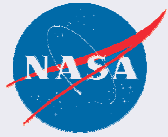


Next-Generation Space- Based IR NEO Surveys

Amy Mainzer
Jet Propulsion Laboratory
California Institute of Technology

Target NEO Workshop



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Why Having the Right Targets Matters



- Without being able to precisely constrain rendezvous dates and Δv , it is very difficult to derive the rest of the requirements for a mission
 - Having only one possible rendezvous date in a 5-10 year window drives cost and schedule
 - Changing requirements increases cost and risk



National Aeronautics and
Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Finding A Target



- Although ~7800 NEOs are known today, only a few are accessible
 - Long synodic periods of most NEOs means that there are few opportunities for follow-up that could improve orbits before 2025 timeframe
 - NEOs discovered near opposition from today onward are unlikely to be accessible with low ΔV in 2025
 - Many of the potential targets have only visible magnitudes, which leads to high uncertainties in diameter
 - With NEOWISE, preliminary pV ranges from 1-60%
 - An object with $H=24$ could be anywhere from 36-475m in diameter
 - Many NEOs are effectively lost due to short observational arcs:
 - 1999 AO10: observational arc of only 33 days -> basically lost now, and only chances for follow-up are in 2013 @ $V\sim 24.5$ or 2019 @ $V\sim 23$ before 2026 rendezvous with huge astrometric uncertainty
 - Need really big telescope to go deep with large enough FOV to find it: very difficult, if not impossible



National Aeronautics and
Space Administration

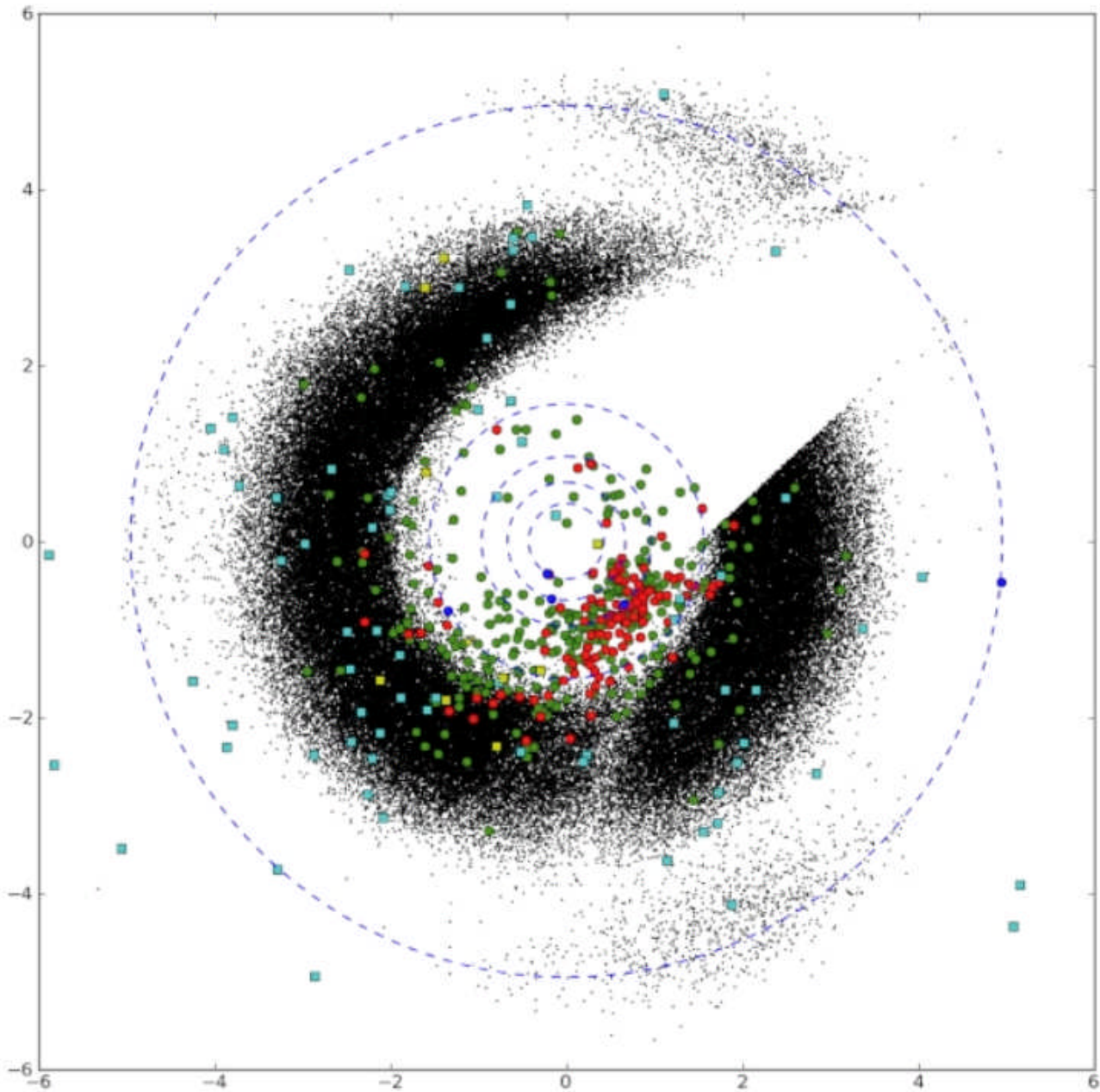
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

