Polarization Related Beam Experiments for the AGS

H. Huang

November 2, 2007
APEX Workshop 2007

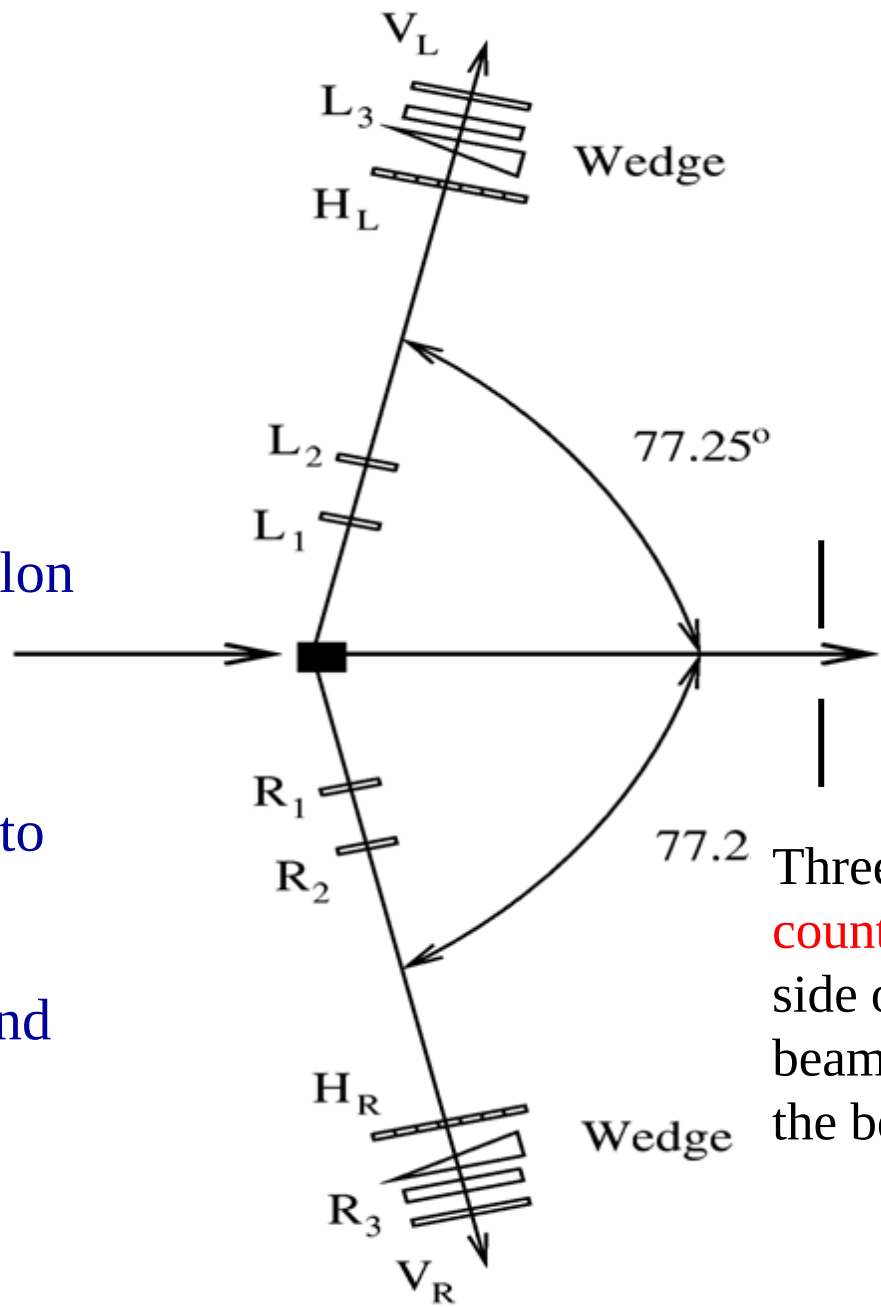
AGS PP Related Beam Experiments

- New CNI polarimeter detector test. (Boris)
- Rate dependence of polarimeter. (Haixin)
- Polarizations for each bunch with higher accuracy. (Haixin)
- Manipulating β_x at snake entrances to reduce horizontal depolarizing resonance strength. Measure horizontal polarization profile with various settings. (Kevin)
- Spin echo experiment at low energy in the AGS. (Mei)

