

Electron Beam Properties of BNL SRF Gun

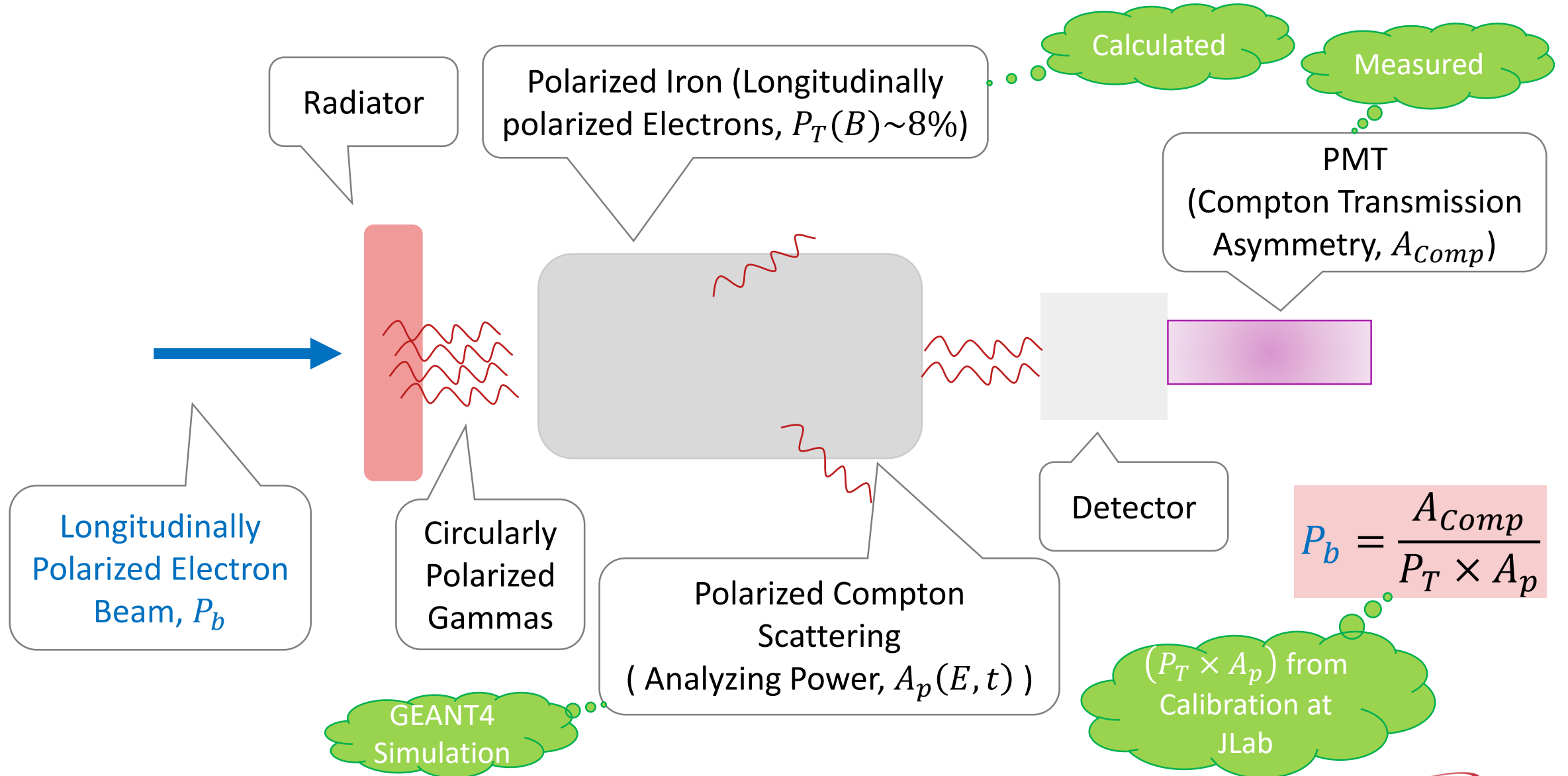
Electron beam properties to measure beam polarization with a Compton Transmission Polarimeter

