

π^0 Background Asymmetry
Cross Check
and PPG Requests

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6/17/20

π^0 Background Asymmetry Cross Check

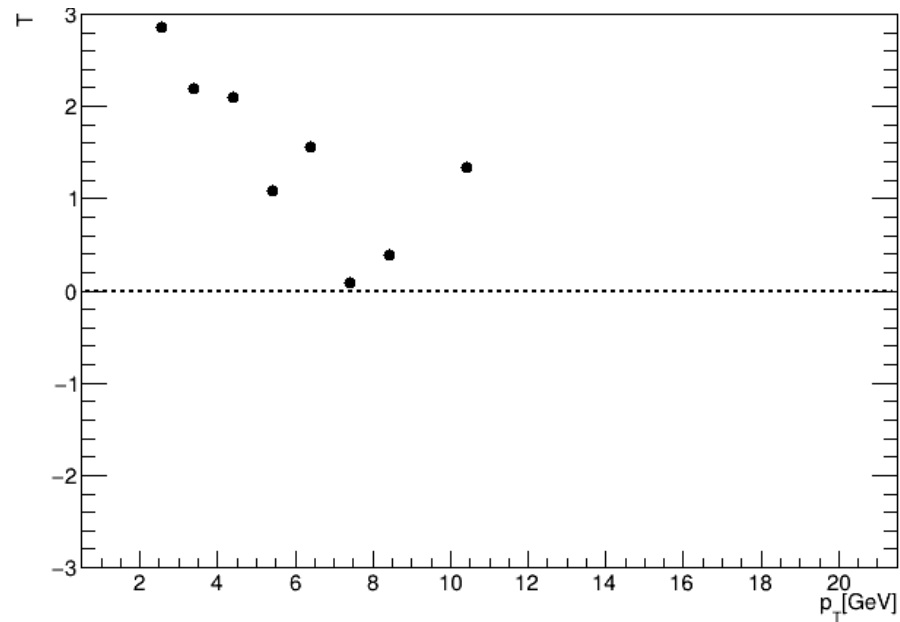
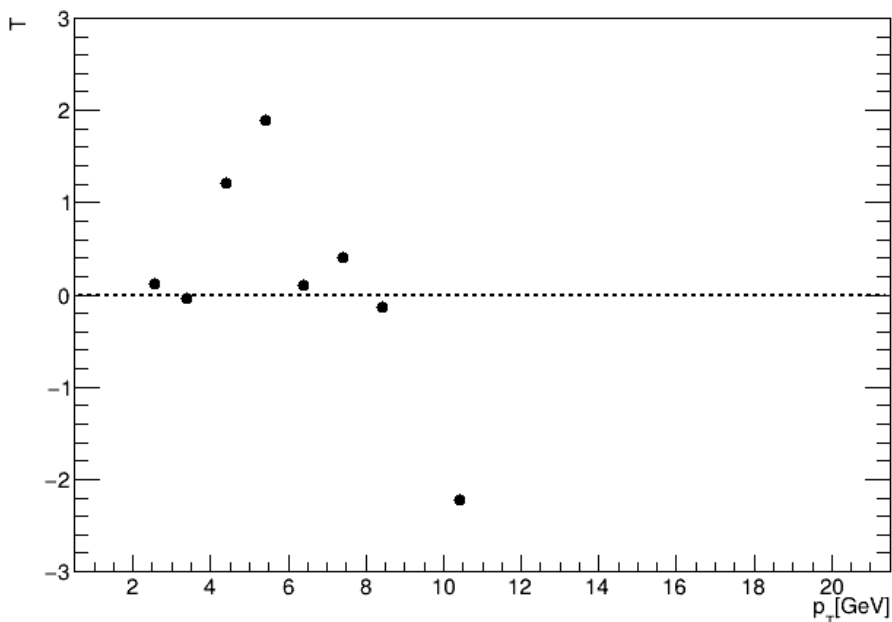
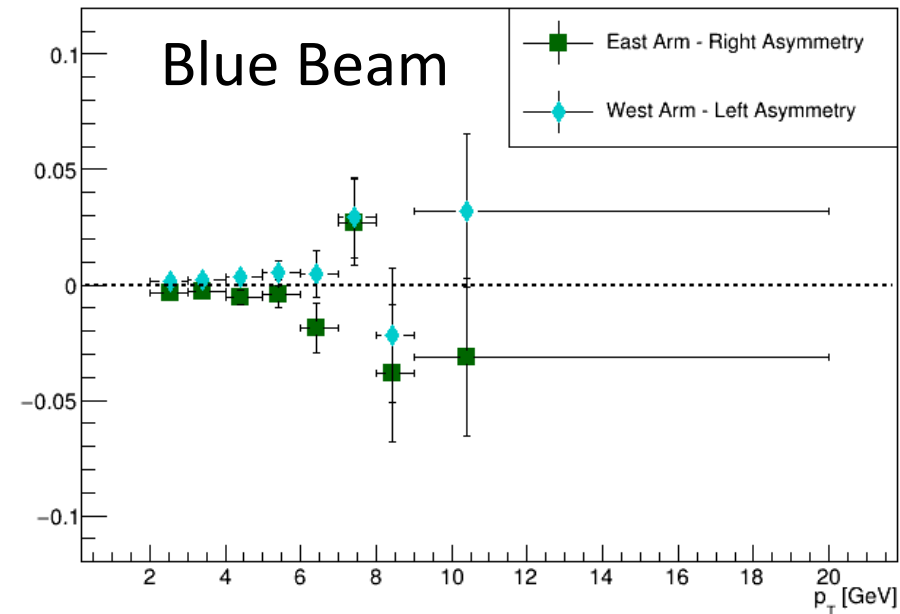
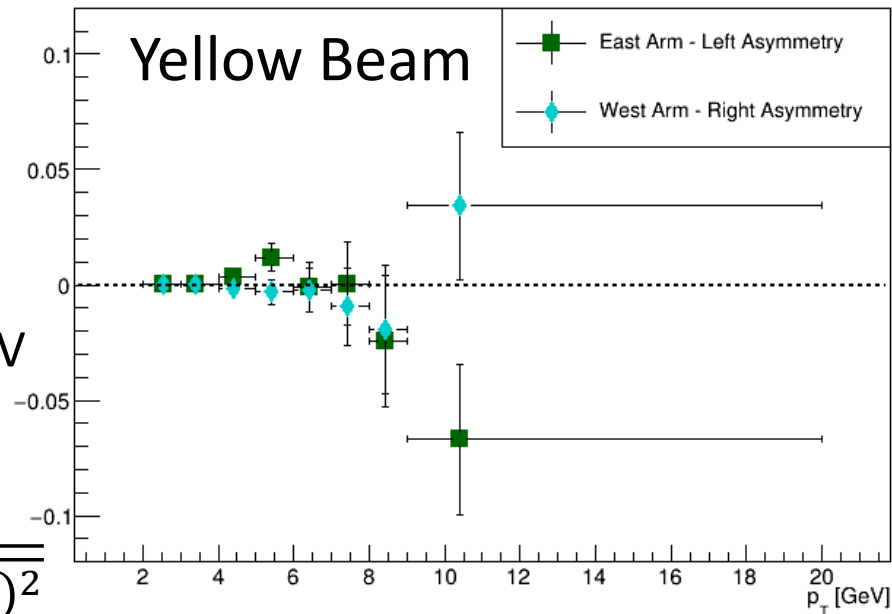
Relative Luminosity
Formula

