

# The ESA Scientific Programme Highlights and CM22 Plan

**Günther Hasinger**

Director of Science

**63rd ESSC Plenary Meeting**

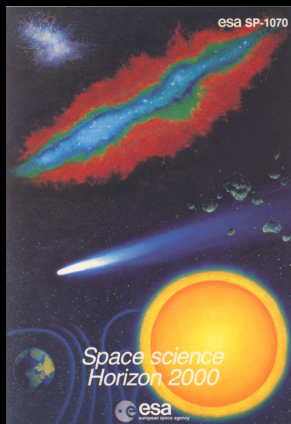
6. 5. 2022



# Scientific Programme Strategic Planning



Cornerstone missions: SOHO; Cluster/Cluster II;  
XMM-Newton; Rosetta; Herschel  
Medium-sized missions: Huygens (Cassini);  
INTEGRAL; Planck

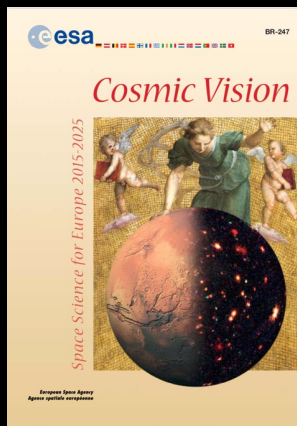


1984



1995

Gaia; LISA Pathfinder; BepiColombo



2005

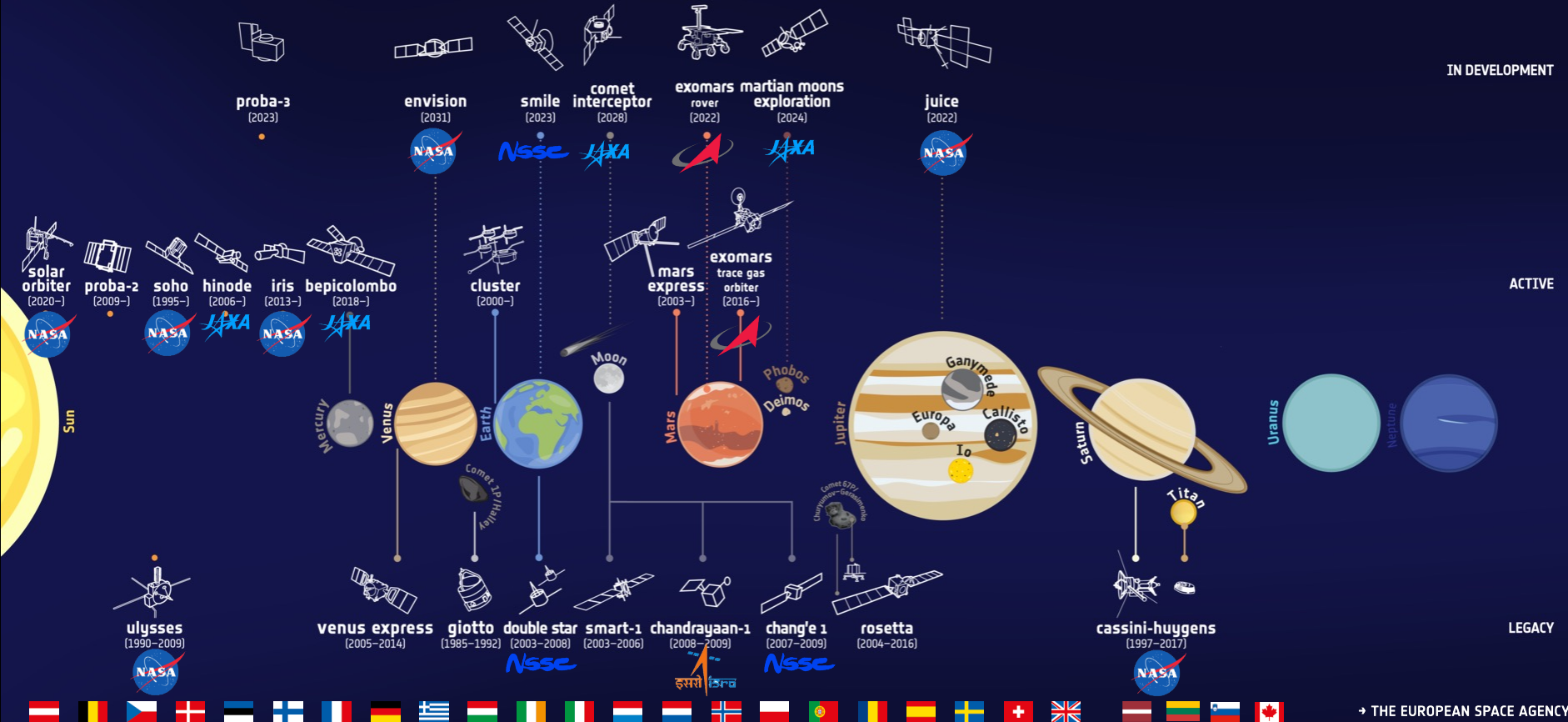
L-class missions: JUICE [L1];  
Athena [L2]; LISA [L3]  
M-class missions: Solar Orbiter  
[M1]; Euclid [M2]; PLATO [M3];  
ARIEL [M4]; Envision [M5]  
S/F-class missions: CHEOPS  
[S1]; Comet Interceptor [F1]  
ESA-CAS mission: SMILE  
Missions of Opportunity



2021



# SOLAR SYSTEM EXPLORERS



# COSMIC OBSERVERS



IN DEVELOPMENT



ACTIVE



microwaves

sub-millimetre

infrared

optical

ultraviolet

x-rays

gamma rays

gravitational waves

LEGACY

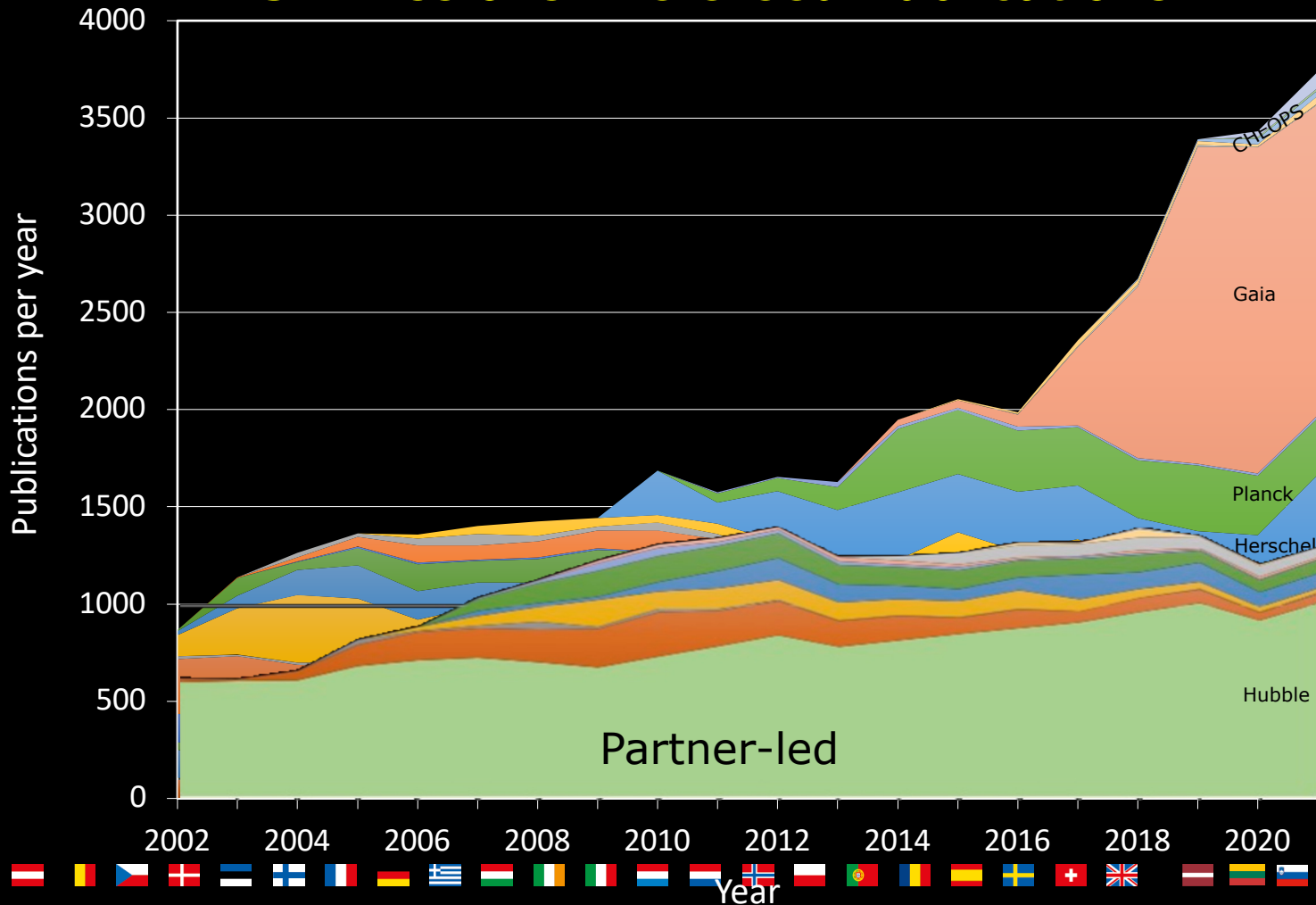


lisa pathfinder (2015-2017)



