SOFIA Program Status

Pamela Marcum
SOFIA Project Scientist

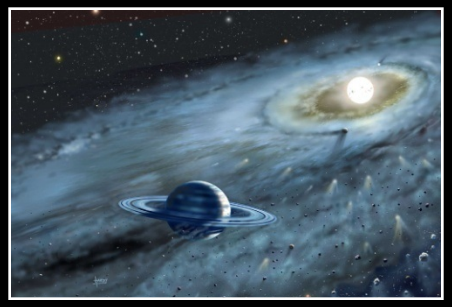
SOFIA
Stratospheric Observatory for Infrared Astronomy

DPS, Monday Oct 4, 2010

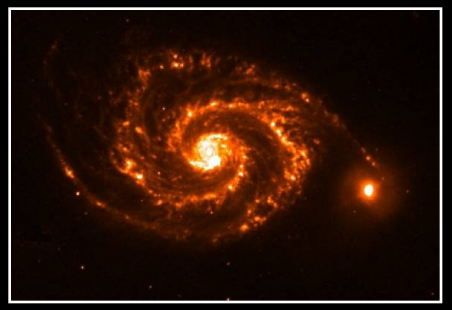
Interstellar Medium

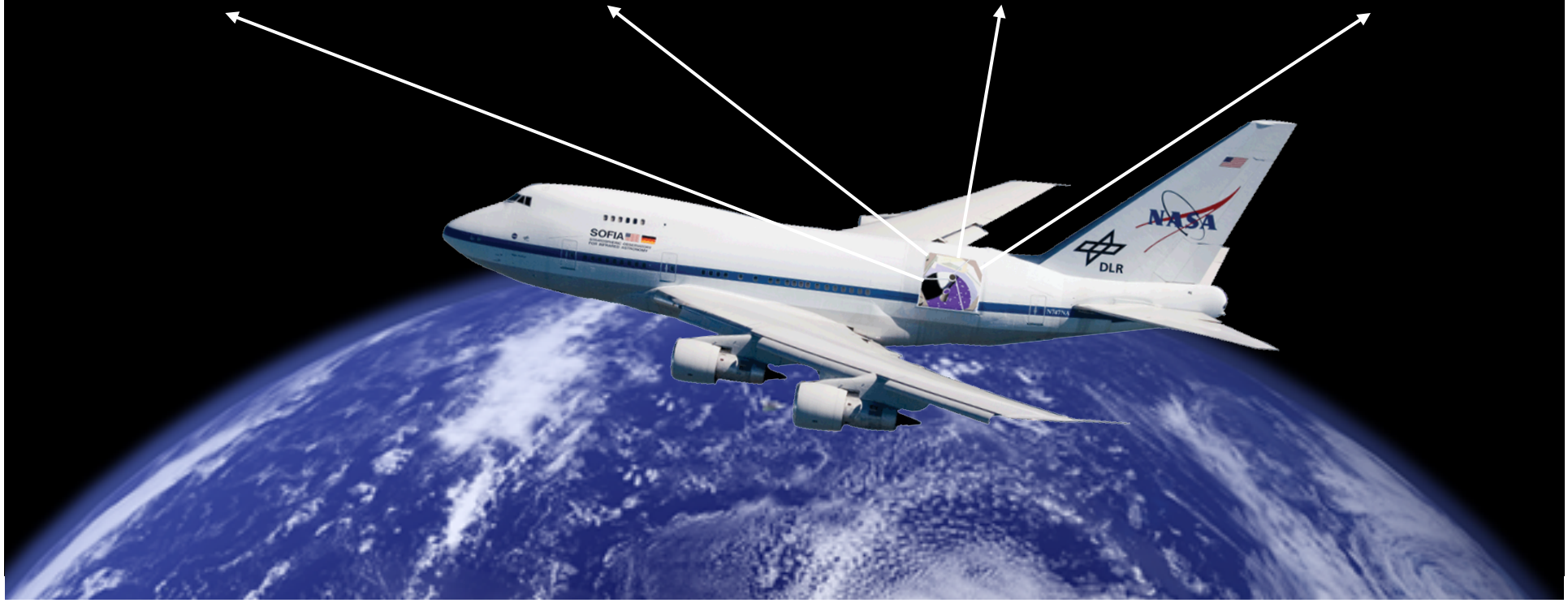
Planetary Science

Formation of Stars and Planets



Galaxies and the Galactic Center





Outline

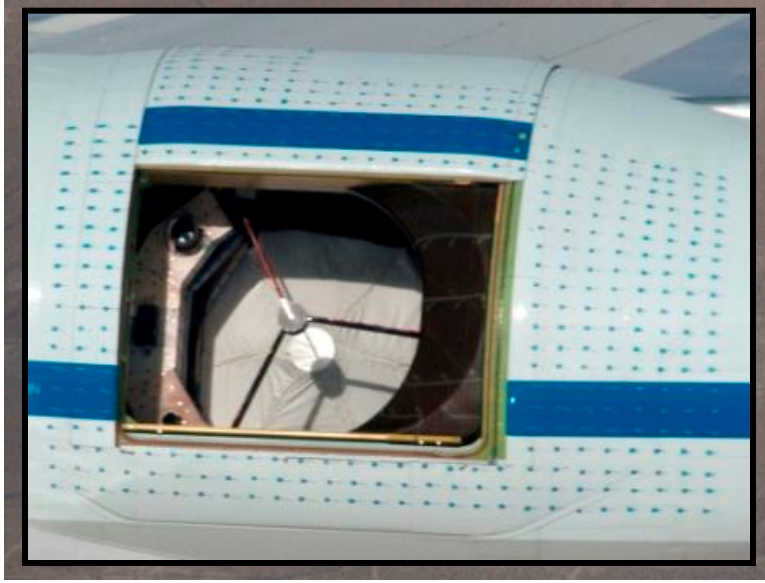
- Recent Achievements
- Near-future Milestones
- Observatory Performance
- Science Instrument Overview
- Observatory Status Summary

