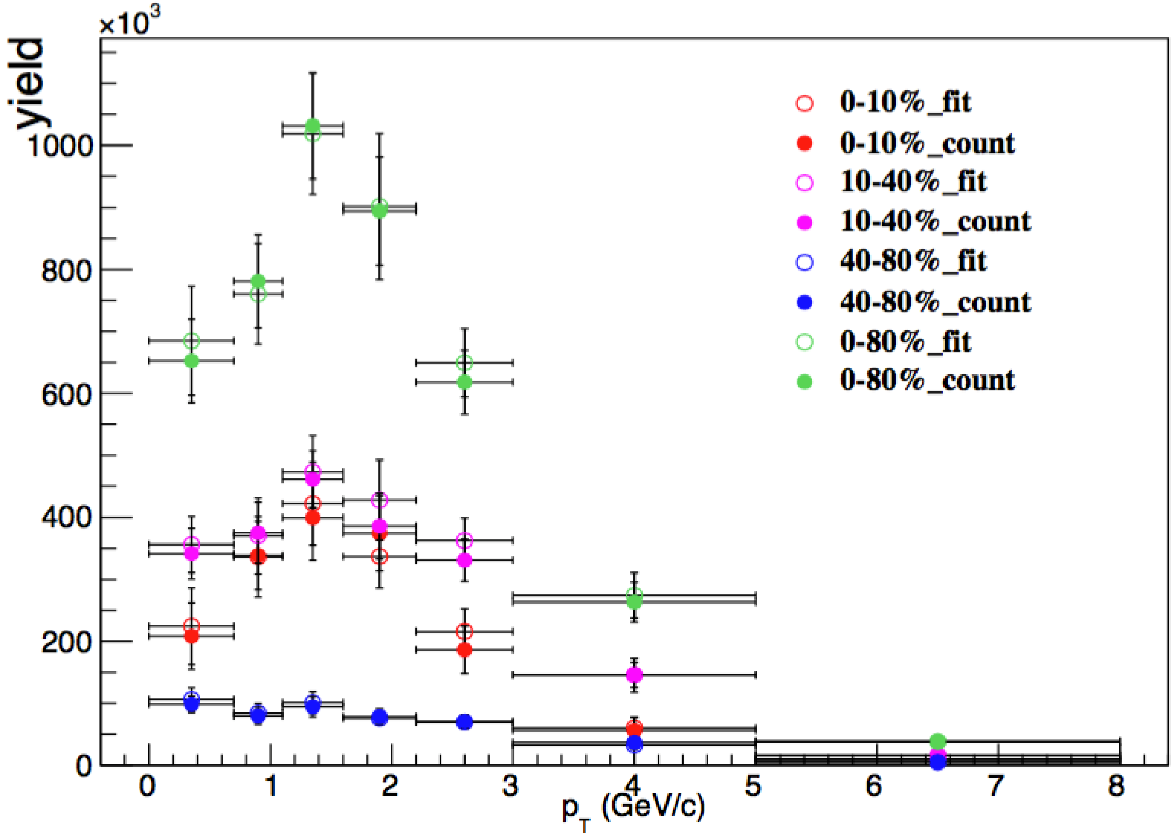
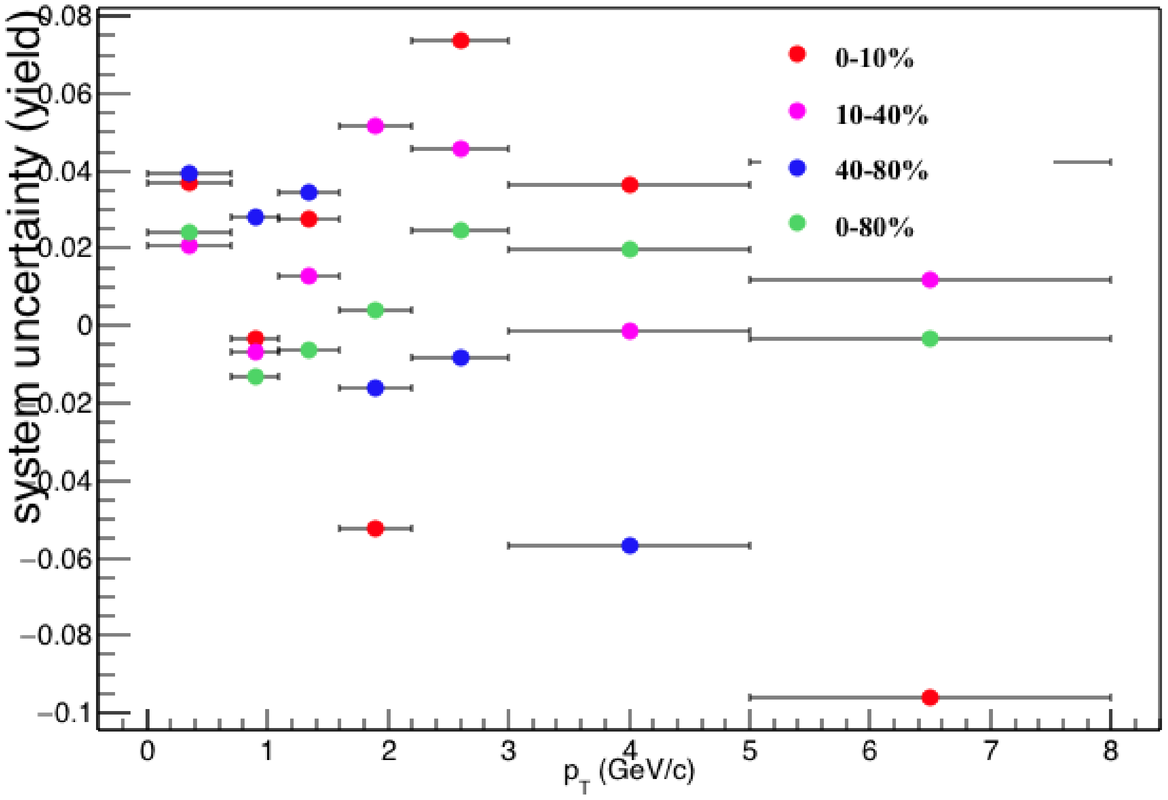
Some problems check in Isobar

