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Fabrication of Quarter-size Scintillating Strip Muon Detector Planes

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Motivation

- Fabrication of quarter-size planes (1.4m × 2.8m) 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

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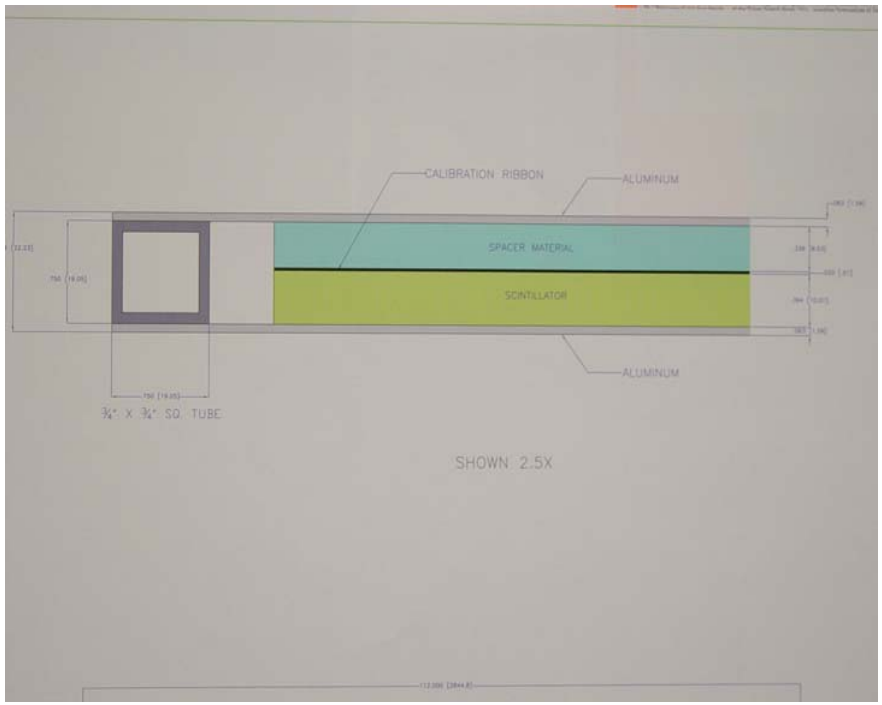
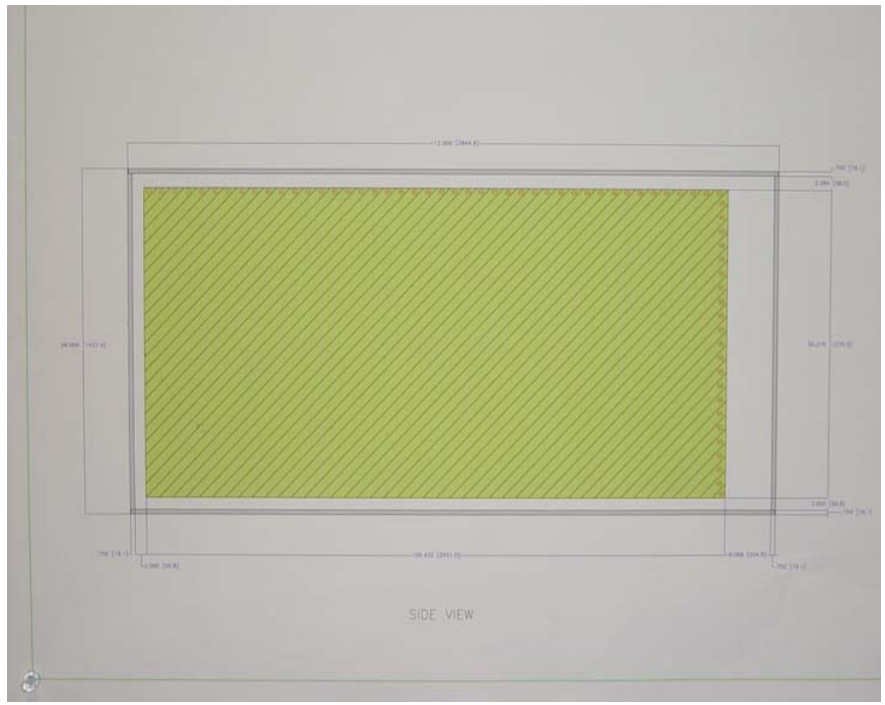
Detector Concept





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

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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

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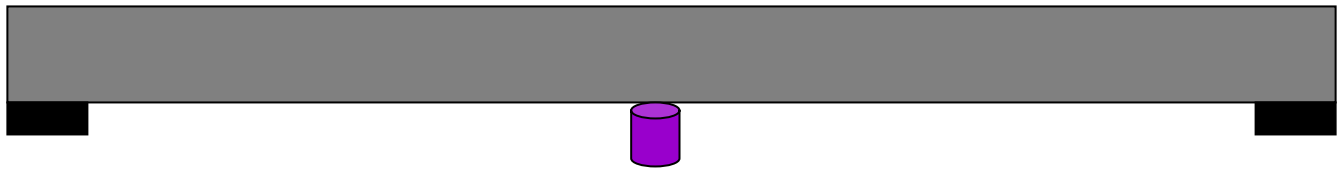
Scintillator Strip Testing

