SOFIA's Status: SOFIA Users Group May 2022 meeting

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May 24, 2022

SOFIA Stratospheric Observatory for Infrared Astronomy

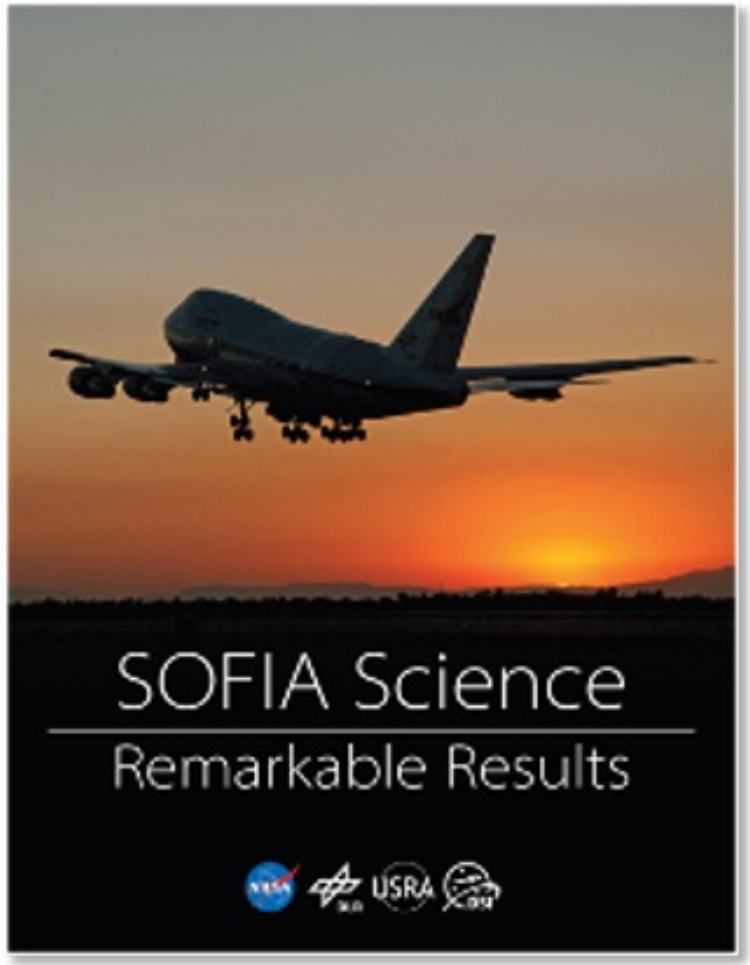
Start	End	Time	Item	Presenter
8:30 AM	9:05 AM	0:35	Welcome and Update on Decadal/Senior Review and FY22 funding	Meixner
9:05 AM	9:35 AM	0:30	Project Update	Rangwala
9:35 AM	9:55 AM	0:20	Cycle 10 and SARP (process/results/plans)	Andersson
9:55 AM	10:25 AM	0:30	Preservation of SOFIA Legacy and Auxiliary Data	Chambers
10:25 AM	10:35 AM	0:10	break	break
10:35 AM	10:55 AM	0:20	Santiago deployment update/report	Reach
10:55 AM	11:15 AM	0:20	LAH Conference, workshops, Outreach update	Moullet
11:15 AM	11:35 AM	0:20	Collaborative efforts (GBT, IRTF, JWST, ALMA etc.)	Andersson
11:35 AM	12:20 PM	0:45	break	break
12:20 PM	12:50 PM	0:30	Future	Meixner
12:50 PM	2:20 PM	1:30	Executive Session	SUG members only
2:20 PM	2:50 PM	0:30	Debrief	All

Outline

- Science Update & progress
- SOFIA timeline of decisions
- Decadal on Far-IR observatories
- SOFIA closeout plan elements
- Response to SUG recommendations & comments from SUG19

