SALTUS: *Single Aperture Large Telescope for Universe Studies*

- 14m Reflector
- ≤ 45K Optics
- Coherent & Incoherent Spectroscopy/Imaging
- ~30 to 660 μm
- >5 yrs Baseline Mission
- ≥ 4 yrs of Guest Observations

Addresses many Science Objectives within the Astro 2020 Decadal

Far-IR Space Observatories

IRAS 1983

0.57m
2º K
~0.8 yr

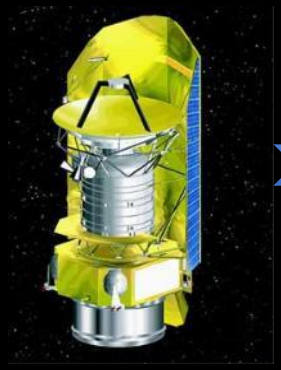
26yr

ISO
SWAS

Odin
Spitzer
AKARI

$0.199 B

Herschel 2009



3.5m
~80º K
3 yr

$0.776 B

22yr

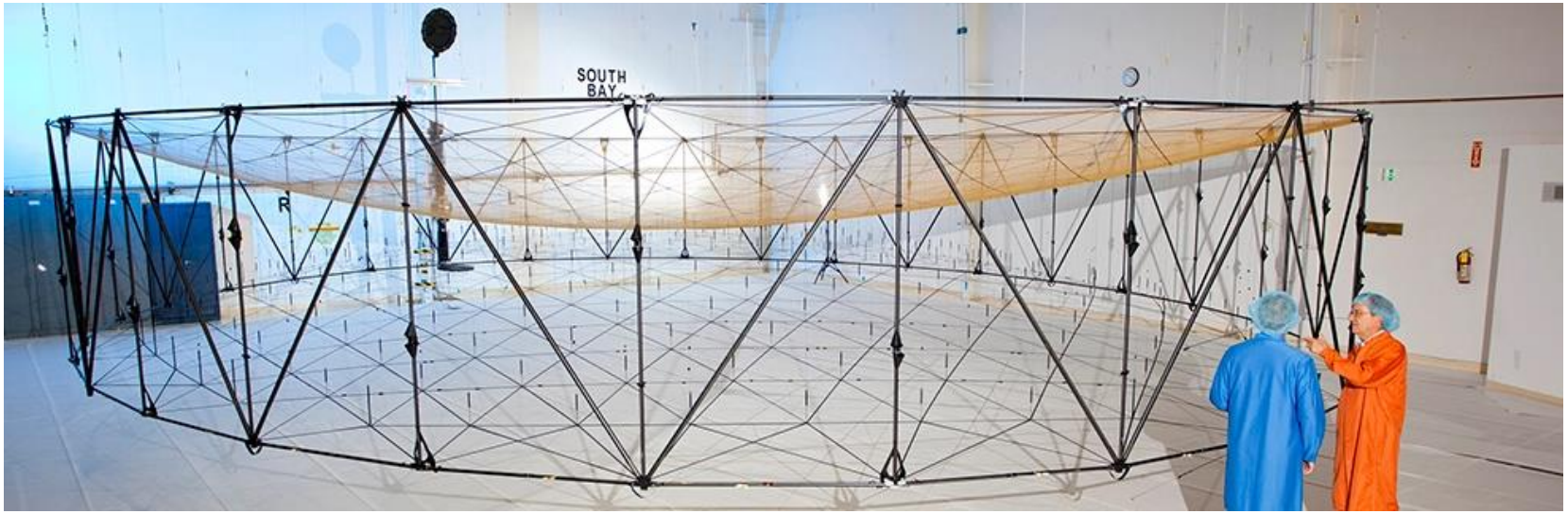
SALTUS 2031

14m
~45K
>5 yr

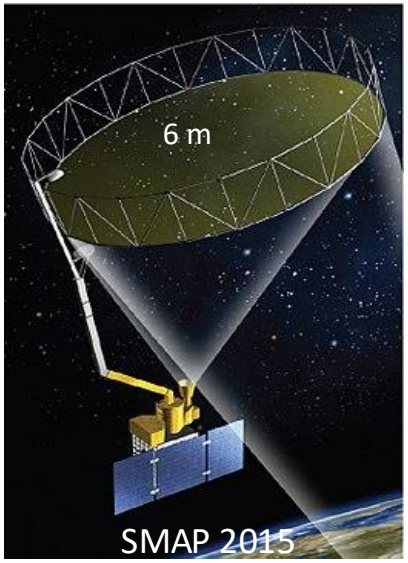
$1 B
How?

Paradigm Shift in realizing far-IR space apertures

SALTUS Truss

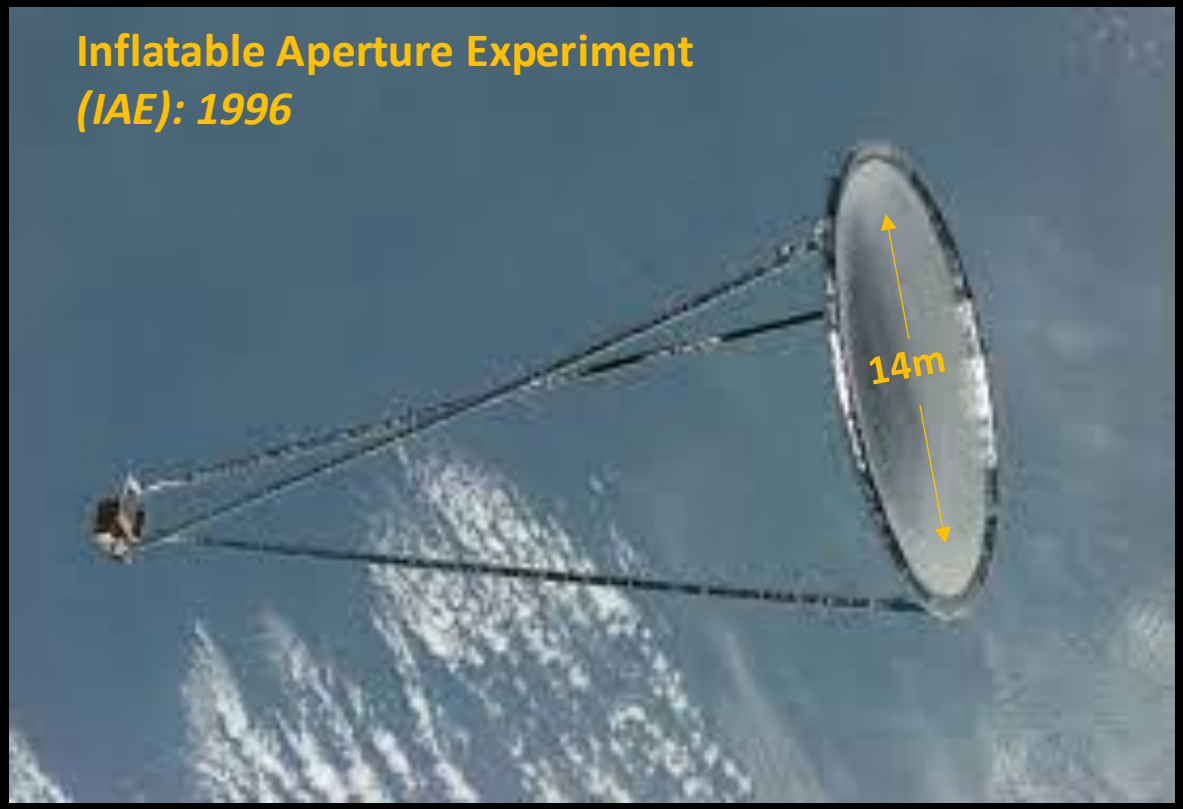


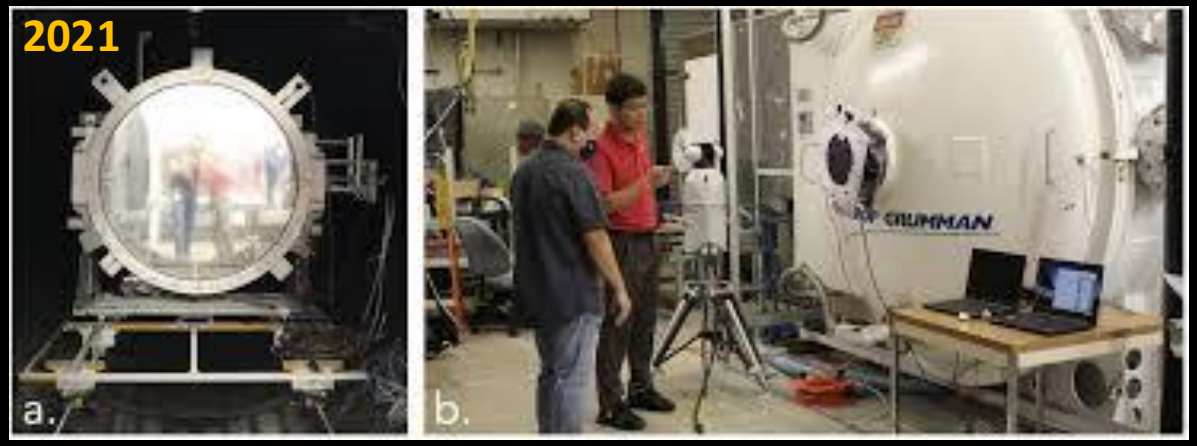
Space Rated 25 m version available



AstroMesh® Reflector Technology

100% On-Orbit Success – No Failures – No Anomalies



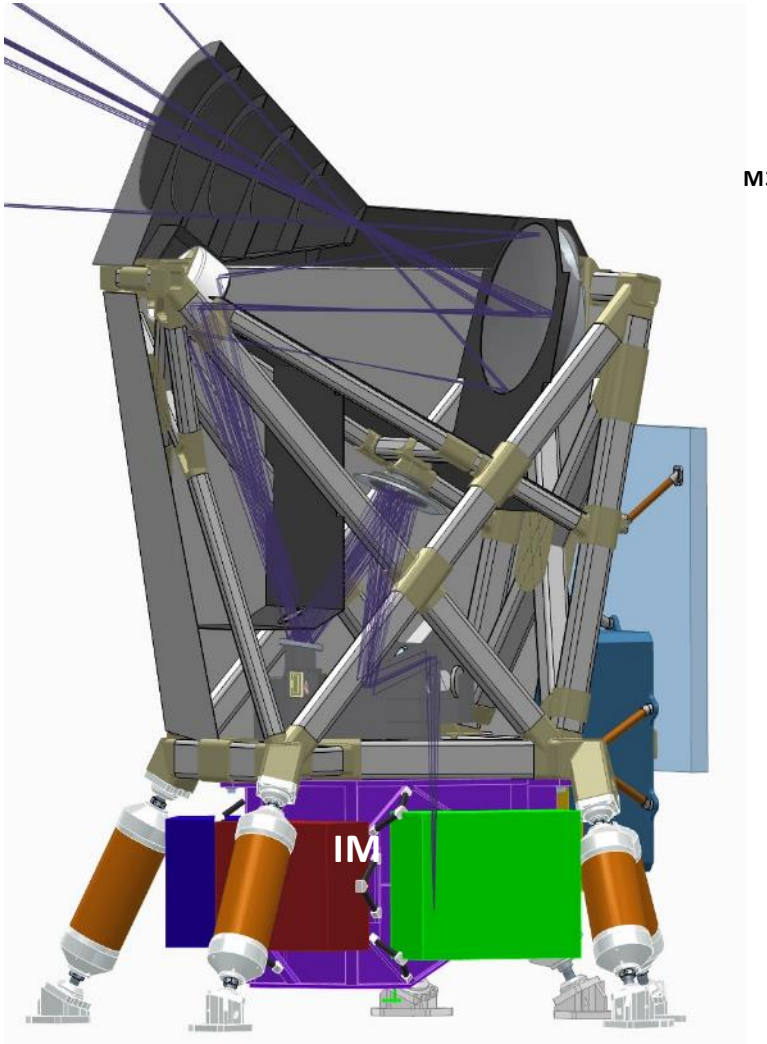


25 years of Advancement

Surface Measurement of a Large Inflatable Reflector in Cryogenic Vacuum
(Quach, et. al. 2021; Special Session, Proceedings SPIE, 24 August 2021, >100 pages)

