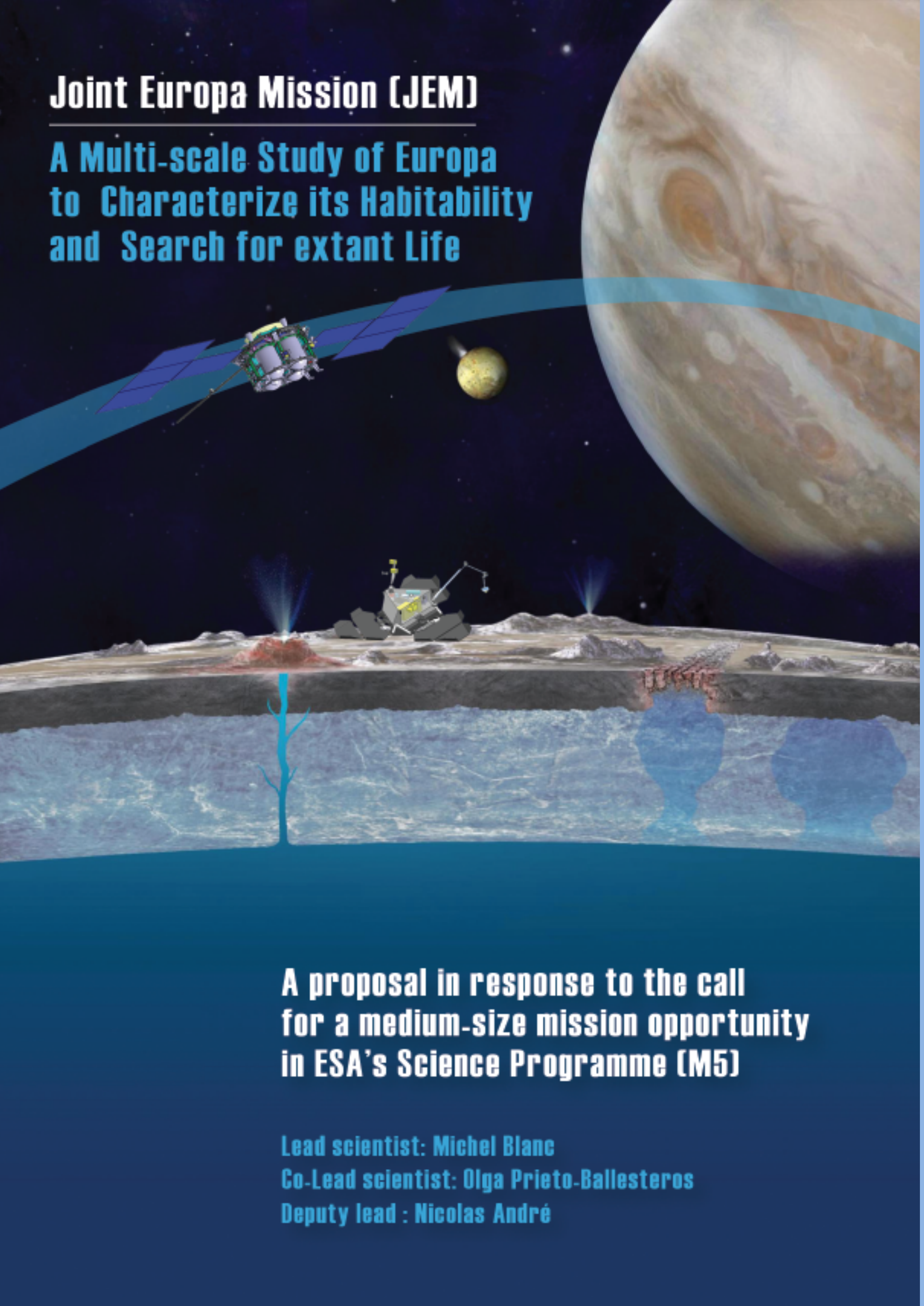

JEM core group

Michel Blanc, Olga Prieto-Ballesteros, Nicolas André, Javier Gomez-Elvira, Geraint Jones, John Cooper, Veerle Sterken, Luciano Iess, David Mimoun, Adam Masters, Zita Martins, Gaël Choblet, Tim van Hoolst, Philippe Garnier, François Leblanc, Valéry Lainey, Frances Westall, Philippe Garnier, Joachim Saur, Bruce Bills, Steve Vance, Ralph Lorenz, Krishan Khurana, Federico Tosi, Paul Hartogh, Sascha Kempf, Peter Wurz, Geoffrey Colins, Edward C. Sittler, William Desprats, Hauke Hussmann, Ralf Srama, Norbert Krupp, Andrea Longobardo, Katrin Stephan, Adrian Jäggi, Károly Szegő, Roland Wagner, Martin Volwerk, Jan-Erik Wahlund.

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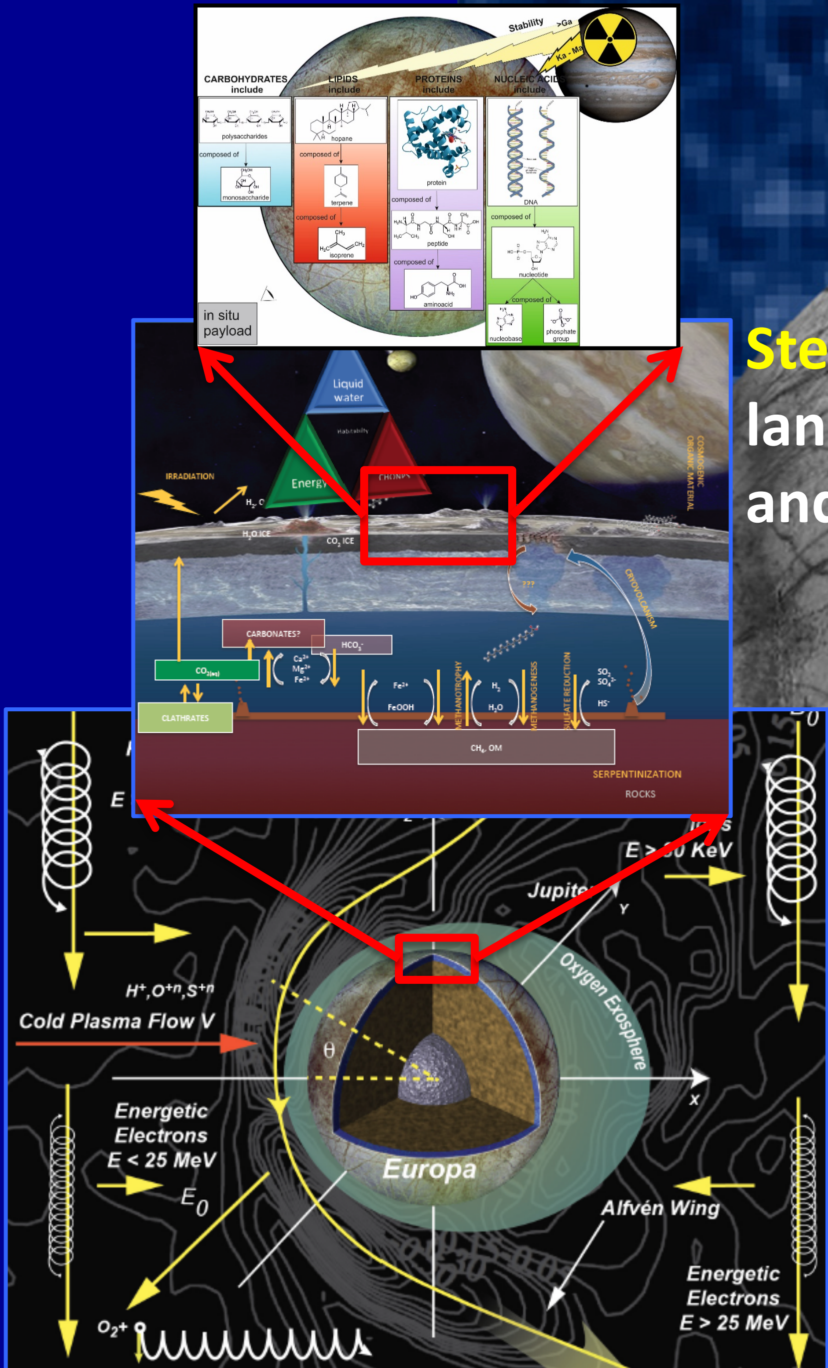
CNES-PASO - André Laurens lead
The CNES Planetary Protction experts - Delphine Faye, André Debus.

