Mott DAQ Upgrade using fADC

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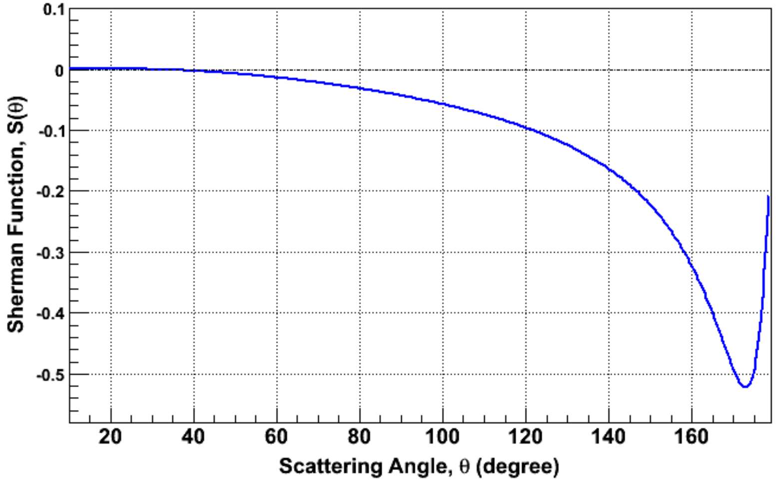
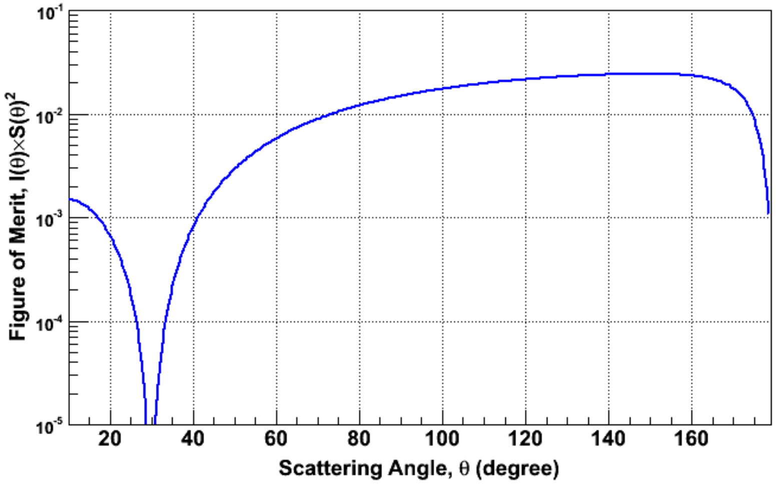
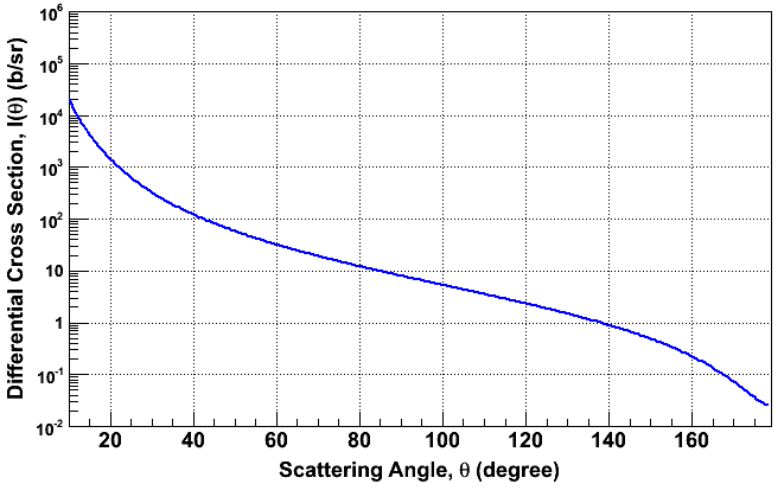
Jefferson Lab

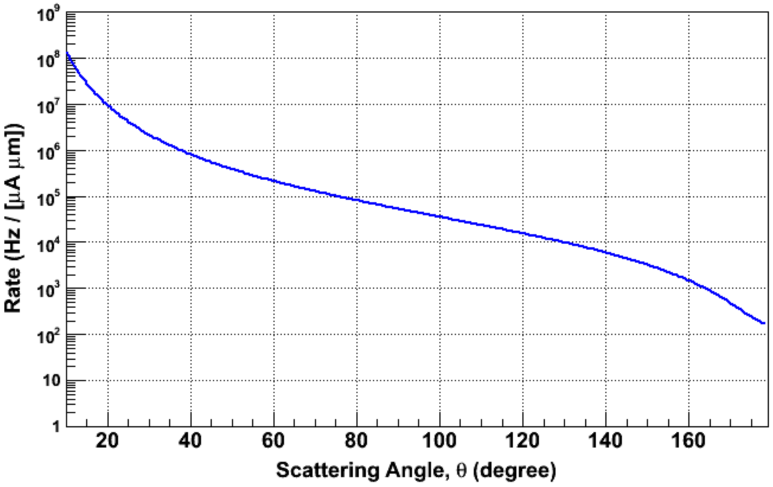
PEPPo Collaboration Meeting
November 8, 2010

