TAS-I contribution to space missions for space weather forecast

Space Weather as a global challenge

Washington D.C., May 18th, 2017

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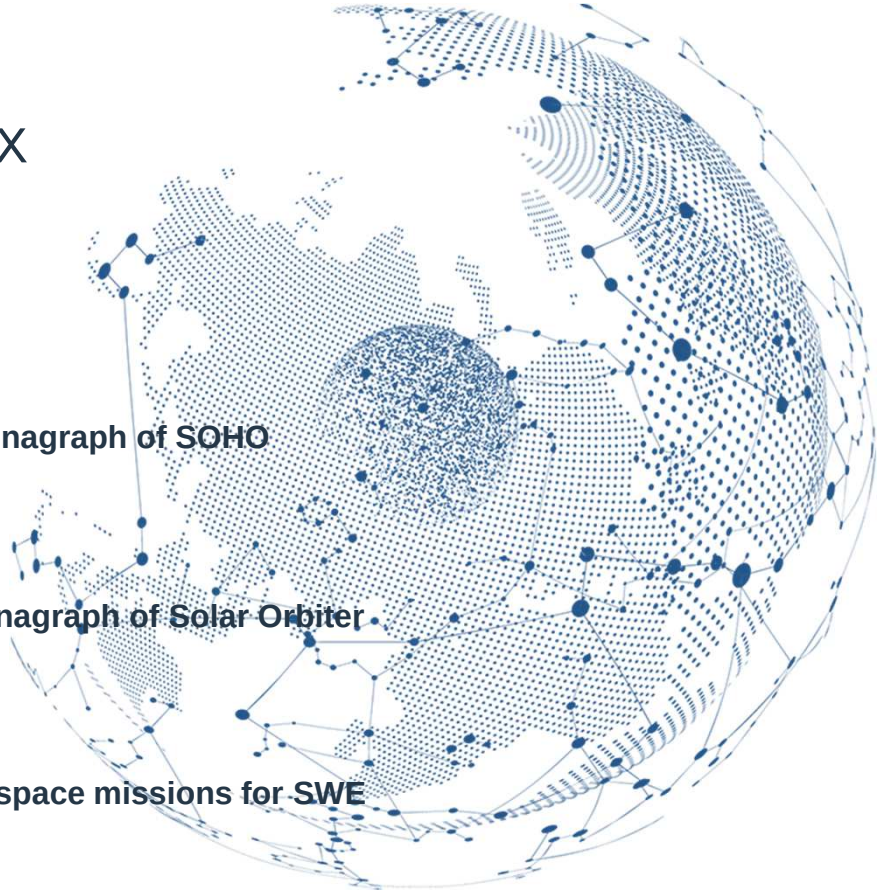
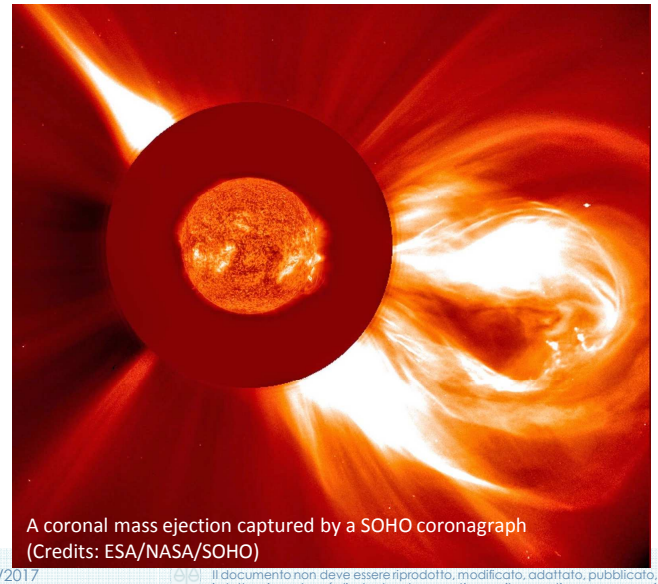


- Space weather introduction
- TAS-I contribution to the UVCS coronagraph of SOHO
- TAS-I contribution to the Metis coronagraph of Solar Orbiter
- TAS-I products applicable to future space missions for SWE

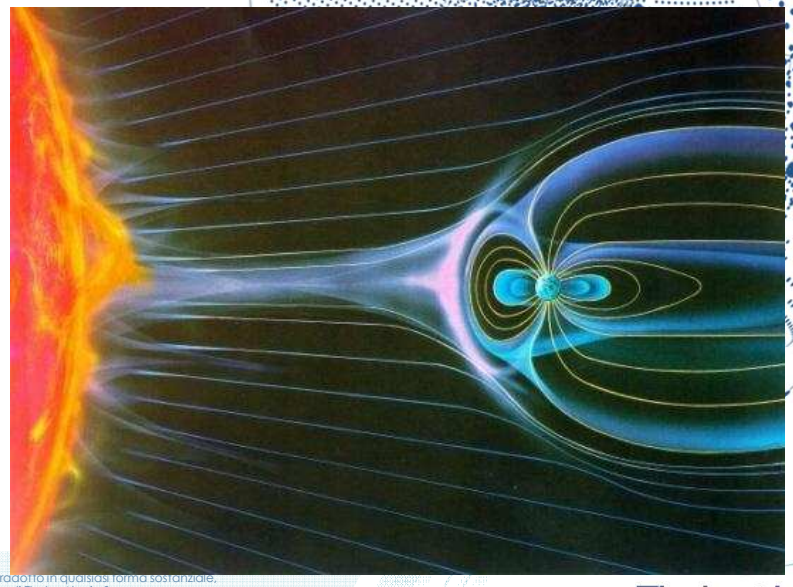
Space weather: when the solar wind meets the Earth

SPACE MISSIONS PLAYS A FUNDAMENTAL ROLE IN MONITORING THE SOLAR WIND AND UNDERSTANDING ITS ORIGIN

- Space Weather refers to the status of Earth magnetosphere, ionosphere and thermosphere mainly influenced by the solar wind, a stream of charged particles (electrons, proton, ions) flowing from the Sun corona towards the outer space. Solar eruptions produce high fluxes of solar wind that, encountering the Earth, give rise to geomagnetic storms.
- Space-borne coronagraphs are ideal instruments for a continuous monitoring of Sun corona at different wavelengths (even not accessible from Earth) and for providing an early warning of the occurrence of geomagnetic storms.