JEM OVERARCHING SCIENCE GOALS

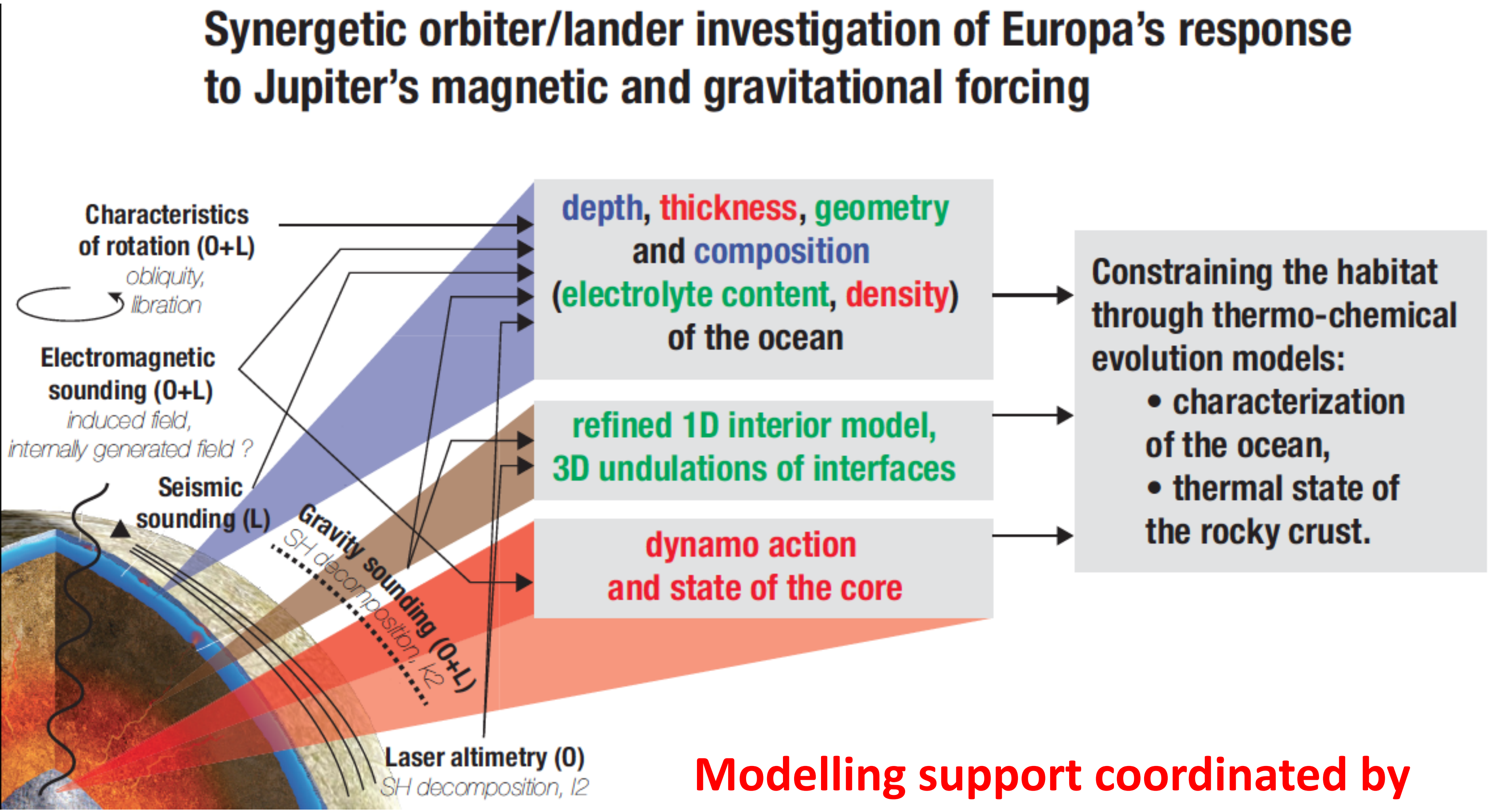


Step C: **Search for biosignatures at the landing site and in the exosphere.**

Step B: **Characterize its potential « dark biosphere »** (ocean and ice shell).

Step A: **Understand Europa at the global scale** as a complex system responding to Jupiter System forcing, from core to plasma envelope.

STEP 1: ACHIEVE A GLOBAL CHARACTERIZATION OF EUROPA SOLID/LIQUID LAYERS

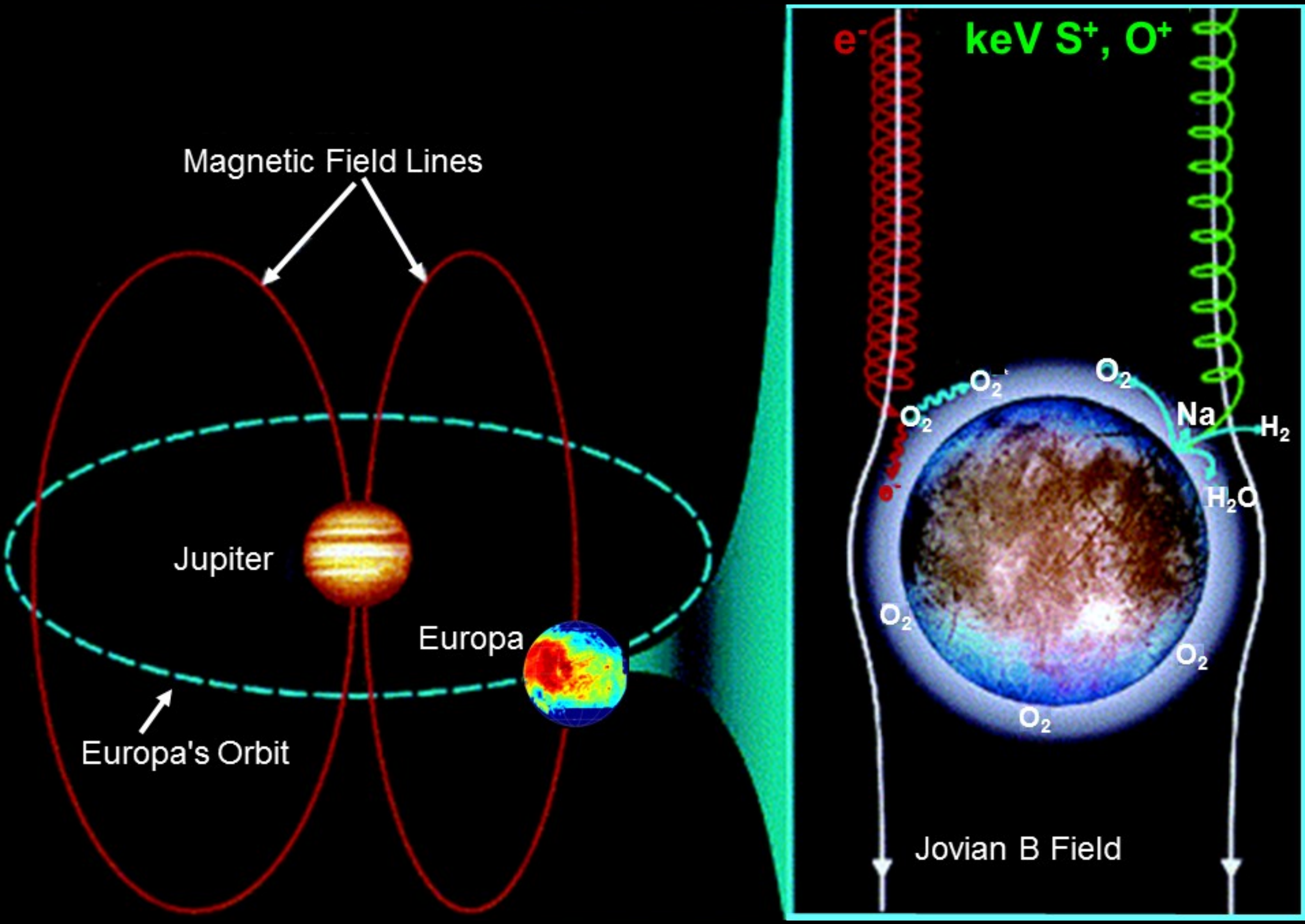


Modelling support coordinated by LPG Nantes

STEP 1: ACHIEVE A GLOBAL CHARACTERIZATION OF EUROPA
MAGNETOSPHERIC INTERACTION, PLASMA ENVELOPE, EXOSPHERE

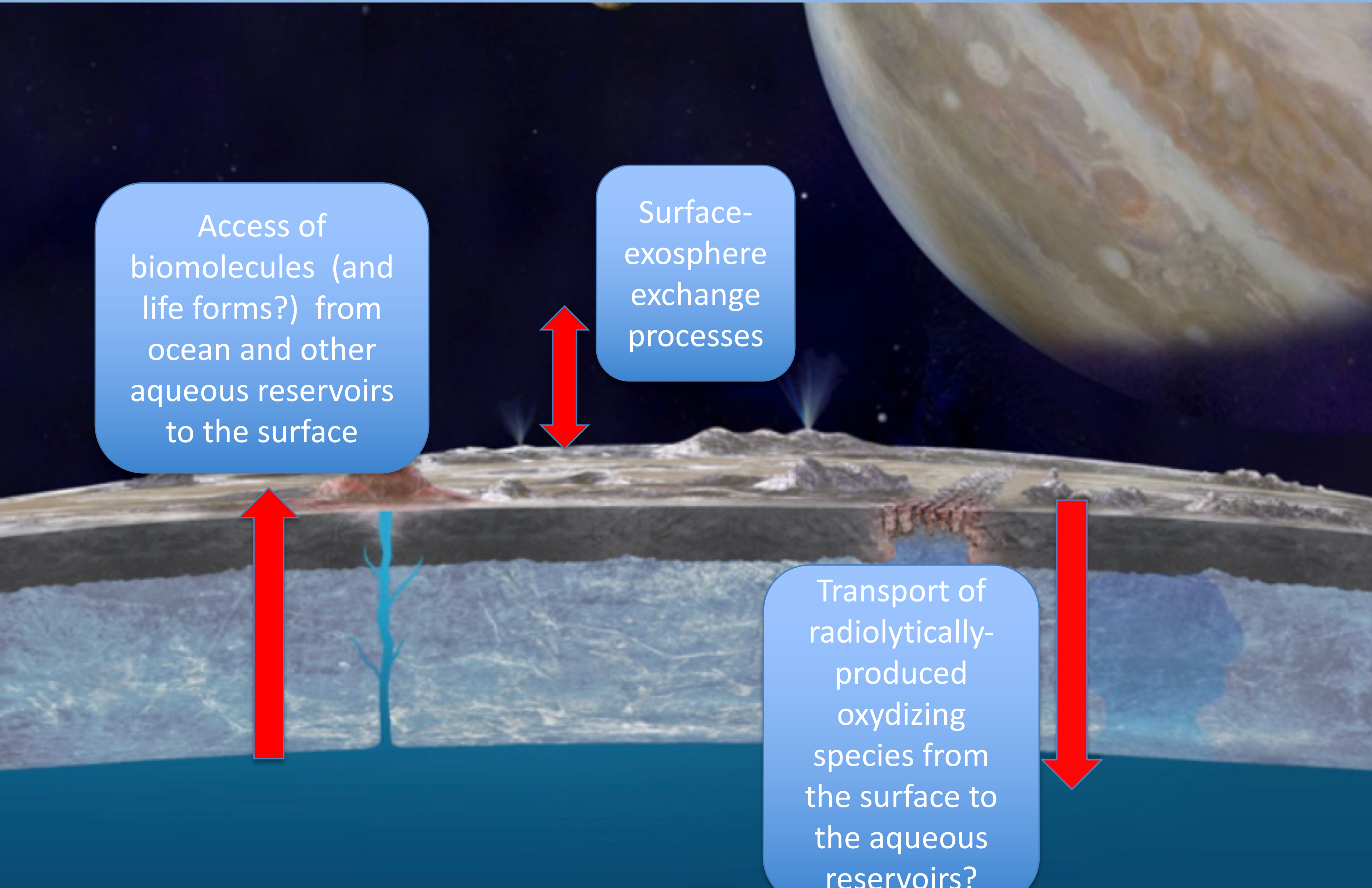
- Magnetospheric interaction with ice shell surface and with conducting ocean