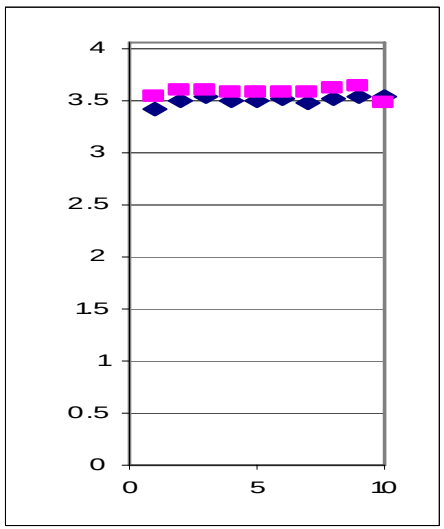
28” long Al bar



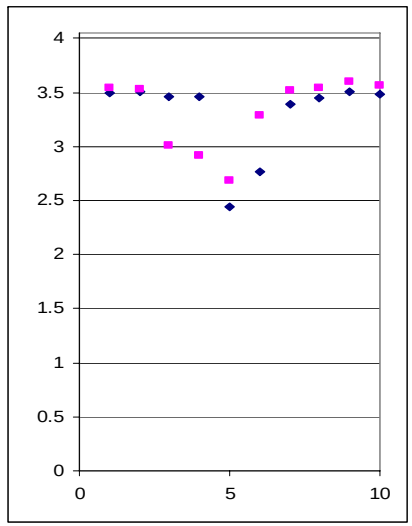
photodiode

UV LED

photodiode



Typical good result



Poor result, strip discarded

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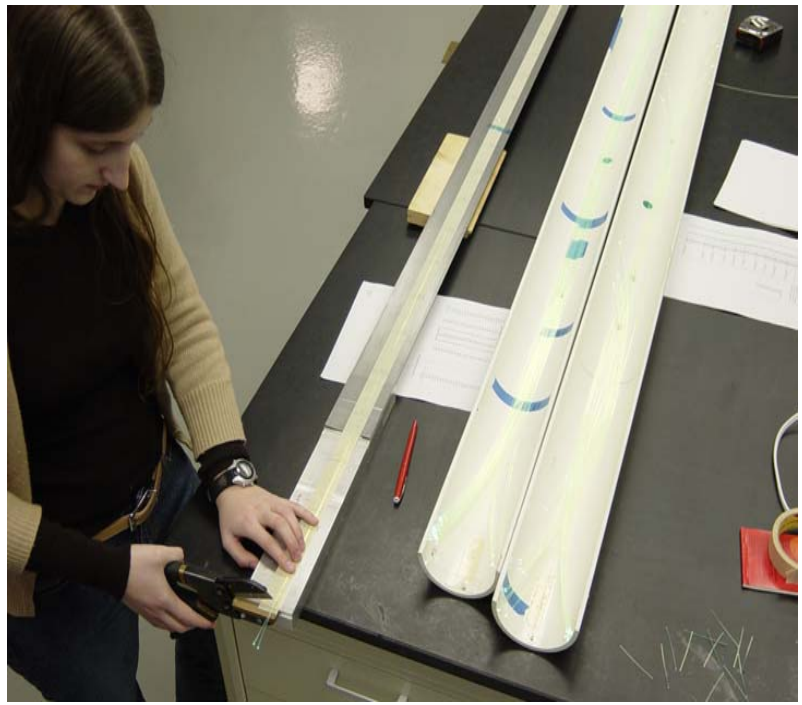
Fiber preparation

- 1.2mm Clear waveguide, spooled
- 1.2mm Wavelength Shifter, spooled

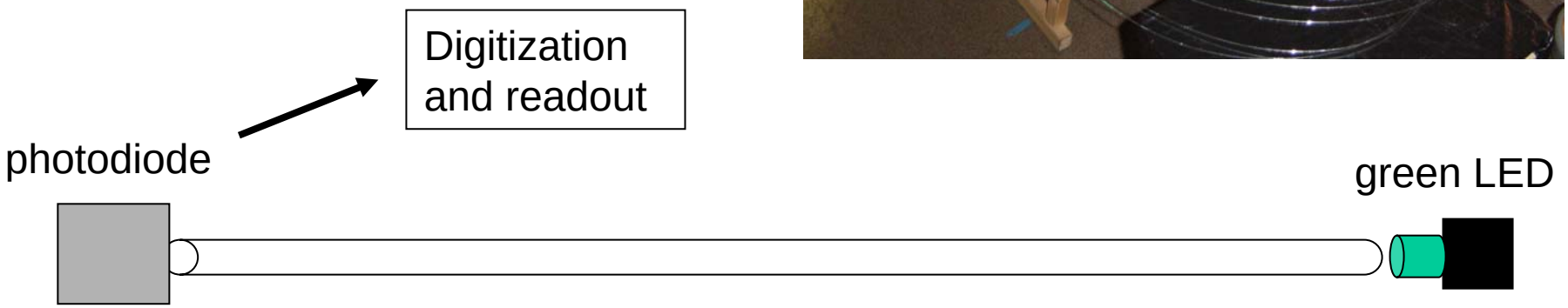
- Visual inspection with LED on end
- Measured on cutting template
- A clean, razor cut is made with ‘HandiCutter’

