Potential FORCAST Upgrades*

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*or uses after decomissioning

SOFIA Instrument Road Map

W51 (FORCAST data)

What is FORCAST?

- FORCAST is a dual-camera MIR imager
  - Short Wavelength Camera (SWC): 5 – 25 µm
  - Long Wavelength Camera (LWC): 25 – 40 µm
- Has a dichroic that allows simultaneous observations in both cameras (at a cost to the LWC)
- Transmissive grisms (R~150) were developed and added to the filter wheel to give modest spectroscopic capabilities with no impact on optical design
- FORCAST is requested for 50% imaging and 50% spectroscopy on average

Why upgrade FORCAST?

- Only full-time MIR (5-25 μm) access from ground/air are VISIR on VLT in the Southern Hemisphere and SOFIA in the Northern Hemisphere
- JWST (+ELT?) will work from 5-25 μm but will do very different science
- FORCAST uniquely has arrays that go out to 40 μm
- New MIR array acquisitions are a crapshoot
- An upgraded FORCAST instrument could add new capabilities to the observatory in the MIR that could be realized faster than building a new MIR instrument from scratch

Possible Upgrades

- Upgrade spectroscopy capabilities by replacing grisms with gratings
- Add a scanning mode for large-field mapping
- Add polarimetry mode

Why replace grisms with gratings?

Grisms in FORCAST have low throughputs since they are transmissive; gratings have much higher throughputs (approaching 100%) because they are reflective

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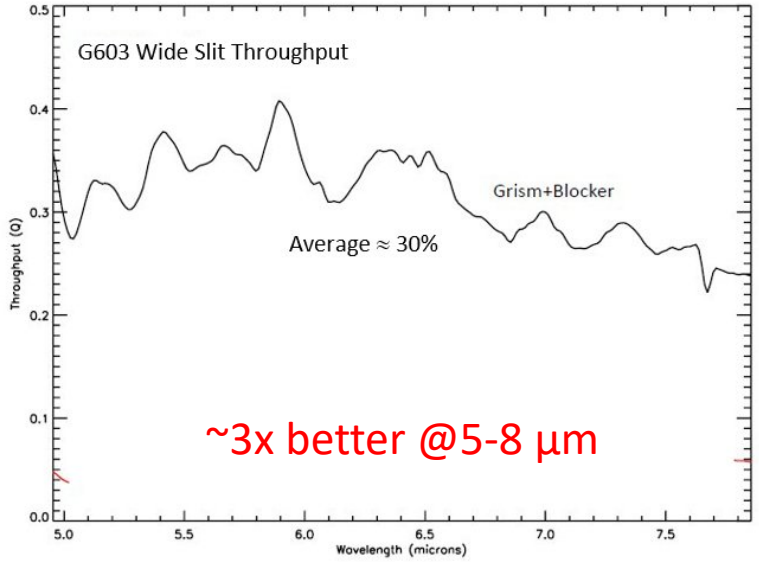
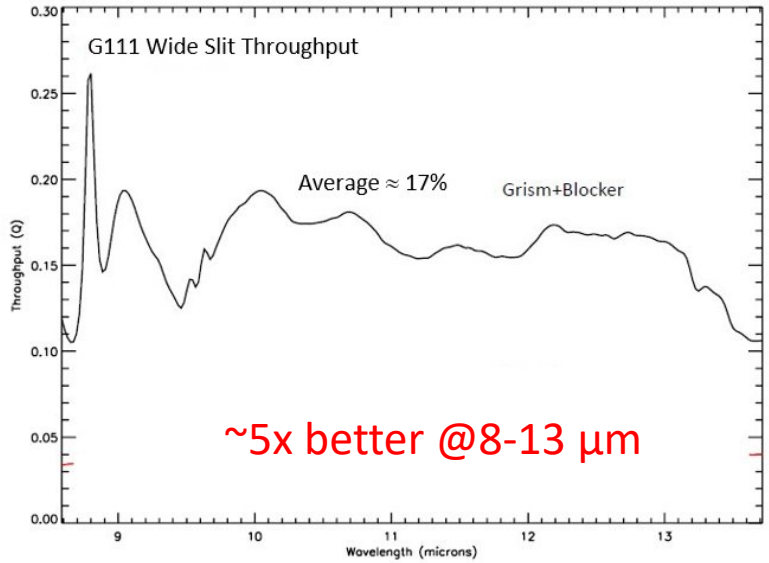
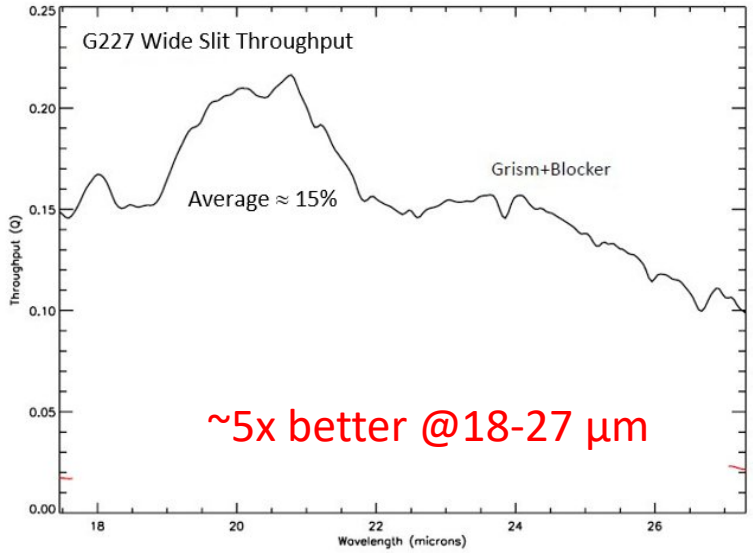
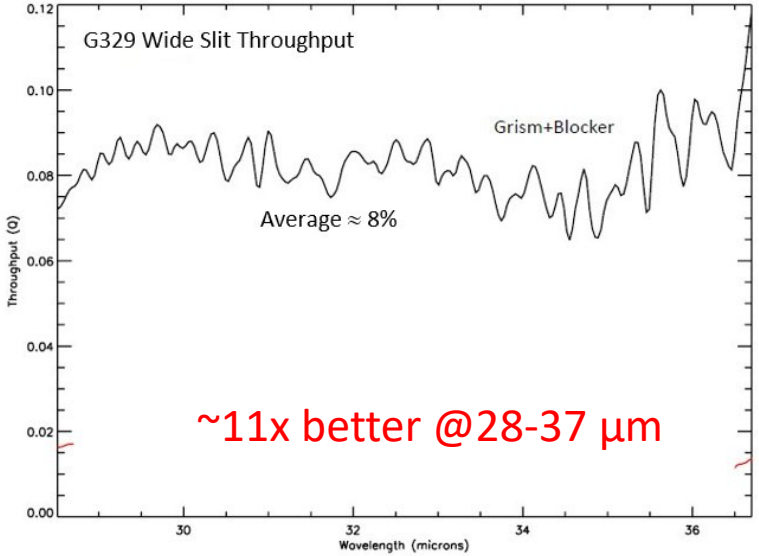




