NASA Update to SMPAG

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NASA's Planetary Defense Officer

Planetary Defense Coordination Office
Planetary Science Division
NASA Headquarters
Washington, DC

09 February 2023

Planetary Defense Coordination Office

The Planetary Defense Coordination Office (PDCO) was established in January 2016 at NASA HQ to manage planetary defense related activities across NASA, and coordinate with both U.S. interagency and international efforts to study and plan response to the asteroid impact hazard.

Mission Statement

Lead national and international efforts to:

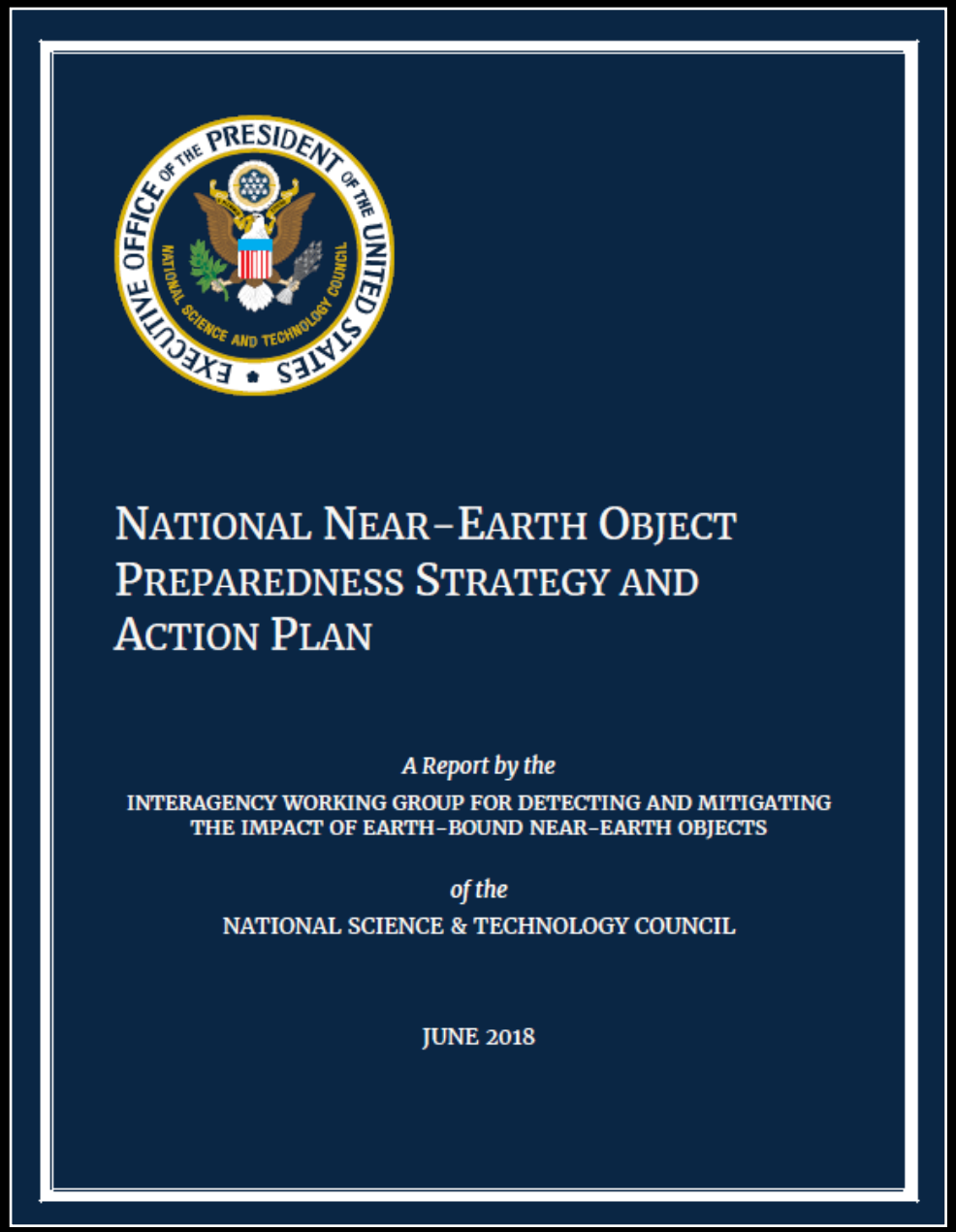
- Detect any potential for significant impact of planet Earth by natural objects
- Appraise the range of potential effects by any possible impact
- Develop strategies to mitigate impact effects on human welfare


IAU
Minor Planet Center
ASSESS
[CENTER FOR NEAR EARTH OBJECT STUDIES]
SEARCH, DETECT & TRACK
[SPACE-BASED & GROUND-BASED OBSERVATIONS, IAWN]
PLANETARY
DEFENSE
MITIGATE
[DART, FEMA EXERCISES]
CHARACTERIZE
[NEOWISE, GOLDSTONE, IRTF]
PLAN &
COORDINATE
[SMPAG, PIERWG, NITEP IWG]

PLANETARY DEFENSE COORDINATION OFFICE

NASA

An OSTP-led Planetary Defense Interagency Working Group is assessing progress on the actions in the 2018 plan and preparing to make updates.



https://www.nasa.gov/sites/default/files/atoms/files/ostp-neo-strategy-action-plan-jun18.pdf

National NEO Preparedness Strategy and Action Plan

Goals in the 10-year Action Plan

- Enhance NEO detection, characterization, and tracking capabilities
- Improve modeling, predictions, and information integration
- Develop technologies for NEO deflection and disruption
- Increase international cooperation on NEO preparation
- Establish NEO impact emergency procedures and action protocols

NEOWISE

NASA-funded Near-Earth Object Survey (Discovery) Telescopes

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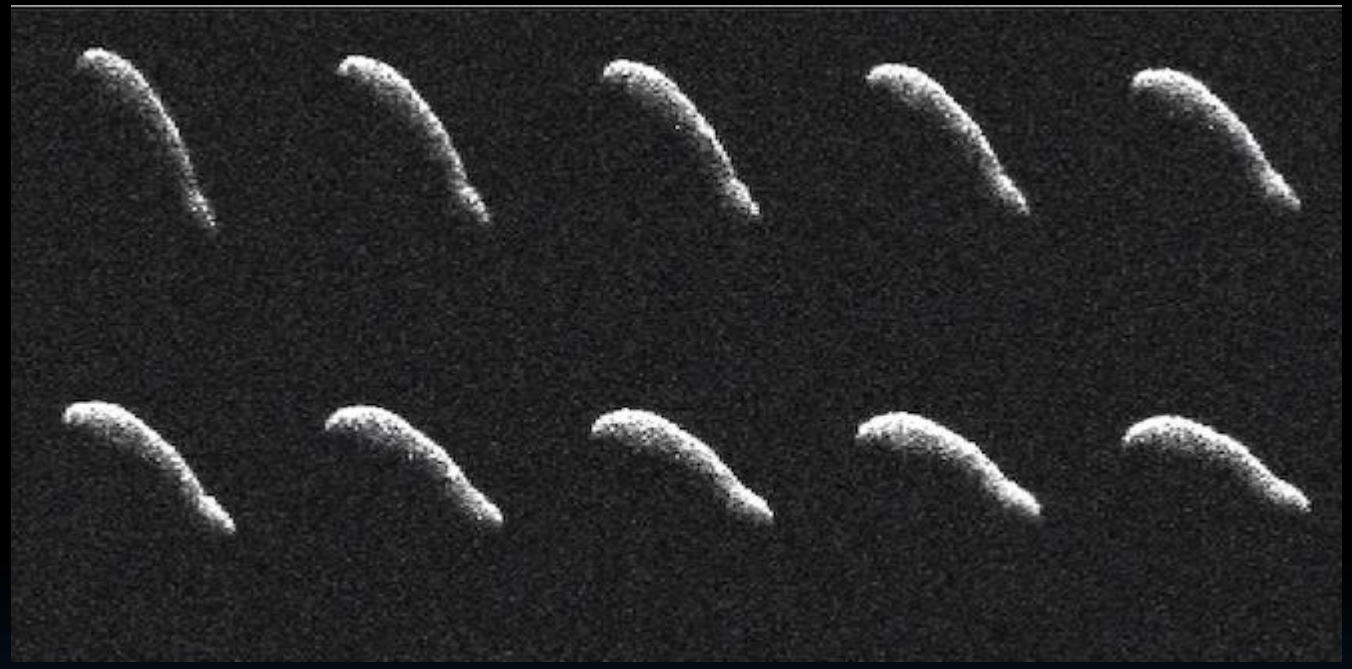
NASA's NEO Characterization Assets

