SUMMARY OF MARS SAMPLE RETURN (MSR) SCIENCE PLANNING GROUP 2: PLANNING FOR THE ARRIVAL AND ANALYSIS OF MSR SAMPLES AT EARTH

MSR Science Planning Group 2[1], [1]For further information please contact David W. Beaty (Jet Propulsion Laboratory, California Institute of Technology, dwbeaty@jpl.nasa.gov) or Brandi L. Carrier (Jet Propulsion Laboratory, California Institute of Technology, bcarrier@jpl.nasa.gov)

Introduction: The Mars Sample Return (MSR) Campaign is one of the most ambitious planetary exploration undertakings ever attempted. Scientifically selected samples will be collected by NASA's Mars 2020 mission and detailed planning is underway to deliver the samples to Earth through the joint efforts of NASA and the European Space Agency (ESA). Upon delivery to Earth, the samples would be made available to the international science community to conduct investigations addressing some of the most fundamental questions about the formation and evolution of the solar system, and potentially the origins of life.

In 2020, ESA and NASA jointly chartered the MSR Science Planning Group 2 (MSPG2). The group's overarching aims were to build upon previous planning efforts in defining an end-to-end MSR Science Program, and addressing a number of important issues that will influence the design and planned implementation of a Sample Receiving Facility (SRF). The challenges for the first samples delivered from another planet include not only maintaining and allocating samples in pristine condition for study, but also maintaining biocontainment until the samples are demonstrated to meet sample safety criteria for distribution outside of containment.

High-level findings: MSPG2 has developed five high-level findings:

1. A joint NASA/ESA MSR Science Program, along with the necessary funding and human resources, is required to accomplish the overall scientific objectives of MSR.
2. Traditional curation of extraterrestrial samples involves cleanroom operations, but MSR curation will need to be done concurrently with BSL-4-level containment. This would lead to complex first-of-a-kind curation implementations, and require further technology development.
3. Most aspects of MSR sample science can be effectively performed on samples deemed safe (either by test or by sterilization) in uncontained laboratories outside of the SRF. However, other aspects of MSR sample science are either time-sensitive or sterilization-sensitive, including the search for life, assessment of habitability, and volatile exchange processes, and would need to be carried out in the SRF. Some sterilization-sensitive measurements would be postponed until samples can be distributed outside of containment.
4. In order to meet the unique science, curation and planetary protection needs of MSR, and even with an explicit goal of performing as many MSR sample analyses as possible outside of the SRF, substantial analytical and sample management capabilities would be required in the SRF.
5. The schedule required to have an SRF designed, constructed, and ready to receive the MSR samples has a longer lead time than perhaps any facility development previously attempted by NASA/ESA. It is important that preparations begin immediately; a potential delay in the return of the samples does not impact the overall science program planning beyond some shift in the mid-term activities.

Discussion: Two significant implications arise from the findings and conclusions of MSPG2:

First, a joint NASA/ESA MSR Science Program, along with the necessary funding and human resources should be established to enable proper interface management with Mars 2020, the MSR transportation missions, and the Sample Receiving Facility. Science considerations must be adequately accounted for in planning and executing the MSR Campaign, and the interfaces involving the samples must be managed correctly in order for the potential value of the samples to be maximized.

Second, the merging of high-performance cleanroom operations and BSL-4-level containment in a single facility has never been done before-doing it successfully will necessitate complex first-of-a-kind curation implementations. The planning lead time for such a facility has some uncertainty, and it may be a significant management challenge in the coming years to avoid underestimating it. Delaying SRF planning could compromise the ability to carry out MSR science in a timely and effective manner. Thus, it is important that preparations begin immediately. Finally, in order for the SRF to effectively achieve its objectives, even with the minimal SRF we envision, it must have a substantial laboratory analysis capability to accomplish analyses needed for curation, planetary protection, and time-sensitive science.