National Aeronautics and Space Administration

HEOMD Update

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Content

- Mars 2020
- Phobos/Deimos SKGs
- HLS2
- ISECG Science White Paper

MARS

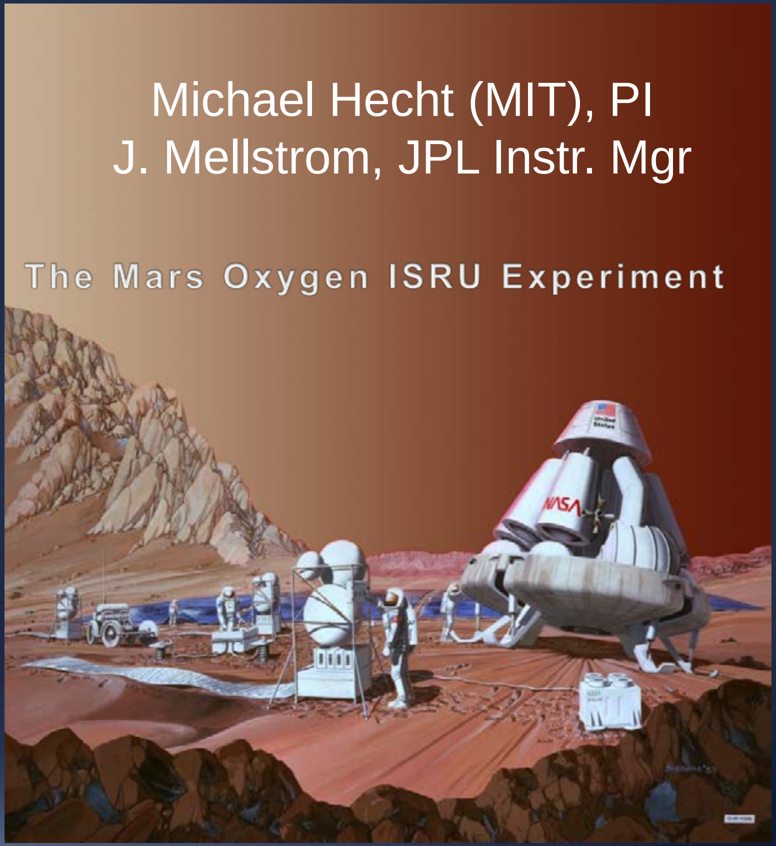
MOXIE

Goals:

- Intermittently operate an oxygen production plant on Mars, demonstrating resilience with respect to dust and other environmental challenges
- Return knowledge of performance parameters that are critical to the design of a full-scale system
- Evaluate (and optimize) extensibility to a human mission in the context of a long-term goal to eliminate the need to carry LOx to Mars for return trip

Top level requirements:

- General agreement that MOXIE shall produce O_2 with at least 98% purity
- Be capable of meeting production requirements for at least 10 operational cycles on Mars

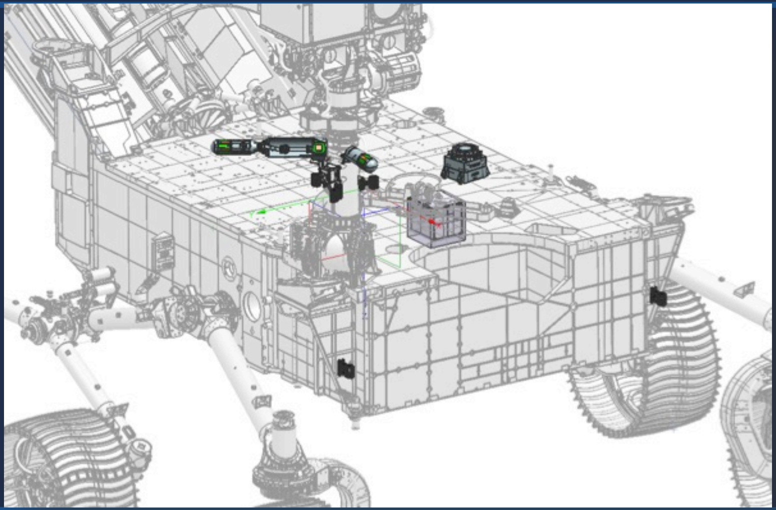


MEDA

MEDA, is a meteorological station that also monitors the Martian dust aerosol cycle.

