Parity Violating Deep Inelastic Scattering of Polarized Electron on the Deuteron

"Status Update of PVDIS: E08-011"

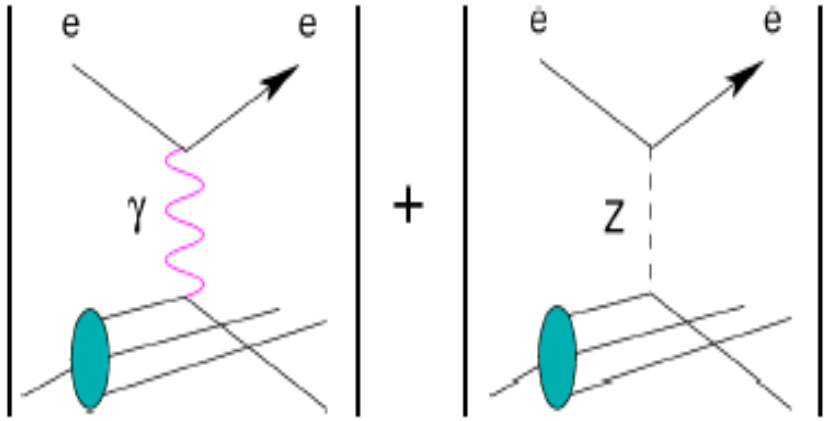
June 13, 2008

Goal of the Experiment

- Measure the parity violating asymmetry with polarized electron on the liquid deuterium in the DIS region. Expected physics asymmetry in the expt is ∼100 ppm.
- Extract the effective coupling constant combination $(2C_{2u} - C_{2d})$ to a high precision.

PVDIS Asymmetries

$A_{PV} =$



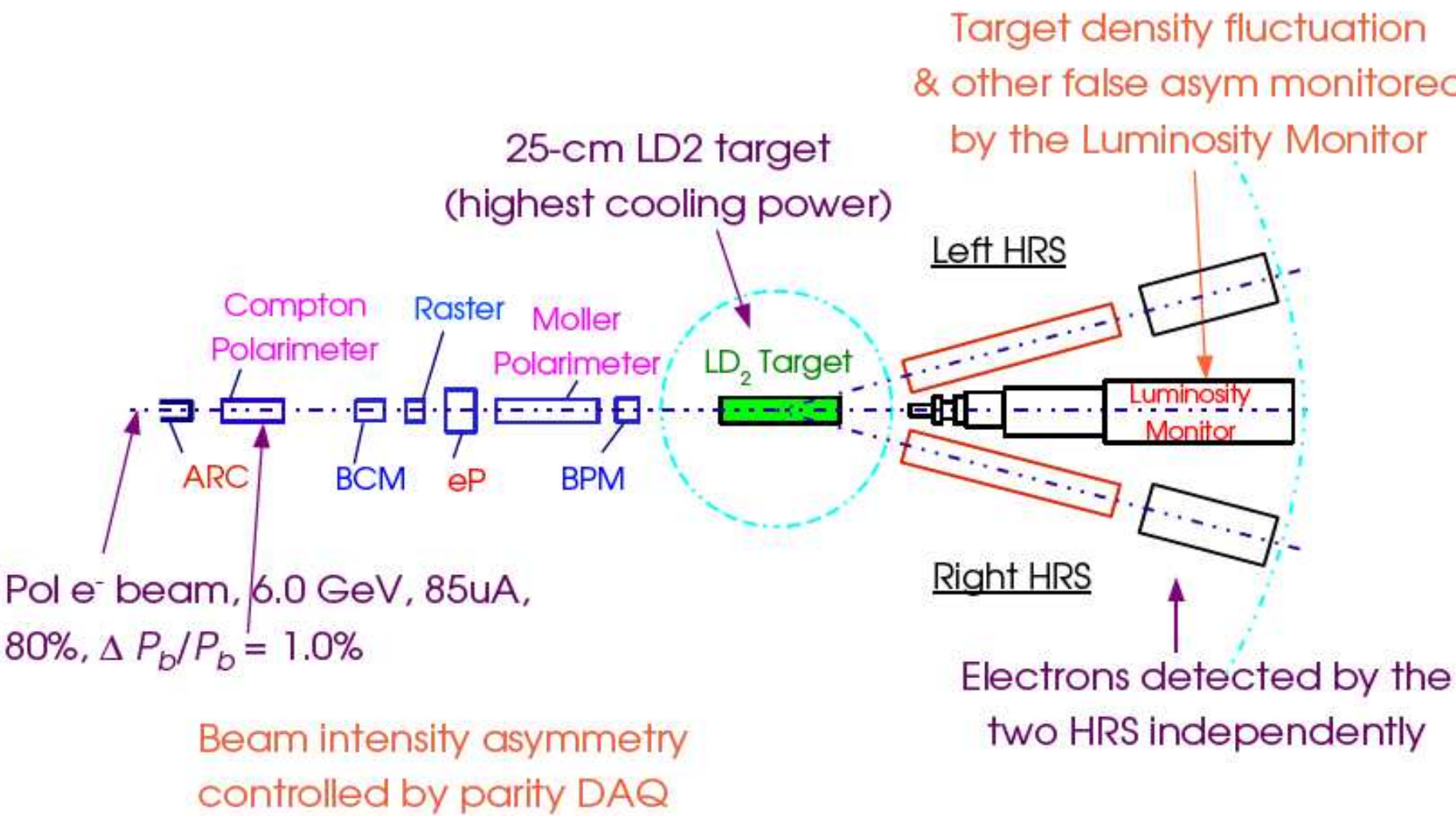
- Deuterium:

$$A_d = (540\,ppm)Q^2 \frac{2C_{1u}[1+R_c(x)] - C_{1d}[1+R_s(x)] + Y(2C_{2u} - C_{2d})R_V(x)}{5 + R_s(x) + 4R_c(x)}$$

$$C_{1u} = g_A^e g_V^u = -\frac{1}{2} + \frac{4}{3}\sin^2(\theta_W) \qquad C_{2u} = g_V^e g_A^u = -\frac{1}{2} + 2\sin^2(\theta_W)$$

$$C_{1d} = g_A^e g_V^d = \frac{1}{2} - \frac{2}{3}\sin^2(\theta_W) \qquad C_{2d} = g_V^e g_A^d = \frac{1}{2} - 2\sin^2(\theta_W)$$

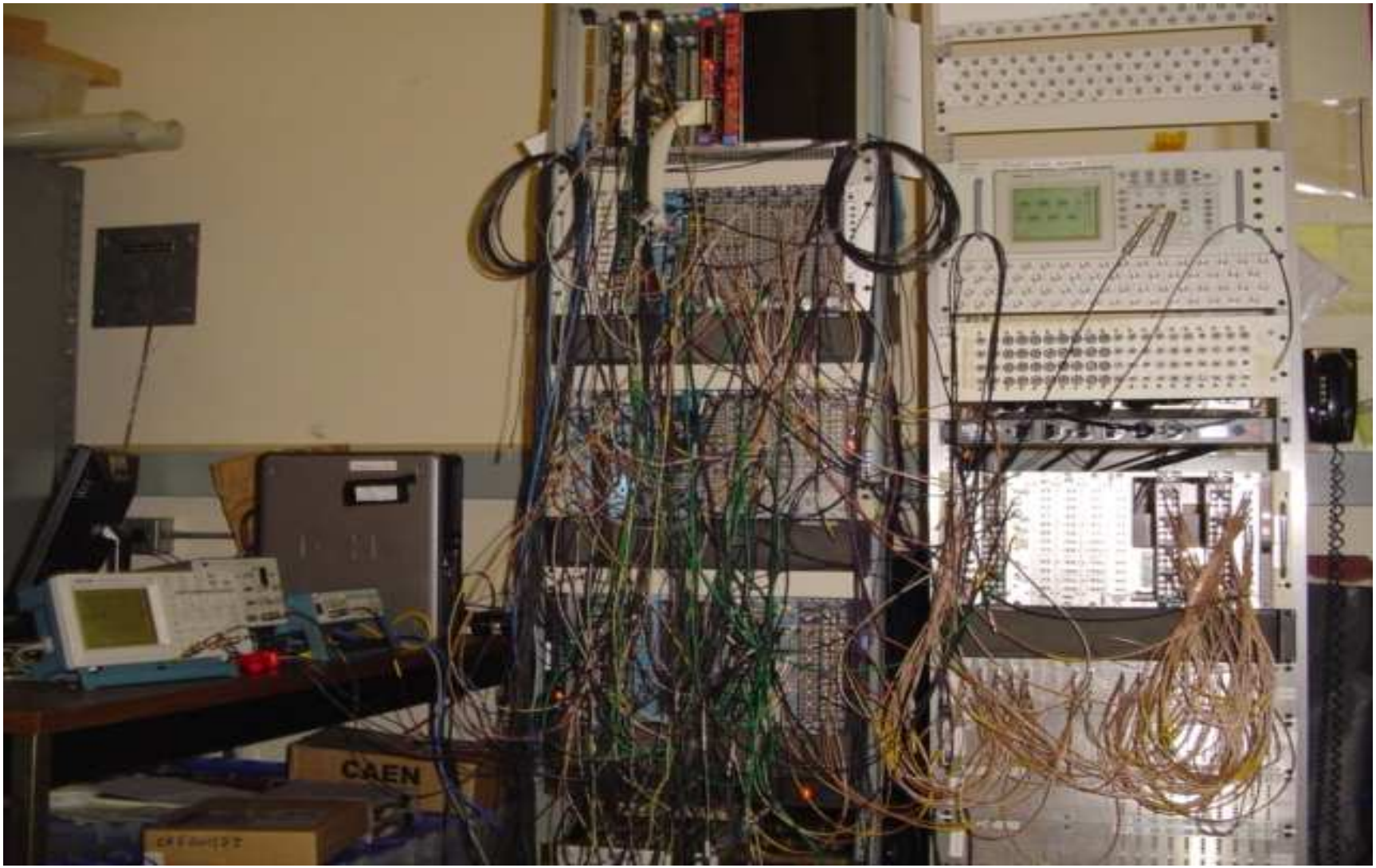
Overview of the Experimental Setup



Work on Progress

- Various tests are underway with the aims of:
  - identifying electrons and pions and counting them in scalers.
  - measuring expected asymmetries.
  - measuring deadtime to 0.3% accuracy using multiple redundant methods.
  - analysing individual pulses using the Flash ADC.
  - recognizing pileup and computing systematic error.

The test setup for the DAQ in room EEL 122.



Asymmetry Measurement

- Made an RC-circuit to produce pulses similar to a PMT signal. A big pulse was made for electron and a small pulse for pion.
- These pulses are input to the DAQ.
- PMT signal is used as a random high rate signal.

