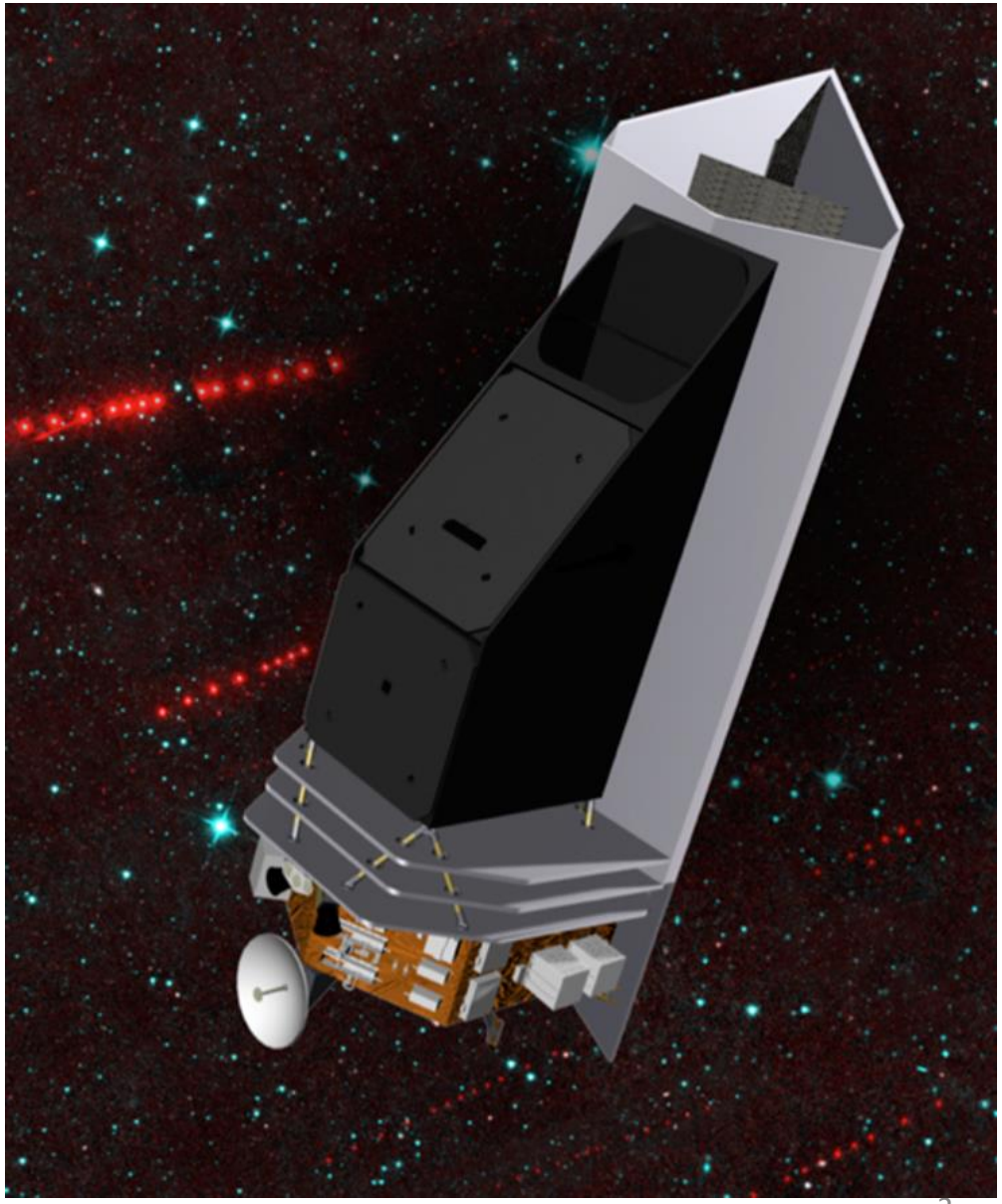
NEO Surveyor: Survey cadence and expected initial knowledge of newly discovered NEOs