- Broad-band magnetic sounding of the ocean

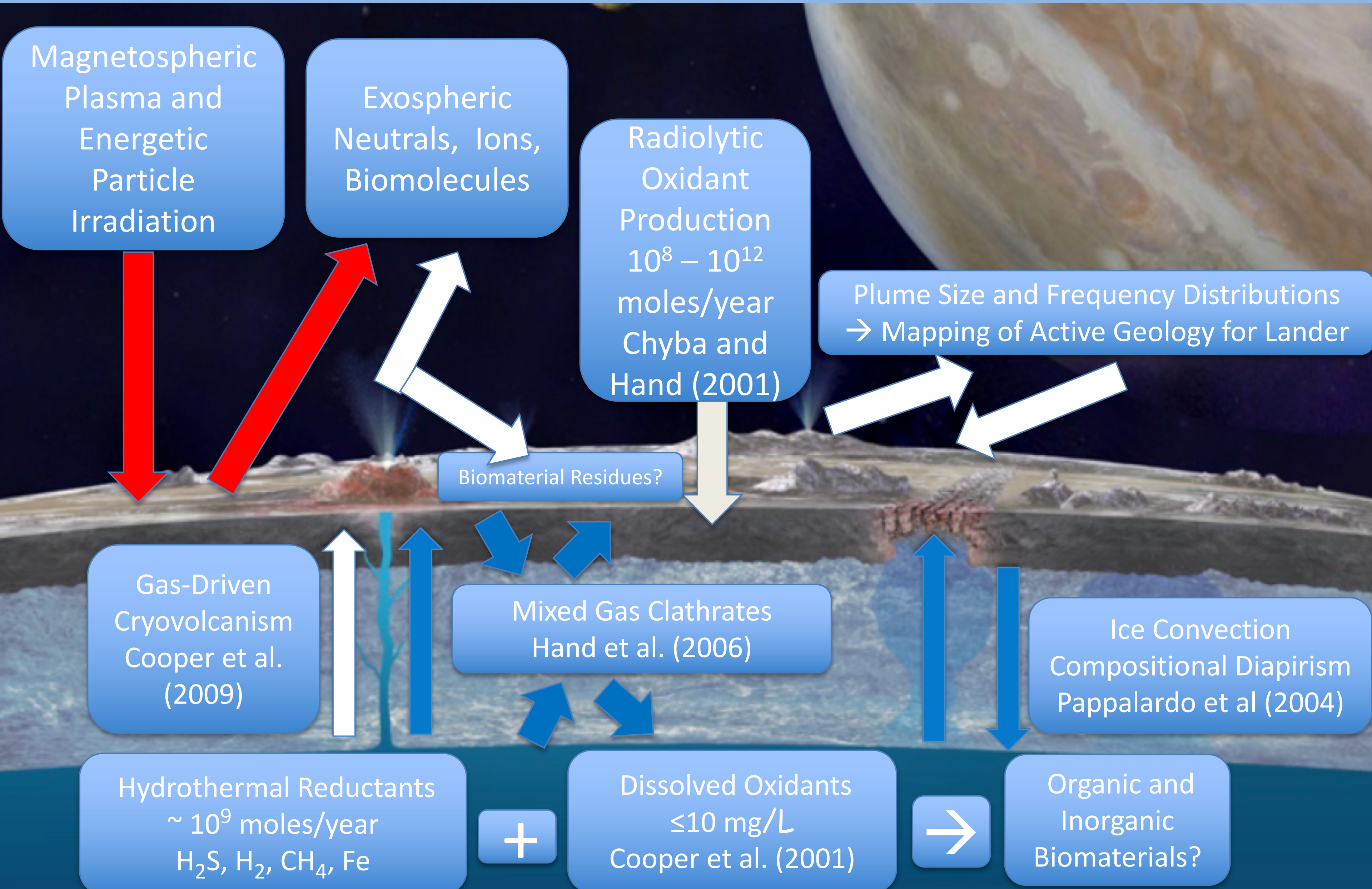


- Exchange processes and exchange of material and chemical species between ice shell surface, subsurface (including possible plumes), exosphere and plasma envelope

STEP 2: CHARACTERIZE THE POTENTIAL BIOSPHERE AND THE EXCHANGE PROCESSES ACROSS THE ICE SHELL



STEP 2: CHARACTERIZE THE POTENTIAL BIOSPHERE AND THE EXCHANGE PROCESSES ACROSS THE ICE SHELL

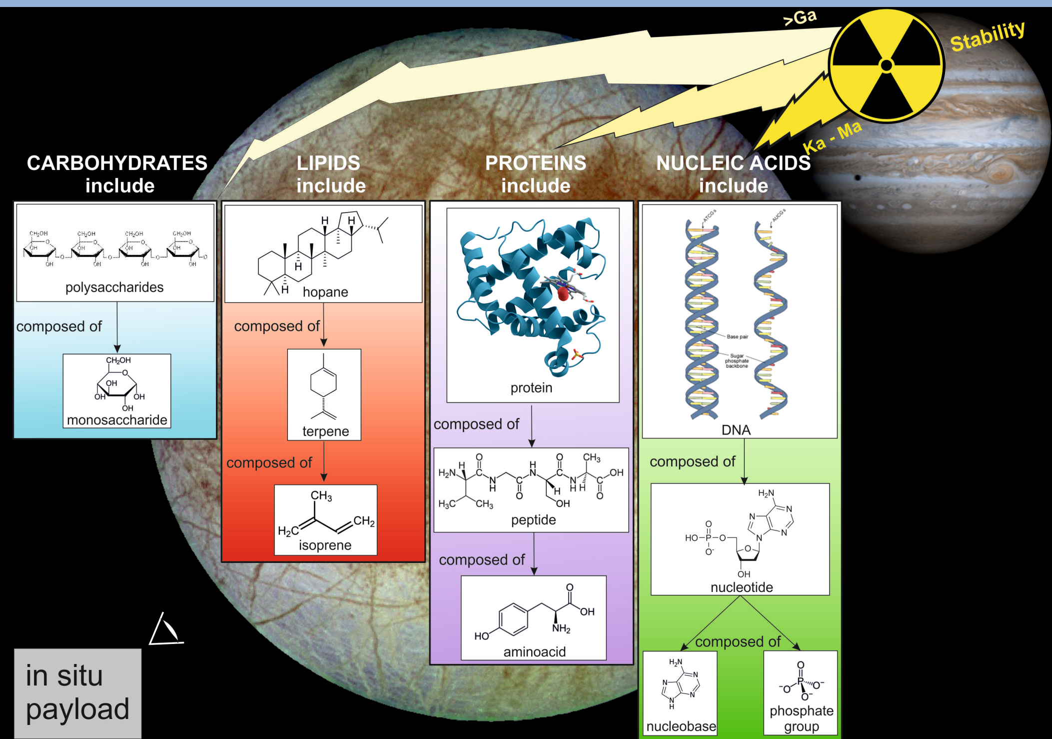


STEP 3: SEARCH FOR LIFE

WHERE TO SEARCH?

Fresh material, mostly in:

- Subsurface (shielded material)
- Exosphere and plumes?



WHAT TO SEARCH FOR?

