



# SOFIA First Light: Observations with FORCAST



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+ Project Team (Ames, Dryden, USRA)



TLH: 11-Jan-11



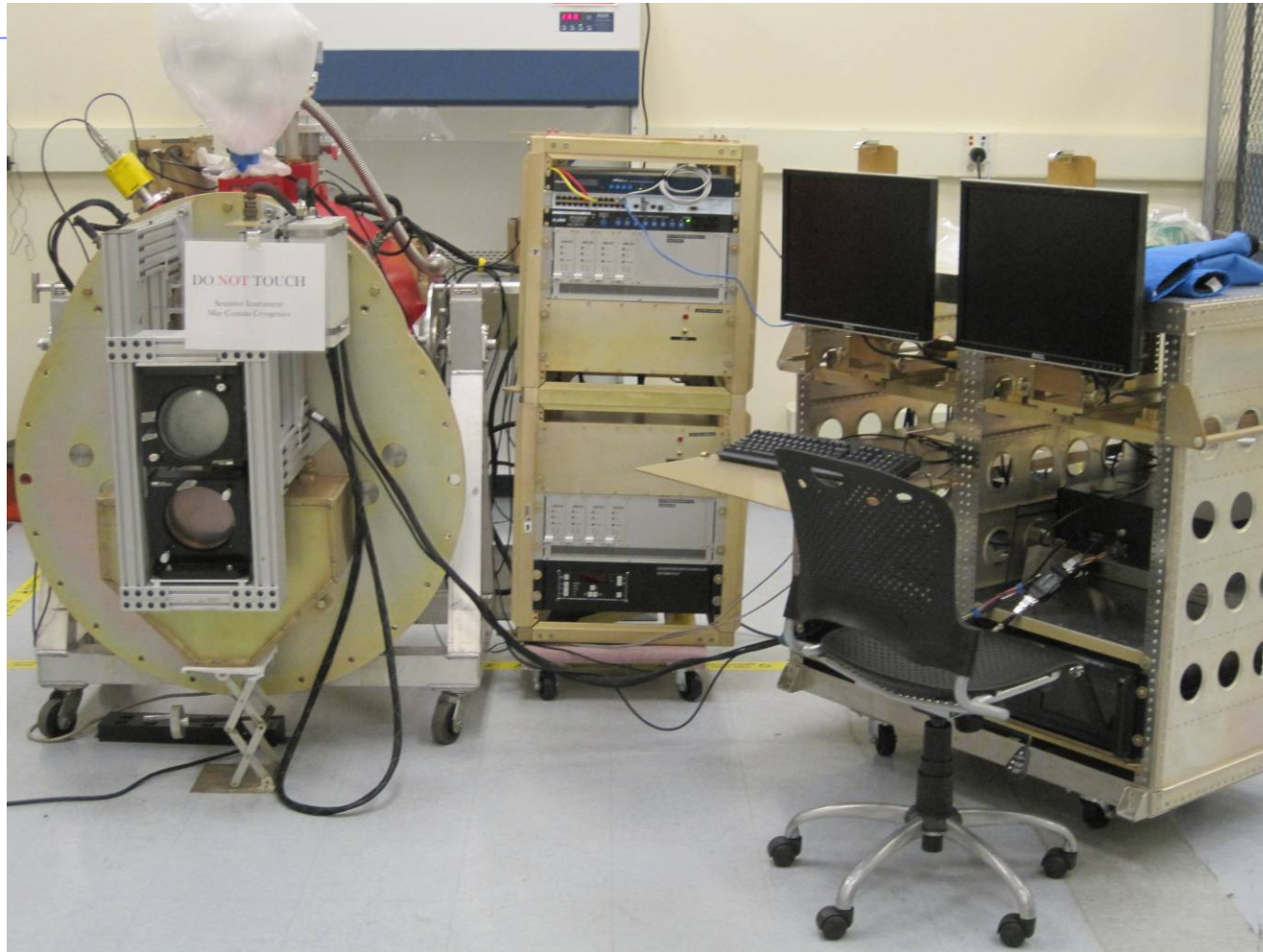
# Bottom Line

- SOFIA works!      FORCAST works!
  - FORCAST images a 3.2x3.2 arcminute FoV with 0.75 arcsecond pixels from 5 – 37  $\mu\text{m}$
- Obtained near diffraction limited performance for  $\lambda > 30$  microns
  
- Flew 10 hour flights with ~ 3 hours at 43,000 feet and 6 hours at or above 41,000 feet
  - See corresponding improvements in background and transmission

