Paper 2038 1
Session 2.06
IEEE Aerospace Conference
Big Sky, Montana
March, 2018

EVA Swab Tool to Support Planetary Protection and Astrobiology Evaluations

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Background

Issue: We have knowledge gaps!

- Weather/how microbes are released from crewed pressure systems

Strategic Knowledge Gap B5
Forward Contamination for Mars

Why do we care?

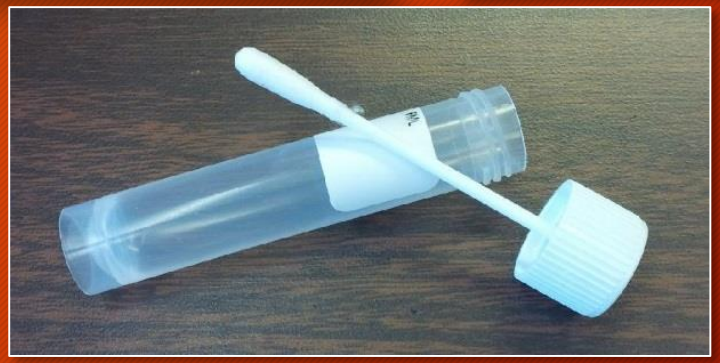
- Informs Mars operational concepts
- Informs architecture decisions
- Informs landing site selection decisions

- *How to protect the science*
- *Open vs. closed life support systems?*
- *How close can we operate to where life may be present?*

First, We Need A Toolbox

Microbial sampling on Earth is simple

Sterile, wetted swab



Sampling in space is more complicated

Difficult to handle swab with bulky gloves

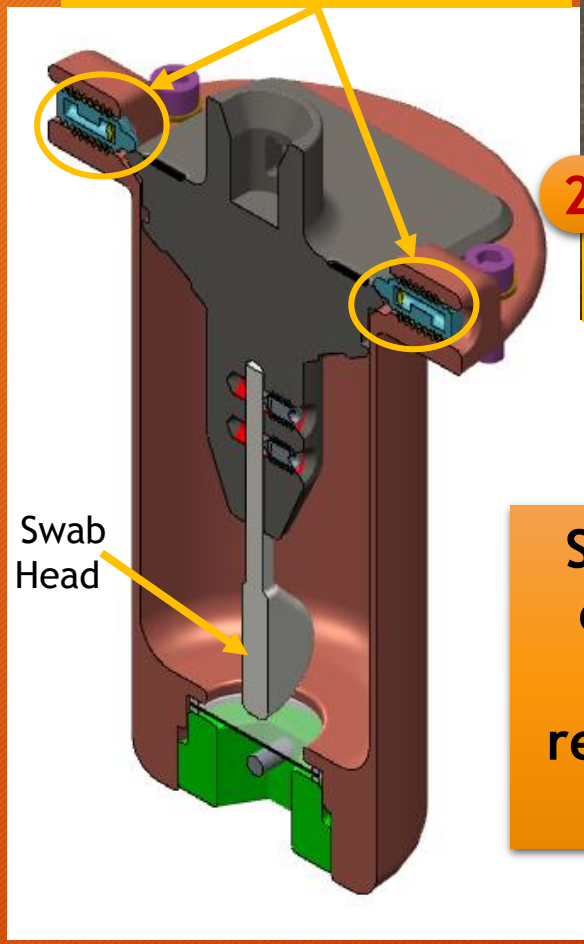
Wetted swab won't work in a vacuum

Sample container has to maintain integrity when transiting from vacuum to pressure cabin

Extravehicular Activity (EVA) Gloves

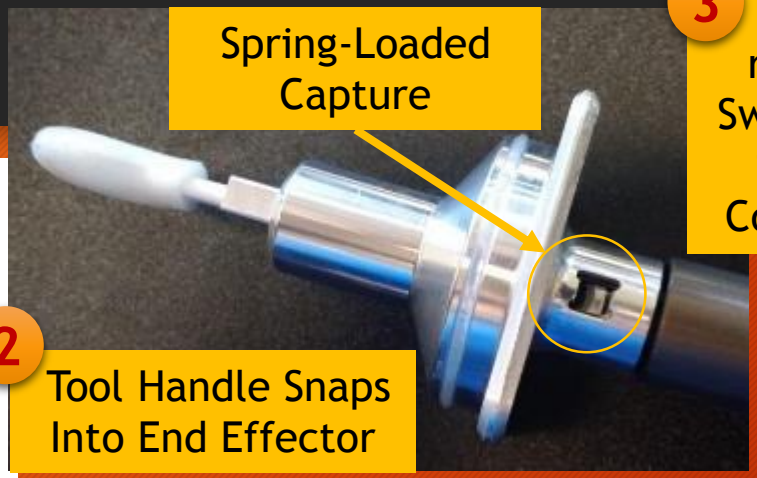
Swab Tool Is Designed for EVA

1 Swab Tip Held in Sterile Container with Ball Detents



Spring-Loaded Capture

2 Tool Handle Snaps Into End Effector



3 Pull to remove Swab from Sterile Container

4 Slide Cover Forward and Squeeze Paddles to Release Swab Tip

Simple push-fit to engage swab tip, but dual-action required to release swab tip

8-Sample Swab Kit

0.22 micron pore Microbial filter stackin bottom of each sample canister allows canisters to vent but remain sterile