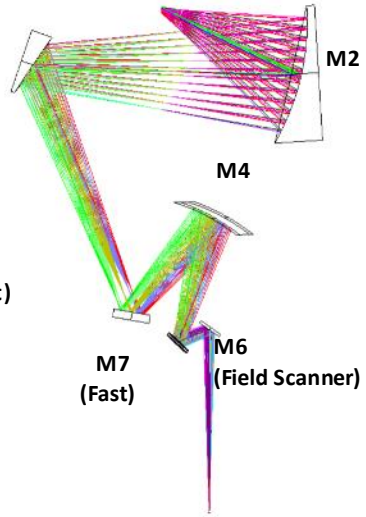
SALTUS Corrector/Instrument Modules

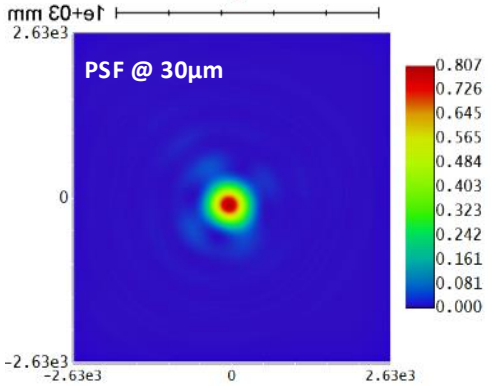
from **M1**



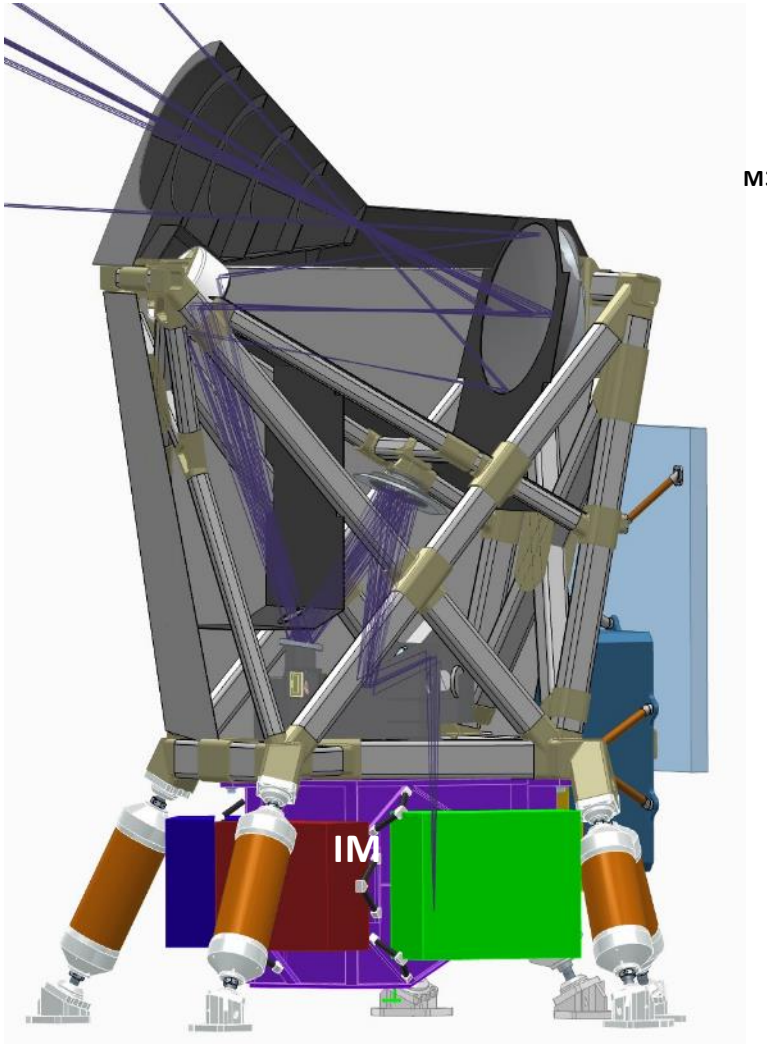
from **M1**

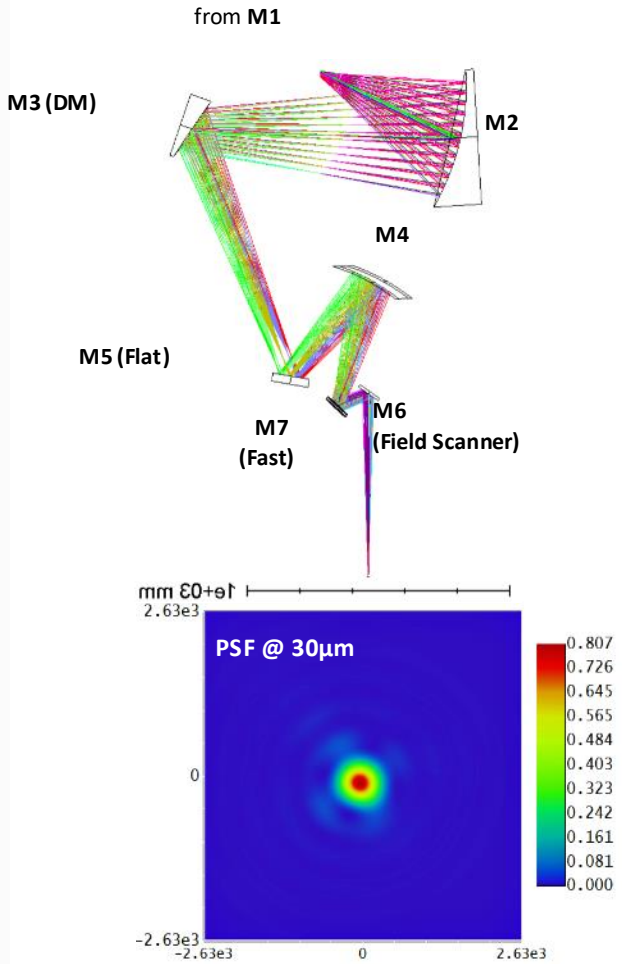
M3 (DM)





SALTUS Corrector/Instrument Modules



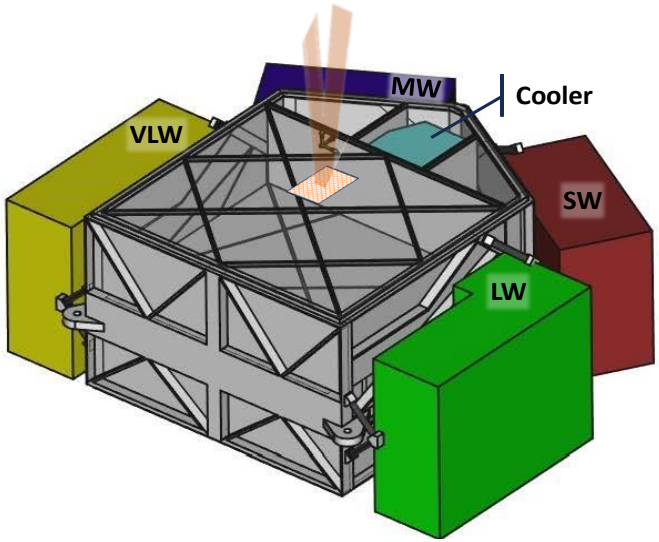


See our architecture poster, Monday June 17, 13092-235

The SAFARI-*lite* instrument - overview

Far-IR grating spectrometer

- 4 bands in the 35-240 µm domain, co-aligned on sky
  - Lower edge limited by KID technology
  - Instantaneous contiguous coverage
- Interlaced KID arrays provide R~300 after processing
  - ~180 pixels in spectral direction
  - 6 pixels in spatial direction
- Sensitivity 5 σ /1hr: ~10^{-20} W/m^2
- Warm electronics
  - Instrument power, monitoring and control
  - Detector control and read-out
- Observing modes
  - Point source staring mode
  - (small) raster maps
  - on-the-fly mapping
  - 'continuum' measurements by averaging spectral channels

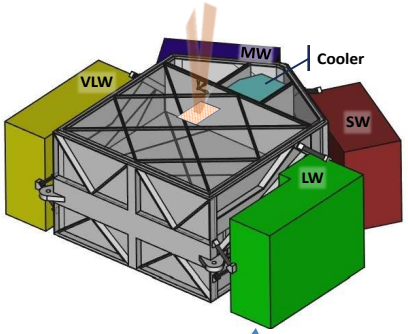


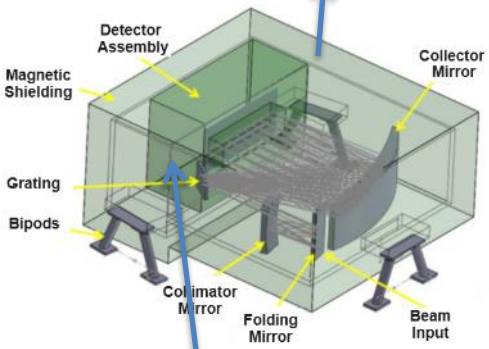
	SW	MW	LW	VLW
Band center / µm	45	72	115	185
Wavelength range / µm	34-56	54-89	87-143	140-230
Band center beam FWHM	0.66"	1.1"	1.7"	2.7"
Point source spectroscopy – R300 (5σ-1hr)				
Limiting flux / x10^{-20} Wm^{-2}	0.5	1	2	2
Limiting flux density / µJy	20	75	250	400
Mapping spectroscopy 1 arcmin2 – R300 (5σ-1hr)				
Limiting flux / x10^{-20} Wm^{-2}	5	5	6	4
Limiting flux density / mJy	2	4	7	7
Photometric mapping 1 arcmin^2 – R1 (5σ-1hr)				
Limiting flux density / µJy	170	330	670	670
Confusion limit / µJy	<0.1	0.6	12	60
Saturation flux density / Jy	15	25	40	50

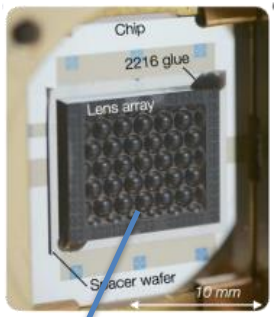
The SAFARI-*lite* Detector Modules

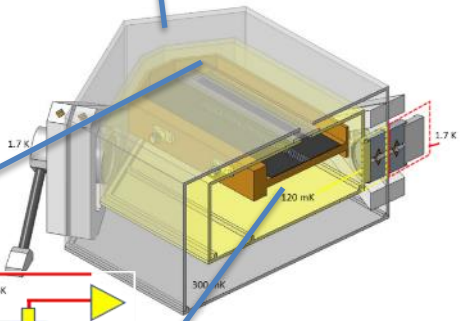
- KID arrays with lenses and readout at 100mK
- Several temperature between 5K and 100mK
  - Actual levels still TBC

