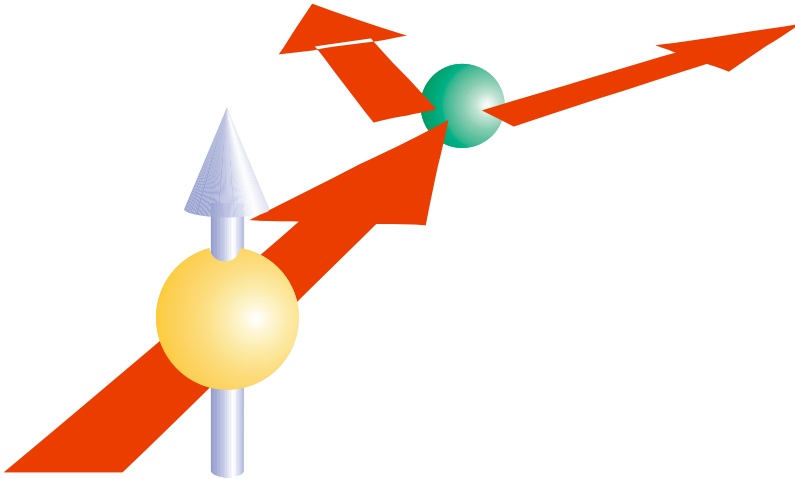


# Introduction

Left

Right



$$A_n = (\sigma^+ - \sigma^-) / (\sigma^+ + \sigma^-)$$

Where the spin cross section is determined with the spin direction defined by  $k_b \times k_{pi}$

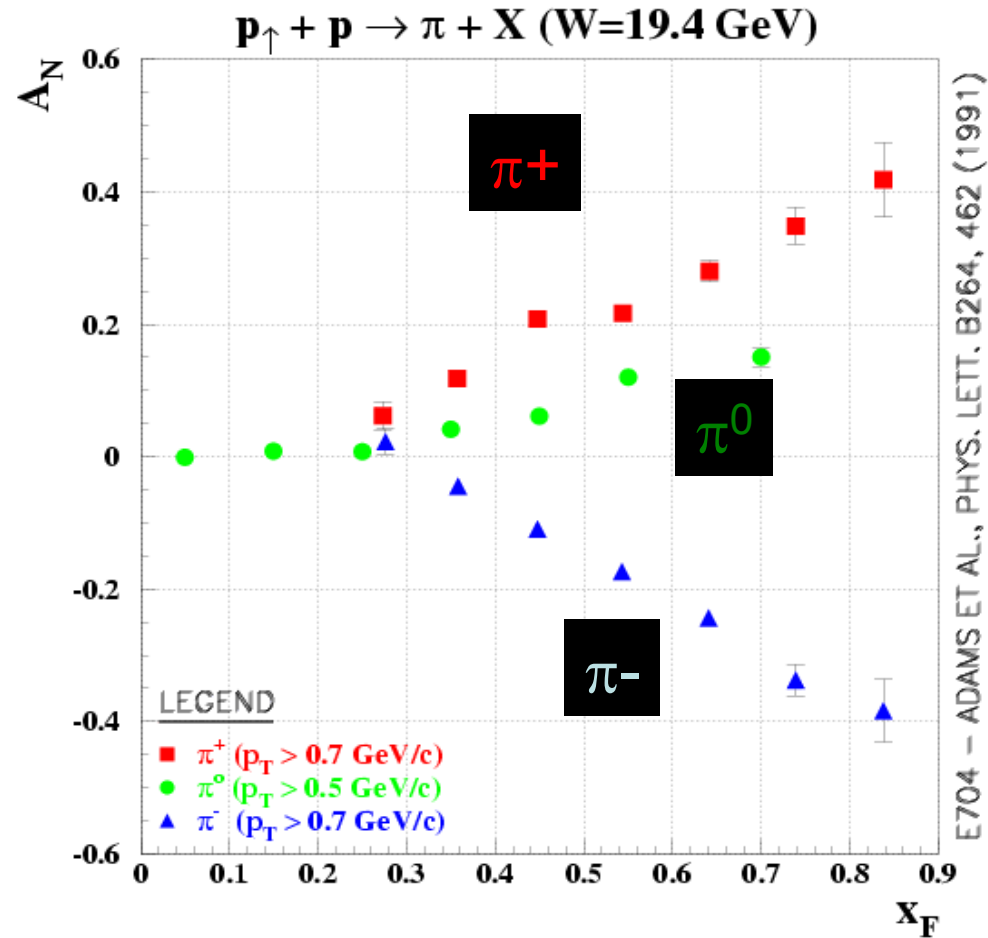
- Early (naive) QCD predicted this effect to be small.
- Non-zero Single Transverse Spin Asymmetry (SSA/  $A_n$ ) requires
  - Spin Flip Amplitude and phase difference in intrinsic states.
- Such studies may clarify properties of transverse quark structure of the nucleon.

# Background

Low energy data (FNAL E704 ) show clear differences between  $\pi^+$  and  $\pi^0$ .

D.L.Adams (E704) Phys.Lett B264,462(1991);  
Phys.Rev D53, 4747 (1996).

