Spin Physics at STAR

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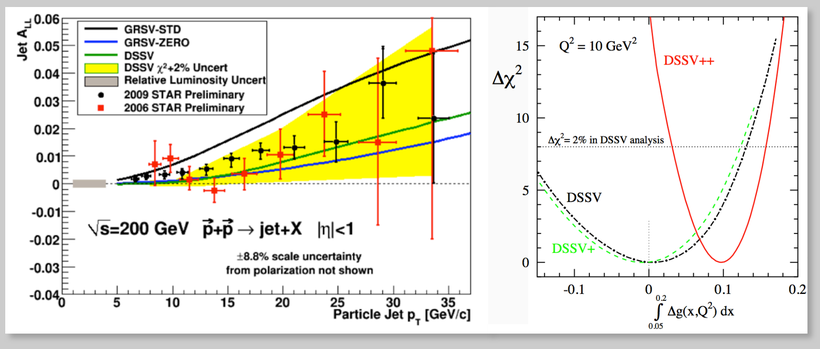
STAR has measured with precision the double beam helicity asymmetry, $\mathbf{A_{LL}}$,in the inclusive production of jets at mid-rapidity.

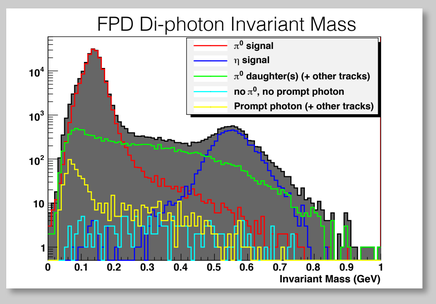


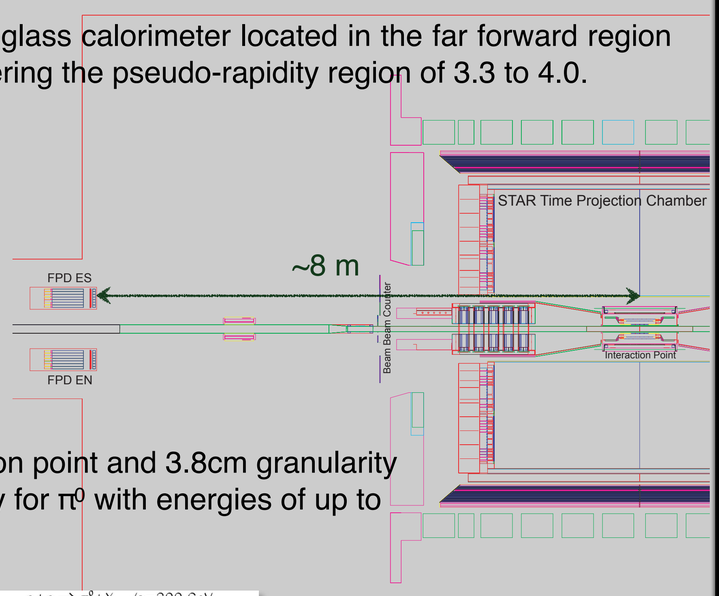
These measurements are sensitive to the gluon spin contribution to the proton spin, **Δg**, for modest gluon momentum fractions, **x**, at the level of 5-20% of the proton momentum.

A main challenge is **to gain access to smaller gluon fractional momenta.** The gluon polarization measurements share this challenge with the transverse spin physics and cold nuclear matter programs. Advances come from beam collisions at higher center-of-mass and instrumentation covering forward rapidities.

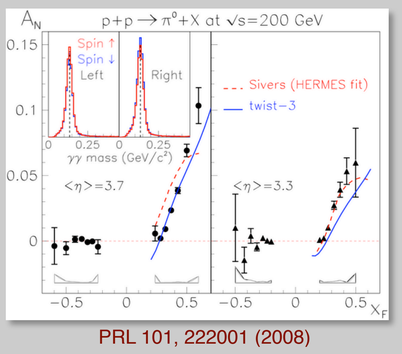
STAR Forward Pion Detector (FPD)

The STAR FPD is a modular, Pb-glass calorimeter located in the far forward region of the STAR wide angle hall, covering the pseudo-rapidity region of 3.3 to 4.0.

