The Gandalf Staff: A Mobile Tool for Lunar Exploration

Michael Evans[1,1], John Bacon[1,1], Lee Graham[1,1], Matthew Leonard[2,2], Michael Zanetti[3,3], Joseph Morgan[4,4], and Christopher Harris[5,5]

[1]NASA Johnson Space Center
[2]Texas Space Technology Applications & Research (T STAR)
[3]NASA Marshall Space Flight Center
[4]Texas A&M University
[5]Jacobs Technology, Inc.

November 30, 2022

Abstract

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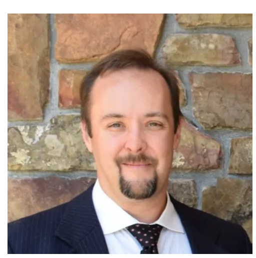

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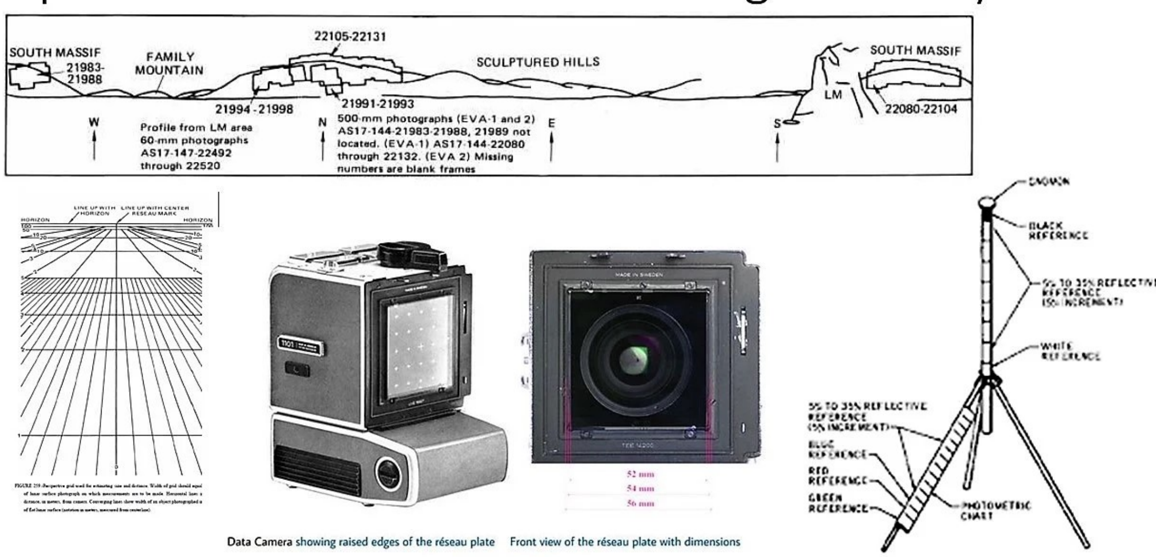
Apollo Lunar Gnomon and Photogrammetry



Data Camera showing raised edges of the réseau plate   Front view of the réseau plate with dimensions

Figure 14. Hasselblad 500EL Data Camera

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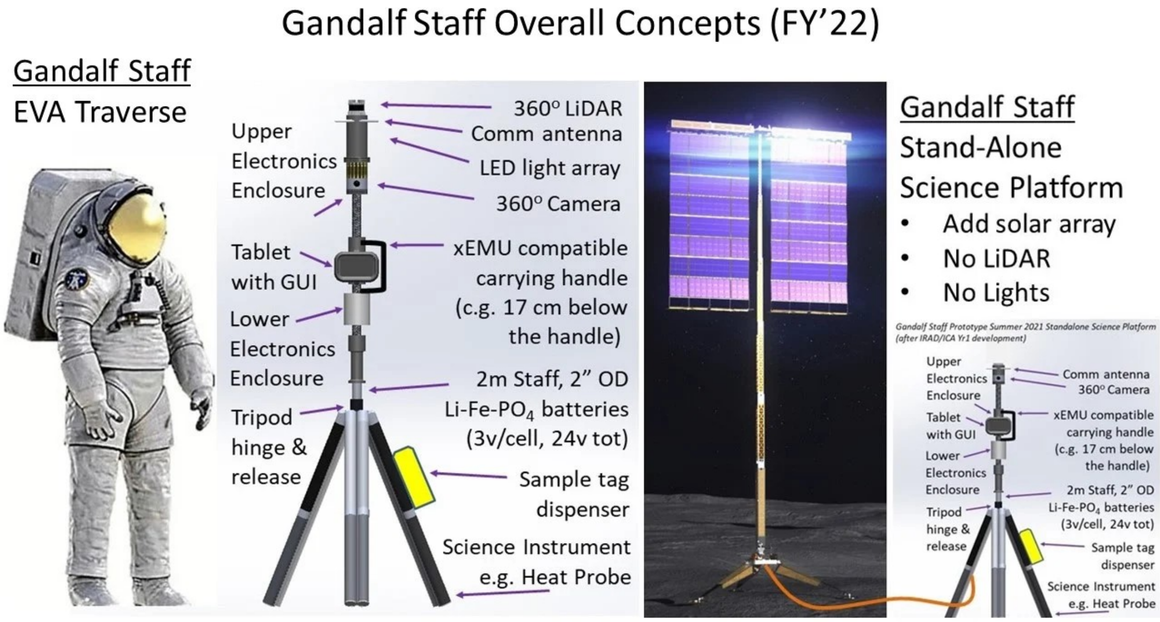
PICTURES OF GANDALF STAFF CONCEPTS

