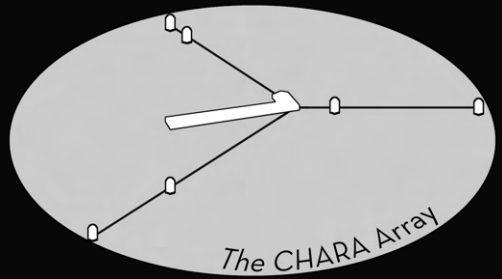
Telescope status update

The CHARA Science Meeting 2023

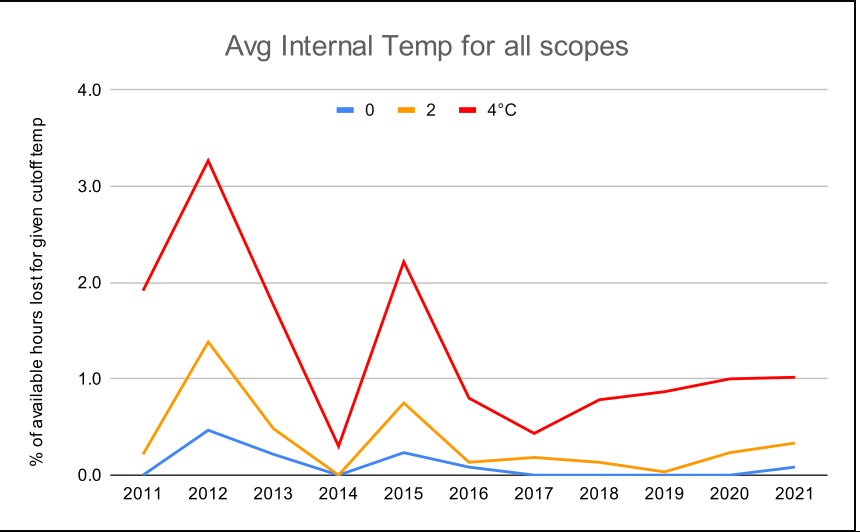


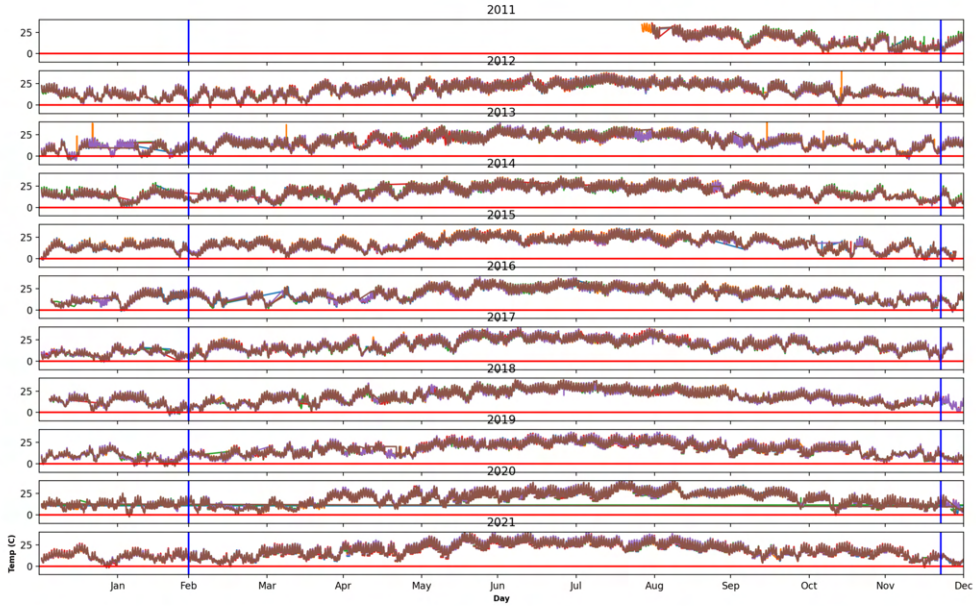
nic scott

Telescope Systems Scientist

- Recoating moving to "as-needed" basis
- New operating limits
- Telescope drive upgrade
- Mobile Telescope Enclosure

Temperature limits





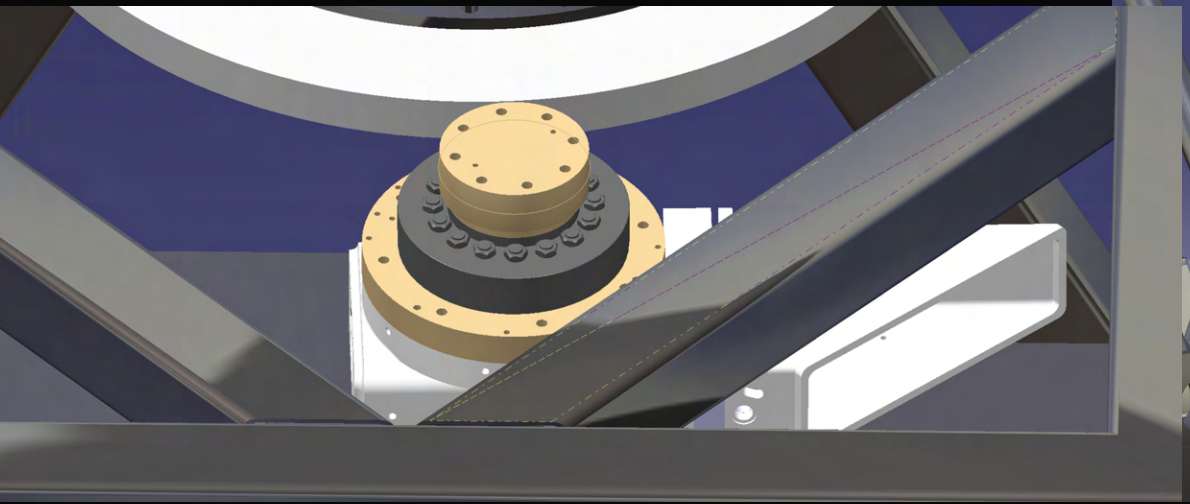
cutoff temp (°C)	avg % lost	avg hours lost
0	0.1	7.0
2	0.4	25.2
4	1.3	93.1

