National Aeronautics and Space Administration

SOFIA Science Instruments

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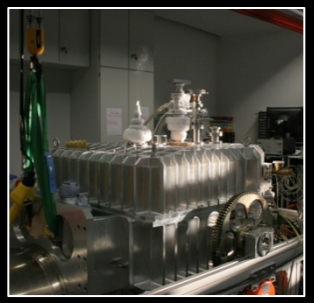
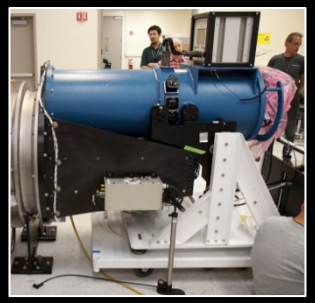
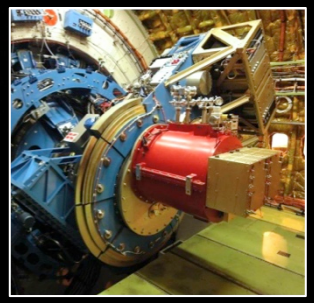





First Generation Science Instruments

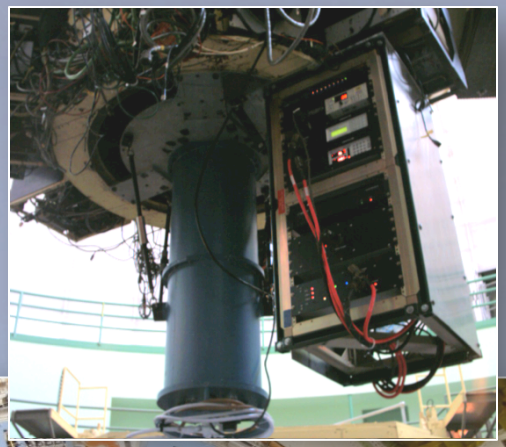
Science Instrument	Type*	Developing Institution	Principal Investigator	Instrument Description
FORCAST	FSI	Cornell University	Herter	Simultaneous Dual Channel Imaging and Grism Spectroscopy (5-25 μm & 25-40 μm)
GREAT	PSI	Max Planck Institute, Bonn	Güsten	High Resolution ($R > 10^6$) Heterodyne Spectrometer (1.6-1.9 THz; 2.4-2.7 THz; 4.7 THz)
HIPO	SSI	Lowell Observatory	Dunham	Visible Light High-Speed Camera (0.3-1.1 μm)
FLITECAM	FSI	UCLA	McLean	Near Infrared Imaging and Grism Spectroscopy, (1-5.5 μm); Can be used in combination with HIPO
FIFI-LS	PSI FSI	University of Stuttgart	Krabbe	Dual Channel Integral Field Grating Spectrometer (42-110 μm; 100-210 μm)
EXES	PSI	UC Davis	Richter	High Resolution ($R > 10^5$) Echelle Spectrometer (5-28 μm)
HAWC HAWC+	FSI	University of Chicago JPL	Harper Dowell	High-Angular Resolution Wide-Band Camera with 4 Channels (50 μm, 100 μm, 160 μm, 200 μm)

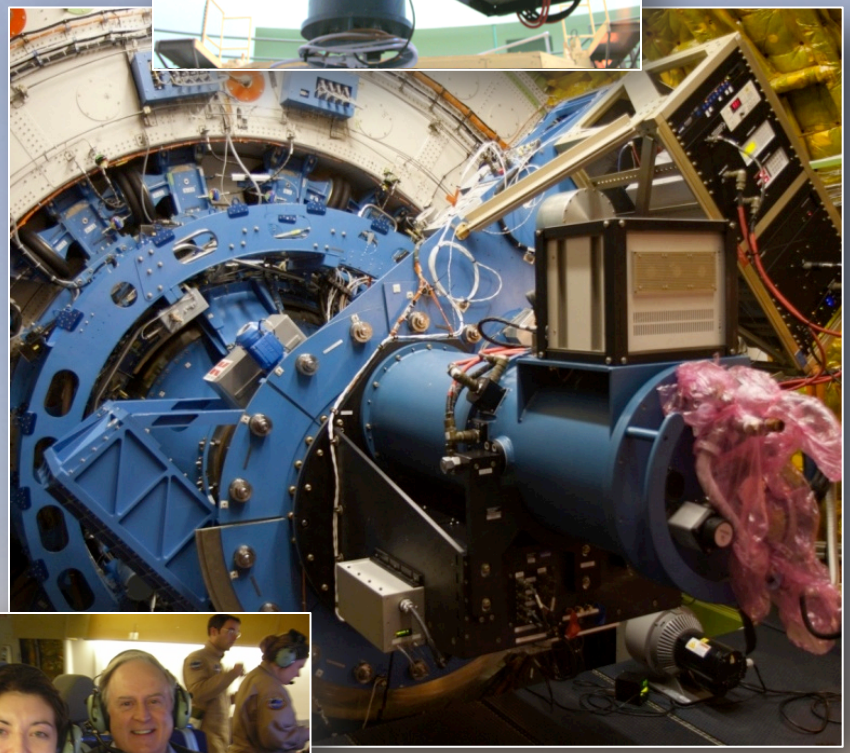
*FSI: Facility Class Science Instrument; PSI: PI Class Science Instrument; SSI: Special Purpose Science Instrument