Indicators of past or present life:

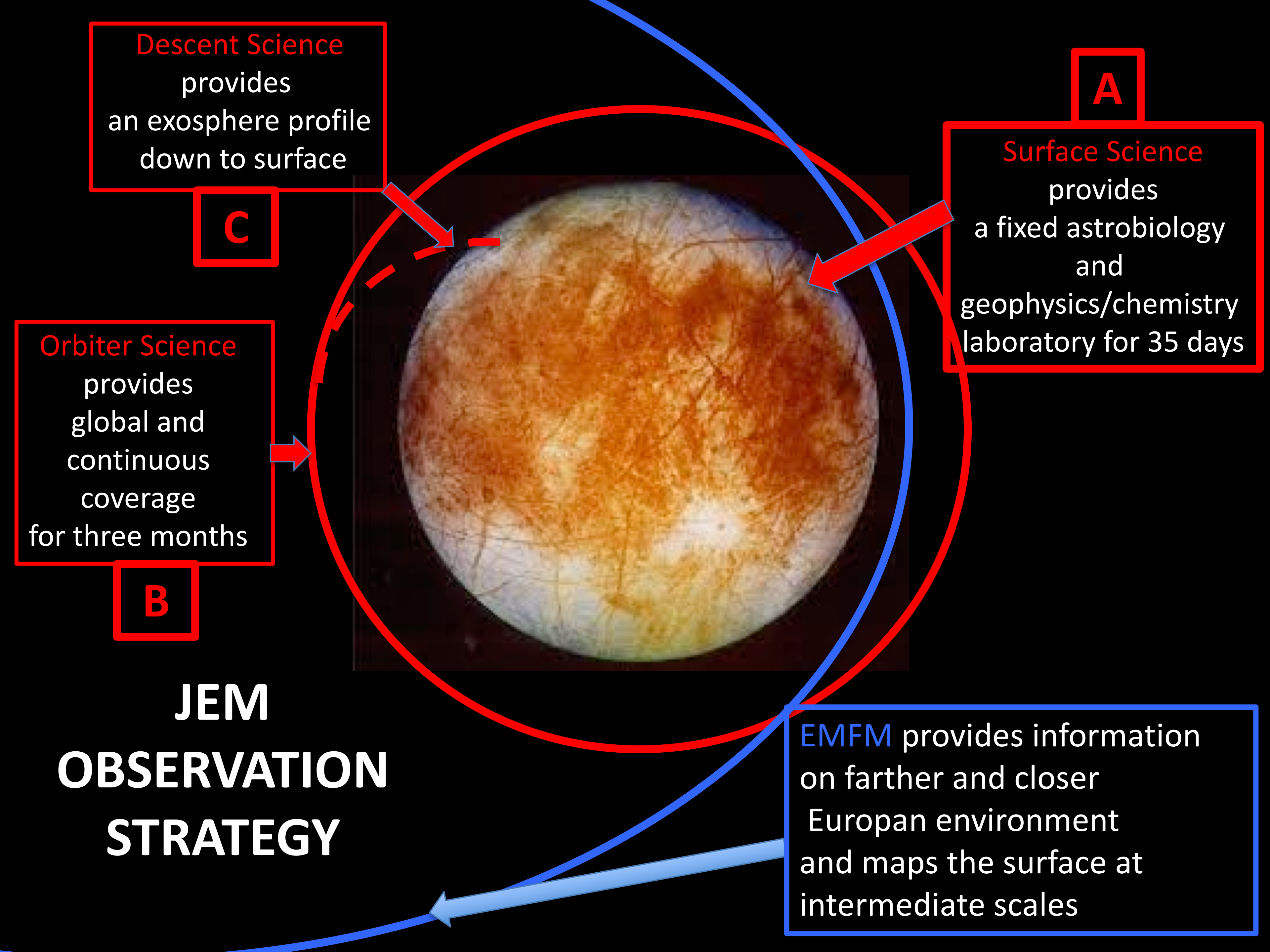
1) « Universal » biomarkers
   - From simple ones with good resistance to radiation
   - To biomolecules of increasing complexity and decreasing resistance to radiation

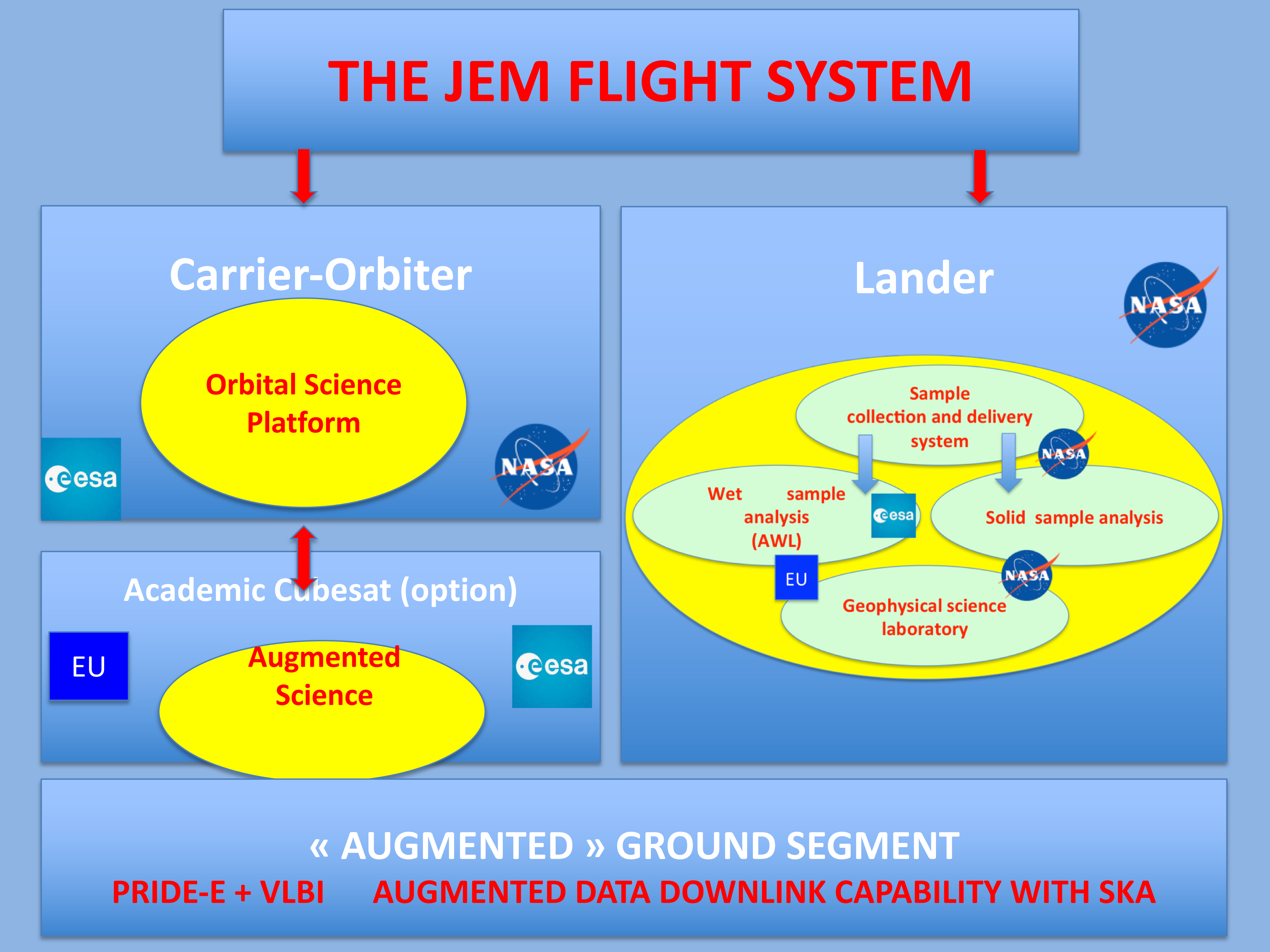
2) Organic indicators
3) Inorganic indicators
4) Morphological/textural indicators

HOW TO SEARCH?

Chemical analysis in liquid, solid and gas phases

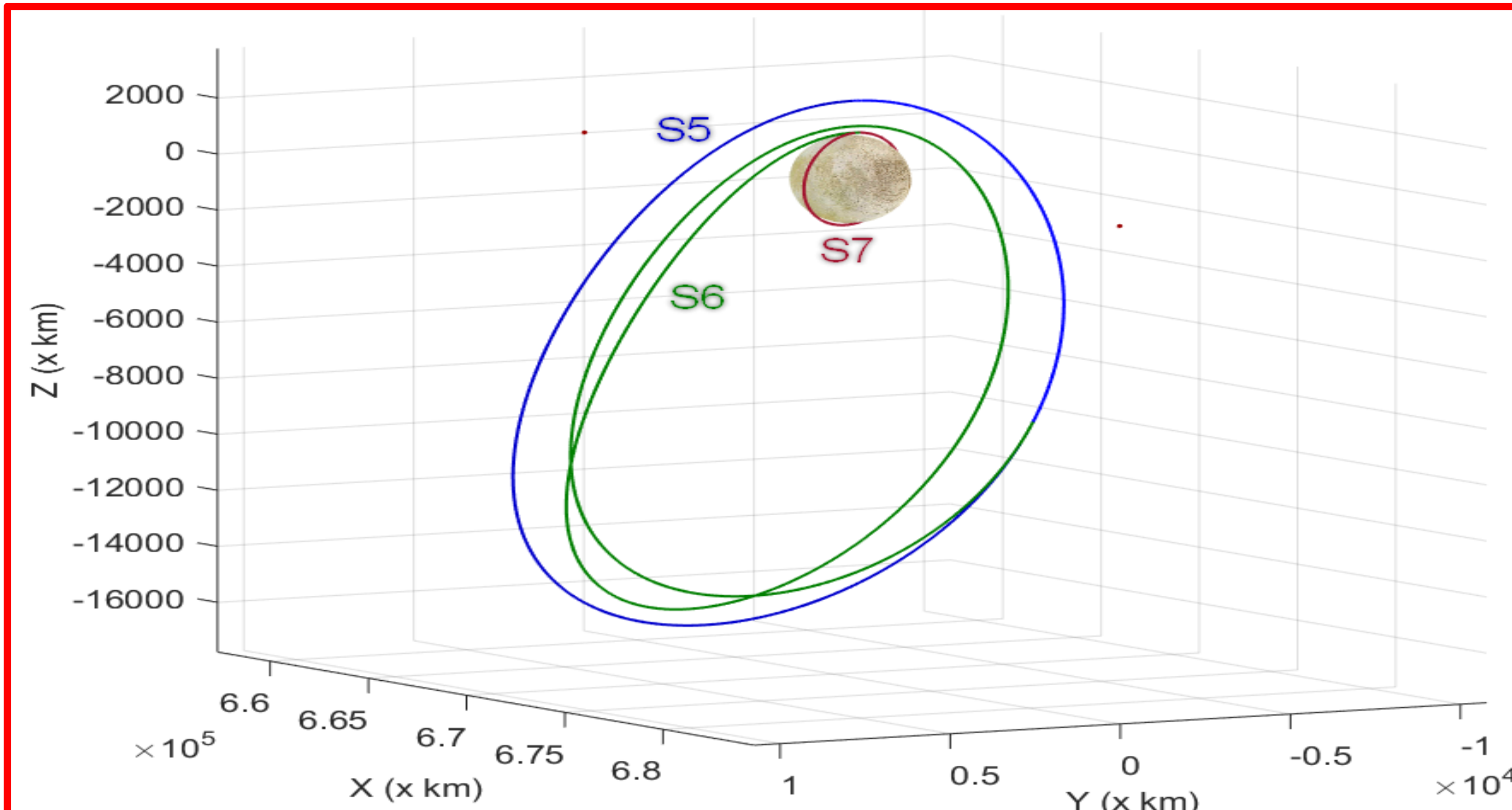
- Liquid: Microarrays (at AWL) , searching for the major macromolecules of life, such as 1)
- Solid: Raman spectroscopy, mainly 2), 3); Microscope, mainly 4)
- Gas: GC/MS, mainly 2)