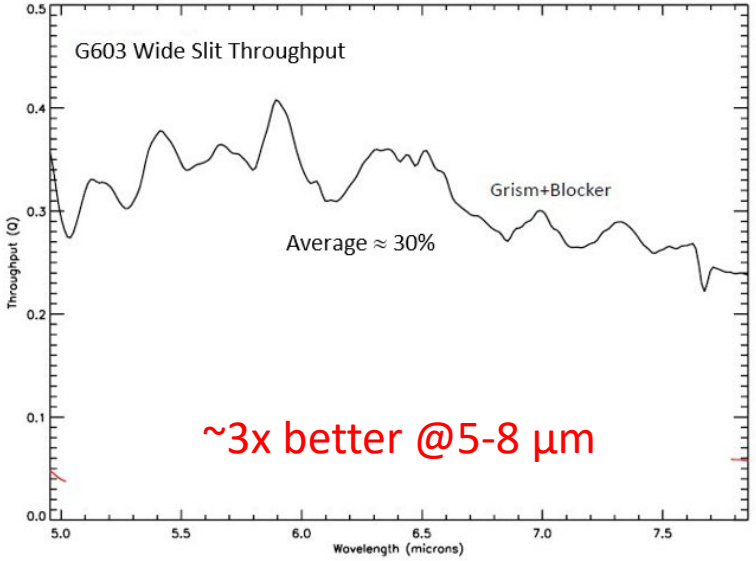


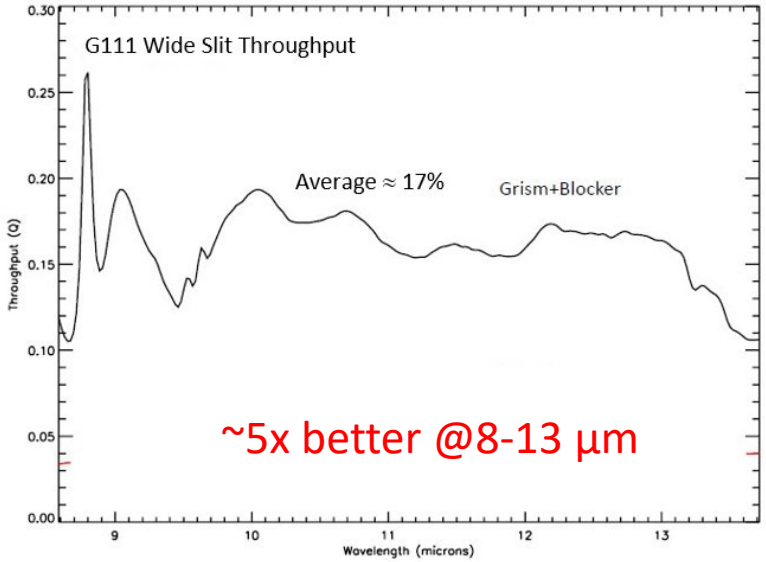


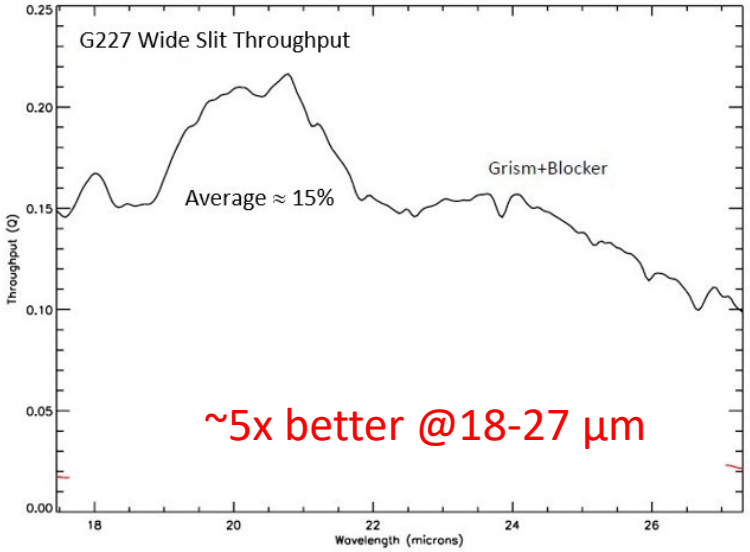
Why replace grisms with gratings?