SOFIA

Stratospheric Observatory for Infrared Astronomy

Boeing 747SP

2.7-meter

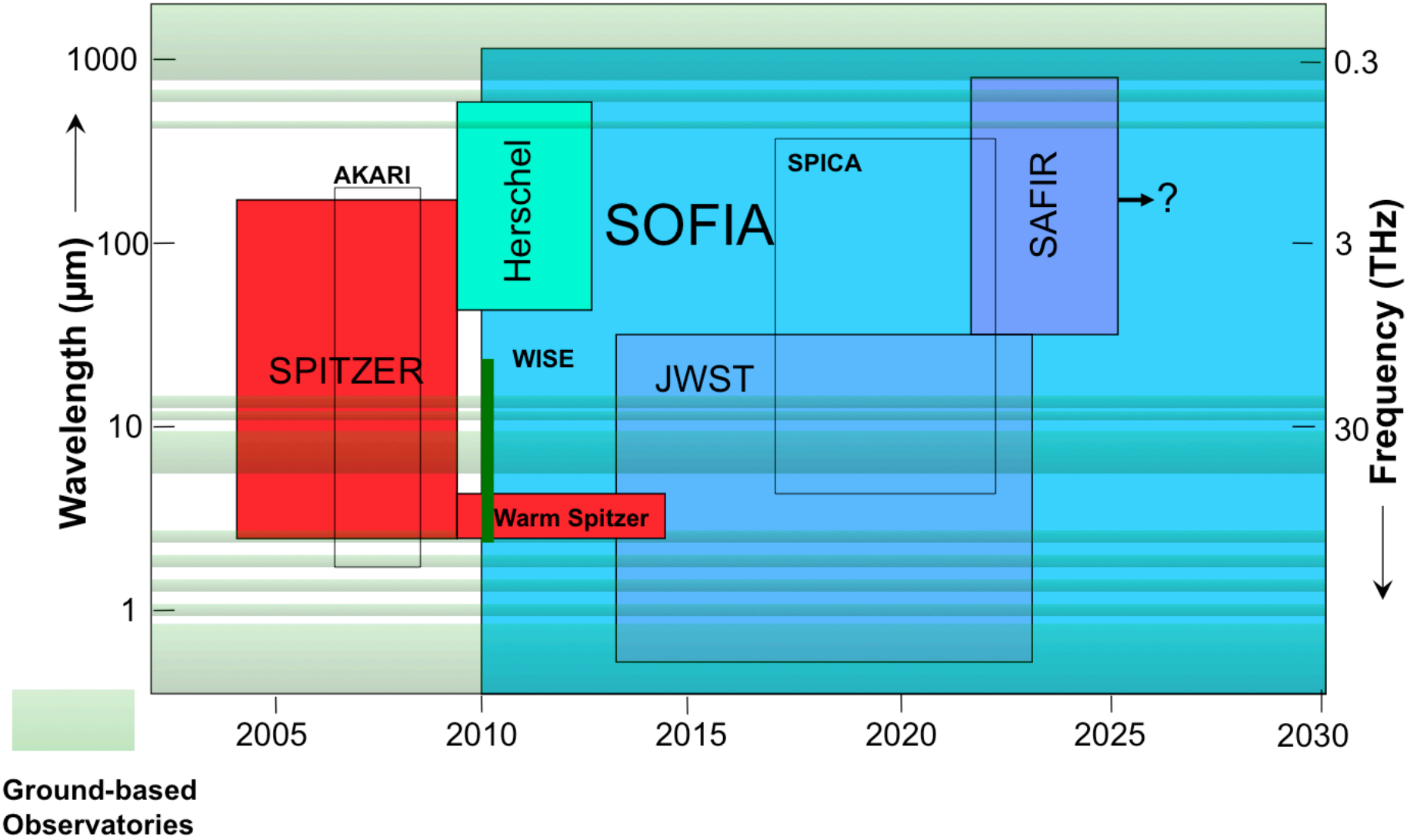


International partnership:
80% -- NASA (US)
20% -- DLR (Germany)

