**SALTUS**: Single Aperture Large Telescope for Universe Studies

**SALTUS (Probe)**

- 20m Off-Axis Design
- 45K Optics
- Coherent & Incoherent Spectroscopy/Imaging
- Adaptive Optics
- ~1 mm to ~30 µm
- EHT Space Node
- >5 yrs Baseline Mission
- >3.5 yrs of Guest Observations

Addresses many Science Objectives within the Astro 2020 Decadal
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

- What is the mass?: Target HD
- Where is O?: Target H$_2$O vapor & ice
- Where is N?: Target NH$_3$
- Where is C?: Target High J CO

Figure: Miotello et al. PPVII

Doppler Tomography of HD and H$_2$O Disk Spectra $R \sim 10^6$

Heterodyne Spectroscopy
1) Trace Formation and Evolution of Planetary Systems

SALTUS Solar System Science will link the origin and evolution of water and CHNOPS compounds in our own solar system to those observed in protoplanetary systems.

Map the abundance of water and its isotopologues emitting directly from the Enceladus torus. This enables us to explore its physical conditions in detail.

Significantly improve the accuracy of present-day D/H measurements by being the first to resolve the broad HD absorption line with the narrow emission core in the middle.

Uniquely suited to study the cold outer solar system, to determine the global content of cometary ice.

Measure D/H in solar system objects to investigate the fractionation of water at low temperatures.
2) Trace Galaxy Evolution

SALTUS will **spatially resolve** and measure the peak of the IR SED of Star Forming Galaxies

- SED of $3.6 \times 10^{12} \ L_{\text{sun}}$ (submm) galaxy redshifted
- SALTUS is well designed to measure the SED of obscured star formation over cosmic history for $z<3$
- Higher redshift is ALMA territory
- 3 mJy mapping sensitivity limit for SALTUS for 1 sq arc min in 1 hr at 10 $\sigma$
- The Hubble deep field will take $\sim$50 hours
2) Trace Galaxy Evolution

SALTUS will **spatially resolve** and measure the peak of the IR SED of Star Forming Galaxies.
2) Trace Galaxy Evolution

Measure small-scale feedback in galaxies at <100pc resolution

- **Context:** To interpret high-z observations and constrain simulations, we must observe impacts of feedback locally where energy and momentum are injected. SALTUS will measure the local impacts of galactic feedback on scales of individual star-forming regions and nuclear BH spheres of influence.

- **Decadal Connection:** Key decadal IR probe call to “prob[e] the co-evolution of galaxies and their supermassive black holes across cosmic time.”

- **Observables:** Mid- and Far-IR fine structure and molecular lines, 25-160um. Uses SAFARI-LITE, some heterodyne possibilities.

- **Instrument Requirements:** R ~ 3000 ideal to resolve outflows. Must target and map 30’x30’ well-known nearby galaxies – Andromeda, Cen A, M82, NGC1068, Circinus, …

- **Competitive Edge:** SALTUS will have ~10x better spatial resolution than a ~2m class telescope and ~6x higher resolution / 30x higher sensitivity than Herschel.
3) Probe Nature of Supermassive Blackholes

SALTUS Microarcsecond VLBI

- **Near apogee:** BH mass census
  Using angular diameters (\(\sim-M/D\)) to weigh black holes across the universe

- **Inbound/outbound:** Precision GR test via lensed photon ring

Gralla, Lupsasca, and Marrone 2020
https://doi.org/10.1103/PhysRevD.102.124004

- **Perigee:** Exploring accretion and jets with BH movies at 5x EHT resolution

LO Timing
- USO
- Maser

Data Back
- Laser Comms
- Big Antenna
SALTUS Sensitivity/Instruments

**Instruments**

**SALTUS Far-IR Spectrometer (SAFARI-Lite)**
- 30 to 240 µm (4 Bands)
- Instantaneous coverage
- ~180 pixel KID arrays, spectroscopic
- R = 300
- *Existing technology*

**SALTUS High Resolution Receiver (HiRX)**
- 60 to 300 µm
  - 4x 7 pixel HEB arrays
- 520 to 650 µm
  - Dual Polarization SIS
- R = ~10^6
- *GUSTO Heritage*

**SALTUS Multifrequency VLBI Instrument (MuVi)**
- 870 to 3500 µm (EHT)
  - Dual Polarization SBS
- R = ~10^6
- *ALMA Heritage*
Far-IR Space Observatories

IRAS 1983
- 0.57m
- 2° K
- ~0.8 yr

ISO
SWAS

ODIN
Spitzer
AKARI

Herschel 2009
- 3.5m
- ~80° K
- 3 yr

SALTUS 2031
- 20m
- ~45K
- >5 yr

$0.199 B

$0.776 B

$1 B

How?
SALTUS
Fully Deployable Telescope

Inflated Lenticular
Primary Sunshield
deployed Rigid Boom
Corrector Instrument Module
Spacecraft

20m
Astromesh Torus

25m
Incoming Light

30°
Canopy

Reflectors (45°K)

Heritage

SMAP 2015
SALTUS Torus

Space Rated 25 m version available

AstroMesh® Reflector Technology
100% On-Orbit Success – No Failures – No Anomalies
Inflatable Aperture Experiment
14m Off-Axis Parabola
(*IAE)*: 1996

25 years of Advancement

Meinel & Meinel
2000

2021

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


Download the Final PDF
**JATIS-22043G_online.pdf**
SALTUS Schedule

SALTUS Meeting (UofA/Virtual)  March 2023
Probe AO Release  July 2023
Probe Proposal  Oct. 2023
Probe Phase A Downselect  Mid 2024
CSR Due  Early 2025
Probe Phase B Downselect  Mid/Late 2025
Launch Readiness  ~2031
Flight Operations  ~2031-2036