→ HERA MISSION

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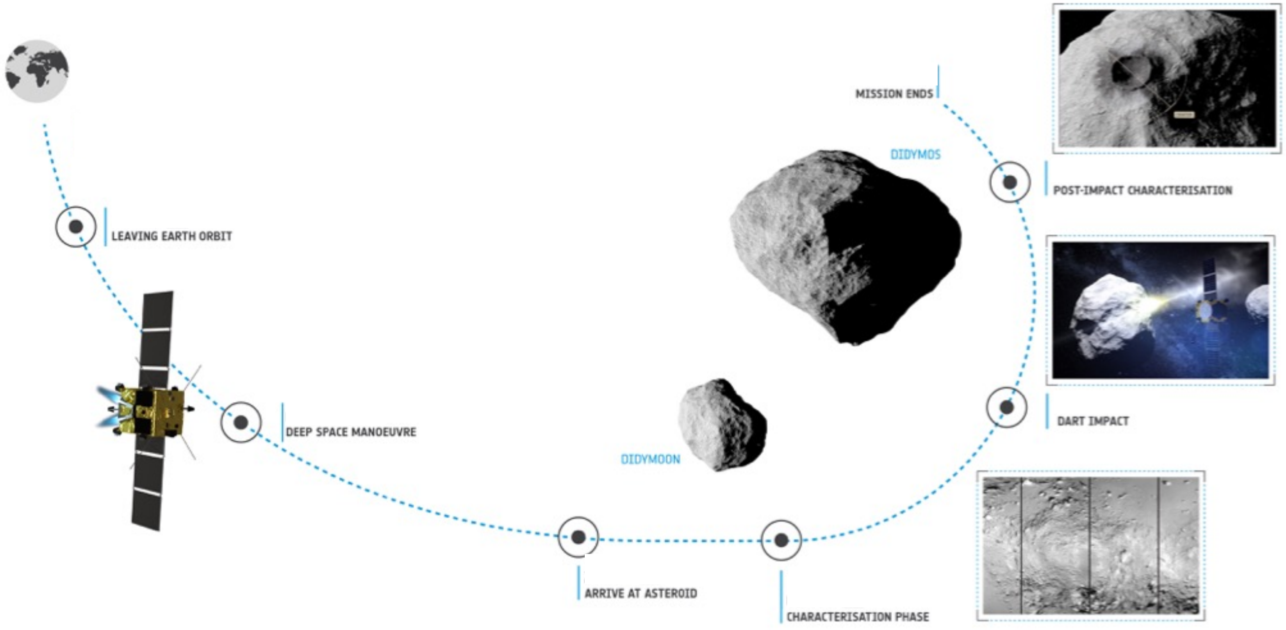
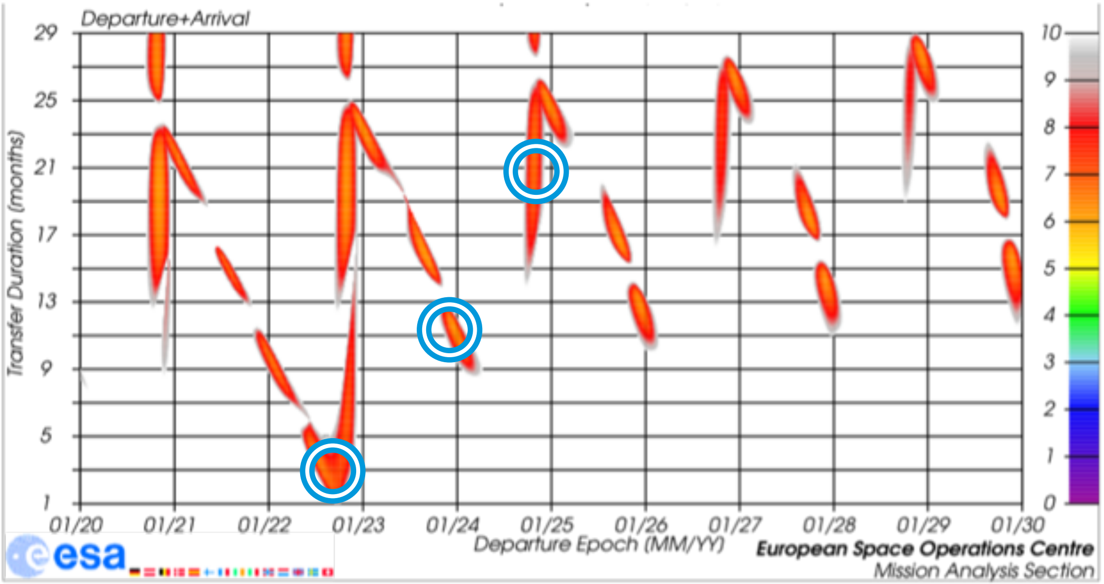
HERA/AIM mission scenario

