SOFIA's Suite of First-Generation Science Instruments

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SOFIA Science Center / USRA

SOFIA Splinter Session

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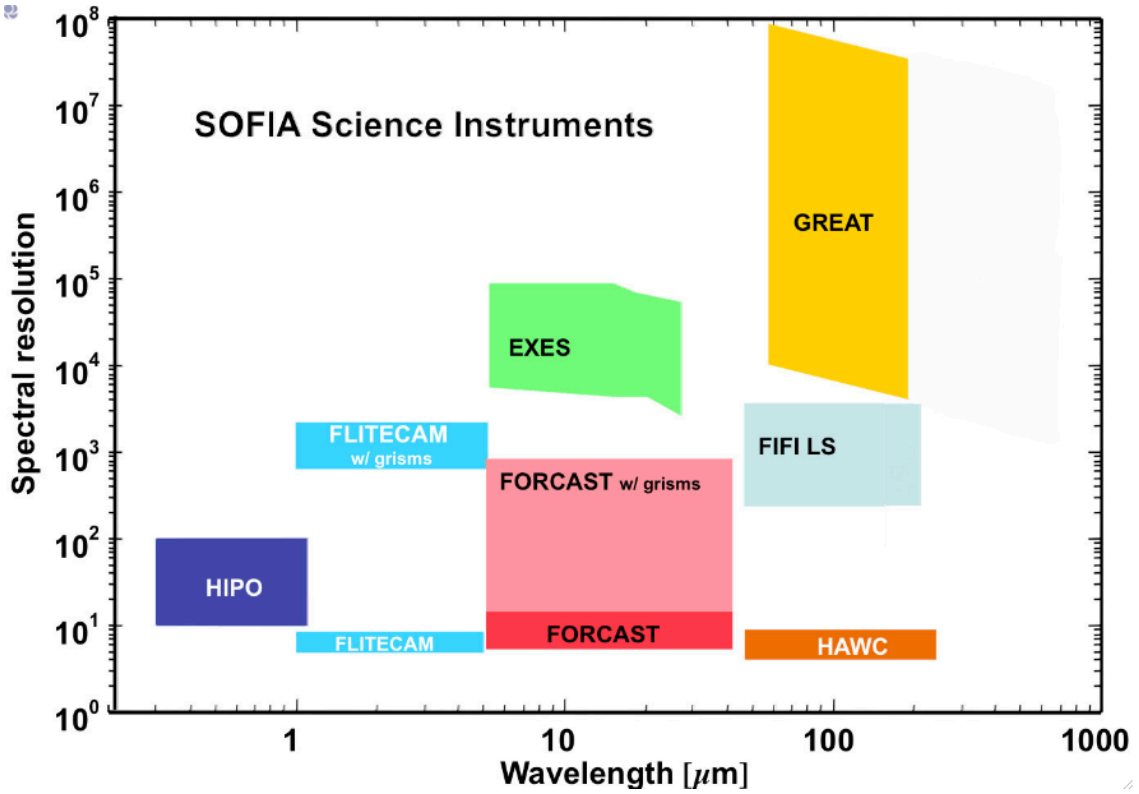
SOFIA's Instrument Complement

The 7 first-generation instruments cover the full IR range with imagers and low-to-high resolution spectrographs

