Forward Tracking Upgrade: Physics Motivation

Nucleon Spin Structure with W-bosons at STAR

Ernst Sichtermann

Lawrence Berkeley National Laboratory

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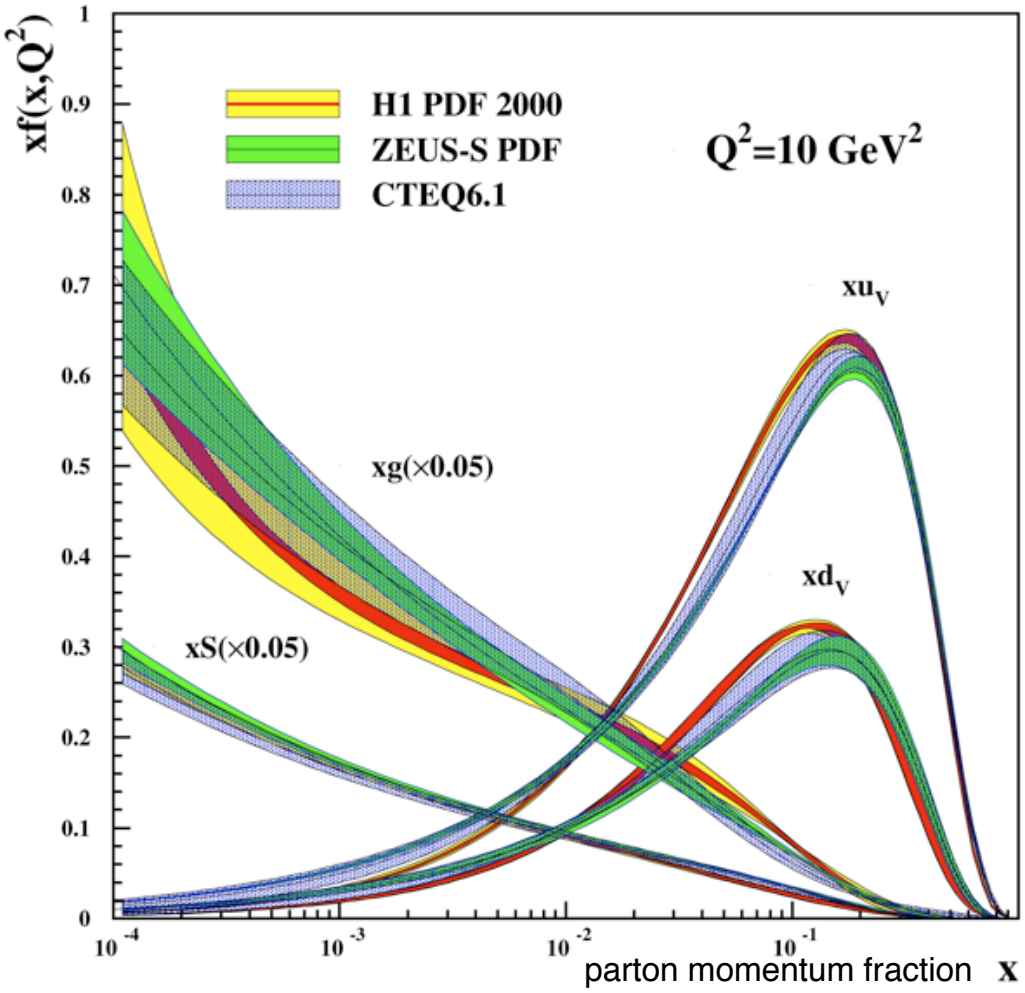
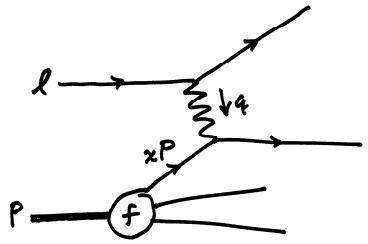
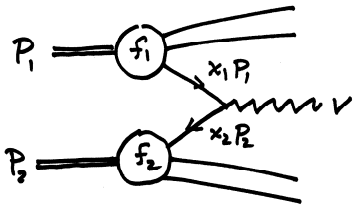
Nucleon Substructure





