Update on high pt neutral meson production in heavy ion collision

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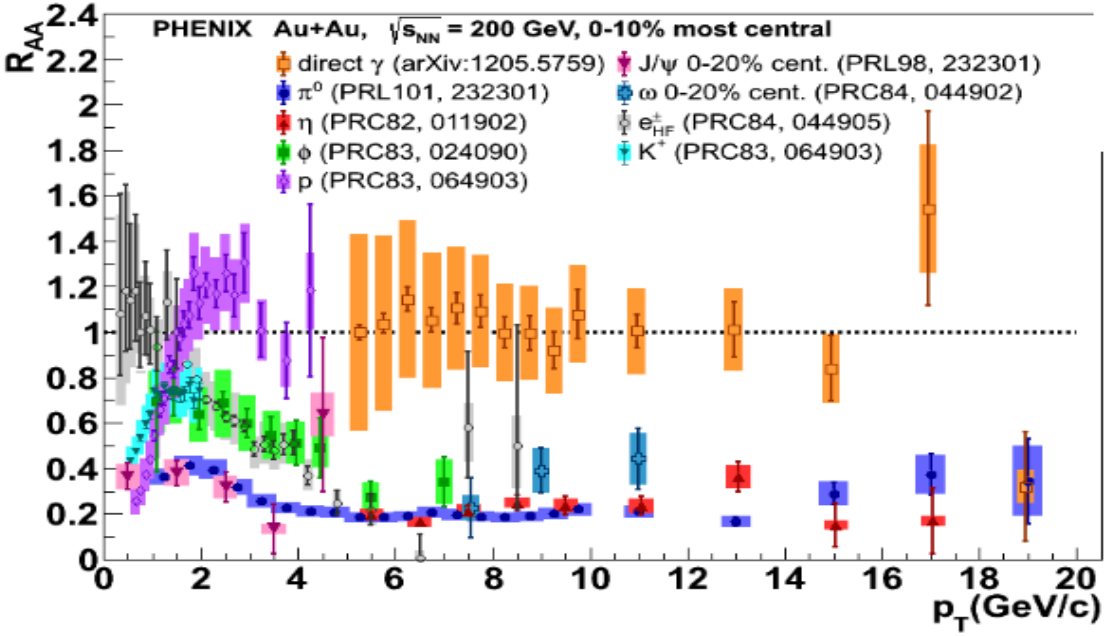
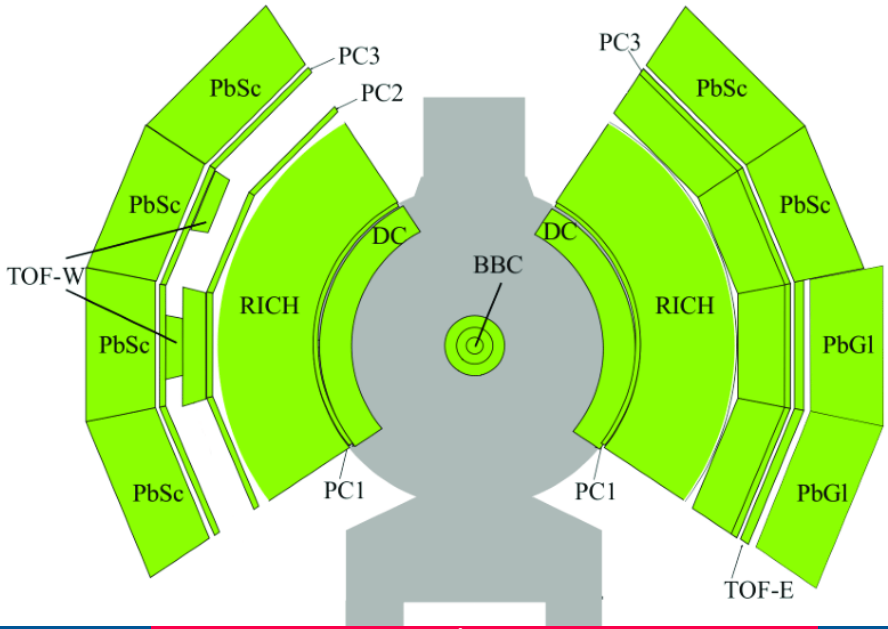
Motivation

- The main particles: π^0, η, ω.
- All the 3 particle have decay channels to γ
- $\pi^0 \to 2\gamma \parallel \eta \to 2\gamma \parallel \omega \to \pi^0 + \gamma$
- The Run16 collected a large amount of data, vastly exceeding the statistics of all similar data taken earlier
- This makes it possible to extend the transverse momentum range + improve the systematic uncertainties



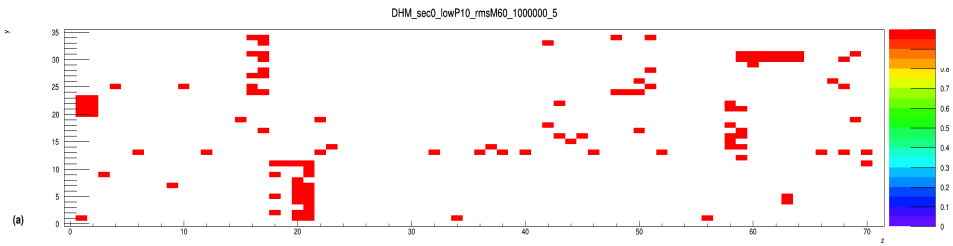
PHENIX Detector

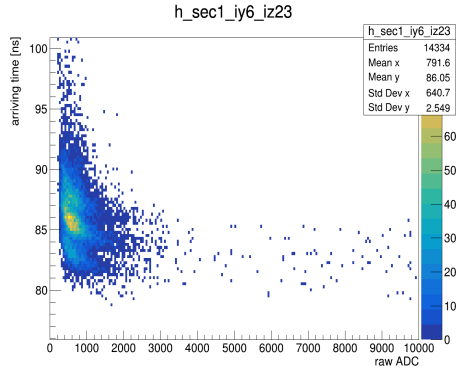
- The η particles also decays into 2γ, like π^0, but the ω decays into 3γ, via a π^0
- The analysis of these particles is same in the sense, that we are searching γ-s
- But the mass differences and the $\omega \to \pi^0 + \gamma$ channel complicates the analysis
- There will be differences in the minimum opening angle too, that means for the 3 cases we need 3 different sector condition

