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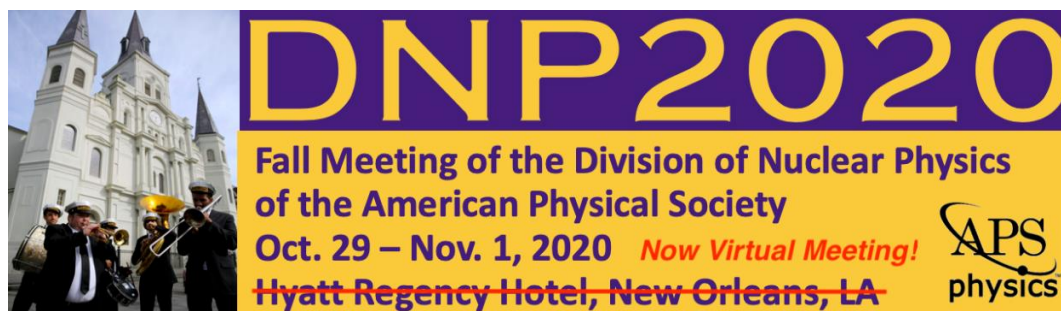


Low- p_T e^+e^- pair production in Au+Au collisions at $\sqrt{s_{NN}} = 54.4$ GeV in centrality 80% – 100%

Xiaofeng Wang (王晓凤)