AGS E880 Polarimeter

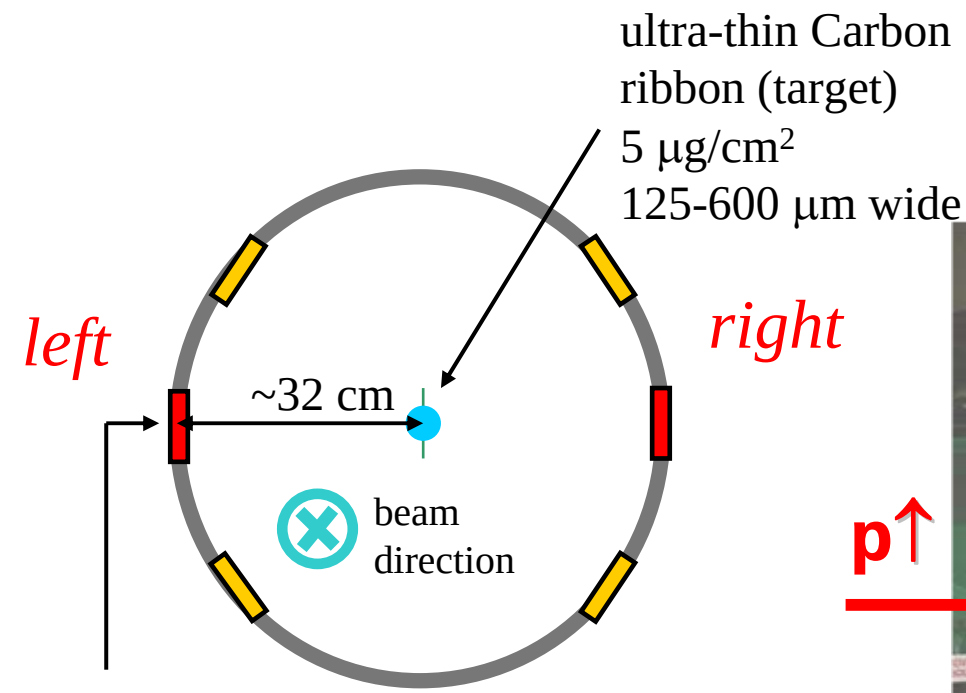
$P=\varepsilon/A_N$

- Quasi-elastic *pp* scattering
  p- + C -> p + p + X
  at $t \sim -0.15\ \mathrm{GeV}^2/c^2$
- Approximately symmetric recoil telescopes of plastic scintillation counters
- Targets are thin fiber ribbons and nylon (fishline).
- For absolute calibrations forward scintillators were added, but limited to 7GeV/c.
- Use a fit to pp polarization data to find A_N (pp).

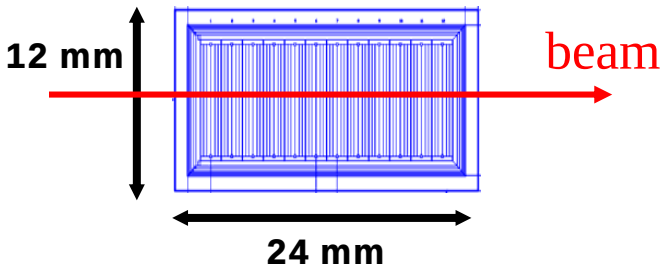


Three forward counters each side of the beam, outside the beam pipe.