•MEDA measures pressure, humidity, wind speed, direction, thermal and UV-visible-NIR-Thermal IR solar radiation cycles.

•MEDA monitors changes of Sun light optical depth and scattering properties caused by the atmosphere. They are used to infer aerosol dust abundance, size distribution, and morphology.



Instrument Description:

Upgraded sensor package & electronics unit serve as follow-on to REMS

- ICU & PS on RAMP
- 170-mm fixed & 396-mm switch blade WS on RSM
- 5 ATSs (3 on RSM, 2 on rover body)
- Thermal IR Sensor on RSM
- Humidity Sensor on RSM
- Radiation and dust sensor, including SkyCam, to image atmospheric dust opacities & scattering, on rover deck

5.2 kg mass

Key Personnel:

PI – Jose Rodriguez-Manfredi (CAB, Spain)

DPI – Manuel de la Torre (JPL/Caltech)

IPM – Roser Urqui (CAB, Spain)

International team:

Europe: CRISA, Finnish Meteorological Institute (FMI), UPC, EHU, UAH, CSIC, AVS.

US: GSFC, APL, TAM, UM, Aeolis.

Recent Activities

Some sensor trade decisions were made at PDR & March 2016:

Using RDS digital signal; TIRS packaging enables new TIR filters; Updated ASIC design:

Instrument Preliminary Design Review:

Key aspects for second half of FY16 prepare for instrument CDR:

Prepare calibration plans and experiment operation plans.
Early validation of concepts and subsystems

Mars Entry Descent and Landing Instrumentation 2 (MEDLI2) Overview

Key Benefits

- MEDLI2 will reduce uncertainty in aeroshell TPS response with the potential to reduce TPS mass by up to 130 kg
- MEDLI2 will reduce uncertainty in supersonic aerodynamics with a potential reduction of the landing uncertainty by 30%
- MEDLI2 fills critical EDL knowledge gaps which represent a technology advancement in EDL
- MEDLI2 advances instrumentation development essential for EDL analysis

Integration with other projects/programs and partnerships

•MEDLI2 co-funded
•STMD/GCD provides ~40% of the LCC
•HEOMD/AES provides ~40% of the LCC
•SMD provides ~20% of the LCC – covers JPL and LM efforts

Technology Infusion Plan:

- MEDLI2 baselined for use on Mars 2020 (signed MOU)

•Hardware technology being developed – TRL 6 by MEDLI2 PDR; Data knowledge – leveraging existing tools and methods – flight data will extend knowledge
•Infusing/potential customer – SMD & HEOMD
•Anticipated use – will support EDL reconstruction; increase understanding of aeroperformance in supersonic regime; increase understanding of backshell aerothermal environment; enhance understanding of turbulent transition

Key Personnel, Participating Centers & Dates:

Project Manager: Henry Wright (LaRC)
Principal Investigator: Deepak Bose (ARC)
Lead Center: LaRC
Supporting Centers: ARC & JPL
Project Start: 1 Oct 2014
System Delivery Date: 15 Apr 2019
Mars 2020 Launch: July 2020
Landing: Feb 2021
Project End Date: 30 Sep 2021

