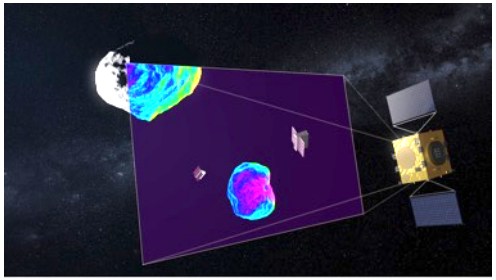
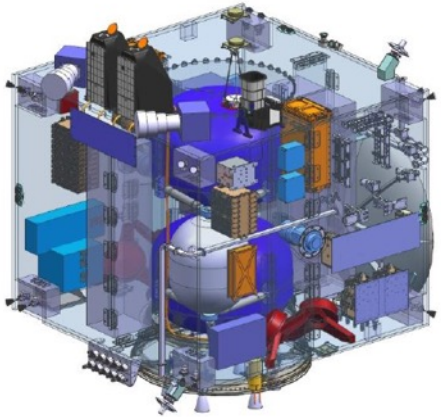

esa
HERA MISSION
European Space Agency

Hera mission





Hera Mission

Validate the kinetic impactor planetary defence technique in collaboration with NASA's DART and ccharacterize a near-Earth asteroid representative of the statistically most hazardous class. In addition:

Technology Demonstration*: autonomous and semi-autonomous navigation, deep-space CubeSats*

Bonus Science: *Characterize the smallest object ever visited and the first binary asteroid ever visited*

Mission Duration

- Commissioning phase: 3 months
- Transfer to Didymos: 2 years
- Asteroid Operations: 3 months

Mission Orbit and Satellite Attitude

Heliocentric orbit 1 to 2.4 AU
Intrinsically safe hyperbolic arcs w.r.t. Didymos
Attitude control: 3-axis stabilized with RW and 8+8 10N RCTs

Payload:

AFC cameras (Navigation and Imaging)
TIRI Thermal infrared imager (JAXA)
PALT Planetary altimeter
2 x 6U CubeSats (multispectral imager, dust detector, low-frequency radar, gravimeter, radioscience)
Radioscience
Monitoring Camera
Hyperscout (TBC) hyperspectral camera

Satellite

Custom built deep-space platform

Mass

- Dry Mass 650 kg (incl. 20% margin)
- Max Fuel Load 450 kg

Power

Deployable solar array, 3G30 cells , SADA
800W at 2.4 AU

Communication Links

X-band up/downlink, HGA + 2 LGA

Launch Vehicle

Ariane 6.2KS, Ariane 6.4 Backup

Flight Operators

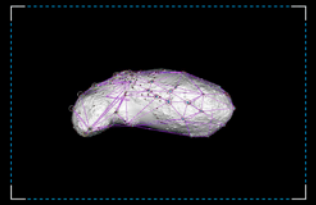
ESOC (ESEC+CNES support for CubeSats)

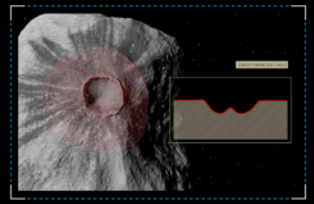
Payload Data Processing

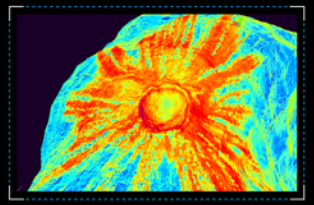
Hera Investigation Team WGs

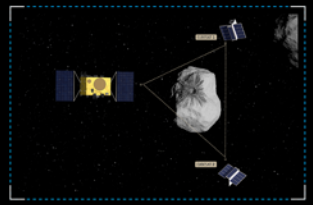
hera mission

esa



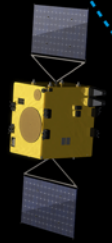






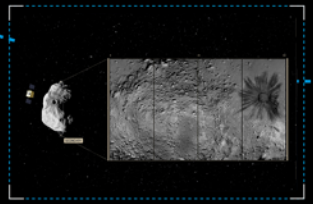
08/10 2024
HERA LAUNCH

Mass at launch = 1081 kg
Mass at arrival = 660 kg
ΔV capability = 1289 m/s
2.18 m × 1.5 m × 13.3 m



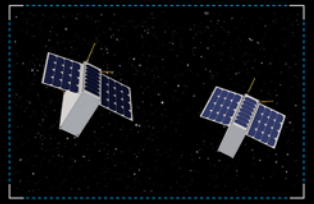
2 x Asteroid Framing Cameras
2 x 6U CubeSats
Laser Altimeter
Thermal Infrared Camera (JAXA)

28/12 2026
ASTEROID ARRIVAL

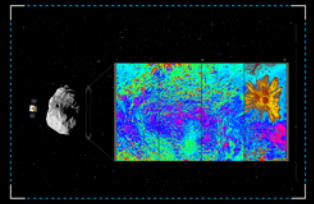


EARLY CHARACTERISATION PHASE
Measuring mass and dynamics

CUBESATS RELEASE



DETAILED CHARACTERISATION PHASE
Measuring surface and interior properties



MULTI-POINT ASTEROID INVESTIGATION
low-frequency radar, multispectral imager, dust dector
gravimeter, UV illuminator

