

# NASA Planetary Defense Missions

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# NASA Missions of Interest



## Planetary Science Missions to Asteroids

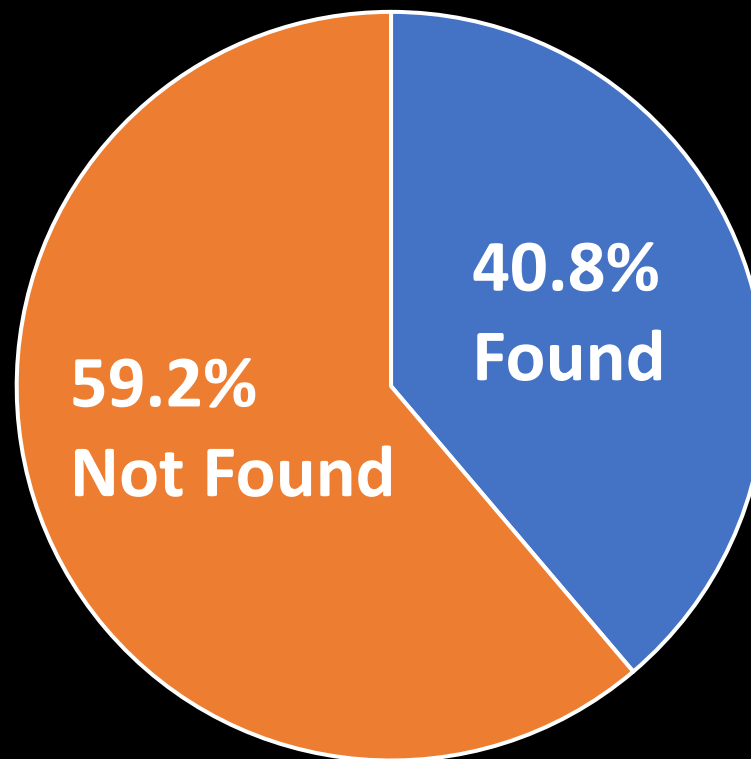
- **OSIRIS-REx – Sample Return from asteroid Bennu**
  - All nominal in cruise return to Earth – September 2023
- **Lucy – Mission to the Jupiter Trojans**
  - Successfully Launched 16 October 2021
  - Working a solar array failure to latch issue
- **Psyche – Mission to a “Metal World”**
  - Integration and test continues for August 2022 launch
- **Janus – SIMPLEx mission to two binary asteroids**
  - Integration and test continues – for now
- **NEO Scout – Destination 2020 GE**
  - Integrated onto Orion stage adapter for March 2022 launch

# Progress: 140 Meters and Larger

Total Population estimated to be ~25,000

## NEO Survey Status as of 31 Dec 2021

George E Brown  
NEO Survey Goal



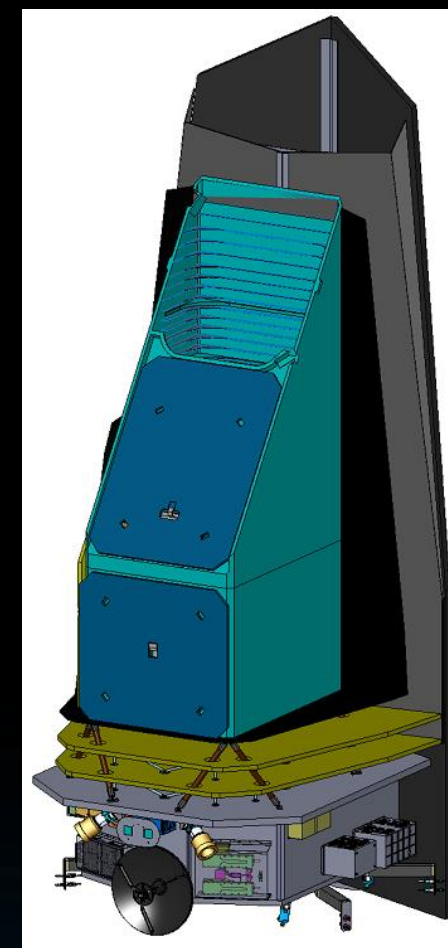
At the current assets' discovery rate, it will take more than 30 years to complete the survey.  
New capabilities in development will cut that time in half.