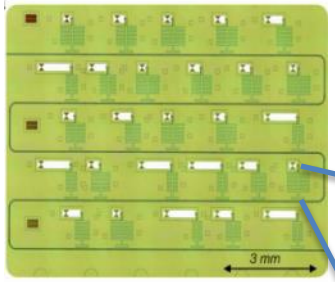
Next Talk

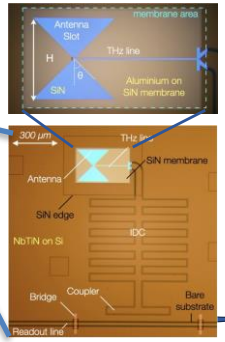


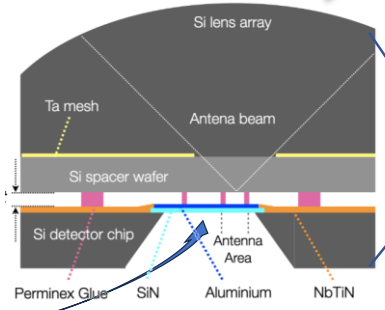


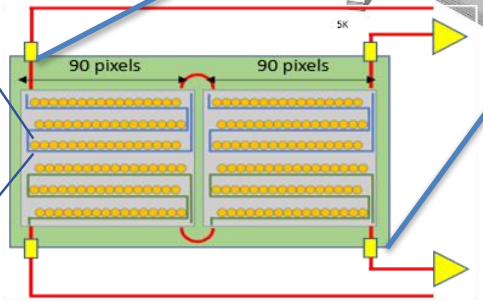




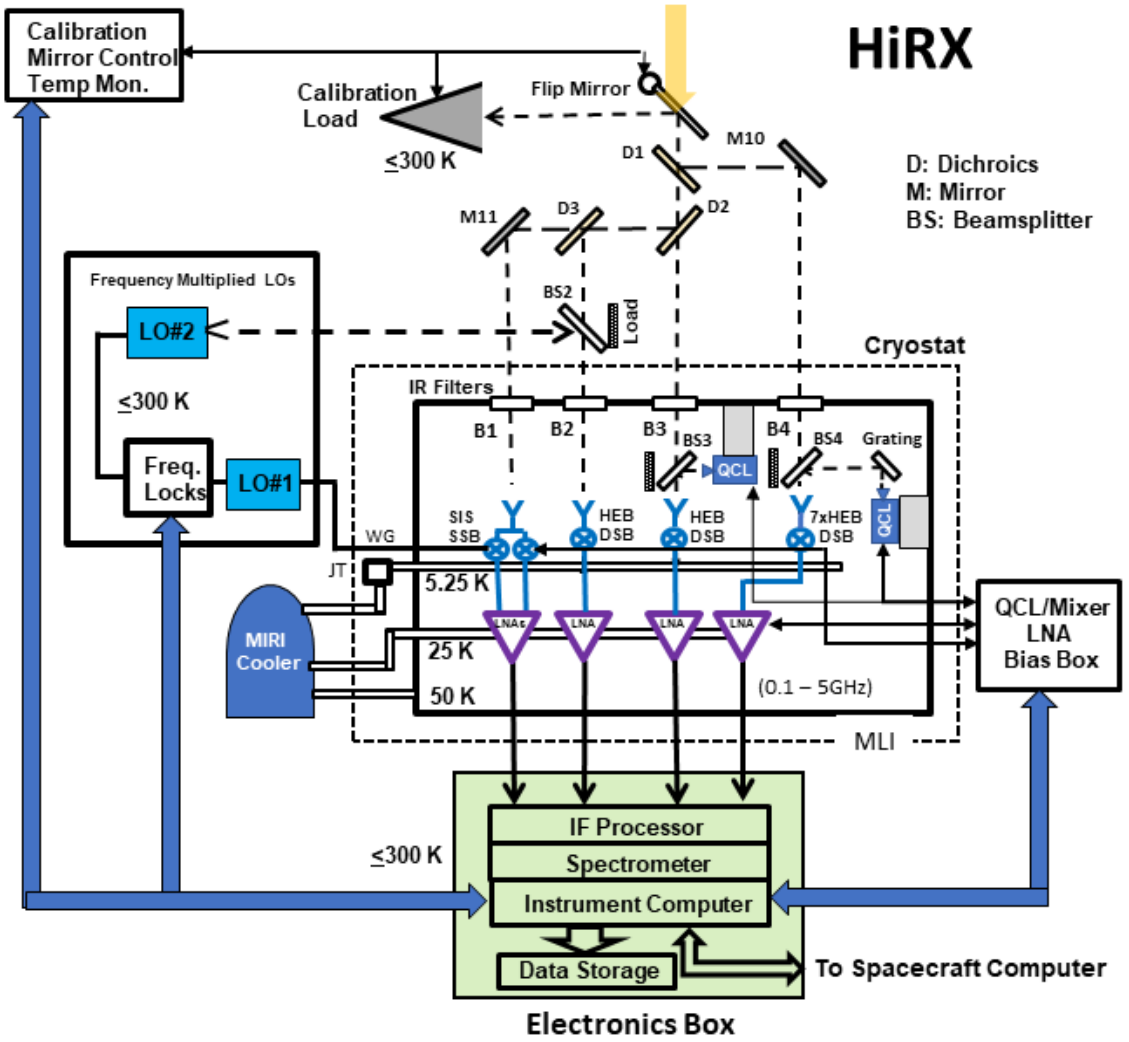








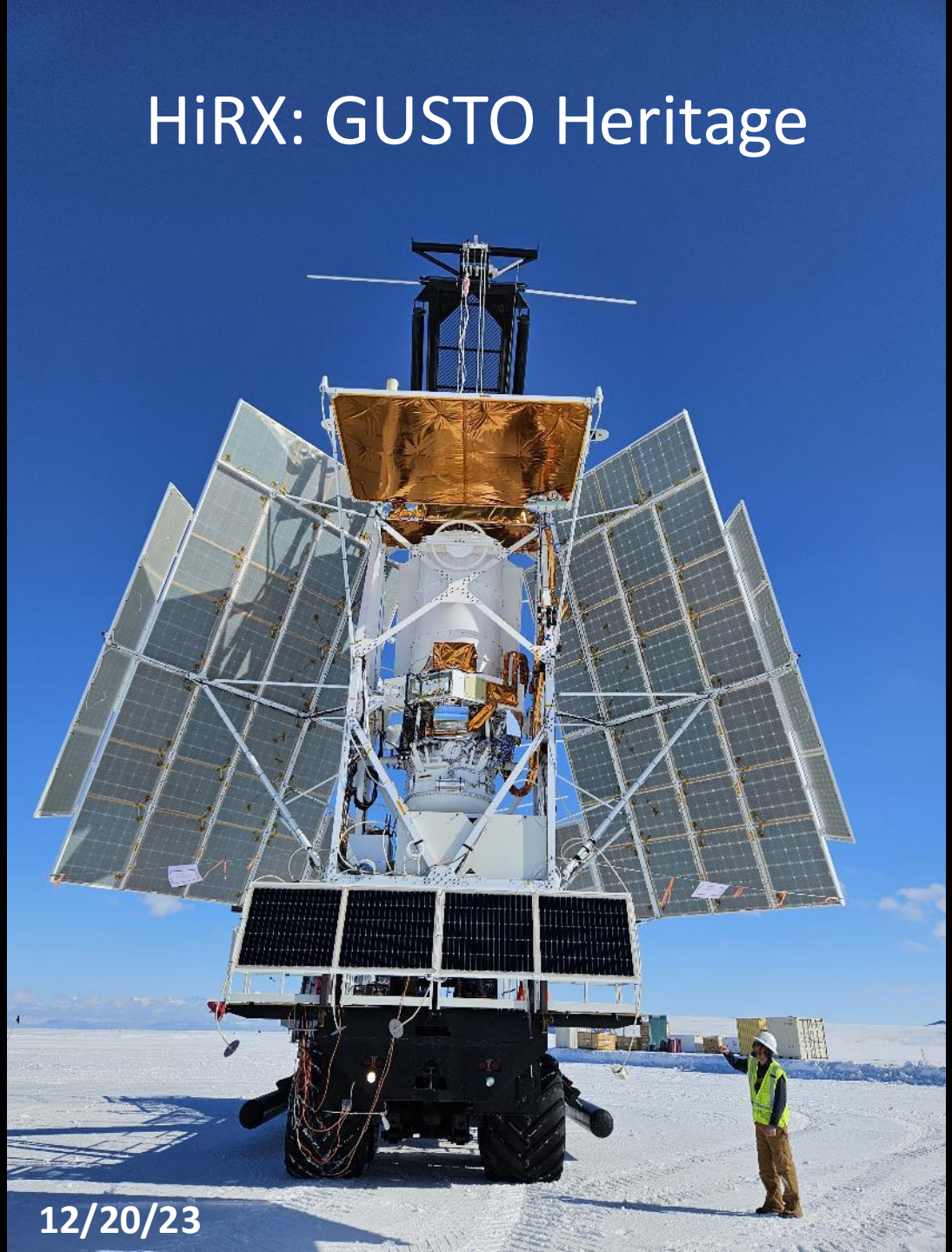
SAFARI-*lite*



Beam/Band	HiRX Bands					
	B1	B2L	B2M	B2H	B3	B4
Ω (")	10.4	4.8	3.6	2.4	2	1
λ (μm)	590	272	204	136	112	60