Joseph Masiero (Caltech/IPAC)

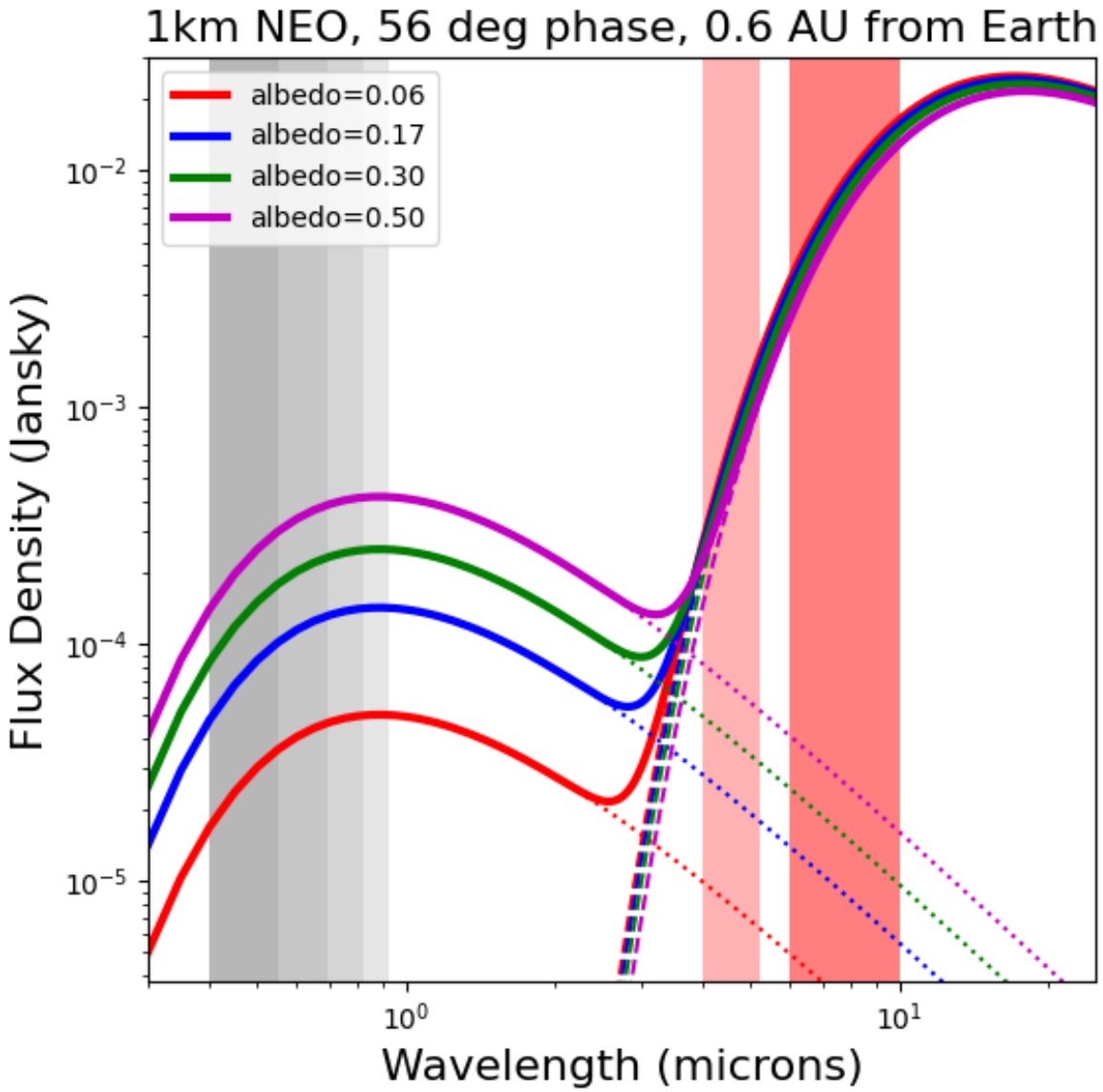
Co-authors: Amy Mainzer, Tim Spahr, Tyler Linder, Dar Dahlen, and the NEO Surveyor Team