5 MeV Mott Analyzing Power and Rate

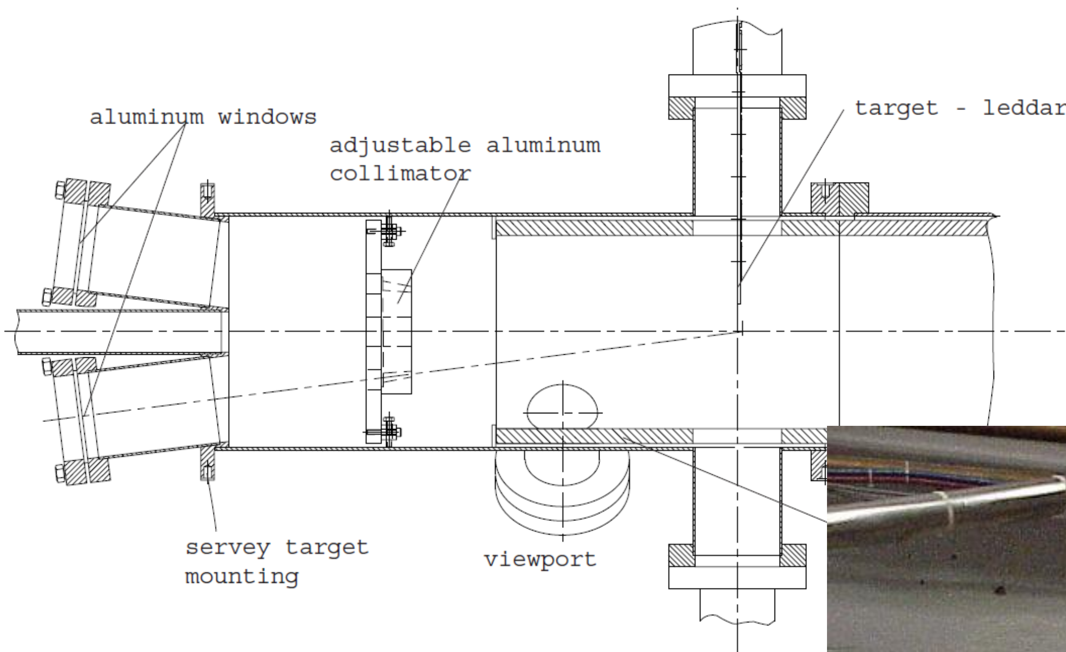


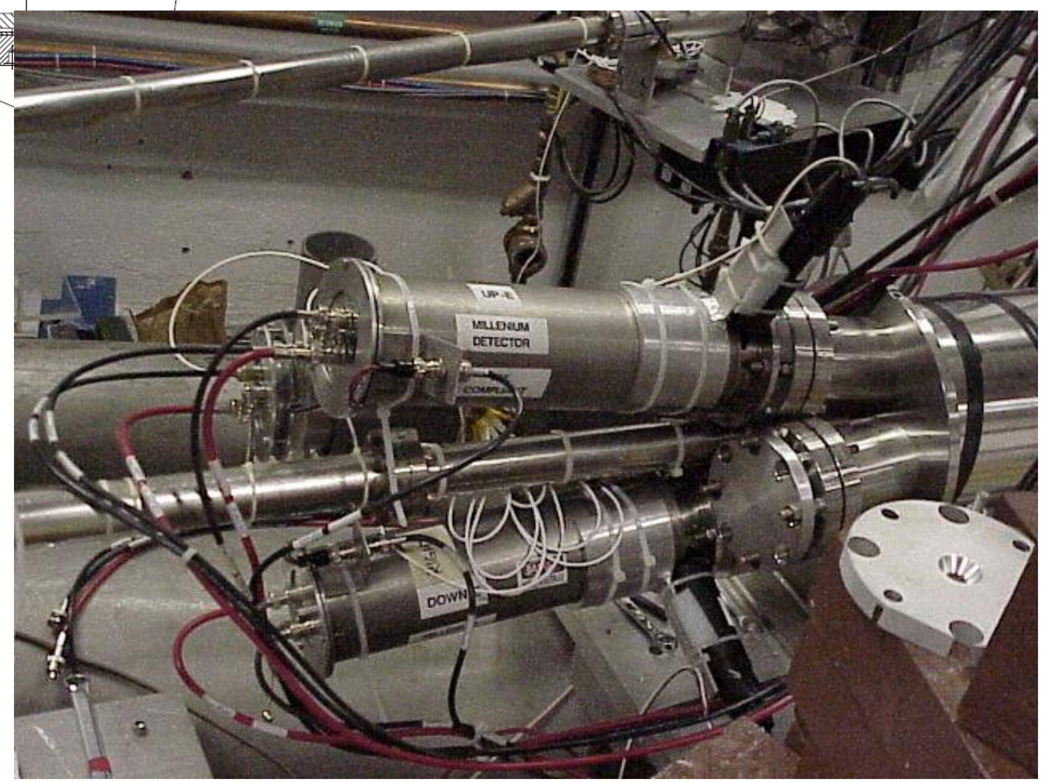






5 MeV Mott Beamline

