FLITECAM, a 1-5 micron camera and spectrometer for SOFIA

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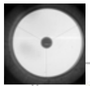
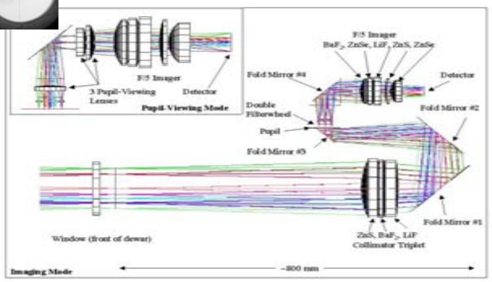
SOFIA, the Stratospheric Observatory for Infrared Astronomy, is a 2.7 m telescope mounted in a Boeing 747 SP.

Altitude: 11-14 km (36,7000-46,700 ft)
Base: NASA Ames Research Center, Moffett Field, CA

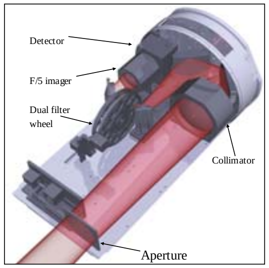
FLITECAM Optical Design





Photons enter the vacuum-cryogenic chamber through an IR-transmitting 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. To convert FLITECAM to spectroscopic mode the aperture is replaced by an opaque metal mask with a long slit, and one of 3 grisms is selected in the second filter wheel.

FLITECAM optical bench



Fold mirrors and mini-optical sub-plate.

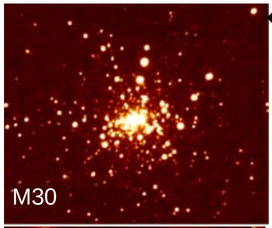
The assembled collimator.

FLITECAM can be mounted directly to SOFIA or co-mounted with HIPO the occultation camera (left).

ABSTRACT

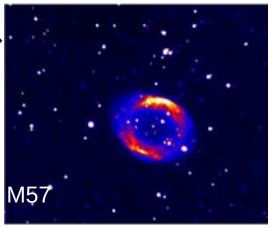
FLITECAM is a 1-5 micron infrared camera for NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA). A 1024 x 1024 InSb ALADDIN III detector and large refractive optics provide a field of view of almost 8 arc minutes in diameter with a scale of just under 0.5 arc seconds per pixel. The instrument is cooled by a double liquid helium and liquid nitrogen cryostat. Using a collimated beam of about 26 mm diameter, a low resolution spectroscopic mode is also available using direct-ruled KRS5 grisms and fixed slits of either 1″ or 2″ width and 60″ length to yield resolving powers of R~1700 and 900 respectively. FLITECAM has been partially commissioned at the 3-m Shane telescope of Lick Observatory where the f/17 optics of this telescope provides almost the same plate scale as SOFIA. Astronomical observing requests (scripts) and a real-time data reduction pipeline (DRP) for dithered image patterns have been demonstrated. The performance of the instrument during ground-based trials is illustrated.

RESULTS

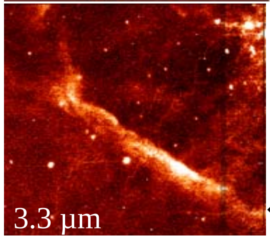


← Globular Cluster

Planetary Nebula →



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



← Ionization Front

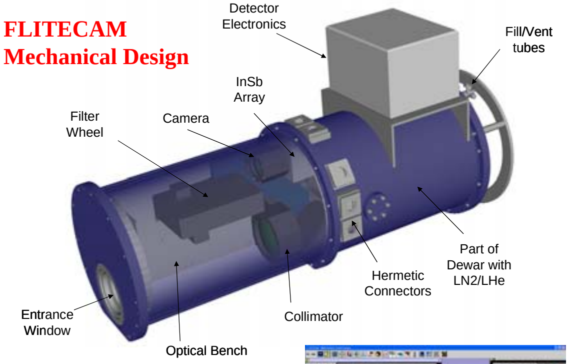
Spiral Galaxy →

Illustrations from observing runs at Lick Observatory. In the center is a picture of the Orion Nebula reduced by the FLITECAM Data Reduction Pipeline and then combined into a 3-color composite. The image of the Orion Bar in the bottom left panel was obtained using a narrow band filter centered on the 3.3 µm PAH feature and 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.

FLITECAM Characteristics

Characteristic	Value
Wavelength range	1 to 5.5 µm; L band for pupil viewing
Filters	J, H, K, L, M, plus narrow bands
Spectral resolution	1000 – 2000 in Grism mode
Spatial resolution	0.46″ per pixel
Detector type	InSb Raytheon ALADDIN III
Detector format	1024x1024 pixels
Field of view on SOFIA	~8′ diameter
Detector operational temperature	30 K
Cryostat type	20 L liquid nitrogen / 20 L liquid helium tanks
Read noise	~49 electrons CDS (Fowler 1)
Well depth	~80,000 electrons
Dark current	~ 1 electron/sec
Instrument efficiency	~40% (not including QE)
Detector quantum efficiency	~80%

FLITECAM Mechanical Design



FLITECAM electronics and computers are mounted in FAA-certified racks as shown. Powerful software makes the instrument easy to use. The "Astronomer's Interface" (AI) program is used to carry out all observations, usually be execution of a pre-written "astronomical observing request" or AOR. The AI program also monitors the telescope and executes any telescope motion commands. A data reduction pipeline (DRP) is available to produce a reconstructed image of the astronomical object corrected for gain variations and anomalous pixels but without flux calibration, i.e. the final result is in counts/second/pixel. In addition, the DRP can be executed automatically as part of the SOFIA Data Cycle System.

SOFIA is a joint project of NASA in the U.S. and DLR in Germany. Please visit http://www.sofia.usra.edu