National Aeronautics and Space Administration

NASA

EXPLORE SCIENCE

PLANETARY DEFENSE STRATEGY

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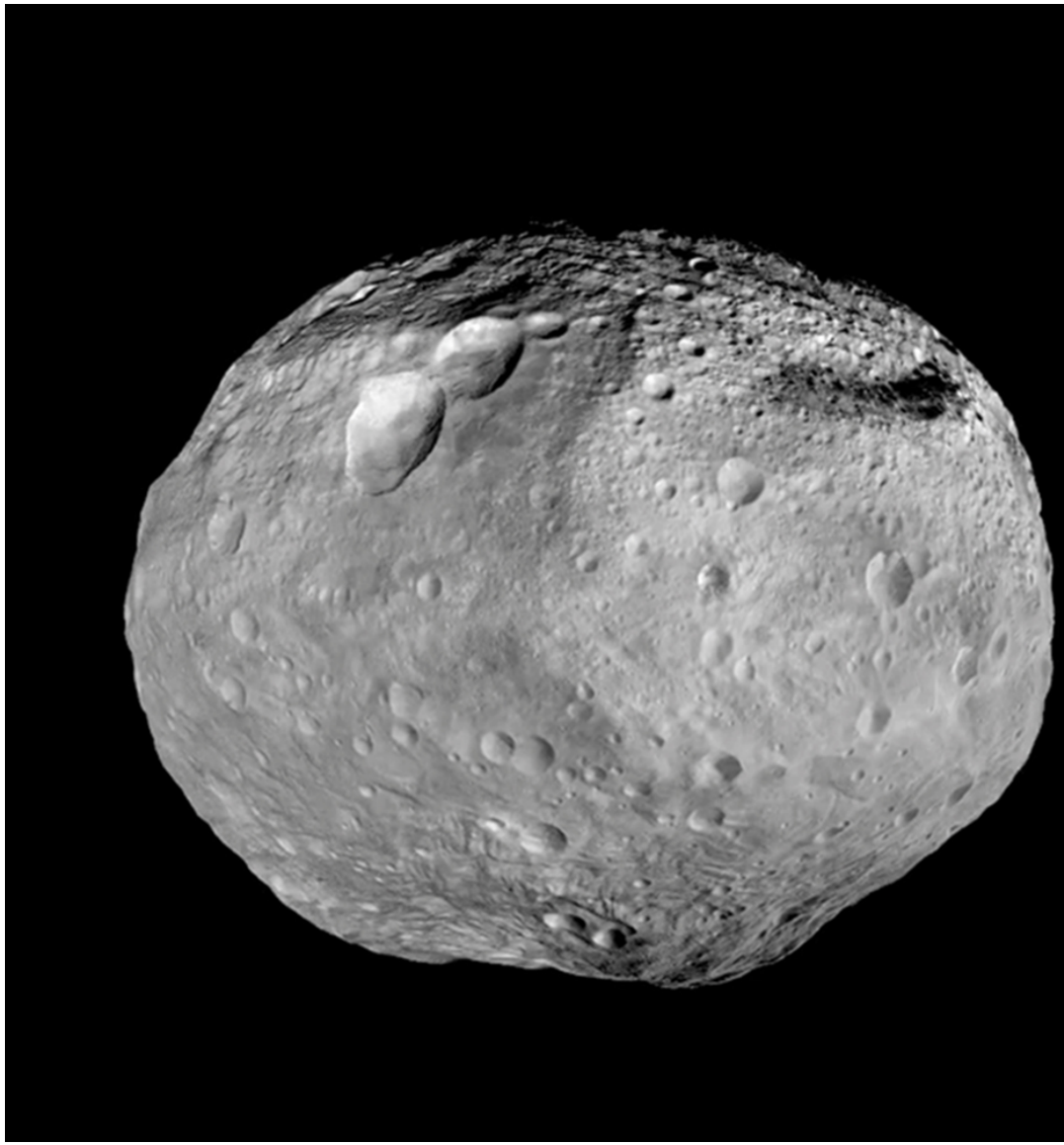
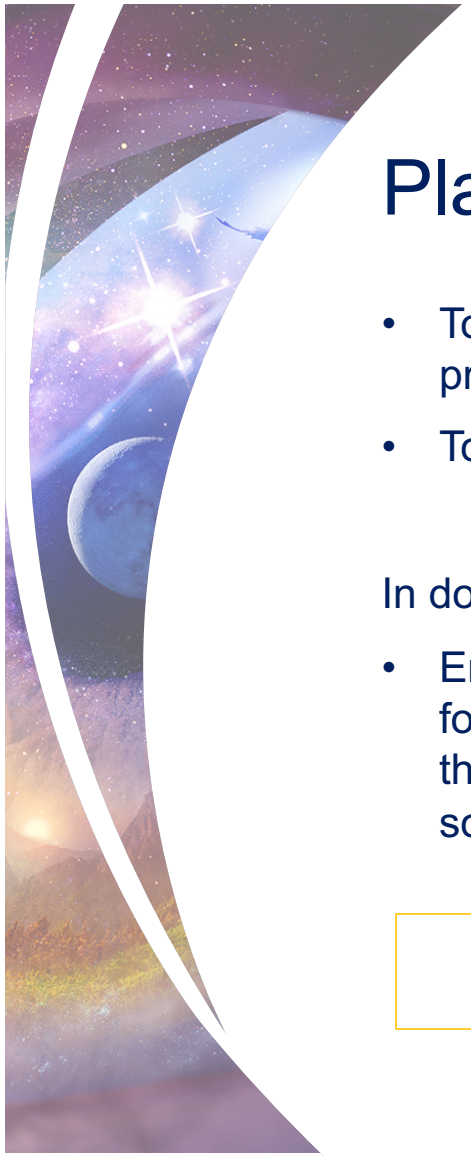


