



Overview of the DART Mission Seven Months to Launch

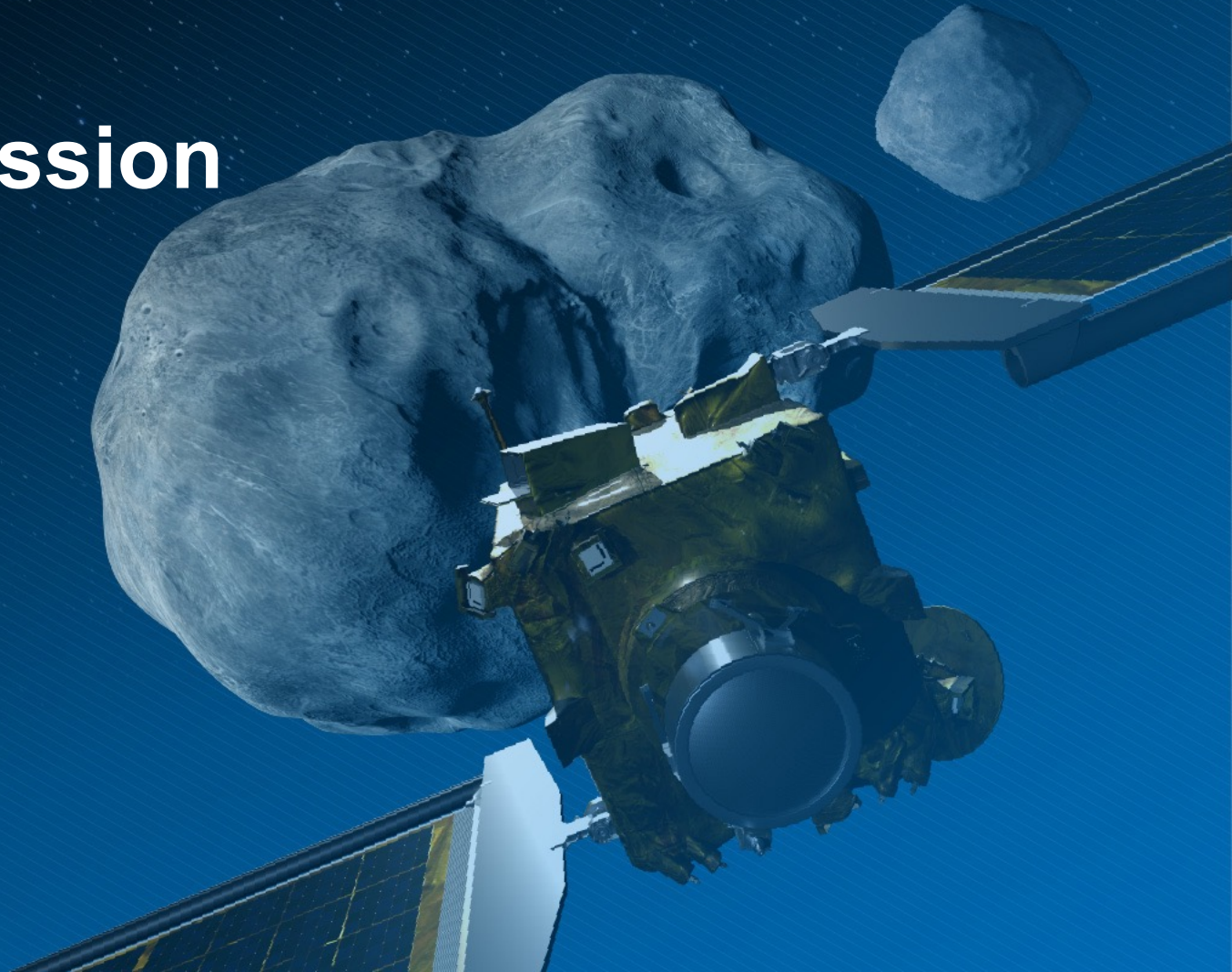
Dr. Thomas S. Statler

DART Program Scientist

Planetary Defense Coordination Office

NASA Headquarters

Washington, DC





NASA's Planetary Defense Coordination Office (PDCO)



- Established January 2016 at NASA HQ
- Manages planetary defense related activities across NASA
- Coordinates with U.S. interagency and international efforts in planetary defense

Mission Statement

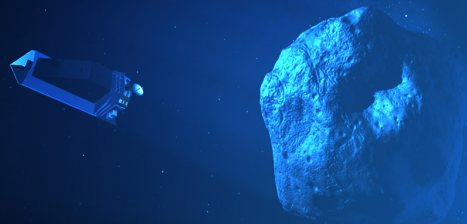
- Lead national and international efforts to:
- Detect any potential for significant impact of planet Earth by natural objects
- Appraise the range of potential effects by any possible impact
- Develop strategies to mitigate impact effects on human welfare





ASSESS

[CENTER FOR NEAR EARTH OBJECT STUDIES]



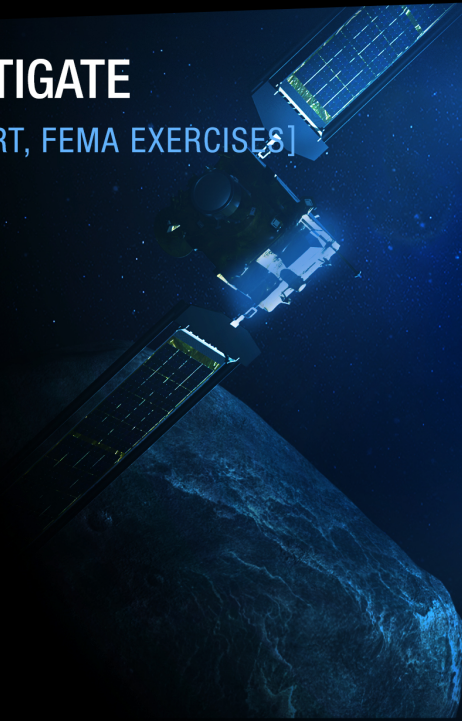
SEARCH, DETECT & TRACK

[SPACE-BASED & GROUND-BASED OBSERVATIONS, IAWN]



MITIGATE

[DART, FEMA EXERCISES]



CHARACTERIZE

[NEOWISE, GOLDSTONE, IRTF]



PLAN & COORDINATE

[SMPAG, PIERWG, NITEP IWG]

