K^{*0} analysis in Pb-Pb collision at $\sqrt{s_{NN}}$ = 2.76 TeV

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Outline:

--- Motivation

--- Data Sets and analysis detail

--- Mass/Width as a function of p_T

--- Systematic error extraction

--- Corrected p_T spectra

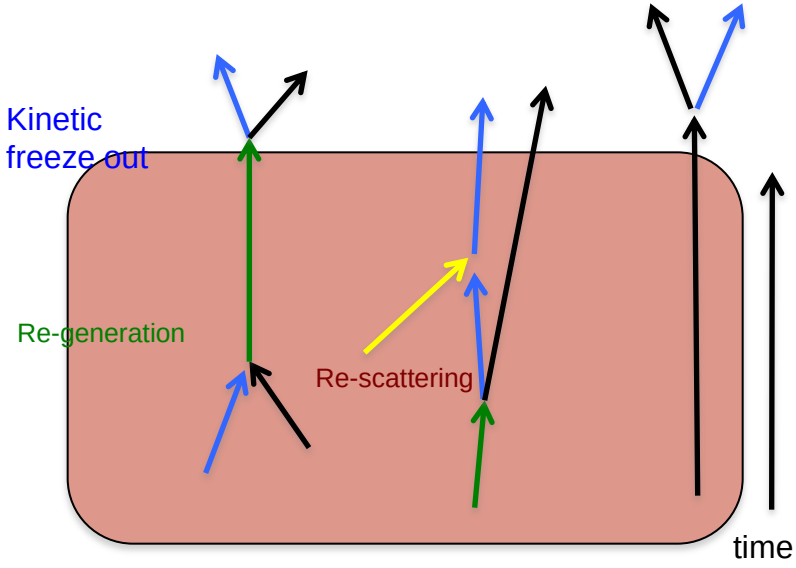
--- Particle ratio: K^{*0}/K^-

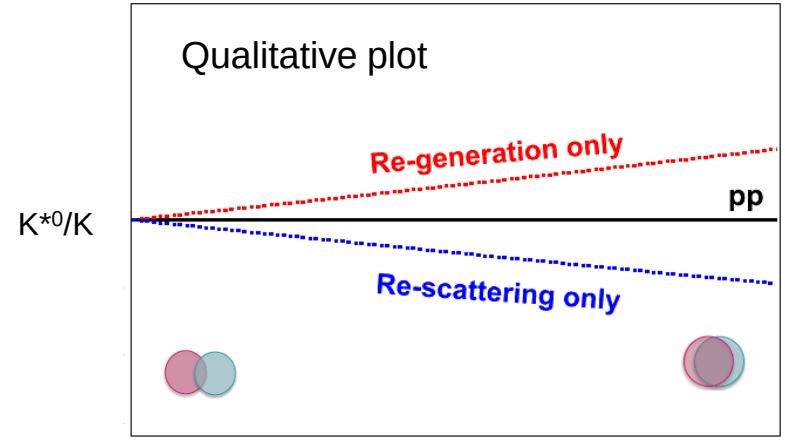
--- Summary

Motivation

- Lifetime of resonances are comparable to the lifetime of fireball → sensitive to the properties of the medium.

Re-scattering and re-generation:





	Lifetime (fm/c)
K^{*0}	4
ϕ	45

➢ $(K^{*0}/K)_{AA}$ and $(K^{*0}/K)_{pp}$ → re-scattering / re-generation effects.

Data Set

Data Sets: Pb-Pb/AOD049
90 Good Runs with No V-drift problems

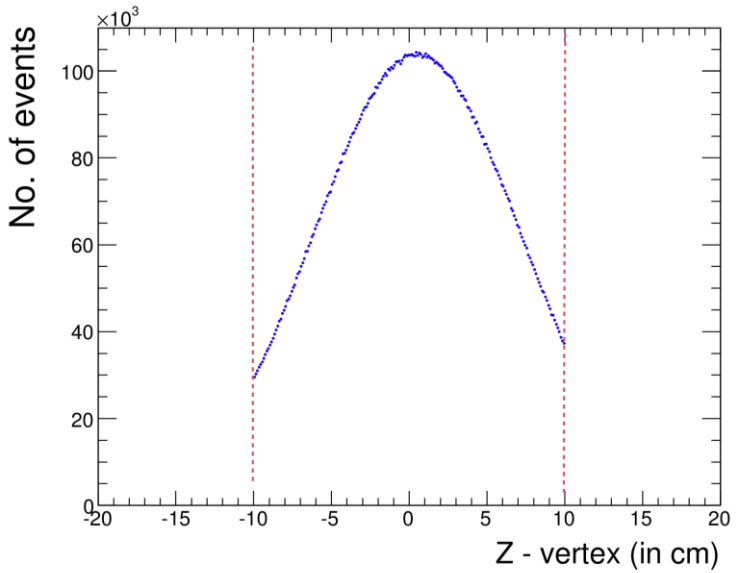
Editing run **60**

AliRoot version	VO_ALICE@AliRoot::v5-04-21-AN-1 Click here for documentation
Datasets	LHC10h(2) AOD049 Good Runs, No V-Drift Problems
Wagons	PIDResponse, TaskEventPlaneTrk, TaskVZEROEPSelection, RsnTask_Kstar_Syst_Default_4,
Comment	
Test	Status: **Finished (49m 43s total time)** Tag: PWGLF/LF_PbPb_AOD/60_20130117-1356 testing output log | testing output dir | wagon configuration

Test Results

Train Run (PWG train overview)

Status	Running triggered on 17 Jan 13 14:56 (2d 3:51 ago) **All jobs submitted, masterjobs submitted: 90, last run: 137161**
Files	Files copied to the Grid successfully | file copying log | train files in FC
Processing	processing progress: **6579 total, 6538 done, 41 error, 0 active, 0 waiting**
Merging	merging progress: **91 total, 91 done, 0 error, 0 active, 0 waiting** intermediate merging: stage1 (**383/383/0/0/0**) stage2 (**0/0/0/0/0**) stage3 (**0/0/0/0/0**) stage4 (**0/0/0/0/0**)
Final Merging	Status of final merging job (stage 5) | merged files in FC AliEn Output dir: /alice/cern.ch/user/a/alitrain/PWGLF/LF_PbPb_AOD/60_20130117-1356/merge



00 to 20 ===> 3.05627e+06
20 to 40 ===> 3.04396e+06
40 to 60 ===> 3.04714e+06
60 to 80 ===> 3.06153e+06
00 to 80 ===> 1.22089e+07

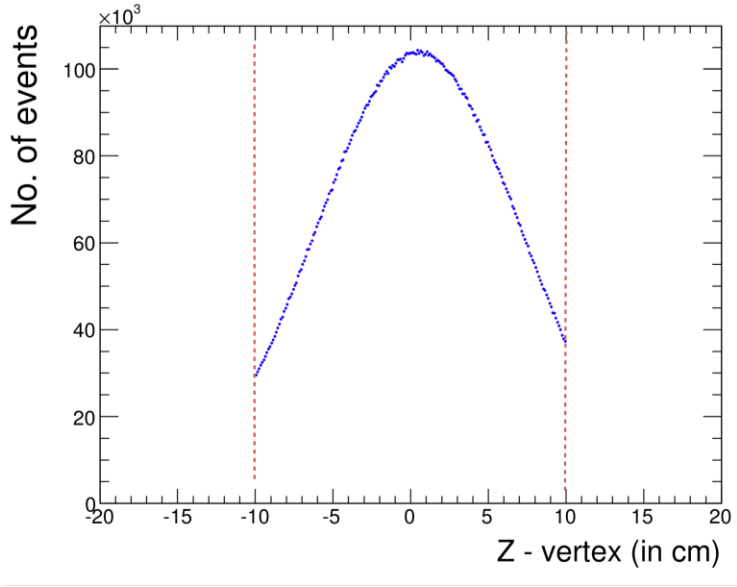
Event, Track and PID selection

Event Selection: Physics Selections, $|v_Z| < 10$ cm

Centrality Selection: using V0M

Track Selection:

--- $p_T > 0.15$ GeV/c.
--- $|\eta| < 0.8$
--- $|(DCA)_r\ (p_T)| < 0.018 + 0.035 p_T^{-1.01}$
--- $|(DCA)_z| < 2$ cm
--- ITS and TPC refits.
--- min cluster in TPC: 70
--- max Chi-square in TPC: 4
--- Kπ pair rapidity $|y| < 0.5$



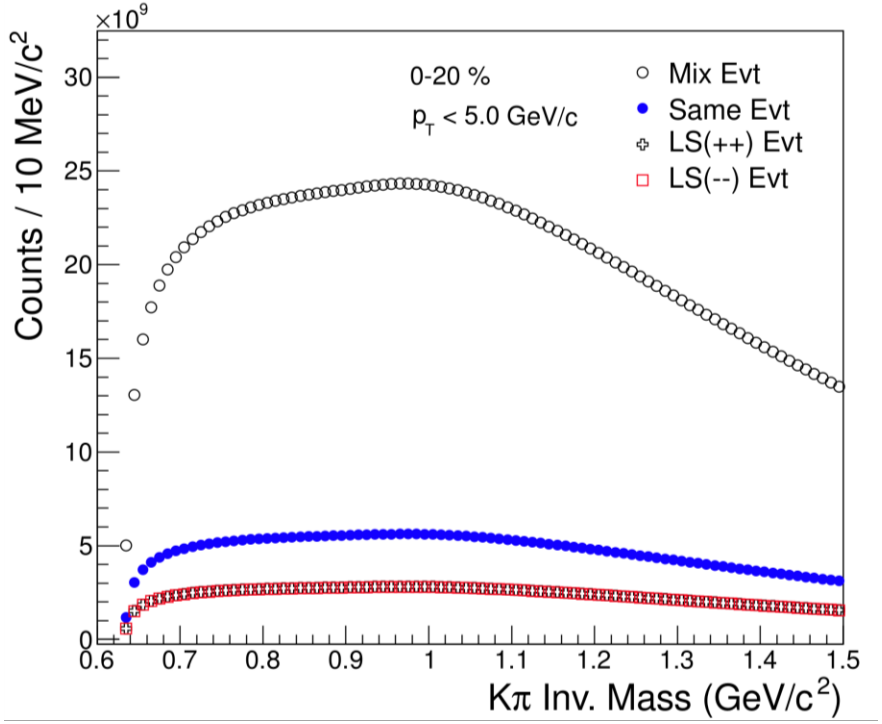
PID Selection: $|N\sigma| < 2.0$ (using TPC only)

Decay Channel:

$K^{*0} \rightarrow K^+ \pi^-$, $K^- \pi^+$ (BR: 66%)

Standard 2010 track quality cuts with filterbit 32

K^{*0} Signal extraction: Event Mixing (EM) and Like Sign (LS) distributions



Event mixing:

Number of mixed events = 5
10 bins in Z vertex (-10, 10)
10 bins in centrality (0,100)
12 bins in event plane angle (0,2π)

R → Normalization factor

Kπ invariant mass distribution

Background estimated using:

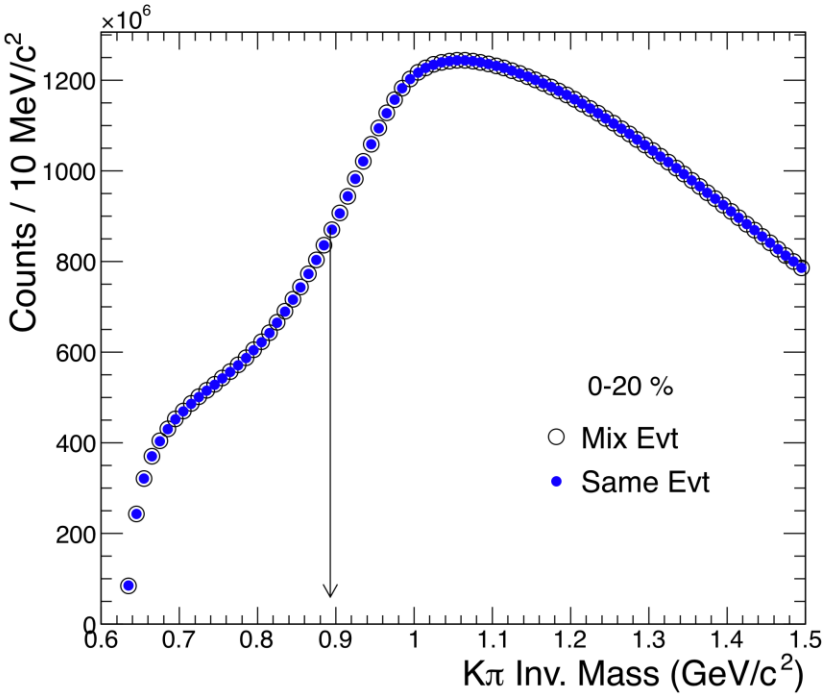
→Event mixing technique
→Like Sign technique

Like Sign:

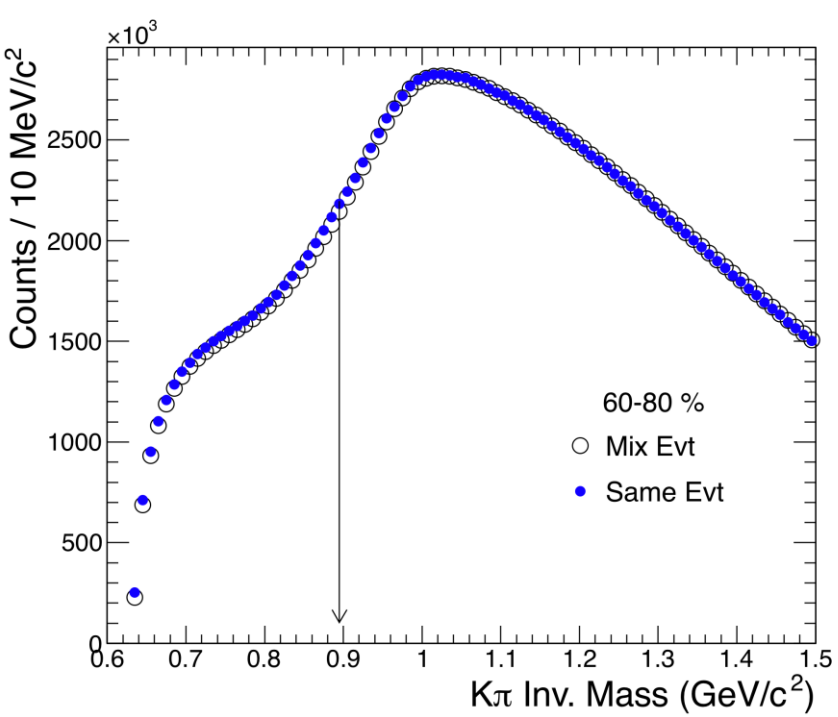
Example of K*^{0} Signal extraction

The combinatorial background is normalized in the invariant mass region (1.1, 1.3) GeV/c^2

$0.8 < p_T < 1.2$ GeV/c^2



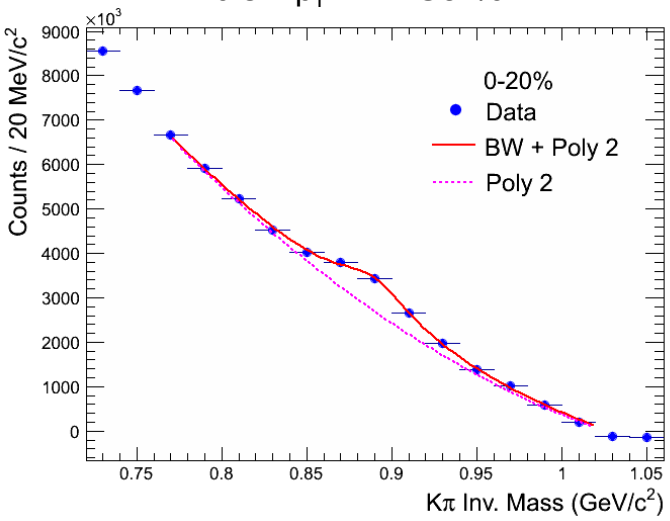
$0.8 < p_T < 1.2$ GeV/c^2



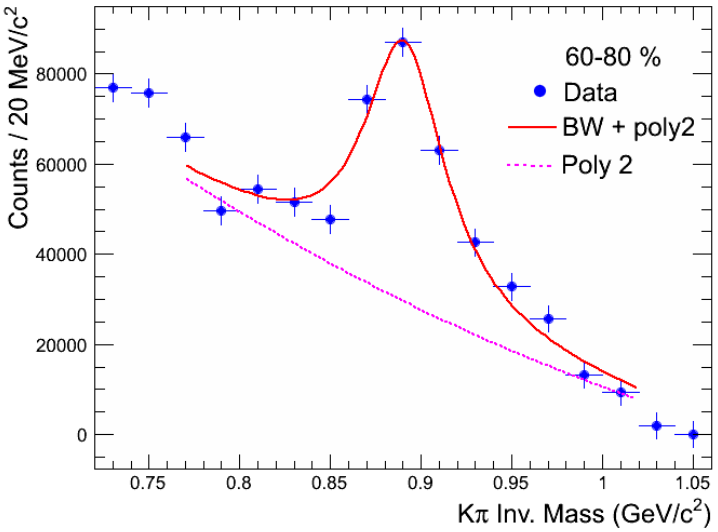
Example of K*^{0} Signal extraction

After combinatorial background subtraction, signal is fitted with a p-wave relativistic Breit Wigner function

$0.8 < p_T < 1.2$ GeV/c^2



$0.8 < p_T < 1.2$ GeV/c^2

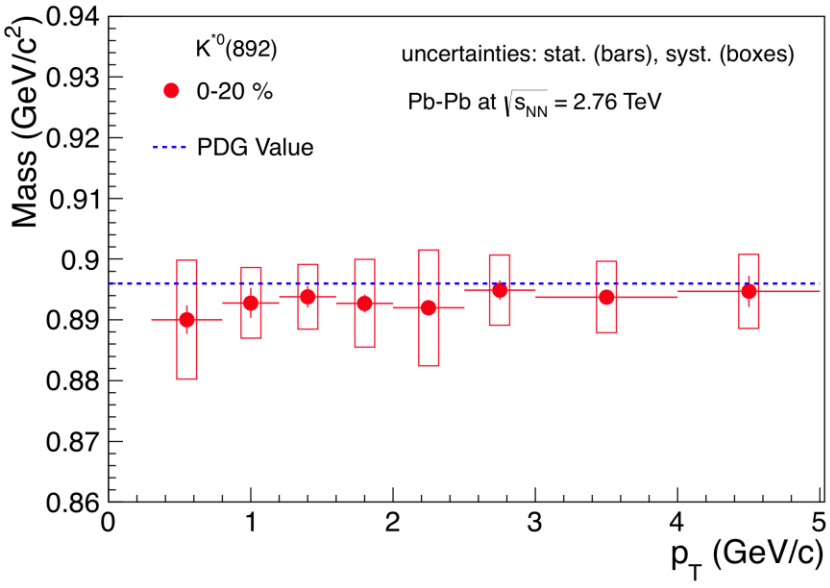


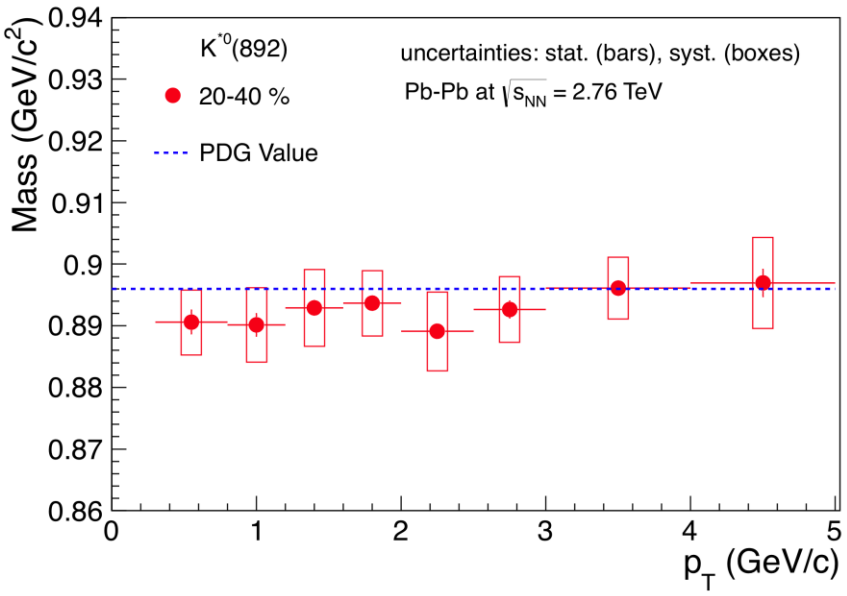
$$BW = \frac{aM\Gamma M_0}{(M^2 - M_0^2)^2 + M_0^2\Gamma^2} \quad \frac{M}{\sqrt{M^2 + p_T^2}} e^{-\frac{\sqrt{M^2+p_T^2}}{T}}$$

