MEUH!

Facility or facilities ? That is the question!

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Mars Sample Return : former statements!

■ **1997: MARS SAMPLE RETURN ISSUES AND RECOMMENDATIONS**

"Samples returned from Mars by spacecraft should be contained and treated as though potentially hazardous until proven otherwise. No uncontained martian materials, including spacecraft surfaces that have been exposed to the martian environment, should be returned to Earth unless sterilized."
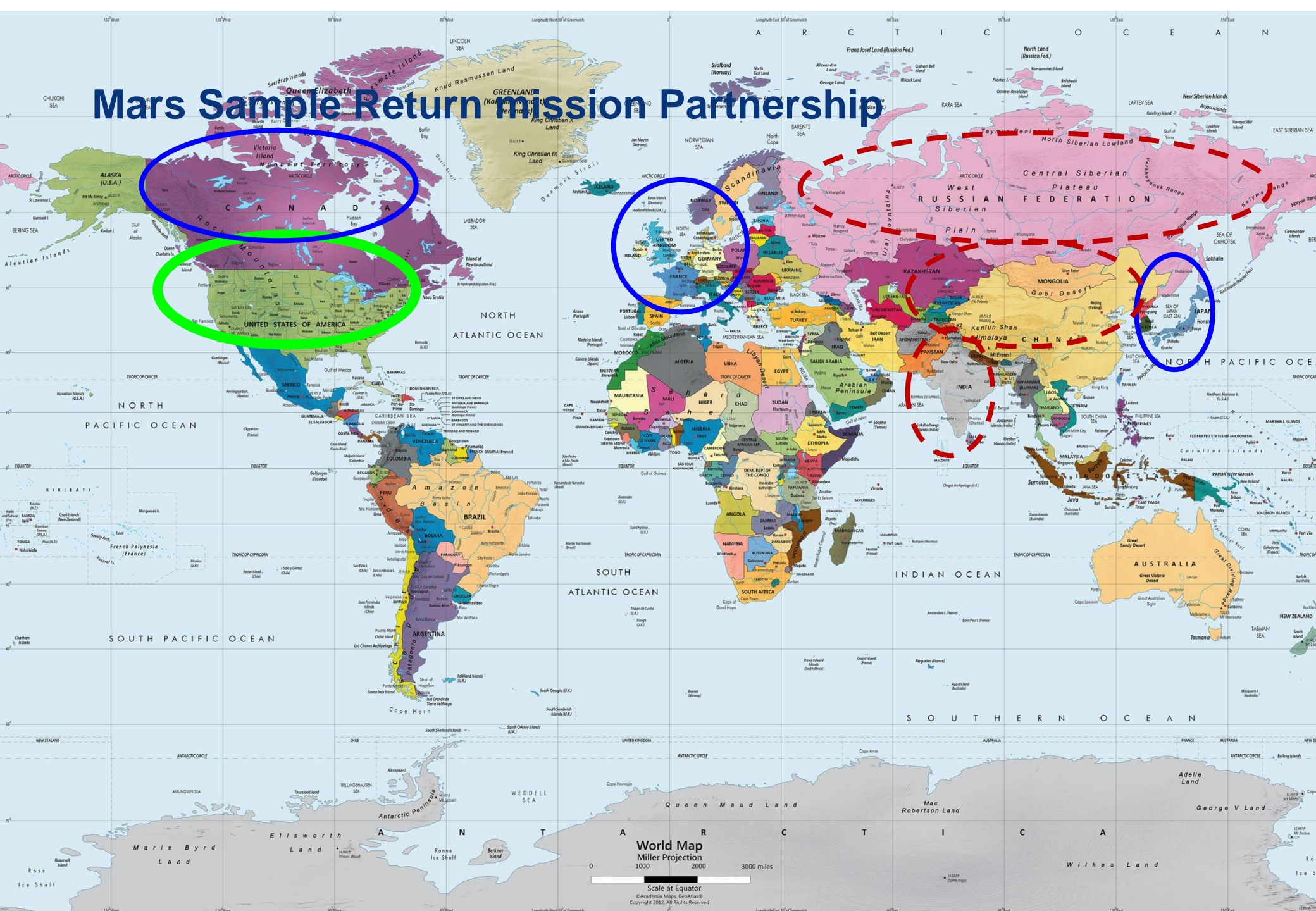
■ **2002: The Quarantine and Certification of Martian Samples**