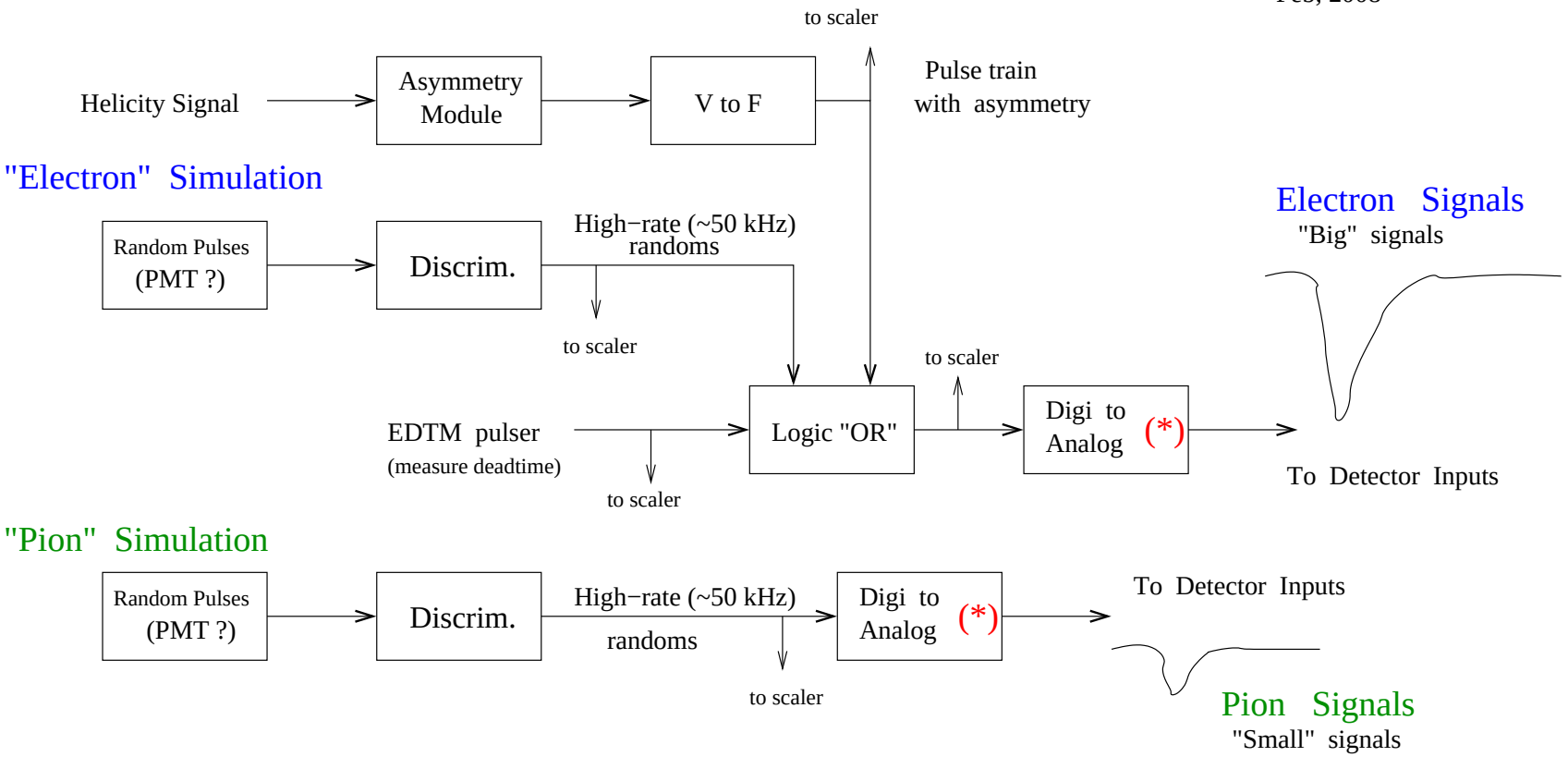
- JLab-made asymmetry module is used as the source of asymmetry for the asymmetry measurement. This module has a fixed frequency of 250 kHz and can produce asymmetry of 1.14%. Wanted to use this module to produce low asymmetry down to 100 ppm.

- After prescaling, the asymmetry module frequency is reduced to 10 kHz, without losing its asymmetry.

- Measuring asymmetry down to $\sim$100 ppm value looks promising.

Diagram for PVDIS Trigger Test

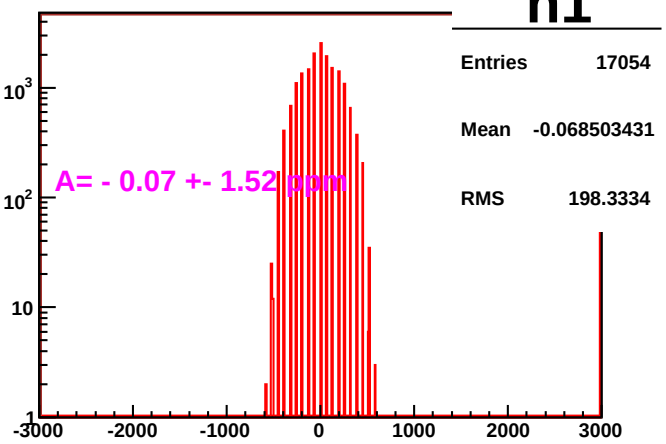
Bob Michaels
Feb, 2008



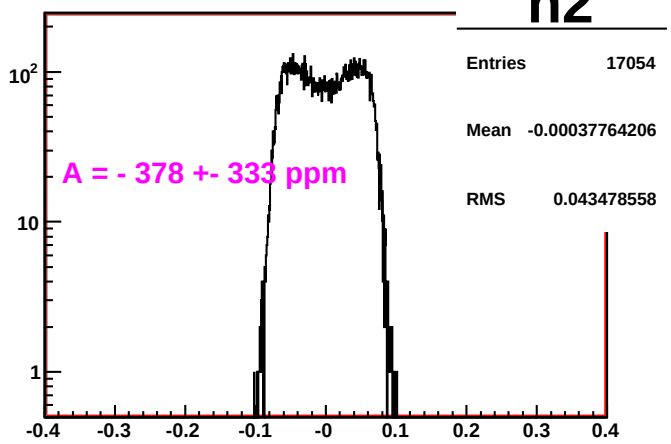
(*) Digi to Analog = An RC circuit in a bud box which converts a NIM pulse to a pulse that "looks like" a PMT signal.