Goldstone Solar System Radar

450 kW operations

An US interagency study on future needs and capabilities for deep space radar is underway, led by NSF with NASA and other agency participation

Goldstone Solar System Radar observations of (367789) 2011 AG5 on Feb. 4, 2023



NASA/JPL/Benner

Known Asteroid Close Approaches to Earth During 2022

123 known close approaches within 1 Lunar Distance

- 1 estimated to be as large as 53 meters in size (Tunguska)
- 21 could be as large as the Chelyabinsk object

10 close approaches within the distance of the geosynchronous satellites, all less than 10 meters in size

2 warned small impactors

All close-approach data available at https://cneos.jpl.nasa.gov/ca

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Known Asteroid Close Approaches to Earth So Far in 2023

10 known close approaches within 1 Lunar Distance

- 2 could be as large as the Chelyabinsk object

2 close approaches within the distance of the geosynchronous satellites, all less than 10 meters in size

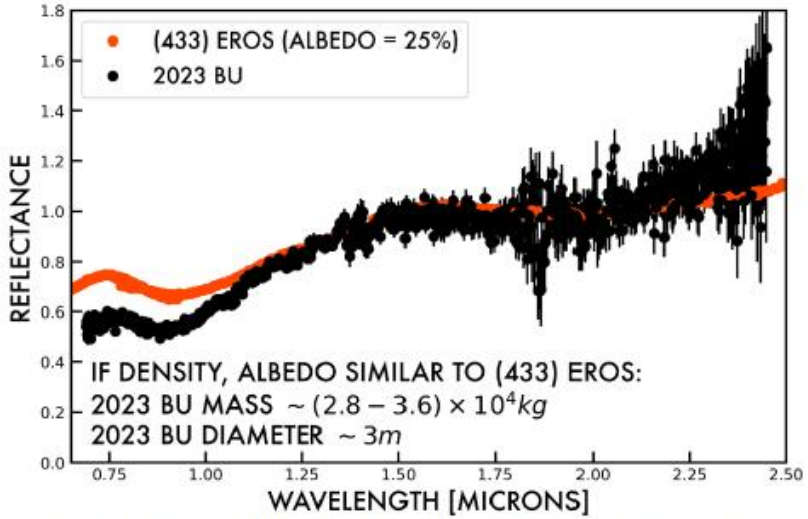
- Notably 2023 BU

All close-approach data available at https://cneos.jpl.nasa.gov/ca

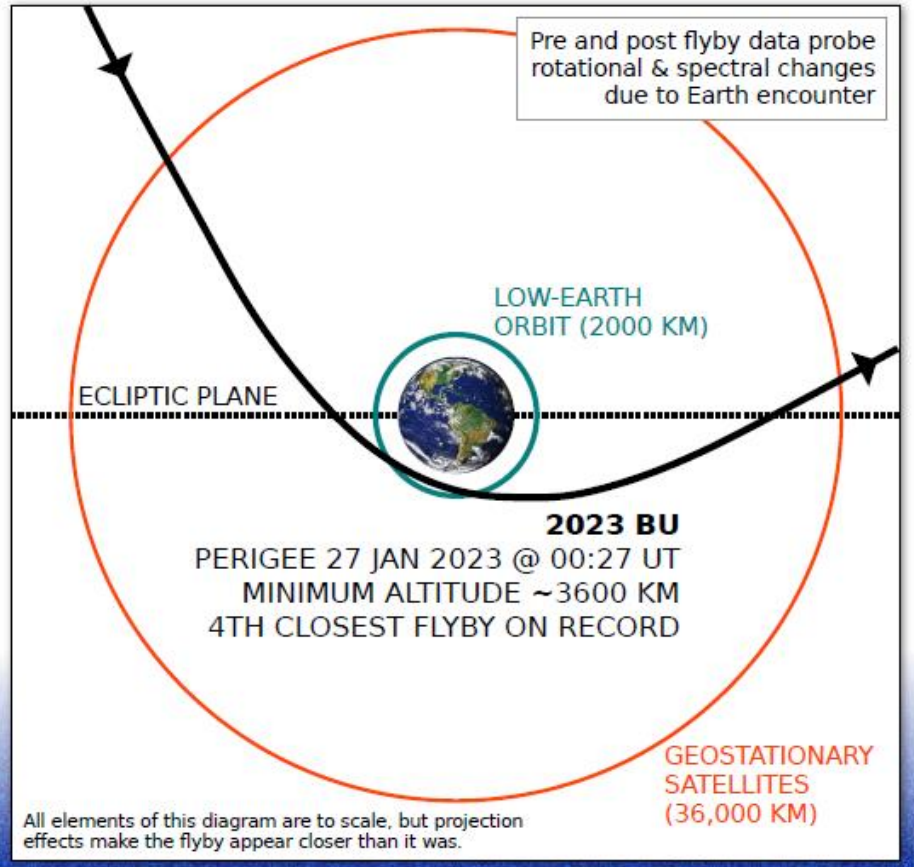
Coordinated ToO Response to the Near-Earth Flyby of Asteroid 2023 BU

N. Moskovitz, T. Kareta, B. Burt (Lowell Obs.)
M. Devogèle (Arecibo), D. Farnocchia (JPL), P. Veres (MPC)
B. Bus (IfA), D. Polishook (Weizmann Inst.), R. Binzel (MIT)

NASA's 3.2-m INFRARED TELESCOPE FACILITY (IRTF)
25 JAN 2023
SpeX data inform taxonomy, albedo, composition

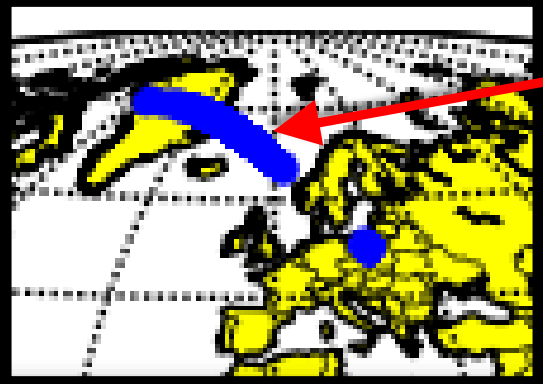


- Targeting possible thanks to timely orbit updates @ MPC & JPL
- Possible compositional link to asteroids like 433 Eros and ordinary chondrite meteorites



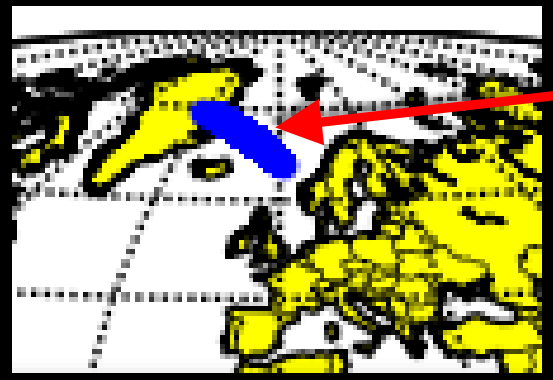
Impact of small asteroid 2022 EB5 - March 11, 2022

Evolution of CNEOS impact solutions



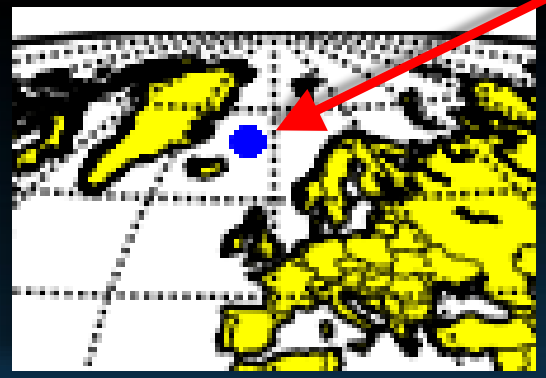
Impact minus 56 min

Potential impact locations from 14 observations of the asteroid over 33 minutes as reported to the Minor Planet Center