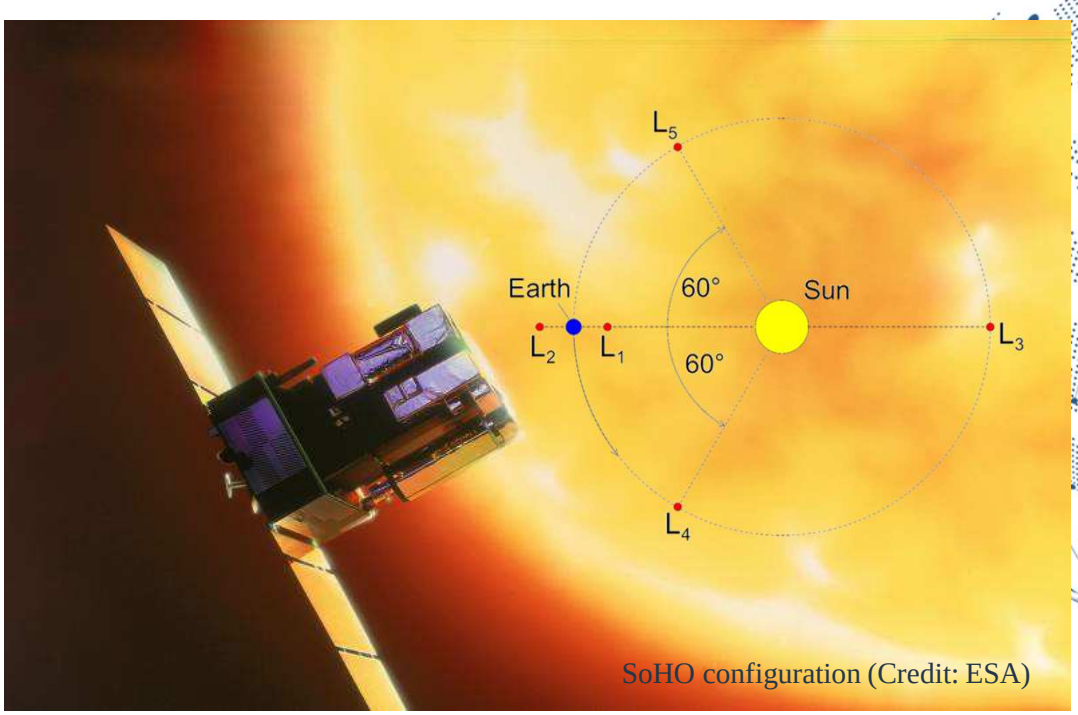
A coronal mass ejection captured by a SOHO coronagraph
(Credits: ESA/NASA/SOHO)



TAS-I contribution to the UVCS coronagraph of SOHO

THE UV CORONAL SPECTROMETER (UVCS) OF THE SOLAR AND HELIOSPHERIC OBSERVATORY

- **SOHO, one of the pillars of the space weather monitoring network, was launched 1995 around the Lagrangian L1**



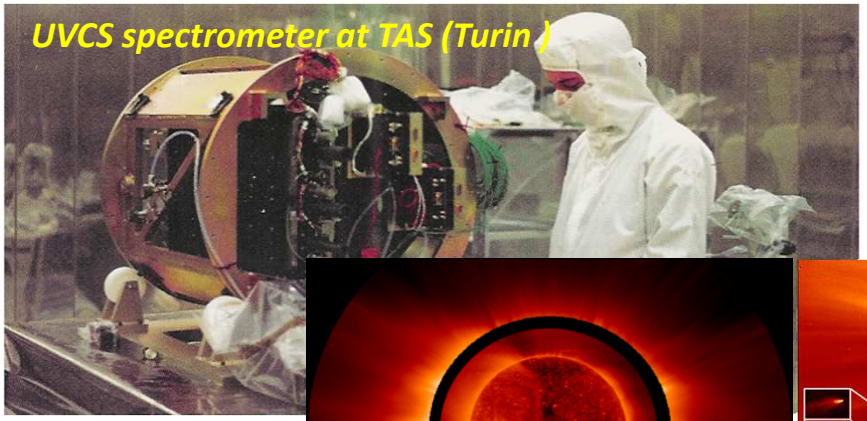
SoHO configuration (Credit: ESA)

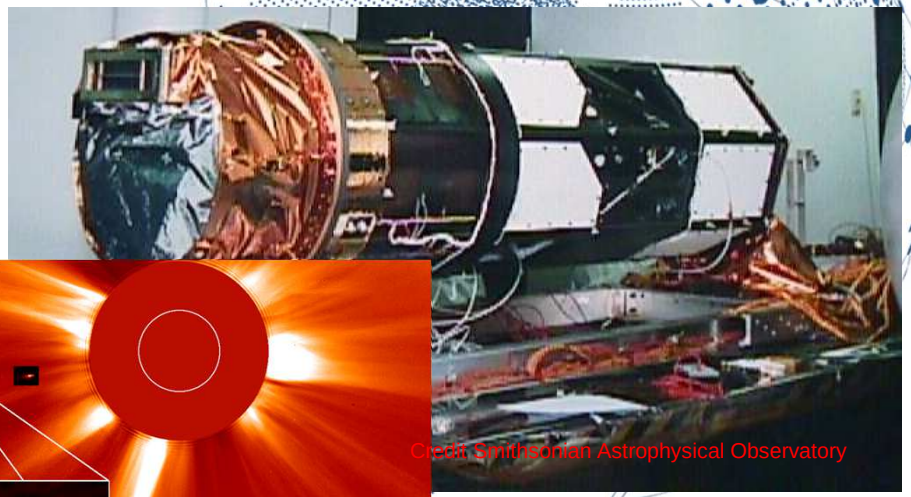
TAS-I in collaboration with Officine Galileo (now Leonardo) implemented the spectrograph of the UV Coronagraph Spectrometer (UVCS).

