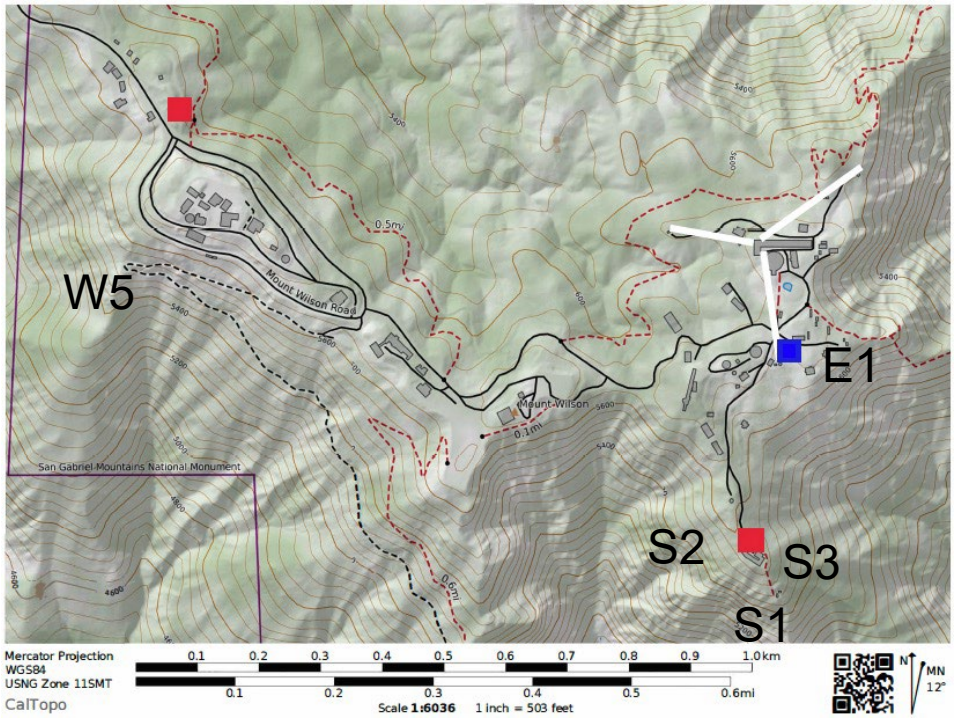
Progress: CHARA Michelson Array Pathfinder (CMAP)

Robert Ligon
eligon@gsu.edu

Goals of the Project

Goals:

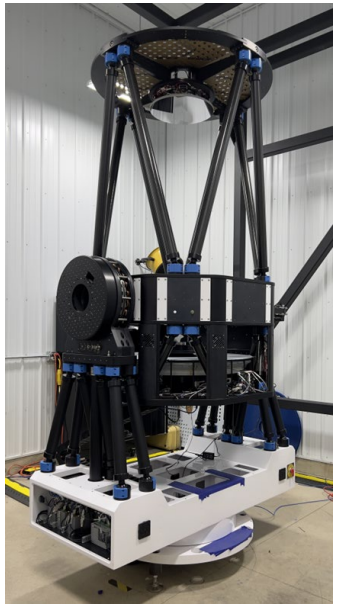
1. To show the capability to use fibers as the mode of transport for science by getting consistent fringes that can be calibrated for science use.
2. Build a mobile telescope with fiber transport to allow baseline flexibility to extend our capabilities.
    - S1-S2-S3 baselines: ~ 20 m
    - E1-S4 baseline: ~ 600 m
    - E1-W5 baseline: ~ 1100 m

