Lowell Observatory

Status of the Peggy and Eric Johnson 1m Telescope at Anderson Mesa

Dr. Ryan T. Hamilton
Head of Instrumentation

Who's Who

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Key Takeaway

- *We try to keep the "lights off" at our research sites*
  - When the lights are on at night, something broke!
- 6 fulltime staff, 1 part time. ~4.5 for hands-on support
- 4 facility instruments at LDT
  - + EXPRES at some level
  - + RIMAS at some level
  - + On-call 24/7 troubleshooting support
- ~6 things on Anderson Mesa and Mars Hill

Time is an illusion. Lunchtime doubly so.

- **2019**: Anderson Mesa committee recommends replacing the ailing 31”
- **2020, Aug**: cryogenic system failure at 31”
- **2021, May**: Fundraising for 31” replacement
- **2021, June**: Funding acquired!
- **2021, November**: LONEOS site chosen
- **2022**: Trade studies and system reqs. Plan renovations. Place orders!
- **2022, December(ish)**: Renovation starts
- **2023, January thru April**: Obs level demo’ed and rebuilt, control room demo’ed, new telescope supports designed, built, installed
- **2023, May**: Telescope installed!
- **2023, June-Oct**: Dome leak mitigation, bogey redesigns. Control room remodeled.
- **2023, Nov**: Start of more regular operations. SOPHIA test mounted and focuser failed immediately. “Ready in two weeks”
- **2023, also Nov**: Death of loaner FLI camera. Telescope power supply issues.
- **2023, Dec**: Acquire new camera via DON
- **2024, Jan**: New camera on sky. FLI camera repaired. Discovery of condensation issues
- **2024, Feb**: Start of 100% remote usage
- **2024, April**: Failed focuser fixed, reinstalled
- **2024, May**: Scripted operations!

