Summary of Instruments and Sample Prep Needs Proposed for the SRF								
				Required for				
Ref. #	**Required Instrument Functionality**	**Reference instrument**	Function	Curation	Sample Safety Assessment	Time-Sensitive Science	Sterilization-Sensitive Science	**Significant Instrument Comments**
	Pre-Basic Characterization (n = 3)							
1	Stereo microscope (see note) [8:1 zoom], ; (possible multiple)	Leica Z16 APO; Leica DMS1000 Macroscope	View/inspect/image all hardware before opening	**X**				
MOSDT1	IP Cameras PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)	Axis Q6074 PTZ 30x optiocal zoom	View/inspect/image all hardware before opening	**X**				
2	High Resolution X-ray Computed Tomography (HR-XCT)	[Nikon XTH 225 ST with a 225 kV rotating source] [JSC has a Nikon XT H 320 LC kV source - 4 Axis - PE 1620 w CFW with 225kV and 320kV]	X-ray scan each sample tube	**X**	**X**			
3	Magnetometer	Mag-03MS100, Bartington Instruments	measure sample tube in nano Teslas	**X**				
4	Magnetic Susceptometer	no recommandation	measure magnetic susceptability of the sample tube	**X**				
	Basic Characterization (n = 2)							
5	Analytical balance (see note) (may need multiple)	Mettler XPR Automatic Balance <0.1 mg readability	weigh samples	**X**				
6	Multispectral/Hyperspectral Imager [10-20 micron resolution]		Image samples in the UV to IR range	**X**	**X**			
1	Stereo microscope (see note) [8:1 zoom]; (possible multiple)	Leica Z16 APO; Leica DMS1000 Macroscope	View/inspect/image all samples	**X**				
MOSDT2	; fully automated Materials reflective micrscope (long-working objectives 1.25X, 5X, 10X, 20X, 50X) BF, DF, P, F; HR camera. (possible multiple)	Leica DM6 M	View/inspect/image all samples	**X**				
MOSDT3	IP Camera PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)		View/inspect/image all Samples	**X**				
	Preliminary Examination (n = 8)							
7.1	Variable Pressure-Field Emission Scanning Electron Microscope with electron and Focused Ion Beam (FIB) columns and multiple detectors	ZEISS Sigma 300 VP with BSE, SE, EDS/EDX, CL, FIB, WDS]	Analysis of unprepared samples	**X**	**X**	**X**	**X**	Three instruments: a VP/FEG-SEM for non-prepared samples, a VP/FEG-SEM for prepared samples (PTS, etc.), and a FIB for sample preparation. The two VP/FEG-SEM instruments to have additional detectors (CL, EDS, WDS, FIB, and EBSD) to be determined later. Notionally, all will have BSE/SE imaging detectors (no additional footprint) and EDS detectors (small additional footprint). Detectors for CL, WDS, and EBSD require prepared samples and have small additional footprint.
8	Deep Ultraviolet Fluorescence	Photon Systems Inc. DUV PL 200	Map distrubution of organic compounds.	**X**	**X**	**X**	**X**	Deep UV and confocal Raman are typically separate instruments, with optics that might not be compatible. For the purpose of MOSDT, they are considered as not combined.
9	Confocal Raman Spectrometer	HORIBA LabRAM HR	Analysis of molecular structure, crystallinity, and molecular interactions in inorganic and organic phases (analysis of minerals)	**X**	**X**	**X**	**X**	
10.1	Fourier Transform-Infrared Spectrometer (FTIR)	ThermoScientific icolet™ iSS0; ATR and DRIFT	Analysis of functional groups (silicates, carobonates, phosphates, sulphates, etc.) and water in mineral phases. Analysis of minerals, hydration state and local bonding environment	**X**	**X**	**X**	**X**	This duciplicate instrument is only needed when KBr or any other substance is added to the powder. There exist some FTIR that do not need to add KBR within the sample. When such an instrument would be used, this duplicate is not needed anymore.
11.1	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	Malvern Panalytical Empyrean powder X-ray diffractometer	Analysis of the phases and degree of chrystallinity of samples. Measure Crystal structure, major and non-volatile minor element abundances and stoichiometric composition of minerals	**X**		**X**	**X**	
12	X-ray Fluorescence	Bruker S2 Puma with light element detector and mapping stage	Analysis of bulk chemical composition	**X**				
13	Microscopy lab (see note)	[Leica DM4 P & DM6 M*]	View/inspect/image all samples	**X**			**X**	
	Headspace Gas analysis							
23.1	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	Thermo Scientific TC/EA (which interfaces with any continuous flow IRMS	optimized for low molecular weight volatiles and their stables isotopes and would be used for the analysis of headspace and other gas samples characterizes mineral-bound volatile concentrations, speciation, and isotopic compositions (i.e., H2O, SO2, CO2, etc.) Uses combustion and isotope ratio mass spectrometry to determine the stable isotopic compositions of components in bulk samples			**X**	**X**	
24	Optical laser spectrometer (e.g., Tunable Laser Spectrometer or Cavity Ring Down Spectroscopy)		Concentration of major/minor gaseous species & isotopic composition of major/minor gaseous species			**X**	**X**	This instrument is recommended by the Time-Sensitive report, and for the scope of MOSDT v
	Science Investigations & SSAP							
7.2	Variable Pressure-Field Emission Scanning Electron Microscope with electron columns and multiple detectors	ZEISS Sigma 300 VP with BSE, SE, EDS/EDX, CL, FIB, WDS]	Anaylsis of samples (prepared)		**X**	**X**	**X**	Three instruments: a VP/FEG-SEM for non-prepared samples, a VP/FEG-SEM for prepared samples (PTS, etc.), and a FIB for sample preparation. The two VP/FEG-SEM instruments to have additional detectors (CL, EDS, WDS, FIB, and EBSD) to be determined later. Notionally, all will have BSE/SE imaging detectors (no additional footprint) and EDS detectors (small additional footprint). Detectors for CL, WDS, and EBSD require prepared samples and have small additional footprint.
10.2	Fourier Transform-Infrared Spectrometer (FTIR)	ThermoScientific icolet™ iSS0; ATR and DRIFT	Analysis of functional groups (silicates, carobonates, phosphates, sulphates, etc.) and water in mineral phases. Analysis of minerals, hydration state and local bonding environment		**X**	**X**	**X**	
11.2	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	Malvern Panalytical Empyrean powder X-ray diffractometer	Analysis of the phases and degree of chrystallinity of samples. Measure Crystal structure, major and non-volatile minor element abundances and stoichiometric composition of minerals			**X**	**X**	
25	Electron Paramagnetic Resonance (EPR) Spectroscopy –	Bruker Magnettech ESR5000 bench-top EPR spectrometer	measurement of free radicals/oxidizing materials in samples. detects and quantifies species with unpaired electrons. These species include free radicals and transition metals.Detect and characterize reactive O-species. Preferably before sample processing steps that seek to preserve or target redox-sensitive minerals, prior to exposure to solvents, elevated temp, humidity			**X**	**X**	EPR should be used on pristine samples, and conserves the pristine nature of the samples. EPR can be located near other isntruments that will use pristine samples, and as such be placed in a room with more stringent contamination control requirements
26	Brunauer-Emmett-Teller (BET) surface area analysis	[Horiba SA-9600]	Measure the total surface area to monitor irreversible phase transitions as samples dehydrate and coarsen. Characterize solid-volatile hosts, monitoring of ripening reactions. It can also support studies about Mineral bound volatiles on poorly crystalline or X-ray amorphous material.			**X**		Sample is placed into a glass tube, open for interaction with the instrument. Implementatio
24b	Optical laser spectrometer (Sample Analysis at Mars (SAM) instrument)		Concentration of major/minor gaseous species & isotopic composition of major/minor gaseous species			**X**	**X**	This instrument is recommended by the Sterilization-Sensitive report, and for the scope of M

