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# **PHENIX Spin Run-5 Beam Use Proposal**

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For

PHENIX Spin WG

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# Expectation from Spin Run-5

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- We assume: 5 weeks (commissioning) + 10 weeks (physics) running
    - Toward the end of 5 weeks commissioning we expect
      - Fills for physics running (night shifts, detector tune-up)
      - Tests of polarized RHIC at 500 GeV (see discussed later)
    - During the 10 wk Physics running:
      - $\sim 1 \text{ pb}^{-1}/\text{wk} \rightarrow 10 \text{ pb}^{-1}$  (written) over all 10 wks
      - Average beam polarization  $\sim 50\%$
  - Based on the success of Run-3 and Run-4 (machine) PHENIX plans to make the first high sensitive measurement of polarized gluon distribution using the  $\pi^0$  production in polarized pp scattering
  - Transverse physics data taking during the 5-wk machine commissioning period. PHENIX will NOT ask for transverse physics running during the 10 wk physics period.
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# Physics & Learning during Run-5

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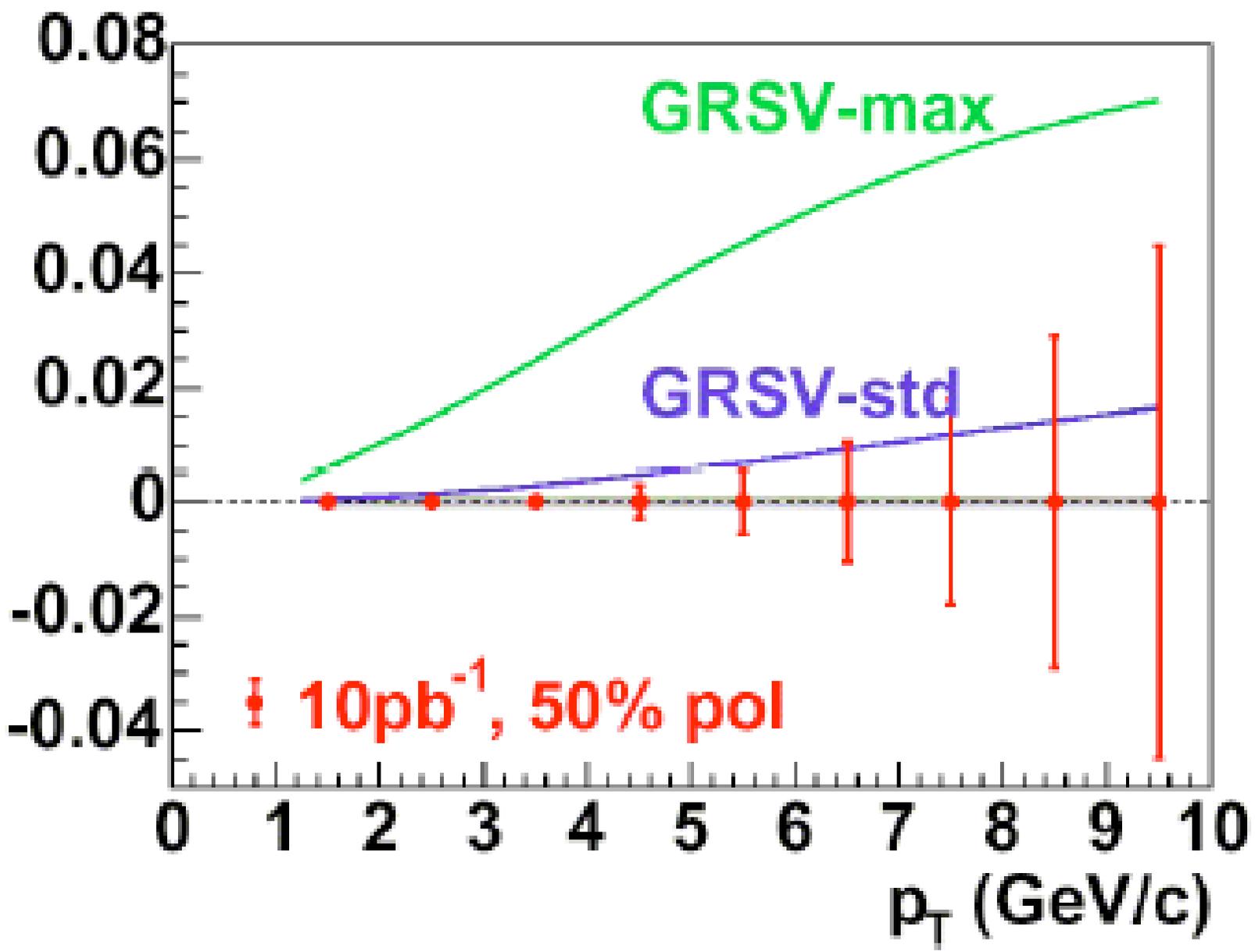
- **Physics:**