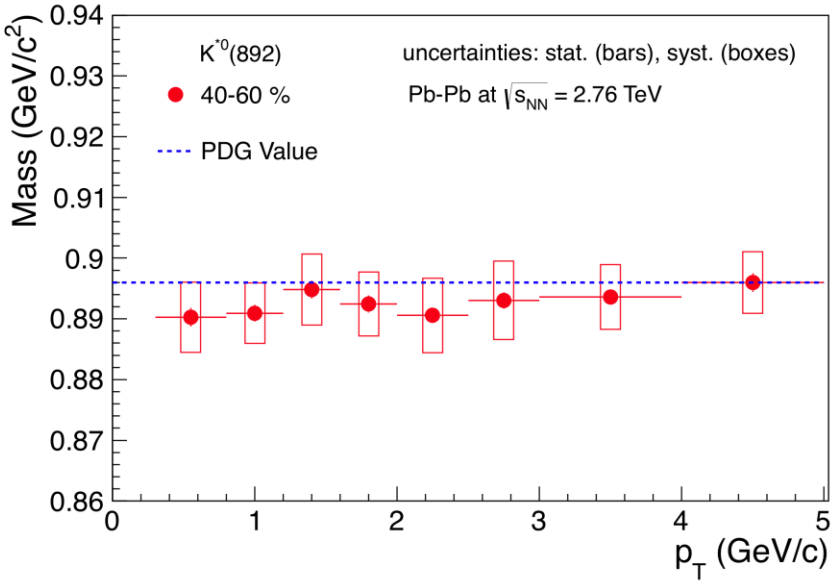
Where $\Gamma(M) = [\frac{M^2 - (M_\pi + M_K)^2}{M_0^2 - (M_\pi + M_K)^2}]^{3/2} \frac{\Gamma_0 M_0}{M}$

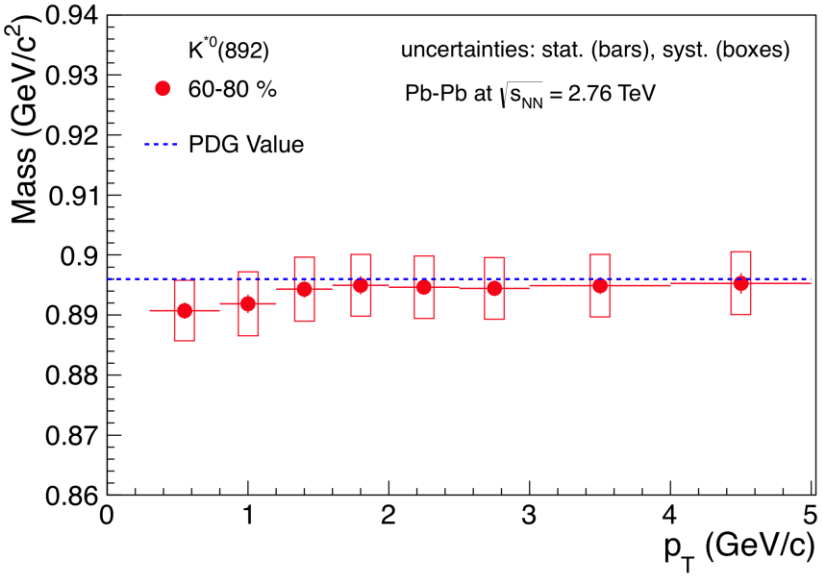
Mass(M_0) and width(Γ_0) extracted from fit parameters

Mass of K^{*0} as a function of p_T



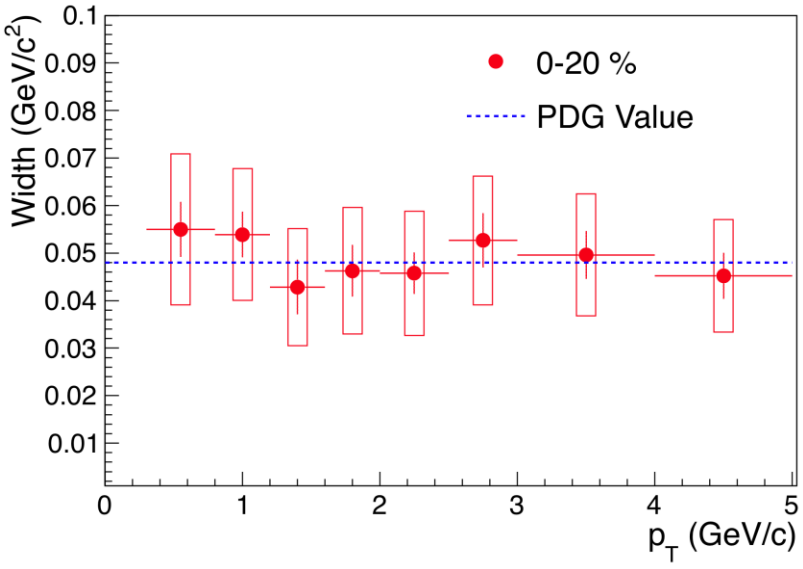


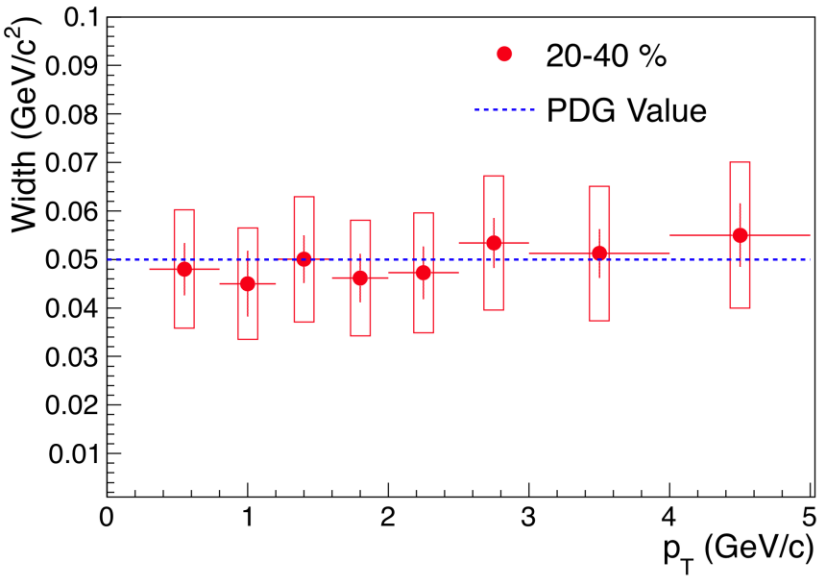


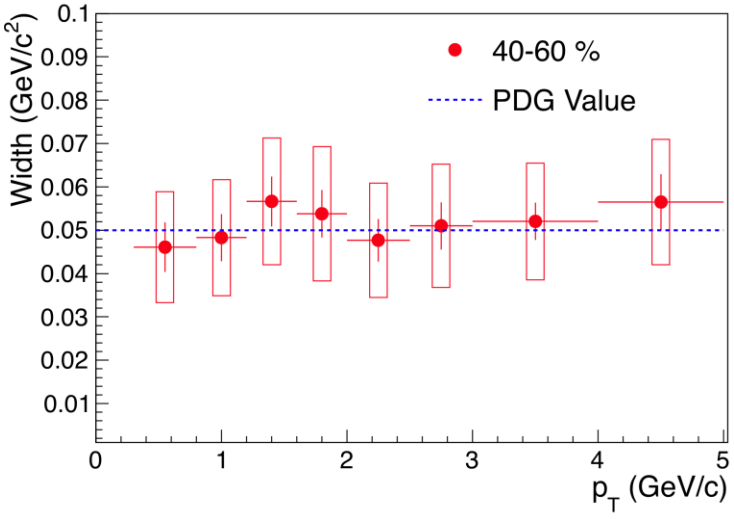


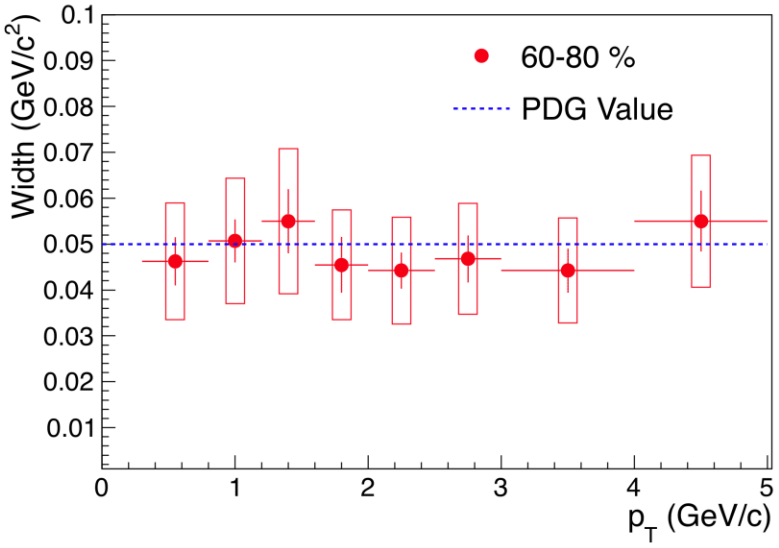
Mass consistent with PDG value

Width of K^{*0} as a function of p_T



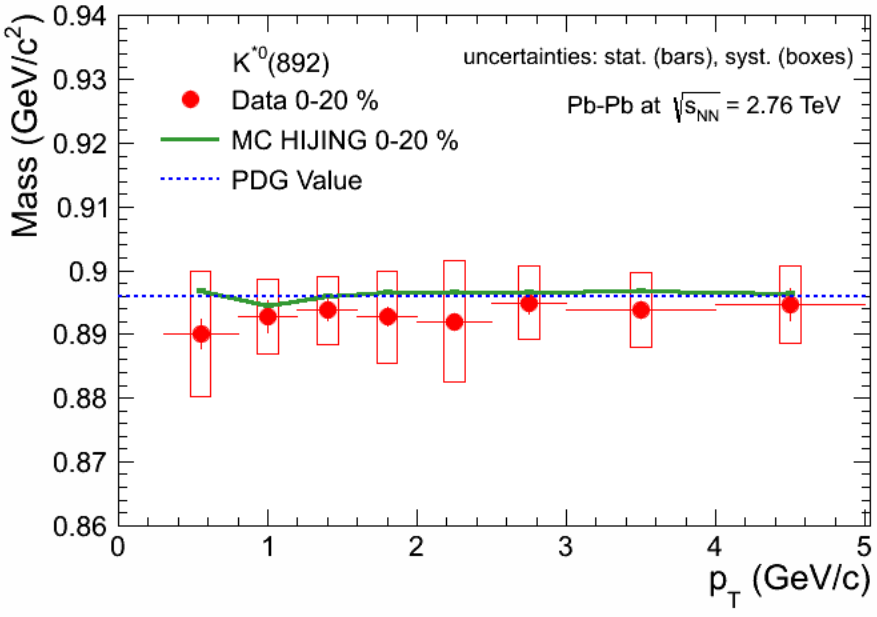


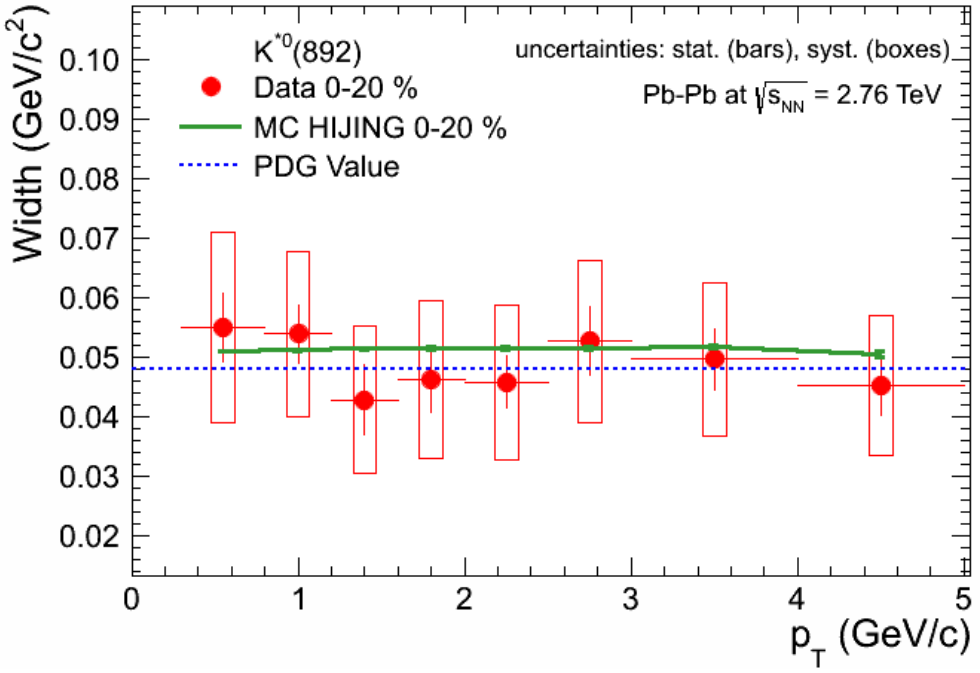




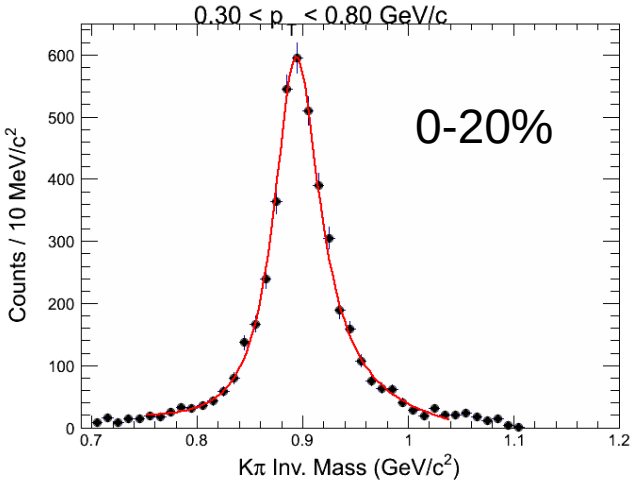
Width consistent to PDG value

Mass and Width of K^{*0}: comparison with MC





K* signal in MC HIJING



Mass and width consistent with MC HIJING simulations

Sources of systematic uncertainty

List of Systematic checks:

→Varying fitting ranges

→Varying normalization regions

→Varying residual backgrounds (poly2 vs. poly3)

→Keeping free width vs. fixed PDG width

→Varying Non Rel. BW and Rel. BW

→Track Selections (10% constant as a function of p_T)

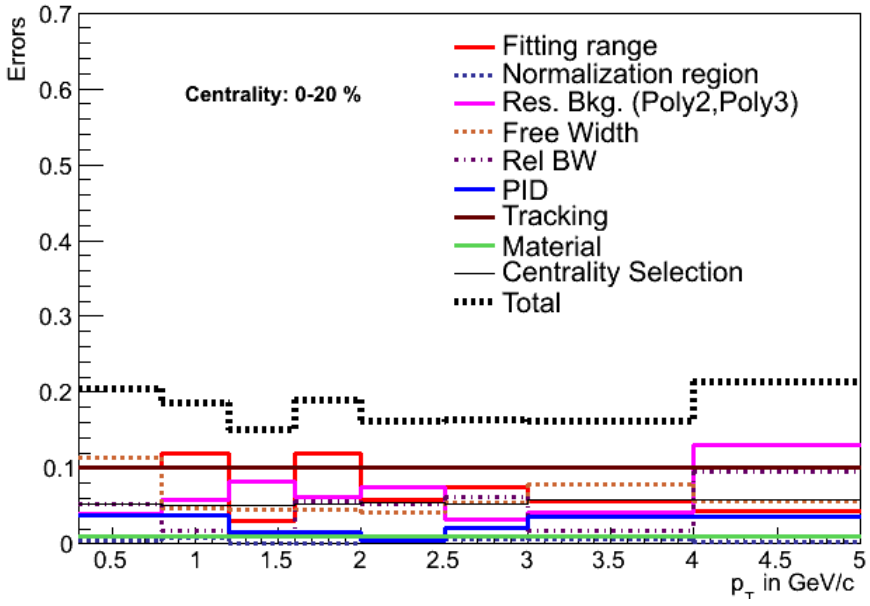
→PID : N sigma cuts

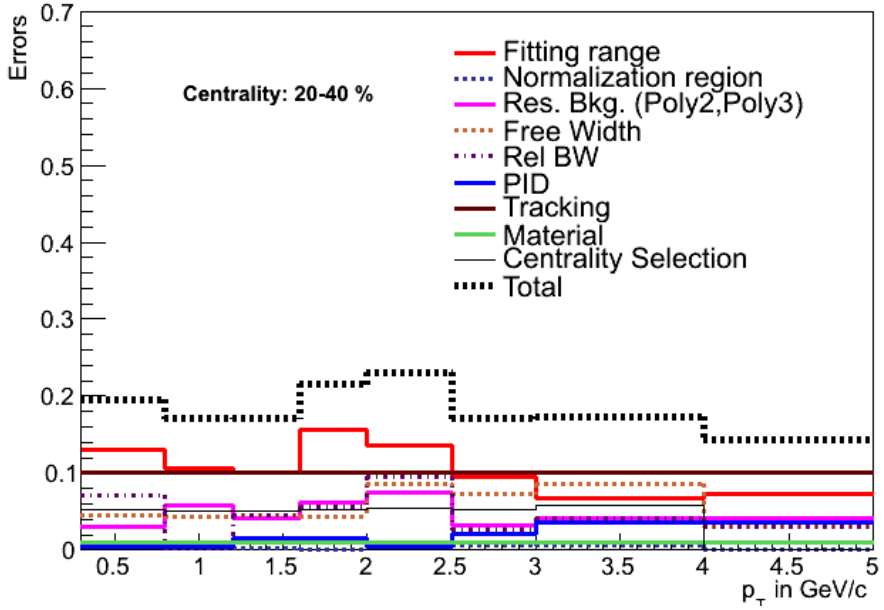
→Material Budget. (1% constant as a function of p_T)

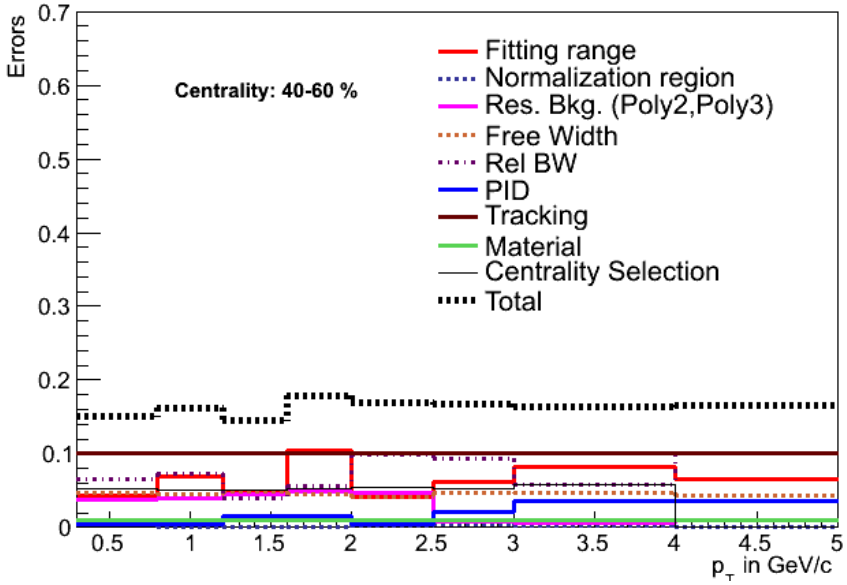
→Centrality Selection

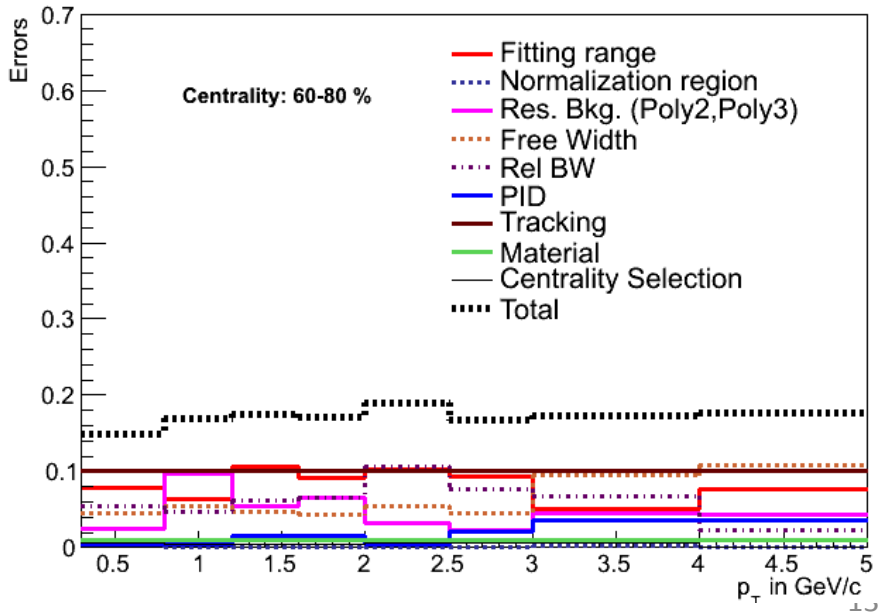
→Like Sign Method (consistency check)