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# ESA Missions: Refereed Publications



Most papers ever in 2019-2022 (>3500)

About half of these were from Gaia

Strong positive trend with doubling time ~8yr

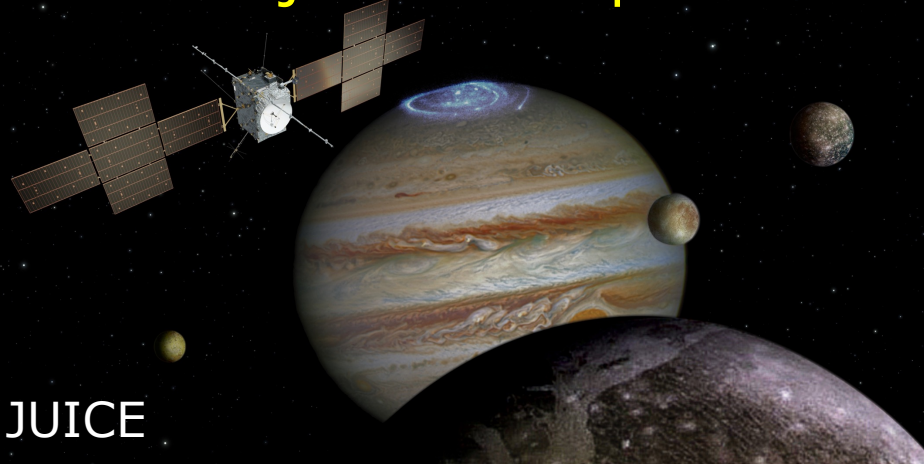
Pandemic caused some slow-down, but has recovered

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

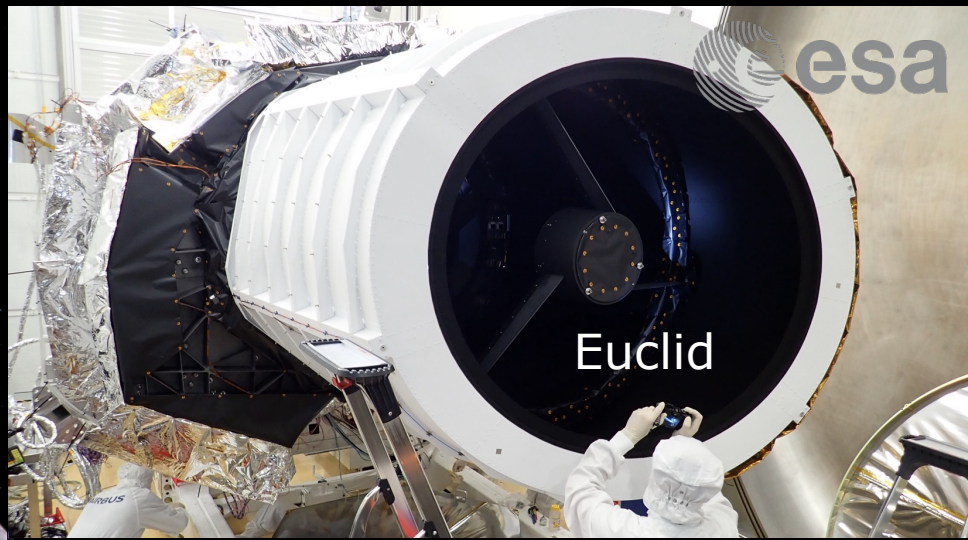
Citation impact strongly increasing.



# Projects in Preparation



JUICE

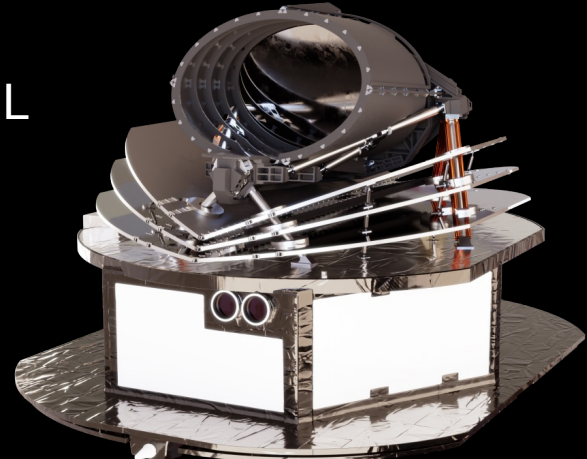


Euclid

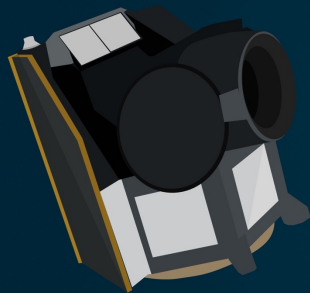
PLATO



ARIEL

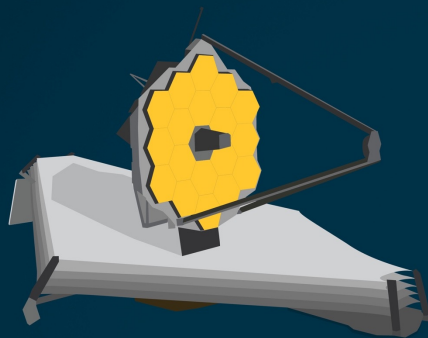


# ESA'S NEW AND FUTURE EXOPLANET MISSIONS



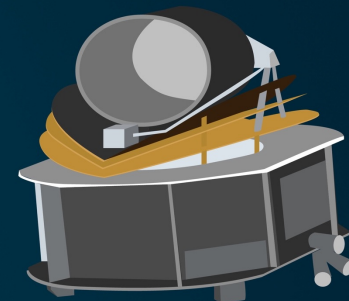
## Cheops

First step characterisation of known Earth-to-Neptune size exoplanets



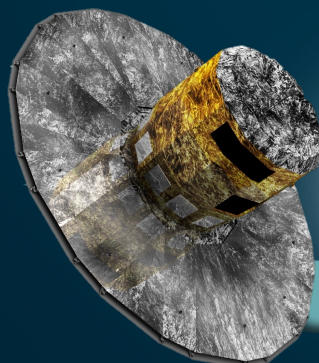
## Webb

Detailed characterisation of exoplanet atmospheres through transit studies and direct imaging

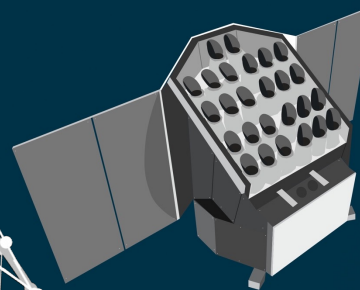


## Ariel

Performing a chemical census of a large and diverse sample of exoplanets by analysing their atmospheres



## GAIA



## Plato

Studying terrestrial planets in orbits up to the habitable zone of Sun-like stars, and characterising these stars



