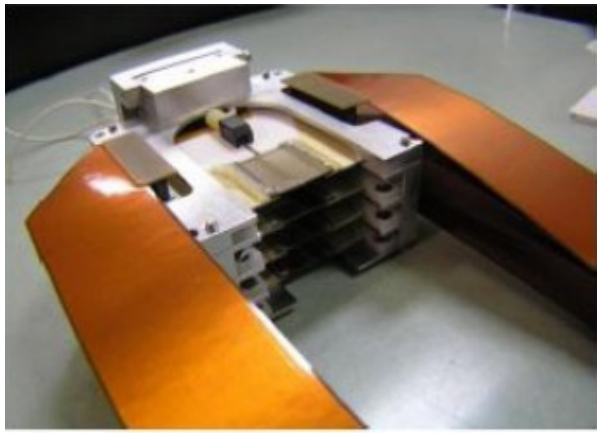
DAQ requirements for EIC Compton Polarimeters

- The two Compton polarimeters for EIC will operate in two very different modes → very different DAQ requirements
- ESR Compton:
  - Operation mode = single photon
  - Want to “count” scattered particles, but bunch spacing small (as low as 10 ns), bunch frequency large (100 MHz)
  - Measure polarization for each bunch
- RCS Compton
  - Operation mode = multi-photon (integrating)
  - Bunch frequency much lower
  - Polarization will be averaged over several bunches

ESR Compton

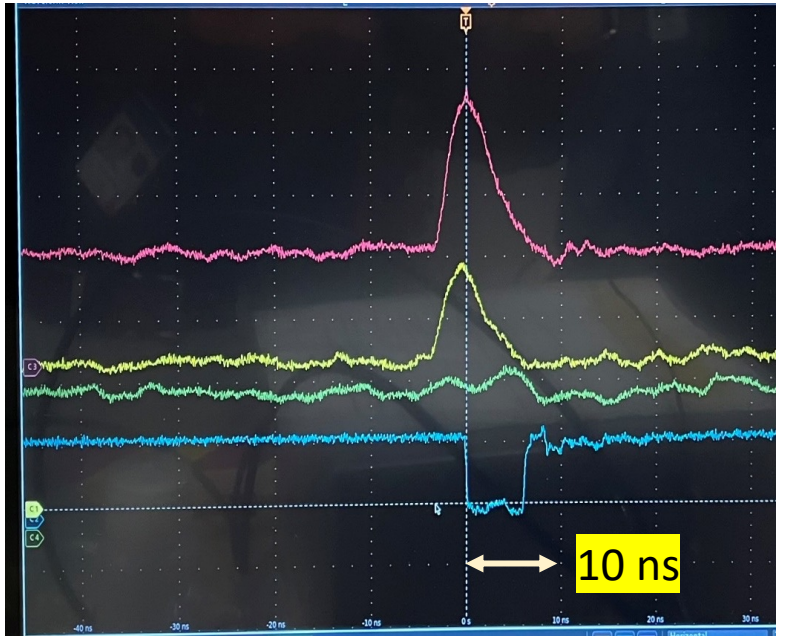
Laser system designed to provide ~ 1 backscattered photon per electron bunch

→ Read out every 10 ns at 100 MHz



Two styles of detectors:

- Position sensitive detectors
  - 4 planes for detecting scattered electrons (on order of 100 strips/plane)
  - 2 planes in front of photon calorimeter
  - Will use diamond strips with custom ASIC (FLAT32?)
  - Just need to count (LVDS) pulses – no amplitude information
  - Time above threshold useful – not a requirement



- Photon calorimeter
  - Tungsten powder + scifi (or something w/ similar time response)
  - Might use single PMT or several smaller PMTs
  - Would like to operate in energy-weighted, threshold-less mode
- Readout
  - Position sensitive detectors → module similar to JLab VETROC or CAEN 1495 with high-rate capability
  - Calorimeter → flash ADC, firmware appropriate for energy-weighted counting

ESR Compton – Thoughts on Readout

I assume that reading out modules at 100 MHz is challenging

We will need to flip laser helicity regularly to measure asymmetry - this will take on the order of 100 μs
→ Perhaps this interval can be used for readout?

Accumulate information in FADC/VETROC for each bunch (1160 bunches) then read out during laser flip?
→ Need each bunch information separately – can modules store this much information?
→ If so, can we retain information about bunch identity?

RCS Compton

Electron bunches injected at 1-2 Hz, ramped from “0.4 GeV” to 5/10/18 GeV
Bunch charge up to 28 nC
Ramping time = 100 ms

Impossible to measure polarization for each bunch due to continuously changing energy
→ Average over all bunches

Use low duty cycle pulsed laser → hundreds to thousands of backscattered electrons per laser pulse

Detectors
- Position sensitive → need to measure spatial dependence since polarization transverse
  - 2 planes, on the order of 100 channels
- Photon calorimeter, 1-16 channels

Parameter	5 GeV	10 GeV	18 GeV
Injection energy [MeV]		400	
Momentum compaction α_c		0.000372	
Max relative pol. loss		5%	
Circumference [m]		3841.35	
Ramping repetition rate [Hz]		1	
Acceleration time [ms], [turns]		100, 8000	

RCS parameters

Readout
- Both position sensitive detectors and calorimeter will operate in integrating mode, so will have to be read out using ADCs
- Readout frequency low – even if we try to measure several energies at once (as bunches are ramped) will have ~ 12.5 μs between bunches
- Will need information from accelerator with respect to where we are in acceleration cycle

Other requirements

Several other signals will need to correlated with detector readout

→ Beam position (check for position asymmetries)
→ Beam intensity
→ Laser signals (power, trajectory, polarization state, etc.)
→ Electron detector position
→ Rates in ancillary detectors (check for changing backgrounds)