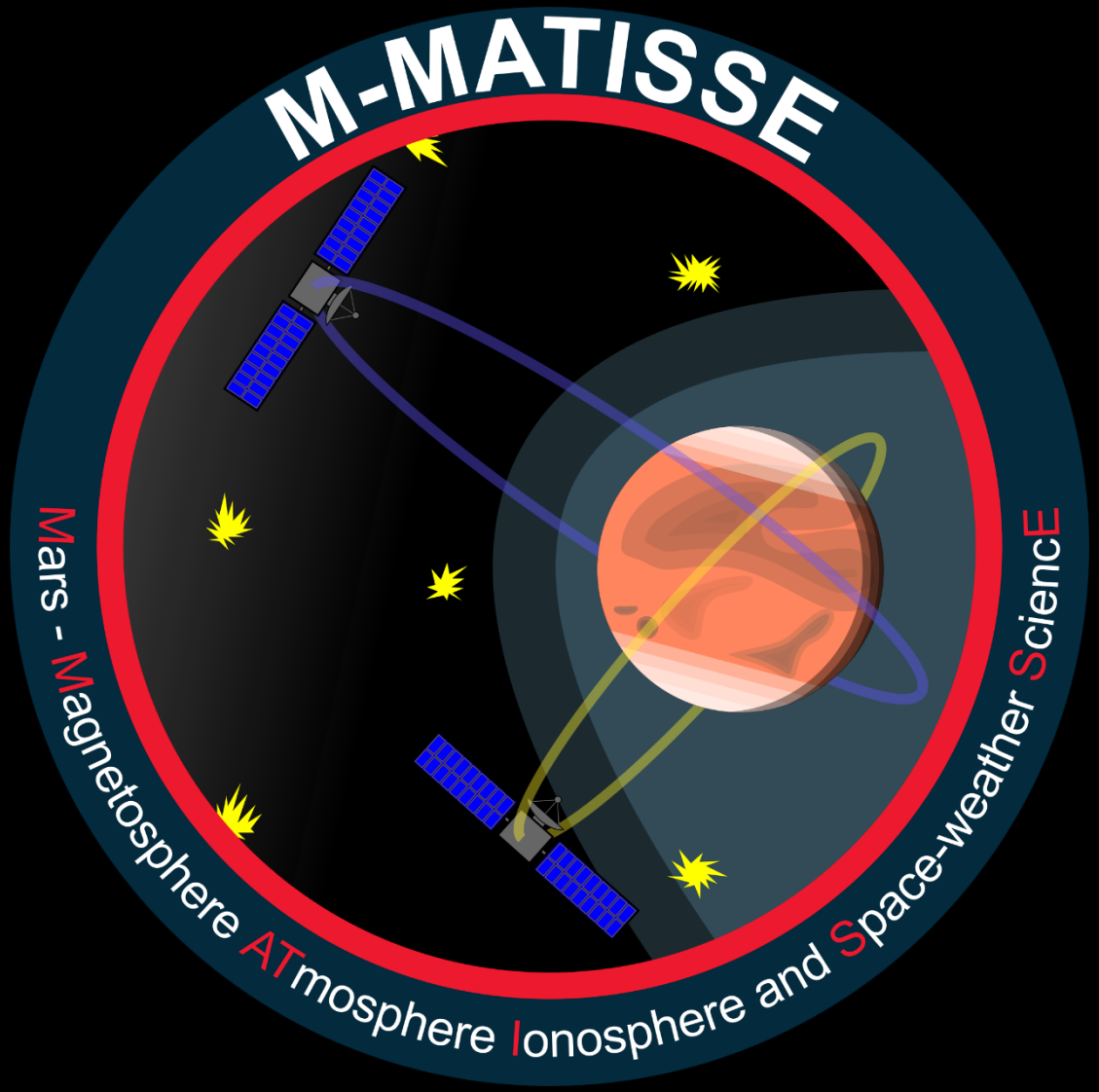
UNIVERSITY OF LEICESTER

LATMOS

ESA-ESTEC, SSC M-MATISSE 12 October 2023



M-MATISSE

Mars Magnetosphere ATmosphere Ionosphere and Space-weather SciencE

"The first dual spacecraft mission at Mars to determine the response of atmospheric coupling to Space Weather"

Beatriz Sánchez-Cano & François Leblanc
On behalf of the scientific team (~300 colleagues)

