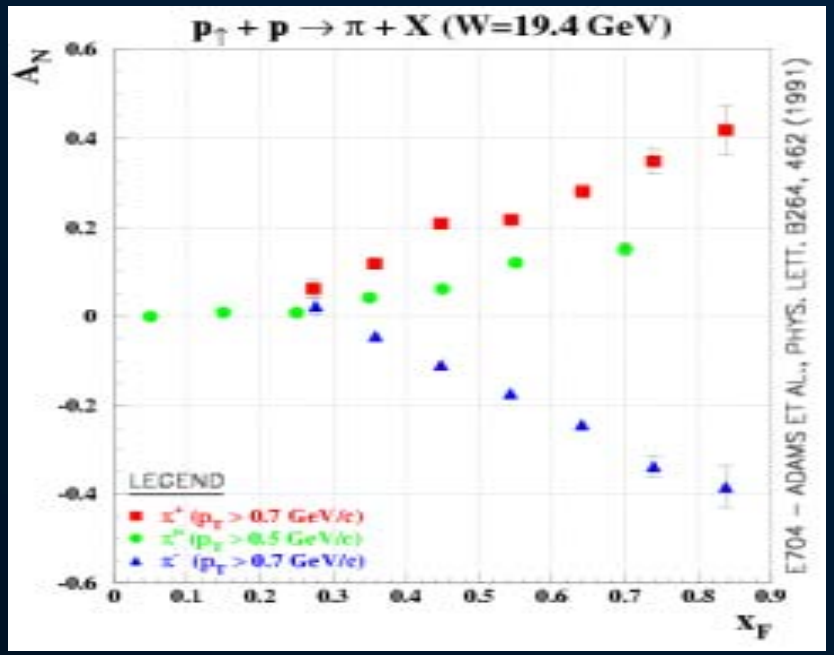
Single Spin Asymmetries for charged pions.
Overview

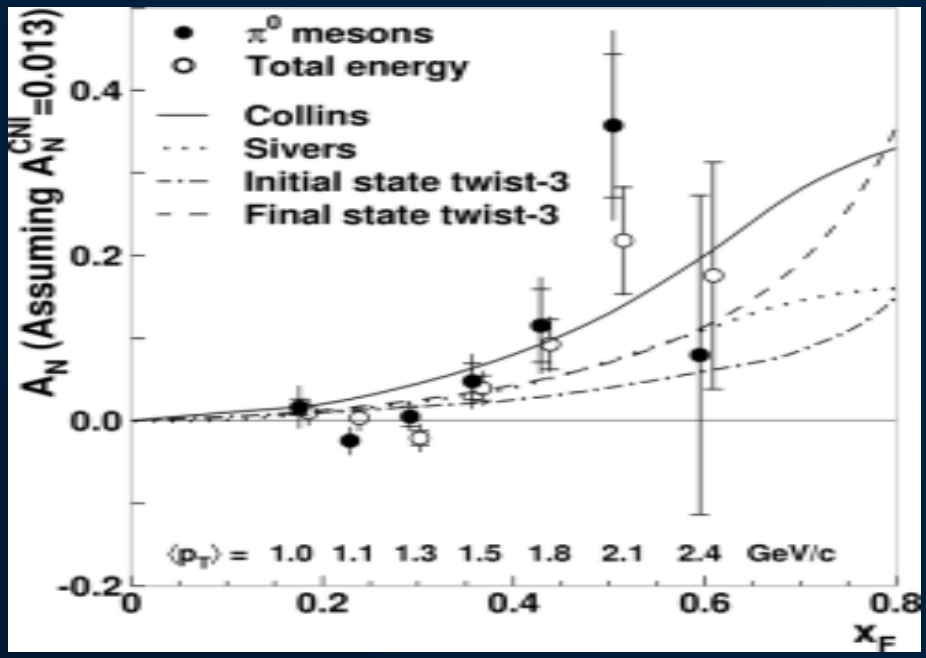
- One physics slide
- What is measured, kinematic variables
- Corrections and issues
  - Polarization
  - Bunch dependent luminosities
  - Systematic errors
- Experimental Checks
- Preliminary Physics results

Will value your comments to analysis and results.

Results will be presented at DNP by me on Thursday and was also shown at the *forward physics workshop* in Lawrence last week.

Transverse Single-Spin Asymmetries





STAR PRL 92,06230(2004)

Low energy data (FNAL) show clear differences between π^{+-} and π^0. At higher energies the models used to describe the data differ.
Large spin effects reported for π^0 by STAR for $\sqrt{s}$ = 200 GeV *pp* collisions

What does the measurement consist of

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

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

  The k are the momenta of the beam and detected particle respectively. In the BRAHMS FS thus the spin direction point down.

