AGS Spin Related Experiments

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Motivation

1. Usually, the AGS operation is behind RHIC store, so we don't need to request beam time for accelerator physics experiment. In the past, the AGS was commissioned all the time.
2. However, there are advantages to discuss and plan the APEX activities beforehand:
    1. As the AGS pp set up becomes "routine" in the near future, commission will not be running all shifts, which leaves the door open for accelerator physics focused experiments.
    2. With experiment plan discussed and prepared beforehand, c better chance for success.
    3. Specifies people involved, another motivation for more publications.

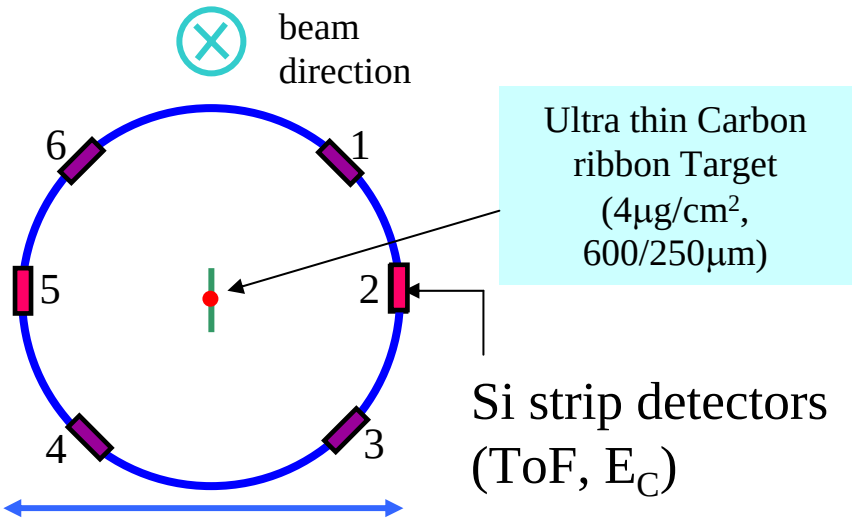
Cold Snake Summary

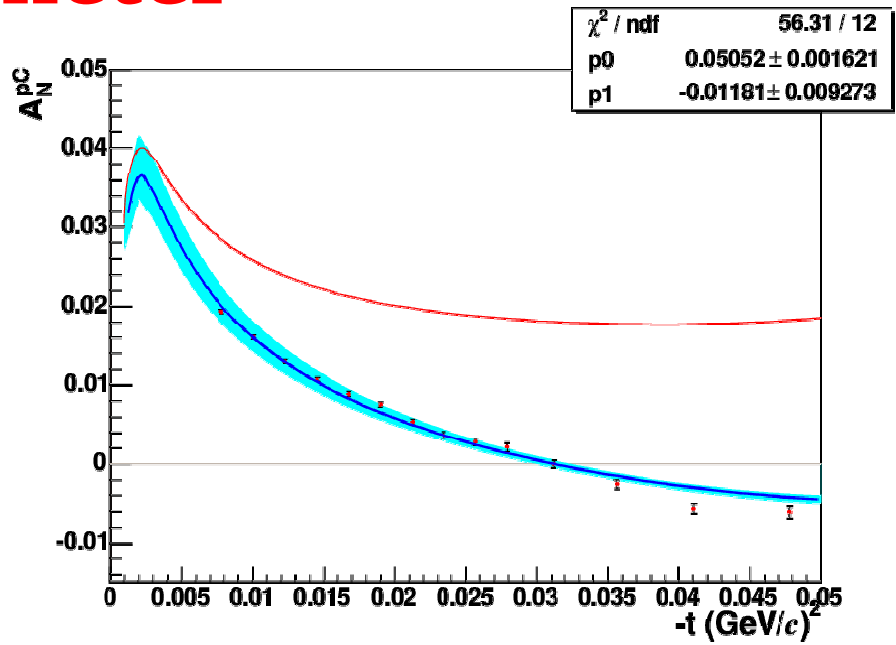
- The multiple strong snake idea works. The vertical tune actually can be set to very high value (>8.98). The polarization level has reached 60% equivalent at AGS extraction.
- The spin dynamics is understood: various polarization vs tune measurements (at different resonances and at different energies) behave quantitatively as expected. There may be a few percents loss due to tune not high enough.
- Possible horizontal resonance effect is also explored. Flattop B-field scan with warm snake only and cold snake only shows that the strength of horizontal resonance is smaller than the strength of general intrinsic resonance. The upper limit of the total effect of horizontal resonances is extracted from horizontal profile as a few percents.

