
SPECIAL PROJECTS
MCMXCVII
Monnier Group

Overview

- Testing of CHARA Coatings
  - Nathaneal England (UM)
- Long Fiber Experiment
  - Matt Anderson (GSU), Kenny Ozdowy (UM), + OHANA friends (Woillez, Perrin)
- Etalons for Binary Ultra-Orbits
  - w/ Keith Jackson (UM), Mike Ireland, Nuria Calvet
  - Discussed already earlier today…

Project 1. Coating Tests

Background:

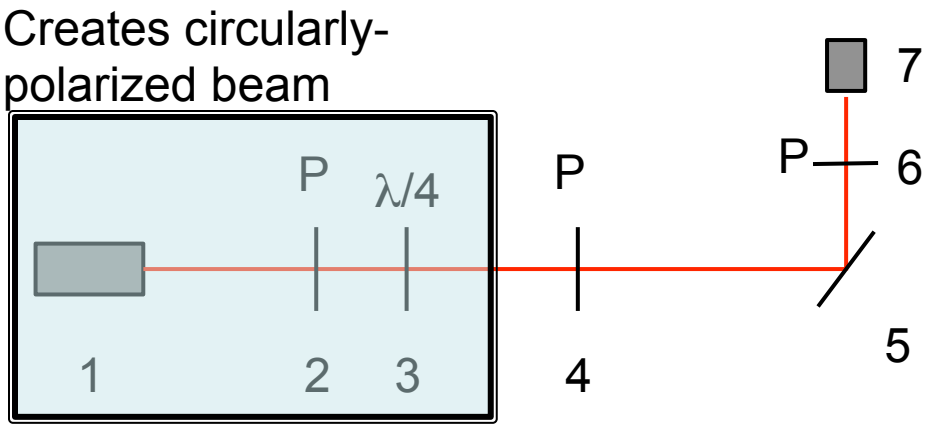
- Possible polarization problems in CHARA beamtrain were discovered in 2007 (VEGA), 2008 (MIRC), 2009 (MIRC photometric channels), PAVO (2010, wiggles), FLUOR (2013)
  - Suggestion of 20-30% linearly polarized (H band) that rotates with coude train
- Part of problem was likely unmatched silver coating in Coude train, for example less problem for intra-arm baselines, mainly inter-arm baselines
- Possible limitation for precision closure phase study (Zhao et al)

Testing Plan:

- Witness pieces started to be taken with primary mirror coating runs for 2011, 2012, 2013
- Monnier group volunteered to attempt to measure the visible and NIR polarization properties in order to allow reliable modeling of system

Methods

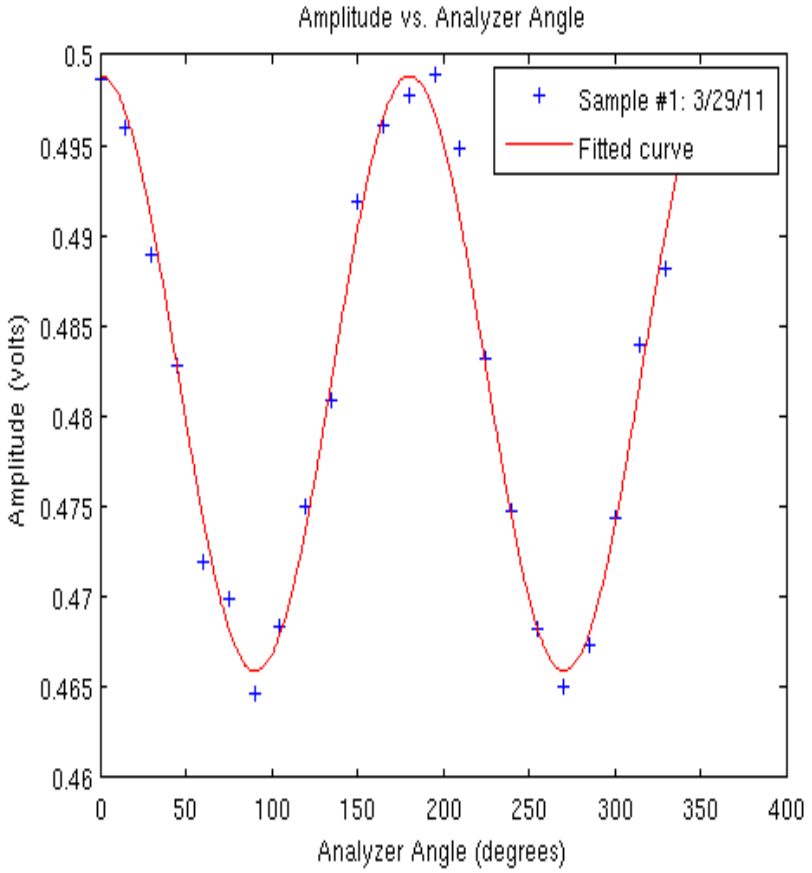
- 1. Laser Source
- 2. Polarizer
- 3. Quarter Wave Plate
- 4. Polarizer
- 5. Sample
- 6. Polarizer
- 7. Detector
- Rotate polarizer (4) by 15°
- Take measurements of voltage by rotating polarizer (6) by 15° from 0° to 360°
- Recalibrate every other measurement to get baseline

