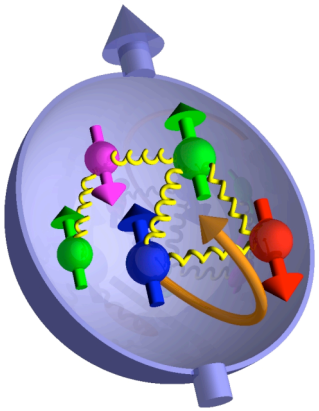
The STAR W Physics Program : New Results and Future Measurements

Joe Seele (MIT) for the

Collaboration

2009 APS DNP/JPS Meeting

The Spin Puzzle



The proton is viewed as being a "bag" of bound quarks and gluons interacting via QCD

Spins + orbital angular momentum need to give the observed spin 1/2 of proton

Being measured at RHIC

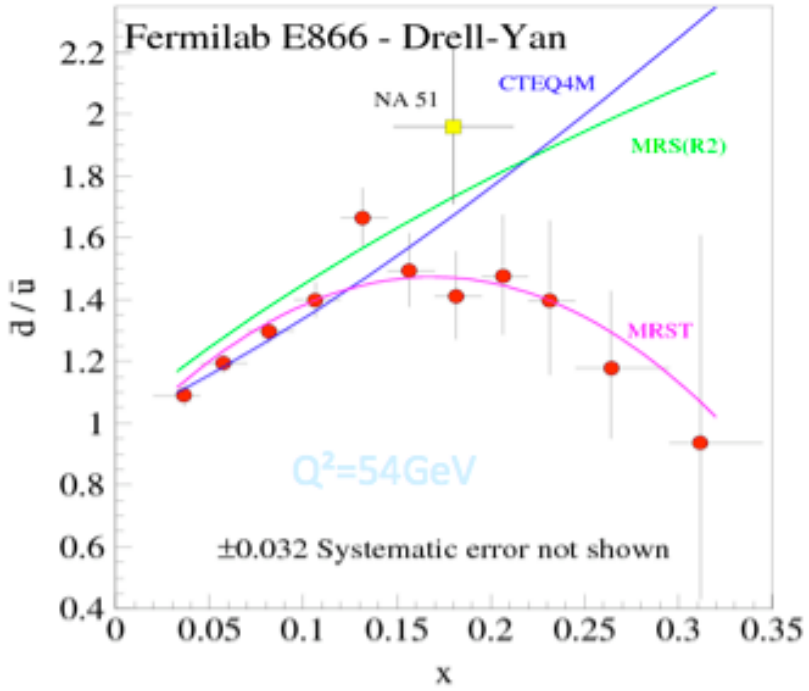
$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + L_q^z + \Delta G + L_g^z$$

Fairly well measured only ~30% of spin

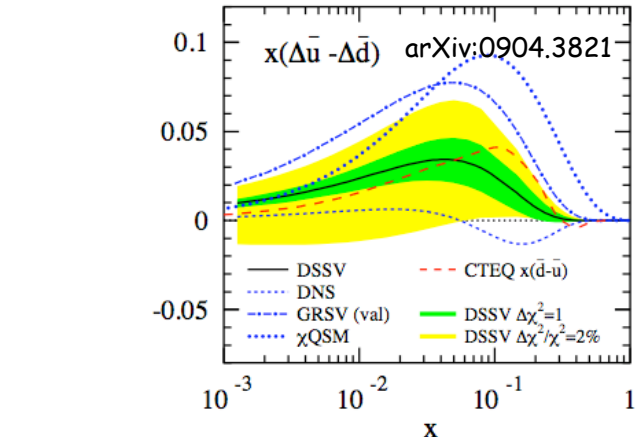
Its decomposition is not well understood, especially the sea… needs data

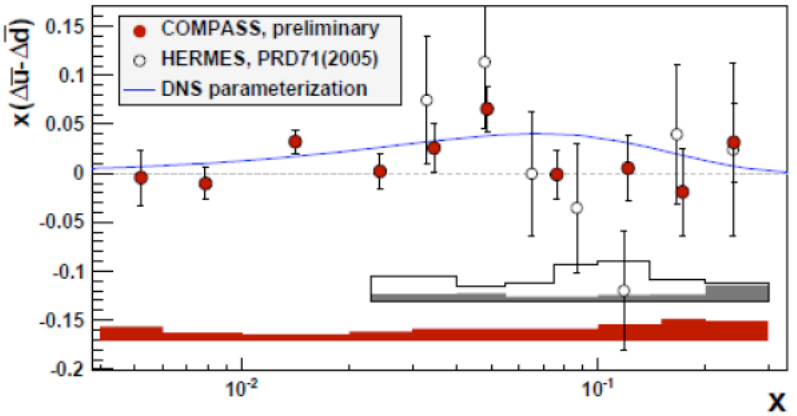
$$\Delta\Sigma = \int (\Delta u + \Delta d + \Delta s + \Delta\bar{u} + \Delta\bar{d} + \Delta\bar{s} + \cdots)dx$$