- First ever investigation of deflection test
- Detailed analysis of impact crater (*before/after* impact or *after* only depending on DART launch)
- First deep-space CubeSat
- First binary asteroid and smallest ever asteroid visited



Launch dates

- **Soyuz launch from Kourou TBC in 2022 timeframe -> international collaboration**
- Didymos still a good target as of 2Q 2017, later launch opportunities:



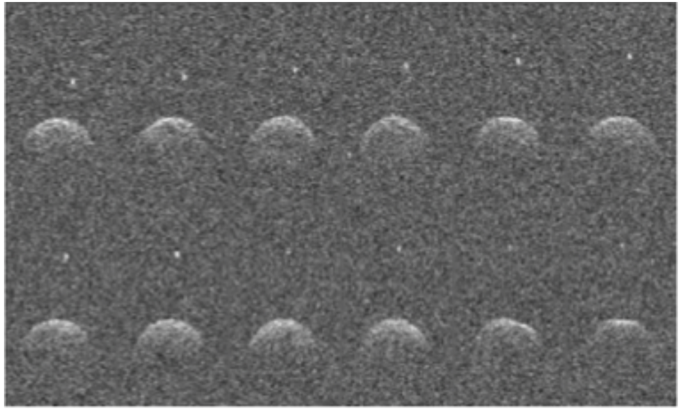
Departure date: **2023/10/22**
Earth swing-by: 2024/10/26
Arrival date: 2026/09/02
Delta-V: 1.405 km/s

Departure date: **2024/10/14**
Earth swing-by: N/A
Arrival date: 2026/7/13
Delta-V: 1.514 km/s

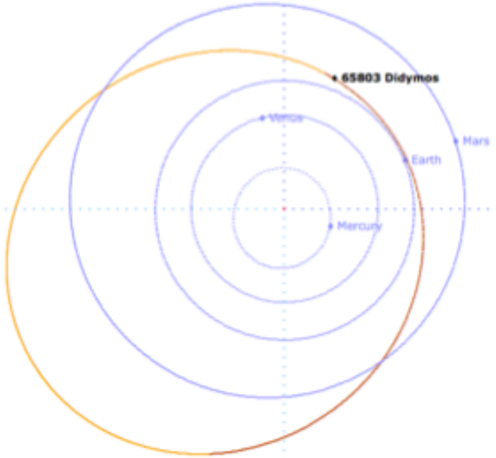
A launch date in 2022 exists with arrival in 2024 but short development time, will be studied

DIDYMOS target

- Didymoon size representative of a potentially hazardous object (generating casualties independently from impact location on Earth)
- Shape and size of primary “well known”, not secondary
- Asteroid observed by ground telescopes and radars
- Heliocentric orbit well known



Parameter	Value
Diameter of Primary D_P	0.780 km +/- 10%
Diameter of Secondary D_S	0.163 km +/- 0.018 km
Bulk density of the primary ρ_P	2104 kg m^{-3} +/- 30%
Distance between the centre of primary and secondary a_{orb}	1.18 km +0.04/-0.02 km
Total mass of system	5.278e11 kg +/-0.54e11 kg
Rotation period of the primary	2.2600 h +/-0.0001 h



