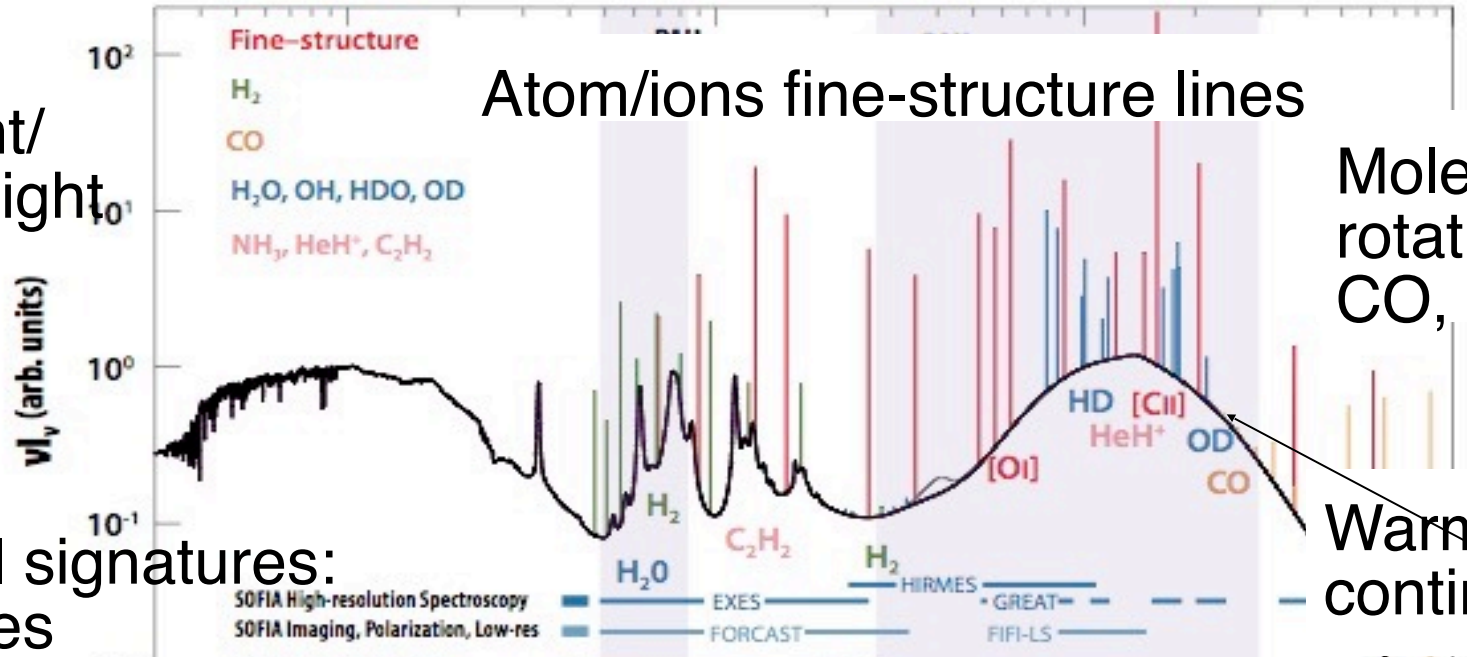
SOFIA Open Calls for Proposals: what you need to know

SOFIA
Stratospheric Observatory for Infrared Astronomy

NASA DLR USRA DSI

Why Infrared Astronomy?

Some starlight/ reflected starlight



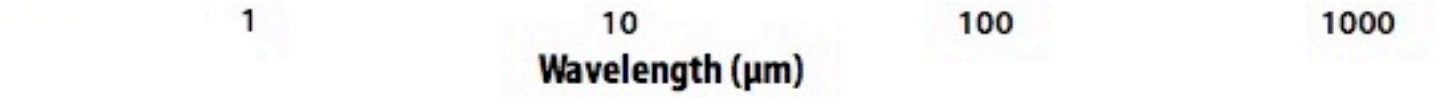
Atom/ions fine-structure lines

Molecular ro-vibrational / rotational lines: HDO, HD, CO, H_2O

Dust spectral signatures: PAHs, silicates

Warm and cold dust continuum thermal emission

Mostly re-radiated starlight, probes the cold-ish universe

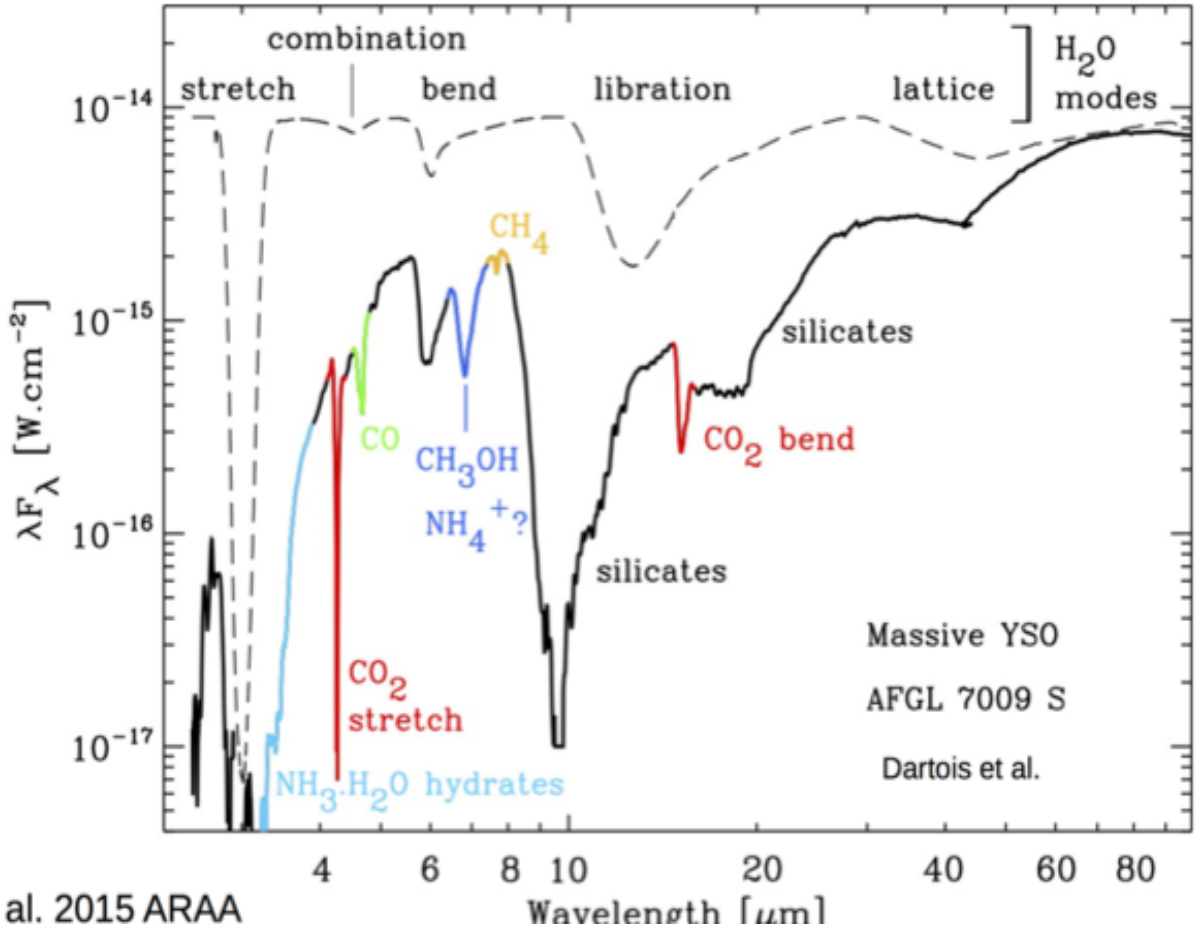


Why Infrared Astronomy?

