FLITECAM

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TOPICS

Overview
Instrument Description
Observing Modes
Commissioning Plans
CfP Availability

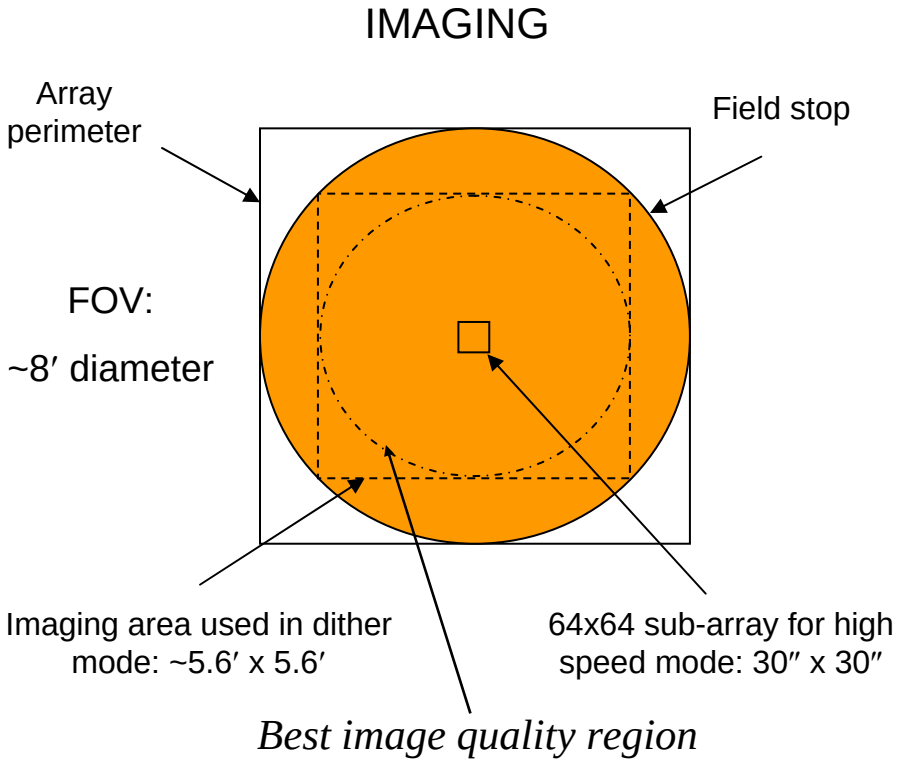
What is FLITECAM?

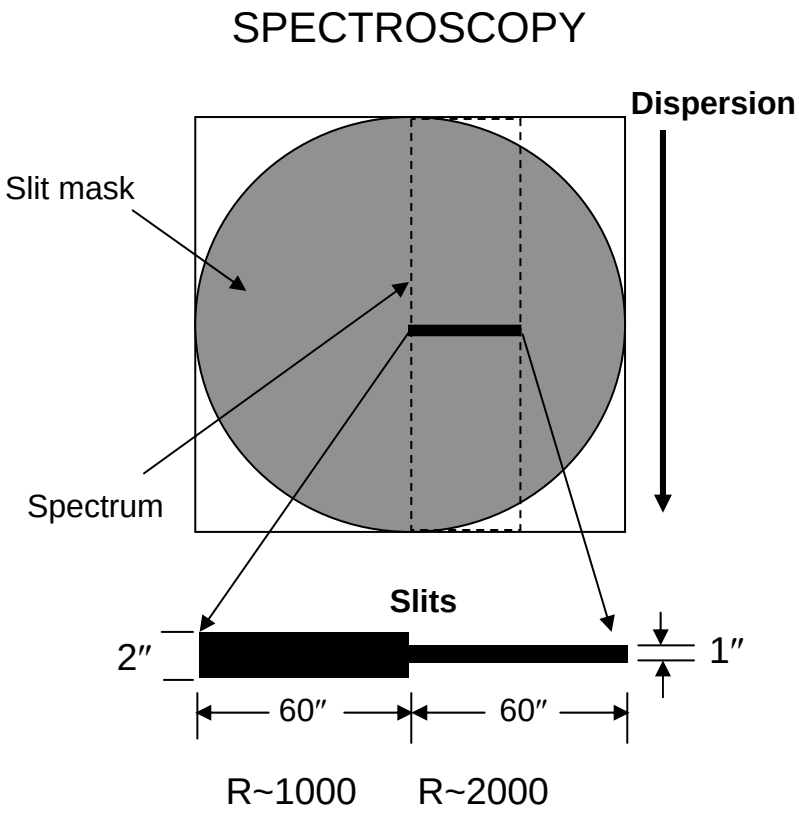
- **FLITECAM is an infrared *camera* and *spectrometer for 1-5 microns***
- 1 megapixel (1024x1024) InSb (ALADDIN III) detector array, large refractive optics, FOV ~8 arc minutes in diameter, scale ~0.5 arcsec per pixel.
- JHKLM broad-band filters and selected narrow-band filters are available.
- Collimated beam ~26 mm diameter; low resolution spectroscopic mode available with direct-ruled KRS5 grisms; aperture mask with a pair of long slits, either 1″ or 2″ in width and each 60″ in length; R~1800 and 900 respectively.
- The instrument is cooled by a liquid helium/liquid nitrogen cryostat.
- *FLITECAM was partially commissioned using the 3-m Shane telescope at Lick Observatory, where the f/17 focus provides almost the same scale as SOFIA*.
- Astronomical observing requests (scripts) and a real-time data reduction pipeline (DRP) for dithered image patterns have been demonstrated.

