Forward Proton Detector
Detector Construction

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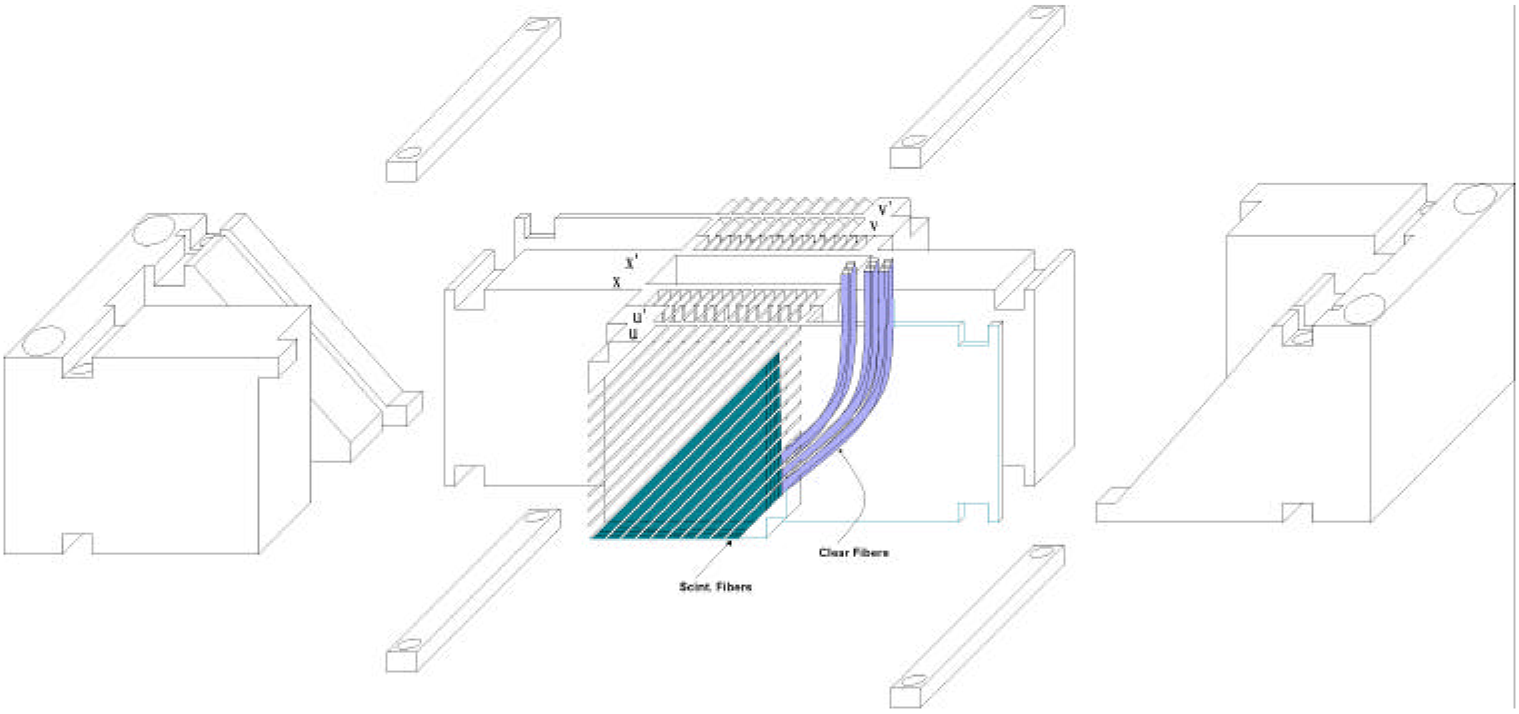
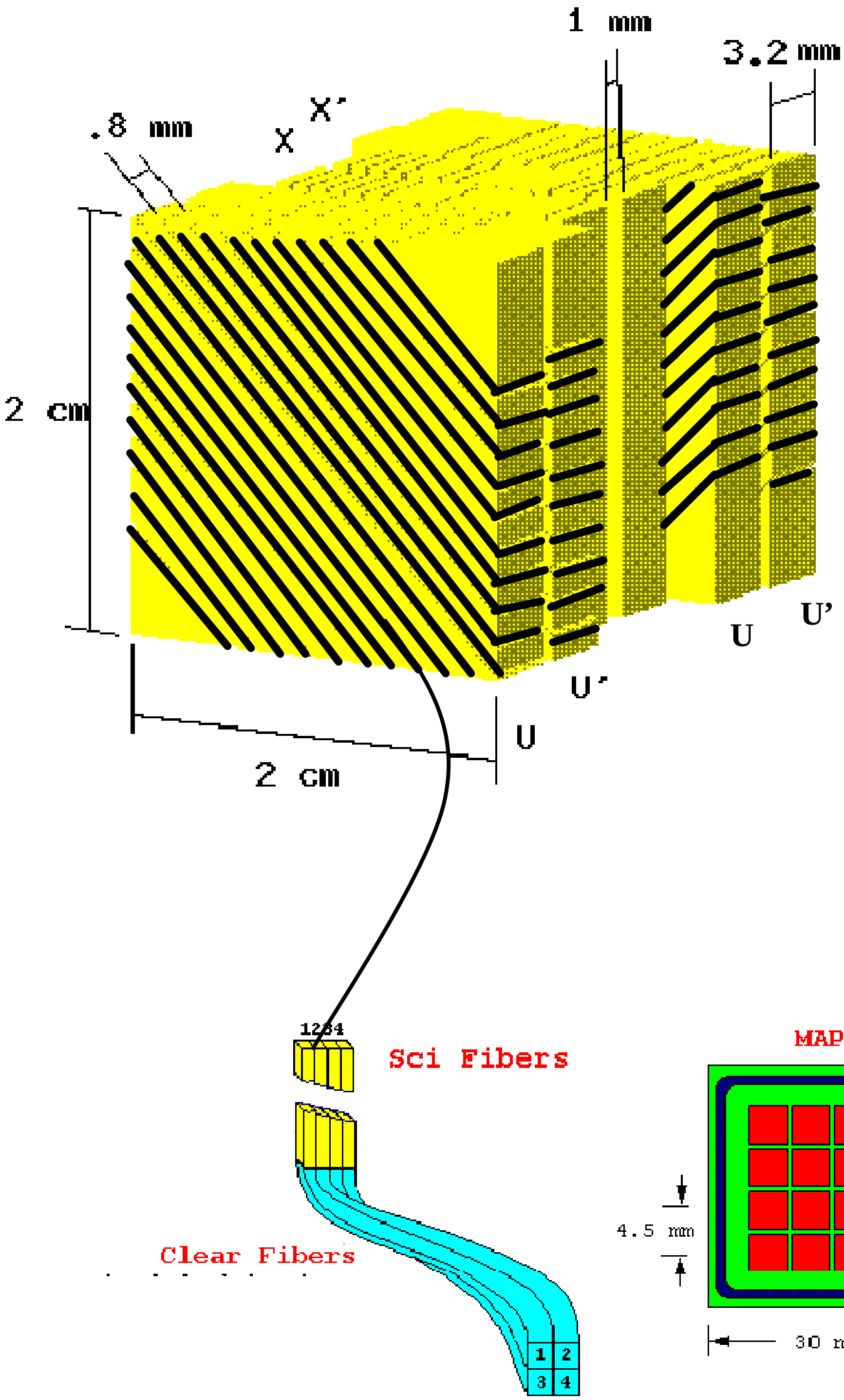