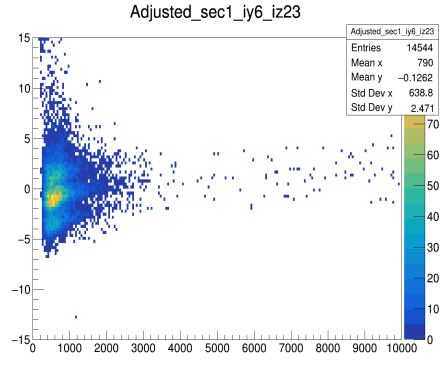


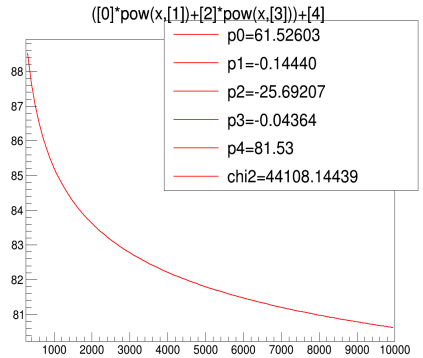
Good calibration

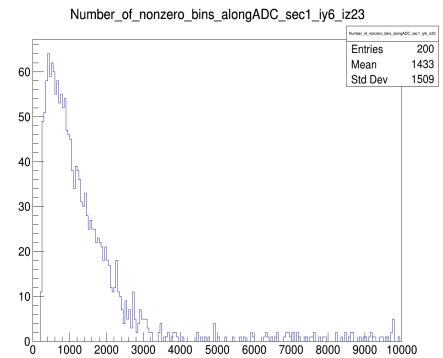
- To be sure that you are identifying photons correctly, you first need to calibrate your properly.
- Two methods: Dead Hot Map + Timing Calibration
- With an energy dependent cut, the bad and good towers were selected
- The fitting function for slewing that corrected every tower within 5ns:
  $([0]) * pow(x, [1]) + [2] * pow(x, [3]))$