Key Components and Capabilities



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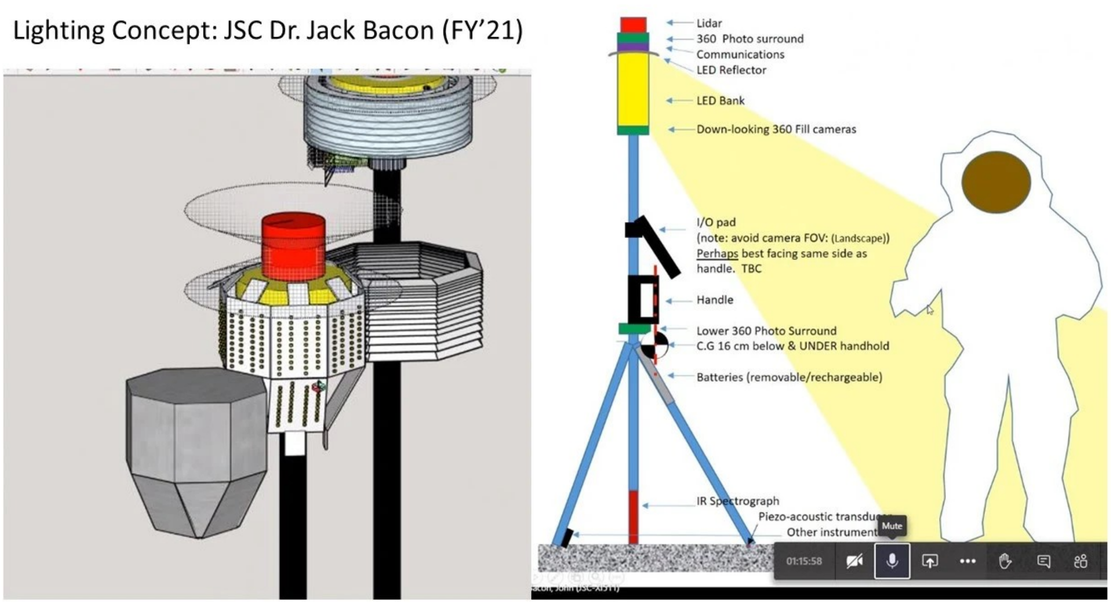