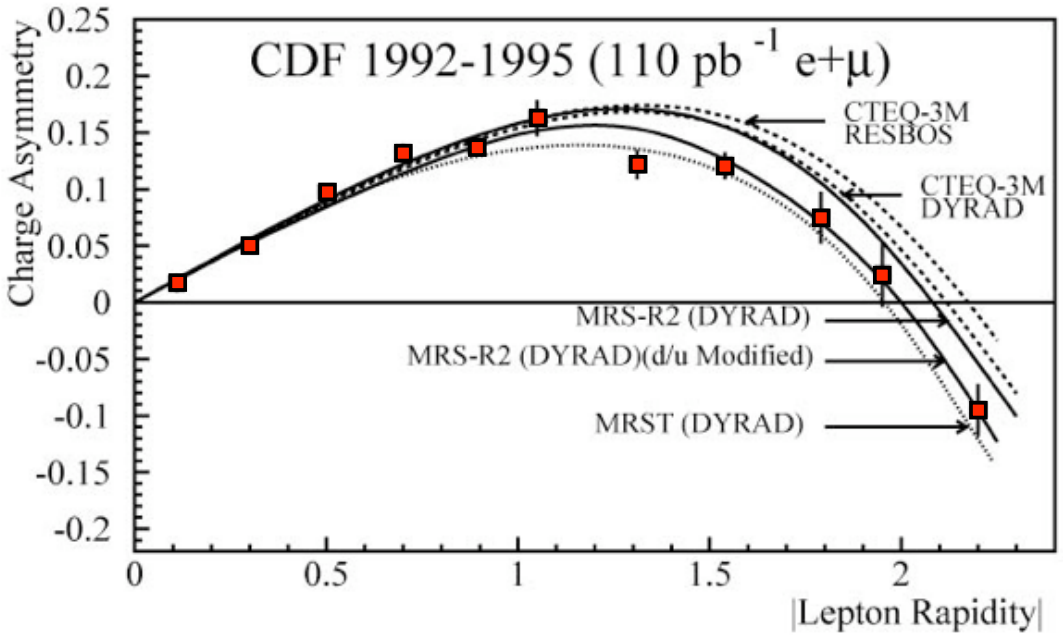
and



W-boson production at the Tevatron gives important insight in *u* and *d*.

W-bosons and PDFs at Hadron Colliders

CDF Collaboration, *Measurement of the lepton charge asymmetry in W boson decays produced by ppbar collisions*, PRL 81, 5754 (1998).



$$u + d \rightarrow W \rightarrow l + \nu$$

$$A_{\text{charge}} = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-}$$

Clean measurement:

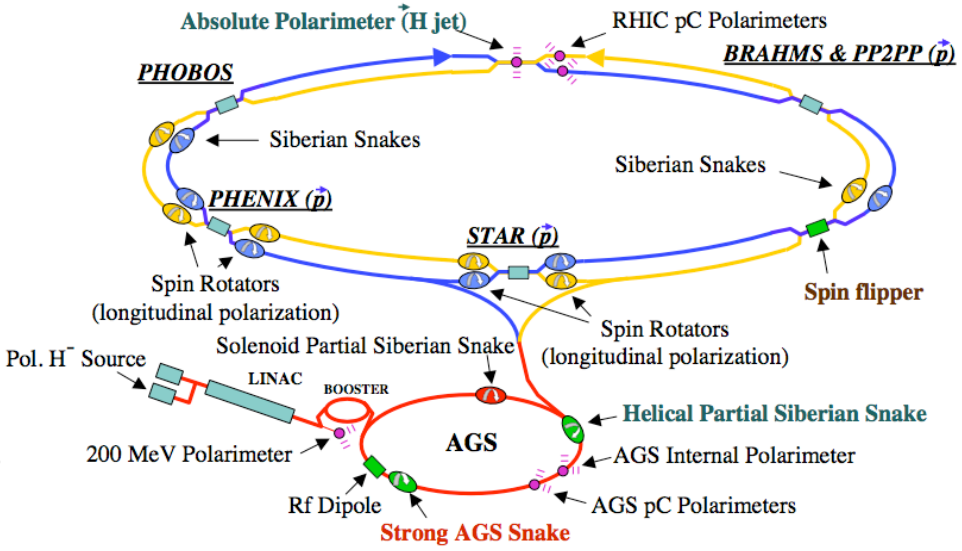
- hard scale,
- convolution with calculable V-A decay,
- sensitive, at large |Lepton Rapidity|

