

Status Report on the ESA Scientific Programme

Günther Hasinger 61. ESSC Meeting 28. 5. 2021

ESA Scientific Programme Fleet



14 missions in orbit; 16 missions in preparation; 22 in archival phase

Solar Orbiter looking back to Earth before Venus Flyby





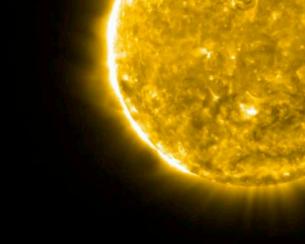
22 hours in the life of Solar Orbiter in the inner Solar System on 18 November 2020



Solar Orbiter / SoloHI Team ESA, NASA, US NRL

Solar Orbiter images Coronal Mass Ejection





2021-02-12T07:31:00



Awards for the Solar Orbiter Mission



Best of What's New award

onster New Airship Will Carry Passengers across the Continent Rich Rewards for Arctic Pioneers—By Stefansson NUARY 10 01 for House Heating Changer than Could (12) 25 CENTS

JACK BINNS' RADIO DEPARTMENT





17th Most Influential Project of 2020 #1 in Space!

The Heliospheric in-situ Orchestra

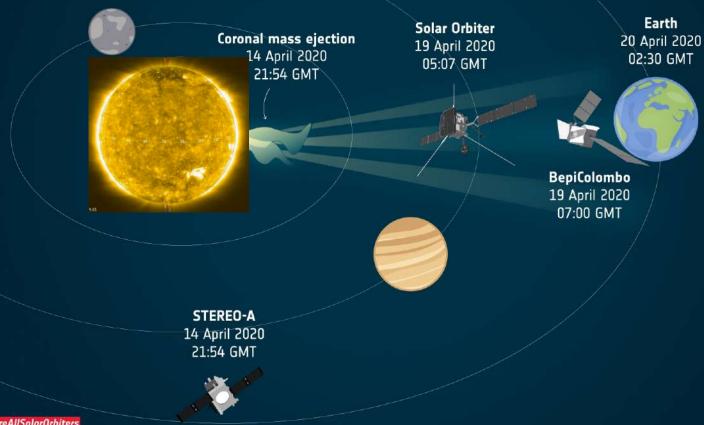
BepiColombo

Solar Orbiter Cluster

Swarm

MULTIPOINT DETECTIONS OF A CORONAL MASS EJECTION







#SolarOrbiter #WeAreAllSolarOrbiters

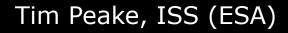
Auroral studies help to understand Space Weather

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Swarm finds that magnetic activity...







Excellent prospects for SMILE

... is stronger in the North!

ESA-CAS joint SMILE Mission

First joint mission with China, a pathfinder for future endeavors "three strategic partners, the United States, Russia and China for primarily scientific and exploration missions" (ESA/C-M/CCXLVII/Res. 3)

> Magnetosheath/ Magnetopause

Highly Elliptical Orbit 5000 km x 19 RE

UVI FOV

Cusp

Aurora

10x10°

SXI FOV Comms 16x27º

Investigate the dynamic response of the Earth's magnetosphere to the solar wind

The Interstellar visitor 11 'Oumuamua accelerates!



Hubble observations show an acceleration, maybe through comet outgassing?

2nd interstellar visitor 2I Borisov: Most pristine comet observed so far



'Oumuamua: a block of N₂ ice ejected from an exo-Pluto ?

Ejection from Parent Syste ~0.4 Gyr ago Axes 92 x91 x54m Axis Ratios 1.7:1

> Erosion by Galactic Cosmic Rays

Entry to Solar System ~1995 72 x 71 x 34 m 2.1:1

> Exit from Solar System ~2040 43 x41 x4.9 m 9:1

Perihelion September 9, 2017 58 x 56 x 20 m 2.9:1

A.P. Jackson & S.J. Desh, 16.3.21, JGR Planets

Observations October-November 2017 45 x44 x 7.5 m 6:1

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WA KHARTMANN

Pluto

Comet Interceptor

Mission to a dynamically young solar system object or to an interstellar visitor.



esa

First ESA Fast/Flexi-Mission! Perfect and quick response to a new scientific challenge!





All eyes on Mars!







