Commissioning of the Compton transmission polarimeter

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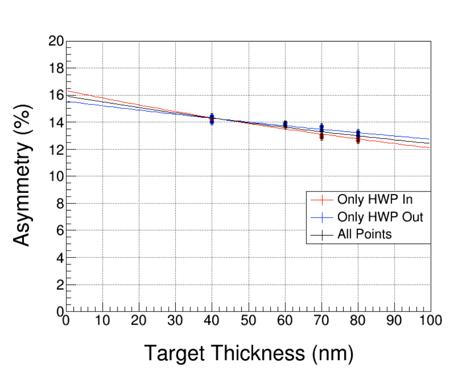
Overview

Cover the results/scans from a 3 week commissioning study

- Beam Polarization from Mott Scattering Polarimeter
- The Compton Transmission Polarimeter
- Results of the commissioning study

Beam Polarization

Used Mott polarimeter at 180 keV to measure beam polarization from bulk GaAs

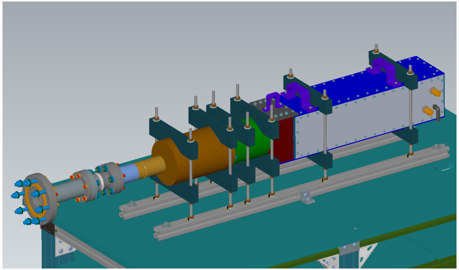


$$P_b = \frac{A_0}{S(E)} = \frac{15.926\%}{0.426135} \tag{1}$$

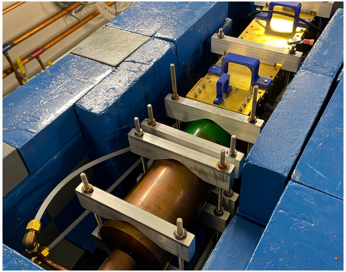
$$P_b = 37.4 \pm 0.9\% \tag{2}$$

Compton Transmission Polarimeter

Main components include: radiator, collimator, polarized target (magnet), and detector



(a) Cad Model of COMTRA

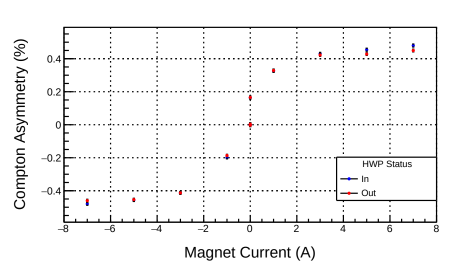


(b) COMTRA as commissioned

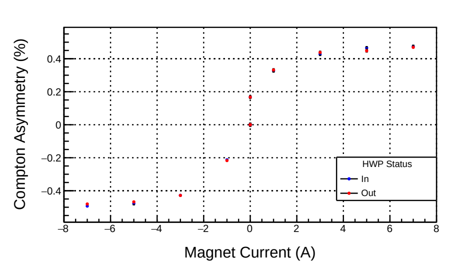
Results - S-Curve

Asymmetry was studied as a function of magnet current for 5 and 7 MeV looking for analyzing power (A)

$$\epsilon = P_b P_t A \tag{3}$$



(a) S-Curve at 5 MeV



(b) S-Curve at 7 MeV

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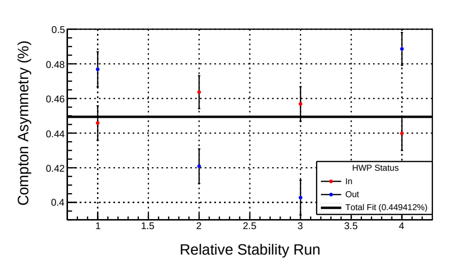
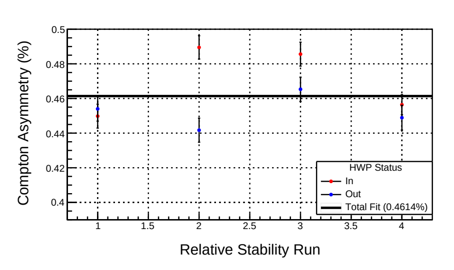
Results - Stability (Calibration) runs

