Extraction-Line Energy Spectrometer

ALCPG 2011
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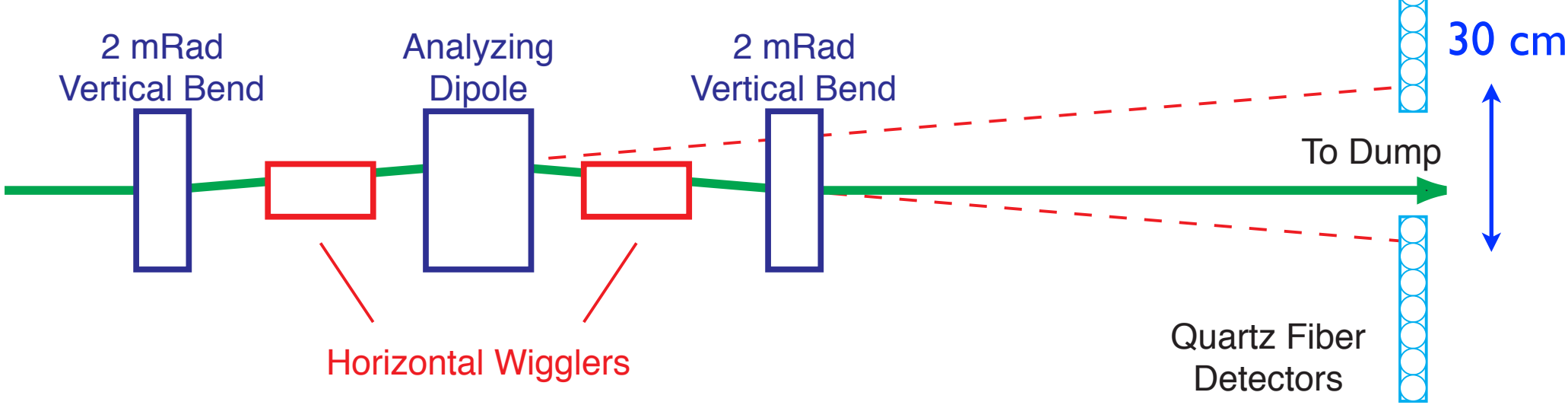
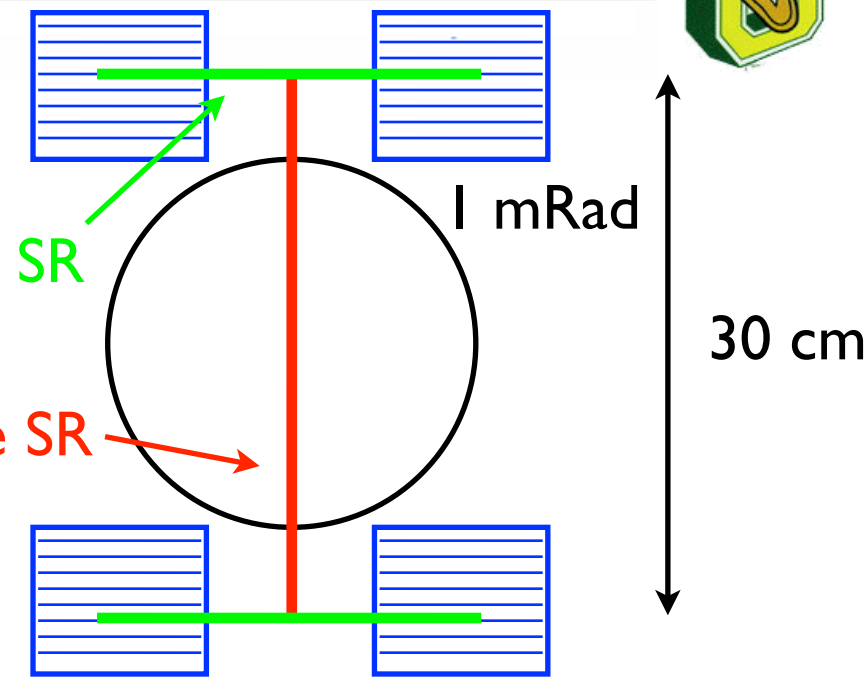
Extraction Line Spectrometer



