A Compton transmission polarimeter for DC and SRF electron photo-injectors

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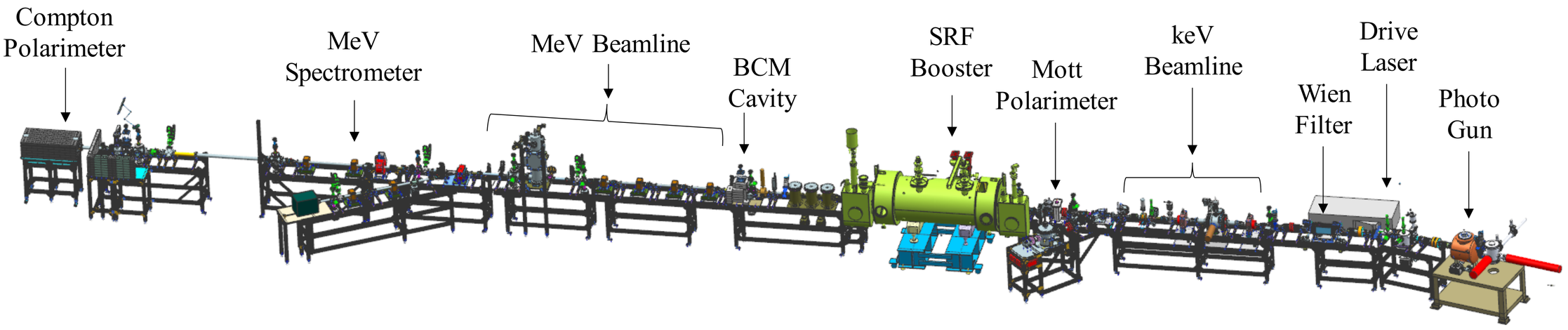
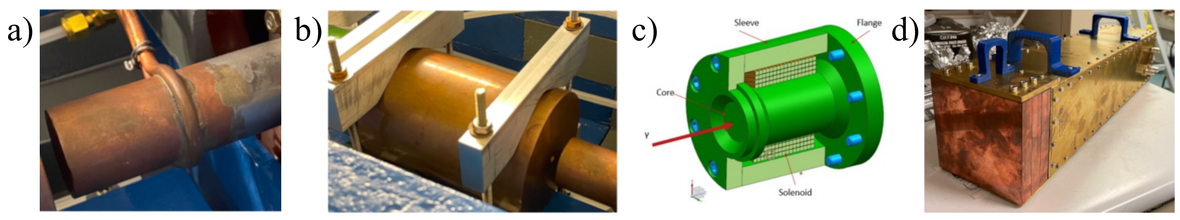
Overview



- A Compton transmission polarimeter was commissioned in the UITF beamline (shown above)
- Four components make up Compton polarimeter structure (shown right) a) Copper radiator b) Copper collimator c) Polarized target magnet d) Photon detector
- We report an effective analyzing power at 5 and 7 MeV

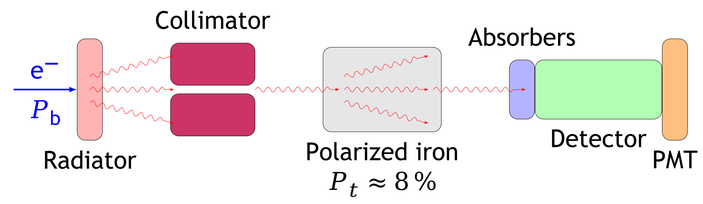


Methods

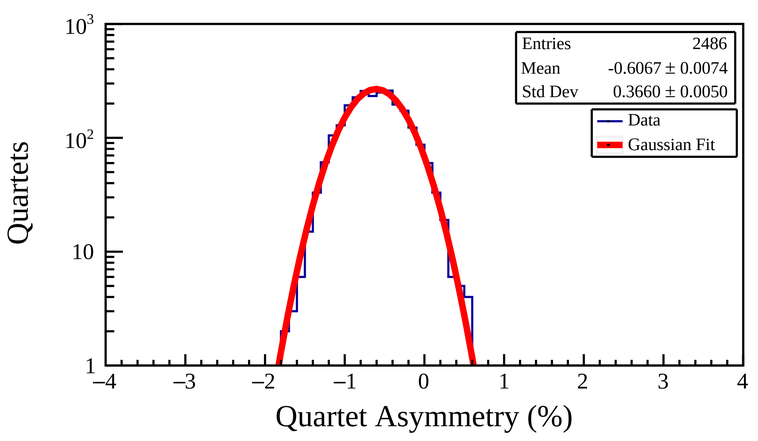
- Polarized photons are generated from a polarized electron beam striking the radiator
- Photons generated by this beam are subject to an asymmetry A_E described by equation 1 after interacting with a polarized electron target