Dust/ice spectroscopy/photometry:

- composition
- size distribution
- morphology (imaging)
- polarization fraction/orientation

- role in heating / cooling
- role in solid/gas chemistry
- role in hydrodynamics
- magnetic field coupling



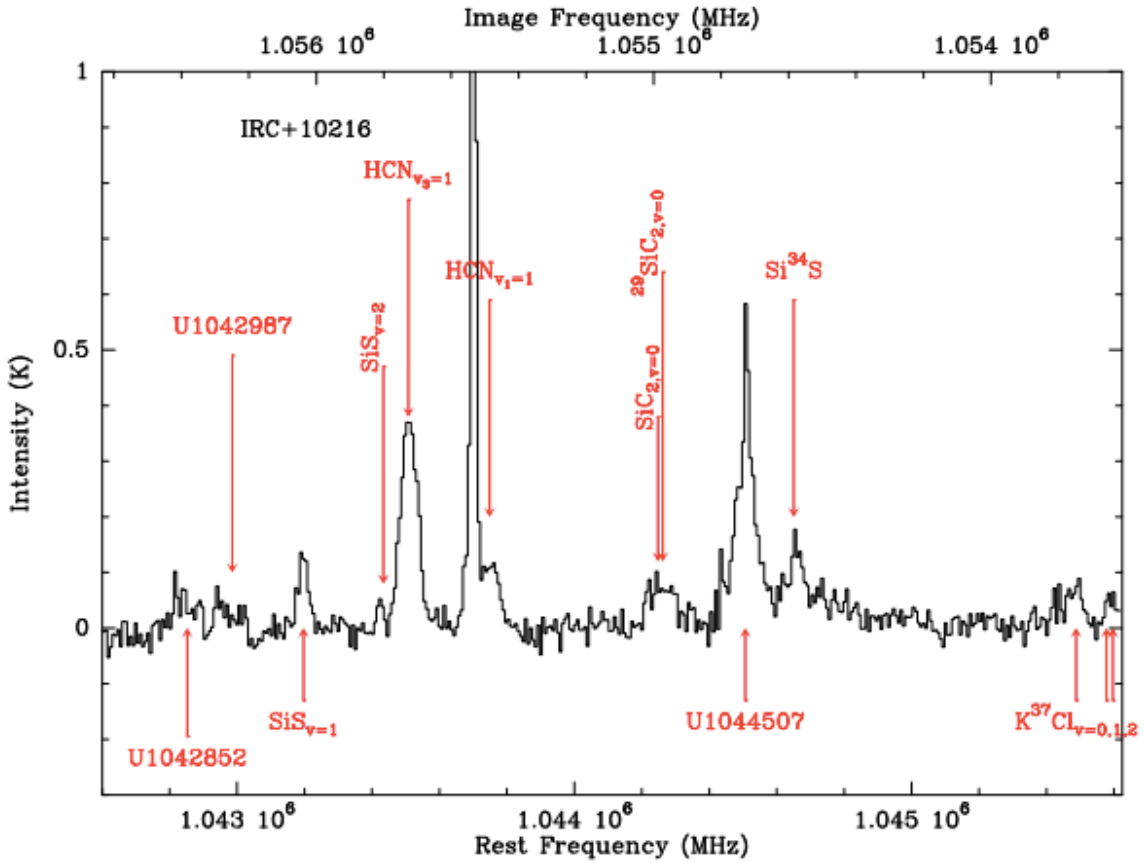
Boogert et al. 2015 ARAA

Why Infrared Astronomy?

Gas spectroscopy:

- composition
- kinematics
- temperature structure
- H_2(2-0)-para: 28 um, H_2(3-1)-ortho: 17 um, water rotational lines > 35 um

- morphology (imaging): [OIII] tracing energetic UV fields
- [CII] role in heating/ cooling ([CII])
- C, Na, Mg, Al, Si, S, Ca, Fe, Ni can all be easily ionized by background starlight -



Siebert et al, 2020: GREAT spectrum of IRC+10216

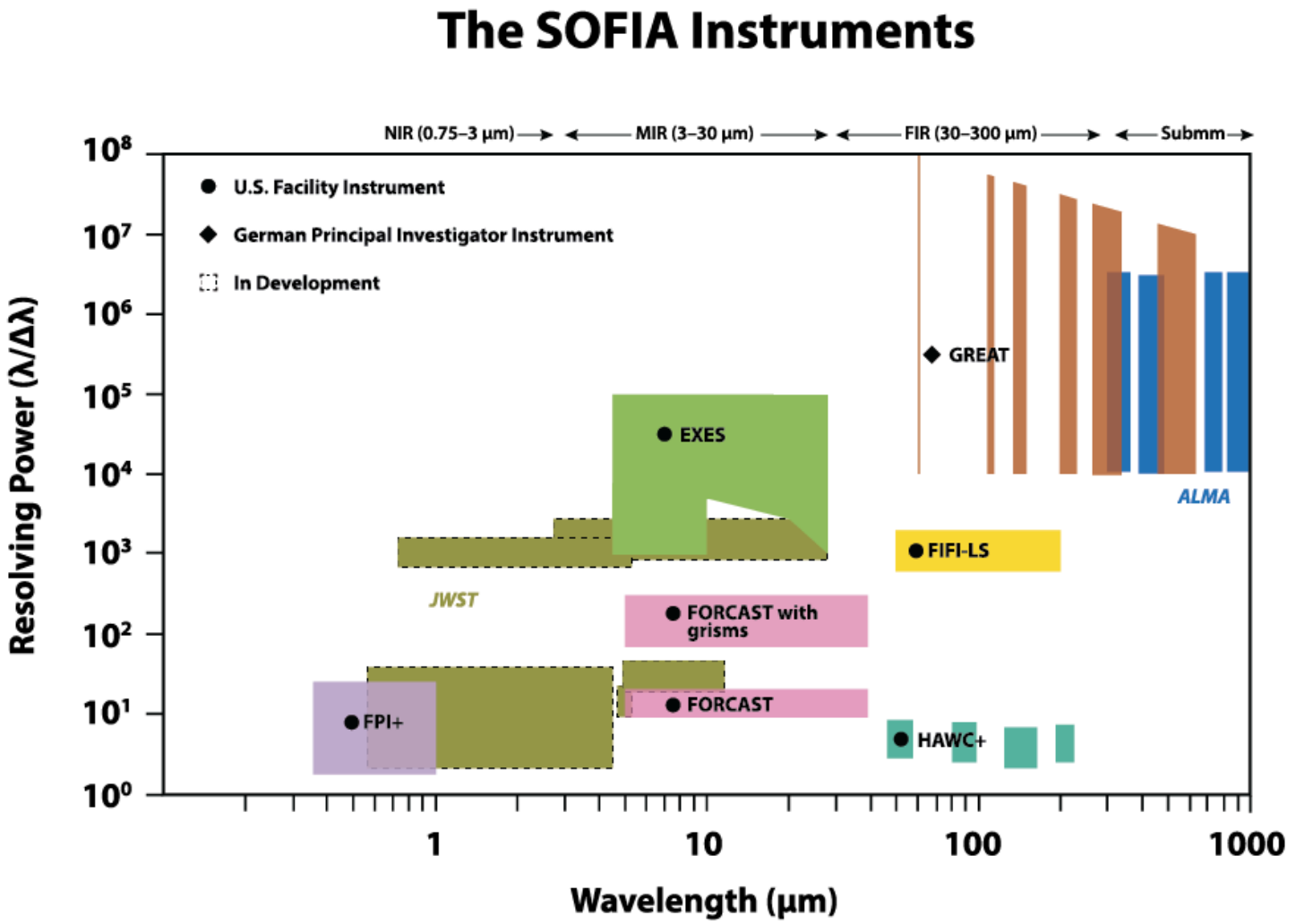
SOFIA: a flying platform for IR at 45+ feet

2.5 m effective diameter mirror

Covers most of the Mid and Far-IR spectrum (5-600 μm), at a variety of spectral resolutions

Instruments installed for series of flights (1-4 weeks each)

Instrument schedule based on proposal pressure



FORCAST: MIR Imager + grisms

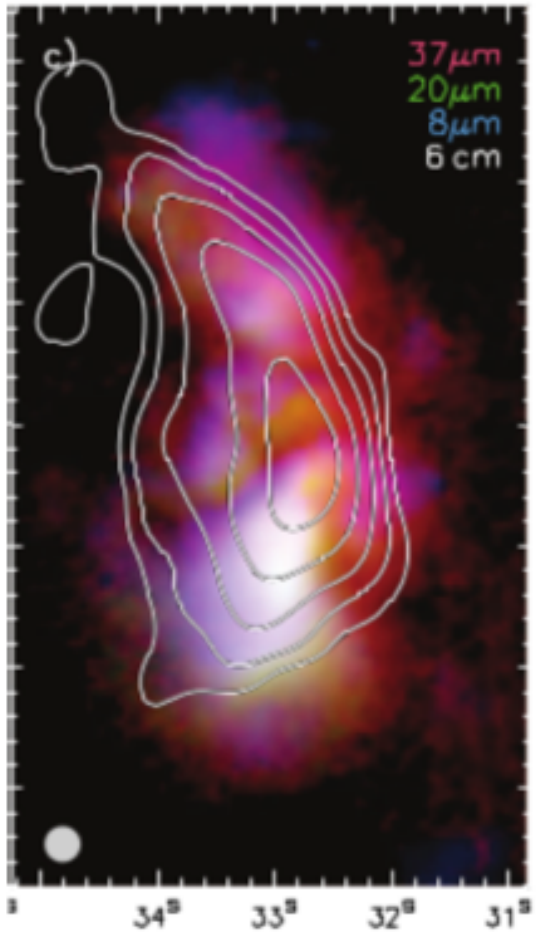
- **5-40 microns**
- 256x256 pixels array
- **R~70-300** with grisms
- PAHs, amorphous silicates, atomic/ ionized features, does not saturate on bright sources

