

e.Inspector

Clean Space Industrial Days
2017

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(presenter)
..and the CDF* team..



(*) ESTEC Concurrent Design Facility

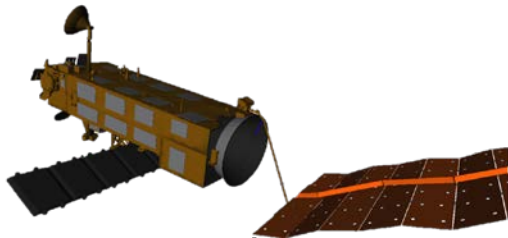
- e.Inspector: on request by GSP
- The study was to:
 - Assess the feasibility of a mission for the imaging of ENVISAT,
 - System level conceptual design of the spacecraft with the contribution of all discipline specialists,
 - Trade-off different system scenarios (e.g. platform options: cubesat versus mini-sat),
 - Assess programmatics, risk and cost aspects of the various design options,
 - Consolidate the Technology road maps in line with the programmatic aspects of the mission,

→ MISSION OBJECTIVES

- R-MIS-1: Image ENVISAT in its current status
- R-MIS-2: Use obtained images for the verification and validation of the e.deorbit or space tug GNC sensors

Mission Options

Target	ENVISAT
Orbit	760 km, SSO
Reliability	>85% after disposal operation
Launch	Piggy-back with Sentinel 1-C TBC



Option 1:
Chemical Propulsion
to ENVISAT

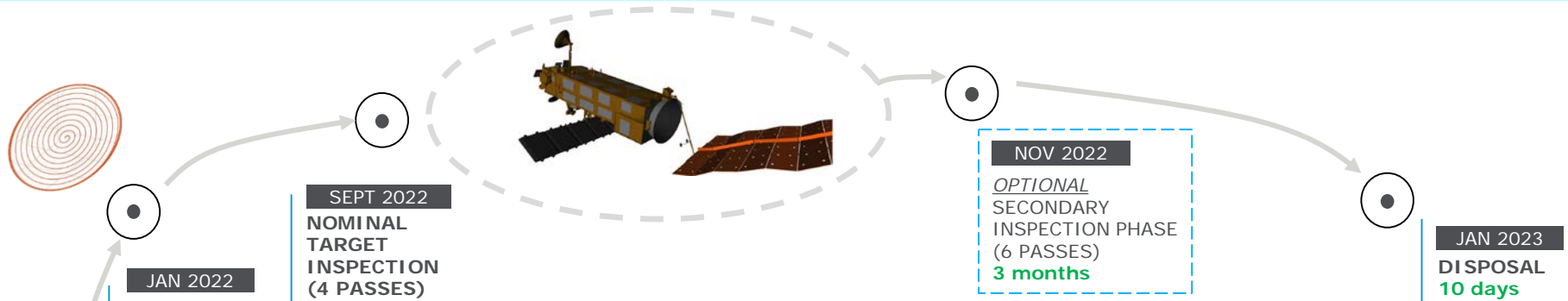
Option 2:
Electric Propulsion
to ENVISAT

Target	TBD
Orbit	500 km (70 m/s)
Reliability	To be derived by customer
Launch	Dedicated – e.g. Electron



Option 3:
Chemical Propulsion
to 500 km

Mission Timeline – EP to ENVISAT



JAN 2022

TRANSFER AND PHASING TO TARGET ORBIT

8 months:
3 weeks to drift orbit
6 months in drift orbit
2 weeks from drift orbit to ENVISAT

SEPT 2022

NOMINAL TARGET INSPECTION (4 PASSES)
2 months

NOV 2022

OPTIONAL SECONDARY INSPECTION PHASE (6 PASSES)
3 months

JAN 2023

DISPOSAL
10 days



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LAUNCH SOYUZ FREGAT AS PIGGY-BACK
1 week

Mission Modes

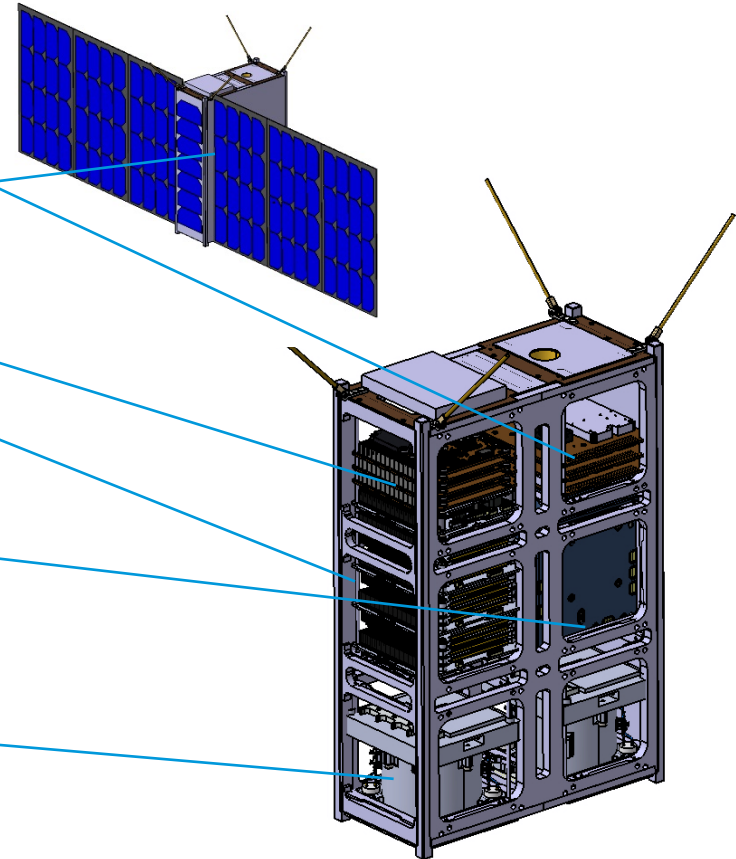
1. Transfer
2. Rendezvous and Hold-point
3. Inspection Mode
4. Communication
5. Disposal
6. Safe Mode

