XXIV Space Resource Roundtable

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LUNARSABER: Lunar Utility with Navigation, Advanced Remote Sensing, and Autonomous Beaming for Energy Redistribution

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HONEYBEE ROBOTICS
Exploration Technology

LUNARSABER Overview

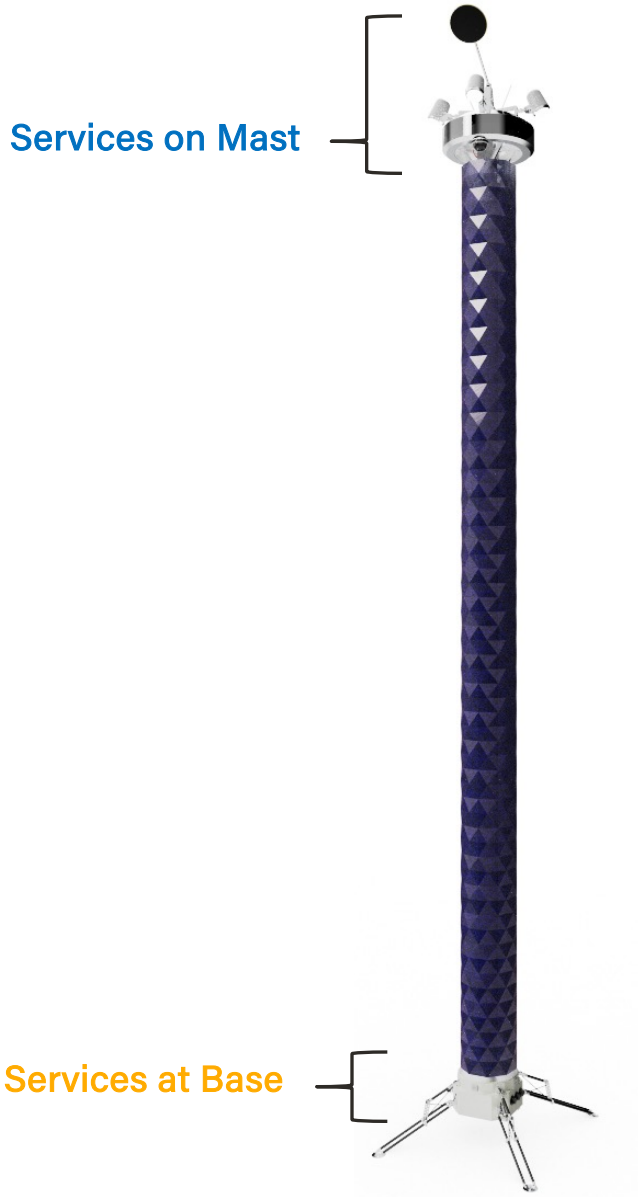
LUNARSABER - Lunar Utility with Navigation, Advanced Remote Sensing, and Autonomous Beaming for Energy Redistribution

DIABLO- Deployable Interlocking Actuated Band for Linear Operations

- Configurable tower (100+ meters) that can raise **payloads** to increase service coverage over lunar terrain.

Payload Service and ISRU Enabling Platform:

- High Availability Solar Energy and Power Transfer
  - IR Power Beaming
  - Wired Power Transmission (DC)
  - Battery Energy Storage
- Masthead Hosted Payloads
- Communications and Data Services
  - Local 3GPP network and Lasercomm terminals
  - Lunar Mesh Network including Direct-to-Earth
  - Edge computing and data storage
- Situational Awareness
  - Asset Monitoring
  - Local Position, Navigation, and Timing (PNT)
  - Lunar Surface Traffic Control



