Fiber Phase Stability Status

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September 8, 2003

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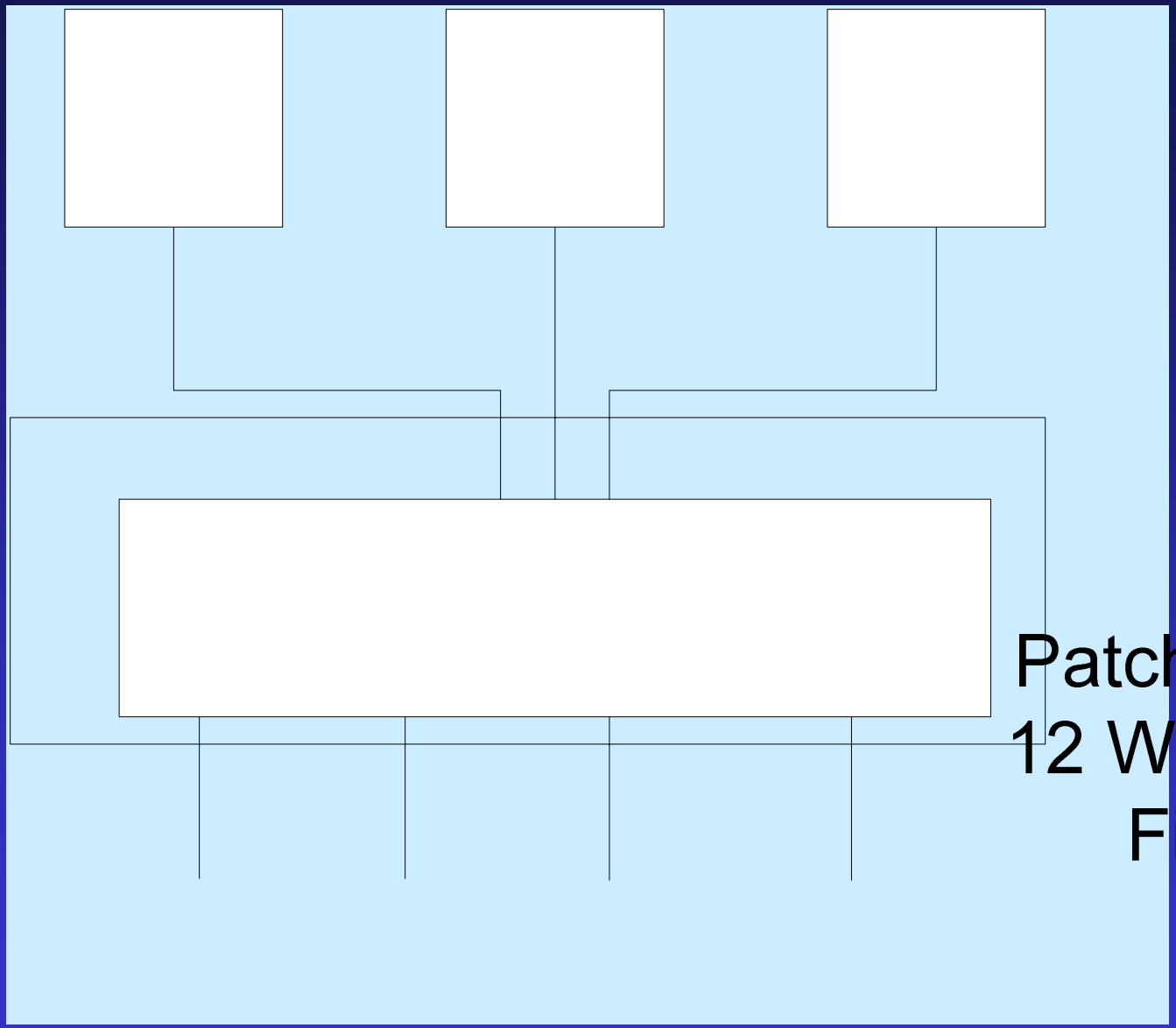


I F
Patch Panel
12 WDM per
Fiber

74 Fi

OFS BrightWave Cable

- Double armor loose tube cable
  - Corrugated, copolymer coated carbon, steel tape applied longitudinally
- Polyethylene jacket
  - 1.4 mm Outer, 1.2 mm Middle, 1.0 mm Inner
- Glass/epoxy composite dielectric rod core

Cable Cross Section

OFS Matched Cladding Fiber

- Matched cladding single-mode
  - Nonzero-dispersion optical fiber
- Gel-filled buffer tubes
  - Installed in a reverse oscillation lay
  - 12 fibers per tube

OFS Matched Cladding Specifications @ 1310 nm

- Attenuation coefficient: 0.31-0.35 dB/km
- Chromatic dispersion: -9 ps/nm-km
- Dispersion slope: 088 ps/nm^2-km
- Group index of refraction: 1.471
- Polarization M dispersion: $\leq$0.5 ps/(km)$^{1/2}$
- Rayleigh Backscattering: -49.6 dB
- Coefficient of Expansion*: 6 PPM/˚C

* NRAO Estimate

LO Technical Requirements

Based on the Scientific Goals after all Round-Trip Corrections

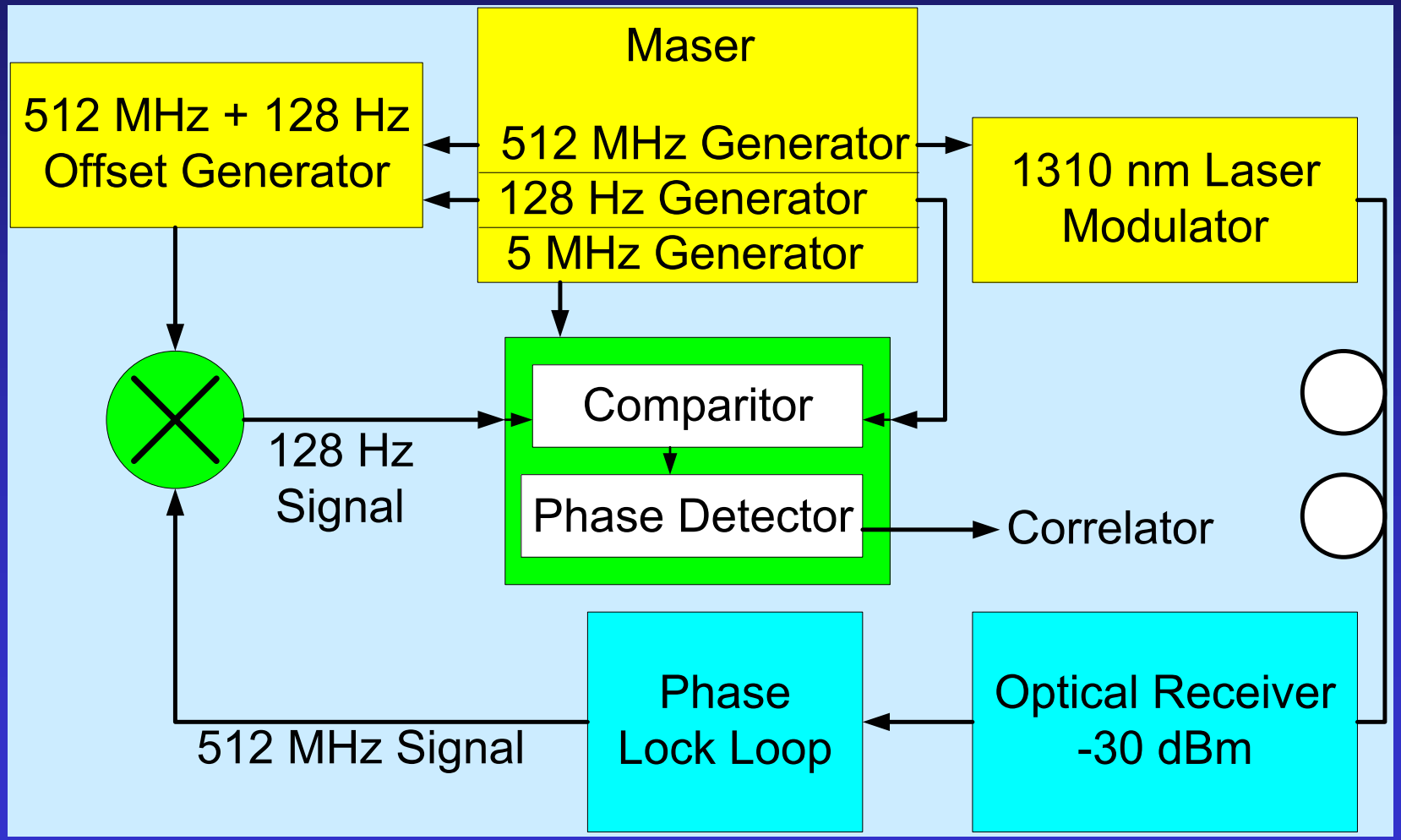
- Short Term: < 0.5 ps RMS per second
- Long Term: < 1.4 ps per 30 minutes
  ~20 degrees at 40 GHz
- Delta Slope: < 0.2 ps change per minute
  Over 30 minutes

