Optical and mechanical analysis and calibration of the EnVisS camera for the Comet Interceptor mission

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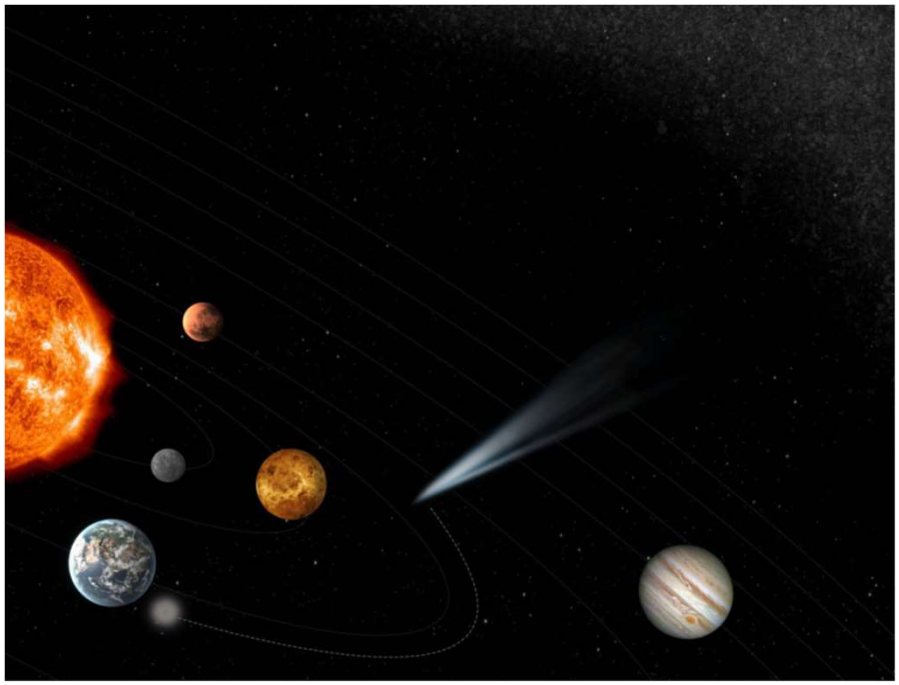
Admission to PhD course - 19 October 2023

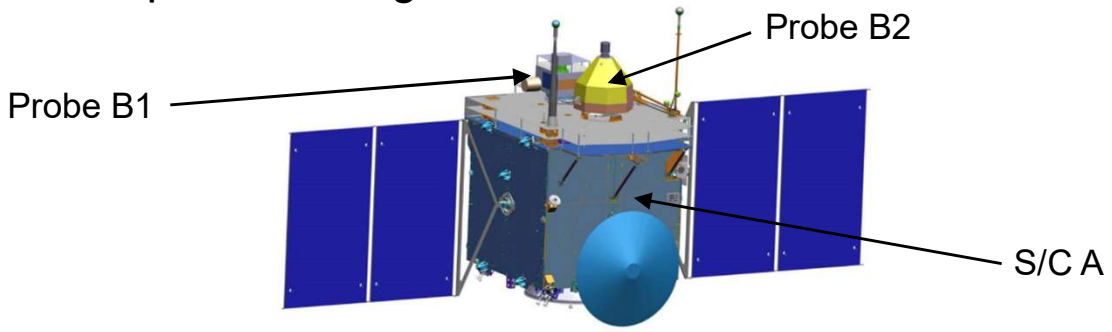
Dynamically New Comets

- A Dynamically New Comet (DNC) is an object that has never ventured close to the Sun in the billions of years since it formed
- DNCs are the most preserved objects in the Solar System
- They provide the opportunity to investigate unaltered pristine materials from which our system generated
- Thousands of Long Period Comets, many of which are dynamically new, have been **observed**, but they have never been **encountered** by a space mission