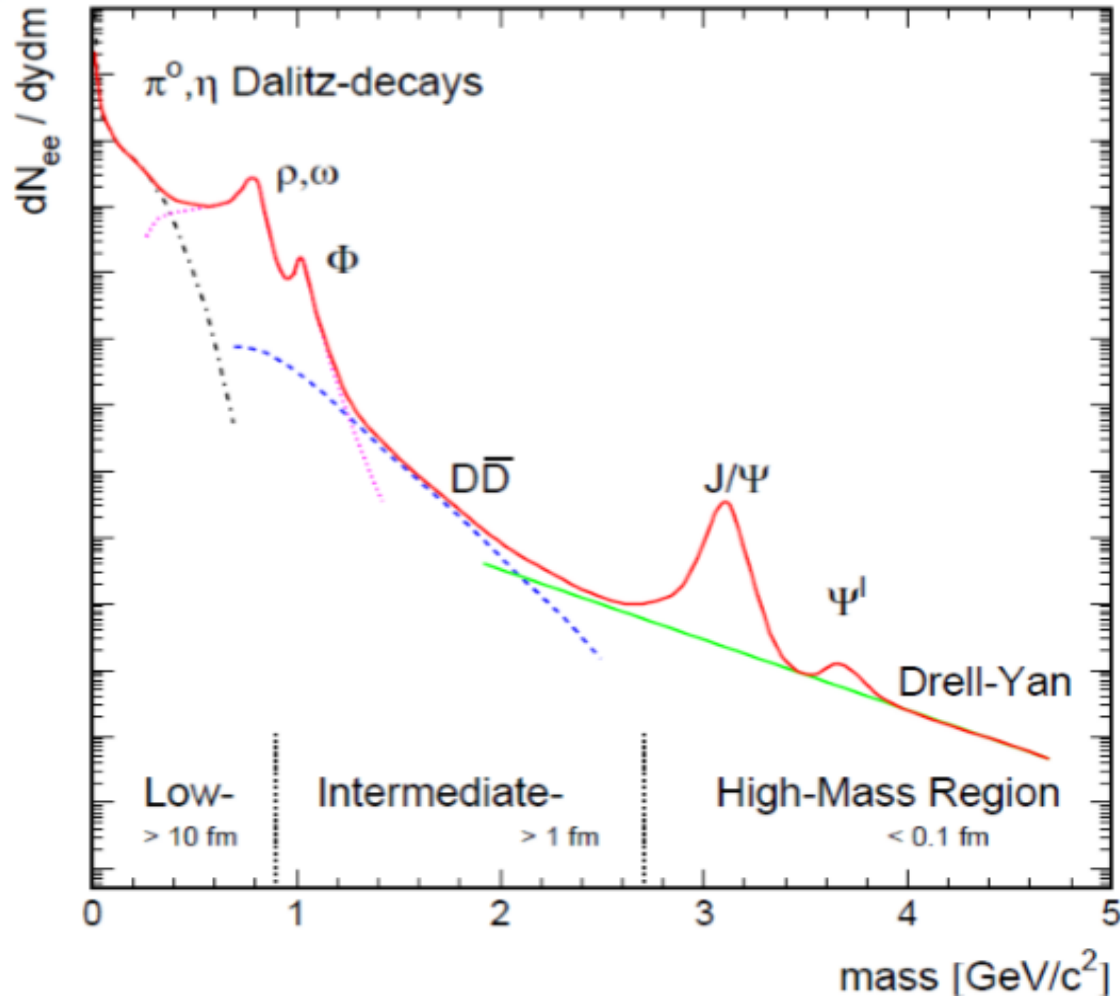
For the STAR Collaboration

Shandong University/Qufu Normal University





Di-electron Production in Heavy-ion Collisions

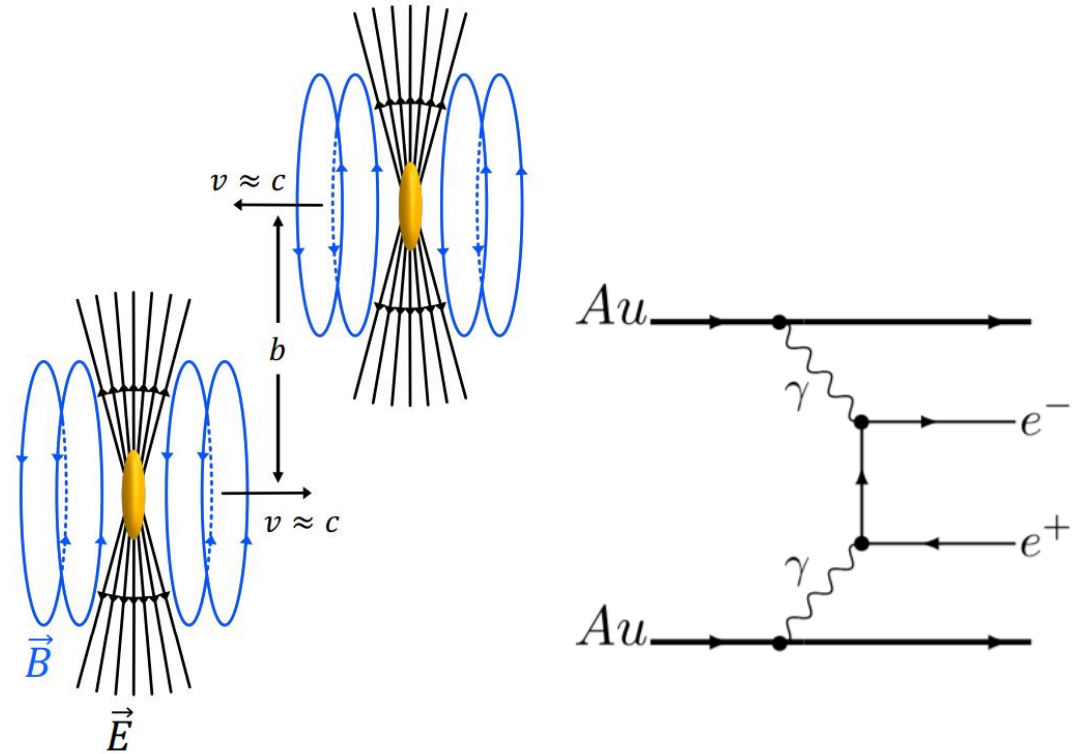
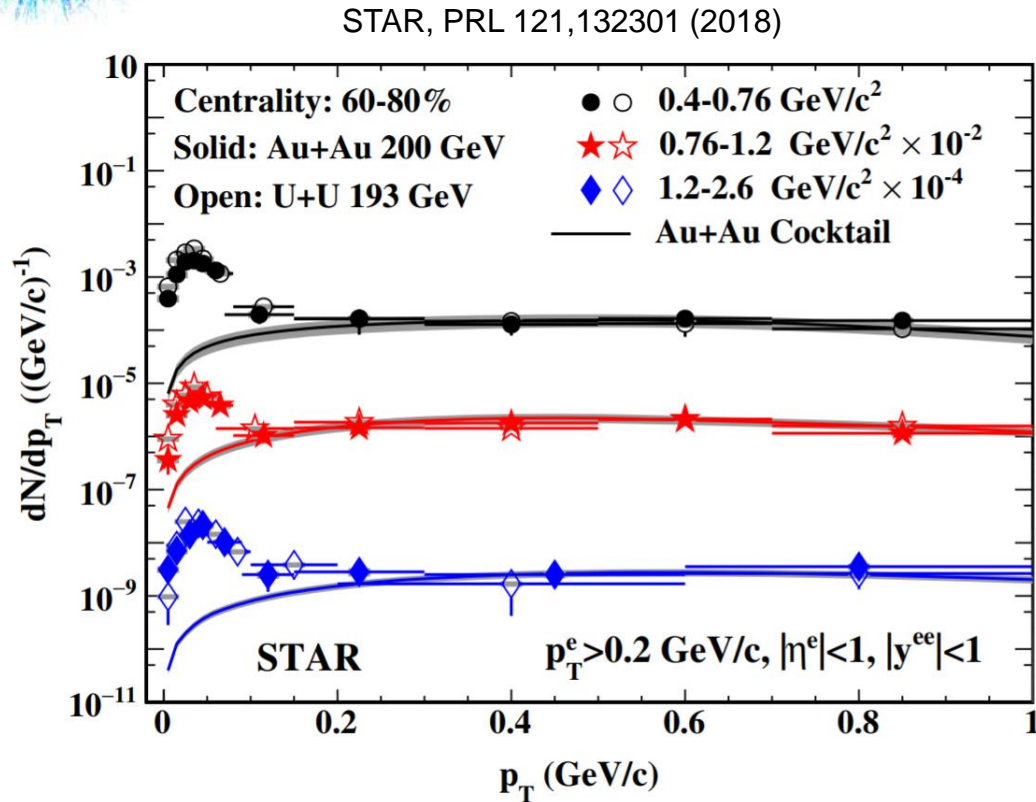