Summary of Instruments and Sample Prep Needs Proposed for the SRF											
		Quick glance							Engineering Details		
Ref. #	**Required Instrument Functionality**	Size (handheld OR tabletop OR self-standing)	Is it possible to interface with isolator/DWI?	Org. cont. sensitive (Y/N)	Sample Preparation (Y/N)	Isolator Manual Manipulation via gloves (Y/N)	Isolator Robotics/ RMS handling (Y/N)		Vibration Sensitive (Y/N)	Power Requirements (V/A)	**Size**
	Pre-Basic Characterization (n = 3)										
1	Stereo microscope (see note) [8:1 zoom], ; (possible multiple)	handheld	on isolator	N	N	N	Y		Y	USB 5V (5W)	
MOSDT1	IP Cameras PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)	handheld	on isolator	N	N	N	Y		Y	Power over Ethernet (PoE)	
2	High Resolution X-ray Computed Tomography (HR-XCT)	self-standing	Instument Box Interface (tbc)	N	N	N	Y		Y	230 VAC, 25 A, 50/60 Hz, 1 PHASE, TN-S	
3	Magnetometer	tabletop	Instument Box Interface (tbc)	N	N	N	Y		?	110V (65mA)	
4	Magnetic Susceptometer	tabletop		N	N	N	Y		?	?	
	Basic Characterization (n = 2)										
5	Analytical balance (see note) (may need multiple)	handheld	inside isolator	N	N	N	Y		Y	110VAC (Low amp)	
6	Multispectral/Hyperspectral Imager [10-20 micron resolution]	handheld	on isolator	N	N	N	Y		Y	110VAC (Low amp)	
1	Stereo microscope (see note) [8:1 zoom]; (possible multiple)	handheld	on isolator	N	N	N	Y		Y	USB 5V (5W)	
MOSDT2	; fully automated Materials reflective micrscope (long-working objectives 1.25X, 5X, 10X, 20X, 50X) BF, DF, P, F; HR camera. (possible multiple)	handheld	on isolator	N	N	N	Y		Y	110VAC	
MOSDT3	IP Camera PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)	handheld	on isolator	N	N	N	Y		Y	Power over Ethernet (PoE)	
	Preliminary Examination (n = 8)										
7.1	Variable Pressure-Field Emission Scanning Electron Microscope with electron and Focused Ion Beam (FIB) columns and multiple detectors	self-standing	Instument Box Interface (tbc)	Y	Y	N/A	N/A		Y	230V, 25A	
8	Deep Ultraviolet Fluorescence	tabletop	inside isolator	Y	N	N	Y		Y	110VAC / 100W	
9	Confocal Raman Spectrometer	self-standing	Instument Box Interface (tbc)	Y	N	N	Y		Y	110 VAC / 150 VA	
10.1	Fourier Transform-Infrared Spectrometer (FTIR)	tabletop	inside isolator/Instument Box Interface (tbc)	Y	Y	N	Y		Y	110VAC (15A)	
11.1	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	self-standing	Instument Box Interface (tbc)	N	Y	N/A	N/A		Y	240 VAC / 4.6kVA	
12	X-ray Fluorescence	tabletop	inside isolator/Instument Box Interface (tbc)	N	N	N	Y		Y	110VAC / 600VA	
13	Microscopy lab (see note)	tabletop	on isolator	N	Y	N	Y		Y	110VAC	
	Headspace Gas analysis										
23.1	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	Tabletop or Stand-alone	Instrument Box Interface (tbc)	N	Y	N/A	N/A			230 V, single phase, 8 A.	45 x 70 x 50 cm (W x D x H
24	Optical laser spectrometer (e.g., Tunable Laser Spectrometer or Cavity Ring Down Spectroscopy)	Stand-alone but it can be quite extensive depending on the scope.	Instrument Box Interface (tbc)	Y	Y	N/A	N/A				
	Science Investigations & SSAP										
7.2	Variable Pressure-Field Emission Scanning Electron Microscope with electron columns and multiple detectors	self-standing	Instument Box Interface (tbc)	Y	Y	N/A	N/A		Y	230V, 25A	
10.2	Fourier Transform-Infrared Spectrometer (FTIR)	tabletop	inside isolator/Instument Box Interface (tbc)	Y	Y	N	Y		Y	110VAC (15A)	
11.2	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	self-standing	Instument Box Interface (tbc)	N	Y	N/A	N/A		Y	240 VAC / 4.6kVA	
25	Electron Paramagnetic Resonance (EPR) Spectroscopy –	tabletop	Inside isolator or Instrument Box Interface (tbc) or adjactent room	Y	N	N/A	N/A		N?	standard	397 x 262 x 192 mm
26	Brunauer-Emmett-Teller (BET) surface area analysis	tabletop	Instrument Box Interface (tbc)	N	Y	N/A	N/A				
24b	Optical laser spectrometer (Sample Analysis at Mars (SAM) instrument)	Tabletop	Inside isolator or Instrument Box Interface (tbc)	Y	Y	N/A	N/A				

Summary of Instruments and Sample Prep Needs Proposed for the SRF							
						Analysis requirements	
Ref. #	**Required Instrument Functionality**	Mass (kg)	Specialized Gas Requirements	Cooling Needs	Special infrastructure req	Analysis under inert gas	Special Lighting Needs
	Pre-Basic Characterization (n = 3)						
1	Stereo microscope (see note) [8:1 zoom], ; (possible multiple)	1.5	None	None	None	Yes, unopened tube	sample needs to be illuminated
MOSDT1	IP Cameras PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)	2.85	None	None	None	Yes, unopened tube	YES
2	High Resolution X-ray Computed Tomography (HR-XCT)	8000	None	YES; chiller	Radiation; electrical; chiller	Yes, unopened tube	None
3	Magnetometer	1	None	None	Magnetic sheilding	Yes, unopened tube	None
4	Magnetic Susceptometer	?	None	None	Magnetic sheilding	Yes, unopened tube	None
	Basic Characterization (n = 2)						
5	Analytical balance (see note) (may need multiple)	1	None	None	None	Yes	None
6	Multispectral/Hyperspectral Imager [10-20 micron resolution]	1	None	None	None	Yes	Needs darkness
1	Stereo microscope (see note) [8:1 zoom]; (possible multiple)	1.5	None	None	None	Yes	YES
MOSDT2	; fully automated Materials reflective micrscope (long-working objectives 1.25X, 5X, 10X, 20X, 50X) BF, DF, P, F; HR camera. (possible multiple)	25??	None	None	None	Yes	YES
MOSDT3	IP Camera PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)	2.85	None	None	None	Yes	YES
	Preliminary Examination (n = 8)						
7.1	Variable Pressure-Field Emission Scanning Electron Microscope with electron and Focused Ion Beam (FIB) columns and multiple detectors	350	compressed air and GN2	Maybe dependant on detector	vacuum Pump; low magnetic field; low vibration		None
8	Deep Ultraviolet Fluorescence	12	None	None	Class 3B laser		Yes
9	Confocal Raman Spectrometer	95	Maybe	Yes and LN2	Class 3B laser, Liquid Nitrogen		YES
10.1	Fourier Transform-Infrared Spectrometer (FTIR)	150	GN2 purge	LN2 detectors	Liquid Nitrogen		None
11.1	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	1150	compressed air and GN2	Cooling Water Supply	Radiation; electrical; chiller; gas		None
12	X-ray Fluorescence	132	helium and GN2	None	radiation, gas		None
13	Microscopy lab (see note)	25??	None	None	None		YES
	Headspace Gas analysis						
23.1	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	l), 59 kg.	High purity helium (99.999% or better).Reference gases (CO and H2) with pressure regulators.To use the TC/EA with CO and H2reference gas, the laboratory must be equipped with CO and H2detectors.				
24	Optical laser spectrometer (e.g., Tunable Laser Spectrometer or Cavity Ring Down Spectroscopy)						
	Science Investigations & SSAP						
7.2	Variable Pressure-Field Emission Scanning Electron Microscope with electron columns and multiple detectors	350	compressed air and GN2	Maybe dependant on detector	vacuum Pump; low magnetic field; low vibration		None
10.2	Fourier Transform-Infrared Spectrometer (FTIR)	150	GN2 purge	LN2 detectors	Liquid Nitrogen		None
11.2	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	1150	compressed air and GN2	Cooling Water Supply	Radiation; electrical; chiller; gas		None
25	Electron Paramagnetic Resonance (EPR) Spectroscopy –	45	None	None. **Can use a temp controller for liquid nitrogen - 180 to 200 deg C**			None
26	Brunauer-Emmett-Teller (BET) surface area analysis		**Uses flowing gas method (N2 and He) to acquire adsorption and desorption curves**				
24b	Optical laser spectrometer (Sample Analysis at Mars (SAM) instrument)						

Summary of Instruments and Sample Prep Needs Proposed for the SRF					
		Sample prep			
Ref. #	**Required Instrument Functionality**	Detailed Sample Preparation Requirments	Sample Prep in sample prep area (separate): is the sample to be analyzed prepared in a general sample pre area? Y: sample must be prepared following a certain protocol using capabilities and isntruments identified in the Sample Prep section, and it doesn't need to be linked to the instrument, but can be trasnported to the instrument. N: sample preparation must occur in co-location with the targetted analytical instrument N/A: no sample prep required	Level of pristinity before prep or analysis	Level of pristinity after prep or analysis (Pristine, Psub,Rest, Terminal
	Pre-Basic Characterization (n = 3)				
1	Stereo microscope (see note) [8:1 zoom], ; (possible multiple)	None	N/A		Pristine
MOSDT1	IP Cameras PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)	None	N/A		Pristine
2	High Resolution X-ray Computed Tomography (HR-XCT)	None	N/A		Pristine
3	Magnetometer	None	N/A		Pristine
4	Magnetic Susceptometer	None	N/A		Pristine
	Basic Characterization (n = 2)				
5	Analytical balance (see note) (may need multiple)	None	N/A		Pristine
6	Multispectral/Hyperspectral Imager [10-20 micron resolution]	None	N/A		Pristine
1	Stereo microscope (see note) [8:1 zoom]; (possible multiple)	None	N/A		Pristine
MOSDT2	; fully automated Materials reflective micrscope (long-working objectives 1.25X, 5X, 10X, 20X, 50X) BF, DF, P, F; HR camera. (possible multiple)	None	N/A		Pristine
MOSDT3	IP Camera PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)	None	N/A		Pristine
	Preliminary Examination (n = 8)				
7.1	Variable Pressure-Field Emission Scanning Electron Microscope with electron and Focused Ion Beam (FIB) columns and multiple detectors	None to flat sample for low vacuum mode.	Y		Psub
8	Deep Ultraviolet Fluorescence	None to flat sample	Y		Psub
9	Confocal Raman Spectrometer	None to flat sample	Y		Psub
10.1	Fourier Transform-Infrared Spectrometer (FTIR)	samples are ground with KBr and pressed into pellets, or doubly polished thin section; ATR and DRIFT would reduce sample preparation	Y		Psub
11.1	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	None to flat sample	Y		Psub
12	X-ray Fluorescence	None to flat sample	Y		Psub
13	Microscopy lab (see note)	None, flat sample, polished mount, or thin section	Y		Psub
	Headspace Gas analysis				
23.1	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	None	N/A		Terminal
24	Optical laser spectrometer (e.g., Tunable Laser Spectrometer or Cavity Ring Down Spectroscopy)	None – Samples Placed in combustion tube	N/A		Terminal
	Science Investigations & SSAP				
7.2	Variable Pressure-Field Emission Scanning Electron Microscope with electron columns and multiple detectors	Flat sample, polished mount, or thin-section sample on glass slide with conductive coating (e.g. carbon, gold, etc.) for high vacuum mode.	Y		Rest
10.2	Fourier Transform-Infrared Spectrometer (FTIR)	samples are ground with KBr and pressed into pellets, or doubly polished thin section; ATR and DRIFT would reduce sample preparation	Y		Rest
11.2	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability	powders and thin-section	Y		Rest
25	Electron Paramagnetic Resonance (EPR) Spectroscopy –	placing the sample in a tube. No contact with the sample so sample is preserved for further analyses.	Yes	Pristine	Psub
26	Brunauer-Emmett-Teller (BET) surface area analysis	Chips and Powders, minimum mass 0.5 g (for best results). Sample needs to be degassed (at least for 16h and depending on the temperature, IUPAC suggestion) for water content removal in vacuum chamber at high temperature (max temperature that do not alter the sample). Samples are placed in glass cells for boing degassed and afterwards analysed.	Yes		Rest
24b	Optical laser spectrometer (Sample Analysis at Mars (SAM) instrument)	None – Samples Placed in combustion tube	Y		Terminal

