SOFIA APAC Update

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June 23, 2020

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SOFIA
Stratospheric Observatory for Infrared Astronomy

NASA DLR USRA DSI

Outline

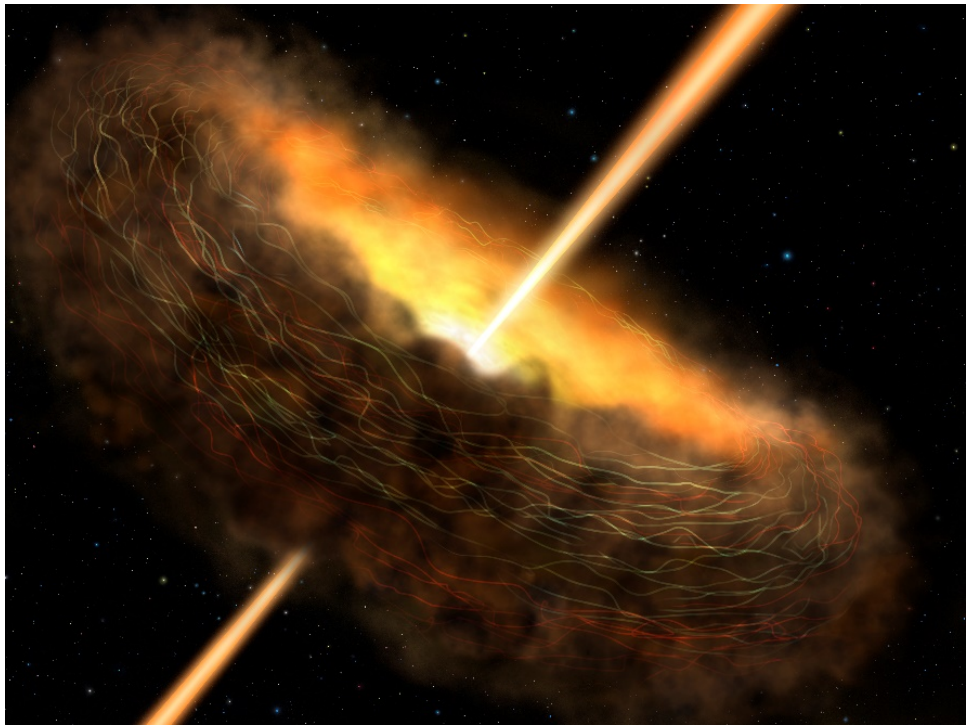
- SOFIA's 10th Anniversary of First Light
- Science highlights
- Science Mission Operations Vision
- Science & Community Metrics
- Community engagement activities
  - Cycle 9 call
  - Instrument roadmap

Congratulations to SOFIA Team for 10th Anniversary of First Light!

Science Highlights from past 10 years

Magnetic Fields May Be Keeping Milky Way's Black Hole Quiet

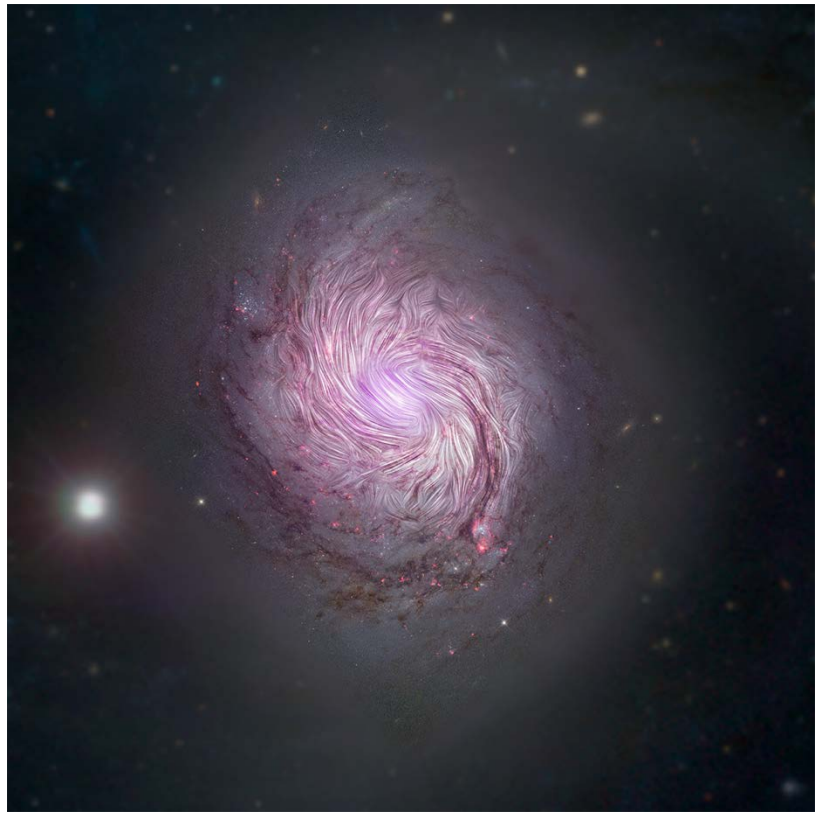
Image credits: Dust and magnetic fields: SOFIA
Star field: Hubble Space Telescope



Magnetic Fields May Be Feeding Active Black Holes – Cygnus A

Illustration credit: NASA/SOFIA/Lynette Cook

Science Highlights from past 10 years



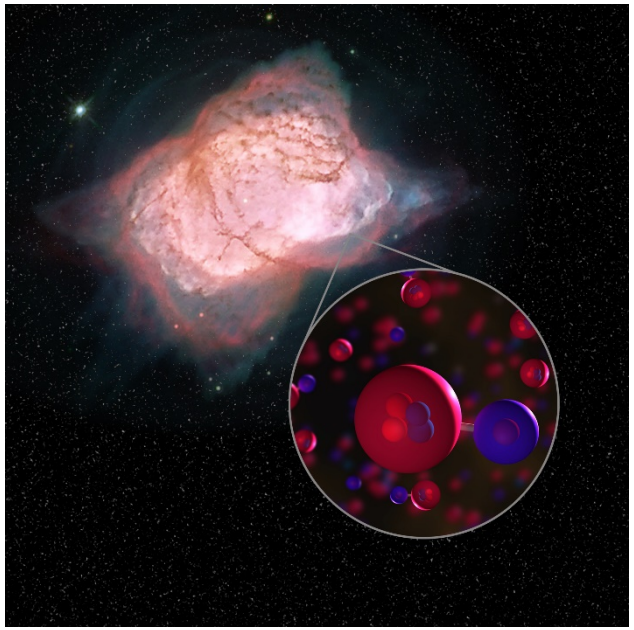
Magnetic field alignment over an entire galaxy, NGC 1068

Image credits: NASA/SOFIA; NASA/JPL-Caltech/Roma Tre Univ.

Weighing a Galactic Wind Provides Clues to the Evolution of Galaxies

Image credits: NASA/SOFIA; NASA/JPL-Caltech

Science Highlights from past 10 years



The Universe's First Type of Molecule, HeH^+, Helium hydride, Found at Last

Image credits: NASA/ESA/Hubble Processing: Judy Schmidt

The excess [CII] 158 µm line emission near this galaxy's center is caused by a jet shocking the gas in the disk.

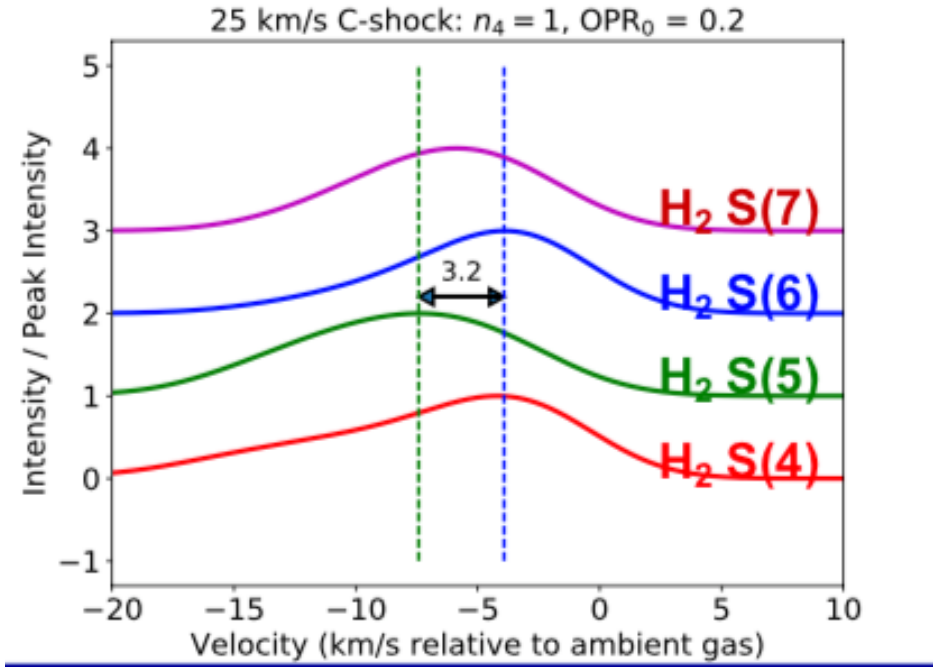
Illustration credits: ESA/Hubble&NASA and NASA/SOFIA/L. Proudfit