- Double spin asymmetry in  $\pi^0$  production leading to  $\Delta G$  (pT-range 1.5 GeV/c to 10 GeV/c)
  - Higher momentum region important for the g-q component of the polarized contribution, allows determination of the sign of  $\Delta G$
- Double spin asymmetry in charged pion production
  - Relative sizes of double spin asymmetries for  $\pi^+$  and  $\pi^-$  indicators of the sign of  $\Delta G$

- **Learning:**

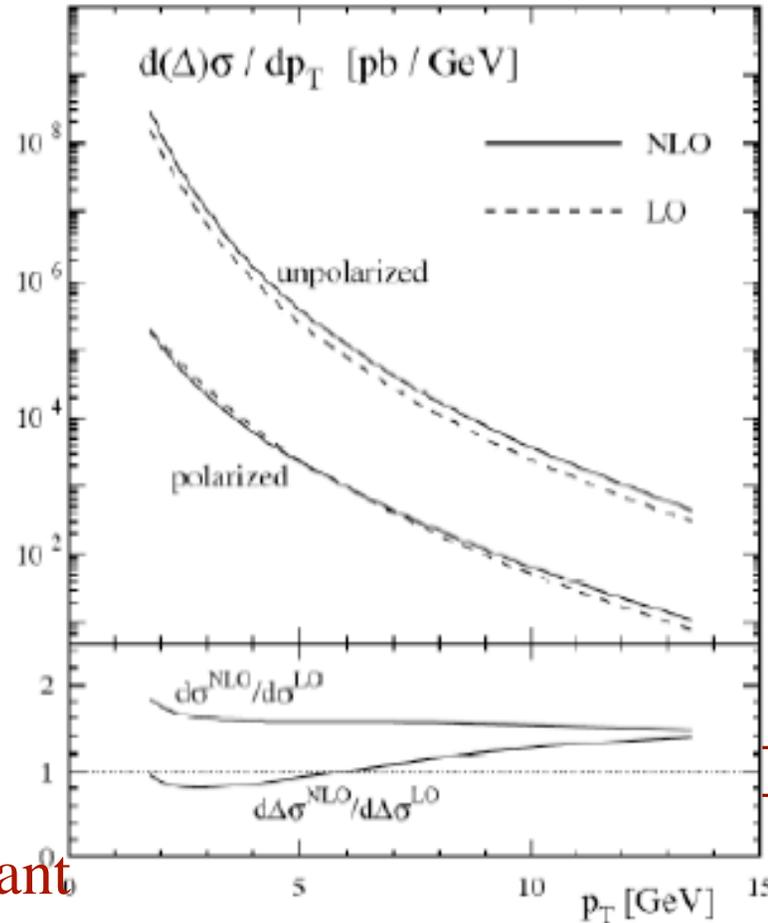
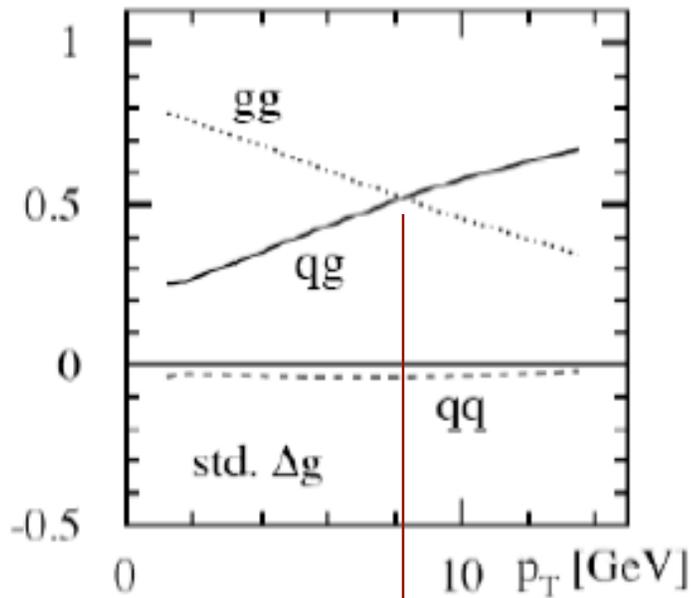
- Unpolarized cross section for direct photon (asymmetry in Run-6)
- Exploratory measurements of electron/muon final states leading towards charm physics in PHENIX in future