Summary of Instruments and Sample Prep Needs Proposed for the SRF				
				Notes
Ref. #	Required Instrument Functionality	Sample Prep under inert gas	Sub Sample mass/volume needed in sample prep	
	Pre-Basic Characterization (n = 3)			
1	Stereo microscope (see note) [8:1 zoom], ; (possible multiple)		N/A	
MOSDT1	IP Cameras PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)		N/A	
2	High Resolution X-ray Computed Tomography (HR-XCT)		None	
3	Magnetometer		None	
4	Magnetic Susceptometer		None	
	Basic Characterization (n = 2)			
5	Analytical balance (see note) (may need multiple)		None	
6	Multispectral/Hyperspectral Imager [10-20 micron resolution]		None	
1	Stereo microscope (see note) [8:1 zoom]; (possible multiple)		N/A	
MOSDT2	; fully automated Materials reflective micrscope (long-working objectives 1.25X, 5X, 10X, 20X, 50X) BF, DF, P, F; HR camera. (possible multiple)		N/A	
MOSDT3	IP Camera PTZ (pan/tilt/zoom) with 12x+ optical zoom (multiple)		N/A	
	Preliminary Examination (n = 8)			
7.1	Variable Pressure-Field Emission Scanning Electron Microscope with electron and Focused Ion Beam (FIB) columns and multiple detectors	None to flat sample for low vacuum mode.	MAX: 0.5 cm thick sub samples to generate thin sections of 30 microns thick	The SEM will need to have ports for additional detectors, possibly including CL, EDS, WDS, FIB, and EBSD, and Focused Ion Beam capability--this is an important sample prep step for other measurements. Gminek et al., 2021 report calls for a Variable Pressure Scanning Electron Microscope with Energy Dispersive X-ray Spectrometer (EDS). Tait et al., 2021 state the need for capability for both Field Emission- and Variable Pressure-SEM, that could potentially be combined in one instrument but also state the benefits of having 2 SEMs
8	Deep Ultraviolet Fluorescence		N/A	Ground-truthing SHERLOCK. Separate instrument from confocal Raman required. Likely require optical separation like the confocal Raman.
9	Confocal Raman Spectrometer		N/A	Should be placed either in a separate room, or with the ability to separate it from the other instruments (by optical curtain, for example)
10.1	Fourier Transform-Infrared Spectrometer (FTIR)		?	
11.1	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability		N/A	
12	X-ray Fluorescence		N/A	Ground-truthing PIXL
13	Microscopy lab (see note)		N/A	
	Headspace Gas analysis			
23.1	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)			to check the functions of different methods (IRMS, EA, TC/EA, Cavity Ring Down, GC-TC) for stable Isotope facility , go to http://www.uwyo.edu/sif/stable-isotopes/terms-and-definitions.html The Thermo Scientific TC/EA can be connected to any currentThermo Scientific Isotope Ratio MS equipped for continuous flowapplications. If hydrogen isotope ratios are to be analyzed, the IRMSmust be equipped with an energy filter to suppress 4He+ions on theDH collector (Thermo Scientific MAT 253, DELTA V Plus, and DELTA VAdvantage IRMS).
24	Optical laser spectrometer (e.g., Tunable Laser Spectrometer or Cavity Ring Down Spectroscopy)	Yes		Mentioned as cavity ringdown in Time-sensitive report
	Science Investigations & SSAP			
7.2	Variable Pressure-Field Emission Scanning Electron Microscope with electron columns and multiple detectors	None to flat sample for low vacuum mode.	MAX: 0.5 cm thick sub samples to generate thin sections of 30 microns thick	The SEM will need to have ports for additional detectors, possibly including CL, EDS, WDS, FIB, and EBSD, and Focused Ion Beam capability--this is an important sample prep step for other measurements. Gminek et al., 2021 report calls for a Variable Pressure Scanning Electron Microscope with Energy Dispersive X-ray Spectrometer (EDS). Tait et al., 2021 state the need for capability for both Field Emission- and Variable Pressure-SEM, that could potentially be combined in one instrument but also state the benefits of having 2 SEMs
10.2	Fourier Transform-Infrared Spectrometer (FTIR)		?	
11.2	Micro-X-ray diffractometer with total scattering and pair-distribution function (PDF) analysis capability		N/A	
25	Electron Paramagnetic Resonance (EPR) Spectroscopy –		**Just requiring placing the sample in a tube.**	
26	Brunauer-Emmett-Teller (BET) surface area analysis		use of samples less than 1g and as low as 0.1 square meters in the sample cell.	30 samples analysed per hour
24b	Optical laser spectrometer (Sample Analysis at Mars (SAM) instrument)	Yes		Mentioned only in Sterilization-Sensitive report

Summary of Instruments and Sample Prep Needs Proposed for the SRF								
				Required for				
Ref. #	**Required Instrument Functionality**	**Reference instrument**	Function	Curation	Sample Safety Assessment	Time-Sensitive Science	Sterilization-Sensitive Science	**Significant Instrument Comments**
23.2	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	Thermo Scientific TC/EA (which interfaces with any continuous flow IRMS. GC-IRMS: δ13C Analysis of PAHs	characterizes mineral-bound volatile concentrations, speciation, and isotopic compositions (i.e., H2O, SO2, CO2, etc.) Uses combustion and			X	X	MOSDT is keeping #23 as separate from #24b (SAM) under the assumption that it can
15	Ultra-High Performance Liquid Chromatography Liquid Chromatography (UHPLC-MS/MS) with tandem Mass Spectrometry		Characterize macromolecular material of potential biological origin and detect organic molecular biosignatures of extant and past/extinct life		X	X	X	
16	Capillary Electrophoresis–Mass Spectrometry (CE-MS)	7100 CE with 6550 QTOF	Equipment capable of carrying out extraction and sequencing of DNA		X	X	X	
17	DNA Sequencer and associated '-omics' equipment (see note)	Oxford Nanopore, MinION Mk1C	Equipment capable of carrying out extraction and sequencing of DNA		X	X	X	
18	Real-time PCR machine, i.e. a thermal cycler with fluorescence reading capability							
19	Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) or Photon Transfer Reaction-Mass Spectrometry (PTR-MS)	https://www.srainstruments.com/p/sift-ms/ https://www.ionicon.com/series/details/ptr-ms-	real-time quantification of several trace gases (e.g. VOCs) simultaneously in air and breath. PTR-MS is real-time monitoring of volatile organic compounds (VOCs) at low concentrations					
20	Electrospray ionization (ESI)-Mass Spectrometry AND/OR MALDI-ESI-MS		structural study or quantitative measurement of metabolites in a		X	X	X	**#20 and #21 are kept as separate instruments, as described in Time-Sensitive report.**
21	Matrix-assisted laser desorption/ionization time of flight (MALDI-TOF-MS)	Shimadzu MALDI-8020	Detection of extant indigenous life or contaminant life in Martian samples		X	X	X	Optimize and devlop protocole outside of containment on analogue and replica instrument. If sample preparation is effectively sterilizing the sample, we strongly
14	Gas Chromatography (GC) Isotope Ratio Mass Spectrometer with quadrople mass spec and higher temperature conversion elemental analyzer (TC/EA) (see note) []	Thermofisher GC-IRMS instrument; TRACE 1310 GC, a GC Isolink preparation device, a CONFLO IV ref. interface	Characterize macromolecular material of potential biological origin and detect organic molecular biosignatures of extant and past/extinct life		X	X	X	
22	Epifluorescence Microscope							
27	Ion chromatograph	[Dionex ICS-6000 Standard Bore and Microbore HPIC	measure concentration of inorganic anions and organic acids in aqueous			X		
28	Inductively coupled plasma - optical emission spectrometry (ICP-OES)	[Perkin Elmer AVIO 550 Max with cyclonic/concentric sample introduction]	used to measure concentrations of inorganic cations in aqueous solutions acid whole rock digests			X		
	Later Science Instruments							
MOSDT4	Electron Probe Microanalysis (EPMA) a.k.a. Electron Microprobe							These instruments were not researched in depth as they are outside of the scope of MOSDT. They are of significant size, and a specific area under containment can be sized and costed without more input from MOSDT.
MOSDT5	High-Resolution Transmission Electron Microscopy (TEM) (TEM-SAED-EDX)						X	
MOSDT6	Nano-SIMS							
MOSDT7	Mössbauer Spectroscopy							
MOSDT8	Added microbiological capabilities		In case of discovery of extant life					
	Sample Preparation		All instruments below are need for preparation of martian samples					Sample Preparation capabilities described in this section are the equipment needed to process and prepare subsets of samples to make them analyzable by the analytical instruments identified by MSPG2. The sample prep capabilities and instruments have been either recommended by MSPG2, or have been added when needed by MOSDT. The sample prep capabilities listed here can be used without being co-located with the instrument they are targetting. When a specific sample prep needs to be co-located with an instrument (add example here), it has been identified and described with said instrument.
29	Sterilization equipment for samples (see note)		Sterilization equipment for martian samples exclusively. Sterlization equipment for other material (waste, tools, etc) are treated separately.	X	X	X	X	
29.1	Heat chambers (1)							We recommend to have one heat chamber. Adding extra heat chambers for redundancy and timing would not change significantly the size of the rest of the SRF, but could be considered as an add-on. We recommend that all gases produced during sterilization should be captured and analyzed, or directly analysed by #23.1. A trade-off could be using #23.1 TC/EA chamber for heating steps and sterilization.
29.2	Radiation chamber (1)							Due to the size and cost of a shielded 60Co source, we recommend to have one source, with possibly separate chambers irradiated by the same source. Adding extra sources for redundancy and timing would not change significantly the size of the rest of the SRF, but could be considered as an add-on. We recommend that all gases produced during sterilization should be captured and analyzed, or directly analysed by #23.1.
30	Rock sample prep capabilities (see note)			X	X	X	X	Use of a sonic bath between different steps of the sample prep is highly recommended in order to eliminate any material that can be stuck inside cracks or pores. This will lower the risk of contaminations from abraded material and especially from polishing pastes/fluids with diamonds/Al2O3 of different grain sizes (e.g. going from 6 to 3 and 1 µm).
30.SP1	Rock Sample Prep Space #1: cutting							
30.SP1.1	Ultramicrotome	LEICA UC7 ultramicrotome or its upgraded version ARTOS 3D, (MOSDT Addition) with cryo capabilities						The ultramicrotome eeds to be kept separately from wire saw. MOSDT recommends a model slightly different to MSPG2 recommendation.
30.SP1.2	Dry Wire Saw	Wells 3500P wire saw: "Premium model" more adapted to MSRF operations						
7.3	FIB-SEM							
30.SP2	Rock Sample Prep Space #2 Embedding and Mounting							
30.SP2.1	Encapsulating and epoxy embedding							For best results with epoxy embedding would better to use a "pressure pot" rather than a "vacuum chamber" as there would be less bubbles forming during the process. The question is..would it be possible to use a pressure pot within as isolator? This step can be moved across the preparation process as encapsulation can also happen at the beginning of the entire process if the material is poorly consolidated.
30.SP.2.2	Thin Section Mounting							Recommendations on mounting resin for future work: high-purity and low-outgassing product
30.SP3	Rock Sample Prep Space #3 Sample grinding and polishing							
30.SP3.1	Thin Section System (incl. vacuum pump...)		For preparation of thin sections. Off cutting of excess material and grinding to a thickness close to 30 µm.					Finishing with lapping (see 30.SP3.2) is suggested.
30.SP3.2	Grinding/lapping Samples:	Struers LaboSystem LaboPol-20 (smallest) with Laboforce 50 (to hold samples) . TegraPol (can be operated remotely when in isolator)	polish samples					Use of a sonic bath between different steps of the sample prep is highly recommended in order to eliminate any material that can be stuck inside cracks or pores. This will allow lower the chance of contaminations from abraded material and especially from lapping with fixed abrasive papers of different grit size.
30.SP3.3	Polishing Samples:	Struers LaboSystem LaboPol-20 (smallest) with Laboforce 50 (to hold samples) . TegraPol (can be operated remotely when in isolator)	polish samples					Use of a sonic bath between different steps of the sample prep is highly recommended in order to eliminate any material that can be stuck inside cracks or pores. This will allow lower the chance of contaminations from abraded material and especially from polishing pastes/fluids with diamonds/Al2O3 of different grain sizes (e.g. going from 6 to 3 and 1 µm). Better located in a separate environment from [engine/grinding to avoid
30.SP4	Rock Sample Prep Space #4: Sputtering							

