CMAP: Nasmyth Instrument Bench Design

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Overview

The CHARA Michelson Pathfinder Project (CMAP)

- Explore the possibility of using fibers for transport to extend the observatories capabilities
- Get 2 telescope fringes with S1 and S2
- Addition of a mobile telescope to demonstrate the ability to add additional baselines
- Observe science targets with two telescopes from multiple locations
- Closure phase on certain subsets of the 7 telescopes

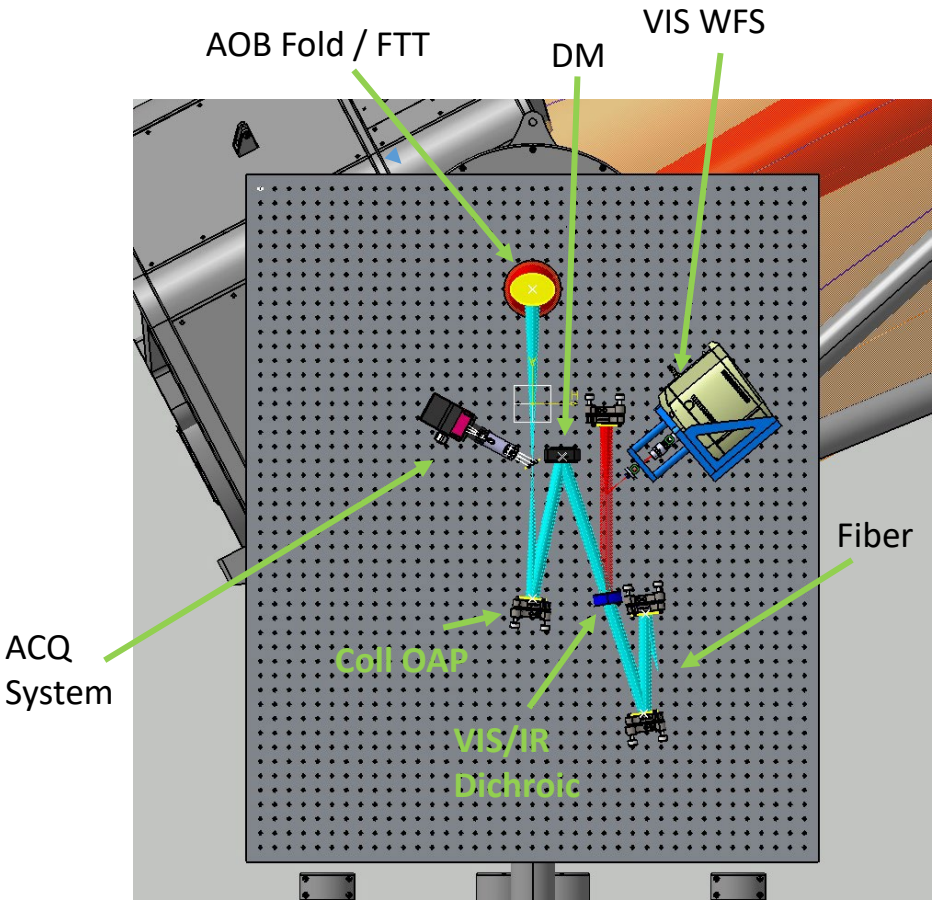
Subsystems required

- Fiber injection modules for S1, S2, W1, E1; starting with the use of the current OAP's installed at S1 and S2 for ALOHA project
- Collimation modules for re-collimation of the beams at the delay line; two that utilize on-axis parabolas initially
- Fiber transport system
- Fiber metrology
- A mobile telescope with enclosure

Parameters for the mobile telescope

1. Telescope F/#- 12.2 +/- 0.3
2. BFD: 650 mm +/- 50 mm from Nasmyth port
3. T WFE: max 0.6 waves @ 633 nm at any angle of elevation within operating range
4. Science band: 1.49-1.78 um
5. Use general design of current telescope WFS system
6. WFS max read out rate: 441 Hz
7. Ability to work with current telescopes
8. Fiber: Corning PM14-U25D
9. Daily temperature fluctuations of 10C – 20C possible over a day. With seasonal temperatures between 0C – 35C for all operations; -5C - 40C survivability
10. Low maintenance- the research will extend over a long period, so the system needs to be robust