2022.4.11

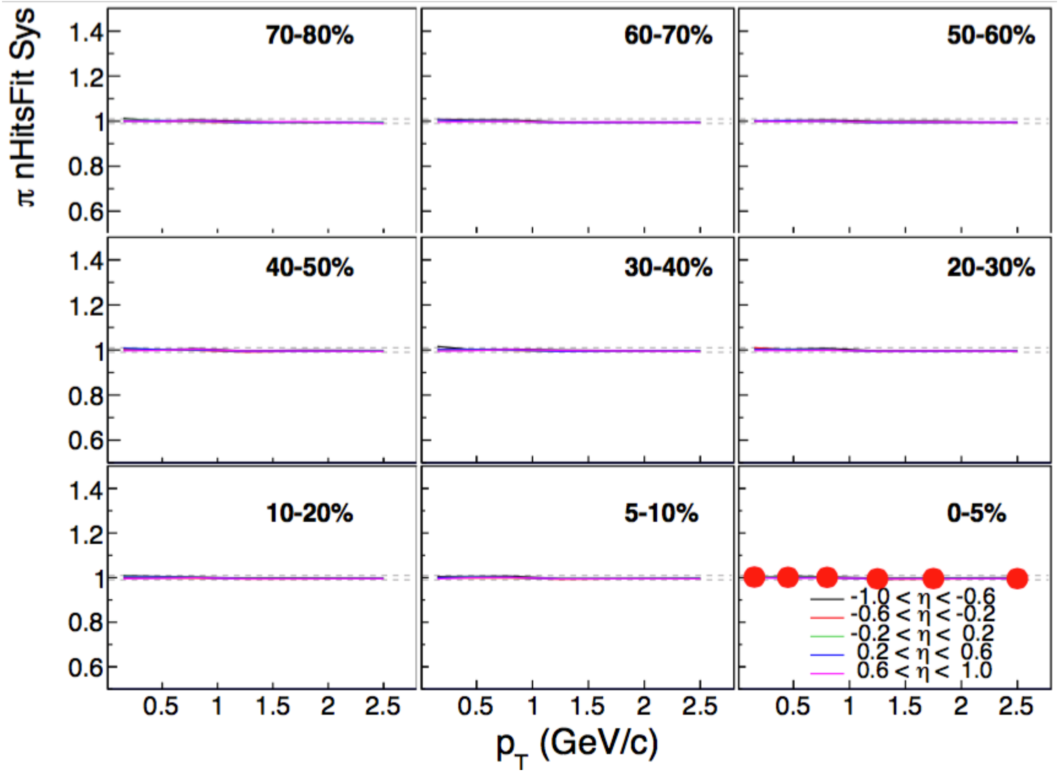
bin-by-bin raw yield extraction sys. uncertainty

