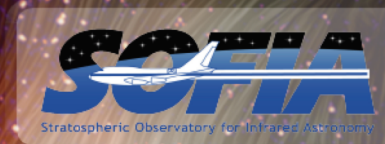


SOFIA Status: Director's Report

Harold Yorke
Director, SOFIA
Science Mission
Operations

May 28, 2019



Flagship Mission Review Proposal

March 22, 2019

Topics

- SOMER and SOFIA 5-Year Flagship Mission Review (FMR)
- Cycle 6 Status (completed April 26)
- Cycle 7 Status (started April 27)
- Cycle 8 Call for Proposals (May 31 release)
- Challenges
 - Future SOFIA Instrumentation
 - Converting the SOFIA program into separate projects

SOFIA 5-Year Flagship Mission Review

- August 2018: Memo from Thomas Zurbuchen announcing plan for reviewing SOFIA
- SOFIA Operations & Maintenance Efficiency Review (SOMER)
 - SOMER was to consider alternate operations and maintenance models to execute a substantially greater number flights and/or reduce cost
 - SOMER internal report to NASA only in March 2019
 - SOMER recommendations summary presented to FMR panel immediately prior to April 24-26 site visit
- SOFIA 5-Year Flagship Mission Review (FMR)
 - FMR proposal development led by USRA (Jim Jackson lead writer) with substantial help from NASA, DSI, DLR
 - Multiple extensive external reviews (Blue 1, Blue 2, Pink, Maroon, and Red Teams)
 - Tentative schedule presented at SUG-13 delayed by one month due to shutdown
 - Proposal submitted on March 22; 50+ RFIs prior to April 24-26 site visit
 - Debrief by FMR panel chair scheduled for Friday, May 31

SOMER Recommendations affecting Science

- Transition SOFIA aircraft operations away from an integrated astrophysics program into an existing independent aircraft management model – such as SMD’s Airborne Science Program (ASP) – in order to leverage aircraft operations expertise.
- Reduce flight profiles to 8 hour flights, improving safety posture, dispatch rate, scheduling flexibility and increasing the percentage of aircraft time at high-value altitudes.
- Schedule 6 flights per week, which would directly correlate to an increased number of total flights per year.
- Adjust aircrew mission briefing, pre-flight, and post-flight duty periods to shorten the overall crew duty day, improving crew turn-around times and maximizing maintenance touch-time.
- Manage the number of instrument changes to allow for more aggressive aircraft scheduling.