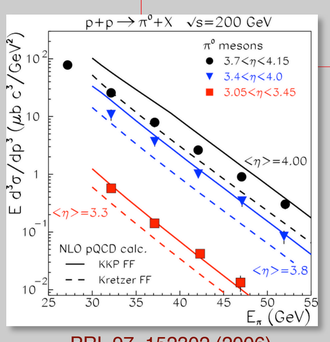




Its 8m distance from the interaction point and 3.8cm granularity results in high detection efficiency for π^0 with energies of up to 55 GeV.



PRL 101, 222001 (2008)



PRL 97, 152302 (2006)

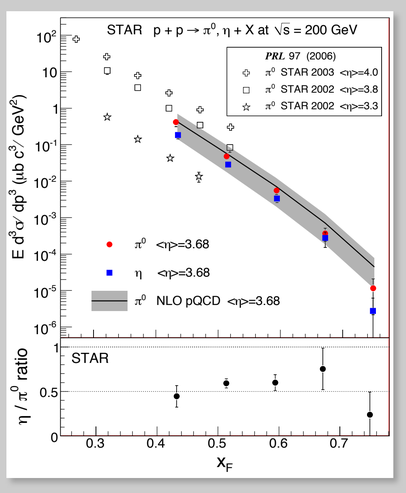
FPD data on the forward π^0 cross-section and the observation of large transverse single beam spin asymmetries, $\mathbf{A_N}$, have renewed the interest in transverse spin phenomena.

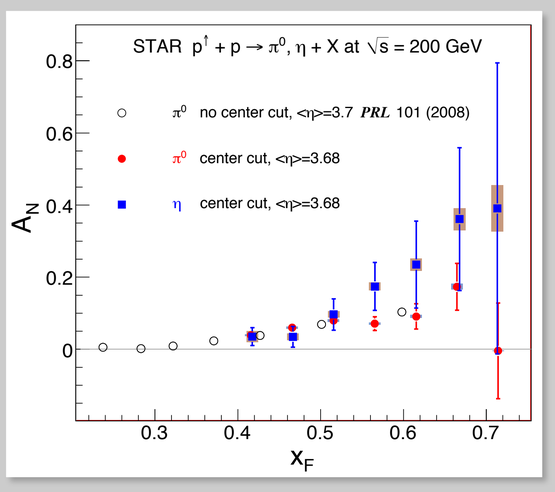
Forward η Cross-section and Spin Asymmetry A_N

We have published the production cross-section and spin asymmetry A_N for forward η-meson production via the decay into two photons observed in the FPD in Phys. Rev. D 86, 051101(R), 2012.

The differential cross-section is described by perturbative QCD calculations at next-to-leading order, and the η to π^0 production ratio is consistent with the global analysis of η fragmentation.

Surprisingly, our observations indicate that **A_N for the η might be larger than π^0 A_N.**





Towards Direct Photons

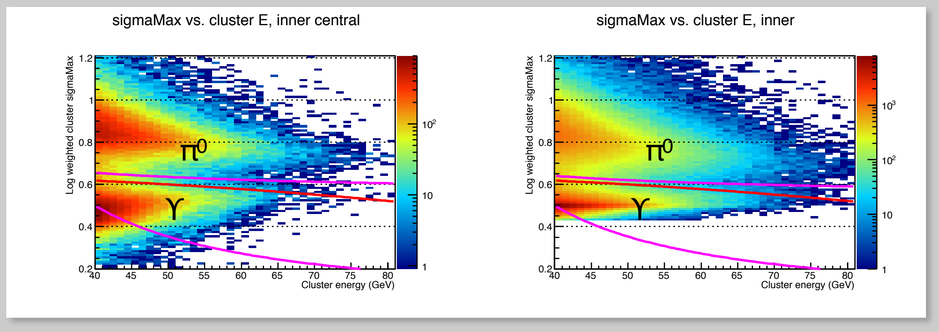
Direct photon probes, in particular at forward rapidity, are of considerable interest. Their production is dominated by quark-gluon scattering contributions.