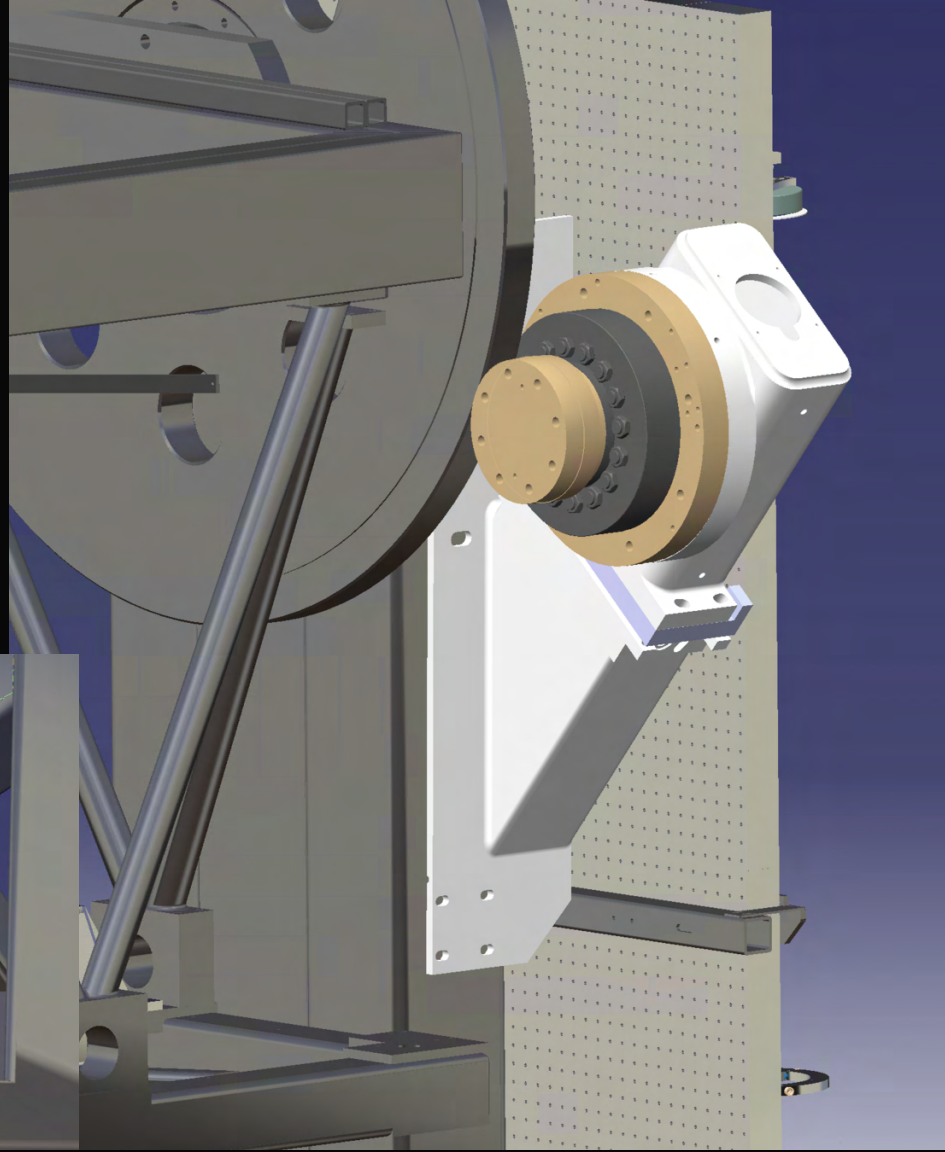
Drive upgrade project

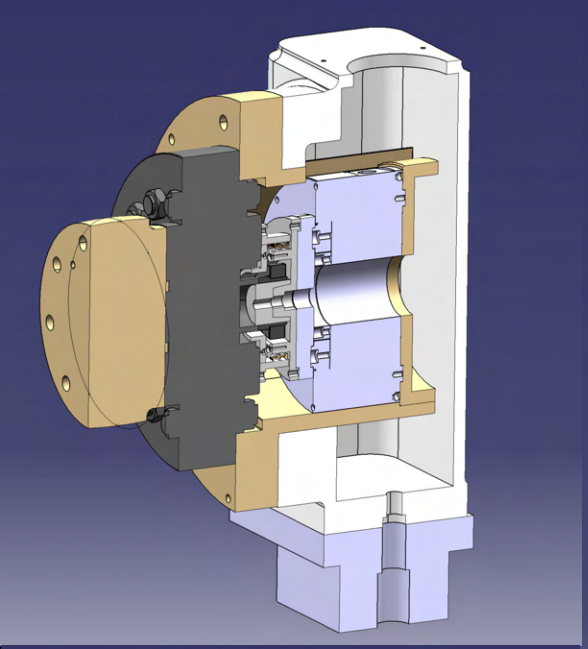
Mid-Scale Innovations Program (MSIP)