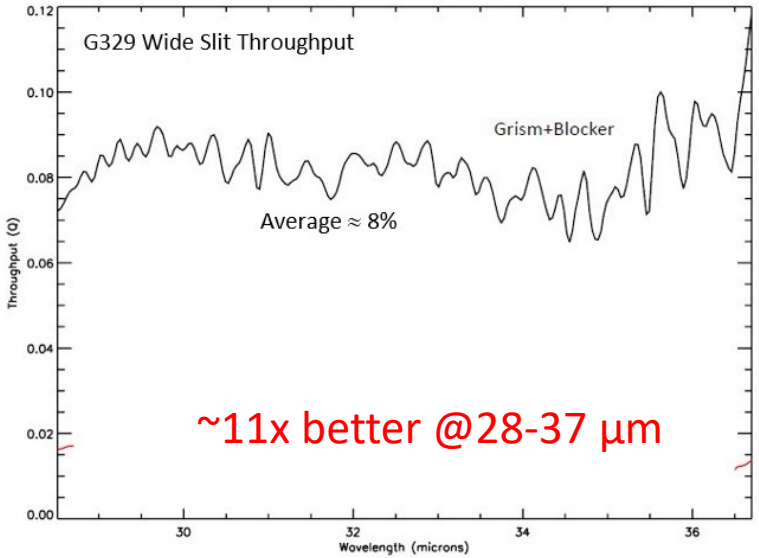
Would require:

- SWC and LWC Gratings
- 2 grating turret assemblies
- Optical design plus new optical elements
- Software/hardware changes





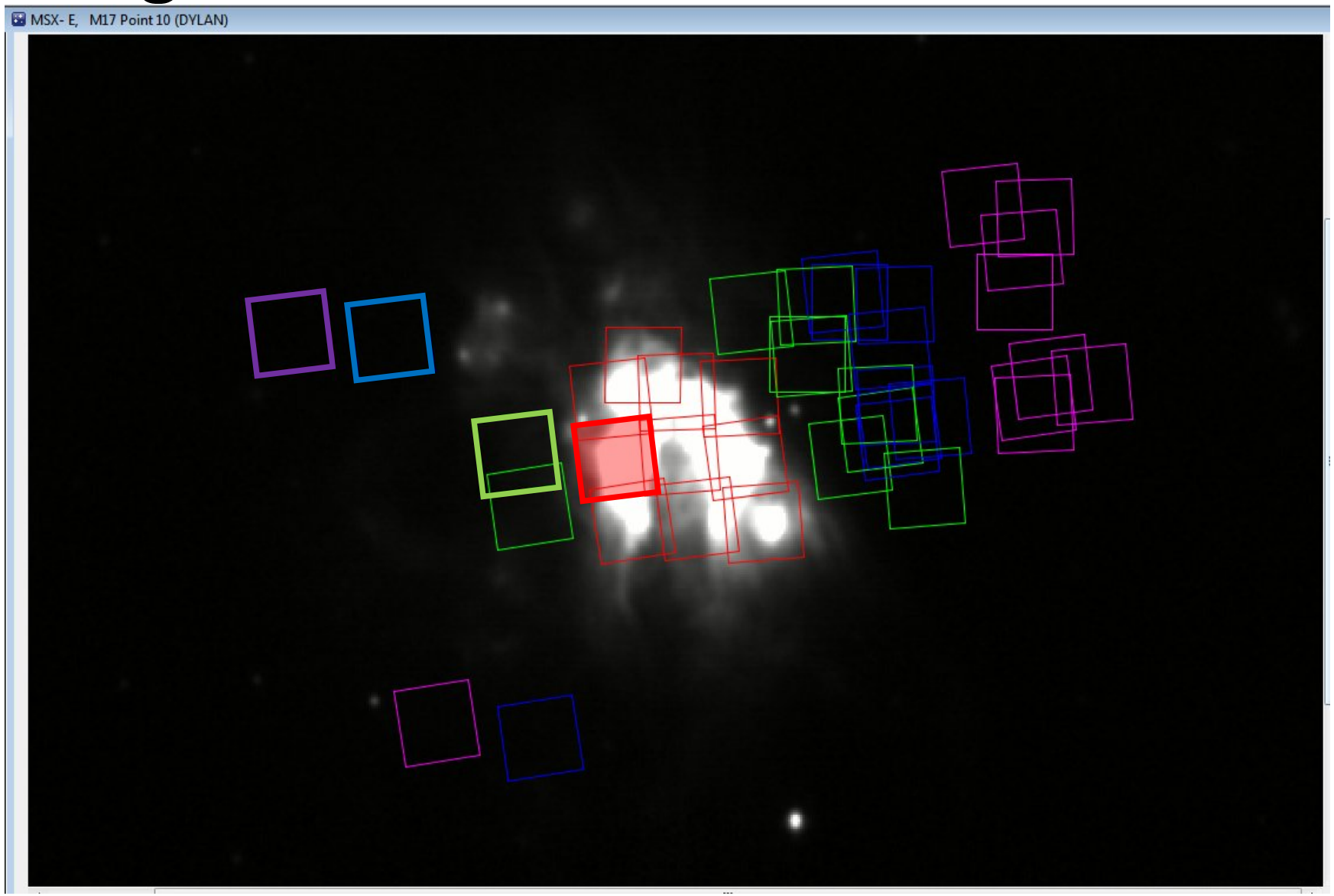




Why add a scanning mode?