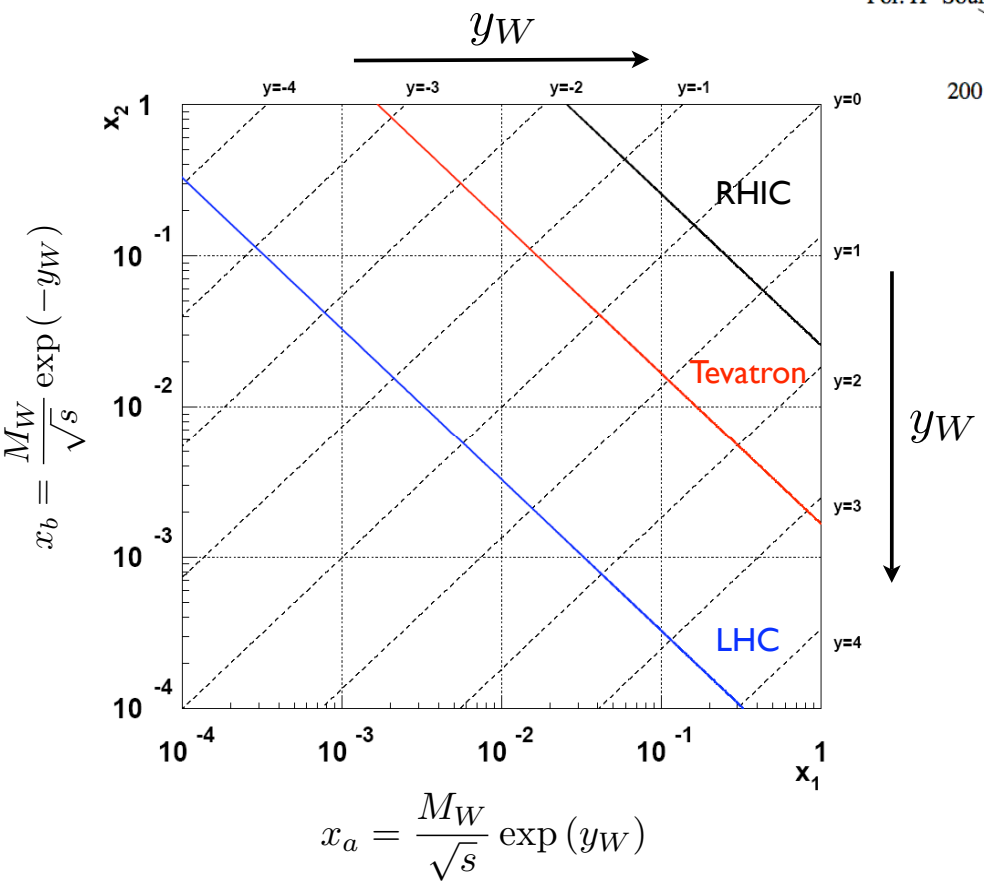
More recent measurements (Phys.Rev.D71 - 2005):

- transverse energy E_T dependence

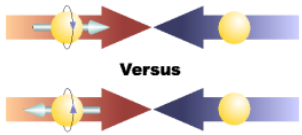
W-bosons at RHIC

RHIC is the first *polarized proton-proton* collider,





Principal measurement:

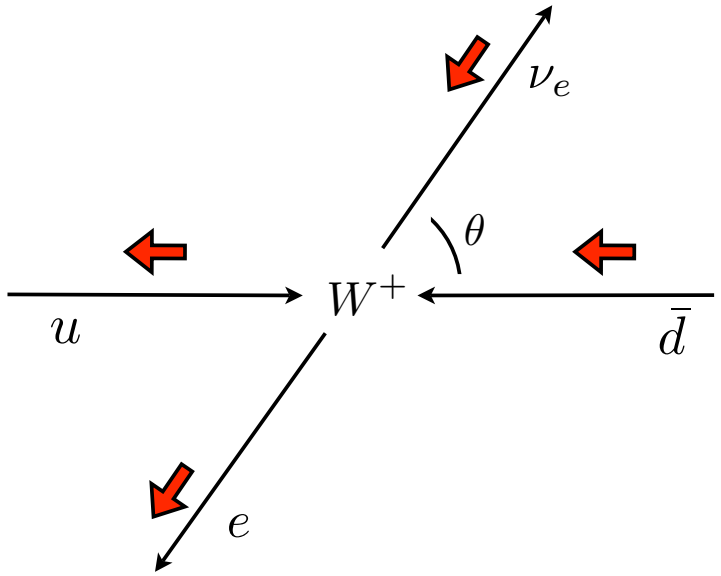


$$A_L = \frac{\Delta\sigma}{\sigma}$$

delineates $\Delta u, \Delta d, \Delta\bar{u}, \Delta\bar{d},$

which is key to resolving the *Proton Spin Puzzle.*

W-bosons at RHIC: Quark Polarimetry



Experiment Signature:
large p_T lepton, missing E_T

$$\Delta\sigma^{\mathrm{Born}}(\vec{p}p \to W^+ \to e^+\nu_e) \propto -\Delta u(x_a)\bar{d}(x_b)(1+\cos\theta)^2 + \Delta\bar{d}(x_a)u(x_b)(1-\cos\theta)^2$$

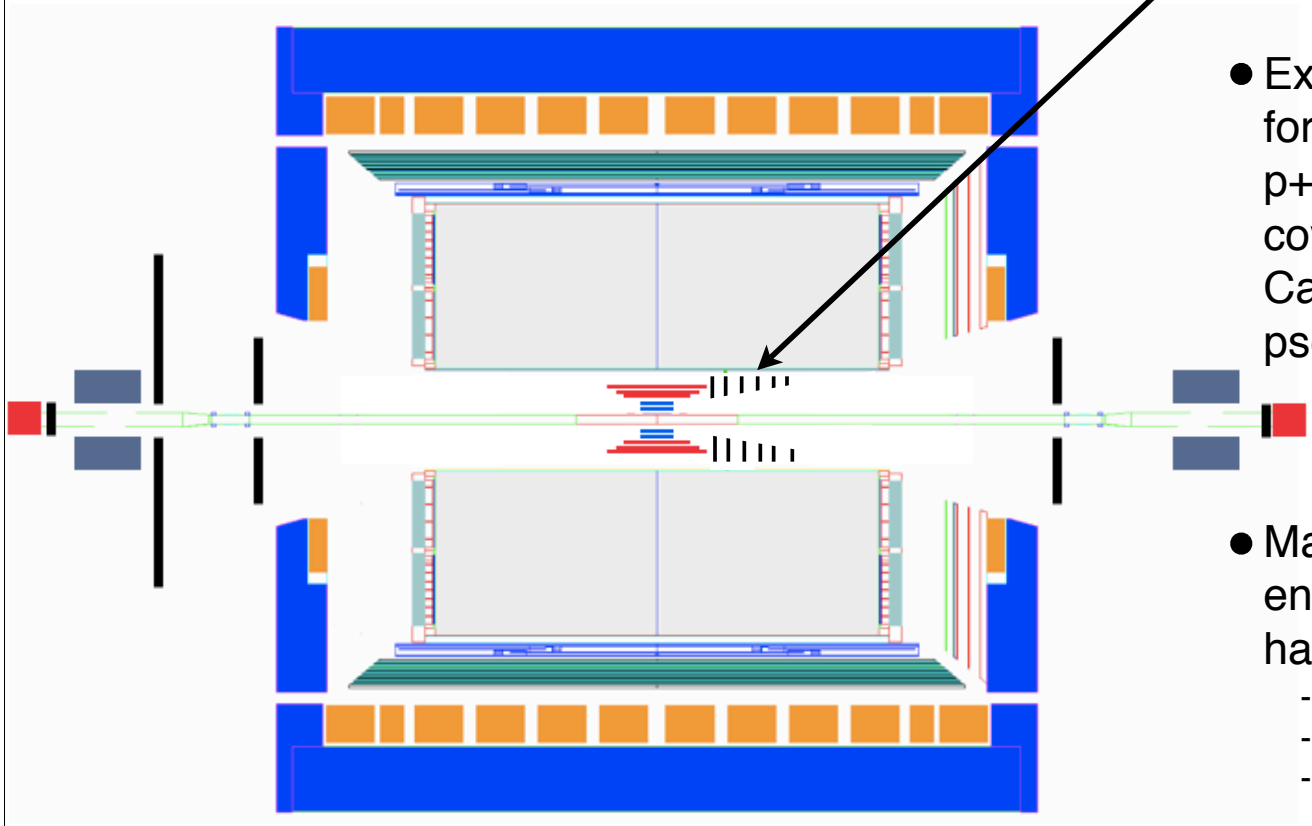
Spin Measurements:

$$A_L(W^+) = \frac{-\Delta u(x_a)\bar{d}(x_b) + \Delta\bar{d}(x_a)u(x_b)}{u(x_a)\bar{d}(x_b) + \bar{d}(x_a)u(x_b)} = \begin{cases} -\dfrac{\Delta u(x_a)}{u(x_a)}, & x_a \to 1 \\ \dfrac{\Delta\bar{d}(x_a)}{\bar{d}(x_a)}, & x_b \to 1 \end{cases}$$

$$A_L(W^-) = \begin{cases} -\dfrac{\Delta d(x_a)}{d(x_a)}, & x_a \to 1 \\ \dfrac{\Delta\bar{u}(x_a)}{\bar{u}(x_a)}, & x_b \to 1 \end{cases}$$

charge-discrimination at large |Lepton Rapidity|

Forward Tracking Upgrade in STAR



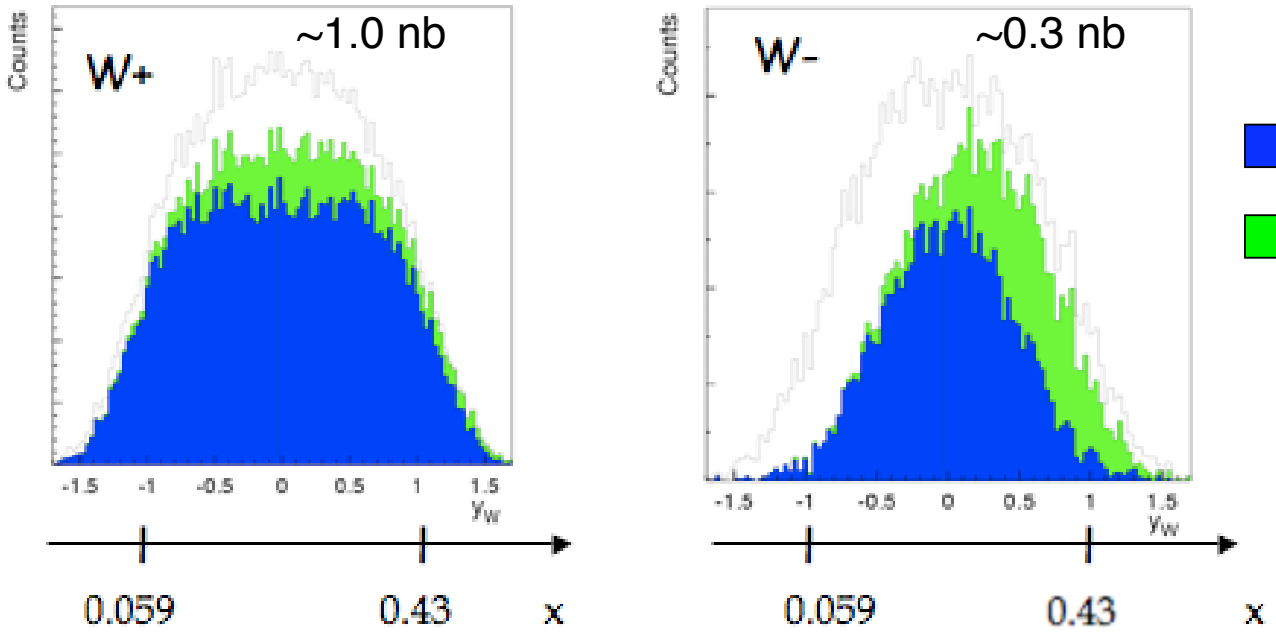
Six triple-GEM disks, build from quarter sections.