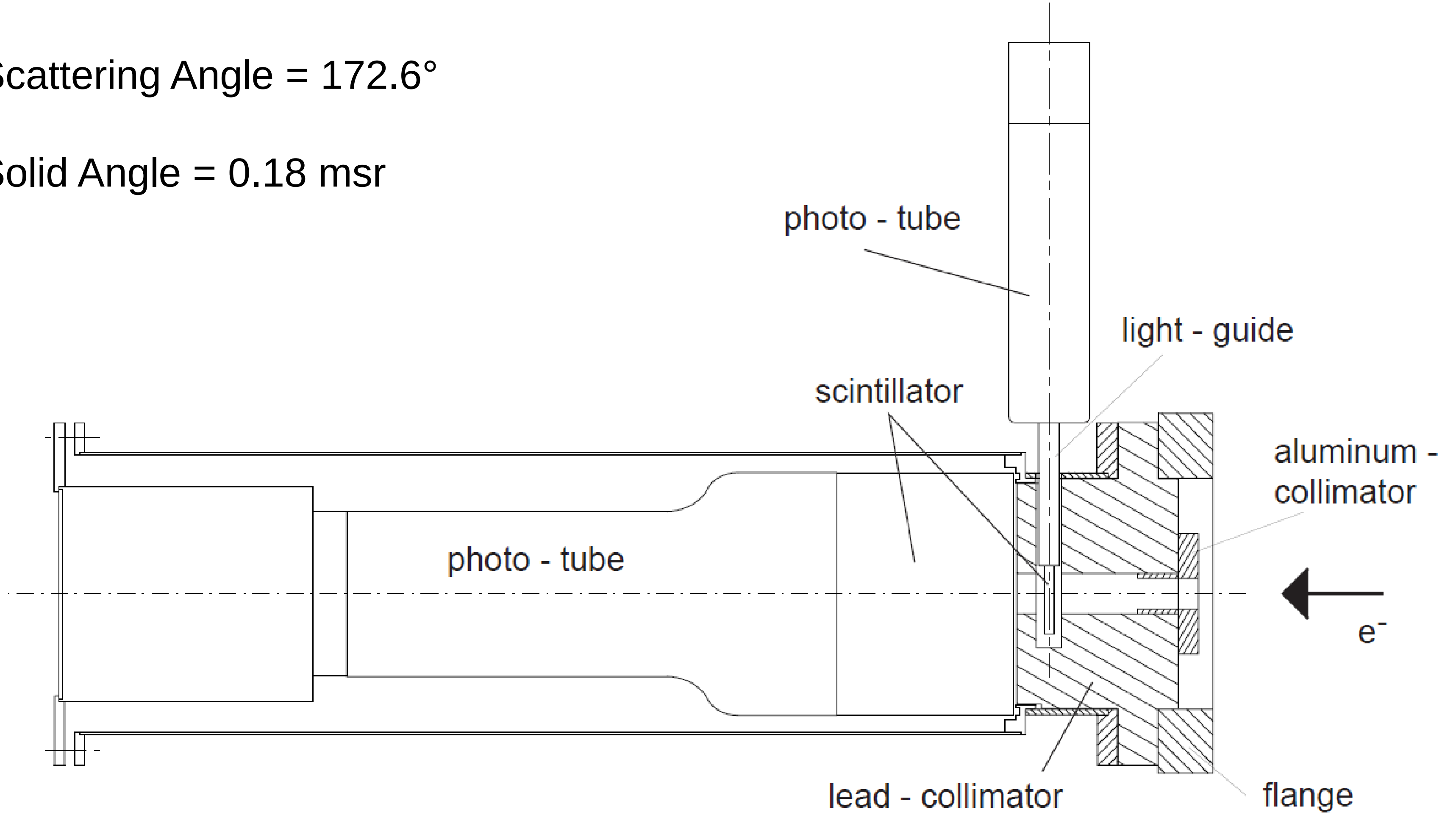




Detector Assembly

- Scattering Angle = 172.6°

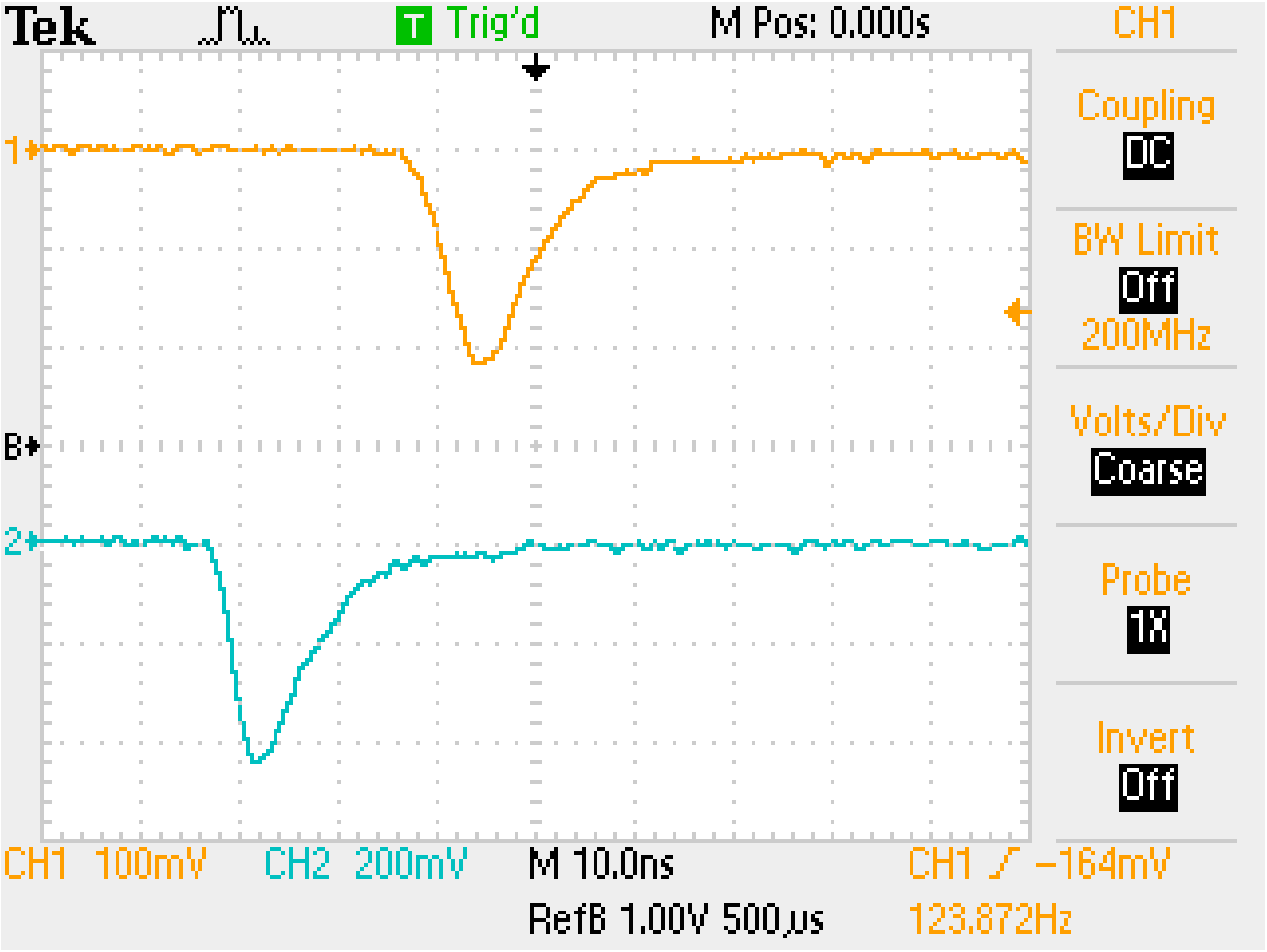
- Solid Angle = 0.18 msr



ΔE and E Signals

ΔE Detector