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March 2023

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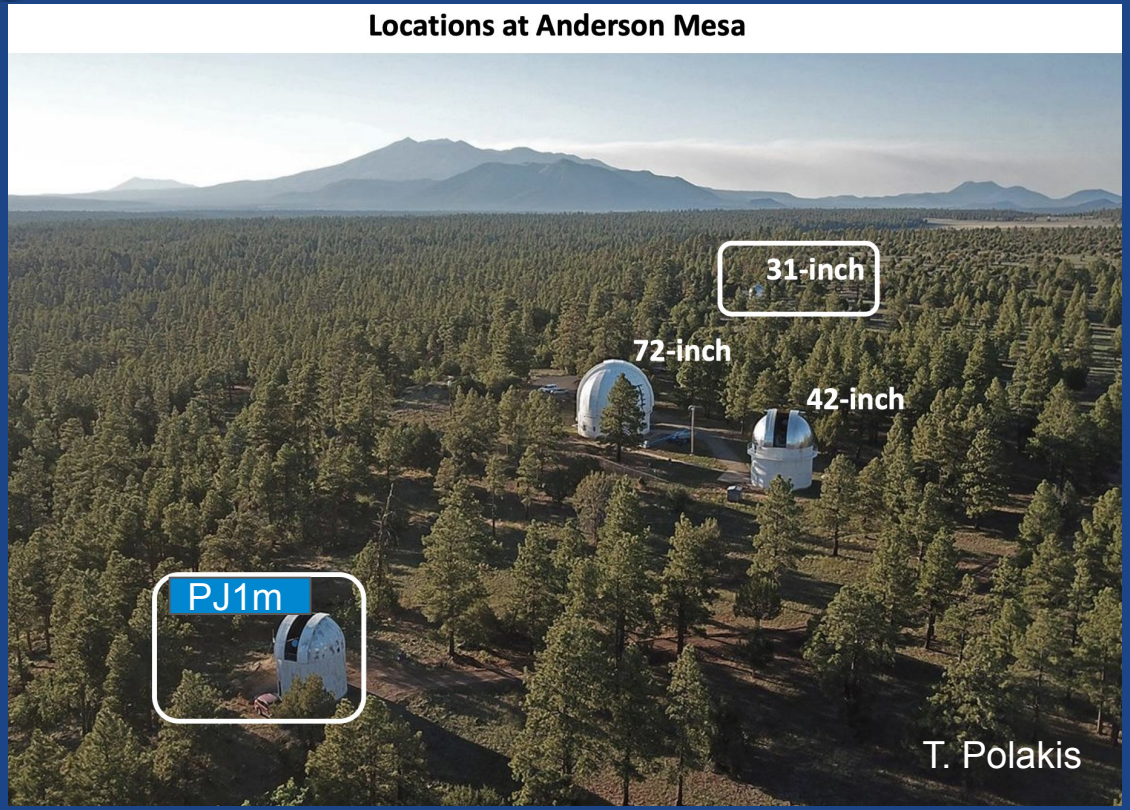
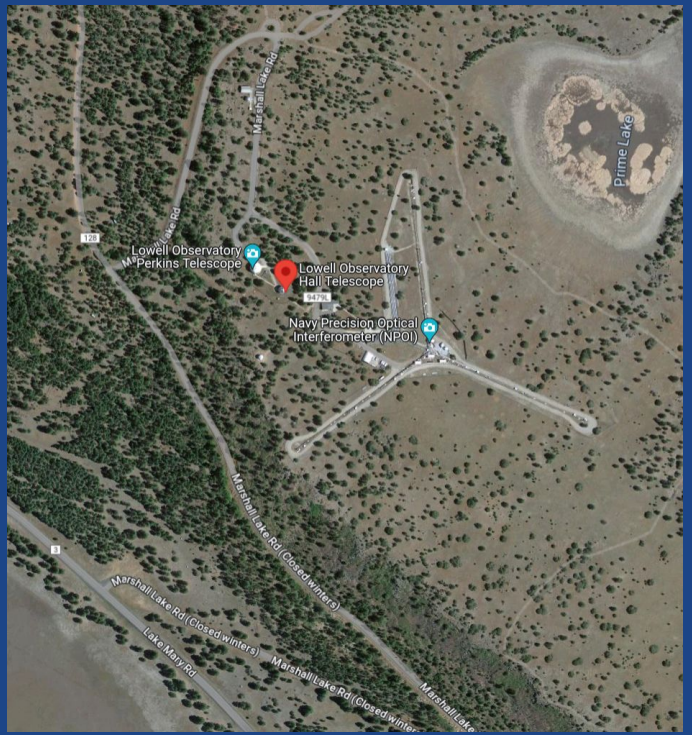
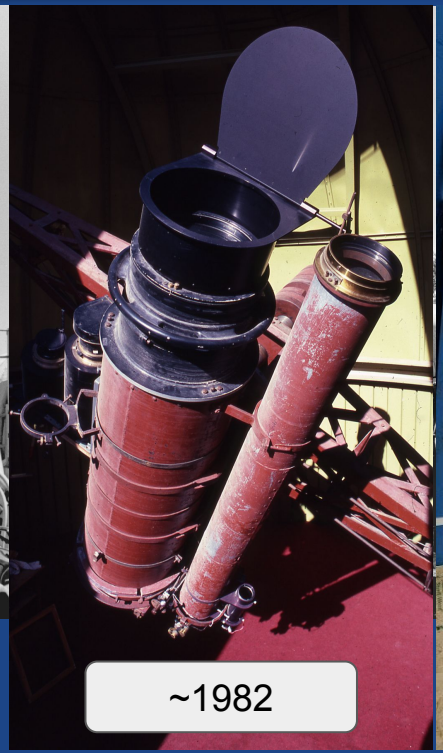
Anderson Mesa Overview





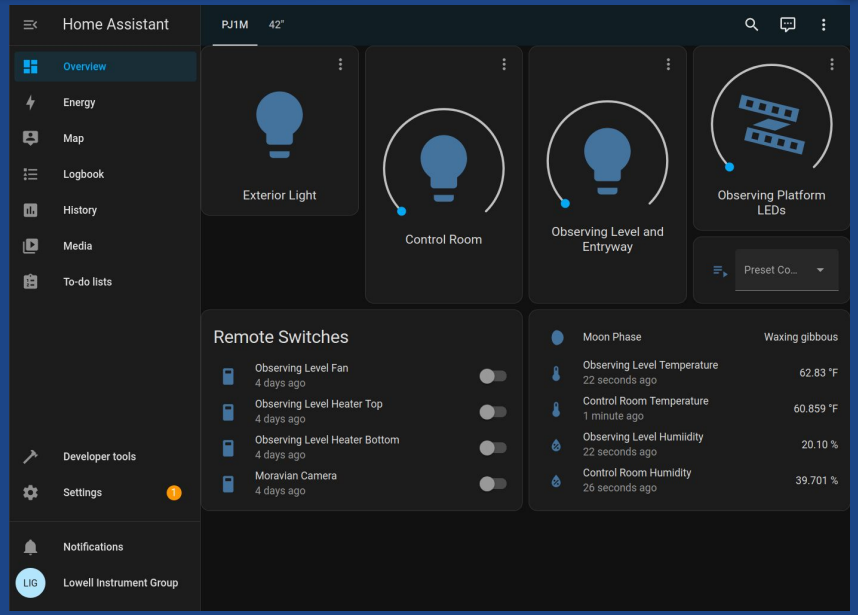
Pluto Discovery -> LONEOS -> ???



