

The Remote-Sensing Package for ESA's Lagrange Mission

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The Space Weather (SWE) element of ESA's Space Situational Awareness (SSA) programme was established to address the increasing risks of solar effects on human technological systems and health. Within its Period 3, the SSA programme was extended to include an additional element (LGR), targeted towards the development of a space weather monitoring mission to the L5 point; it is envisaged that this mission, entitled Lagrange, will operate in coordination with a US-led mission to L1. Under the auspices of LGR, a number of Phase A/B1 studies have taken place; these studies, recently completed, covered the remote-sensing payload, the in-situ payload, and overall Lagrange system. The remote-sensing instrument package includes a Photospheric Magnetic Field Imager (PMI), EUV Imager (EUVI), Coronagraph (COR) and Heliospheric Imager (HI). In this presentation, we will review the instrument designs, including the control and processing philosophy, and the progress that was achieved towards the generation of an End-to-End simulator for this instrument package.

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Introduction

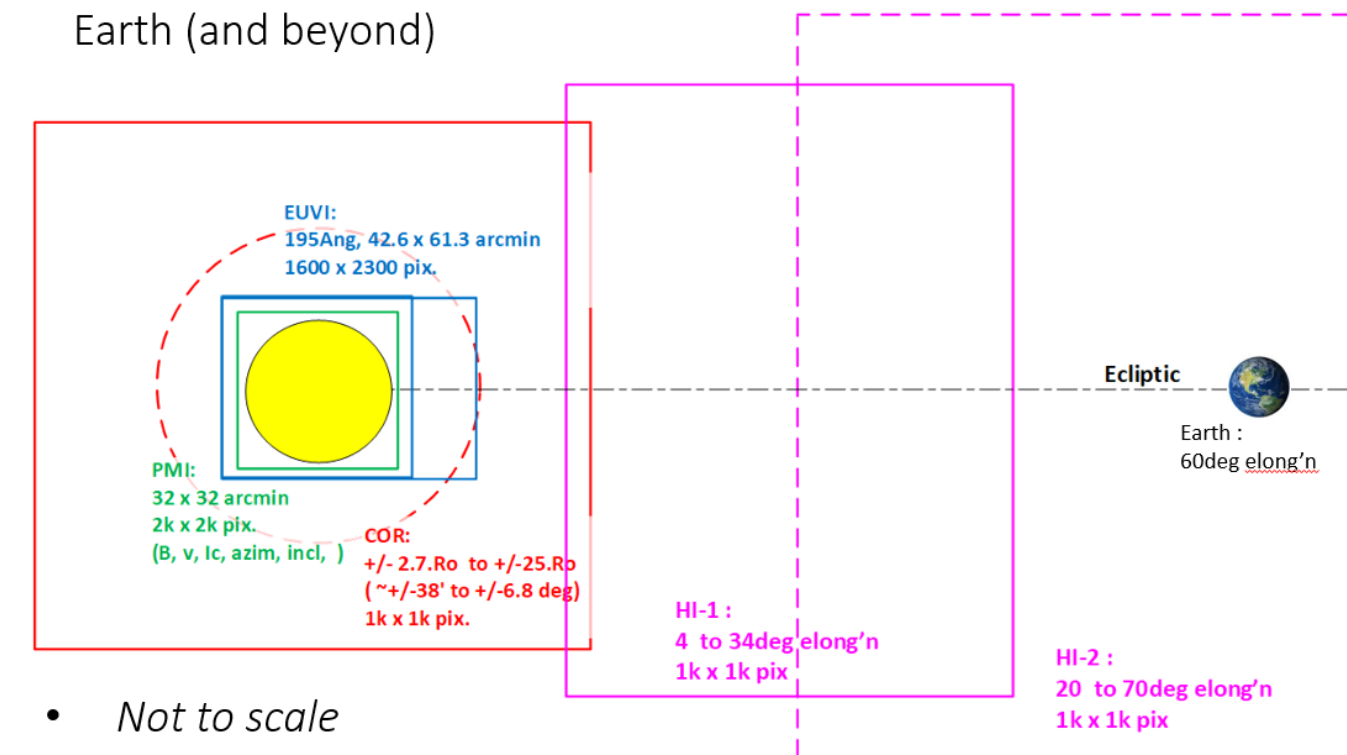
The four instruments that comprise the remote-sensing package based-lined for ESA's Lagrange mission to L5,

- **PMI** : Photospheric Magnetic Field Imager;
- **EUVI** : EUV Imager;
- **COR** : Coronagraph;
- and **HI** : Heliospheric Imager,

are being developed by a European consortium (below, left) with extensive scientific and technical expertise, and heritage, in solar and heliospheric instrumentation on ESA, joint ESA/NASA and NASA missions such as SOHO, Proba-2, STEREO, SDO and Solar Orbiter.