Understanding the present - Preparing the future

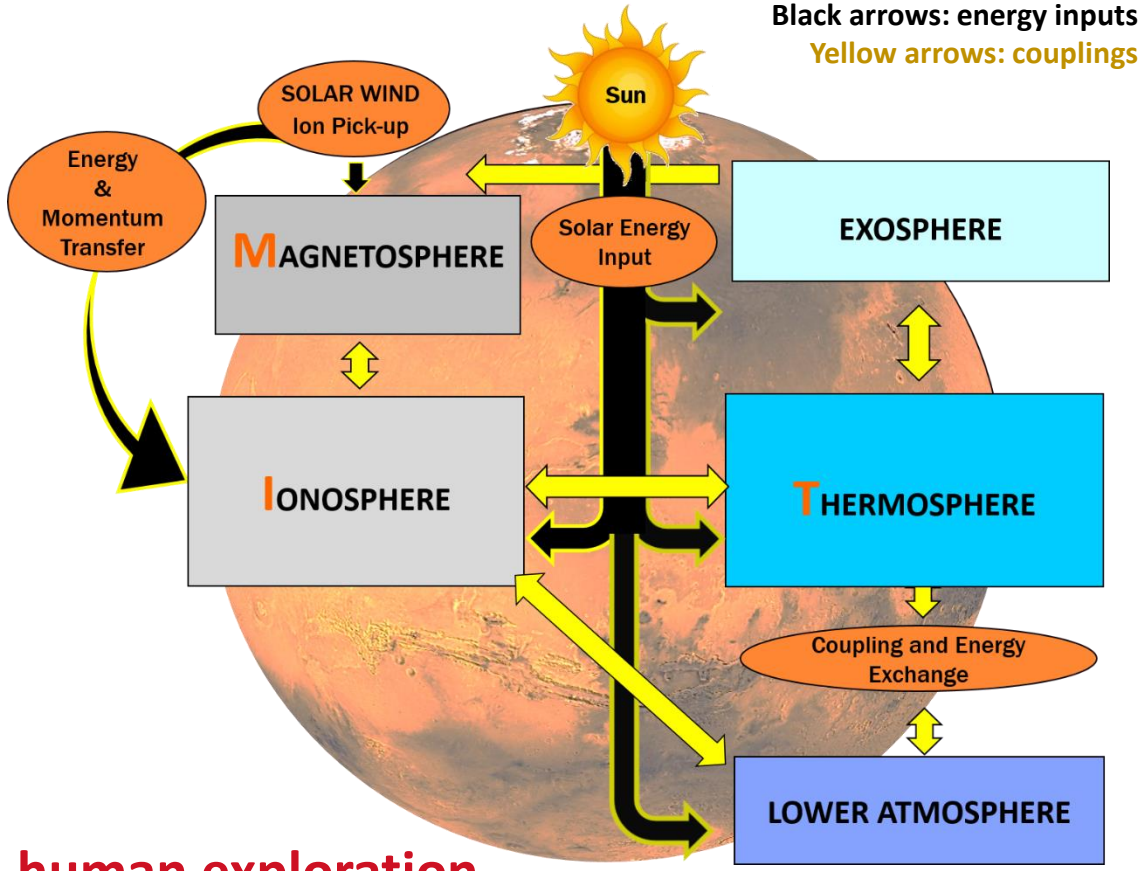
- **Quantifying the energy flow** through the system from space until the surface, **resolving temporal and spatial variabilities**
- **Unravelling the complex response** of the M-I-T coupling to Space Weather

  → **Key to understanding the evolution of terrestrial-planets climate**, as well as its past/present habitability.

  → Only possible with multi-point observations

- **Uncovering** the fate of Mars' atmosphere

→ **M-MATISSE will be essential for future robotic and human exploration**

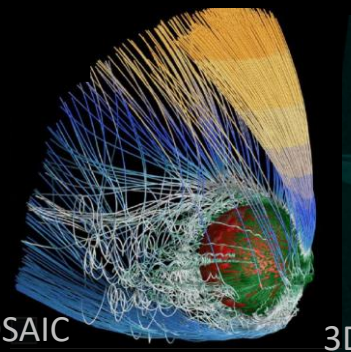


Solar wind & solar transients → Planetary Space Weather → Ionosphere-Thermosphere → Atmospheric evolution & radiation environment → Planetary Space Weather forecast, Solar System Worlds/Exoplanets