Background invariant mass
regions: $47 < M_{\gamma\gamma} < 97$ MeV
or $177 < M_{\gamma\gamma} < 227$ MeV

$$T(p_T) = \frac{A_N^{left} - A_N^{right}}{\sqrt{(\sigma^{left})^2 + (\sigma^{right})^2}}$$

Last time I presented I said
both the yellow beam and
blue beam left and right
asymmetries were
inconsistent

But the yellow beam result
actually has 3 out of 8 t
values that are negative



π^0 Background Asymmetry Cross Check

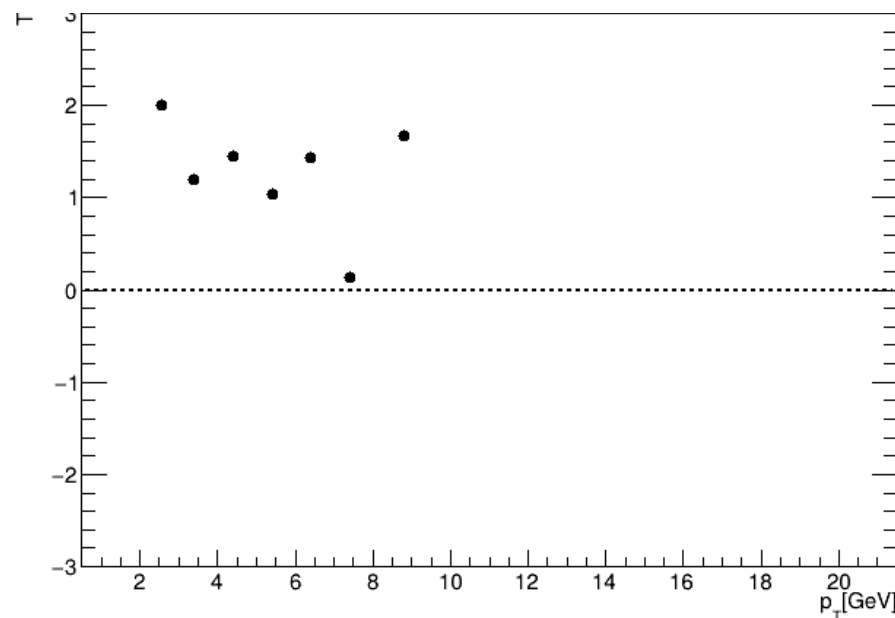
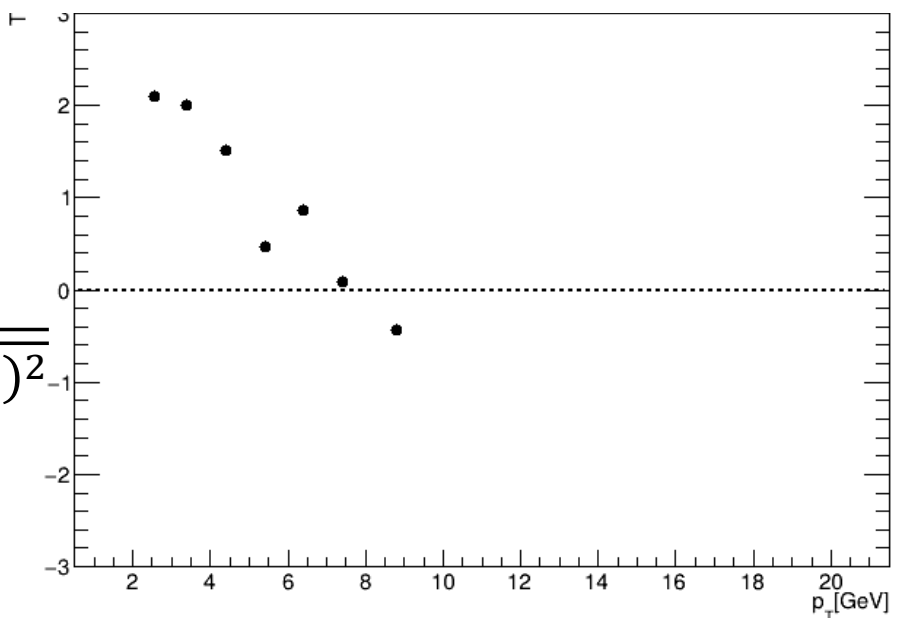
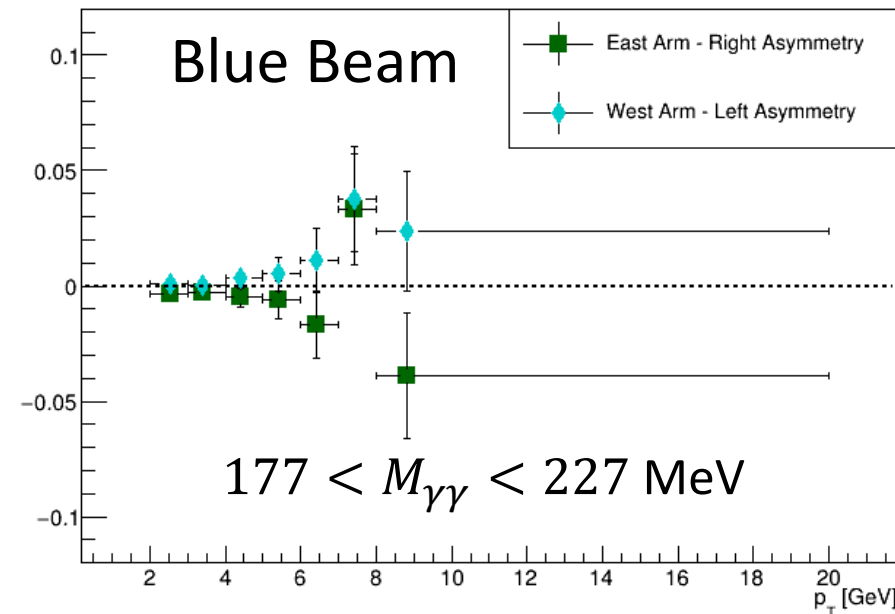
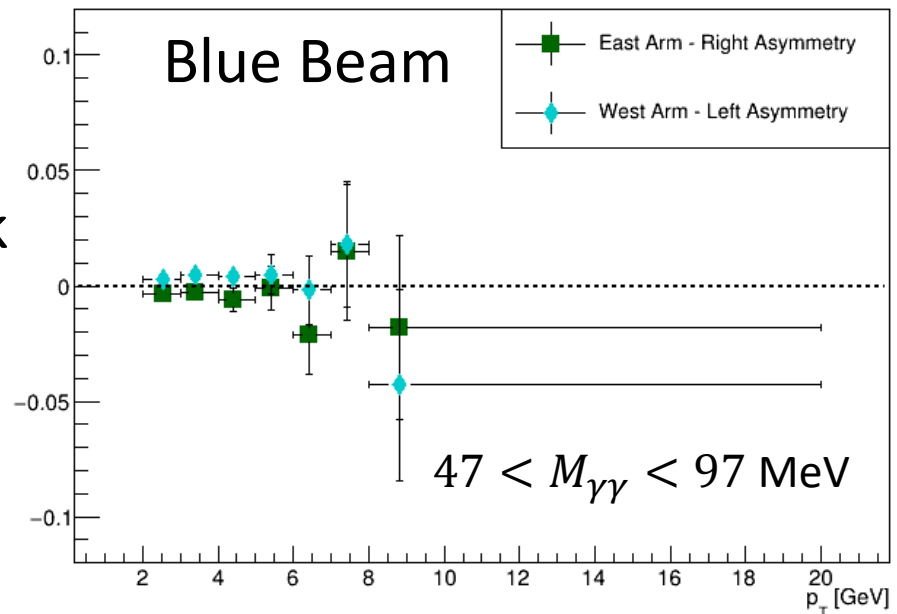
Relative Luminosity