Combined, the suite of instruments will image the photosphere, chromosphere/inner corona, outer corona and heliosphere to 1 AU (right).

Continuous imaging from Sun to Earth (and beyond)



- Not to scale
- Downlinked image sizes

Consortium members

The institutes that were involved in the Lagrange remote-sensing package phase A/B1 study, which includes the pre-development of critical hardware and software, are:

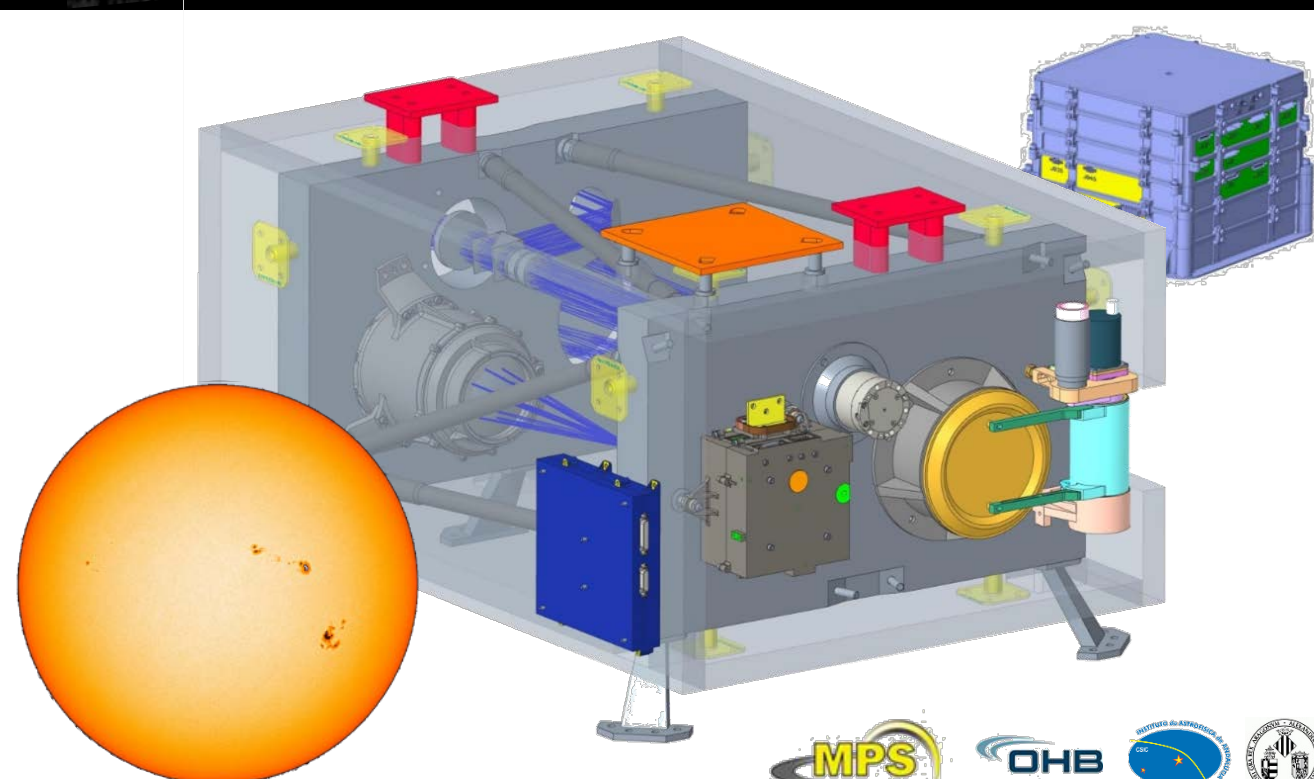
- RAL** : STFC-RAL Space, UK (Prime)
- ADS** : Airbus Defence and Space, Germany
- CSL** : Centre Spatial de Liège, Belgium
- DMU** : Deimos Space UK Ltd, UK
- DMR** : Deimos Space D.R.L, Romania
- IAA** : Instituto de Astrofísica de Andalucía, Spain
- PMOD** : Physikalisch-Meteorologisches Observatorium / World Radiation Centre, Switzerland
- MPS** : Max-Planck-Inst. für Sonnensystemforschung, Germany
- OHB** : OHB System AG, Germany
- RDA** : Research & Development in Aerospace, Switzerland
- ROB** : Royal Observatory of Belgium, Belgium
- UGOE** : Georg-August-Universität Göttingen Stiftung Öffentlichen Rechts, Germany
- UKMO** : Met Office, UK
- UV** : Universitat de València, Spain

PMI : Photospheric Magnetic Field Imager

Monitors magnetic activity on the Sun – basis for calculating background solar wind needed to forecast Coronal Mass Ejection (CME) arrival at Earth. Also provides visible-light continuum for monitoring sunspot activity/complexity.