- 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



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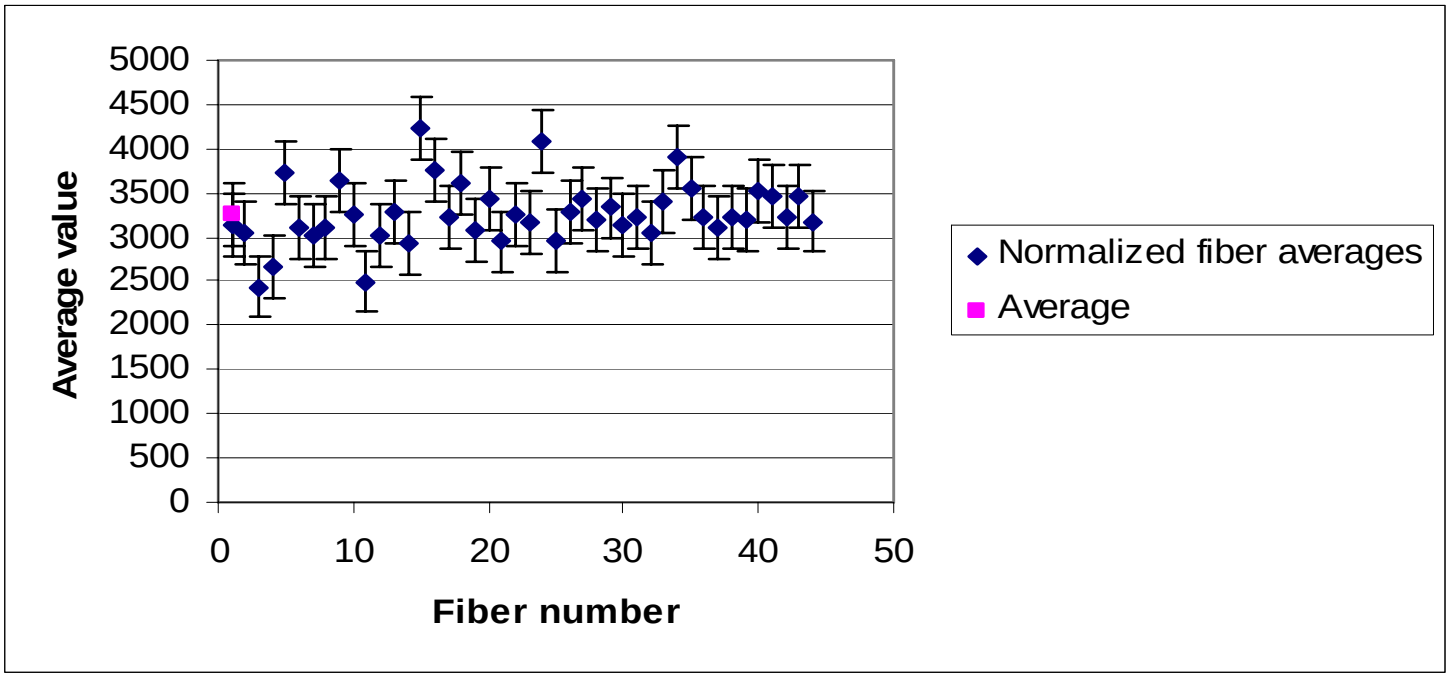
Light Test of Waveshifting Fiber for S+



44 separate pieces - no rejected fiber

Sigma of ~ 10%

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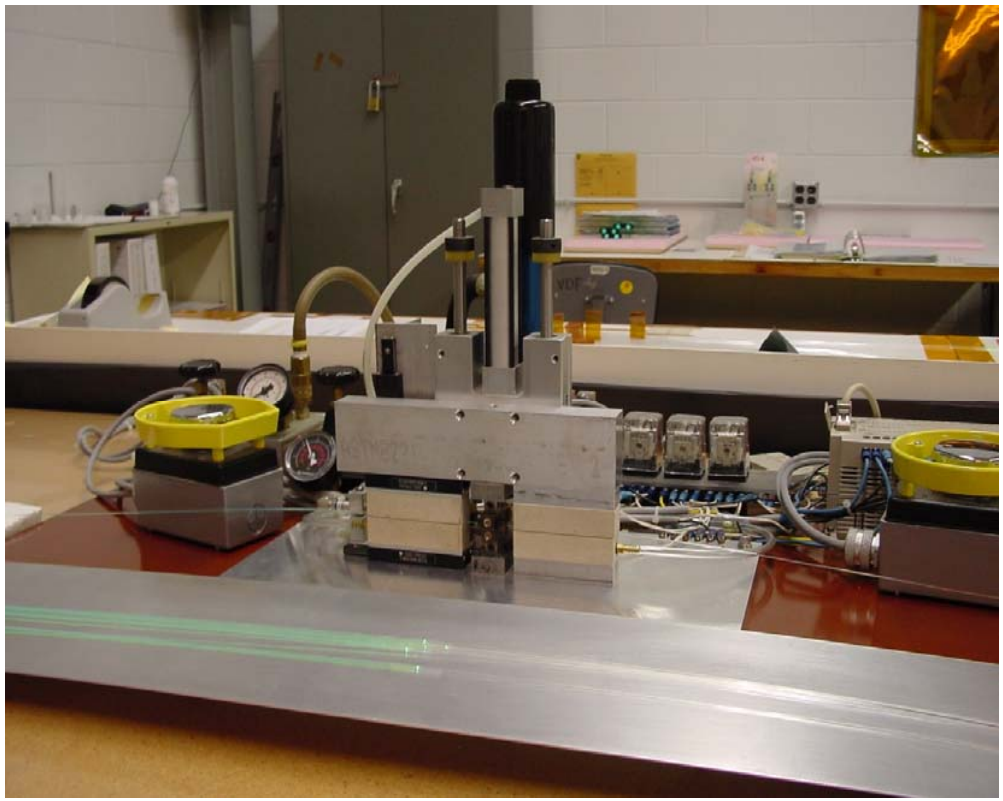
Thermal Splicing