PLANETARY DEFENSE:
Two Asteroids Flyby Earth

- Two medium-sized asteroids flew safely past Earth overnight September 13-14, 2019
- NASA was tracking these objects, but orbit calculations ruled out any chance the objects could pose a threat to the Earth
- Both asteroids passed about 14 lunar distances from Earth, or about 3.5 million miles away
- Multiple news outlets carried this story, including Space.com and Forbes.com



Planetary Defense Strategy and Goals

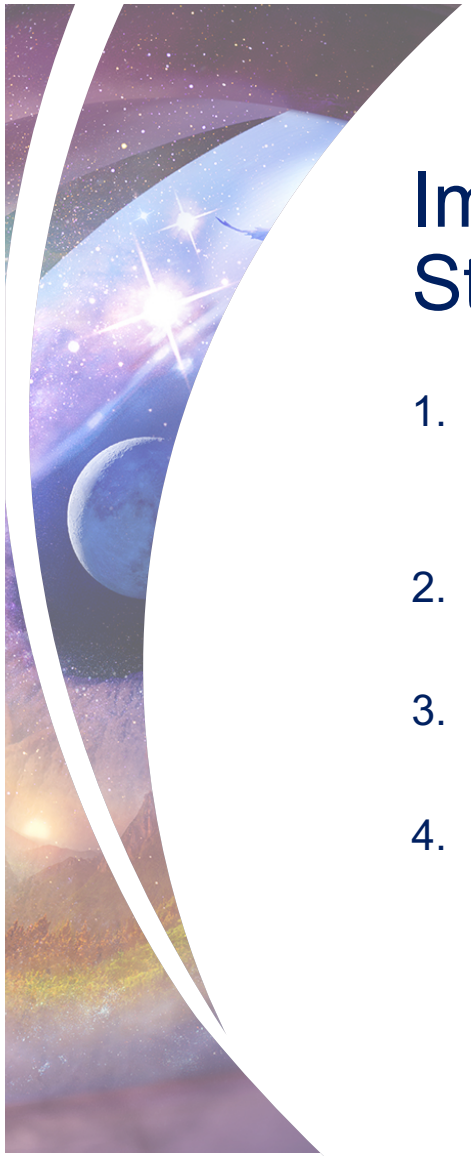
- To detect NEOs, determine their orbits, and characterize their physical properties using all data-sources, per Congressional guidelines
- To develop new technologies for NEO detection and impact mitigation