"A major obstacle to design for the Mars quarantine facility is the problem of combining biological containment with clean room conditions. It is essential that work on the solution of this problem be started immediately…"

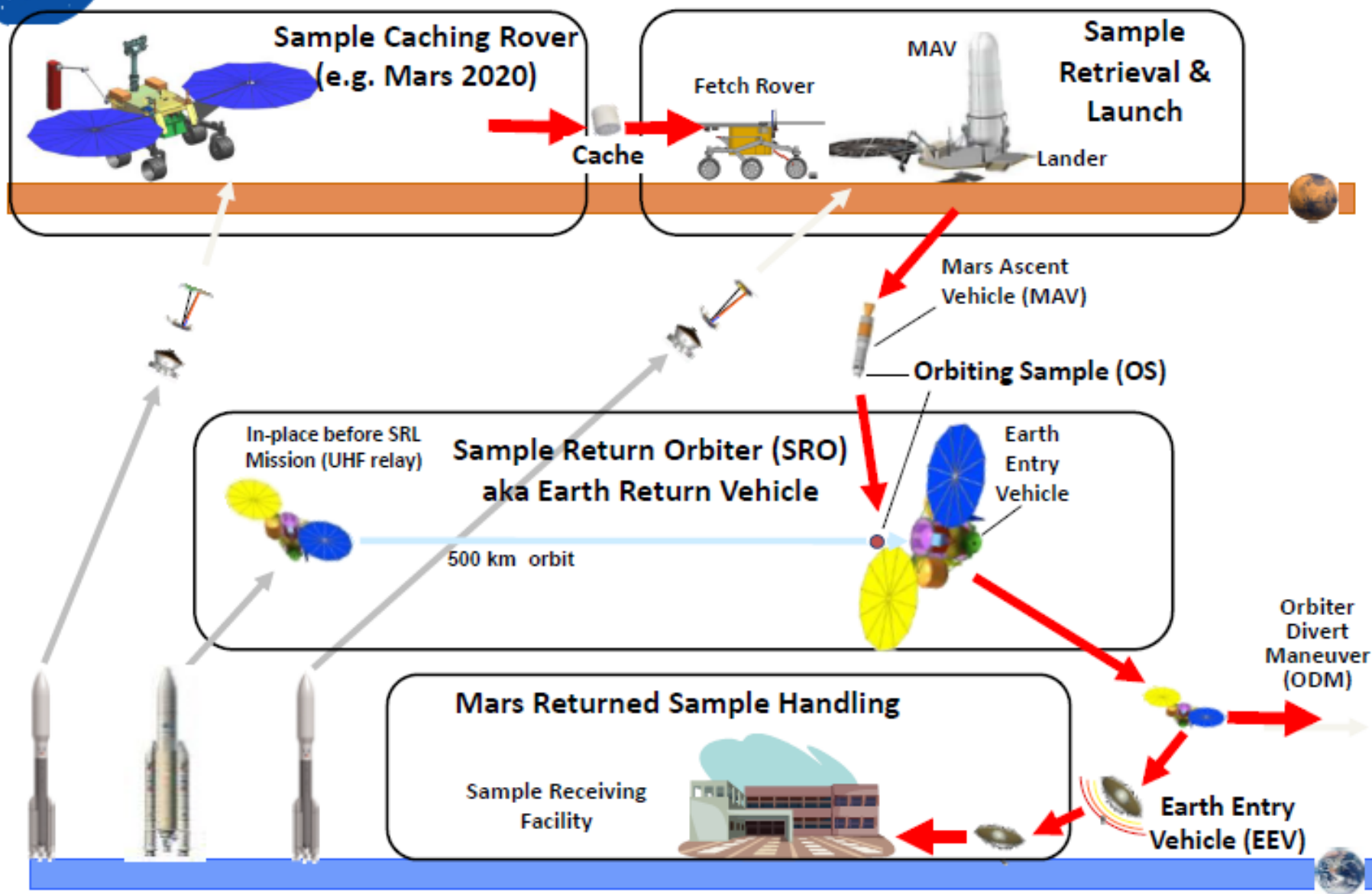■ **2002: A DRAFT TEST PROTOCOL FOR DETECTING POSSIBLE BIOHAZARDS IN MARTIAN SAMPLES RETURNED TO EARTH**