Gunar Hering. "Dielectron production in heavy ion collisions at 158-GeV/c per nucleon." 2001. Ph.D. Thesis

- Di-electron: an ideal electromagnetic probe of QGP
 - ✓ Di-electrons are produced in the whole evolution of the created matter
 - ✓ Little interaction with the strongly interacting medium



Di-electron from Photon Interactions

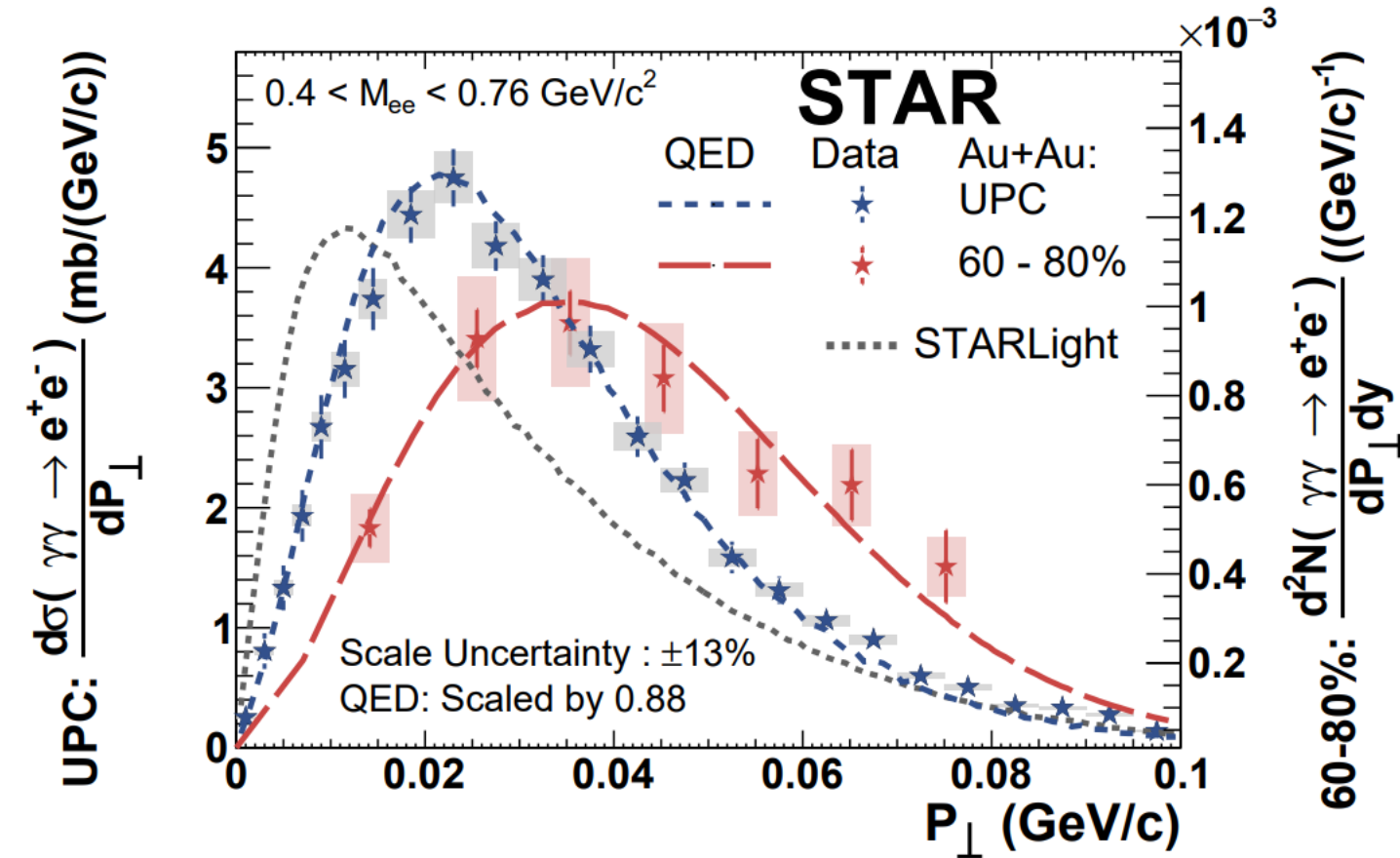


- The hadronic cocktail, can describe the data for $p_T > 0.15 \text{ GeV}/c$ in all three mass regions
- The observed excess is found to concentrate below $p_T \approx 0.15 \text{ GeV}/c$

- Equivalent Photon Approximation (EPA): → In a specific phase space, EM fields can be quantized as a flux of quasi-real photons