David Neufeld
New Evidence for a Special Type of Interstellar Shock

Molecular hydrogen exists in two forms: para-H_2 (proton spins antiparallel, J even) and ortho-H_2 (spins parallel, J odd)

In continuous ("C")-type shocks, the gas is slowly decelerated while the conversion between ortho and para molecular hydrogen is happening

➔ We expect a spectral shift between the even– and odd–J lines

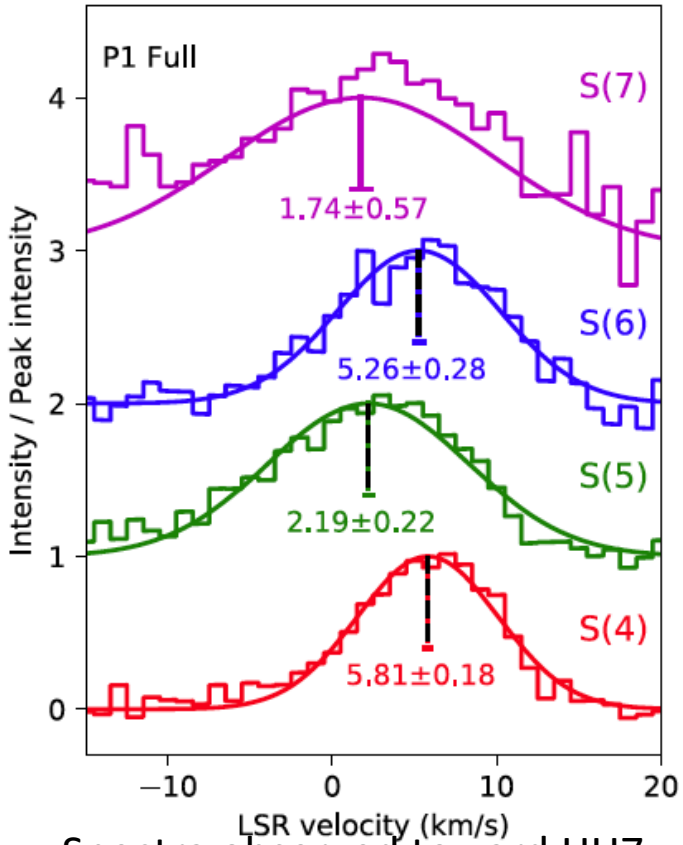


Pierre Lesaffre predictions
(Paris-Durham shock code)

Prediction Confirmed with SOFIA/EXES

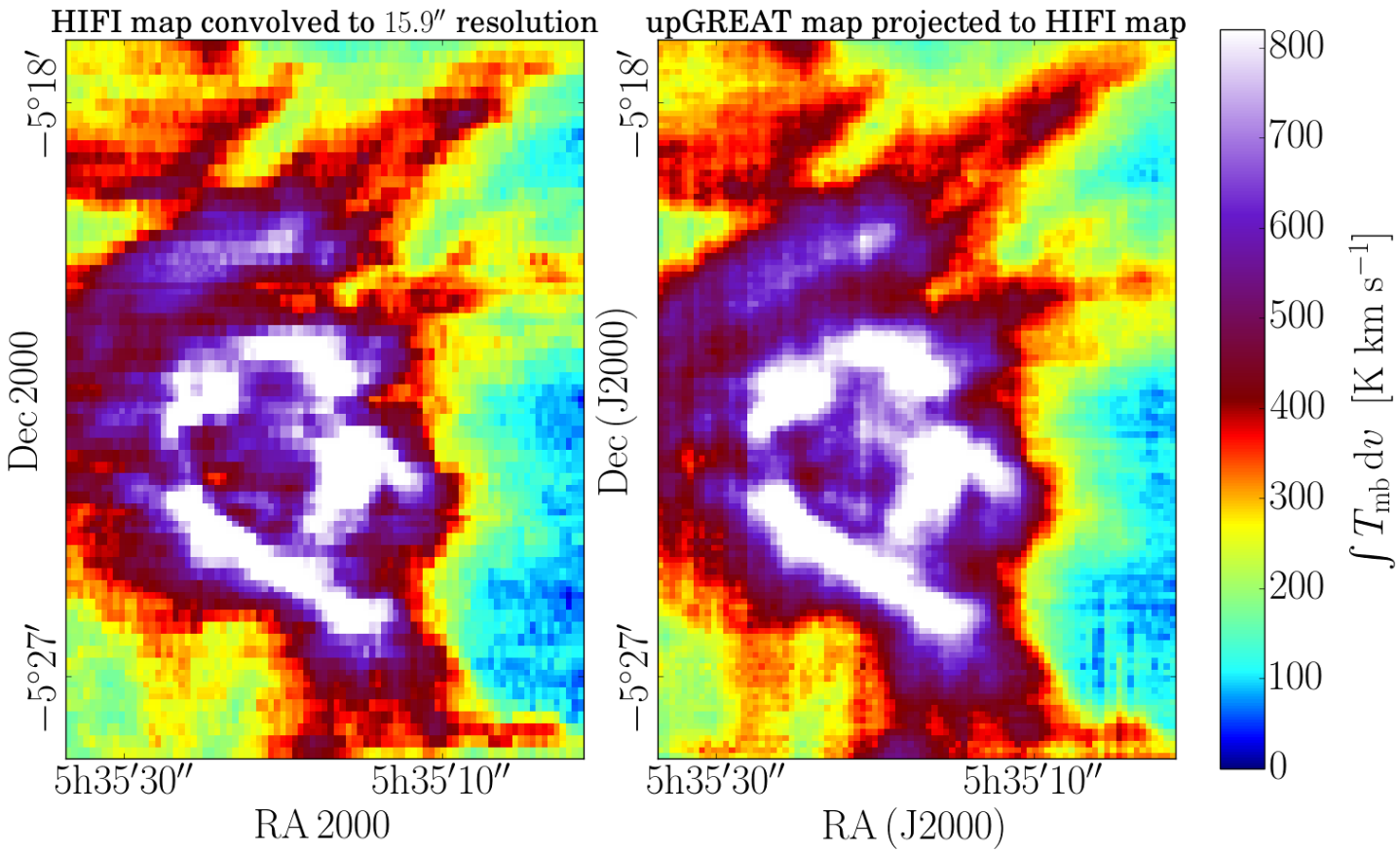
- To test this prediction, we need very high spectral resolution in the 5 – 8 μm region

- EXES, with $\lambda/\Delta\lambda$ = 80,000 and an operating altitude of 41kft, provided a unique opportunity to search for the predicted ortho-para shift



Spectra observed toward HH7
(Neufeld et al. 2019, ApJL)

