Compton Transmission Polarimeter for BNL SRF Gun

5 MeV Polarimeter

Riad Suleiman

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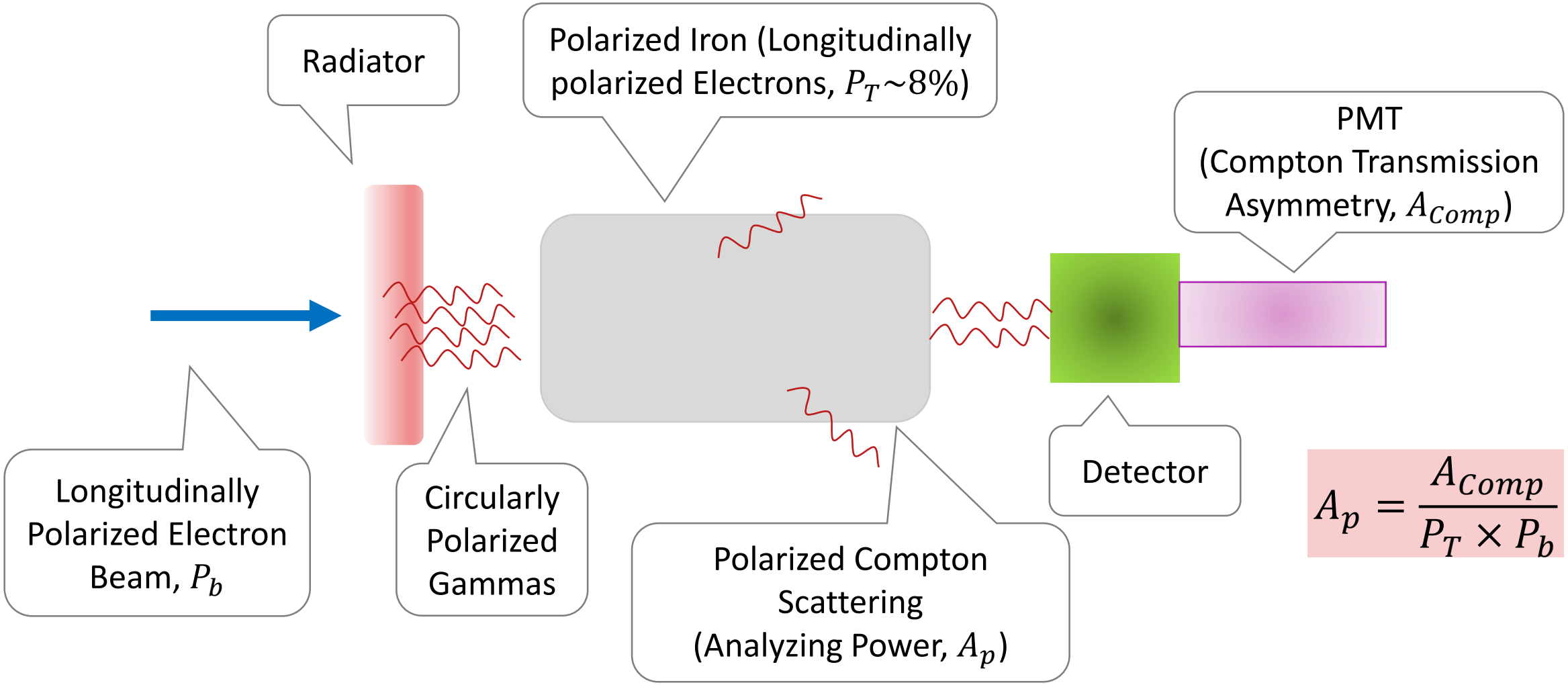
Jefferson Lab