"Clarity of meaning is essential to the implementation of any process especially when the process involves international agreements. Therefore, absolute consistency should be used in the language for any documents and charters associated with the eventual final protocol".
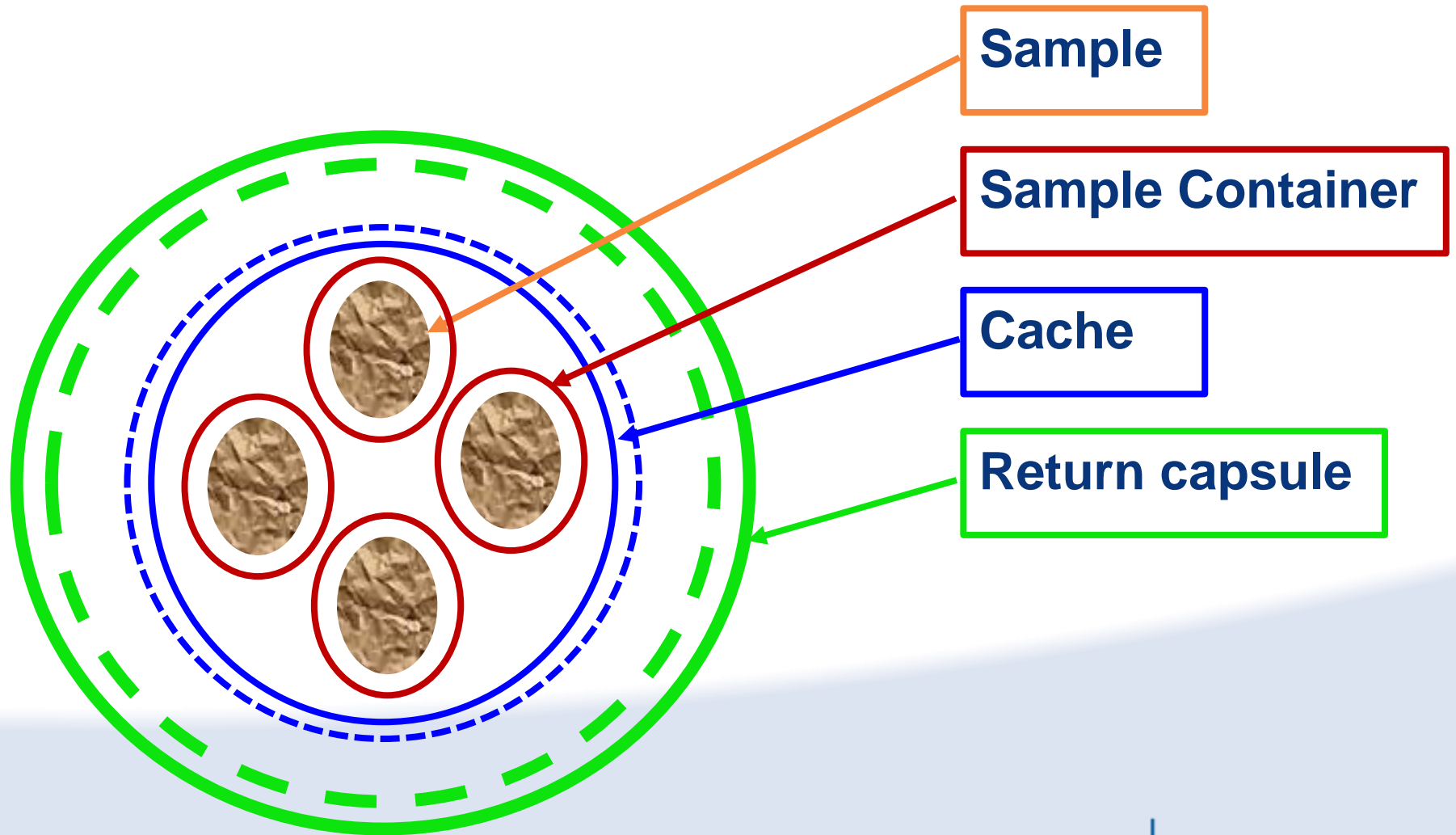
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Mars Sample Return mission Partnership

Four-element Robotic MSR Campaign Concept
(for reference)

Sample Caching Rover (e.g. Mars 2020)

Sample Retrieval & Launch

Cache

Fetch Rover

MAV

Lander

Mars Ascent Vehicle (MAV)

Orbiting Sample (OS)