  Experimentally this is determined from

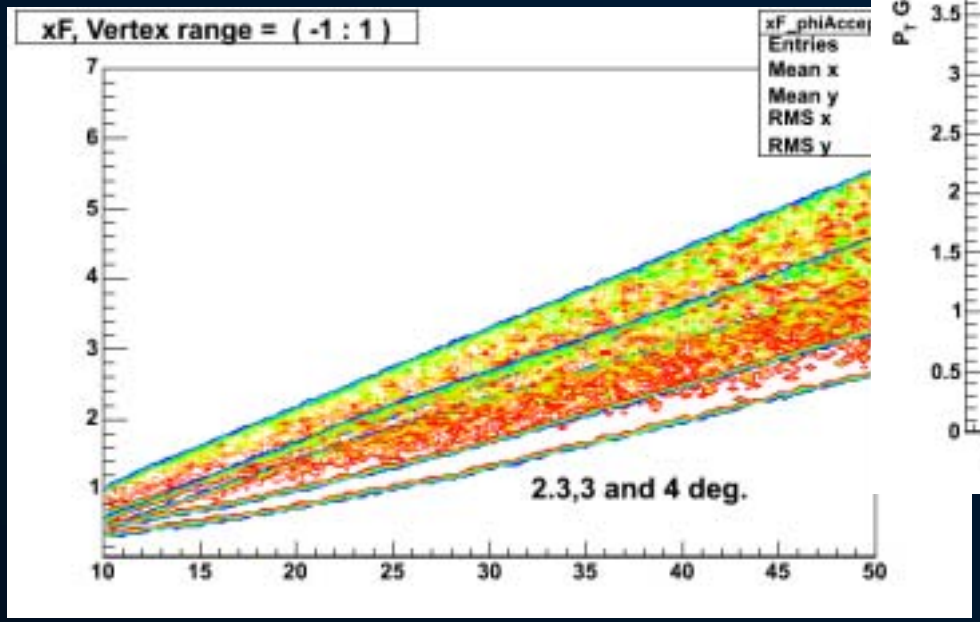
  $A_n = 1/P\ \varepsilon$

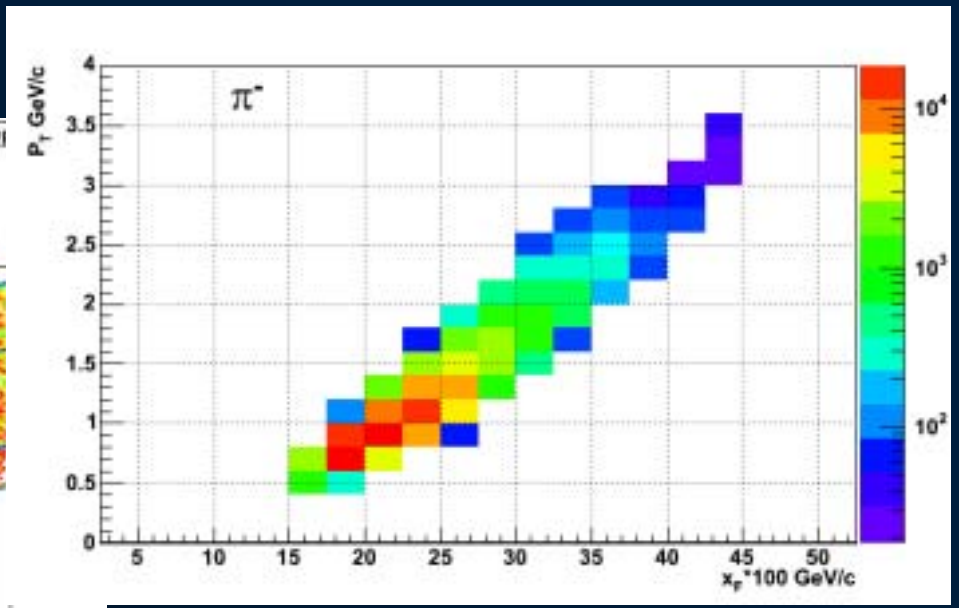
  With $\varepsilon = (N^+ - N^-) / (N^+ + N^-)$ where the is the yield of pion in a given kinematic bin with the beam spin direction (up). The normal RHIC definition of + thus is down just to confuse you.

- The kinematic variables of interest are Feynman x (xF) and pT.
- The BRAHMS acceptance in these variables are

Nominal coverage for 2.3, 3 and 4 deg in x_F-p_T space.
Thus is in range of 1-3 GeV/c
All data here from 2.3 deg and Maximum Field setting

.



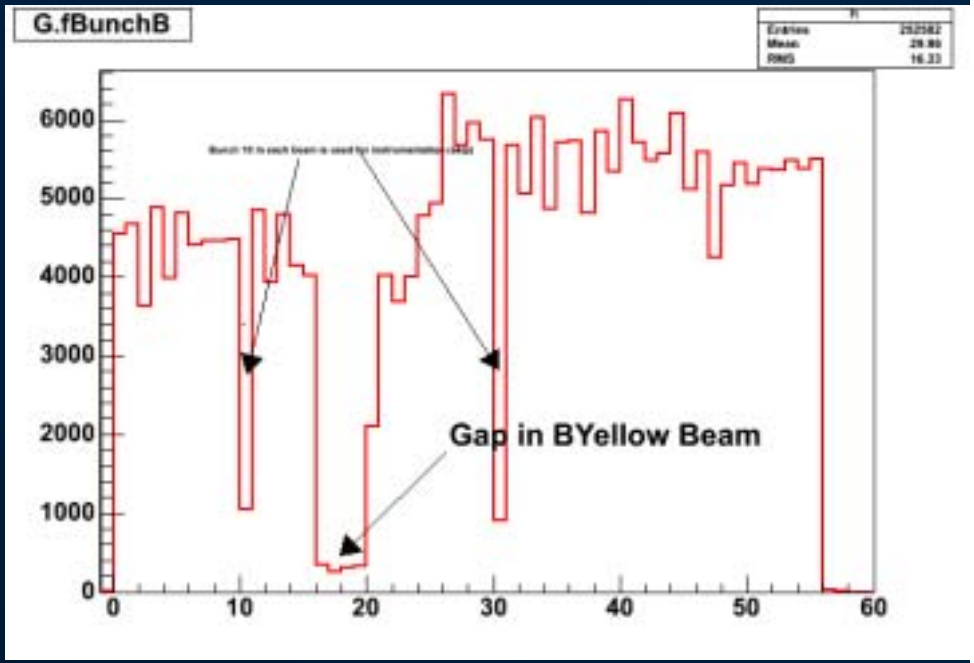


Population for π- (negative Polarization.

Bunch information

The bunch information comes from 3 sources.

1. A V124 module is coded to provide a 7-bit counter 0…60
2. The bunch 1 from Blue and Yellow are recorded in a pipeline TDC. This time can be converted into bunch number.