$\gamma\gamma \rightarrow e^+e^-$: Ultra-Peripheral vs. Peripheral



STAR, ArXiv : 1910.12400

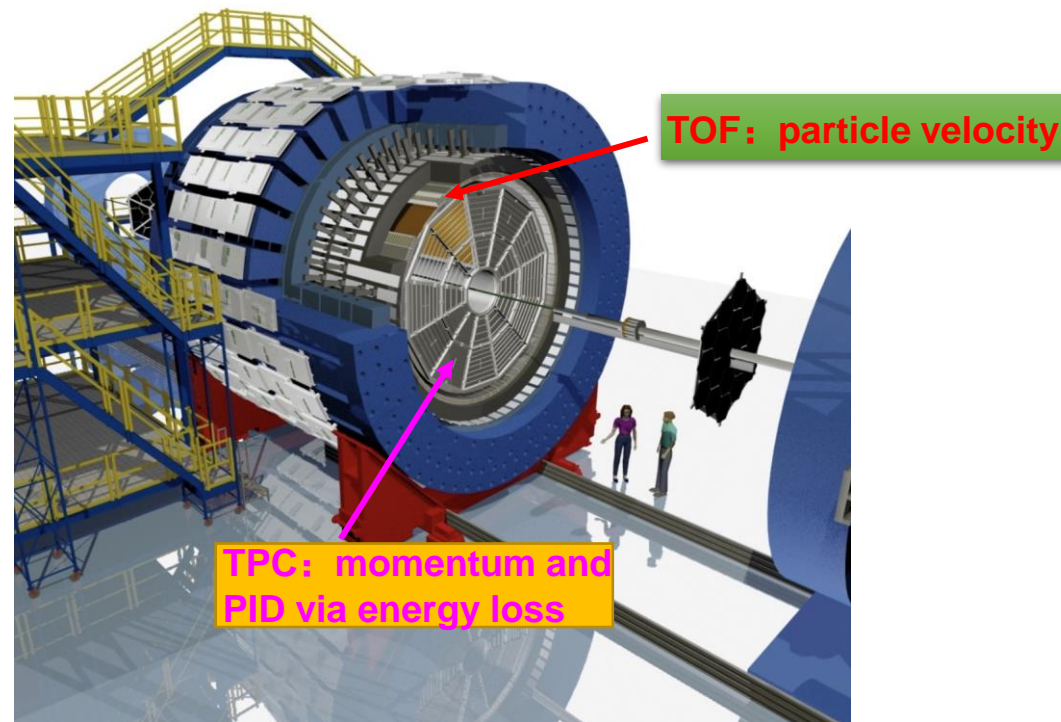
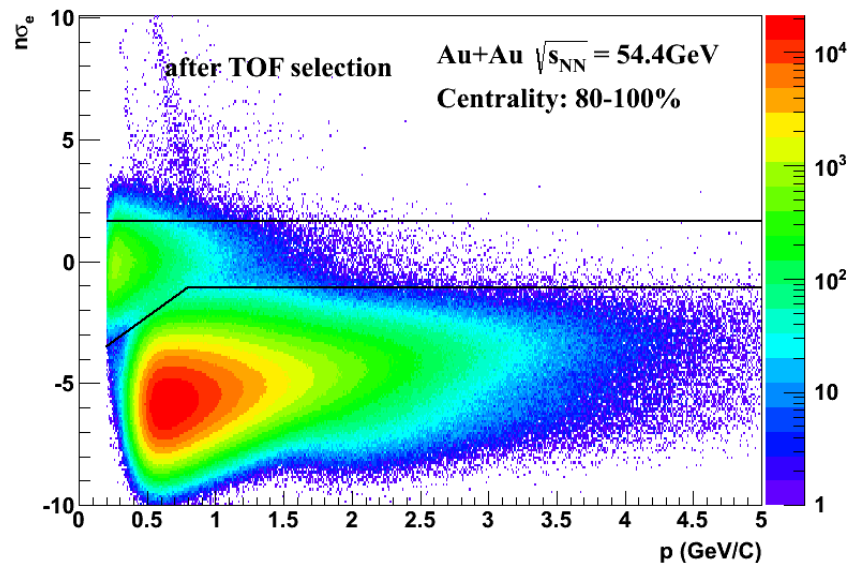
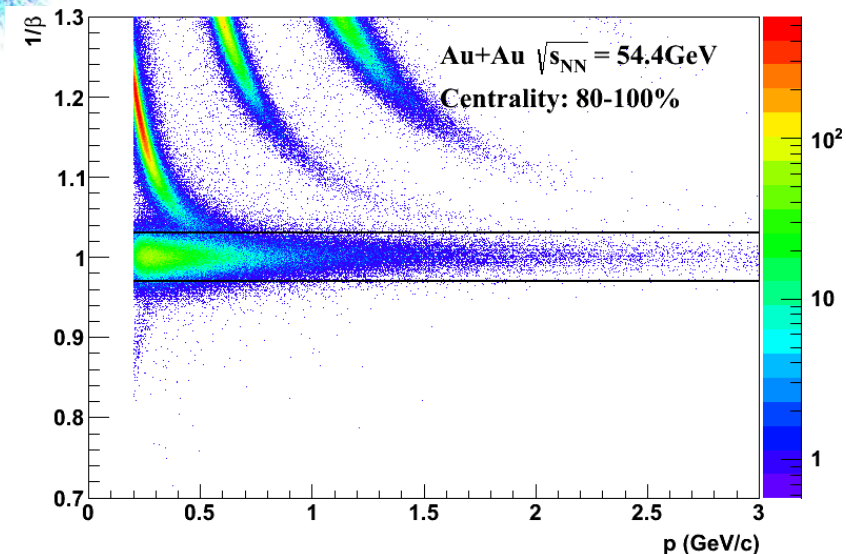
Characterize difference in spectra via $\sqrt{\langle P_{\perp}^2 \rangle}$