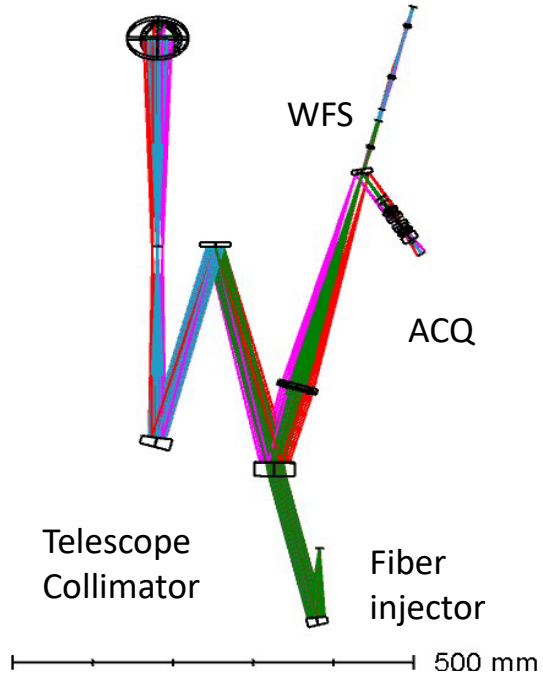
Initial design



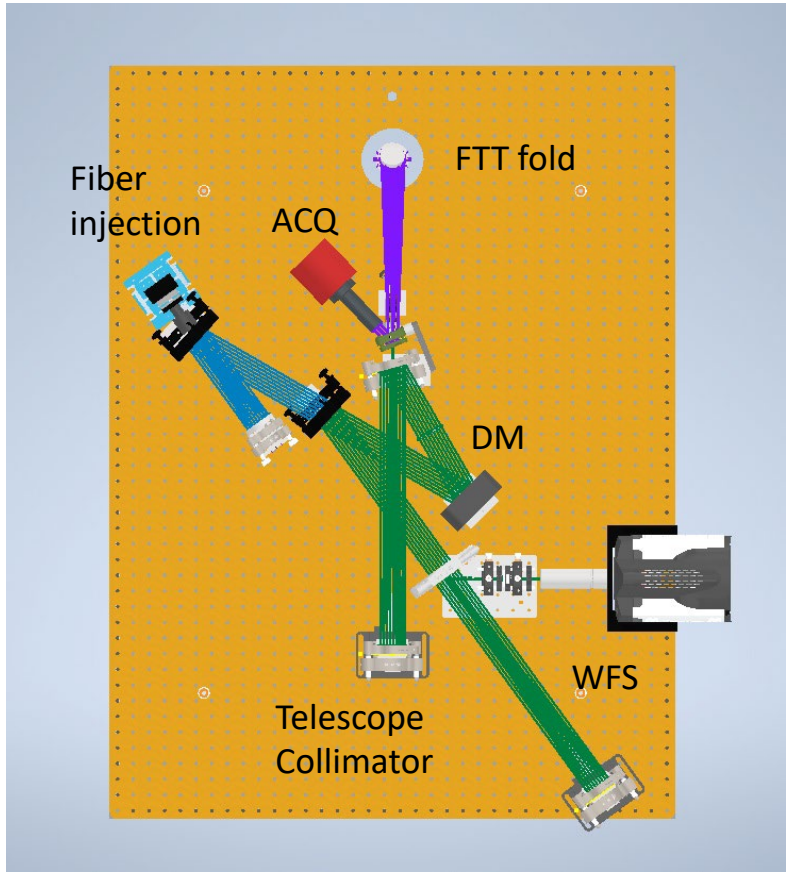
- ACQ: 2x2 arcmin FOV
- Tel F/#: 12.2
- ALPAO DM97-25; 8 sub apertures for a 20 mm pupil
- WFS- modified design of current telescopes

The design was preliminary in needed some details worked on

- WFS system converted to an all-lens system
- WFS Operational range: 600 nm – 950 nm
- Off-axis fiber injector