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



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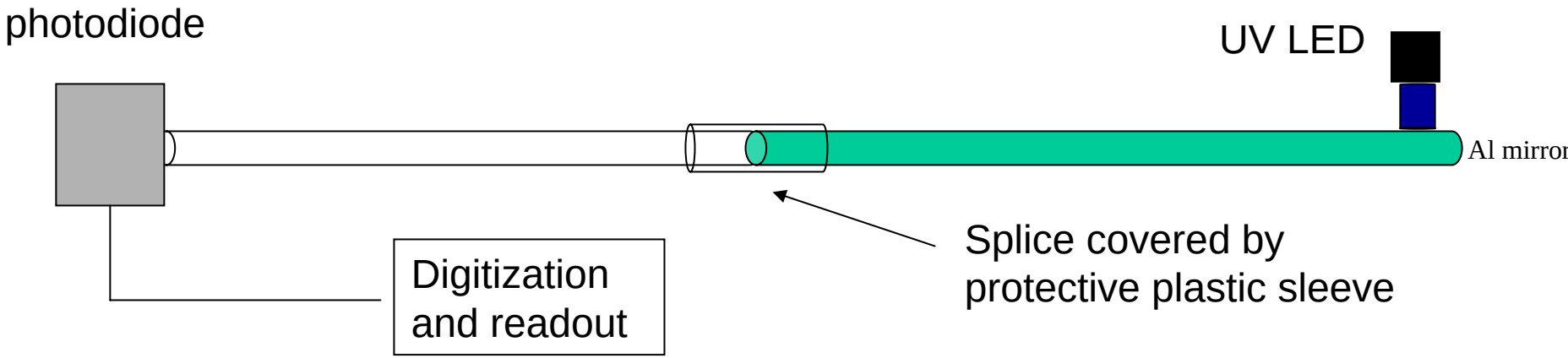
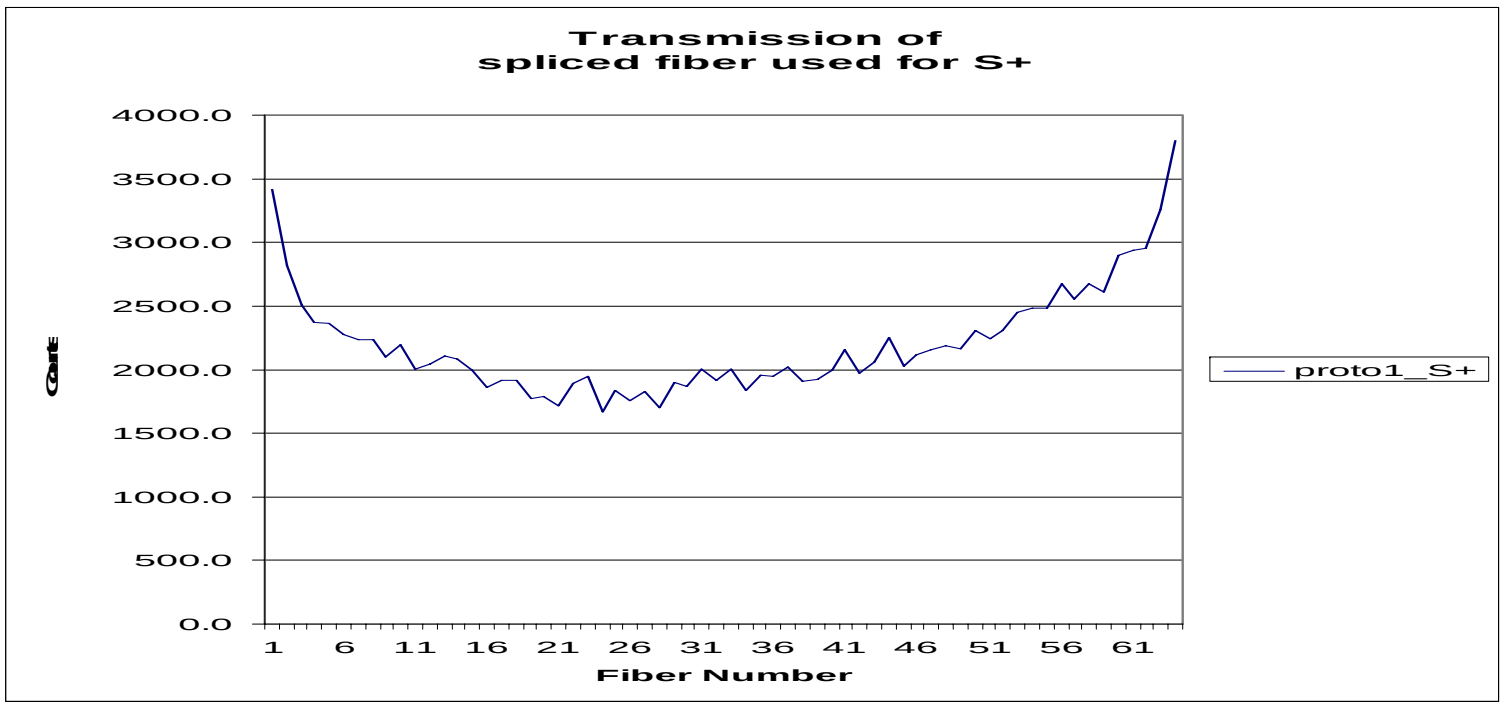
LED Test of Single-ended Spliced Fibers