- **See also: McLean, I. S. *et al*. 2006, Proc. SPIE, 6269, 168; Smith, E.C.D. & McLean, I. S. 2008, Ap. J., 676, 408.**

Summary for Imaging and Spectroscopy

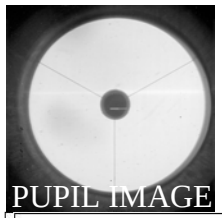
InSb Detector Format: 1024 x 1024 pixels Pixel size on sky: 0.475″ x 0.475″

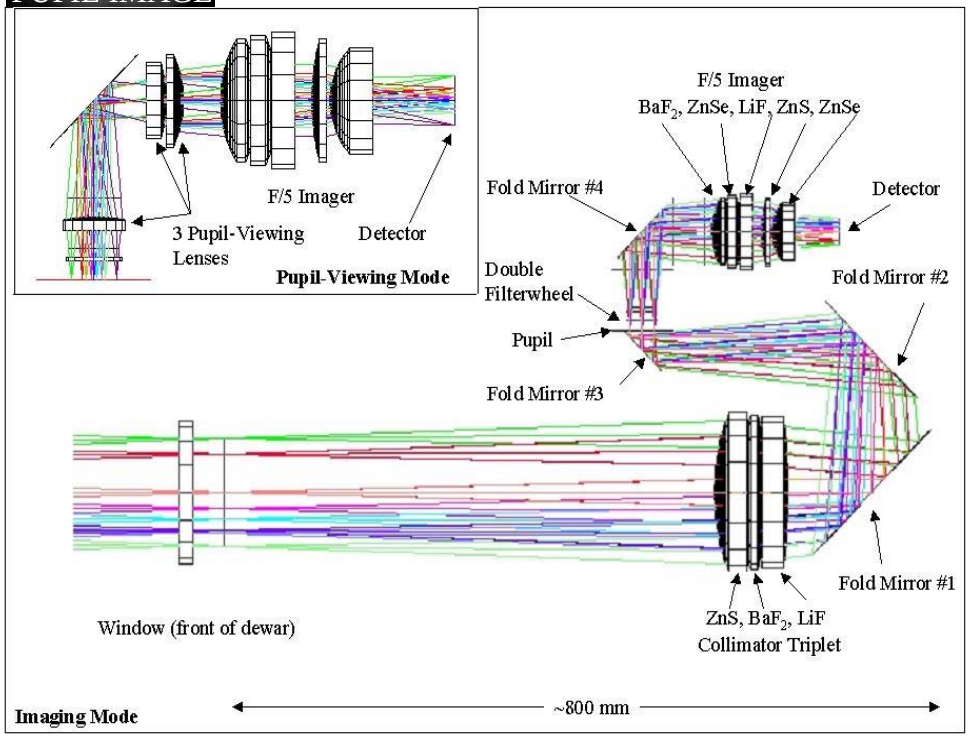




The detector has poor performance in the corners.

Optical Design



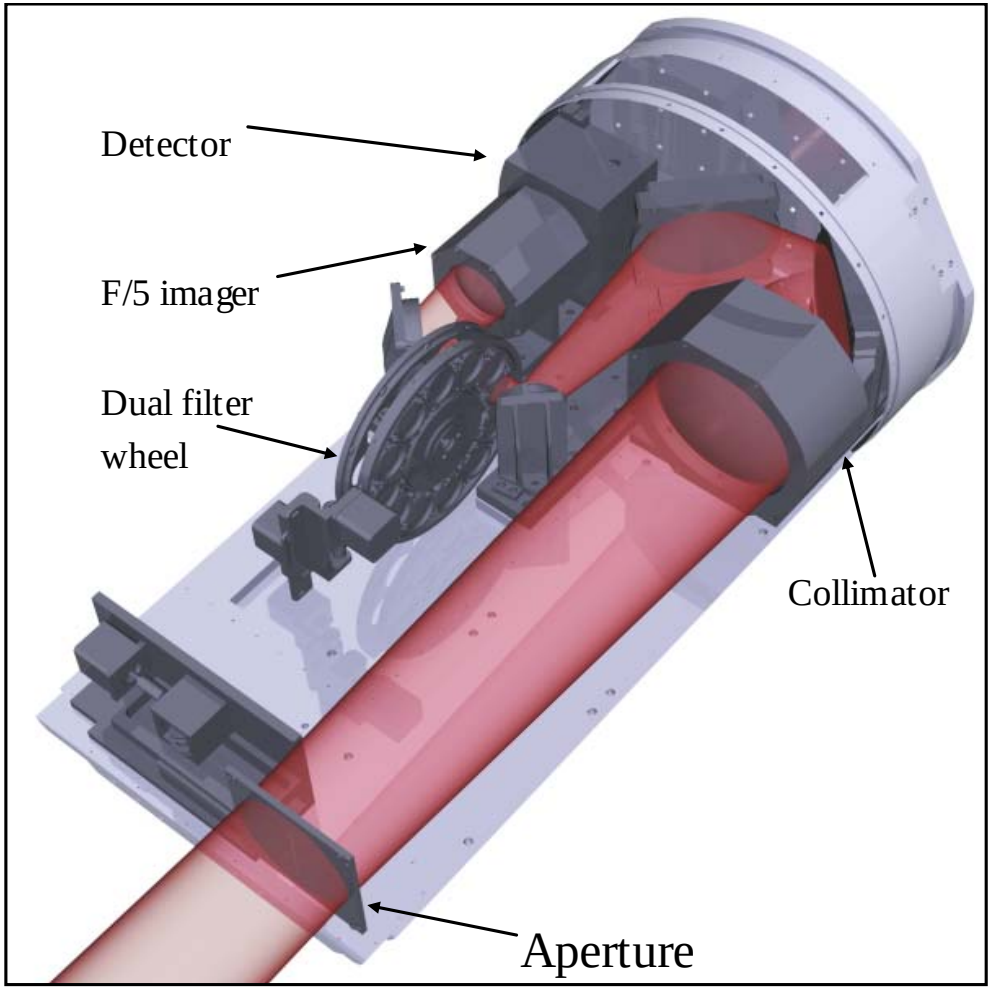


The insert shows how the Pupil-Viewing mode is created. The singlet lens in the filter wheel is sufficient to create a pupil image, but the doublet on a slide mechanism gives a x2 magnification.

