Mars Sample Receiving Project

MSR Sample Receiving Project – Ongoing Activities, Curation, and Facility Planning

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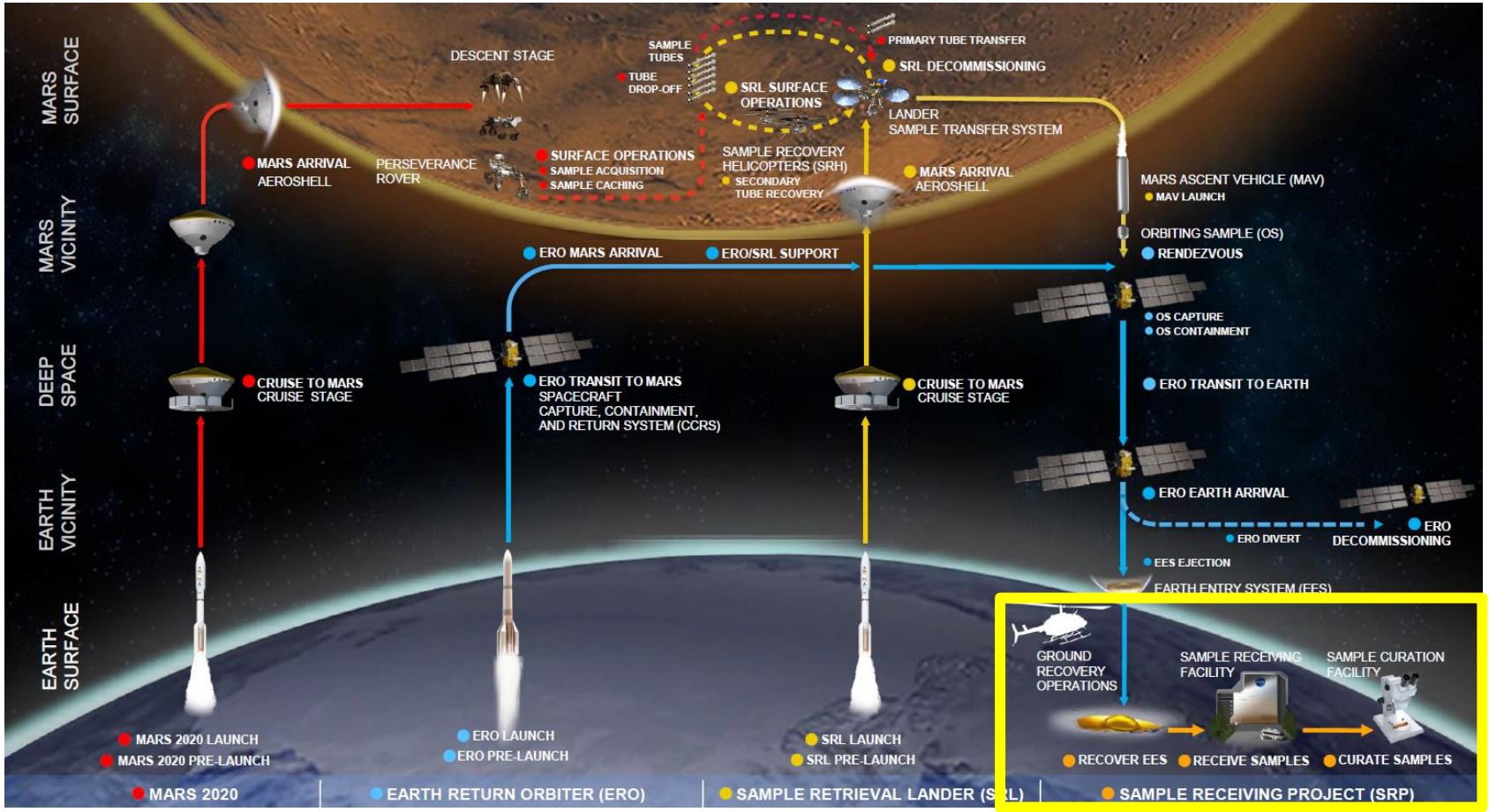
INTRODUCTION

- Mars Sample Return (MSR) is a joint venture between NASA and ESA.
- The Campaign will notionally return between 10-26 geologically diverse samples (plus witness tubes) able to answer an array of science objectives.
- The Sample Receiving Project (SRP) is the last component of the MSR Campaign with operations beginning when the samples arrive on Earth.
- The NASA Curation Office will take formal custody of the samples and the collection will be jointly managed by NASA and ESA.