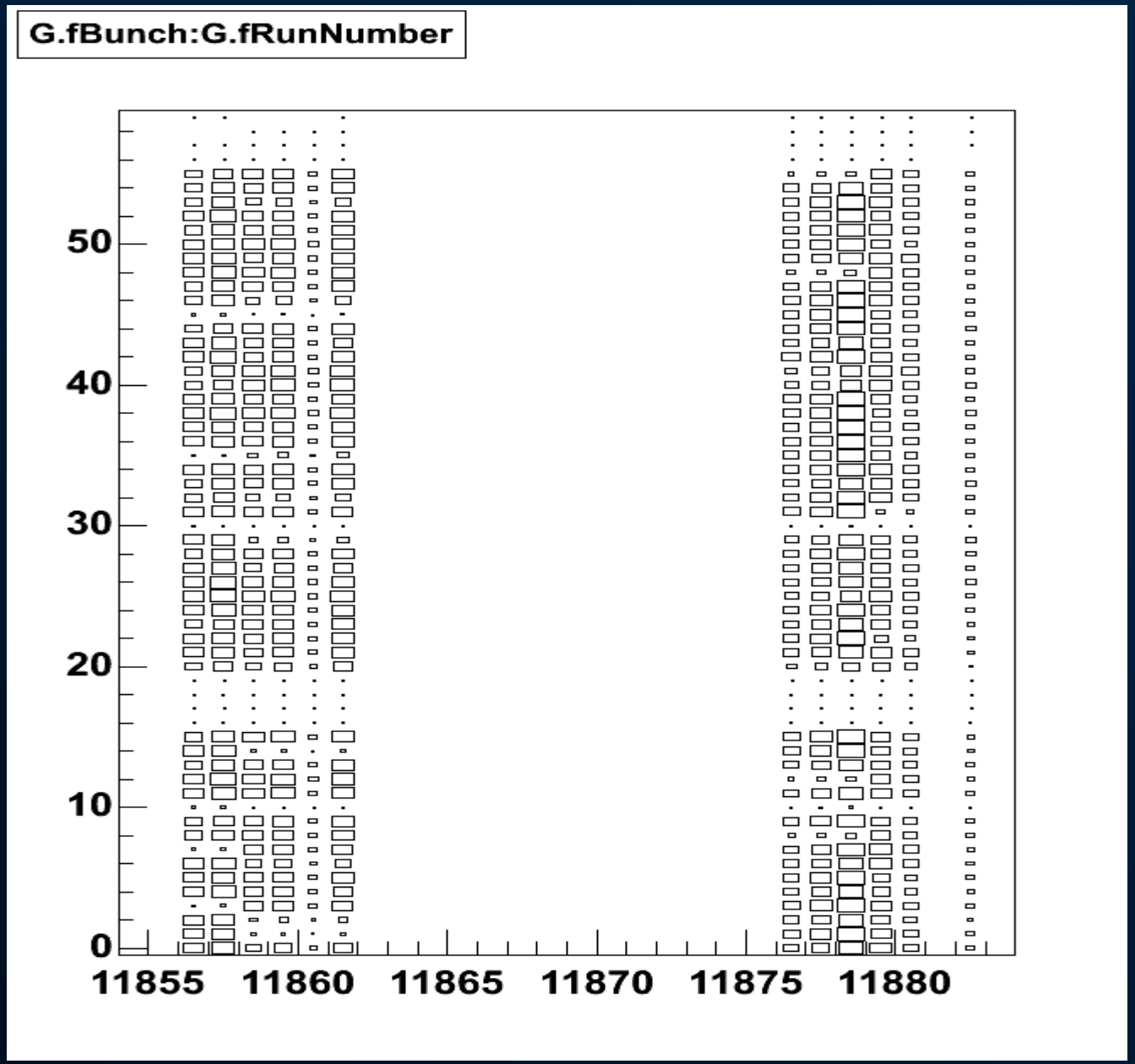
The bunch distribution from run 11880 is shown here. Notice the Gap on 16-20. This corresponds to the gap in the yellow beam
The bunch 10 in each beam is probed by beam diagnostics and has bad luminosity , vertex information and will be discarded.
Other bunches may have low luminosity due to poor filling ,…

Formula for raw asymmetries.

$\varepsilon = (N^+ - N^-) / (N^+ + N^-)$ equation assumed that each bunch has same luminosity.
This needs need not be the case and the generalized equation is
$= (N^+ / L^+ - N^- / L^-) / (N^+ / L^+ + N^- / L^-)$
$= (N^+ - L*N^-) / (N^+ + L*N^-)$ where $L = L^+ / L^-$

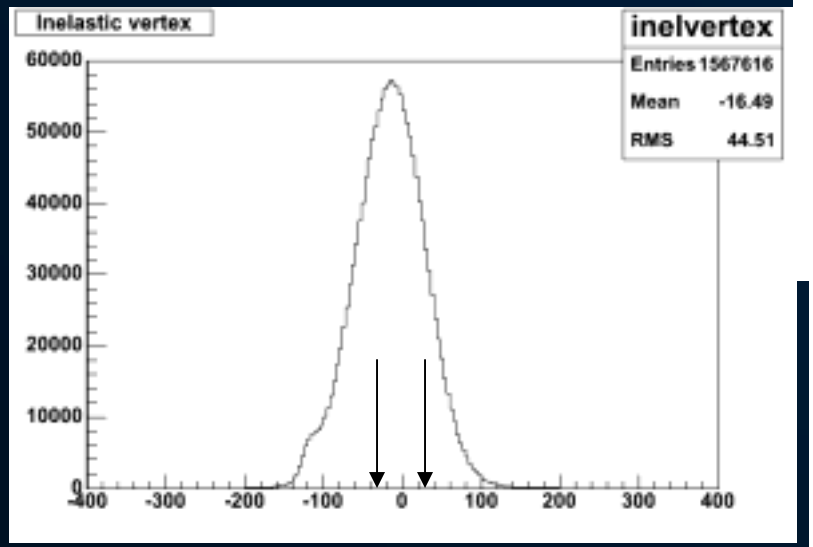
The Polarisation pattern is +-+-+-… for the Blue beam
And ++--++--++--++--… for the Yellow beam (away from spectrometer).