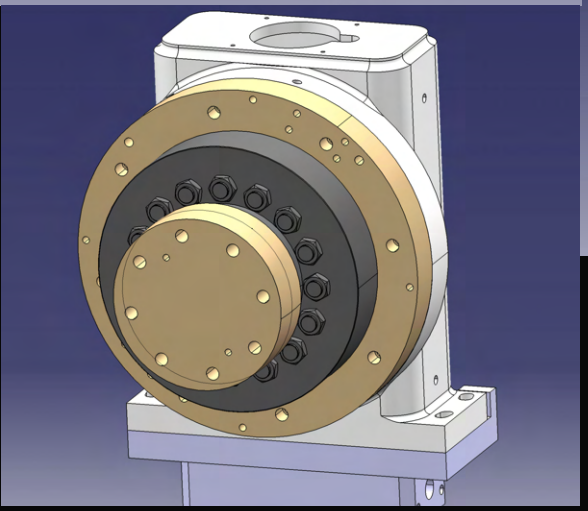
replace the existing motors and drives

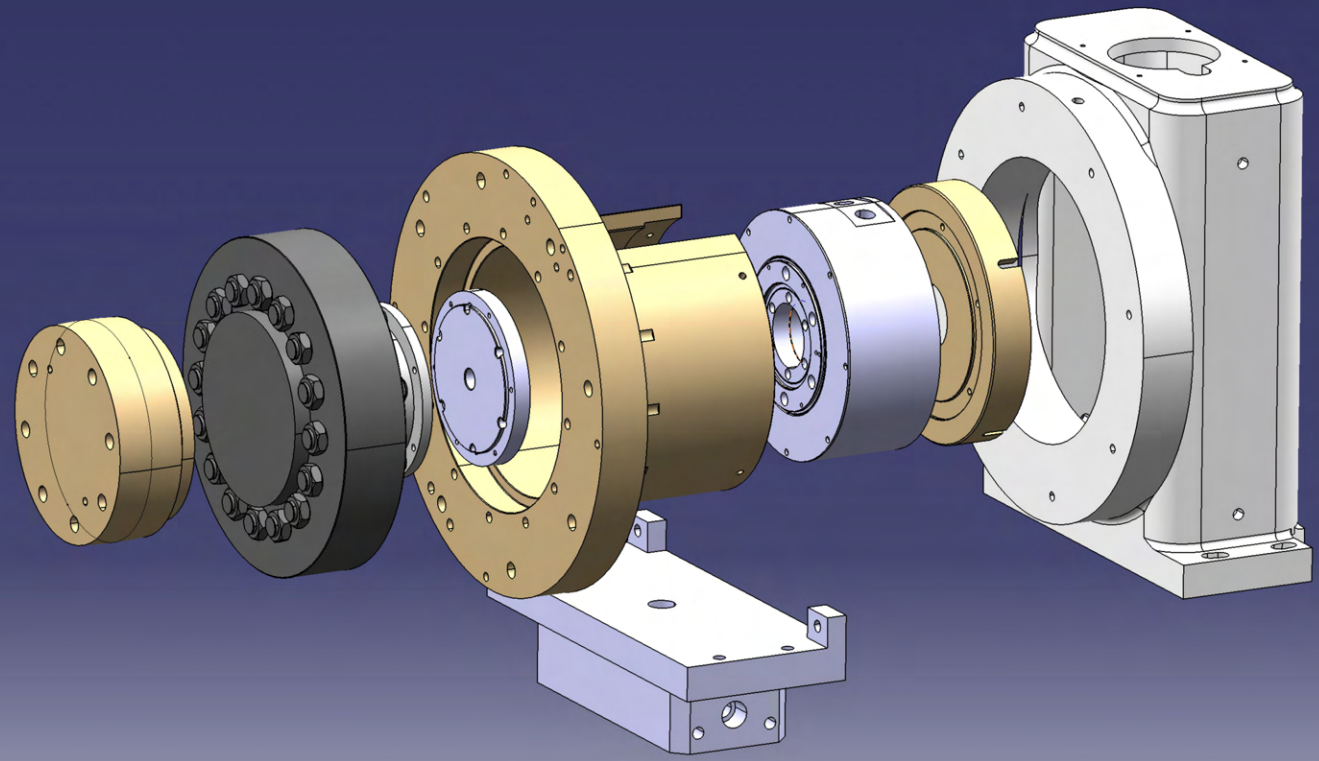
- Existing drives are ~25 years old & discontinued
- Reduce vibration, improve tuning











Drive Upgrade - Hardware

- One prototype assembly and short pivot arm made by UCryo
- Adapter plate made by GSU
- 2 drives and motors in hand from Parker
- S2 EL drive assembly removed and reinstalled
  - modifications made to mount to aid removal
- Found problem with currently used bearing-old motor (unrelated to upgrade)
  - re-machined and built a spare at GSU shop
- Spare Dojen ordered
- Test fit the new motor and entire assembly
  - procedure documented
  - found some manufacture issues with prototype drive assembly
  - re-machined and re-plated in Tucson
- Hardware now ready for EL install
- Install can be completed during daytime without impacting observing
- Next hardware challenge is AZ motor removal procedure


permatex

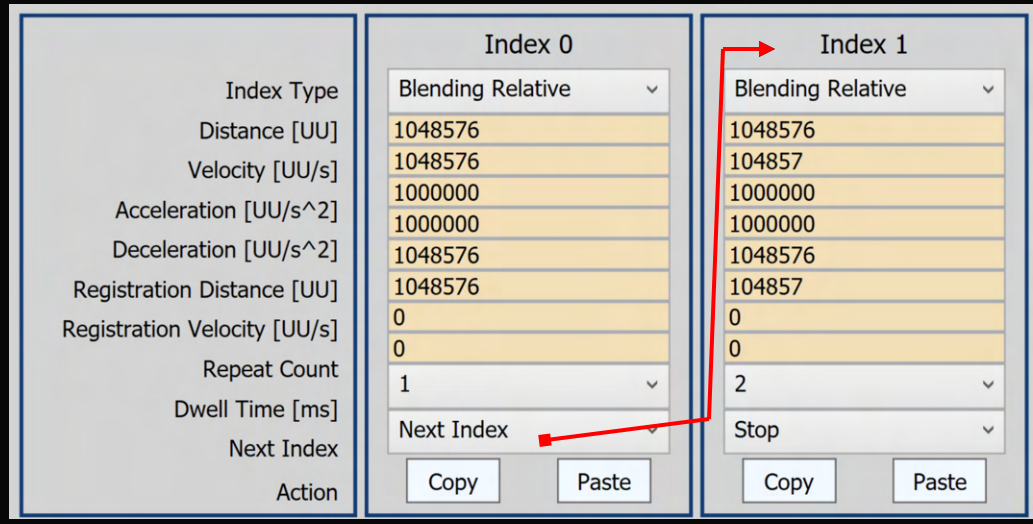

Hydraulic Jack
CAUTION
MADE IN CHINA



Drive Upgrade - Software

Two modes:

- Pulsed velocity control
- Indexed movement



Old drives use software to control a pulse generator to control the drives

New drives can operate in this mode, but it's not required. Index mode is more flexible.

motor capable of 200rpm,

~7.7 scope deg/s

2deg/s ~ 52 motor rpm

Up to 64 indexes can be populated, each with distance, speed, acc, dec.

Indexes can be repeated, or cycled from one to the next.

Smooth transition between different velocities.