Sources of systematic uncertainty in K^{*0} yield

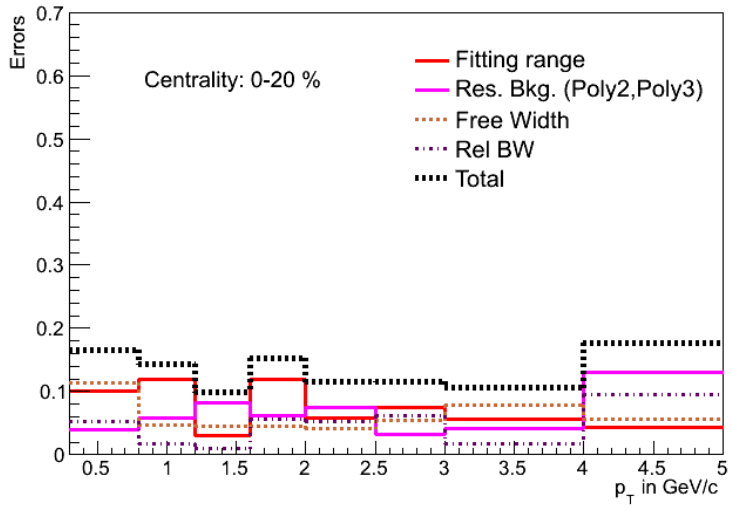


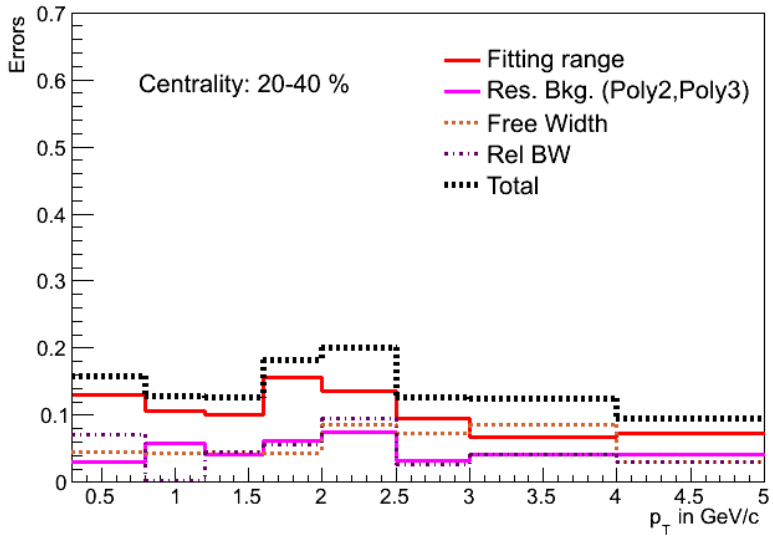


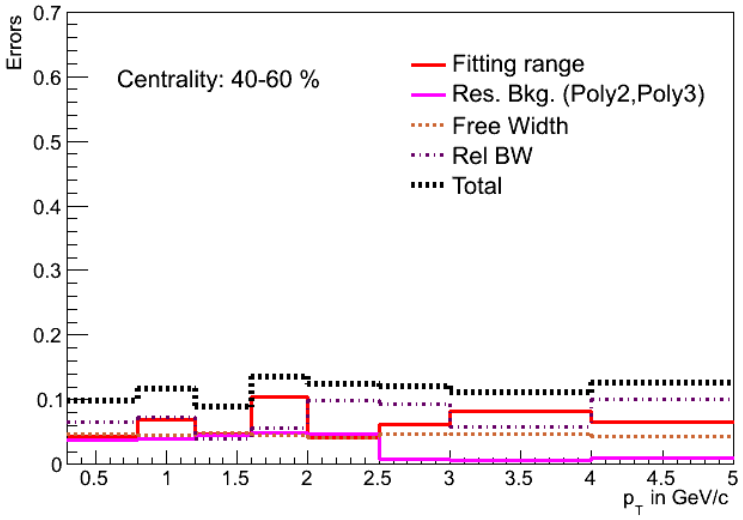


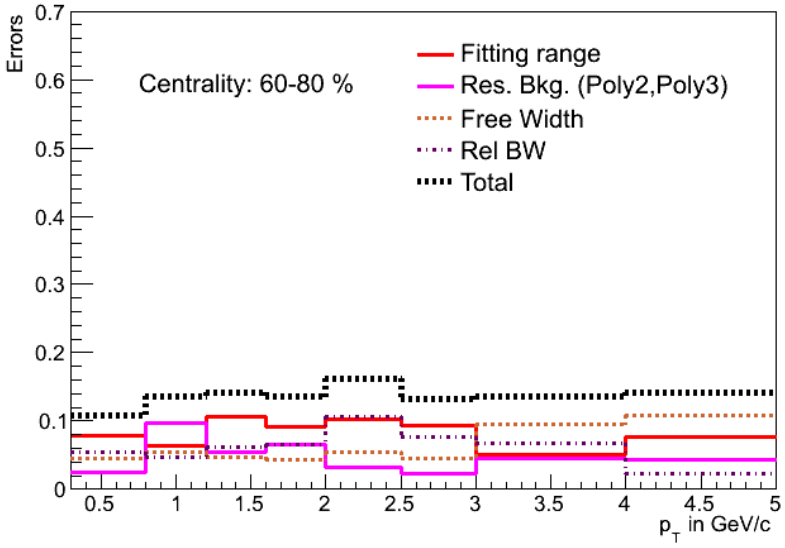


Sources of uncorrelated systematic uncertainty in K^{*0} yield

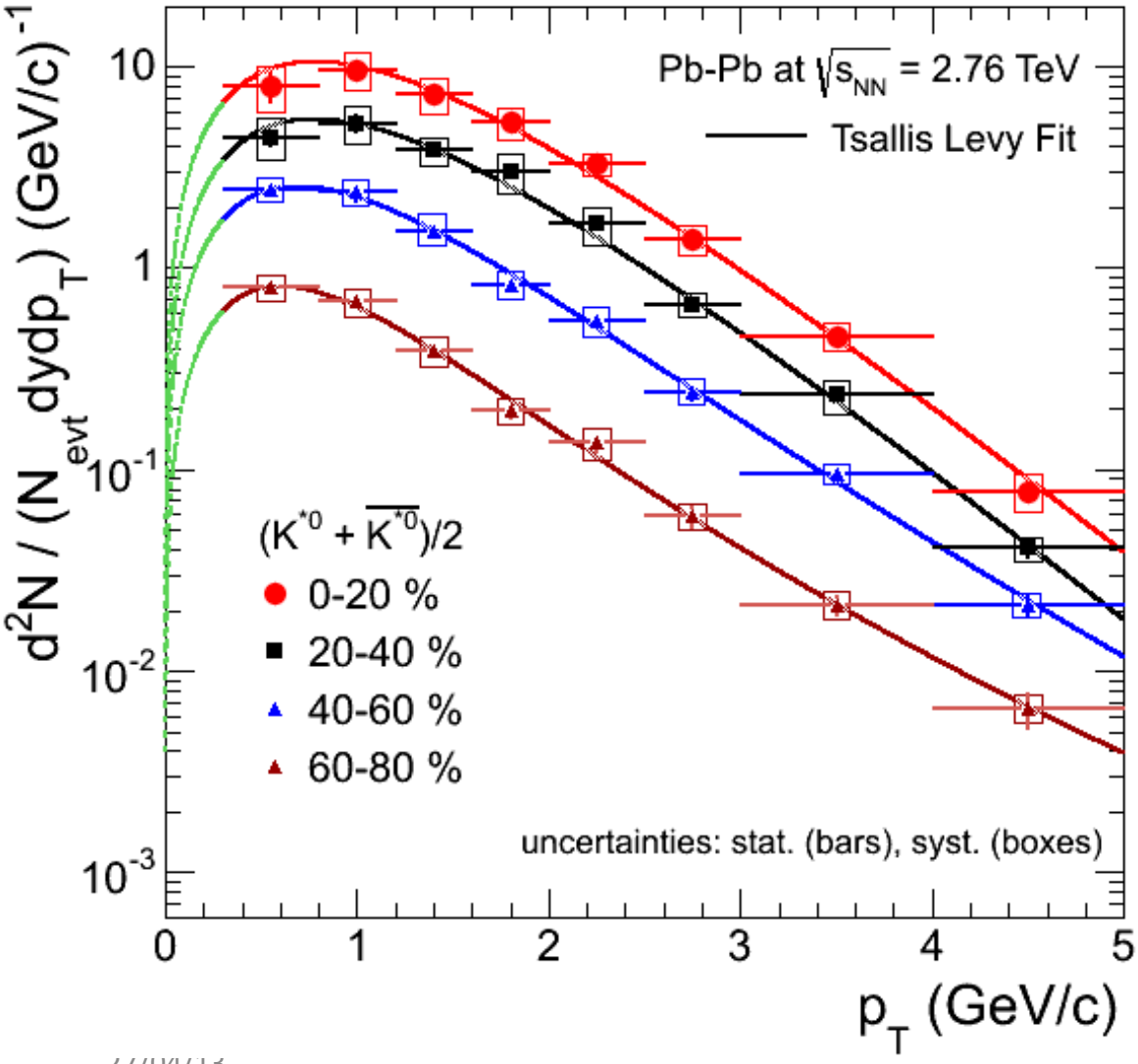








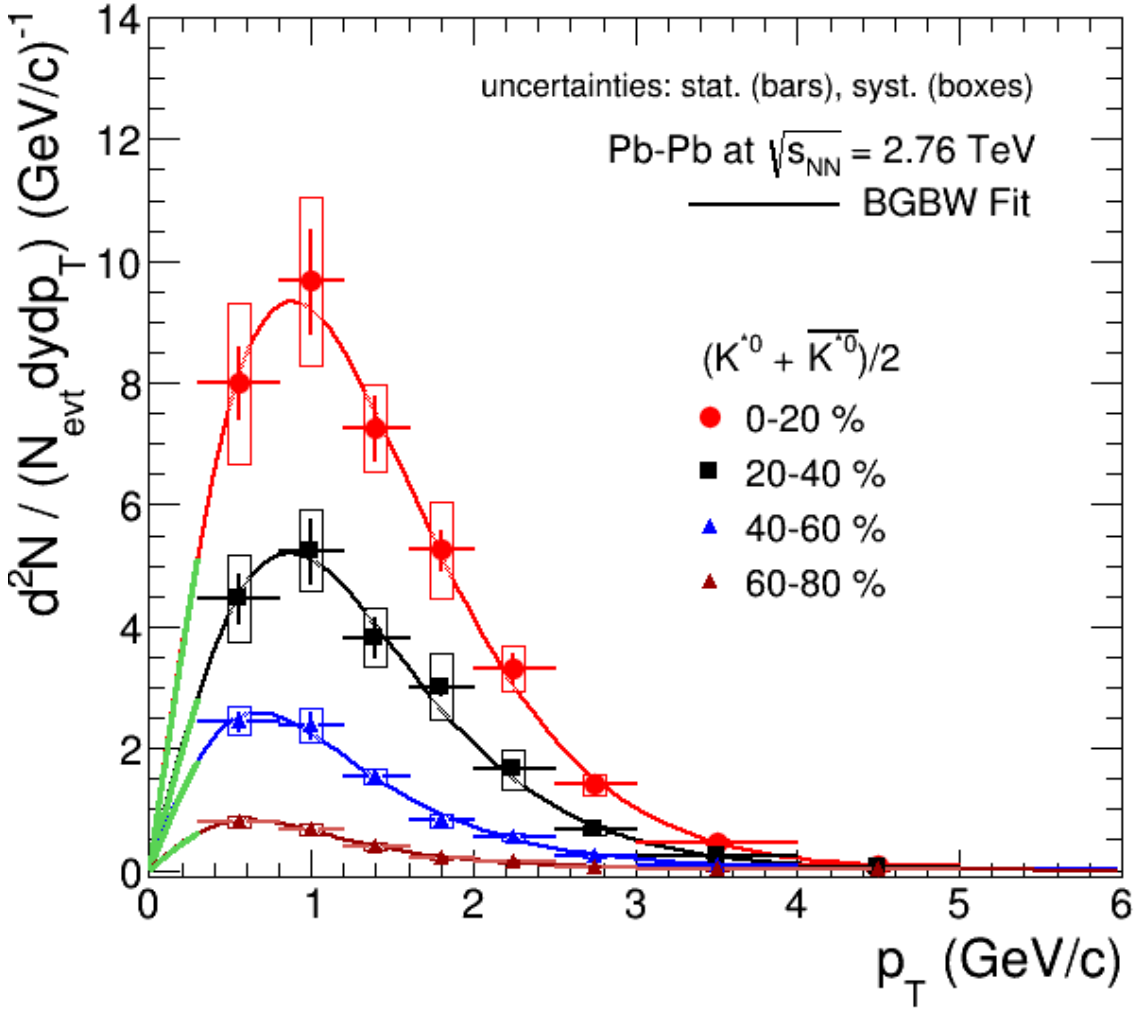
p_T Spectra of K^{*0}: Tsallis Levy Fit



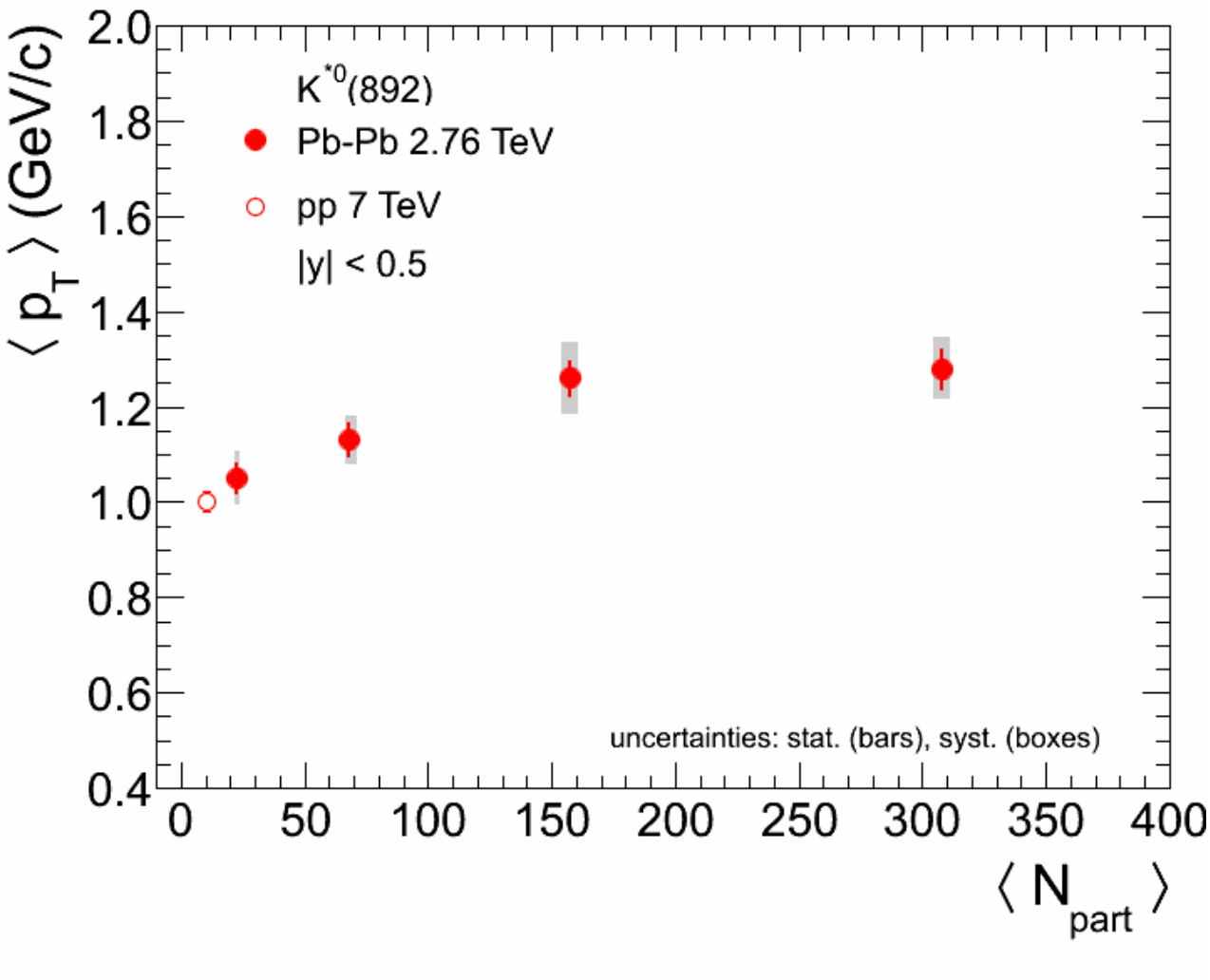
dN/dy and <p_T> calculated using data in the measured region and fit in the extrapolation region.

p_T Spectra of K^{*0}: Boltzmann Gibbs Blast Wave Fit

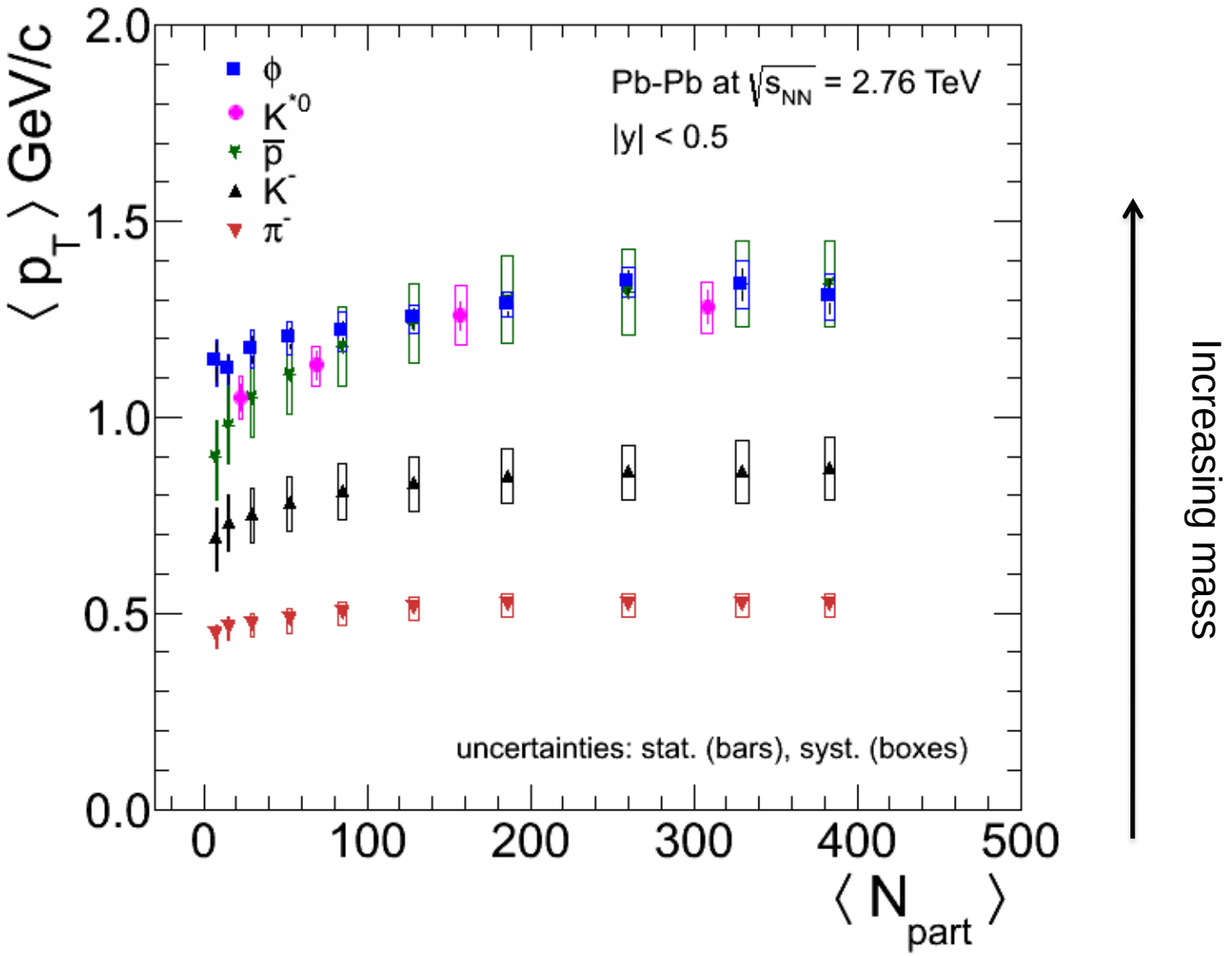
$$\frac{d^2N}{dp_T dy} = p_T \times A m_T \int_0^1 x I_0\left(\frac{p_T}{T}\sinh \operatorname{atanh}\left[\beta_s x^n\right]\right) K_1\left(\frac{m_T}{T}\cosh \operatorname{atanh}\left[\beta_s x^n\right]\right) dx,$$