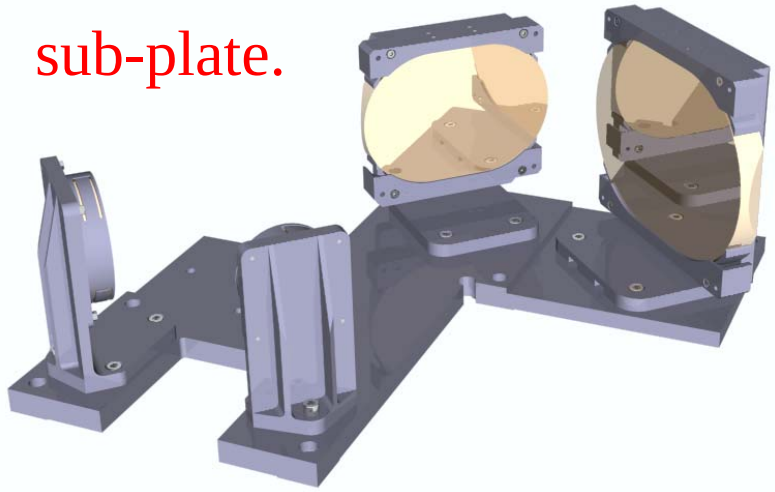
- Photons enter the vacuum-cryogenic chamber through a window of CaF2 and come to a focus at the Aperture stop.
- The beam is collimated by a triplet of ZnS, BaF2 and LiF and then folded into a compact geometry by four flat mirrors.
- A pupil image is formed at the entrance into a double filter wheel.
- After the fourth folding flat a camera lens group working at about f/4.7 re-images the aperture onto the 1024 x 1024 pixel array of the ALADDIN III InSb detector (Raytheon) which has 27-micron pixels.
- The camera has five elements consisting of BaF2, ZnSe, LiF, ZnS and ZnSe.

Mechanical Layout

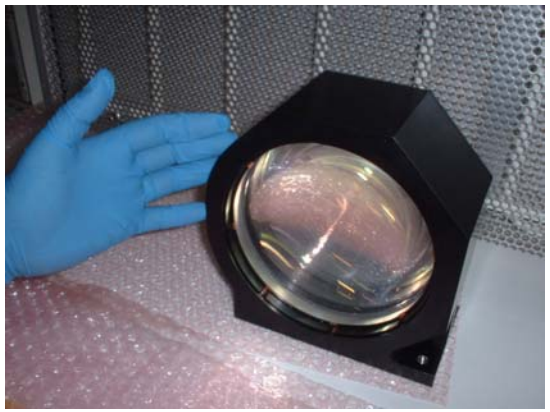
FLITECAM optical bench



Fold mirrors and mini-optical sub-plate.



Assembled collimator

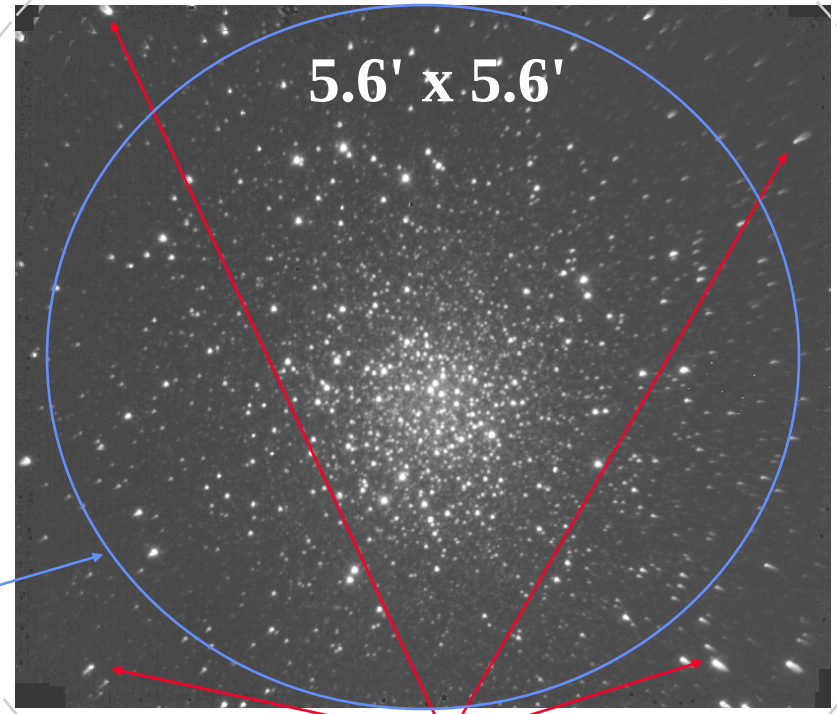


FLITECAM FILTER SET

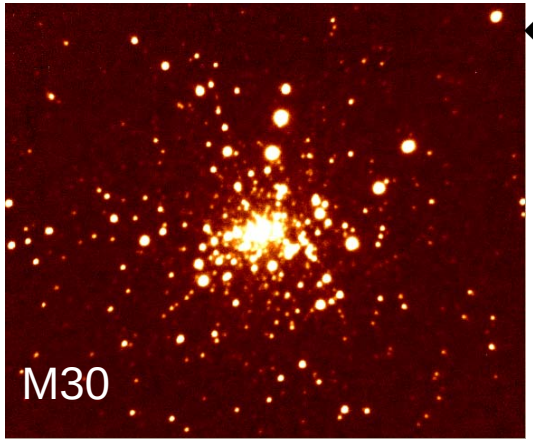
Filter Wheel 1	Filter Wheel 2
blank/dark (77 K)	Pupil Viewing lens
open	Open
J	Paschen-alpha (1.88 μm)
H	A grism – spectroscopy
K	Paschen-alpha continuum)
L′	Narrow Band L (3.6 μm)
L	B grism – spectroscopy
M	Ice (3.08 μm)
Hwide	PAH (3.29 μm)
Kwide	Narrow Band M (4.6 μm)
Klong	C grism – spectroscopy
L&M	N/A

Imaging Mode

- The FLITECAM optics were not really designed to cope with the enlarged field of view
- Comatic flare degrades the image quality to worse than ~2 arcsec FWHM beyond a radius of 2.8 arcmin from the center of the field.
- **The central area produces excellent images**

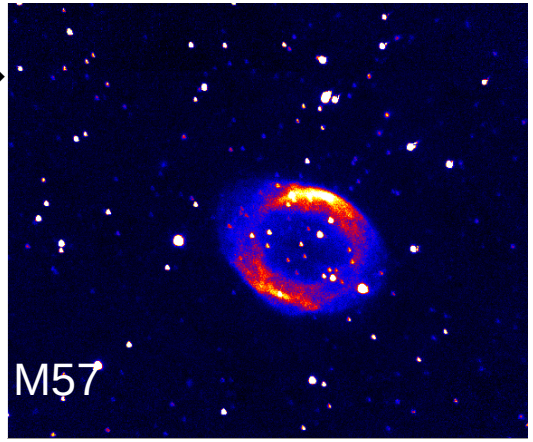


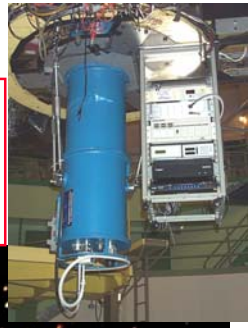
Ground-based Commissioning at Lick Observatory