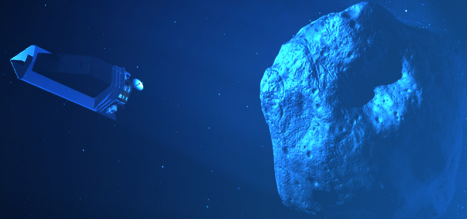


PLANETARY DEFENSE



ASSESS

[CENTER FOR NEAR EARTH OBJECT STUDIES]



SEARCH, DETECT & TRACK

[SPACE-BASED & GROUND-BASED OBSERVATIONS, IAWN]

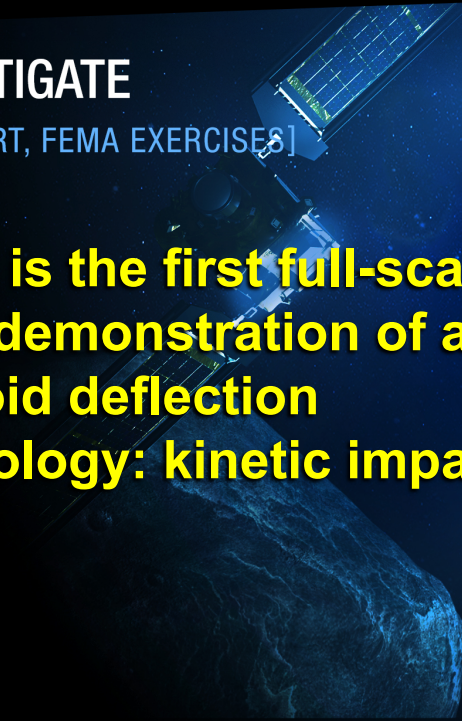


MITIGATE

[DART, FEMA EXERCISES]



DART is the first full-scale flight demonstration of an asteroid deflection technology: kinetic impact



CHARACTERIZE

[NEOWISE, GOLDSTONE, IRTF]



PLAN & COORDINATE

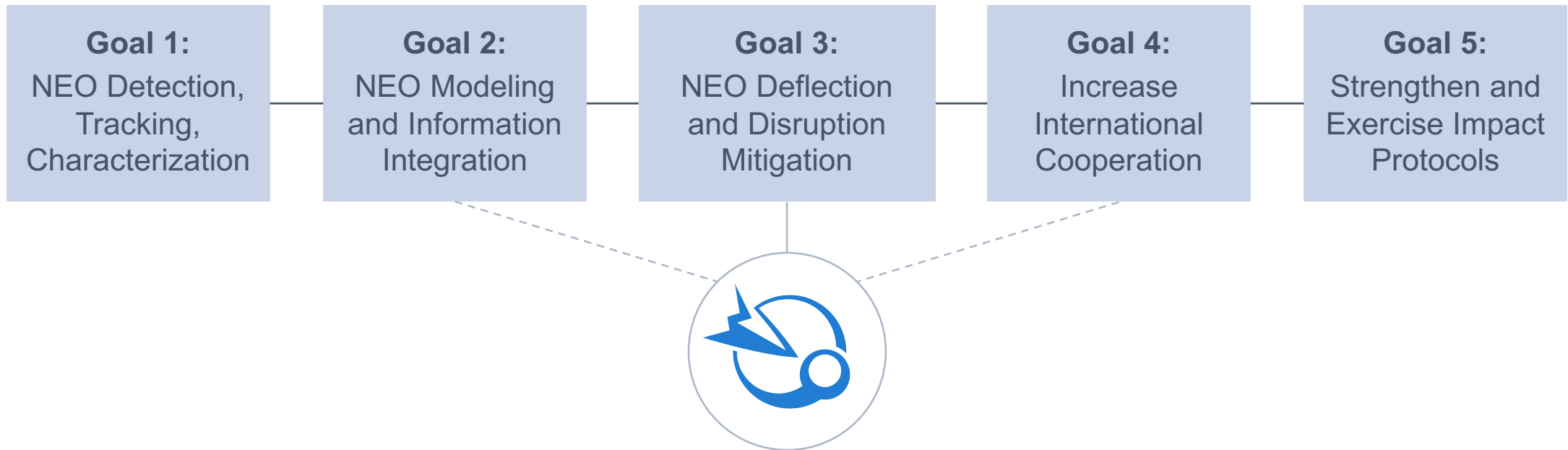
[SMPAG, PIERWG, NITEP IWG]



Part of a Larger Strategy

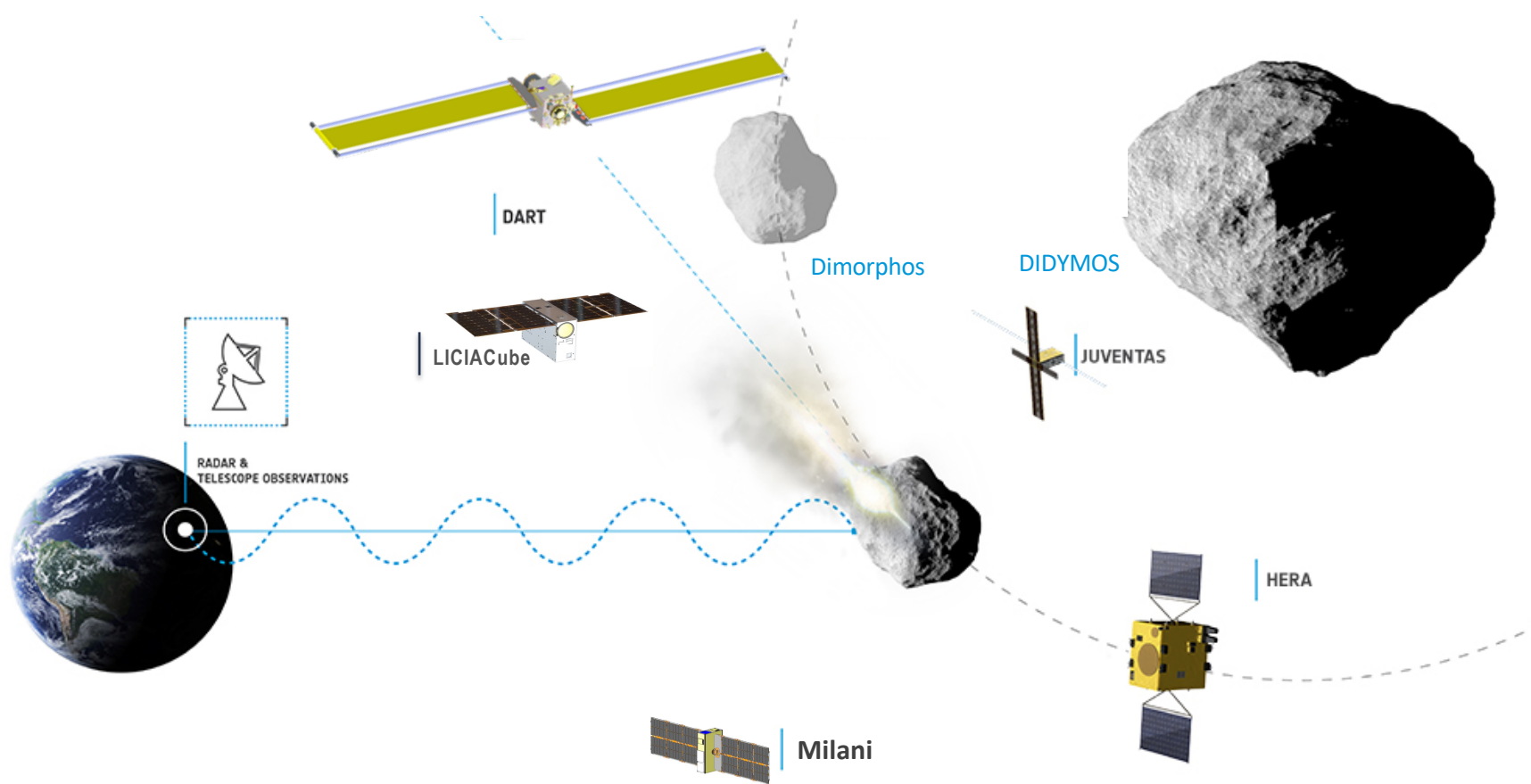
National Near-Earth Object Preparedness Strategy and Action Plan

