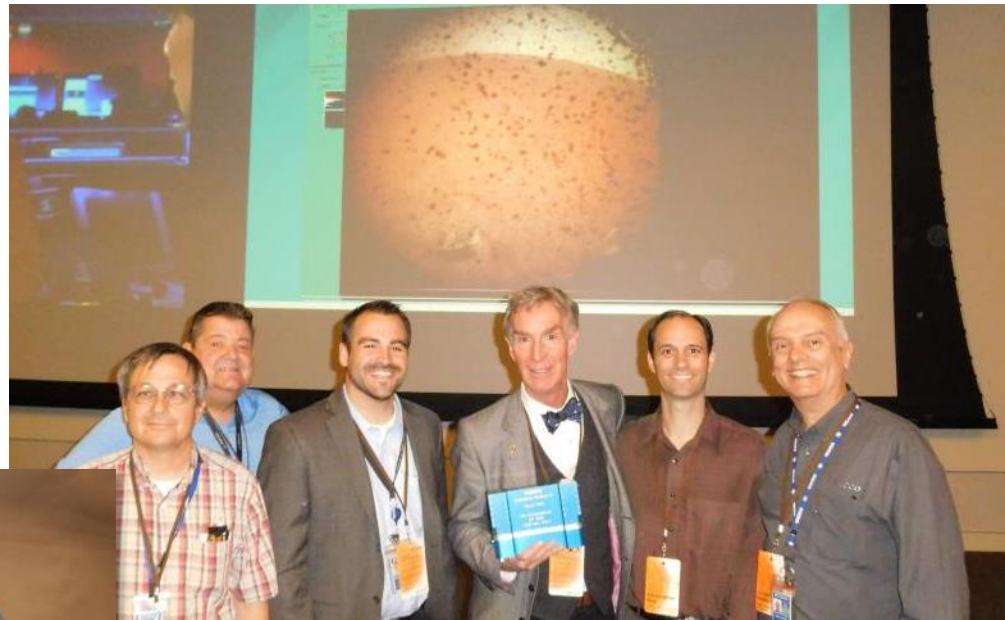
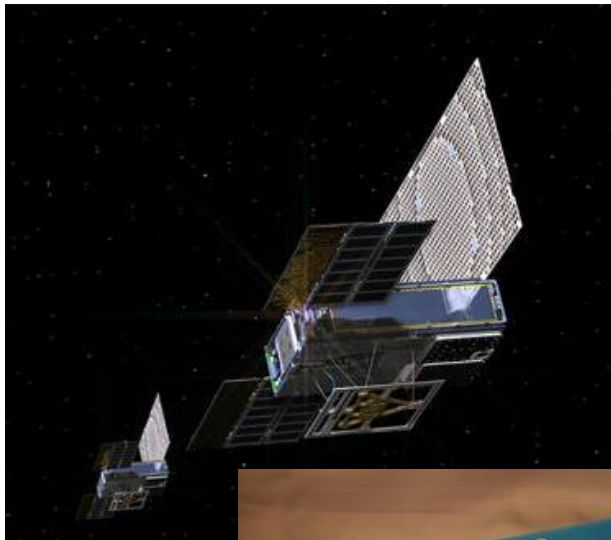