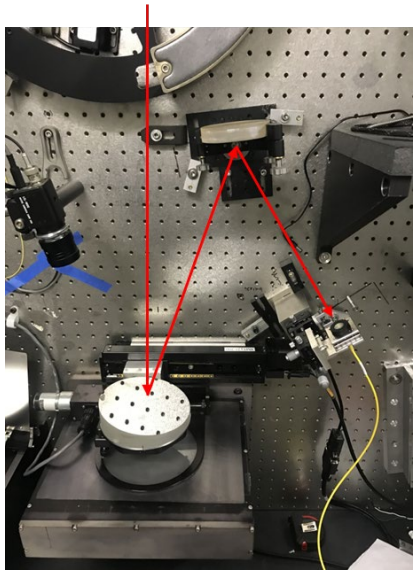


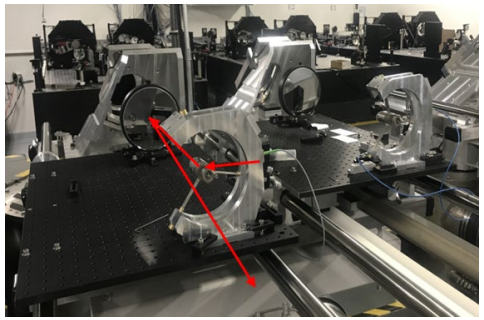
Topo map of CHARA

Major Aspects of the Project

1. Mobile Telescope: telescope, instrument bench, enclosure, and sites
2. Fiber transport- Injection/transport/collimation
3. Control software
4. Fiber zero path stabilization







Work done from 2024 mtg

- Iron out fiber metrology system design- 0% (work has been done in prior year)
- Experiments on fiber before going on-sky- 50%
- Installation of the fiber conduit- 50%
- Build, test, and integration of the nasmyth instrument bench onto the mobile telescope- 25%
- Continued work on the control software- 25%
- Fringes(in lab, outside, on-sky)- 20%
- On-sky tests- 0%

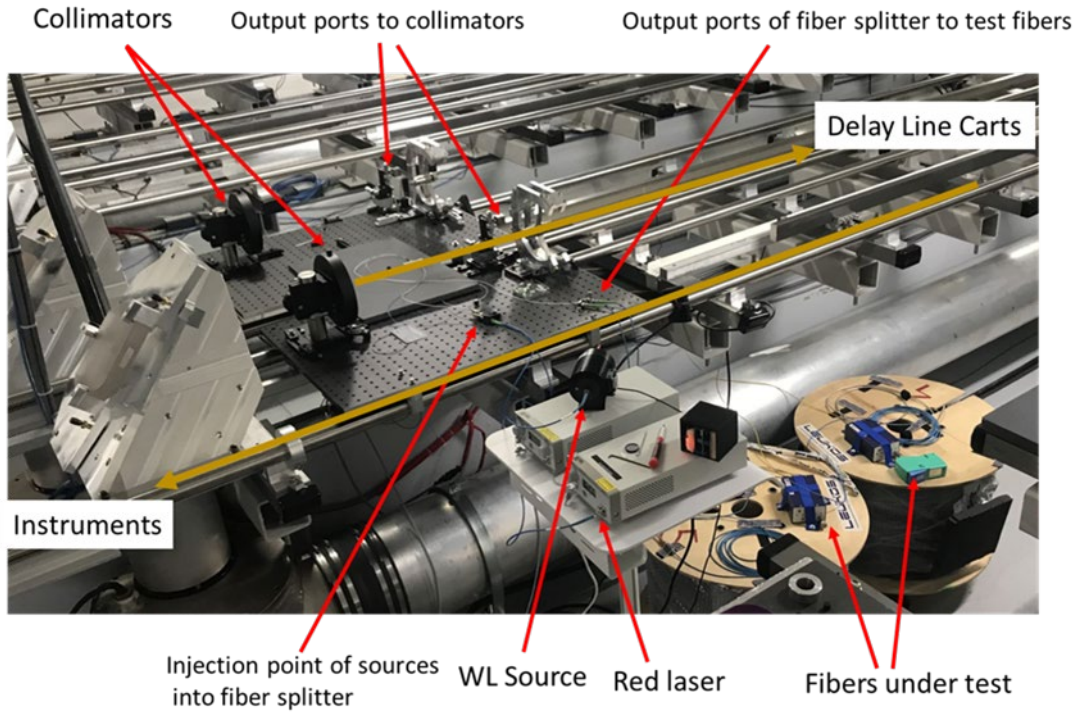
Fibers

- The fibers arrived in April of 2024
- Power test done at 1470 nm

	delivery	
IN-OUT	[dBm]	% out/in
F1	-0.9	0.81
F2	-1.1	0.78
F3	-1.2	0.76
F4	-0.4	0.91
F5	-0.8	0.83
F6*	-1.9	0.65