Phase Error Allocation

- Front End 0.4 ps per 30 Min
- LO Converters 0.6 ps per 30 Min
- Fiber System 0.4 ps per 30 Min
  - RTP measurement accuracy* 0.05 ps
  - 512 MHz + 128 Hz jitter* 0.1 ps
  - Fiber induced errors 0.25 ps

*NRAO estimates

Round Trip Block Diagram

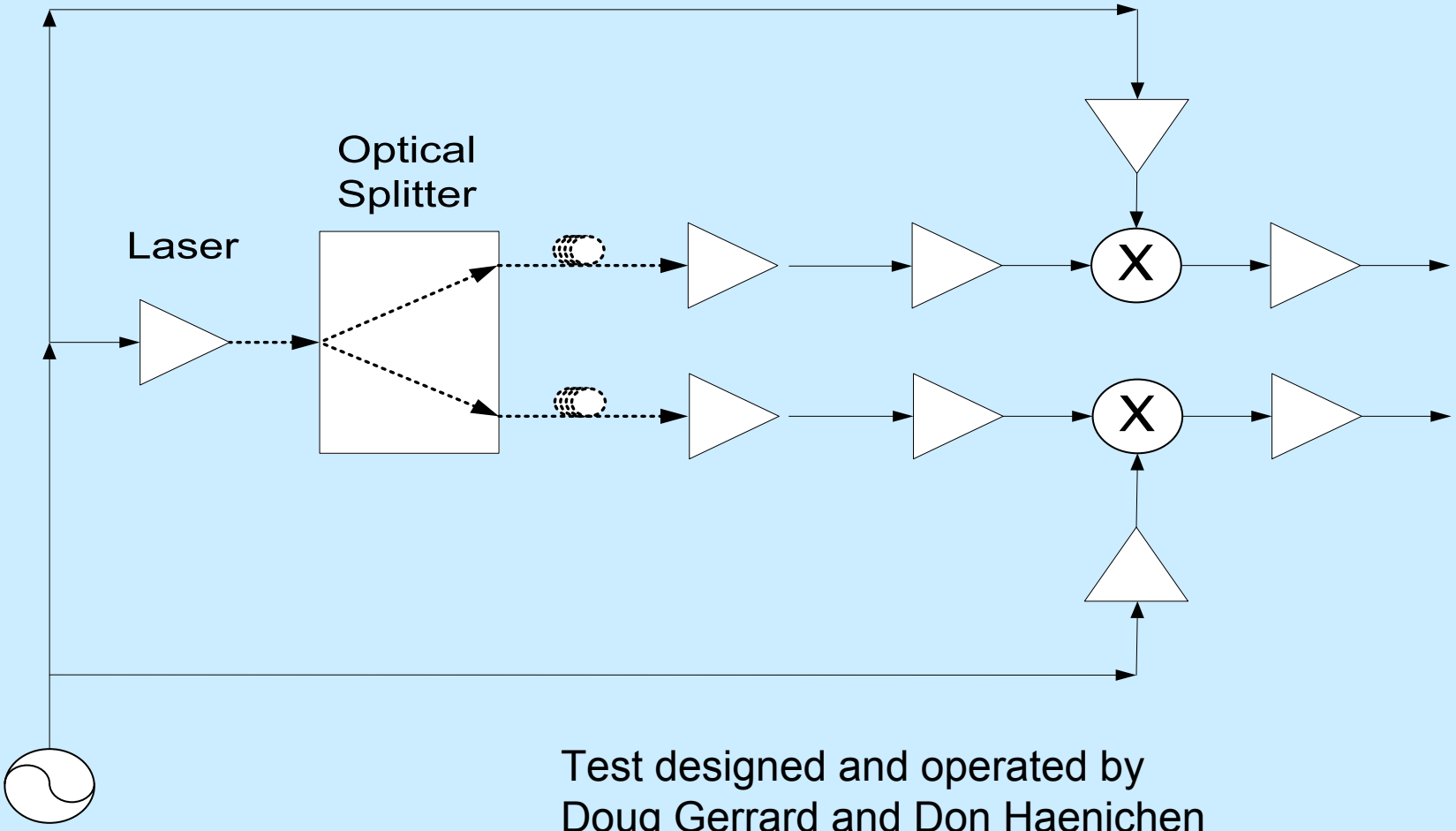


Verification

- Is the magnitude and rate of change of the phase caused by the 22Km tolerable?
- How identical are the two fibers used in the round trip phase measurement system?

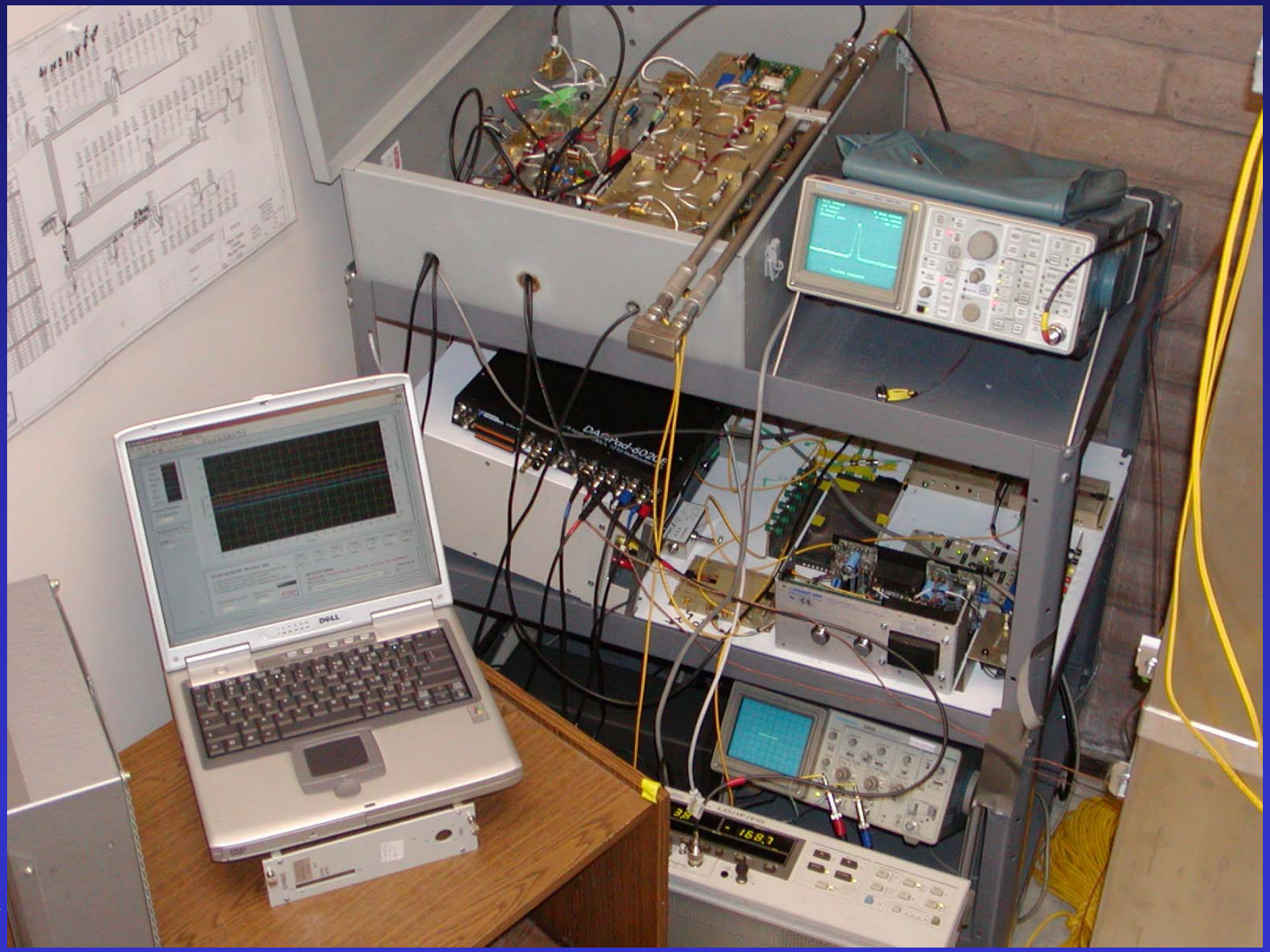
  Or Is the un-compensated difference in phase uncertainty tolerable?

