EPSC Abstracts
Vol. 18, EPSC-DPS2025-1989, 2025, updated on 20 May 2026
https://doi.org/10.5194/epsc-dps2025-1989
EPSC-DPS Joint Meeting 2025

The Entire Visible Sky (EnVisS) camera for the ESA Comet Interceptor mission

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The **EnVisS (Entire Visible Sky) camera** is a key instrument aboard the **Comet Interceptor** mission, designed to map and study the environment of the yet to be selected mission target, i.e. a pristine comet or interstellar object.

Mounted on the spin-stabilized probe B2, EnVisS is an all-sky imaging system featuring a rotational push-broom technique aiming to capture the entire scene around the probe during the foreseen 24-hour fly-by of the target object.

1 - Introduction

The F-class mission Comet Interceptor [1] has been selected by the European Space Agency (ESA) in June 2019 and adopted in 2022. This mission aims to study a comet entering the inner Solar System for the first time or an interstellar object originating from another star.

Targeted for a launch in 2028, Comet Interceptor comprises a main spacecraft (A) and two probes (B1 and B2), each equipped with dedicated payload. The EnVisS camera, mounted on Probe B2, will play a crucial role in imaging the comet coma and surrounding environment.

2 - Instrument design characteristics

EnVisS (see Figure 1) is designed to image the entire sky using a compact, low-mass, and low-complexity camera system. The probe B2 spinning motion enables the continuous scanning of the surrounding scene. The camera employs filter strips mounted as close as possible to the detector to study the mission target in the 550-800 nm wavelength range, including **polarimetric analysis.**

EnVisS features a sophisticated optical system tailored for the Comet Interceptor mission requirements. The instrument main components are:

- a fisheye optical head;
- detector package and filters;
- ad-hoc electronics (power and data handling units);
- software.

The optical head comprises a fisheye lens with a 180° × 45° field of view (FoV), enabling wide-angle imaging essential for capturing the extended coma environment [2].

Coupled with the optical head is a commercial space-qualified detector [3] equipped with a filter strip assembly (FSA) [4]. The FSA includes three filter strips: a central non-polarizing broadband filter and two polarizing filters on either side, with the transmission axis oriented at 45° relative to each other. This configuration allows simultaneous acquisition of intensity and polarization data without the need for a filter wheel, reducing mechanical complexity and mass.

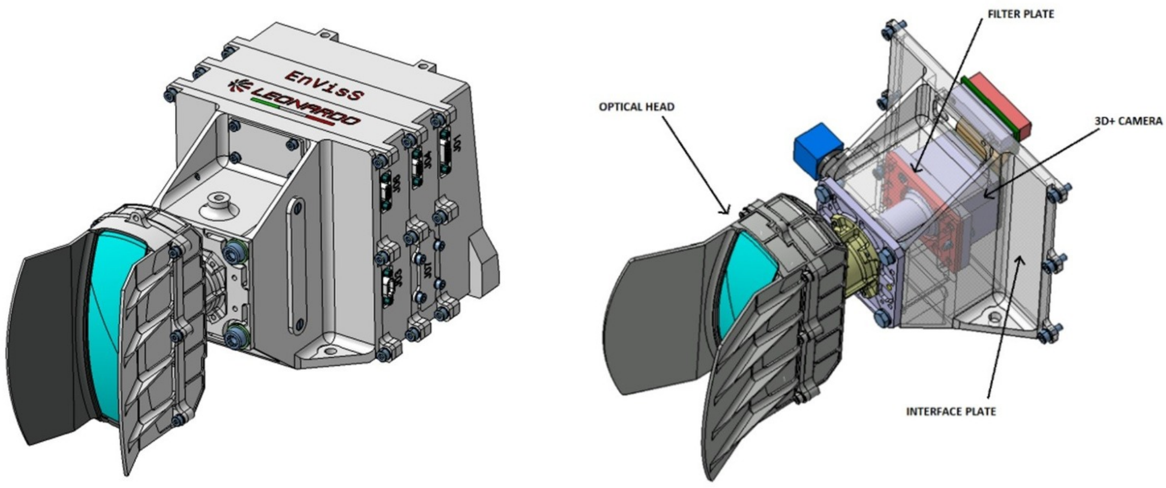

Figure 1: Left: EnVisS current CAD model. Right: Optical head and camera components highlighted [2].

3 - Scientific Objectives

The primary goal of EnVisS is to study the coma of the target comet providing insights into its composition, structure, and dynamics. By imaging the entire sky, EnVisS contributes to the 3D mapping of the dust surrounding the comet, complementing observations from other instruments such as CoCa (Comet Camera) on Spacecraft A and OPIC (Optical Periscope Imager for Comet) on Probe B2.

EnVisS has been conceived to capture images of the comet dust environment in the visible spectrum (550–800 nm) [5]. Its primary scientific goals include:

- **Intensity Mapping**: Measuring the radiance of light scattered by dust particles within the coma at different phase angles to understand their distribution and density.
- **Polarimetric Analysis**: Assessing the degree and angle of linear polarization of scattered light, which offers insights into the physical properties of dust particles, such as size distribution, morphology, porosity, and composition.

These measurements are unprecedented in space exploration, offering a full 180° phase angle coverage, surpassing previous missions like Giotto's Halley Optical Probe (HOPE), which had limited observational angles.

4 - EnVisS operation

The B2 probe spin stabilisation enables EnVisS to employ a hybrid push-broom/push-frame imaging technique, exploiting the spacecraft continuous rotation to scan and acquire the full-sky. As the probe spins, the detector capture narrow, and slightly overlapping, slices of the sky. These slices are then post-processed on-ground to reconstruct a full-sky mosaic.

EnVisS operation is tuned to the mission concept and present uncertainty of the target characteristics. Ad-hoc electronics for power and data handling, along with a dedicated application software for image acquisition management and pre-processing, have been developed. The integration time for each filter strip is adjustable, allowing optimization of the signal-to-noise ratio (SNR) based on the coma radiance.

5 - Conclusions

The EnVisS camera represents a significant advancement in cometary science instrumentation. The data collected by EnVisS will enhance our understanding of **cometary activity and shed light on the physical characteristics of cometary dust and the evolution of pristine comets**.

EnVisS innovative design combines wide-field imaging with polarimetric analysis. This dual capability enables the simultaneous mapping of the cometary coma morphology and polarisation properties, and allows **continuous imaging** throughout the comet flyby.

Acknowledgements

This work has been done thanks to the collaborative effort of an international consortium including different institutions (CNR-IFN (Italy), IAA-CSIC (Spain), INAF-OACN (Italy), University of Naples "Parthenope" (Italy), Aalto University (Finland), ASI and ESA) and industries (Leonardo SpA (Italy), Sener (Spain), Huld (Finland)).

It has been funded: by the Italian Space Agency (ASI) through contracts to the Istituto Nazionale di Astrofisica (2020-4-HH and 2023-14-HH.0) and to Leonardo SpA (2024-61-I.0); by the European Space Agency (ESA) under a Contract to the Italian National Research Council (CNR) (Contract n. 4000136673/21/NL/IB/ig); by the Spanish Ministerio de Ciencia e Innovación (MCIN) through ESA PRODEX and the Spanish National Plan Ref PID2021-126365NB-C21.

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