Measurement of $\mathbf{A_{LL}}$ in their production provides process-selective sensitivity to Δg.

Measurement of $\mathbf{A_N}$ delineates spin phenomena in the initial state, thus allowing us to observe the relation to the Sivers asymmetry in hard lepton-nucleon scattering.

As an initial step, we attempted the measurement of the production cross section at forward rapidity with the FPD.

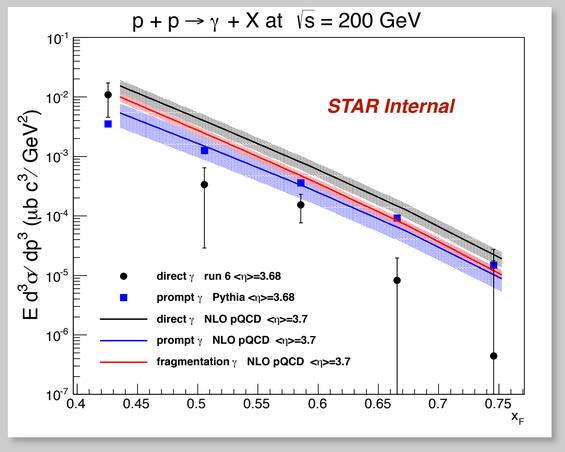
Separation of π^0 and photons was achieved up to energies of about 80 GeV,



In addition, the shower-shape was used to suppress hadronic background.

We find that **the yield of direct photons in the FPD is below perturbative QCD expectations at next to leading order,**

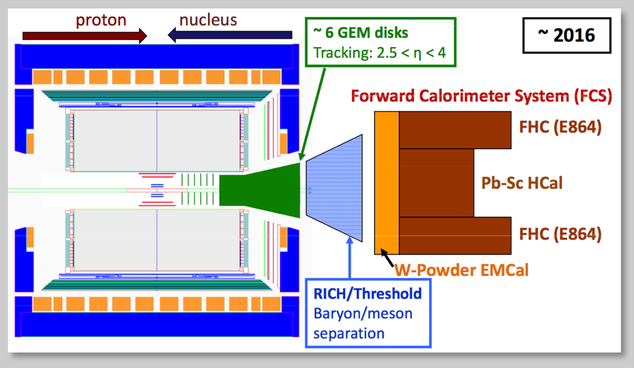
thus limiting the precision of measurements of direct photon asymmetries within the FPD acceptance.



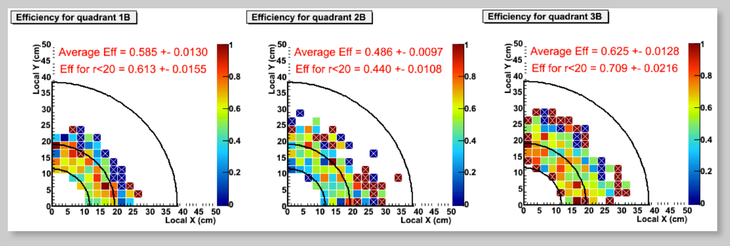
STAR Forward Upgrade

STAR plans a forward upgrade, **motivated by spin and cold nuclear matter physics goals**.

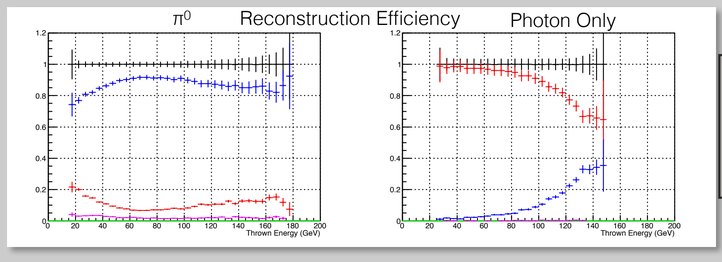
The concept envisions an extension of the forward tracker upgrade and large acceptance electromagnetic and hadronic calorimeters.



We made key contributions to the commissioning of the ongoing tracking upgrade,



and in collaboration with UCLA are leading the simulation effort for the calorimeters



aimed at a robust physics program **forward photons, hyperons, and jets in polarized p+p and p+A collisions.**

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