DETAILED SUBSURFACE
CRATER INVESTIGATION

DETAILED CRATER
SHAPE INVESTIGATION

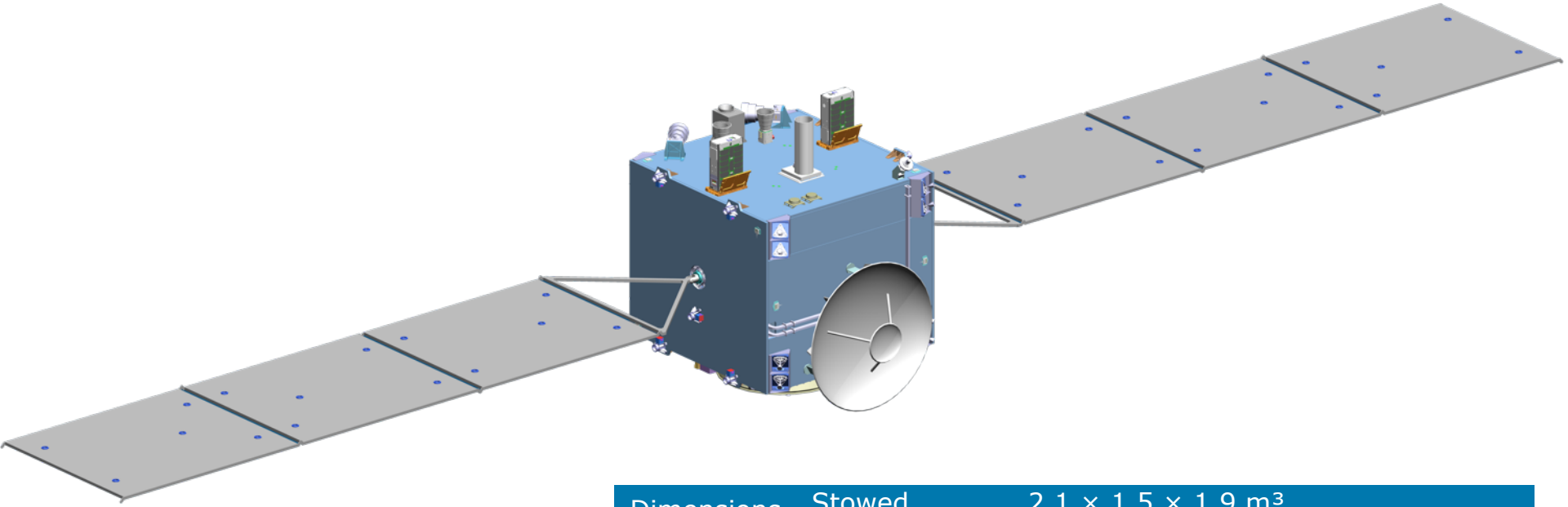
AUTONOMOUS PROXIMITY
OPERATIONS DEMONSTRATION

DIDYMOS

LANDING ON DIDYMAIN
MISSION ENDS

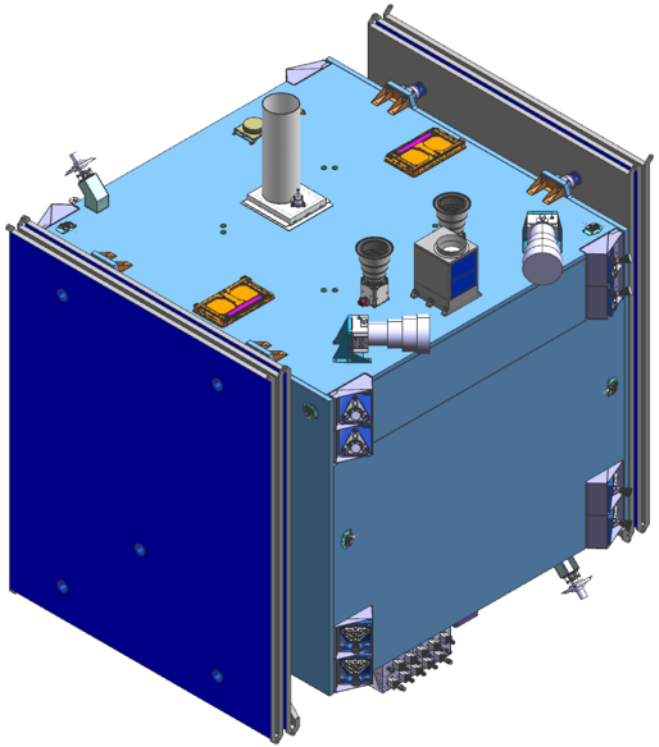
