LOW P_T DIRECT PHOTON MEASUREMENT IN DIFFERENT COLLISION SYSTEMS AT $\sqrt{S_{NN}}$=200GEV

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DIRECT PHOTON, A PROBE OF QGP

- **What is quark gluon plasma (QGP)?**
  - extremely high temperature and density
  - protons and neutrons "melted" into a plasma of quarks and gluons

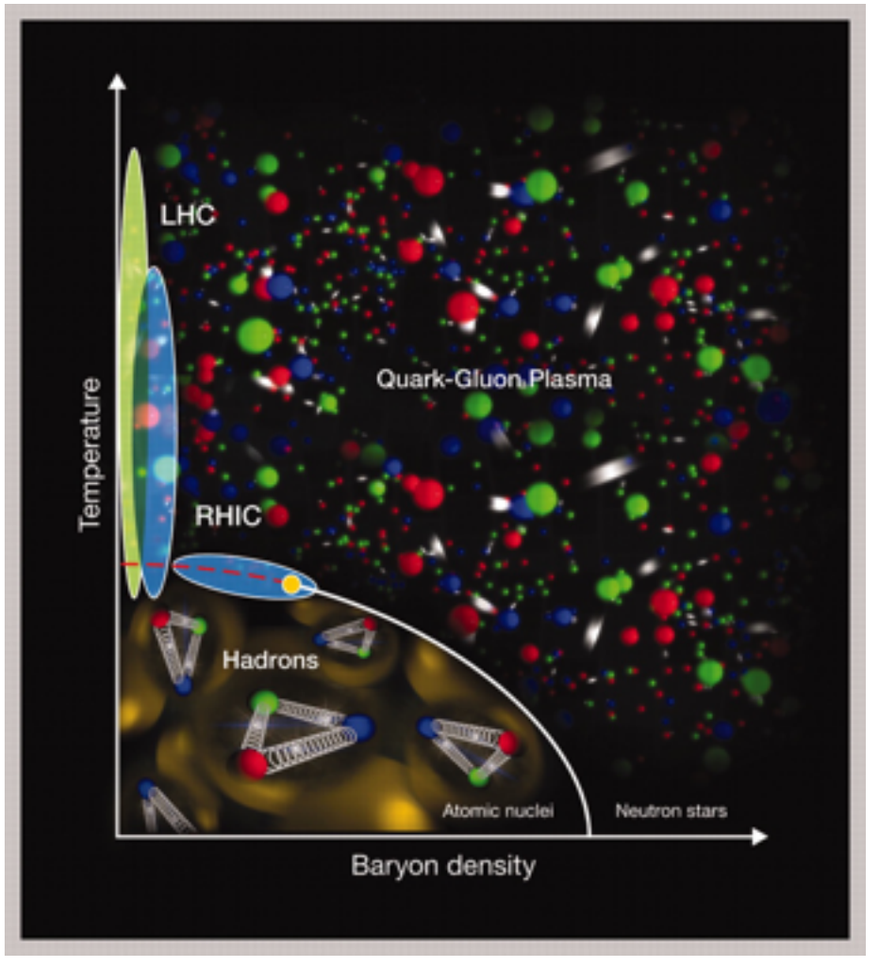
probe QGP with direct photons

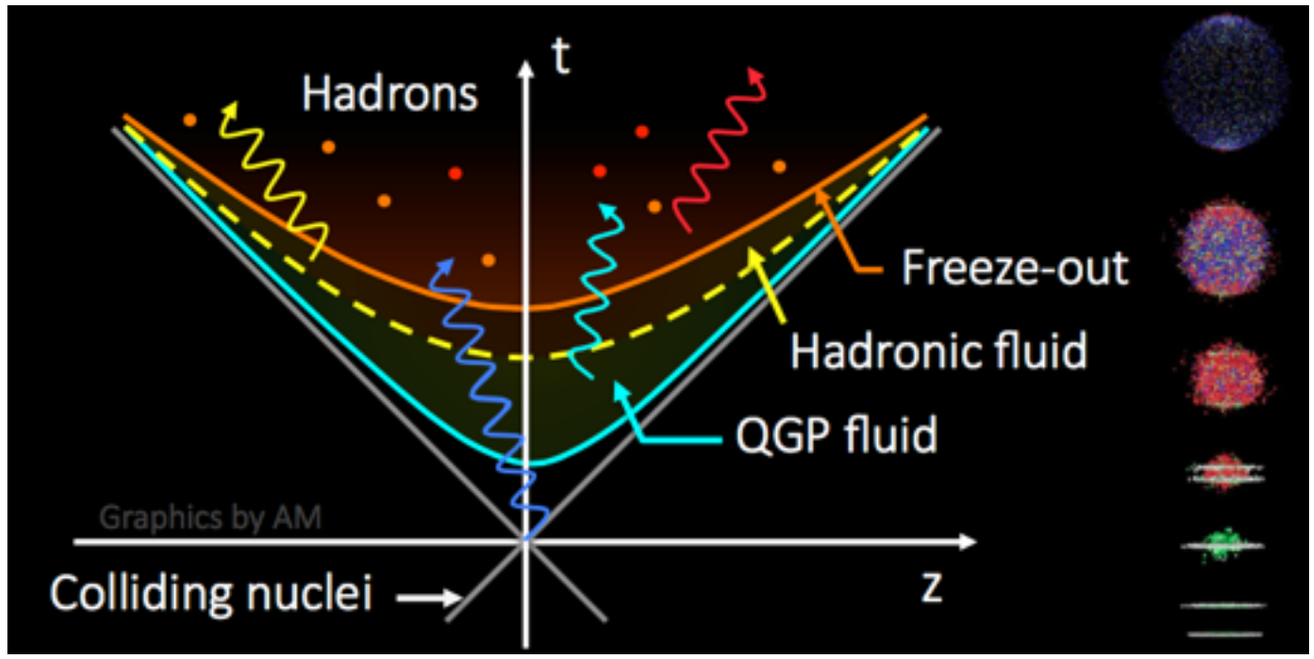
- **Advantage**
  - do not suffer strong interaction

- **Cross-over temperature: Tc~170MeV**
  - analogy: blackbody radiation
  - p_T (E) spectra