# Outline

- Preparation in pictures
  - lab, hanger, lineops, characterization flights
- Observatory performance
  - Emissivity, PSF
- Images
- FORCAST Science observations

# FORCAST in DAOF lab



- From left: FORCAST w/ foreoptics (test equipment), counterweight rack, and PI rack

# FORCAST on the telescope



- Positioning FORCAST to mount on telescope



- Cryogen transfers on the plane



# Taking Flight

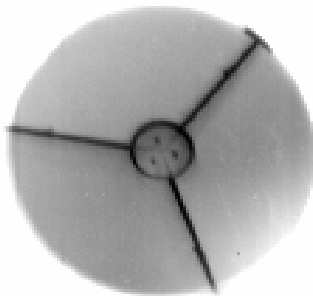
## Preparation and flights consisted of the following:

- LineOps (Line Operations, 15 in total)
  - Park plane on tarmac and look at stars
  - Allows end-to-end testing of H/W & S/W
- Observatory characterization flights
  - 25-May-2010, 10-Nov-2010, 18-Nov-2010
    - ◆ Observatory operational and performance checkout
    - ◆ High speed “jitter” measurements of bright stars
    - ◆ Also measured primary-secondary telescope emissivity
- Short Science flights
  - 30-Nov-2010, 03-Dec-2010, 07-Dec-2010
    - ◆ Observed Jupiter, Comet Hartley 2, M42, W3, M82 and a number of calibrators

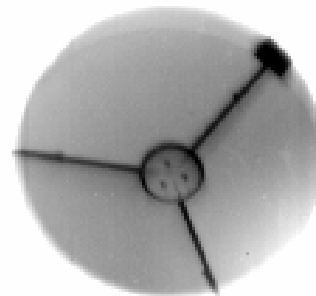
# Thermal Backgrounds

- Telescope mirror temperatures -30 to -40 C
- Primary-secondary emissivity ~ 7 %
  - Made by tipping FORCAST collimator off nominal