Grism Details

Grism	Coverage (μm)	R (λ/Δλ)[a]
G063	4.9–8.0	120[c]/180
G111	8.4–13.7	130[c]/260
G227	17.6–27.7	110/120
G329	28.7–37.1	160/170[b]

Filter Parameters

SWC Filters		LWC Filters	
λ_{eff} (μm)	Δλ (μm)	λ_{eff} (μm)	Δλ (μm)
5.4	0.16	24.2	2.9
5.6	0.08	31.5	5.7
6.4	0.14	33.6	1.9
6.6	0.24	34.8	3.8
7.7	0.47	37.1	3.3
8.8	0.41	A subset of these will be chosen each cycle as the nominal set.	
11.1	0.95		
11.2	2.7		
11.3	0.24		
11.8	0.74		
19.7	5.5		
25.4	1.86		



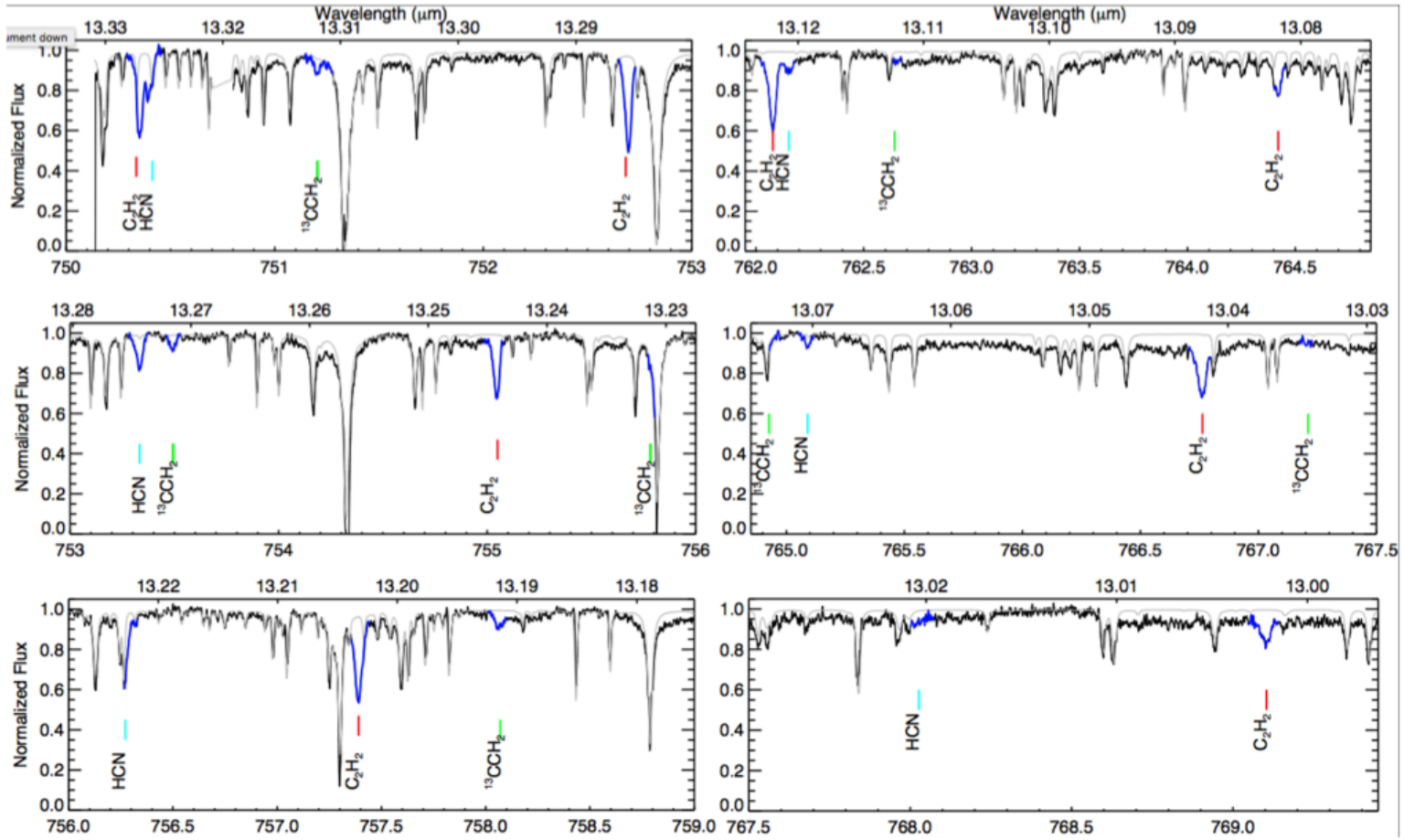
W51A - G49.5 (Lim et al., 2019)

EXES: High-res MIR Spectrometer

- Mid-IR High-Resolut ɒn Spectrograph: **4.5-28.3 µm**
- *Slit mapping mode available*

Configuration	Slit Length	Spectral Resolution
Low	25”– 180”	1,000 – 3,000
Medium		5,000 – 20,000
HIGH_MED	1.5” – 45”	50,000 – 100,000
HIGH_LOW	1” – 12”	

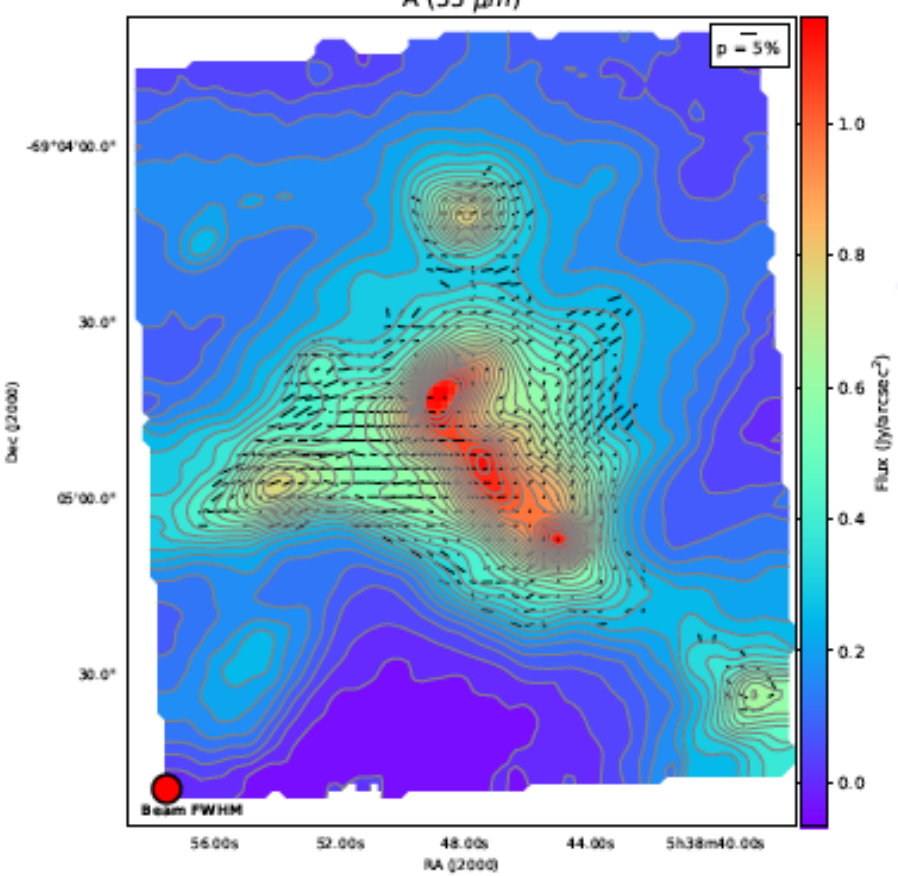
In the Medium and Low configurations the slit lengths vary from 25” to 180” depending on the number of rows to be read.



