Analysis Progress

for the d_2^n analysis meeting

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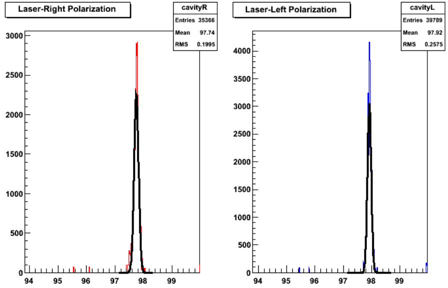
1. Compton
   - Cavity Polarization
   - Better Estimated Beam Polarizations
2. BPM Calibration
   - Coordinate Transformations
3. What's Next?

Compton Cavity Polarization

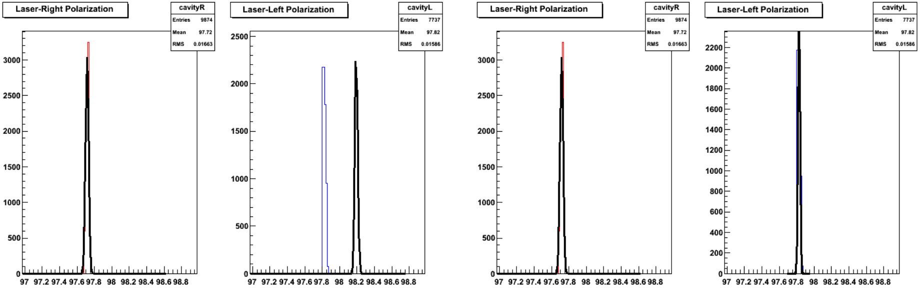
- What do we need to extract the beam polarization P_e from a Compton measurement?
  - Measured Compton asymmetry A_{exp}
  - Analyzing power A_l of Compton polarimeter
  - Polarization P_γ of photons in Compton cavity
- P_γ is measured from laser light transmitted through the Fabry-Pérot cavity and reported through EPICS



Compton Cavity Polarization: Fit Check

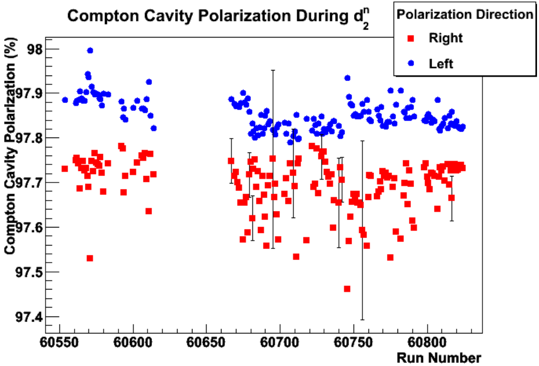
- Our cavity polarization numbers don't always have a nice Gaussian distribution
- "Grass" can lead to ROOT fits that fail or are just plain wrong
- Fits for 19 measurements (out of 296 total) had to be redone by hand

Run 60771



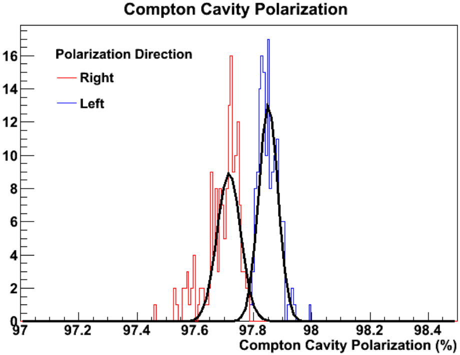
Cavity Polarization History

- Did P_γ change significantly over the course of d_2^n?



- No – variation is of a few tenths of a percent
- However, right and left states are systematically different

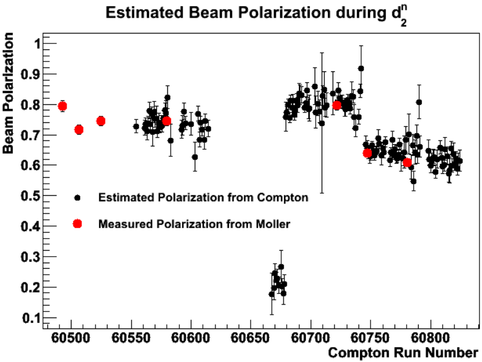
Representative Cavity Polarization Numbers



- Fitting the cavity polarization distributions allows us to extract the average laser polarization for the experiment
- We end up with two representative numbers, which can be applied when seeking the beam polarization

Better Estimated Beam Polarizations

- We now have a new and improved estimate of beam polarizations measured by the Compton over the course of d_2^n, including:
    - Laser cavity polarizations
    - Photon detector PMT nonlinearity
- Still needed: collimator misalignment



Where We Left Off ...

