

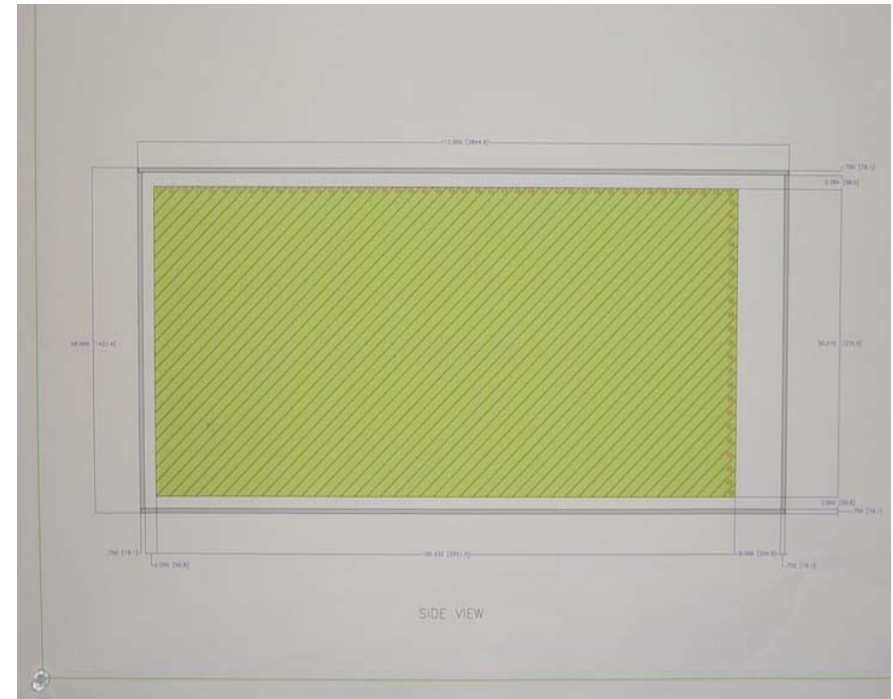
# Fabrication of Quarter-size Scintillating Strip Muon Detector Planes

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University of Notre Dame

# Motivation

- Fabrication of quarter-size planes ( $1.4\text{m} \times 2.8\text{m}$ ) will exercise all the steps required to make full-sized planes
- Develop techniques: splicing, routing, calibration, etc.
- Provides a benchmark for future development:
  - New photodetectors - APDs, VLPCs, etc
  - New scintillator and/or waveshifting materials
- Conserves raw materials – scintillating strips and fiber

# Detector Concept

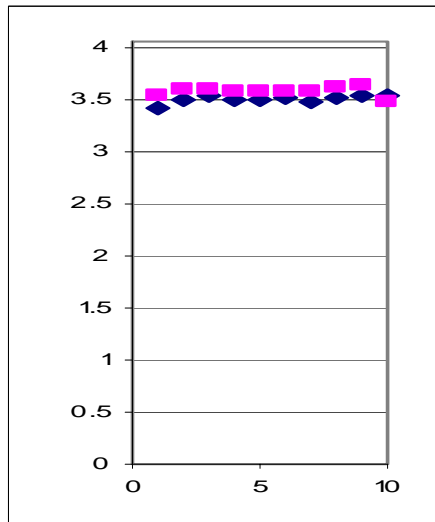
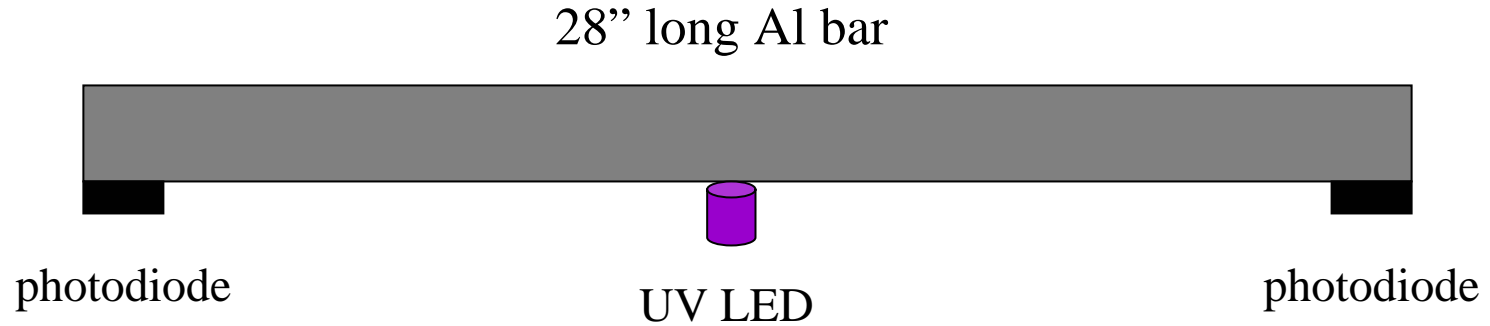


- Dimensions: 2.2cm x 1.4m x 2.8m
- 64 active strips with wave shifting fiber readout

