



Cosmic Vision and other missions for Space Science in Europe 2015-2035

Athena Coustenis

LESIA, Observatoire de Paris-Meudon

Chair of the Solar System and Exploration Working Group of ESA

Member of the Space Sciences Advisory Committee of ESA

Current ESA space science missions



The call



BR-247

Cosmic Vision

Space Science for Europe 2015-2025



European Space Agency
Agence spatiale européenne

The call for proposals for Cosmic Vision missions was issued in March 2007. This call was intended to find candidates for two medium-sized missions (M1, M2 class, launch around 2017) and one large mission (L1 class, launch around 2020).

Fifty mission concept proposals were received in response to the first call.

From these, five M-class and three L-class missions were selected by the SPC in October 2007 for assessment or feasibility studies.

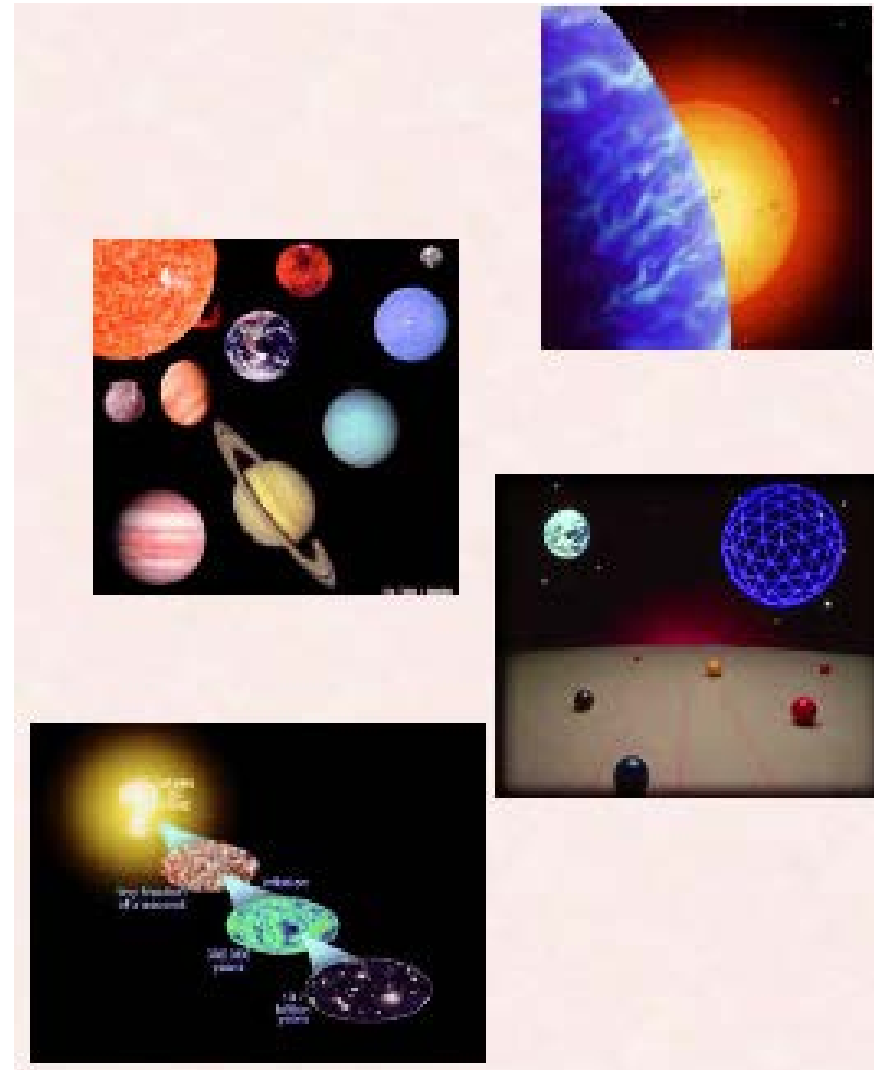
In July 2010, another call was issued, for a medium-size (M3) mission opportunity for a launch in 2022.

Also about 50 proposals were received for M3 and 4 concepts were selected for further study.

The COSMIC VISION “Grand Themes”



1. What are the conditions for planetary formation and the emergence of life ?
2. How does the Solar System work?
3. What are the physical fundamental laws of the Universe?
4. How did the Universe originate and what is it made of?

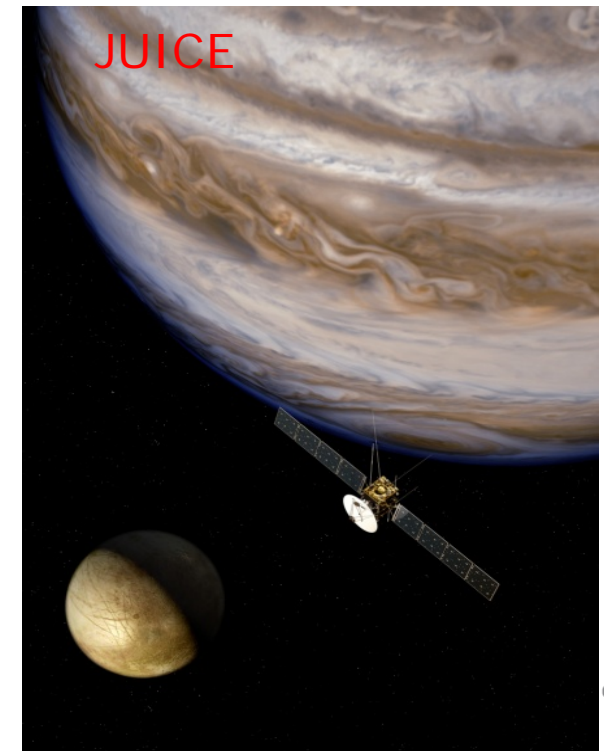


COSMIC VISION (2015-2025)

Step 1



- Proposal selection for assessment phase in October 2007
 - 3 M missions concepts: Euclid, PLATO, Solar Orbiter
 - 3 L mission concepts: X-ray astronomy, Jupiter system science, gravitational wave observatory
 - 1 MoO being considered: European participation to SPICA
- **Selection of Solar Orbiter as M1 and Euclid as M2 in 2011.**
- **Selection of Juice as L1 in 2012.**

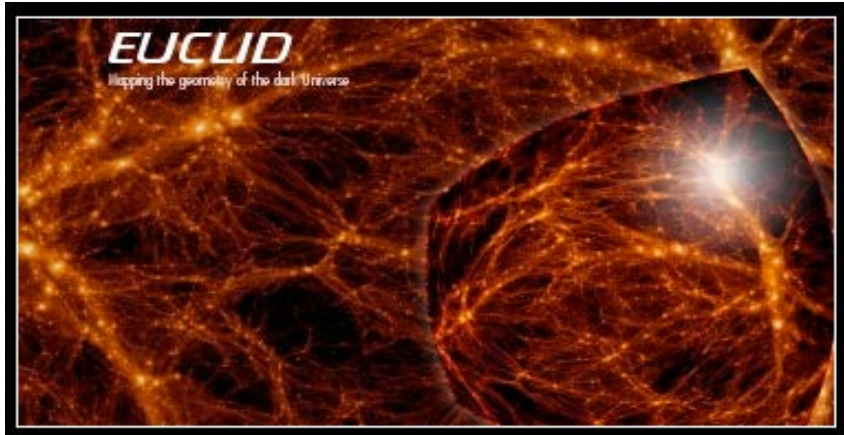


ency

The finally selected M1/M2-class missions



Solar Orbiter (theme 2), a mission intended to produce images of the Sun at an unprecedented resolution and perform the closest-ever measurements of local, near-Sun phenomena. Solar Orbiter was carried over from Horizon 2000 Plus.