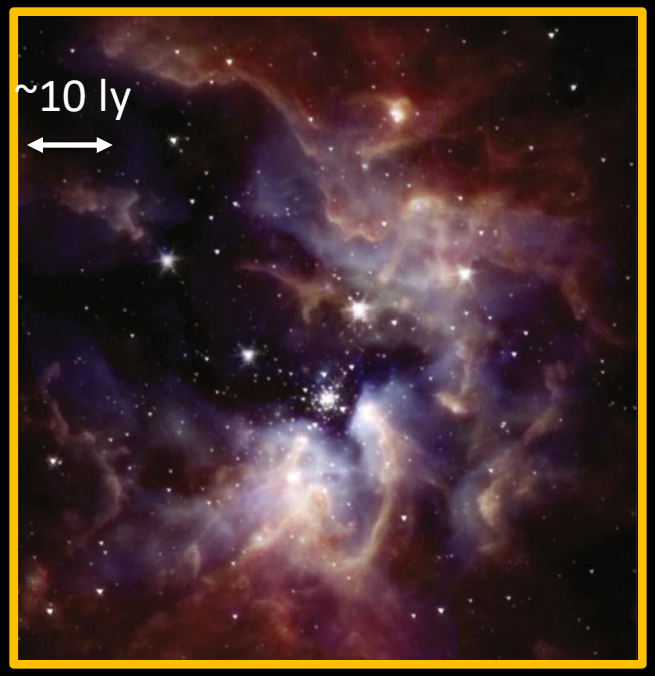
Bands Observed Simultaneously

HiRX: GUSTO Heritage



12/20/23

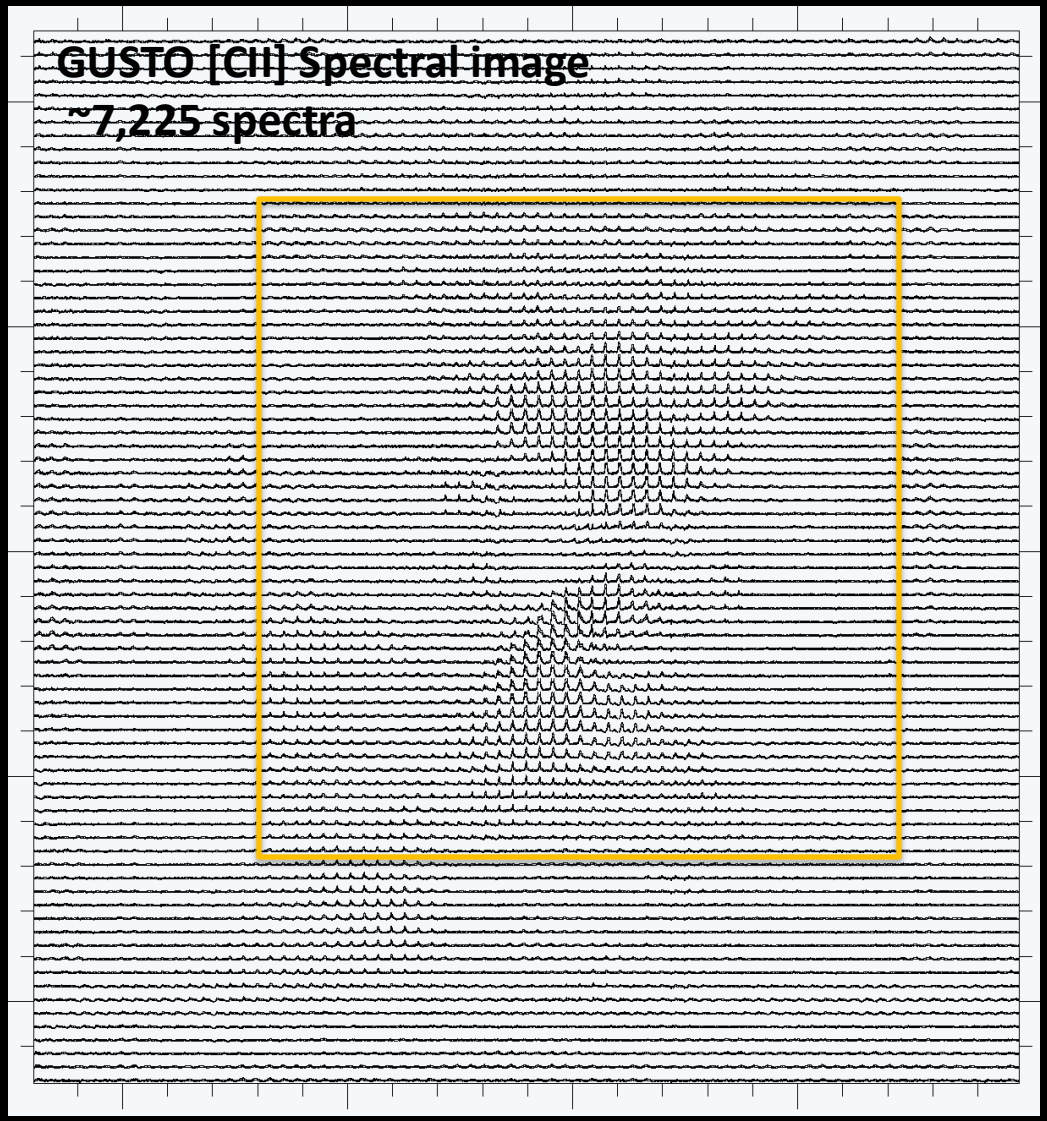
Targeted Deep Sky Survey: NGC 3603



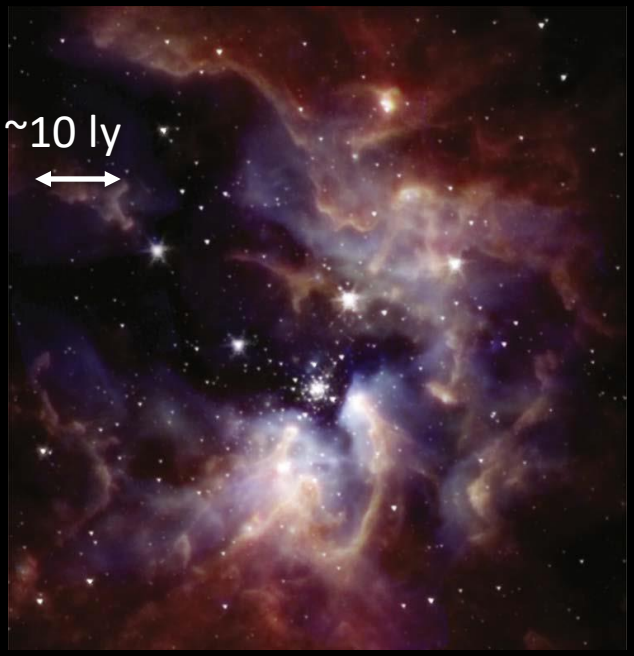
Buizer et al. 2024
(Dust: SOFIA + Herschel)

Massive Star Forming Region (100x Orion)

Dist: ~20,000 ly
Mass: ~4x10^5 M_{sun}
Luminosity: ~3x10^6 M_{sun}



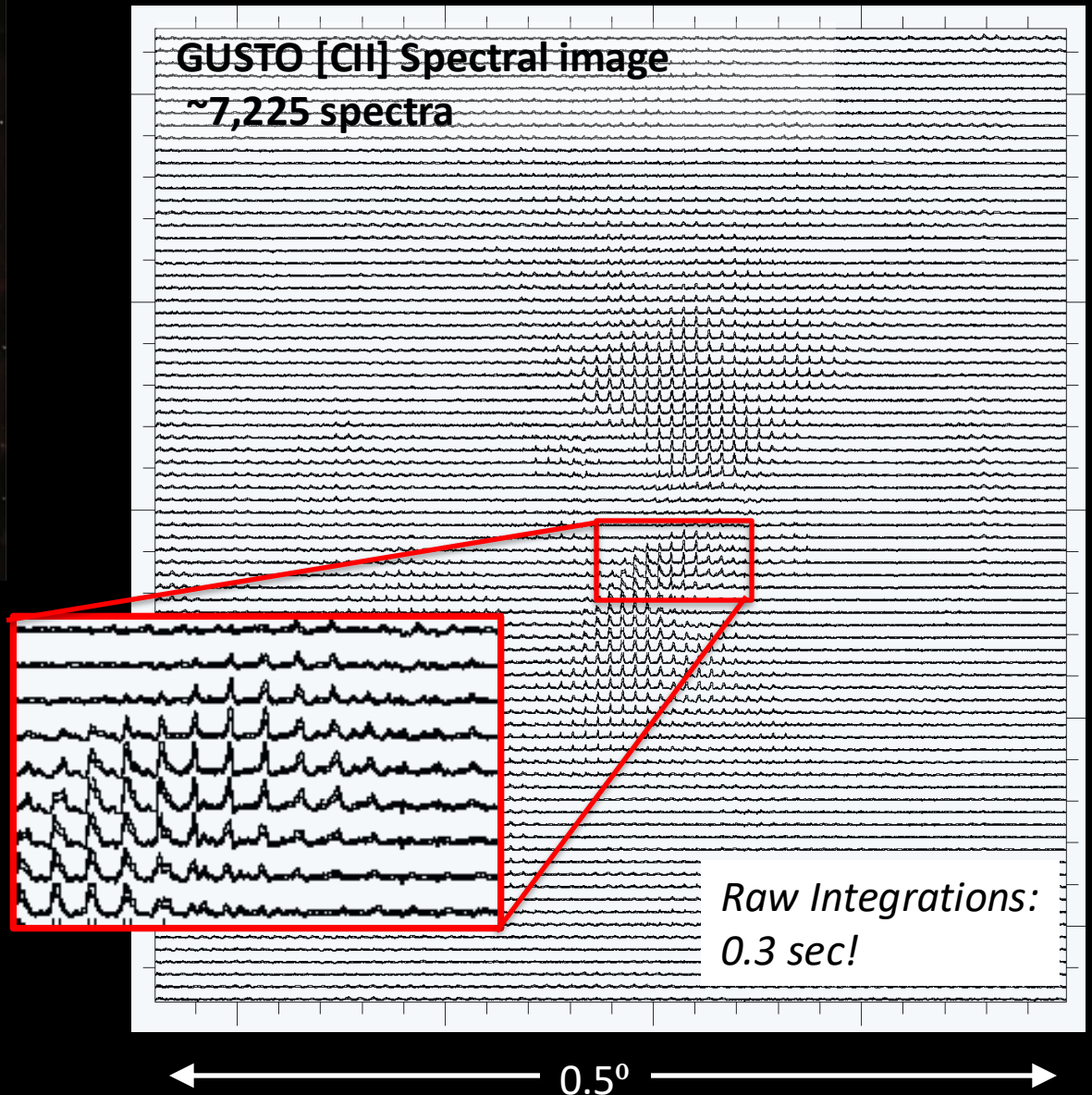
Targeted Deep Sky Survey: NGC 3603



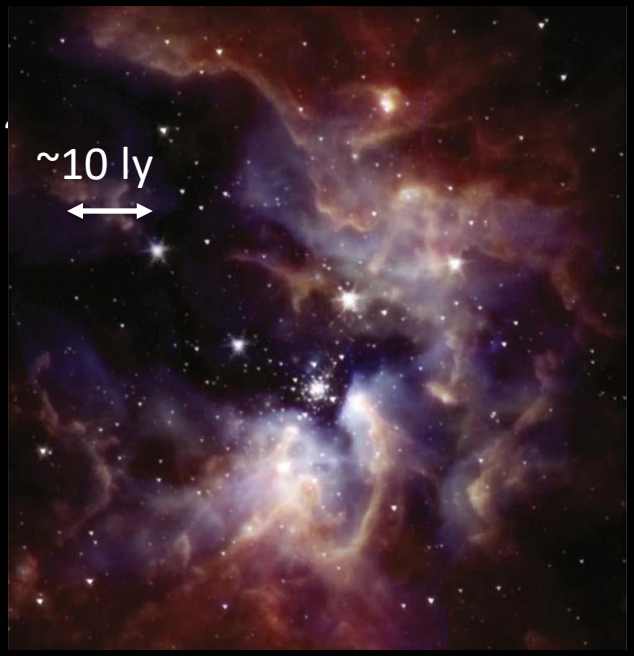
Buizer et al. 2024
(Dust: SOFIA + Herschel)

Massive Star Forming Region (100x Orion)