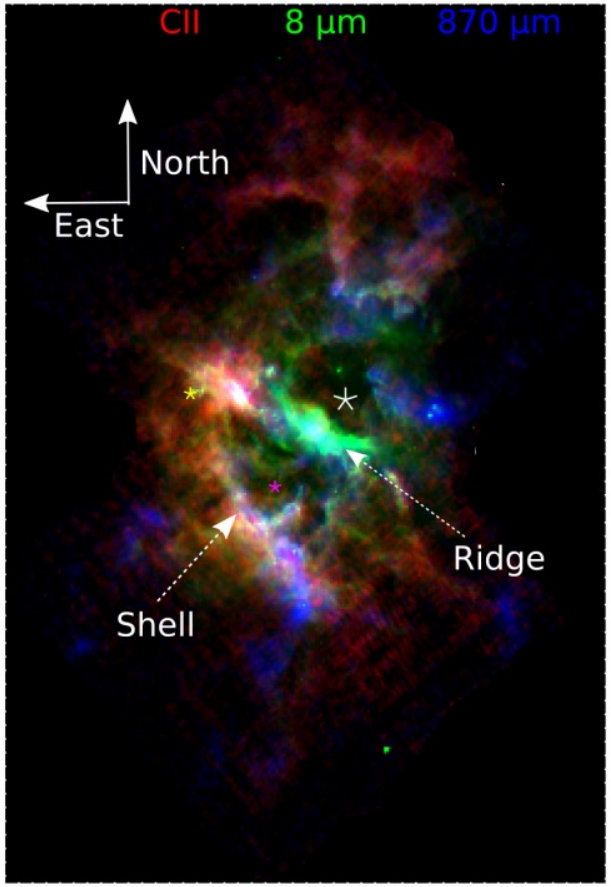
SOFIA Science

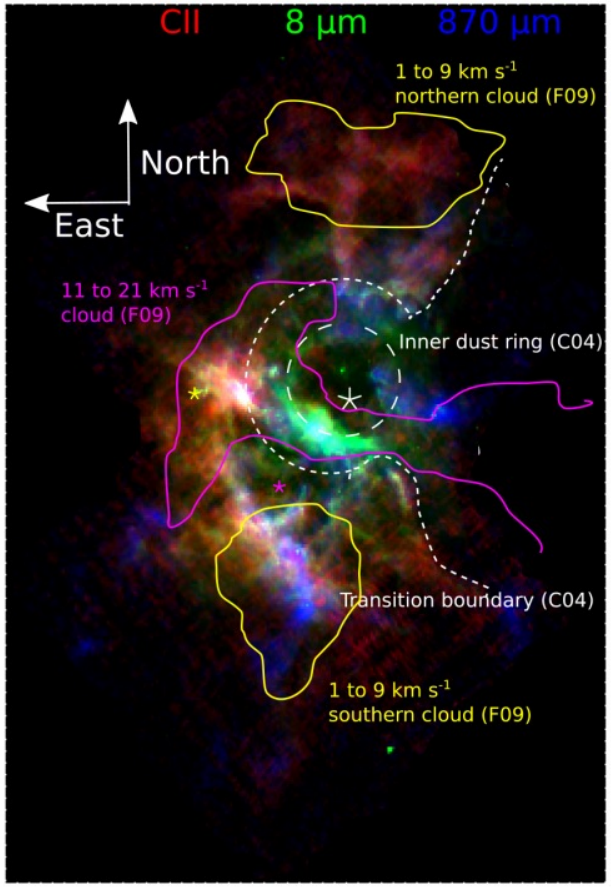
- SOFIA's efficiency and science productivity have been on the right trajectory for SOFIA to achieve its full scientific potential.
- Annual publication rates for SOFIA have doubled over the past three years on topics ranging from the Earth to high-z galaxies.
  - https://www.sofia.usra.edu/sites/default/files/2021-11/SOFIA-Science-2021.pdf
- Legacy Science Programs are 30% of SOFIA schedule.



FEEDBACK:
co-PIs: Tielens & Schneider

- F-Q1: How do star-forming structures arise from, and interact with, the diffuse interstellar medium?
- GREAT maps of [CII] 158 μm and [OI] 63 μm in 11 regions
- Studying massive stellar feedback in star-forming regions
- M16: Eagle nebula
- Will be 90% complete



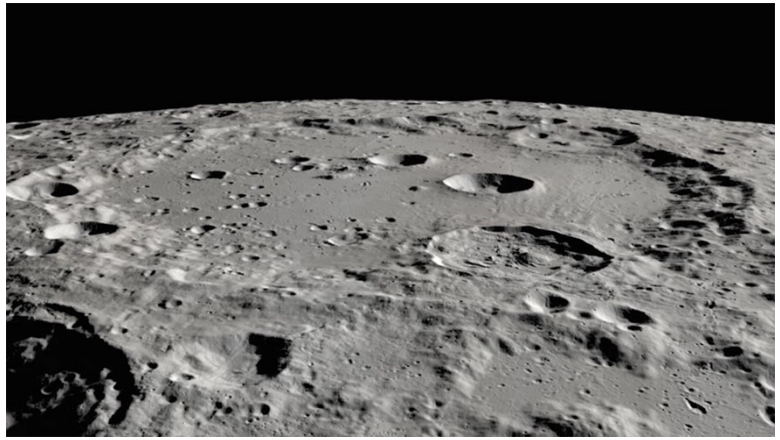


GalMag: Magnetic Fields of Galaxies,
PI: Lopez-Rodriguez, HAWC+, will be >50% Complete

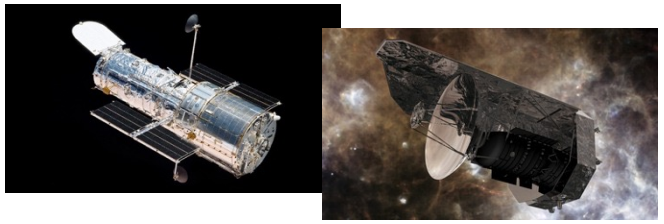
- D-Q2: How do gas, metals, and dust flow into, through, and out of galaxies?
- F-Q1: How do star-forming structures arise from, and interact with, the diffuse interstellar medium?

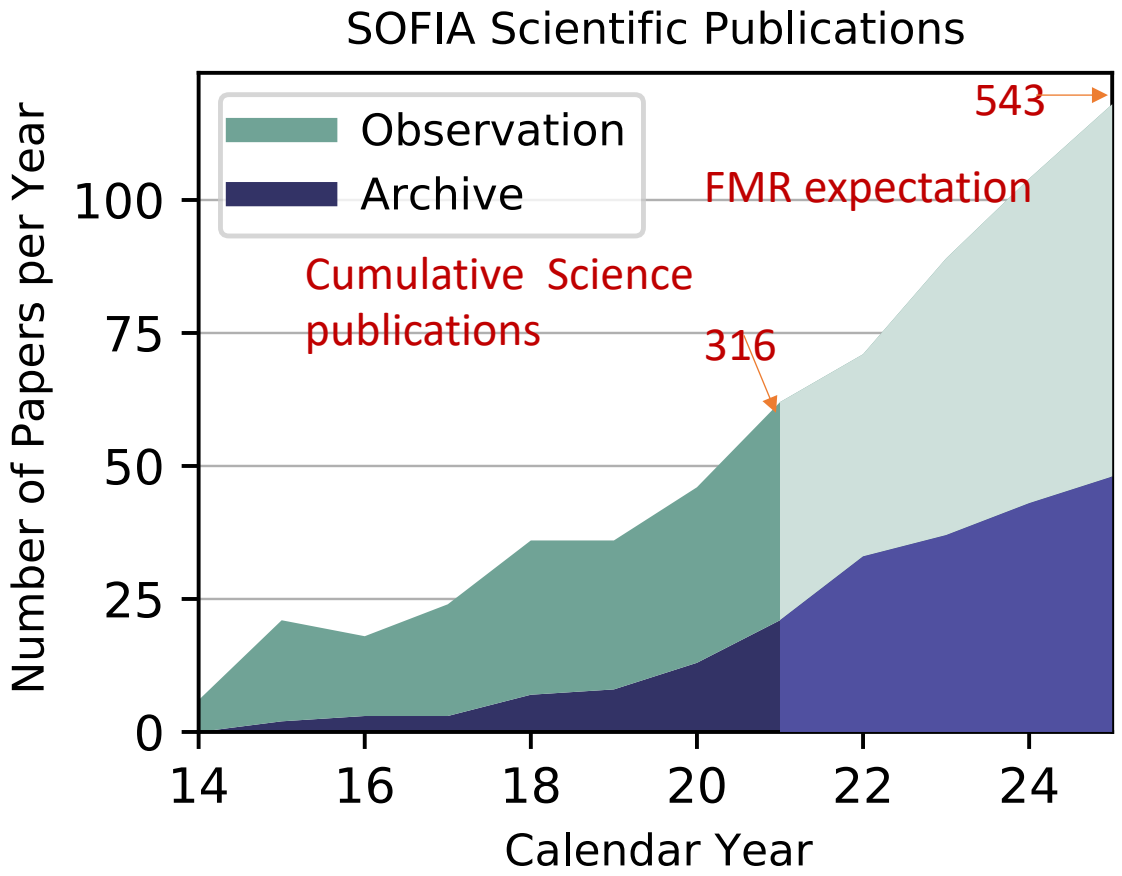
Lunar: Water on the Moon Legacy Program,
PI: Lucey, will be 42% complete