Orion Hot Core line survey (Rangwala et al. 2018)

HAWC+: FIR Polarimetric Imager

30Dor polarization map
(Gordon et al., 2018)



- **53-220 microns , 64x40 array**
- Superconducting TES
- **Polarimeter (half wave plates)**
- Diffraction limited at all bands
- dust polarization and distribution

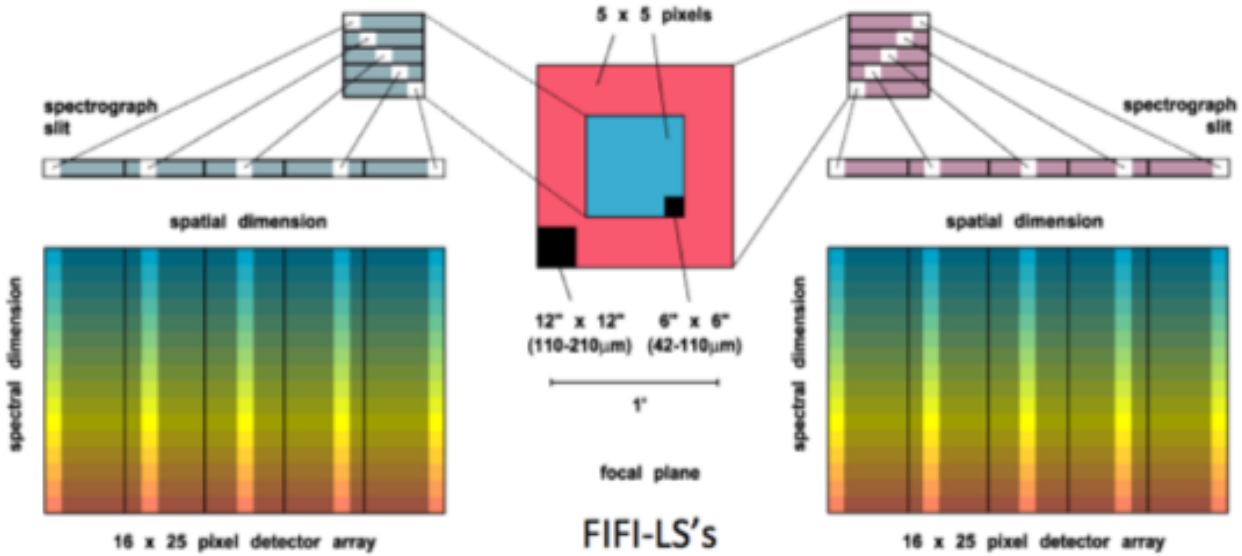
Band / Wavelength	Δλ/λ	Angular Resolution	Total Intensity FOV (arcmin)	Polarization FOV (arcmin)
A / 53 µm	0.17	4.7" FWHM	2.7 x 1.7	1.3 x 1.7
C / 89 µm	0.19	7.8" FWHM	4.2 x 2.6	2.1 x 2.6
D / 154 µm	0.22	14" FWHM	7.3 x 4.5	3.6 x 4.5
E / 214µm	0.20	19" FWHM	8.0 x 6.1	4.0 x 6.1

FIFI-LS: FIR Integral field Spectrometer

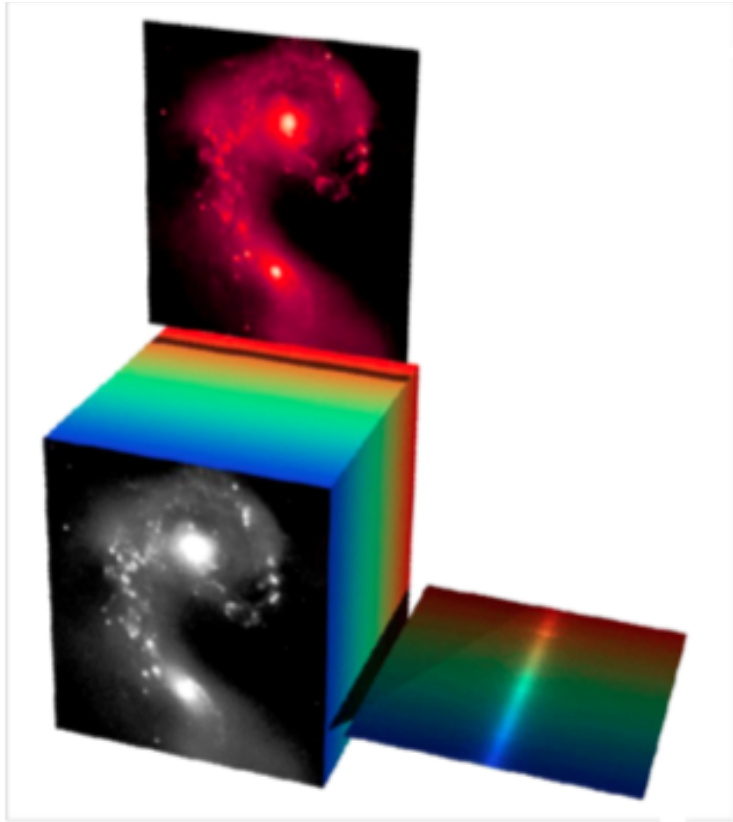
FIFI-LS: Far-infrared spectrometer with two parallel channels and an integral field unit:

Blue 50-110 μm & Red 110-200 μm

Spectral resolution: R=500-2000



FIFI-LS's image slicer concept

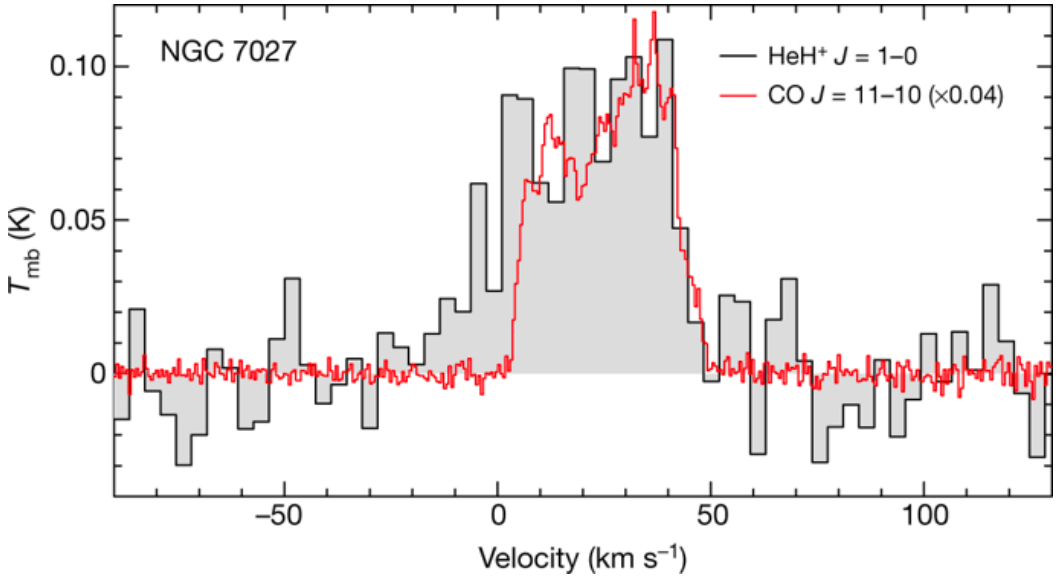


Standard pipeline product is a *datacube*.