Dist: ~20,000 ly
Mass: ~4x10^5 M_{sun}
Luminosity: ~3x10^6 M_{sun}



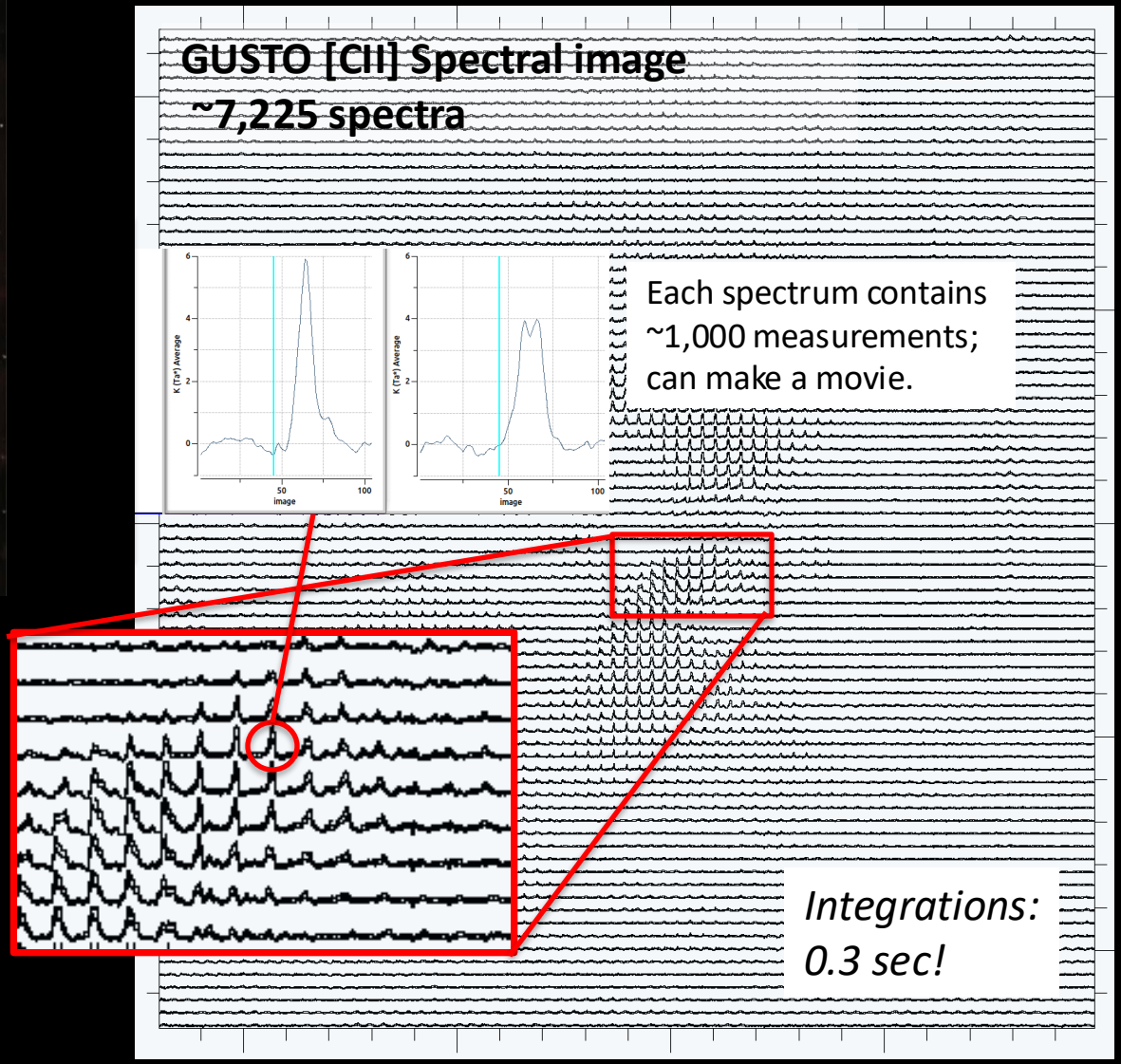
Targeted Deep Sky Survey: NGC 3603



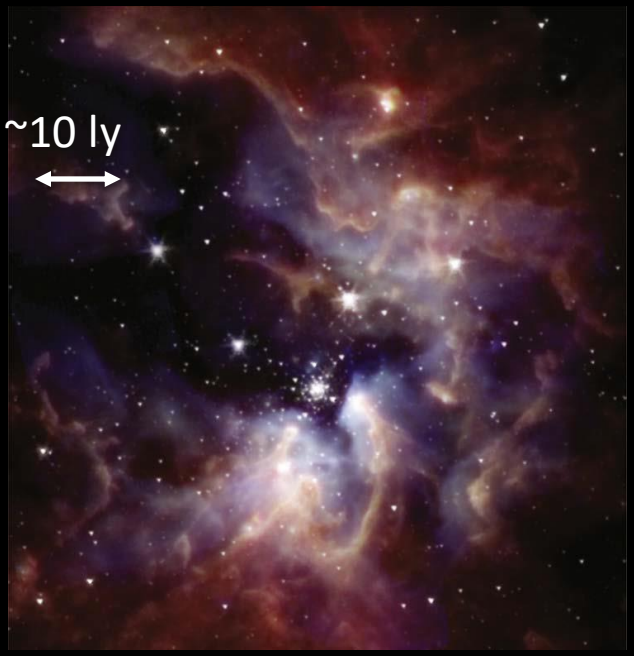
Buizer et al. 2024
(Dust: SOFIA + Herschel)

Massive Star Forming Region (100x Orion)

Dist: ~20,000 ly
Mass: ~4×10^5 M_{sun}
Luminosity: ~3×10^6 M_{sun}



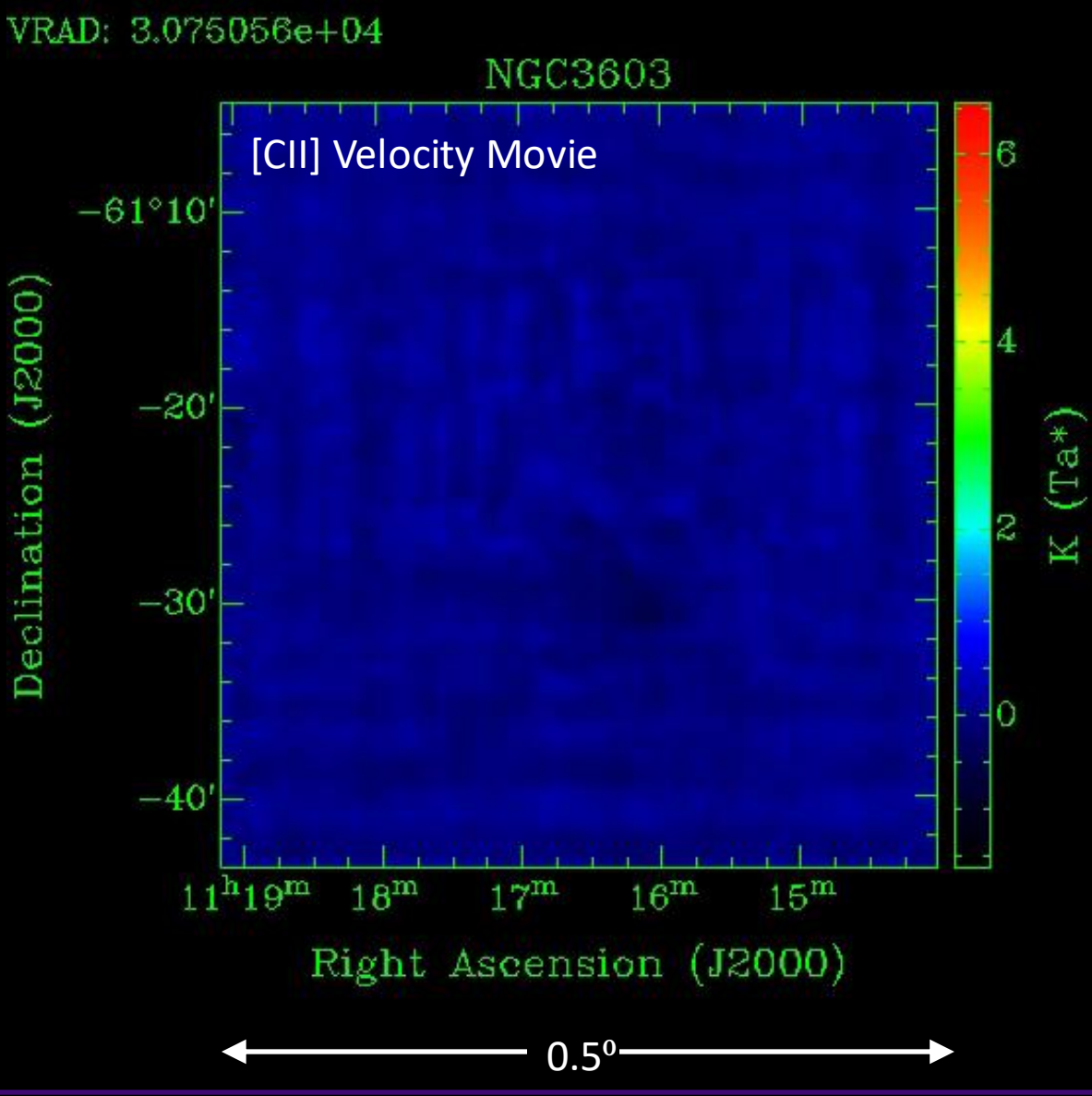
Targeted Deep Sky Survey: NGC 3603



Buizer et al. 2024
(Dust: SOFIA + Herschel)

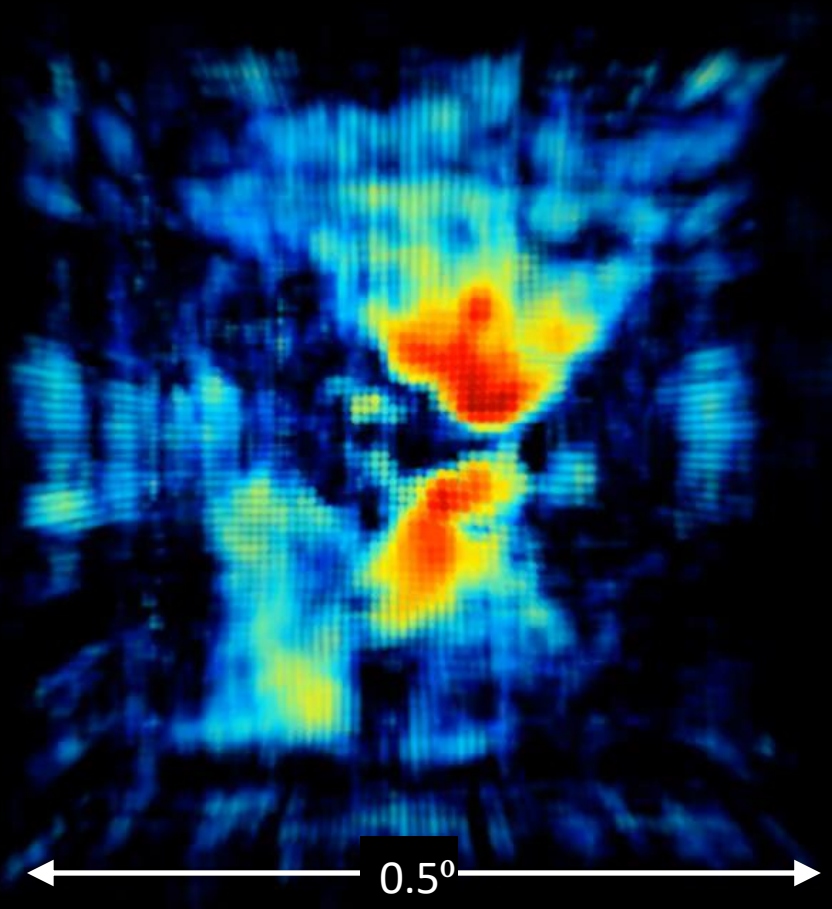
Massive Star Forming Region (100x Orion)