MarCO MiPS

Going Where no CubeSat Propulsion System Has Gone Before

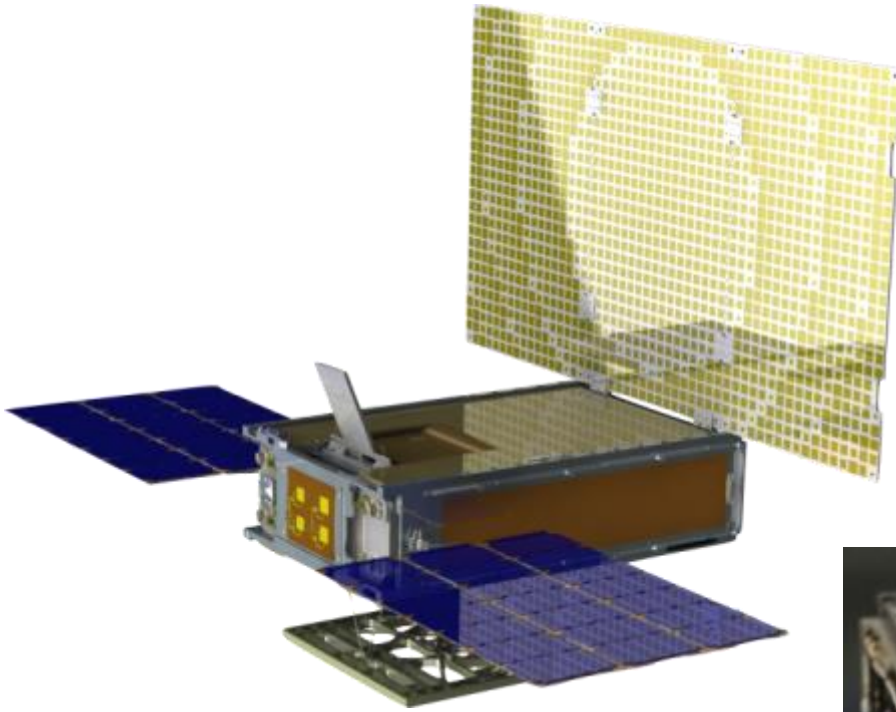


Chris Day
April 24st, 2019



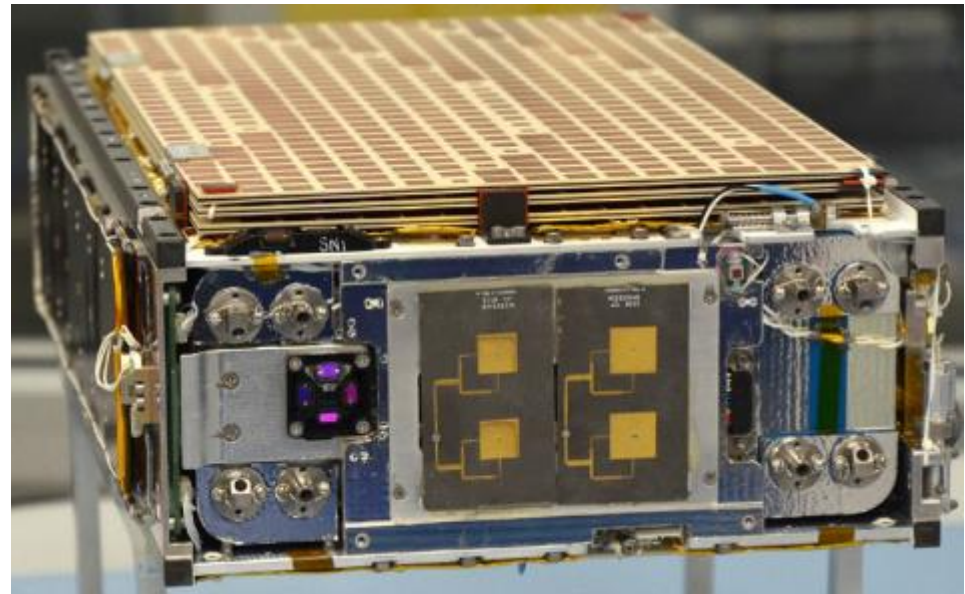
JPL Mars Cube One (MarCO) Mission

**Two Units were
Launched with the