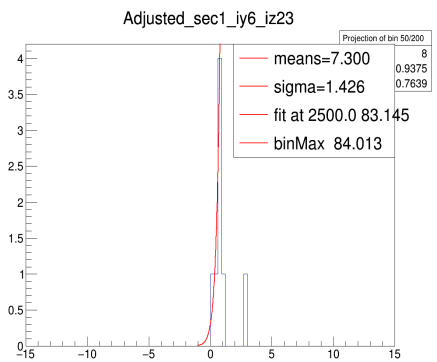


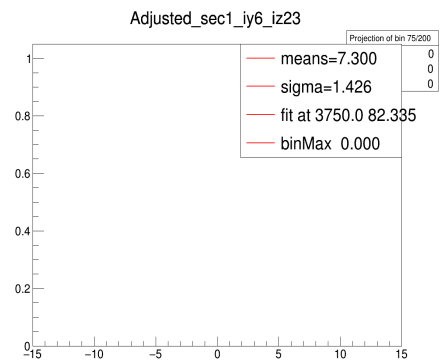






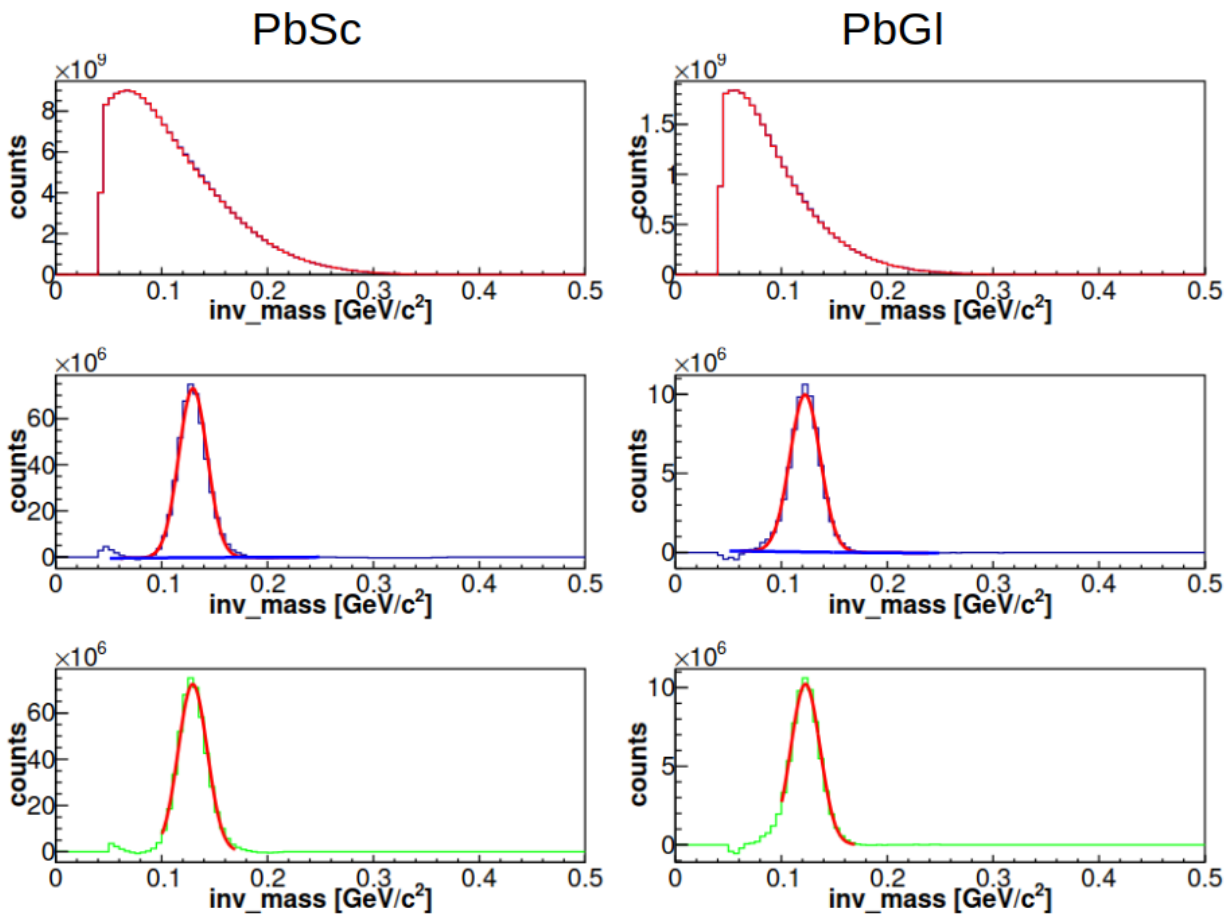






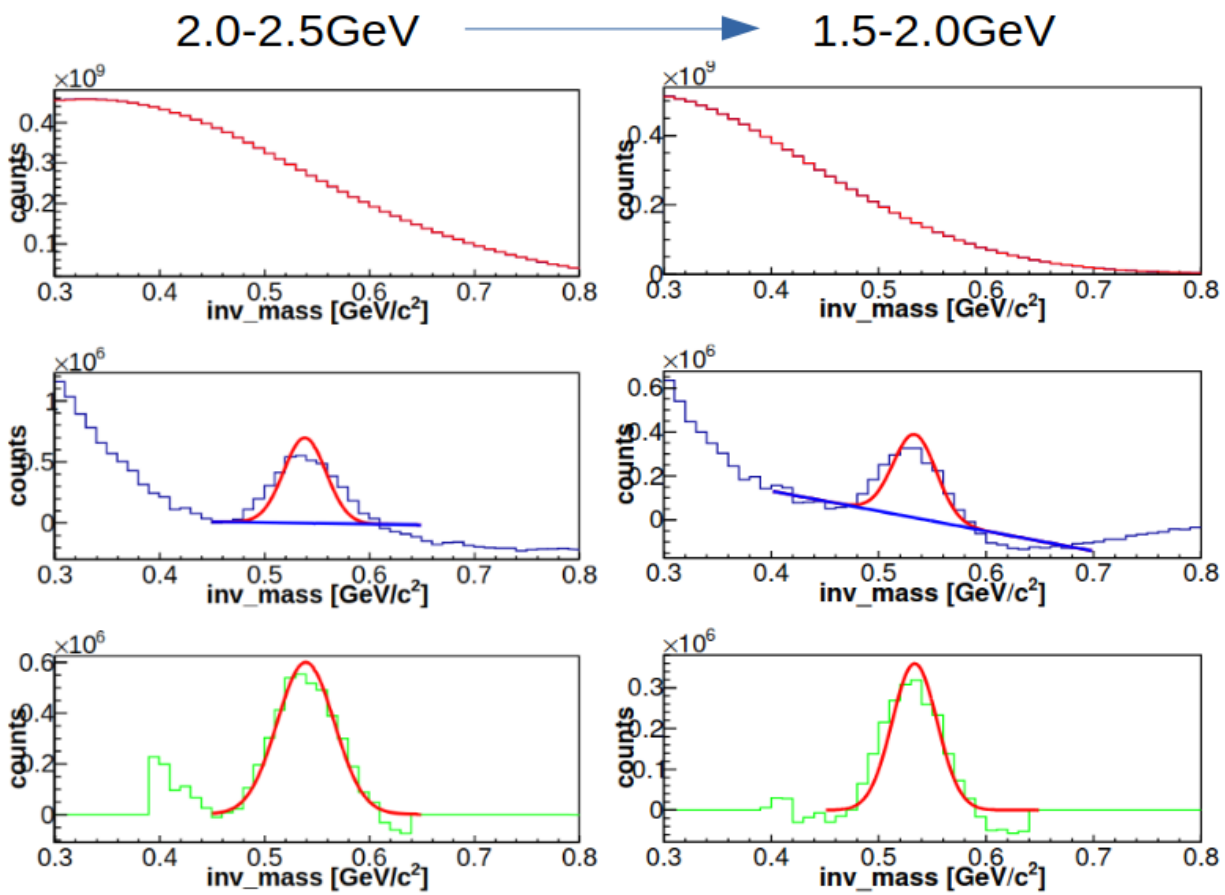
Raw invariant mass for π^0

- Mixed event subtraction
- 0.5-1.0GeV
- 5ns tof cut
- No pid cut
- MB trigger (BBCLL1 > 0 narrowvertex)
- MB centrality $0 - 100\%$



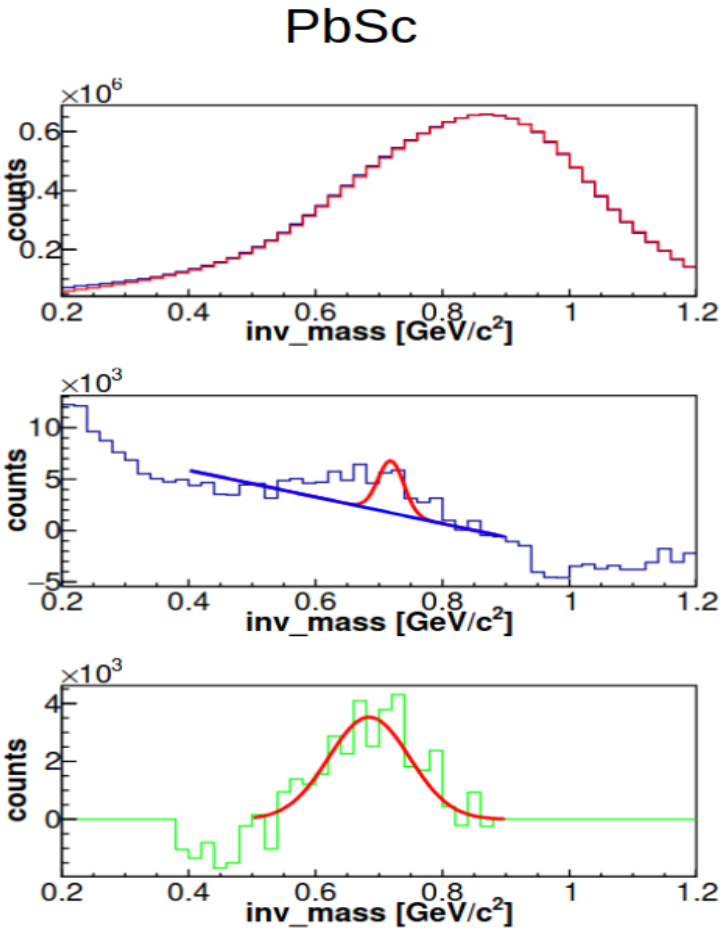
Improved Raw invariant mass for η

- Mixed event subtraction
- PbSc
- 5ns tof cut
- No pid cut
- MB trigger (BBCLL1 $>$ 0 narrow vertex)
- MB centrality $0 - 100\%$