Dist: ~20,000 ly
Mass: ~4x10^5 M_{sun}
Luminosity: ~3x10^6 M_{sun}

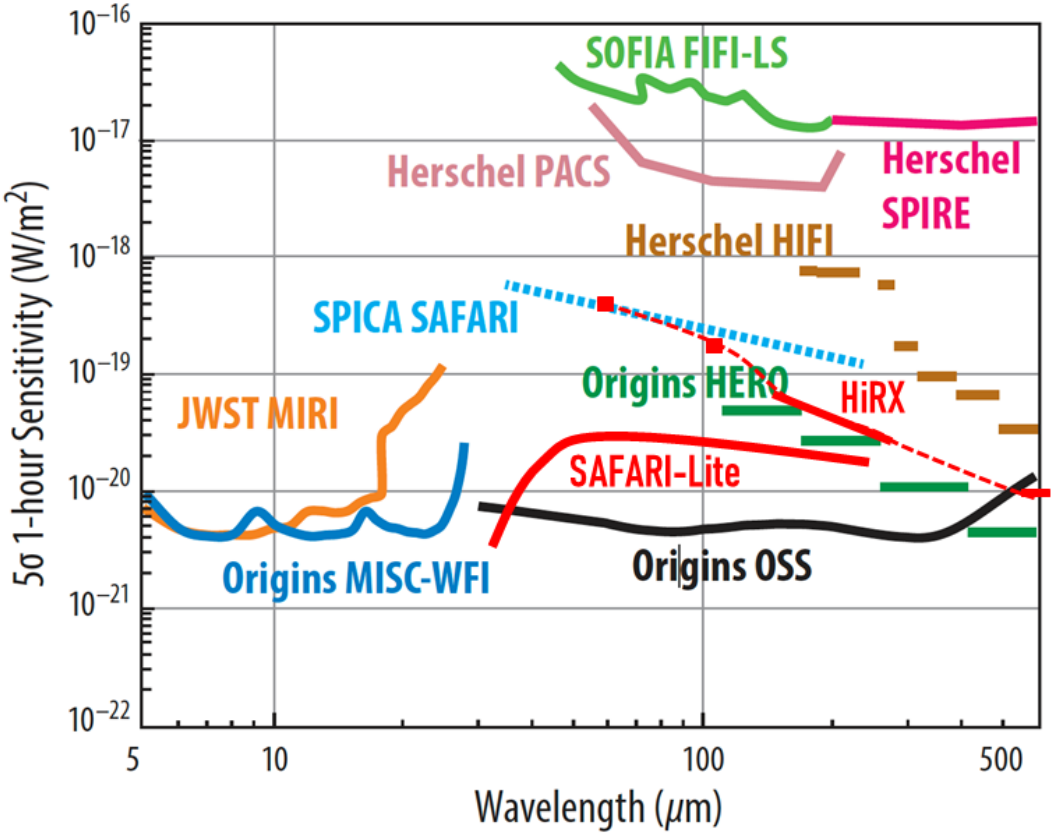


Targeted Deep Sky Survey: NGC 3603
Velocity fields used to Probe 3-D structure

[CII] 3D Movie



Large Aperture Provides High Sensitivity



Instruments

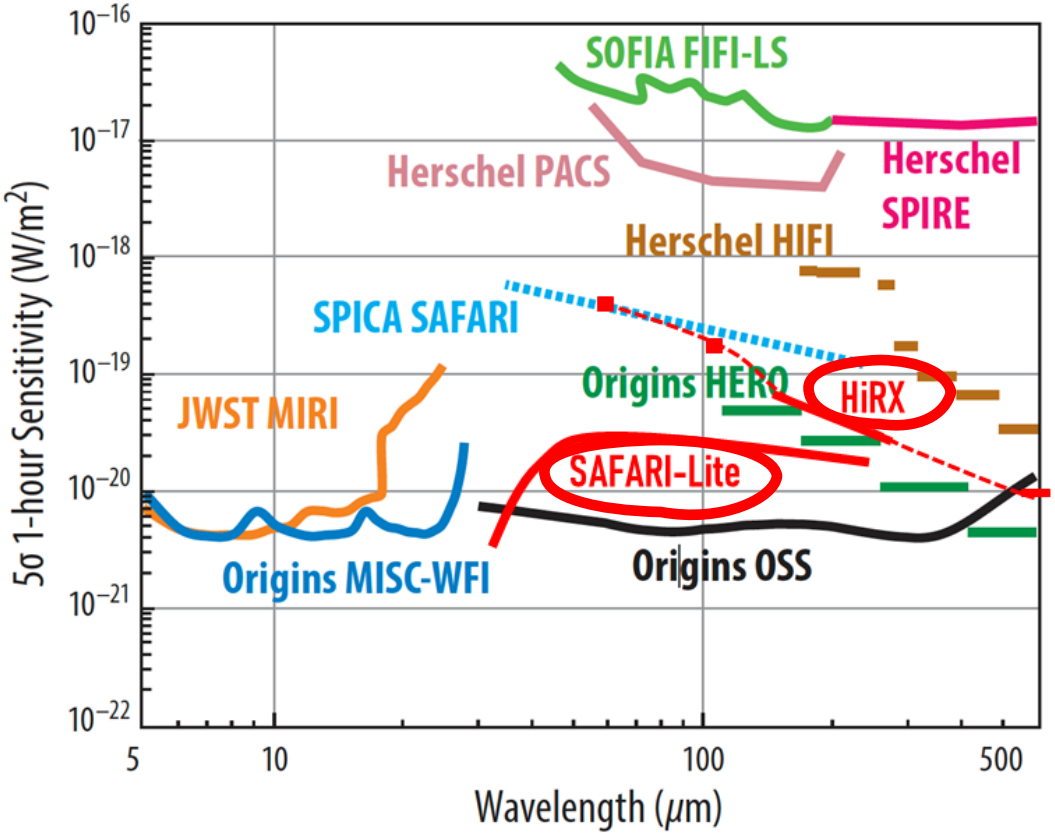
SALTUS Far-IR Spectrometer (SAFARI-Lite)

- 34 to 230 μm (4 Bands)
- Instantaneous coverage
- ~180 pixel KID arrays, spectroscopic
- R = 300
- *Existing technology*

SALTUS High Resolution Receiver (HiRX)

- 56 to 300 μm
  4 Bands HEB mixers
- 520 to 660 μm
  Dual Polarization SIS
- R = ~$10^{6\text{-}7}$
- *GUSTO Heritage*

Large Aperture Provides High Sensitivity



Instruments

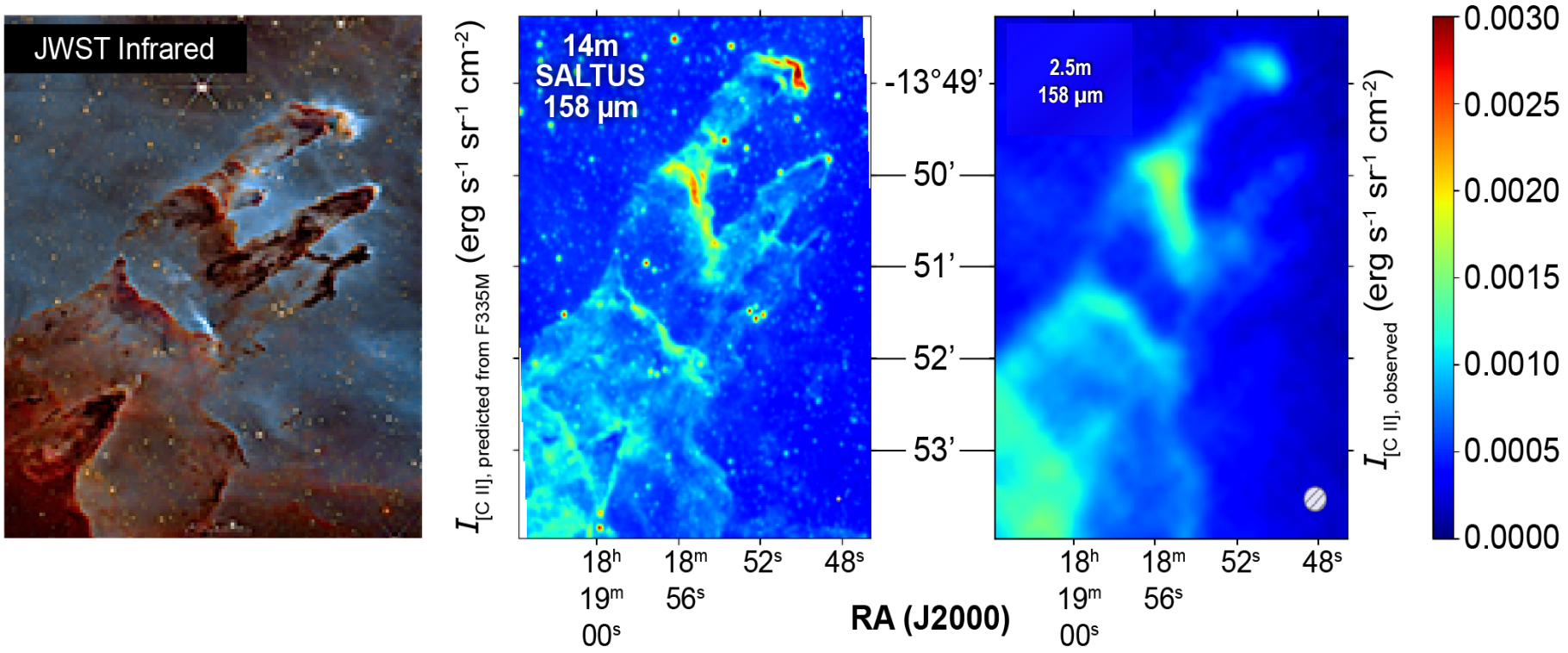
SALTUS Far-IR Spectrometer (SAFARI-Lite)

- 34 to 230 μm (4 Bands)
- Instantaneous coverage
- ~180 pixel KID arrays, spectroscopic
- R = 300
- *Existing technology*

SALTUS High Resolution Receiver (HiRX)

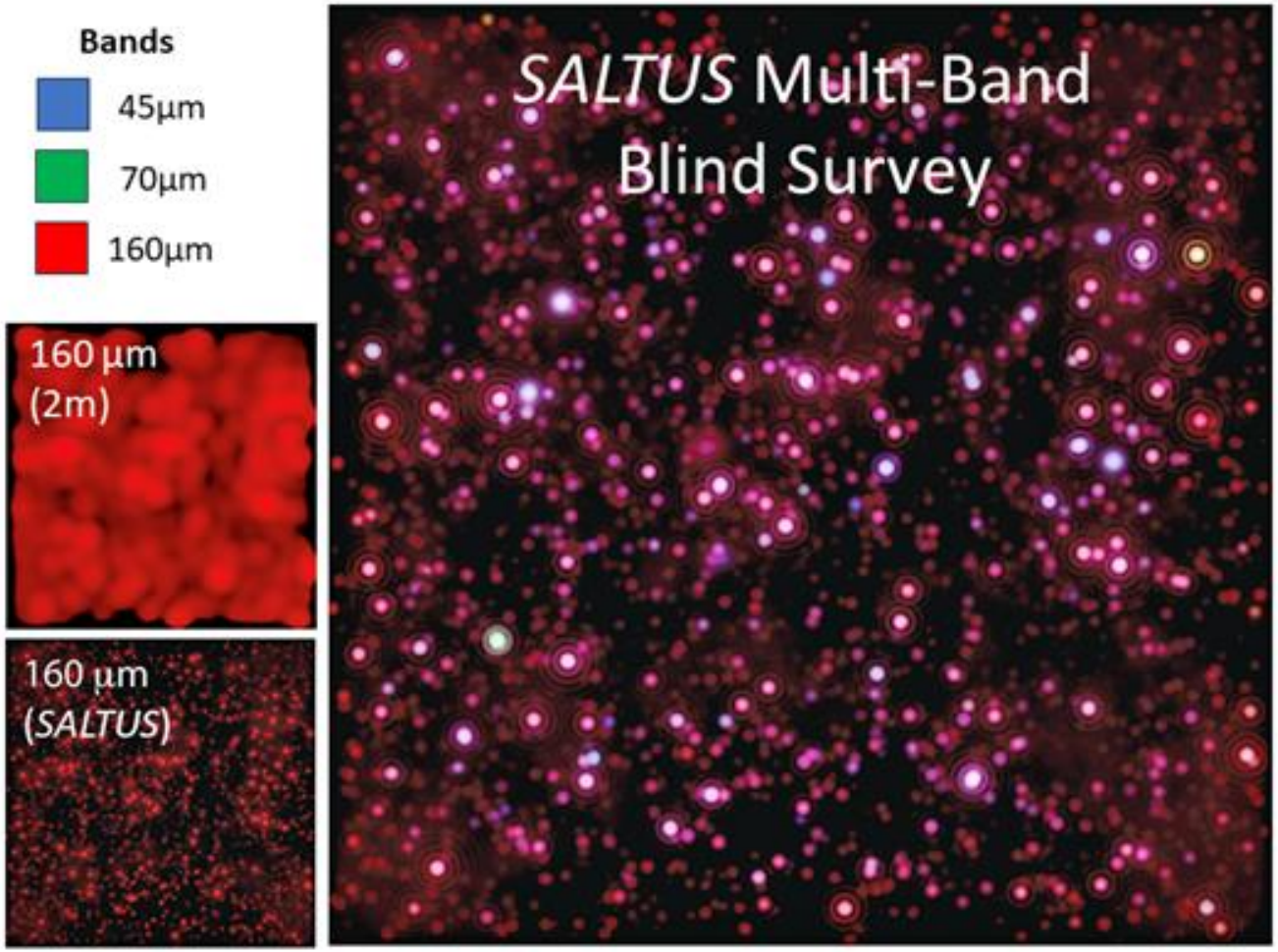
- 56 to 300 μm
  4 Bands HEB mixers
- 520 to 660 μm
  Dual Polarization SIS
- R = ~$10^{6\text{-}7}$
- *GUSTO Heritage*