InSight Mission in May
2018**

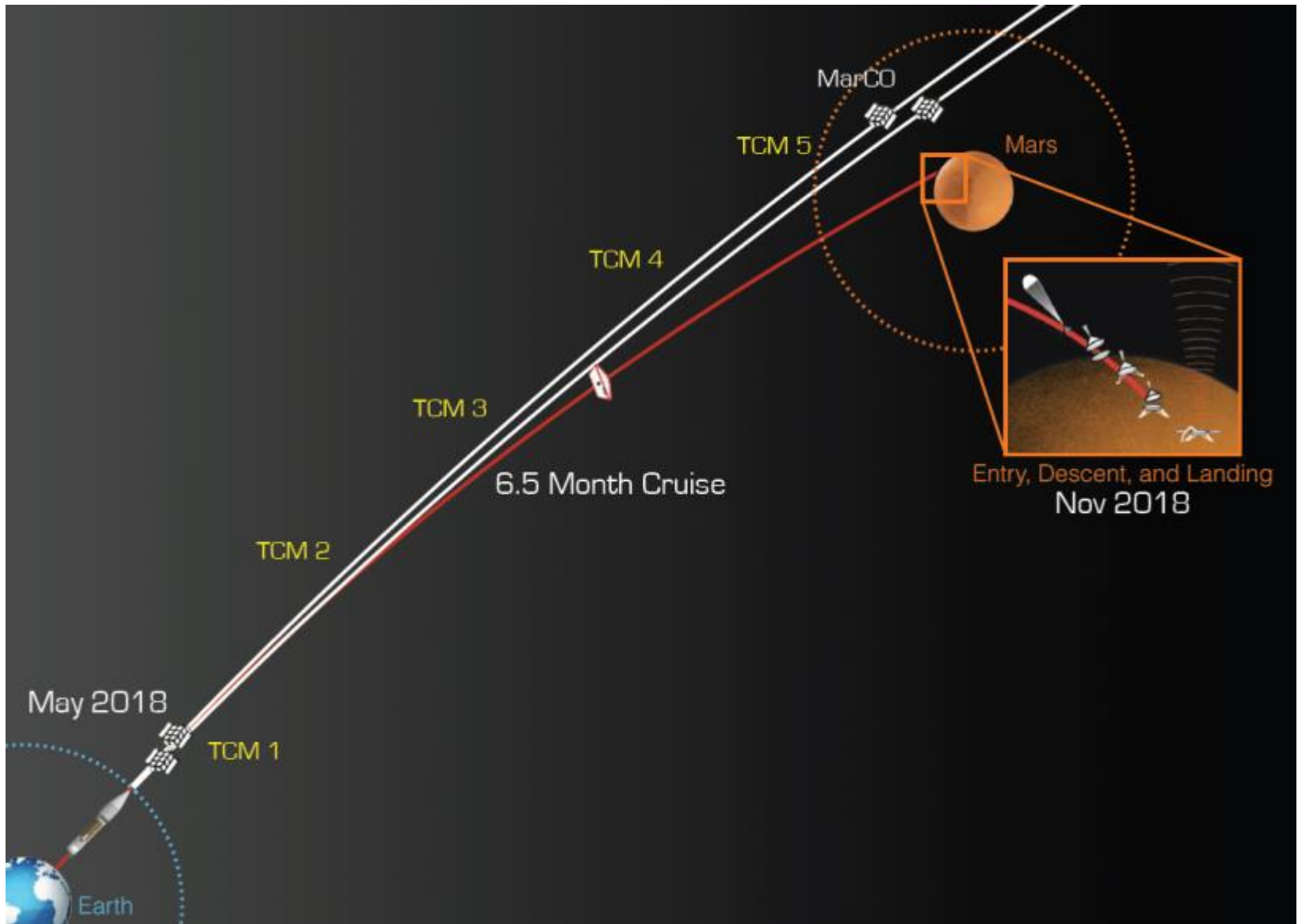


Mission Objective:

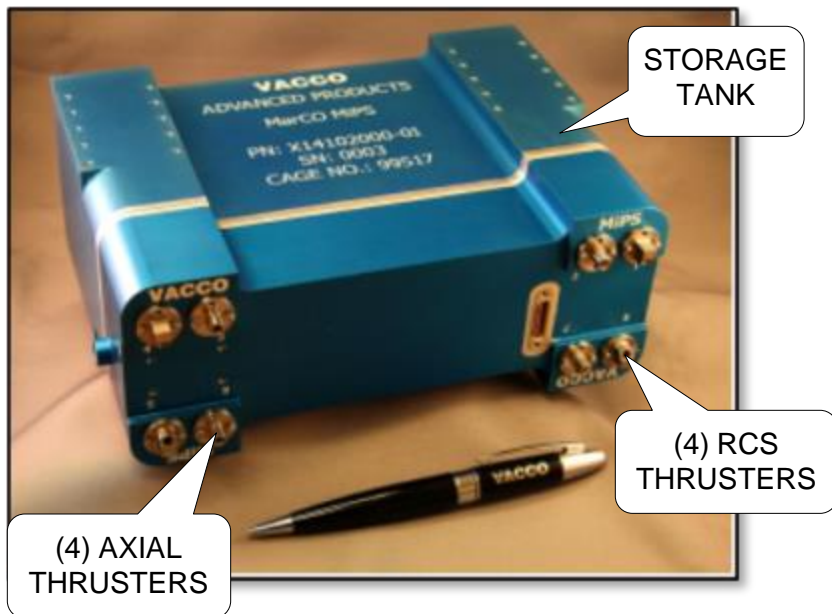
Successfully provided an 8kbps real-time relay for InSight's Entry, Descent and Landing at Mars