Peggy and Eric Johnson 1m Telescope (PJ1m)

Modus Operandi

- *Telescope lifetime <= 20 years*
  - LCOGT is now $400/hr for > 100 hrs, or $53.2k for 133 hours (~16 nights)
  - Assuming ~160 clear & observable nights at Anderson Mesa (a guess!):
    - 40 years == $ 35.71/hour
    - 20 years == $ 71.43/hour
    - 10 years == $ 142.86/hour
    - For fun: SOFIA == $104,000/hour (but the OIG included salaries)
- A long life demands a number of things
  - Flexibility in both HW & SW interfaces
    - Open source when *feasible*
    - Be wary of vendor lock-in!
- Remote-first operations
  - Definitely dictates a lot of choices!



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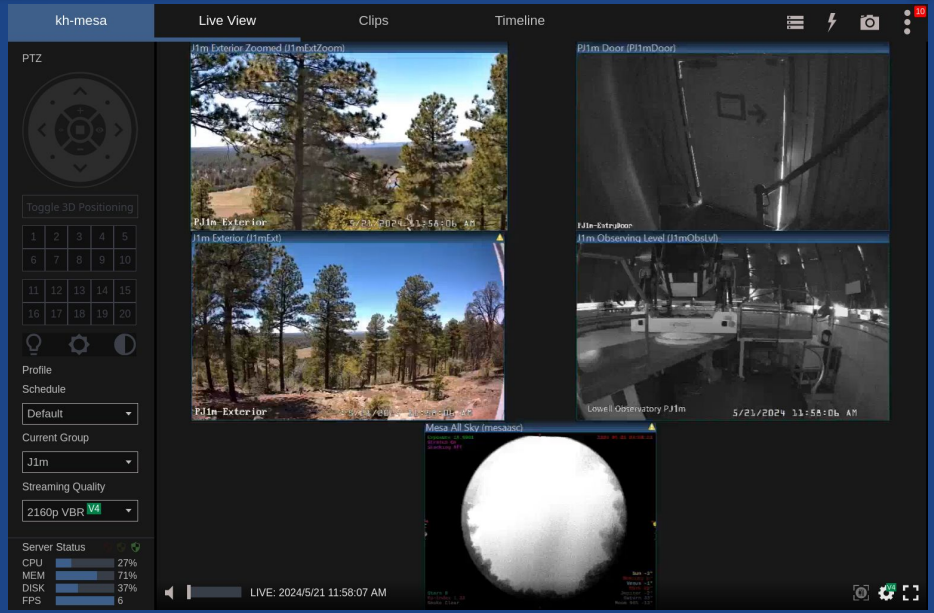
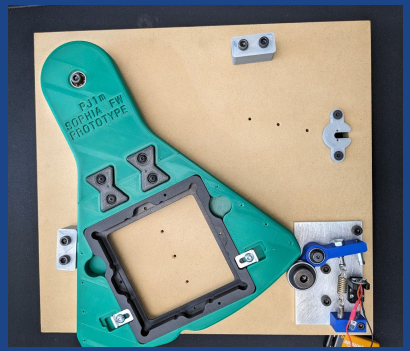
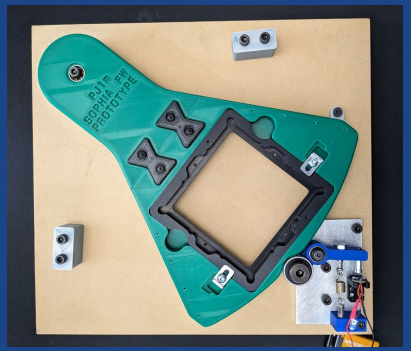
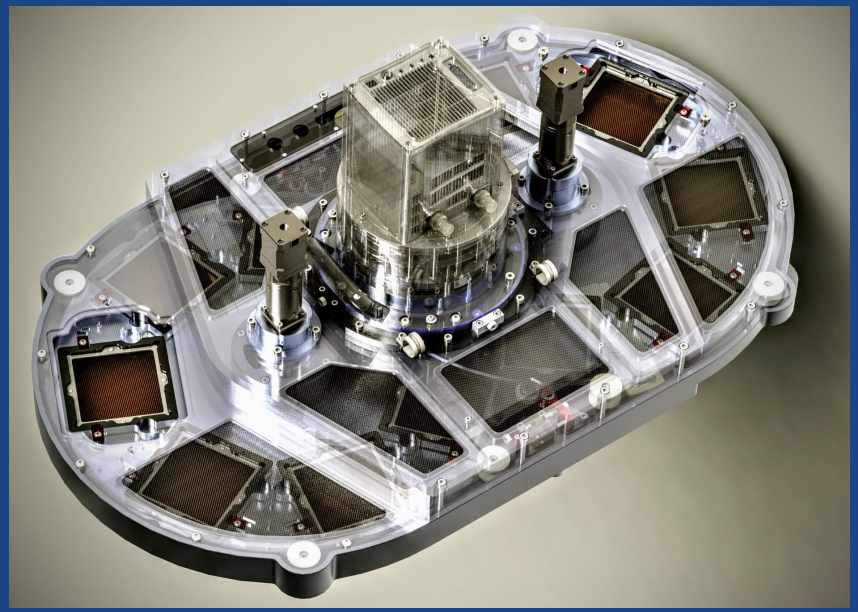