In-place before SRL Mission (UHF relay)

Sample Return Orbiter (SRO) aka Earth Return Vehicle

Earth Entry Vehicle

500 km orbit

Orbiter Divert Maneuver (ODM)

Mars Returned Sample Handling

Sample Receiving Facility

Earth Entry Vehicle (EEV)

Mars Sample Return : proposed statements

- **MSR will be an international cooperative mission, Mars samples will be an asset for mankind and will be treated accordingly**

- **The samples even shared and distributed will remain part of a unique "batch" which will be under the supervision of an international "body" for management and distribution.**

- **The samples will be considered as non-commercial items**

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Матрёшка

Sample

Sample Container

Cache

Return capsule

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Mars Sample Return : what could be collected?

Sample Type	Mechanical Properties	Number Proposed science floor, 1st MSR	Mass Mass/ sample (gm)	Mass Total Sample Mass
Case B. Cache from a previous mission is NOT returned				
Sedimentary suite	rock	20	10	200
Hydrothermal suite	rock			
Low-T W/R suite	rock			
Igneous Suite	rock			
Other	rock			
Lander-based sample	rock or reg.	4	20	80
Regolith	granular	4	15	60
Dust	granular	1	5	5
Ice	ice or liquid	0		
Atmospheric Gas	gas	1	0.001	
Cache from previous mission	rocks			0
TOTAL		30		345

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Mars Sample Return : Cooperation or distribution

1   **Exclusive**

2   **Distributive**

3   **Cooperative**

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Mars Sample Return : Cooperation or distribution

1 ~~Exclusive~~

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3 Cooperative

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Ambient conditions around the item of interest

- **External ambiant conditions**

- **Protection of the samples and protection of the environment « nothing coming in, nothing coming out » samples can be considered as « pristine »**

- **No chemical protection fo the samples but nothing coming out**

- **No biological protection of the samples but nothing coming out**

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PPL-type	Biocontainment	Cleanliness	'Ambient' Conditions	Used For:
PPL α	Maximum (BSL-4)	Maximum	Mars-like (pristine); *Although at 1 atm w/inert gas environment*	Incoming container and materials; some preliminary tests; sample bank/storage; some Life Detection
PPL β	Maximum (BSL-4)	Maximum	Earth-like	Life Detection; some Physical/Chemical; TBD
PPL γ	Maximum (BSL-4)	Moderate	Earth-like	Some Biohazard testing, some Physical/Chemical processing, and animal testing
PPL δ	Strict BSL-3-Ag	Ambient	Earth-like	Some Biohazard testing; 'post-release' tests TBD

Mars Sample Return : functional analysis

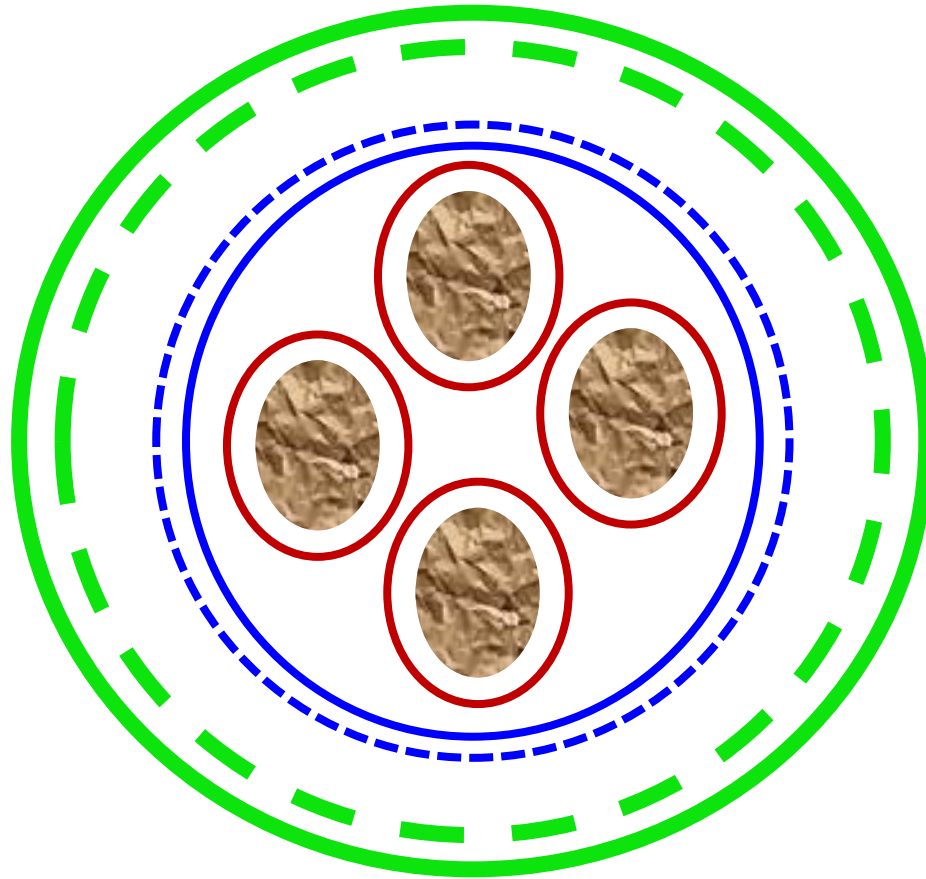■ **Landing site step: A sample capsule lands somewhere on a continent**