$\sqrt{\langle P_{\perp}^2 \rangle}$ (MeV/c)	UPC Au+Au	60-80% Au+Au
Measured	38.1 ± 0.9	50.9 ± 2.5
QED	37.6	48.5

- Leading order QED calculation of $\gamma\gamma \rightarrow e^+e^-$ describes both spectra ($\pm 1\sigma$)
- STAR observes 4.8σ difference between UPC and 60-80% Au+Au collisions
- Proposed as a probe of trapped magnetic field or Coulomb scattering in QGP
- Di-electron measurement at the centrality of 80-100% is a bridge between HIC and UPC $\gamma\gamma \rightarrow e^+e^-$ process



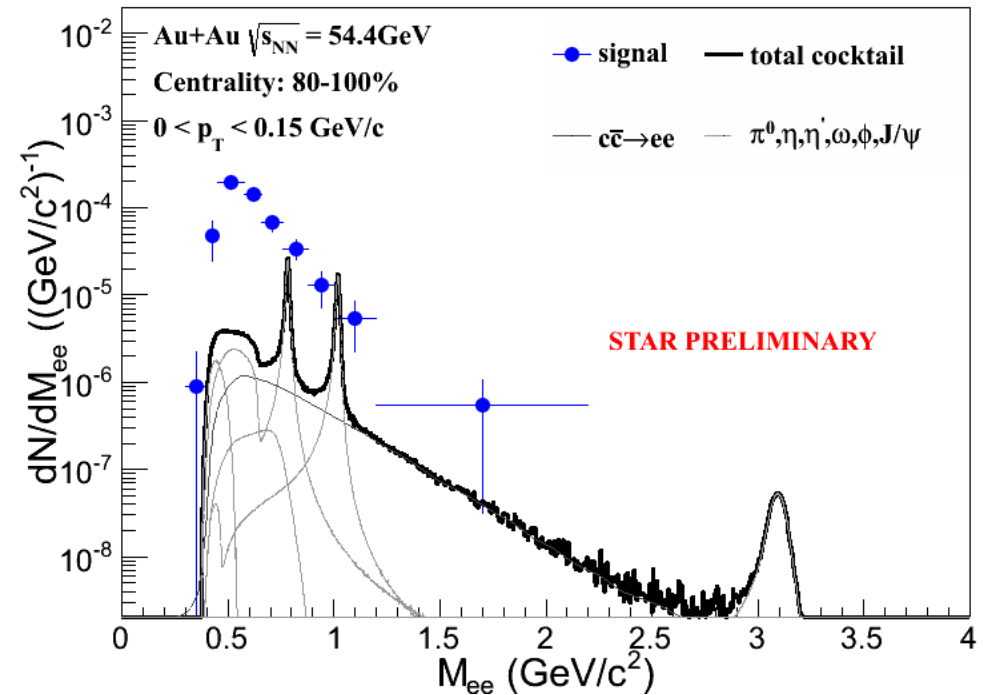
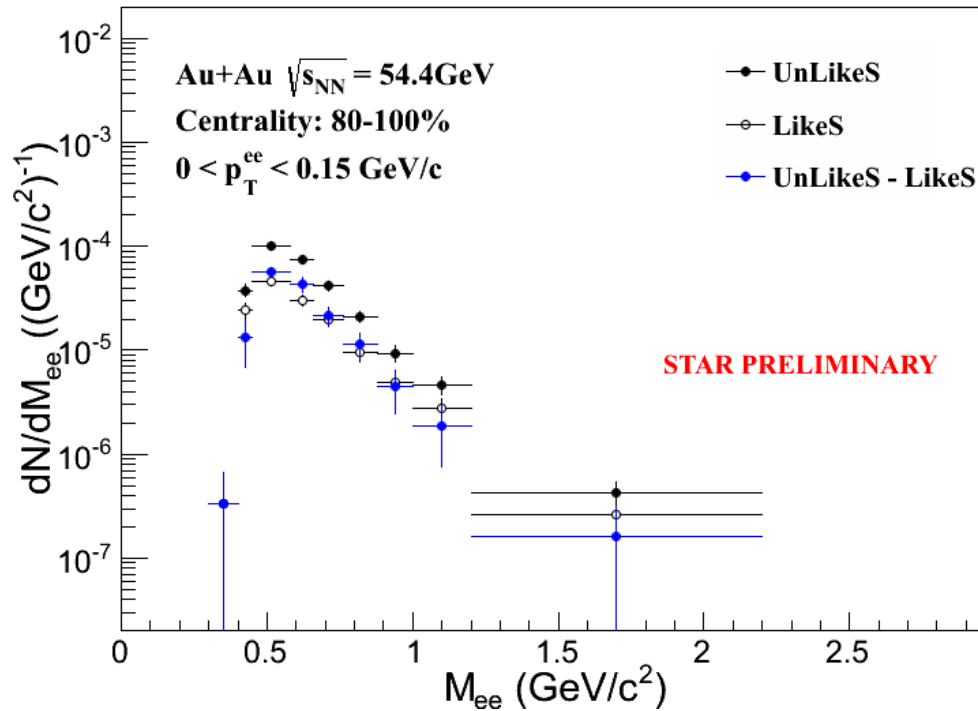
The Solenoid Tracker At RHIC (STAR)