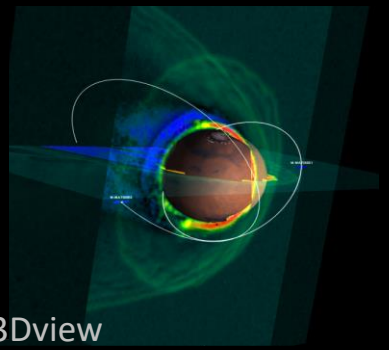
(Energy source) (Energy sink) LONGER-TERM IMPACTS

3 Science Goals to untangle Mars plasma system as never before

Multipoint plasma measurements are needed to understand mass and energy flows throughout Mars' uniquely rich and interconnected hybrid magnetosphere



MOSAIC



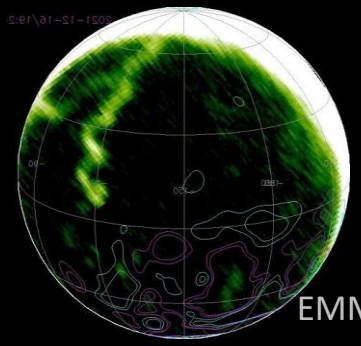
3Dview

Global system Dynamics

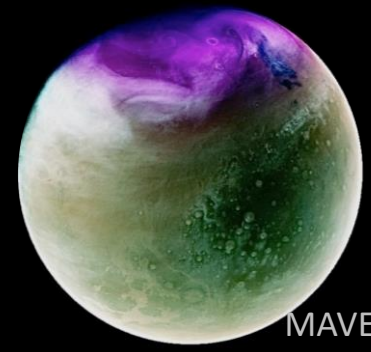
Global dynamics of the M-I-T system as a result of the Mars - solar wind interaction, and processes driving their coupling

Processes that drive the radiation environment throughout Mars' M-I-T, and its response to solar wind drivers

The radiation environment



EMM



MAVEN

ESA

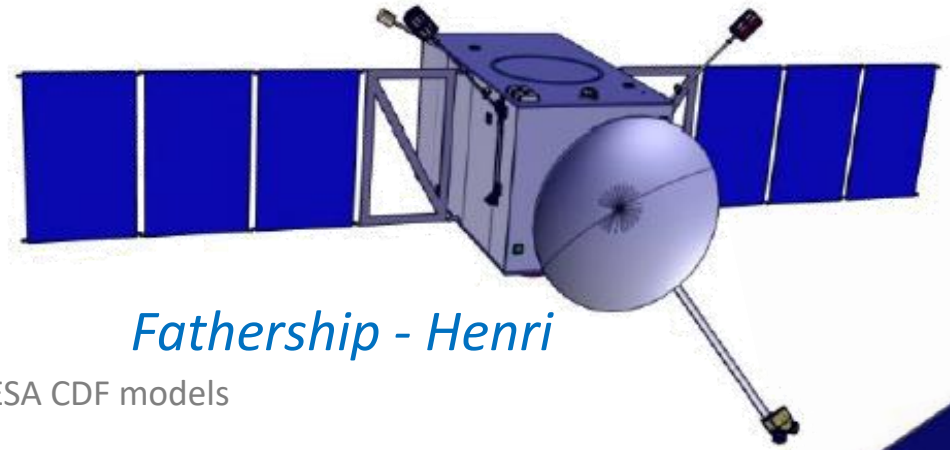
MRO

Ionosphere-lower atmosphere coupling

Mars's Space Weather effects on the lower atmosphere and so, on future human exploration