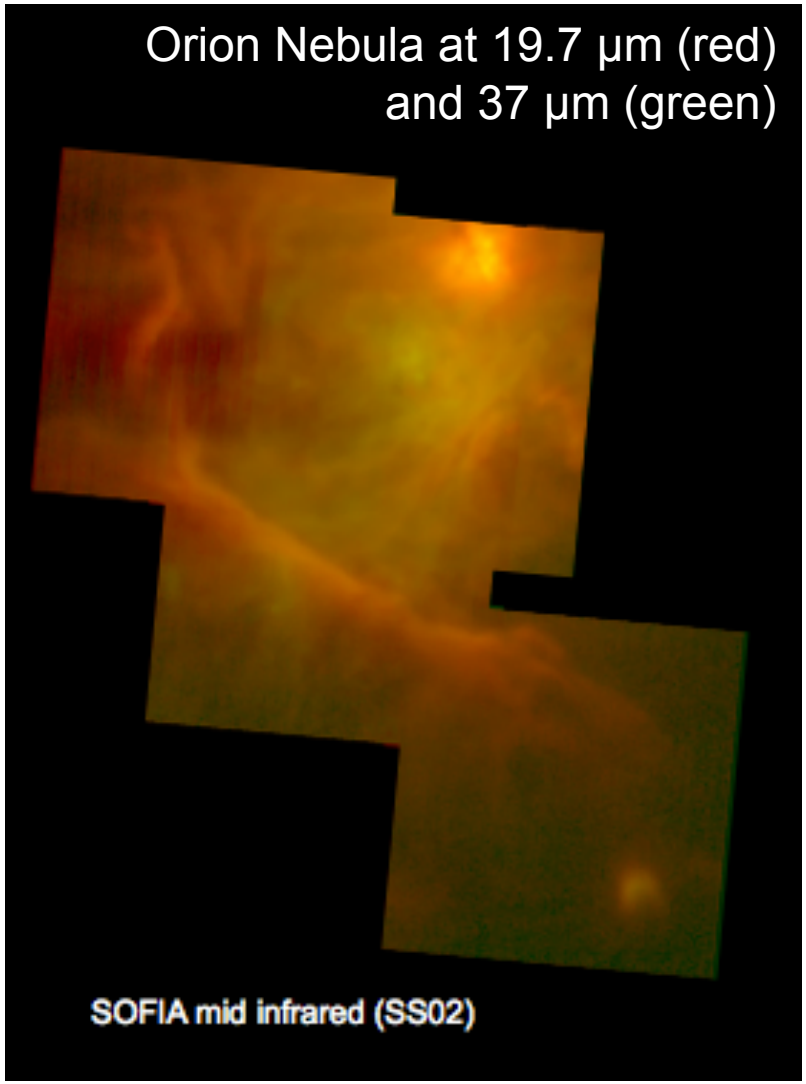
(http://www.sofia.usra.edu/Science/instruments/)

see also Gehrz et al. 2011 (arXiV:1102.1050)



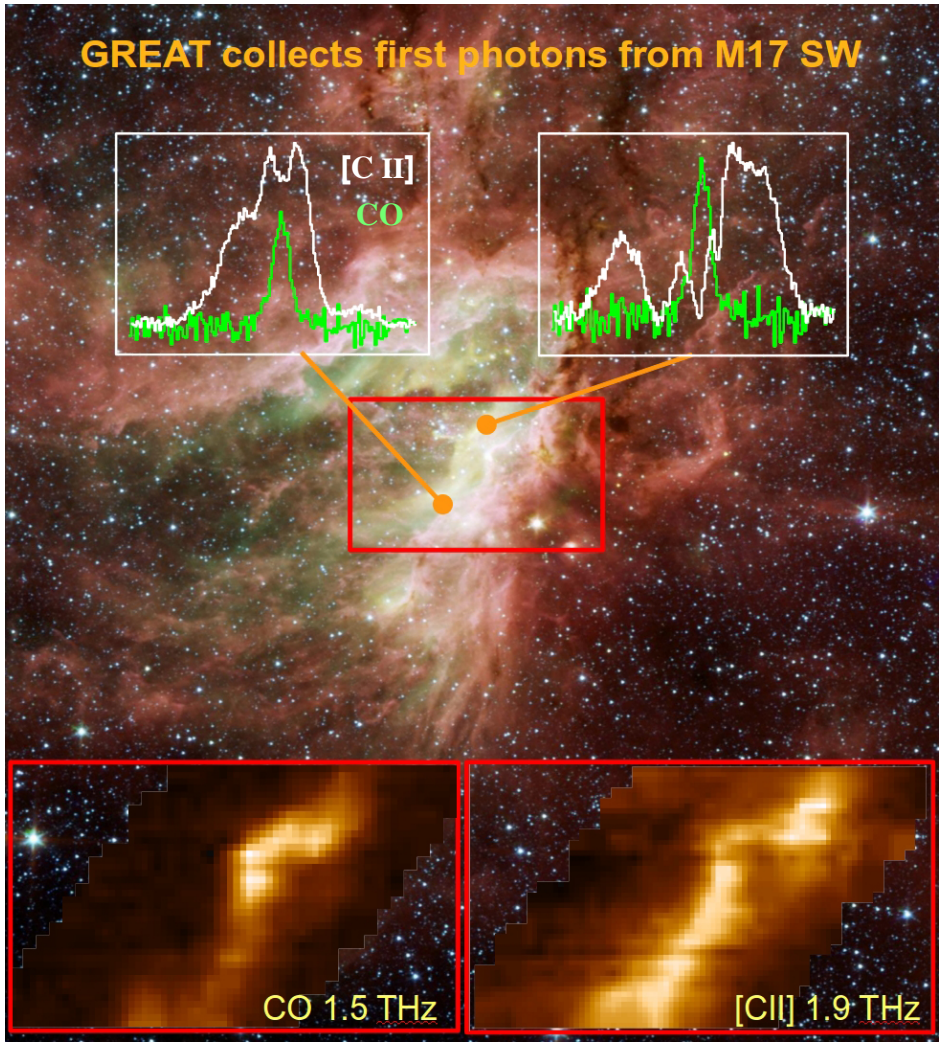
FORCAST (PI: Terry Herter, Cornell)