Formula

Blue Beam Cross Check

Left Blue Beam Asymmetry is still systematically larger than the Right Blue Beam Asymmetry even when I split the background asymmetry into the different side band regions

$$T(p_T) = \frac{A_N^{left} - A_N^{right}}{\sqrt{(\sigma^{left})^2 + (\sigma^{right})^2}}$$



PHENIX PPG Formation Request

Physics Working Group Presentation

Working Title: **Transverse single-spin asymmetries of midrapidity π^0 and η mesons in polarized $p + p$ collisions at $\sqrt{s} = 200$ GeV**

Intended Journal: **Physical Review D**

PPG Chair: **Nicole Lewis (UM)**

PPG Members: **Christine Aidala (UM), Sasha Bazilevsky (BNL), Gabor David (SBU), Norbert Novitzky (SBU), Joe Osborn (UM/ORNL)**

Basic Information

- Analysis developed in Physics Working Group(s): **Spin**
- Collision System(s): **$p + p$ at $\sqrt{s} = 200$ GeV**
- Data from Run Number(s): **Run-15**
- Preliminary Results Leading Towards the PPG:
 - (A_N^η) -
https://www.phenix.bnl.gov/WWW/p/plots/show_plot.php?editkey=p1493
- Analysis note(s):
 - **AN1373** (A_N^η) -
www.phenix.bnl.gov/phenix/WWW/p/draft/nialewis/etaA_N/EtaA_N_v4.pdf
 - **AN1433** $(A_N^{\pi^0})$ -
www.phenix.bnl.gov/phenix/WWW/p/draft/nialewis/pi0A_N/Pi0A_N.pdf