FLITECAM

First-Light Infrared Test Experiment CAMera
Principal Investigator: Ian McLean, UCLA
Facility-class Science Instrument

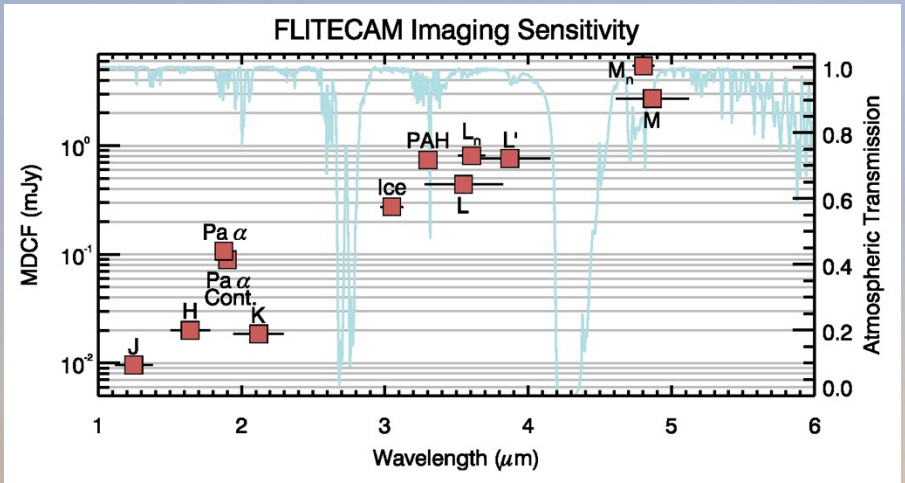
- Early Science flights logged
  - 4 flights conducted in the FLIPO configuration
- Cycle 1 flights logged
  - 2 FLIPO commissioning flights completed, including exoplanet observation (½ flight)
- Long wavelength stray light issue solved by improving baffling around the 4 K filter wheel
- Suffered and repaired another detector electronics failure using spare parts
  - Developing plans for detector electronics upgrade
- Currently working issue with shortened helium hold time, causing us to postpone FLITECAM commissioning to 2014

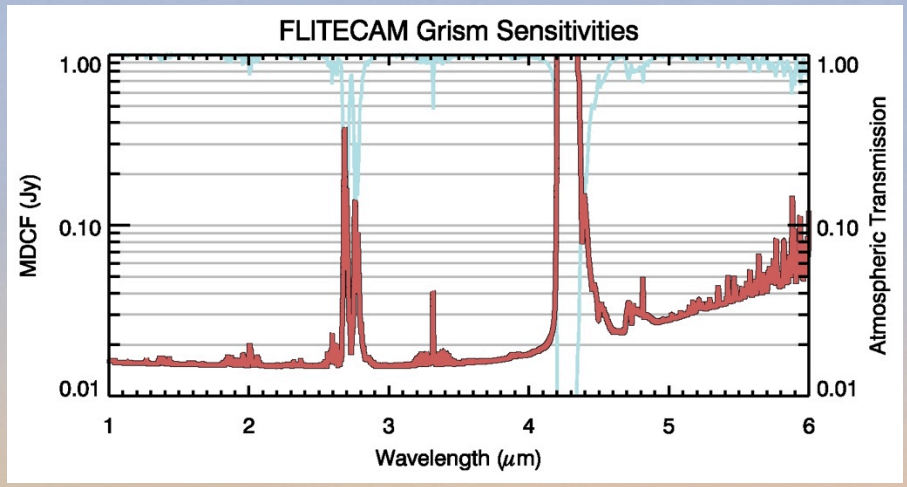




FLITECAM Performance

FLITECAM	
Description	Wide-field imager with grism spectroscopy
Wavelength Range	1-5.5 μm
Detector	Raytheon Aladdin III InSb
Array Format	1024×1024
Pixel Scale	0.475″
FOV	8′×8′

