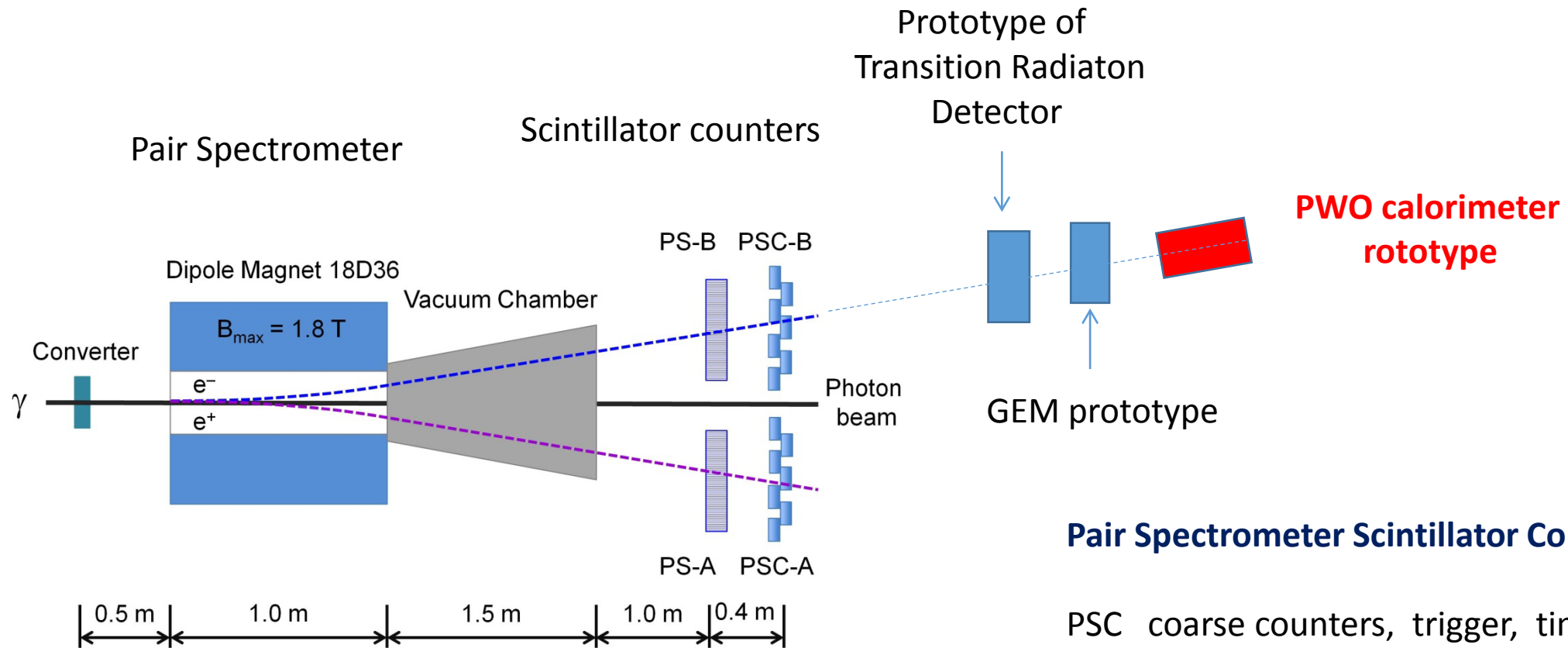


Beam Test of the PWO Calorimeter Prototype

NPS meeting, April 5, 2018

V. Berdnikov and A. Somov

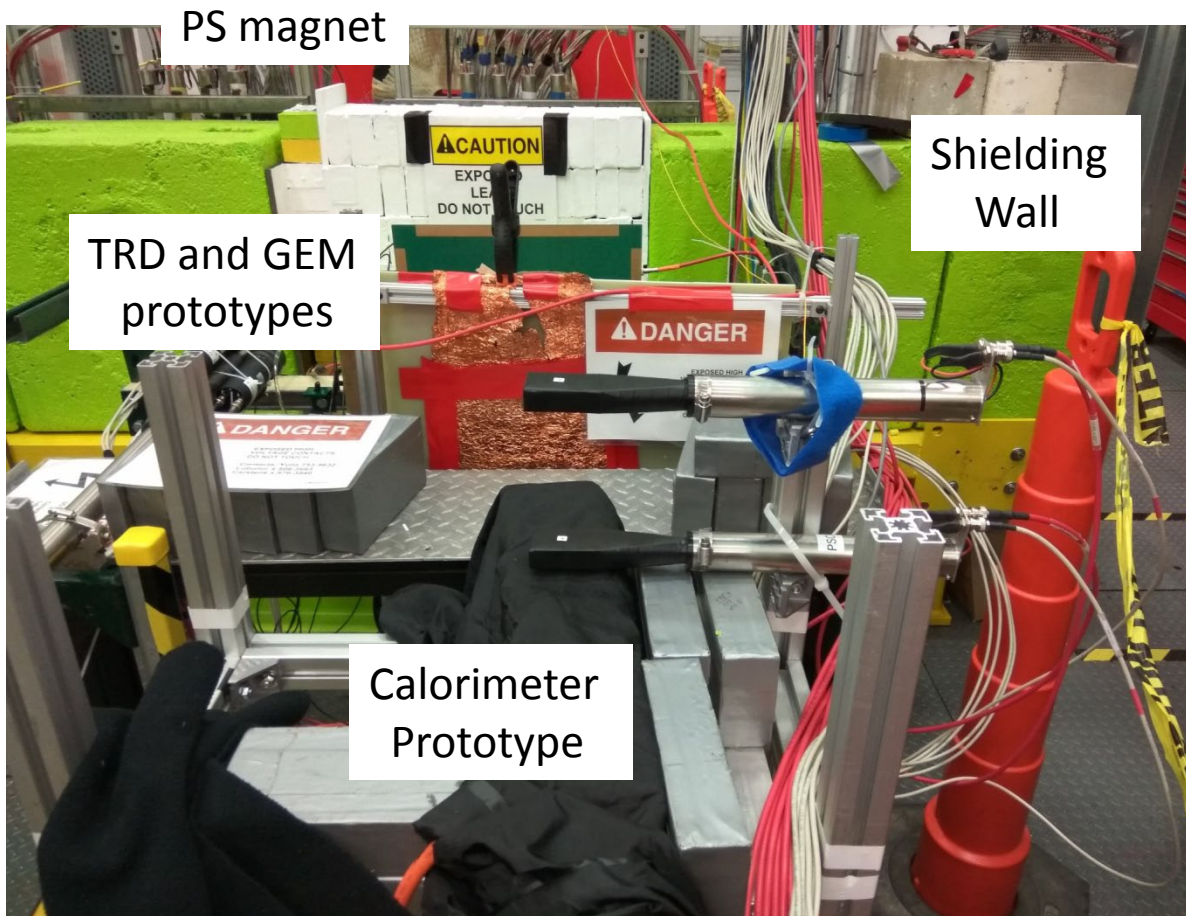
Prototype behind Hall D Pair Spectrometer



Pair Spectrometer Scintillator Counters:

- PSC coarse counters, trigger, time
- PS high-granularity, energy measurement
 - 145 counters per PS arm
 - energy range: 3 GeV – 6.25 GeV
 - energy resolution < 1 %