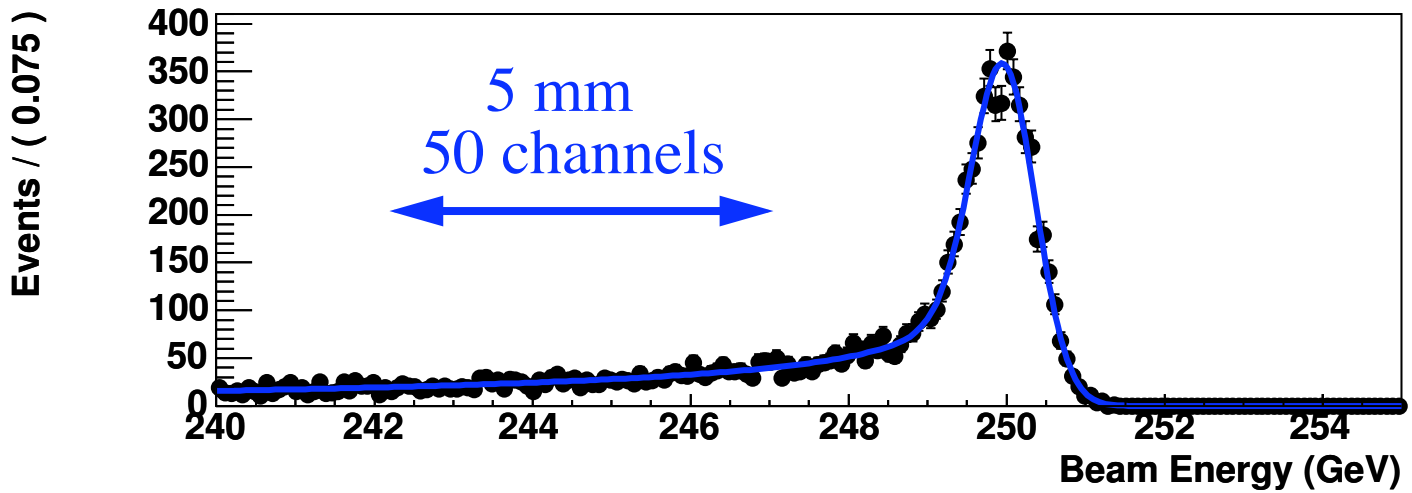
- Secondary focus at detector plane
- Wigglers can be turned off for background measurements
- Long flight distance (~75m) to position-sensitive detector
- 30 cm separation on detector plane
- ~100 MeV / 100 microns - need O(20 micron) accuracy

