# Extraction-Line Energy Spectrometer

American Linear Collider Physics Workshop 2007
23 October 2007
FNAL

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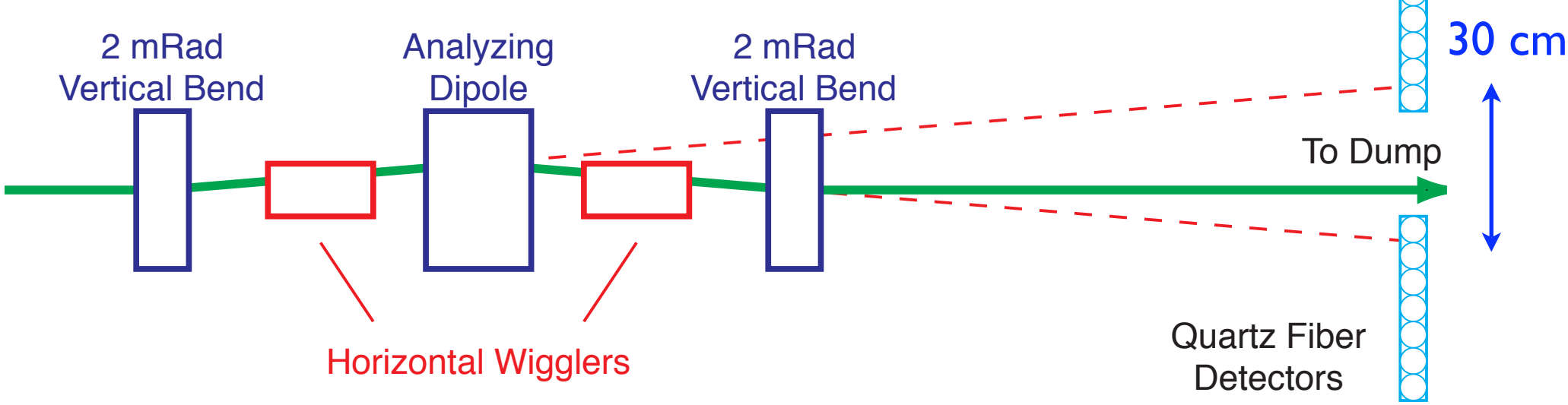
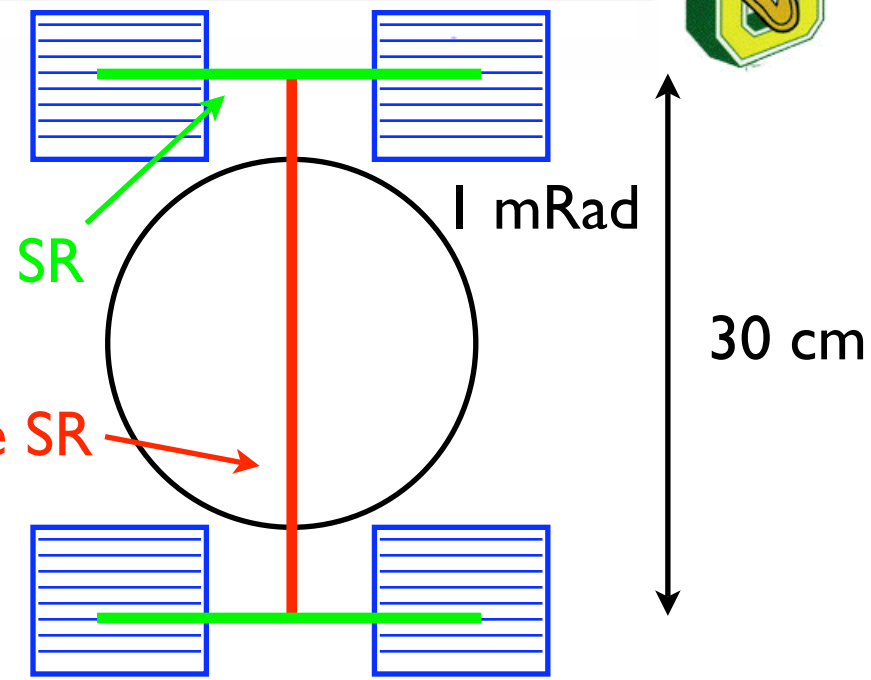
University of Oregon

# 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

- 4 mRad bend (+/- 2 mRad) over ~75 meters
- 30 micron accuracy for 100 ppm (optical survey OK)
- Instrument with 100 micron quartz fibers, Multi-anode PMT
- Double detector improves wiggler alignment tolerance

Rad hard and robust, fast and simple readout,
easy gain adjust, no RF pickup, modest cross-talk

# T-475 program

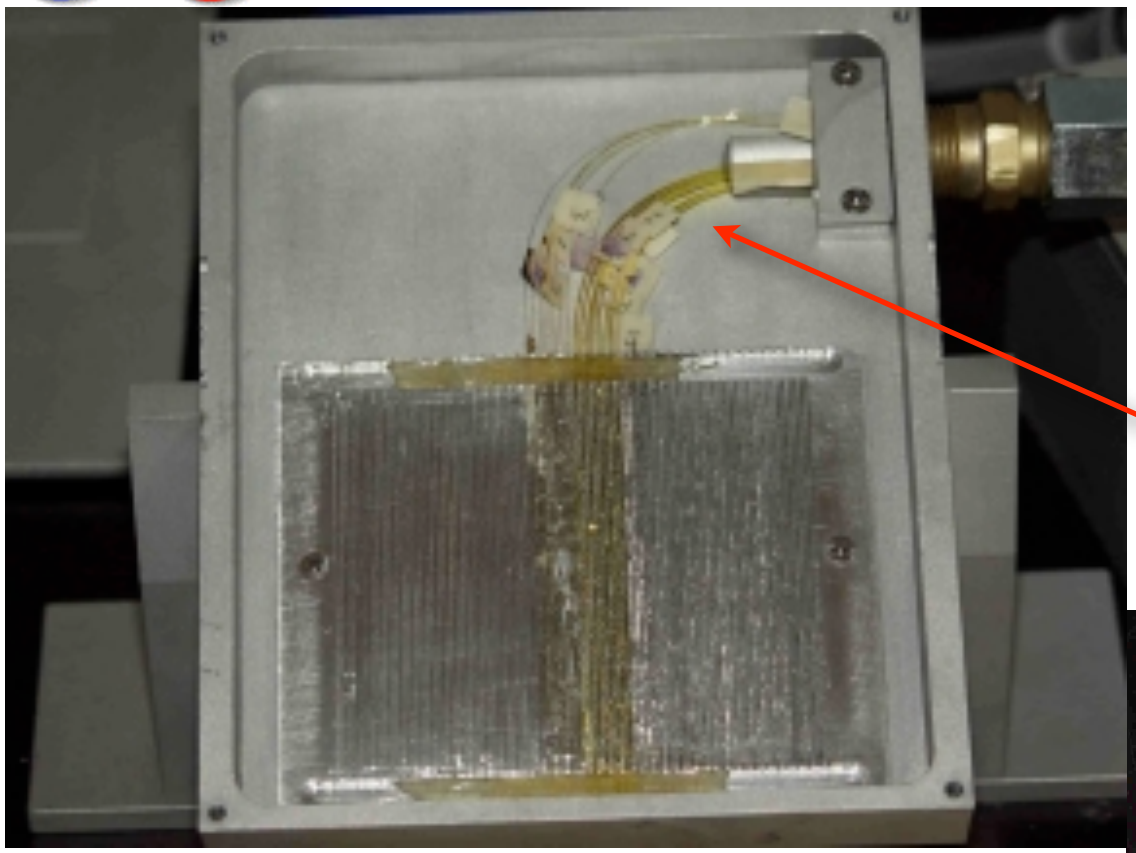
## Stage 1

- Check SR detection by Cherenkov in quartz fibers
- Compare efficiency (very small) to MC
- Check for other anomalous background sources
- Operational and design experience

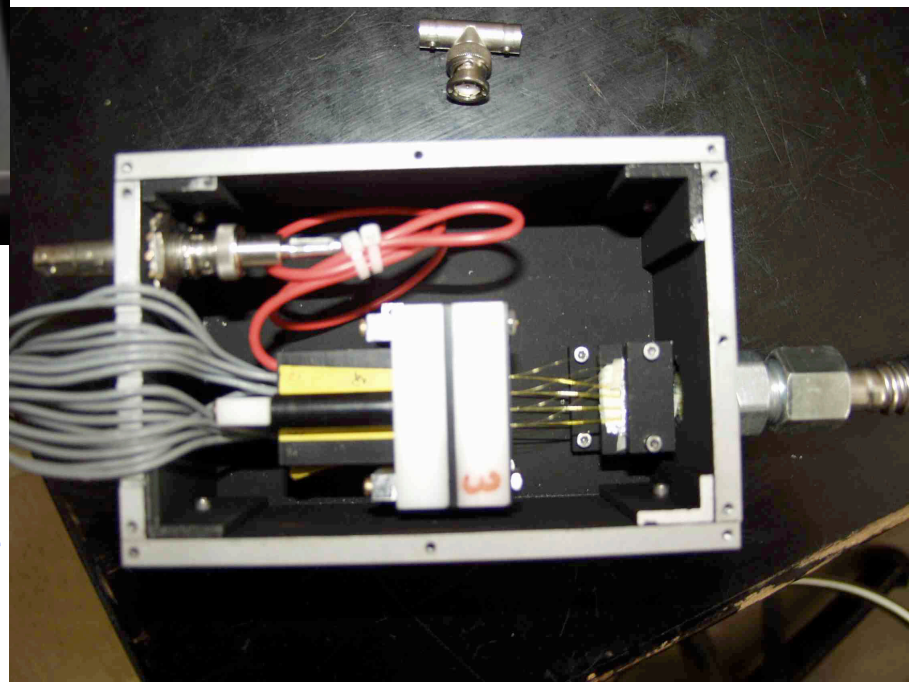
## Stage 2

- Refine design to be closer to XLS
- Demonstrate E measurement by this technique
- Demonstrate width measurement
- Compare to BPM-based measurement