#ExploreFarther



# Gaia unravels star formation on the Local Bubble



Sun

Local  
Bubble

14

MILLION YEARS AGO





# JWST picture-book launch

PRIMARY MIRROR SELFIE

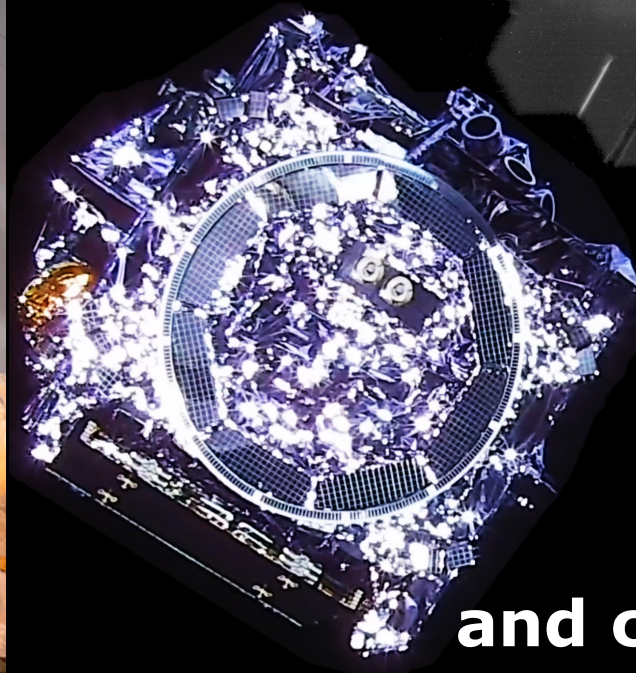
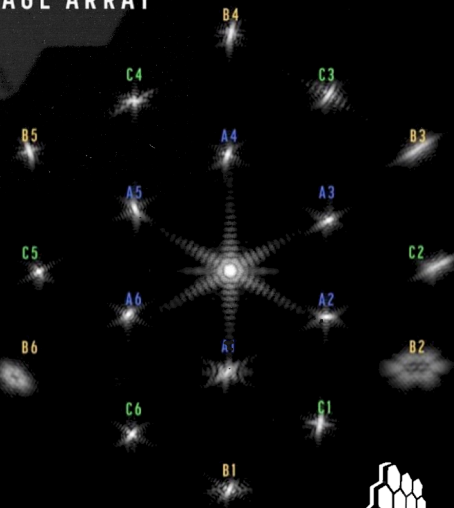


IMAGE ARRAY

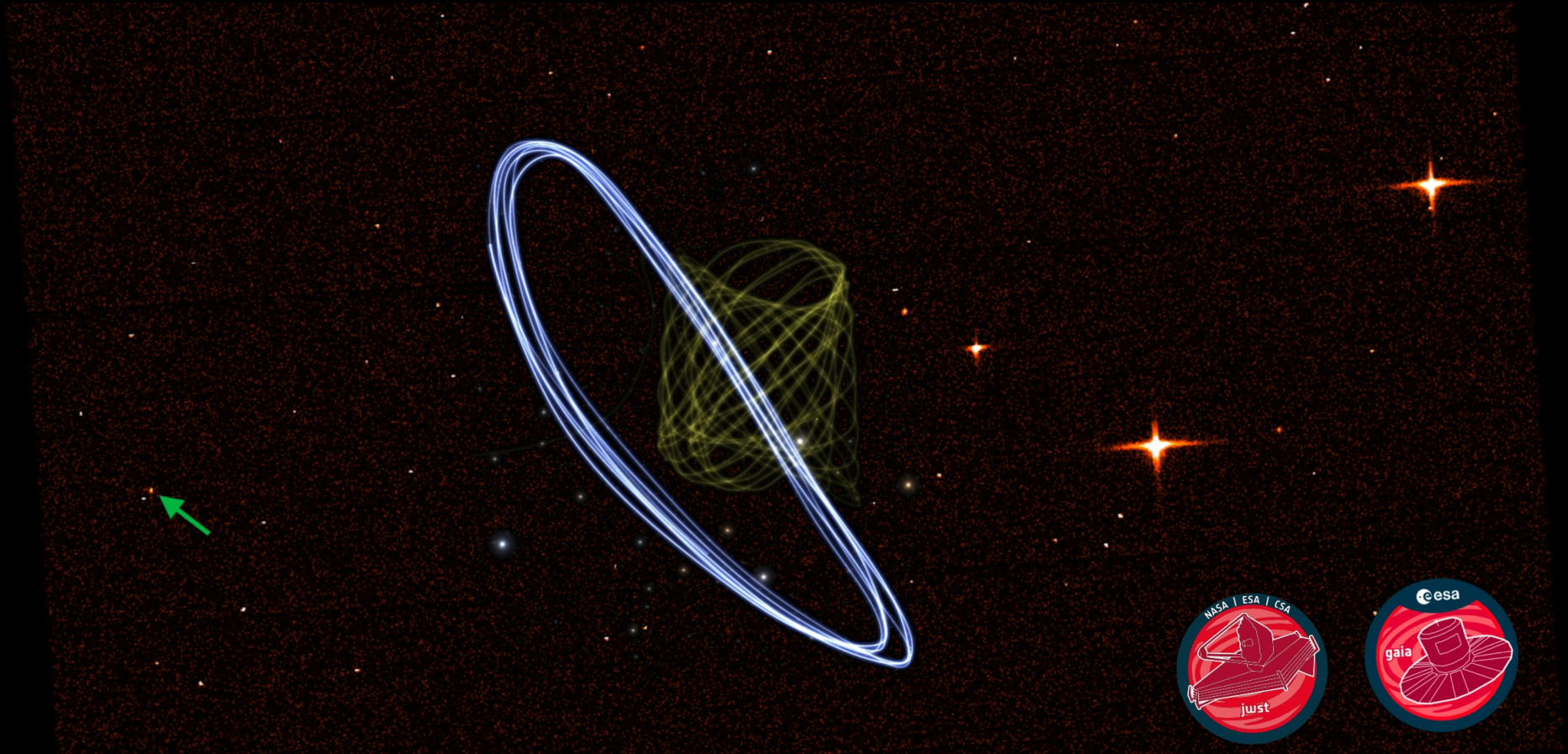


## and commissioning



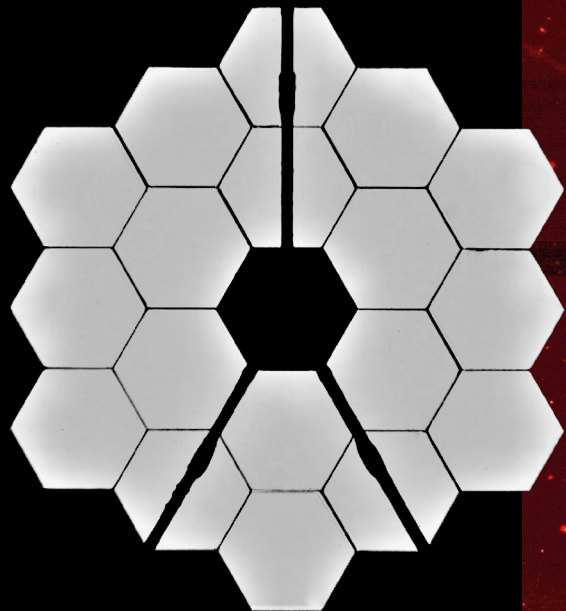
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# Gaia snaps a picture of Webb