Asymmetry should remain constant throughout an entire day of operation

At running parameters (5nA beam, $\pm$5A magnet current) asymmetry was recorded over a full run day



(a) PMT Asymmetry stability at 5 MeV



(b) PMT Asymmetry stability at 7 MeV

Results - Effective Analyzing Power

We calculate an effective analyzing power at operational parameters

$$A_{eff} = P_t A \tag{4}$$

P_t is constant due to an unchanging magnet current. Calculations of COMTRA's effective analyzing power at 5 and 7 MeV respectively yield

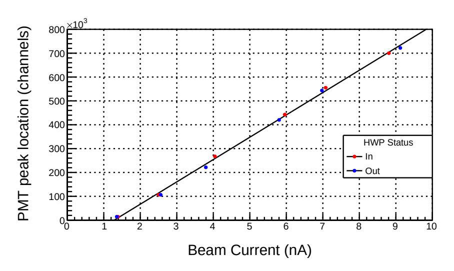
$$A_{eff} = \frac{\epsilon}{P_b} \implies \frac{0.449412 \pm 0.003479\%}{37.4 \pm 0.9\%} = 0.0120 \pm 0.0003 \tag{5}$$

$$A_{eff} = \frac{\epsilon}{P_b} \implies \frac{0.461400 \pm 0.002411\%}{37.4 \pm 0.9\%} = 0.0124 \pm 0.0003 \tag{6}$$

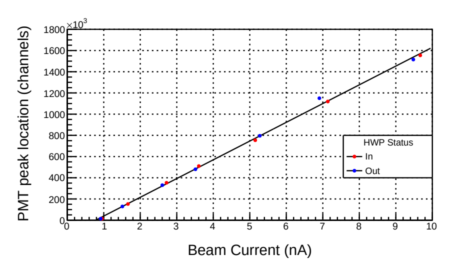
Results - I-Scan

Peak Location, Asymmetry, and Sigma were studied as a function of beam current for 5 and 7 MeV beginning with the peak location

Linear behavior is expected, more current gives more events which produces more signal!



(a) PMT Peak Location I-scan at 5 MeV



(b) PMT Peak Location I-scan at 7 MeV

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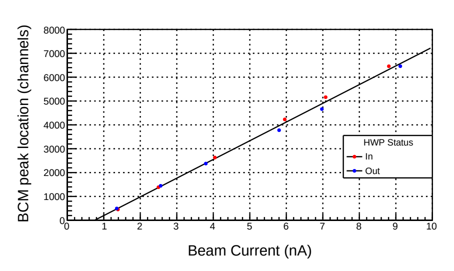
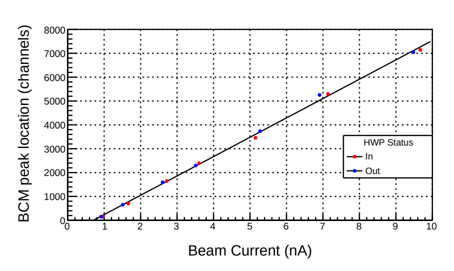
Results - I-Scan

Quantities are found for both the PMT signal as well as the BCM



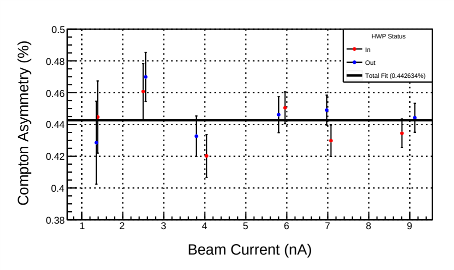
(a) BCM Peak Location I-scan at 5 MeV



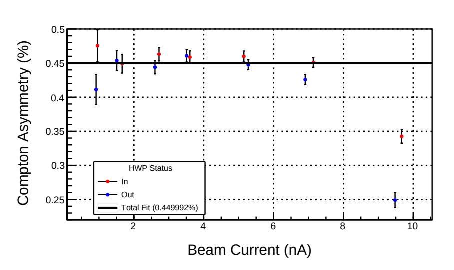
(b) BCM Peak Location I-scan at 7 MeV

Results - I-Scan

Asymmetry is only a function of beam polarization which does not depend on beam current!



