

Measurement of D⁰ and D* production in p+p collisions at $\sqrt{s} = 200$ GeV

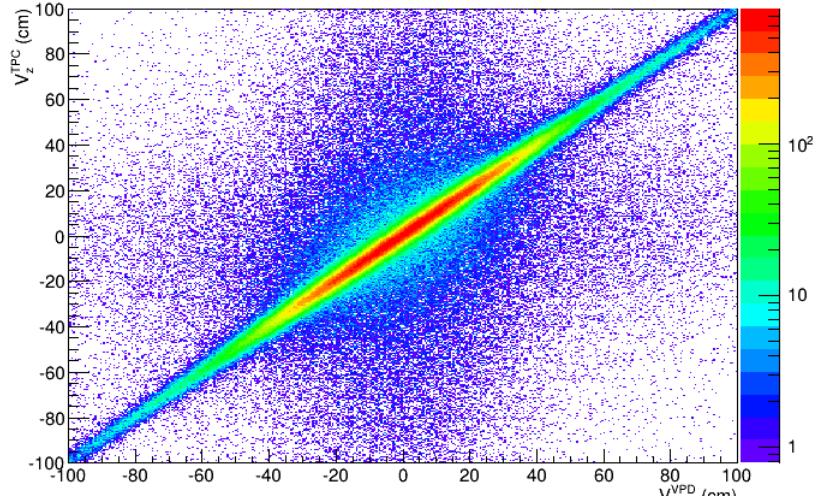
RHIC Run 12

Mustafa Mustafa, Hao Qiu,
Xin Dong

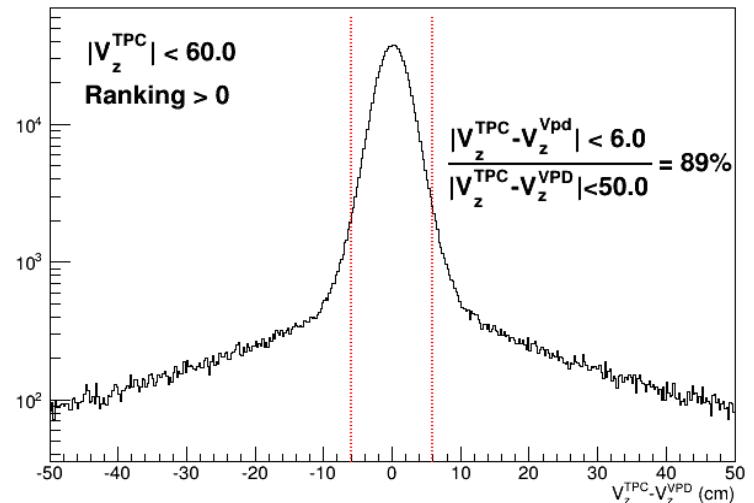
2014 - 04 - 17
HF PWG Group Meeting

Events cuts:

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



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



Tracks selection:

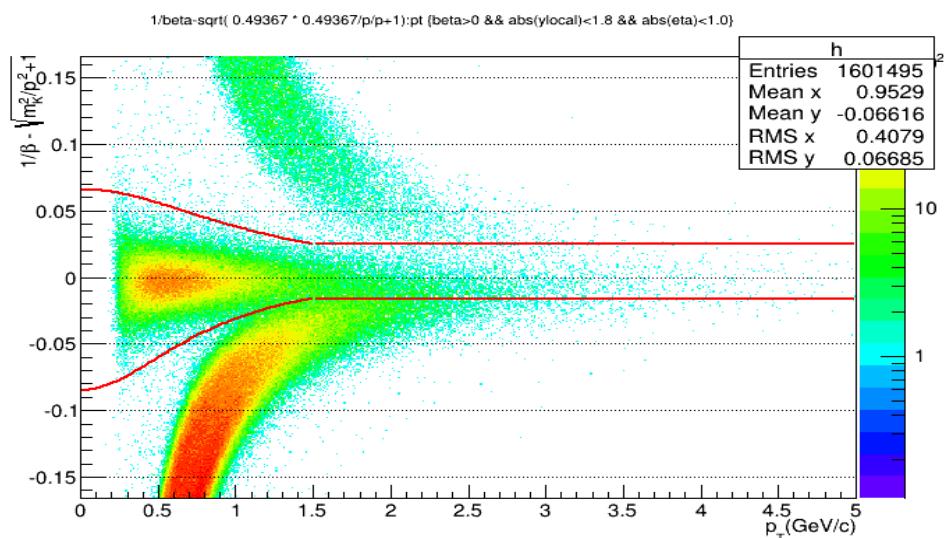
- $n\text{HitsFit} > 15 \ \&\& n\text{HitsFit}/n\text{HitsMax} > 0.52$
- $g\text{DCA} < 2. \text{ cm.}$
- $p_T > 0.2, > 0.15 \text{ for soft pions.}$
- $|\eta| < 1.$
- No Eta cut on soft pions.

PID:

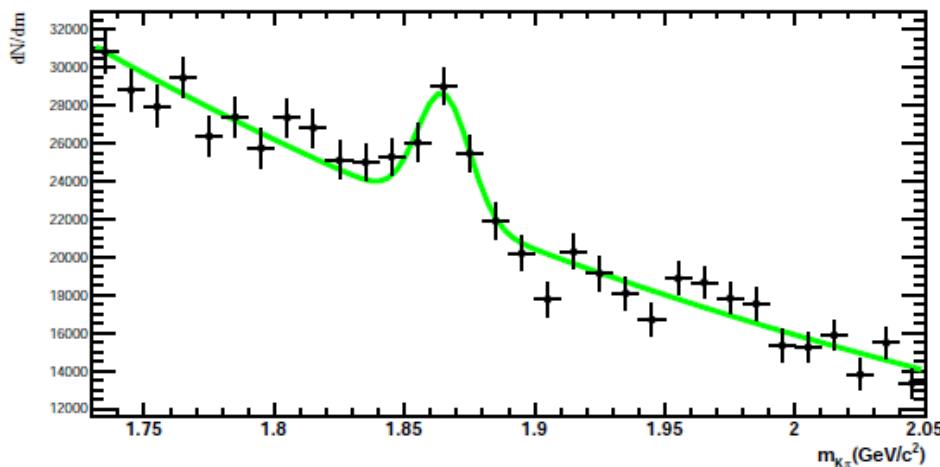
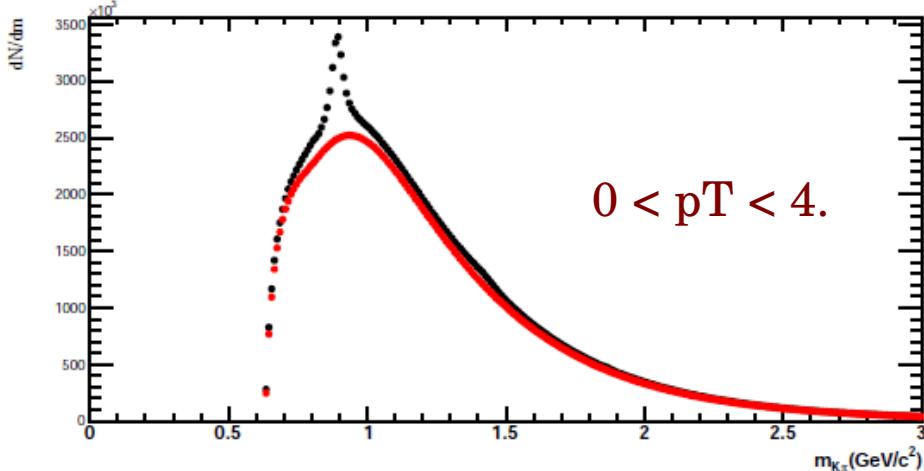
- $|n\text{SigmaPion}| < 3.$
- $|n\text{SigmaKaon}| < 3.$

Kaons TOF cut:

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

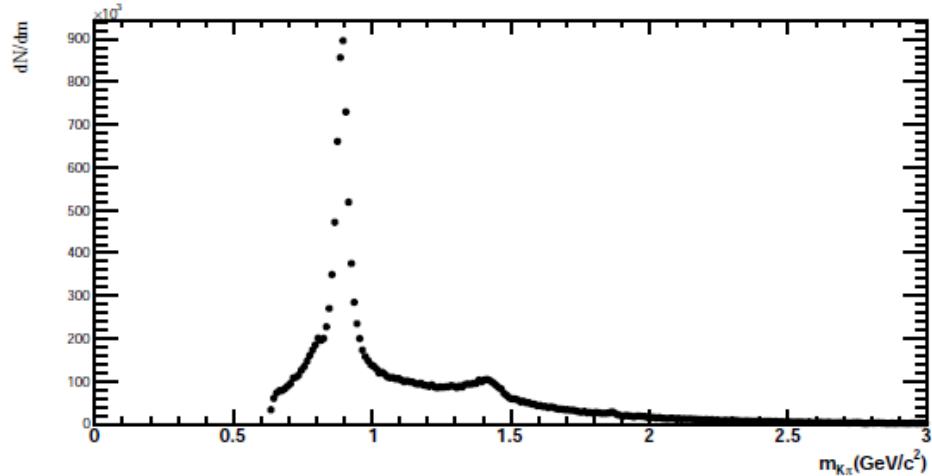


D⁰ reconstruction



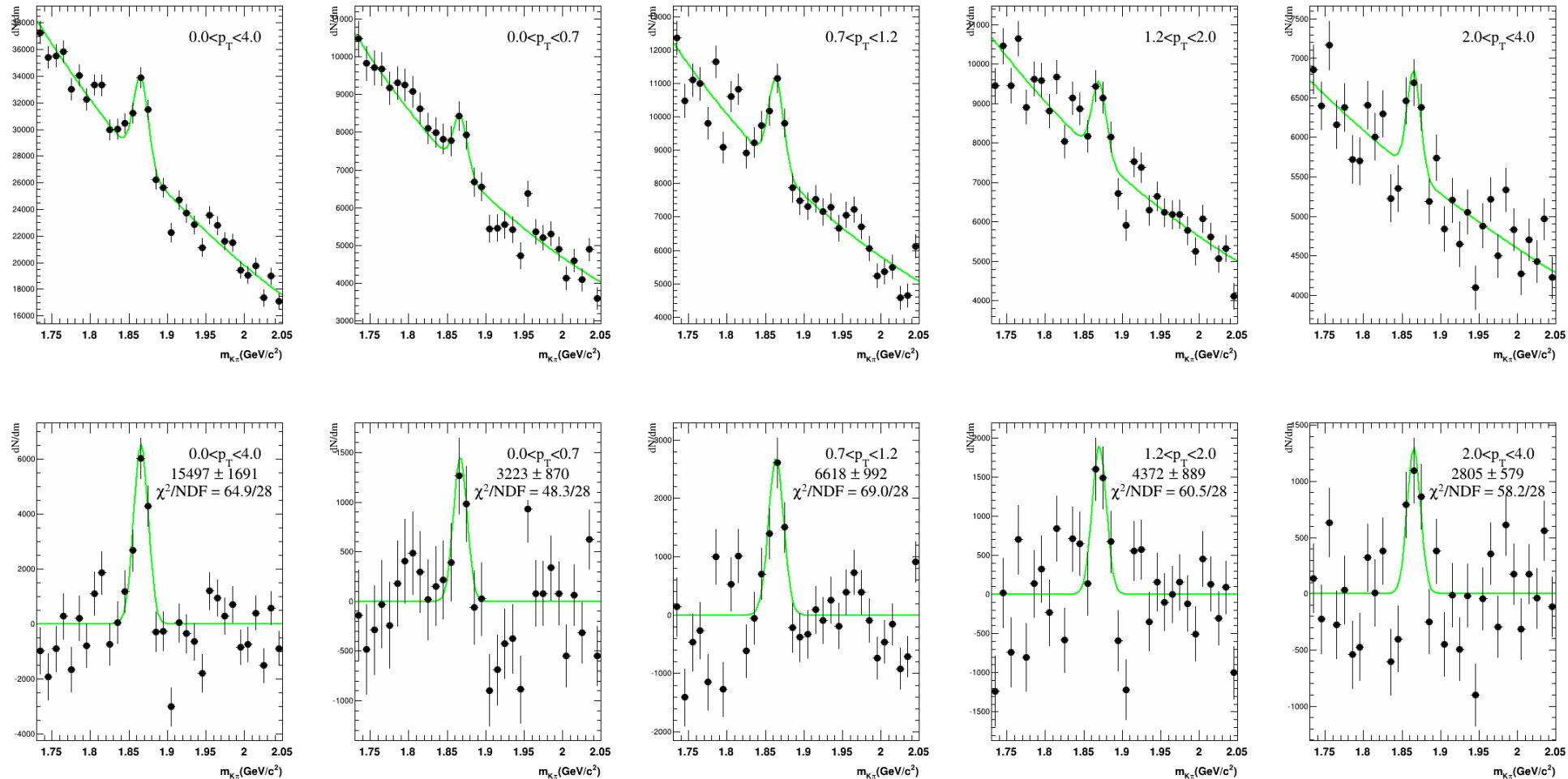
All plots are at

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

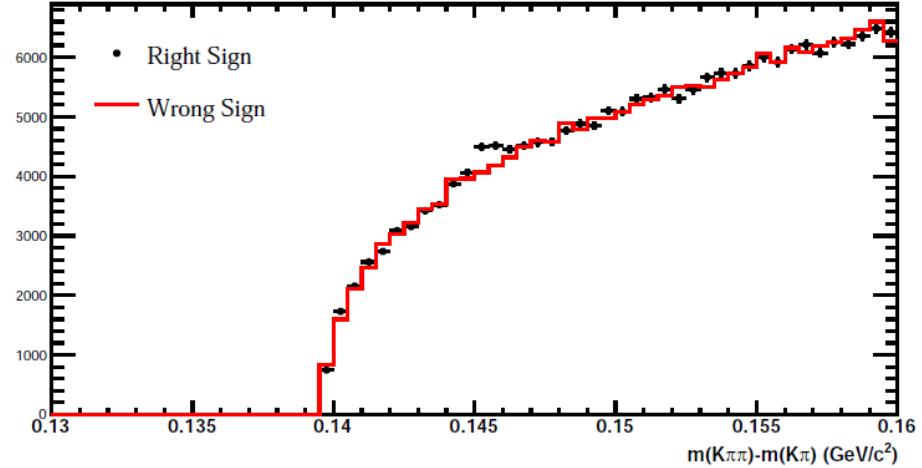
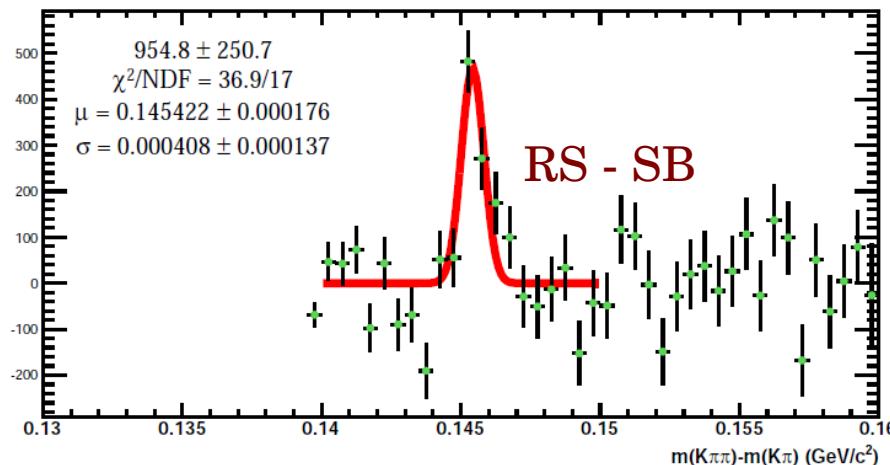
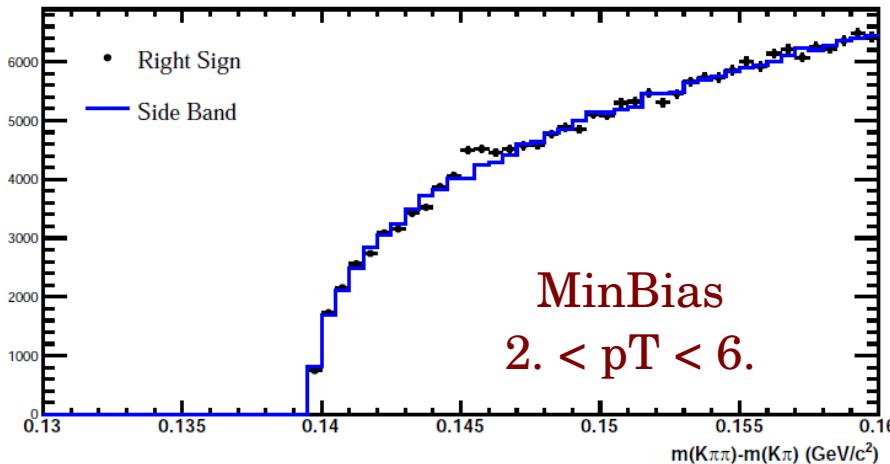


- $D^0 \rightarrow K^- \pi^+$ (BR. 3.88%)
- TOF Kaons.
- Like sign background. (No scaling).
- Free fits: Exp+Gaus.
- $1.83 < m(D^0) < 1.89$
- $|y(D^0)| < 1.0$