DIDYMOON

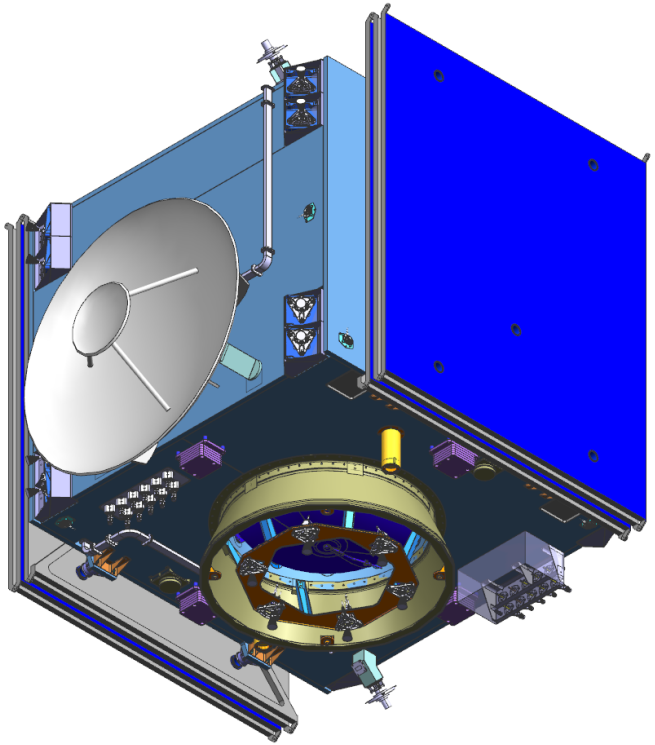
Spacecraft design



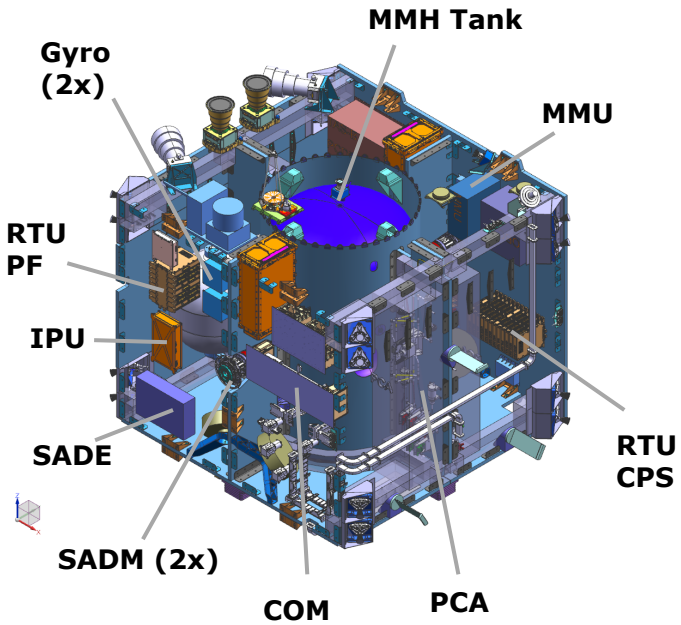
Dimensions	Stowed	2.1 × 1.5 × 1.9 m³
	Deployed	2.1 × 1.5 × 13.2 m³
Mass	Dry Mass	700 kg
	Wet Mass	1050 kg

