ISRU Pilot Plant Deployment with the Flexible Logistics & Exploration (FLEX) Rover. J. B. Matthews[1], A. J. Welter[1], C. M. Western[1], [1]Venturi Astrolab, Inc., 12536 Chadron Ave Hawthorne, CA 90250 (Contact: jaret@astrolab.space)

Introduction: NASA and private industry investments will soon make it possible to land unprecedented amounts of cargo on the Moon at a regular cadence. Venturi Astrolab, Inc. (Astrolab) is developing the multi-functional Flexible Logistics & Exploration (FLEX) rover with this burgeoning environment in mind. The FLEX rover's unique commercial potential comes from its novel mobility system architecture, which gives it the ability to pick up and deposit modular payloads in support of human operations, robotic science, exploration, logistics, infrastructure deployment, site survey/preparation, construction, maintenance, & repair, resource utilization, and other activities critical to a sustained presence on the Moon and beyond (Figure 1).

Figure 1: FLEX's modular payload interface and novel mobility system enable it to perform a multitude of functions, including crew transport, outpost logistics, robotic science, and infrastructure deployment

Adaptive Utility: FLEX is a Lunar Terrain Vehicle (LTV)-class, semi-autonomous, remotely-operable rover that can carry two suited astronauts and all their associated equipment, tools, instruments, and samples. FLEX features a novel wheel-on-limb mobility system that can raise and lower the ground clearance of the chassis and adapt to variable terrain while maintaining stability. This system also allows the rover to lower attached instruments and equipment to the ground and/or independently collect and deploy modular payloads. FLEX can accommodate payloads with volumes in excess of $3m^3$ and masses of up to 1,500 kg.

Robotic Arm & Payload Mezzanine: Astrolab recently completed the design and build of a 2.4m long, six degree-of-freedom robotic arm that interfaces to FLEX (Figure 2). The arm includes a dust-tolerant quick disconnect end effector that is used to attach-to and extract payloads, instruments, and tools that are housed in a mezzanine below the arm. Each of the 15 payloads in the mezzanine can be as large as a 12U cubesat (22cm x 22cm x 36cm) and 25kgs. In addition to deployable customer payloads, the mezzanine can contain instruments or other implements such as a scoop for collecting samples or transferring regolith.

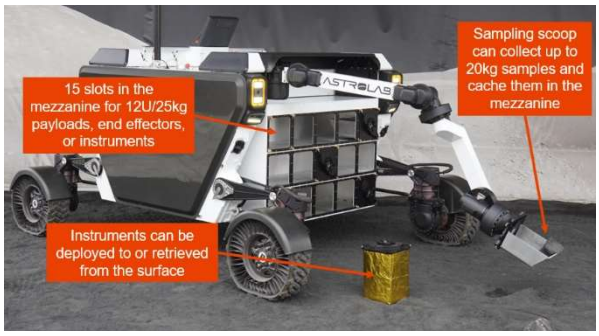

Figure 2: Astrolab's 6-DoF Robotic Arm and Payload Mezzanine attached to the FLEX rover

Analog Testing: Astrolab has developed a full-scale, fully-functional terrestrial proof-of-concept FLEX rover and has conducted multiple field tests at analog sites in the California desert. At these field trials, FLEX was used to conduct demonstrations of various activities and operational scenarios that will be required on the Lunar surface [1]. Recent testing included an end-to-end in-situ resource utilization (ISRU) demonstration (Figure 3). This test included the transport and deployment of a 5kW vertical solar array tower (VSAT) mockup and an ISRU pilot plant (1.5m x 1m x 1m) mockup. The ISRU plant included a cable spool that connected the VSAT to the plant. After deploying this equipment, the FLEX robotic arm extracted a scoop implement from the payload mezzanine and used the scoop to collect and deposit feedstock material into the ISRU plant. This test successfully demonstrated how an ISRU pilot plant of a meaningful scale could be deployed and operated on the lunar surface in a series of practical steps using FLEX.

Figure 3: Astrolab recently conducted an end-to-end ISRU plant deployment demonstration at an analog test location in California

[1] NASA HEOMD-006: Human Exploration Operations & Utilization Plan (2021)