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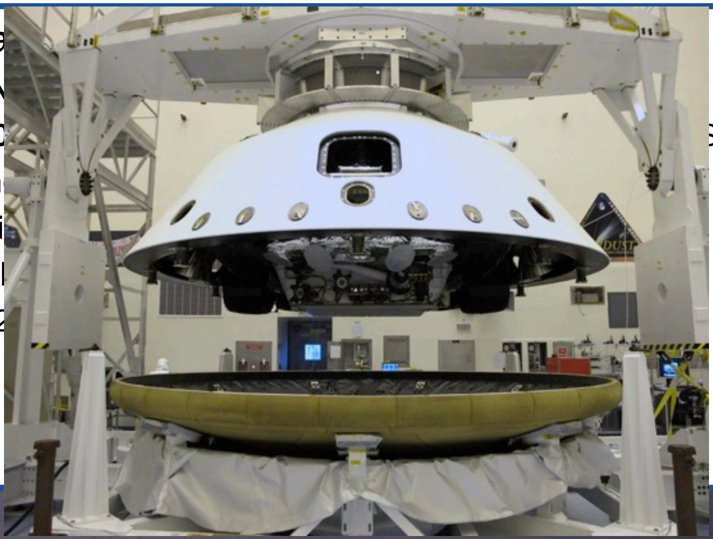
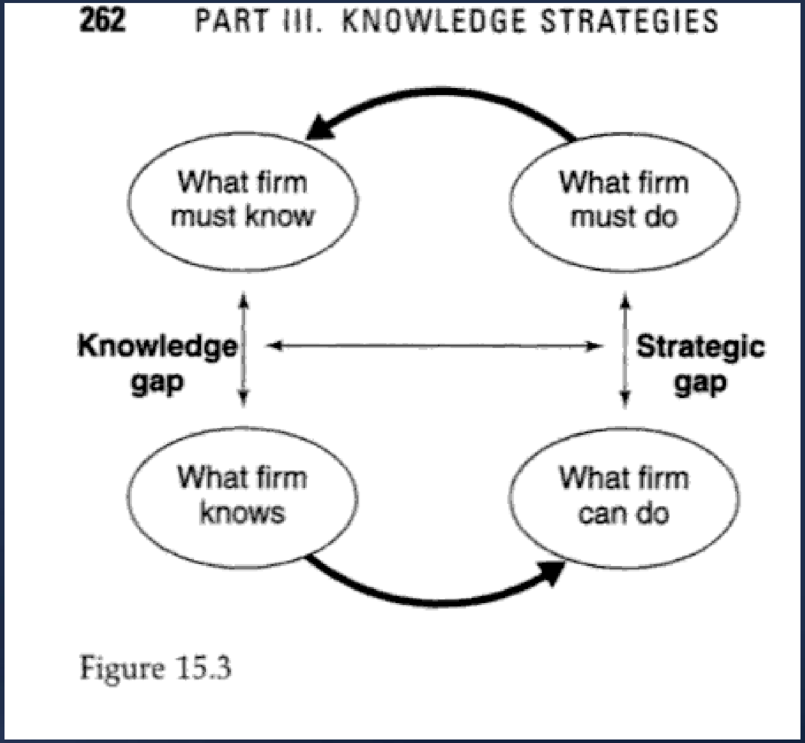


Strategic Knowledge Gaps

- "The gap between what the organization needs to know and what it knows now"
- Taking a human visit to a particular destination as a given, what don't we know how to do, and how do we learn to do it?
- Ultimately, generate list of measurements, allowing design of precursor missions



Zack, in *The Strategic Management of Intellectual Capital and Organizational Knowledge*, Choo & Bontis eds. (2002)

SKG Activities

- During FY16, we focused on updating and publishing the Phobos/Deimos and Lunar SKGs
- Decision to have separate P/D and NEO SKGs
- Previously the P/D-related SKGs were developed in a joint SBAG/MEPAG activity
  - SSERVI included in this iteration
- Secondary goal was to produce useful web presence for the SKGs
- https://www.nasa.gov/exploration/library/skg.html

The Team

- Steering Committee
  - SBAG: Andy Rivkin
  - MEPAG: Scott Anderson
  - SSERVI: Brad Bailey, Greg Schmidt

- SAT Members
  - Paul Abell
  - Julie Bellerose
  - Jule Castillo-Rogez
  - Barb Cohen
  - Christine Hartzell
  - Pascal Lee
  - Brad Thomson