# NEO Surveillance Mission

## Objectives:

- Find 65% of undiscovered Potentially Hazardous Asteroids (PHAs) >140 m in 5 years (goal: >90% in 10 years)
- Estimate sizes directly from IR signatures
- Compute cumulative chance of impact over next century for PHAs >50 m and for comets
- Deliver new tracklet data daily to the Minor Planet Center
- **On track for PDR and KDP-C “Confirmation” Fall 2022**
- **President’s Budget Request for FY22, if enacted, would fully fund the Phase B project development**
- **Planned Launch Readiness Date in early 2026**

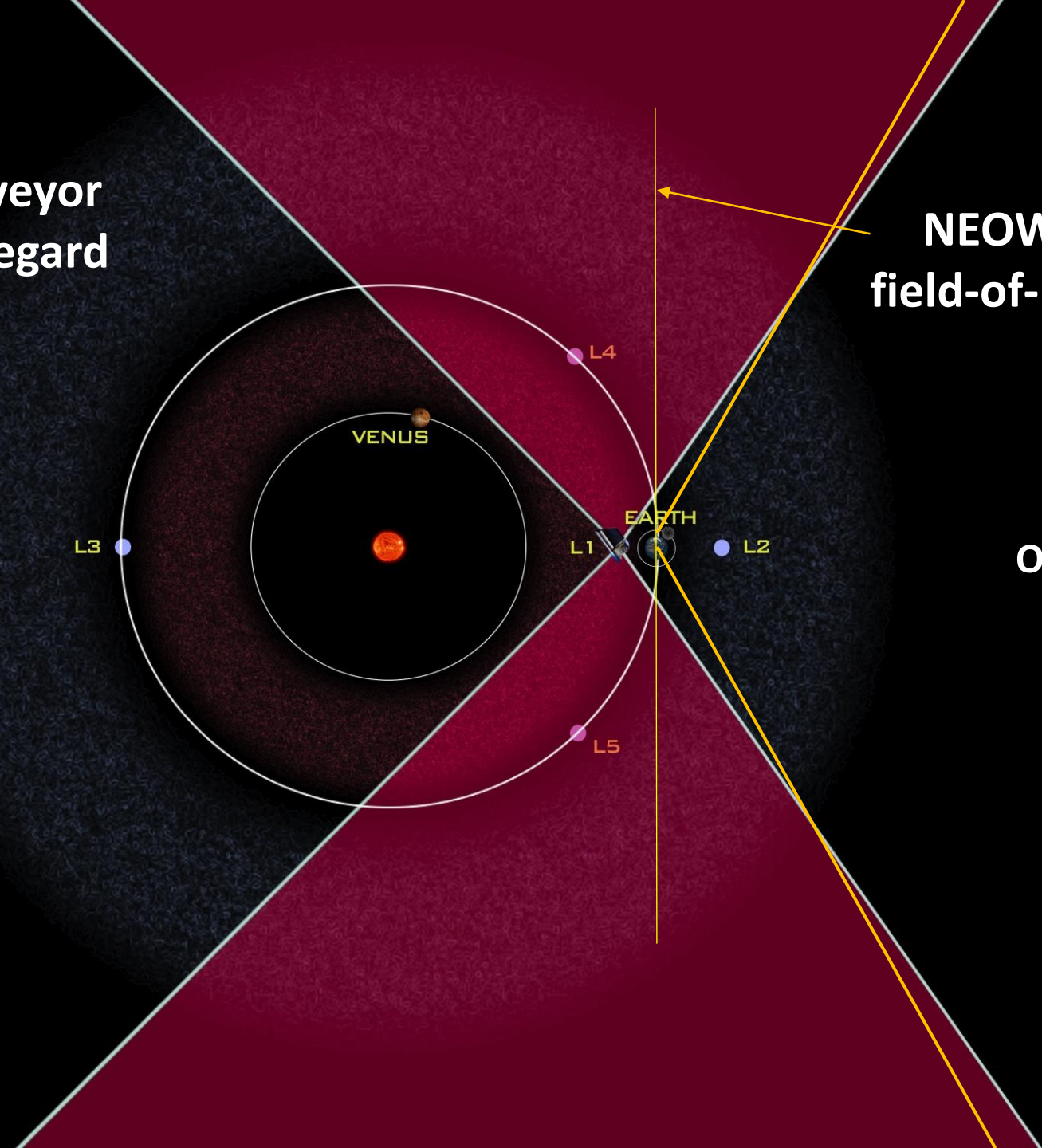
NEO Surveyor  
Space-based IR  
Observatory