LUNARSABER Infrastructure

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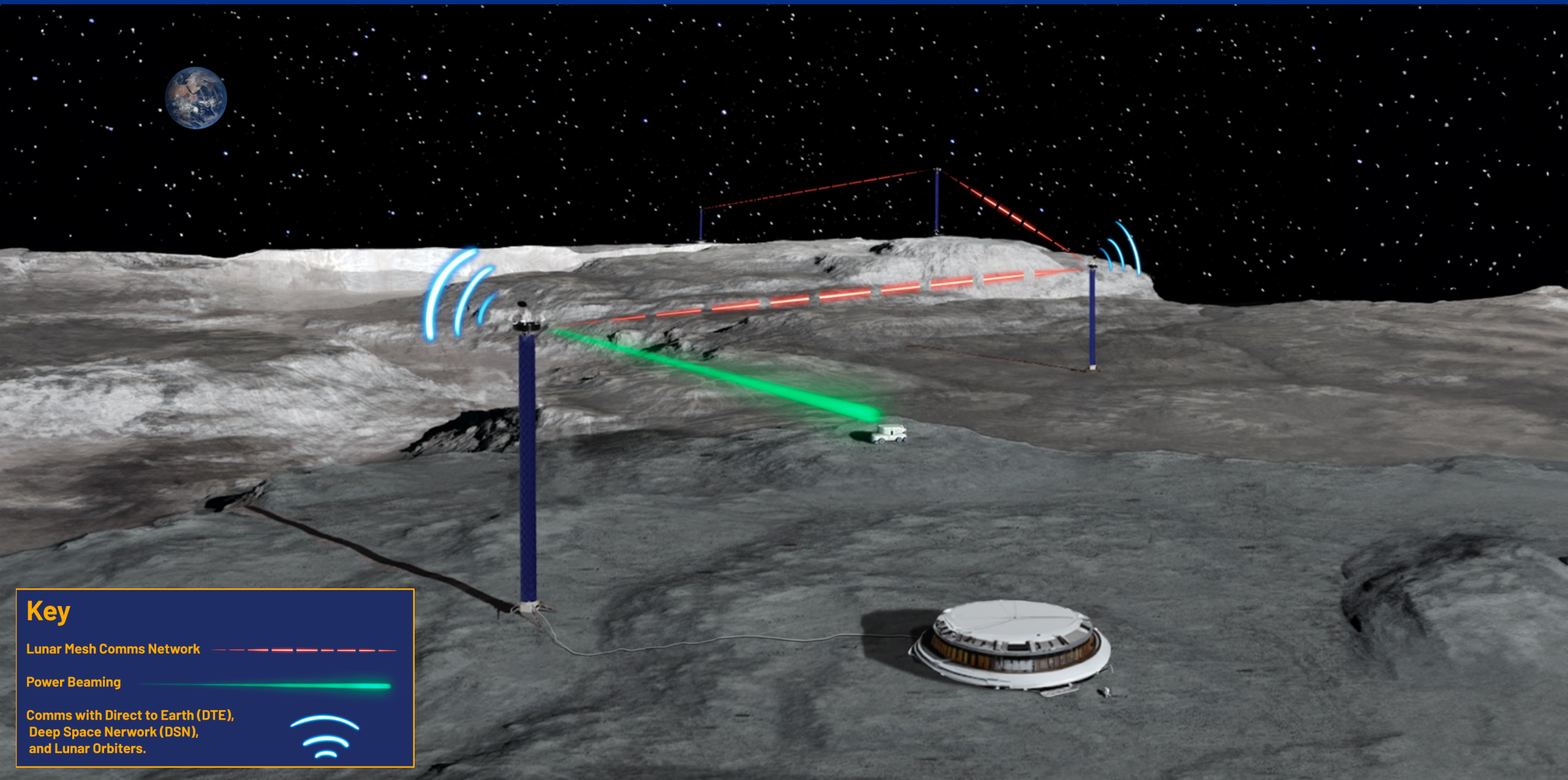
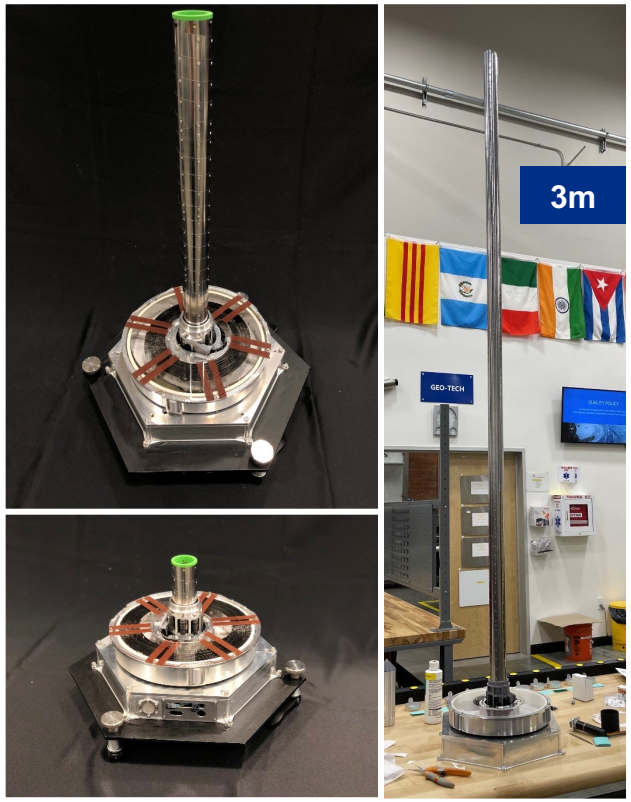
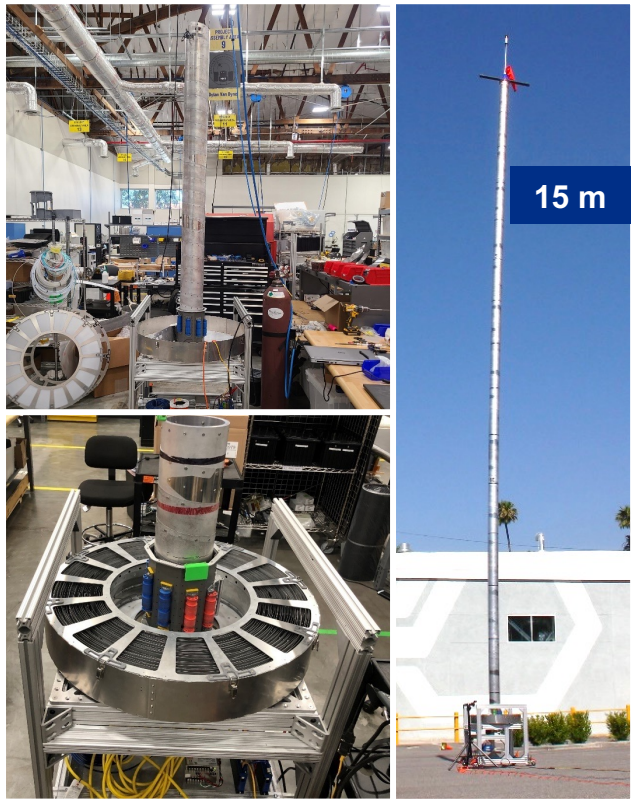


LUNARSABER - DIABLO

- LUNARSABER uses Honeybee's DIABLO technology to deploy the payloads
- DIABLO provides a design solution with advantages in volume, cost, materials and scalability
- DIABLO mast is comprised of:
  - DIABLO: Deployable boom and Helical Drive Mechanism (HDM)
  - Band storage reel