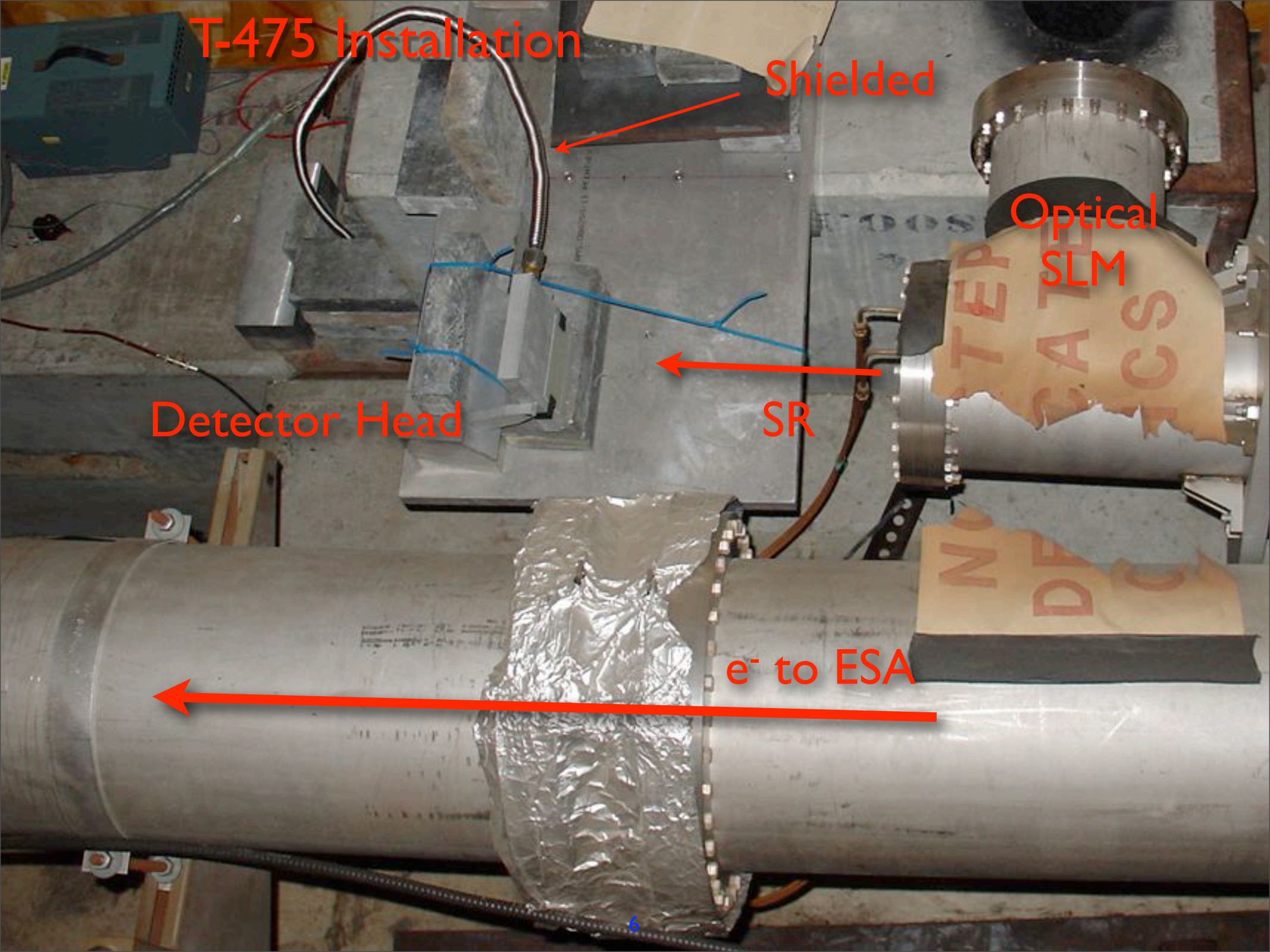
# Stage I T-475 Detector



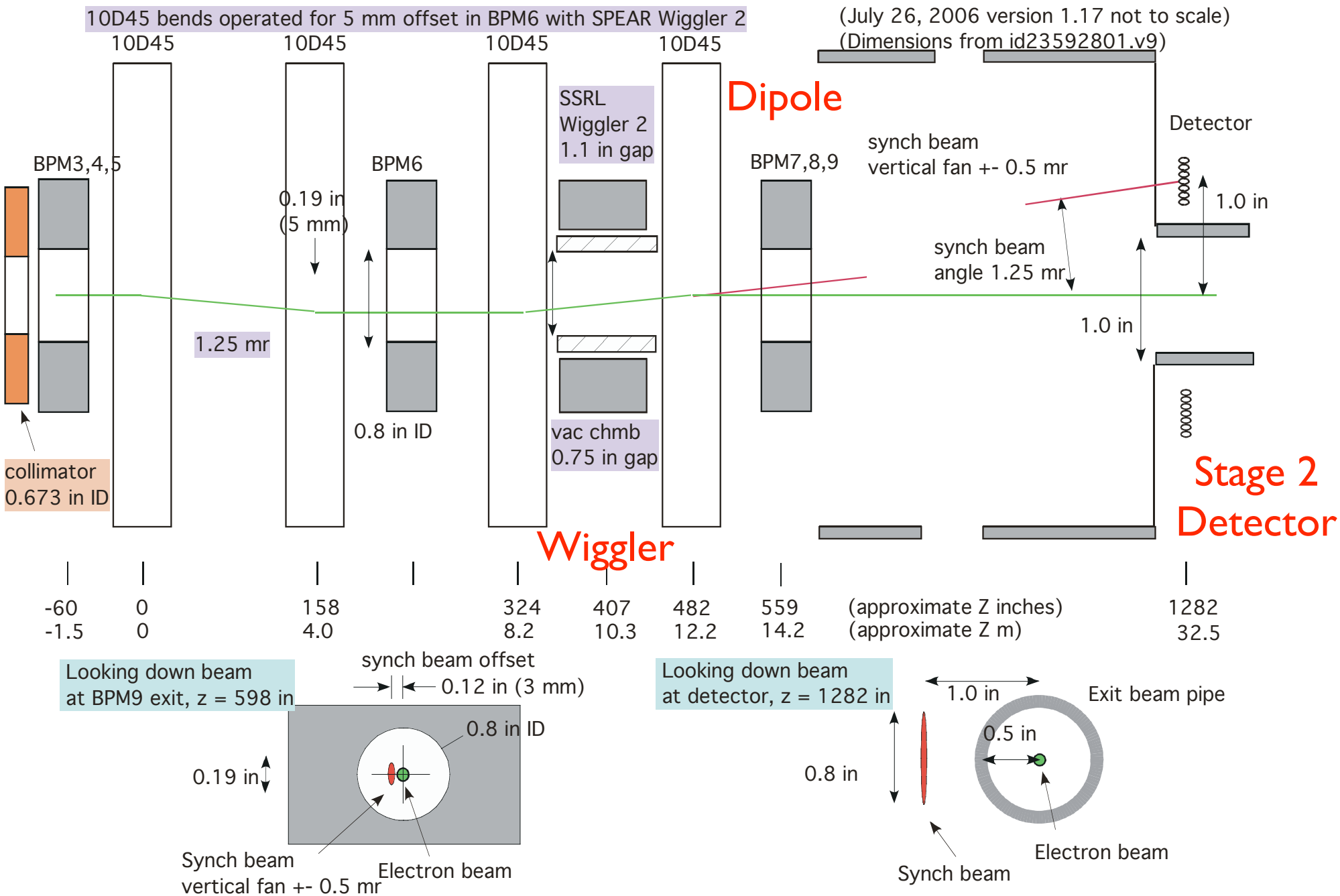
8 100 micron fibers
8 600 micron fibers
(one cut at entry)
1 mm pitch



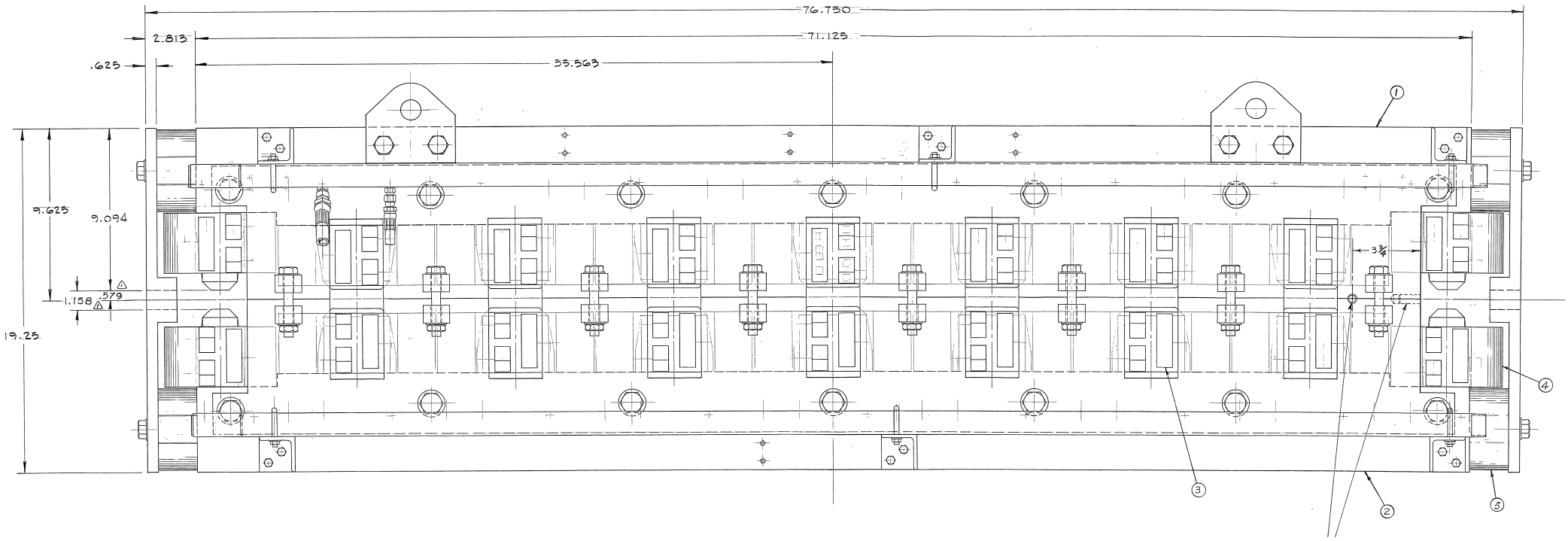
16 channel R6568 MAPMT
Line driver for long analog cable