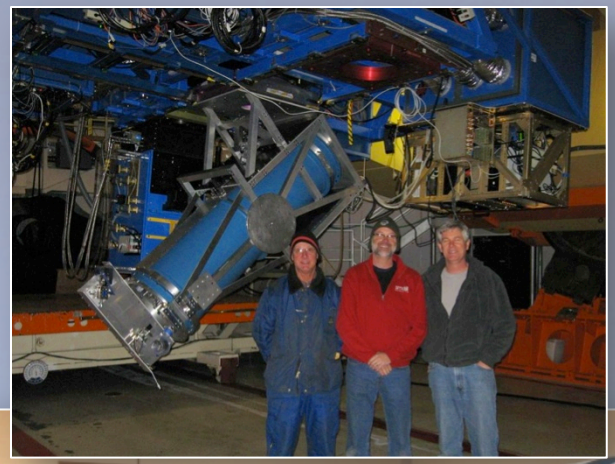


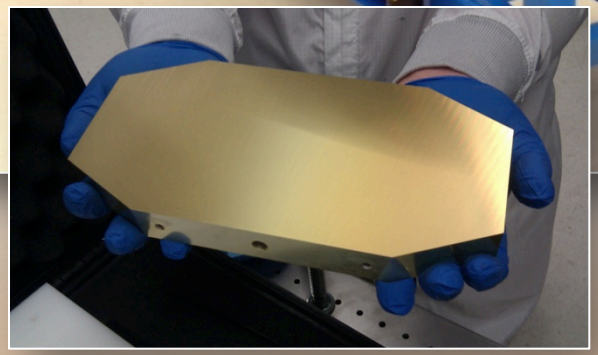


EXES

Echelon Cross Echelle Spectrograph
Principal Investigator: Matt Richter, UC Davis
PI-class Science Instrument

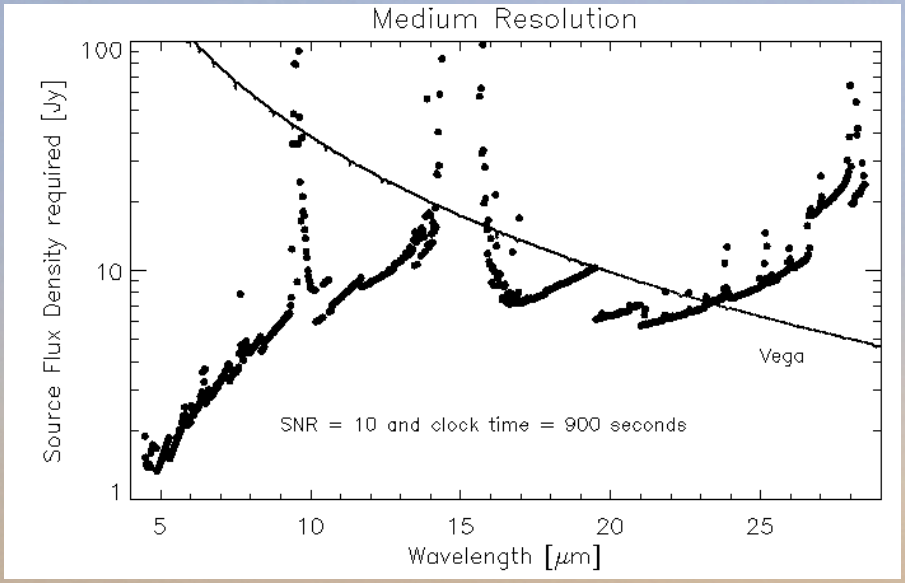
- Instrument cold for laboratory verification of flight configuration and performance capability metrics
- Pre-Ship Review scheduled 18-Dec-2013
- EXES ships to Palmdale in February 2014
- EXES scheduled to install on aircraft 14-Mar-2014
- Commissioning flights planned in late March and November 2014

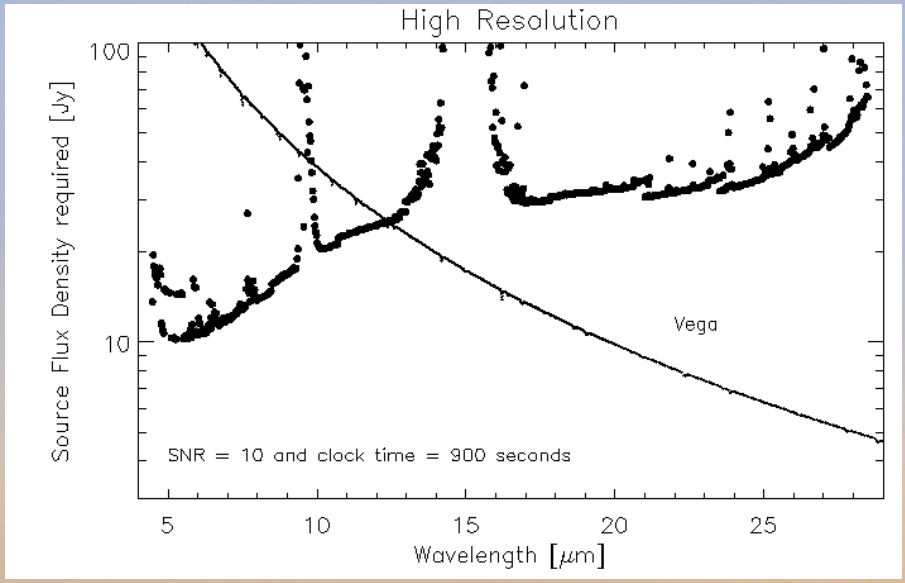




EXES Performance

EXES			
Description	High-resolution echelle spectrometer		
Wavelength Range	4.5-28.3 μm		
Detector	Raytheon Si:As		
Array Format	1024×1024		
Spectral Resolution	50,000–100,000	5,000-20,000	1,000-3,000
Slit Length	Up to 45″	Up to 180″	