Summary of Instruments and Sample Prep Needs Proposed for the SRF											
		Quick glance							Engineering Details		
Ref. #	**Required Instrument Functionality**	Size (handheld OR tabletop OR self-standing)	Is it possible to interface with isolator/DWI?	Org. cont. sensitive (Y/N)	Sample Preparation (Y/N)	Isolator Manual Manipulation via gloves (Y/N)	Isolator Robotics/ RMS handling (Y/N)		Vibration Sensitive (Y/N)	Power Requirements (V/A)	**Size**
23.2	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	Tabletop or Stand-alone	Instrument Box Interface (tbc)	N	Y	N/A	N/A			230 V, single phase, 8 A.	45 x 70 x 50 cm (W x D x H
15	Ultra-High Performance Liquid Chromatography Liquid Chromatography (UHPLC-MS/MS) with tandem Mass Spectrometry	self-standing	Instument Box Interface (tbc)	Y	Y	N/A	N/A			UHPLC-FD: five 120V outlets ; UHRMS-MS: one	**UHPLC-FD:** (L x W x H) = 75 cm x 54 cm x 62 cm,
16	Capillary Electrophoresis–Mass Spectrometry (CE-MS)	tabletop	inside isolator/Instument Box			N/A	N/A				38 kg. W 35 cm, H 61 cm,
17	DNA Sequencer and associated '-omics' equipment (see note)	handheld	inside isolator/Instument Box	Y	Y	N/A	N/A				11 kg; W 37 cm, H 22 cm,
18	Real-time PCR machine, i.e. a thermal cycler with fluorescence reading capability	tabletop	inside isolator/Instument Box								
19	Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) or Photon Transfer Reaction-Mass Spectrometry (PTR-MS)	self-standing	Instument Box Interface (tbc)								
20	Electrospray ionization (ESI)-Mass Spectrometry AND/OR MALDI-ESI-MS	Tabletop or integrated into MALDI	inside isolator or Instrument Box	Y	Y	N/A	N/A				
21	Matrix-assisted laser desorption/ionization time of flight (MALDI-TOF-MS)	stand alone.	Instrument Box Interface (tbc)	Y	Y	N/A	N/A				9.7 x 28.0 x 42.2" Weight: 75 kg / 165.4 lb net
14	Gas Chromatography (GC) Isotope Ratio Mass Spectrometer with quadrople mass spec and higher temperature conversion elemental analyzer (TC/EA) (see note) []	**tabletop or self-supported (depending on configuration)**	Instrument Box Interface (tbc)	Y	Y	N/A	N/A		None	230V Power Supply (Electronics boards - 55 nd	**GC-QMS:** (H x W x D) = 44 cm x 94 cm x 68 cm, 100
22	Epifluorescence Microscope	Tabletop	on isolator or inside isolator								
27	Ion chromatograph	tabletop	Instrument Box Interface (tbc)	Y	Y	N/A	N/A				(41Wx23Dx56H cm chart)
28	Inductively coupled plasma - optical emission spectrometry (ICP-OES)	tabletop	Instrument Box Interface (tbc)	N	Y	N/A	N/A			2800w; 2000w chiller;	76Wx84Dx87H cm
	Later Science Instruments										
MOSDT4	Electron Probe Microanalysis (EPMA) a.k.a. Electron Microprobe	large stand alone	NC								
MOSDT5	High-Resolution Transmission Electron Microscopy (TEM) (TEM-SAED-EDX)	large stand alone	NC								
MOSDT6	Nano-SIMS	large stand alone	NC								
MOSDT7	Mössbauer Spectroscopy	handheld or small tabletop	NC (on isolator)								
MOSDT8	Added microbiological capabilities										
	Sample Preparation										
29	Sterilization equipment for samples (see note)			Y	Y						
29.1	Heat chambers (1)	standalone	NC								
29.2	Radiation chamber (1)	standalone	NC								
30	Rock sample prep capabilities (see note)			Y	Y				Y		
30.SP1	Rock Sample Prep Space #1: cutting										
30.SP1.1	Ultramicrotome	**tabletop**	**in isolator**		**Y**	**Y**	**Y?**		**Y, equiped with internal**	**100-240 V**	
30.SP1.2	Dry Wire Saw	**tabletop**	**in isolator**								**W x L x H: 410 mm x 345 mm x 460 mm,**
7.3	FIB-SEM										
30.SP2	Rock Sample Prep Space #2 Embedding and Mounting										
30.SP2.1	Encapsulating and epoxy embedding										
30.SP.2.2	Thin Section Mounting										
30.SP3	Rock Sample Prep Space #3 Sample grinding and polishing										
30.SP3.1	Thin Section System (incl. vacuum pump...)	tabletop	in isolator								
30.SP3.2	Grinding/lapping Samples:	In isolator (BUT ...may be quite messy)									40 x 67 x 22 (58 Laboforce)
30.SP3.3	Polishing Samples:	In isolator (BUT ...may be quite messy)									40 x 67 x 22 (58 Laboforce)
30.SP4	Rock Sample Prep Space #4: Sputtering										

Summary of Instruments and Sample Prep Needs Proposed for the SRF							
						Analysis requirements	
Ref. #	**Required Instrument Functionality**	Mass (kg)	Specialized Gas Requirements	Cooling Needs	Special infrastructure req	Analysis under inert gas	Special Lighting Needs
23.2	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	l), 59 kg.	High purity helium (99.999% or				
15	Ultra-High Performance Liquid Chromatography Liquid Chromatography (UHPLC-MS/MS) with tandem Mass Spectrometry		ultrahigh purity compressed N2, mass				None
16	Capillary Electrophoresis–Mass Spectrometry (CE-MS)						
17	DNA Sequencer and associated '-omics' equipment (see note)	11kg (depends on which	None	None	None		None
18	Real-time PCR machine, i.e. a thermal cycler with fluorescence reading capability						
19	Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) or Photon Transfer Reaction-Mass Spectrometry (PTR-MS)						
20	Electrospray ionization (ESI)-Mass Spectrometry AND/OR MALDI-ESI-MS						
21	Matrix-assisted laser desorption/ionization time of flight (MALDI-TOF-MS)		None	None	None		None
14	Gas Chromatography (GC) Isotope Ratio Mass Spectrometer with quadrople mass spec and higher temperature conversion elemental analyzer (TC/EA) (see note) []	See column O	High purity He, O2, CO2, N2 (specifics in	liquid N2 tank for oven cooling			None
22	Epifluorescence Microscope						
27	Ion chromatograph	(20.4kg per slide) ~			deionized water		none
28	Inductively coupled plasma - optical emission spectrometry (ICP-OES)	163kg; 81kg chiller; 80kg	Argon, 80-120 psig 1-	Chiller needed	vent with damper to		none
	Later Science Instruments						
MOSDT4	Electron Probe Microanalysis (EPMA) a.k.a. Electron Microprobe						
MOSDT5	High-Resolution Transmission Electron Microscopy (TEM) (TEM-SAED-EDX)						
MOSDT6	Nano-SIMS						
MOSDT7	Mössbauer Spectroscopy						
MOSDT8	Added microbiological capabilities						
	Sample Preparation						
29	Sterilization equipment for samples (see note)						
29.1	Heat chambers (1)						
29.2	Radiation chamber (1)						
30	Rock sample prep capabilities (see note)						
30.SP1	Rock Sample Prep Space #1: cutting						
30.SP1.1	Ultramicrotome					y	
30.SP1.2	Dry Wire Saw	**13.8 kg**					
7.3	FIB-SEM						
30.SP2	Rock Sample Prep Space #2 Embedding and Mounting						
30.SP2.1	Encapsulating and epoxy embedding						
30.SP.2.2	Thin Section Mounting						
30.SP3	Rock Sample Prep Space #3 Sample grinding and polishing						
30.SP3.1	Thin Section System (incl. vacuum pump...)						
30.SP3.2	Grinding/lapping Samples:	22kg (36, 5 kg laboforce)			interface with water , "air" supply.		
30.SP3.3	Polishing Samples:	22kg (36, 5 kg laboforce)			interface with water , "air" supply.		
30.SP4	Rock Sample Prep Space #4: Sputtering						