Detector Needs

- Position resolution of 100µm
  - Beam dispersion and uncertainty in beam position make better resolution unnecessary
- Efficiency close to 100%
- Modest Radiation Hardness
  - Operates at 8σ from beam axis, 0.03 MRad yearly dose expected
- High Rate capability
  - Active at every beam crossing
- Low background rate
  - Insensitive to particles showering along beam pipe
- Small dead area close to the beam
  - Protons are scattered at very low angles, acceptance is very dependent on position relative to beam

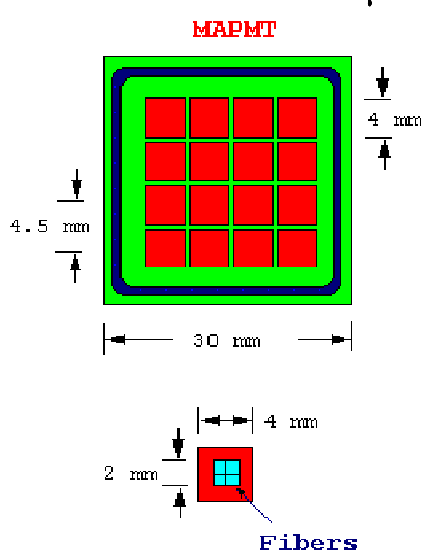
- Scintillating Fiber detector meets these needs