D⁰ reconstruction - MinBias



D* reconstruction

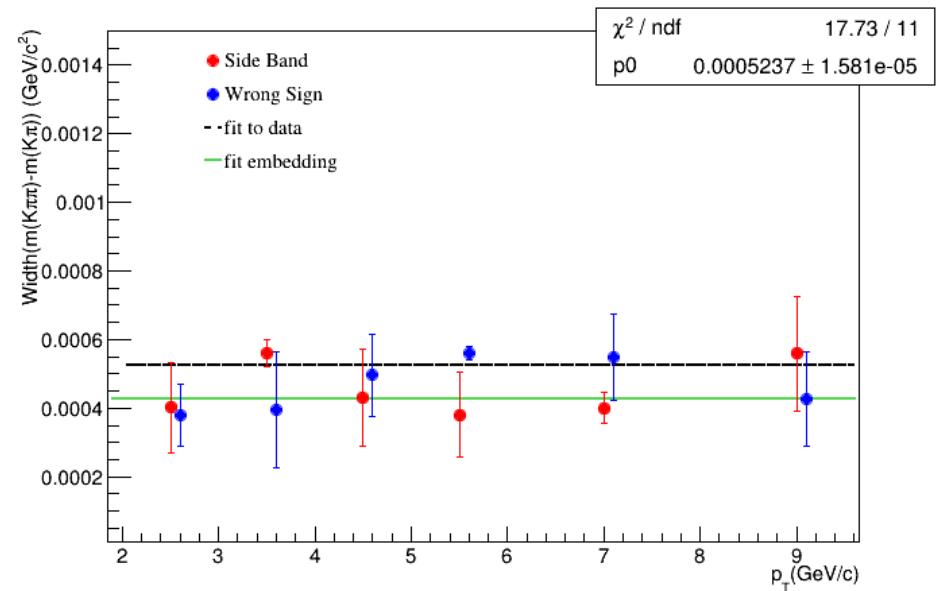
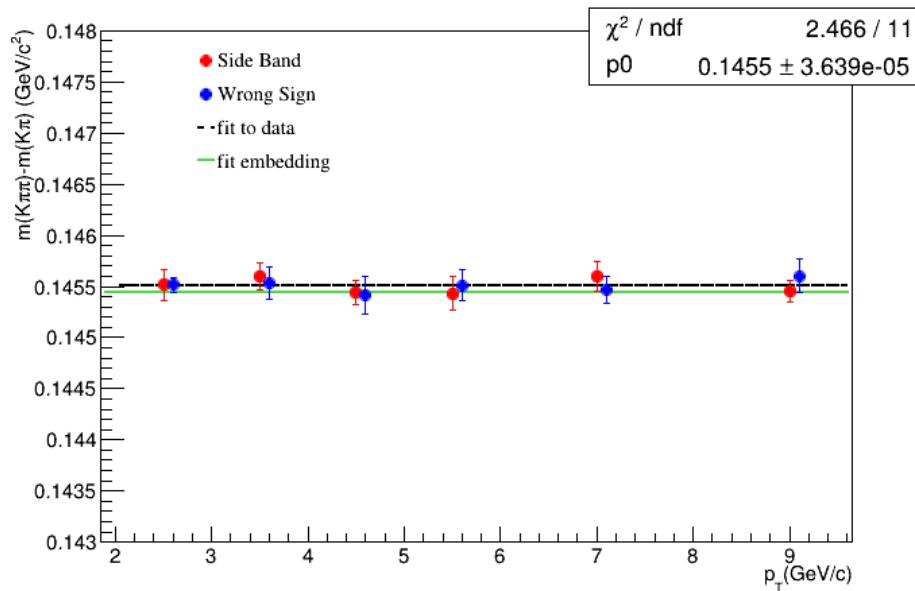


- $D^{*+} \rightarrow D^0 \pi^+ \rightarrow K\pi^+\pi^+$ (BR 67.7% * 3.88%)
- TPC only.
- $1.83 < m(D^0) < 1.9$
- No η on soft pion.
- $7. < pT(D^0)/pT(\text{softPion}) < 20.$
- SB $m(D^0)$: (1.72, 1.8) || (1.92, 2.)
- Fit: Gaus.
- $0.144 < m(D^*) - m(D^0) < 0.147$
- In HT, D^0 Kaon or Pion to fire trigger.

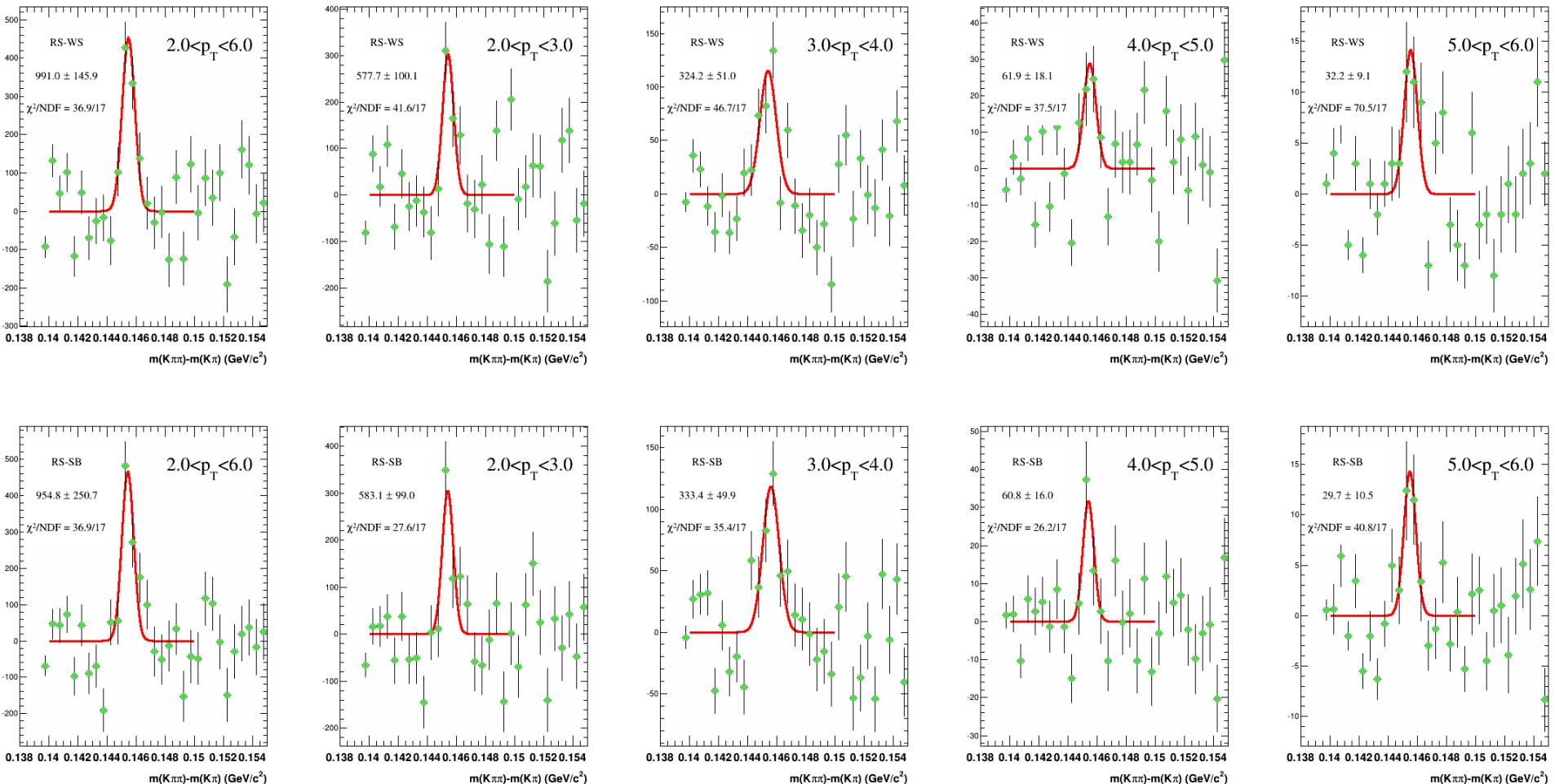
All plots are at <http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/invariant-mass/>

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.

