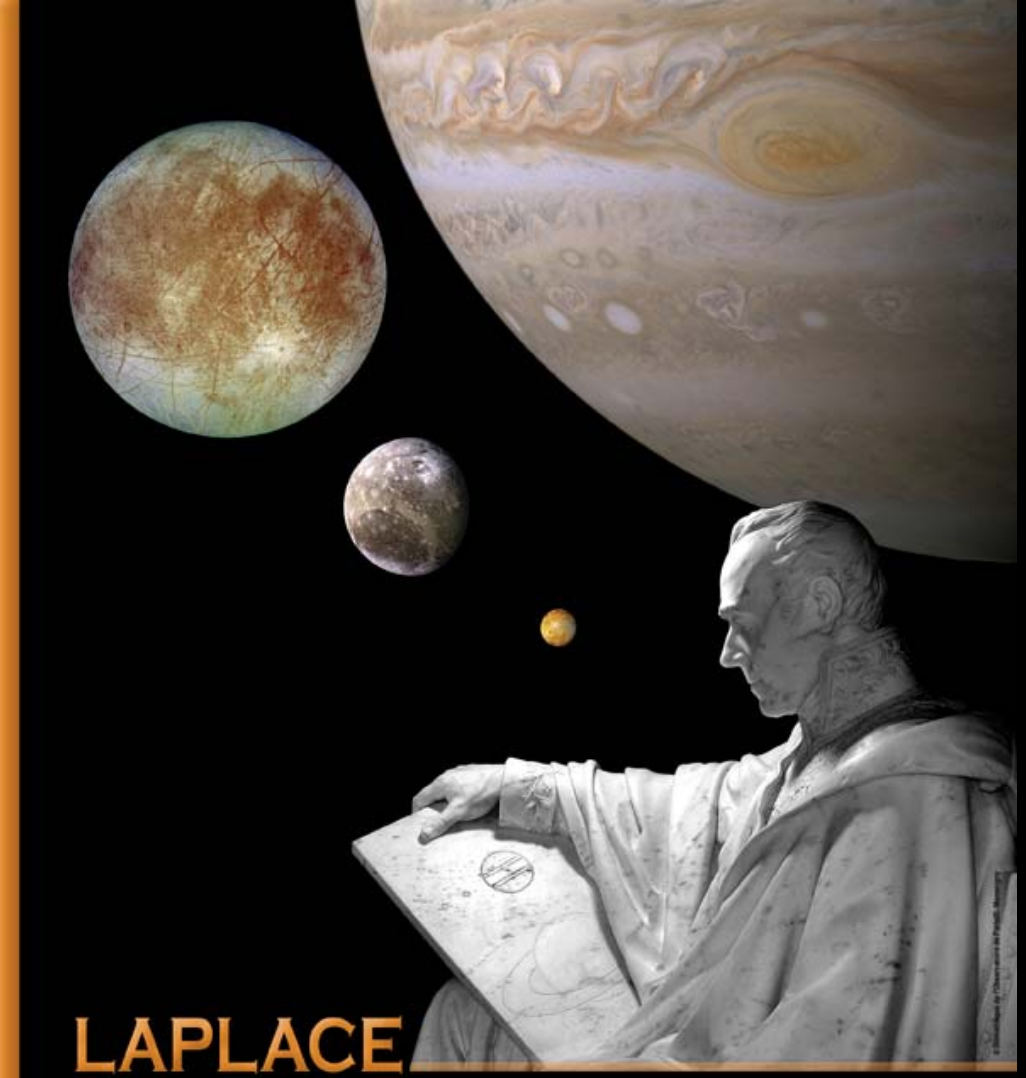

LAPLACE

A MISSION TO EUROPA AND THE JUPITER SYSTEM
FOR ESA'S COSMIC VISION PROGRAMME

http://jupiter-europa.cesr.fr/

Presentation to ESA's Solar System Working Group Oct. 11, 2007

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Many thanks to Astrium and CNES PASO for their support