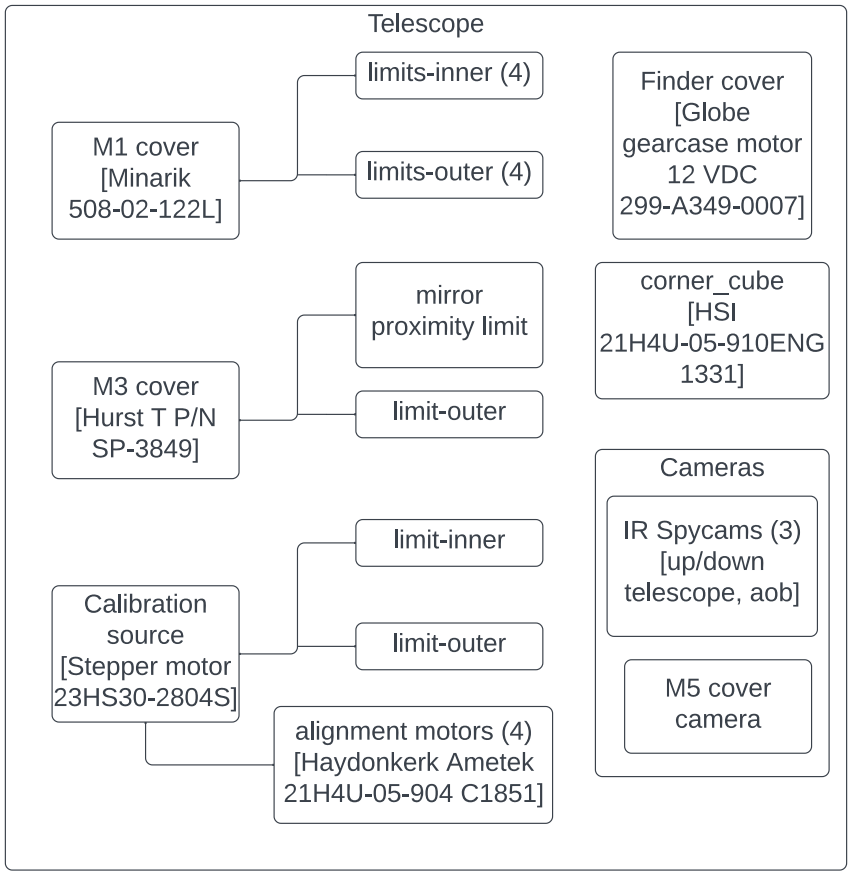
Timeline

- New telescope drives and motors picked
- First drive purchased -Dec 2021
- New drive housing assembly designed
- Bids secured, final decision pending
- Build one complete assembly from stock

- Test drive for month(s)
- Replace each drive in succession, with the removed drive assembly being sent for modification
- Repeat 11x


UNIC
SPIDER CRANE
UNIC

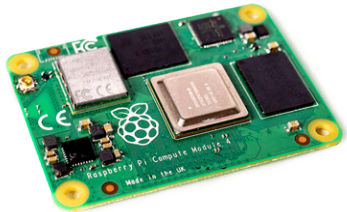

DEERE
325G

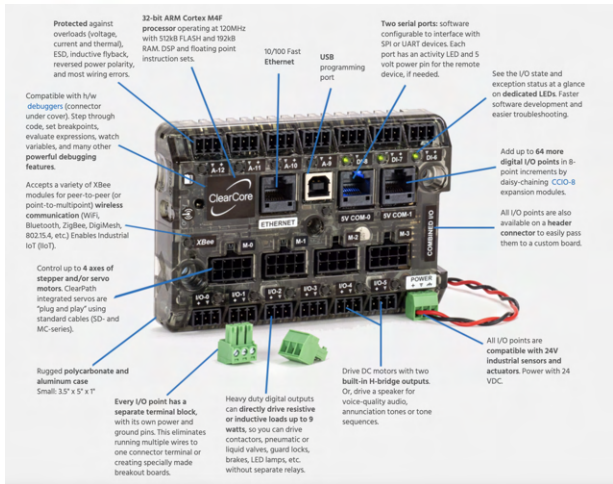


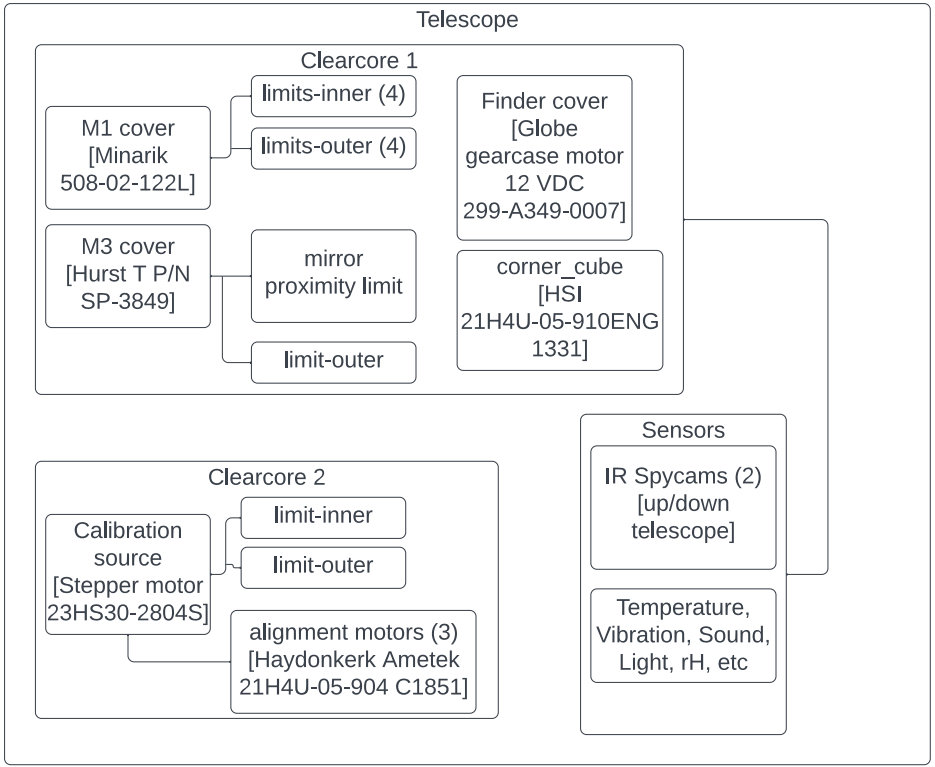
Desires for the new system:

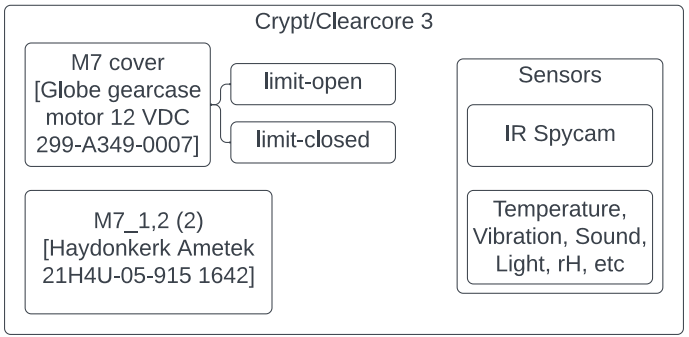
- **Minimize Failure points** - Eliminate custom parts, circuits, and cabling as much as possible.
- **Minimize Comms issues** - Replace custom cabling with system that utilizes dome ethernet and/or wifi.
- **Modularity/longevity** - Ideal would be identical common, well-supported microcontrollers with many spares, flash them with the appropriate software.
- **Parallel operation** - Multiple mirror axis/motors/covers could be commanded simultaneously (or at least buffered).
- **Internet control and local operation** - web-based log
- **Code** - Arduino C++, RPi Firmata control