Flavor Asymmetry in the Sea



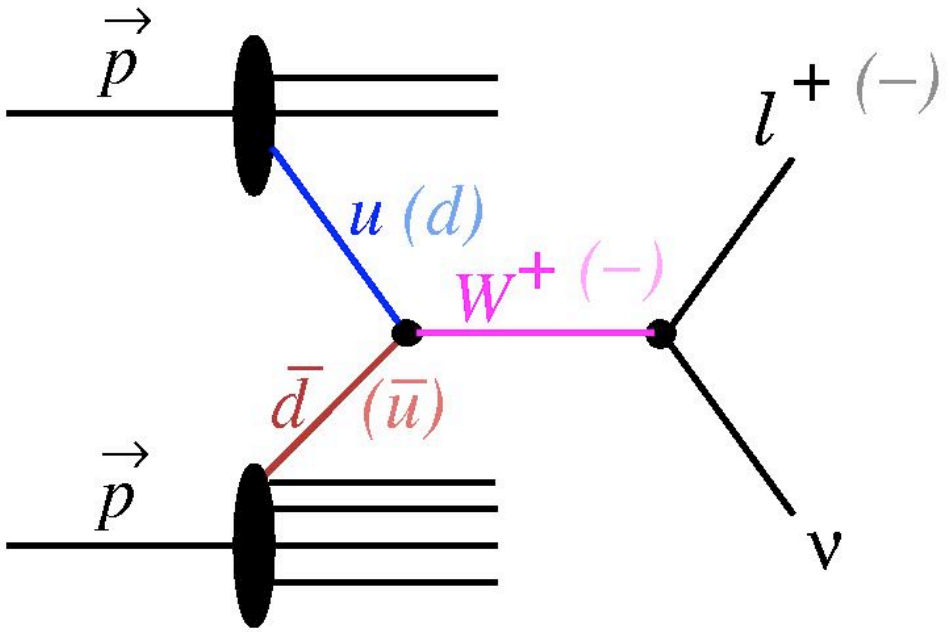
• E866 results are qualitatively consistent with pion cloud models, instanton models, chiral quark soliton models, etc.





• Pauli blocking should contribute to the observed signal, but how much is currently debated
• Non-perturbative processes may be needed in generating the sea

Probing the Sea through Ws



$$u + \bar{d} \rightarrow W^+ \rightarrow e^+ + \nu$$

$$\bar{u} + d \rightarrow W^- \rightarrow e^- + \bar{\nu}$$

- Detect Ws through e^+ and e^- decay channels
- V-A coupling leads to perfect spin separation
- Neutrino helicity gives preferred direction in decay

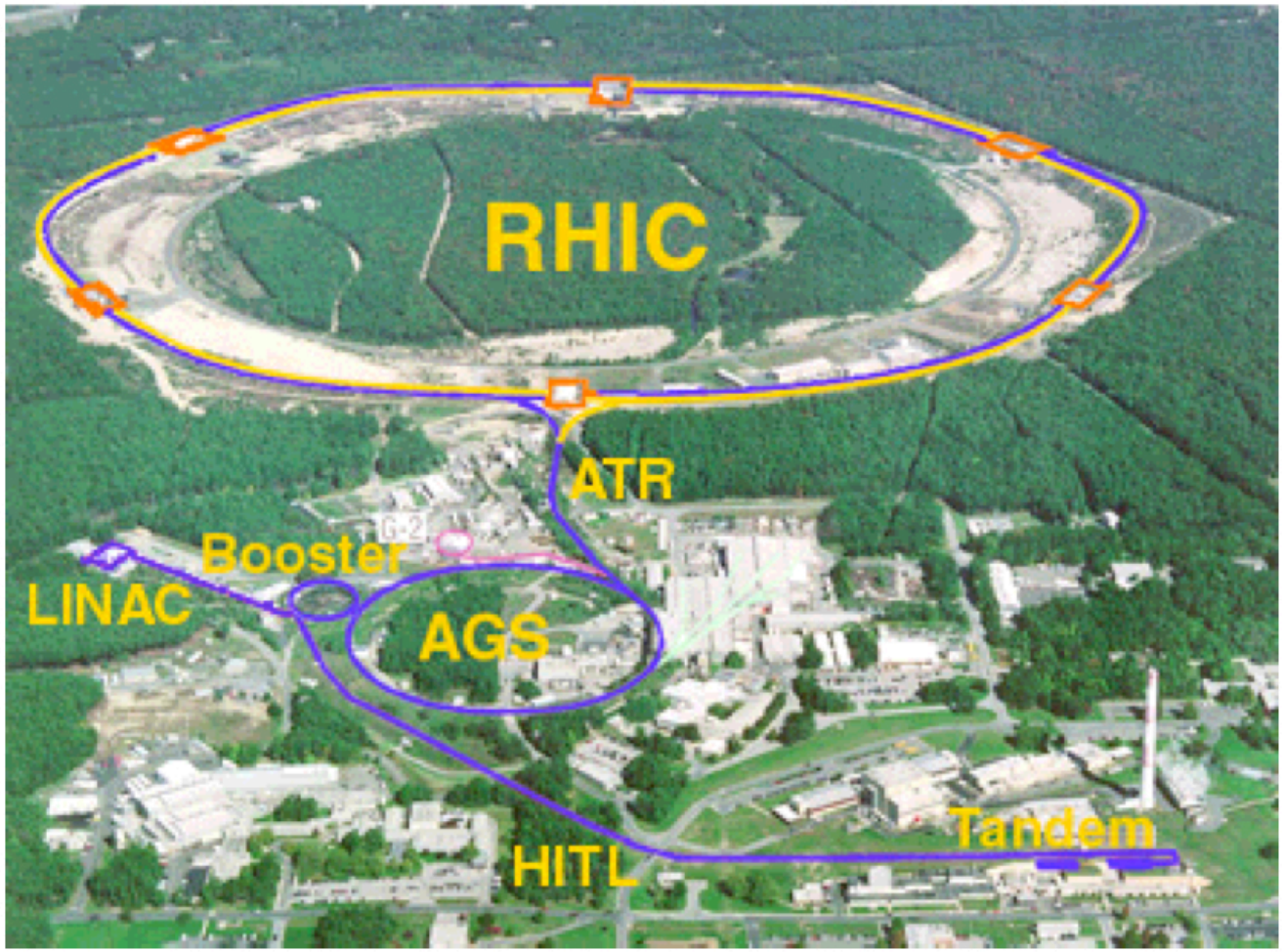
Measure parity violating single helicity asymmetry A_L