Descent Science
provides
an exosphere profile
down to surface
C
A
Surface Science
provides
a fixed astrobiology
and
geophysics/chemistry
laboratory for 35 days
Orbiter Science
provides
global and
continuous
coverage
for three months
B
JEM
OBSERVATION
STRATEGY
EMFM provides information
on farther and closer
Europan environment
and maps the surface at
intermediate scales



THE JEM FLIGHT SYSTEM
Carrier-Orbiter
Orbital Science Platform
esa
NASA
Academic Cubesat (option)
EU
Augmented Science
esa
Lander
NASA
Sample collection and delivery system
Wet sample analysis (AWL)
esa
EU
Solid sample analysis
NASA
Geophysical science laboratory
NASA
« AUGMENTED » GROUND SEGMENT
PRIDE-E + VLBI
AUGMENTED DATA DOWNLINK CAPABILITY WITH SKA

JEM MISSION SEQUENCES

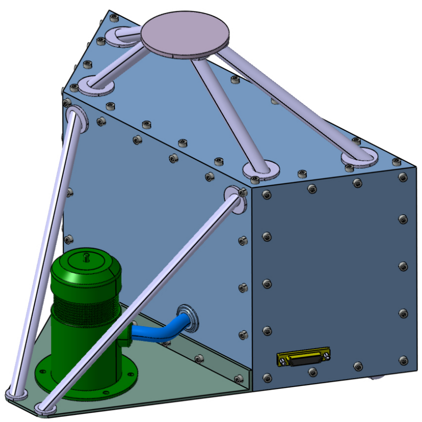


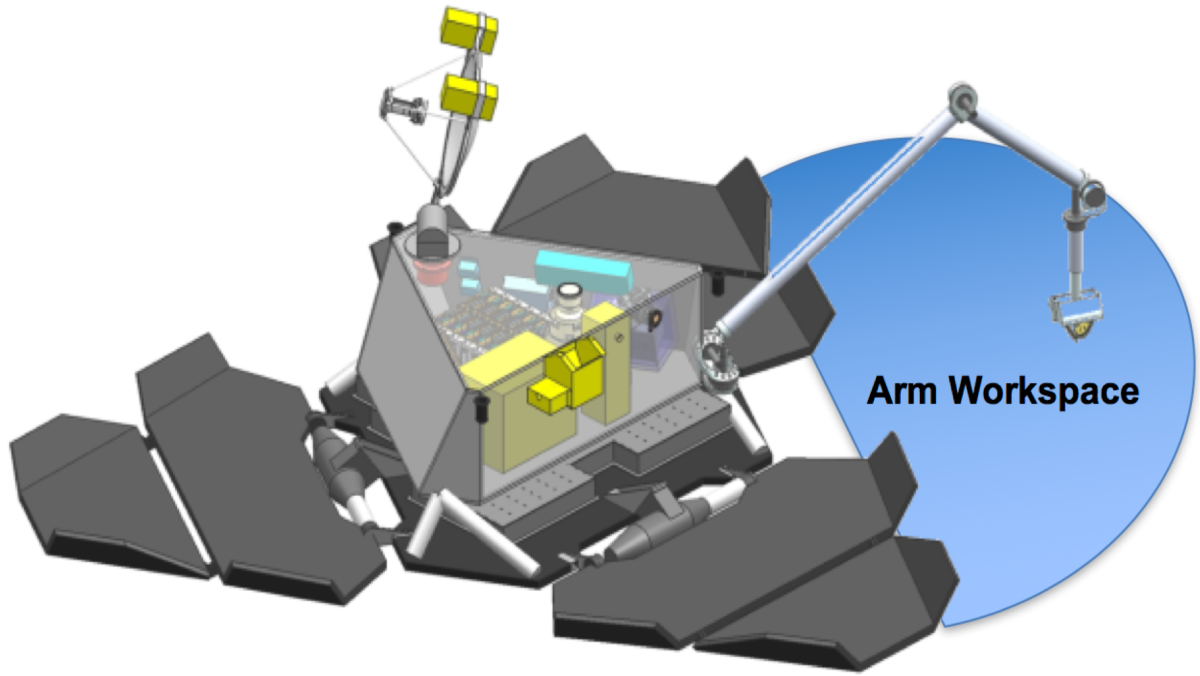
S-9	Impact	End of mission			
Total			6,6 years	3,05 km/s	1,5 Mrad

Mission constraints: Planetary Protection & Radiation Mitigation

JEM SURFACE SCIENCE PLATFORM

Technical description





Astrobiology Wet Laboratory (ESA)

(not to scale)

Sample analysis in liquid phase

Two deployment options:

- Inside the NASA platform
- deployed on the surface by the Arm.

Lander Platform (NASA)

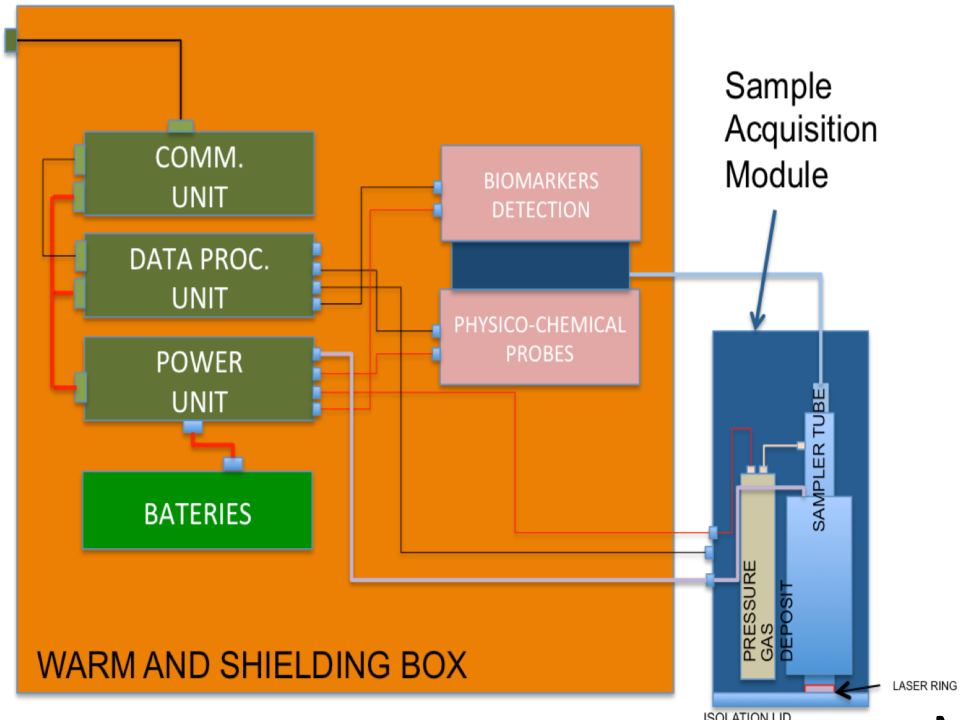
Direct support to:

Sample analysis in solid/gas phases

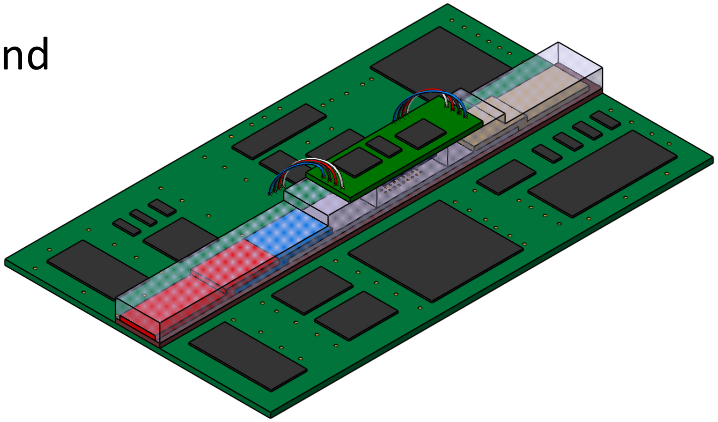
Geophysical science laboratory

AWL
The Astrobiology Wet Laboratory

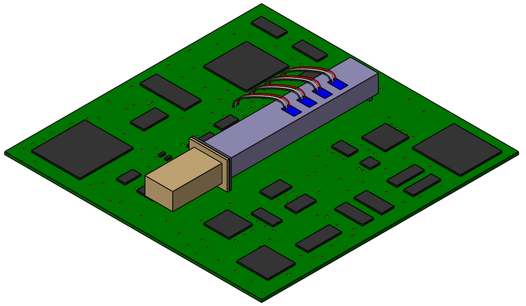
The AWL is composed of two sensors: MPAS and MPP and of a Sample Acquisition Module (SAM) to obtain liquid samples from the subsurface (10 cm deep).