- FORCAST Grism
- Follow-up to first direct detection of molecular water on the sunlit surface
- study the distribution of water across the lunar surface
- E-Q3: How do habitable environments arise and evolve with-in the context of their planetary systems?



SOFIA vs. space missions





- SOFIA's science publications (316) are significantly higher than the science return from far-IR balloon programs (8).
- SOFIA has been compared to Hubble, a mature robotic space mission (~30 years) with a substantial archive.
- A better comparison is with Herschel, a recent far-IR mission that provided 23,500 hours and produced 2145 publications within 8 years of launch.
- SOFIA has observed for 3458 hours and produced 316 science publications within 8 years of science operations start.
- SOFIA (10.9 hr/paper) is the same as Herschel (11 hr/paper) in paper-writing efficiency.

SOFIA: far-IR observatory for this decade

- SOFIA has transformed over the past 2 years, with tremendous growth in science productivity,
  - https://www.sofia.usra.edu/SOFIA-Status-and-Future-Prospects
- SOFIA advances Astro2020 science addressing **one half** of the decadal science priorities in all three science themes
  - Cosmic EcoSystems,
  - Worlds and Suns in Context,
  - New Messengers and New Physics.
- The **SOFIA community (2138 strong and growing)** can exploit the opportunity SOFIA provides to train the next generation of astronomers and instrument builders who will define, develop, and use the future far-IR space observatories described in the Astro2020 report.

SOFIA SCIENCE TRACEABILITY MATRIX

Decadal Science Questions †	Key Measurements	SOFIA Instruments	SOFIA Observations
HOW DID WE GET HERE? COSMIC ECOSYSTEMS			
F-Q1: How do star-forming structures arise from, and interact with, the diffuse interstellar medium?	[C II] 158μm, [O I] 63 & 145μm, light hydrides, kinematics & Far-IR polarimetry	GREAT, FIFI-LS, HAWC+, *THzMap	FEEDBACK, HyGal, LMC+, GalMag, C+SQUAD
F-Q2: What regulates the structure and motions within molecular clouds?	[C II] 158μm, light hydrides, Far-IR polarimetry at 0.1 pc	HAWC+, GREAT, *THzMap	SIMPLIFI, GalCen, HyGal
F-Q3: How does gas flow from parsec scales down to protostars and their disks?	Far-IR polarimetry at 0.1 pc, Mid/Far-IR variability & high-res spectroscopy	HAWC+, EXES, GREAT, FORCAST, FIFI-LS, *DirectDet	FIELDMAPS, SIMPLIFI, HyGal
D-Q2: How do gas, metals, and dust flow into, through, and out of galaxies?	[C II] 158μm, light hydrides, [O III] 88μm, Far-IR polarimetry <200 pc	GREAT, FIFI-LS, HAWC+, *THzMap, *DirectDet	HyGal, GalMag, LMC+
D-Q4: How do the histories of galaxies and their dark matter halos shape their observable properties?	[C II] & [O III] in galaxies (< 200pc), [^{13}C II]	GREAT, FIFI-LS, *THzMap	M51, LMC+, Galaxies

https://www.sofia.usra.edu/sites/default/files/2022-01/SOFIA_Traceability_Matrix.pdf

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ARE WE ALONE? WORLDS AND SUNS IN CONTEXT