45 mm OD 304 SS

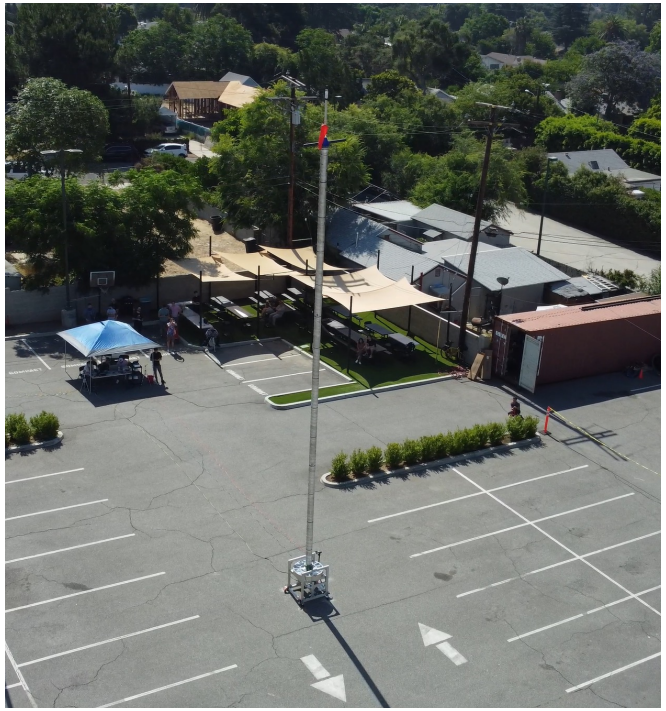


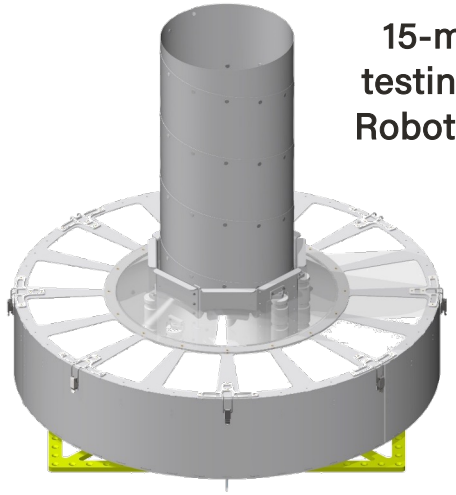
200 mm OD Al 6061

300 mm OD Al 6061

DIABLO - Deployable Interlocking Actuated Band for Linear Operations

HONEYBEE ROBOTICS

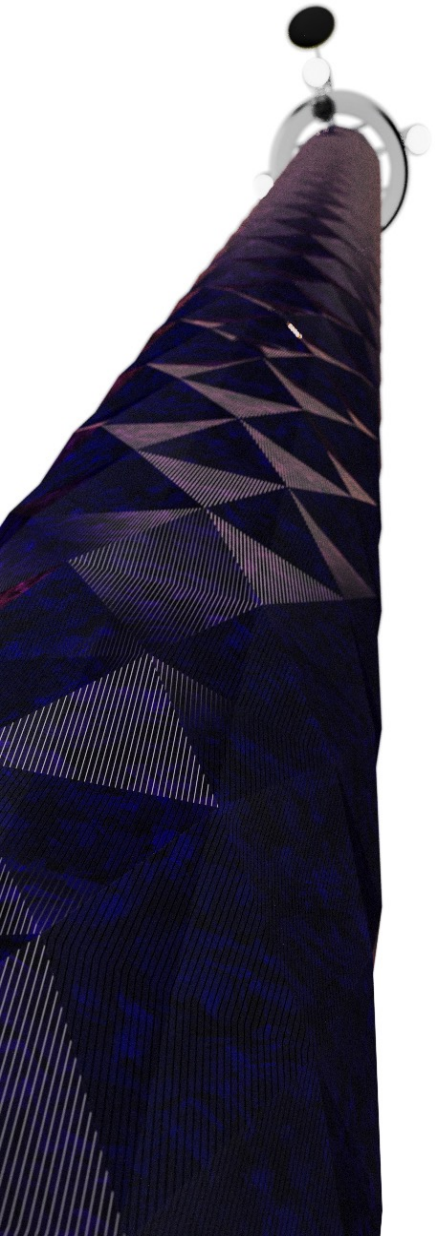




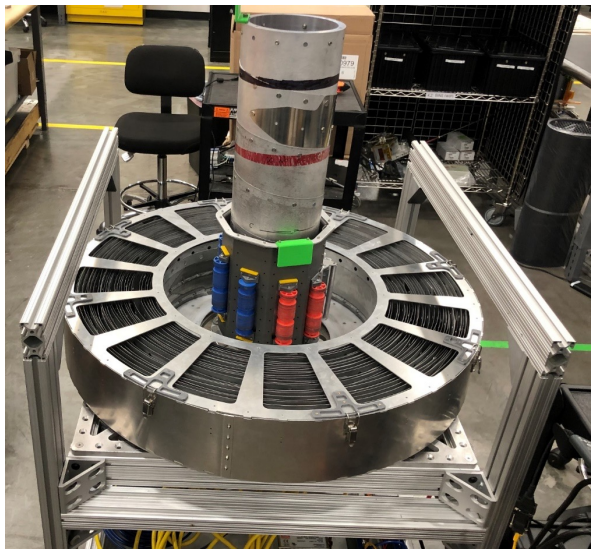
15-meter DIABLO testing in Honeybee Robotics Parking Lot

LUNARSABER Services and Subsystems

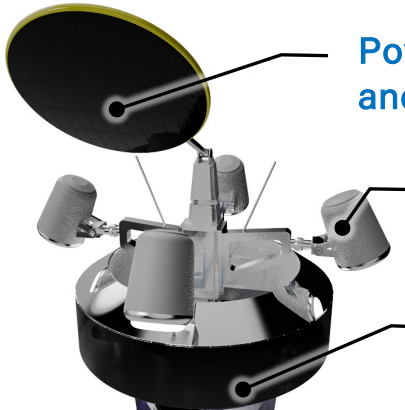
HONEYBEE ROBOTICS



Services on Mast
100+ meters



DIABLO Mechanism
[PATENT PENDING]



Power Beaming and Receiver

Broad Beam Lights + Cameras

Comms + GPS + Fiducials

Origami Solar Panel Bellow (6 meter deployed diameter)
[PATENT PENDING]

break line

Energy Storage + Data Storage +

Services at Base

Breakout Panel with Dust Tolerant Connector (DTC)
[PATENTED]

Current State of the Art – Honeybee Robotics

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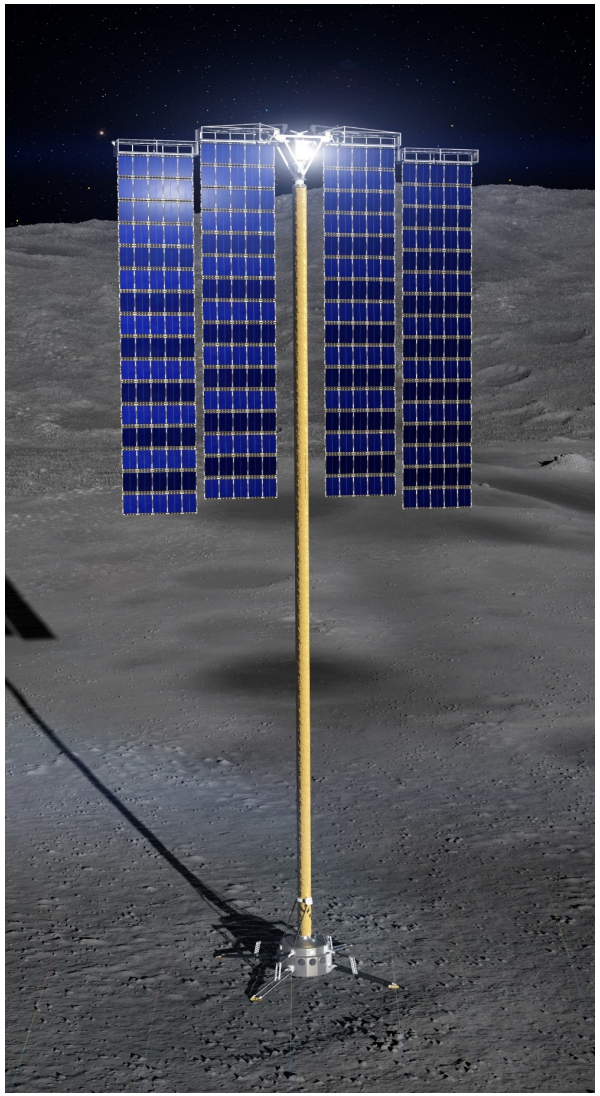
Renewable Solar Energy