Euclid (theme 4) – to map the geometry of the dark Universe, measuring the distance-redshift relation and the growth of structure by using two complementary dark energy probing methods, baryonic acoustic oscillations and weak gravitational lensing.



+ possible contribution to SPICA

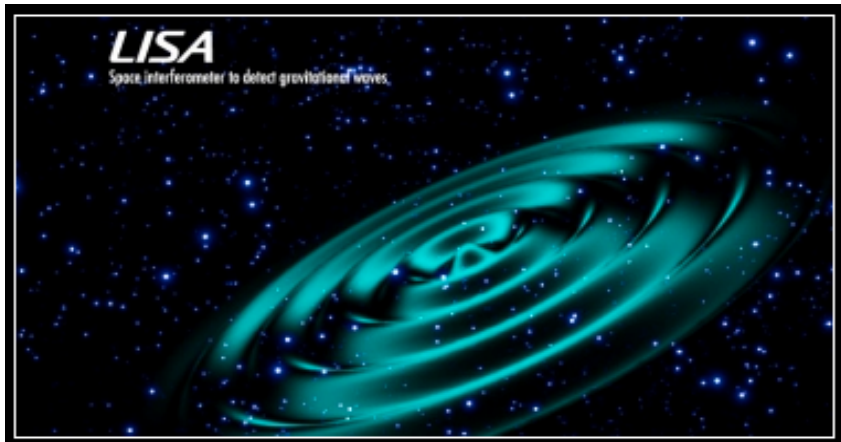
(SPace Infrared telescope for Cosmology and Astrophysics; theme 4) – a next-generation infrared space observatory to probe galaxy, star and planetary system formation, as well as the evolution of dust and gas in the interstellar medium of our own and distant galaxies by performing imaging and spectroscopic observations in the 5–210 micron waveband. Mission led by JAXA.

The candidate L-class missions



ATHENA –It was the result of the reformulation, in 2011, of the IXO mission, a next-generation facility to address some of the most fundamental questions in astrophysics and cosmology by investigating black holes and matter under extreme conditions, the formation and evolution of galaxies, clusters and the large scale structure, and the lifecycles of matter and energy.

NOR



The New Gravitational wave Observatory (**NGO**) is a space mission designed to measure gravitational radiation over a broad band at low frequencies, from about 100 μHz to 1 Hz, a band where the Universe is richly populated by strong sources of gravitational waves. It was the result of the reformulation, in 2011, of the LISA mission.

JUICE L1 ESA CV mission! (2 May 2012)

The JUperiter ICy moons Explorer mission, JUICE, will be the first Large-class mission in ESA's Cosmic Vision 2015–2025 programme.

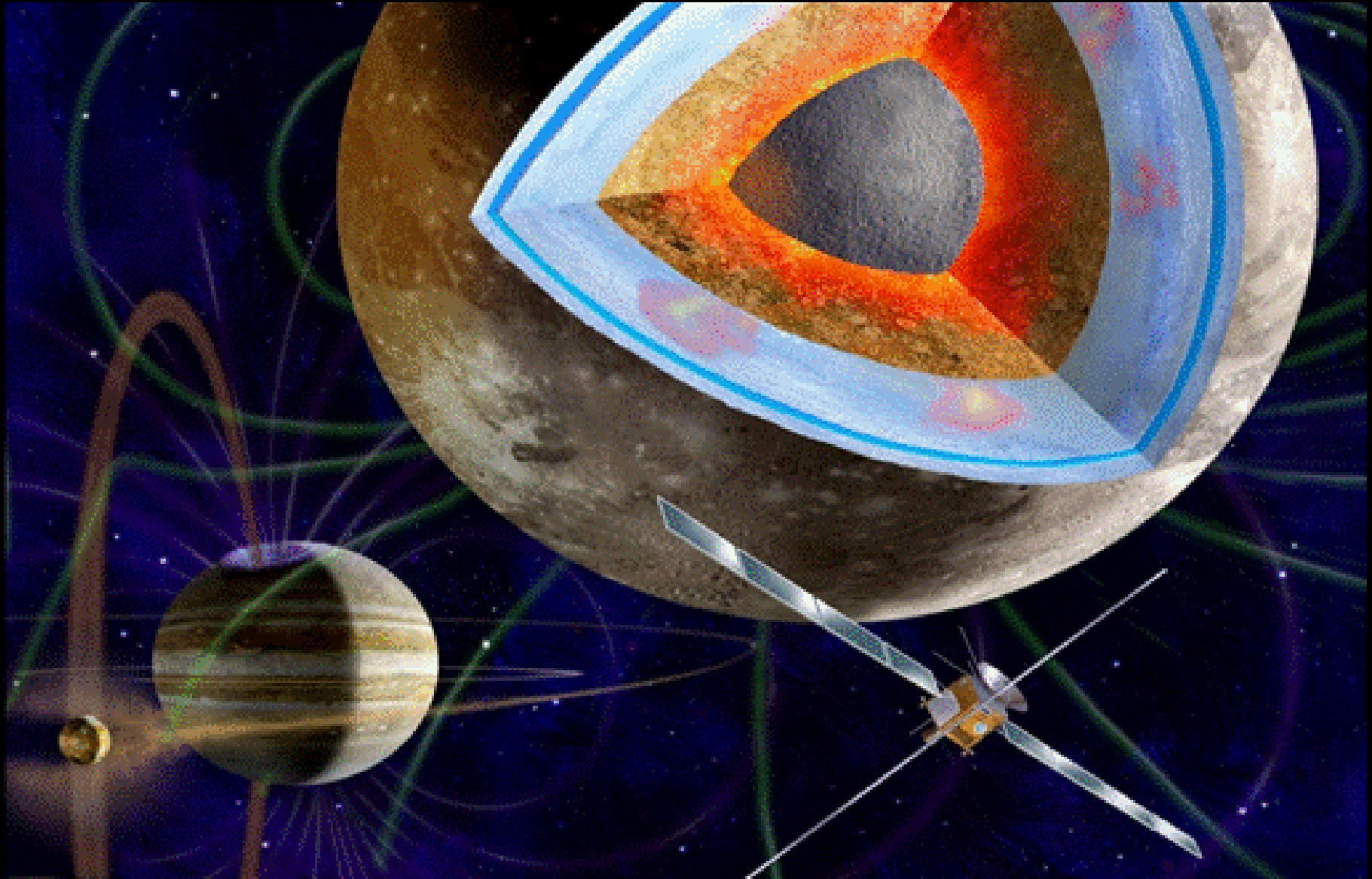
Planned for launch in 2022 and arrival at Jupiter in 2030, it will spend at least three years making detailed observations of the biggest planet in the Solar System and three of its largest moons, Ganymede, Callisto and Europa.

These moons are thought to harbour vast water oceans beneath their icy surfaces and JUICE will map their surfaces, sound their interiors and assess their potential for hosting life in their oceans.