Two major subjects in the coming AGS study:

1. Need more study to quantify horizontal resonance effect.
2. Is there intensity dependence in polarimeter?

AGS *pC* CNI Polarimeter

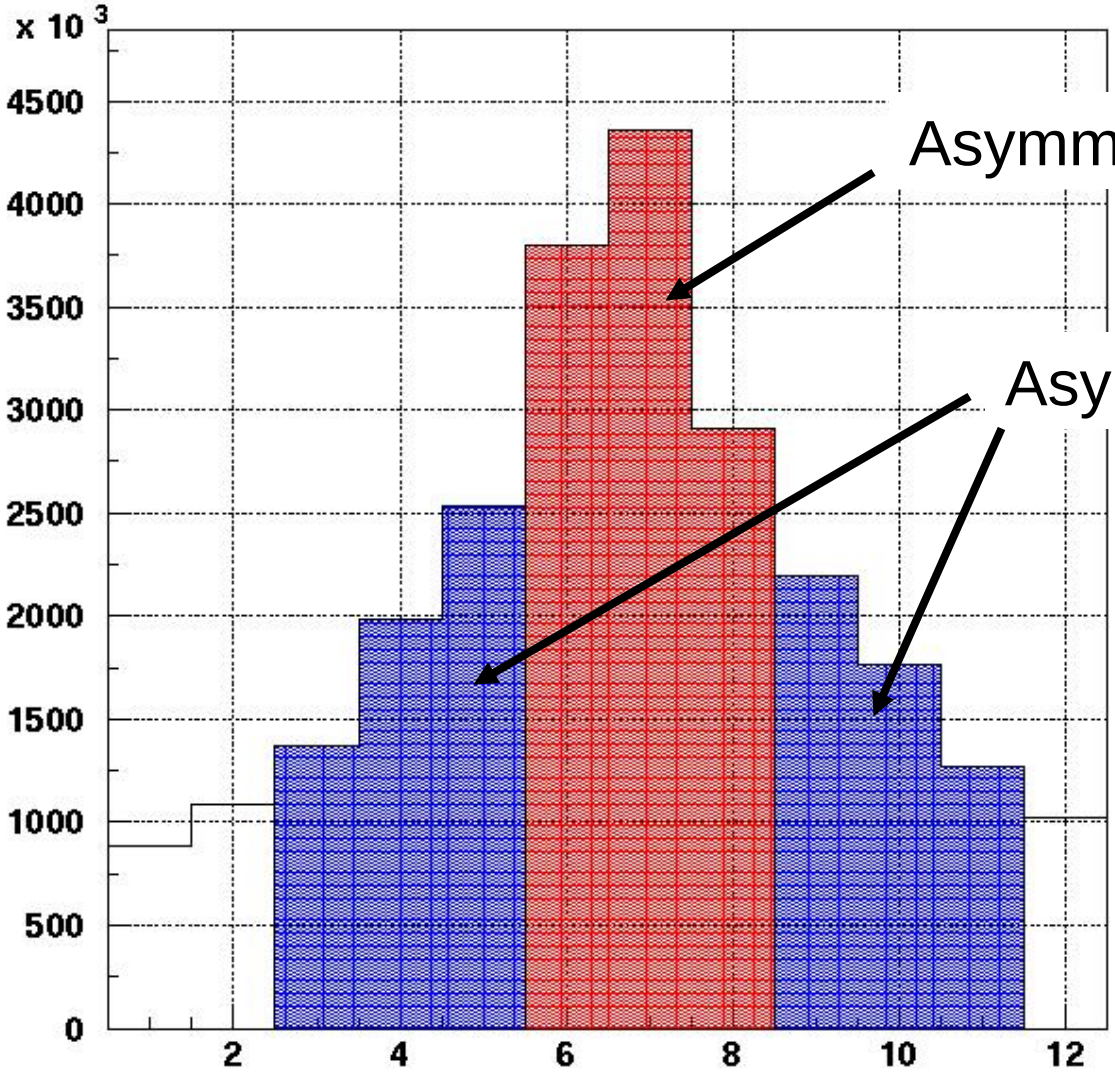




$$P_B = -\frac{1}{A_N} \cdot \frac{N_{left} - N_{right}}{N_{left} + N_{right}}$$

Even though we are using the same Si detector design, same A_N, RHIC injection measured 10% higher polarization. The only difference is carbon target width. This difference is not easy to solve just by working on AGS polarimeter.