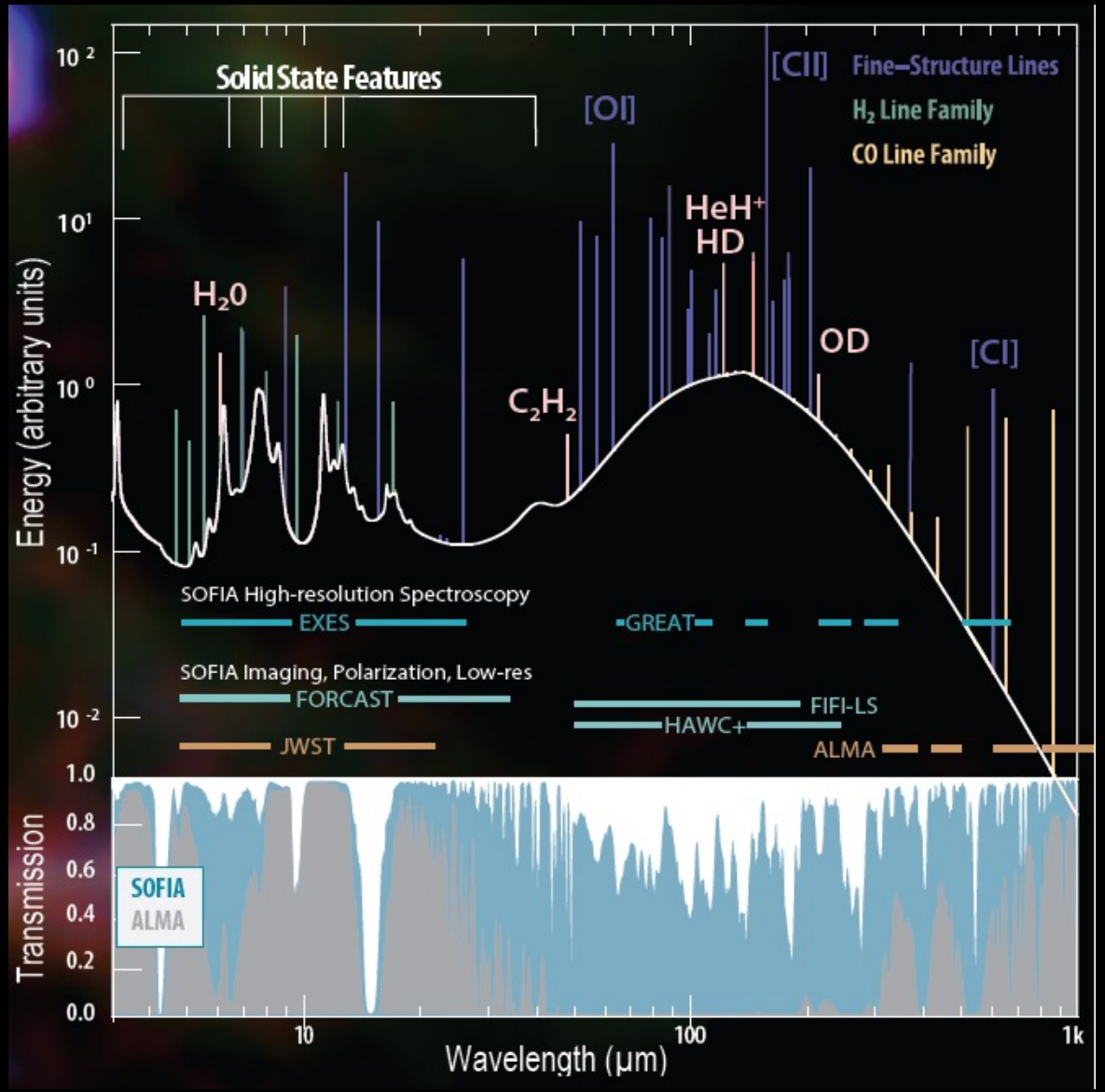
E-Q3: How do habitable environments arise and evolve within the context of their planetary systems?	6μm H_2O, [O I] 63μm, PH_3, D/H ratio from HDO	FORCAST, EXES, GREAT	Lunar, Europa, Earth, Venus, Comets
F-DA: Detecting and characterizing forming planets	D/H ratio from HD	FORCAST, EXES, *DirectDet	Jupiter
E-Q2: What are the properties of individual planets, and which processes lead to planetary diversity?	R~10^5 spectroscopy of H_2 and organics, seasonal variation, occultations, high-speed (<0.1s) photometry, atmospheric haze evolution	FORCAST, EXES *DirectDet, FPI+,	Titan, Jupiter, Pluto, Triton
G-Q2: How does multiplicity affect the way a star lives and dies?	Mid/Far-IR photometric variations *Time Domain*	FORCAST, HAWC+	Stellar Mergers
G-Q3: What would stars look like if we could view them like we do the sun?	Mid/Far-IR photometry & spectroscopy, multi-epoch data *Time Domain*	FORCAST, FIFI-LS, GREAT, *DirectDet	Evolved Stars
E-Q1: What is the range of planetary system architectures and is the configuration of the solar system common?	Mid-IR photometry variation *Time Domain*	FORCAST	Debris Disk
F-Q4: Is planet formation fast or slow?	HD 112μm velocity-resolved of proto-planetary disks for gas mass	*DirectDet	Proto-planetary Disks

HOW DOES THE UNIVERSE WORK? NEW MESSENGERS AND NEW PHYSICS

B-DA: Transforming our view of the universe by combining new information from light, particles, and gravitational waves	Mid/Far-IR photometric variations *Time Domain*	FORCAST, EXES, HAWC+, FIFI-LS, GREAT	Supernovae
B-Q4: What seeds supermassive black holes and how do they grow?	Far-IR polarimetry, Mid-IR photometry, Far-IR R ~10^6 spectroscopy	FORCAST, HAWC+, GREAT	Galactic Center
D-Q3: How do supermassive black holes form and how is their growth coupled to the evolution of their host galaxies?	Far-IR photometry	HAWC+	High-z Galaxies