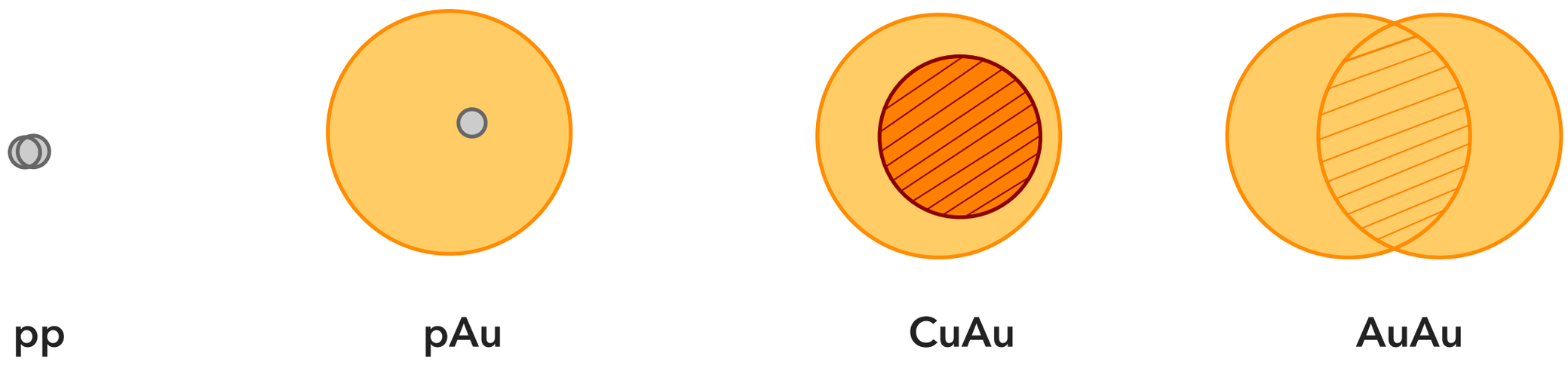
thermal photons

- **Experiments measure the time integrated yield**





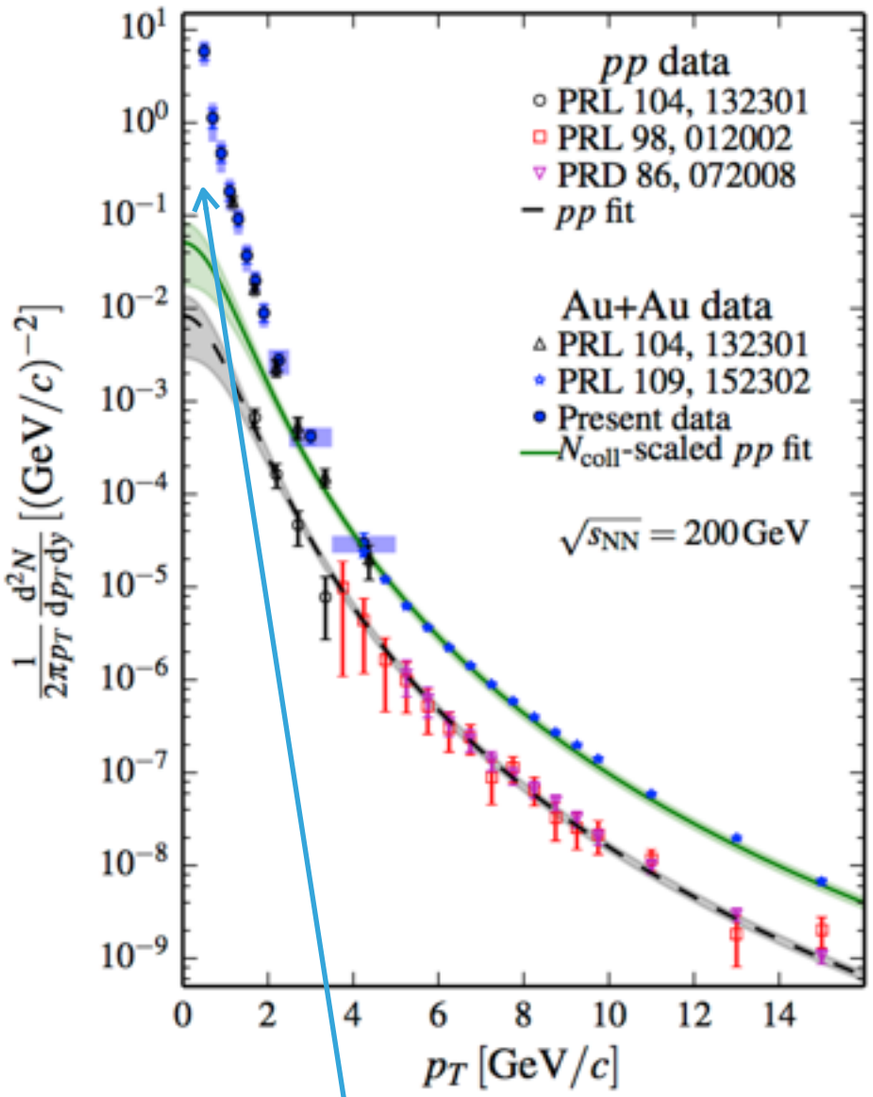
MOTIVATION—DIFFERENT COLLISION SYSTEMS



- What is the direct photon spectrum shape in low p_T for pp?
- Is there hot medium created in pAu collisions?
- What is the p_T dependence of v_2 for CuAu most central collision? (magnetic field effect)
- What is the p_T dependence of v_3, v_4 for AuAu collision? (compare with theoretical models)
- …

PREVIOUS PHENIX RESULTS

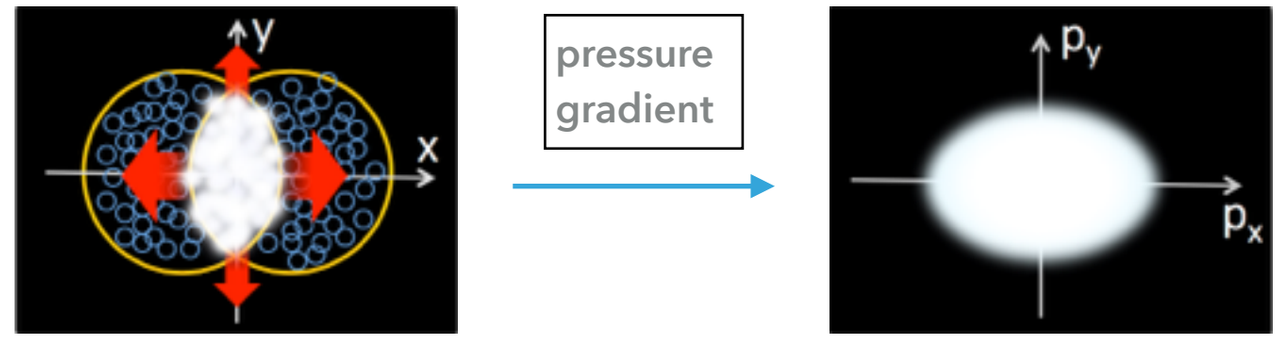
PRC 91,064904(2015)