MSR Campaign Architecture under evaluation

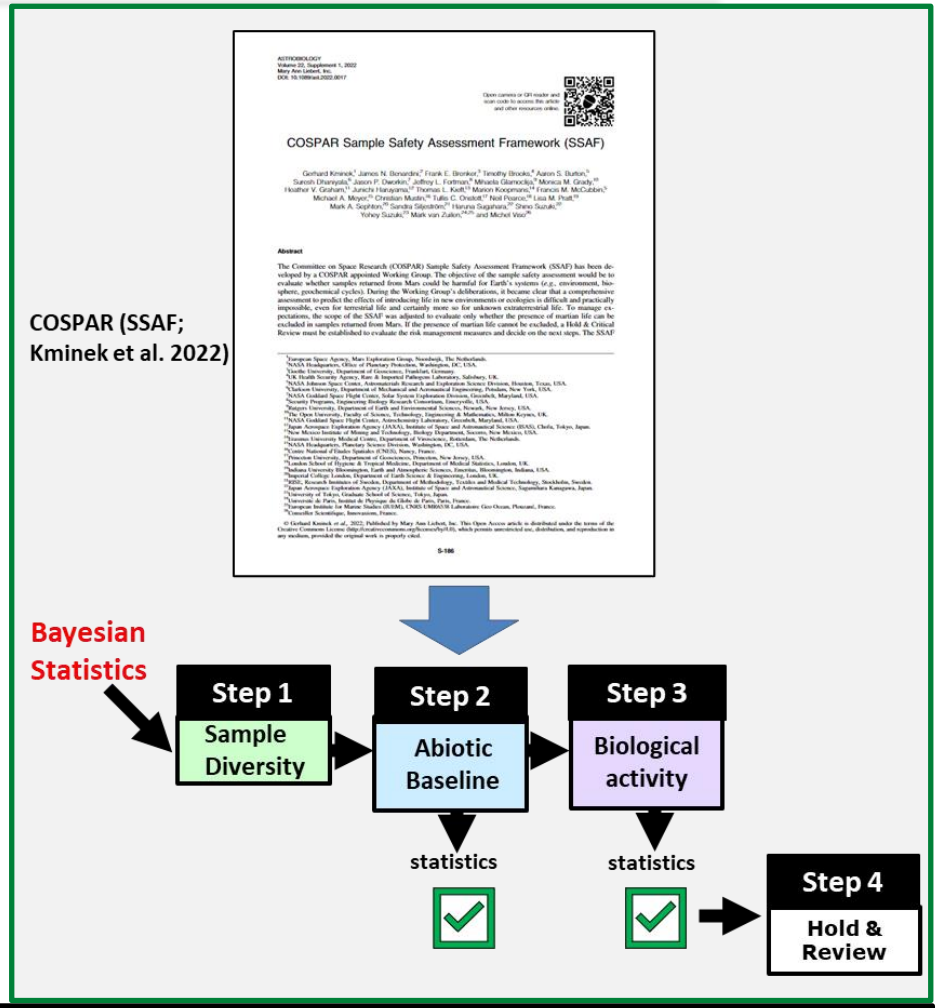
Sample Receiving Project Updates

- As a part of the MSR Campaign, SRP is aligned with the SMD recommended path forward following the MSR IRB Response Team's (MIRT) briefings
- Study Agreement between ESA and NASA, which allows for continued collaboration and serves as a bridge to an ultimate Memorandum of Understanding (MOU), is proceeding through the approval process
- Sample Safety Assessment Protocol (SSAP) Tiger Team and Measurement Definition Team (MDT) finalizing their efforts.
  - SSAP-TT developing protocol to determine the necessary measurements for sample release from high-containment laboratories
  - Measurement Definition Team (MDT) developing a traceability matrix of measurements needed to accomplish sample safety assessment, curation, and initial science