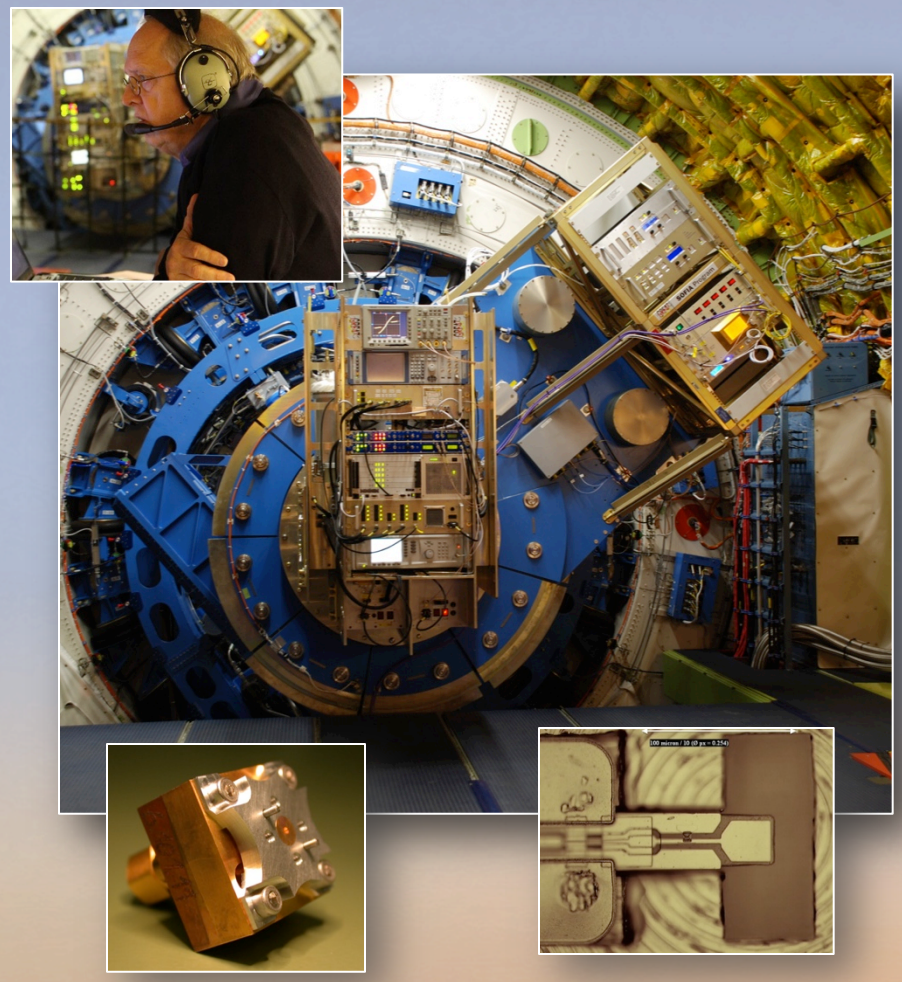




GREAT

German REceiver for Astronomy at THz Frequencies
Principal Investigator: Rolf Güsten, Max-Planck-Institut für Radioastronomie
PI-class Science Instrument

- Flights logged
  - 18 flights conducted during Early Science in 2011
  - 2 commissioning flights completed: L1, L2, M channels
  - 13 Cycle 1 flights completed, including 9 on deployment to New Zealand
- H channel will be ready next year
- upGREAT in work with three 7-pixel heterodyne receiver arrays
  - upGREAT commissioning planned for Jan-Feb 2015



GREAT Performance

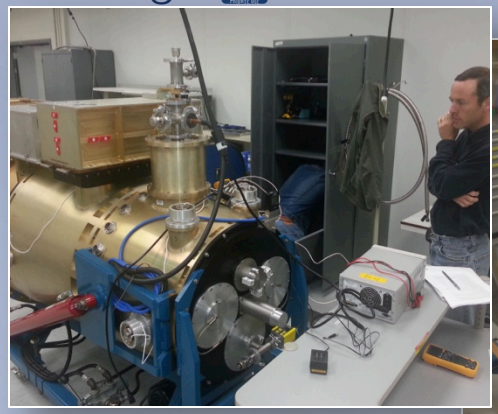
Dual-channel high-resolution ($R \gtrsim 10^6$) heterodyne spectrometer