◆ **Function: to search, to check and to secure then to transport**

Open conditions

Capsule and cache step: the Earth return capsule untouched arrives in a dedicated facility

◆**Function: to check, to place in right ambient conditions, to open the capsule; to open the cache and then to identify, to sort and to characterize sample containers.**

PPL α

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Mars Sample Return : functional analysis

Sample Container distribution step

Option 1 : all containers are then treated at the same place

Option 2 : Containers are distributed among the various PARTNERS of the mission

Each sample container (special case to be described for atmospheric samples) is then considered as a unique sample. Then transferred in each appropriate partner's curation facility

PPL α

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Mars Sample Return : functional analysis

Samples Step: retrieved from the samples containers and in appropriate ambient conditions are then treated according with the appropriate plan

- ◆ **Function: sample characterization, identification, classification and division. Sample allocation to further steps**

PPL α

■Long term storage: samples are preserved for future generation analysis.

- ◆**Function: to store in appropriate conditions to be considered in the future as "pristine" samples**

PPL α

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Mars Sample Return : functional analysis

Short term storage: samples are preserved for distribution and analysis after the end of the quarantine

- ◆ **Function: to be characterized and stored in appropriate conditions to be immediately released after sterilization or released unsterilized after the end of the quarantine.**

PPL α

Quarantine distribution: samples are selected to undergo under quarantine, physical/chemical processing, life detection and biohazard testing;

- ◆ **Function: allocate samples after checking that they are representative**

PPL β

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Mars Sample Return : functional analysis

■ **Physical/chemical analysis: restricted to those "required in support of planetary protection.**
  ◆ **Function to characterize and describe the individual samples to be tested in further life detection and Biohazard testing**

  PPL β

■ **Life detection analysis : restricted to those "required in support of planetary protection.**
  ◆ **Function** to detect specific evidence whether life of any kind exists in the sample, or rule out the presence of such evidence of life.

  PPL γ

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Mars Sample Return : functional analysis

- **Biohazard testing: testing Martian samples against various organisms from bacteria to animal and vegetal cells**
  - ◆ Function: to determine if samples from Mars pose any threat to terrestrial organisms or ecosystems, regardless of whether the samples are found to contain life-forms or non-replicative hazards.

  PPL γ

- **Biohazard testing: Post release tests of Martian samples against various organisms**