$$A_E = P_e^l P_t A = P_e^l \langle \mathcal{A} \rangle \quad (1)$$

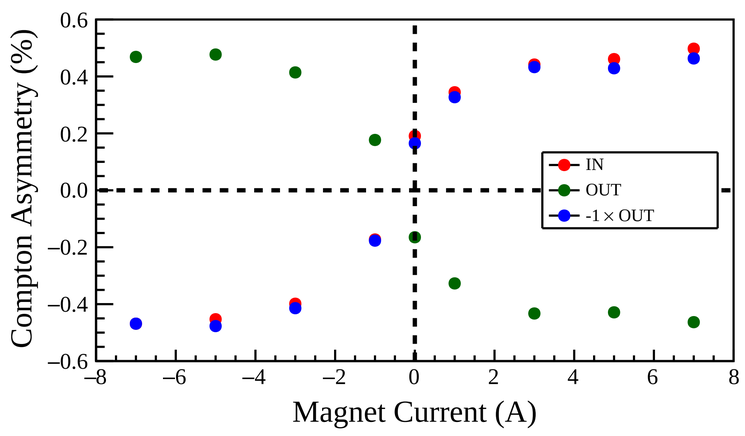
- P_e^l is the polarization of the electron beam, P_t is the polarization of the target, A is the analyzing power, and $\langle \mathcal{A} \rangle$ is the effective analyzing power
- Signals generated by experiment are sent to a DAQ, and asymmetries are calculated for individual quartets
- Binned quartet asymmetries yield net run asymmetries (example right)

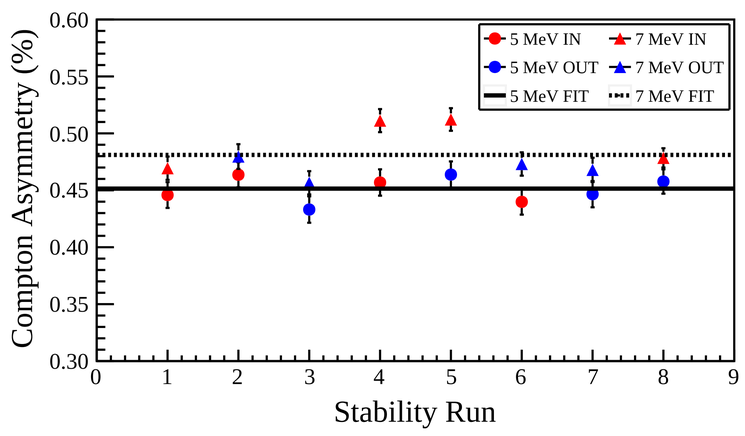


- Red lines are circularly polarized bremsstrahlung photons



Results





- S-Curve is observed for asymmetry as a function of magnet current (example shown for 5 MeV)
- Asymmetry is constant for a fixed magnet current and used to calculate effective analyzing power
- Beam polarization is found to be $(37.4 \pm 0.8)\%$ using an upstream Mott polarimeter

$$\langle \mathcal{A}^{5\,\mathrm{MeV}} \rangle = \frac{(0.452 \pm 0.004)\%}{(37.4 \pm 0.8)\%} = 0.0120 \pm 0.0003, \quad (2)$$

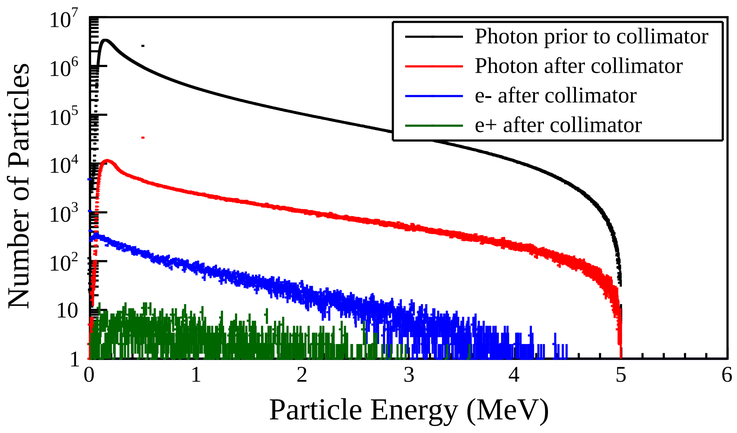
$$\langle \mathcal{A}^{7\,\mathrm{MeV}} \rangle = \frac{(0.481 \pm 0.007)\%}{(37.4 \pm 0.8)\%} = 0.0129 \pm 0.0004. \quad (3)$$

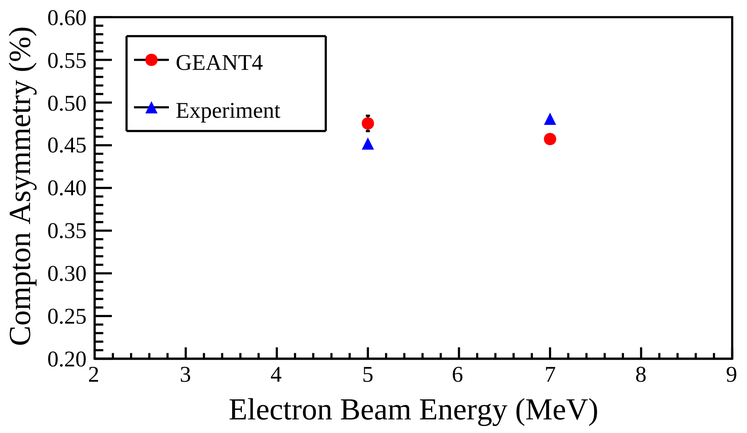
GEANT4 Simulations

- Collimated particles interact with the polarized target and produce energy deposit asymmetries in the BGO
- High experimental event counts require integrated asymmetry for simulation comparison

$$A_S = \frac{\sum_i A(E_i)(E_i^+ + E_i^-)}{\sum_i (E_i^+ + E_i^-)}. \quad (4)$$

- GEANT4 asymmetry is scaled by measured beam polarization and deduced magnet polarization $(7.89 \pm 0.16)\%$
- Magnet polarization is very close to theoretical limit of 8.0%





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