A science Road Map to the Jupiter system

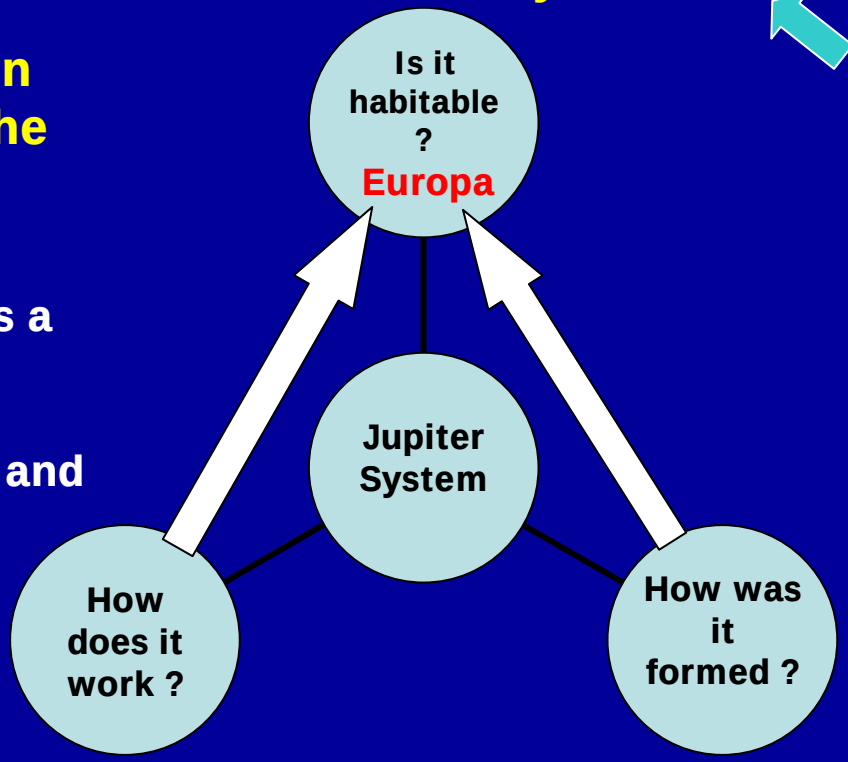
	Galileo 1st global exploration	JUNO 1st polar orbiter	LAPLACE 1st multi-platform mission	Europa Lander
Jupiter	Science return limited (data volume & Instruments) *Key science questions identified*	Origin & int. Structure (1) troposphere	Int. Structure (2) Upper/middle atm. S and D	
Magneto-sphere		Polar	Magnetodisk Satellite interactions	
Satellites			Formation S & D (oceans?) System coupling	
Europa			Characterizing ocean & habitability	Search for biosignatures and life

LAPLACE is tailored to address the themes of Cosmic Vision

1.3 Life and habitability in the Solar System

2.1 From the Sun to the edge of the Solar System:

The Jovian magnetosphere as a local template for astrophysical magnetized disks and binary systems



CV theme 1:

What are the conditions for planet formation and the emergence of life?

1.1 From gas and dust to stars and planets.

2.2 Gaseous Giants and their Moons

2.3 The Building Blocks of the Solar System: Asteroids and Small Bodies

CV theme 2: How does the Solar System work?