Detector Plane

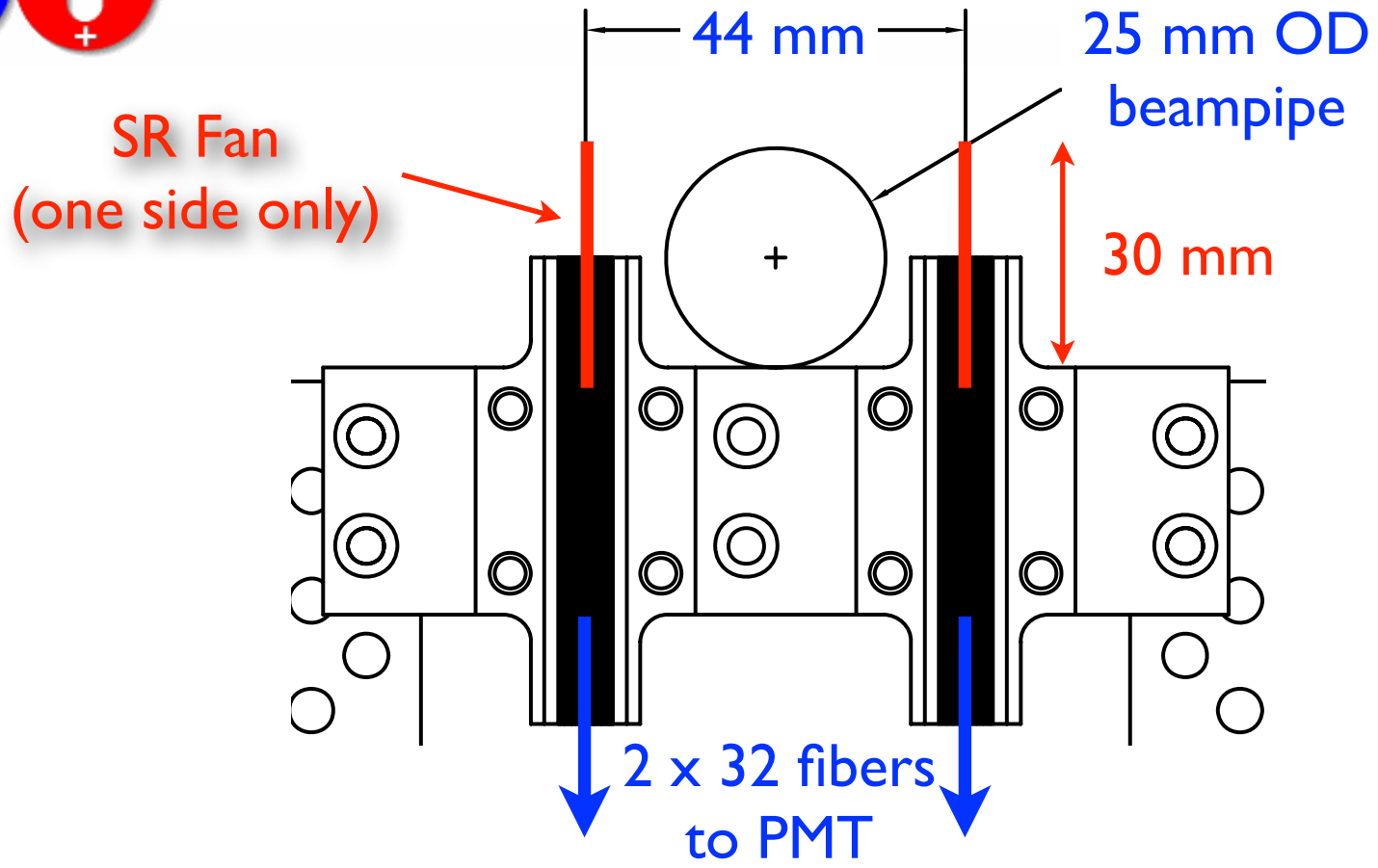


150 MeV / 100 um
for 250 GeV beam

Peak gives Ebeam
Tail monitors disruption

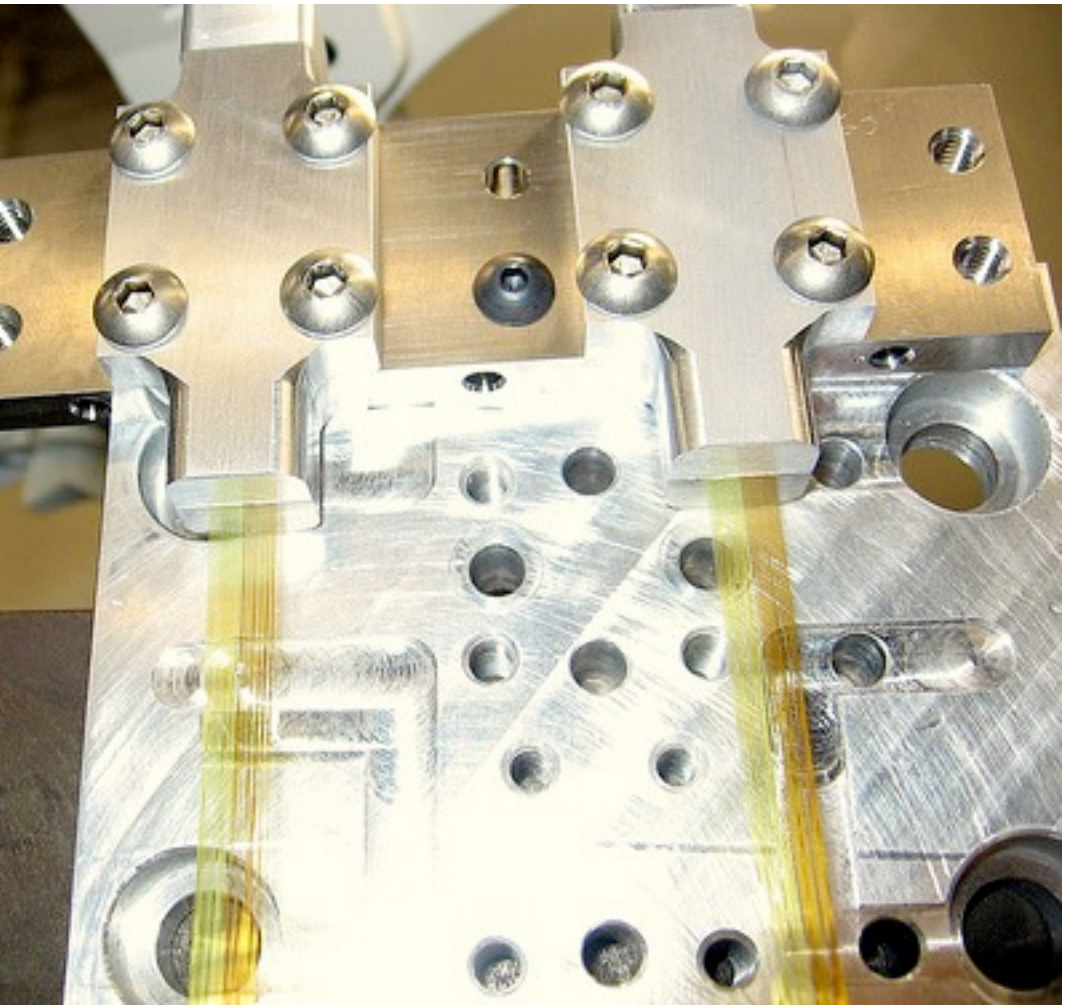


2nd prototype detector

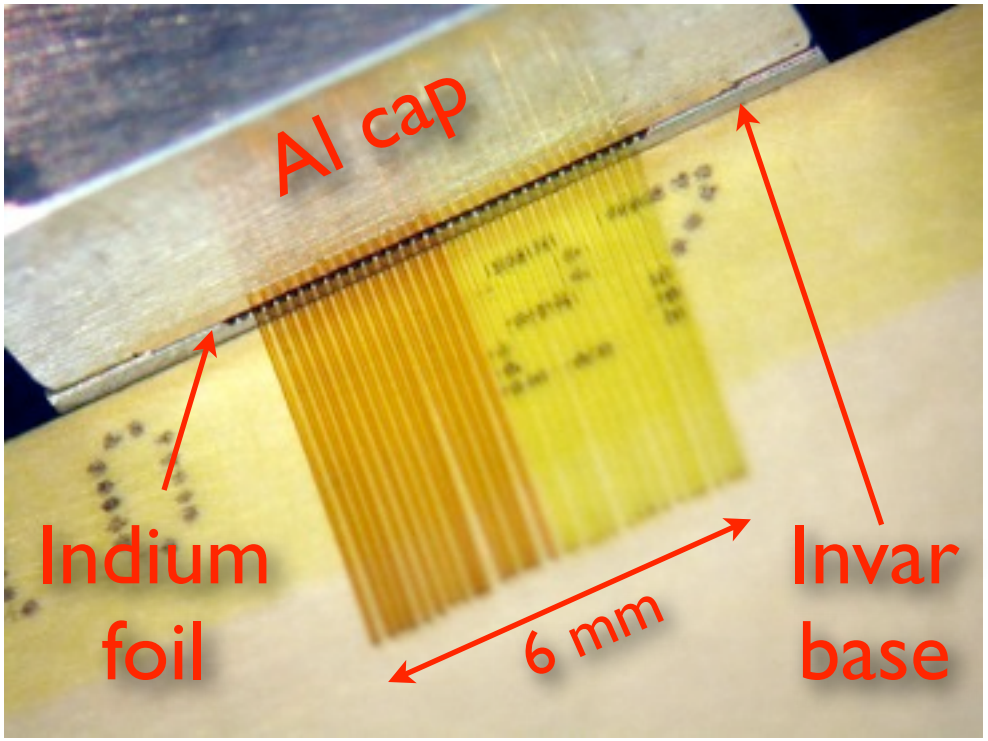


- 64 x 140 micron (100 micron active) UV fibers (Polymicro)
- Spaced on 200 micron pitch w/ grooves engraved on Invar
- Built for T-475 testbeam (SLAC)

Finished Assembly



60 fibers in place
(4 background fibers)



