

# *Development of Beam Polarimeter for BNL SRF Gun*

NP Accelerator R&D + Data Science  
AI/ML virtual PI Exchange meeting on  
November 30, 2021

Riad Suleiman

Monday, November 29, 2021

 Jefferson Lab

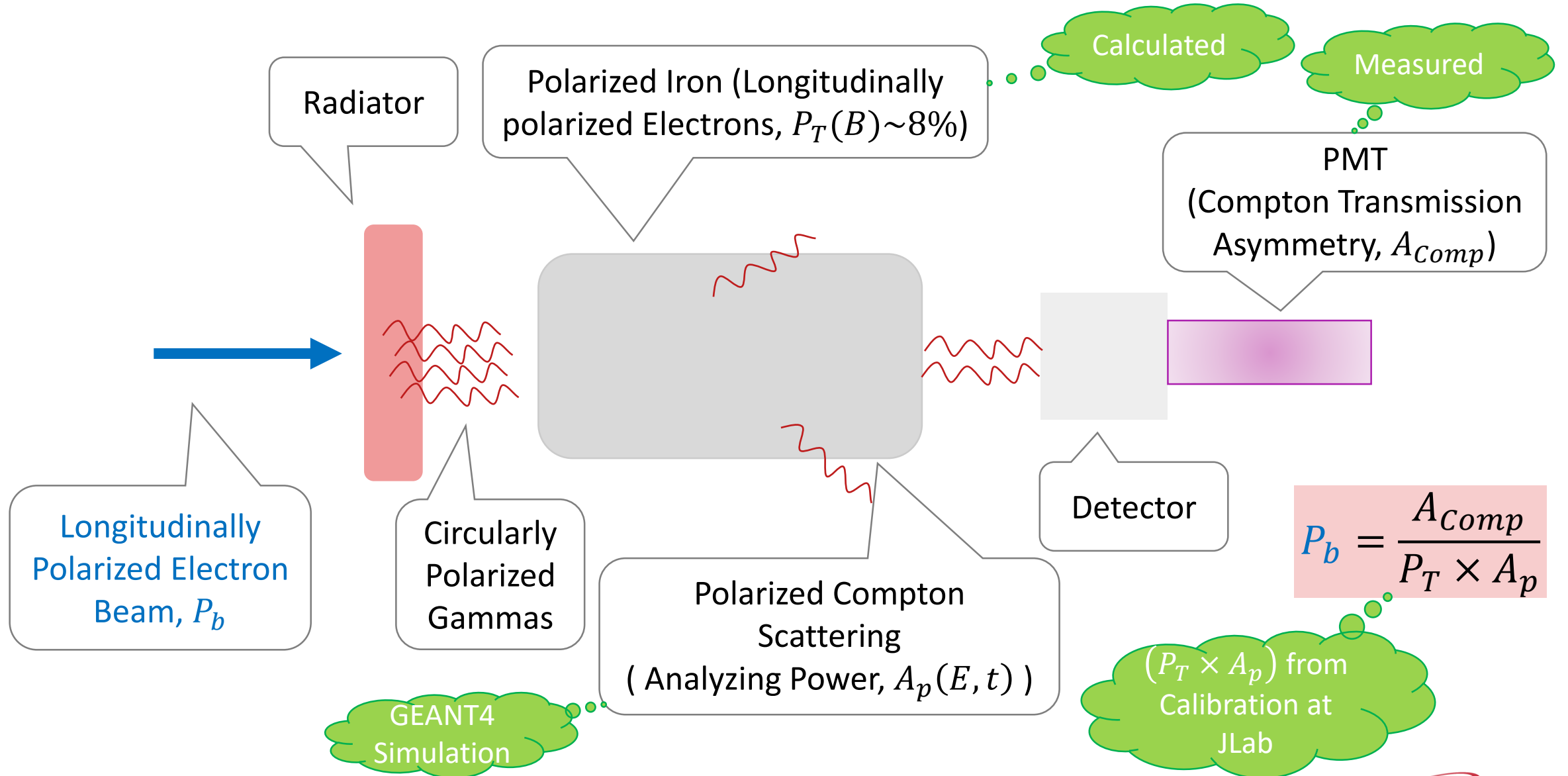
# Goals, Timeline, and Budget

- Co-Principal Investigator: Riad Suleiman, with Joe Grames and Matt Poelker (Jefferson Lab), and Eric Voutier (IJCLab, Orsay, France)
- Jefferson Lab's contribution to this project is to provide a Compton Transmission Polarimeter, which will be used to measure beam polarization when SRF photogun employs a GaAs photocathode. IJCLab is contributing to Jefferson Lab's effort.