Recent STAR results on  $\pi^0$  also shows a significant SSA/  $A_n$  at RHIC energies.

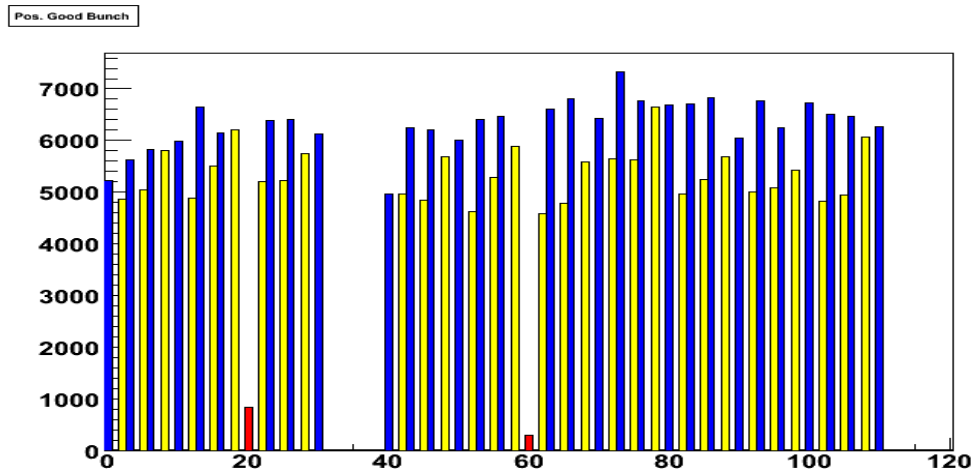


# Recent Spin analysis

- The spin scaler data files are copied on a regular basis to the RCF. The home location is `~brahmlib/spin/05/data`. The scripts to convert the files are in `~brahmlib/spin/05/scripts`.
- The conversion of files saved manually, as well as those where the increment was cumulative is in progress.
- The good bunches, the spin pattern as well as the lumi is done from the spin scaler content and does not utilize external information.
- A set of run has been looked at reasonably extensive to see that the data we take as well as the analysis produce reasonable results.
- The runs are the 14502-14517 ( $\pi^-$ ) and 14455-14560 for ( $\pi^+$ ).

# Bunch Pattern Selection

- Bad bunches with different intensity outside norm is rejected.
- L+/L-  $\sim$  1.05-1.15 typical factors
- Current run-5 have more systematic check with varying patterns.

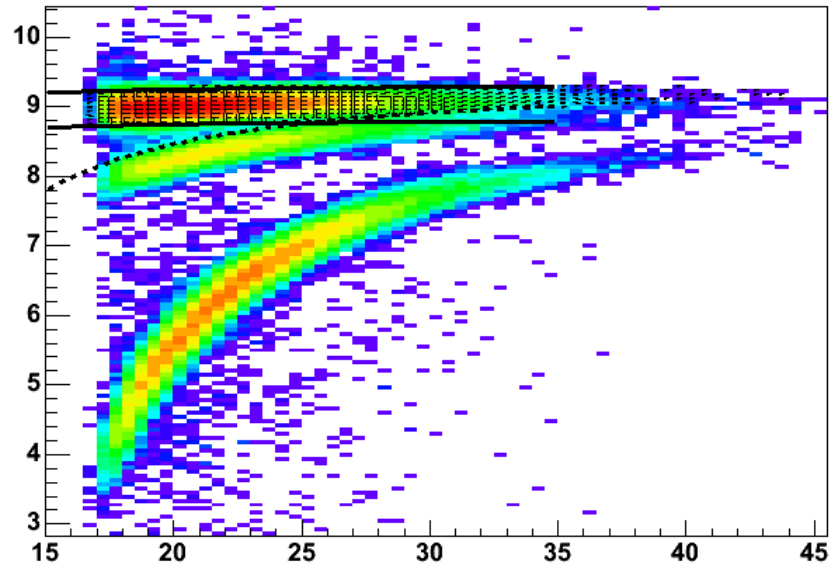


# PID using RICH

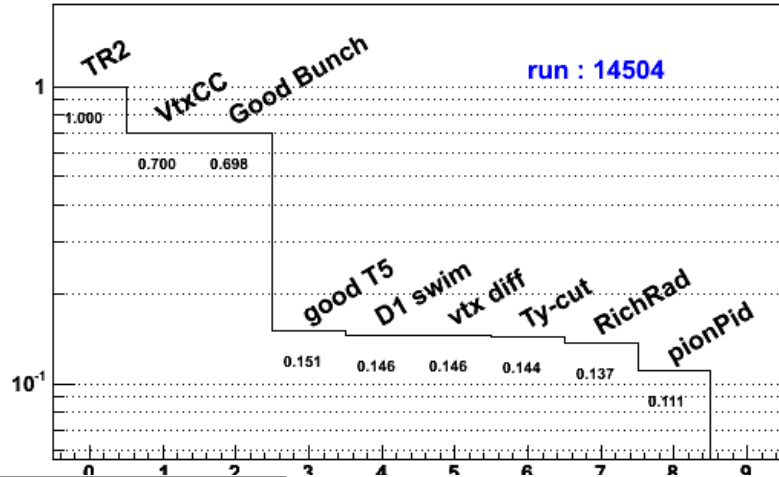
Mass determined from momentum and Radius measured in a Ring Imaging Cherenkov Counter.