NEO Surveyor mission

- **NEO Surveyor is a dual-channel imager operating in a single step-and-stare survey mode.**
  - 50 cm telescope
  - Two 16-megapixel HgCdTe focal planes at 4-5.2 & 6-10 µm simultaneously imaged
  - Detectors passively cooled to 40K
  - Sun-Earth L1 orbit
  - Launch Readiness Date: September 2027
  - Mission lifetime 5 years; Goal of 12 years
  - Principal Investigator: Prof. Amy Mainzer (UCLA)
  - Daily full-frame data downlinks, processing at IPAC, submission to MPC
  - Semiannual image and source list releases

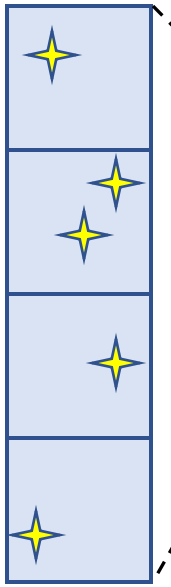


NEOs at infrared and visible wavelengths



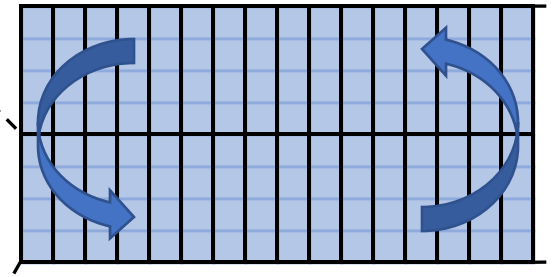
NEO Surveyor – Cadence design

1 Visit =
6 Exposures
(4 detectors per exposure)



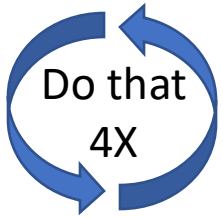
(3 minutes)

1 Loop =
~30 Visits

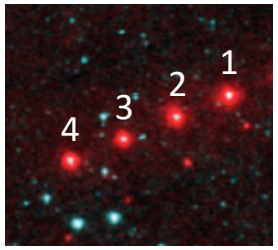


(2 hours)

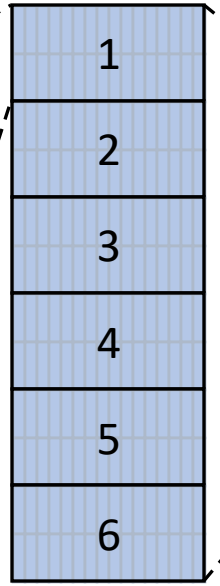
1 Quad =
4 Loops



(8 hours)

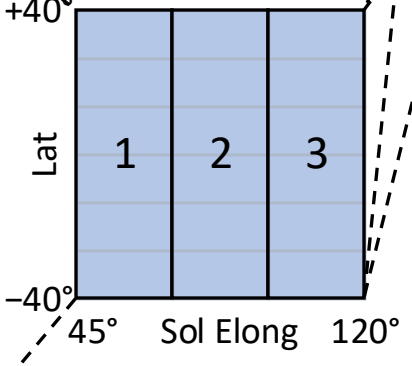


1 Stack =
6 Quads



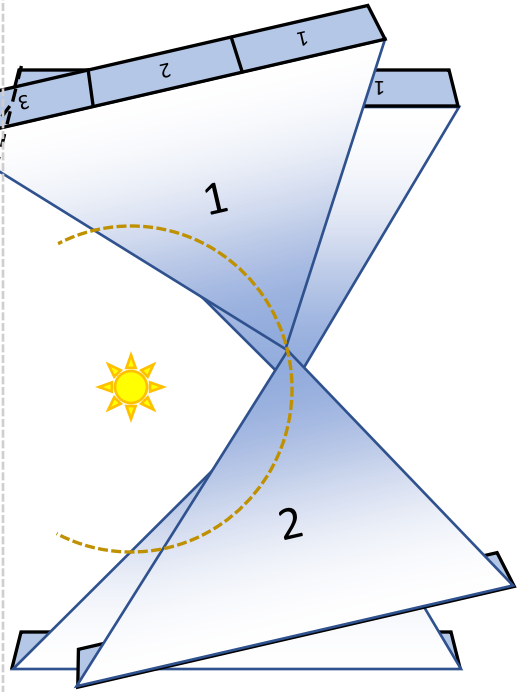
(2.2 days)