Chinese Tianwen-1 Orbiter and Zhurong Rover





CHEOPS reveals unique planetary system



ESA's exoplanet mission CHEOPS has revealed a unique planetary system consisting of six exoplanets, five of which are locked in a rare rhythmic dance as they orbit their central star.

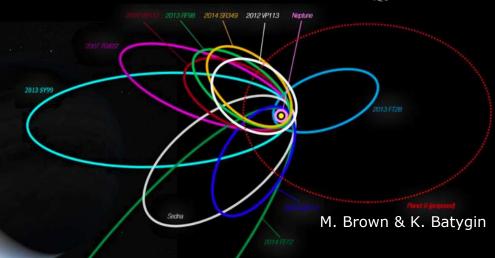
ESA 2020 Team Achievement Award

The sizes and masses of the planets, however, don't follow such an orderly pattern. This finding challenges current theories of planet formation.

Hubble Discovers exo-"Planet 9" HD 106906 b

esa

11 Jupiter mass planet at 730 AU from binary host star



However, see Napier et al., 2021 PSJ debunking the claim for a Planet 9!

But: Mike Brown still on P9 hunt.

M.M. Nguyen, R.J. De Rosa, P. Kalas, 10.12.20, AJ









Gaia Early Data Release EDR3



Bandwidth

75 Gbps

5 Gbps

2.5 Gbos

V Ups

03 Dec

12:00

EDR3

03 Dec

14:00

03 Dec

16:00

03 Dec

18:00

03 Dec

20:00



DR2

04 Dec

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04 Dec

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Cache

Gaia discovers disruption of the Hyades Cluster





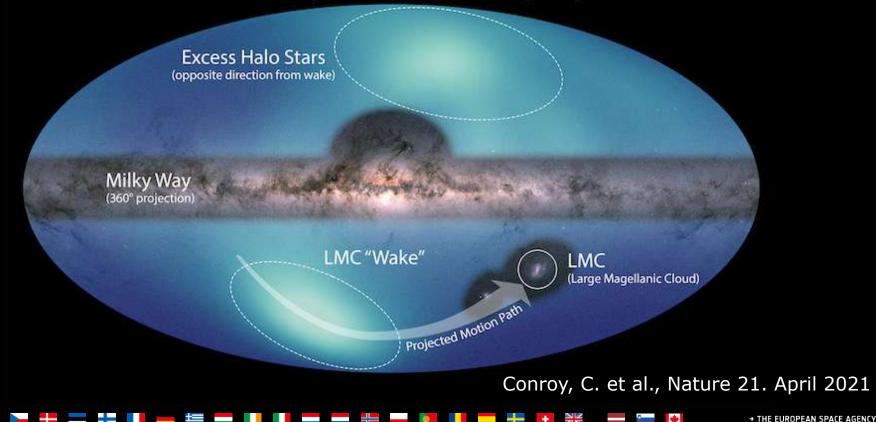
"The 800pc long tidal tails of the Hyades star cluster: Possible discovery of candidate epicyclic over-densities from an open star cluster" by Tereza Jerabkova et al. *Astronomy and Astrophysics* on 24 March 2021.

"The 800pc long tidal tails of the Hyades star cluster: Possible discovery of candidate epicyclic over-densities from an open star cluster" by Tereza Jerabkova et al. *Astronomy and Astrophysics* on 24 March 2021.

Gaia discovers Dark Matter Wake of the LMC



Observed Density of Stars in the Milky Way's Halo



Gaia discovers 12 rare Einstein Crosses





Machine learning applied to Gaia data & WISE photometry to select the best strong gravitational lensing (GraL) candidates.

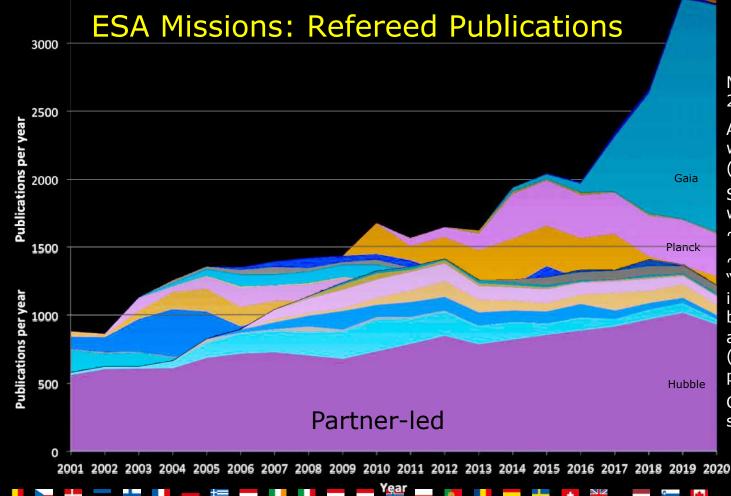
Spectroscopic follow-up at Keck I, Palomar 200", ESO NTT and Gemini South.