FMR Proposal



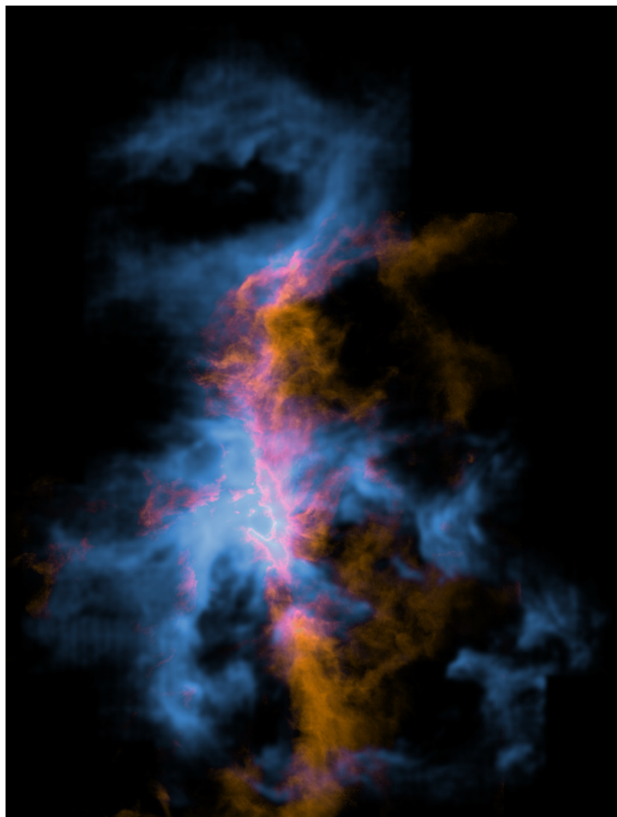
March 22, 2019

EXECUTIVE SUMMARY	1
1 INTRODUCTION AND VISION FOR THE FUTURE.....	3
1.1 The Hidden Infrared Universe	3
1.2 State of the Art Instrumentation	4
1.3 SOFIA's Place in a Balanced Astrophysics Portfolio.....	6
1.4 Commitment to Innovation and Improvement	7
2 SCIENCE: ACCOMPLISHMENTS AND PROSPECTS	9
2.1 Birth of Stars and Planets	9
2.1.1 Star Formation	9
<i>SOFIA Focused Investigation #1:</i>	
<i>Magnetic Fields in Filamentary Infrared Dark Clouds</i>	<i>10</i>
2.1.2 Birth of Planets	12
<i>SOFIA Focused Investigation #2:</i>	
<i>Finding the Hidden Mass in Protoplanetary Disks</i>	<i>15</i>
2.2 Path to Life: Water, Organics, and Ices	16
2.2.1 Light Hydrides: The First Compounds in the Chemical Path to Life	16
2.2.2 Water and Organics: The Simplest Pre-Biotic Molecules	17
<i>SOFIA Focused Investigation #3:</i>	
<i>A Complete MIR Organic Molecule Inventory of Hot Cores</i>	<i>18</i>
2.2.3 Polycyclic Aromatic Hydrocarbons: Complex Ringed Molecules	19
2.2.4 Ices: The Seeds of Terrestrial Life	20
2.3 Calibrating the Distant Universe	20
2.3.1 The Extreme Environment of the Galactic Center	21
<i>SOFIA Focused Investigation #4:</i>	
<i>A Complete Census of Star Formation in the Galactic Center</i>	<i>21</i>
2.3.2 Magnetic Fields on Galaxy Scales	22
2.3.3 Full-Disk Fine-Structure Line Mapping of Nearby Galaxies	23
2.4 Other Science	25
2.4.1 Planetary Atmospheres	25
2.4.2 Occultations of Trans-Neptunian Objects	25
2.4.3 Comets and asteroids	26
2.4.4 Time Domain Science	26
2.5 Summary	27
3. OBSERVATORY LEADERSHIP	28
3.1 Increasing Scientific Impact	28
3.1.1 Extended Southern Deployment	29
3.1.2 Daytime Operations	31
3.1.3 Signal-to-Noise Based Optimization	31
3.2 Supporting the Community	31
3.2.1 Maximizing Scientific Productivity	31
3.2.2 Vitality of the SOFIA Science Community	33
3.3 Outreach	34
3.3.1 User Support	34
3.3.2 Public Outreach	35
4 SCIENCE OPERATIONS	36
4.1 Annual Strategic Planning	37
4.1.1 Balanced Observing Program	37
4.1.2 Scheduling	38