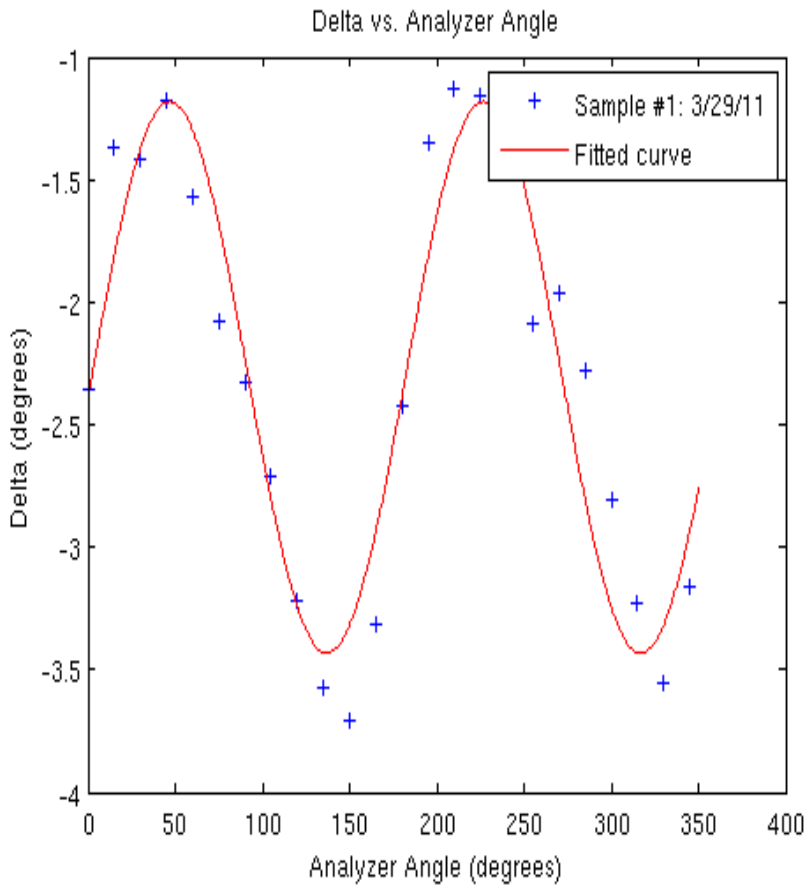


Analysis

- Interpolate calibration measurements
- Divide data by corresponding calibration value
- Plot data for polarizer (4) angle
  - Calculate mean and phase
- Plot both quantities vs polarizer angle
- Allows for two methods of determining birefringence

Example of Data





Complications

- Quarter Wave Plates
- Imperfect alignments
  - Mirror angle
  - Polarizer angles
- Bias in reading oscilloscope

Results

Coating	r_p / r_s @ 635nm		r_p / r_s @ 1550nm	
	Method 1	Method 2	Method 1	Method 2
2011a	0.967	0.962	0.962	0.976
2011b	0.967	0.963	0.96	0.976
2012a	0.964	0.959	0.978	0.978
2013a	0.968	0.957	0.973	0.977
MEAN:	0.967+/- 0.002	0.960+/- 0.003	0.968 +/- 0.009	0.977 +/- 0.001
SQUARED:	0.935	0.921	0.937	0.955