$\langle p_T \rangle$ of K^{*0}



$\langle p_T \rangle$ of ϕ, K^{*0} with π, K, p-bar

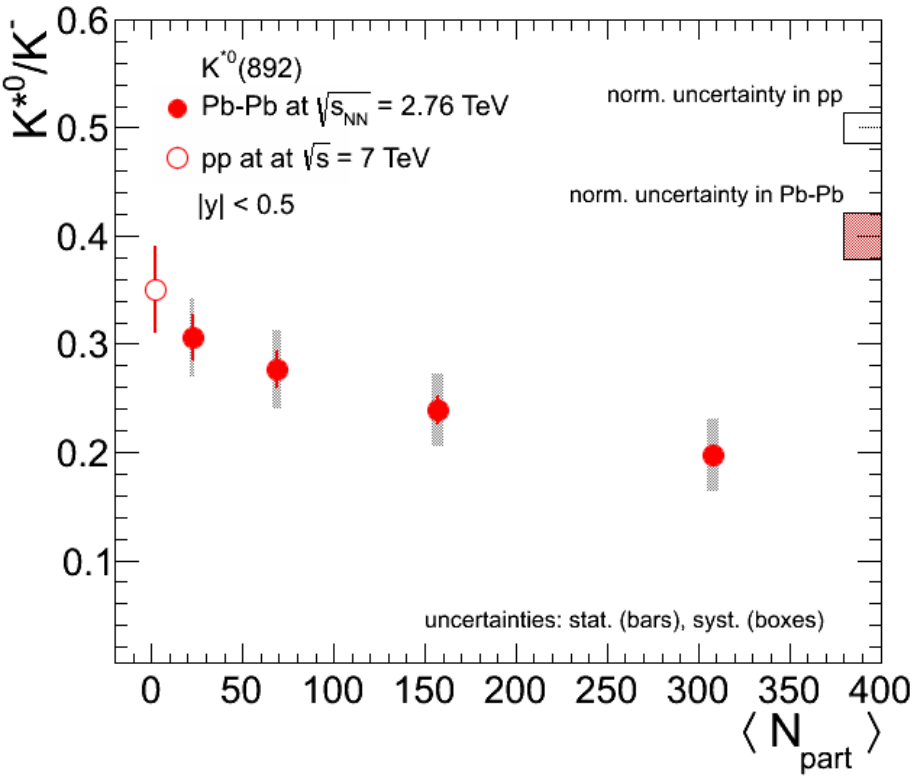


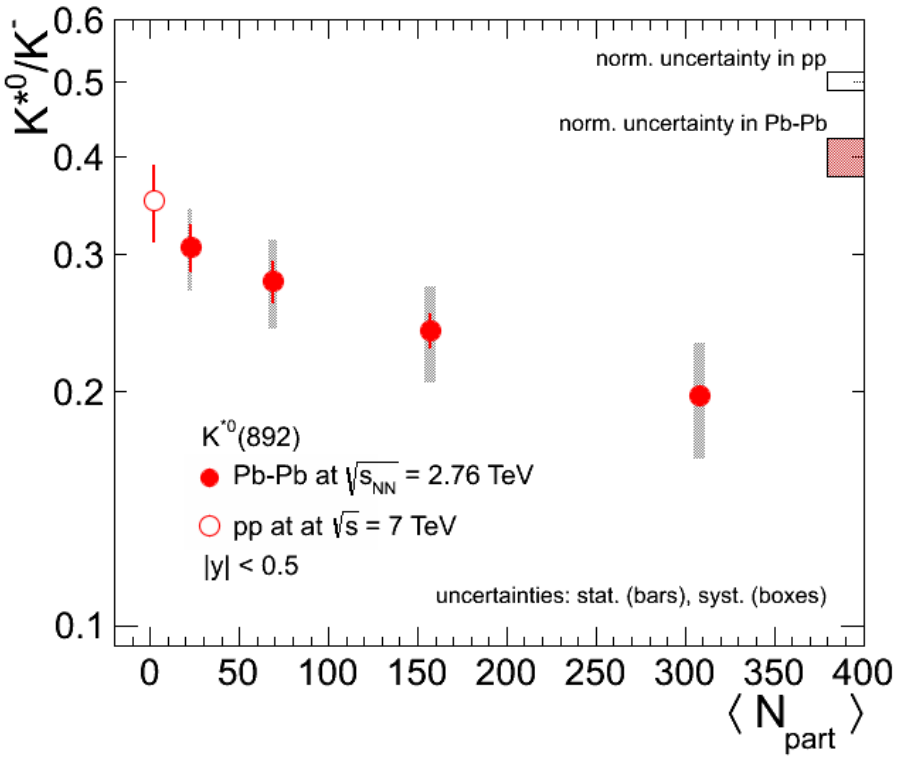
Increasing mass

$\langle p_T \rangle_{\phi} \sim \langle p_T \rangle_{K^{*0}} \sim \langle p_T \rangle_{pbar}$

Particle ratio: K^{*0}/K^{-} vs N_{part}

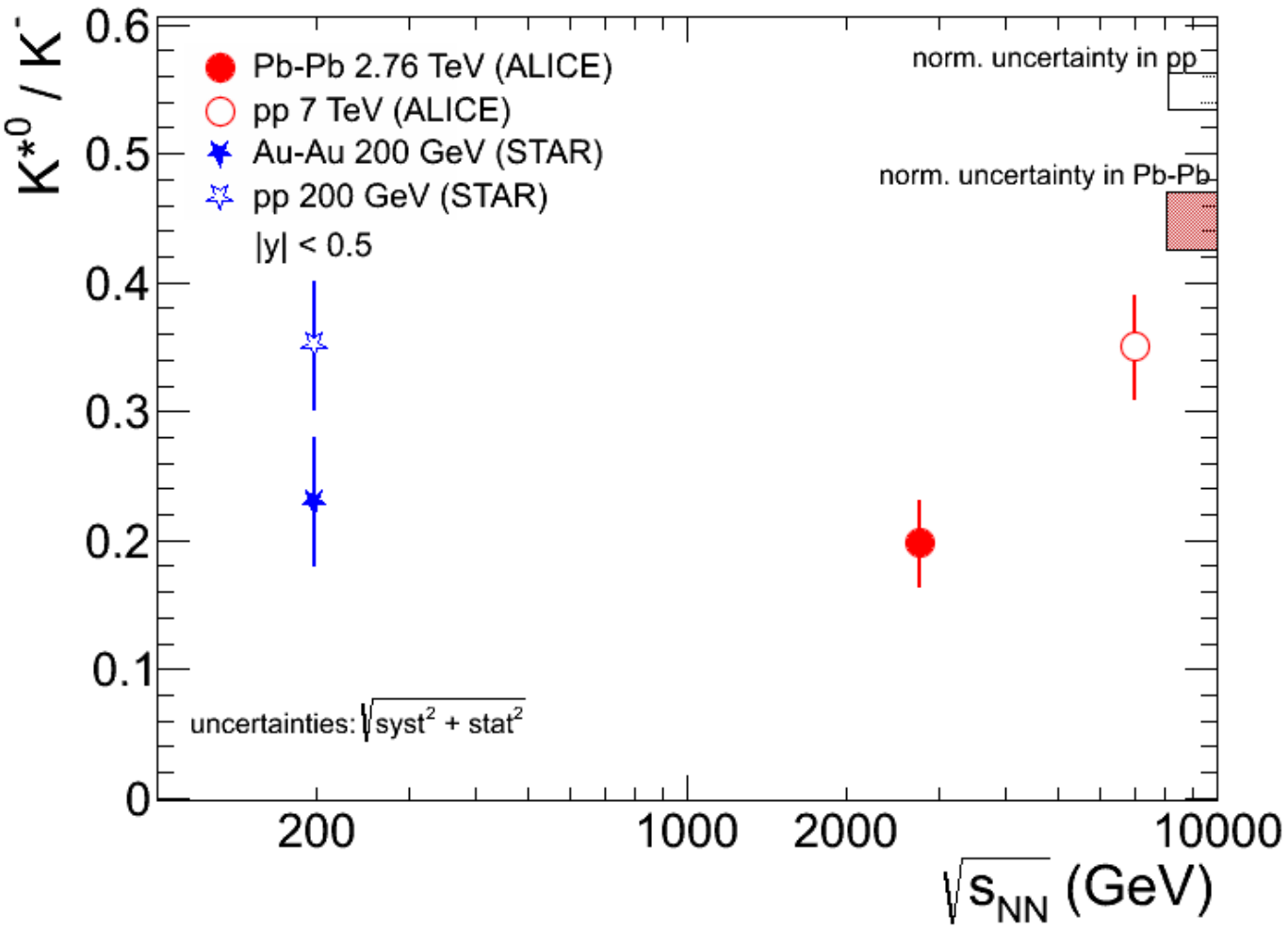
Log scale on Y-axis





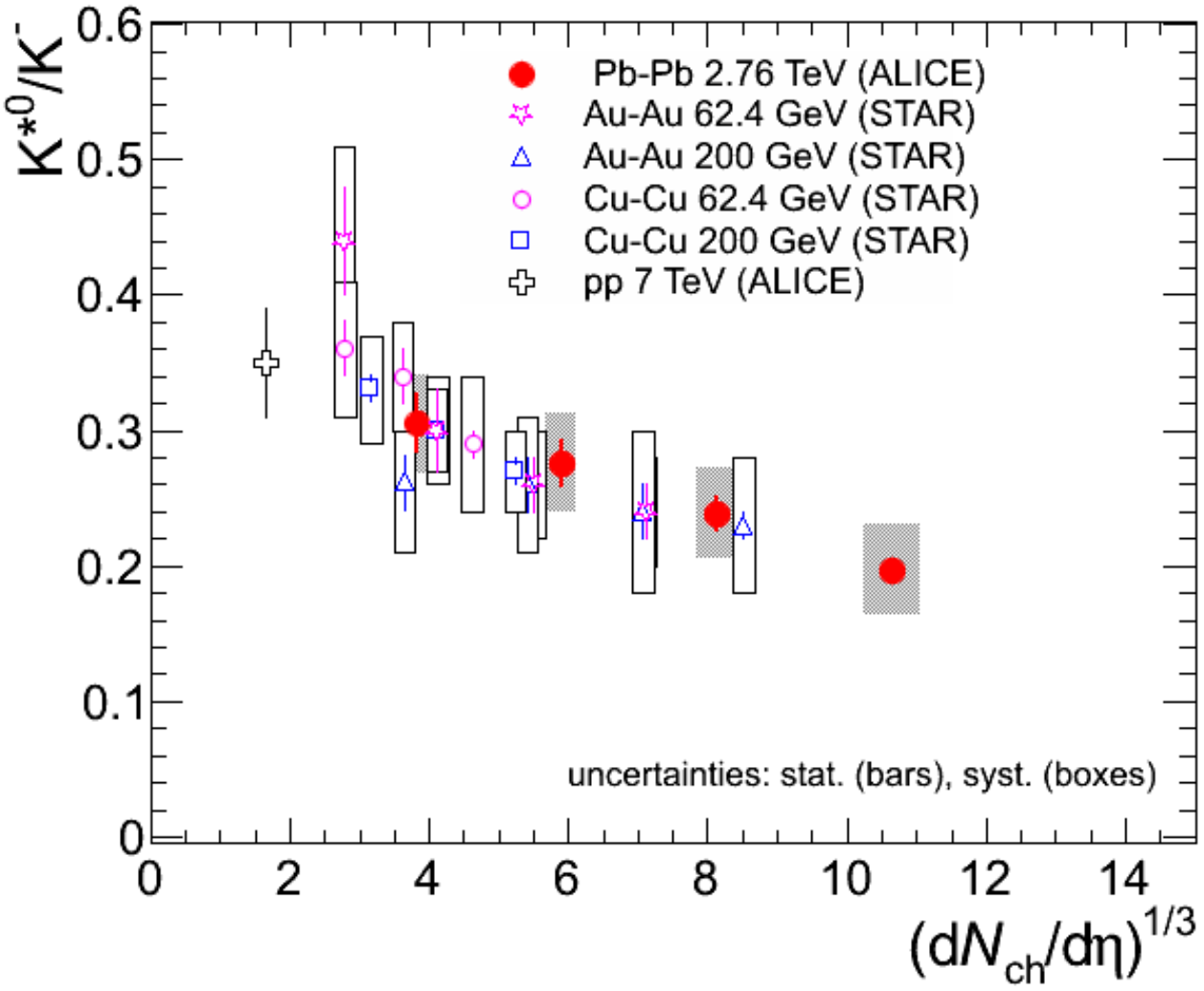
K^{*0}/K^{-} ratio vs N_{part} → hadronic rescattering for central collisions(?)

Particle ratio: K^{*0}/K^{-} vs $\sqrt{s_{NN}}$



$(K^{*0}/K^{-})_{AA} < (K^{*}/K^{-})_{pp}$ → hadronic recattering (?)

Particle ratio: K^{*0}/K^{-} vs $(dN/d\eta)^{1/3}$



K^{*0}/K^{-} vs $(dN/d\eta)^{1/3}$ → effect of size of the fireball (?)

Summary:

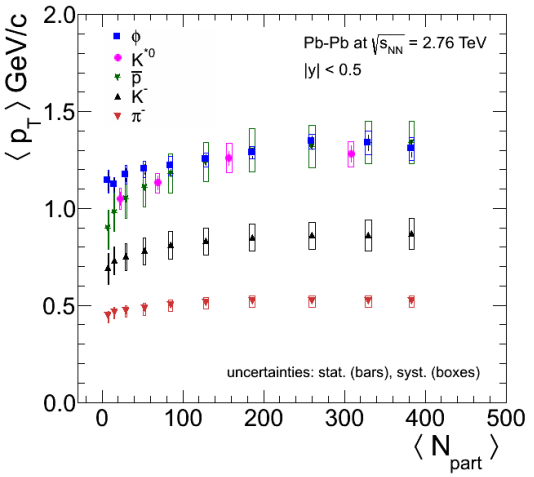
-- Mass and width of K^{*0} consistent with PDG value.

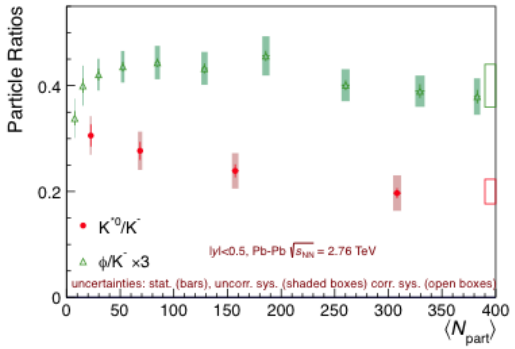
-- $\langle p_T \rangle_{\phi} \sim \langle p_T \rangle_{K^{*0}} \sim \langle p_T \rangle_{pbar}$

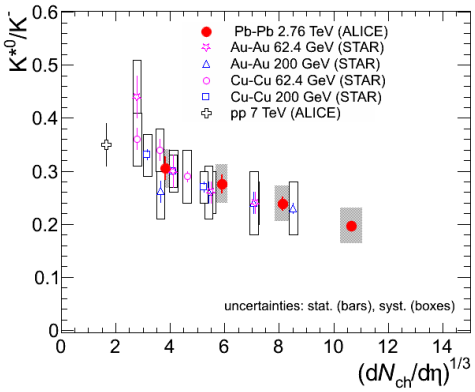
-- K^{*0}/K^{-} ratio vs N_{part} → hadronic rescattering for central collisions(?)

-- $(K^{*0}/K^{-})_{AA} < (K^{*}/K^{-})_{pp}$ → hadronic recattering in AA collision.

-- K^{*0}/K^{-} vs $(dN/d\eta)^{1/3}$ → effect of size of the fireball(?).

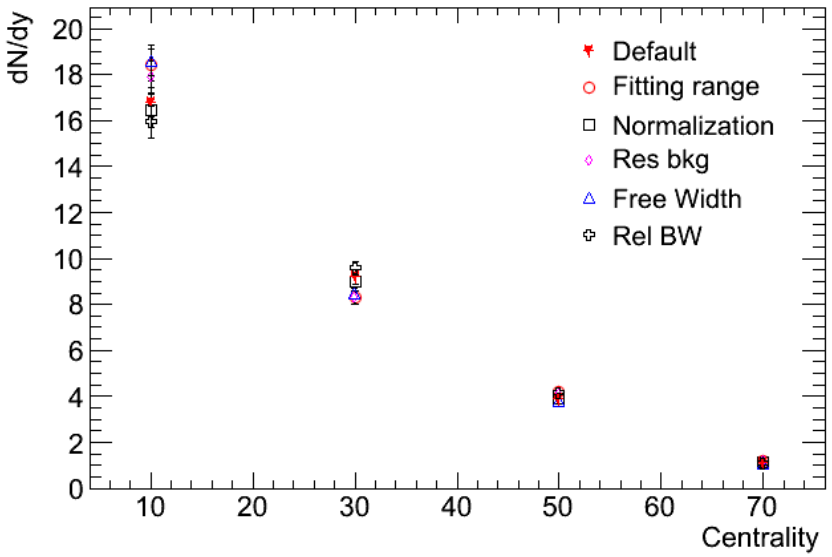


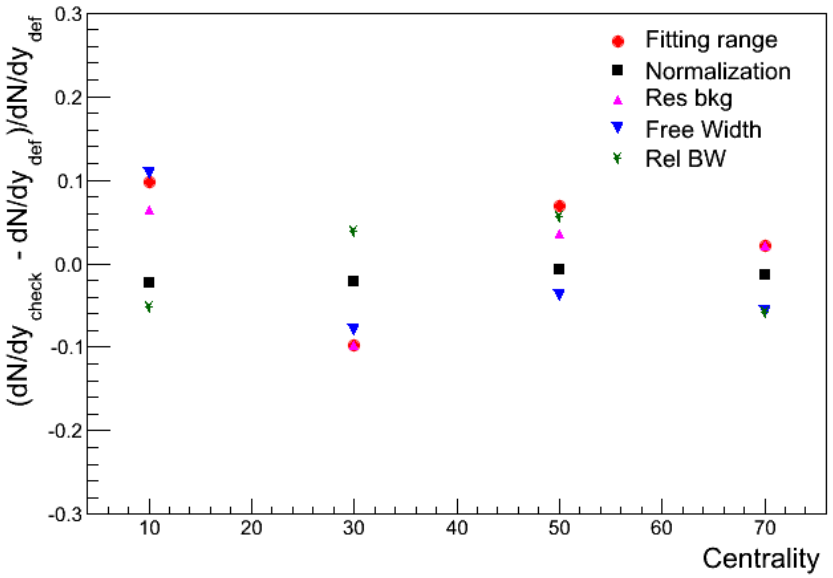




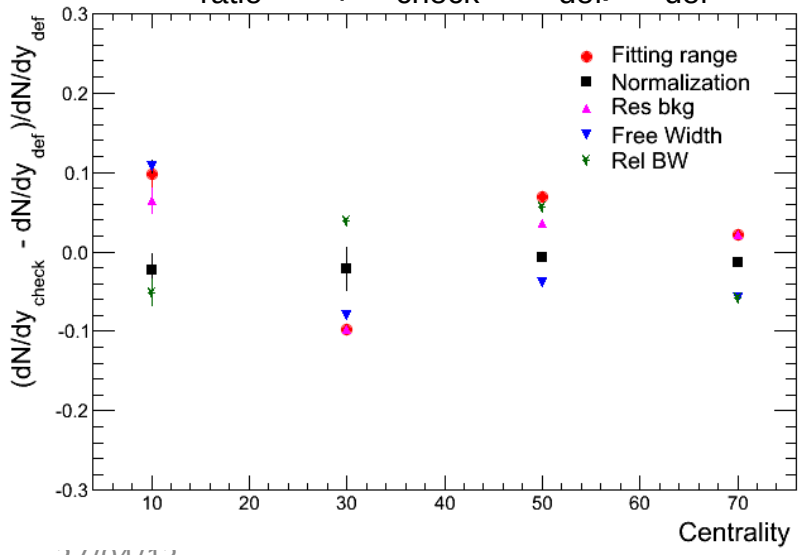
Back Up Slides

Correlated and uncorrelated errors

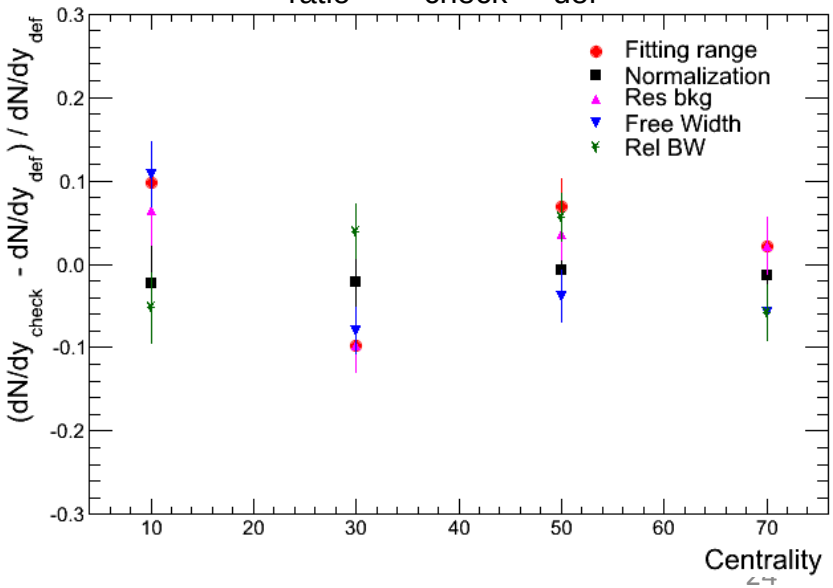




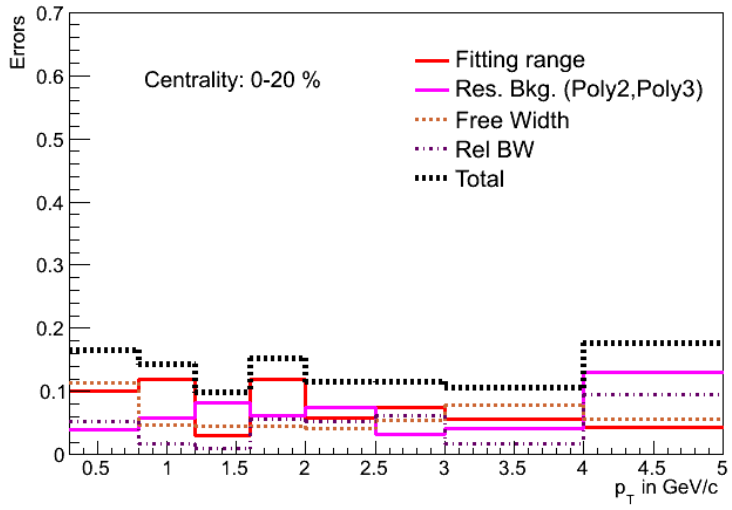
$E_{ratio} = \sqrt{(E^2_{check} - E^2_{def})}/Y_{def}$