**NEO Surveyor  
field-of-regard**

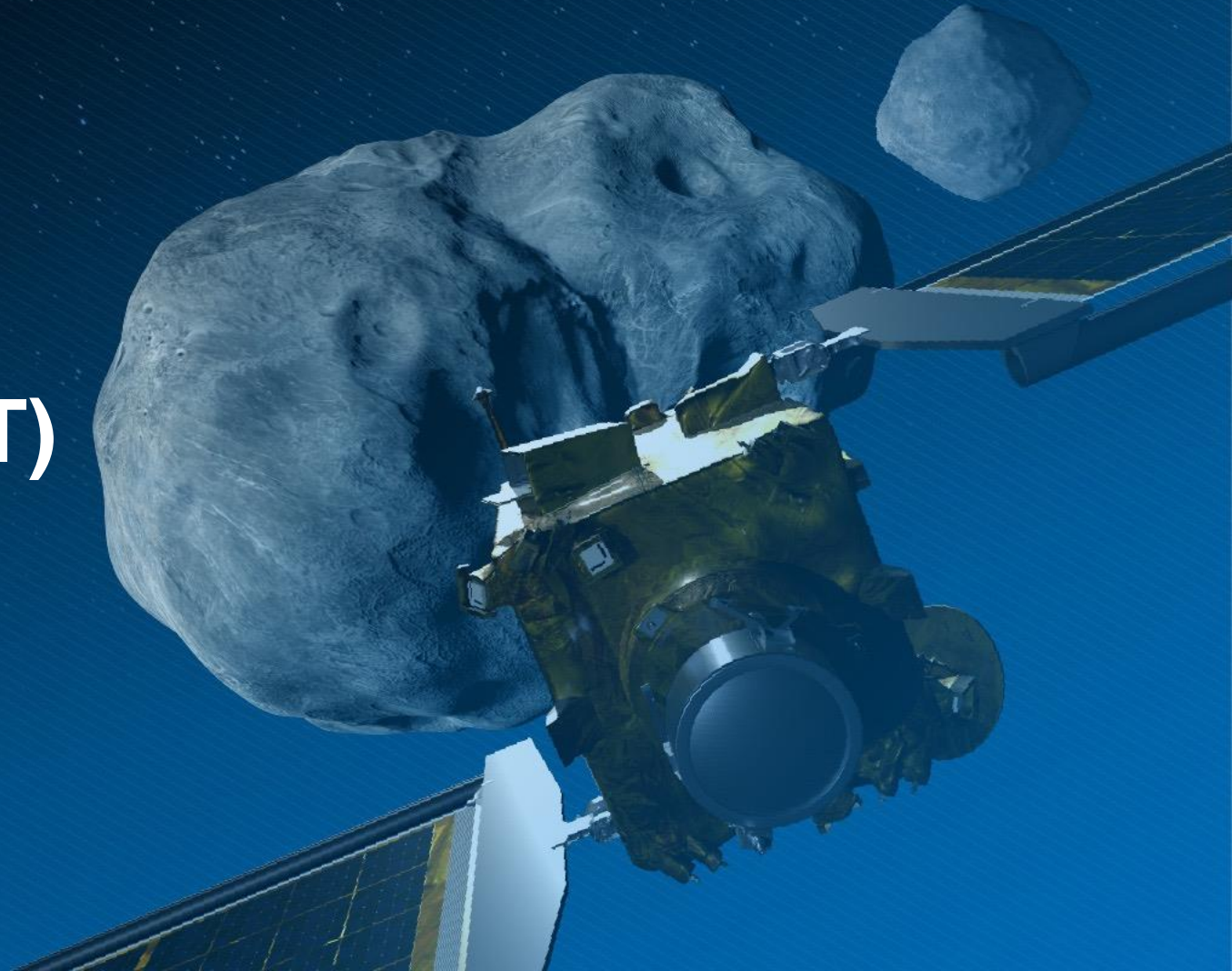
**NEOWISE  
field-of-regard**

**Area at  
Opposition**





# Double Asteroid Redirection Test (DART)



# PLANETARY DEFENSE



## ASSESS

[CENTER FOR NEAR EARTH OBJECT STUDIES]



## SEARCH, DETECT & TRACK

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



## CHARACTERIZE

[NEOWISE, GOLDSTONE, IRTF]



## PLAN & COORDINATE

[SMPAG, PIERWG, NITEP IWG]



## MITIGATE

[DART, FEMA EXERCISES]