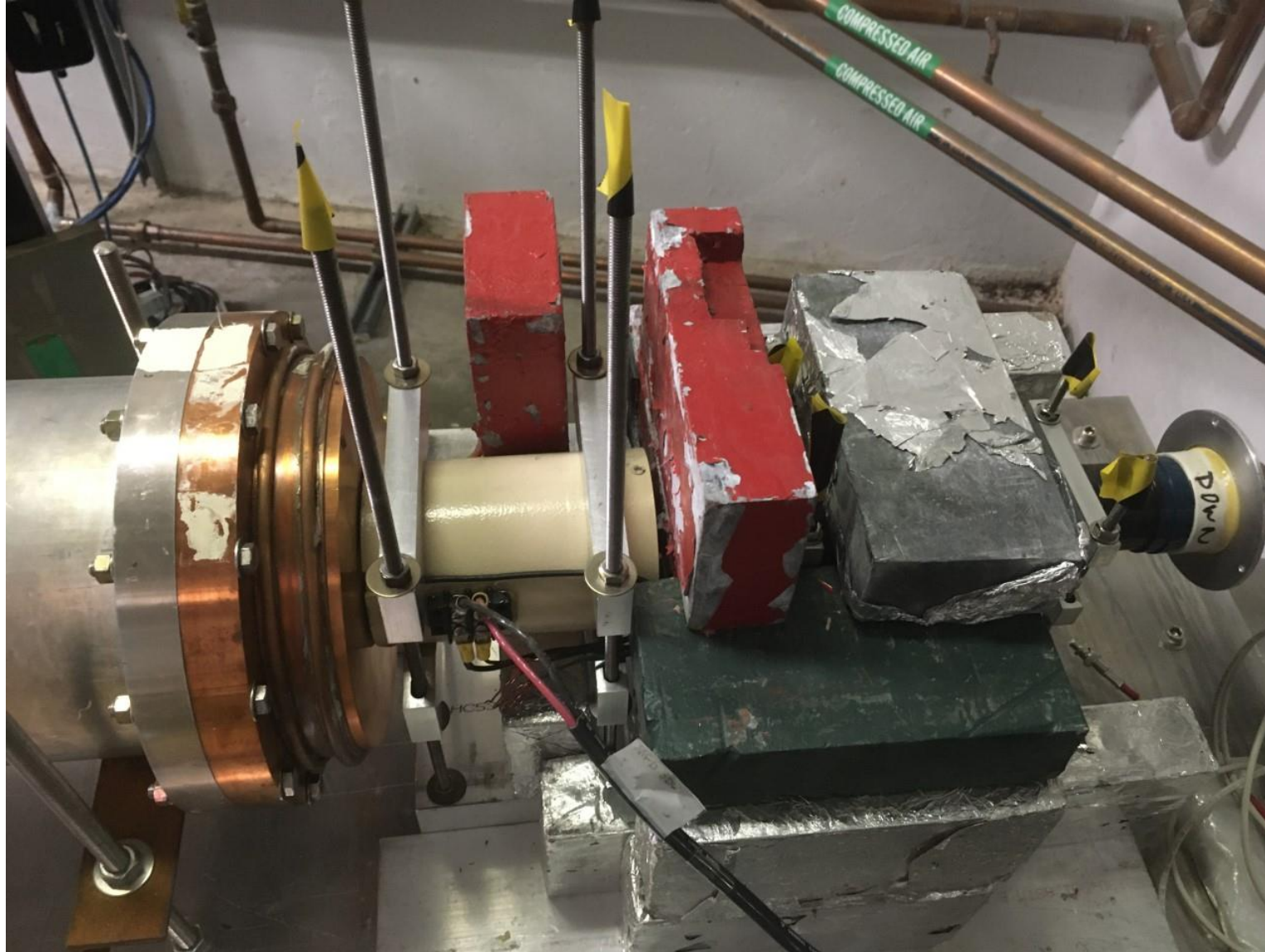
	FY20	FY21	Totals
	(\$k)	(\$k)	(\$k)
<b>a) Funds allocated</b>	200.1	200.1	400.2
<b>b) Actual costs to date</b>	10.9		