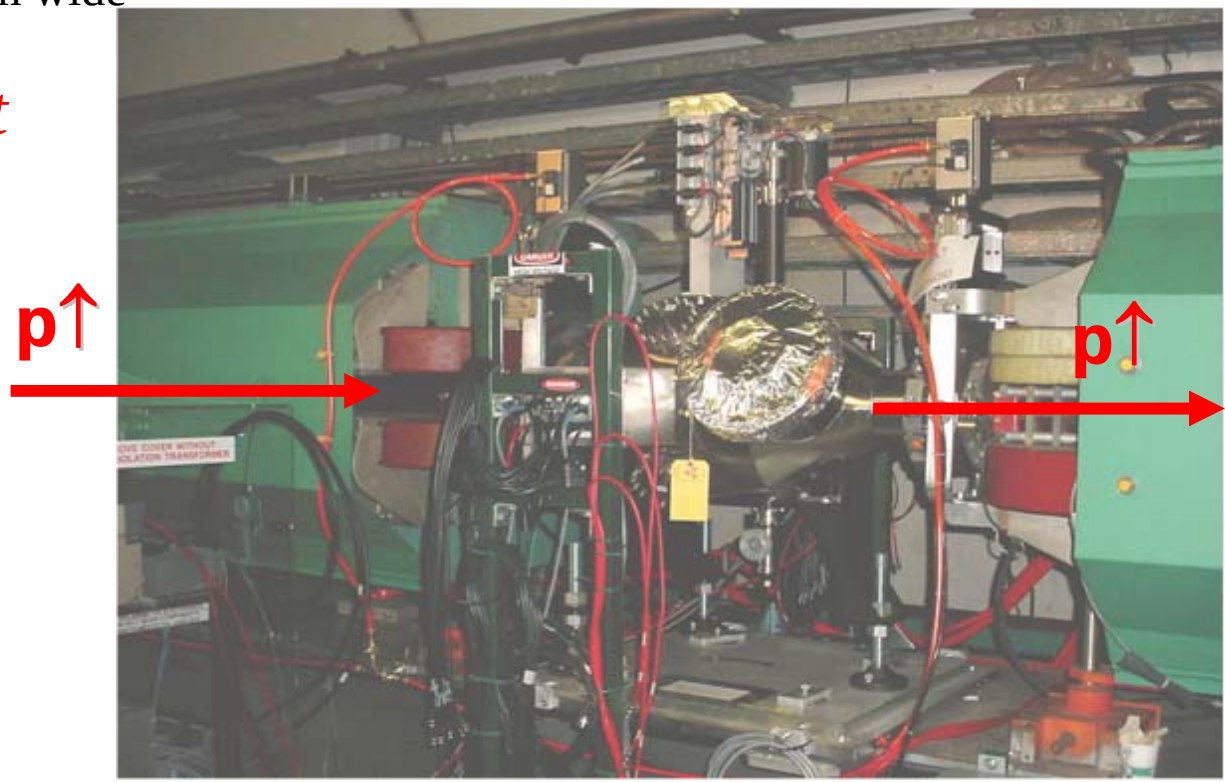
pC CNI Polarimeter in the AGS



Si strip detectors
12 vertical strips



read-out with
waveform digitizers

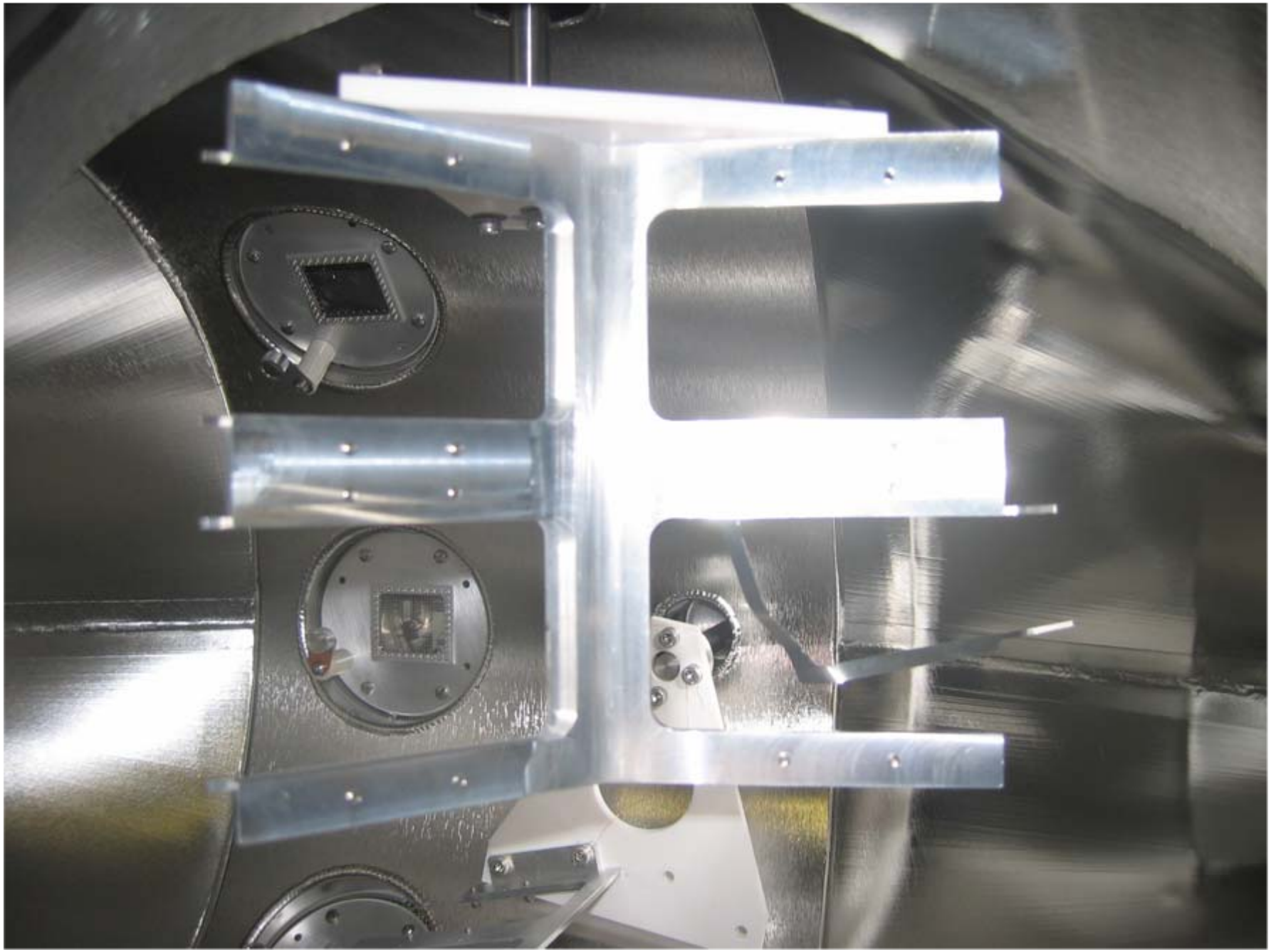


$$P=\varepsilon/A_N$$

AGS Polarimeter Upgrades

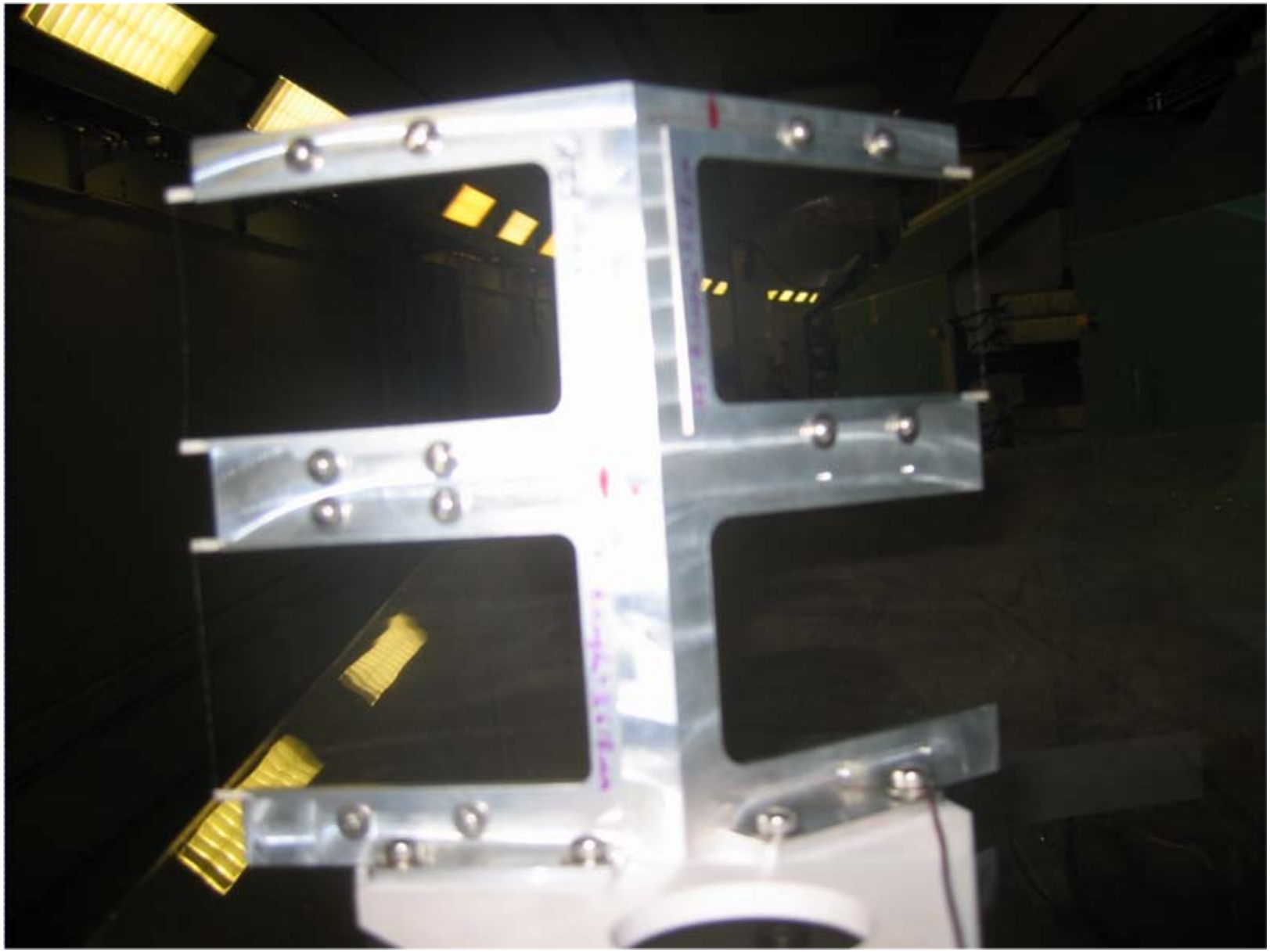
- CNI polarimeter mechanical drives have been upgraded to get smoother motion. (not seen the improvement)
- The target holders have been modified to have clearance between vertical and horizontal targets.
- The target holder mounting is also changed to give better position accuracy.
- E880 polarimeter target control has been upgraded to VME based interface. This established remote control capability.