Clock does not have asymmetry, other signals do.

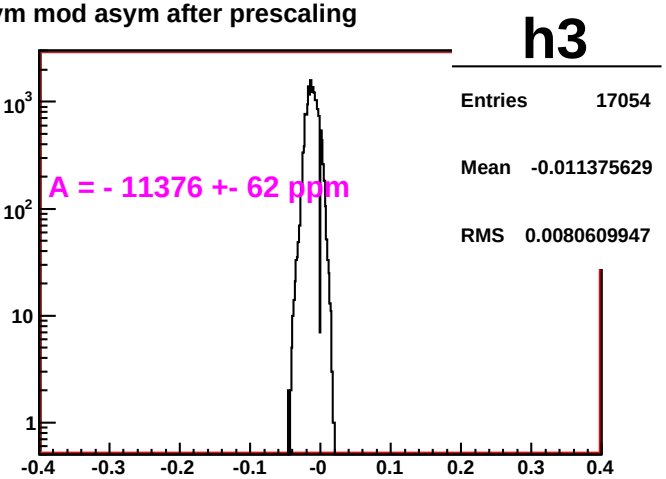
Clock asym



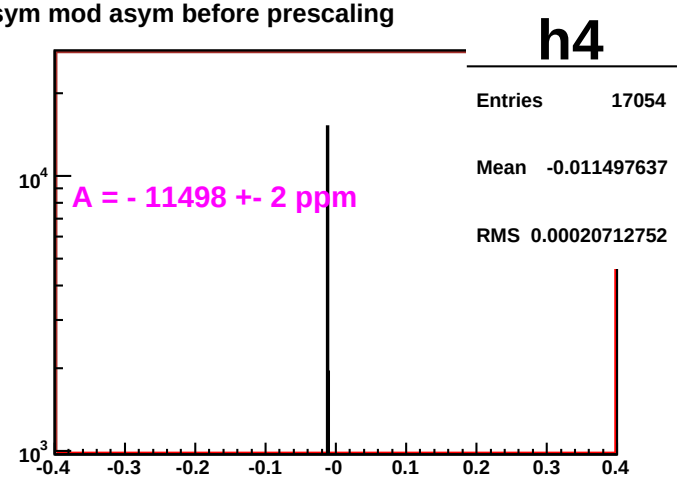
Elec asym



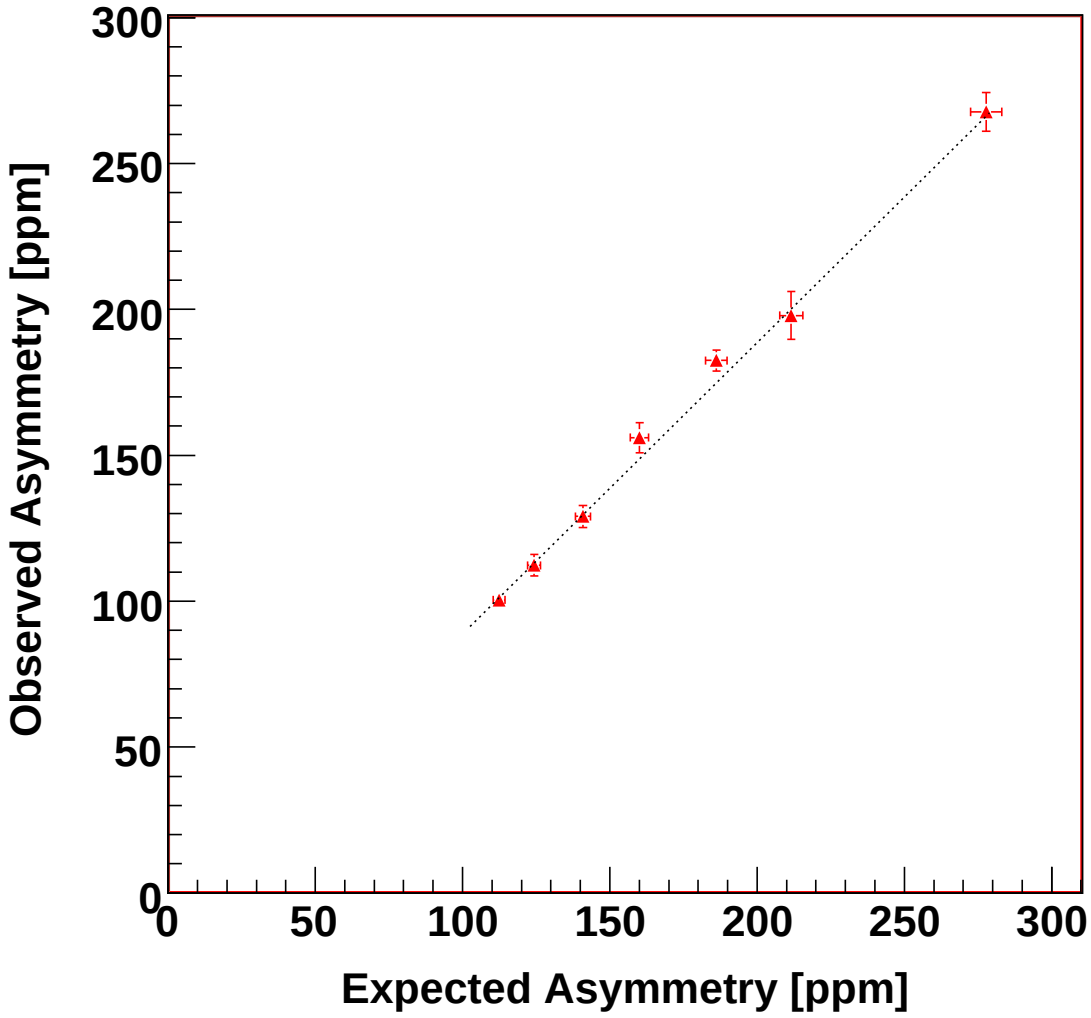