Detector Setup



Six planes (u,u',x,x',v,v') of 800 μm scintillating fibers
(') planes offset by 2/3 fiber

20 channels/plane(U,V)(')
16 channels/plane(X,X')
112 channels/detector
18 detectors
2016 total channels
4 fibers/channel
8064 fibers
1 250 μm LMB fiber/channel
8 LMB fibers / bundle
252 LMB bundles
80 μm theoretical resolution



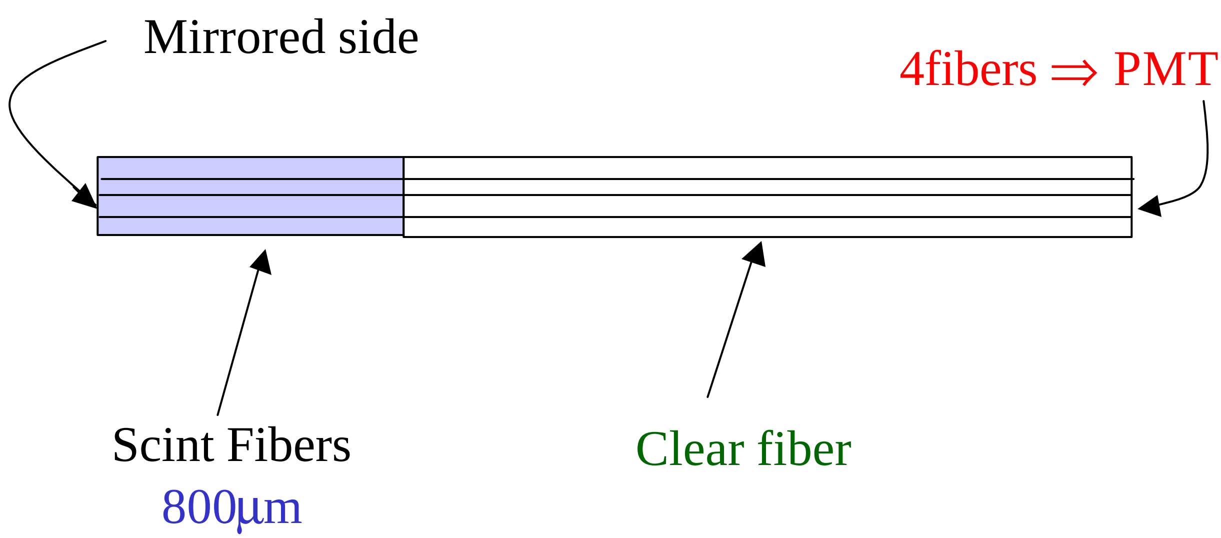
4 fiber bundle fits well the pixel size of H6568 16 Ch. MAPMT

7 PMT's/detector

16 250 μm fibers each PMT

Detector Fibers

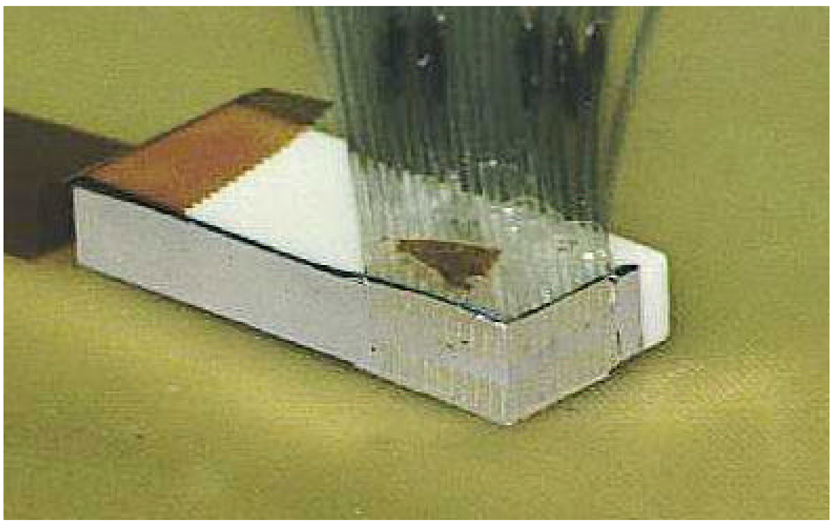
- Scintillating fiber is spliced to clear fiber
  - Increased halo background with scintillating only
  - Light output improved due to longer attenuation length of clear fiber
  - Cross talk is reduced