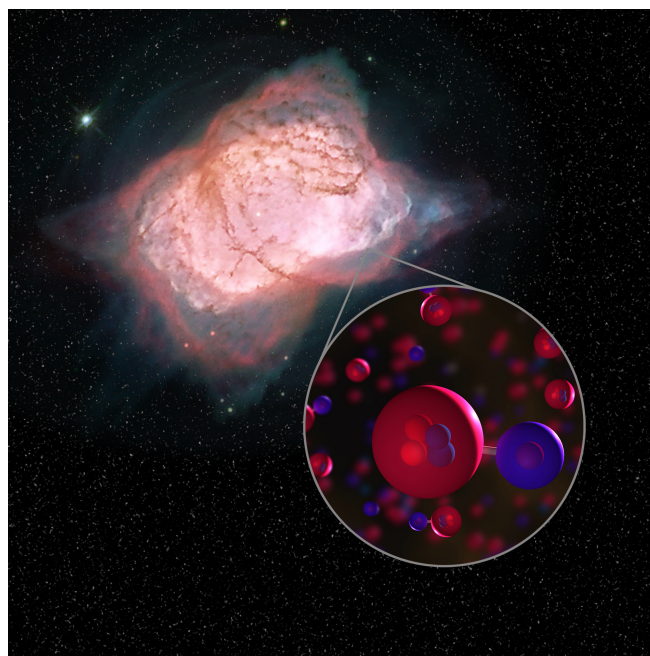
4.1.3 Funding and Management of Programs	39
4.2 Cycle and Series Planning	39
4.2.1 Deployments	39
4.2.2 Annual Schedule	39
4.2.3 Series Planning	40
4.3 Data Processing	40
5. MISSION OPERATIONS	42
5.1 Flight Preparation	42
5.1.1 Hardware and Script Preparation	42
5.1.2 Instrument Transitions	42
5.2 In-flight Operations	43
5.2.1 Science and Mission Operations Crew	43
5.2.2 Guest Observers, VIPs, Journalists, Educators	44
6 OBSERVATORY STEWARDSHIP	45
6.1 Telescope	45
6.1.1 Image Quality	45
6.1.2 Guide Cameras	47
6.2 Science Instruments	47
6.2.1 SOFIA on the Cutting Edge	47
6.2.2 Managing SOFIA's Instrument Suite	48
6.2.3 Future SOFIA Science Instruments	50
6.3 Observatory Infrastructure	51
6.3.1 Laboratories and Science Instrument Maintenance	51
6.3.2 SOFIA's Primary Mirror	51
6.4 Data Dissemination	52
6.4.1 Increasing Importance of Archive	52
6.4.2 Infrared Science Archive	52
6.4.3 Archival Research Program	52
7 STAFFING AND BUDGET	53
8 APPENDICES	55
8.1 References	55
8.2 Publications	59
8.3 Acronyms	60
8.4 Budget Details	63
8.5 Findings of the SOFIA Users Group	66
8.6 SOFIA Observatory Performance Metrics	69

FMR Science Focus Themes

1. Birth of Stars and Planets
2. Path to Life: Water, Organics, and Ices
3. Calibrating the Distant Universe
4. Other Science (planetary science, time domain science)