- Mid-IR imager with both short- and long-wavelength detector arrays (5 – 24 μm, 9 filters; 31 – 38 μm, 4 filters)
- 3.2 × 3.2 arcmin field of view
- ~ 3 arcsec FWHM resolution
- First-light in Dec. 2010, Basic Science began May 2011; instrument performance as expected
- planned upgrade for detector arrays
- FORCAST grism mode planned:
  - R = λ/Δλ ~ 200 – 1200
  - available late 2012



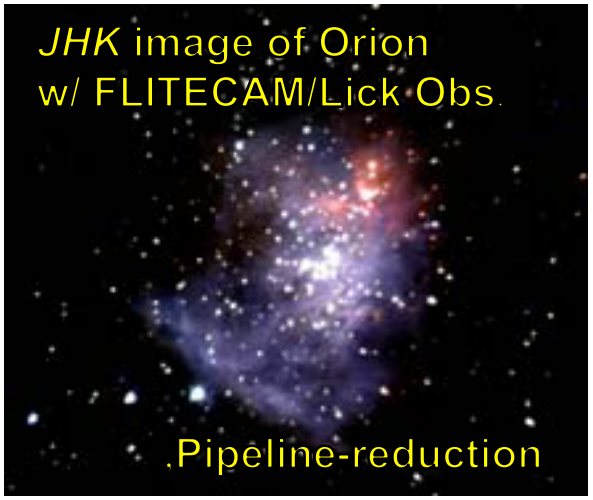
GREAT (PI: Rolf Güsten, MPIfR-Bonn)

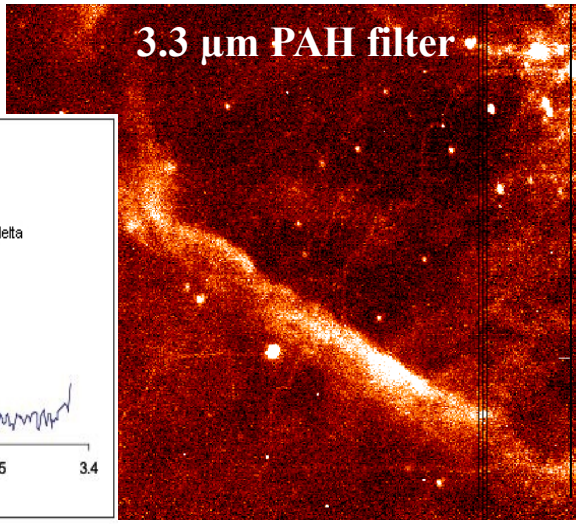
- Dual-channel heterodyne spectrometer
- 2 Backend options:
  - CTS: 200 MHz b-width, $\Delta\nu$ = 50 kHz
  - AOS: 1.5 GHz b-width, $\Delta\nu$ = 1 MHz
  - new XFFT → 2.5 GHz bandwidth
- L#1 (1.25 – 1.50 THz; 200 – 240 μm)
- L#2 (1.82 – 1.92 THz; 156 – 165 μm)
- Mid-freq.: 2.4 - 2.7 THz (110 – 125 μm)
  - centered on HD(1-0) and OH ($^2\Pi_{3/2}$)
  - June 2011 integration
- High-freq.: 4.6 – 4.8 THz (62 – 65 μm)
  - e.g., [O I] at 63 μm