PROOF-OF-CONCEPT TEAMS

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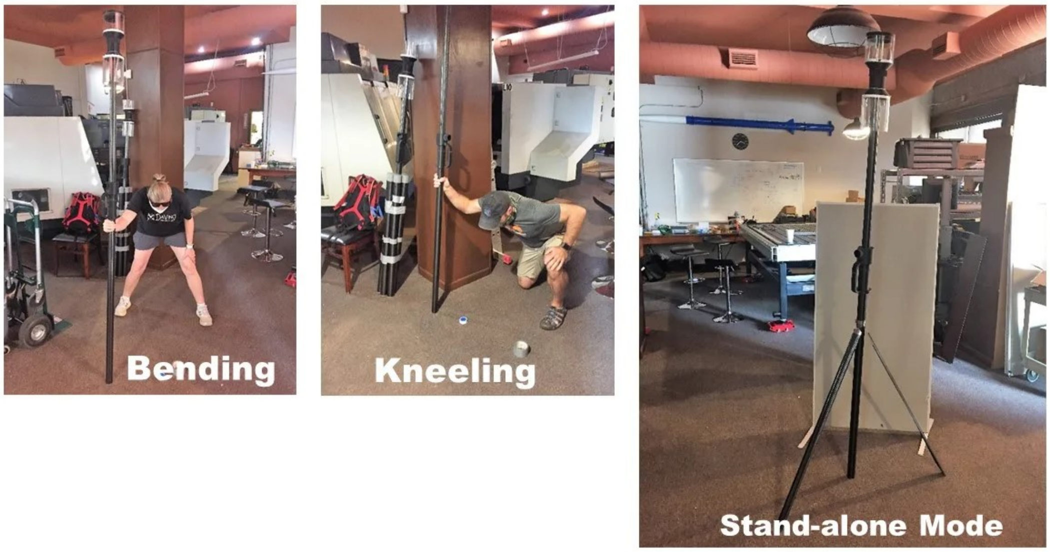
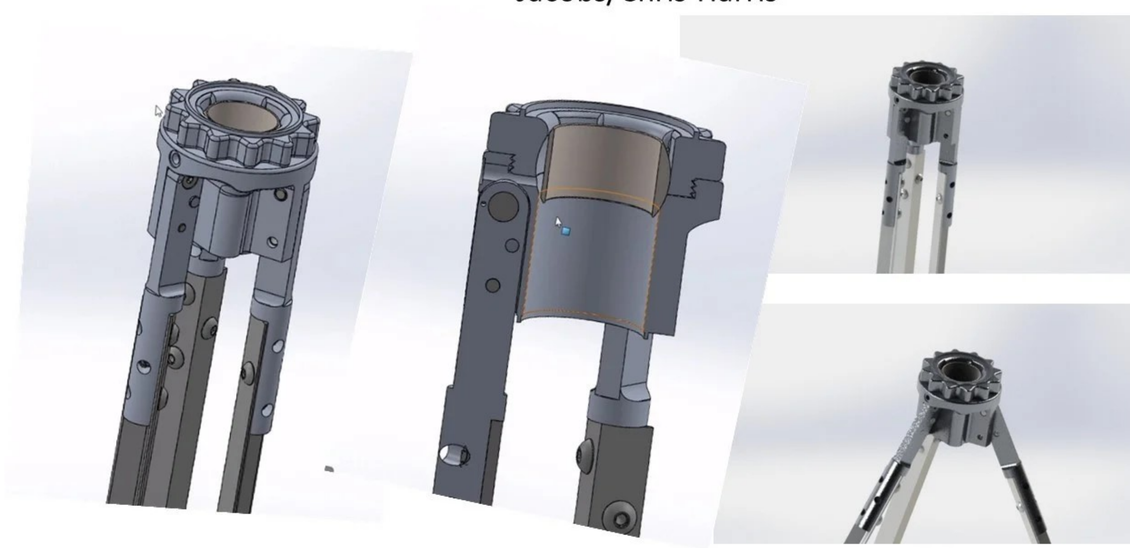
- Tripod Stand

Mechanical Proof-of-Concept Testing (FY'20)



Gandalf Staff – Year1 IRAD (FY'21) Tripod Leg Prototype
Jacobs/Chris Harris



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2nd generation mechancal prototype for field testing

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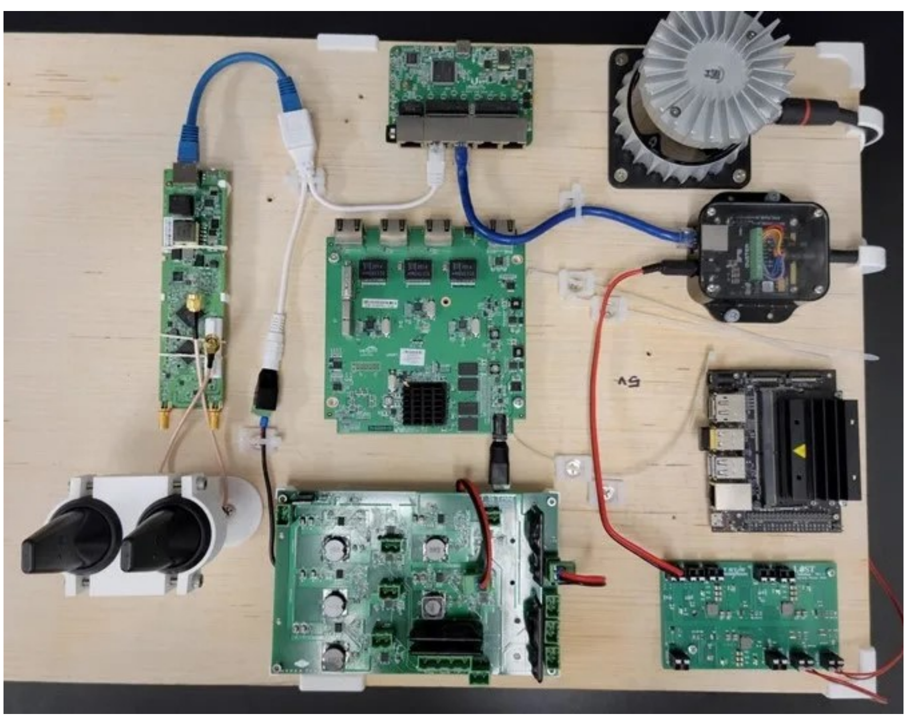

