

Systematic studies
regarding multiple polarimeters
around the ring

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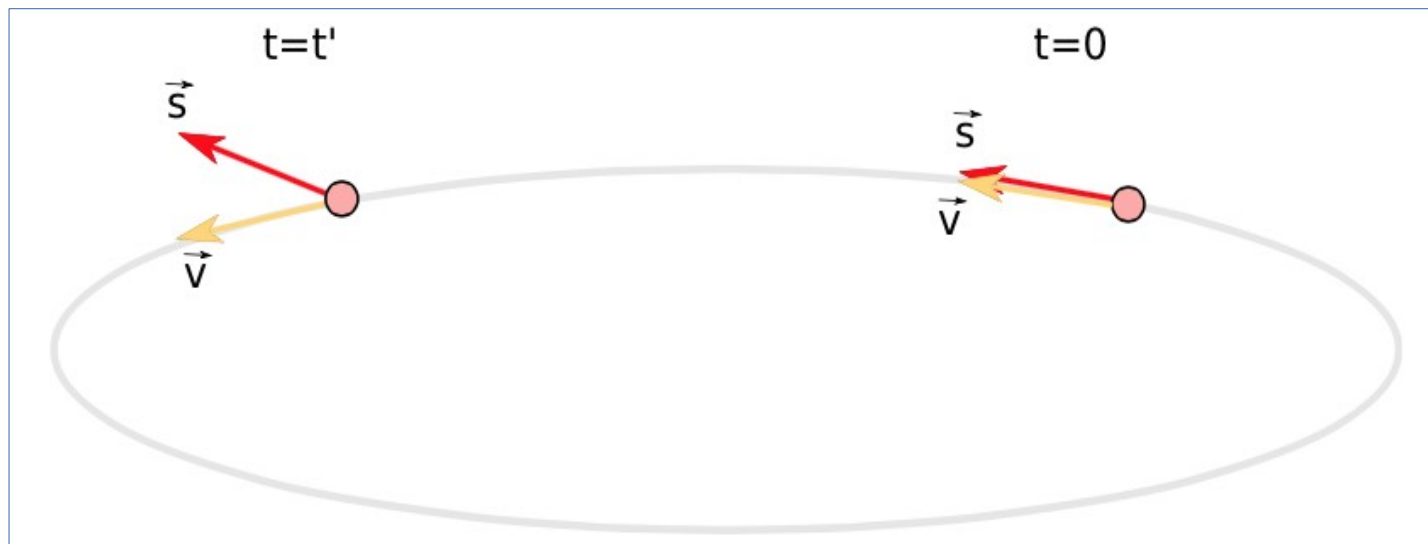
Overview

- The estimations are based on spin and beam tracking of one-particle.
- These are preliminary results. Not completely finalized.
- We plan to finish the studies by the end of the summer.
- Previous studies imply requirement of multiple polarimeters around the ring (srEDM)
- This talk focuses on some geometric phase effect as calculated around the ring.