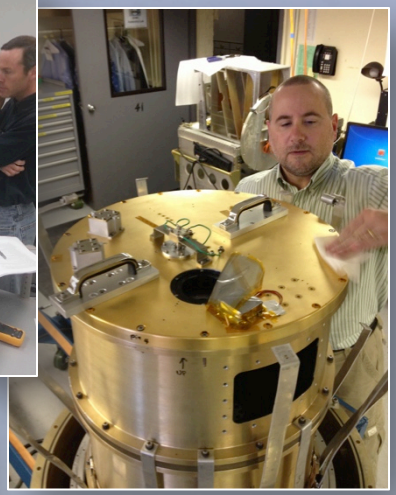
Front-End	Frequencies (THz)	Wavelength (μm)	T_{sys}	Astronomical Lines
$L1_a$	1.262-1.396	237.6-214.7	1860 K	CO(11-10), CO(12-11), OD, SH, H_2D^+, HCN, HCO^+
$L1_b$	1.432-1.523	209.4-197.0	1900 K	$^{(12)}$CO(13-12), $^{(13)}$CO(13-12), [N II]
L2	1.800-1.910	166.6-157.1	2500 K	NH_3(3-2), OH($^2\Pi_{1/2}$), CO(16-15), [C II]
M_a	2.495-2.519	120.2-119.1	5000 K	$^{(16)}$OH ($^2\Pi_{3/2}$), $^{(18)}$OH ($^2\Pi_{3/2}$)
M_b	2.67–2.68	112.3–111.9	TBD	HD(1-0)
H	4.745	63.18	TBD	[O I]

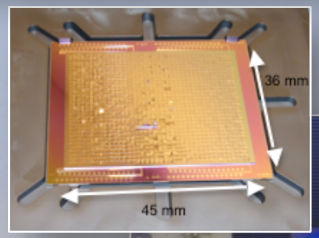
HAWC+

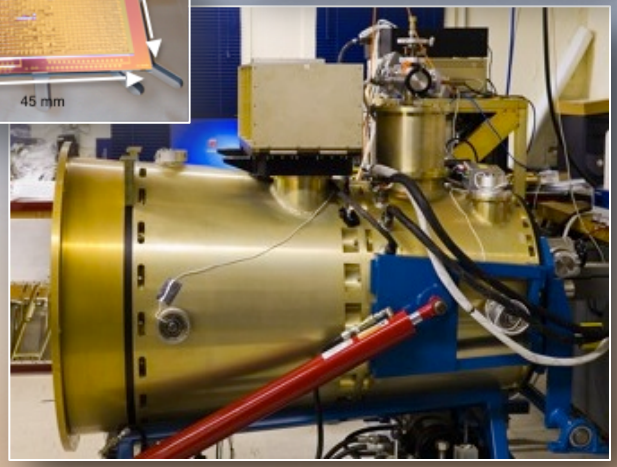
High-resolution Airborne Wideband Camera
Principal Investigator: Al Harper, University of Chicago Darren Dowell, JPL
Facility-class Science Instrument

- Completed development at University of Chicago; shipped to JPL in June 2013 for upgrade with new larger-format detectors and polarimeter
- Completed HAWC+ SRR 8 May 2013
- Completed HAWC+ PDR 15-16 Aug 2013
- Completed ADR cold test Oct 2013
- CDR scheduled 14-15 Jan 2014
- Delivery and commissioning planned for Summer 2015.