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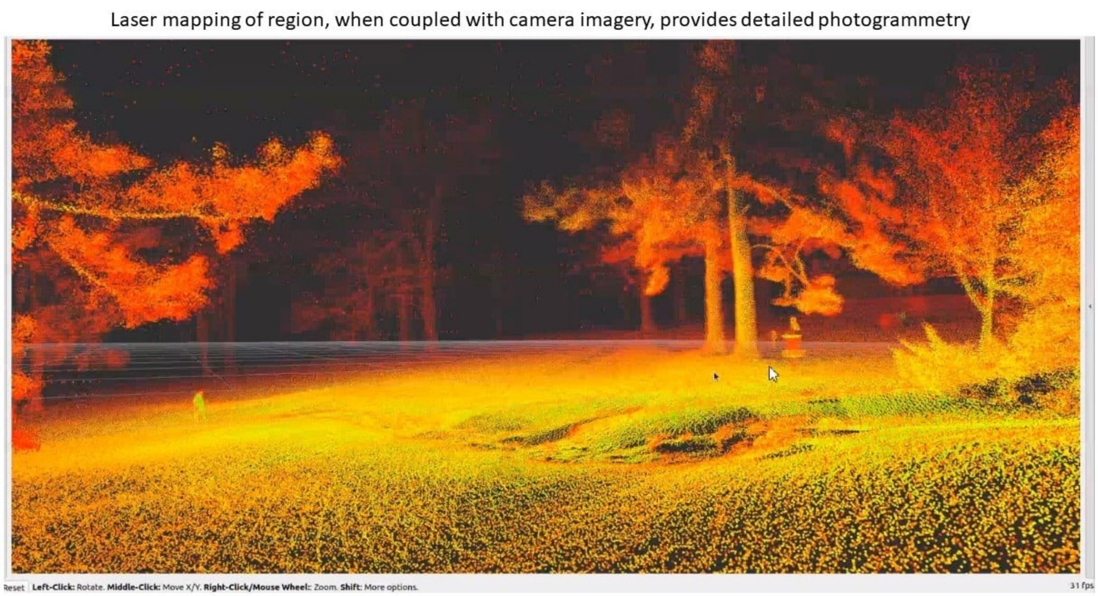
LOST Summary (click on picture for video)



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Talos Summary

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1. LunaSAR component testing (handheld unit with properly formatted message) to terrestrial network of Earth orbiting satellites

1. 2. Lighting lab test to characterize illumination parameters and develop lunar surface requirements. Pics below are from the test in December 2021.

Video from the single LED board testing at JSC lighting lab Sept. 2021: video (https://youtu.be/oeJGKiBXeoM)

3. Field testing of mechanical prototype and/or electronic components to assess ergonomics and EVA viability (click on picture for video of 2021 portable LiDAR field test led by Dr. Michael Zanetti)

(https://youtu.be/_VeQvgsJefc)

AUTHOR INFORMATION

Dr. Michael Evans (PI, Gandalf Staff Project):

NASA Johnson Space Center, Planetary Scientist, email michael.e.evans@nasa.gov (Houston, Tx)

Texas A&M University - Galveston (TAMUG) adjunct lecturer

REFERENCES

[1] NASA (1965) Summer Conference on Lunar Exporation and Science

[2] NASA (1967) Summer Study of Lunar Science and Exploration

[3] Glaser, P. et al (2014) Illumination conditions at the lunar south pole using high resolution digital terrain models from LOLA, Icarus #243, p78-90