- NASA initiated Vertical Solar Array Technology (**VSAT**) to advance work on deployable solar array under Artemis
- Honeybee Robotics developed Lunar Array, Mast, and Power System (**LAMPS**)
- 10kW Solar Power

Power Transfer

- Dust Tolerant Connectors (DTC) – tested in JSC-1A
  - Fully configurable and scalable based on power requirements



NASA VSAT
Honeybee Robotics LAMPS

DIABLO TRL 5 Test in Honeybee Parking Lot

Honeybee Robotics testing DTC in JSC-1A

LAMPS Deployment Demonstration

HONEYBEE ROBOTICS

LUNARSABER Configurations

HONEYBEE ROBOTICS

LUNARSABER can be configured, scaled, and deployed to meet future mission needs

Size Scaling

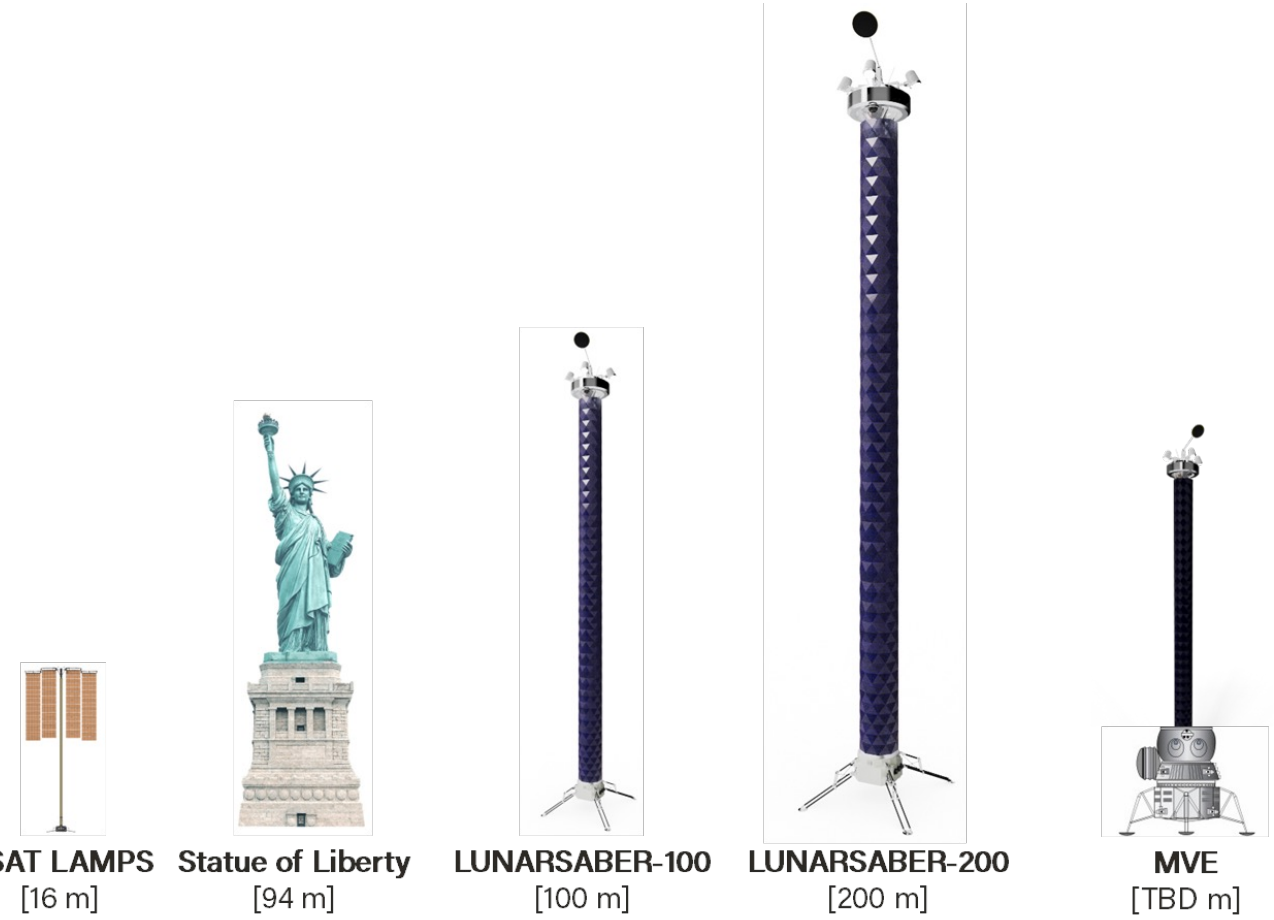
- **Diameter** – Increase mast payload mass capability
- **Height** – increase payload service range

Number of Deployments

- Strategically placed to maximize coverage
- Scaled based on the energy needs for lunar activity

Configurations

- Lander integrated vs. independent system
- Can remove or add subsystems/payloads based on mission goals
- Power optimized vs. payload optimized



VSAT LAMPS [16 m] **Statue of Liberty** [94 m] **LUNARSABER-100** [100 m] **LUNARSABER-200** [200 m] **MVE** [TBD m]