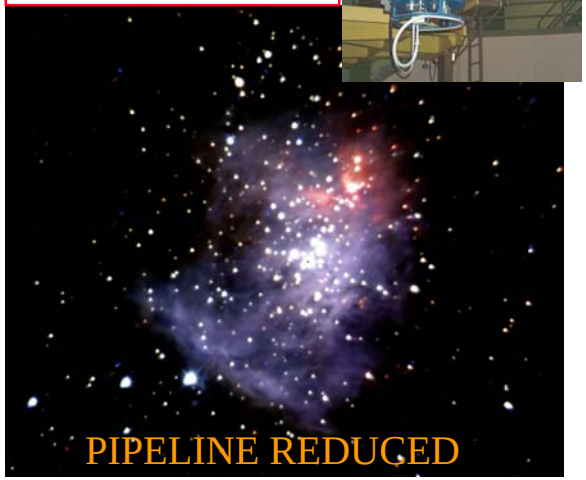
← Globular Cluster

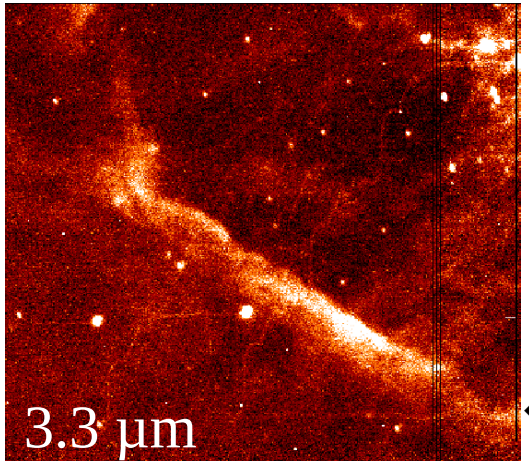
Planetary Nebula →





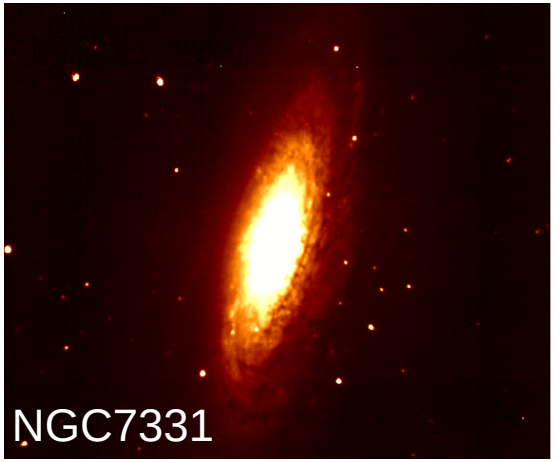
JHK color composite of Orion obtained with FLITECAM on the Lick 3-m telescope.





←Ionization Front

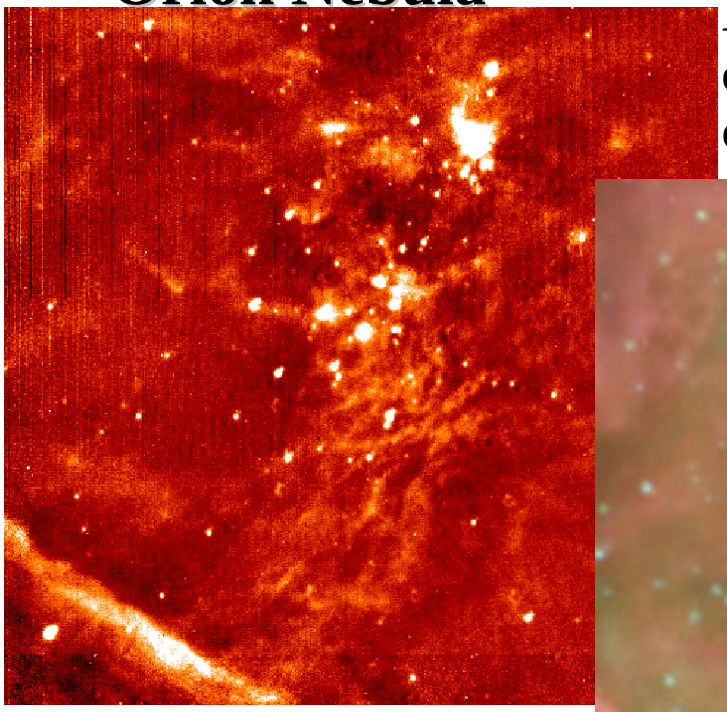
Spiral Galaxy →



Center: the Orion Nebula reduced by the FLITECAM Data Reduction Pipeline and combined into a 3-color composite. The image of the Orion Bar (bottom left) was obtained using a narrow-band filter centered on the 3.3 µm PAH feature; a 512 x 512 sub-array was used to improve readout time. Apart from the JHK color composite, the results are as-seen at the telescope.

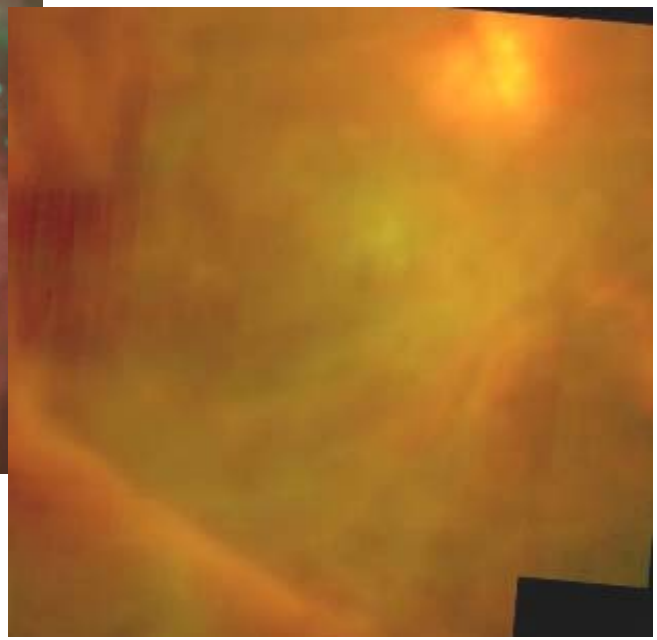
Ground-based Commissioning at Lick Observatory

Orion Nebula



Left: Narrow band image showing 3.3 micron emission from PAHs. Observed by FLITECAM on the 3-m telescope at Lick Observatory.