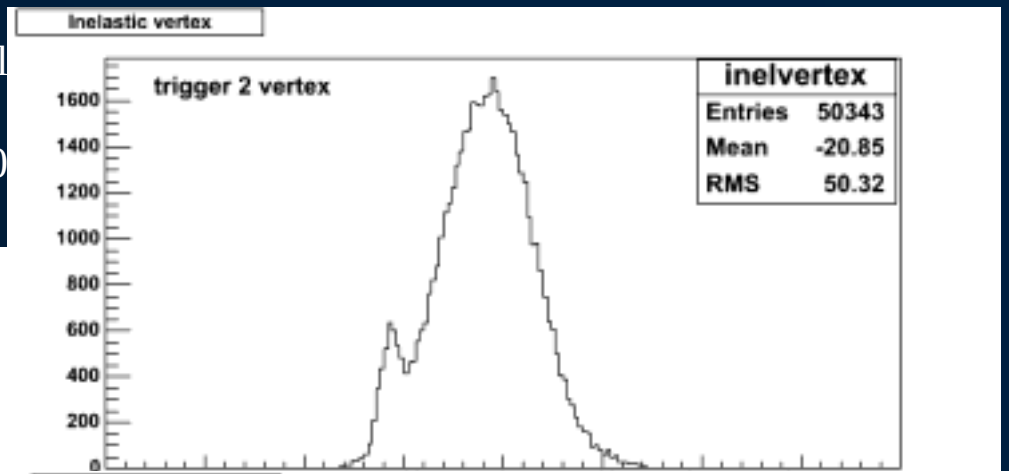
For all the data runs used in the last ~4 days of the RHIC run the polarization is ~45%. There are some issue with the measurements of Blue polarization using the CNI.


G.fBunch:G.fRunNumber
50
40
30
20
10
0
11855
11860
11865
11870
11875
11880

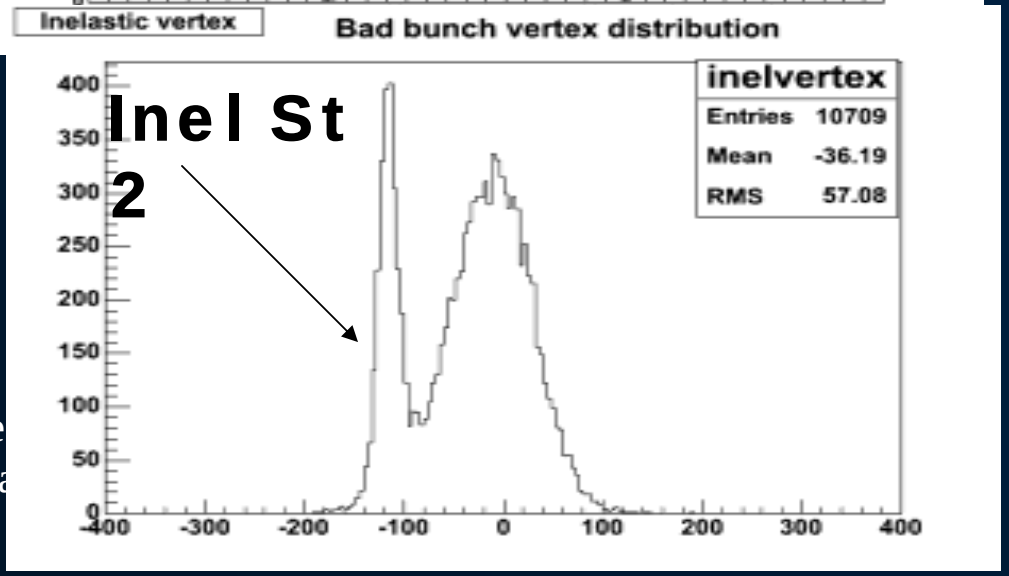
Typical vertex plots.

Inel vertex from runs 11880 and 11882, all
bunches, trigger 2 only
Below vertex from all good bunches (1180
-)





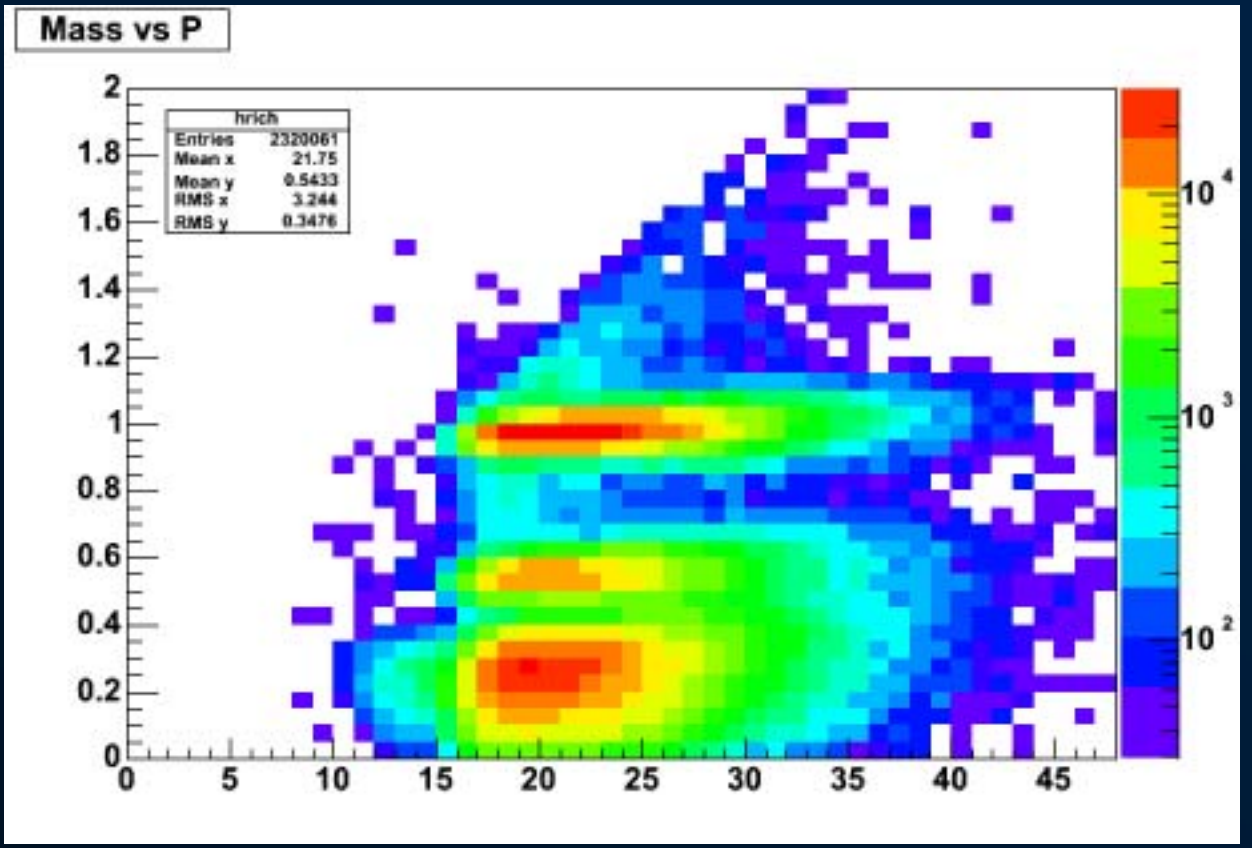
Inel vertex from Bad bunches. The satelite pe
is mainly from the **gap** bunches, I.e single bea
background due to interaction in Ring2 left.
This data are from runs 11803-11834