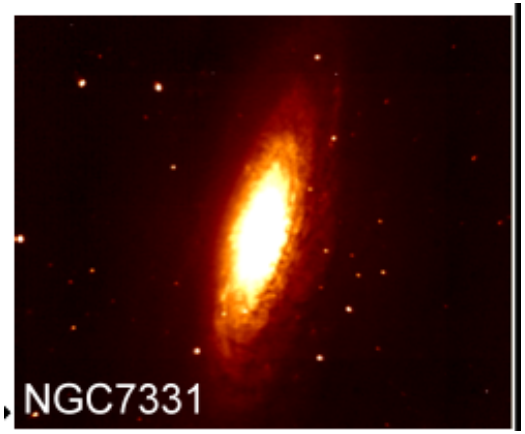


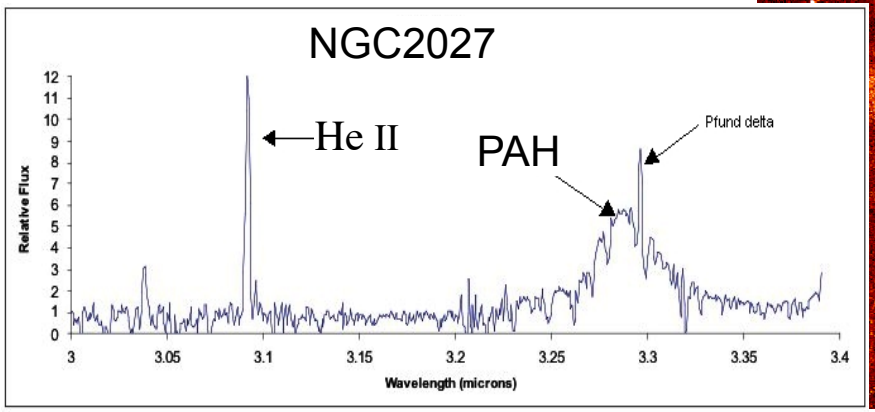
FLITECAM (PI: Ian McLean, UCLA)

- A Facility-class camera at 1 – 5 μm
- Seeing/diffraction limited (3" – 5"), 8 arcmin FOV
- Filters: *J, H, K, L, M*, PAH, Water-ice, Pa-α, Pa-contin.
- Grisms: R ~ 2000 across 1 – 5 μm band, 1" & 2" slits
- FLITECAM is complete, has been field-tested on 3-m telescope at Lick observatory
- 1st test flights Fall 2011
- Imaging & spectroscopy modes available 2012



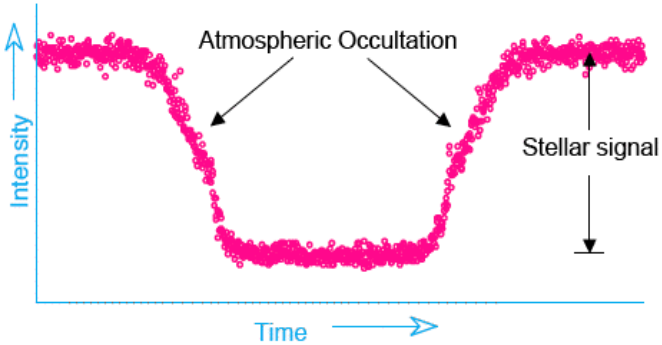




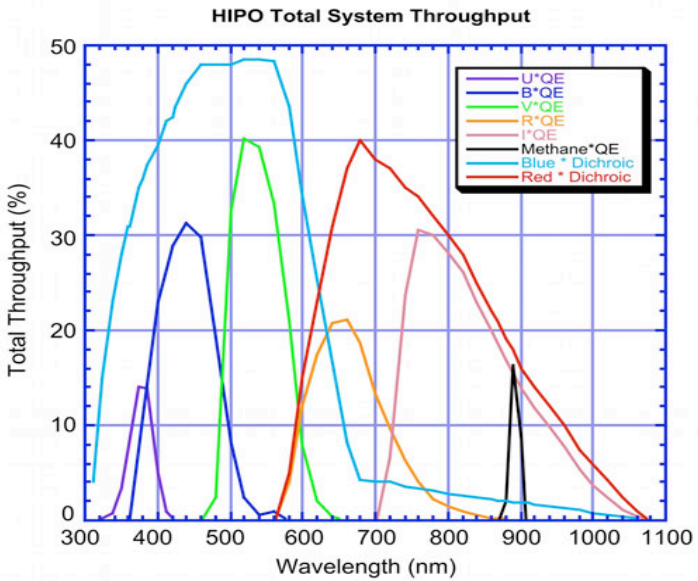


HIPO (PI: Ted Dunham, Lowell Obs.)