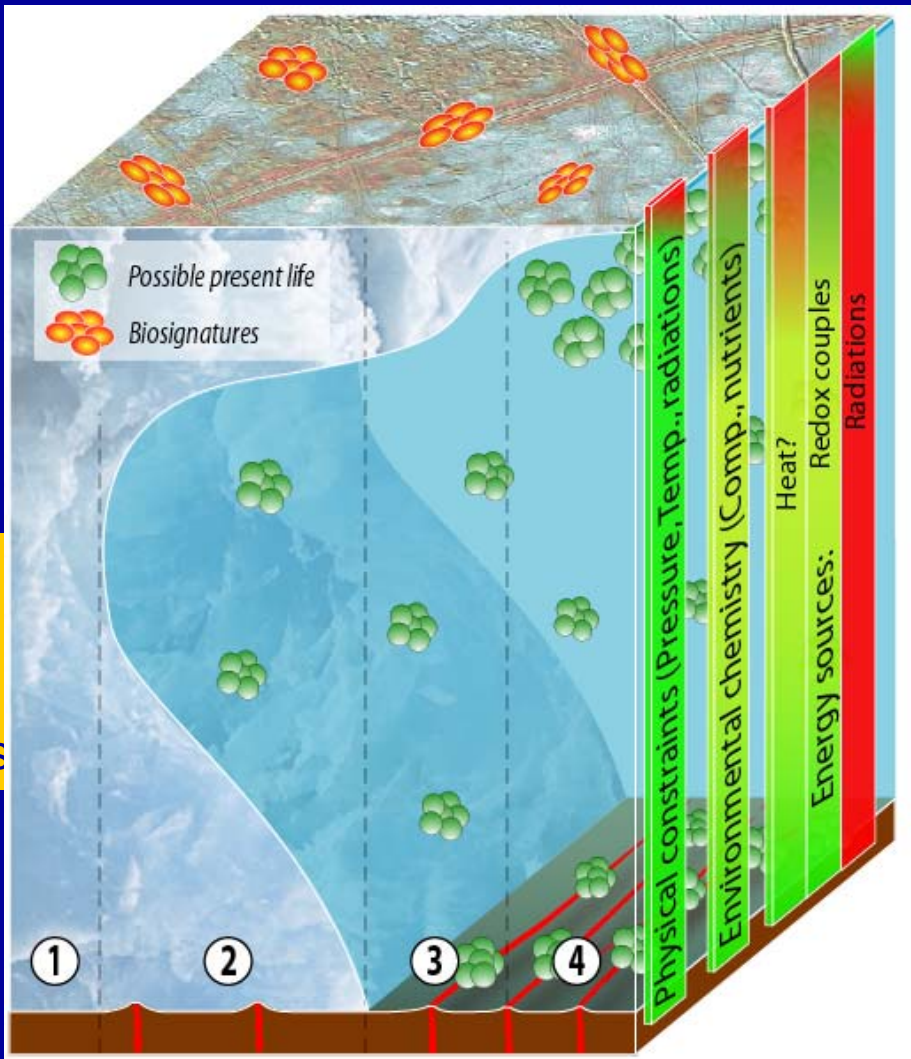
I- Is Europa habitable?

Highest Priority

- Existence of a sub-surface ocean
- Surface composition and chemistry
- Characterization of the liquid layer
- Silicate/ocean surface topography
- Search for astrobiological signatures

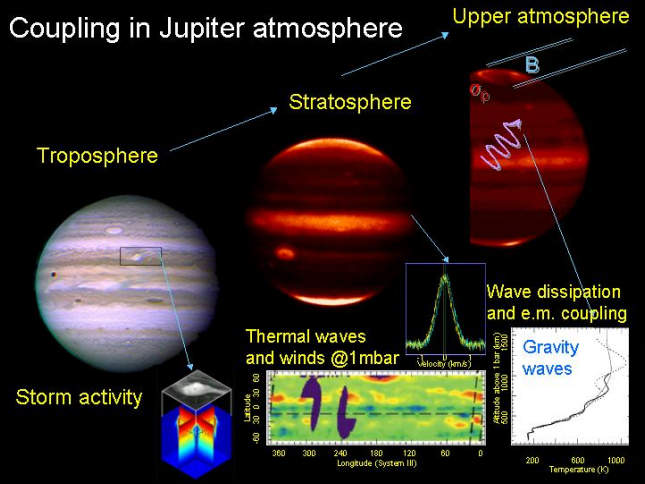
Lower Priority

- Global surface morphology & dynamics
- Constraints on mantle dynamics
- Exosphere & Magnetospheric interactions