The Case for Space



- By observing from space, we can reach regions of the sky that are inaccessible from the ground
- This facilitates finding an NEO that will be at the right place in 2025 – long synodic periods -> likely to be on the other side of the solar system for the next decade
- Space-based IR surveys have
 - No weather
 - No day/night
 - No seeing
 - No moon
 - Survey can be optimized to find low Δv targets

Example: NEOs discovered by NEOWISE travel in “clumps” due to their long synodic periods





National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California



The Case for IR

- IR data yield characterization:
 - Diameters
 - With visible data, albedos
 - Fraction of population that is of cometary origin
 - Thermal lightcurves: shape, rotational state
 - Thermal inertia, surface properties (roughness), better estimates of density, mass, Yarkovsky force
- Sample is independent: capable of discovering new NEOs
 - Not biased against low albedo NEOs which may be resource-rich (water, other volatiles)



National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Important Considerations for Space-Based IR Surveys

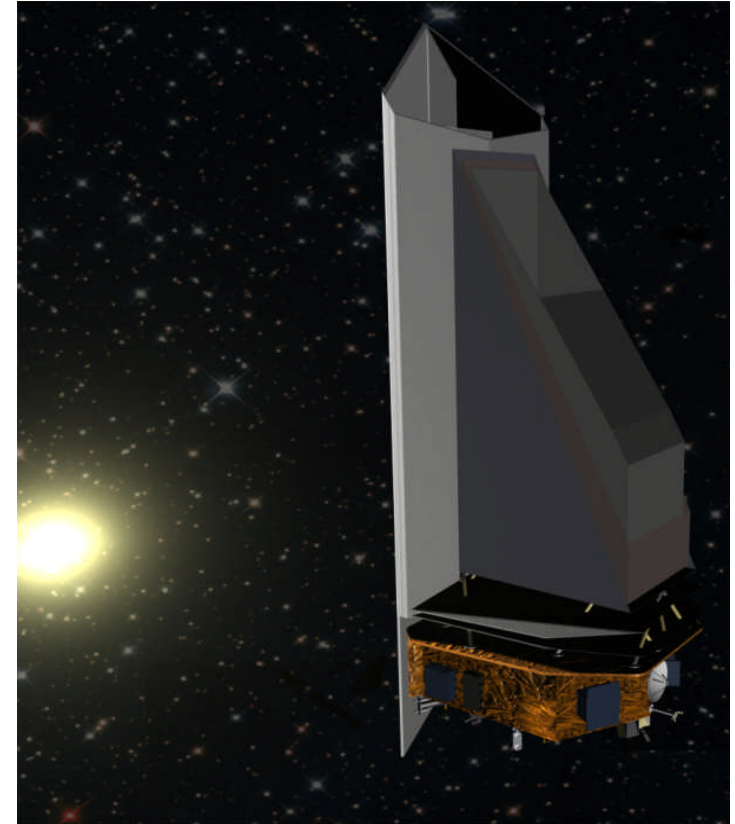


- A next-generation IR survey needs to be capable of doing its own follow-up:
 - Needs to produce observational arcs long enough to allow object to be found reliably
- Important because survey will likely look in parts of the sky that are inaccessible from ground (solar elongations $< \sim 70^\circ$)
- Pipeline software is CRITICAL: must adequately characterize artifacts (latent images, cosmic rays, optical ghosts, instrumental signatures, astrometric distortion)
 - Accurate moving object detection absolutely dependent on this
 - NEOWISE: survey operations began 1/14/10, first mass tracklet delivery to Minor Planet Center began 3/8/10.
- Launch is always a risk, but solution is use a reliable rocket (e.g. Delta II is 99% reliable)
- Advantage of space-based survey is that it can be precisely optimized to find NEOs