Alexander Tielens: SOFIA's upGREAT View of Orion

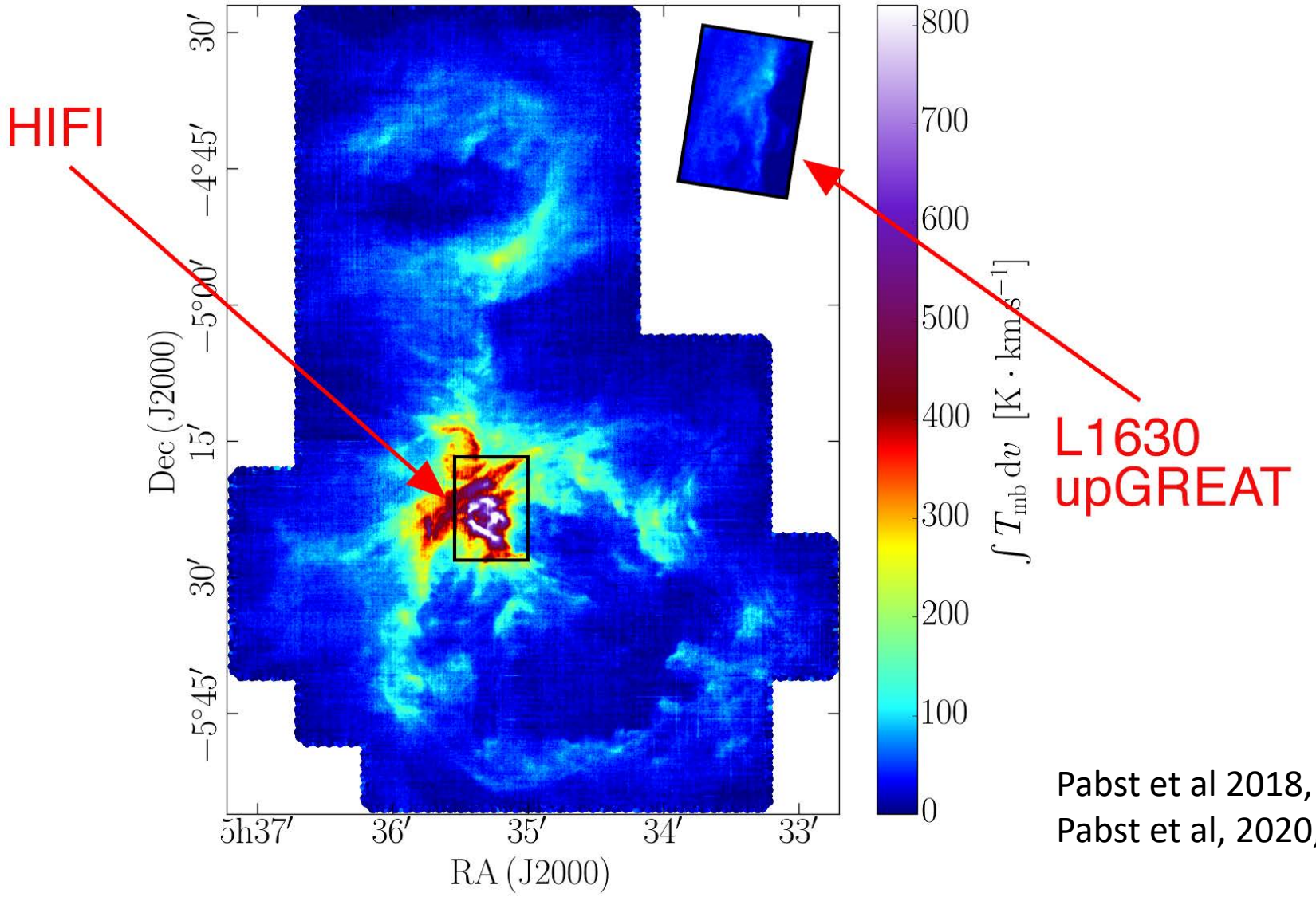


HIFI/Herschel
9 Hours

upGREAT/SOFIA
~35 minutes

Goicoechea et al, 2015, ApJ, 812, 75
Higgins et a 2020, to be submitted

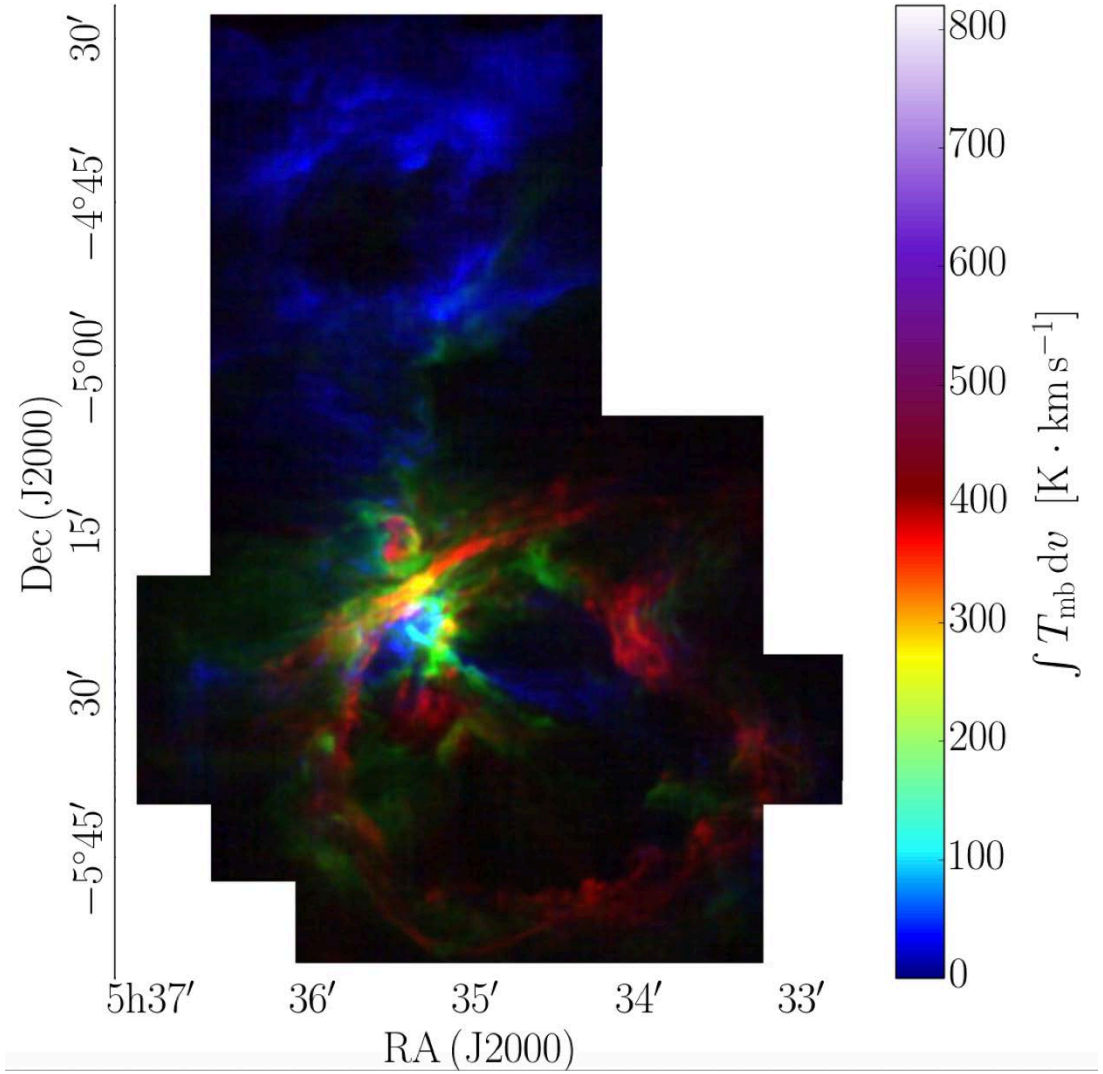
In Perspective



Pabst et al 2018, Nature, 565, 618
Pabst et al, 2020, A&A, in press

In Perspective

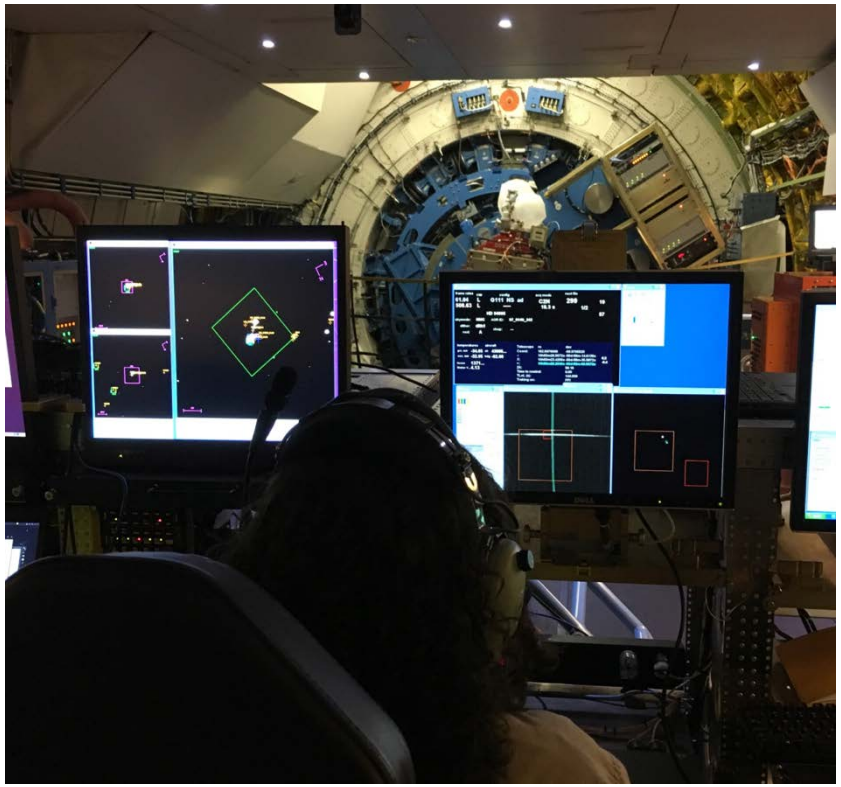
Cornelia Pabst

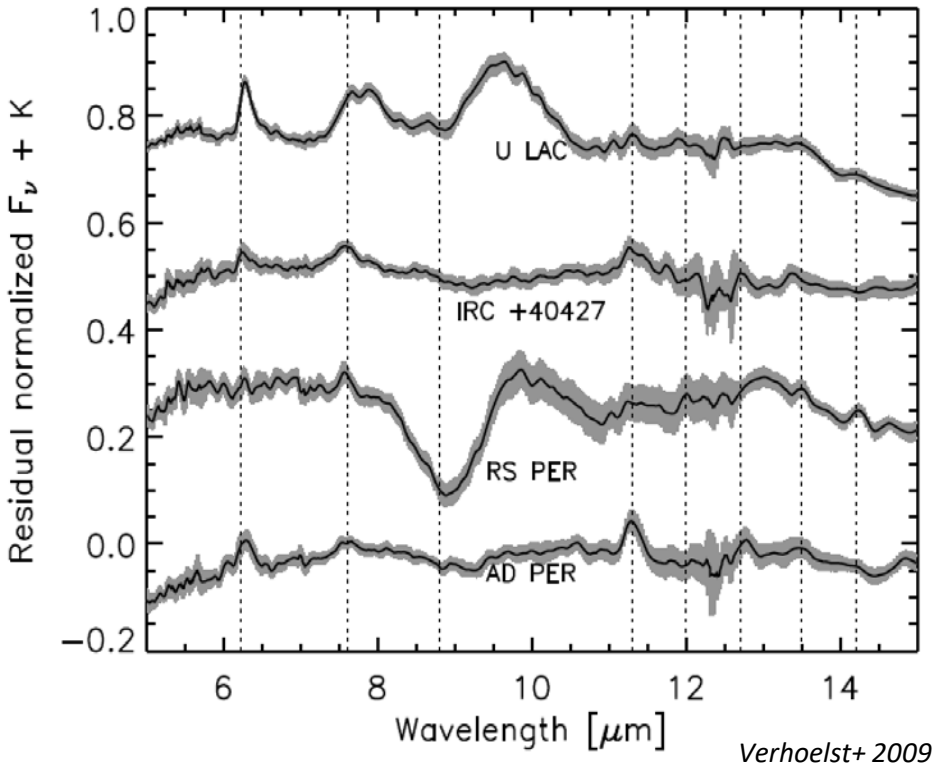


Emily Levesque: Research for a book on the adventures of observing

- Visits to Palmdale and New Zealand
- Flight, observations and aurora over Antarctica
- Thank you to everyone who made this happen!