- Excellent electron identification capability with the information from TPC and TOF
- High electron purity(95% in $n\sigma_e$ non-overlapping area) sample with STAR PID



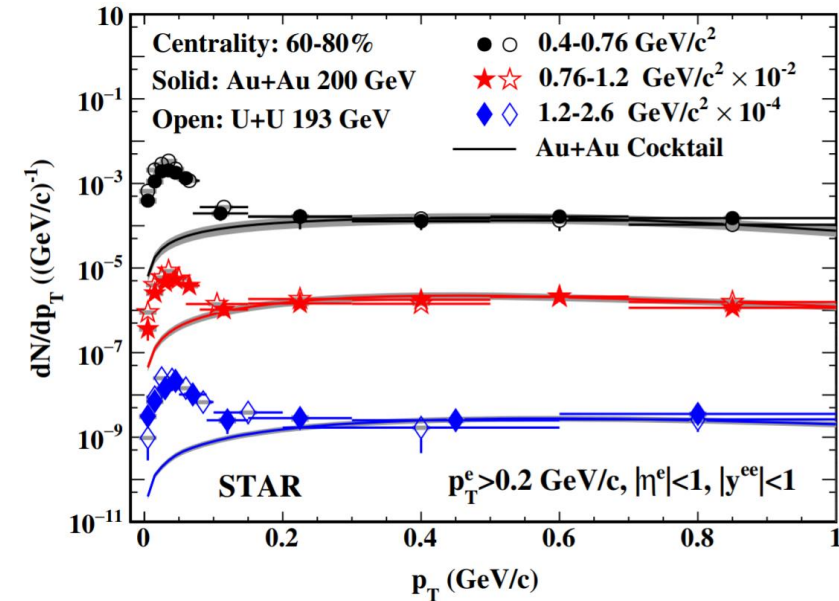
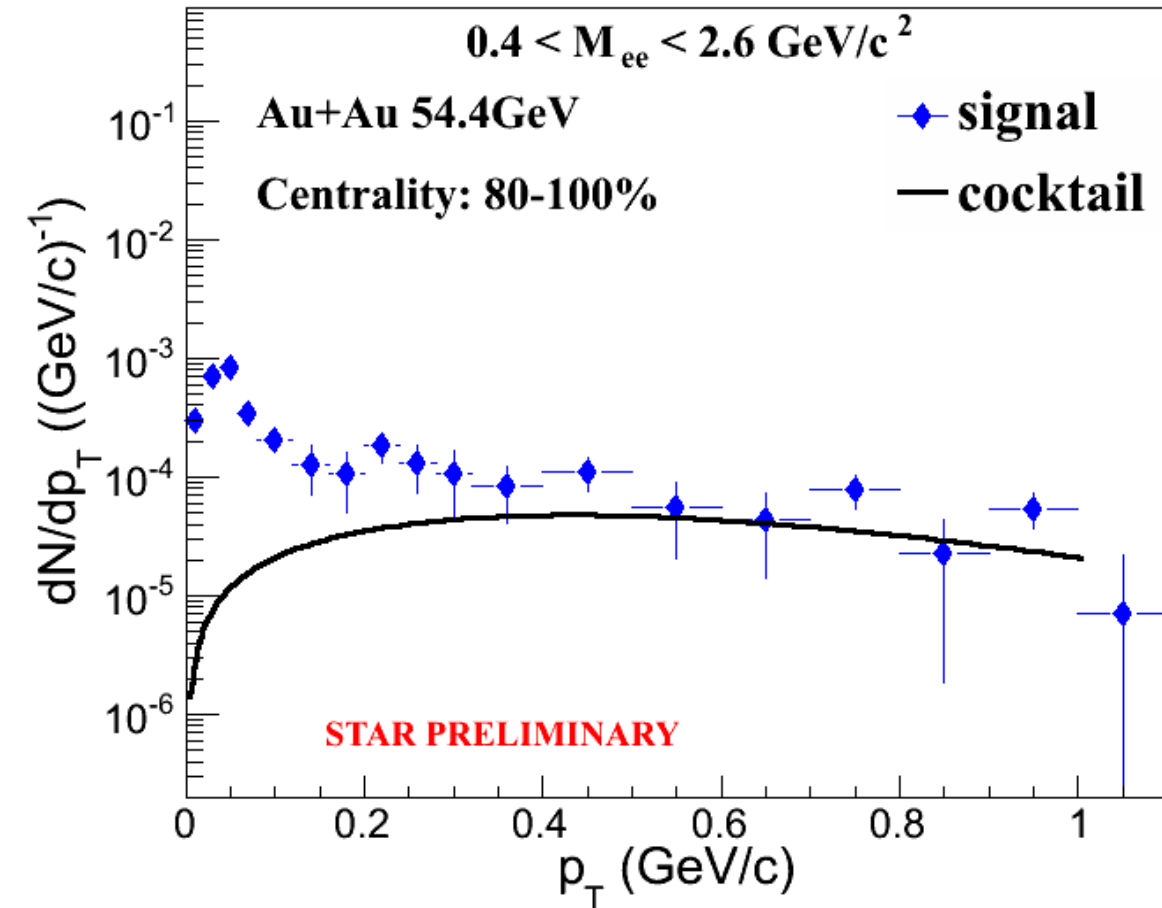
Mass Distribution in Low- p_T