Compare Central and Outer Strips (last run)



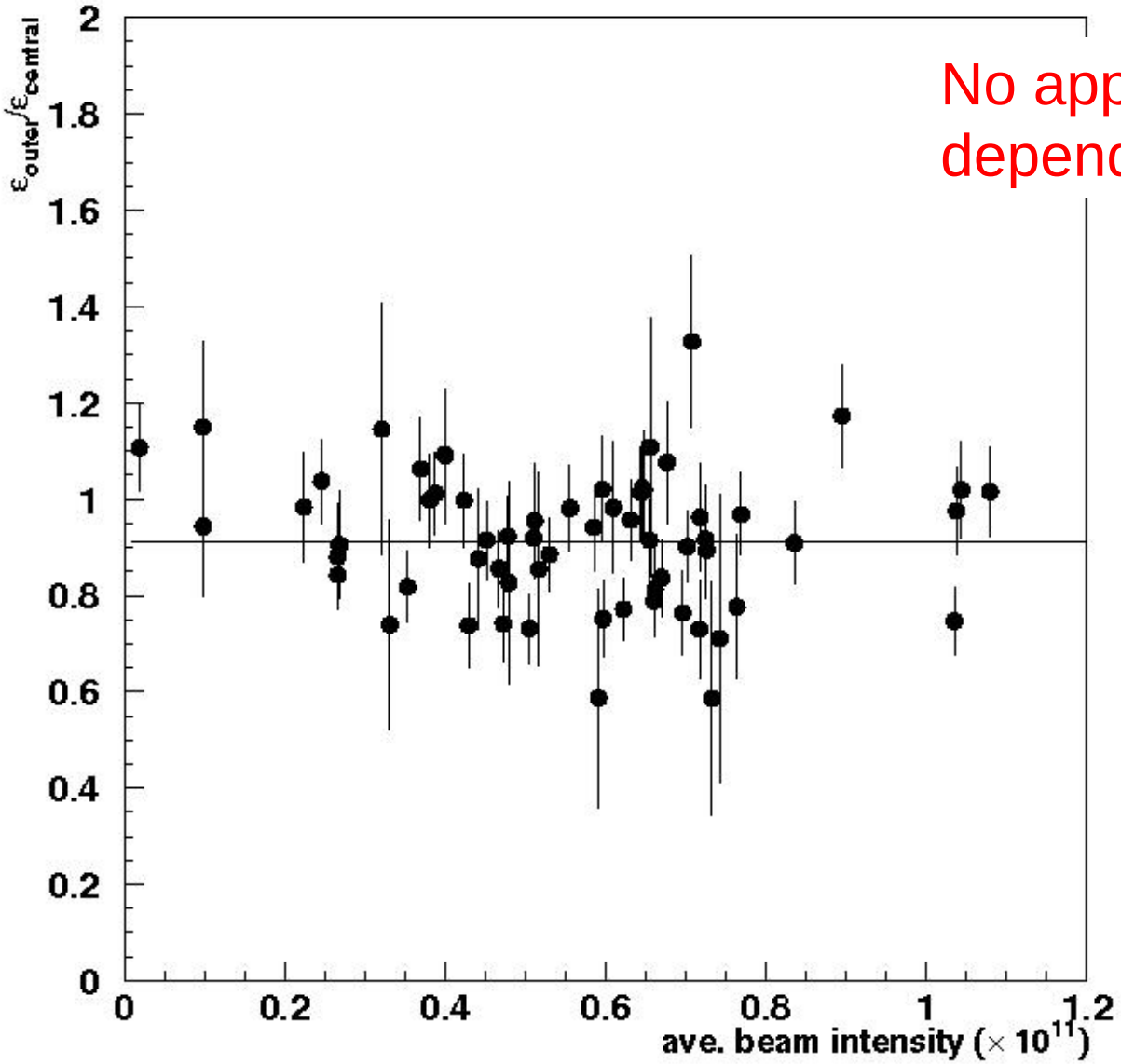
Asymmetry Central, $\varepsilon_{central}$