U.S. DEPARTMENT OF ENERGY | Office of Science

JSA

Compton Transmission Polarimeter

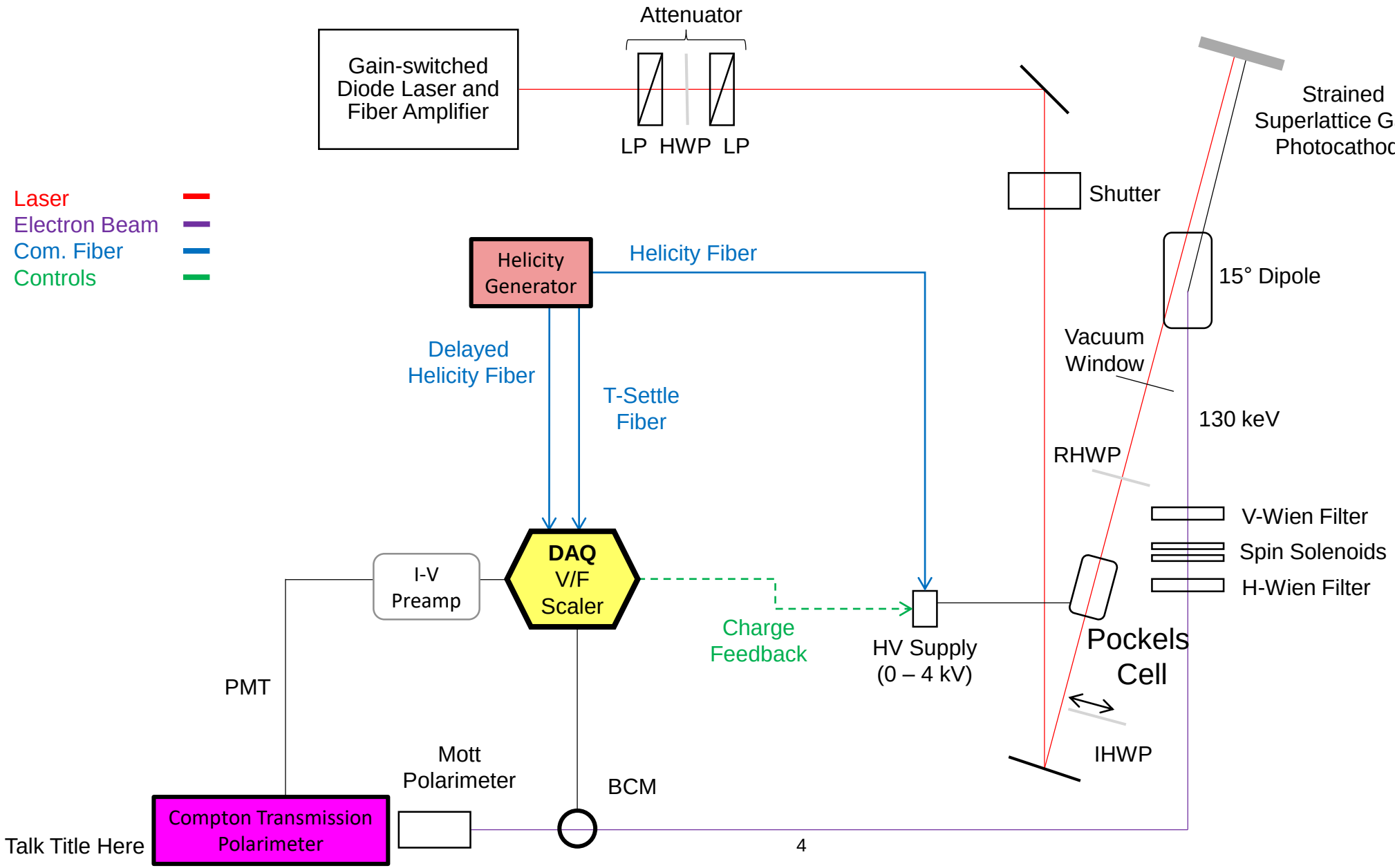


$$A_p = \frac{A_{Comp}}{P_T \times P_b}$$

July 10, 2018 Test at CEBAF Injector

Dalia Lucero Ramírez Guadarrama

Laser Table, Beamline & DAQ Schematics



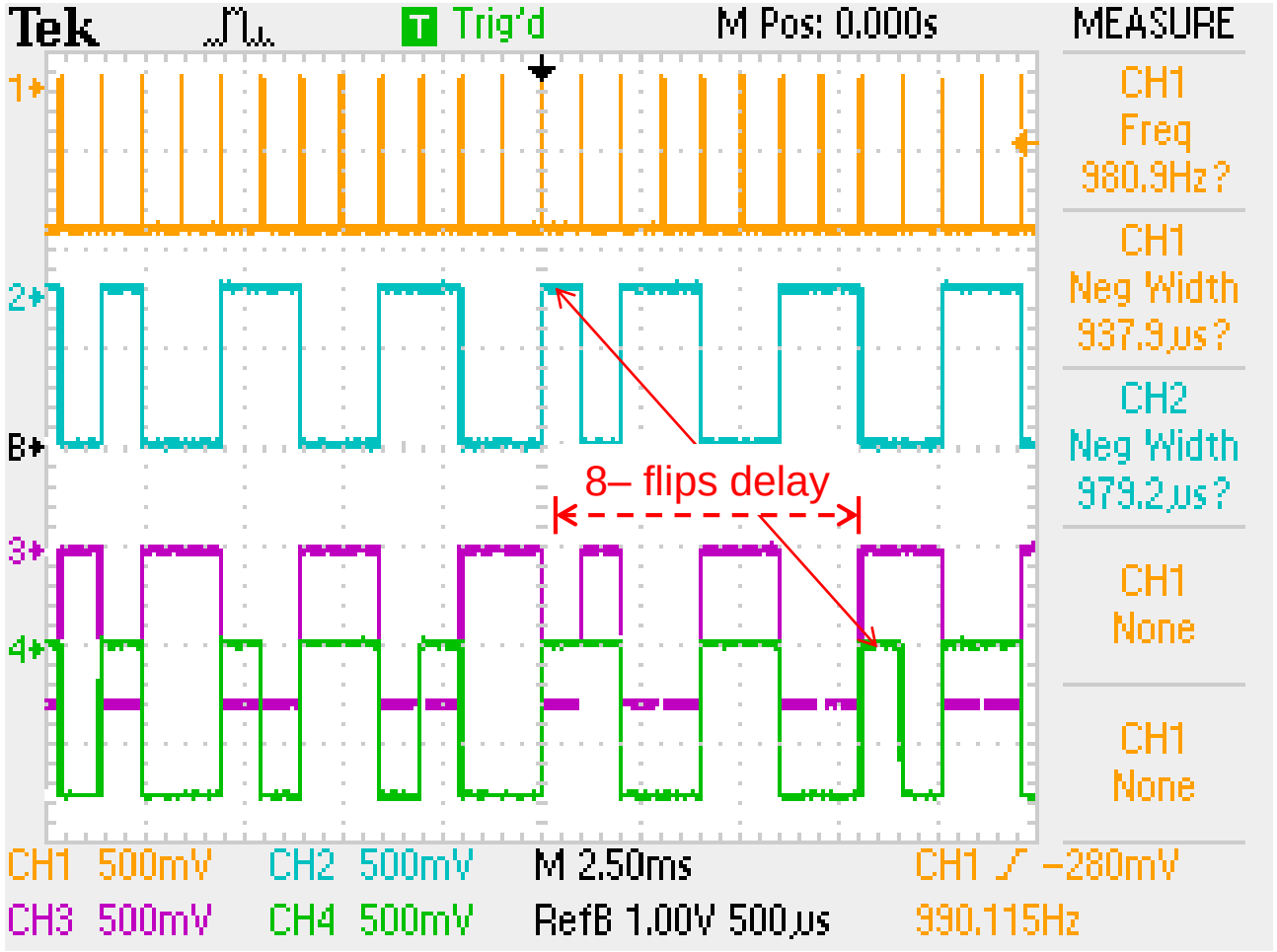
Helicity Generator Signals

T_Settle

Helicity Flip

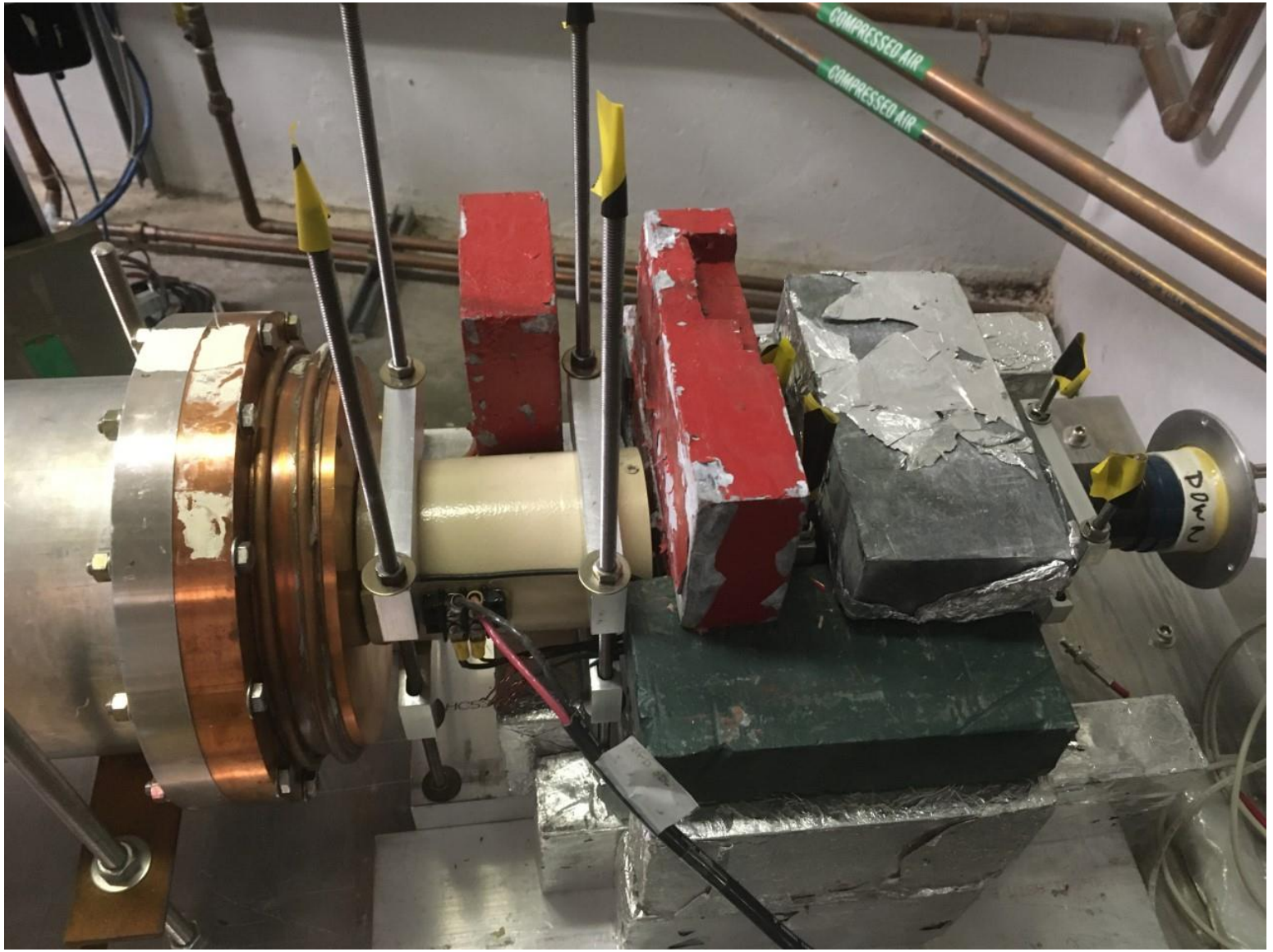
nHelicity Flip

Delayed Helicity



Test Setup

- Strained SupperLattice GaAs
- 780 nm, 50 ps, 250 MHz, Circularly polarized
- Insertable Half-wave-plate, IHWP: IN/OUT
- Beam Total Energy: 5.9 MeV
- Beam current: 0 – 3.5 μA
- Helicity Settings:
  - Clock: Free Clock
  - Delay: 0, 8 windows
  - Pattern: Quartet
  - Settle Time: 500 μs
  - Stable Time: 33330 μs
  - Frequency: 29.6 Hz



Compton Transmission Polarimeter

- Detector:
  - Compton Transmission detector at -1.2 kV

- Magnet:

Asymmetries

- Charge Asymmetry:
  - I^+ : Raw channel for +helicity
  - I^- : Raw channel for – helicity

$$A_{BCM} = \frac{I^+ - I^-}{I^+ + I^-}$$

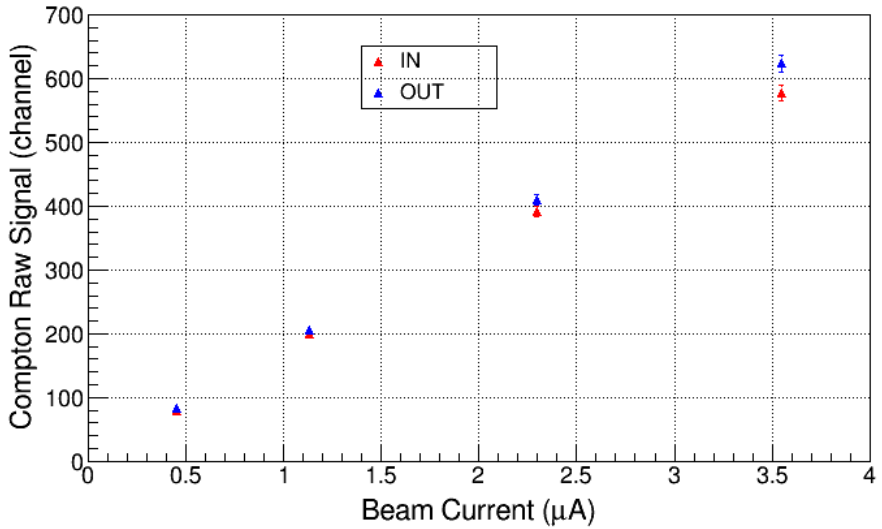
- Detector Asymmetry:
  - D^+ : Raw channel for +helicity
  - D^- : Raw channel for – helicity

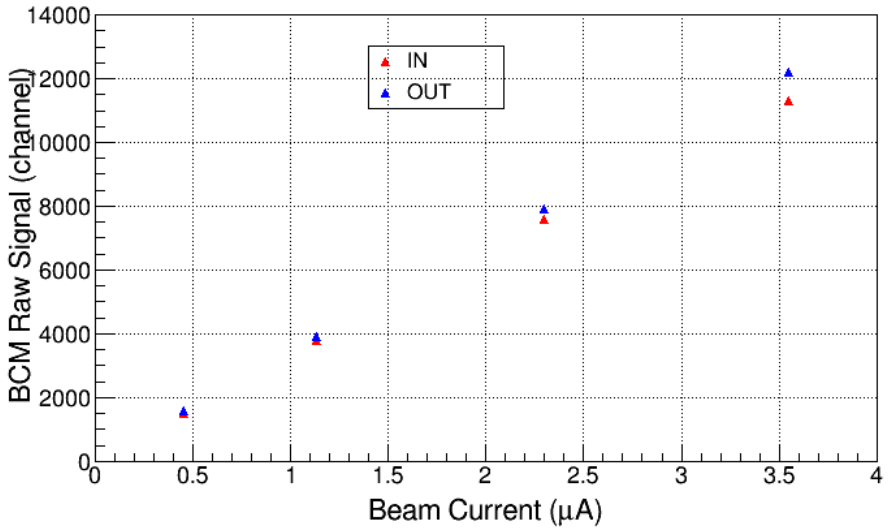
$$A_{Det} = \frac{D^+ - D^-}{D^+ + D^-}$$

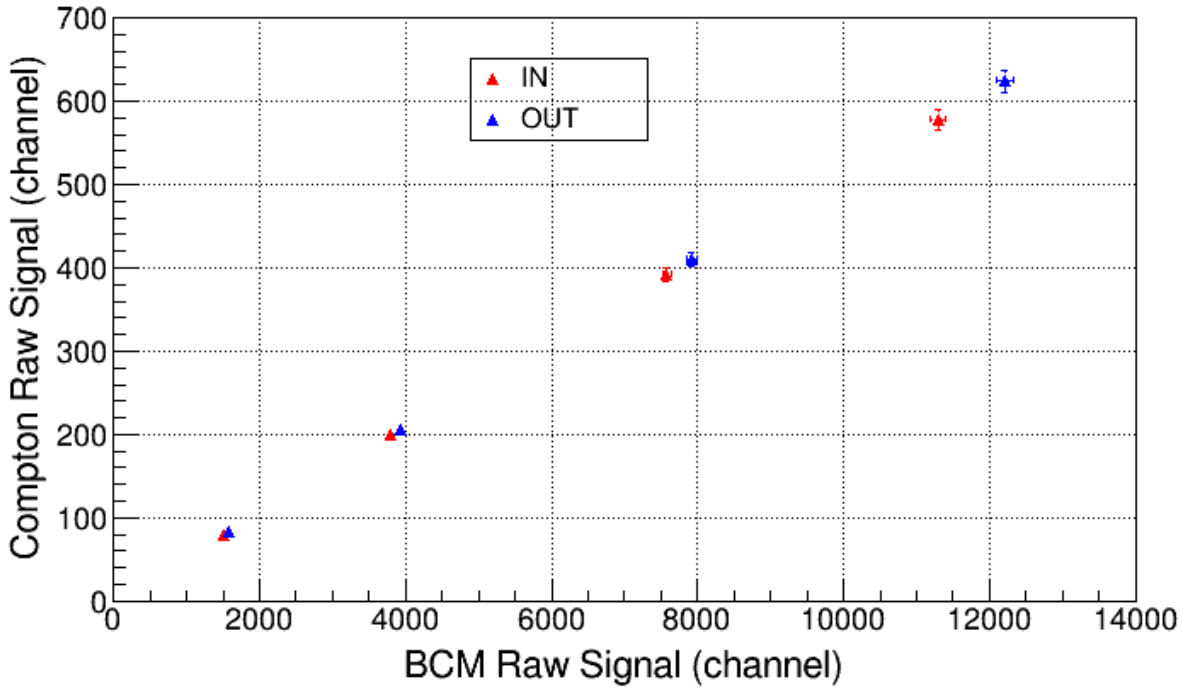
- Compton Transmission Asymmetry:

$$A_{Comp} = \frac{D^+/I^+ - D^-/I^-}{D^+/I^+ + D^-/I^-} = A_{Det} - A_{BCM}$$

Raw Signals vs Beam Current

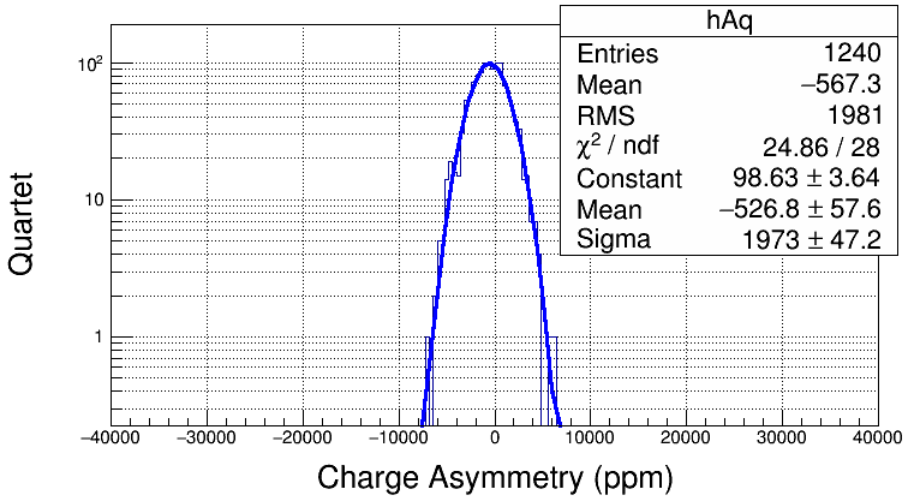


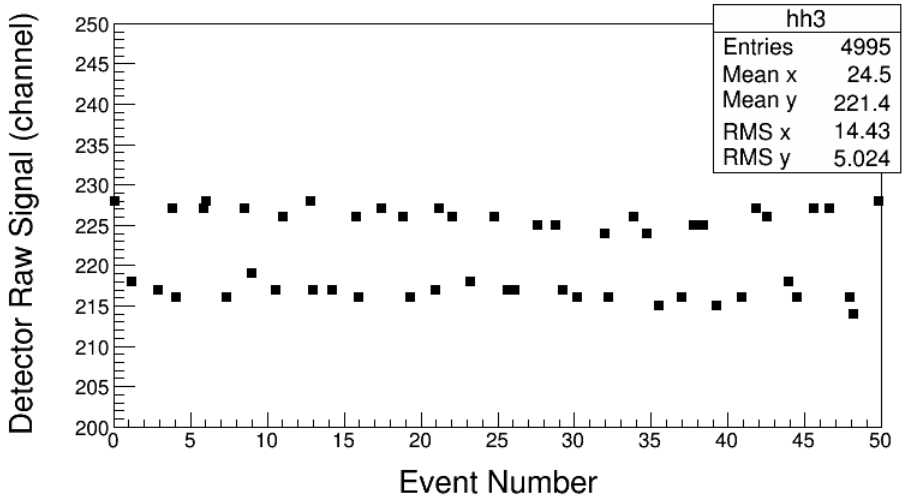


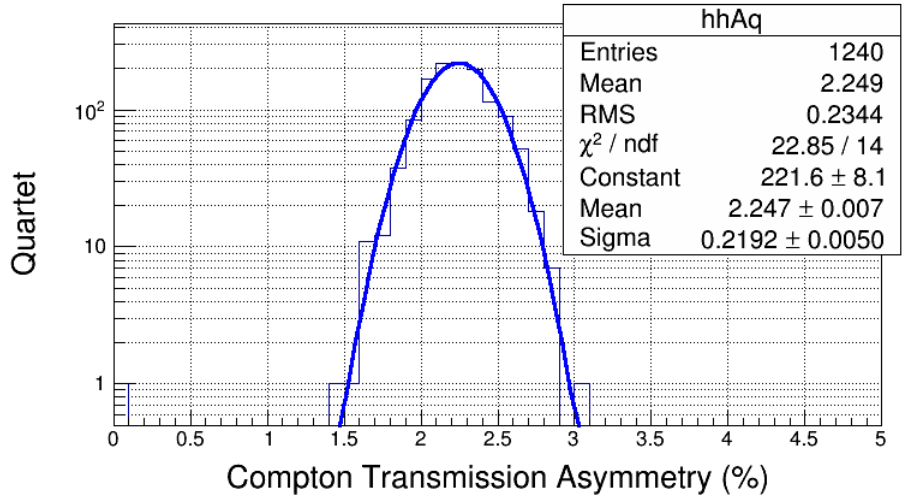


Raw Signals and Asymmetries – Run 8823

- 4 Amps, OUT, 1.9 μA, 175 sec.