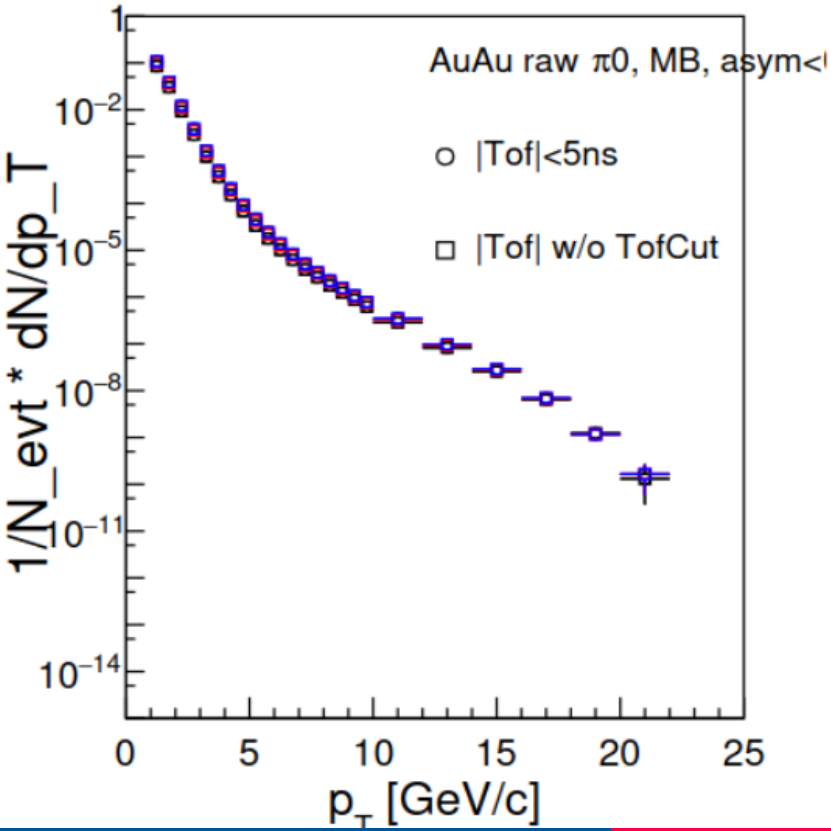
Raw invariant mass for ω

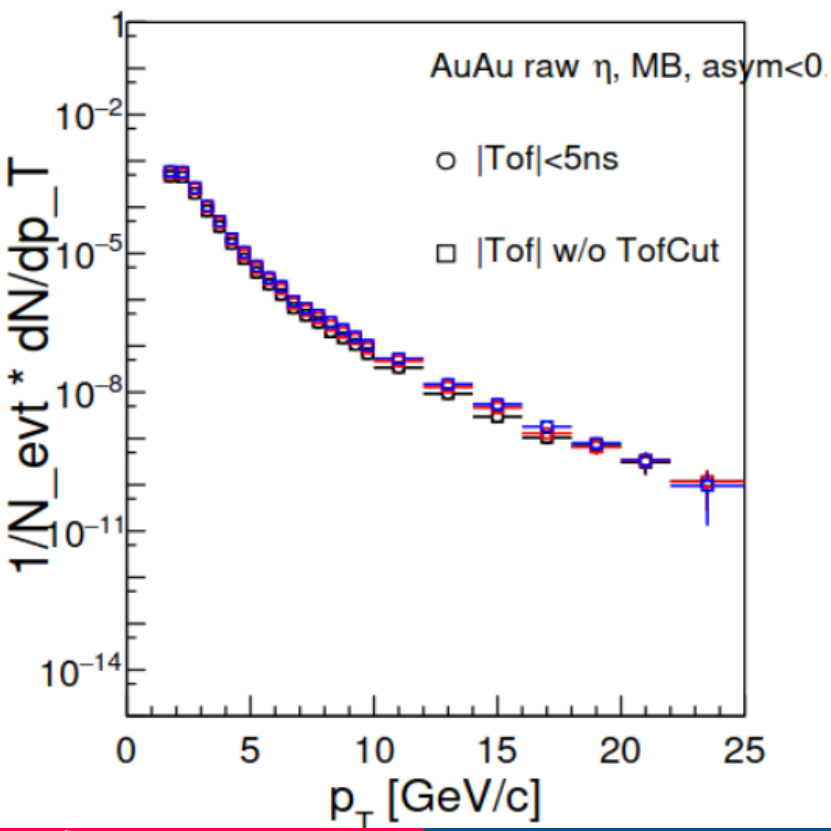
- Mixed event subtraction
- 1.0-3.0GeV
- 5ns tof cut
- No pid
- ERT trigger
- MB centrality $0 - 100\%$



From Invariant mass to Combined raw spectra

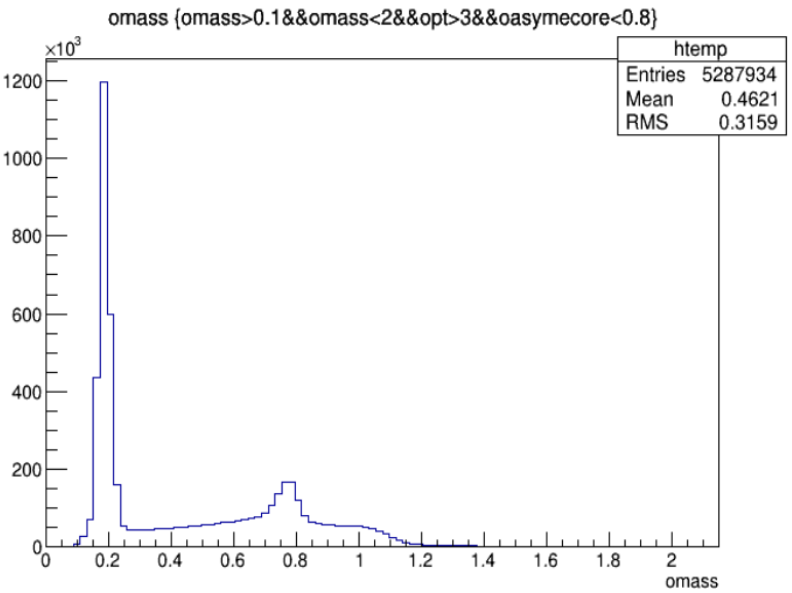
- Extract the peak content from every invariant mass peak all the 0-30GeV $\rightarrow$ got the Raw spectra
- Then compare the MB and ERT to each other $\rightarrow$ Normalization factor $\frac{ERT}{MB}$ to have better statistics in the high energy region
- The combined raw spectra from MB and ERT are shown below