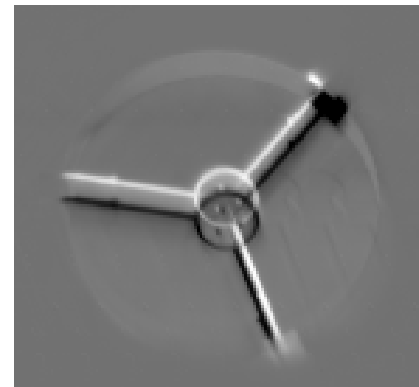
## Pupil Images



centered

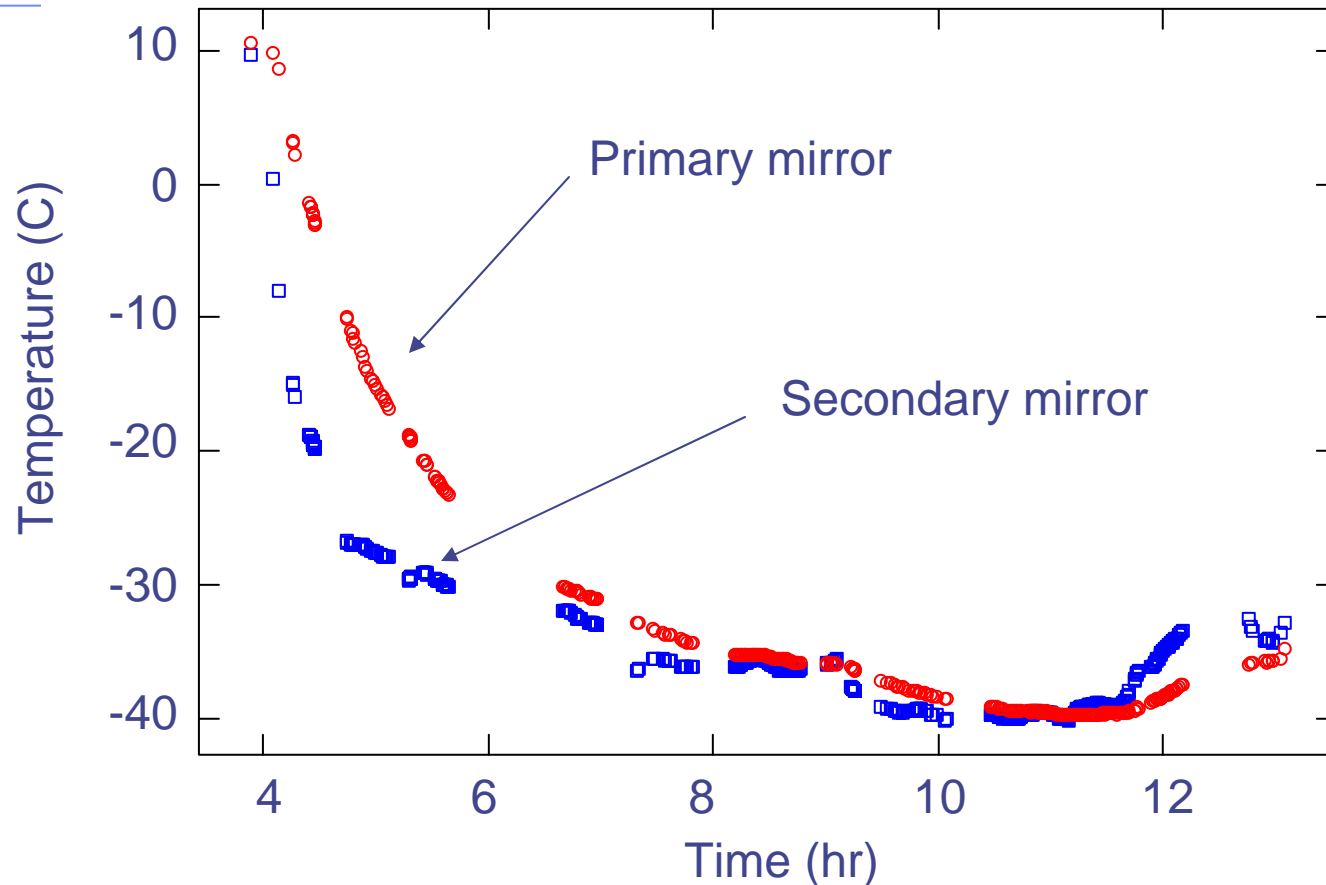


tipped



difference

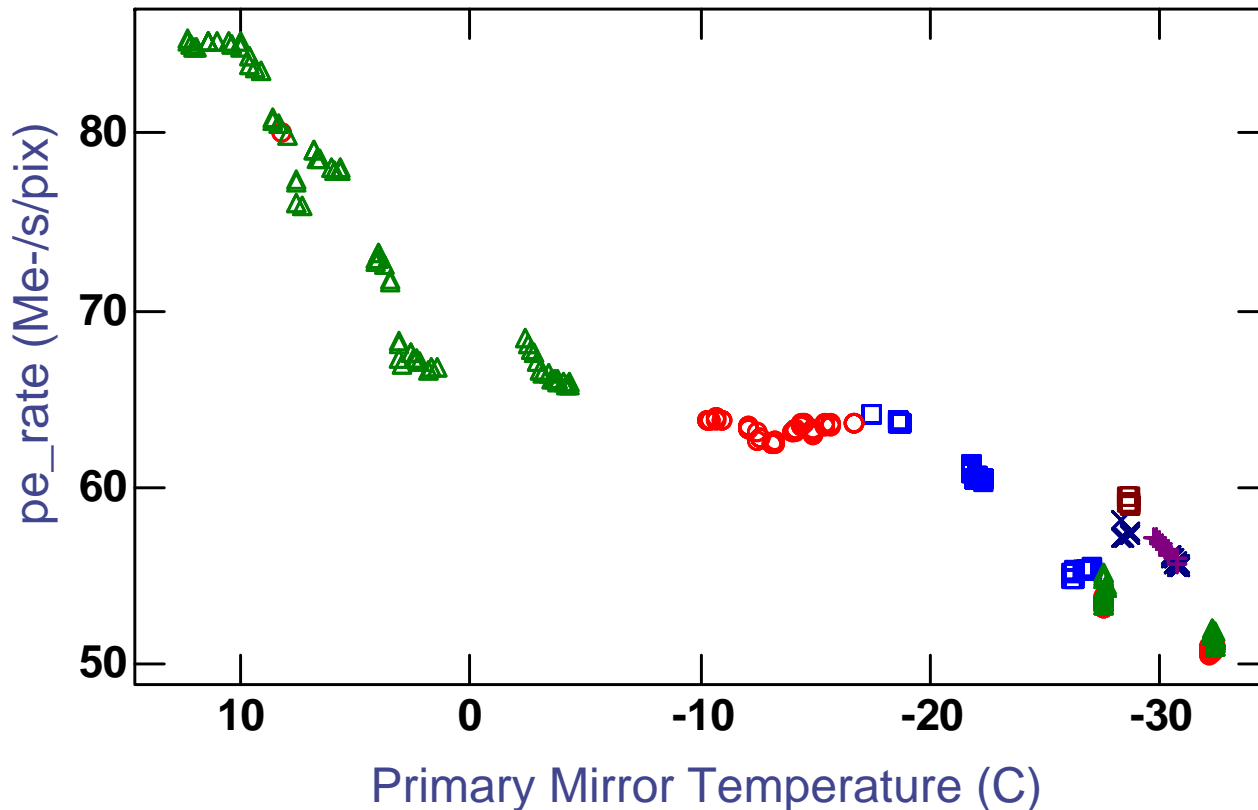
# Telescope Temperature vs. time



- TA primary (red) and secondary (blue) temperatures vs. UT for short science flight #1