Old AGS CNI Polarimeter Target Holder



New AGS CNI Polarimeter Target Holder

AGS CNI Polarimeter Targets



Carbon Event Selection

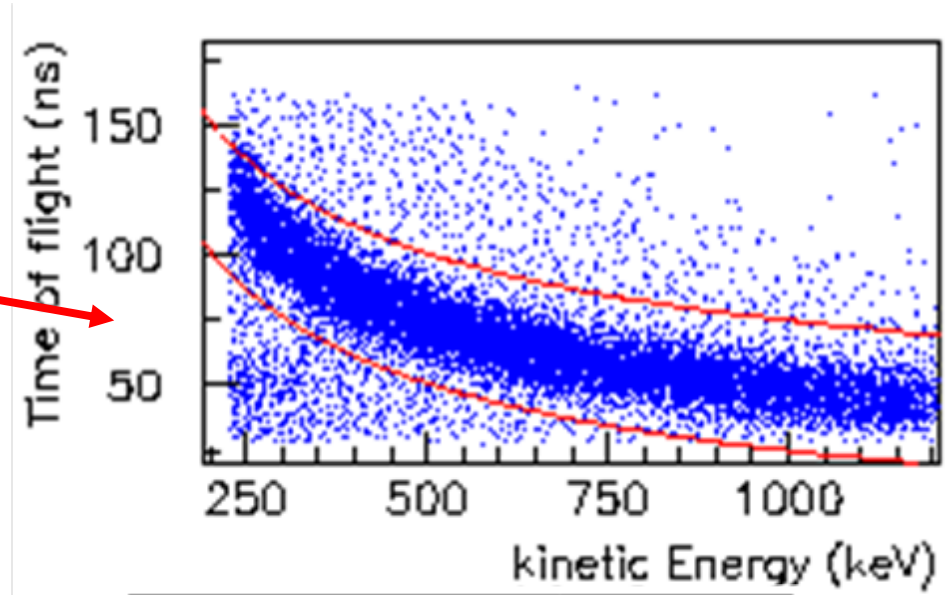
$T_{kin} = ½ M_R (dist / ToF)^2$

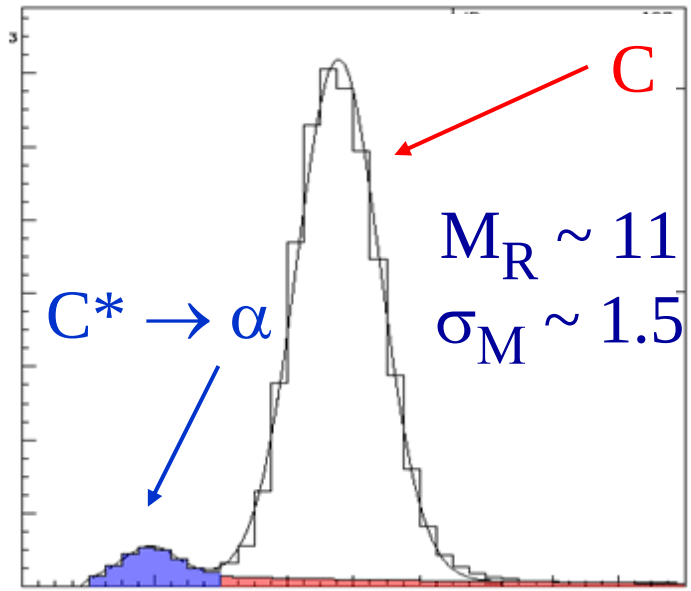
non-relativistic kinematics

- recoil carbons detected with Si detectors
- "identified" via ToF vs T_{kin} correlation ⇒ inv. mass recoil gives only "particle ID"