(Helicity flip in one beam while averaging over the other)

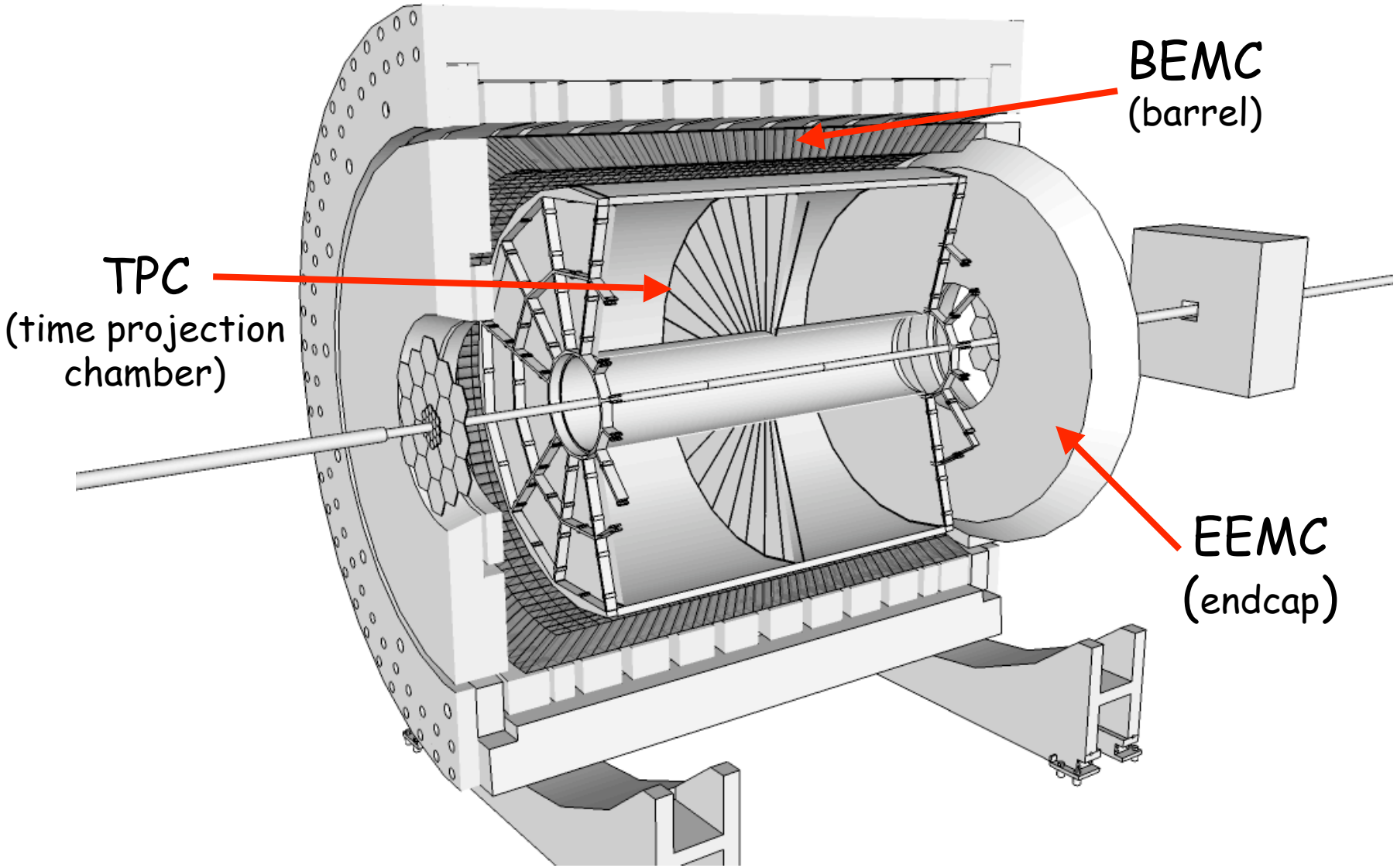
$$A_L^{W^-} \propto -\Delta d(x_1)\bar{u}(x_2) + \Delta\bar{u}(x_1)d(x_2) \qquad A_L^{W^+} \propto -\Delta u(x_1)\bar{d}(x_2) + \Delta\bar{d}(x_1)u(x_2)$$