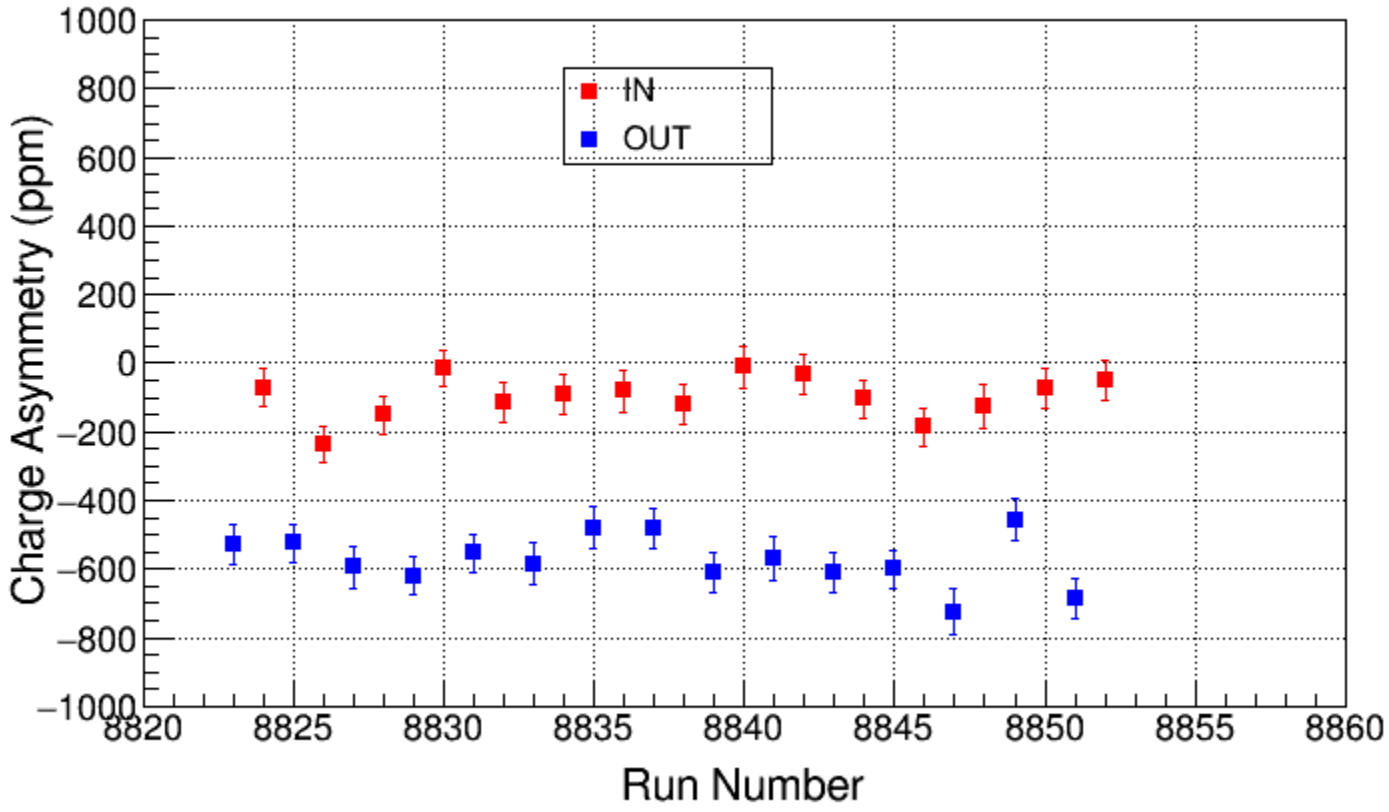






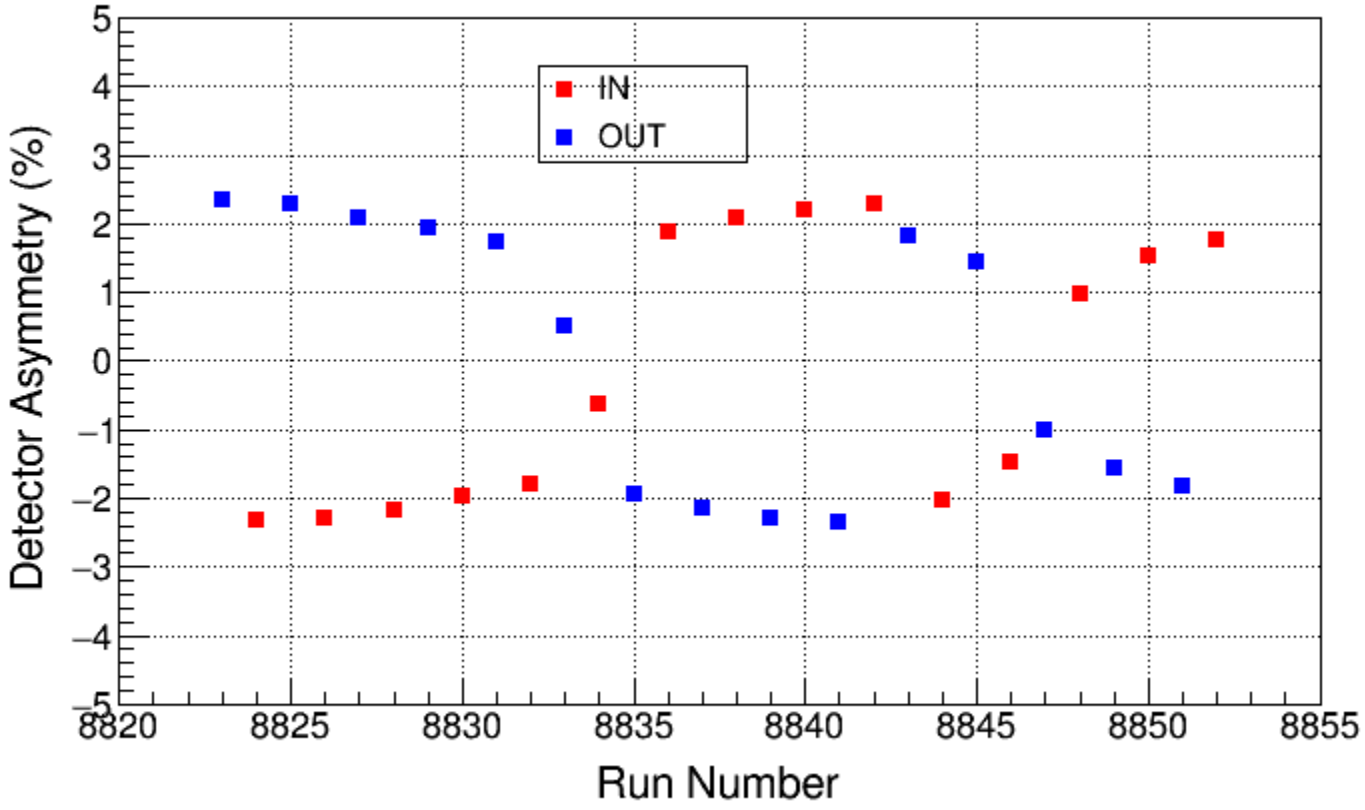
Charge Asymmetry

- Beam current: 1.7 μA



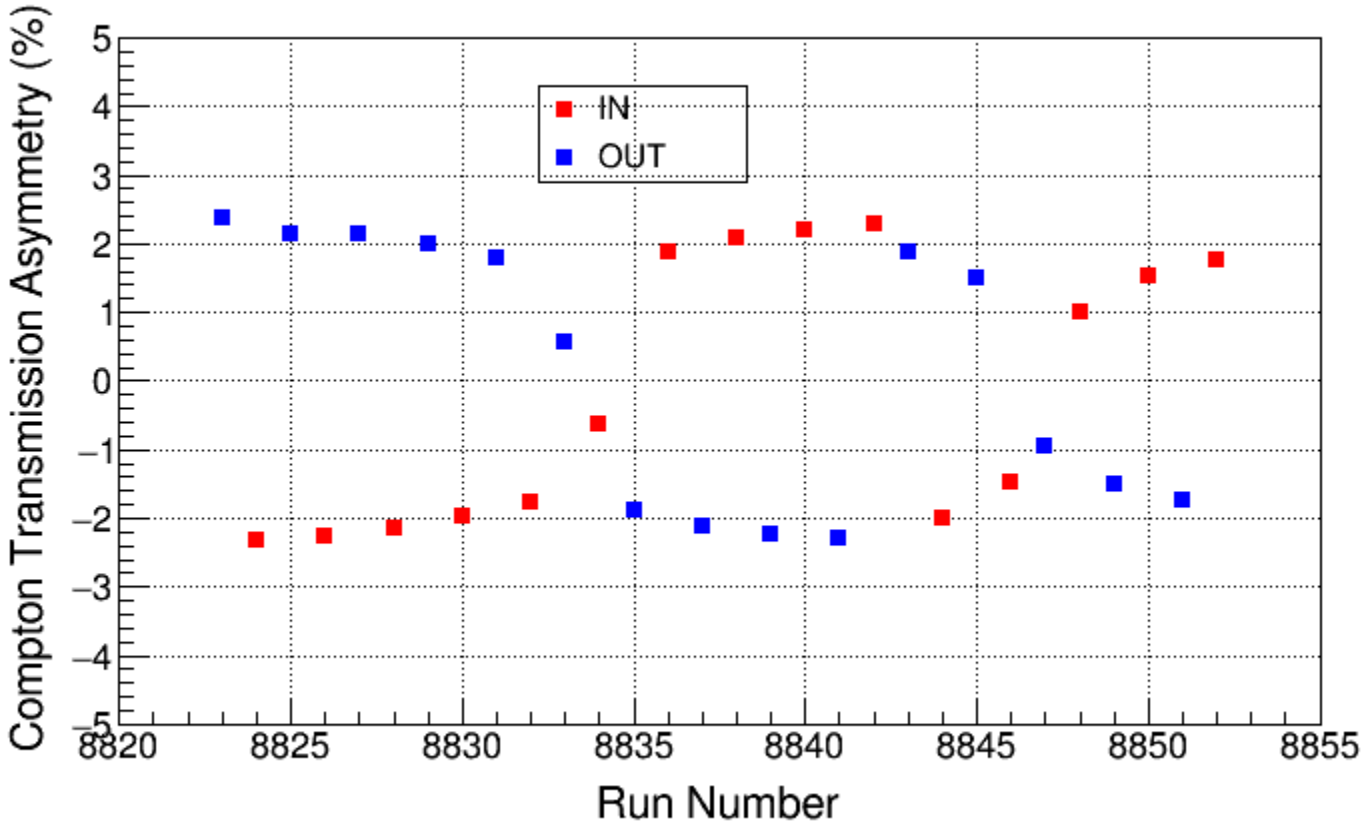
Detector Asymmetry vs Run Number

- Beam current: 1.7 μA
- Magnet Current: -4 – 4 Amps



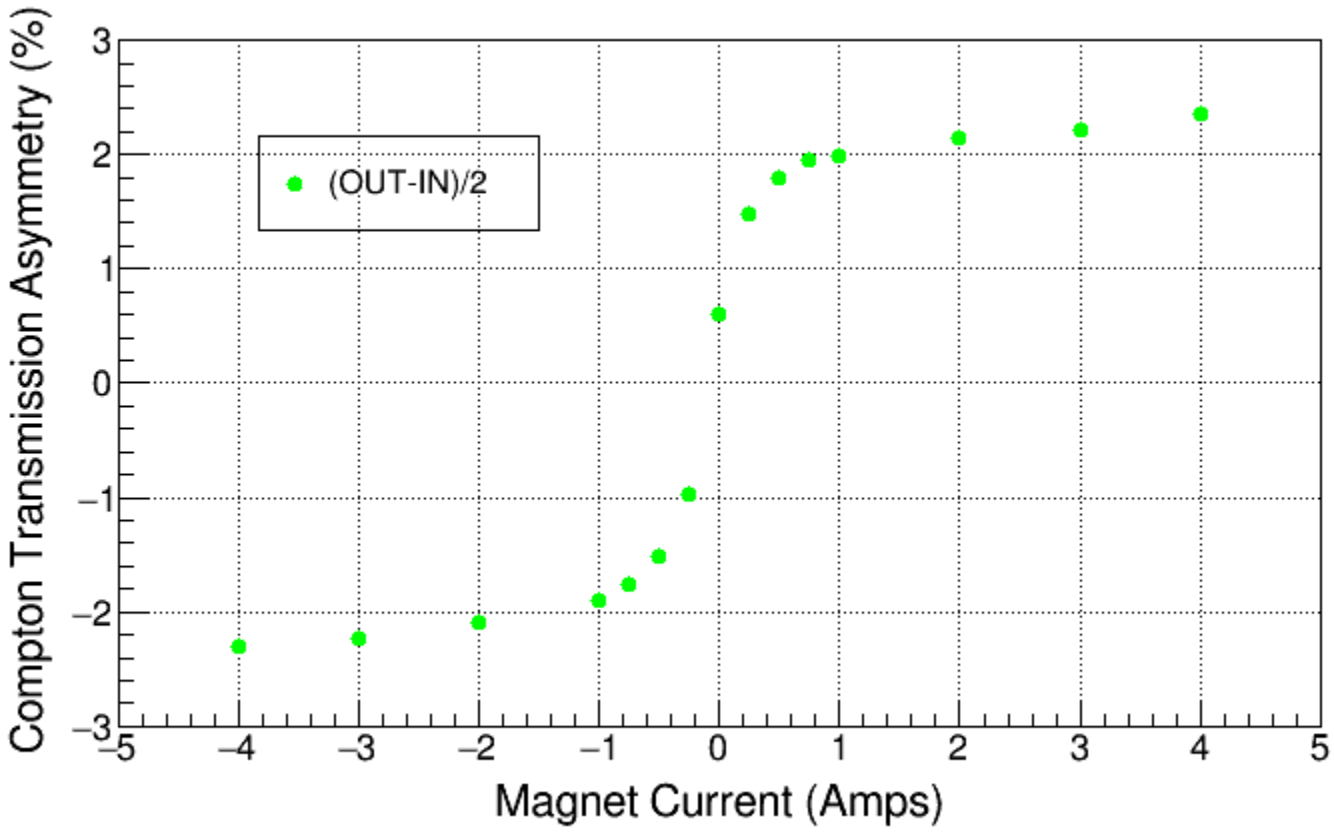
Compton Transmission Asymmetry vs Run Number