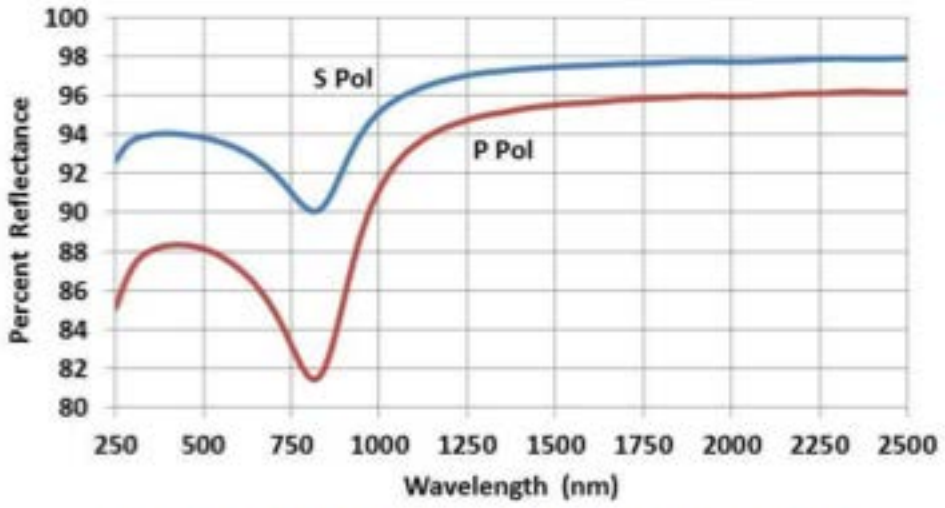


Figure 3. Typical spectra of an aluminum standard mirror at 45 degrees incidence, S and P polarization.

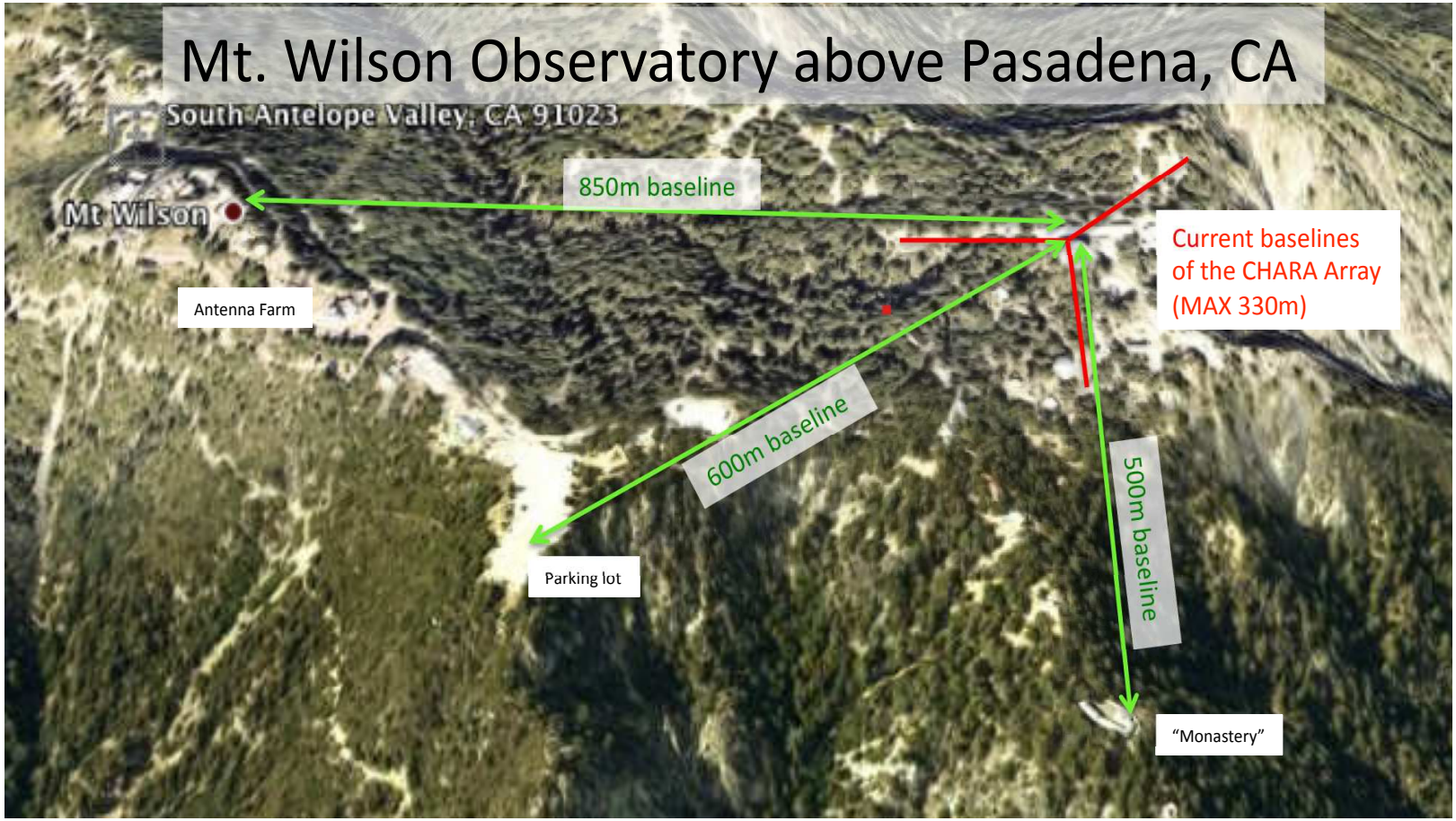
Expected@635nm: 93.5%
(compared to ours 92.1%)