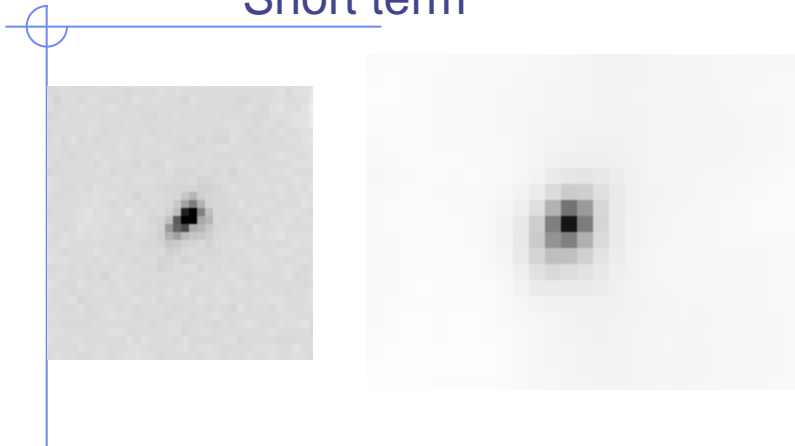
# Telescope Temperature vs. time



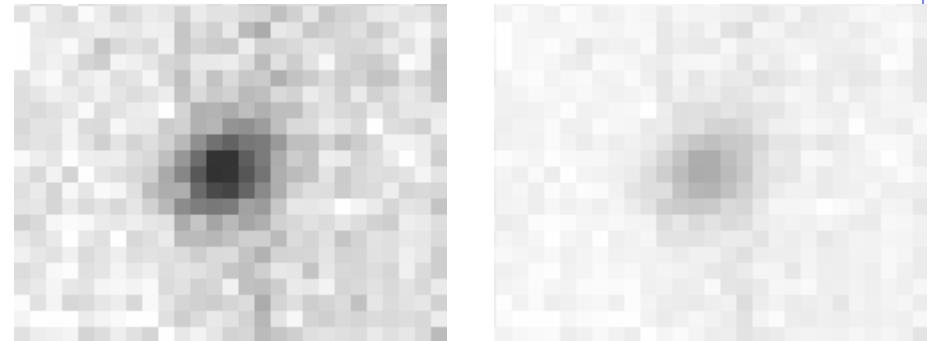
- FORCAST/SOFIA background (photoelectron rate per pixel) at 37  $\mu\text{m}$  (with dichroic) for short science flight #2. Symbols indicate different zenith angles.