FORCAST image at 19 and 37 microns with SOFIA



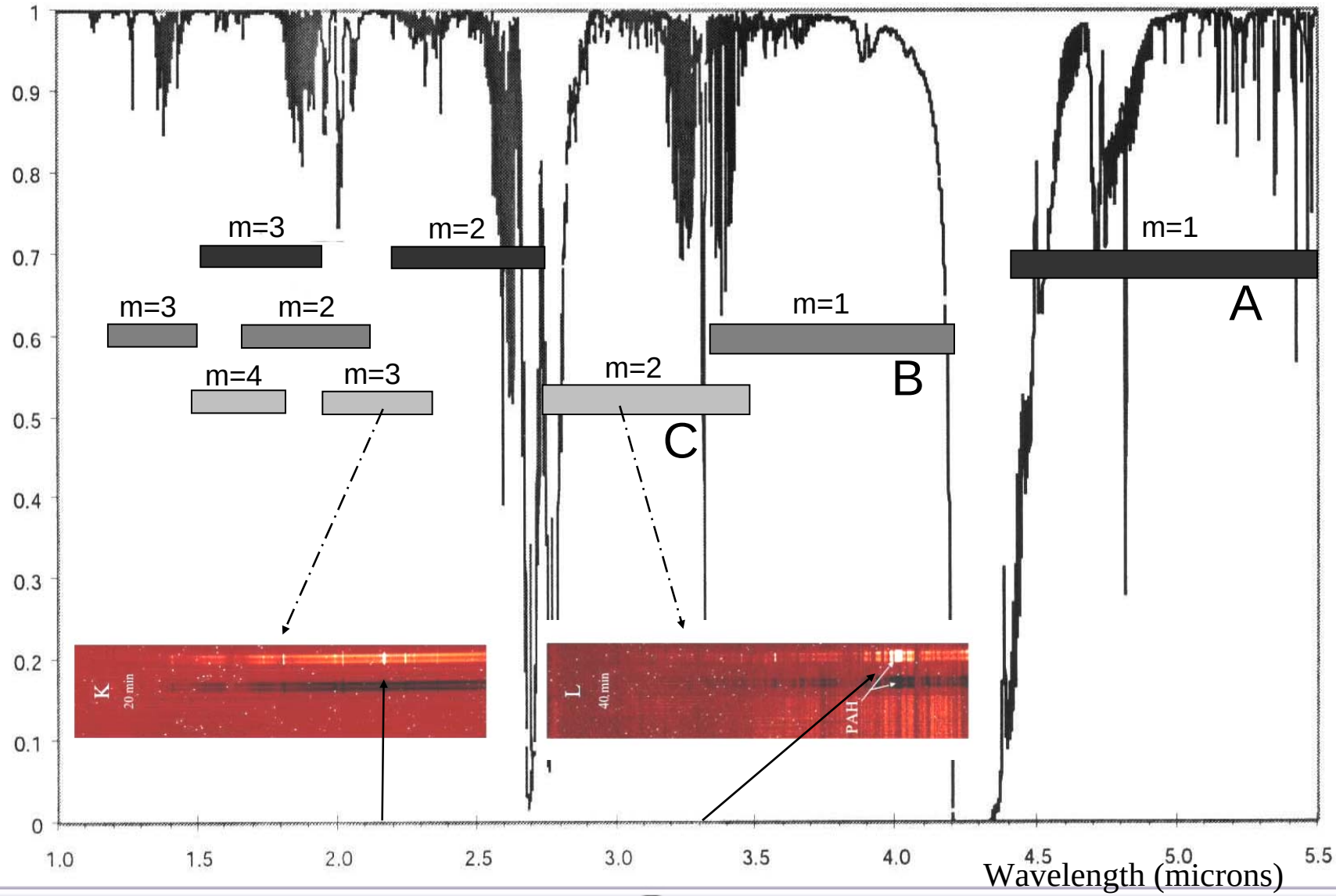
Spitzer **image of same region of Orion. Pink = 8 micron emission from PAHs. Good correspondence with FLITECAM.**