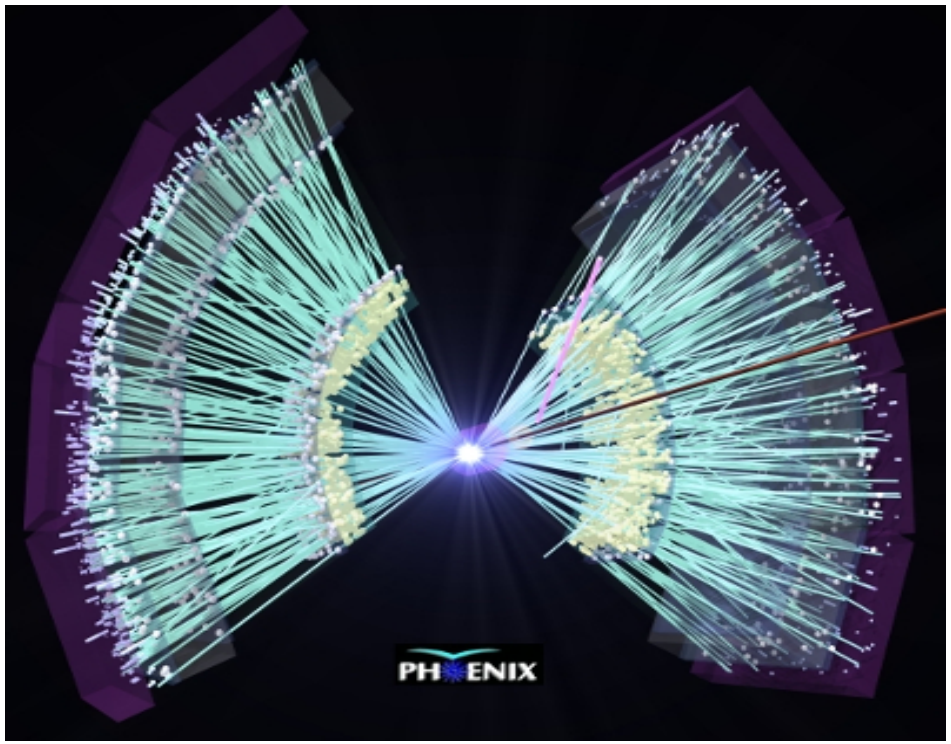




PISA Simulation

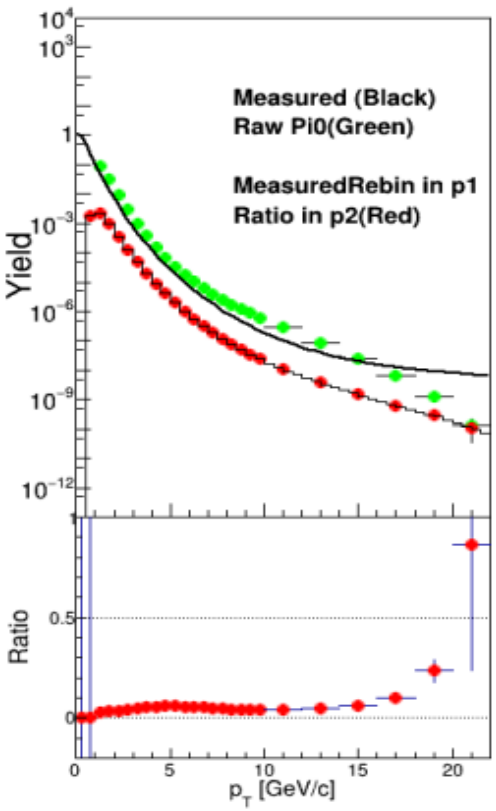
- PISA stands for PHENIX Integrated Simulation Application
- What does it do? $\rightarrow$ PHENIX's GEANT3 based simulation package for geometry and event particle tracking software
- I used this simulation to create the simulated data and getting a 2D response matrix