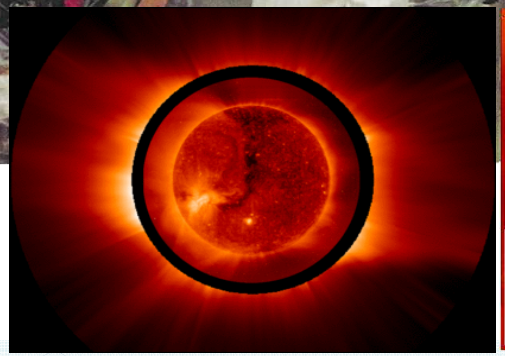
TAS-I contribution to the UVCS coronagraph of SOHO

THE FUNDAMENTAL CONTRIBUTION OF UVCS

- UVCS allowed for the first time the ultraviolet spectroscopy of the outer solar corona to explore the solar wind sources and acceleration regions, exploiting the diagnostic technique (Doppler dimming) proposed in the seventies by G. Noci (UVCS Co-PI) to the Smithsonian Astrophysical Observatory.
- UVCS observed the Sun corona from 1.3 to 10 solar radii, in the band 60-130 nm, for nearly two 11-year solar cycles.



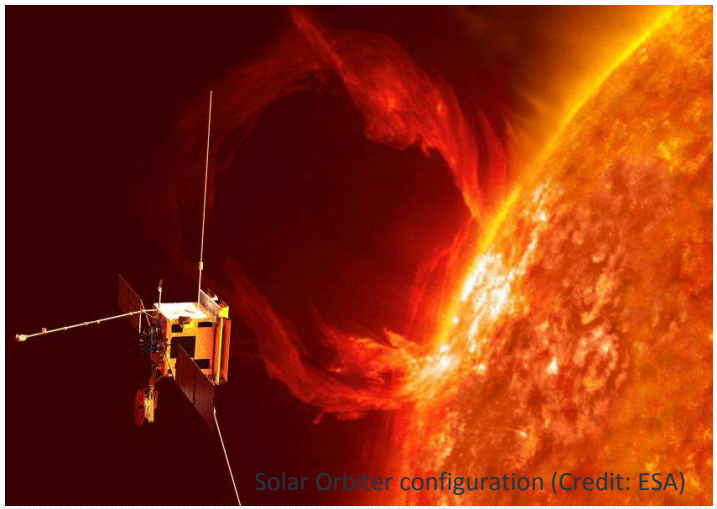




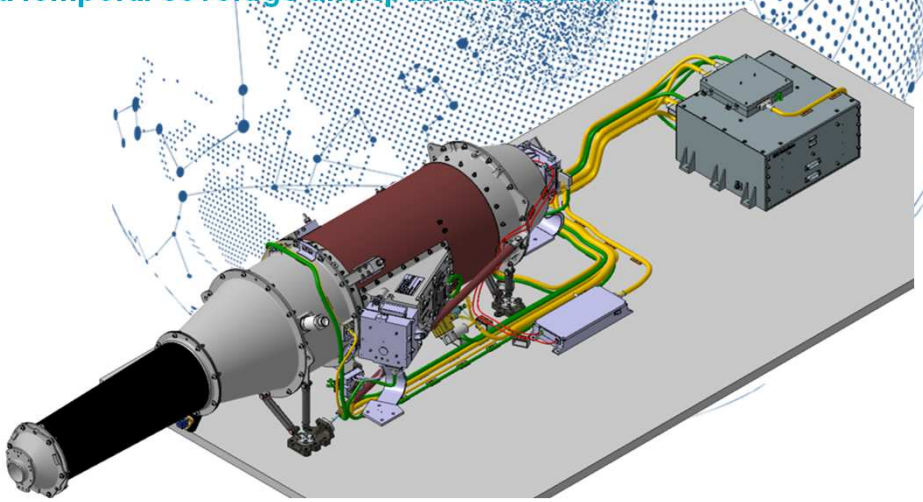
TAS-I contribution to the Metis coronagraph of Solar Orbiter

METIS, AN INNOVATIVE CORONAGRAPH, WILL ALLOW UNDERSTANDING THE ORIGIN AND ACCELERATION OF THE SOLAR WIND

- **Solar Orbiter, mission of ESA's CV program planned for launch on beginning 2019, will observe for the first time the Sun and its environment from a minimum distance of just 0.28 AU and a maximum solar latitude of 34°.**
- **TAS-I, in consortium with OHB Italia, implemented the Metis coronagraph for Solar Orbiter, an instrument proposed by an international scientific consortium led by the PI Prof. Ester Antonucci and funded by ASI.**
- **Metis is an innovative coronagraph based on an inverted-occultation optical design that will provide for the first time simultaneous imaging of the full corona in polarized visible-light (580-640 nm) and narrow-band ultraviolet HI Ly-α (121.6 nm), with unprecedented *temporal coverage and spatial resolution*.**



Solar Orbiter configuration (Credit: ESA)