E Detector

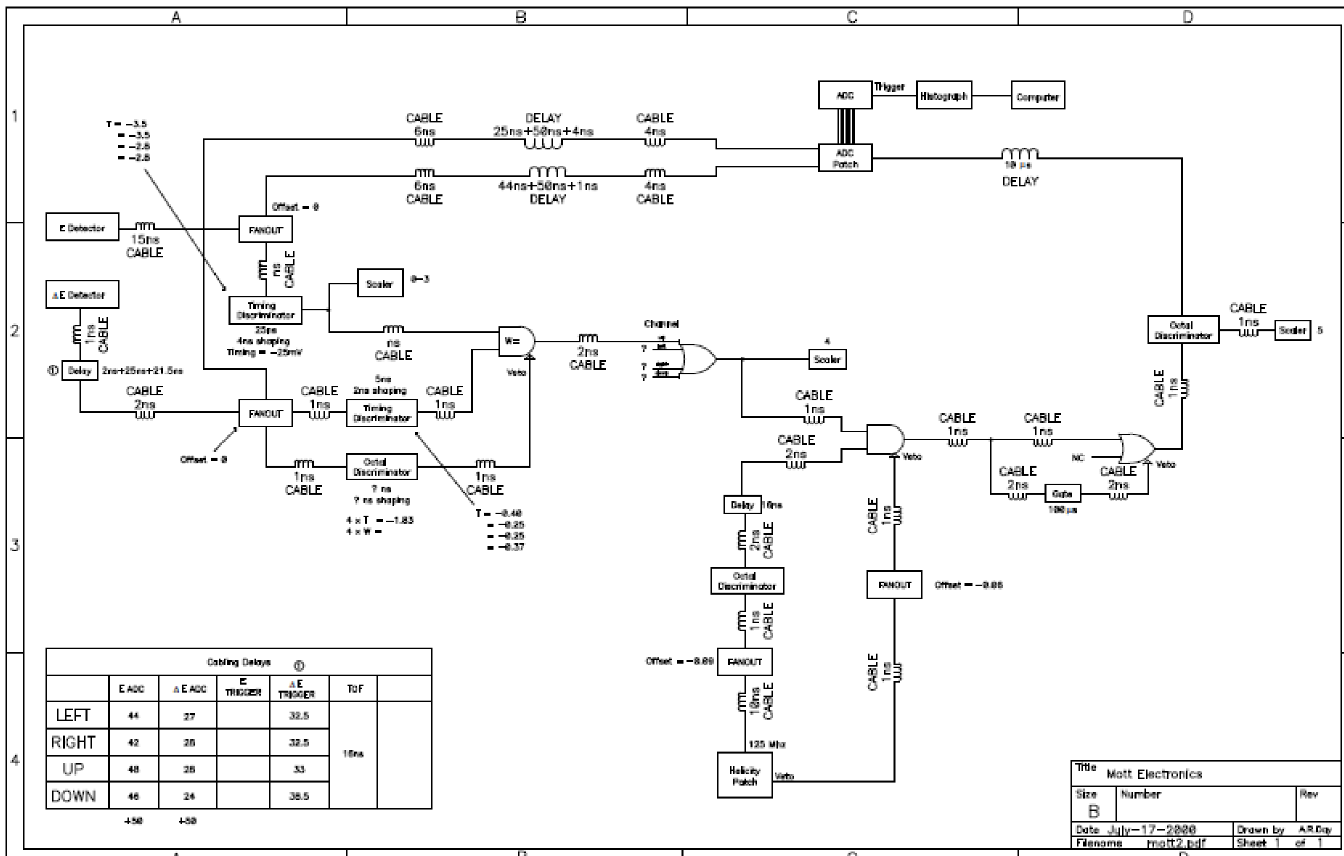


5 MeV Mott DAQ

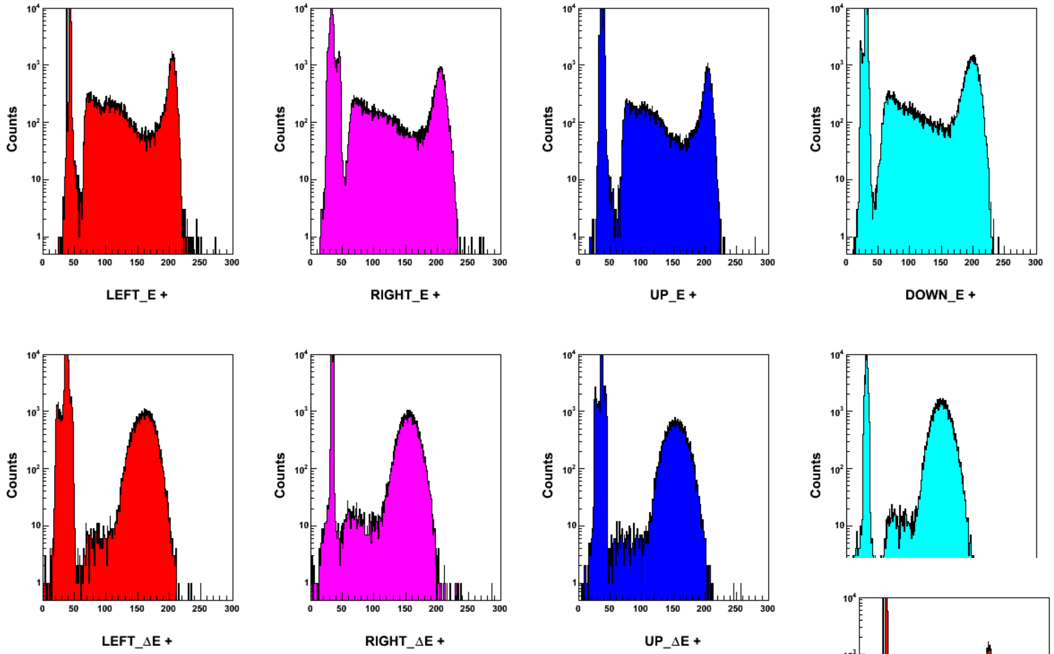
- LeCroy CAMAC 4303 Time-to-FERA Converter (TFC)