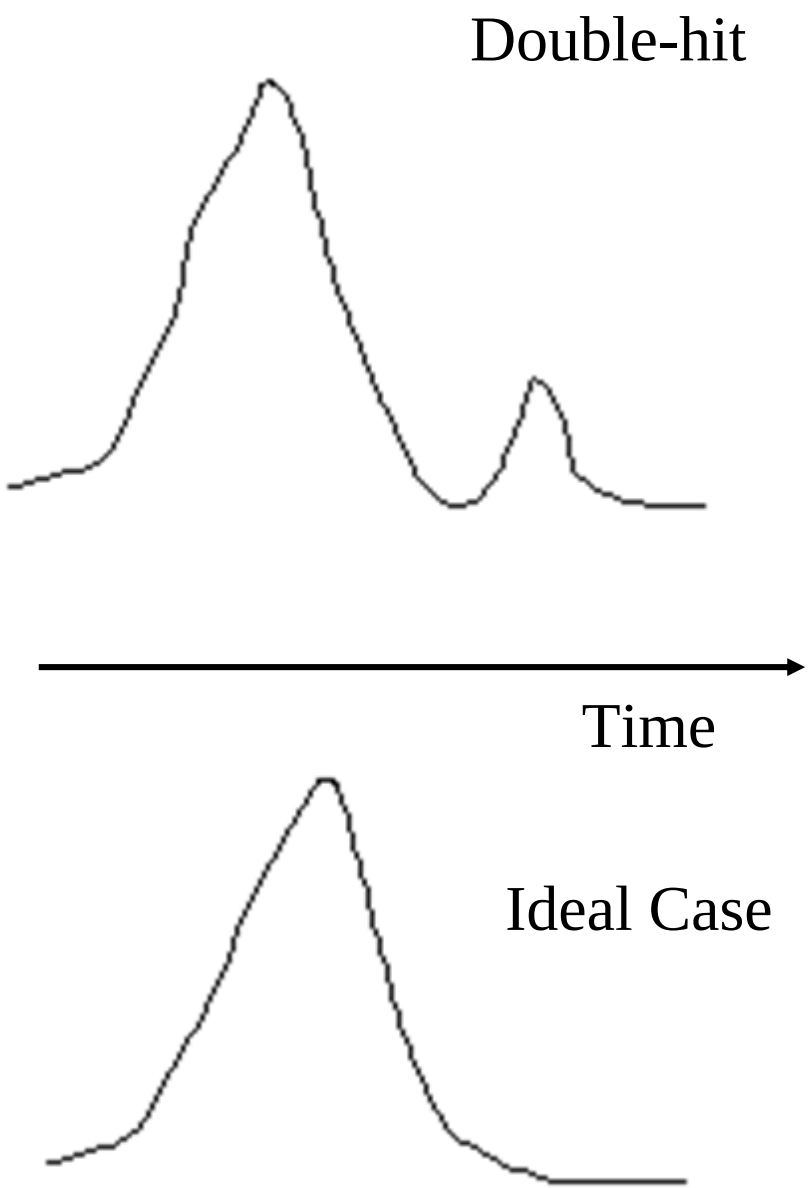
  Δ (Tof) ~ 20 ns from bunch length

  (⇒ σ_M ~ 1.5 GeV)
- background events < few % within the "banana" cut
- very high event rate (> 10^5 ev/sec/ch)