Asym mod asym after prescaling



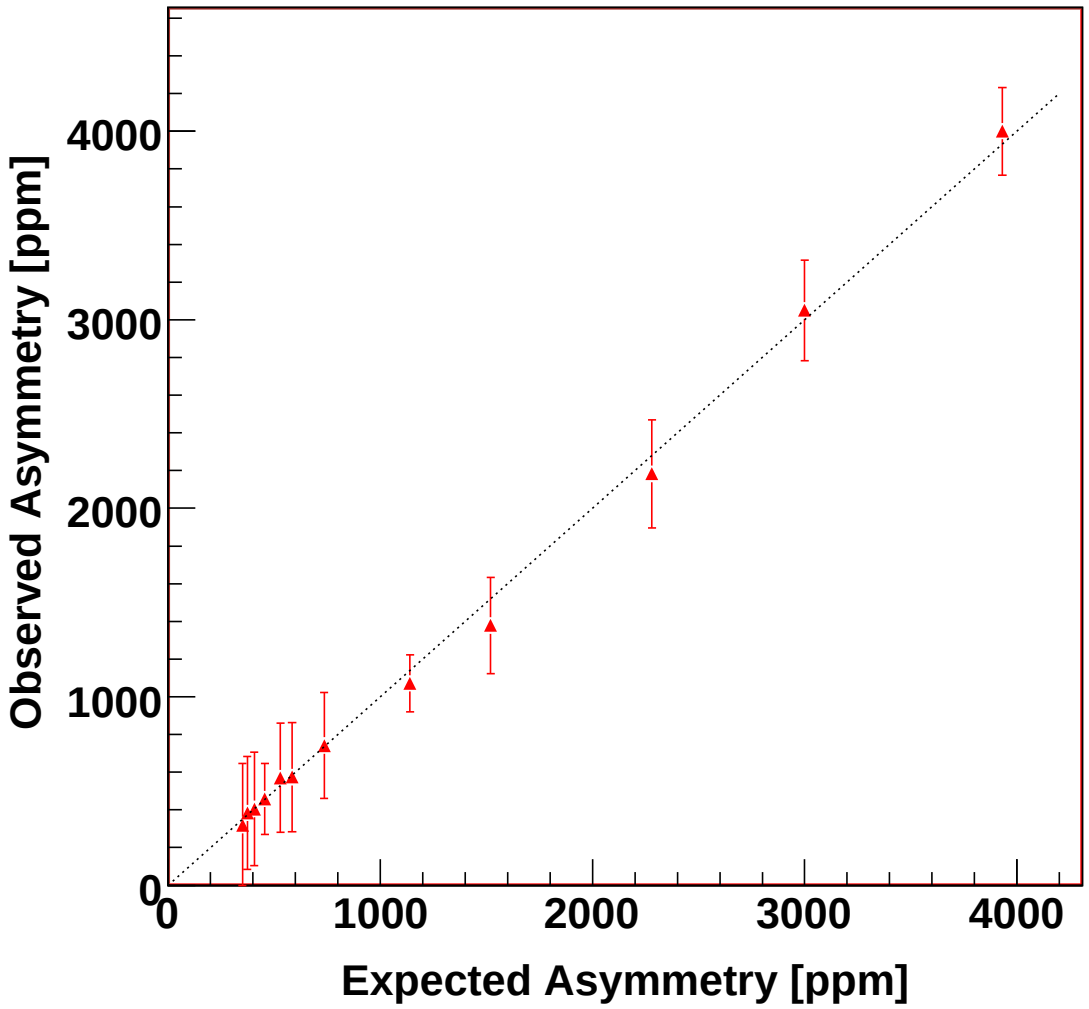
Asym mod asym before prescaling



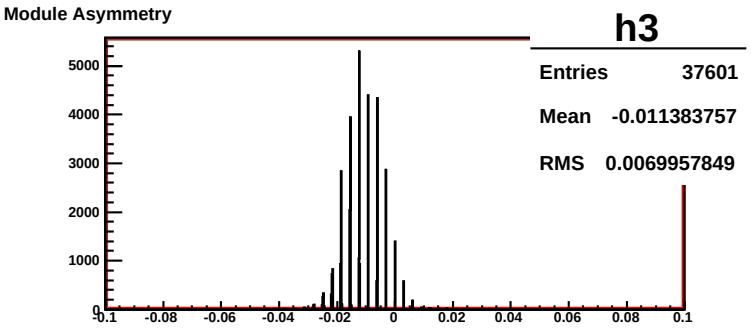
With pulser, the expected and observed asymmetries agree well.