Expected@1550nm: 98.0%
(compared to ours 95.5%)

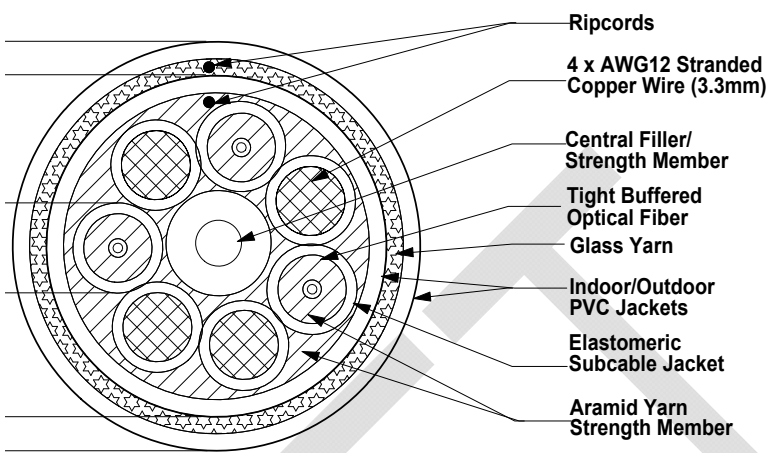
Polarization Conclusion

- Each reflection at 45 degrees can introduce a 4.5% (H band) to 7% (Red) difference in power between s and p-wave directions
  - IR is 2x worse than expected from standard reference
- We should work on a model
  - Could the combination of polarized rotating beam incidence on other polarized components downstream cause calibration issues?
    - E.g., dicroics, fibers, pick off mirrors?