RTP Test Setup

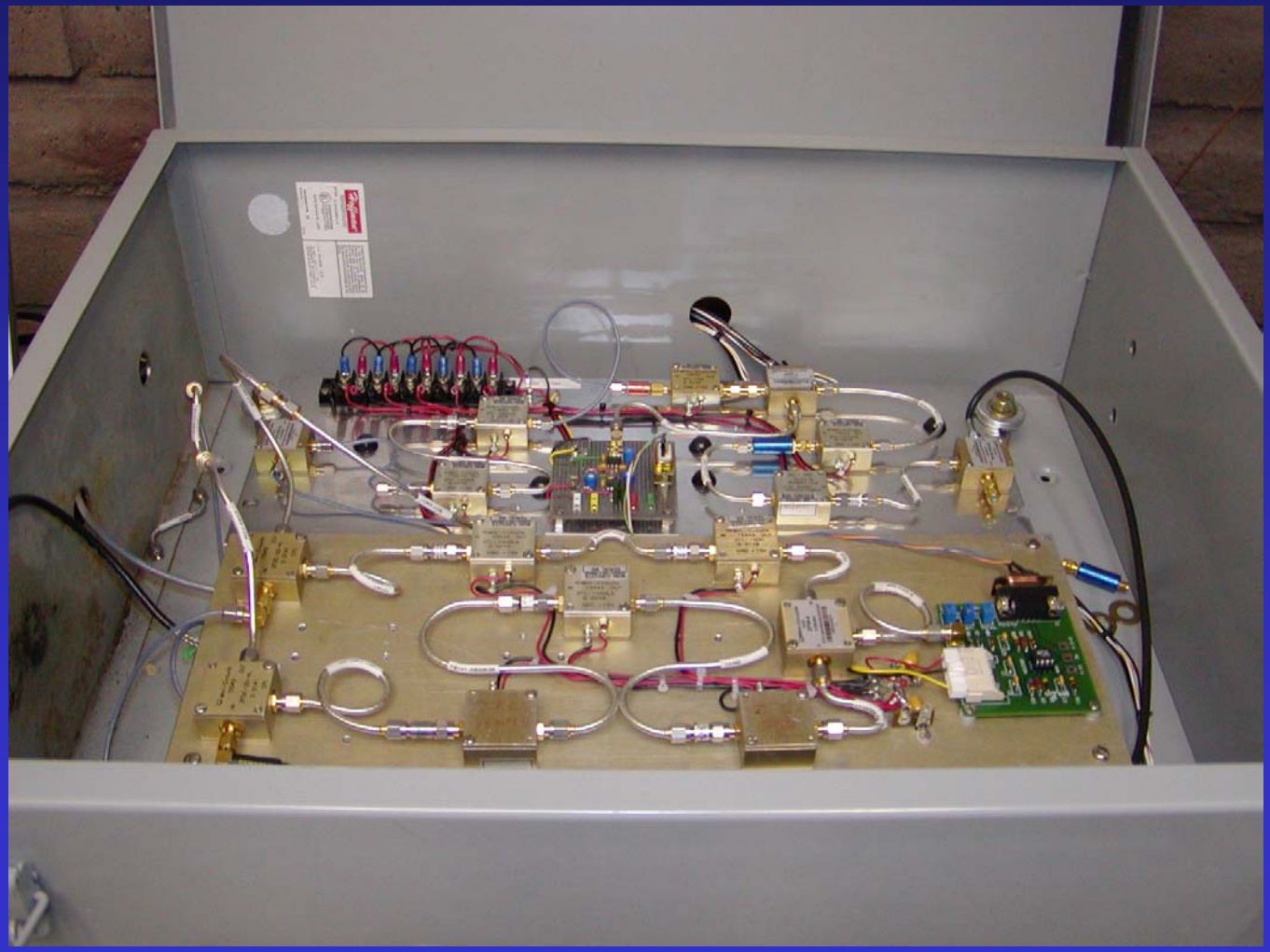


Test designed and operated by
Doug Gerrard and Don Haenichen

RTP Test Hardware

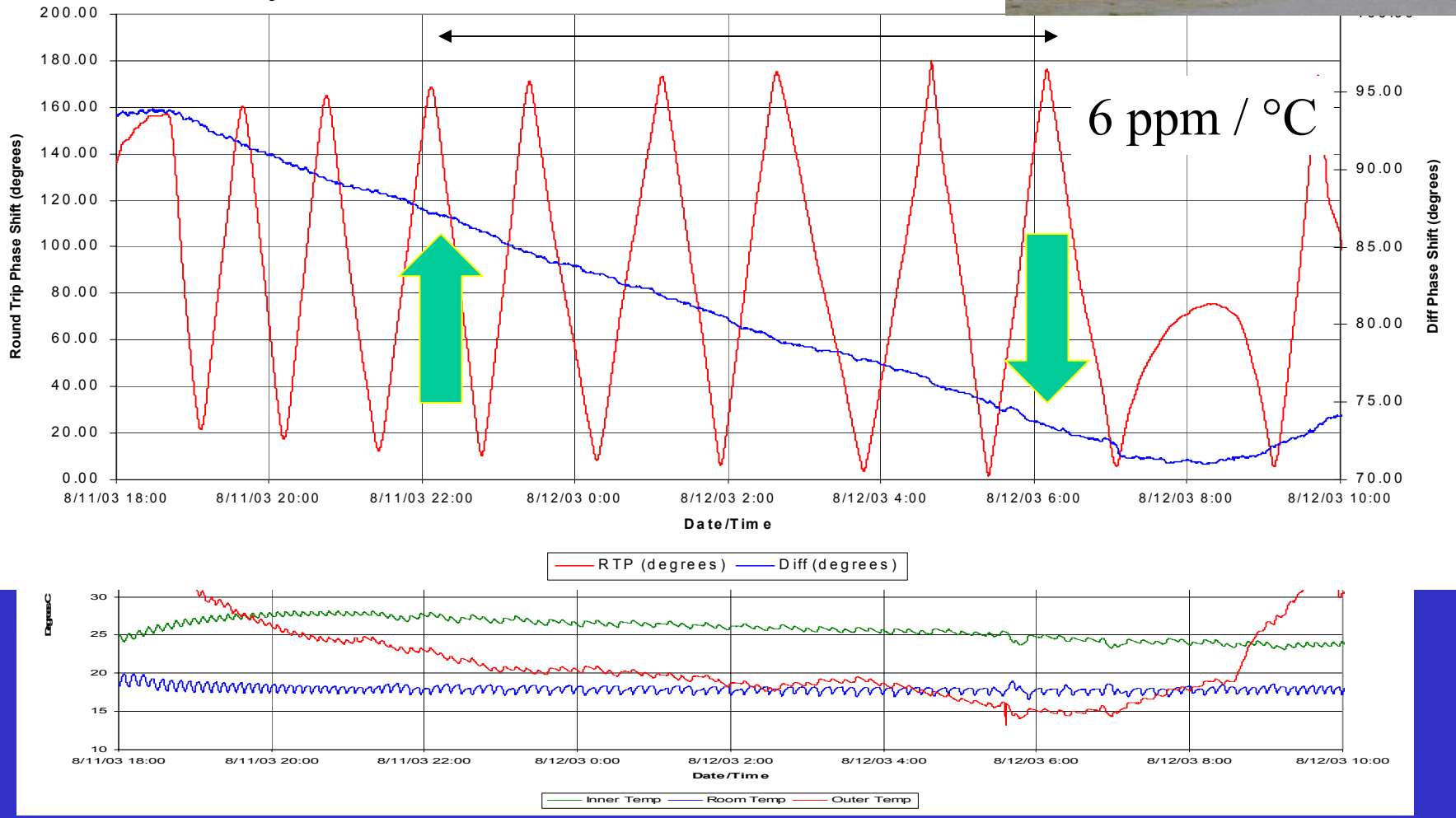


Analog Mixer as a Phase Detector



65 Km Spool Test

5 cycles X 360° / 13° = 137 Ratio



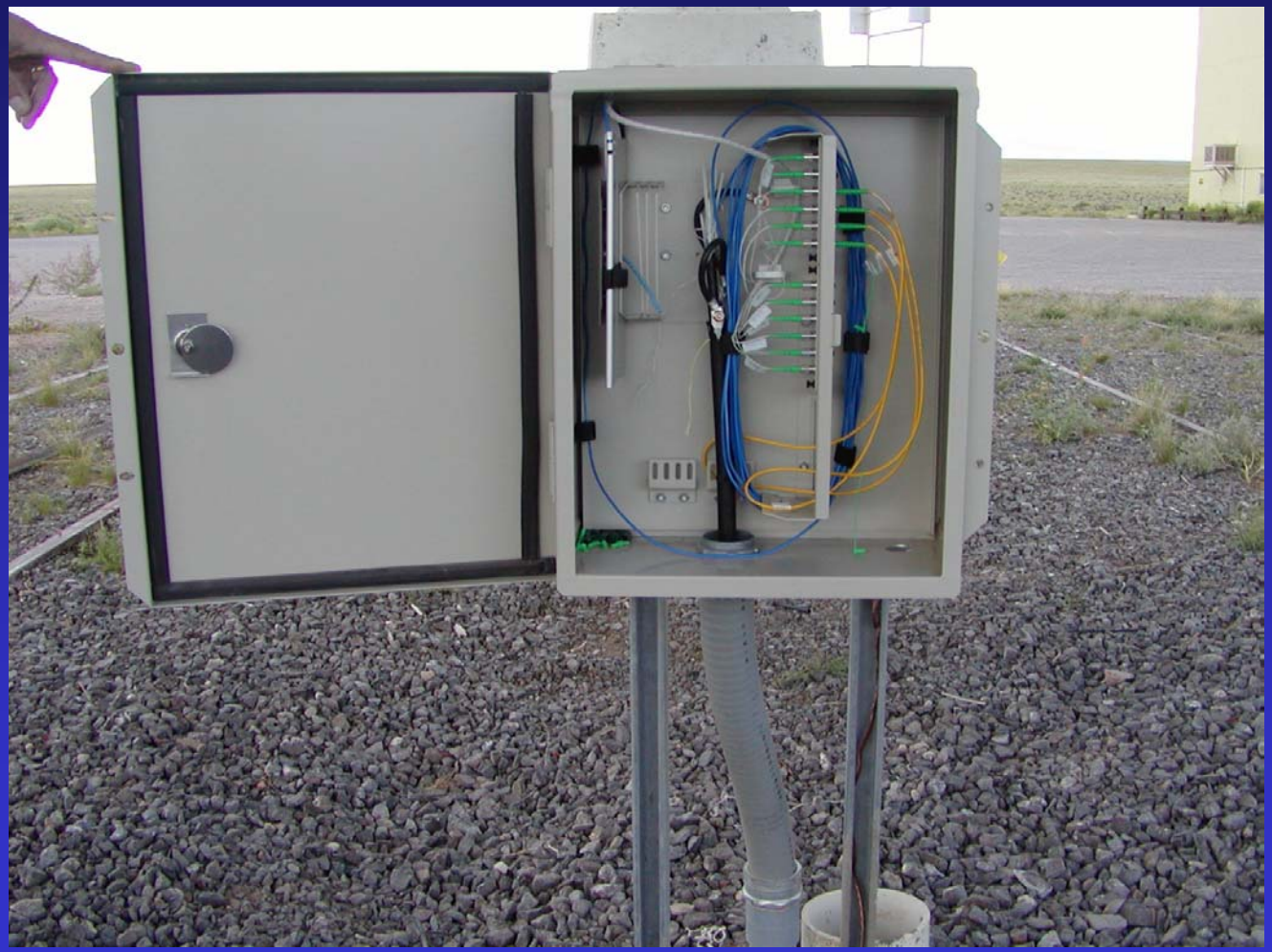
Calculated Temperature Effects on Phase