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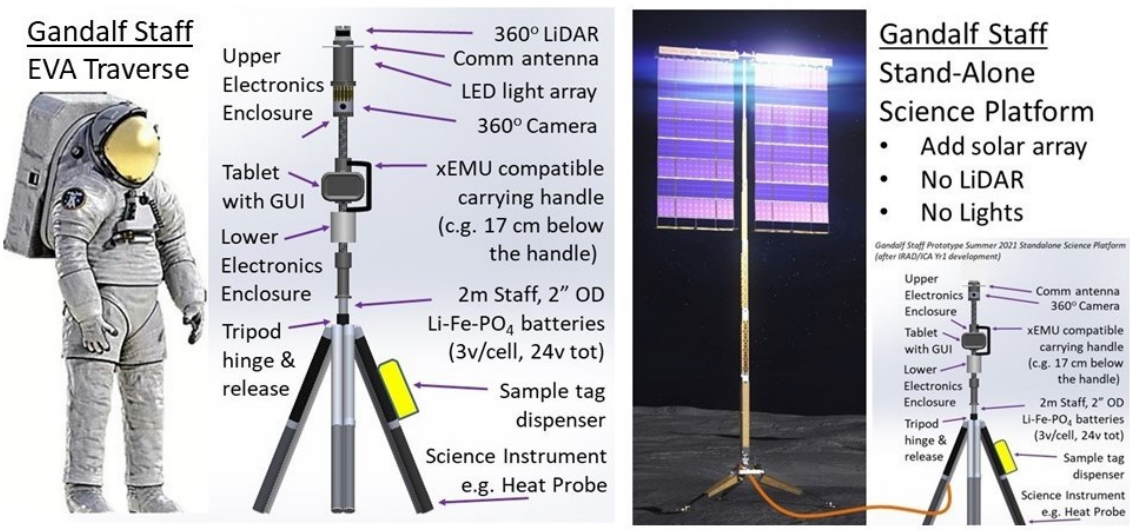

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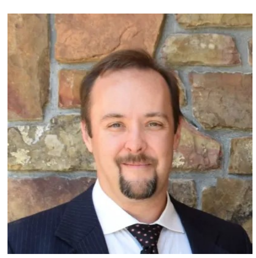

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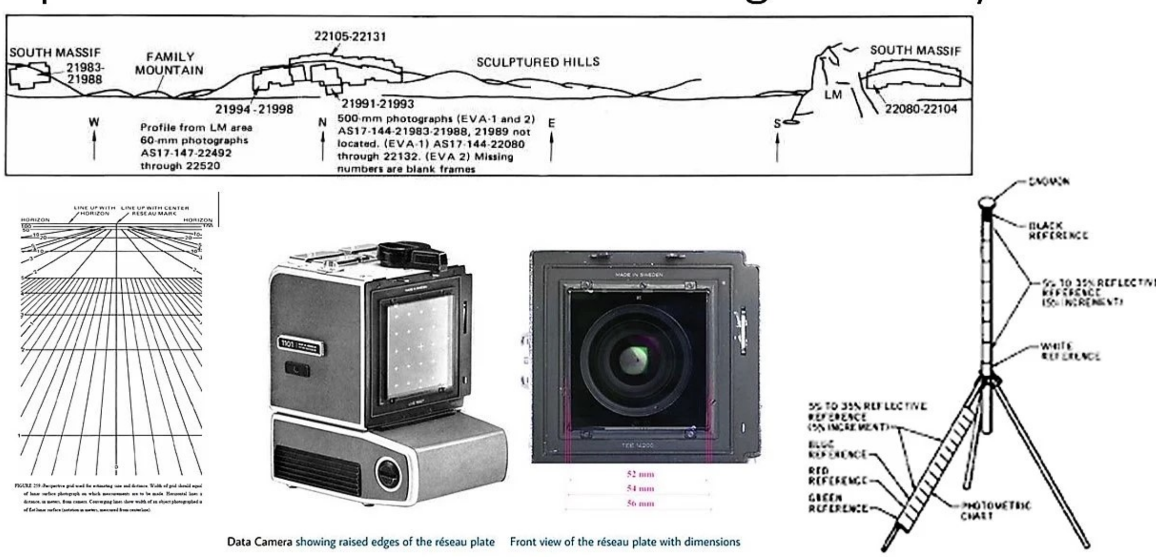