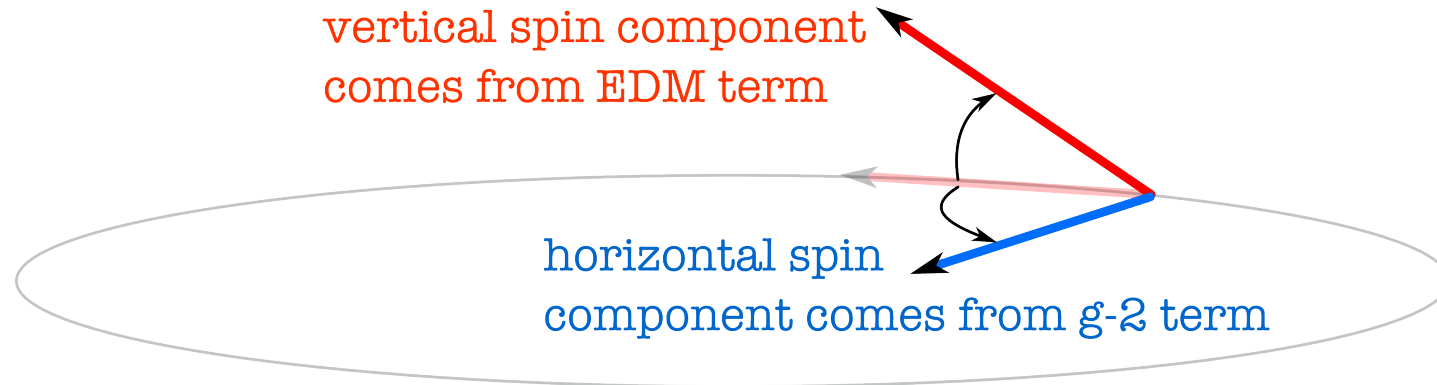
Storage ring method - 1

T-BMT Equation

$$\frac{d\vec{s}}{dt} = \frac{e}{m} \vec{s} \times \left[\underbrace{\left(\left(\frac{g}{2} - \frac{1-\gamma}{\gamma} \right) \vec{B} - \left(\frac{g}{2} - 1 \right) \frac{\gamma}{\gamma+1} (\vec{\beta} \cdot \vec{B}) \vec{\beta} - \left(\frac{g}{2} - \frac{\gamma}{\gamma+1} \right) \frac{\vec{\beta} \times \vec{E}}{c} \right)}_{\text{g-2 precession}} + \underbrace{\frac{\eta}{2} \left(\vec{\beta} \times \vec{B} + \frac{\vec{E}}{c} - \frac{\gamma}{\gamma+1} \frac{\vec{\beta} \cdot \vec{E}}{c} \right)}_{\text{EDM precession}} \right]$$



Storage ring method - 2



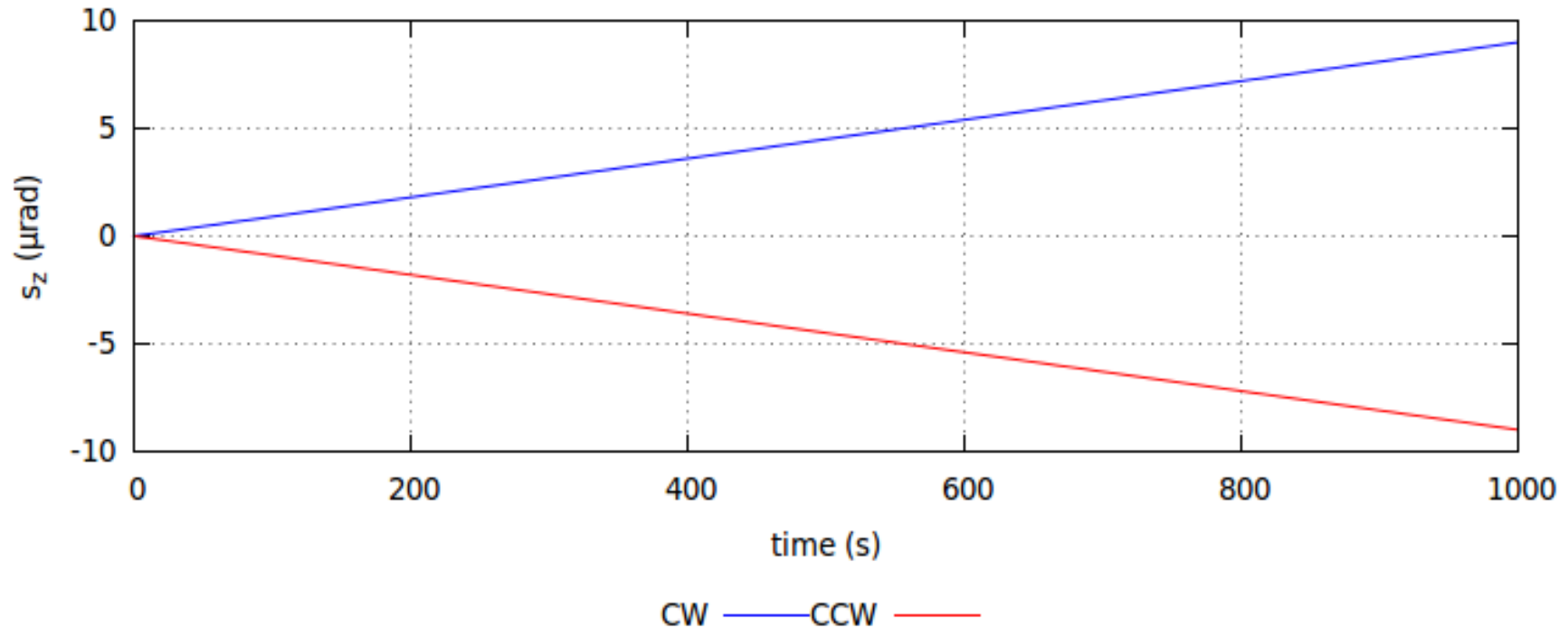
$$\vec{\omega} = \frac{e}{m} \left[\left(\frac{1}{\gamma^2 - 1} - \frac{g-2}{2} \right) \frac{\vec{\beta} \times \vec{E}}{c} + \frac{\eta}{2} \left(\frac{\vec{E}}{c} \right) \right]$$

Angle between spin and momentum
in the absence of B-field

$$= 0 \quad \leftarrow \quad \gamma_0 = 1.248, \quad p_0 = 0.7007 \text{ GeV}/c$$