- Goals:
  - Year 1: Design and build electron beam polarimeter
  - Year 2: Install and commission polarimeter at CeC accelerator
- Current Status:
  - Design of polarimeter and new portable data acquisition system (DAQ) is completed
  - NCE for one more year was approved

# Compton Transmission Polarimeter



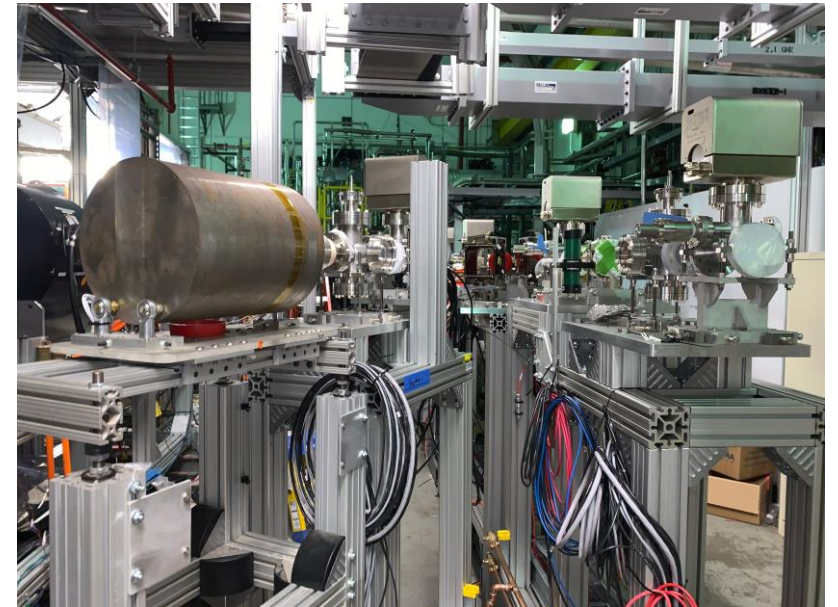
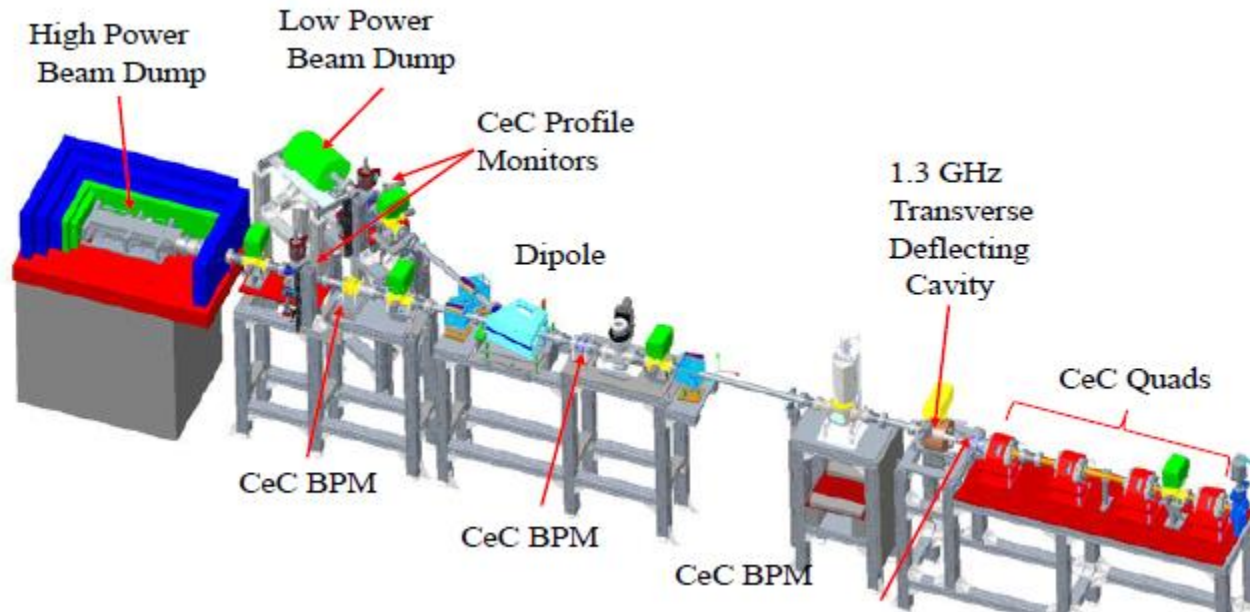
# An Example of Polarimeter at Jefferson Lab CEBAF – Summer 2018