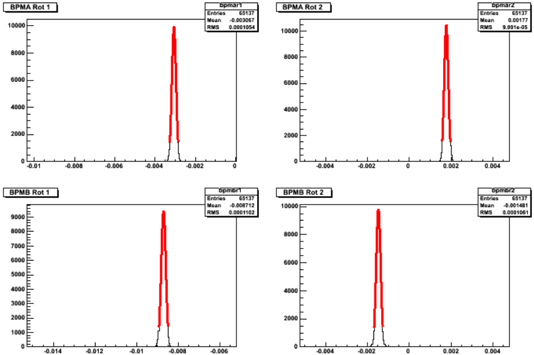
- According to Vince's analysis, the Hall A HARPs were effectively useless during our experiment
  - Slipping encoders
  - Insufficient survey data
- Vince proposed using the EPICS variables (calibrated by MCC from previous HARP scans) as "absolute beam position measurements" for calibrating our beam-position scalers
  - Once we've carried through the calibration, we can check our conclusions using LHRS data
- On February 4, I showed EPICS measurement results from our bull's-eye scan

Coordinate Transformations

- We need to be able to transform from BPM coordinates to Hall A coordinates
- This requires a 2x2 rotation matrix and an offset vector in the DB files
- What we need from our bull's-eye scan:
  - "Absolute" position measurements in Hall A coordinates (from EPICS)
  - Position in BPM system
    - BBurb.BPMA.rotpos1, BBurb.BPMA.rotpos2
    - BBurb.BPMB.rotpos1, BBurb.BPMB.rotpos2
- Standard code get_bpm_calib2.C contains transformation algebra

Beam Position Measurements in BPM Frame

- The bull's-eye scan placed the beam at 5 points: (-2,-2), (-2,+2), (+2,-2), (+2,+2), (0,0)
- For each run we examine the beam position in the bpm frame (x'_a, y'_a) and (x'_b, y'_b) from scalers
- We fit a Gaussian to the reported beam positions:



The Transformation

- The coordinate transformation for BPM A is defined below

$$\begin{pmatrix} \Sigma x_a'^2 & \Sigma x_a' y_a' & \Sigma x_a' \\ \Sigma x_a' y_a' & \Sigma y_a'^2 & \Sigma y_a' \\ \Sigma x_a' & \Sigma y_a' & 5 \end{pmatrix}^{-1} \begin{pmatrix} \Sigma x_a x_a' \\ \Sigma x_a y_a' \\ \Sigma x_a \end{pmatrix}$$

$$\begin{pmatrix} \Sigma x_a'^2 & \Sigma x_a' y_a' & \Sigma x_a' \\ \Sigma x_a' y_a' & \Sigma y_a'^2 & \Sigma y_a' \\ \Sigma x_a' & \Sigma y_a' & 5 \end{pmatrix}^{-1} \begin{pmatrix} \Sigma y_a x_a' \\ \Sigma y_a y_a' \\ \Sigma y_a \end{pmatrix}$$

- The first two elements of each solution vector give elements of the rotation matrix
- The third element of each solution vector gives part of the offset vector
- BPM B's transformation is the same

Coordinate Transformation: Results

- The results of our coordinate transformation go into the DB

BPM A

d_2^n	0.614534	-0.65991	0.61804	0.669433	0.00322684	0.000669938
Transv.	-0.682	0.729	0.701	0.717	-0.00112	0.00081

BPM B

d_2^n	0.816705	-0.557122	0.816639	0.559635	0.00609878	0.00779028
Transv.	-0.604	0.624	0.65	0.601	7.8e-05	4.25e-05

What's Next?

- BB Optics
  - Raster calibrations
- Compton
  - Analyzing power work continues in background
  - Systematics (Cavity State ID)