thermal photon yield

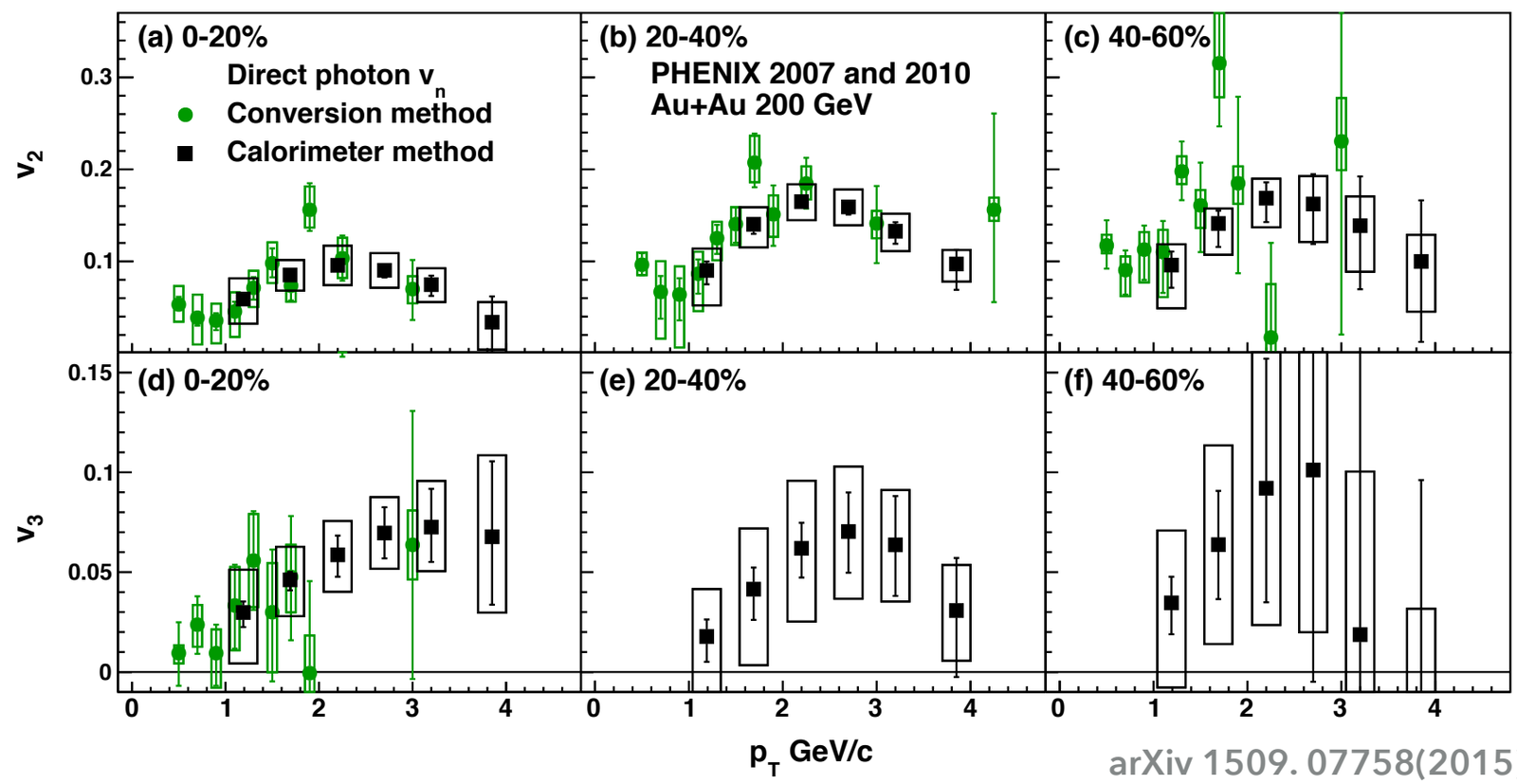
exponential fit

Inverse slope 221 ± 38MeV



space anisotropy

momentum anisotropy

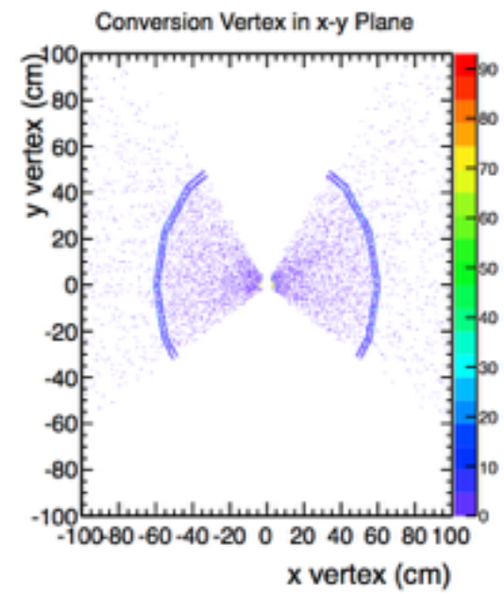


arXiv 1509. 07758(2015)