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



# Launched on Nov. 24 EST

SpaceX Falcon 9  
Vandenberg Space Force Base, CA

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

**IMPACT: 26 Sep 2022**

**LICIACube**  
(Light Italian Cubesat  
for Imaging of  
Asteroids)  
Italian Space Agency  
contribution

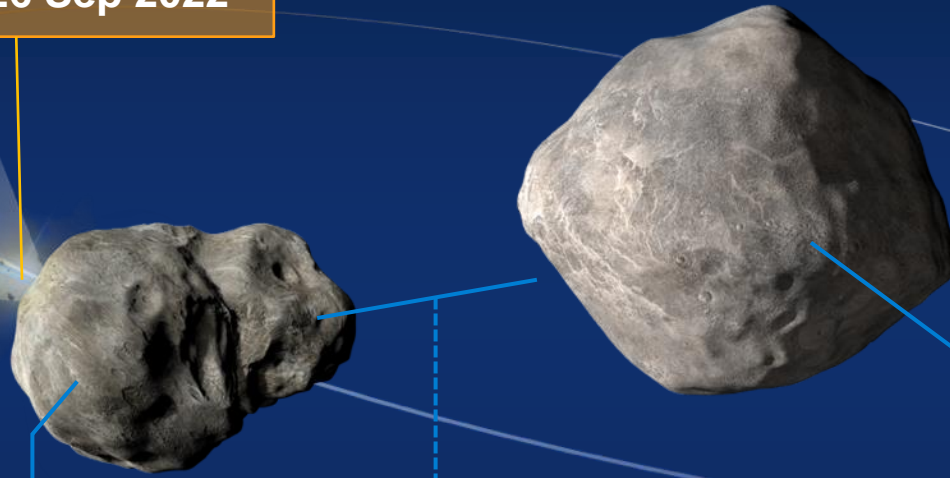
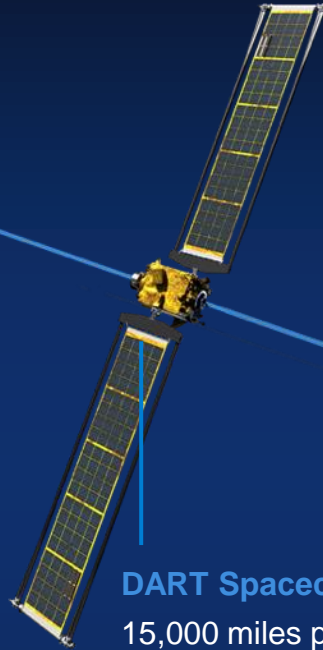
**DART Spacecraft**  
15,000 miles per hour