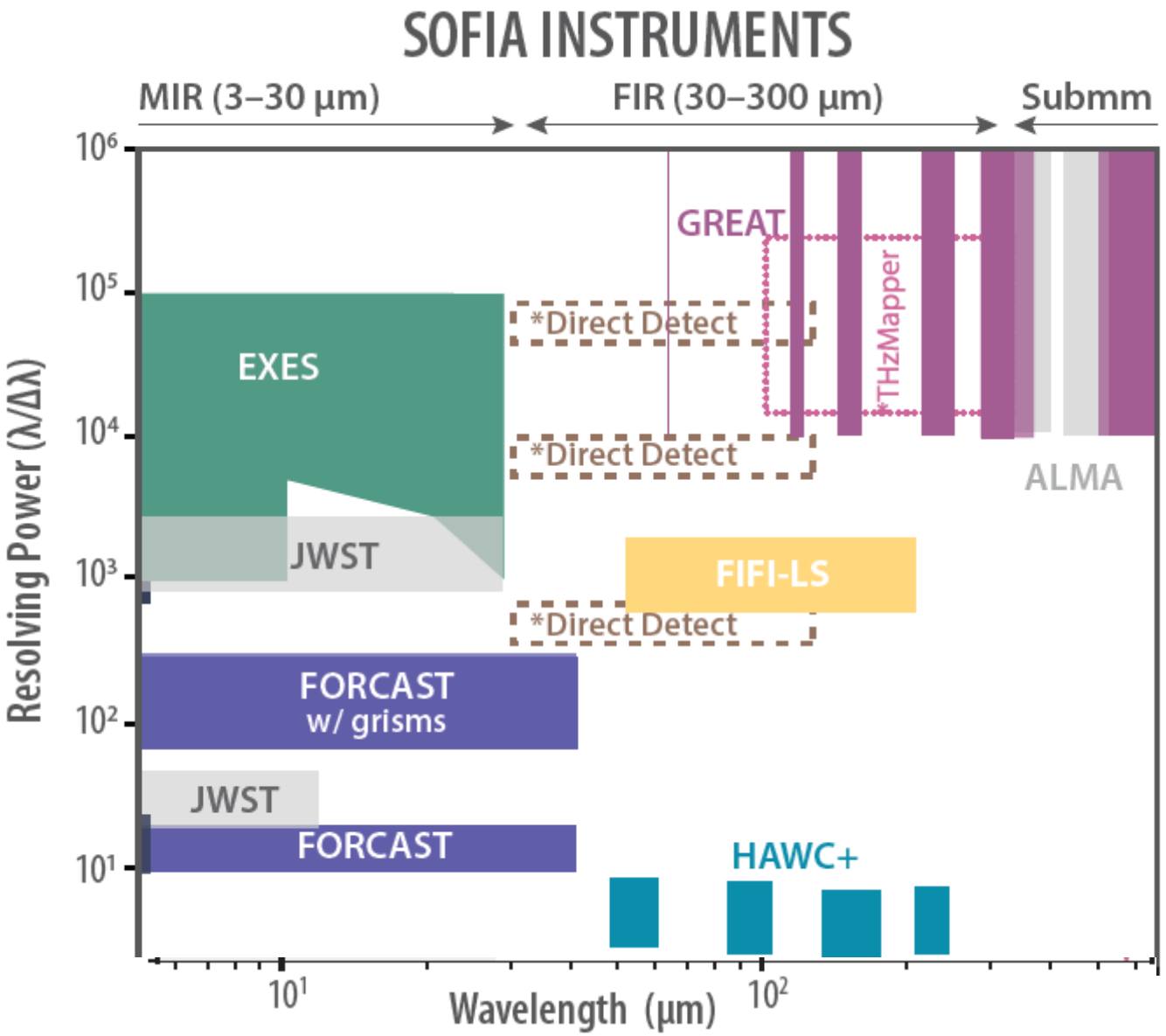
† Table 2.1 of Astro2020 Report *THzMap and *DirectDet are potential future SOFIA instruments SOFIA Legacy Programs

https://www.sofia.usra.edu/sites/default/files/2022-01/SOFIA_Traceability_Matrix.pdf



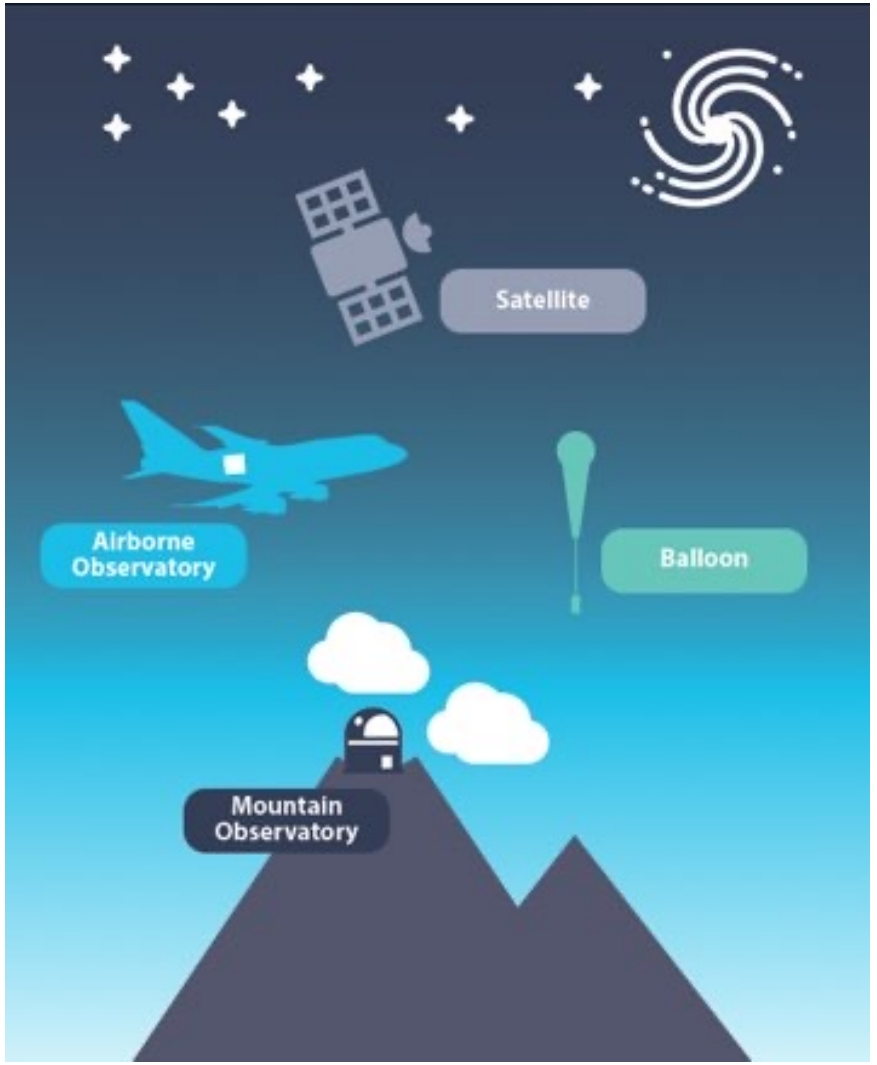
SOFIA flies above 99.99% of atmospheric water vapor