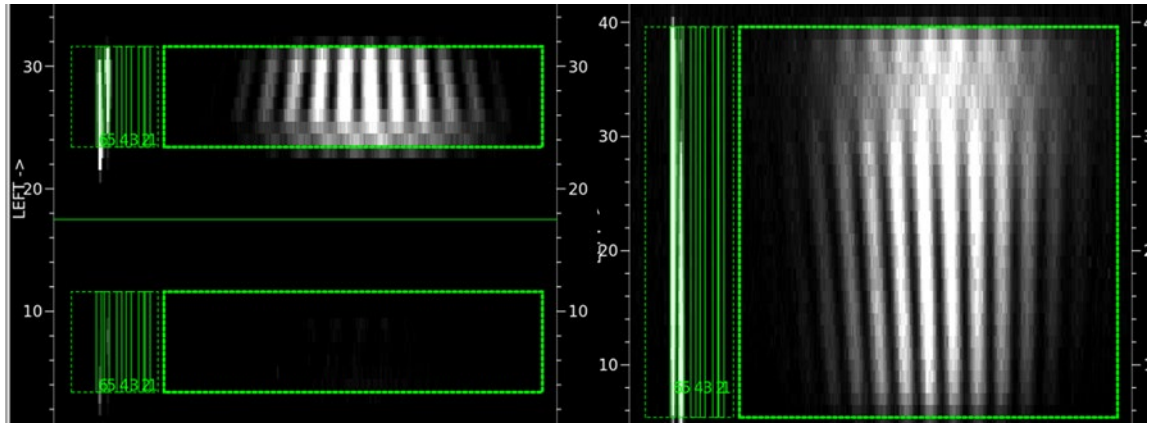
Fiber Testing Setup

After the basic tests for functionality, we worked on getting fringes between fiber pairs
We have been using a Thorlabs PM fiber splitter for 1550 nm.
The red laser was used for labao