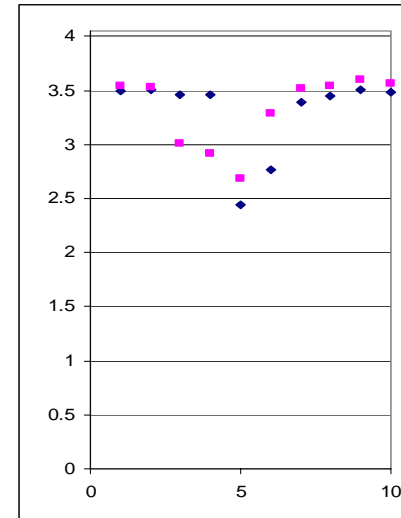
# Production Plan

- Two units (S+,S-) with single-ended readout already complete, under test at Fermilab
- Two units (D+,D-) with double-ended readout nearly complete
- A few features
  - Clear readout fiber spliced to waveshifting fiber
  - All fiber routing internal to the detector
  - LED calibration of each strip with flat optical panel
  - Thermally straighten fiber ends
  - Paint ends of tiles with BC620
  - Bond WLS in grooves with Epon815,TETA

# Scintillator Strip Testing



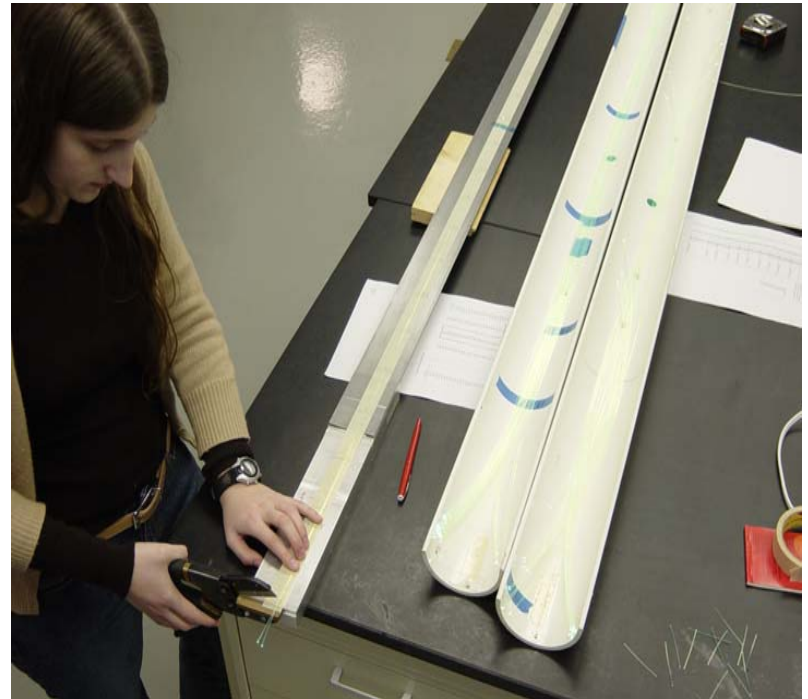
Typical good result



Poor result, strip discarded

# Fiber preparation

- 1.2mm Clear waveguide, spooled
- 1.2mm Wavelength Shifter, spooled
- Visual inspection with LED on end
- Measured on cutting template
- A clean, razor cut is made with 'HandiCutter'
- All fiber, both clear and waveshifting is characterized before and after splicing to assure quality



# Fiber testing

- Fibers characterized with respect to each other
- Acceptance cut is 70% of average for group
- LED, photodiode, water couplant
- Three test runs each