40 mm design



- ALPAO DM97-50; 8 sub apertures for a 40 mm pupil
- WFS system on axis parabola with fold
- WFS Operational range: 560 nm – 950 nm
- On-axis fiber injector

- On-axis parabolas are easier to align
- The fiber injector is in unmonitored space
- FTT not being at pupil- less than 1% pupil shear
- DM not being at pupil – also less than 1%
- Wider bandwidth for the WFS camera then the 20 mm design
- ACQ using same input lens as current telescopes

DM

- ALPAO DM97-25: 7 nm rms best flat
- ALPAO DM97-50: 25 nm rms best flat (as built better)
- For the DM97-25, assuming all surfaces have 21 nm rms WFE at a higher spatial frequency then the apertures: 95% SR
- SR loss of less than 7% using DM97-50
- Use less then 25% of the DM range

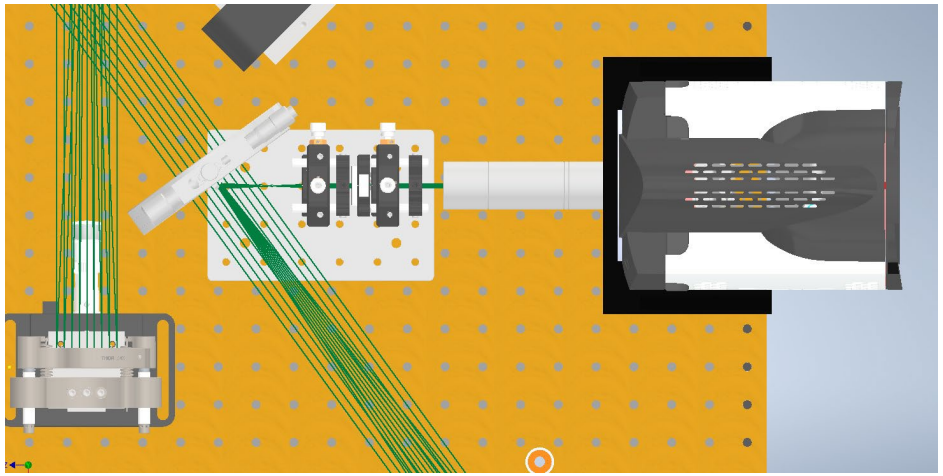
WFE	PV [nm]	rms [nm]
Telescope	189.9	37.98
FTT	105	21.00
tell coll	105	21.00
holey mirror	105	21.00
DM97-50		50.00
WFS dichr trans	158.25	31.65
fiber fold	105	21.00
injector	105	21.00
total rss [nm]		84.55
Strehl at 1500nm		0.882

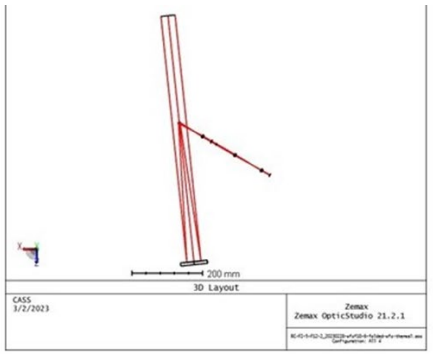
Component	rms error	um PV
2 axis T/T atmos	4.4 urad	2.5
tracking	0.1 arcsec	0.25
atmos WFE	4.4 rad	1.05
telescope	0.4 um PV	0.2
focus comp	0.6 um PV	0.3
Total		4.3

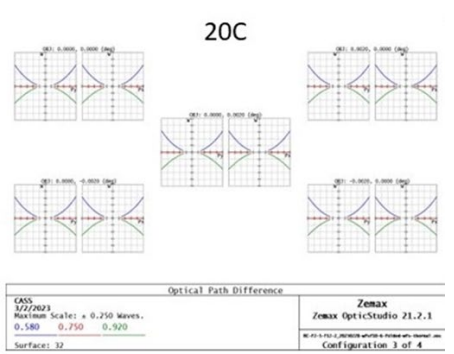
WFS

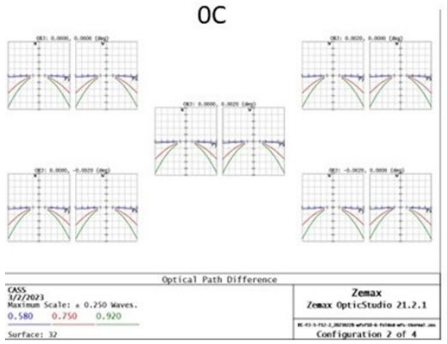
Uses a similar design as the current WFS system