Impact minus 36 min

…from 20 observations over 40 min

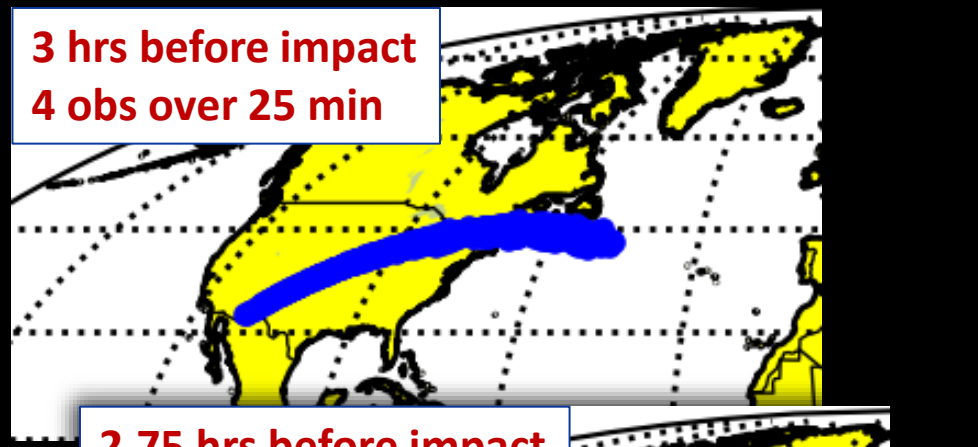


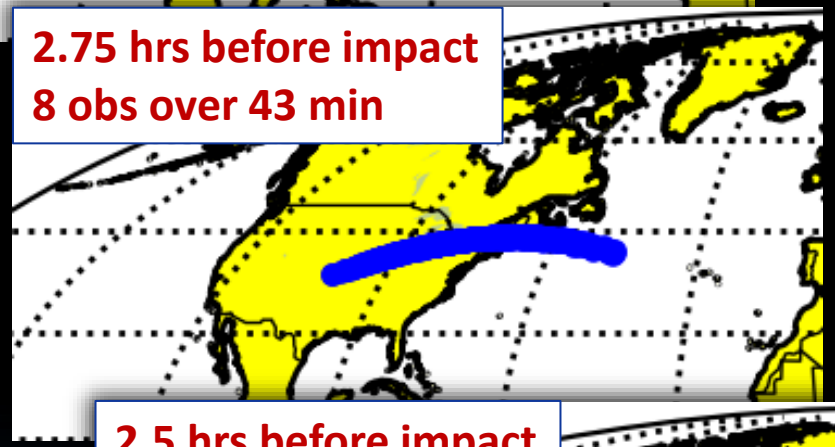
Impact minus 18 min

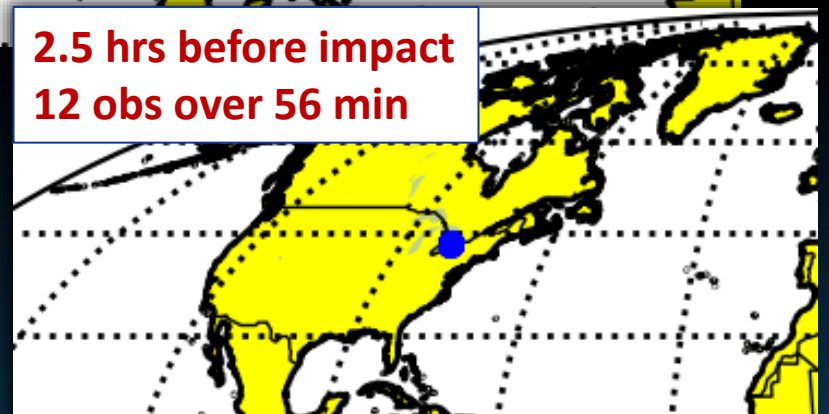
…from 33 observations over 65 min

Observation arc now long enough for CNEOS to precisely identify impact location

2022 WJ1 - Warned Impact on Nov. 19, 2022, 08:27 UTC (3:27 AM EST)



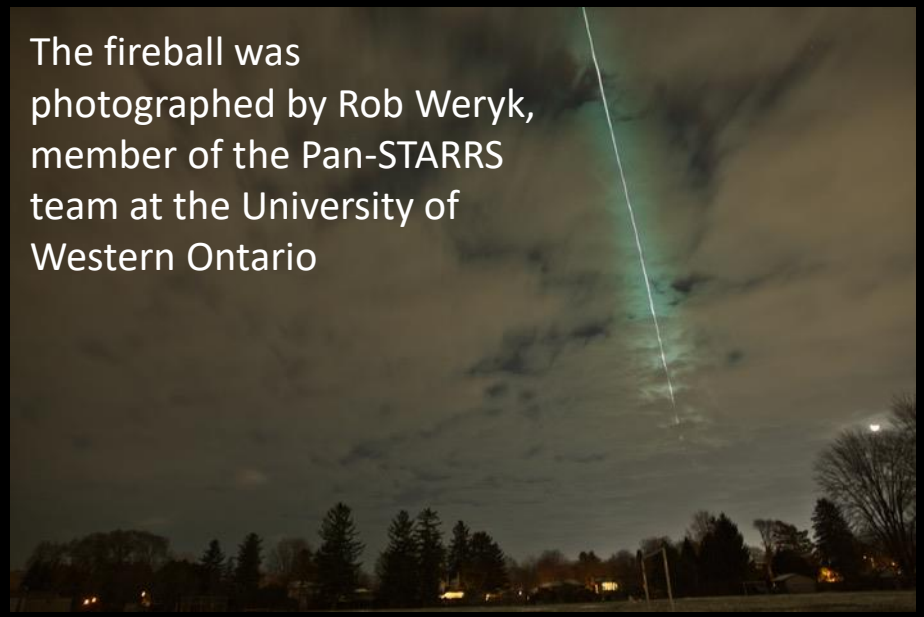




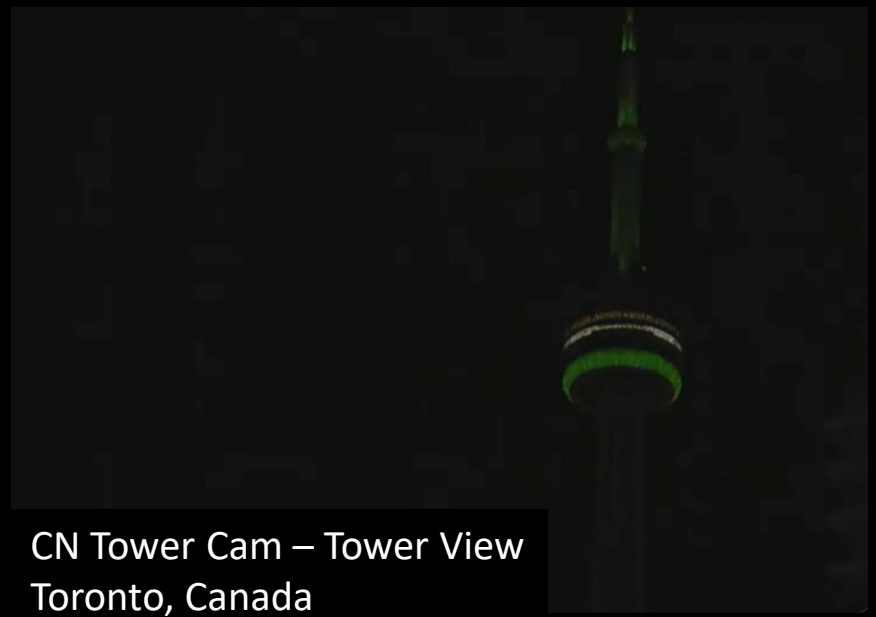
- First observed by the **Catalina Sky Survey**
- Placed on the NEO Confirmation Page by the **Minor Planet Center**
- Impact probability and corridor calculated within minutes by the **Center for Near-Earth Object Studies (CNEOS) Scout** system.
- Additional observations by the Catalina Sky Survey and **Farpoint Observatory, Northeast Kansas Amateur Astronomers' League** allowed Scout to narrow the impact location to Southern Ontario, Canada
- Observations by the community continued and ground observers were notified

https://www.nasa.gov/feature/jpl/nasa-program-predicted-impact-of-small-asteroid-over-ontario-canada