Large Aperture Provides High Angular Resolution



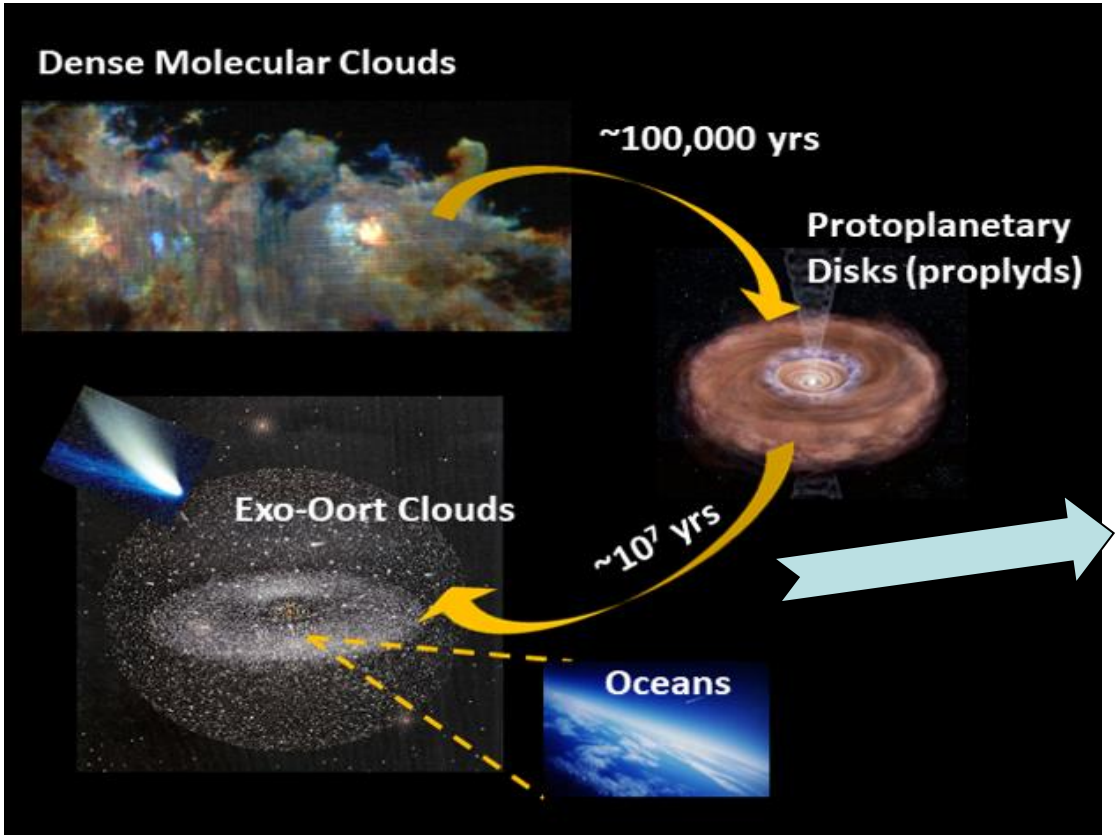
Simulated *SALTUS* image at 2.5" angular resolution (middle) of the [CII] 158µm emission in NGC 6611 (Pillars of Creation) is similar to the *JWST* image (left) and compared to a 2.5m reflecting telescope-created map (right). SAFARI-Lite can map this 10 arcmin^2 region in 10 hours and simultaneously provide maps in all diagnostic lines of photo-dissociation regions (PDRs) and HII regions in our galaxy and the local group, probing the physical environment produced by radiation feedback of massive stars and its link to stellar clusters and its molecular core.

Large Aperture Provides Unbiased View of Distant Universe

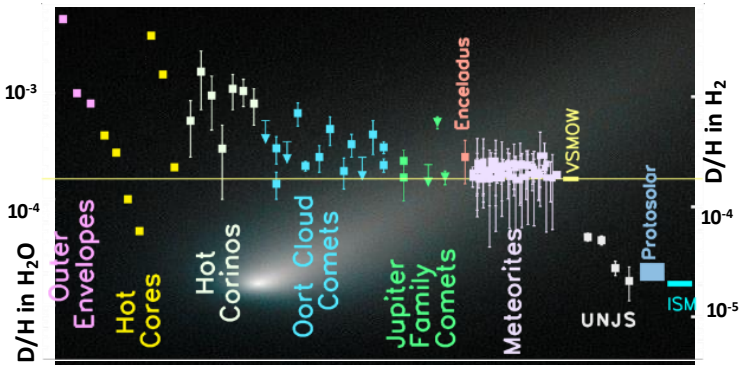


Without the resolving power of SALTUS, the existence of the vast majority of low luminosity galaxies would be lost in the glare of the brighter objects, obscuring the true nature of the early universe.

SALTUS follows the Water Trail from Molecular Clouds to Oceans



Measure D/H in solar system objects to investigate the fractionation of water at low temperatures.



SALTUS is designed to probe the water trail using low lying rotational H_2O lines that probe cold gas with HiRX and the icy grain reservoir through their phonon modes in emission with SAFARI-Lite

1) Trace Formation and Evolution of Planetary Systems

How does habitability develop during planet formation?

Distribution of mass and C/N/O in 1000 protoplanetary disks

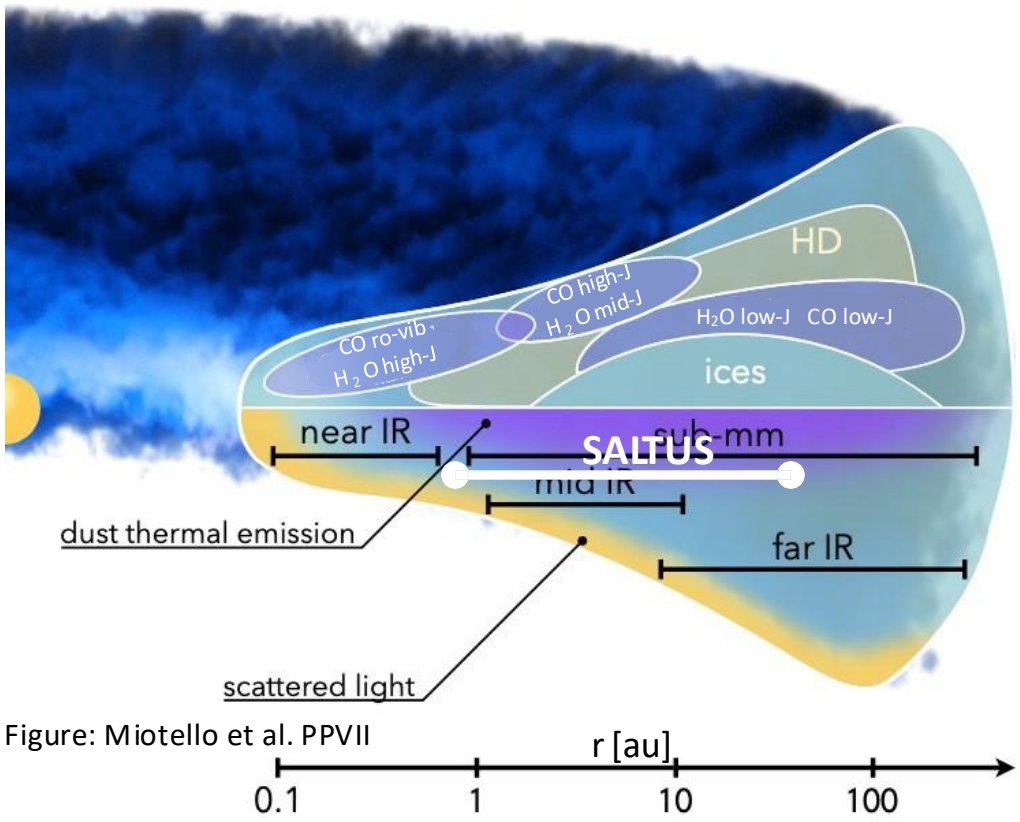
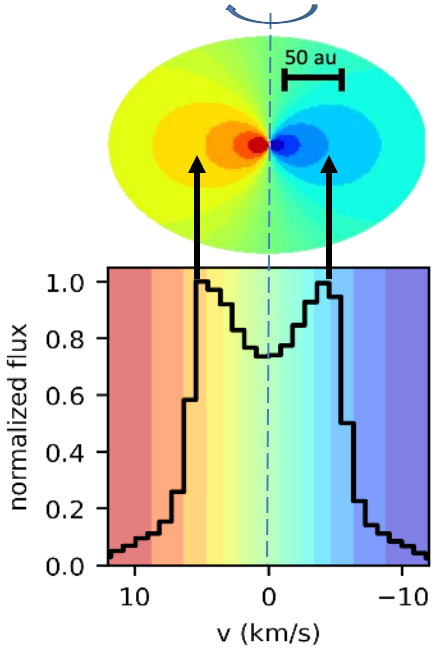


Figure: Miotello et al. PPVII

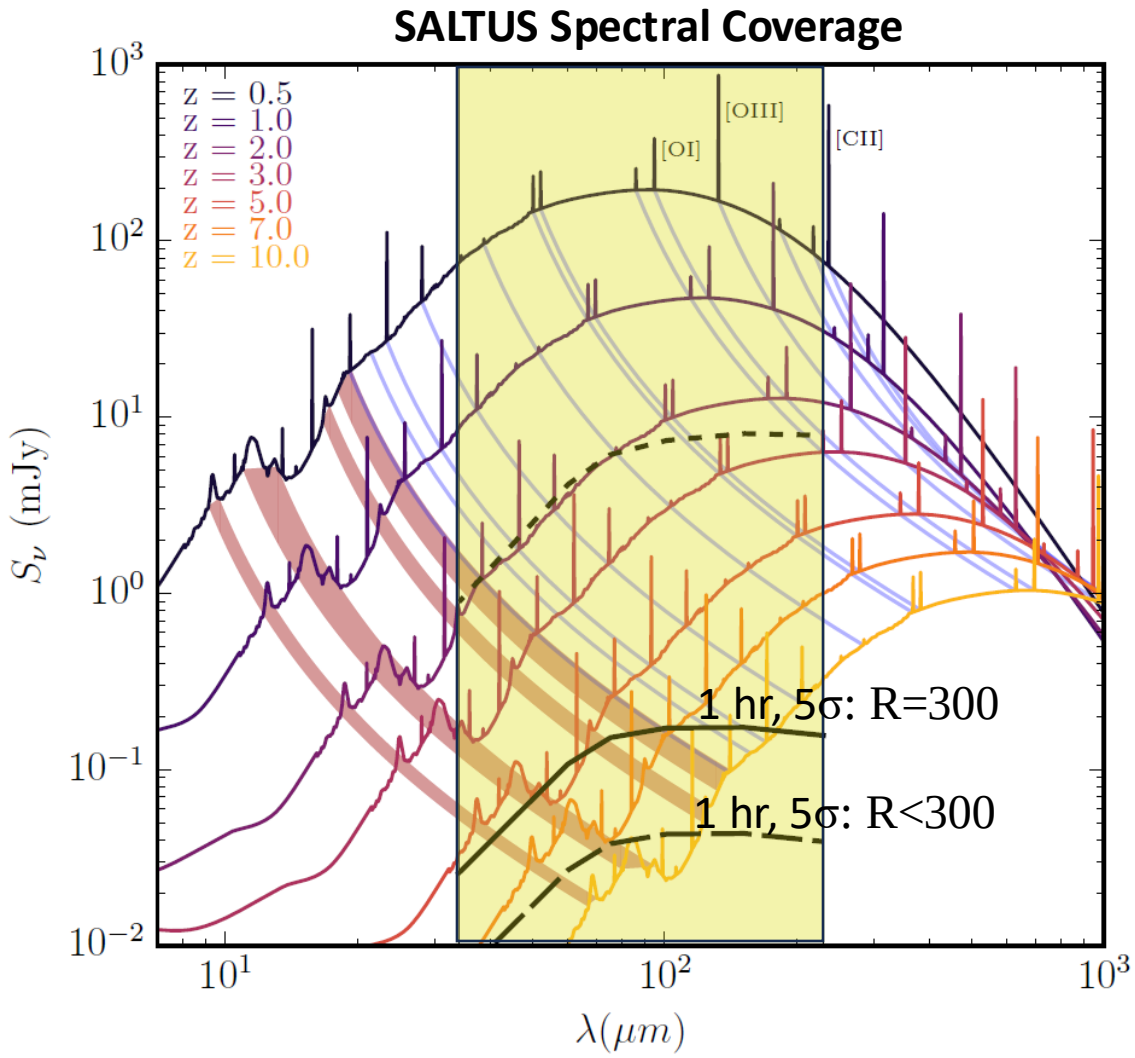
- What is the mass?: Target HD
- Where is O?: Target H_2O vapor & ice
- Where is N?: Target NH_3
- Where is C?: Target High J CO



