Mars Sample Return Science Planning

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On behalf of

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Disclaimer: The decision to implement Mars Sample Return will not be finalized until NASA's completion of the National Environmental Policy Act (NEPA) process. This document is being made available for information purposes only.

What is the MSR Science Planning Group (MSPG)?

MSPG established by NASA and ESA to help develop a stable foundation for international scientific cooperation for the purposes of returning and analyzing samples from Mars.

If MSR is carried out by an international partnership:

- What are the science-related attributes of a Sample Receiving Facility (SRF) that can be used as the basis for cost and schedule estimation (assume additional independent requirements will come from planetary protection)?
- What are the mechanisms whereby sponsor-affiliated scientists will be given fair access to the returned samples?

MSPG Workshops

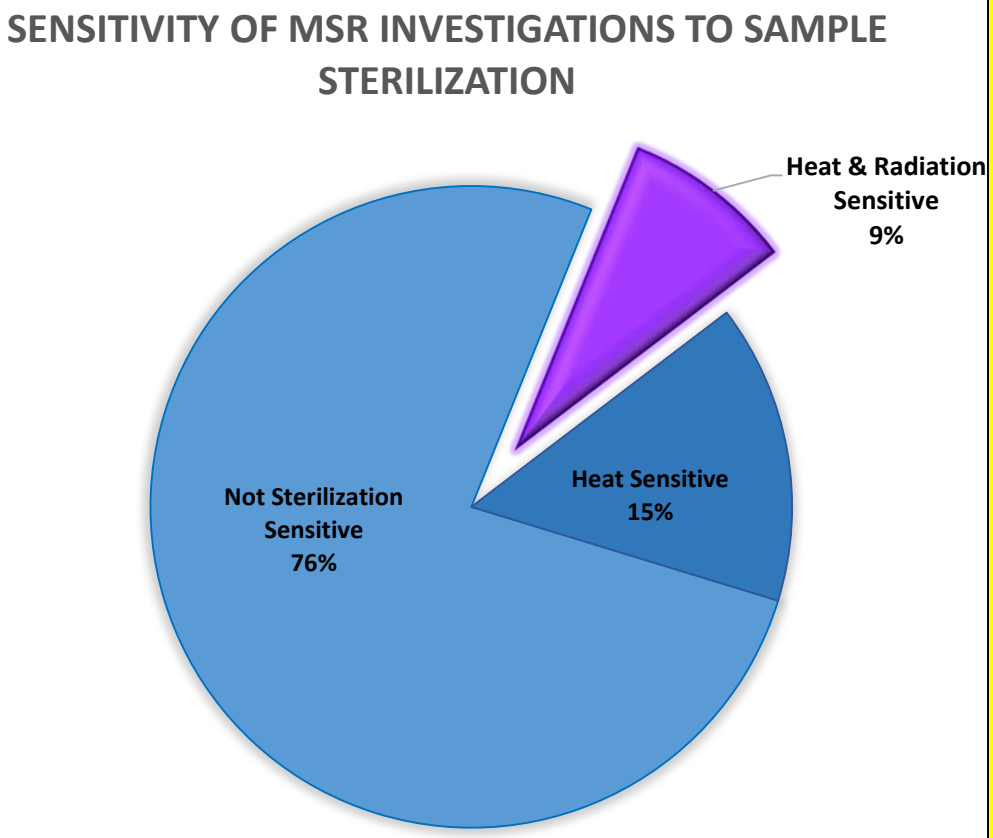
- The main science-related cost drivers for the Sample Receiving Facility (SRF) are thought to be:
  1. The challenge of conducting science activities inside high containment (BSL-4) space
  2. Contamination control
- Two workshops have been held to date:

WORKSHOP #1	***WORKSHOP #2***
To what extent does MSR science need to be done in containment?	How do the science objectives affect SRF contamination control requirements?

- In addition, a Sample Management working group is formulating options for the involvement of international scientists in different aspects of MSR.

Workshop #1-Science in Containment

What role does contained space need to play in ensuring that all MSR scientific objectives are met?



MAJOR FINDING: It appears that a large majority (>90%) of the MSR-related science investigations, as identified by iMOST (2019), could be acceptably performed on sterilized samples, thus potentially enabling the analysis of MSR samples in uncontained laboratories without a dependency on the results from PP testing.

Workshop #1-Summary

What role does contained space need to play in ensuring that all MSR scientific objectives are met?

Contained space functionalities implied

BC+PE

PP tests

Time-sensitive science

Steriliz.-sensitive science

\+

Steriliz.-tolerant science

Not contained

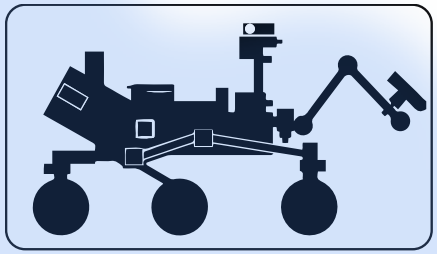
OPTION A: Sterilize then analyze

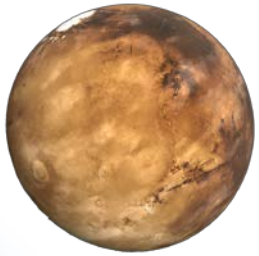
OPTION B: Wait for PP tests, analyze unsterilized material.

MAJOR FINDING: The scientific community, for reasons of scientific quality, cost, timeliness, and other reasons, strongly prefers that as many sample-related investigations as possible be performed in PI-led laboratories outside of containment.