2022 WJ1 - Warned Impact on Nov. 19, 2022, 08:27 UTC (3:27 AM EST)

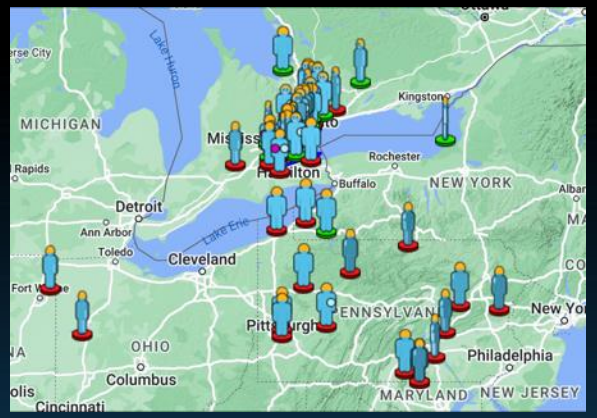


The fireball was photographed by Rob Weryk, member of the Pan-STARRS team at the University of Western Ontario



CN Tower Cam – Tower View
Toronto, Canada

University of Western Ontario
All-Sky Camera Network



Over 50 witness reports on the American Meteor Society website
https://fireball.amsmeteors.org/members/imo_view/event/2022/8984

https://www.nasa.gov/feature/jpl/nasa-program-predicted-impact-of-small-asteroid-over-ontario-canada

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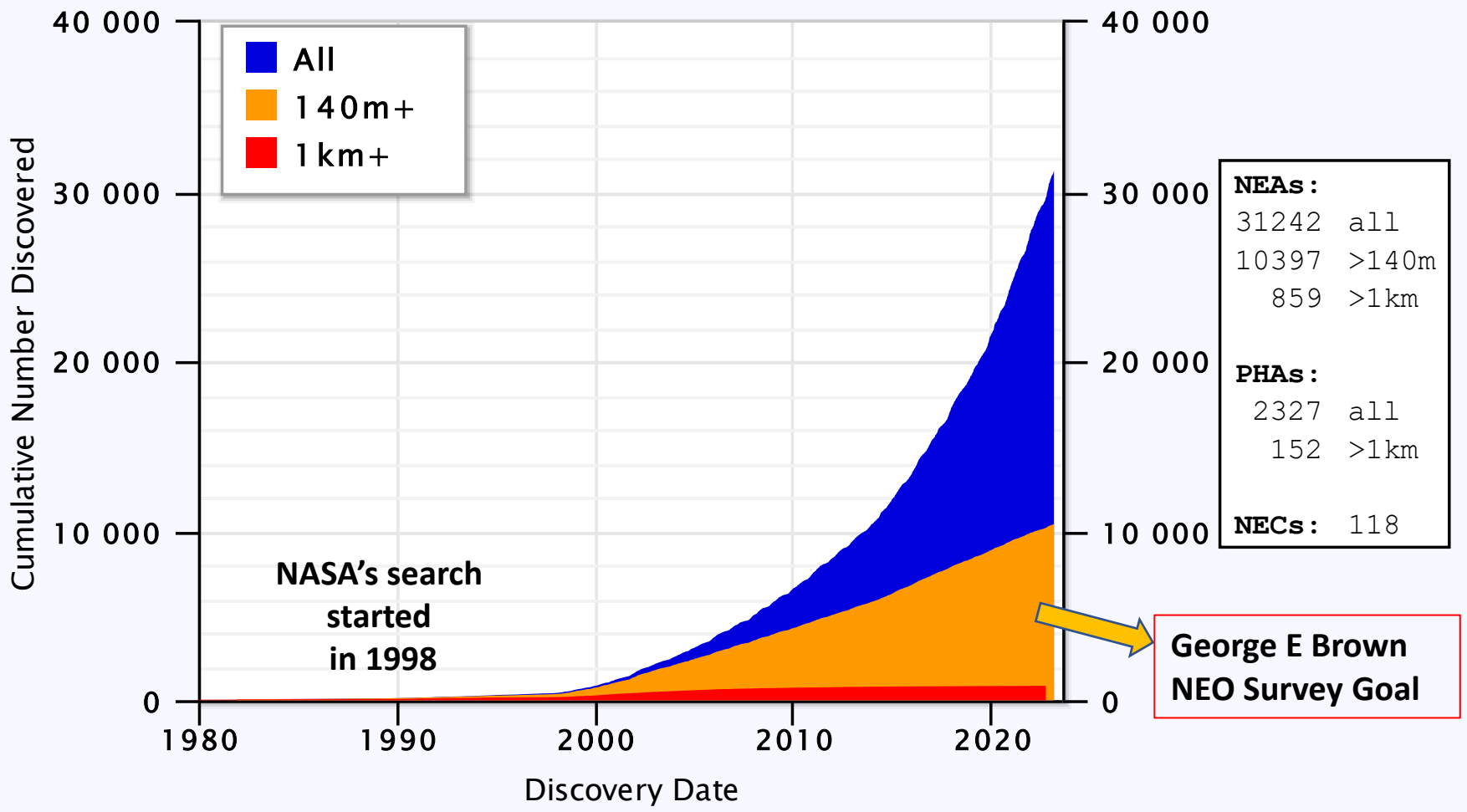
Near-Earth Asteroids Discovered

Most recent discovery: *2023-Feb-02*



https://cneos.jpl.nasa.gov/stats/

Alan Chamberlin (JPL/Caltech)

**Potentially Hazardous Asteroids come within 7.5 million km of Earth orbit*

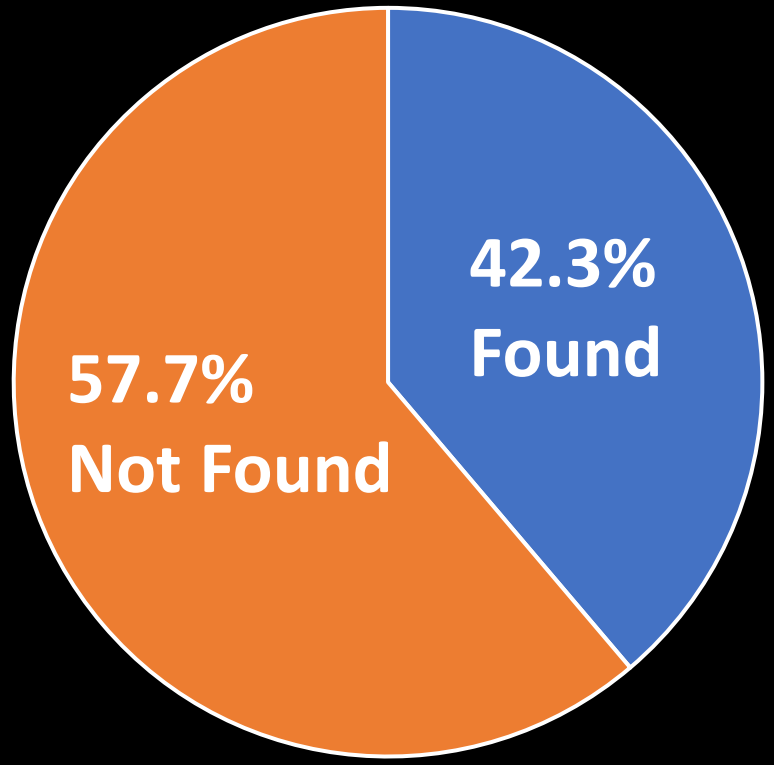
Progress: 140 Meters and Larger

Total Population estimated to be ~25,000

NEO Survey Status as of 31 Dec 2022

George E Brown NEO Survey Goal: (tasked in 2005)