# PSF comparisons

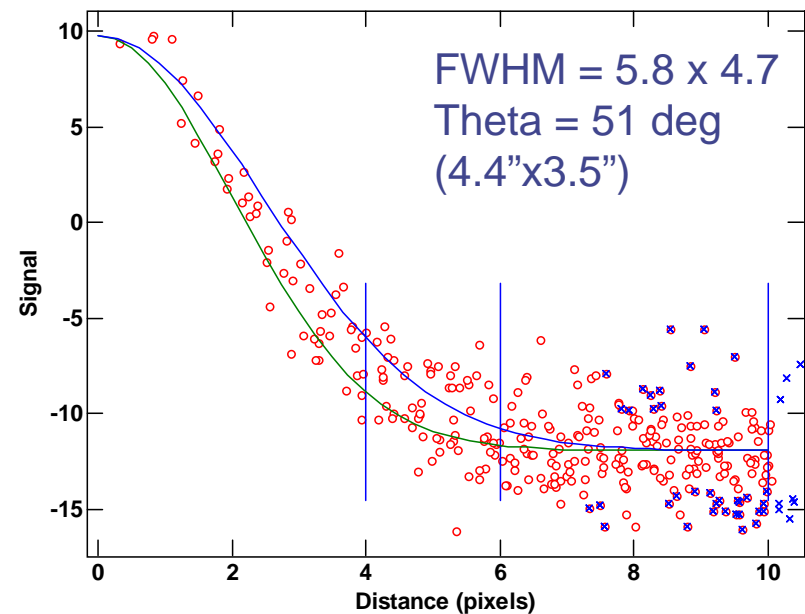
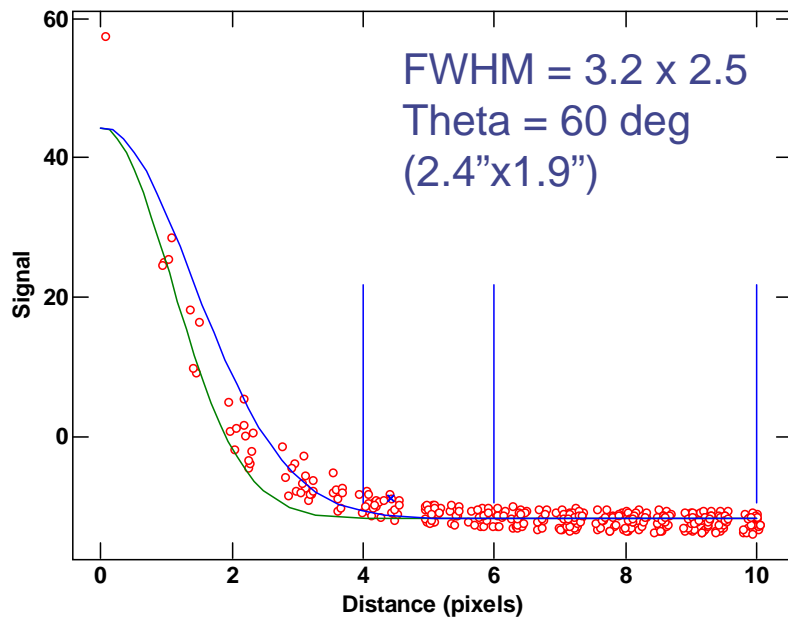
Short term