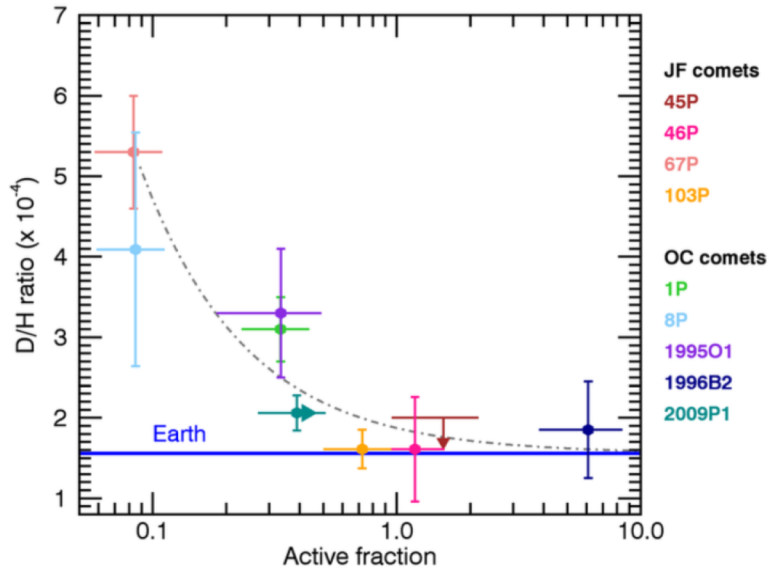
C[II] (blue) with CO (orange)
Orion



First interstellar detection of HeH⁺
NGC 7027

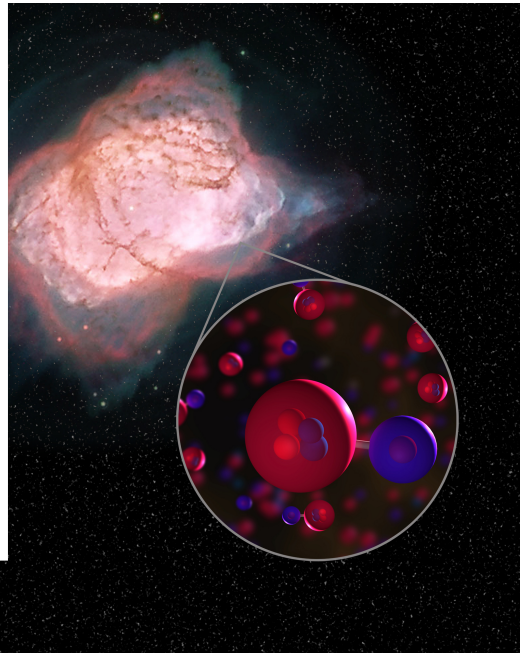


Magnetic field directions
30 Doradus



Terrestrial deuterium-to-hydrogen ratio in water in hyperactive comets

Lis, et al. 2019, A&A (in press)



First interstellar detection of HeH⁺
NGC 7027



Magnetic field directions
30 Doradus

FMR Science Focus Investigations

Table 2-1. Summary of SOFIA High-Priority Focused Science Investigations 2019 to 2021.

Legacy Programs are indicated by bold font.

Program	Goal	Science Theme	Targets	Primary Instrument	Number of Targets	Hours
Magnetic Fields in Infrared Dark Clouds	To measure B-field strengths and orientations in IRDCs	Birth of Stars and Planets	IRDC filaments	HAWC+	10	100
Constraining Recent Star Formation in the Galactic Center: A SOFIA/FORCAST Legacy Program	To identify and characterize protostars in the Galactic Center	Calibrating the Distant Universe	Galactic Center/ Central Molecular Zone	FORCAST	34	30
The Hidden Mass in Protoplanetary Disks	To use HD to measure the mass of protoplanetary disks	Birth of Stars and Planets	Well-studied disks	HIRMES	35	150
A Complete Organic Inventory of Hot Cores	To identify the organics in hot cores, quantify their abundances, and test chemical models	Path to Life	Hot Cores	EXES	6	100
Radiative and mechanical feedback in regions of massive star formation	To measure mechanical and radiative feedback using [C II] images	Calibrating the Distant Universe	High-Mass Stars and Clusters	GREAT	11	96

FMR Site Visit 24-26 April 2019

Day 1 April 24

- 9:00 – 10:30 **Session 1** Project presentation on past and current science operations and mission operations performance (~45 min)
- 11:00 – 12:30 **Session 2** Project description of the expected returns and their merit from SOFIA in FY20-22 and FY23-24 (~45 min)
- 1:30 – 3:30 **Session 3** Tour facility, meet the staff as panel walks around, and have staff describe their work, challenges, opportunities, "day-in-the-life" of a SOFIA staff member (3 Demos presented; Science Gallery tour)
- 3:30 – 4:30 **Session 4** Response to the SOMER report (will be preliminary – FMR panel will send specific questions after they see the SOMER report)

Day 2 April 25

- 8:00 – 10:30 **Session 5** Full FMR panel meets with individual Associate Directors
- 10:45 – 12:45 **Session 6** FMR Panel A/B groups meet with various groups