MW1 Mitchell Wayne, 3/20/2005

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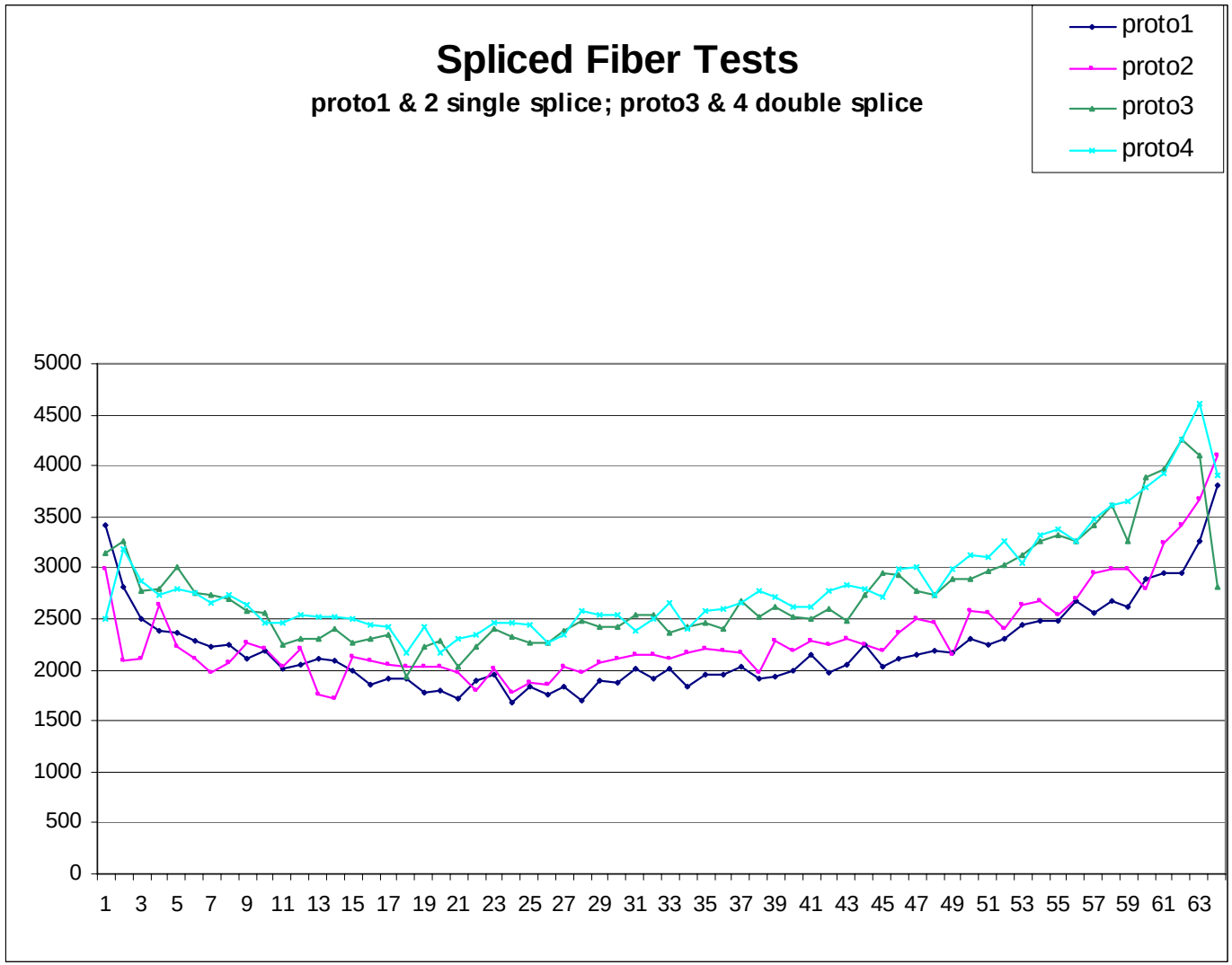
Comparison of Single, Doubled-ended Splices



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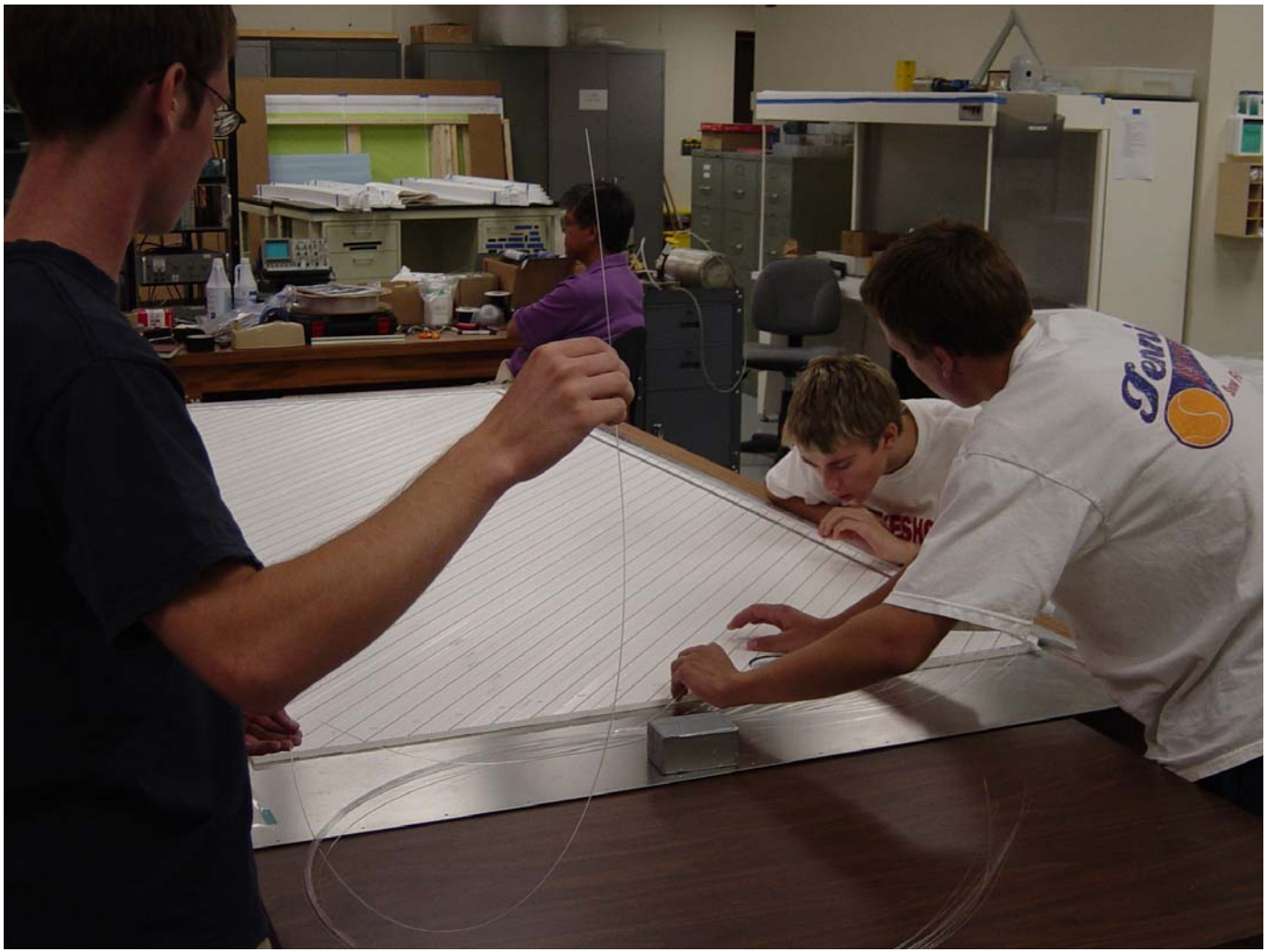
Detector Assembly

Detector Assembly (cont.)