- 22 Km Length Change per (6 ppm / °C)
  - 30 minutes = 5.4 um → 0.028 ps
  - 6 months = 1.4 m → 6677 ps (3.4 cycles)
- 30 meters in Control Building per
  - 30 minutes = 10.4 mm → 49 ps
- 28 meters up the Antenna per
  - 30 minutes = 10.7 mm → 51 ps

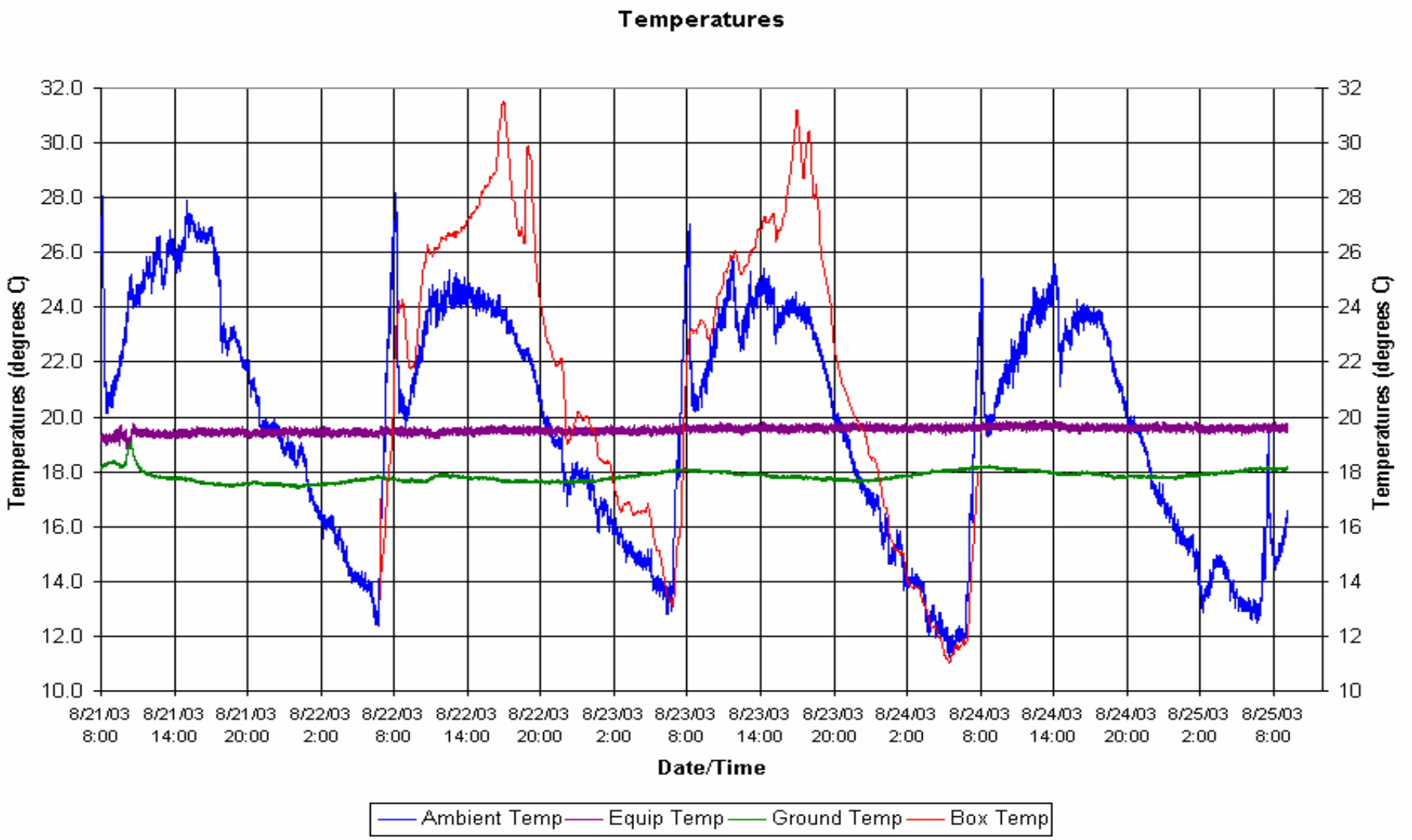
Total ~ 100 ps/30 min (EVLA Memo – 44)