Summary of Instruments and Sample Prep Needs Proposed for the SRF					
		Sample prep			
Ref. #	**Required Instrument Functionality**	Detailed Sample Preparation Requirments	Sample Prep in sample prep area (separate): is the sample to be analyzed prepared in a general sample pre area? Y: sample must be prepared following a certain protocol using capabilities and isntruments identified in the Sample Prep section, and it doesn't need to be linked to the instrument, but can be trasnported to the instrument. N: sample preparation must occur in co-location with the targetted analytical instrument N/A: no sample prep required	Level of pristinity before prep or analysis	Level of pristinity after prep or analysis (Pristine, Psub,Rest, Terminal
23.2	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)	Destructive sample preparation : Pyrolysis of solid (powders) and liquid samples to characterize volatiles hosted in mineral phases. Getting a representative sample of larger samples usually requires grinding and homogenizing. Soils should be ground	Y		Terminal
15	Ultra-High Performance Liquid Chromatography Liquid Chromatography (UHPLC-MS/MS) with tandem Mass Spectrometry	Unprepared samples or Powders and Solvents (in same instrument, with different input) (acid-hydrolyzed to inactivate any biopolymers for analysis of free amino acid molecules)	Y		Terminal
16	Capillary Electrophoresis–Mass Spectrometry (CE-MS)		**Y**		Terminal
17	DNA Sequencer and associated '-omics' equipment (see note)		**Y**		Terminal
18	Real-time PCR machine, i.e. a thermal cycler with fluorescence reading capability	relies on chemical ionization of the trace gas molecules in air/breath samples introduced into helium carrier gas using H_3O^+, NO^+, and O	**Y**		Terminal
19	Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) or Photon Transfer Reaction-Mass Spectrometry (PTR-MS)	SIFT-MS and PTR-MD: Real-time, quantitative analysis is achieved by applying precisely controlled soft chemical ionization and eliminating sample preparation, pre-concentration and chromatography.			Terminal
20	Electrospray ionization (ESI)-Mass Spectrometry AND/OR MALDI-ESI-MS	Acetonitrile-methanol-water (1:1:1) with 0.1% formic acid and 0.01 M 18-crown-6. Multistep sample preparation, very sensitive			Terminal
21	Matrix-assisted laser desorption/ionization time of flight (MALDI-TOF-MS)	Acetonitrile-methanol-water (1:1:1) with 0.1% formic acid and 0.01 M 18-crown-6. Multistep sample preparation, very sensitive to contamination (interferes with crystallization and ionization), need pure water, inert gas to dry plates. Choice of matrices and			Terminal
14	Gas Chromatography (GC) Isotope Ratio Mass Spectrometer with quadrople mass spec and higher temperature conversion elemental analyzer (TC/EA) (see note) []	Powders and Solvents (acid-hydrolyzed to inactivate any biopolymers for analysis of free amino acid molecules)			Terminal
22	Epifluorescence Microscope				
27	Ion chromatograph	Sample type – aqueous solutions	Yes		Terminal
28	Inductively coupled plasma - optical emission spectrometry (ICP-OES)	aqueous solutions or in whole rock digests (acid digestion or fusion). Acid digestion: dissolution of a sample in a hot acid, or a	Yes		Terminal
	Later Science Instruments				
MOSDT4	Electron Probe Microanalysis (EPMA) a.k.a. Electron Microprobe				
MOSDT5	High-Resolution Transmission Electron Microscopy (TEM) (TEM-SAED-EDX)				
MOSDT6	Nano-SIMS				
MOSDT7	Mössbauer Spectroscopy	special radiation shielding accomodation for glove box might be needed			
MOSDT8	Added microbiological capabilities				
	Sample Preparation				
29	Sterilization equipment for samples (see note)				
29.1	Heat chambers (1)				n/a
29.2	Radiation chamber (1)				n/a
30	Rock sample prep capabilities (see note)				
30.SP1	Rock Sample Prep Space #1: cutting				
30.SP1.1	Ultramicrotome	If sample is not hard enough, need embedding in epoxy			Rest
30.SP1.2	Dry Wire Saw				Psub
7.3	FIB-SEM				Rest
30.SP2	Rock Sample Prep Space #2 Embedding and Mounting				
30.SP2.1	Encapsulating and epoxy embedding				Rest
30.SP.2.2	Thin Section Mounting				Rest
30.SP3	Rock Sample Prep Space #3 Sample grinding and polishing				
30.SP3.1	Thin Section System (incl. vacuum pump...)				Rest
30.SP3.2	Grinding/lapping Samples:	Need Water, or liquid on lapping paper. Despite the antisplash system, it could be quite a dirty operation.			Rest
30.SP3.3	Polishing Samples:	Need Water, or liquid on polishing plates. Despite the antisplash system, it could be quite a dirty operation.			Rest
30.SP4	Rock Sample Prep Space #4: Sputtering				

Summary of Instruments and Sample Prep Needs Proposed for the SRF				
				Notes
Ref. #	**Required Instrument Functionality**	Sample Prep under inert gas	Sub Sample mass/volume needed in sample prep	
23.2	High Temperature Conversion Elemental Analyzer (TC/EA) with Gas Chromatograph Isotope Ratio Mass Spectrometer (IRMS) (see note)		To measure the isotopic ratio of water samples 0.5-1 µl of liquid is needed. For	must be kept in containment for time-sensitive measurement of non-igneous rocks
15	Ultra-High Performance Liquid Chromatography Liquid Chromatography (UHPLC-MS/MS) with tandem Mass Spectrometry	Powders can be measured in DWI to preserve pristinity. Should not be an	https://www.nature.com/articles/srep061	*As a note, ultrahigh-performance liquid chromatography tandem mass spectrometry with electrospray ionization (UHPLC-ESI-MS/MS) is available. https://pubs.acs.org/doi/10.1021/acs.analchem.8b05884*
16	Capillary Electrophoresis–Mass Spectrometry (CE-MS)	Should not be an issue, but additional		
17	DNA Sequencer and associated '-omics' equipment (see note)	Should not be an issue, but additional		small footprint
18	Real-time PCR machine, i.e. a thermal cycler with fluorescence reading capability	Should not be an issue, but additional		
19	Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) or Photon Transfer Reaction-Mass Spectrometry (PTR-MS)	No sample preparation: The gaseous sample is directly analyzed		BENEFITS OF SIFT-MS INCLUDE: Instantaneous, quantitative analysis of air and headspace with very high sensitivity and selectivity. Simultaneous analysis of chemically diverse VOCs (e.g. aldehydes, amines and
20	Electrospray ionization (ESI)-Mass Spectrometry AND/OR MALDI-ESI-MS			The ESI-MS can be stand alone or integrated into a MALDI (MALDI-ESI-MS). However, I am not sure if a MALDI-
21	Matrix-assisted laser desorption/ionization time of flight (MALDI-TOF-MS)			Sample prep requires complex sample loading onto micro-chip. Accurate and precise micorpipetting. If in high containment, may require specialized robotics, or micro manipulation tools *MALDI MS: Are*
14	Gas Chromatography (GC) Isotope Ratio Mass Spectrometer with quadrople mass spec and higher temperature conversion elemental analyzer (TC/EA) (see note) []	Powders can be measured in DWI to preserve pristinity. Should not be an		
22	Epifluorescence Microscope			
27	Ion chromatograph			
28	Inductively coupled plasma - optical emission spectrometry (ICP-OES)			
	Later Science Instruments			
MOSDT4	Electron Probe Microanalysis (EPMA) a.k.a. Electron Microprobe			
MOSDT5	High-Resolution Transmission Electron Microscopy (TEM) (TEM-SAED-EDX)			
MOSDT6	Nano-SIMS			
MOSDT7	Mössbauer Spectroscopy			
MOSDT8	Added microbiological capabilities			
	Sample Preparation			
29	Sterilization equipment for samples (see note)			
29.1	Heat chambers (1)			Necessity for reduncancy should be considered later
29.2	Radiation chamber (1)			Necessity for reduncancy should be considered later
30	Rock sample prep capabilities (see note)			
30.SP1	Rock Sample Prep Space #1: cutting			
30.SP1.1	Ultramicrotome			Equiped with FC7 cryo flow chamber (low temp GN2) and CRION (for electrostatic discharge and charge mode)
30.SP1.2	Dry Wire Saw			The WELL 3500 "Premium" wire saw is identical to the 3500 "Base" saw, but accepts a series of additional accessories. Thanks to these, visualisation of the cutting point is significantly improved because the sample is
7.3	FIB-SEM			
30.SP2	Rock Sample Prep Space #2 Embedding and Mounting			
30.SP2.1	Encapsulating and epoxy embedding			1) Encapsulation/embedding system: https://globalsource.ro/en/sample-preparation/Metallography/accessories-for-mounting-resins/Technomat%20-Pressure-Pot 2) For consolidation of loose highly porous rock there is the need for consolidation before mounting as thin section
30.SP.2.2	Thin Section Mounting			For mounting rock samples on glass slide: need of mounting fixture for creation of a zero-bonding layer of resin and elimination of eventual trapped bubbles (e.g. https://www.kemet-international.com/sg/products/metallography/geofix-mounting-fixture), mounting resin and eventually UV light for resing curing.
30.SP3	Rock Sample Prep Space #3 Sample grinding and polishing			
30.SP3.1	Thin Section System (incl. vacuum pump...)			Automated thin section machine (need link to the model suggested by Mike), need of a vacuum pump. If material is particularly hard, due to vibrations, the glass slide will break.
30.SP3.2	Grinding/lapping Samples:			Mainly used for embedded samples/grain mounts/finish stage of very delicate thin sections.
30.SP3.3	Polishing Samples:			
30.SP4	Rock Sample Prep Space #4: Sputtering			