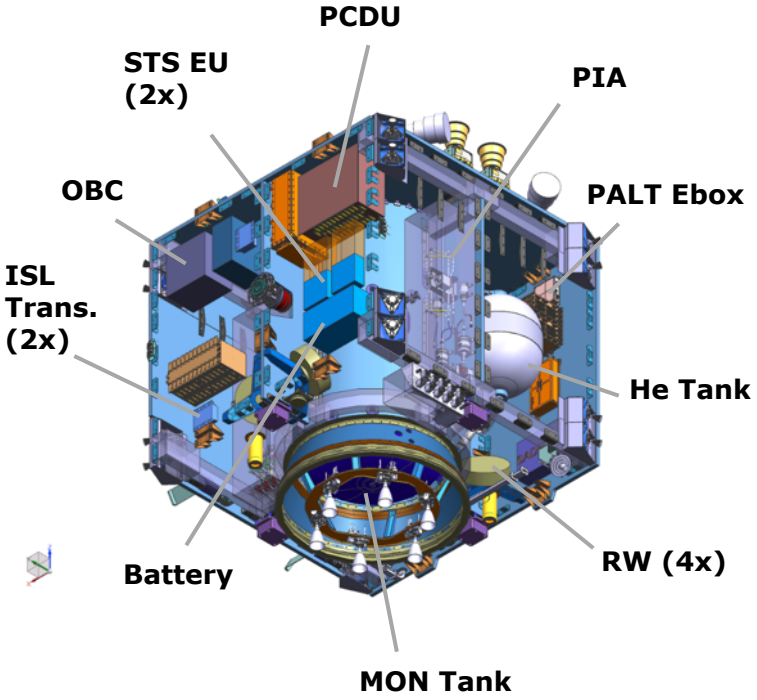
Spacecraft design



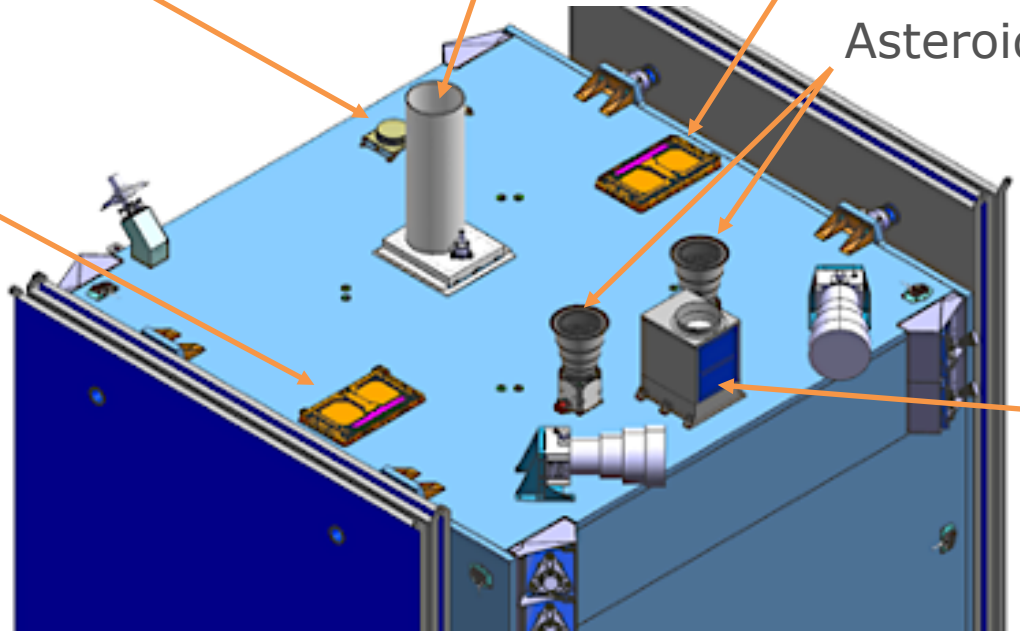


Spacecraft design (internal)





Payload

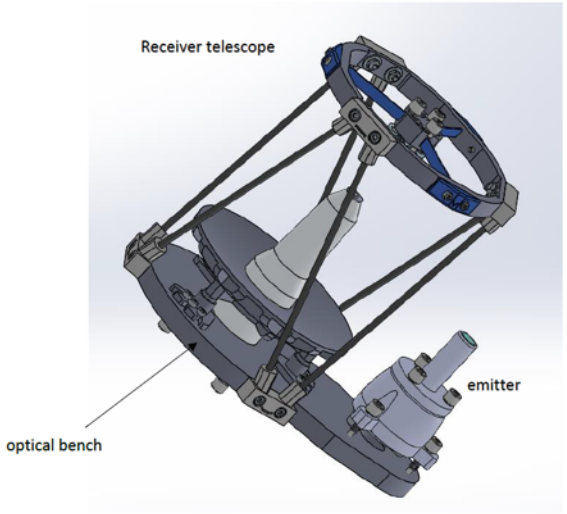

Laser altimeter
(PALT)
Inter-satellite link
(ISL)
CubeSat 2
(name tbc)
Asteroid Framing Cameras
(AFC)
CubeSat 1
(Juventas)
Thermal Imager
(TIRI)
Radioscience
(X-DST)

AFC

	JOP Astrohead
Mass	6.5 kg
Power (AVG)	Launch:~0W Transfer:~0W Operational:16.6W
Data interface	SpaceWire
Sun exposure tolerance	Optics: Yes Radiator: Yes
FOV	5.5 degrees
Sensor technology	CMOS APS (AMS FaintStar)
Pixels	1024
Angular resolution	93.7 µrad px−1
Focal length (mm)	106mm (TBC)
F-number	5.3 (TBC)
PSF (best case)	~60% in centre pixel
MTF	> 25 % at 50 LP/mm > 25 % at 25 LP/mm for close objects > 10 m
Aperture size	20 mm (TBC)
Quantum efficiency	35%

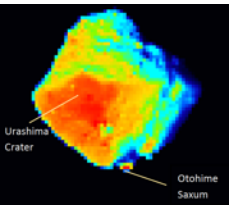
PALT (Helena)

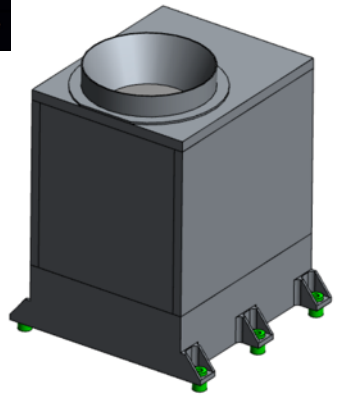
Requirement	Nominal Values	Goal Values
Operational Wavelength	1.5 µm	1.5 µm
Field of View	< 3 deg	< 0.5 deg
Measurement Rate	1 Hz	10 Hz
Measuring Distance	0.5 – 14 Km	0.1 – 20 Km
Measuring accuracy	0.5 meters	0.1 meters
Total Mass	1,4kg	
Dimensions	120 x 150 x 100 mm^3	
Peak Power	11,4 W	

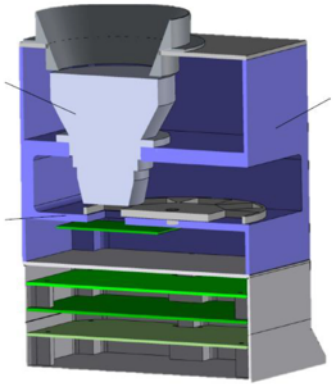


- contribute to the **mass** determination (scale the imaging observations, additional info on landmark positions)
- contribute to **shape model** and **volume** by measuring the distance between Hera and surface elements on Dimorphos
- measure the **reflectance** of Didymos and Didymoon at the laser wavelength of 1.535 µm.
- observations by AFC and RSE shall be complemented by **distance measurements** with PALT.