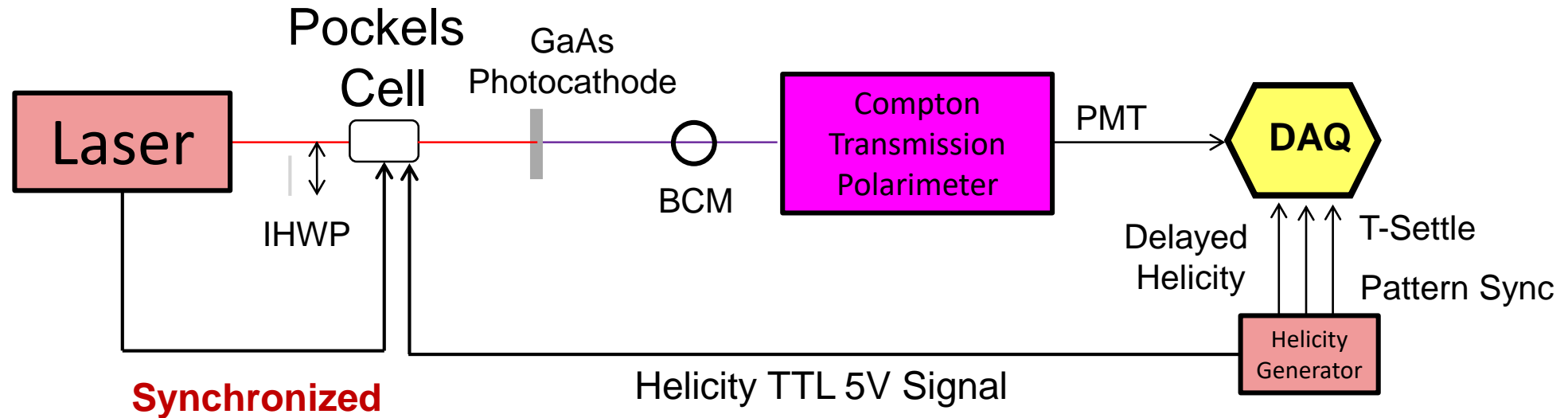


# Polarimeter Parameters

- CEBAF Injector can deliver electron beam with 5 – 9 MeV kinetic energy
- CEBAF Mott polarimeter ideally works at 5 MeV kinetic energy
- At BNL, electron beam kinetic energy will be 5.0 MeV (total energy 5.5 MeV)
  - Minimum radiation levels and no risk of activation
- Compton Transmission Polarimeter will be installed in place of Low Power Beam Dump
- Maximum average current is limited to 2.5  $\mu\text{A}$  by Low Power Dump