NEOCam: The Near-Earth Object Camera



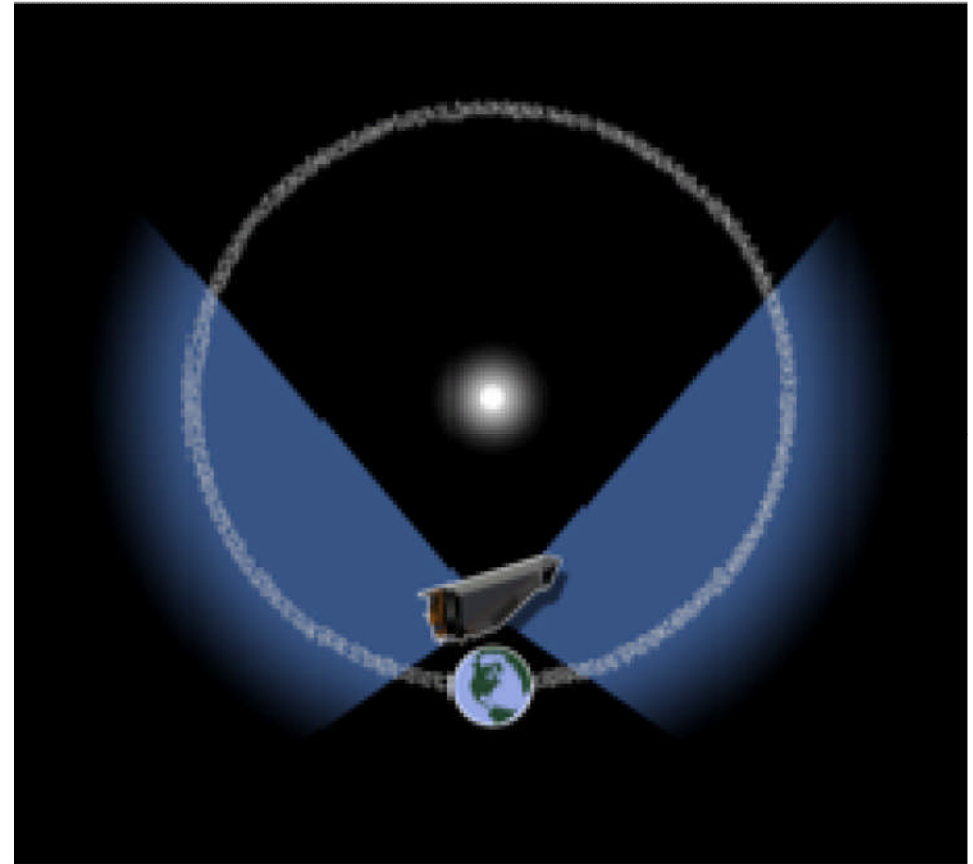
- Discovery Mission Proposal
 - PI: A. Mainzer; partners: IPAC, Ball, Teledyne, Rochester
 - Submitted to Discovery 2006, not selected
 - Submitted to Discovery 2010, under consideration
- Science Objectives:
 - Study the origins and evolution of the NEOs, MBAs and comets
 - Assess the present-day risk of NEO impact
- NEOCam achieves multiple NASA goals by
 - Addressing fundamental issues in Solar System science:
 - NEO origins and evolution
 - Chronology of breakups in Main Belt
 - Origins and evolution of comets
 - Precisely quantifying PHO impact hazard. Detect and characterize 2/3 of all PHOs >140 m in diameter in 4 years
 - Identifying and characterizing asteroids as destinations for human exploration



NEOCam



- Dual-channel imager operating in a single step-and-stare survey mode:
 - 50 cm telescope
 - Two 16 megapixel HgCdTe focal planes at 4-5.4 and 6-10.3 μm simultaneously imaged
 - Detectors & optics passively cooled
 - 23/7 science ops, 13GB/day (compressed)
- 4 year Mission, launch 2016
- Earth-Sun L1 orbit
- Can send NEOCam into orbits interior to Earth
 - This speeds up discovery rates, but increases cost



Summary



-
- A next-generation space-based survey can find and characterize new low Δv targets
 - More targets with good orbits will allow requirements definition
 - Saves cost and minimizes risk