- **H**igh **S**peed **I**maging **P**hotometer for **O**ccultations
- science goals include occultations by solar-system objects; possibility of extrasolar planet transits
- simultaneous dual-color imaging
  - 0.3 – 0.7 μm and 0.4 – 1.1 μm ranges
  - *UBVRI* and custom filters
- co-mounts with FLITECAM (3rd color in NIR)
- 5.6 × 5.6 arcmin FOV, 1024^2 pixels
- Flexible layout supports future modifications
- Working/complete
- Flight tests this summer, including a planned Pluto occultation

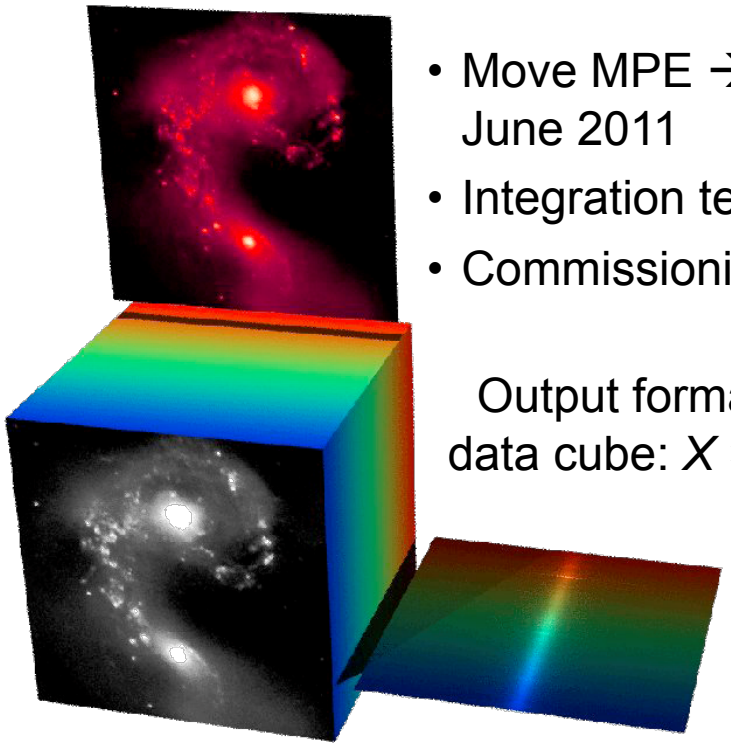


Pluto from KAO (Elliot et al. 1989)



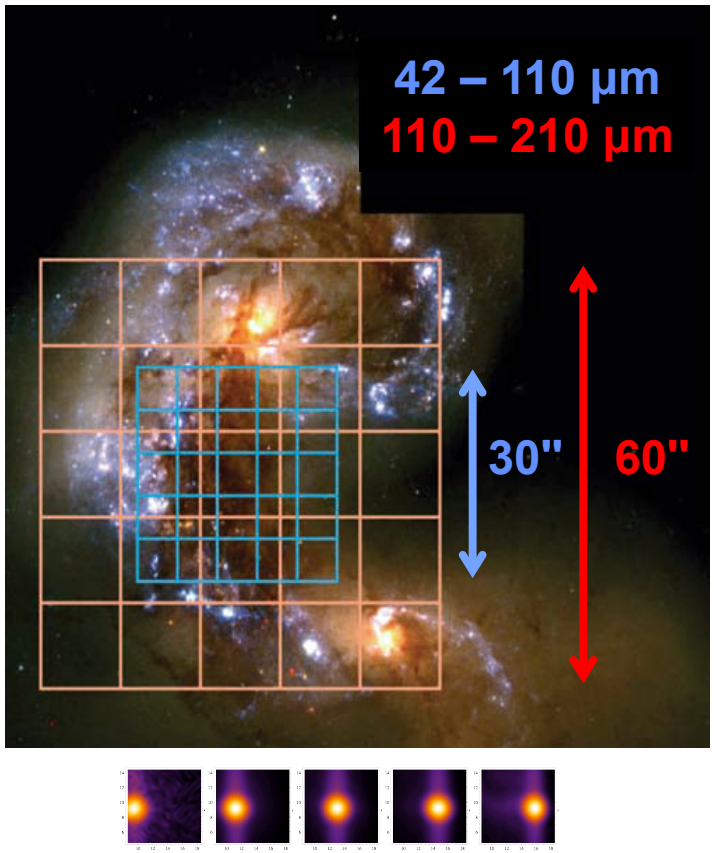
FIFI-LS (PI: Poglitsch/Krabbe, MPE/IRS)