What We Planned

- Camera: Princeton Instruments SOPHIA
  - e2v CCD231, same family as LMI at LDT
- Bonn linear shutter (just like LMI)
- Filter wheel: entirely custom (12 slots)
  - Asahi filters
    - UVBRcIc, ugriz
    - “double-wide VR” filter
    - 101.6x101.6 mm, >= 96mm clear
  - Accommodate filters up to 101.6mm sq







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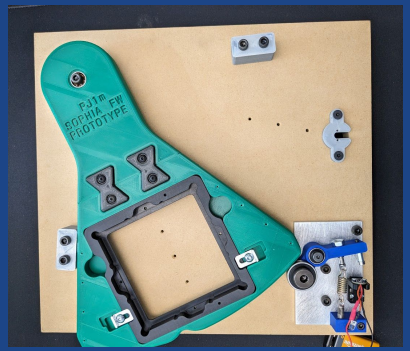
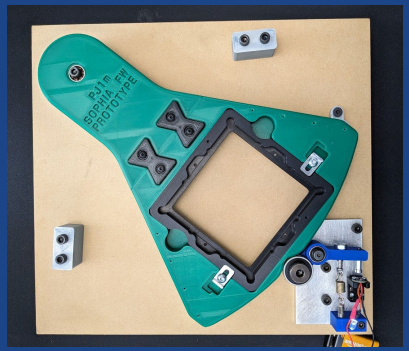
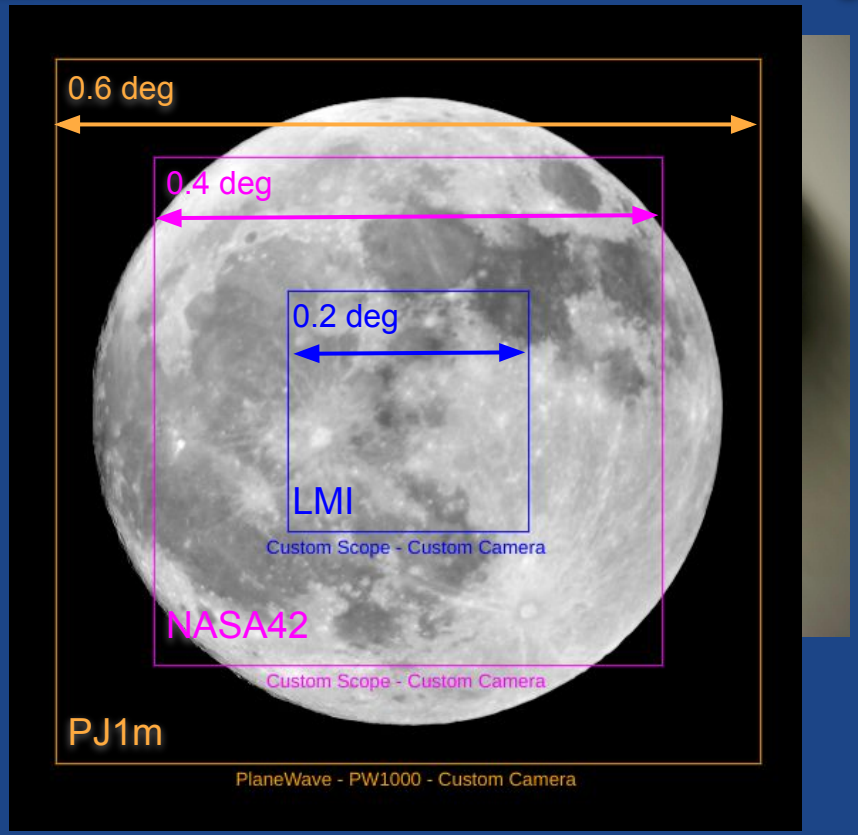
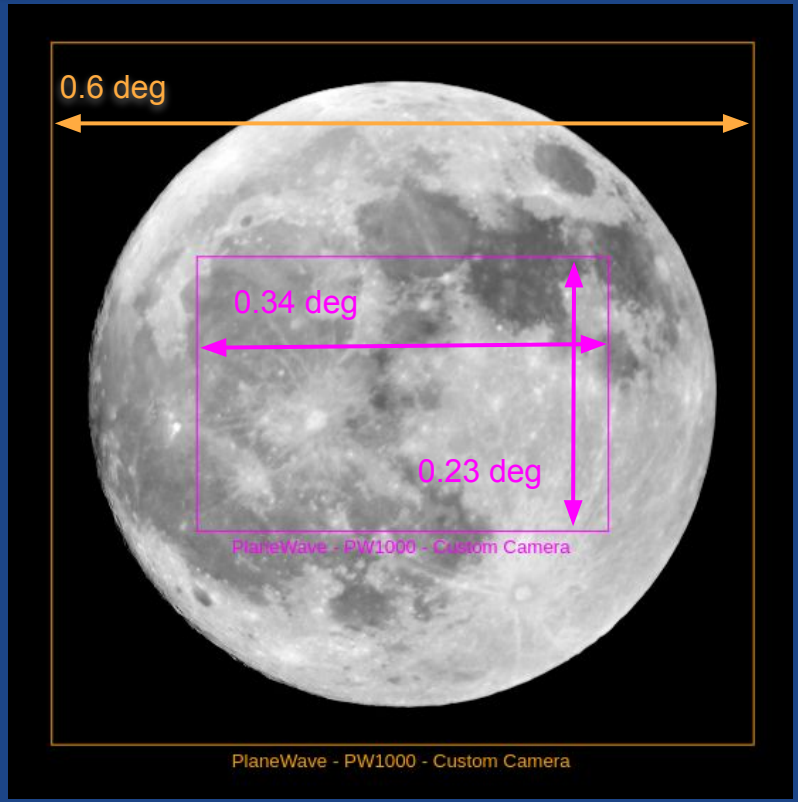