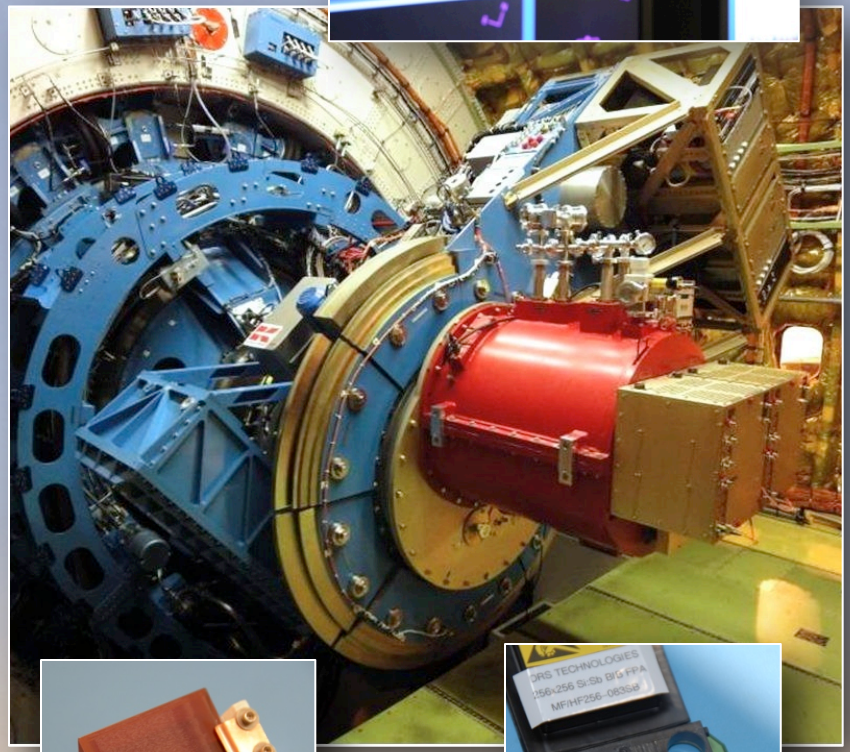
HAWC+ Performance

HAWC					
Description	Diffraction-limited imager and polarimeter				
Wavelength Range	50-240 μm				
Detector	TES BUG with SQUID multiplexer				
Array Format	Two 32×40 butted to 64×40				
Band	53 μm	63 μm	89 μm	155 μm	216 μm
Pixel Scale	2.55″	3.97″	3.97″	6.81″	9.08″
FOV	1.7′×2.7′	2.6′×4.2′	2.6′×4.2′	4.5′×7.3′	6.1′×9.7′
MDCF (mJy)	120	110	100	80	70
Minimum Flux Density for Polarization Measurements* (Jy)	10	9	9	7	5

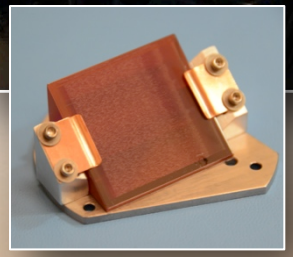
*Uncertainty in the measured percent polarization $\sigma(P) < 0.3\%$ in 1 hr

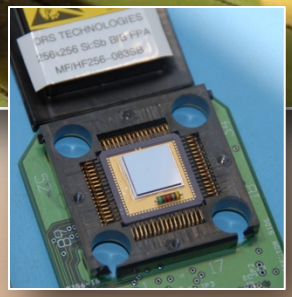
FORCAST

Faint Object InfraRed CAmera for the SOFIA Telescope
Principal Investigator: Terry Herter, Cornell University
Facility-class Science Instrument



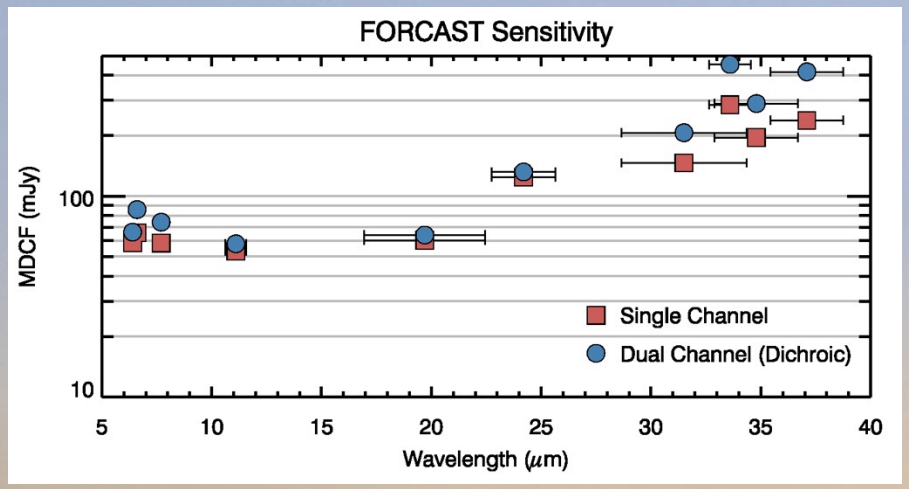
- Flights logged
  - 16 flights conducted during Early Science in 2010 and 2011
  - 7 commissioning flights completed
  - 8 out of 11 planned Cycle 1 flights completed (8 flights canceled due to govt shutdown)
- FORCAST commissioning report in work
  - Draft in review
  - Acceptance Review probably next March
- G4 grism is not usable due to ghost spectra
  - Grism and its mount was replaced for Cycle 1 following previous failure due to mechanical stress
  - Replacement G4 grism (both primary and spare) have a periodic ruling error that causes the ghost
  - Working with Zeiss to solve ruling error
  - One Cycle 2 award is affected.