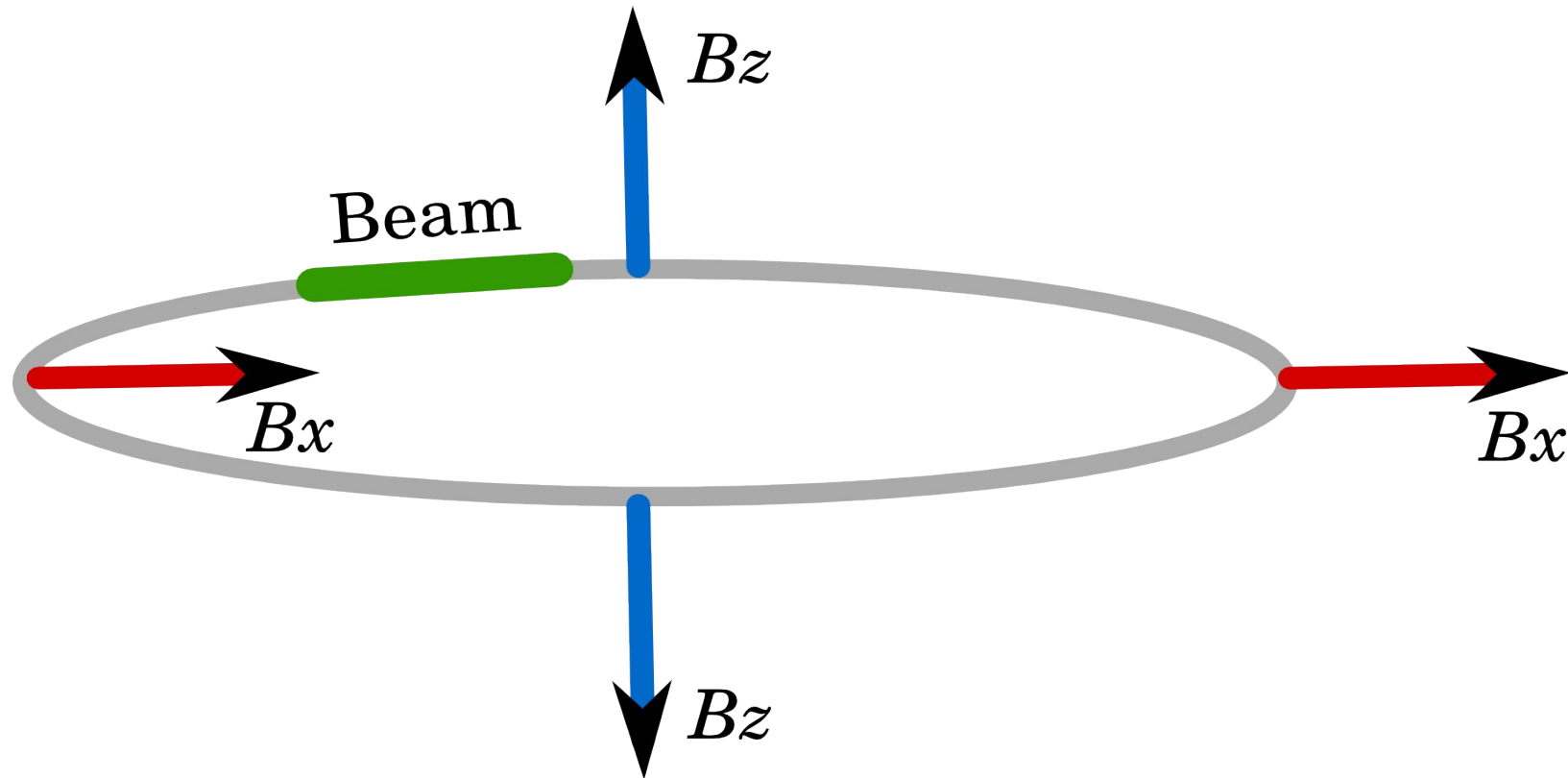
Magic momentum for proton

Vertical spin component



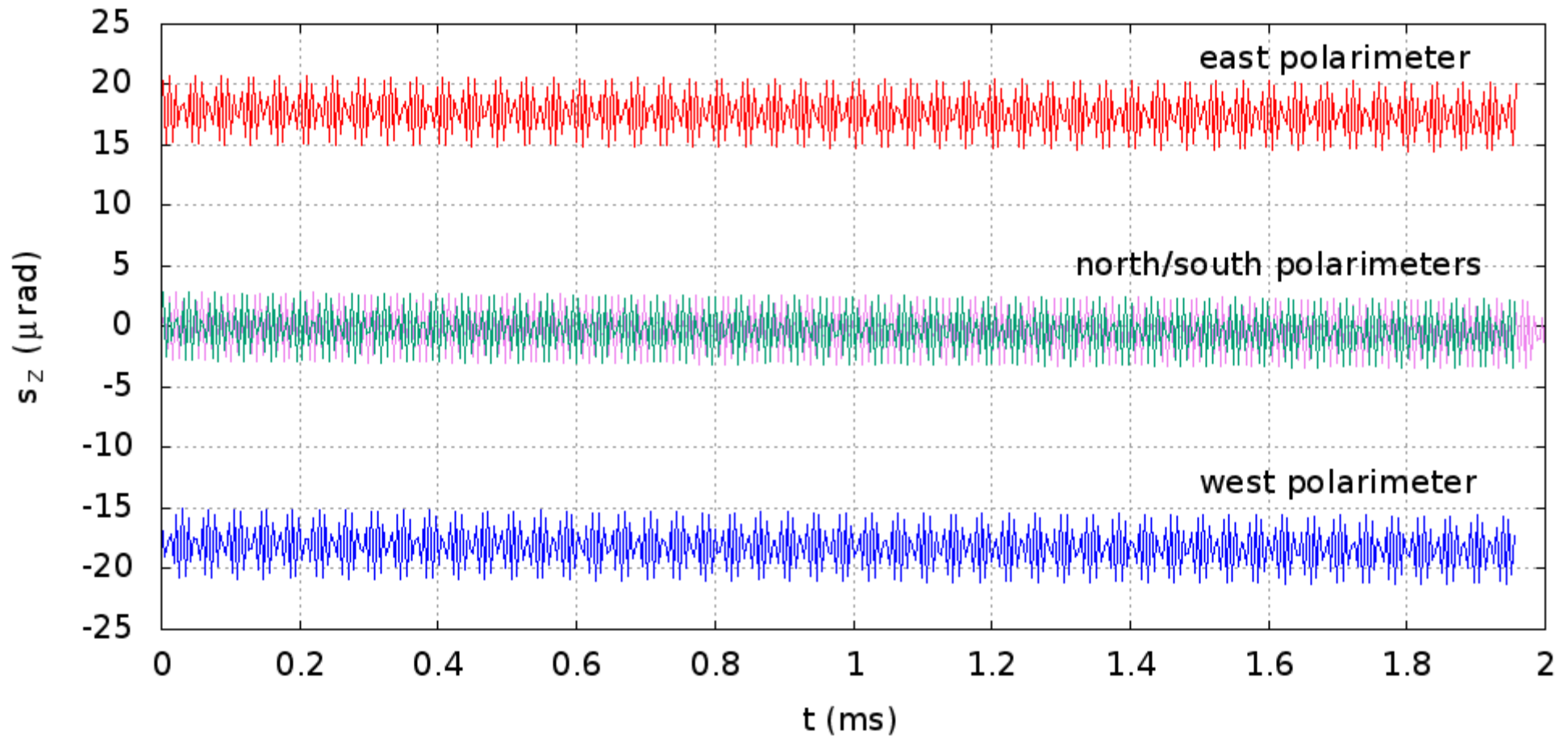
- 10^{-29} e.cm \rightarrow approx. 9 nrad/s vertical spin precession rate
- \mathbf{s}_z in opposite directions for CW and CCW
- EDM proportional to $\mathbf{s}_z^{\text{CW}} - \mathbf{s}_z^{\text{CCW}}$
 \rightarrow If some other effect leads opposite directional \mathbf{s}_z , it mimics EDM.

Geometric phase effect



- Originates from specific configurations of perpendicular components of EM fields
- The field cancels on average
- But causes accumulation of vertical spin component (\mathbf{s}_z)