In doing so…

- Enable research in small planetary bodies to study how our solar system formed and evolved and determine hazards to life on Earth - two of the three fundamental science questions that guide NASA's exploration of the solar system

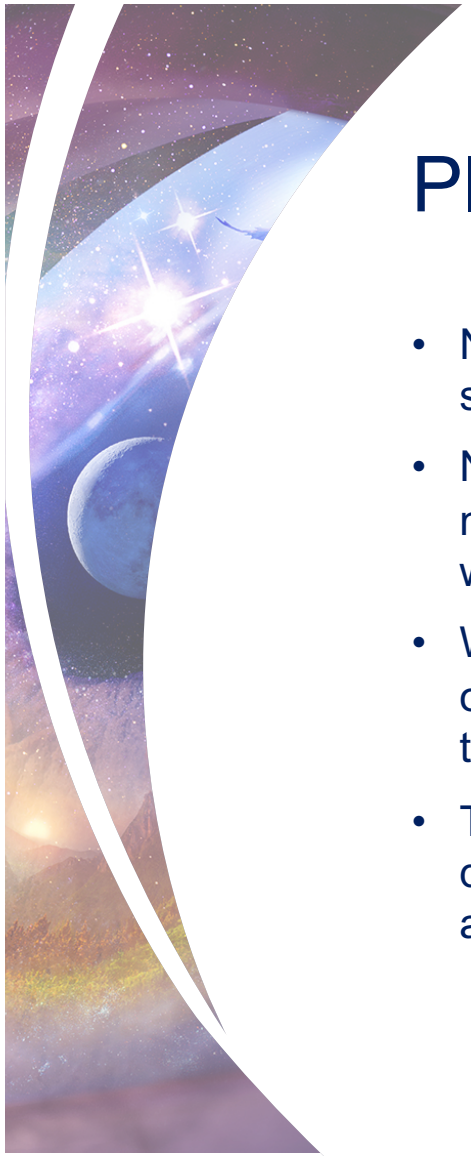
This is done using an innovative program of ground-based technologies, targeted research, and small- and modest sized, optimized spaceflight projects.


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



Implementing the Planetary Defense Strategy

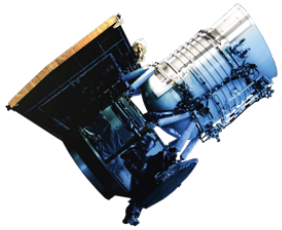
1. Centralized NEO search, follow-up, and characterization data assimilation to process and archive NEO positional and characterization measurements from ground and space-based assets
2. Dedicated ground-based activities, and leveraging of astronomical missions and facilities, if needed, to observe NEOs
3. A series of small and medium-sized missions focused to meet NEO survey goals and develop technologies for impact mitigation
4. Competitively-selected NEO research that enables the analysis of breakthrough science focused on small planetary bodies (e.g., small body population studies, meteor monitoring, meteorite and analogue laboratory analysis, and citizen science)



Planetary Defense Mission Approach

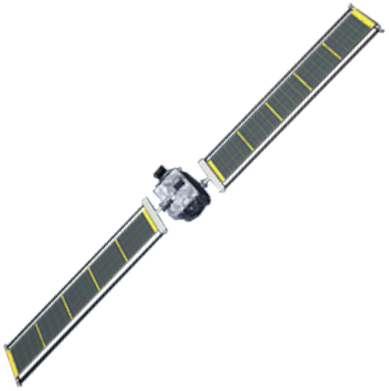
- NASA Planetary Defense missions are focused on NEO search/characterization or mitigation technology development
- NASA does NOT approach planetary defense as a science-driven mission line; instead, we approach these missions more like space weather, NOAA or other operational programs
- Where possible, and following other government programs focused on operations and data-gathering, missions are operationally focused, targeted, and goal-driven
- The missions contain only the science activities needed to sufficiently design, validate/verify, and operate the mission, and ground-based astronomical support for meeting mission success criteria