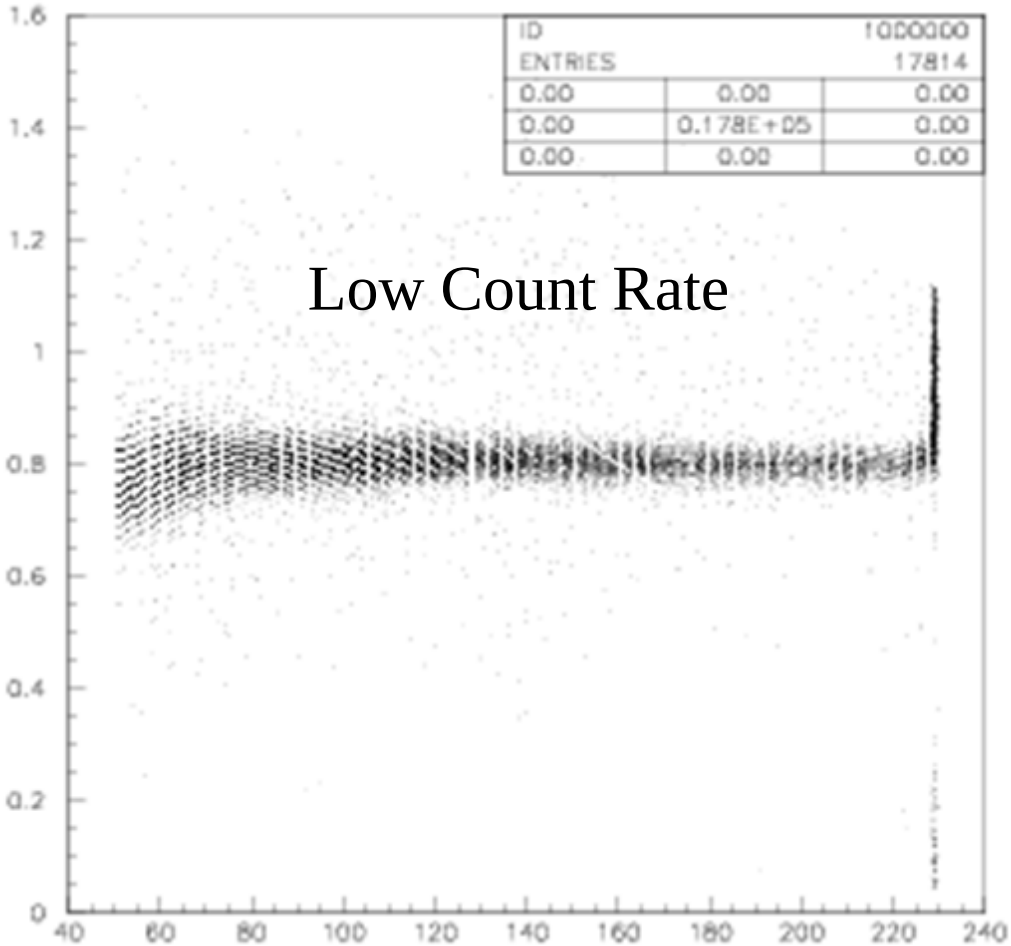


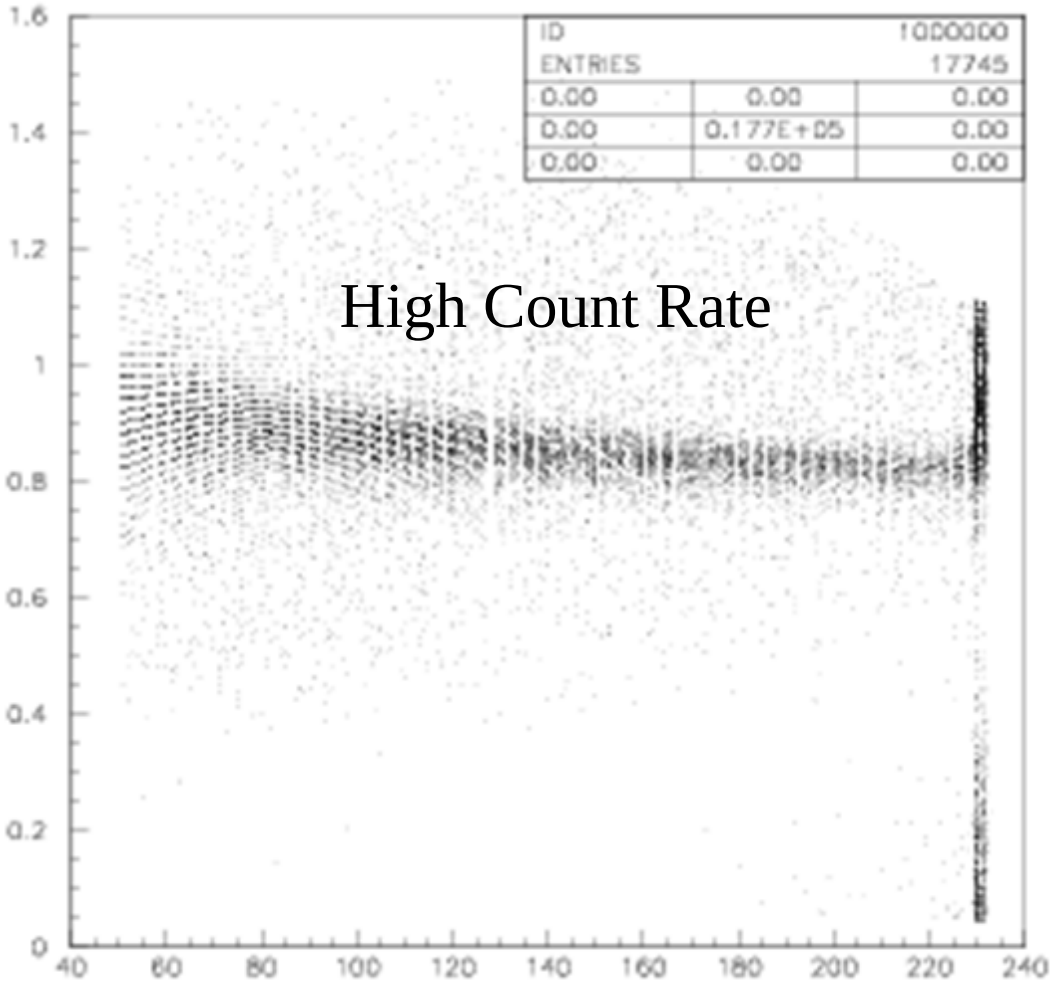
Double-hit in Si Detectors



- The waveform is digitized, the ToF and energy of each event is recorded.
- Double hit (two events in one detector strip for each bunch crossing) is always a concern for high rate. It can change the measured asymmetries.
- Double-hit can be detected by comparing the pulse amplitude and integration.

I/A Ratio vs. Amplitude (Energy)





- Initial test in run6 for $2*10^{11}$ intensity with 250μm and 600μm targets, respectively.
- The ratio is constant for low rate, but not the high rate.
- Two possible problems with high count rate: double hit and baseline calculation.

