

Near-Earth Asteroid risk mitigation strategy in the next decade: from Earth-based facilities to **DART** and **Hera** space missions

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Planetary defence strategy from NEOs



Find & follow up NEOs

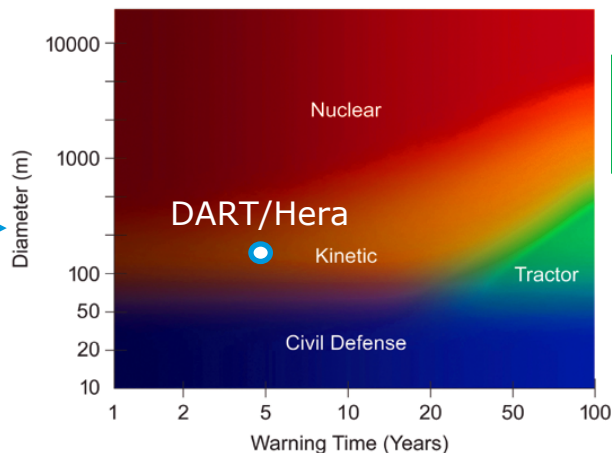
From **ground**, ongoing (~5 new NEOs/day)

Assess threat

From **ground**, ongoing (NEOCC + SENTRY)

Prevent

Can only be done in space



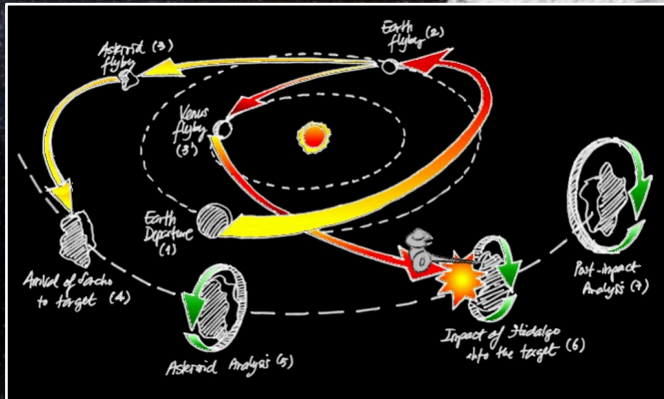
Kinetic Impactor:
most flexible, realistic, tech-ready

Validation = Impactor + Rendezvous

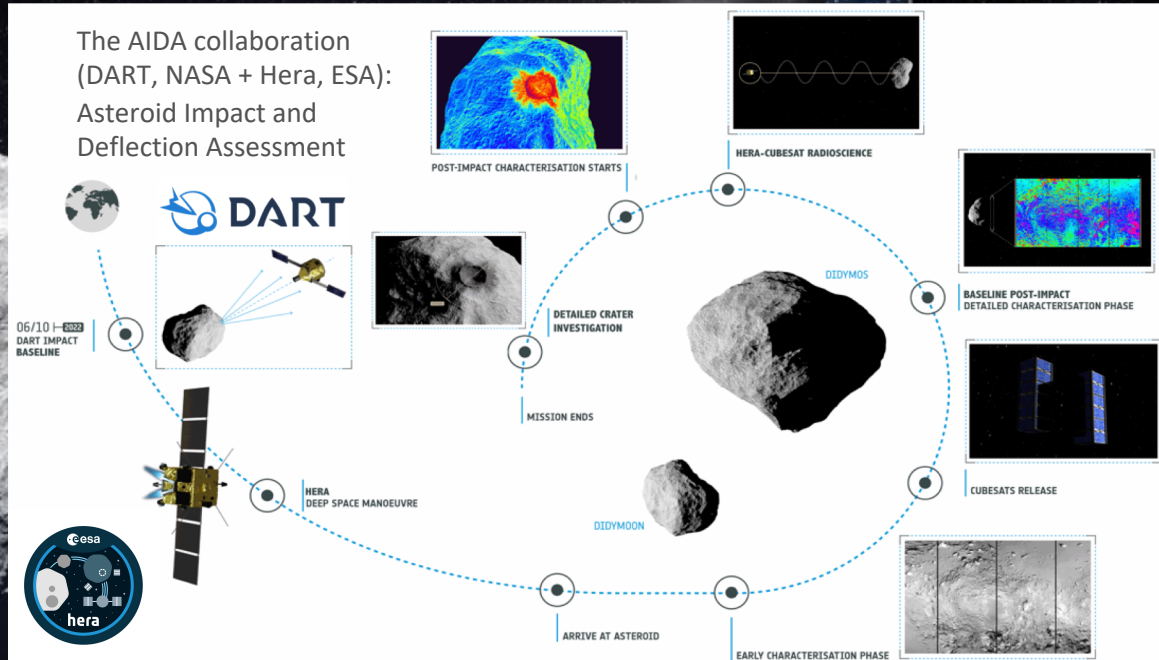
From the 'Don Quijote mission' to the AIDA collaboration