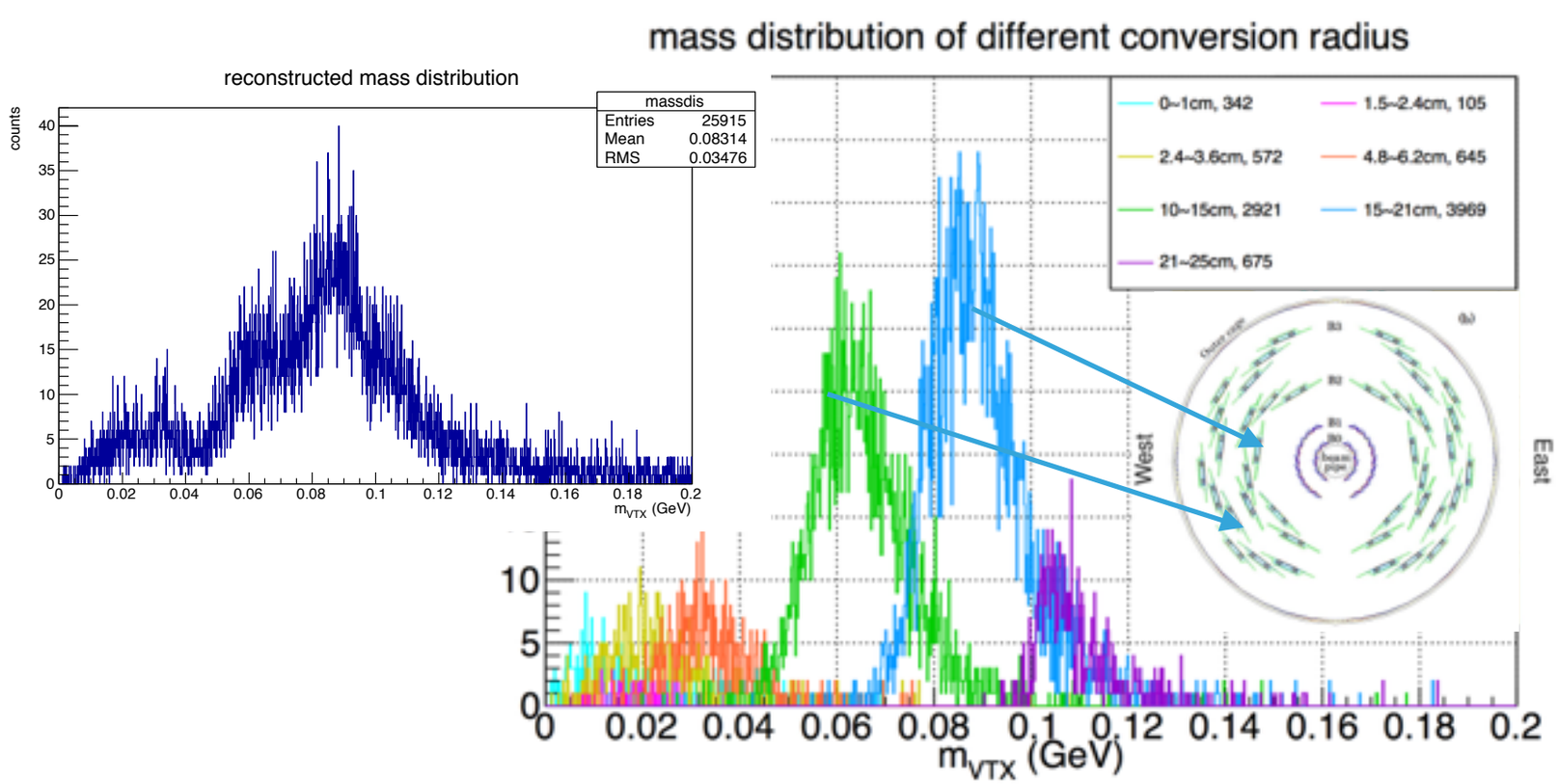
- Challenge for theoretical models to describe simultaneously large yield and large v2

NEW RECONSTRUCTION METHOD

- Due to the detector setup change, new reconstruction technique is developed to identify and reconstruct photons via external conversions to e^+e^- pairs



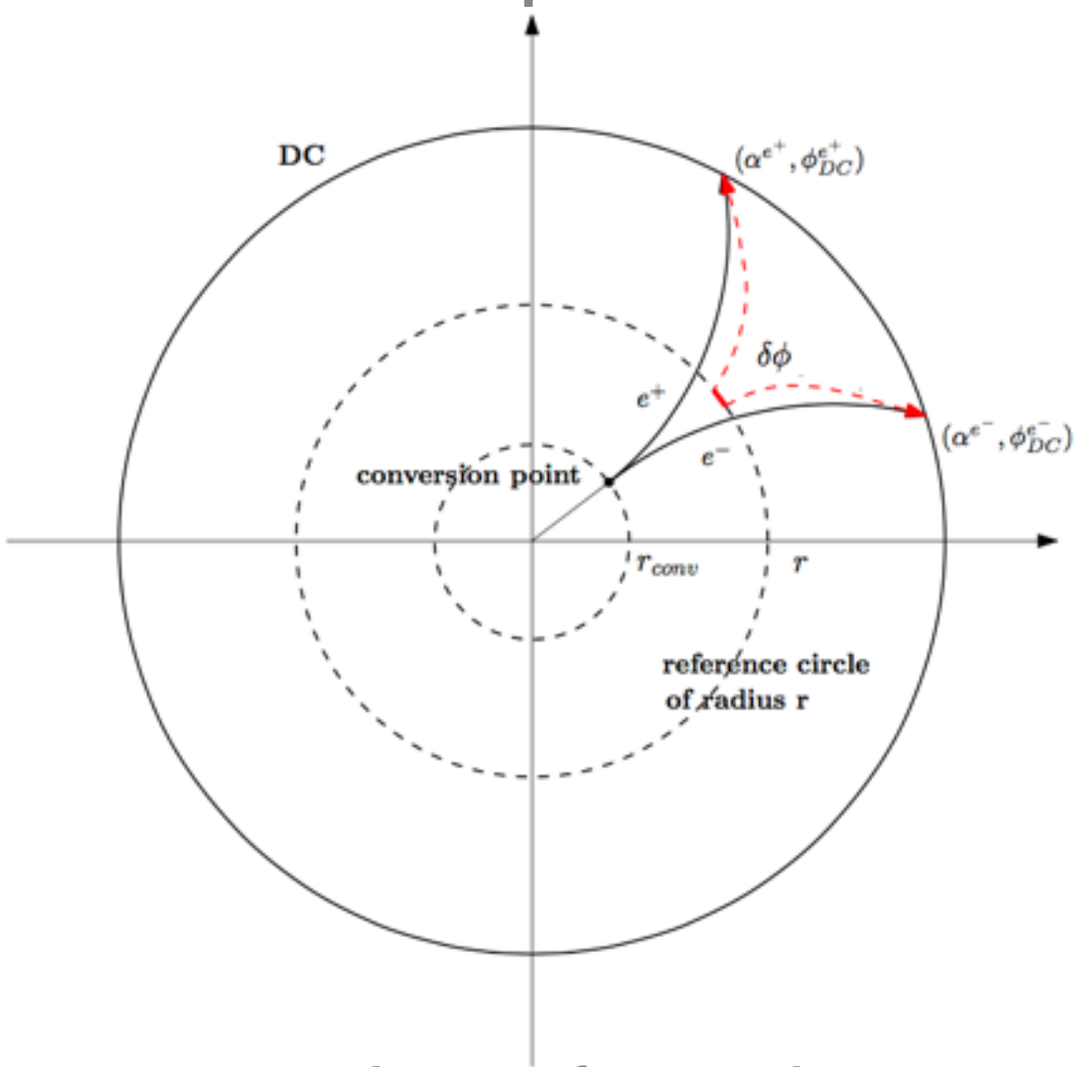
- previous method used **single** e^+/e^- tracks
  - required fixed assumption for the track origin or track pT (~60cm HBD shell)
- new method uses e^+e^- **pairs**
  - no assumption needed for the track origin or pT
  - allows to reconstruct conversions at any radius (VTX 3rd and 4th layer, ~10%)



