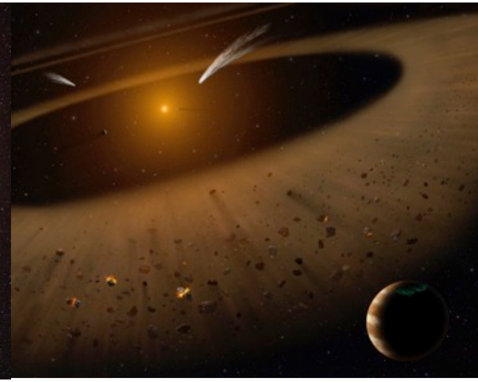
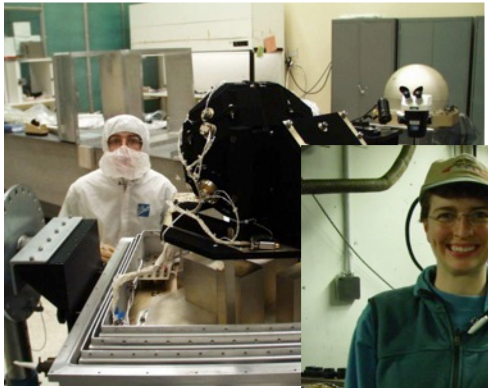



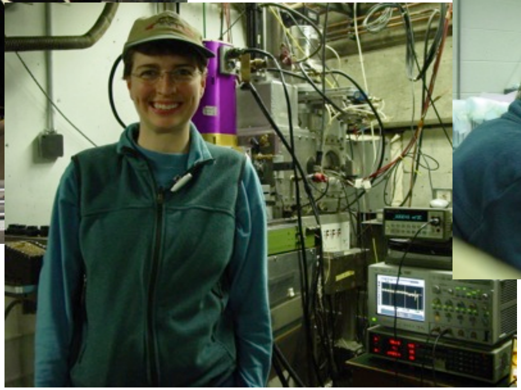
SOFIA Today & the Extended Mission: the New PS’s Perspective

Dr. Kimberly Ennico Smith
NASA SOFIA Project Scientist
SOFIA Community Forum (SCF) Teletalk
October 11, 2017

- Started as SOFIA Project Scientist, December 5, 2016
- Based at NASA Ames Research Center, Moffett Field, California
- Kimberly.Ennico@nasa.gov
- Eager for conversations about all that's happening with SOFIA Today

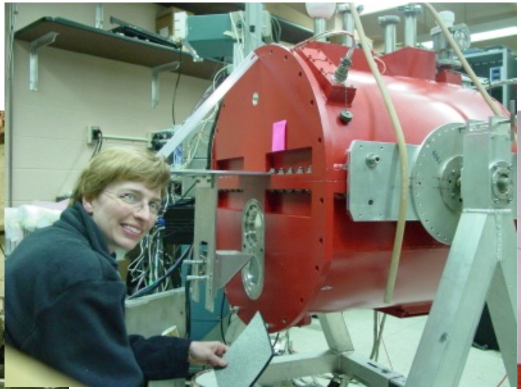
Spitzer/MIPS





JWST Detectors

SOFIA/FORCAST Grisms



LCROSS

New Horizons

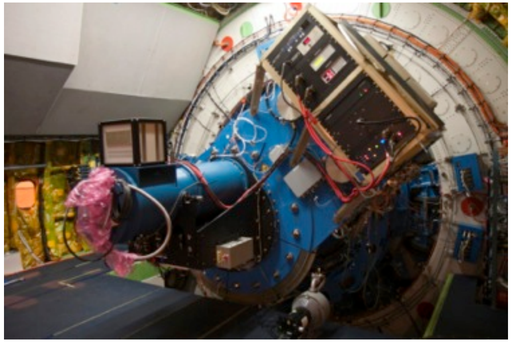
@kennicosmith

https://sofia.usra.edu/

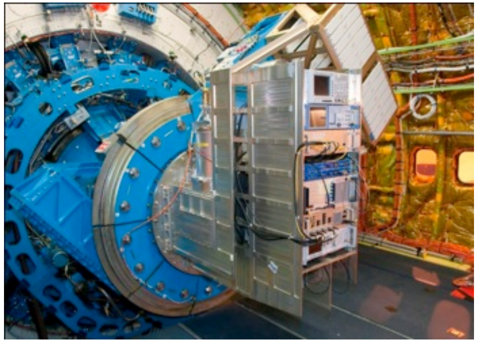
- SOFIA is currently the largest observatory with access to infrared and sub-millimeter wavelengths above 99% Earth's water vapor.

- SOFIA is an outstanding on-sky laboratory for development of future space-based instruments.

- SOFIA maintains a working infrared community in preparation for a future IR-submm space mission in the 2030s.

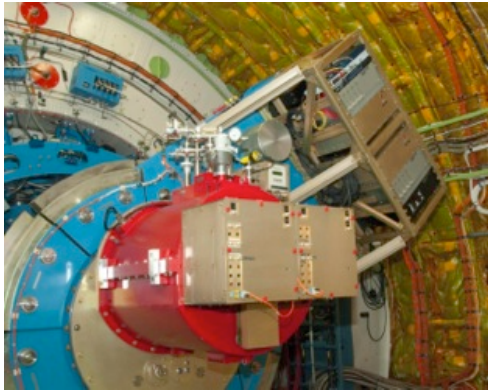


FLITECAM - Near IR Camera
HIPO – Occultation Photometer

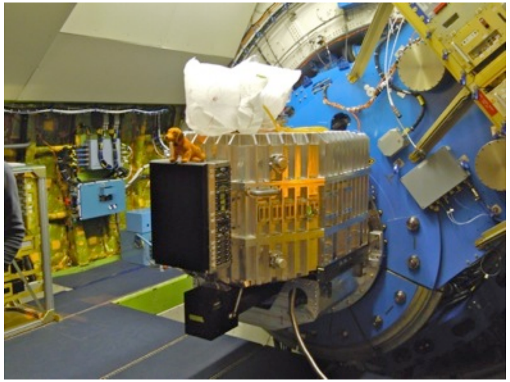


upGREAT –
Heterodyne Spectrometer

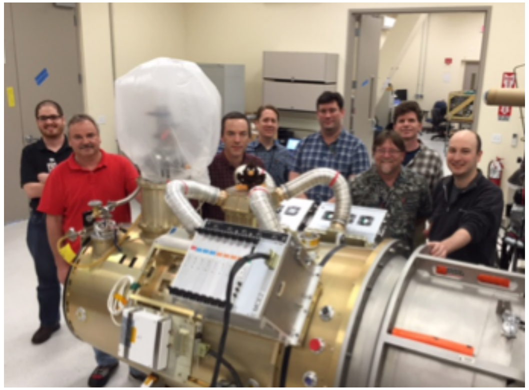
EXES -
High Resolution IR Spectrometer



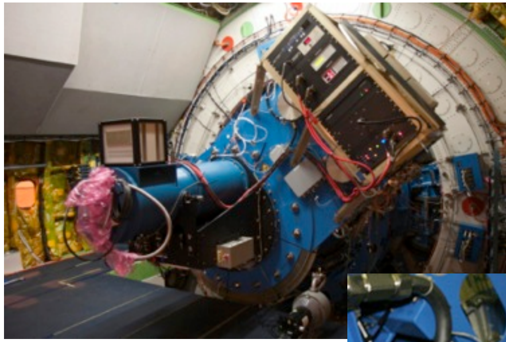
FORCAST - Mid-IR Camera

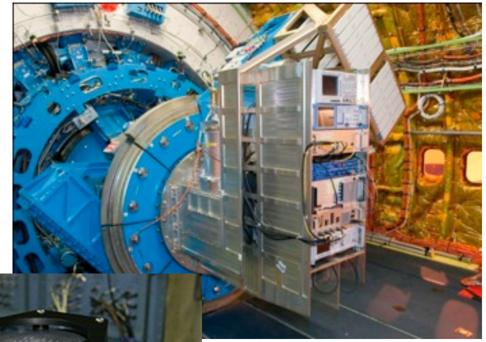


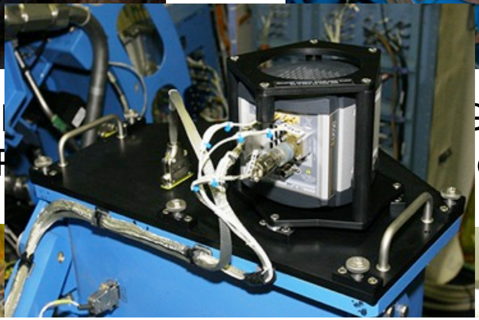
FIFI-LS
Integral Field Spectrometer



HAWC+
Far IR Camera & Polarimeter





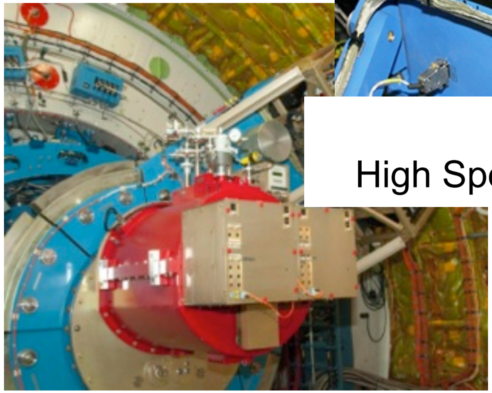


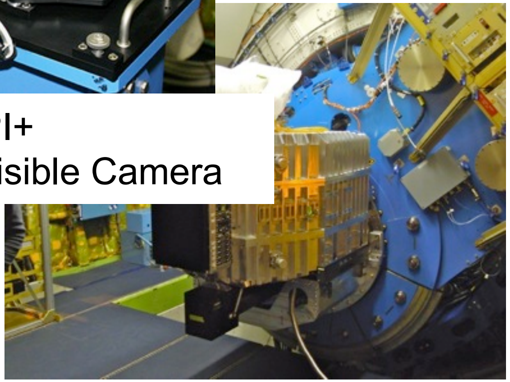
FLITECAM - Near I
HIPO – Occultation P

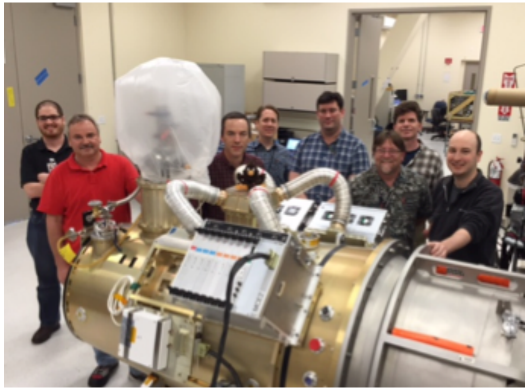
GREAT –
e Spectrometer

EXES -
High Resolution IR Spectrometer

FPI+
High Speed Visible Camera



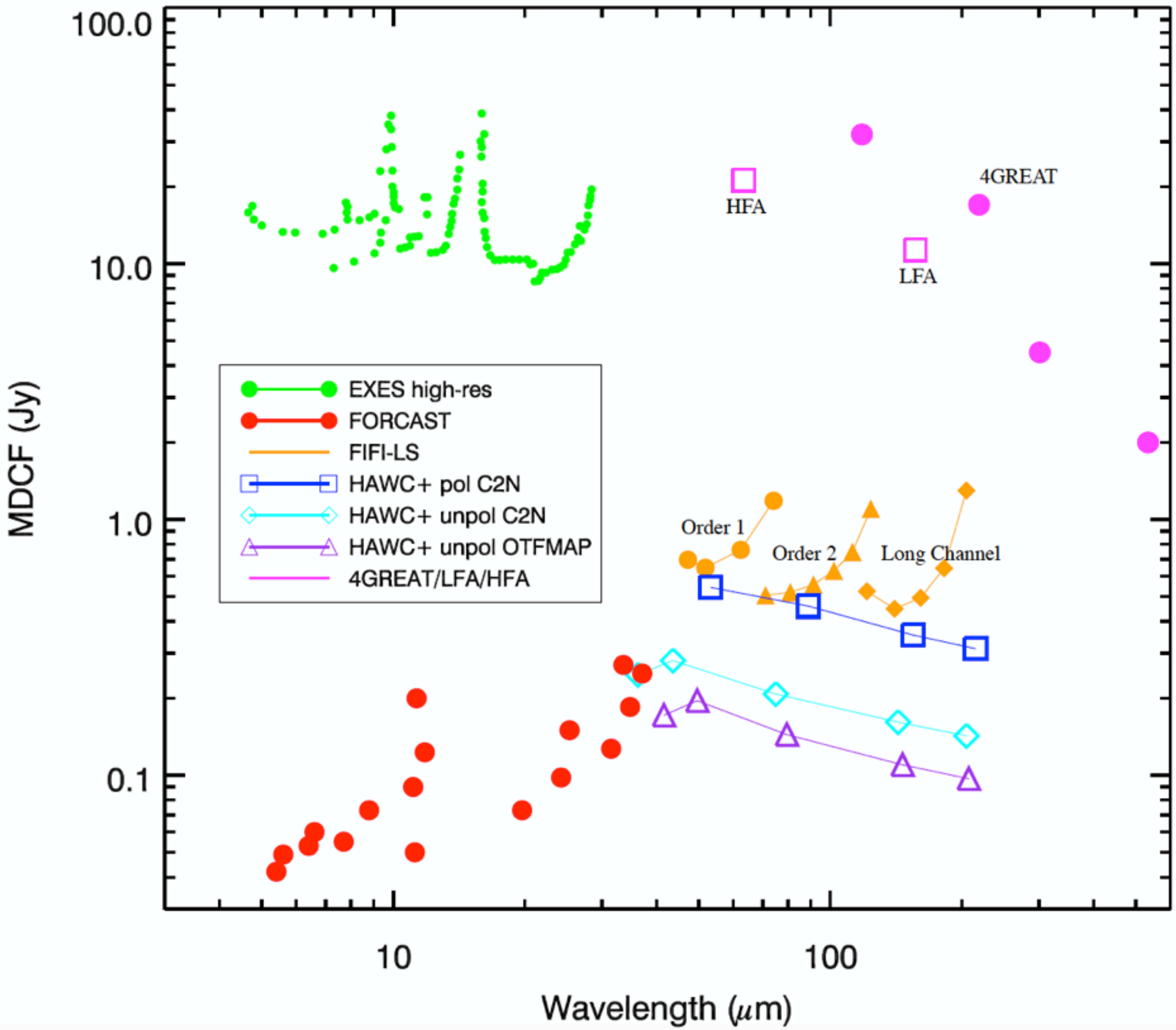




FORCAST - Mid-IR Camera

FIFI-LS
Integral Field Spectrometer

HAWC+
Far IR Camera & Polarimeter



"Review: Far-Infrared Instrumentation and Technology Development for the Next Decade" Farrah, D. et al, 2017, submitted to JATIS

Continuum sensitivities, as a function of wavelength, of SOFIA's mid- to far-infrared instrument suite.
Shown are the 4-σ Minimum Detectable Continuum Flux (MDCF) densities for point sources in Janskys for 900 s of integration time.

Meeting (some) of the SOFIA (extended) Family

Ringberg March 2017

Christchurch July 2017

…so many I have not met…

The PS Perspective

- Science Demand
- Science Performance
- Science Productivity
- Science Future

The PS Perspective

- Science Demand
- Science Performance
- Science Productivity
- Science Future

GO Program Background

- One Call for Proposals per Year for the Guest Observer (GO) Program
- SOFIA has two independent TACs (Telescope Allocation Committees), US and German, that rank GO proposals scientifically, with a review of their technical feasibility for the unique operational needs of an airborne observatory.
- Proposers from other countries are part of the US-TAC time.
- US: German time is 80:20 ratio per NASA/DLR SOFIA Joint Program Plan.
- GO Program began with Basic Science (call released Apr 28, 2010).
  - Two instruments available – FORCAST and GREAT
  - Limited number of science flights
  - Prior to the full operational capability
- **Full Operational Capacity reached in May 2014 during Cycle 2.**
- **Increased funding for US GOs ($10,000/hr) began in Cycle 4.**
- Request for large impact programs began in Cycle 4.

