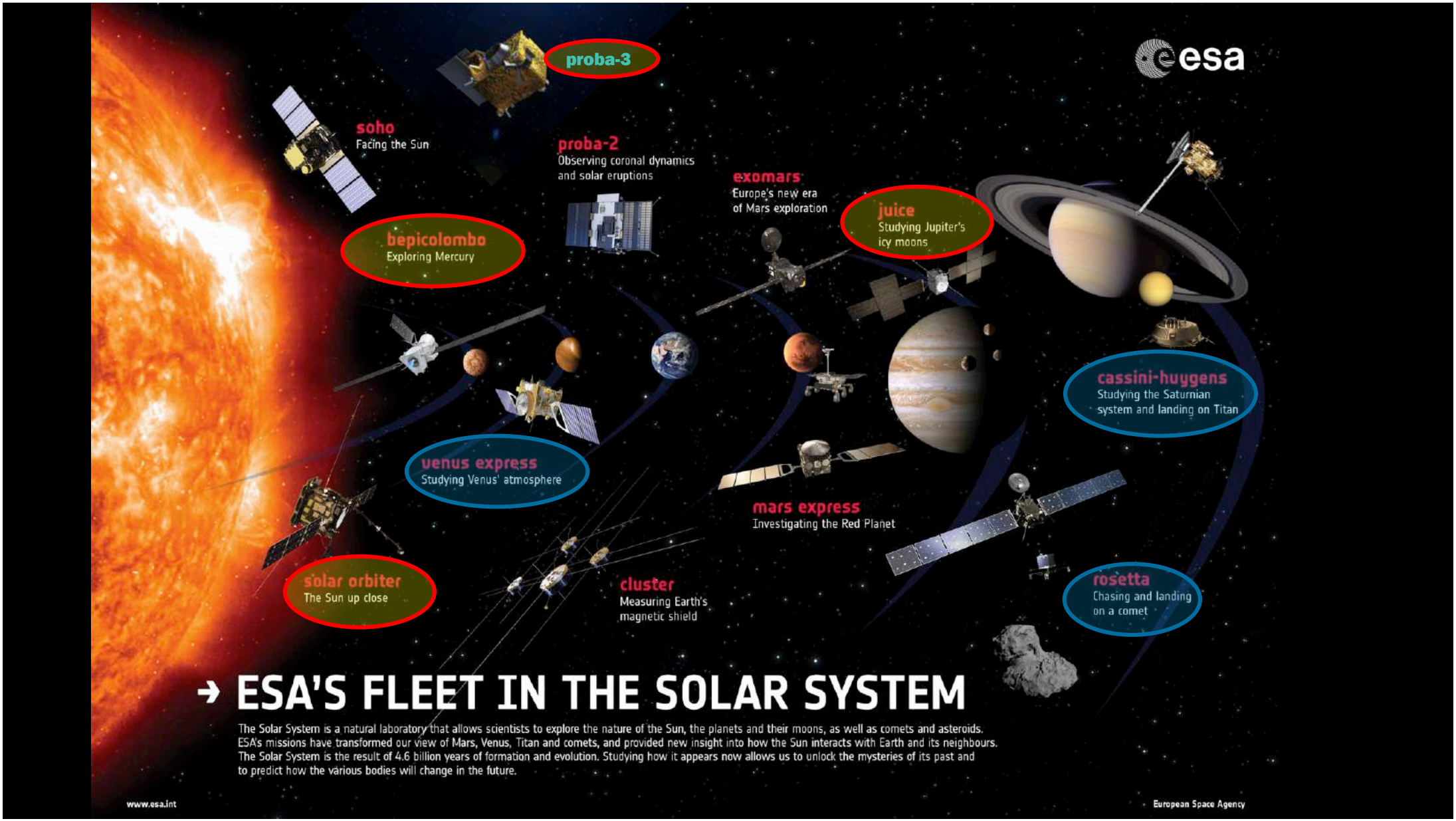
54th European Space Sciences Committee
Plenary Meeting

Status of the Science Programme

Luigi Colangeli
Head – Science Coordination Office
Directorate of Science

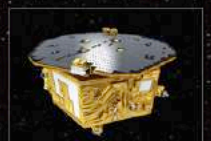
Contents

- Overall status
- M4 and M5 selection processes – status
- “New ideas”
- Other activities


esa
proba-3
soho
Facing the Sun
proba-2
Observing coronal dynamics
and solar eruptions
exomars
Europe's new era
of Mars exploration
juice
Studying Jupiter's
icy moons
bepicolombo
Exploring Mercury
cassini-huygens
Studying the Saturnian
system and landing on Titan
venus express
Studying Venus' atmosphere
mars express
Investigating the Red Planet
solar orbiter
The Sun up close
cluster
Measuring Earth's
magnetic shield
rosetta
Chasing and landing
on a comet
→ ESA'S FLEET IN THE SOLAR SYSTEM
The Solar System is a natural laboratory that allows scientists to explore the nature of the Sun, the planets and their moons, as well as comets and asteroids. ESA's missions have transformed our view of Mars, Venus, Titan and comets, and provided new insight into how the Sun interacts with Earth and its neighbours. The Solar System is the result of 4.6 billion years of formation and evolution. Studying how it appears now allows us to unlock the mysteries of its past and to predict how the various bodies will change in the future.
www.esa.int
European Space Agency

→ ESA'S FLEET ACROSS THE SPECTRUM

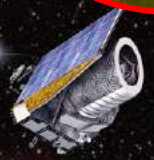
Thanks to cutting edge technology, astronomy is unveiling a new world around us. With ESA's fleet of spacecraft, we can explore the full spectrum of light and probe the fundamental physics that underly our entire Universe. From cool and dusty star formation revealed only at infrared wavelengths, to hot and violent high-energy phenomena, ESA missions are charting our cosmos and even looking back to the dawn of time to discover more about our place in space.



lisa pathfinder
Testing the technology for gravitational wave detection

herschel
Unveiling the cool and dusty Universe

jwst
Observing the first light

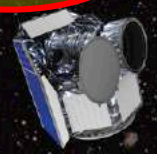


euclid
Exploring the dark Universe

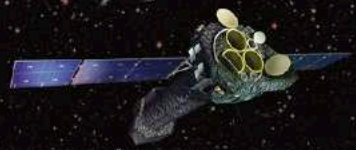
plato

gaia
Surveying a billion stars

cheops
Characterising exoplanets



xmm-newton
Seeing deeply into the hot and violent Universe



planck
Looking back at the dawn of time

hst
Expanding the frontiers of the visible Universe

integral
Seeking out the extremes of the Universe

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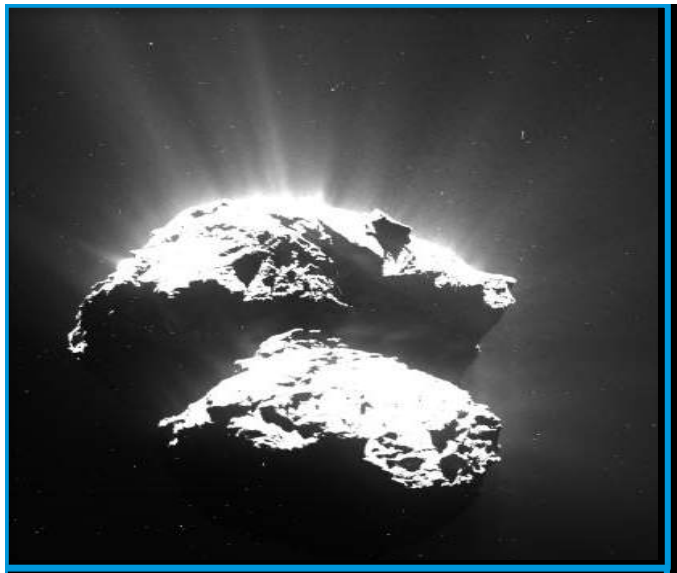
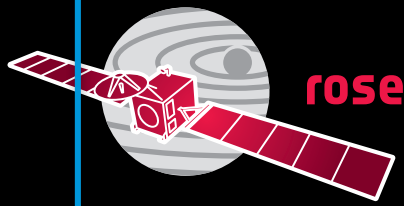