(a) PMT Asymmetry I-scan at 5 MeV



(b) PMT Asymmetry I-scan at 7 MeV

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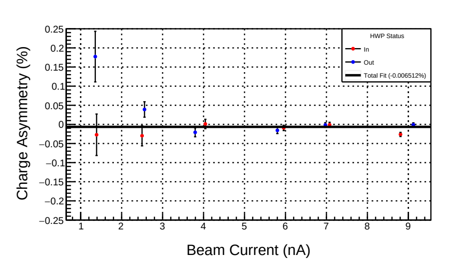
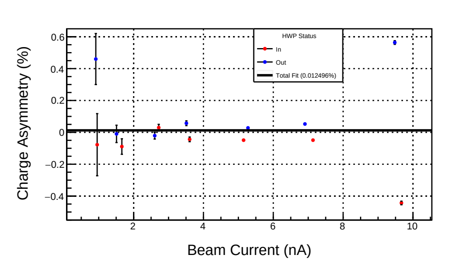
Results - I-Scan

Asymmetry on the BCM reflects asymmetry on the beam to which there should be none!



(a) BCM Asymmetry I-scan at 5 MeV



(b) BCM Asymmetry I-scan at 7 MeV

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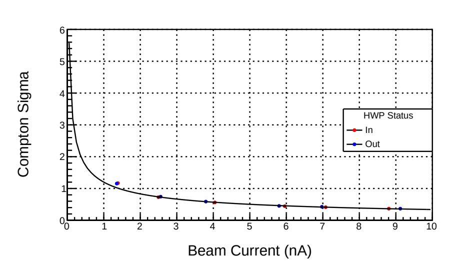
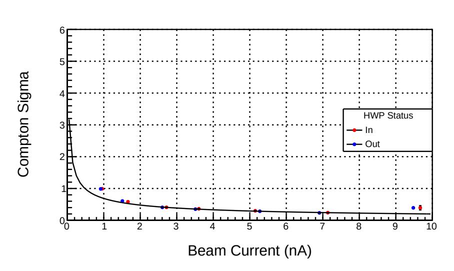
Results - I-Scan

A Gaussian fit is used to find the asymmetry which has an associated σ



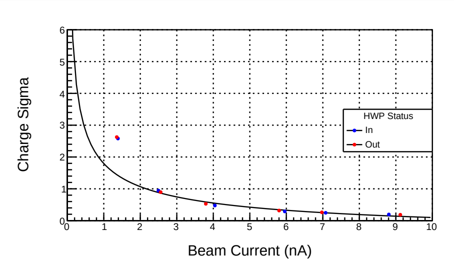
(a) PMT Sigma I-scan at 5 MeV



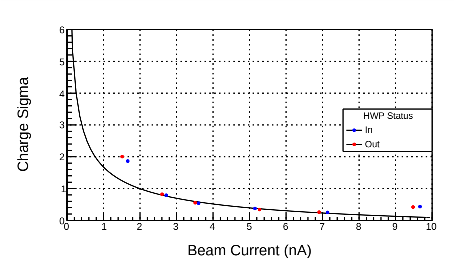
(b) PMT Sigma I-scan at 7 MeV

σ is expected to fall off as $1/\sqrt{N}$ where N is the number of events.

