Measurement of the Drell-Söding process in UPC Au+Au 200 GeV collisions

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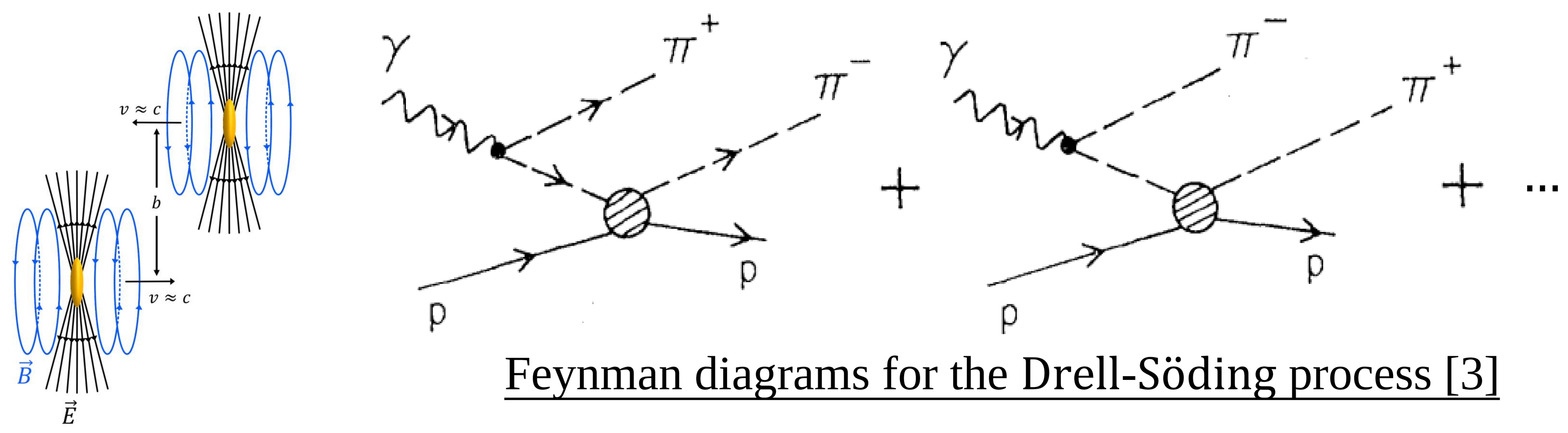
Introduction:

- Clouds of quasi-real photons with relativistic heavy ions (EPA) [1-2]
- Vector mesons and dihadron continuum produced by photon-nuclear interaction
- $\pi^+\pi^-$ production with arbitrary single virtual pion scattering with nucleus — Drell-Söding process



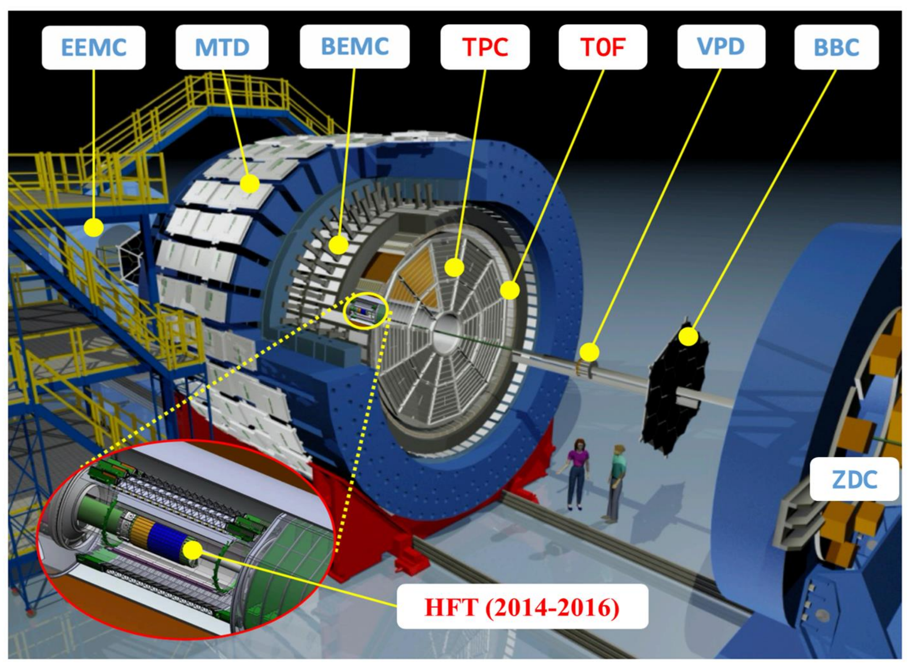
Feynman diagrams for the Drell-Söding process [3]