Planned Trajectory Correction Maneuvers



JPL MarCO Micro Propulsion System



First Interplanetary Cubesat

Launch with InSight Lander, May 2018

Smart, Self-Contained Propulsion System:

- ⊕ Contract for (2) Flight Systems
- ⊕ **755 N-Sec Total Impulse**
- ⊕ 3490 gram Wet Mass

System-in-a-Tank Design Including:

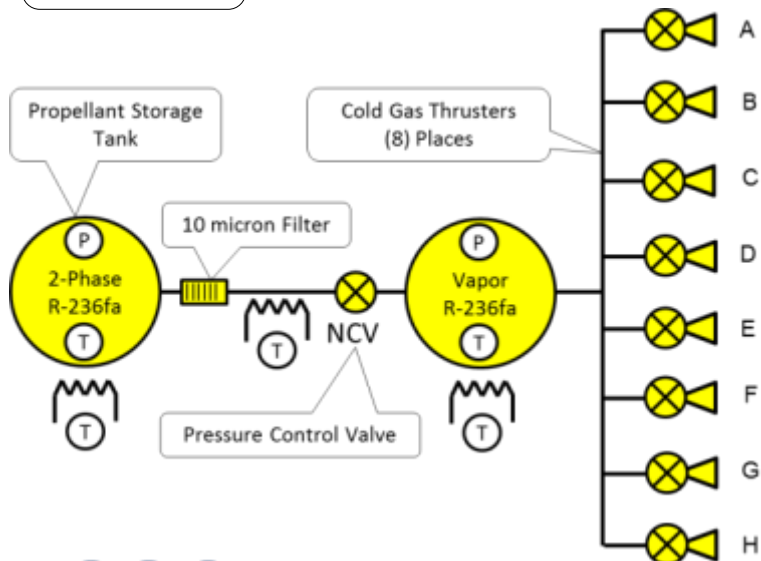
- ⊕ Propellant Storage & Feed System
- ⊕ (4) Axial & (4) RCS 25mN Thrusters
- ⊕ Controller & Sensor Suite

Two Interrupts Against Leakage

All-Welded Aluminum Alloy Construction

Microcontroller Driven:

- ⊕ RS422 Digital Interface
- ⊕ Controls Burn Type & Duration
- ⊕ Closed-Loop, Variable Thrust Control
- ⊕ (3) Settable Thermal Control Zones
- ⊕ (3) Power Supplies, (9) Valve Drivers



Leaving Earth

MarCO-B (Wall-E)