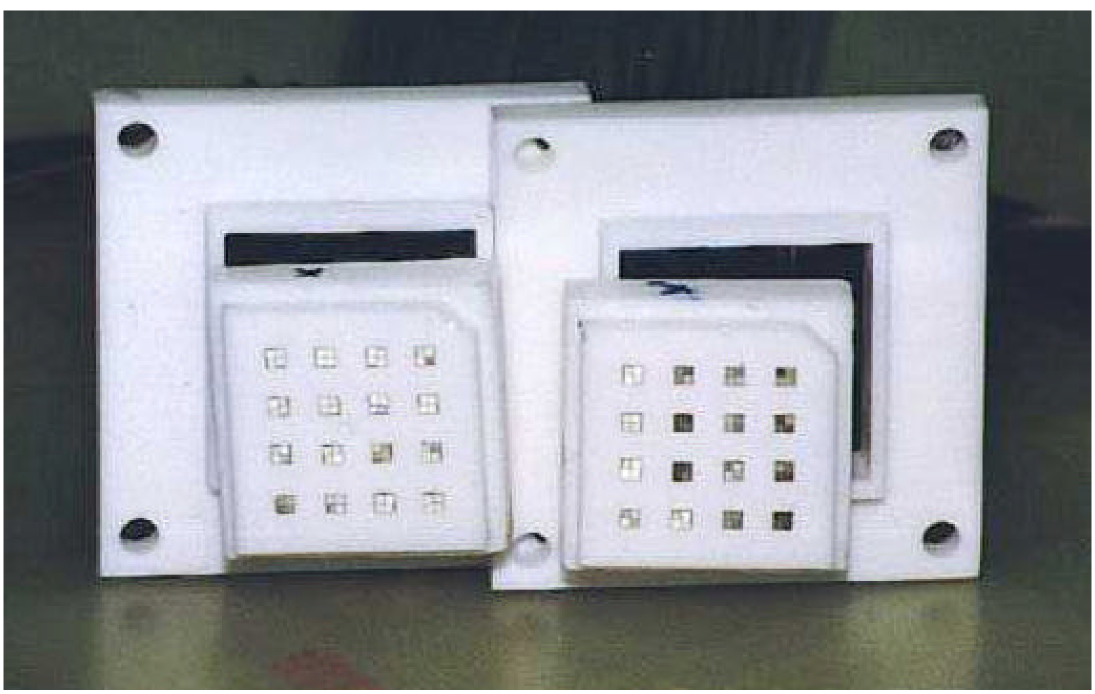


- Fibers produced by Bicron
  - 0.80 mm square multiclad fiber emitting in blue λ
- Square fiber can only be polished using ice polishing method at FermiLab Lab 7
- After polishing fibers are inspected for deformity and cladding damage and repolished if needed

Detector Frames

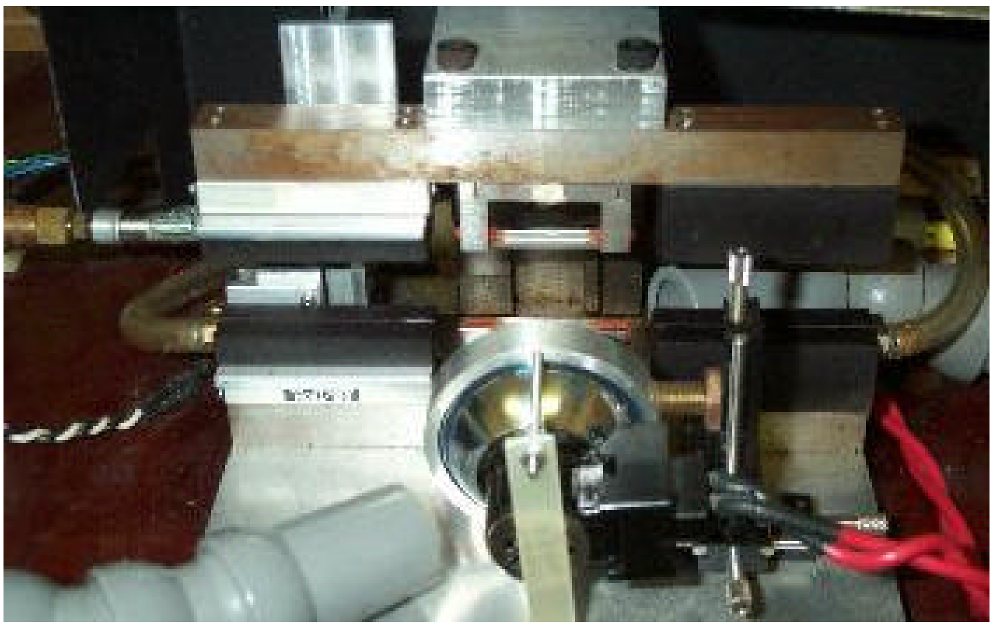
- Cast at FermiLab Lab 5 plastics shop
- Original aluminum machined piece is molded and production pieces are cast in polyurethane