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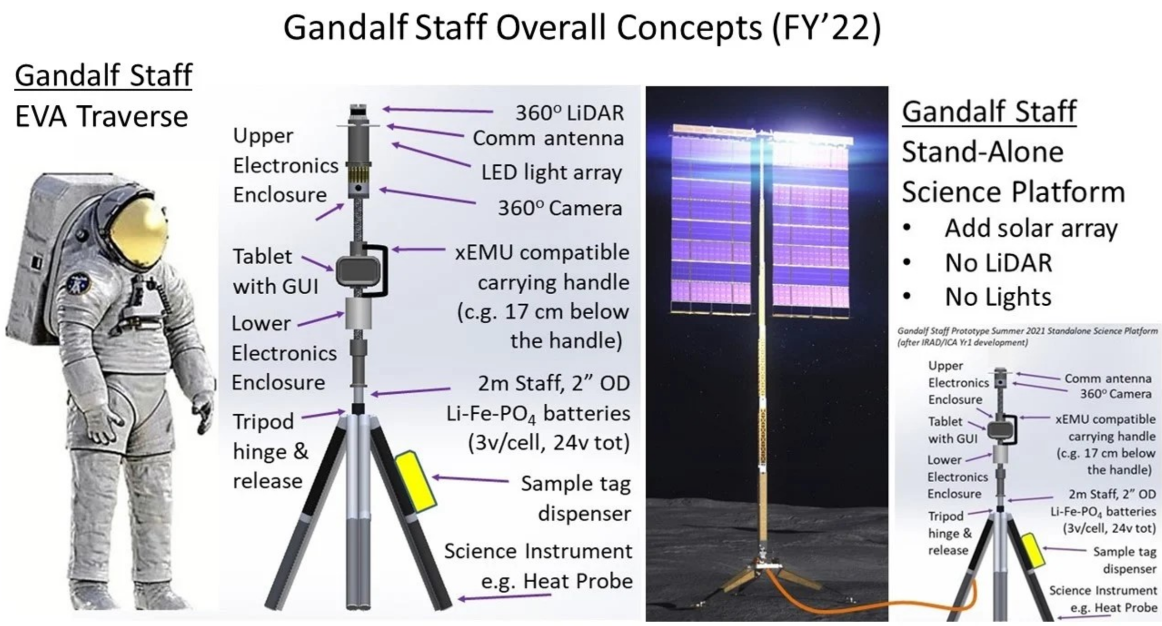

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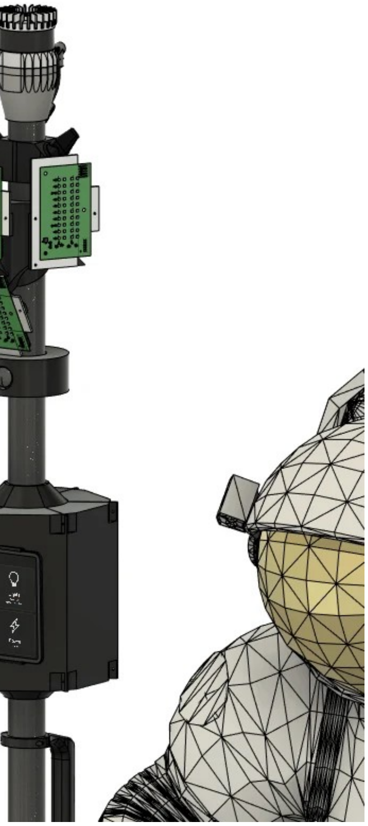
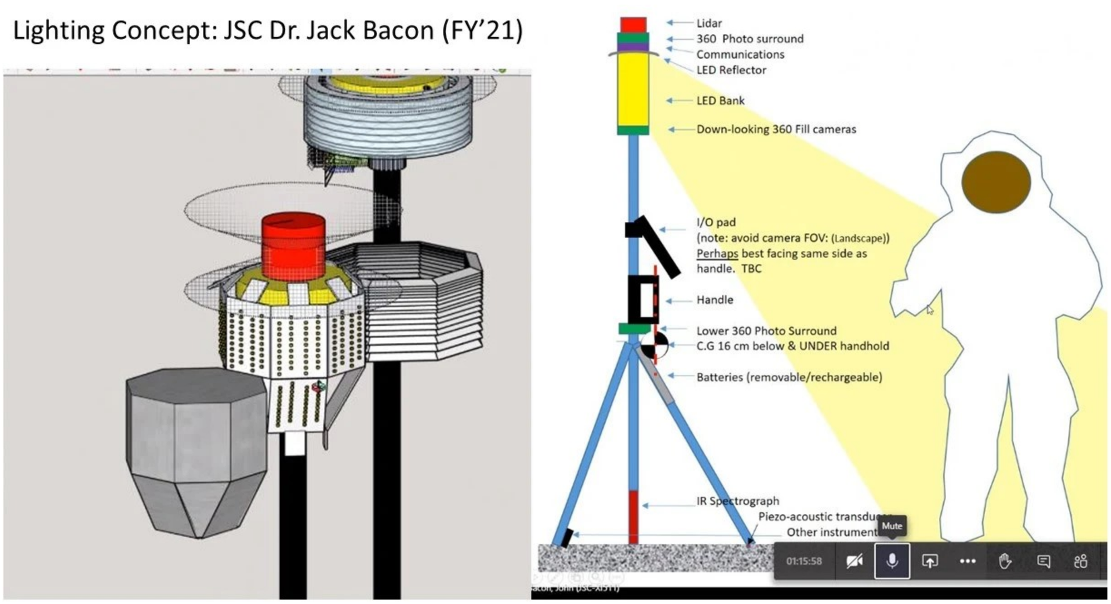