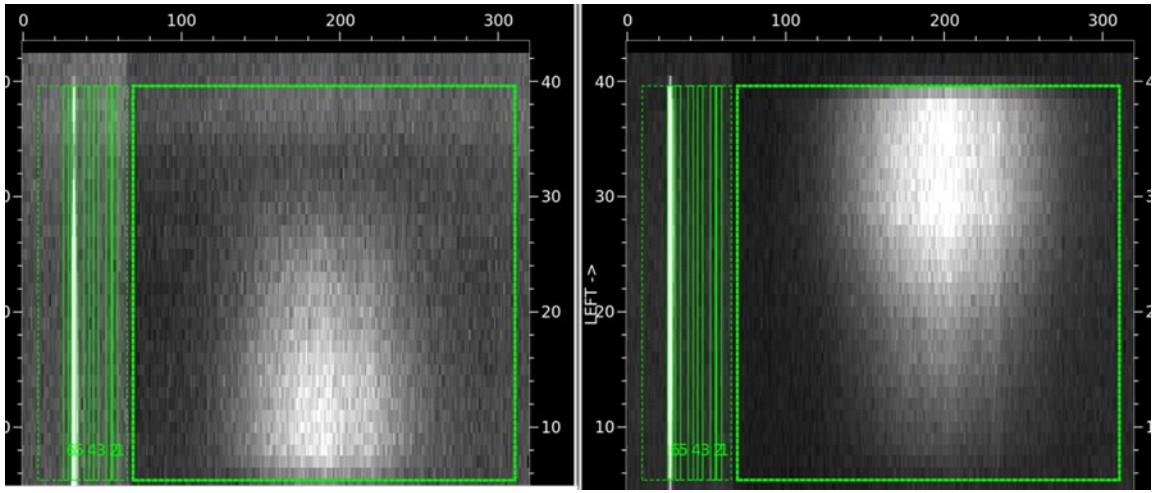


Woll50

G190 ~ 9 nm/pixel



Flux from each arm



Fiber Testing 1

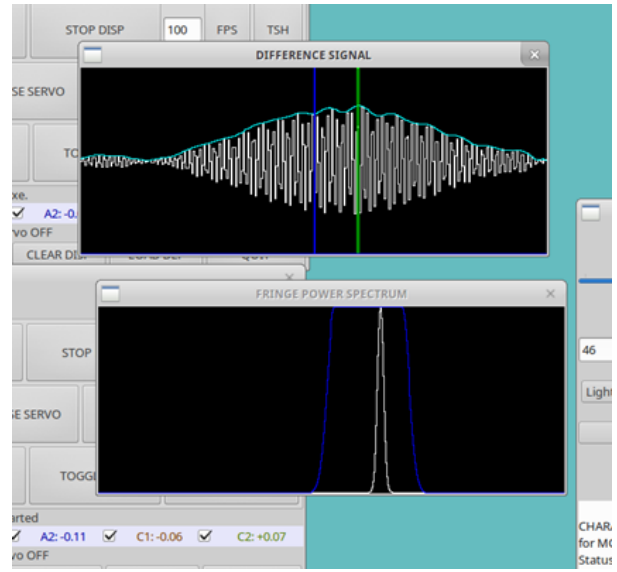
The plan was to scan for the fringes with CLASSIC then look in detail with MircX

Contrast from LEUKOS: no fiber setup contrast 82%

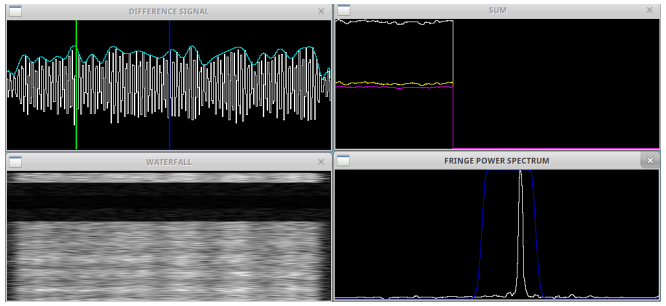
Fringe contrast at λ =1.55µm Δλ = 12nm

B\A	Fibre 1	Fibre 2	Fibre 3	Fibre 4	Fibre 5	Fibre 6
Fibre 1		33%	55%	53%	37%	51%
Fibre 2	32%		37%	28%	26%	37%
Fibre 3	53%	36%		40%	43%	60%
Fibre 4	56%	30%	42%		72%	42%
Fibre 5	39%	27%	41%	72%		44%
Fibre 6	55%	38%	60%	42%	42%	

