# Prop tubes and fine-grained hodocsopes

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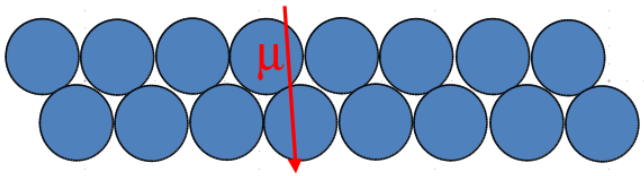
# Recommissioning

- LANL group is responsible for the prop tubes and fine-grained hodoscopes
  - St-4 prop tubes: Xuan Li
  - St-1 and St-2 fine-grained hodoscopes: Sho Uemura
- Help is welcome; we need expertise more than raw manpower

# Prop tubes: basic design

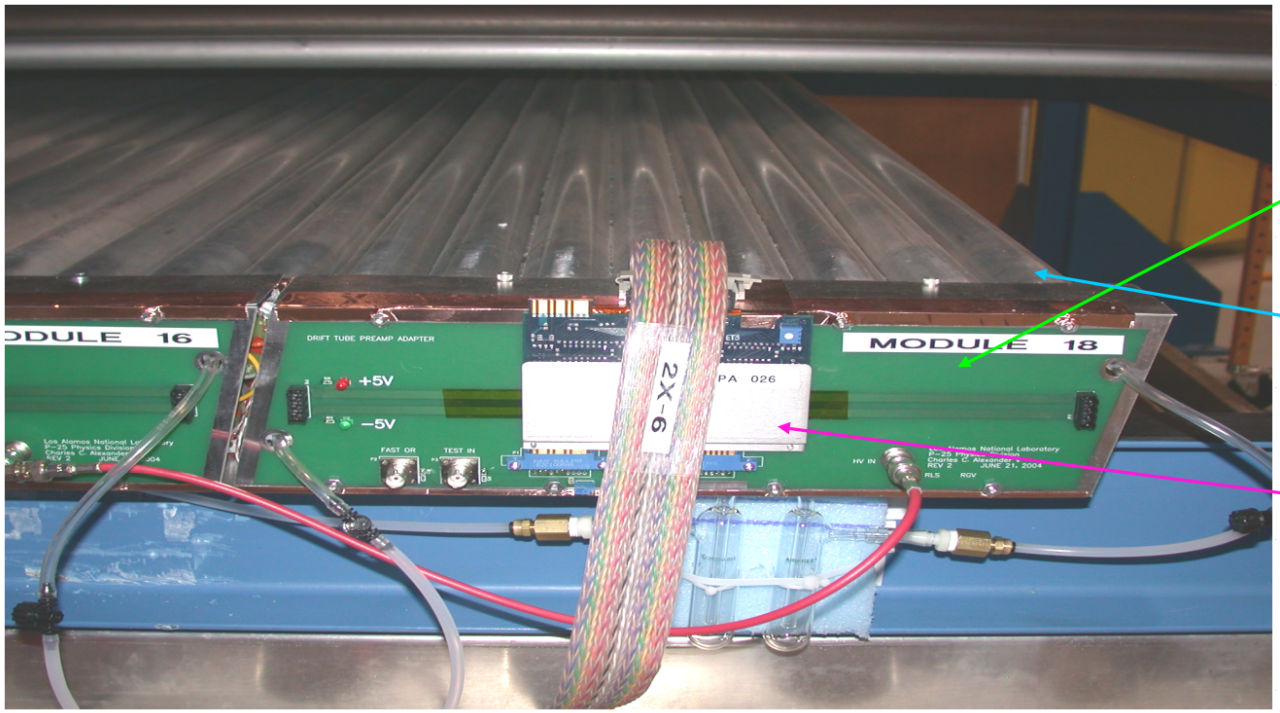
- 2 X and 2 Y layers, coverage $> 250 \times 250$ cm
- Aluminum drift tubes for good position resolution $\rightarrow$ track matching to Station 3 drift chambers
- Each plane constructed of 2 staggered rows of 2" diameter tubes for excellent efficiency and reasonable channel count