6 canisters on top, 2 on bottom (not shown)

Tool Form, Fit, Function Tests
Suit differential pressure

Lab Environment (Not Vacuum Chamber)

Form, Fit, Function Testing

- Suited subject in a Mark III suit at differential suit pressure

Swab Tip Environmental Testing

- Macrofoam + two other types of swab
- Bend and pull tests at temperatures from -73.3°C (-100°F) to 37.8°C (100°F)
- Testing indicated swabs would maintain integrity under expected loading, even at temperature extremes

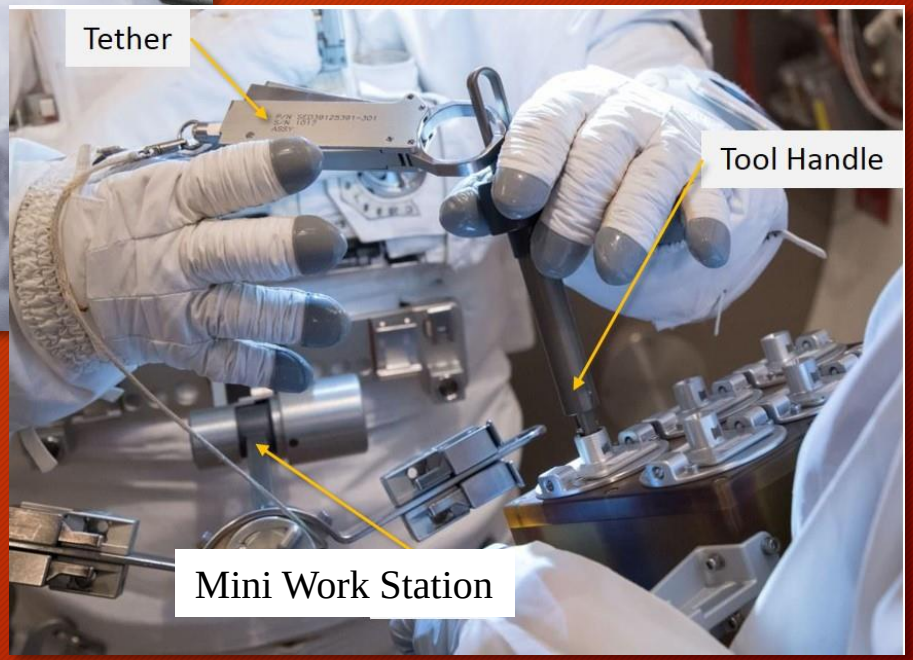
Swab Tip Effectiveness

- Tests at JPL and JSC demonstrated dry macrofoam swab was at least as effective as standard wetted swabs

Extravehicular Mobility Unit (EMU)

Suit differential pressure

We need to characterize the suits before we send suited crew to sample anything else



Saved cost by piggy-backing onto EMU-suited ISS crew training runs

EMU Wrist Joint Swabbing
4.3 psi differential suit pressure

Initial tests: did not modify any suit cleaning or handling protocols

Suit joints & vents are the most likely microbial escape paths

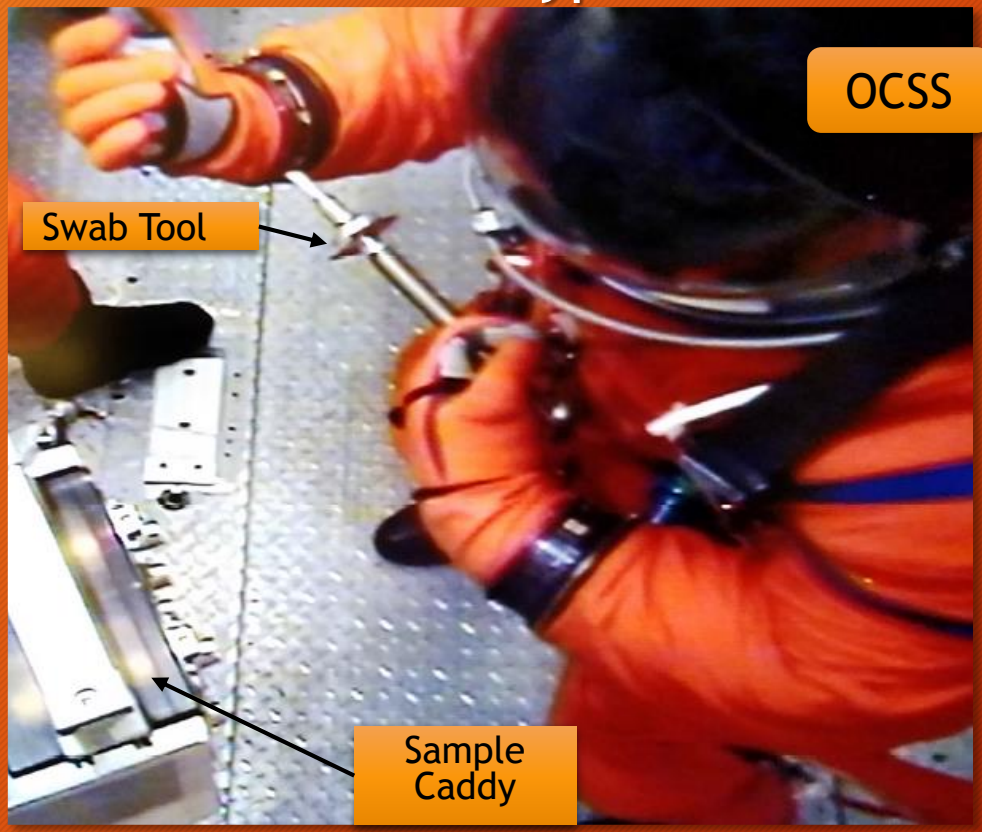
- Microbes only need 0.5 to 1.0 µm gap
- Vents can be filtered, but joints can't