Splicing

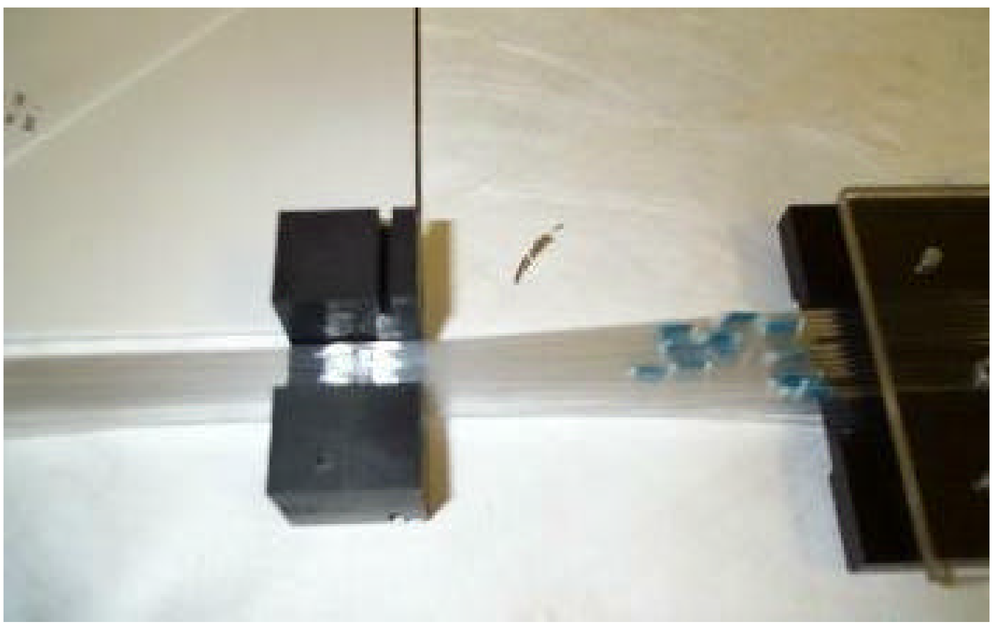
- Splicing being completed at UTA
- Fibers spliced using a version of the MSU splicing machine modified for square fibers



- With proper setup, light transmission through splice point of over 90% possible
- Afterwards, splice point is sensitive to bending stresses so care must be taken
    - Shrink tubing cannot be used to strengthen splice due to space constraints