Detector Assembly (cont.)

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Detector Assembly (cont.)

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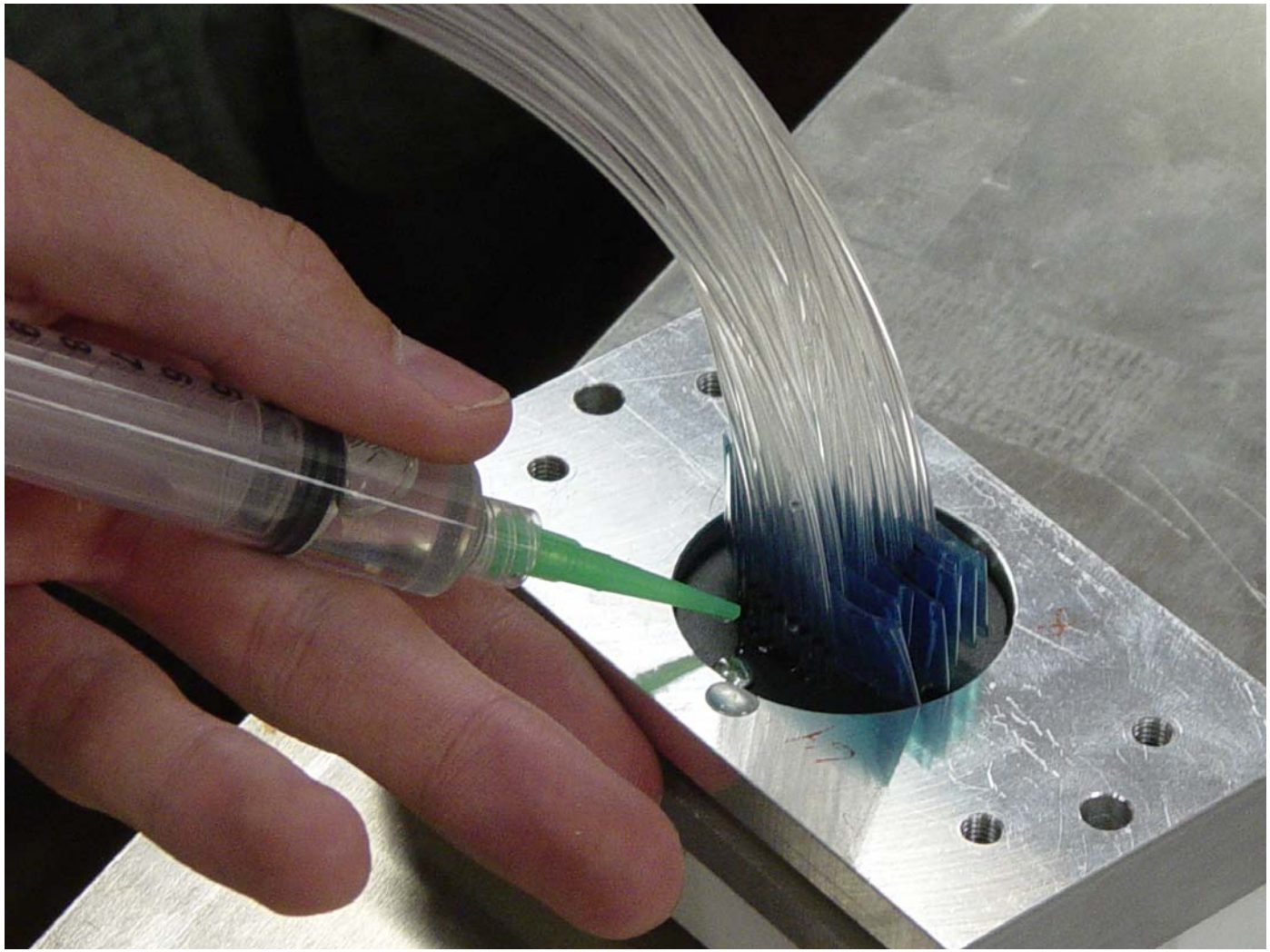
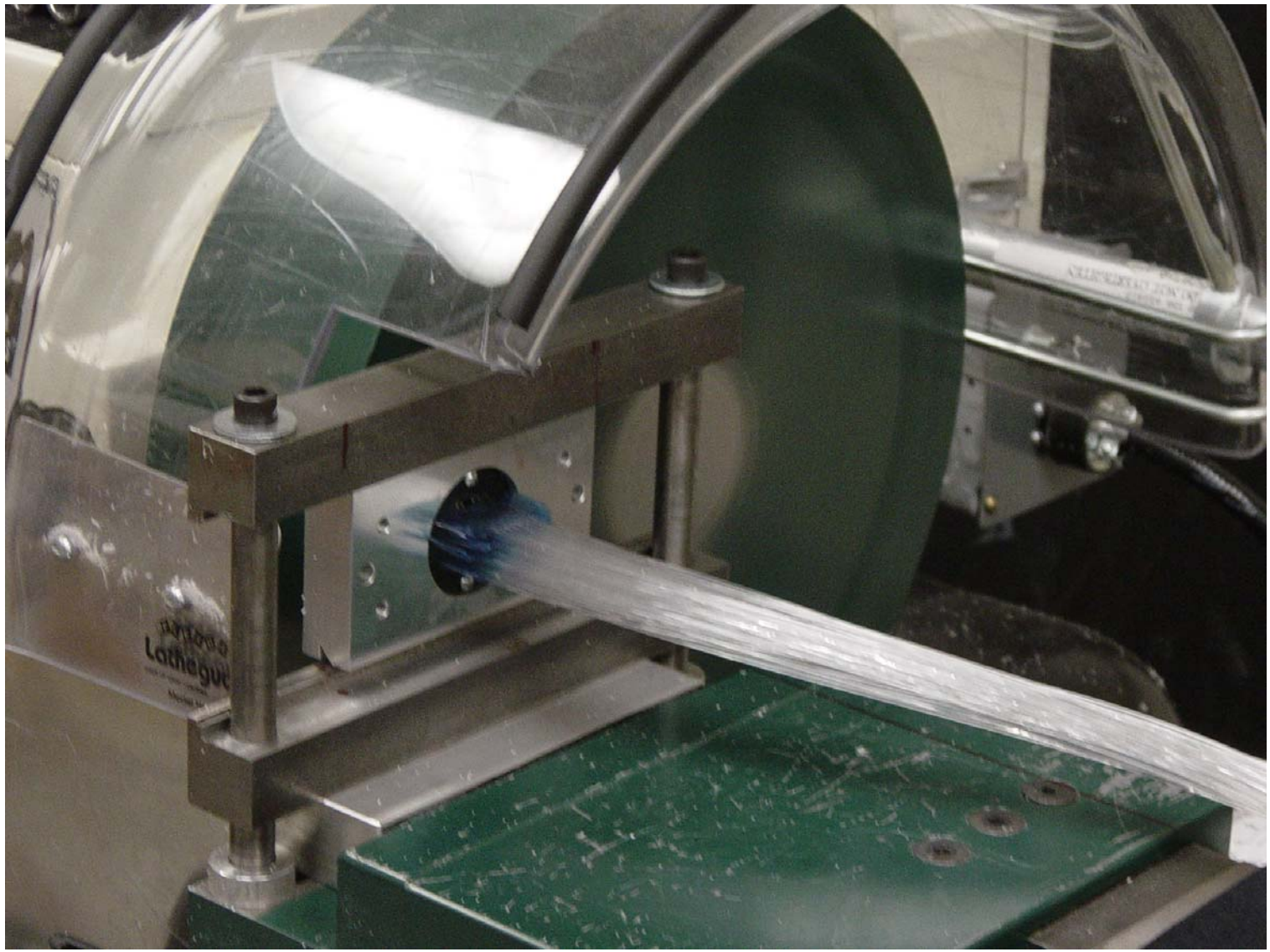
Gluing of Clear Fiber to Cookie