Presently FORCAST has the ability to map large areas with its asymmetric chop mode (C2NC2)

Since only 1 of 4 chop-nod beams are on-source, efficiency is low (~3x longer than NMC chop-nod)



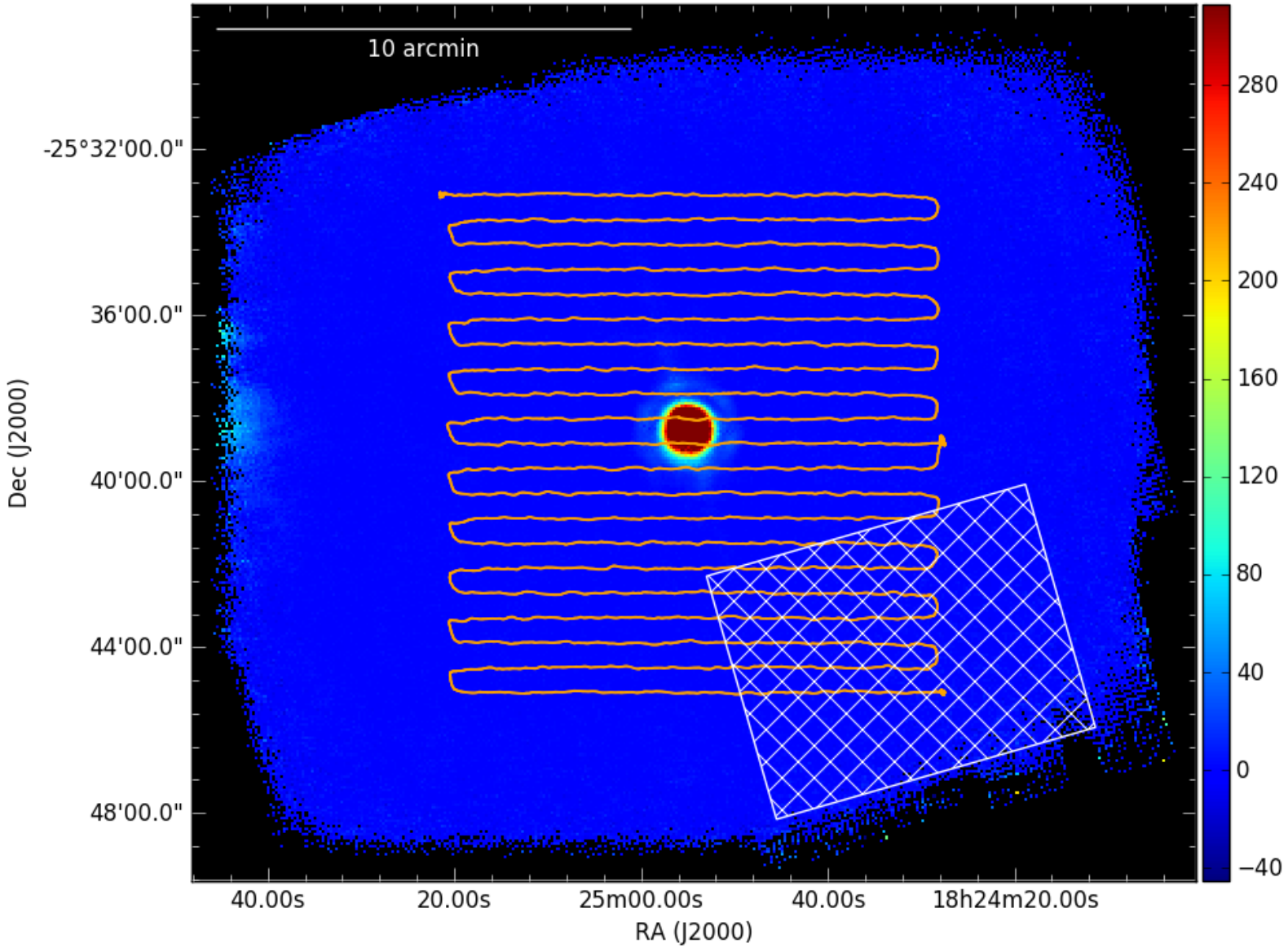
Why add a scanning mode?

The telescope can perform scan maps and lissajous patterns, as used by HAWC+.

The FORCAST arrays could be configured to read out in a continuous fashion to work in a similar way.

Scanning would be ~6x faster than C2NC2.