RHIC

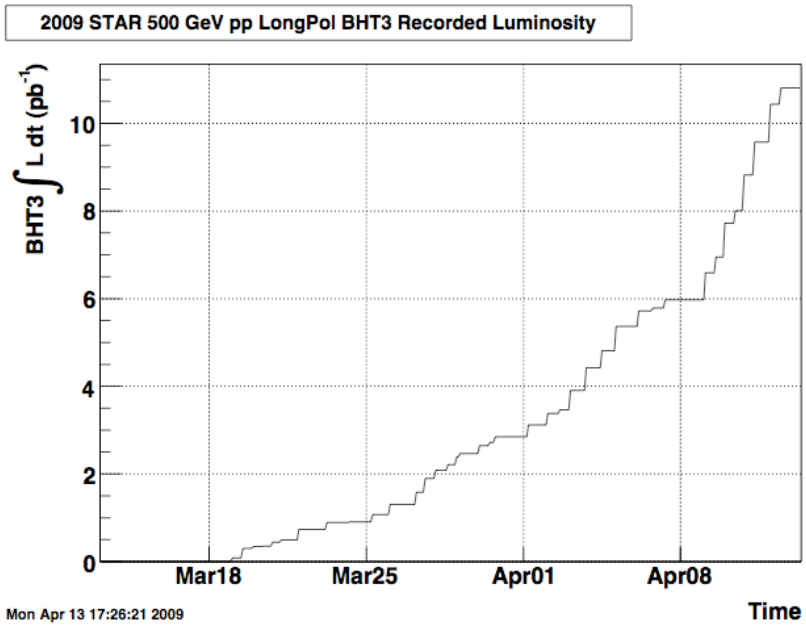
A polarized proton collider to study spin in QCD



