MARS SAMPLE RETURN SCIENCE PLANNING GROUP PHASE 2 (MSPG2): OVERVIEW & INTERIM REPORT. G. Kminek[1], M. A. Meyer[2], T. Haltigin[3], D. W. Beaty[4], B. L. Carrier[4], and the MSPG2 Members (C. Agee, H. Busemann, B. Cavalazzi, C. Cockell, V. Debaille, D. P. Glavin, M. M. Grady, E. Hauber, A. Hutzler, B. Marty, F. M. McCubbin, L. M. Pratt, A. B. Regberg, A. L. Smith, C. L. Smith, R. E. Summons, T. D. Swindle, K. T. Tait, N. J. Tosca, A. Udry, T. Usui, M. A. Velbel, M. Wadhwa, F. Westall, M.-P. Zorzano) [1]European Space Agency (gerhard.kminek@esa.int), [2]NASA Headquarters (michael.a.meyer@nasa.gov), [3]Canadian Space Agency, [4]Jet Propulsion Laboratory, California Institute of Technology (see Table 1 for full affiliation list).

Introduction: Mars Sample Return (MSR) has been a high priority of the international planetary science community for decades. In recent years, significant programmatic advances have brought MSR closer to becoming a reality. In 2018, NASA and the European Space Agency (ESA) signed a joint Statement of Intent to continue defining respective roles and responsibilities in the flight missions required to realize MSR. In October 2020, NASA and ESA formalized this partnership with the signature of a Memorandum of Understanding for the MSR flight elements. The MSR campaign consists of M2020, two MSR flight elements and the ground-based infrastructure to receive, handle and curate the samples from Mars. In an engineering sense, MSR consists of a linked set of missions, and a concluding set of ground-based activities, that we refer to as the MSR Campaign.

The scientific benefits of MSR would be immense, though would come with some unique challenges. Thus, extensive planning efforts are required to ensure the science return would be maximized through advance planning to fulfill planetary protection requirements, for analysis and curation of the samples, and to ensure a productive international science partnership that would provide open, fair, and competitive opportunities for the science community.

Detailed planning for MSR science program elements has been steadily growing in importance during the past 10+ years. Most recently, in 2019, the ESA- and NASA-chartered MSR Science Planning Group (MSPG) developed a foundation to formulate and implement an overarching science strategy for handling returned samples brought from Mars. MSPG reports were completed and posted in October 2019 (https://mepag.jpl.nasa.gov/reports.cfm). Building from this effort, the MSPG2 was chartered in April 2020 to further develop many of the concepts therein and specifically to address MSR science and curation planning. This information needs to be fed forward to establish/justify scientific integrity requirements for the sample transportation missions, and it is needed for long-lead planning for a Sample Receiving Facility (SRF) [1] and the competed scientific investigation processes.

Composed of 6 agency representatives and 24 competitively selected scientists representing 10 countries, the MSPG2 has been tasked with: (1) drafting an overall Science Management Plan (SMP) for the end-to-end MSR Campaign; (2) identifying technical issues that could impact the scientific utility of the samples, including sample sterilization and penetrative imaging (e.g., synchrotron or CT scanning); (3) developing approaches and a working list of high-level requirements for a potential SRF, and; (4) compiling a list of key decision points related to the samples from the perspectives of science, curation, and planetary protection.

Focus Groups & Progress: The MSPG2 has been organized into several focus groups concentrating on different activities related to all of the MSPG2 tasks.

Science Management Plan Focus Group: The SMP focus group has been tasked with defining the organizational structures, strategies, and processes by which decisions regarding the samples will be made. This group will prepare the proposed science management plan, in both Power Point and text format, for NASA & ESA consideration.

Curation Focus Group: The curation focus group has been discussing issues related to Basic Characterization and Preliminary Examination of the samples, to contribute to the proposed SRF requirements, and are also tasked with defining the interfaces between curation, science, and planetary protection.

Sterilization Effects Focus Group: The sterilization effects focus group has been tasked with evaluating which MSR measurements and investigations would be compromised if performed on samples that had been sterilized by either heat. This group has produced a draft report detailing the types of measurements that cannot be successfully carried out on sterilized samples, and this information is being used to propose SRF requirements related to doing these measurements inside the SRF on unsterilized samples.

Time-Sensitive Science Focus Group: The time-sensitive science focus group is working to determine what properties of the samples are subject to alteration or degradation with time, in order to determine what types of measurements need to be done relatively

quickly after samples tubes are opened. For investigations that have very short timelines, it is expected that the work will need to be carried out inside the SRF as soon as possible after the tubes are opened, before the opportunity to make the measurements has been permanently lost.

SRF Requirements Focus Group: This group has been tasked with developing a compendium of draft high-level requirements for the SRF which are derived from the work of the aforementioned focus groups as well as previous SRF studies. These draft requirements will form the basis for iteration and review with multiple stakeholders. They should also be useful as the basis for facility engineering studies, and SRF cost/schedule estimation exercises and sensitivity studies.

Strategic Team: This sub-team of MSPG2 has been tasked with reviewing the reports and deliverables of other MSPG2 focus groups for completeness and quality. This team has also been tasked with writing white papers on specific topics such as the importance of a dust sample to MSR science, and with drating key talking points for public communication.

The group kicked off its work in June 2020. Sub-teams focusing on the SMP, effects of sterilization techniques and time on the potential science utility of the samples, and on curation have been formulated to provide early deliberations that will feed into SRF requirements development. Final products are anticipated in mid-2021 and are expected to include:

- A refined version of the MSR Science Management Plan
- Reports and recommendations related to
  - Effects of sample sterilization on high-priority science measurements
  - Time-sensitive measurements and investigations
  - Curation planning and processes
  - High-level science and curation requirements for a potential SRF sample receiving facility

This presentation will consist of a progress report on MSPG2 activities and seeks community feedback.

References: [1] MSPG2 (2021). Defining the Science and Curation Functionalities for a Mars Sample Return (MSR) Sample Receiving Facility (SRF). *LPSC LII.*

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 informational purposes only.

Table 1. MSPG2 Membership

MSR Science Planning Group Phase 2			
Michael Meyer	NASA Headquarters	Francis McCubbin	NASA Johnson Space Flight Center
Gerhard Kminek	European Space Agency	Lisa Pratt	NASA Headquarters
Timothy Haltigin	Canadian Space Agency	Aaron Regberg	NASA Johnson Space Flight Center
David Beaty	JPL/Caltech	Alvin Smith	JPL/Caltech
Brandi Carrier	JPL/Caltech	Caroline Smith	Natural History Museum, London
Carl Agee	University of New Mexico	Roger Summons	Massachusetts Institute of Technology
Henner Busemann	ETH Zurich	Timothy Swindle	University of Arizona
Barbara Cavalazzi	Università di Bologna	Kimberly Tait	Royal Ontario Museum
Charles Cockell	University of Edinburgh	Nicholas Tosca	University of Cambridge
Vinciane Debaille	Université Libre de Bruxelles	Arya Udry	University of Nevada, Las Vegas
Daniel Glavin	NASA Goddard Space Flight Center	Tomohiro Usui	Japanese Aerospace Exploration Agency
Monica Grady	Open University	Michael Velbel	Michigan State University
Ernst Hauber	German Aerospace Center (DLR)	Meenakshi Wadhwa	Arizona State University
Aurore Hutzler	European Space Agency	Frances Westall	CNRS-Oraleans
Bernard Marty	CRPG-CNRS & Université de Lorraine	Maria-Paz Zorzano	Centro de Astrobiologia (CAB)