Order-sorting filter (OSF) passbands

Start, Center and End wavelengths for each passband are given in microns

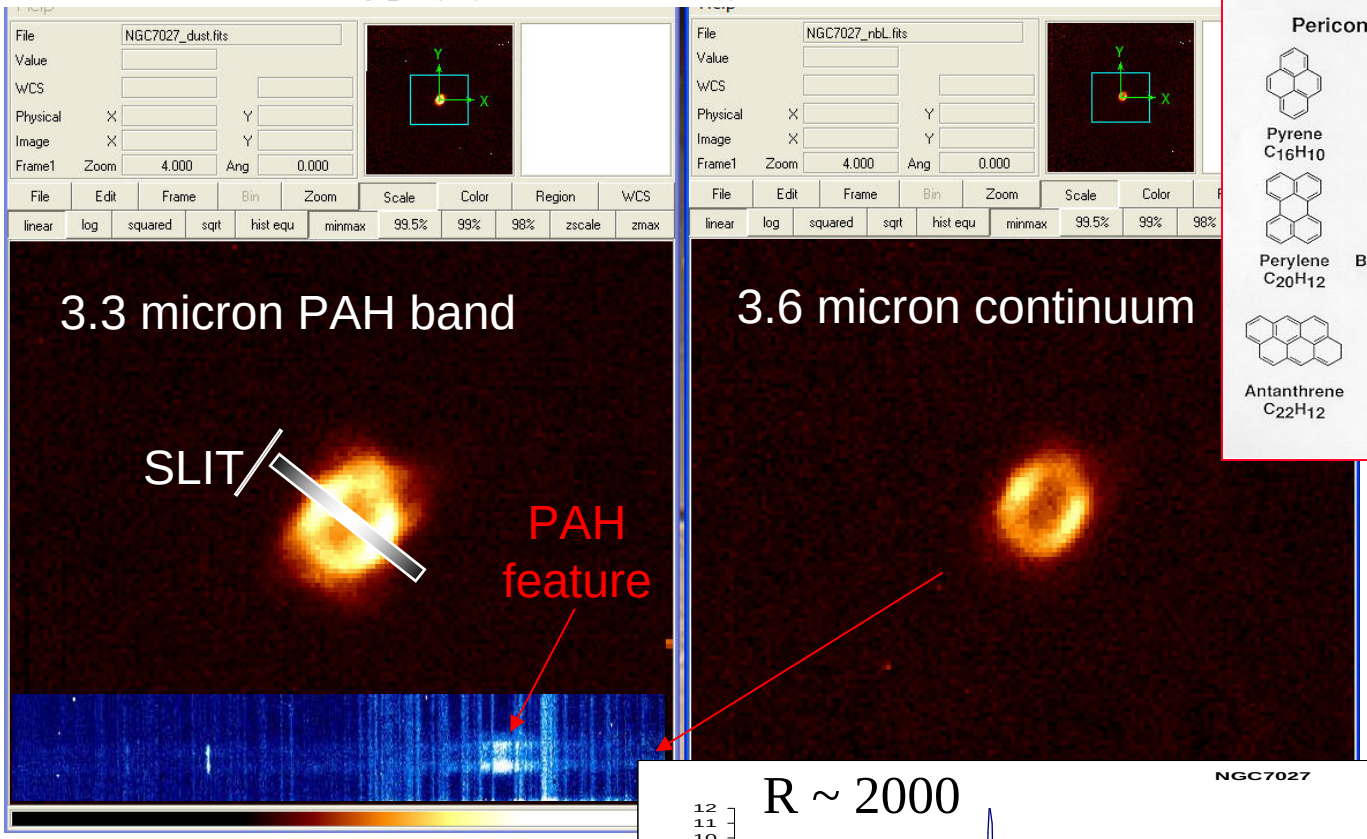
Grism	lines/mm	Order (m)	OSF	Start	Center	End
A	162.75	1	LM	4.395	4.96	5.533
A	162.75	2	Klong	2.216	2.5	2.784
A	162.75	3	Hwide	1.497	1.69	1.877
B	217	1	LM	3.307	3.73	4.16
B	217	2	Hwide	1.649	1.86	2.076
B	217	3	J	1.14	1.28	1.424
C	130.2	2	LM	2.756	3.11	3.467
C	130.2	3	Kwide	1.872	2.11	2.346
C	130.2	4	H	1.445	1.62	1.801

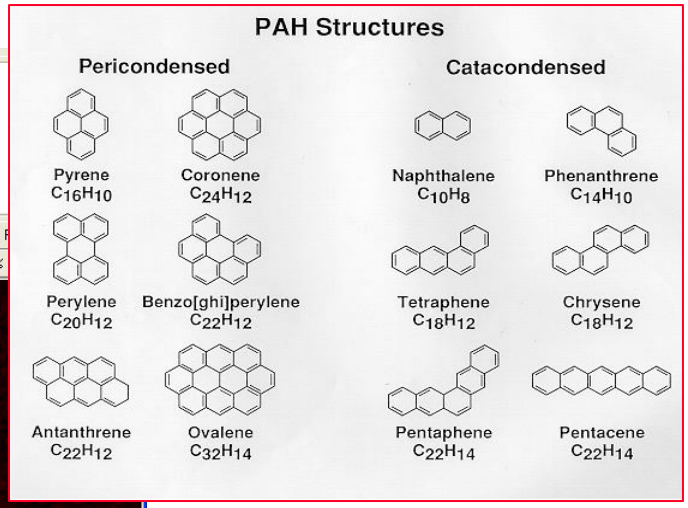
FLITECAM GRISM SPECTROSCOPY



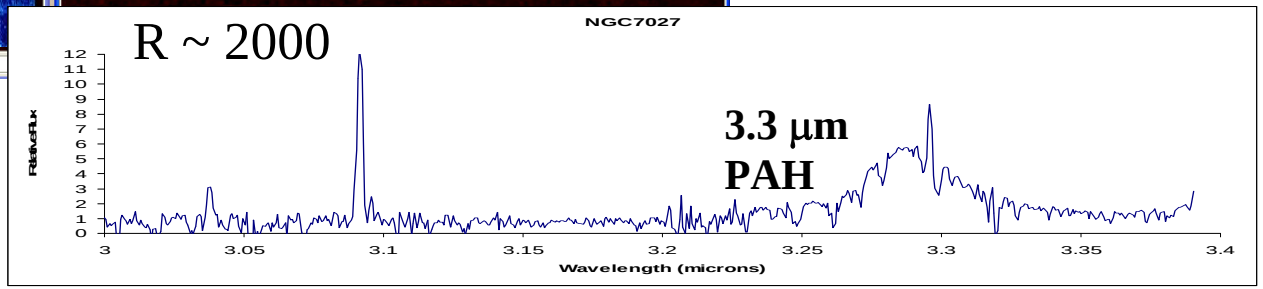
Ground-based Commissioning at Lick Observatory

NGC7027: Observing polycyclic aromatic hydrocarbons (PAHs)





IMAGES AND SPECTRA

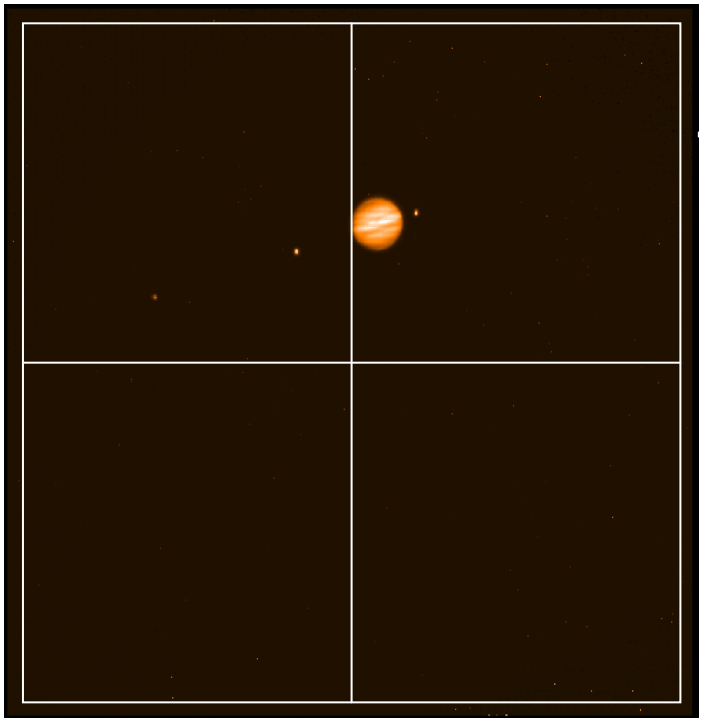


PAH 3.3 micron feature is important & complimentary to longer wavelength features.