T-475 Installation
Shielded
Optical
SLM
Detector Head
SR
e- to ESA

# T474 BPM Spectrometer and T475 Synch Light Spectrometer Plan View



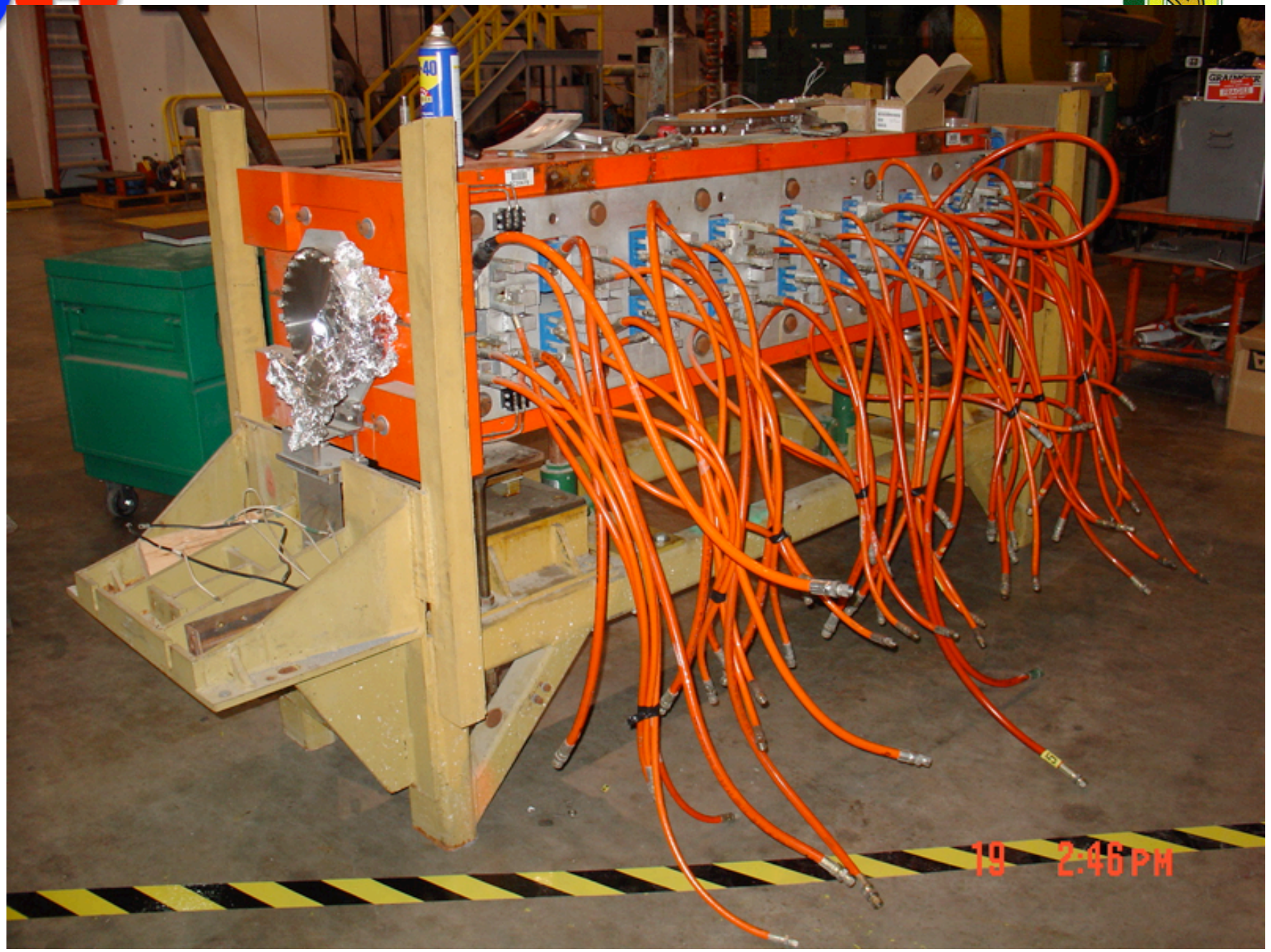
# Mk-II Spear wiggler



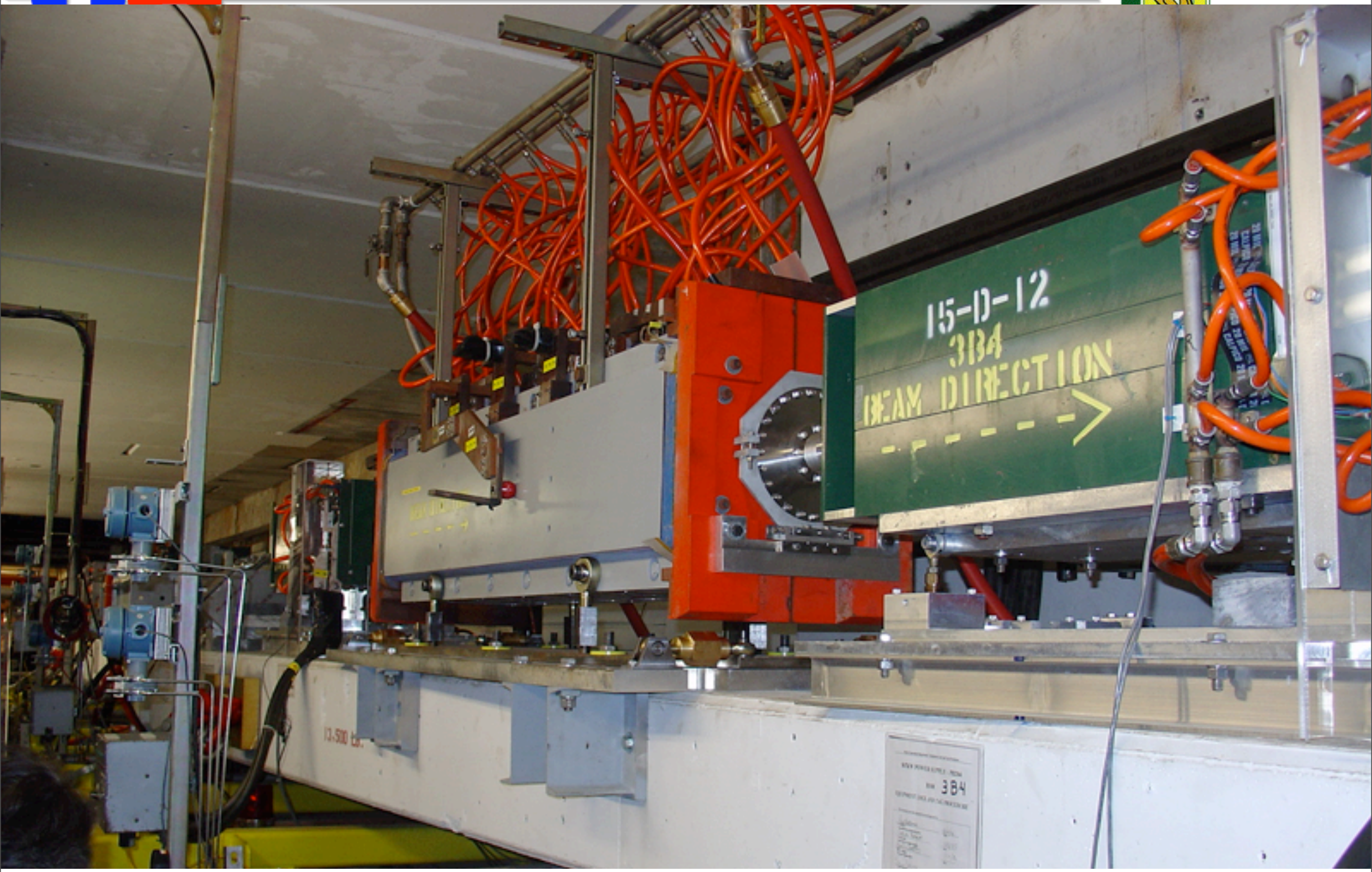

8-pole Mk-II Spear wiggler
16 kGauss field - 1.8 meters long
+/- 0.75 mRad vertical stripe