**Dimorphos**  
160 meters  
11.92-hour orbital period

1,180-meter separation  
between centers

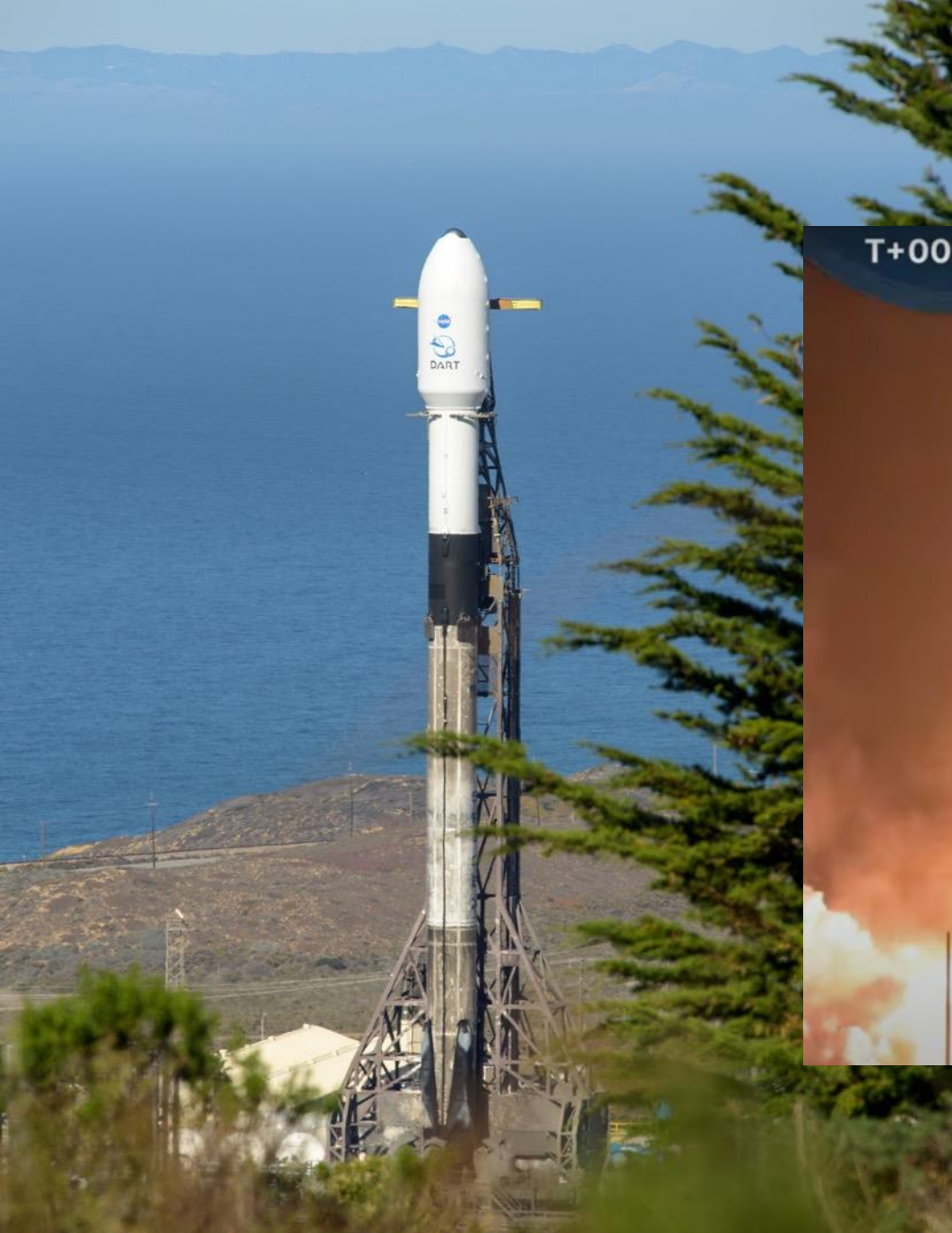
**Didymos**  
780 meters

**Earth-Based Observations**  
6.8 million miles (0.07 AU) from  
Earth at DART impact