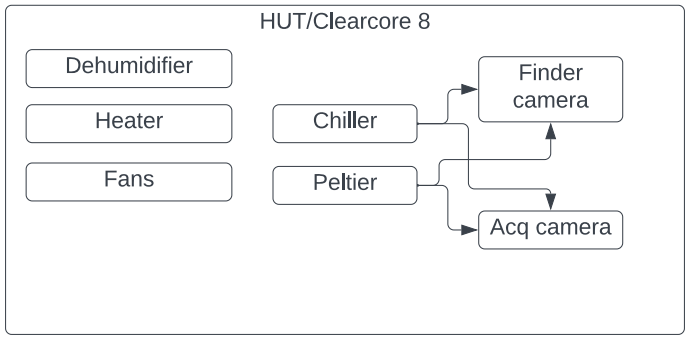
Industrial RPi+Arduino based system

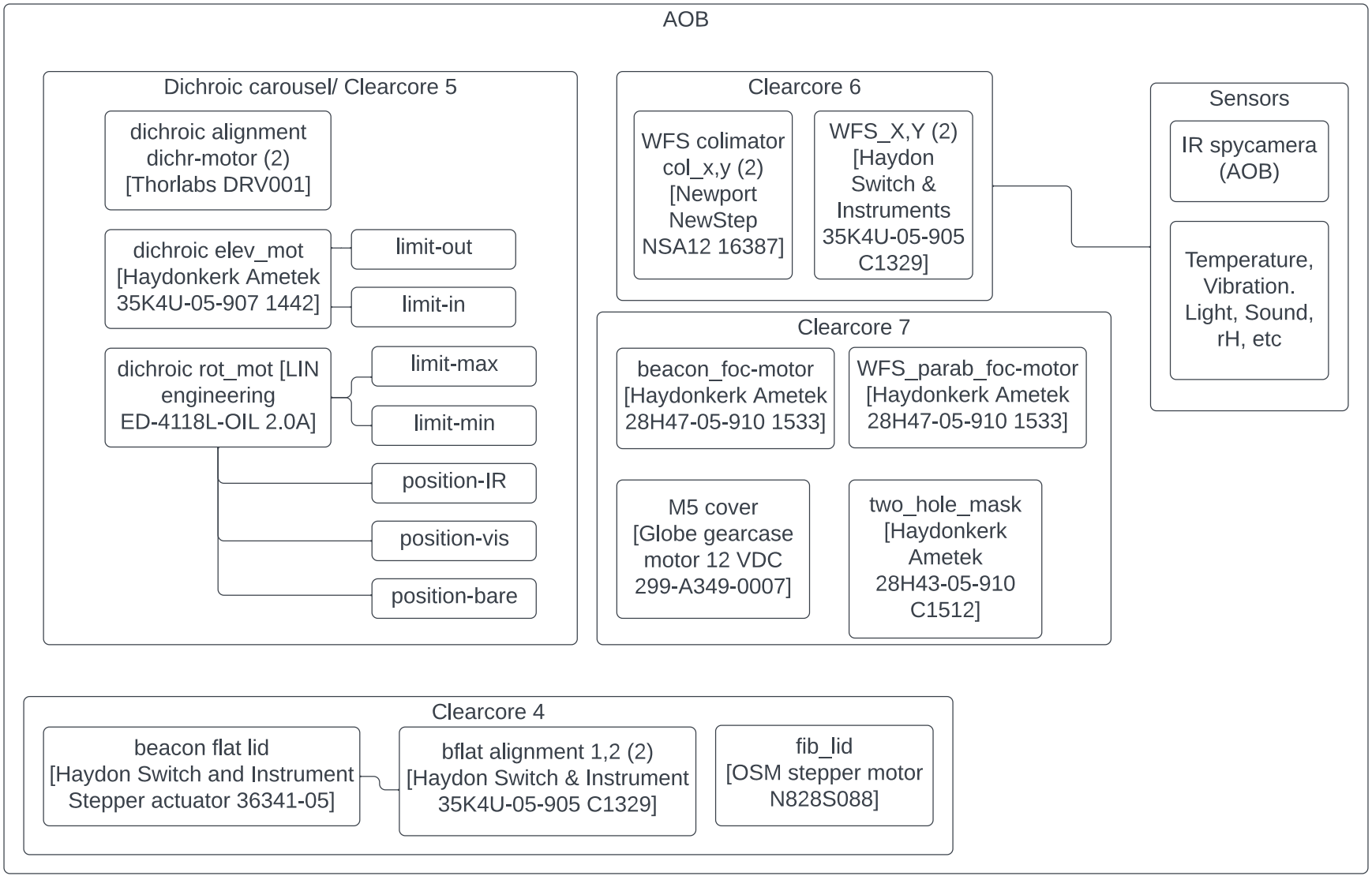




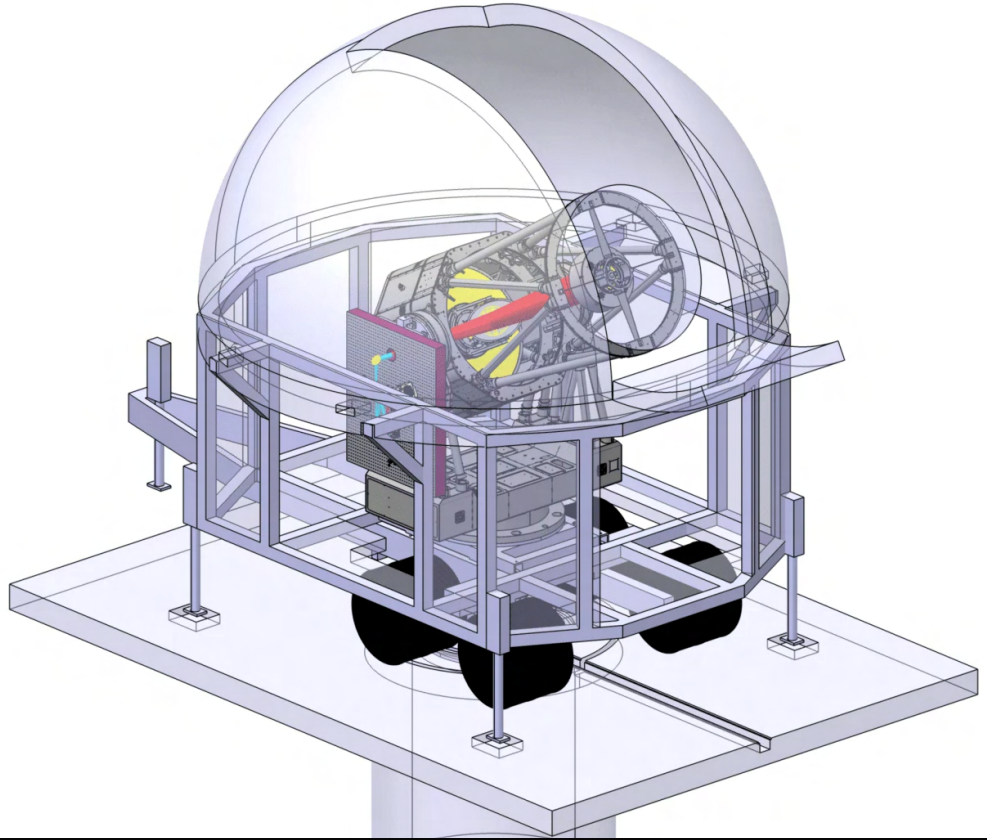


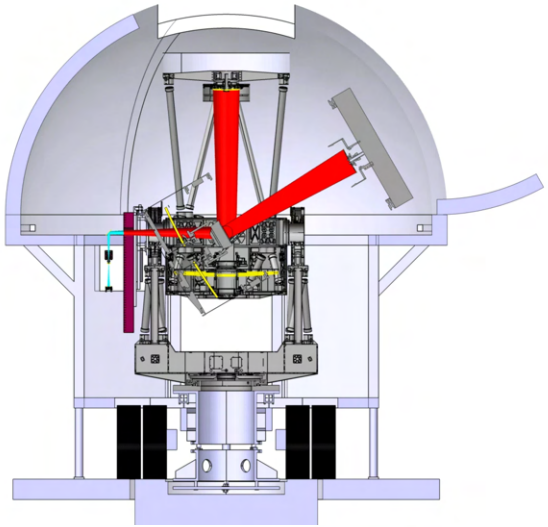


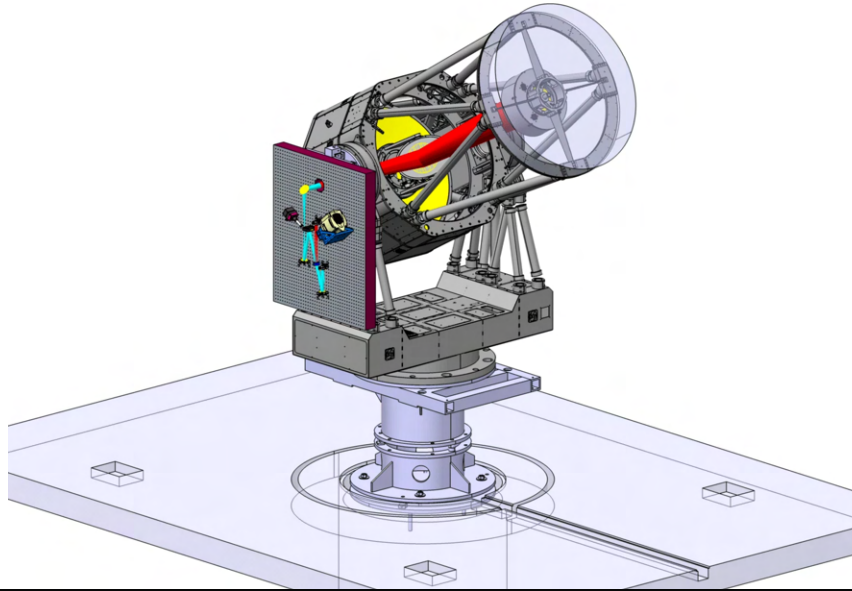



AOB
Dichroic carousel/ Clearcore 5
dichroic alignment dichr-motor (2) [Thorlabs DRV001]
dichroic elev_mot [Haydonkerk Ametek 35K4U-05-907 1442]
limit-out
limit-in
dichroic rot_mot [LIN engineering ED-4118L-OIL 2.0A]
limit-max
limit-min
position-IR
position-vis
position-bare
Clearcore 6
WFS colimator col_x,y (2) [Newport NewStep NSA12 16387]
WFS_X,Y (2) [Haydon Switch & Instruments 35K4U-05-905 C1329]
Clearcore 7
beacon_foc-motor [Haydonkerk Ametek 28H47-05-910 1533]
WFS_parab_foc-motor [Haydonkerk Ametek 28H47-05-910 1533]
M5 cover [Globe gearcase motor 12 VDC 299-A349-0007]
two_hole_mask [Haydonkerk Ametek 28H43-05-910 C1512]
Sensors
IR spycamera (AOB)
Temperature, Vibration. Light, Sound, rH, etc
Clearcore 4
beacon flat lid [Haydon Switch and Instrument Stepper actuator 36341-05]
bflat alignment 1,2 (2) [Haydon Switch & Instrument 35K4U-05-905 C1329]
fib_lid [OSM stepper motor N828S088]

Mobile Telescope Transport (TR116)







https://www.youtube.com/embed/T5hPlE_MIzo?rel=0&autoplay=1&loop=1&enablejsapi=1&playlist=T5hPlE_MIzo&vq=hd1024

- **Ash dome**
  - Wide 54” shutter
  - A raised dome horizon/skirt (to allow for clearance below the shutter motor)
  - Heavier gauge track (extra skirt/transport stress)
- **A rolled dome mount ring**
  - Continuous dome mount connection to maintain concentricity.
  - Dimensionally more stable during transport (may minimize dimensional steel requirements for enclosure walls)
  - Potentially reduce gussets outboard of the trailer
- **Removable cross bar** alternative:
  - Lateral/dimensional rigidity provided by dome ring.
  - Lifting of the telescope via synchronized linear actuators instead of hoists in order to provide
    - *coordinated, repeatable, level-lifting.*
    - 4 – 7,000N actuators (w/ 6” travel)
      - Mount to trailer frame
      - Available in 12V configuration (~$300 ea) plus controller
- Pair of removable wheel **guide-rails/stops**
- **Trailer Tie-down**: anchor points on trailer and slab for turnbuckle type tie-downs (wind, seismic, etc)