- Function: to determine broad spectrum potential effects of Mars terrain on living terrestrial systems
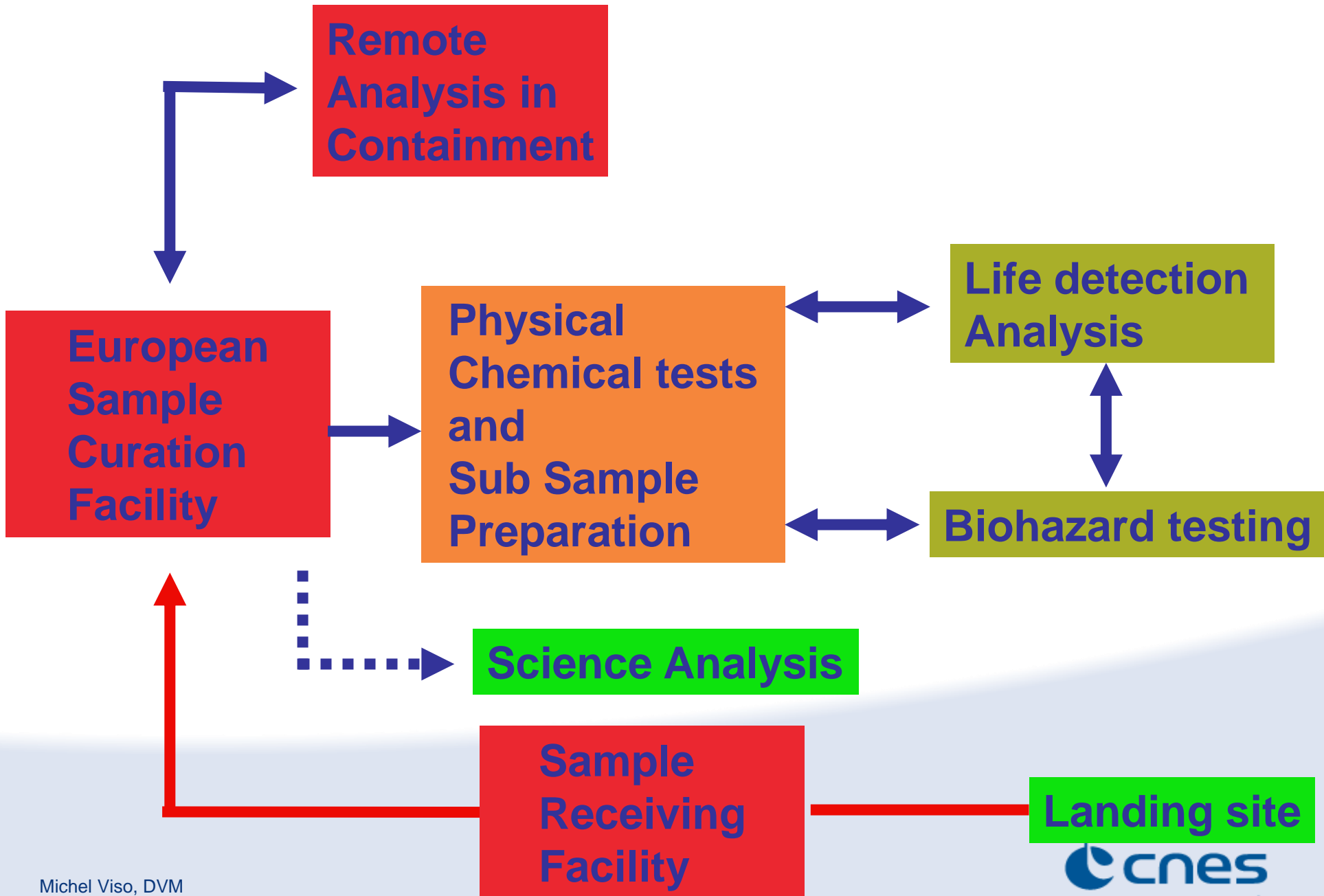
  PPL δ