- LeCroy CAMAC 4300B Fast Encoding and Readout ADC (FERA), 10 Bit

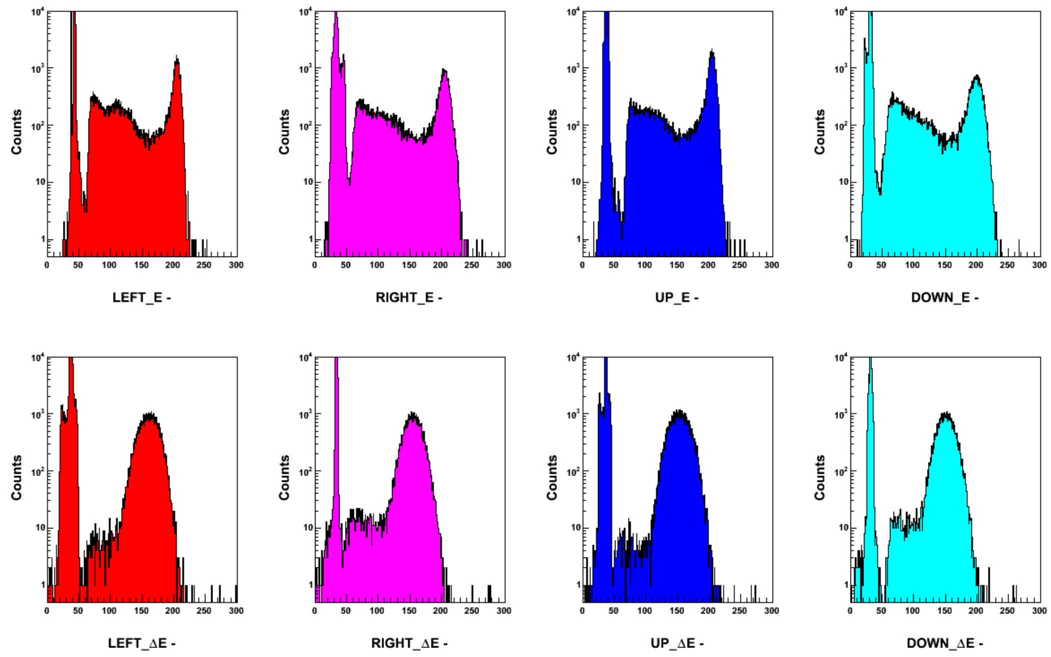
- ORTEC CAMAC HM 413 HISTO-MEMORY



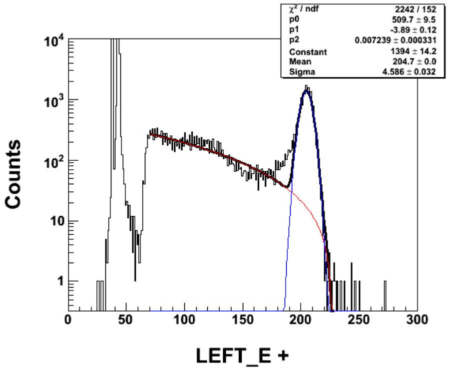
Detectors Spectra

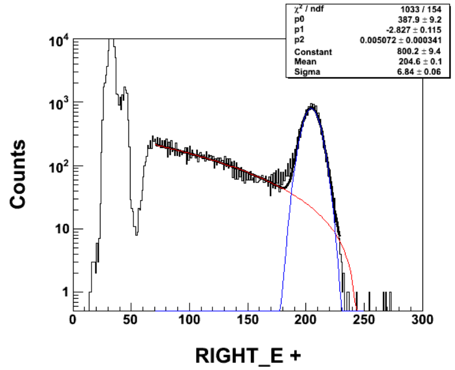


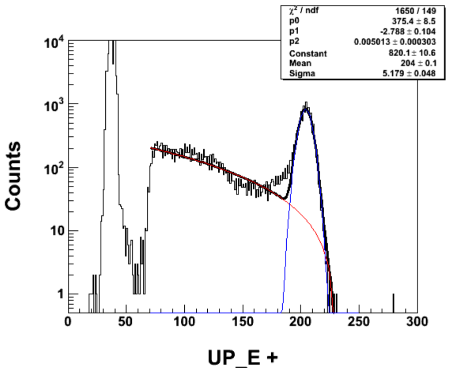
- Beam Current = 0.5 μA
- Gold Target 1.0 μm
- Trigger Rate 1 kHz
- 5 minutes of data

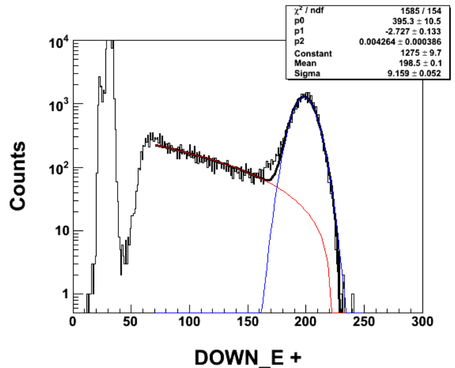


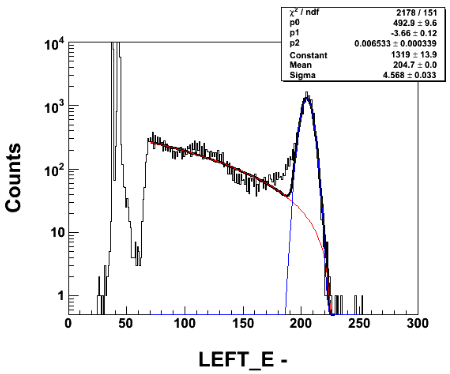
E Detectors Spectra

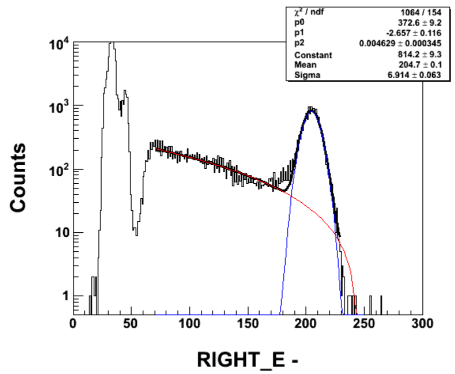


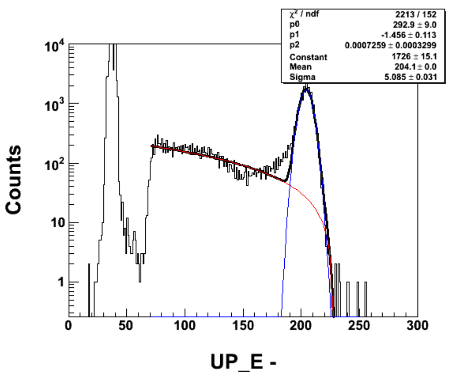


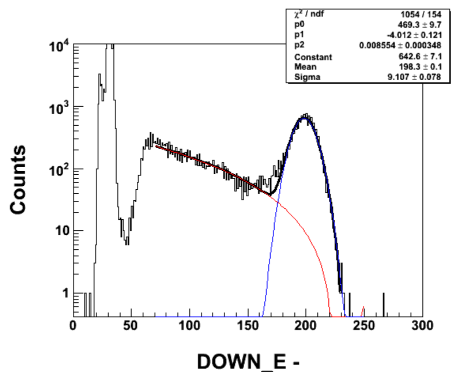












Measuring Mott Asymmetry

- How to measure the Mott Asymmetry A_{LR}?
  - For one helicity state, measure the number of left and right E detector events, $N_L^{\uparrow}$ and $N_R^{\uparrow}$
  - Flip the electron polarization, measure the number of events again, $N_L^{\downarrow}$ and $N_R^{\downarrow}$
  - Calculate the *cross-ratio* (r),

$$r = \sqrt{\frac{N_L^{\uparrow} N_R^{\downarrow}}{N_L^{\downarrow} N_R^{\uparrow}}}$$