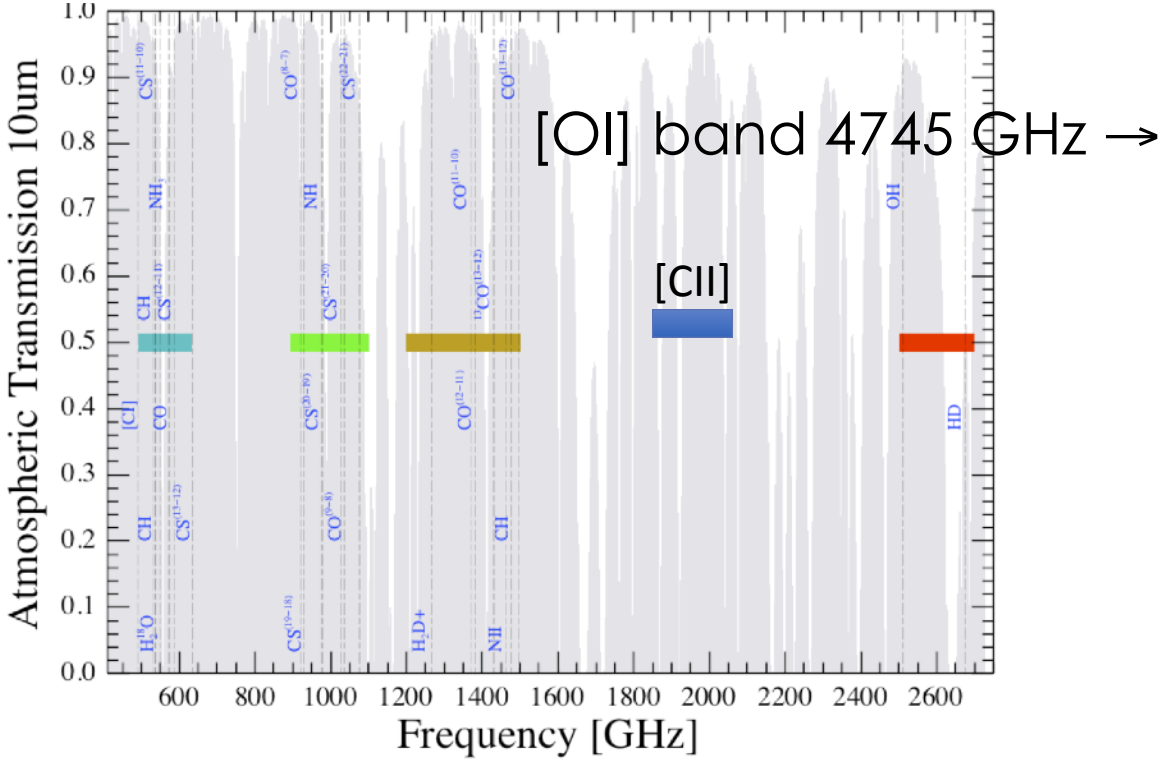
GREAT: THz heterodyne spectroscopy

- Six bands in the 0.5 – 4.7 THz range
- Two bands with 7-beam array (2 polarization), 4 bands with 1 pixel

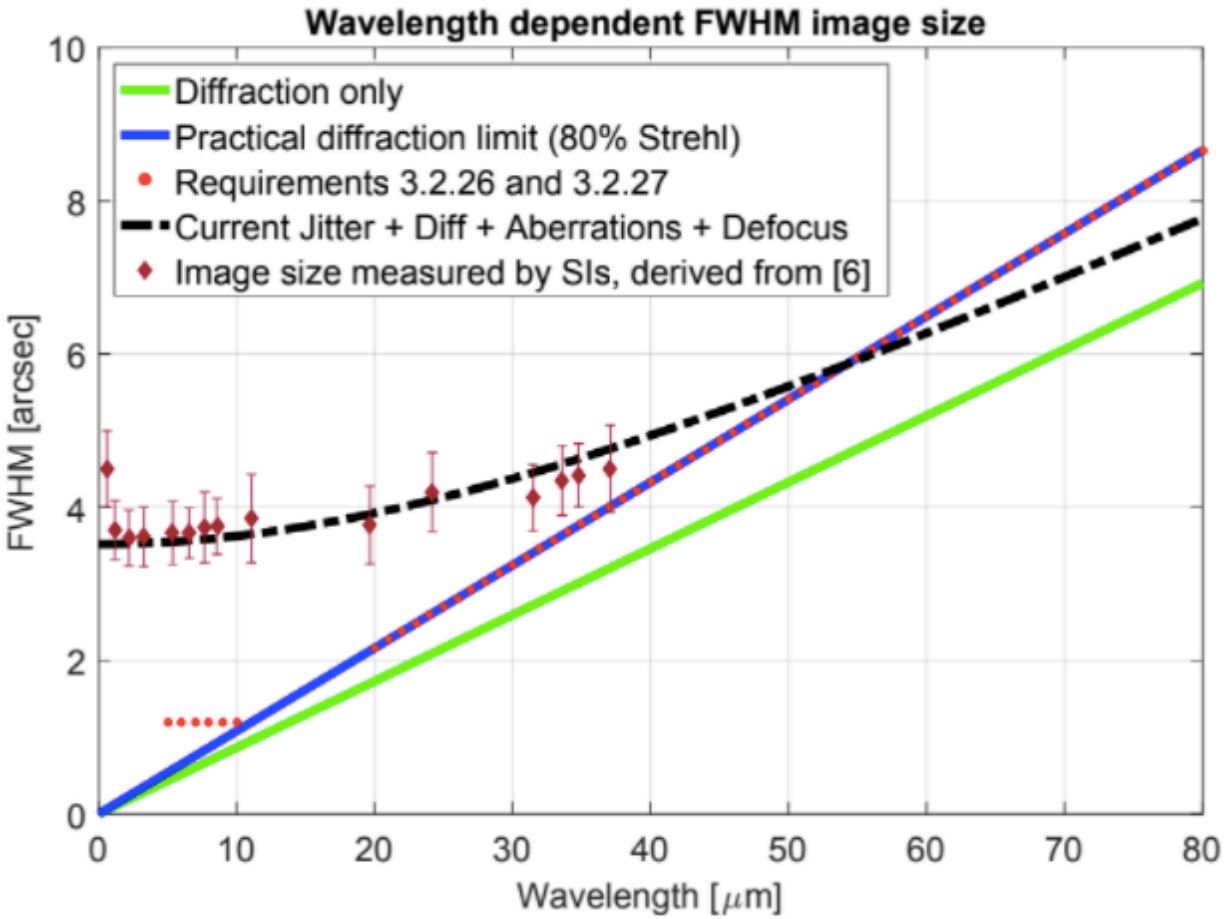
- R = 10^8 (<0.1 km/s!)
- Compares to Herschel-HIFI, with faster mapping and similar point source sensitivity



HeH+ first detection (149μm, NGC 7027), Güsten et al. (2019) Nature 568, 357.



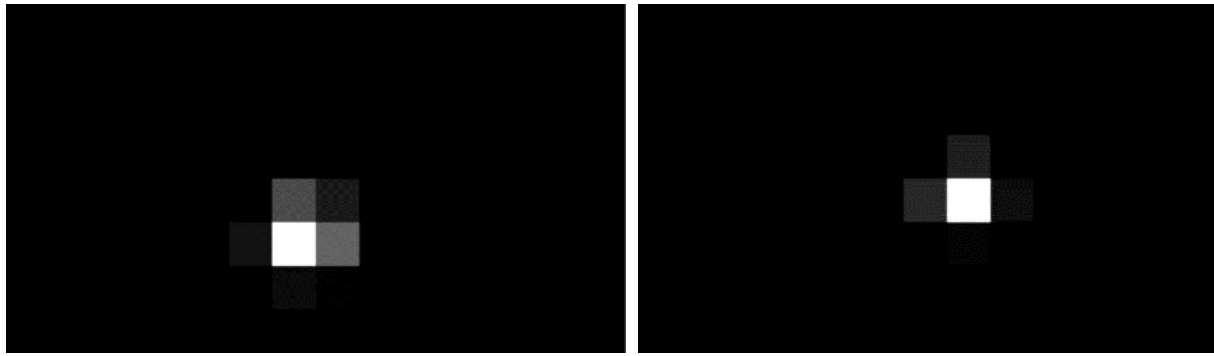
Optics and Imaging



PSF FWHM ~ 3.5” at short wavelengths, **diffraction limited >35 um**.

PSF contribution comes from Pointing jitter + Diffraction + Aberrations + Defocus