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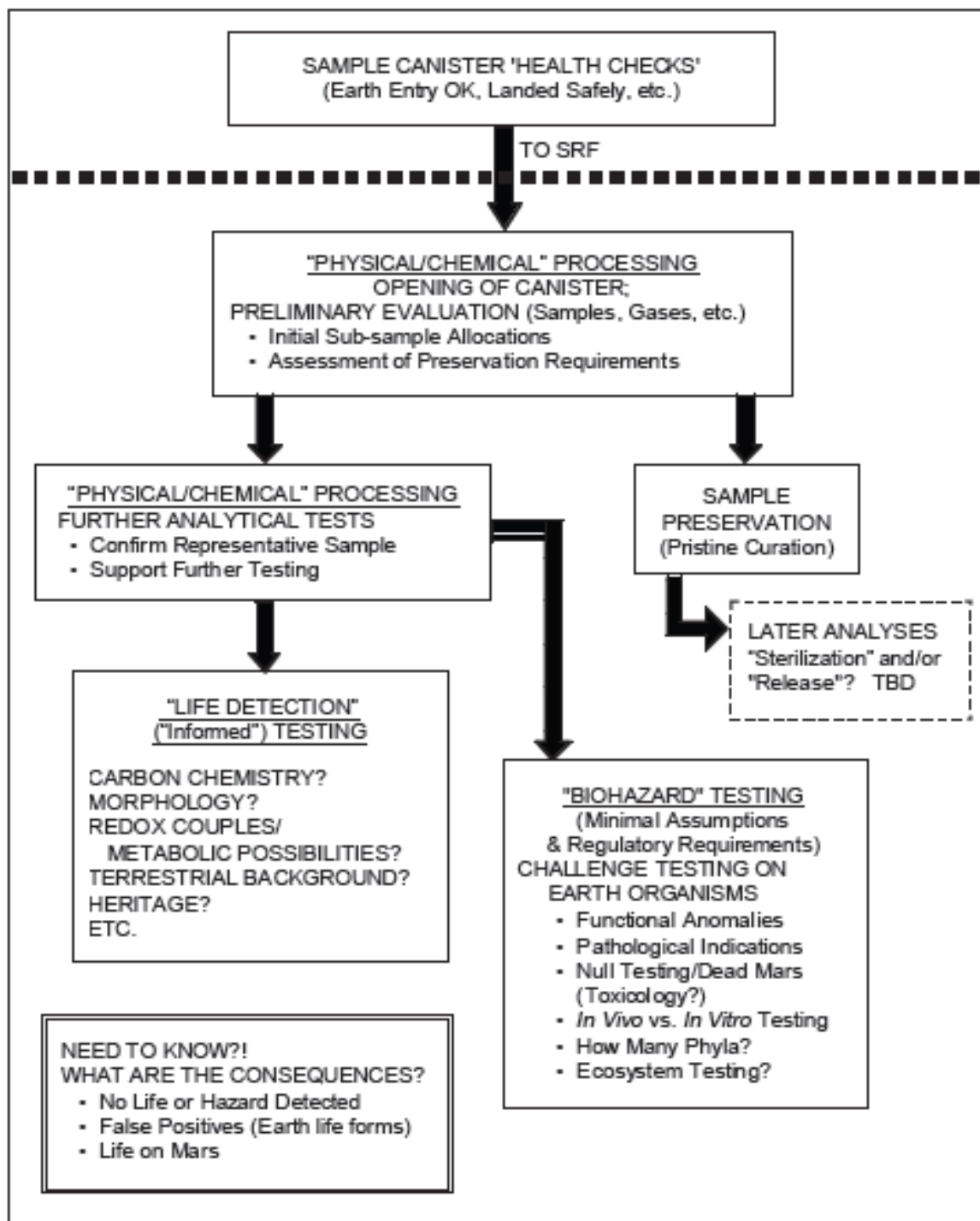| PPL-type	Biocontainment	Cleanliness	'Ambient' Conditions	Used For:
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PPL β	Maximum (BSL-4)	Maximum	Earth-like	Physical/Chemical; TBD
PPL γ	Maximum (BSL-4)	Moderate	Earth-like	Life Detection; Biohazard testing, some Physical/Chemical geological analysis and in vivo testing
PPL δ	Strict BSL-3-Ag	Ambient	Earth-like	Some Biohazard testing; 'post-release' tests TBD

Mars Sample Return : functional analysis

- **Landing site step: the Earth return capsule lands somewhere on a continent**
  - ◆ Function: to search, to check and to secure then to transport
- **Capsule step: the Earth return capsule untouched arrives in a dedicated facility**
  - ◆ Function: to check, to place in right ambient conditions, to clean, to open the capsule; to identify, to sort and to characterize sample containers; to open with appropriate care each sample containers.
- **Samples Step: retrieved from the samples containers and in appropriate ambient conditions samples are then treated according with the appropriate plan**
  - ◆ Function: sample characterization, identification, classification and division. Sample allocation to further steps

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Mars Sample Return : functional analysis

■ **Long term storage: samples are preserved for future generation analysis.**

- ◆ **Function: to store in appropriate conditions to be considered in the future as "pristine"**

■ **Short term storage: samples are preserved for distribution and analysis after the end of the quarantine**

- ◆ **Function: to be characterized and stored in appropriate conditions to be immediately released after sterilization or released unsterilized after the end of the quarantine.**

■ **Quarantine distribution: samples are selected to undergo under quarantine, physical/chemical processing, life detection and biohazard testing;**

- ◆ **Function: allocate samples after confirming that they are representative**

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MARS SAMPLE RETURN CAPSULE RETRIEVAL
- INTEGRITY CHECK AND TEST
- PRELIMINARY HEALTH CHECK