Mid-IR spectroscopy of the dust around red supergiants

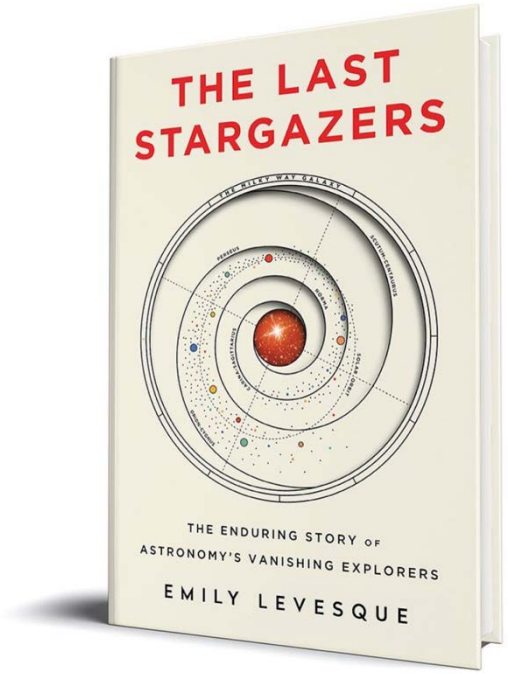




Verhoelst+ 2009

- Content and distribution of circumstellar dust
- RSG-driven contributions to ISM and enrichment
- Mass loss and environments of supernova progenitors

From Chapter 8, “Flying with the Stratonauts”:



Telescope operator Emily Bevins hit on a description of SOFIA that struck me as perfect. “It’s like a symphony,” she explained, with multiple well-rehearsed groups of people each contributing their own meticulously prepared parts to create a complex but cohesive piece of music.

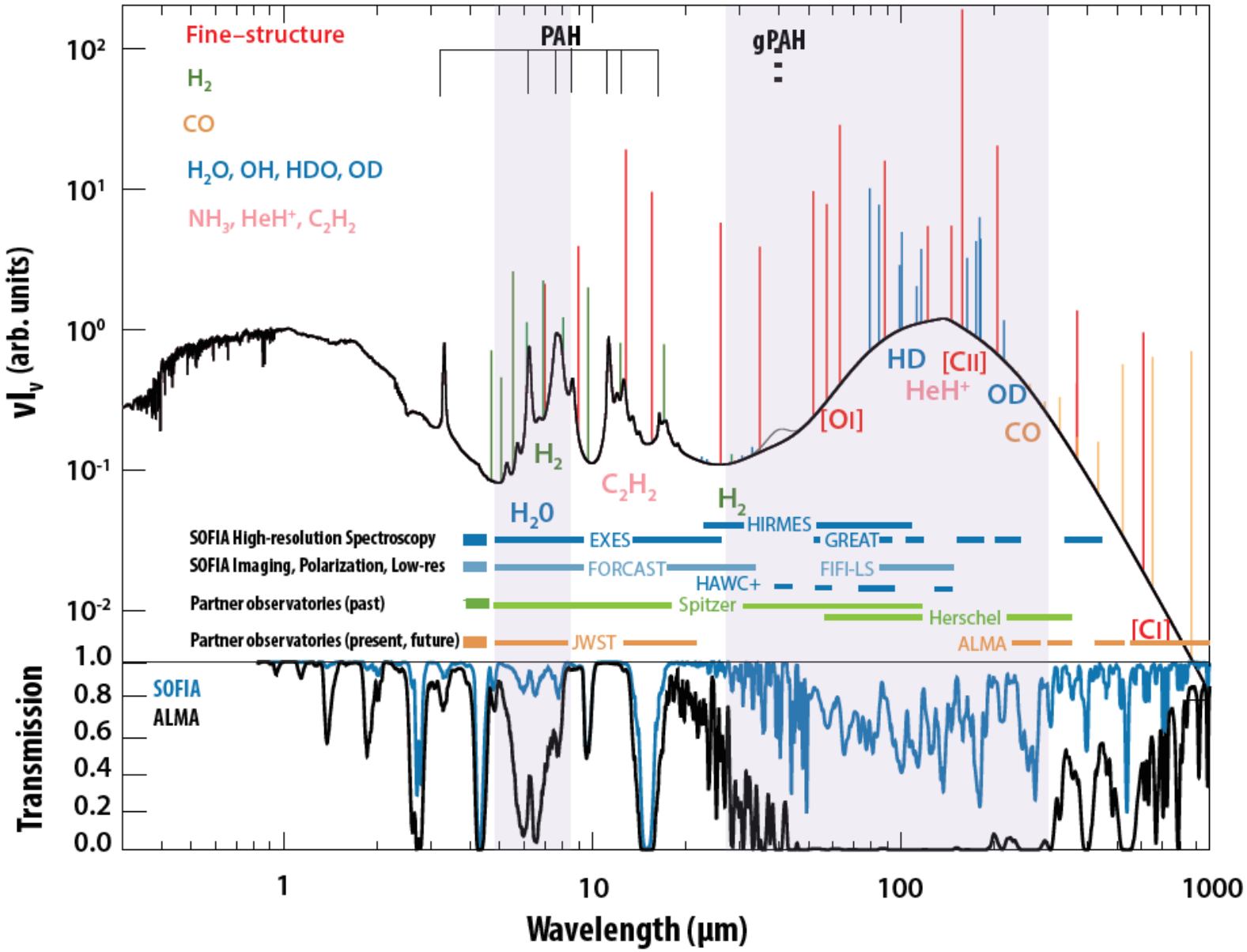
SOFIA Legacy Programs: Galactic Center mapping