Illumination Advantage

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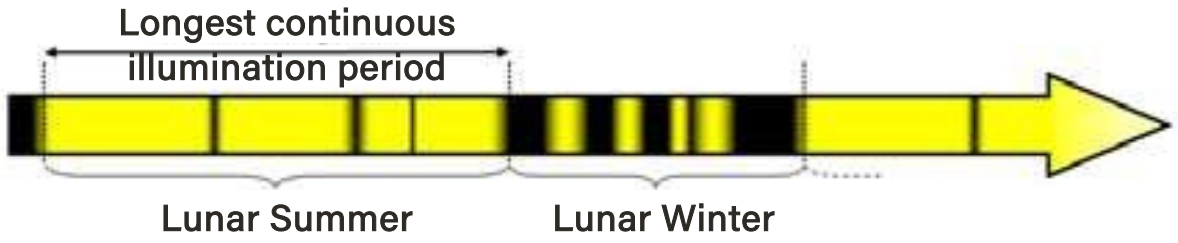
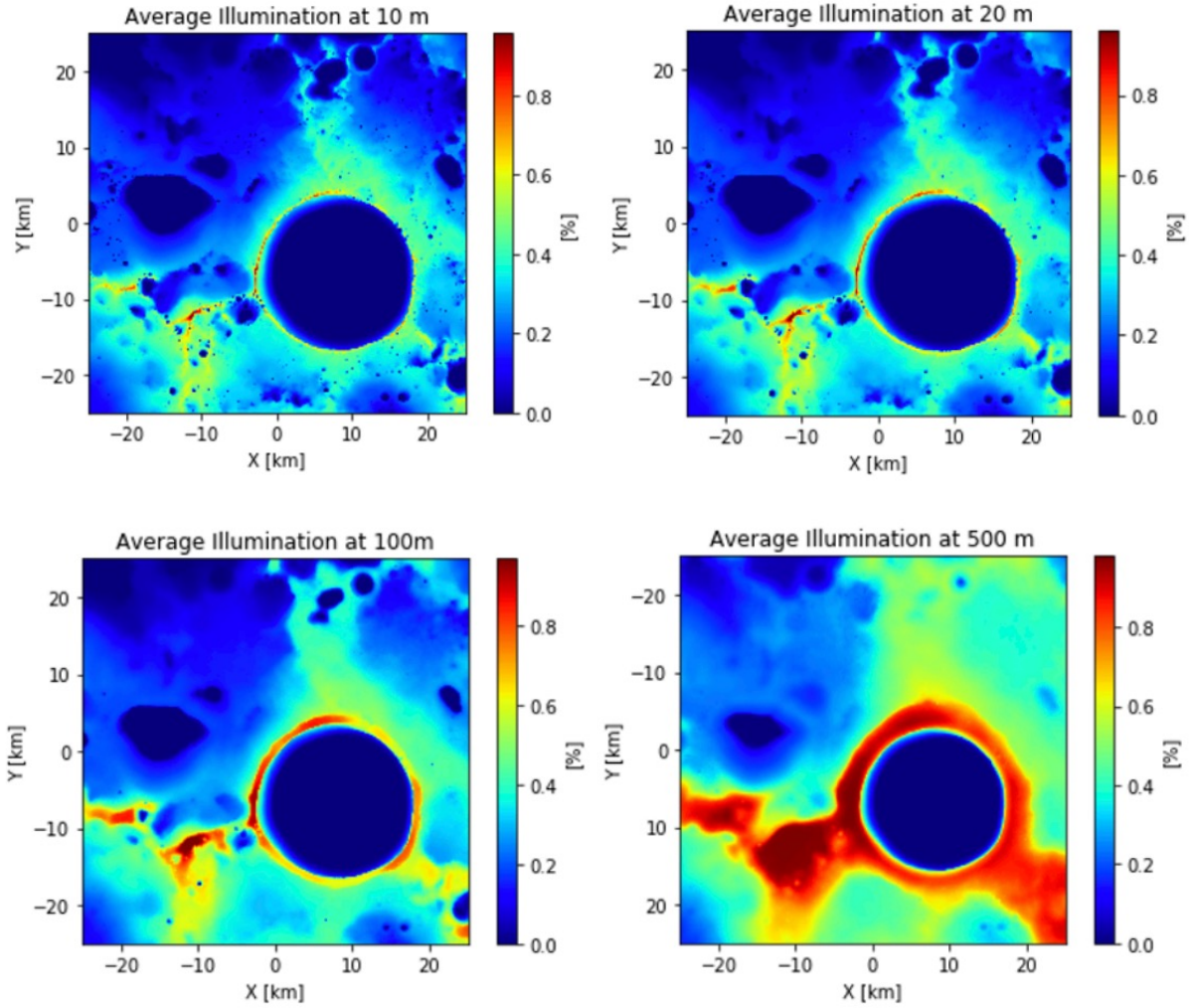
LUNSABER Height Advantage for Illumination

- **100+ meters** provides **>90%** average illumination
  - Average illumination through a lunar precession cycle (~18.6 years)
- **Taller** translates to more **deployment area**
  - Versatility in options for strategic deployment positions and less stringent requirement for landing
- Generate power through lunar nights when survival power is in high demand
  - Limited to lunar summers*
  - ~50-100 hours in complete darkness



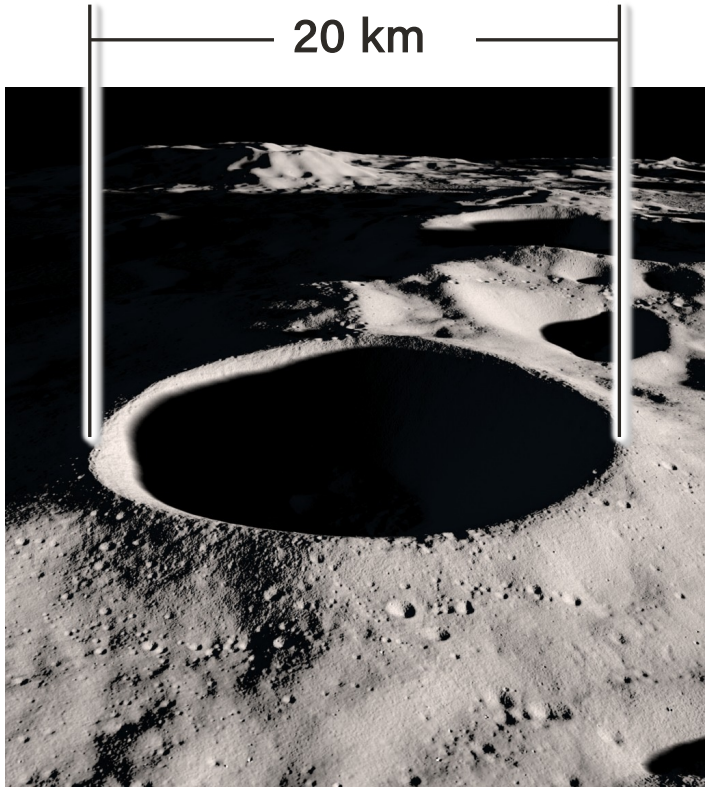
Reference
An Analysis of Illumination And Communication Conditions Near Lunar South Pole Based On Kaguya Data