End view of a 16 tube module

- Nanometrics amplifier / discriminator electronics with ECL output. Option for more modern electronics with LVDS output (<50$/chan)
- Well-tested design with 1000's of operational tubes
- Works with a variety of gas mixtures at $\sim +2300$V

# Prop tube front end readout



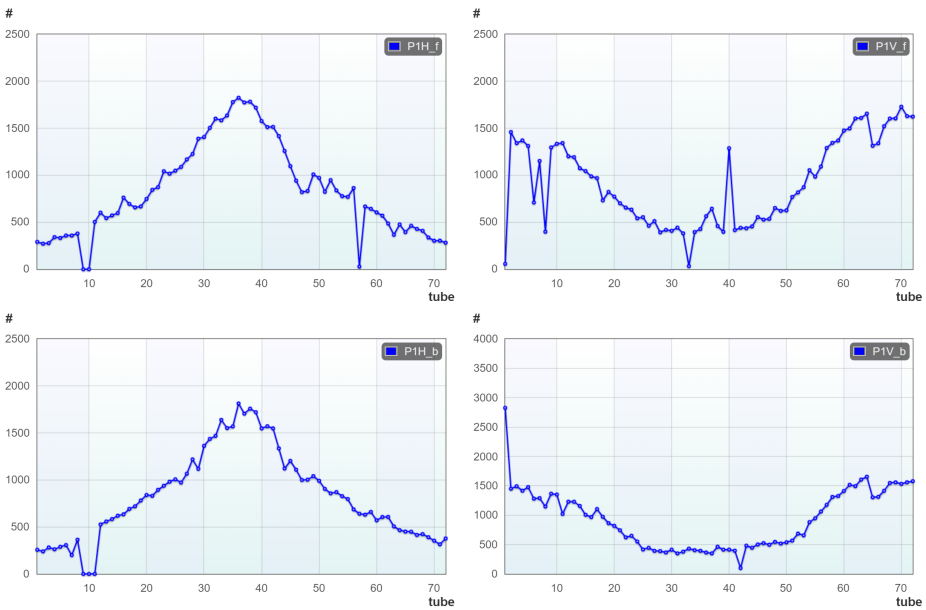

**Close-up of one 16-channel module**

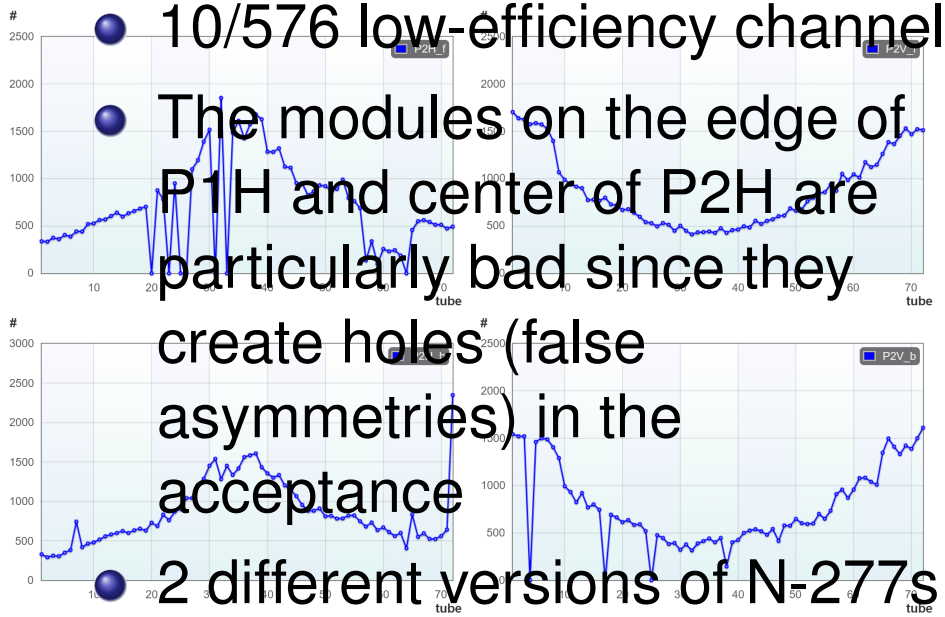
A module consists of 2 staggered rows of 8 tubes, 16 tubes total
~ 4” X 16” X 12’