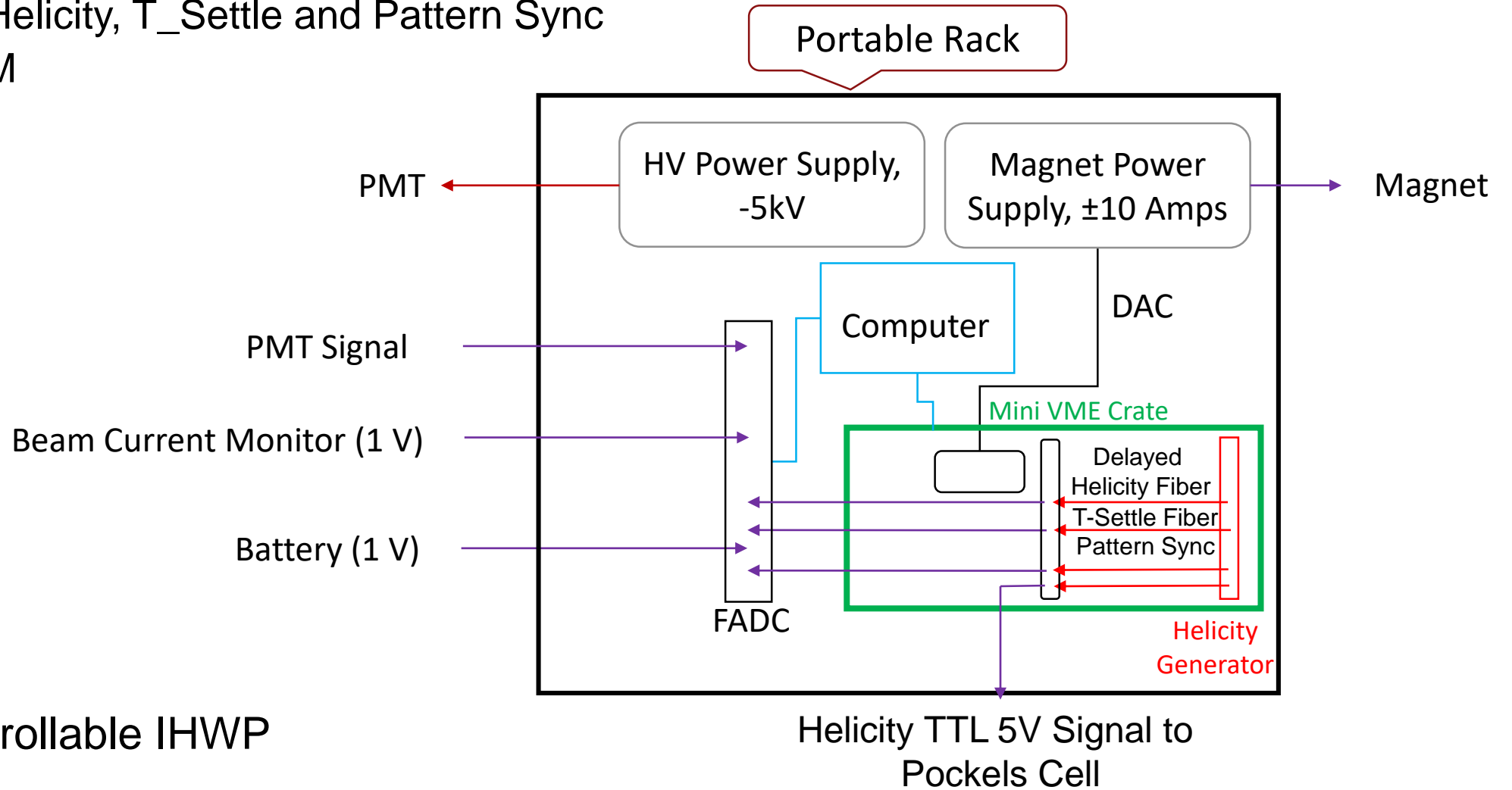
# Polarimeter Schematics at BNL



- Pockels Cell is synchronized to laser
- Helicity board will just provide a gate to determine which voltage (helicity) Pockels Cell gets set to

# New Portable Data Acquisition System (DAQ)

- DAQ Readout:
  - Delayed Helicity, T\_Settle and Pattern Sync
  - PMT, BCM
  - Battery



- Remote controllable IHWP

# Polarimeter Design Optimization

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- Student Benjamin Fernandes Neres (from France)
- [https://wiki.jlab.org/ciswiki/images/8/82/CompPol\\_Optimization\\_B.Fernandes-Neres.pdf](https://wiki.jlab.org/ciswiki/images/8/82/CompPol_Optimization_B.Fernandes-Neres.pdf)
- GEANT4 simulation model of Compton transmission polarimeter was successfully implemented
- Optimization of polarimeter:
  - Radiator length = 7.0 mm, magnet iron core length = 8.0 cm, crystal detector radius = 3.5 cm and length larger than 18.0 cm
- Evaluated of performance within BNL beam conditions (duration of a measurement, radiation damage to crystal detector)