- Integral field-unit spectrometer, 5×5 spatial pixels, 16 spectral pixels
- Two (simultaneous) channels: **Blue** & **Red**
  - Spatial resolution: **7" – 12"** & **16" – 24"**
  - λ/Δλ ~ **1200 – 4000** & **1000 – 2000**



- Move MPE → IRS / Stuttgart: June 2011
- Integration tests through 2012
- Commissioning on SOFIA 2013

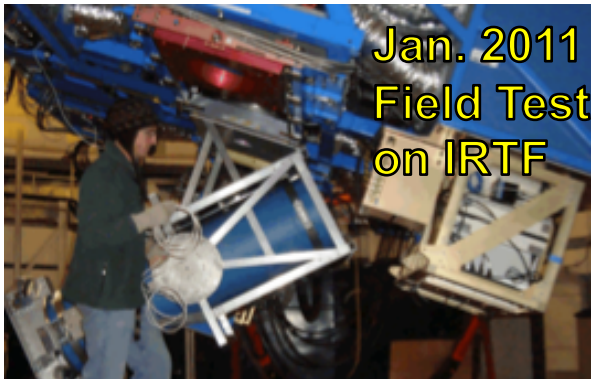
Output format is a data cube: $X \times Y \times \lambda$

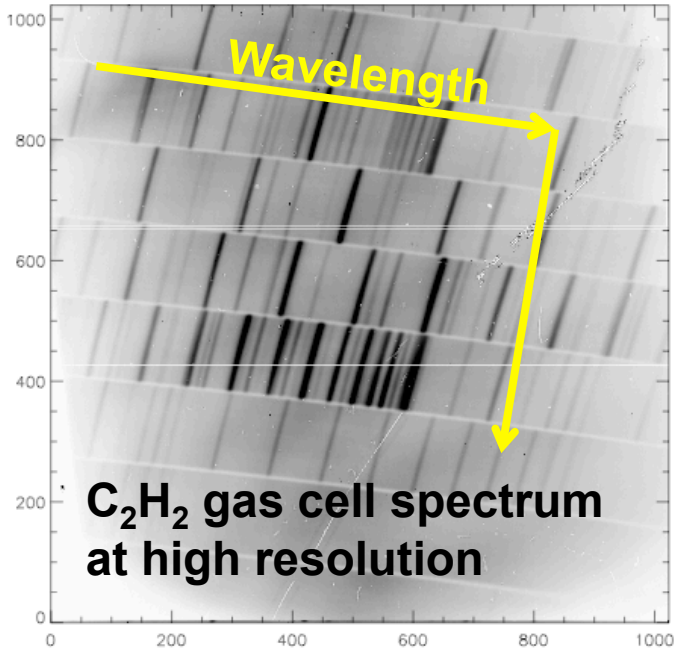


Scan of 108 µm point-source

EXES (PI: Matt Richter, U. Calif.-Davis)

