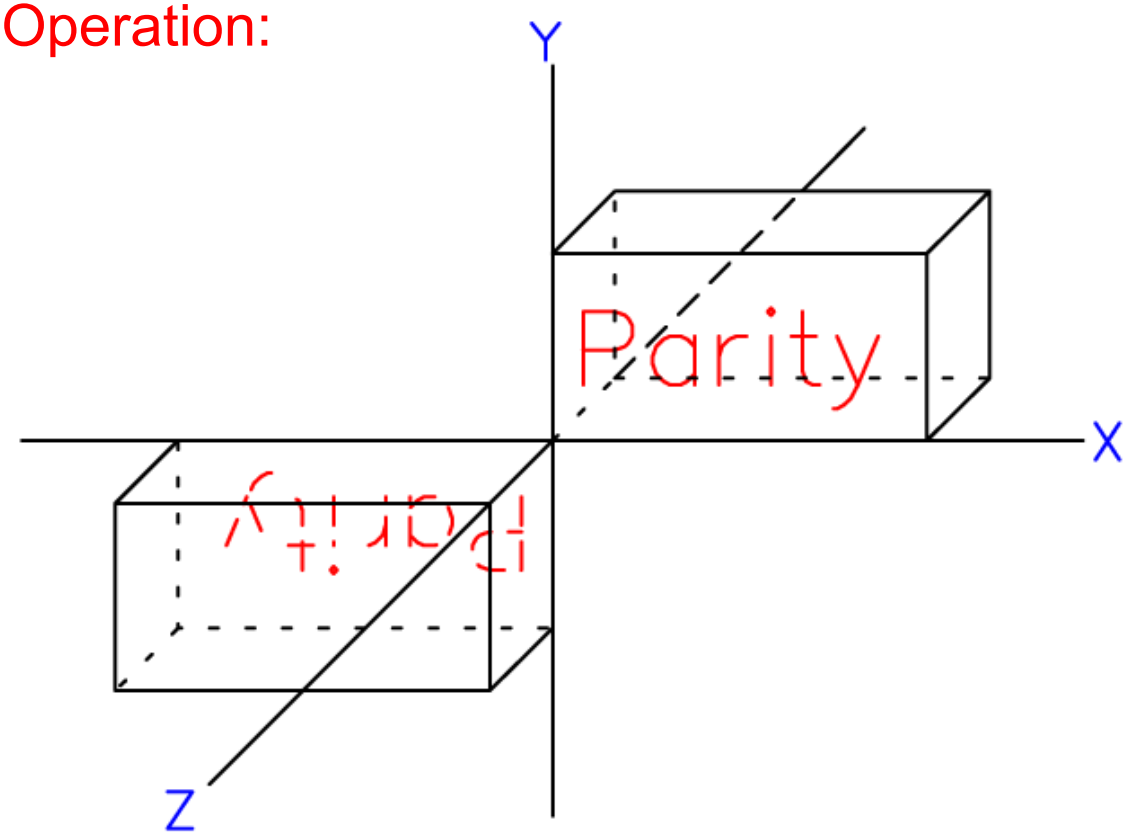
Parity Violation in the Scattering of Spin-1/2 Particles

Parity Violating A_x and A_z

The Parity Operation:



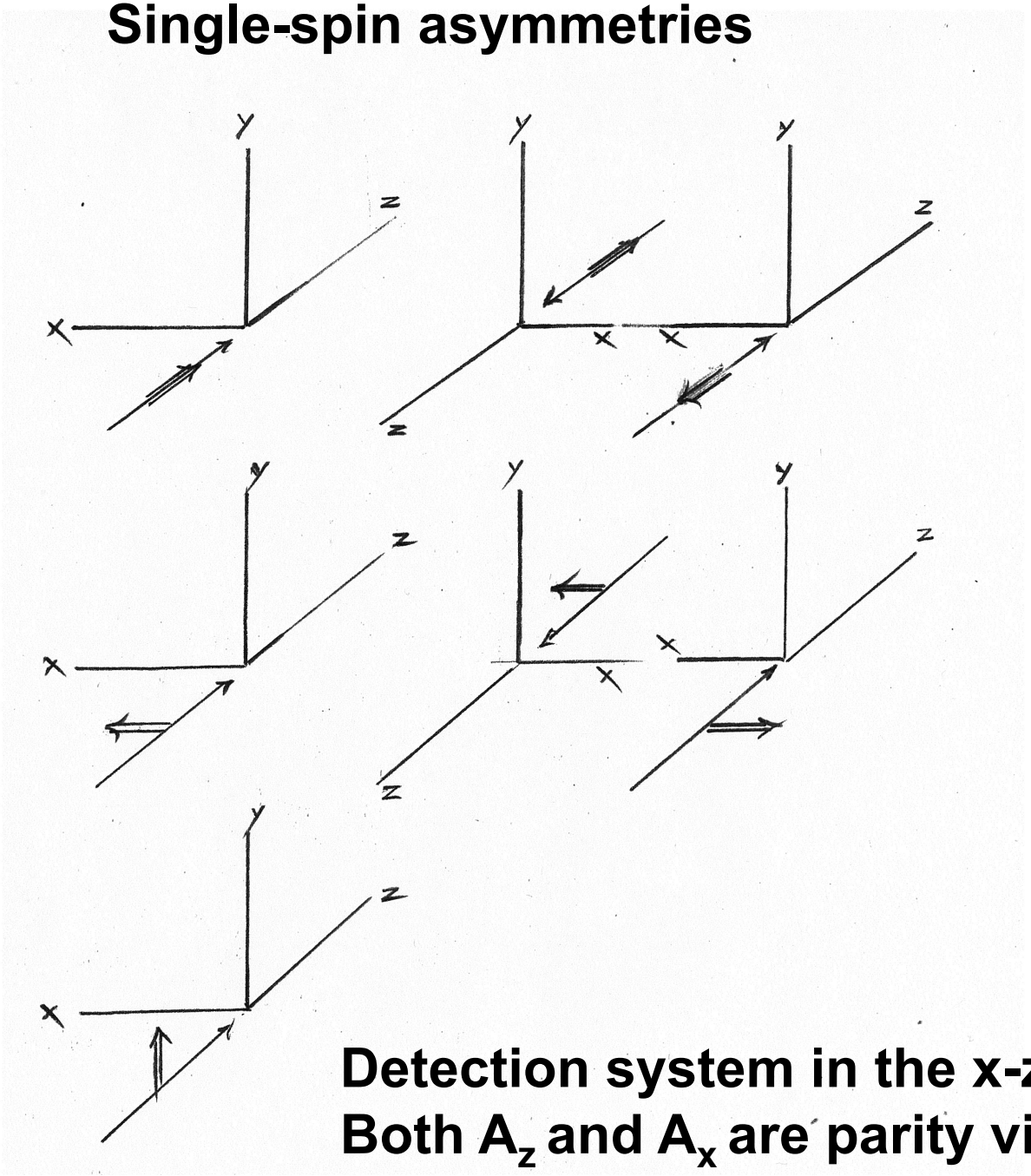
- Simultaneous reflection of all space coordinates through the origin
- Equivalent to reflection plus 180^{o} rotation
- If one assumes rotational invariance it is a mirror reflection

Single-spin asymmetries

A_z

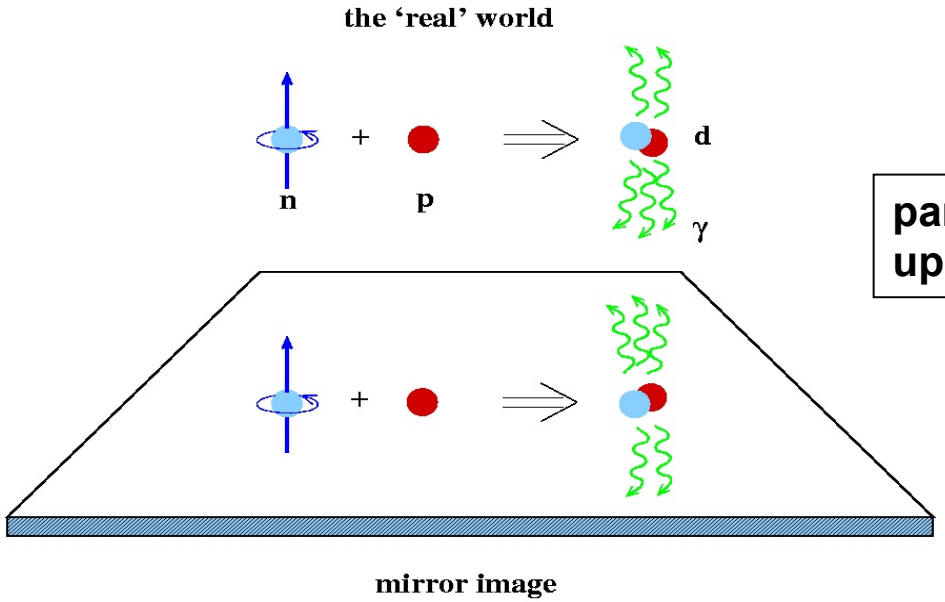
A_x

A_y



Detection system in the x-z plane
Both A_z and A_x are parity violating

The NPDGamma Experiment



parity violating
up-down asymmetry A_x

- The deuteron is weakly bound and OPE is 30 times larger than short distance contributions.
- The experiment will provide a clean measure of the weak pion-nucleon coupling, f_π
- The parity-violating up-down asymmetry, $A\gamma \sim -0.11 f_\pi$
- The best theoretical estimates are $A\gamma \sim -50$ ppb
- NPDGamma is aiming for 10 ppb uncertainty in $A\gamma$