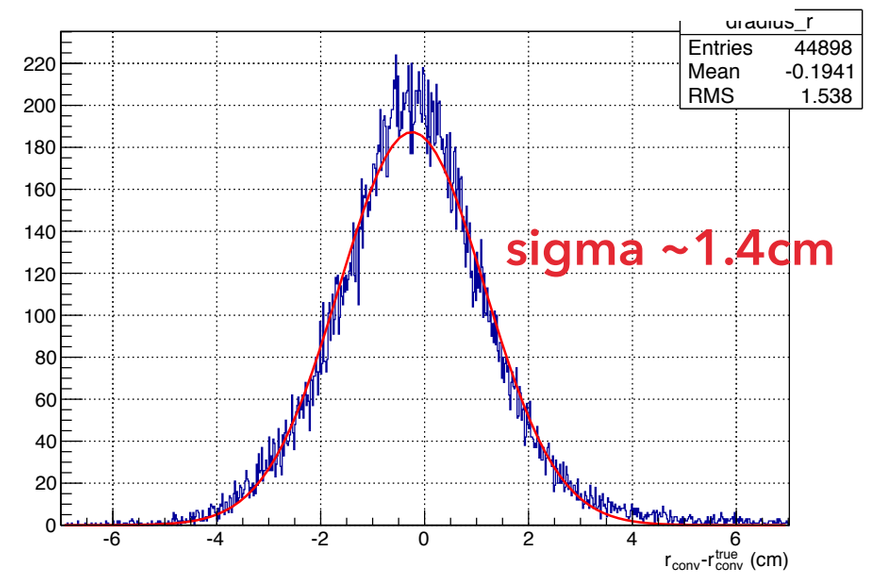
simulation result

RECONSTRUCTION TECHNIQUE

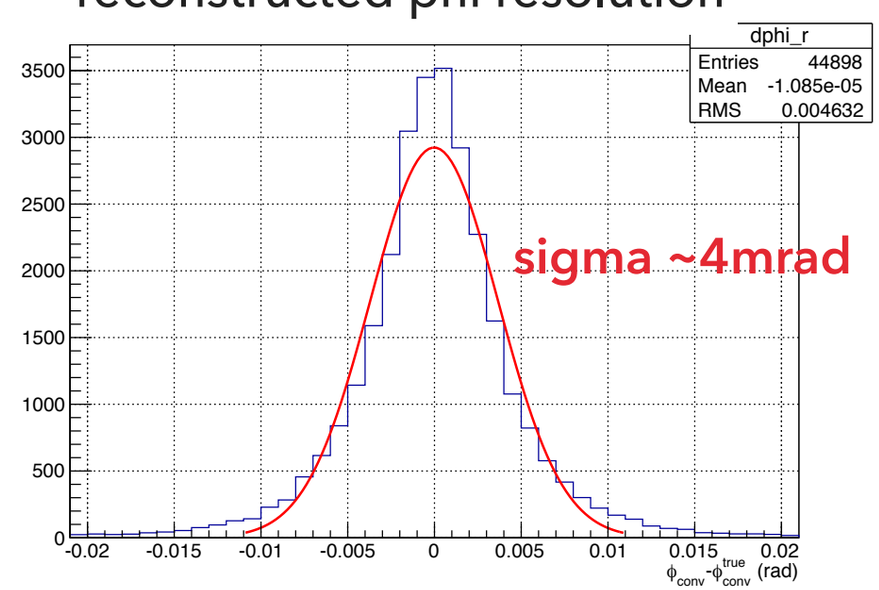
- **Pairs originate from its real conversion point**
- Reconstruct converted photon position $\{r_{conv}, \phi_{conv}\}$ & momentum based on a lookup table