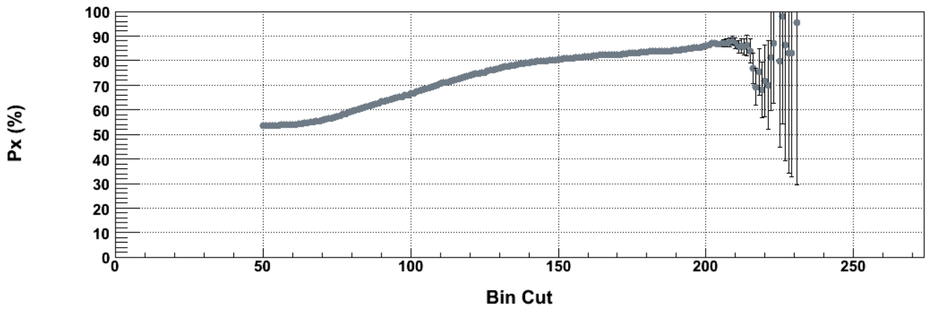
  - Then, the Mott Asymmetry (*A*),

$$A_{LR} = \frac{1-r}{1+r}$$

- The same for A_{UD}

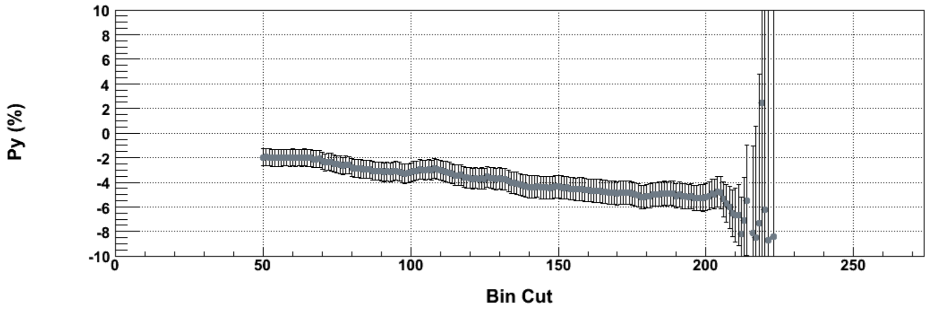
- This cancels false asymmetries from detector efficiency, beam current, target thickness, and solid angle

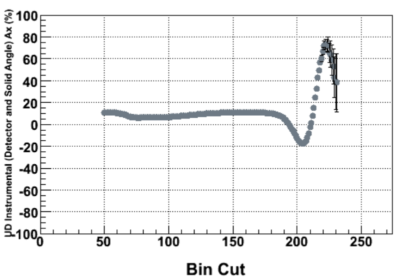
Mott Asymmetries

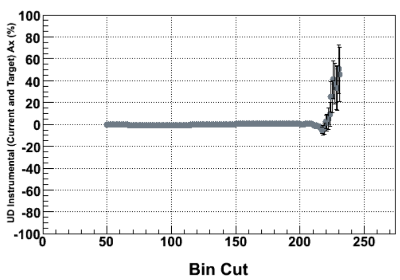


- A_{UD} = 33.98 ± 0.36 %

- A_{LR} = -2.11 ± 0.44 %

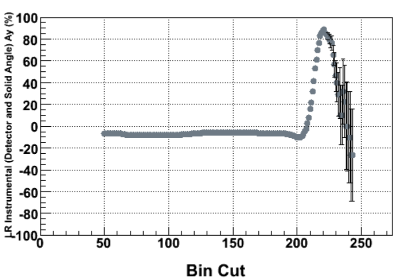


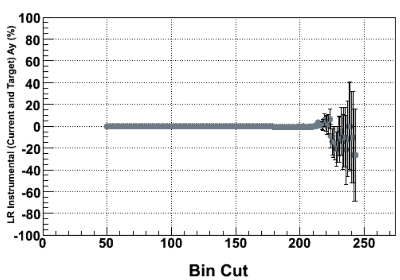




- UD Instrumental (Detector Efficiency and Solid Angle)
A1 = 12.91 ± 0.40 %

- LR Instrumental (Detector Efficiency and Solid Angle)
A1 = -3.78 ± 0.44 %





- UD Instrumental (Beam Current and Target Thickness)
A2 = 0.75 ± 0.41 %

- LR Instrumental (Beam Current and Target Thickness)
A2 = -0.75 ± 0.44 %

Corrections to Measured Asymmetry

I. Background

II. Electronics Dead Time

- Mott Asymmetry will depend on beam current

III. Target Thickness:

- Single-Atom Sherman Function must be corrected for plural scattering (a few large angle scattering) in the target:

$$S(d) \cong \frac{S_{SA}(0)}{1+\alpha \cdot d}$$

- $S_{SA}(0)$ = -0.5215, S(1.0 μm) = -0.4006

- If possible, run with the thinnest target

New DAQ for Mott Polarimeter

- Will record the pulse shape and timing of the detected electrons
- Study Dead Time and Pile-up: Run at higher beam current
- Can process delayed helicity reporting and measure time-of-flight of detected electrons

- Consists of:
  - CODA (CEBAF Online Data Acquisition)

  - Hardware:
    - VME64x Backplane 6U Crate
    - EMERSON MVME61006E-0161
    - (1) JLab Flash ADC:
      - 16 channel, 10 bit, 250 MS/s
      - Data Processing: Charge, Time (Threshold, Relative to trigger), Operation (Arithmetic, Logical – Single & Multi-channel)

Signals to fADC

- (8) Detectors Signals:
  I. (4) ΔE Detectors
  II. (4) E Detectors

- (1) 10 – 100 MHz RF signal from the source

- (1) BCM0L02 beam current signal

Signals to fADC (continued)