Fiber ends
before trimming

In Beamline

SR Exit Window

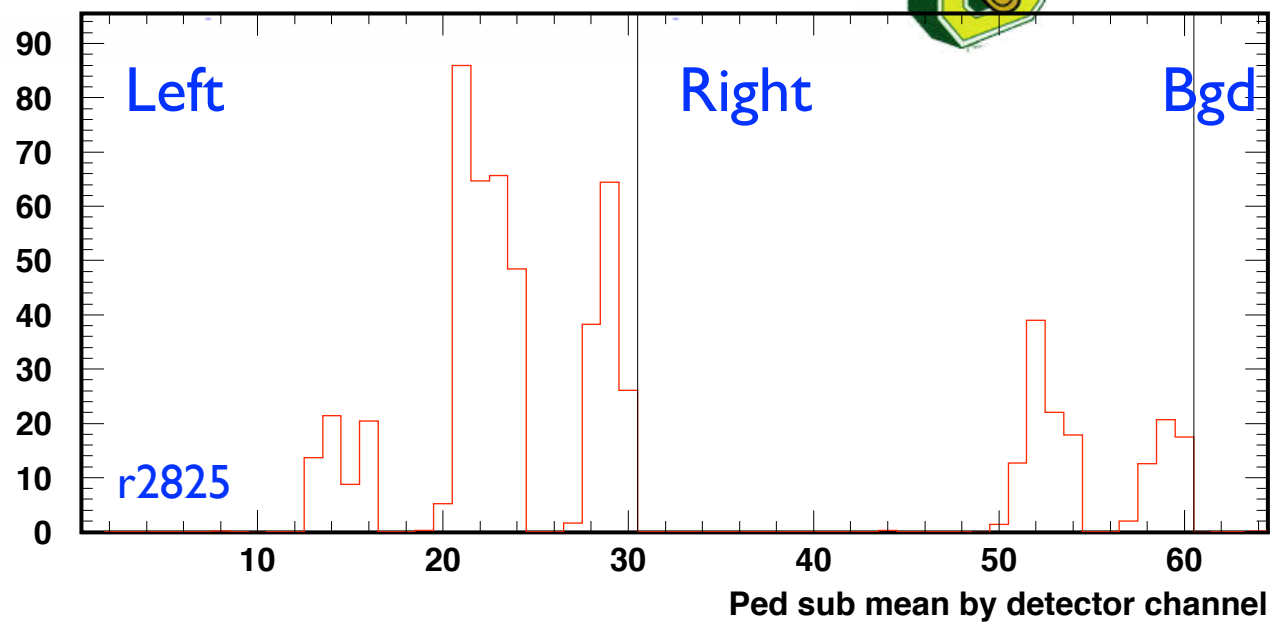
Detector Stand

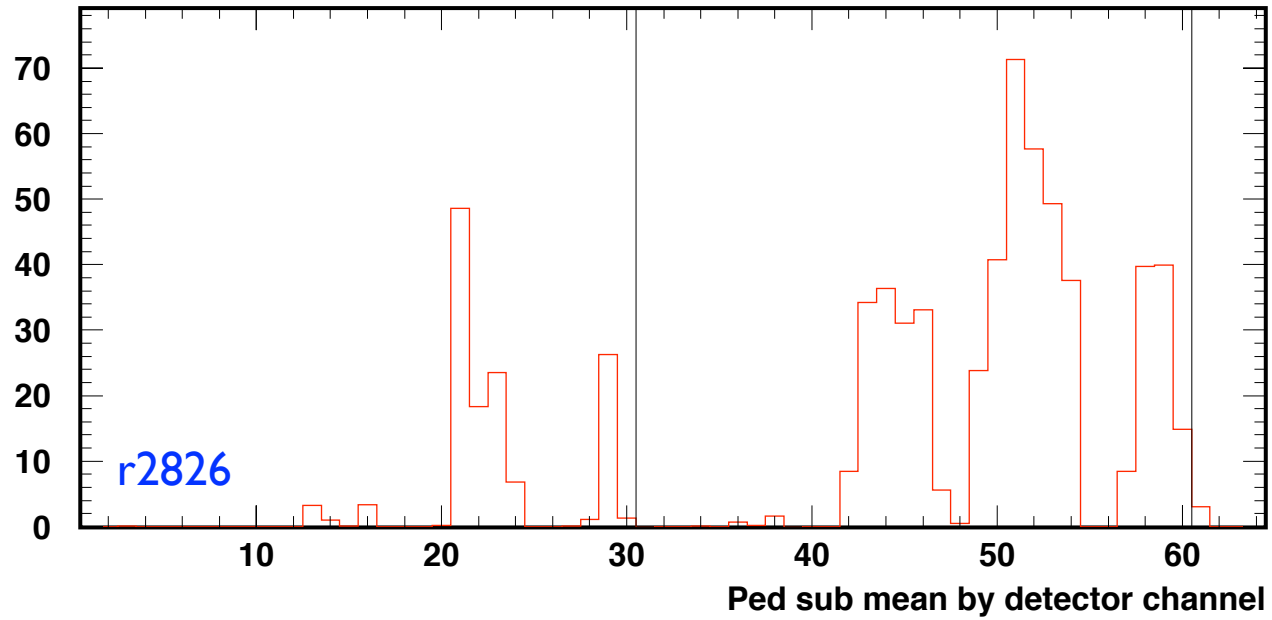
PMT Shelf

July 2007 Run Data

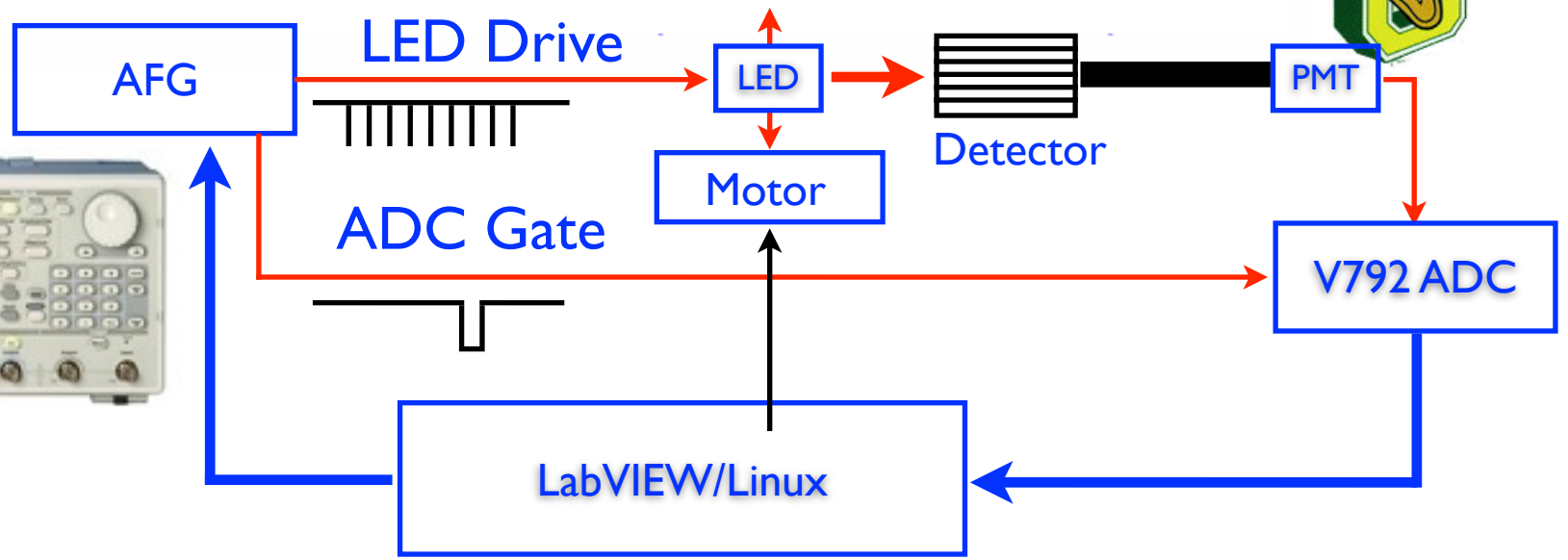
- Reversing chicane moves beam from Left to Right
- Good "signal" strength
- Low/zero backgrounds
- Significant crosstalk