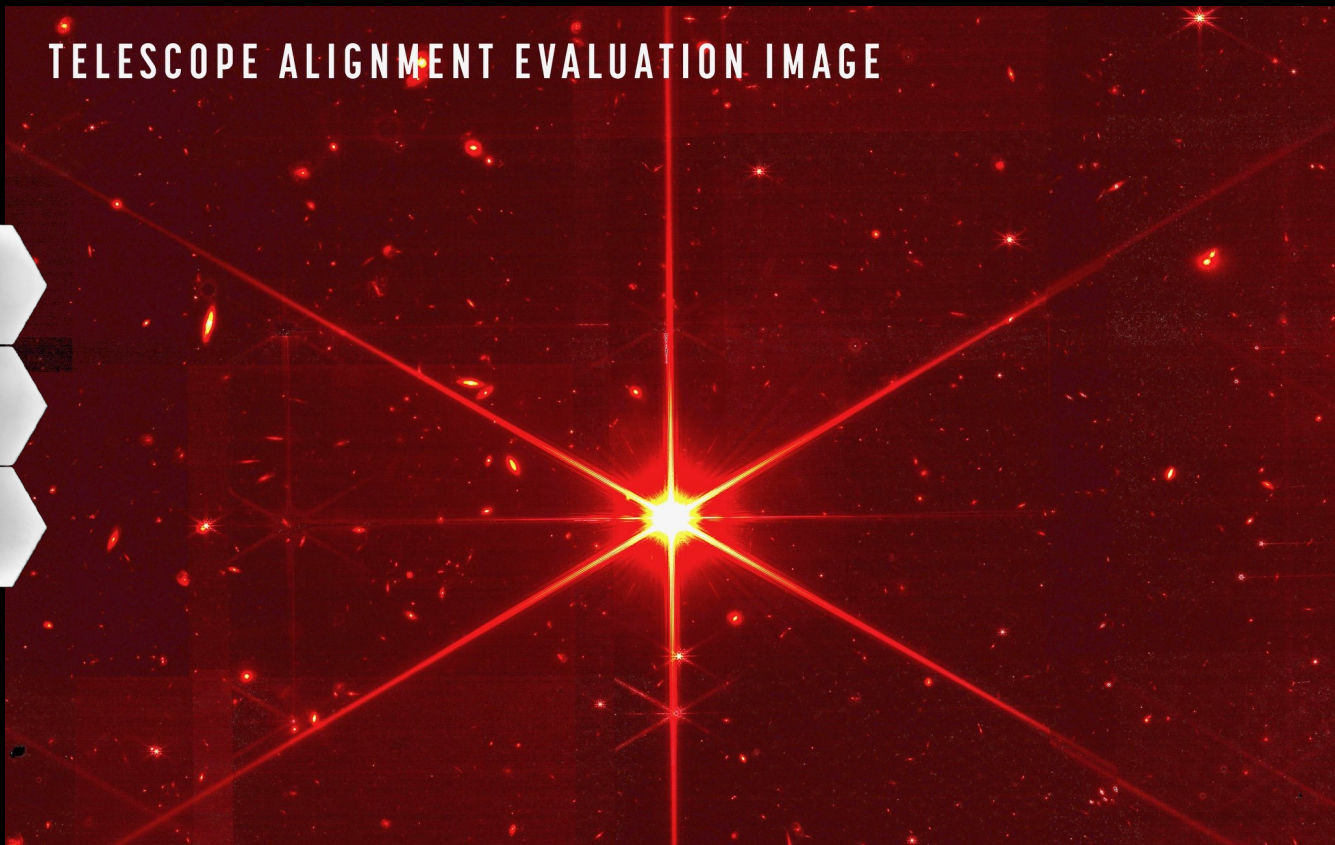


# JWST Alignment Image

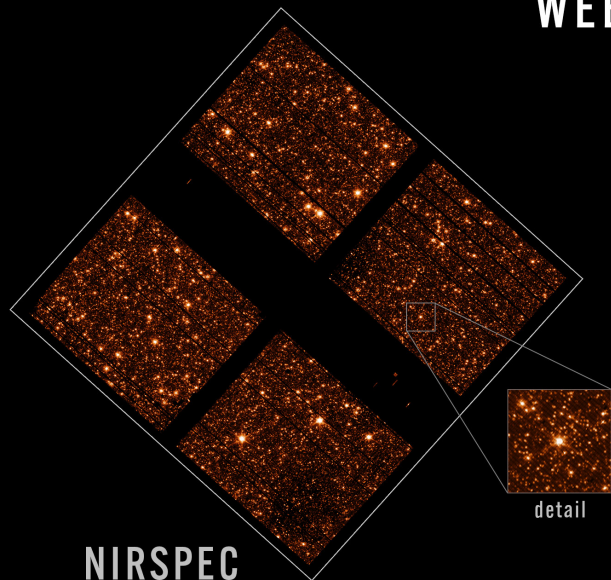
NIRCAM ALIGNMENT SELFIE



TELESCOPE ALIGNMENT EVALUATION IMAGE

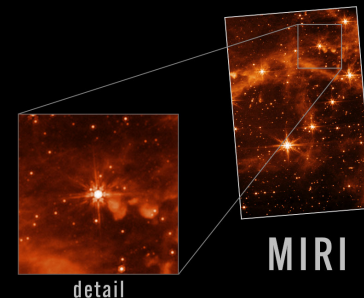
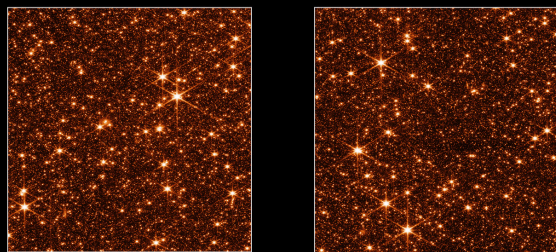