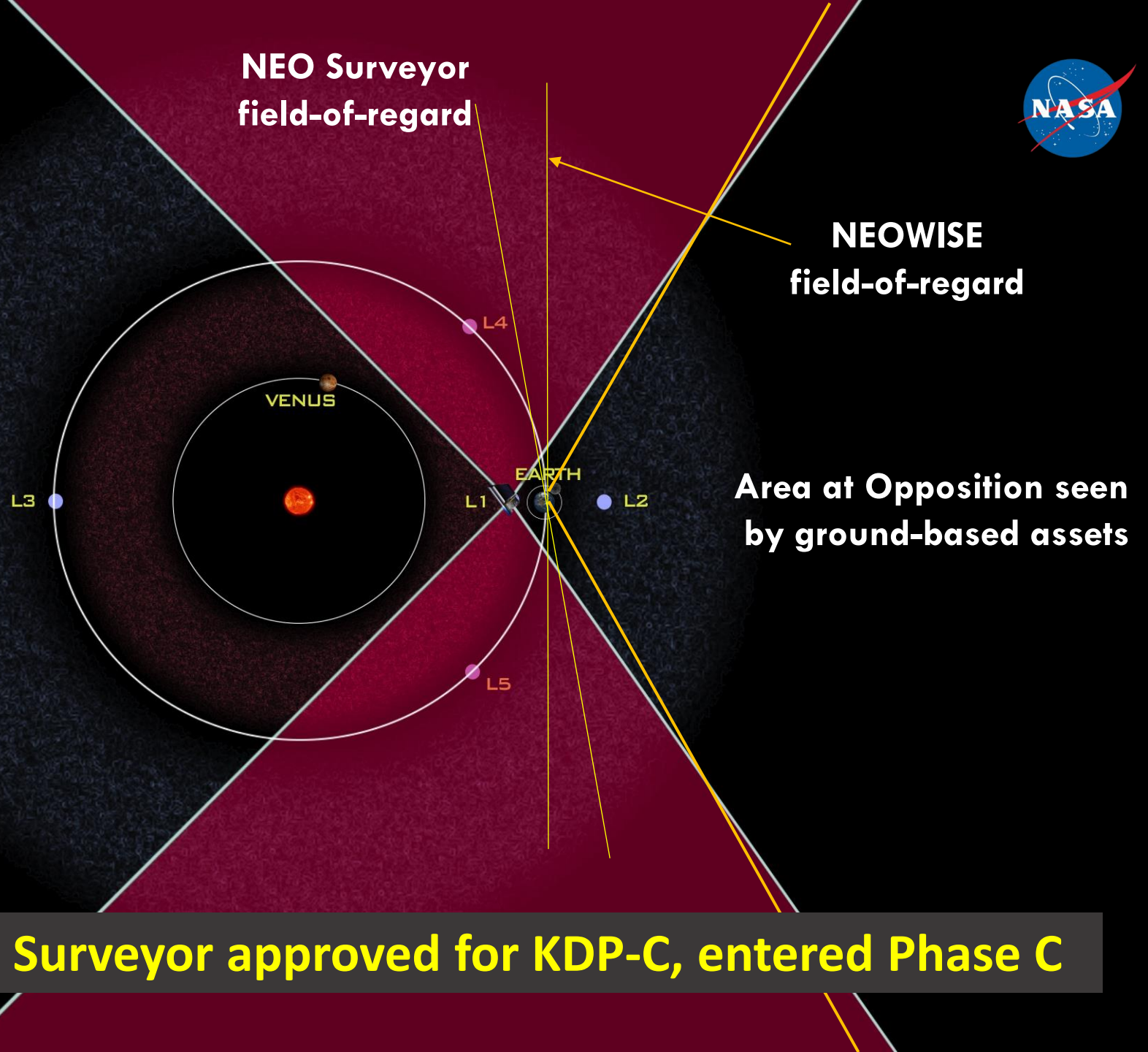
Find at least 90% of NEOs 140 meter and larger within 15 years



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

NEO Surveyor

- Space-based infra-red telescope
- Objectives:
  - Find 65% of Potentially Hazardous Asteroids (PHAs) >140 m in 5 years (>90% in 10 years)
  - Estimate object sizes



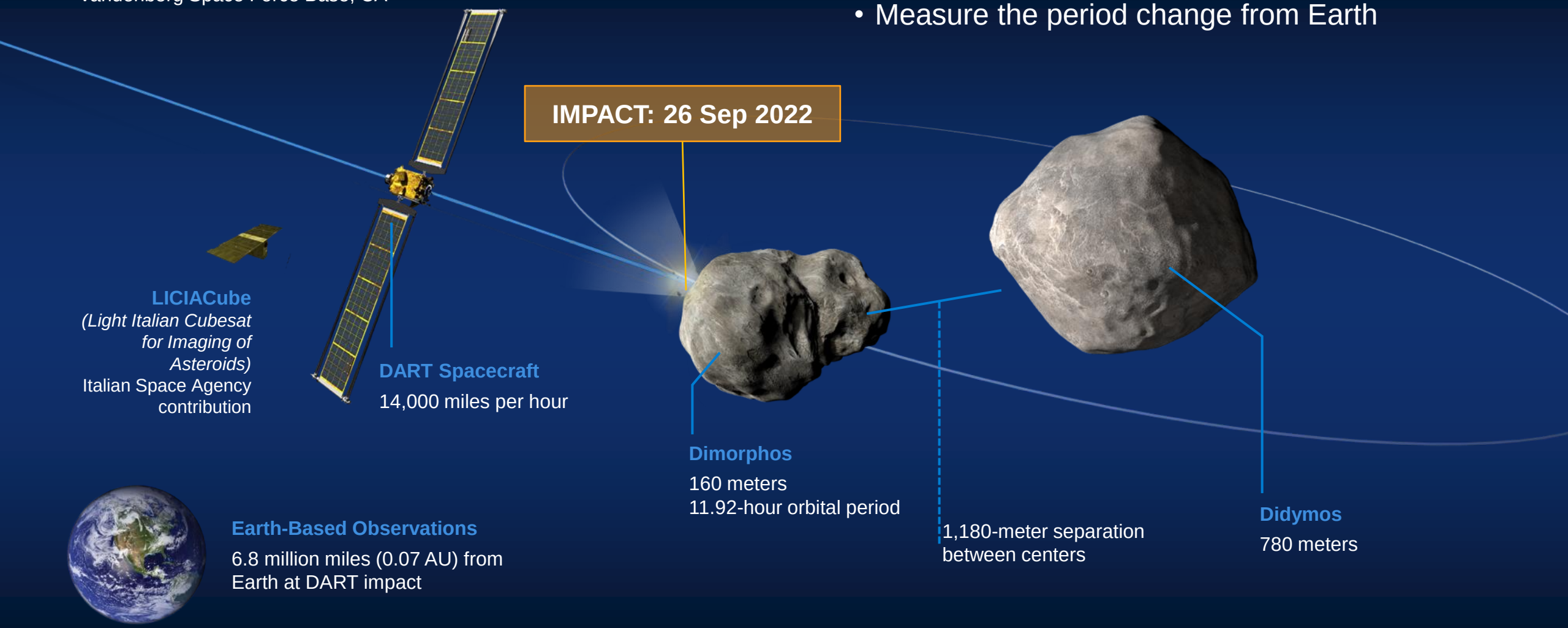
11/29/2022 – NEO Surveyor approved for KDP-C, entered Phase C

Launched on Nov. 24 EST

SpaceX Falcon 9
Vandenberg Space Force Base, CA

DART Mission:

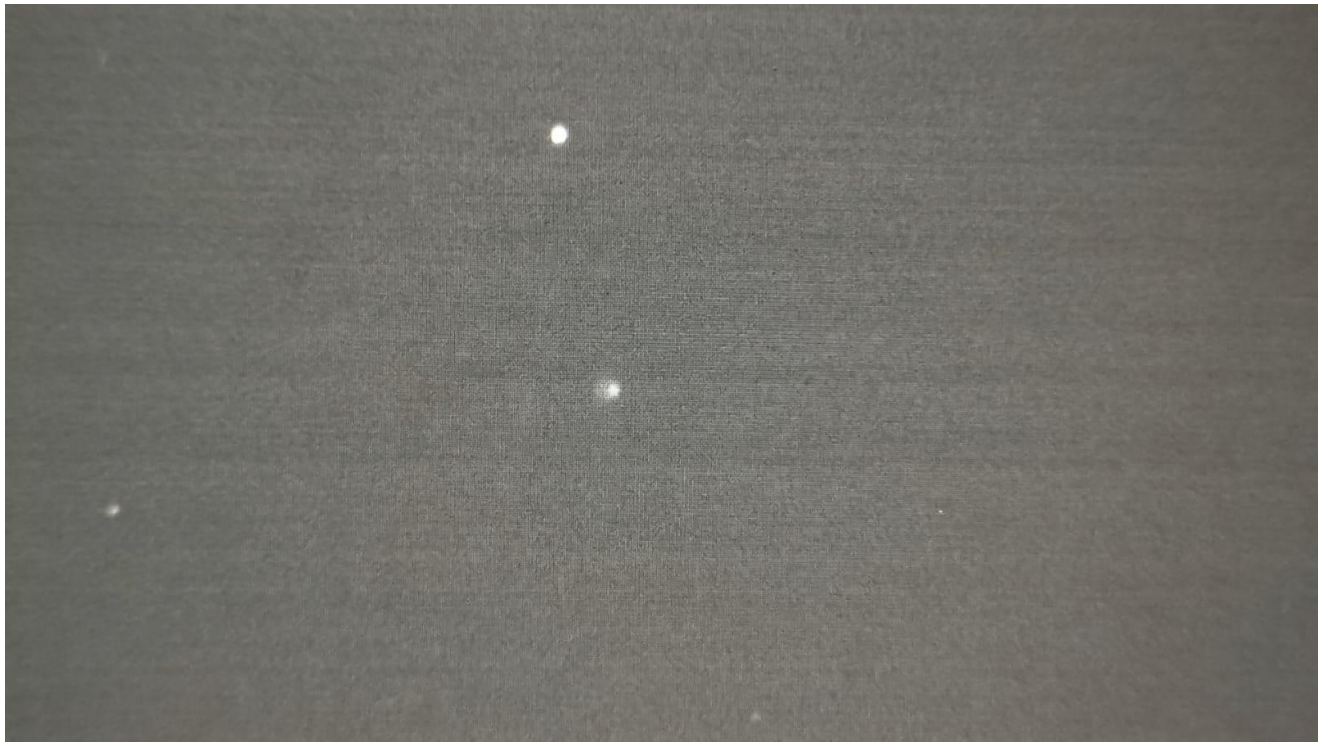
- Target the binary asteroid Didymos system
- Impact Dimorphos and change its orbital period
- Measure the period change from Earth



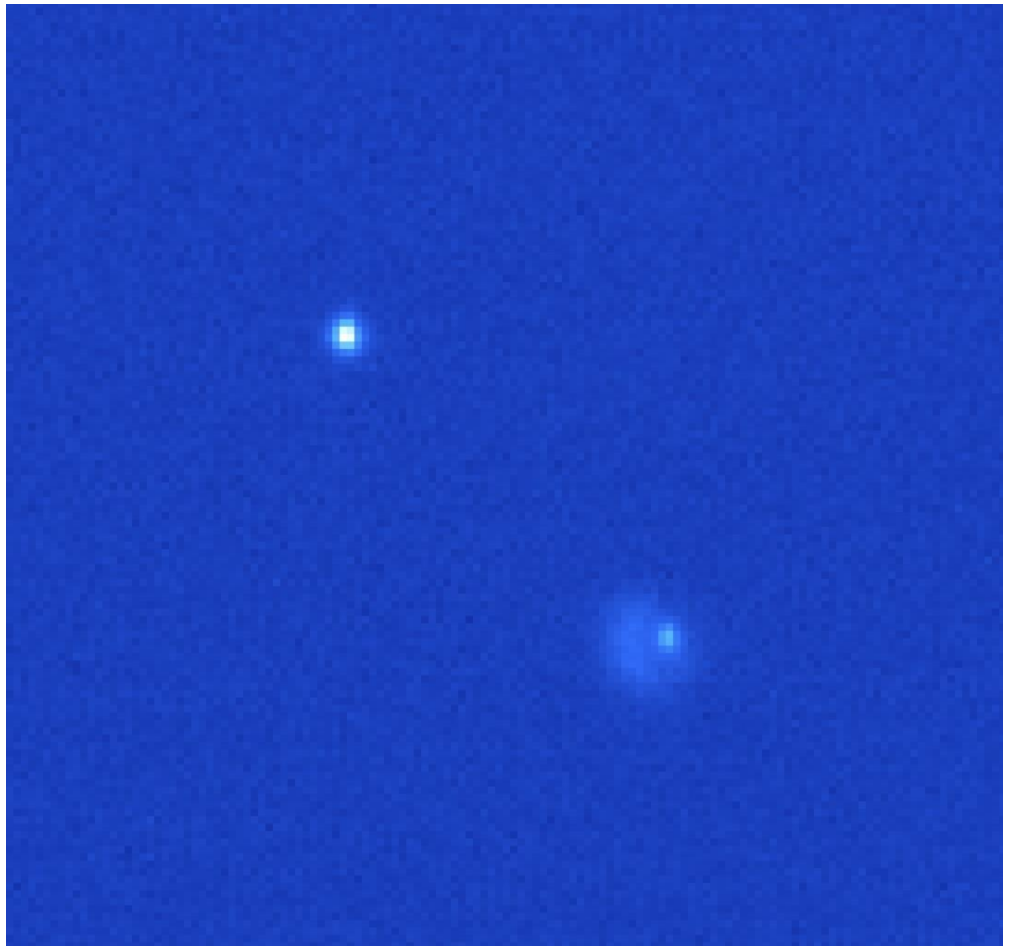
DART Impact Replay


WORLDWIDE OBSERVING CAMPAIGN 2022 2023
DART
Double Asteroid Redirection Test
Arizona
LDT (4.3 m)
Hall (1.1 m)
California
Goldstone
Palomar (5 m)
TMO (1 m)
Hawaii
IRTF (3 m)
ATLAS (0.5 m x 2)
New Mexico
MRO (2.4 m)
Texas
LCOGT (1 m)
West Virginia
Green Bank
Canary Islands
TNG (3.5 m)
NOT (2.56 m)
LCOGT (1 m)
Italy
Asiago (1.8 m, 1 m)
Israel
Wise (0.71 m)
Qatar
Qatar Univ. (0.3 m)
Kenya
OPTiK (0.4 m)
Namibia
Drebach South (0.4 m)
Springbok (0.36 m)
Réunion
Les Makes (0.6 m)
Australia
LCOGT (1 m)
Chile
ALMA
VLT (8.2 m x 4)
Magellan (6.5 m)
SOAR (4.1 m)
La Silla (1.54 m)
LCOGT (1 m)
Swope (1 m)
ATLAS (0.5 m)
Argentina
Jorge Sahade (2.15 m)
EABA Bosque Alegre (1.5 m)
South Africa
LCOGT (1 m)
SAAO (1 m)
ATLAS (0.5 m)
SMARTnet (0.5 m)
Watcher (0.4 m)
Antarctica
ASTEP (0.4 m)
New Zealand
Mt. John (1.8 m)
HST
JWST
Lucy

Kenya, posted to Slack 4 minutes after the impact
Credit: Murabana, Owen, Tilson (Travelling Telescope), Snodgrass (U. Edinburgh)



South Africa, posted to slack 6 minutes after impact
Erasmus (South African Astronomical Observatory) and Sickafoose (Planetary Science Institute)

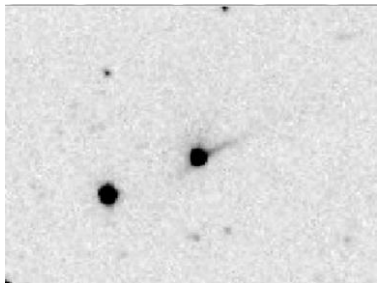


DART – Double Asteroid Redirection Test

ATLAS South Africa (University of Hawai’i/NASA PDCO)

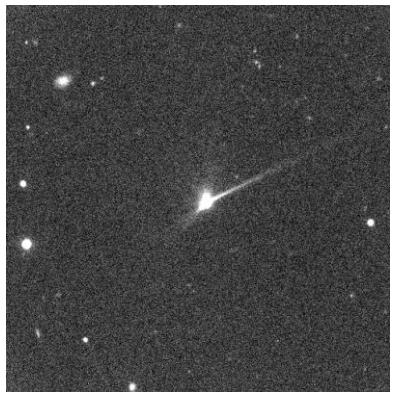
Telescopic observations from around the world

Africa (South Africa)



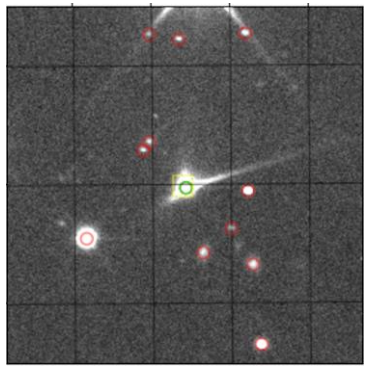
ATLAS project, HQ at U. Hawai'i.