1 Side =
3 Stacks



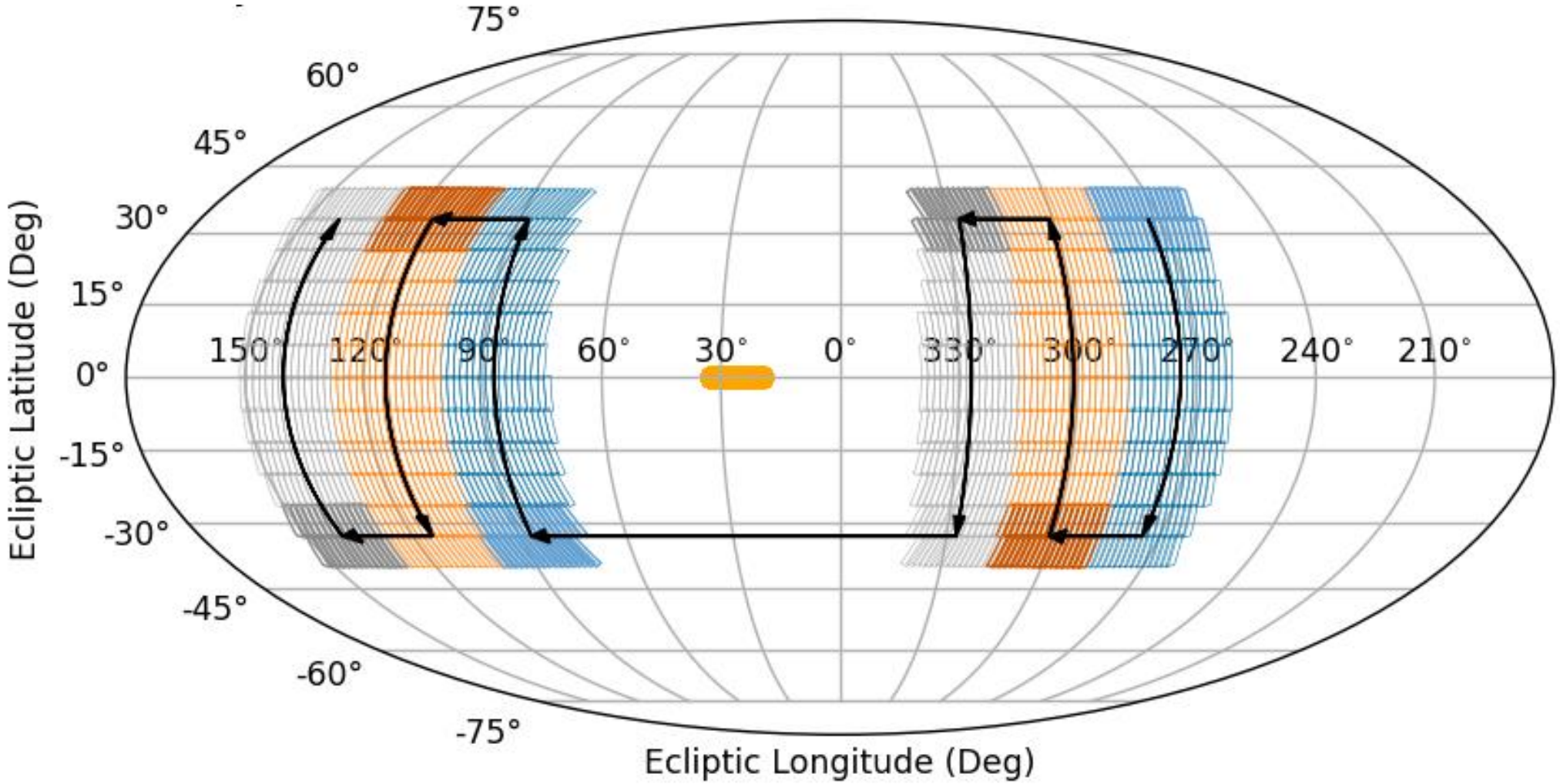
(6.6 days)