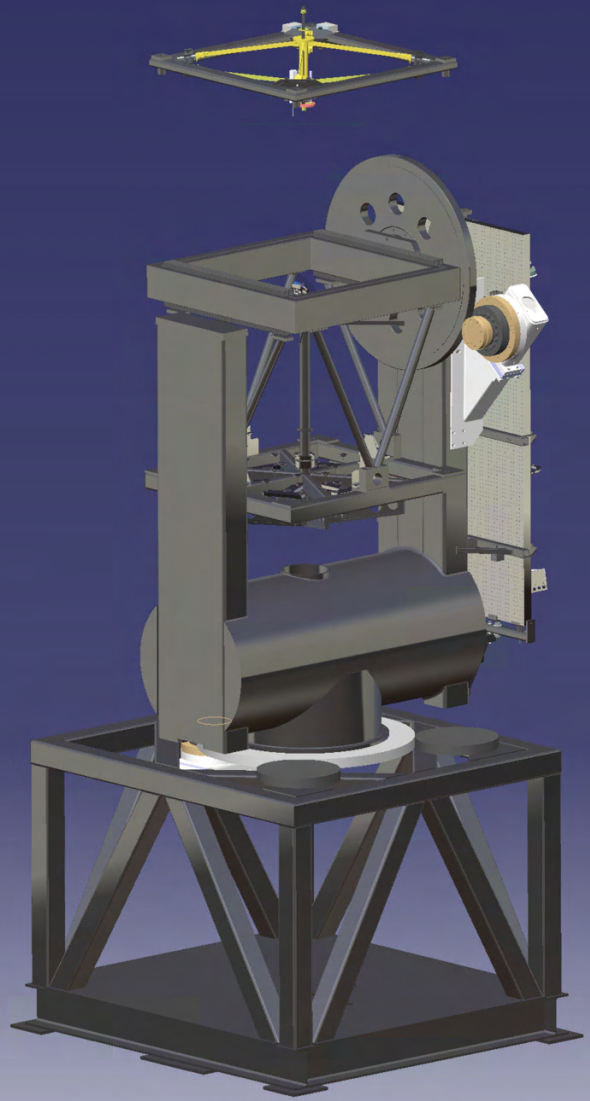
- The Planewave 1m telescope is expected to arrive Fall 2023.
- The Ash Dome is ordered and expected to arrive in Spring 2023.
- We have the base trailer for the preliminary design we have shown here and are in the process of mechanical analysis.
  - SeaWest, UCryo for enclosure
- Currently upgrading trailer (paint, brakes, tires, etc)
- Fabrication of the enclosure should begin in Spring of 2023 as well.
- During Spring/Summer of 2023 the sites will be prepared and concrete pads poured.

