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Author: Mr. Shravan Hariharan
Blue Origin LLC, United States, shravanh@mit.edu

Mr. Parker Steen
Massachusetts Institute of Technology (MIT), United States, psteen@mit.edu
Prof. Jeffrey Hoffman
Massachusetts Institute of Technology (MIT), United States, jhoffma1@MIT.EDU
Dr. Michael Hecht
Massachusetts Institute of Technology (MIT), United States, mhecht@haystack.mit.edu

THE MOXIE FLATSAT: A GROUND-BASED ISRU OPERATIONAL TESTBED

Abstract

The Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE) is a payload onboard NASA's Perseverance Rover demonstrating the production of oxygen through solid oxide electrolysis of carbon dioxide in the Martian atmosphere. MOXIE has successfully generated oxygen on Mars over 10 times since landing in February 2021 and will continue to demonstrate oxygen production during night and day throughout all Martian seasons.

Opportunities to run MOXIE on Mars are limited due to mission constraints such as the operations of other Mars 2020 instruments, and MOXIE runs themselves are constrained in length and form due to limits on energy usage. In addition, instrumentation within MOXIE is limited to what was launched as a part of the instrument, resulting in a fixed set of sensors and resulting data streams from the payload. Therefore, the MOXIE team at the Massachusetts Institute of Technology (MIT), MIT Haystack Observatory, and NASA Jet Propulsion Laboratory (JPL) developed the MOXIE FlatSat as a ground-based operational testbed to further characterize the MOXIE system, evaluate and validate planned MOXIE operations on Mars, and demonstrate potential operating modes and configurations for a next-generation Mars in-situ resource utilization (ISRU) system. The FlatSat consists of the main MOXIE subsystems and components arranged in a spread-out configuration within a laboratory, allowing for additional instrumentation, environmental control, and flow path modifications. This allows for more aggressive and flexible experimentation than is possible on Mars, furthering knowledge of and experience with ISRU systems and their operation without the risk and cost of a flight mission.

This paper discusses the FlatSat testbed configuration and capabilities, as well as characterization activities completed using the FlatSat that inform design and operation of a next-generation Martian ISRU system. Now fully operational, this novel ground-based testbed allows for cost and time-effective characterization of existing and planned ISRU systems without subjecting flight hardware to additional wear.