Image stabilization : 50 Hz updates to tip-tilt secondary mirror



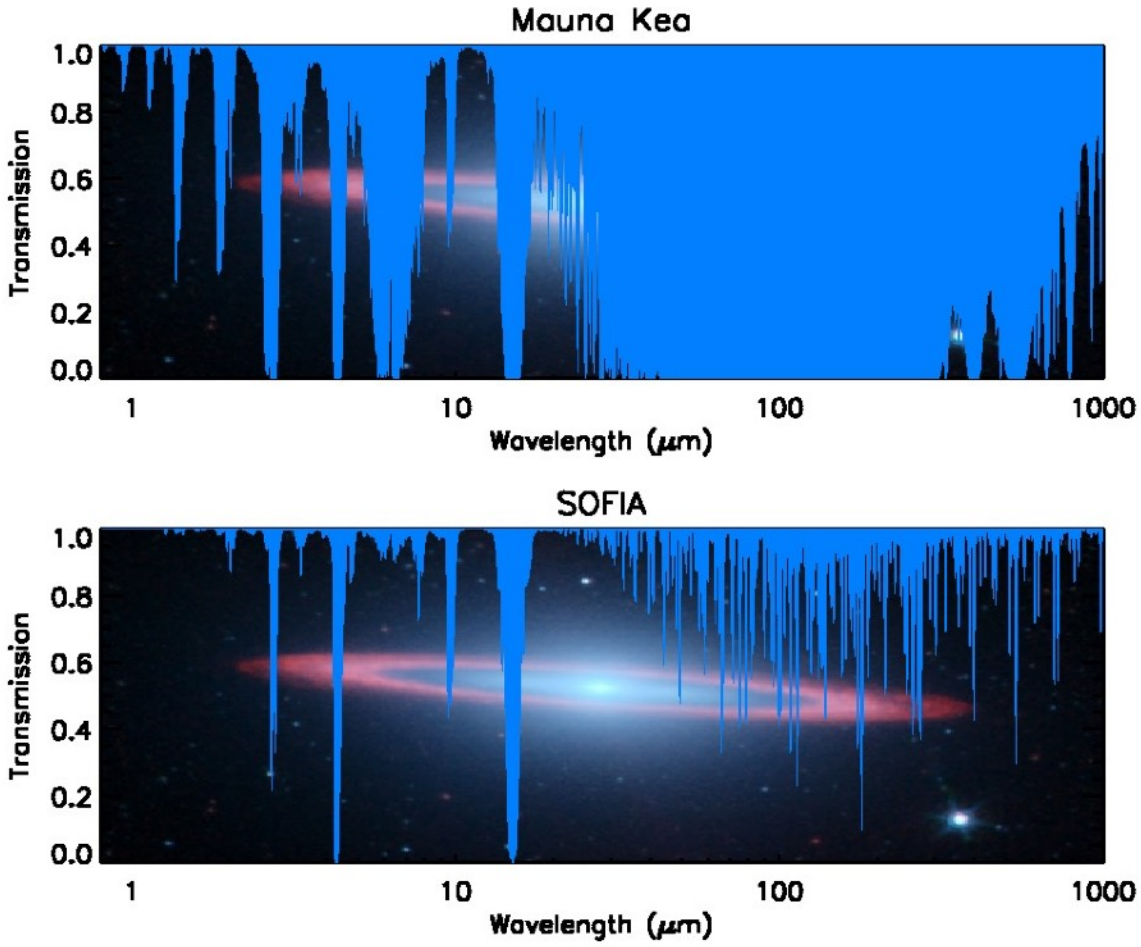
off on

A flying telescope: some considerations

SOFIA flies above ~99% of water vapor in the atmosphere, **but remaining 1% is still significant…**

- SOFIA pwv: 4 – 27 um (45k – 35k feet)
- Mauna Kea pwv: 0.8 – 4.5 *mm*

Maximum leg length ~ 4 hours : easier to schedule observations which can be easily 'chopped' in a few hours chunks



SOFIA Open observing calls

- Cycle 10 Call For Proposals: observations + funding
  Deadline January 28, 2022 21:00 PST (January 29, 2022 05:00 UTC)

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- Directors' Discretionary Time (DDT): observations
  Proposals accepted year long
  New sources / time-critical / pilot technique testing / flight plans gaps / Short observations necessary to complete a publication / PhD

What is offered in Cycle 10

In short:

- Oct 1, 2022 to Sep 30, 2023

- All six instruments

- 4 instruments deployed to the South
GREAT and HAWC + (June-Sep 2022)
FIFI-LS (Fall 2022), EXES (Spring 2023)

New:

- new sub-category of programs '**Multi-Cycle Target Monitoring**' , for up to three cycles

- EXES going to the South

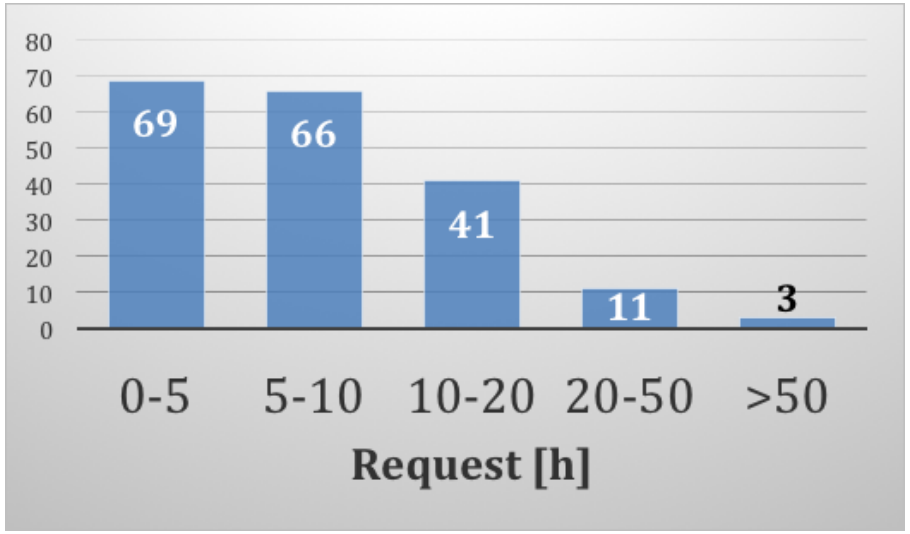
- Joint proposal opportunity with GBO, IRTF

- Up to 20 hours reserved for JWST support

What is offered in Cycle 10

2 different types of proposals

- **Regular**: ~ 550h total



- **Legacy:** "programs targeting a rich archival dataset of significant scientific value to the astronomical community for future analysis."
1-3 large proposals, up to 200h observations each over 2 cycles. No proprietary period, team contributes enhanced products. GREAT not offered

What is offered in Cycle 10

Associated funding (for US-institutions only)

- Up to $5.5M for Regular Proposals (~$10k/ h)
- **New: minimum $75K grant**
- Up to $2M / year for Legacy Proposals

- Additional funding can be requested through the Thesis-enabling Program (up to two years of graduate student funding)

Preparing your proposal

Science case

Evaluate feasibility

Define observations in USPOT

Upload justification and bio pdfs

Validate then Submit!
Deadline Jan 28th, 21h PST

Science case tips

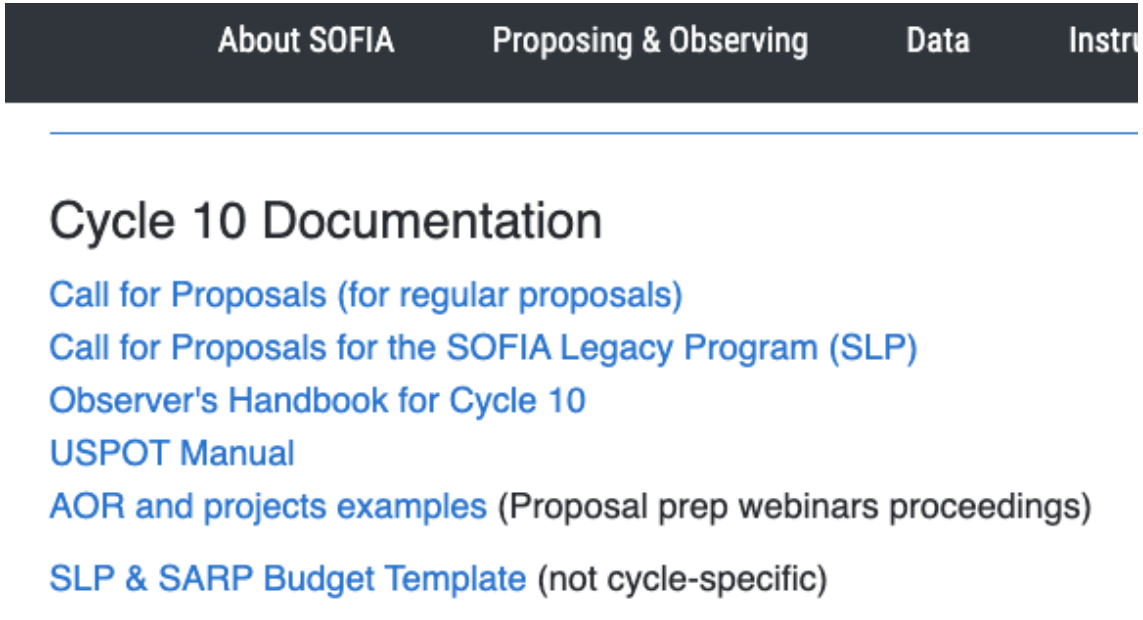
- Substantial investigations that demonstrate significant scientific impact
- Degree to which the investigation uses SOFIA's Unique capabilities.

- Programs using multi-wavelength data from major facilities (ALMA, HST, Spitzer, etc) are highly encouraged

-Up to 20 hours reserved for programs informing accepted JWST observations

- Survey proposals are encouraged. Plan is to have up to 100 hours for survey proposals.