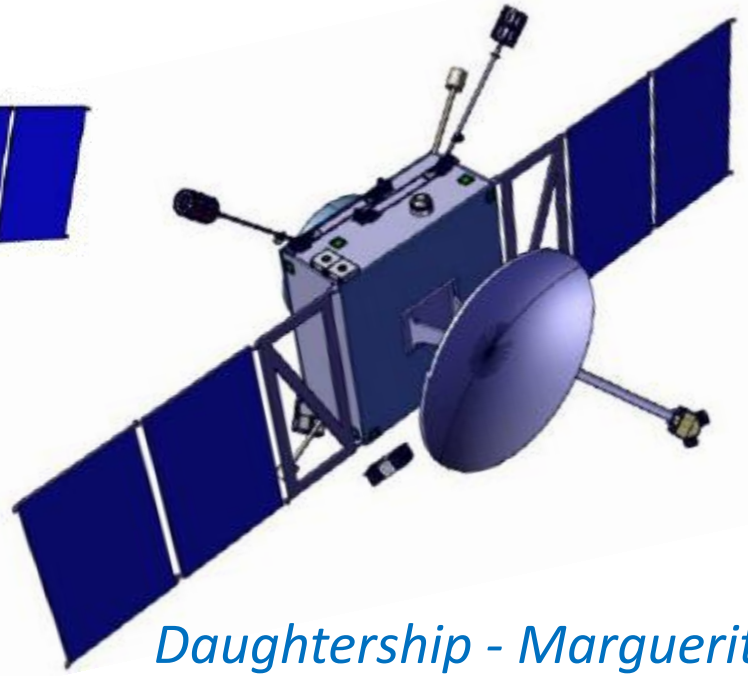
Two spacecraft – multiple vantage points

- *Henri:* In-situ observations from **3,000 km-250 km,** focus on the induced magnetosphere and upper ionosphere
- *Marguerite:* In-situ observations from **10,000-250 km**, focus on the solar wind and magneto-tail
- *Both:* remote observations of the lower-middle, upper atmosphere and ionosphere



Fathership - Henri

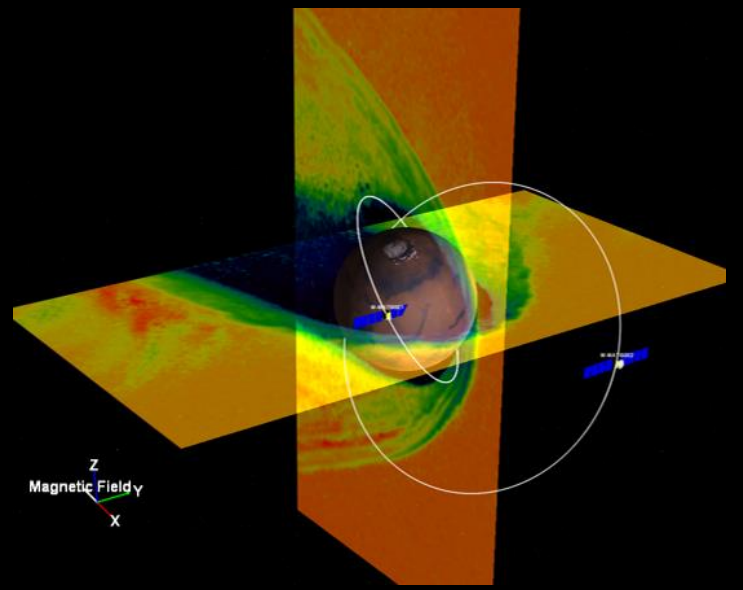
ESA CDF models

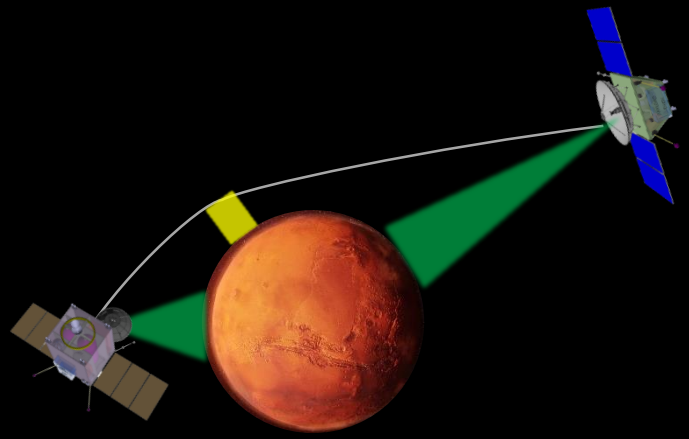


Daughtership - Marguerite

Orbit inclination of 60°

Independent communication with Earth





Scientific payload of M-MATISSE

M-MATISSE has **6 instruments** on both spacecraft, all of them with:

- High TRL, most of them already flying in other missions
- Enough time and spatial resolution and accuracy to resolve the system dynamics
- Major improvements with respect to current missions