12 Nov. 2014



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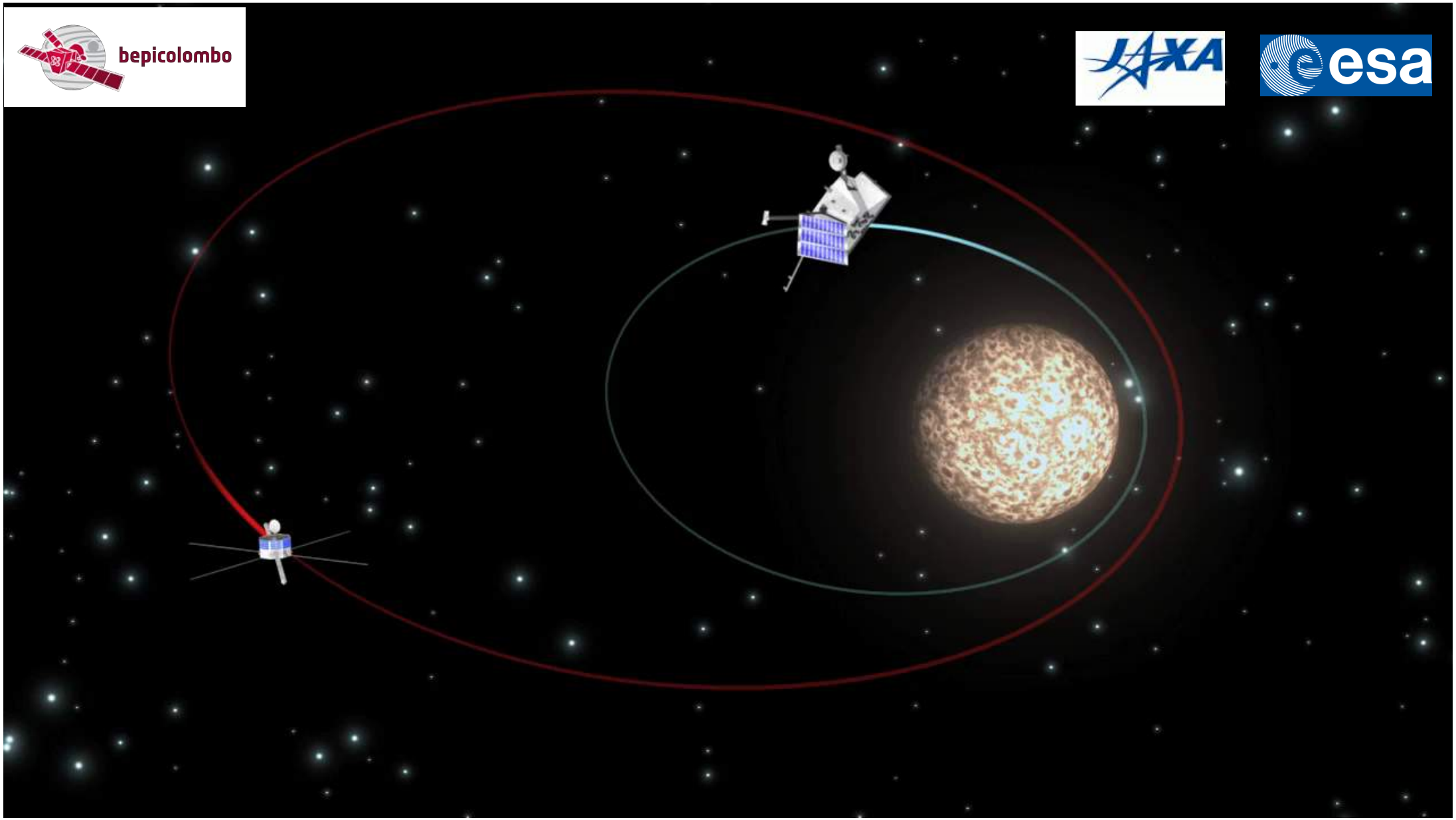
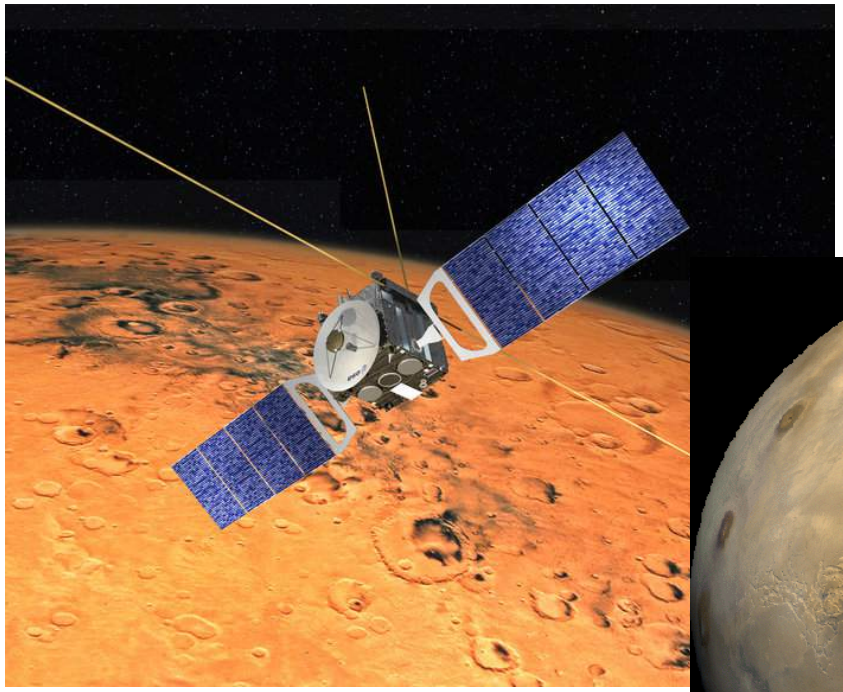
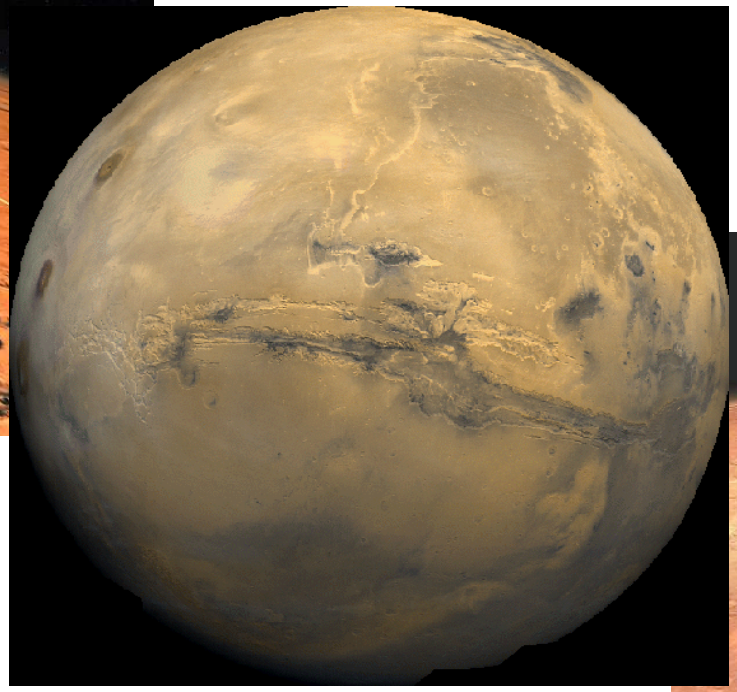
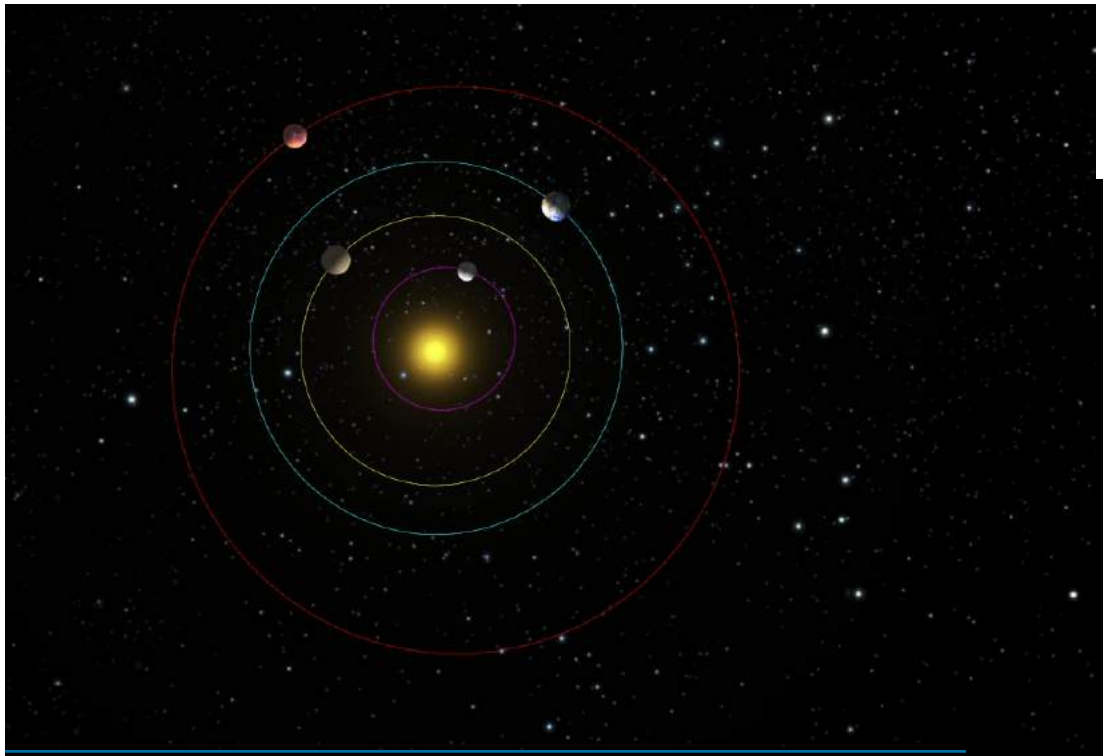