Significan increase of the number of "Golden Lenses" useful for determination of the Hubble constant.

Cluster HSC J023336-053022 (XLSSC 105)



Dark Matter (Subaru) Hot dense Gas (XMM-Newton) Hot thin gas (Greenbank radio)





Most papers ever in 2019&2020 (3357)

About half of these were from Gaia (1668)

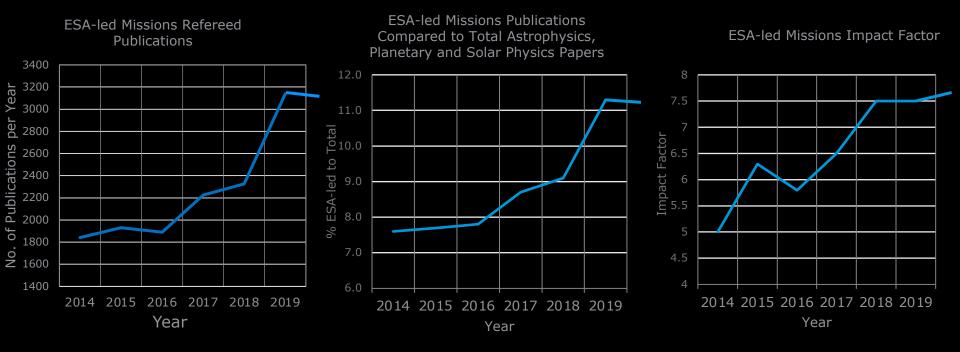
Strong positive trend with doubling time ~8yr

~11% of worldwide "market share", including all ground based and theoretical astrophysics (15% including partner missions).

Citation impact strongly increasing.

KPIs – Publication Metrics Time Dependence









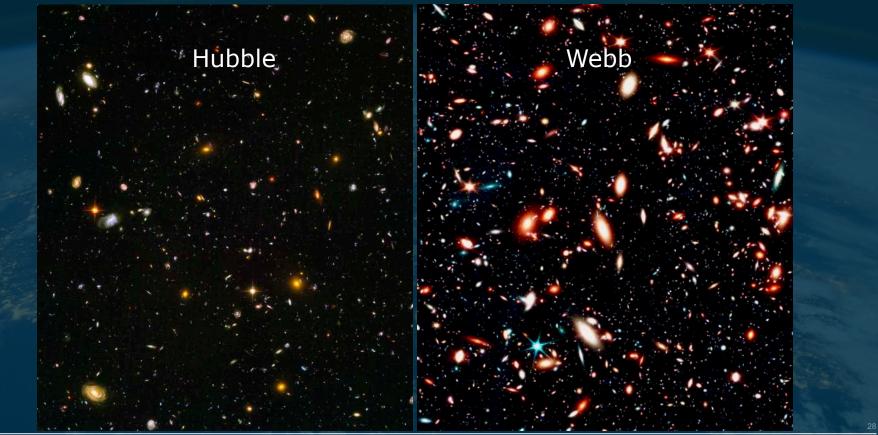






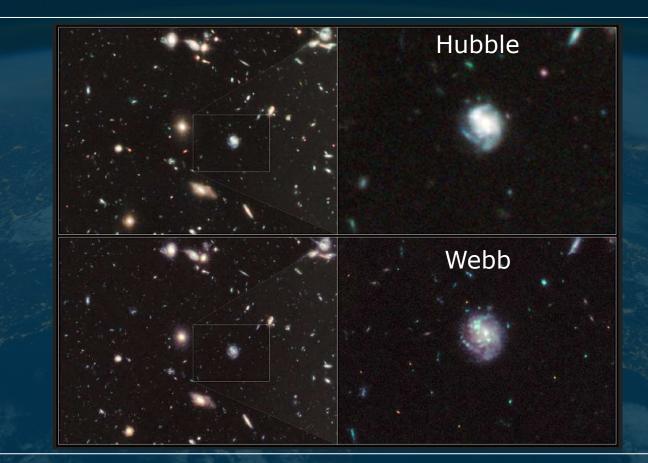
Dive into the early Universe – Hubble /Webb comparison