STAR

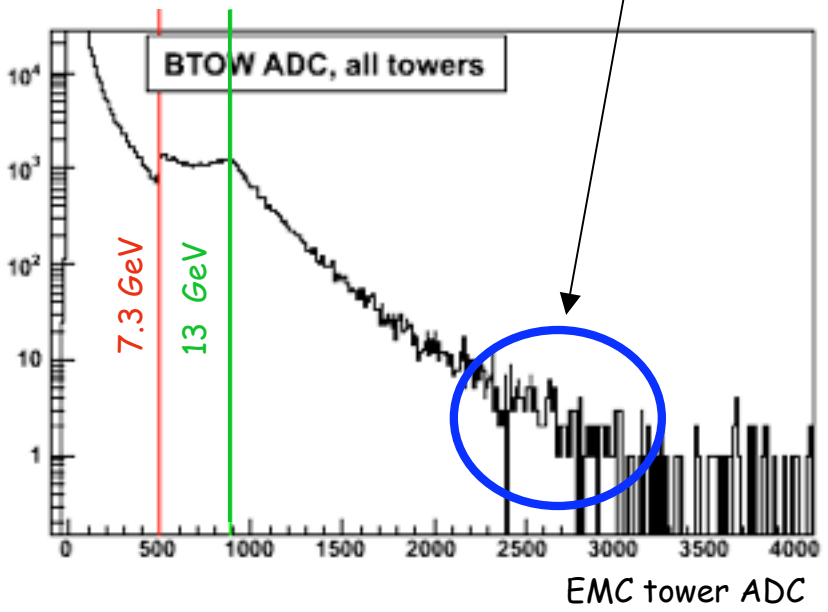


2009 500 GeV Data Set



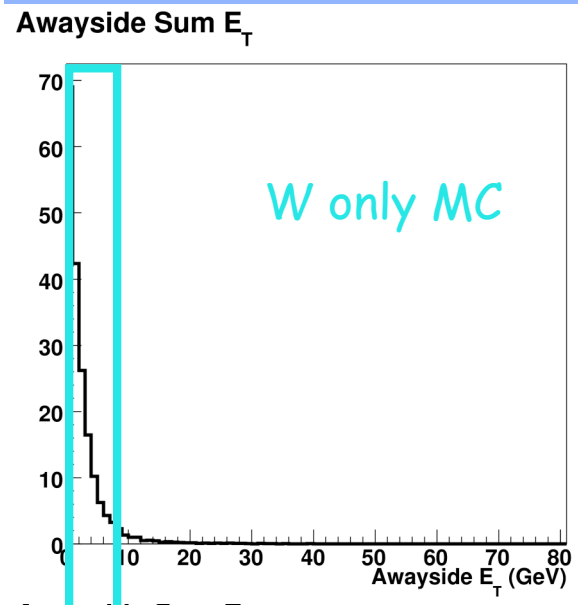
STAR recorded ~10pb^{-1} in the 500 GeV

leptons from Ws should appear here

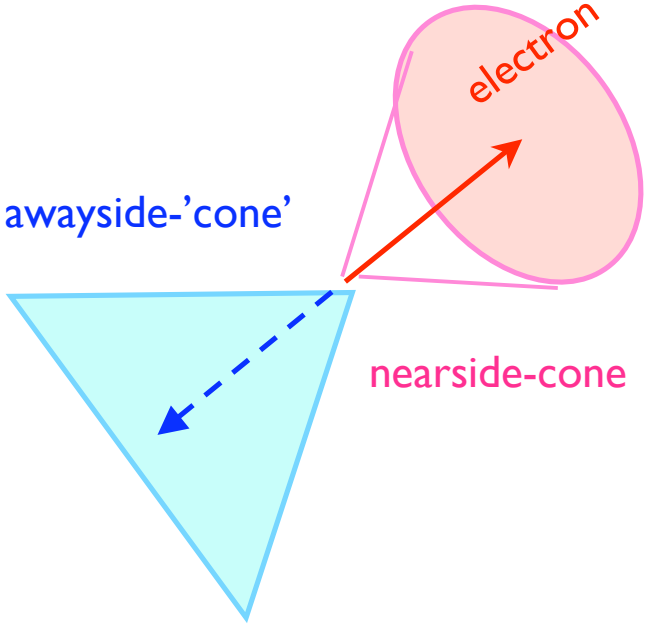


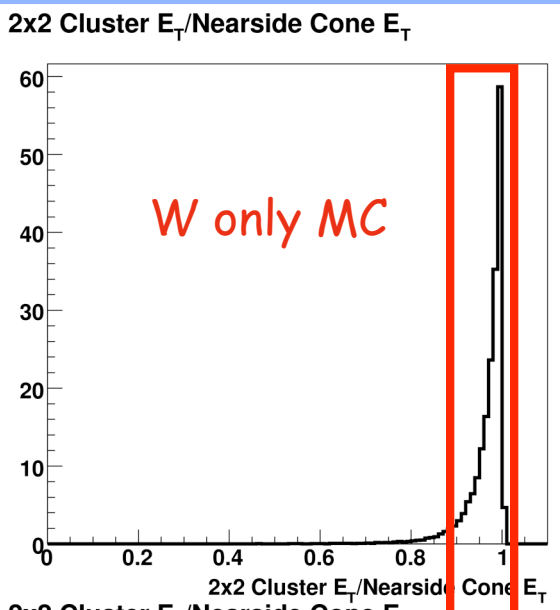
Required a high tower trigger (E_T > 7.3 GeV) and a high E_T 2x2 clusters (E_T > 13 GeV)

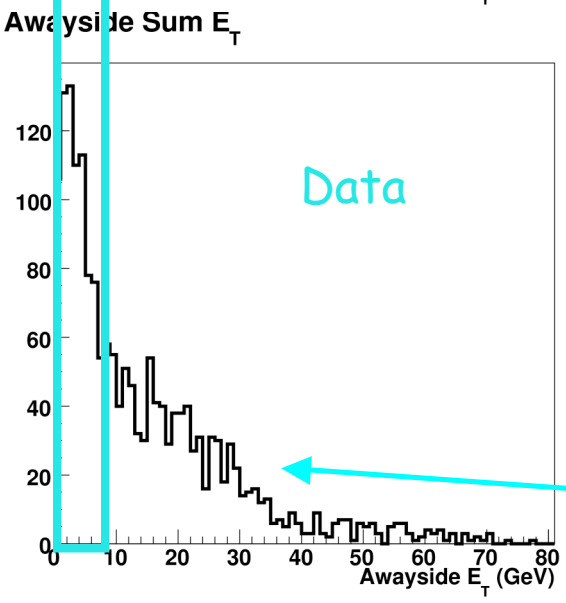
W Algorithm

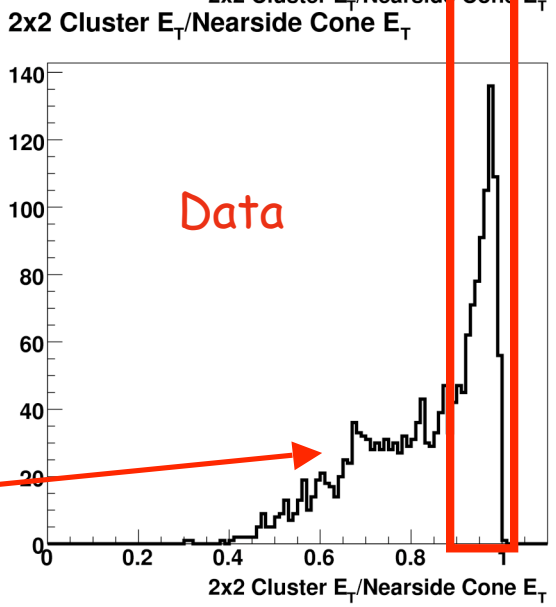


$$W \rightarrow lepton + neutrino$$









Expect a large QCD background

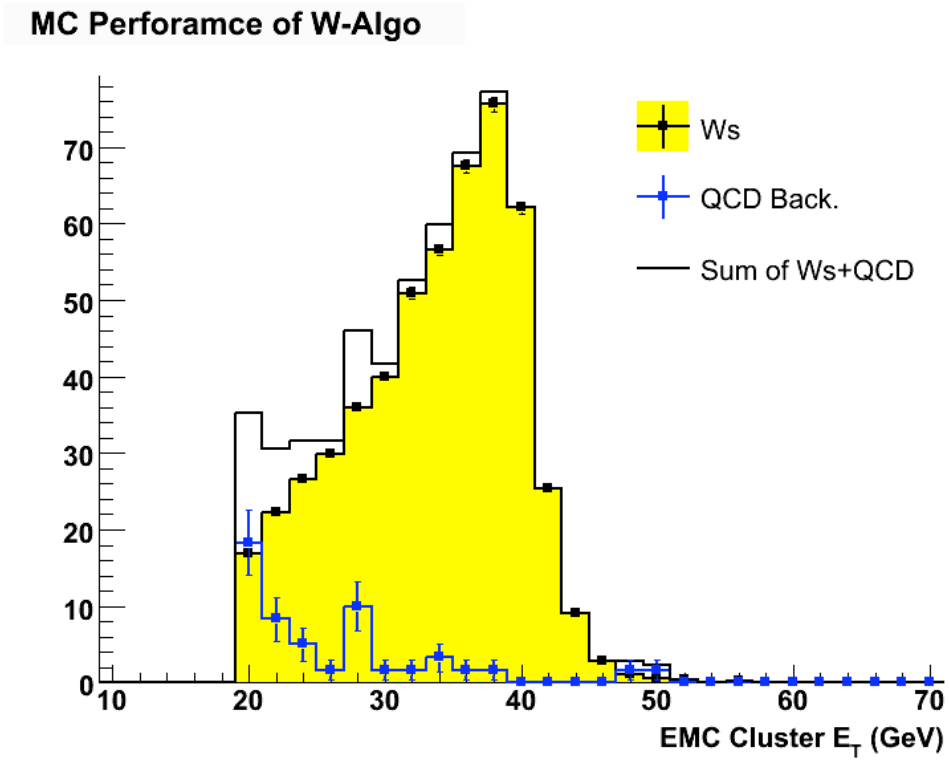
(data shown after some cuts are applied)