Produces Ec ~ 1 MeV photons
+/- 1.5 cm at detector plane

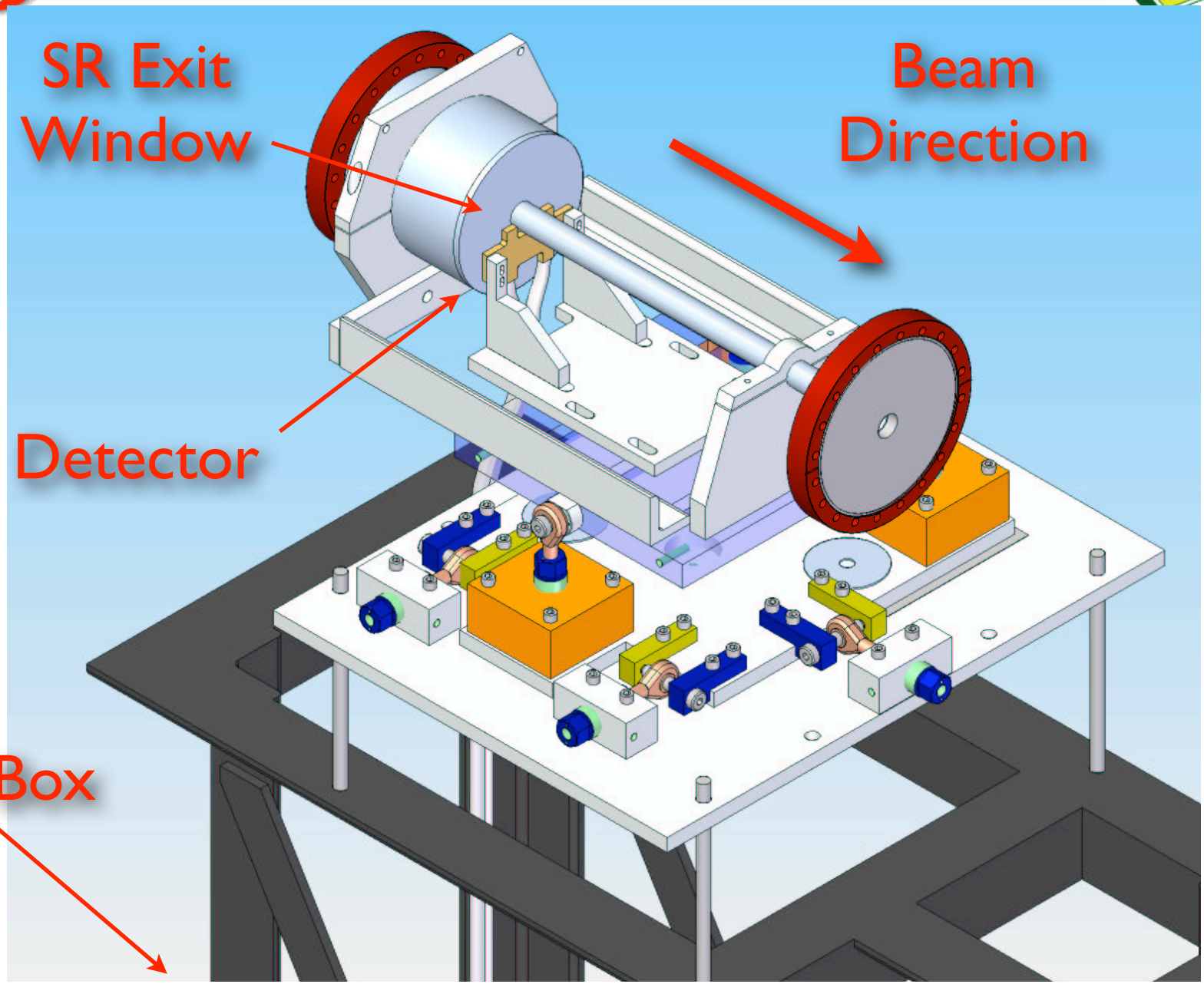
# Wiggler before rotation



# Wiggler in-situ



# Detector Stand



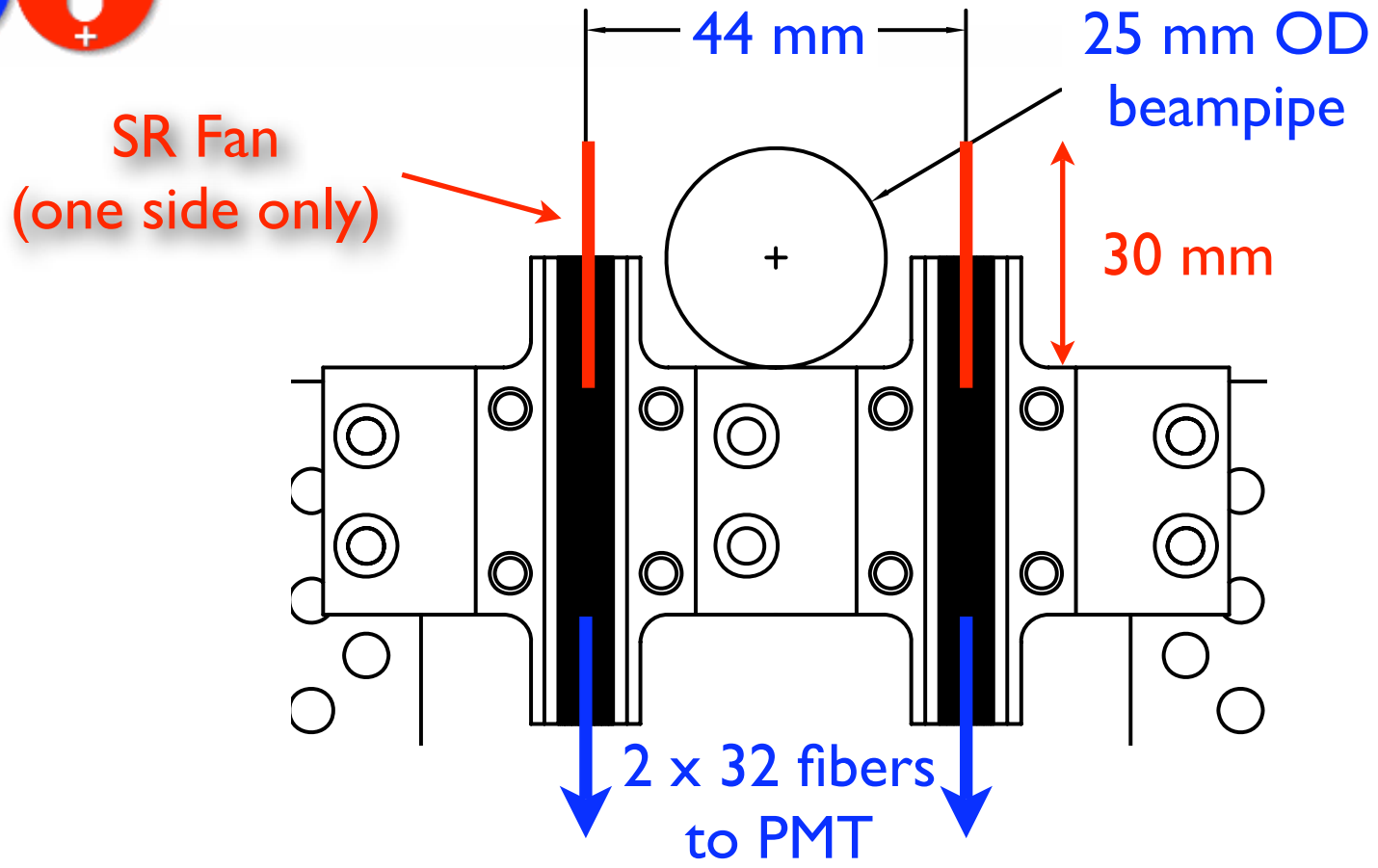
# In Beamline

SR Exit Window

Detector Stand

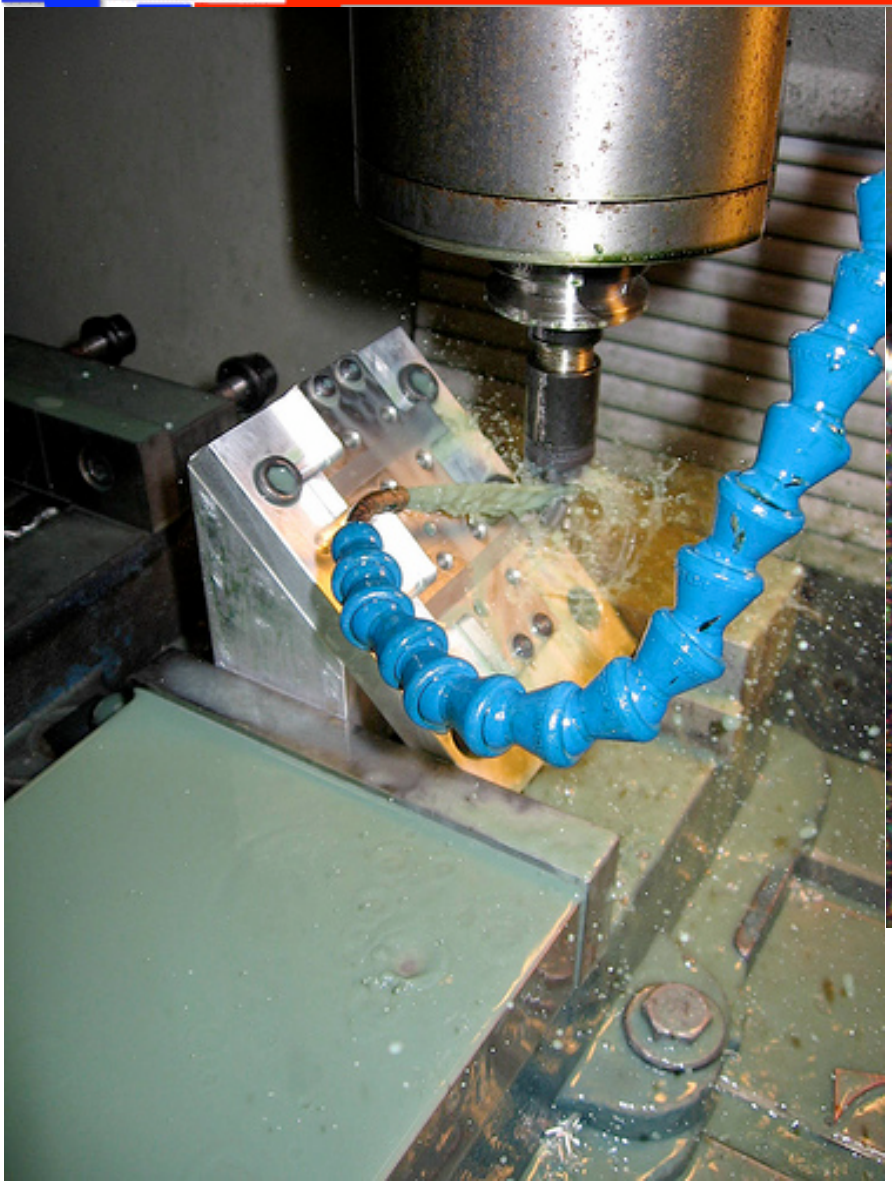
PMT Shelf

# 2nd prototype detector

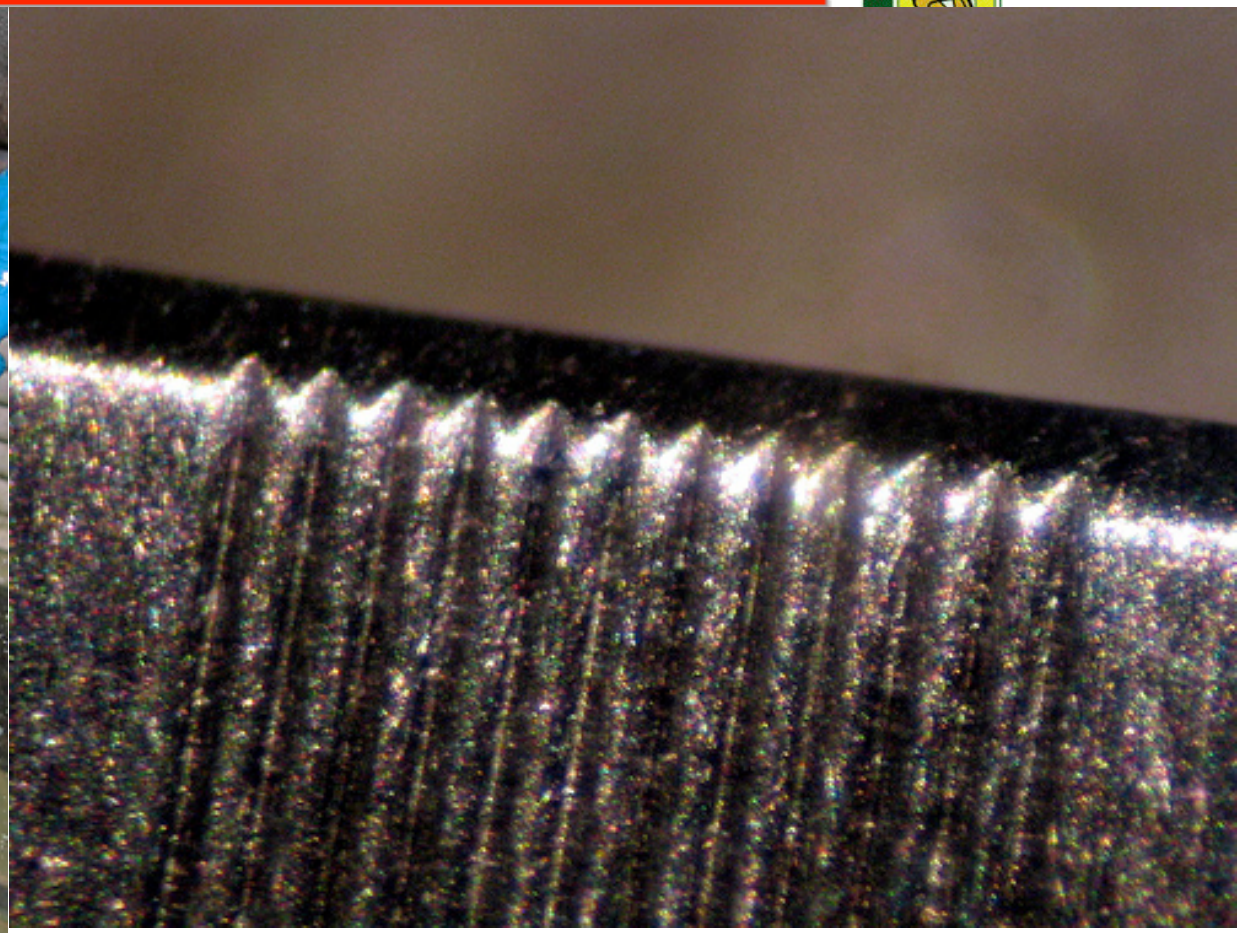



- 64 x 140 micron (100 micron active) UV fibers (Polymicro)
- Spaced on 200 micron pitch w/ grooves engraved on Invar
- Fibers held in place with Indium foil "gasket"

# Construction Photos



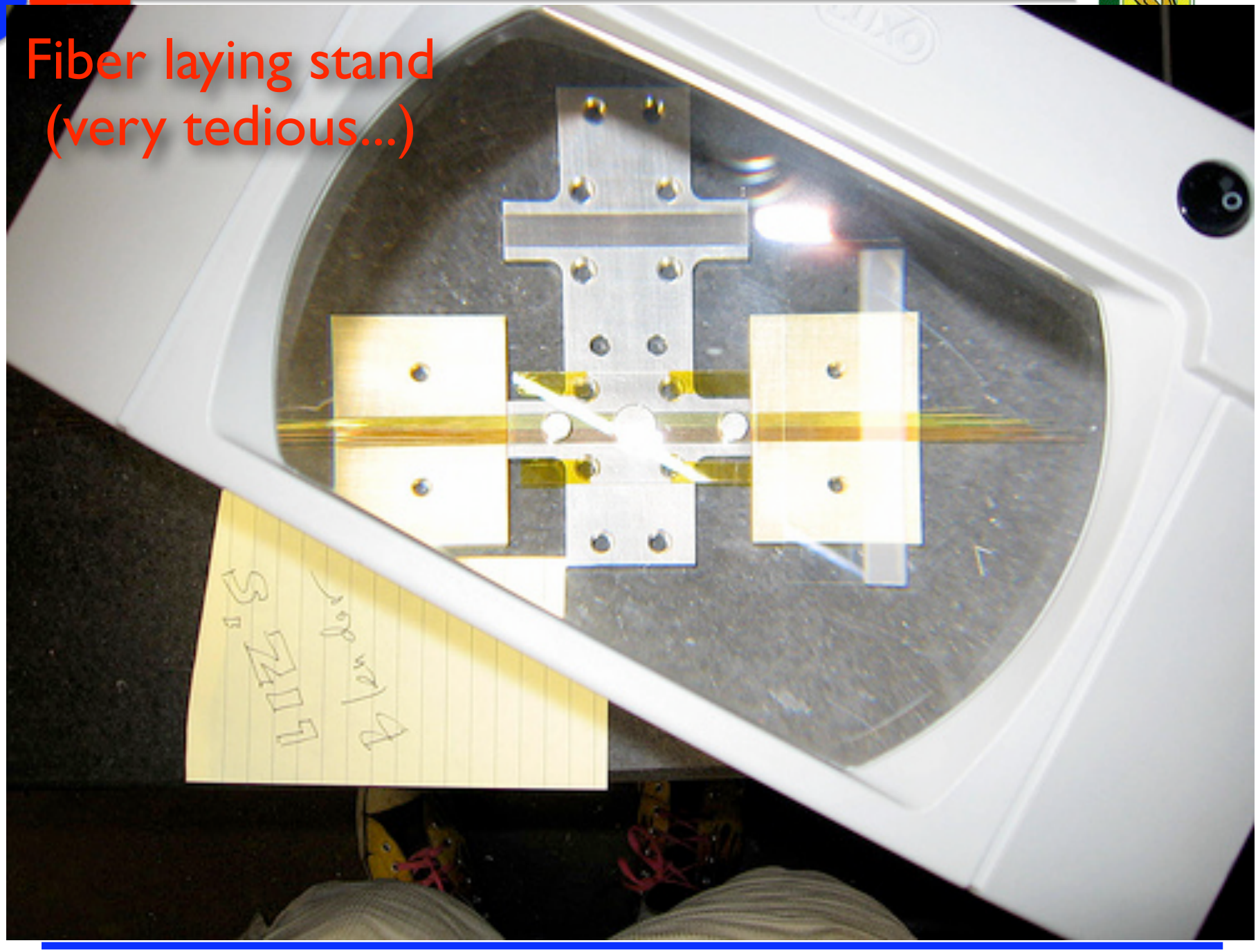
CNC Goodness



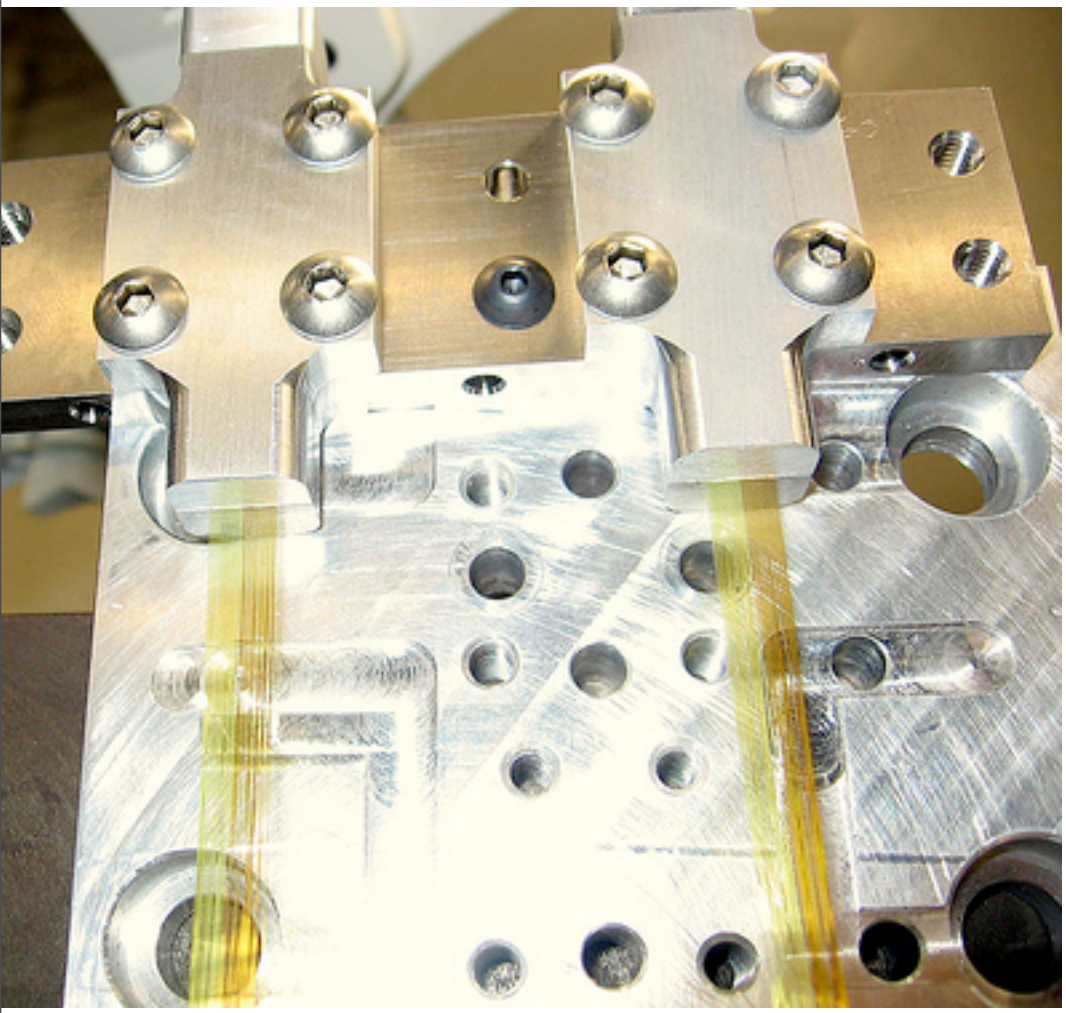
200 micron
grooves in Invar

(Photos courtesy J. Garman)