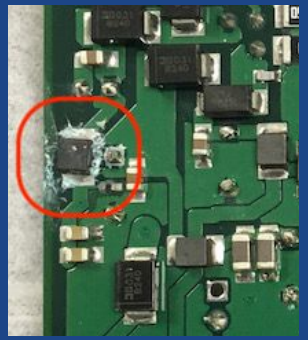
What We've Got

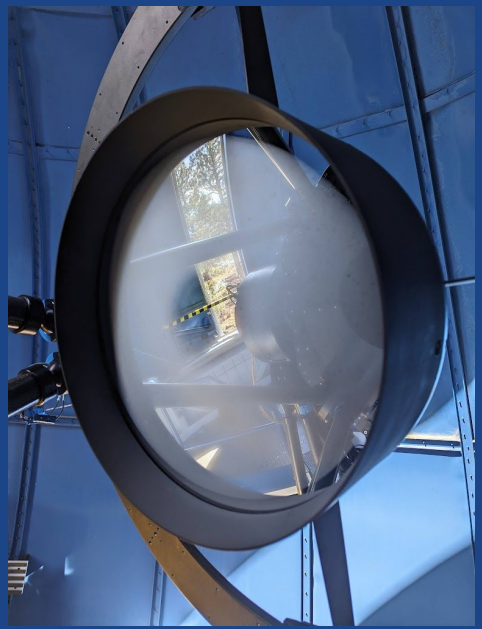
- Moravian C3-61000 Pro
  - Acquired with DON funds (thanks!!)
  - Includes Moravian 7 position filter wheel
  - CMOS camera, Sony IMX455
- Telescope performance: good!
  - 3-600s unguided totally possible when pointing is well calibrated. 900s shown!
  - 0.67" min seeing measured so far
- Remotely controlled site
  - Facility, dome, camera, filter wheel, telescope all fully remotely controlled using a mix of off the shelf and custom interfaces
- Script-driven interface is *tantalizing close*
  - ASCOM Remote + ASCOM Alpaca
    - Will transition to INDI soon
  - Custom software for dome and mount



Disclaimer

- I will now show some of that problems that can occur in this line of work
- *You can plan all you want, but things happen and you just have to adapt*
  - **“If it’s not one thing…it’s two things”**
  - **“If you never make a mistake, you’re not doing anything.”**