WFOV Camera

5/9/2018

High Gain Antenna

Corner of
Thermal Blanket

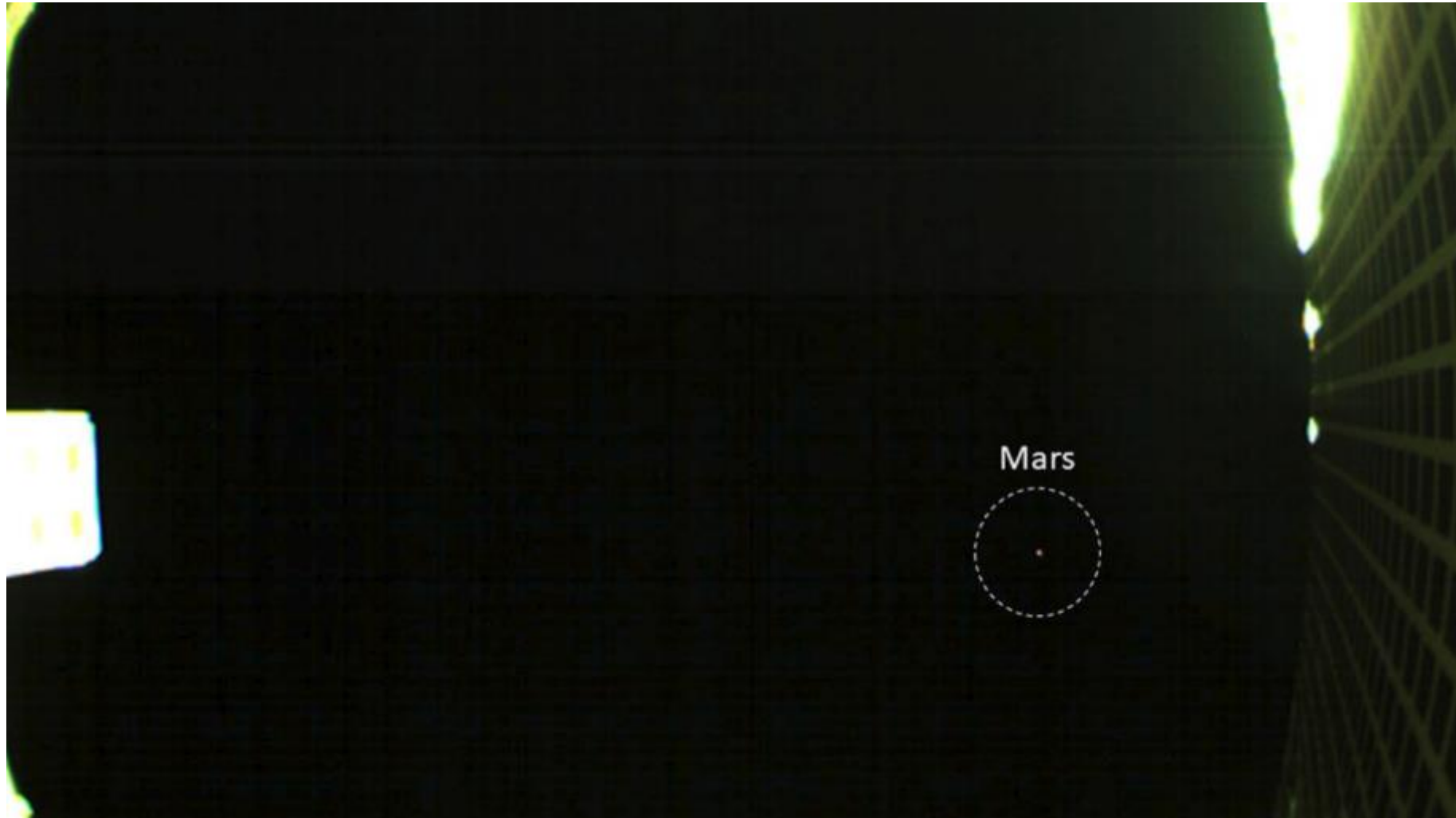
HGA Feed
(lit due to
reflection from HGA)

Corner of
Thermal Blanket



Shadow of HGA Feed

Approaching Mars



MarCO Lessons Learned

1. Contamination of Aluminum Welds:

Problem: Weld depths were not consistent due to surface contamination.

Solution: Developed proprietary surface treatments and controls.

2. Electron Beam Welding of Aluminum:

Problem: Rounded corners on MarCO complicated welding and weld fixtures.

Solution: Replace with chamfered corners that are stitched together.

3. Chemical Contamination:

Problem: Chemicals leached from plastic parts in test equipment attacked EPDM seals.

Solution: Replace all test equipment lines with PTFE lined flex hoses.

4. Leakage after Launch:

Problem: Flushing and cleanliness verification with GN2 was ineffective.

Solution: Flush and verify cleanliness with liquid.

5. Leakage after Cold Soak to -30°C:

Problem: Inadequately specified EPDM seal material.