The pion identification is clean up to 35 GeV.

Rich radius vs p All



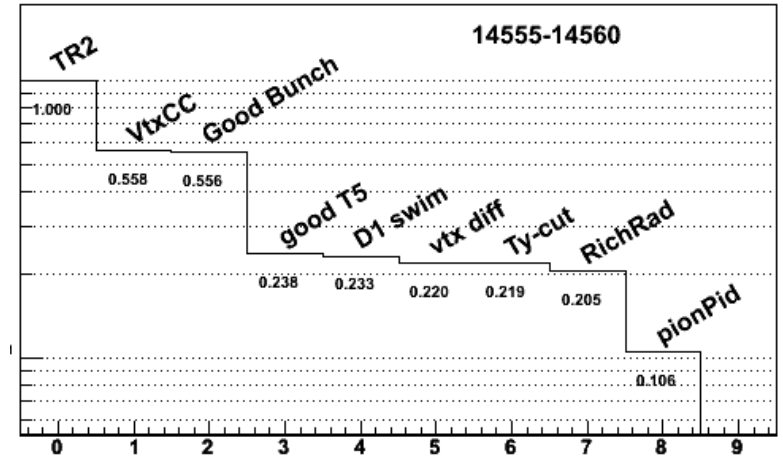
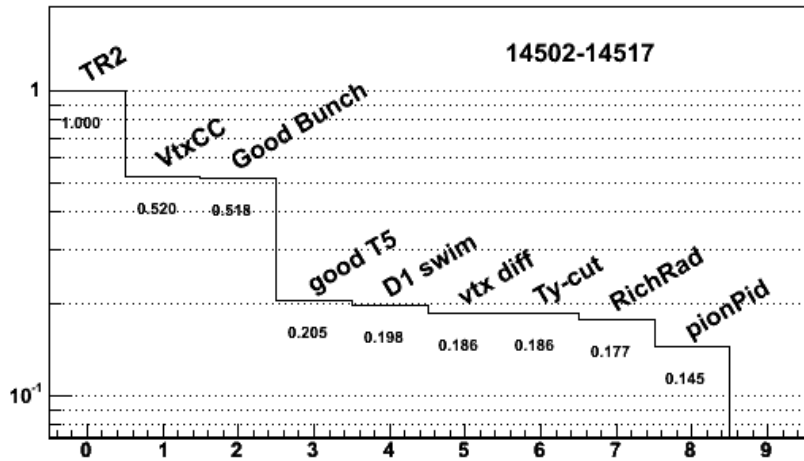
Reduction in TR2 for cuts



Reduction in TR2 for cuts

- a) VTX (-200,200)
- b) VTX (-80,80)
- c) VTX (-80,80) pi+

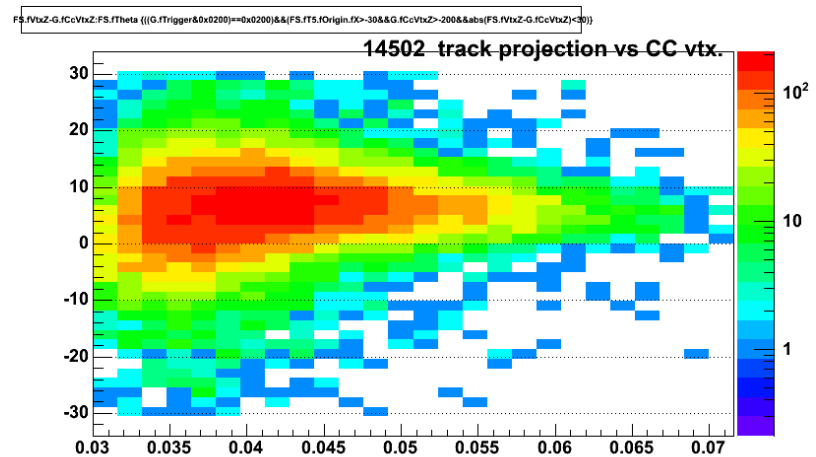
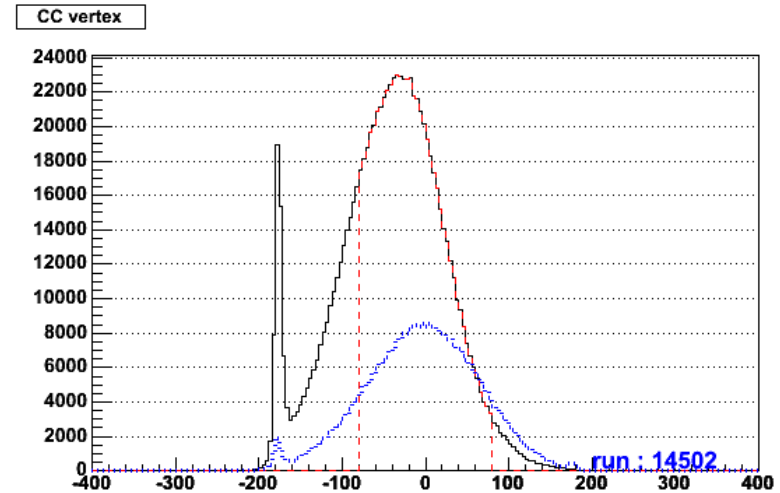
Reduction in TR2 for cuts



# Vertex selection and issues

The plot shows **Min Bias** data (CC-vertex) , for Tr2 events, and **accepted** for analysis

The correlation between Track vertex and CC vertex is good  $\sigma \sim 8\text{cm}$ , and with only a small theta dependence.