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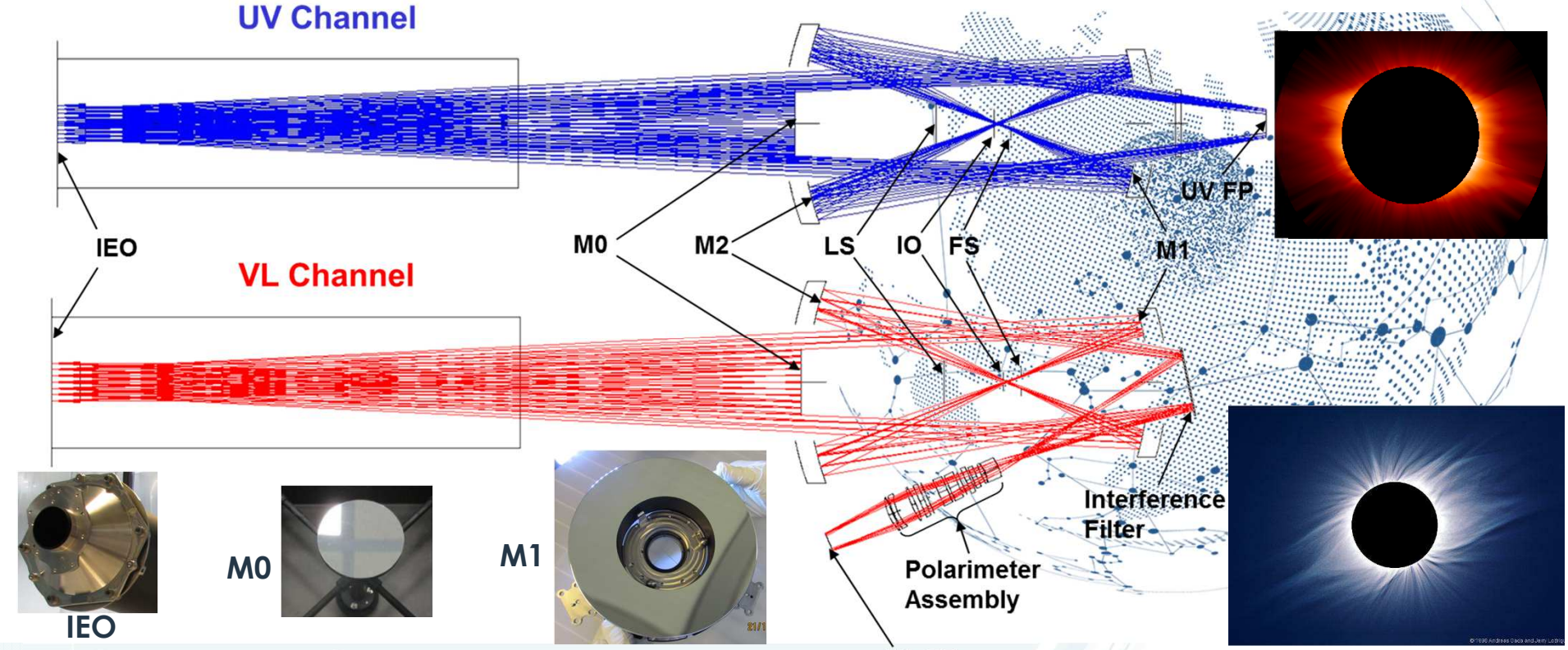
TAS-I contribution to the Metis coronagraph of Solar Orbiter

OPTICAL DESIGN FOR SIMULTANEOUS IMAGING OF FULL SUN CORONA IN VL AND UV



TAS-I contribution to the Metis coronagraph of Solar Orbiter

SOLAR ORBITER: A UNIQUE MISSION

0.28 AU minimum perihelion:

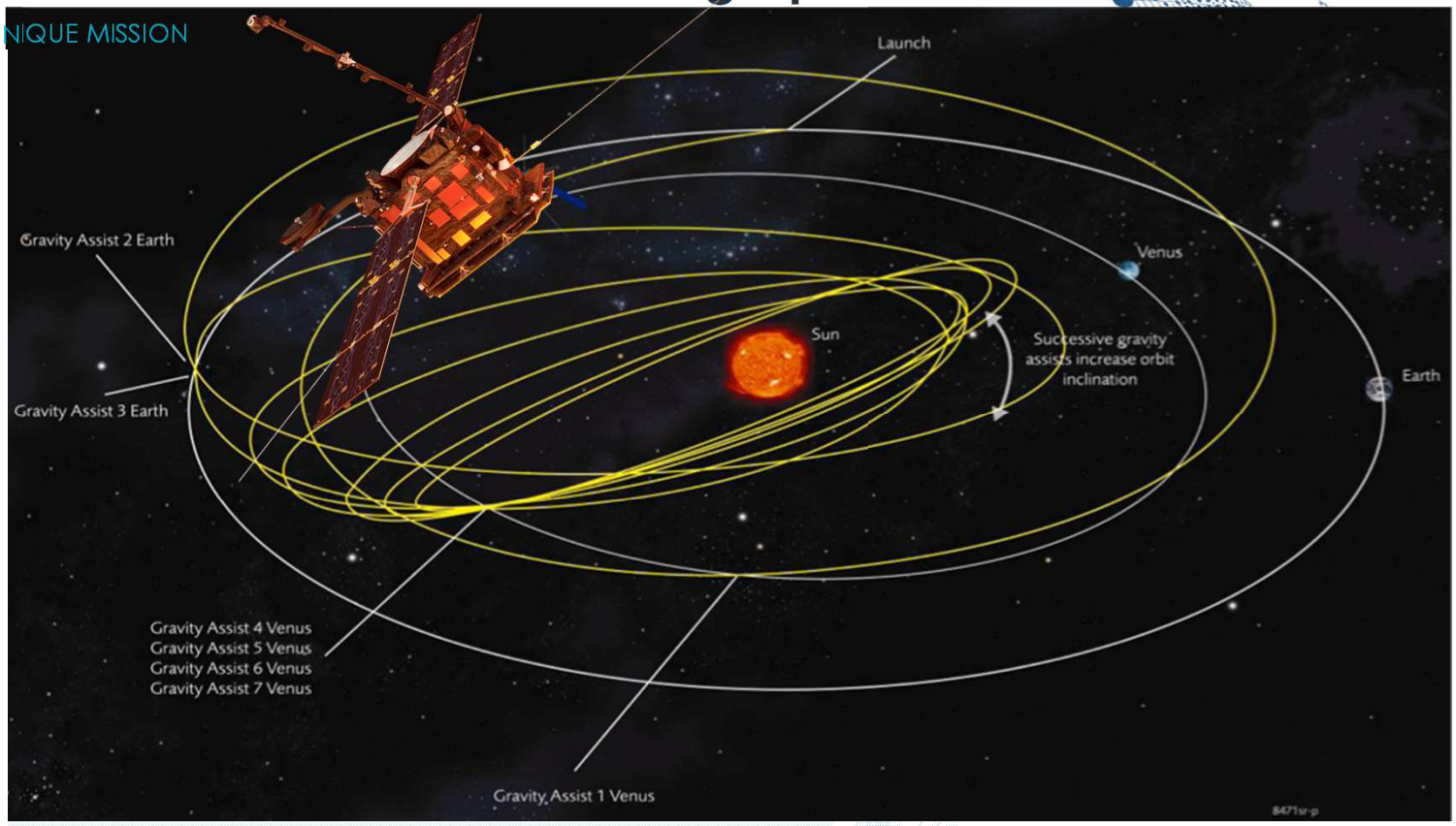
Coronal fine structure at all latitudes & longitudes