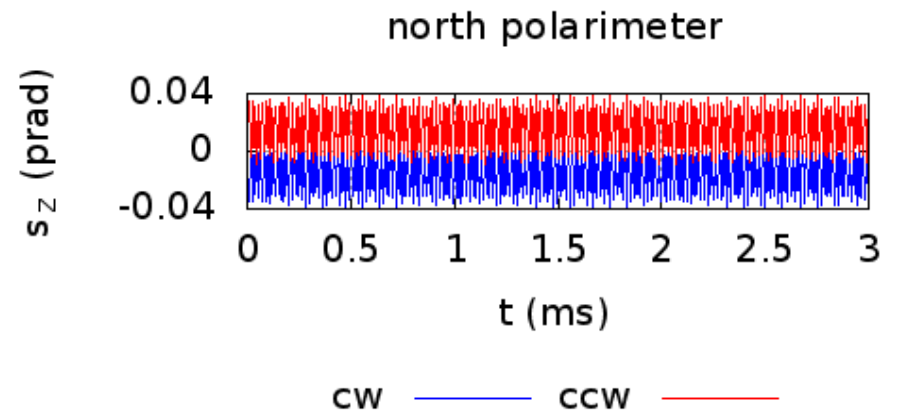
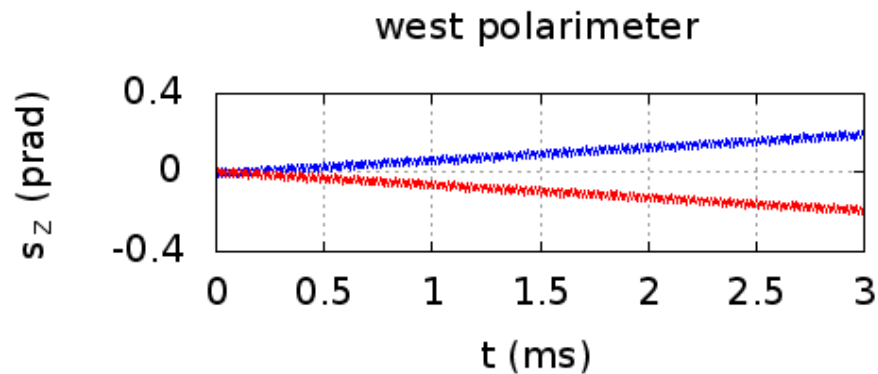
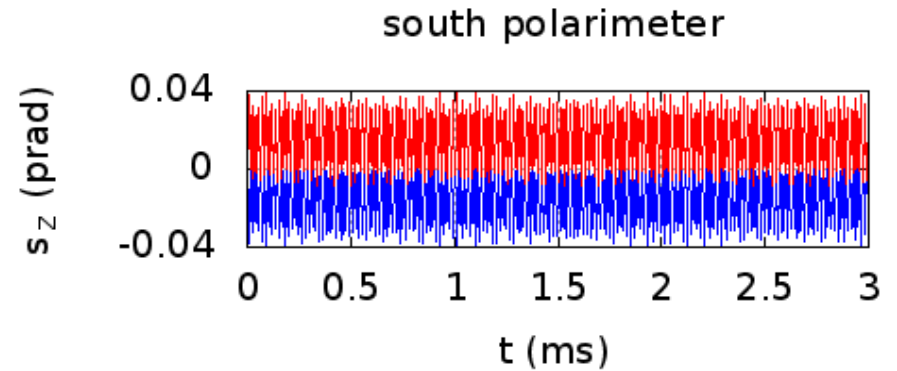
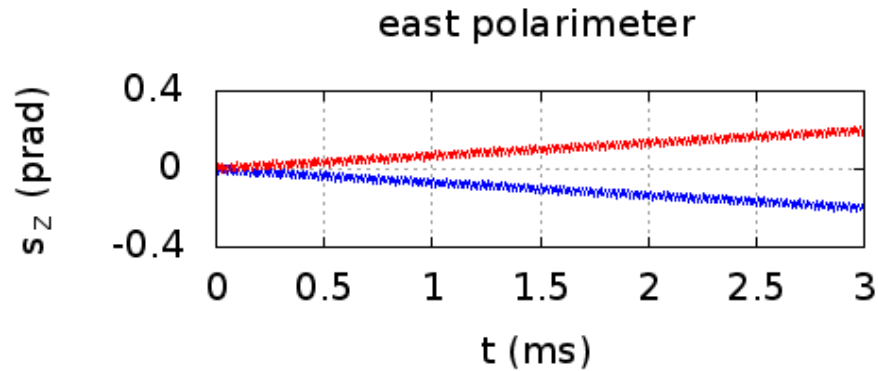
Position of the polarimeter around the ring



- s_z originates from E and B-field configurations along the beamline
- s_z oscillates with azimuth around the ring
- Polarimeter measurement at one location may not be reliable.