- Beam current: 1.7 μA
- Magnet Current: -4 – 4 Amps



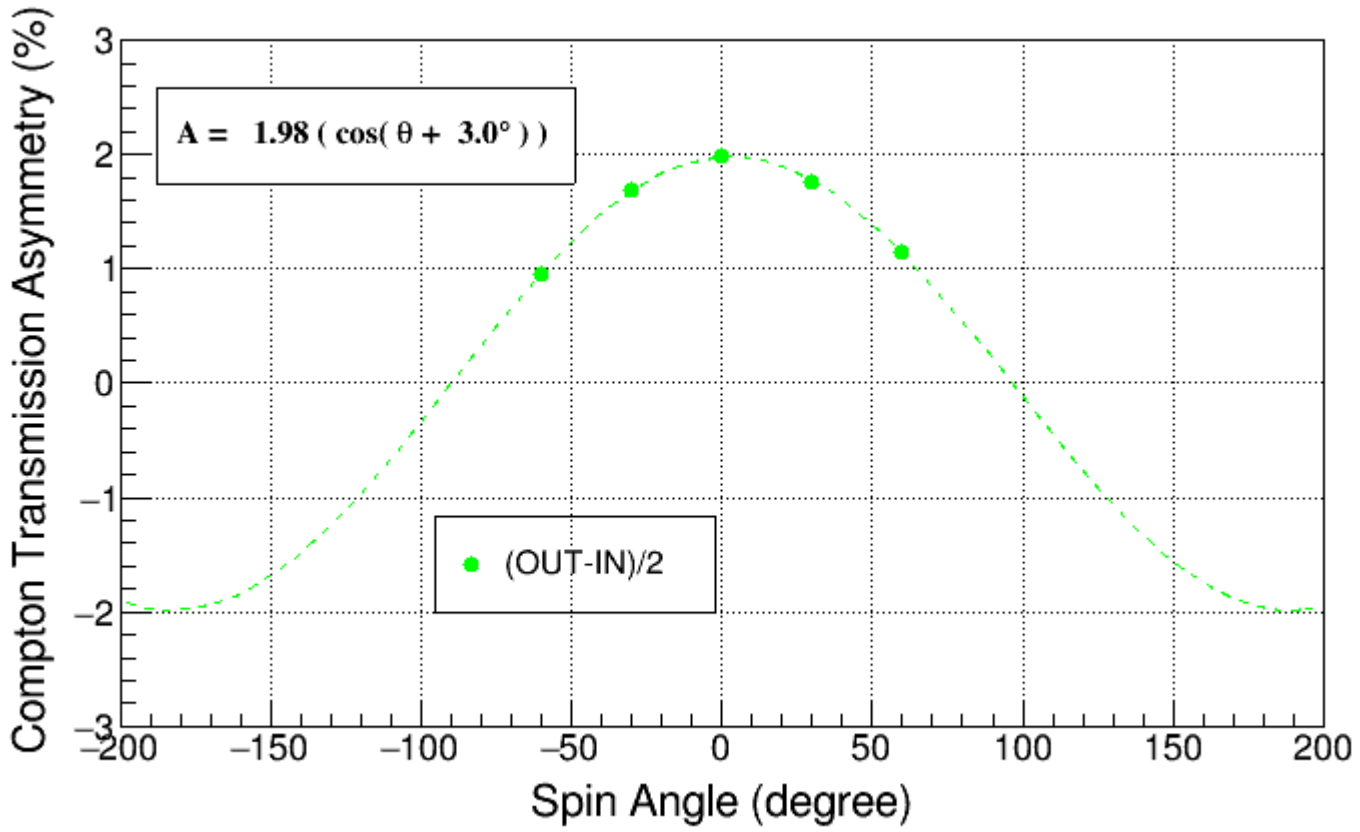
Compton Asymmetry vs Magnet Current

- Average Compton Transmission Asymmetry: (OUT – IN/)/2



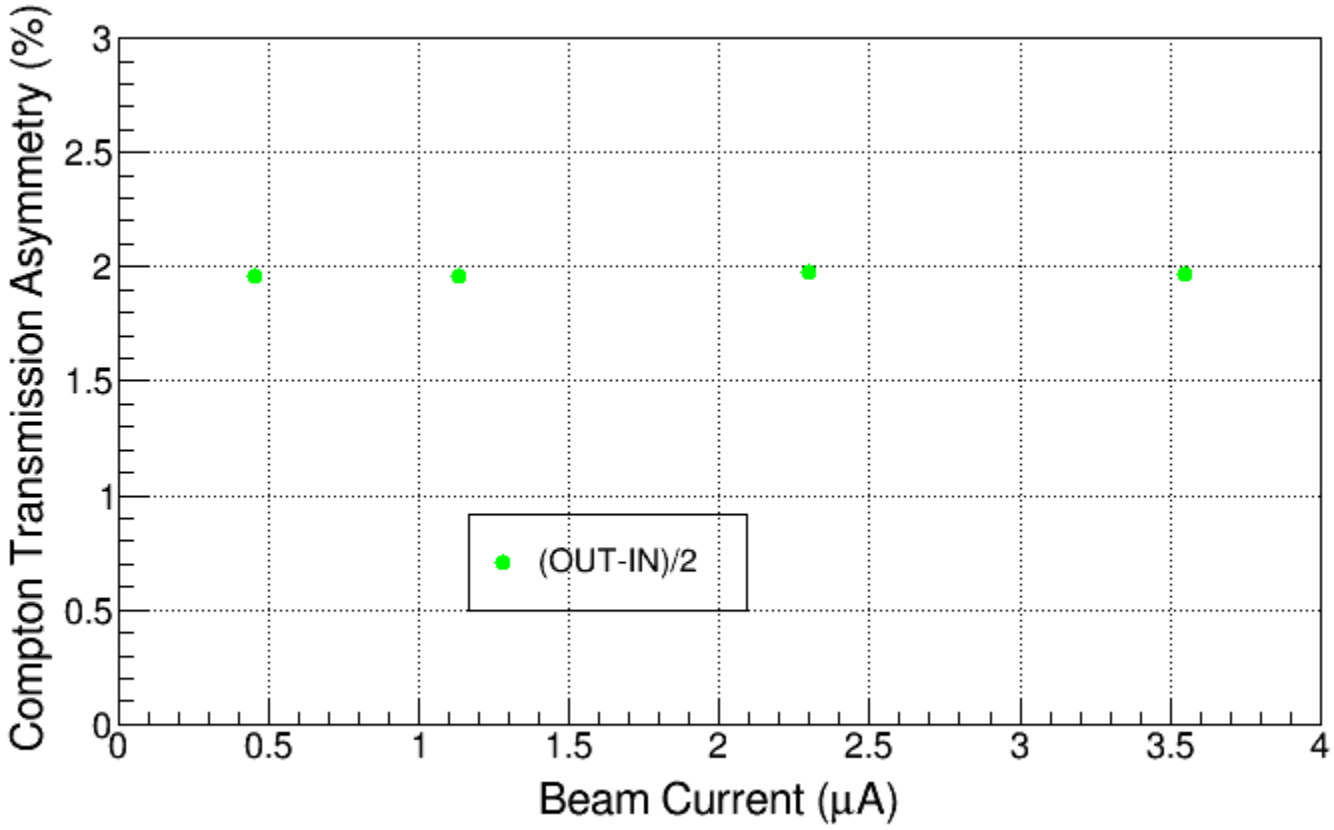
Compton Asymmetry vs Horizontal Wien Angle