(100 ps / 30 min) / (137 Ratio) = ~.73 ps / 30 min

Master Pad Fiber Enclosure

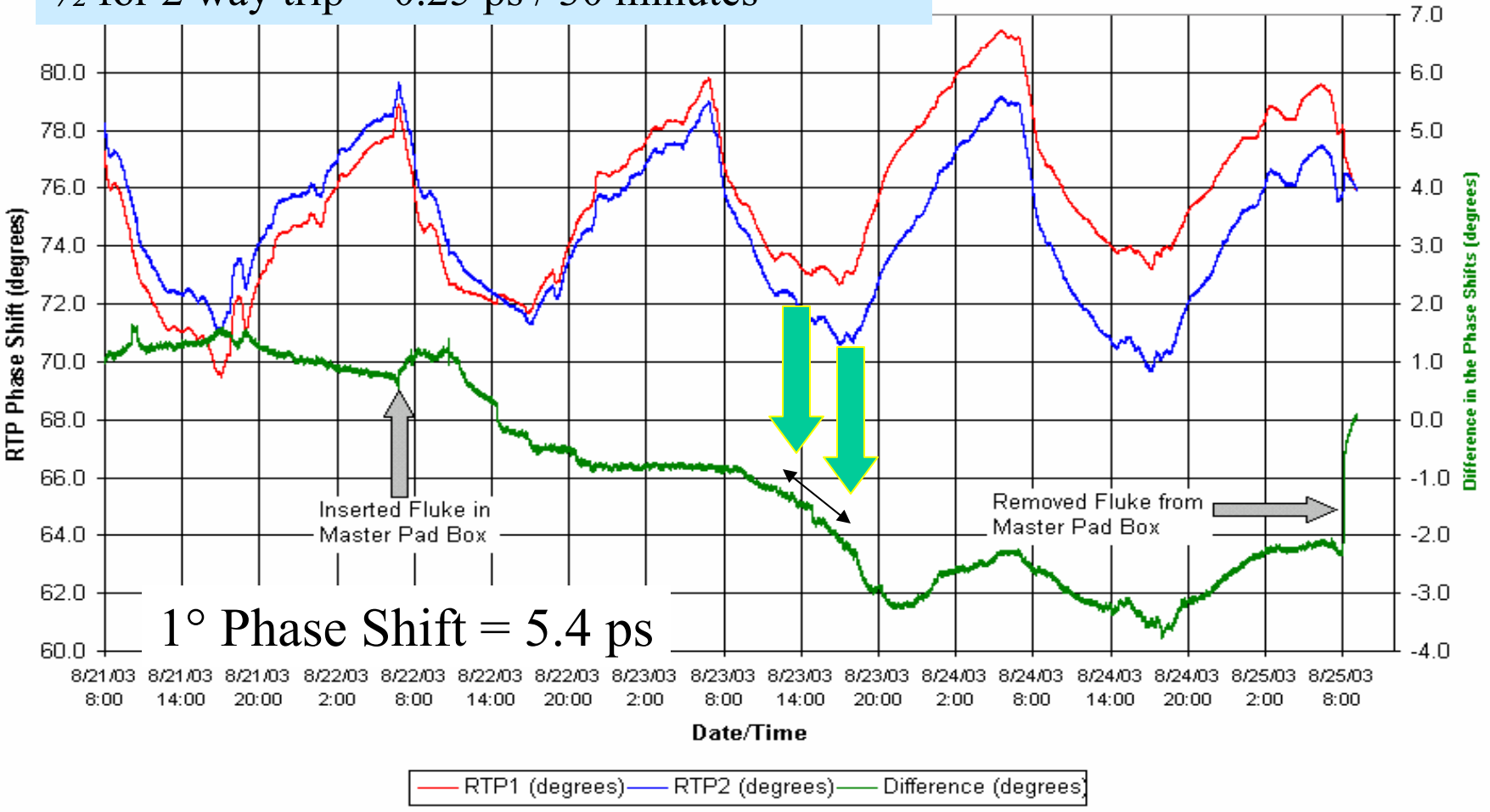


Fiber Enclosure Temperature



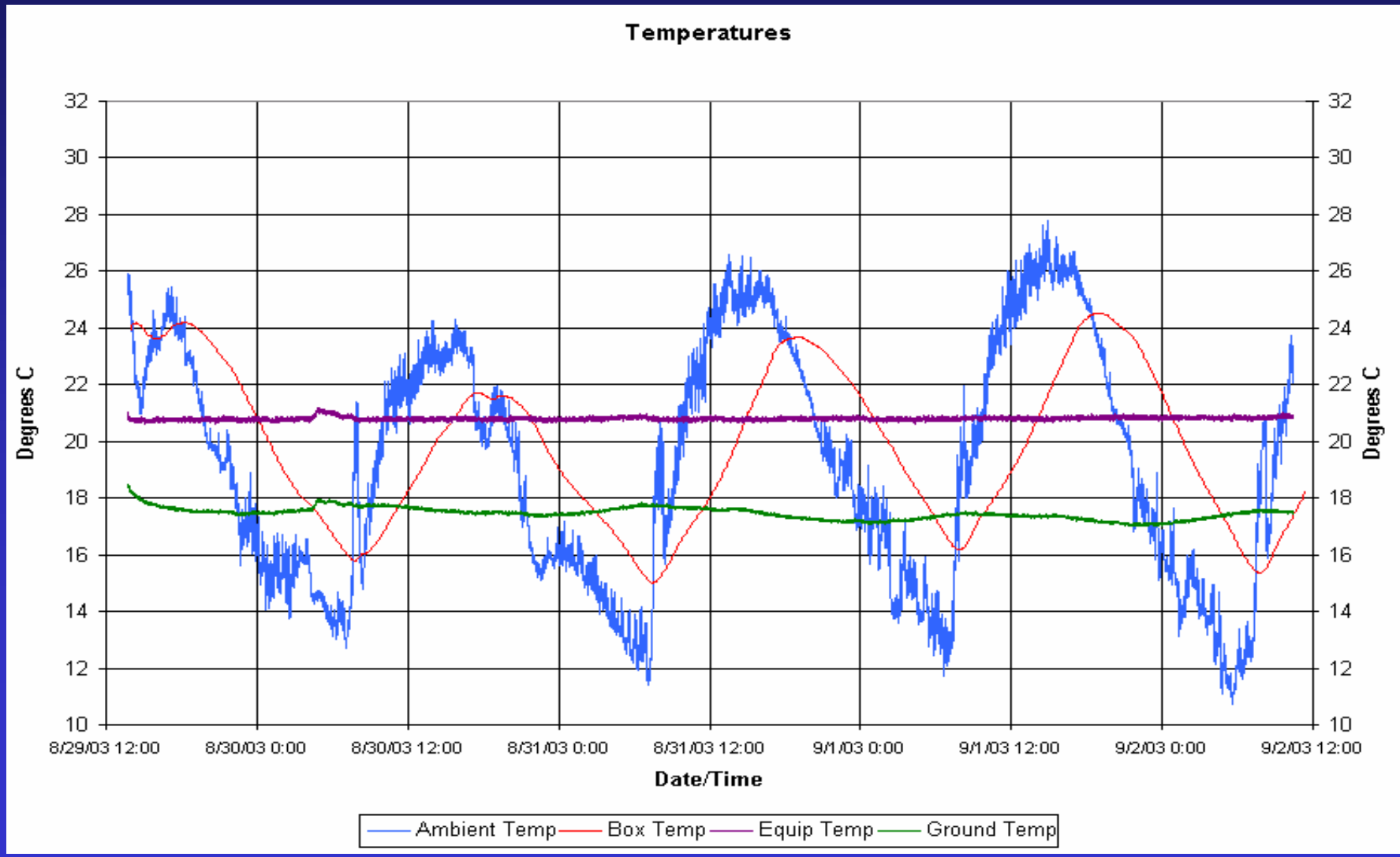
Master Pad Fiber Enclosure

Slope represents 0.5 ps / 30 minutes
½ for 2 way trip = 0.25 ps / 30 minutes

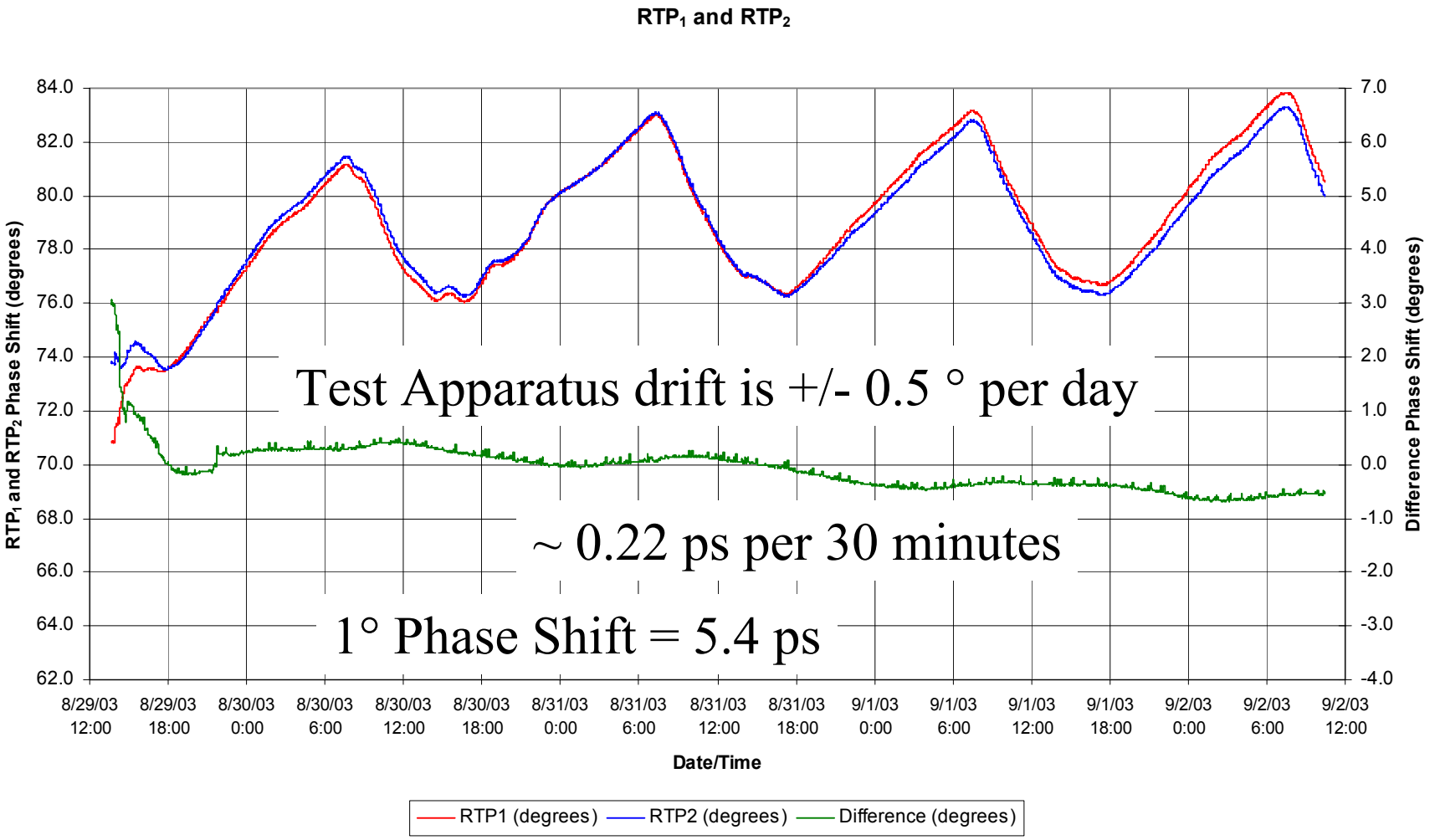


Master Pad Fiber Enclosure with Insulation

Insulated Fiber Box Temperatures



Insulated CB to MP



