# Summary of the 2019 Work of the MSR Science Planning Group (MSPG)

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This report constitutes an executive summary of the 2019 work of the MSR Science Planning Group.

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 planning and information purposes only.

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## Introduction

For decades the international planetary science community has advocated for Mars Sample Return (MSR). This enterprise would fundamentally change our understanding of what Mars can tell us about the history of our solar system, about its evolution, and about the past and current habitability of Mars. In addition, as the first ever effort to return samples from another planet, an international MSR Campaign would represent an enormous achievement in engineering and space exploration technologies. As per the April 2018 Statement of Intent signed by NASA and ESA, we have both the motivation and the technical ability to deliver to Earth the samples that will be collected by the Mars 2020 rover. NASA & ESA's expressed goal is to carry out MSR by means of an international partnership.

## Why The MSPG Study?

A fundamental premise of an international partnership is that scientists working in the U.S. and Europe, (and potentially in association with other national agencies with MSR interests), would equitably share in the processes of scientific planning/optimization, and have equitable access to the samples. The MSR Science Planning Group (MSPG) was established by NASA and ESA in Fall 2018 as part of the next steps forward in internationalizing the planning for the Returned Sample Science component of MSR. A primary purpose of MSPG was to support the formation of an international MSR partnership.

***MSPG'S OBJECTIVE*: To establish the basis for a mutually beneficial international partnership in Mars Returned Sample Science.**

## What Is MSPG's Approach?

MSPG was tasked with developing a stable foundation for international scientific cooperation on issues related to planning for the reception, handling, distribution, and analysis of the returned samples, collectively termed Mars Returned Sample Handling (MRSH). MSPG, comprised of an international committee of ~ 18 U.S., European, and Canadian scientists and engineers, was asked to address several distinct but related areas of science planning including:

- Beginning the definition of the functional requirements for the science-related attributes of a Sample Receiving Facility (SRF) that could be used as inputs for scope, cost and schedule estimates, as well as for defining other important next steps forward.
- Establishing a clear understanding of the science benefits of the MSR collaboration to all international stakeholders, especially in terms of access by European and American scientists to the Mars samples, and to the science planning processes.

In order to achieve these goals, MSPG held two workshops, one in the U.S. and one in Europe. The foci of these workshops, broadly stated, was 1) issues associated with carrying out science in containment, and 2) issues associated with contamination control. These two topics were deemed to have the most significant implications for the requirements (and by implication, the cost/complexity/schedule) of the SRF. These workshops were attended by the members of MSPG, as well as an invited set of active multi-disciplinary, multi-national sample scientists. Documentation was developed for each workshop, and summaries were presented at conference town halls and other community engagement activities in both the United States and in Europe in order to broaden the connection with as diverse a set of scientists as possible. In parallel, a sub-committee was formed inside MSPG to develop organizational concepts for how to manage MSR returned sample science on an international basis.