Proposed Figures

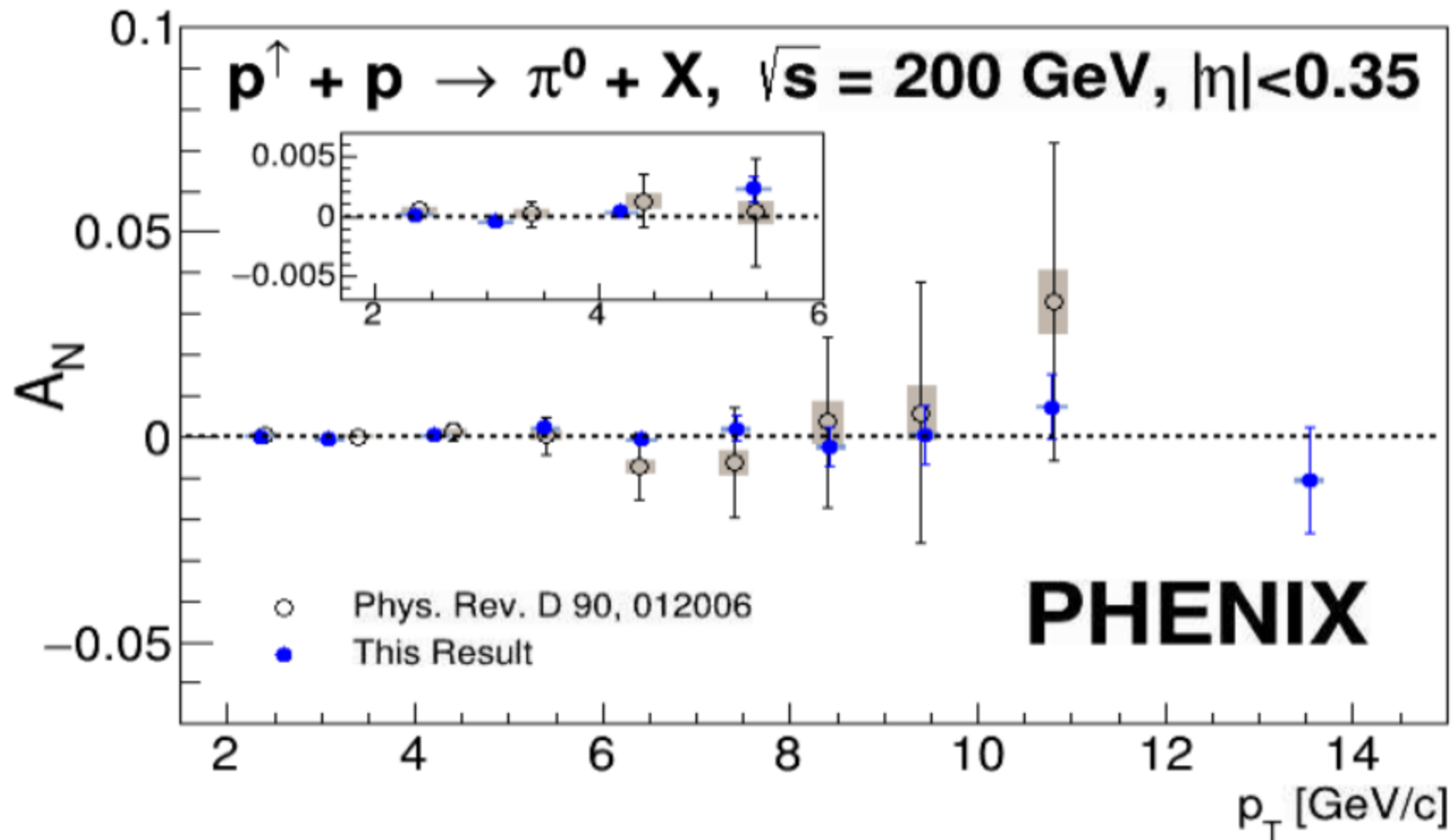


Figure 1: The midrapidity π^0 TSSA measured in $p^\uparrow + p$ collisions with $\sqrt{s} = 200 \text{ GeV}$ plotted with the previously published PHENIX result

Proposed Figures

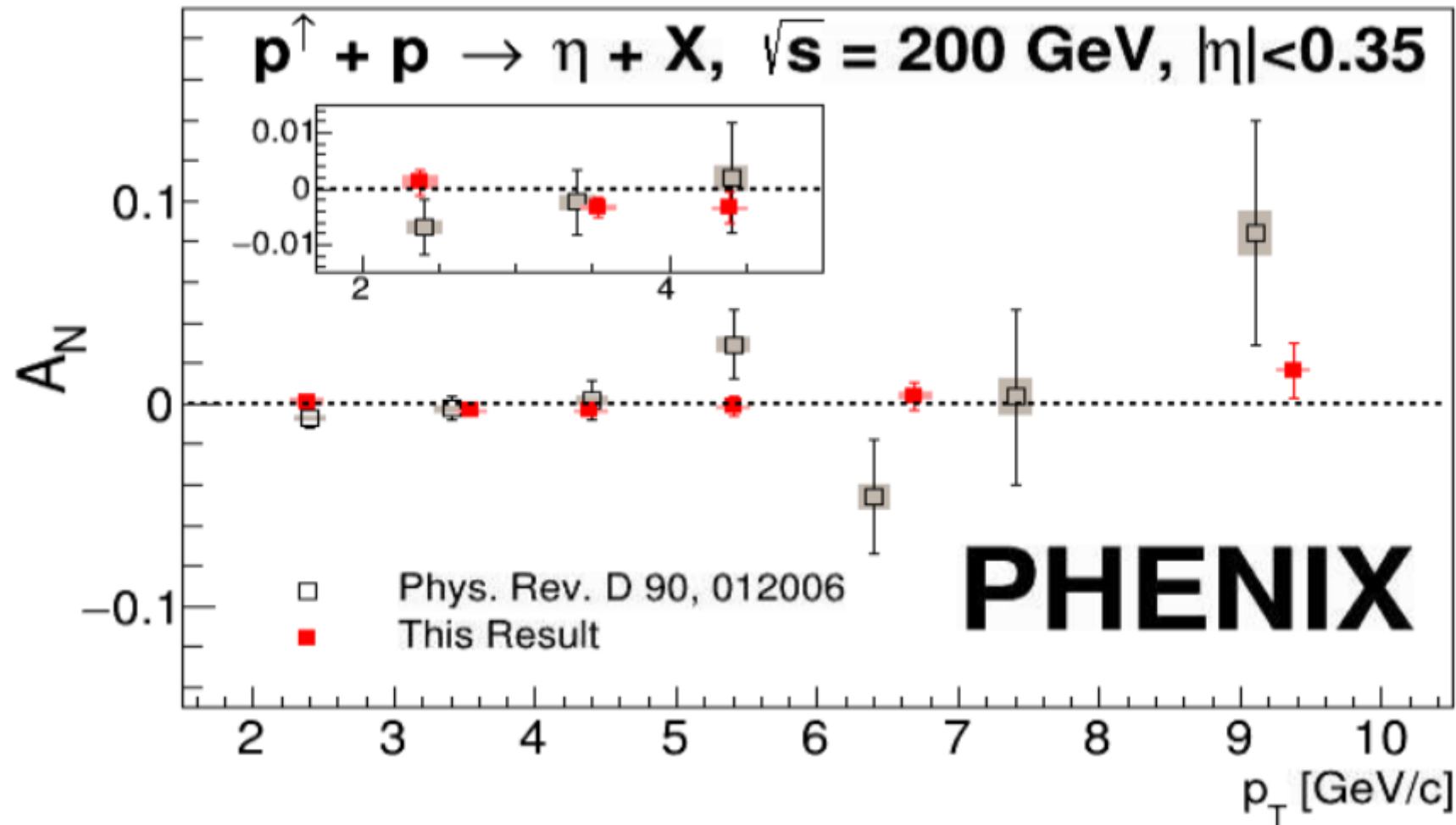


Figure 2: The midrapidity η TSSA measured in $p^\uparrow + p$ collisions with $\sqrt{s} = 200 \text{ GeV}$ plotted with the previously published PHENIX result