Asymmetry Outer, ε_{outer}

calculate $\varepsilon_{outer}/\varepsilon_{central}$

$\frac{\text{rate outer}}{\text{rate central}} \approx 60\%$

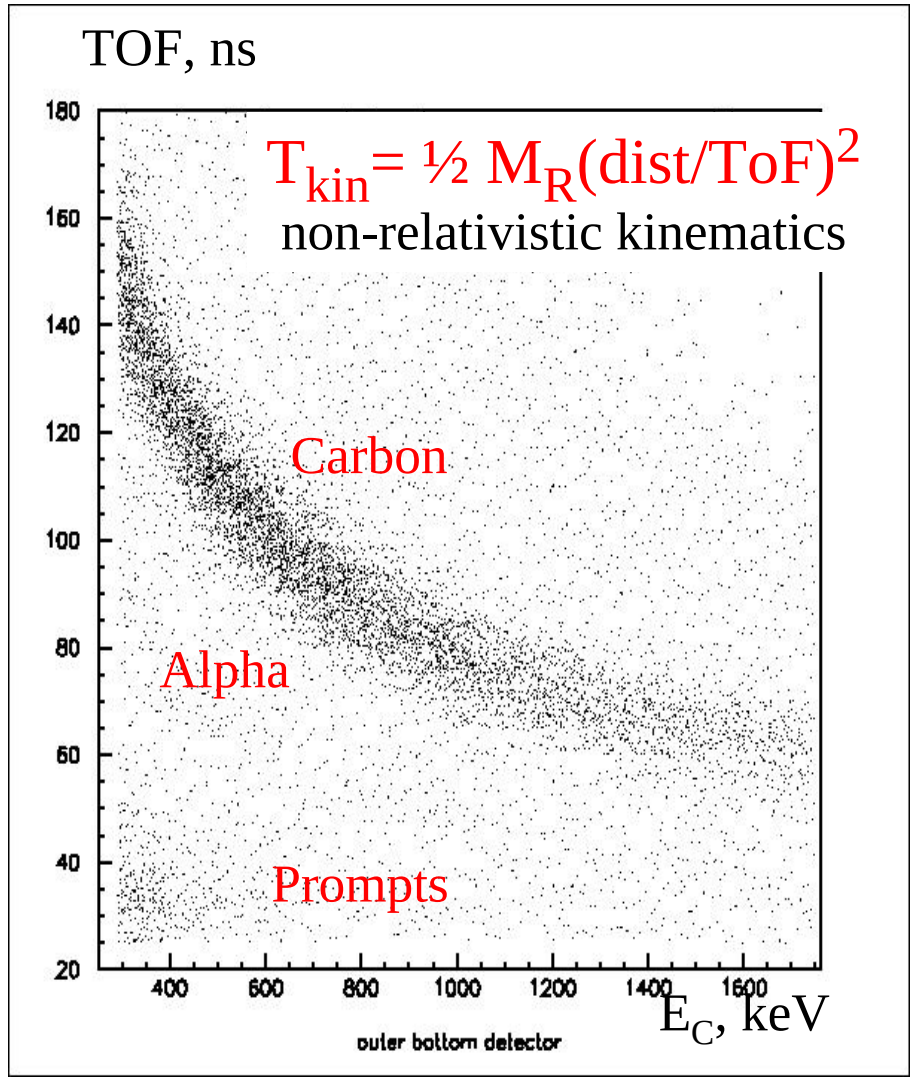
$\varepsilon_{outer}/\varepsilon_{central}$ vs. Intensity



No apparent intensity dependence

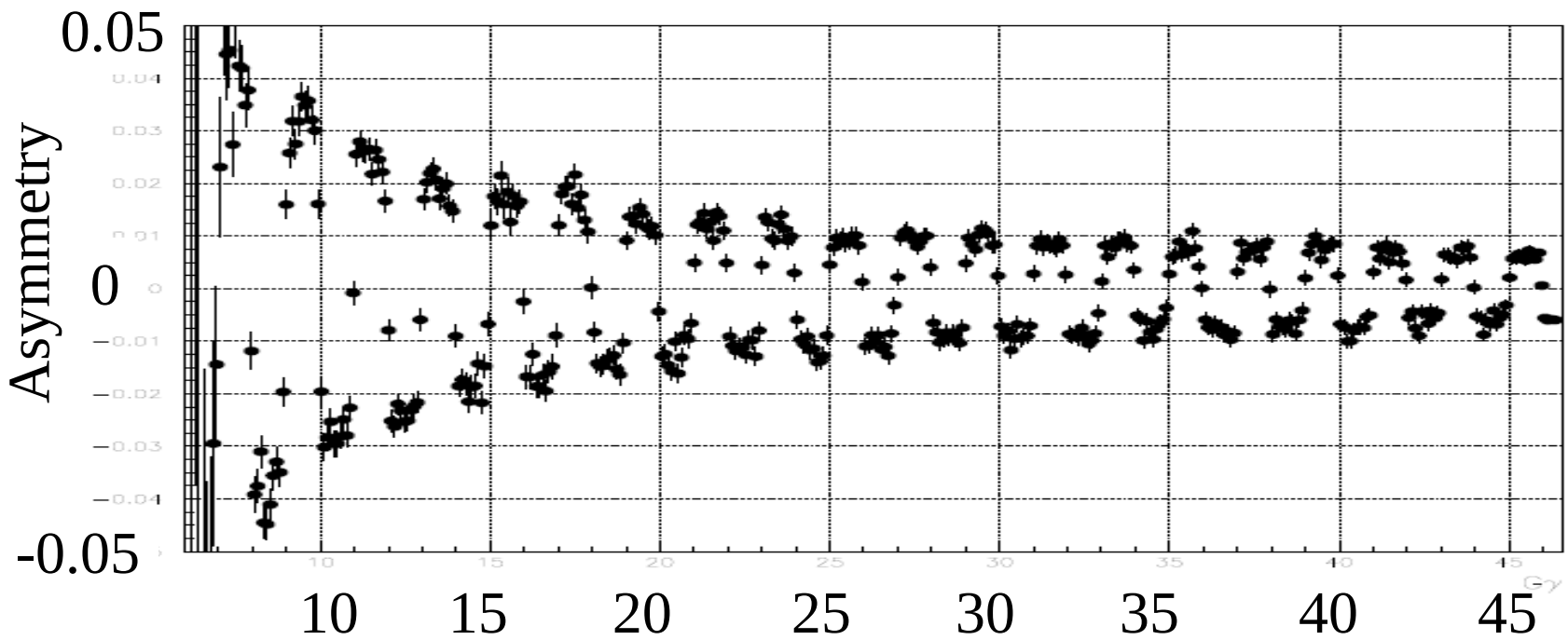
AGS Polarimeter Intensity Dependence?