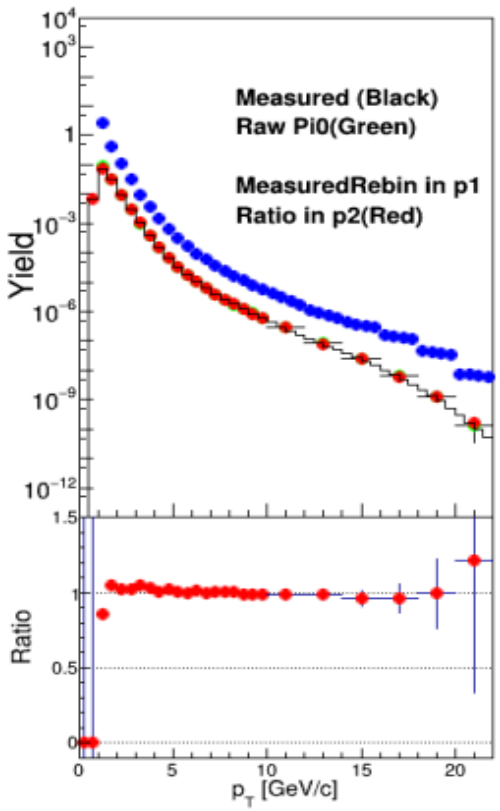


Unfolding for π^0 - some technical plot

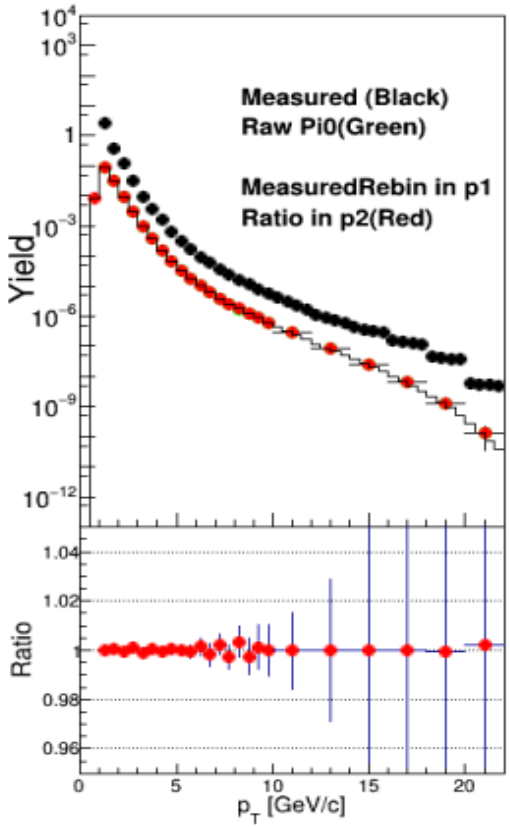
1. Iteration



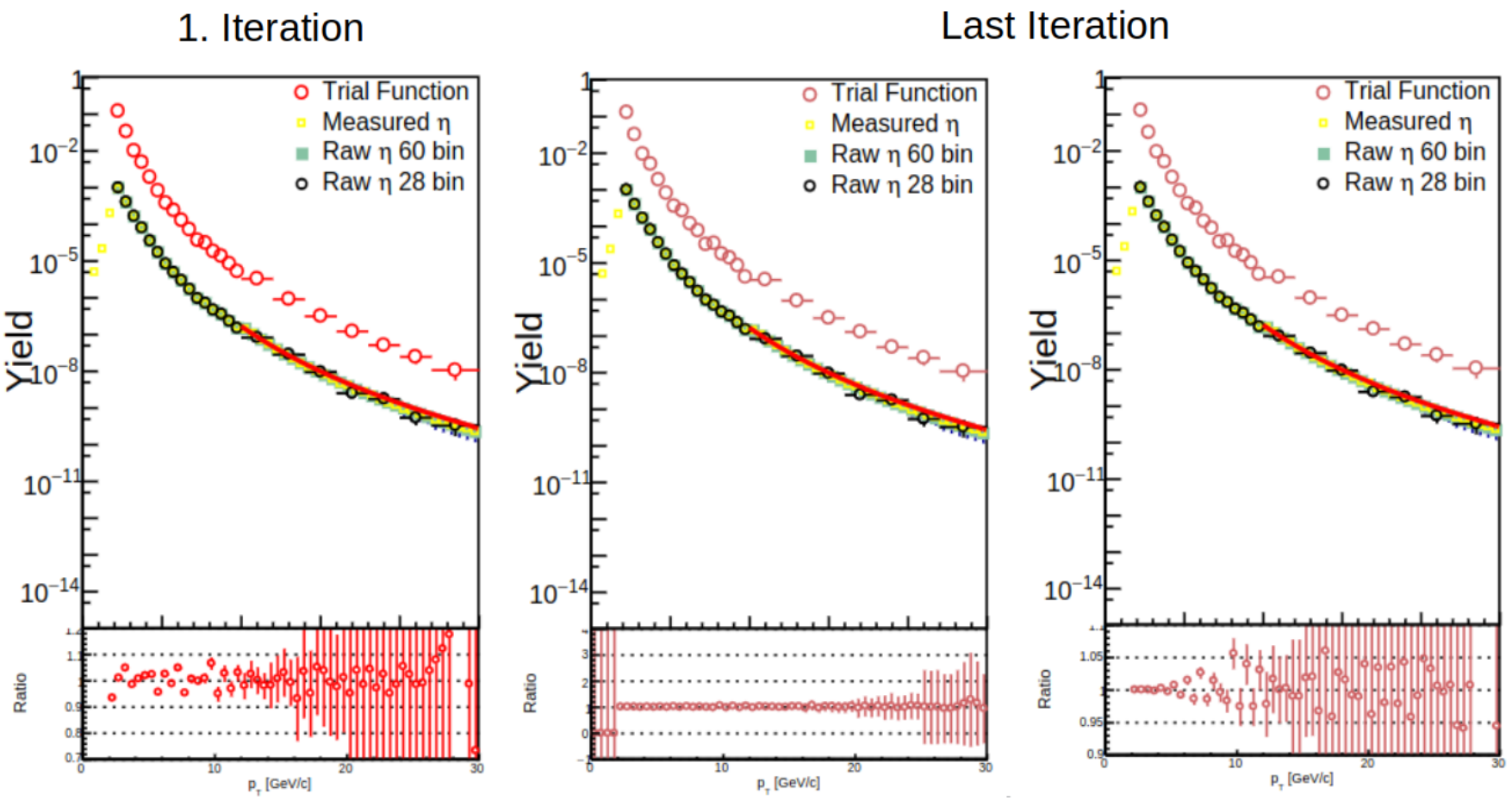
2. Iteration



Last Iteration

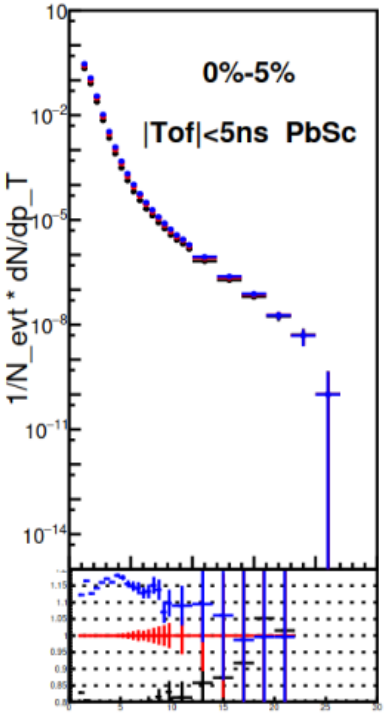


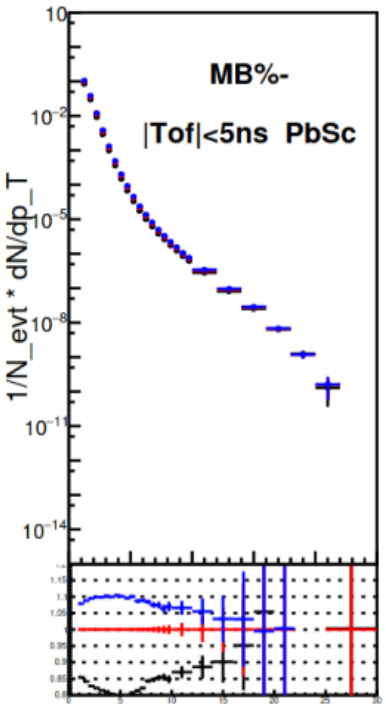
Unfolding for η - some technical plot



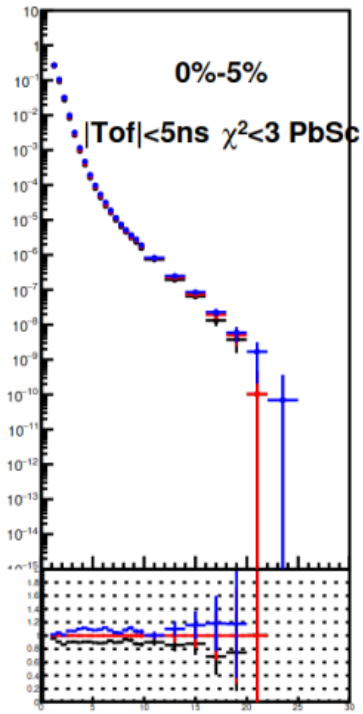
Systematical uncertainties for π^0 - Raw spectra