Support documents and tools



Call For Proposals

Observers' Handbook

Time estimates: SITE

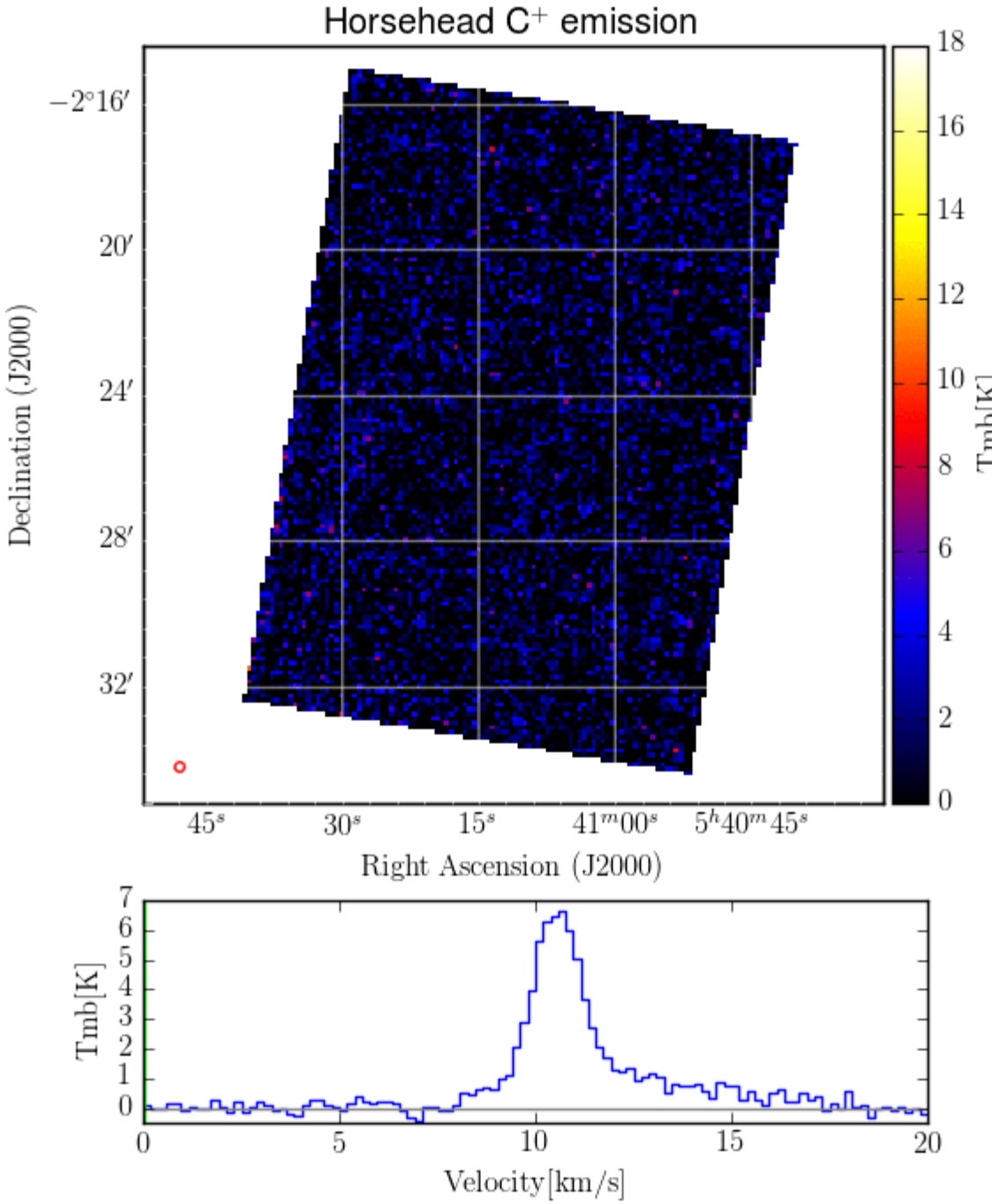
USPOT (to download)

Any missing information: Help Desk
sofia_help@sofia.usra.edu

Feasibility: Signal

Expected source signal: needs to be soundly justified!
- archival data (possibly w. SED extrapolation)
- your own radiative transfer model (describe)
- classic models/ correlations: Hyperion (dust), Planetary Spectrum Calculator, Meudon PDR ...

Signal must be defined by **flux density by beam/ pixel or surface brightness** (depends on instruments)



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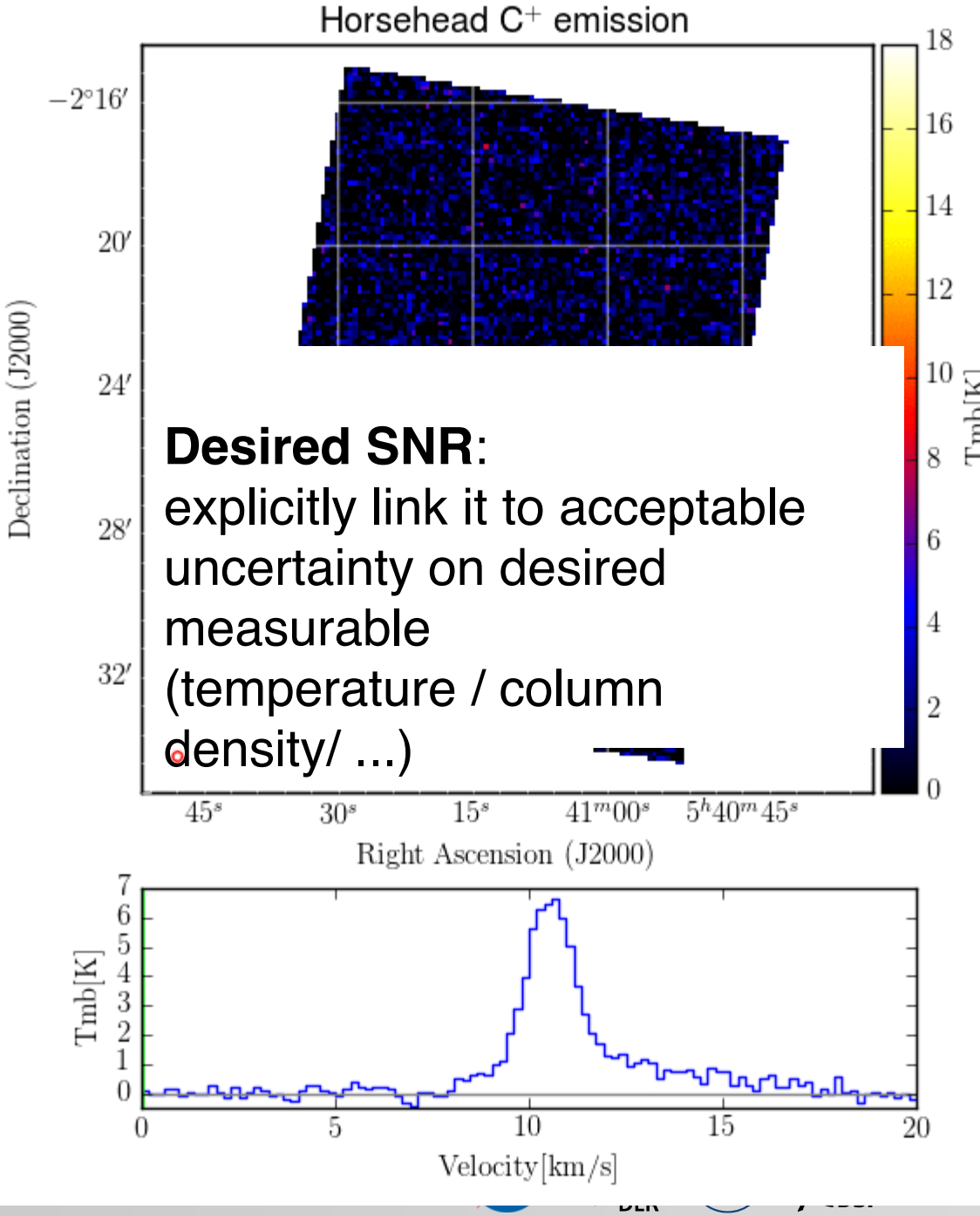
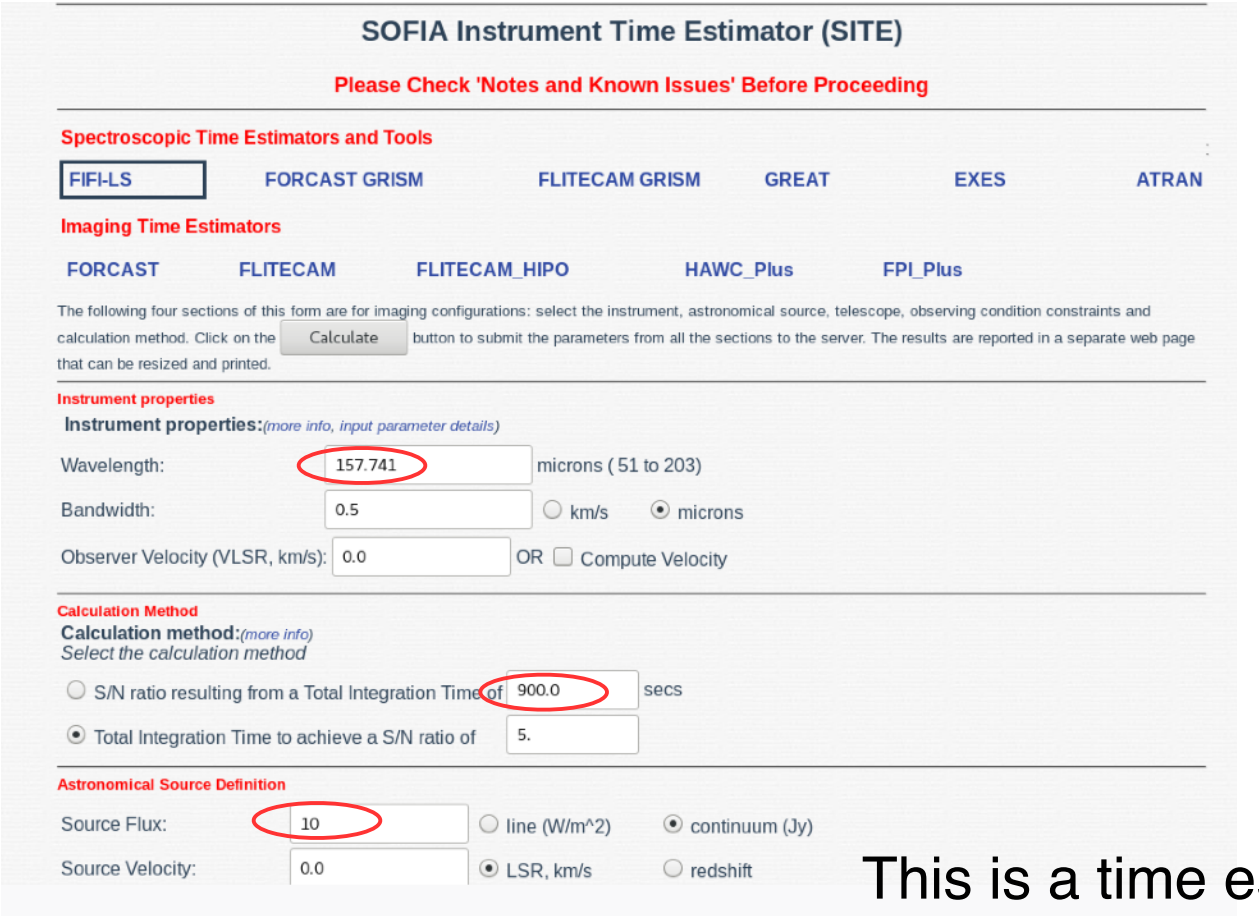