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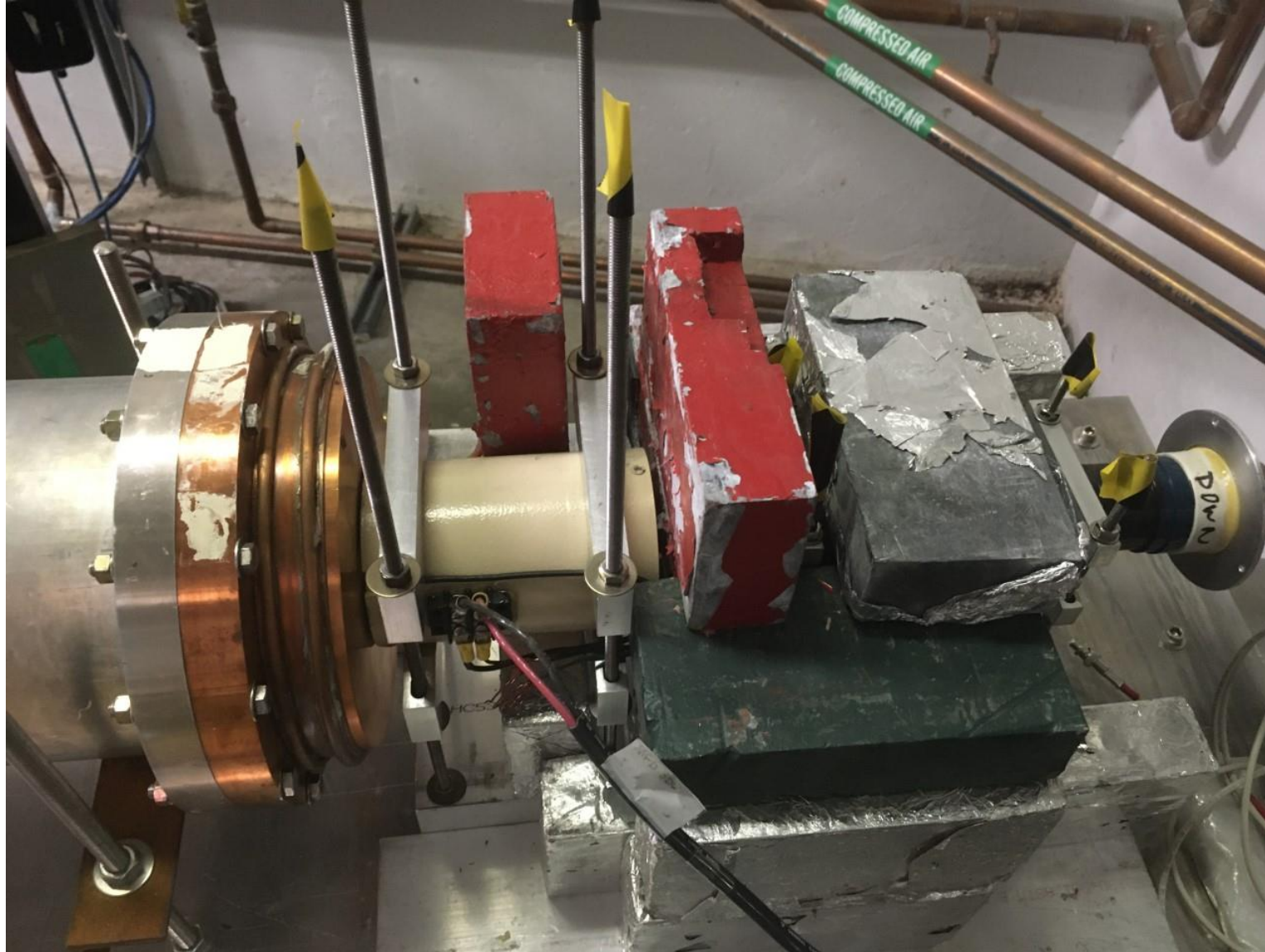
Friday, February 19, 2021

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Compton Transmission Polarimeter