Jupiter Icy Moons Explorer : JUICE

ESA's first L-class mission



Exploration of the Jupiter system

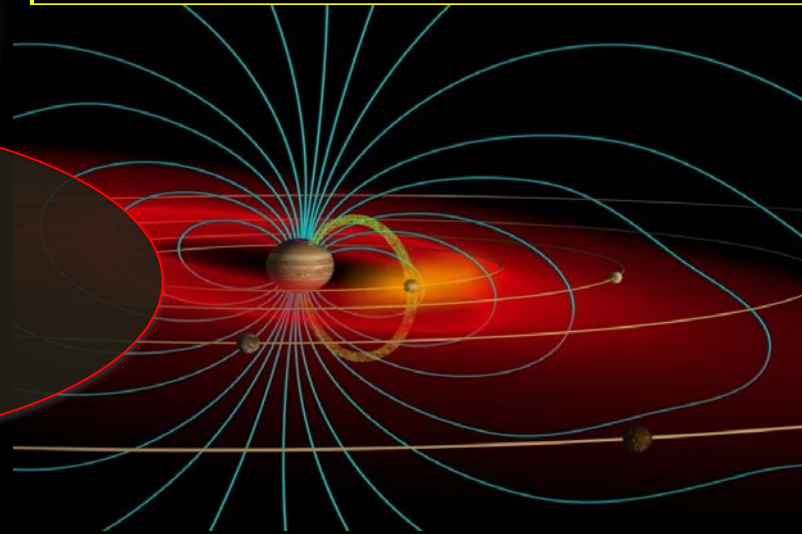
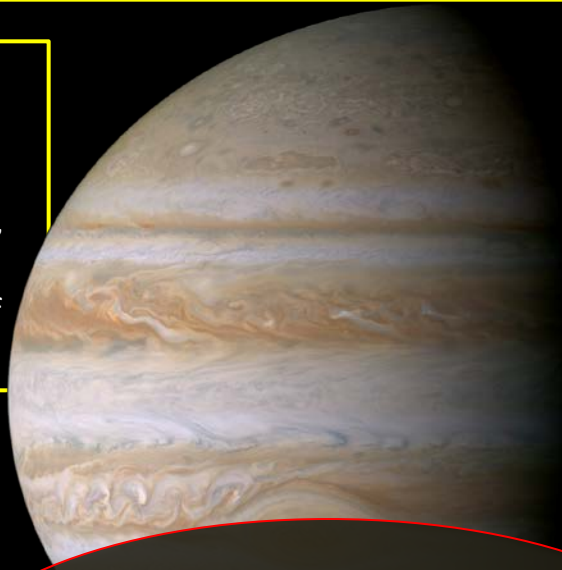
The biggest planet, the biggest magnetosphere, and a mini solar system

Jupiter

- Archetype for giant planets
- Natural planetary-scale laboratory for fundamental fluid dynamics, chemistry, meteorology,...
- Window into the formational history of our planetary system

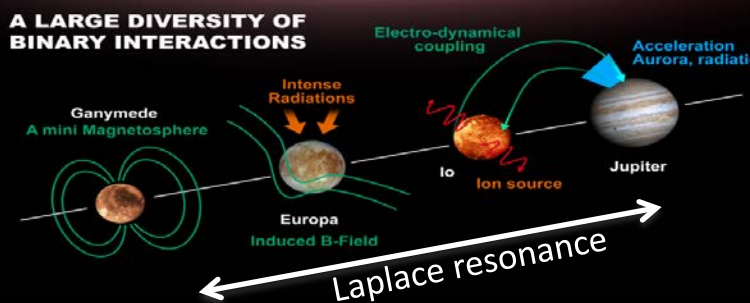
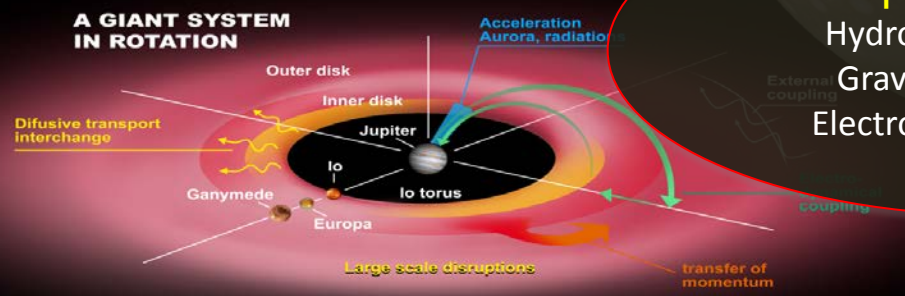
Magnetosphere

- Largest object in our Solar System
- Biggest particle accelerator in the Solar System
- Unveil global dynamics of an astrophysical object



Coupling processes

- Hydrodynamic coupling
- Gravitational coupling
- Electromagnetic coupling



Satellite system

- Tidal forces: Laplace resonance
- Electromagnetic interactions to magnetosphere and upper atmosphere of Jupiter

JUICE instruments chosen ! (21 February 2013)

The JUpiter ICy moons Explorer mission, JUICE, will carry a total of 11 scientific experiments to study the gas giant planet and its large ocean-bearing moons.

These moons are thought to harbour vast water oceans beneath their icy surfaces and JUICE will map their surfaces, sound their interiors and assess their potential for hosting life in their oceans.

On February 21, 2013 ESA's Science Programme Committee approved a complement of instruments that includes cameras and spectrometers, a laser altimeter and an ice-penetrating radar. The mission will also carry a magnetometer, plasma and particle monitors, and radio science hardware. The instruments will be developed by scientific teams from 16 European countries, the US and Japan, through

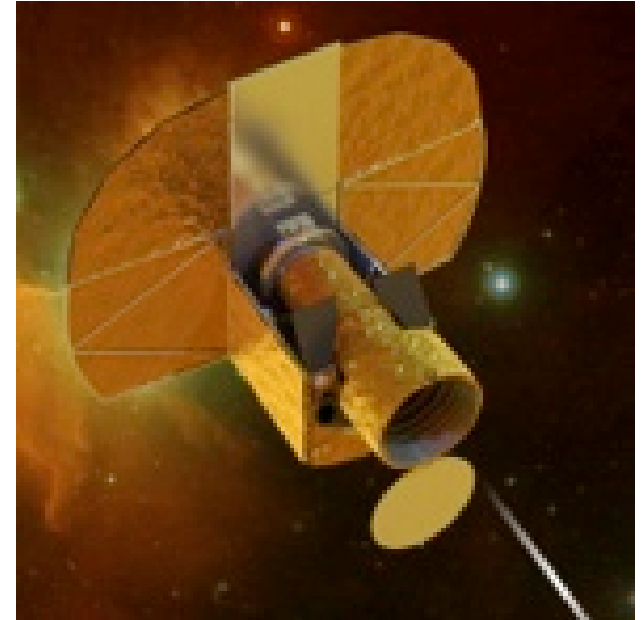
Imaging		
JANUS (NAC and acting as WAC)	14 kg	IT, G
Spectroscopy		
Visible Infrared Hyperspectral Imaging Spectrometer (MAJIS)	22 kg	FR, IT
UV Imaging Spectrometer (UVS)	6 kg	USA
Sub-mm Wave Instrument (SWI)	10 kg	G
In situ Fields and Particles		
Magnetometer (J-MAG)	2.4-5 kg	UK
Radio and Plasma Wave Instr. (RPWI)	12 kg	SUE
Particle and Plasma Instrument - Ion Neutral Mass Spectrometer (PEP)	23/18/13 kg	SUE
Sounders & Radio Science		
Laser Altimeter (GALA)	12 kg	G
Sub-surface Radar (RIME)	10 kg	IT
Radio Science Instrument (3GM = KaT+USO)	4 kg	IT