F4 and F5

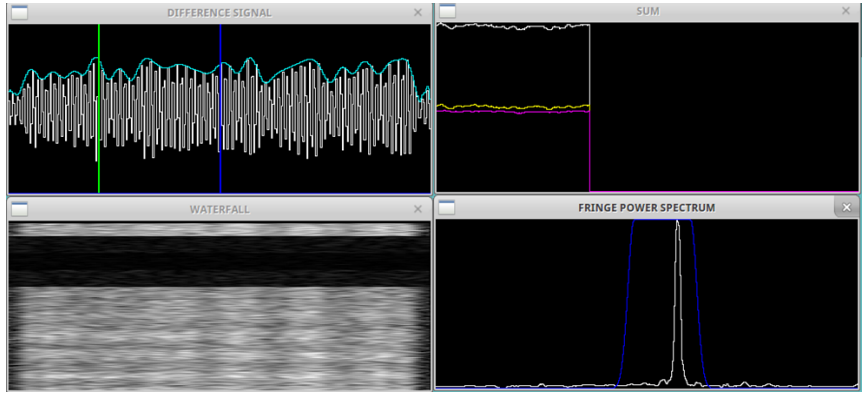


F3 and F5

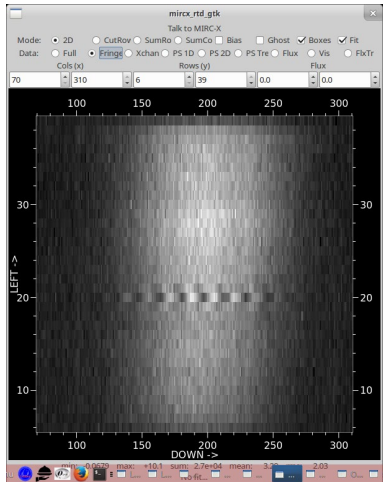


Fiber Testing 2

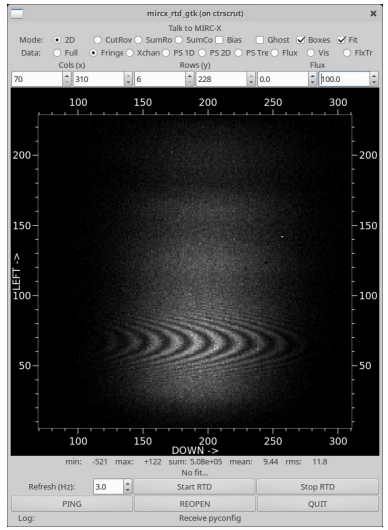
F3 and F5



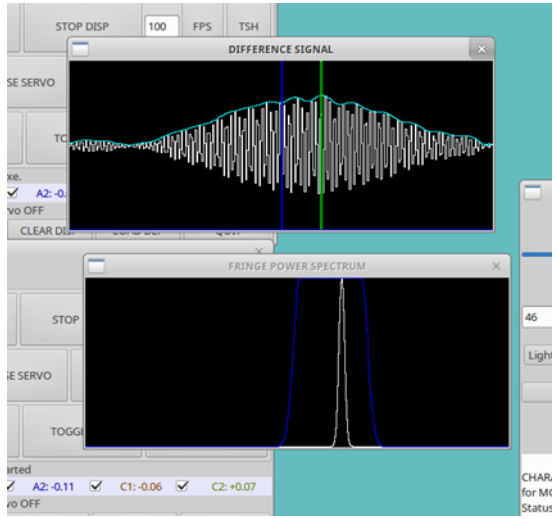
G190



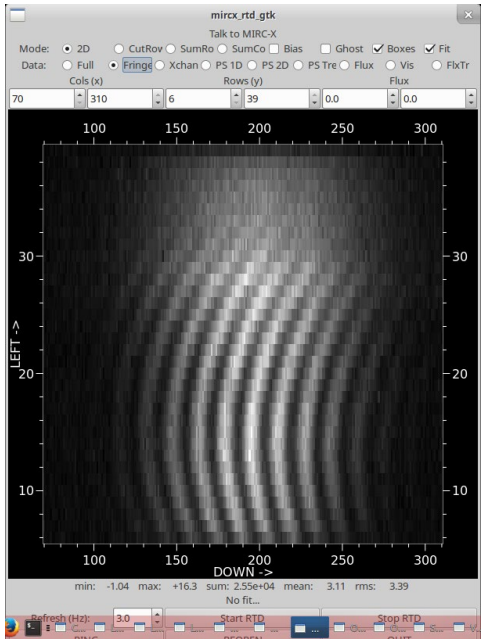
P1170



F4 and F5



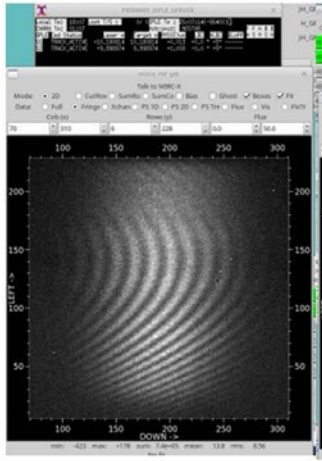
G190



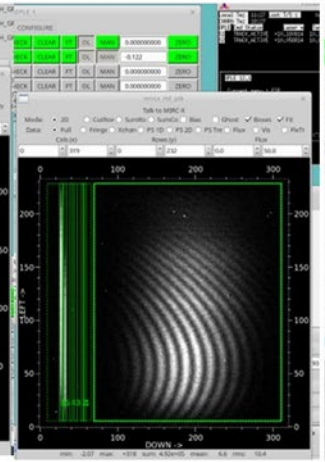
Fiber Testing 3

Looking at all the combinations for fibers 1,2,3,6 P1170

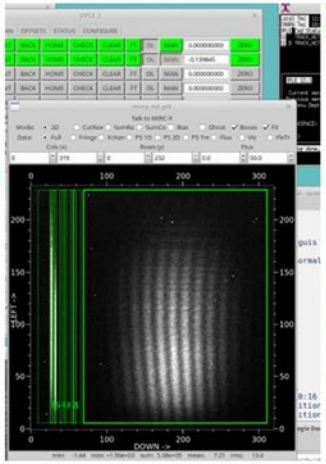
F3/S2/W F2/S1/R -0.1818



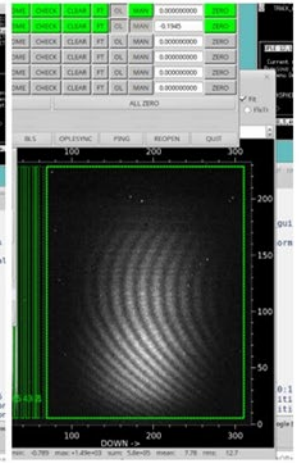