Zoom on simulated JWST/NIRCam observations





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STScI | SPACE TELESCOPE SCIENCE INSTITUTE

EXPANDING THE FRONTIERS OF SPACE ASTRONOMY

JWST Cycle 1 GO/AR Results

Summary for Agencies March 23, 2021



Executive Summary

- CSA Acceptance
 - Pls 4% for proposals and hours of total program
 - CSA Submitted vs Accepted is
 - 23% for proposals 10 accepted from 44 submitted
 - 31% for hours 249 allocated from 813 requested
 - Cois are 2% of the total Cols
 - ESA Acceptance
 - Pls for proposals 34% and 30% for hours of total program
 - ESA Submitted vs Accepted is
 - 24% for proposals 89 out of 374
 - 22% for hours 1786 out of 8222
 - Cols are 36% of the total Cols
- Student-led proposals
 - 25 accepted proposals from 122 submitted
- Calibration & mission support
 - 4 calibration proposals
 - 4 mission support proposals

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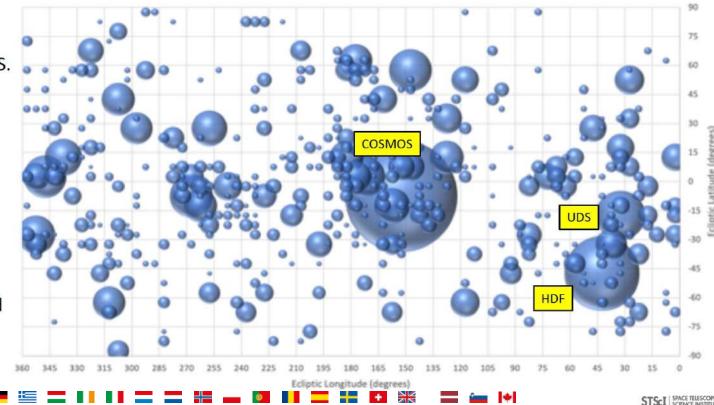


JWST SCIENCE PLANNING AND SCHEDULING



All-Sky plot

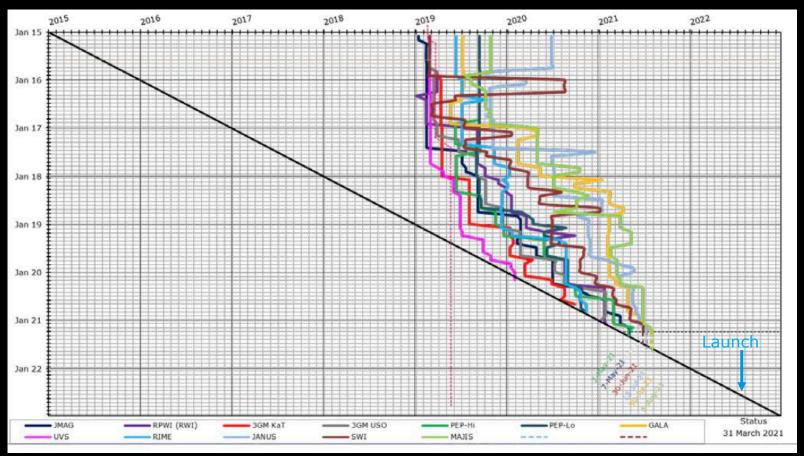
- Largest bubble: COSMOS.
 21 programs, 28 days charged duration.
- Not included:
 - Moving Targets (14.2 days charged duration)
 - Targets of
 Opportunity
 (9.1 days of charged duration)



An on-going issue: Delivery of Payloads



JUICE FM Payload Delivery



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~10% of P/L cost in ESA additional contributions to support the payload CD phase!