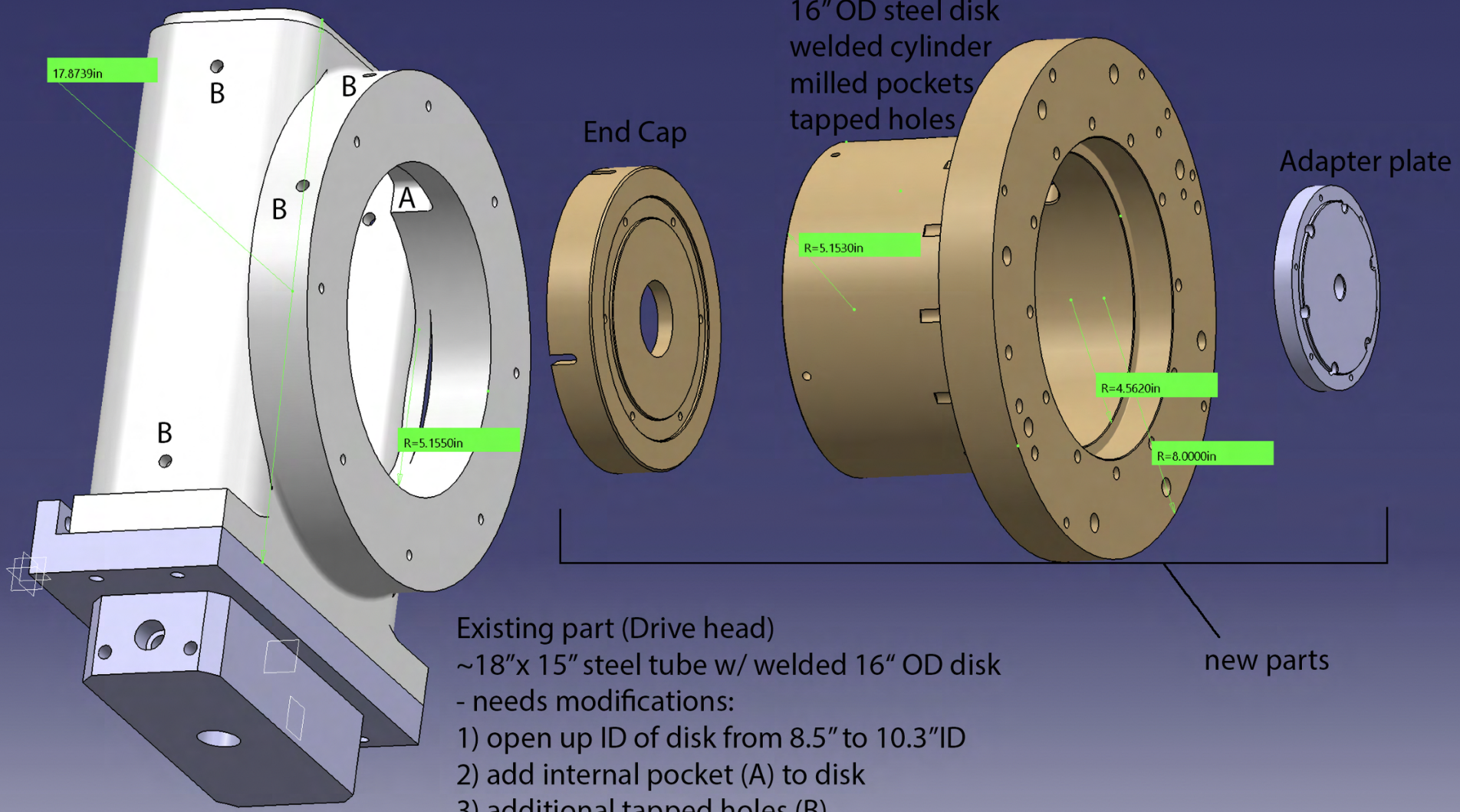
Some thoughts from AAS 241

- Planewave:
  - 2-3 yrs until a 2 meter
  - $2.5 million ea
  - 6.25x the current collecting area
  - > 2 magnitudes deeper
  - move existing telescopes to CMAP sites?
    - 1m outriggers?
  - 6x2m + 4x1m array? 45 baselines!
- John Mather (JWST lead) plenary talk:
  - Showed a pic of NPOI and said “imaging interferometer are coming online”
- How to get more hands at the Array/instrumentation interest
  - REU options
  - Shadow-a-Scientist programs
  - Elliott Horch’s intensity interferometers - try at HLCO?

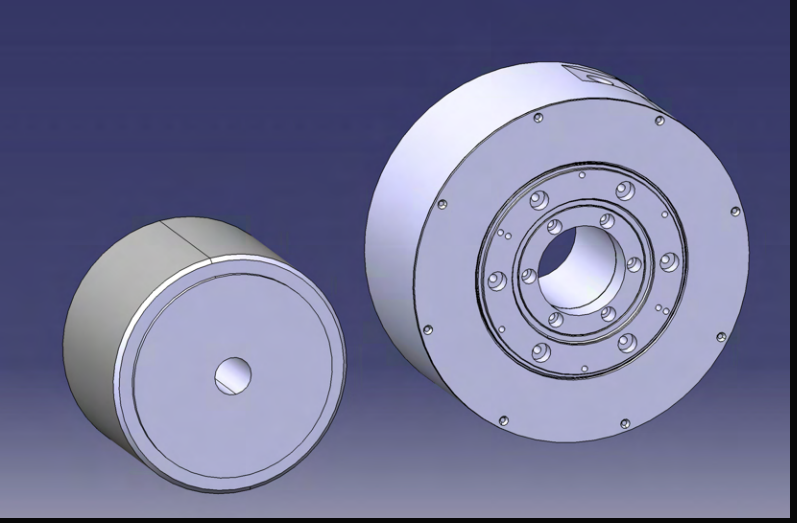
    https://ui.adsabs.harvard.edu/abs/2022AJ....163...92H%2F/abstract
- Funding
  - NSF wants astronomers to compete for MSIPs with MSRI funds
  - Workshops on centers of excellence, partnerships with industry (TIP)
  - Could chara get solar panel funding?
  - Grow local and state politician interest/investment?

other slides





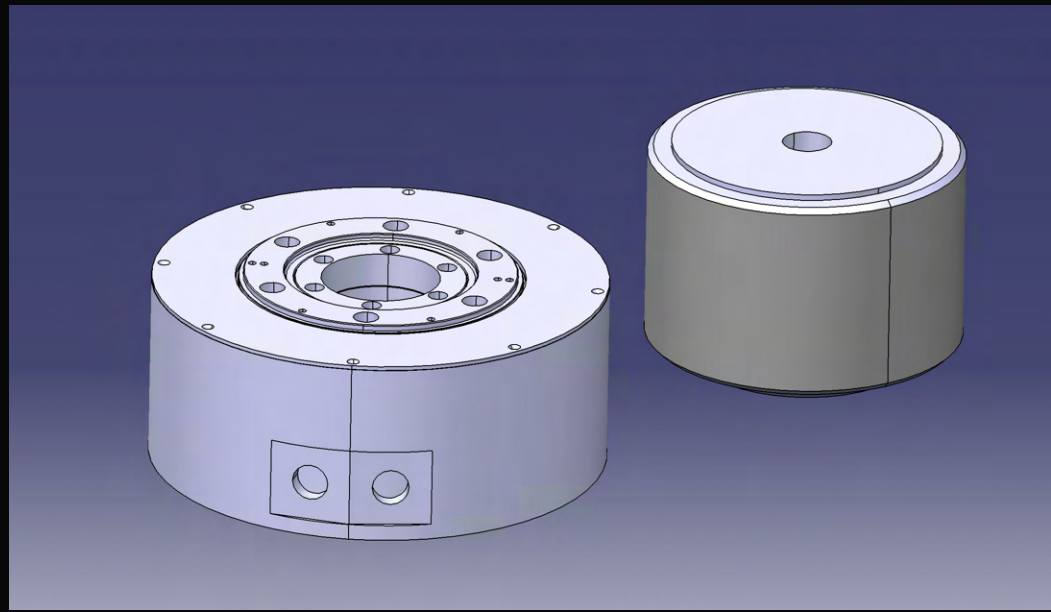
Existing part (Drive head)
~18"x 15" steel tube w/ welded 16" OD disk
- needs modifications:
1) open up ID of disk from 8.5" to 10.3"ID
2) add internal pocket (A) to disk
3) additional tapped holes (B)



	Peak Torque	Rated Torque	Rated Speed	Max Velocity
	(Nm)	(Nm)	rpm	rpm
1015B (existing)	15	5	120	
PM-DDD22 (new)	66	22	200	400

The P series direct drive have higher resolution absolute encoders so the system should be even better than the older Dynaserv series.

Motor accuracy of ±30 arcsec with repeatability of ±1.3 arcsec. This is before the gear reduction, current setup gets <10 arcsec after gearing



Ideal inertia ratio is 10:1 or less

Based on Parker's calculation, this motor has an ratio of 96:1 on the azimuth axis. But since your gear ratios are high and speeds are very low, the inertia ratio of less than 100:1 should be sufficient.

Altitude: 2300 kg-m^2

Load inertia = 2300/(24*6.5)^2 = 0.0945 kg-m^2

Existing motor inertia = 120 kg-m^2 x 10-4

New motor inertia = 57 kg-m^2 x 10-4

Existing inertia ratio = 7.9:1

New inertia ratio = 16.5:1

Azimuth: 11,000 – 13,400 kg-m^2 = kg-m^2

Load inertia = 13,400/(24*6.5)^2 = 0.551 kg-m^2

Existing motor inertia = 120 kg-m^2 x 10-4

New motor inertia = 57 kg-m^2 x 10-4

Existing inertia ratio = 45.9:1

New inertia ratio = 96:1