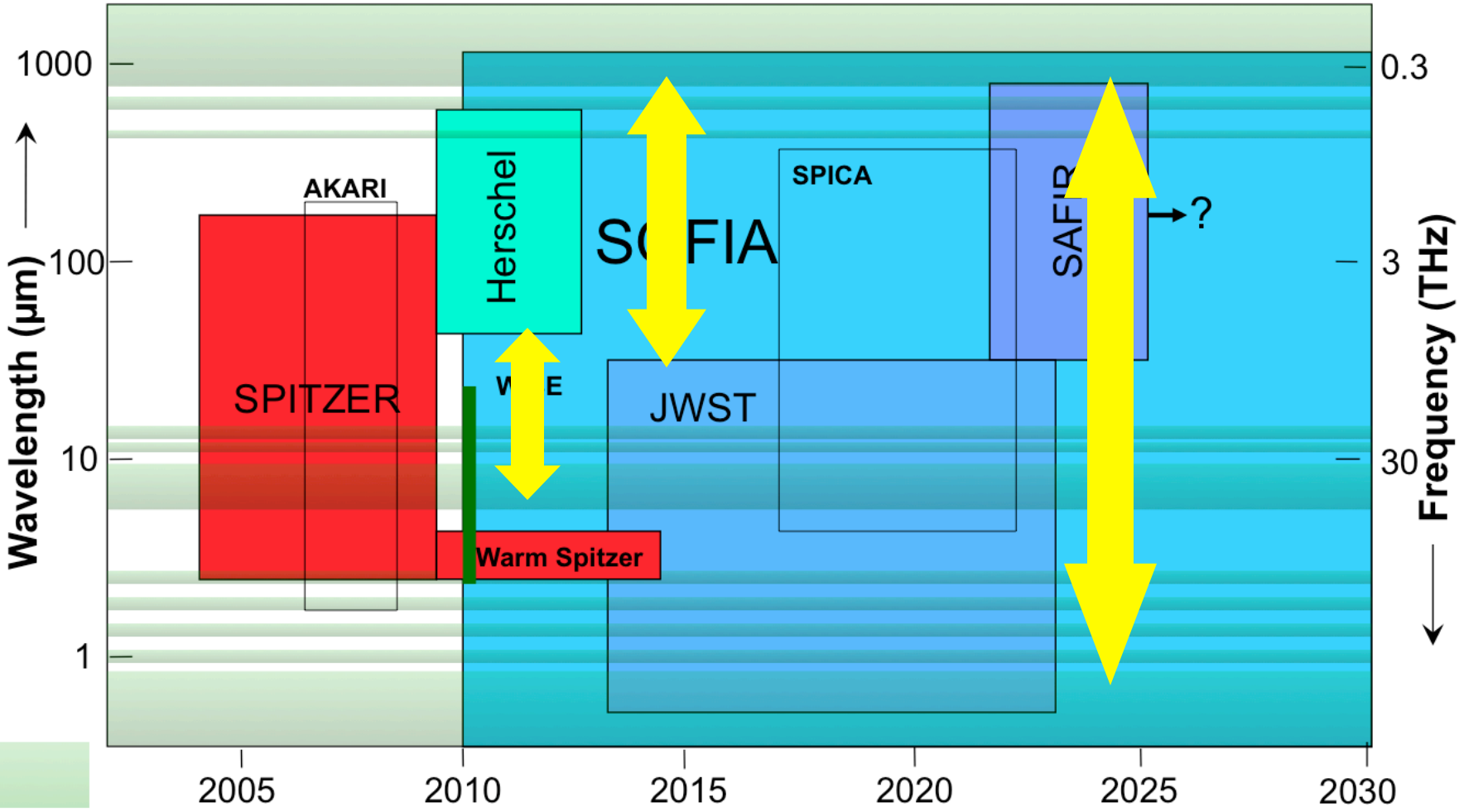
100% Open Door test flight

December 18, 2009

SOFIA and Major IR Imaging/Spectroscopic Space Observatories

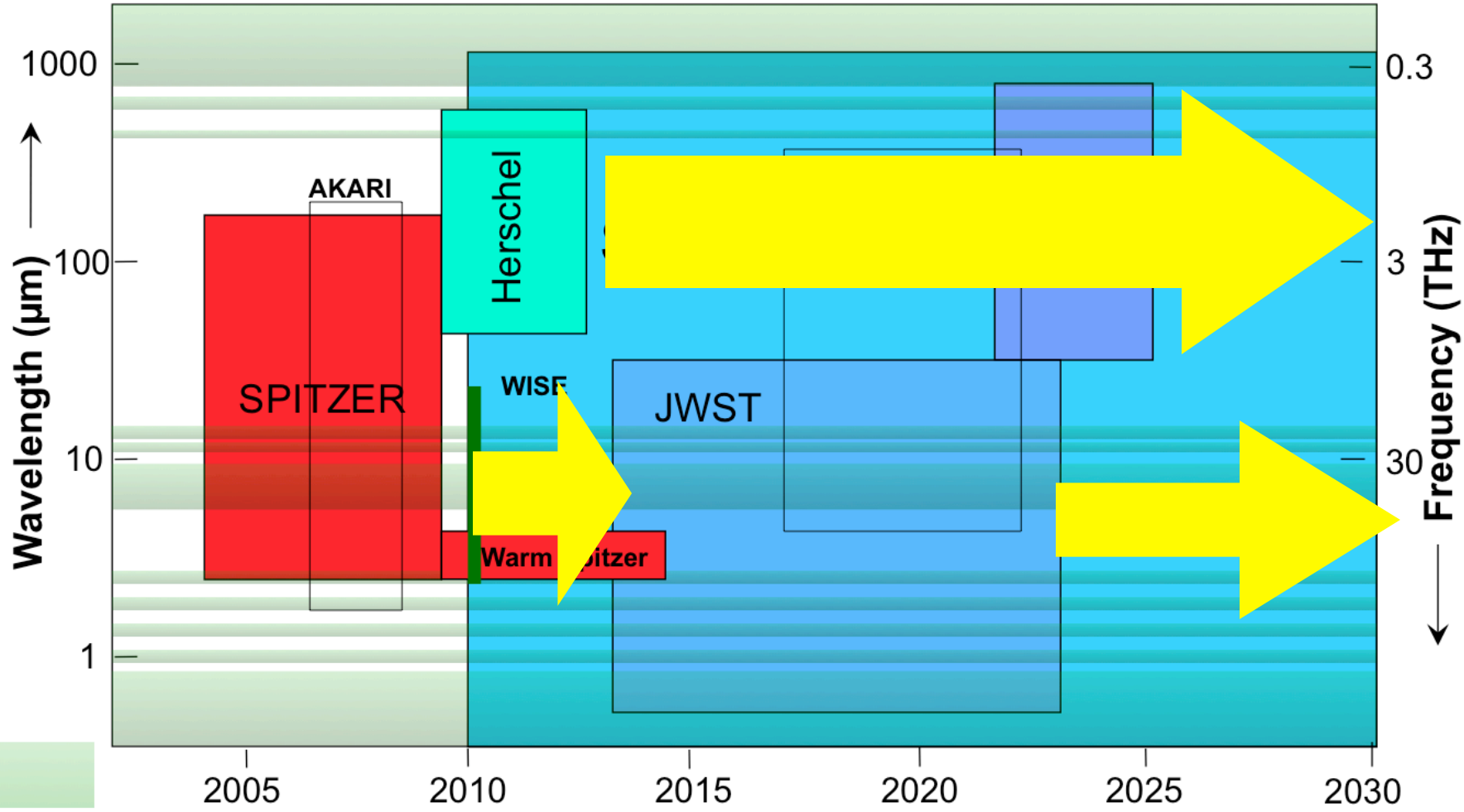


SOFIA and Major IR Imaging/Spectroscopic Space Observatories



SPANS WAVELENGTH GAPS … and

SOFIA and Major IR Imaging/Spectroscopic Space Observatories



… PROVIDES LONG TEMPORAL BASELINE: LONG-TERM MONITORING PROGRAMS AND FOLLOW UP FOR SHORTER-LIVED SPACE-BASED MISSIONS

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Recent Successes!