Project 2: Long Fibers for CHARA



Composite Cables



Composite Cable w/ 3 fibers and 4 wires

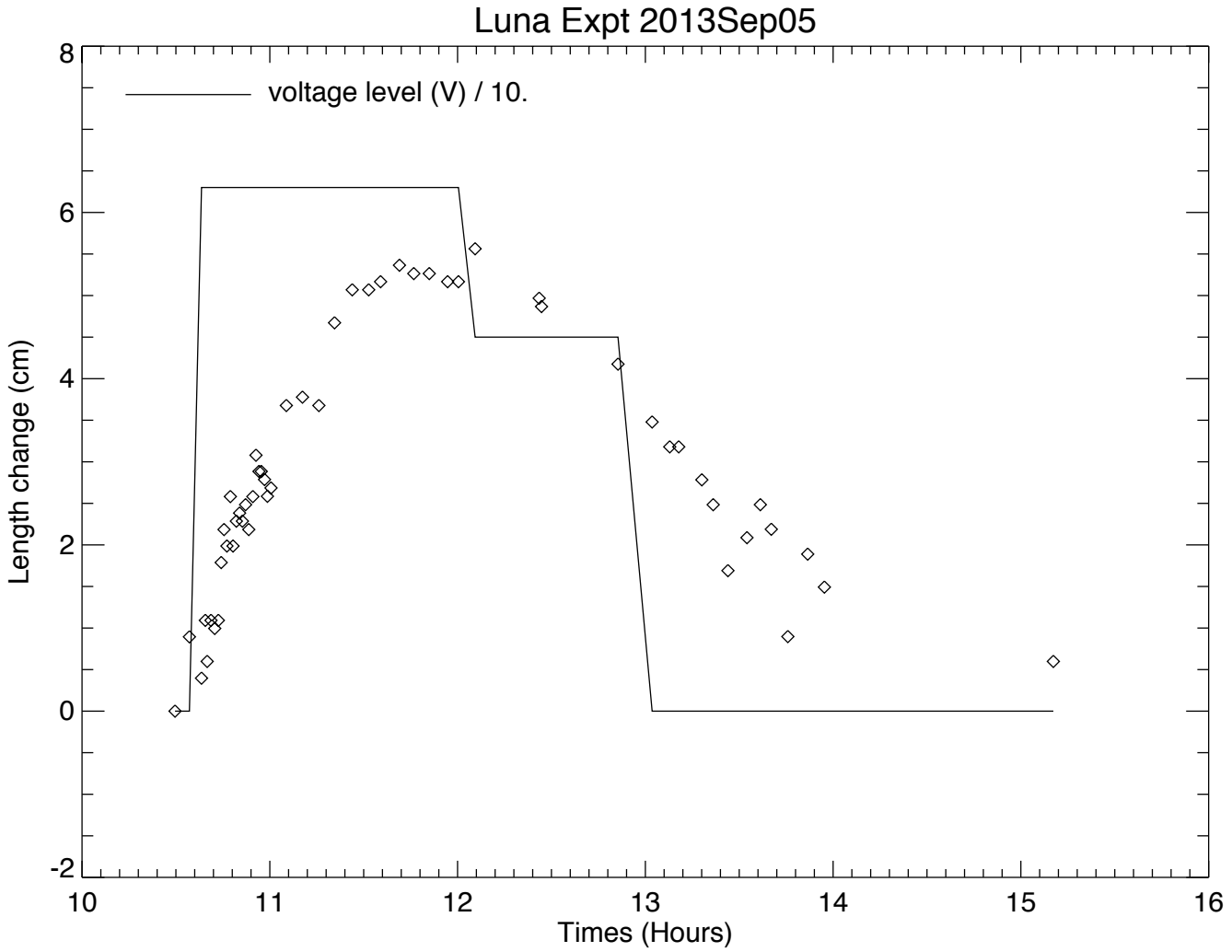
- Three spools of ~500m each
- Two fibers are specialty PM IR fibers