bepicolombo
JAXA
esa







esa

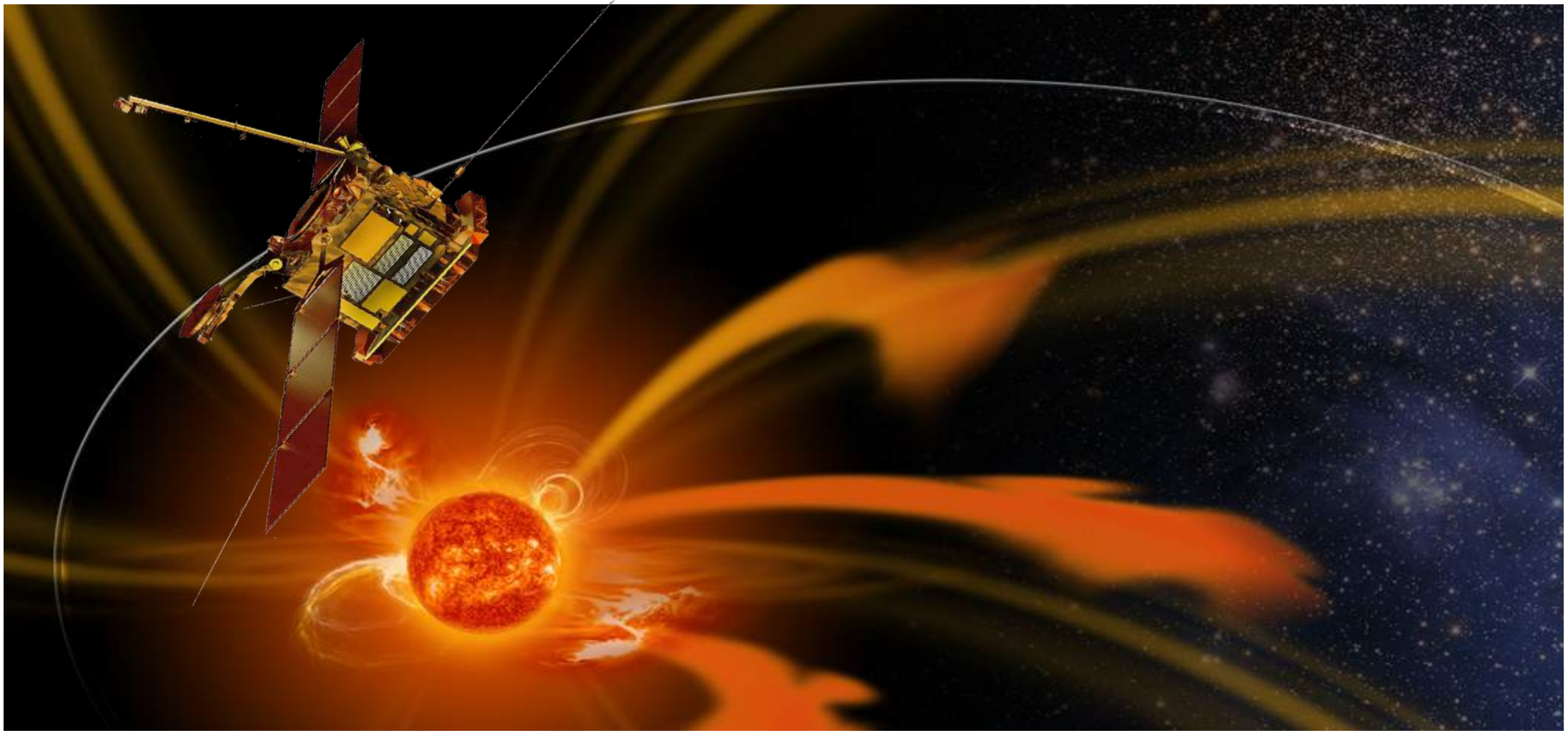
Moons of the Solar System

solar orbiter

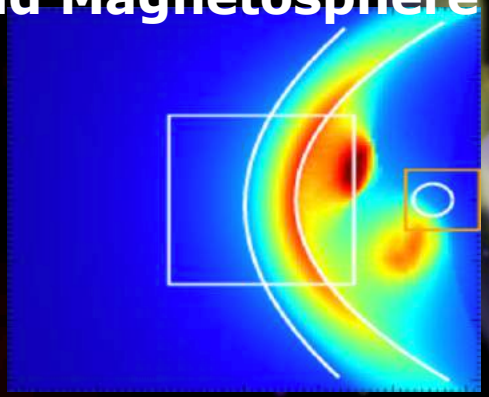
Solar Orbiter: Exploring the Sun-Heliosphere Connection

NASA

esa



ESA – Chinese Academy of Sciences
Joint mission
SMILE
(Solar wind Magnetosphere Ionosphere Link Explorer)



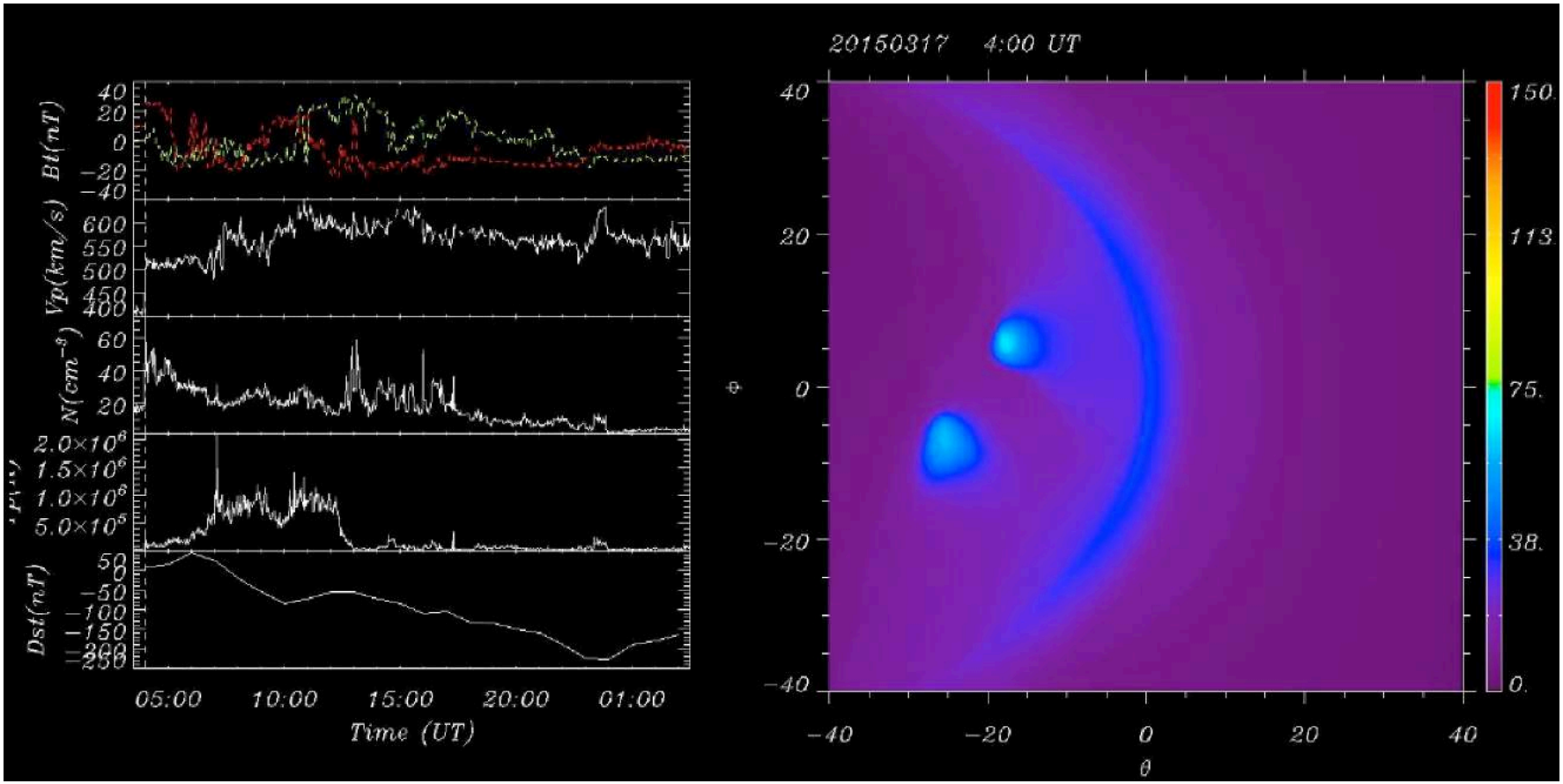
Co-Pis: G. Branduardi-Raymont and C. Wang

Smile will investigate the interaction between Earth's protective shield – the magnetosphere – and the supersonic solar wind

Goal: understanding the physical processes taking place during the continuous interaction between the solar wind and the magnetosphere

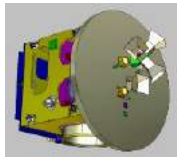
Aurora: NASA Polar

Simulated SMILE X-ray movie: 17th March 2015 solar storm, Earth impact

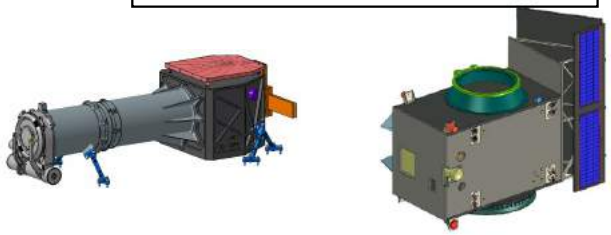


T. Sun, NSSC, CAS

PROBA-3 - MoO



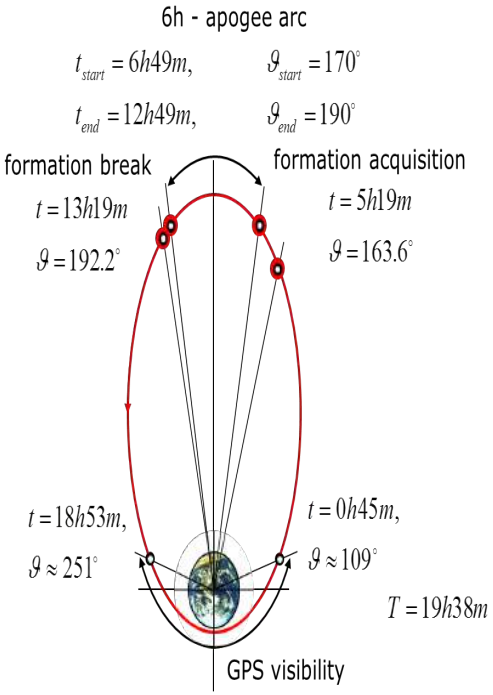
Occulter Spacecraft



Coronagraph Spacecraft

Formation flying
Distance, resizing : 25 – 250 m
Position Precision: ~ 1 mm,
attitude arcsec
Launch: 2020