Prototype behind Hall D Pair Spectrometer



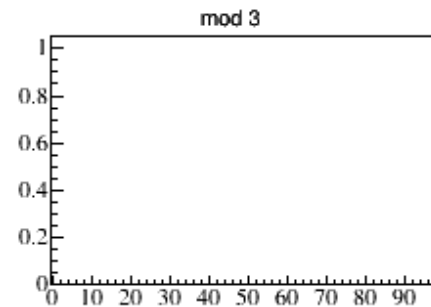
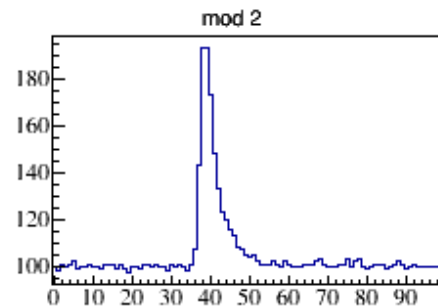
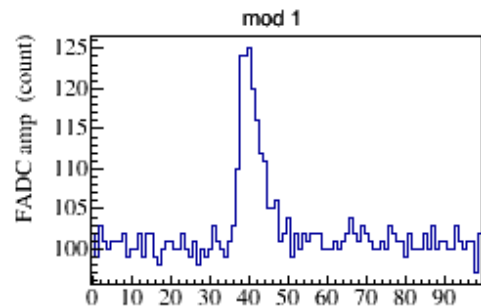
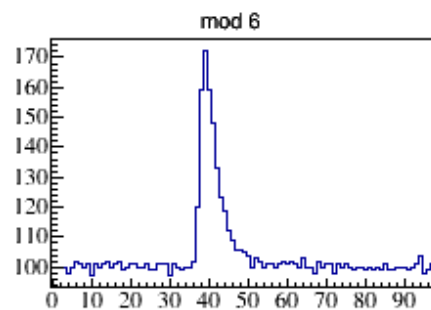
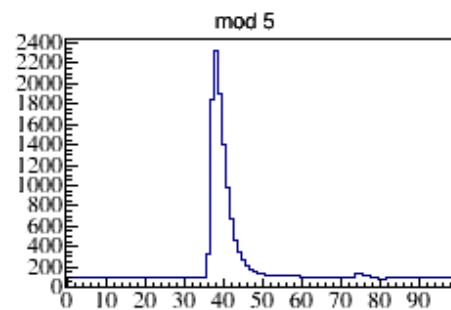
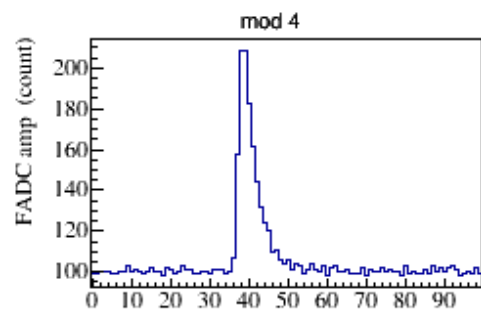
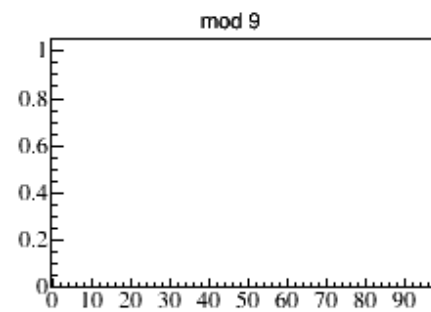
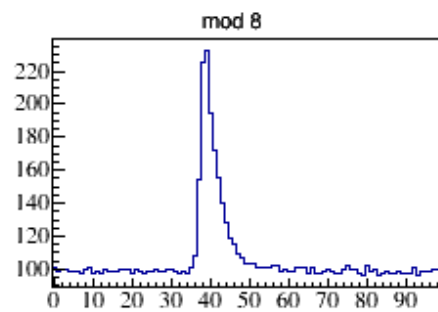
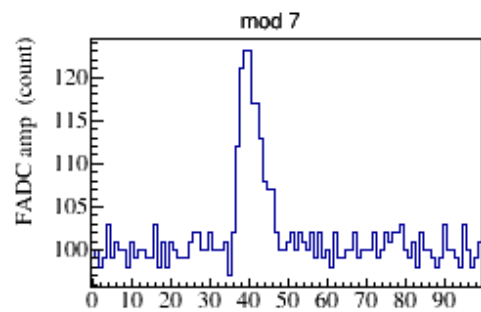
- 3x3 PWO calorimeter prototype installed in Hall D behind the pair spectrometer

<https://logbooks.jlab.org/entry/3544274>

<https://logbooks.jlab.org/entry/3543505>

- Integrated into Hall D global DAQ
- Analyze data recorded with the GlueX PS trigger
- Also implement cosmic ray trigger (self trigger for stand alone read out)
- HVs on all PMTs were set to 750 V
 - will be individually adjusted after calibration

Event Display



Example:

- electron hits the middle module
($E = 4.69 \text{ GeV}$)