Complete Observing
Cycle = 2 Sides

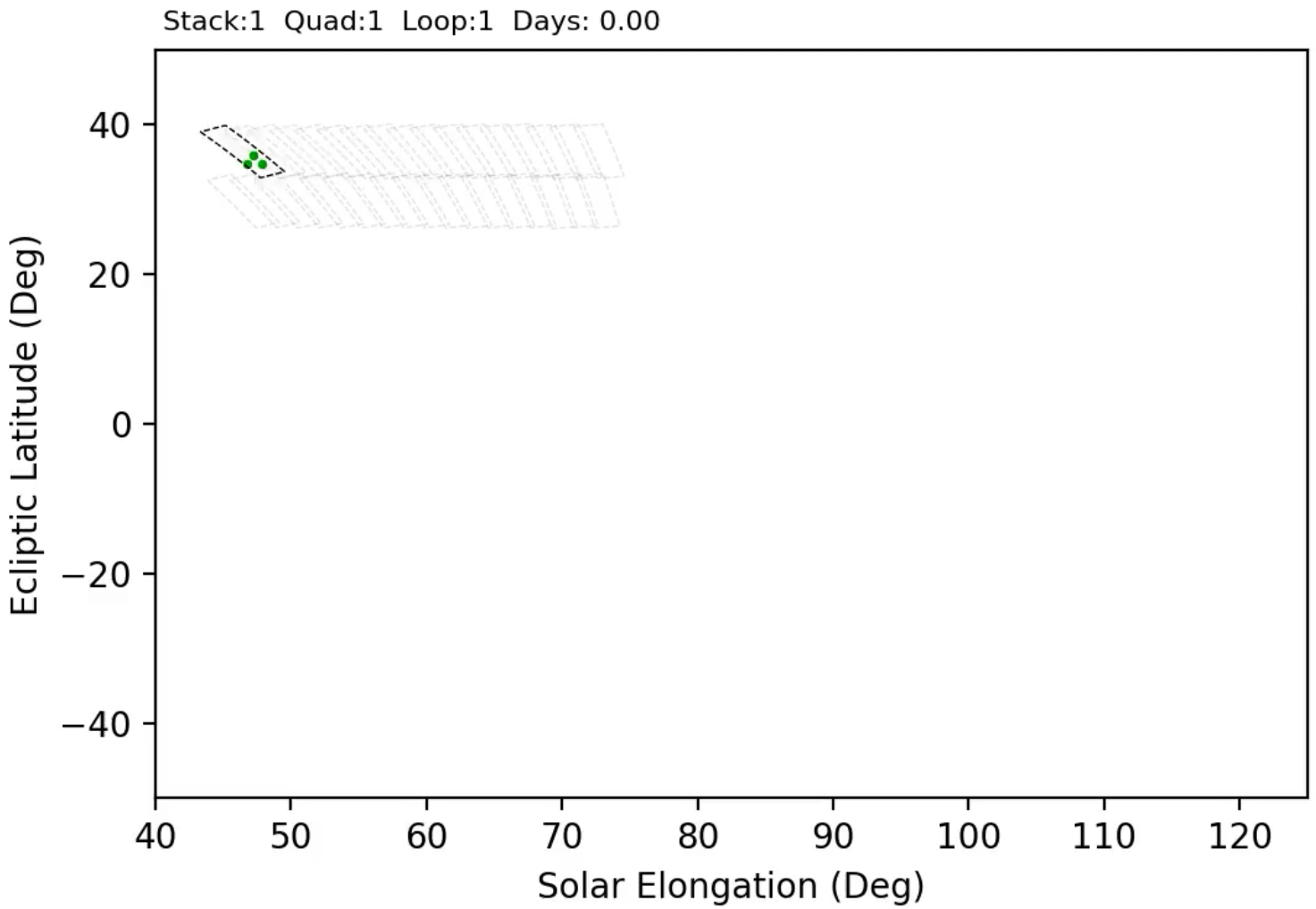


(13.2 days)