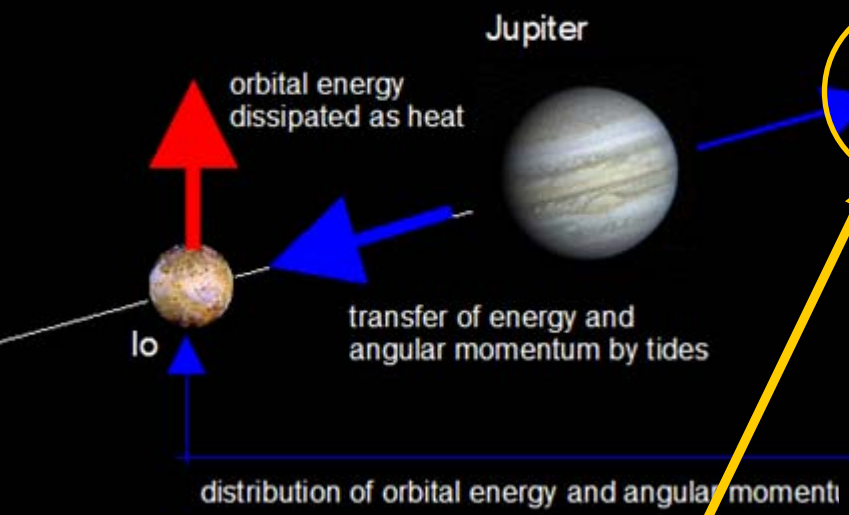


II- How does the Jupiter system work?

Does it provide present conditions favorable to Europa's habitability?