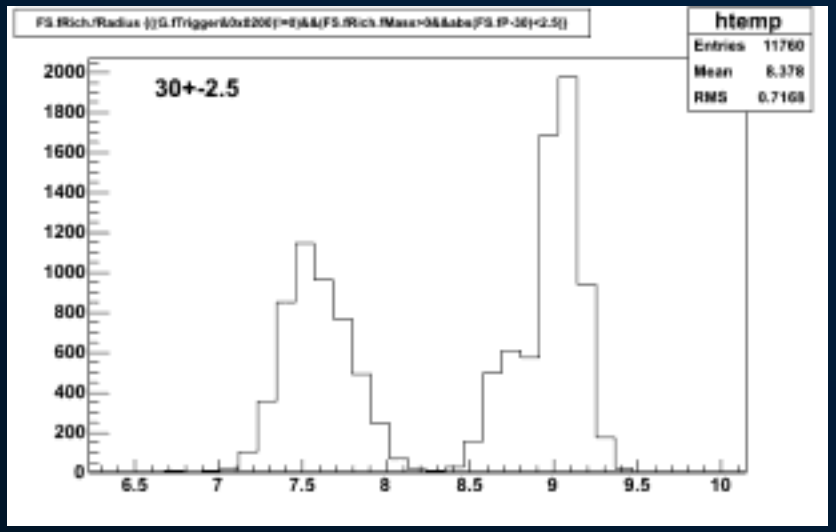
Track Selection Criteria

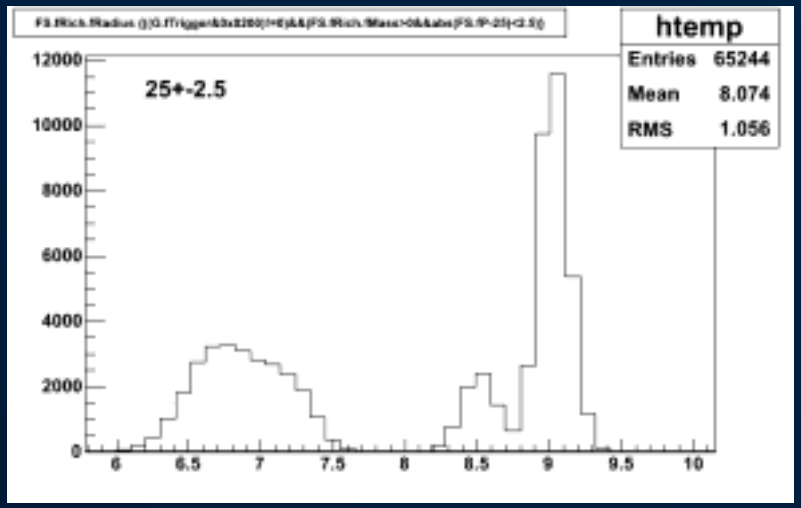
- Trigger 2 events exclusively
- Momentum from FS track
- SwimD1 status == 1
- -40< InelVertex <40
- |trackProjection-InelVtx|<45
- -2<Ty<2
- Good Bunches Only (selected per store)
- 0< Mass < .400 (or .350)
- Data above >= .35 has been excluded (statistics). For these typically <pt> and <xf> are somewhat different for + and – bunches.