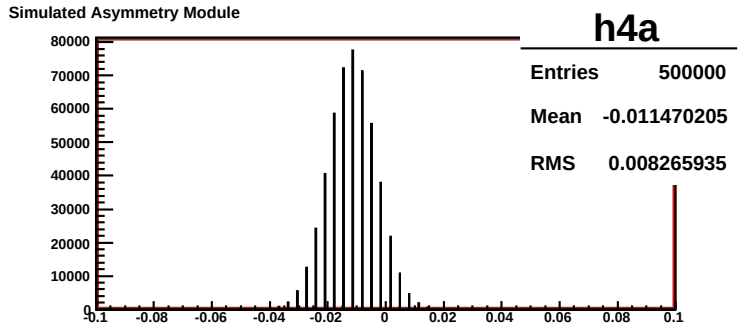


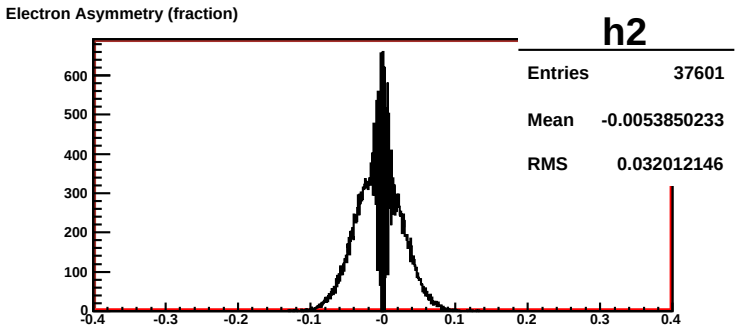
With randoms, there is 3% asymmetry noise causing large error bars.

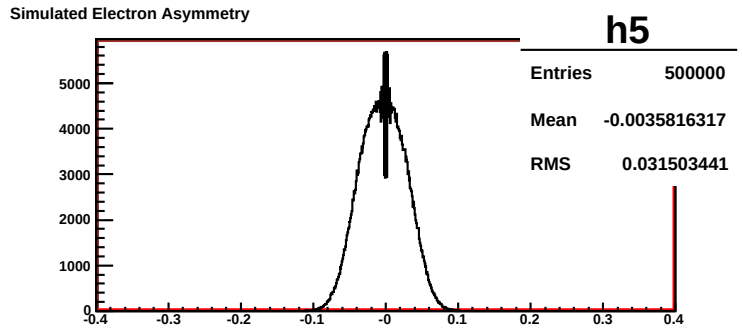


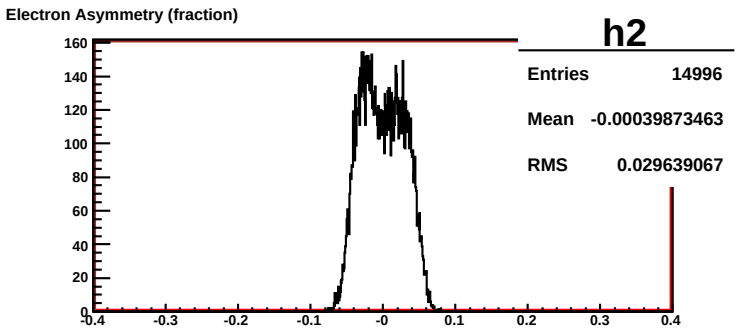
Simulation reproduces PMT data when added 3% jitter; mystery!