A Report by the Interagency Working Group for Detecting and Mitigating the Impact of Earth-Bound Near-Earth Objects of the National Science & Technology Council, June 2018

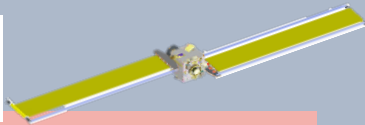


DAMIEN (Detecting and Mitigating the Impact of Earth-Bound Near-Earth Objects) Membership: Department of Commerce, Department of Defense, Department of Energy, Department of Homeland Security, Department of the Interior, Department of State, NASA, National Science Foundation, Office of the Director of National Intelligence, National Security Council, Office of Management and Budget, Office of Science and Technology Policy

AIDA international collaboration



AIDA



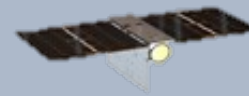
Synergy from

First demonstration of asteroid deflection by kinetic impact on Dimorphos, to change its orbit

with

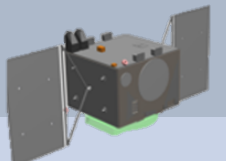


LICIACube



First prompt imaging of the impacted surface, ejecta plume evolution and of the non-impacted hemisphere of Dimorphos

+



Mass of Dimorphos
Detailed dynamical characterization
Detailed investigation of final crater
Overall characterization of the asteroids

DART = Double Asteroid Redirection Test

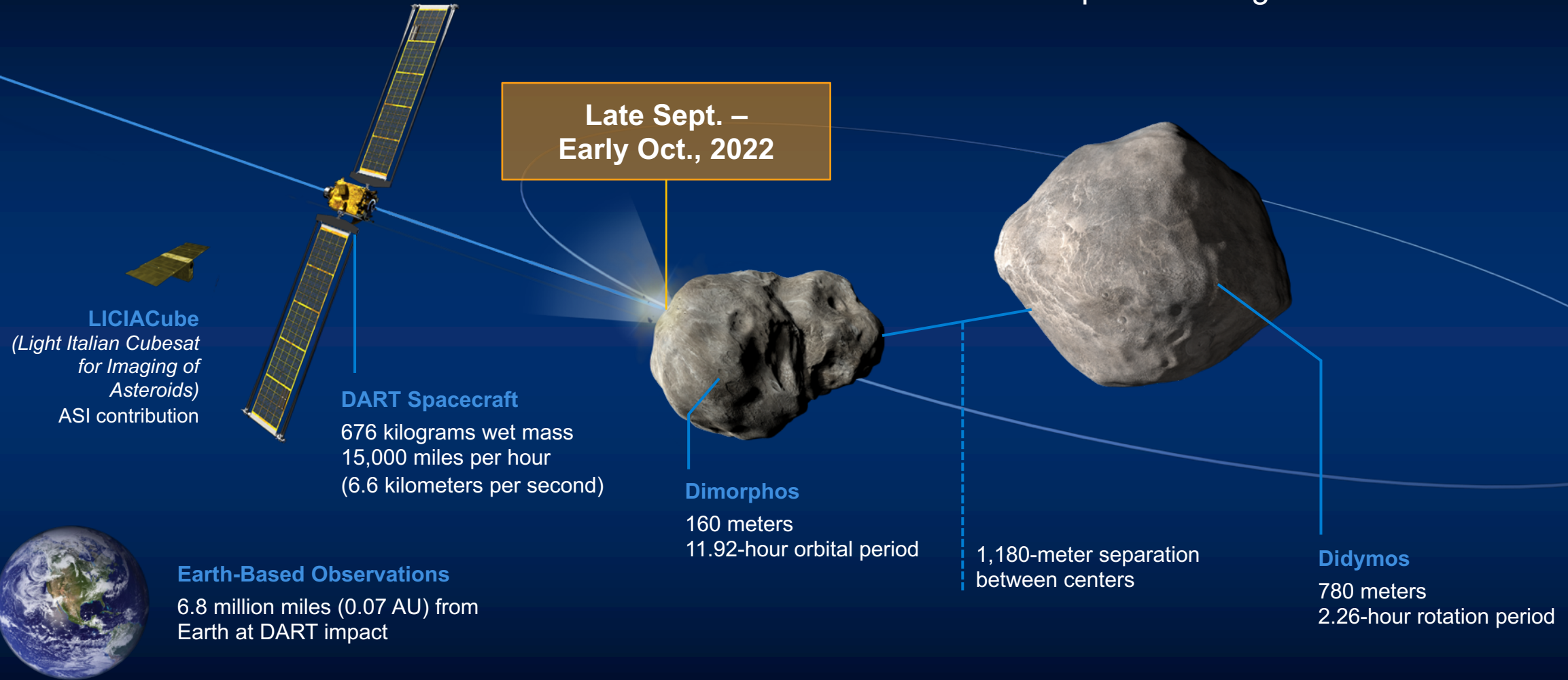
DART = Double Asteroid Redirection Test

- **There is no known asteroid that poses an actual impact risk to Earth.**
- The current impact hazard comes from asteroids not yet discovered.
- The test is being conducted to develop a deflection capability, in case one is needed in the future.