Diamond Finishing of Fiber Cookie



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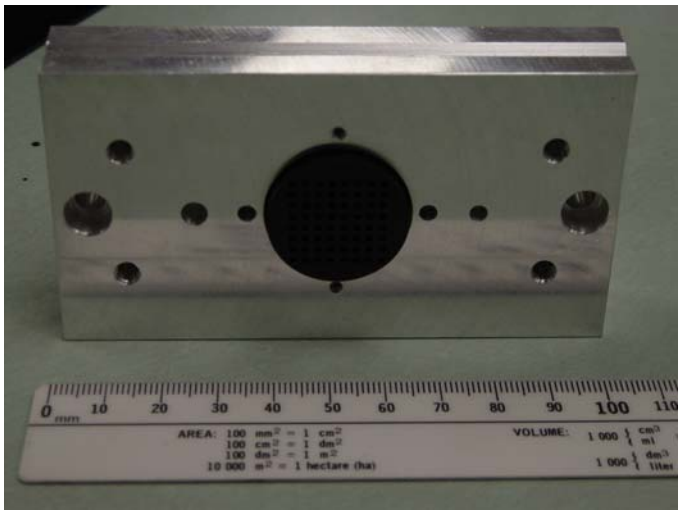
Detector Ready to Close Up

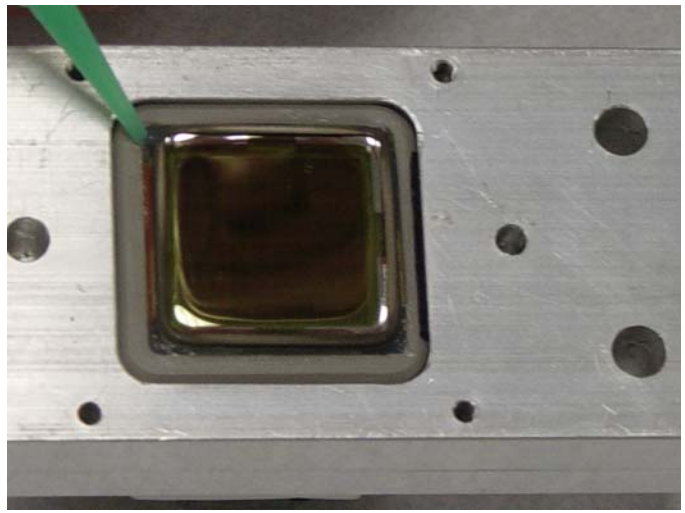
Cookie – PMT Alignment

- 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

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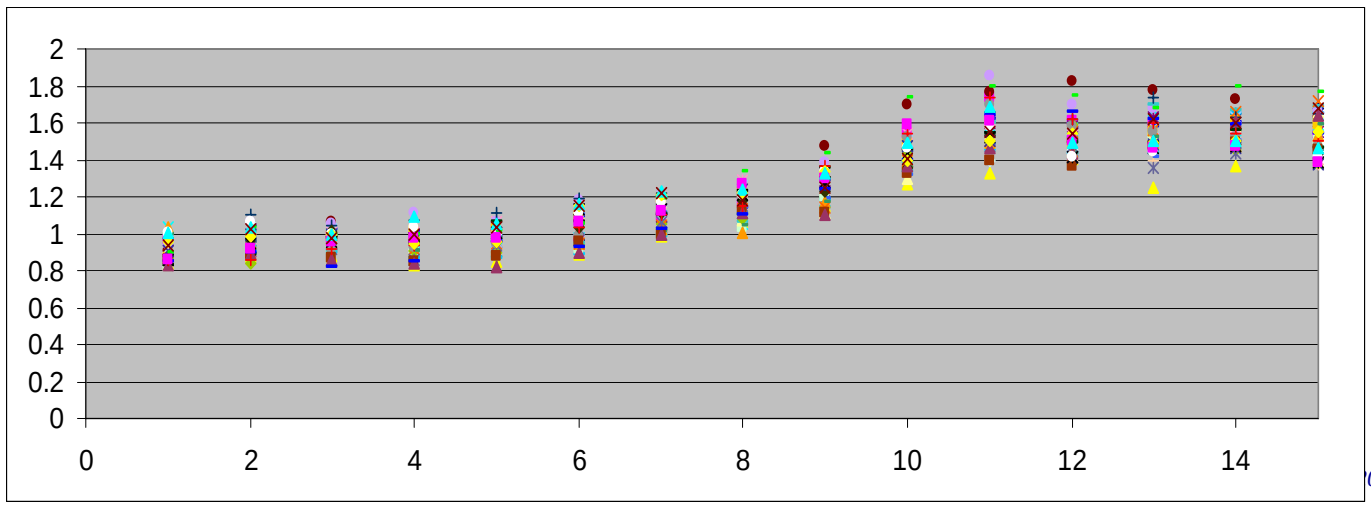
LED Calibration