34° out of the ecliptic

Third dimension of coronal structure and CME‘s

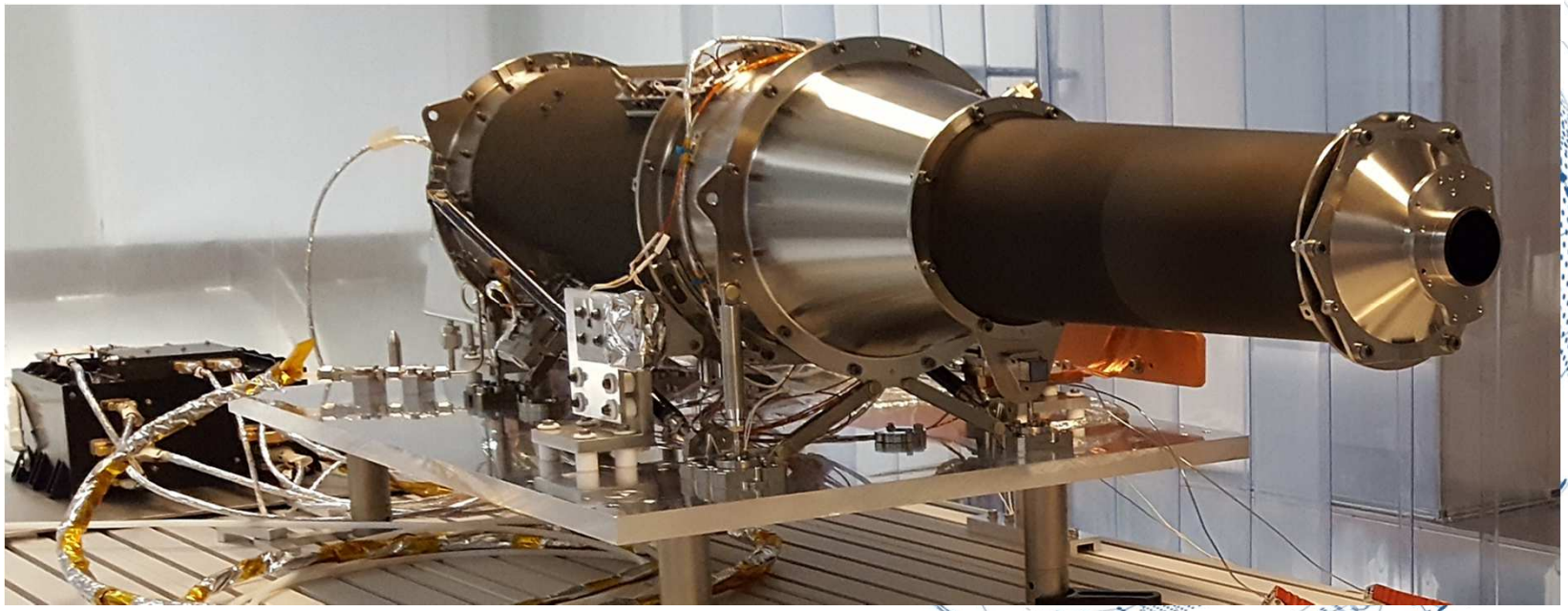
Quasi-Corotation

Intrinsic evolution of the corona cancelling rotation effects, e.g. coronal fluctuations, slow wind origin, streamer physics, evolution of configuration prior and post CMEs



