



## Flight Description



*Obs Cycle: OC8M*

**Flight name: MAXINE**

**SOFIA flight: 0**

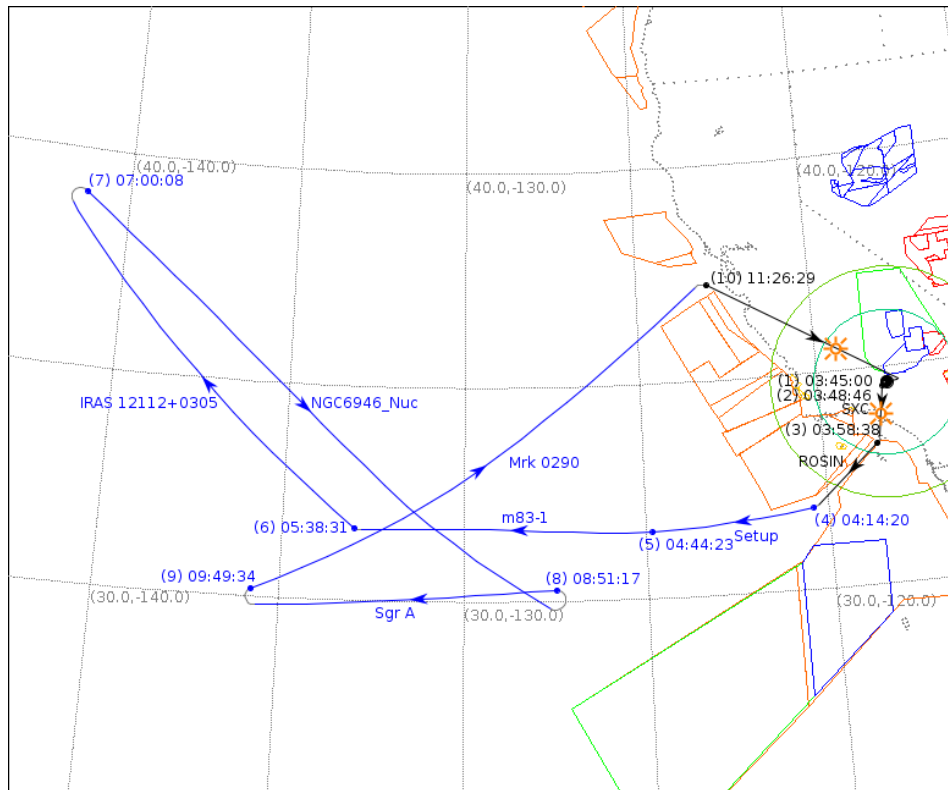
**FIFI-LS flight: 0**

**Date: 2021-06-05**

## 1 Definitions & Parameters

Chop angle in J2000	<b>Counterclockwise from North</b>
FOV angle in J2000	<b>Counterclockwise from North (blue)</b>
Focus Position (xml)	372 mm
Focus Relation	4.3 $\mu\text{m}$ secondary move is -1mm Focus point move
Blue bias Voltages	75 mV
Red bias Voltages	60 mV
Chopper Phase	356°
D130/D105 switch blue M2	[OIII]51.815 $\mu\text{m}$ + 5000 km/s
Blue grating switch positions	Home/far: 44000/191000 induct
Red grating switch positions	Home/far: 37000/1753000 induct
Blue spixel size	800 induct
Red spixel size	730 induct
TO: Focus at	0 $\mu\text{m}$
KOSMA: Setpoint:	-X: -5.3 arcsec -Y: -7.3 arcsec
TEL.hardware_status:	Instr_rotator_axis_x = -0.096 mm Instr_rotator_axis_y = -1.057 mm
In Rx.hardware_status [mm]:	
BD130	Rx_cx[2] = 0.90, Rx_cy[2] = -0.74
BD105	Rx_cx[1] = 1.41, Rx_cy[1] = -0.60
Red	Rx_cx[0] = -0.77, Rx_cy[0] = -0.69
K-Mirror 0 Position:	52 steps