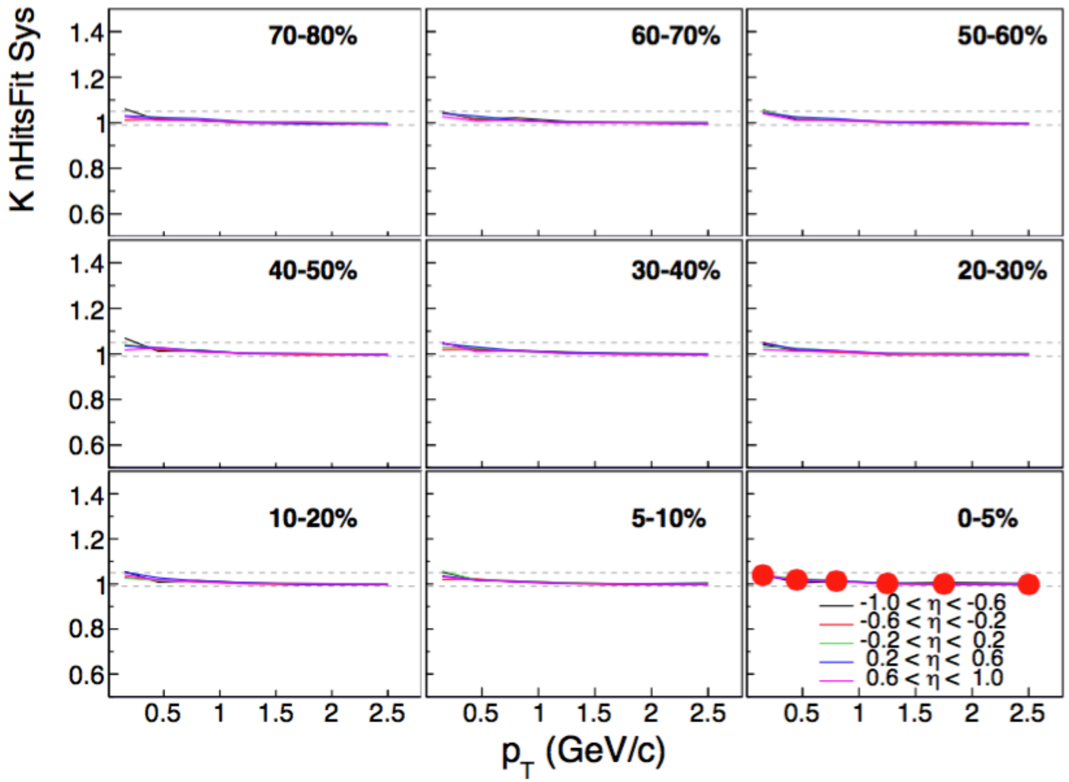




0.5%-8%

the efficiency correction sys. Uncertainty-TPC tracking





$$R(nHitsFit) = \frac{N_{data}(nHitsFit > 15)/N_{data}(nHitsFit > 20)}{N_{emb}^{MC}(nHitsFit > 15)/N_{emb}^{MC}(nHitsFit > 20)}$$

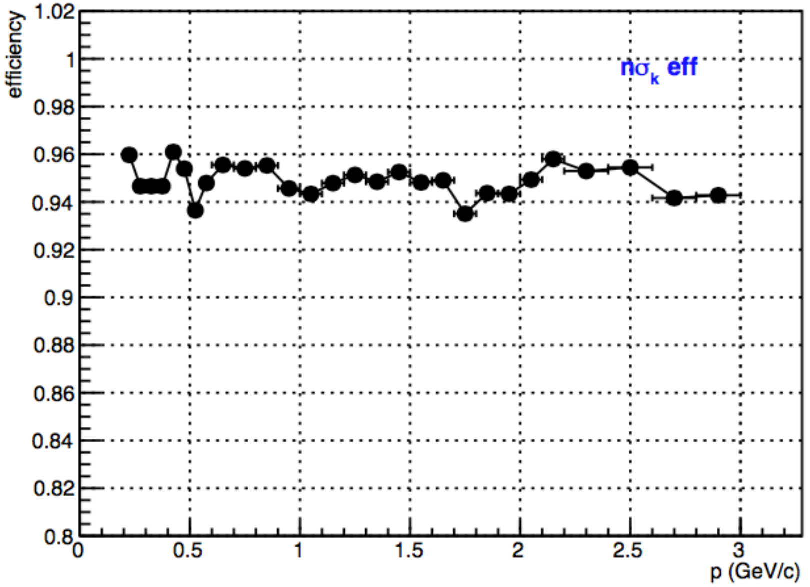
(-1%, 5%) for Kaon ±1% for Pion

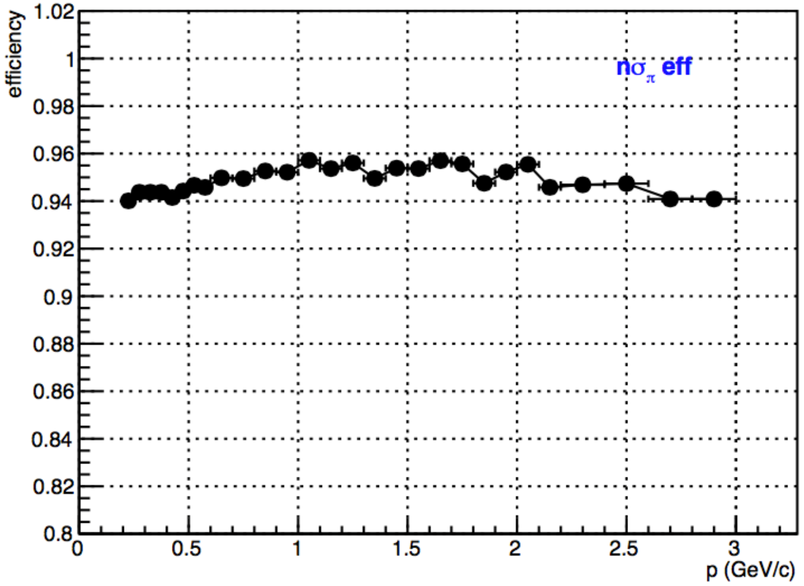
$$R(DCA) = \frac{N_{data}(DCA < 2)/N_{data}(DCA < 3)}{N_{emb}^{MC}(DCA < 2)/N_{emb}^{MC}(DCA < 3)}$$