SITE: estimating corresponding observing time



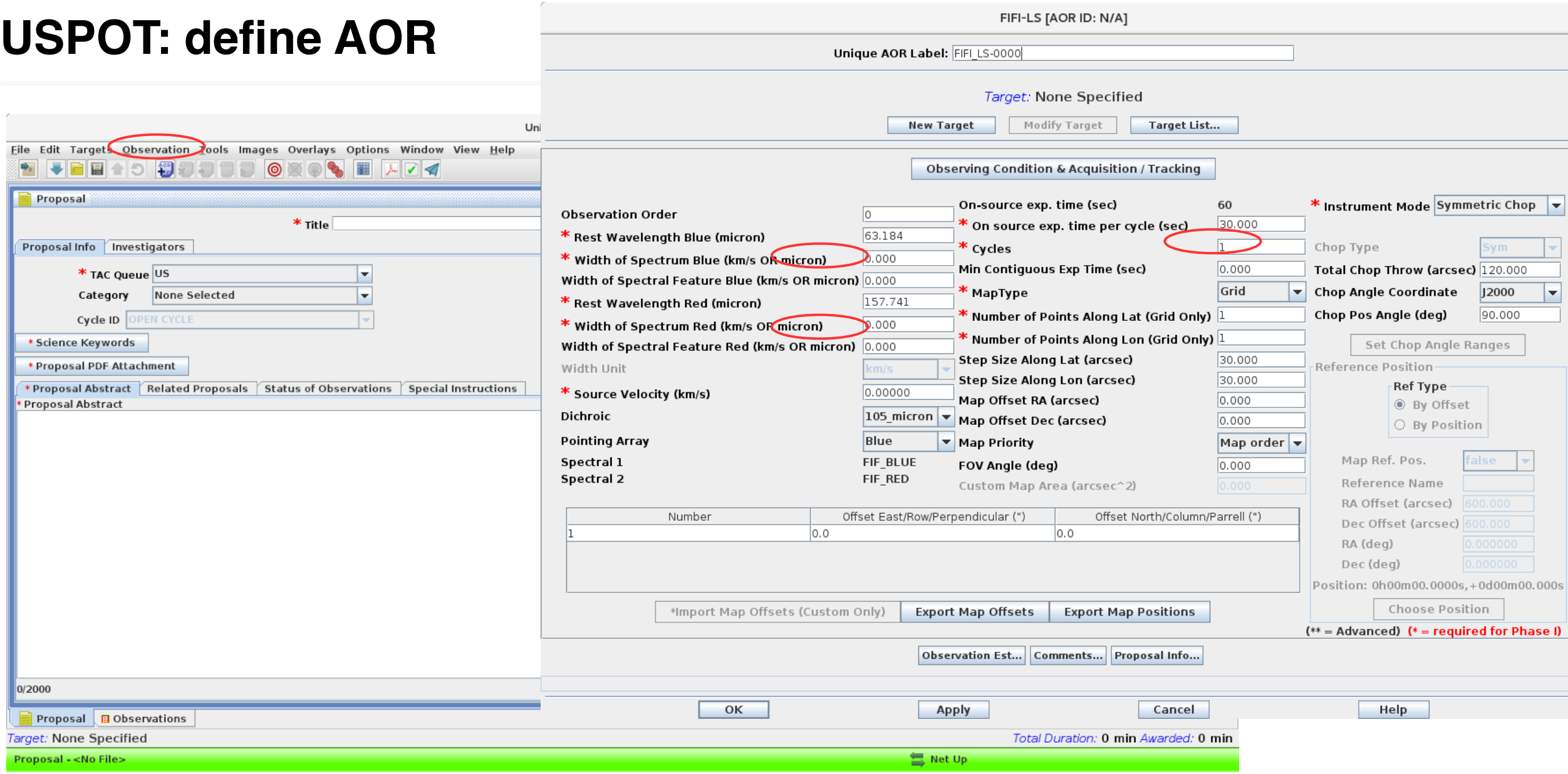
https://dcs.arc.nasa.gov/proposalDevelopment/SITE/index.jsp

Output Parameters

V_LSR:	0.000	km/s
Velocity corrected Wavelength:	157.741	microns
Plotted wavelength range:	156.938 - 158.544	microns
Interpolated values from data table:		
Bandwidth =	0.803	microns
MDLF =	2.087e-17	W/m^2
MDCF =	0.570	Jy
Atmospheric Transmission:	0.843 (smoothed)	0.862 (unsmoothed)
Integration time (t_on):	0.107 (smoothed)	0.102 minutes (unsmoothed)

This is a time estimate **per ON point or ON-OFF pair , per array element, does not include calibration overheads**

USPOT: define AOR



Write and upload justification pdf (main body)

- Context, aim, methods, synergies, anticipated results (0.5p / 1p)
- Scientific justification (3p + references / 5 p)
  Don't forget instrument and data justification
- Feasibility + path to publication (3p)
  Instrument and modes, exposure time, time constraints
- For Legacy only: Budget (2p), Implementation (2p)
- Thesis enabling program (1 p)

Justification PDF must follow Dual Anonymous Guidelines
The TAC will not know the identity of the proposers during the science review

SOFIA Townhall: now! (10 am Pacific)

Helpdesk: sofia_help@sofia.usra.edu

Newsletter sign up:

Next opportunities in 2022

- SOFIA School: February 2-4, online
- ‘Galactic Ecosystems’ conference, Feb 28- March 4, Lake Arrowhead CA
- Archival Research Funding Call Spring 2022 (details TBD)