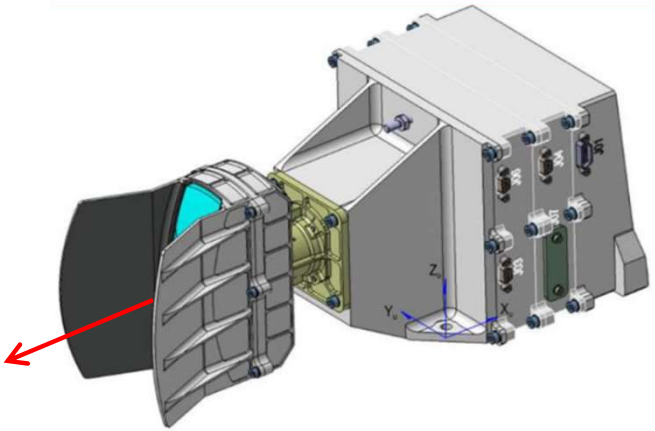


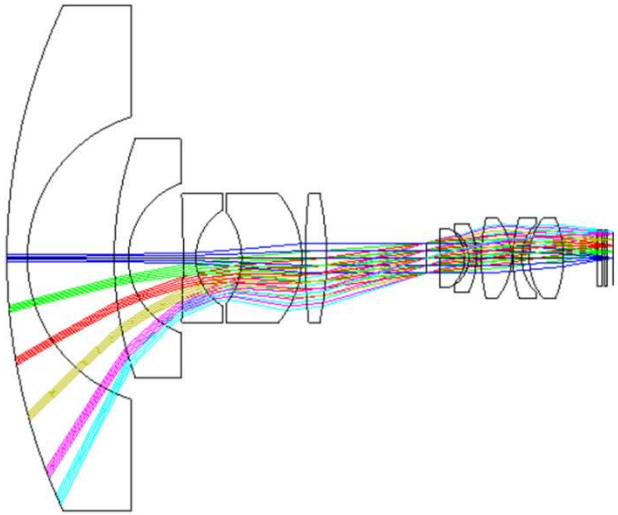
Comet Interceptor

- Comet Interceptor is the first Fast mission designed by ESA
- Scientific task: interception and exploration of a Dynamically New Comet to gain information about the target's morphology, composition and plasma environment.
- The mission is composed of a spacecraft, S/C A, and two probes, Probe B1 e Probe B2
- Launch planned for the end of 2029
- Direct transfer to the Sun-Earth Lagrange Point SEL2, where the mission will wait until a potential target is found



- The EnVisS (Entire Visible Sky) camera is one of the optical instruments designed to perform remote sensing
- All-sky camera aboard of Probe B2
- Scientific task: mapping and studying the comet's coma in the visible range
- Principal components: optical head (10 lenses), Filter Strip Assembly (FSA), CMOS detector
- CNR-IFN is the scientific institution hosting the instrument Principal Investigator





EnVisS – state of development

- In January 2023, the CNR-IFN in collaboration with Leonardo SpA began mission Phase C-D, working on the Structural and Thermal Model (STM) and the Electrical/Engineering Functional Model (EFM)
- The STM CAD has been completed and the model is presently under construction
- In September 2023, the Instrument Critical Design Review (I-CDR) has been successfully performed
- Leonardo SpA has recently completed the integration and tests of the BreadBoard optical head of EnVisS, which is now at CNR-IFN for further tests and integration on the full EnVisS BB

EnVisS – future milestones

Milestone	Date
Instrument EFM and STM Delivery Review Board (DRB)	February 1st, 2024
End of EFM and STM campaigns	September, 2024
Instrument FM Delivery Review Board (DRB)	October 1st, 2025
Probe B2 integration and functional tests	Q1 2026
Payload Qualification and Acceptance Review (QAR) completed by	Q1 2026
Delivery of integrated B1 and B2	Q2 2026
End of S/C integration and functional tests	Q4 2026

Research activities - overview

Optical tests and simulations of the EnVisS BreadBoard (BB) optical head and filter strips

Characterization of the optical components, tests and calibration of the Proto-Flight Model (PFM)

Analysis and elaboration of the collected data and simulation of the in-flight performance

Research activities - I

Optical tests and simulations of the EnVisS BreadBoard (BB) optical head and filter strips

- Exhaustive study of the design and optical properties of the camera
- Experimental activities will be performed in the CNR-IFN laboratories (Padova)
- The filter strips will be tested by means of a Bentham Reflectometer
- The optical head will be characterized by means of a Zygo Interferometer
- Numerical simulation and analysis of the BB optical head by means of the ray-tracing software Zemax OpticStudio

Research activities - II

Characterization of the optical components, tests and calibration of the Proto-Flight Model (PFM)

- Experimental activities will be performed in the Leonardo SpA laboratories (Campi Bisenzio, Firenze)
- Tests and analysis on the optical components of the PFM will take place
- Alignment Integration Test and Verification (AIT/AIV) of the model
- Each of EnVisS PFM components will be calibrated and tested individually, then aligned and integrated, to be later calibrated and tested again as a whole