# WEBB TELESCOPE IMAGE SHARPNESS CHECK



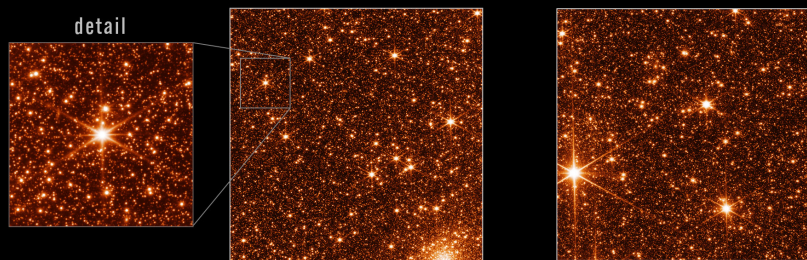
NIRSPEC

NIRCAM

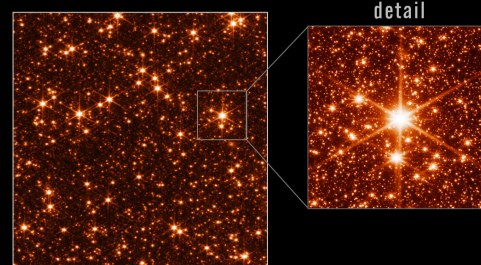


MIRI

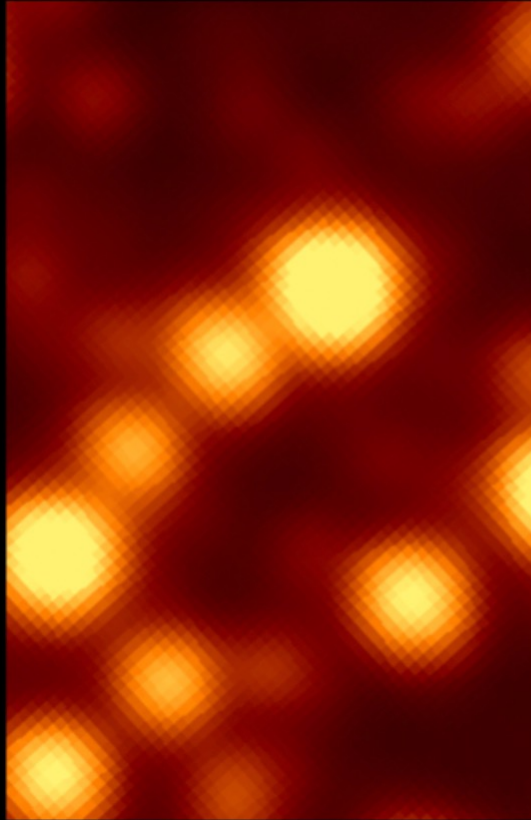
FINE GUIDANCE SENSOR



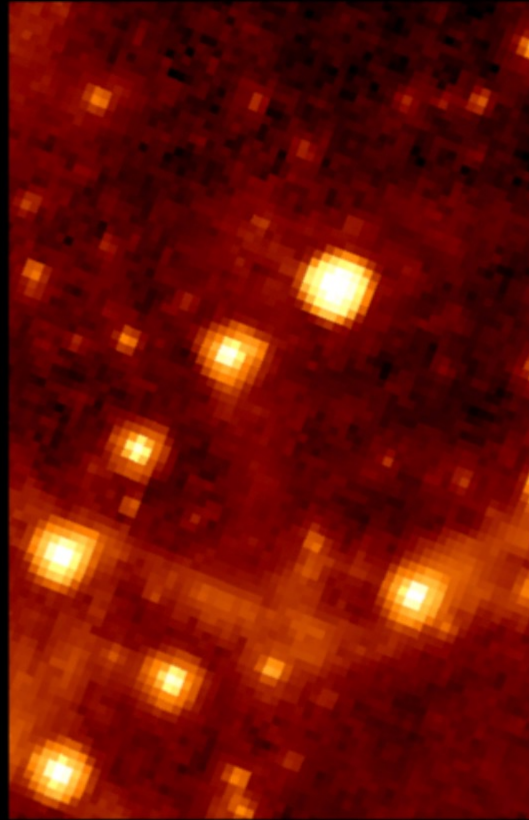
NIRISS



# The evolution of Infrared Space Telescopes



WISE W2 4.6  $\mu\text{m}$

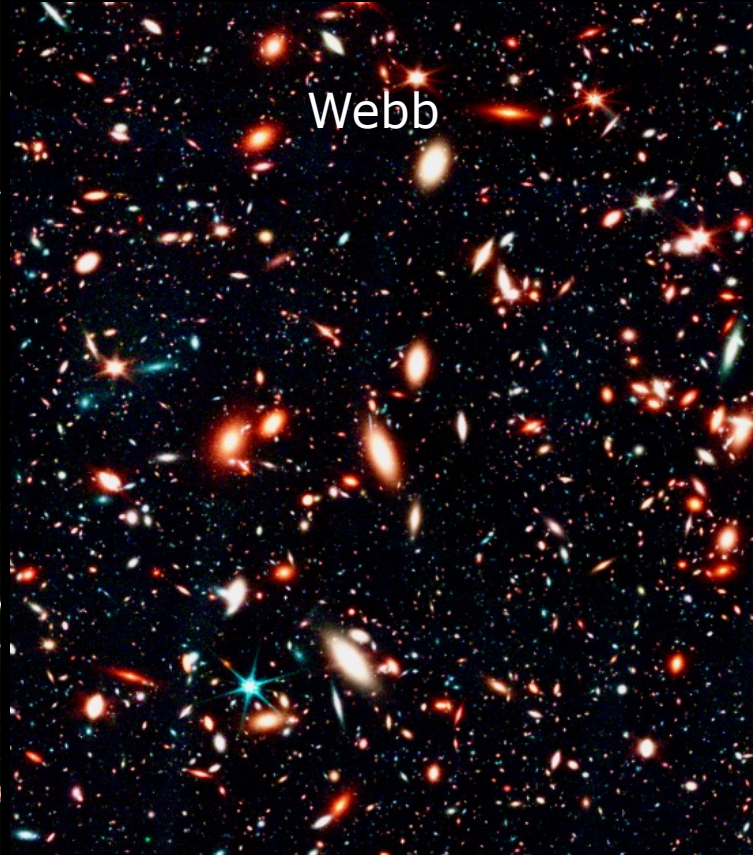
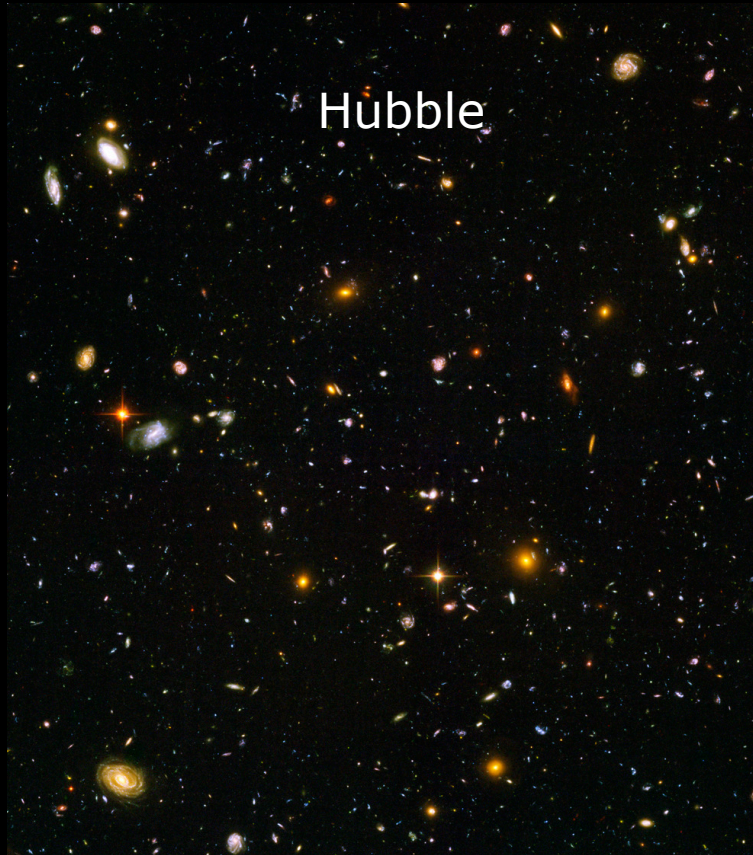