- **COMPASS: a fields instrument with 4 sensors**
  - **FGM:** A dual magnetometer
  - **LP:** A dual Langmuir Probe
  - **MIX:** A mutual impedance experiment
  - **3DVI:** A 3D velocity of ion meter

- **M-EPI: a suite of particle instruments served by a common DPU**
  - **M-EAS:** An electron analyser
  - **M-INEA:** An ion and neutral analyser
  - **SP@M:** A solar particle detector

- **M-MSA: an ion mass spectrometer**

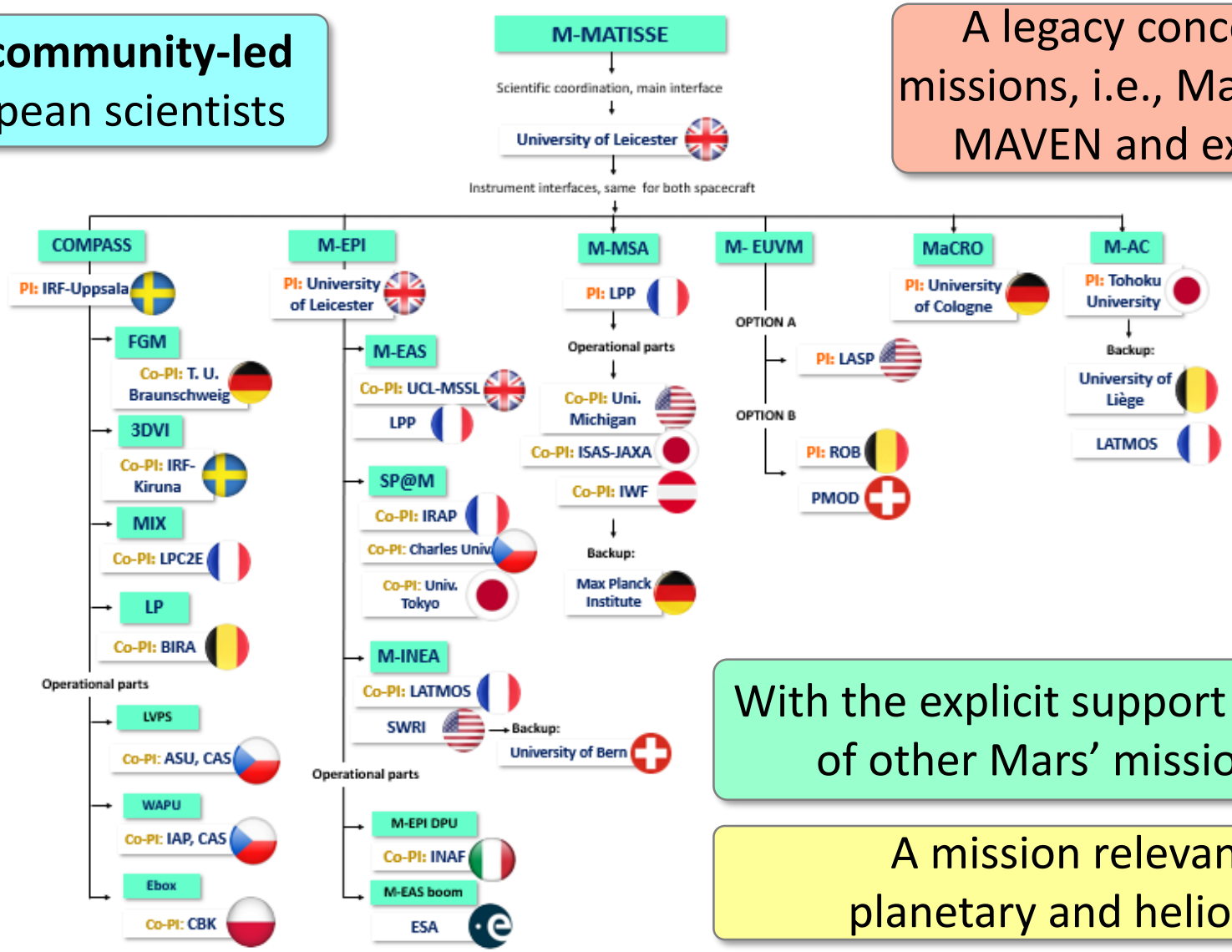
- **M-EUVM: an EUV monitor**

- **MaCRO: 2-spacecraft radio-occultation**