GO Hours Available

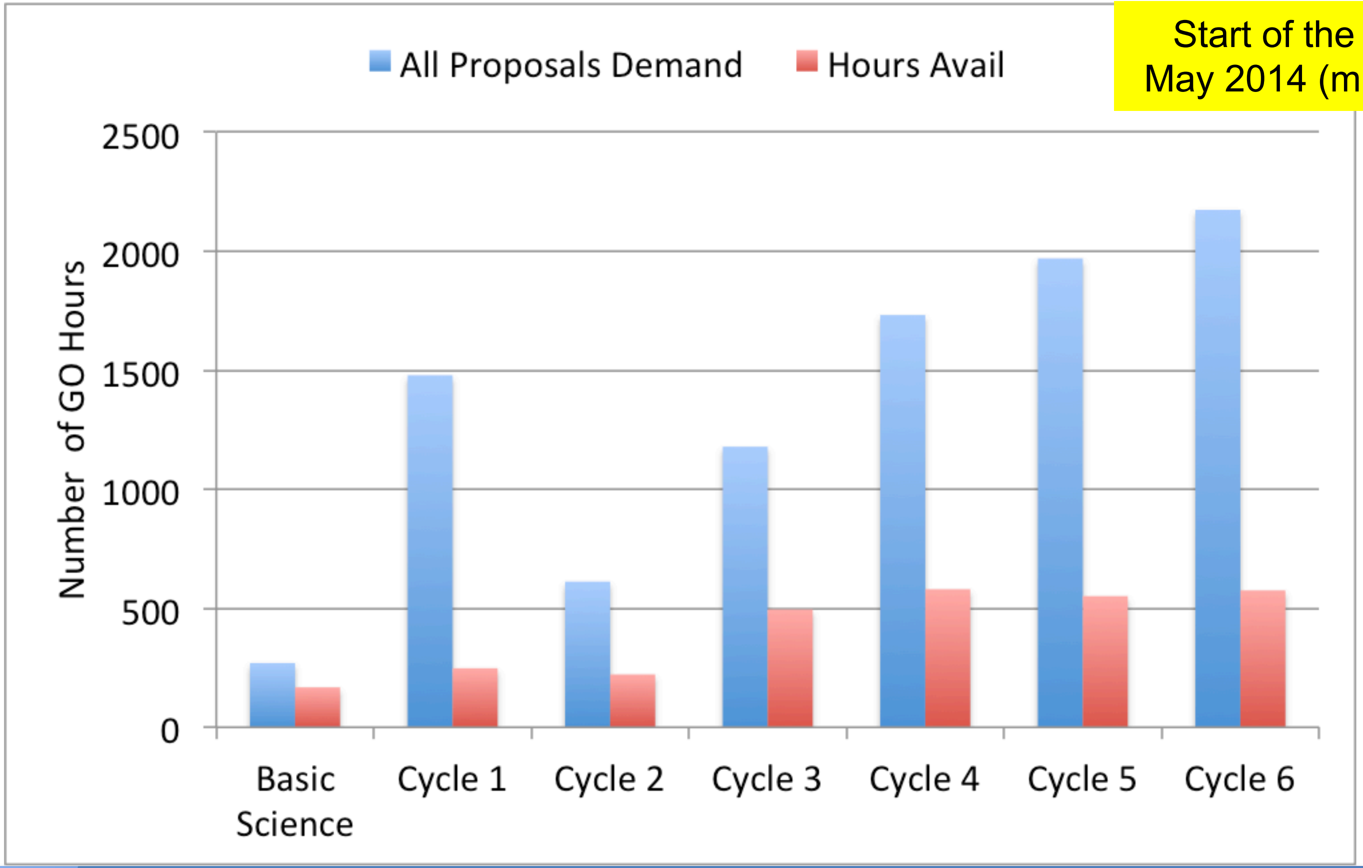
- Time on the observatory with door open is split among US+German Guest Observer (GO), Instrument Guaranteed Time (GTO), Calibration/Engineering, and Director's Discretionary Time (DDT).
- Call for Proposals for GO time has had different allocations each Cycle.

	Period	Duration (months)	Total GO Hrs Avail
Basic Science	June 2011 - Sep 2011	4	168
Cycle 1	June 2013 - Feb 2014	7	248
Cycle 2 [1,2]	Feb 2014 - Feb 2015	12	222
Cycle 3	Mar 2015 - Jan 2016	11	495
Cycle 4	Feb 2016 - Jan 2017	12	585
Cycle 5	Feb 2017 - Jan 2018	12	551
Cycle 6	Feb 2018 - Feb 2019	12	575

[1] May 2014 Start of KDP-E (transition from Phase D to Phase E (full operations).

[2] Heavy Maintenance Period in Cycle 2, lowered available flight opportunities.

Demand for SOFIA has outpaced the increased available hours

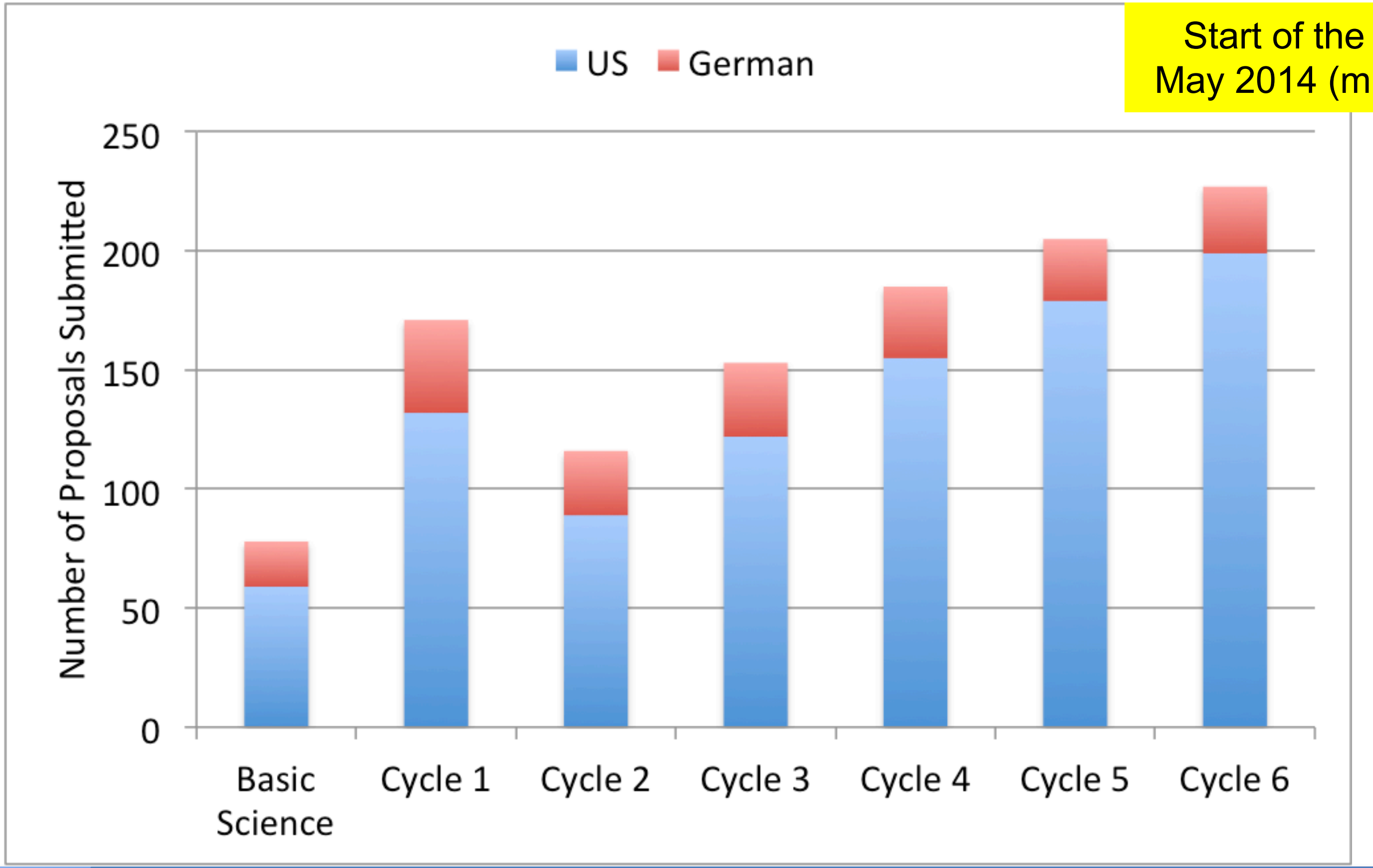


Start of the Prime Mission
May 2014 (middle of Cycle 2)

Due Dates: Basic Science: July 2010 Cycle 1: Jan 2012 Cycle 2: June 2013
Cycle 3: June 2014 Cycle 4: June 2015 Cycle 5: June 2016 Cycle 6: June 2017

Increased # of proposals over multiple cycles

Start of the Prime Mission
May 2014 (middle of Cycle 2)

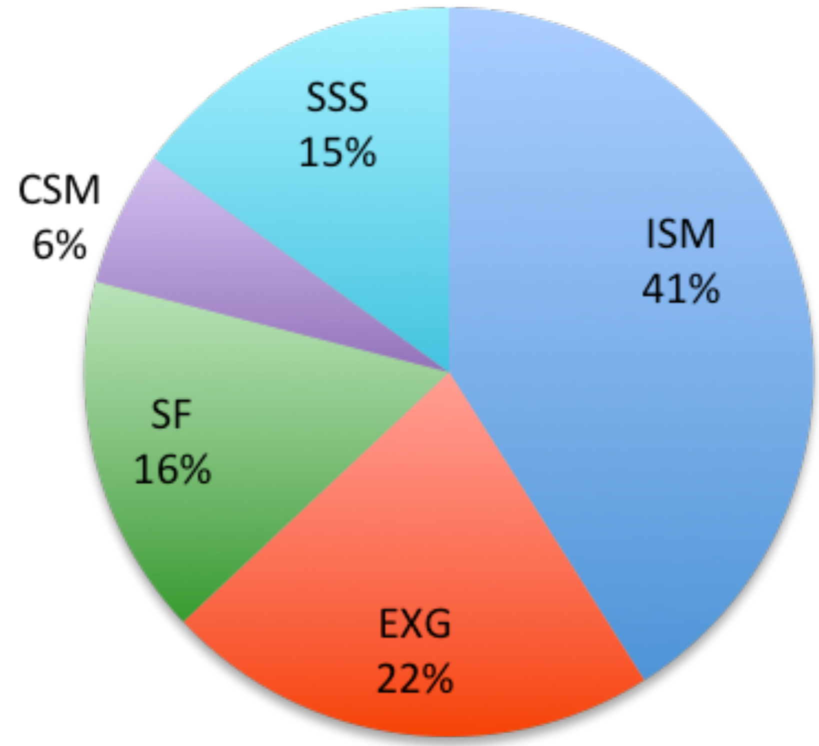


Due Dates: Basic Science: July 2010 Cycle 1: Jan 2012 Cycle 2: June 2013
Cycle 3: June 2014 Cycle 4: June 2015 Cycle 5: June 2016 Cycle 6: June 2017

SOFIA Today's Science Breadth

- **Interstellar Medium (ISM)**
  - magnetic fields, interstellar chemistry
- **Extragalactic (EXG)**
  - galaxies, AGN
- **Star Formation (SF)**
  - protostars, star forming clouds, jets
- **Circumstellar Matter (CSM)**
  - debris disks, planetary nebulae, proto-planetary nebulae
- **Stars and Solar System Studies (SSS)**
  - planets, comets, asteroids, stellar phenomena