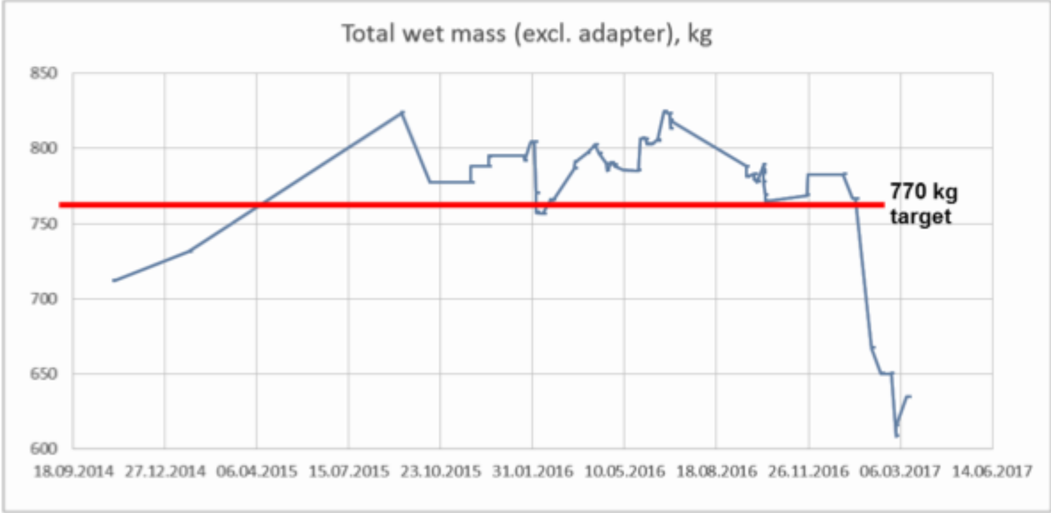
Minimum Earth-Didymos distances:

Sept 2022 > 0.07 AU (1.04e+7 km)
Dec 2024 > 0.56 AU (8.37e+7 km)
Jun 2026 > 0.90 AU (1.34e+8 km)

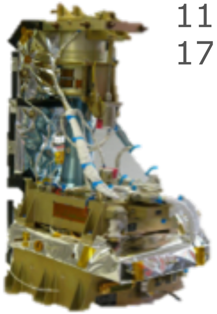
Spacecraft mass budget

Subsystem	Nominal [kg]	Margin [%]	Total [kg]
EPS	34.9	10%	38.4
OBDH	26.4	10%	29.0
TT&C	22.0	8%	23.8
AOCS/GNC	12.2	5%	12.8
CPS	50.6	6%	53.8
TCS	11.9	16%	13.8
Harness	24.7	30%	32.1
Structure	84.8	20%	101.7
Platform total	**267.4**	**14%**	**305.5**
Payload	19.0	0%	19.0
Payload total	**19.0**	**0%**	**19.0**
Spacecraft dry mass	**286.4**	**13%**	**324.5**
System margin		20%	64.9
Spacecraft dry mass + Margin			**389.4**
Propellant mass			249.0
Pressurant			1.0
Spacecraft launch mass			**639.4**
Launcher performance (w.o. adapter)			**770.0**
Launcher Margin			**130.6**

Dry mass growth potential of **40kg** for additional payload **-> potential for international collaboration**



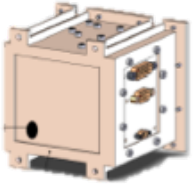
POTENTIAL PAYLOAD CONTRIBUTIONS



11.6 kg
17-34 W

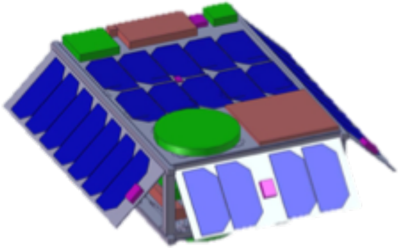
NAVCAM
(In storage)

1.4 kg
9 W



µLidar

14.9 kg (6U)



CubeSat

2 x 1U payloads among:
- Hyperspectral imaging
- Volatiles
- Relative Radioscience
- Seismometry
- Minearology
- Dust environment
- Gravimetry

Option: study accommodation and release of JAXA's Small Carry-on Impactor

Opportunities for additional international collaborations

Additional Europeans interests expressed to ESA (to be discussed with MS in frame of B1):

Radiation Monitor	Monostatic radar	Multi-/hyper-spectral camera
Micro-imagers	Thermal imager	Bifocal metrology

HERA phase B1 (SSA + GSTP)

