

SOFIA Science Update Astrophysics Subcommittee Meeting

Astrophysics Subcommittee Meeting Aug 12, 2014

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Program Status



- SOFIA now in Phase E (Operations) as of May 29, 2014
- Science Instruments:
 - <u>All</u> 1st Generation Science Instruments have now flown (6 science instruments)
 - Five of the 1st generation instruments have completed commissioning flights
 - 2nd Generation science instruments, upGREAT & HAWC+, to be commissioned in 2015
- Aircraft now in Germany for a scheduled Heavy Maintenance Visit
 - Brings the aircraft maintenance up to date to maximize science operations
 - Telescope Assembly maintenance is being performed, in parallel
 - Aircraft returns to Palmdale base in November 2014
- Cycle 2 and EXES commissioning to be completed during Nov-Dec 2014
- Cycle 3 call for observation proposals:
 - Deadline July 18
 - Selection announcement planned October
 - Observations start March 2015



1st Generation Science Instruments

Instruments span extensive wavelength range



EXES-UC Davis



FLITECAM - UCLA HIPO - Lowell <u>Imagers:</u> HIPO (0.3 – 1.1 μm) FLITECam (1.0 – 5.5 μm) FORCAST(5 – 40 μm)

Spectrometers :

FLITECam (w/grisms, $R(\lambda/\Delta\lambda) = 800-1800$) FORCAST (w/grisms, $R(\lambda/\Delta\lambda) = 200-1200$) EXES (grating, 4.5 – 28.3 µm, $R(\lambda/\Delta\lambda) = 1,000-100,000$) FIFI-LS (integral field, 42 – 210 µm, $R(\lambda/\Delta\lambda) = \sim 1,700$) GREAT (heterodyne, 63 – 240 µm, $R(\lambda/\Delta\lambda) \sim 1 \times 10^8$)



FORCAST -Cornell



GREAT Max Planck



FIFI-LS U. Stuttgart





- 1st-generation GREAT provides mapping with a single pixel
 - 1 pixel @ 1.9 to 2.5 THz
 - 1 pixel @ 4.7 THz [O I]





Next-generation Instruments: upGREAT



- Expansion of the current GREAT Medium and High-Frequency channels from a single beam to a 7-beam hexagonally close-packed array.
- Multi-pixel heterodyne arrays will significantly increase mapping speed
- First use of cryo-cooler on SOFIA greatly reduces liquid Helium fills and associated costs
- First light expected by Summer 2015





Next-generation Instruments: HAWC+







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HAWC+ -Yerkes, JPL

Upgraded H/AWC+ Array

Replaces the original 12 x 32 HAWC instrument bolometer detector arrays with 40 x 64 pixel arrays
Also adds polarimetric capability at 50 – 240 µm
First light expected Fall 2015



SOFIA Baseline Science Domain







Guest Investigator Statistics (Cycle 1-2)







Astrochemistry







Solar System







Solar System





Step slit position across Jupiter's disk, generate Ortho and Para spectral maps:







Strong global winds and lower atmosphere haze layer (cryo-vulcanism?) Haze had faded over past 2 decades but now returned to 1998 level (KAO)

S(1) to S(0) ratio established by local temperature, with long equilibrium time when environment changes

S(1)/S(0) measures circulation, gas convection between Jovian stratosphere and lower atmosphere



Faint 19.7 μ m emission \rightarrow coma had steep size distribution of carbon-rich 0.7-1 μ m grains



EXOPLANETS







EXOPLANETS







Galactic Center







Galactic Center



SOFIA/GREAT/FORCAST: Clumps in the Circum-Nuclear Disk are transient features

Color maps (FORCAST 19.7, 31.5, 37.1 μ m): consistent with the inner edge of a dusty CNR centrally heated by inner cluster of hot young stars, and clumps not dense enough to be stable against tidal shear over the timescale of an orbital period (~10⁵ yr) (Lau et al 2013, ApJ 775, 37)



CO lines (GREAT): clouds are heated by shocks formed in fast-moving accretion flows, and gas densities are too low to be stable against internal

turbulence or tidal forces (Requena-Torres et al 2012)







Star Formation and Evolution







Star Formation and Evolution





NH₃ line absorption (3-10x10⁻³ M_{sun}yr⁻¹)







Aug 12, 2014



SOFIA Science Highlights









SOFIA offers unique capabilities enabling high impact science, and holds potential for changing the way that investigators approach studies of star formation, Solar System objects, astrochemistry, and dust, and provides an experimental facility that appeals to a broad user base.





Backup charts



Heavy Maintenance Visit Hamburg, Germany







Cycle 2 Cumulative Research Hours



As of 12 Aug 2014

Chart Revision 7-28-14







SOFIA Proposal Call Statistics (US Only)

	Basic Science	Cycle 1	Cycle 2
Release Date	4/19/2010	11/21/2011	4/29/2013
Hours Offered	75	200	175
Instruments Offered	FORCAST GREAT	FORCAST GREAT FLITECAM HIPO	FORCAST GREAT FLITECAM HIPO EXES FIFI-LS
Proposals Received	59	133	90
Hours Requested	270	1269	548
Oversubscription Rate	3.6	6.3	3.1
Investigation Teams Supported	27	42	37+DIT
Fraction US	85%	79%	83%
Fraction International	15%	21%	17%





Cycle 1 Statistics

Instrument	US Queue	German Queue	Total
FLITECAM	11.5		11.5
FLITECAM/FORCAST	14.4		14.4
FLIPO	6.5	3.5	10.0
FORCAST	99.9	4.0	103.9
GREAT	40.5	44.8	85.3
Total	172.8 hours	52.3 hours	225.1 hours
Number of Teams Awarded Time	35 US+ 7 International GIs	16 German GIs	





Cycle 2 Statistics

Instrument	US Queue	German Queue	Total
EXES	7.8	0.0	7.8
FIFI-LS	1.5	3.0	4.5
FLITECAM	10.0	2.2	12.2
FLITECAM/FORCAS T	20.1	0.0	20.1
FLIPO	8.0	5.3	13.3
FORCAST	95.9	0.0	95.9
GREAT	21.8	30.3	52.1
Total	165.1 hours	40.8 hours	205.9 hours
Number of Teams Awarded Time	30 US+ 7 International GIs	14 German GIs + 1 DSI Staff	