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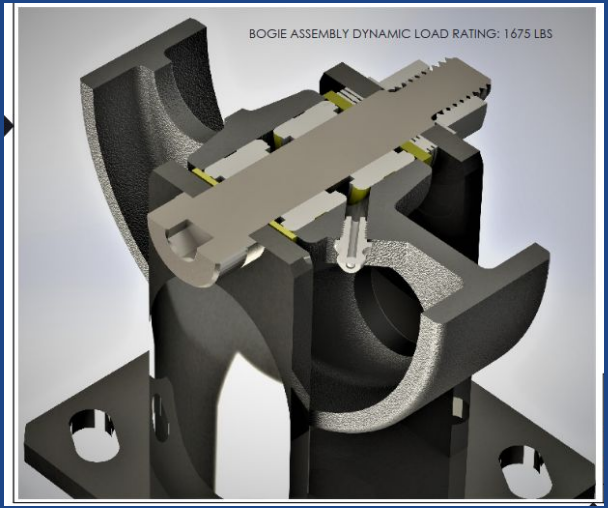
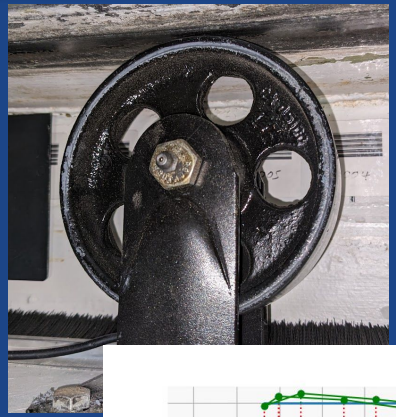
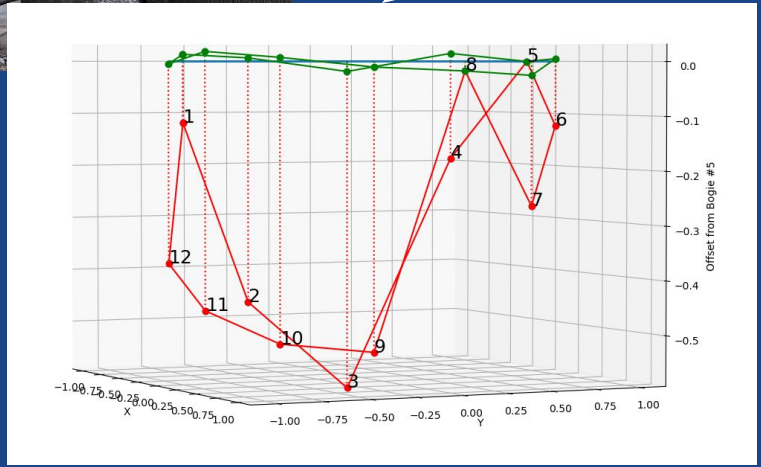
2023: Lowell's Year of the Dome Bogey

- PJ1m Dome dates back to 1970 - rollers ("bogies") were in need of refurbishment
  - Dome is both rigid and taco-shaped, number of bogies in contact varied heavily. Exacerbated problems due to loading.
- Complete redesign, installed Sept 2023



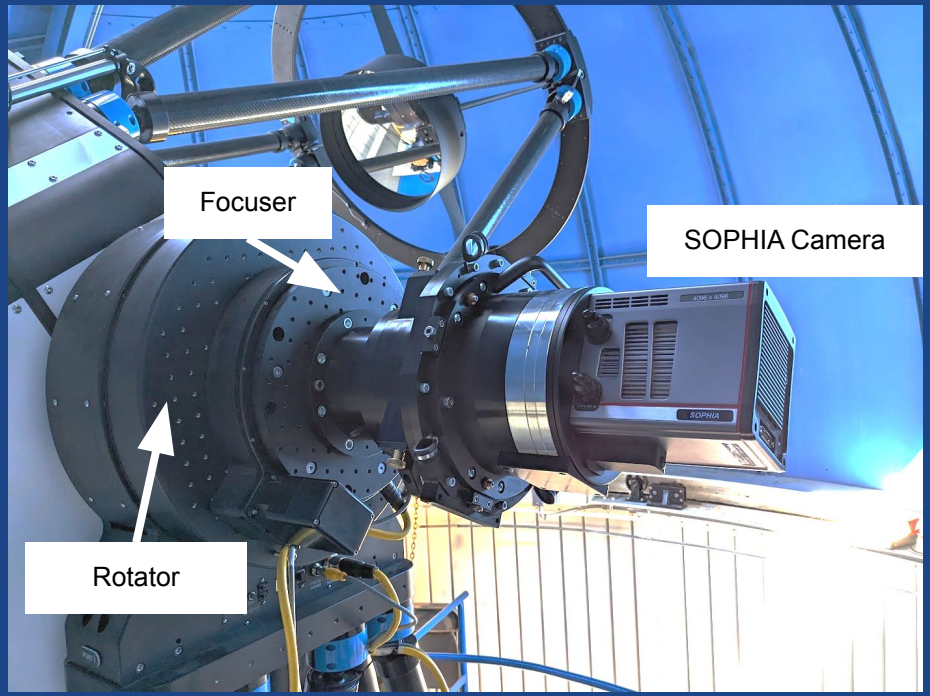


3D scatter plot of all bogies before (red) and after (green) shimming to common plane. 0.5" deviations before!