F6/S2/W F2/S1/R -0.122



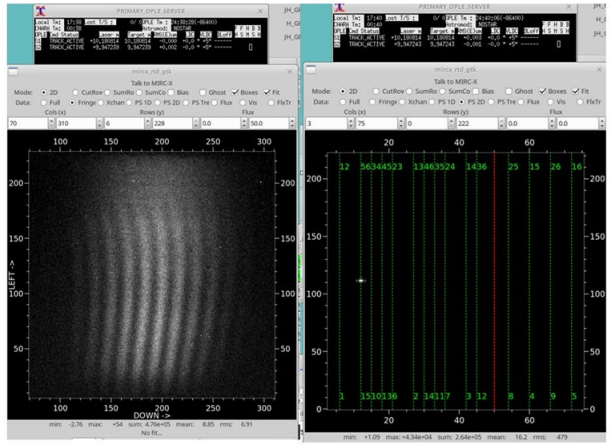
F1/S2/W F2/S1/R -0.140



F6/S2/W F1/S1/R -0.122



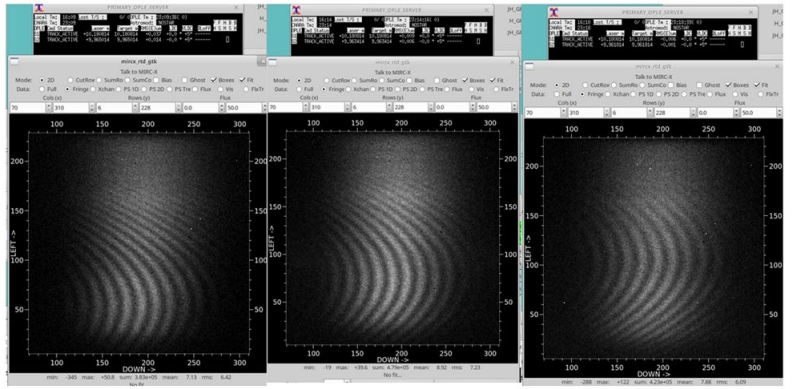
F3/S2/W F6/S1/R -0.2336



F3/S2/W F1/S1/R -0.2158

F3 fiber DL -0.5 mm move
F3/S2/W F1/S1/R -0.2174

F3 fiber DL -1.0 mm move
F3/S2/W F1/S1/R -0.219

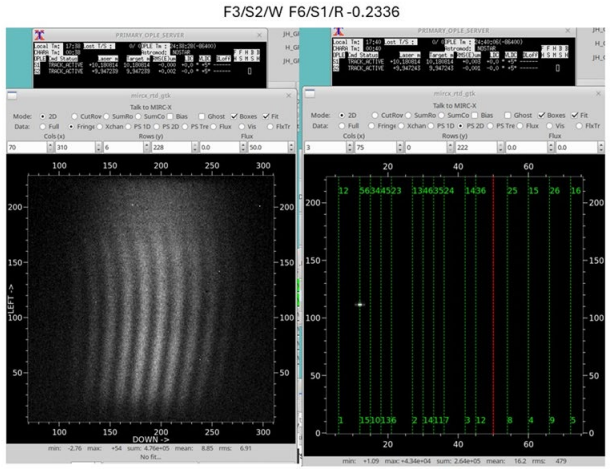


Fiber dl 6mm air/mm dl actuator

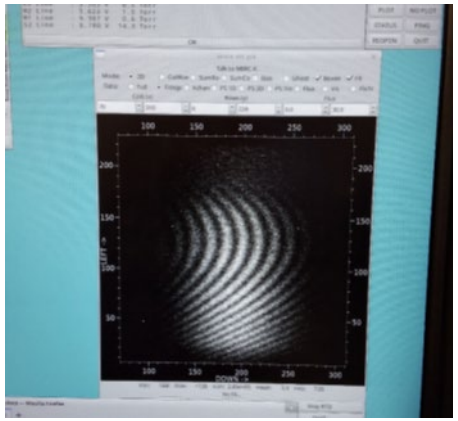
Fiber Testing 4

Unspooling fiber 3: There is ~ 630 meters of fiber wrapped around the spool.
~ 600 meters was unspooled: with F6 and P1170