# DART Launch – November 23, 2021 PST (Nov. 24 EST) Vandenberg Space Force Base, California



T+00:00:04



T+ 00:55:46



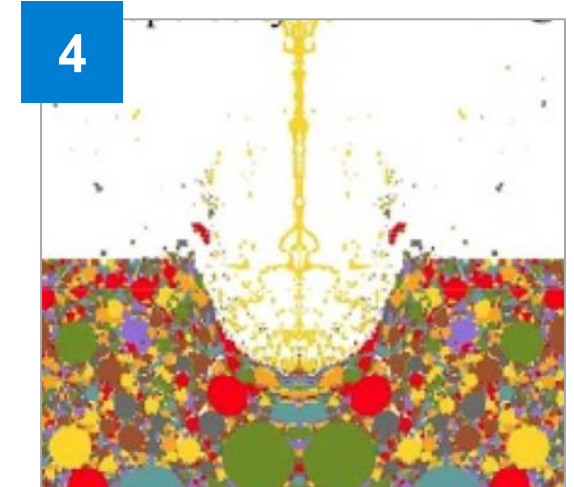
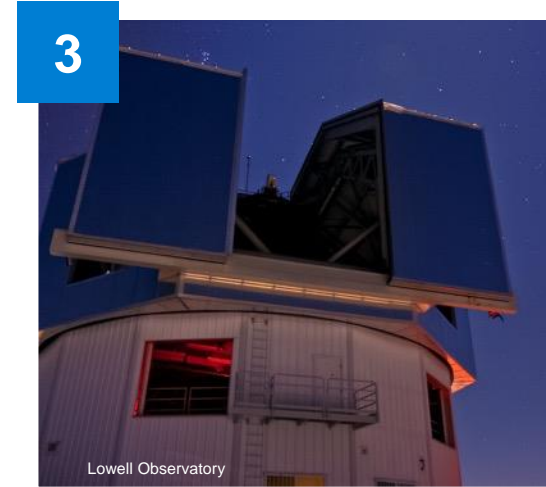
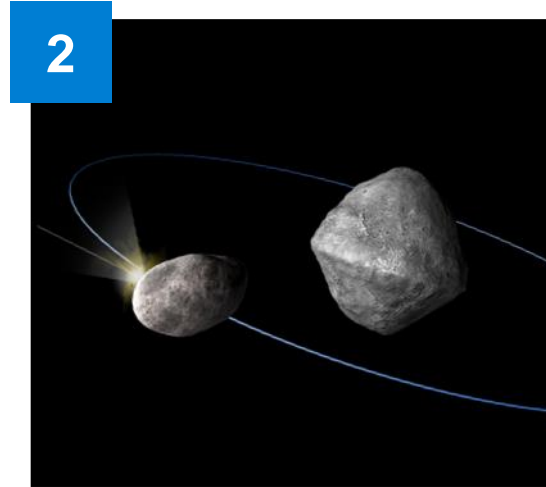
LIVE