Read out FADCs in a raw mode

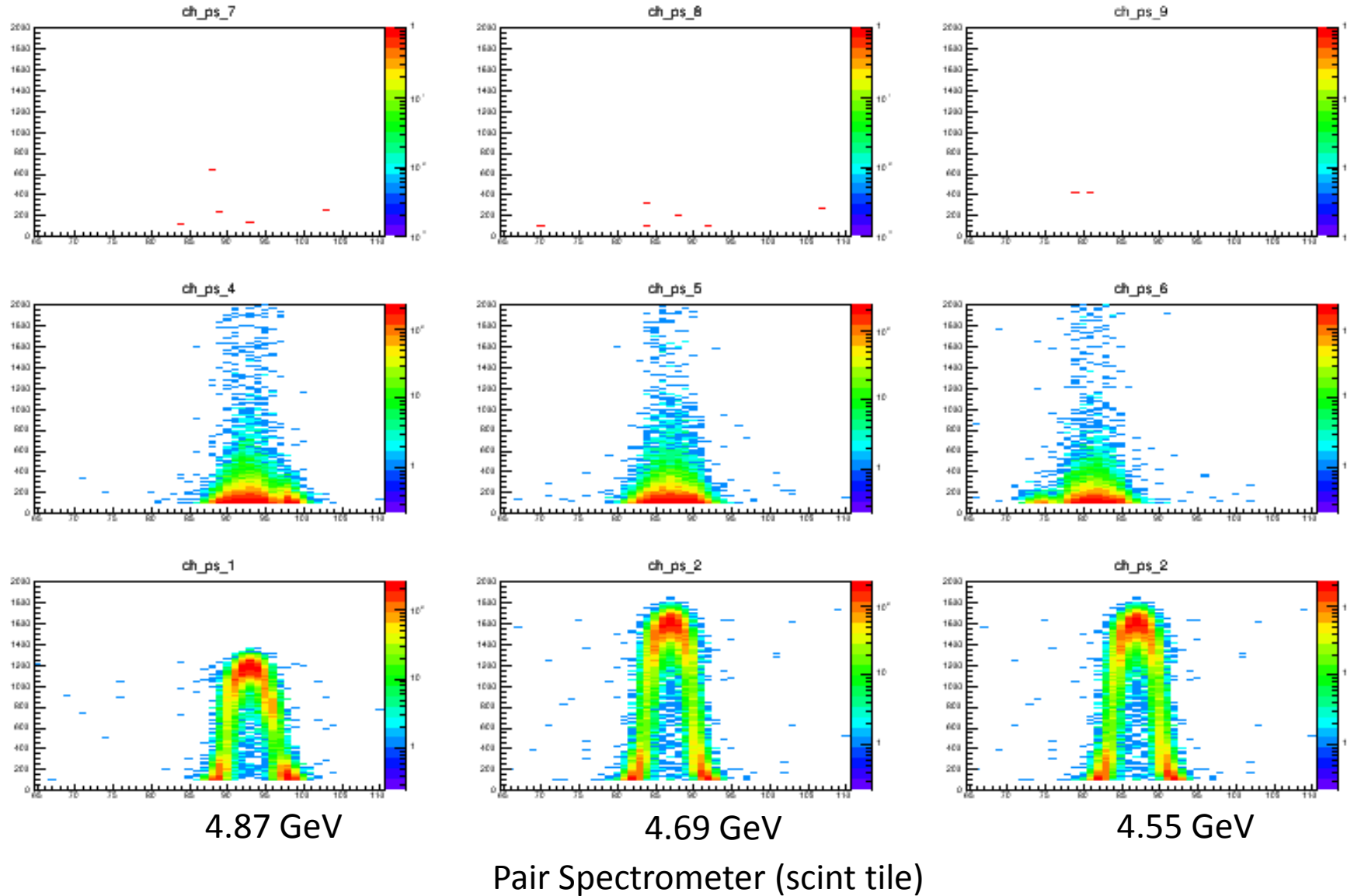


FADC wave waveforms

FADC samples

Calibration

Projection of PWO modules to the Pair Spectrometer Hodoscope



Each scintillator tile of the Pair Spectrometer corresponds to different electron energy