- Beam current: 1.7 μA
- Magnet Current: +1 Amps



Compton Asymmetry vs Beam Current

- Magnet Current: +1 Amps



Compton Asymmetry Width and Detector Rate

- Magnet Current:

Detector Rate (if width only statistical):

$$R = \frac{1}{4 \times 0.0333 * 0.002344^2}$$

~ 1.4 MHz

Design of
BNL Compton Transmission Polarimeter

GEANT4 Optimization

- Include Polarized Physics:

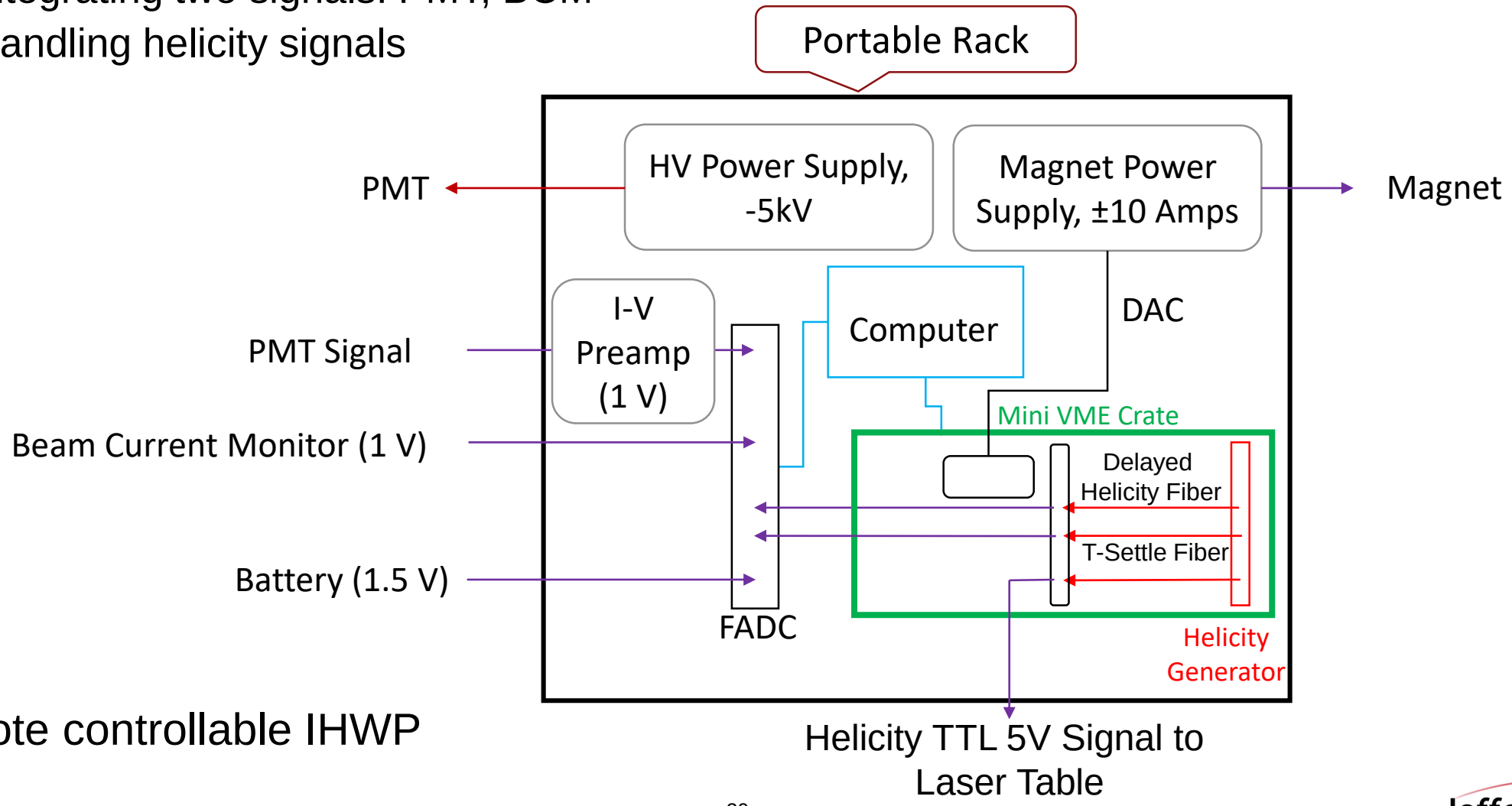
Particle	Process Name	Class Name (GEANT4)
Electron	Multiple Scattering	**G4eMultipleScattering**
	Discrete and Continuous Energy Loss	**G4ePolarizedIonisation**
	Bremsstrahlung	**G4ePolarizedBremsstrahlung**
Positron	Multiple Scattering	**G4eMultipleScattering**
	Discrete and Continuous Energy Loss	**G4ePolarizedIonisation**
	Bremsstrahlung	**G4ePolarizedBremsstrahlung**
	Annihilation	**G4eplusPolarizedAnnihilation**
Gamma	Photoelectric Effect	**G4PolarizedPhotoElectricEffect**
	Compton Scattering	**G4PolarizedCompton**
	Gamma Conversion	**G4PolarizedGammaConversion**

- Goal: maximize Figure-pf merit: $\mathrm{fo}m\left(E_b, T_{radiator} L_{magnet}, L_{detector} \ldots\right) = A_p^2 \times N$

  where *N* is number of gammas in detector

New Portable DAQ

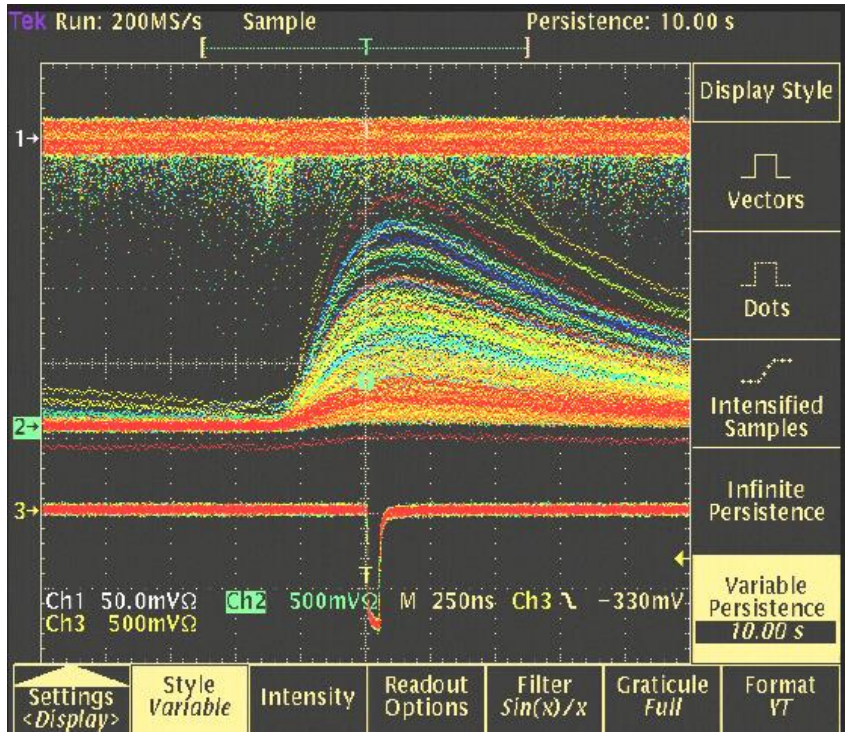
- DAQ capable of :
  - Integrating two signals: PMT, BCM
  - Handling helicity signals