- **M-AC: an auroral and dust camera**

A large, organized and experienced consortium

M-MATISSE is a **community-led mission** by European scientists



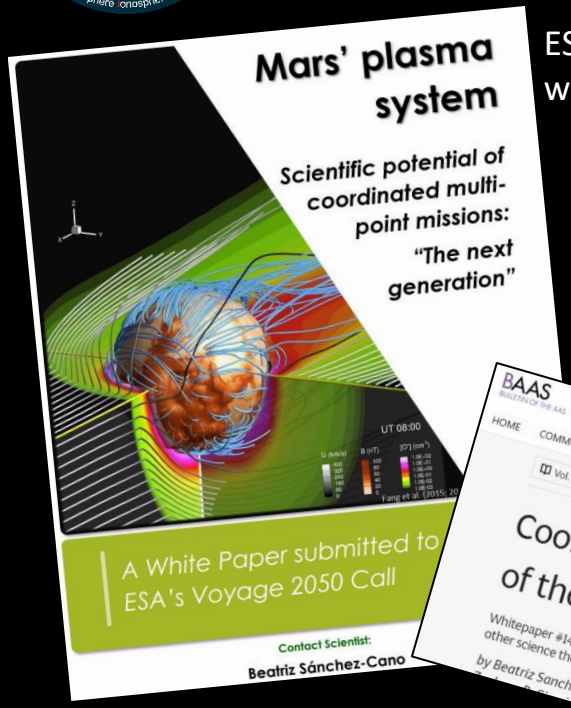
A legacy concept from pioneer missions, i.e., Mars Express, TGO and MAVEN and experienced teams

With the explicit support of the science teams of other Mars' missions, and agencies

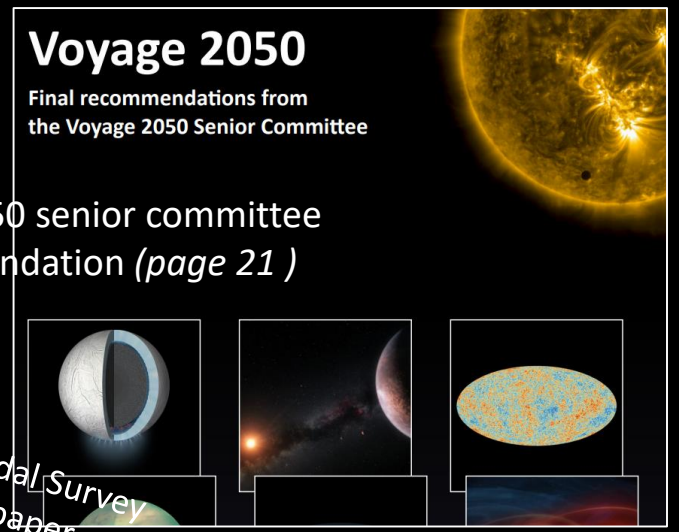
A mission relevant for plasma, planetary and heliophysics science

A need for the scientific community

ASTRONET Europe roadmap 2022-2035
(pages 98-99)