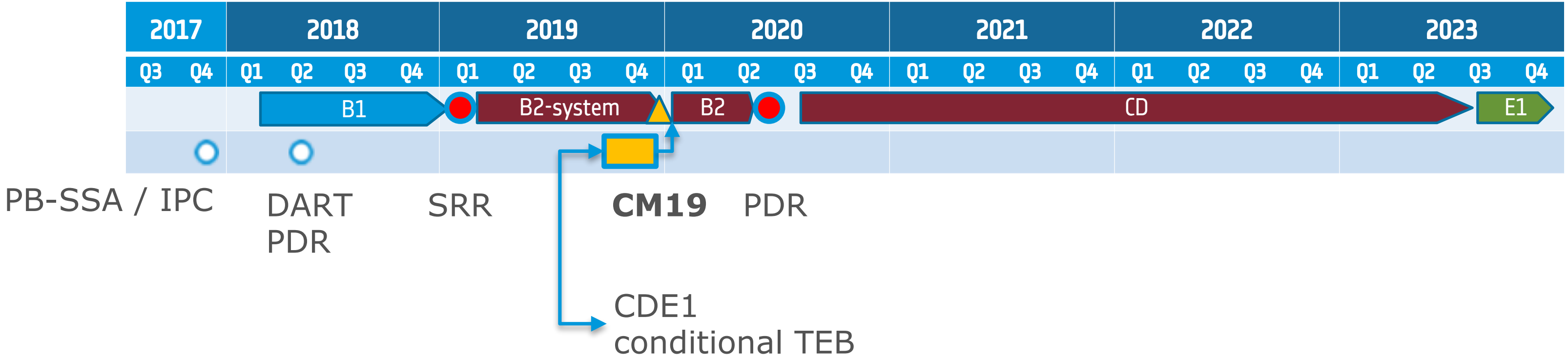
Procurement proposals approved in IPC and Feb PB-SSA enabling CM19 preparation:

HERA system Phase B1 study (co-funding GSTP 6 + SSA-NEO)	4.000 K€

Technology developments and support activities:

ISL breadboard (GSTP, G61M-005ET, PT)	250 K€
Engineering Model of a laser altimeter (GSTP, G61M-002EC, PT+PL+IE)	400 K€
HERA deep-space cubesat phase-A (GSTP)	400 K€
Asteroid environment analyses, simulations and science support (GSP)	500 K€

HERA schedule



START	END	PHASE	
Mar-18	Dec-18	**Phase B1**	ITT to be released latest in January 2018
Jan-19	Feb-19	**SRR**	
Feb-19	Dec-19	**Phase B2-system**	
Dec-19		**CM19**	*Sep-Nov 19: PhB2CD Conditional TEB
Jan-20	May-20	**Phase B2**	
May-20	Jul-20	**PDR**	
Aug-20	Aug-23	**Phase CD**	
Aug-23	Oct-23	**Margin/Launch Campaign**	
Oct-23		**Launch**	

HERA Implementation

- (Optional) programmatic frame to be agreed with MS before CM19: **Space Safety**
- Participating States contribute to common costs pro-rata of their contribution.
- In-kind contributions possible: e.g. technology, payload, facilities…
- Participation to the phase B1 important to consolidate system requirements for selected technologies through analyses and preliminary validation of algorithms
- Preliminary CubeSat operations interfaces to be analysed and OIRD defined during phase B1
- Phase B2 proposal (FFP) at the end of B1 and committed ceiling price financial proposal for C/D/E1 to be converted in FFP after CM19.

Conclusions

- HERA provides a robust and cost effective means to perform a planetary defense validation test with a solid balance between risk and innovation.
- HERA brings European industry one step forward in CubeSat relayed operations for future missions architectures (swarms in LEO, deep-space exploration).
- Asteroid close-proximity operations provide optimal environement to test GNC solutions applicable to active debris removal and in-orbit servicing.
- HERA provides unique visibility and public engagement in space activities
- HERA maintains strong international collaboration with a robust schedule and clear interfaces.
- **Support from SMPAG is important to explain necessity for planeteray defense precursor mission**

INSPIRATION AND OUTREACH


sand art performance

Asteroid Day press conf


planetarii


Astrofest (London, June 2016)

Science&Vie Magazine


PD videogame

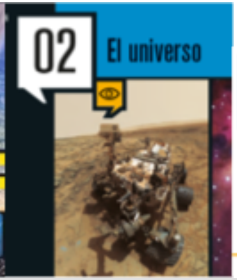

Design your asteroid school contest


"Men vs Asteroid" Discovery Channel documentary

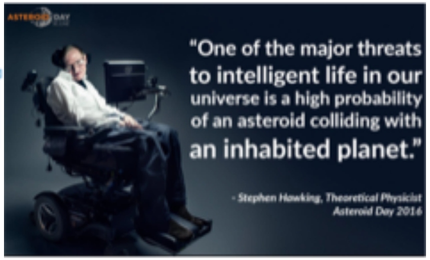

AD (Milan, 2016)