J. Seele - 2009 DNP

W Algorithm - MC

Full PYTHIA + GEANT simulations were done to assess the performance of the algorithm

Spectra are scaled to 10pb^{-1}



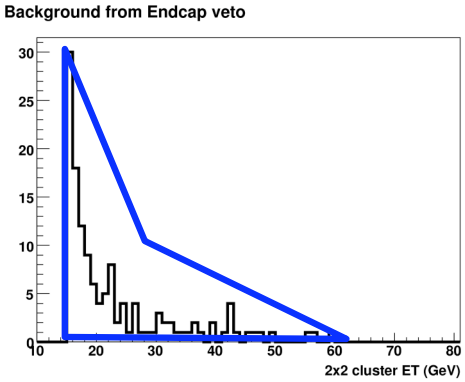
Disclaimer : PYTHIA has been known to not accurately predict the number of high-z fragmenting jets

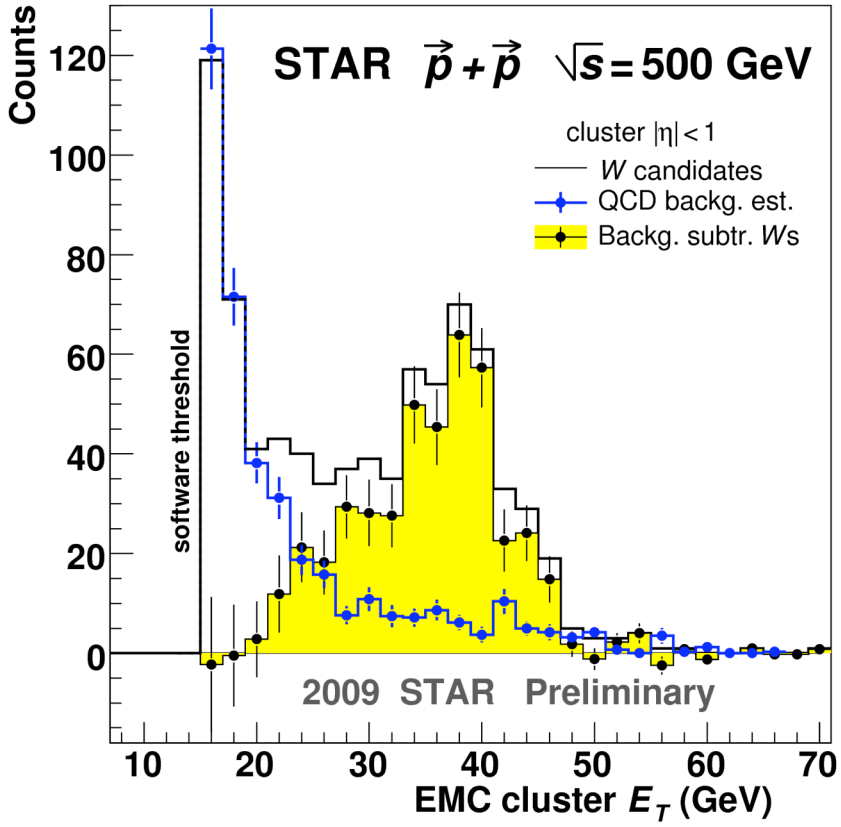
First STAR W Results

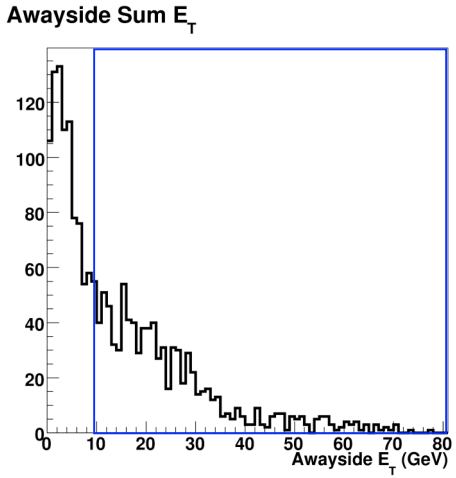
Using the algorithm a clear Jacobian peak can be seen in the data

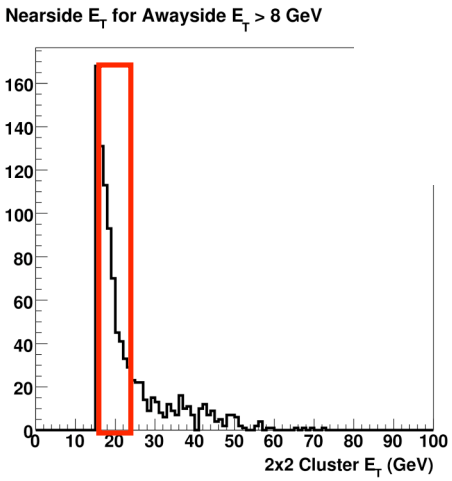
Estimate QCD background in a fully data-driven manner

