# Next-Generation Space-Based IR NEO Surveys

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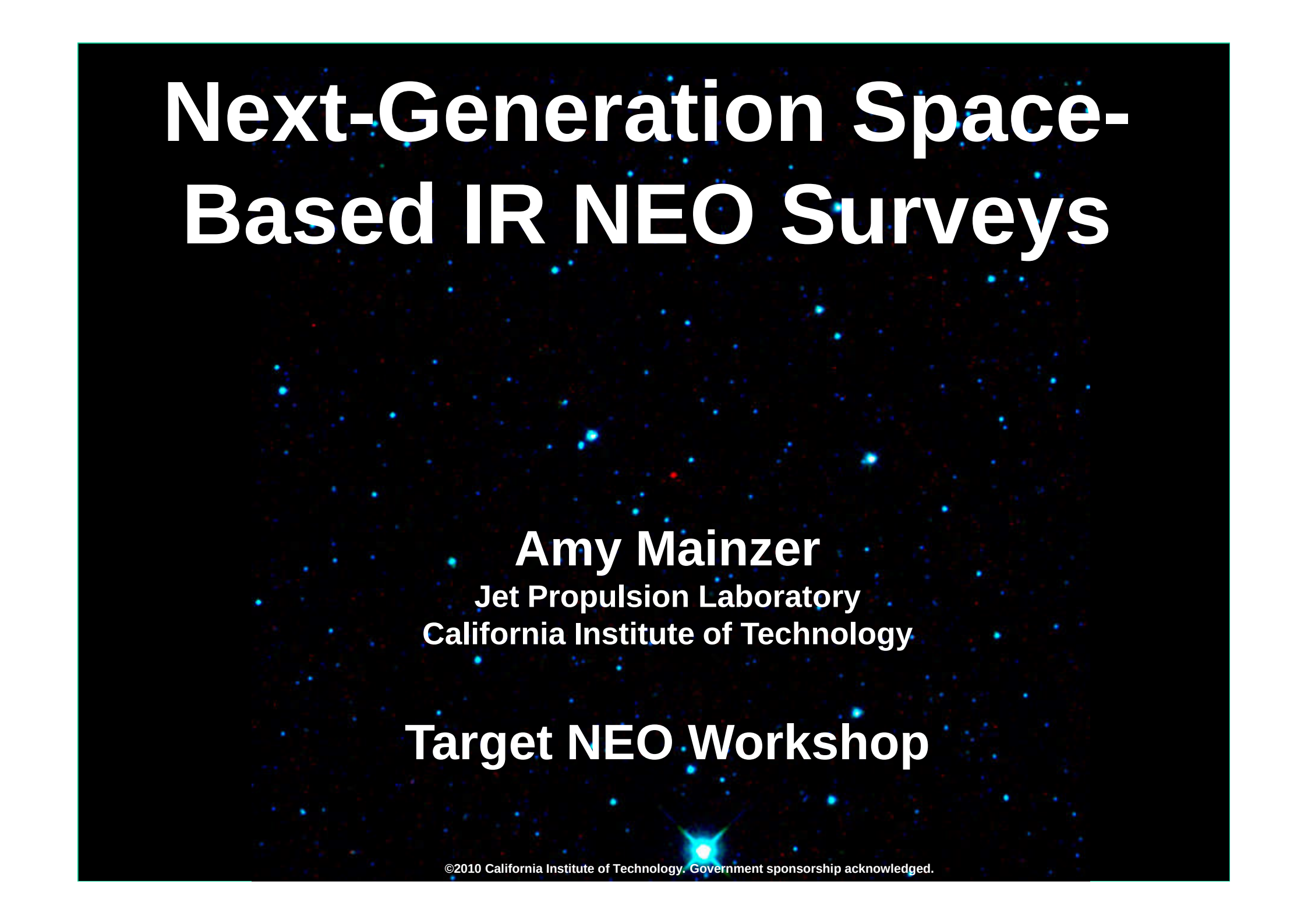
## Target NEO Workshop



# Why Having the Right Targets Matters

- Without being able to precisely constrain rendezvous dates and $\Delta v$, 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

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# 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 $\Delta V$ 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~24.5 or 2019 @V~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