Spitzer/IRAC 8.6  $\mu\text{m}$



JWST/MIRI 7.7  $\mu\text{m}$

# Diving into the early Universe – Hubble / Webb

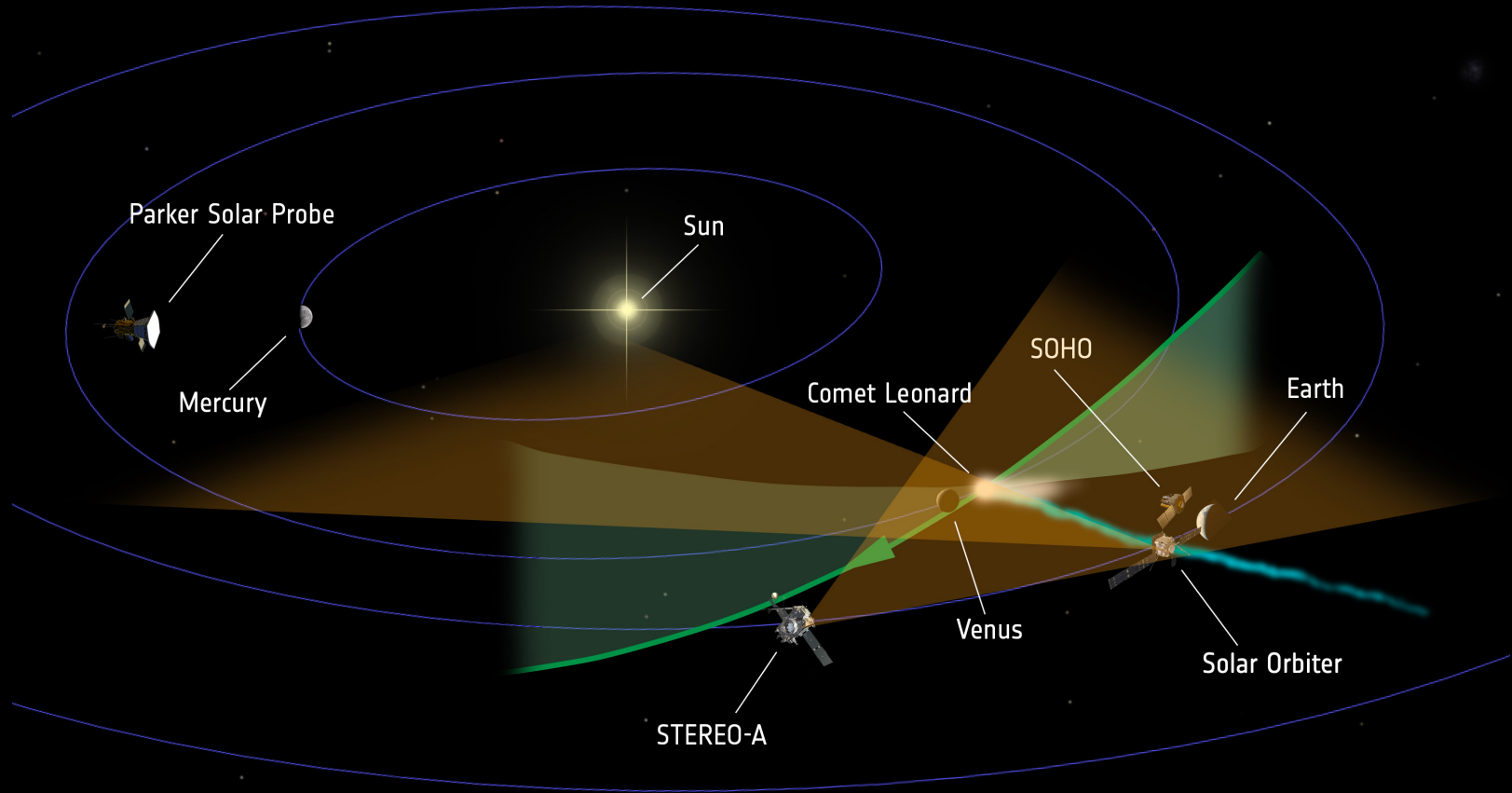


JWST  
Ariane 5  
upper stage

Comet  
Leonard  
C/2021 A1

**Observed from Thailand**  
Doi Inthanon National Park  
Matipon Tangmatitham (NARIT)

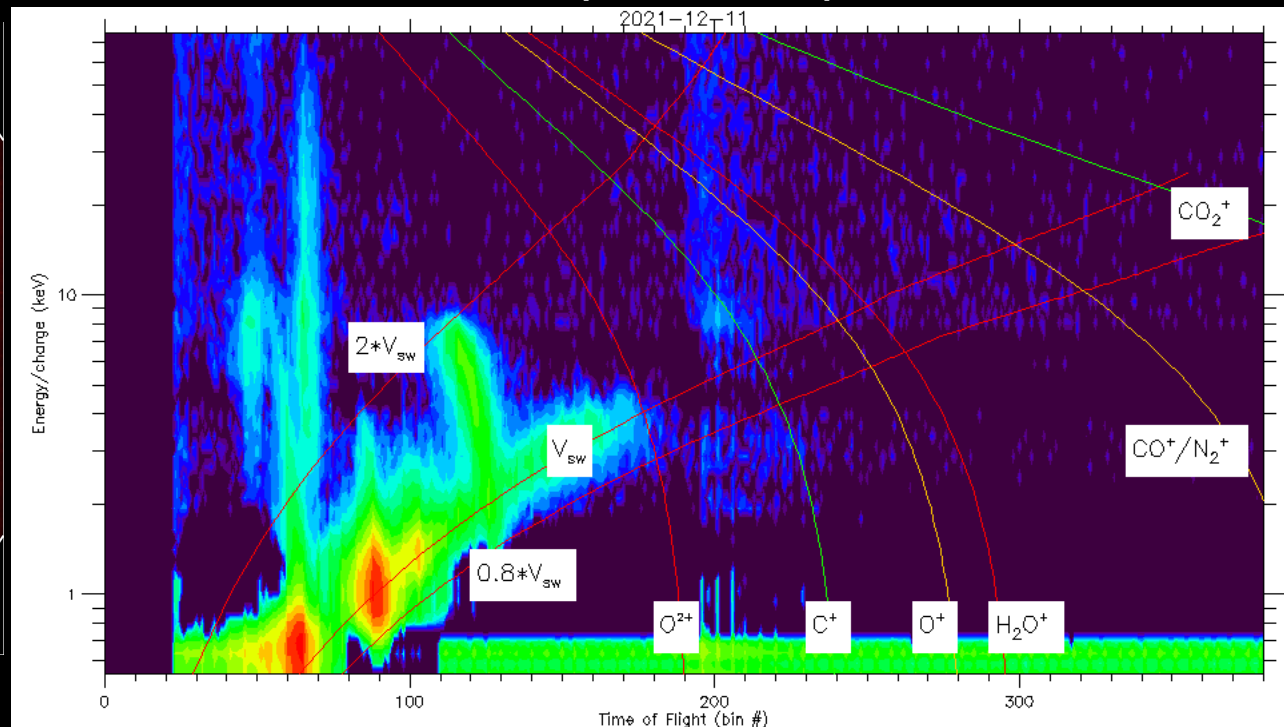
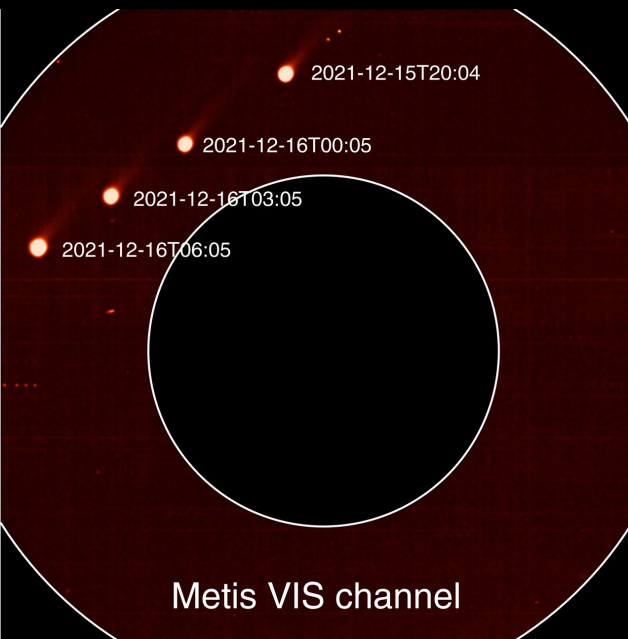
# Solar Orbiter flies through tail of Comet Leonard





# Solar Orbiter samples cometary tail material

## Solar Wind Analyzer Heavy Ion Sensor



Carbon, Oxygen, Nitrogen etc. discovered!

# Comet Interceptor

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

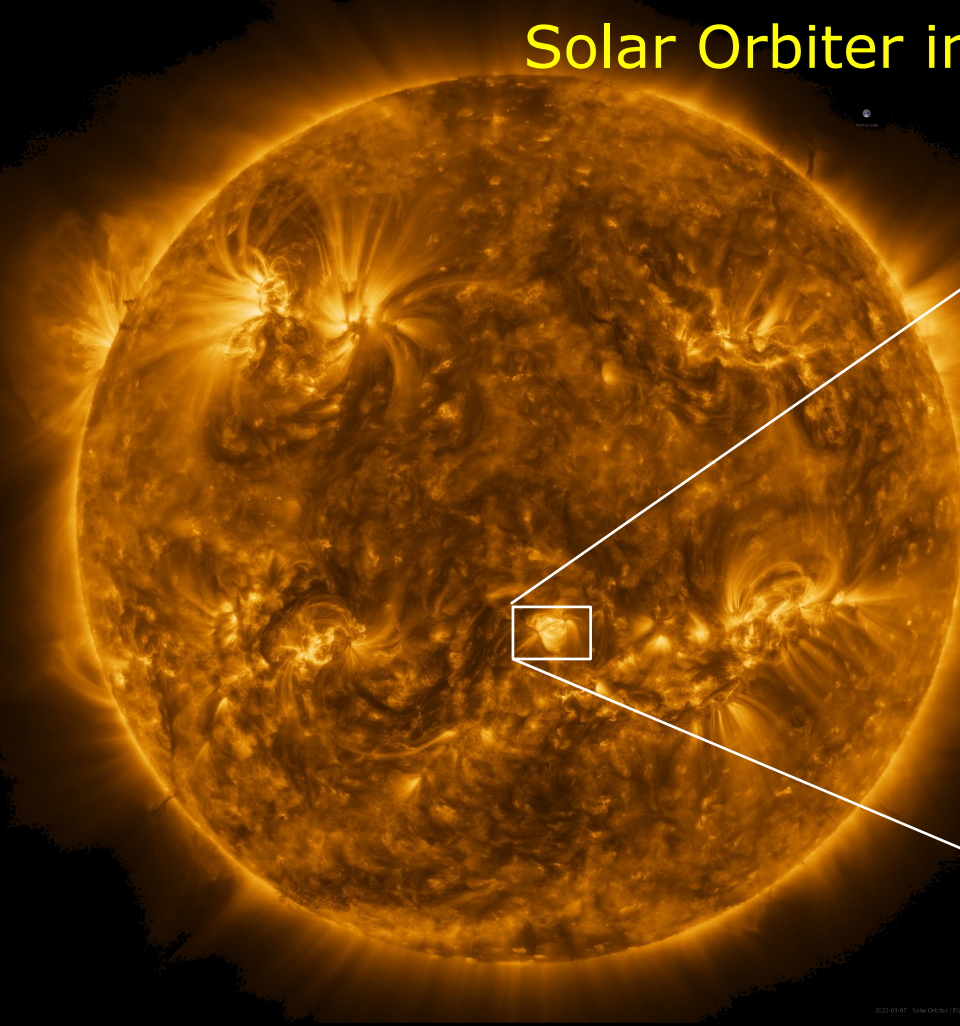


First ESA Fast/Flexi-Mission!  
Perfect and rapid response to a new scientific challenge!