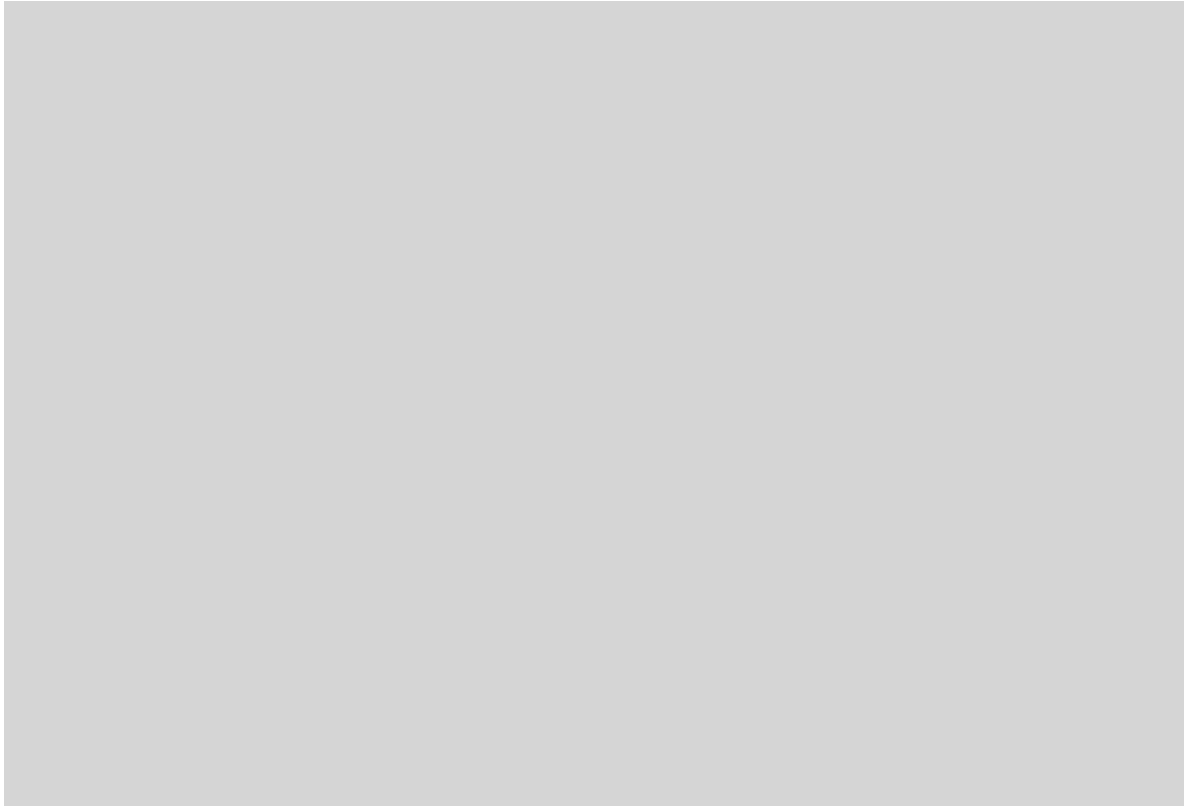


# Achievements, Milestones and New Timeline

- Year 1:
  - Agreed upon basic operational parameters of polarized electron beam and polarimeter
  - Portable DAQ design completed and implementation started
  - Jefferson Lab Fast Electronics Group has finished programming of flash analog-to-digital convertor (FADC) and now working on user interface of DAQ
  - Polarimeter (radiator, magnet, and detector) design was optimized using GEANT4
- Year 2:
  - Magnet engineer started design of electro-magnet with iron core
  - Build two polarimeters (radiator, magnet, and detector) and one portable DAQ – one polarimeter will stay at CEBAF
- Year 3:
  - Calibrate polarimeter at CEBAF with portable DAQ
  - Install and commission polarimeter at CeC accelerator
- When SRF photogun employs a GaAs photocathode: Measure electron beam polarization



**Jefferson Lab**



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