Launch Window

Nov. 18, 2021 – Feb. 15, 2022

- Target the binary asteroid Didymos system
- Impact Dimorphos and change its orbital period
- Measure the period change from Earth

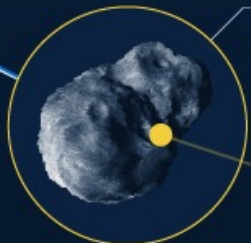
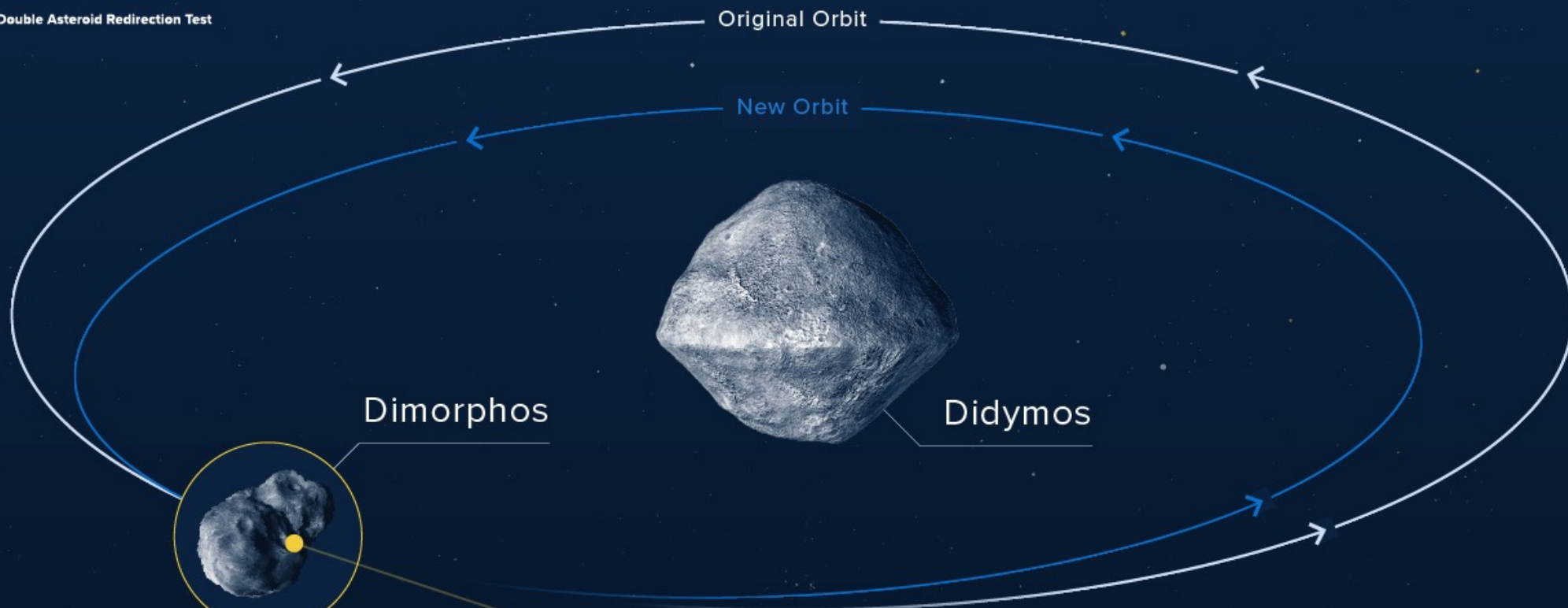