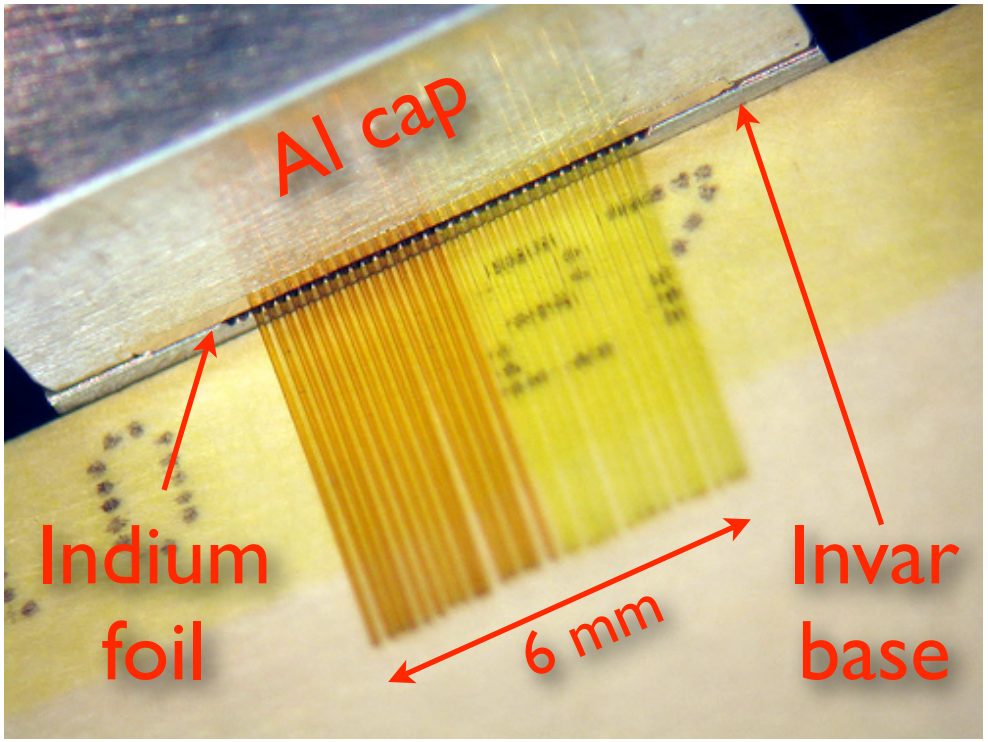
# Hand Assembly



# Finished Assembly

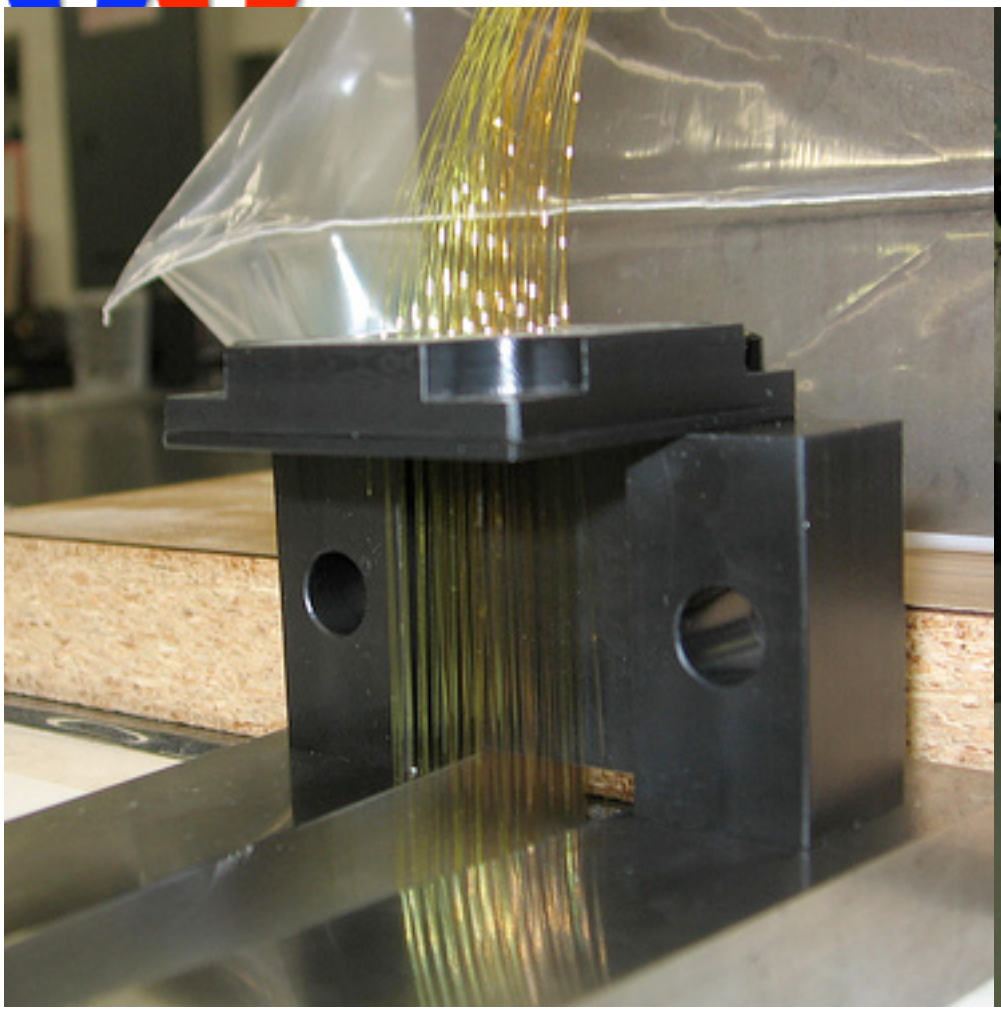


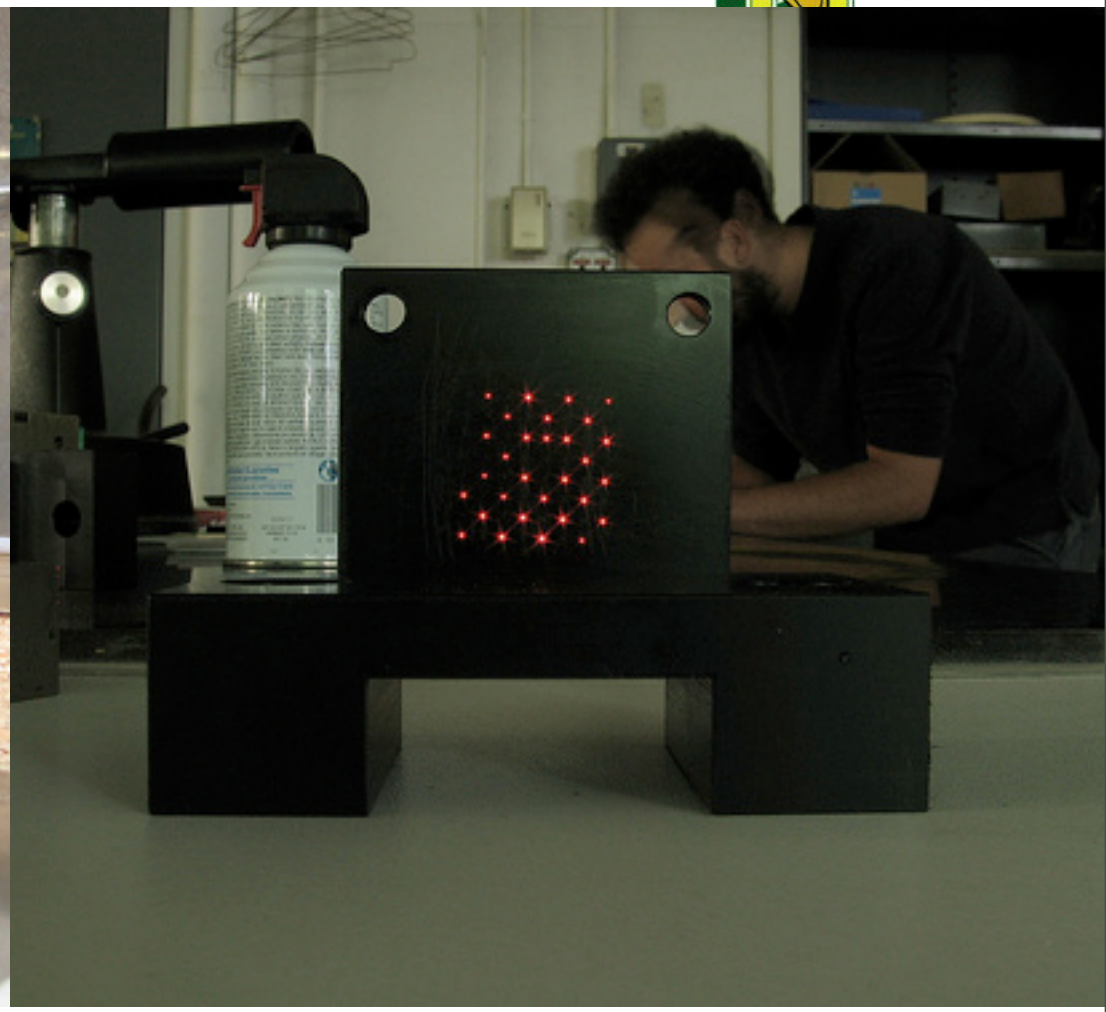
60 fibers in place
(4 background fibers)