L5 view enables monitoring of that part of the solar disk yet to rotate towards Earth.

- PMI lead : MPS; PMI partners : IAA, OHB, UV
- Concept : optically-modified version of HRT of PHI on Solar Orbiter mission
- Products : vector solar magnetograms, line-of-sight velocities and continuum mapping
- FoV : full disk + alignment margin
- Spatial resolution : 2 arcseconds (1 arcminute APE)
- Cadence : 30 minutes

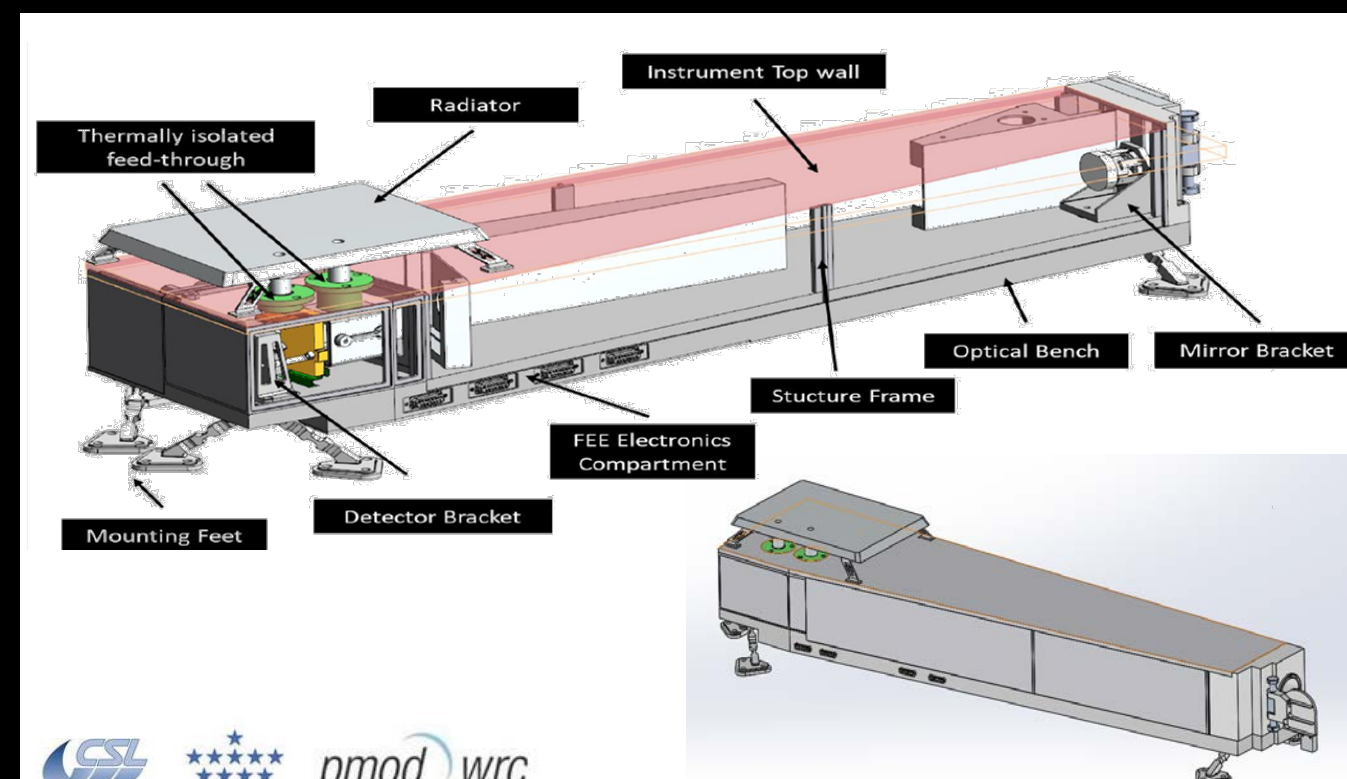


EUVI : Extreme Ultraviolet Imager

Monitors evolving activity in the chromosphere/low corona of the Sun's atmosphere including prominences (an early signature of CME eruption), active regions, coronal holes and solar flares.