DART

Double Asteroid Redirection Test

The Ideal Target: A Natural Laboratory



IMPACT

Dimorphos

Didymos

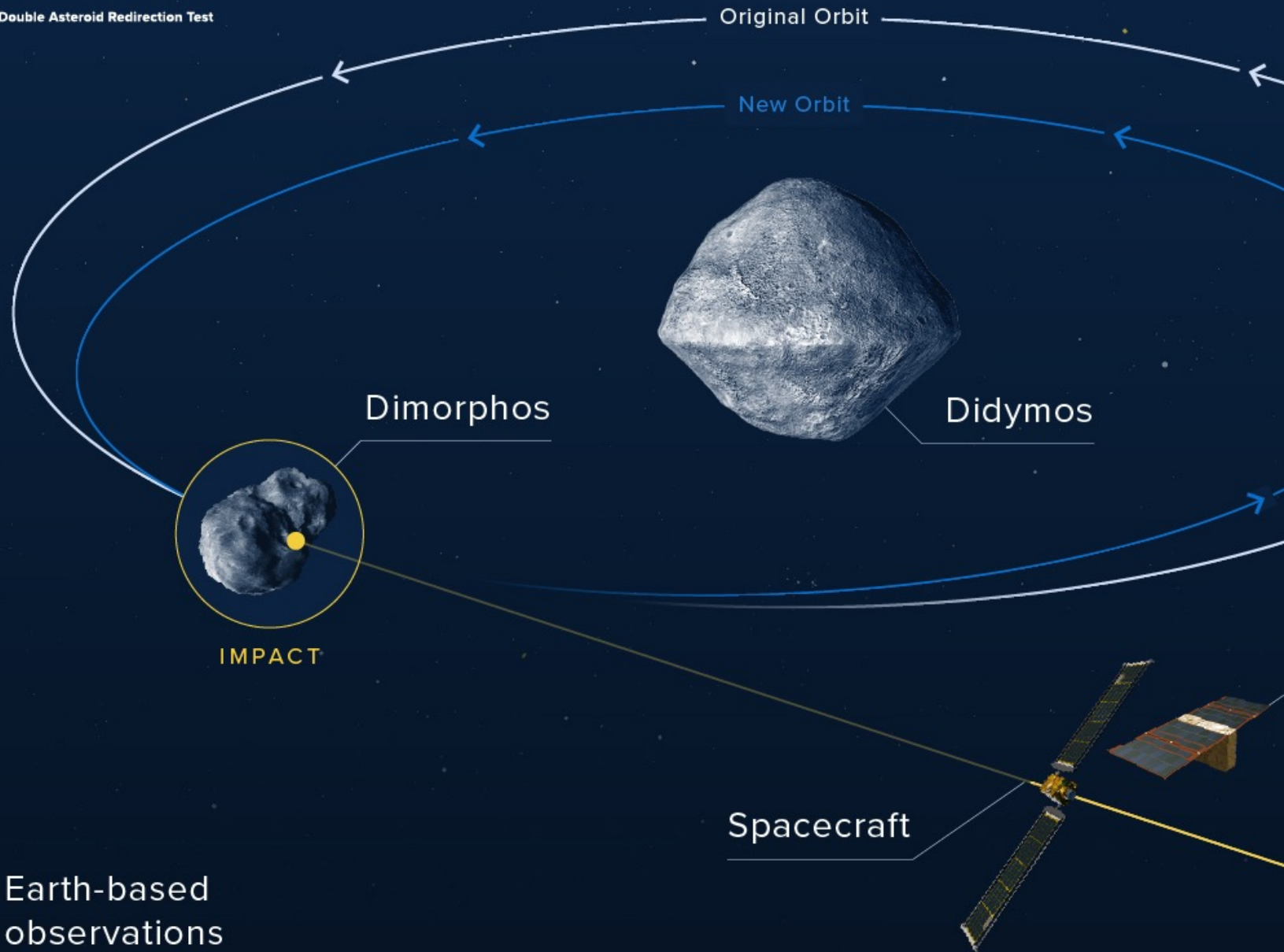
LICIACube

Spacecraft



Earth-based observations

The Ideal Target: A Natural Laboratory

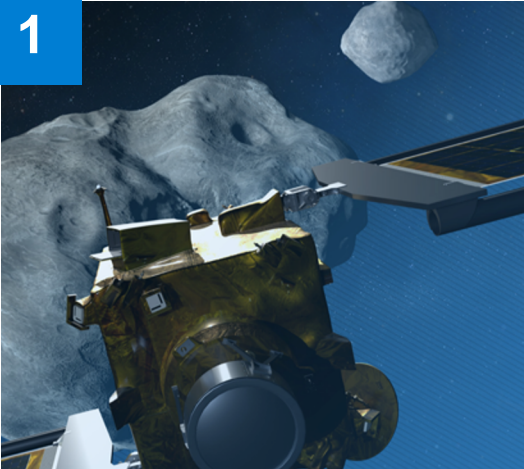


- A binary asteroid allows a **detectable deflection** of an asteroid of **relevant size**.
- DART's kinetic impact will change the orbital period **about the larger asteroid** by $\sim 1\%$.
 - Detectable in **weeks to months**.
- Same kinetic impact on a non-binary asteroid would change the orbital period **about the Sun** by $\sim 0.000006\%$.
 - Would take **many years** to detect.