Each tube is 2” X 12’ with 20μ sense wire at +HV

Each module is readout with a Nanometrics N-277 amp/disc card using +-5V power

# Prop tube status as of July 1, 2017



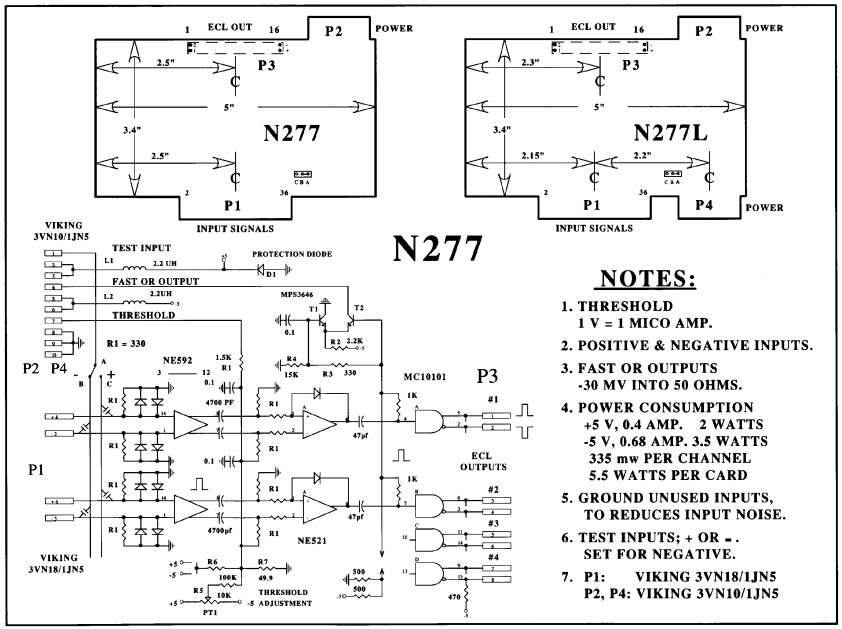

- 19/576 dead channels
- 10/576 low-efficiency channels
- The modules on the edge of P1H and center of P2H are particularly bad since they create holes (false asymmetries) in the acceptance
- 2 different versions of N-277s (different gain) were used. We ran out of spares for both.

# Plan for the detectors

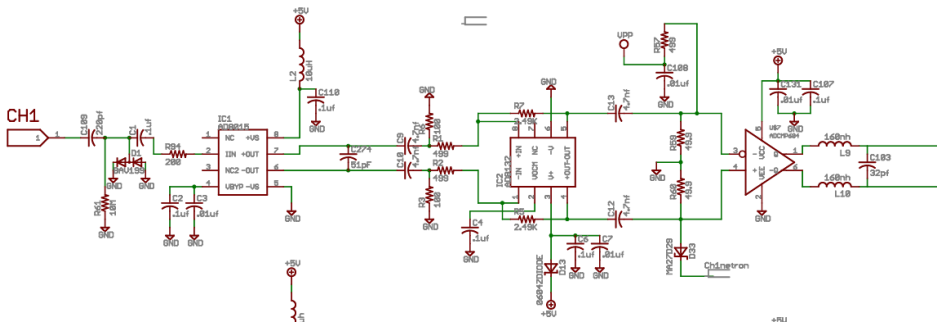
- Evaluate the status of the spares on the corner of the loading dock
- Identify the bad tubes/modules and replace with good spares
- 2 weeks of work planned in July, but will need to coordinate with shielding/target installation efforts