- Extend STAR tracking capability for high-p_T leptons in 500 GeV p+p collision environment to cover the existing Endcap EM Calorimeter (EEMC), spanning pseudo-rapidities $1 < \eta < 2$

- Make use of EEMC to measure energy, trigger, and suppress hadronic background;
  - $E_T > 20$ GeV,
  - pre-shower, shower-max, post-shower,
  - isolation

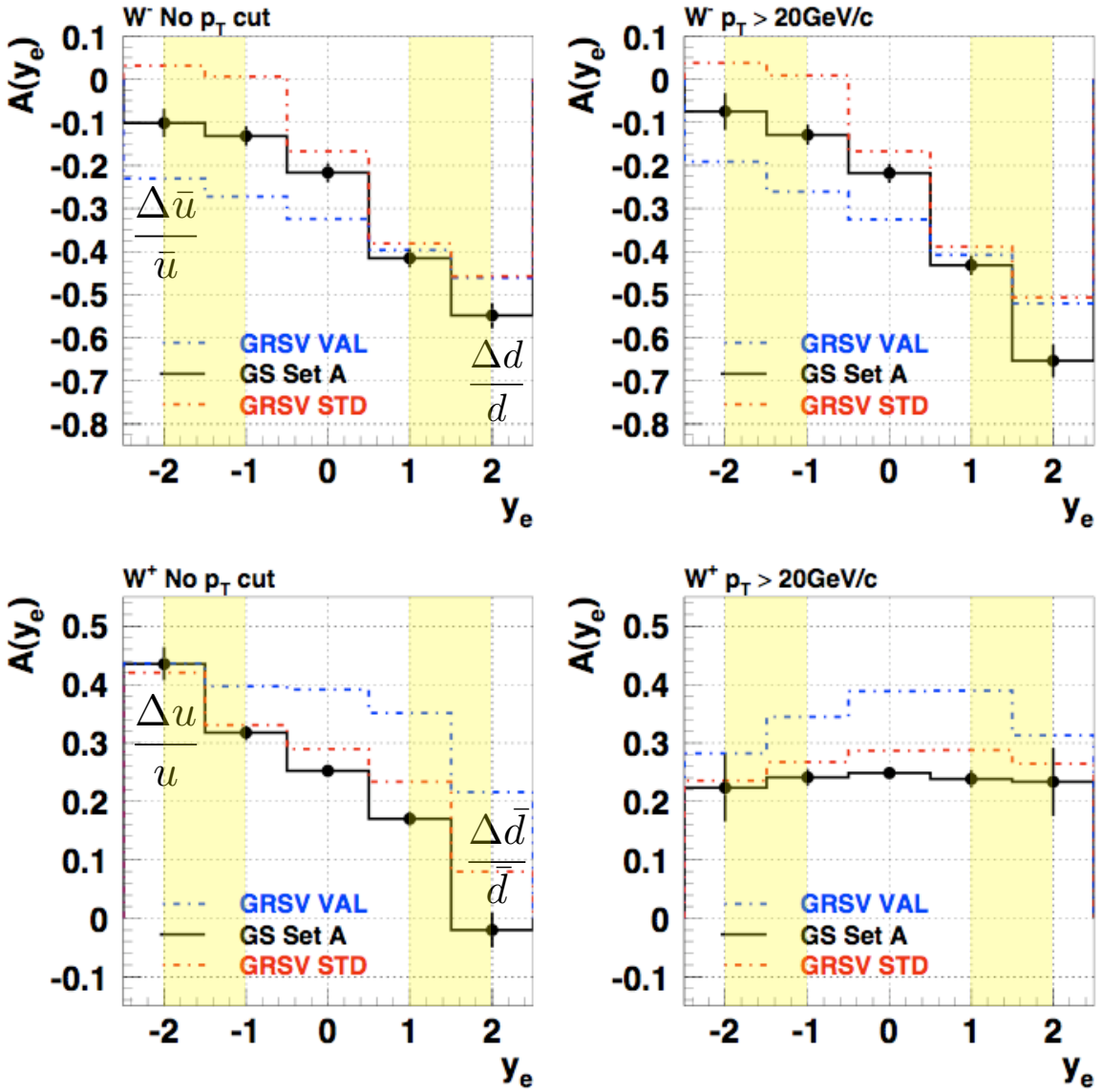
- Subsequent talks:
  - simulations and technology - F.Simon
  - cost and schedule - B.Surrow