Current Planetary Defense Flight Mission Projects



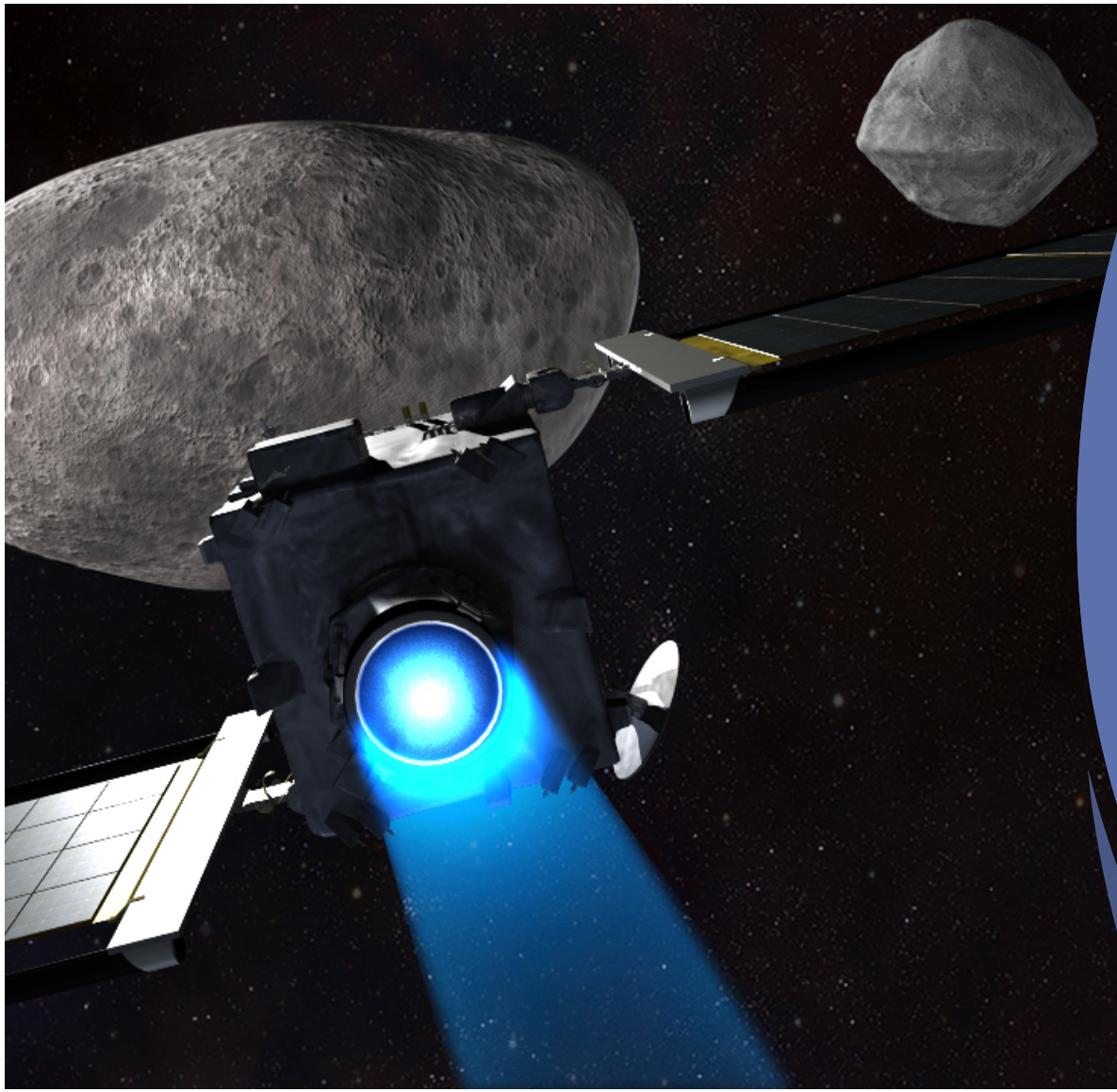
NEOWISE

- Continues in extended NEO survey operations
- Expected to exceed max useful temperatures in ~Summer 2020



