Measuring Transverse Asymmetries

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1 Introduction

Transverse beam asymmetries can induce a false parity asymmetry if there are imperfections in the symmetry of the apparatus. This document describes how to monitor and correct for these effects.

2 Horizontal polarization

A transverse component of the beam in the horizontal direction will result in a ϕ dependence in the asymmetry, which in turn will cause a y-dependence in the asymmetry, where y is the vertical axis. The asymmetry will be proportional to y for small y, so the effect will be proportional to $y_{misalignment}$, which is defined as the average y of the events averaged over one spectrometer. The tolerance is $y_{misalignment} < 1$ mm.

Assuming that the slit is 20 cm from the beam axis, the tolerance on $y_{misalignment}$ corresponds to a misalignment in ϕ of 5 mr. If the transverse asymmetry is 15 ppm, or 30 times A_{PV}, the effect of the misalignment will be 15% of A_{PV}, which will be hard to observe.

3 Slits

To monitor the transverse beam polarization in the horizontal direction, we plan to hae slits with y =5 cm. The slits will have a transverse symmetry that is enhanced by a factor $E \sim 50$ over the assumed misalignment. The ratio of rates of the slit relative to that of the parity asymmetry is denoted R, which

is $\sim 1/50$. In addition, there is significant background under the slit signal, parameterized by a background to signal ratio B/S, which is estimated be be about 1. Then there is a figure of merit M, defined by:

$$M = \frac{1}{E}\frac{1}{\sqrt{R}}\sqrt{1+\frac{B}{S}} = \frac{1}{50}\sqrt{50}\sqrt{2} = \frac{1}{5}.$$

This in the relative increase in statistical error (added in quadrature) due to this systematic effect. The factor of 5 we have is barely adequate. We have assumed that the beam has been fed back to null the obsereved slit asymmetry.

4 Geometry of the slits

There are two possible geometries for the slits. They may be up on both arms, or one arm may have the slit up and the other down. If both are up, the transverse polarization is proportional to the average of the signals. The problem is that the asymmetry of the background must be subtracted. There may be some inelastic levels that have an unknown asymmetry. It is not clear how significant this effect is.

If the slits are up-down, the transverse asymmetry is proportional to the difference, and the background asymmetry is automatically subtracted. The problem is that left-right position jitter does not cancel. Since the statistics for the slits are 25 times less, the noise may be acceptable.