Fiber ends
before trimming

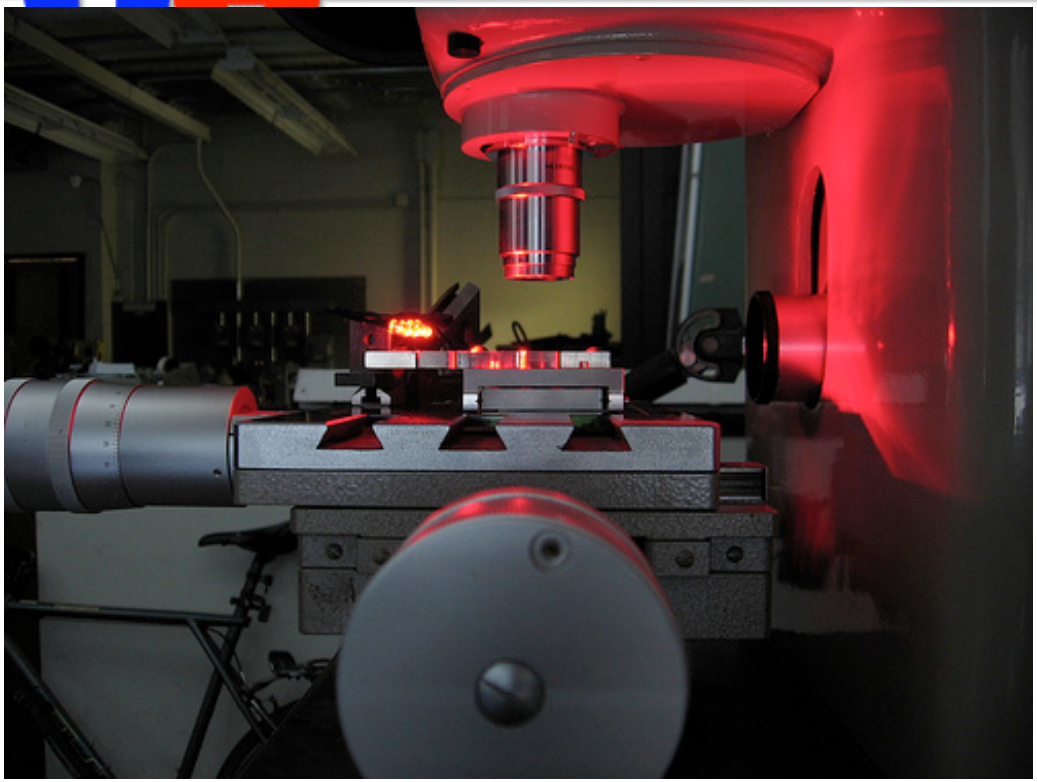
# PMT View

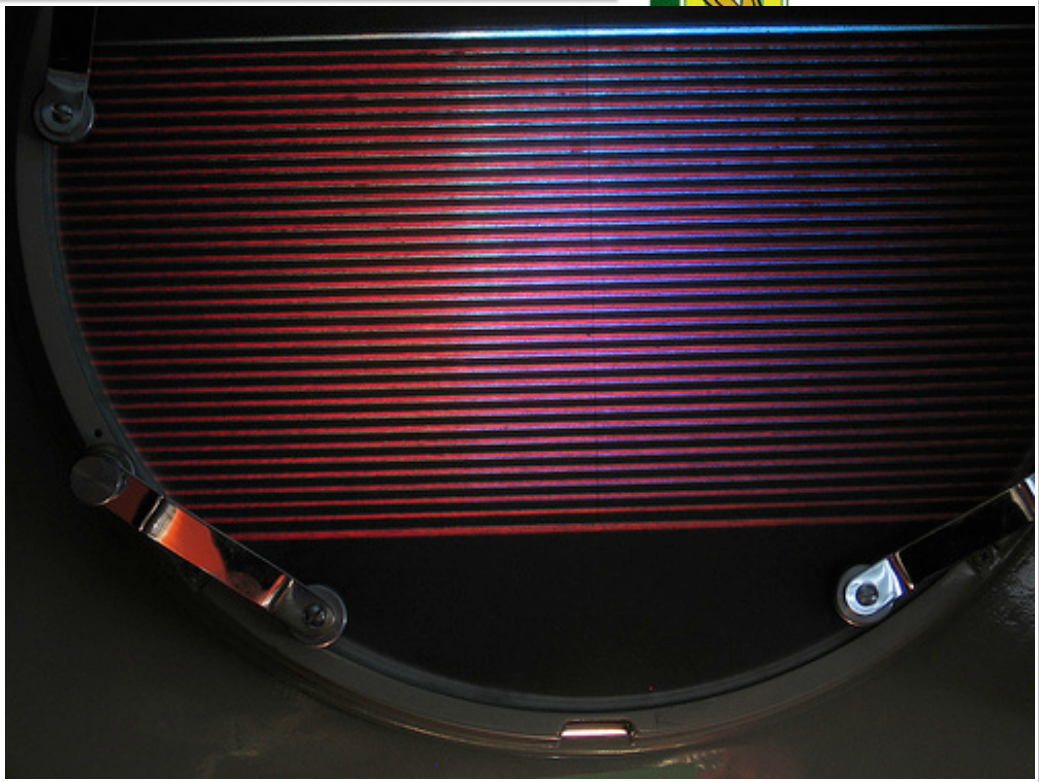




Delrin “cookie” for 64 channel PMT

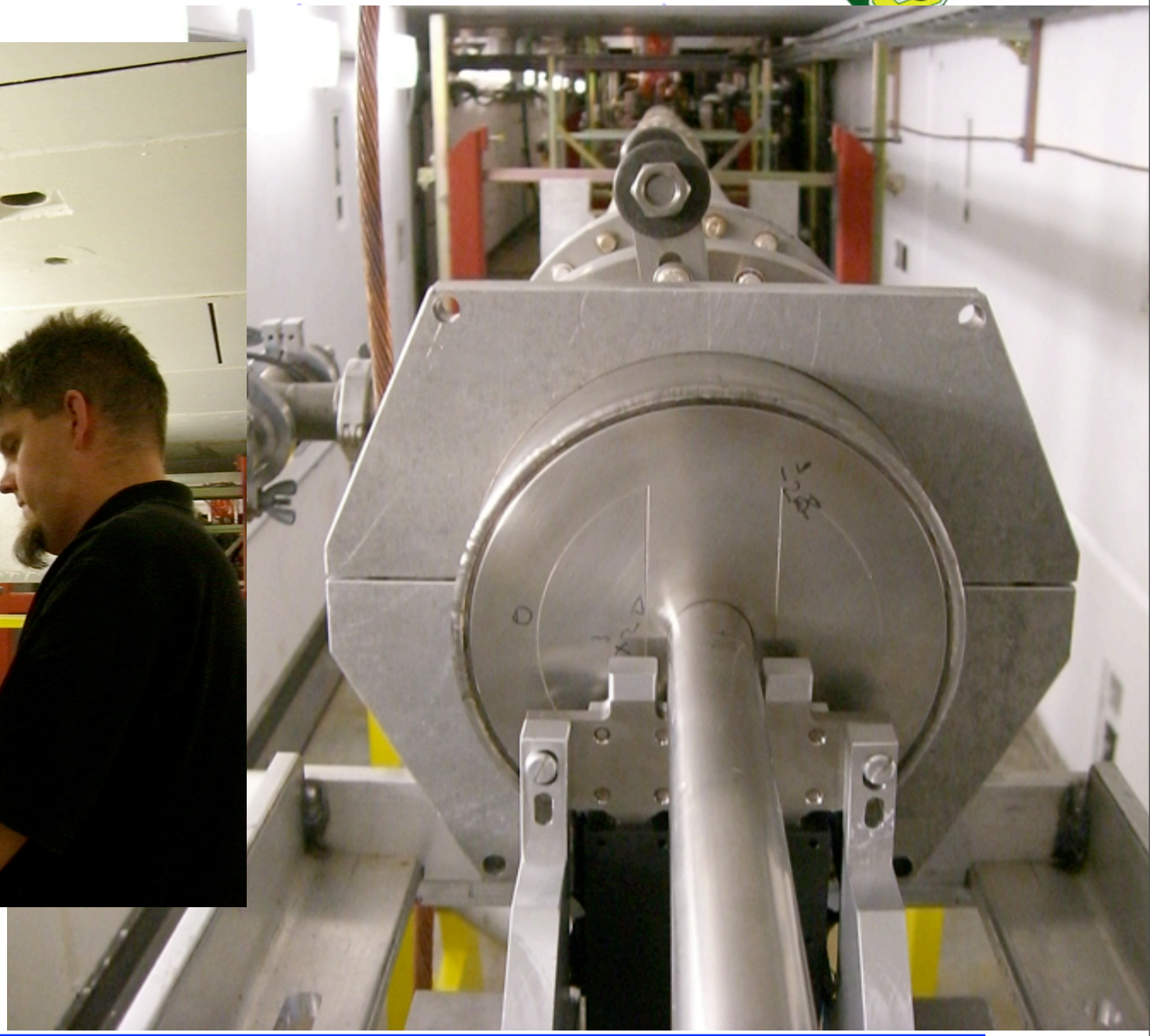
# Optical Survey





- Length scale determined by dimensions of Invar plate
- (Old) optical survey machine good to < 5 microns
- Sample rotation with respect to survey axis limits absolute length to 20 microns over 40 mm (0.5 mRad) or 500 ppm
- Similar constraints on detector axis vs. dipole plane

# Installation

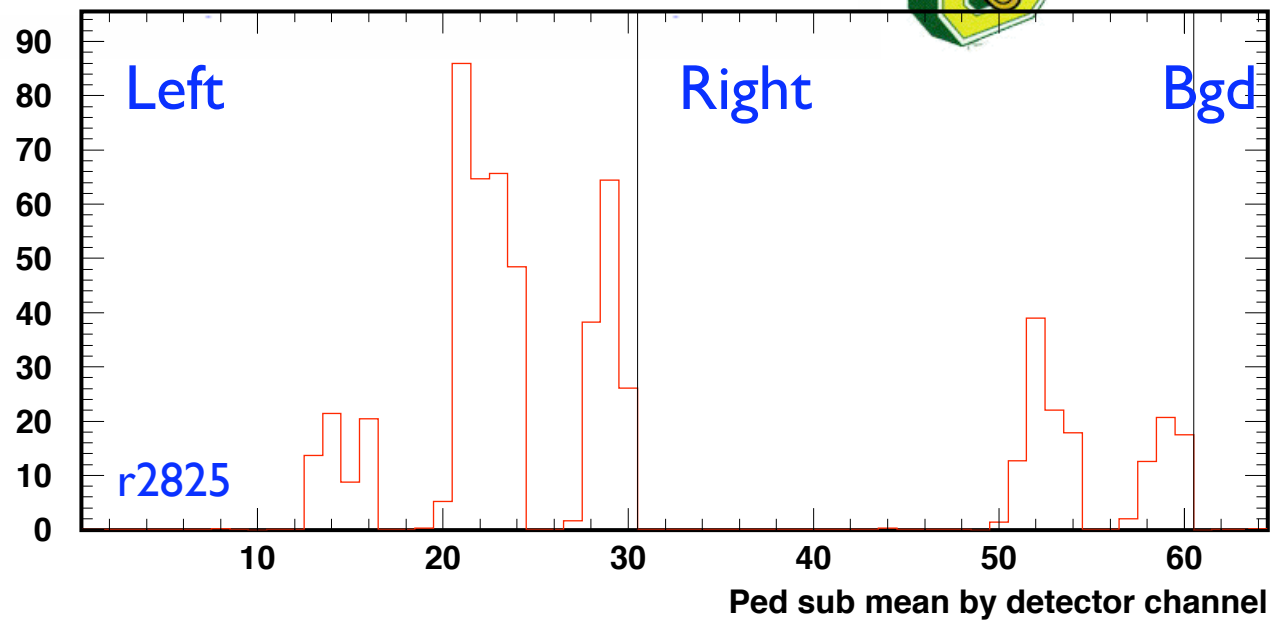


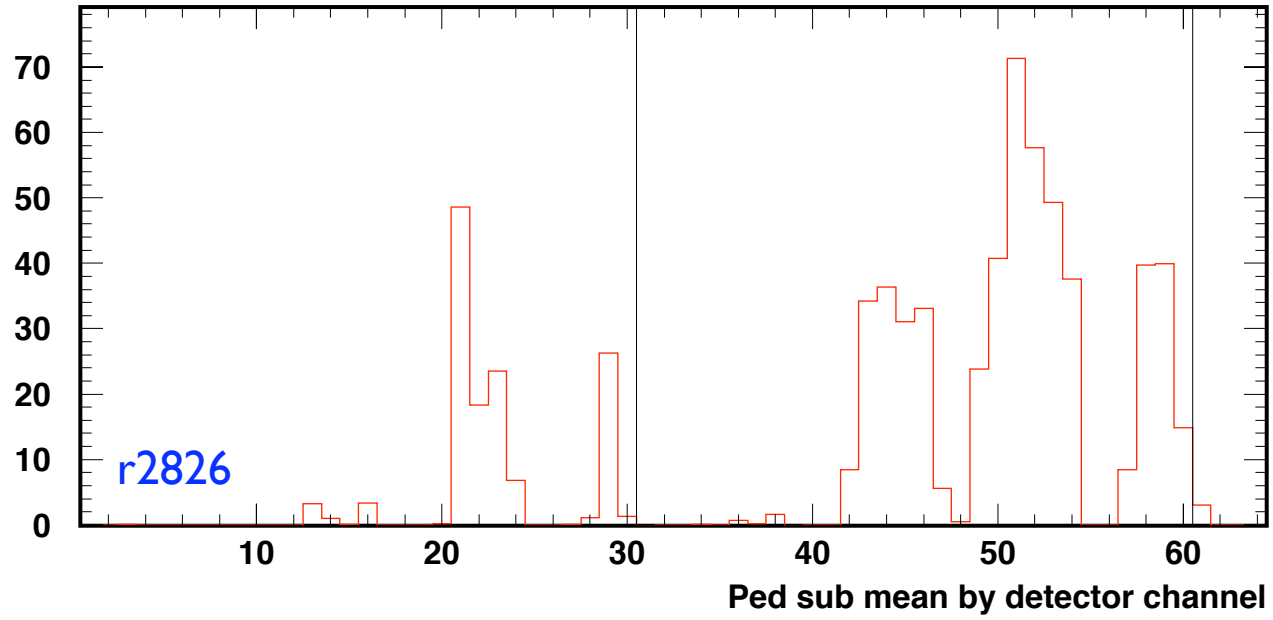
(Photo: S. Boogert)

# July Run Data

- Reversing chicane moves beam from Left to Right
- Good "signal" strength
- Low/zero backgrounds
- Weird artifacts
  - Crosstalk?
  - Channel mapping?
  - PMT Saturation?

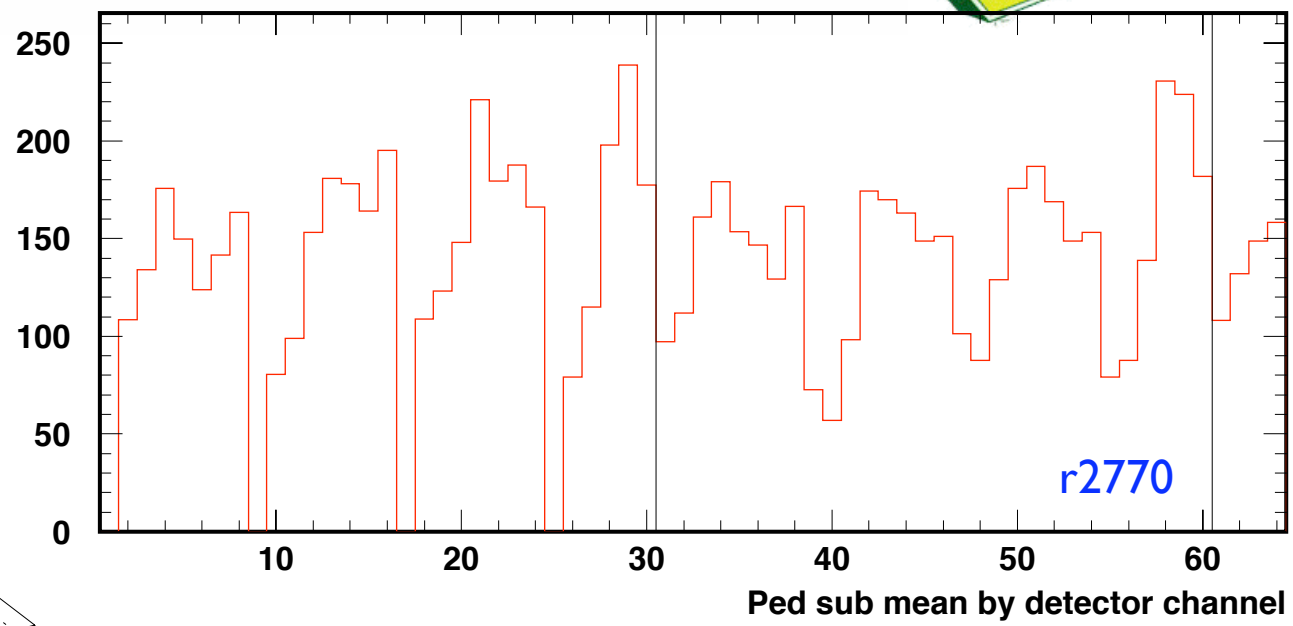
Working to understand this with bench measurements