MARS SAMPLE RECIEVING FACILITY
Opening the Sample return capsule
Opening the Cache
Identifying and checking the sample containers

MARS SAMPLE CURATION **FACILITIES**
OPENING THE SAMPLE CONTAINERS
Prelinnary observation
Initial subsampling allocation
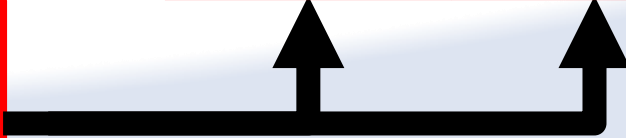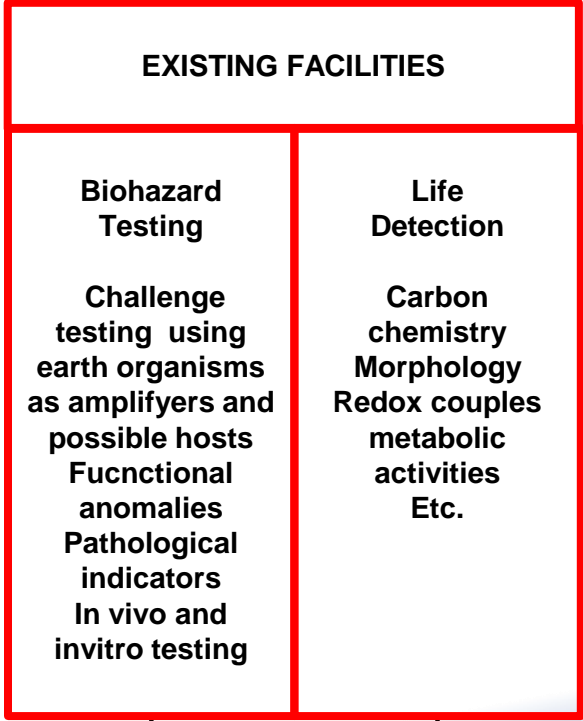Assessment of preservation requirements

PHYSICO CHEMICAL PROCESING
CONFIRM REPRESENTATIVE SAMPLE
SUPPORT FURTHER TESTING

SAMPLE CURATION (LONG TERM)
Pristine preservation
Future generation

SAMPLE CURATION (SHORTTERM)
Pristine preservation
Release post quarantine

SAMPLE SELECTION
Biahazard testing
life detection

EXISTING FACILITIES

Biohazard Testing

**Challenge testing using earth organisms as amplifyers and possible hosts
Fucnctional anomalies
Pathological indicators
In vivo and invitro testing**

Life Detection

**Carbon chemistry
Morphology
Redox couples
metabolic activities
Etc.**

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MARS SAMPLE RETURN CAPSULE RETRIEVAL
- INTEGRITY CHECK AND TEST
- PRELIMINARY HEALTH CHECK

MARS SAMPLE RECEIVING FACILITY
Opening the Sample return capsule
Opening the Cache
Identifying and checking the sample containers

UNIQUE

MARS SAMPLE CURATION **FACILITIES**
OPENING THE SAMPLE CONTAINERS
Prelinnary observation
Initial subsampling allocation
Assessment of preservation requirements

PHYSICO CHEMICAL PROCESING
CONFIRM REPRESENTATIVE SAMPLE
SUPPORT FURTHER TESTING

SAMPLE CURATION (LONG TERM)
Pristine preservation
Future generation

SAMPLE CURATION (SHORTTERM)
Pristine preservation
Release post quarantine

SAMPLE SELECTION
Biahazard testing
life detection

SEVERAL PERMANENT

EXISTING FACILITIES

Biohazard Testing
Challenge testing using health organisms as amplifyers and possible hosts Functional animals pathological indicators In vivo and invitro testing

Life Detection
Carbon chemistry Morphology Redox couples metabolic activities Etc.

SEVERAL TRANSIENT

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26

Recommendation

- **No backward track for the samples**
- **Be modular and with fully independent modules : all the treatment of fluids (air, water, effluents) must be fully separated and sized accordingly.**
- **Avoid the single point of failure catastrophy**
- **Modules could be adjacent or spread across various European countries (national pride, money, industry…)**

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US - KISS

KEEP
IT
SIMPLE
STUPID

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French - KISSS

KEEP
IT
SIMPLE
STUPID
SHAREABLE

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