Heterodyne Spectroscopy → **Doppler Tomography of HD and H_2O Disk Spectra R~10^6**

2) Trace Galaxy Evolution

SALTUS will ***spatially resolve*** and measure the peak of the IR SED of Star Forming Galaxies **in addition** to spectral lines

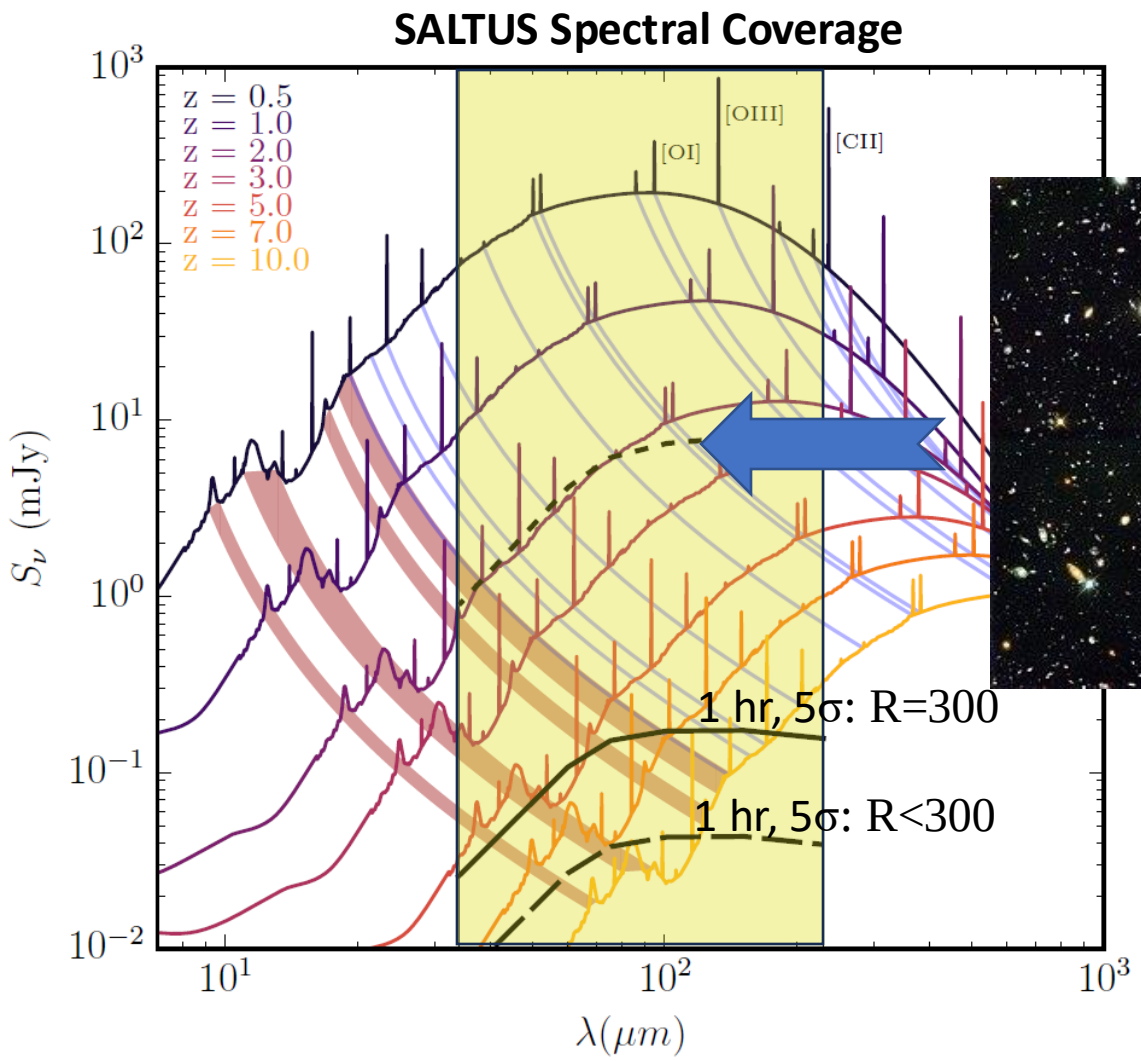


Spectral Energy Distribution (SED) of $3x10^{12}$ $L_\odot$ star forming galaxy with redshift.

- Spectral lines and PAH features traced through redshift
- Out to z ~3, SAFARI-Lite probes the peak of the dust continuum and the bulk of the dust emission.
- Beyond z ~3, SAFARI-Lite takes over from *JWST*/MIRI

2) Trace Galaxy Evolution

SALTUS will ***spatially resolve*** and measure the peak of the ***IR SED*** of Star Forming Galaxies **in addition** to ***Spectral Lines***

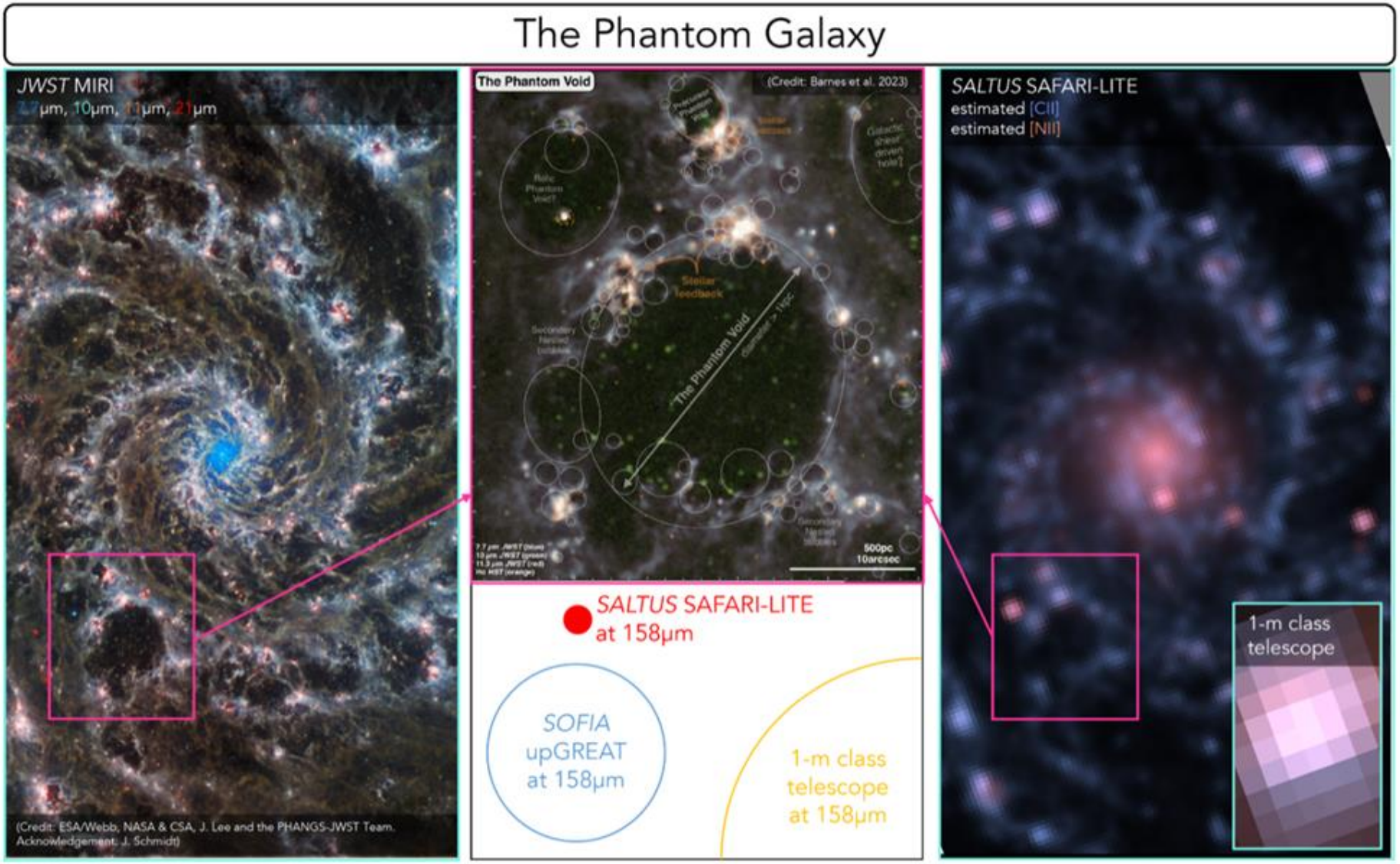


Spectral Energy Distribution (SED) of $3x10^{12}$ $L_\odot$ star forming galaxy with redshift.

…es and PAH …ced through

… SAFARI- … the peak of …tinuum and … the dust

…3, SAFARI-Lite takes over from *JWST*/MIRI



Left: A composite image of the nearby (D < 10 Mpc) galaxy M74 (AKA The Phantom Galaxy or NGC628), observed with *JWST* MIRI. *Center*: A zoom in to the "Phantom Void" (pink boxes in other panels) a supernova-driven superbubble surrounded by many smaller supernova-driven bubbles (Watkins et al. 2023; Barnes et al. 2023). ***Only SALTUS is capable of resolving the FIR properties of stellar and AGN feedback and their impact on energy balance in the local Universe ISM*.**

SALTUS Schedule

SALTUS Meeting (UofA/Virtual)	March 6-7, 2023
Probe AO Release	July 2023
Probe Proposal	Nov. 16, 2023
Probe Phase A Down select	Late 2024
CSR Due	Early 2025
Probe Phase B Down select	Mid/Late 2025
Launch Readiness	~2031
Flight Operations	~2031-2036+

SCAN ME!

cwalker@arizona.edu

SALTUS Schedule

SALTUS Meeting (UofA/Virtual)	March 6-7, 2023
Probe AO Release	July 2023
Probe Proposal	Nov. 16, 2023
Probe Phase A Down select	Late 2024
CSR Due	Early 2025
Probe Phase B Down select	Mid/Late 2025
Launch Readiness	~2031
Flight Operations	~2031-2036+

5 (~250 pages) papers on arXiv, Search SALTUS

cwalker@arizona.edu