Cycle 5 – at a glance
Feb 5, 2017 – Jan 1, 2018

Kimberly Ennico Smith
SOFIA Project Scientist
2017-03-02
SOFIA International Summit
FIFI-LS Series OC5B
Flight # 3 of 7; M42; M 51 impact proposal; IC10 dwarf galaxy
What’s happening just now!

FIFI-LS Series OC5B
Flight # 4 of 7; In the air now! M42, NGC1333, S255 M51, NGC 5633, ~Landing 10:30 UT
Cycle 5 – Science Demand

- 206 Submitted Proposals
- 92 Awarded Proposals

1970 hrs (US+DE) requested

Science area by hours
Cycle 5 – Baseline Plan

- 7 Instruments in Use
- 3 New Capabilities (HAWC+, upGREAT 4G/LFA/HFA*)
- 3 Instrument Southern Deployment (upGREAT, FIFI-LS, FORCAST)
- 102 Science Flights (baseline)
- 758 Research Hours (baseline) 505 Guest Investigator, 100 GTO, 45 DDT, 108 Calibration

*two cryocoolers

Cycle 4 Completed 646 research hours: 386 Guest Investigator, 106 GTO, 20 DDT, 134 Calibration
Target Distribution: Cycle 5 Selected Targets

The image shows a graph with the axes labeled as Declination (Deg) on the y-axis and Right Ascension (Hr) on the x-axis. The graph plots the positions of various targets with different symbols representing different instruments or projects:
- EXES
- FIFI-LS
- FLITECAM
- FLIPO
- FORCAST
- FP+/
- GREAT
- HAWC+

The distribution of the targets indicates the coverage and concentration of the selected Cycle 5 targets across the sky.
Cycle 5 – Large Proposals (>13 hrs)

- 05_0041 (Tielens) – “EXES Survey of the Organic Inventory of Hot Cores”; 27 hours; EXES.
- 05_0043 (Rangwala) – “An EXES High-Resolution Molecular Line Survey towards Orion IRc2”; 30 hours; EXES.
- 05_0008 (De Buizer) – “Revealing the Embedded Structures and Sources within Giant HII Regions: Wrapping up the Survey”; 15 hours; FORCAST
- 05_0022 (Harris) & 05_0033 (Guesten) – “Joint Impact Proposal: Mapping C+ Across the Galaxy's Central Molecular Zone”; 15 hours; upGREAT.
- 05_0076 (Bally) – “Impact Program: The Outer CMZ C+ Survey”; 14 hours; upGREAT.
- 05_0063 (Guzman-Ramirez) – “Understanding the Nebular Abundance Discrepancy Problem with SOFIA”; 14 hours; FORCAST
- 05_0129 (Tremonti) – “Probing Dust-obscured Star Formation and AGN Activity in Massive Ultra-compact Galaxies”; 13 hours; HAWC+.
- 05_0002 (Woodward) – “Comet NEOs 41P and C/2015 V2 – The FORCAST Story”; 13 hours; FORCAST
Cycle 5 Highlight – Galactic Center

Four very highly rated proposals were selected to investigate the Galactic Center with upGREAT

• [CII] Mapping
  – 05_0076 Bally – “Impact Program: The Outer CMZ C+ Survey”
  – 05_0022 Harris & 05_0033 Guesten – “Joint Impact Proposal: Mapping C+ Across the Galaxy's Central Molecular Zone”

• [O I] Mapping
  – 05_0021 Ragan – “Cooling and kinematics in the Central Molecular Zone”
  – 05_0102 Morris – “Characterizing Neutral Gas in the Central Parsec of the Galaxy”
Comparison of Mapped Regions

Yellow: 05_0076 Bally
White: 05_0022/0033 Harris-Güsten
Ragan and Morris Fields

Our Galactic center, because of its proximity, is the only galactic nucleus we can observe in detail at wavelengths across the entire electromagnetic spectrum. Multi-wavelength studies have been critical in understanding its structure, contents, energetics, dynamics, star formation activity and history, and chemistry. Velocity-resolved spectroscopy with resolution of 15 km sec\(^{-1}\) has proved essential in separating different gas components that overlap along the line of sight. Questions of how the dense gas collected at the center, why the large clouds are distributed as they are, and why star formation occurs in some places but not others, are all key to understanding the Galactic center. It is not only very important to study the Galactic center in the context of its role in Galactic structure and evolution, but also because studies of our own Galactic center form the basis of our understanding of all other "normal" galactic nuclei. With far less information on these, including those at high redshift that are increasingly within the reach of ALMA and JWST, or those that are potential targets for the Far-IR Surveyor under NASA study, we search for similarities and differences from measurements of our Galactic center to interpret those less complete measurements.