Total mass: ~110 kg

ESA S1 MISSION SELECTED ! (19 October 2012)

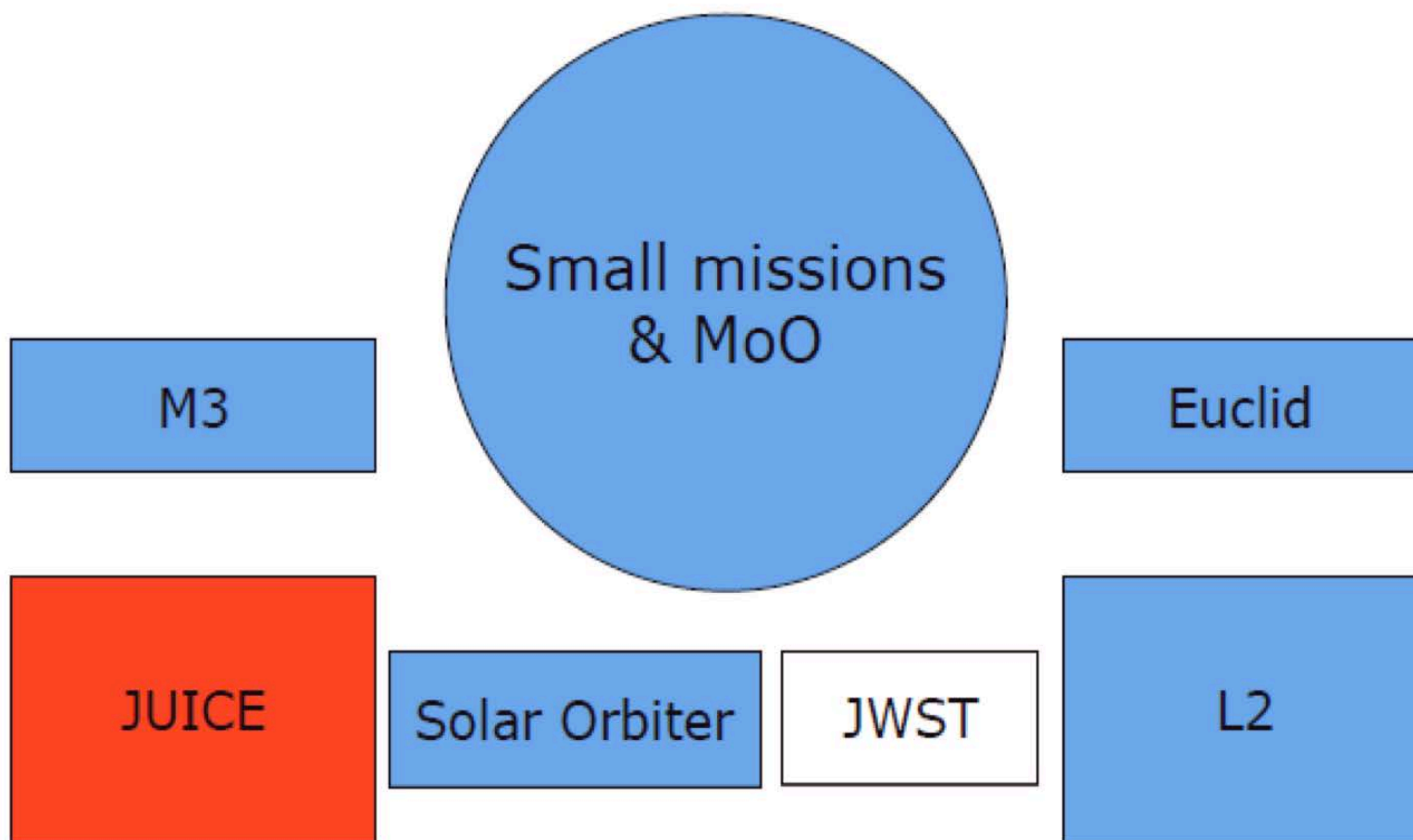
CHEOPS has been selected as the S1 mission, with targeted launch date in 2017.

A technical screening was carried out by ESA on all proposals received in response to the call for S-class missions. On 20 September 2012, the proposals that passed the screening were evaluated by the Space Science Advisory Committee, which recommended CHEOPS as the S1 mission. The Science Programme Committee selected CHEOPS at their meeting on 19 October 2012.



CHEOPS - *CH*aracterizing *ExO*Planet Satellite - will be the first mission dedicated to searching for exoplanetary transits by performing ultrahigh precision photometry on bright stars already known to host planets. It will provide the unique capability of determining *accurate radii for a subset of those planets, in the super-Earth to Neptune mass range*, for which the mass has already been estimated using ground-based spectroscopic surveys. CHEOPS will also provide precision radii for new planets of Neptune-size and smaller that are discovered by the next generation of ground-based transit surveys.