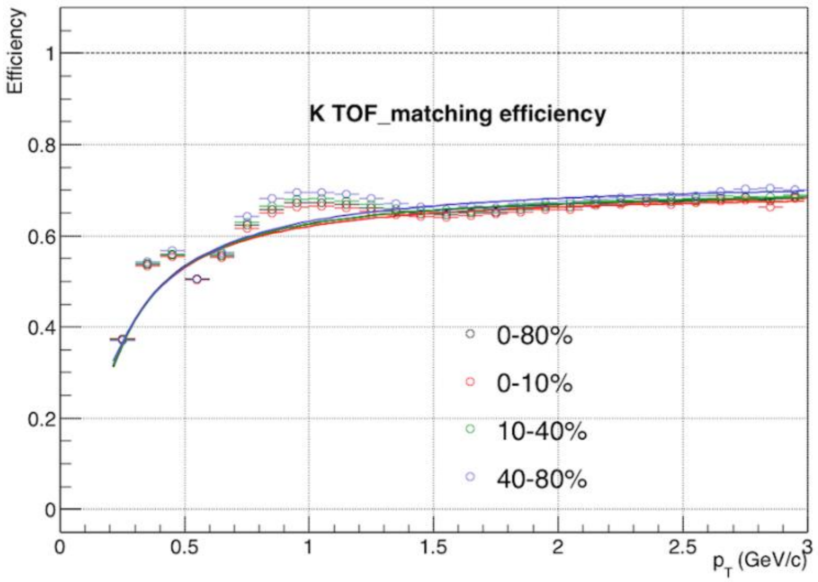
~0 primary tracks, so its effect is negligible.

PID efficiency and TOF matching efficiency

For isobar analysis, hybrid PID is the best method at present. So other methods should not be used to calibrate sys. uncertainty.







$\pm 1\%$

$\pm 1\%$

Pt<1.6 $\frac{0.6982-0.6758}{0.6982} \sim \pm 3\%$

N_{coll}

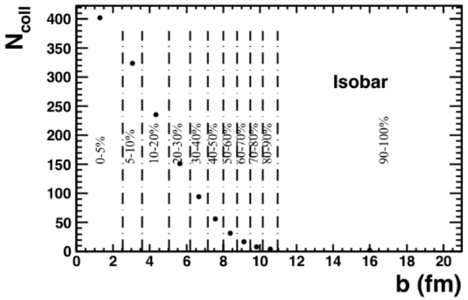
TABLE III. Centrality definition by $N_{trk}^{offline}$ ranges (efficiency-uncorrected multiplicity in the TPC within $|\eta| < 0.5$) in Ru+Ru and Zr+Zr collisions at $\sqrt{s_{NN}}$ =200 GeV. The first column is the centrality range labels we use throughout the paper. The two centrality columns are the actual centrality ranges which are slightly different because of integer edge cuts used for the centrality determination. The mean $\langle N_{trk}^{offline} \rangle$ values, the mean number of participants ($\langle N_{part} \rangle$), and the mean number of binary collisions ($\langle N_{coll} \rangle$) are also listed. The statistical uncertainties on $\langle N_{trk}^{offline} \rangle$ are all significantly smaller than 0.01. The uncertainties on $\langle N_{part} \rangle$ and $\langle N_{coll} \rangle$ are systematic.

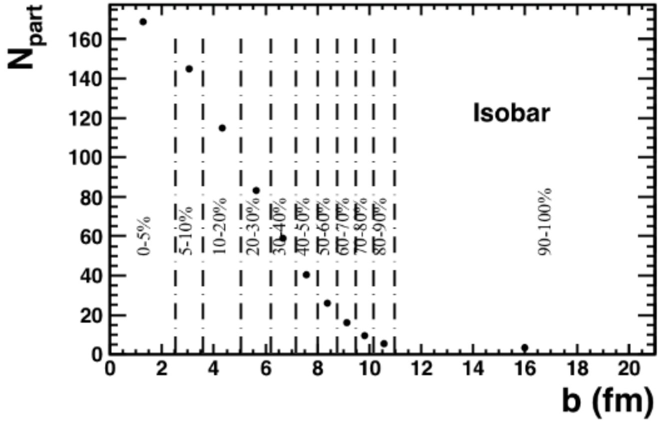
Centrality	Ru+Ru					Zr+Zr				
label (%)	Centrality(%)	$N_{trk}^{offline}$	$\langle N_{trk}^{offline} \rangle$	$\langle N_{part} \rangle$	$\langle N_{coll} \rangle$	Centrality(%)	$N_{trk}^{offline}$	$\langle N_{trk}^{offline} \rangle$	$\langle N_{part} \rangle$	$\langle N_{coll} \rangle$
0–5	0–5.01	258.–500.	289.32	166.8±0.1	389±10	0–5.00	256.–500.	287.36	165.9±0.1	386±10
5–10	5.01–9.94	216.–258.	236.30	147.5±1.0	323±5	5.00–9.99	213.–256.	233.79	146.5±1.0	317±5
10–20	9.94–19.96	151.–216.	181.76	116.5±0.8	232±3	9.99–20.08	147.–213.	178.19	115.0±0.8	225±3
20–30	19.96–30.08	103.–151.	125.84	83.3±0.5	146±2	20.08–29.95	100.–147.	122.35	81.8±0.4	139±2
30–40	30.08–39.89	69.–103.	85.22	58.8±0.3	89.4±0.9	29.95–40.16	65.–100.	81.62	56.7±0.3	83.3±0.8
40–50	39.89–49.86	44.–69.	55.91	40.0±0.1	53.0±0.5	40.16–50.07	41.–65.	52.41	38.0±0.1	48.0±0.4
50–60	49.86–60.29	26.–44.	34.58	25.8±0.1	29.4±0.2	50.07–59.72	25.–41.	32.66	24.6±0.1	26.9±0.2
60–70	60.29–70.04	15.–26.	20.34	15.83±0.03	15.6±0.1	59.72–70.00	14.–25.	19.34	15.10±0.03	14.3±0.1
70–80	70.04–79.93	8.–15.	11.47	9.34±0.02	8.03±0.04	70.00–80.88	7.–14.	10.48	8.58±0.02	7.12±0.04
20–50	19.96–49.86	44.–151.	89.50	60.9±0.3	96.7±1.0	20.08–50.07	41.–147.	85.68	58.9±0.3	90.3±0.9