## 2 Flight Plan



Flight Plan Filename: 202105\_FI\_MAXINE\_WX36.fp  
 Flight Plan ID: 202105\_FI\_MAXINE  
 Est. Takeoff Time: 2021-Jun-05 03:45 UTC  
 Est. Landing Time: 2021-Jun-05 12:11 UTC  
 Flight Duration: 08:26  
 Sunset: 03:02:06 Sunset Az: 298 Sunrise: 12:39:30 Sunrise Az: 61 UTC  
 Weather Forecast: 0000 Thu Jun 03 2021 - 0600 Sun Jun 06 2021 UTC  
 Forecast Timestamp: 0416 Thu Jun 03 2021 PT  
 Flight Plan Comment: enters OCEANIC  
 triggers Rule 12  
 Saved: 2021-Jun-03 15:04 UTC User: sdavis

Leg	Target	Obs Block	Pr	Elevation	UTC start	Duration	Altitude
1	Departure				03:45:00	00:02	10 Kft
2	Climb				03:48:46	00:08	35 Kft
3	Climb				03:58:38	00:14	36 Kft
4	Setup			24.3-25.0	04:14:20	00:30	38 Kft
5	m83-1	70-0808-02	C	28.3-28.4	04:44:23	00:53	39 Kft
6	IRAS 12112+0305	08-0095-07	C	54.4-43.4	05:38:31	01:17	39/35/41 Kft
7	NGC6946_Nuc	09-0198-01	B	32.6-44.5	07:00:08	01:45	41/75/43 Kft
8	Sgr A	71-0024-14	C	30.3-31.1	08:51:17	00:54	43 Kft
9	Mrk 0290	08-0226-04	D	54.8-42.1	09:49:34	01:35	43 Kft
10	Arrival				11:26:29	00:45	43 Kft
	Landing				12:11:52		0 Kft
Total flight time						08:26	

### 3 FIFI-LS GTO Cycle 7

**AOR ID:** 70\_0808 **PI:** Alfred Krabbe

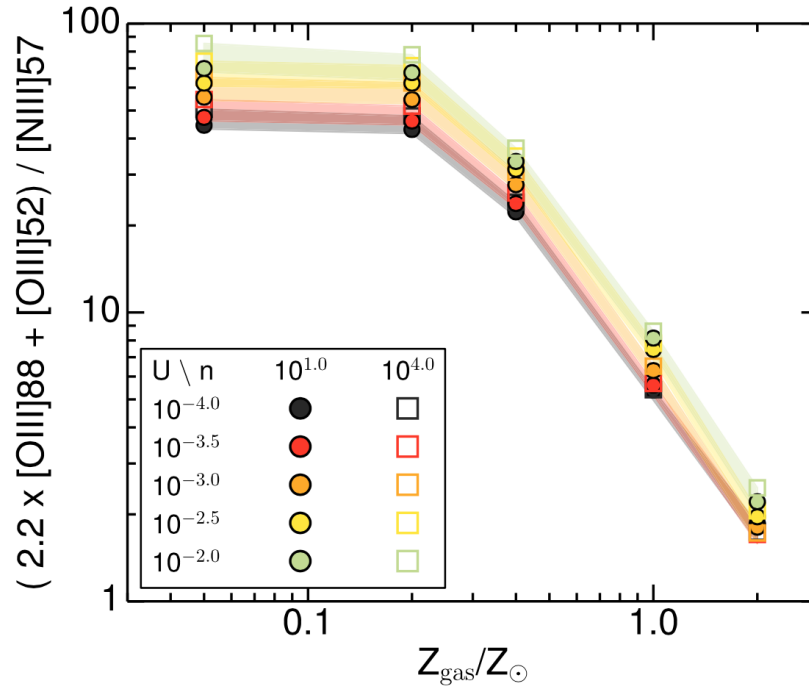
**Comments:** 122 minutes requested in DCS; 120 minutes planned in DCS; 54 of 120 minutes in this series; 66 on MARIO; 54 on MAXINE (this flight)