- First di-electron measurement at the centrality of 80-100% at STAR
- Significant enhanced di-electron yield compared to hadronic cocktail
- No vector meson is observed
 - ✓ Forbidden for real photons with helicity ± 1



p_T Distribution



STAR, PRL 121,132301 (2018)

- Observed excess is concentrated below $0.2 \text{ GeV}/c$ in 80-100% compared to the cocktail
- Similar p_T distribution of e^+e^- pairs to those of Au+Au at $\sqrt{s_{NN}} = 200 \text{ GeV}/c$ 60-80% centrality
 - ✓ Indication of $\gamma\gamma \rightarrow e^+e^-$ production

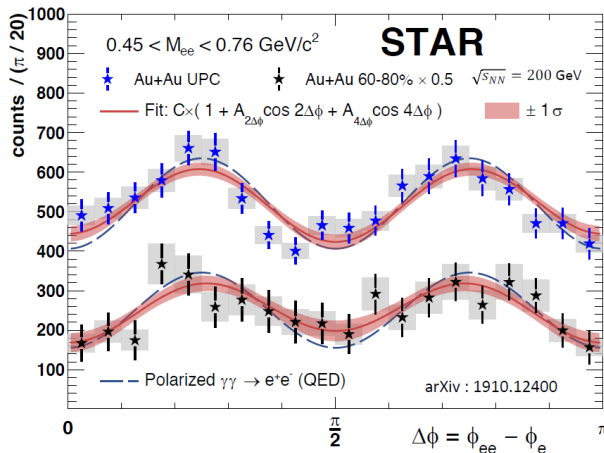


cos(4Δφ) Modulations

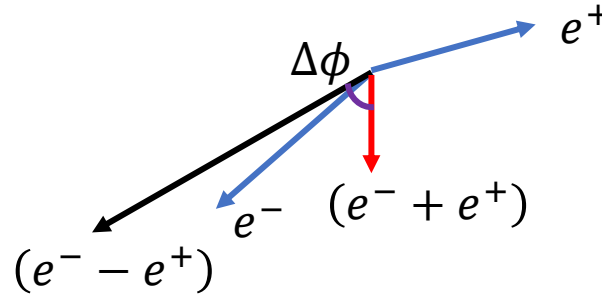
- Lorentz contraction of EM fields → Quasi-real photons should be **linearly polarized** ($\vec{E} \perp \vec{B} \perp \vec{k}$)

- Recently realized, there are $\cos(4\Delta\phi)$ modulations in polarized $\gamma\gamma \rightarrow e^+e^-$ [1]

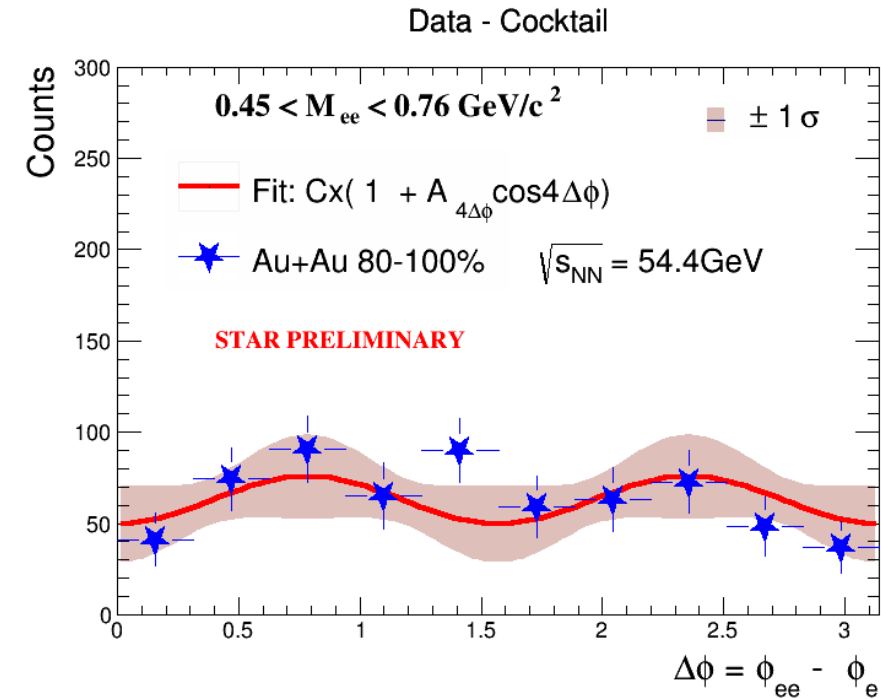
[1] C. Li, J. Zhou, Y.-j. Zhou, Phys. Lett. B 795, 576 (2019)