Move prototype in the vertical direction

- calibrate energy for modules in the top, middle, and bottom rows

Measure fadc amplitude for electrons going through the middle of each module



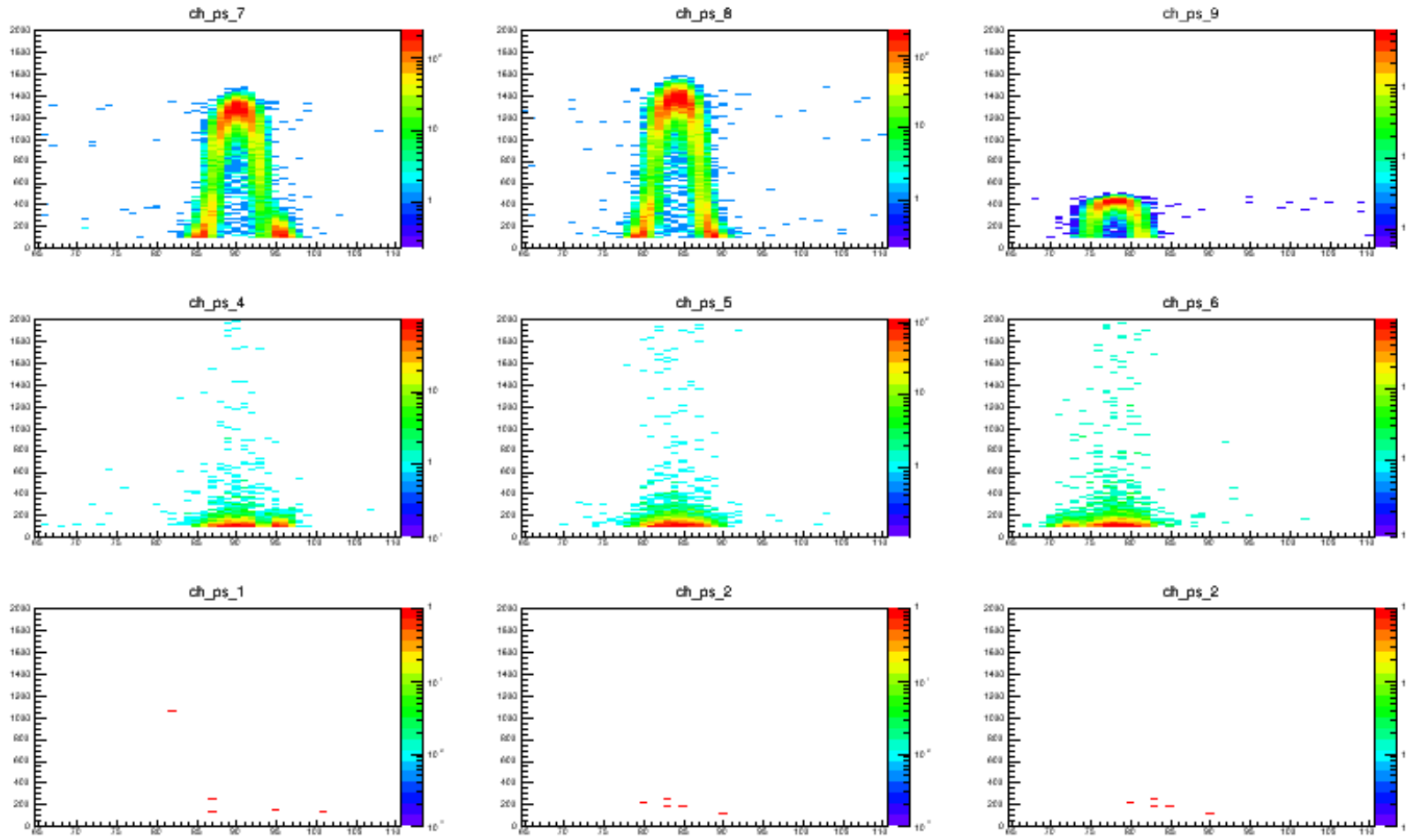
Pair Spectrometer electrons

(calibrate bottom row)

Calibration

Projection of PWO modules to the Pair Spectrometer Hodoscope

FADC amplitude



Pair Spectrometer
electrons
(calibrate top row)