Cable Wrap Test Fixture

- Antenna
  - 540 ° Total
  - 40 ° / minute
- Test Fixture test results:

  < 0.5 ° shift

  @ 1.2 GHz

Conclusion

- The magnitude and rate of change of the phase shift caused by the buried 22Km is tolerable.

  6 ppm / °C or Total ~ 0. 028 ps / 30 min

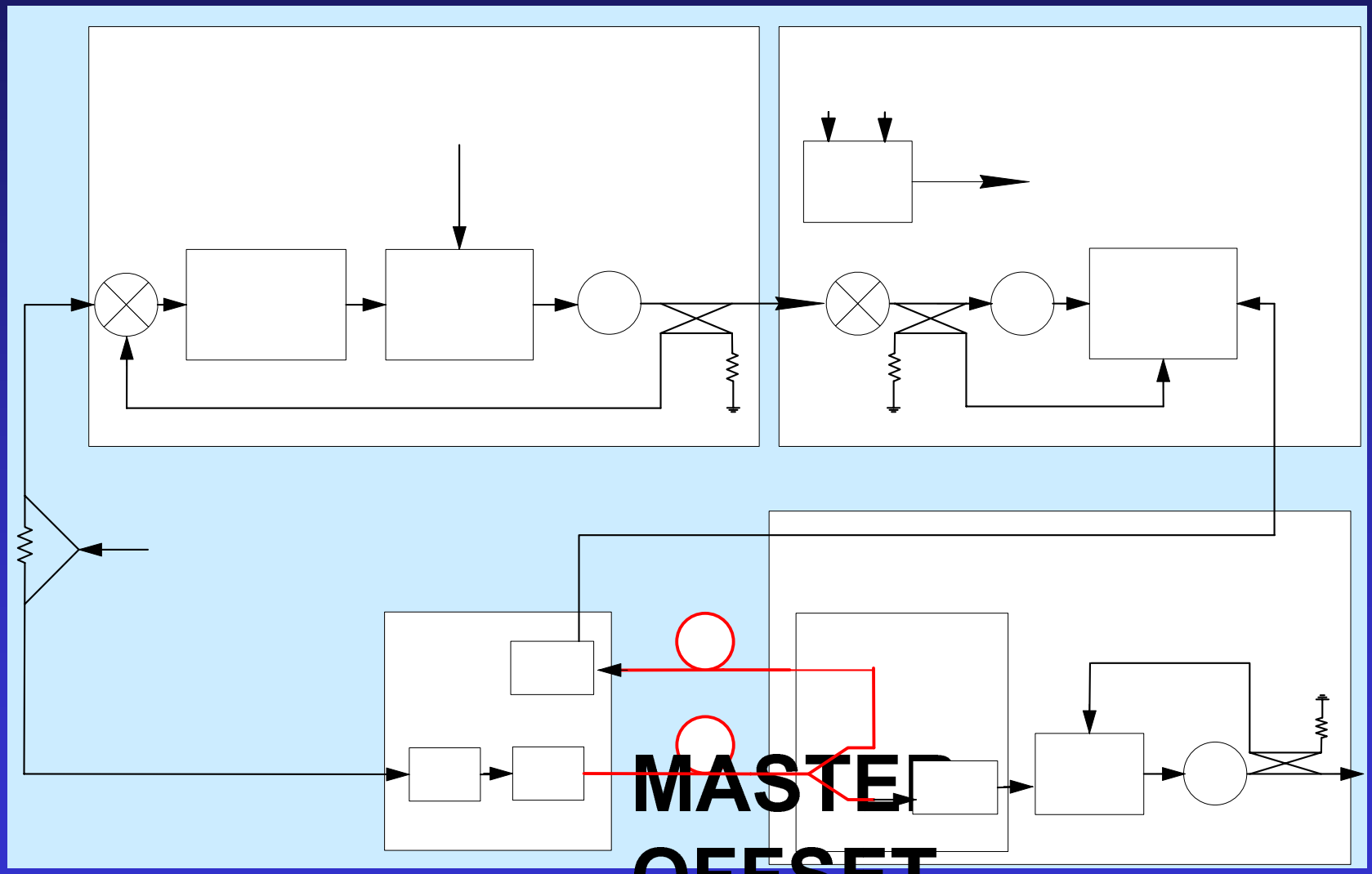
  ~ 3.4 cycles per 6 months

  May have a problem with CB and Antenna fiber
- The un-compensated difference of two fibers is