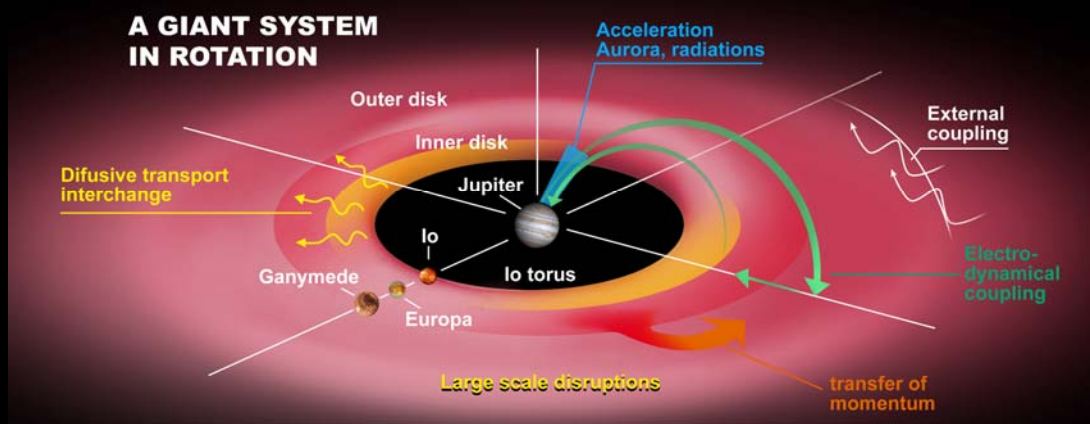


Jupiter



Satellite system

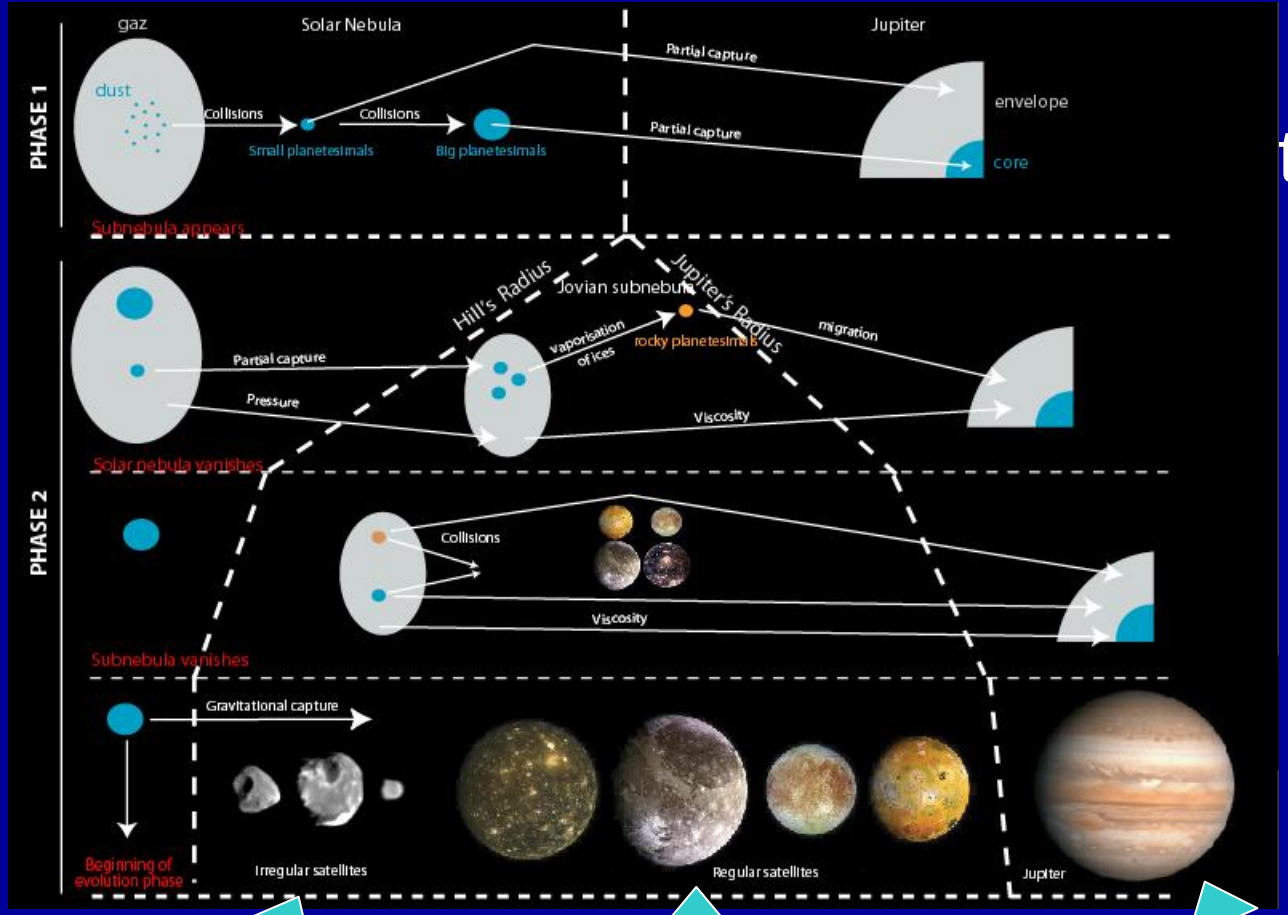
Magnetodisk/ radiation belts



III- How did the Jovian system form ?

Did it provide

initial conditions favorable to Europa's habitability?