Frame Assembly

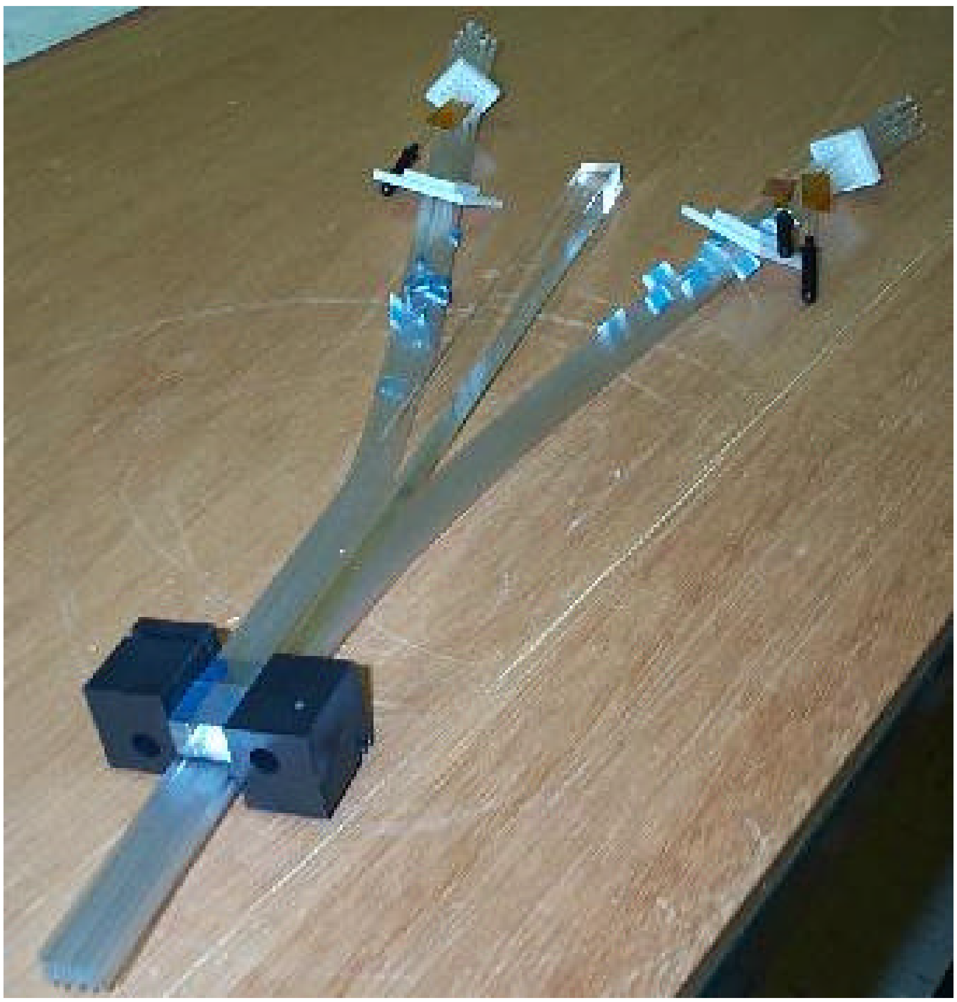
- Being completed at UTA
- Detector active area (17.42 mm from bottom) is marked on frame
- Four fibers have splice point aligned
- Splice point is aligned with mark in frame



- Bicron optical epoxy is used to secure the fibers into the frame once completely assembled. The glue cures overnight.

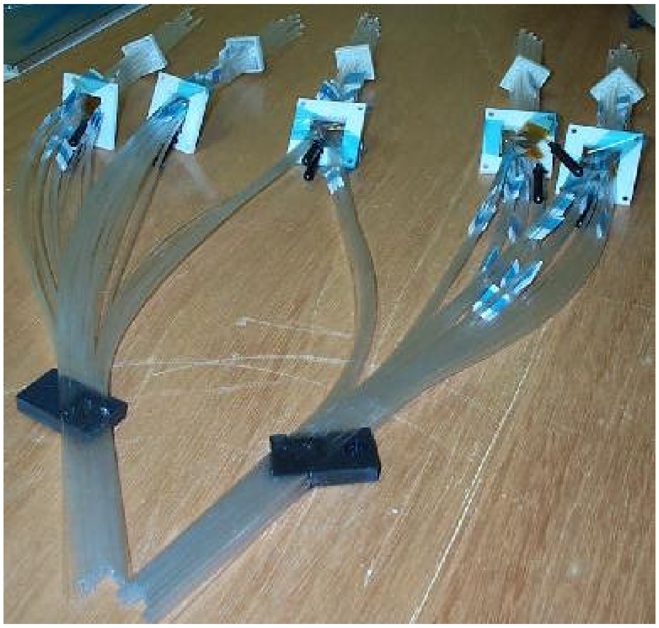
Trigger Scintillator

- With x' frame an additional step is needed because of trigger scintillator
  - Trigger scintillator is cut and glued to wave guide at FermiLab Lab 6
    - + Scintillator is coated with Aluminum at FermiLab Lab 7