Matt Anderson (GSU) setup lab experiment

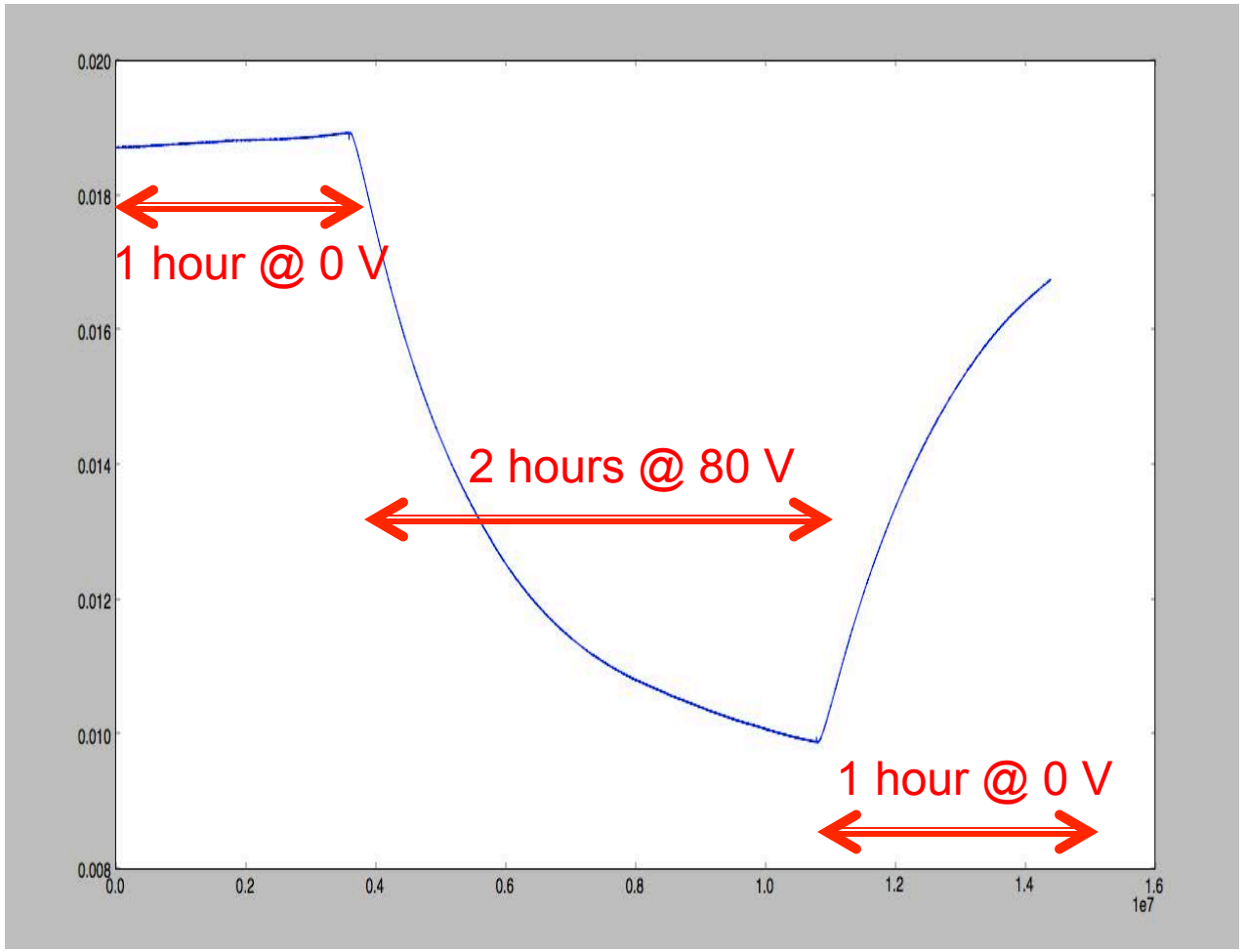
- First fringes 8/29/2013

Funded by UM internal fund ($100K)