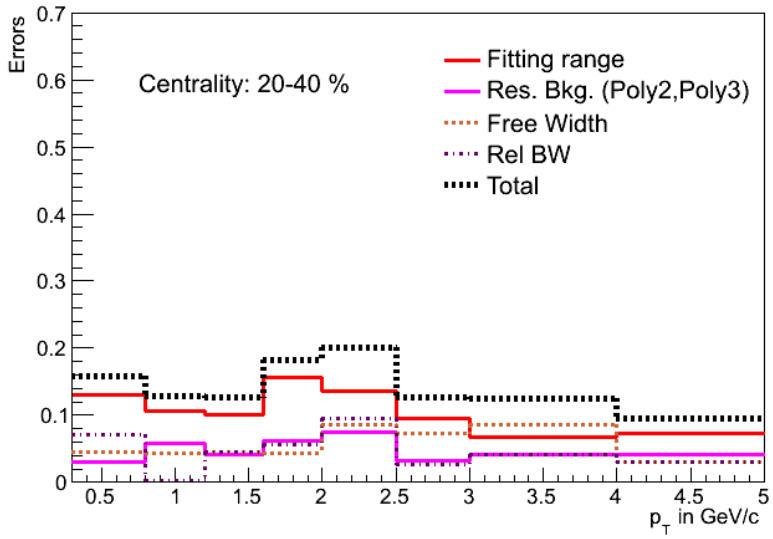


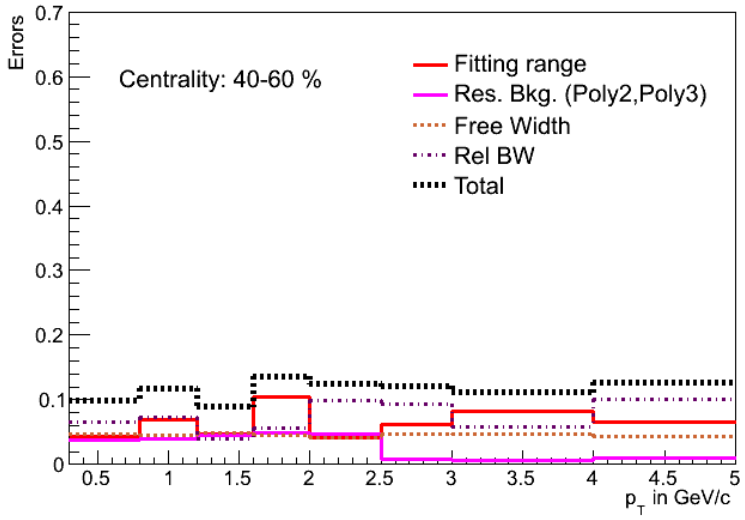
$E_{ratio} = E_{check}/Y_{def}$

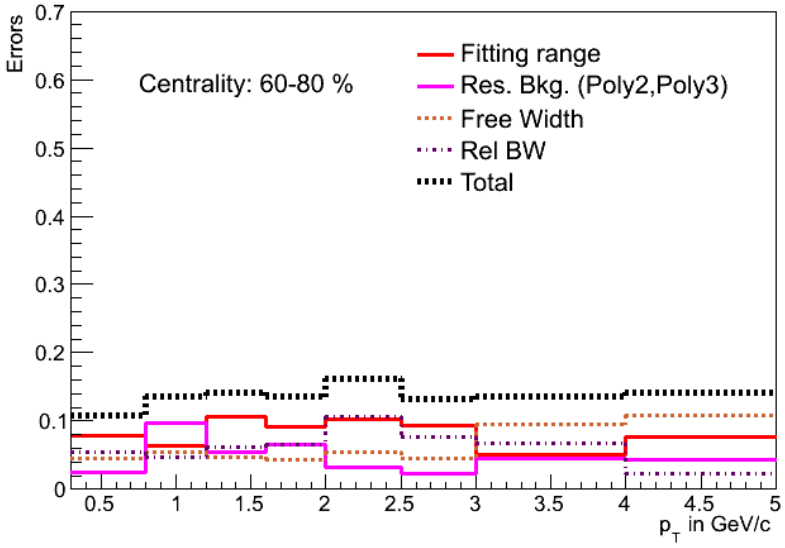


Sources of uncorrelated systematic uncertainty in K^{*0} yield

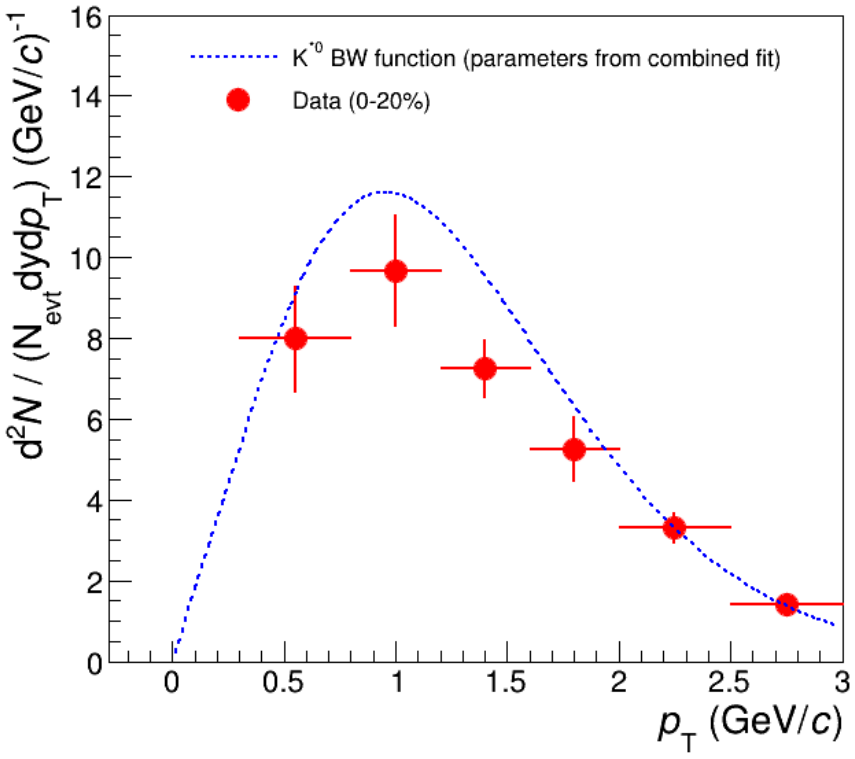


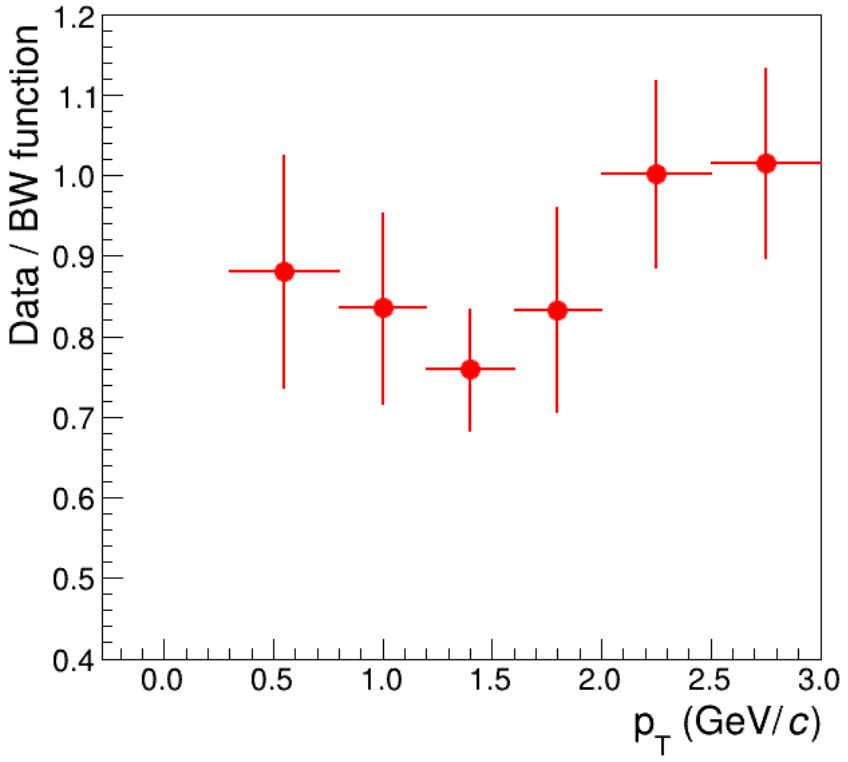






p_T Spectra of K^{*0}: Blast Wave predictions (0-20%)





Integral of BW function = 19.88
Integral of K* = 15.22

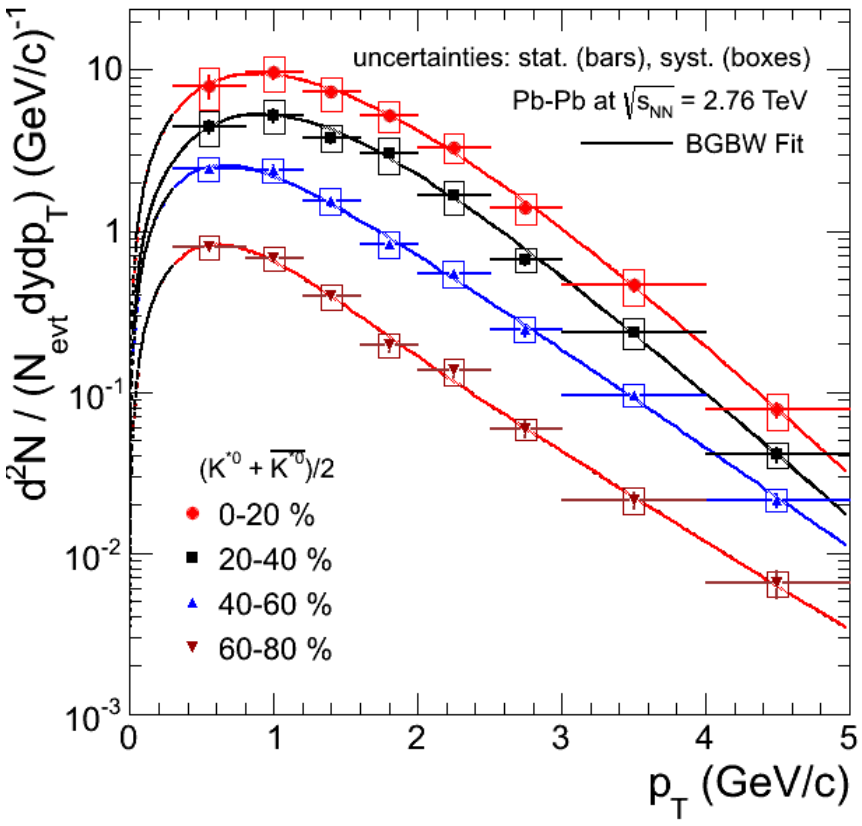
Blast wave parameters:

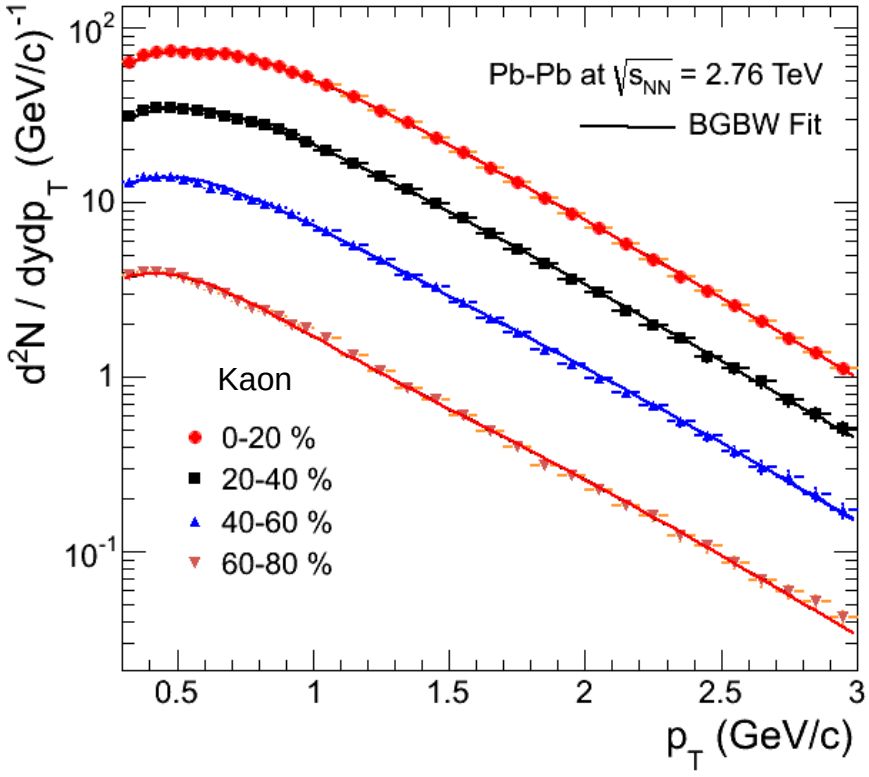
==========

beta_max = 0.878514
<beta> = 0.644618 +- 0.002296 (e+ = 0.002262, e- = -0.002292)
T = 0.096984 +- 0.002141 (e+ = 0.002103, e- = -0.002047)
n = 0.725690 +- 0.011371 (e+ = 0.011362, e- = -0.011364)
chi2 = 57.718817
ndf = 124.000000

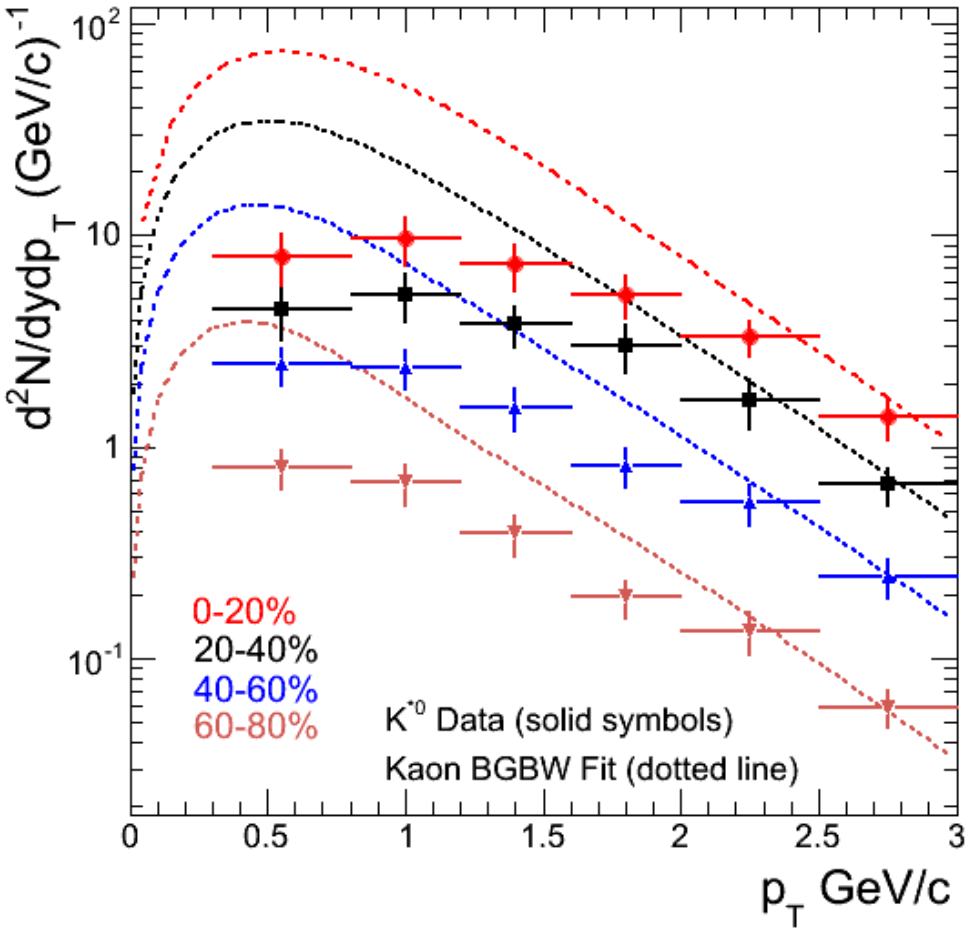
==========

K^{*0} /K as a function of p_T





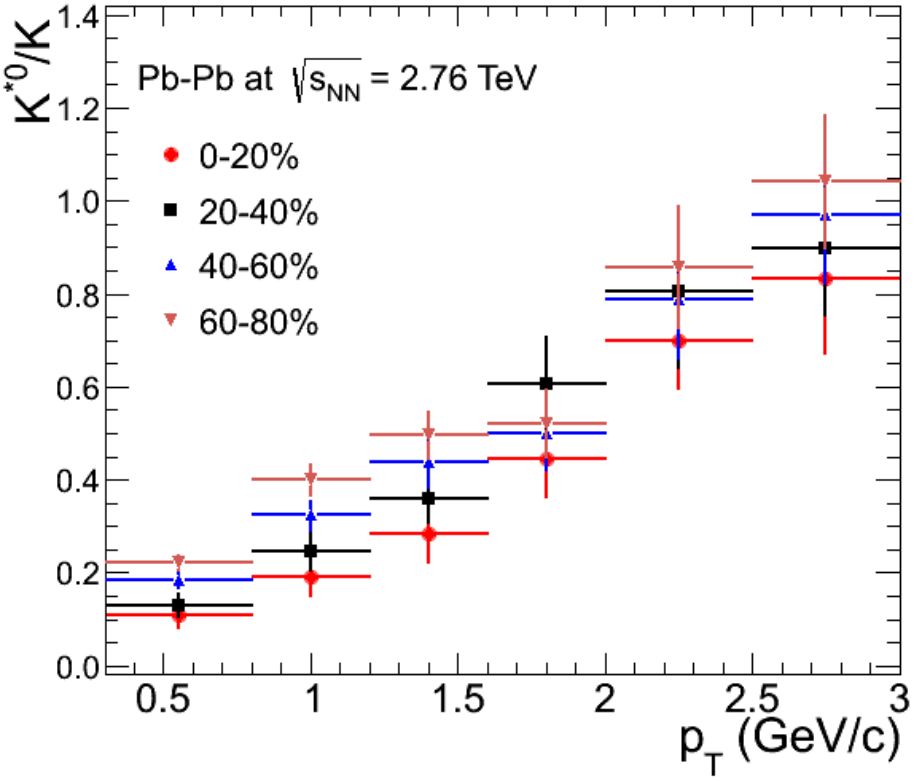
K^{*0} and K spectra



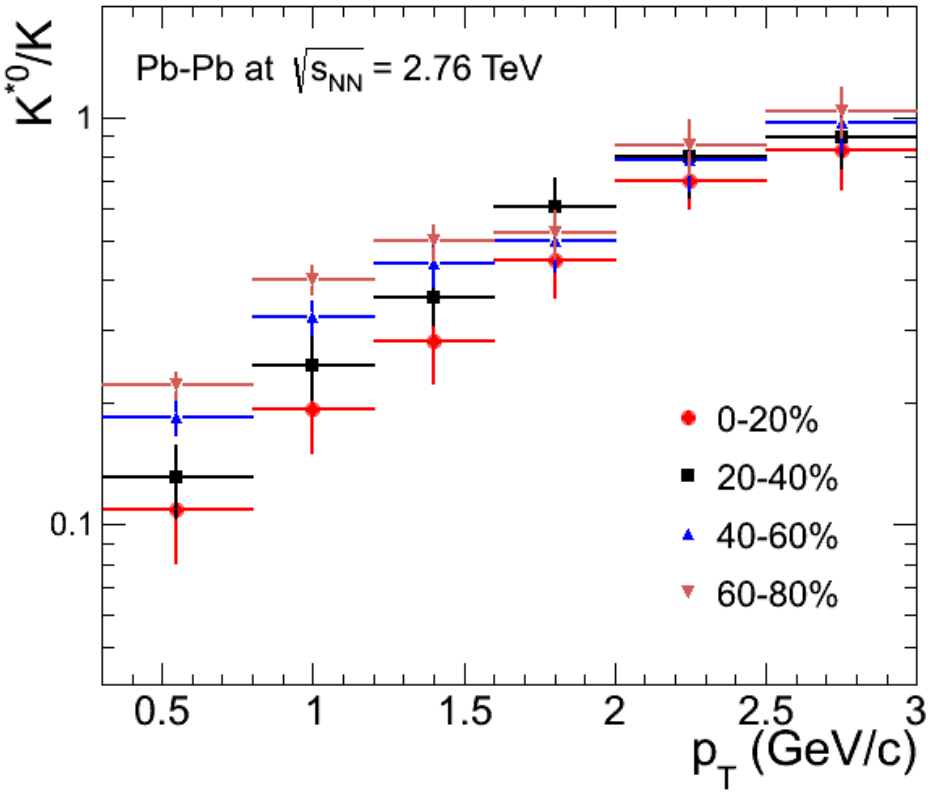
Since the p_T binning of Kaon and K^{*0} spectra are different, I have taken the Kaon yields using the fit function Boltzmann Gibbs Blast Wave.