HAWC+ Scan Map



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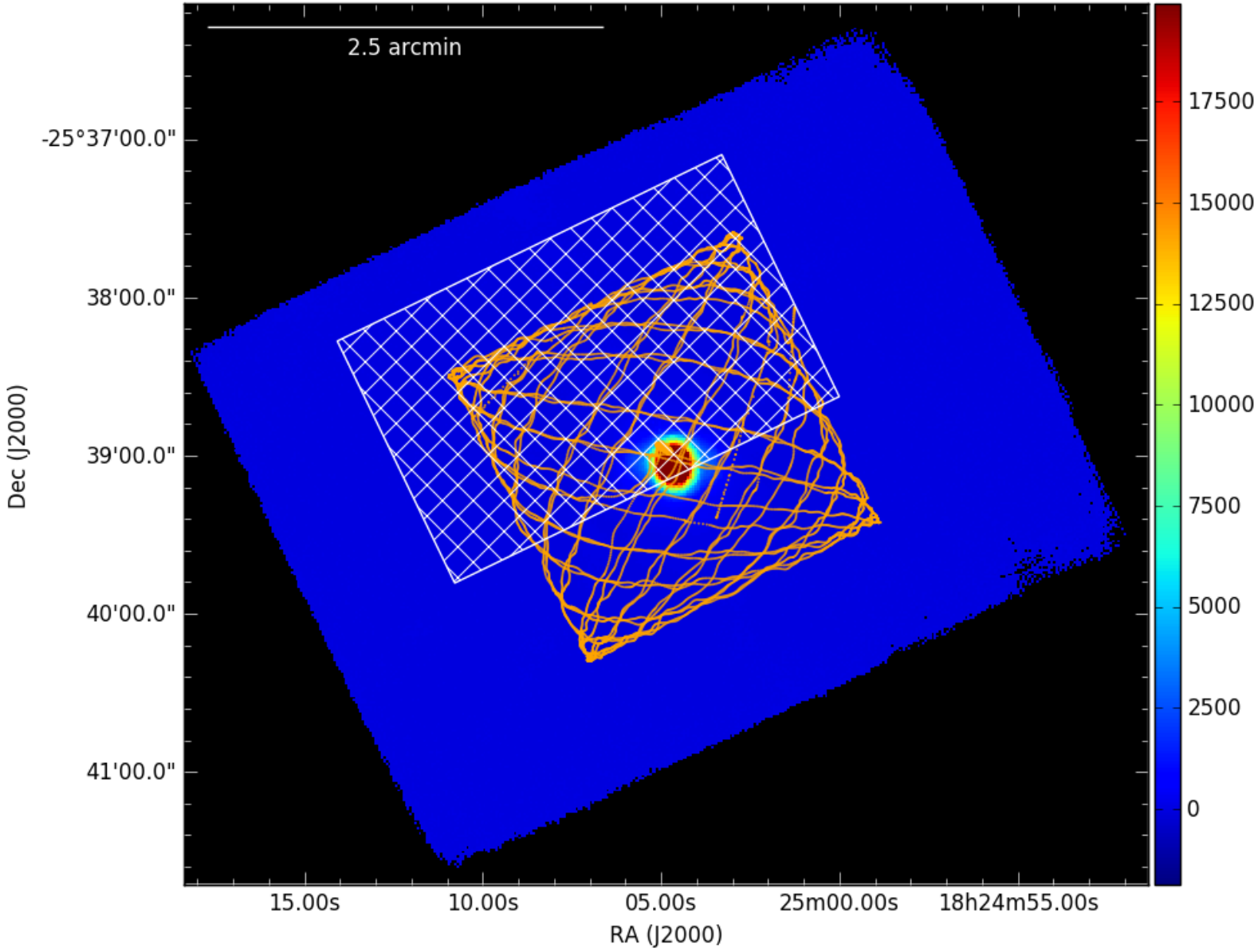
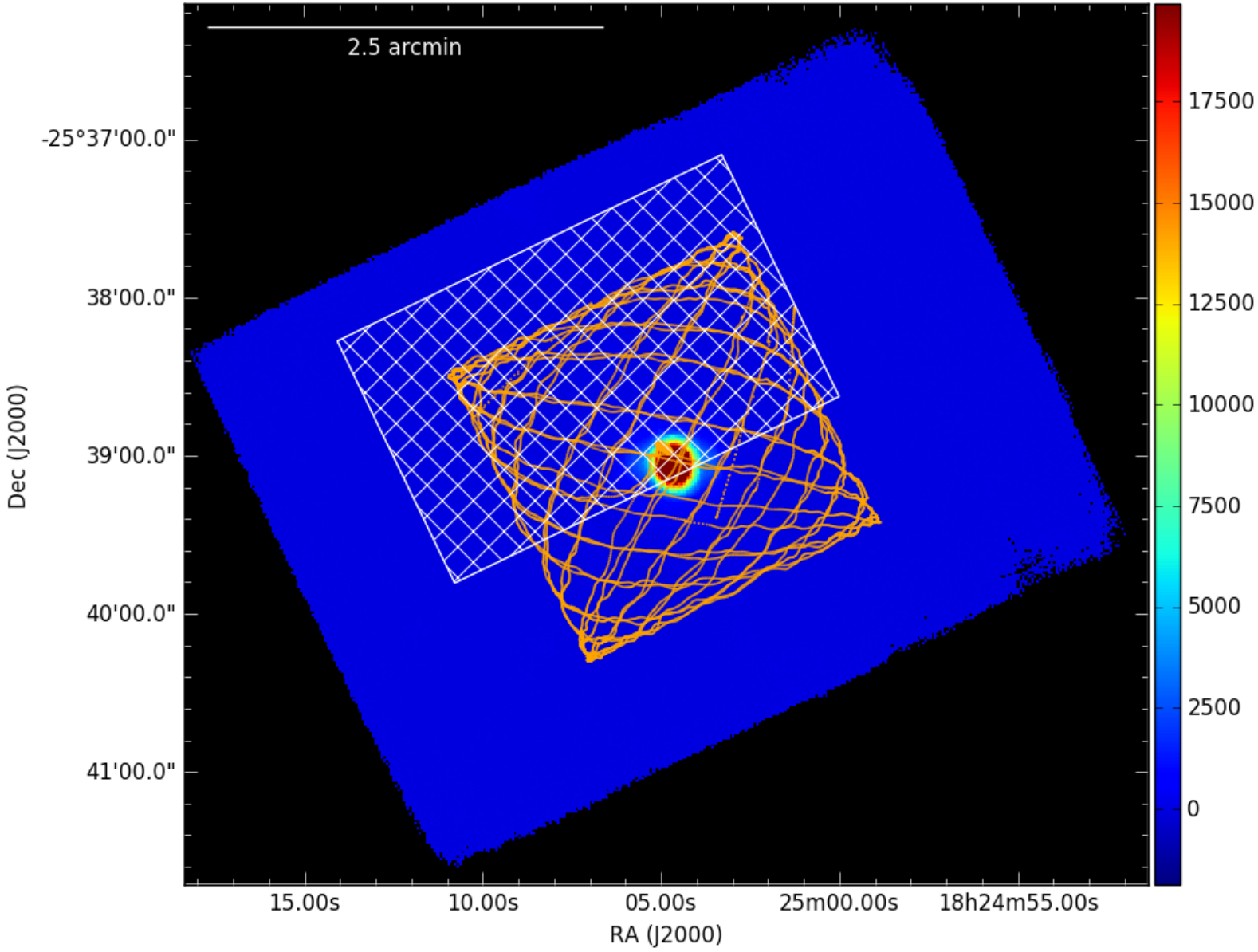
HAWC+ Lissajous Map