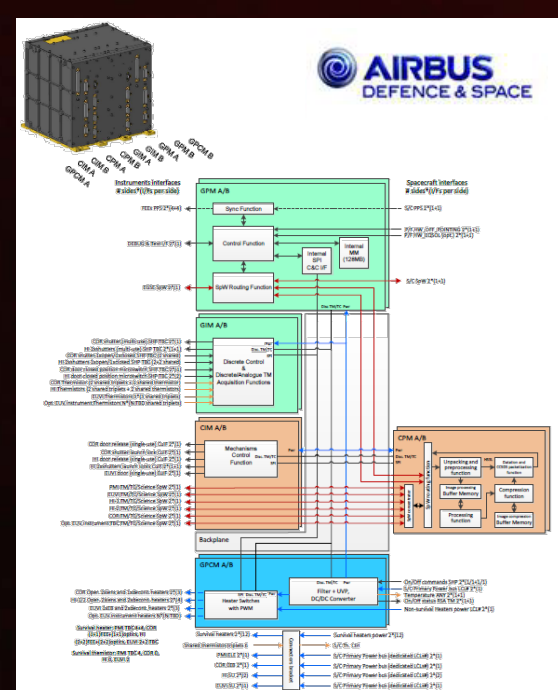
L5 view enables such monitoring of that part of the solar disk yet to rotate towards Earth.

- EUVI leads : CSL, ROB; EUVI partner : PMOD
- Concept : modified SWAP on PROBA-2 mission
- Product : EUV imagery in waveband centred on 195Å (Fe XII)
- FoV : 42.6 x 61.3 arcmin (extended towards Earth out to 2.7 R_sun from Sun-centre)
- Spatial resolution : 3.2 arcseconds
- Cadence : 2 minutes



IPCU : Instrument Processing and Control Unit

To provide • control, commanding and telemetry • power routing to instruments from spacecraft • digital processing • mechanism control • thermal control.

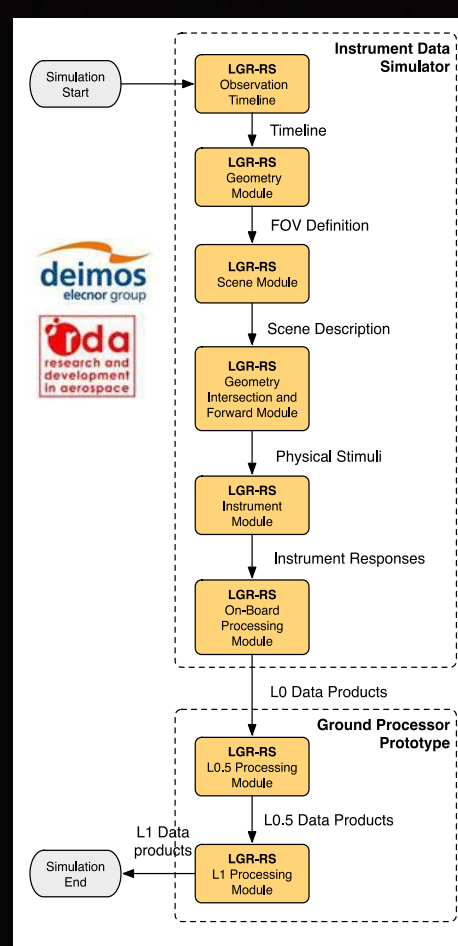


- IPCU lead : ADS
- Concept : single unit for package (except PMI)
- Five modules : three based on heritage from MetOp 2nd Generation; two application specific modules.

E2ES: End-To-End Simulator

To support definition of • instrument/IPCU • flight operations • ground segment.