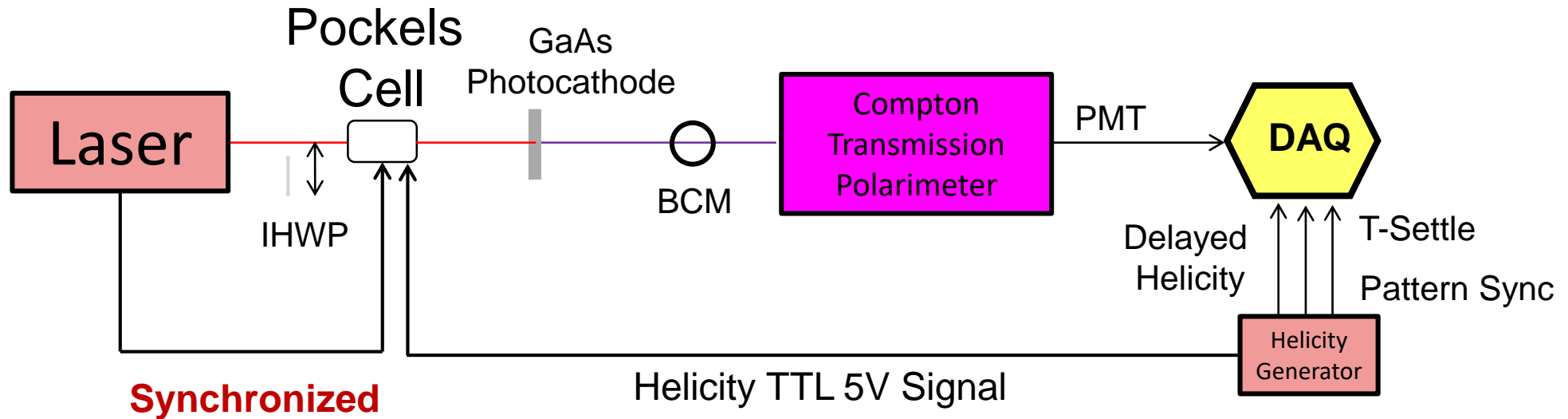
Test Setup at Jefferson Lab



Beam Energy

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

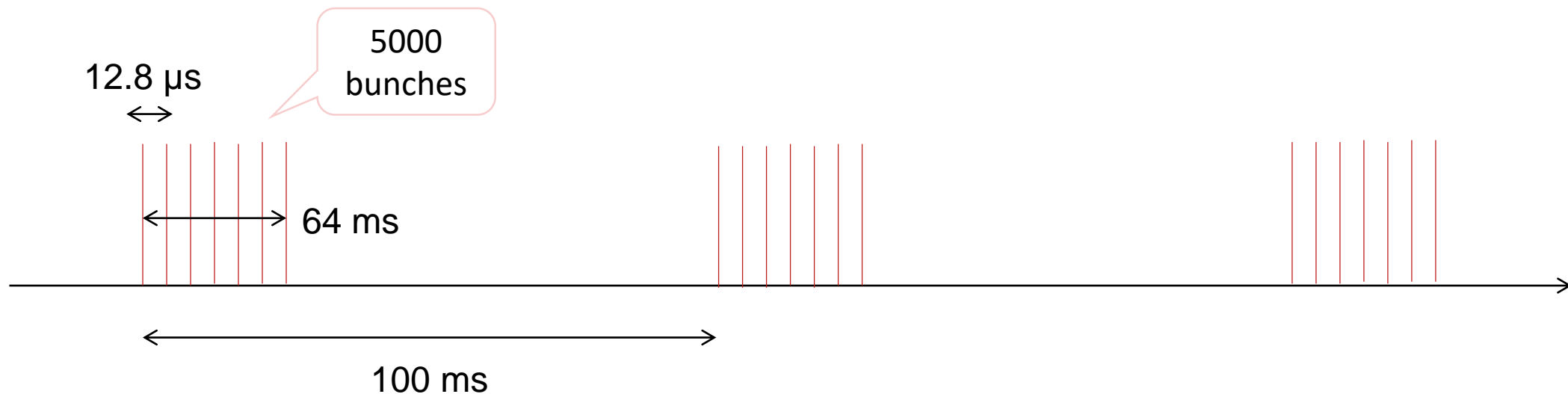
Polarimeter Schematics at BNL



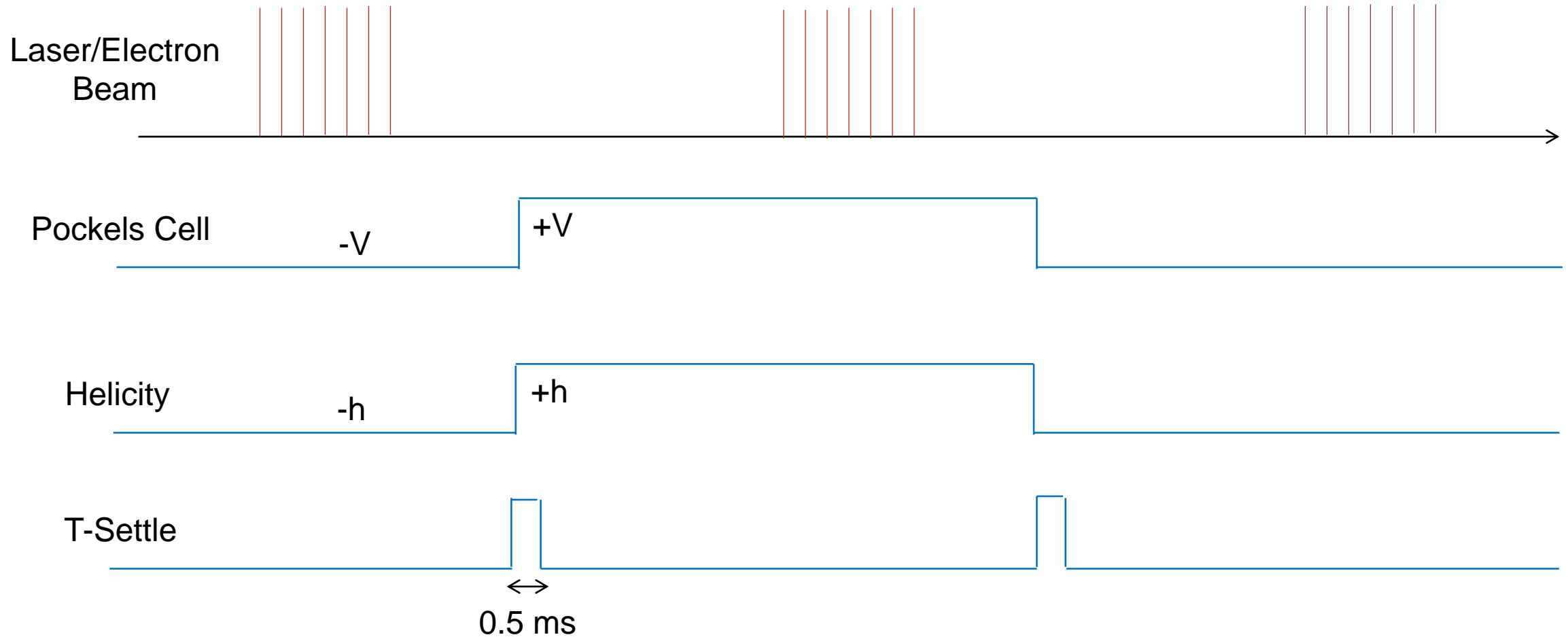
- Pockels Cell is synchronized to laser
- Helicity board will just provide a gate to determine which voltage (helicity) Pockels Cell gets set to

Laser (Electron) Beam Timing at BNL

- Microbunch structure: 78 kHz, or 12.8 μ s, 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
- Drive laser is capable of providing any random pattern of pulses when running at 78 kHz. CW, without any macropulse structure, is no issue.