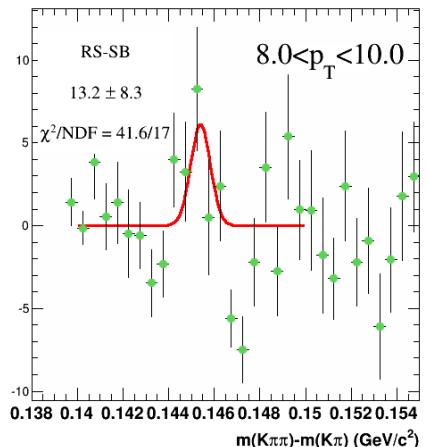
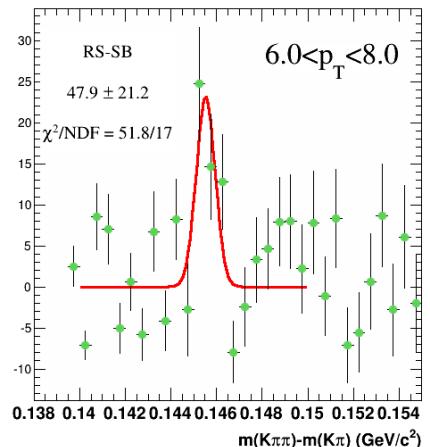
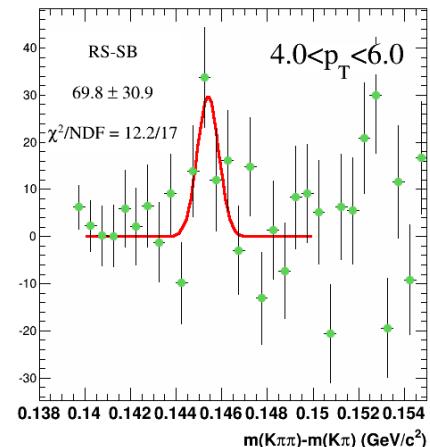
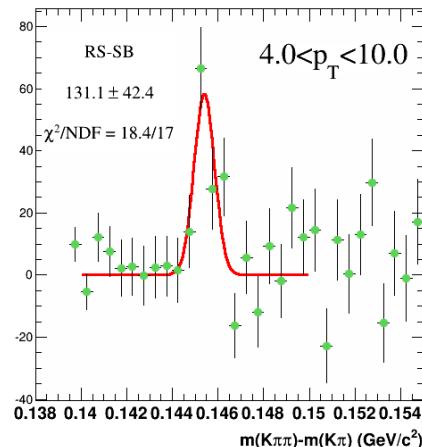
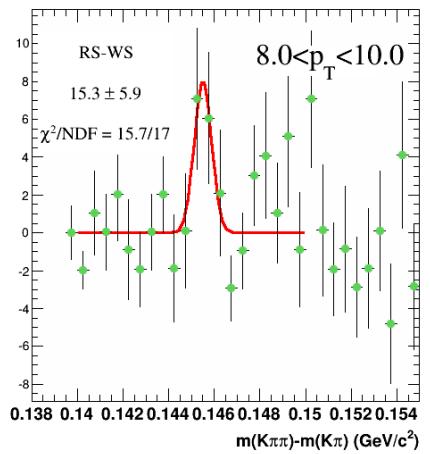
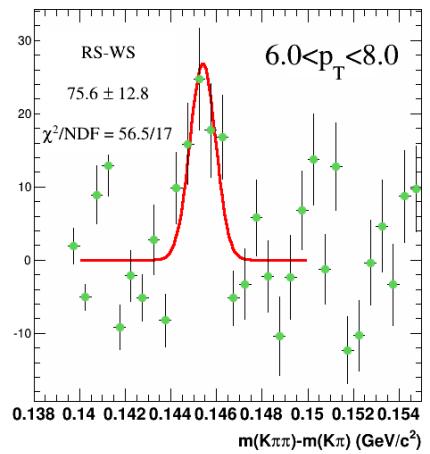
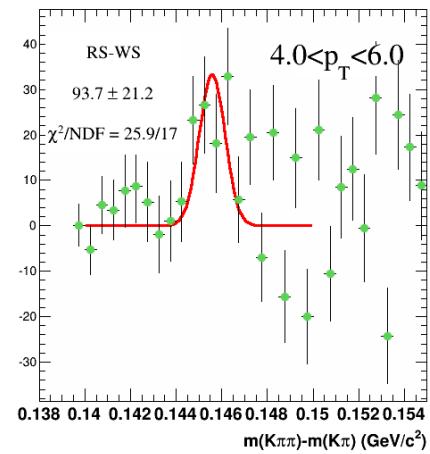
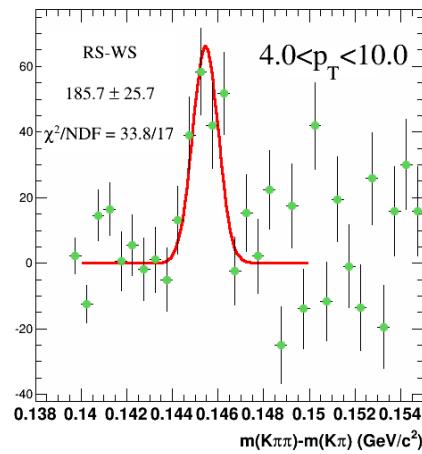


D* reconstruction - MinBias

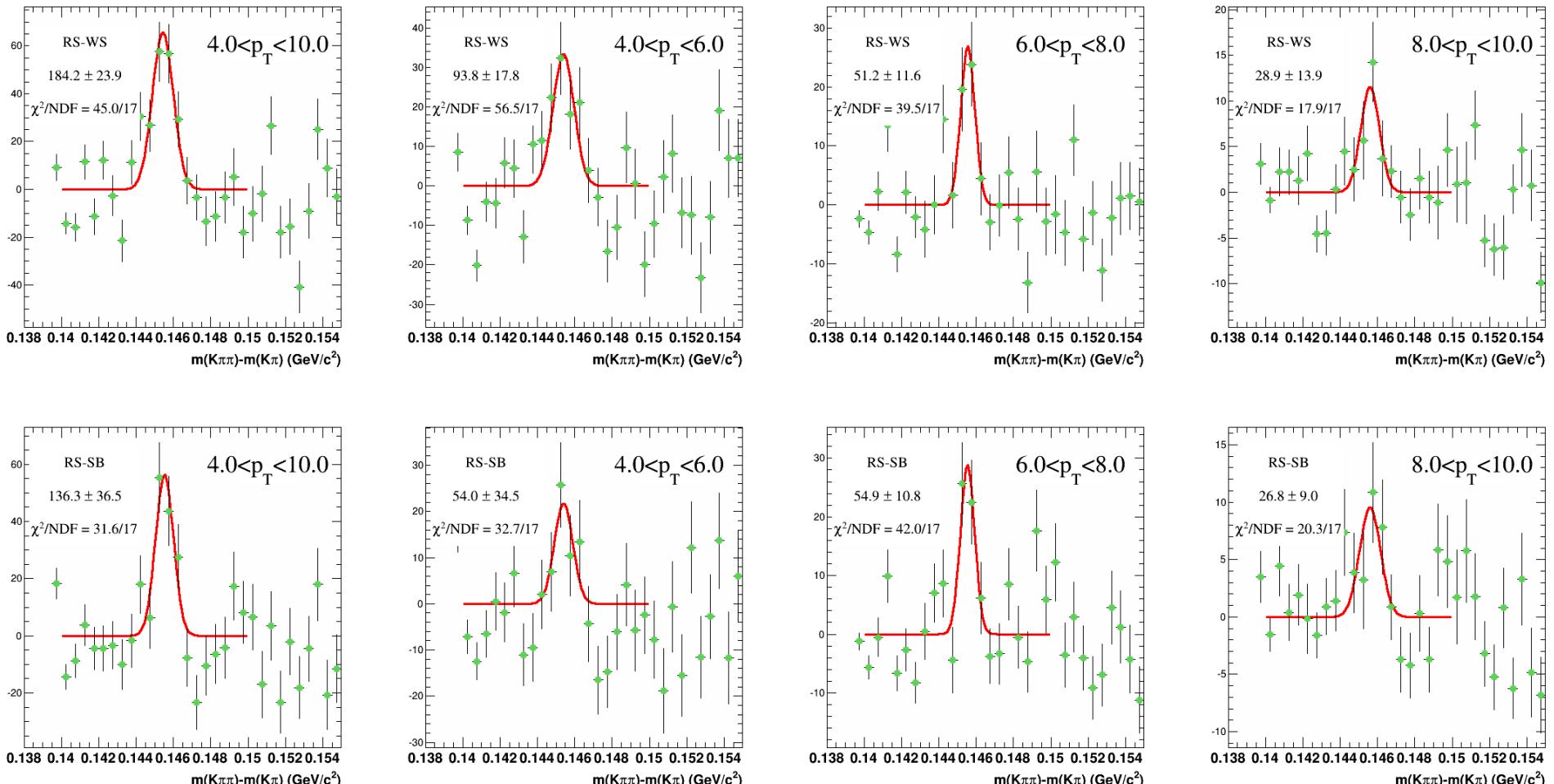


FG and BG plots at <http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/invariant-mass/>