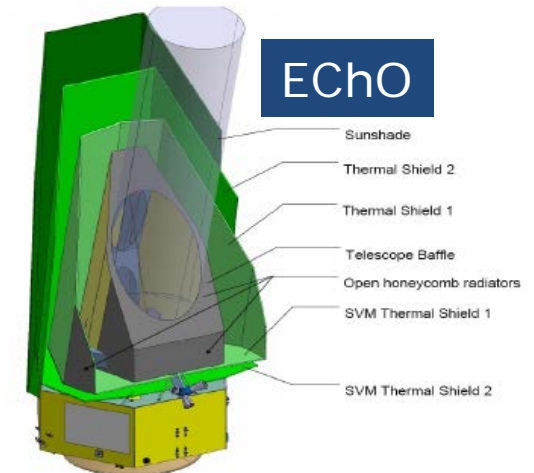
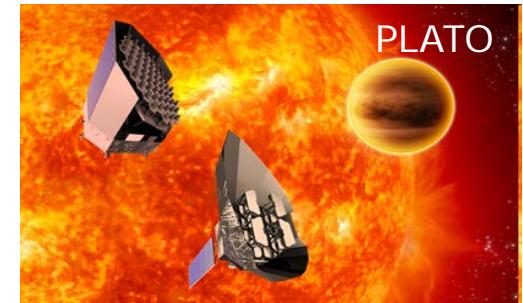
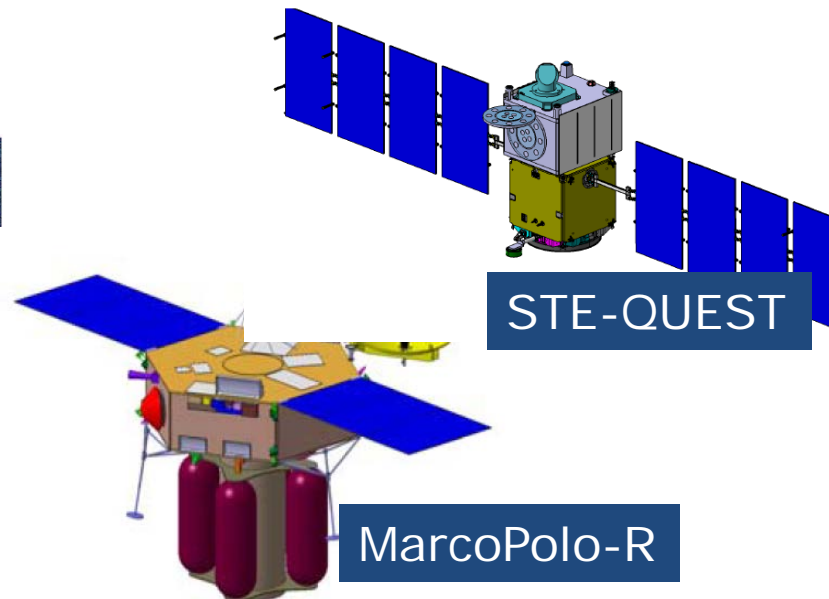
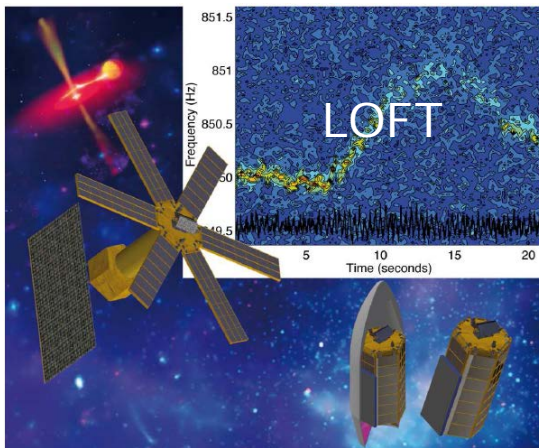
CV First Slice (2015-2025)



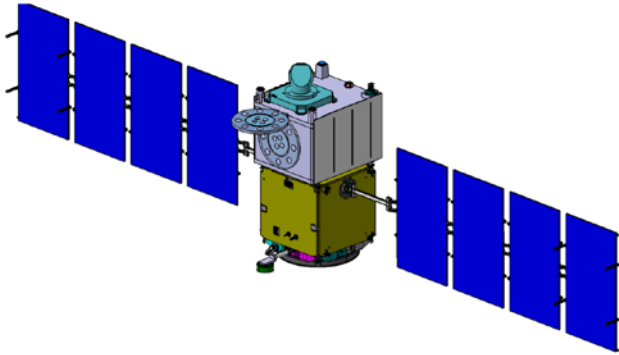
COSMIC VISION (2015-2025)

Step 2

- Second “Call for Missions” issued in 2010
- Only M mission proposals solicited
- ECHO, MarcoPolo-R, LOFT, STE-QUEST selected for assessment with PLATO retained from previous round
- Selection planned for the beginning of 2014

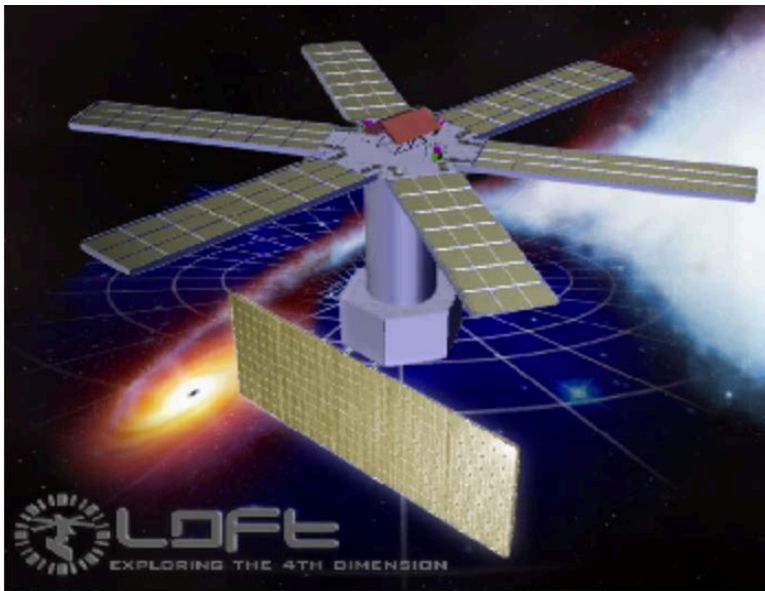


ESA SELECTS 5 M-CLASS CANDIDATE MISSIONS TO FLY IN 2022+

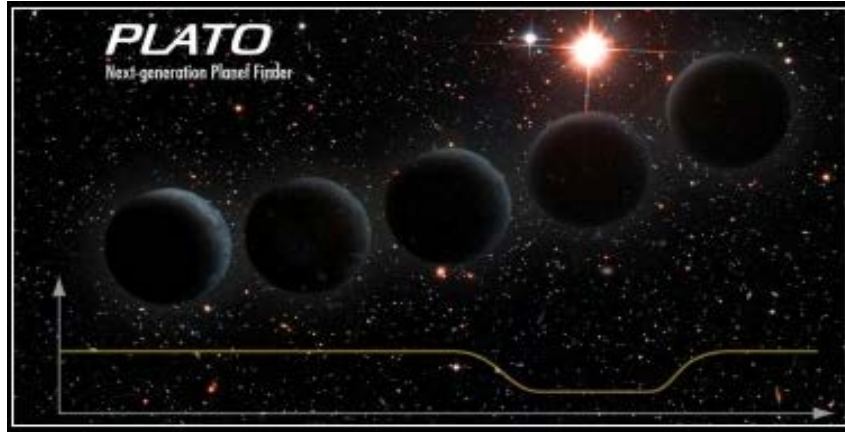


STE-QUEST—The Space-Time Explorer and Quantum Test of the Equivalence Mission is devoted to a *precise measurement of the effect of gravity on time and matter using an atomic clock and an atom interferometer*. It tests a fundamental assumption and one of the most fundamental predictions of Einstein's Theory of General Relativity with high precision and thereby searches for hints of quantum effects in gravity. The first primary goal of the mission will be to measure space-time curvature via the precise determination of gravitational time dilation.