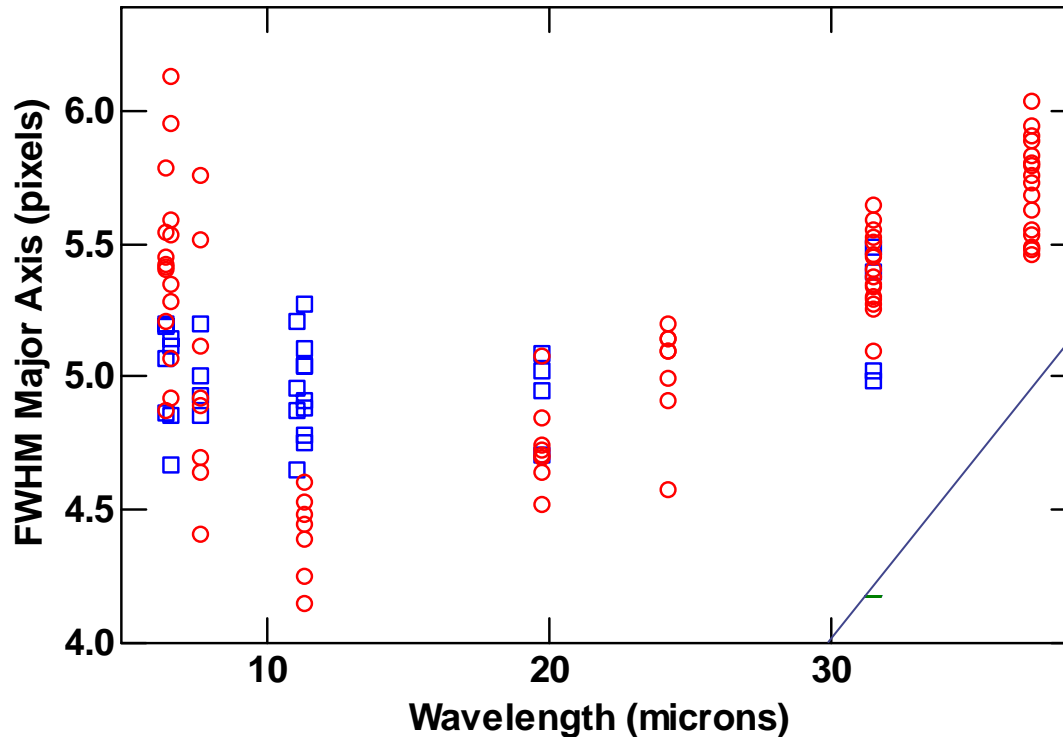
Long term



Scale same as short term

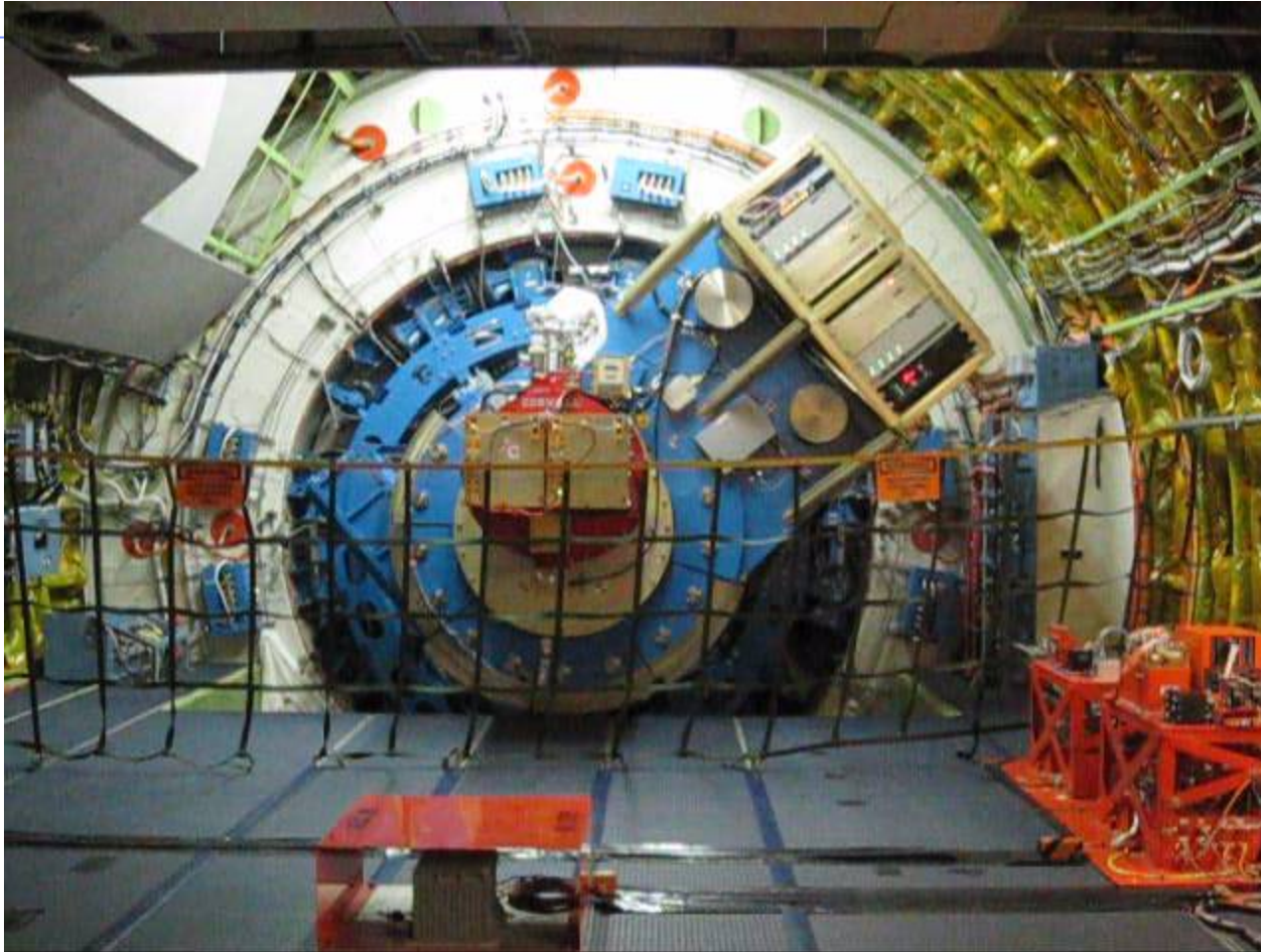


# Image Quality



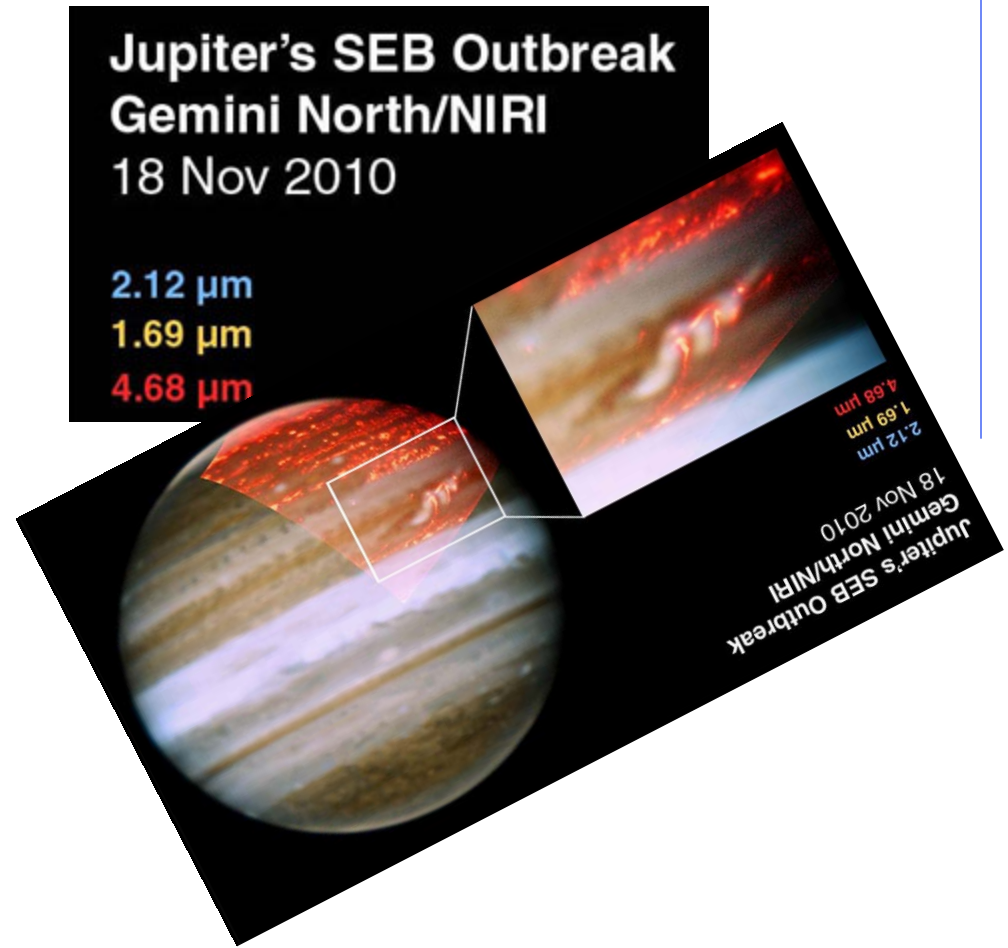
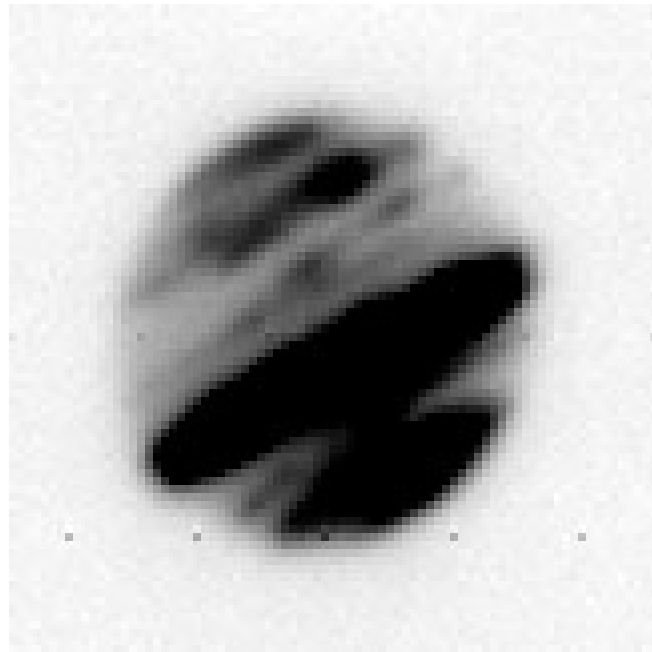
- FWHM of PSF major axis vs wavelength from Short Science Flight #3 for two calibrators (red and blue symbols) at altitudes > 41k feet. The line shows the diffraction limit. Pixels are 0.75 arcseconds.