Sub-array and Movie Mode

1.650micron Filter

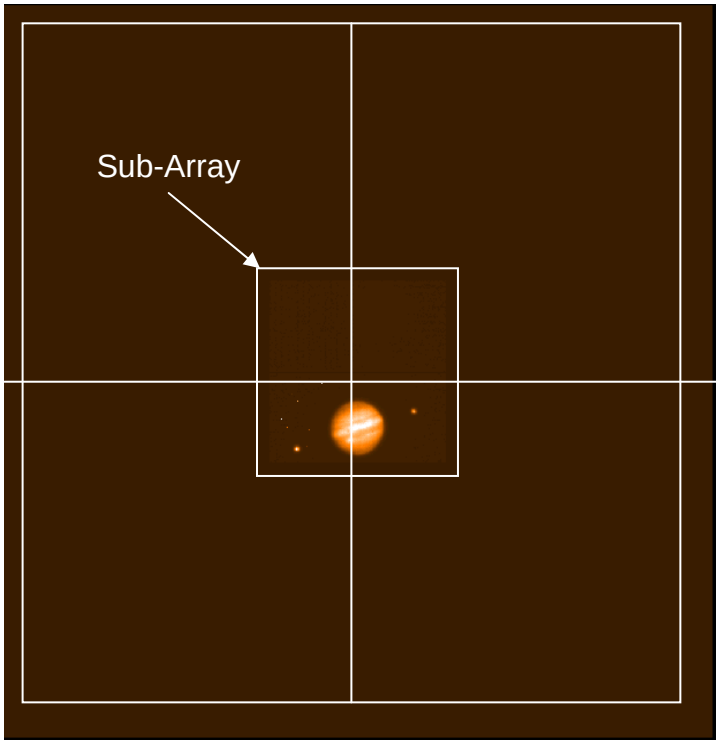
Full Frame 1024x1024 Image



20 Co-Adds 0.3 second Integration

1.650micron Filter

Sub-Array 256x256 Image



50 Co-Adds, 0.03 second Integration

Minimum 0.3 second Integration
Full Frame

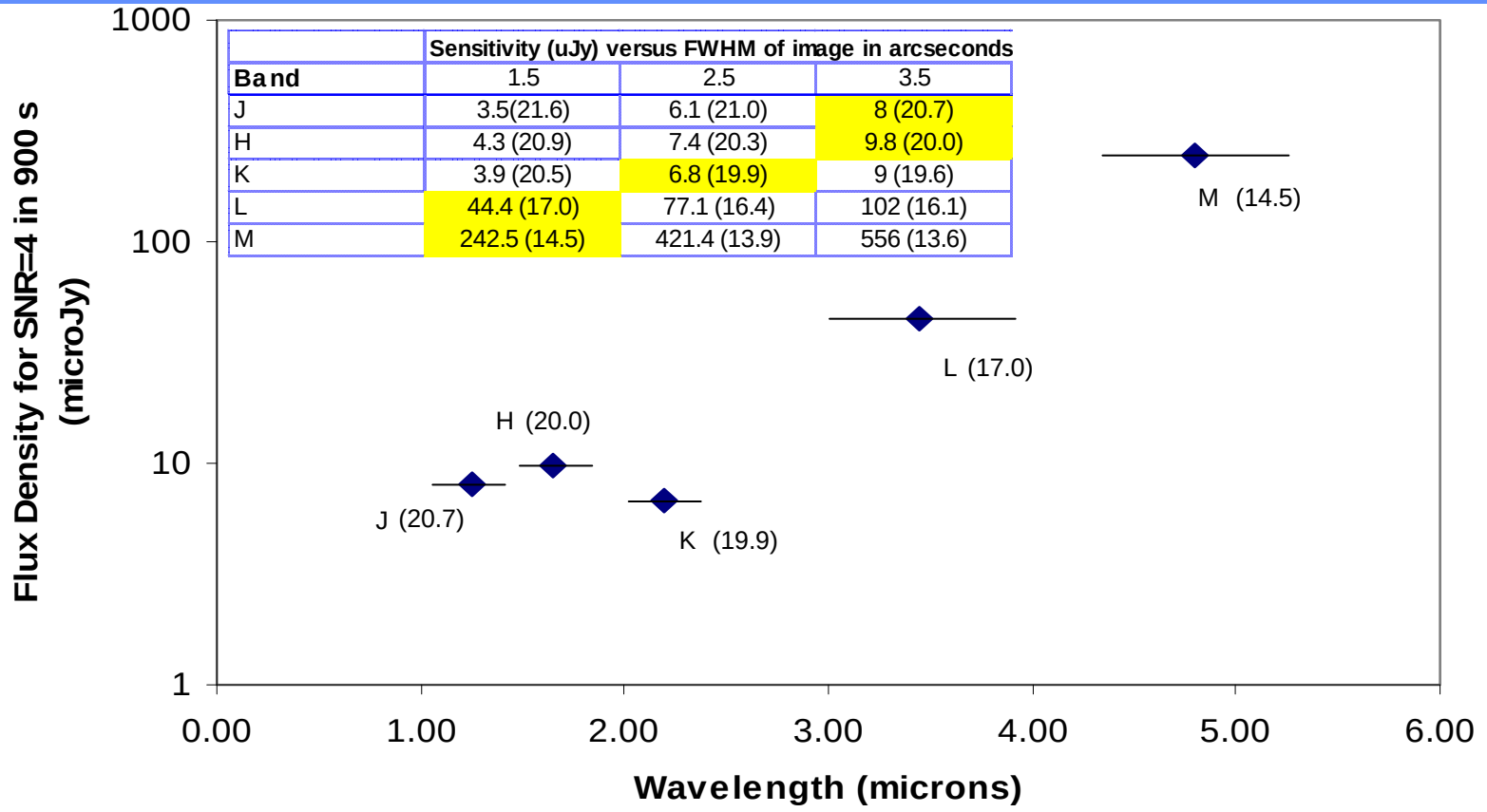
→

Minimum 0.03 second Integration
256x256 Sub-Array

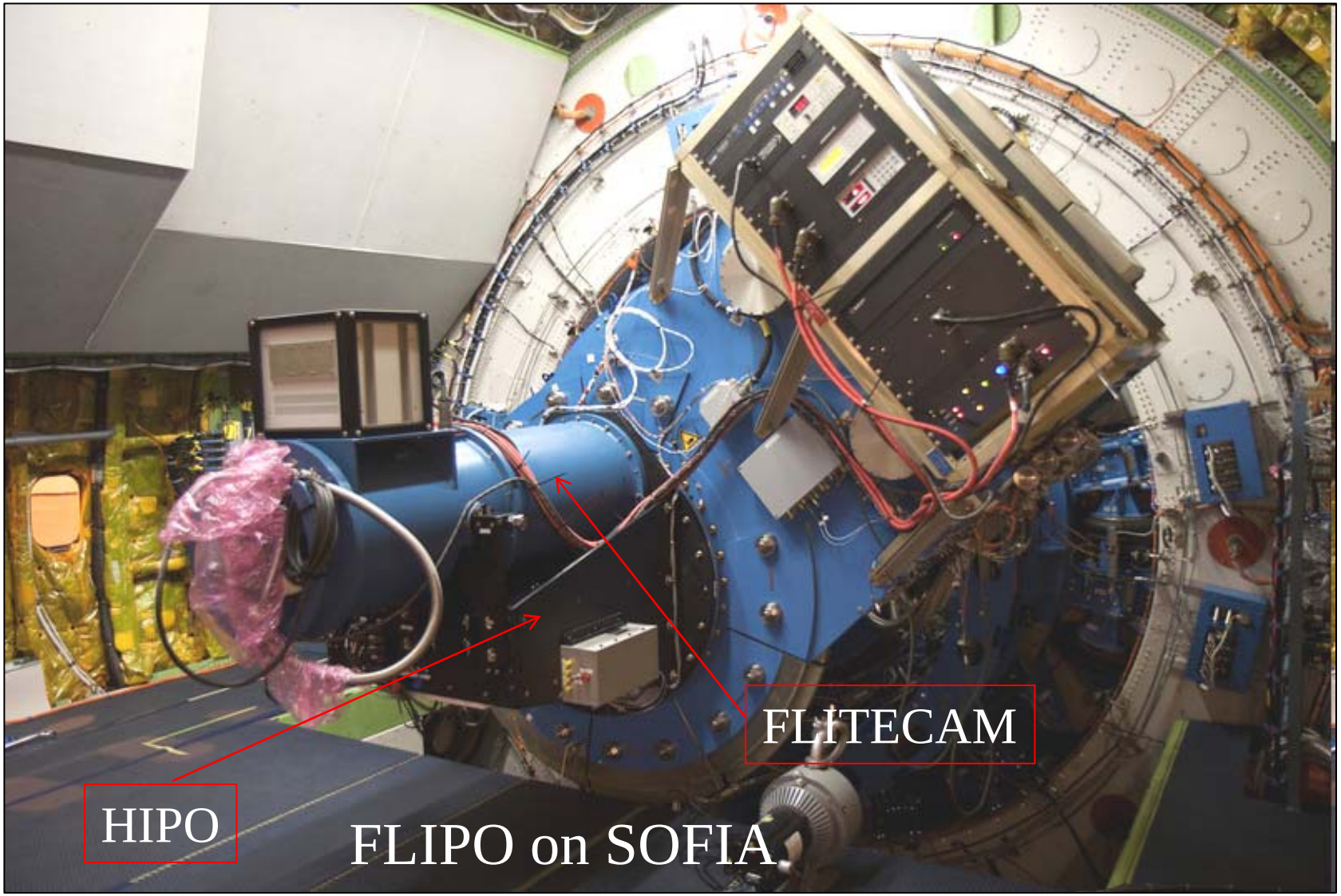
Predicted Sensitivity

- Point source sensitivity (SNR = 4 in 900 s) for FWHM = 3.5 asec to 1.5 asec
- Telescope at 240 K and 15 % emissivity
- JHK consistent with Lick Observatory; LM extrapolated from performance model

	Sensitivity (uJy) versus FWHM of image in arcseconds		
Band	1.5	2.5	3.5
J	3.5(21.6)	6.1 (21.0)	8 (20.7)
H	4.3 (20.9)	7.4 (20.3)	9.8 (20.0)
K	3.9 (20.5)	6.8 (19.9)	9 (19.6)
L	44.4 (17.0)	77.1 (16.4)	102 (16.1)
M	242.5 (14.5)	421.4 (13.9)	556 (13.6)



•Sensitivity limits in grism mode: ~7.5 magnitudes brighter than equivalent broad band



FLIPO on SOFIA

FLITECAM Commissioning status

FLITECAM observing since 2002

Commissioned at Lick Observatory

8 observing campaigns

Imaging and spectroscopy in bands available from ground

Installed on SOFIA as part of the "FLIPO" configuration

HIPO and FLITECAM co-mount

Support to SOFIA Characterization and Integration team (SCAI)

Partial FLITECAM commissioning

4 flights achieved through end of October 2011

