Electron Beam Properties of BNL SRF Gun

Electron beam properties to measure beam polarization with a Compton Transmission Polarimeter

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Saturday, February 13, 2021

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U.S. DEPARTMENT OF ENERGY | Office of Science

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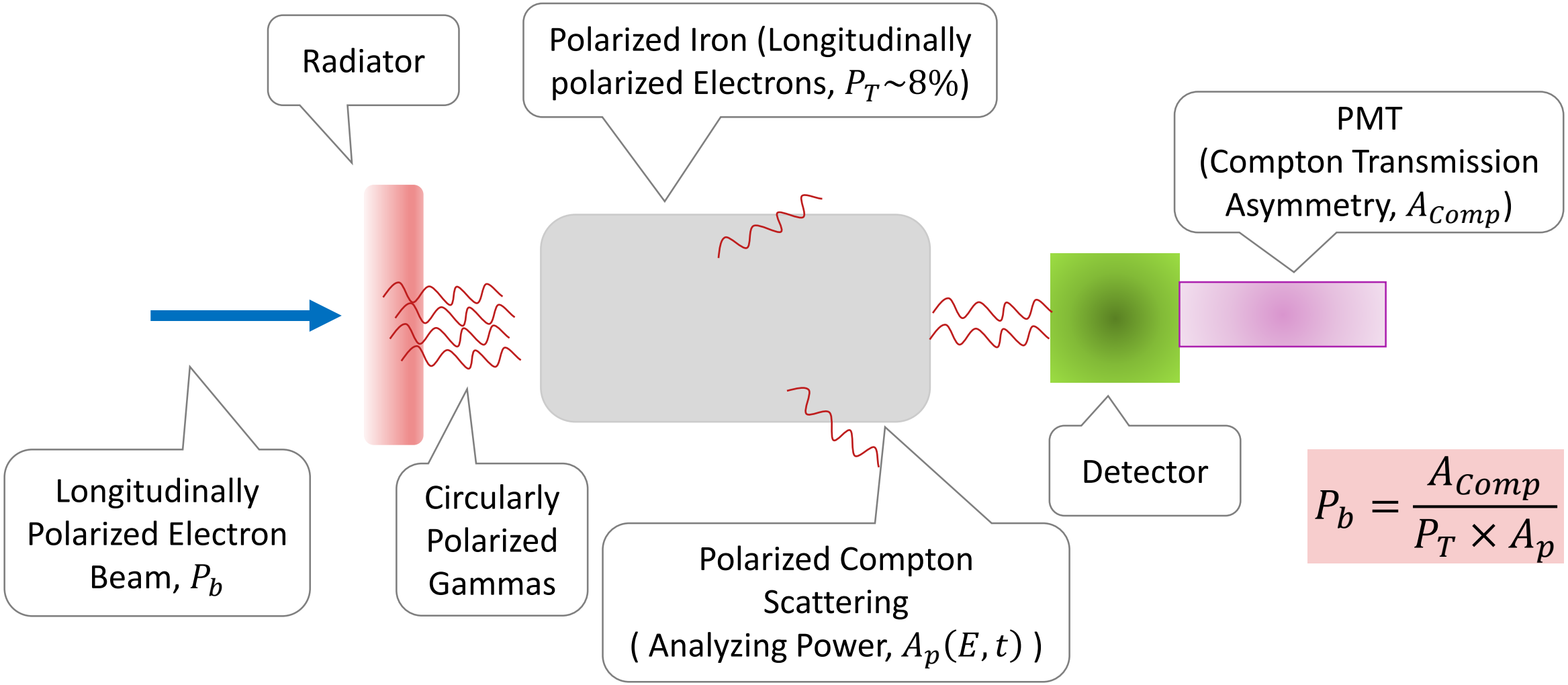
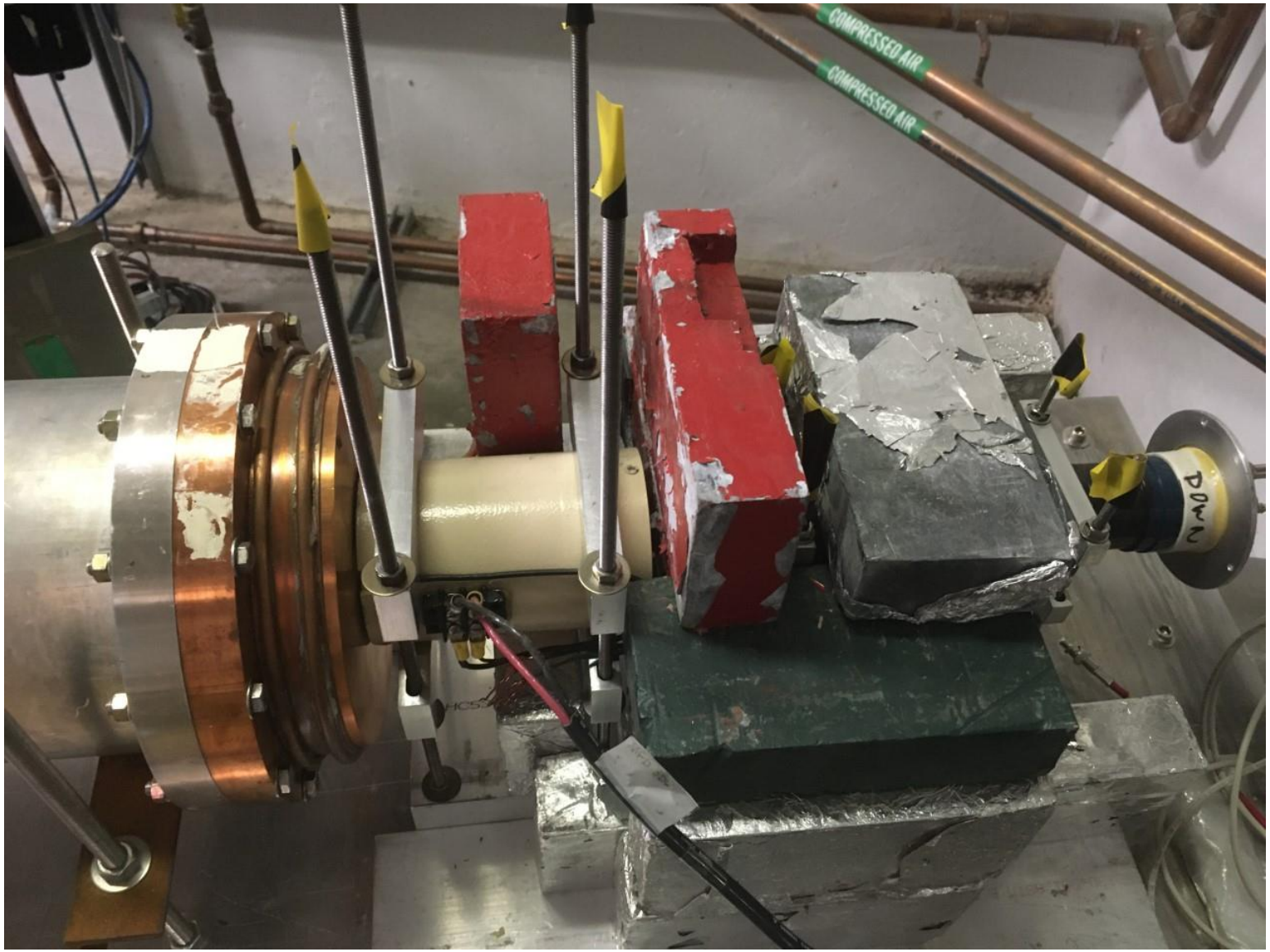
Compton Transmission Polarimeter