Physics opportunities:

- Interference enabled between different amplitudes (virtual $\pi^+/\pi^- A$ collisions)?
- How does decay influence observable interference patterns?
- Scattering effect for the entanglement of the initial dipion
- Nuclear dissociation difference for $\pi^+\pi^- A$ and $\rho^0 A$ scattering [4]

Data, detector and trigger:

- Run10, 11, 14 three years upc-main trigger data with around 134 million events and over 1 million ρ^0



Trigger detail:

- BBC veto
- ZDC coincidence
- Activity in bTOF

Event selection:

- $|V_z|$<100 cm
- Only 2 primary tracks
- Both match TOF

STAR: Solenodial Tracker At RHIC:

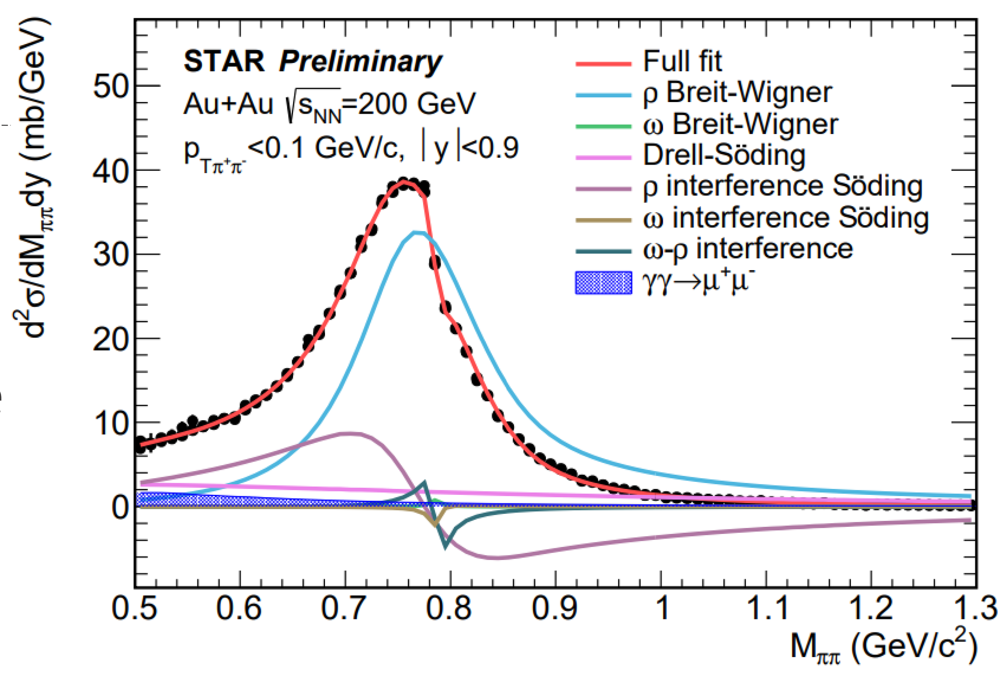
- TPC: Particle identification using dE/dx
- TOF: Reduce pile-up effect
- ZDC: luminosity and neutron detection

The fitting algorithm for Drell-Söding process:

Fit $\pi^+\pi^-$ mass spectra with the fitting function:

$$\frac{d\sigma}{dM_{\pi^+\pi^-}} = \left|A_\rho BW_\rho(M_{\pi\pi}) f_{fluxcorr}(M_{\pi\pi}) + B f_{Söding}(M_{\pi\pi}) + C_\omega e^{i\phi_\omega} BW_\omega(M_{\pi\pi})\right|^2 + f_{dimuon} + f_{background}$$