$\pi^0 A_{LL}$

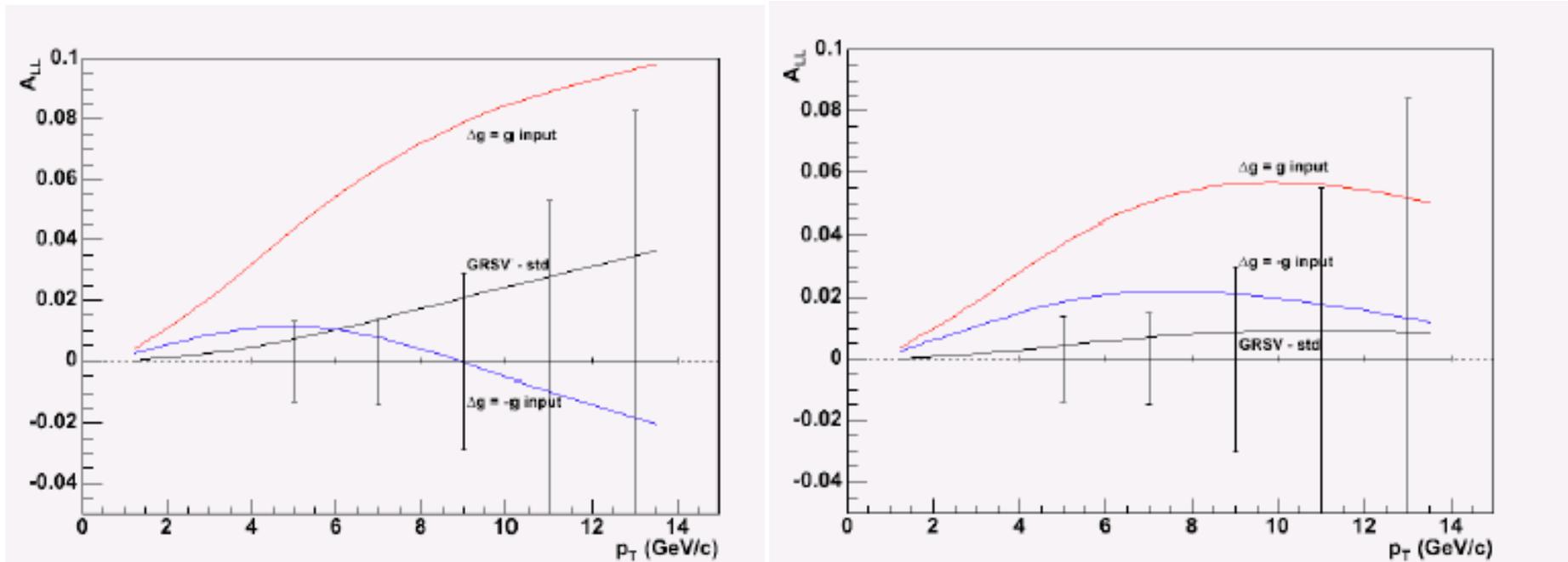


# Contributing processes & NLO corrections to polarized scattering

Polarized  $pp \rightarrow \pi^0 + X$



# $\pi^{+/-}$ double spin asymmetries



- Left:  $\pi^+$ , Right:  $\pi^-$  asymmetries. Statistical uncertainties for Run-5 shown.
- Difference in shapes of positive and negative DG scenario need to be measured. Probably possible only in Run-6