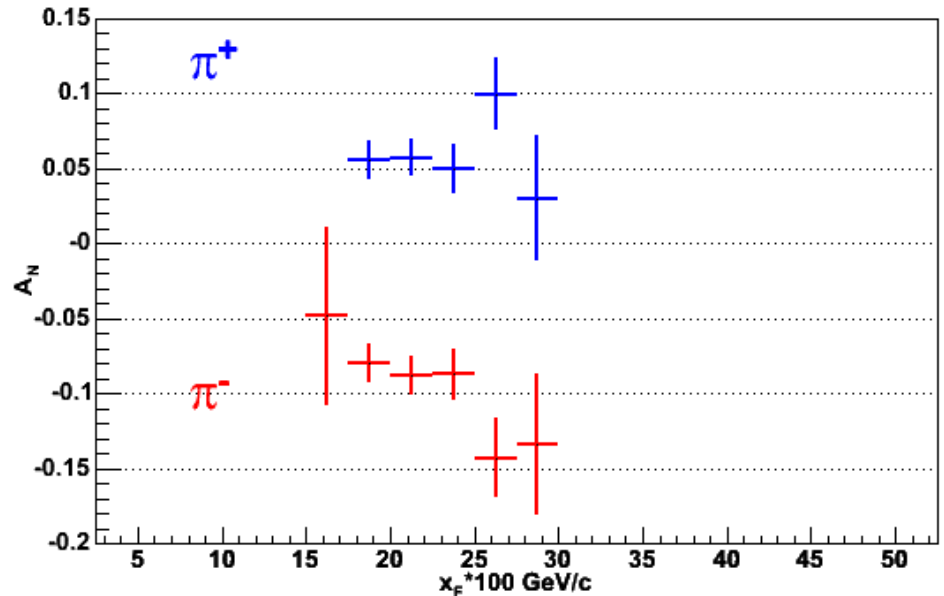


# Comparing $A_N$ for $\pi^+$ and $\pi^-$

Polarization was  $\sim 42\%$  for  $\pi^+$  measurements and

$\sim 38\%$  for  $\pi^-$ .

Systematic scale error on  $P \sim 20\text{-}30\%$ . Will improve final final analysis of CNI and Gas Jet data.



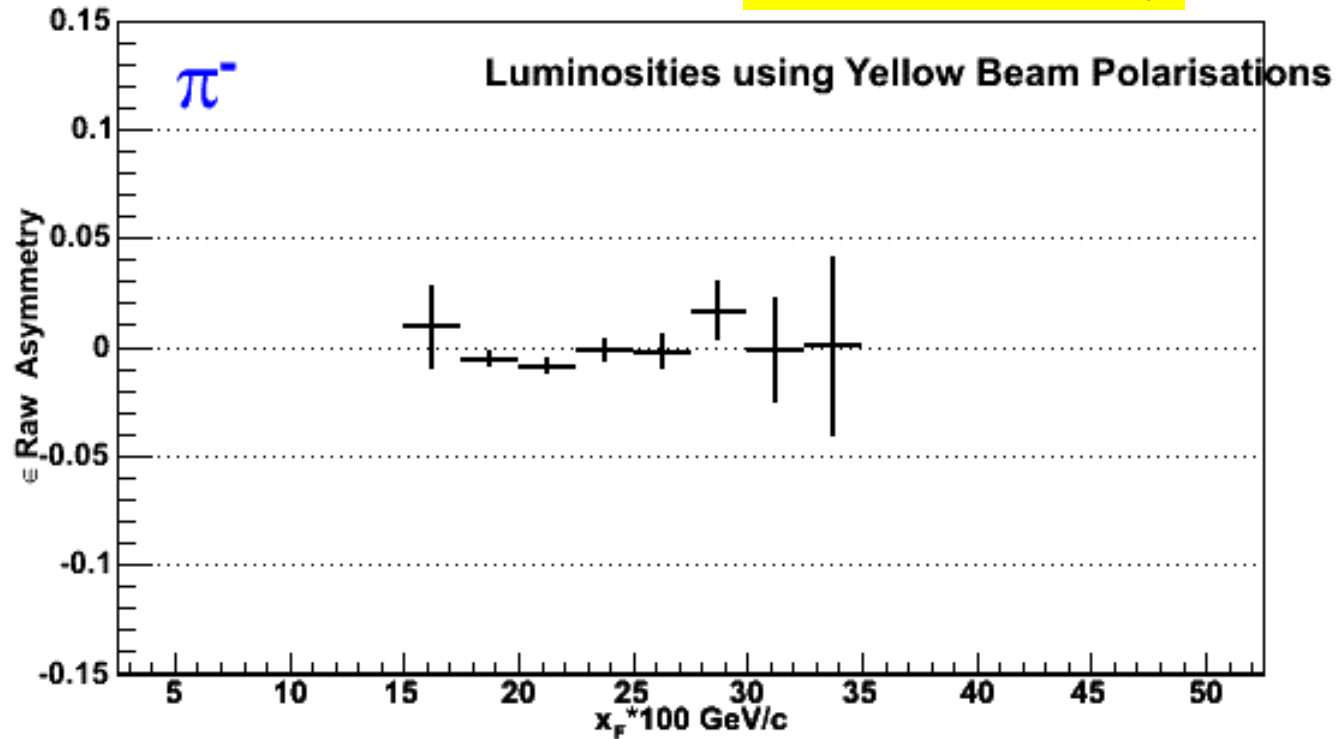
$$A_N = +0.05 \pm 0.005 \pm [0.015] \text{ in } 0.17 < x_F < 0.32$$