*Galactic Center – was split b/n SF and ISM

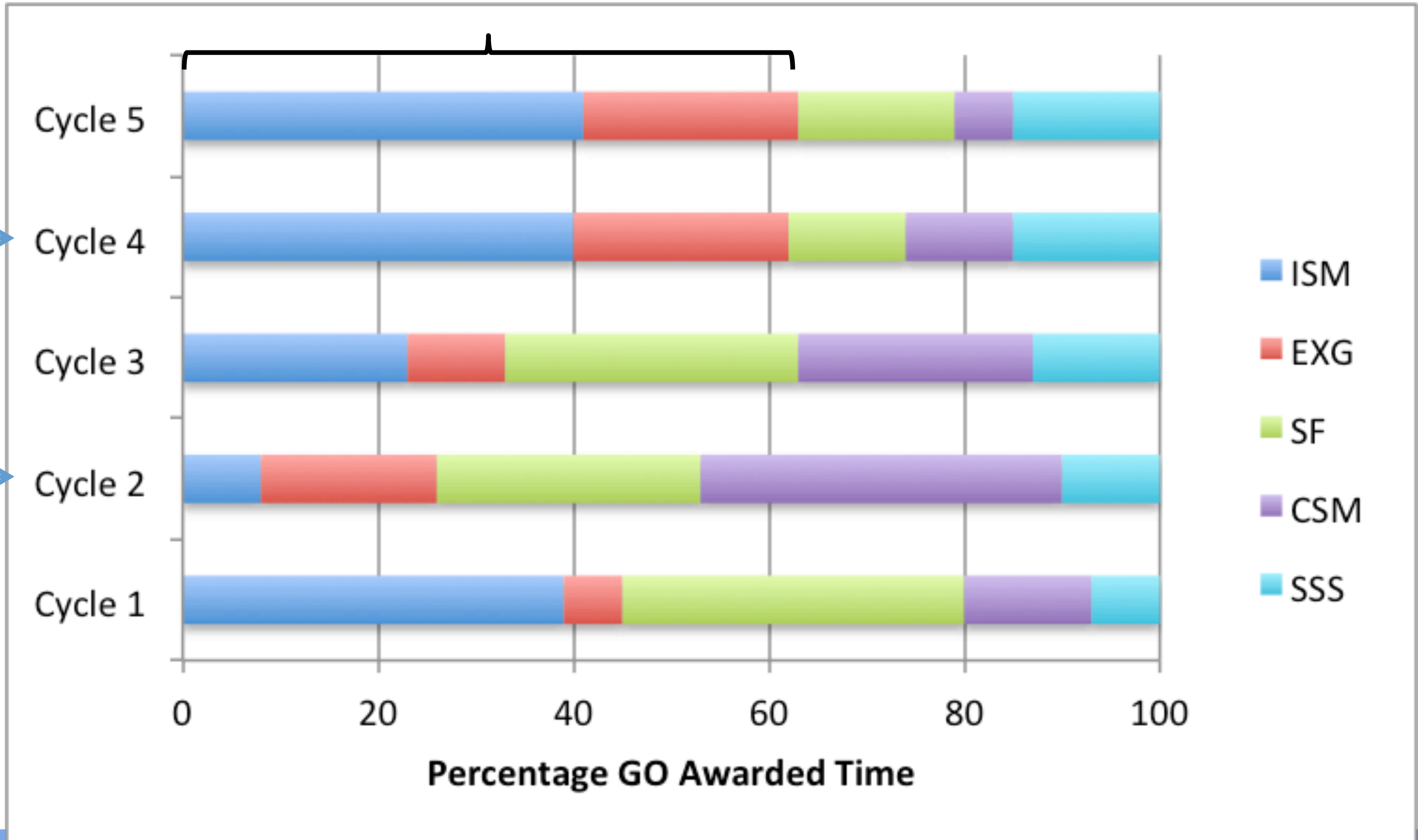


Cycle 5 – GO Time Awarded

Evolution of Science Area Demand

HAWC+, LFA(2x7) HFA(1x7) 1st Avail

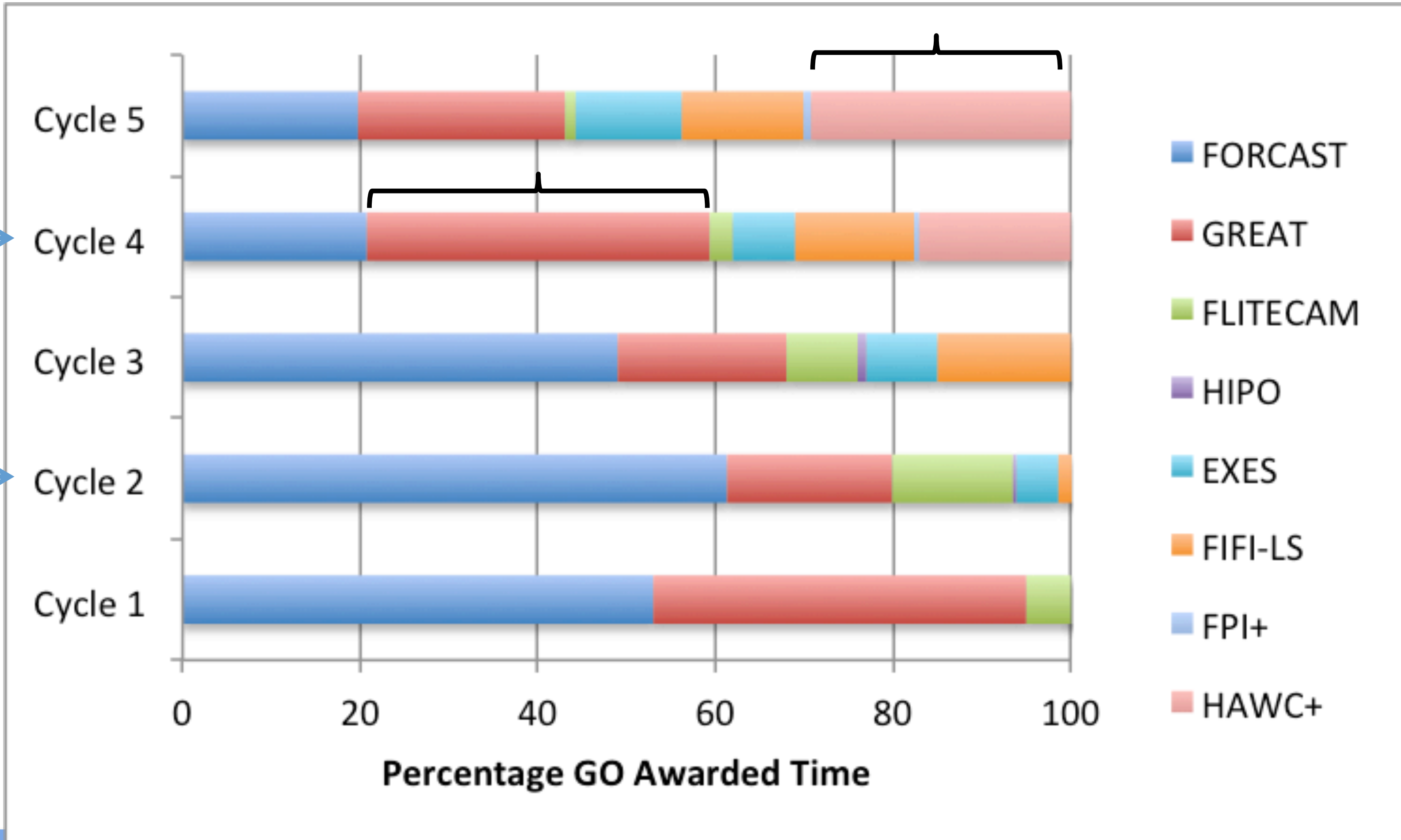
EXES, FIFI-LS 1st Avail



Evolution of Science Instrument Demand

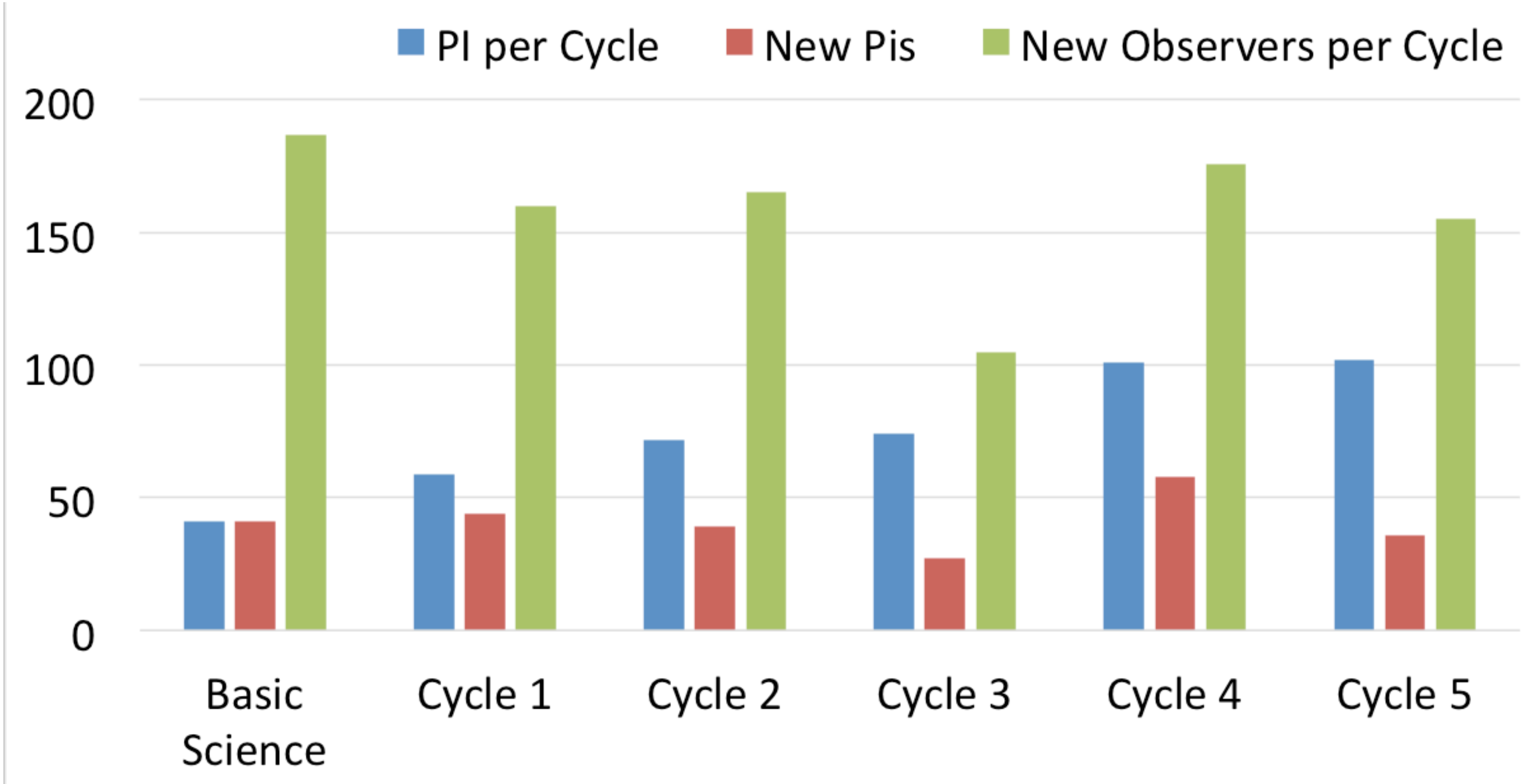
HAWC+, LFA(2x7) HFA(1x7) 1st Avail

EXES, FIFI-LS 1st Avail

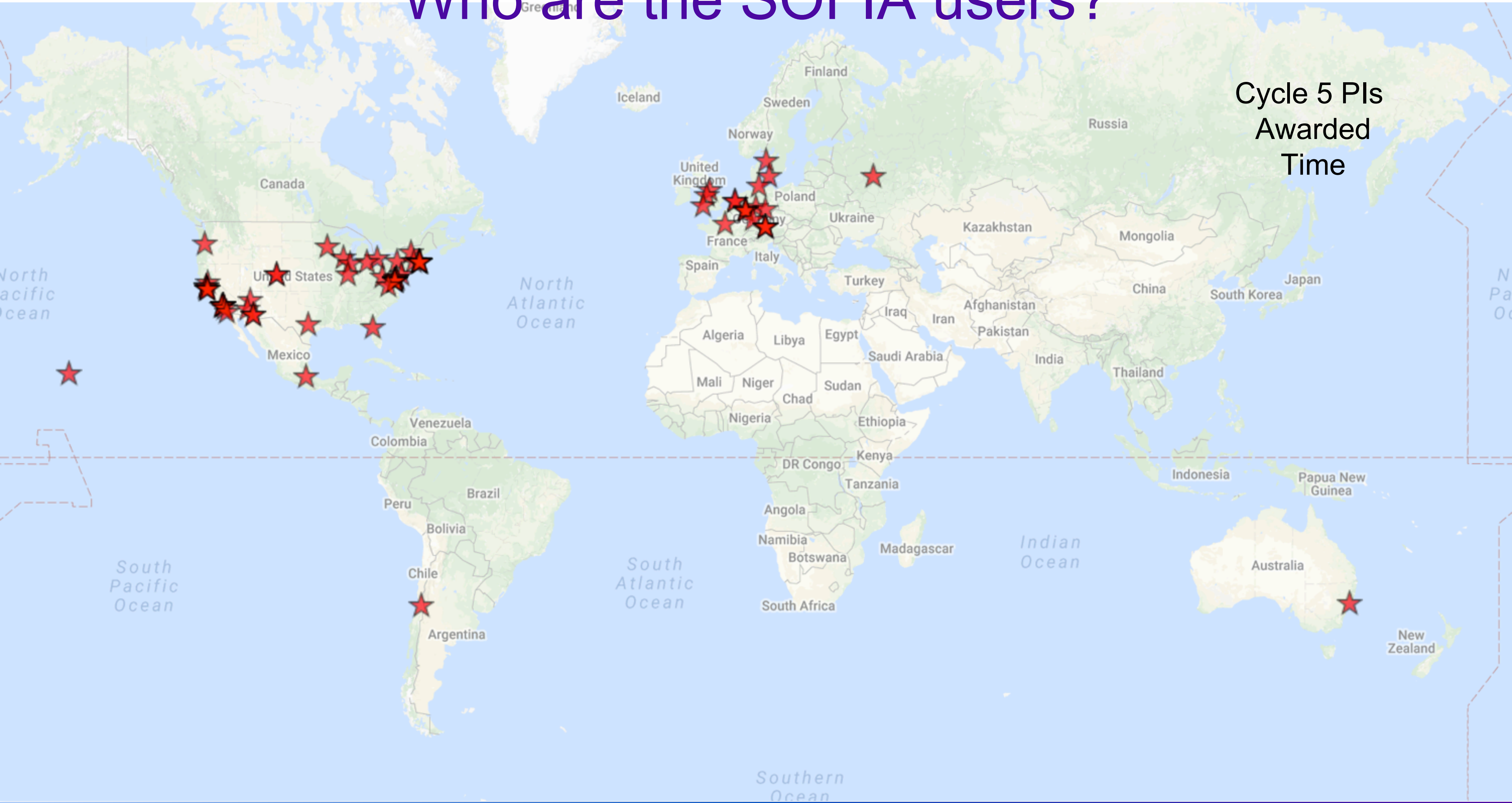


Cycle 6: GREAT LFA+HFA and 4-GREAT 1st Avail

Evolution of Science GOs



Who are the SOFIA users?



https://www.sofia.usra.edu/science/proposing-and-observing/sofia-cycle-5-results

The PS Perspective

- Science Demand
- Science Performance
- Science Productivity
- Science Future

SOFIA "Established" Science Areas

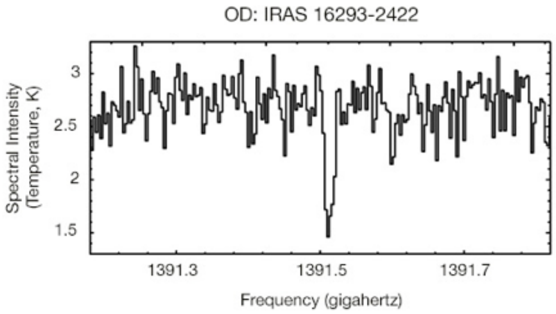
- Physics of the Interstellar Medium
  - –Energy balance in clouds
  - –Lifecycle of the Interstellar Medium
- Star Formation
  - –Physics of star forming filaments
  - –Star formation in nearby galaxies
- Solar System
  - –High resolution spectroscopy of planets
  - –High resolution of comets
  - –Atmospheres of Trans-Neptunian Objects

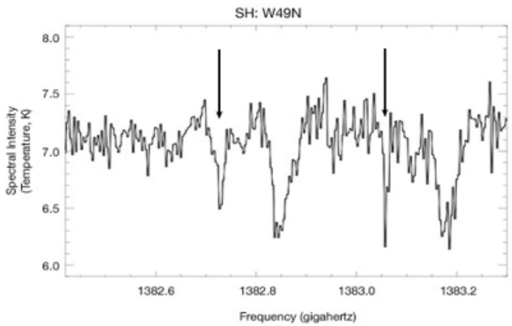
Physics/Lifecycle Interstellar Medium

Cycle 2 / GTO / FORCAST / FLITECAM

"Mapping PAH sizes in NGC 7023 with SOFIA." Croiset, B. et al 2016
(Sep 10, 2014 O. Berne Teletalk)

Cycle 1 / GTO / GREAT

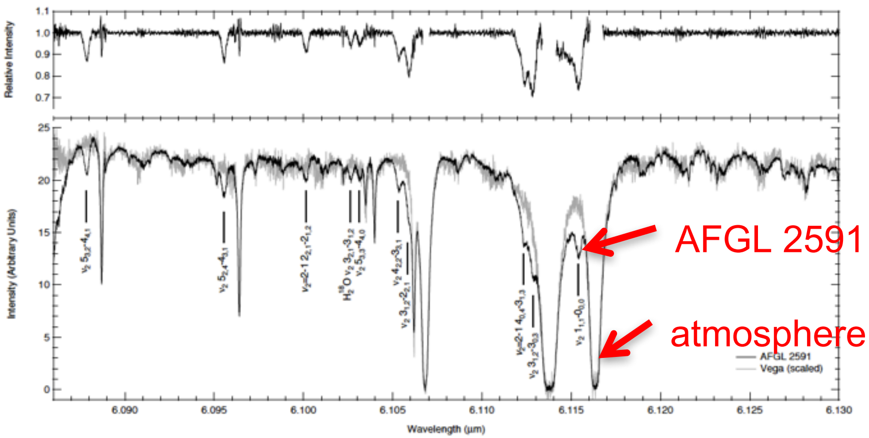




"Discovery of interstellar mercapto radical SH and the deuterated hydroxyl radical OD." Neufeld, D. et al 2012

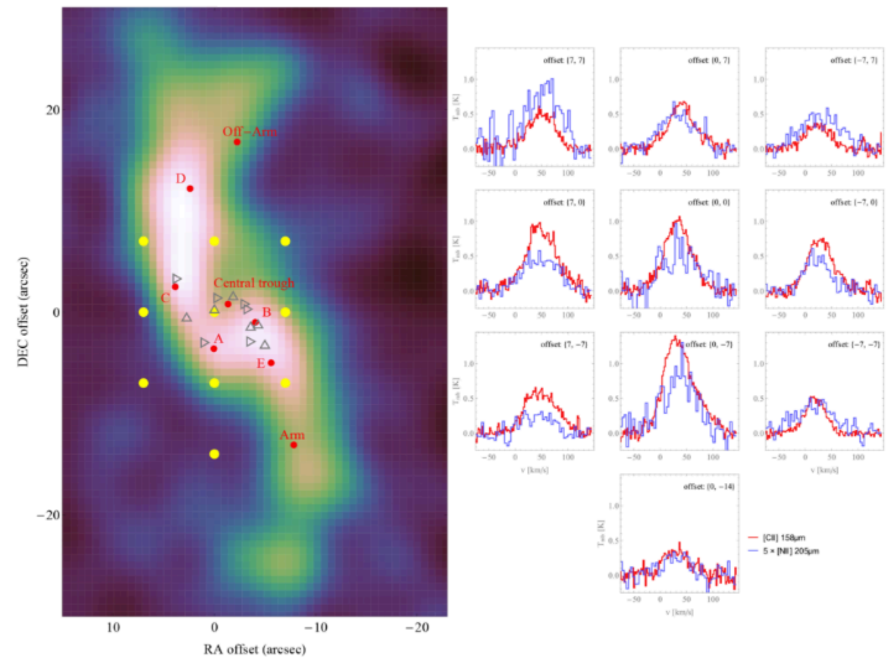
Star Formation

Cycle 3 / GTO / EXES



"SOFIA/EXES Observations of Water Absorption in the Protostar AFGL 2591 at High Spectral Resolution." Indriolo, N. et al. 2015 (Teletalk May 23, 2015)

Cycle 1 / GO / GREAT



"[CII] 158μm and [NII] 205μm emission from IC 342 - Disentangling the emission from ionized and photo-dissociated regions." Röllig, M. et al 2016

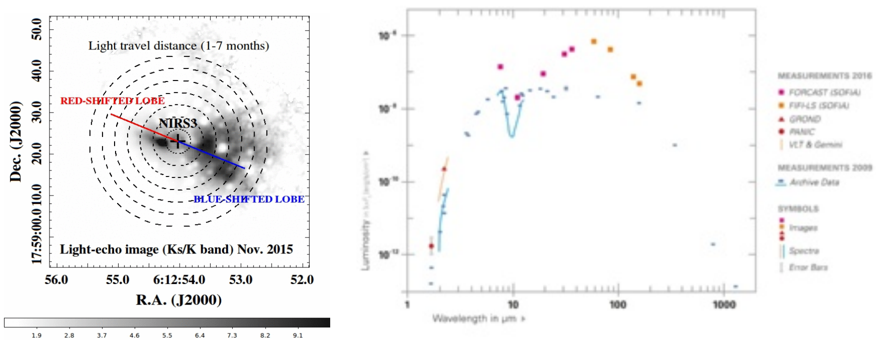
JWST + SOFIA together can probing the physical conditions of the gas in regions of star formation