$K^{*0}(p_T)/K(p_T)$

Linear scale

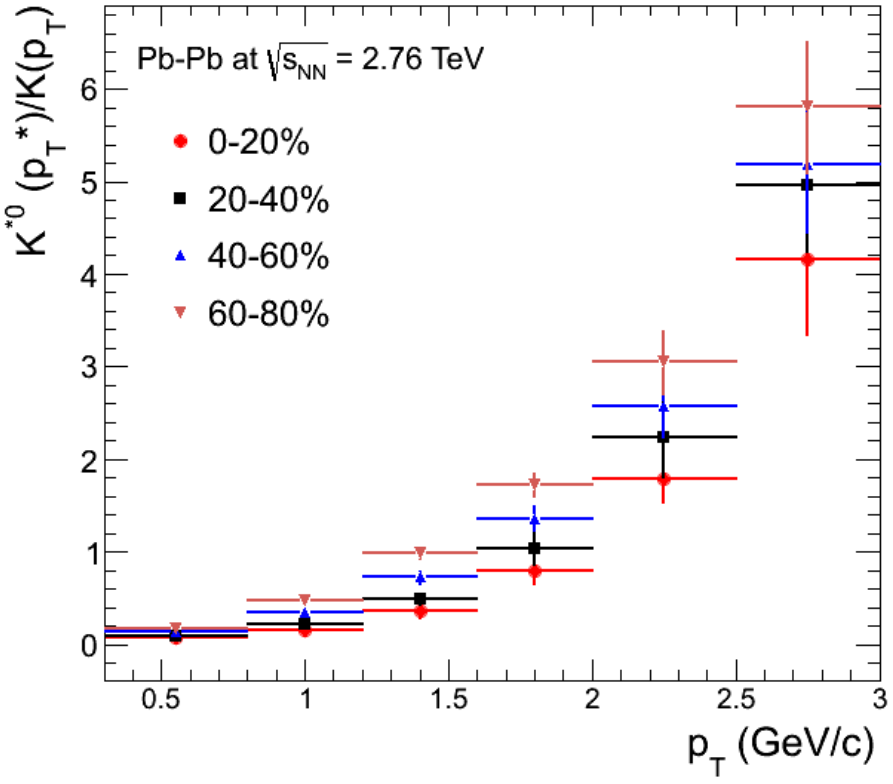


Log scale

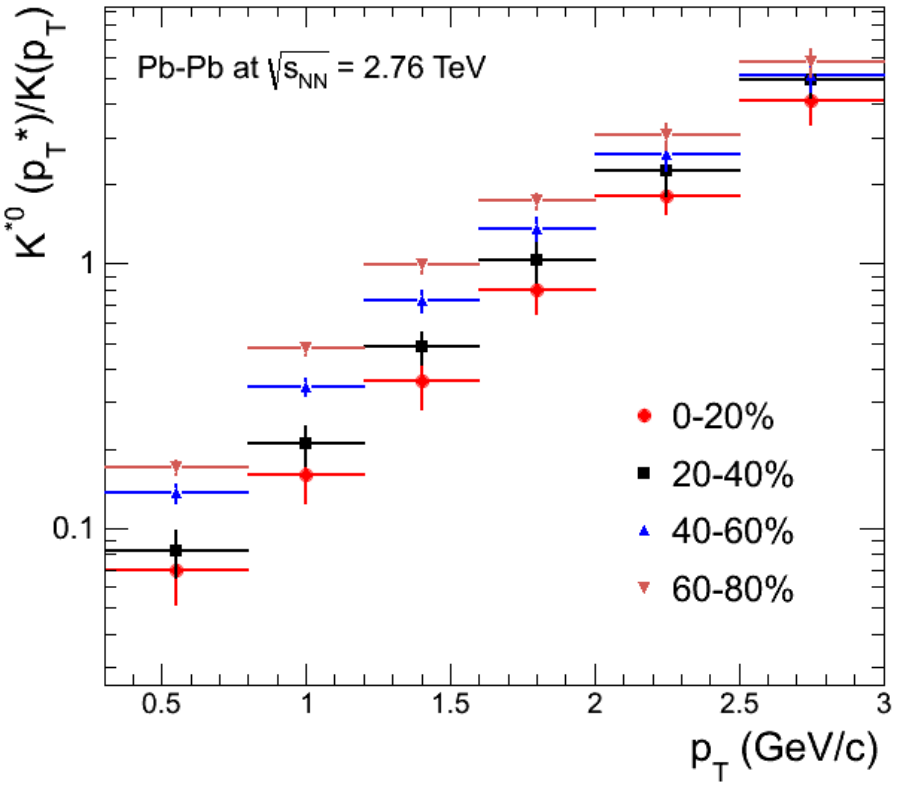


K^{*0} $(p^*_T)/K(p_T)$

Linear scale



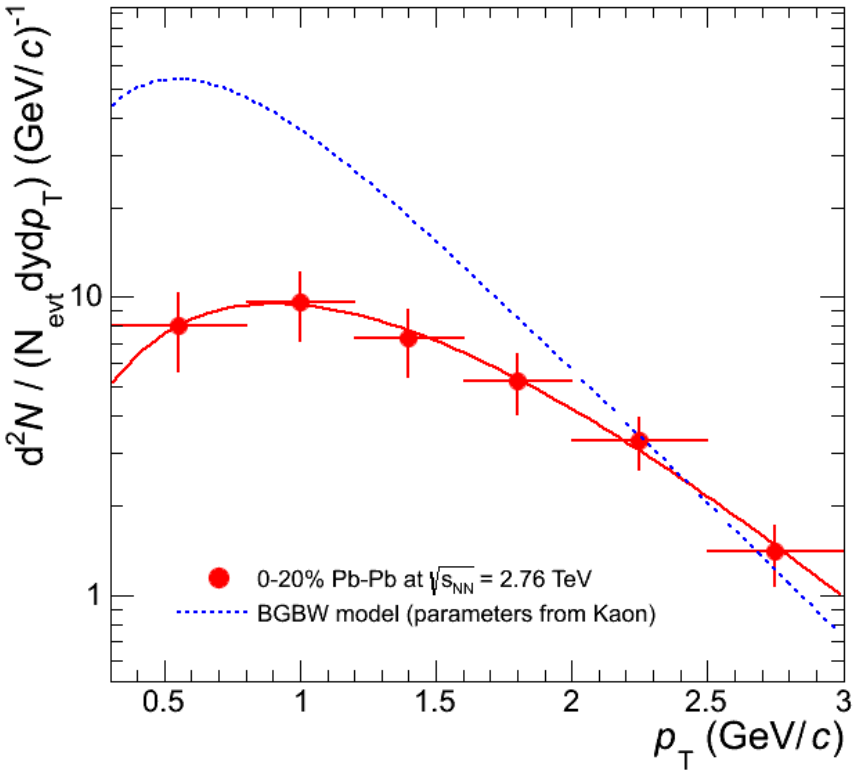
Log scale

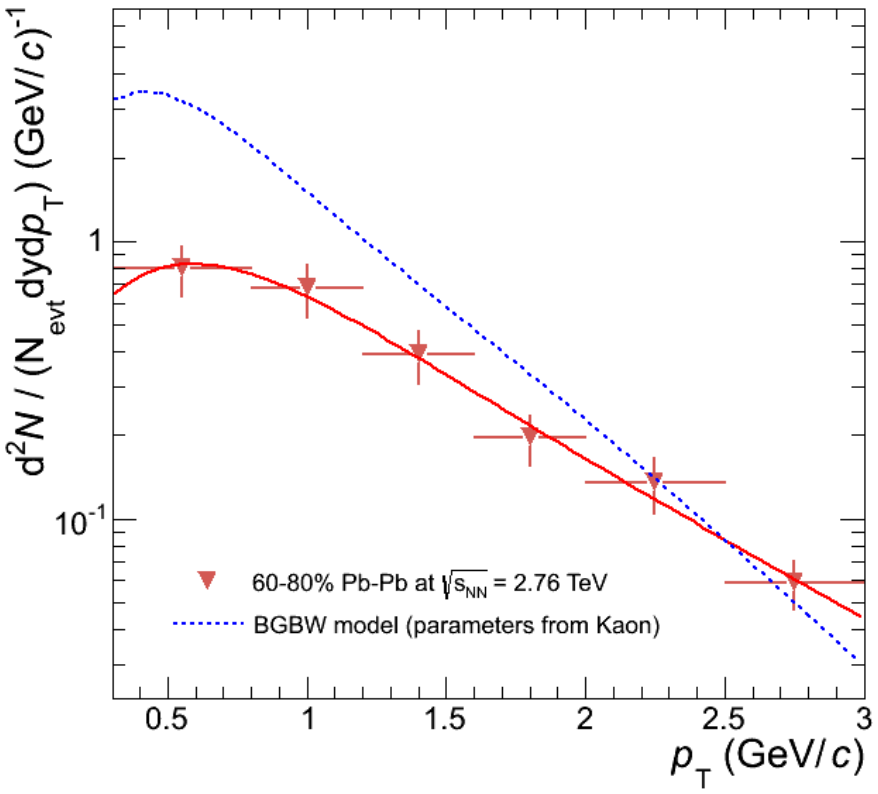


After mass correction for radial flow

$p^*_T = p_T (M_K/M_{K^*})$

K*0 and K spectra: With BGBW model

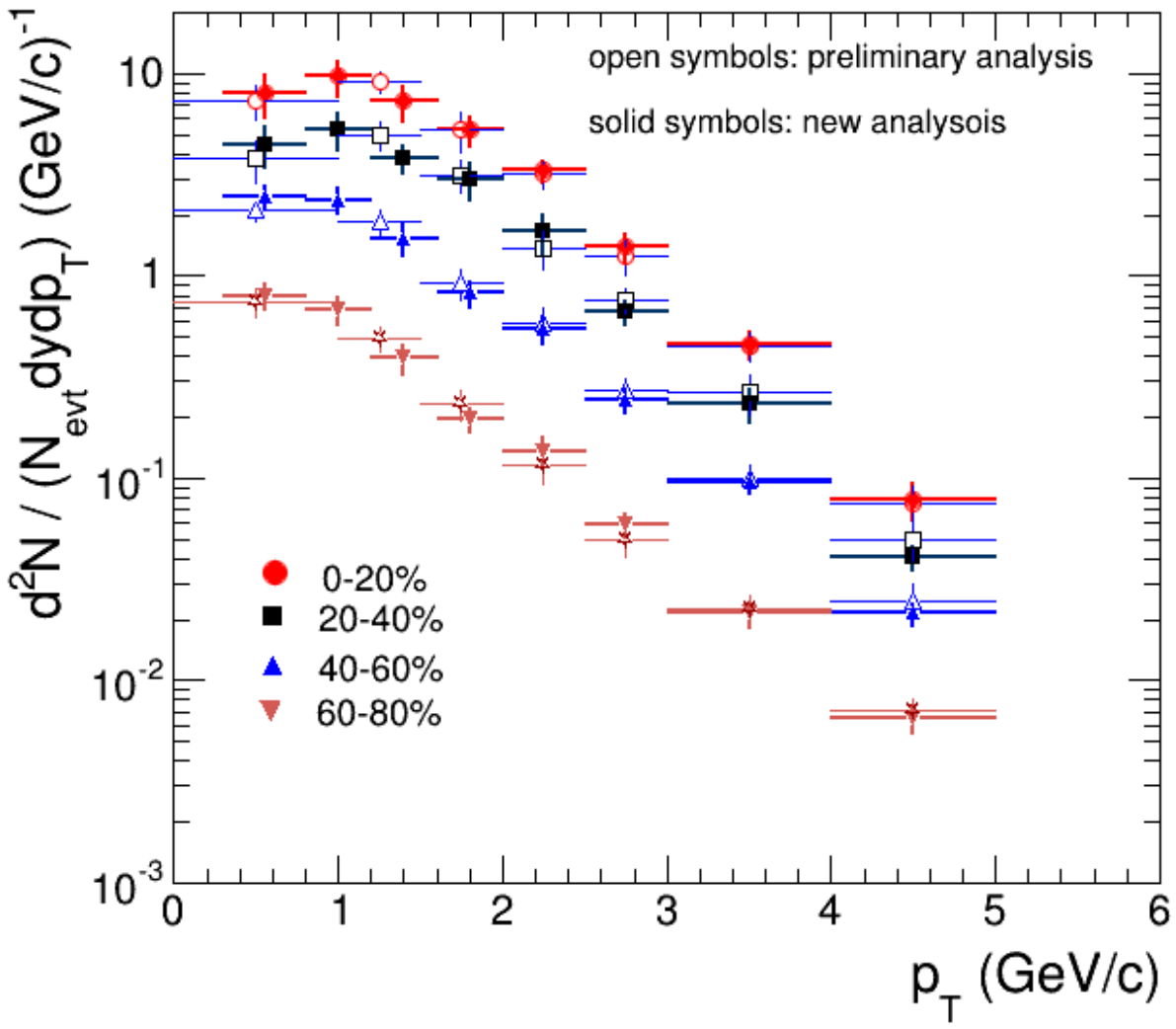




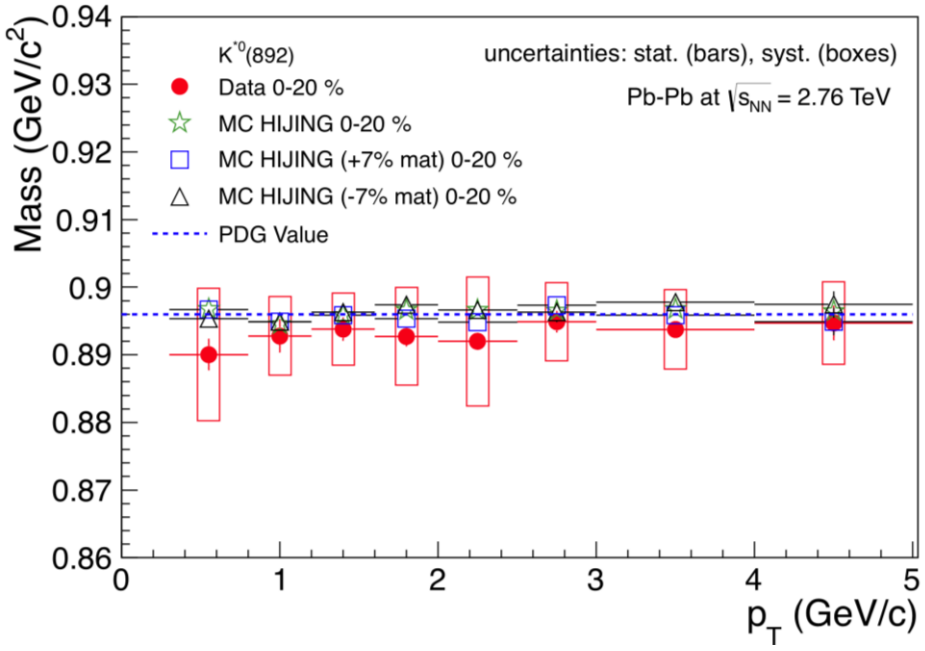
K*0 BGBW model with parameters taking from Kaon