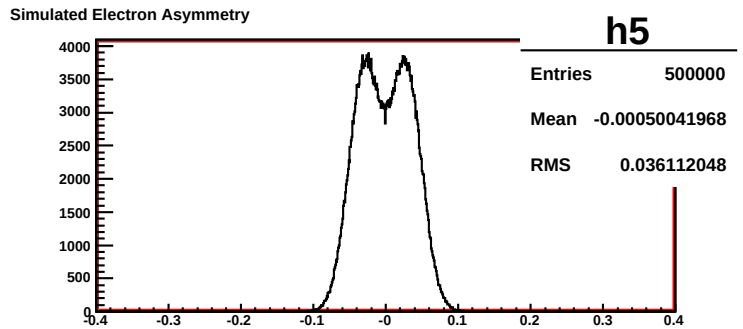






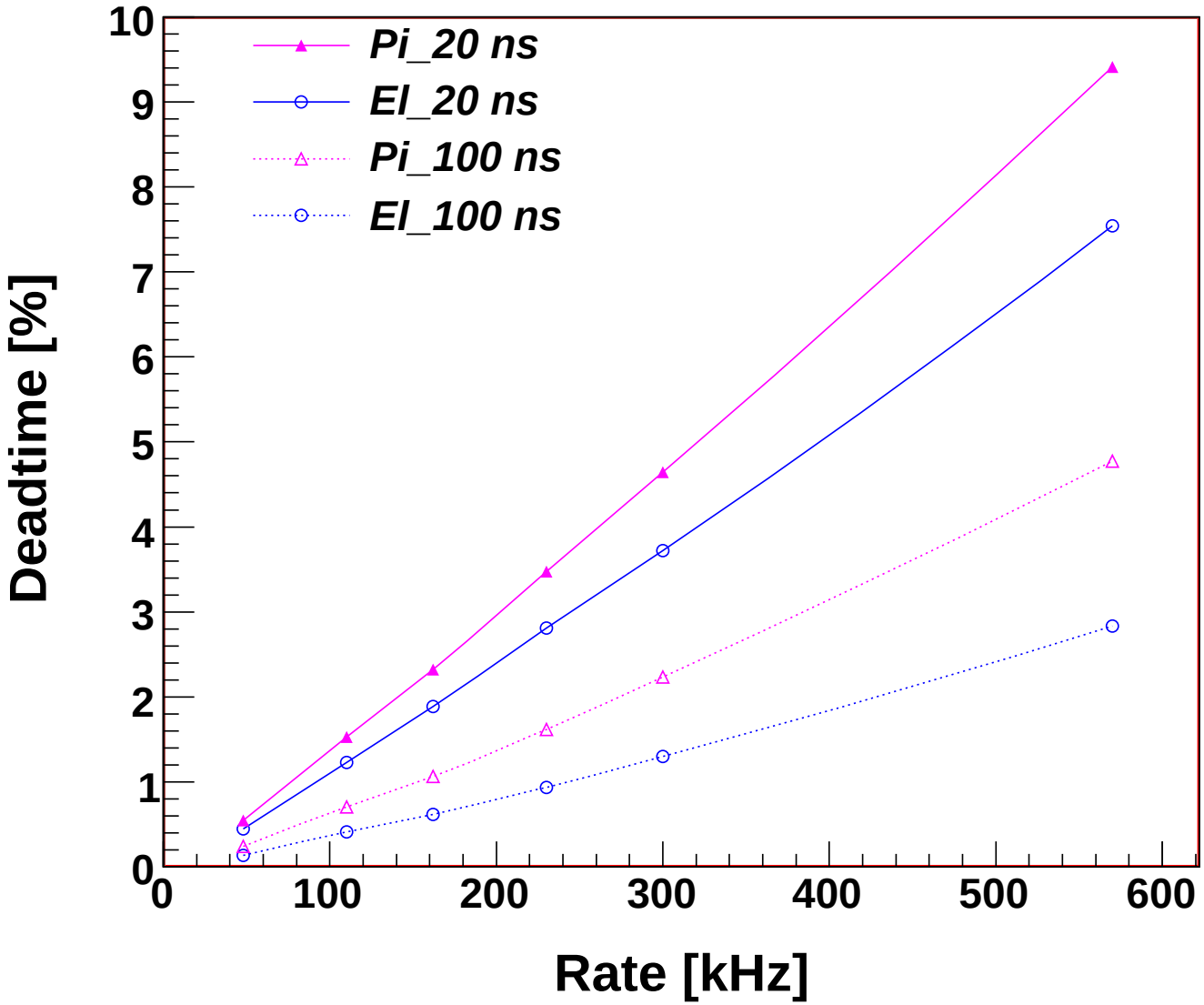






Deadtime

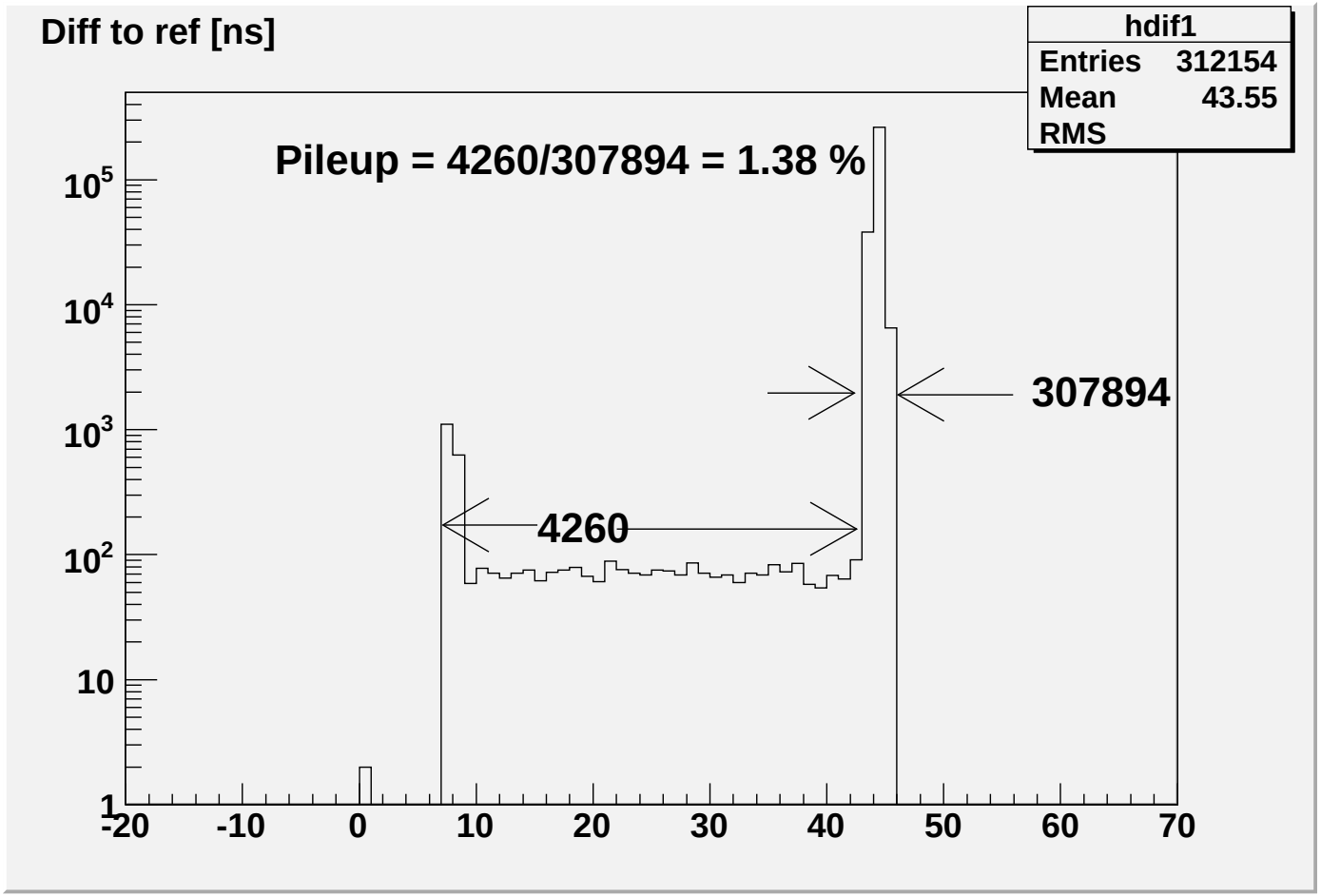
- Deadtime-study as a function of random signal rate is in progress.
- Deadtime $= \frac{(Rate_{tagger} - Rate_{signal})}{Rate_{tagger}}$, where Rate_{signal} is the PMT signal ANDed with tagger, and tagger is a pulser signal.
- Deadtime of narrow path (20 ns) appears to be higher than that of wide path (100 ns). This was expected to be the other way around. Still being investigated.