reconstructed radius resolution



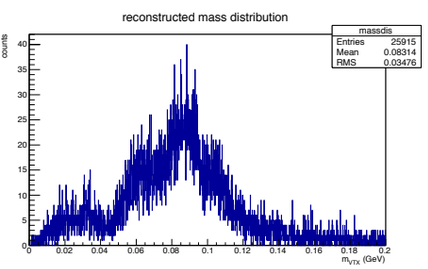
reconstructed phi resolution

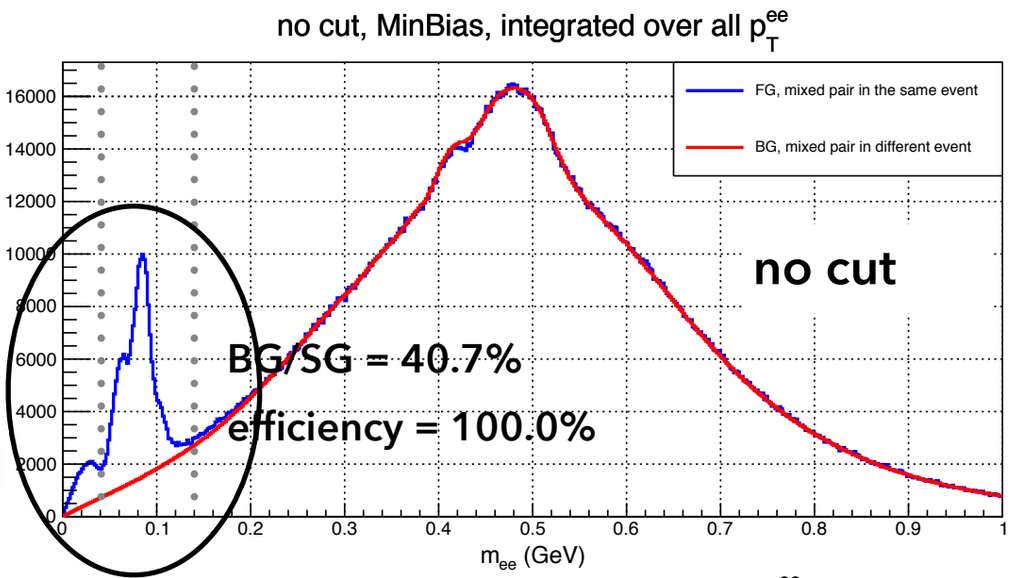


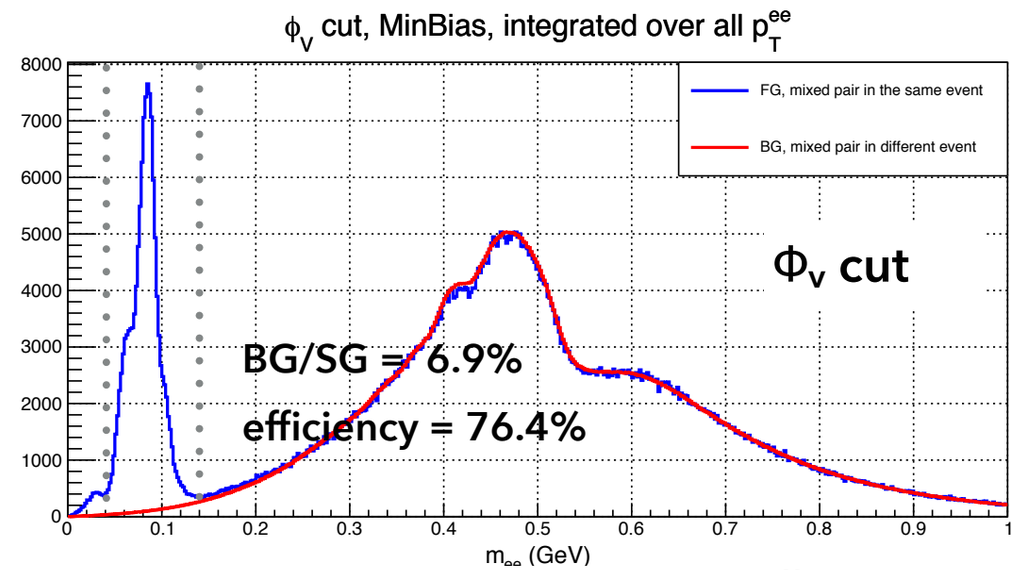
- assume e^+ and e^- are from radius r
- intersection exist only at true conversion radius
- $r_{conv} \rightarrow p_T, \phi_{conv}$

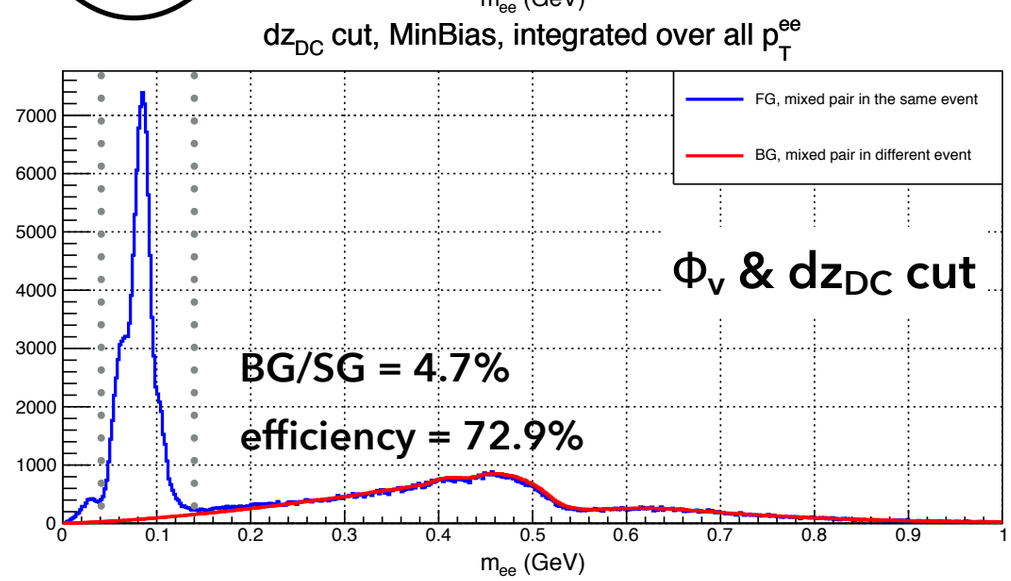
BKG/SIG & EFFICIENCY OF CONVERTED PHOTON (RUN14 AU+AU)

