Space Studies of the Earth-Moon System, Planets, and Small Bodies of the Solar System (B)
Mars Sample Return (B4.4)
Consider for oral presentation.

MARS SAMPLE RECEIVING FACILITY RESEARCH AND DEVELOPMENT TO ENABLE PRESERVATION, SAFE CONTAINMENT, AND SCIENTIFIC RESEARCH OF MARTIAN SAMPLES ON EARTH

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NASA and ESA are working together to plan a joint campaign to potentially bring back the first Martian samples to Earth in the early 2030s. On the surface of Mars, the Mars 2020 *Perseverance Rover* is selecting and packaging samples that could be returned to Earth for careful examination by an international team of scientists. In preparation for this historic sample return, advance planning is underway to design and build a Mars Sample Receiving Facility (SRF) in the mid-2020s. In 2022, a Mars Sample Receiving Facility Assessment Study (MSAS) will be conducted to further define construction modality and capability options for a facility in the conterminous United States. Since Mars Sample Return (MSR) is currently categorized as a planetary protection restricted Earth return, this new facility would feature biosafety level 4 (BSL-4)-like high containment to protect Earth's biosphere from any potential hazard. In addition, the facility also requires integration of cleanroom technologies to mitigate against terrestrial contamination and preserve sample integrity for science investigations. The integration of both clean handling and high containment requires significant technology research and development (R&D) by the mid-2020s to support the definition and planning of a SRF before commencing the site specific design phase.

The SRF project will need to solidify the inorganic, organic, and biological contamination control (CC) requirements for the facility. This could entail a translation of Mars 2020 mission CC requirements for geologic material to engineering requirements for surfaces and airborne molecular contamination inside isolators and cleanrooms. In tandem, the project will need to determine precision cleaning and sterilization approaches for cleanrooms, isolators, equipment, and tools. Initial material selections for the facility construction materials, cleanrooms, isolators, and BSL-4 suits/garments are an important activity. The recent construction of the OSIRIS-REx and Hayabusa2 curation cleanroom laboratories greatly benefited from early ma-

terials testing, before the design phase, to reduced organic outgassing and particulate shedding inside the laboratory. While the early biohazard investigations in the SRF may deem the samples safe to release to laboratories throughout the world, sterilization methods need to be defined to safely release Martian samples.

One key aspect of enabling simultaneous sample containment and cleanliness is the concept of a Double-Walled Isolator (DWI) that ESA has been pursuing. Further R&D is needed about DWIs, sample handling, and instrumentation interfaces before beginning the SRF site specific design phase. A working isolator/DWI engineering model should be developed and fabricated. Isolator sizes, connections, pass-through antechambers, and configurations and basic interfaces with instruments and tools as well as the use of robotic, mechanical, and/or human manipulation need to be considered. Inert high purity gas supply (one-pass or recirculation) and other isolator utilities must be determined. Special accommodations for large instruments (e.g., XCT, SEM, etc.) need to be developed. Techniques for opening the sample tubes packaged by M2020 and extracting the headspace gas while keeping samples pristine will be challenging, requiring additional R&D, and engagement of the M2020 project. In addition, careful micromanipulation for subdivision and packaging of samples will also need to be included.

These combined R&D activities are important before commencing the SRF design phase to ensure safe biohazard containment, sample preservation, and science integrity for the samples that would be studied in the SRF and in laboratories around the world.

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