Increasing beam current increased the number of events linearly, so we expect to see $1/\sqrt{I_b}$

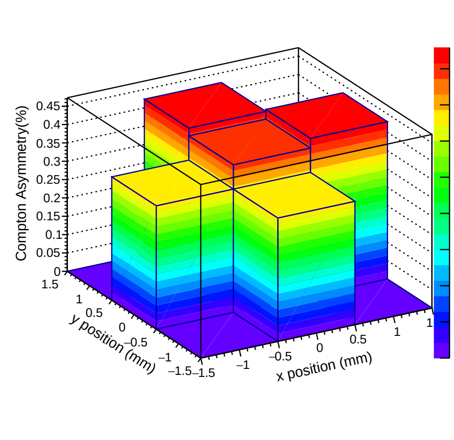


(a) BCM Sigma I-scan at 5 MeV



(b) BCM Sigma I-scan at 7 MeV

PMT Asymmetry was studied at 5 locations relative to the operating "center"

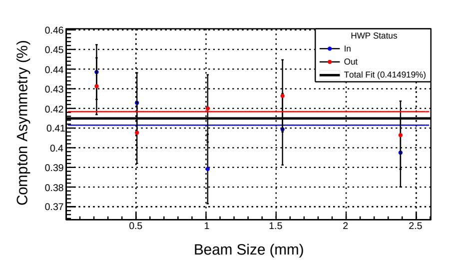


(a) PMT Asymmetry for a relative position at 5 MeV

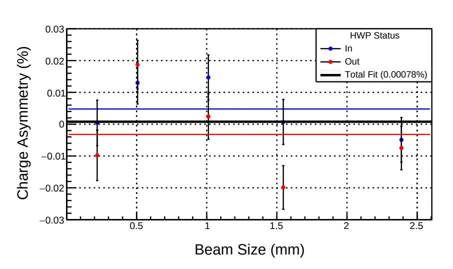
Results - Size Scan

Asymmetry was studied over a range of beam sizes (otherwise unchanged)

The asymmetry is plotted against the beam size plotted as radius. This is approximating a cylindrical beam.



(a) PMT Asymmetry against spot size at 5 MeV



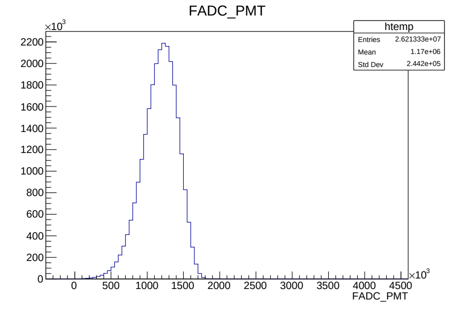
(b) BCM Asymmetry against spot size at 5 MeV

Questions?

Thank you for your time!

Spectra

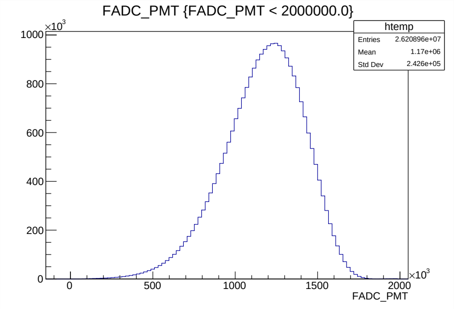
Example Spectra for a good run at 5 MeV as a function of channel (FADC)



(a) Spectra at optimal operational parameters

Spectra

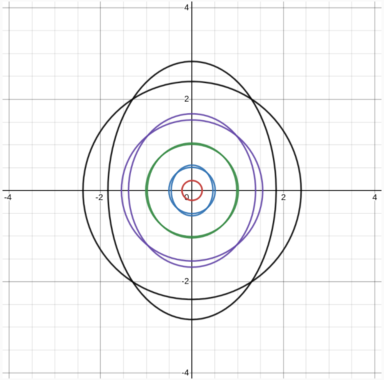
Example Spectra for a good run at 5 MeV as a function of channel (FADC)



(a) Spectra at optimal operational parameters

Beam Sizes

Quick plot of the real beams against the circular approximations



(a) Beam size approximations