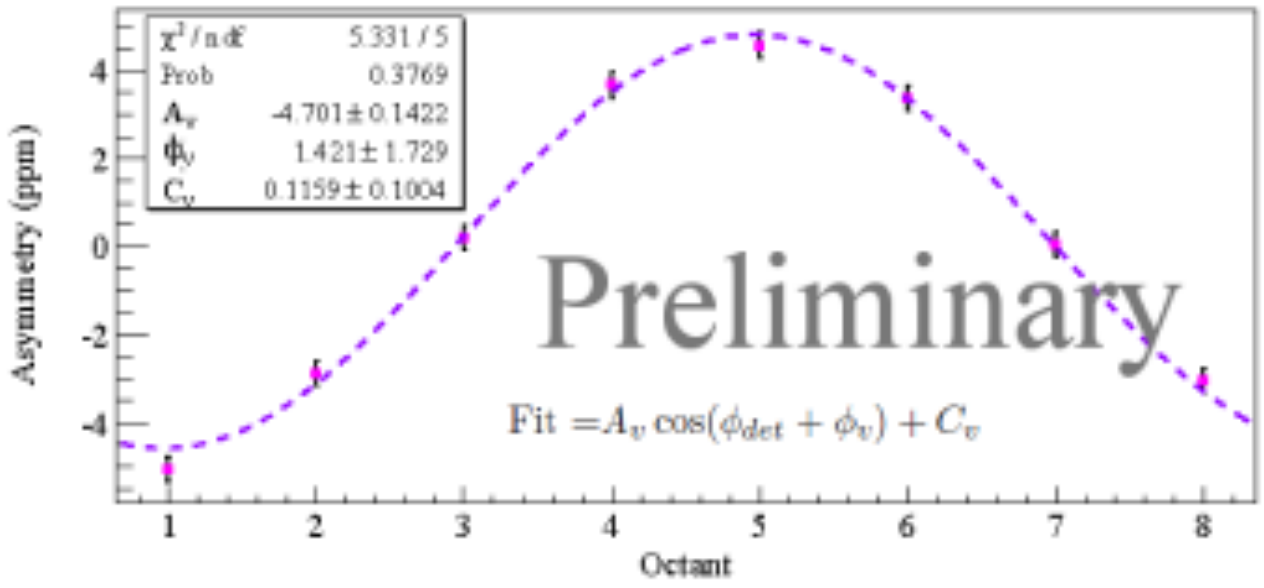
Beam Normal Single Spin Asymmetry in e+p Scattering

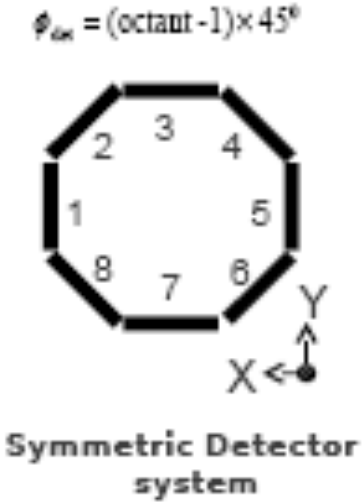
- Parity even and time reversal odd.
- Measured asymmetry has a small azimuthal dependence.

$$A^{Meas} = \frac{\sigma\uparrow - \sigma\downarrow}{\sigma\uparrow + \sigma\downarrow} = -B_n |P_T| \sin(\phi_{det} - \phi_s)$$

- Qweak vertical transverse measurement – asymmetry from a subset of full data set yields (not corrected for polarization or backgrounds)

Asymmetry Measured Using Vertical Transverse Polarization





Symmetric Detector system

Beam Normal Single Spin Asymmetry in elastic e+p Scattering

- Parity even and time reversal odd operator
- Measured asymmetry has a small azimuthal dependence.

$$A^{Meas} = \frac{\sigma\uparrow - \sigma\downarrow}{\sigma\uparrow + \sigma\downarrow} = -B_n |P_T| \sin(\phi_{det} - \phi_s)$$

- Qweak vertical transverse measurement – asymmetry from a subset of full data set yields (not corrected for polarization or backgrounds)