4.87 GeV

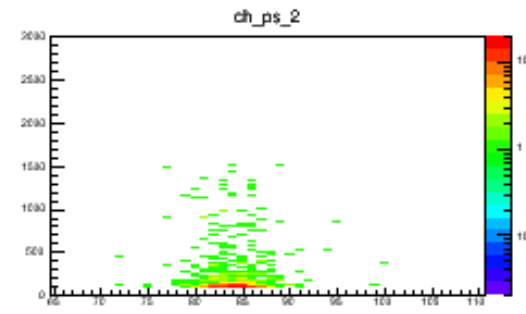
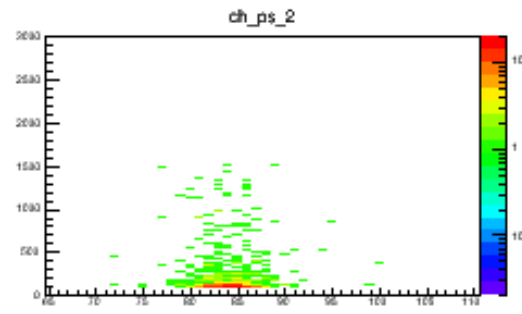
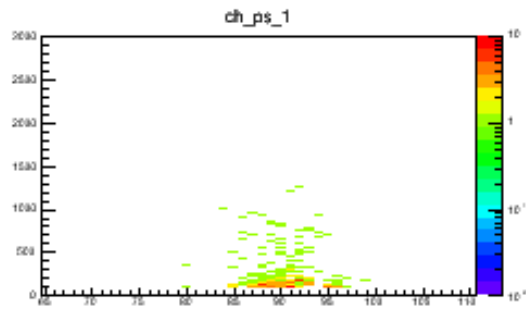
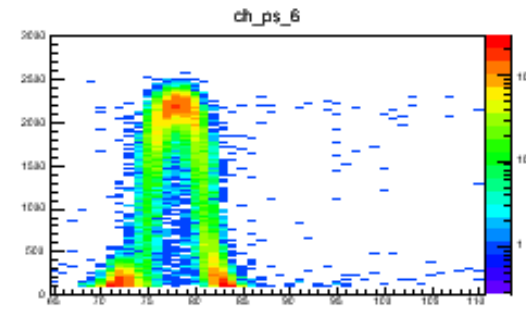
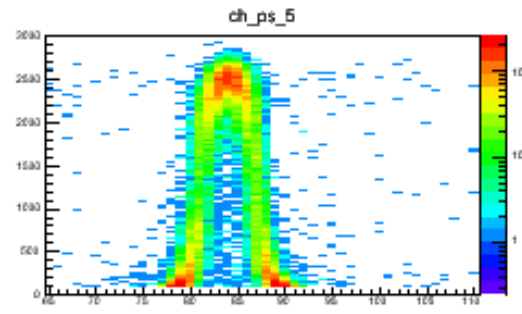
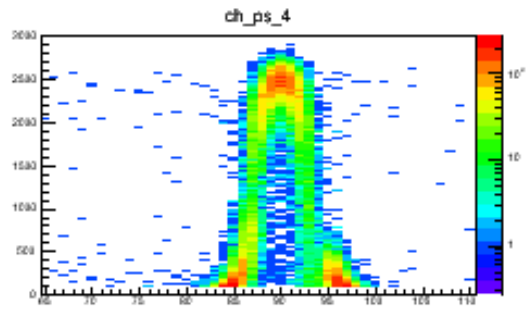
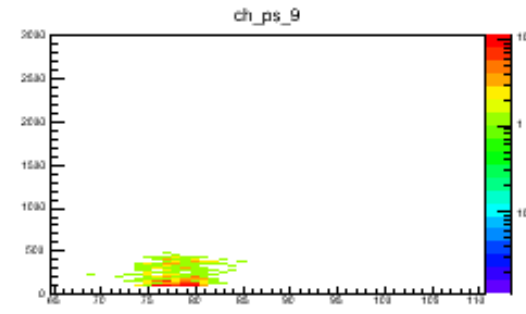
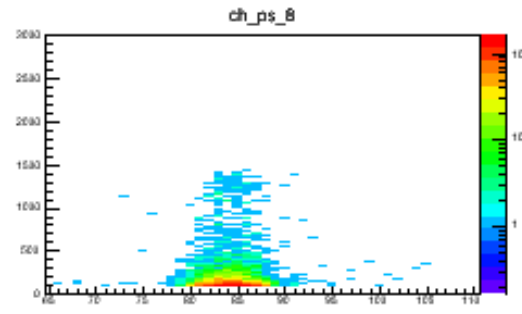
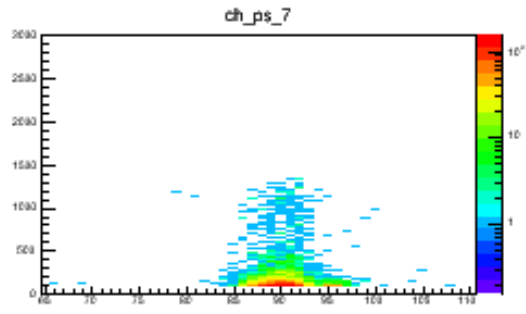
4.69 GeV

4.55 GeV

Pair Spectrometer (scint tile)