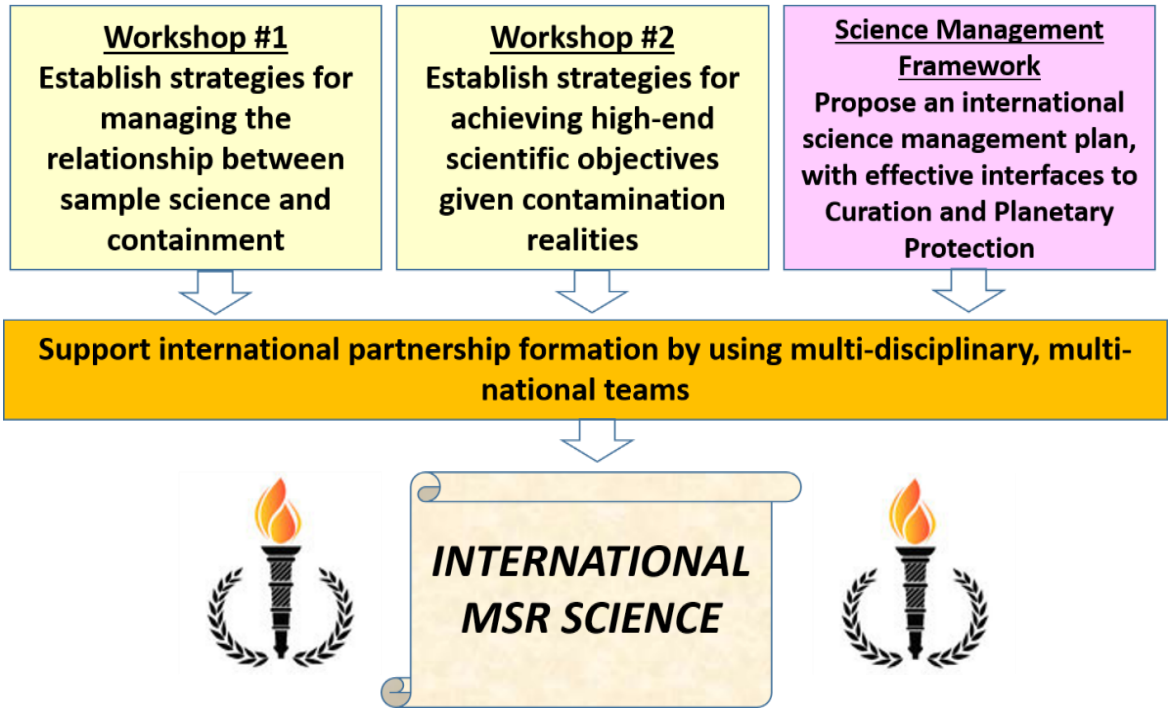
***MSPG'S APPROACH*: To hold two international workshops, with broad community representation, on what were deemed to be the most important challenges for the science to be accomplished and the potential barriers to international partnership formation, and by means of MSPG's own efforts, to design the framework of an international MSR science management plan.**

## Summary of Results

This work resulted in three MSPG reports (illustrated in Fig. 1):

- *The Relationship of Mars Sample Return Science and Containment [the results of Workshop #1]*;
- *Science-Driven Contamination Control Issues Associated with the Receiving and Initial Processing of the MSR Samples, [the results of Workshop #2]* and;
- *A Framework for Mars Returned Sample Science Management [developed by the MSPG Team]*.

*Figure 1: Conceptual overview of MSPG activities and outputs.*

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## Workshop #1. Science and Containment

*The Relationship of Mars Sample Return Science and Containment* is the report of the MSPG Workshop "MSR Science in Containment" which took place from January 14-16, 2019 in Columbia, Maryland, U.S. The overarching question that drove this workshop and the resultant report is "To what extent does MSR science need to be done in containment?" The answer to this would determine the character of the science-sourced requirements on a notional SRF.

The starting point was the recent IMEWG (International Mars Exploration Working Group) sponsored International MSR Objectives and Samples Team (iMOST) report, which developed international consensus on a set of scientific objectives for MSR.

Three high-level findings were established:

- The international science community expressed an overwhelming preference to conduct MSR investigations at scientists' home laboratories rather than within a sample containment facility;
- For a large number of the proposed MSR science objectives, the investigations appear to be tolerant to at least one sterilization method that is used on Mars spacecraft (and might be permitted for use on Mars samples) that would allow for analysis outside of a containment facility;
- The few investigations that would need to be conducted within a containment facility are those that are either time-sensitive (at the scale of hours/days/weeks) or those that are entirely sterilization-sensitive.

As a result, it was concluded that most MSR science could be effectively planned for in laboratories distributed around the world outside of containment using either sterilized samples or samples that have passed the (to-be-defined) Sample Safety Assessment Protocol. Science requirements for investigations within the SRF, therefore, would fall primarily into the areas of preliminary sample characterization, sterilization-sensitive investigations (including measurements needed to conduct the Sample Safety Assessment Protocol), and time-sensitive investigations.