$$A_N = -0.08 \pm 0.005 \pm [0.02] \text{ in } 0.17 < x_F < 0.32$$

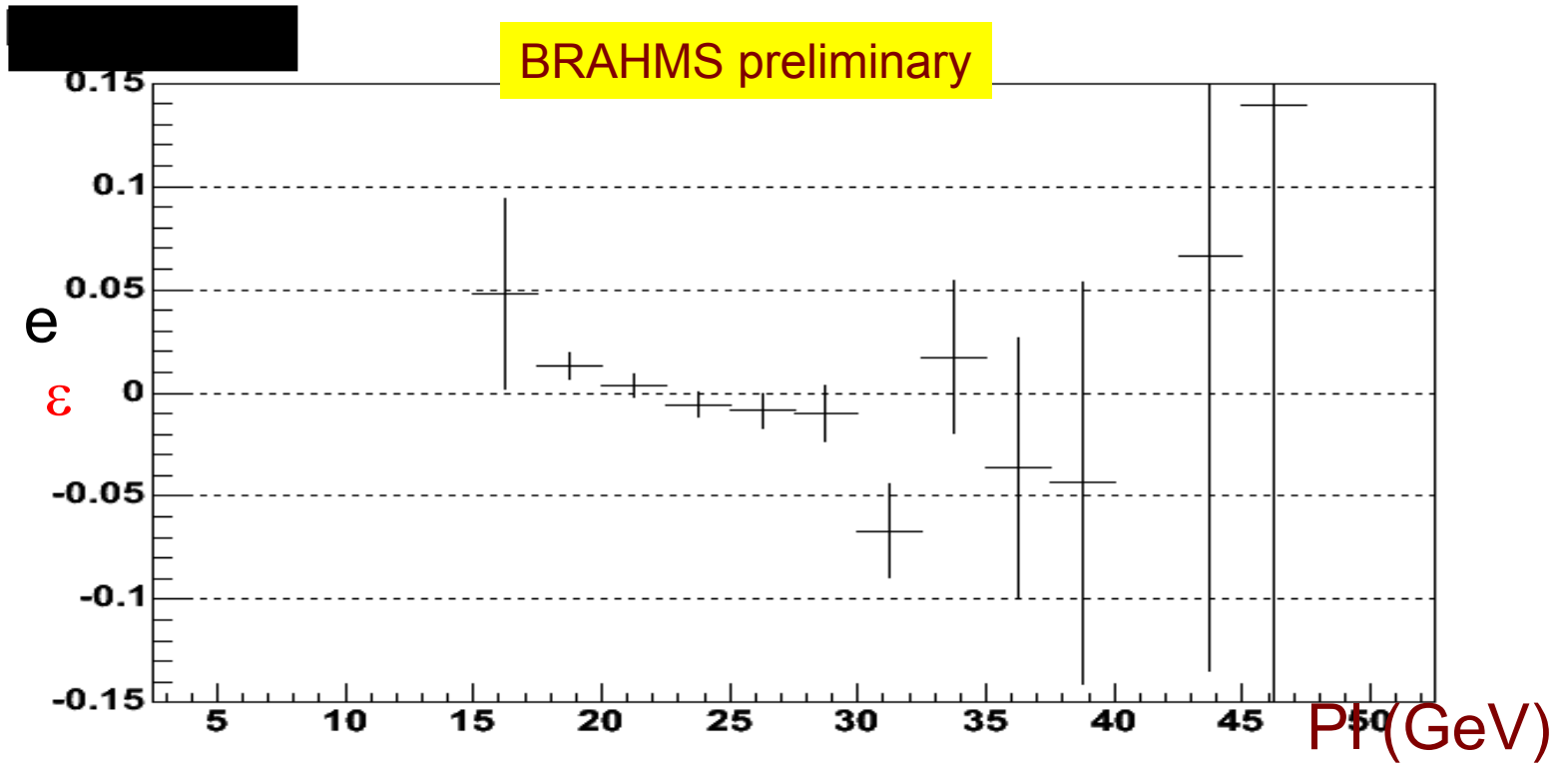


# $\pi^-$ and $\pi^+$ with yellow Polarization pattern.

BRAHMS preliminary

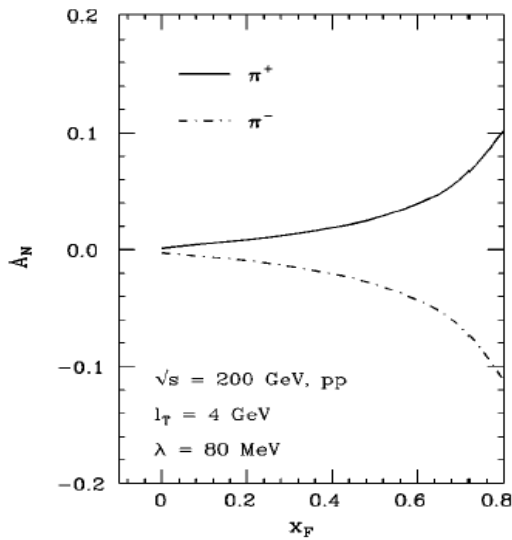