Proposed Figures

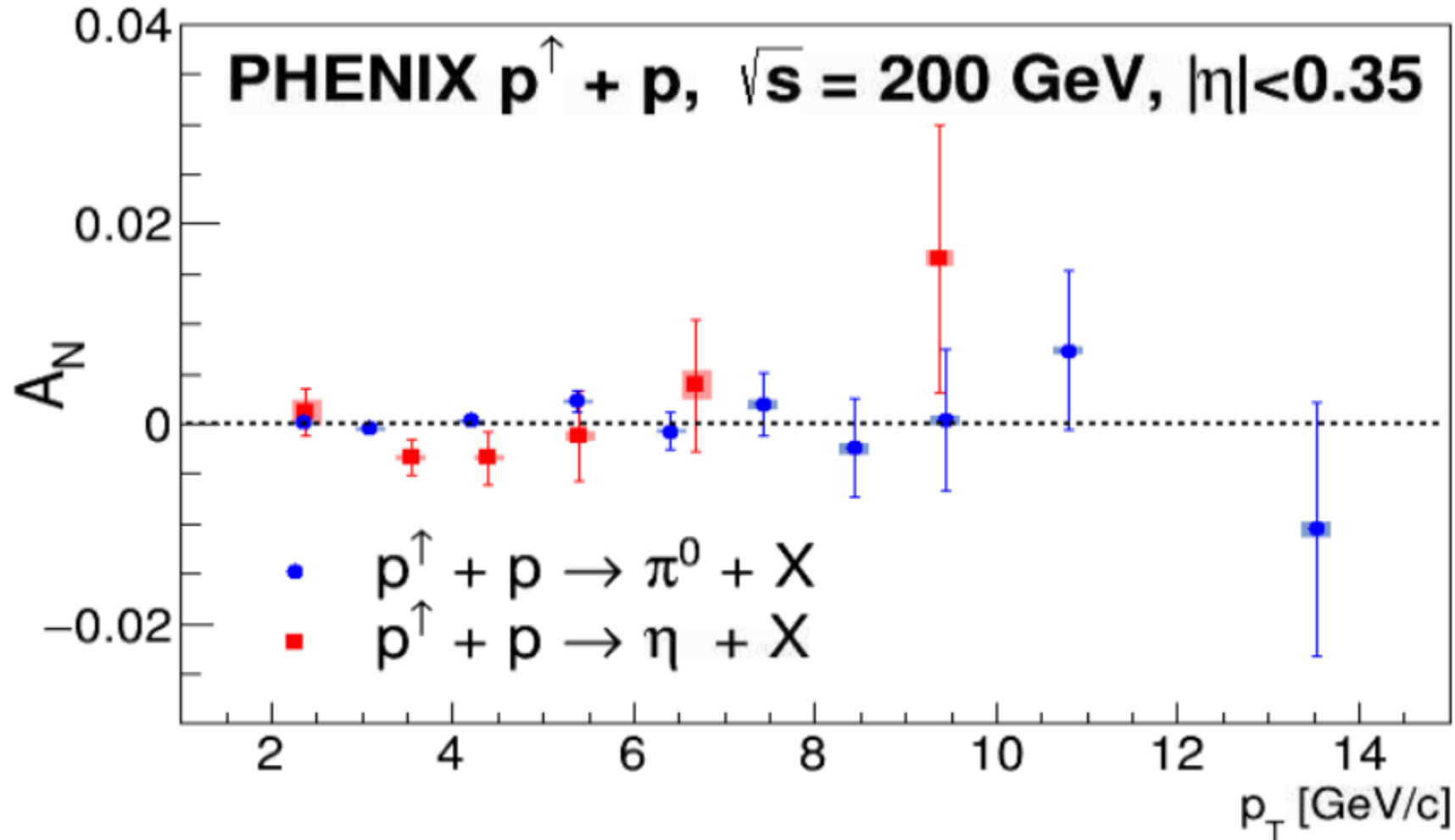


Figure 3: The midrapidity π^0 and η TSSA measured in $p^\uparrow + p$ collisions with $\sqrt{s} = 200$ GeV

Proposed Figures

Waiting for calculations from theorists

Example Abstract

We present a measurement of the transverse single-spin asymmetry (TSSA) for neutral pions and eta mesons in $p + p$ collisions in the pseudorapidity range $|\eta| < 0.35$ and at a center-of-mass energy of 200 GeV with the PHENIX detector at the Relativistic Heavy Ion Collider. In comparison with previous measurements in this kinematic region, these results have a factor of 3 smaller uncertainties. As hadrons, π^0 and η mesons are sensitive to both initial- and final-state nonperturbative effects for a mix of parton flavors. Comparisons of the differences in their TSSAs are sensitive to the potential effects of strangeness, isospin, or mass. These results can constrain the twist-3 trigluon collinear correlation function as well as the gluon Sivers function.

Relation to other publications

1. Previously published relevant PHENIX results
 - PPG050 <https://arxiv.org/abs/hep-ex/0507073>
First published midrapidity π^0 TSSA
 - PPG135 <https://arxiv.org/abs/1312.1995>
Most recently published midrapidity π^0 and η TSSA. Our new results are a factor of three increase in precision
2. Previously published other experimental results
 - STAR forward rapidity π^0 and η TSSA
<https://arxiv.org/abs/1205.6826>
Asymmetries go to zero as x_F goes to zero
3. Previously published theoretical papers
 - Constraining the gluon Sivers function with midrapidity π^0 TSSA results from PPG135 <https://arxiv.org/abs/1506.03078>
 - The trigluon twist-3 correlation function's contribution to light hadron TSSA <https://arxiv.org/pdf/1312.6862.pdf>
 - The quark-gluon twist-3 correlation functions' contribution including hadronization <https://arxiv.org/abs/1404.1033>

Related to the Previous Slide...

What is the Competition?

None

What is the target journal?

Physical Review D

This is the same journal that published PPG135, the previous PHENIX midrapidity π^0 and η TSSA.

Time Scale and People-Power

What is the expected timescale for a full internal PPG draft?
End of June 2020

What is the expected timescale for a first collaboration PPG release?
Mid July 2020

What are the 2-3 main drivers in that timescale?