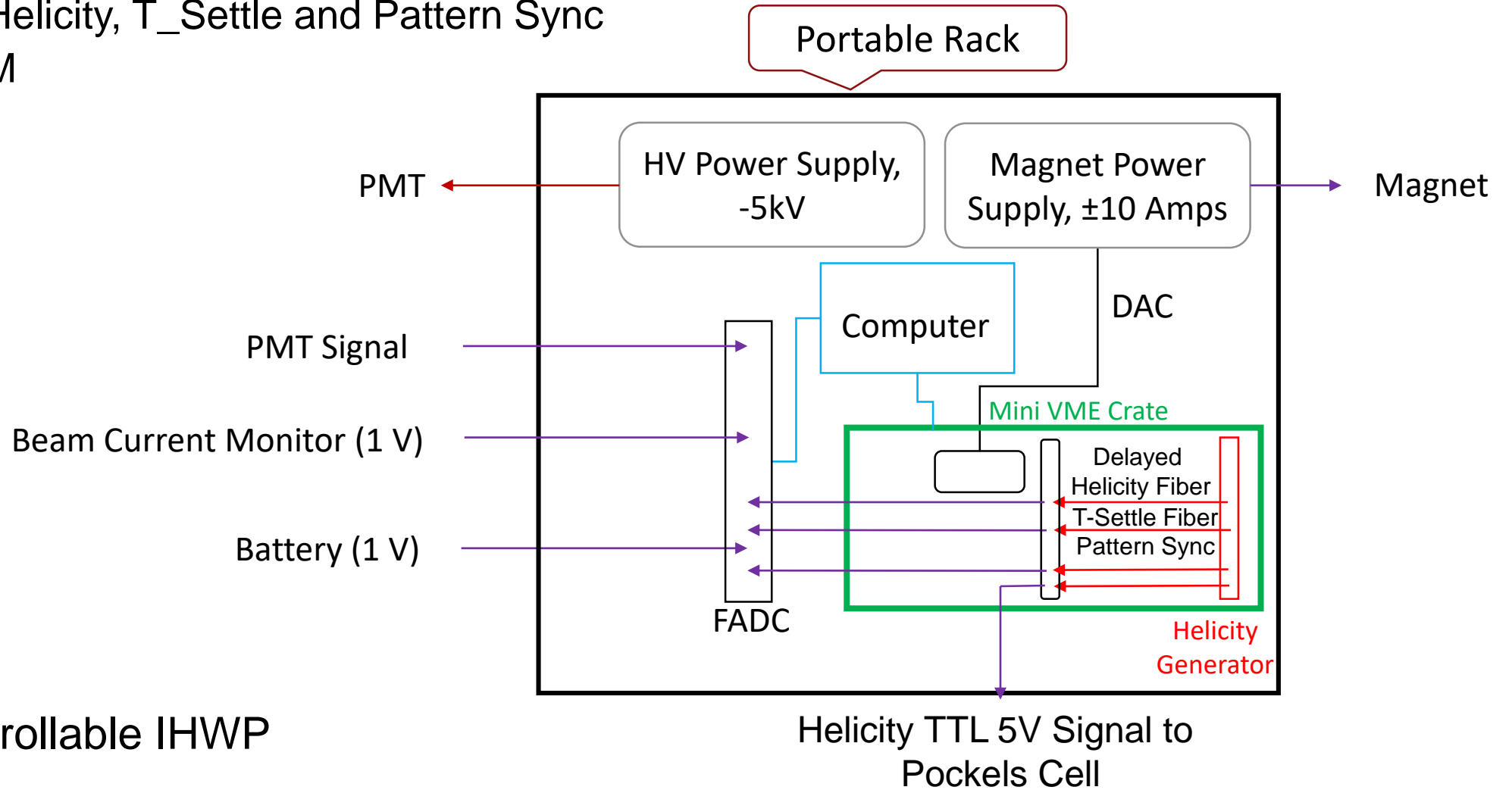


Laser/Electron Beam, Pockels Cell, and Helicity Board Timing



New Portable DAQ

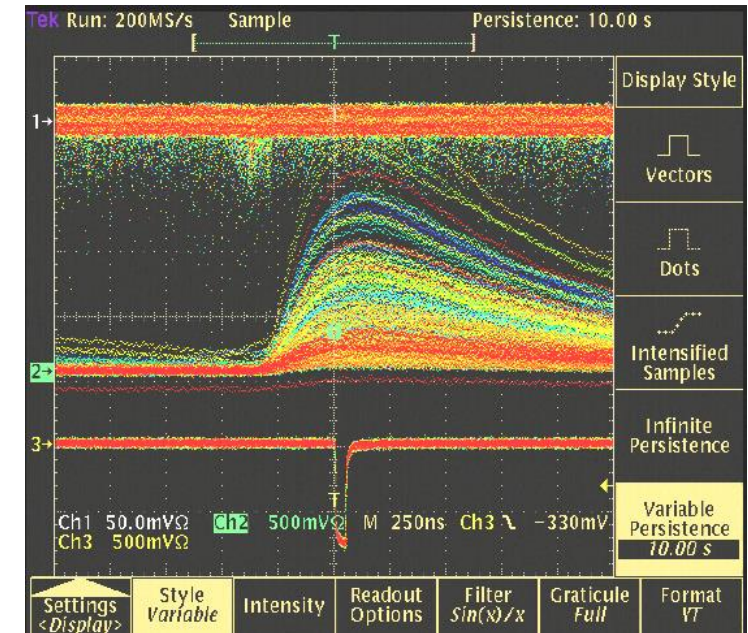
- DAQ Readout:
 - Delayed Helicity, T_Settle and Pattern Sync
 - PMT, BCM
 - Battery