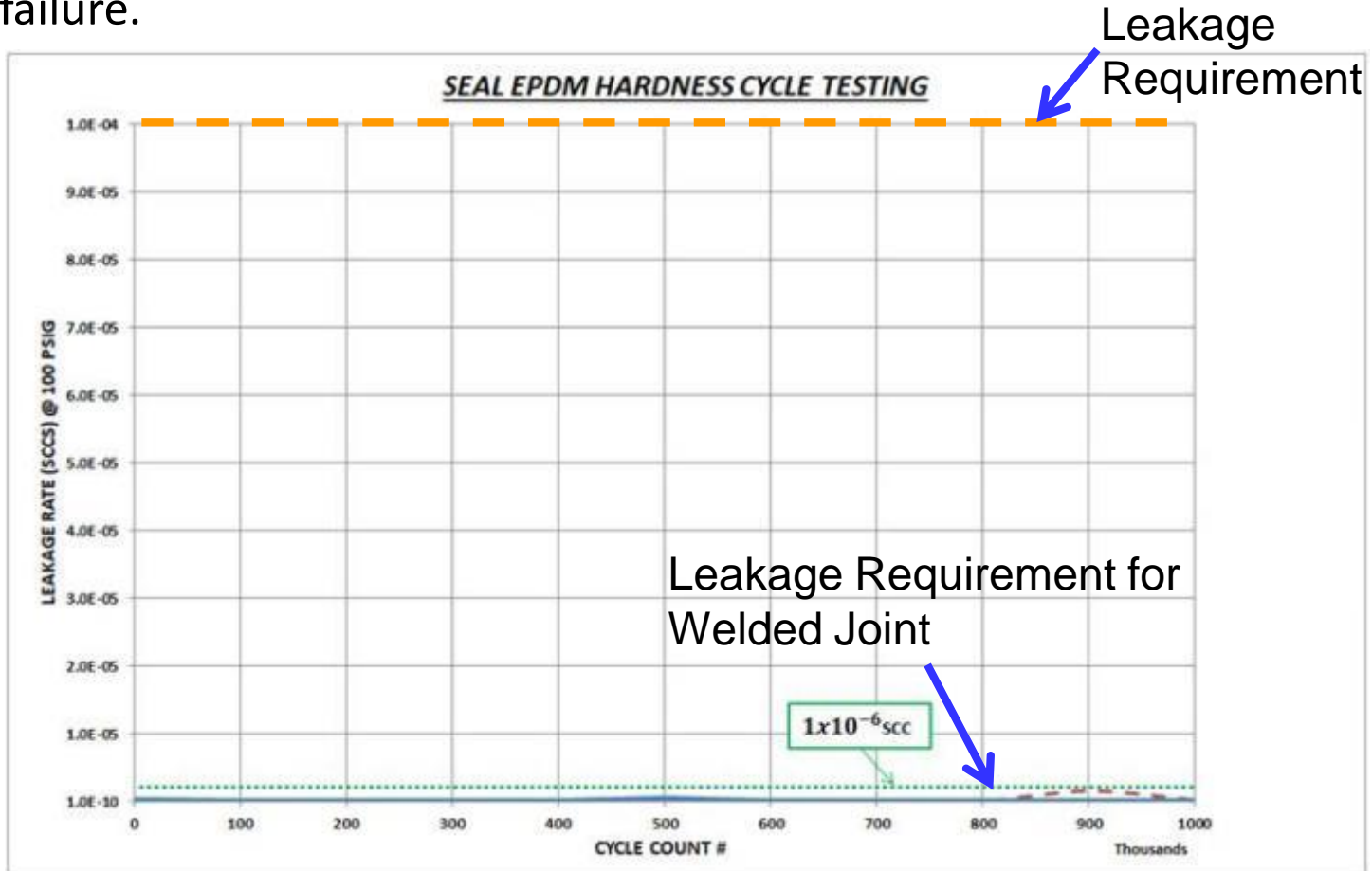
Solution: Fabricate seals from new batch of EPDM already tested by NASA.

Micro Valve Design Verified to 1 Million Cycles Without Leakage

Verify Cycle Life of Micro Valve with EPDM seal:

Concern: Is PCV cycle life adequate?

Solution: VACCO performed a PCV cycle life test that verified one million cycles without failure.



VACCO MiPS Supported MarCO Mission Success

- ⊕ First two interplanetary CubeSat propulsion systems
- ⊕ Both propulsion systems successfully completed their mission
- ⊕ Inflight issues were encountered and overcome
- ⊕ Both systems completed mission with large propellant margins
- ⊕ Lessons learned enhanced the designs of later propulsion systems



Questions?

MarCO at Mars