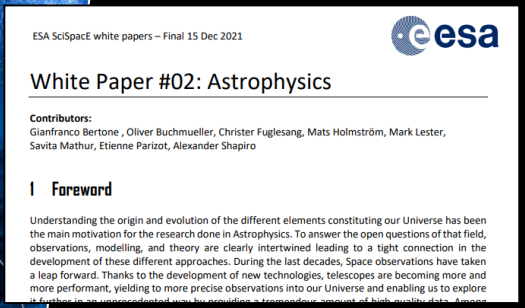


ESA Voyage-2050 white paper

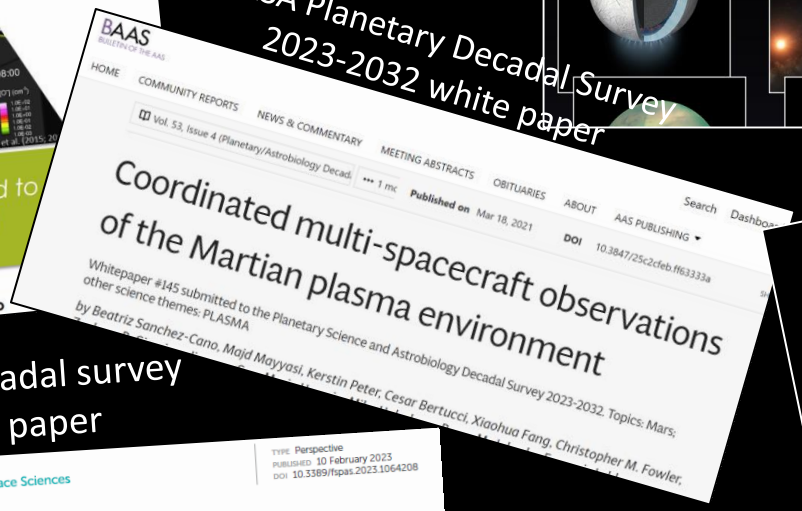


Voyage 2050 senior committee recommendation *(page 21)*

ESA SciSpacE White Papers

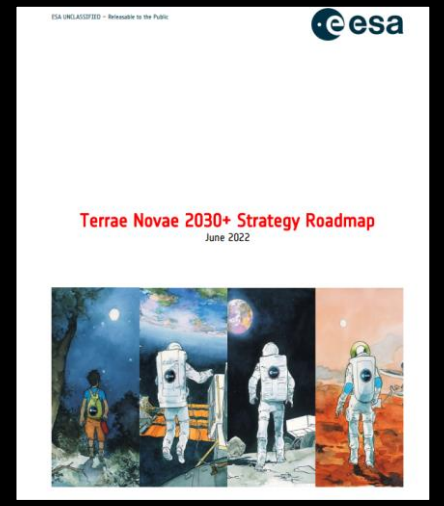


NASA Planetary Decadal Survey 2023-2032 white paper

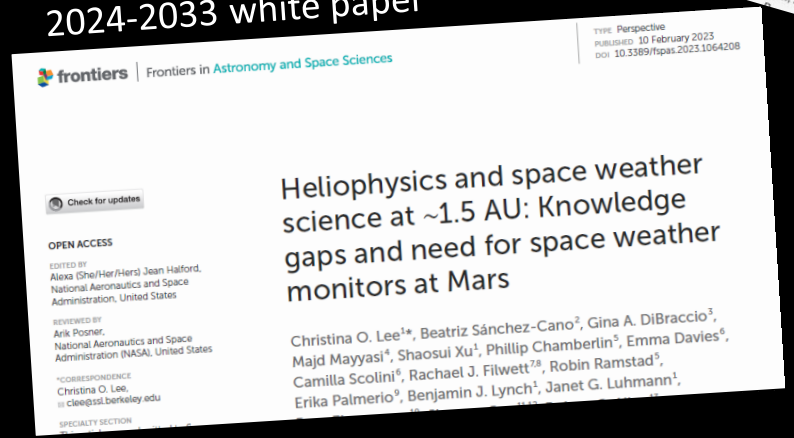


ESA Terrae Novae 2030+

"to prepare the horizon goal of Europe being part of the first human mission to Mars."



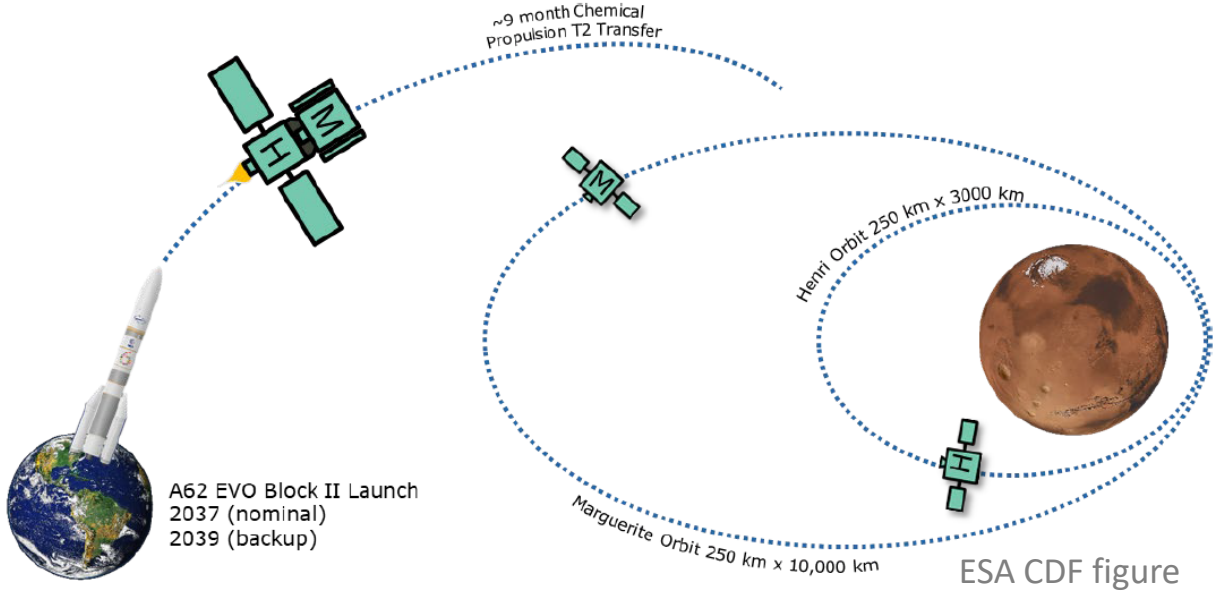
NASA heliophysics decadal survey 2024-2033 white paper