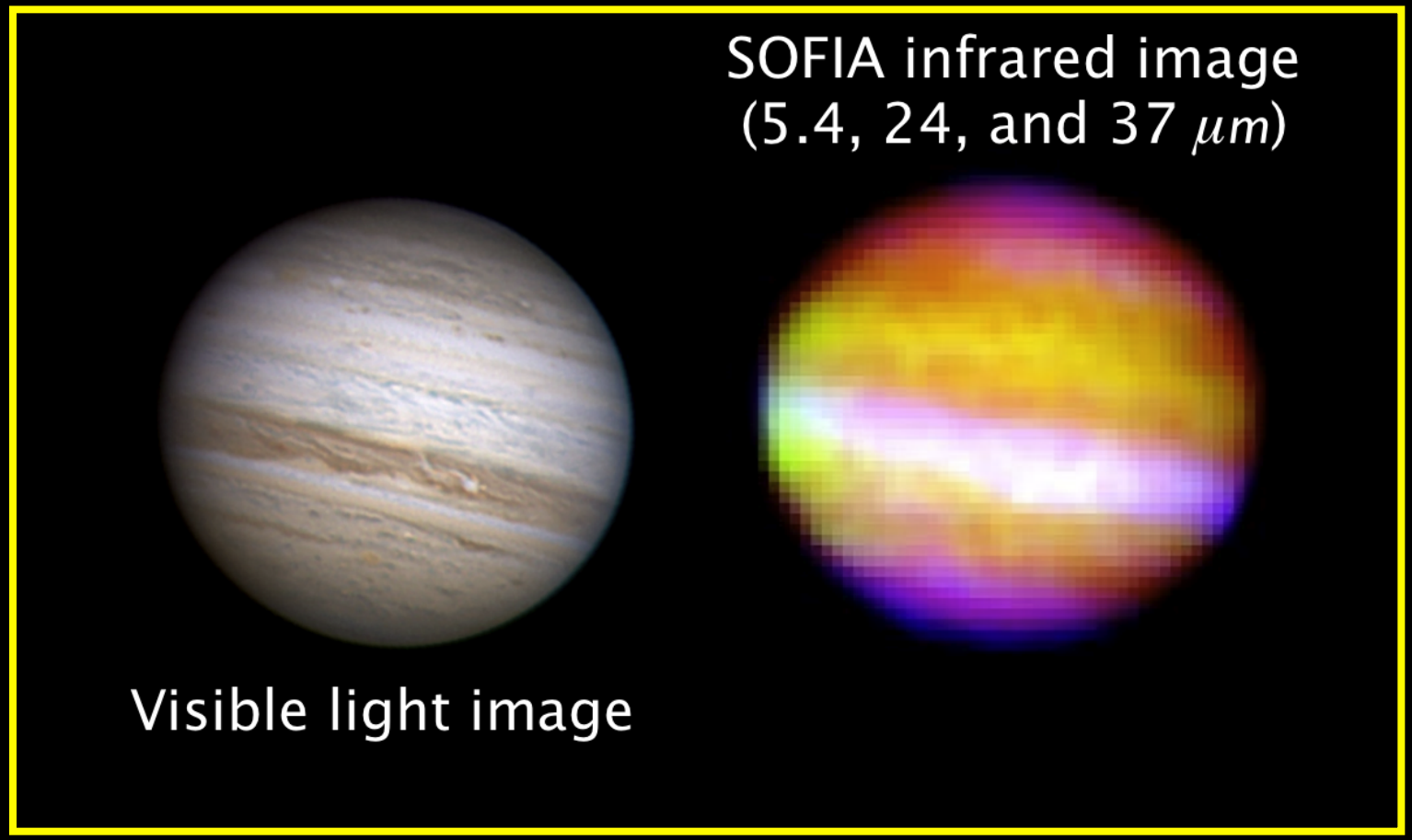
- ✓ Functional Check Flight (FCF) on December 9, 2009
- ✓ 10% Open-Door test flight on December 14, 2009
- ✓ 100% Open-Door test flight on December 18, 2009
- ✓ "Misalignment" flight on April 30, 2010

} initial series of flights to test aircraft modifications and provide flight safety assurance

- ✓ Open Door full envelope expansion complete!
  - ✓ 100% Door Open envelope cleared **up to 45 kft**
  - ✓ No cavity acoustics or aircraft issues in flight
  - ✓ 3 unplanned partial Door-Open Landings without incident
  - ✓ Planned 100% Door-Open Landing accomplished successfully
- ✓ Telescope activation; Jan 15, 2010
- ✓ Call for Basic Science; April 2010
  - ✓ Call for Proposals released on Apr 19, 2010;
  - ✓ Proposal deadline July 30, 2010
- ✓ Science Instrument workshop, Asilomar, CA; June 2010
- ✓ Telescope characterization/First light; night of May 25, 2010
- – Complete Observatory Line Operations, Summer 2010
- – Short Science #1 flights (FORCAST); fall 2010
- – Short Science #2 flights (GREAT); early 2011
- – Basic Science flights; 2011
- – Proposal call for new instruments

SOFIA FIRST LIGHT!