# Plans for the preamps (2 options)

- Option 1: repair the broken N277s (the exact model we used are very hard to find)
  - Appreciate help if a collaborator could help find the same N227s or fix them




- Option 2: Replace with more modern electronics (Decision Sciences amplifier/discriminator, needs some redesign to fit the form-factor)

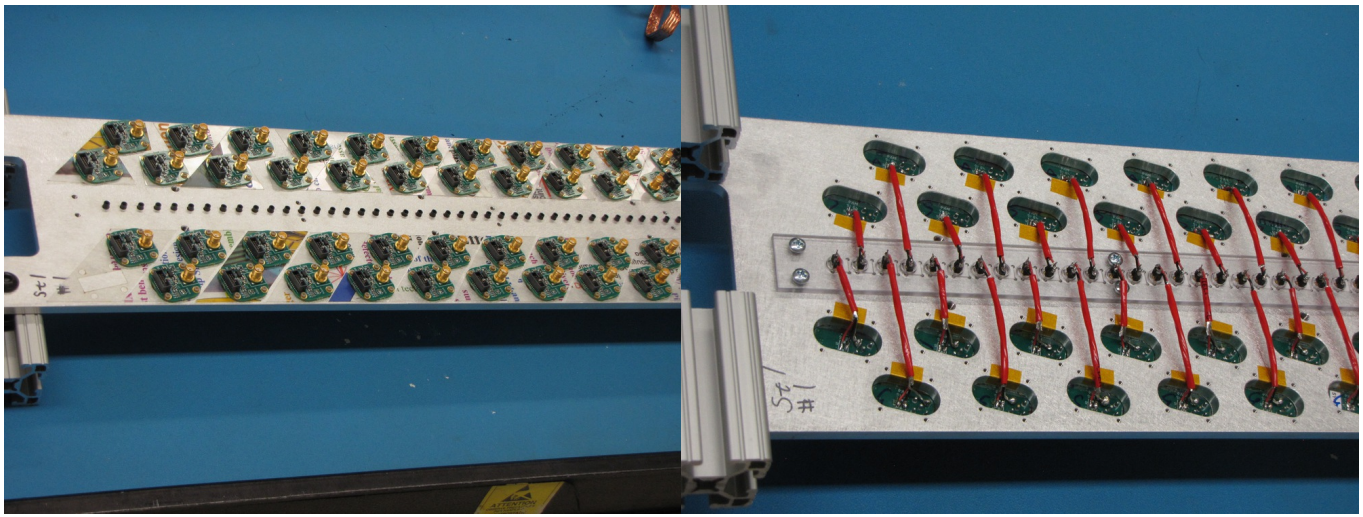


# Fine-grained hodoscopes: basic design

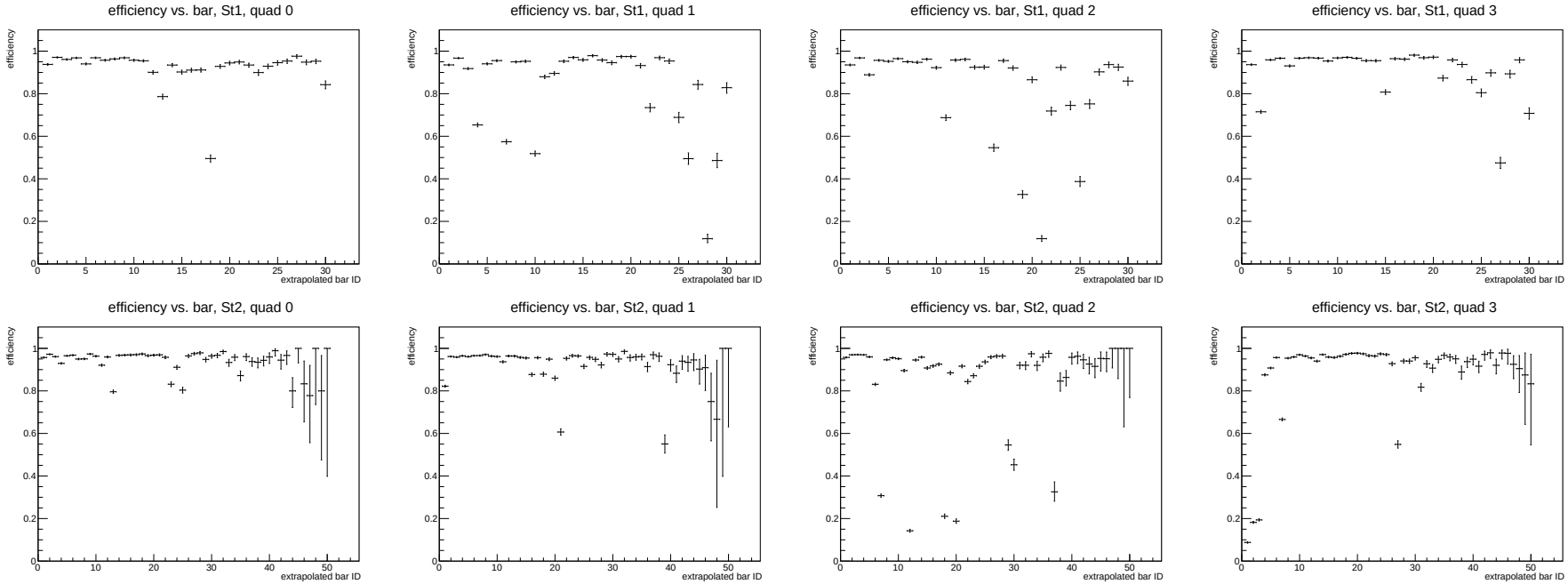
- Constructed in quadrants ($4 \times 4$ ft boxes, light-tight); quadrants are bolted together using 1.5” 80-20 hardware and supported by I-beams