Andrea Milani (1848-2019)



Don Quijote mission. (ESA, 2003)



DART + Hera target: Binary NEA (65803) Didymos



Heliocentric eccentricity e	$e = 0.383752501 \pm 7.7e-9$
Heliocentric semimajor axis a	$1.6444327821 \pm 9.8e-9$ AU
Heliocentric inclination to the ecliptic i°	$3.4076499^\circ \pm 2.4e-6^\circ$
Diameter of Primary Dp^1	0.780 km ± 0.03 km
Didymos A extents along principal axes x; y; z	$832 \pm 3\%$ m; $837 \pm 3\%$ m; $786 \pm 5\%$ m;
Diameter of Secondary Ds	0.164 km ± 0.018 km
Bulk density of the primary ρp^2	2170 kg m $^{-3}$ ± 350 kg m $^{-3}$
Secondary (shape) elongation a_s/b_s and b_s/c_s (assumed) 3	1.3 ± 0.2 >1 (assumed 1.2)
Distance between the centre of primary and secondary a_{orb}	1.19 km ± 0.03 km
Total mass of system	$5.278e11$ kg $\pm 0.54e11$ kg 4
Geometric Albedo	0.15 ± 0.04
Rotation period of the primary	2.2600 h ± 0.0001 h



Obliquity to the heliocentric orbit	$175^\circ \pm 9^\circ$
Diameter ratio Ds/Dp	0.21 ± 0.01
Secondary orbital period P_{orb}	11.9217 h ± 0.0002 h
S type (maybe LL analogue meteorite)	

ESA



European Space Agency

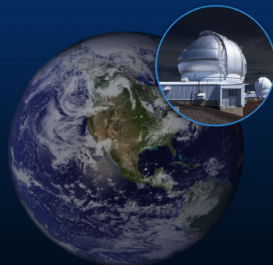
DART outline



Falcon 9, VAFB
Ballistic Trajectory

Launch:
July 22nd, 2021

LICIACube
(Light Italian Cubesat
for Imaging of Asteroids)
ASI contribution



IMPACT: September, 2022

DART Spacecraft

650 kg
6.65 km/s

Dimorphos

163 m
11.92-h orbital period

**65803 Didymos
(1996 GT)**

1,180-m binary separation

Didymos

780 m, S-type
2.26-h spin period

Earth-Based Observaciones

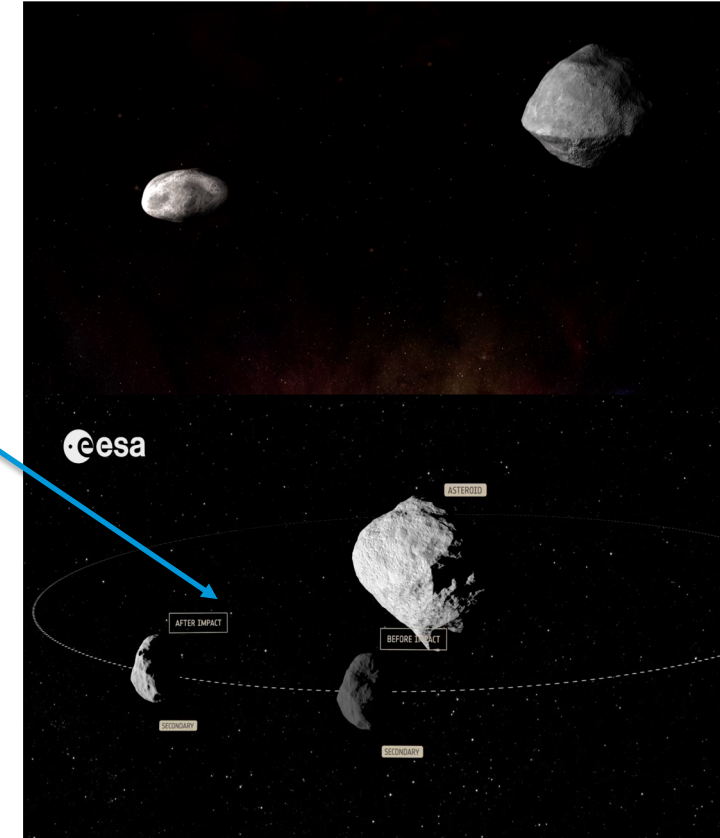
0.07 AU distance to Earth at impact.
~10-min (~1%) change in Dimorphos orb. Period.