D* reconstruction - HT1



D* reconstruction - HT2



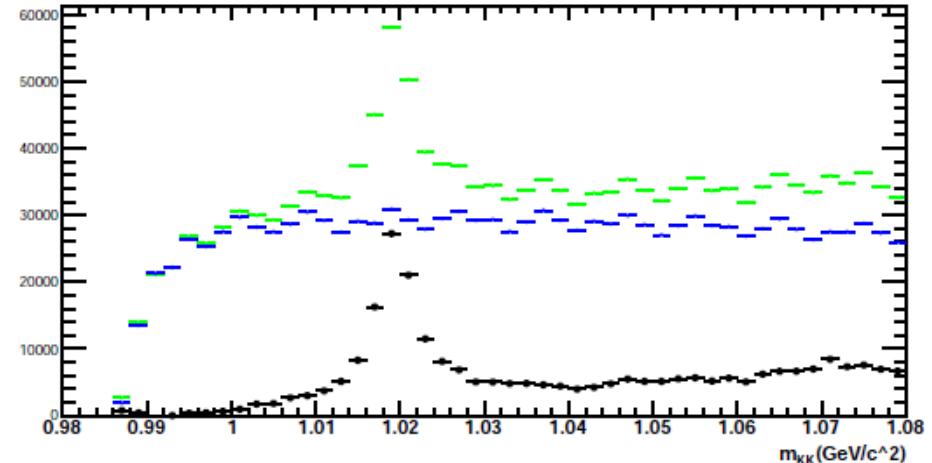
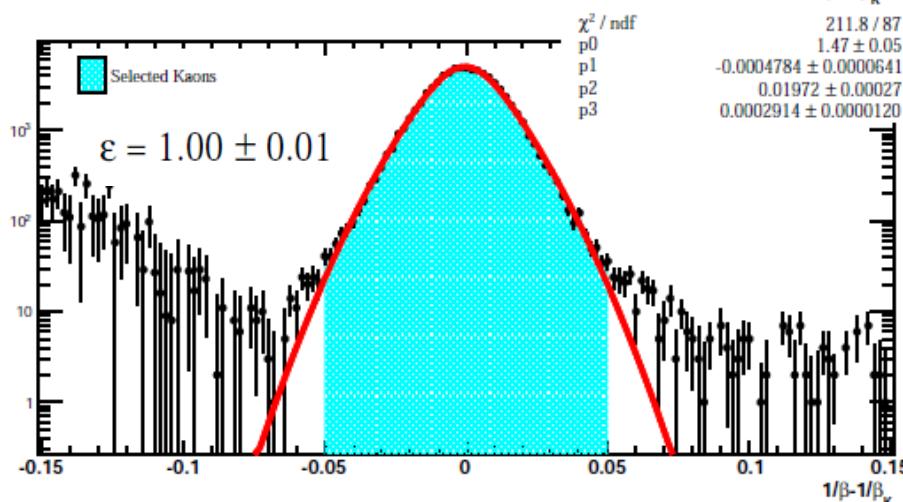
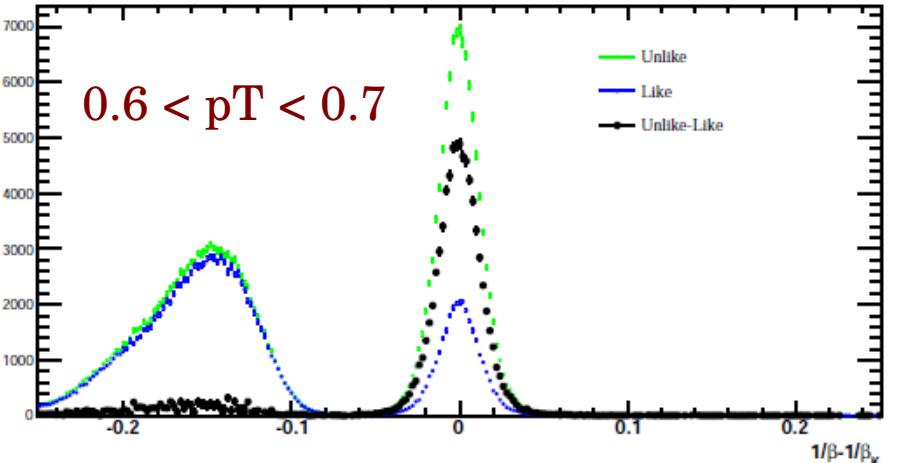
FG and BG plots at <http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/invariant-mass/>

Summary of signal counts:

- Minbias data used to extract $\sim 16k$ 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.

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

TOF Kaon PID

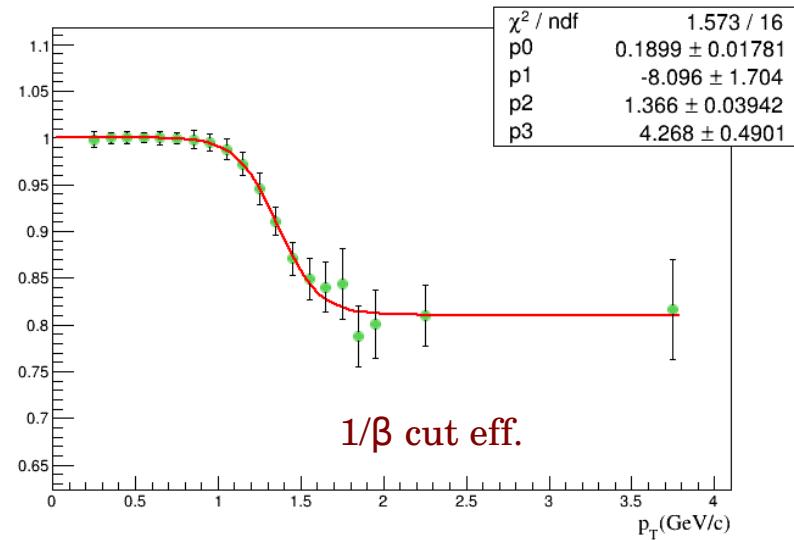
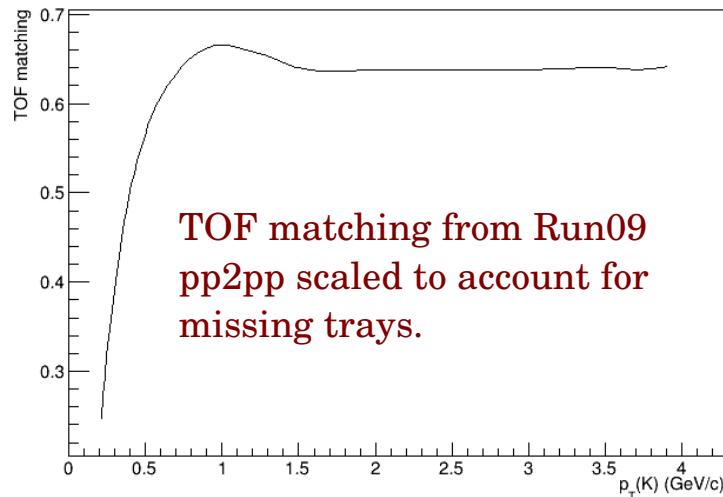


- ϕ is used to select a pure K sample.
- Asymmetric p_T dependent cut on $1/\beta$ is used to reject pions and protons.
- $\text{Gaus}(\mu, \sigma)/((x-\mu)^2 + c)$ is used to fit the signal.

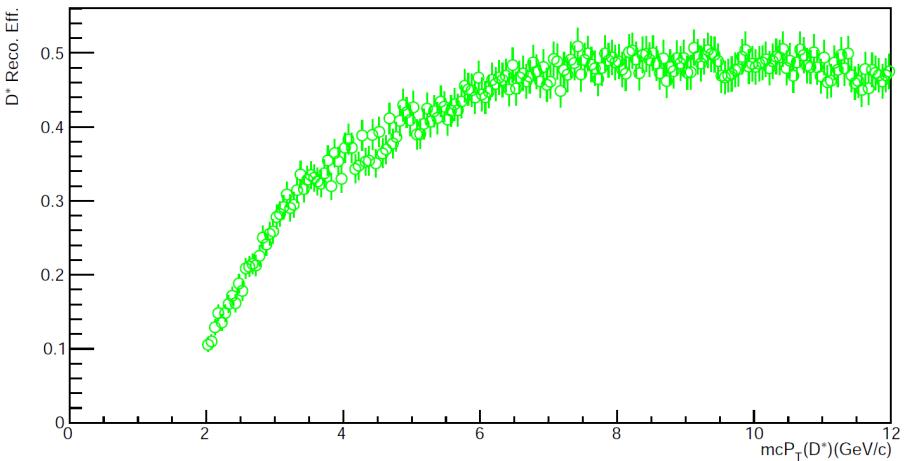
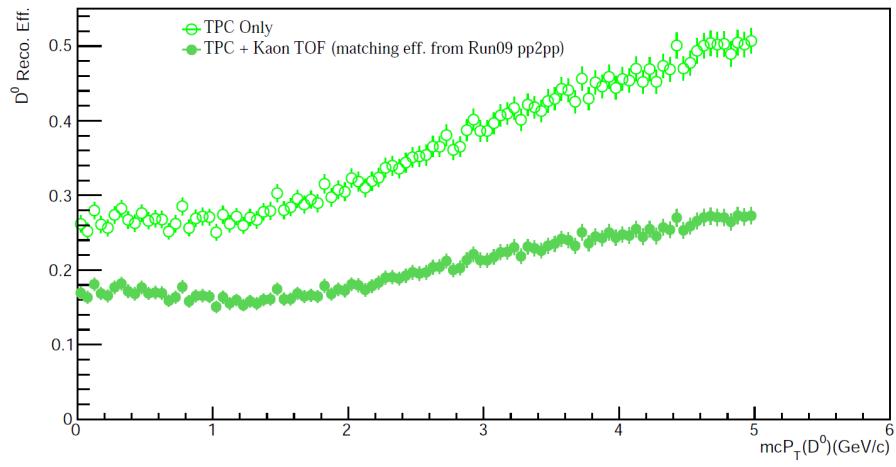
All plots are at:

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

Reconstruction efficiency:

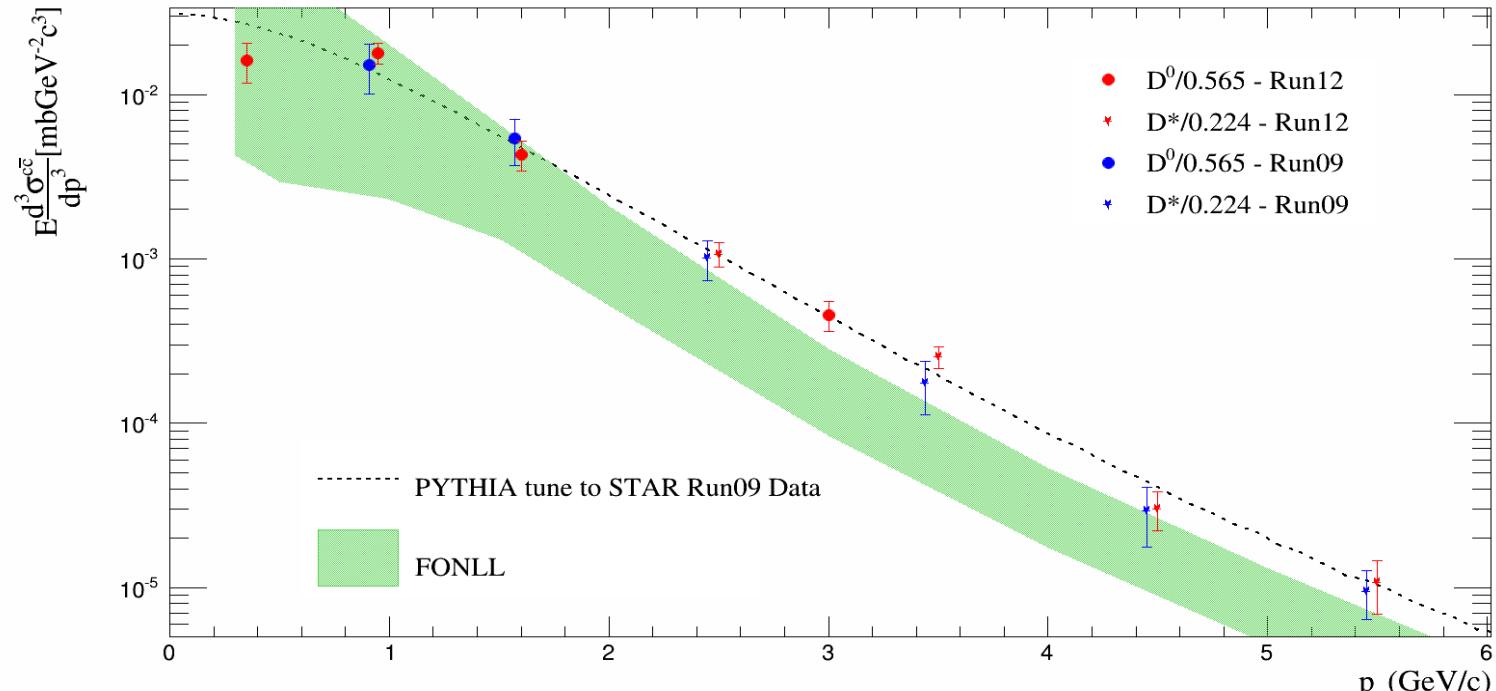


Reconstruction efficiency:



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

Cross-section (Minimum-Bias):



Published (Run09):

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

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

Run12:

$$\frac{d\sigma}{dy} = 154 \pm 13(\text{stat}) \mu\text{b.}$$

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

Summary:

- We have measured charm differential cross-section down to transverse-momentum 0 GeV/c.
- Work is ongoing to extend our measurement to 10 GeV/c using high E_T triggered data.
- Potentially, charm total cross-section will be significantly constrained (factor of ~2 compared to our previously published result).

To do:

0 – Get spectra at high p_T with Hao's trigger efficiency.

1 – D^0/\bar{D}^0 ratio.

2 – Fix Kaons TOF cut.

3 – Bin shift correction.

4 – Systematics.

5 – Double counting estimates.

6 – Data QA.

Backup slides

STAR published results

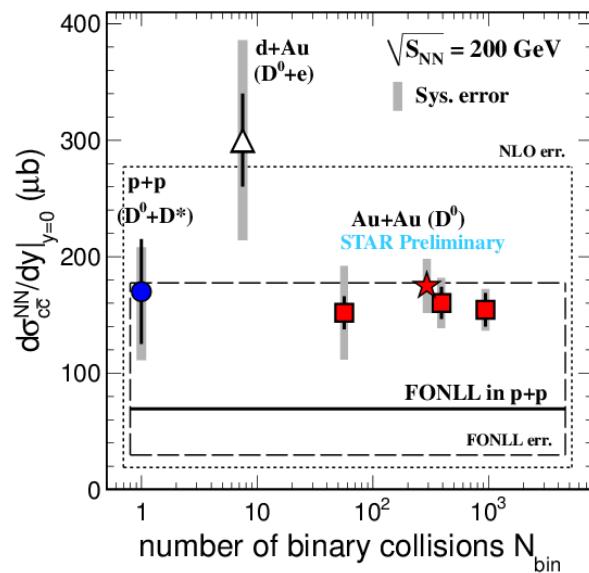
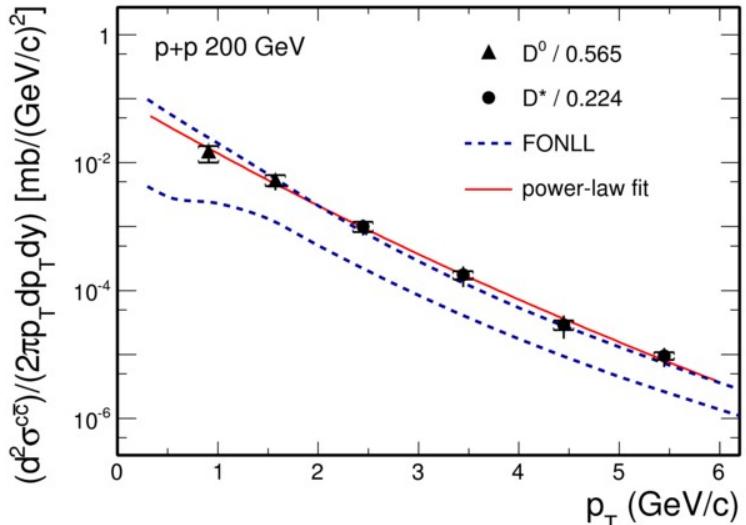
- Used $\sim 100\text{e}6$ VPDMB events (Run09).
- $\sim 70\%$ of TOF was installed.
- Charm cross-section

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

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

STAR Run12 events:

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



Run12 pp200GeV events counts

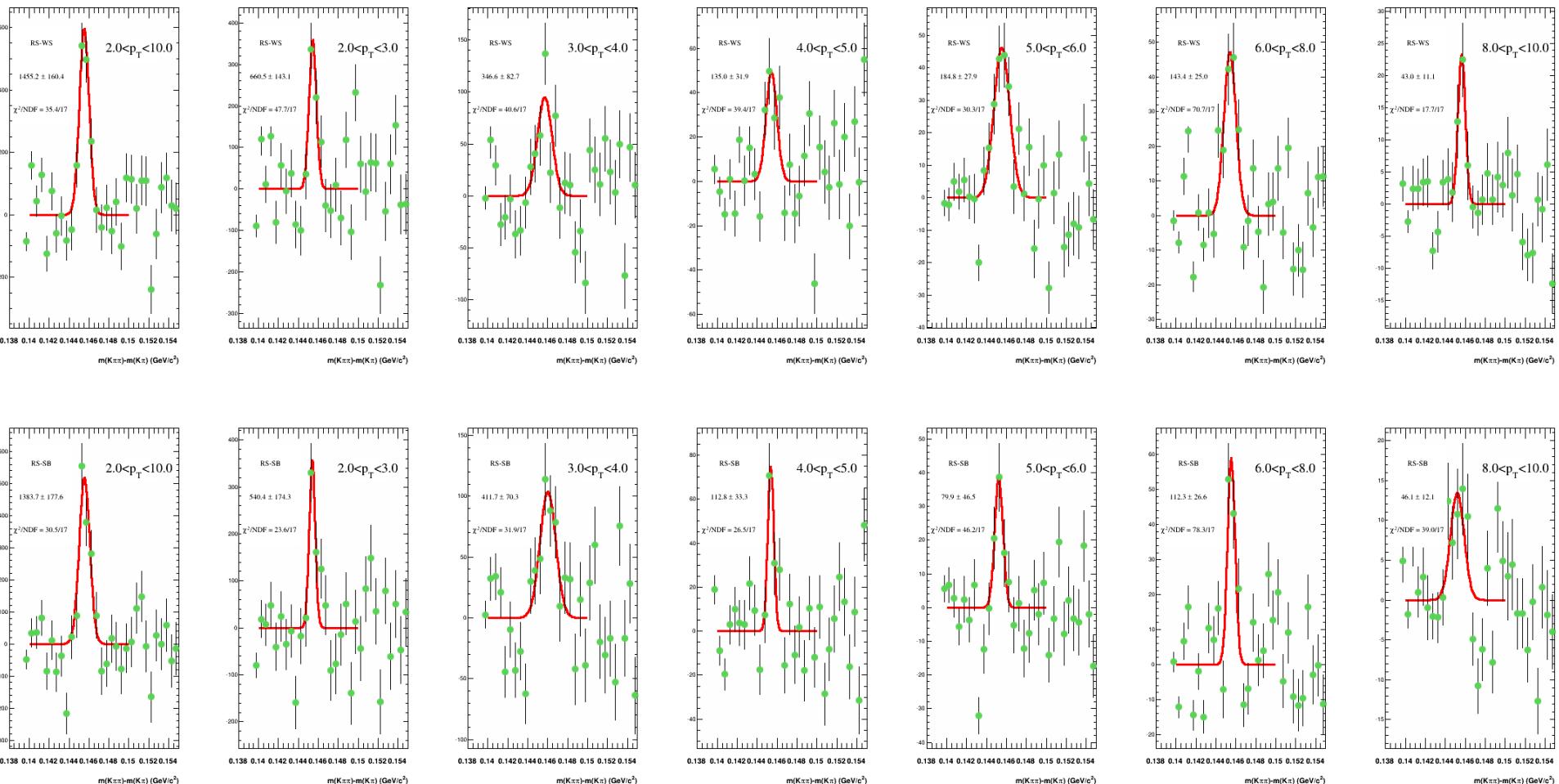
Trigger	ID	L(pb^-1) from Jamie's tables	N_evt before cuts x10^6	N_evt after cuts x10^6	
VPDMB	370001 370011	0.029	677	343	
HT0*BBCMB*TOF0	370542	1.371	35.9	31.8	0.1*
HT0*VPDMB	370501	0.398	8.7	8.1	
HT1*BBCMB*TOF0	370546	9.422	40.0	35.3	3.5*
HT1*VPDMB	370511	2.932	9.9	9.3	
HT2	370531	24.575	46.7	39.5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

* Shared cells are common events.

Event cuts:

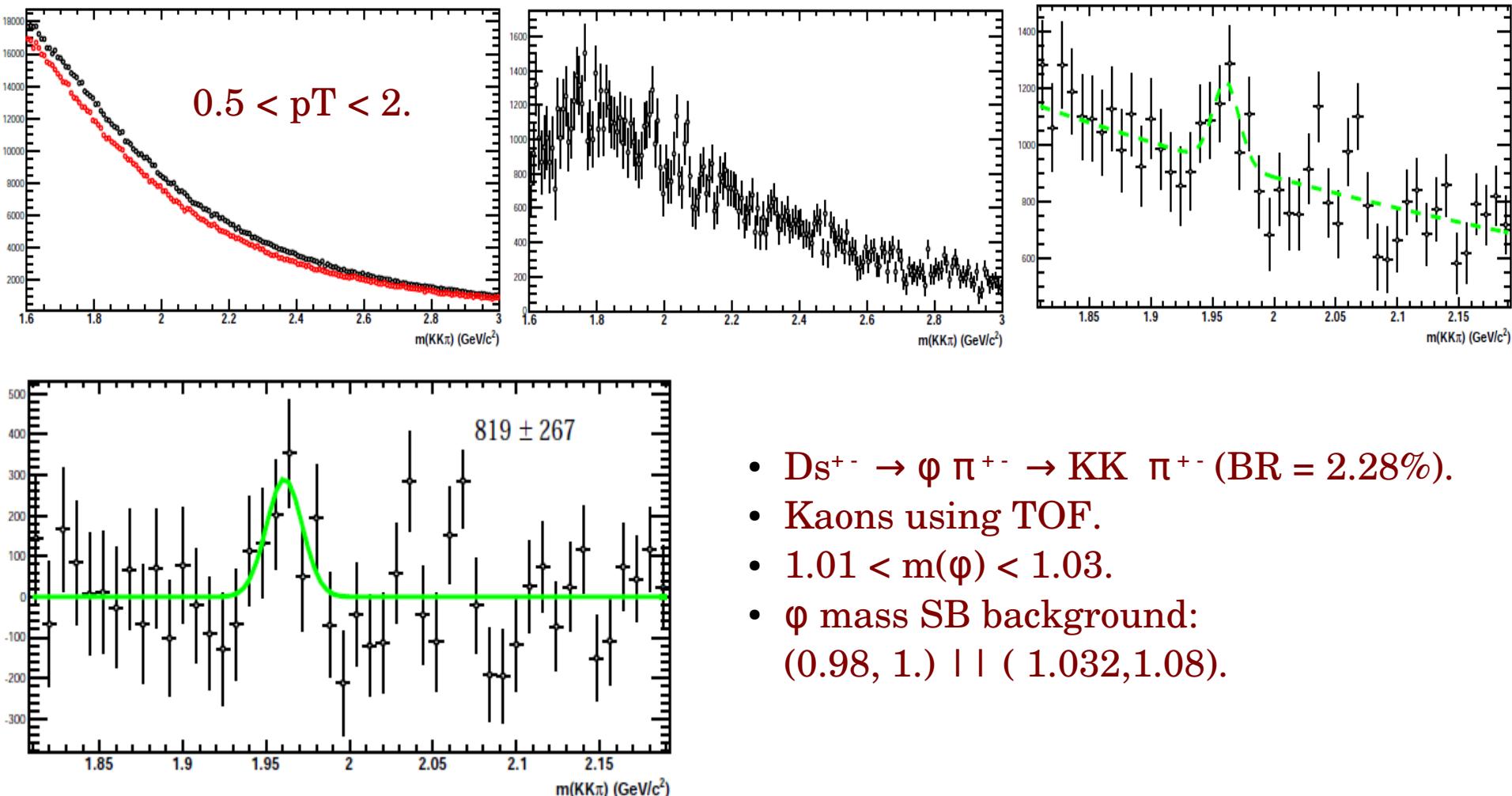
- $|Vz| < 100\text{cm}$.
- Ranking > 0
- $|Vz - Vz_{VPD}| < 6\text{ cm}$ for VPDMB only.