Centrality definition for isobars: Case 1

Ru-96	R=5.085 fm	a=0.46 fm	beta2=0.158
Zr-96	R=5.02 fm	a=0.46 fm	beta2=0.08

	Zr		Ru	
16 Bins	High bin	Low bin	High bin	Low bin
0-5%	500	259	500	260
5-10%	258	217	259	218
10-15%	216	182	217	183
15-20%	181	153	182	153
20-25%	152	127	152	128
25-30%	126	106	127	106
30-35%	105	87	105	87
35-40%	86	71	86	71
40-45%	70	57	70	58
45-50%	56	46	57	46
50-55%	45	36	45	37
55-60%	35	28	36	29
60-65%	27	22	28	22
65-70%	21	17	21	17
70-75%	16	13	16	13
75-80%	12	8	12	9





Global sys. uncertainty, isobar is much less than AuAu.

	RuRu		ZrZr		Isobar	
	$< N_{coll} >$	$< N_{part} >$	$< N_{coll} >$	$< N_{part} >$	$< N_{coll} >$	$< N_{part} >$
0-10%	379.21±8.55	163.94±0.17	375.80±8.55	163.03±0.17	377.51±6.05	163.49±0.12
10-40%	170.55±1.49	92.15±0.40	162.78±1.48	89.95±0.74	166.67±1.05	91.05±0.42
40-80%	33.36±0.21	27.32±0.05	30.13±0.17	25.83±0.05	31.75±0.14	29.54±0.04

sys. uncertainty for D^0 p_T spectra

$\epsilon_{D^0}^{reco} = \epsilon_{Accept} \otimes \epsilon_{Track}$

$\epsilon_{Track} = \epsilon_{TPC} \otimes \epsilon_{PID}$

ϵ_{PID} → $\pm$1% for Kaon, Pion $\epsilon_{n\sigma_X}$; $\pm$3% for ϵ_{TOF} at $p_T < 1.6\text{GeV/c}$

ϵ_{TPC} → (-1%, 5%) for Kaon; ±1% for Pion

$\epsilon_{PID\_clean} = \epsilon_{n\sigma_X} \cdot \epsilon_{TOF} \cdot \epsilon_{\Delta\frac{1}{\beta}}$	3.6~6.1%	$(p_T < 1.6\text{GeV/c})$
$\epsilon_{PID\_hybrid} = \epsilon_{n\sigma_X} \cdot \epsilon_{TOF} \cdot \epsilon_{\Delta\frac{1}{\beta}} + \epsilon_{n\sigma_X} \cdot (1 - \epsilon_{TOF})$	2.8~5.7%	$(p_T > 1.6\text{GeV/c})$

Note: assuming no correlation

$$\frac{d^2 N}{2\pi p_T dp_T dy} = \frac{\Delta N^{raw} / \epsilon_{D^0}^{tot} / 2}{2\pi p_T \Delta p_T \Delta y \times N_{events} \times B.R.}$$

ΔN^{raw}: 0.5%-8%

$B.R.$: $\pm 0.5\%$

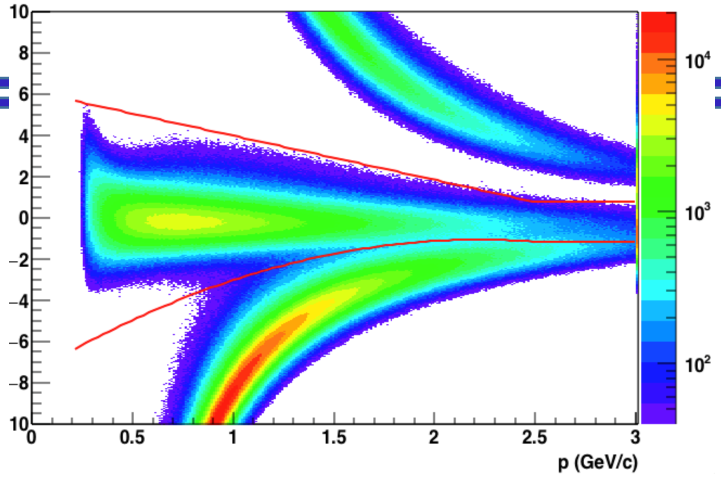
Total:

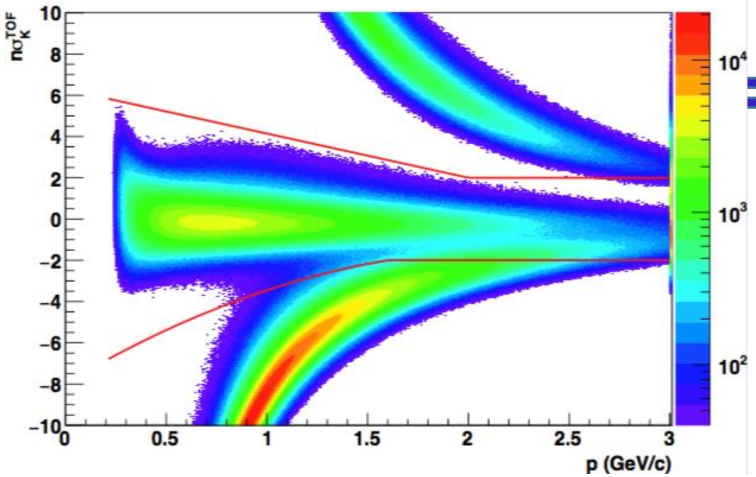
3.7~10.1% $(p_T < 1.6\text{GeV/c})$

2.9~9.8% $(p_T > 1.6\text{GeV/c})$

TODO: correlation efficiency calculation for yield, R_{AA}, R_{cp}.