European Space Agency

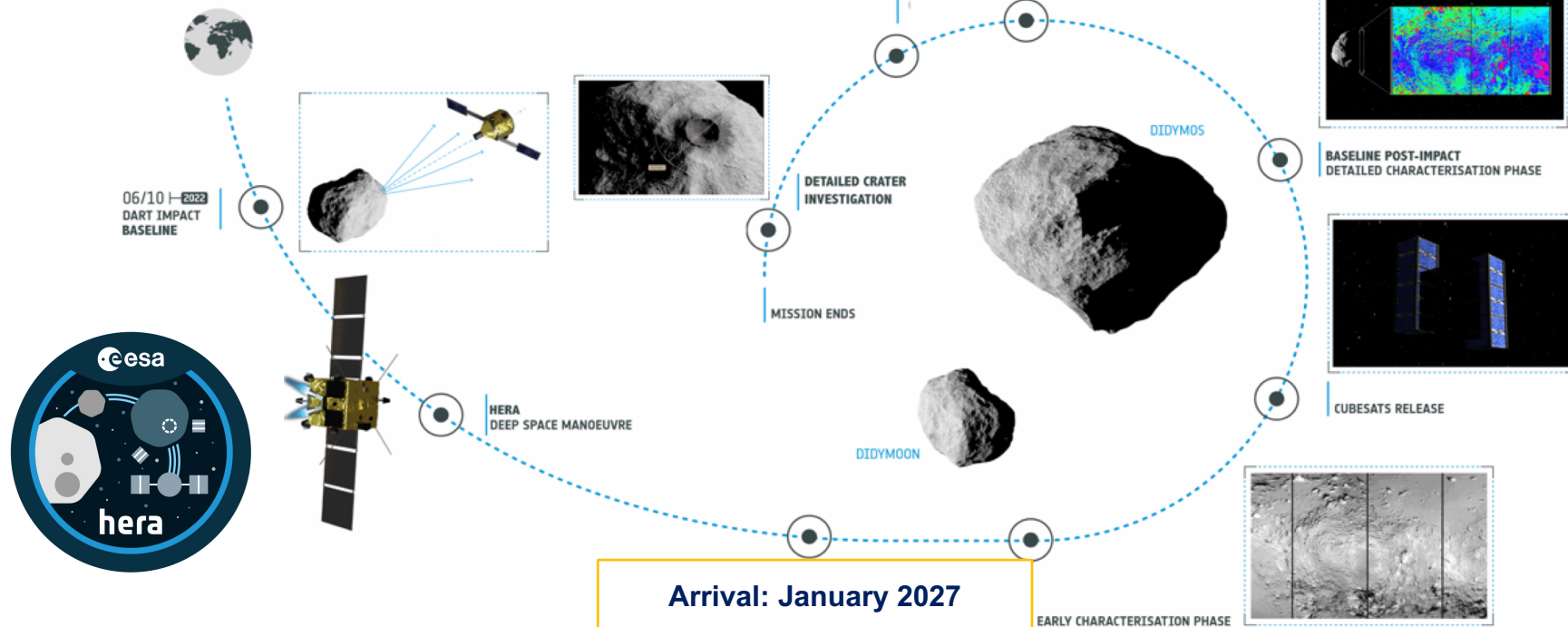
What will **DART** provide?

1. First **demonstration of KI technique** to deflect an asteroid.
2. Test **autonomous GNC** for hypervelocity impact on 150 m target.
3. Measure Didymoon's **orbital period change due to the DART collision**
(only from ground observations: e.g. Arecibo).
4. **LICIA Cubesat (ASI)** to perform ~5-6 min Didymoon fly-by + confirm impact and image ejecta plume.



Hera outline

Launch: October 2024



What will Hera provide?



- Validate DART impact (crater properties/dust environment)
- Full characterization of the system (mass of components/orbital parameters)
- Laser ranging to fine shape and size measurement
- Deployment of 2 cubesats and radio networking
- Radio science/gravimeter/accelerometer to constrain gravity field and internal properties
- Hyperspectral imaging of the surface of Dimorphos
- Bonus science:

Cratering physics

Internal structure

Binary asteroid formation

A mission of 'Firsts'

- First investigation of a binary asteroid
- Smallest asteroid ever visited
- First full scale cratering physics experiment
- First radar tomography of an asteroid
- First inter-satellite (cubesats) communication in deep space