- Coverage: both stations are dead $|y| < 7.5$ cm
  - St-1: $|x| < 80$ cm, $|y| < 80$ cm
  - St-2: $|x| < 100$ cm, $|y| < 100$ cm

# Fine-grained hodoscopes: basic design

- Extruded scintillator bars with wavelength-shifting fiber+SiPM readout
  - St-1: 1 $\times$ 1 cm bars, 80 bars/quadrant
  - St-2: 2 $\times$ 2 cm bars, 50 bars/quadrant
- Preamps push analog signals out over coax to LeCroy 4413/4416 discriminators, same as other hodoscopes



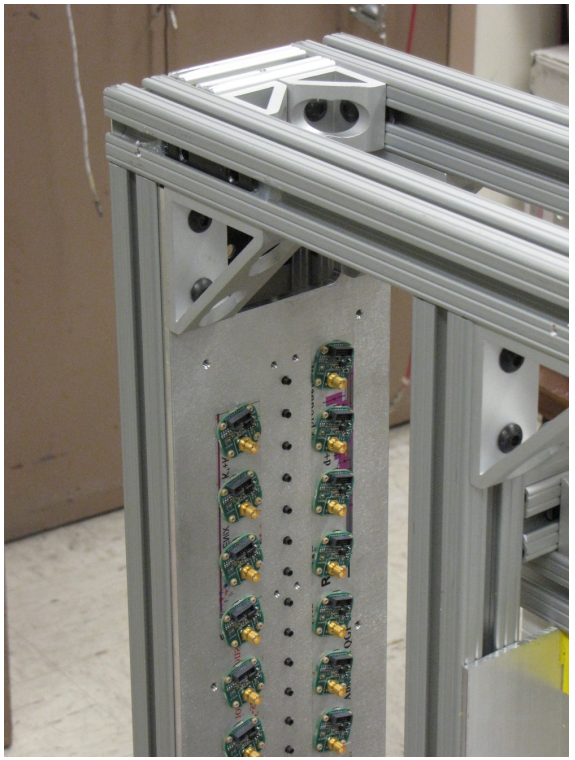
# Fine-grained hodoscopes as of July 2018