Day 3 April 26

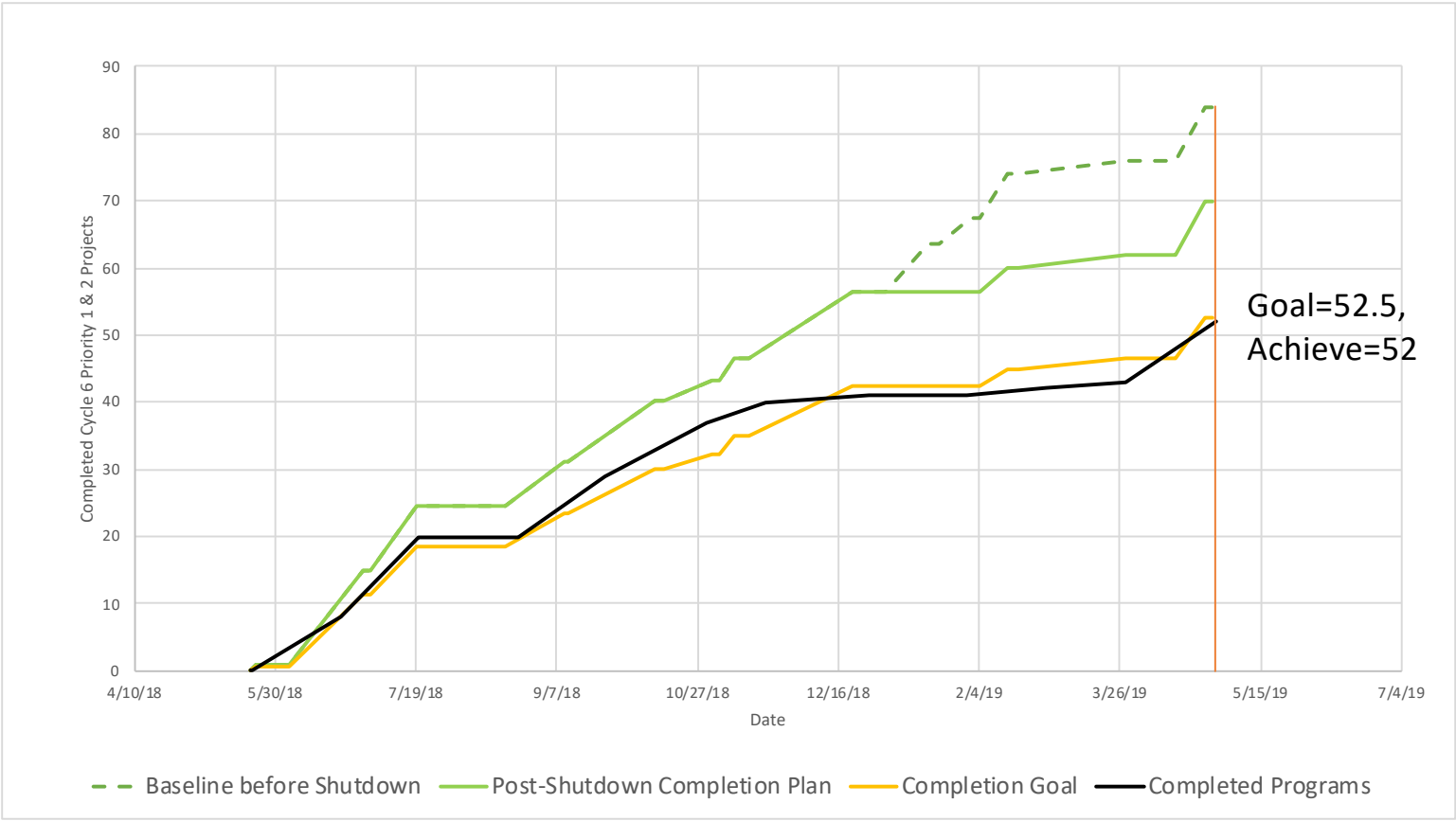
- 11:30– 12:30 **Debrief** to Paul Hertz (no one from SOFIA Program or Centers present)