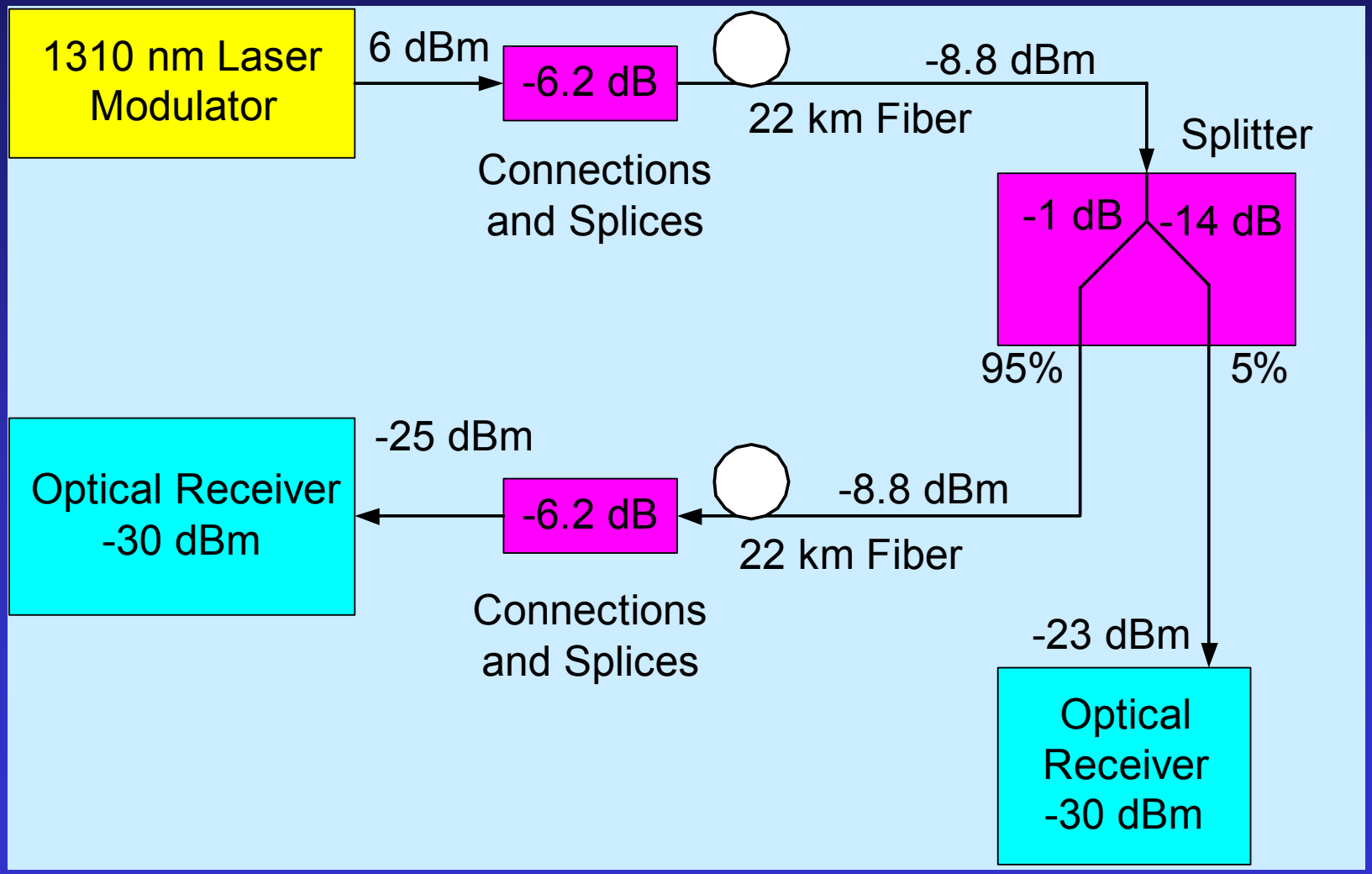
  Measured less than ~.73 ps / 30 min
- The cable wrap may also work.