- Remote controllable IHWP

DAQ Readout

- Each electron beam bunch < 1 ns
- Each bunch will generate a detector signal of about $1 \mu\text{s}$
- Bunch separation is $12.8 \mu\text{s}$
- Helicity Board will run at 10 Hz:
 - T-Settle = 0.5 ms
 - T-Stable = 99.5 ms
- DAQ Modes (self-triggered):
 - Sample Mode: 250 samples (two channels) and 25 samples (four channels) at rate up to 78 kHz – integrate offline
 - Semi-Int Mode: integrate over $1 \mu\text{s}$ at rate up to 78 kHz
- No deadtime/pileup since events (bunches) are not random

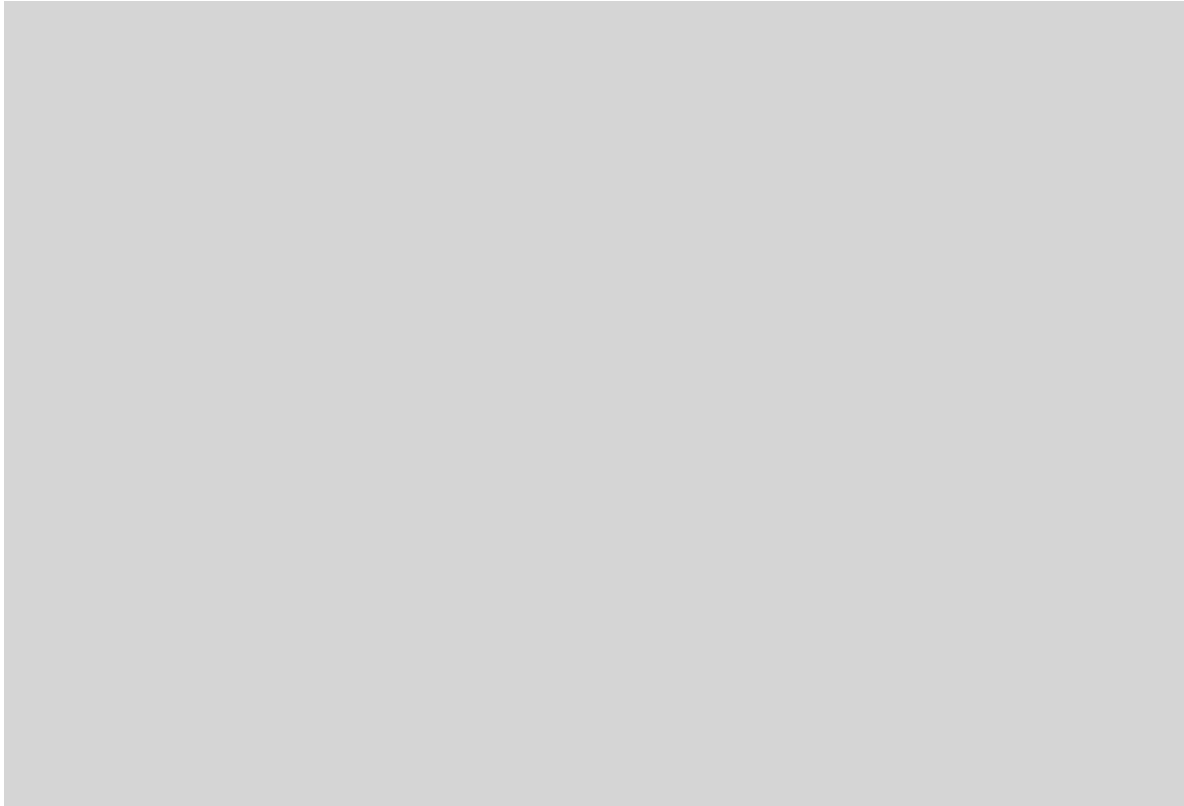


Bunch Charge and Average Beam Current

- Assume an average beam current of 1 μA
 - Bunch Charge = $10^{-6} / 7.8 \times 10^4 = 13 \text{ pC}$
- Maximum average current is limited to 2.5 μA by Low Power Dump
- At Jefferson Lab, for polarimeter calibration: 13 pC can be spread over 0.5 μs , for example
- Field emission of a few nA at 113 MHz may reach polarimeter – not a real problem
- 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, coupled to 50 Ω , with large bandwidth) proportional to beam current to measure charge asymmetry. BNL uses ICT, <https://gmw.com/product/ict/>



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