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

Test Setup at Jefferson Lab



Beam Energy

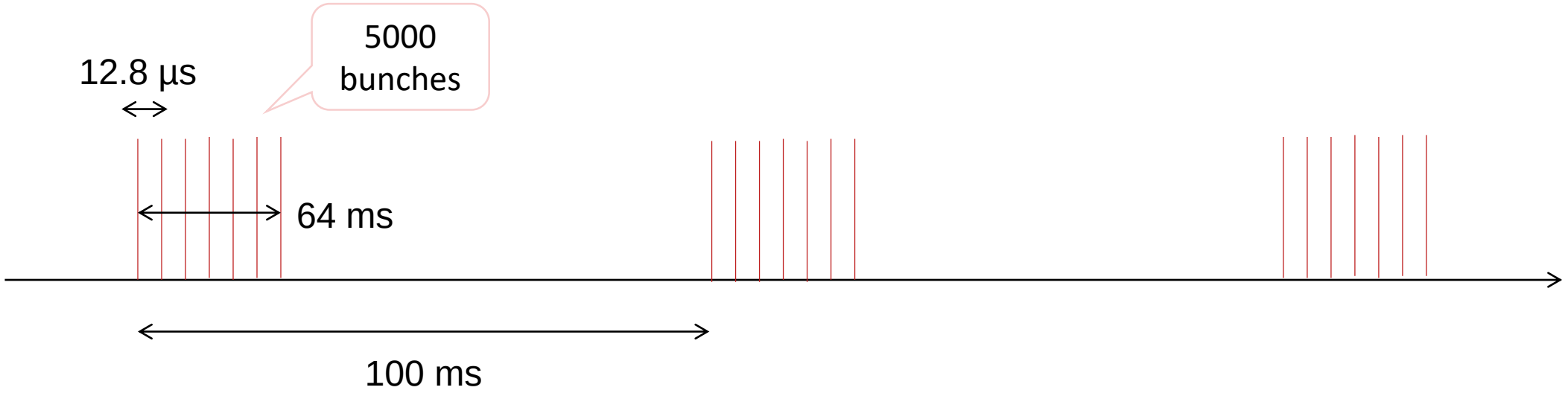
- CEBAF Injector can deliver electron beam with 5 – 9 MeV kinetic energy
- CEBAF Mott polarimeter ideally works at 5 MeV kinetic energy

- **<u>BNL beam kinetic energy should be 5.0 MeV (total energy 5.5 MeV)</u>**
  - Minimum radiation levels and no risk of activation