New method for thermal control

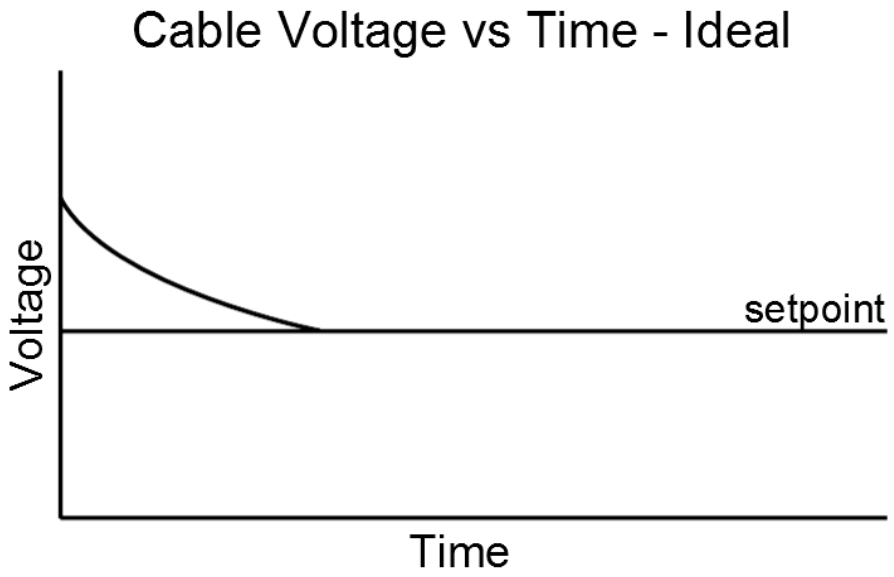


New method for thermal control

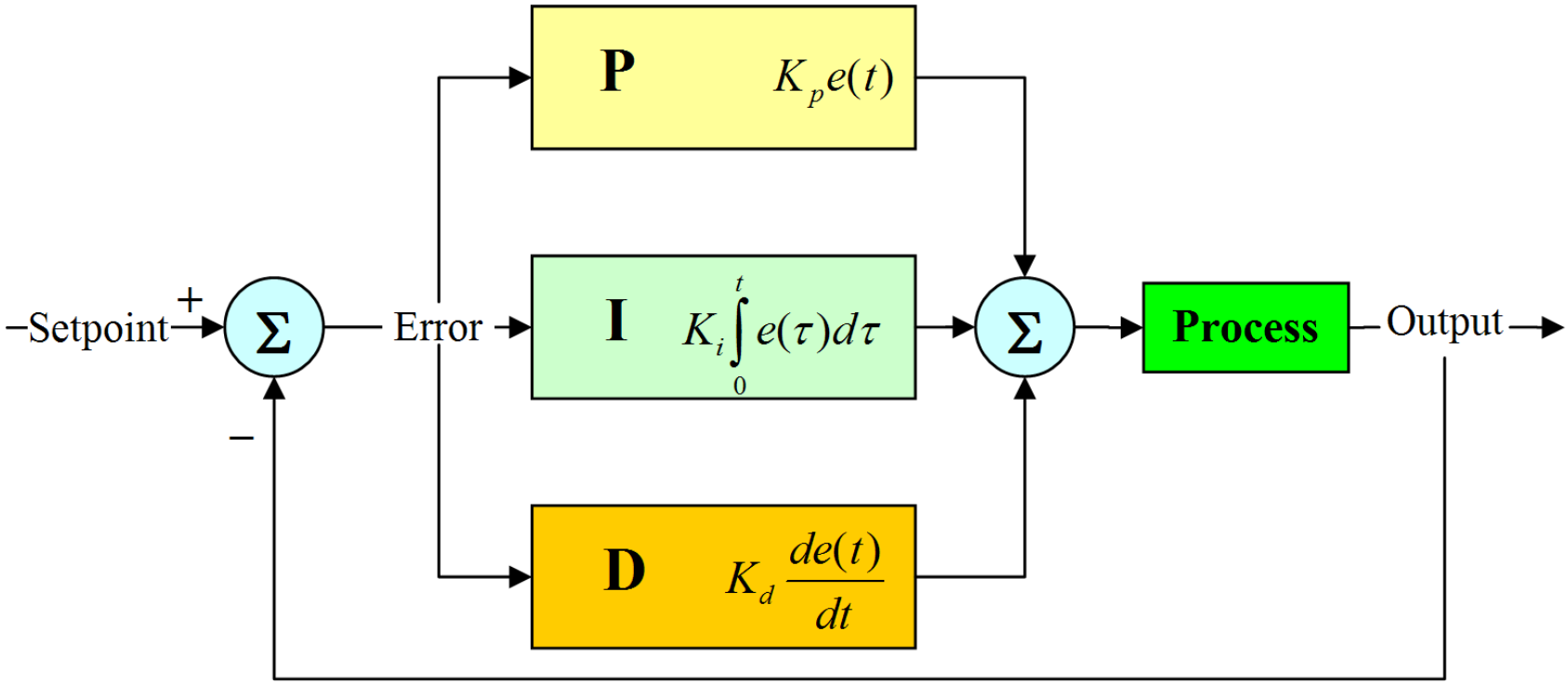


Goal: Equalize length of cables

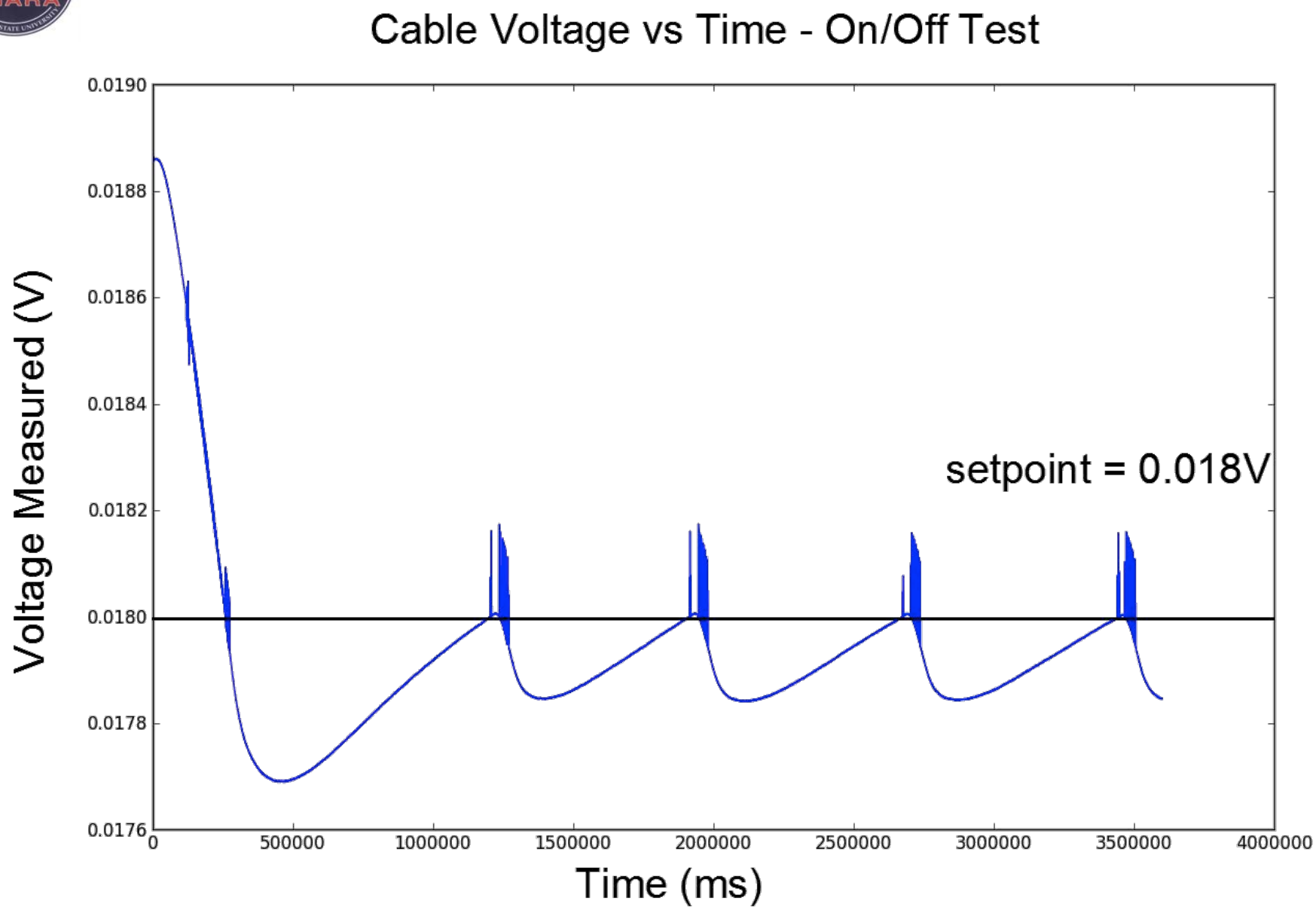
- Sending voltage through adjacent wire
- Using PID loop to control output voltage
  - Proportional: error value
  - Integral: total change over time
  - Derivative: How fast it is changing



PID Loop Diagram



http://radhesh.files.wordpress.com/2008/05/pid.jpg


Cable Voltage vs Time - On/Off Test
Voltage Measured (V)
0.0190
0.0188
0.0186
0.0184
0.0182
0.0180
0.0178
0.0176
setpoint = 0.018V
0
500000
1000000
1500000
2000000
2500000
3000000
3500000
4000000
Time (ms)

Conclusions

Fiber Lessons learned and Plans:

1. AC heating causes fiber vibrations due to changing forces between neighboring wires (DC heating ok!)
2. Vibrations in building cable tray equivalent to bad seeing, requiring fast scanning
3. Resistance measurements appear to track temperature with high precision
4. We still need CLEAN white light fringes to test full system and feedback control (Laser diode results were confusing)
5. Lab experiments will continue after move to new building and will motivate new grant to try ‘on sky’ work taking advantage of new “Fiber port” on CHARA adaptive optics bench

The End!