Summary of Instruments and Sample Prep Needs Proposed for the SRF								
				Required for				
Ref. #	**Required Instrument Functionality**	**Reference instrument**	Function	Curation	Sample Safety Assessment	Time-Sensitive Science	Sterilization-Sensitive Science	**Significant Instrument Comments**
30.SP4	SPI Module Sputter Coater with pump or **Q150 GB Turbo-Pumped Sputter Coater / Carbon Coater for Glove Box**	https://www.quorumtech.com/q150t-plus-turbomolecular-pumped-coater-duplicate-1/	Thin film applications Super fine carbon coating for higher quality imaging using carbon rods and carbon cord	X		X	X	
31	Basic wet chemistry sample prep capabilities (see note)		Extraction and dissolution of samples for geochemistry analytical needs. This does not include microbiolgoical capabilities (see #32). Depending on the elements to be analyzed, and on the type of contamination ot avoid, there might be a need to have several labs		X	X	X	Need UPW
31.1	Vortex							
31.2	Sonicator							
31.3	Samples digestion with hot acid							
32	Microbiological laboratory capabilities (see note)		Biological sample prep and manipulation/storage of samples		X	X	X	
32.1	heated and cooled incubators							
32.2	freezers (-20, -80C)							
32.3	refrigerator							
32.4	analytical balance							
33	Gas extraction and handling capabilities (see note)			X		X	X	
MOSDT9	Vacuum chamber with T control for BET analyses sample prep							
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor cleanrooms and isolators		Monitoring the health of the cleanrooms and isolators					MOSDT is providing this list as a placeholder for standard real-time monitoring of cleanrooms and isolators. The capabilities should be planned and integrated when feasible into the infrastructure itself.
CR1	Cleanroom Air Particle Counters							
CR2	Cleanroom Differential Pressure (Room-to-Room)							
CR3	Cleanroom Oxygen Monitors							
CR4	Cleanroom Radiation Monitors							
CR5	Cleanroom CO2 Monitors							
CR6	Cleanroom Temp. and RH%							
CR7	Isolator Air Particle Counters							
CR8	Isolator Differential Pressure							
CR9	Isolator O2 & H2O Monitors in ppm or ppt							
CR10	Isolator Temp. and RH%							
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates contamination in cleanrooms and isolators		Perform regular (daily) monitoring assessment of contamination within the laboratory/clean rooms.					MOSDT recommends the following list for monitoring of spaces under BSL4 equivalent level in contact with the Martian samples. Witness plates, swabs and any other contamination monitoring plates should be measured under biocontainment, as any step of sterilization will not keep the CCK samples pristine
CCK1	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination							
CCK2	FEG-SEM/EDX for Micro Particulate Identification (JEOL 7600)+C94:C111							
CCK3	XPS for Gross Surface/Thin-films/Oxidation (Thermo K-alpha)							
CCK4	LA-HR-ICP-MS for Gross Surface Inorganics (Agilent)							
CCK5	VPD-HR-ICP-MS for Molecular Airborne Inorganics (Agilent)							
CCK6	TD-GC-MS with GL Sciences SWA-256 wafer analyzer for Molecular Airborne Organics/Outgassing							
CCK7	DART-qTOF-MS for Gross Surface Organics (JEOL)							
CCK8	LC-MS for Amino Acids							
CCK9	AFM (Atomic Force Microcopy) for Surface Roughness/Thin-Films/Cleaning Changes							
CCK10	IC (Anions and Cations)							
CCK11	Particle Deposition Monitor (PDM)	https://particle-deposition.com/products/	To monitor heavy sedimented particles in clean room					
CCK12	Optical Particle Counter (OPC)		Standard for monitoring the airborne particle concentration, also small permanently installed systems are available for cleanroom. These are necessary to monitor the ISO Class according to ISO 14644-1.					
CCK14	Automated Thermal desorption -GC-MS							
CCK15	FTIR							
CCK17	PTR-MS							
CCK18	Photo Ionization Detector Gas Detector		A Photoionization Detector (*PID*) is a *gas detector* used to measures volatile organic compounds (VOCs), such as benzene, and other gases.					
CCK19	Online Bacterial Counter							
CCK20	Incubator	**Standard lab equipement**	to grow microorganisms responsible for biological contamination					
CCK21	DNA Analyzer							
CCK23	Acids/Bases/Tox Cabinet		Preparation of reagents in safe conditions					
CCK24	High Temp. Emission Chamber	http://www.labtesting-equipment.com/quality-9896637-high-temperature-test-chamber-chamber-for-testing-voc-and-formaldehyde-emission	for testing VOC and Formaldehyde Emission. Particularly relevant in BSL 4 with presurized suits					
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates in the UPW system real-time							We expect UPW to be used in and out of containment. We recommend that the main production unit to be kept outside of containment, and to setup a loop with a sterilization point after the point of use. We recommend this specific list for real-time monitoring to be kept and used outside of containment. Specific CCK measurements at the point of use of UPW can be done using the CCK instruments below. MOSDT recommends this strawman list for monitoring UPW, for TOC, organic, inorganic and microrganisms
UPW1	Liquid Particle Counter for gross particulates > 1 micron (HIAC 8011+)							
UPW2	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination							
UPW3	TOC Counter (bench top) for Total Organic Carbon > 0.05 ppb (GE M9 TOC)							
UPW4	Flow Cytometry: Cell particle count/biomarker (Orflo zEPI Flow)							

Summary of Instruments and Sample Prep Needs Proposed for the SRF											
		Quick glance							Engineering Details		
Ref. #	**Required Instrument Functionality**	Size (handheld OR tabletop OR self-standing)	Is it possible to interface with isolator/DWI?	Org. cont. sensitive (Y/N)	Sample Preparation (Y/N)	Isolator Manual Manipulation via gloves (Y/N)	Isolator Robotics/ RMS handling (Y/N)		Vibration Sensitive (Y/N)	Power Requirements (V/A)	**Size**
30.SP4	SPI Module Sputter Coater with pump or **Q150 GB Turbo-Pumped Sputter Coater / Carbon Coater for Glove Box**	In isolator			Y	Y	Y				267mm W x 490mm D x 494mm H, (total height with
31	Basic wet chemistry sample prep capabilities (see note)			Y	Y						
31.1	Vortex										
31.2	Sonicator										
31.3	Samples digestion with hot acid										
32	Microbiological laboratory capabilities (see note)			Y	Y						
32.1	heated and cooled incubators										
32.2	freezers (-20, -80C)										
32.3	refrigerator										
32.4	analytical balance										
33	Gas extraction and handling capabilities (see note)			N	N						
MOSDT9	Vacuum chamber with T control for BET analyses sample prep										
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor cleanrooms and isolators										
CR1	Cleanroom Air Particle Counters										
CR2	Cleanroom Differential Pressure (Room-to-Room)										
CR3	Cleanroom Oxygen Monitors										
CR4	Cleanroom Radiation Monitors										
CR5	Cleanroom CO2 Monitors										
CR6	Cleanroom Temp. and RH%										
CR7	Isolator Air Particle Counters										
CR8	Isolator Differential Pressure										
CR9	Isolator O2 & H2O Monitors in ppm or ppt										
CR10	Isolator Temp. and RH%										
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates contamination in cleanrooms and isolators										
CCK1	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination										
CCK2	FEG-SEM/EDX for Micro Particulate Identification (JEOL 7600)+C94:C111										
CCK3	XPS for Gross Surface/Thin-films/Oxidation (Thermo K-alpha)										
CCK4	LA-HR-ICP-MS for Gross Surface Inorganics (Agilent)										
CCK5	VPD-HR-ICP-MS for Molecular Airborne Inorganics (Agilent)										
CCK6	TD-GC-MS with GL Sciences SWA-256 wafer analyzer for Molecular Airborne Organics/Outgassing										
CCK7	DART-qTOF-MS for Gross Surface Organics (JEOL)										
CCK8	LC-MS for Amino Acids										
CCK9	AFM (Atomic Force Microcopy) for Surface Roughness/Thin-Films/Cleaning Changes										
CCK10	IC (Anions and Cations)										
CCK11	Particle Deposition Monitor (PDM)										
CCK12	Optical Particle Counter (OPC)										
CCK14	Automated Thermal desorption -GC-MS										
CCK15	FTIR										
CCK17	PTR-MS										
CCK18	Photo Ionization Detector Gas Detector										
CCK19	Online Bacterial Counter										
CCK20	Incubator										
CCK21	DNA Analyzer										
CCK23	Acids/Bases/Tox Cabinet										
CCK24	High Temp. Emission Chamber	Self standing	N/A								**from 90*136*154 to maximum 150*186*267.**
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates in the UPW system real-time										
UPW1	Liquid Particle Counter for gross particulates > 1 micron (HIAC 8011+)										
UPW2	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination										
UPW3	TOC Counter (bench top) for Total Organic Carbon > 0.05 ppb (GE M9 TOC)										
UPW4	Flow Cytometry: Cell particle count/biomarker (Orflo zEPI Flow)										