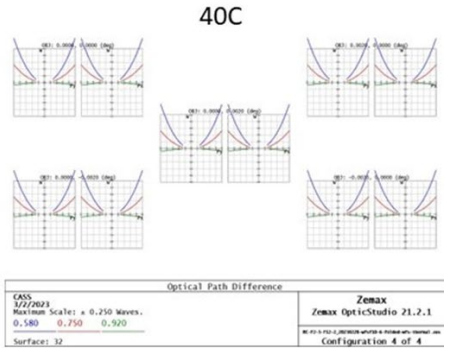
- On-axis Edmund parabola
- Spider fold: in progress
- 49315/APO-Q-P300-F15.9(633)/49319/49315
- Image 68x68; ROI 90x90
- Andor 897
  - NUVU Hnu 128
    - Has possible benefits
    - Gains might be difficult to use when operating with other telescopes
    - More dark current
    - Might need more software work
- Thermal
  - +/- 1/8 average wave change (20 nm rms)







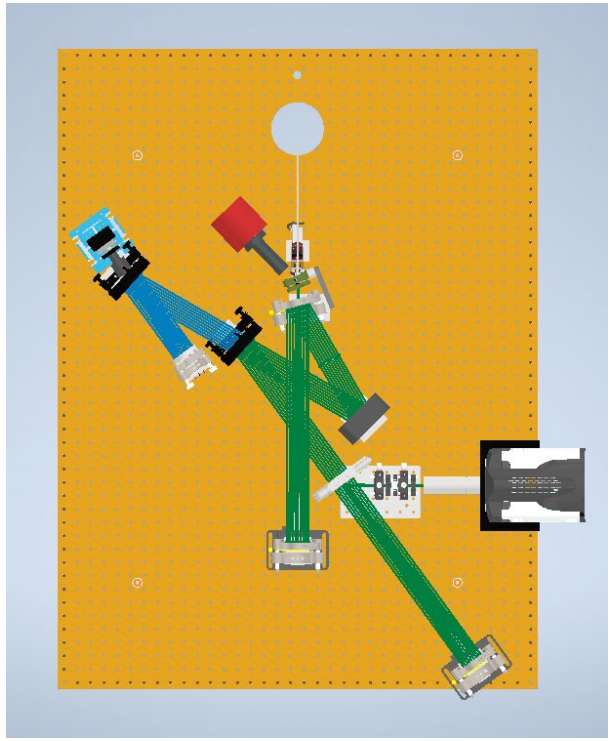