SOFIA Instruments are Complementary to JWST and ALMA



SOFIA is an important sub-orbital mission

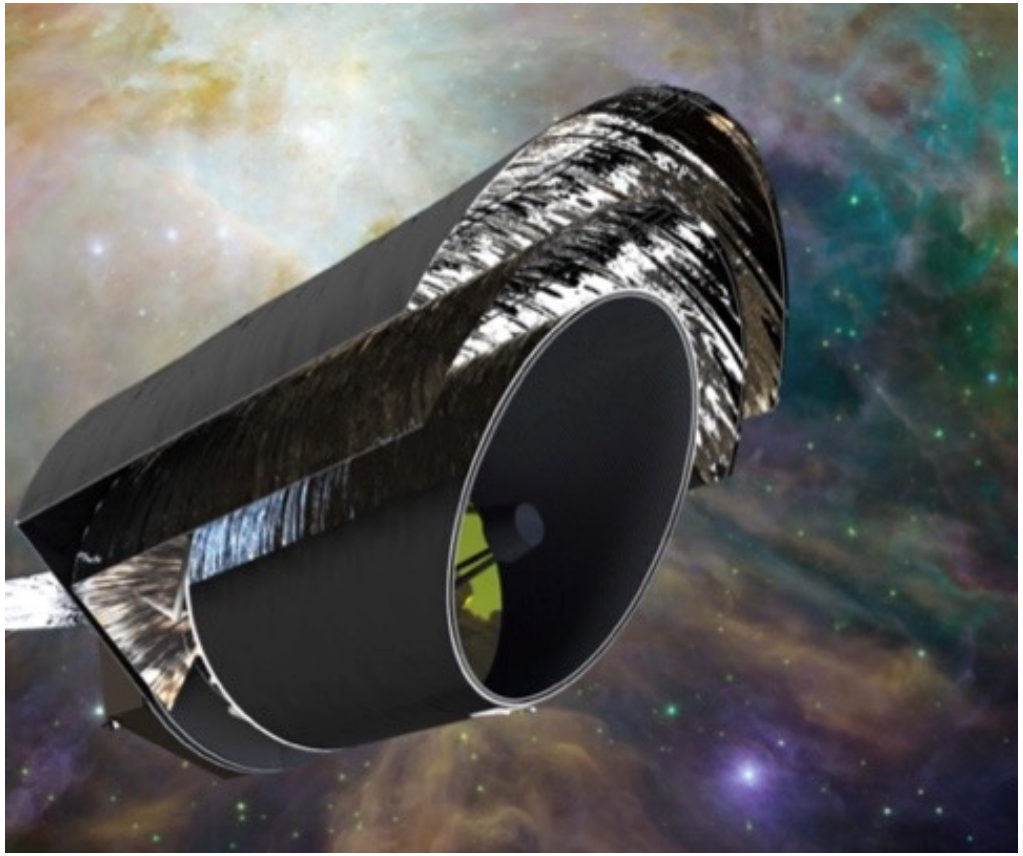
- Suborbitals such as SOFIA have been essential to further science and technology to be used in the Astro2020 space missions.
- The balloon program, which is another suborbital portfolio, focuses on PI-driven far-infrared observations
- Far-IR technology developed in balloon platforms have been applied in a more capable instrument on SOFIA which has larger aperture, power, mass and volume envelopes and has been a repeatable and reliable platform.
- Astro2020 requests a technology maturation plan for the Great Observatories.



SOFIA timeline of decisions in FY22

- SOFIA senior review proposal preparation: April 2021 to January 2022
  - Red team version completed end of October 2021
- Decadal report released November 4, 2021, senior review proposal was updated with Decadal material by early January.
- SOFIA presents virtually its townhall early January (same time as AAS but on our own).
- January 14, NASA HQ pulls SOFIA from senior review proposal submission because it decided to use Decadal recommendation in its planning process.
- April 2022: NASA and DLR announce plans to finish SOFIA operations by September 30, 2022.

Decadal on Far-IR observatories



- Far-IR is an important wavelength range
- Recommends next fleet of Great Observatories including a far-IR observatory such as Origins Space Telescope (30+ years out)
- Recommends a technology maturation plan for these great observatories
- Recommends a probe line with first probe call for either a far-IR or X-ray probe; 10+ years away
- Recommends termination of SOFIA by 2023 due to lack of science productivity (based on pre-June 2021 information).
- There will be a 10+ years gap in Far-IR observatory capability.

SOFIA Closeout plan elements:
proposed, not final

- Assume flights end by September 30, 2022
  - Maximize completion of legacy programs
  - Built into SOFIA scheduling is a 2 year time period to ensure completion of high priority programs
  - SOFIA will not complete Cycle 9 programs:
    - We have obtained 45% but will finish at most 74% of high priority programs with summer deployment.
  - Planning to complete 4 legacy programs from Cycle 7 to 9
  - Cycle 10 selection completed, but will not be released, not started except as filler for Cycle 9
- Instrument decommissioning and securing of Federal property – Palmdale
- Instrument software and flight planning software collected, finalized documents for archiving

SOFIA Closeout plan elements:
proposed, not final

- Science data archiving at IRSA – FY23
  - Legacy data sites
- Improve data processing pipelines and finalize
- Reprocessing all SOFIA data with the finalized and improved pipelines and deliver to archive
- GO grants closeout by end of FY24
- Third archival SOFIA call for proposals.
- Continued GO support in FY23
- Final performance of observatory documented in writeups
- Infrared Training workshops
- Final celebratory conference of SOFIA science achievements to advertise the archive and give it a good send off.