- Large prompt events are gated out but they still hit Si detectors and could cause sagging effect on the detector's response.
- To evaluate the effect, we will run the polarimeter in a special mode to record all raw event pulses with various intensities.
- Measure polarization with difference target widths (600/250μm).

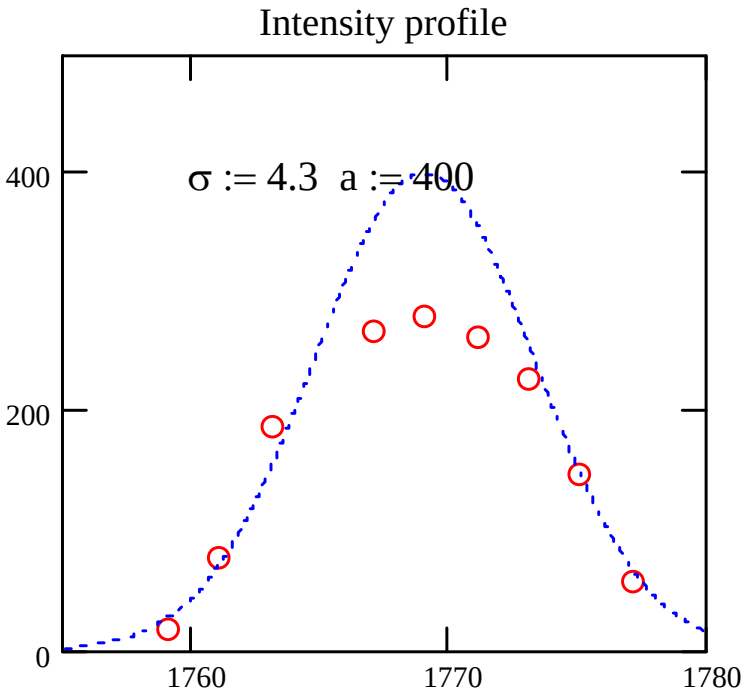


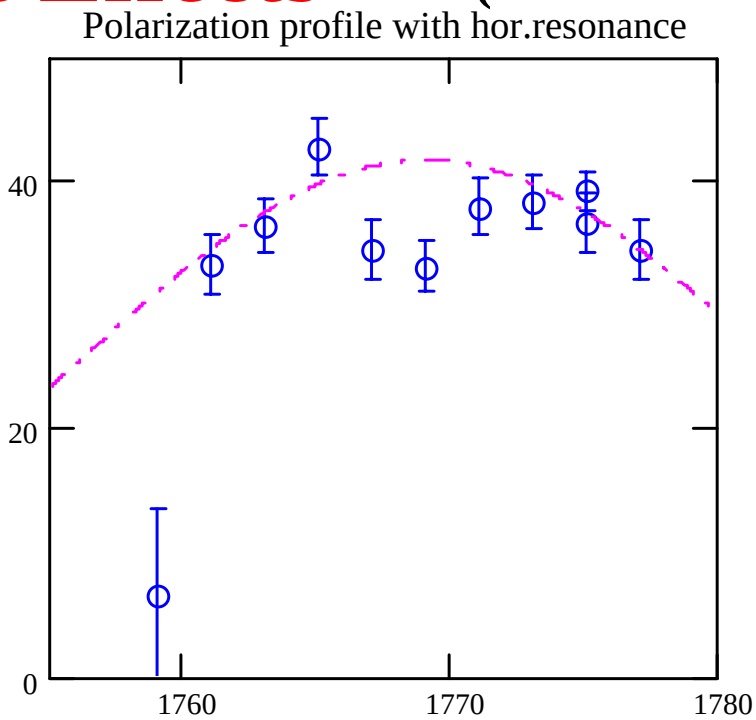
Ramp Polarization Measurement

- Ramp measurement: The strong snake introduces a measurable radial component. This will be the first time we can measure both vertical and radial components along the ramp. Since partial snakes flips spin every 0.5GeV, this added component could tell us more on the polarization loss along the ramp.