Block diagram for the surface option.



Multiprobe Array Sensor (MPAS). Based on immunoassay tests.



Multiparametric Probe (MPP) . ChemFet component for measuring. pH, conductivity,..

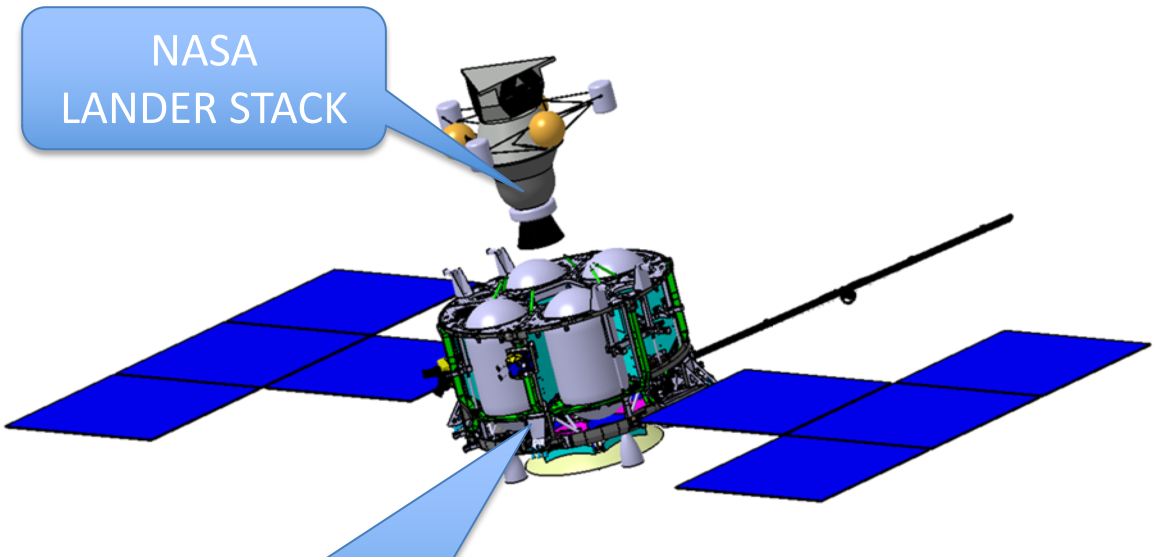
SURFACE SCIENCE INVESTIGATIONS

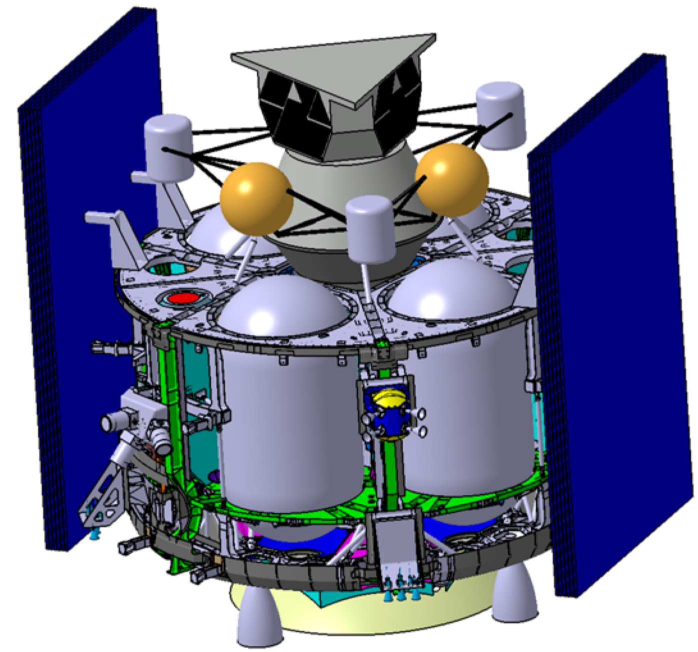
Surface Science Platform - JEM (Lander) NASA			
Facility/Instrument	**Lead Agency**	**Reference institute**	**Reference PSO**
1. Solid Sample Analysis	**NASA**		
GCMS			PSO#4, PSO#5
Raman Spectrometer			
Microscope			
PanCam			
2. Liquid Sample Analysis Astrobiological Wet Laboratory	**ESA**		
Multiprobe Array Sensors (MPAS)	Spain	CAB-CSIC.INTA	PSO#5
Multiparametric Probes (MPP)	Spain	CAB-CSIC.INTA	PSO#5
Thermogravimeter	Italy	INAF	PSO#5
3. Geophysical Science			
Geophone	NASA		PSO#2, PSO#4
Magnetometer	Austria	IWF Graz	PSO#1
Laser reflector	ESA		PSO#2

Our life detection strategy at the landing site combines

- The search for
- Complementary analytical techniques in solid, gas and liquid (AWL) phases

CARRIER/RELAY/SCIENCE ORBITER (with SLS launch)





based on ESA-NASA existing collaboration framework + double ESA s/c development heritage:

- Mechanical+propulsion bus derived from the **European Service Module (ESM) of the ORION MPCV** (maiden flight planned for 09/18);
- Rad-hard avionics protected within lead-shielded vault derived from **JUICE**
- Planetary Protection: approach following **ExoMars** experience

ORBITER AND DESCENT SCIENCE INVESTIGATIONS

	Orbiter Science Platform - JEM (Orbiter-Carrier) ESA/NASA			
	Facility/Instrument	**Lead Agency**	**Reference institute**	**Reference PSO**
Core Payload Cosmic Vision M5	Gravity Science Investigation (GSI)	ASI (Italy)	**Univ. Roma La Sapienza**	PSO#2, PSO#4
	Magnetometer (MAG)	UKSA (UK)	**Imperial College**	PSO#1, PSO#3, PSO#4
	Laser Altimeter (ELA)	DLR (Germany)	**DLR**	PSO#2, PSO#4
	Ion Mass Spectrometer + Electron Spectrometer (IMS/ELS)	CNES (France)	**IRAP**, LPP, Wigner, MPS, ISAS, GSFC	PSO#1, PSO#3, PSO#5
	Ion and Neutral Mass Spectrometer (INMS)	Switzerland	**University of Bern**	PSO#3, PSO#5
	Dust Analyser (SUDA)	DLR (Germany)	**Univ. Stuttgart, NASA**	PSO#1, PSO#3, PSO#5
Augmentation	Langmuir Probe (LP)	Sweden	**IRF Uppsala**	PSO#1, PSO#3

2 proposed scientific investigations with FR contributions:

- IMS/ELS (H/W - LFA: CNES)
- PRIDE-E (Astrometry – VLBI)