TAS-I contribution to the Metis coronagraph of Solar Orbiter

METIS CHALLENGES

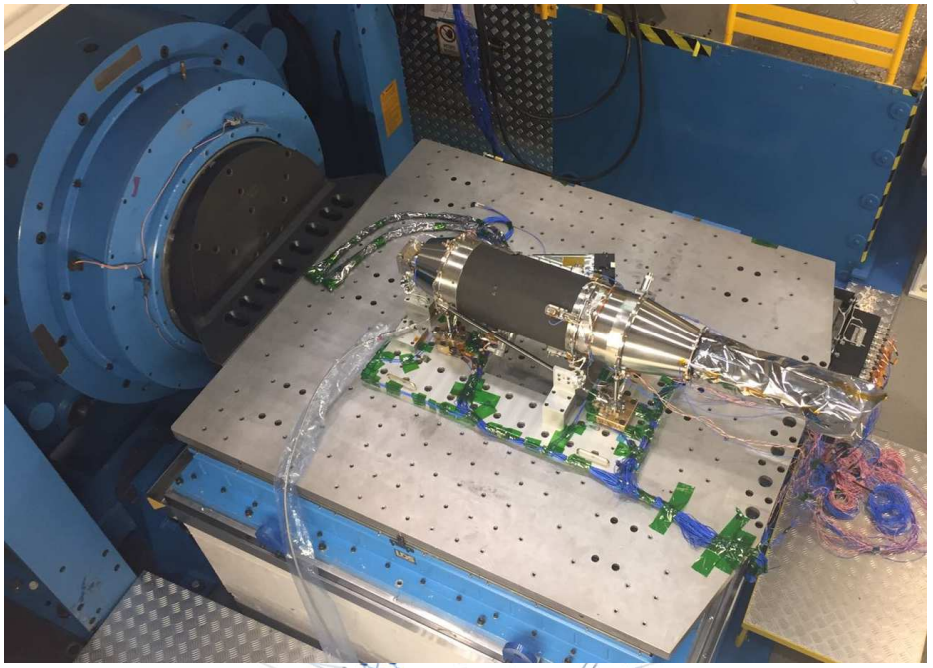


- At the minimum solar distance Metis will experience a thermal flux of ~17 kW/m² that will bring the temperature of the external occulter at ~400 °C, while the detectors (~1 m apart) will have to operate at -20/-30°C.
- To observe the Sun corona, the light of the solar disk entering the aperture must be suppressed by a factor 10^{-9}.
- Metis shall be able to operate autonomously, to identify the occurrence of CMEs and adapt the observation plan.

TAS-I contribution to the Metis coronagraph of Solar Orbiter

METIS MAIN QUALIFICATION/ACCEPTANCE STEPS

Qualification of the whole Metis Telescope (STM) under the flight thermal environment (including solar flux at 13 solar constants) in ETS test facility, Noordwijk.



Metis Telescope PFM submitted to sine and random vibration environment up to acceptance level along the three axes in TAS-I test facility located in Roma.

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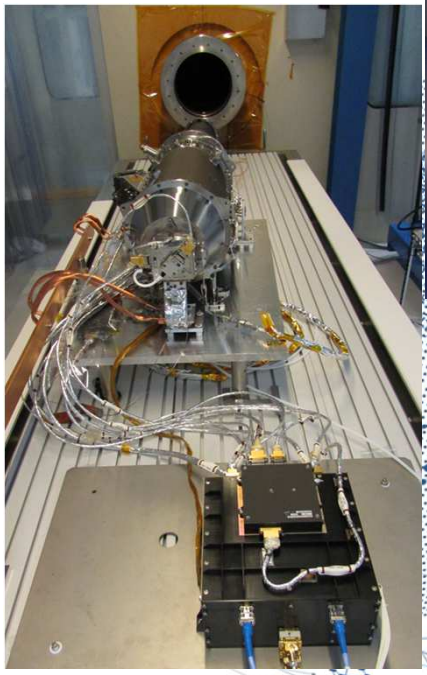
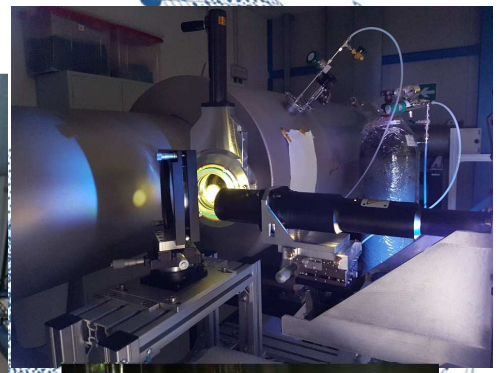
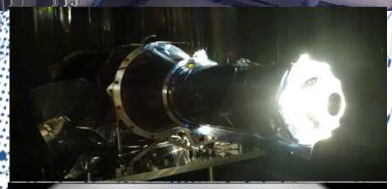
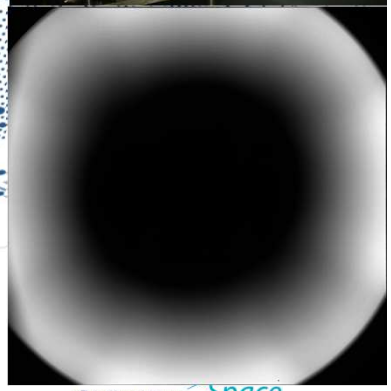
TAS-I contribution to the Metis coronagraph of Solar Orbiter

A UNIQUE FACILITY HAS BEEN SET UP AT ALTEC FOR TESTING AND CALIBRATING METIS







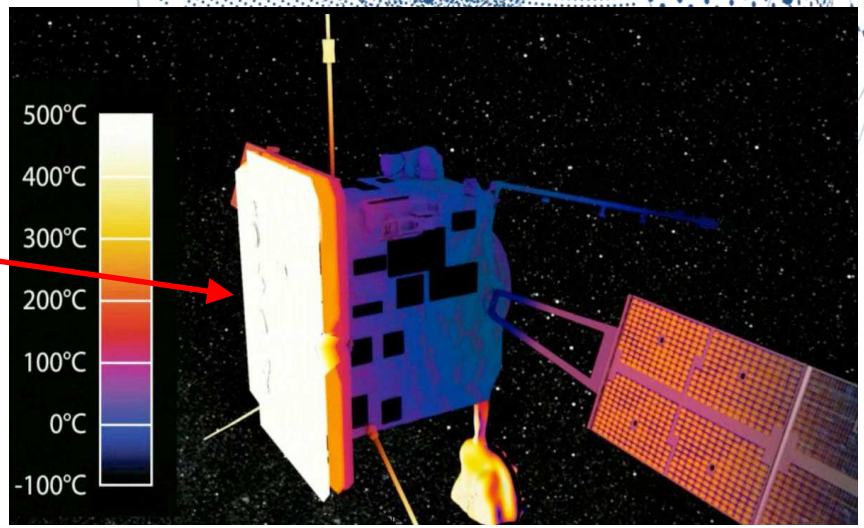


Metis on the optical bench of the Space Optics Calibration Chamber of the OPSys facility in ALTEC, where it has been submitted to the final performance test and calibration campaign.