Cycle 6

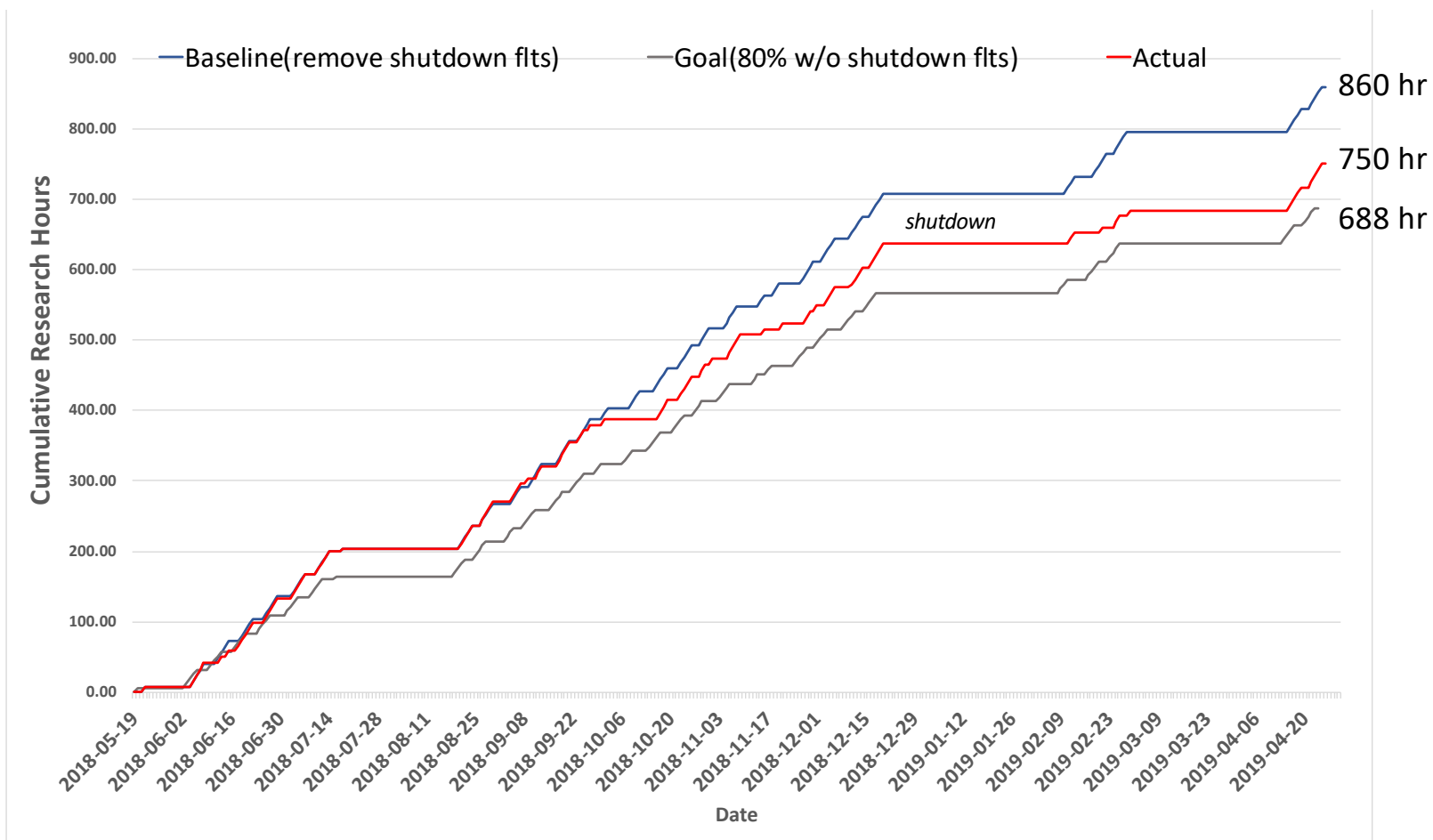
5/19/2018 – 4/26/2019

Updated Apr 29; through flight 560

Cycle 6 Priority 1 and 2 Project Completions



Cycle 6 Cumulative Research Hours



Cycle 7

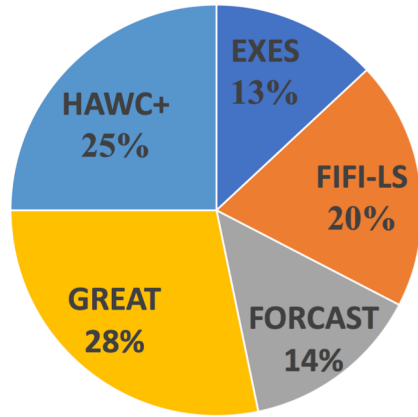
4/27/2019 – 4/24/2020

Cycle 7 Selection (1/4)

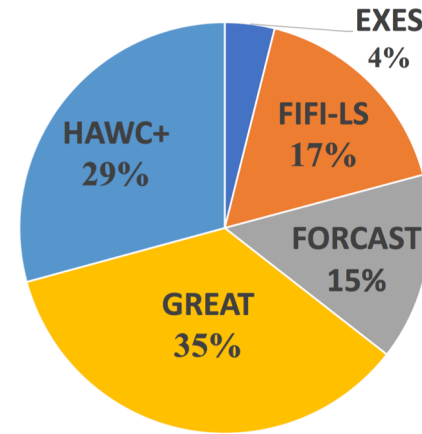
	US + INT hours	German hours	Total hours	US + INT numbers	German numbers	Total numbers