DART's Level 1 Requirements

Defining the Mission's Planetary Defense Investigation

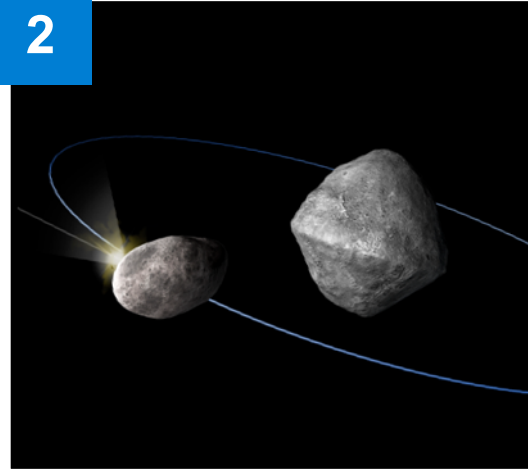
1



Impact Dimorphos

During its Sept/Oct 2022 close approach to Earth

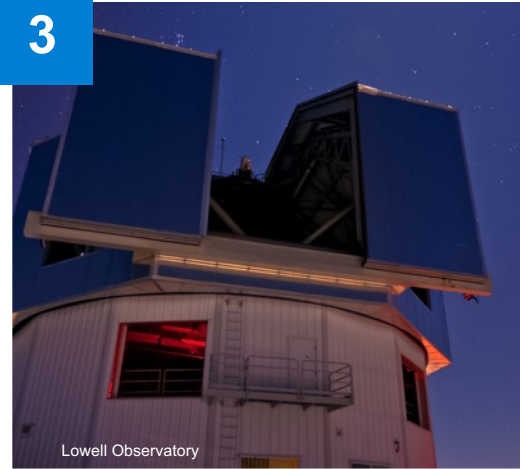
2



Change the binary orbital period

Cause a ≥ 73 -second change in the orbital period of Dimorphos

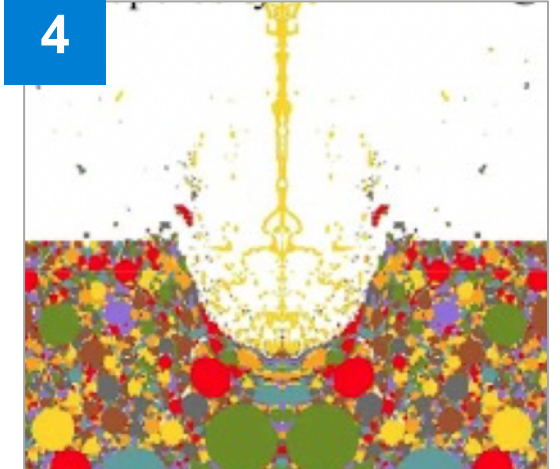
3



Measure the period change

To within 7.3 seconds, from ground-based observations before and after impact

4

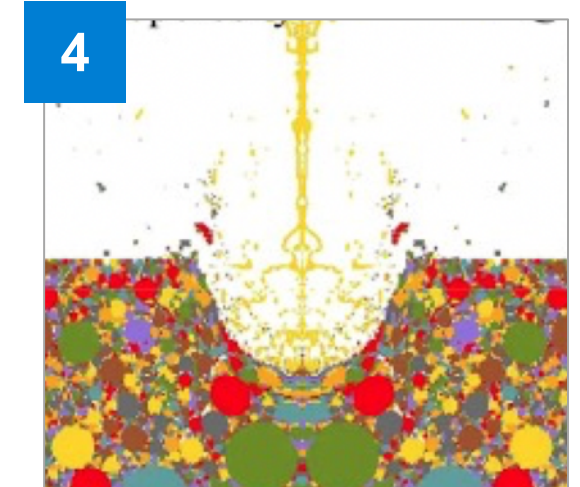
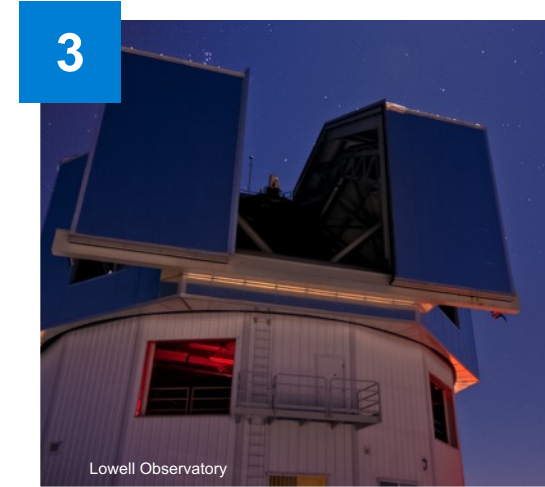
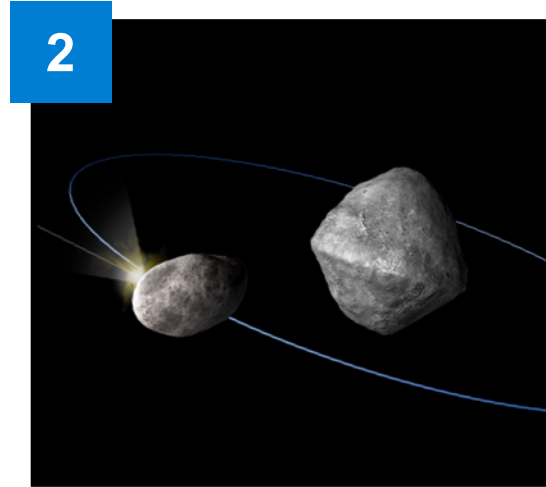


Measure "Beta" and characterize the impact site and dynamics

Beta = the momentum enhancement factor

DART's Level 1 Requirements

Defining the Mission's Planetary Defense Investigation



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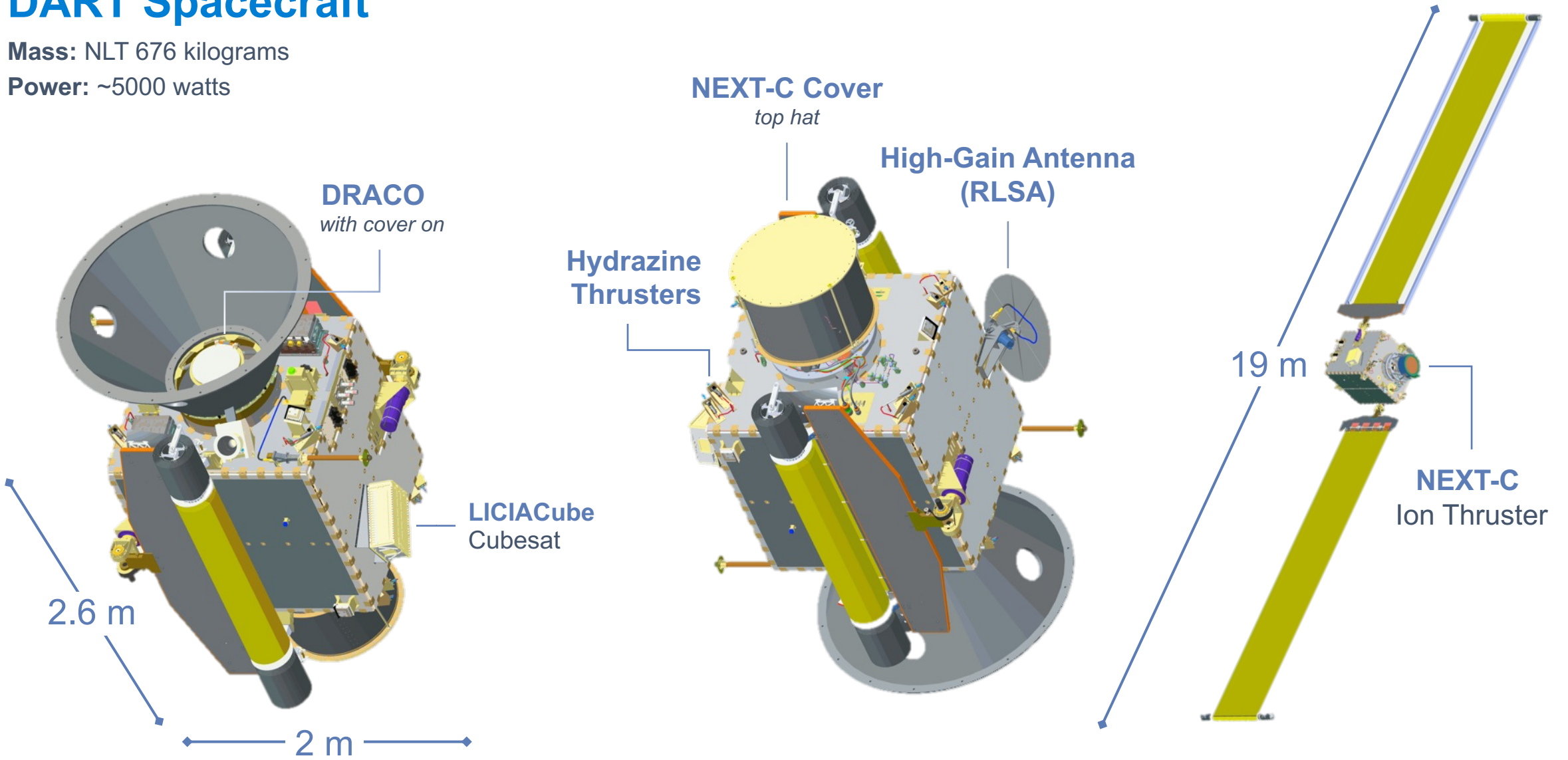
- 1. Test the ability to achieve a kinetic impact on a real asteroid**
- 2. Test how a real asteroid responds to a kinetic impact**

Test 1 ends, and Test 2 begins, at the moment of impact.