TIRI







- Main body size: 150 x 180 x 230 [mm]
- Mass: 4.2 kg (3.5 kg + margin 0.7 kg)
- Power: 17 +/- 3 W (nominal), max 30W

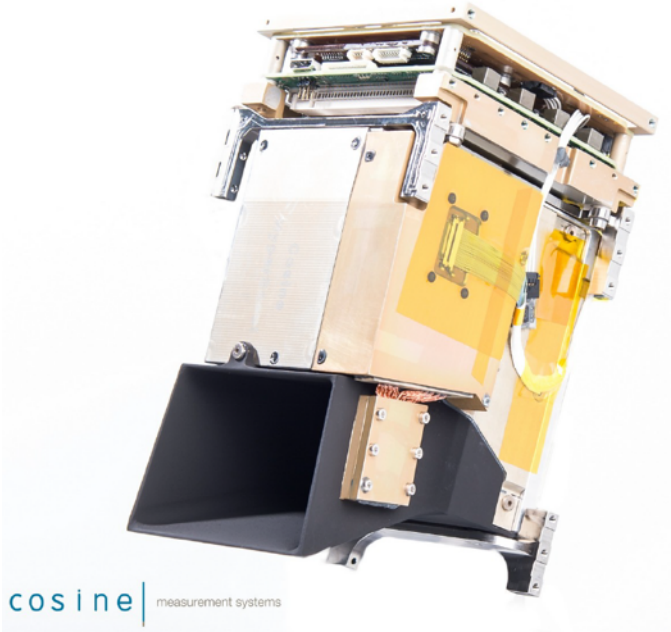
Item	Spec
Detector	Lynred PICO1024 Gen2
Wavelength	8 – 14 µm
Number of pixels	1024(H) x 768 (V)
Pixel size	17 µm
Detection area size	17.5 x 13.1 mm
Readout frame rate	30 Hz
Image bit	14 bit
NETD	< 0.1 K @300K
Absolute temperature accuracy	~ 3K
Temperature range	150 ~ 450K
Ge-Lens	F=75mm, F/1.0
Field of View (FOV)	13.3 x 10.0
Angular resolution (IFOV)	0.226 mrad (0.013°/pixel)
MTF	> 0.3
Number of Filters	8 points (close, wide, 6x narrow)
Summation of images	2^N (N=0,1,2,..7)

HYPERSCOUT (TBC)

Parameters	Value
FOV [deg]	31º x 16º
Focal length [mm]	41.25
Pixel size [µm]	5.5
ACT pixels [px]	4096
Spectral range [nm]	400-1000
Spectral resolution [nm]	15-20
Instrument data throughput @ 2.2 fps frame rate from 550 km orbit [MB/s]	34
ACT GSD from 550 km [m]	73
Swath from 540 km ACT [km]	295
Data volume frame image (16 bit uncompressed) [MB]	15.2

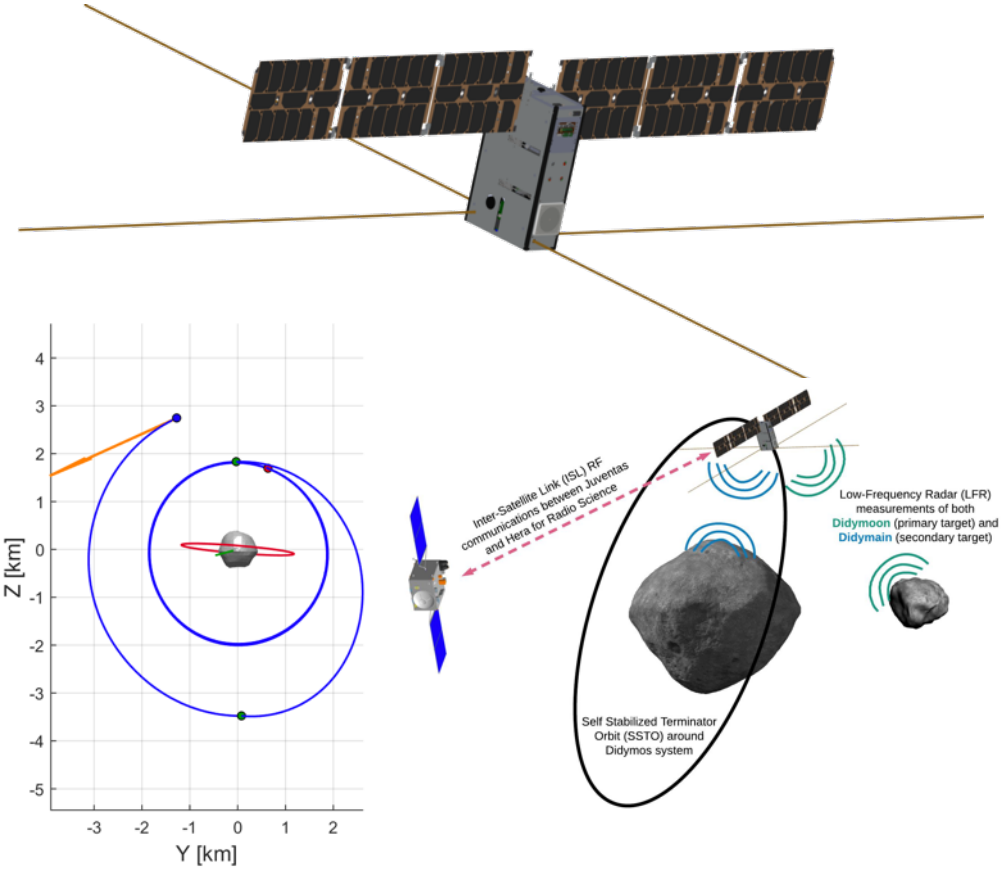
Unit	Weighted Mass [g]	Mass with 10% margin
HyperScout® 1	1300	1430