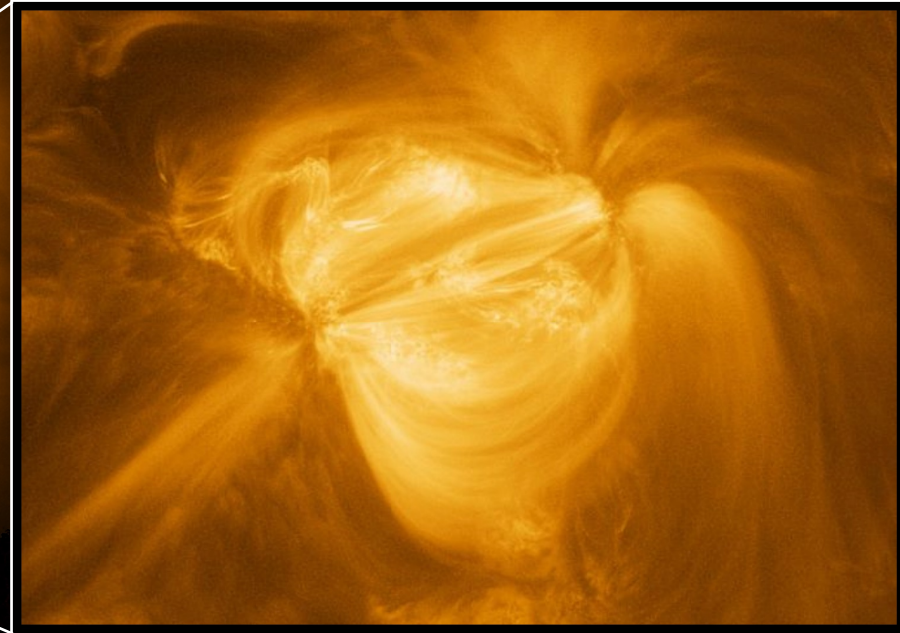


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# Solar Orbiter images at 0.5 AU



Solar Orbiter/EUI FSI 304  
Magnetism\_204\_44\_L1 Priority 0  
Resolution 14 (Step 0.56 Lateral) (km)  
Orbit -1.700 (deg) RA/Dec 0.087 (AU)  
View 2.72078:102.58 (arcsec) #107\_20220106\_001 #row  
2-01-09 00:00:20 (UTC)



9000x9000 Pixels; March 24, 2022



# Strategic Objectives: Voyage 2050 sets sail



Moons of the  
giant planets

L4

From temperate  
exoplanets to the  
Milky Way

L5

New physical probes  
of the early Universe

L6

**Possible Technology development:** cold atom interferometry, X-ray interferometry, new power and heat sources, cryogenic sample return, solar sails  
**Member State provision of payloads** is a key enabler and will use a new paradigm developed with the Member States in preparation for CM22



# Synergies between ESA and US Strategic Plans

## ESA Voyage 2050

- Moons of Giant Planets
- Temperate Exoplanets/Milky Way
- New Physical Probes of the Early Universe

## NAS Astro 2020

- Temperate Exoplanet Flagship
- FIR Probe
- X-ray Probe

## NAS Planetary 2023

- Uranus Orbiter/Atmospheric Probe
- Enceladus Orbi-Lander

## NAS Heliophysics 2025

- Interstellar Probe ???

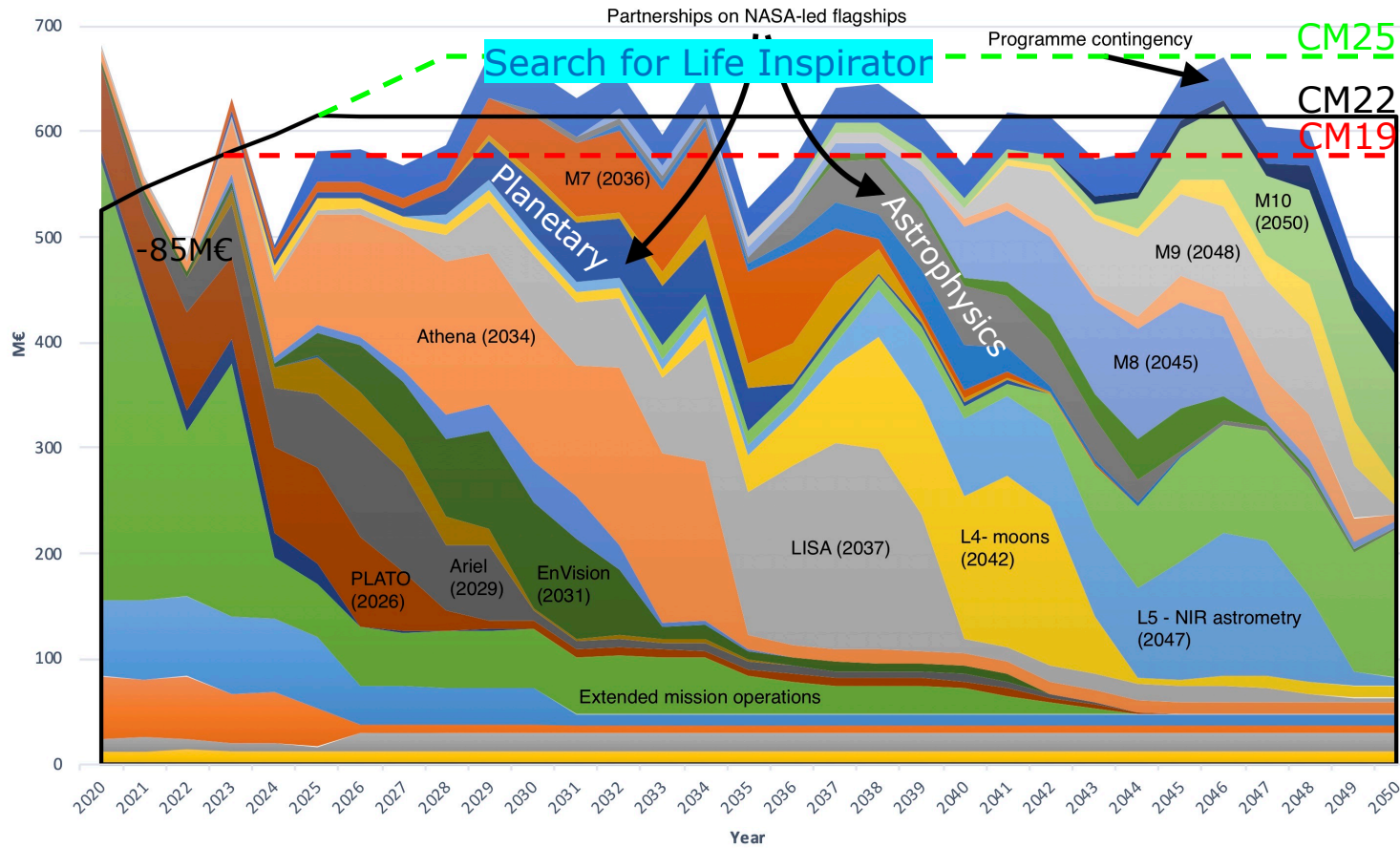
→ L4 could be ESA-led Enceladus mission with NASA participation

L5 could be ESA-only GAIA-NIR

ESA contribution to Uranus mission (e.g. atmospheric probe like Cassini/Huygens)

ESA Contributions to Astrophysics and Heliophysics flagship missions

# CM22 Long-term Implementation Plan



# First Voyage 2050 elements: Call for the M7 and F2 Missions



- 2-stage process (similar as the one implemented for Comet Interceptor)
- Released December 2021
- Community Workshop with ~100 participants and 2+ hrs. Q&A on January 13
- Phase-1 proposals were due mid February: high-level descriptions similar to the Voyage 2050 White Papers
- 12 M- and 4 F-Proposals selected for Phase-2
- Phase-2 deadline mid July
- New candidates selected at the time of the November 2022 SPC meeting
- In time for the Ministerial CM22 end of November

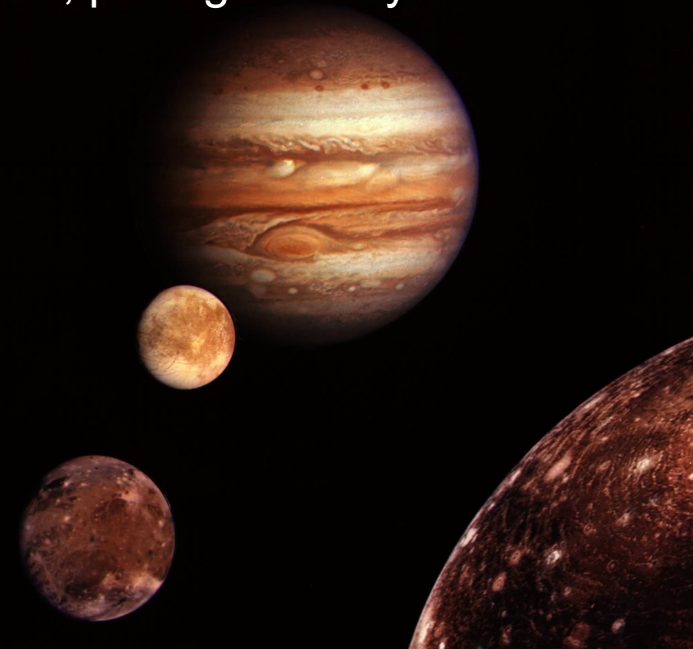


# A mission to the moons of Jupiter or Saturn

The ambitious next destination for the Science Programme

A competitively selected team of European scientists has started to define the first “Large” mission of Voyage 2050...