TAS-I contribution to Solar Orbiter

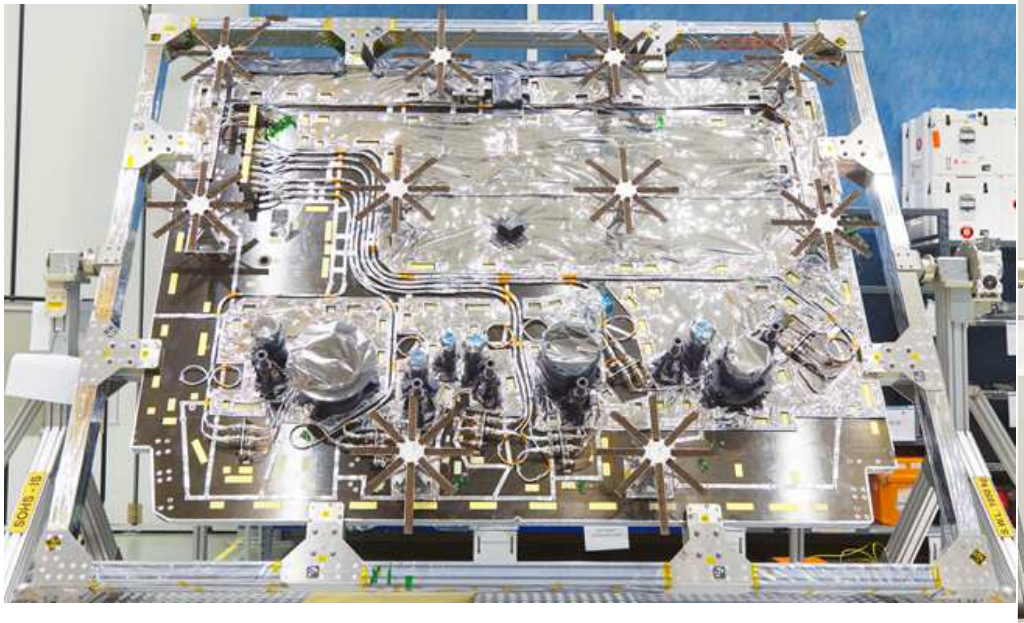
THE HEAT SHIELD OF SOLAR ORBITER: A KEY ELEMENT FOR THE SUCCESS OF THIS UNIQUE MISSION

- At the minimum distance from the Sun, Solar Orbiter will experience 13 times the intensity of terrestrial sunlight
- For protecting the spacecraft and its payloads, TAS-I has designed and implemented the Heat Shield.
- Composed by a series of thermal barriers of special materials, the Heat Shield will maintain inside the spacecraft a temperature not exceeding 50°C even when the temperature of the outer surface exceeds 500°C.



TAS-I contribution to Solar Orbiter

HEAT SHIELD FLIGHT MODEL IS ALMOST READY FOR INTEGRATION ON SOLAR ORBITER



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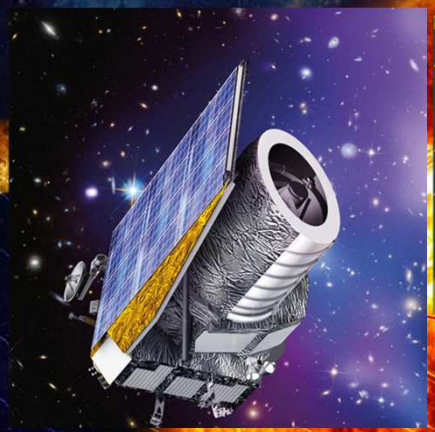
TAS-I products applicable to future space missions for SWE

TAS-I CAN OFFER A FULL RANGE OF PRODUCT FOR THE FUTURE SPACE MISSIONS FOR SWE MONITORING AND FORECAST

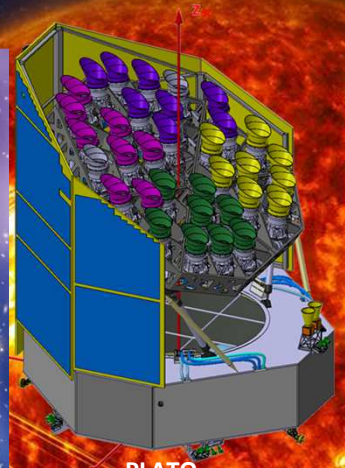
Platforms and spacecraft specifically designed for missions operating in Sun-Earth Lagrangian points (optimal location for solar activity monitoring missions):

Herschel, launched in 2009

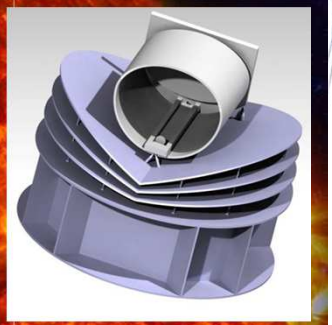
Planck launched in 2009



Euclid, under implementation for launch in 2020



PLATO



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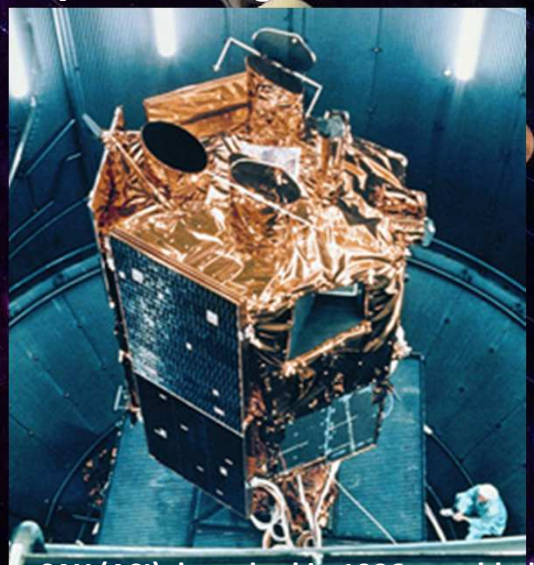
TAS-I products applicable to future space missions for SWE

