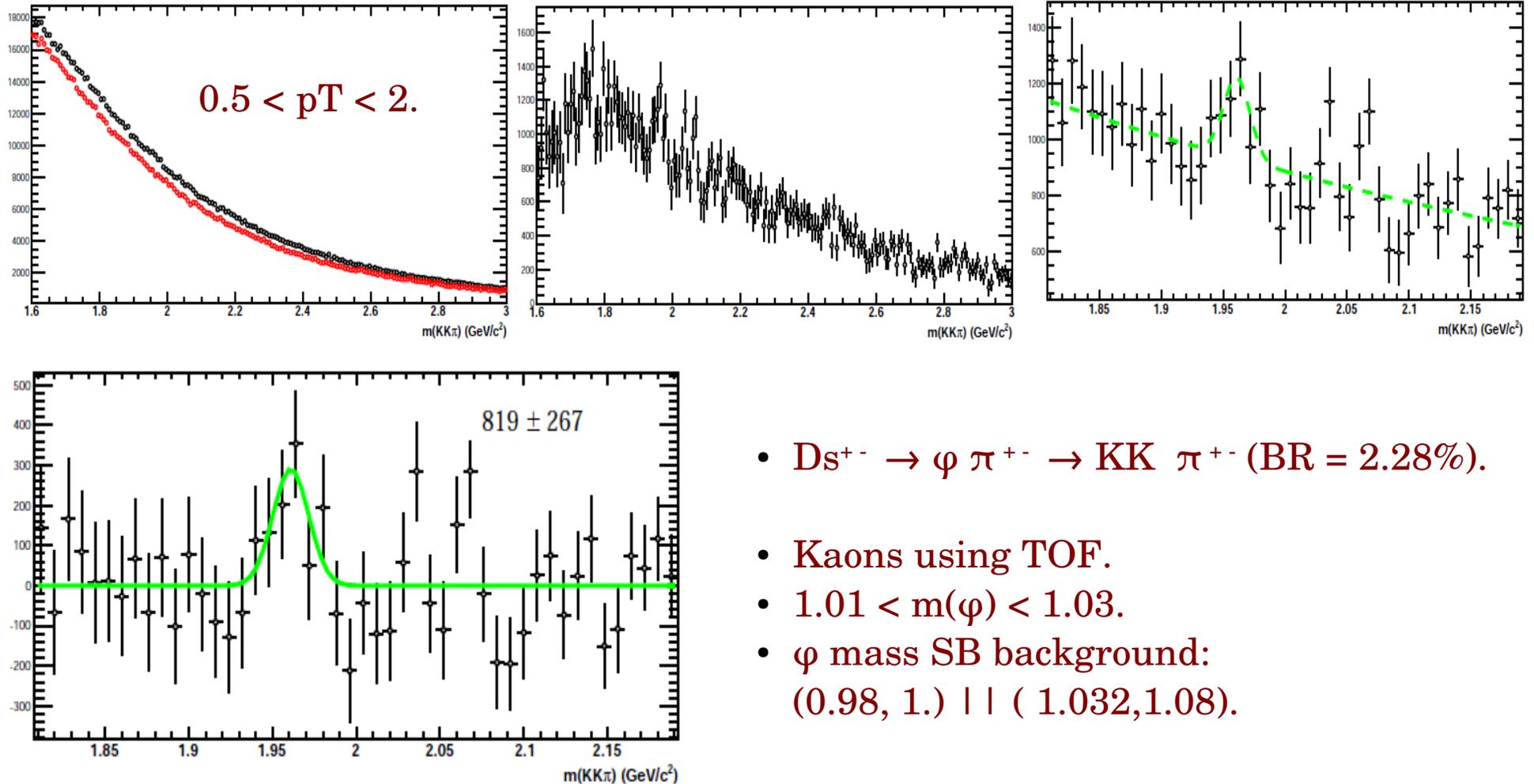


Reconstruction efficiency:



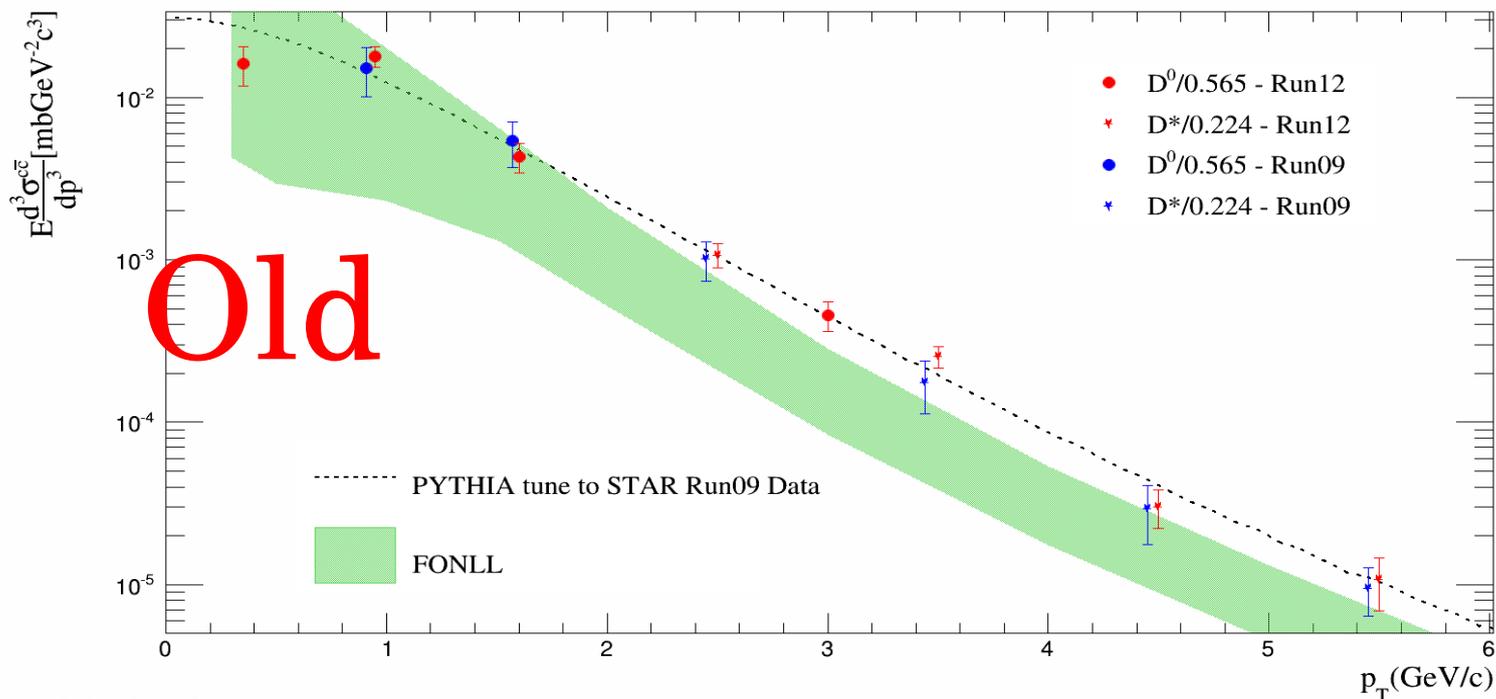
Embedding details in backup slides. QA plots can be found at <http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/embedding/>

Ds reconstruction - MinBias



- $Ds^{+-} \rightarrow \varphi \pi^{+-} \rightarrow KK \pi^{+-}$ (BR = 2.28%).
- Kaons using TOF.
- $1.01 < m(\varphi) < 1.03$.
- φ mass SB background:
(0.98, 1.) || (1.032, 1.08).

Cross-section (Minimum-Bias):



Published (Run09):

$$\left. \frac{d\sigma}{dy} \right|_{y=0}^{c\bar{c}} = 170 \pm 45(\text{stat})_{-59}^{+38}(\text{sys}) \mu\text{b.}$$

$$\sigma_{c\bar{c}} = 797 \pm 210(\text{stat})_{-295}^{+208}(\text{sys}) \mu\text{b.}$$

Run12:

$$\left. \frac{d\sigma^{c\bar{c}}}{dy} \right|_{y=0} = 154 \pm 13(\text{stat}) \mu\text{b.}$$

$$\sigma^{c\bar{c}} = 723 \pm 63(\text{stat}) \mu\text{b.}$$