Jets and outflows from young protostellar objects

–JWST can observe the mid-infrared shocked H2 emission

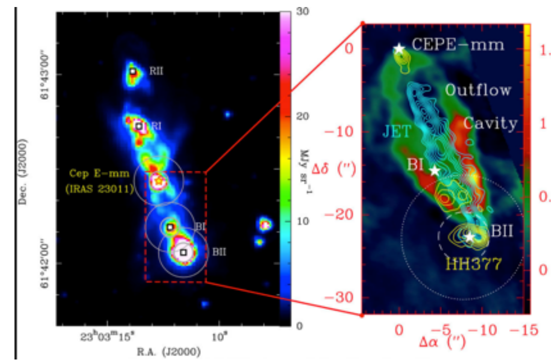
–SOFIA can investigate atomic [OI] emission believed to stem from the jets

–Use both JWST (MIR) and SOFIA (FIR) to study periodic accretion events



Cycle 4 /ToO / FORCAST (MIR) / FIFI-LS (FIR)

Caratti o Garatti, A. et al. 2016 Nature Physics
Demonstrated measurement of accretion event on S255IR NIRS 3



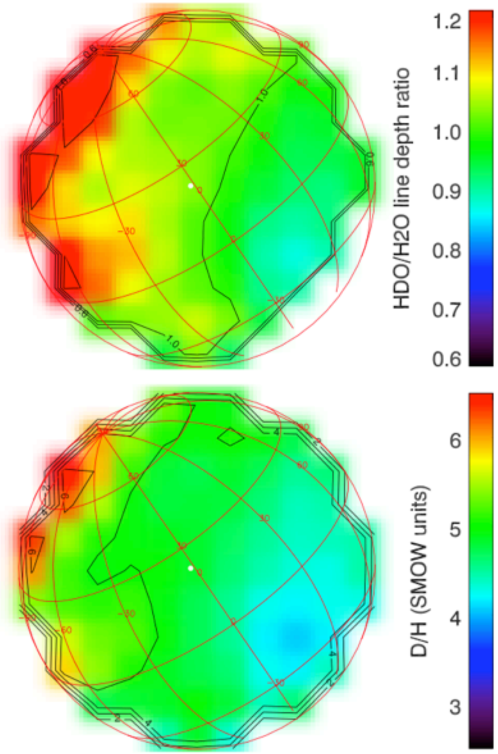
Cycle 4 / GO / GREAT

“Nature of shocks revealed by SOFIA OI observations in the Cepheus E protostellar outflow.” Gusdorf, A. et al. 2017

SOFIA
Stratospheric Observatory for Infrared Astronomy

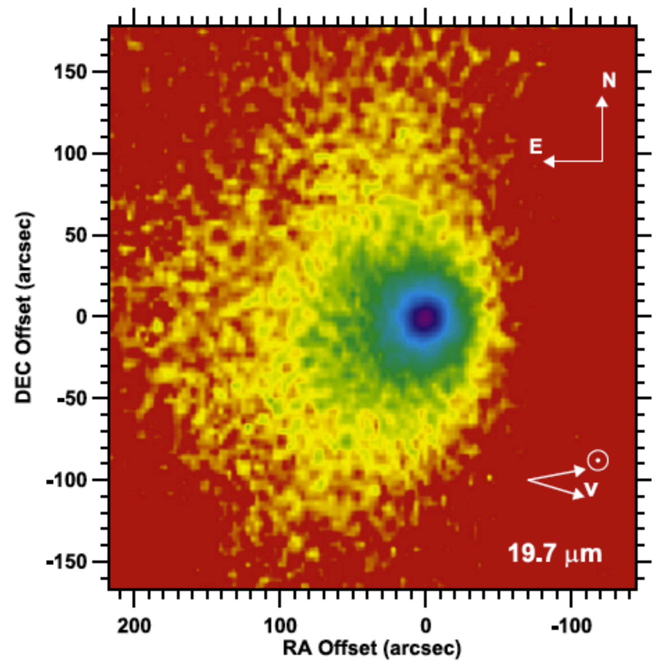
Solar System

Cycle 2 / GO / EXES



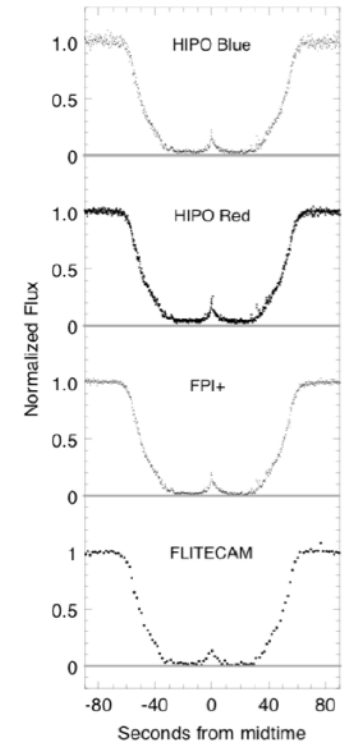
"A map of D/H on Mars in the thermal infrared using EXES aboard SOFIA."
Encrenaz, T. et al 2016
(March 30, 2016 Teletalk)

Cycle 2 / GO / FORCAST



"SOFIA Infrared Spectrophotometry of Comet C/2012 K1 (Pan-STARRS)."
Woodward, C. et al 2015
(Oct 28, 2015 Teletalk)

Cycle 3 / GO / FLIPO / FPI+



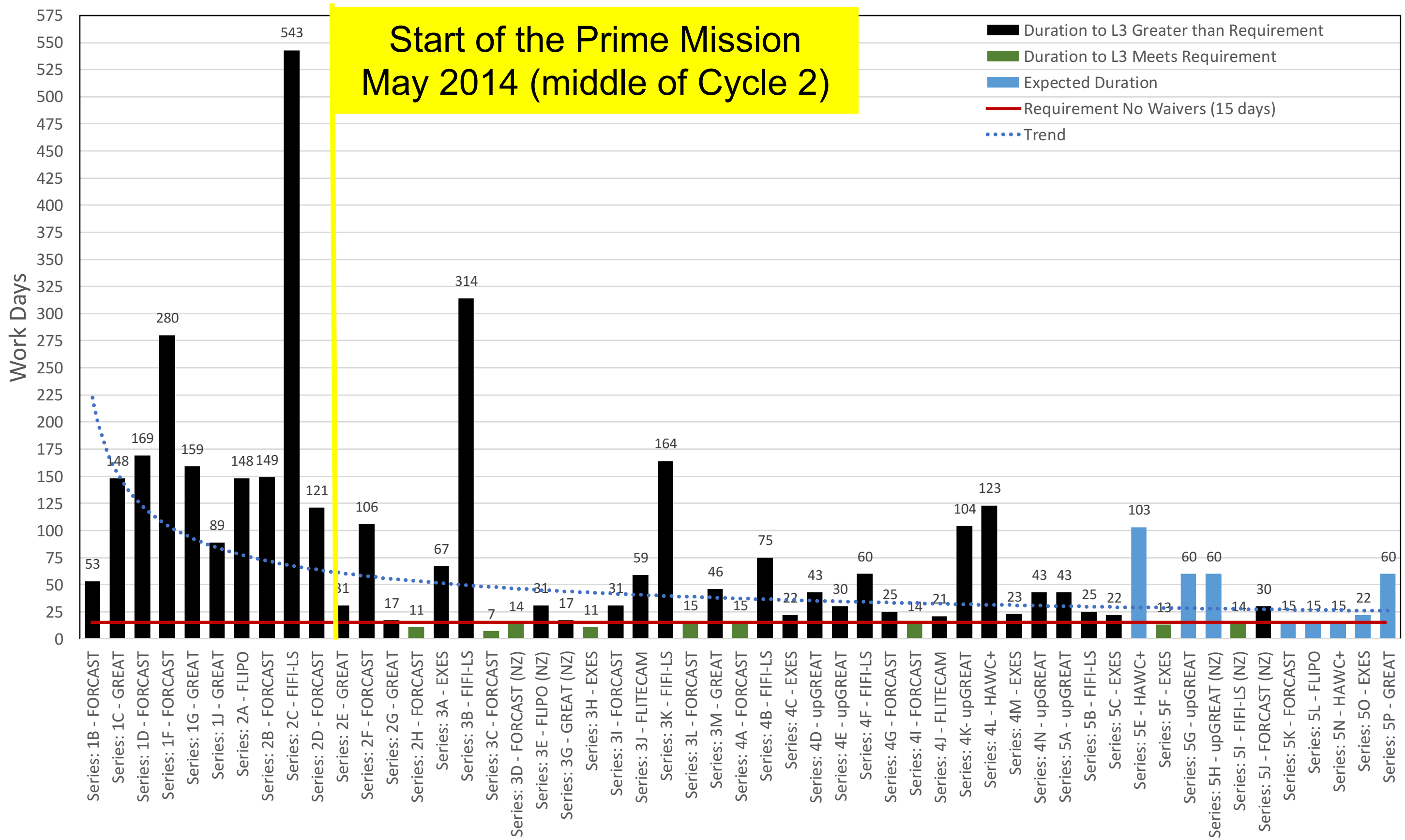
June 29, 2015 Pluto Occultation
Person et al 2017 (in prep)
(Aug 10, 2016
E. Becklin Teletalk)

SOFIA
Stratospheric Observatory for Infrared Astronomy

The PS Perspective

- Science Demand
- Science Performance
- Science Productivity
- Science Future

Program has improved getting data to GOs



There is a lot of data now public…

Cycle 1	OC-1B FORCAST Public	OC-1C GREAT Public	OC-1D FORCAST Public	OC-1F FORCAST Public	OC-1G GREAT Public									
Cycle 2	OC-2A FLIPO Public	OC-2B FORCAST Public	OC-2C FIFI-LS Public	OC-2D FORCAST Public	OC-2E GREAT Public	OC-2F FORCAST Public	OC-2G GREAT Public	OC-2H FORCAST Public						
Cycle 3	OC-3A EXES Public	OC-3B FIFI-LS Public	OC-3C FORCAST Public	OC-3D FORCAST Public	OC-3E FLIPO Public	OC-3G GREAT Public	OC-3H EXES Public	OC-3I FORCAST Public	OC-3J FLITECAM Public	OC-3K FIFI-LS Public	OC-3L FORCAST Public	OC-3M GREAT Public		
Cycle 4	OC-4A FORCAST Public	OC-4B FIFI-LS Public	OC-4C EXES Public	OC-4D GREAT Public	OC-4E GREAT Public	OC-4F FIFI-LS Public	OC-4G FORCAST Public	OC-4I FORCAST L3	OC-4J FLITECAM L3	OC-4K GREAT L3	OC-4L HAWC+ L3	OC-4M EXES L3	OC-4N GREAT L3	
Cycle 5	OC-5A GREAT L3	OC-5B FIFI-LS L3	OC-5C EXES L3	OC-5E HAWC+ L1	OC-5F EXES L3	OC-5G GREAT L1	OC-5H GREAT L1	OC-5I FIFI-LS L3	OC-5J FORCAST L3	OC-5K FORCAST L1	OC-5L FLIPO	OC-5N HAWC+	OC-5O EXES	OC-5P GREAT

SOFIA Archive – DCS
https://dcs.sofia.usra.edu/

IRSA Transition in 2018

KEY

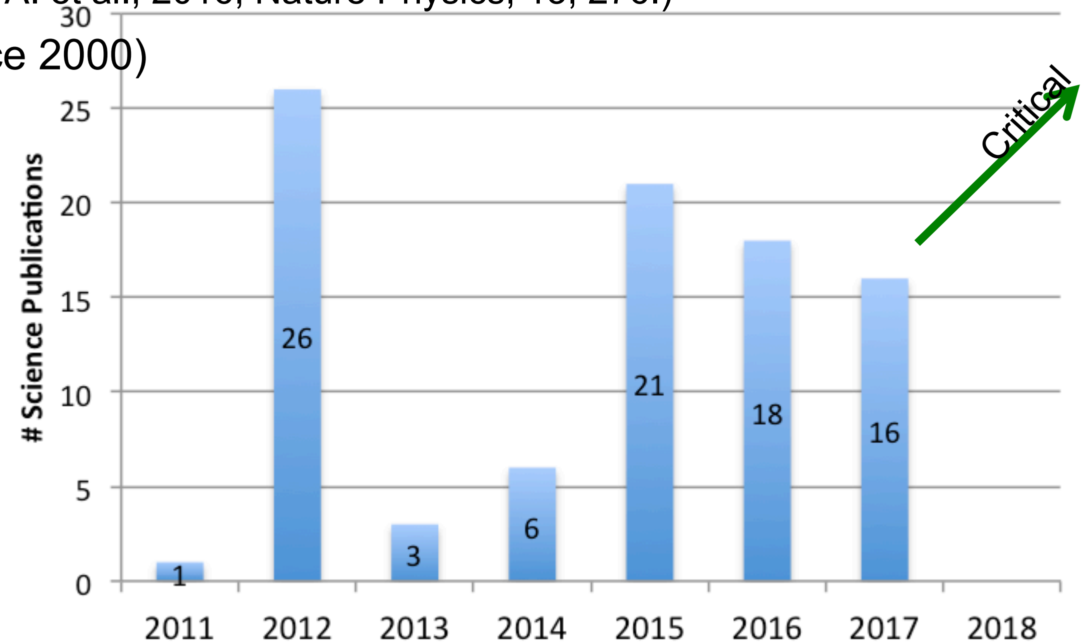
- Series Instrument (dashed box): Series not yet flown
- Series Instrument (dotted box): Series not yet flown, Draft schedule
- Series Instrument L1 (green): L1 data archived, L2/L3 data processing on schedule
- Series Instrument L1 (red): L1 data archived, L2/3 data processing late / expected late
- Series Instrument L1 (yellow): L3 data processing late / expected late (best effort for newly commissioned instrument)
- Series Instrument L3 (blue): L3 data processed and archived
- Series Instrument Public (grey): All L3 data public

For the community to take advantage of the growing SOFIA science archive, NASA's Astrophysics Data Analysis Program (ADAP) can provide funding for such work. ROSES Appendix D.2

SOFIA Publications Status October 1, 2017

- 91 Peer-Reviewed Science (since 2011)
  - –1 Science (Lau, R. M., et al., 2015 Science 348, 413)
  - –1 Nature (Brünken, S., et al., 2014, Nature, 516, 219)
  - –1 Nature Physics (Caratti O Garatti, A. et al., 2016, Nature Physics, 13, 276.)
- 37 Peer-Reviewed Instrument (since 2000)

Start of the Prime Mission May 2014 (middle of Cycle 2)



Spike in 2012 from special issue, data mainly from Basic Science (Jun-Sep 2011 observations)