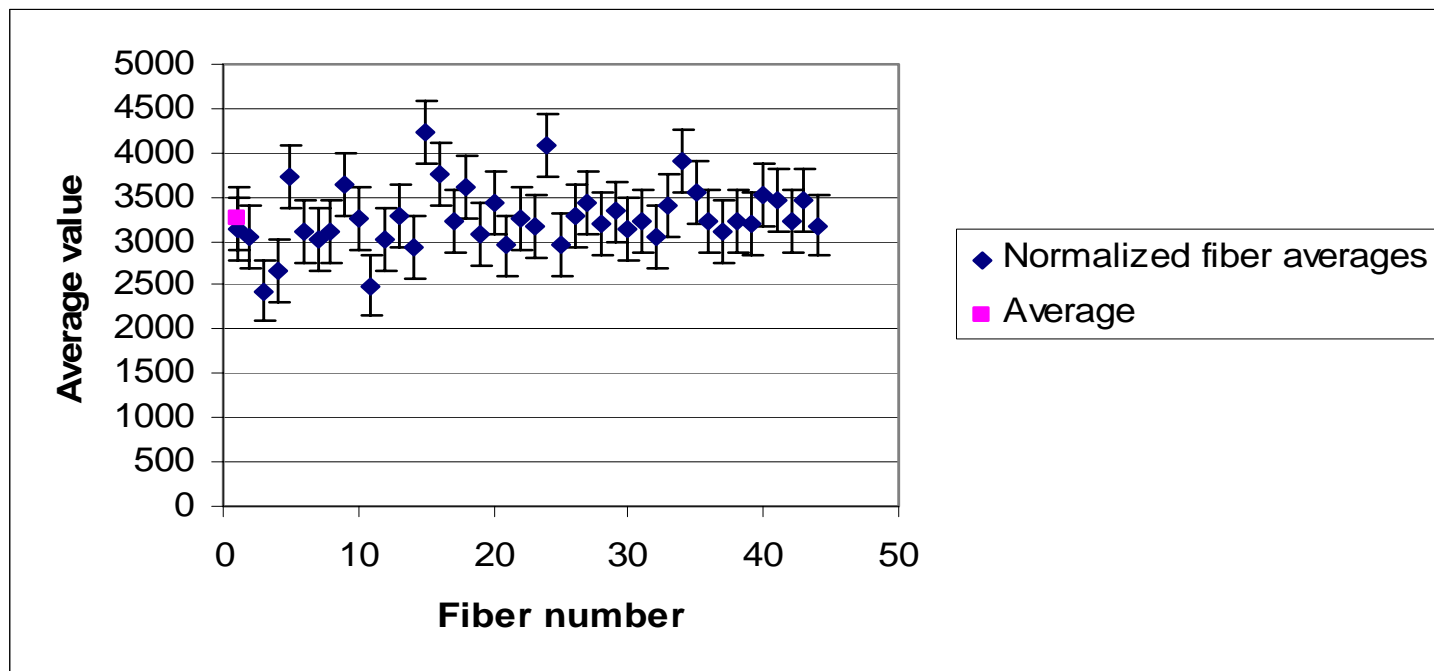
Digitization  
and readout

photodiode



green LED

# Light Test of Waveshifting Fiber for S+



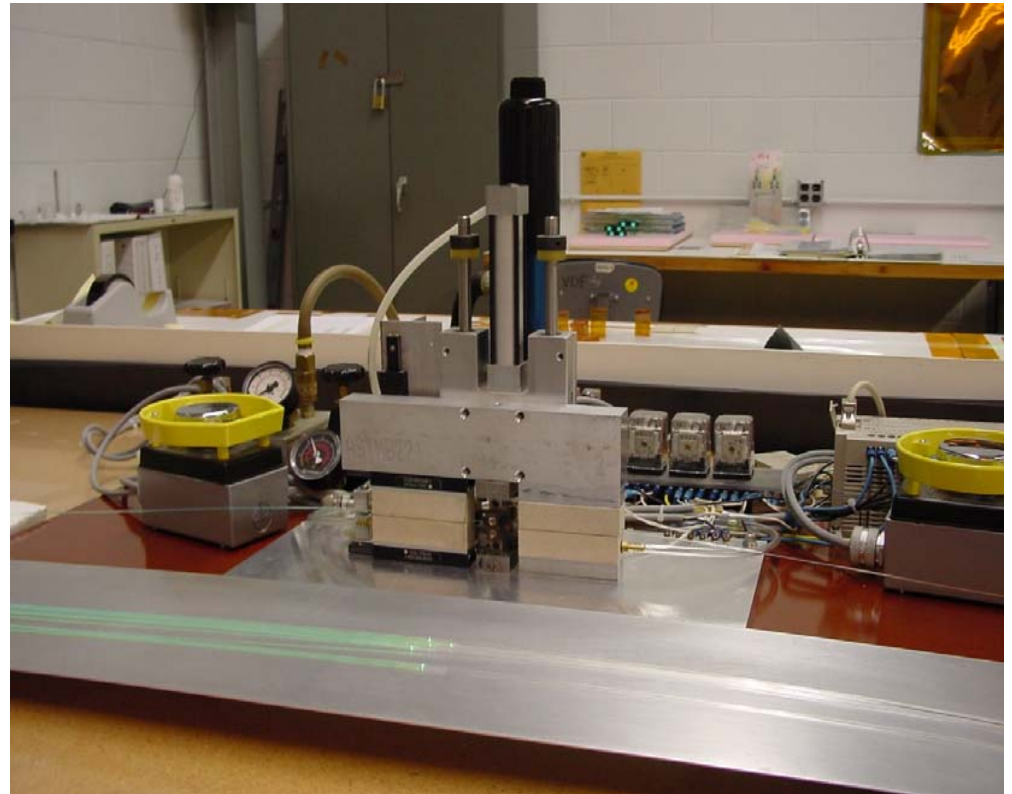