Matt Hankins

Vision for SOFIA's Science Mission

- SOFIA holds a critical unique science capability for astronomers

SOFIA's Science Capability



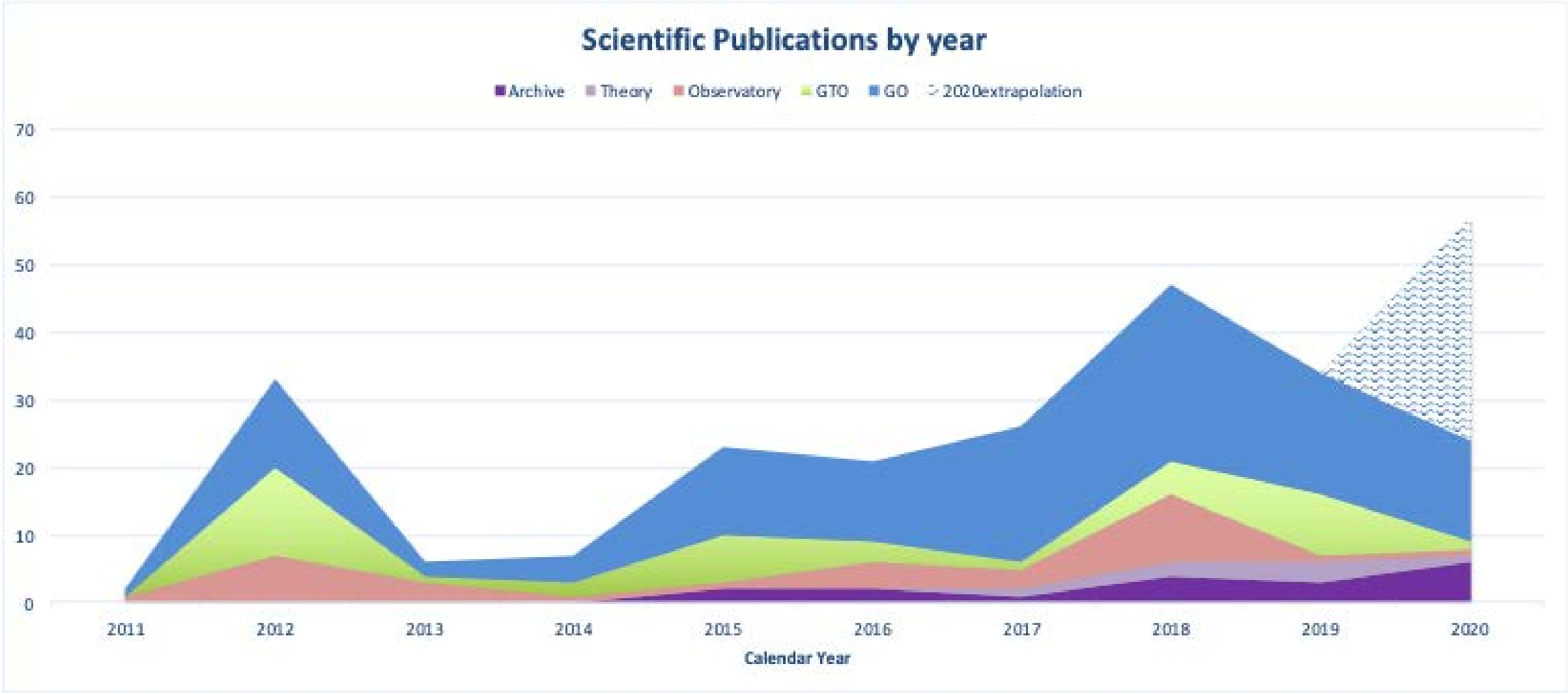
Vision for SOFIA's Science Mission

- SOFIA holds a unique, critical science capability for astronomers
- SOFIA has a hard working and dedicated staff – operational protocols are in place for operation this complex observatory

Vision for SOFIA's Science Mission

- SOFIA holds a unique, critical science capability for astronomers
- SOFIA has a hard working and dedicated staff – operational protocols are in place for operation this complex observatory
- FMR provides some clear guidance on where to make improvements
- SOFIA needs to invest and emphasize science, science, science - SMO's domain
- Community building is essential to SOFIA's future
- Partnerships on science with other NASA great observatories and assets to improve community engagement
- Working towards an automated data base for SOFIA metrics

Science Metrics: number of refereed publications



Strategy for publications:

- SOFIA observations provide unique data => discovery publications
- Pre-FMR initiatives
- Priority scheme was implemented in cycle-6 to boost program completion rate
- Contingency flights were added in cycle-6
- Legacy call for proposal was introduced in cycle-7

Measures	Productivity: Annual Publications
FY19	36
FY20- current #	33
FY20 Year-End Target	45
SMO goal by 2022	75

Strategy for publications:

- Cycle-8 (post-FMR)
- Better program selection
  - Higher priority programs
  - Improved technical evaluation process'
- Improve user and community support:
  - Higher completion rate, 80% goal
  - Decrease delivery time to get data to GO/Archive
  - Have a "Friend of the Project"

Measures	Productivity: Annual Publications
FY19	36
FY20- current #	33
FY20 Year-End Target	45
SMO goal by 2022	75

Strategy for publications:

- Increase community participation in SOFIA –
  - Transition to IRSA archive,
    - ADAP funded programs
  - legacy programs to fill archive
  - modify call for proposals (cycle-9)
    - Shorten proprietary period
    - Increase collaboration with other observatories
- ADAP successful proposals in FY20:
  - Goldsmith/JPL: SOFIA [OI] kinematics & abundance
  - Megeath/UofToledo: Protostellar Variability
  - Pineda/JPL: Electron Density & Nitrogen Abundance

Measures	Productivity: Annual Publications
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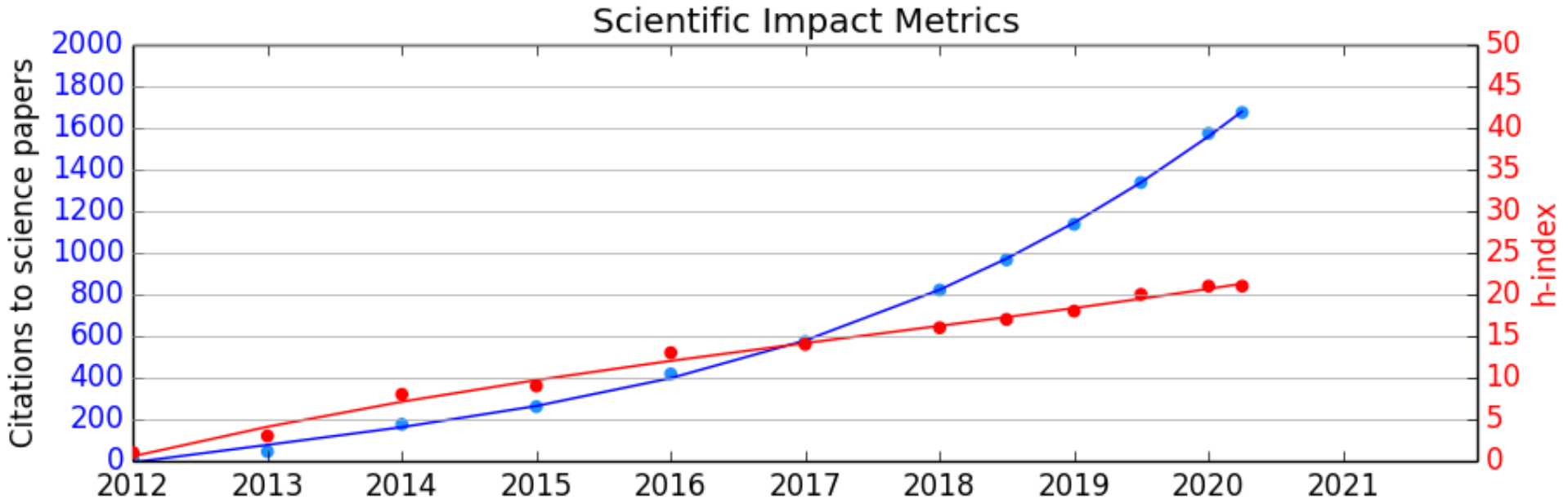
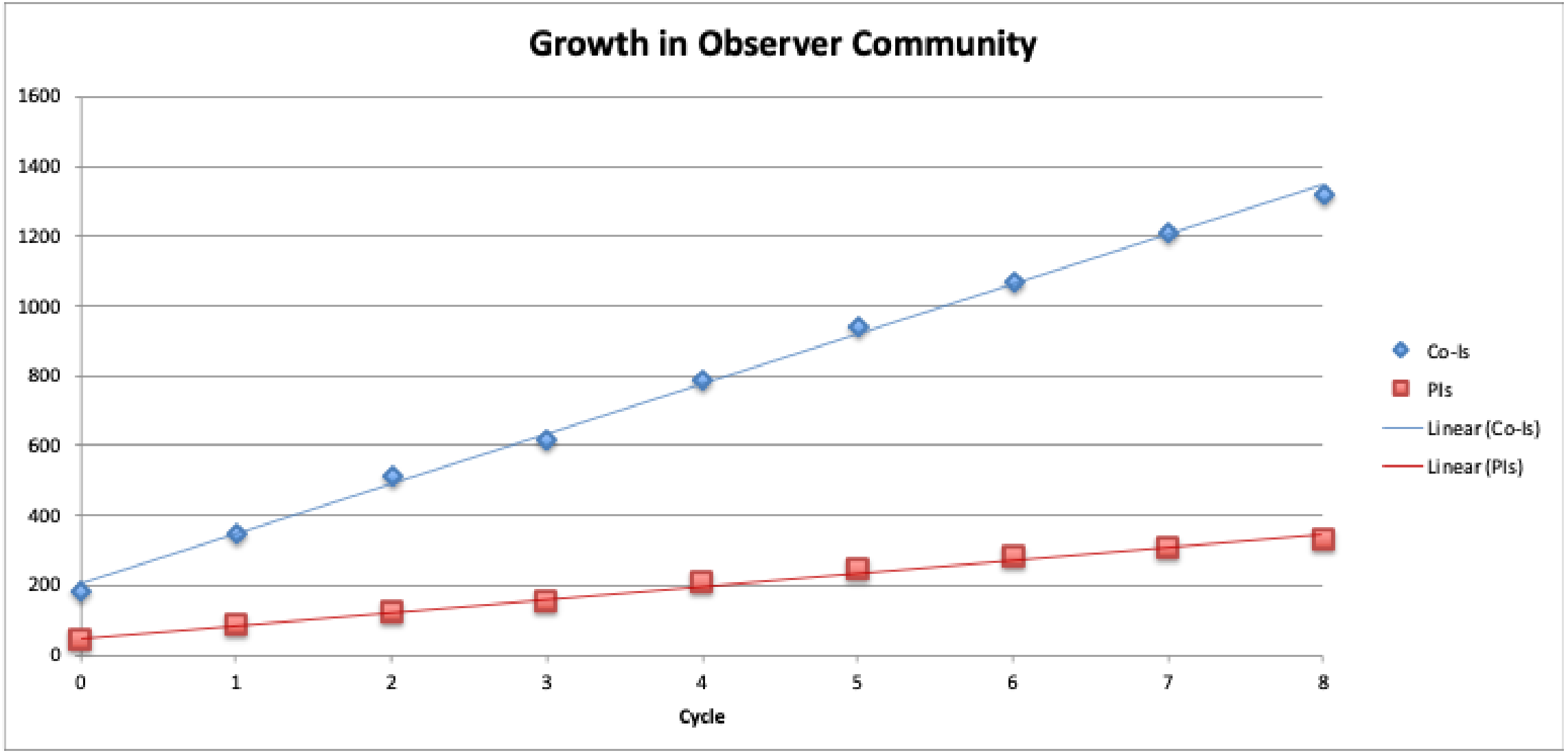
Science Metrics: Impact