Lighting Concept



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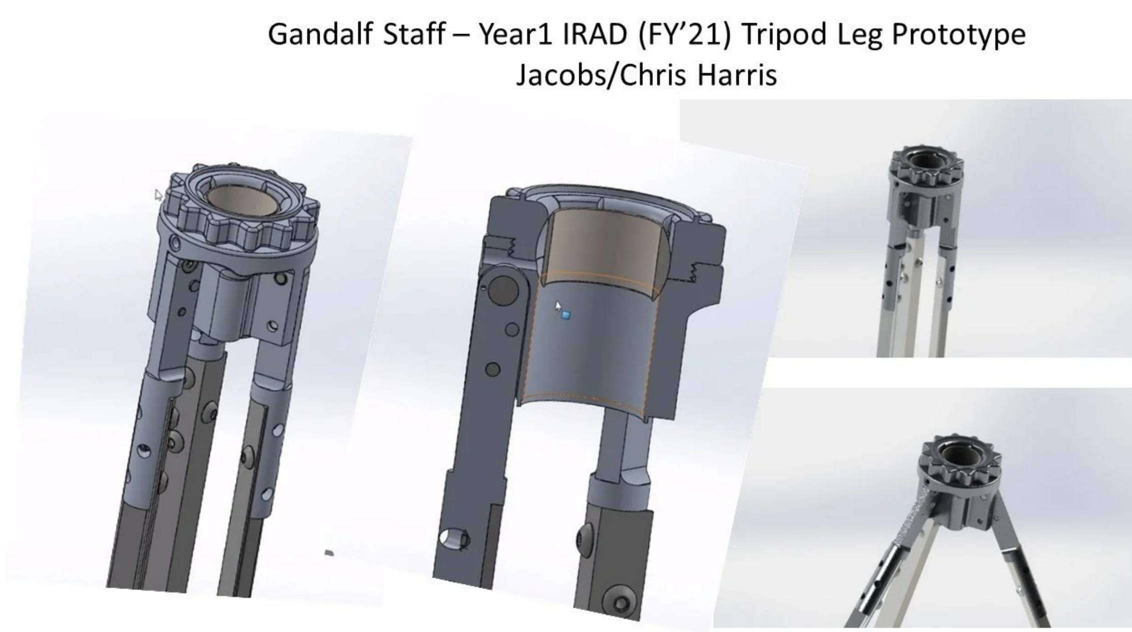

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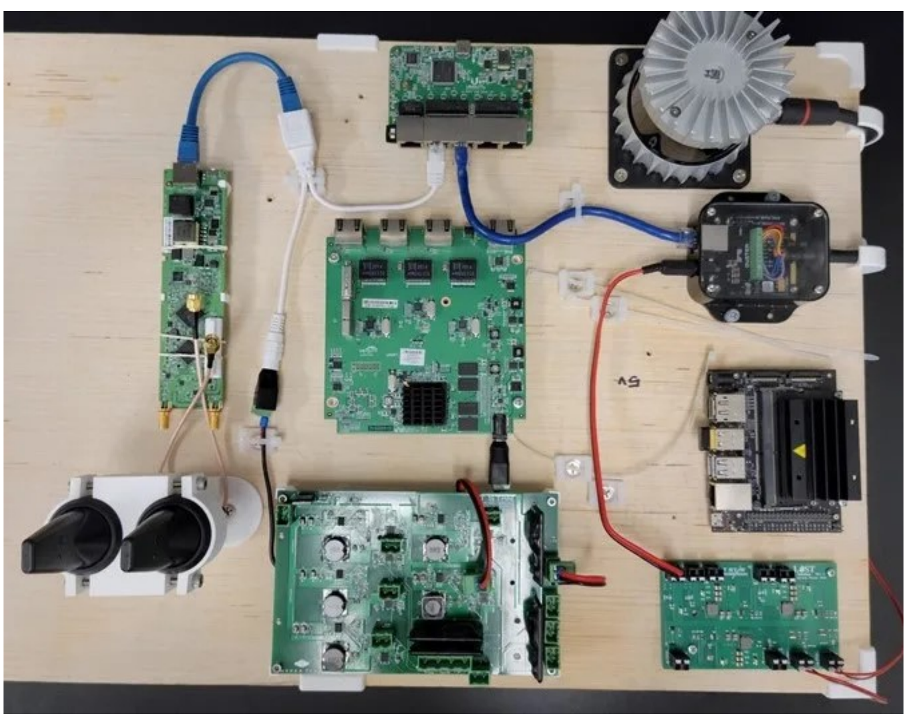

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LOST Summary (click on picture for video)

Laser mapping of region, when coupled with camera imagery, provides detailed photogrammetry

(https://youtu.be/O-Hmr5qvZaM)

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1. LunaSAR component testing (handheld unit with properly formatted message) to terrestrial network of Earth orbiting satellites

1. 2. Lighting lab test to characterize illumination parameters and develop lunar surface requirements. Pics below are from the test in December 2021.