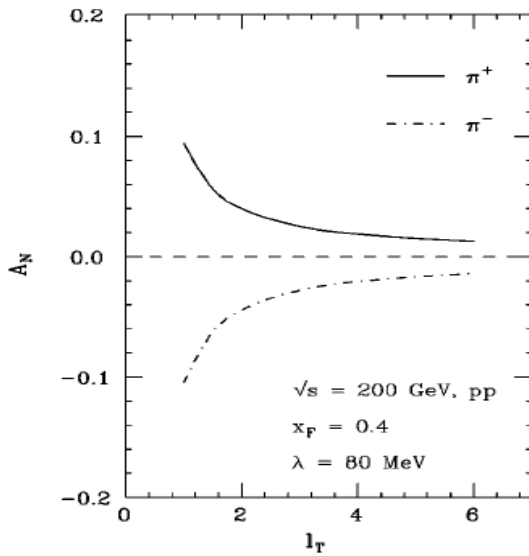


This corresponds to negative  $x_F$ , and is consistent with 0 as expected.

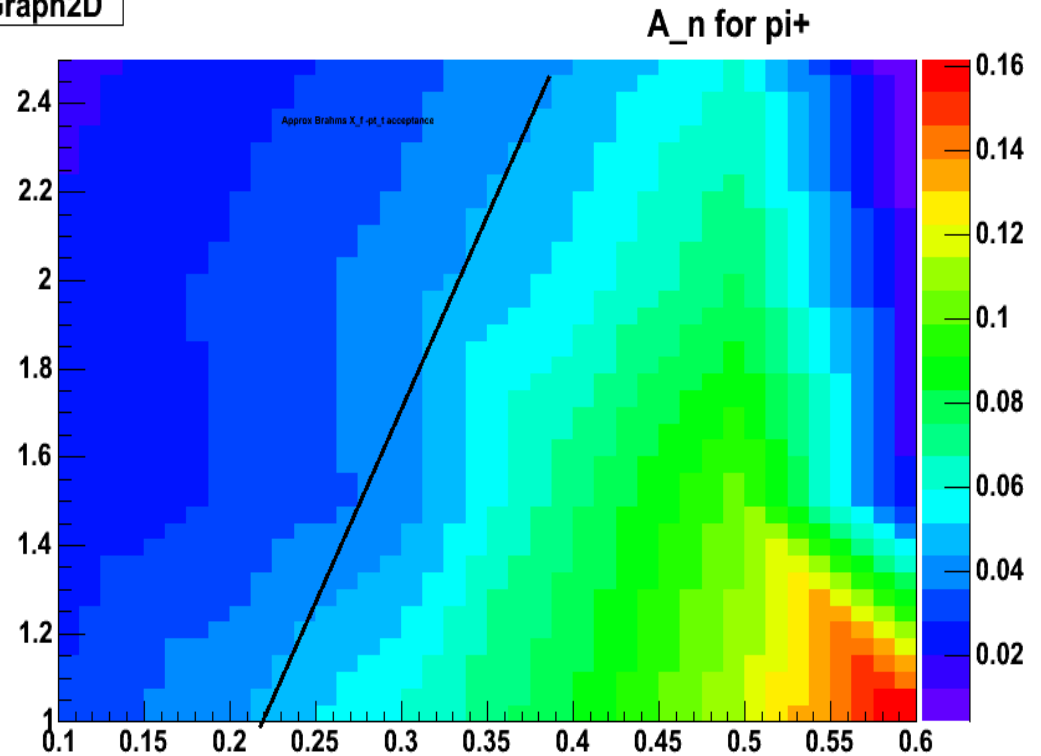


The proton  $A_n$  is also consistent with 0.