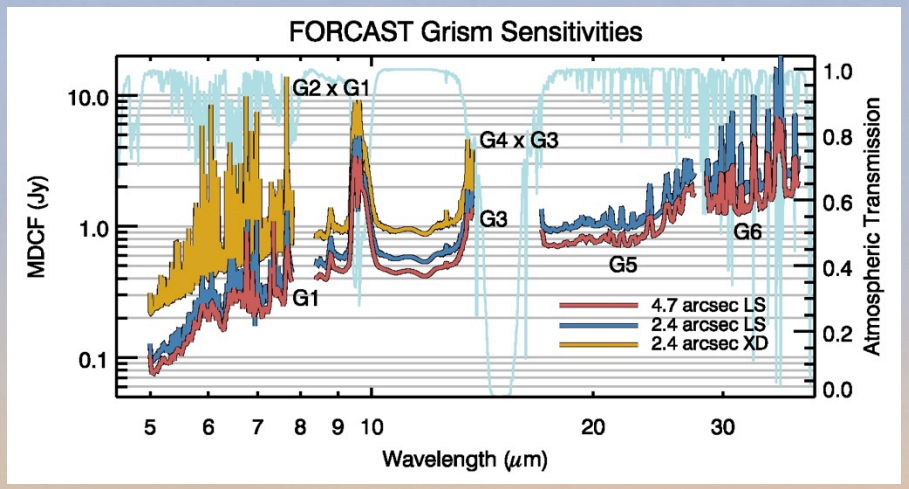




FORCAST Performance

FORCAST		
Description	Dual-channel imager with grism spectroscopy	
Wavelength Range	5-25 μm	25-40 μm
Detector	DRS Tech Si:As BIB	DRS Tech Si:Sb BIB
Array Format	256×256	
Pixel Scale	0.768″	
FOV	3.4′×3.2′	