T+ 00:55:52



# DART's Level 1 Requirements

Defining the Mission's Planetary Defense Investigation



## Impact Dimorphos

During its Sept/Oct 2022 close approach to Earth

## Change the binary orbital period

Cause a  $\geq 73$ -second change in the orbital period of Dimorphos

## Measure the period change

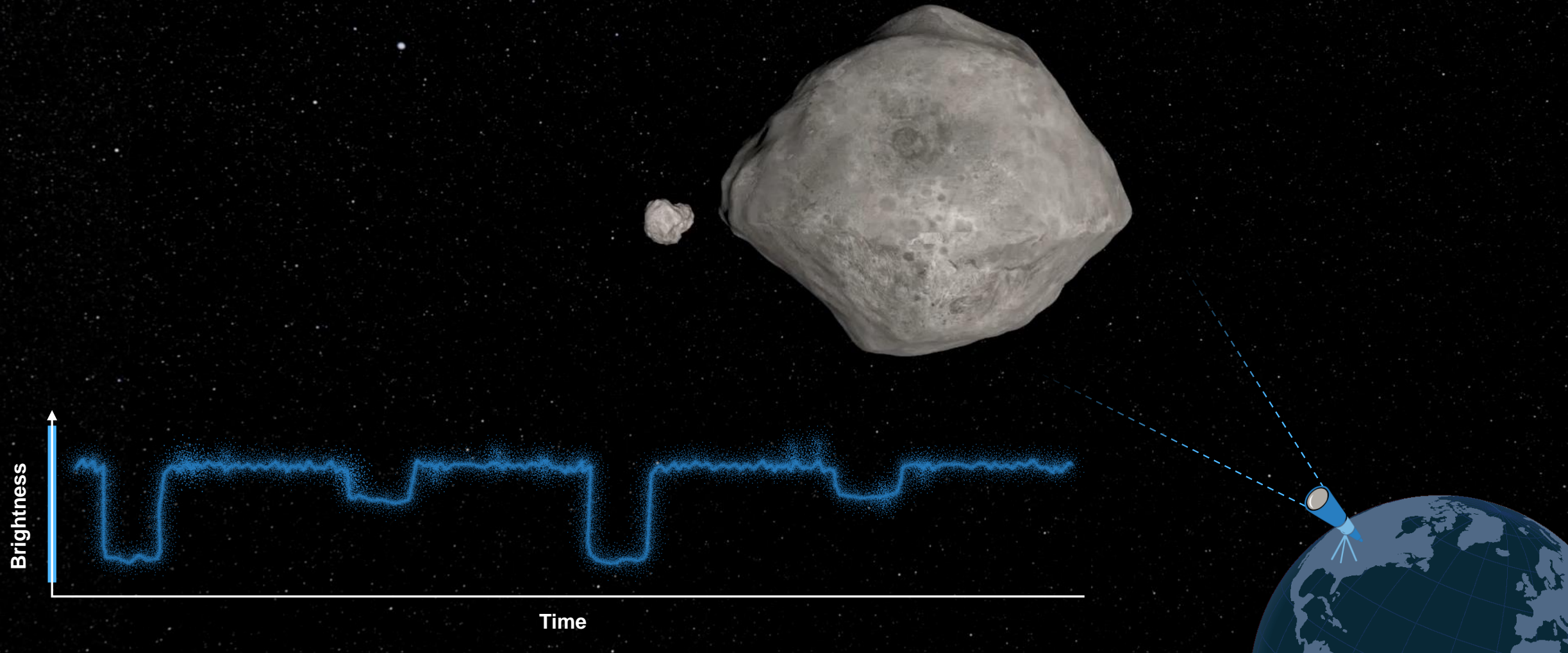
To within 7.3 seconds, from ground-based observations before and after impact

## Measure "Beta" and characterize the impact site and dynamics

*Beta* = the momentum enhancement factor



# Measuring result of the impact from Earth: new orbit for Dimorphos



# Plan for Pre-Impact and Post-Impact Observations

- Plan will begin observations during 22 Jun—6 July 2022 dark time, end during 15—28 March 2023 dark time
- 1. Contracted Observatories to obtain required data
  - Lowell Observatory
  - Magdalena Ridge Observatory
  - Las Cumbres Global Observatory Network
  - Las Campanas Observatory
- 2. Competed time already successfully in hand
  - JWST, HST, Goldstone planetary radar
- 3. To-be competed time via proposals
  - US and non-US facilities
- 4. Telescopes operated by team members
  - Mt. John (New Zealand), a few others
- Observatory schedules typically not formally set until a few weeks prior to observations, but planning to observe near new moon each month



Sites of contracted/participating ground-based telescopes

**Combined Observation plans provide assurance that required data will be obtained, some margin in case of bad weather/equipment issues, flexibility as needed**