Summary of Instruments and Sample Prep Needs Proposed for the SRF							
						Analysis requirements	
Ref. #	**Required Instrument Functionality**	Mass (kg)	Specialized Gas Requirements	Cooling Needs	Special infrastructure req	Analysis under inert gas	Special Lighting Needs
30.SP4	SPI Module Sputter Coater with pump or **Q150 GB Turbo-Pumped Sputter Coater / Carbon Coater for Glove Box**	40 kg					
31	Basic wet chemistry sample prep capabilities (see note)						
31.1	Vortex						
31.2	Sonicator						
31.3	Samples digestion with hot acid						
32	Microbiological laboratory capabilities (see note)						
32.1	heated and cooled incubators						
32.2	freezers (-20, -80C)						
32.3	refrigerator						
32.4	analytical balance						
33	Gas extraction and handling capabilities (see note)						
MOSDT9	Vacuum chamber with T control for BET analyses sample prep						
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor cleanrooms and isolators						
CR1	Cleanroom Air Particle Counters						
CR2	Cleanroom Differential Pressure (Room-to-Room)						
CR3	Cleanroom Oxygen Monitors						
CR4	Cleanroom Radiation Monitors						
CR5	Cleanroom CO2 Monitors						
CR6	Cleanroom Temp. and RH%						
CR7	Isolator Air Particle Counters						
CR8	Isolator Differential Pressure						
CR9	Isolator O2 & H2O Monitors in ppm or ppt						
CR10	Isolator Temp. and RH%						
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates contamination in cleanrooms and isolators						
CCK1	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination						
CCK2	FEG-SEM/EDX for Micro Particulate Identification (JEOL 7600)+C94:C111						
CCK3	XPS for Gross Surface/Thin-films/Oxidation (Thermo K-alpha)						
CCK4	LA-HR-ICP-MS for Gross Surface Inorganics (Agilent)						
CCK5	VPD-HR-ICP-MS for Molecular Airborne Inorganics (Agilent)						
CCK6	TD-GC-MS with GL Sciences SWA-256 wafer analyzer for Molecular Airborne Organics/Outgassing						
CCK7	DART-qTOF-MS for Gross Surface Organics (JEOL)						
CCK8	LC-MS for Amino Acids						
CCK9	AFM (Atomic Force Microcopy) for Surface Roughness/Thin-Films/Cleaning Changes						
CCK10	IC (Anions and Cations)						
CCK11	Particle Deposition Monitor (PDM)						
CCK12	Optical Particle Counter (OPC)						
CCK14	Automated Thermal desorption -GC-MS						
CCK15	FTIR						
CCK17	PTR-MS						
CCK18	Photo Ionization Detector Gas Detector						
CCK19	Online Bacterial Counter						
CCK20	Incubator						
CCK21	DNA Analyzer						
CCK23	Acids/Bases/Tox Cabinet						
CCK24	High Temp. Emission Chamber	100*161*210					
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates in the UPW system real-time						
UPW1	Liquid Particle Counter for gross particulates > 1 micron (HIAC 8011+)						
UPW2	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination						
UPW3	TOC Counter (bench top) for Total Organic Carbon > 0.05 ppb (GE M9 TOC)						
UPW4	Flow Cytometry: Cell particle count/biomarker (Orflo zEPI Flow)						

Summary of Instruments and Sample Prep Needs Proposed for the SRF					
		Sample prep			
Ref. #	**Required Instrument Functionality**	Detailed Sample Preparation Requirments	Sample Prep in sample prep area (separate): is the sample to be analyzed prepared in a general sample pre area? Y: sample must be prepared following a certain protocol using capabilities and isntruments identified in the Sample Prep section, and it doesn't need to be linked to the instrument, but can be trasnported to the instrument. N: sample preparation must occur in co-location with the targetted analytical instrument N/A: no sample prep required	Level of pristinity before prep or analysis	Level of pristinity after prep or analysis (Pristine, Psub,Rest, Terminal
30.SP4	SPI Module Sputter Coater with pump or **Q150 GB Turbo-Pumped Sputter Coater / Carbon Coater for Glove Box**				Rest
31	Basic wet chemistry sample prep capabilities (see note)				
31.1	Vortex				
31.2	Sonicator				
31.3	Samples digestion with hot acid				
32	Microbiological laboratory capabilities (see note)				
32.1	heated and cooled incubators				
32.2	freezers (-20, -80C)				
32.3	refrigerator				
32.4	analytical balance				
33	Gas extraction and handling capabilities (see note)				
MOSDT9	Vacuum chamber with T control for BET analyses sample prep				
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor cleanrooms and isolators				
CR1	Cleanroom Air Particle Counters				
CR2	Cleanroom Differential Pressure (Room-to-Room)				
CR3	Cleanroom Oxygen Monitors				
CR4	Cleanroom Radiation Monitors				
CR5	Cleanroom CO2 Monitors				
CR6	Cleanroom Temp. and RH%				
CR7	Isolator Air Particle Counters				
CR8	Isolator Differential Pressure				
CR9	Isolator O2 & H2O Monitors in ppm or ppt				
CR10	Isolator Temp. and RH%				
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates contamination in cleanrooms and isolators				
CCK1	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination				
CCK2	FEG-SEM/EDX for Micro Particulate Identification (JEOL 7600)+C94:C111				
CCK3	XPS for Gross Surface/Thin-films/Oxidation (Thermo K-alpha)				
CCK4	LA-HR-ICP-MS for Gross Surface Inorganics (Agilent)				
CCK5	VPD-HR-ICP-MS for Molecular Airborne Inorganics (Agilent)				
CCK6	TD-GC-MS with GL Sciences SWA-256 wafer analyzer for Molecular Airborne Organics/Outgassing				
CCK7	DART-qTOF-MS for Gross Surface Organics (JEOL)				
CCK8	LC-MS for Amino Acids				
CCK9	AFM (Atomic Force Microcopy) for Surface Roughness/Thin-Films/Cleaning Changes				
CCK10	IC (Anions and Cations)				
CCK11	Particle Deposition Monitor (PDM)				
CCK12	Optical Particle Counter (OPC)				
CCK14	Automated Thermal desorption -GC-MS				
CCK15	FTIR				
CCK17	PTR-MS				
CCK18	Photo Ionization Detector Gas Detector				
CCK19	Online Bacterial Counter				
CCK20	Incubator				
CCK21	DNA Analyzer				
CCK23	Acids/Bases/Tox Cabinet				
CCK24	High Temp. Emission Chamber				
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates in the UPW system real-time				
UPW1	Liquid Particle Counter for gross particulates > 1 micron (HIAC 8011+)				
UPW2	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination				
UPW3	TOC Counter (bench top) for Total Organic Carbon > 0.05 ppb (GE M9 TOC)				
UPW4	Flow Cytometry: Cell particle count/biomarker (Orflo zEPI Flow)				

Summary of Instruments and Sample Prep Needs Proposed for the SRF				
				Notes
Ref. #	Required Instrument Functionality	Sample Prep under inert gas	Sub Sample mass/volume needed in sample prep	
30.SP4	SPI Module Sputter Coater with pump or **Q150 GB Turbo-Pumped Sputter Coater / Carbon Coater for Glove Box**			The Q150 GB turbo pumped sputter coater is dedicated to work in glove box Key features
31	Basic wet chemistry sample prep capabilities (see note)			
31.1	Vortex			
31.2	Sonicator			
31.3	Samples digestion with hot acid			
32	Microbiological laboratory capabilities (see note)			
32.1	heated and cooled incubators			
32.2	freezers (-20, -80C)			
32.3	refrigerator			
32.4	analytical balance			
33	Gas extraction and handling capabilities (see note)			
MOSDT9	Vacuum chamber with T control for BET analyses sample prep			
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor cleanrooms and isolators			
CR1	Cleanroom Air Particle Counters			
CR2	Cleanroom Differential Pressure (Room-to-Room)			
CR3	Cleanroom Oxygen Monitors			
CR4	Cleanroom Radiation Monitors			
CR5	Cleanroom CO2 Monitors			
CR6	Cleanroom Temp. and RH%			
CR7	Isolator Air Particle Counters			
CR8	Isolator Differential Pressure			
CR9	Isolator O2 & H2O Monitors in ppm or ppt			
CR10	Isolator Temp. and RH%			
ANCILLARY LABORATORIES IN HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates contamination in cleanrooms and isolators			Assumption on BSL4 level for overall facility: what part of the lab (or of the isolators) will be hot? What to do with the CCK samples from the hot area? Can we sterilize some of the CCK samples to get out of containment for measurement?
CCK1	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination			
CCK2	FEG-SEM/EDX for Micro Particulate Identification (JEOL 7600)+C94:C111			
CCK3	XPS for Gross Surface/Thin-films/Oxidation (Thermo K-alpha)			
CCK4	LA-HR-ICP-MS for Gross Surface Inorganics (Agilent)			
CCK5	VPD-HR-ICP-MS for Molecular Airborne Inorganics (Agilent)			
CCK6	TD-GC-MS with GL Sciences SWA-256 wafer analyzer for Molecular Airborne Organics/Outgassing			
CCK7	DART-qTOF-MS for Gross Surface Organics (JEOL)			
CCK8	LC-MS for Amino Acids			
CCK9	AFM (Atomic Force Microcopy) for Surface Roughness/Thin-Films/Cleaning Changes			
CCK10	IC (Anions and Cations)			
CCK11	Particle Deposition Monitor (PDM)			it's an "advanced" Particle Fall Out Meter (PFO): A PFO can only measure a particle area coverage/obscuration; the PDM can also measure particle size and number as well as time resolved analysis.Meanwhile, there are also other systems available we would consider for sedimented particle monitoring systems, e.g. ASML is currently using a system from FastMicro https://fast-micro.com/
CCK12	Optical Particle Counter (OPC)			Larger particles are more subject to gravity, so they cannot be controlled by the flow and therefore sediment faster. In this respect, airborne particles and their measurement methods must always be seen as complementary to the methods for measuring sedimented particles (like PDM). And you have to consider also that the processes, material, personnel etc. inside a clean environment could significantly contribute to (particle) contamination:
CCK14	Automated Thermal desorption -GC-MS			
CCK15	FTIR			
CCK17	PTR-MS			
CCK18	Photo Ionization Detector Gas Detector			
CCK19	Online Bacterial Counter			
CCK20	Incubator			
CCK21	DNA Analyzer			
CCK23	Acids/Bases/Tox Cabinet			
CCK24	High Temp. Emission Chamber			
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to monitor organic, inorganic, biological, and particulates in the UPW system real-time			
UPW1	Liquid Particle Counter for gross particulates > 1 micron (HIAC 8011+)			
UPW2	Optical Stereomicroscopy/Microscopy for Macro Particulate/Other Contamination			
UPW3	TOC Counter (bench top) for Total Organic Carbon > 0.05 ppb (GE M9 TOC)			
UPW4	Flow Cytometry: Cell particle count/biomarker (Orflo zEPI Flow)			