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JUICE Trip to ESTEC



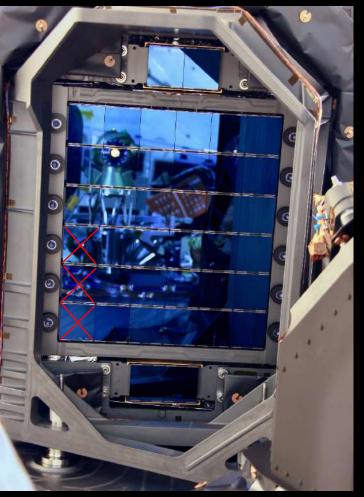


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Euclid fully integrated and being tested at CSL



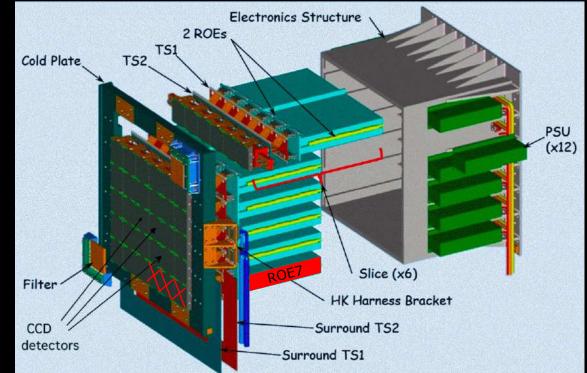




Euclid VIS FPA ROE7 Problem



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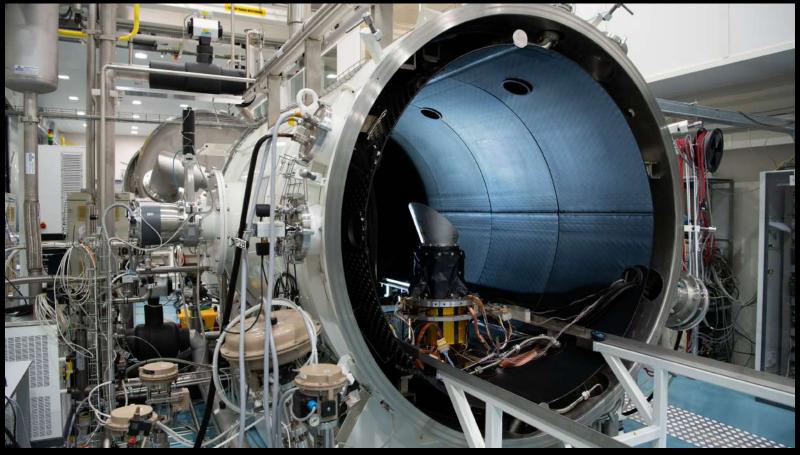


Fly as is?Replace ROE7?Replace ALL ROEs?L: 08/2206/2306/24

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PLATO Camera STM in ESTEC Test Centre

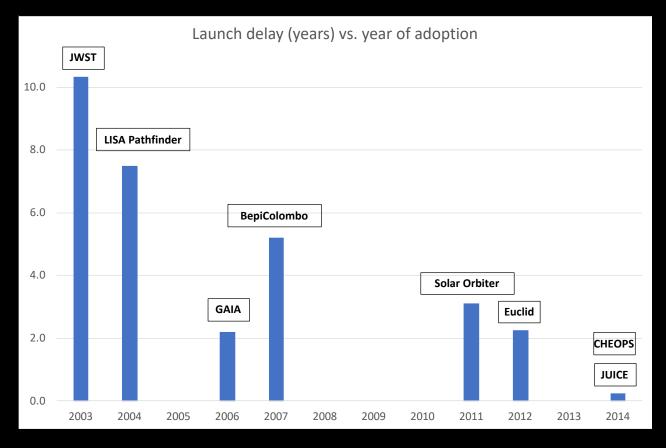




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Launch evolution mapped to adoption date