Video from the single LED board testing at JSC lighting lab Sept. 2021: video (https://youtu.be/oeJGKiBXeoM)

3. Field testing of mechanical prototype and/or electronic components to assess ergonomics and EVA viability (click on picture for video of 2021 portable LiDAR field test led by Dr. Michael Zanetti)

(https://youtu.be/_VeQvgsJefc)

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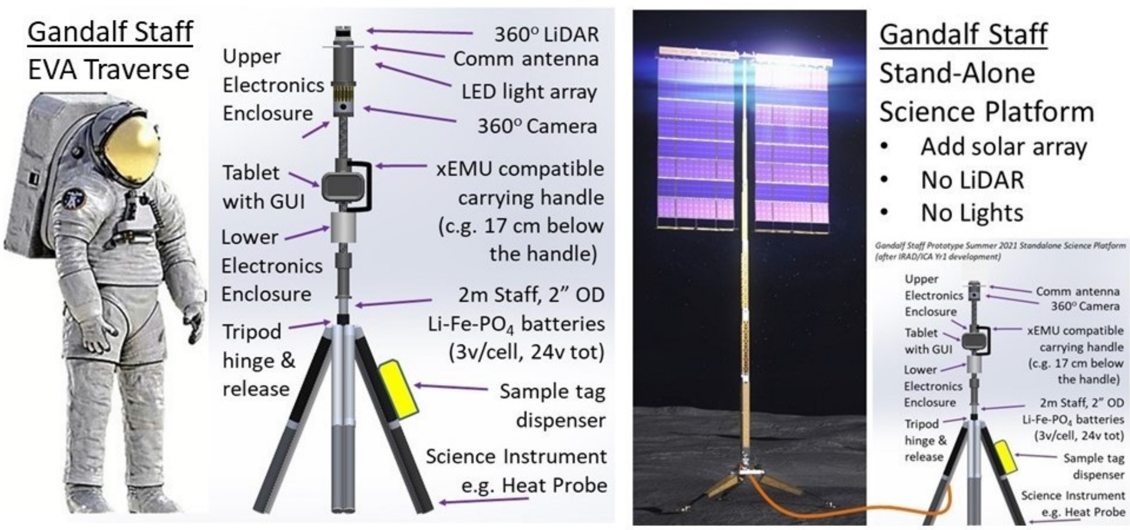
[3] Glaser, P. et al (2014) Illumination conditions at the lunar south pole using high resolution digital terrain models from LOLA, Icarus #243, p78-90

ABSTRACT

The Gandalf Staff is a mobile tool designed to be a flexible device supporting crewed and uncrewed operations on the lunar surface. The core of the device is a 24v battery with communications and data storage systems. Initial optional components supporting crewed Extra-Vehicular Activity (EVA) include a LiDAR and 360˚ camera. These provide 3D mapping of the traverse for documentation, and to aid future planning. The mapping also creates outreach opportunities for the public to "stand beside" the astronaut in Virtual Reality (VR). The staff provides external lighting for field site illumination in the south polar region low sun angle environment. Navigation instruments for crew position determination with Lunar Search and Rescue (LunaSAR) are also included. The staff itself can be used as a walking aid or as a splint for Incapacitated Crew Rescue (ICR). As a stand-alone device, the staff operates as a long duration untended science platform collecting environmental data and sending it to a lunar base station. The stand-alone mode requires connection to an auxiliary power source (e.g. solar array) and energy storage system (e.g. battery), so it could become an electrical recharging station.

To make rapid progress in the 1st year, and also to demonstrate innovative project management techniques, NASA guided a private industry partner, T STAR, in leading Capstone Engineering student teams at Texas A&M University (TAMU) for proof-of-concept development and testing. These teams developed the power system and demonstrated successful integration of LiDAR, WiFi communications, and external lighting subsystems. Another industry team at Jacobs Technology prototyped a tripod to hold the staff upright. For the 2nd year (FY'22), NASA will again collaborate with partners to prototype enhanced power and lighting concepts. Year 2 will also add new capability for LunaSAR and geophysical science instrumentation using a heat probe. The heat probe is based upon Apollo heritage but modified to measure subsurface volatile ice regimes at the Artemis landing site.

Components of the Gandalf Staff can be developed, tested, and deployed independently, or on the integrated staff, rovers, or utility trailers. The project supports crew safety, lunar sample curation, mission science, and public outreach goals of NASA.



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