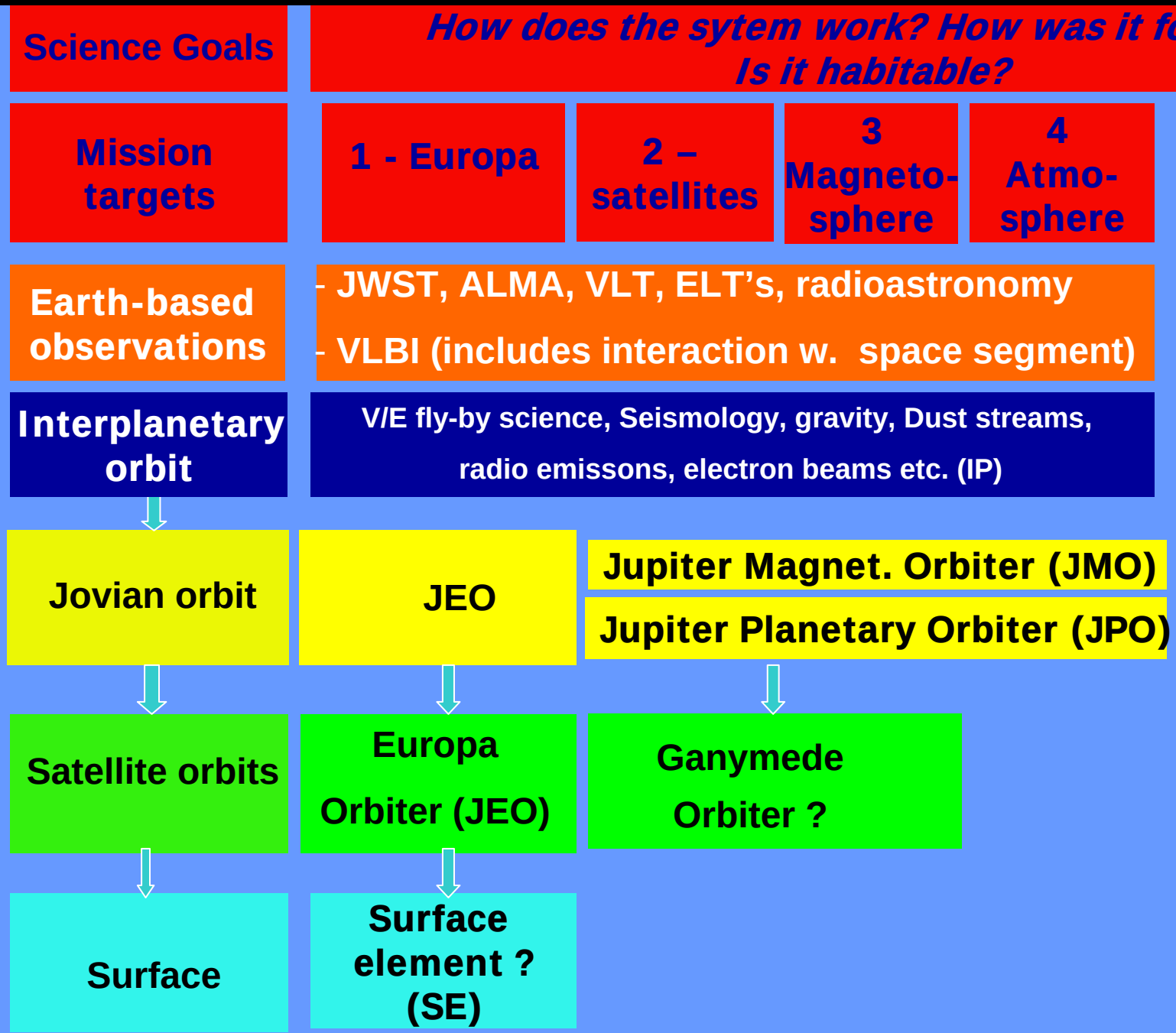


Constraints on early evolution of the system from the cratering records of irregular and regular satellites

Constraints on the proto-jovian nebula from chemical and isotopic abundances of the regular satellites

Constraints on internal structure and core size (complementary to JUNO) using seismology

The LAPLACE observing system (1)



The LAPLACE observing system (2)

- **two Jovian orbiters:**

  one 3-axis-stabilized platform for remote sensing instruments:

  JPO Jovian Planetary Orbiter

  one spinning platform for in-situ fields-and particles measurements:

  JMO Jupiter Magnetospheric Orbiter

- **one** nadir-pointing platform:

  JEO Jupiter Europa orbiter

Two options for ESA L-class (Astrium support studies):

- Backup scenario : **ESA-only mission**.
  One S/F launch.
  Two s/c: Jupiter Relay Satellite (= JMO + JPO), JEO.
- Preferred scenario : **Two medium capacity launchers with**:
  - JPO **+ JMO** on one launch – JPO final injection to Ganymede orbit to be studied
  - **JEO** on the second launch

  Many options for international collaboration

3 categories of scientific investigations required:

- **measurements of the main planetary fields (Europa, other satellites)**
- **multi-spectral remote sensing of the surfaces, atmospheres and gas tori, and possibly sub-surfaces**
- **in situ remote sensing of the plasmas, fields, energetic particles gas and dust populations**

Distributed between the platforms to:

- Maximize complementarities and synergies
- Take advantage of the specific pointing requirements of each platform