Horizontal Resonance Effects (from T. Roser)

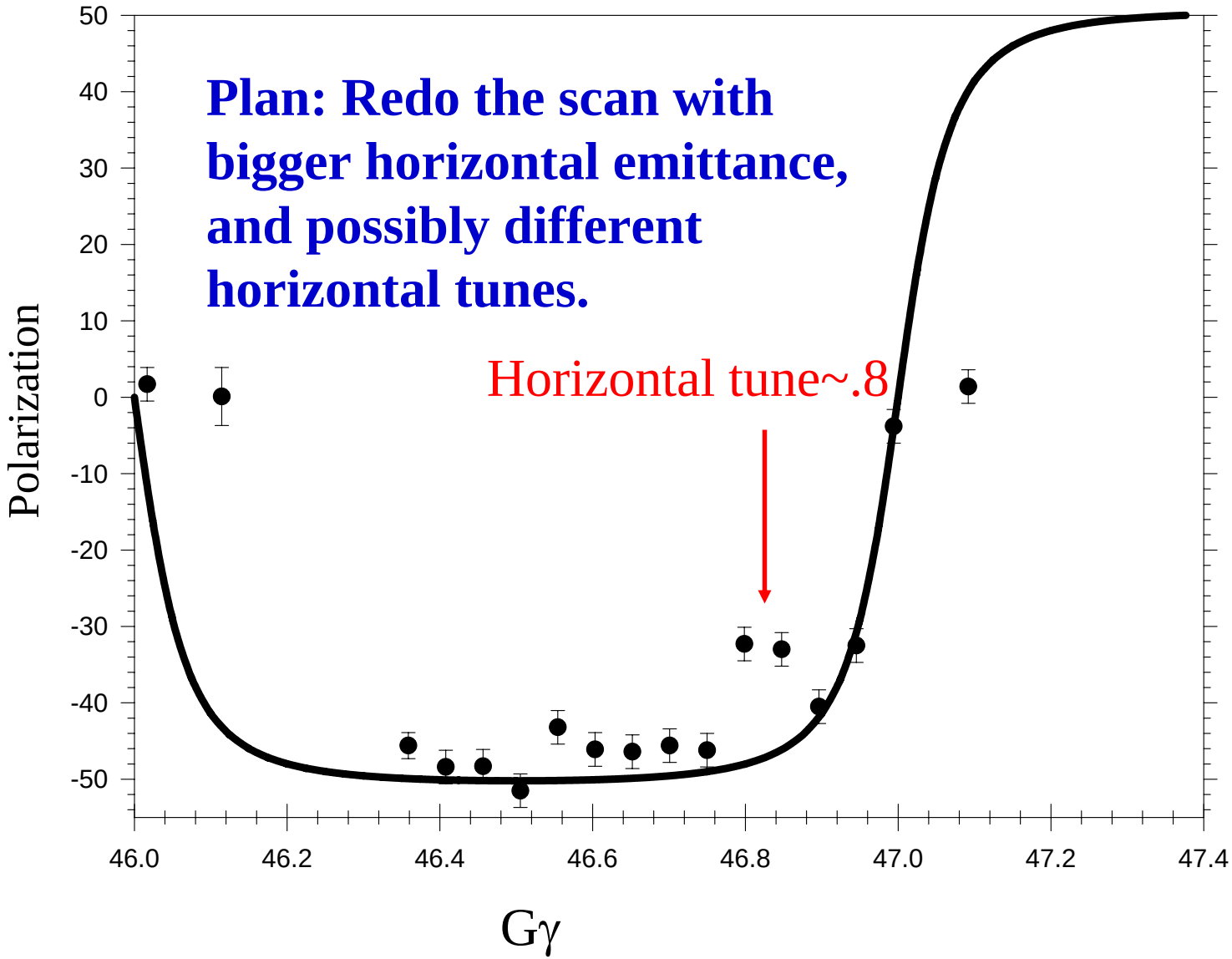




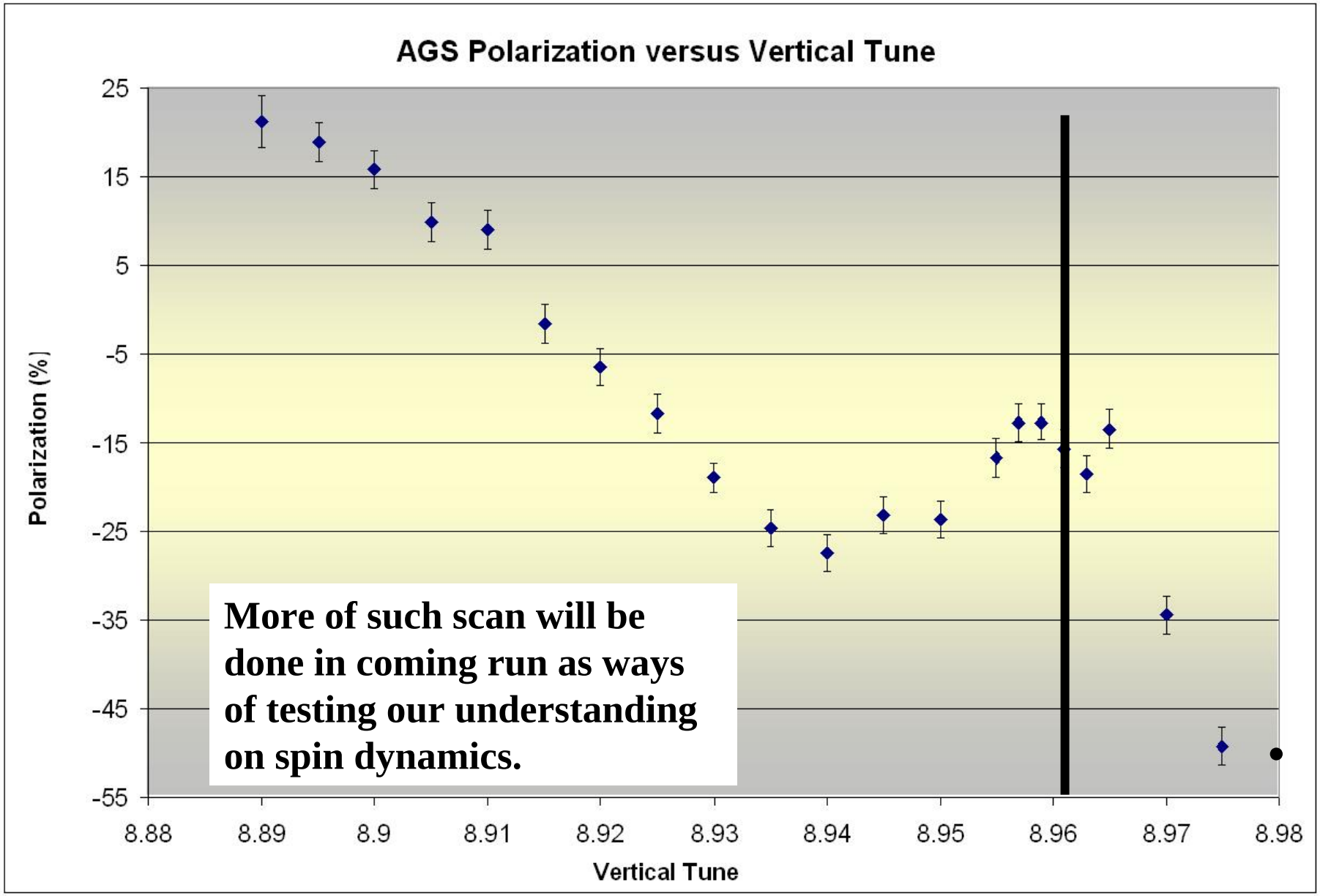
The polarization profile can be fitted as a flat line or a profile. Assuming the profile is real and is due to horizontal resonance effect, one can set the upper limit of the horizontal resonance effect from 84 horizontal resonances. It is about 5% in the relative scale.

More systematic study will follow this year: with different bunch intensity, emittance. The horizontal target will make horizontal polarization profile measurement possible.

Field Scan (2T CSNK+1.5T WSNK)



Vertical Tune Scan at Gγ=36+

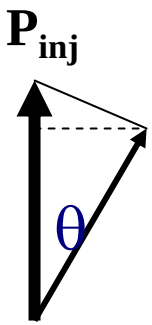


Backup Slides

Polarization at Injection

CSNK(2.5T)	WSNK	Asymmetry	Ratio	Expected Ratio
off	on	65.0+-0.8 $*10^{-3}$		
on	on	61.1+-0.8 $*10^{-3}$	0.94+-0.02	0.924
on	off	58.8+-1.1 $*10^{-3}$	0.90+-0.02	0.895