44 separate pieces - no rejected fiber

Sigma of  $\sim 10\%$



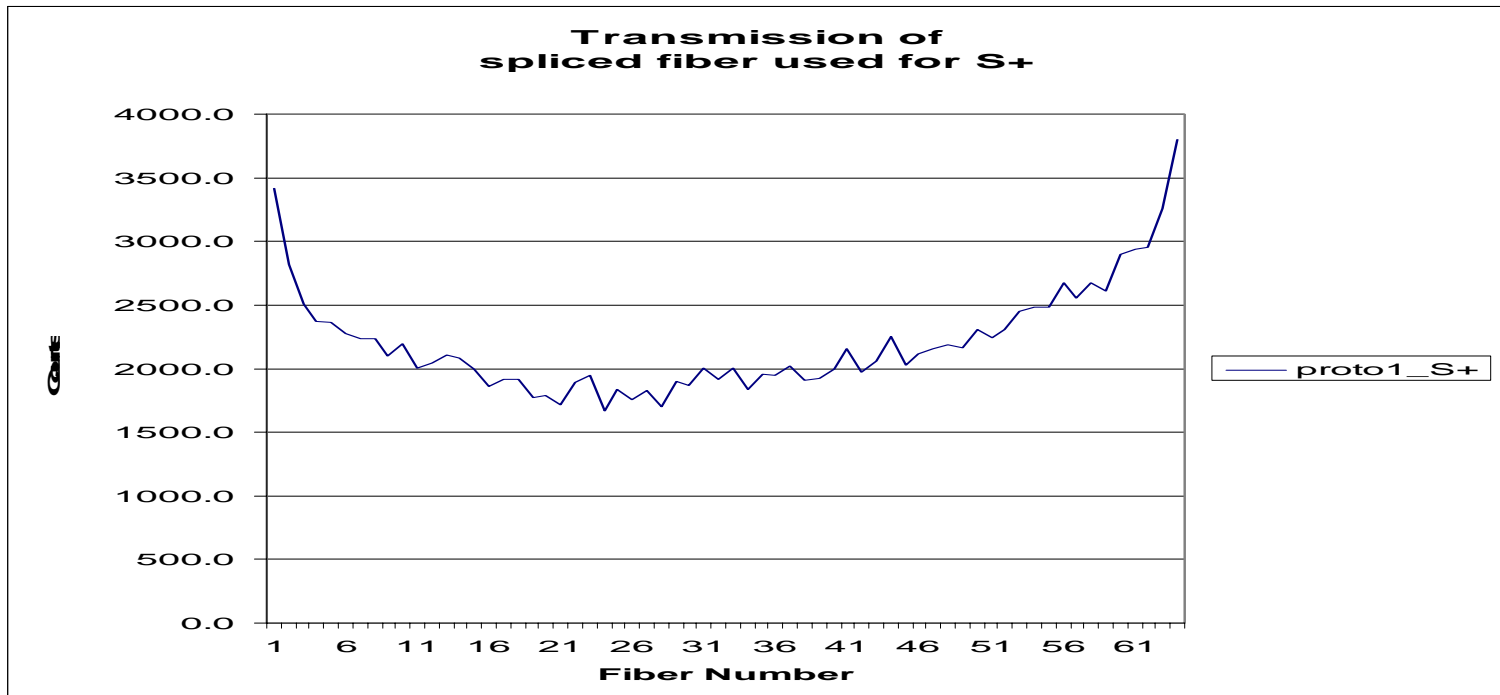
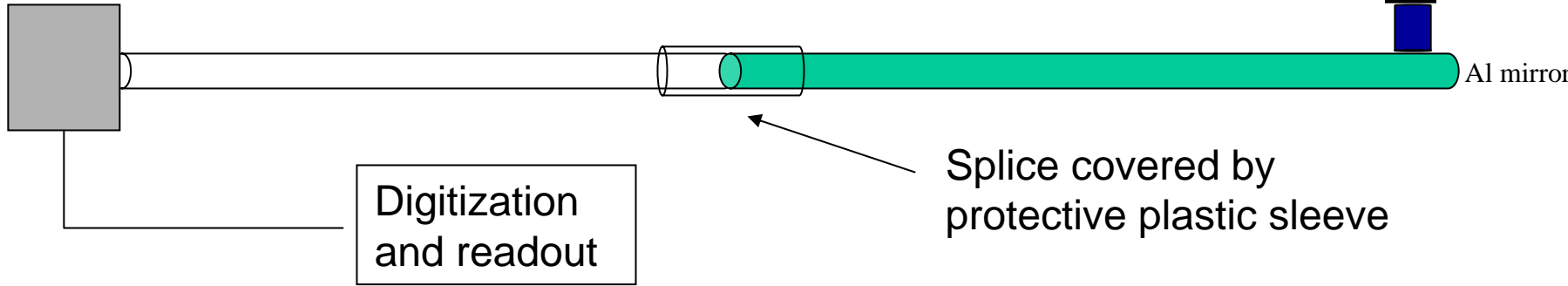
# Thermal Splicing