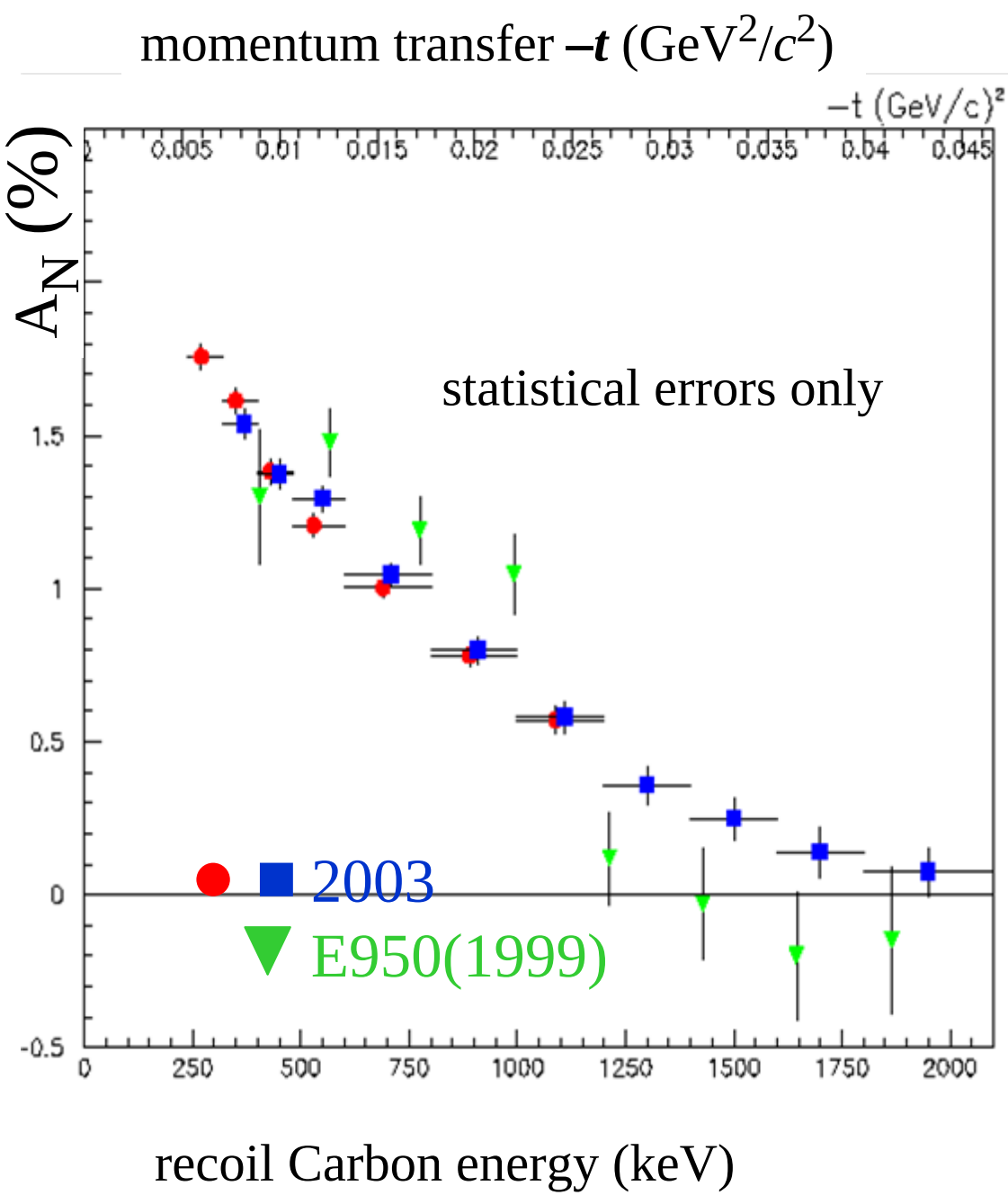
AGS CNI Polarimeter Rate Dependence

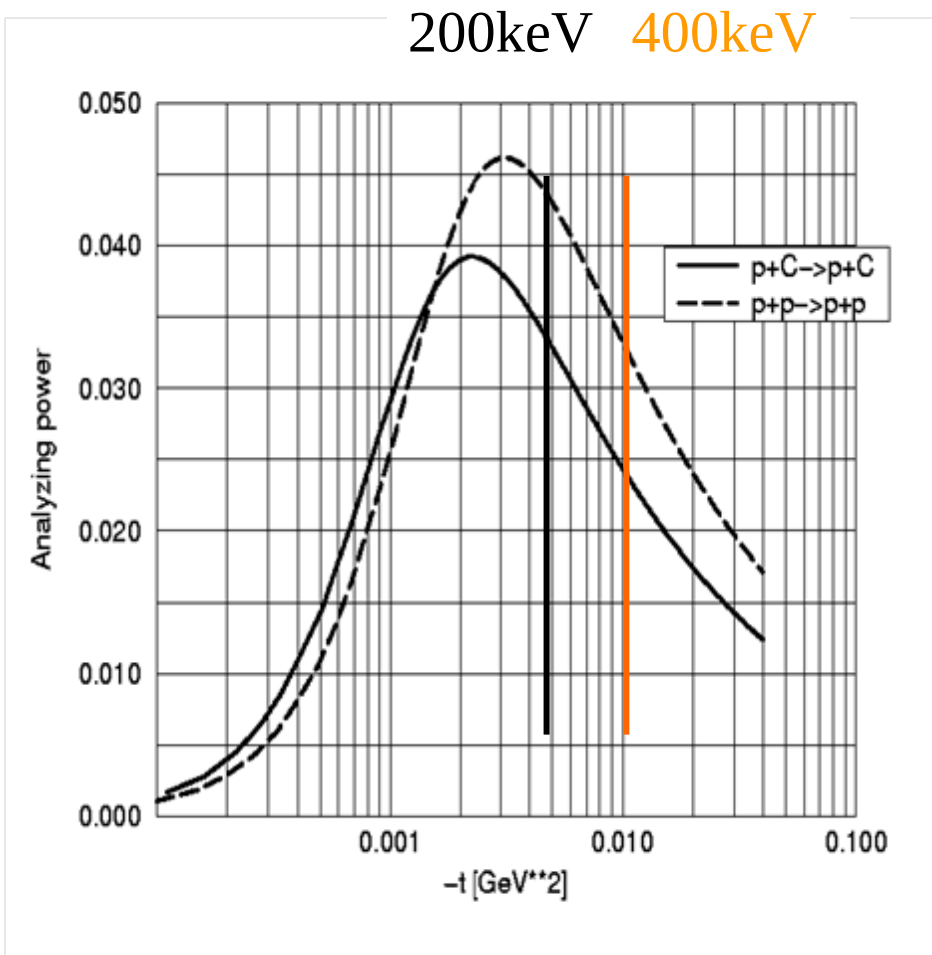
- The past data already shown that 600μm Carbon target can cause rate problem with intensity higher than $1.5*10^{11}$.
- This study is aimed to further quantify the effect.
- Measure polarization for the same beam using targets with different width.
- Measure polarization with one target for various intensities (intensity scan).
- We have currently targets with three widths: 600μm, 250μm and 125μm.