There are 5 more in the queue…thank you

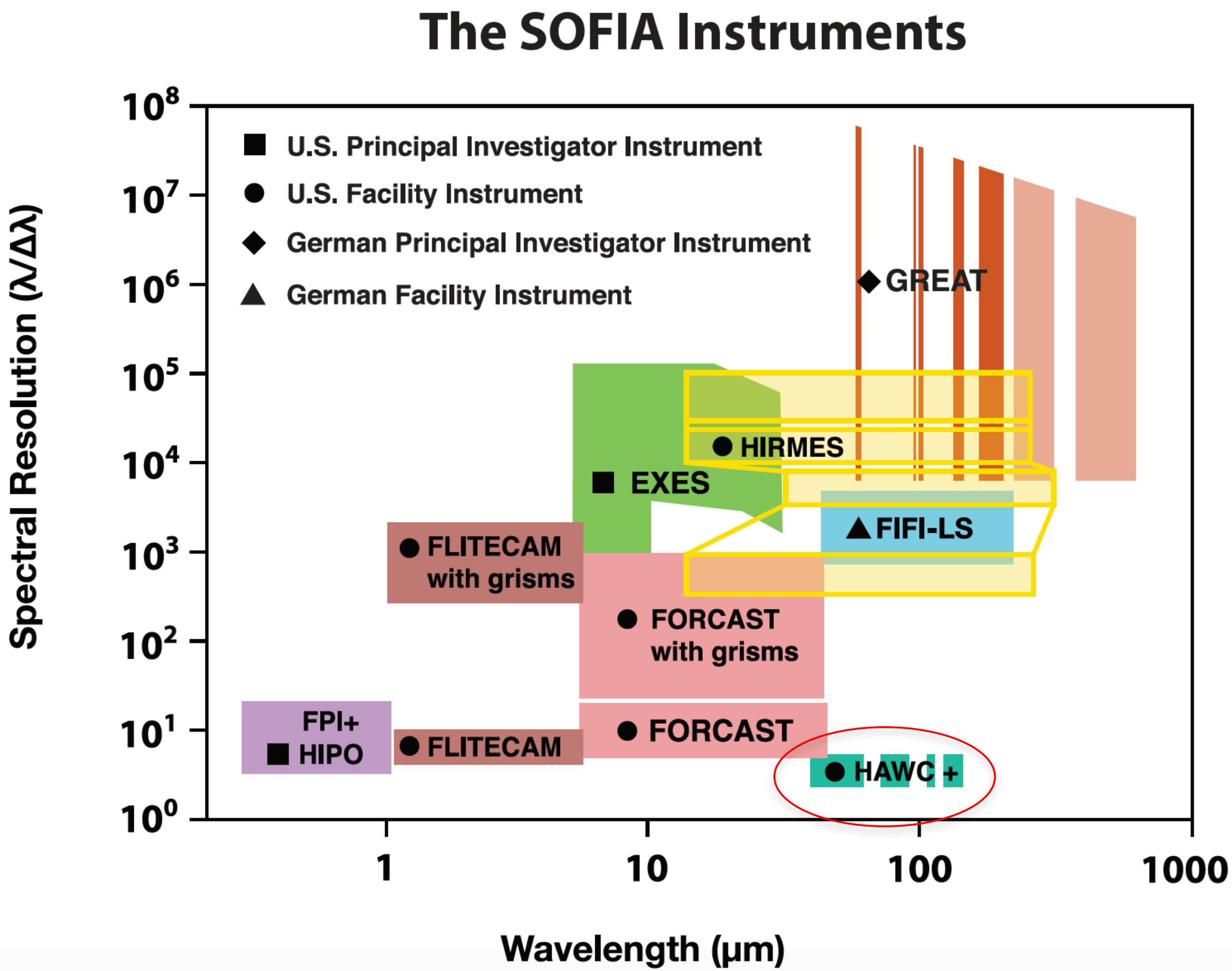
1. Gordon, M. et al "Searching for Cool Dust: II. Infrared Imaging of the OH/IR Supergiants, NML Cyg, VX Sgr, S Per and the Normal Red Supergiants RS Per and T Per", submitted to ApJ. [FORCAST, Cycle 3 & 4]
2. Langer, W. et al. "Ionized gas in the Sputum spiral arm as traced by [N II] and [C II]," submitted to A&A. [GREAT, Cycle 4]
3. Herpin, F. et al. "First detection of THz water maser in NGC7538-IRS1 with SOFIA and new 22 GHz e-MERLIN map," submitted to A&A. [GREAT, Cycle 3]
4. Rangwala, N, et al. "High Spectral Resolution SOFIA/EXES Observations of C2H2 Towards Orion Irc2," submitted to ApJ. [EXES, Cycle 3]
5. Angerhausen, D, et al. "Simultaneous multicolour optical and near-IR transit photometry of GJ 1214b with SOFIA," submitted to A&A. [HIPO, FLITECAM, Cycle 2]

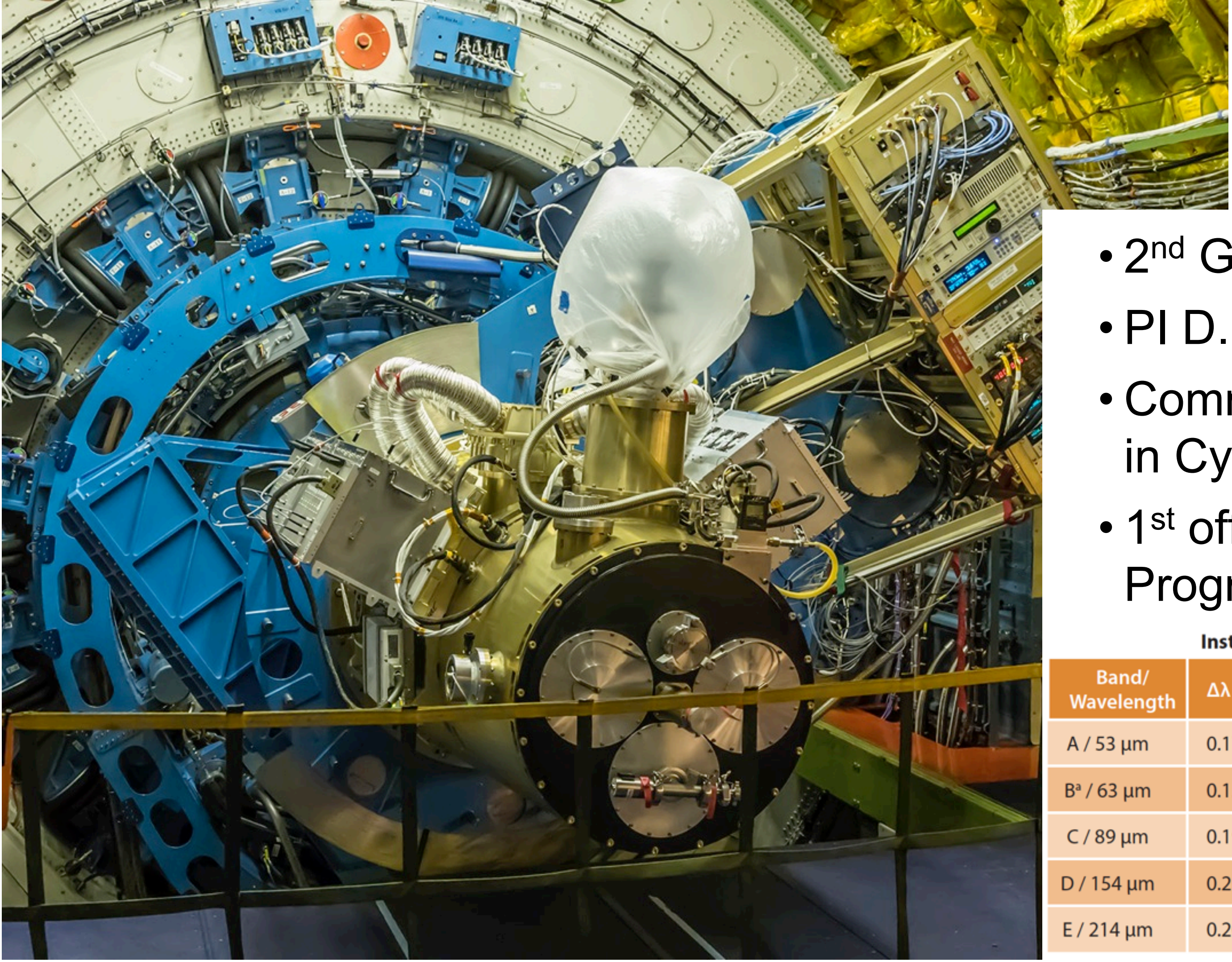
…we need much more!

The PS Perspective

- Science Demand
- Science Performance
- Science Productivity
- Science Future

New Science Enabled by New Capabilities





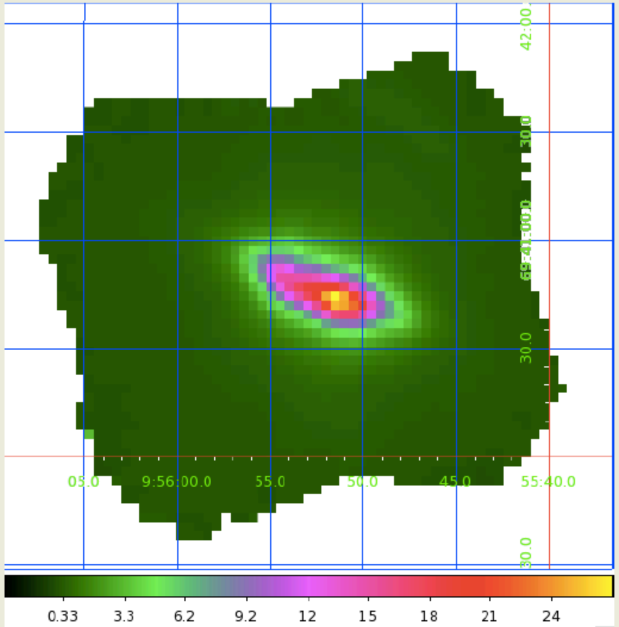
HAWC+

- 2^{nd} Gen Instrument
- PI D. Dowell (JPL)
- Commissioned Dec 2016 in Cycle 4
- 1^{st} offered Cycle 5 GO Program

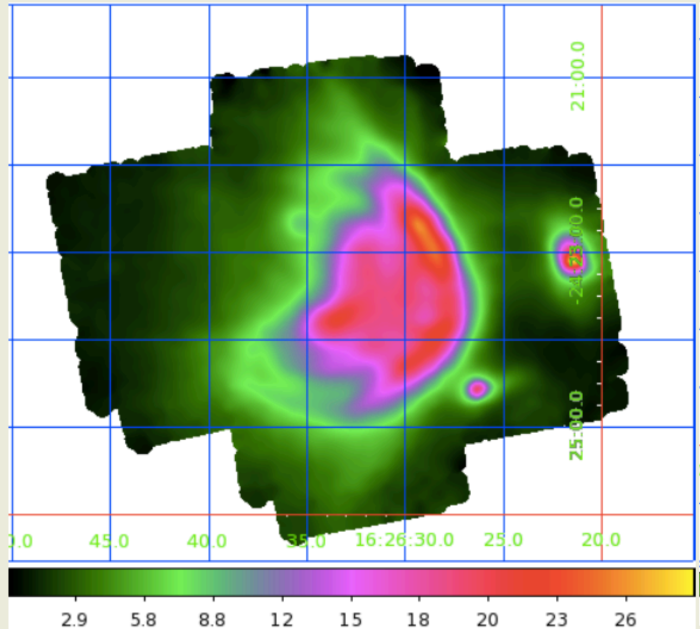
Instrument Parameters for Bands A–E

Band/ Wavelength	Δλ /λ	Angular Resolution	Total Intensity FOV (arcmin)	Polarization FOV (arcmin)
A / 53 µm	0.17	4.9" FWHM	2.8 x 1.7	1.4 x 1.7
B[a] / 63 µm	0.15	5.8" FWHM	4.2 x 2.7	2.1 x 2.7
C / 89 µm	0.19	7.8" FWHM	4.2 x 2.7	2.1 x 2.7
D / 154 µm	0.22	13.6" FWHM	7.4 x 4.6	3.7 x 4.6
E / 214 µm	0.20	18.2" FWHM	10.0 x 6.3	5.0 x 6.3

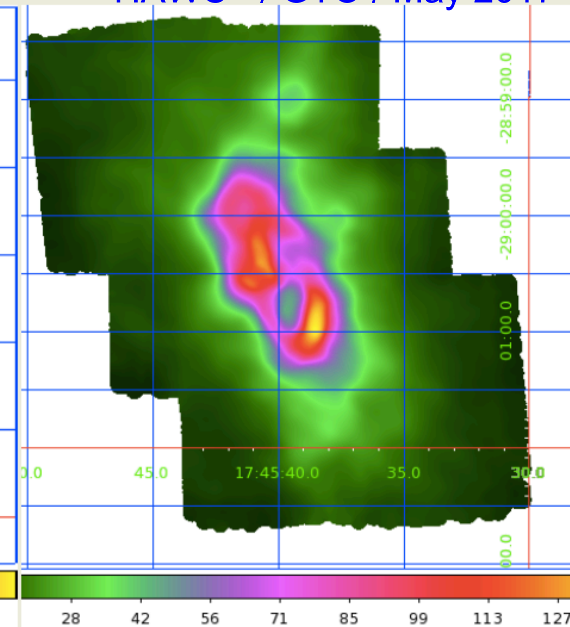
HAWC+ / GTO / May 2017



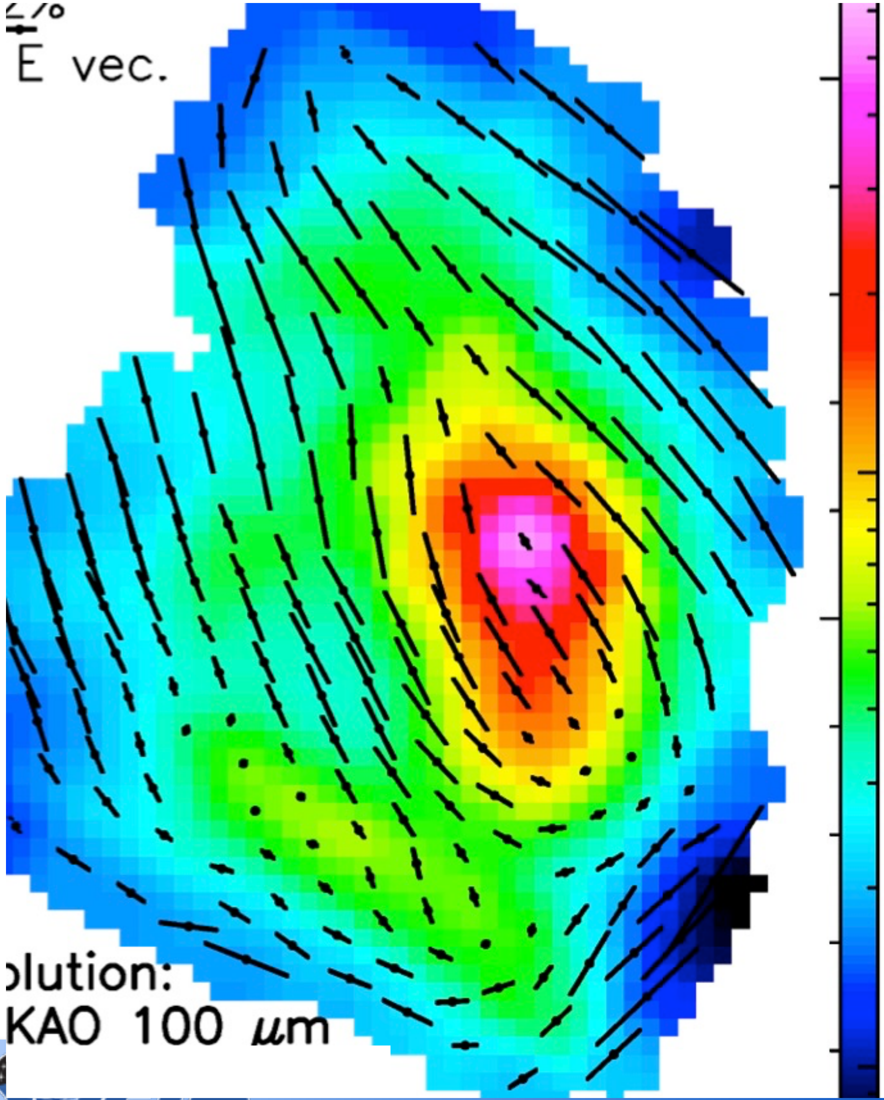
M82 is a galaxy with active ongoing star formation (star-burst galaxy)



Rho Oph is a nearby region of active star formation in our Galaxy



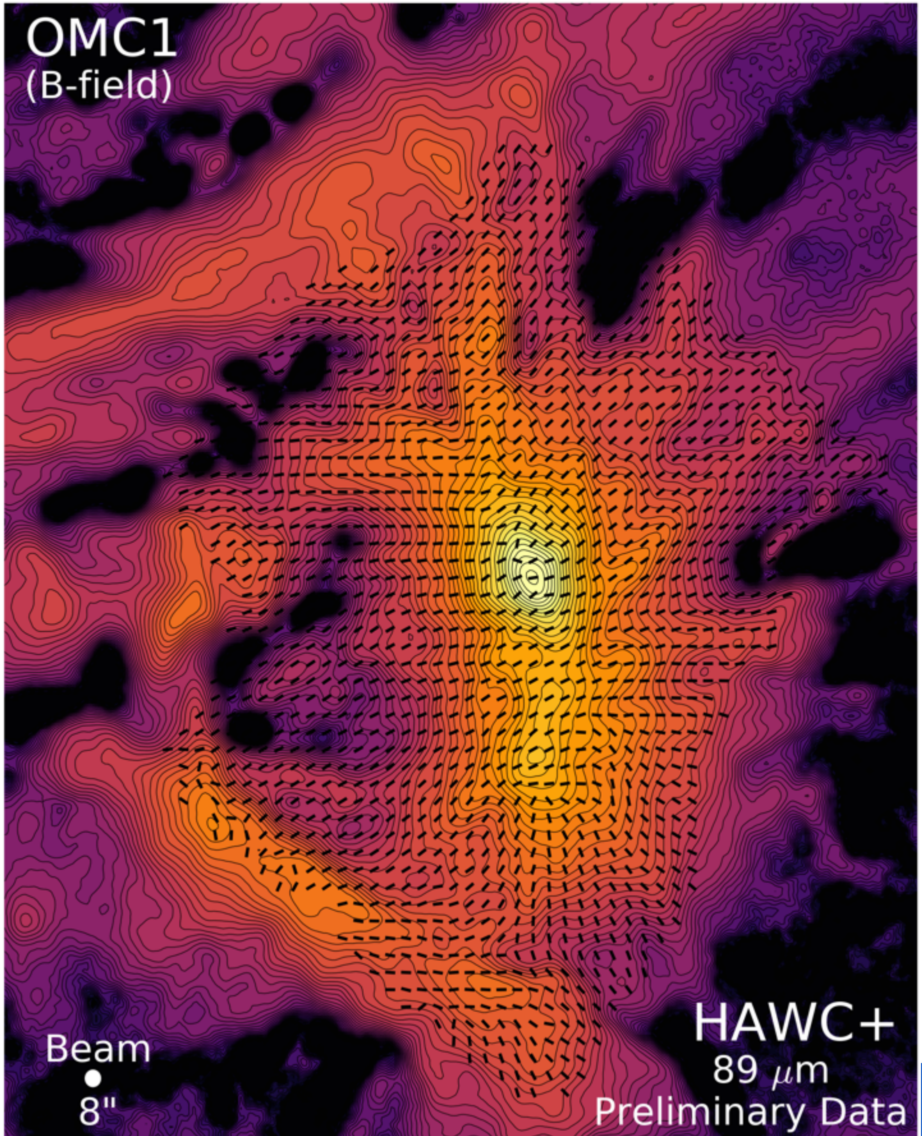
The Galactic Center region houses the closest Supermassive Black Hole (~4 Million solar masses)