Illumination near Shackleton Crater Based on Height from Lunar Surface

Reference
Towers on the Peaks of Eternal Light: Quantifying the Available Solar Power

Strategic Deployment and Optimization



Legend:

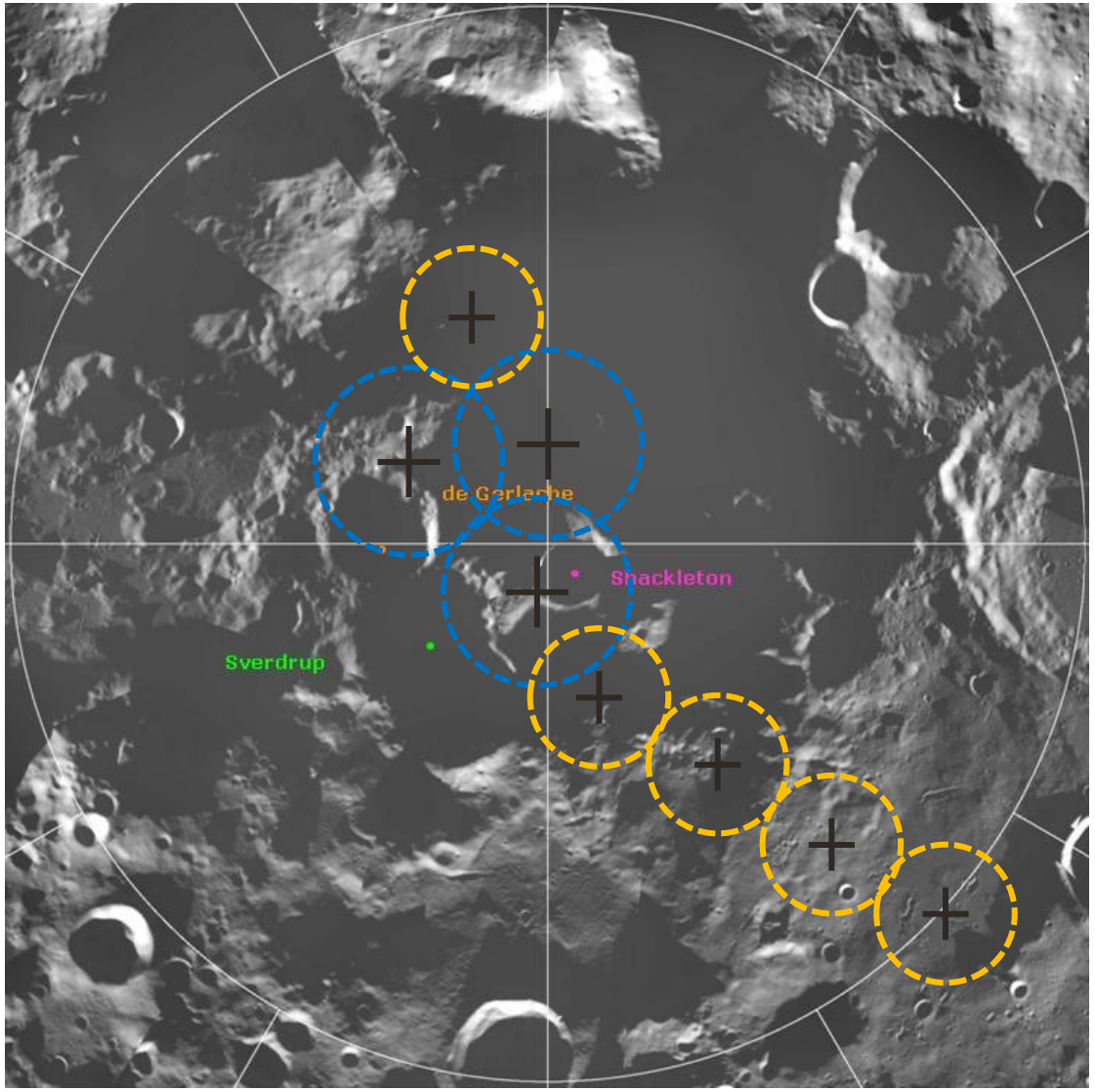
Deployment

LUNARSABER
Services Range

Configuration 1
100-meter height
37 km Diameter - service

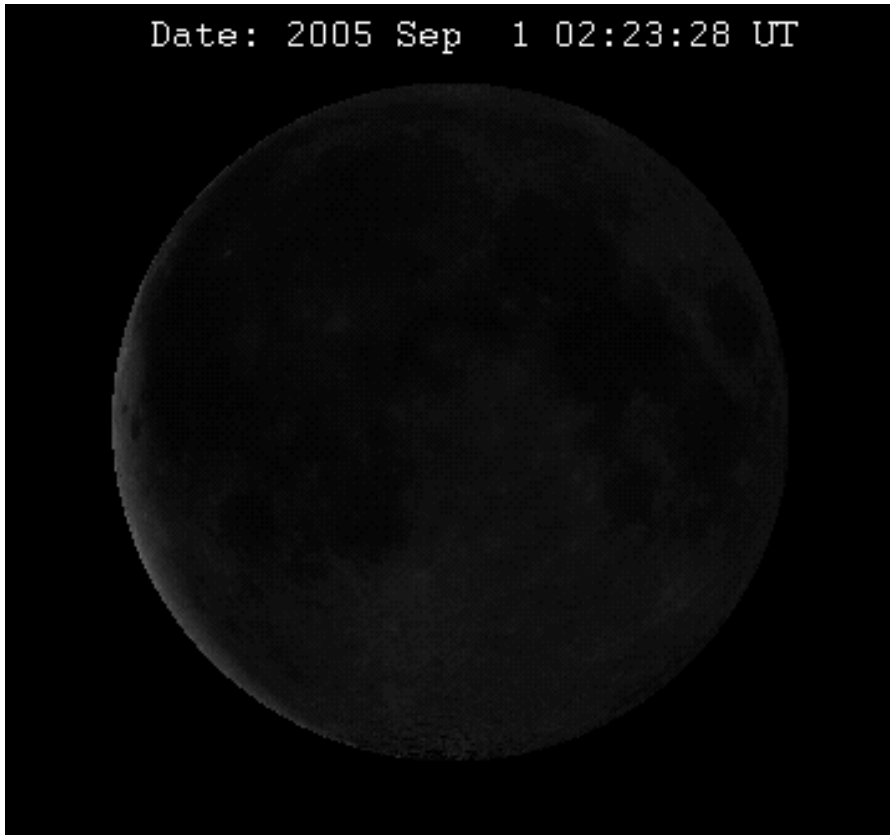
Configuration 2
30-meter height
20 km Diameter - service