SSAP-TT and MDT in Houston for joint face-to-face meetings on January 28 – February 1, 2024

Origins of the Sample Safety Assessment Protocol

- Starting point for SSAP was the COSPAR SSAF (Framework) publication
- SSAP refined the SSAF test plan into 3 critical measurement steps, leveraging a statistical model to enable better decision-making when working with small sample sizes and limited initial data
- Critical measurement steps are:
    1. Understanding sample heterogeneity
    2. Comparison of sample geochemistry to the abiotic baseline
    3. Biochemical measurements to test for biological activity



Sample conservation was key for protocol development to support long-term sample-based scientific research.

Mars Sample Receiving Project

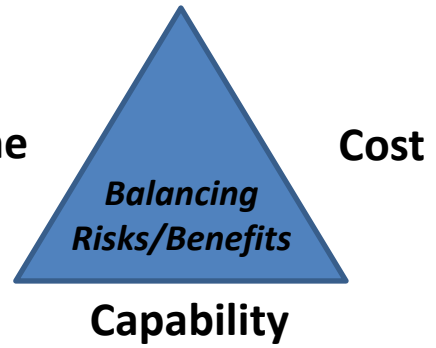
HIGHLIGHT OF OVERARCHING SRF CONSIDERATIONS

Mars Sample Receiving Facility (SRF) Assessment Study (MSAS) –

Phase 1: Assess major building modality options and accommodation potentialities

Phase 2: Assess high-containment implementation strategies and develop high-concept designs

Structural Constraints
Personnel Safety
PP Requirements
CC Requirements
Preliminary Examination Requirements
Science Requirements
Construction Timeline
Operational Timeline
Adaptability to Changing Needs
Facility Fair Use/Access to Samples
Partnership/Reutilization Opportunities
Cost Effectiveness (short and long-term)
Pristine Sample Conservation



Upon completion of the assessment studies, the preferred modality and refined requirements would be utilized for site-specific design but will not be finalized until NASA's completion of the National Environmental Policy Act (NEPA) process.

MSR SRF CAPABILITIES

Receive Spacecraft

Hardware Disassembly

Sample Tube
Pre-Basic Characterization

Samples Opened and
Basic Characterization

Samples Picked
and/or subdivided

Sample Safety Assessment,
Preliminary Examination,
and/or Select Early Science

Allocated Sample
Sterilization Process
(Irradiation or Heat)

Global Safe Sample Distribution for
Earth-based Science Investigations

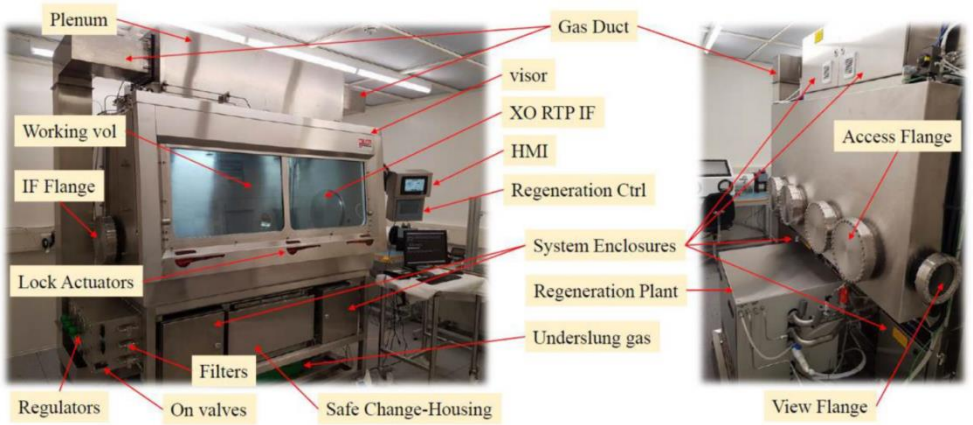
Provide High-Containment & Contamination Control
Accommodate highest priority instrumentation
Fully operational by sample arrival
Enable rapid of release of samples