DART: Double Asteroid Redirection Test

- Demonstration of kinetic impactor technique
- Target - Moon of 65803 Didymos
- Launch NET July 2021, impact September 2022
- Completed Mission-level PDR April 2018
- KDP-C “Confirmation” signed August 2018
- CDR completed June 2019, DPMC completed August 2019



Double Asteroid Redirection Test (DART)

- First-ever mission to demonstrate asteroid deflection technique for NASA's Planetary Defense Coordination Office
- Uses kinetic impact to change motion of asteroid in space
- Current DART target, Didymos, will have distant approach to Earth October 2022
- Successfully completed post-CDR SMD DPMC in August 2019
- Mission is on track for 2021 launch aboard a SpaceX Falcon 9

National Academies Study (2019)

- Since 2013, the NEO Wide-field Infrared Explorer (NEOWISE) has assisted NASA's efforts to identify and characterize populations of near-Earth asteroids and comets but the technique for determining NEO diameters has been challenged
- NASA's Chief Scientist requested the National Academies of Sciences, Engineering, and Medicine (NASEM) to evaluate the relative advantages and disadvantages of infrared and visible observations of NEOs
  - The NASEM report was issued in June 2019
- One key finding was that a "space-based mid-infrared telescope designed for discovering NEOs and operating in conjunction with currently existing and anticipated ground-based, visible telescopes is the most effective option for meeting the George E. Brown Act completeness and size determination requirements in a timely fashion"

2019 NASEM Study Recommendations

- Objects smaller than 140 meters in diameter can pose a local damage threat. When they are detected, their orbits and physical properties should be determined, and the objects should be monitored insofar as possible.
- If the completeness and size requirements given in the George E. Brown, Jr. Near-Earth Object Survey Act are to be accomplished in a timely fashion (i.e., approximately 10 years), NASA should fund a dedicated space-based infrared survey telescope. Early detection is important to enable deflection of a dangerous asteroid. The design parameters, such as wavelength bands, field of view, and cadence, should be optimized to maximize near Earth object detection efficiency for the relevant size range and the acquisition of reliable diameters.
- Missions meeting high-priority planetary defense objectives should not be required to compete against missions meeting high-priority science objectives.
- If NASA develops a space-based infrared near Earth object (NEO) survey telescope, it should also continue to fund both short- and long-term ground-based observations to refine the orbits and physical properties of NEOs to assess the risk they might pose to Earth, and to achieve the George E. Brown, Jr. Near-Earth Object Survey Act goals.
- All observational data, both ground- and space-based, obtained under NASA funding supporting the George E. Brown, Jr. Near-Earth Object Survey Act, should be archived in a publicly available database as soon as practicable after it is obtained. NASA should continue to support the utilization of such data and provide resources to extract near Earth object detections from legacy databases and those archived in future surveys and their associated follow-up programs.

NEO Survey Development Background

- Infrared (IR) survey capability proposed to several cycles of the Discovery Program AOs
- Proposal to the 2014 AO (NEOCam) did well, but was not selected for flight
- NEOCam was identified for extended Phase A study by NASA's Planetary Defense Coordination Office
  - Extended Phase A effort allowed mission concept to be further matured and focused more on Planetary Defense objectives
  - Also supported further maturation of IR instrument technology and implementation

NEO Surveillance Mission Characteristics

- Consistent with Planetary Defense strategy
- Benefits from technology development and extended Phase A from NEOCam
- Anticipated mission costs for future Phase B-D in the $500-600M range, including options for shared or dedicated launch vehicle
- Separately funds supporting research and analysis

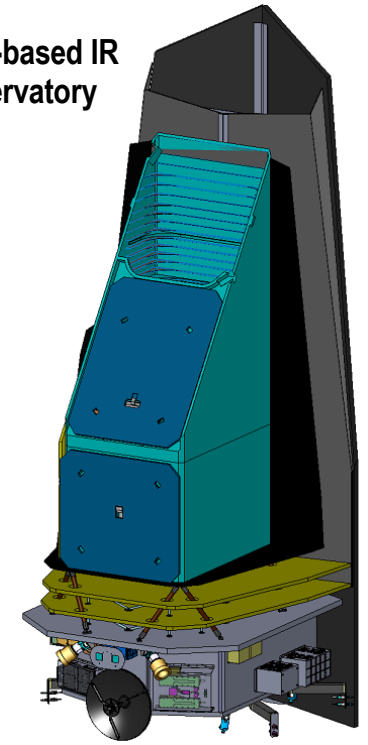
Designed to meet George E. Brown Act goals in mid-2030s, accelerating completion by at least 15 years (NASEM, 2019)