- Remote controllable IHWP

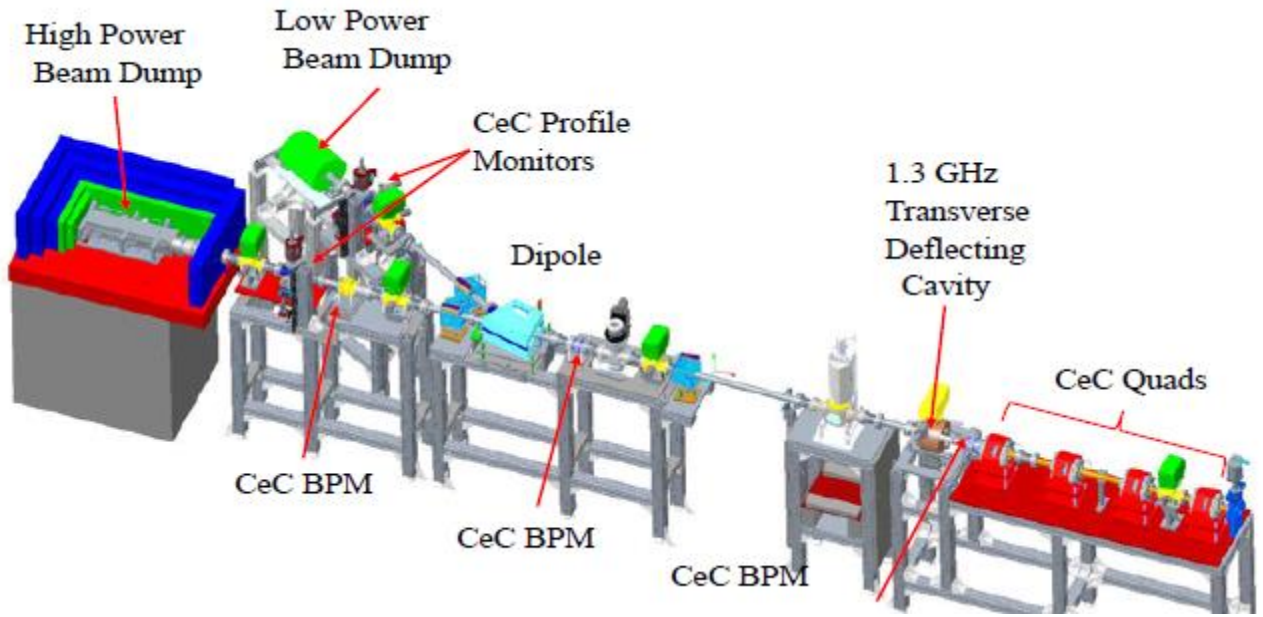
SRF Source at BNL

- Laser:
  - IHWP
  - Control of Pockels Cell HV switch – will provide 5V TTL helicity signal
  - No requirement on pulse width

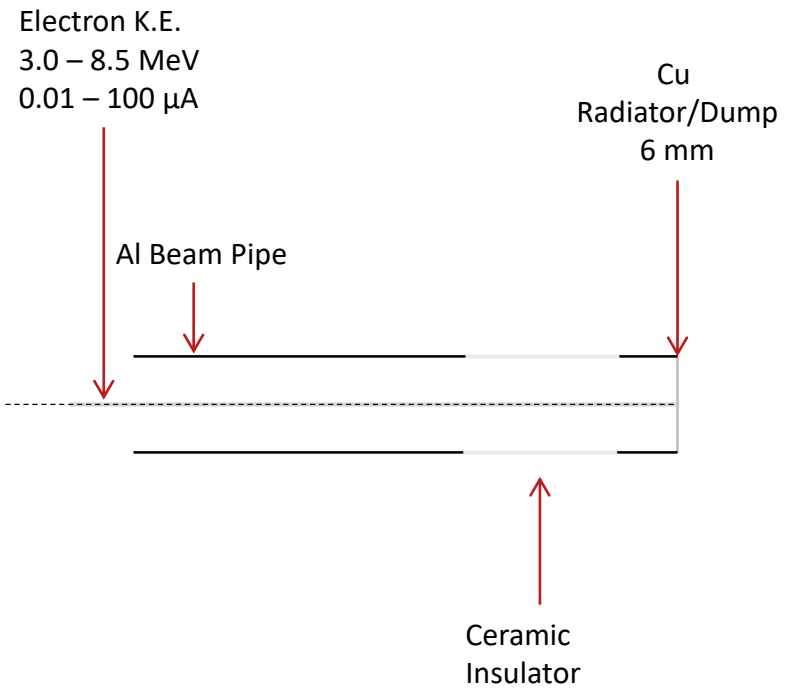


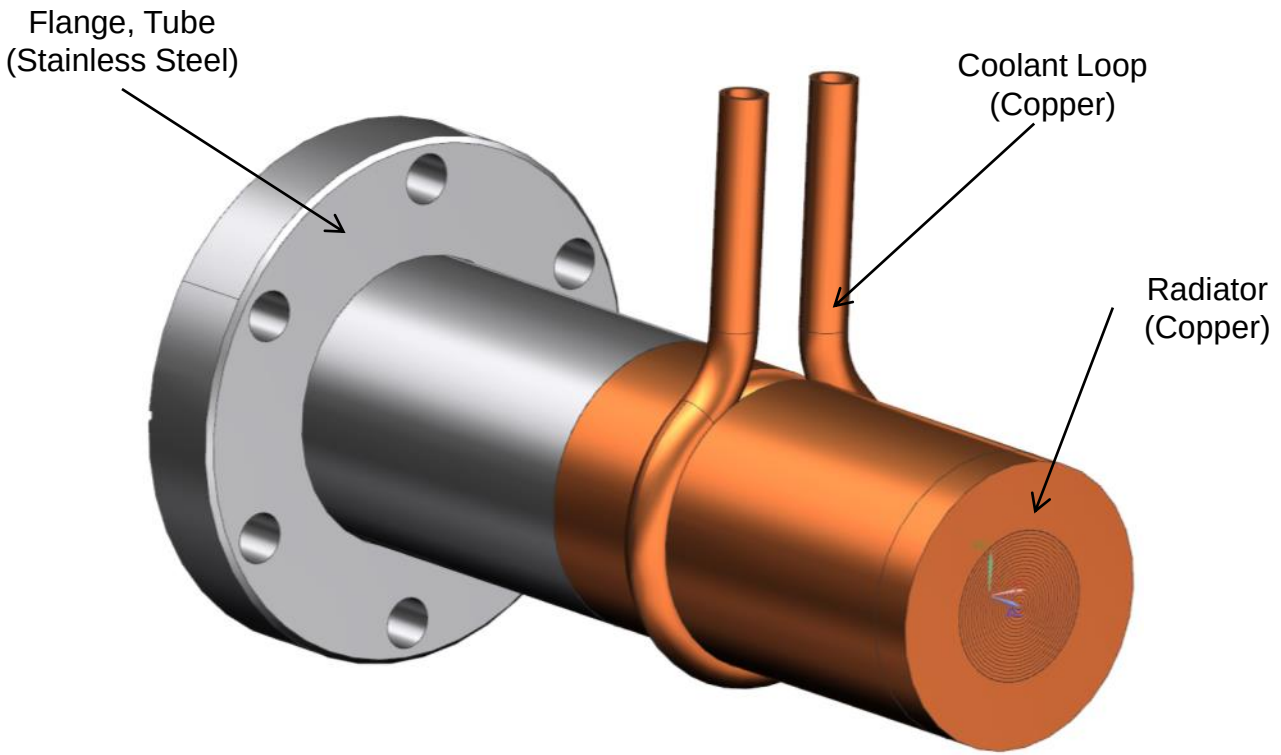
- Electron Beam:
  - Beam Current: ~µAs ?
  - Beam Energy: 5 – 9 MeV ?
  - Beam Frequency: > 1MHz ?
  - Need full schematic of beamline
  - Expected location of polarimeter
  - Is there any possibility to measure beam energy ?

BNL Beamline



Radiator


Electron K.E.
3.0 – 8.5 MeV
0.01 – 100 µA
Cu
Radiator/Dump
6 mm
Al Beam Pipe
Ceramic
Insulator


Flange, Tube
(Stainless Steel)
Coolant Loop
(Copper)
Radiator
(Copper)