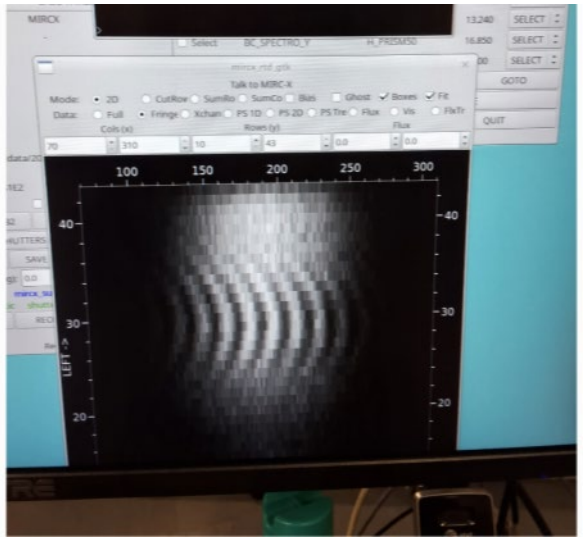
Before unspooling



After unspooling



After unspooling: G182

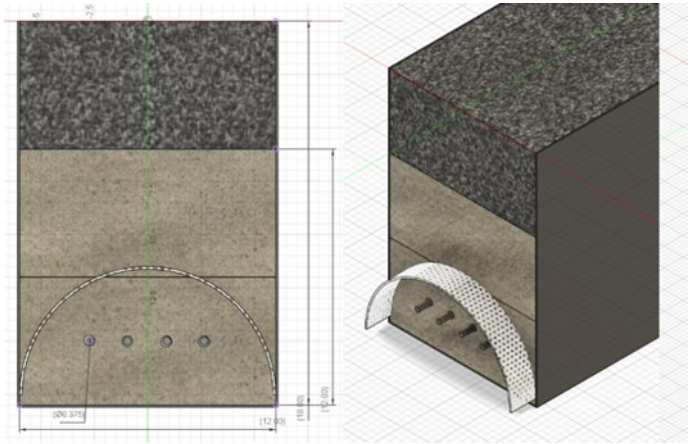


Fiber Transport

- Trench at about an 18 inch depth for thermal stability
  Insulated pipe where burial not feasible

Fiber Transport

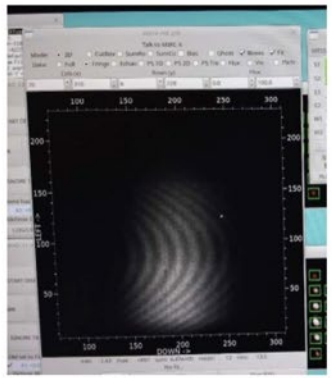
- Trench at about an 18 inch depth for thermal stability
- Insulated pipe where burial not feasible
- 1 week of contracted work to dig trench
- 1 week of CHARA labor to lay the fiber: pipes at ends, ople trench

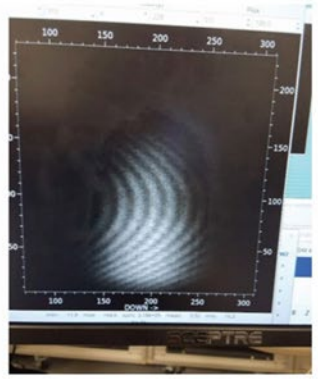


Fiber Testing 5 outside

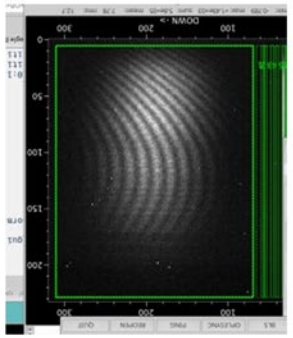
Trenching the fibers before winter were critical else we could not get started till this spring.