KAO Orion Molecular Cloud 1

Observation took 3 half flights on KAO

Schleuning 1998, ApJ, 493, 811

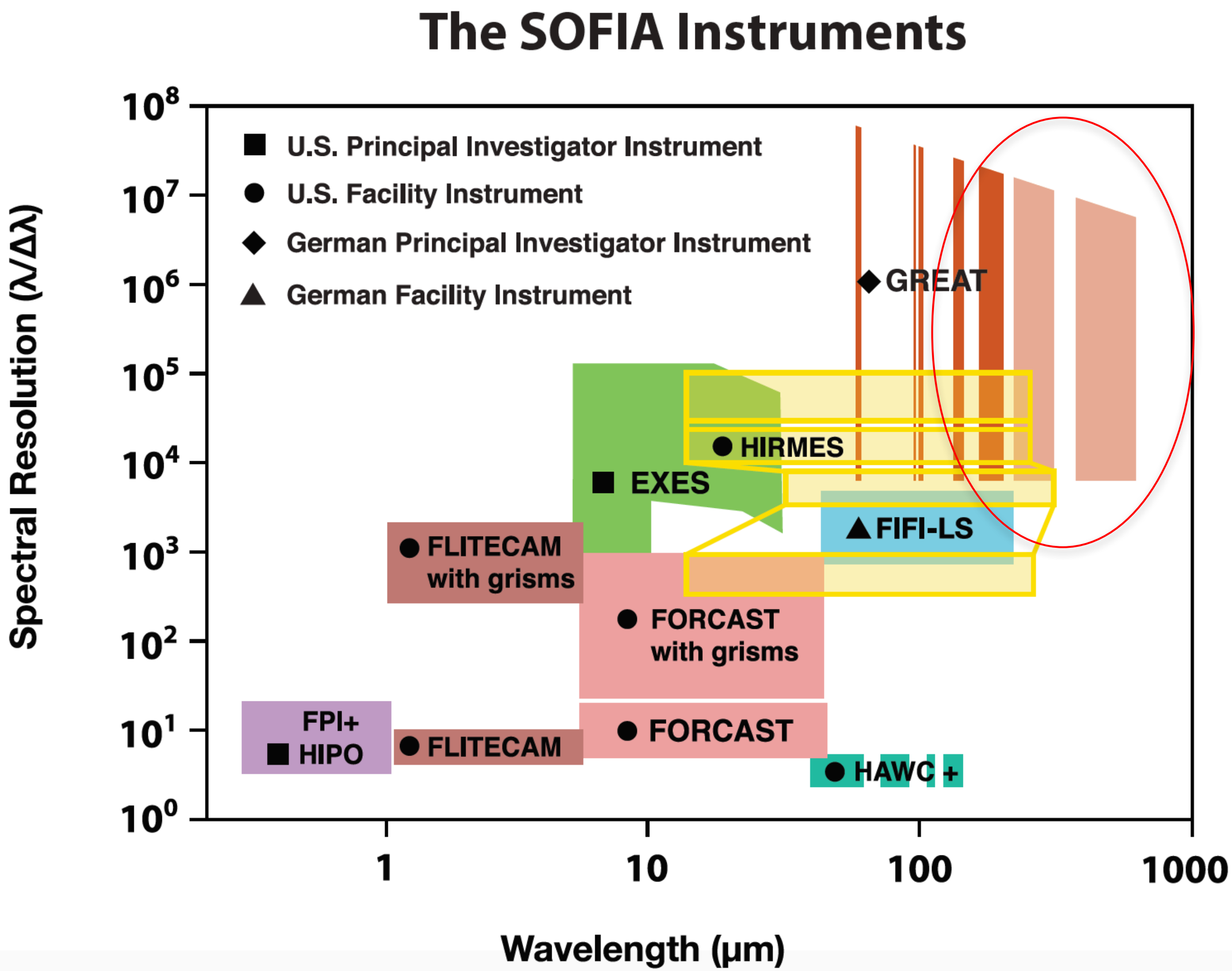


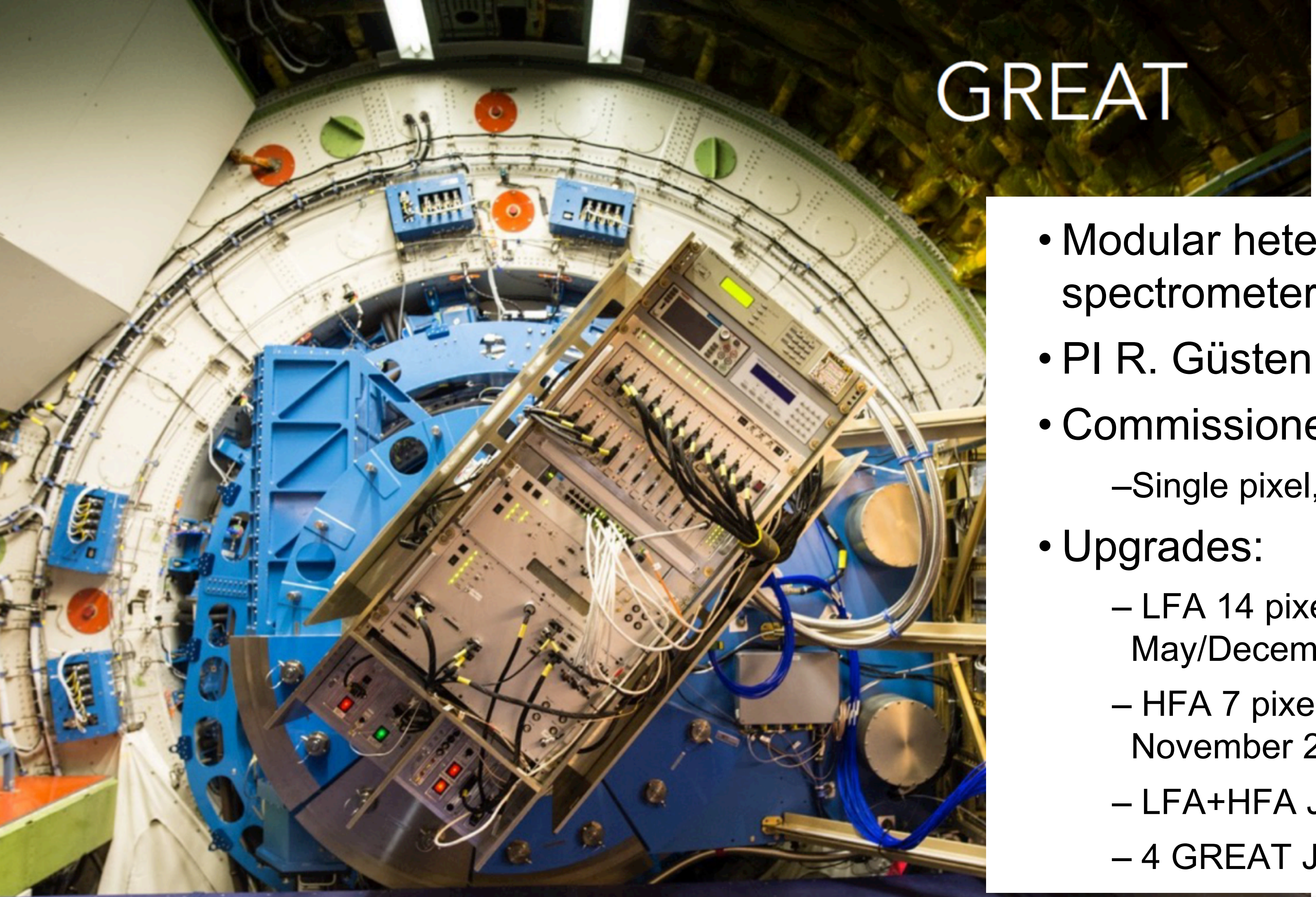
SOFIA
Orion Molecular Cloud 1

2 hours observing for polarization.
2 minutes for continuum image.

Note: Vectors show polarization direction but not amount of polarization

New Science Enabled by New Capabilities





GREAT

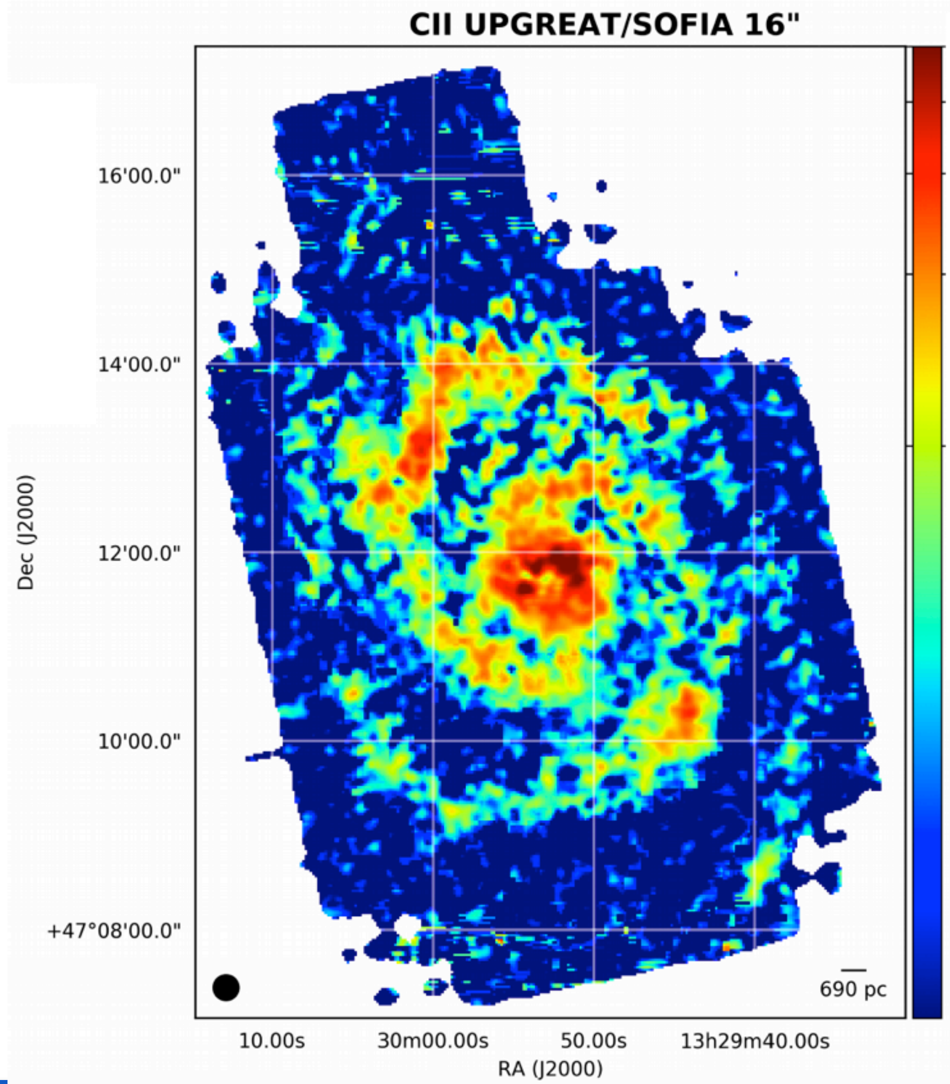
- Modular heterodyne spectrometer
- PI R. Güsten (Bonn)
- Commissioned Apr 2013
  - –Single pixel, 4 channels
- Upgrades:
  - – LFA 14 pixels at 1.9 THz May/December 2015
  - – HFA 7 pixels at 4.7 THz November 2016
  - – LFA+HFA July 2017
  - – 4 GREAT July 2017

Several subcomponents mounted on SI flange + counterweight rack + SI electronics rack + PI rack (FE SW)

Arrays of heterodyne pixels

Available since Cycle 4, upGREAT LFA (2x7) CII Maps ***more than 50 times faster*** than Herschel/ HIFI

- increased sensitivity
- 7 element array, and
- two polarizations



M51 "Grand Design Spiral" GREAT 158 micron C+ mapping (Cycle 4, Joint Impact GO Program, PIs: J. Stutzki, J. Pineda). 17 Flights May 2016 – February 2017.

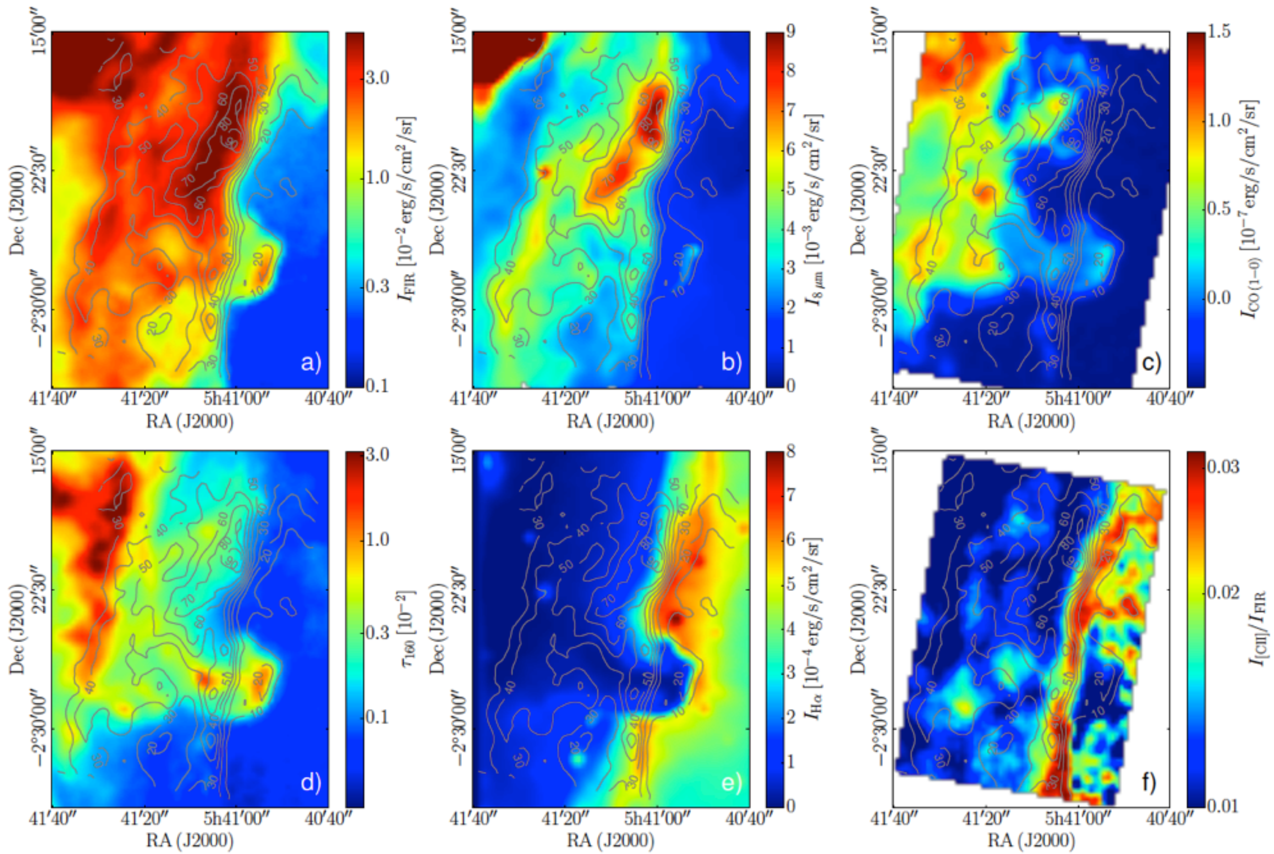
[CII] emission from L1630 in the Orion B molecular cloud