ESA test-beam shut down after 2007, have continued at low level with local teststand



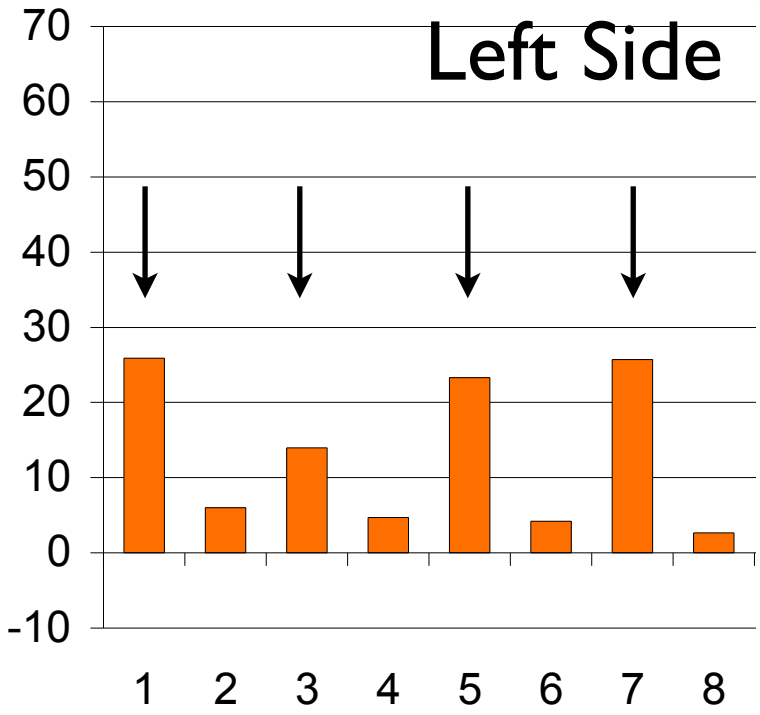


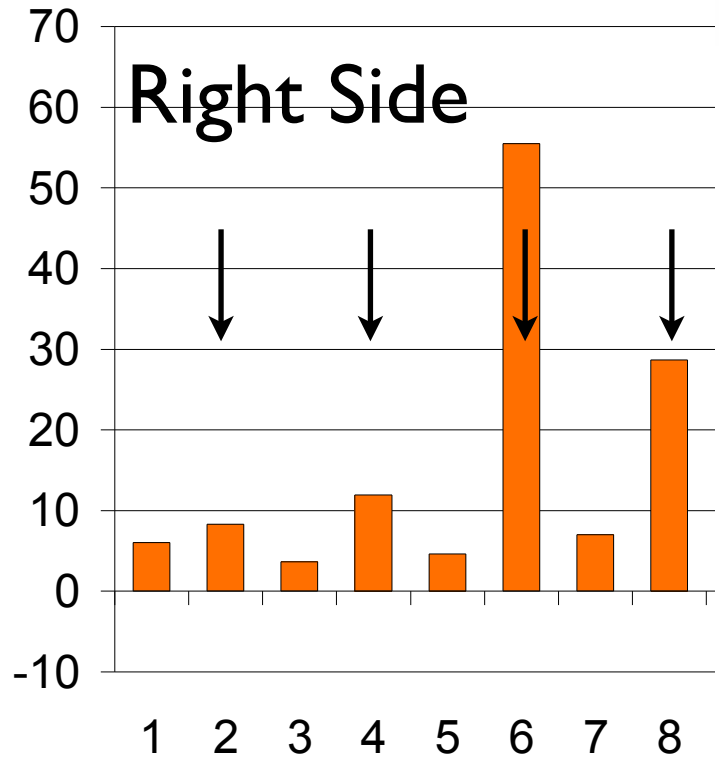
Oregon Teststand



- Use Tektronix AFG3022 to simulate ILC bunch train, second channel produces sliding gate (read out one bunch per train)
- UV LED (395 nm), adjustable intensity from pulse amplitude, light injected into fiber ends of prototype detector
- Motor stage to scan signal across channels, precision linear resistor to give micron-level position readback
- VME readout by CAEN V792 ADC - VME-PCI bridge