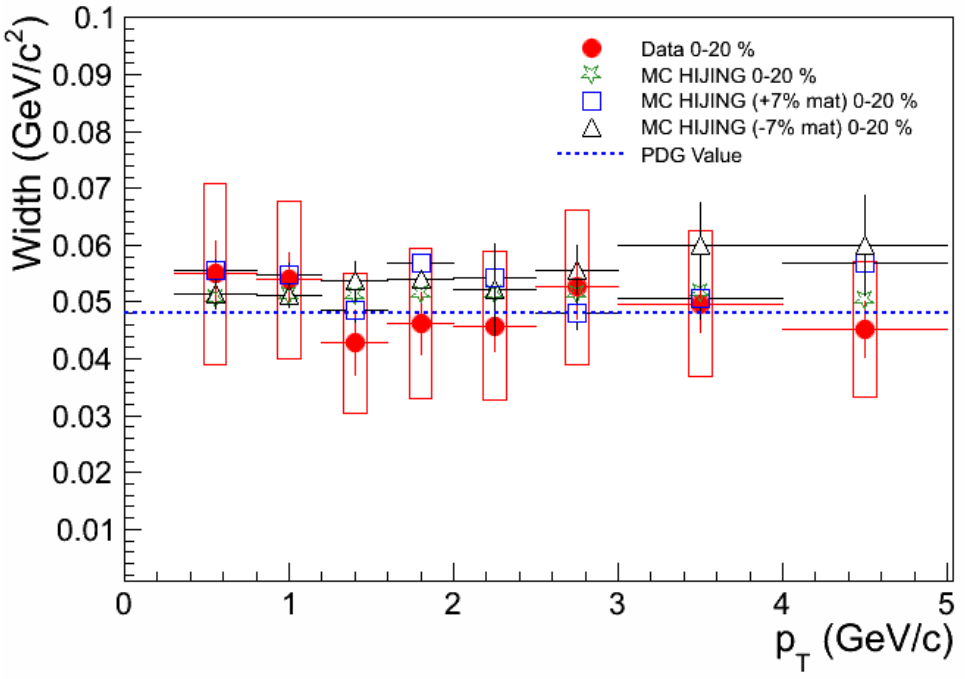
Comparison with preliminary analysis

Comparison: K^{*0} Spectra



K*^{0} : Mass/Width : Material Budget productions

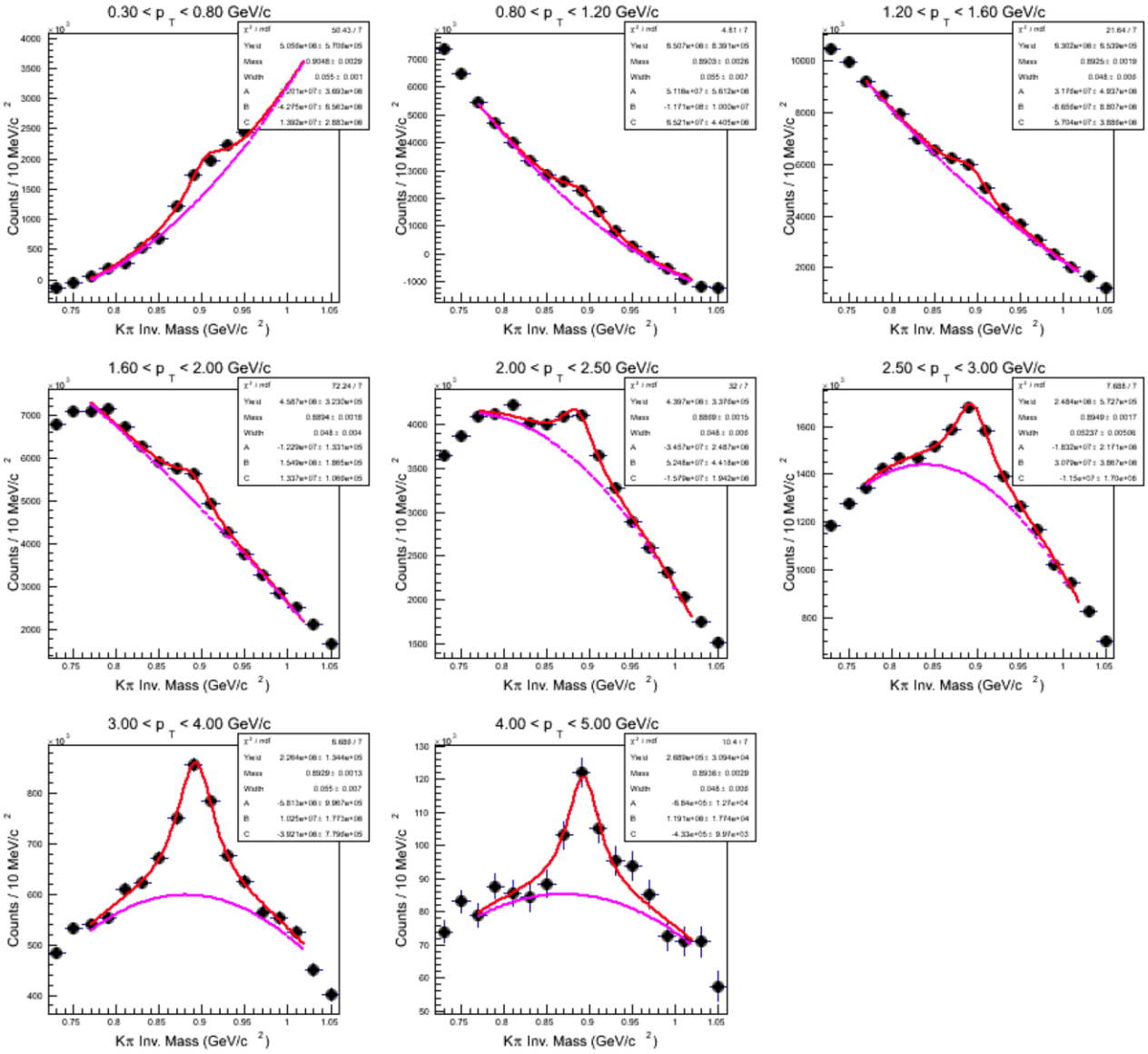




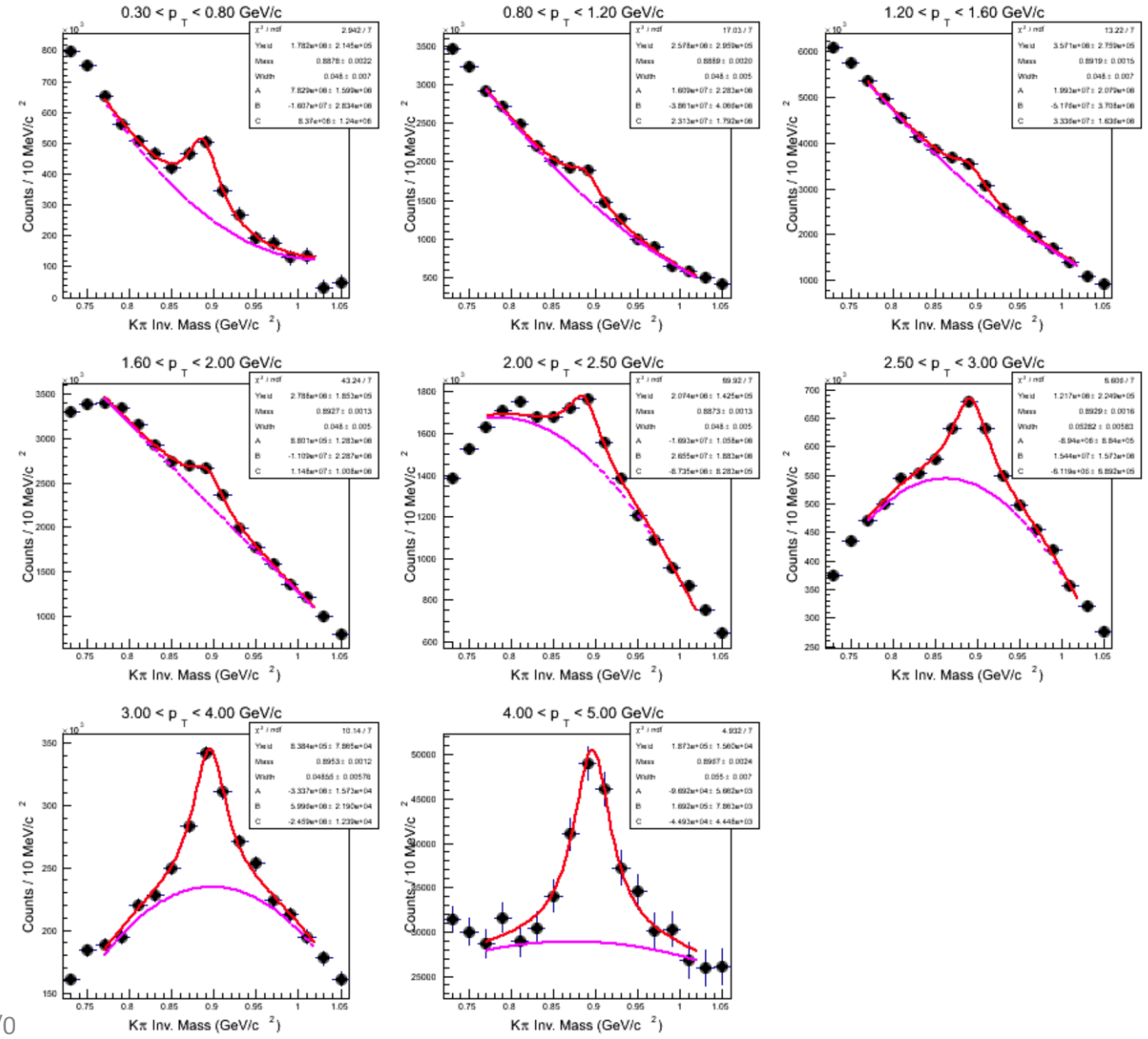
Mat. Budg. Productions:
LHC10h9 →Pb-Pb Hijing (137366), 25 K events, +7% material
LHC10h10 →Pb-Pb Hijing (137366), 25 K events, -7% material

K^{*0} Signals

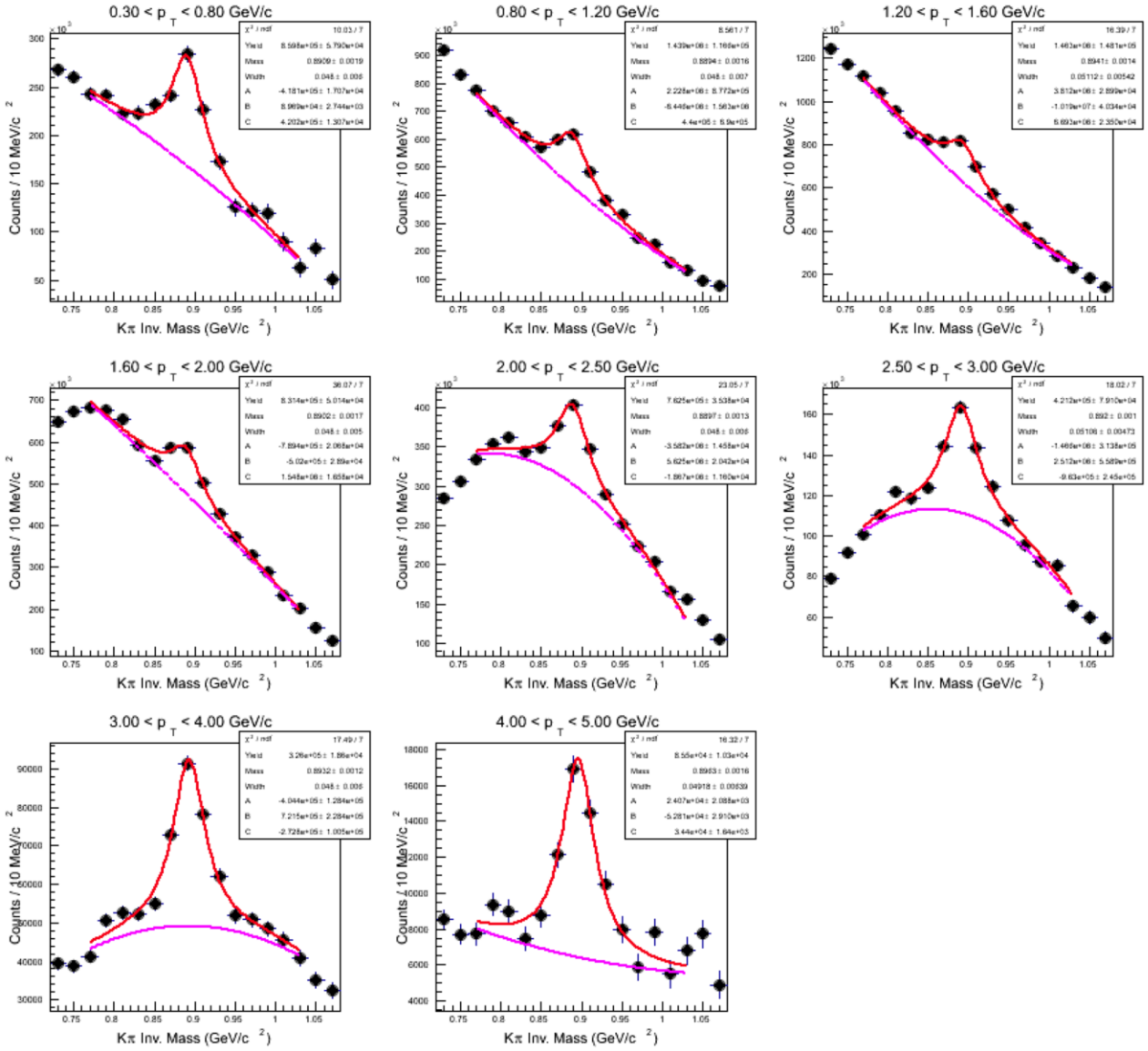
K*^{0} signals : BW Fits (TPC analysis) 0-20%



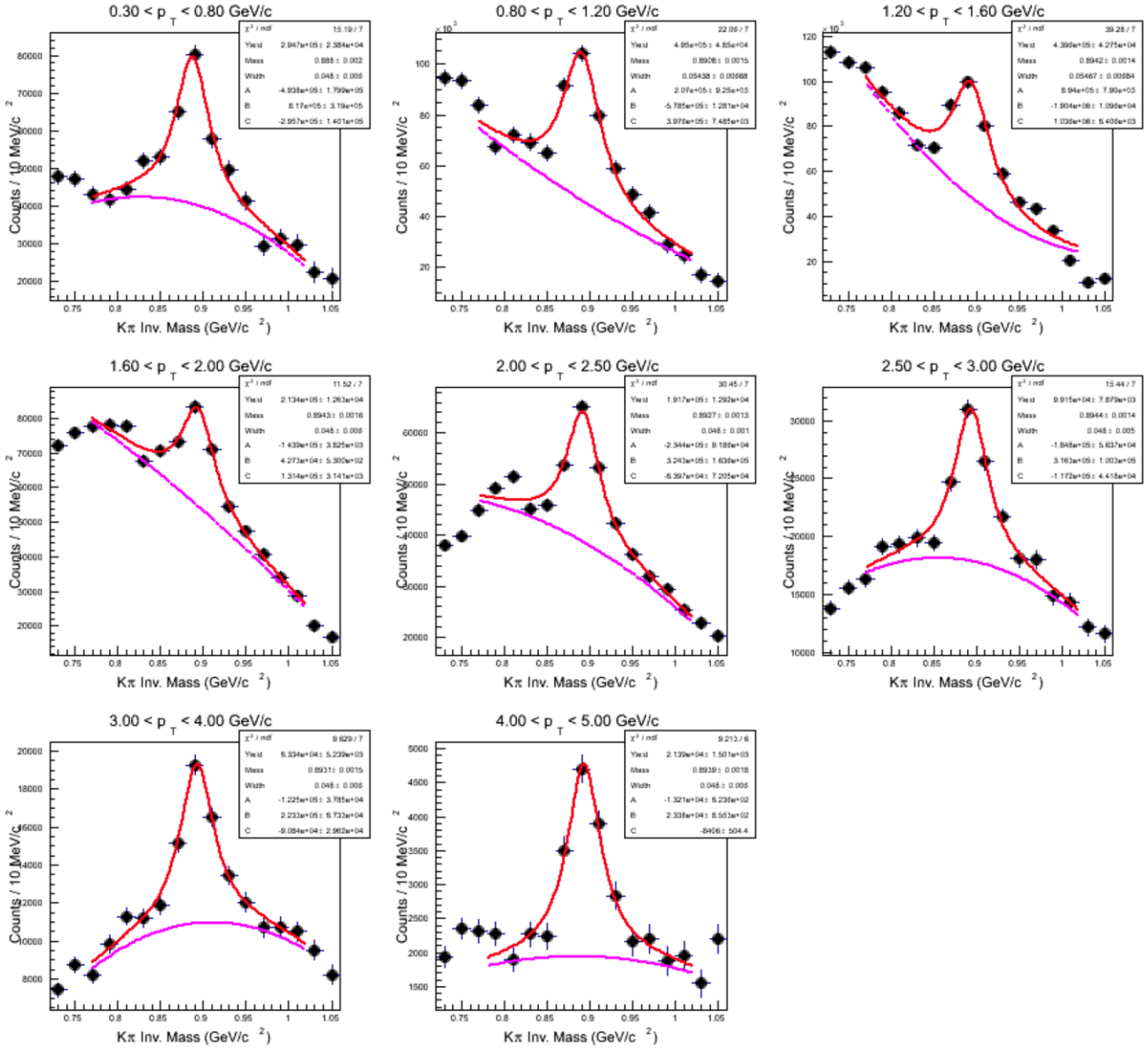
K*^{0} signals : BW Fits (TPC analysis) 20-40%