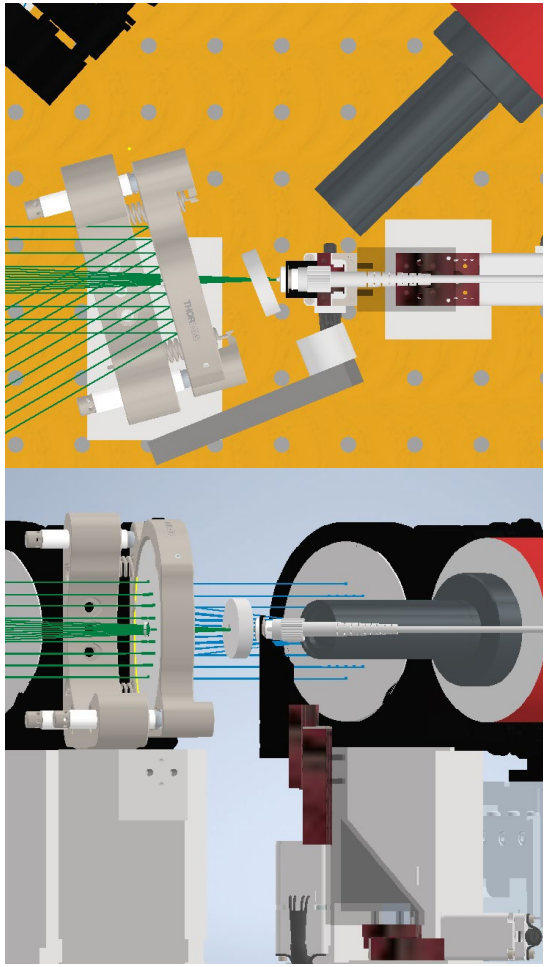


Sources: Cal and beacon

Cal source

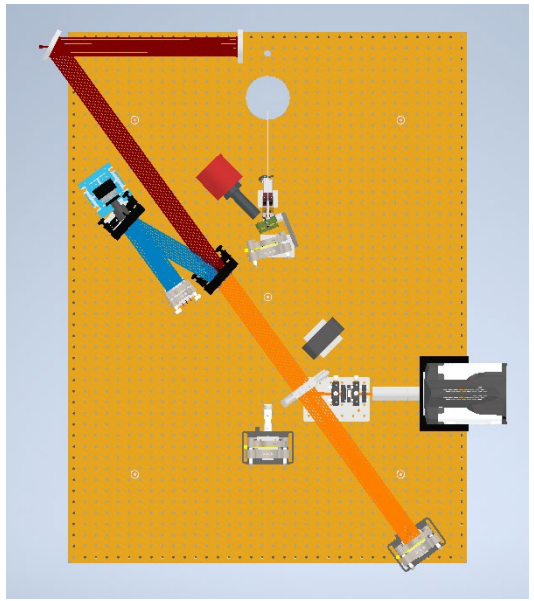
- Retractable fiber at telescope focus
- Vertical and focus stages



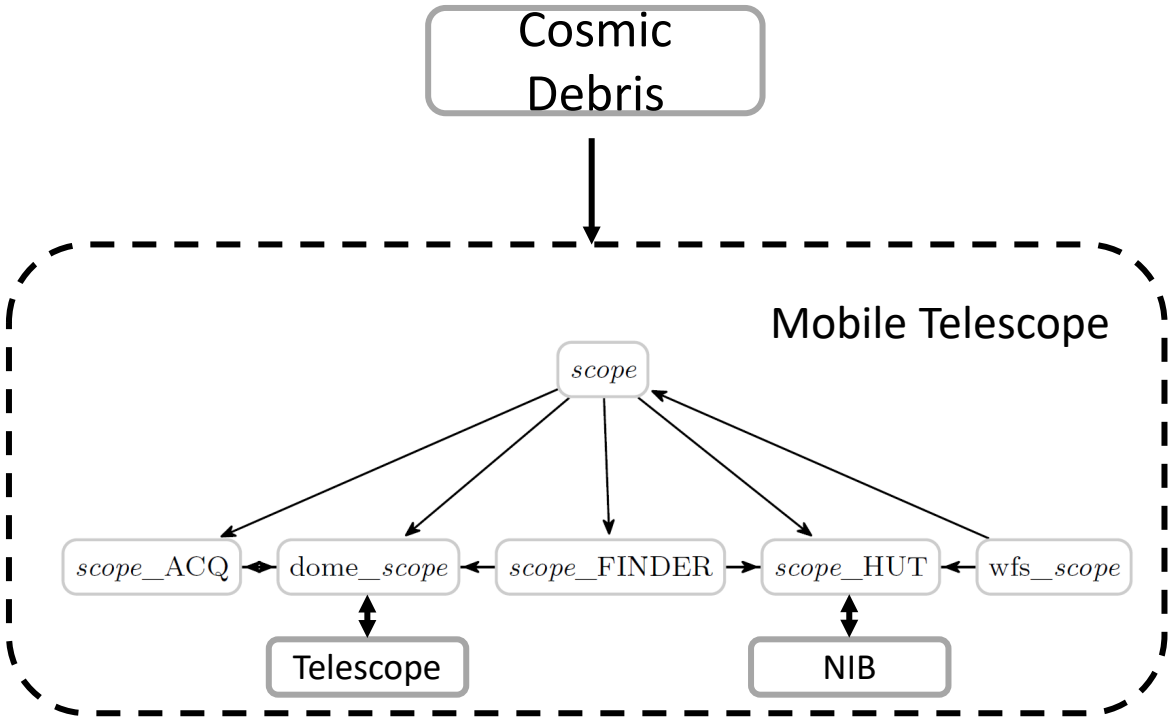


Beacon

- Thermal fluctuations of the WFS may be minimum so no need for a beacon
- Maybe use to inject visible light into fiber for labao
- Possible fiber metrology pick off in this arm