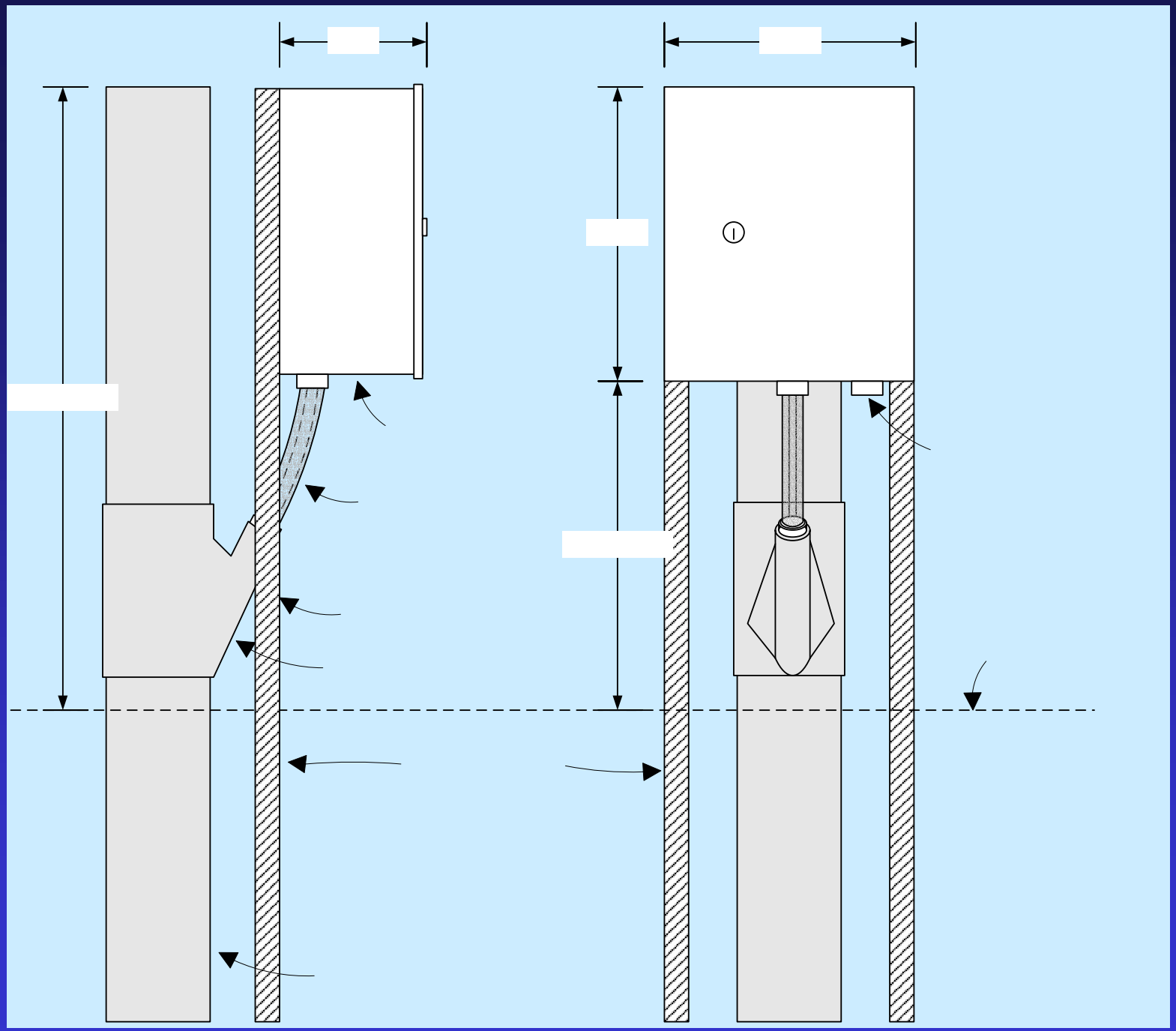
Elevation Cable Bend

LO Block Diagram



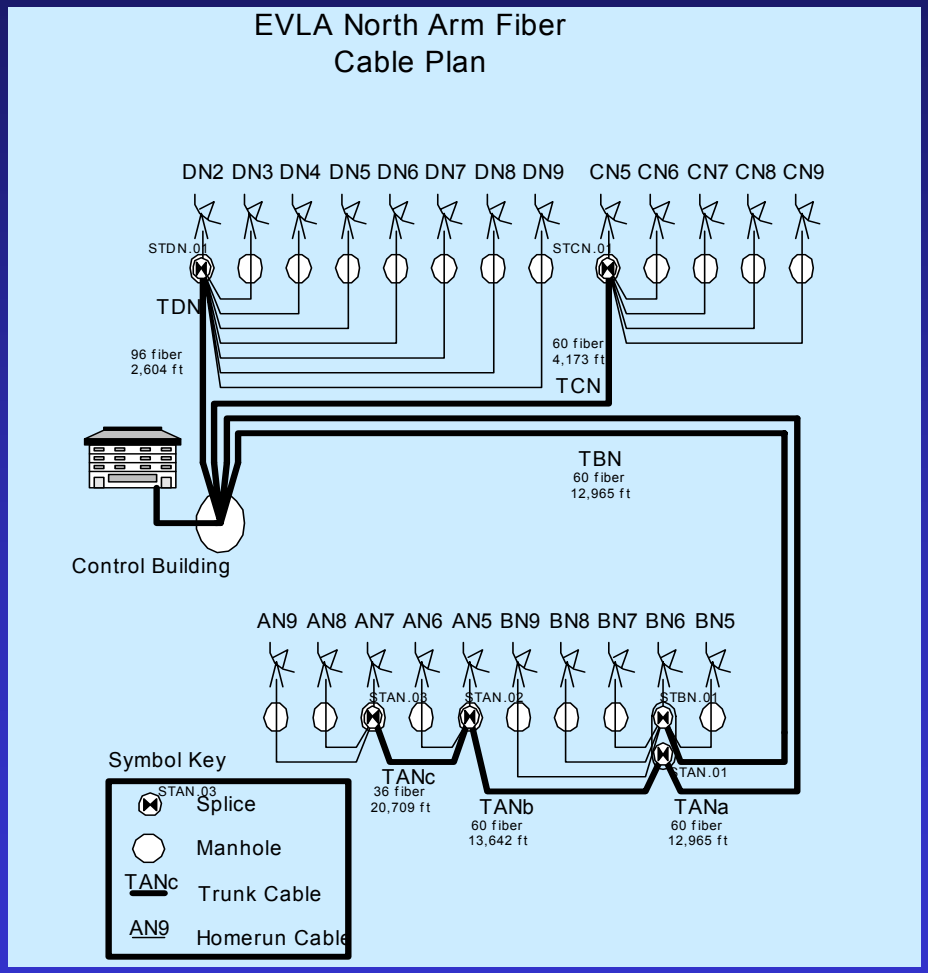
LO Optical Loss Budget

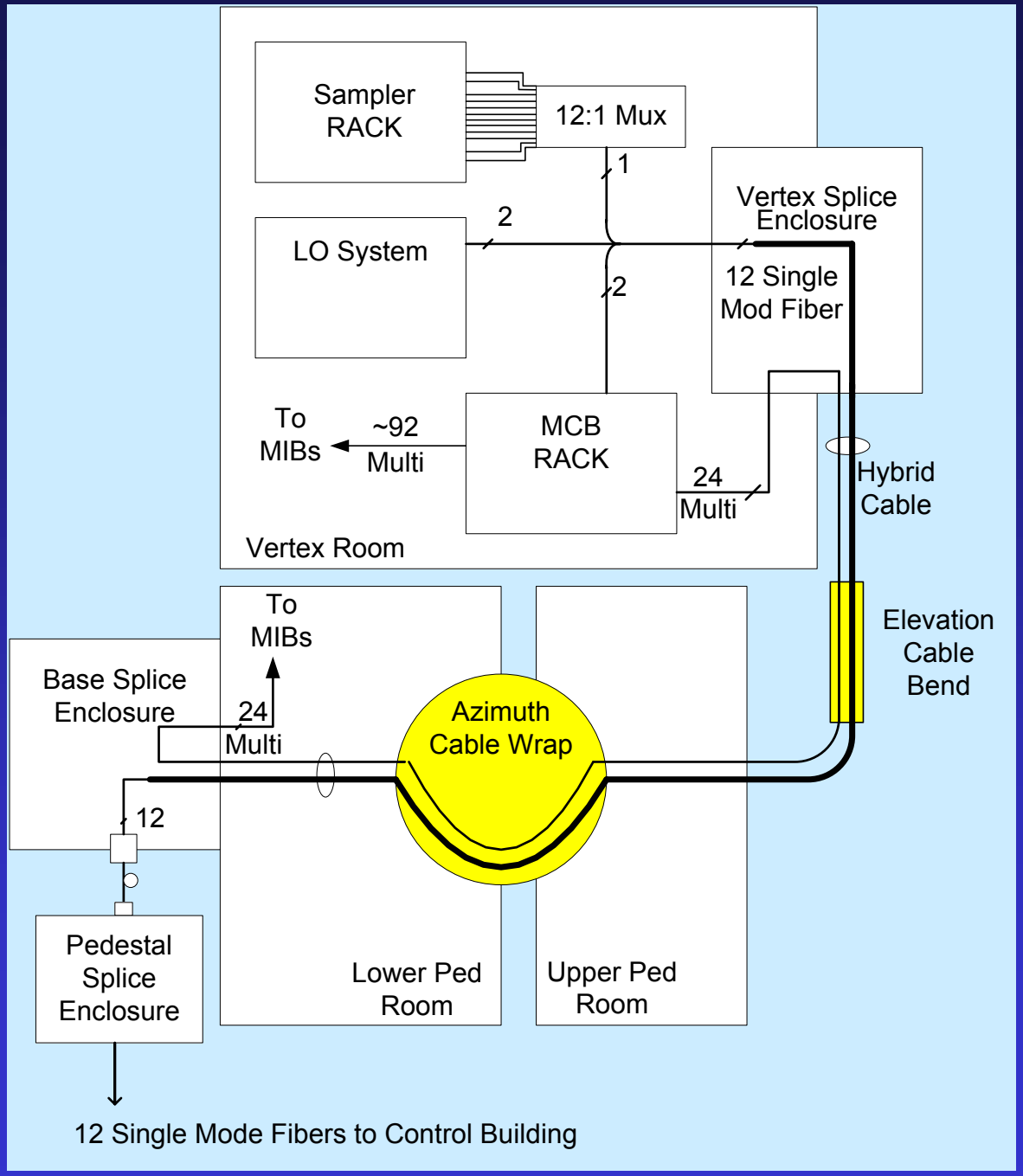




8.5in.

EVLA Fiber


EVLA North Arm Fiber
Cable Plan
DN2 DN3 DN4 DN5 DN6 DN7 DN8 DN9
CN5 CN6 CN7 CN8 CN9
STDN.01
STCN.01
TDN
96 fiber
2,604 ft
60 fiber
4,173 ft
TCN
TBN
60 fiber
12,965 ft
Control Building
AN9 AN8 AN7 AN6 AN5 BN9 BN8 BN7 BN6 BN5
STAN.03
STAN.02
STBN.01
STAN.01
TANc
36 fiber
20,709 ft
TANb
60 fiber
13,642 ft
TANa
60 fiber
12,965 ft
Symbol Key
STAN.03
Splice
Manhole
TANc
Trunk Cable
AN9
Homerun Cable


Sampler RACK
12:1 Mux
1
2
LO System
2
Vertex Splice Enclosure
12 Single Mod Fiber
To MIBs
~92 Multi
MCB RACK
24 Multi
Hybrid Cable
Vertex Room
To MIBs
Base Splice Enclosure
24 Multi
Azimuth Cable Wrap
Elevation Cable Bend
12
Pedestal Splice Enclosure
Lower Ped Room
Upper Ped Room
12 Single Mode Fibers to Control Building