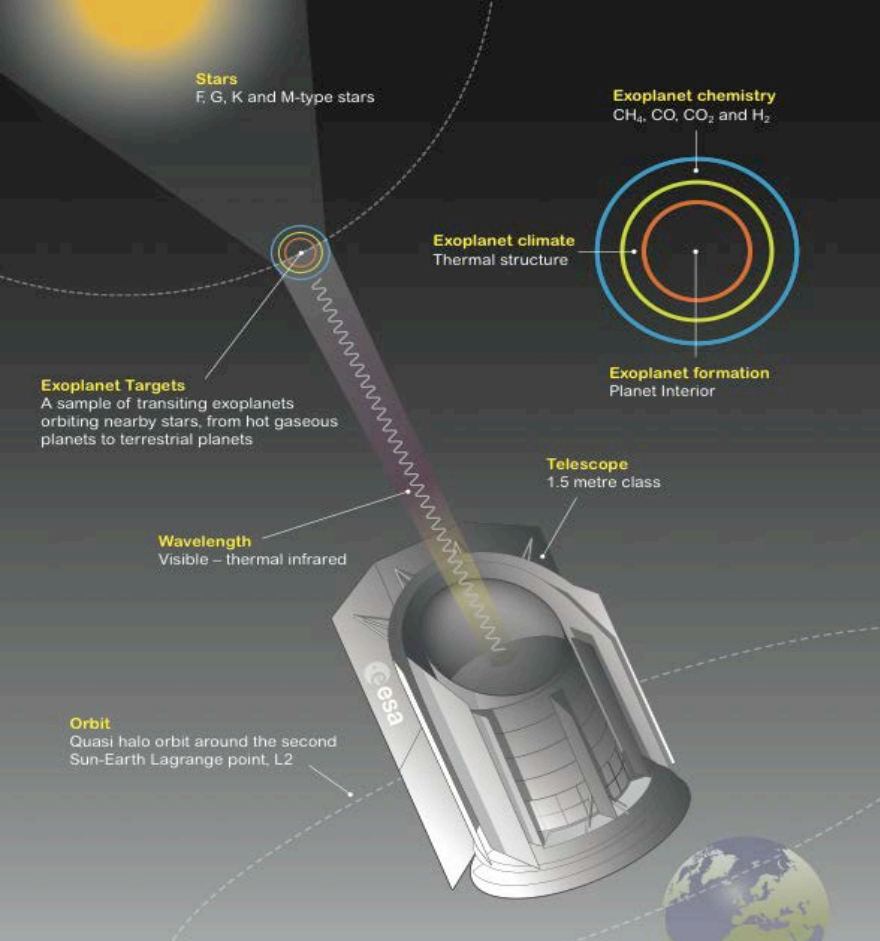
The Large Observatory for X-ray Timing (**LOFT**) is devoted to the *study of neutron stars, black holes and other compact objects by means of their very rapid X-ray variability*. The main scientific objectives of LOFT are the determination of the neutron star structure and its equation of state & the study of physics in strong gravitational fields, e.g. in the accretion disks around black holes the direct measurements of black hole mass and spin



Exoplanetary missions in competition



PLATO (PLANetary Transits and Oscillations of stars; theme 1) – to open a new way in exoplanetary science, by providing a full statistical analysis of exoplanetary systems around stars that are bright and nearby enough to allow for simultaneous and/or later detailed studies of their host stars.



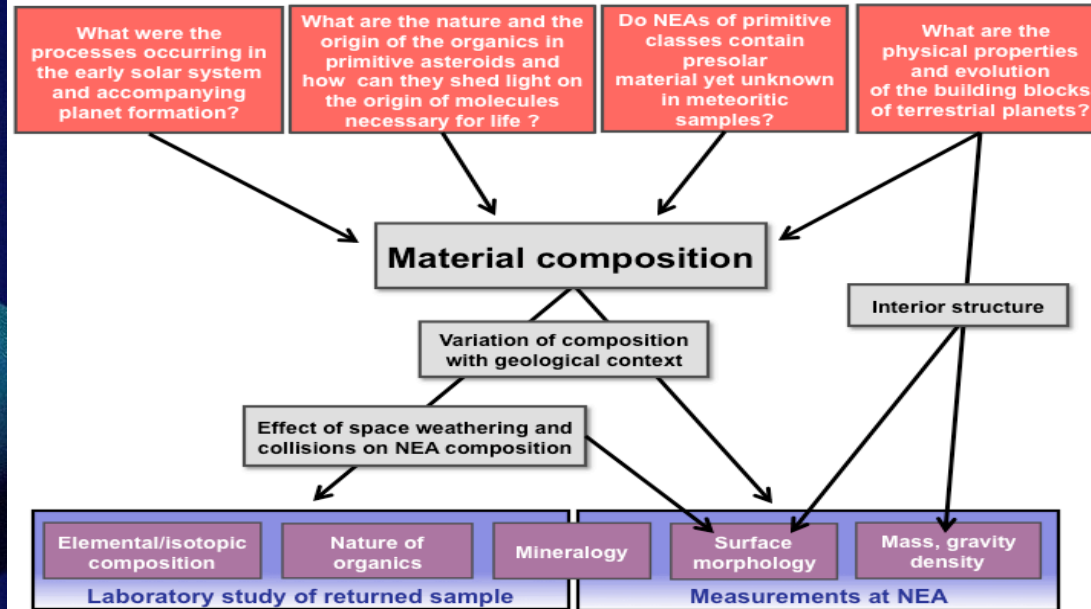
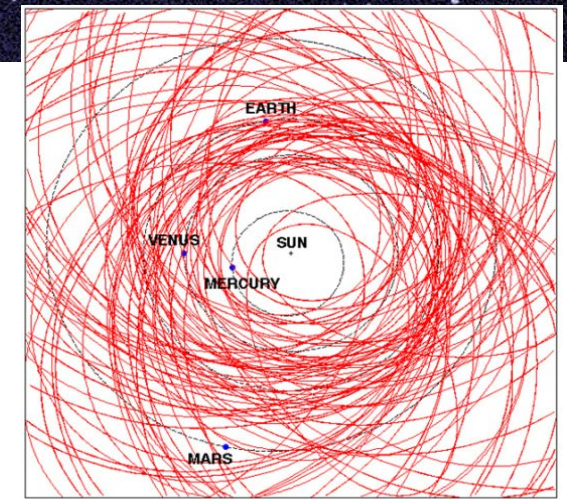
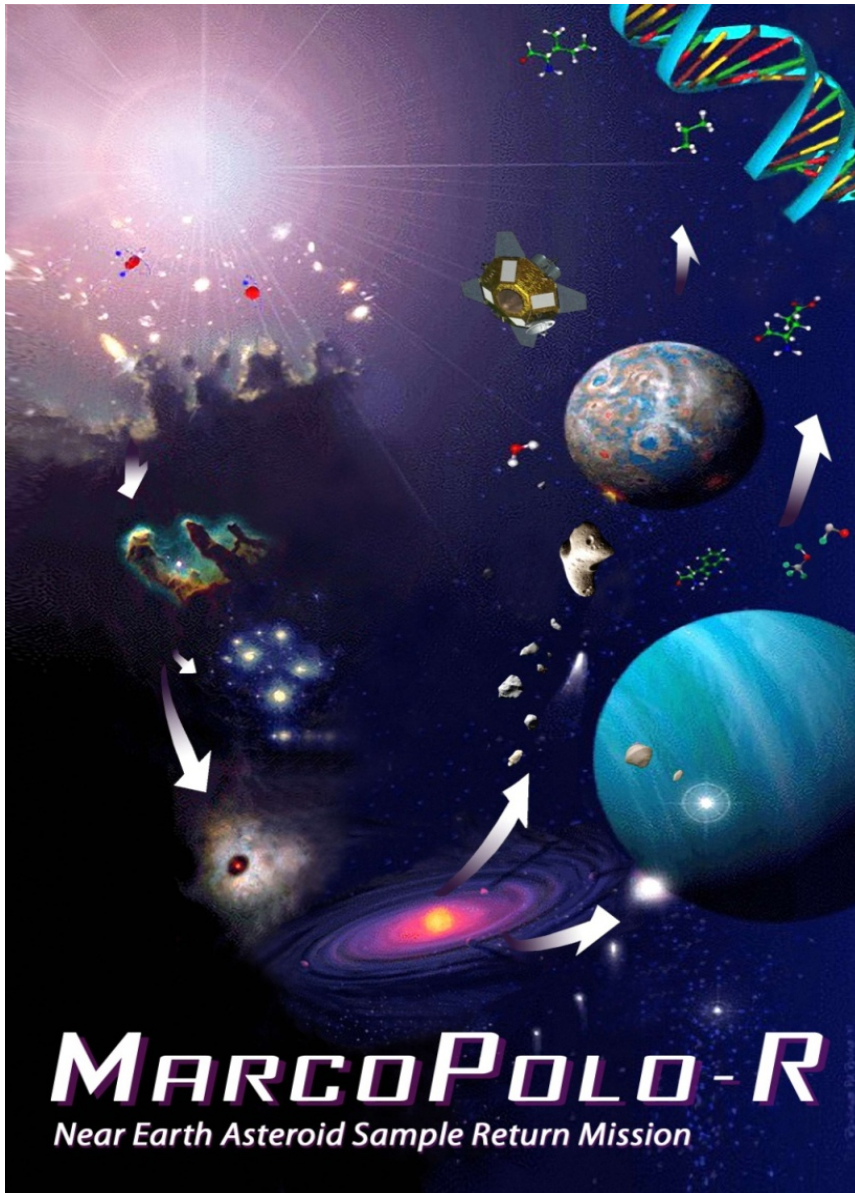
Science objectives