Figure 1: Composite orientation view of the Central Molecular Zone (CMZ). Labels indicate some of the dominant massive clouds. Red shows ATLASGAL 870\(\mu\)m dust continuum (Schuller et al., 2009), blue Herschel 70\(\mu\)m (Molinari et al., 2011), and green dense molecular gas (Jones et al., 2012). The outline box shows the region we propose to map in the 158\(\mu\)m line.

The Central Molecular Zone (CMZ) surrounds the nucleus with a radius of about 250 pc (see, e.g., Morris & Serabyn, 1996; Ferri`ere et al., 2007). Its most famous resident is a surprisingly quiescent \(\sim 3 \times 10^6\) M\(_\odot\) black hole. Young hot stars, many in dense clusters, are distributed throughout the region. Most of the mass in the CMZ, however, is in a collection of molecular clouds (including Sgr B2, Sgr C, and the \(+50\) and \(+20\) km sec\(^{-1}\) clouds) with a few \(\sim 10^7\) M\(_\odot\). These clouds are typically substantially denser, warmer, and more turbulent than typical disk clouds (G¨usten et al., 1981; Genzel & Harris, 1994; Morris & Serabyn, 1996; Mart´ın-Pintado et al., 1997; Ferri`ere et al., 2007; Ginsburg et al., 2016, and references therein).

Maps of selected parts of the Galactic center clouds in fine structure lines have provided almost all of our understanding of the gas ionization states and how the hardness of the ionizing sources varies across the region. Only now, however, does the combination of SOFIA and upGREAT make it possible to make complete large-scale velocity-resolved maps at sub-parsec resolution (at 8.3 kpc, upGREAT’s 14.8\(\times\)00 beam covers 0.6 pc). As shown by the box in Figure 1, our target for...
Cycle 5 Highlight – Water on Europa

• 05_0153 Sparks “Confirmation of Water Plumes on Europa”
• Observations with EXES at 6.27 µm (H₂O vibrational band) to confirm HST observations of water plumes on the moon of Jupiter.
  • SOFIA observations Mar 15 & May 26
  • HST observations Mar 12 & 23
• These observations would provide input to a future Europa probe mission.

Fig. 1. Left, STIS transit image Jan 2014 with ellipse indicating dark off-limb features. Upper center, “plume” image from Roth et al (2014). Lower right, probability image for transit, indicating significance, formally (Sparks et al 2016). Peak is ≈4.0σ.
Cycle 5 Highlight - Occultation of Triton

- 05_0125 Person – “A New Look at Triton's Atmosphere”
- To characterize the atmosphere of Neptune’s moon Triton. Monitoring of Triton’s expanding atmosphere has not been re-examined since 2001.
- FLITECAM/HIPO observations of Trion occcluding a R=12 mag star Oct 6, 2017.
- Will be conducted using GTO time.
- Requires a mini-deployment to the US East Coast.
• 05_0043 Naseem Rangwala
  An EXES High-Resolution Molecular Line Survey towards Orion IRc2, a prototypical hot-core source.
• Unprecedented resolving power (R = 50,000) will be 5 to 50 times more powerful than ISO in identifying narrow lines
• Study will provide a wealth of information on hot core chemistry

a) Spectrum from Cycle 3 pilot program toward IRc2
b) Likely molecules from hot core models
Cycle 5 Highlight - Studying Magnetic Fields

- 05_0133 Novak - “Joint HAWC+/ALMA study of magnetic fields in Ophiuchus”
- HAWC+ will have 35x better angular resolution than the Planck polarimeter and provides a bridge to the very much higher resolution observations of 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.
Back-up Charts
# Cycle 5 Daily Overview

## Cycle 5 Start

- OC5A (upGREAT + LFA)
  - 7 Flights
- OC5B (FIIR-LS)
  - 7 Flights
- OC5C (EXES)
  - 6 Flights

## Feburary – 2017

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## NZ

- 8 Flights

## Key

- **Observing Cycle:** 5
- **Baseline Science Flights:** 102
- **Baseline RHs:** 758
- **Planned Science Flights:** 104
- **Estimated RHs:** 766 (*Year to date + Estimate)

## Distribution Details

- **Distributed:** 17 February 2017
- **Slide Revision:** 17 February 2017
- **Page:** 16
Cycle 5 Daily Overview – Page 2 of 2

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- **Observing Cycle:** 5
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- **PMB sequence approval:** 2/13/17

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### Cycle 5 Observing Cycle

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