- E2ES lead : DMU; E2ES partners : DMR, RDA
- Concept : Standard approach built on Space Science E2ES Reference Architecture
- Status : Standard tailored to required high-level architecture and modules defined. Prototyped for HI, being extended for COR and EUVI

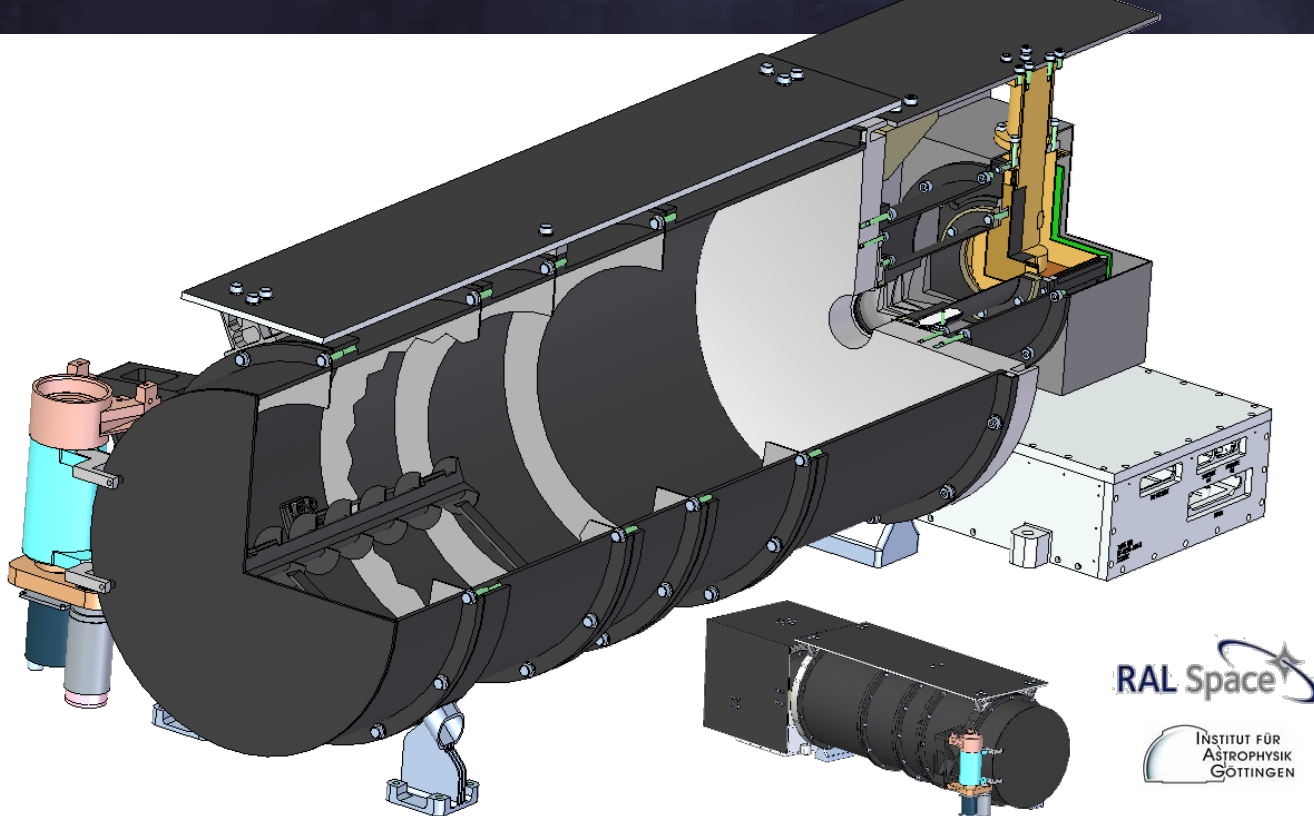


COR : Coronagraph

Early CME detection and tracking; provides the basis of CME parameterization for most operational CME arrival forecasts.

L5 provides clear side-on view of Earth-directed CMEs for more accurate arrival speed/time determination, especially when combined with corresponding near-Earth imagery.

- COR lead : RAL; COR partner : UGOE
- Concept : SCOPE study undertaken under ESA's GSTP programme
- Product : visible-light imagery of the outer corona
- FoV (radial) : 2.7 to 25 R_sun
- FoV (azimuthal) : 360°
- Spatial resolution : 1.6 arcminutes
- Cadence : 5 minutes



HI : Heliospheric Imager

Monitors CME propagation through vast under-sampled region between outer corona and 1 AU; also gives information on the background solar wind.

L5 provides clear side on view of Earth-directed CMEs to mitigate deficiencies in modelling arrival based on near-Sun data.

- HI lead : RAL; HI partner : UGOE
- Concept : optically-modified version of twin-camera HI instrument on STEREO mission
- FoV (ecliptic extent) : 4 – 70° elongation
 HI1 : 30° FoV; boresite 19°
 HI2 : 50° FoV; boresite 45°
- Spatial resolution :
 HI1 : 3.5 arcminutes
 HI2 : 6 arcminutes
- Cadence : 30 minutes