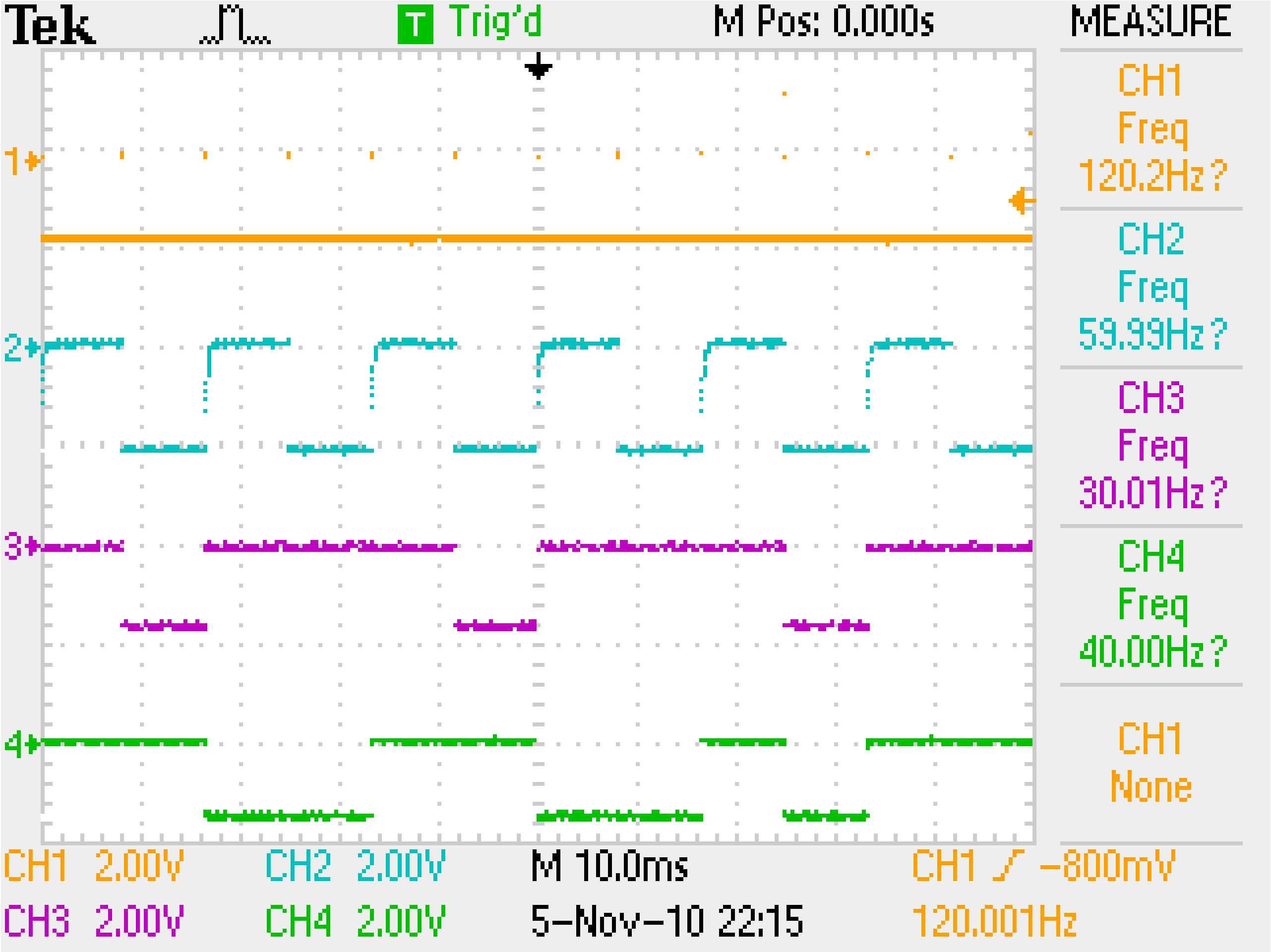
- (4) Helicity Board Signals:

T- Settle

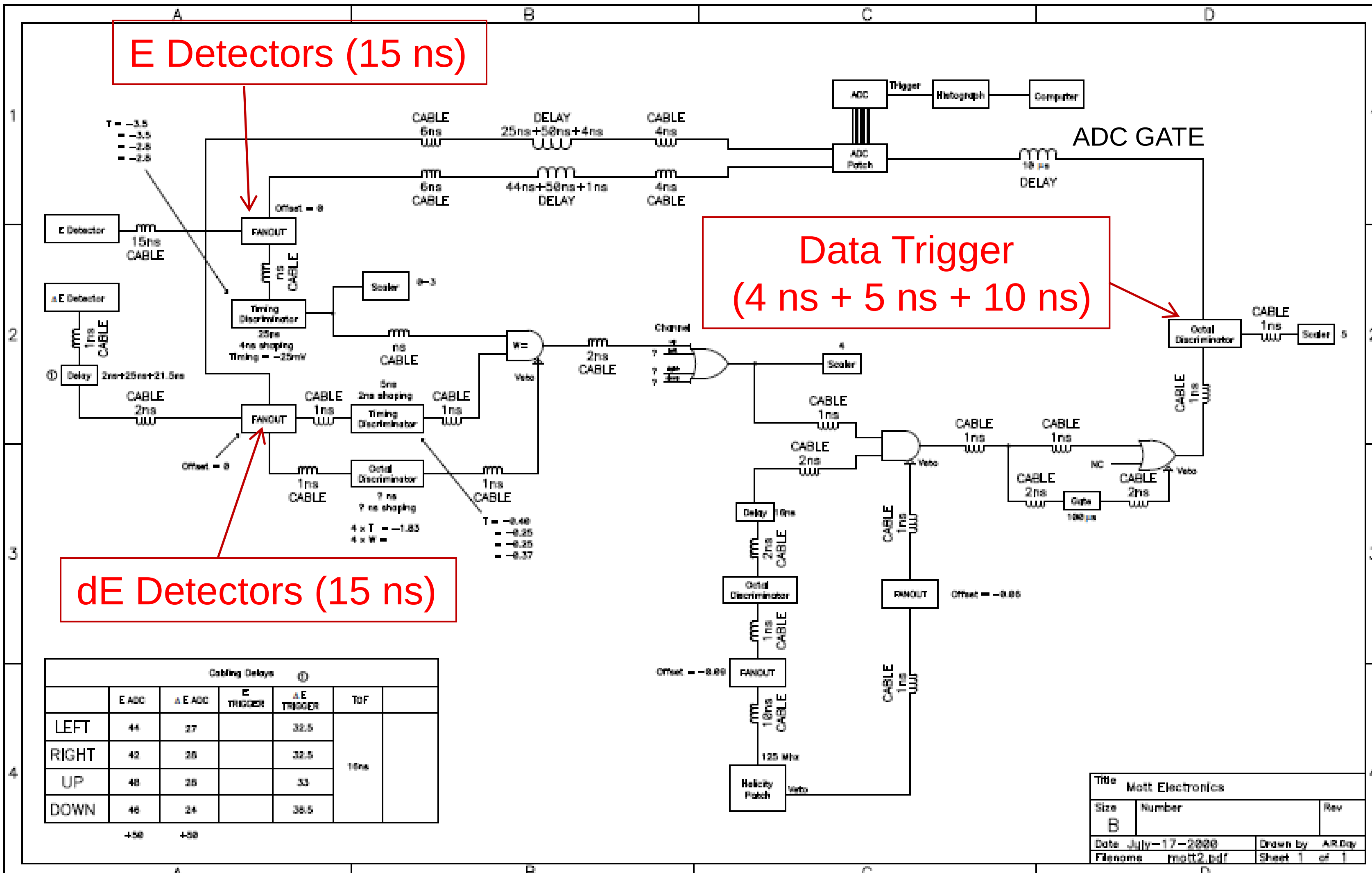
Pair Sync

Pattern Sync

Delayed Helicity



Detector Signals to fADC (Parasitic to old DAQ)