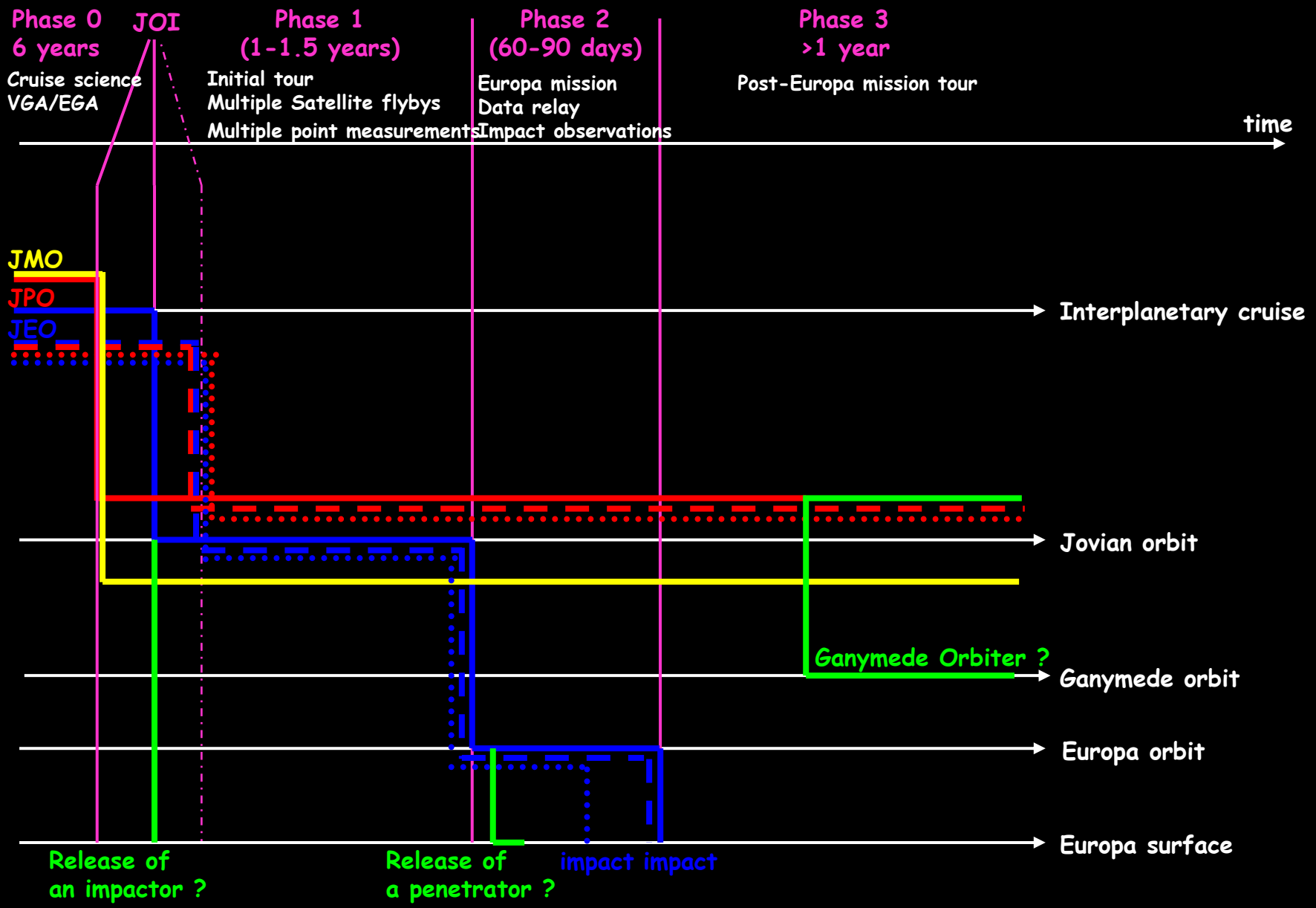
A possible science payload consists of:

- **core instruments** addressing high-priority science objectives,
- specific high-priority **instruments to be studied** during the assessment phase,
- complementary **additional instruments**.