Mars Sample Receiving Facility (SRF) Modality Options

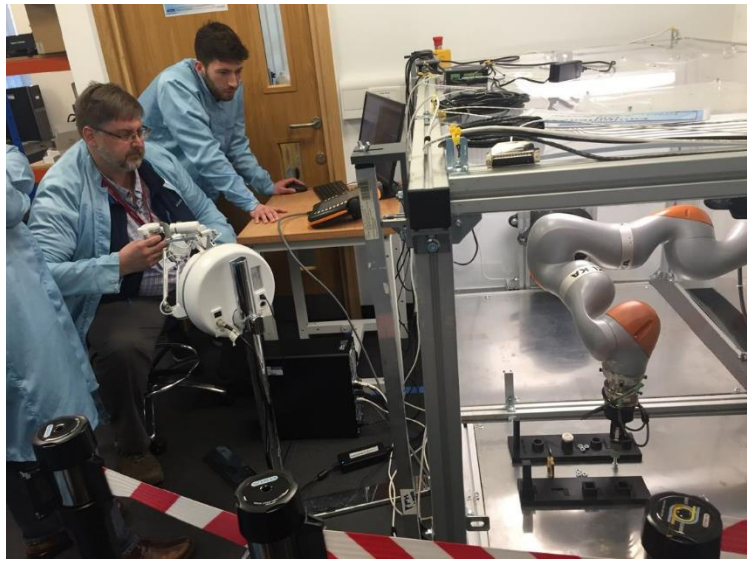
- Decommissioned Existing BSL-4 facilities ONLY
- New Traditional, Fixed High-Containment Facility
- New Modular High-Containment Facility
- Hybrid (New + Existing facilities)

Sample Receiving Facility (SRF) Planning

- In addition to collaborating on the assessment study, NASA is working with ESA on implementation strategies for fulfilling the facility, instrumentation, and science requirements outlined by MSR WGs
  - Translation of science requirements into preliminary engineering requirements
  - R&D identified as necessary to support the SRF design and operations
    - Double Walled Isolator (DWI) Design (ESA anticipated lead)
    - Sample handling - Robotic and/or Remote Manipulation
    - High-Containment suit and infrastructural material contamination control testing
    - Quantify contamination loads of existing BSL-4 facilities
    - Instrument accommodations
    - Sample sterilization
    - Infrastructural cleaning and sterilization procedures
    - Gas extraction
    - Feasibility of XCT and Magnetometry within sample tubes



DWI Breadboard at U. Leicester

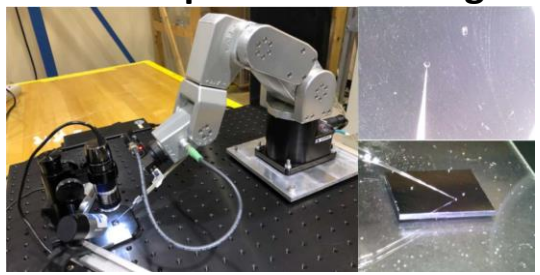


Robotic Manipulation Breadboard at Thales Alenia UK

Mission Enabling Technology Development in Curation

Other Astromaterial Collections

Microparticle Handling



OSIRIS REx (JSC)

Gloveboxes

Apollo Laboratory (JSC)

Bag Spring Clamps vital for ANGSA

Inform Mars sample manipulation

Isolation cabinets to be utilized by OREx

Inform Mars core dissection and best practices in contamination control

DWI and SRF could enable future Restricted Earth Return missions and/or handle samples with potential chemical hazards

MSR Collection

Isolation Cabinets

MSR CK (JSC)

Bag Spring Clamps

MSR CK (JSC)

Double Walled Isolators

MSR Sample (ESA/Thales Alenia)