Why add a scanning mode?

Would require:

- Electronics changes
- Software changes



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The Cycle 7 FORCAST Legacy Project required 35 hours spread over 10 flights.

If performed in scan mode, it would have required less than 6 hours over two flights.

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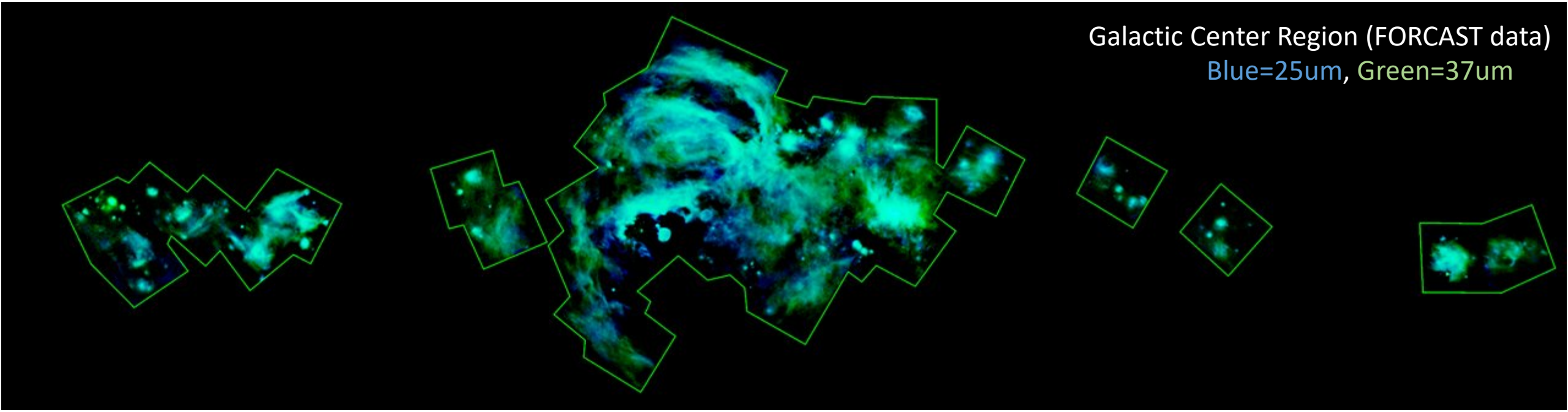