A **highly integrated payload approach** will optimise science return

		Scenario 1		Scenario 1 Integrated approach	
Jupiter Europa Orbiter		Payload mass (kg) 50/75 Shielding coefficient 0.6		Payload mass (kg) 50/75 Shielding coefficient 0.6	
	Core	Radio Science	3	Radio Science	3
		*Micro-Gradiometer	1	*Micro-gradiometer	1
		Laser altimeter	5	Laser altimeter/Camera int.	7
		Magnetometers	3	Magnetometers	3
		Camera package	8	Camera/NIR/UV integrated	8
		V/NIR spectrometer	5	Integrated plasma package	4
		INMS	3	INMS	3
		Dust analyzer	3	Dust analyzer	3
	TBS	Penetrating radar	15	Penetrating radar	15
		*Micro-gradiometer	1	*Micro-gradiometer	1
	Additional	X-ray imaging spectrometer	5	X-ray imaging spectrometer	5
		Reduced plasma package	5		
		ENA low-energy imager	2	ENA low-energy imager	2
		UV imaging spectrometer	4		
		γ/neutron spectrometer	5	γ/neutron spectrometer	5
		Sub-mm wave sounder	7	Sub-mm wave sounder	7
Jupiter Planetary Orbiter		Payload mass (kg) 50/75 Shielding coefficient 0.8		Payload mass (kg) 50/75 Shielding coefficient 0.8	
	Core	Radio Science	3	Radio Science	3
		Magnetometers	2	Magnetometers	2
		Camera package	15	Camera/NIR/UV integrated	15
		TIR imaging spectrometer	4	TIR imaging spectrometer	4
		V/NIR imaging spectrometer	5	Sub-mm Wave Sounder	7
		Sub-mm Wave Sounder	7	Integrated plasma package	6
		Reduced plasma package	5	X-ray imaging spectrometer	5
	TBS	Doppler spectro-imager	5	Doppler spectro-imager	5
	Additional	ENA high-energy imager	3	ENA high-energy imager	3
		X-ray imaging spectrometer	5		
		UV imaging spectrometer	4		
		Dust analyzer	3	Dust analyzer	3
Jupiter Magnetospheric Orbiter		Payload mass (kg) 25/30 Shielding coefficient 0.8		Payload mass (kg) 25/30 Shielding coefficient 0.8	
	Core	Magnetometers	2	Magnetometers	2
		Plasma spectrometers	7	Integrated plasma package	10
		Energetic particle detectors	6	Radio & Wave instrument	5
		Radio & Wave instrument	5	Dust Analyzer	3
	Additional	Dust Analyzer	3		

LAPLACE mission timeline



Key technology areas to be addressed in study phase

- Energy source: solar panels vs. RPS ?
- Radiation tolerance of on-boars systems and instruments
- Planetary protection compliance (for JEO)
- Tight mass/energy budget, calls for specific integrated strategy
- Optimisation of data storage/transmission
- High navigation/positioning accuracy, a key element for Europa and the satellites (gravity, topography, ocean detection, internal structure, Laplace resonance)

To be assessed during first study phase, but

no show-stoppers at preliminary study

Mission scenarios and international collaboration

- LAPLACE is feasable by ESA only (scenario 3), by narrowing-down to main science target: Europa characterisation + its coupling to the Jupiter system
- Broadly multi- and inter-disciplinary misison. Raises considerable interest for the exploration of Jupiter and Europa in the scientific communities of the U.S.A., Japan, Russia and beyond.
- Specific architecture (multi-platform, multi-target) provides an outstanding framework for international collaboration
- ESA has an ideal collaboration experience to lead the mission:
  - Cassini-Huygens with NASA
  - BepiColombo with JAXA
  - Long experience of collaboration with Russia in Europe
- ESA-JAXA-NASA collaboration, with RosCosmos participation, offers a unique potential to fly the mission in its most ambitious scenario:
  - Let us join our resources, our technology and science know-how,
  - And share science payloads on all three platforms via an international call for investigations
- We shall be ready for a 2018 launch!

Complements by Bob and Masaki on interests and contributions from U.S. and Japanese science communities

End of the presentation