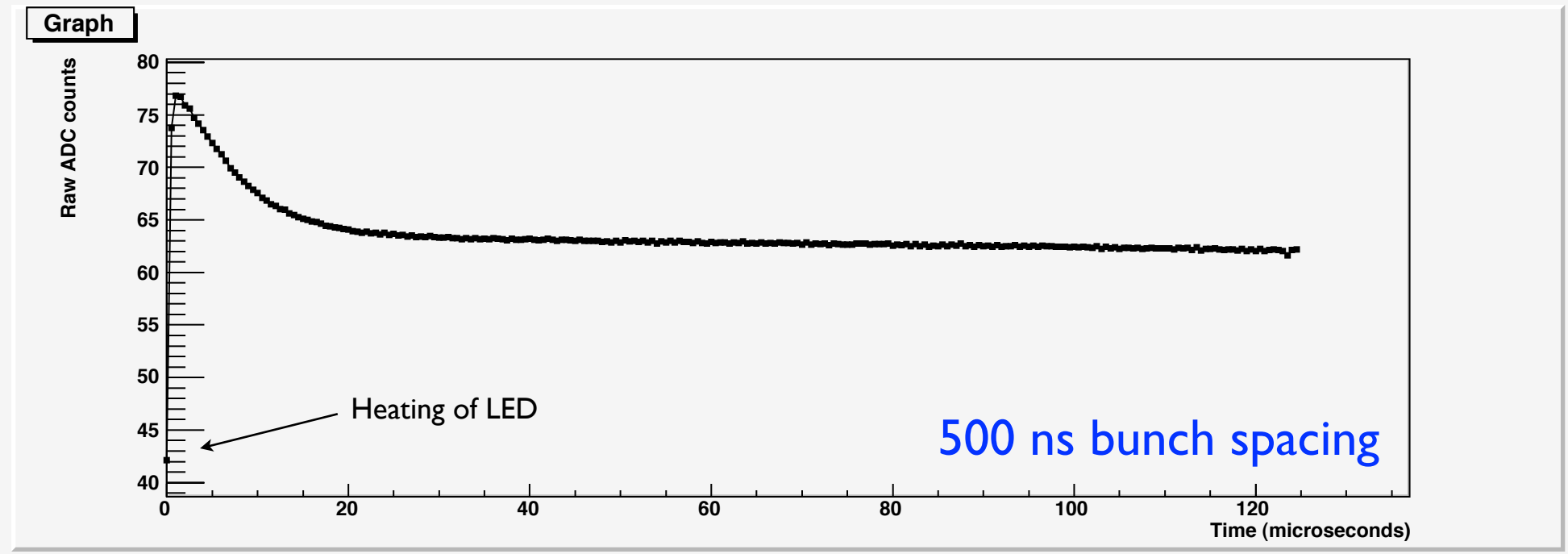
Bench Crosstalk





- Large variation in response as expected (poor optical coupling)
- Clear L/R pattern seen (as expected)
- Large cross-talk (10-20%)
- Fixed in mechanical assembly, ~1% crosstalk after

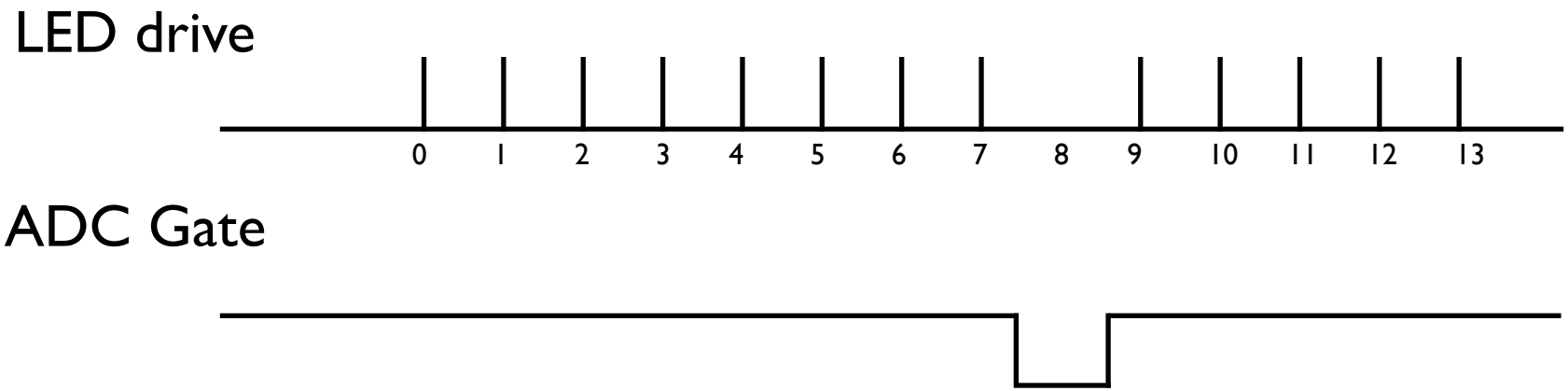
PMT Loading



- MA-PMT response measured in individual train pulse
- Response depends on bunch position within train
- Relatively stable after ~ 20 microseconds

Originally thought this was PMT loading, but...