Calibration

FADC amplitude



4.87 GeV

4.69 GeV

4.55 GeV

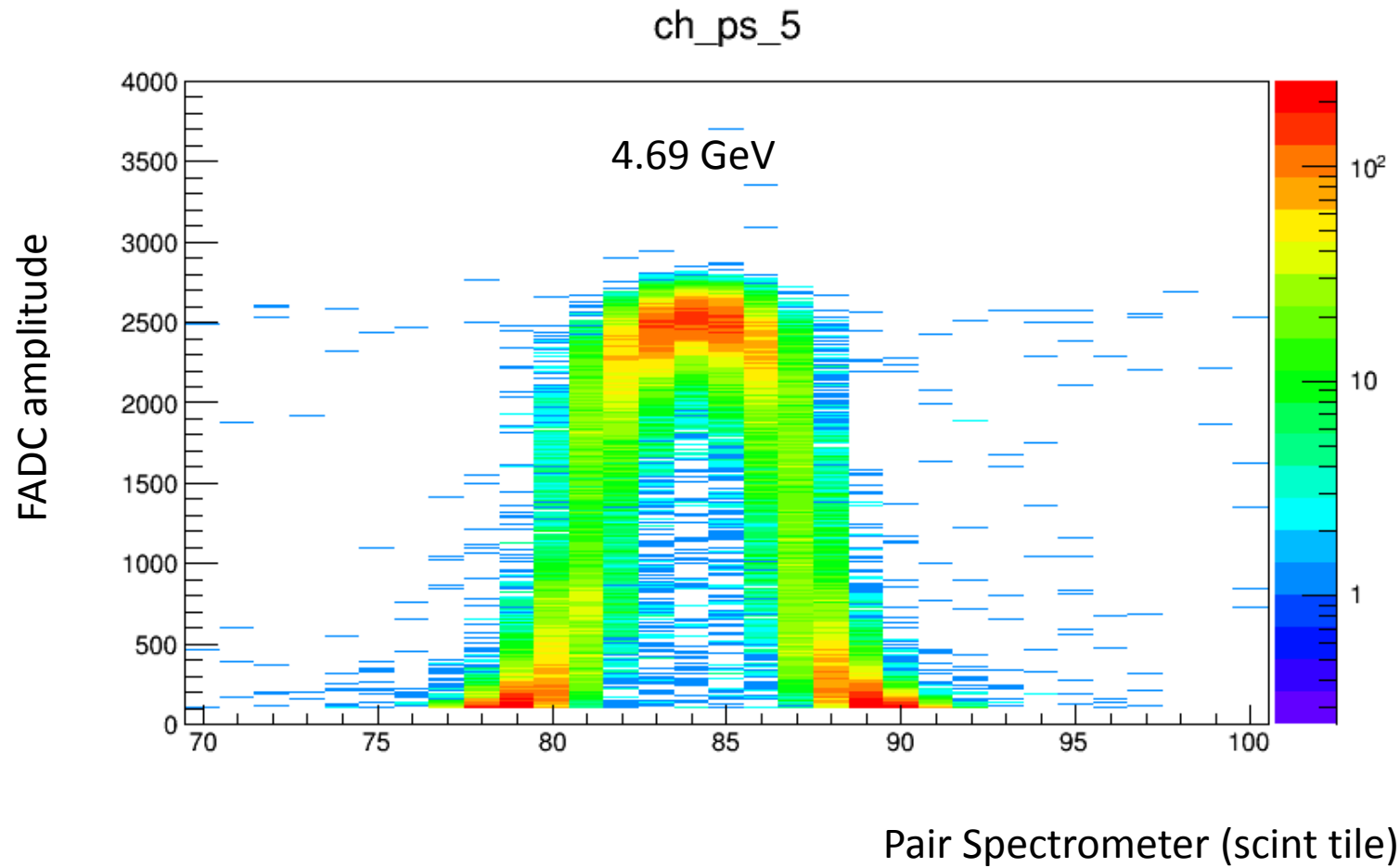
Pair Spectrometer (scint tile)

Prototype location:
- 4.69 GeV middle cell

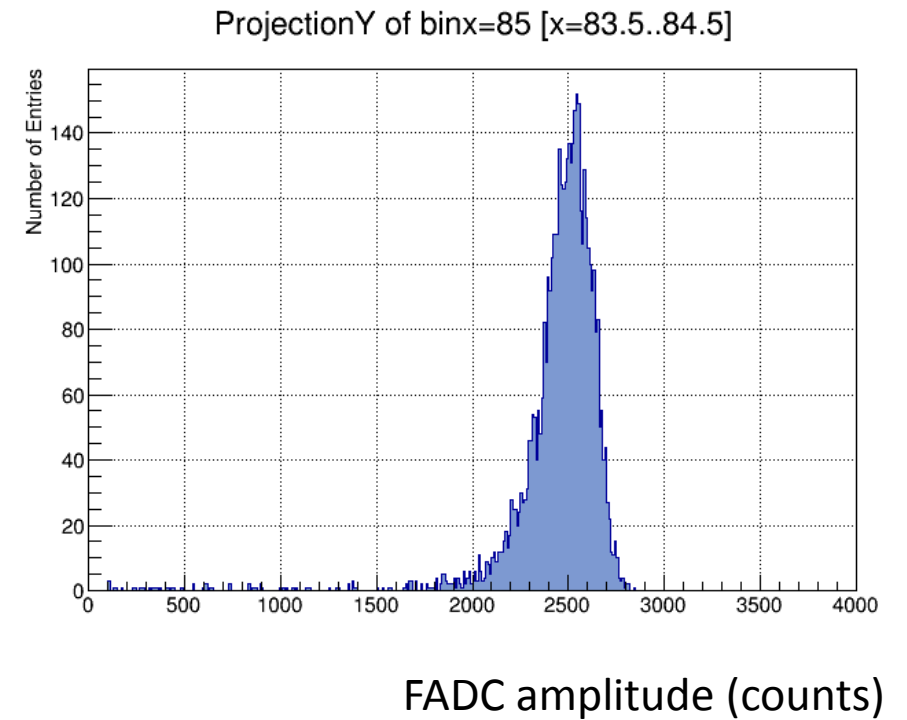


Pair Spectrometer
electrons
(calibrate middle row)