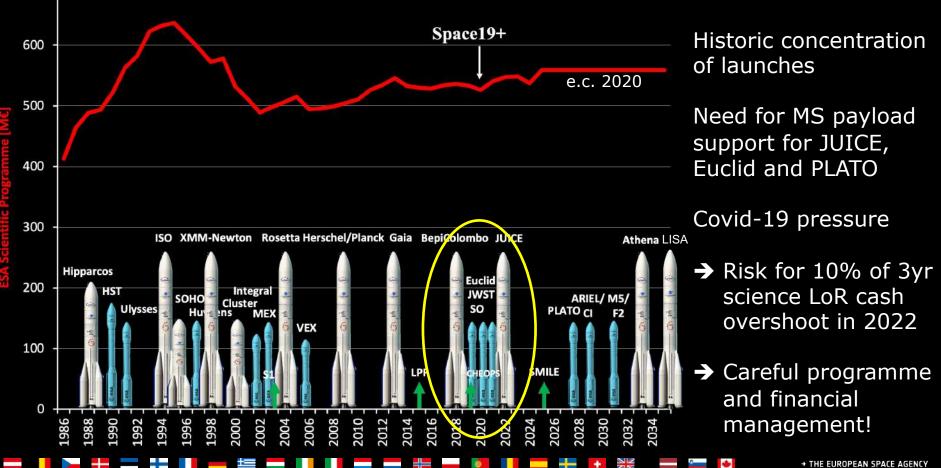
This strongly positive trend, however, leads to a historical concentration of launches in the years 2018-2022 with a significant effect on our cash balance in this period.

Past planning had anticipated significant delays, while the recent performance shows the need for a different approach.

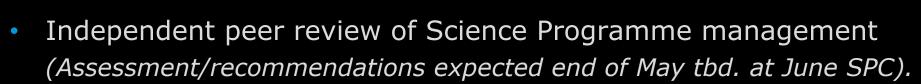
Scientific Programme Short-term challenges

700





D/SCI Management Actions (1/2)



- Internal independent spending review & ongoing reorganization of the D/SCI financial and strategic planning.
- Proactive management of payments, cash flow, etc. to minimize deficit at the end of 2022. Proactive risk management.
- Securing significant programme-level contingency up to 2024.



D/SCI Management Actions (2/2)

- Full transparency towards the SPC
- Frequent (bimonthly) additional reporting of Programme's financial situation to SPC during current LoR.
- Current assessment is based on published 05/21 financial plan.
- SPC consultation Workshop on May 25/26.
- AFC decision & SPC budget recommendation June 9, 2021

Draft Long-term Plan: Cosmic Vision

20

Progression of ESA Science missions (from Herschel & Planck onwards)



LISA Responsibility Scheme and next steps

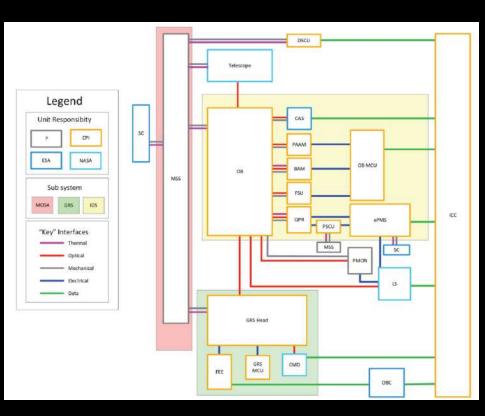


Responsibility scheme for LISA is converging:

- MOSA system engineering and AIT under ESA
- Three major hardware contributions from the Member States:
 - Gravitational Reference Sensor Subsystem, incl. GRS-FEE
 - Data and Diagnostics Subsystem
 - Interferometric Detection System (Optical Bench, Mechanisms and Photoreceivers on the optical Bench, extended Phasemeter)
- A document is being prepared by the LISA Consortium, and confirmation with stakeholders and Delegations expected in July (tbc)

Next Steps:

- Mission Formulation Review (start October 2021)
- Bridging Phase for industrial system studies until Phase B1 kick-off (S1 2022, tbc)