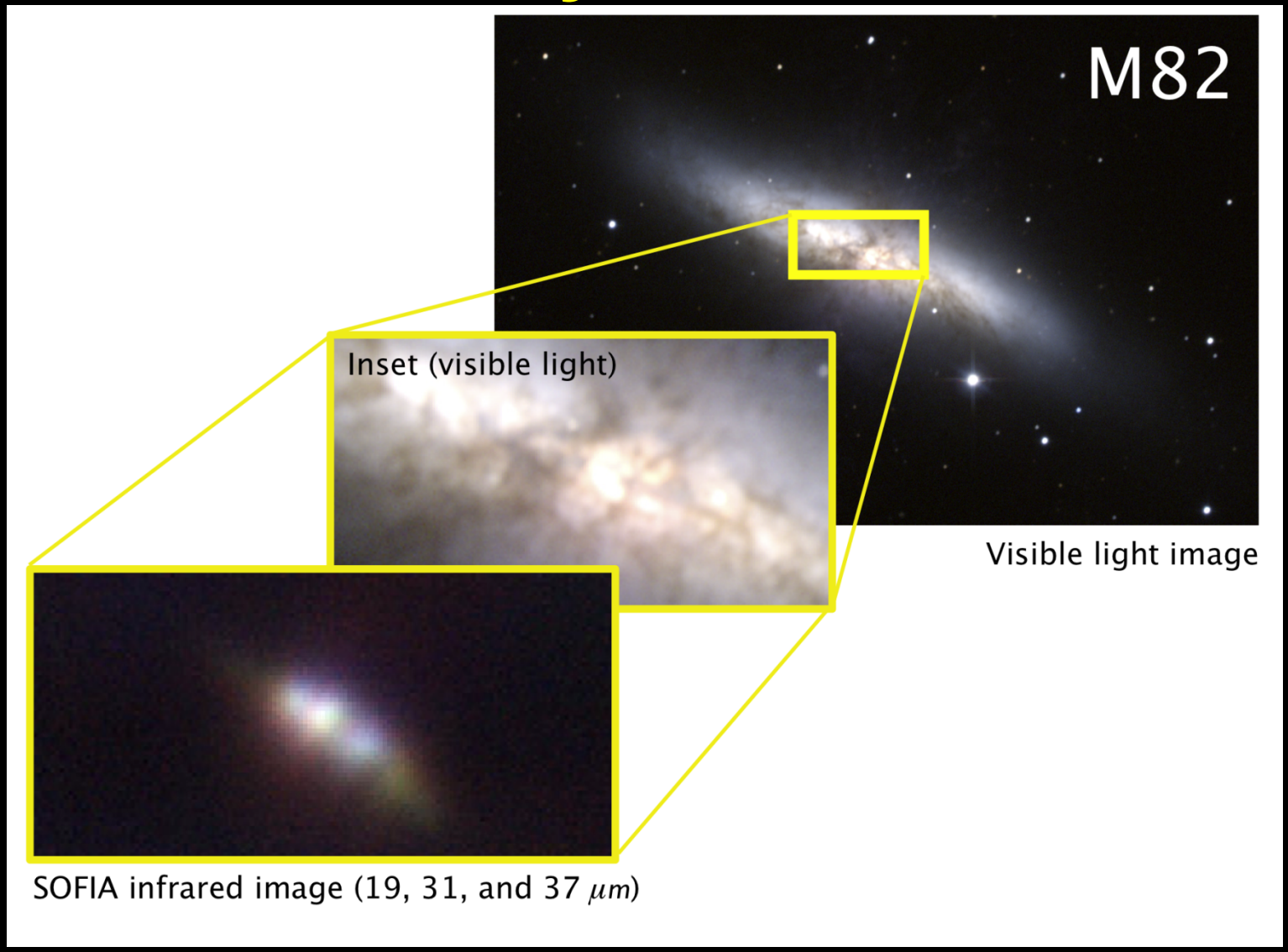
May 25, 2010



(Eric Becklin's upcoming talk will discuss these observations in detail)

SOFIA FIRST LIGHT!

May 25, 2010



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What's Left to Do in the Near Term…

- ✓ Functional Check Flight (FCF) on December 9, 2009
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- – **Basic Science flights; 2011**
- – **Proposal call for new instruments**

} "Early Science"

Early Science Definitions

- **Early Science flights occur before the flight envelop is fully cleared and while some onboard mission systems are still in development.**
  - a shared-risk activity
  - the science community gains earlier access to SOFIA
  - early tests of astronomical observing

<table>
<tr><th></th><th colspan="3">EARLY SCIENCE</th></tr>
<tr><th></th><th>SHORT SCIENCE</th><th colspan="2">BASIC SCIENCE</th></tr>
<tr><td>FORCAST
mid-IR imager (US)</td><td>3 flights
GIs selected</td><td colspan="2">12 flights -- 80% NASA share</td></tr>
<tr><td>GREAT
sub-mm heterodyne receiver (German)</td><td>3 flights
GIs selected</td><td>3 flights
20% DLR share
GREAT consortium</td><td>US Guest Investigators
US, international proposals (except from German institutions) accepted.</td></tr>
</table>

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SOFIA Level 1 Requirements

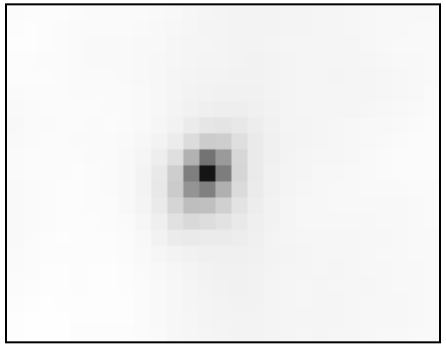
	REQUIREMENT	STATUS
Effective aperture diameter	2.5 meters	✓
Telescope elevation range	20-60 degrees	✓
Image size @ 0.55μm	D(80%)=1.5 FWHM= 5.3" (1st science flight) 1.6" (1st science flight + 3 years)	✓(~4") ‡ future capability
Operations capability	6 hours at/above 41000 feet	✓
Wavelength range	0.3-1600 microns	
Operations capability	40 PI/GI teams per year	
Operations capability	960 hr/yr nominal operations	

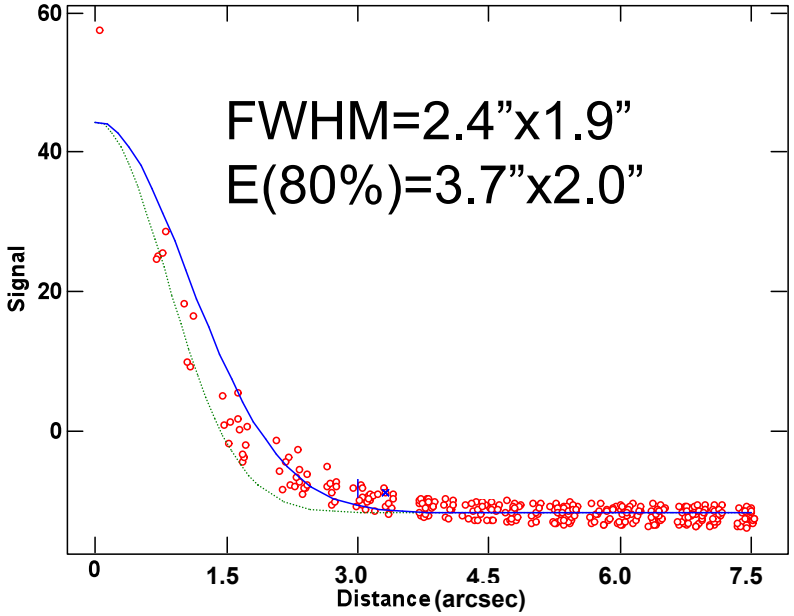
‡ Improvements to reach +3 year requirement will concentrate on jitter reduction and chopper performance.

SOFIA IS READILY MEETING ITS REQUIREMENTS TO START EARLY SCIENCE!

PSF
(Telescope Characterization/First Light)

3000 registered, averaged frames





Martin Burgdorf will have more to say about telescope performance in his presentation.