TAS-I CAN OFFER A FULL RANGE OF PRODUCT FOR THE FUTURE SPACE MISSIONS FOR SWE MONITORING AND FORECAST

Spacecraft and detectors for high-energy (X-ray, Gamma-ray) astrophysics (for the study of extragalactic sources of space weather):



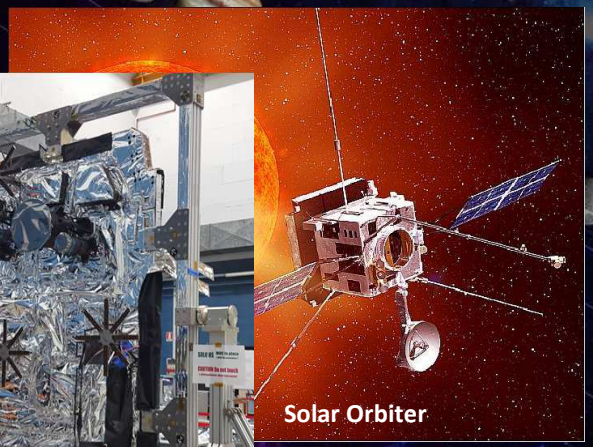
BeppoSAX (ASI), launched in 1996, enabled to identify for the first time the X-ray and optical counterparts of a GRB (GRB970228)

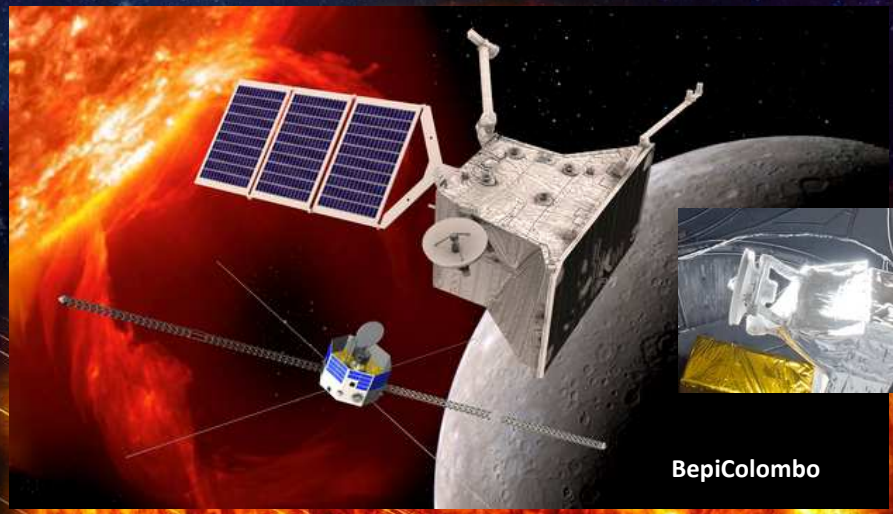
INTEGRAL (ESA), large satellite (4000 kg) for Gamma-ray astrophysics launched in 2002 in HEO, and still operative.

TAS-I products applicable to future space missions for SWE

TAS-I CAN OFFER A FULL RANGE OF PRODUCT FOR THE FUTURE SPACE MISSIONS FOR SWE MONITORING AND FORECAST

Thermal control and other subsystems for spacecraft subject to high solar radiation fluxes:

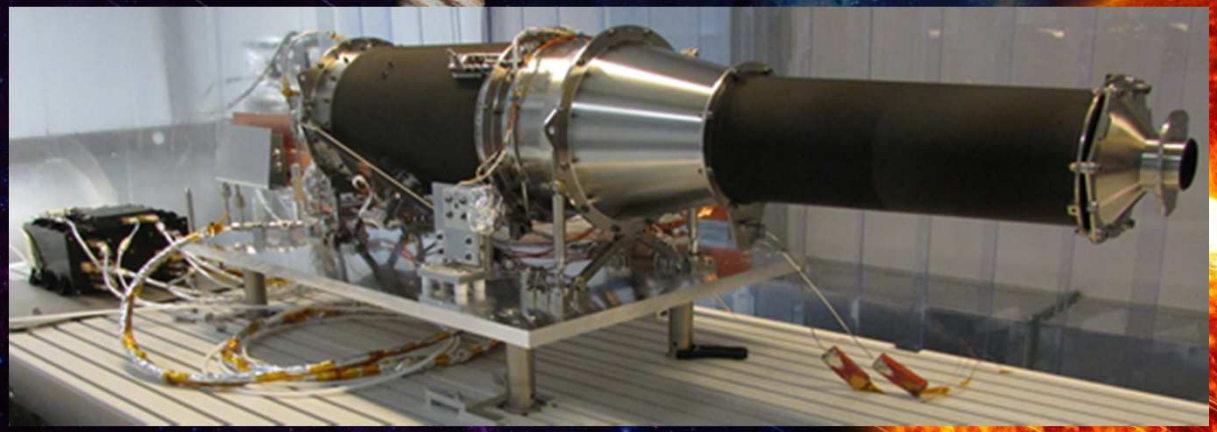




TAS-I products applicable to future space missions for SWE

TAS-I CAN OFFER A FULL RANGE OF PRODUCT FOR THE FUTURE SPACE MISSIONS FOR SWE MONITORING AND FORECAST

Instruments for solar activity and heliosphere monitoring



Coronagraphs

Radiation monitors