- **Planning on using PPG204 internal draft (π_0 TSSA in $p + p$ and $p + A$) as a starting point**
- **Writing my thesis and graduating this summer**
- **Waiting for potential calculations from theorists**

Filled out ascii template:

-
- (1) Working Title: Transverse single-spin asymmetries of midrapidity π^0 and η mesons in polarized $p + p$ collisions at $\sqrt{s} = 200$ GeV
 - (2) Intended Journal: Phys. Rev. D
 - (3) PPG Chair: Nicole Lewis (UM) PPG Members: Christine Aidala (UM), Alexander Bazilevsky (BNL), Gabor David (SBU), Norbert Novitzky (SBU), Joseph Osborn (UM/ORNL)
 - (4) Names of non-MGS PPG members (or others) to be added to author list: Nicole Lewis (UM)
 - (5) Analysis developed in Physics Working Group(s): Spin
 - (6) Collision System(s): p+p, at 200 GeV
 - (7) Data from Run Number(s): Run-15
 - (8) Target for first internal release: July 10, 2020
 - (9) Analysis note(s): AN1373, AN1433
 - (10) If this was a protoPPG, then number was:
 - (11) Web Page: <https://www.phenix.bnl.gov/phenix/WWW/p/info/ppg/>
 - (12) Current version of paper draft:
 - (13) Number of figures: _
Fig. 1: _short title_ <https://www.phenix.bnl.gov/phenix/WWW/p/...>
Fig. 2: _short title_ <https://www.phenix.bnl.gov/phenix/WWW/p/...> ...

Second PPG Formation Request

PHENIX PPG Formation Request

Physics Working Group Presentation

Working Title: **Transverse single-spin asymmetry of midrapidity isolated direct photons in polarized $p + p$ collisions at $\sqrt{s} = 200$ GeV**

Intended Journal: **Physical Review Letters**

PPG Chair: **Nicole Lewis (UM)**

PPG Members: **Christine Aidala (UM), Sasha Bazilevsky (BNL), Gabor David (SBU), Joe Osborn (UM/ORNL)**

Basic Information

- Analysis developed in Physics Working Group(s): **Spin**
- Collision System(s): $p + p$ at $\sqrt{s} = 200 \text{ GeV}$
- Data from Run Number(s): **Run-15**
- Preliminary Results Leading Towards the PPG:
https://www.phenix.bnl.gov/WWW/p/plots/show_plot.php?editkey=p1563
- Analysis note(s):
 - **AN1326**
www.phenix.bnl.gov/phenix/WWW/p/draft/nialewis/PhotonA_N/Run15DirectPhotonA_N-version6.pdf

Proposed Figures

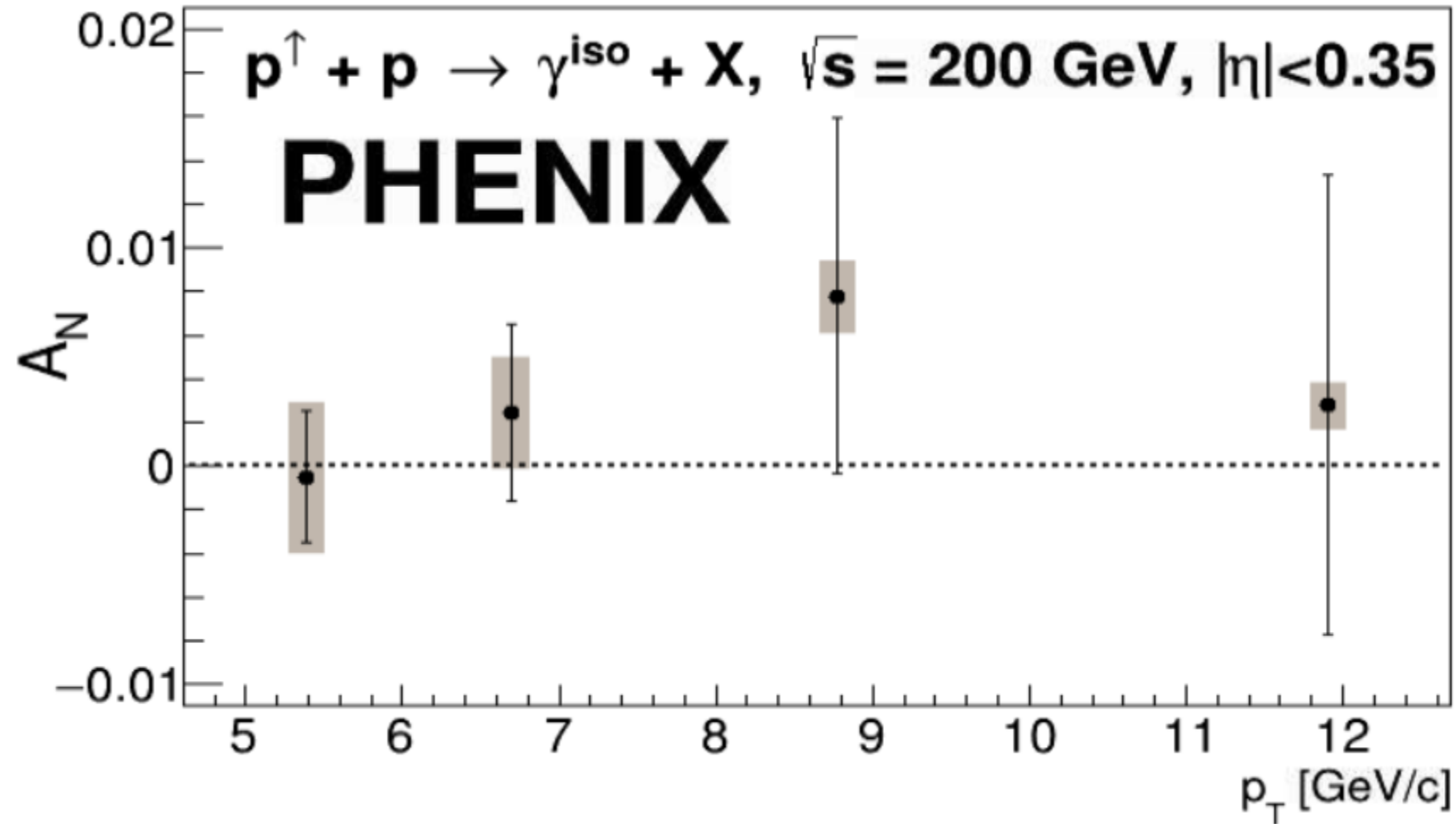


Figure 1: The midrapidity isolated direct photon TSSA measured in $p^\uparrow + p$ collisions with $\sqrt{s} = 200 \text{ GeV}$