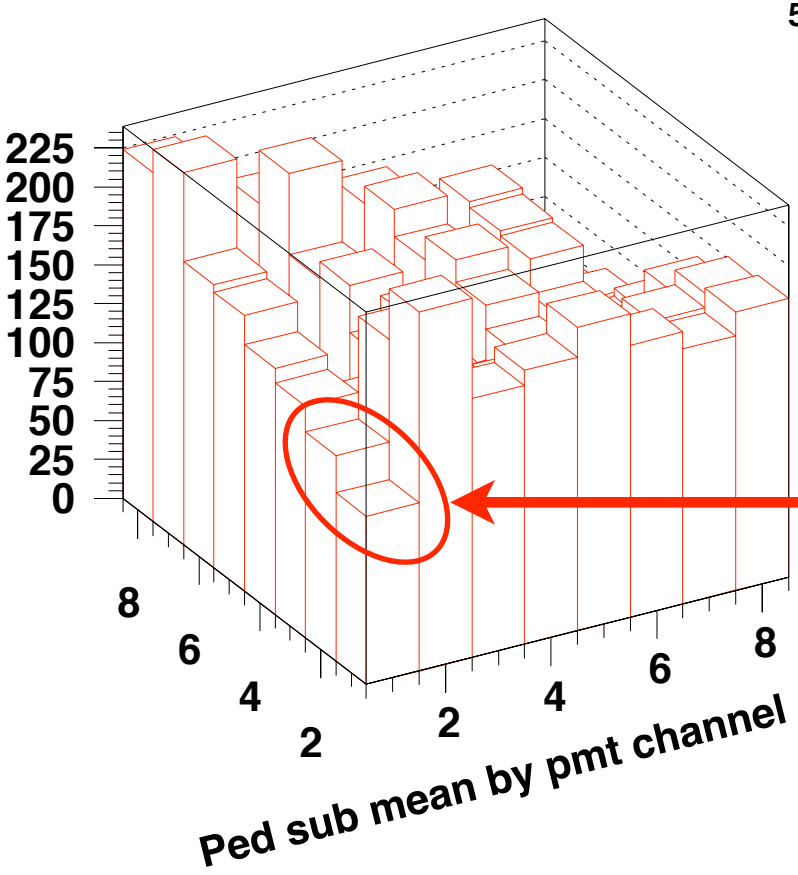


# July Run Data

"Dirty" conditions
PR2 in - spraying tunnel
with junk

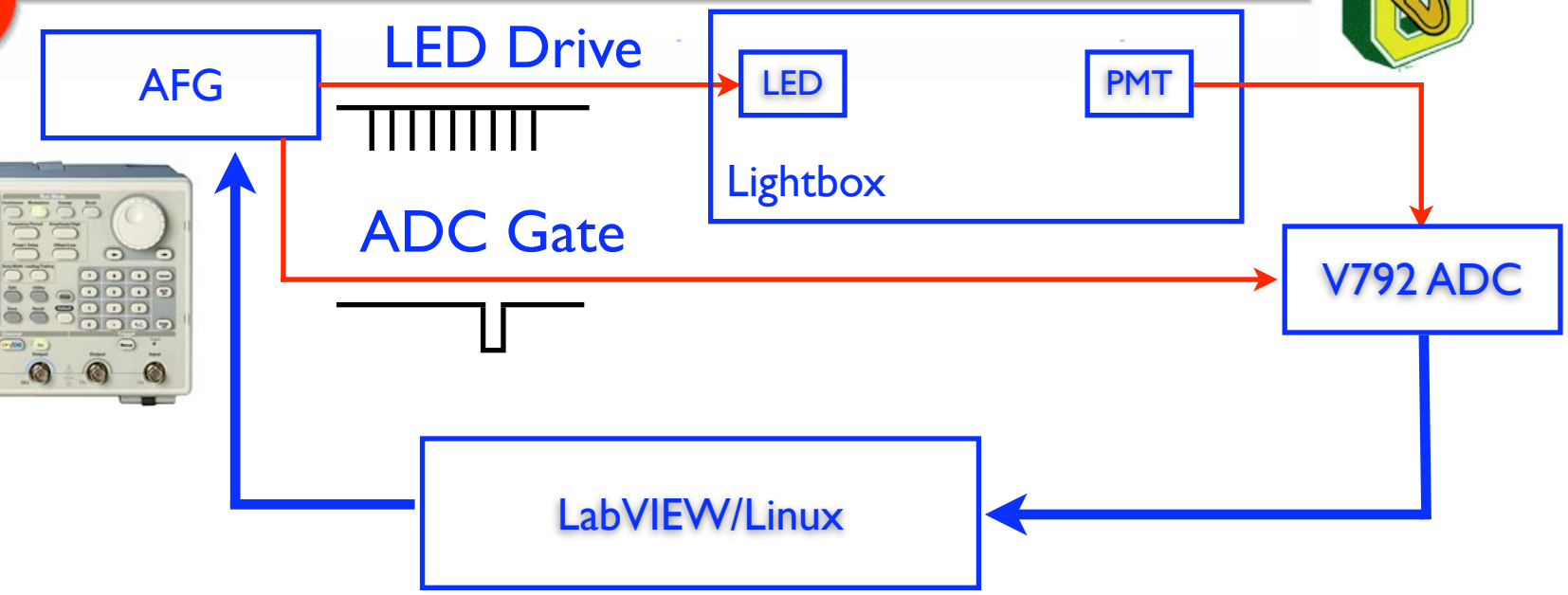



PMT view

Unconnected PMT pixels show
large backgrounds
Direct PMT hits!
(or huge cross-talk at PMT)

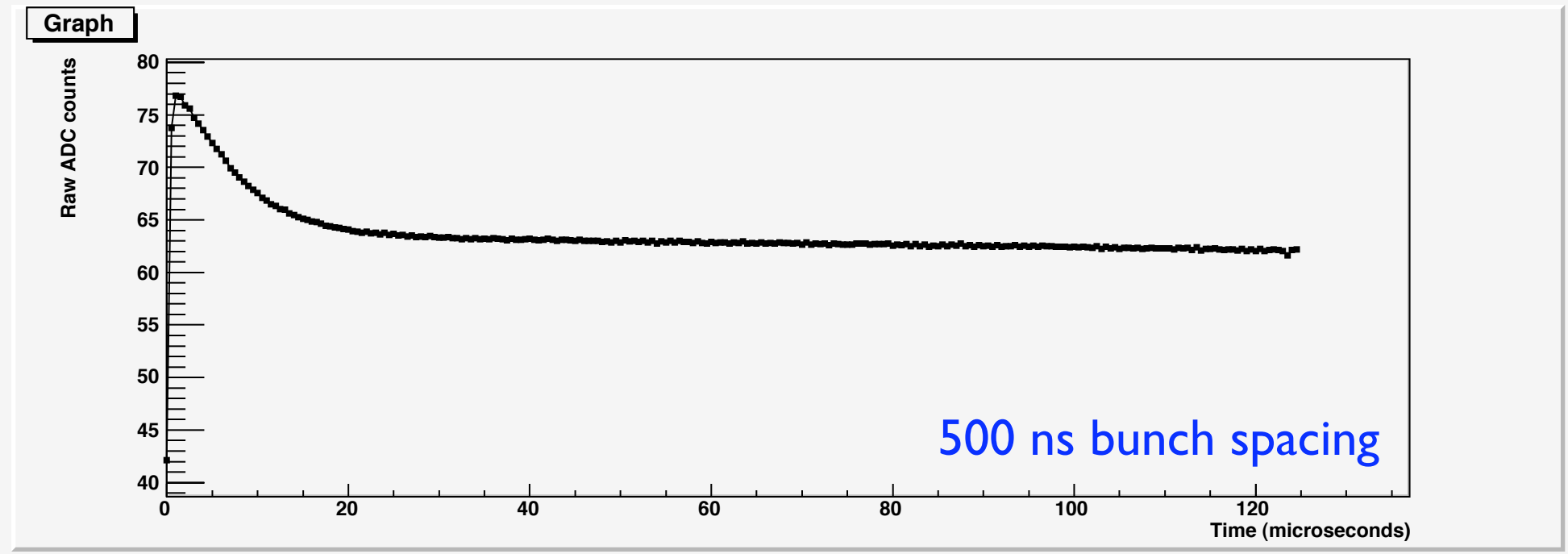
# Oregon Teststand




- Use Tektronix AFG3022 to simulate ILC bunch train
- Second AFG channel produces sync. sliding gate
- UV LED (395 nm), adjustable intensity from pulse amplitude
- VME readout by CAEN V792 ADC - VME-PCI bridge

Test MAPMT gain and linearity in long ILC-like bunch train

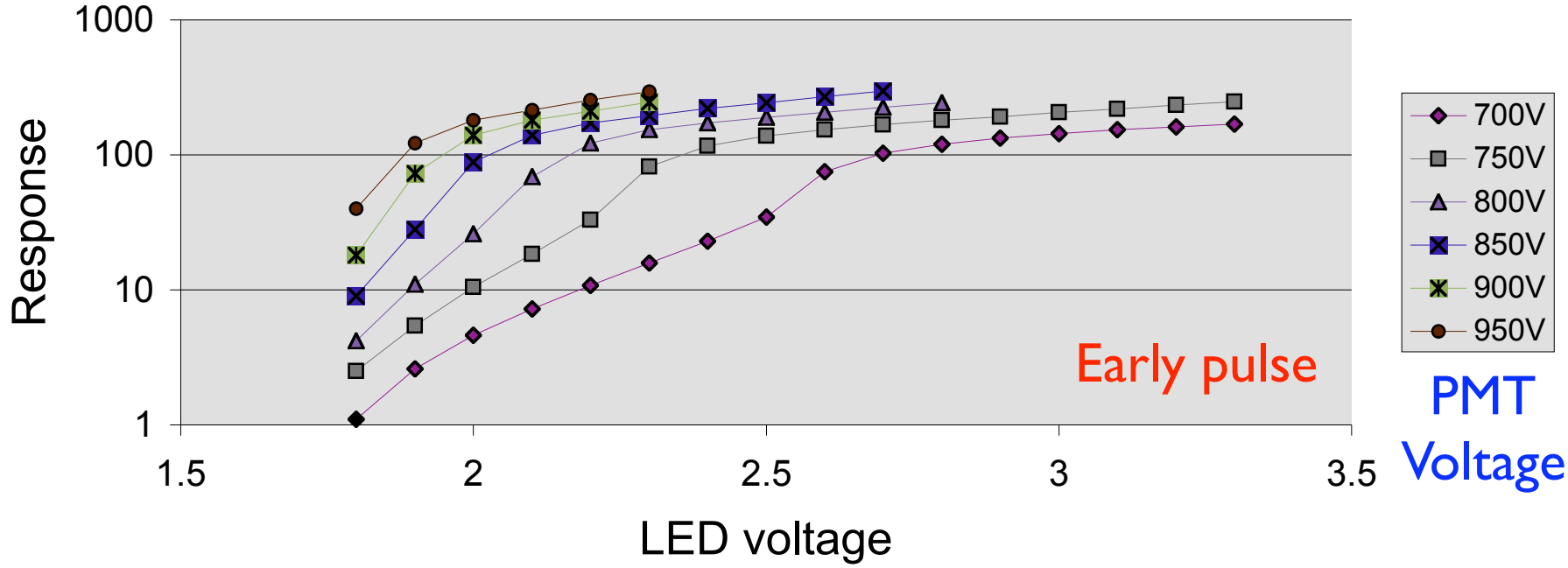
# PMT Loading

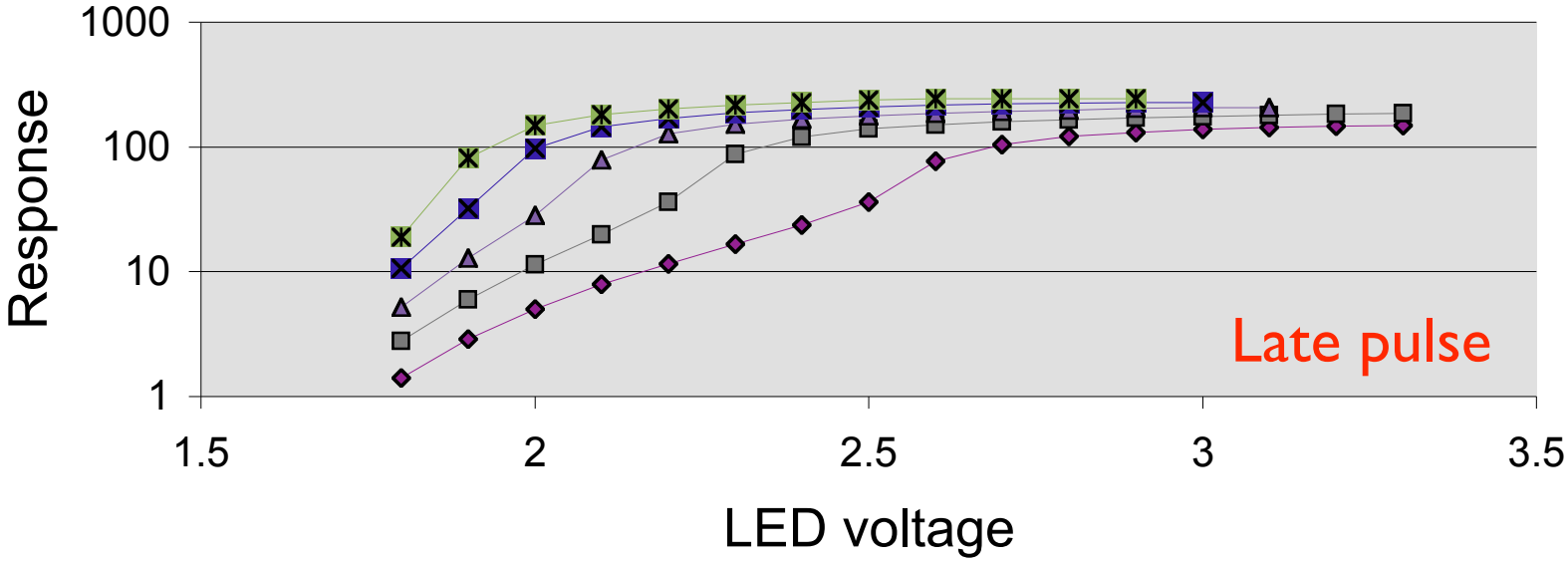



- MA-PMT response measured in individual train pulse
- Clear loading seen as pulse amplitude increases
- Relatively stable after ~ 20 microseconds

What changes? Gain, Linearity, or both?