- Bad channels: 21/120 (+200 uninstrumented) St-1, 18/200 St-2
- The outer 50 channels in each St-1 quadrant are not connected: tested before installation, fully cabled, but coax cables do not go to 4413's
  - Not used for the displaced-vertex trigger, but would be needed for a target/dump separation trigger

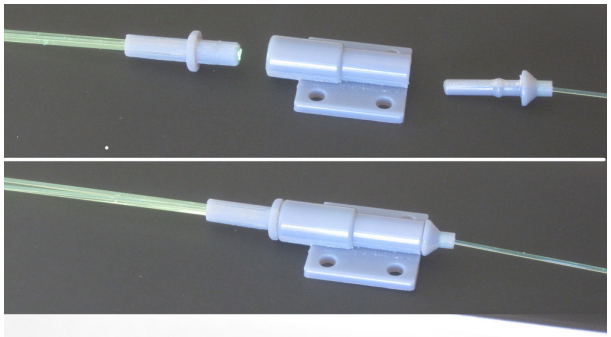
# Plan for the fine-grained hodoscopes

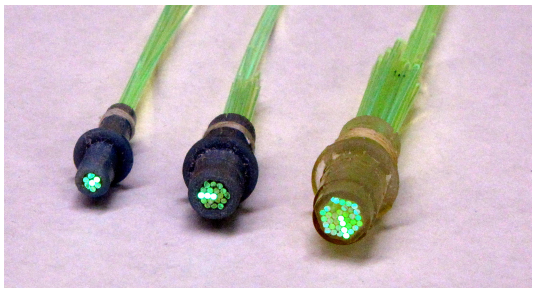
- Fix bad channels
  - We don't think we have any completely dead channels, they just have low amplitude/efficiency
  - Before installation, all channels were checked on a scope for visible response to LED pulser and cosmics (no requirement on the amplitude — takes too long with cosmics, LED pulsers are not calibrated)
  - Likely problem (also seen in bench tests): optical coupling from WLS fibers to SiPMs'
  - Wiggling the fibers has worked in the past; optical grease should make things more consistent
- Connect and re-test the remaining St-1 channels

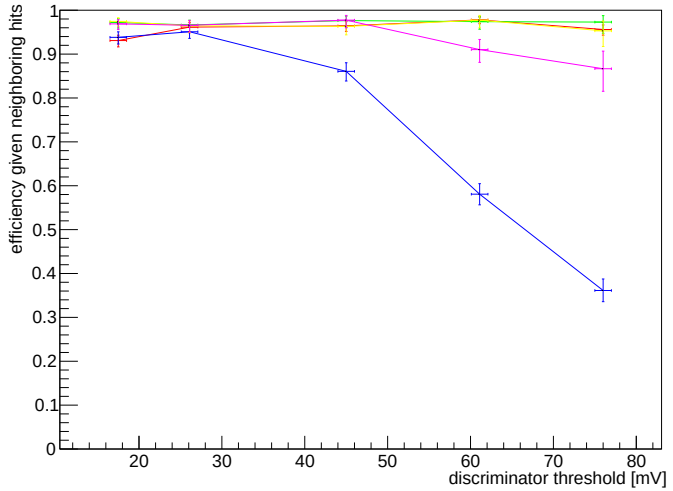


# Testing tools

- LED pulser: each LED is connected to 19 bars through a splitter
  - The splitters were not designed for perfect uniformity, but we see similar amplitudes between bars pulsed from a single splitter; we see large variations between different splitters
  - With oscilloscope, this tells us when the detector response changes as we tweak the optical coupling
- Cosmics: use V1495 trigger+readout to measure efficiency as a function of bias or threshold (as seen on right)
  - Final test of detector efficiency and signal margin







# Getting to the fibers; plan

- Access through the side edges of the downstream faces of the hodoscopes
- Station 2 is accessible by Lift-A-Loft, station 1 must be craned out (easier while Colorado chamber is out)
- Plan: work on station 2 in situ, then fix station 1
  - Expect O(2 weeks), with local support for crane lifts