Pedestal Test



- Exact same pattern seen in 'pedestal' data - baseline shift
- Currently trying to verify that this makes sense in terms of LED drive amplitude and pulse spacing
- Could correct with active PMT base, or in readout electronics, or just measure and correct

Bench program

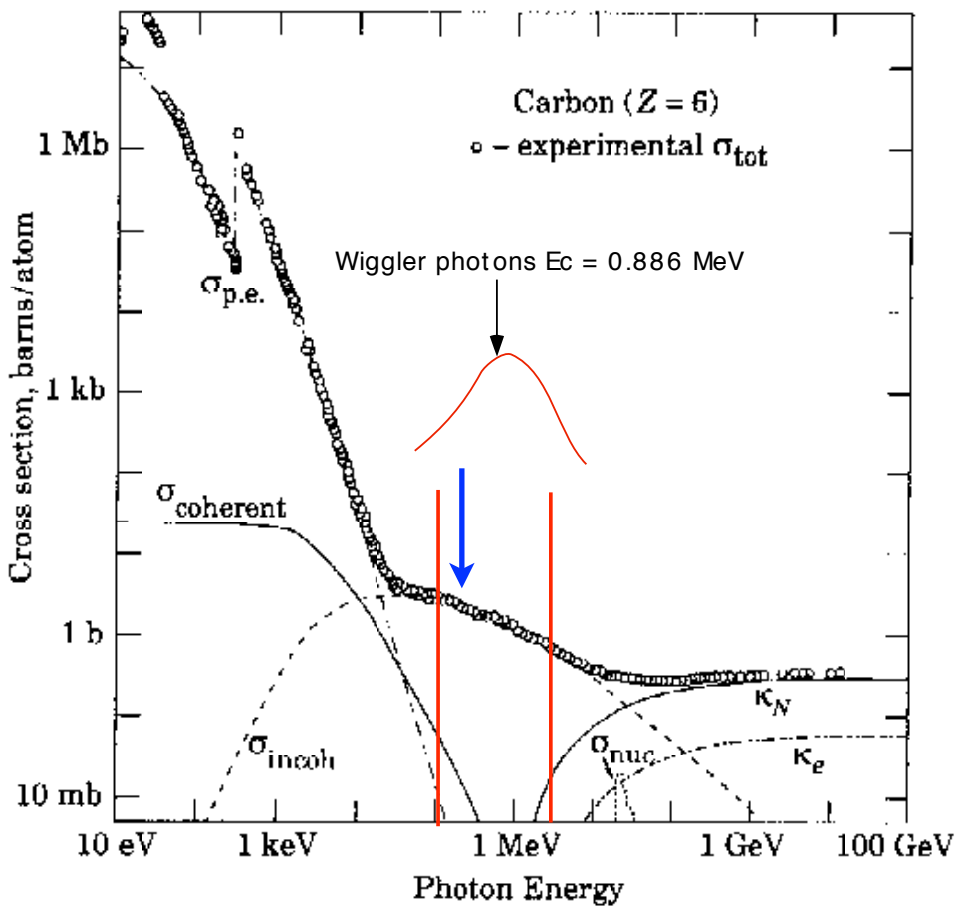
- Slow but steady progress with UG students
  - Full computer control of AFG, DAQ, and motor control
- Summer 2009 measurements
  - Crosstalk map for full 64 PMT channels
  - mechanical issues with test beam detector fixed
  - Begun spatial linearity tests
- Summer 2010 measurements
  - Goal to make linearity measurements by pulse number
  - Instead discovered that our loading assumptions probably wrong - pursuing this actively now

Ultimate goal to understand linearity of MAPMTs under bunch train conditions

Return to ESA?

- Very interested in taking more beam data in ESA
- Lower Ebeam presents a challenge
  - Cherenkov threshold is KE = 0.23 MeV
  - Wiggler E_{crit} goes as B E_b^2
  - E_{crit} (28 GeV) = 0.89 MeV, down to 0.22 keV at 14 GeV
  - Need to Compton scatter secondary electrons
  - Cross-section still OK, but need detailed simulation to get number above Cherekov threshold

R. Arnold, E. Torrence
IPBI-TN-2004-7



Sync. Spectrum does extend upwards a bit, may still be OK

Other Options

- No other good source of ~30 GeV electrons in the world
- Could use single electron test beam + preradiator
  - Does not demonstrate energy measurement
  - Does demonstrate collection efficiency and provide data to validate simulation
  - Quartz fiber calorimeters are well established already, however...
- Also potentially interesting to measure 'background' with sub-critical beam
  - Test of scintillation in fiber cladding for instance

Conclusions

- XLS work has been far from my first priority for some time
- Detector from T-475 has been used for bench tests, ready for more beam
- Good test bench now set up for PMT testing
  - can proceed in parallel to beam tests
- Have requested money for second student to get working on real GEANT4 simulation
- Looking forward to ramping up (slightly) the effort here again
- Will investigate possibility of BEAN readout chip (what is the polarimeter doing here?)