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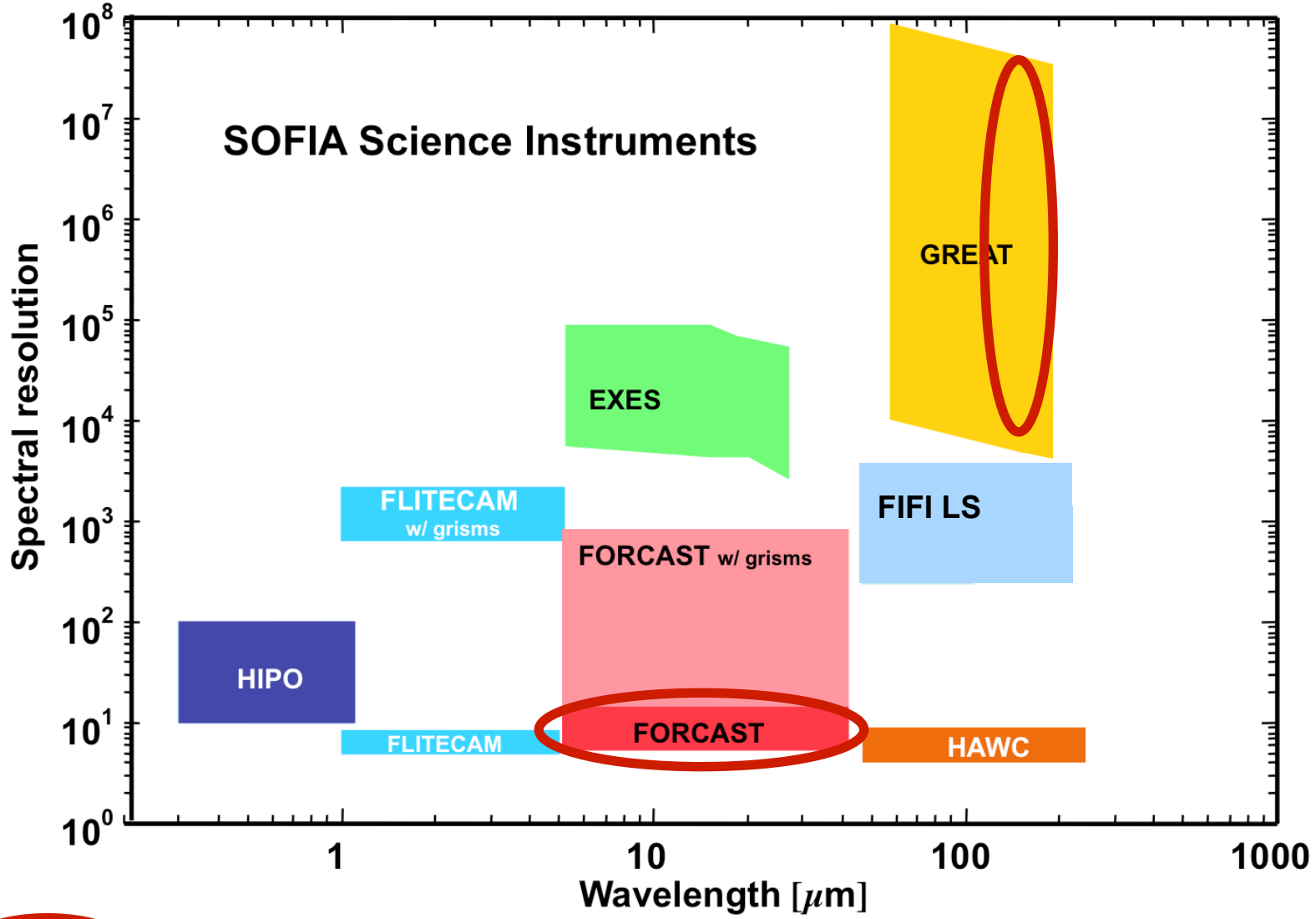
Instrument R/λ graph



= Basic Science availability

TWO EARLY SCIENCE INSTRUMENTS

FORCAST

Faint Object infraRed CAmera for the SOFIA Telescope

- Facility-class instrument
- Mid IR, two-channel camera for simultaneous imaging
- Selectable ($\Delta\lambda \sim 2\mu m$) filters in 4-8 μm, 16-40 μm regimes
- 0.75 arcsec/pixel
- 3.2x3.2 arcmin field-of-view

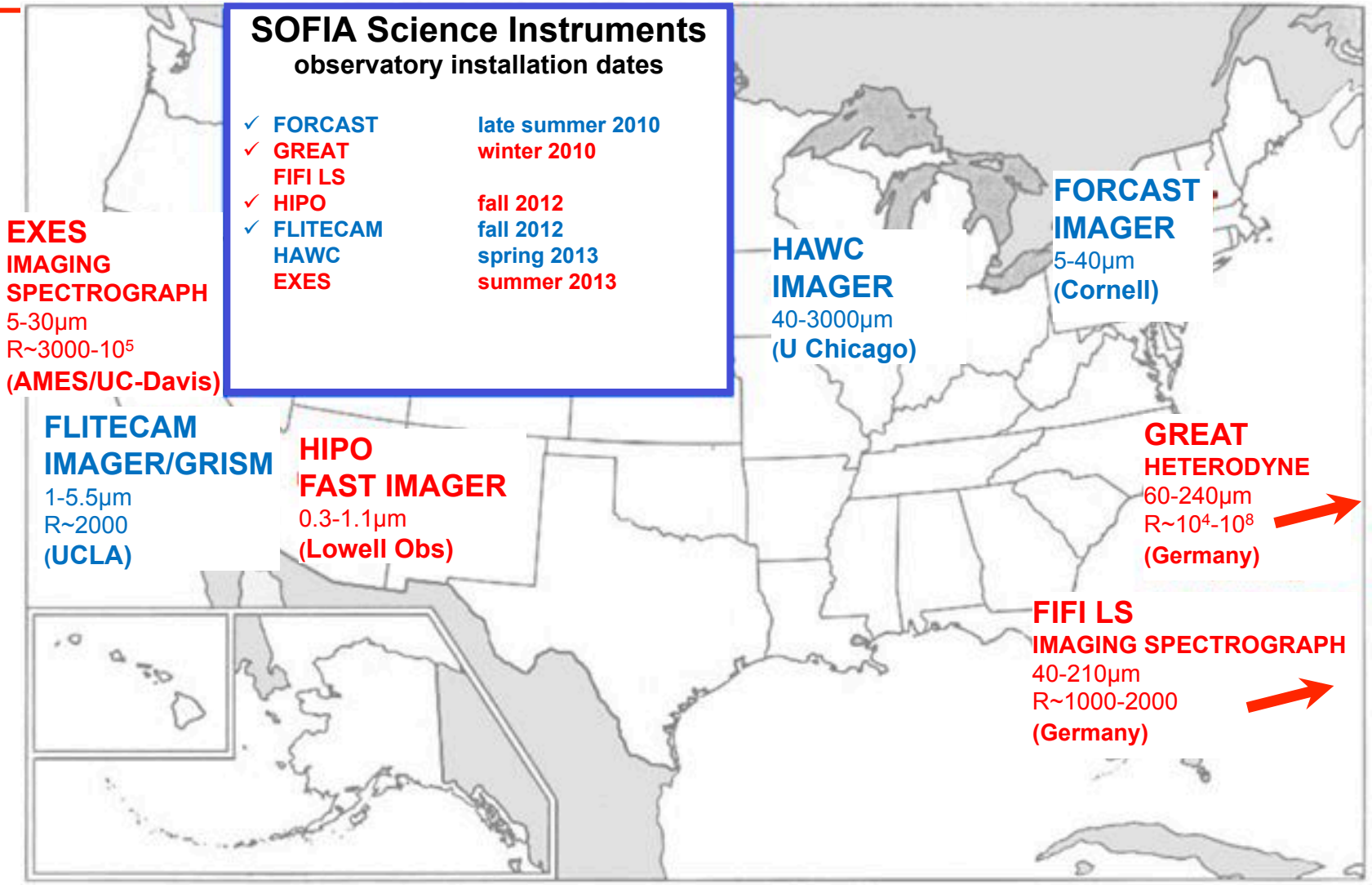
GREAT

German REceiver for Astronomy at Terahertz frequencies

- Principal Investigator instrument
- Heterodyne spectrometer
- Dual-channel, 3 frequency windows
  - 1.25-1.52Thz, 1.82-1.92 THz (158-187 microns)
  - 2.4-2.7 THz (100-125 microns)