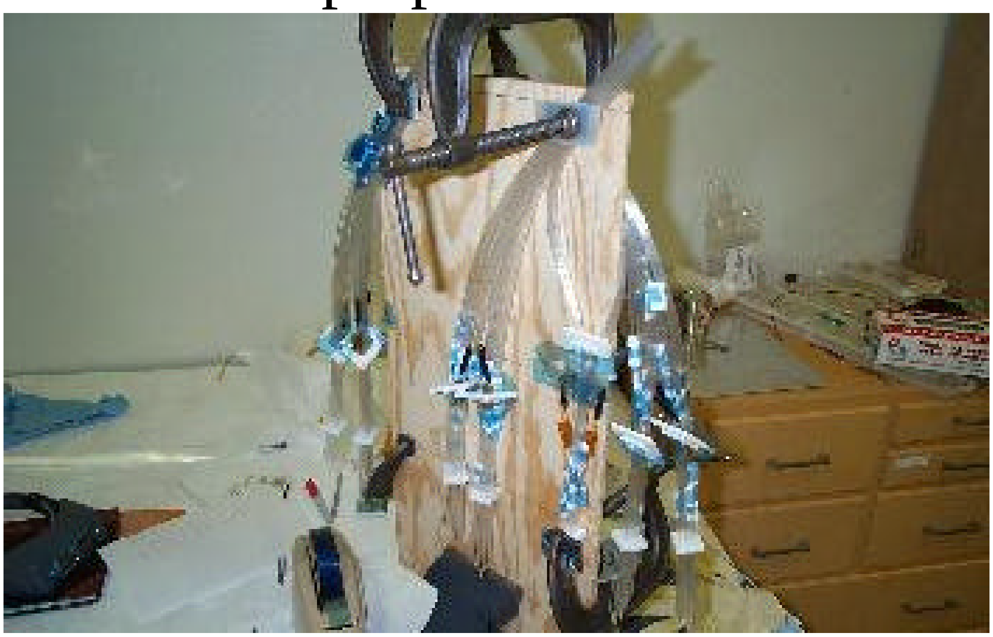


Cookie Assembly

- After both sides of frame are completed the fibers can be glued into the cookies



- Detector is clamped to a vertical wooden backboard and proper distances are measured



- Fibers are secured with Bicron optical epoxy.

Phototube Testing

- At D0 DAB3, phototubes are tested using an LMB with a modified cookie
- The LMB pulses all 16 channels of the MAPMT simultaneously and ADC information is recorded for each channel
- The average ADC count of the 16 channels is used to bin the tubes in groups of 7 with spares and these bins are assigned to locations in the tunnel
- The LMB also strobes the L0 tubes and they are binned in groups of 4 with spares

Full Detector Assembly

- After arrival at FNAL, the inside edge of the U/V frames are cut and diamond polished at Lab 6 then aluminized at Lab 7
- The detector frames are assembled with care taken in alignment of U/V with the X into a block and secured with screws
- The bottom is cut and diamond polished then aluminized

Mapping

- The aluminized detector is disassembled and mapped using a 2 micron optical scanner
  - The aluminization helps light reflection to measure the edges of three overlapping fibers in each frame
- Each frame is measured in it's "native" coordinates. The locations where 3 fibers overlap are used to define an active channel
- Data is collected for alignment of frames with respect to each other and with respect to a common reference point in the pot
- This allows us to have a real pixel map for each detector

Cartridge Assembly

- The cartridge houses the detector and phototubes in the roman pot in the tunnel

- The cartridge bottom is installed in the tunnel and the detector is pushed to the bottom of the pot
- The Cartridge top fits over the bottom and is secured down causing good contact between the tubes and cookies

Detector Installation

- The cartridge bottom is installed in the tunnel and the detector is pushed to the bottom of the pot

- The Cartridge top fits over the bottom and is secured down causing good contact between the tubes and cookies

- The HV is tested to ensure that the splitter is working properly

- Signals are measured from the tubes using dark current to verify bad channels

- LMB signals are amplified and measured at the SCR using the DAQ

Status

- 8 detectors are installed in the tunnel
- 4 additional detectors are being finished at UTA and assembled for insertion in tunnel. Tubes are available for 10 detectors and installed
- 8 additional detectors will be constructed for insertion into tunnel next Summer for Phase II
- New subcomponent of FPD project is the Veto Counter located on the inside edge of Low Beta Quads at the beam pipe for more effective veto