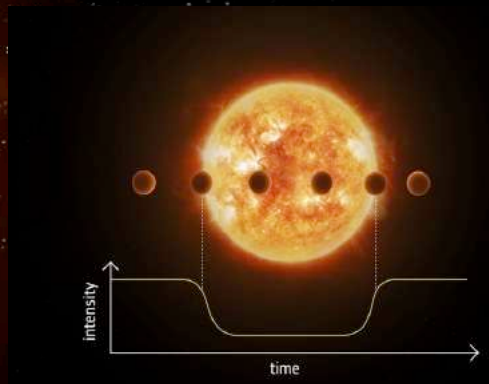
2 satellites in HEO, *600x60530km,*
~59º 2-4 years lifetime



CHEOPS

cheops

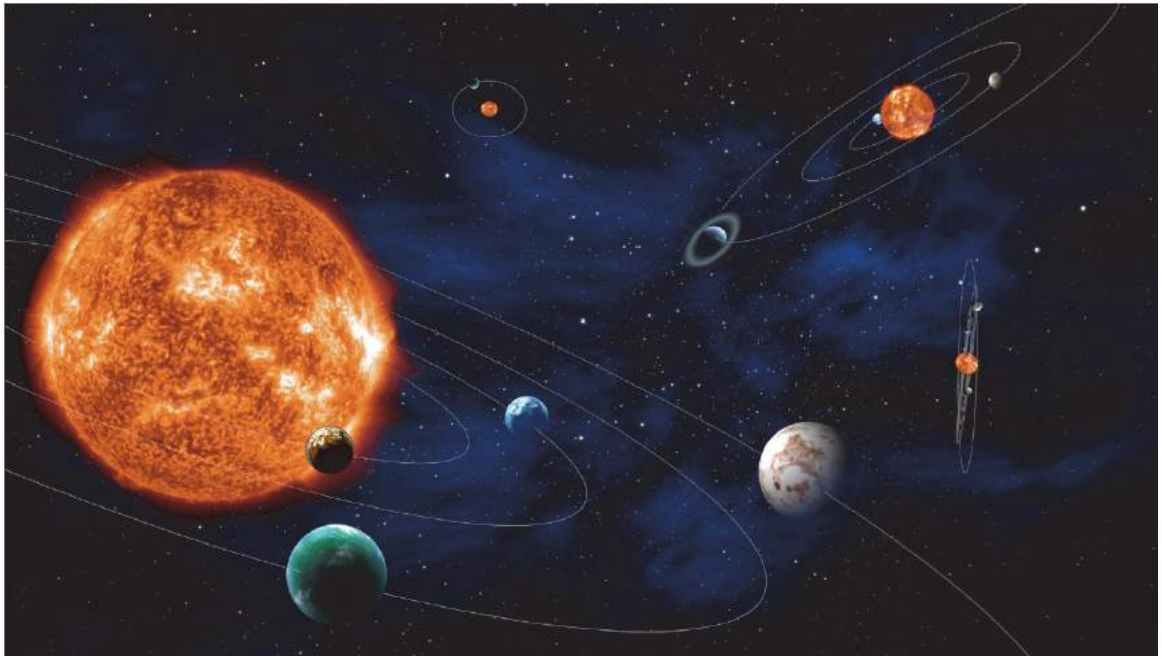
esa

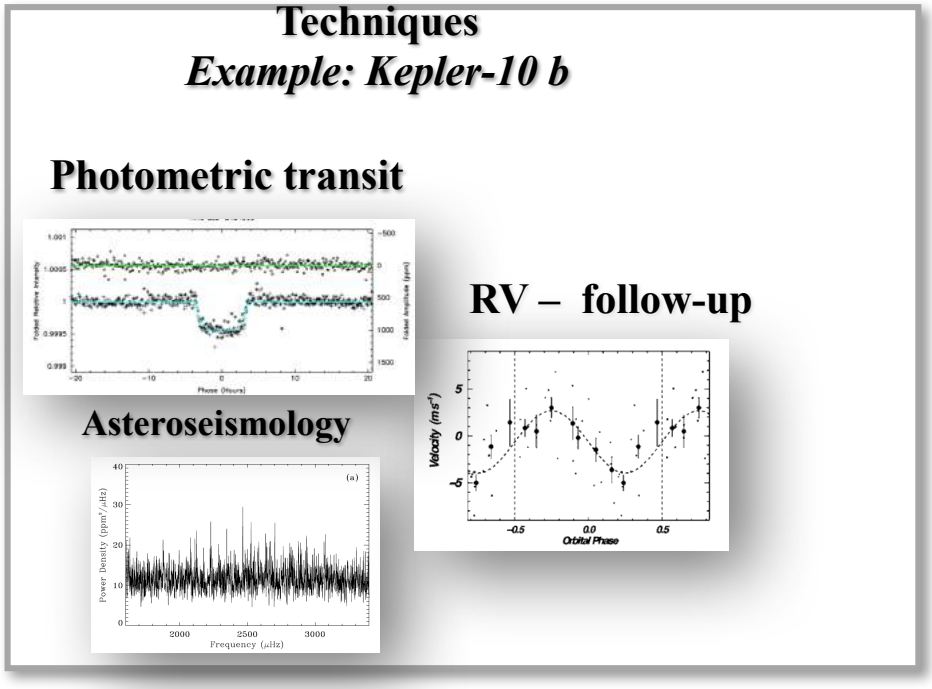


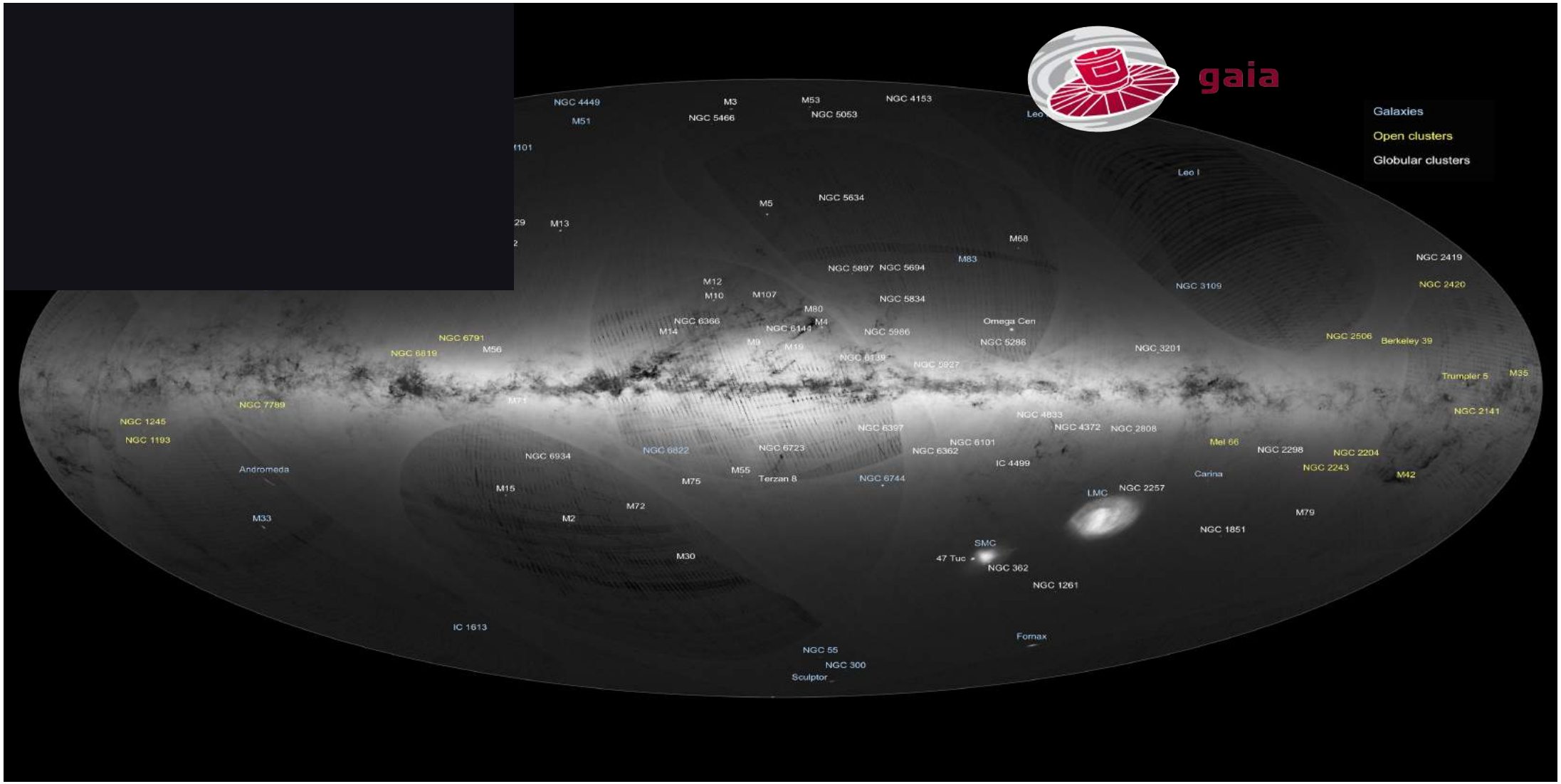
CHEOPS (CHaracterising ExOPlanet Satellite) – a mission dedicated to study exoplanet transits of local, bright stars already known to host exoplanets:

- Characterisation of transiting exoplanets with masses < 30 M_{earth} through precision, wideband transit photometry
- Follow-up, pointed observations
  - Pointed observations
  - Bright host stars (V<12)
- Characterisation of super-Earths and Neptunes: precision masses + radii → measurement of bulk density
- Identification of "golden targets" for spectroscopic characterisation
- Probing atmospheres of hot-Jupiters using phase curve measurements