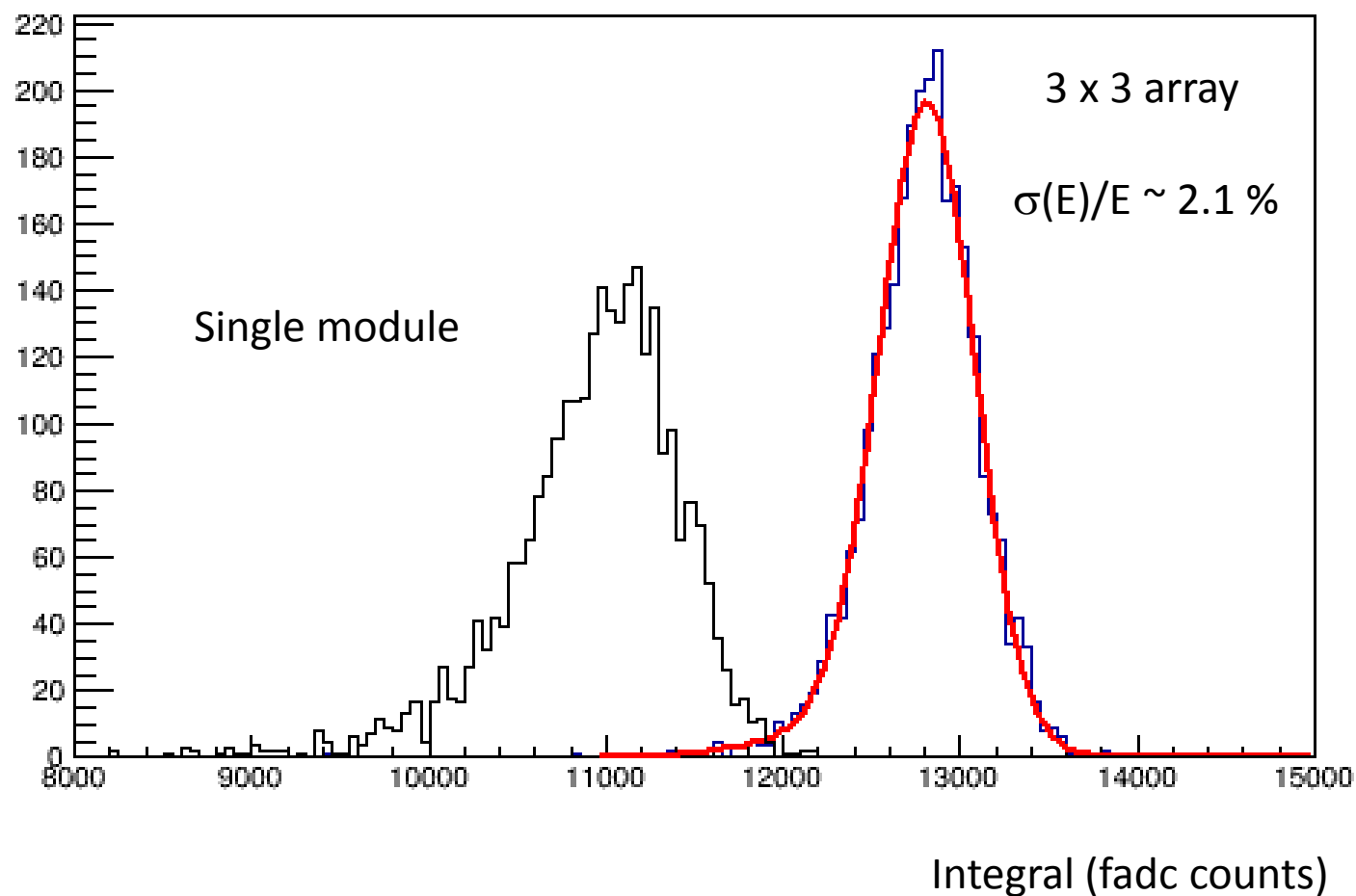
Calibration



fadc amplitude for the PS tile in the middle
of the PWO module



Energy Resolution: Middle Module



- Select electrons going through the center of the middle module
- There is room for some improvements of the energy resolution
 - need to consider limitations from the PS setup and prototype
 - use PS energy constraint to calibrate modules (regression analysis), work in progress

Some Topics for Discussion

Gain of PMTs in the middle row is rather high, Vlad has also checked gains with an LED .

We had to lower HVs to 750 V to make sure that FADC amplitudes for 4.6 GeV electrons were within a 1 V fadc range; amplitudes corresponded to about 2500 fadc counts (the maximum amplitude is 4096 counts).

- note, amplitudes for other PMTs in the prototype are about a factor of 2 smaller.

For the larger dynamic range of the calorimeter (also if we consider to use a 0.5 V fadc range), HVs for these 3 PMTs have to be lowered below 700 V

- linearity (and quantum efficiency) has to be checked if we need to run at small HVs

We have to compare gains of PMTs from the prototype (old PMTs) with that recently purchased from Hamamatsu (gains from the later ones seem to be rather uniform)