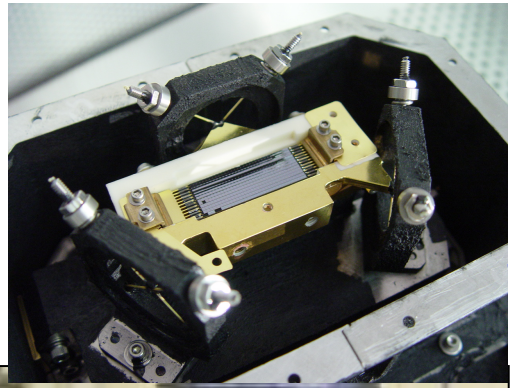
- Designed primarily to study gas phase using
  - molecular ro-vibration bands that provide multiple energy levels in single observation
  - kinematic information that resolves structure and multiple components
- High spectral resolution in mid-IR: 4.5 – 28.4 μm
  - R = 50,000 – 120,000 cross-dispersed
  - In single observation:
    - ~0.7% with ~30" long slit, echelle X-disperser
    - ~5% with ~2" long slit, low-order X-disperser
- Single order long slit (~100” long)
  - R = 3,000 with 5% coverage
  - R = 20,000 with ~0.7% coverage
- Instrument Status: testing in the lab
- General availability: Cycle 2

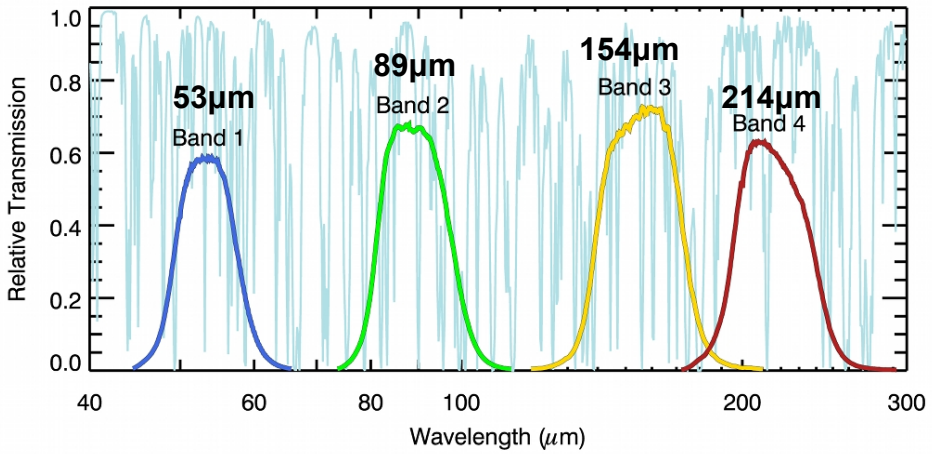




HAWC (PI: Al Harper, U. Chicago)

- Four passbands at 53, 89, 154, and 214 μm, $\Delta\lambda/\lambda$ ~ 0.2
- Diffraction limited resolution: 5 – 20 arcsec FWHM
- 12 × 32 pixel detector array, FOV ~ 0.5 – 4 arcmin
- All cryogenic systems successfully tested in lab
- Final (non-cryogenic) optics are being fabricated
- Final pre-ship full-system test to be conducted summer 2011
- Commissioning 2012 / 2013





SOFIA's First-Generation Instruments

(http://www.sofia.usra.edu/Science/instruments/)

see also Gerhz et al. 2011 (arXiV:1102.1050)

Instrument	Type	λλ (μm)	νν (THz)	Resolution	PI
FORCAST (in operation)	imager / (grism)	5.4 - 37	8.1 - 56	filters / (R~2000)	T. Herter / Cornell U.
GREAT (H-Freq.) (M-freq. -- June 2011) (L-freq.'s -- operating)	heterodyne spectrometer	 (62 - 65) (110 - 125) 156 - 165 200 - 240	 (4.6 - 4.8) (2.4 - 2.7) 1.82 - 1.92 1.25 - 1.50	$R \sim 10^4 - 10^8$	R. Güsten / MPIfR
HIPO (summer 2011)	fast imager	0.3 - 1.1		filters	E. Dunham / Lowell Obs.
FLITECAM (summer 2011)	imager / (grism)	1.0 - 5.5		filters / (R~2000)	I. McLean / UCLA
FIFI-LS	imaging grating spectrograph	42 - 110 110 - 210	2.7 - 7.1 1.4 - 2.7	R ~1000 - 2000	Poglitsch,Krabbe /MPE,IRS
EXES	imaging echelle spectrograph	4.5 - 28.4	10.6 - 67	$R \sim 3000 - 10^5$	M. Richter / UC-Davis
HAWC	imager	45 - 270	1.1 - 6.6	filters	D. A. Harper / U. Chicago