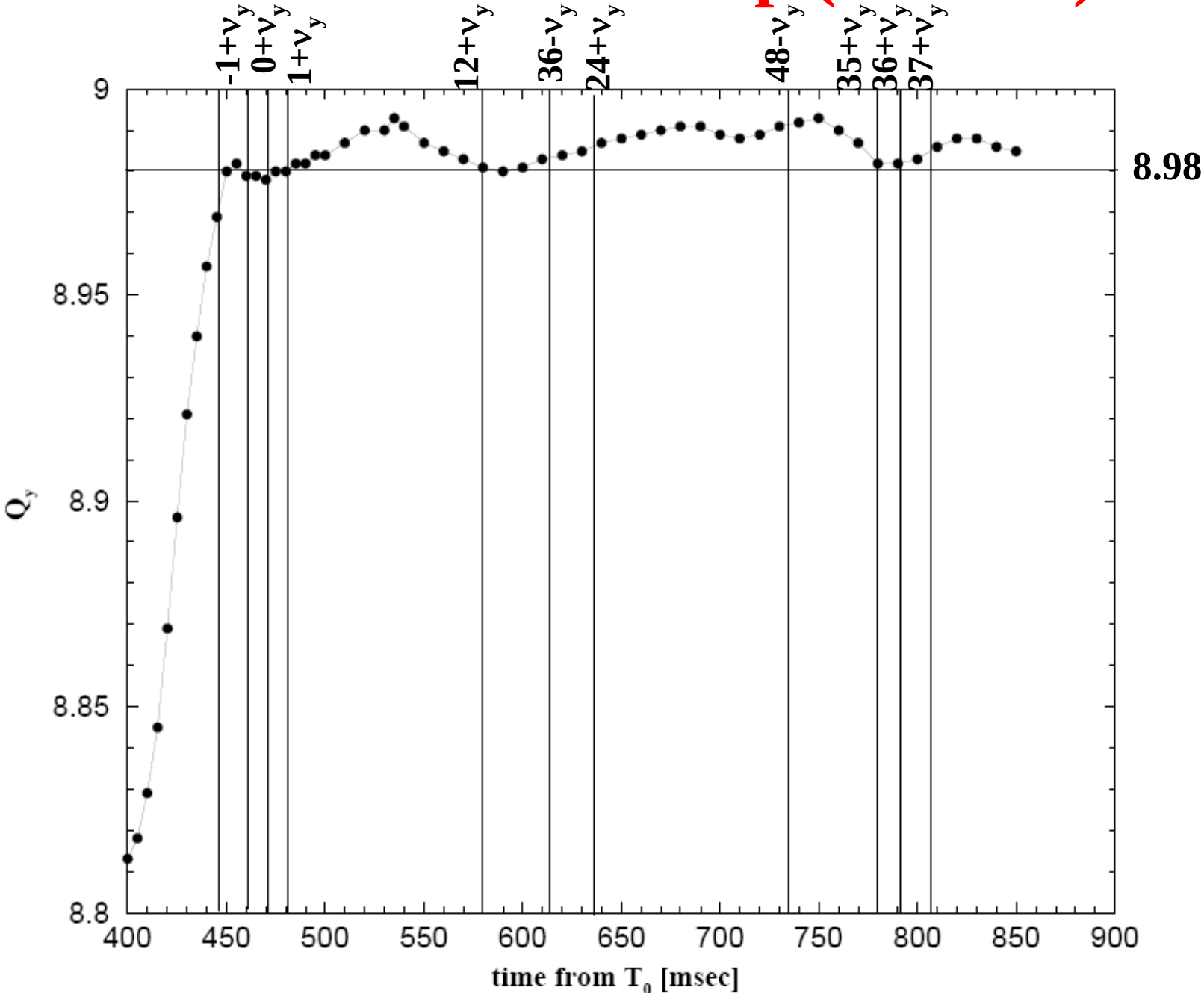
The stable spin direction is tilted due to stronger snake in the AGS. The ratio of polarization measured at injection with E880 polarimeter agrees with the expectation.



$$P_{mea}=P_{inj}*(\cos\theta)^2$$

The analyzing power is about 0.08, so the polarization with warm Snake only is about 80%.

Tune Measurement on Ramp (June 15)



Polarization Loss

	C2.5T	C2.5T,W1.5T[4]	C2T,W1.5T	AC dipole
Hori. res.[1]:	0.94	0.89	0.94	0.99
Low ν_y at 36+[1]:	0.95	0.95	0.95	1.00
Inj./Ext.:	0.915	0.967	0.994	0.987
Weak int.	1.00	1.00	1.00	0.85
Total[2]	0.817	0.818	0.888	0.830
Measured[3]	0.765	0.761	0.800	0.800
Expected at Ext.	0.86	0.86	0.93	0.83

1. The polarization loss due to horizontal res. and low ν_y at 36+ is given as the upper limit, especially in the two snake cases (total snake strength varies).
2. There is also possible loss at early part of ramp when vertical tune is outside the tune window. It is estimated no more than a couple percents but spin tracking will follow.
3. 80% source polarization assumed. There is still a factor of 1.07 is missing.
4. C2.5T,W1.5T provides wider tune window, preferred for stable operation.

Comparison

	C2.5TW1.5T	C2TW1.5T	C2.5T	AC dipole
ε_x (π mm-mrad)	12	11	13	25
ε_y(π mm-mrad)	13	15	13	10
Vert. aperture limit	No	No	Yes	Limited at 0+
Hori. aperture limit	Yes	Yes	No	No
C15 vs. Extraction	0.960	0.974	1.0	1.0
A_N too high	0.90	0.90	0.90	0.90
Meas. Max. Polarization	52.5%	56.4%	55.1%	57.6%
Expected Ext. Polarization	60.8%	64.3%	61.2%	64.0%
Difficulty	intensity	intensity	Raise Qy	0+ ν aperture

The expected ext. polarization is obtained from dividing meas. Max. polarization by the factors of A_N too high and C15 vs. extraction. CSNK15% is with four quads, which gets horizontal beta function under control, but vertical beta function fluctuation getting worse.