Mars 2020 Perseverance CK Collection Status

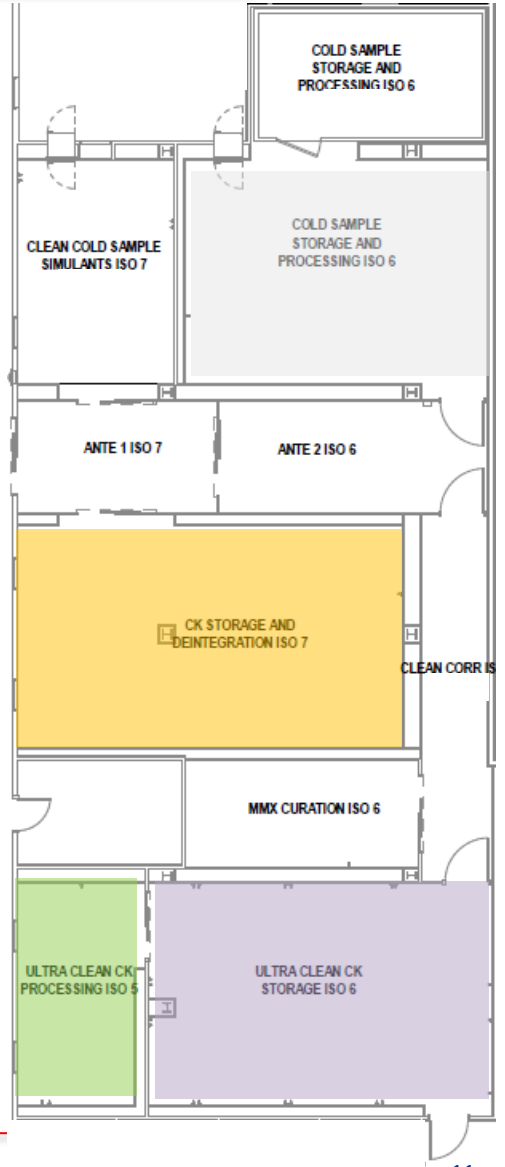
- Entirety of the Mars 2020 CK Collection is housed in the Curation Office
  - Biological CK
    - Swabs
    - Wipes
  - Flight Vacuum Bake-Out Witness Plates
  - Flight Replicates
    - Sample Tubes
    - Drill Bit
    - Coring Bit
    - Abrading Bit
    - Drillable Blank
  - Environmental Witness Plates & Foils
    - SIH Flow Benches
    - Assembly Rooms
    - Organic
    - Inorganic
  - SIH Witness Items
    - Gloves
    - Wipes

  - Flight Replicates
    - SHERLOC Cal Target
    - 7 Sample Tube Assemblies
    - 7 Glove Assemblies
    - 7 Sample Tube Storage
    - Volume Station Assembly
    - Seal Dispenser Assembly
    - 7 Hermetic Seal Assemblies
    - 2 Cover Assemblies
    - 2 Witness Tube Assemblies
  - Material Samples
  - Final Solvent Rinses
    - Hexane
    - Isopropanol
    - Acetone
    - Ethanol
    - DI Water

MSR Campaign CK Collection Planning

- New CK Laboratory Suite in upcoming B31 Annex
  - ISO 7 Storage Room with ISO 5 Stainless Steel Flow Bench
  - ISO 6 Ultra-Clean Storage Room with Custom Designed Low-Organic Outgassing Desiccators/Isolators
  - ISO 5 Ultra-Clean/Low-Organic Outgassing Processing Room with Additional Glovebox
  - ISO 6 Biological Storage with a BSCII Cabinet for Processing Allocations

- Developing the database for the CK Collection catalogue
  - Includes cross-referencing and cataloguing ~1TB of data provided by the project (pertinent sample data tracking flight items from manufacturing to cleaning to installation)



Closing Highlights

- NASA and ESA are taking a “safety first” approach to designing and engineering every step of Sample Receiving Project (SRP).
  - Complementary NASA/ESA SRF studies will inform site-specific design.
  - Conducting R&D activities (e.g., DWI) to comply with Planetary Protection and Contamination Control objectives.

- MSR should be seen as a mission enabling endeavor
  - Future technology development will lay the foundation for other, even more complex sample return missions
    - Restricted Earth Return Facilities
    - Clean and contained processing and storage technology
  - Technology developed for the Mars2020 Contamination Knowledge collection has become curation standards at JSC