SOFIA Closeout

- NASA HQ is following the plan for the president's budget which includes funds to closeout SOFIA.
- USRA will abide by NASA's decision to fly out the science mission safely by September 30, 2022, and conduct an orderly close out of the program in FY23.
- USRA is working with NASA to ensure a proper closeout.
- USRA has permission from NASA to discuss possible alternative uses of SOFIA with other organizations.

SPD-41

- NASA SMD Policy regarding the data from the publically funded projects.
- For current missions, SPD-41 compliance is best effort.
- Nevertheless, SOFIA is pretty well-aligned with SPD-41, and the following information was submitted to NASA-HQ
- SOFIA science archive at IRSA
- Pipelines have been made public and will continue to be made public
- Publications in journals do become public
- Proprietary time:
  - SOFIA allows propriety time for GO's up to 6 months
  - Legacy and DDT are available immediately
  - Thesis enabling proposals get 12 months proprietary time

Response to SUG19 report

Recommendation	Response
[SUG19 – 1] DECADAL SURVEY COMMENTS AND THE SENIOR REVIEW PROPOSAL, The SUG encourages a lean forward messaging that emphasizes SOFIA's stewardship of the Decadal survey's science vision, and how SOFIA supports the Decadal Survey's science goals for the next decade.	This was done in senior review proposal, but NASA-HQ removed SOFIA from senior review proposal process, see SOFIA status and future prospects report: https://www.sofia.usra.edu/SOFIA-Status-and-Future-Prospects
The SUG emphasizes the importance of broadcasting SOFIA's science goals, progress, and relevance to the general science community in a visible and positive manner. The SUG recommends that the SMO utilizes professional public relation resources in drafting a positive and forward-looking messaging, aimed at the science community at large.	SMO used USRA communications specialist to help with crafting message, and also used science outreach group, and feedback from SOFIA scientists. Delivered a very positive and balance message to astronomy community at virtual-AAS SOFIA townhall in early January.

Response to SUG19 report

Recommendation	Response
[SUG19 – 2] DATA REDUCTION PIPELINES The SUG was delighted with the Python pipeline development, and their availability to the user community together with tutorials. The SUG looks forward to the HAWC+ and EXES Python pipelines becoming available to the user community as soon as practically possible.	Thank you. HAWC+ pipeline is now released. Plans for EXES's pipeline in python part of SOFIA closeout plans, FY23 release
[SUG19 – 3] CYCLE 10 CALL FOR PROPOSALS -SUG approved of elements in Cycle 10 call: multi-cycle time measurements, SN Team, -Separate archival call supported	Thank you. Third Archival call released on May 2, deadline July 8 Cycle 10 proposals were the best SOFIA has received as noted by TAC members. Selection document completed and delivered to NASA. Per NASA's current instruction: Cycle 10 is on hold and not likely to be executed. Note: APAC has recommended that NASA execute Cycle 10

Response to SUG19 report

Recommendation	Response
[SUG19 – 4] SOUTHERN HEMISPHERE DEPLOYMENTS Liked two short and one long deployment in Cycle-10 – advertise. The SUG is also happy to see the instrument rotation schedule for southern deployments included in the CfP. For better visibility, it could also be listed more prominently on the SOFIA portal.	Approved Flight series plans are now published online as soon as they are publicly disclosable. The announcement of accepted Southern deployments is made through blog posts, social media and e-newsletters.
The SUG welcomes the use of Santiago, Chile as a base for one of the suitcase deployments. Recommends Outreach campaign and workshop	Chilean deployment was a success; largest map done by FIFI-LS; Large public outreach event targeting schools was held. Local astronomers, e.g. Monica Rubio, were involved in press conferences and advertising SOFIA. Given the complexity of deployments, holding a workshop at the same time is not feasible.

Response to SUG19 report

Recommendation	Response
[SUG19 – 5] SOFIA ARCHIVE Please with publications and presentations selected archival datasets The SUG encourages the SMO to maintain a discussion with IRSA about ways the SOFIA archival data can be identified, selected, and downloaded, including object type.	Thank you. Continued improvements to IRSA have been made over the year. More proposed in closeout plan.
The SUG encourages the SMO to explore means of extracting additional metrics regarding the archive and its usage, such as publication by instrument and publication by target and/or target type.	We have explored the publications per observing program, consolidating reproposals. We have not done a study of archival data access by instrument or target, as this is not readily tracked by IRSA.

Response to SUG19 report

Recommendation	Response
[SUG19 – 6] COMMUNITY ENGAGEMENT The SUG is happy to see the increased community engagement activities. The SUG recommends that future activities, even in a non-COVID environment, will continue to allow virtual participation, as hybrid events in order to increase attendance.	Thank you. Virtual events have continued. The Lake Arrowhead meeting was made hybrid to enable participation from speakers who could not come on site due to Covid restrictions. This model allowed a significant participation of remote attendees.
The SUG finds the engagement on social media encouraging. ….. The SUG recommends that the impact of the different social media outlets be monitored and evaluated as a mean to refine the messaging channels.	The primary metric we use to measure the impact of our posts are “engagement” – defined as the sum of likes, comments, and shares – and “reach” – the total number of people that have seen the post. Among our three social media accounts, there are subtle differences in the types of messaging that receive the most engagement: puns and snappy summaries do well on Twitter; our Facebook audience is more interested in programmatic content.