Evaluations with EMU Suits

Click here to play video

External Vacuum Swab Test

- Piggy-backed onto a 6-test Orion project series
  - Two different types of suits

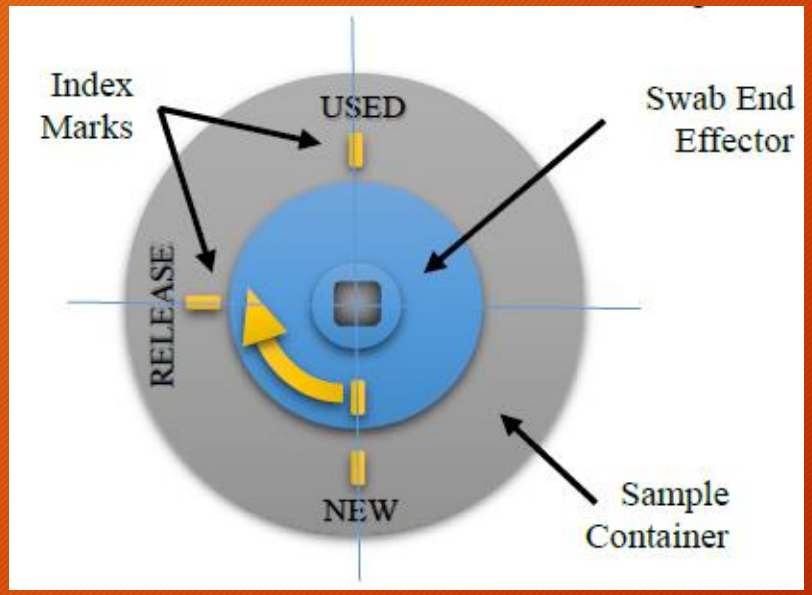


Orion Crew Survival System

Modified Advanced Crew Escaped System

Design Improvements

- *End Effector-to-Canister Seal Redesign*
  - Seal retaining ring, alternate seal profile, or alternate seal type
- *End Effector Locking Device*
  - To ensure end effectors remain inside canisters during handling or shipping



- *Swab Re-Use Prevention*
  - Ratcheting device to prevent inadvertent re-use of a swab
- *Additional Caddy Handle*
  - For better operator control

Will be incorporated into flight design

Next Steps
Analysis, flight certification, and ISS swab

Culture and DNA analysis in progress

- Will feed results back to suit designers and publish test data
- Working with CASIS to identify potential commercial partners
  - Companies interested in looking for extremophiles outside ISS

From: InnoCentive [mailto:no-reply@innocentive.com]
Sent: Thursday, August 24, 2017 4:44 PM
Subject: Award Announcement for NASA@work Challenge: Submit Your Research Idea to be Conducted on ISS!: Congratulations!

Congratulations, your submission to NASA@work Challenge: 2270 - has been awarded!

- Payload integration agreement in place for 2018

Conclusions

- **Ground testing validated tool effectiveness and interface with pressurized EVA suits**
  - Test subjects found tool straightforward to operate
  - Design improvements identified
  - Minimized development costs by repurposing retired hardware and piggy-backing onto flight crew training
  - Additional potential uses identified: astrobiology research and micrometeoroid/orbital debris evaluation
- **Baseline suit microbial data collected**
  - Supports development of human mission planetary protection protocols

Acknowledgements

The authors thank Douglas Terrier and the Science and Technology Mission Directorate, and a cross-organizational test and analysis team, including Mary Sue Bell, Alex Horvath, Justin Connolly, Bekki Bruce, Christian Castro, Dr. Aaron Regberg, Dr. Ganesh Babu Malli Mohan, and Dr. Camilla Urbaniak

Questions?

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