- 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



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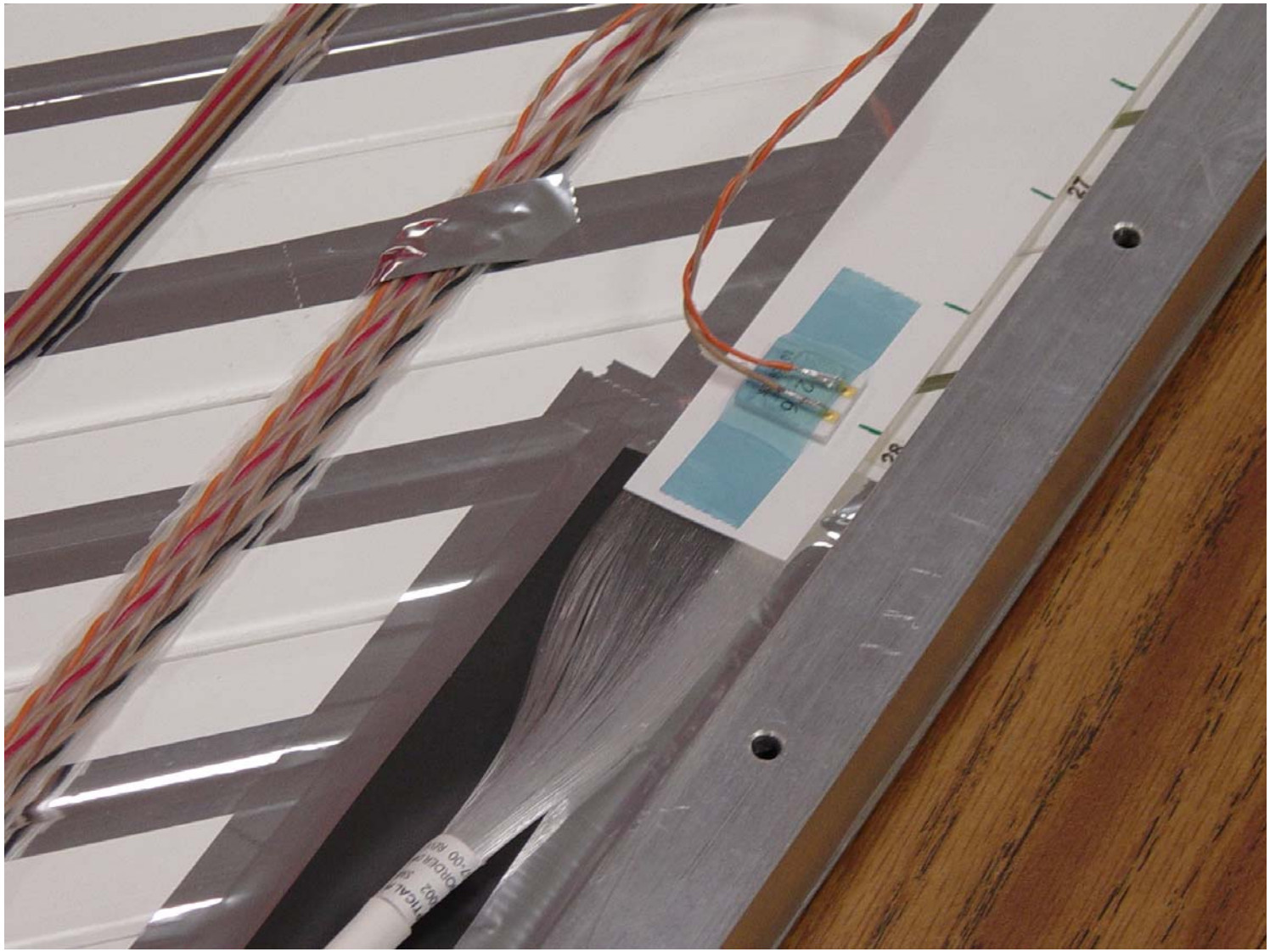
LED Calibration – Flat Panel Location



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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

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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