Cabling Delays ①

	E ADC	ΔE ADC	E TRIGGER	ΔE TRIGGER	ToF
LEFT	44	27		32.5	16ns
RIGHT	42	28		32.5	
UP	48	28		33	
DOWN	46	24		38.5	
	+50	+50			

New 5 MeV Mott DAQ

Located in Rack IN02B23 in ISB

Chan	Signal
0	E LEFT
1	E RIGHT
2	E UP
3	E DOWN
4	ΔE LEFT
5	ΔE RIGHT
6	ΔE UP
7	ΔE DOWN
8	T-Settle
9	Pair-Sync
10	Pattern-Sync
11	Delayed Helicity
12	BCM-0L02
13	
14	
15	

Expected Data Rate and Storage

- Expected Data Rate:

  (2 Bytes / 4 ns)(200 ns window)(16 channels)(10 kHz trigger) = 20 MBytes/s

- Data Storage on host computer: 1 hour per week for a month = 300 GB

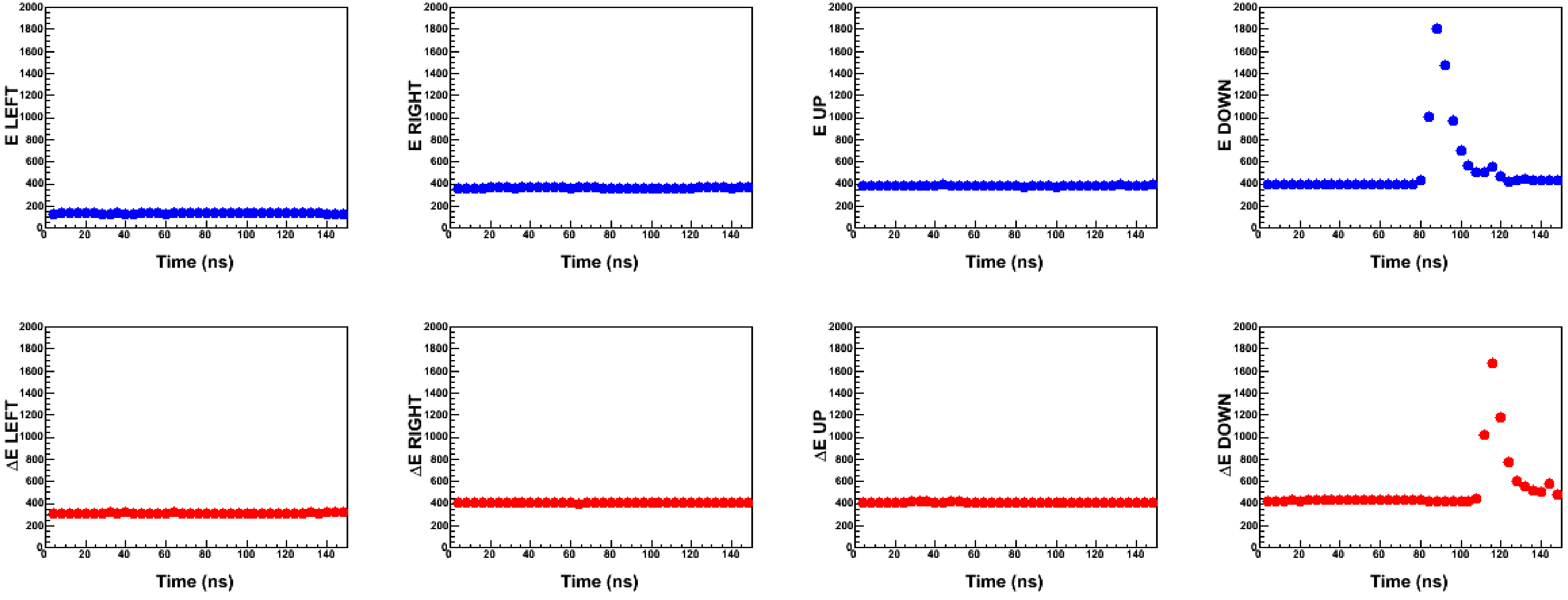
- Data Back-up: Once a month

Hardware and Firmware

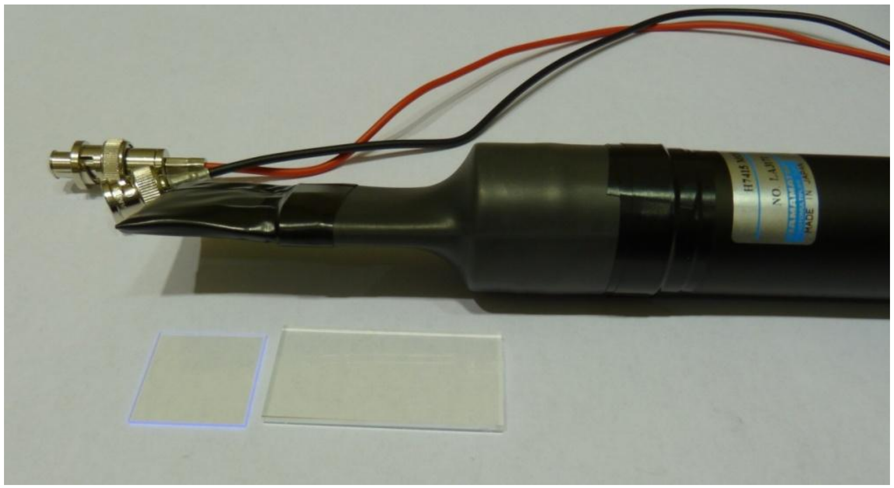
- MVME6100-0161 (iocmdaq1): CPU 1.3 GHz, 512 MB RAM.
- Linux host computer (opsmdaq1) is mounted in rack below VME Crate. Hard Drives = 1346 GB.
- Gigabit Ethernet between host and VME and between host and ACC
- CODA 2.6.1

Preliminary Results

- Took parasitic data on Nov 4, 2010
- Data rate was 1 MBytes/s



New ΔE and E Detectors are Ready



- H7415 (R6427) 1" PMT
- 1 mm x 1" x 1" EJ-212 Plastic Scintillator
- 0.125" x 1" x 2" Acrylic Light Guide

- H6559 (R6091) 3" PMT
- 3" diameter x 2.5" long EJ-200 Plastic Scintillator painted with EJ-510

Future Plans

- Develop Analysis Code
- Optimize fADC parameters
- Install the new detectors