System summary

Subsystems:

- **Communications:** UHF (housekeeping) and S-band (payload data) (1 antenna, 1 transceiver of each)
- **Data-handling:** 1 CubeSat computer, 1 FPGA, 1 power board
- **Power:** 1 PCDU, Battery, 1 Body Mounted 3U SA, 2 SA wings of 3x6U
- **Mechanisms:** 2 HDRM, 12 Hinges
- **AOCS:** GPS rcvr, 6 SAS, IMU, 3 MT, 1 Rel Nav Imager, 3 RW, 1 STR
- **Thermal Control:** 45 Temp sensors, 15 Heaters, BP, MLI, OSR
- **Propulsion:** 2 FEPP systems

Cubesat Dispenser Type: ISIS – 6U



- Delta-V budget:

Mission Phase	Delta-v Budget	EP_Env Unit
LEOP	Launcher dispersion correction manoeuvre	0 m/s
Transfer	Orbit raising	350 m/s
	Margin on stochastic delta-v	0 %
	Margin on deterministic delta-v	5 %
	Total det. and stoch. Manoeuvres	367.5 m/s
Disposal	Disposal manoeuvre	50.94 m/s
	Margin on disposal manoeuvre	5 %
	Total disposal manoeuvre	53.487 m/s
Inspection	Total AOCS delta-v	17.6 m/s
	Total delta-v without margin	424.54 m/s
	Total delta-v including margin	444.887 m/s

- Power budget:

EP_Env	LEOP	TRA	RHP	Insp	COM	DIS	SAF
AOGNC	1.1	3.3	3.4	4.0	3.5	3.3	3.5
COM	2.8	0.5	0.5	0.5	6.0	0.5	2.8
CPROP	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DH	0.9	1.7	1.7	2.4	1.7	1.7	1.7
MEC	0.5	0.0	0.0	0.0	0.0	0.0	0.0
PWR	1.0	1.0	1.0	1.0	1.0	1.0	1.0
TC	8.6	6.6	8.1	7.2	8.1	0.3	6.5
EPROP	0.0	23.4	10.9	7.8	10.9	57.6	7.8
Total w/o margin	14.8	36.4	25.6	22.8	31.2	64.2	23.2
Total with 20% margin	17.7	43.7	30.7	27.4	37.4	77.1	27.9

- Target wet mass for 6U: 12kg
- Total wet mass: 11.85 kg
- Below target mass: 0.15 kg

S/C Mass Budget - EP_Env	Mass [kg]
Attitude, Orbit, Guidance, Navigation Control	1.30
Communications	0.30
Chemical Propulsion	0.00
Data-Handling	0.38
Electric Propulsion	1.37
Mechanisms	1.14
Power	3.63
Structures	1.57
Thermal Control	0.59
Harness	3% 0.31
Dry Mass w/o System Margin	10.59
System Margin	10% 1.06
Dry Mass incl. System Margin	11.65
Propellant Mass	0.21
Total Wet Mass	11.85
Launcher Adapter	7.04
Wet Mass + Adapter	18.89
Target Wet Mass excl. Adapter	12.00
Below Target Mass by	0.15

Mission Timeline – CP to 500km



JAN 2022
DEDICATED LAUNCH
WITH ELECTRON &
LEOP
1 week

- Operational lifetime reduces **from 1 year to < 4 months**
 - **Inverted design** procedure due to **undefined target**:
 - Assumption 6U = 12kg available
 - 70 m/s total delta-v:
 - 15 m/s for inspection
 - 55 m/s for target acquisition
- ➔ Dry mass 10.4kg with 2 x 1U CP thrusters

- Unique opportunity for low-cost mission, with possible strong role of new and small ESA member states, to inspect a space debris with relative navigation
- Images made can be used for validation purposes for e.Deorbit & space tug GNC sensors
- Difficult to meet 2021 end of mission, but 2022 feasible
- Post mission disposal will have a strong impact on design (rare occasion for a cubesat to go to high altitude, in vicinity of other satellite)