A LUNARSABER placed near the rim of Shackleton crater can provide key services such as power and communication to lunar assets inside of Permanently Shadowed Region (PSR)



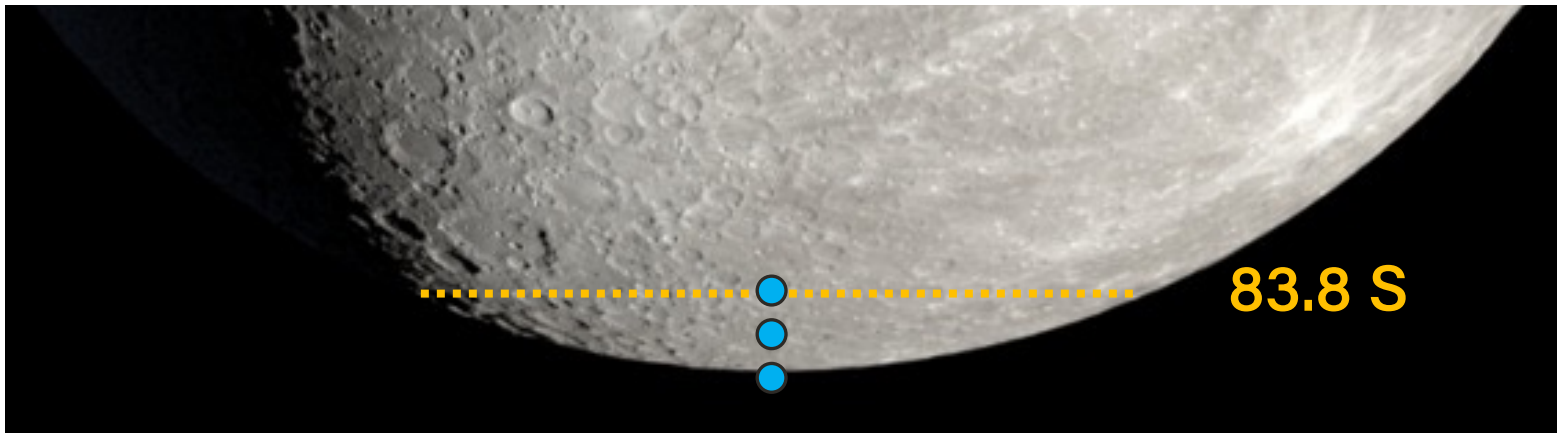
LUNARSABER Strategic Deployment near South Pole
(NOTIONAL)

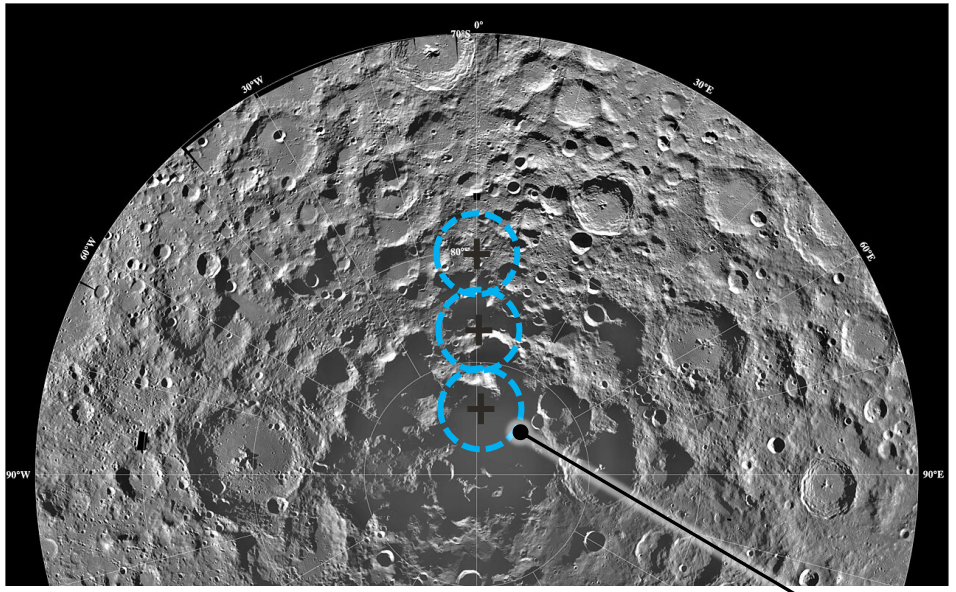
Continuous Direct-To-Earth Communications