Twist 3 (initial state) calculations by  
 J.Qiu and G.Sterman,  
 Phys.Rev.D59,014004(98)  
 Extrapolated to lower  $p_T$

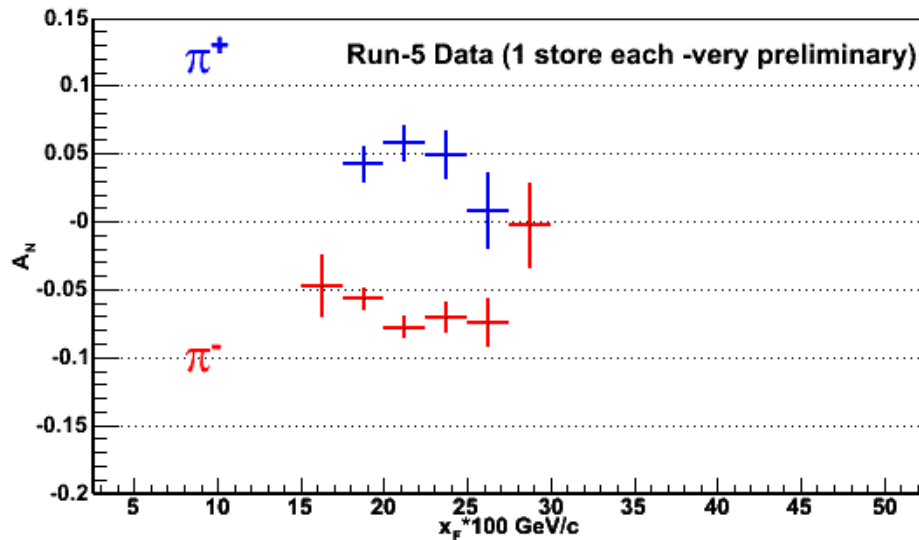


Graph2D



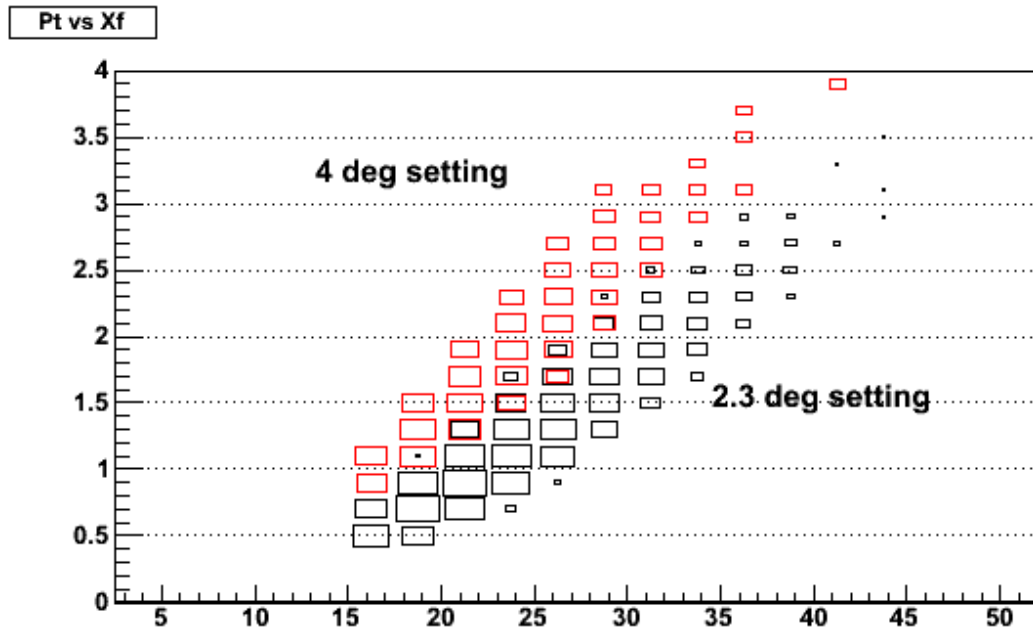
# Preliminary Run-5 Data

- Very preliminary data from Run-5 confirms the run-4 measurements.
- Data from just 1(2) stores. Total statistics  $\sim 10$ -20 times this.



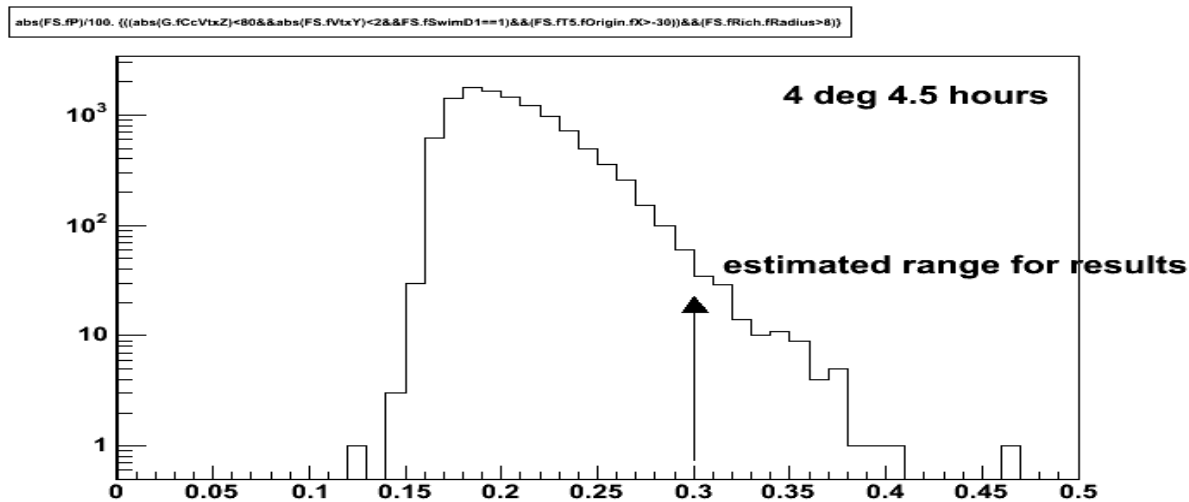
# $P_T$ - $x_F$ acceptance

The measurements at 4 deg in addition to 2.3 deg will allow for some  $p_t$  coverage.



