Observation of Coherent $\phi(1020)$ Resonance in Photonuclear Ultra-Peripheral Collisions at STAR

Xihe Han, *for the STAR Collaboration*
The Ohio State University

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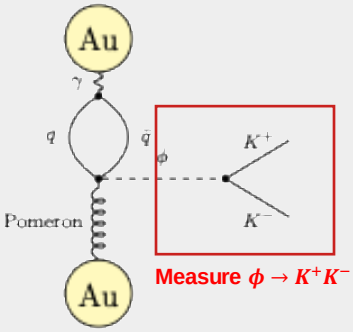
Motivation

Physics Goals

- Utilize ultra-peripheral collisions for clean electromagnetic interactions with minimal hadronic background.
- Leverage coherent production for sensitivity to the nuclear gluon density profile.
- Probe gluon distributions at low Bjorken-*x* using ϕ meson photoproduction.



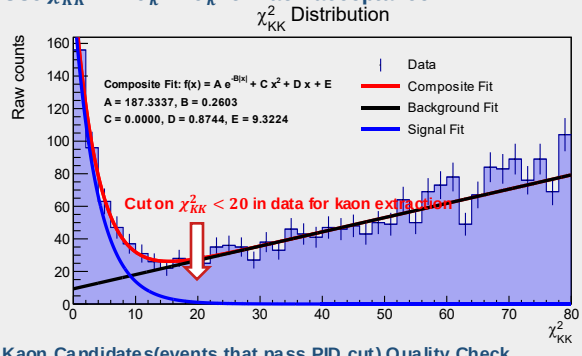
Measure $\phi \rightarrow K^+K^-$ Decay Channel

Theoretical Impact

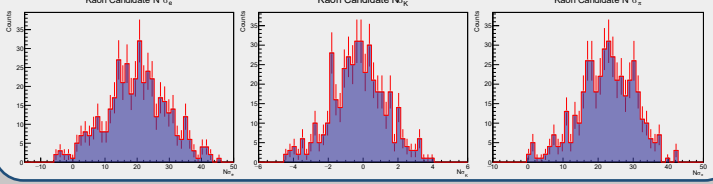
- Examine the energy dependence of the exclusive photoproduction cross section.
- Test and constrain cross-section models, including:
  - Vector Meson Dominance
  - Color Dipole Model

Particle Identification

- Use $\chi^2_{KK} \equiv N\sigma^1_k + N\sigma^2_k$ for kaon acceptance



- Kaon Candidates(events that pass PID cut) Quality Check

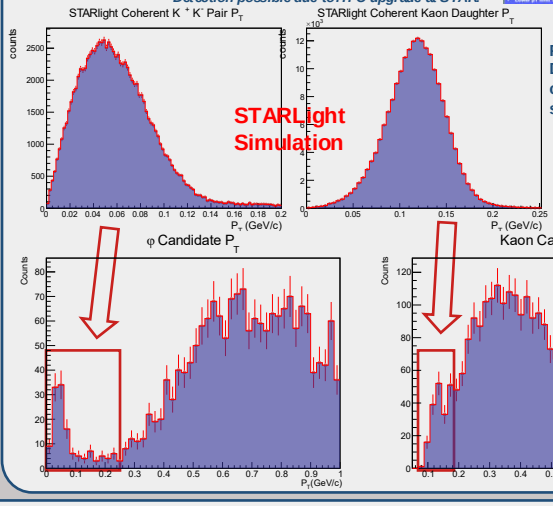


Phase Space Selection

The STARLight Model Suggests that:

- The ϕ meson itself should have a ~50 MeV p_T peak
- The kaon daughters should have a ~ 120 MeV p_T peak

Detection possible due to iTPC upgrade at STAR!

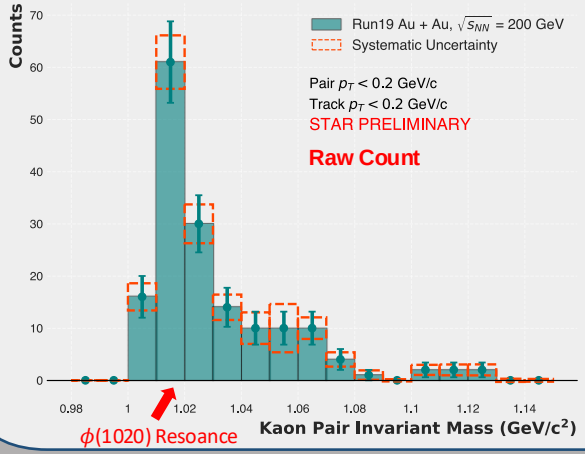


From both model and Data, the phase space cut to select for coherent signal is:

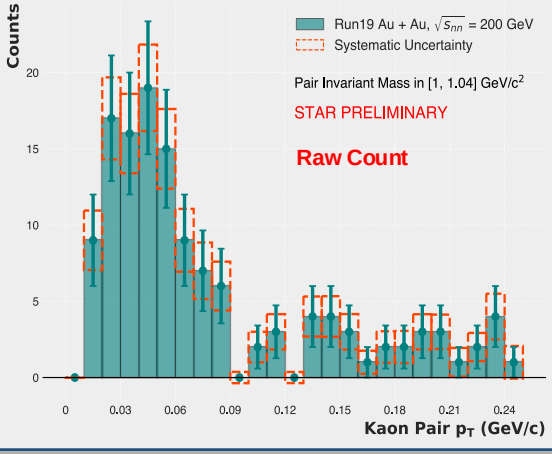
Pair $p_T < 0.2$ GeV, track $p_T < 0.2$ GeV

Results

Coherent Kaon Pair Invariant Mass Distribution



Coherent Kaon Pair Transverse Momentum Distribution



- Mass Peak at ϕ resonance
- Low Pair p_T peak in ϕ resonance window

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