pp baseline; Double counting





3

```
fPion_up = new TF1("fPion_up", "(x<=1.6)*(5.1-2.143*x)+\(x>1.6)*1.5", 0.2, 20.);
fPion_low = new TF1("fPion_low", "-2.", 0.2, 20.);
fKaon_up = new TF1("fKaon_up", "(x<=2.5)*(6.129-2.143*x)+\(x>2.5)*(1.1)", 0.2, 20.);
Kaon_low = new TF1("fKaon_low", "(x<=2.5)*(-7.54+5.83*x-1.31*x*x)+\(x>2.5)*(-1.1)", 0.2, 20.);
```
1

```
fPion_up = new TF1("fPion_up", "(x<=1.6)*(5.44-2.15*x)+\(x>1.6)*2.0", 0, 20.);
fPion_low = new TF1("fPion_low", "-2.", 0, 20.);
fKaon_up = new TF1("fKaon_up", "(x<=2.0)*(6.286-2.143*x)+\(x>2.0)*(2.0)", 0, 20.);
fKaon_low = new TF1("fKaon_low", "(x<=1.6)*(-7.974400+5.83*x-1.31*x*x)+\(x>1.6)*(-2.0)", 0, 20.);
```

The upper limit of Pion: (x <= 1.6) * (5.1 – 2.143 * x) +\ (x > 1.6) * 1.6712
The lower limit of Pion : -2
The upper limit of Kaon: (x <= 2.5) * (6.129 – 2.143 * x) +\ (x > 2.5) * (0.7715)
The lower limit of Kaon: (x <= 2.5) * (-7.54 + 5.83 * x – 1.31 * x * x) +\ (x > 2.5) * (-1.1525)

2

isGoodEvent: (0-80); (vr<=2);(vz<=30);(vzdiff<=3); (verror)

isGoodTrack: (isPrimary); (pMom,[0.2,40]); (eta<=1); (fab(nhits)>=15); (hitratio[0.52, 1.2]); (fabs(gdca)<=1.5); (hitdedx>=15); |tofylocal|<=1.8