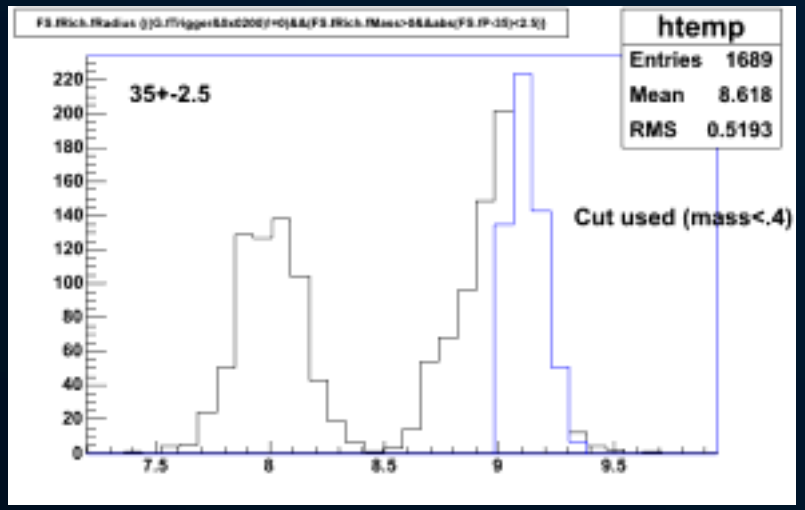
PID using RICH



Individual bins for PID



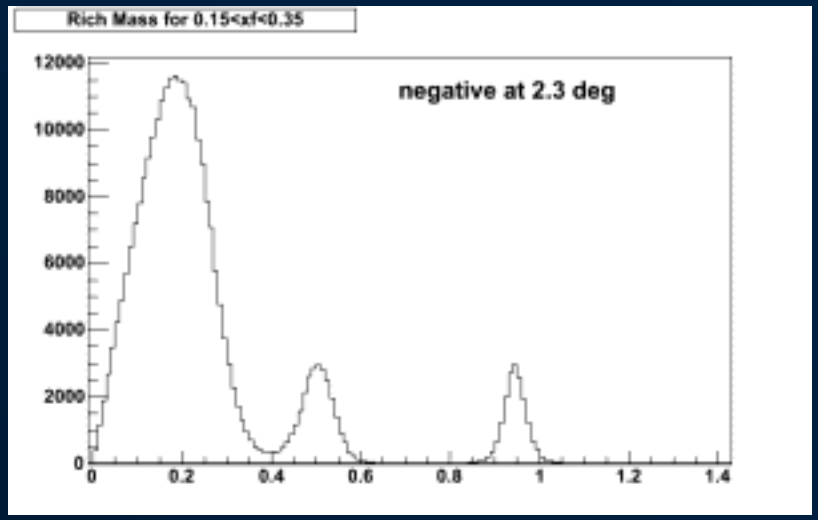


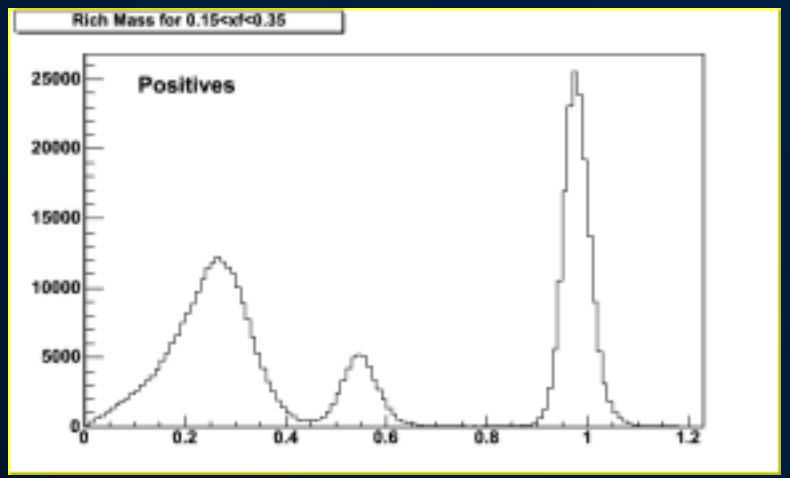


Yields that can be used for analysis

	positive	negative
pion	219K	216K
kaon	46K	26K
proton	165K	17K

Integrated yields of π, K and proton in x_F range 0.15-0.35

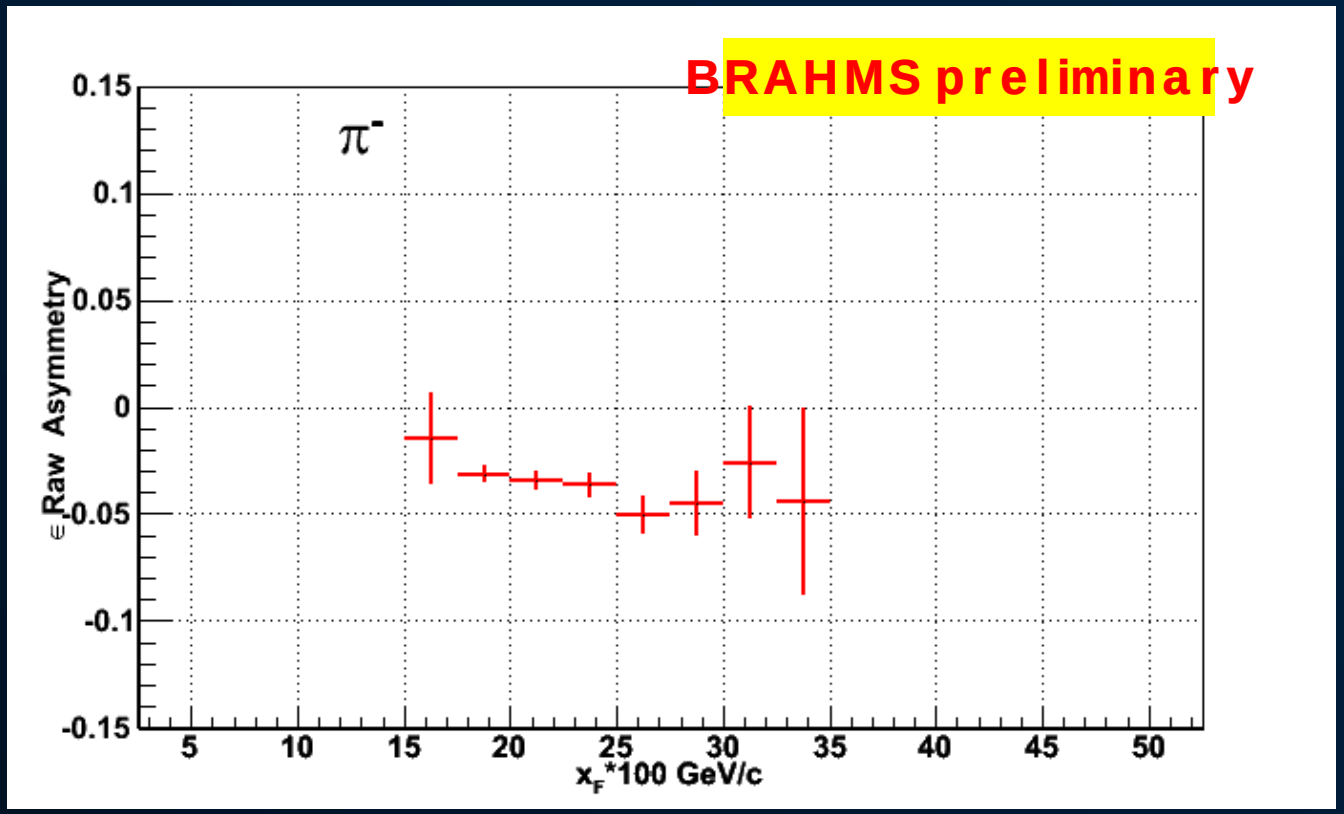




Checks for data

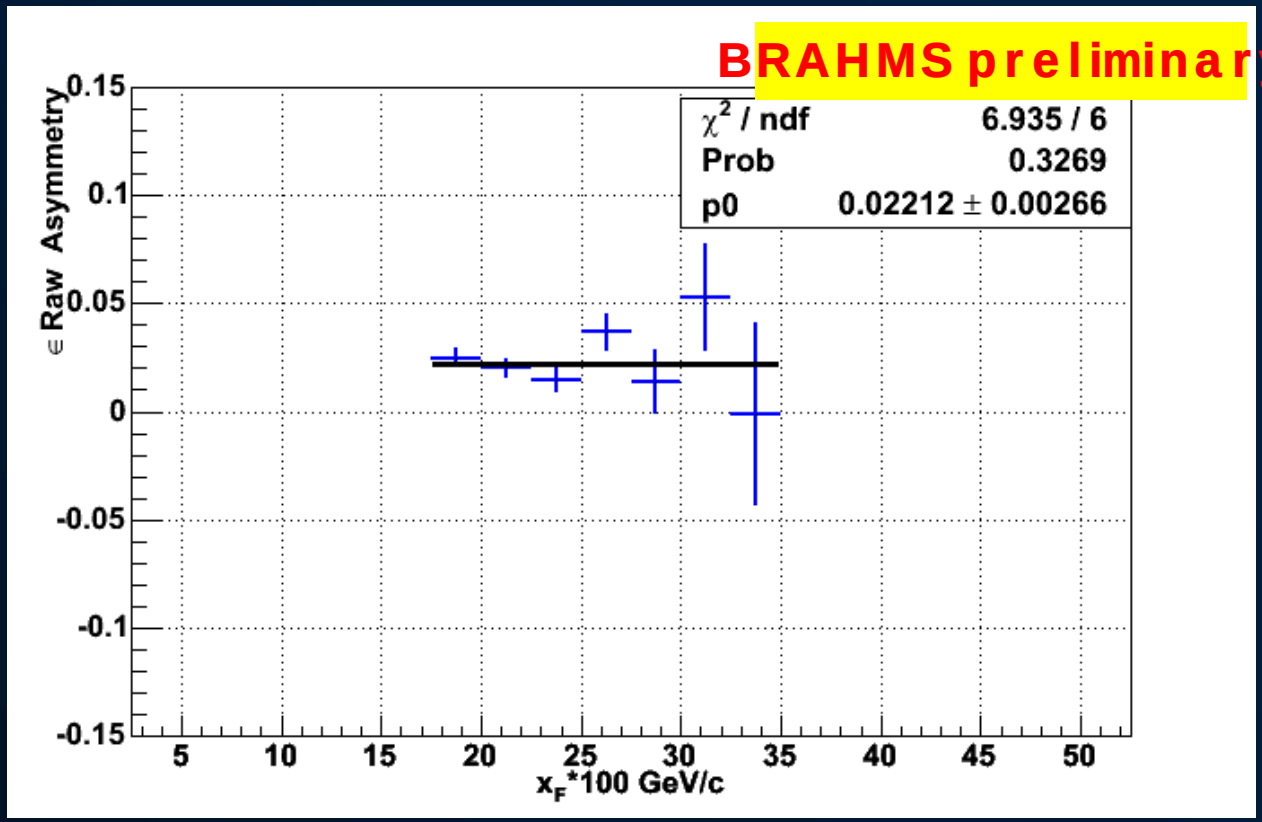
- For singles stores explored changing several data cuts