... also look into much more ambitious mission profiles, paving the way for the *Icy Moons Sample Return Inspirator*



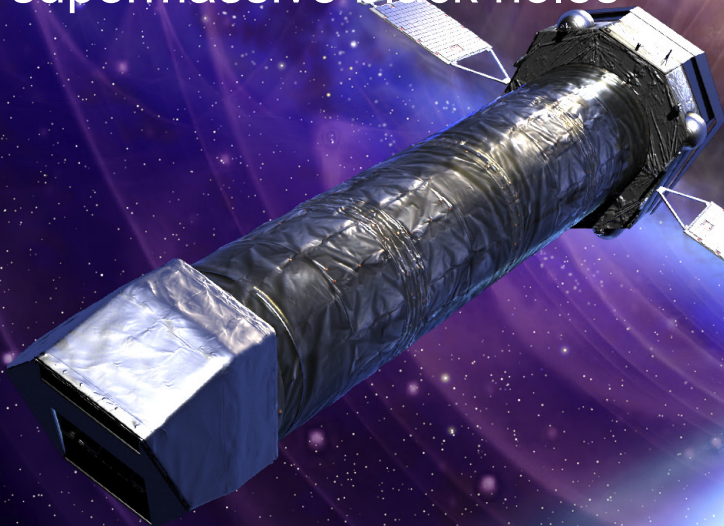


# “Bringing sound to the cosmic movies”



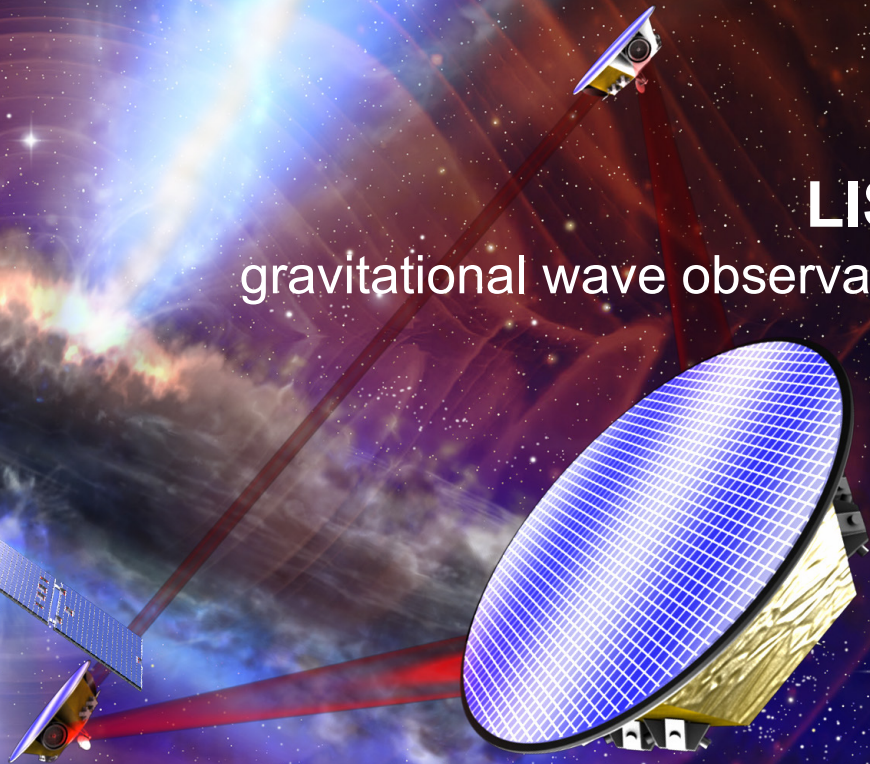
## Athena

hot gas structures  
supermassive black holes

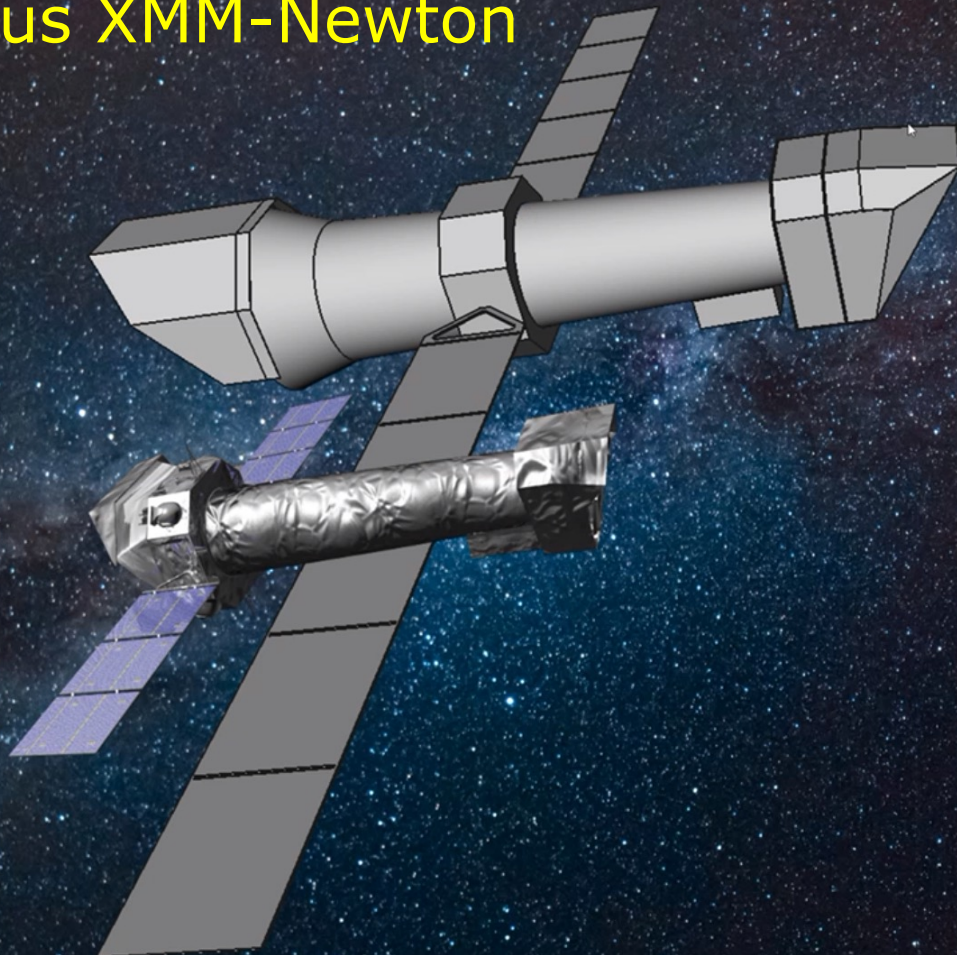


## LISA

gravitational wave observation



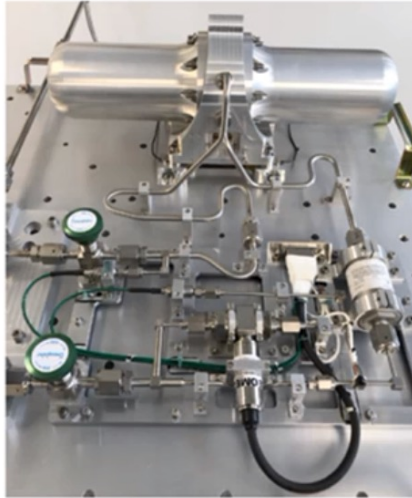
# Athena versus XMM-Newton



# A challenging example: the Athena Coolers



15K PT cooler (x 4)

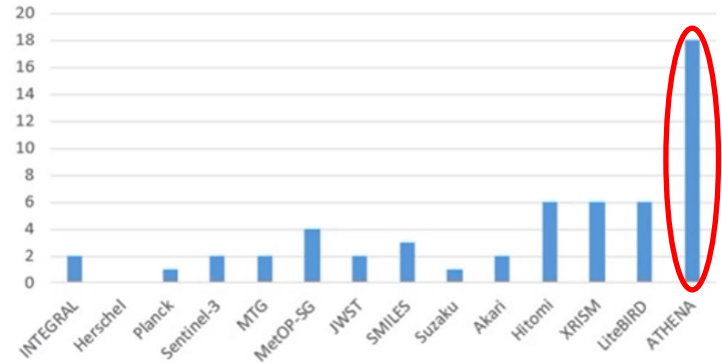


4K JT cooler (x 2)



2K JT cooler (x 2)

# Mechanical Compressors



# Thank you very much!