P1	125	20	145	22	4	26
P2	197	26	223	24	5	29
ToO	21	0	21	3	0	3
P1+P2	321	45	368	46	9	55
P3	277	62	339	36	14	50
Survey	97	0	97	2	0	2
Thesis- enabling	-	-	-	1 "P2"	0	1

Cycle 7 Selection (2/4)

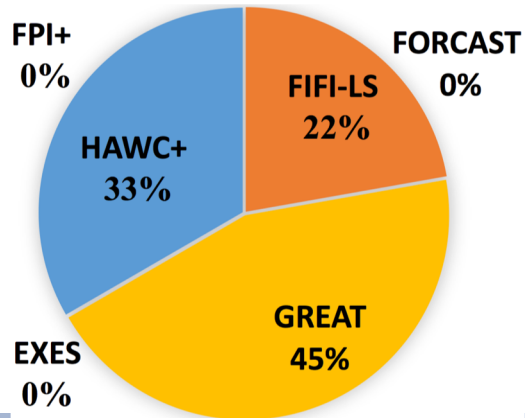
US P1 + P2 # by instrument (46)



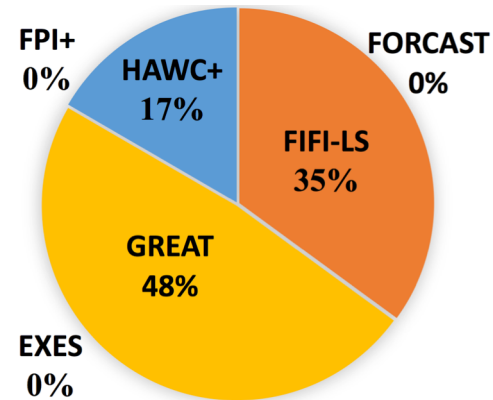
US P1 + P2 time by instrument (321 h)



DE P1 + P2 # by instrument (9)