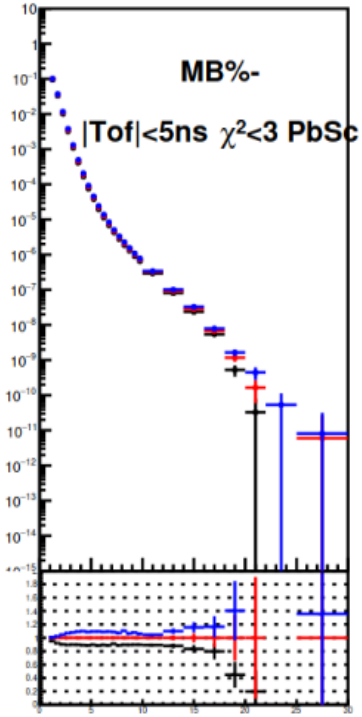
Asym=0.8





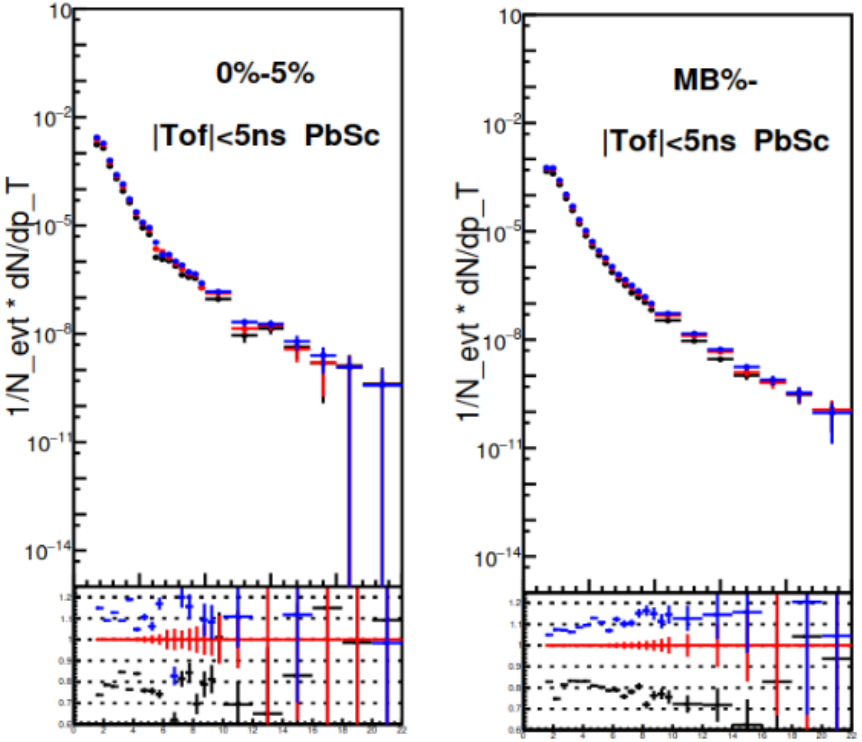
$\chi^2 < 3$



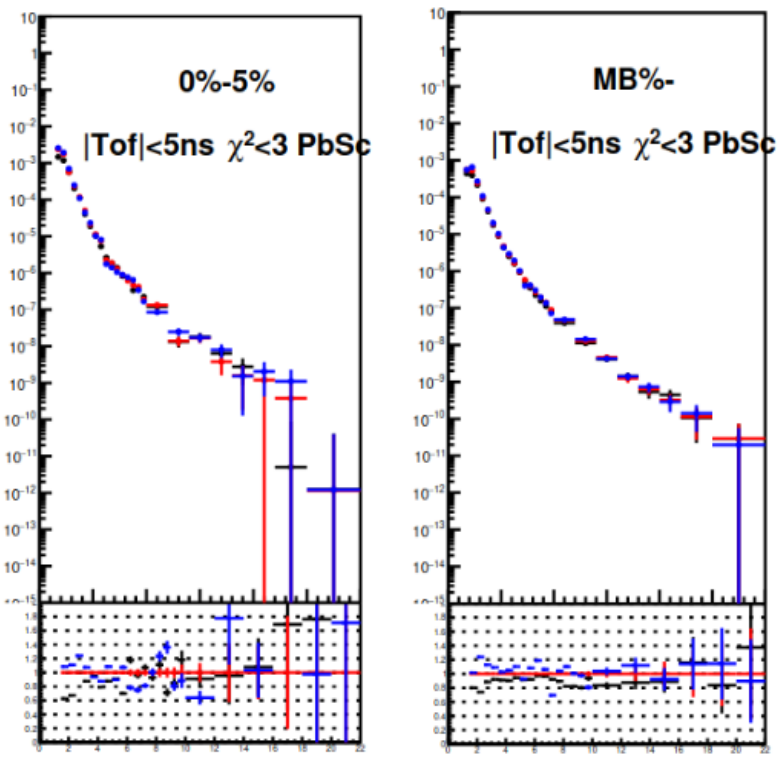


Systematical uncertainties for η - Raw spectra

Asym=0.8

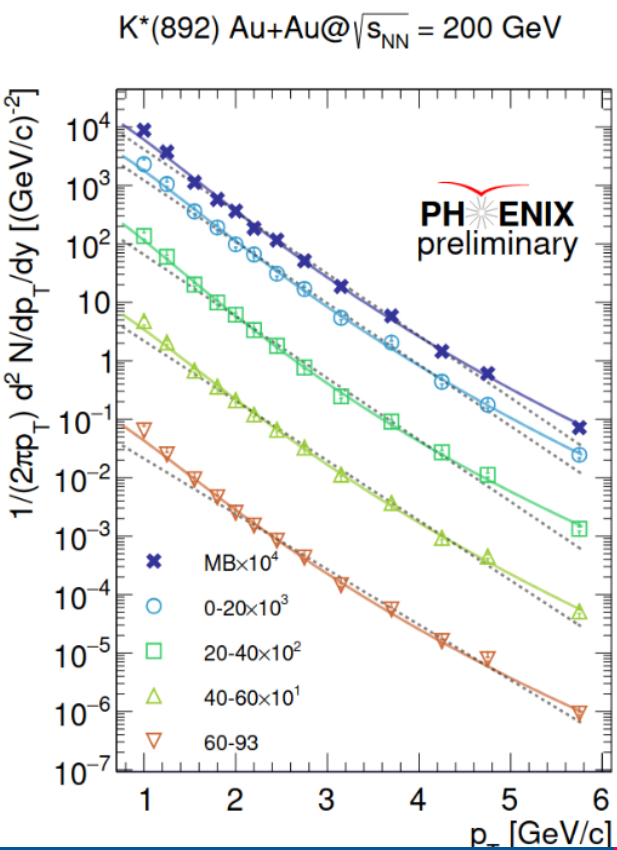


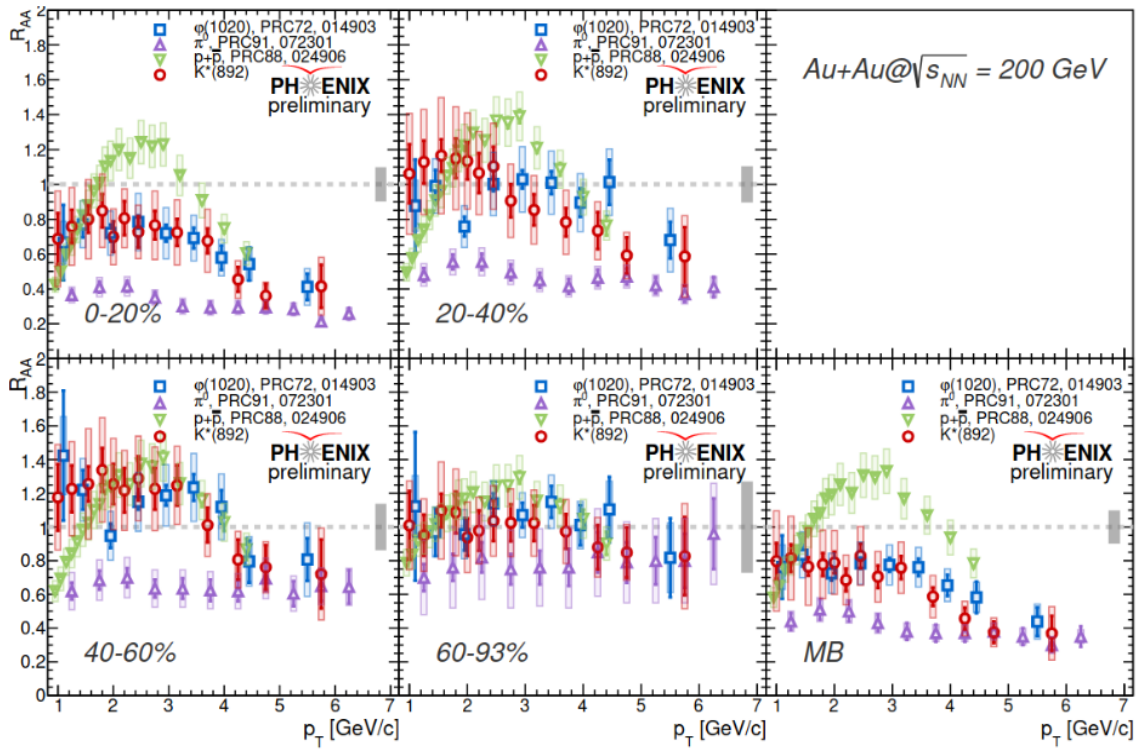
$\chi^2 < 3$



Outlook - Recent result on K^* at PHENIX

- The production of quark-gluon plasma (QGP) causes the enhanced strangeness production due to the process absent in normal matter called gluon fusion
- This effect can be detected by observing the enhancement of production of strange hadrons