D* reconstruction - MinBias+HT1+HT2

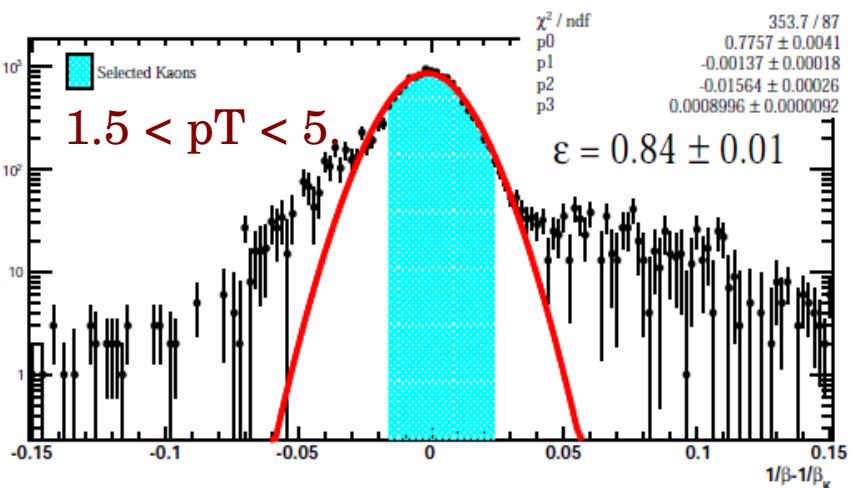
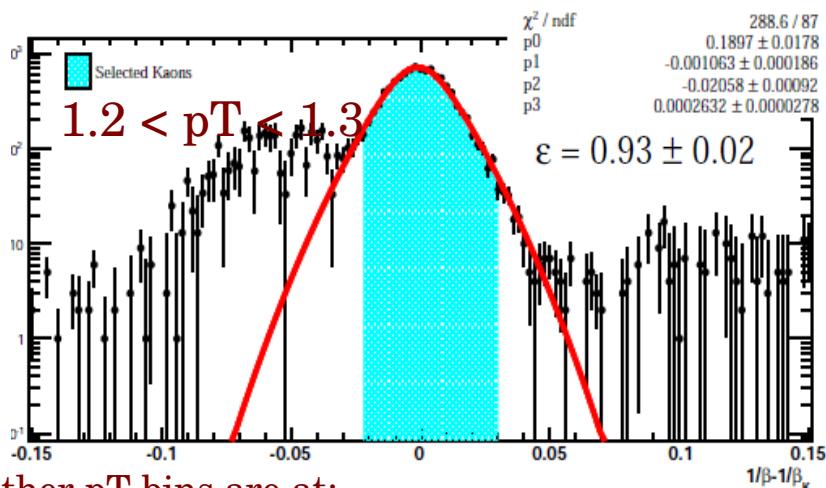
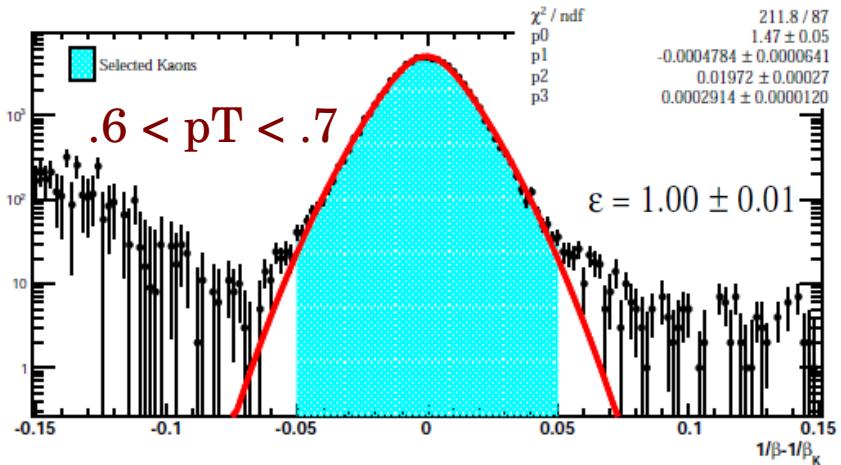
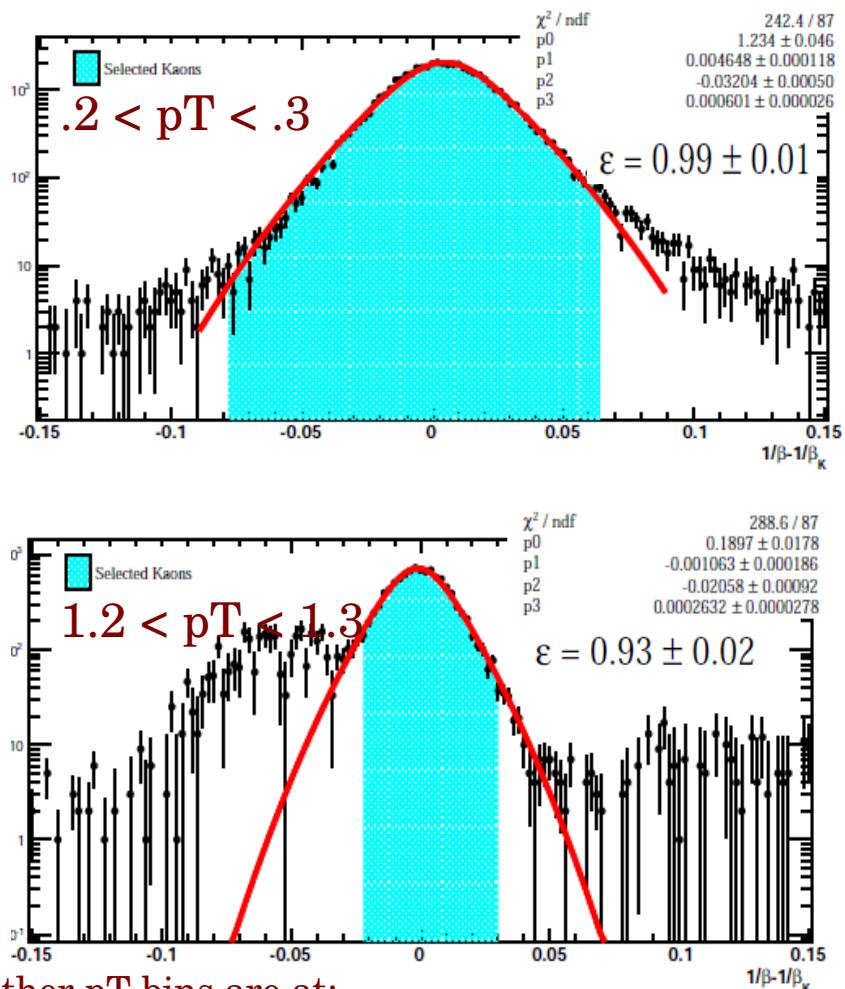


FG and BG plots at <http://portal.nersc.gov/project/star/mustafa/pp200Run12Dmesons/invariant-mass/>

Ds reconstruction - MinBias



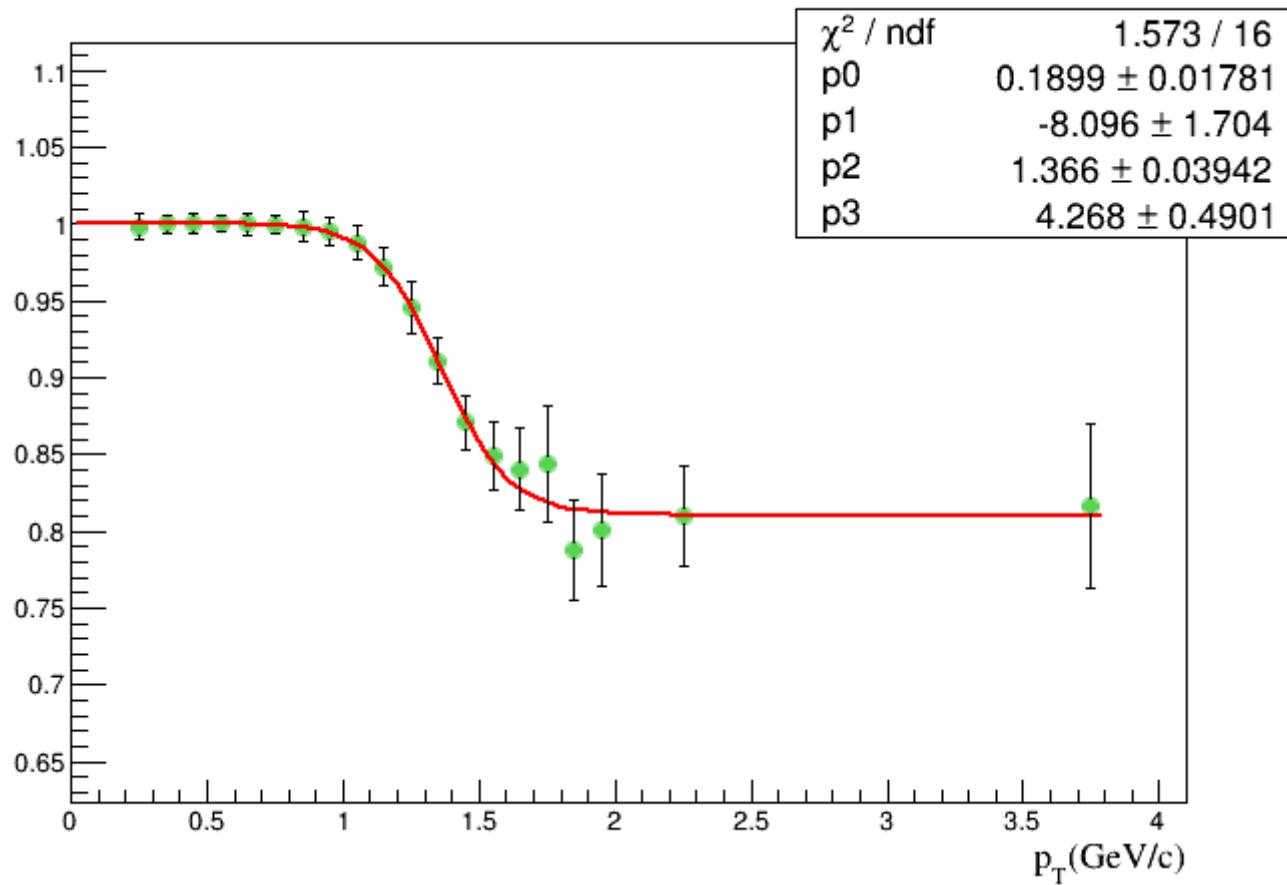
TOF Kaon PID



Other pT bins are at:

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

TOF Kaon PID



Embedding requests:

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