  - Vertex cuts (40->20, even outside the nominal by mistake)
  - PID limits (.350 , .450)
  - Using different luminosity measure (ZDC rather than BBC)
  - Have overlapped results from individual stores
- Have not looked at subsets of Blue Pol bunches e.g. randomly selecting half of up and down bunches.

π^- ε vs. x_F * 100



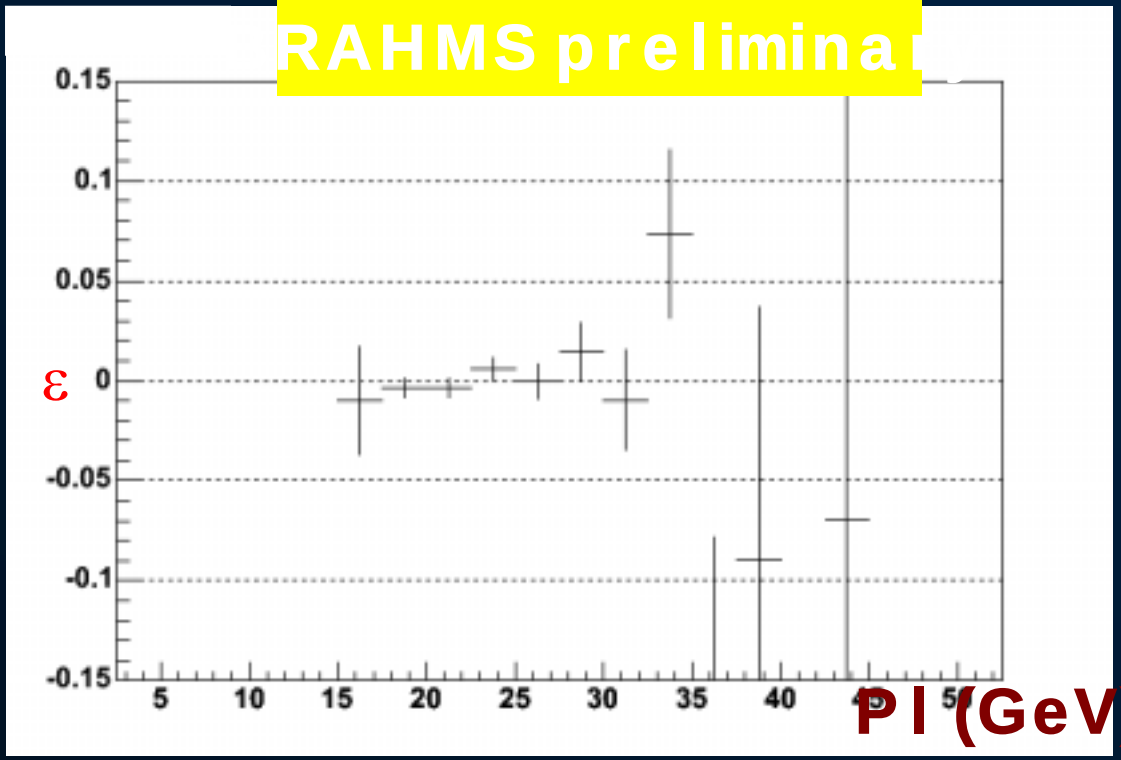
$\langle\varepsilon\rangle \sim -0.035 \Rightarrow A_N = -0.08 \pm 0.005 \pm [0.015]$ in $0.17 < x_F < 0.32$