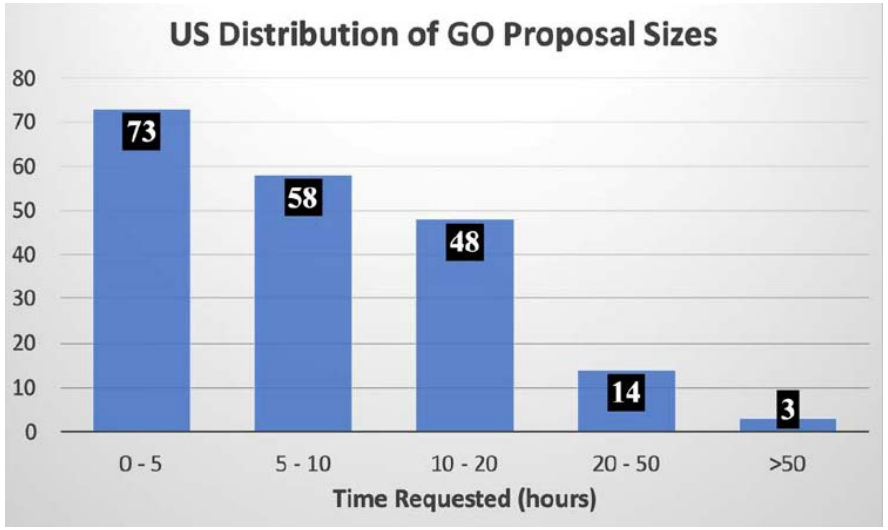


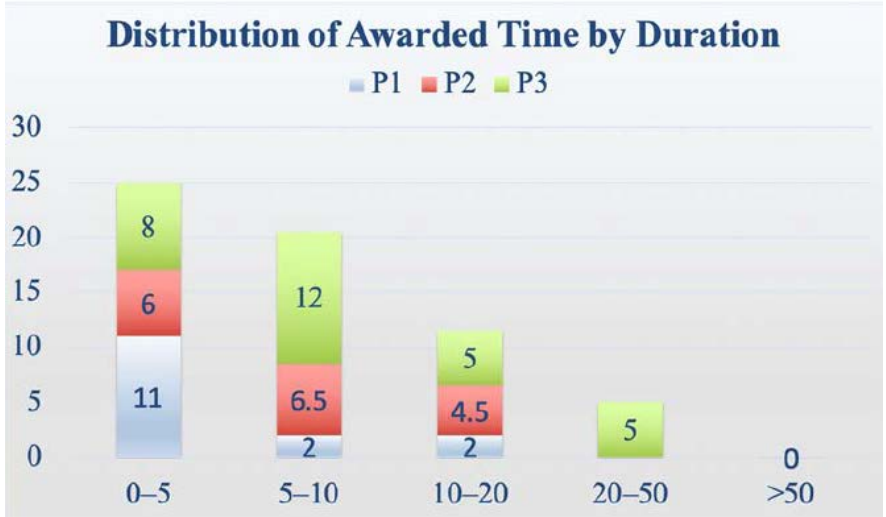
	1/1/12	1/1/13	1/1/14	1/1/15	1/1/16	1/1/17	1/1/18	6/30/18	1/1/19	6/30/19	1/1/20	3/30/20	6/30/20
Citations	8	45	176	261	418	573	821	966	1137	1338	1574	1674	
h-index	1	3	8	9	13	14	16	17	18	20	21	21	

Unique PI's and Co-I's have increased



Cycle-8 Selection Statistics





Grades of proposals on the program:

Priority 1: Excellent grades

Priority 2: Very Good to excellent grades

Priority 3 (filler – do if time): Good to Very Good

Legacy Programs in Cycle 8:
-Priority 1
-3 selected, 2 of these 3 as pilots

Cycle 9 Call for Proposals: Key Dates

Milestone	Date
Release (US GO)	June 2, 2020
Update on Website	July 17, 2020
Proposals Due	September 4, 2020 (9:00 pm PDT)
US TAC	October 14 – 16, 2020
Selections Announced	December 2020
Observing Period	July 6, 2021 – March 31, 2022

Changes from Cycle 8

- **Accepted proposals stay “live” for two years.**
  - **Mitigates confusion over resubmission of proposals for active programs that may yet be observed in current Cycle.**
  - **Allows for flexibility for more optimal scheduling and planning**
  - **Maintains richer “filler” target pool**
- Dual-Anonymous Review
- Modes to improve observing speed and efficiency
  - FIFI-LS Total Power and On-the-Fly modes, shared risk
  - GREAT “honey-comb” On-the-Fly mapping mode
  - GREAT: dual wavelengths at LFA array, e.g. [CII] 158 µm & [OI] 145 µm
  - HAWC+ Band B (63 micron) filter, shared-risk

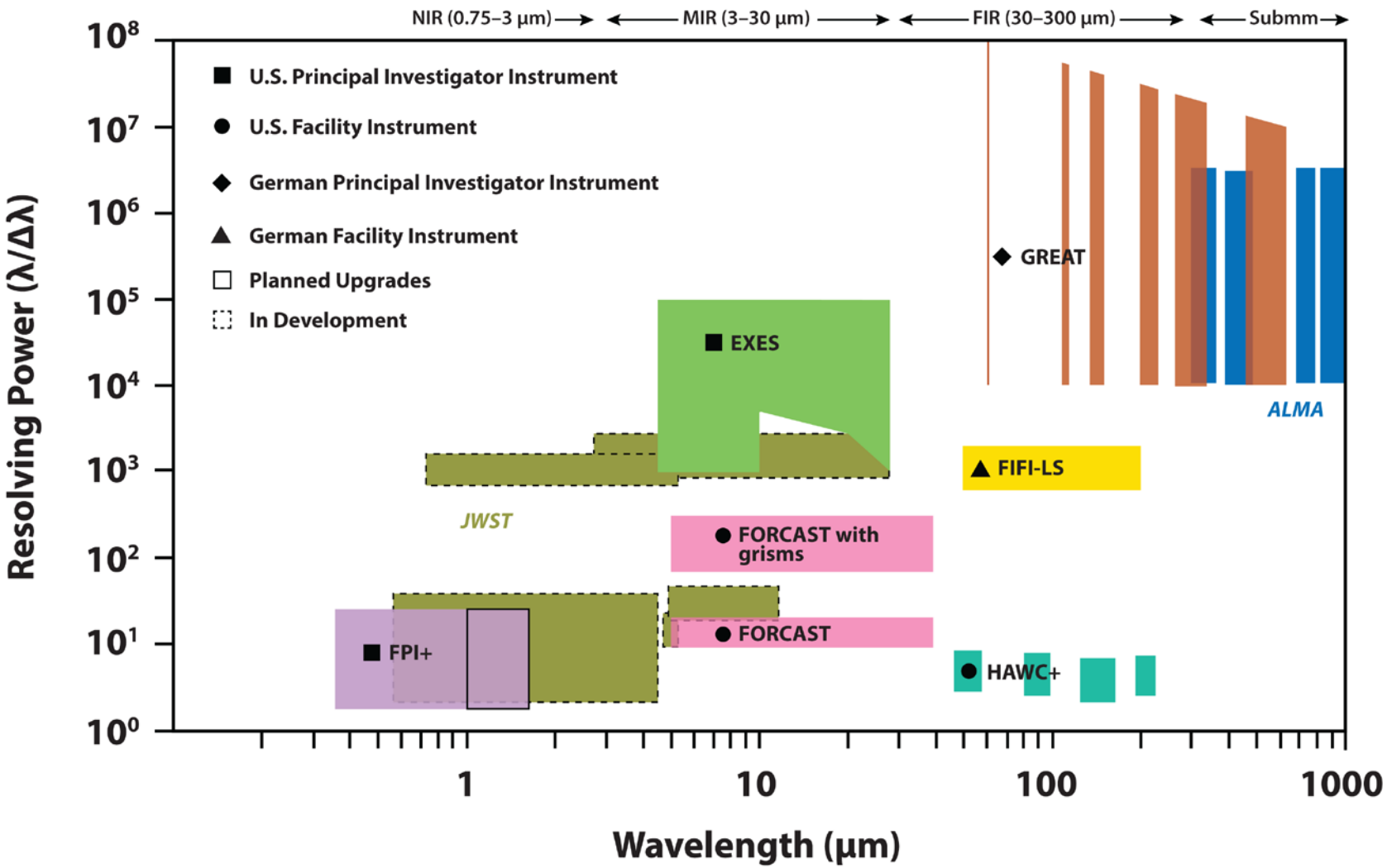
Changes from Cycle 8 (continued)