New Detector Test for the CNI Polarimeter

- Problems with the existing Si detectors:
  - Not commercially available. Made at BNL instrumentation division.
  - Dead layer thickness varies. Due to the dead layer, the very low energy Carbon particles (with high asymmetries) can not be detected. The lowest energy it can reliably detect is ~400keV.
  - The very high rate due to large cross section forced us to use ultra narrow targets which are fragile and hard to make. In addition, it is hard to mount such a target tight and straight.
- New detectors: Hamamatsu photodiode arrays (32 channels with 0.4mm width instead of 2mm).
  - Commercially available ($150/array).
  - Uniformed dead layer and capable of measuring recoil carbons at energy ~200keV.
  - Smaller detector strips allows higher rate.

A_N ($p\uparrow C \rightarrow pC$) at 21.7 GeV





Lower recoil energy means better accuracy of polarization measurement

New Detectors Test for the CNI Polarimeter (2)

- Advantages to do it in the AGS:
  - We have extra detector space at 45 degree detector ports.
  - "Easier" access to vacuum here.

Plan:

1. Measure asymmetry (symmetrically placed at +/- 45 degrees) simultaneously with the ordinary strips detectors.
2. Use wider target in order to study rates dependence and the multiple scattering corrections.

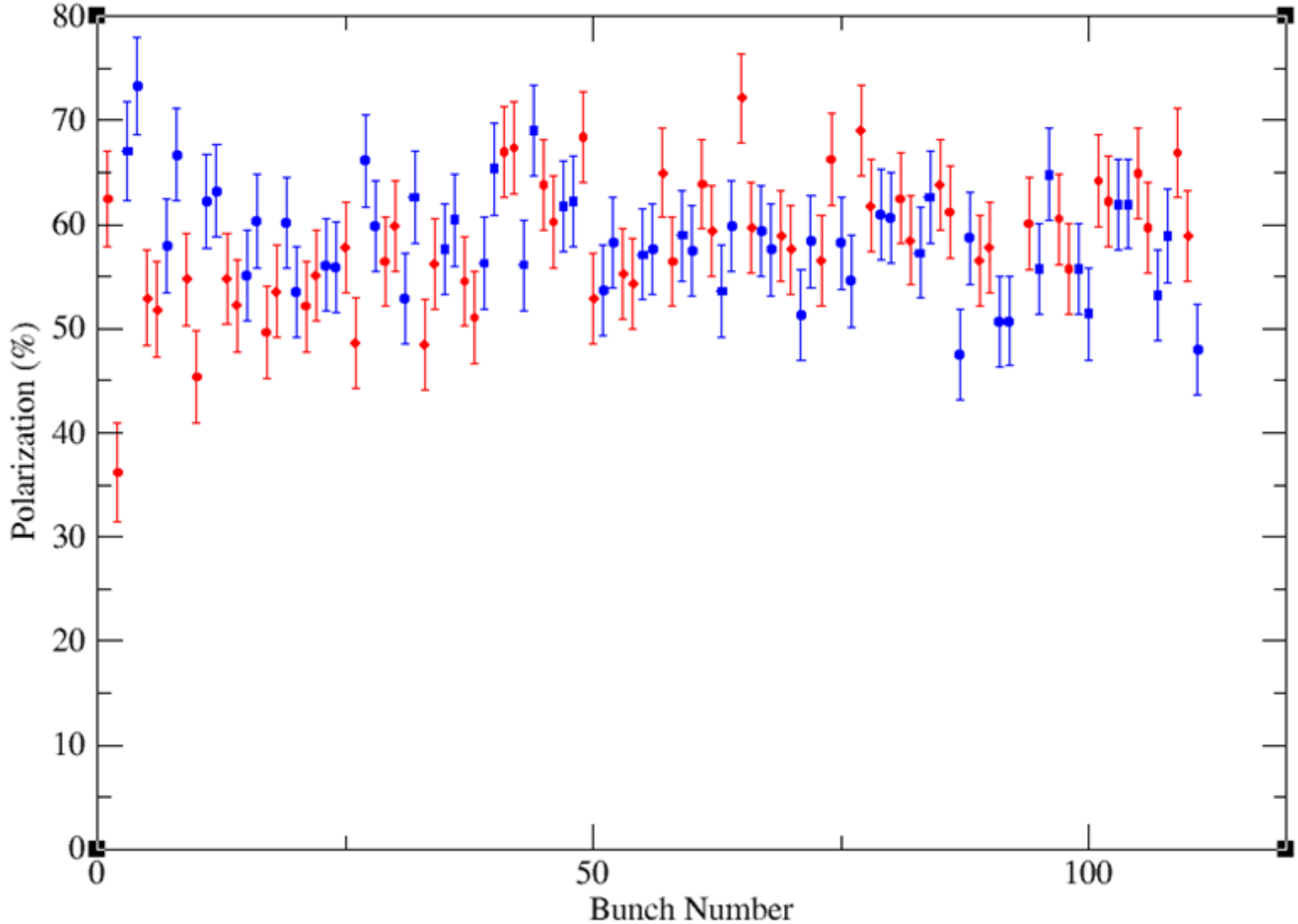
Status:

1. New signal cables have been pulled.
2. The detector arrays have been ordered.
3. Some new electronics will be added in the counting house.
4. Expected to be ready during pp run.

Polarization of each bunch with high accuracy

- Determine if there is any short time (shot to shot) variation in the AGS which caused the polarization fluctuation.
- Only RHIC can provide long measuring time to get small error bar for bunch polarization.
- This experiment is a mixed one involved both AGS and RHIC. The polarization measurement will be done in RHIC while many other beam parameters (emittances, orbits) will be documented in the AGS and AtR.
- It has been done in run6. The data taken does show a stable AGS (Variation of emittances and intensity are less than 10%).
- Another two hours experiment with intensity $1.5*10^{11}$ can reduce error bar by half.

Polarization vs. Bunch Number



Averaged over 420 million events. Error bar for each bunch is 4.7%. Data taken in 20 minutes with $110*1.4*10^{11}$ at injection.