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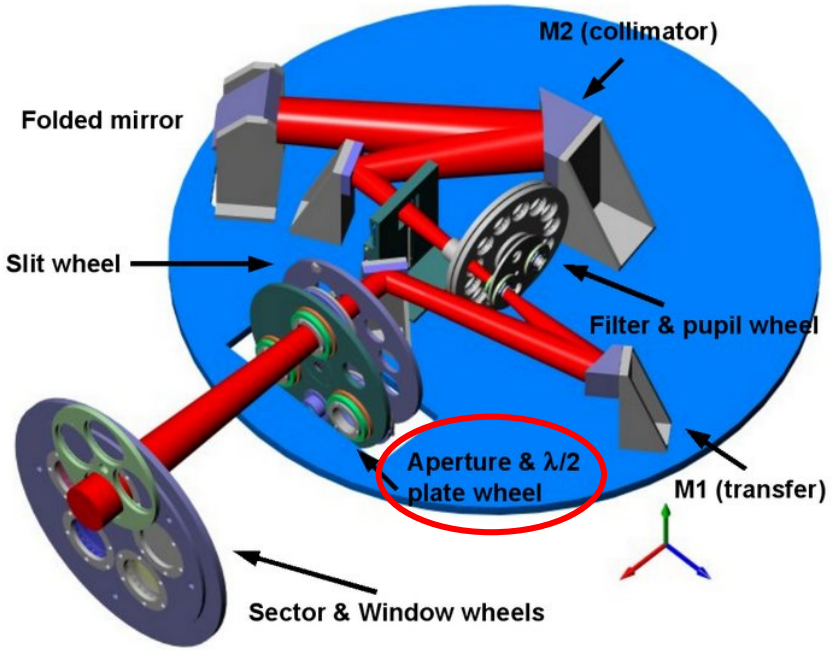
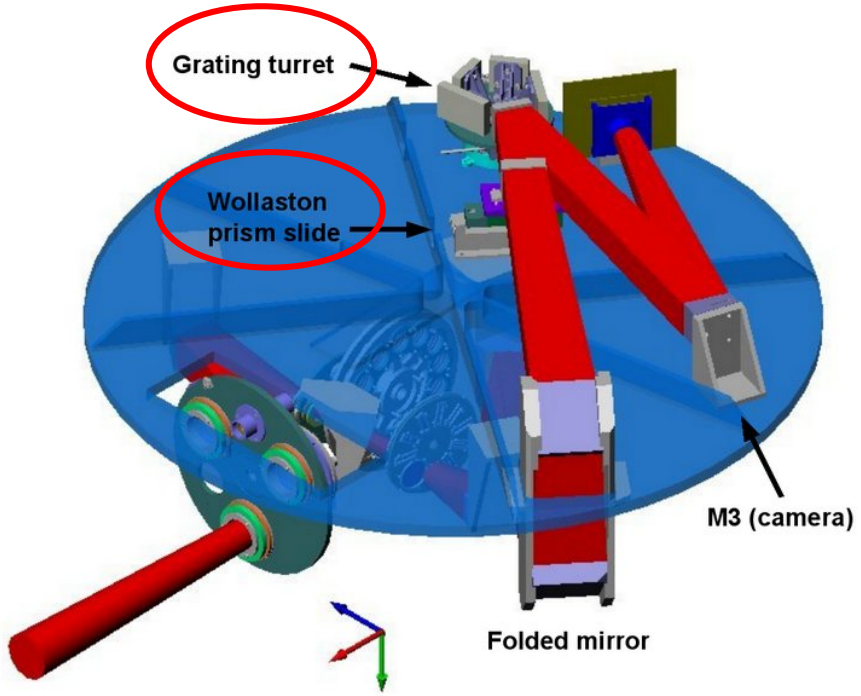
How could we add a polarimetric mode?

The FORCAST optics bench has some space, and we may be able to add in the necessary optical elements to perform polarimetry.