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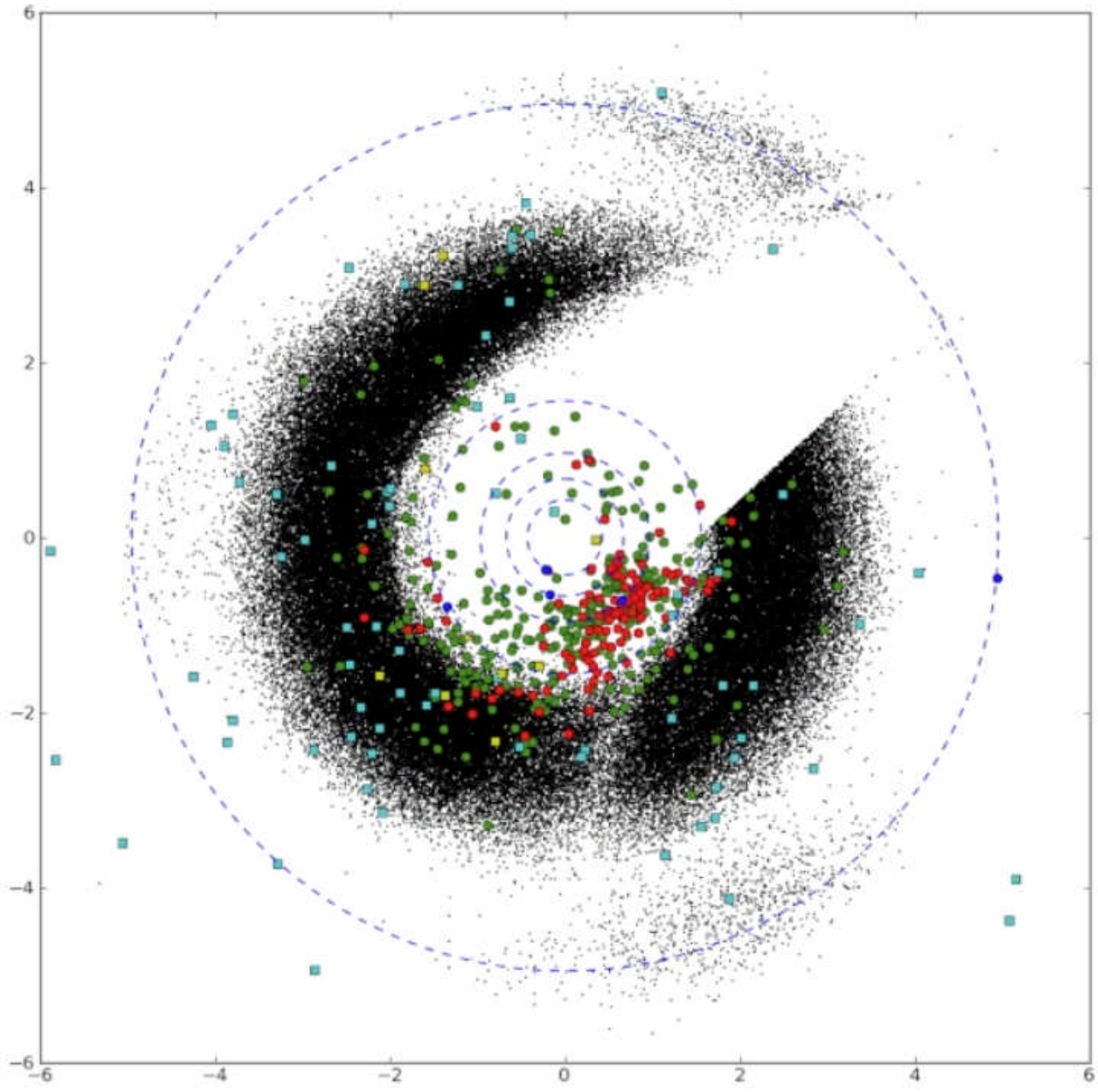
# The Case for Space

- 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 $\Delta v$ targets

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



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# 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)

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# 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 <~70°)
- 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