DART Spacecraft

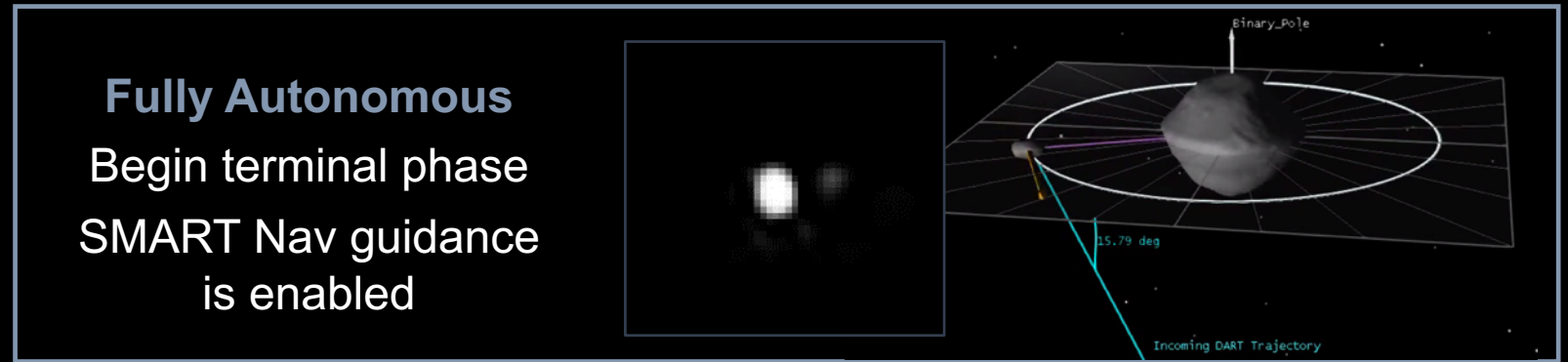
Mass: NLT 676 kilograms

Power: ~5000 watts



DART Operations

How DART targets Dimorphos



Camera detects
Didymos system

Continuous ground
antenna coverage

Begin
pre-terminal phase

30 days

10 days

8 hours

4 hours

30 days

10 days

8 hours

4 hours

60 minutes

4 minutes

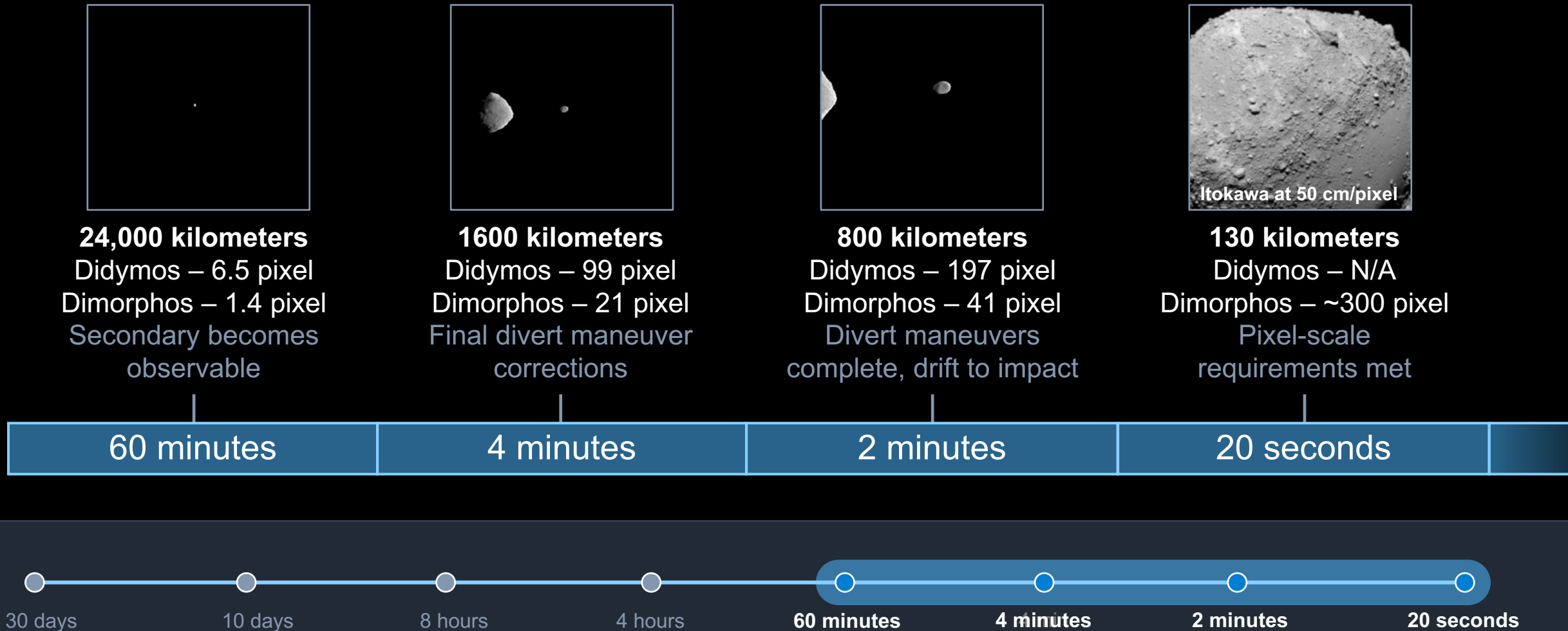
2 minutes

20 seconds



DART Operations

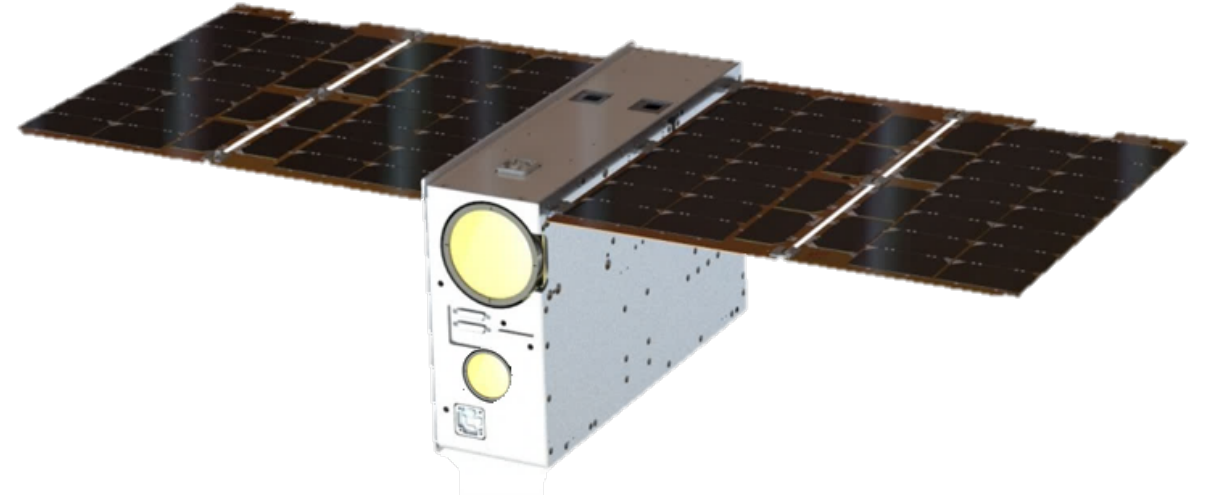
How DART targets Dimorphos



Light Italian CubeSat for Imaging of Asteroids

LICIACube Goals

1. Obtain multiple (at least three) images of the DART impact ejecta plume over a span of times and phase angles, to allow estimation of plume density structure
2. Obtain multiple (more than three) images of the DART impact site with sufficient resolution to allow measurements of impact crater size and morphology
3. Obtain multiple (at least three) images of the non-impact hemisphere of Dimorphos
4. Obtain images of the ejecta plume and of the asteroid target to characterize color and spectral variations