# PMT Linearity




Clear "knee" independent of PMT voltage, harder cutoff

# Summary

July ESA run

- Second T-475 Detector has seen first beam
- Detailed analysis just starting - beam clearly seen

Oregon Teststand

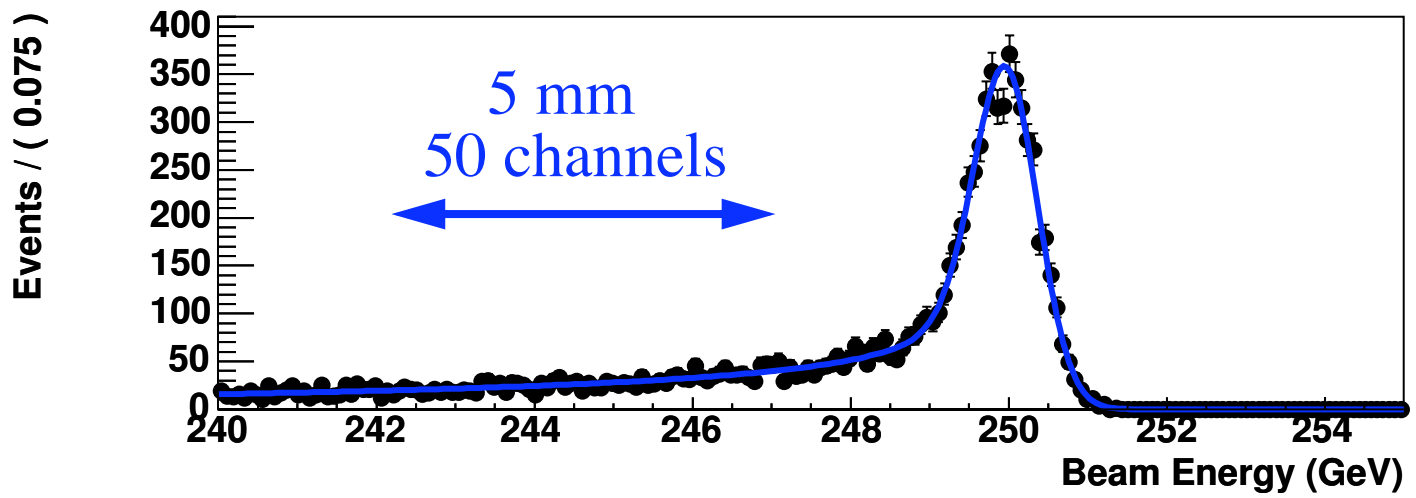
- Other PMT and fiber tests also ongoing
- Lab tests to understand electronics issues starting
- Detailed bench measurements of gain and cross-talk

2008 run

- Fix any electronic/cross-talk problems
- Visible SR camera system?

# Backup

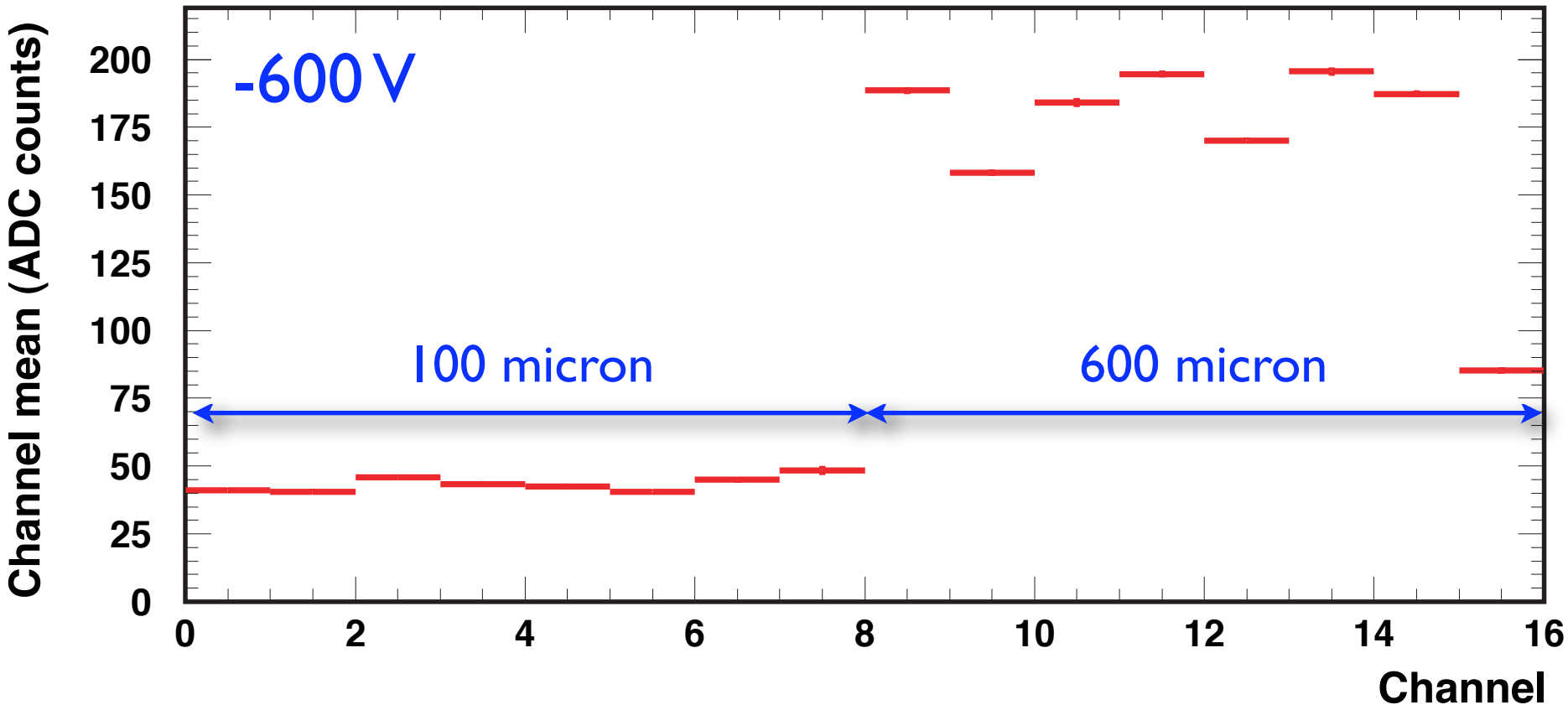
# Detector Module




- Fused silica (quartz) fibers, read out with 8x8 MaPMT
- Observe Cerenkov light from secondary electrons
- 100 micron pitch in core region (~2 cm - 128 fibers)
- 1 mm pitch (600 micron fibers) else (~26 cm - 256 fibers)

More signal/channel, lower channel count
~1600 fibers, 24 PMTs per beam
26 cm detector can see to 50% of Enom

# Real Data



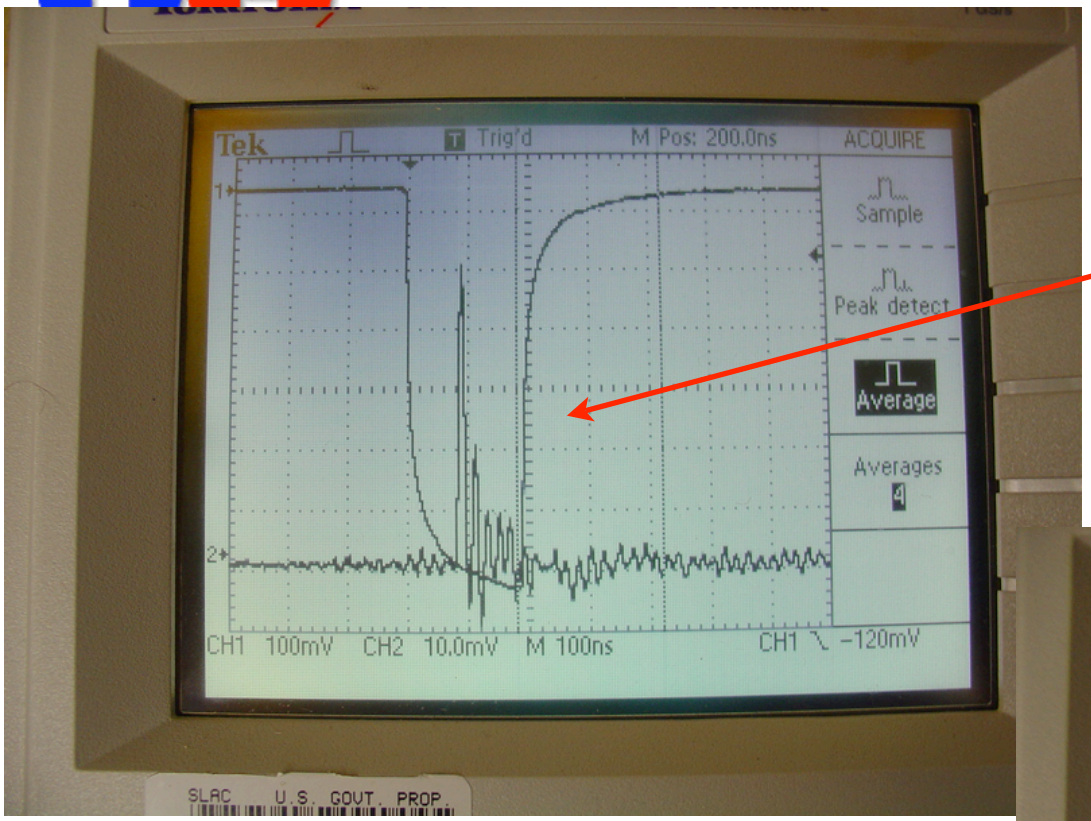

Ch 15 is cut (background monitor)

Signal/Noise ~ 1

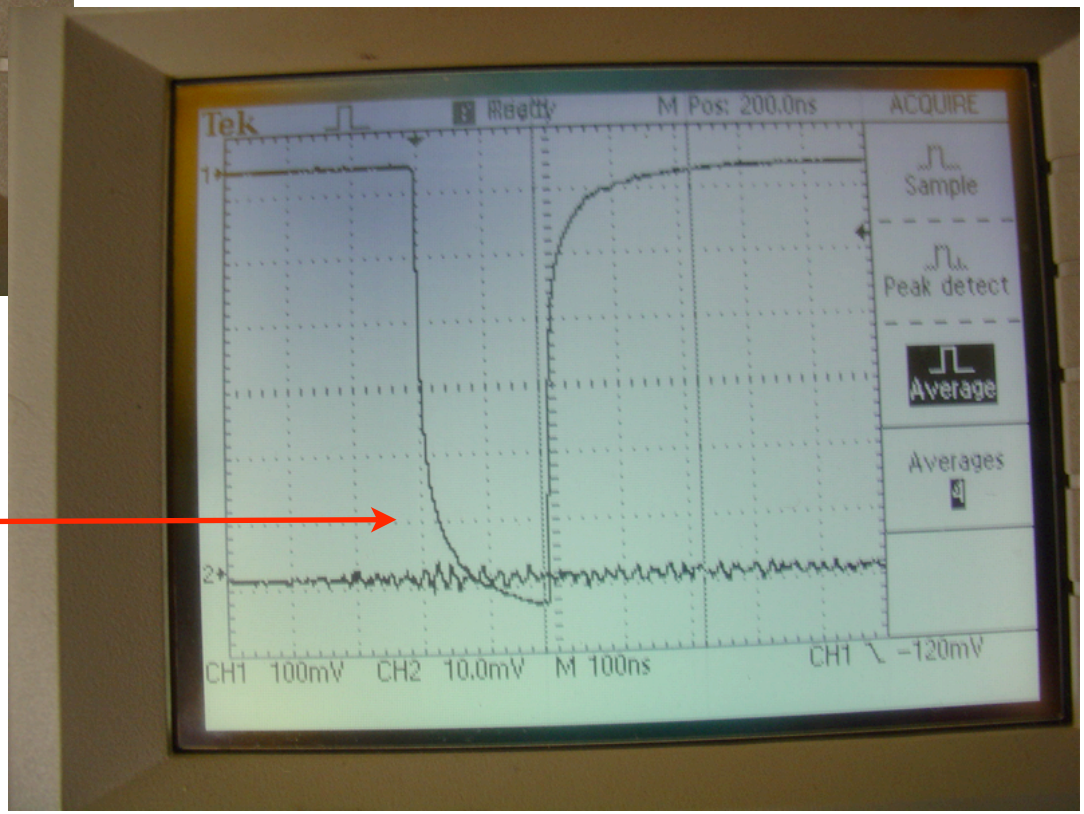
Large/Small is not $6^2$

Very limited ability to understand data

# First T-475 Data




Wiggler On




Wiggler Off