North America (United States)



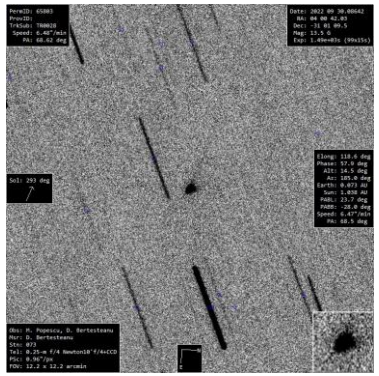
Bill and Eileen Ryan: Magdalena Ridge Obs. NM Tech

South America (Chile)



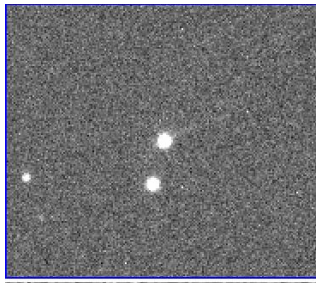
T. Lister, J. Chatelain, E. Gomez / Las Cumbres Observatory

Europe (Romania)



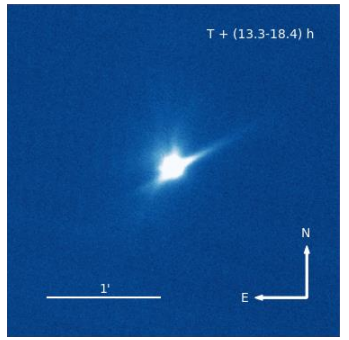
Popescu: Astronomical Institute of the Romanian Academy

Asia (Israel)



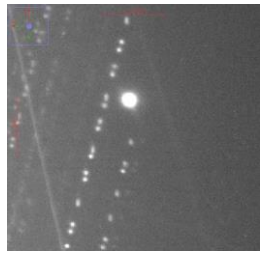
Ofek/Polishook, Weizmann Institute of Science.

Oceania (New Zealand)



R. Ridden-Harper/M. T. Bannister/N. Tan/T. Brown/P. Tristram, U. Canterbury

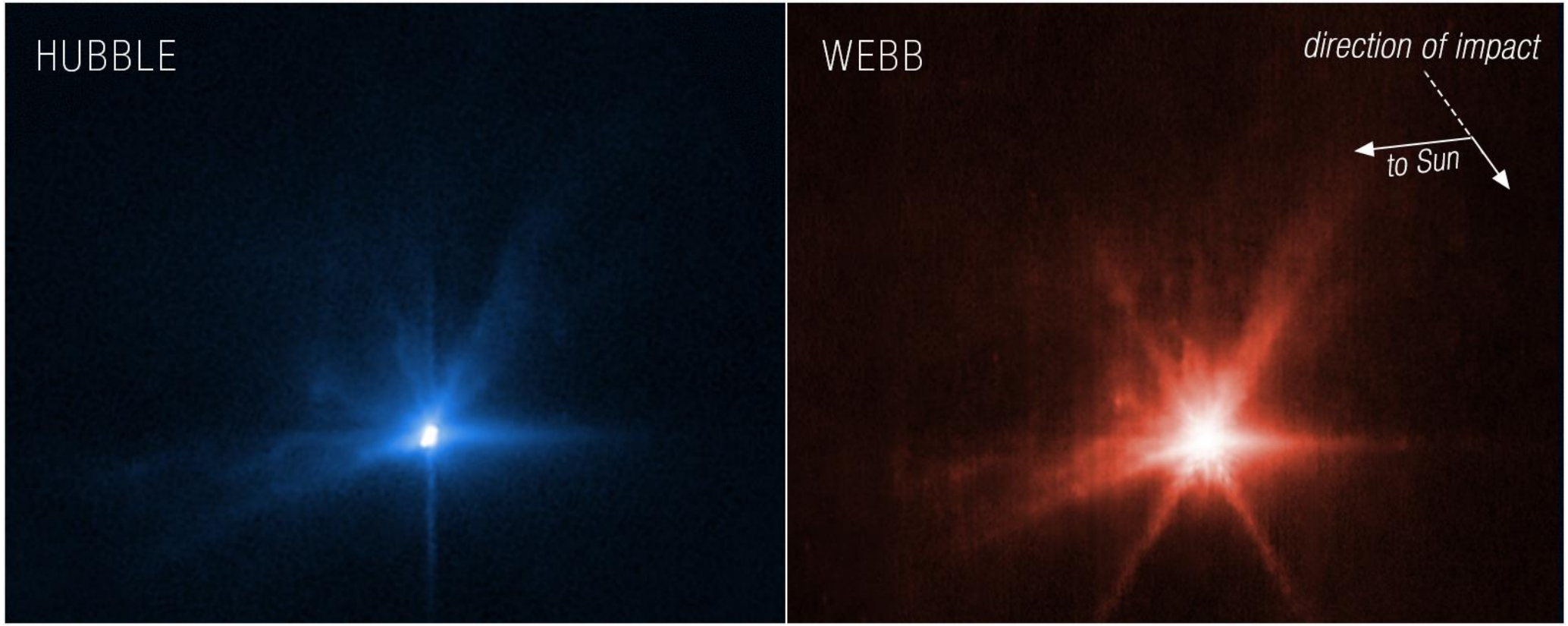
Antarctica (Concordia)



Abe/Guillot: Antarctic Search for Transiting ExoPlanets Project

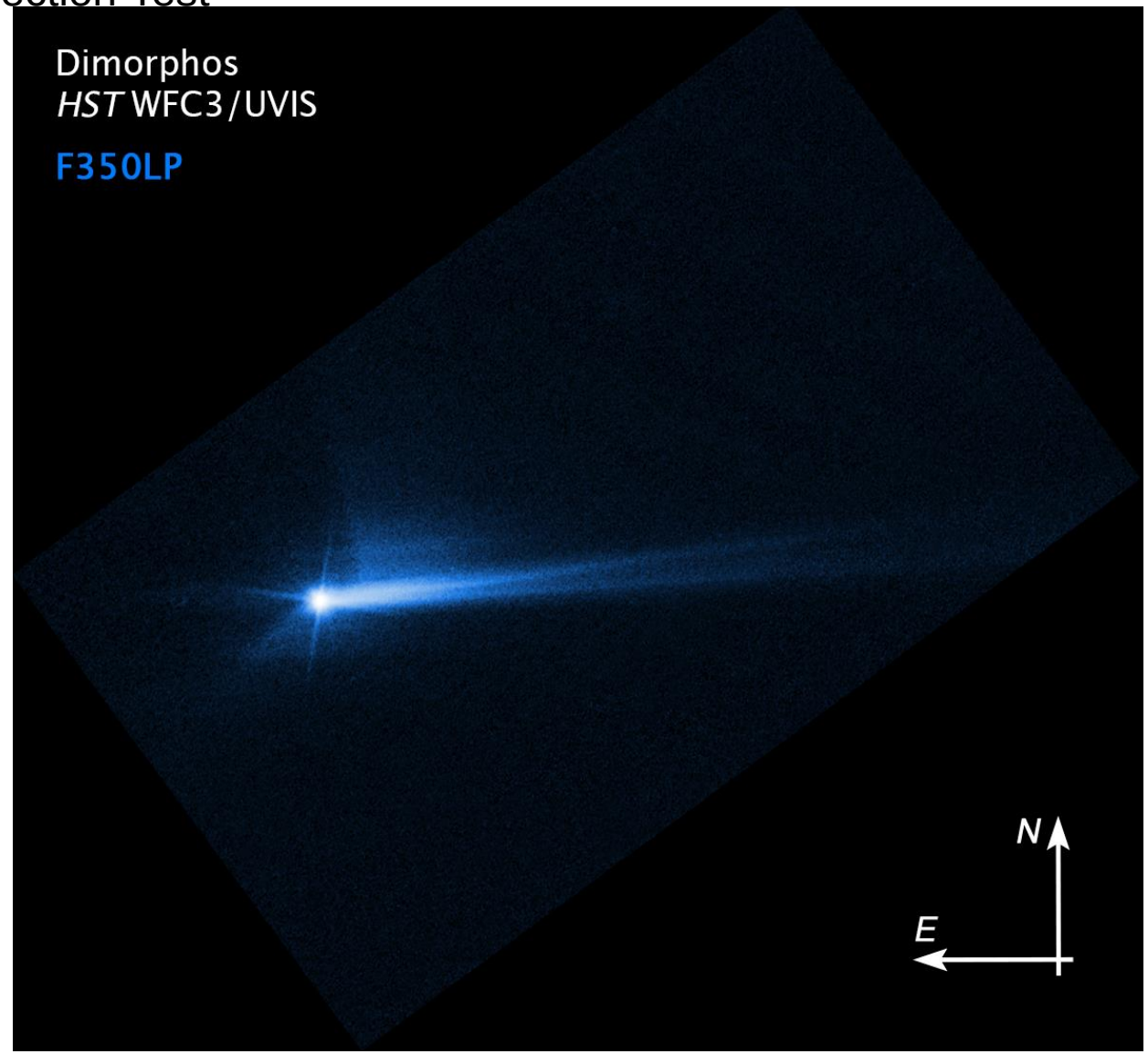
And this is just a snapshot! There is so much more than this and telescopes continue to provide new data daily.