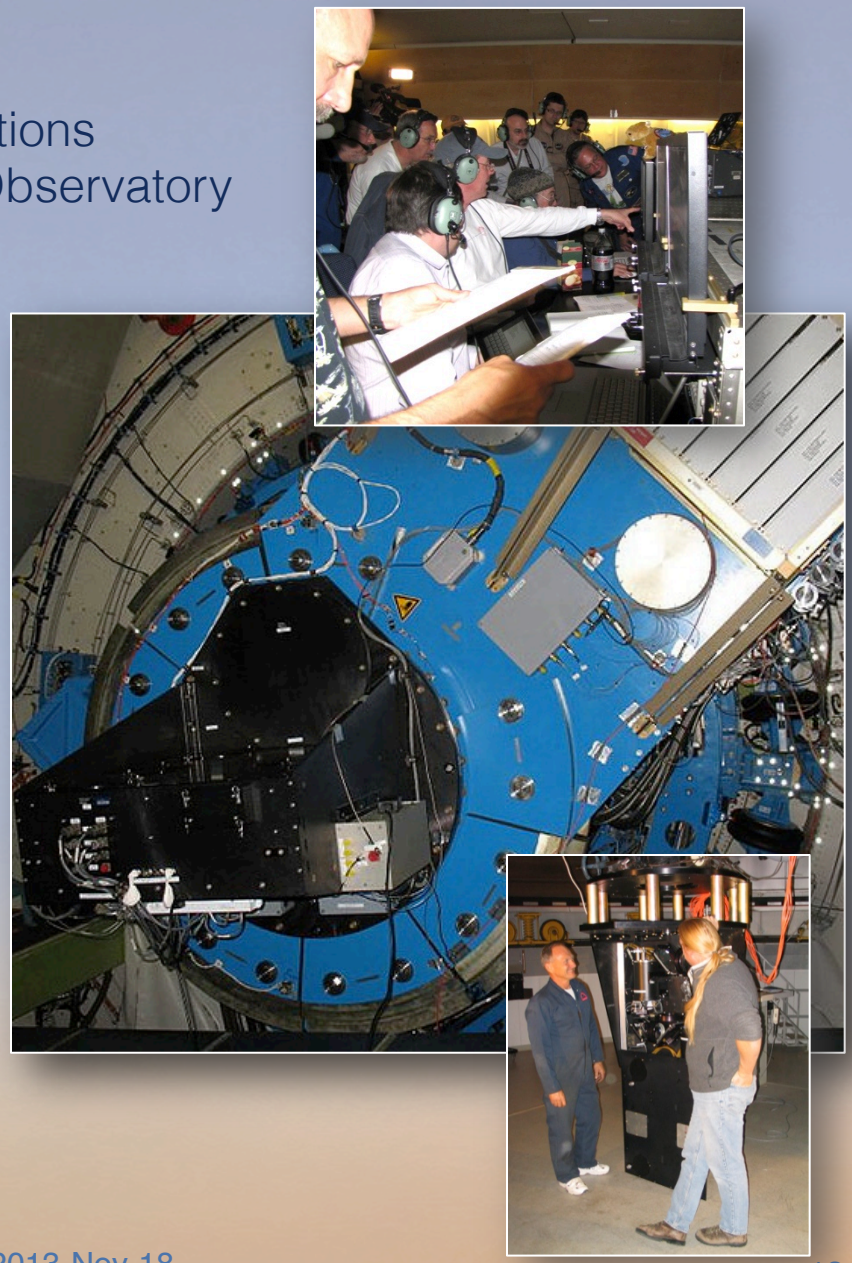




HIPO

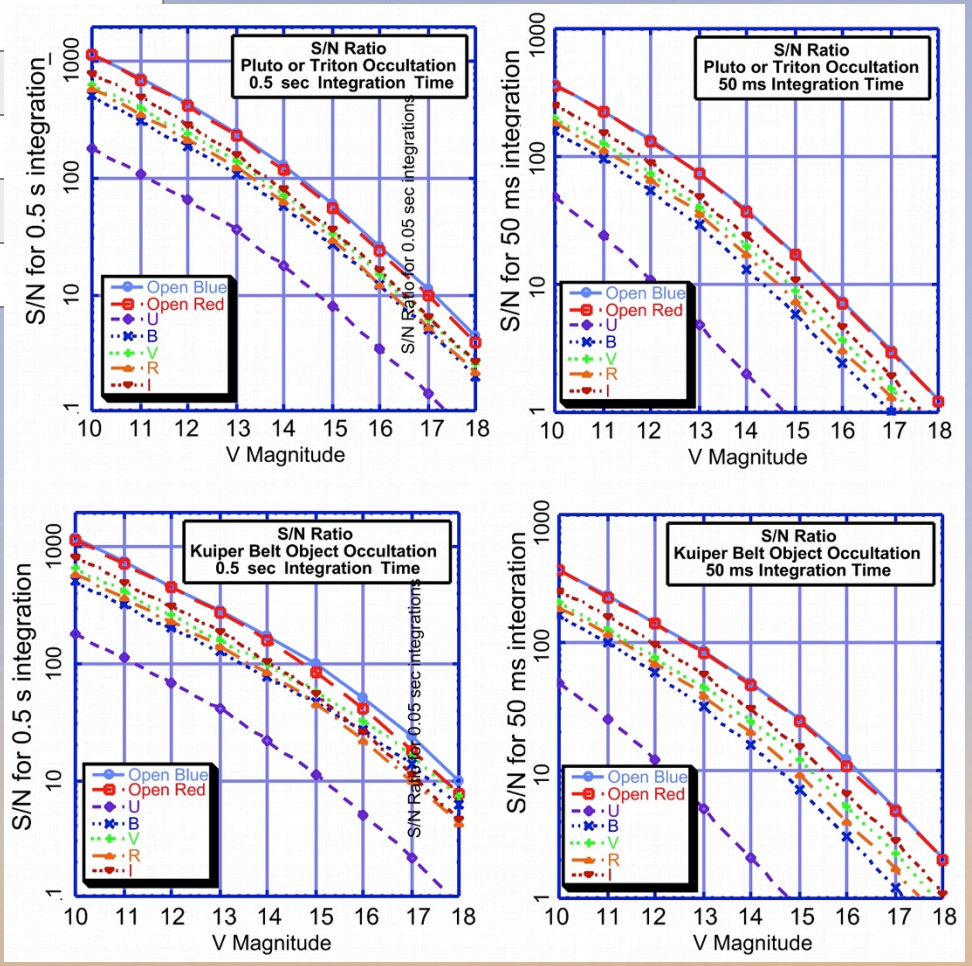
High-speed Imaging Photometer for Occultations
Principal Investigator: Ted Dunham, Lowell Observatory
PI-class Science Instrument

- Early Science flights logged
  - 9 flights conducted, including the June 2011 Pluto occultation flight (4 of these flights were in the FLIPO configuration)
- Cycle 1 flights logged
  - 3 HIPO commissioning and observatory engineering flights completed
  - 2 FLIPO commissioning flights completed, including exoplanet observation
- Installed new CCD detectors with faster readout and better AR coatings
- Installed a new FLIPO beamsplitter with lower emissivity and better HIPO red channel transmission



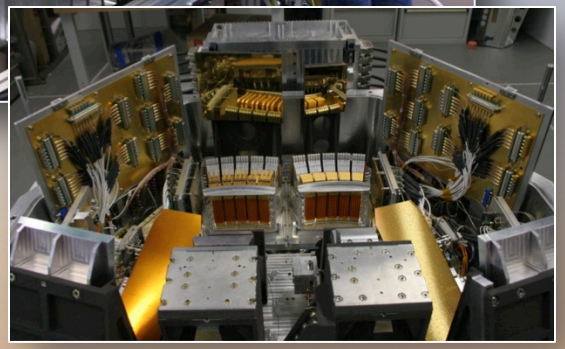
HIPO Performance

HIPO	
Description	Dual-channel high speed imager
Wavelength Range	0.3-1.1 μm
Detector	e2v CCD47-20
Array Format	1024×1024
Pixel Scale	0.33″
FOV	5.6′×5.6′



FIFI-LS

Field-Imaging Far-Infrared Line Spectrometer
Principal Investigator: Alfred Krabbe, University of Stuttgart
PI-class Facility-class Science Instrument



- Completed Pre-Ship Review 29-Oct-2013
- FIFI-LS has been shipped to DAOF; team arrives November 25 to begin setup in the lab at DAOF
- FIFI-LS scheduled to install on aircraft 25-Feb-2014
- Commissioning flights planned in early March and late April 2014

FIFI-LS Performance

FIFI-LS		
Description	Dual-channel integral field imaging spectrometer	
Wavelength Range	42-125 μm	105-210 μm
Detector	Ge:Ga	Stressed Ge:Ga
Array Format	16×25	
Pixel Scale	6″	12″
FOV	30″×30″	60″×60″