F1/F6 outside 11/14/2024



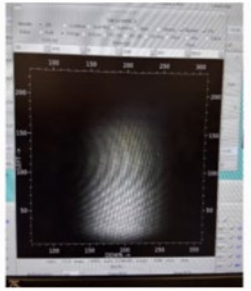


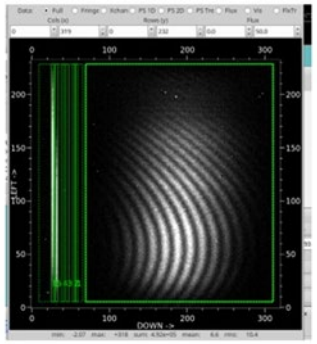
F6/S2/W F1/S1/R -0.122



F6/S2/W F2/S1/R -0.122

F2/F6 20241114

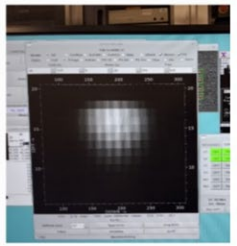




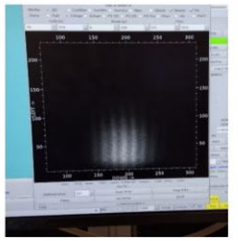
outside left; lab right
Less of higher wavelengths? Splitter?

F1/F2 20241115

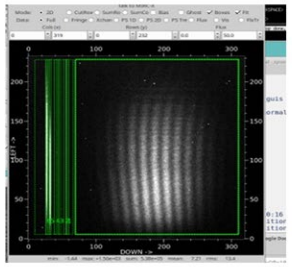
P102
23:39 -.227



P1170

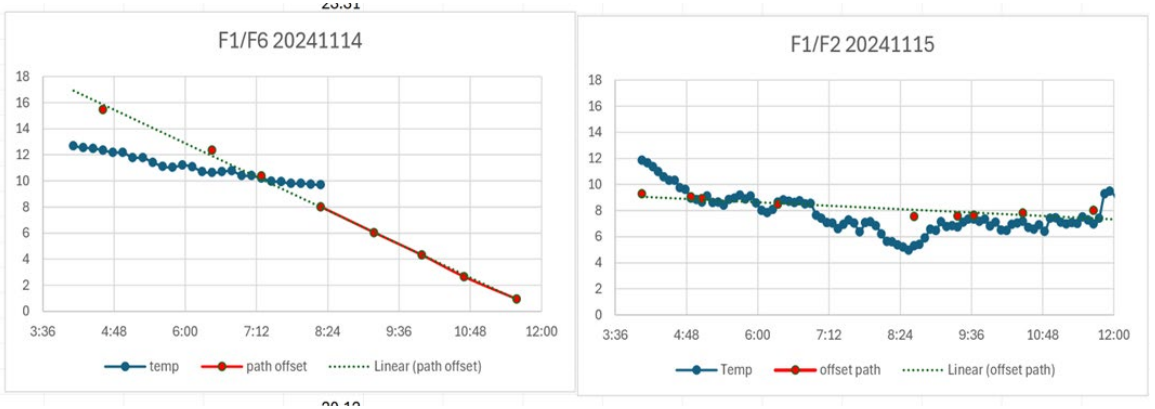


F1/S2/W F2/S1/R -0.140



Fiber Testing 6 outside

Thermal opd changes: F1 and F2 were in the same fiber vault for this test
F6 was in the S3 fiber vault
Linear change in length with temperature.



Fiber Testing 7: loose spools

Fiber unspooling apparatus

Unspooled fiber

Summary/Future Work

What do we have left? Lots

- Fiber tests
  - two fibers left in lab
  - when fibers are unspooled into the loose foam
  - calibrate wl source flux
  - polarization checks at the back end
- Installation of the fiber conduit to E1 and S4: F4 and F5
- Build, test, and integration of the nasmyth instrument bench on the mobile telescope
- Experiments on fiber stability- Ongoing
- On-sky fringes

Concerns: The dominating component of the dispersion can only be dealt with by the fiber delay line

- Bulk glass for length difference
- Birefringent material to match the beat lengths of the two polarization axi
- Lay fibers to E1 and S4 or above?