Imaging and dither observing in most filters – full array and sub-array modes

Spectroscopy observations in both low and hi resolution

Gyro drift observations, emissivity tests, image size as a fn of wavelength

Unable to complete critical tests to verify performance

On slit nodding difficult, full dither pattern execution unreliable (timing?)

LOS Reset pointing errors during spectroscopy

FLITECAM Commissioning Continued

- Backgrounds are higher due (partly) to FLIPO warm optics
  - requires use of sub-array mode in Ice, PAH, L, M filters
- Backgrounds will be reduced in FLITECAM alone mode
- Data analysis in works – can't confirm sensitivity at this time
- Additional FLIPO flights (3) are in discussion for December 2011
  - Support to SCAI team – no further specific FLITECAM commissioning
- Formal FLITECAM alone commissioning
  - **scheduled for October 2012**

FLITECAM CfP Availability

Current status:

Imaging: stare and dither tested in *most* bands

Overheads ~75% due to interface problems with telescope

Caveat: in the thermal bands a sub array is required to prevent array saturation (but this will be better known after FCAM alone commissioning).

Spectroscopy: will be shared risk; unsolved guiding/nodding

Low resolution is recommended for Cycle 1

On/Off slit nodding OK

Nods along slit not available yet

Expect update after formal instrument commissioning fall 2012

FLITECAM cycle one observations available in spring 2013