|D0yCut|<=1

Cuts before

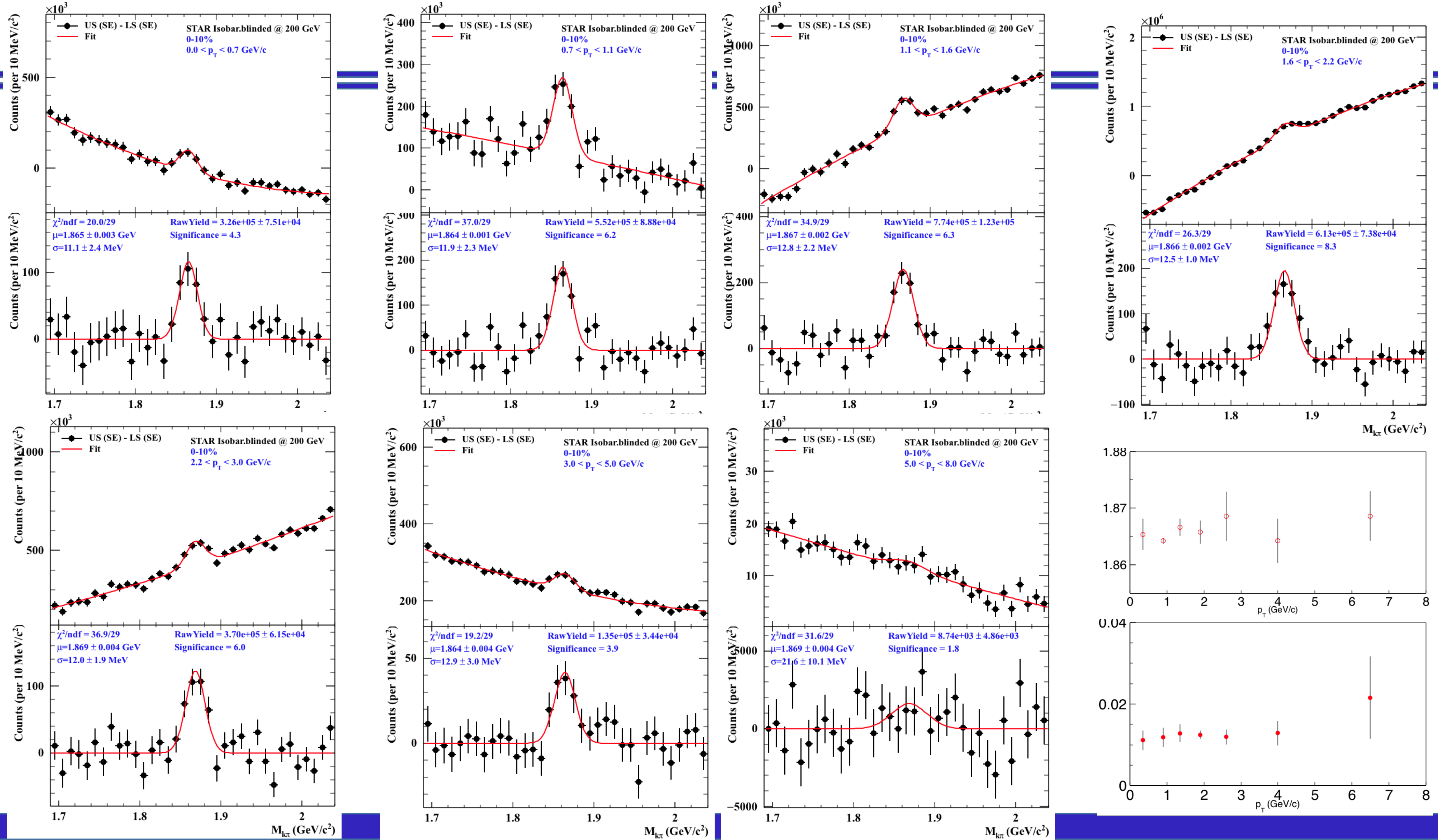
isBadrun && !isgoodtrigger

Event level: (vz(-35, 25)); (vzdiff<=3); (vr<=2); (refmul>=0);(xerr); (!isbadrun && !pileup); (mcent[0,8])

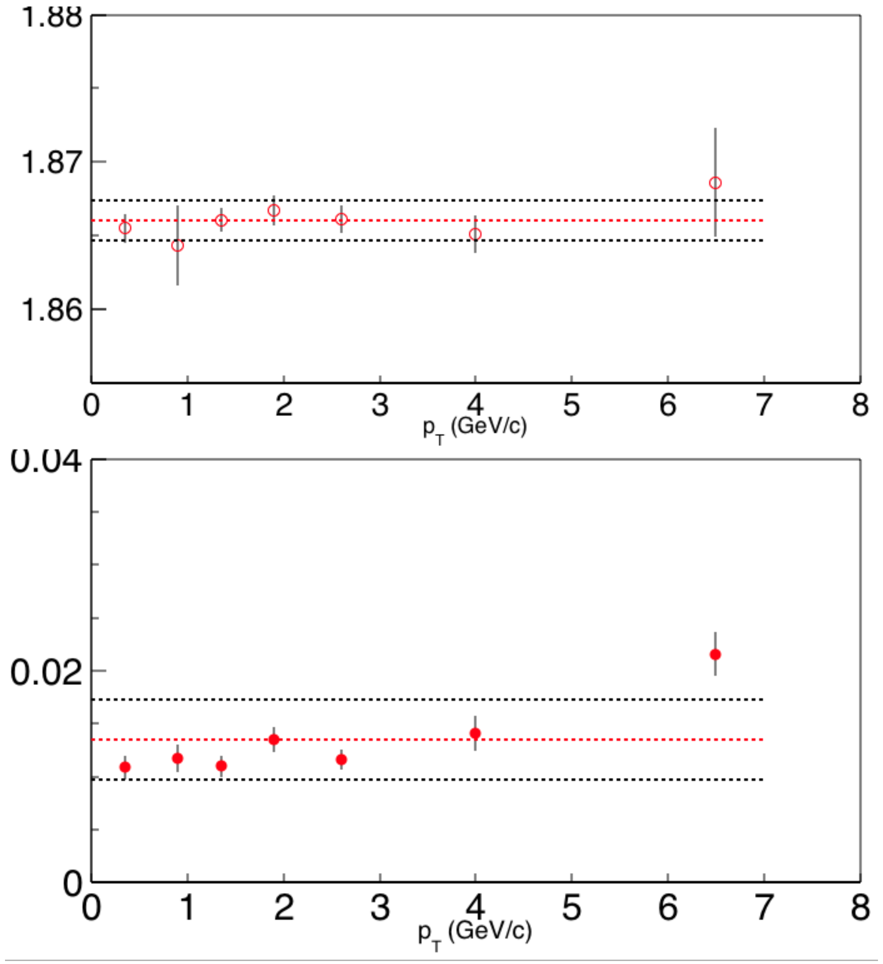
Track level: (isprimary); (pt>0.2); (|gdca|<=2.0); (|eta|<1.0); (|hitfit|>=20); (fitration[0.52, 1.2]); (hitdedx>10);
(|charge|=1)