LISA Technology Development Plan



	NOW MFR									
System		Ref	Title	Half 2, 2020 Half 1, 2021		Half 1, 2022	Half 2, 2022 M J S	Huff 1, 2023 N J M M	Half 2, 2023	Half 1, 2024 N J M M
LASERS	C217-030MM	High-power laser system for eLISA					TRL6			Mission
	C217-046FM	Gravitational Wave Observatory Metro	ology Laser - CCN	1			TREE			Adoption
	C217-089FI	Laser Pre-stabilisation System for the LISA Mission				-				TRL 6
	C217-084FT	Photonic Components Analysis in support of the USA Laser system development				i				
	C217-095FI	LISA Laser System Performance Metrology								
	C217-091FI	Development of a master oscillator for the USA laser system		I	10			-		
	C217-068MM	Fine-structure of laser radiation in the far-field - CNN		T.						
	T217-066MM	Hollow core fibre gas cell for laser free	quency stabilization	L						
Telescope, OB & Mechanisms	C221-016MT	Enhanced temperature measurement	for LISA A (ES)	L	-					
	C221-016MT	Enhanced temperature measurement	for LISA B (DN)		-					
	C216-164MM	Molecular contamination derisking act	tivities for LISA	•	-					
	C215-137FT	LISA Optical Assembly Tracking Mecha	inism Development	•						
	T215-016FT	Development of prototype Active Ape	erture Mechanism for LISA	•						
	C215-136FT	Antenna Pointing Mechanism for the L	LISA High-Gain Antenna - Concept and Verification	•	1					
	T217-072MT	Optical fiber micro-Kelvin temperature	e sensor network for sensitive optical payloads	1	E.					
	T208-022MM	Straylight UDAR OGSE verification tool	i, hardware pre-development	1						
	T207-064EP	Advanced DC and AC Magnetic Verifica	ation	•						
Metrology	C217-045FM	Phase Reference Distribution for Laser	r Interferometry		-	TRL6				
	C201-037FT	LISA Phasemeter Unit Development				T				
	T201-052ED	High-Speed High Resolution Quad-AD	C for Science Instruments	1						
GRS	T204-125EP	Test mass charging toolkit and LPF less	sons learned	•				C. C		
	C217-076MM	Delta Development Assessment of the	e LISA GRS GPR mechanism	•	the second se					
	T205-033EC	Assessment and Preliminary Prototype Observatory	ing of a Drag Free Control System for the L3 Gravity Wave	•						
	T205-033EC-8	Assessment and Preliminary Prototype Observatory (B)	ing of a Drag Free Control System for the L3 Gravity Wave	+	-					
AOCS,	T205-053SA	Adaptive control for fast acquisition an	nd re-acquisition of precise scientific constellations							
Micropropulsion	C219-009MP	Preliminary qualification status assess	ment of heritage Cold Gas Micro-thruster for USA (CCN2)		h.					
	C219-012MP	Delta-developments of heritage Cold	Gas Micro-thruster for USA	T	1					
	C204-120EP	Development and validation of a conta subsystems for LISA	amination package in SPIS for liquid based Electric Propulsion	T	Pla	anned 🔴	Running	Finisl	ned 🔵	0

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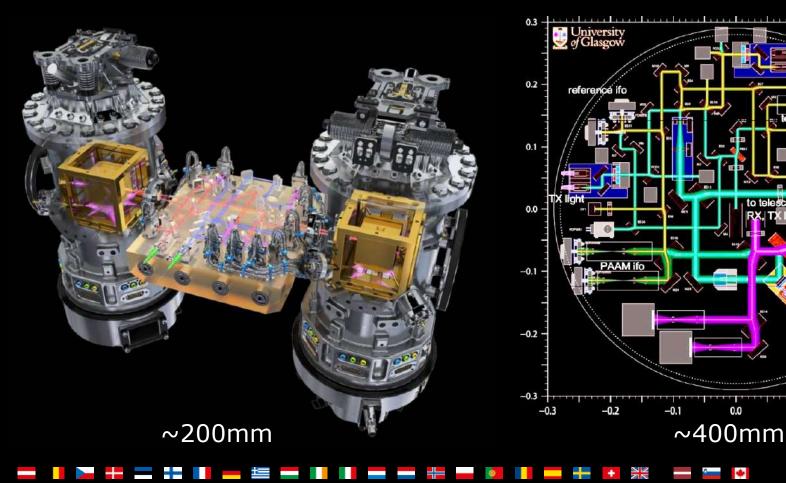
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LPF vs. LISA Optical Bench



sciend



0.3

0.2

943

0.1

0.0





EnVision Venus mission in cooperation with

THESEUS Gamma-ray burst NIR follow-up

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Voyage 2050 towards CMIN'22



- Science topics for 3 Large missions will be recommended in spring 2021.
- Driving Technology Development priorities.
- A new paradigm for MS payload provision will need to be proposed to CMIN22.





Thank you very much!