NEO Surveillance Mission Objectives

- Find 65% of undiscovered PHAs >140 m in 5 years (goal: 90% in 10 years)
- Produce sizes from IR signatures
  - Compute albedos when visible data are available
- Compute cumulative chance of impact over next century for PHAs >50 m and comets
- Deliver new tracklet data daily to the Minor Planet Center
  - Images and extracted source lists every 6 months to archive

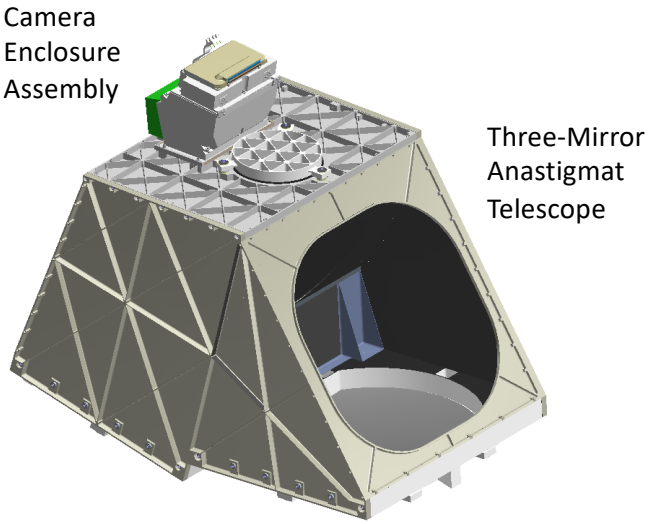
NEO Surveillance Mission High-Level Description

- Wide-field Infrared (IR) instrument
- Heritage-based spacecraft
- Observatory compatible with two launch vehicles
  - Falcon 9 or Atlas 401
  - S/C wet mass CBE < 1300 kg
- Launch possible 346 days of the year
- Operations in Sun-Earth L1 halo orbit
- Fixed survey pattern; 12-yr life (extended mission)
- Deep Space Network (DSN) for telecom and nav
- IPAC for data processing and analysis

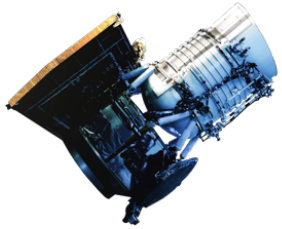


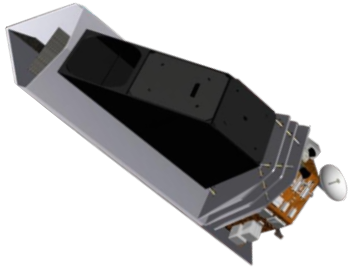
NEO Surveillance Telescope

- 50 cm unobscured aperture, wide FOV telescope for NEO detection at 4-10 μm (Infrared; IR)
  - Optimized to detect NEOs at wavelengths where they are bright, but background stars and galaxies are dim
- Passively cooled – No cryo-cooler required
  - Enabled by
    - Mission design: Position at Sun-Earth L1
    - Two HgCdTe high temperature detectors (new technology)
- Simple instrument optimized for detecting moving objects; it has no moving parts except for ejectable aperture cover
- Instrument mass and power requirements
  - Mass less than 400 kilograms
  - Average Power for operations less than 60 watts