Response to SUG19 report

Recommendation	Response
[SUG19 – 7] SOFIA PORTAL AND HELPDESK The SUG is impressed with the new and updated SOFIA website/portal design, and its connection to the DSC and IRSA sites. SOFIA publication lists are good: recommend syncing web portal lists to the DCS lists. (accessible by users only)	The DCS is now updated like the web page is; however the DCS contains some earlier information like preprints
The SUG supports annual surveys to understand the needs of the community, and as feedback on the products produced by the SMO (Call for Proposals, Cookbooks, tutorials, etc).	We are planning to send out our annual survey in July.

Response to SUG19 report

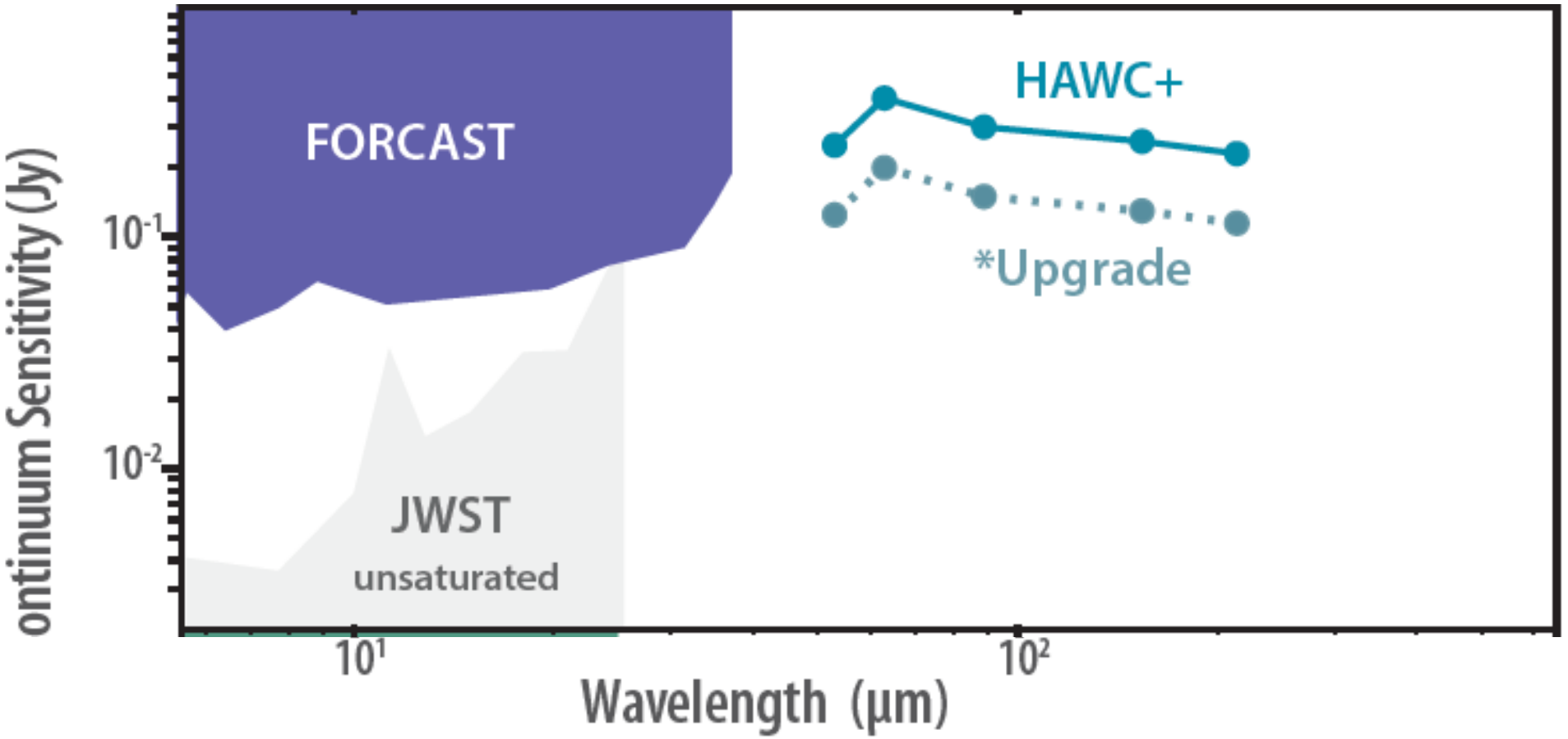
Recommendation	Response
[SUG19 – 8] PUBLICATION METRICS The SUG finds the rate of increase of published SOFIA papers encouraging, as well as the number of SOFIA users. The SUG recommends that the definitions and metrics used by the SMO regarding published papers, and user community, be such that they are directly comparable to those at other facilities, such as for HST, Chandra, Herschel, etc.	Thank you Yes we do use similar definitions as other observatories and have a member on the publication discussion group.
The SUG suggests that the SMO explore alternative metrics that reflects 'observatory efficiency', i.e. number of papers published per telescope hour on sky, or similar types of measures. This allows a normalization of facility-dependent boundary conditions.	We did this in the SOFIA status and future prospects report.

Response to SUG19 report

Recommendation	Response
[SUG19 – 9] SPD-41 EXCLUSIVE USER PERIOD The SUG concurs that a proprietary period of 6 months for SOFIA data is appropriate. This applies to the date from which data are ingested in the archive. The SUG emphasized that the Pis need to be informed in a timely manner when this occurs.	This was reported to NASA-HQ We have both an automated alert to our users as well as a detailed report from the instrument scientists.
The SUG also discussed the release time scales for Legacy Programs. Currently the data become available as they are ingested in the archive, but it was unclear what time scales applies to promised deliverables under SPD-41. The SUG recommends that the SMO work with the Legacy teams on defining, and meeting release dates. The SMO also recommends that the release of Legacy deliverables are publicly announced on the SMO information channels.	These discussions with Legacy teams are happening. SPD-41 timescales are satisfied by our Legacy programs. The improved data products deliverables and associated schedules are being discussed with Legacy teams.

Backup slides

SOFIA Instruments are Complementary to JWST and ALMA



SOFIA Instruments are Complementary to JWST and ALMA