Capable 6U CubeSat provided by Agenzia Spaziale Italiana (ASI)

Based on Argomoon CubeSat that will be flying on EM-1 mission (first flight of SLS in 2020)

Two cameras (goal of 2 m/pixel resolution imagery)

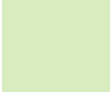



Current concept of operations includes flyby of Didymos ~3 minutes after DART impact and downlinking data after event

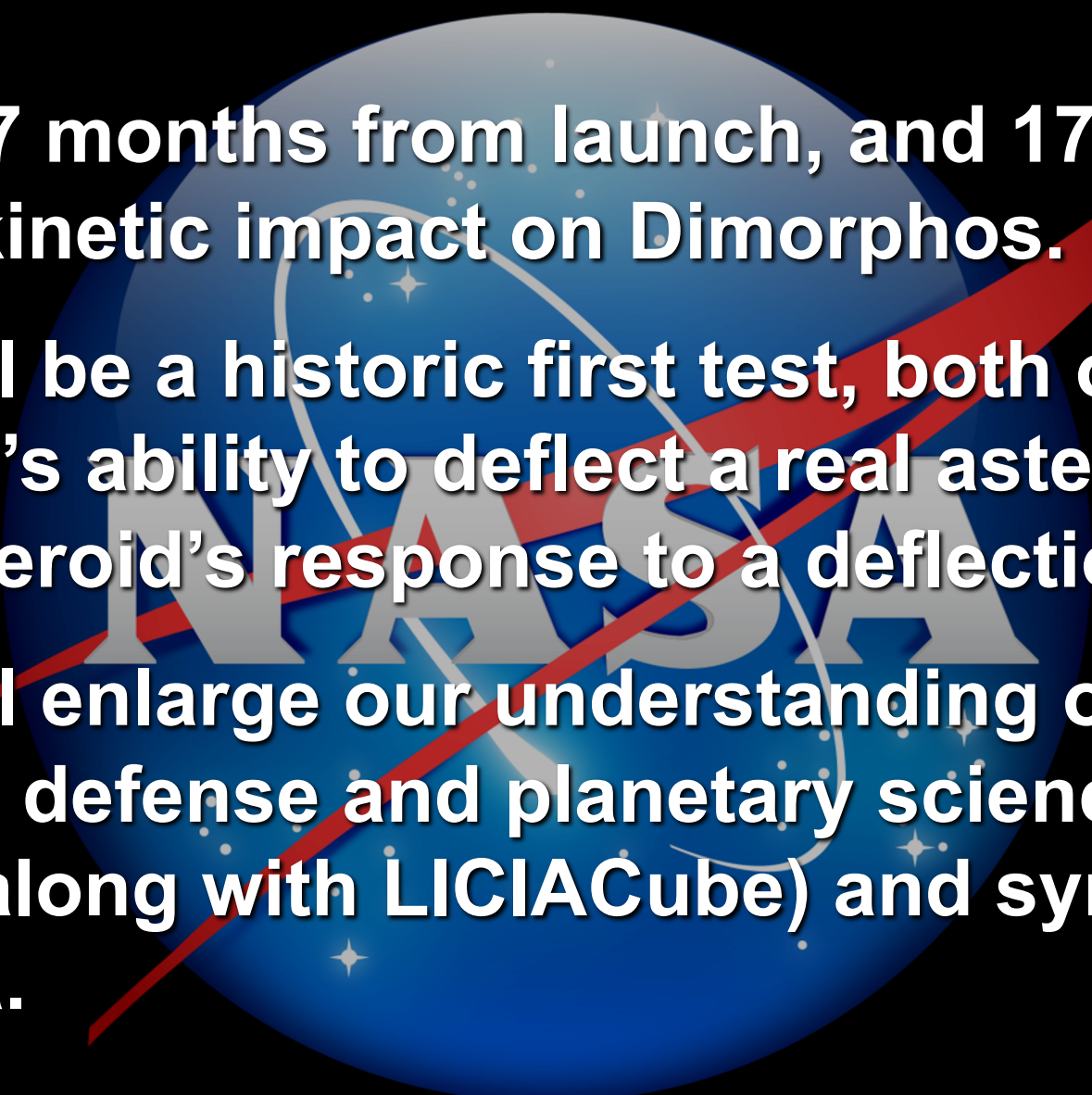
From Kinetic Impact to Beta – Looks Easy, but Isn't!

$$\beta = \frac{\frac{M}{m_{sc}} \Delta V_T - \vec{V}_{\infty \perp n} \cdot \hat{e}_T + V_{\infty n} \vec{\epsilon} \cdot \hat{e}_T}{V_{\infty n} (\hat{n} + \vec{\epsilon}) \cdot \hat{e}_T}$$

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-  Determined directly from ground-based measurement of period change
-  Known spacecraft & binary asteroid parameters
-  Constrained by DART & LICIAC imaging of Dimorphos and impact site
-  Constrained by impact simulations and LICIAC imaging of ejecta plume

- 
- The background features the NASA logo, which consists of a blue circular field with the word "NASA" in white, bold, sans-serif capital letters. A red swoosh, resembling a comet tail or a stylized "7", curves across the logo from the top right towards the bottom left. The entire graphic is set against a black background with several small white stars scattered throughout.
- **DART is 7 months from launch, and 17 months from its kinetic impact on Dimorphos.**
 - **DART will be a historic first test, both of humanity's ability to deflect a real asteroid and of a real asteroid's response to a deflection.**
 - **DART will enlarge our understanding of NEOs for planetary defense and planetary science, both on its own (along with LICIAcube) and synergistically with Hera.**