Top of CanariCam Optics Bench



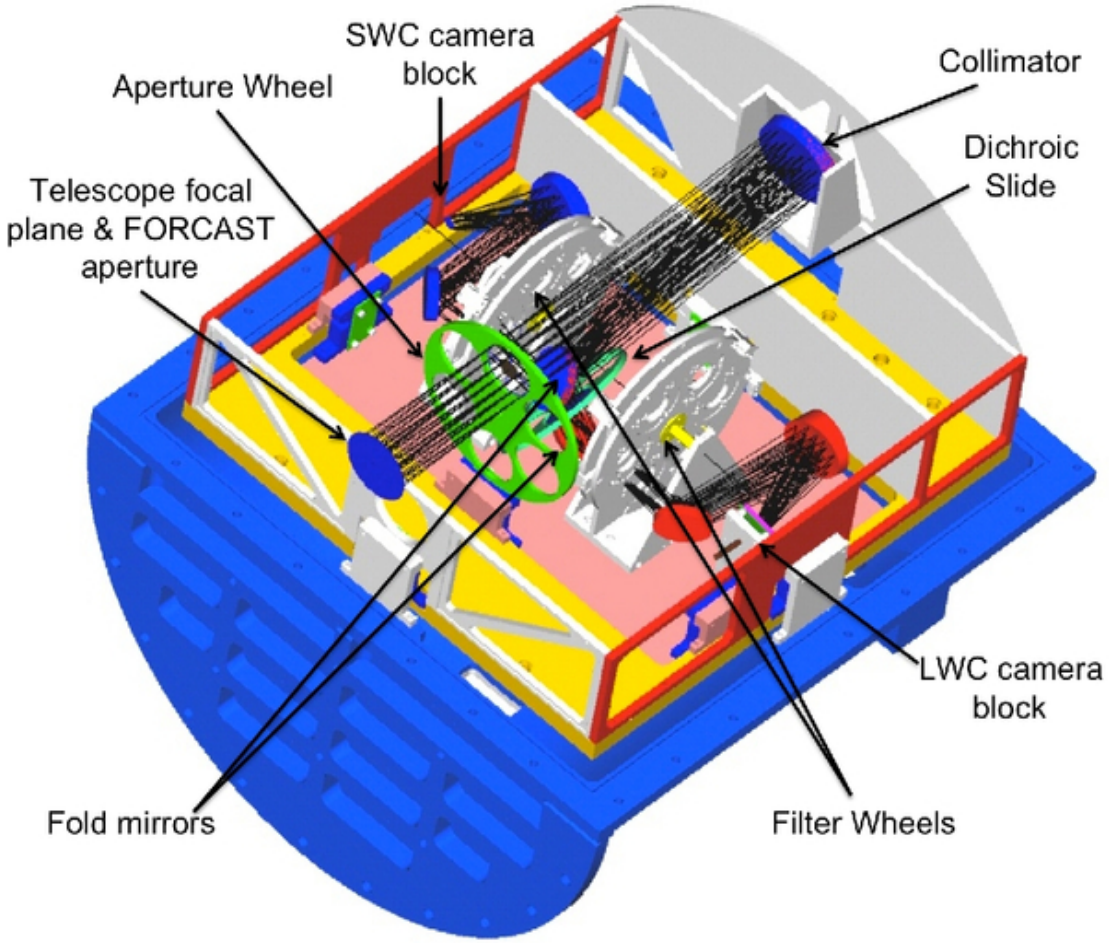
Bottom of CanariCam Optics Bench

How could we add a polarimetric mode?

Would require:

- New optical design (to even see if feasible) and optical elements
- Half-wave plate in aperture wheel
- Wollaston prism and slide mechanism
- Gratings/grating turret (if spectropolarimetry desired)
- Hardware/software changes

FORCAST Optics Bench



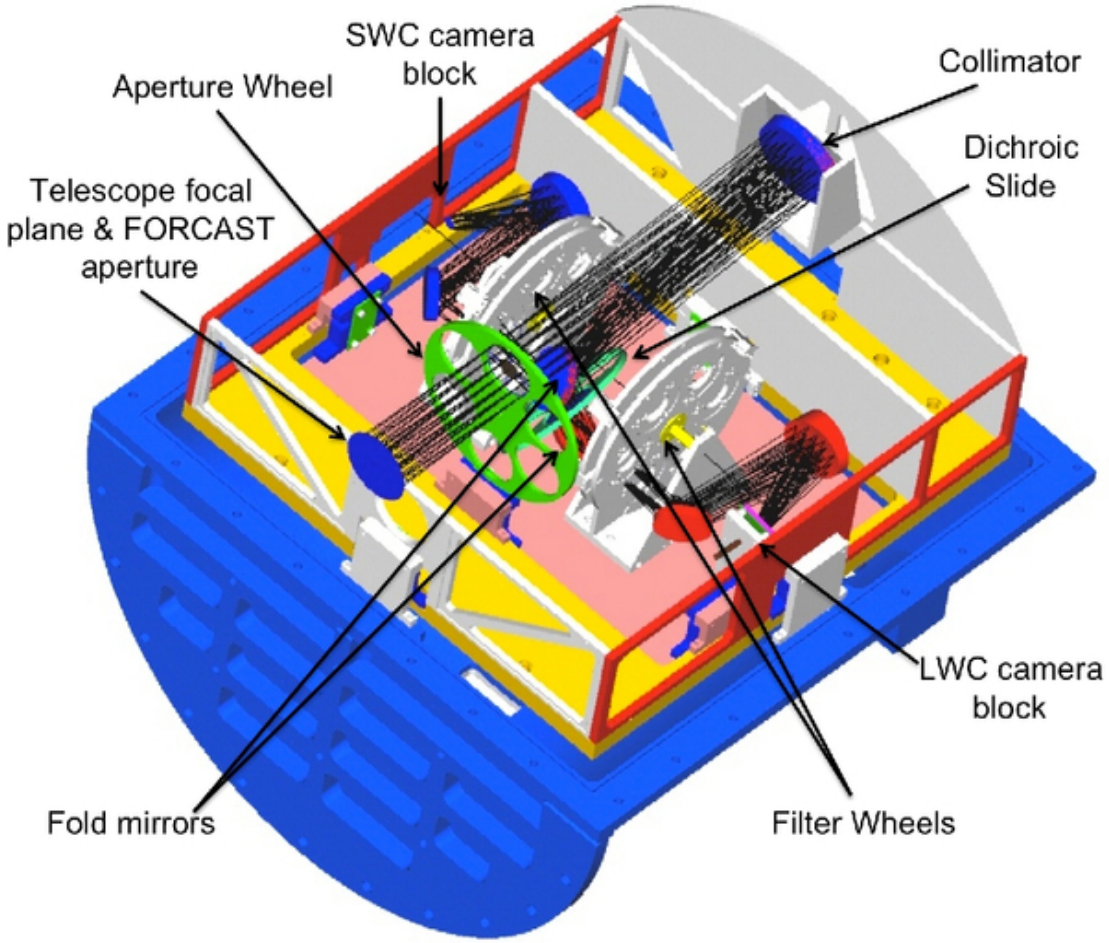
How could we add a polarimetric mode?

For simplicity, and for highest scientific use, perhaps only add this to short wavelength (5-25 µm) arm of FORCAST.

Could be combined with gratings to provide spectropolarimetry

Could be combined with scanning mode to provide high-speed imaging polarimetry like HAWC+'s scanpol mode

FORCAST Optics Bench



“Cycle 9 is potentially the last cycle in which FORCAST will be offered, depending on funding and proposal pressure.”

- SOFIA Cycle 9 Call for Proposals

Uses after decommisioning

- Functional mid-infrared arrays are hard to come by (esp. 25-40 µm)
  - Make FORCAST arrays (and electronics) available to a future next-gen instrument (like SMIRPh)
- Airworthiness can be a significant obstacle to overcome
  - Make cryostat available for a future next-gen instrument, or as a testbed for development projects