SOPHIA First Mounting: Tough!

- No-filter-wheel assembly tested on 2023 11 09; focuser mechanism bound
- PlaneWave tested themselves, found the mechanism to be well short of their own design spec. Modified it to meet that spec, returned to us on 2024 Apr
  - End result: better for everyone!
- We were worried about this already, and had designed in additional supports for the final assembly. Ended up back-porting those changes to the intermediate assembly too



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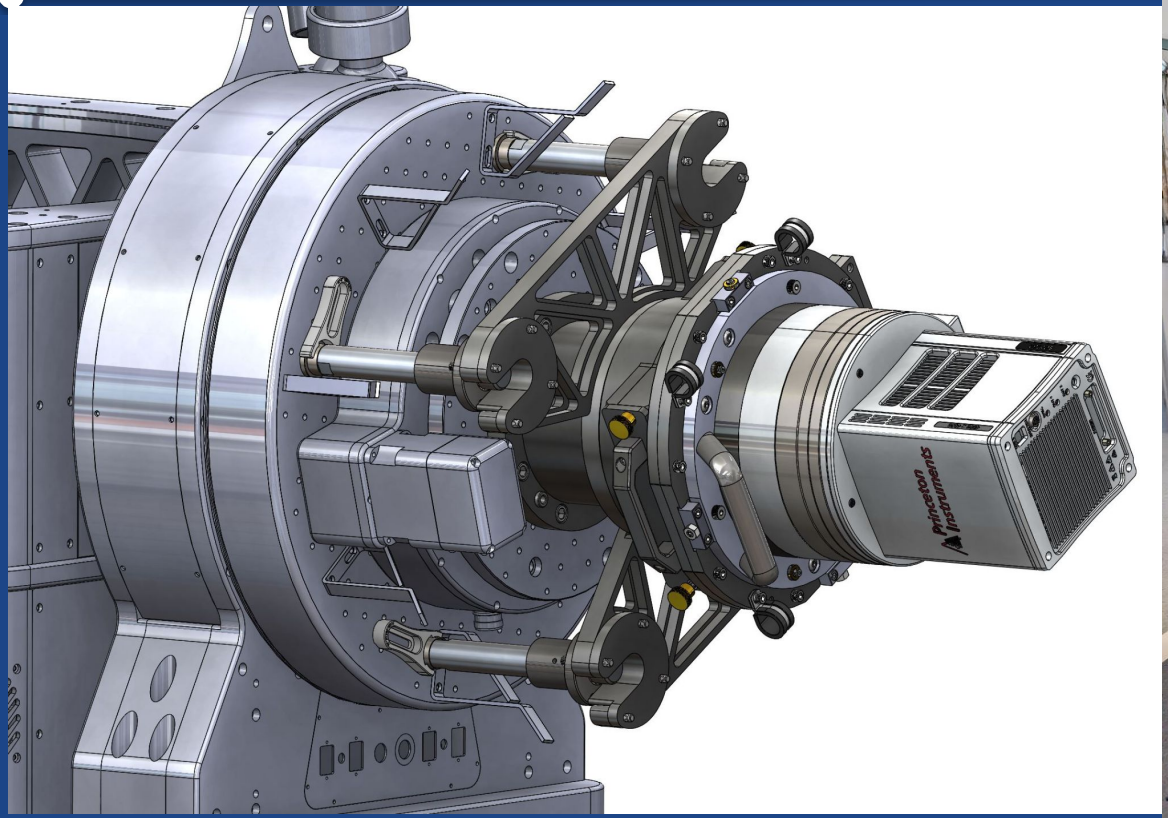