- Splicing machine (U. of Mississippi design) used at Fermilab lab 7

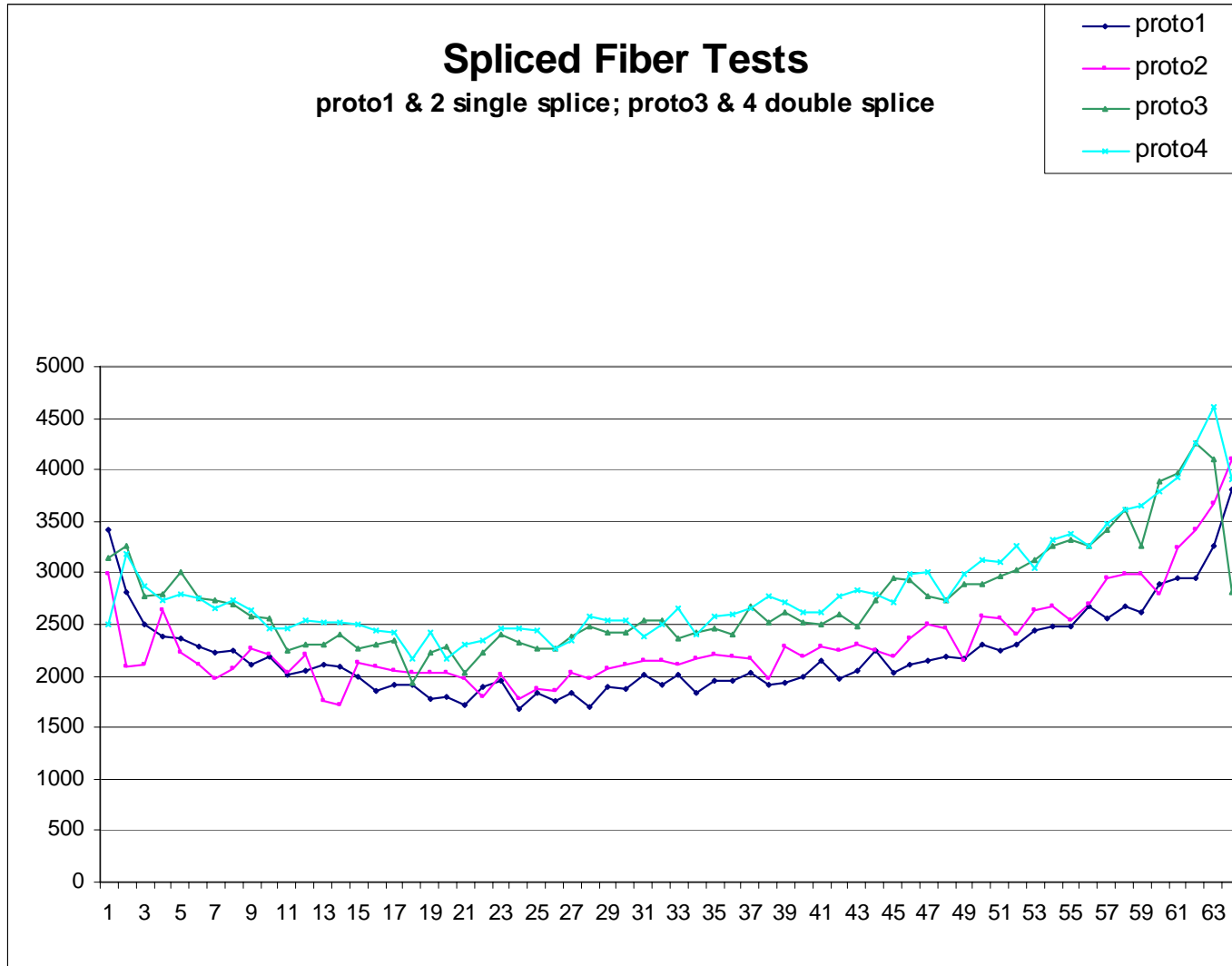


# LED Test of Single-ended Spliced Fibers

photodiode