Operational mode	Measured power consumption (average) [W]	Power budget with 10% margin [W]
Idle (ICU only)	0.2	0.22
Acquisition	9.2	10.1
Processing	5.0	5.5
Data transfer OBDH	3.8	4.2



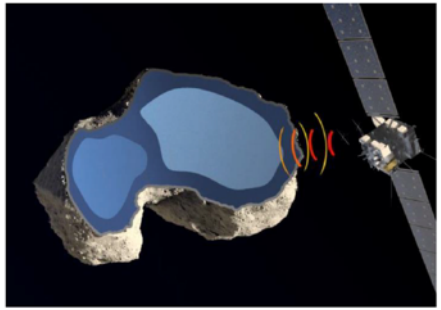
Funding for this instrument is still in discussion with the delegation

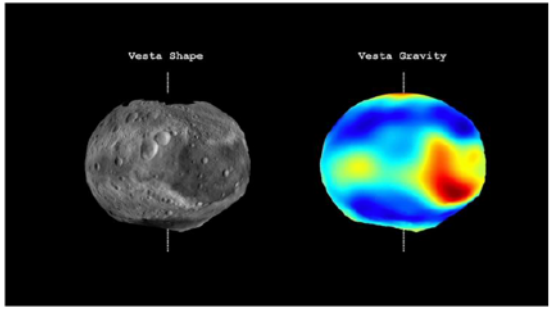
JUVENTAS (GOMSPACE)

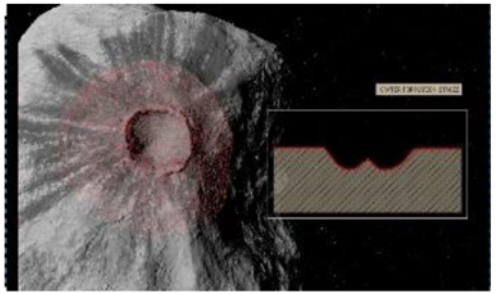


Country	Company	Role
BE	Royal Observatory of Belgium	PI, landing science / gravimeter
BE	Spacebel	Operations partner (TBD)
CZ	Filip Zaplata	LFR digital
DK	GomSpace	Spacecraft platform subsystems
FR	Univ. Grenoble / IPAG	LFR design lead (Co-I), Rx chain
FR	CNES	Operations partner
DE	TU-Dresden	LFR Tx chain and antenna simulation
IT	U. Bologna	Radio Science (Co-I)
LU	GomSpace Luxembourg	Mission and system lead, ISL lead to OHB
LU	EmTroniX	LFR electronics
NL	ISIS	Deployer interface (procurement)
PL	Astronika	LFR antenna
RO	gmv	GNC subsystem
ES	Emxys	Gravimeter payload
SE	GomSpace Sweden	Propulsion (procurement)

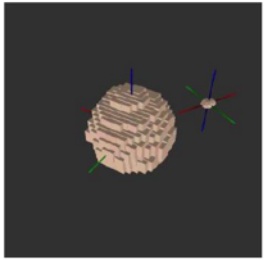
JUVENTAS OBJECTIVES and PAYLOAD







(Secondary)