$\pi+$ ε vs. $x_F * 100$

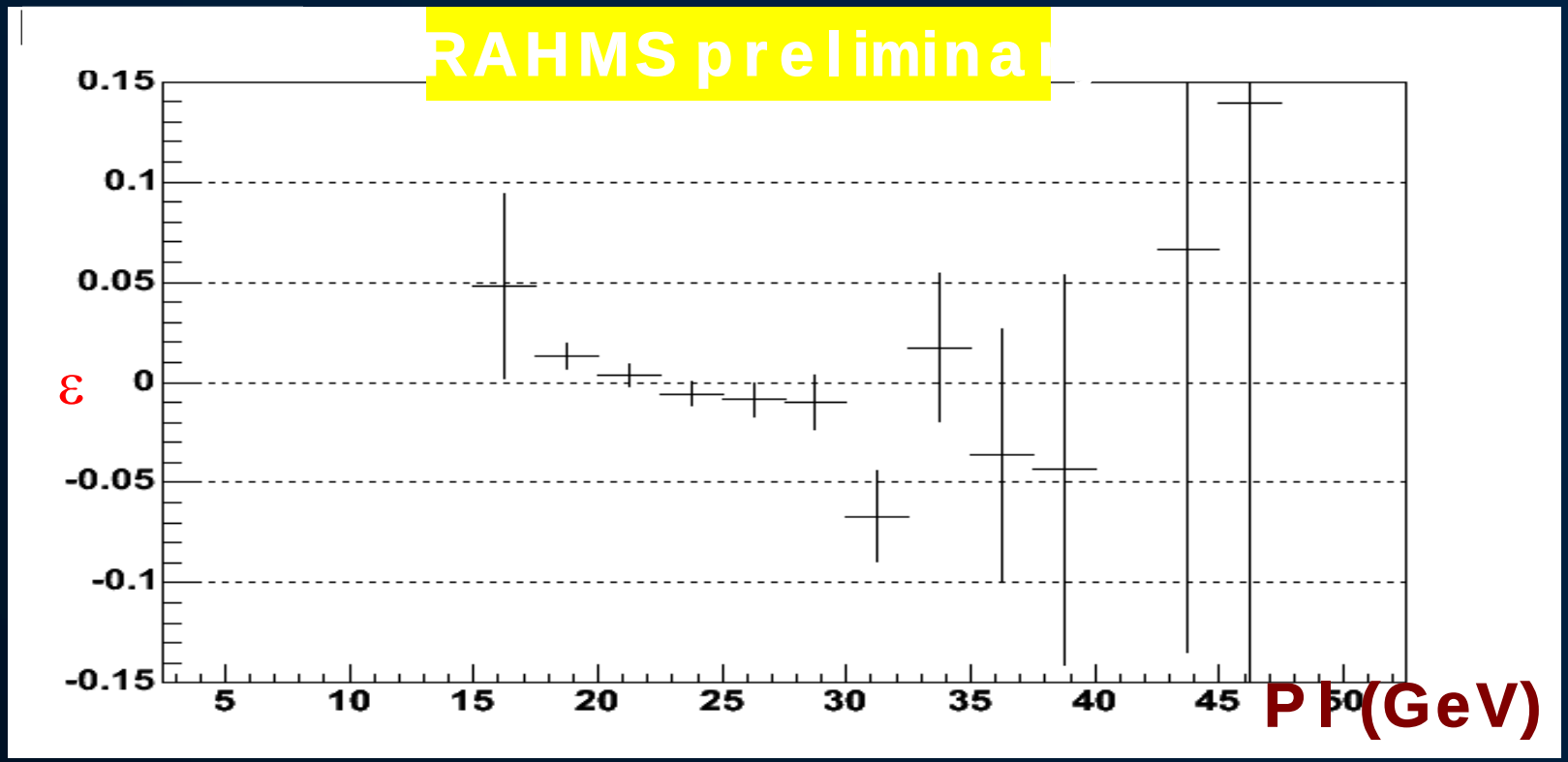


$\langle\varepsilon\rangle \sim +0.022 \Rightarrow A_N = +0.05 +- 0.005 +-$ [0.015] in $0.17 < x_F < 0.32$

π^+ with yellow Pol.



This corresponds to negative x_F, and is consistent



The proton An is consistent with 0. Analyzing po

Conclusions

- BRAHMS has obtained the first preliminary result for single spin asymmetries for p+ and p- in 200 GeV pp collisions at RHIC in the x_F range of 0.17 to 0.32.
- The value for π+ and π- are significantly different from each other and the π- < 0 at ~ 3 sigma level and π+ >0 at ~ 1 sigma level
- The negative x_F for pions are consistent with 0 (as also found by STAR)
- The protons is found to have An ~0.
- Have some data at ½ Field and from 4 deg, but with less statistics
- The upcoming run-5 should enable BRAHMS to extend the measurements to xF ~ 0.45 and to get some information on pt-dependence at xF~0.25