|D0y|<1

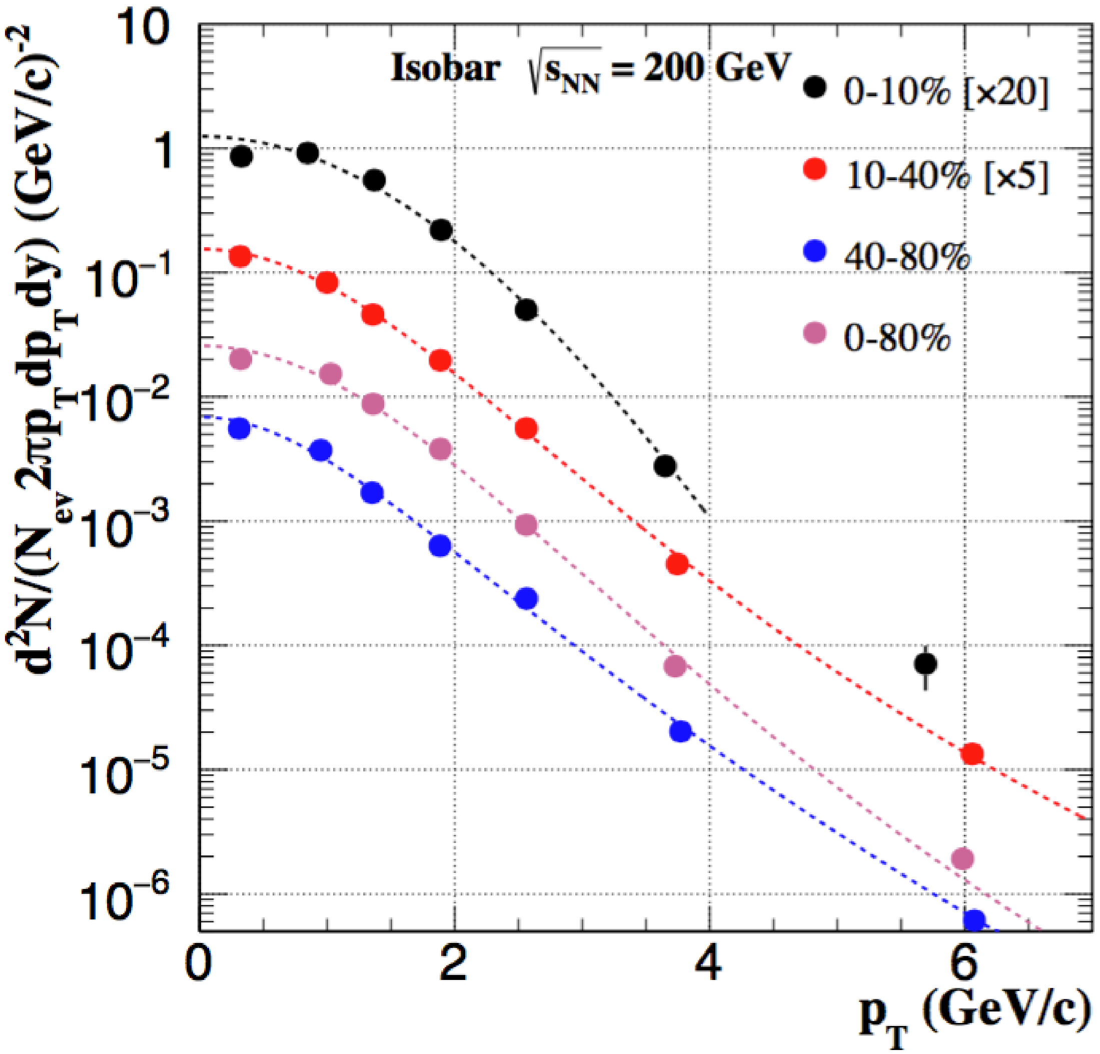
Cuts now



US (SE) - LS (SE)
Fit
STAR Isobar.blinded @ 200 GeV
0-10%
0.0 < p_T < 0.7 GeV/c
χ²/ndf = 20.0/29
μ=1.865 ± 0.003 GeV
σ=11.1 ± 2.4 MeV
RawYield = 3.26e+05 ± 7.51e+04
Significance = 4.3
0.7 < p_T < 1.1 GeV/c
χ²/ndf = 37.0/29
μ=1.864 ± 0.001 GeV
σ=11.9 ± 2.3 MeV
RawYield = 5.52e+05 ± 8.88e+04
Significance = 6.2
1.1 < p_T < 1.6 GeV/c
χ²/ndf = 34.9/29
μ=1.867 ± 0.002 GeV
σ=12.8 ± 2.2 MeV
RawYield = 7.74e+05 ± 1.23e+05
Significance = 6.3
1.6 < p_T < 2.2 GeV/c
χ²/ndf = 26.3/29
μ=1.866 ± 0.002 GeV
σ=12.5 ± 1.0 MeV
RawYield = 6.13e+05 ± 7.38e+04
Significance = 8.3
2.2 < p_T < 3.0 GeV/c
χ²/ndf = 36.9/29
μ=1.869 ± 0.004 GeV
σ=12.0 ± 1.9 MeV
RawYield = 3.70e+05 ± 6.15e+04
Significance = 6.0
3.0 < p_T < 5.0 GeV/c
χ²/ndf = 19.2/29
μ=1.864 ± 0.004 GeV
σ=12.9 ± 3.0 MeV
RawYield = 1.35e+05 ± 3.44e+04
Significance = 3.9
5.0 < p_T < 8.0 GeV/c
χ²/ndf = 31.6/29
μ=1.869 ± 0.004 GeV
σ=21.6 ± 10.1 MeV
RawYield = 8.74e+03 ± 4.86e+03
Significance = 1.8
Counts (per 10 MeV/c²)
M_kπ (GeV/c²)
p_T (GeV/c)



1.88
1.87
1.86
0.04
0.02
0
0 1 2 3 4 5 6 7 8
p_T (GeV/c)



Isobar √s_NN = 200 GeV
0-10% [×20]
10-40% [×5]
40-80%
0-80%
d²N/(N_ev 2πp_T dp_T dy) (GeV/c)^-2
p_T (GeV/c)