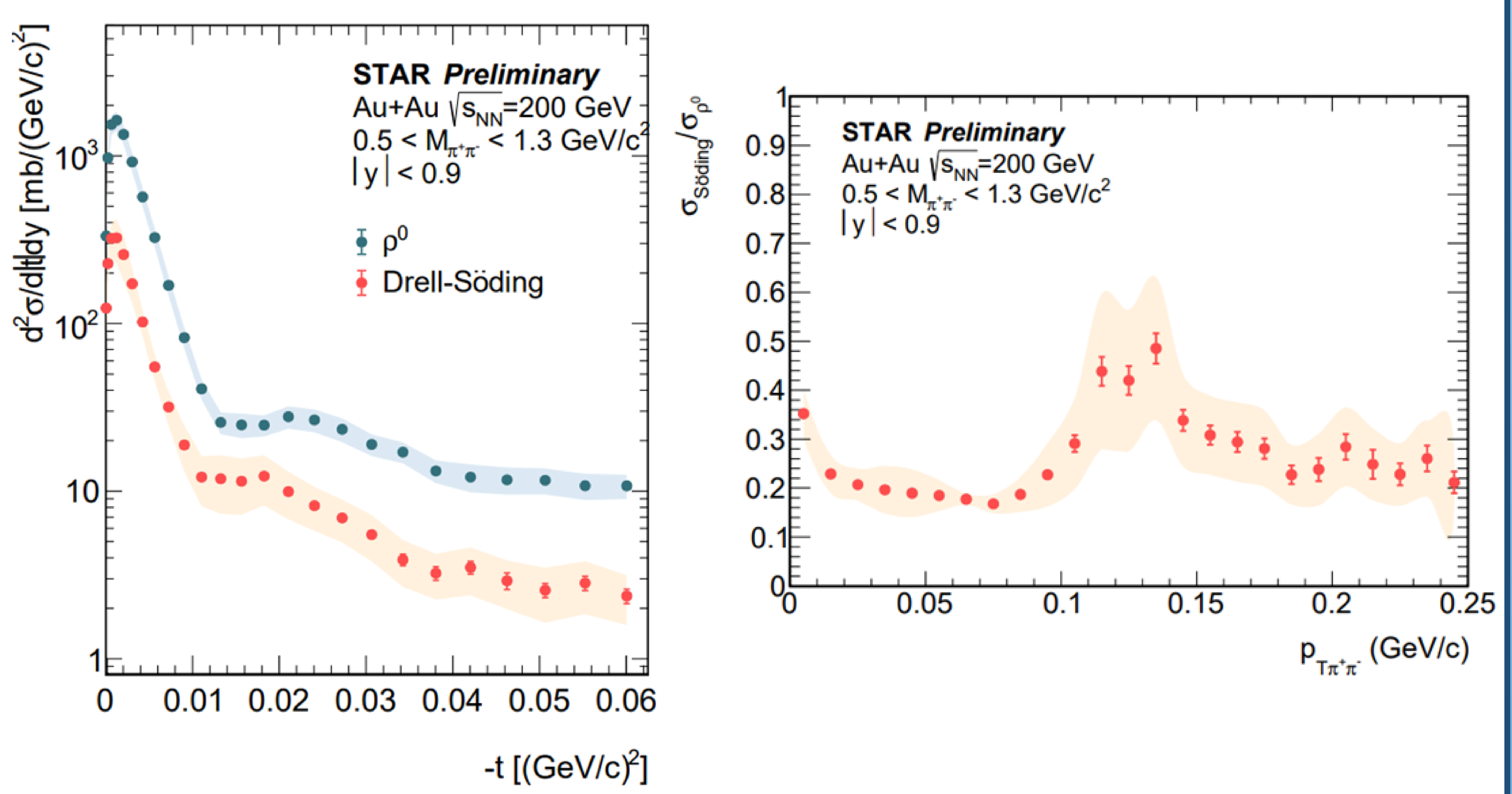
BW: relativistic Breit-Wigner function.
A_ρ and C_ω: amplitudes for ρ^0 and ω
ϕ_ω: the mixing phase angle.
$f_{fluxcorr}$: the mass correction due to the photon flux
$f_{Söding}$: normalized spectra from model calculation [5-6] with scale B;
f_{dimuon}: $\gamma\gamma \to \mu^+\mu^-$ from QED calculation [7];
$f_{background}$: a linear polynomial that accounts for the remaining background



- Reduce the parameters by fixing ω parameters from fit to mass spectra for $p_T < 0.1$ GeV/c
- Fit mass distributions per p_T or $\Delta\phi$ interval ($\Delta\phi = \phi_{(\vec{\pi_1}-\vec{\pi_2})} - \phi_{\pi\pi}$)