# Comparison of Single, Doubled-ended Splices



# Detector Assembly



# Detector Assembly (cont.)



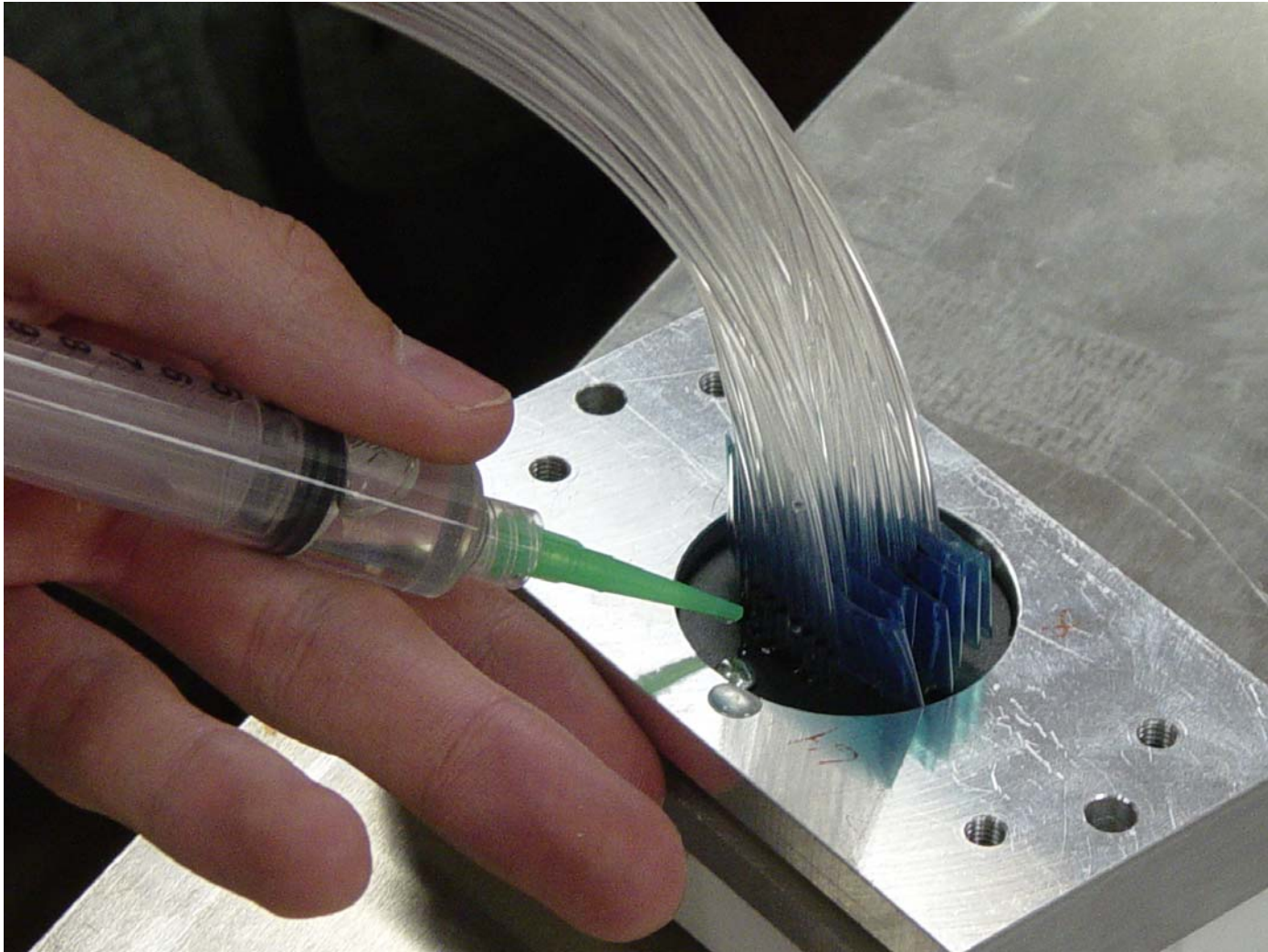
# Detector Assembly (cont.)