For a representative portfolio of exoplanets

(Jupiters, Saturnes, Neptunes, Super Earths), warm to temperate, get composition and temperature in the atmospheres and many more parameters

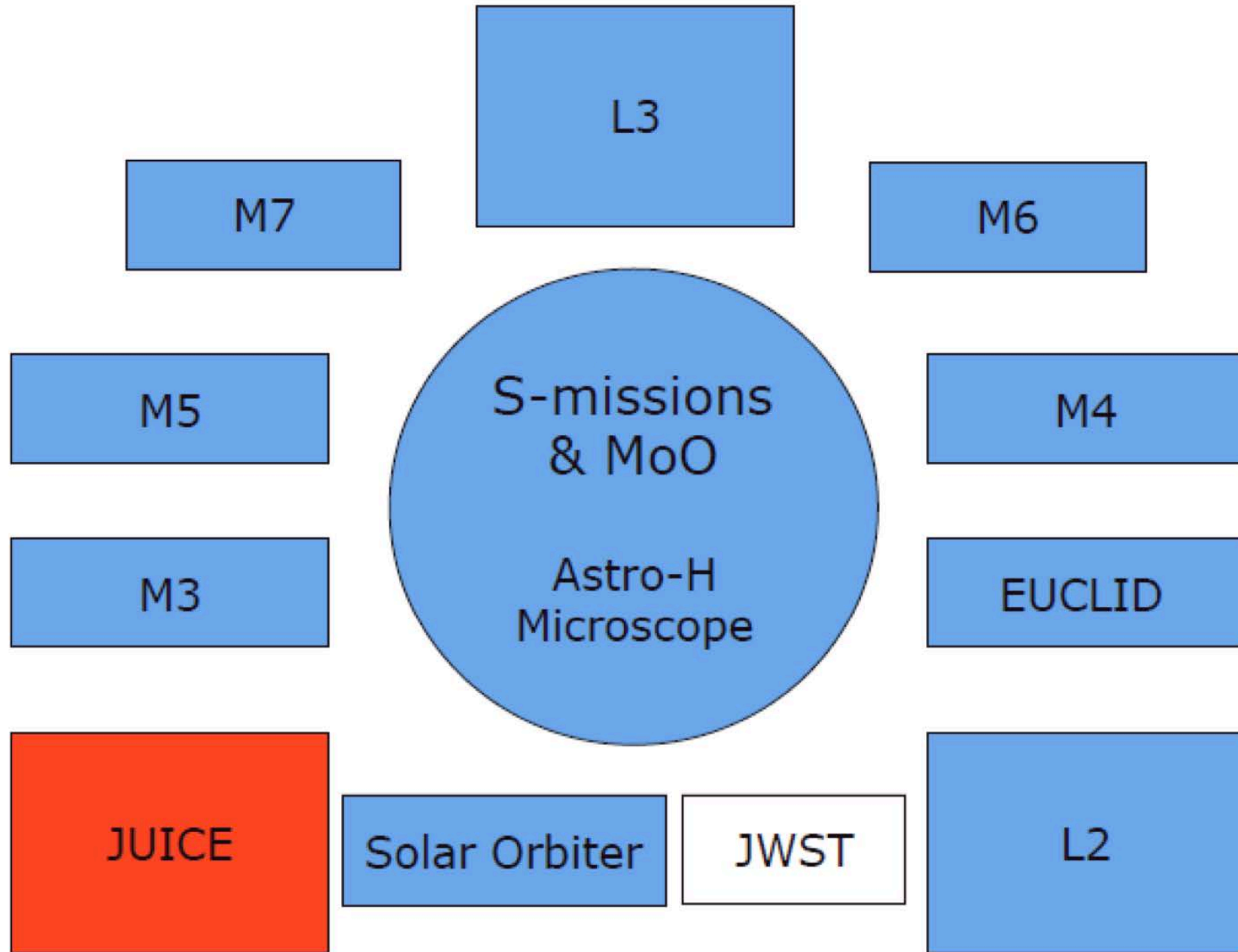
A dispersive spectrograph design covering continuously the 0.4-16 μm spectral range in 6 channels (1 VIS, 5 IR) which allows the spectral resolution to be adapted to the target brightness from several tens ($\lambda \geq 11 \mu\text{m}$) to several hundreds ($\lambda \leq 11 \mu\text{m}$). Thus optimising for the scientific objectives over the observation spectral range. The instrument is mounted behind a 1.2/1.5 m class telescope passively cooled