Diffractive p_T and t spectra

- The p_T of produced pair is the convolution of photon and nuclear gluon p_T distributions. [9]
- The suppressed production at very low p_T (p_T<0.01 GeV/c) is due to the interference. [9]



- The Söding diffractive pattern is like a shrunken mode for ρ^0
—The diffractive dip moves forward due to smaller Söding pair mass
- The ratio is flat except at the diffractive dip and very low p_T

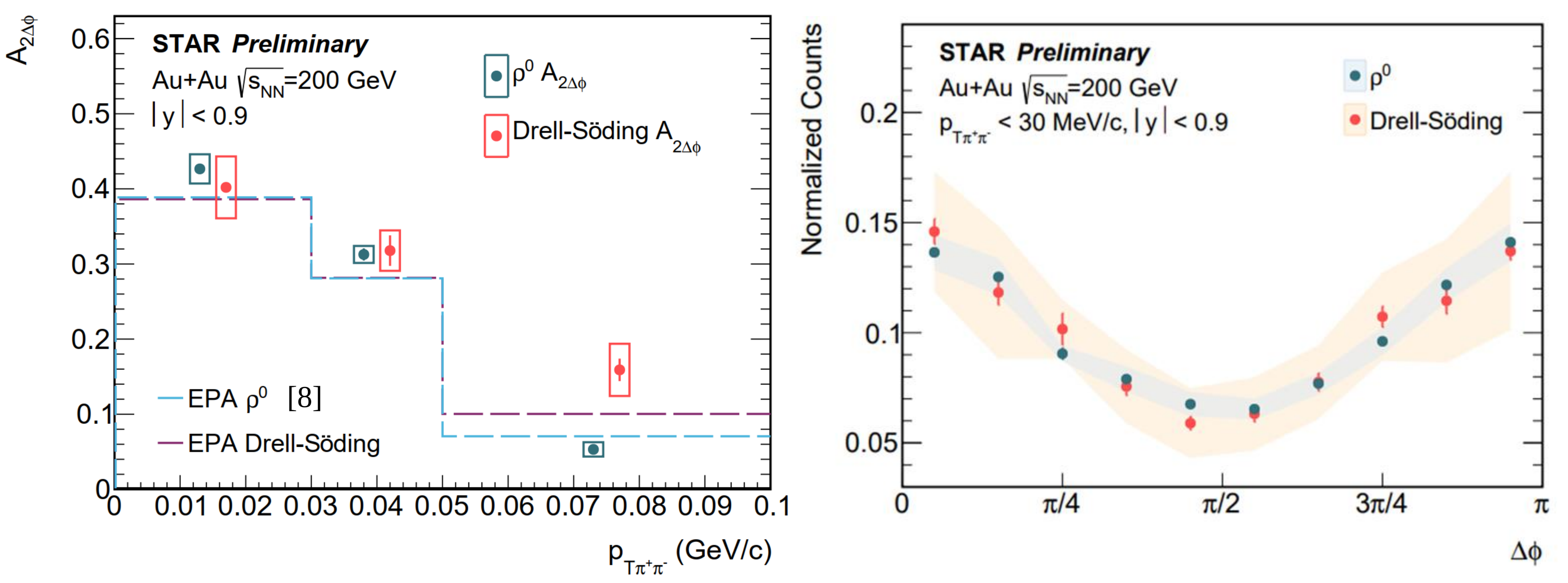
Interference measurement

$$A_{2\Delta\phi} = \int d\Delta\phi f(\Delta\phi) cos2\Delta\phi / \int d\Delta\phi f(\Delta\phi)$$

Interference intensity represented by $A_{2\Delta\phi}$

Q1: Different amplitudes of virtual $\pi^+ A$ and $\pi^- A$ might cause destructive interference

Q2: Scattering with nucleus might lead to decoherence of entangled dipion



- $A_{2\Delta\phi}$ for Söding and ρ^0 coherent production agree perfectly for first two bins.
- Need more studies at higher p_T (p_T>0.25GeV/c) and very low p_T (p_T<0.01 GeV/c)

Summary

- ✓ The first measurement of diffractive p_T and interference of the Drell-Söding process
- ✓ Perfect platform to study interference of photoproduction
- ✓ Interference enabled between virtual $\pi^+/\pi^- A$ scattering for the Drell-Söding process.

Reference

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