Summary of Instruments and Sample Prep Needs Proposed for the SRF								
				Required for				
Ref. #	**Required Instrument Functionality**	**Reference instrument**	Function	Curation	Sample Safety Assessment	Time-Sensitive Science	Sterilization-Sensitive Science	**Significant Instrument Comments**
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to clean isolators and tools - Cleaning Lab (see notes)		Cleaning Lab to support preparation /maintenance of clean material before integration in hot areas.					In order to prepare all material to be installed in "hot areas", within isolator, a dedicated room for precision and utra clean preparation of equipment is recommended. The room should be large enough to host several isolators being cleaned at the same time. A trade-off
Clean1	Supercritical Fluid cleaning			**X**	**X**			
Clean2	CO2 Snow-Cleaning (separate Mini-Environment) incl. Robotic Arm + handheld nozzle							
Clean3	Oxygen Plasma or other low-pressure plasma Cleaning							
Clean4	H2O2 Cleaning							
Clean5	Ultrasonic Bath made of quartz glass							
Clean6	Ultrasonic Bath made of PVDF/PFA							
Clean7	Ultrasonic Bath made of stainless steel							
Clean8	Ultrasonic Cleaning Unit							
ANCILLARY LABORATORIES ACROSS BIOBARRIER	Instrumentation for sterilizing and releasing materials other than samples from the biocontained area		Releasing material and effluents that is not the samples					MOSDT recommends to have the full range of sterilization equipment typical of a BSL4 labor

Summary of Instruments and Sample Prep Needs Proposed for the SRF											
		Quick glance							Engineering Details		
Ref. #	**Required Instrument Functionality**	Size (handheld OR tabletop OR self-standing)	Is it possible to interface with isolator/DWI?	Org. cont. sensitive (Y/N)	Sample Preparation (Y/N)	Isolator Manual Manipulation via gloves (Y/N)	Isolator Robotics/ RMS handling (Y/N)		Vibration Sensitive (Y/N)	Power Requirements (V/A)	**Size**
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to clean isolators and tools - Cleaning Lab (see notes)										
Clean1	Supercritical Fluid cleaning				N						
Clean2	CO2 Snow-Cleaning (separate Mini-Environment) incl. Robotic Arm + handheld nozzle										
Clean3	Oxygen Plasma or other low-pressure plasma Cleaning										
Clean4	H2O2 Cleaning										
Clean5	Ultrasonic Bath made of quartz glass										
Clean6	Ultrasonic Bath made of PVDF/PFA										
Clean7	Ultrasonic Bath made of stainless steel										
Clean8	Ultrasonic Cleaning Unit										
ANCILLARY LABORATORIES ACROSS BIOBARRIER	Instrumentation for sterilizing and releasing materials other than samples from the biocontained area	atory.									

Summary of Instruments and Sample Prep Needs Proposed for the SRF							
						Analysis requirements	
Ref. #	**Required Instrument Functionality**	Mass (kg)	Specialized Gas Requirements	Cooling Needs	Special infrastructure req	Analysis under inert gas	Special Lighting Needs
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to clean isolators and tools - Cleaning Lab (see notes)						
Clean1	Supercritical Fluid cleaning						
Clean2	CO2 Snow-Cleaning (separate Mini-Environment) incl. Robotic Arm + handheld nozzle						
Clean3	Oxygen Plasma or other low-pressure plasma Cleaning						
Clean4	H2O2 Cleaning						
Clean5	Ultrasonic Bath made of quartz glass						
Clean6	Ultrasonic Bath made of PVDF/PFA						
Clean7	Ultrasonic Bath made of stainless steel						
Clean8	Ultrasonic Cleaning Unit						
ANCILLARY LABORATORIES ACROSS BIOBARRIER	Instrumentation for sterilizing and releasing materials other than samples from the biocontained area						

Summary of Instruments and Sample Prep Needs Proposed for the SRF					
		Sample prep			
Ref. #	**Required Instrument Functionality**	Detailed Sample Preparation Requirments	Sample Prep in sample prep area (separate): is the sample to be analyzed prepared in a general sample pre area? Y: sample must be prepared following a certain protocol using capabilities and isntruments identified in the Sample Prep section, and it doesn't need to be linked to the instrument, but can be trasnported to the instrument. N: sample preparation must occur in co-location with the targetted analytical instrument N/A: no sample prep required	Level of pristinity before prep or analysis	Level of pristinity after prep or analysis (Pristine, Psub,Rest, Terminal
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to clean isolators and tools - Cleaning Lab (see notes)				
Clean1	Supercritical Fluid cleaning				
Clean2	CO2 Snow-Cleaning (separate Mini-Environment) incl. Robotic Arm + handheld nozzle				
Clean3	Oxygen Plasma or other low-pressure plasma Cleaning				
Clean4	H2O2 Cleaning				
Clean5	Ultrasonic Bath made of quartz glass				
Clean6	Ultrasonic Bath made of PVDF/PFA				
Clean7	Ultrasonic Bath made of stainless steel				
Clean8	Ultrasonic Cleaning Unit				
ANCILLARY LABORATORIES ACROSS BIOBARRIER	Instrumentation for sterilizing and releasing materials other than samples from the biocontained area				

Summary of Instruments and Sample Prep Needs Proposed for the SRF				
				Notes
Ref. #	Required Instrument Functionality	Sample Prep under inert gas	Sub Sample mass/volume needed in sample prep	
ANCILLARY LABORATORIES OUTSIDE OF HIGH-CONTAINMENT	Instrumentation to clean isolators and tools - Cleaning Lab (see notes)			Supporting equipment should be: Storage Shelf (Stainless Steel), Handling Space/Table (Stainless Steel) closed surface, Handling Space/Table (Stainless Steel) perforated, Rolling Cart (Stainless Steel) (2), Solvent Cabinet, Storage for Cleaning Agents/Detergents, Drainage on Floor Level, Drying Cabinet, Thermal
Clean1	Supercritical Fluid cleaning			
Clean2	CO2 Snow-Cleaning (separate Mini-Environment) incl. Robotic Arm + handheld nozzle			
Clean3	Oxygen Plasma or other low-pressure plasma Cleaning			
Clean4	H2O2 Cleaning			
Clean5	Ultrasonic Bath made of quartz glass			
Clean6	Ultrasonic Bath made of PVDF/PFA			
Clean7	Ultrasonic Bath made of stainless steel			
Clean8	Ultrasonic Cleaning Unit			
ANCILLARY LABORATORIES ACROSS BIOBARRIER	Instrumentation for sterilizing and releasing materials other than samples from the biocontained area			

instrument ref. #	NOTES (update 28/09 from Supplement B)
1	Assume that more than one optical reflected (non-polarized) light microscope will be required to support optimal work flow. Needed for both pre-BC, BC, and PE. For BC, assume one is needed in each isolator
5	Assume that more than one analytical balance will be required to support optimal work flow and sample prep for multiple instruments, and one analytical balance will be needed inside each pristine isolator used for BC
7	The SEM will need to have ports for additional detectors, possibly including CL, EDS, WDS, FIB, and EBSD, and Focused Ion Beam capability--this is an important sample prep step for other measurements. Gminek et al., 2021 report calls for a Variable Pressure Scanning Electron Microscope with Energy Dispersive X-ray Spectrometer (EDS). Tait et al., 2021 state the need for capability for both Field Emission- and Variable Pressure-SEM, that could potentially be combined in one
8+9	Confocal Raman Spectrometer and Deep UV Fluorescence Spectrometer functionality could potentially be combined in one instrument
13	Assume that different kinds of microscopes (and in some cases more than one copy) will be required to support optimal work flow. This may include, but not be limited to: petrographic microscope, reflected light microscopy with Z-(focus) stacking, binocular microscope (Ref. #1 above). See Table 2.
14	This GC-IRMS system must optimized for complex, high molecular weight volatiles and their stable isotopes for SSAP related investigations and time-sensitive life science. This is a distinct instrument from the GC-IRMS called for in row 23. This would mainly be used to analyze high-molecular weight organic compounds extracted from the samples via solvent extraction. These analyses are destructive.
17	Would include nanopore, Bioanalyzer, MiSeq, etc.
23	This GC-IRMS system must be optimized for low molecular weight volatiles and their stables isotopes and would be used for the **analysis of headspace and other gas samples**, including those evolved during sample sterilization, and would also need to include a high temperature conversion elemental analyzer (TC/EA) for pyrolysis of solid samples and extracts to characterize volatiles hosted in mineral phases. Quadropole mass spec (QMS) to measure noble gas isotope ratios (e.g., 40/36 Ar, 84Kr/132Xe, 129/132 Xe)
24	Laser spectrometer will be used for **sample headspace gas characterization** and to analyze gases evolved during sample sterilization. These techniques are non-destructive and could be performed before analyzing samples via GC-IRMS using instruments named in rows 14 or 23, depending on the intent of the analysis. It should be noted that important progress in these types of techniques is being made, and a final decision on instrumentation for the SRF should take forthcoming improvements into account.
29	Sterilization equipment will be needed for both samples (as required by PP) and for hardware and tools that come in contact with samples (to meet contamination control requirements)
30	Rock sample prep lab will need to include multiple functions, including but not limited to: Thin section preparation and polished thick section preparation, Sputter coaters and vacuum evaporators for C and Au or Ir or Pt-Pd conductive coatings, Agate mortar and pestle, Capability to grind samples with KBr and press into pellets, capability to prepare a flat surface, Micro-drilling, particle micro-manipulator, microtome.
31	Basic wet chemistry lab would need to include multiple functionalities including the capability to perform solvent extractions and other preparations. Would need to include equipment such as laminar flow hoods, glassware, sample handling tools, and other equipment commonly found in wet chemistry laboratories
32	Microbiology lab will need to include items for biological sample prep and manipulation/storage of samples: heated and cooled incubators, freezers (-20, -80C), refrigerator, analytical balance, laminar flow hood, vortexer, microbiological glassware, plasticware consumables,
33	Gas extraction and handling equipment (e.g., custom vacuum lines, inert carrier gas(es)) to facilitate extraction and preparation of sample headspace gas