Planetary Defense Flight Mission Projects





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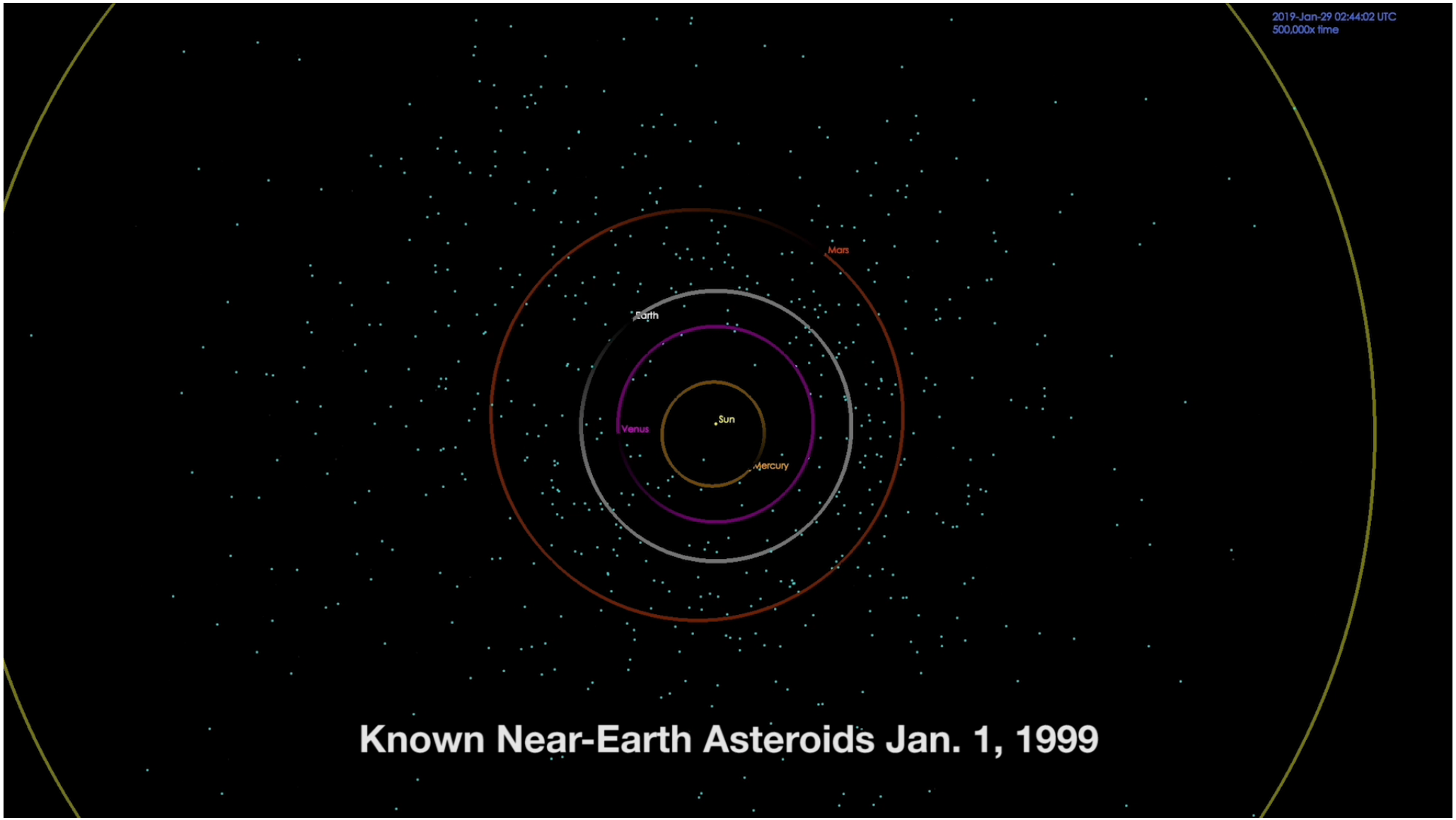
NEO Surveillance Mission

- Infrared survey space telescope optimized for meeting Congressional direction to find and characterize NEOs down to 140 meters in size
- Finished Extended Phase A Study
- SRR/MDR completed February 2018
- “Instrument-first” project review completed March 2019, ready for Phase B with LRD no earlier than FY25


2019-Jan-29 02:44:02 UTC
500,000x time
Mars
Earth
Venus
Sun
Mercury
Known Near-Earth Asteroids Jan. 1, 1999

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