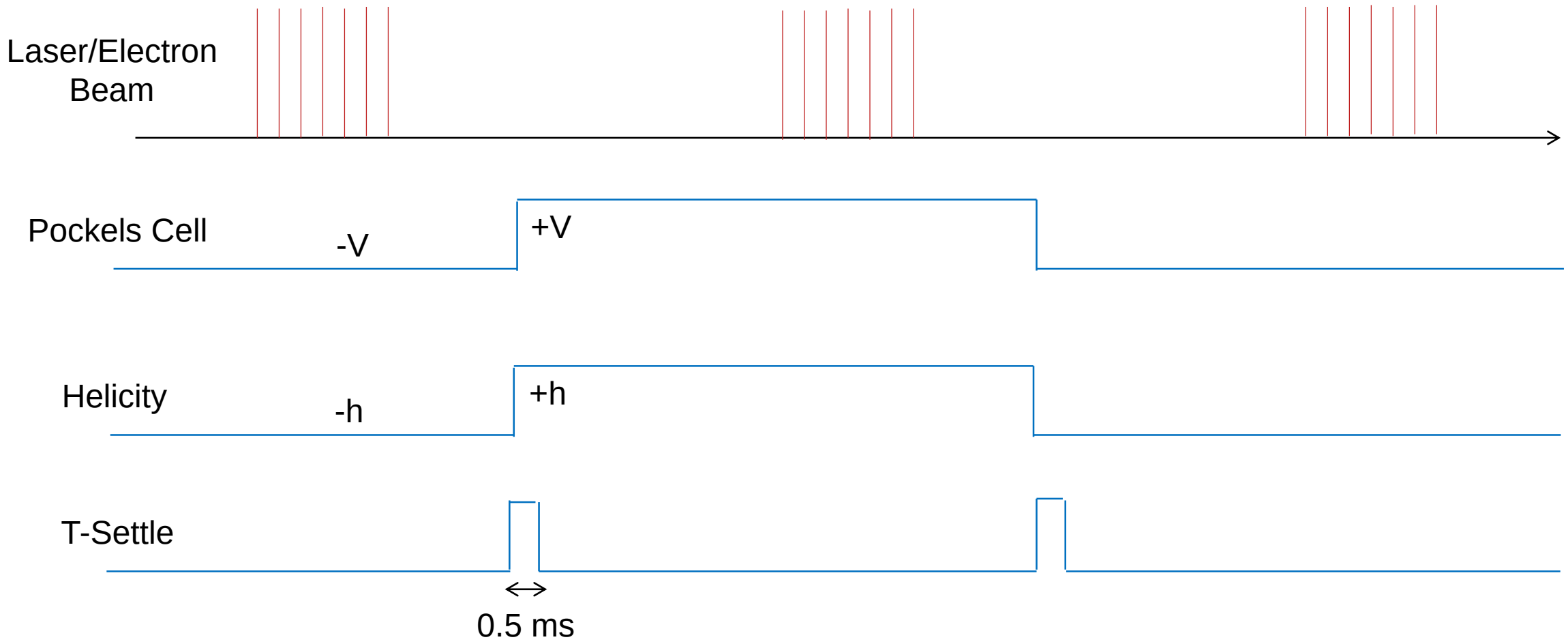
Laser (Electron) Beam Timing at BNL

- Microbunch structure: 78 kHz, or 12.8 µs, each bunch < 1 ns

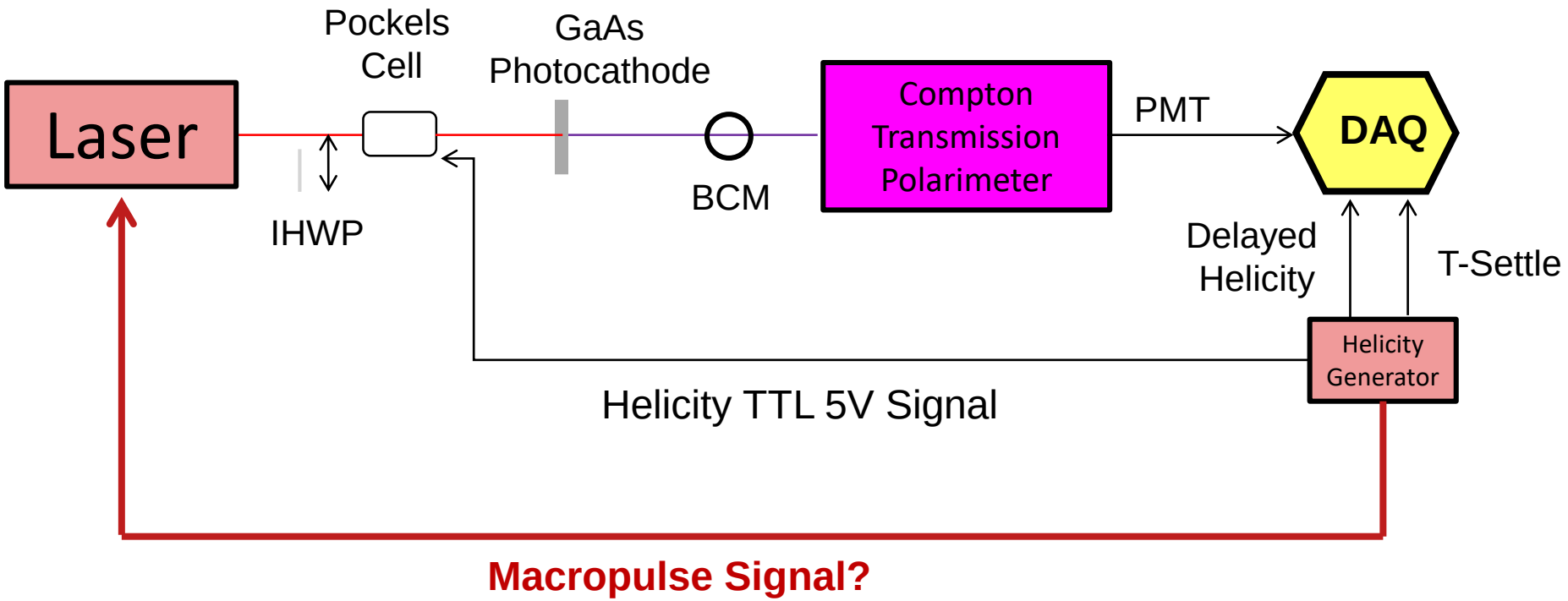
- Macropulse repetition rate: 1 Hz, 5 Hz or 10 Hz for microbunch trains. Number of microbunches in train can be 1,10, …, 5000 …, with bunch repetition rate of 78 kHz