# Physics in Run-6

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- **Assumptions:**
  - 70% beam polarization
  - 5+10/11 weeks of pp running
  - *At least* a factor  $\sim 2$  up luminosity compared to Run-5  $\Rightarrow 20 \text{ pb}^{-1}$
- **Physics:**
  - Direct photon double spin asymmetry
  - Increased statistics for charged and neutral pion production
  - Based on exploratory Run-5 measurements of transversity, a certain fraction associated with this physics
  - Exploratory cross section measurements for electron and muon physics (charm physics)

# Run-7 and beyond

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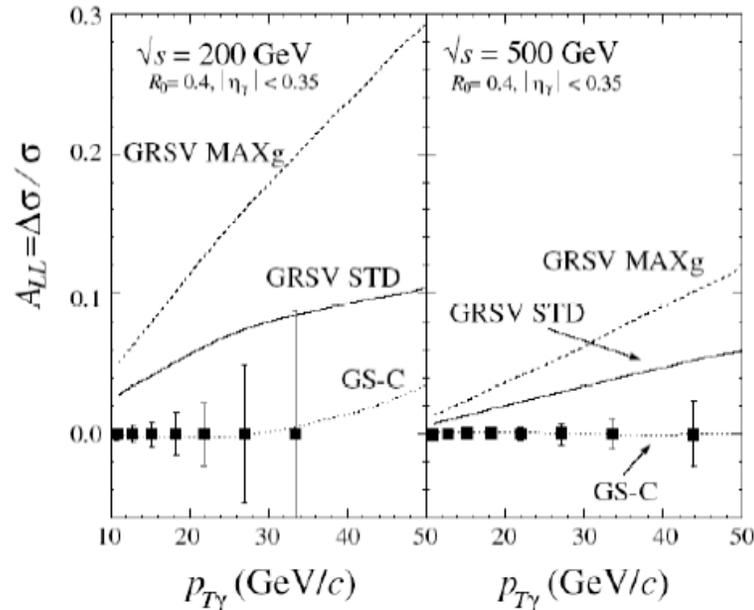
- Assumption of PHENIX decadal plan (not writing on stone!)
  - No spin pp in Run-7; only in Run-8,9
- Total luminosity written to tape  $120 \text{ pb}^{-1}$  and 70% beam polarization
- Physics:
  - Direct photon, photon+jet with Si VTX (run 8,9 ?)
  - Start of charm physics (?)
  - Muon trigger upgrade run-9 =>Exploratory W physics run-9 (?)
  - Charged and neutral pion production
- **When should we move to 500 GeV?**
  - Is W physics the only argument?
  - **Are there others?**

# When should we move to 500 GeV?

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- Since W physics at STAR & PHENIX need detector upgrades expected some time around 2009-10, people think of 500 GeV RHIC running ONLY after that, in the “RHIC-II” era
- For polarized gluon measurements, it is important to cover as wide an x- range as possible: the first moment is crucial, not just the value of  $\Delta G/G$  at a fixed or narrow range of x.
- What do we do if in Run-5 we learnt that  $A_{LL}(\pi^0)$  is zero or very small?
  - Do we try to make finer measurements at the same kinematics or should we go to lower-x?
    - Lower x => higher CM (500 GeV)
  - Assuming direct photon or photon+jet measurements would be the “in” thing at the time we see:

# Direct photon $A_{LL}$ 200 vs. 500 GeV



- 320 pb-1 and 800 pb-1 assumed for 200 and 500 GeV
- Polarization 70% at both CMs & no issues with the measurements
- Background levels low
- Relative luminosities issues under control

- Ratio of statistical uncertainty to the difference between different polarized gluon distribution scenarios favorable at 500 GeV at comparable  $p_T$  of the direct photon.
- **200 GeV data only significant for Comparison with Heavy Ions?**

# Summary

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- Run 5 will make the first highly sensitive measurement of  $\Delta G$  and will start exploratory measurements crucial for the rest of the Spin program
- Run 6 will focus mainly on direct photon physics and measure  $\Delta G$  using this method along with significantly improved statistics in neutral and charged pions
- Runs 8,9 will consolidate the RHIC-I spin physics goals and embark up on the next phase: gamma-jet, charm and W physics
- If gluon distribution at intermediate to high  $x$  is low, it might be worth moving to 500 GeV RHIC running as early as Run 6