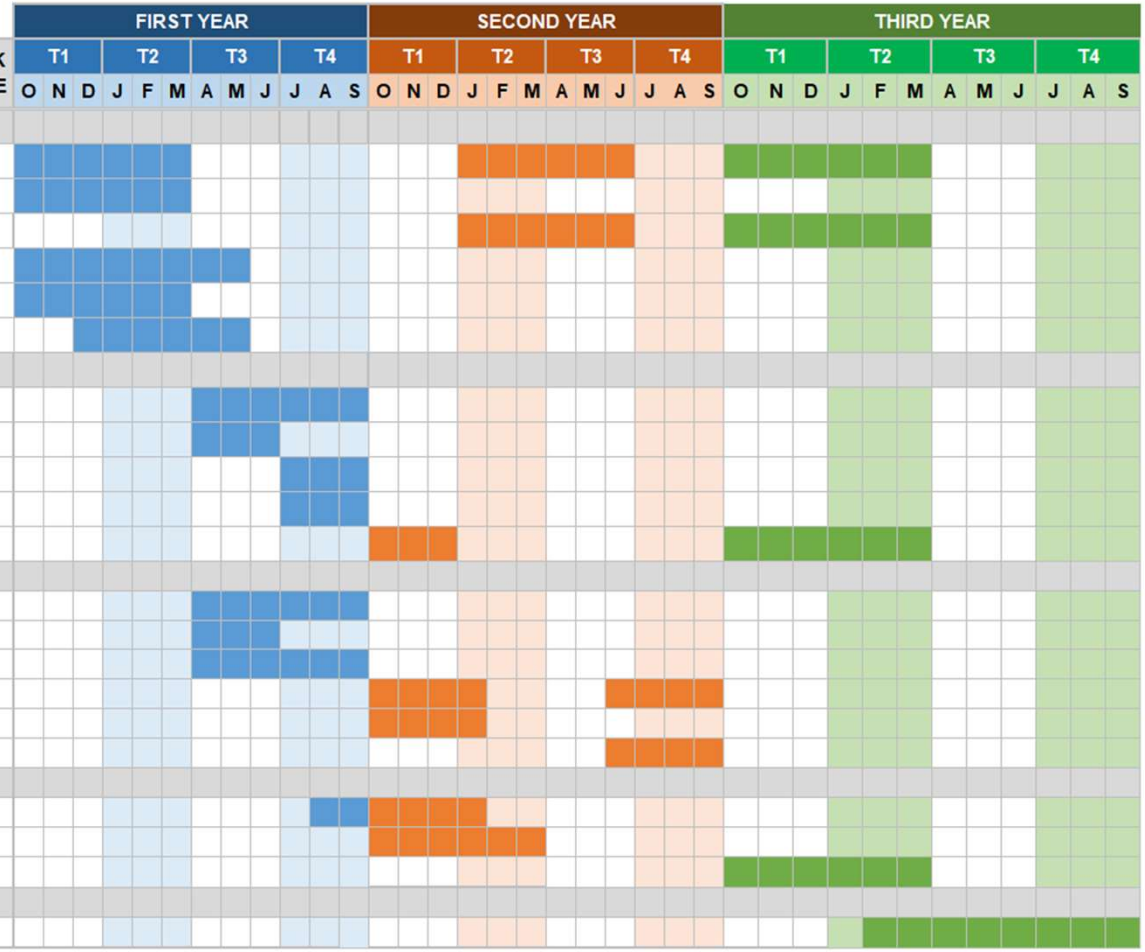
Research activities - III

Analysis and elaboration of the collected data and simulation of the in-flight performance

- Analysis and elaboration of the experimental data collected from the previous activities
- Analysis and elaboration of the pre-flight calibration data, to determine if the instrument optical performance is in line with the expected one
- Realization of EnVisS radiometric model

Work organization

WBS NUMBER	TASK TITLE	% OF TASK COMPLETE
1	Bibliographic research	
1.1	Study of the Comet Interceptor mission background	0%
1.1.1	Mission objectives and Instruments	0%
1.1.2	Pristine comets' composition	0%
1.2	Study of the EnVisS camera	0%
1.2.1	Fish-eye cameras	0%
1.2.2	Optical design and performance	0%
2	Simulations	
2.1	Optical simulations	0%
2.1.1	Ghost analysis	0%
2.1.2	Wavefront distorsion	0%
2.2	Thermo-mechanical simulations	0%
2.2.1	Radiometric model	0%
3	Optical characterization	
3.1	BreadBoard (BB)	0%
3.1.1	Optical characterization of the Filter Strip Assembly and/or representative samples	0%
3.1.2	Interferometric tests of the BB optical head	0%
3.2	Proto-Flight Model	0%
3.2.1	Alignment, Integration, Test and Verification (AIT/AIV)	0%
3.2.2	Calibration	0%
4	Data Analysis and report	
4.1	Simulations	0%
4.2	Optical characterization	0%
4.3	Pre-flight calibration data	0%
5	Thesis writing	
		0%



Thanks for the attention

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