Laser/Electron Beam, Pockels Cell, and Helicity Board Timing

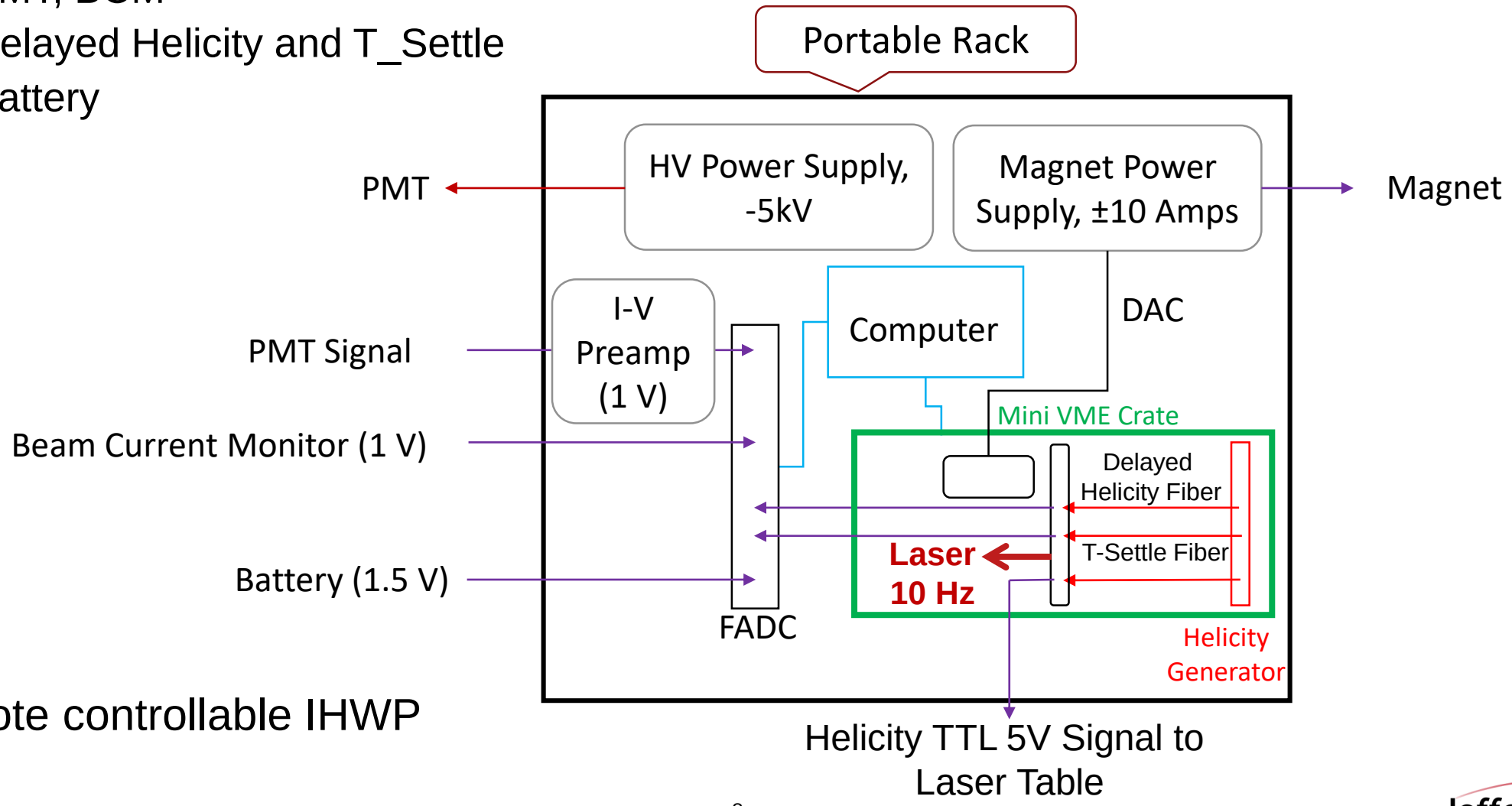


Polarimeter Schematics at BNL



New Portable DAQ

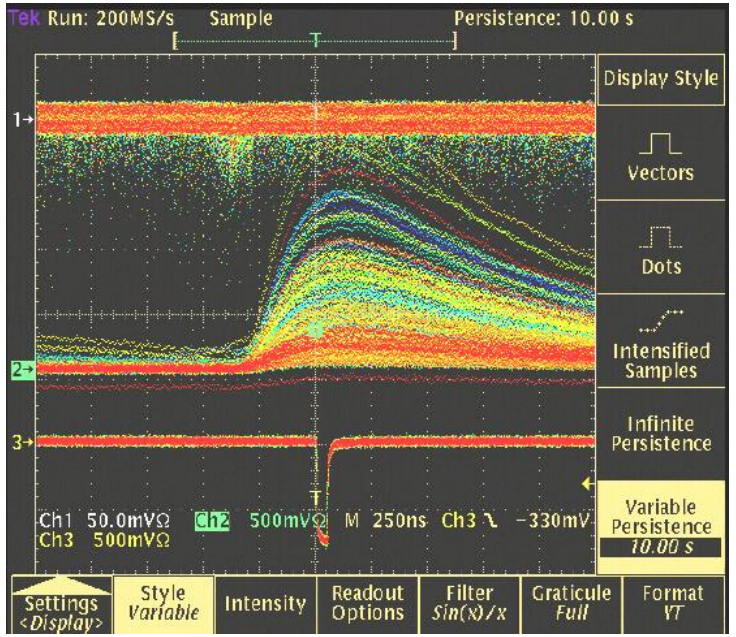
- DAQ Readout:
  - PMT, BCM
  - Delayed Helicity and T_Settle
  - Battery



- Remote controllable IHWP

DAQ Readout

- Each electron beam bunch < 1 ns
- Each bunch will generate a detector signal of about 1 μs
- Bunch separation is 12.8 μs
- There are 5000 bunches per helicity window



- Helicity Board will run at 10 Hz:
  - T-Settle = 0.5 ms
  - T-Stable = 99.5 ms

- DAQ Modes (self-triggered):
  - Semi-Int Mode: integrate over 1 μs at rate of 50 kHz
  - Sample Mode: 250 samples (two channels) and 25 samples (three channels) at 50 kHz
- No deadtime/pileup since events (bunches) are not random

Synchronization by Helicity Board

- **T-Settle signal will provide 10 Hz synch signal to laser. Is this possible? If not, how do we plan to synchronize laser and Pockels Cell?**
- **Can we run at 78 kHz with no macropulse structure?**
- **Would field emission reach polarimeter?**

- Helicity TTL 5V Signal to Pockels Cell
- DAQ will self-trigger at 50 kHz

Bunch Charge and Average Beam Current

- Assume an average beam current of 1 μA
  - Bunch Charge = 10^{-6} / 7.8x10^{4} = 13 pC

- What is the expected bunch charge at BNL? Average current?
- At Jefferson Lab, 13 pC can be spread over 0.5 μs, for example

- To plan for unknown bunch charge, PMT high voltage will be used to keep detected signal at required level – prevent saturation of PMT/ADC or too small signal relative to pedestal

- Need a voltage signal (~1 V) with large bandwidth from a Beam Current Monitor to measure charge asymmetry