Lunar Libration

Libration in Longitude -4.7 deg
Libration in Latitude **6.2 deg**

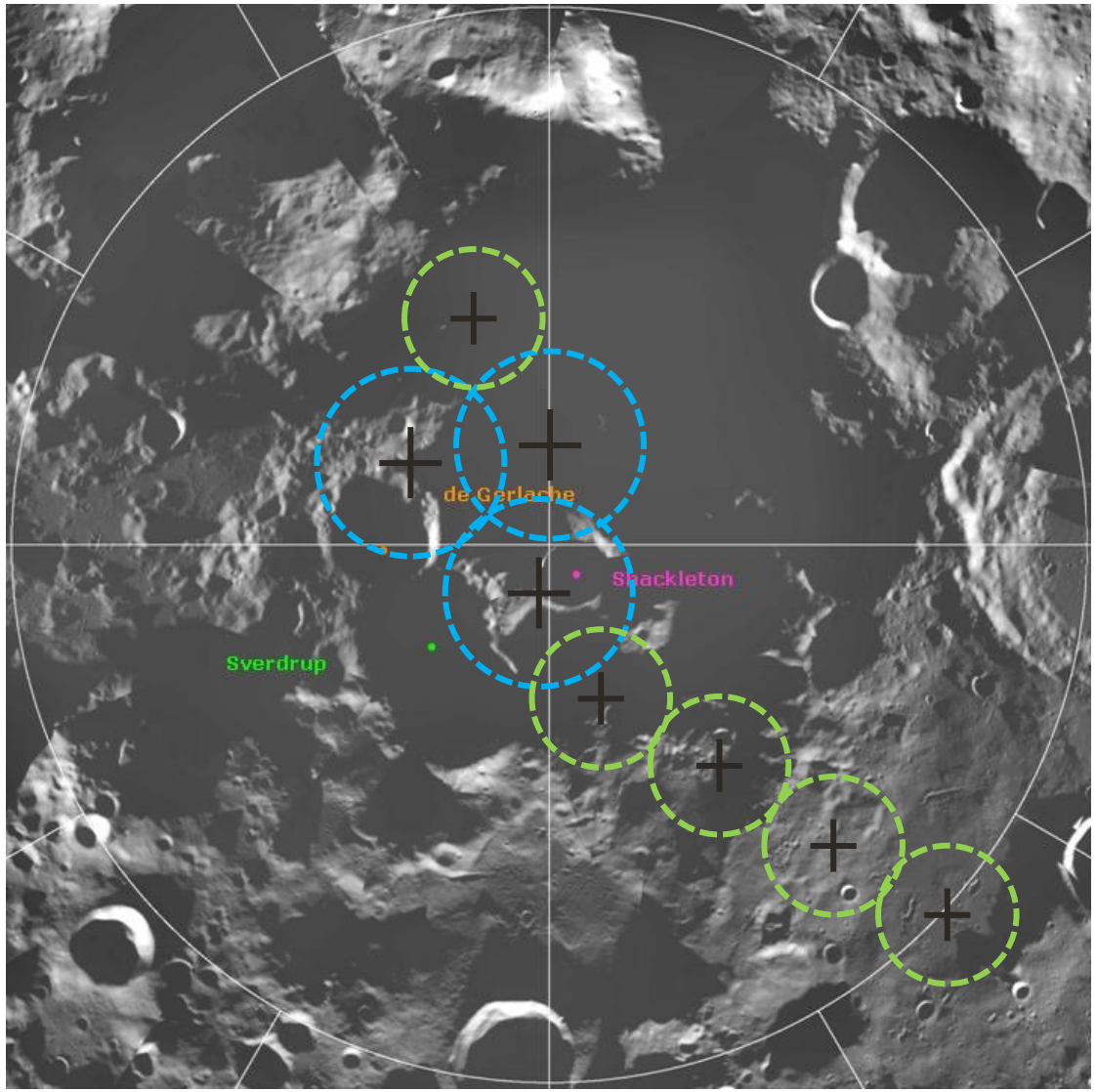




Setup a network of LUNARSABER to have **continuous Direct-to-Earth** communications from base to the near side of the Moon, past 83.8 deg S latitude to circumvent lunar libration

Configuration 1
200-meter height
53 km Diameter - service

Network Integration and Scalability



LUNARSABER Strategic Deployment near South Pole
(NOTIONAL)

Boost in service capability when scaled and set up in network with LUNARSABER nodes

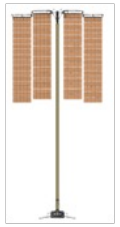
- **Lunar Network** – instantly access data across lunar assets without line-of-sight
  - **Data Storage** – provide a data storage services for asset monitoring, science data, or decentralized lunar network
- **Power "checkpoints"** – allow for lunar assets to transit across crater and regions without worrying about power and lunar nights
- **PNT services –** high accuracy position state as the number of deployments scale
- **Space Traffic Control** – future-forward to monitor and regulate space traffic while providing PNT services for more precision landing

LUNARSABER

HONEYBEE ROBOTICS

LUNARSABER provides a unique architecture to host various payload and services on the Moon

- Building upon existing technologies at Honeybee Robotics
- Partnerships with wider community to host payloads and understand user requirements

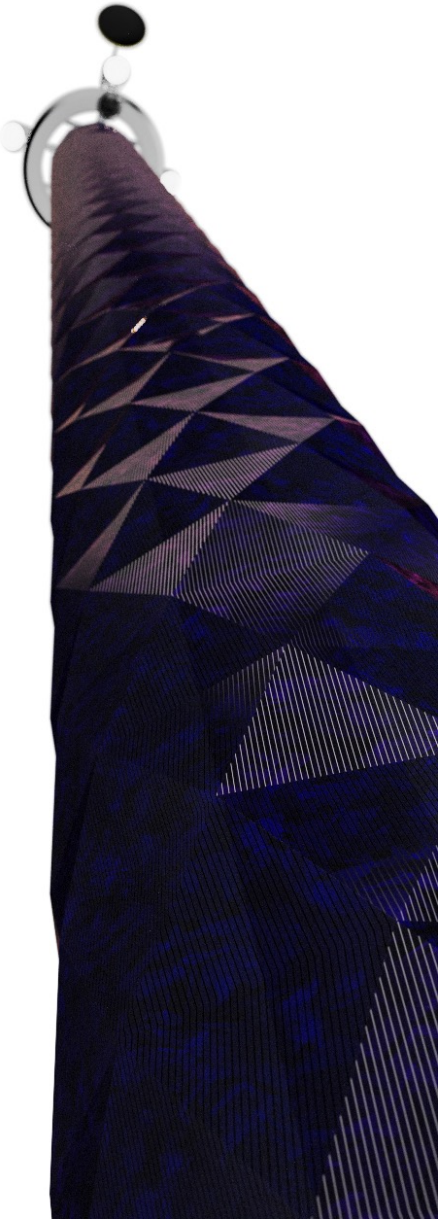


VSAT LAMPS
[16 m]

Statue of Liberty
[94 m]

LUNARSABER-100
[100 m]

LUNARSABER-200
[200 m]




HONEYBEE ROBOTICS