Magnetic field - 1

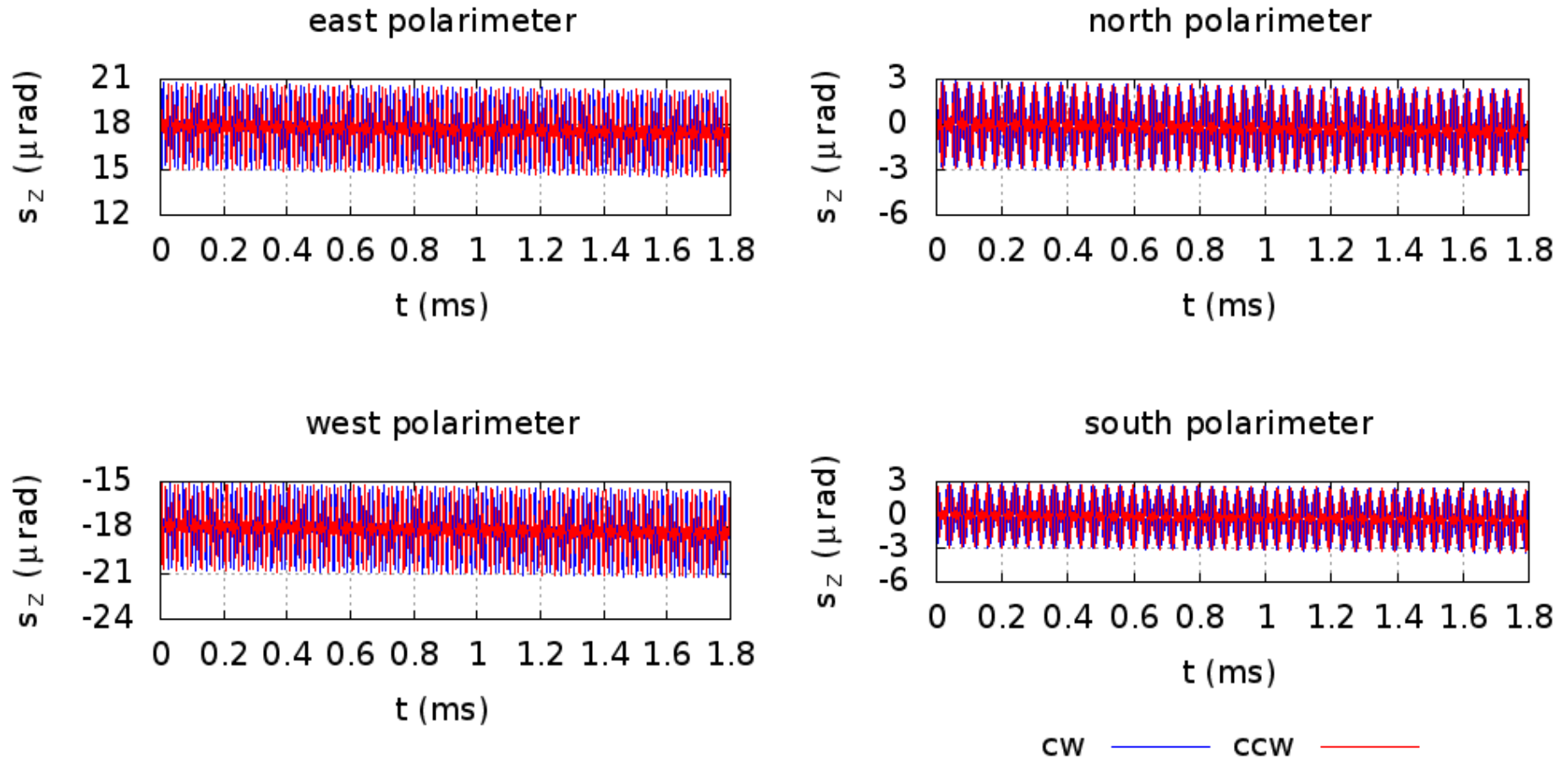
1 nT longitudinal and vertical B-field



- Spin precession looks like EDM signal (70 nrad/s).
- Multiple polarimeters seems critical.