# Expectations for 4 deg

- Statistics obtained for partial run last week.



# Conclusions

- BRAHMS has obtained the first preliminary result for single spin asymmetries for  $\pi^+$  and  $\pi^-$  in 200 GeV pp collisions at RHIC in the  $x_F$  range of 0.17 to 0.32.
- The  $A_N$  value for  $\pi^+$  and  $\pi^-$  are significantly different with opposite sign, and the  $\pi^- < 0$  at  $\sim 3$  sigma level and  $\pi^+ > 0$  at  $\sim 1.5$  sigma level
- The sign of  $A_n$  is consistent with behavior from lower energy.
- $A_n$  at negative  $x_F$  for  $\pi^+$  and  $\pi^-$  are consistent with 0 (as also found by STAR for  $\pi^0$ )
- The protons are found to have  $A_N \sim 0$

# Summary

- The ongoing Run-5 should enable BRAHMS to extend the measurements to  $x_F \sim 0.45$  and to get some information on  $p_T$ -dependence at  $x_F \sim 0.25$
- RICH operating mode can be changed to  $K^+/K^-$  out to about 40 GeV/c ( $x_F$

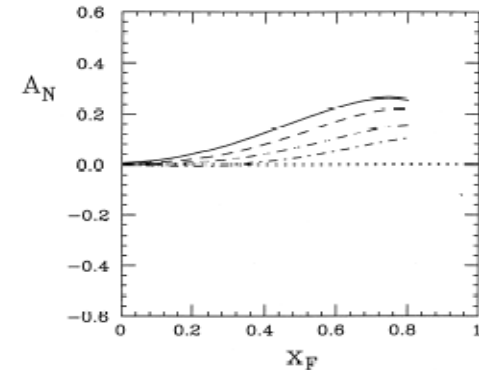
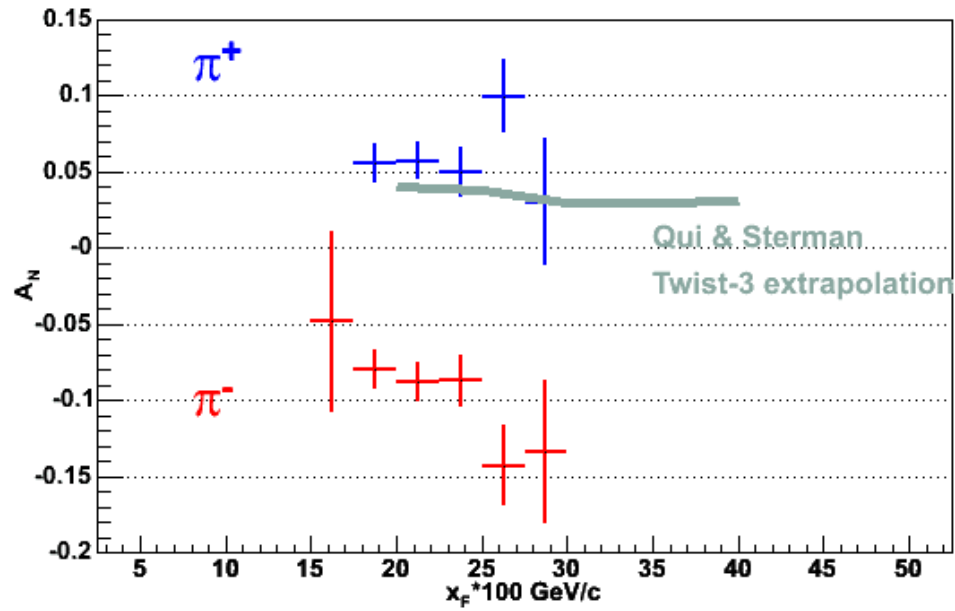


Fig. 4. Predicted single spin asymmetries for the process  $p^+ p \rightarrow K X$ , with the set of kaon FF's BKK1 [19]; kinematical conditions are the same as for the pion case, at  $p_T = 1.5$  GeV/c. The solid, dashed, dot-dashed, double dot-dashed curves refer respectively to the  $K^+$ ,  $K^-$ ,  $K^0$ ,  $K_S^0$  cases. Results for  $\bar{K}^0$  meson are very similar to those for  $K^-$  case.



# Comparison



# Software to-do list

- Convert early RS datafile
- Add bunch polarization to rdo and dst.
- Automated control histograms for luminosity information, to catch run dependent information
- Get RICH calibration over full run range.
- Investigate misc. lumi measures.
- Need good calibrations for TPC, DC

Calc with brag and no D1.