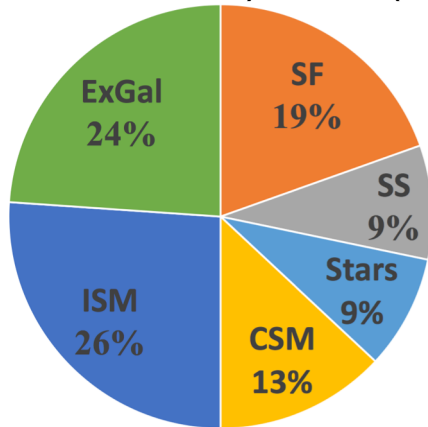


DE P1 + P2 time by instrument (45 h)

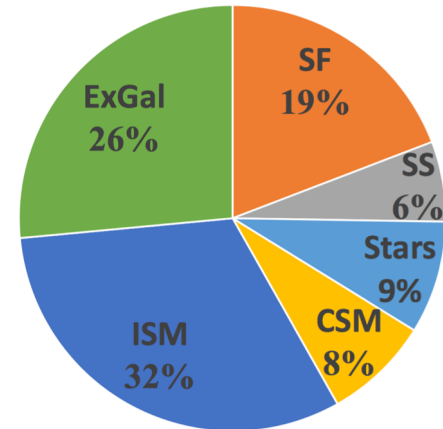


Cycle 7 Selection (3/4)

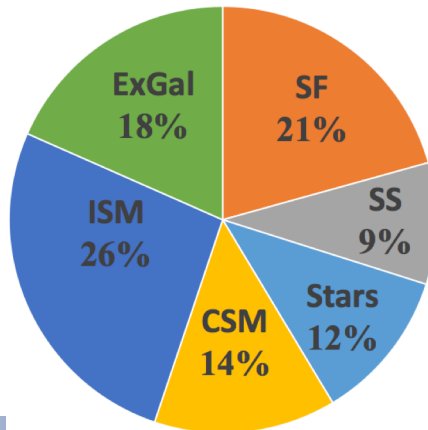
US P1 + P2 # by science (46)



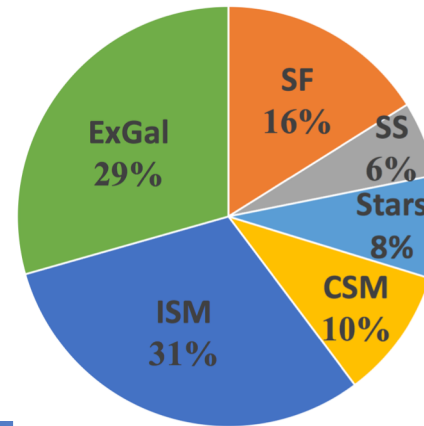
US P1 + P2 time by science (321 h)



US all # by science (87)



US all time by science (716 h)



Cycle 7 Selection (4/4)

Instrument distribution of submitted and selected SOFIA Legacy Programs

	Submitted	Time requested	07_0077 (PI: Tielens)	07_0189 (PI: Hankins)
GREAT	4.5	348.2 h	96.4 h	
HAWC+	4	527.2 h		
FIFI-LS	0.5	36.8 h		
FORCAST	1	30.3 h		30.3 h
Joint Proposals	4		1	
Total	10	942.5 h	96.4 h	30.3 h
Cycle 7 Funding			\$500k	\$180k

[1](#) Proposals requesting two instruments are counted as 1/2 for each instrument

Cycle 7 Status

- **Baseline Plan**
 - 148 flights planned (111 “blue” and 37 “orange” flights)
 - Extended New Zealand deployment (9 weeks)
 - First cycle with Legacy programs
 - ~30 hours of carry-in from Cycle 6 due to unfinished P1 & one TE projects (largely due to government shutdown)
- **Current Progress**
 - First flight series OC7A (FIFI-LS): 12/12 flights flown
 - Second flight series OC7B (GREAT): 1/3 flights flown; (2 lost due to weather)
 - Flight plans completed for NZ deployment
 - OC7C (GREAT) 16 flights
 - OC7D (FORCAST) 8 flights
 - OC7E (HAWC+) 8 flights