Proposed Figures

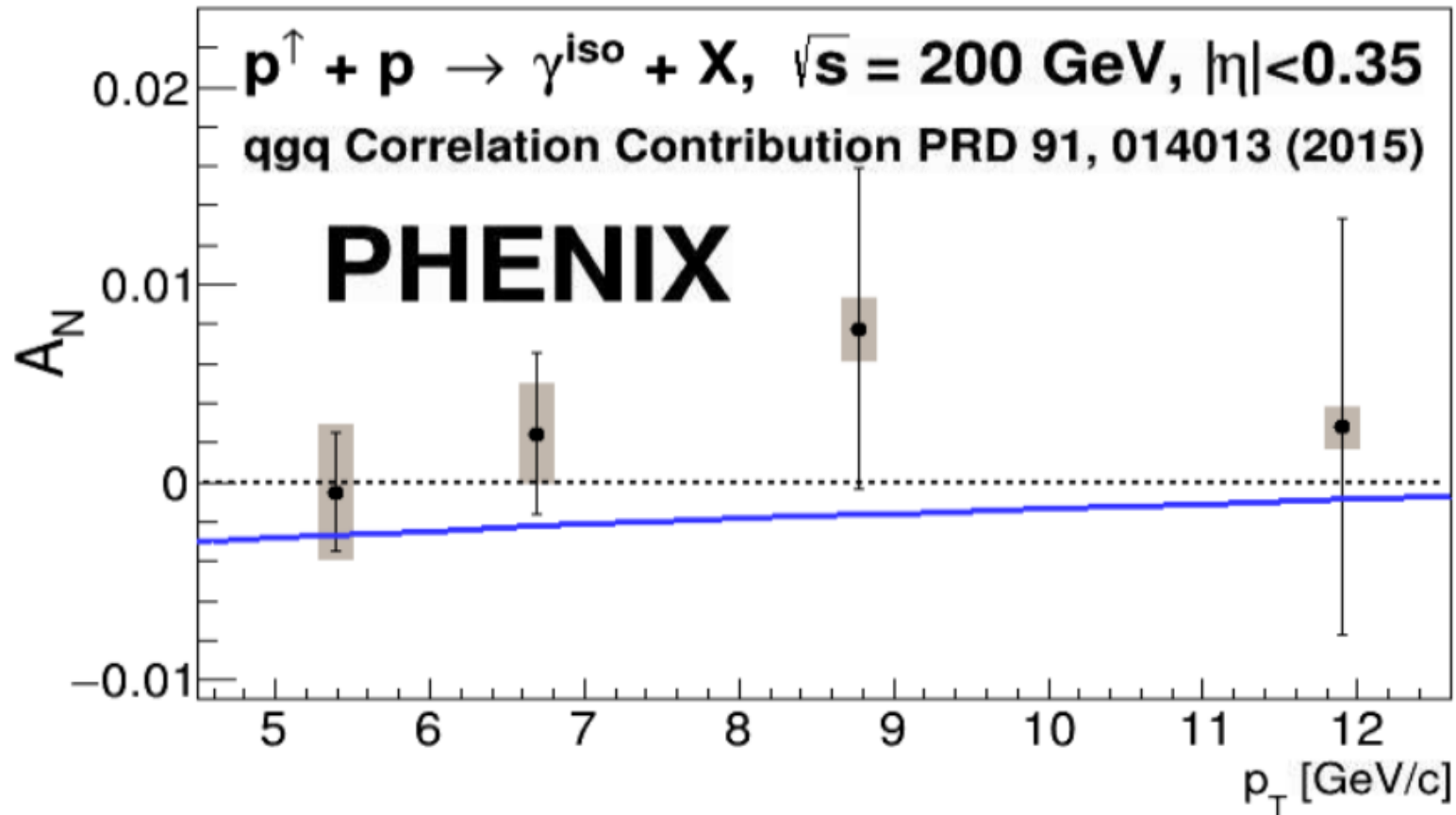


Figure 2: The midrapidity isolated direct photon TSSA measured in $p^\uparrow + p$ collisions with $\sqrt{s} = 200 \text{ GeV}$ plotted with the predicted quark-gluon-quark twist-3 correlation function contribution from <https://arxiv.org/pdf/1410.3448.pdf> but evaluated for $|\eta| < 0.35$