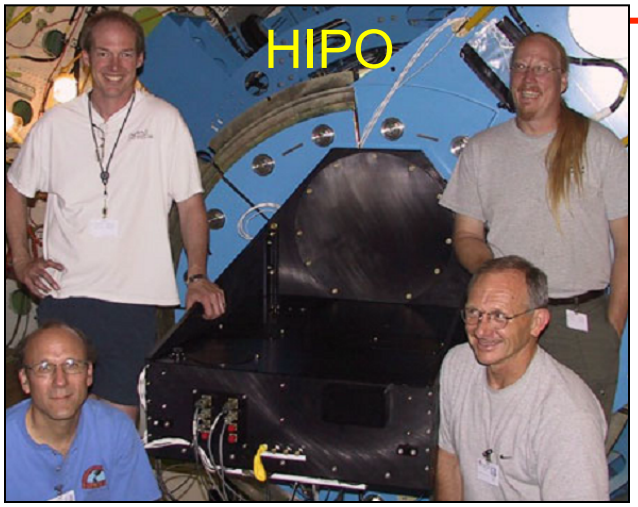
Available to Basic Science Guest Investigators

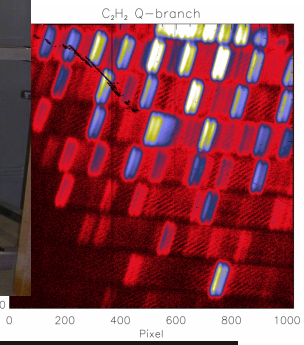
1st Generation Science Instruments

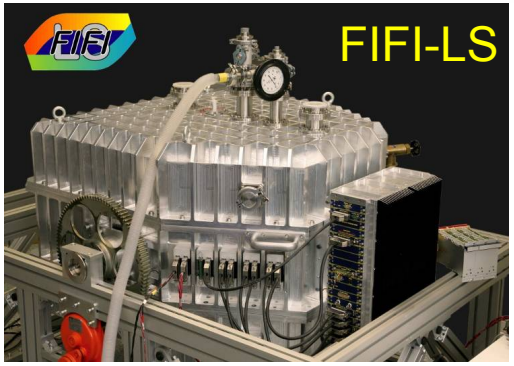


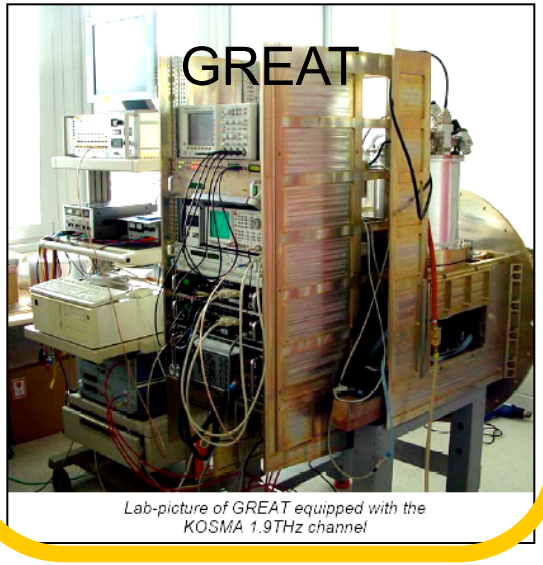
Bill Reach and Ted Dunham will be discussing the kinds of science investigations possible using these instruments.

First-Generation Instruments









Lab-picture of GREAT equipped with the KOSMA 1.9THz channel

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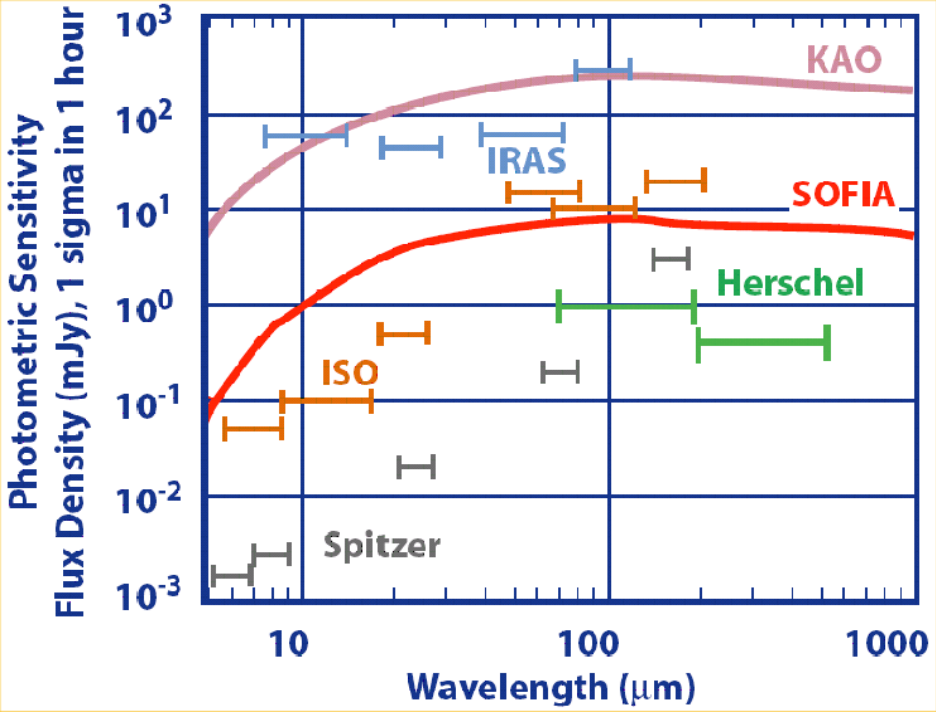
Program Summary

The SOFIA Program has made significant recent progress:

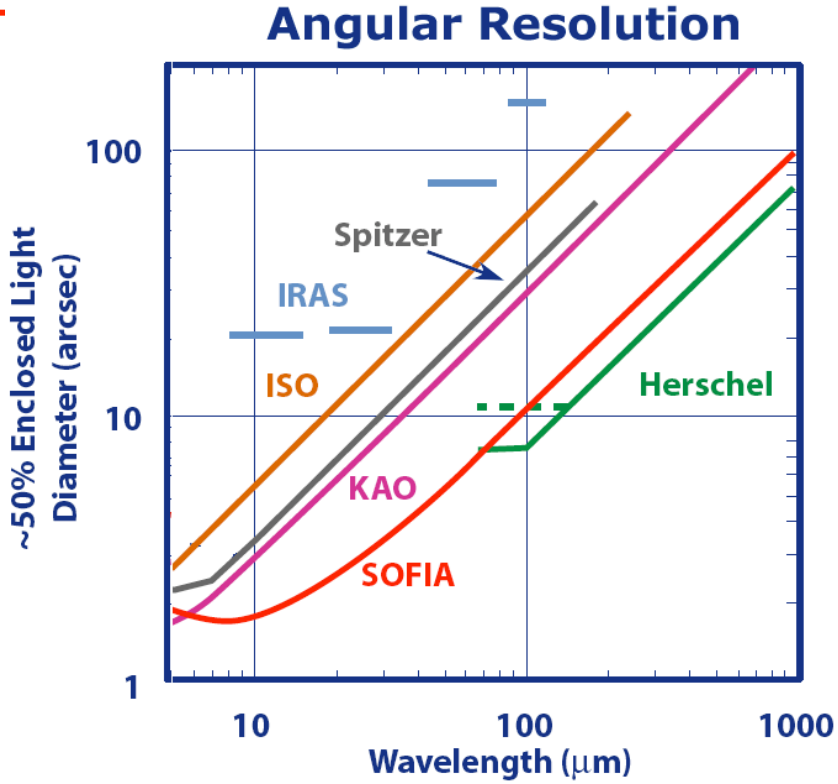
- Successful First Light flight accomplished this summer.
- Envelope expansion to fly at maximum altitude completed earlier than originally planned.
- On-schedule for a 2nd generation science instrument AO next year.
- **SOFIA is meeting its observatory performance requirements to start science observations next month!**

BACKUP

Photometric Sensitivity and Angular resolution



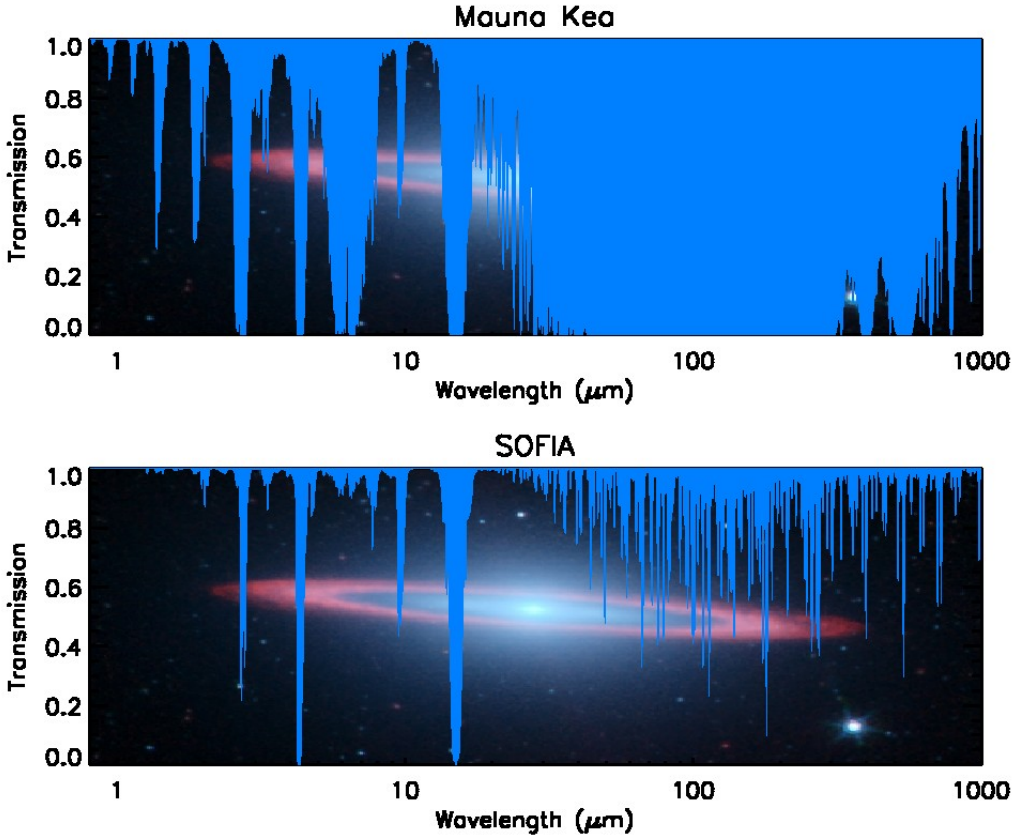
SOFIA is as sensitive as ISO



SOFIA is diffraction limited beyond 25 μm (θmin ~ λ/10 in arcseconds) and can produce images three times sharper than those made by Spitzer

The Advantages of SOFIA

- *Above 99.8% of the water vapor*
- *Transmission at 14 km >80% from 1 to 800 μm; emphasis on the obscured IR regions from 30 to 300 μm*
- *Instrumentation: wide variety, rapidly interchangeable, state-of-the art – SOFIA is a new observatory every few years!*
- *Mobility: anywhere, anytime*
- *Twenty year design lifetime*
- *A near-space observatory that comes home after every flight*



SOFIA's First-Generation Instruments

Instrument	Type	λλ (μm)	Resolution	PI	Institution
HIPO	fast imager	0.3 – 1.1	filters	E. Dunham	Lowell Obs.
FLITECAM *	imager/grism	1.0 – 5.5	filters/R~2000	I. McLean	UCLA
FORCAST *	imager/(grism?)	5.6 – 38	filters/(R~2000)	T. Herter	Cornell U.
GREAT	heterdyne receiver	62-65 111 – 125 158 – 214 200 – 240	R~10^4 – 10^8	R. Gusten	MPIfR
FIFI LS	imaging grating spectrograph	42 – 100 110 – 210	R~1000 – 2000	A. Krabbe	DSI
HAWC *	imager	40 – 300	filters	D.A. Harper	Yerkes Obs
EXES	imaging echelle spectrograph	5 – 28.5	R~3000 – 10^5	M. Richter	ARC/UC-Davis

** Facility-class instrument*