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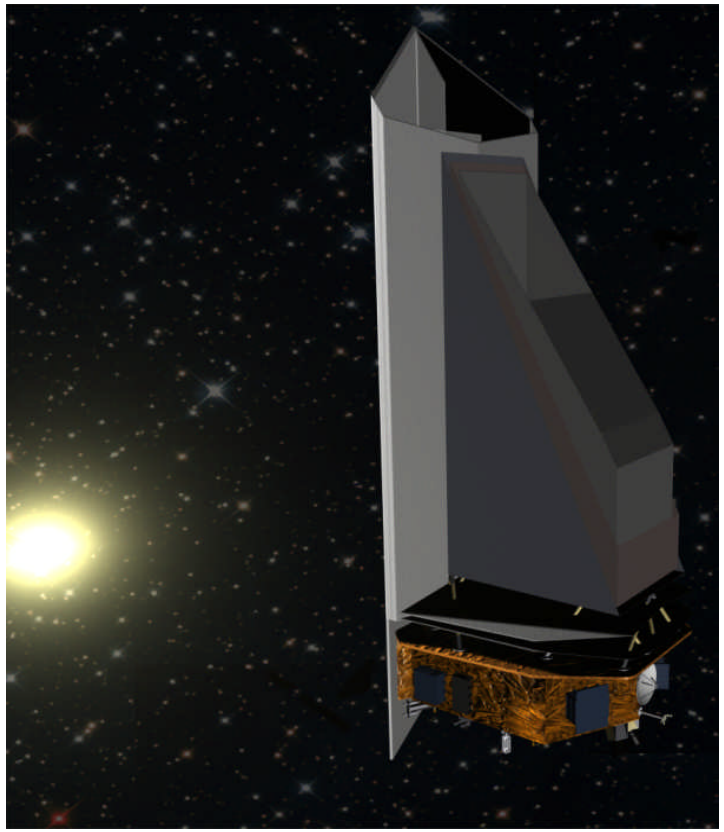
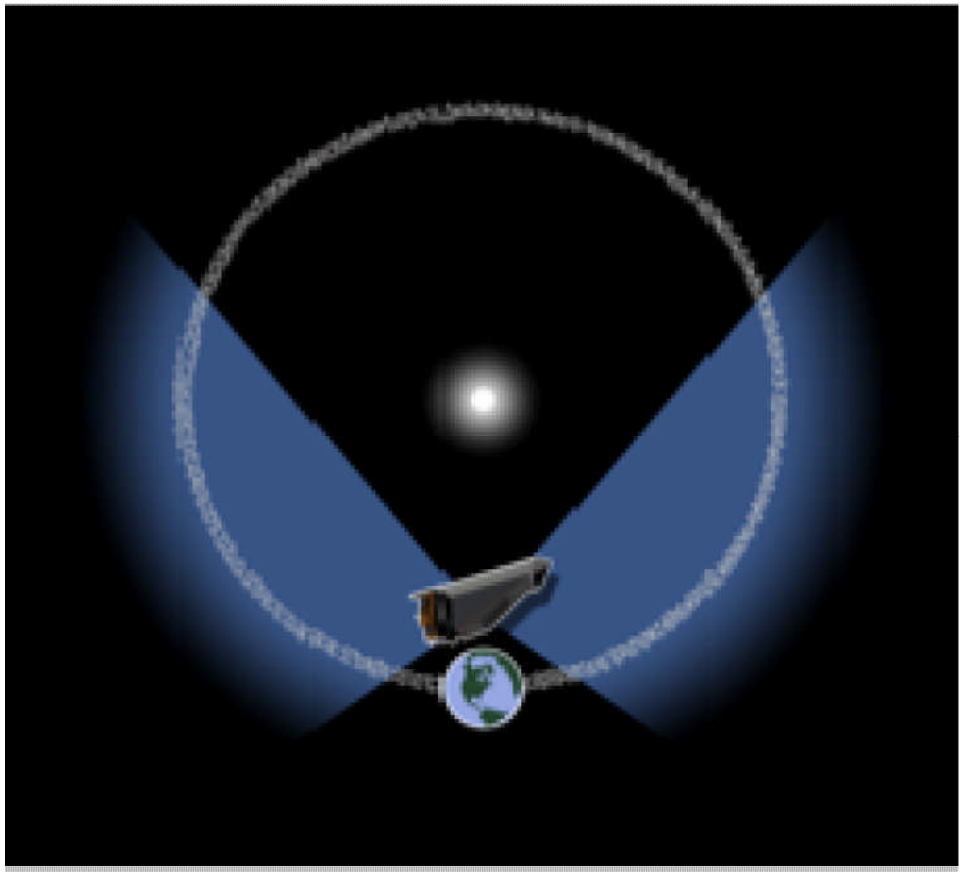
# NEOCam: The Near-Earth Object Camera

- 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 $\Delta v$ targets
- More targets with good orbits will allow requirements definition
  - Saves cost and minimizes risk