Cycle 4 / DDT / GREAT

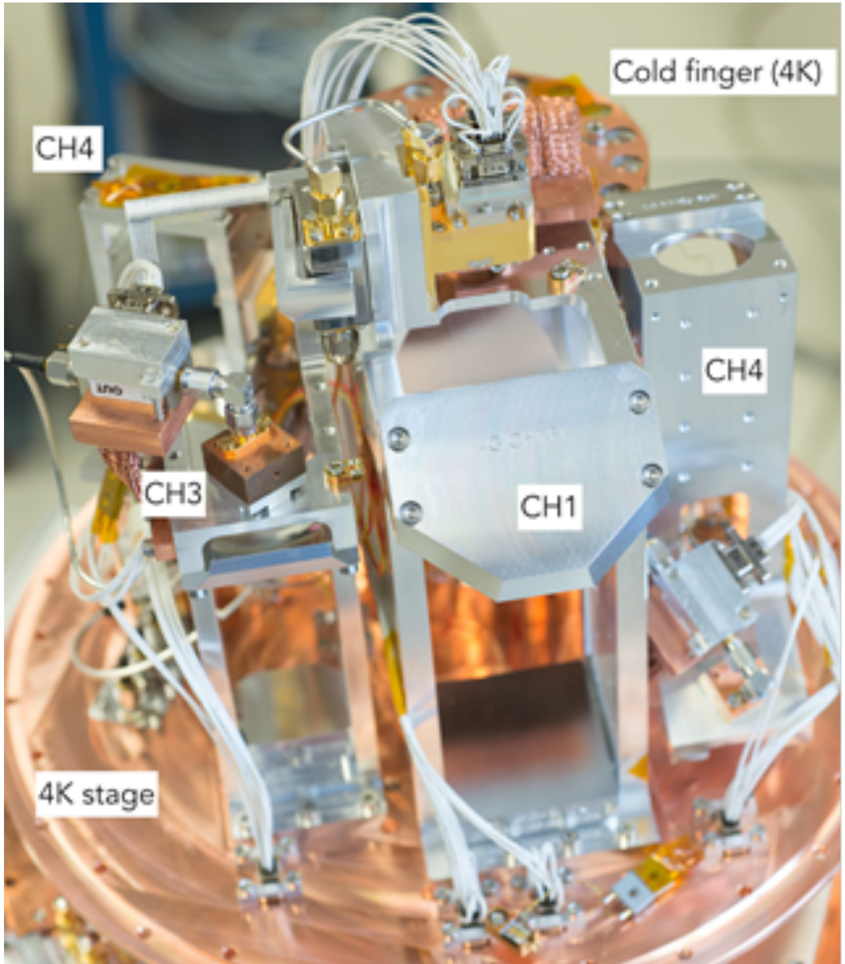
Commonly assumed gas heating mechanisms over-predicts the observations by a factor of two.

Fundamental understanding of small grain abundances in PDRs challenged by the SOFIA results.

https://www.sofia.usra.edu/science/proposing-and-observing/proposal-calls/sofia-directors-discretionary-time/horsehead-nebula



Contours are [CII] 158 μm flux measured by SOFIA

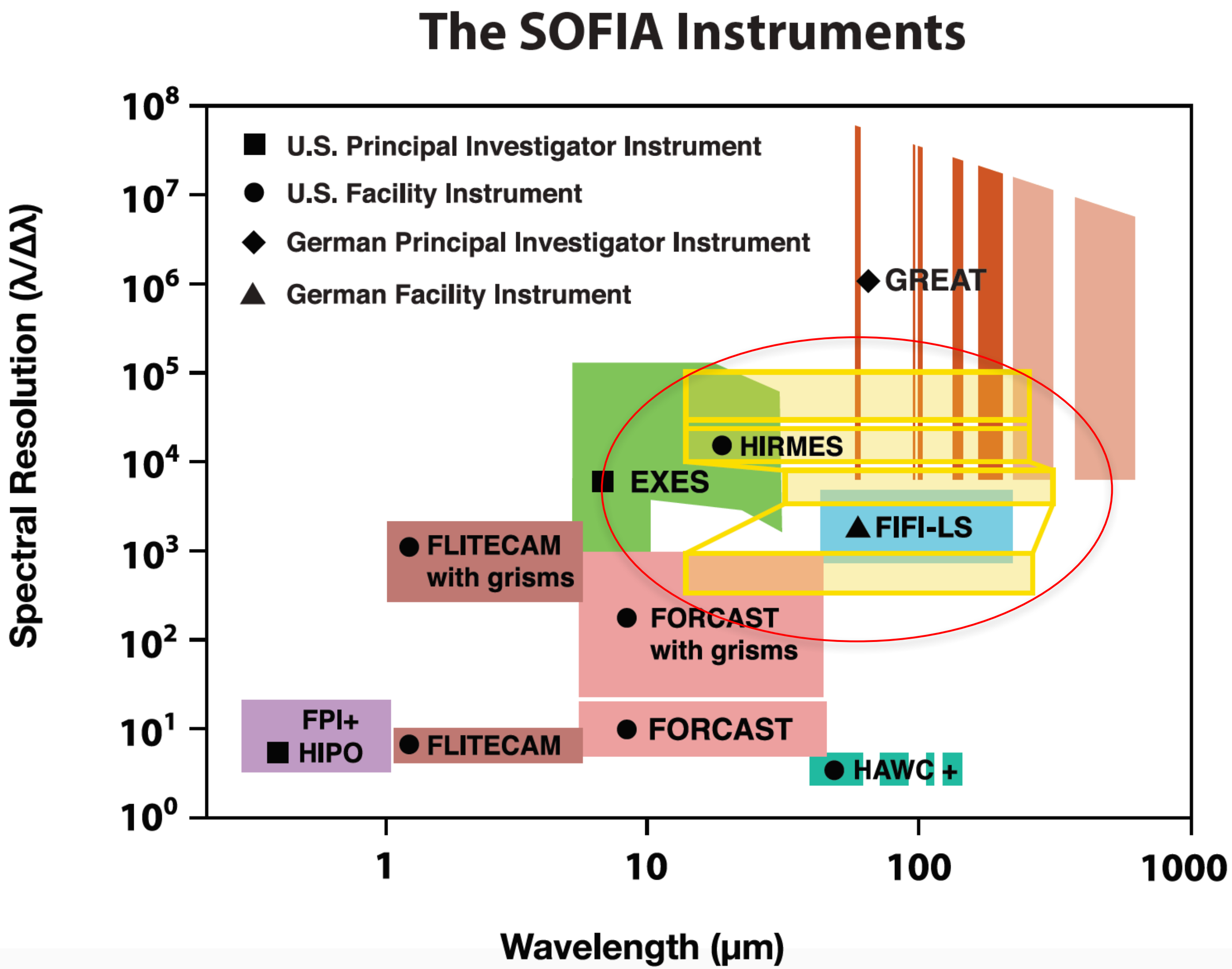


4 Channels Multiplexed

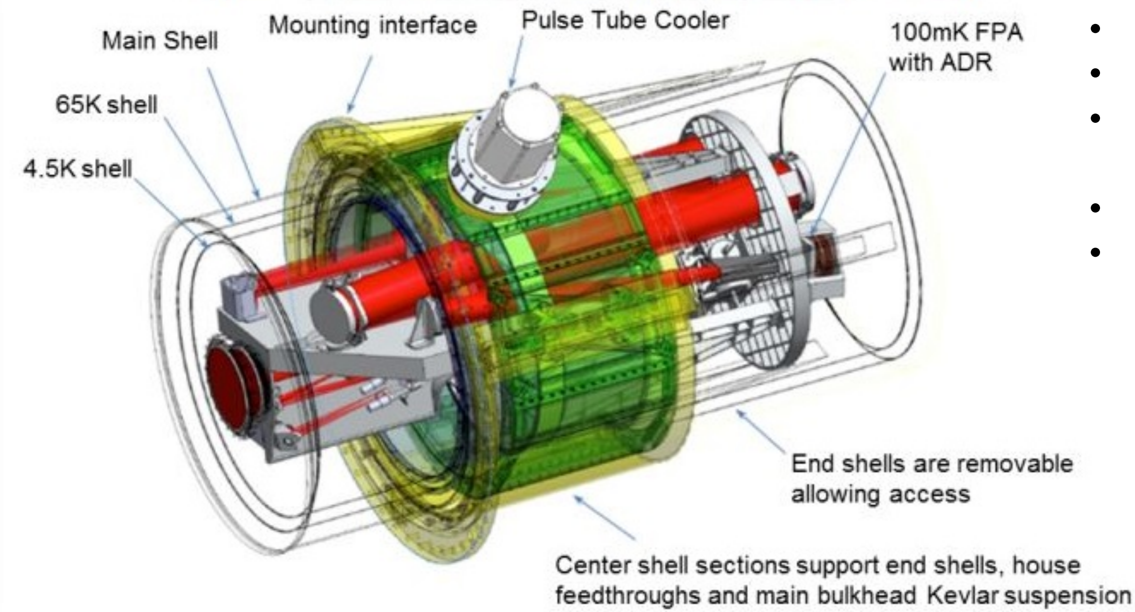
4G-1	480-635 GHz	NH_3, [CI]	HIFI spare flight mixer, by LERMA/Obs.Paris
4G-2	890-1100 GHz	CH, CS	HIFI spare flight mixer, by SRON NL
4G-3	1200-1500 GHz	[NII], CO series, OD,HCN,H_2D^+	L1 - KOSMA
4G-4	2480-2700 GHz	OH(2π3/2),HD	M-HD - KOSMA

*Can also be operated with HFA (4745 GHz, [OI])

New Science Enabled by New Capabilities



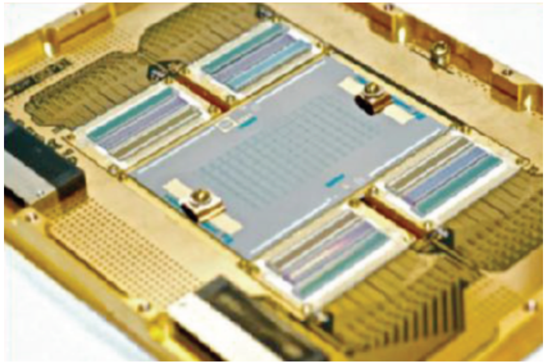
High Resolution Mid-infrared Spectrometer (HIRMES)



Direct detection spectrometer 25 to 122 μm

- High-res mode R ~ 100,000
- Mid-res mode R ~ 10,000
- Low-res mode R ~ 600
- Imaging spectroscopy mode R ~ 2000

- Background limited bolometers
- Fabry-Perot Interferometers and gratings



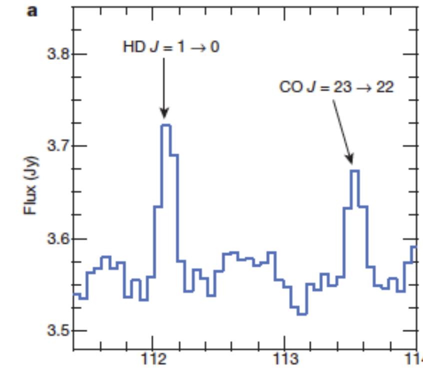
TES bolometers 1-2 order magnitude more sensitive that those in HAWC+

PI. S.H. Moseley, GSFC

HIRMES Science Goals

Study protoplanetary disks

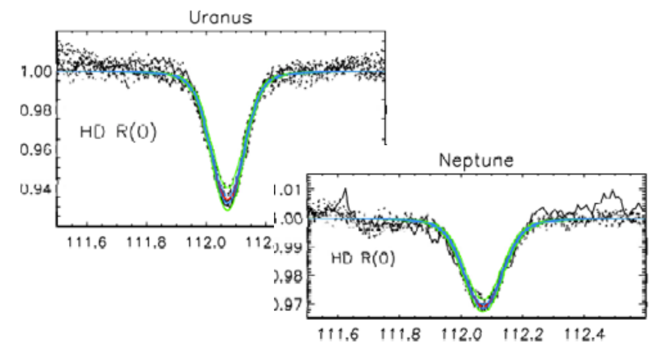
- Measure the mass, composition, and kinematics of protoplanetary disks
  - –HD 1-0 R(0) line at 112 μm with R~100,000
  - –[OI] line at 63 μm with R~50,000
  - –Warm H_2O at 28-38 μm
  - –Solid-state H_2O at 43 μm and 63 μm at R=100



Bergen, E. et al 2013 Nature Herschel/PACS detection of HD in TWHya protoplanetary disk

H and D in the Solar System

- Determine the isotopic composition of the constituents giant planets
  - –H2 S(0) at 28 μm with R~10,000
  - –HD lines at 112, 56, 37, 28 μm with R~10,000



Feuchtgruber, H. et al 2013 Herschel/PACS data

Next Gen / ROSES 2017

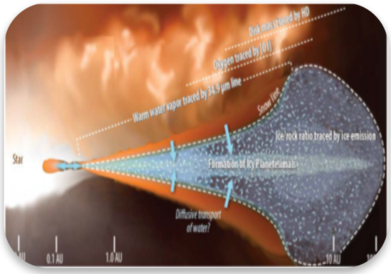
It's coming!

NOTICE: NASA expects to issue a call for proposals for the development of the next generation of instrumentation for SOFIA in the late summer / early fall of 2017. Final text will be released by Amendment to ROSES-2017 at least 90 days prior to the due date for proposals. Until then the due dates will appear as TBD in Tables 2 and 3.

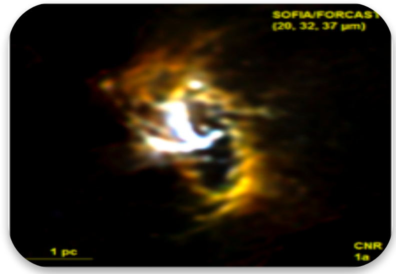
1. Overview

The Stratospheric Observatory for Infrared Astronomy (SOFIA) consists of a German-built 2.7- meter (2.5-meter useable aperture) telescope mounted in a Boeing 747- SP aircraft supplied and modified by NASA. Flying at altitudes up to 45,000- feet, SOFIA observes from above more than 99 percent of Earth's atmospheric water vapor, thereby providing wavelengths for astrophysical observations not available from the ground. SOFIA observes primarily at mid- and far-infrared wavelengths with a suite of instruments that have a wide-range of imaging and spectroscopic capabilities (https://www.sofia.usra.edu/Science/instruments/). Since SOFIA returns to the ground

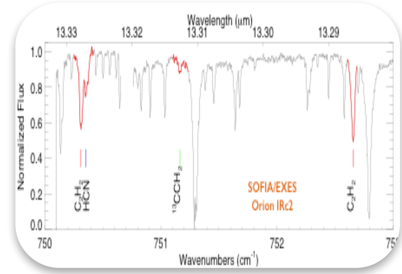
SOFIA Today is aligned to advance these fields…



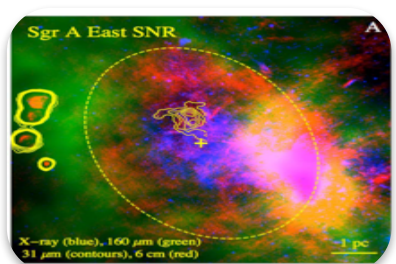
Evolution of planetary systems



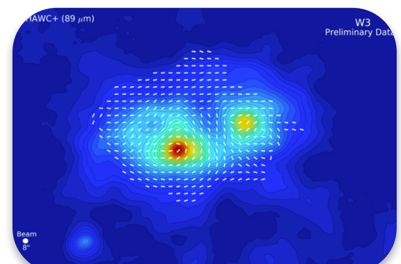
Physics of extreme environments



Formation of complex molecules



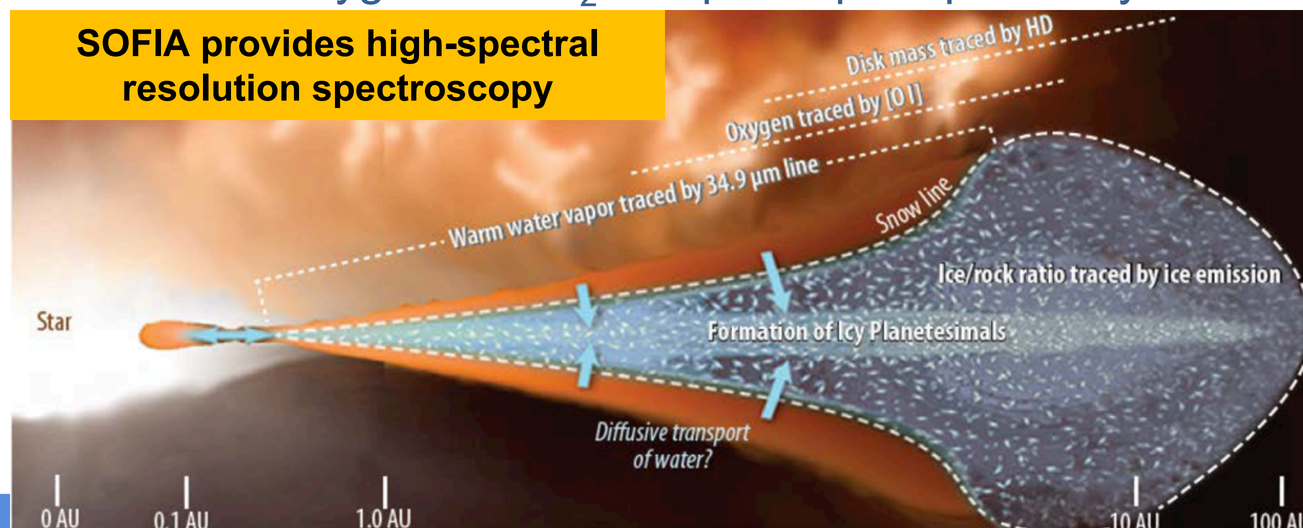
Dust in the universe



Role of magnetic fields

How do we trace water from protoplanetary disks to habitable zones?