DART – Double Asteroid Redirection Test



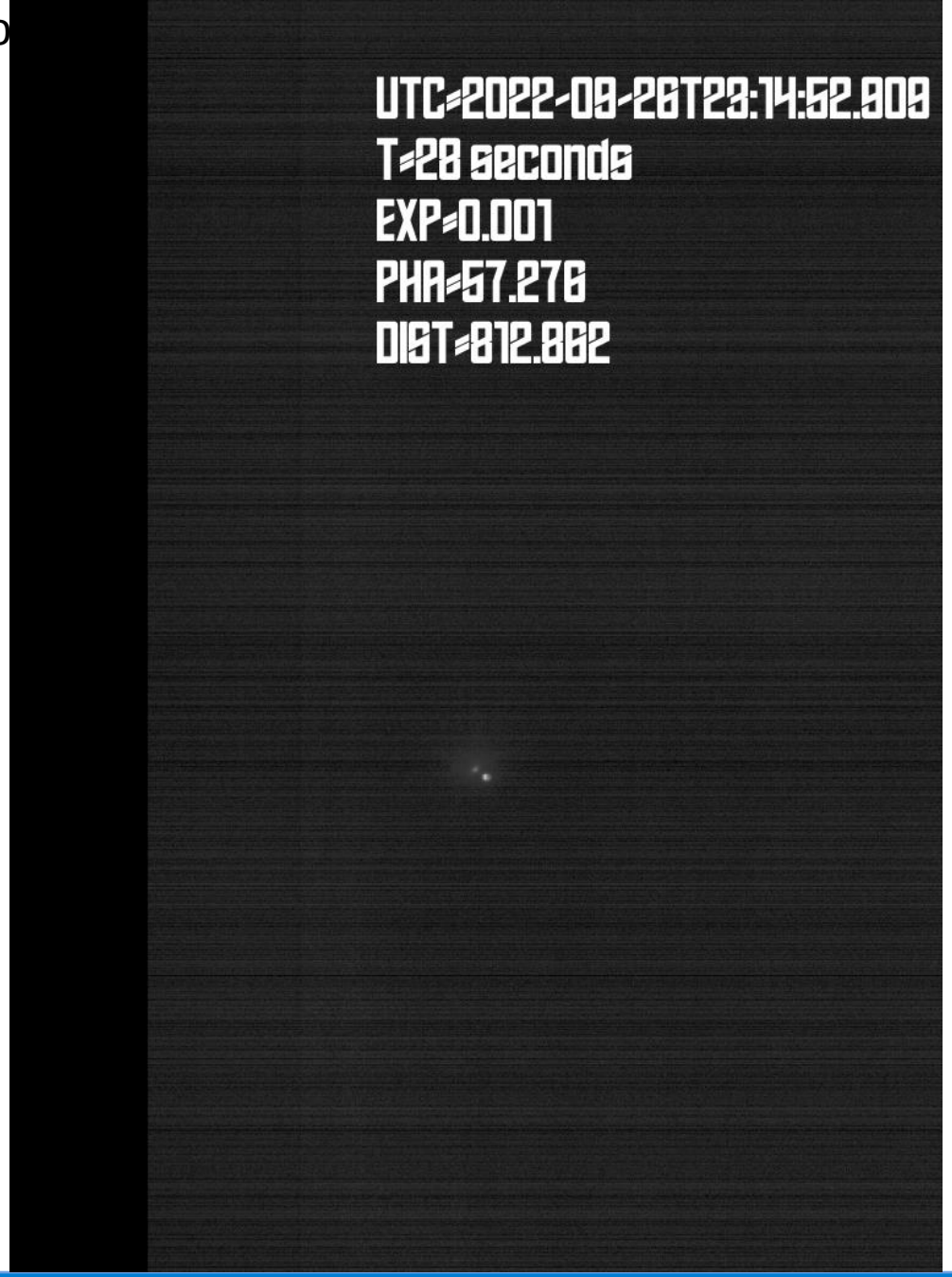
Webb, Hubble Capture Detailed Views of DART Impact
These images, Hubble on the left and Webb on the right, show observations of the Didymos-Dimorphos system several hours after NASA's Double Asteroid Redirection Test (DART) intentionally impacted the moonlet asteroid.
Credit: Science: NASA, ESA, CSA, Jian-Yang Li (PSI), Cristina Thomas (Northern Arizona University), Ian Wong (NASA-GSFC); image processing: Joseph DePasquale (STScI), Alyssa Pagan (STScI)

DART – Double Asteroid Redirection Test



Hubble Captures Detail in Debris Trail

This imagery from NASA's Hubble Space Telescope from Oct. 8, 2022, shows the debris blasted from the surface of Dimorphos 285 hours after the asteroid was intentionally impacted by NASA's DART spacecraft on Sept. 26. The shape of that tail has changed over time. Scientists are continuing to study this material and how it moves in space, in order to better understand the asteroid. **Credits: NASA/ESA/STScI/Hubble**



LICIACube LUKE Images
not debayerized yet

Exp time < 0.007s

Image roll, sunward angle, and DART angle still being investigated

Credit: Pedro Hasselmann
INAF-Osservatorio Astronomico di Roma

Observations after DART impact show orbit change

- Prior to DART's impact, it took Dimorphos 11 hours and 55 minutes to orbit its larger parent asteroid, Didymos.
- Since DART's intentional collision with Dimorphos on Sept. 26, astronomers have been using telescopes on Earth to measure how much that time has changed.
- Now, the investigation team has confirmed the spacecraft's impact altered Dimorphos' orbit around Didymos by **33 minutes**, shortening the 11 hour and 55-minute orbit to 11 hours and 22 minutes.
- This measurement has a margin of uncertainty of approximately plus or minus 1 minute

Other Missions of Interest

- OSIRIS-REx – Sample Return from asteroid Bennu
  - All nominal in cruise return to Earth – SRC EDL September 2023
  - Extended mission to Apophis “OSIRIS-APEX” awarded by New Frontiers
- Lucy – Mission to the Jupiter Trojans
  - Successfully completed EGA 16 October 2022
  - Continues with one solar-array unlatched
- Psyche – Mission to a “Metal World”
  - Continuation/Termination Review held in October 2022
  - Remanifested for October 2023 launch
- Janus – SIMPLEx mission to two binary asteroids
  - Demanifested from Psyche launch. Awaiting decision for continuation
- NEO Scout – Destination 2020 GE
  - Apparently did not survive Artemis 1 launch

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nasa.gov/planetarydefense