Asteroid Day (Bucharest, 2015)

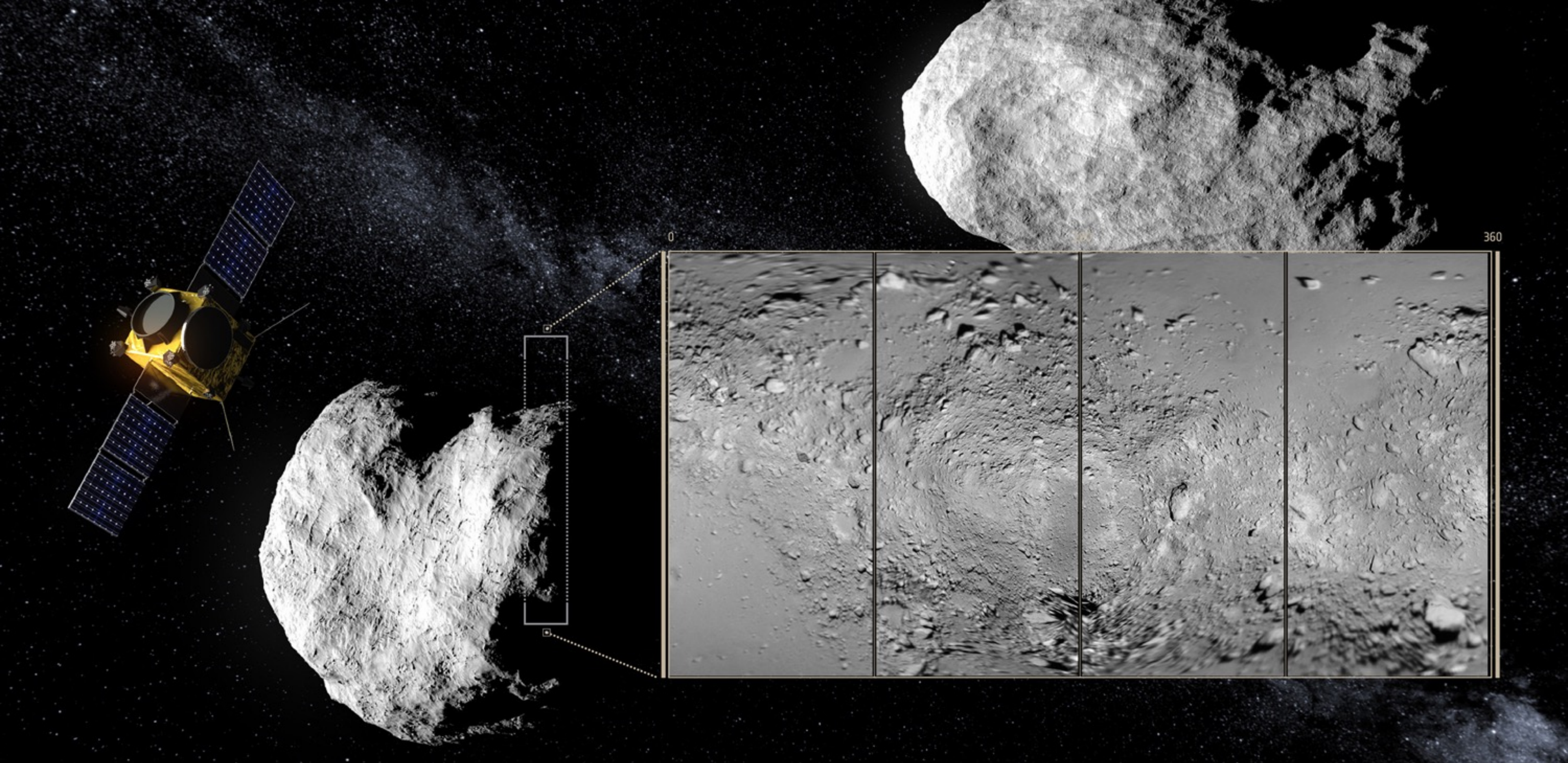
CNN TV news



Science school book (Spain)



Stephen Hawking supporting AD



→ HERA MISSION

Ian Carnelli (Ian.Carnelli @ esa.int)
Advanced Concepts and Studies office (TEC-SF)