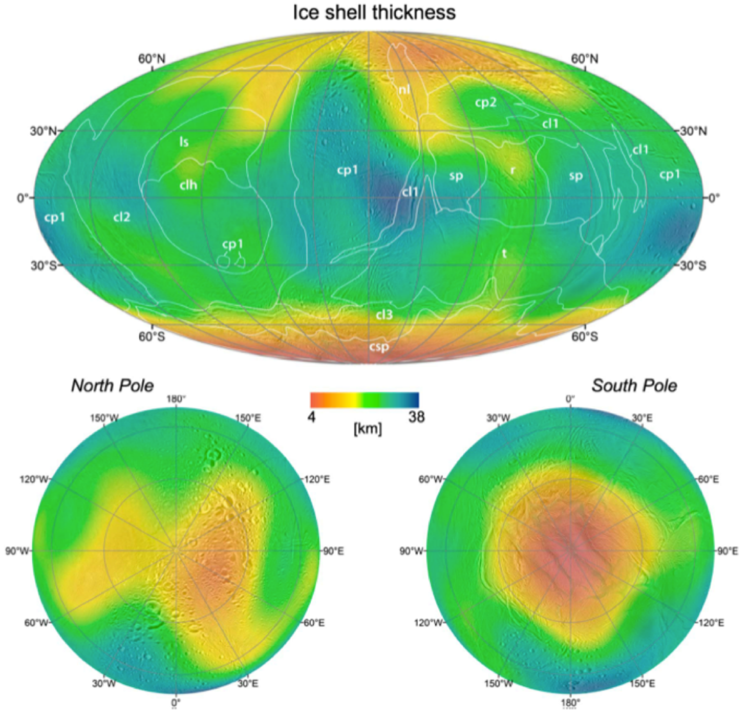
Thank you for your attention

Back-up slides

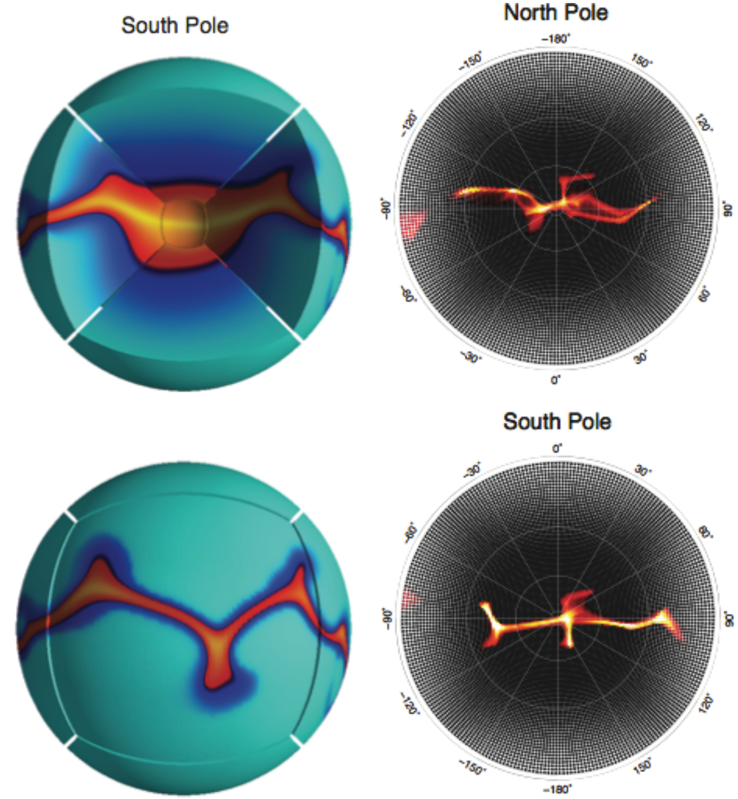
STEP 1: ACHIEVE A GLOBAL CHARACTERIZATION OF EUROPA

SOLID/LIQUID LAYERS (MODELLING SUPPORT)

COMPLEMENTARITY OF GEOPHYSICAL DATA SETS TO INVERT FOR INTERNAL STRUCTURE AND MASS/HEAT TRANSFER: THE EXAMPLE OF CASSINI @ ENCELADUS



3D interior structure



hotspots at the seafloor

LPG NANTES

(COLLAB: JPL/CALTECH, UNIV. CHARLES PRAGUE)

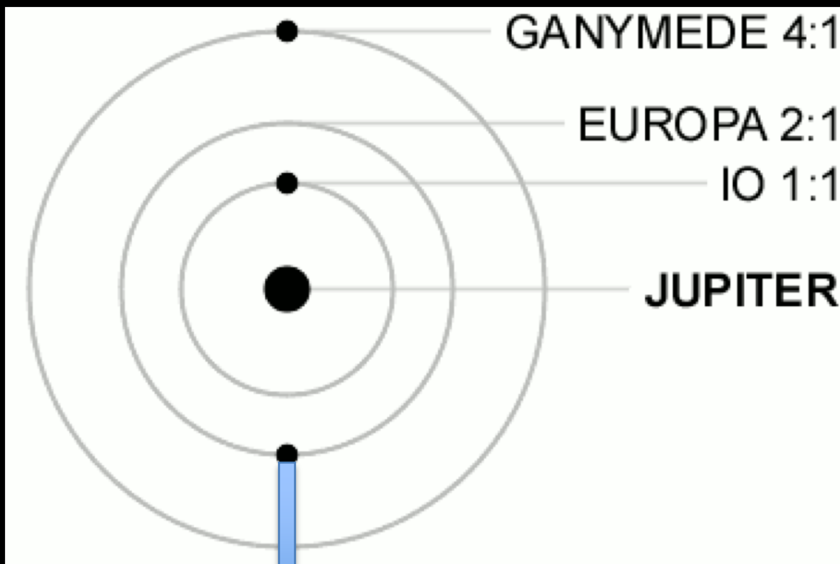
ESA-PROCURED CARRIER/RELAY/SCIENCE ORBITER
Main technical characteristics

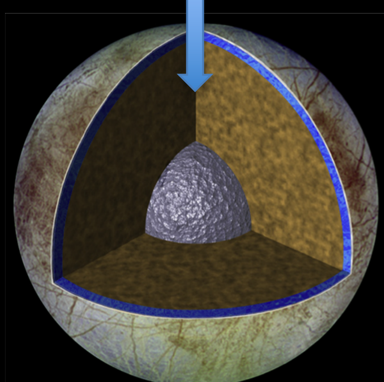
- Accommodates a 2,8 tons lander stack
- Very large tank capacity provides the required deltaV (~ 3 km/s) for a ~13 tons composite
- Two wings solar generator, 75 m^2 → 600W EOL
- Faces very harsh environment (high radiation in Europan orbit, very cold temperature at Jupiter…).
  - Target of 100 krad corresponding to 6 mm of lead shielding (250 kg of shielding)
  - 300 µm thick coverglass protecting the solar cells
- X-band communication system with 2.5m antenna, UHF antenna for lander data reception
- Cylindrical shape of 4m in diameter and 3m in height
- Orbiter Payload allocations: 100 W maximum and 50kg

A KEY STUDY WITH THE ORBITER

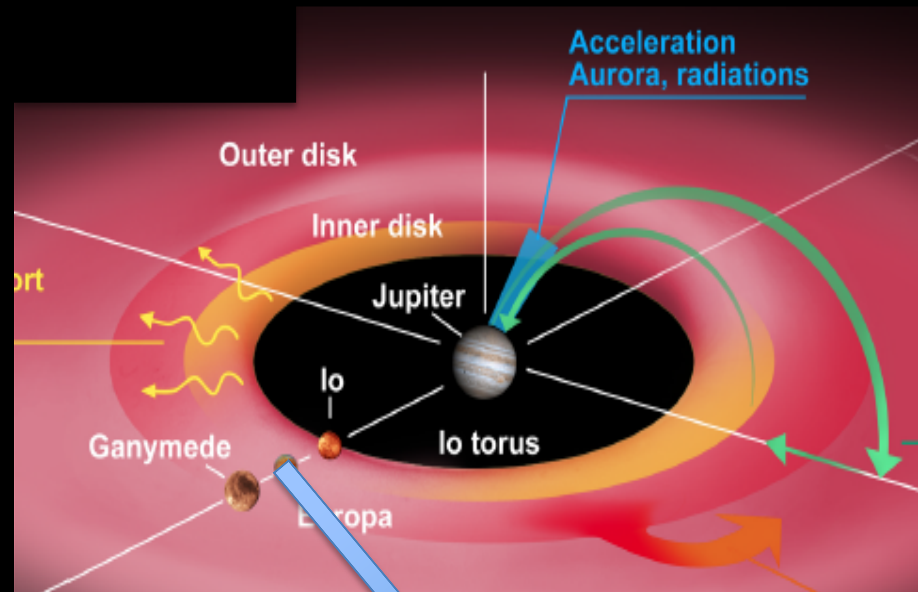
JUPITER SYSTEM FORCING ON EUROPA

GRAVITATIONAL/TIDAL
(Maintained by the Laplace rsonance)