MarcoPolo-R mission



A. Barucci et al

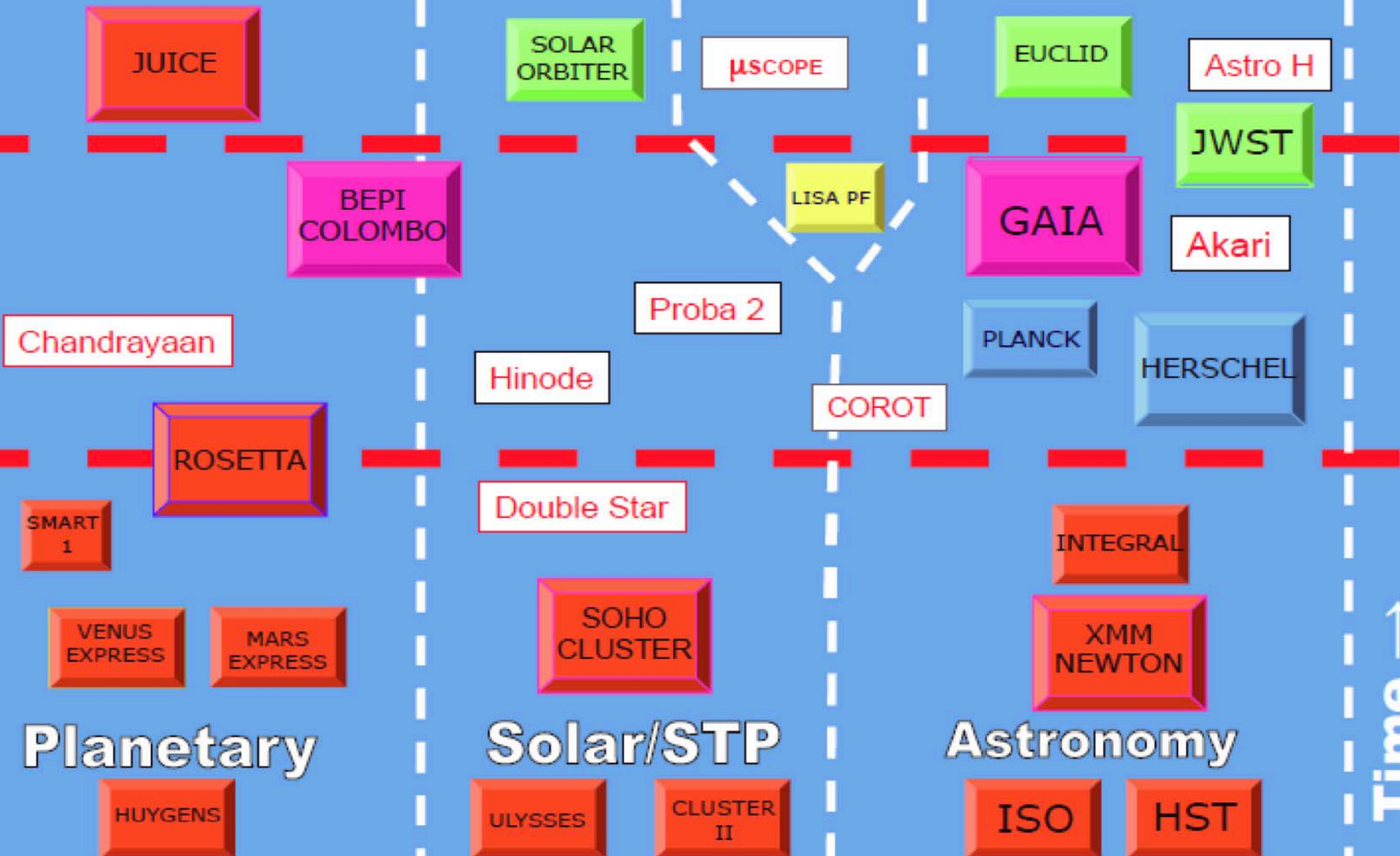
COSMIC VISION (2015-2035)



Mission ESA

Sun	Solar System	Astrophysics	Fundamental
Operations			
Proba-2 [2009]	Venus Express [2005]	Planck [2009]	
SOHO [1995]	Rosetta [2004]	Herschel [2009]	
	Mars Express [2003]	Integral [2002]	
	Double Star [2003]	XMM-Newton [1999]	
	Cluster [2000]	Hubble [1990]	
	Cassini-Huygens [1997]		
Implementation			
Solar Orbiter [2017]	BepiColombo [2015]	Gaia [2013]	LISA Pathfinder [2015]
		JWST [2018]	
		Euclid [2020]	
Completed			
Ulysses [1990]	SMART-1 [2003]	ISO [1995]	
	Giotto [1985]	Hipparcos [1989]	
		Exosat [1983]	
		IUE [1978]	
		Cos-B [1975]	
Future Missions			
Cosmic Vision 2015-2025:			
Mission of Opportunity:		SPICA	
M3 candidate missions:		EChO, LOFT, MarcoPolo-R, PLATO, STE-QUEST	
L1 mission:		JUICE	
S1 mission:		CHEOPS	
Collaborative Missions			
Akari, Chandrayaan-1, Chang'E 1, CoRoT, Hinode, Microscope, Phobos-Soil (Phobos-Grunt), Suzaku			

Fundamental Physics



Time ↑

Call for whiter papers to define the L2/L3 Science Themes

The Directorate of Science and Robotic Exploration intends to define, in the course of 2013, the science themes and questions that will be addressed by the next two Large (L-class) missions in the Cosmic Vision 2015-2025 plan, "L2" and "L3", currently planned for a launch in 2028 and 2034, respectively. This process started with a consultation of the broad scientific community, in the form of a Call, soliciting White Papers to propose science themes and associated questions that the L2 and L3 missions should address.

The submission deadline for White Papers was 24 May 2013, 12:00 CEST (noon). 32 WPs were submitted, 2/3 were for Solar System.

Direct link : <http://sci.esa.int/Lmissions2013>

The Senior committee is now working on the selection. Presentations in Paris 3-4 Sept.

Large (L-class) missions are the pillars of ESA's Science Programme, representing the stability and long-term planning for the scientific community and the ESA Member States. The definition of the Programme's pillars should rely on an adequate long-term perspective to achieve the adequate technological and scientific preparation required by missions that set out to provide a significant, paradigm-changing advance in their respective fields.

The ESA Science Programme can implement three L-class missions every 20 years (two decades being the planning horizon covered by the Programme's successive long-term plans). Considering that the JUICE mission was recently selected for the L1 launch opportunity in 2022, the two other L-class missions (L2 and L3) can be launched in



ESA missions Extensions

ESA science missions continue in overtime:

ESA has extended the productive lives of 10 of its operating space science missions. This decision secures funding for ESA's world-class science missions until at least the end of 2014, and provides a framework for planning until end of 2016.

On 19 June, the SPC approved new extensions – until 31 December 2016 - for **Cassini-Huygens**, Cluster, Hinode, Hubble Space Telescope, INTEGRAL, Mars Express, SOHO and XMM-Newton. Consistent with previous cycles, these are subject to mid-term confirmation, in late 2014.

An extension to the operations of Venus Express until 2015 was also approved, subject to a mid-term review and confirmation by SPC in 2014. This extension will allow an aerobraking campaign to be carried out within the timescale permitted by the remaining fuel on board.

OBJECTIVES FOR 2013-2015:

- **2013:**
 - Launch of GAIA
 - Instruments for JWST delivered
 - Identification of L2 and L3,
 - Selection of M3 and call for M4
- **2014:**
 - Launch of LISA Pathfinder
 - Arrival of Rosetta to the comet Ch-G
 - Competitive review of mission extensions
- **2015:**
 - Launch of Bepi Colombo
 - Call for Small Mission 2
 - Preparation of CM2015

Uranus Workshop

In the frame of the rising interest of the community for Uranus and its environment, an international conference on "Uranus beyond Voyager 2 : from recent advances to future missions » will take place from 16 to 18 September 2013 at the Observatory of Paris (Meudon, France), immediately after the EPSC meeting (the week before in London, UK) to facilitate travels.

The meeting will be organized along eight sessions addressing the various aspects of the study and the exploration of this planetary system, with ample time for presentations and discussions. Contributions to the sessions * by 15 June 2013 *** are welcome.**

**More details can be found on the webpage :
<http://uranus.sciencesconf.org>**

Cassini's 10th birthday

**A session proposed at the EGU 2014
week of 28 April in Vienna
for Cassini's 10th anniversary**