FIFI-LS GTO Cycle 8

### 4 Are local ULIRGs low in metals? Testing a new metallicity diagnostic with FIFI-LS.

**AOR ID:** 08\_0095 **PI:** Jingzhe Ma

**Comments:** 70 minutes requested in DCS; 70 minutes planned in DCS; 70 of 70 minutes in this series



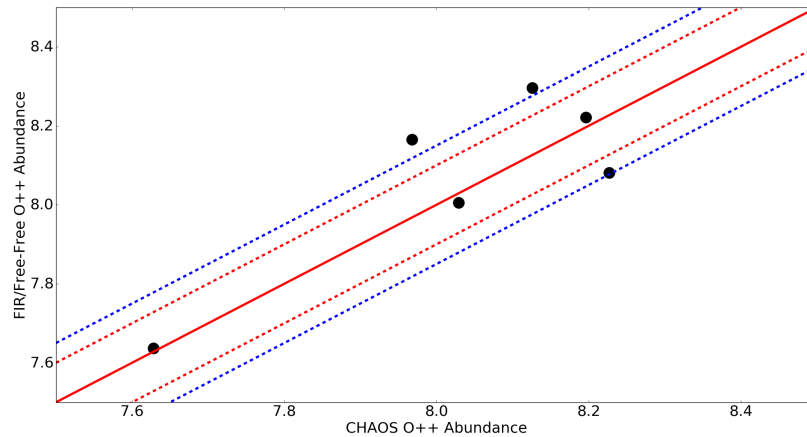
A comprehensive study of the physical properties of low- $z$  ultra luminous infrared galaxies (ULIRGs), specifically their interstellar medium (ISM), is critical to understanding the evolution of  $>L^*$  galaxies and active galactic nuclei across cosmic time. ULIRGs at low redshifts are central to this endeavor, as they establish a baseline from which to measure evolution with redshift in the ULIRG population. We propose FIFI-LS observations of the far-IR (FIR) fine structure lines of 11 ULIRGs selected by IRAS at  $0.01 < z < 0.13$ , primarily targeting the [OIII]52 and [NIII]57  $\mu\text{m}$  lines, which are currently only accessible by FIFI-LS. The proposed observations will provide comprehensive diagnostics of the physical conditions of the ISM such as the gas density, radiation field intensity, and metallicity that is much less susceptible to extinction than traditionally used UV/optical transitions. We will be able to apply the excellent FIR metallicity diagnostic,  $([\text{OIII}]52 + 2.2[\text{OIII}]88)/[\text{NIII}]57$ , for the first time, which breaks the density degeneracy and reduces the scatter in the correlation to within 0.2 dex. The unprecedentedly reliable metallicity measurements will address whether ULIRGs lie below the mass-metallicity relation of star-forming galaxies as previously thought based on optical metallicity diagnostics. Along with archival Herschel/PACS+SPIRE observations, we will be able to test all the line-ratio diagnostics by comparing to models (e.g. Cloudy) and identify the best pairs to optimize future observations with ALMA for high- $z$  analogs. This pilot SOFIA program will open up the opportunity to increasing

the sample of low-redshift ( $0.1 < z < 0.3$ ) ULIRGs with the full set of FIR line observations by a factor of 2-3. This program will also demonstrate a key science program for the Origins Space Telescope that focusses on metallicity measurements out to  $z$  of 6 with results from Cycle 8 potentially making an impact in Astro2020 Discussions.

## 5 Securing Far-Infrared Metal Abundances in NGC 6946

**AOR ID:** 09\_0198 **PI:** Cody Lamarche

**Comments:** 711 minutes requested in DCS; 406 minutes planned in DCS; 100 of 245 minutes in this series; 50 on MADDILYN; 50 on MATTHEW; 100 on MAXINE (this flight); 45 on MIRIAM