## Workshop #2. Contamination Control Issues

*Science-Driven Contamination Control Issues Associated with the Receiving and Initial Processing of the MSR Samples* is the report of the 2nd MSPG Workshop "MSR Contamination Control" which was held on May 1st-3rd, 2019, in Leicester, UK. The focus of this workshop was on determining high-level strategies related to contamination control (CC) and contamination knowledge (CK) requirements for the MSR samples.

CC and CK considerations are expected to be a driving factor on the requirements and cost for the SRF. Major findings in this report include:

- The Mars 2020 Sample CC requirements should be the starting point for CC planning in the SRF and are considered achievable;
- The science and sample curation communities are unlikely to accept a one-size-fits-all solution for the materials that would be allowed to touch pristine martian samples within a sample processing cabinet; these materials should be tailored to each type of sample.
- Effective strategies for contamination knowledge for returned samples are judged to be extremely important due to the inevitable contribution of some level of contamination during sample collection and processing.

## Science Management Planning

*A Framework for Mars Returned Sample Science Management* represents a proposal to structure the planning and management of MSR returned sample science. The currently envisioned MSR campaign is different from any other precedent sample return mission due to its international nature, which means

that the programmatic mechanisms governing the MSR samples would need to depart from past practice. MSPG's approach was to begin with a number of organizational recommendations from iMARS-2, adopt critical lessons learned from Apollo and other sample return missions, use best practices identified in the management of other major international scientific collaborations, incorporate several key conclusions from the 2019 MSPG workshops, and develop input from various stakeholders on their needs and priorities, and blend together into an implementable structure. The inputs were synthesized into five guiding principles: transparency, science maximization, generating opportunities for the scientific community, ensuring fair balance in the scientific discovery process for the agency partners in MSR, and one return canister: one collection, which specifies that samples should be managed as a single collection, independent of where they are located/curated).

International governance would be achieved by means of the establishment of an international management body, notionally termed the MRSH Council. The Council would provide long-term continuity of management and oversight of all aspects of MRSH, one aspect of which would be Returned Sample Science (other aspects would include sample curation and planetary protection). The membership of this council would be made up from the primary MSR partners. The allocation and treatment of samples would be under the Council's purview. An implementation framework would include a number of science working groups that change significantly with time, at least one open workshop, and one major concluding international science conference. The proposed framework includes a timeline of work, scientific opportunities, and decisions that form the schedule of planning activities needed to realize sample science benefits for MSR. Importantly, and for responsible MSR partners to take note, this includes a time-ordered list of crucial working groups/teams and recommendations for their composition, responsibilities, tenure, inputs and outputs. Adopting a principle of broad participation in these various science planning activities would greatly enhance our ability to achieve proper international and technical balance.

Fundamentally, the framework reflects the philosophy of "equitable access," where the primary MSR partners jointly would have control over the planning and control of the samples, initial access for analysis and key results, while eventually the samples would additionally be accessible to the broader scientific community, based on merit.

## Conclusions

On the basis of the above work, we have reached three essential conclusions:

1. It is possible to design solutions to the most important technical issues facing Mars returned sample science, including those associated with the SRF.
2. An international science management model can be constructed, and it is understood to be mutually acceptable by the communities represented by MSPG; i.e., the scientific and technical stakeholders in returned Mars sample science.
3. There is a high level of agreement between U.S. and ESA-affiliated scientists regarding sample science planning, equitable sample access, and a genuine eagerness to work together on the exciting endeavor that is MSR.

## Summary of Deliverables Produced

The most important documents prepared by MSPG as part of its 2019 planning activity have been archived in the following locations:

1. Web folder #1: 54-page text-formatted report on Workshop #1, 16-page PPT-formatted summary presentation file. These documents have been cleared for public release, and are posted on the referenced web site.
2. Web folder #2: 53-page text-formatted report on Workshop #2, YY-page PPT-formatted summary presentation file. These documents have been cleared for public release, and are posted on the referenced web site.
3. A 75-page text-formatted report entitled "A Framework for Mars Returned Sample Science Management". This document has been made available to NASA and ESA management to support partnership discussions, and will be made public in the near future in the same location as the above reports.

## MSPG Members

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