MARS

List of Phobos/Deimos SKGs

- A: SURFACE MAPPING
  - A.1 Surface Composition
    - A.1.1 Mineralogical Composition
    - A.1.2 Elemental Chemistry
  - A.2 Surface Topography
- B: SURFACE & PROXIMITY ENVIRONMENTS
  - B.1 Radiation and Plasma Environment
    - B.1.1 Orbital Radiation Environment
    - B.1.2 Surface Radiation Environment
    - B.1.3 Electric and Plasma Environments
  - B.2 Gravitational Fields
    - B.2.1 Gravitational Fields of Phobos and Deimos
    - B.2.2 Orbital Debris Hazard
  - B.3 Regolith Properties
    - B.3.1 Regolith Particle Size-Frequency Distribution
    - B.3.2 Geotechnical Properties
    - B.3.3 Upper-surface Stratigraphy
    - B.3.4 Surface Boulder Distribution
    - B.3.5 Macroporosity
  - B.4 Thermal Environment
    - B.4.1 Thermal Environment
- C: RESOURCES
  - C.1 Resource Characterization
    - C.1.1 Volatile Distribution
    - C.1.2 Volatile Concentration
    - C.1.3 Volatile Form and Characterization - Andy
    - C.1.4 Volatile Extraction
- D: HUMAN FACTORS
  - D.1 Reverse Planetary Protection Potential
  - D.2 Human Health and Performance
    - A.2.1 Chemical Toxicity
    - A.2.2 Physical Toxicity

MARS

B.3.2 Geotechnical Properties

- SKG Theme: Theme B Surface/Proximity Environments
- SKG Category: B-3 Regolith Properties
- Narrative: Determine effect of regolith mechanical & geotechnical properties (e.g. particulate cohesion, compressibility properties) on mechanical systems (spacecraft, astronauts, science instruments).
- Measurements or Missions needed to retire: Density, compressibility, cohesion, adhesion, and spatial variation in thickness/properties.
- Venue: Lander/Sample Return
- Priority: High
- Timeline: Near