MSR Sample Contamination—the big picture

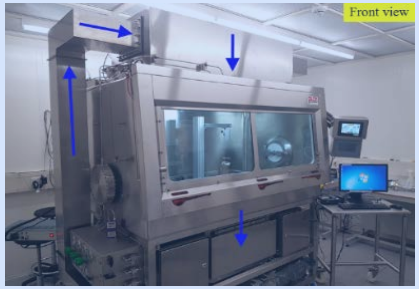
Earth-sourced contamination





Mars-sourced signal

Instruments: GC-MS etc.



Receiving isolator

Modified after M-2020 SDT (2014)

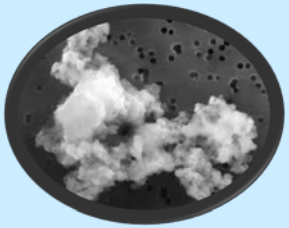
What are our strategies to achieve MSR science objectives, given SRF-related contamination?

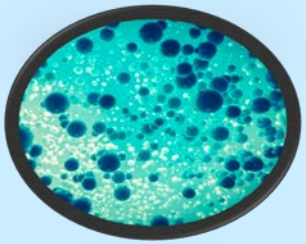
Potential SRF Sample-Intimate Hardware Cleanliness Requirements

Viable Organisms (<1)

Outgassing (~1 ng/cm2/hr)

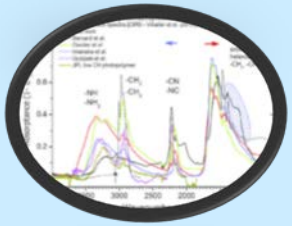
Particulate (PCL 50-300)





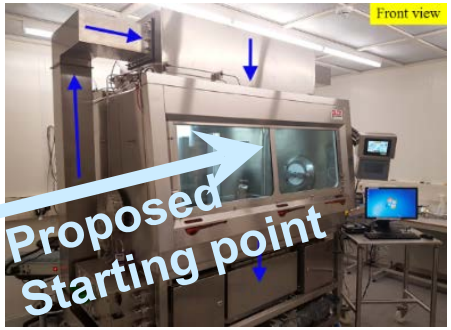
Total Organic Carbon
Tier 1 Compounds: 1 ppb
Tier 2: 10 ppb
TOC: 10ppb

Inorganics pg-mg of 34 elements



Non-volatile residue (<100 ng/cm2)

Notional sample-receiving isolation cabinet inside SRF (example only)

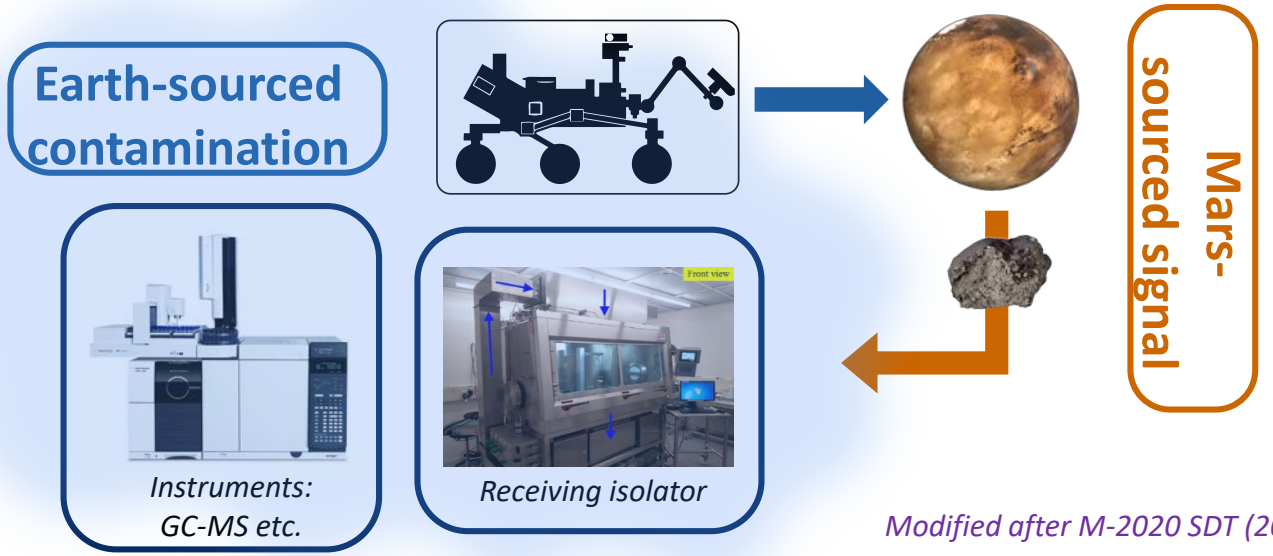


NOTE: Select SRF reqs. should be more strict than M-2020

For the SRF, requirements have not yet been established

MAJOR FINDING: Even though the Mars 2020 Sample CC Requirements have very low values, the workshop participants were collectively not aware of reasons why these requirements could not also be implemented in isolation cabinets on Earth. This should therefore be the starting point for CC planning in the SRF and/or sample curation facilities.

Workshop #2-Summary



Modified after M-2020 SDT (2014)

What are our primary strategies to achieve MSR science objectives, given SRF-related contamination?

- Establish CC requirements in SRF that are as (or more) ambitious than Mars 2020 requirements
- Characterize contamination at all phases of MSR campaign and in SRF using multiple/optimized contamination knowledge (CK) strategies
- Need to plan sequence of BC and PE activities to minimize sample handling
- Characterize and curate all tools and materials used in construction of the SRF and that have been in contact with the samples

Multiple Competed Access Points for Scientists