NASA Planetary Mission Concept Study, Planetary Decadal Survey 2023-2032

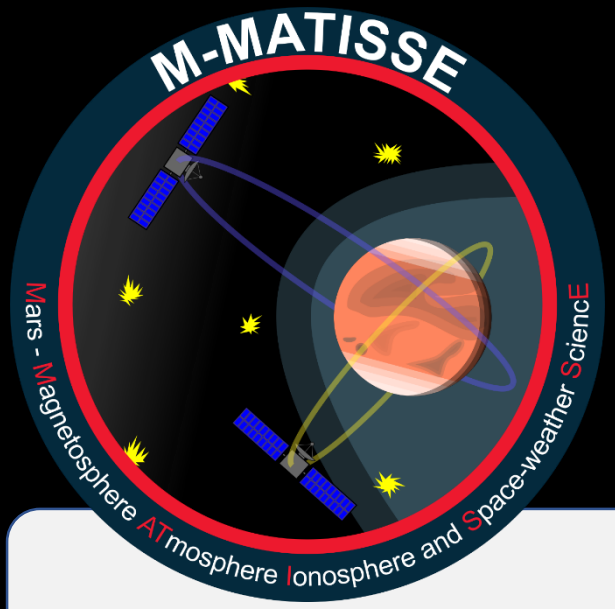
M-MATISSE CDF and MDR results

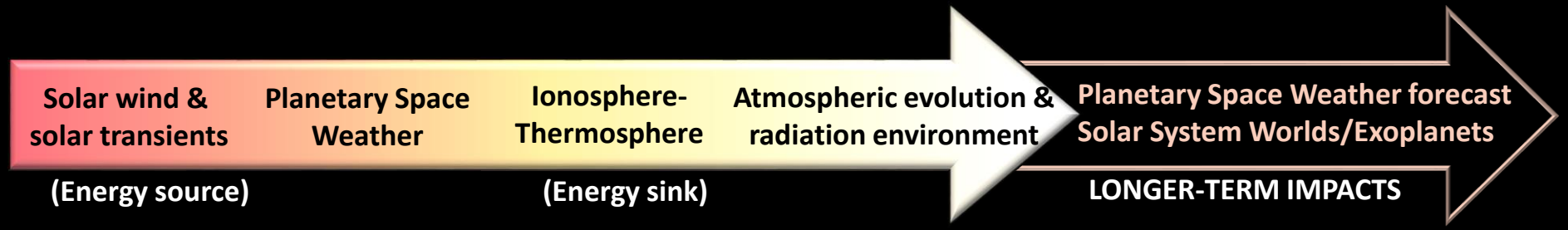
- The mission is compatible with a Phase-0 investigation and it is considered under control.
- No identified technical or programmatic showstoppers for the M7 M-MATISSE mission.
- All the review objectives have been fully achieved and the MDR can be considered successful.
- A solid work plan for the science instruments is planed for the Phase-A.



ESA CDF figure

M-MATISSE: “the first flotilla to another planet”





- A dual spacecraft approach with an optimal set of plasma instruments and radio-occultation experiment
- A **unique capability** to track solar perturbations from the Solar Wind down to the surface
- A mission dedicated to understand planetary space weather at Mars
- An **essential step** for future robotic and human exploration
- A **large organized and experienced** international consortium