Background from "missing" endcap





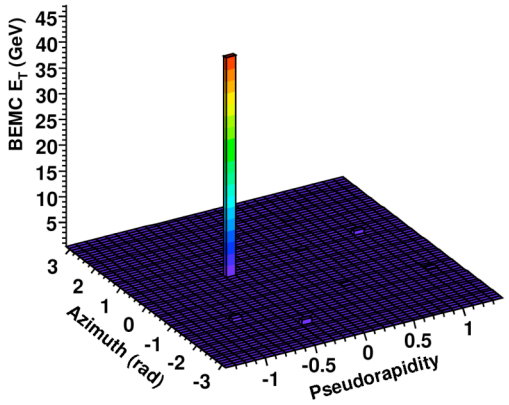




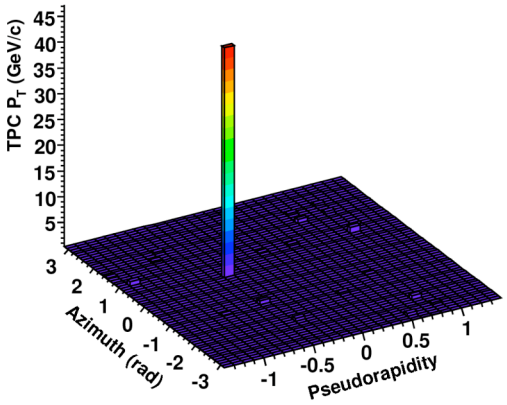
The normalized background is subtracted from the E_T spectrum to obtain a W signal.

Example Lego Plots

BEMC E_T Distribution (GeV)



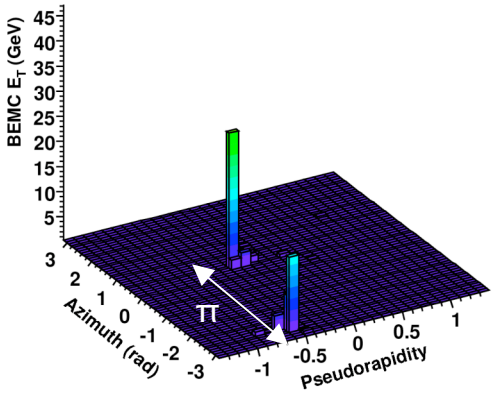
TPC p_T Distribution (GeV/c)



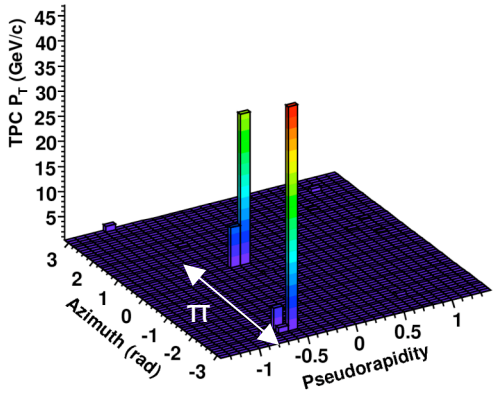
← W event

Dijet event →

BEMC E_T Distribution (GeV)

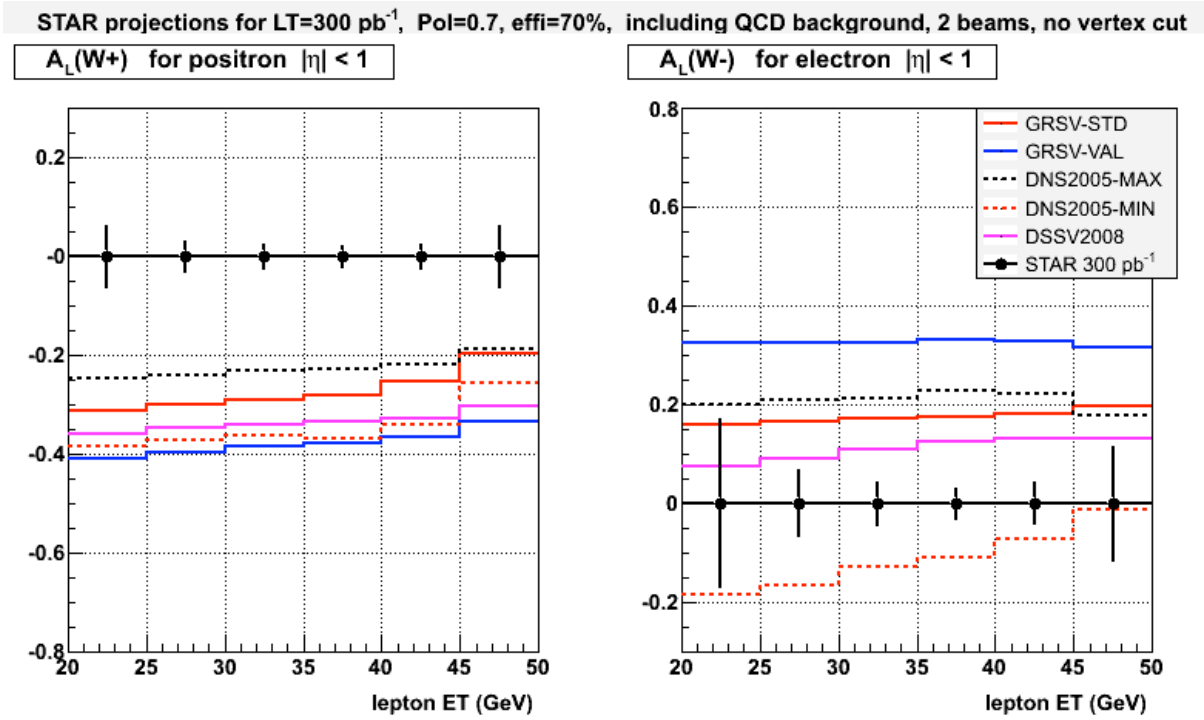


TPC p_T Distribution (GeV/c)



Future W Measurements

Future Ws at mid-rapidity



STAR has shown the capability to detect the W at mid-rapidity.