PLATO mission – M3 - Adopted






gaia
Galaxies
Open clusters
Globular clusters
NGC 4449
M51
M3
NGC 5466
M53
NGC 5053
NGC 4153
Leo
Leo I
M5
NGC 5634
M13
M68
NGC 5897
NGC 5694
M83
NGC 2419
M12
M10
M107
NGC 3109
NGC 2420
NGC 5834
M80
M4
NGC 6366
M14
NGC 6144
NGC 5986
Omega Cen
NGC 5286
NGC 6791
NGC 6819
M56
M9
M19
NGC 6139
NGC 5927
NGC 3201
NGC 2506
Berkeley 39
Trumpler 5
M35
NGC 7789
M71
NGC 1245
NGC 1193
NGC 4833
NGC 4372
NGC 2808
NGC 6397
NGC 6101
NGC 6362
Mel 66
NGC 2298
NGC 2204
NGC 2141
NGC 6822
NGC 6723
NGC 6934
Andromeda
IC 4499
NGC 2243
M42
M55
Terzan 8
M75
NGC 6744
Carina
M15
LMC
NGC 2257
M72
M2
M33
M79
NGC 1851
SMC
M30
47 Tuc
NGC 362
NGC 1261
IC 1613
Fornax
NGC 55
NGC 300
Sculptor

JWST mission

NASA flagship mission

partnership between NASA, ESA and the Canadian Space Agency

- General purpose near and mid-infrared observatory
- Largest astronomical telescope ever flown
- Observing objects ranging from planets and bodies of our Solar System to some of the most distant galaxies

The JWST mission - themes

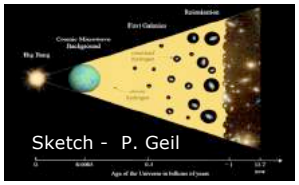
Four (very) broad science themes:

The end of the dark ages: first light and reionisation.

The assembly of galaxies.

The birth of stars and proto-planetary systems.

Planetary systems (including our Solar System) and the origin of life.



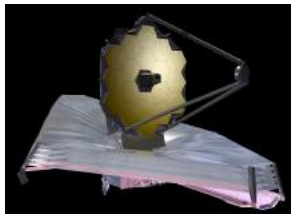
See Gardner et al., 2006, Space Science Reviews,123, 485

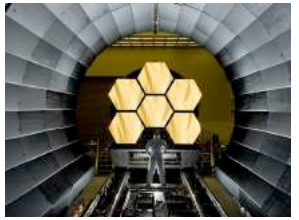
The JWST mission - partnership

JWST is a partnership between NASA, ESA and CSA

ESA (and CSA) have been present since the very early phases of the mission

In return for this contribution, ESA shall obtain a portion of the observing time on JWST that will be no less than 15% of the observing time on average over the lifetime of the mission.



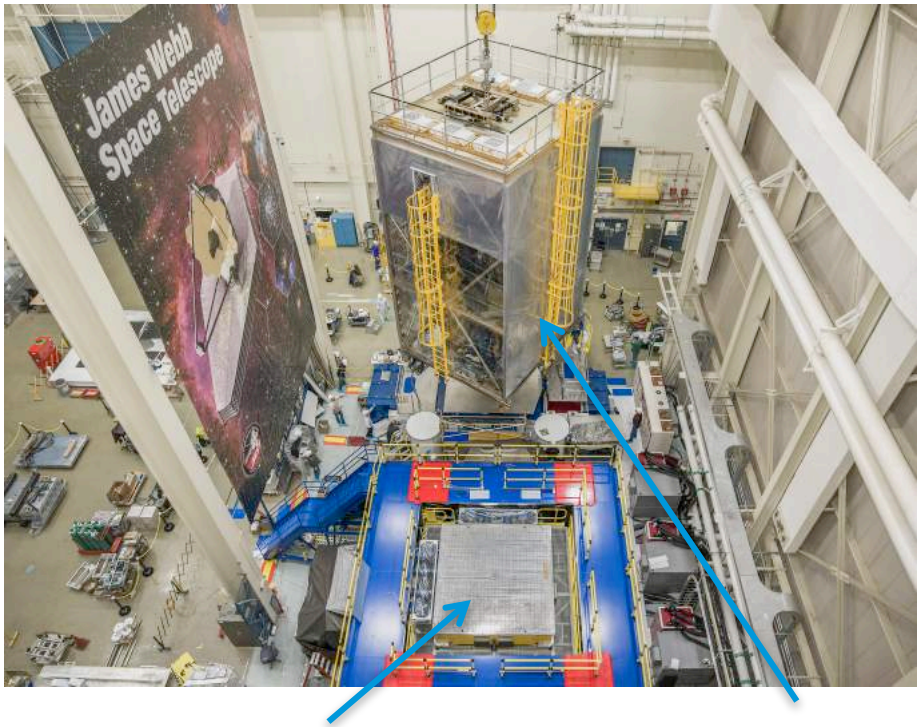


European Space Agency

JWST hardware status - OTIS

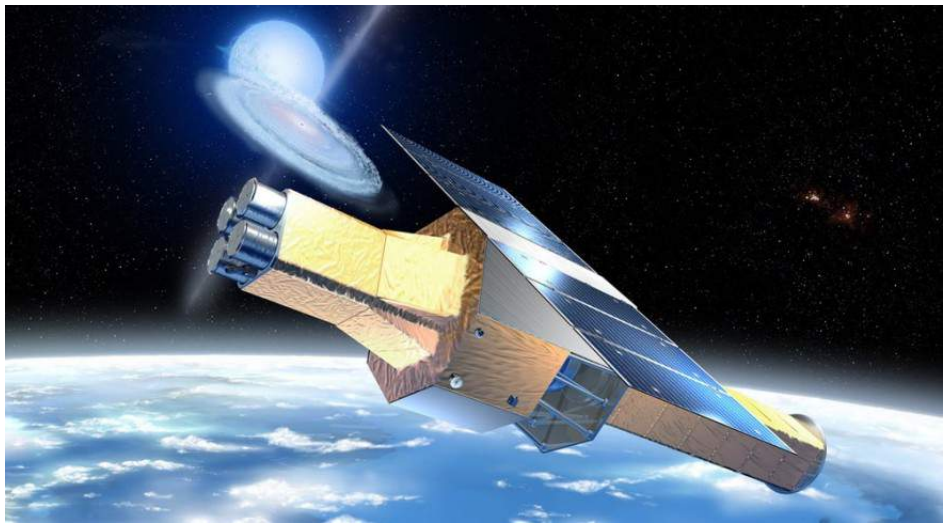
Making sure the telescope and the instruments can survive the harsh conditions of a rocket launch: acoustic and vibration testing.

Credits: NASA/Chris Gunn



X-ray Astronomy Recovery Mission (XARM) - MoO

- Hitomi (pioneering X-ray micro-calorimeter science) was lost 6 weeks after launch.
- 2 *Nature* papers on the first ~1 week-long observation of the Perseus Cluster.

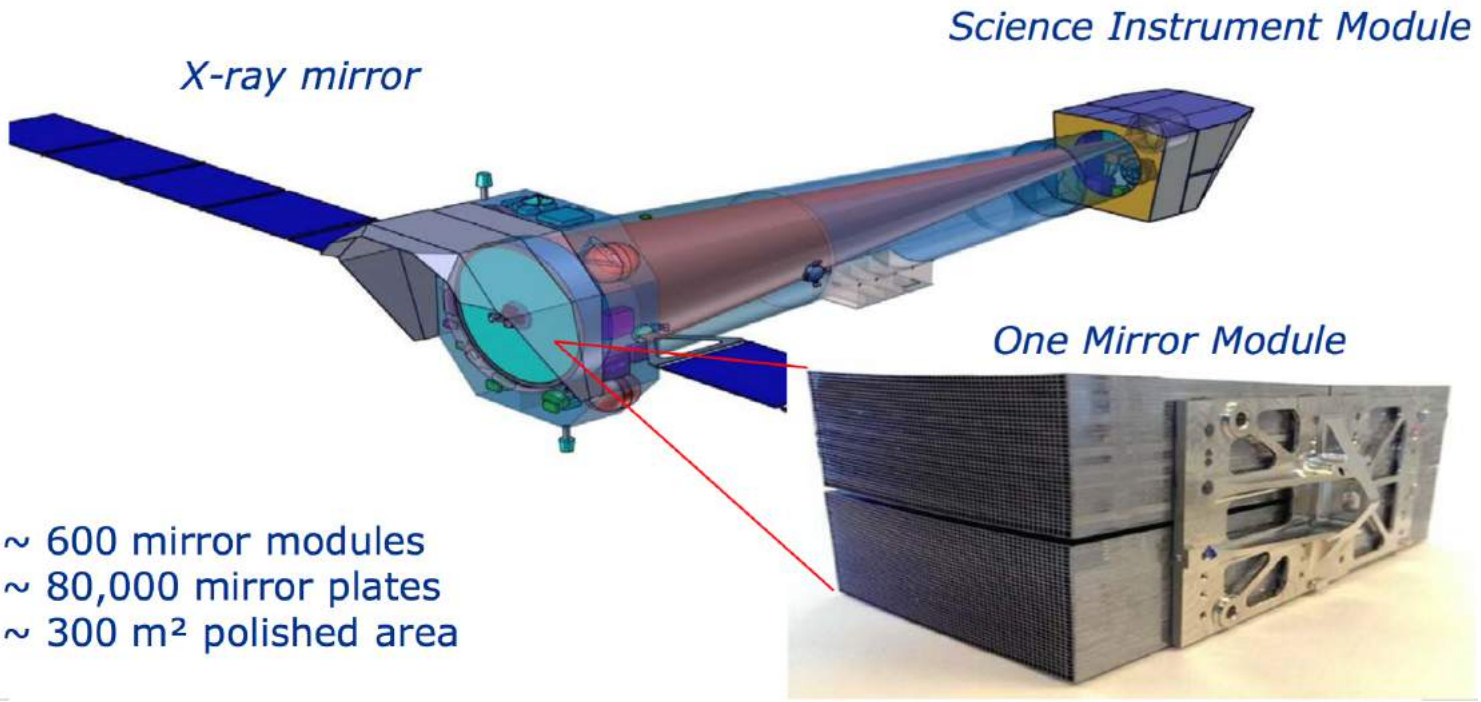


- JAXA Recovery mission
  - Micro-calorimeter (*Resolve*), ≤7 eV energy resolution. 3'x3' field-of-view
  - Large-field (~40'x40') CCD detectors (*Xtend*), ≤170 eV resolution @6 keV
  - Soft X-ray telescope, ~1.3' Half Energy Width
- ESA MoO + CH and NL national contributions
- Return to European scientists:
  - Membership of the Science Team as Participating Scientists (access to PV data) – Call will be issued shortly
  - 8% (TBC) of Open Time for European proposals.