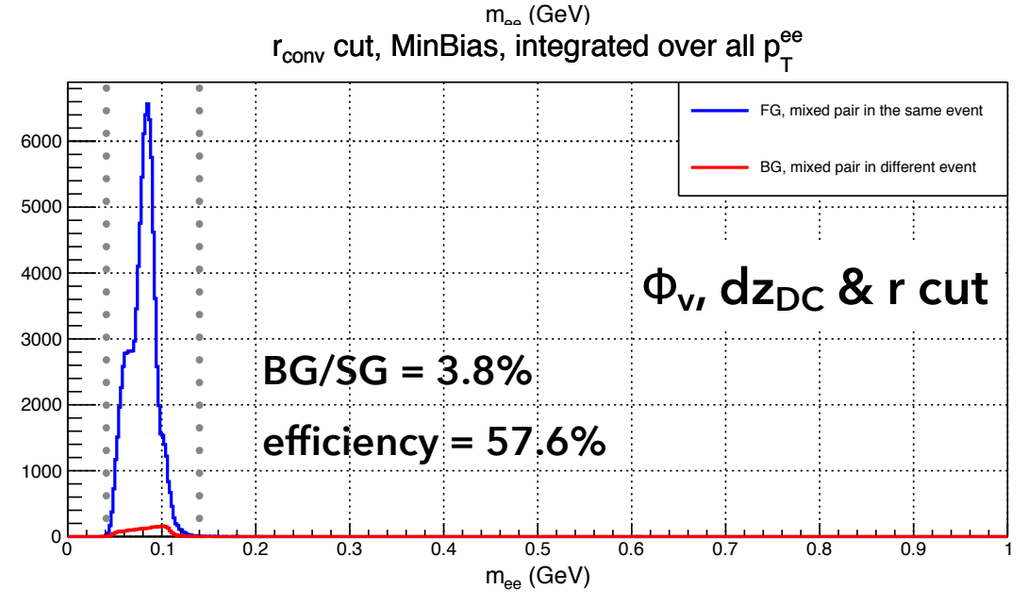
consistent with simulations

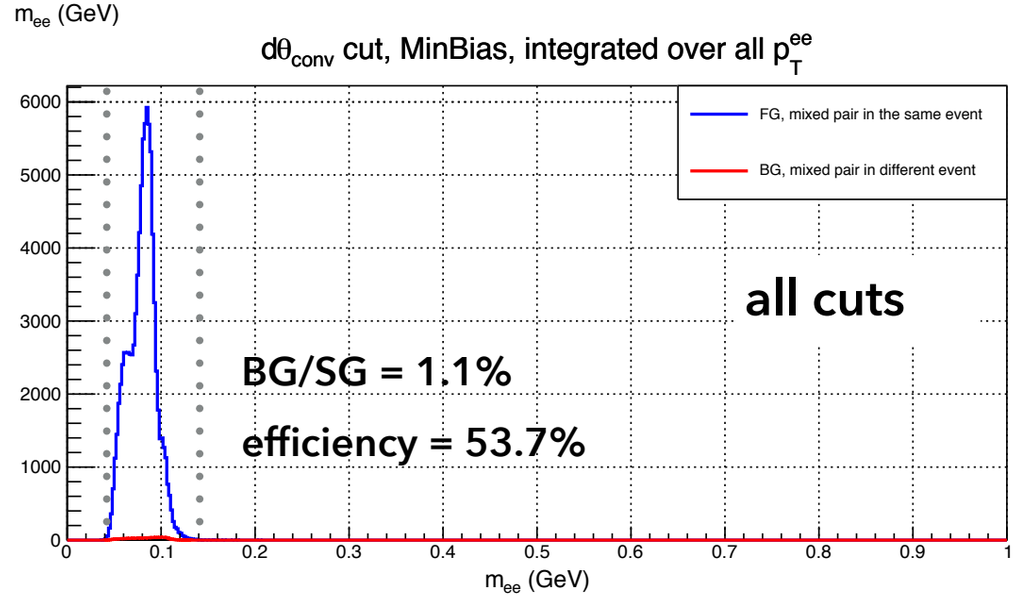










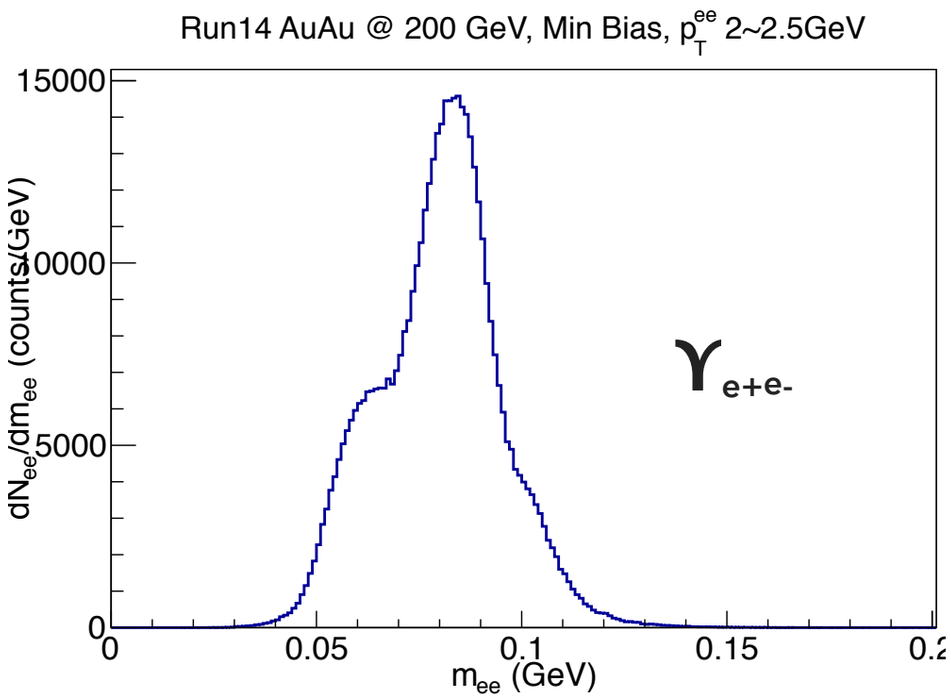


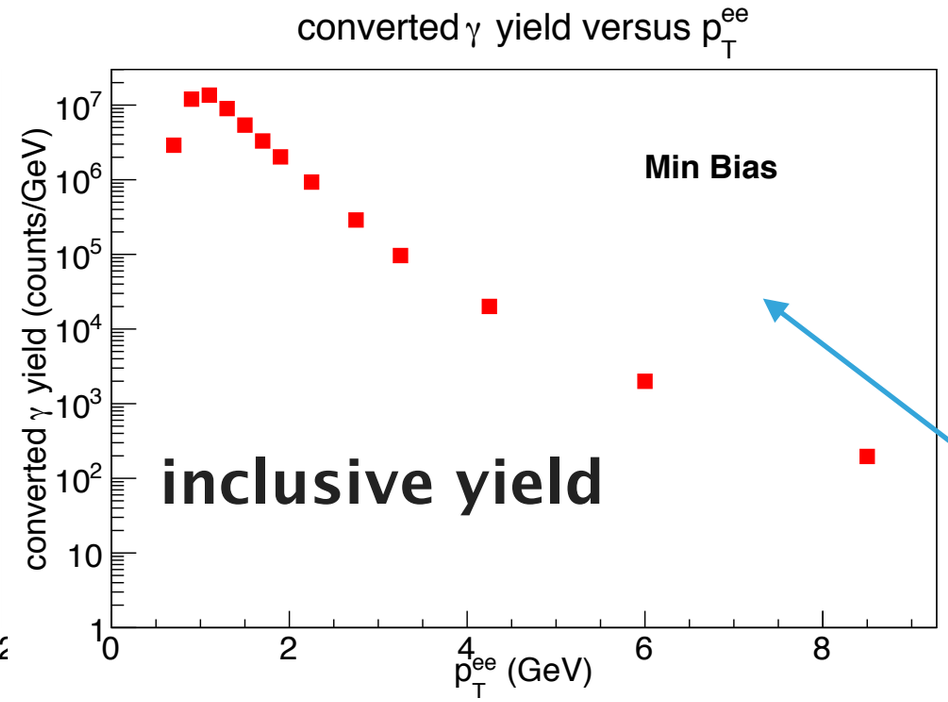
to have cleaner signal for direct photons, we need bkg/sig 1~2% for inclusive photons

plots do not represent the total statistics

- two tracks from the same arm
- $\pi - \phi_V < 0.1 rad$
- $|dz_{DC}| < 4cm$
- $9cm < r_{conv} < 23cm$
- $|d\theta_{conv}| < 0.1 rad$