With the expected 300pb^{-1} for the 500 GeV program STAR will provide strong constraints on the polarized sea pdfs using the mid-rapidity data

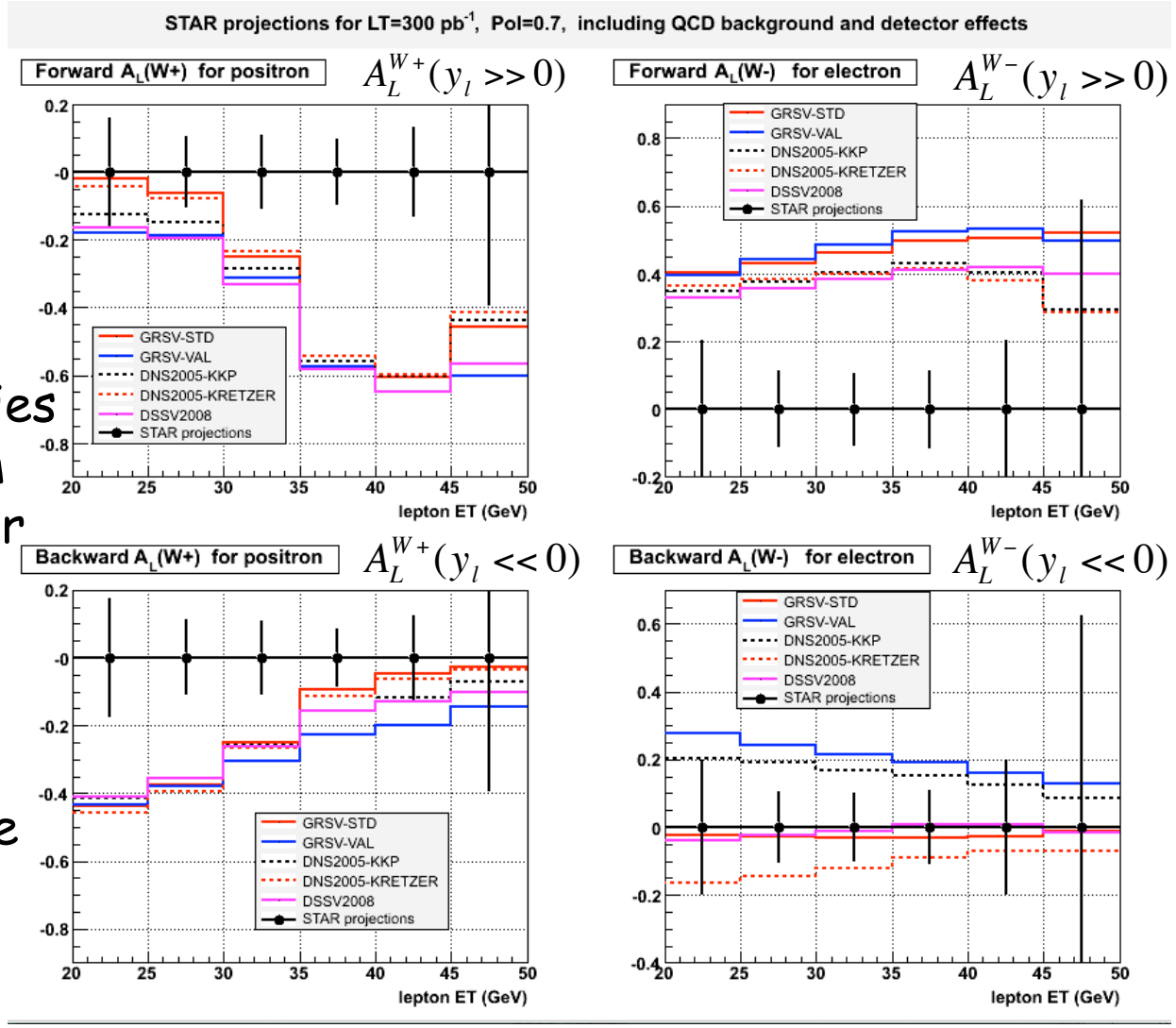
Future Ws at forward rapidity

At forward/backward rapidity the A_Ls become more sensitive to a single quark flavor

The expected uncertainties for the 500 GeV program are shown to the right for the endcap acceptance

$$1 < \eta < 2$$

Measurements rely on the planned Forward GEM Tracker upgrade (see B. Surrow's talk on Sat.)



Conclusions

- Measurements of the W in polarized p+p collisions provide needed information about the polarized sea in the proton.
- STAR has shown a first extraction of a Jacobian peak of a W signal in p+p collisions at sqrt(s)=500 GeV confirming our expectations.
- Planned STAR measurements will provide strong constraints on the polarized sea of the proton.

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