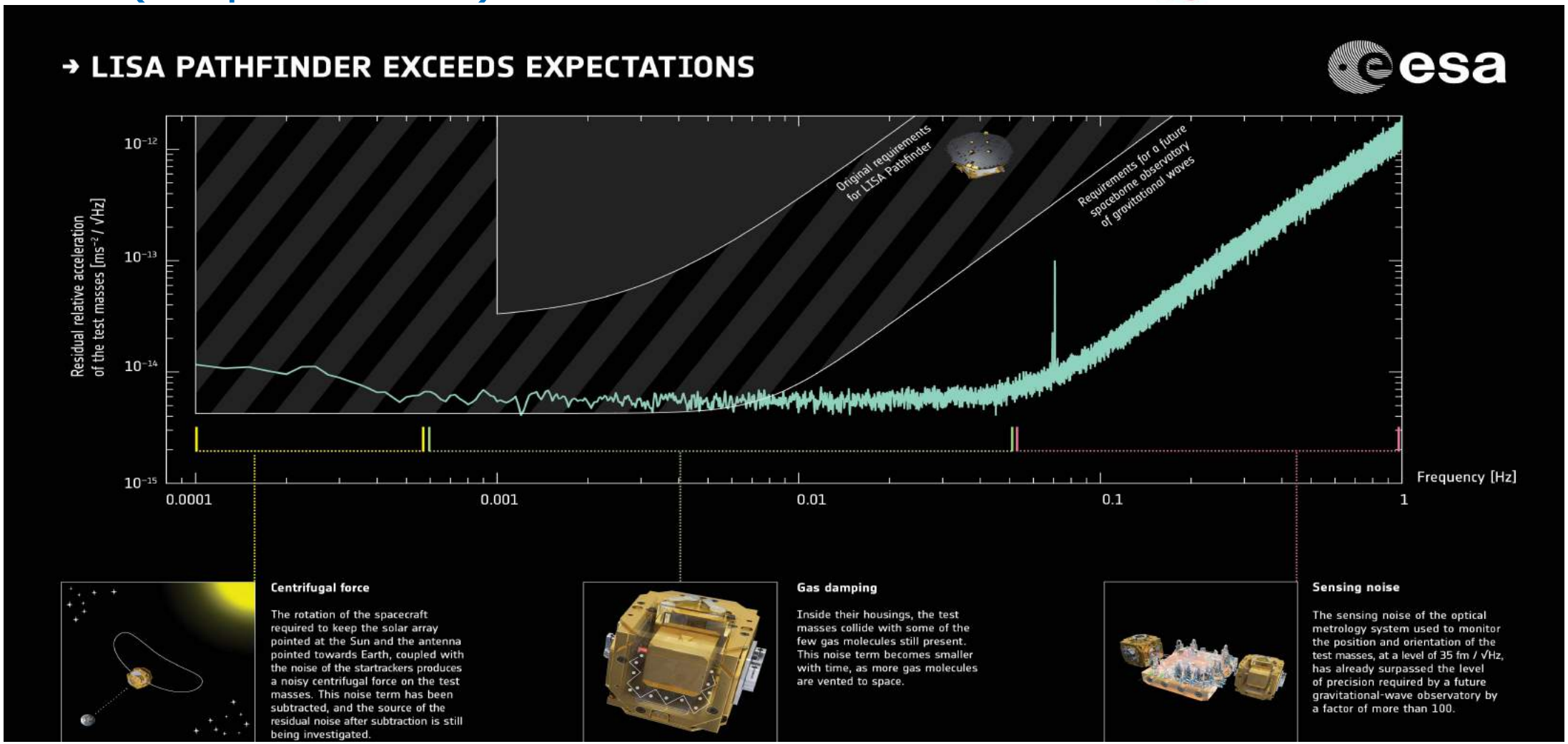
Athena mission

addressing the “Hot and Energetic Universe” science theme

Athena X-ray Telescope

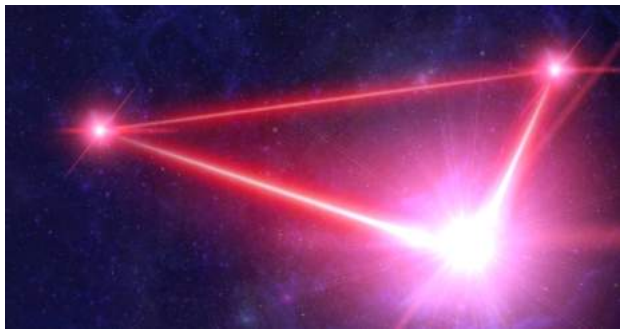


Differential Acceleration noise (as published)



LISA mission – L3 - Selected

- LISA is a mission to detect and observe gravitational waves
  - Gravitational wave astronomy,
    Fundamental physics, cosmology
- Laser interferometry to register changes in distance between test-masses moving on geodesics
- LISA Pathfinder successful technology demonstrator
  - Demonstrated ability to keep test-masses on geodesics with disturbances ~fN
- System and payload CDF's completed, Mission Definition Review starting, industrial phase A April 2018, launch planned for 2034



The elements of the Science Programme

The building blocks of the programme include:

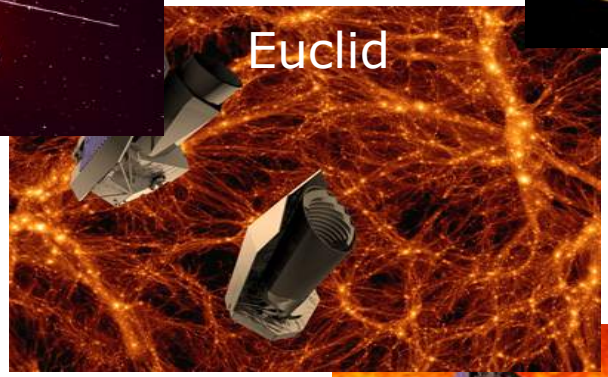
a. **L-missions**, large European led flagship missions with a cost to ESA of around 2 annual budgets, one every 7-8 years.

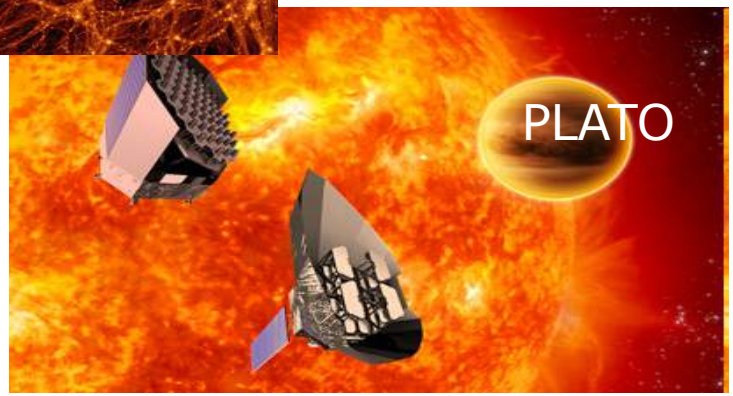
b. **M-missions**, provide the programme with flexibility. ESA led or implemented through international collaboration. Cost to ESA of around one annual budget, one every 3-4 years.

c. **S-missions**, new concept allowing national agencies to play a leading role in missions, 0.1 annual budgets, one every 4 years, potentially.