K*^{0} signals : BW Fits (TPC analysis) 40-60%

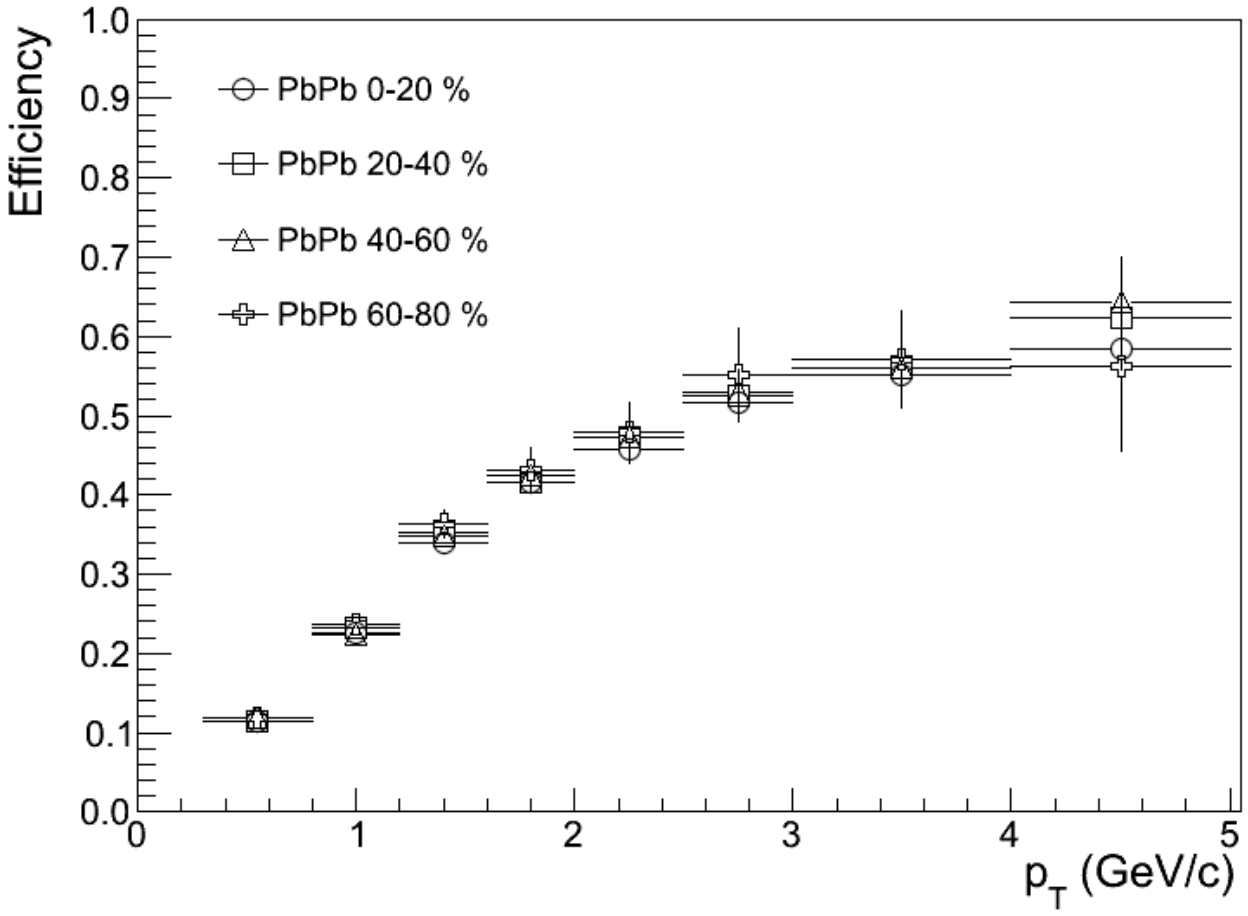


K*^{0} signals : BW Fits (TPC analysis) 60-80%



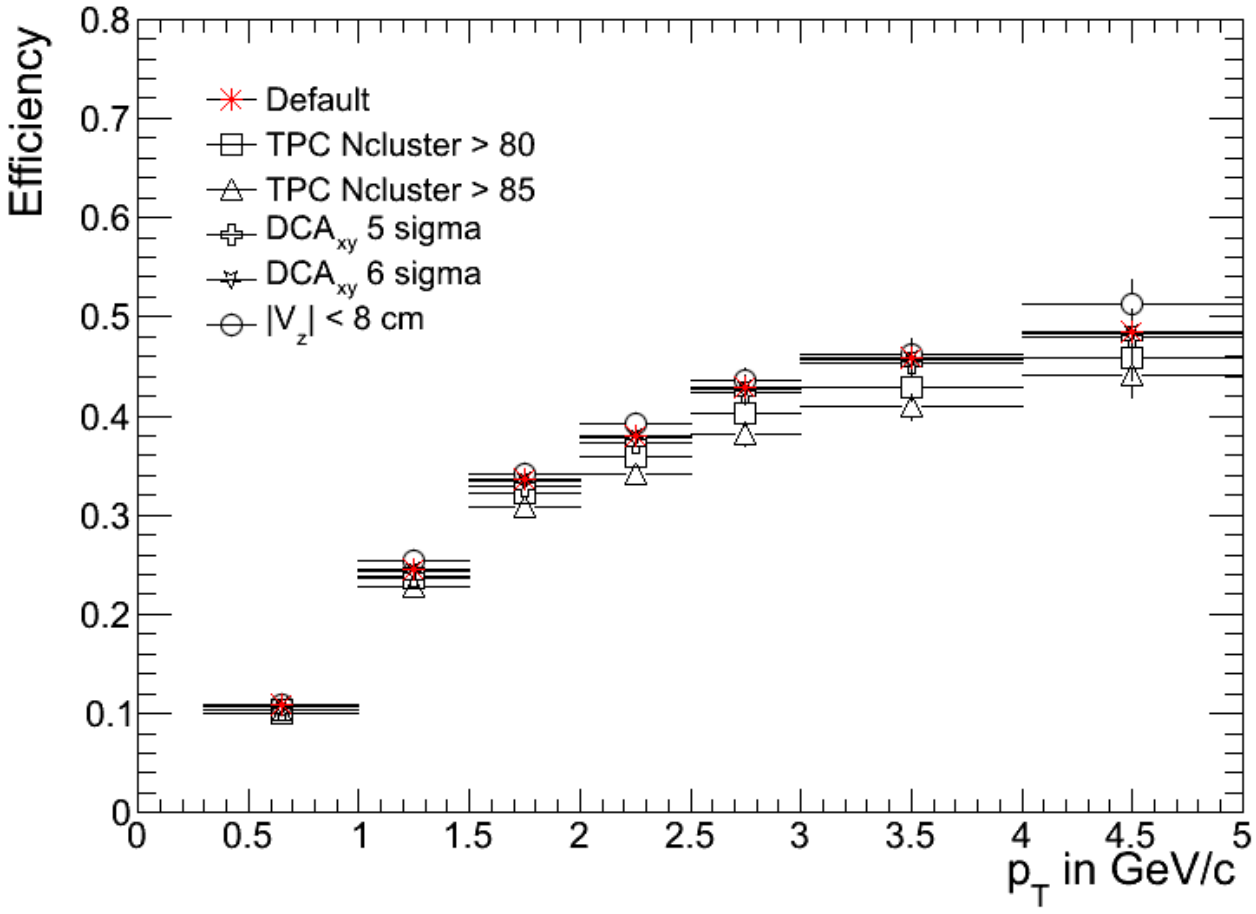
Efficiency x Acceptance

Efficiency x Acceptance

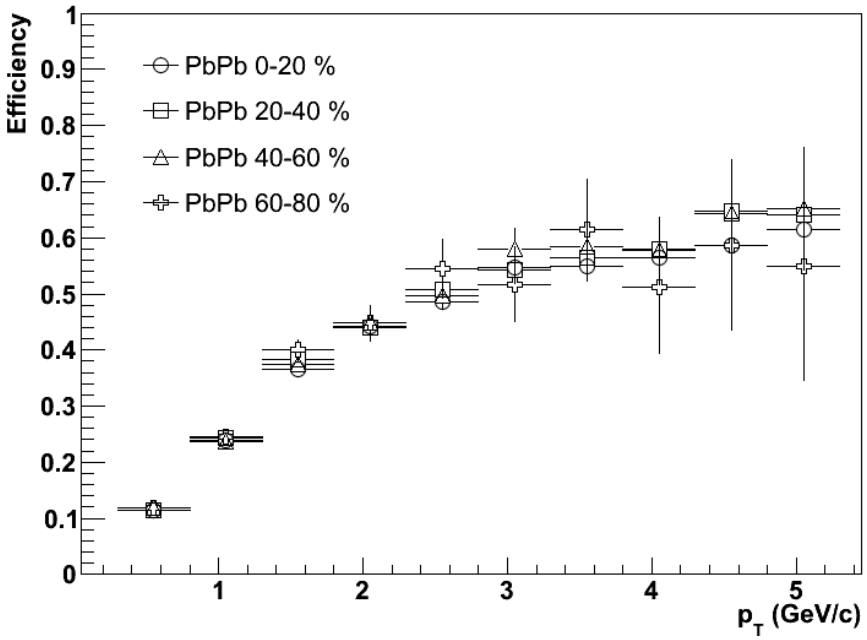


Production: LHC10a11a_bis/ESDs

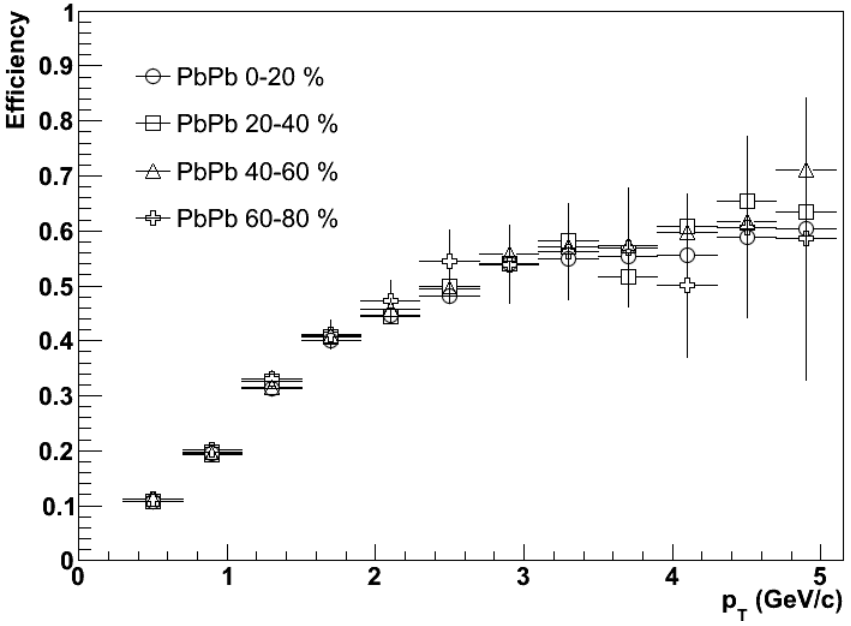
Efficiency of K* with different event and track selections



Efficiency of K* with different pT combinations

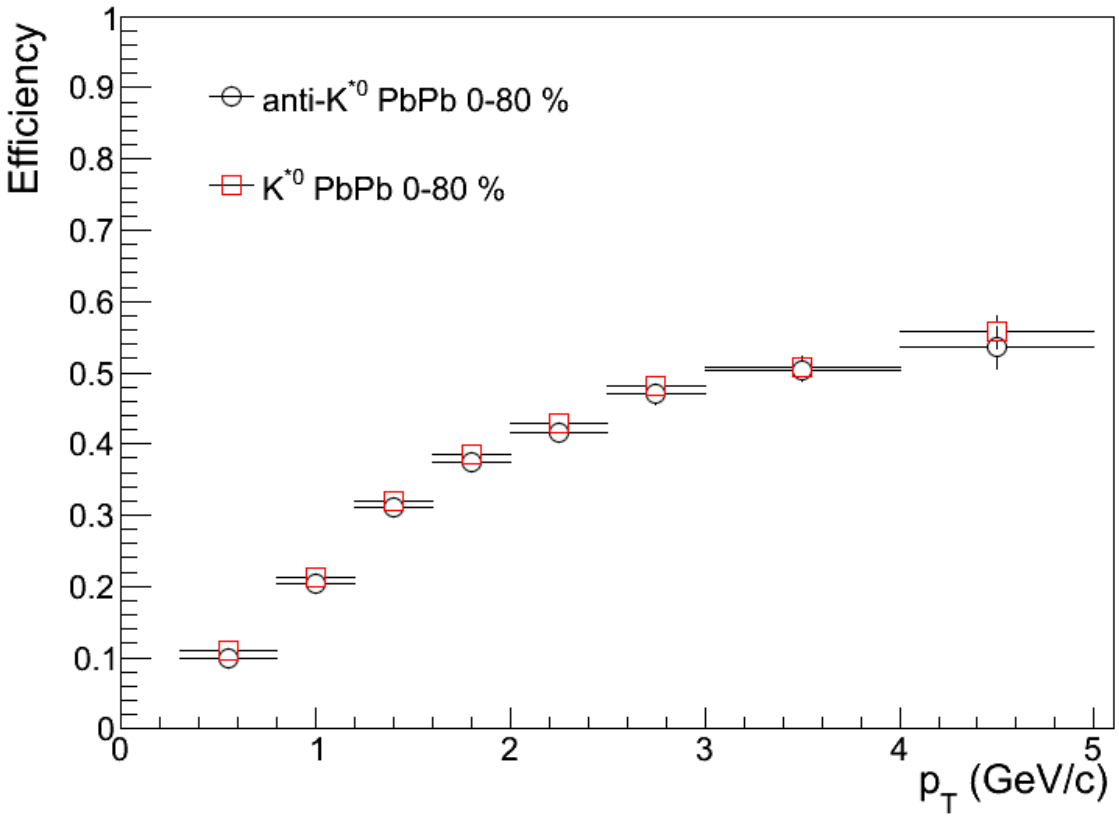


(0.3-5.0) in 0.5 GeV step



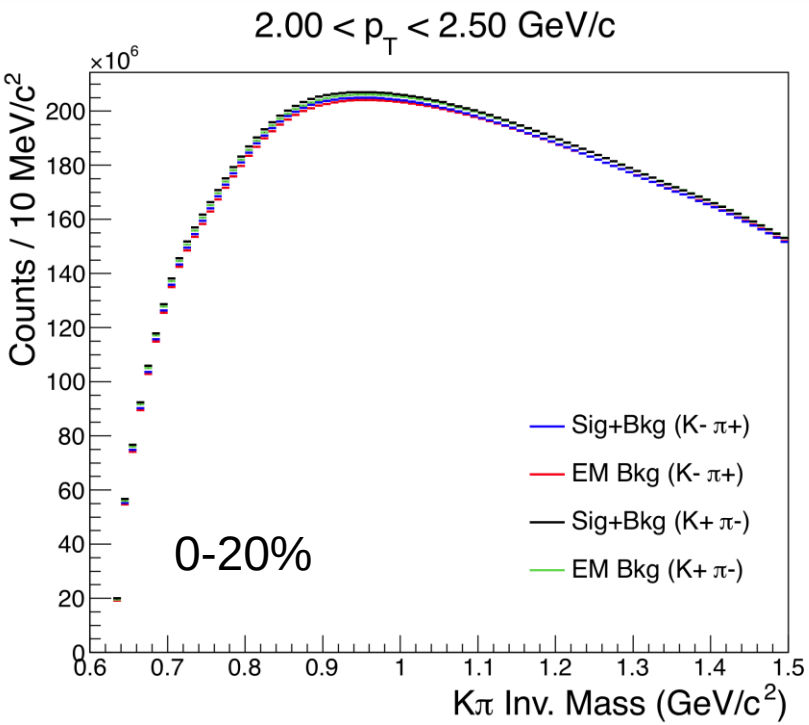
(0.3-5.0) in 0.4 GeV step

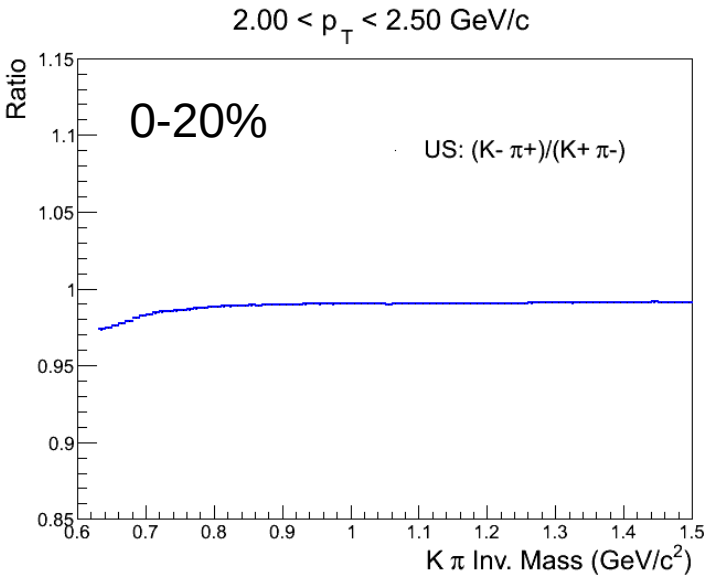
Efficiency of K* and anti-K*

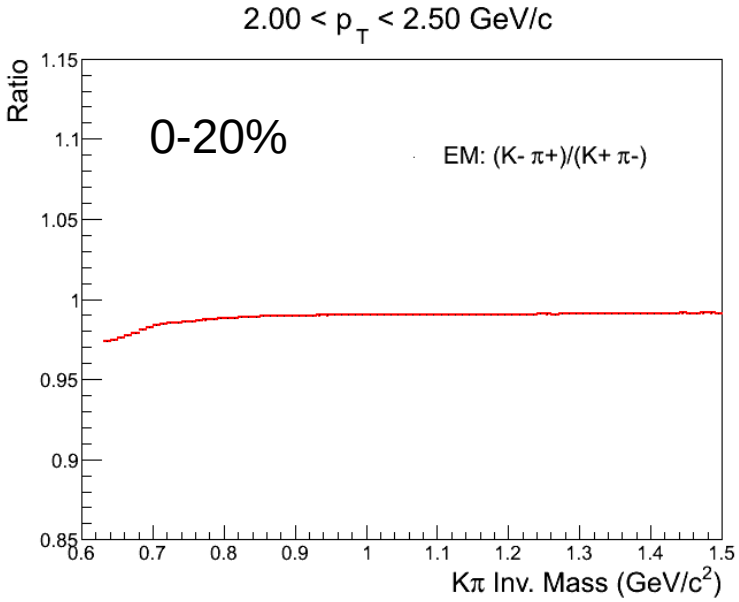


Looking at K* and anti-K* separately

An example:
Comparison K+ π- and K- π+ distributions



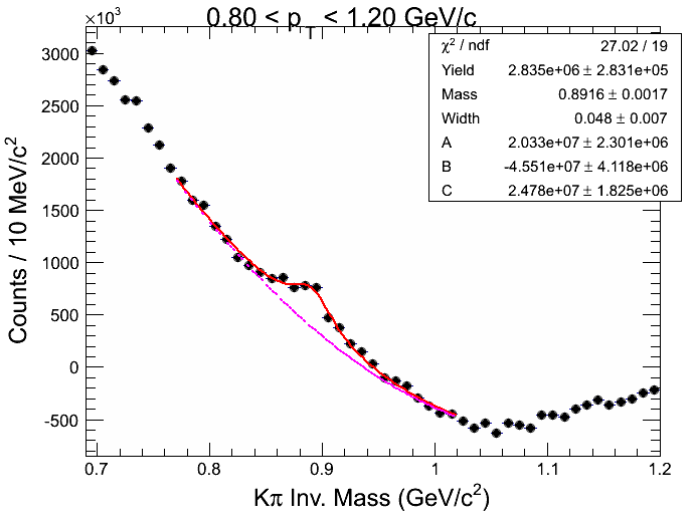


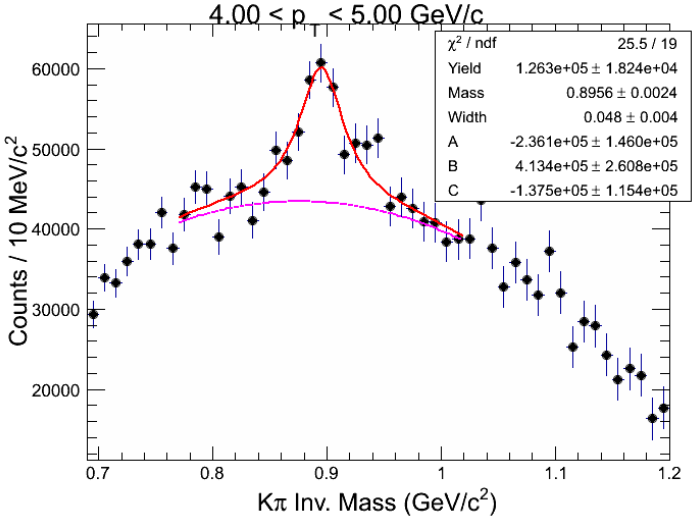


Difference ~ 2%

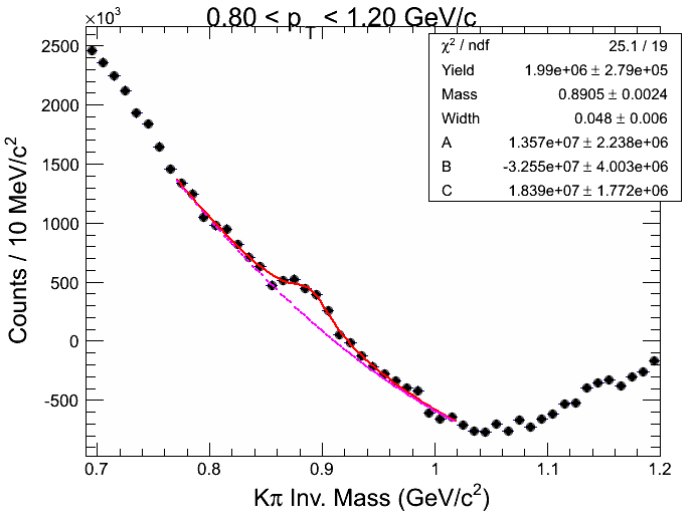
K*/anti-K* signals : 0-80%

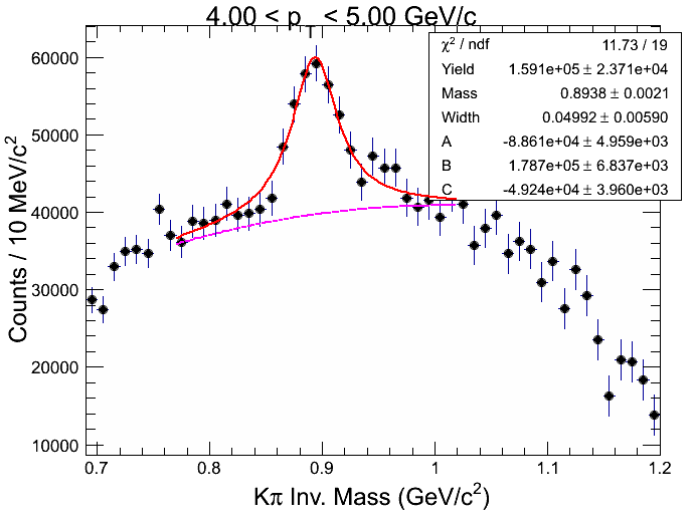
K*



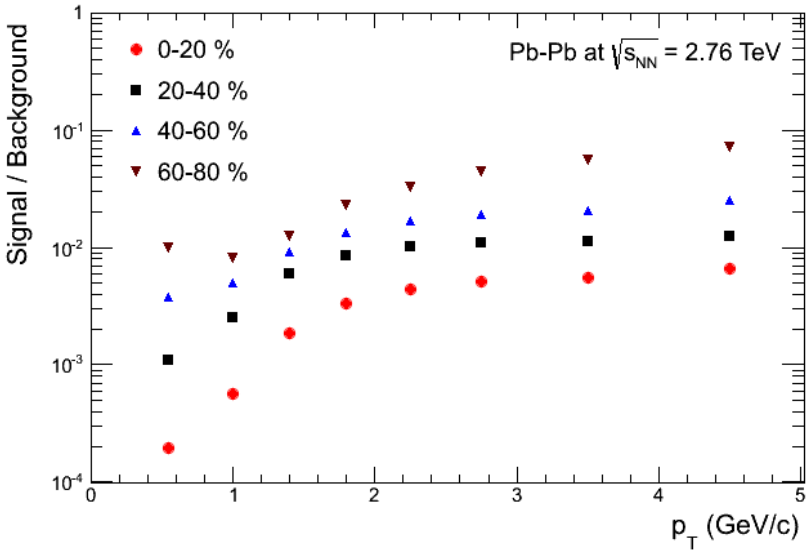


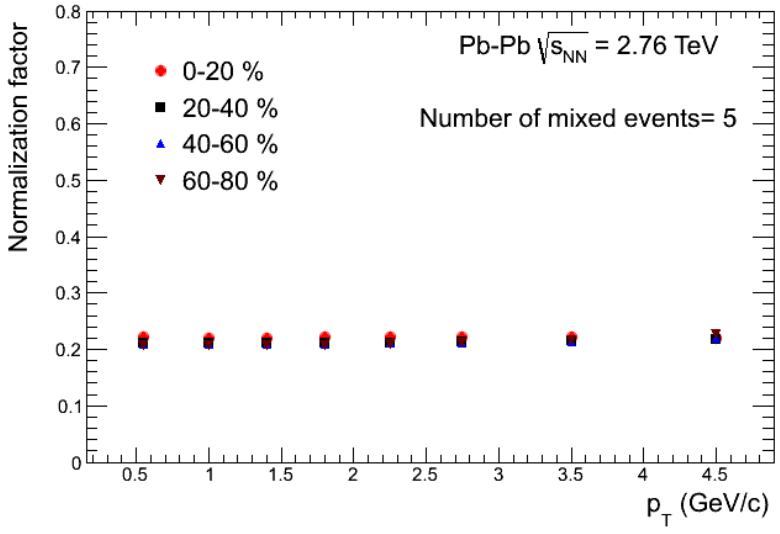
Anti-K*

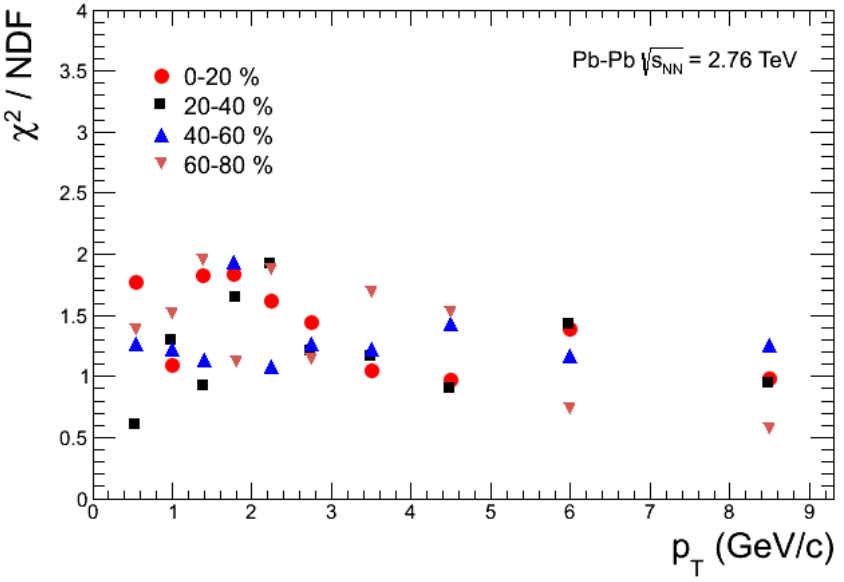




Other plots


Signal / Background
0-20 %
20-40 %
40-60 %
60-80 %
Pb-Pb at $\sqrt{s_{NN}}$ = 2.76 TeV
p_T (GeV/c)


Normalization factor
0-20 %
20-40 %
40-60 %
60-80 %
Pb-Pb $\sqrt{s_{NN}}$ = 2.76 TeV
Number of mixed events= 5
p_T (GeV/c)


χ^2 / NDF
0-20 %
20-40 %
40-60 %
60-80 %
Pb-Pb $\sqrt{s_{NN}}$ = 2.76 TeV
p_T (GeV/c)