Pi_20 ns
El_20 ns
Pi_100 ns
El_100 ns
Deadtime [%]
Rate [kHz]
0
1
2
3
4
5
6
7
8
9
10
0
100
200
300
400
500
600

Pileup

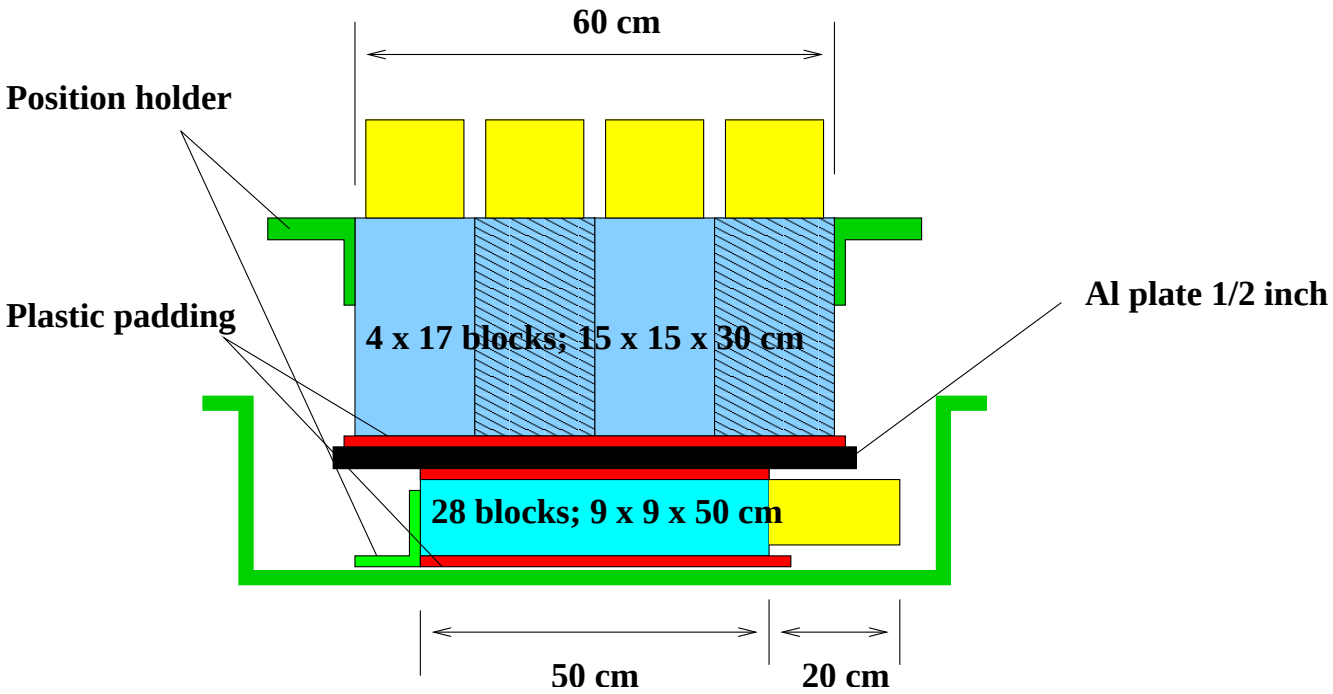
- When two pulses come very close in time, shorter than the time resolution of the detector, pileup develops.
- The signal from a pileup is meaningless since the event may be due to two valid events, two invalid events, or one valid and one invalid events. Need to understand how many events are like this.
- Count the number of pileup events. Find what percentage of events are effected by pileup. Less than a percent expected.
- Used TDC to estimate pileup. Will use FADC too.

Used TDC to see pileup effect



Future Plans - I

Will setup a new preshower/shower detector stack in the left HRS in close collaboration with Jack, Bogdan , Eugene, and others. PVDIS students (Dian-Cheng Wang and Xiao-Yan Deng) will work on this all this summer. Here is Bogdan's drawing for the new preshower/shower detectors.



Future Plans - II

- Finish all the proposed tests: asymmetry measurement down to 100 ppm, deadtime and pileup studies.
- Move the DAQ-setup to the right HRS detector hut this August for the parasitic test with the Transversity expt.
- Duplicate the DAQ for the left HRS.