STAR, ArXiv : 1910.12400



Quantity	Value	χ^2/ndf
C	62.5 ± 5.3	8.9/8
$-A_{4\Delta\phi}(\%)$	20.8 ± 11.8	



- Indication of $\cos(4\Delta\phi)$ modulations in linearly polarized $\gamma\gamma \rightarrow e^+e^-$ process with a significance of 2σ
- ✓ More statistics is needed to confirm the trend



Summary

- First di-electron measurement at the centrality of 80-100% at $\sqrt{s_{NN}} = 54.4$ GeV at STAR
 - ✓ Bridge of HIC and UPC $\gamma\gamma \rightarrow e^+e^-$ process
- The very low- p_T di-electron mass spectra are significantly higher than hadronic cocktail and the p_T distribution is similar to 60-80% Au+Au 200 GeV results
 - ✓ Indication of $\gamma\gamma \rightarrow e^+e^-$ process
- Indication of $\cos(4\Delta\phi)$ modulations in linearly polarized $\gamma\gamma \rightarrow e^+e^-$ process, but more precise measurement is needed to improve the significance



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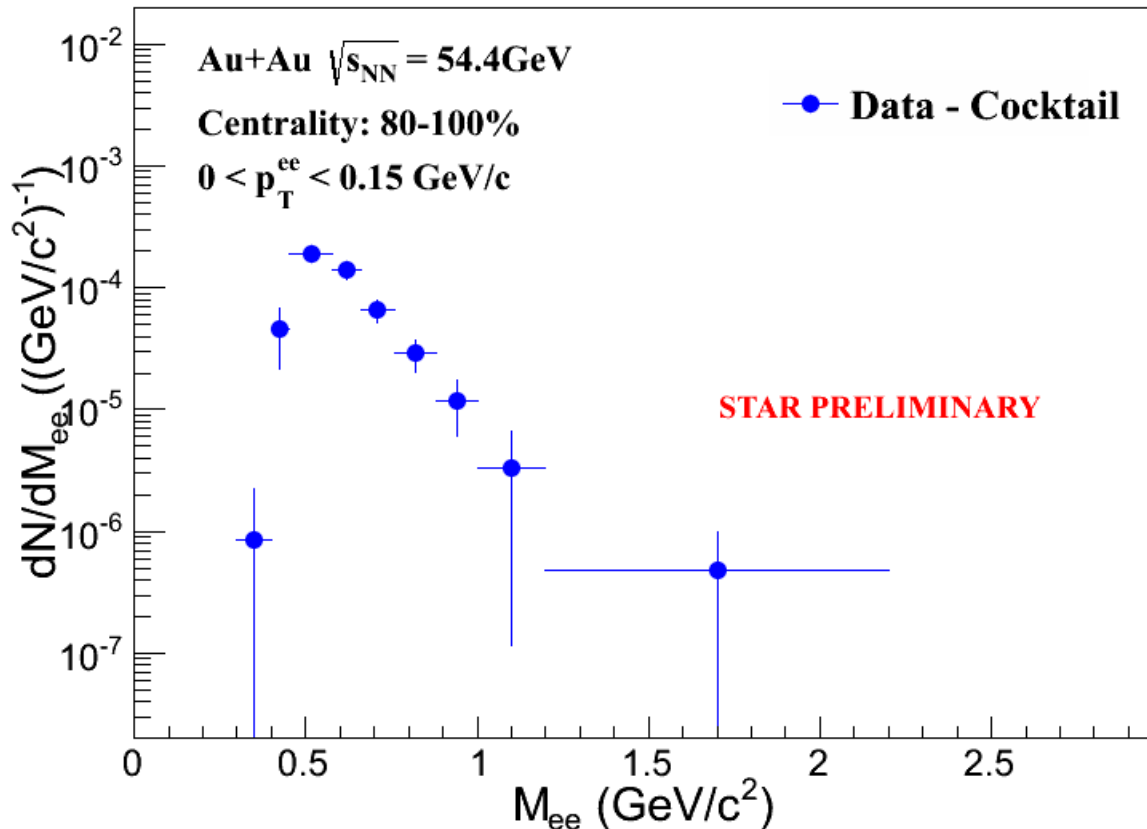
Thanks for Your Attention



Backup



Mass Distribution in Low- p_T



- A smooth e^+e^- invariant mass distribution
- $\gamma\gamma \rightarrow e^+e^-$: no vector meson production \longrightarrow forbidden for real photons with helicity ± 1 (i.e. 0 is forbidden)