- **JWST Early Release Science support observations**
- **Joint Call for Proposals with Green Bank Observatory**
- **Proprietary period 6 months; 1 year if Thesis**
- Southern Deployment Plan specified
  - Long deployment: late-July to mid-September 2021 with GREAT and HAWC+
  - Short (“suitcase”) deployment: March 2022 with FIFI-LS
- Two-Step Legacy Proposal process (Pilot first, then full-blown project) is encouraged

Legacy Proposals

- Legacy proposals are important to the astronomy community and are part of our Cycle 9 call.
- Build up the archive for ADAP proposals
- Virtual Legacy workshop: June 30 11:00 am to 12:30 pm EDT

The SOFIA Instruments



Instrument Roadmap

- An opportunity to enlarge the SOFIA community
- The HIRMES instrument project has been canceled by NASA.
- HIRMES detector development may continue under separate funding.
- The SMO has been charged by NASA to develop an Instrument Roadmap for the next 5-10 years.
- To gather community input, SOFIA will hold TWO workshops: https://www.sofia.usra.edu/science/instruments/instrument-development/workshop-building-2020-2025-instrument-roadmap
  - June 22 to 24. workshop 1 science drivers
  - July 27 to 29. workshop 2. instrument requirements

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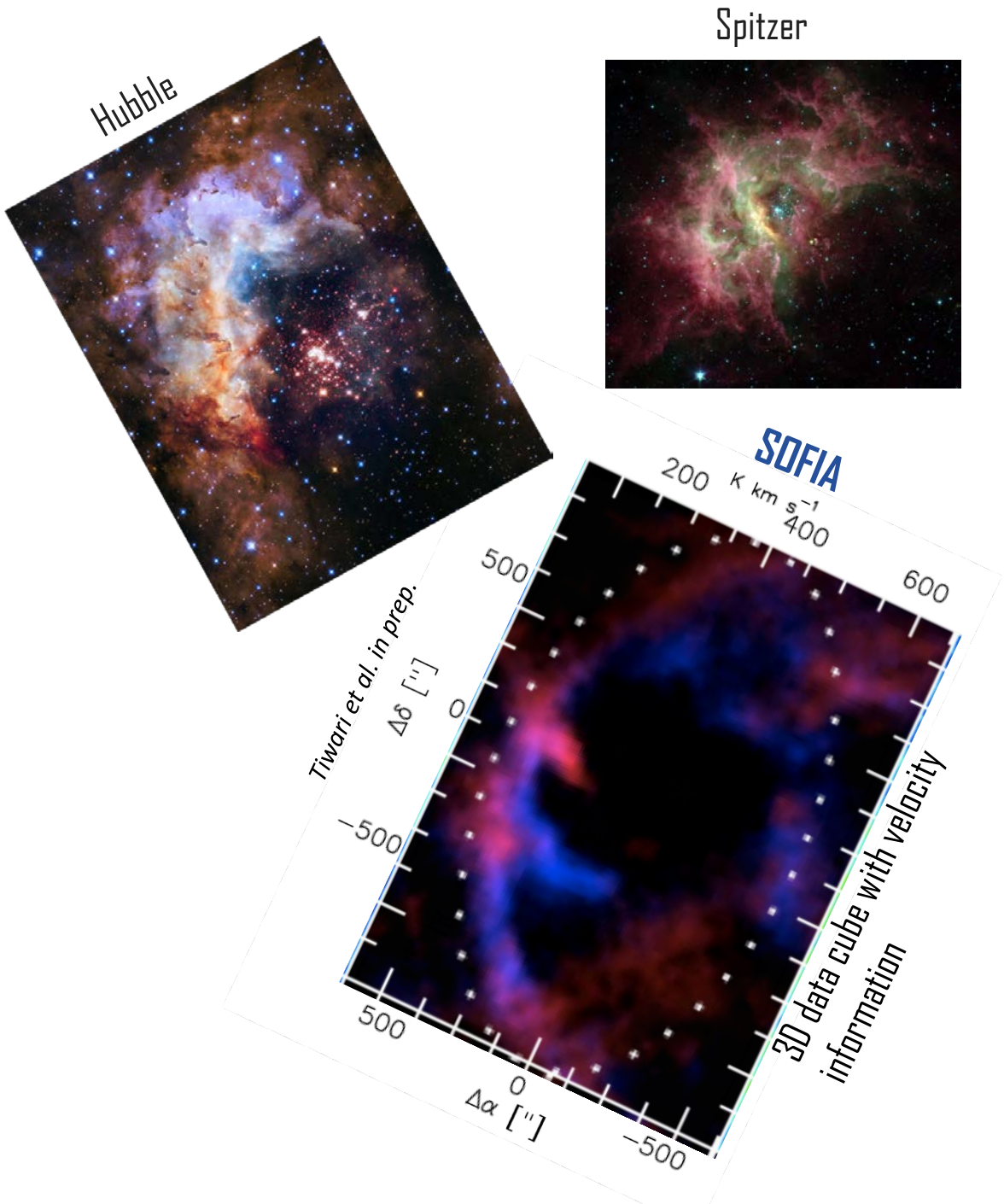
NASA DLR USRA DSI



SOFIA FEEDBACK Legacy Program

Alexander Tielens
Nicola Schneider

How do massive stars regulate star formation?

How do molecular clouds assemble and dissolve and how does this relate to star formation and nearby massive stars?

Radiative & kinematic interaction of massive stars with their environment drives the evolution of the Interstellar Medium and the evolution of galaxies.

SOFIA GREAT [CII] survey of 11 regions of massive star formation to study feedback on scales of a single star, few stars, stellar group & a mini starburst.

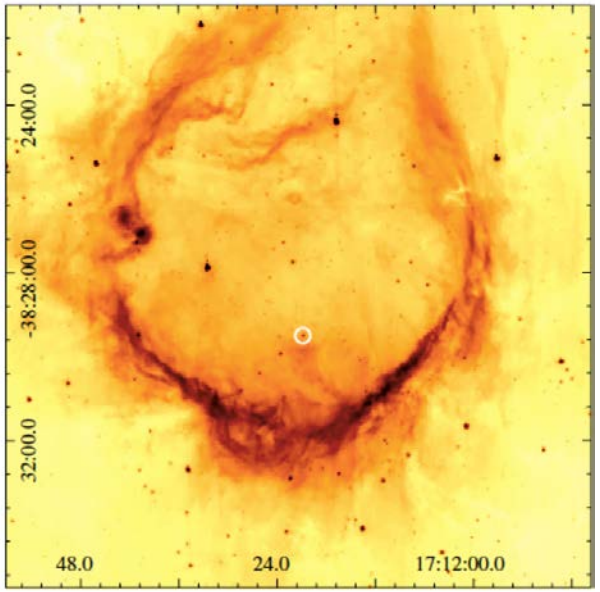
SOFIA
Stratospheric Observatory for Infrared Astronomy

Southern Hemisphere Opportunities

Presented by:

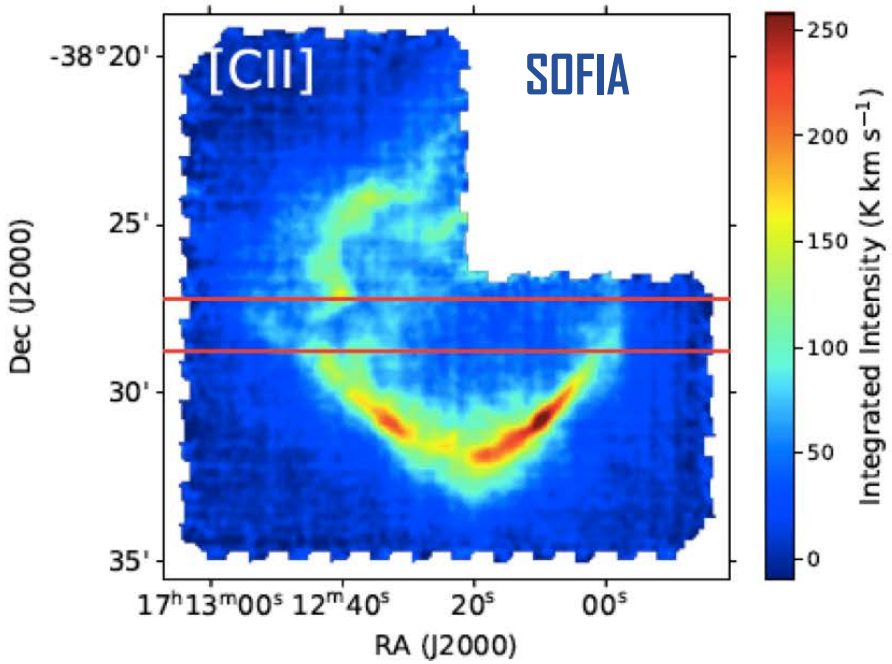
SOFIA Project Scientist
Naseem Rangwala

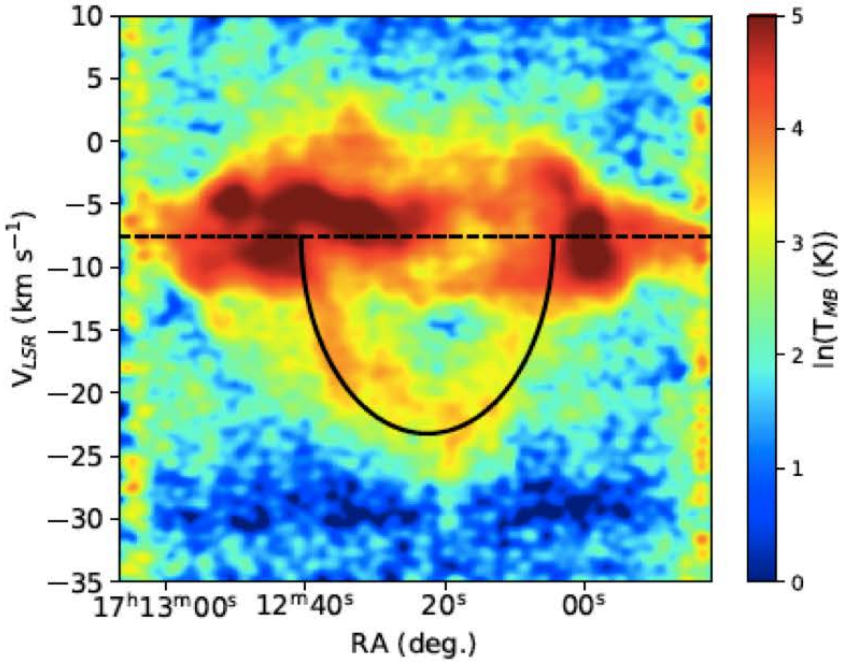
GLIMPSE/Spitzer



The stellar wind from the single O8 star (white circle) has created a bubble filled with a million-degree plasma and photo-ionized gas

SOFIA reveals a few hundred $M_\odot$ shell expanding at ~15 km/s





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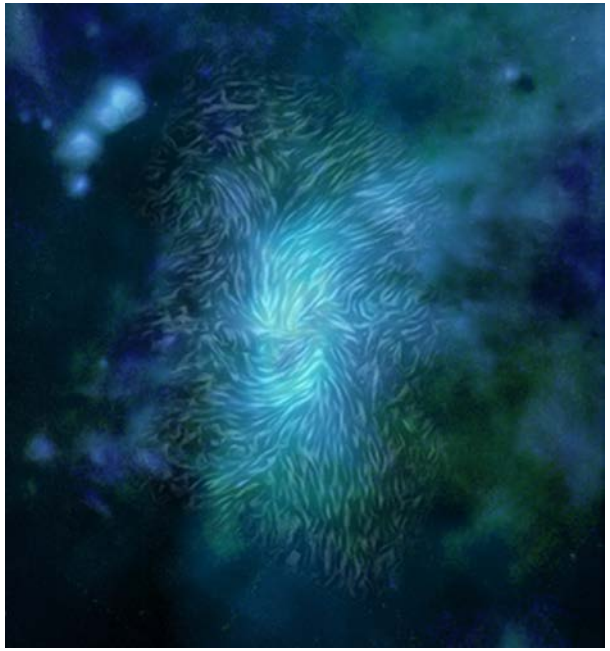
SOFIA Southern Hemisphere 2020 Deployment Status

Project/Observatory Status:

- SOFIA suspended operations on March 19, 2020 due to COVID-19
- SOFIA started maintenance work to prepare the observatory for return to science operations in July
- The SOFIA Science Center remains active. Services such as data pipeline operations, the helpdesk, and user support are fully functioning.
- A 28-flight Southern Hemisphere deployment was planned with the GREAT instrument for July & August.
- Project made the decision on June 11th to cancel the New Zealand deployment due to COVID-19 restrictions
  - SOFIA team explored & evaluated multiple options
  - 14-day strict quarantine in New Zealand is mandatory
  - International travel constraints
- Near-term science observing plan in lieu of New Zealand deployment
  - Planning underway to complete the high-priority programs from Palmdale
  - Planning will focus on maximizing observing opportunities and program completion

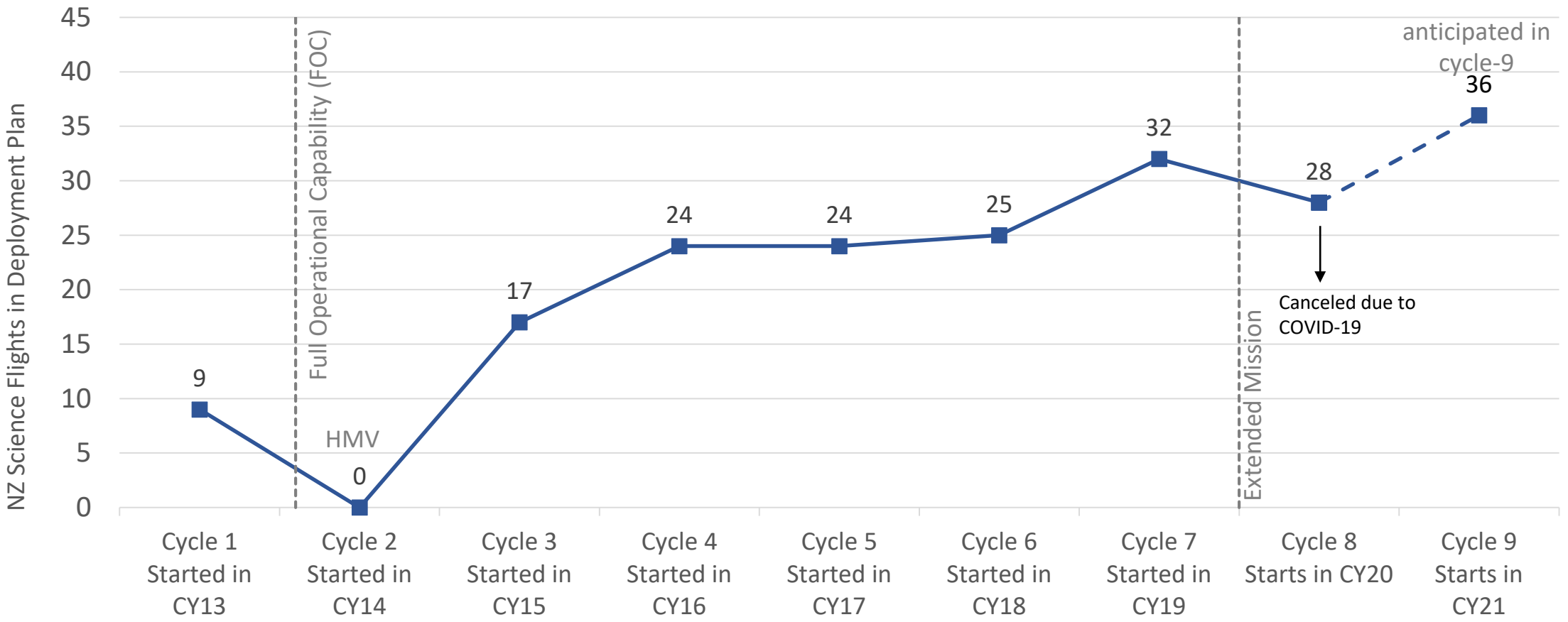
SOFIA Observatory Science Operations/Planning



Composite image of central region of our Milky Way galaxy. SOFIA found that magnetic fields, shown as streamlines, are strong enough to control the material moving around the black hole, even in the presence of enormous gravitational forces. This can help answer long-standing, fundamental questions about the galactic center region: why the star formation rate is significantly lower than expected and why our galaxy's black hole is quieter than those in other galaxies. SOFIA data is shown in green (37 microns) and dark blue (25 and 53 microns). The light blue is from Herschel Space Observatory (70 microns) and the gray is from the Hubble Space Telescope. Credits: NASA/SOFIA/L. Proudfit; ESA/Herschel; Hubble Space Telescope

- SOFIA has a healthy proposal pressure for both Northern and Southern Hemisphere skies
- SOFIA receives high-quality, high-impact proposals for both Hemispheres
- Operationally, we get excellent observing conditions (>90% of the time) in both hemispheres, but during different times of the years
  - For Palmdale, November – April is ideal; October & May are reasonably good
  - For New Zealand, May – September is ideal
- SOFIA's primary operations base is Palmdale, CA
- Operations move to New Zealand in the austral winter (Northern Hemisphere summer)
  - Allows access to key Southern Hemisphere targets such as the Galactic center and the Magellanic clouds
  - Excellent (dry) observing conditions during the Northern Hemisphere summer when conditions from Palmdale are not ideal
- Our planning and scheduling tries to maximize and optimize the overall science program aimed at maximizing science productivity, impact and data quality.

SOFIA's Increasing Footprint in the Southern Skies



Cycle-9 Call for Proposal, SOFIA is offering a long and a short deployment
Long Deployment: GREAT and HAWC+ instruments (July - September 2021)
Short Deployment: FIFI-LS (March 2022)

Chart Revision: 3-June-2020

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