Proposed Figures

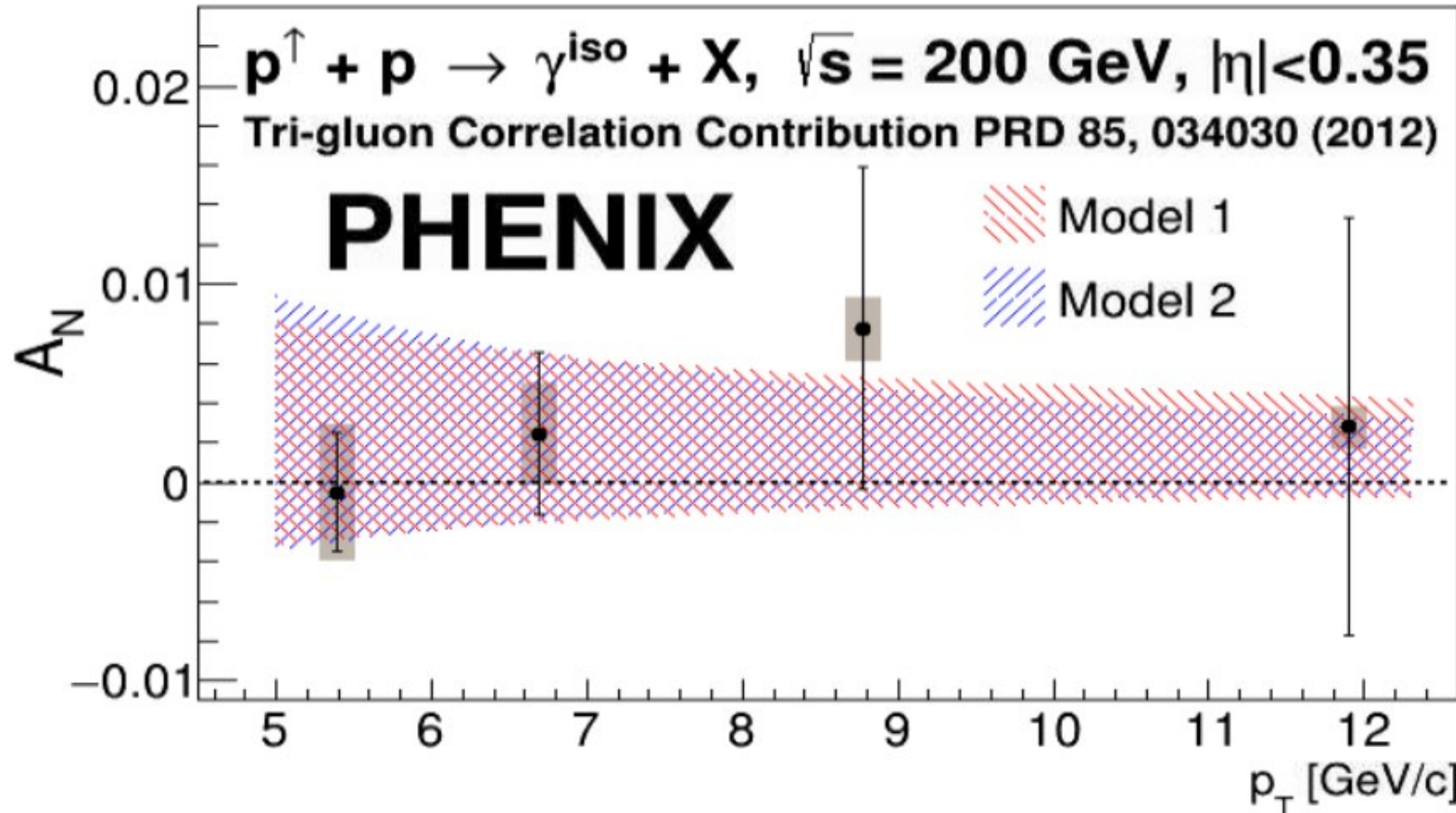


Figure 3: The midrapidity isolated direct photon TSSA measured in $p^\uparrow + p$ collisions with $\sqrt{s} = 200 \text{ GeV}$ with the predicted range for the trigluon twist-3 correlation function's contribution to the asymmetry which was originally published in <https://arxiv.org/abs/1112.1161> but reevaluated for $\eta = 0$

Example Abstract

The transverse single-spin asymmetry for midrapidity isolated direct photons in $p + p$ collisions at $\sqrt{s} = 200$ GeV with the PHENIX detector at the Relativistic Heavy Ion Collider (RHIC) is presented. Because direct photon production does not involve hadronization, these results are a clean probe of initial-state spin-momentum correlations in the proton. In the measured kinematics, direct photons are in particular sensitive to gluon dynamics. This is the first time direct photons have been used as a probe of spin-momentum correlations in polarized protons at RHIC. These results constrain multigluon correlations in transversely polarized protons.

Detailed Justification Paragraph (if intended journal is PRL or Physics Letters)

Physical Review Letters now requires this justification.

For details see Brant's email below to phenix-p-l

<https://www.phenix.bnl.gov/phenix/WWW/p/lists/phenix-p-l/msg20143.html>

This is the first direct photon spin asymmetry measurement to be published at RHIC, the only collider in the world able to run polarized proton beams. Isolated direct photons are a unique probe of polarized proton structure because they are a fundamental particle produced *directly* by the partonic hard scattering event and thus are not affected by final-state hadronization. Furthermore in the measured kinematics, direct photon production is particularly sensitive to gluon dynamics in transversely polarized protons. Gluon spin-momentum correlations in polarized protons remain poorly constrained because lepton-proton collisions are not sensitive to gluons at leading order, and other RHIC asymmetry measurements that are sensitive to these gluon dynamics are either difficult to interpret phenomenologically because of effects from hadronization and/or are comparatively statistically limited.

Relation to other publications

1. Previously published relevant PHENIX results
 - **Direct photon cross section PPG136**
<https://arxiv.org/abs/1205.5533>
2. Previously published other experimental results (STAR, ALICE, ATLAS, CMS)
 - **Fermilab E704 A_N^{γ} measurement - consistent with zero with large error bars**
<https://www.sciencedirect.com/science/article/abs/pii/0370269394016959>
3. Previously published theoretical papers (one or two that might have directly comparable predictions)
 - **Predicted full quark-gluon-quark correlation functions' contribution to A_N^{γ}** : <https://arxiv.org/abs/1410.3448>
 - **Predicted range for the tri-gluon correlation function contribution to A_N^{γ}** : <https://arxiv.org/abs/1112.1161>

Related to the Previous Slide...

What is the Competition?

none

What is the target journal?

Physical Review Letters

This is will be the first published direct photon spin asymmetry measurement at RHIC. It is uniquely capable of constraining the twist-3 trigluon correlation function in the polarized proton because it is not affected by spin-momentum correlations in the process of hadronization and it is statistically precise.

Time Scale and People-Power

What is the expected timescale for a full internal PPG draft?

End of June/Mid July 2020

What is the expected timescale for a first collaboration PPG release?

End of July/Mid August 2020

What are the 2-3 main drivers in that timescale?

- **Writing my thesis and graduating this summer**
- **Planning on starting with the π^0 and eta draft first and then moving on to this one**

Filled out ascii template:

-
- (1) Working Title: Transverse single-spin asymmetry of midrapidity isolated direct photons in polarized $(p + p)$ collisions at $(\sqrt{s} = 200)$ GeV
 - (2) Intended Journal: Phys. Rev. Lett.
 - (3) PPG Chair: Nicole Lewis (UM) PPG Members: Christine Aidala (UM), Alexander Bazilevsky (BNL), Gabor David (SBU), Joseph Osborn (UM/ORNL)
 - (4) Names of non-MGS PPG members (or others) to be added to author list: Nicole Lewis (UM)
 - (5) Analysis developed in Physics Working Group(s): Spin
 - (6) Collision System(s): p+p at 200 GeV
 - (7) Data from Run Number(s): Run-15
 - (8) Target for first internal release: July 27, 2020
 - (9) Analysis note(s): AN1326
 - (10) If this was a protoPPG, then number was:
 - (11) Web Page: https://www.phenix.bnl.gov/phenix/WWW/p/info/ppg/___/
 - (12) Current version of paper draft: <https://www.phenix.bnl.gov/phenix/WWW/p/draft/...>
 - (13) Number of figures: _
 Fig. 1: _short title_ <https://www.phenix.bnl.gov/phenix/WWW/p/...>
 Fig. 2: _short title_ <https://www.phenix.bnl.gov/phenix/WWW/p/...> ...