# Detector Assembly (cont.)

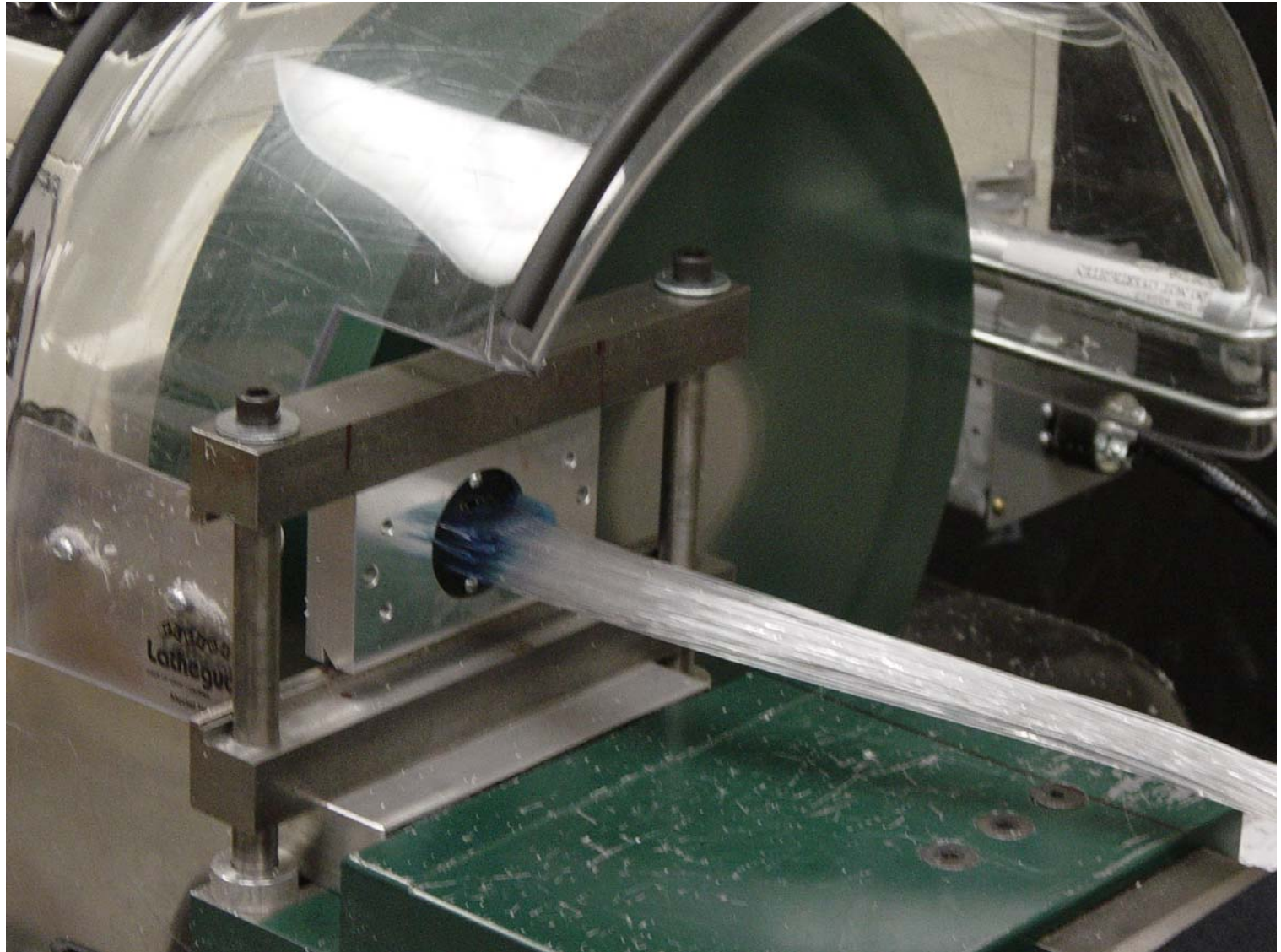


# Gluing of Clear Fiber to Cookie





# Diamond Finishing of Fiber Cookie



# Detector Ready to Close Up

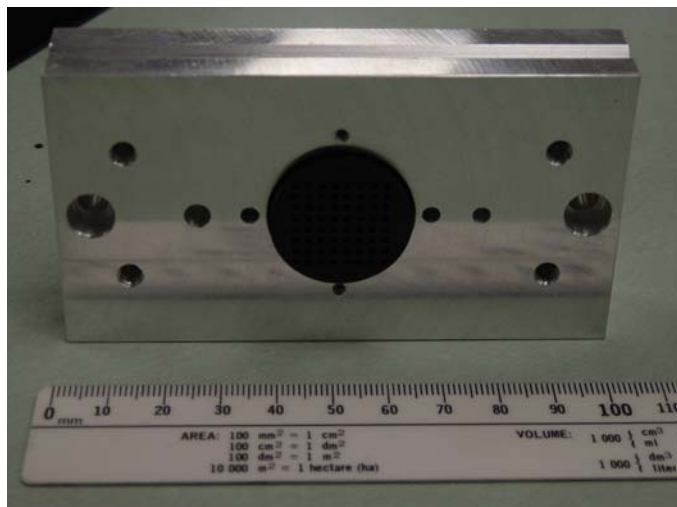


# Cookie – PMT Alignment

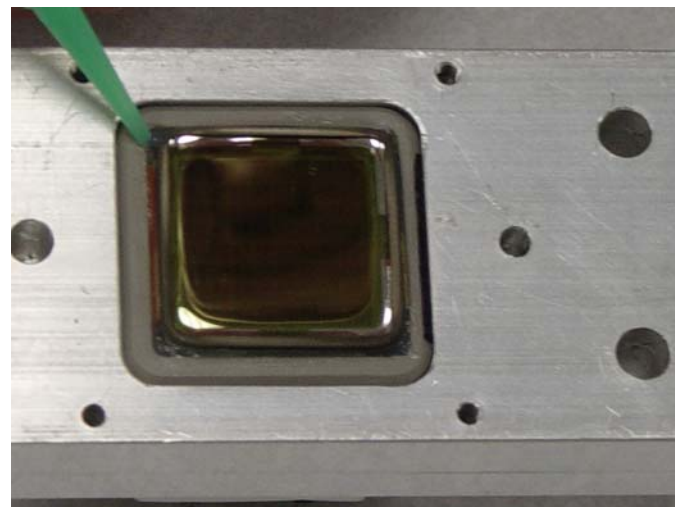
- Need to center each 1.2 mm readout fiber on a 2 x 2 mm pixel