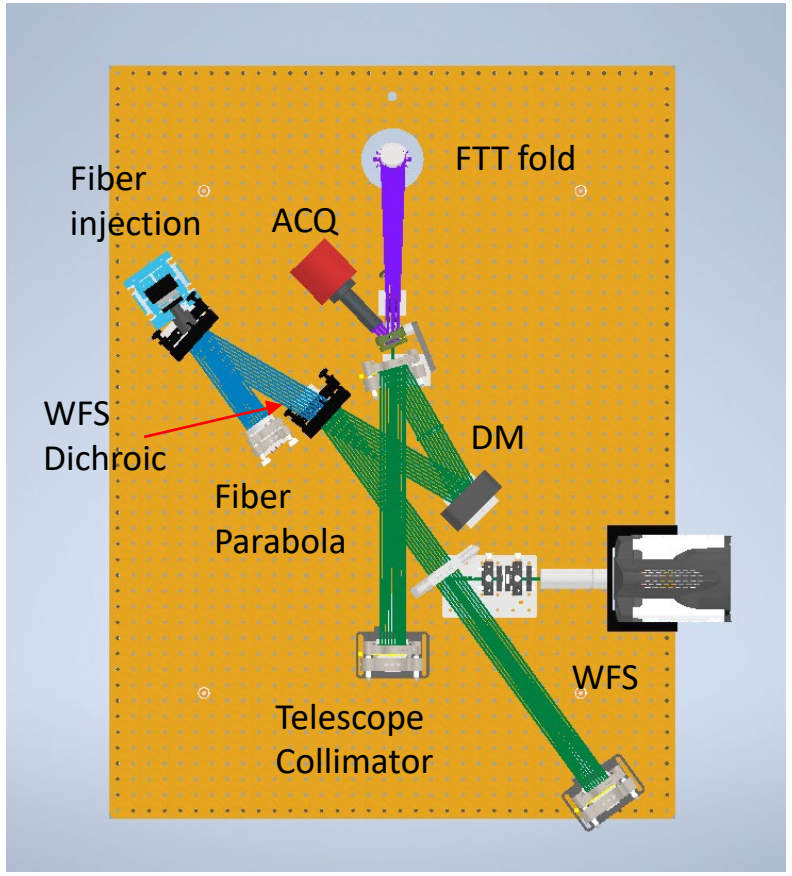
Control overview



Equipment:

- Andor iXon Ultra 897
- ALPAO DM97-50
- ZWO ASI294MM Pro
- PI 315
- Zaber actuators, stages

Actuation



- FTT fold- PI 315
- Cal source- Zaber stages focus/vertical
- WFS Dichroic T/T - Zaber LCA actuators
- Fiber injection fold T/T - Zaber actuators
- Fiber parabola- PI 315: future or needed?
- Fiber- flexure XYZ stage with focus actuation using zaber actuator
- WFS parabola- flexure Z stage with zaber actuator
- (F)Telescope collimator- flexure Z stage with zaber actuator
- WFS camera- X/Y actuation for ROI alignment: zaber

Summary

- Using the DM97-50 to get a pupil of 40 mm to allow an on-axis design
- Use of equipment already used at CHARA to minimize software work
- Finishing up
  - Fold mirror for WFS parabola
  - Metrology pick-off
  - Various bases for alignment purposes
  - The FTT fold mirror mount
  - Specifications
- Testing, building
  - Bonding of the WFS parabola fold
  - Flexure stages with zaber actuators
  - Alignment of WFS system
  - Acquisition camera