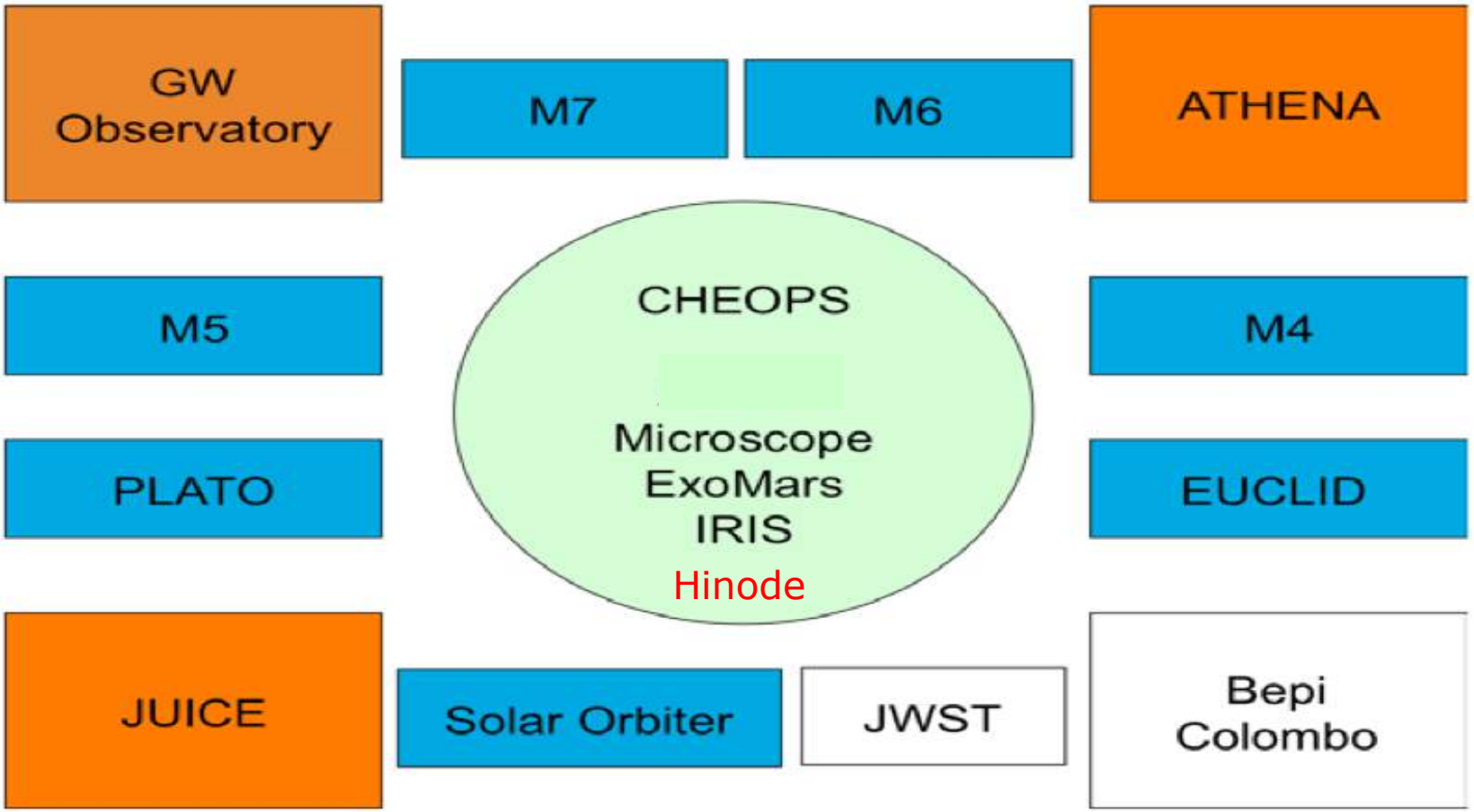
d. **O-missions**, which are "missions of opportunity", led by other agencies, small contributions.

Science Programme

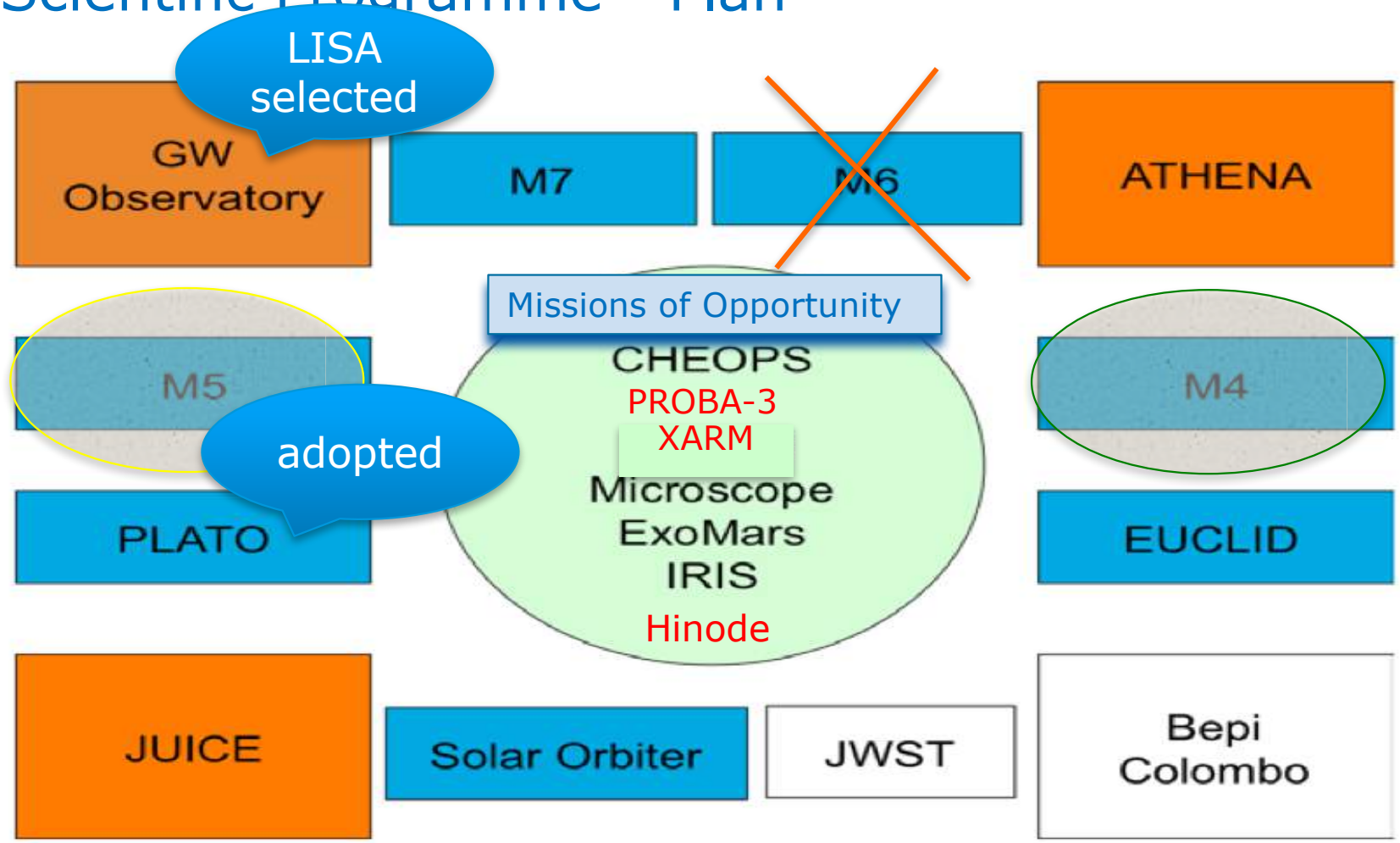




Scientific Programme - Plan



Scientific Programme - Plan



F missions?

Call for new science ideas

Recent SPC decisions (June & November 2017)

- Financial Situation and Projections of the Scientific Programme
- Adoption of the PLATO mission
- Selection of the L3 mission => LISA
- Participation in the JAXA X-ray Astronomy Recovery mission (XARM) as MoO
- Participation in the PROBA-3 mission as MoO
- "Rules of the game" for Missions of Opportunity
- Extension of missions in operation for 2019-2020
- Resolution on the Chairship of Council's subordinate bodies

  Science Programme Committee:

  Chair: Prof. Stefano Vitale (IT)

  Vice-Chair: Mr. Pauli Stigell (FI)

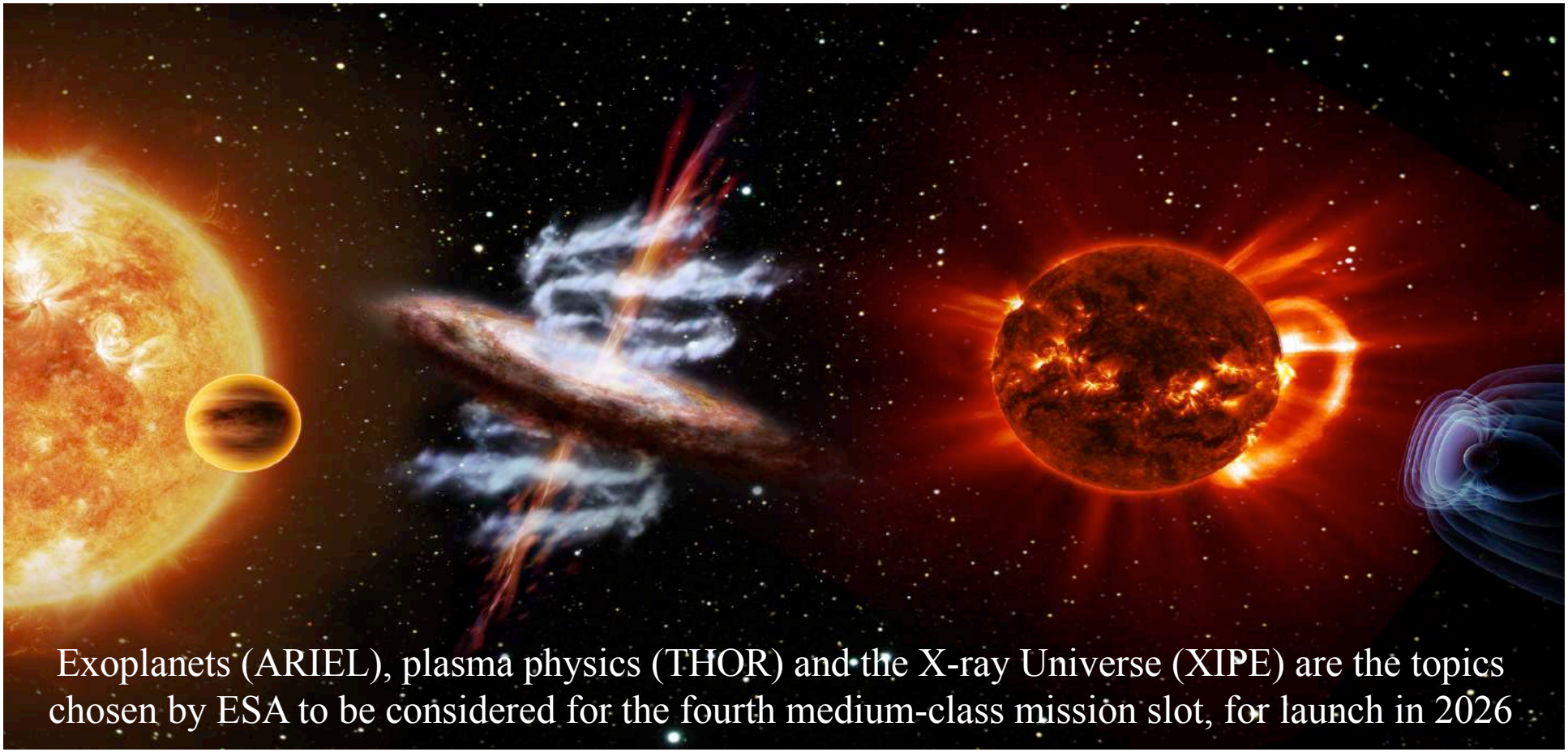
Mission “indicative” extension 2019-2020