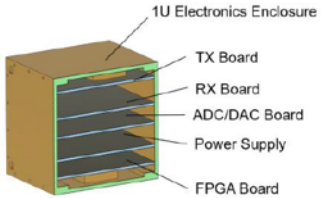
Interior Structure

Gravity Field

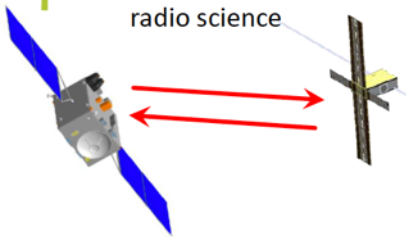
Surface Properties

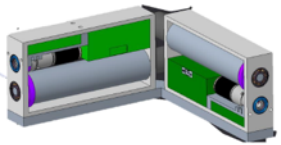
Dynamical Properties

Low-frequency Monostatic Radar



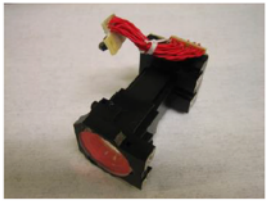
Inter-satellite link radio science



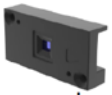


3-axis Gravimeter

Gyroscopes and accelerometers

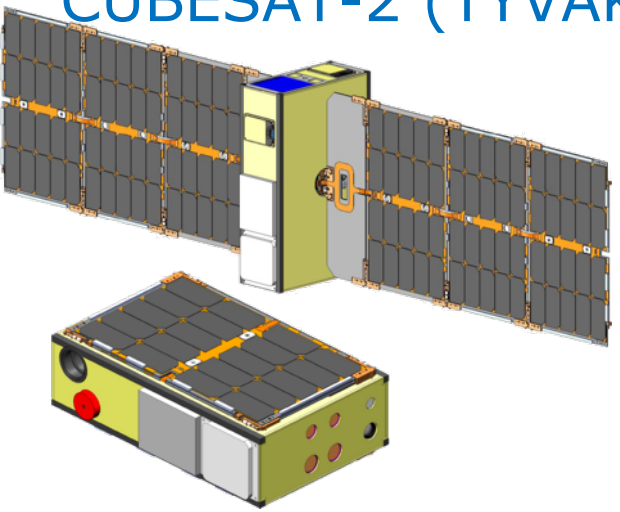


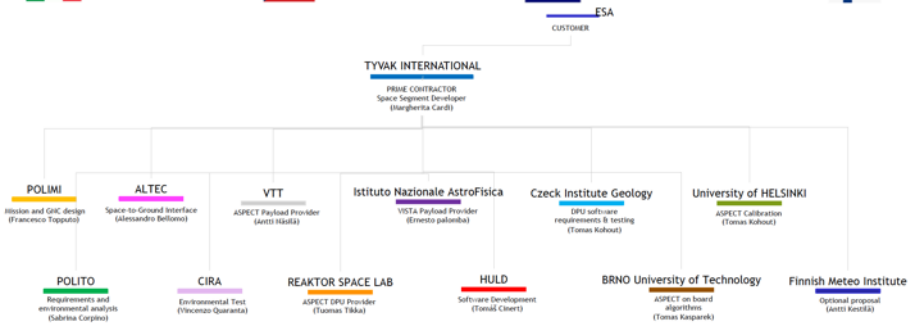
Visible context camera



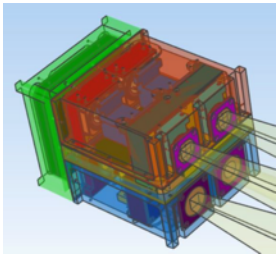
Sun sensors and star trackers (surface attitude)

CUBESAT-2 (TYVAK)





ASPECT



parameter	VIS channel	NIR1 channel	NIR2 channel	SWIR channel
Field of View [deg]	10° x 10°	6.7° x 5.4°	6.7° x 5.4°	5° circular
Spectral range [nm]	500 - 900	850 - 1275	1225 - 1650	1600 - 2500
Image size [pixels]	1024 x 1024	640 x 512	640 x 512	1 pixel
No. spectral bands	Ca. 14	Ca. 14	Ca. 14	Ca. 30
Spectral resolution [nm]	< 20 nm	< 40 nm	< 40 nm	< 40 nm

- Payload: ASPECT + VISTA
- Based on Trestles 6U bus
- Optical Navigation Sensors
- Inter-Satellite Link (ISL) Radio
- Umbilical Interface
  (CubeSat IF Board (CIB) + external LSIB)
- Tyvak Perseus twin cold gas thrusters

VISTA micro-oscillator made up of piezoelectric crystals with a metal electrode acting as collector of µm and sub-µm size particles. Gas/particle sensors converts mass changes into fundamental resonance frequency variations.

Cubesat-2 Mission objectives

OBJ ID	Objective Description
OBJ1	To reconstruct the global properties of Didymos asteroids (e.g. size, global shape)
OBJ2	To determine the mineral and elemental composition difference between Didymos bodies
OBJ3	To confirm Didymoon taxonomy as a S-type asteroid
OBJ4	To detect hydrated minerals
OBJ5	To determine surface roughness or regolith grain size
OBJ6	To characterize the distribution of the fall-back ejecta on the Didymos asteroids
OBJ7	To characterise the crater caused by DART impact
OBJ8	To inspect the local material properties changes caused by DART Impact
OBJ9	To compare mature and freshly exposed material
OBJ10	To support HERA Gravity Field measurements enhanced by ISL network
OBJ11	To detect inorganic materials, volatiles (e.g. water) and light organics
OBJ12	To detect the existence of dust particles
OBJ13	To provide ISL communication with HERA
OBJ14	To provide relative positioning
OBJ15	To measure the effects of the asteroid environment on key hardware

Primary Objectives – related to direct observation of the asteroid bodies with **primary payload** – do not depend on DART impact