W-bosons in STAR



An integrated luminosity of 400 pb^{-1} results in 47(12)k $W^{+(-)}$ events (11% branching ratio); expect RHIC measurements, especially W^-, to be statistics limited.

Projected Sensitivities



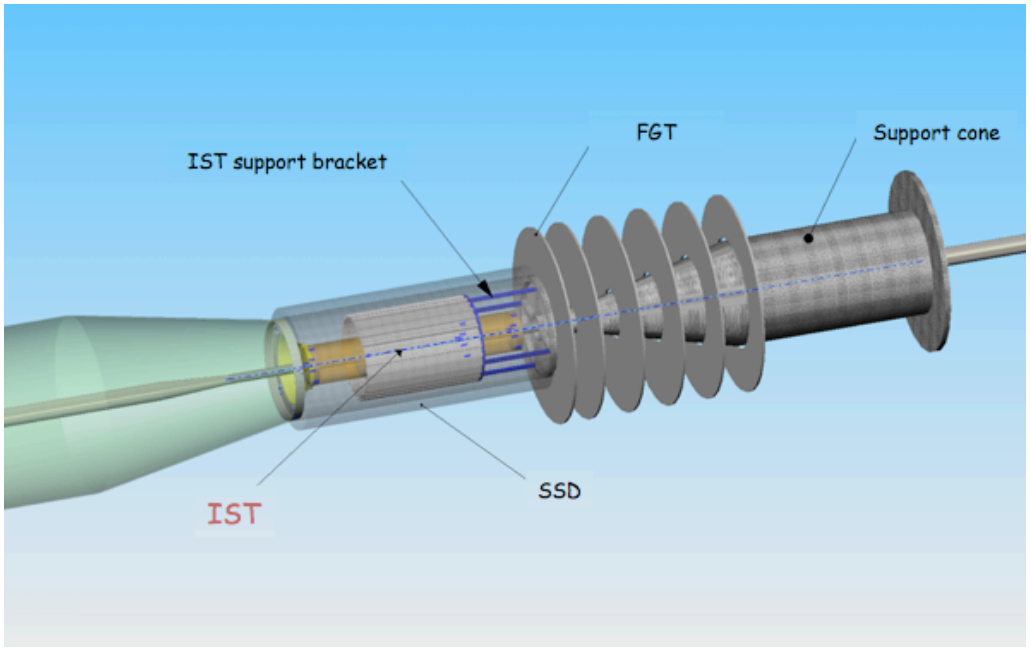
$\mathcal{L} = 400\,\mathrm{pb}^{-1}, \quad P = 70\%$

Forward Tracking Upgrade

STAR forward tracking upgrade is motivated by the 500 GeV spin-physics program,

Its purpose is to discriminate charge for high-p_T electrons/ positrons from $W^{+,-}$ decay,

It extends STAR's capability in the region of the (existing) Endcap E.M. Calorimeter, where sensitivities are large,



Charge discrimination is essential to delineate the quark polarizations $\Delta u, \Delta d, \Delta \bar{u}, \Delta \bar{d}$