Hammamatsu 64 channel MAPMT



Fiber cookie aligned in mating piece



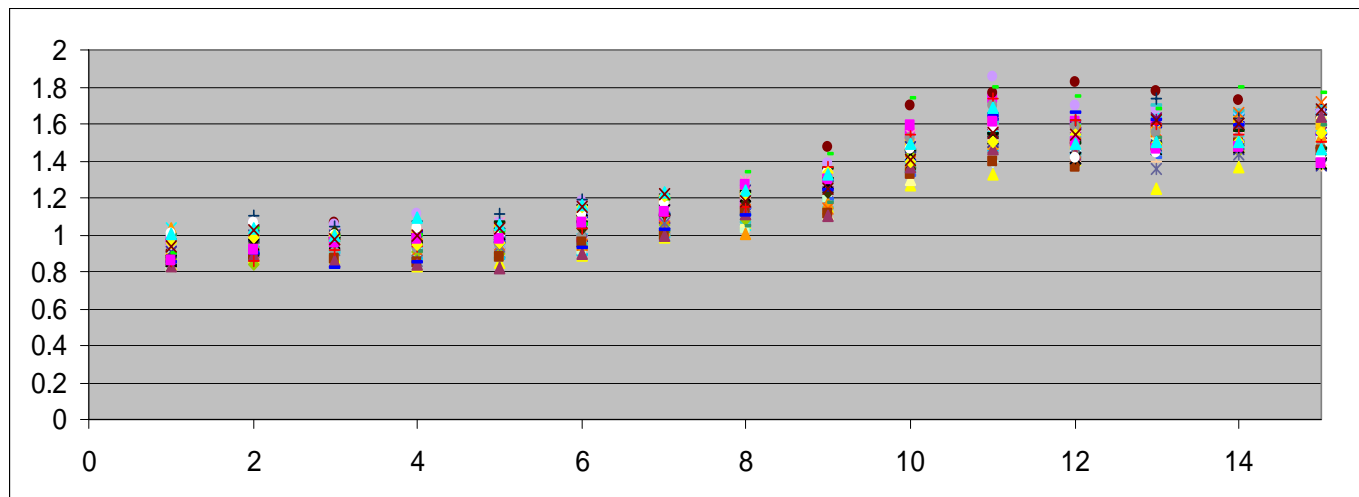
MAPMT optically aligned in jacket

# LED Calibration

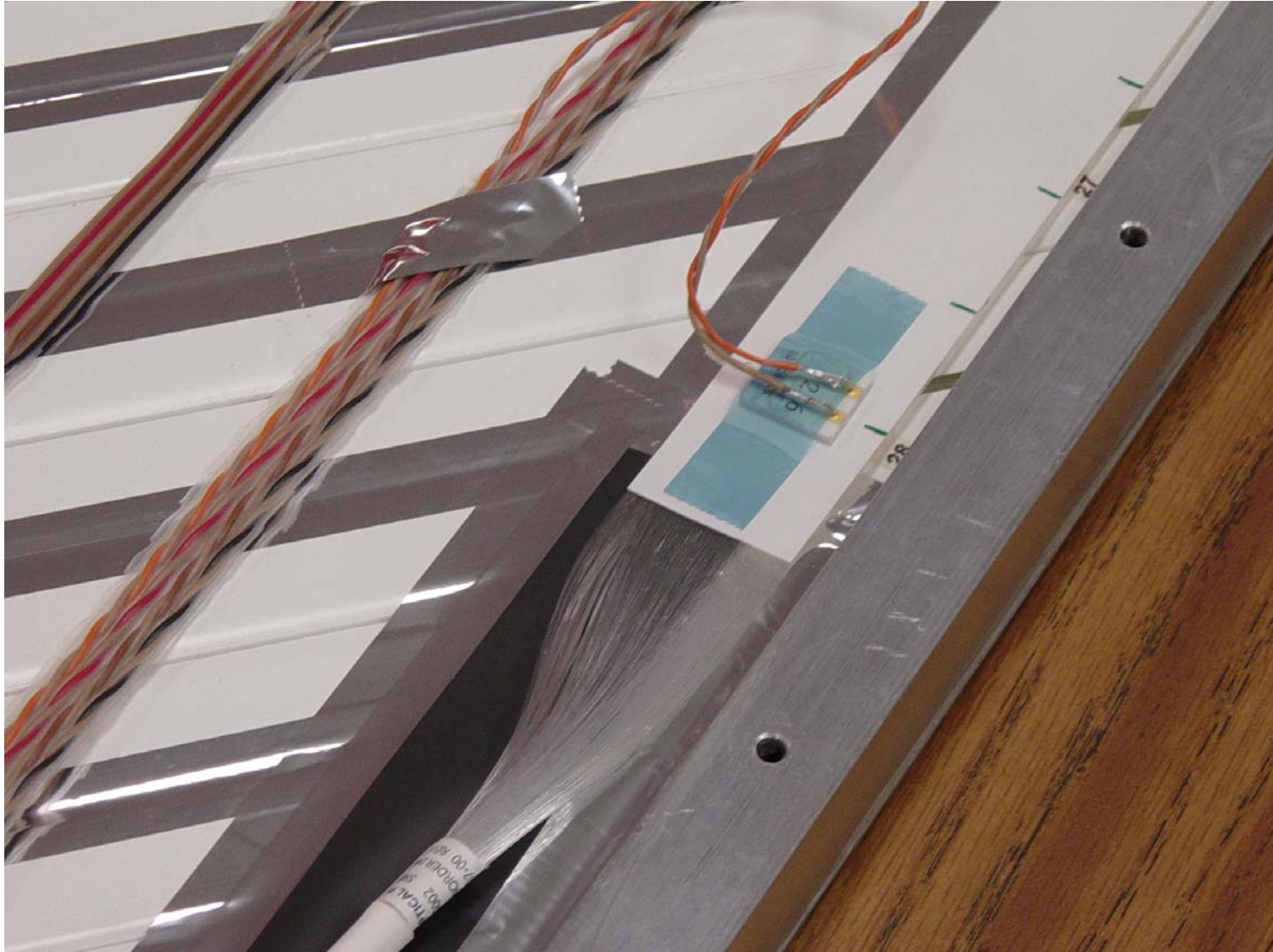
- Uses “flat optical panels” to produce a fairly uniform ribbon of LED light
- Green Nichia LEDs
- Each panel covers 8 scintillator strips
- Each panel monitored by pin diode



Results of light tests for 40 panels



# LED Calibration – Flat Panel Location



# Outreach

- Much of the work done this summer under the Notre Dame QuarkNet program
- Talented, enthusiastic workforce
- Nice connection with the cosmic ray “grid” program
- Excellent recruiting tool for future young physicists



## The Team

Leroy Castle, Rich Eberly – HS teachers

Pat Kosciuk, Stan Strycker, Matt Weis – HS students

Mike McKenna - technician

# Summary and Future Outlook

- Two single-sided muon detectors are complete and under test at Fermilab (see talk of R. Abrams)
- Two double-sided detectors nearly complete, ready for deliver within a couple of weeks
- Fabrication techniques well understood, some improvements on original design already in place
- Future plans:
  - Fabricate another 4 quarter-size detectors for beam test
  - Tool up for fabrication of a full-size detector
  - Respond to ongoing cosmic ray measurements at Fermilab
  - Explore new, better materials and alternative photodetectors