Magnetic field - 2

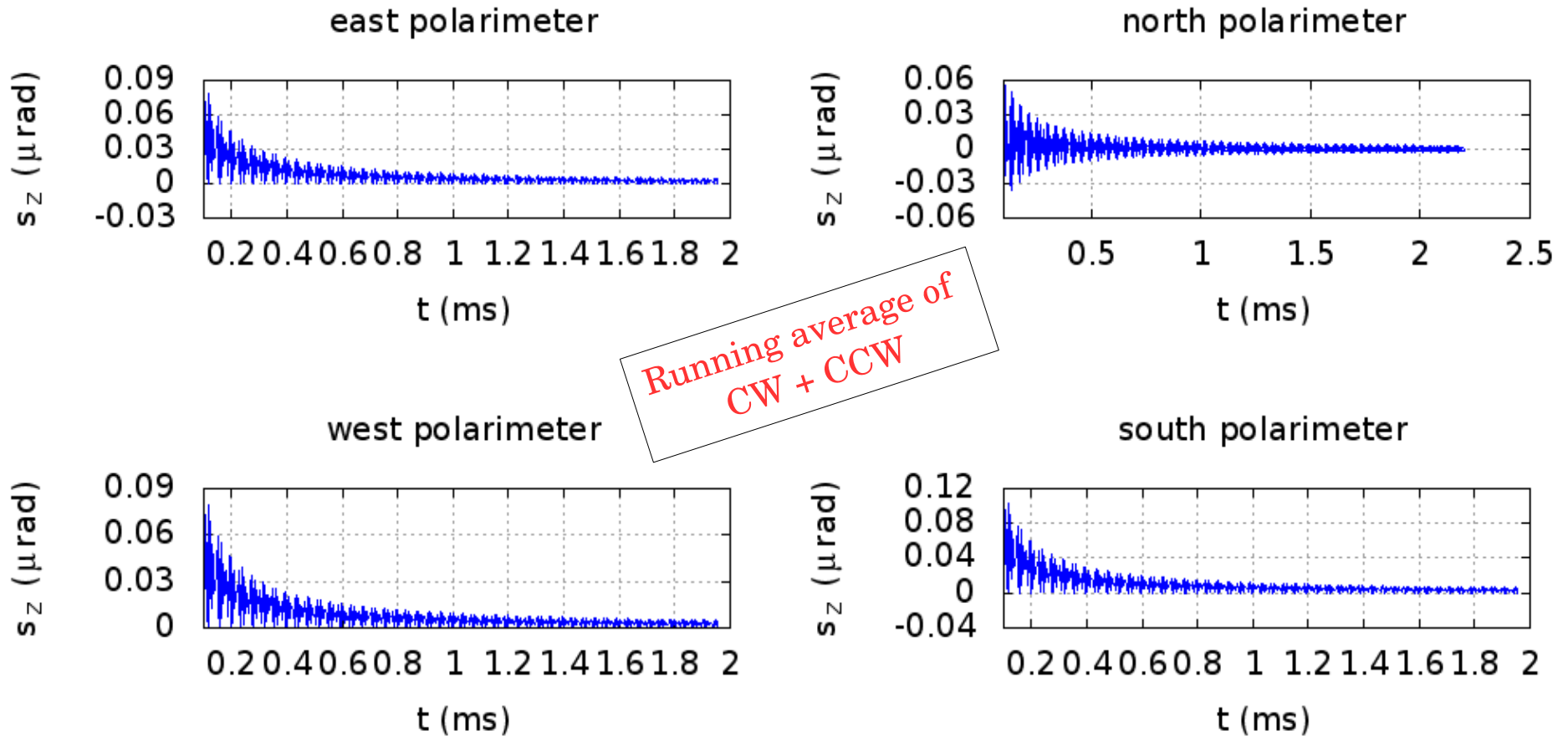
100 nT radial and vertical B-field



- s_z precession rate about 300 nrad/s
- CW and CCW cancel, unlike EDM

Magnetic field - 3

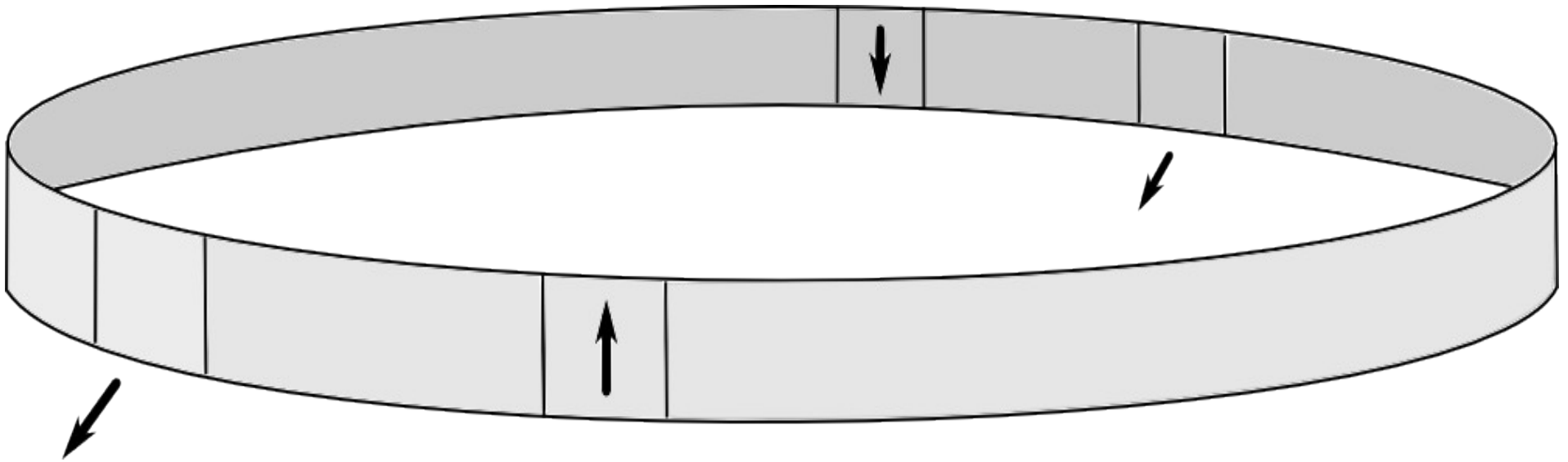
100 nT radial and vertical B-field



- Basically no vertical spin precession rate when CW and CCW are summed, within the accuracy of the method