Summary and Outlook

- Light meson analysis for search the direct photon in different decay channels
- With the Dead Hot Map and Timing calibration we exclude out all malfunctioning towers
- Reconstructed raw invariant mass $\rightarrow$ Normalization $\rightarrow$ Combined (MB+ERT) spectra
- PISA Simulation $\rightarrow$ 2D Response Matrix $\rightarrow$ Unfolding $\rightarrow$ Study the uncertainties
- Consistency between results with various cuts studied
- Finish the systematic uncertainties
- Continue the ω analysis
- First result for K^* meson at PHENIX shown $\rightarrow$ strange mesons less suppressed

Thank you for your attention!

Melinda Orosz

Supervisior:

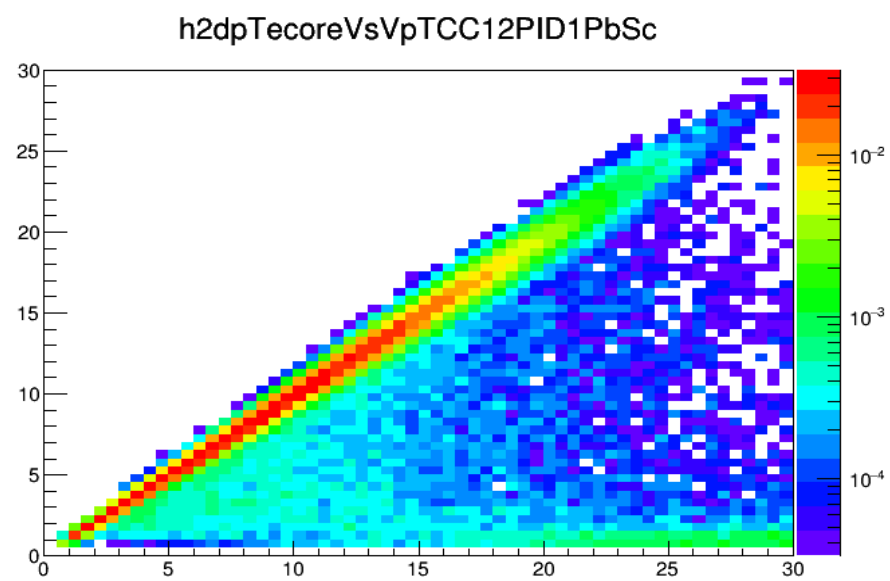
Dr. Gábor Dávid

Back Up slides

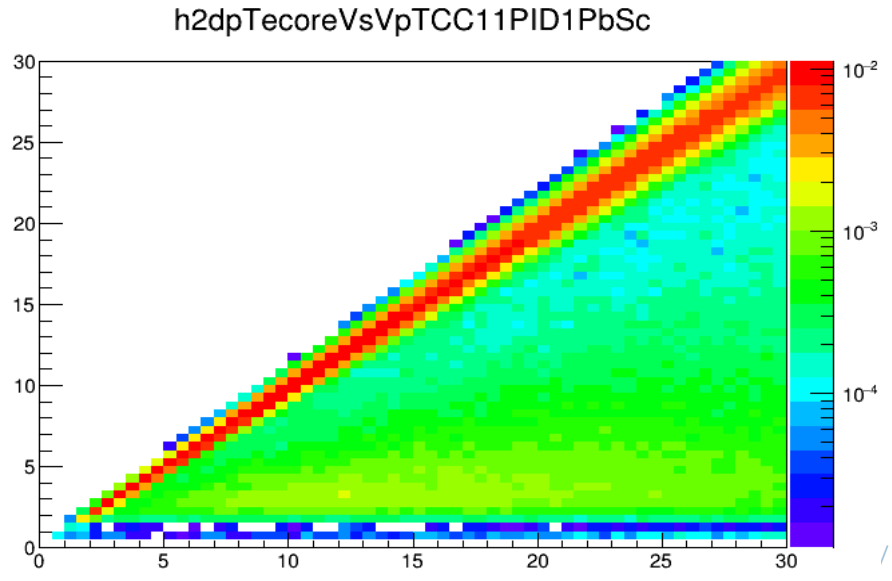
2D response Matrix

- The response matrix describes the probability that a true value x is reconstructed at value y, where y belongs to the set of all possibilities
- A two dimensional matrix is created with the x axis as the generated Pt and the y axis as measured or reconstructed Pt
- This takes care in one single step of the acceptance, reconstruction efficiency and energy smearing.

π^0:



η:



Unfolding

$$\begin{bmatrix} R_{11} & R_{21} & \bullet & R_{n1} \\ R_{12} & \bullet & \bullet & \\ & & & \\ R_{1n} & & & R_{nn} \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ \\ T_n \end{bmatrix} = \begin{bmatrix} O_1 \\ O_2 \\ \\ O_n \end{bmatrix}$$

Measured pion Pt

Generated pion Pt

Response Matrix

Trial yield (generated)

Measured yield (that which is expected from trial function

Compare with yield measured from data

$$\begin{bmatrix} O_1 \\ O_2 \\ \\ O_n \end{bmatrix} \quad \begin{bmatrix} M_1 \\ M_2 \\ \\ M_n \end{bmatrix}$$

Yield from trial function Yield from data

$$\frac{\begin{bmatrix} M \end{bmatrix}}{\begin{bmatrix} O \end{bmatrix}} = \begin{bmatrix} M_1/O_1 \\ M_2/O_2 \\ \\ M_n/O_n \end{bmatrix}$$

$$\begin{bmatrix} R_{11} & R_{21} & \bullet & R_{n1} \\ R_{12} & \bullet & \bullet & \\ & & & \\ R_{1n} & & & R_{nn} \end{bmatrix} \begin{bmatrix} M_1/O_1 T_1 \\ M_2/O_2 T_2 \\ \\ M_n/O_n T_n \end{bmatrix} = \begin{bmatrix} O'_1 \\ O'_2 \\ \\ O'_n \end{bmatrix}$$