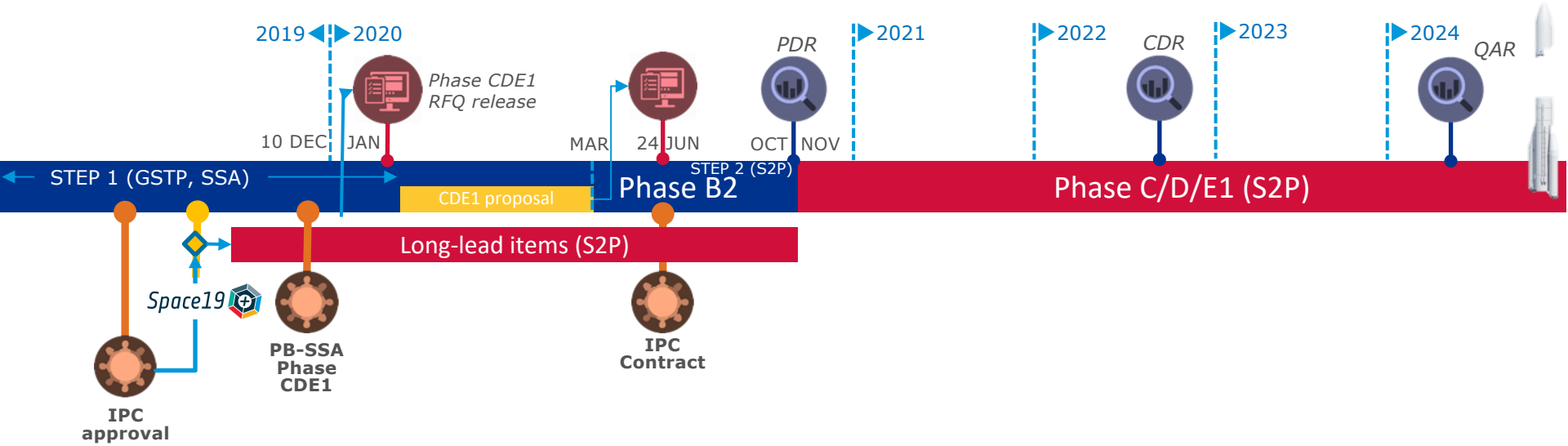
Secondary Objectives – require only **primary payload** – depend on DART impact

Additional Objectives – require **additional payload** – depend on DART impact

To provide **ISL** communication with JUVENTAS (option)

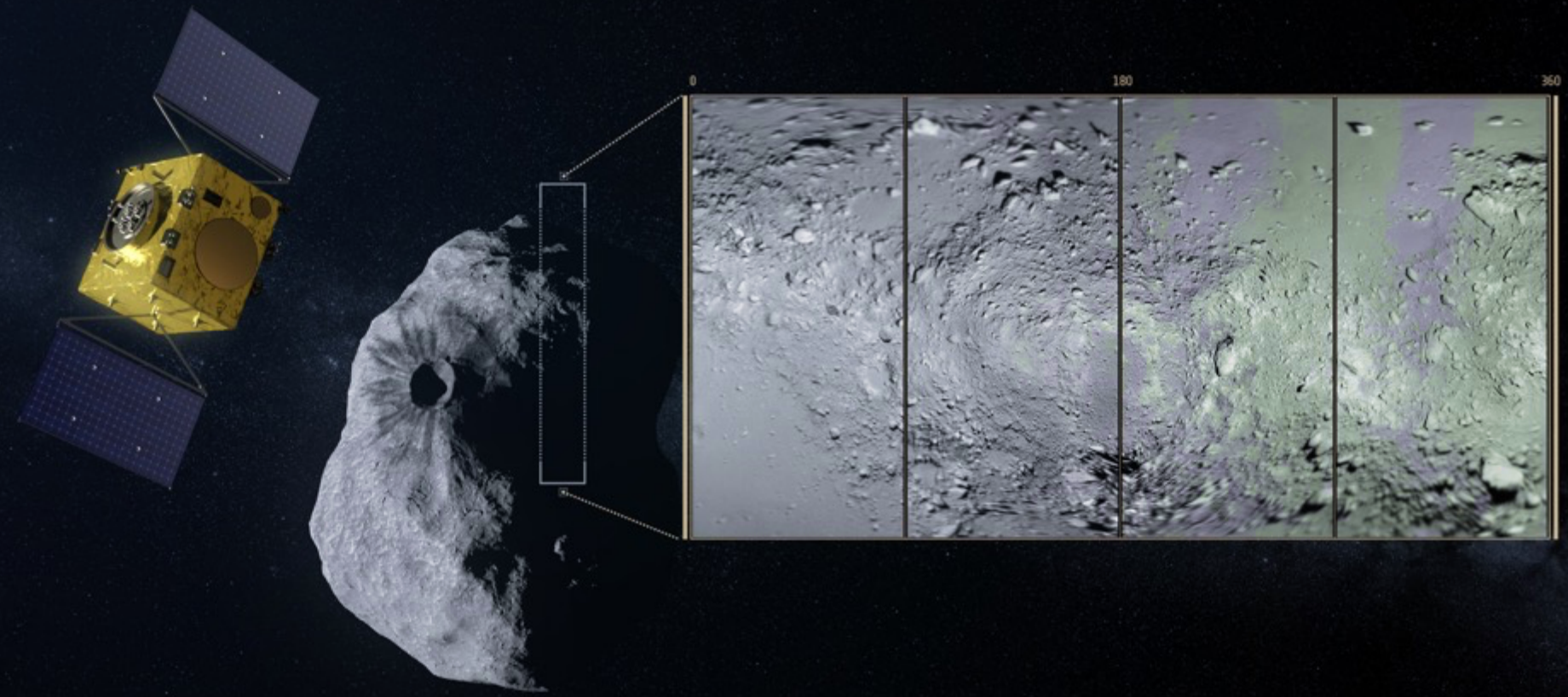
Opportunity payload – do not require additional payloads nor DART impact – mission technology by-product

Next steps



Next milestone: system PDR

KO 15 October 2020
Board close-out 10 December 2020



European Space Agency