Electric field - 1

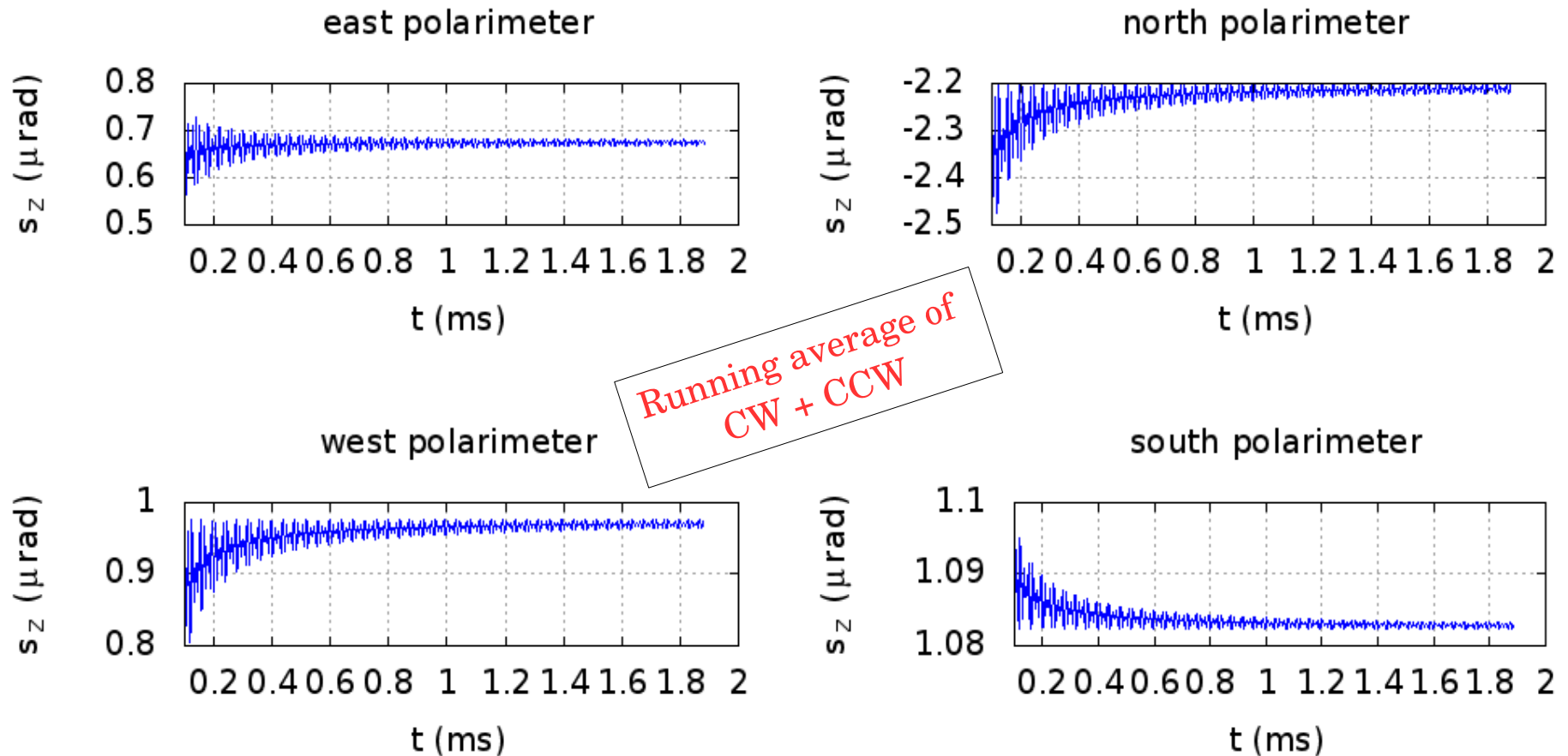
100 nT radial and vertical B-field



- Field index $n=0.2$
- 4 plates are misaligned by 1cm: 2 horizontal, 2 vertical
→ average misalignment is zero

Electric field - 2

100 nT radial and vertical B-field



- Again, no vertical spin precession rate when CW and CCW are summed, within the accuracy of the method

Conclusions

- These are preliminary results and require extensive study
- While CW and CCW design help cancellation of geometric phase effect, still some configurations show EDM-like signals
- Multiple polarimeters around the ring can solve the problem