- INTEGRAL from 1 January 2019 to 31 December 2019
- Gaia from 25 July 2019 to 31 December 2020
- Hinode*, HST*, IRIS*, Mars Express, SOHO and XMM-Newton from 1 January 2019 to 31 December 2020

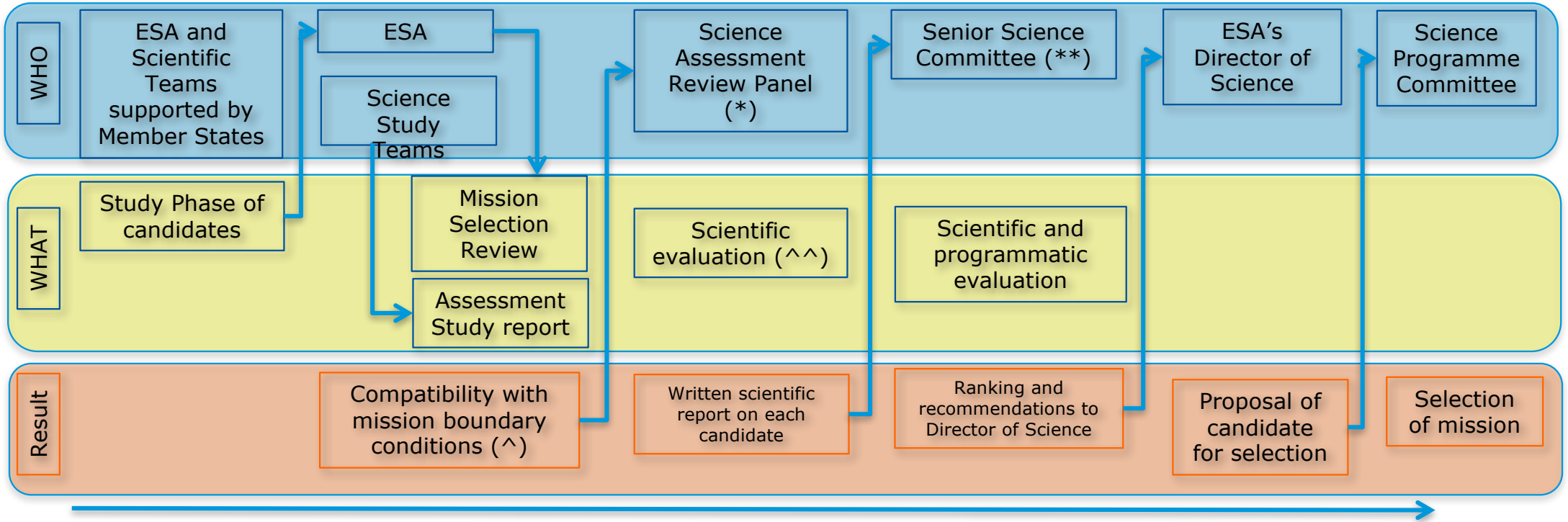
subject to a mid-term review and subsequent SPC confirmation in 2018

- Cluster will be considered in February 2018, as well as INTEGRAL for 2020

M4 selection

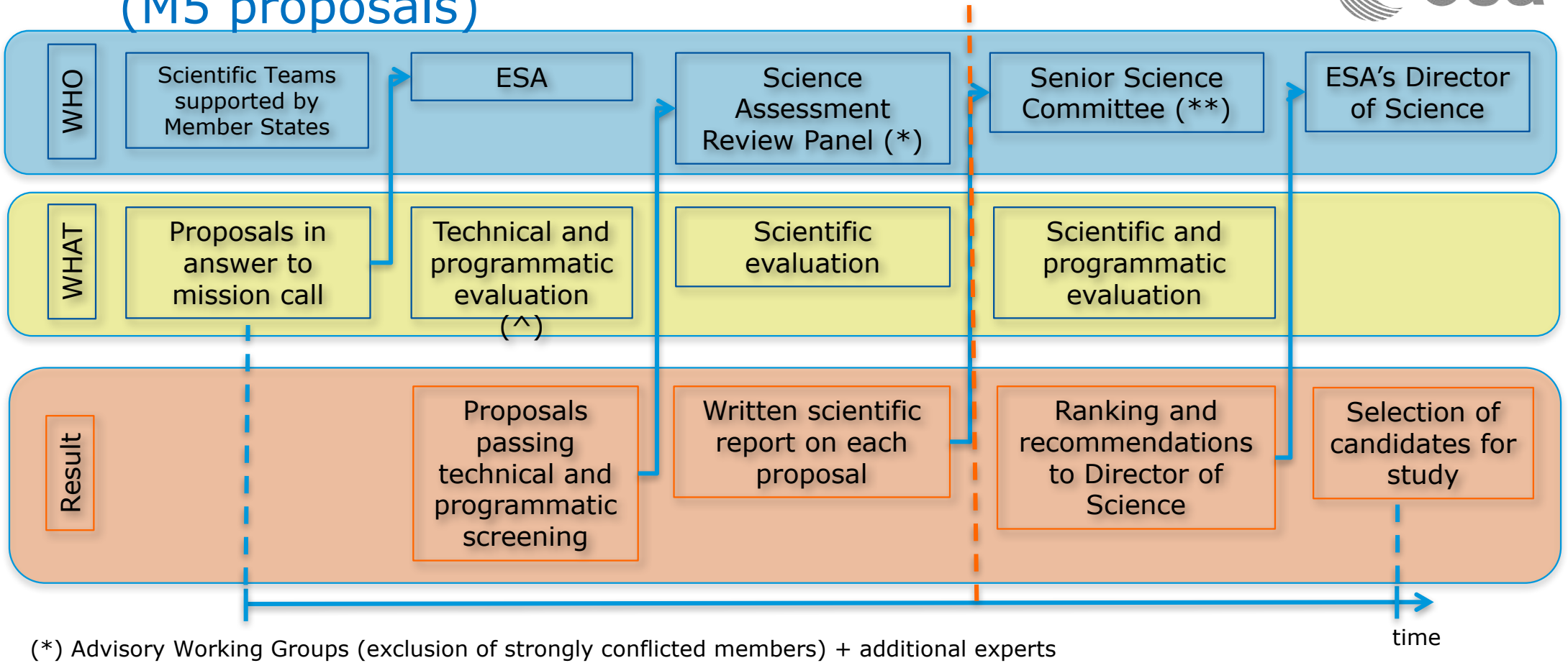


Mission – selection process (M4 candidates)



(*) Advisory Working Groups (exclusion of strongly conflicted members) + additional experts
(**) SSAC members (exclusion of strongly conflicted members) + experts
(^) Including financial envelope, TRL of mission elements and readiness of Funding Agencies to fund mission elements proposed not to be under ESA's responsibility
(^^) Including demonstrated capability to obtain the scientific objectives declared at the time of candidate selection

Mission candidates – selection process (M5 proposals)



(*) Advisory Working Groups (exclusion of strongly conflicted members) + additional experts
(**) SSAC members (exclusion of strongly conflicted members) + additional senior experts
(^) Letters of Support from Funding Agencies

New Science Ideas in ESA's Science Programme

- 26 proposals received by the deadline (14 September 2016)
- No a priori technical screening.
- Scientific assessment under the responsibility of the Advisory Structure, in two stages.
  - No prioritization, only identification of potentially interesting themes
- Post facto technical assessment
- Work on going on the three selected “themes”
- Results will be made public for the whole community

Selected themes (1/3) – Quantum Decoherence

- Strong interest in quantum physics (emphasis on boundaries of quantum decoherence, connection between gravitation and quantum physics)
- Science area with potentially high impact
- Needs long, low-noise free fall -> ideally suited for LPF-like platform
- P/L, science requirements, mission definition still immature
- Workshop (Trento, 6-7 June, 2017) with proposing teams and independent experts to better understand requirements, maturity, etc., to be followed by CDF study to assess mission maturity and identify areas for enabling technology developments
- Interaction with the community on going to prepare the CDF study – target: early 2018

Selected themes (2/3) – Planetary science vs. platform size

- Strong interest in “focused” planetary missions based on small platforms
- Could enable significant additional opportunities for planetary science on rocky planets, small bodies
- Ideally suited for potential partnerships
- Workshop on “Planetary science missions vs. platform size” held on 6-7 September
- Interaction with the community => CDF started in November 2017

Selected themes – (3/3)
High accuracy astrometry in the near IR

- Gaia-like mission in the near IR: beat reddening, access bulge, Galactic centre, hidden regions -> global view of the Milky Way
- Interaction with relevant community completed
- CDF study completed