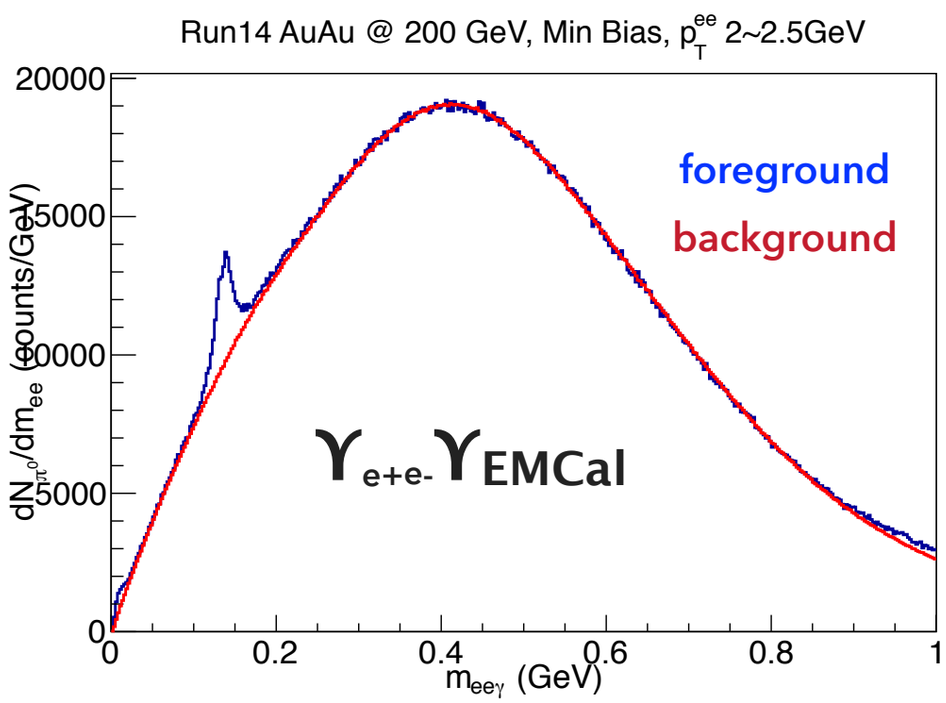
INCLUSIVE & π^0 TAGGED PHOTON YIELD FROM RUN14 AU+AU

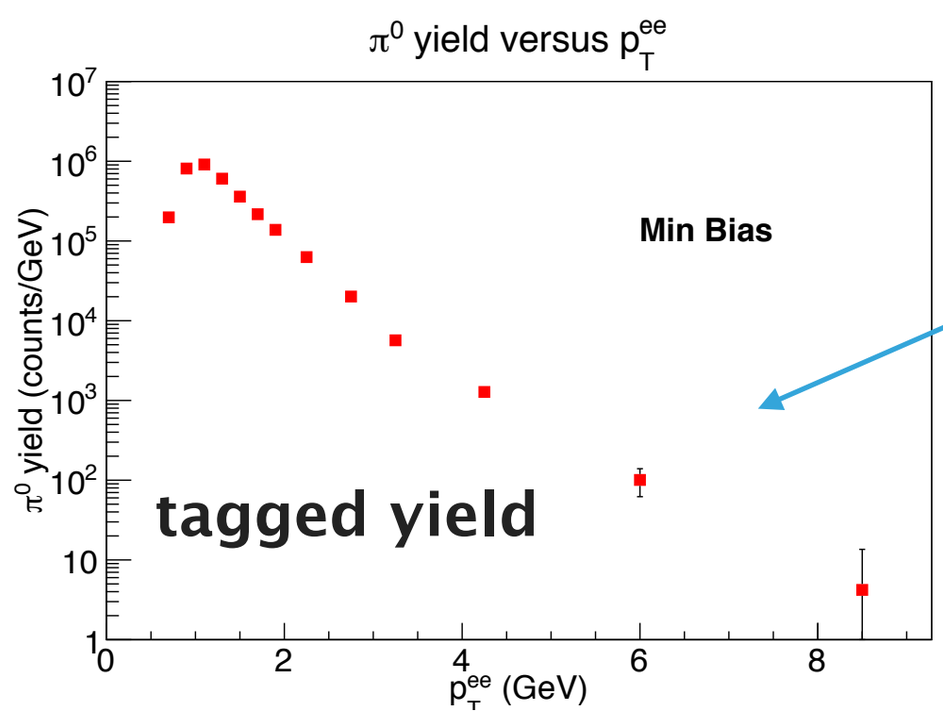




relative photon yield

$$R_\gamma(p_T) = \frac{\gamma^{incl}(p_T)}{\gamma^{hadron}(p_T)} = \frac{\langle \varepsilon_\gamma(p_T) f(p_T) \rangle \left(\frac{N_\gamma^{incl}(p_T)}{N_\gamma^{\pi^0 tag}(p_T)} \right)_{Data}}{\left(\frac{N_\gamma^{hadron}(p_T)}{N_\gamma^{\pi^0}(p_T)} \right)_{Sim}}$$





lower p_T reach ~0.6GeV : ++magnetic field, conversions from <30cm

plots correspond to ~50% of the total statistics

SUMMARY

- External conversions reconstructed with a resolution of ~1.4cm
- Achieved very good bkg/sig ratio with reasonable efficiency
- Larger statistics from Run14 AuAu will provide accurate measurement of v_n (v_2, v_3, v_4) at low p_T
- v_n measurement in most central CuAu will provide useful input in understanding of chiral magnetic field effect, if any
- pA results will help to understand properties of the medium created in small systems
- New pp results will extend the measurement to lower p_T

ACKNOWLEDGEMENT

- Great thanks to Prof. Axel Drees, Alan Dion, all my group members, especially Norbert Novitzky and Deepali Sharma
- Thanks to the PHENIX collaboration
- Thank you all for your attention