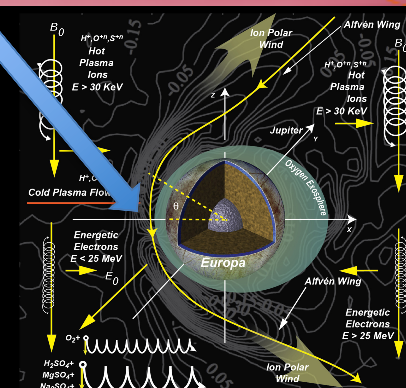


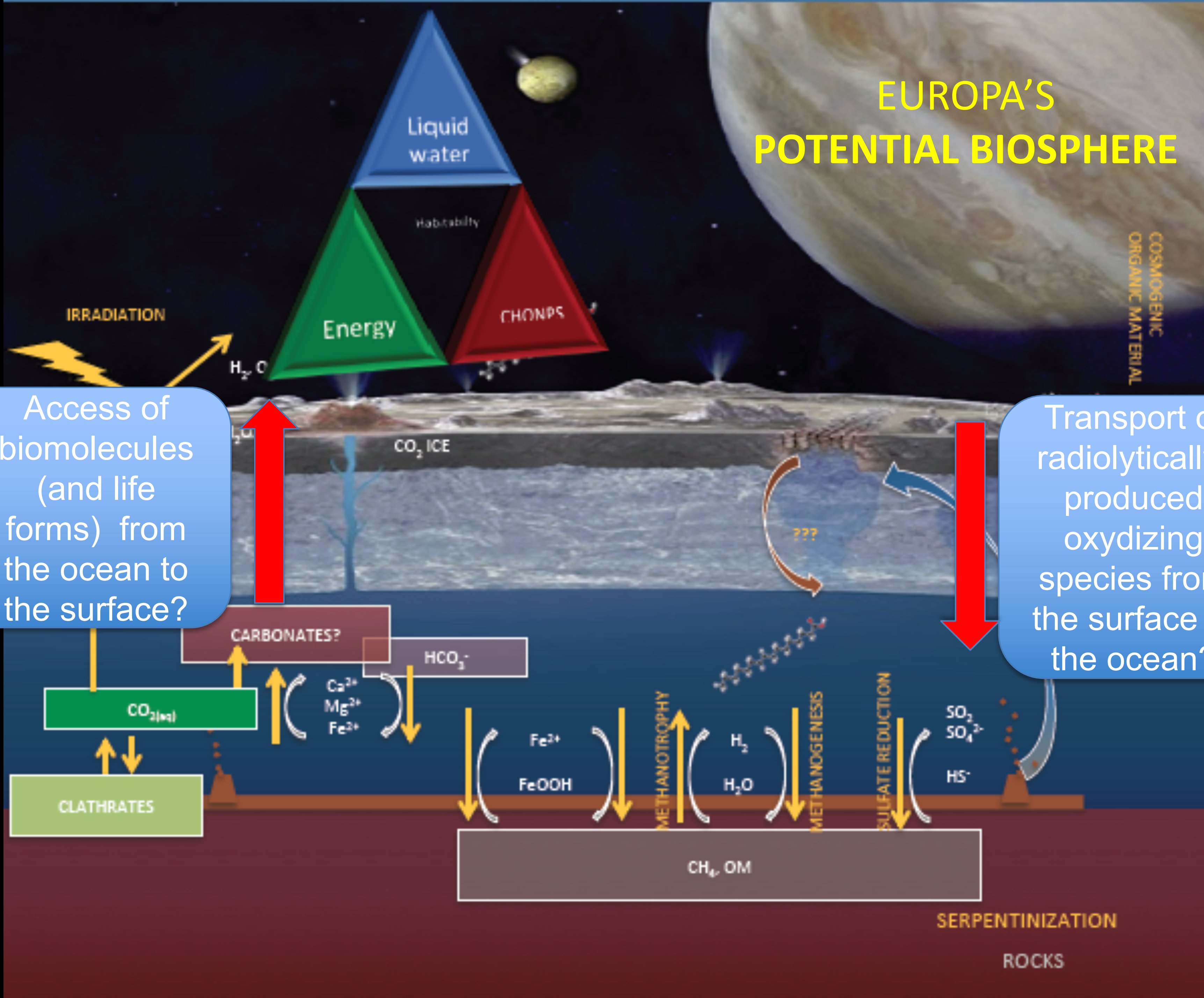
ELECTRODYNAMICAL/MAGNETOSPHERIC



THE FORCING ACTIONS OVERLAP AT:
Ocean
Ice shell

= EUROPA'S
POTENTIAL BIOSPHERE

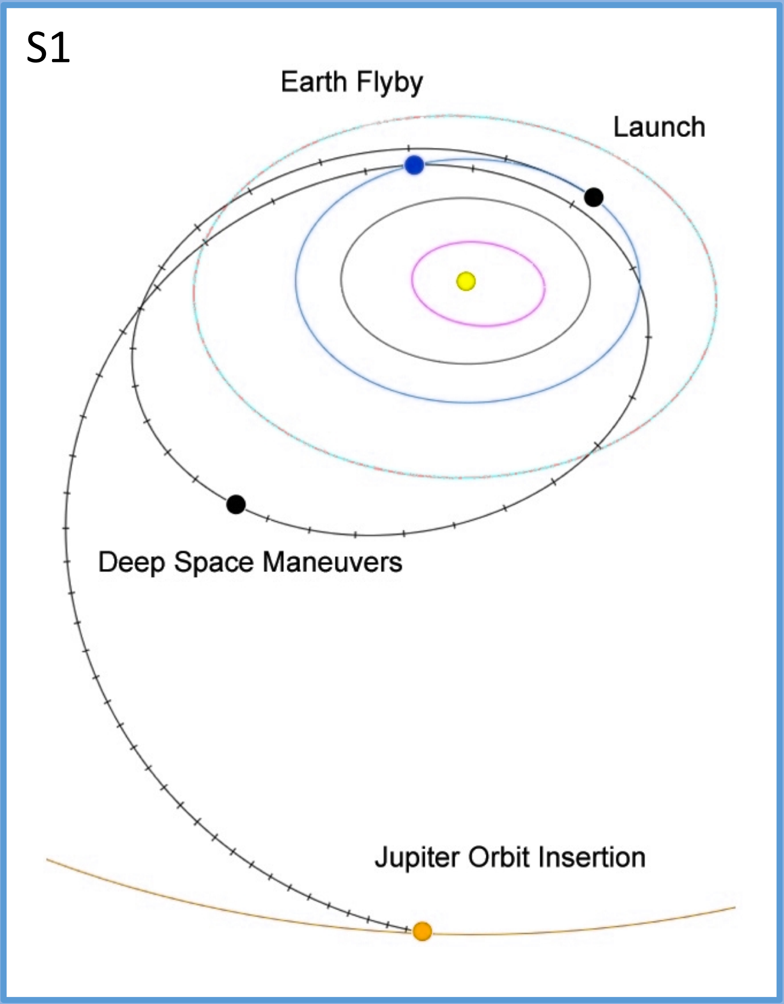



EUROPA'S
POTENTIAL BIOSPHERE
Liquid water
Habitability
Energy
CHONPS
IRRADIATION
COSMOGENIC ORGANIC MATERIAL
Access of biomolecules (and life forms) from the ocean to the surface?
Transport of radiolytically-produced oxydizing species from the surface to the ocean?
CO_2 ICE
???
CARBONATES?
HCO_3^-
$CO_{2(aq)}$
CLATHRATES
Ca^{2+}
Mg^{2+}
Fe^{2+}
Fe^{2+}
FeOOH
METHANOTROPHY
H_2
H_2O
METHANOGENESIS
SULFATE REDUCTION
SO_2
SO_4^{2-}
HS^-
CH_4, OM
SERPENTINIZATION
ROCKS

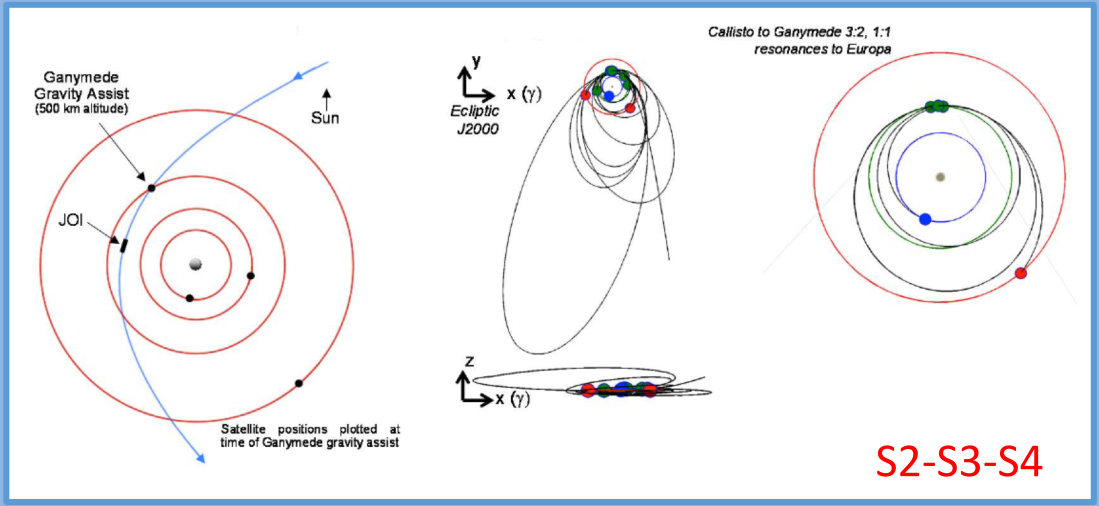
JEM TRACEABILITY MATRIX

Priority Science Objectives (PSO)	Carrier-Orbiter		Lander	
	Required measurements	Constraints on mission and platform	Required measurements	Constraints on mission and platform
PSO #1: Determine the global structure of the Europan magnetic field and plasma environment including potential plume characterization, and the associated response of Europa, including its ocean, to Jupiter System magnetospheric forcing.	Magnetometer Ion Mass Spectrometer/ Electron Mass Spectrometer (Langmuir Probe) Radiation Monitor Ion and Neutral Mass Spectrometer Dust analyzer	-3D Coverage of the Europan environment including crossing of the Alfven wings -Low-altitude (100-200 km) near-polar, circular orbit for at least 30 days -Low-altitude crossing of plumes (< 160 km) for orbiter	Magnetometer	Lander lifetime of at least 7 days (2 Europa rotations)
PSO #2: Determine the global structure of the solid body and potential biosphere of Europa, and their response to Jupiter System tidal forcing.	Radio Science Instrument Laser Altimeter		Geophone Laser Reflector	
PSO #3: Understand the exchange and transformation processes at the interface between the ice-shell surface/subsurface and the exosphere/ionosphere including potential plume characterization.	Ion and neutral MS Ion MS + electron Spectrometer Dust Analyzer	-Spatial resolution of few 10's km horizontally and few km in altitude up to 1 Europa radius from the surface; of 100's km horizontally and 10's km in altitude for major species -Full latitudinal and longitudinal coverage at few phase angles with a temporal resolution from one hour to few 10s of hours -Coverage of Europa's exosphere during eclipse		
PSO #4: Understand the exchange processes between the ice-shell surface/subsurface and the aqueous interior environments, focusing on the hydrochemistry and physical state of the ice crust.	Laser altimeter	Altimetry from the orbiter combined with in situ measurements	Imaging camera, Microscope, GCMS, Raman, Geophone Thermogravimeter, Electrochemical sensors, Magnetometer	In situ analysis from the landing site. Sampling and analysis in solid and liquid state
PSO #5: Search for biosignatures at the surface/subsurface and potential plumes	Ion and neutral MS		Microarray immunoassay detector, GCMS, Raman, Imaging camera, Microscope Thermogravimeter	In situ analysis from the landing site. Sampling and analysis in solid and liquid state Characterize potential plumes if there is some activity

APPROACH ORBITS



Interplanetary cruise



Jovian Tour

Descent Science with NIMS

Critical exosphere measurements below 15 km altitude