# It's the plane that's moving



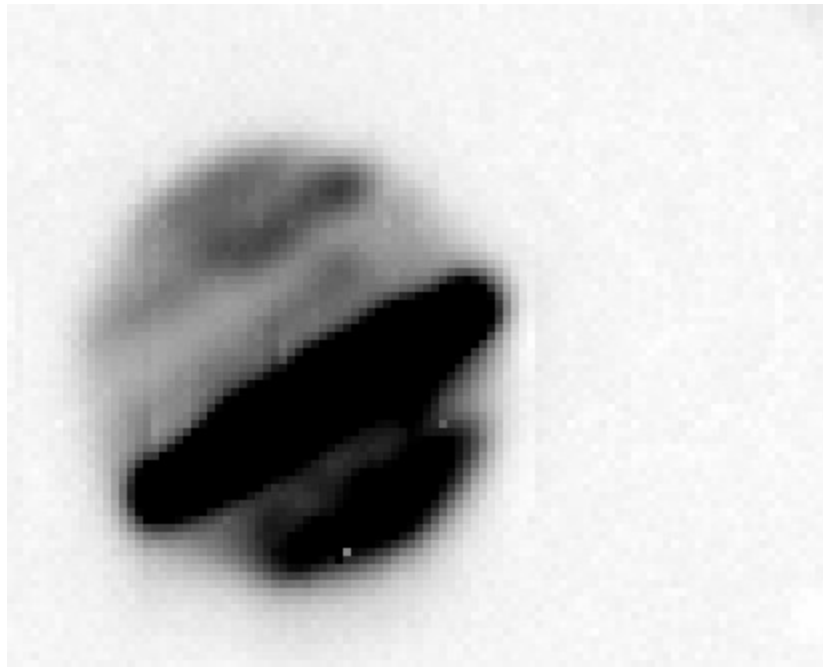
- Apparent motion of telescope as plane pitches, rolls, and yaws.

# Jupiter



- Dark South Equatorial Belt (SEB) disappeared earlier this year, it is now reappearing. FORCAST Observed SEB Outbreak (SEB) at a variety of wavelengths including filters in the H<sub>2</sub> absorption trough on 12-Dec-2010.

# Jupiter



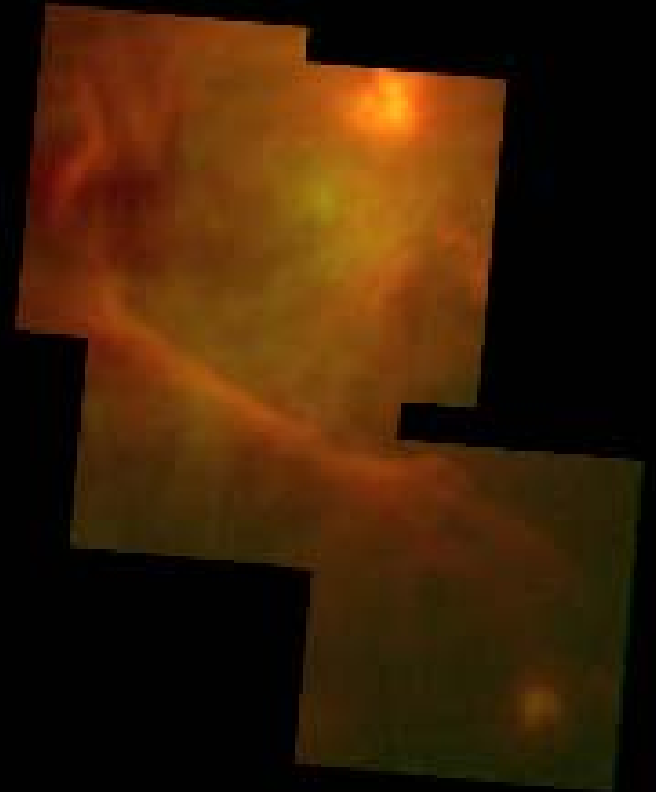
- ❑ Rough animation at 5.4 micron show rotation of Jupiter using observations from a single observing segment. The images are the same except with the scaling changed. Covering 35 minutes

# M42

- Observed M42  $\theta^1_c$  and Orion bar regions
  - 6.4 (PAH), 6.6, 7.7 (PAH), 11.3 (PAH), 19.7, 31.4, and 37.1  $\mu\text{m}$
- Science Objectives:
  - Determine luminosities of sources in the BNKL region
  - Measure SED of Orion proplyds to look at disk termination
    - ◆ Very hard due to structure in nebular emission
  - Excitation and destruction of PAH through the bar (ionization/shock front)



# SOFIA: Orion Image



- ❑ Left: Visible (HST, O'Dell and Wong),
- ❑ Middle: Near-IR (McCaughrean),
- ❑ Right: SOFIA 19.7  $\mu\text{m}$  (green) + 37  $\mu\text{m}$  (red) image

# Questions?



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