Elements heavier than helium contribute less than one percent to the total mass of the local Universe, yet they significantly affect the way in which stars and galaxies form and evolve. Therefore, understanding the chemical enrichment history of the Universe is an essential part of understanding galaxy evolution. The ground-state fine-structure levels of the abundant metals oxygen and nitrogen, accessible to SOFIA in the far-infrared, will play a major role in uncovering this history. With the ability to penetrate the significant dust columns present in galaxies during the peak epoch of cosmic star formation, and little sensitivity to the unknown temperature structure of ionized nebulae that has plagued traditional optical strong-line metal-abundances for decades, FIR abundances offer many powerful advantages. Yet substantial work is still needed locally before these FIR methods can be extended to high-redshift galaxies. We propose a program to study NGC 6946, a bright, metal-rich, nearby spiral galaxy, targeting 8 HII regions that will be observed in concert with the ongoing CHAOS program on the LBT – the largest, deepest survey of direct spectroscopic optical auroral-line metal-abundances ever undertaken in the local Universe. Combining SOFIA/FIFI-LS with CHAOS spectroscopy, archival Herschel/PACS and Spitzer/IRS, and VLA free-free continuum observations of the targeted HII regions in NGC 6946, we will explore several interrelated temperature-insensitive infrared abundance tools, including direct [OIII] abundances normalized to hydrogen using recombination or free-free emission, and expand and validate the novel O3N3 pure FIR-line abundance diagnostic. Our ancillary data also include deep optical IFU spectral mapping data, which bridge the resolution divide between the SOFIA and ground-based optical surveys.

## 6 Instrument Characterization Request: OTF Mapping for FIFI-LS

**AOR ID:** 71\_0024 **PI:** Christian Fischer

**Comments:** 53 minutes requested in DCS; 53 minutes planned in DCS; 53 of 53 minutes in this series

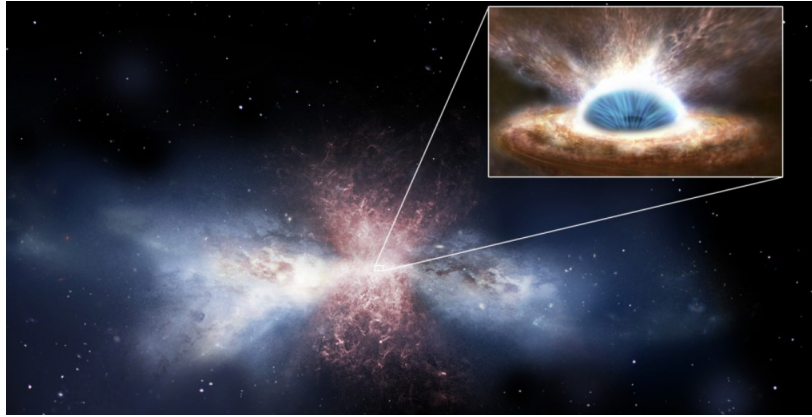
We propose to test the possibility of implementing an OTF raster mapping mode for FIFI-LS. This mode will be almost identical to that used by the GREAT instrument and to take full advantage of the common KOSMA translator interface. We estimate this mode could increase the efficiency of large mapping done with FIFI-LS in total power mode by about 30 integrations on large maps. In addition, OTF mapping will result in better self-flat-fielding of the data,

since more FIFI-LS spaxels will integrate on the same positions on the sky. In summary, OTF mapping with FIFI-LS would greatly improve the data obtained with the instrument by improving the flat-fielding and spatial sampling, enable rapid mapping of large sources, avoid the difficulties of finding nearby chop positions without emission, and simultaneously increase observing efficiency by reducing the telescope overheads

## 7 Star-formation efficiencies in nearby, optically luminous Quasars

**AOR ID:** 08\_0226 **PI:** Andreea Petric

**Comments:** FFI guided; 129 minutes requested in DCS; 150 minutes planned in DCS; 75 of 108 minutes in this series; 75 on MAXINE (this flight); 33 on MILDRED



Most bulge-dominated galaxies have at their centers black holes with masses that tightly correlate with the masses of their hosts' bulges. This may indicate that the black holes may regulate galaxy growth, or vice versa, or that they may grow in lock-step. The quest to understand how, when, and where those black-holes formed motivates much of extragalactic astronomy. The [CII] 157.74 micron fine structure line of singly ionized carbon has been calibrated both as a measure of star-formation rates and as a way to estimate the star-formation efficiencies. Recent SOFIA observations of [CII] in nearby low-luminosity AGN suggest that: high ratios of [CII] to FIR may be associated with obscured AGN outflows and that the [CIII] may be at the interface between warm and cold gas in those outflows. The observations we propose here will test whether luminous, obscured AGN have higher [CII]/FIR ratios than luminous, non-obscured AGN.