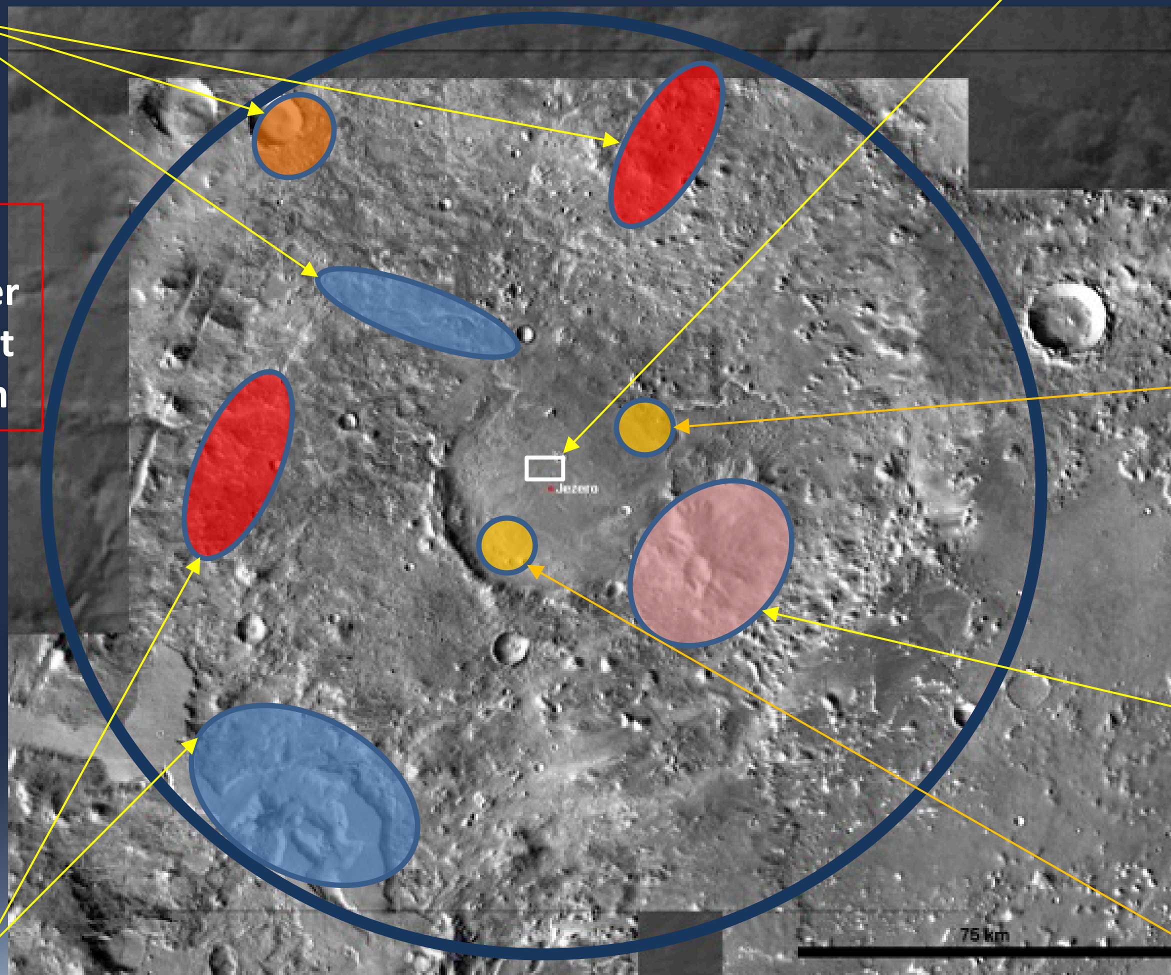
Goals of the Human Landing Sites Study

- Identify landing sites for human surface exploration of Mars.
  - These landing sites provide access to Exploration Zones (EZs) which are regions on Mars that contain multiple sites of scientific interest as well as satisfying engineering and human constraints for human exploration
  - Leverage Mars Reconnaissance Orbiter (MRO) data collection capabilities to acquire data of potential prioritized human Mars landing sites within the exploration zones
  - Exploration Zones will be chosen to maximize science return as well as support human operations
  - This work will result in a database of high science interest sites, which can easily be updated as we learn more about Mars and what is needed to support humans on the planet

This effort is a joint Human Exploration and Operations Mission Directorate (HEOMD) / Science Mission Directorate (SMD) study

MARS

Exploration Zone Layout



ROI = Regions of Interest

Post Workshop Progress

- MRO Imaging opportunity to support the HLS2 effort was initiated
  - We received 74 HiRISE targets & 43 CRISM
  - Currently have acquired 28 HiRISE and 7 CRISM
- Mars Water ISRU Planning (M-WIP)
  - Study set up by the Mars Program Office
  - Considering the complexities associated with different water feeds tocks
- NASA/NSF/CRREL study on applicability of Earth-based down-hole water extraction on Mars

Activities This FY

- Assess ability to identify potential water resources (hydrated minerals and shallow ice) for *in situ* resource utilization (ISRU) by future Mars missions using acquired or soon-to-be acquired data. Plan to have a workshop in 2017.
- Prototyping to determine how we actually image and assess the potential for something as large as an EZ
- More details in an upcoming Telecon

- **COSPAR workshop on refining the planetary protection requirements for human missions**, LPI, Oct 25-27

MARS

ISECG Science White Paper

- ISECG is a non-political agency coordination of 15 space agencies
- ISECG agencies acknowledge science communities as major stakeholders and scientific knowledge gain as important benefit of human exploration activities.
- This has led to the development of a Science White Paper
  - Describe the international view of the science enabled by human exploration after ISS, as outlined in the GER
    - DSH in the lunar vicinity, the lunar surface, asteroids
  - Engage the scientific communities in identifying these opportunities
  - Highlight activities that have feed-forward benefits to Mars exploration
    - Mars shown as the horizon goal in the GER
- MEPAG part of the NASA review process
- Specifically helped with:-
  - Mars-forward science
  - Mars content in the Executive Summary
  - Production of a Mars section in the SWP