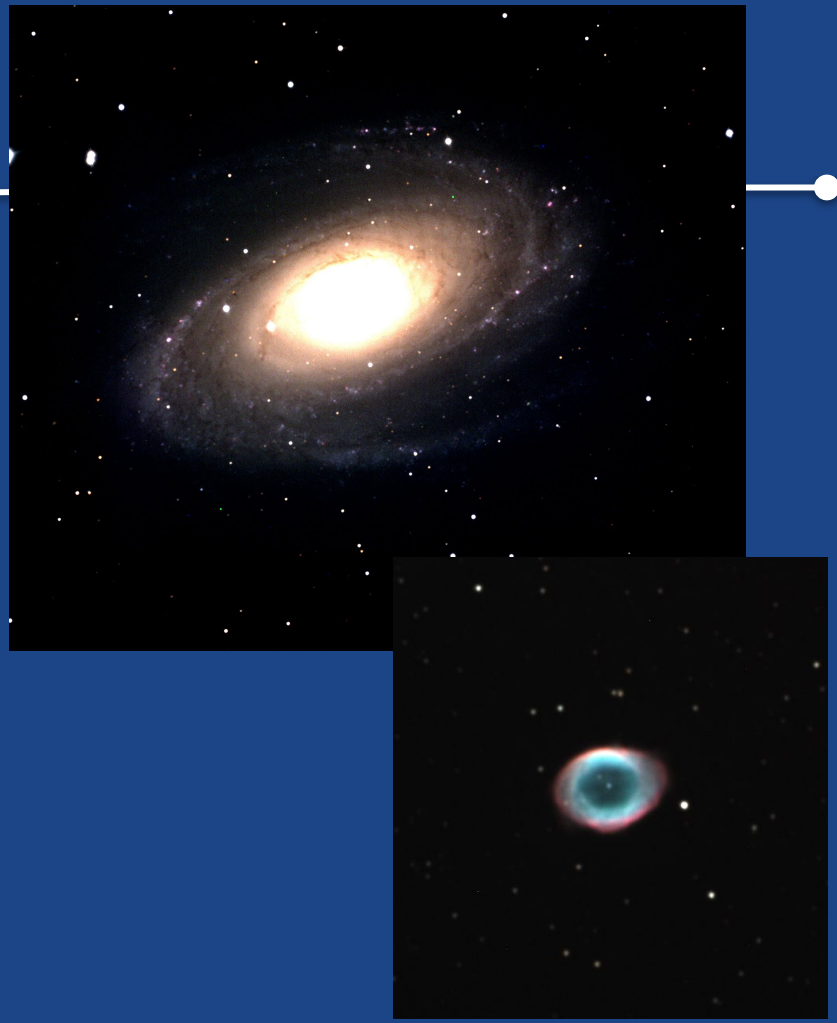
High Notes

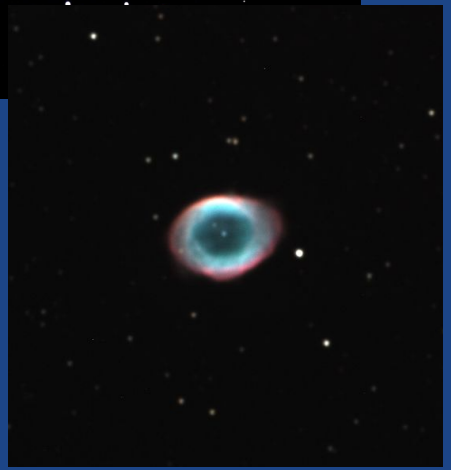
- LONEOS -> PJ1m: 1.5 years, small team
  - 10 people at various FTEs
  - 5-7 people in the trenches
- Telescope in box -> fully operational remotely monitored and controlled facility in 1 year. Script driven in < 3 months.
  - Script interface preliminary, will get folded into the LORAX project as that matures
- Telescope performing great but requires good pointing calibration
  - 3-600s unguided regularly, 900s shown
  - 0.67” seeing across 20 arcmin shown
  - Pointing model generation now 100% auto

Remaining Work

- Finish SOPHIA stackup design and integrate it to PJ1m
  - Filter wheel, camera control software
- Q3 science user documentation
  - Esp. zero points and exposure estimates
- Initial scripting interface
  - Will include an input target file creator
- Flesh out non-sidereal everything
  - Will likely mimic LDT file formats/methods

First science quarter: Q3 2024!





Where's What

LDT	Instrument Control Operations/Nighttime Observing Support Optomechanical Controls for Instrument Cube
	Guider and Wavefront Sensor System (GWAVES)
	Large Monolithic Imager (LMI)
	DeVeny Spectrograph
	Near Infrared High Throughput Spectrograph (NIHTS)
	Extreme Precision Spectrometer (EXPRES; Yale)
	Rapid Infrared Imager-Spectrometer (RIMAS; Goddard Space Flight Center/Univ. of Maryland)

Peggy and Eric Johnson 1m Telescope	Telescope & Facility
	SOPHIA
	Moravian C3-61000 Pro
Hall 42"	Telescope & Facility
	NASA42
	Kron Photometer
TiMo	General support