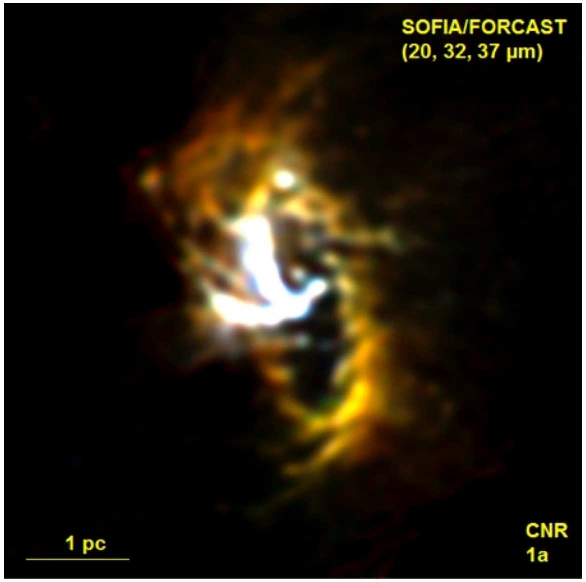
- SOFIA with HIRMES will address fundamental questions about the evolution of planetary systems.
    - How does the disk mass evolve during planetary formation?
    - What is the distribution of oxygen, H_2O-ice and H_2O-vapor in different phases of planet formation?
    - What are the kinematics of oxygen and H_2O-vapor in protoplanetary disks ?
- 100's of disks within 500 pc are within HIRMES' grasp!



What is going on in extreme environments?

SOFIA to continue to address key outstanding questions in galaxy formation:

- What is the local truth of processes going on at z=2?
- How does material find its way into super-massive black holes (dynamics, magnetic fields)?
- What are the feedback effects on massive SF and SMBH on their immediate environments?



SOFIA resolved the geometry of the Central Nuclear Ring, a dust and gas disk surrounding a massive black hole near the plane of the Galaxy (Lau et al. 2013).

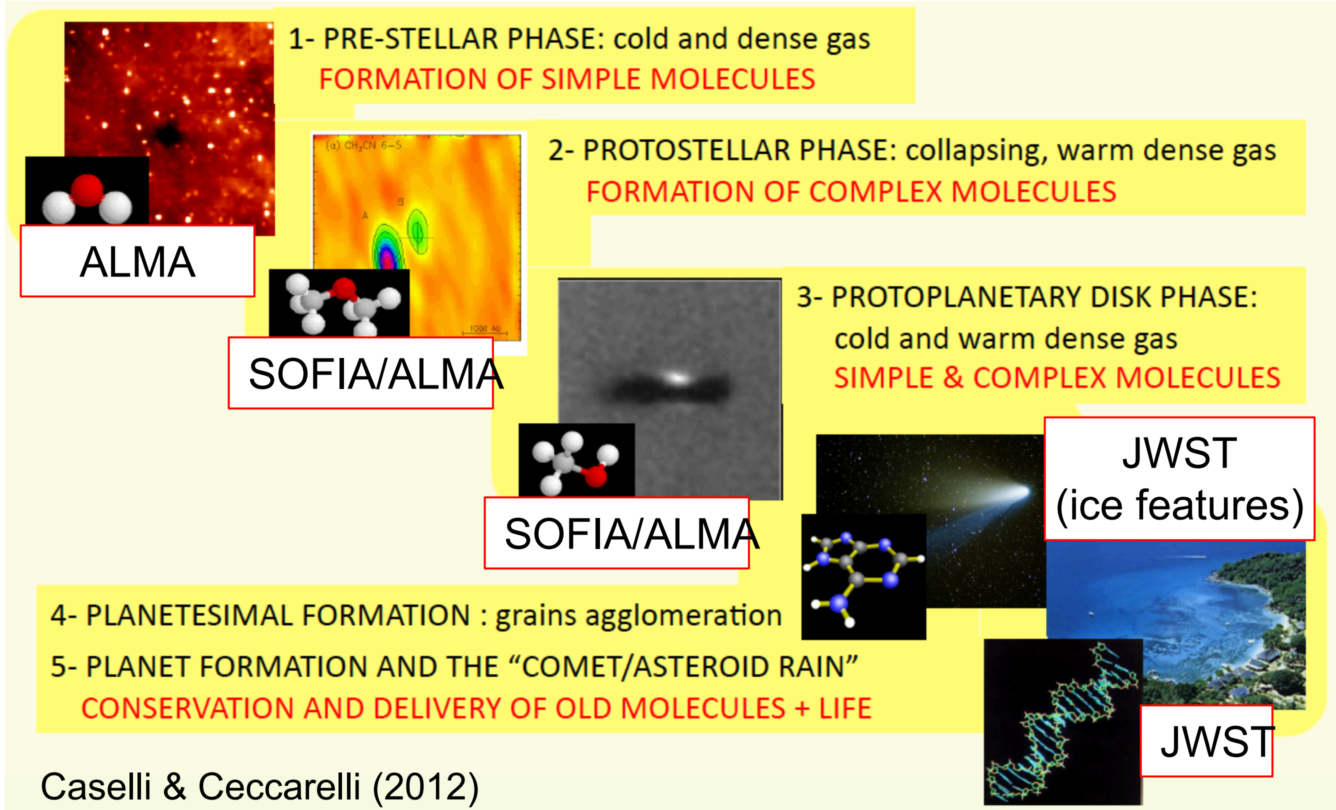
Cycle 1 / GTO / FORCAST

SOFIA provides high-spectral resolution spectroscopy and FIR polarimetry

How do atoms and simple molecules lead to life?

SOFIA and ALMA, together probe all phases of star formation. JWST follows delivery to worlds.

- How do we get the complex molecules from interstellar material transported to planetary systems?



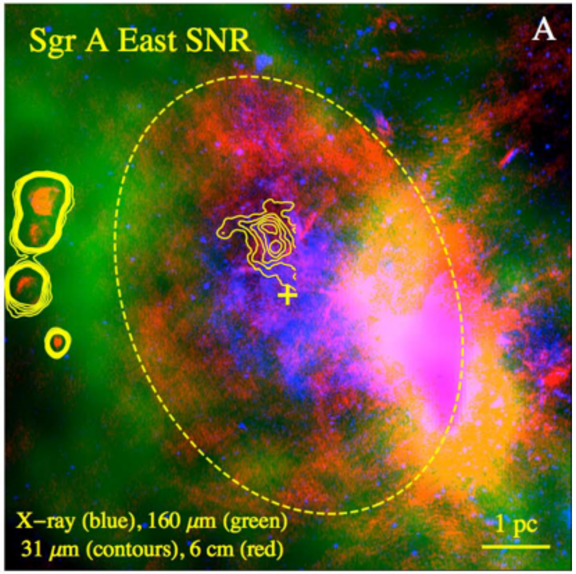
Caselli & Ceccarelli (2012)

SOFIA provides high-spectral resolution spectroscopy

How Did Dust Build the Universe?

SOFIA is the premier observatory to study dust in the wavelength regime of its maximum emission.

- How and where is dust formed in explosive events (novae/SNe)?
- How does dust survive in the initial/reverse shocks?
- How is dust formed in outflows of evolved stars?
- How does dust evolve in star-forming dense molecular cores? In proto-planetary disks?



Observations of Sgr A East remnant. First discovery of dust in an older SNR that has survived the passage of the reverse shock. (Lau et al. Science, 2015)

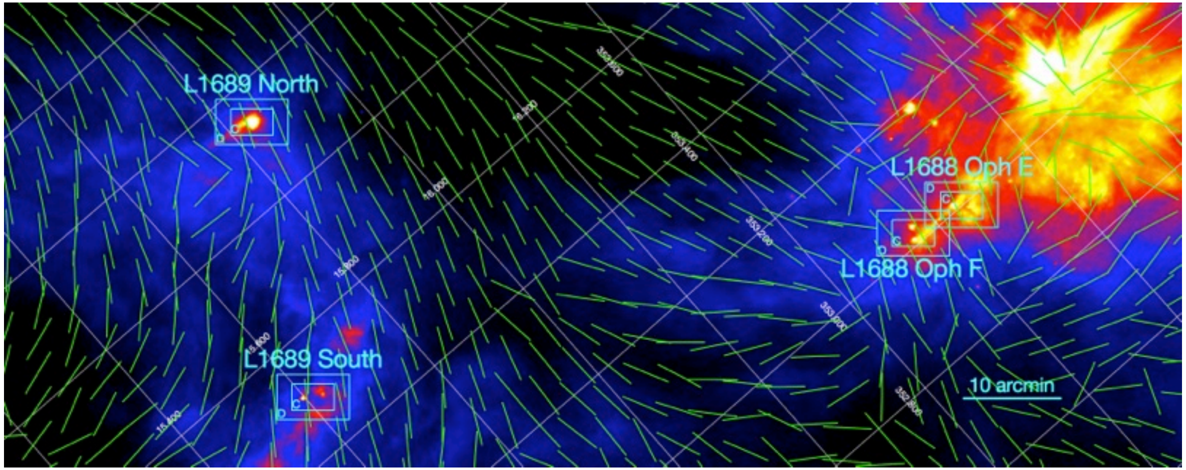
Cycle 3 / GO / FORCAST

SOFIA provides FIR Imaging and polarimetry

What is the Role of Magnetic Fields for Galaxy Formation & Evolution?

We are missing important physics in galaxy formation and evolution. Additional quantitative information for galaxy models is needed.

- What is the structure of magnetic fields at various spatial scales?



PLANCK
+
SOFIA
+
ALMA

Large scale B-field directions from Planck 850 μm polarimetry superposed on Herschel 160 μm dust emission. Individual targets are being studied using ALMA.

SOFIA provides FIR polarimetry

Program Prepares for Senior Review

Schedule

- –Proposal request in Summer 2018
- –Written proposal (30 pages) is due Dec 2018/Jan 2019
- –Oral presentation/site visit will be in early Spring 2019
- –Decision late Spring/early Summer 2019

1/3 Review is based on past performance

- –Metrics, particularly publications (quantity/quality) and citations are important
- –Aircraft reliability

2/3 Review is based on future plans for 3+3 years

Significant cost savings generally expected

Current Thinking on the State of SOFIA Science

- The latest instrumentation on SOFIA Today is creating a renewed excitement!
  - upGREAT 14-pixel (1.9 THz) array commissioned in 2016
  - HAWC+ commissioned in December 2016
  - upGREAT 7-pixel (4.7 THz) + 14 pixel (1.9 THz) commissioned July 2017
  - 4GREAT commissioned in July 2017
- We need this data shared more openly in the community!
- We have respectable proposal pressure.
- **We do need stronger publications.**
  - **True urgency for community to publish Cycle 4, 5, 6 & 7 faster than 2 years.**
- We need archival participation. What can we do to help?
- We are in the “era of JWST & ALMA.”

SOFIA Today Must…

- Exploit that wavelength regime that is not available to the rest of the observatories.
  - High spectral resolution spectroscopy
  - FIR polarimetry
- Maintain flexibility.
  - New approaches to science execution in Cycle 6
- Continue be infused with new technologies that enable new science.
  - Infrared detectors are not commercially available: SOFIA provides the funding and focus required to keep technologists advancing this field
  - US next gen call coming out soon!

January 2018 AAS

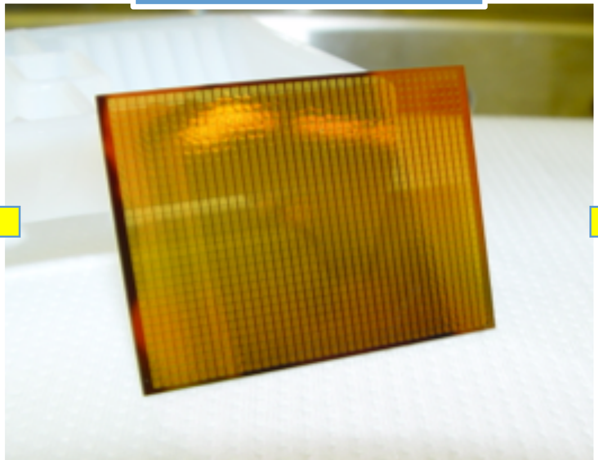
- Mark your calendars! SOFIA Science Center will hold the SOFIA Town Hall (**Thur Jan 11, 7:30pm ET**) at the 231st AAS meeting in Washington, D. C. and we will announce new exciting opportunities with the observatory.

- Students or postdocs presenting their research based on SOFIA results, in particular as thesis presentations, may request to have their registration fees paid by the SOFIA project. Please send a note to sofia_help@sofia.usra.edu and include the title of your presentation.

SOFIA is an Amazing and Unique Asset to Astrophysics Research

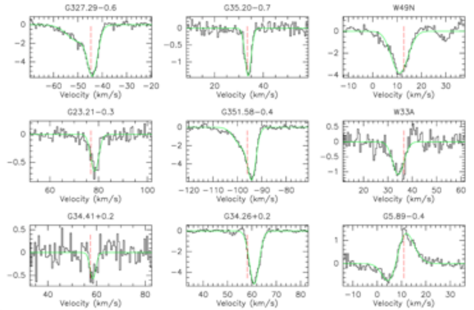
People

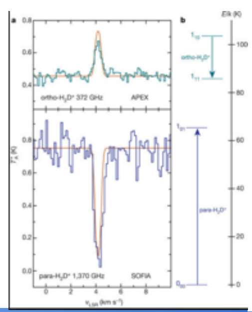
Technology

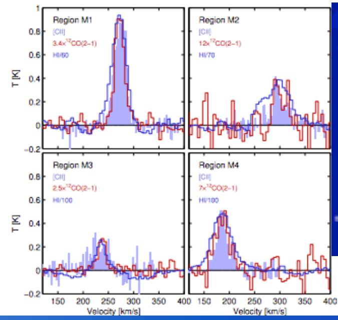


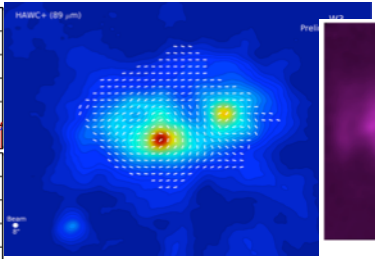
Platform

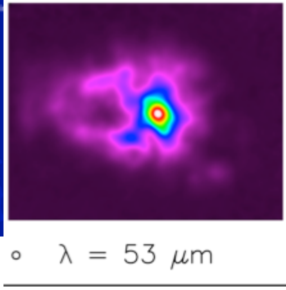
Science

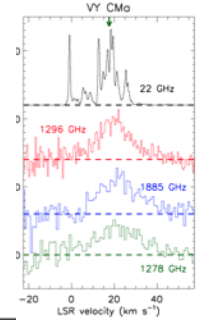












Welcome your new science ideas & your papers!!!

SOFIA
Stratospheric Observatory for Infrared Astronomy