Survey Plan mapped on sky



Survey Plan In Action



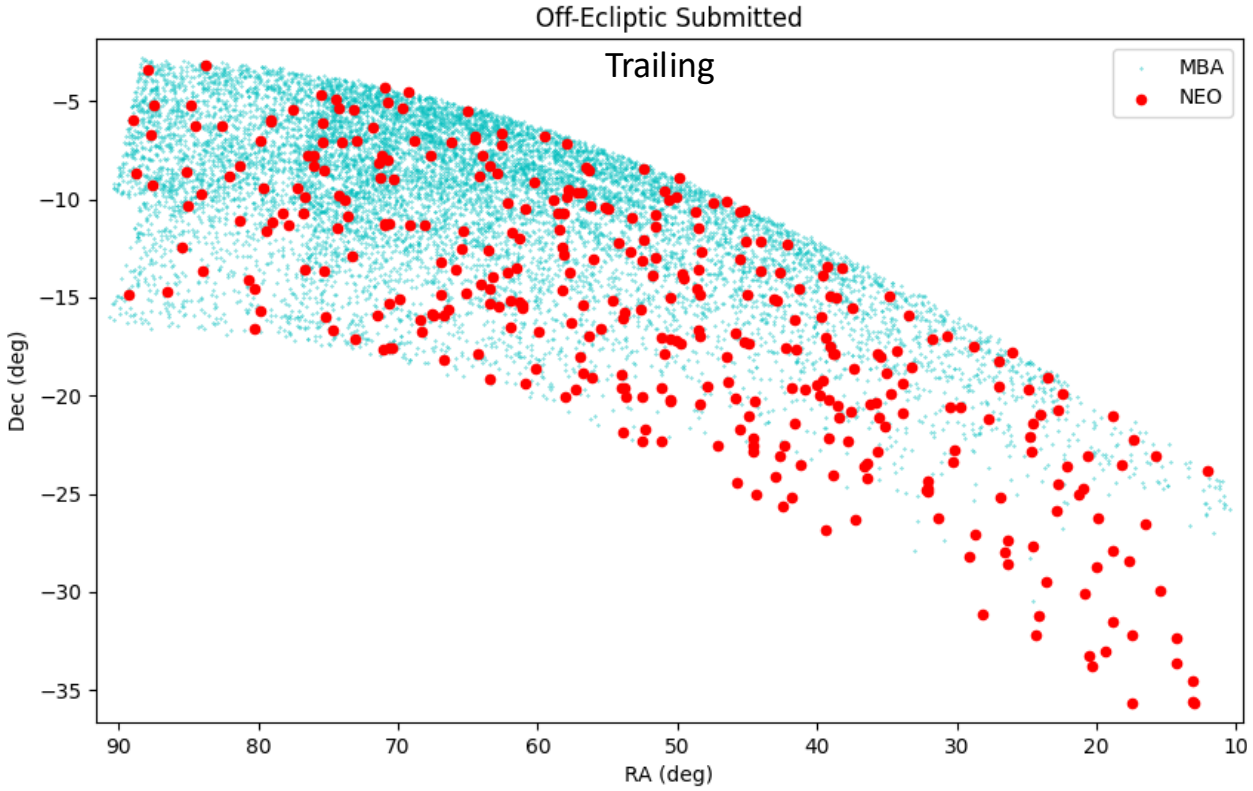
NEO Surveyor Image Simulator

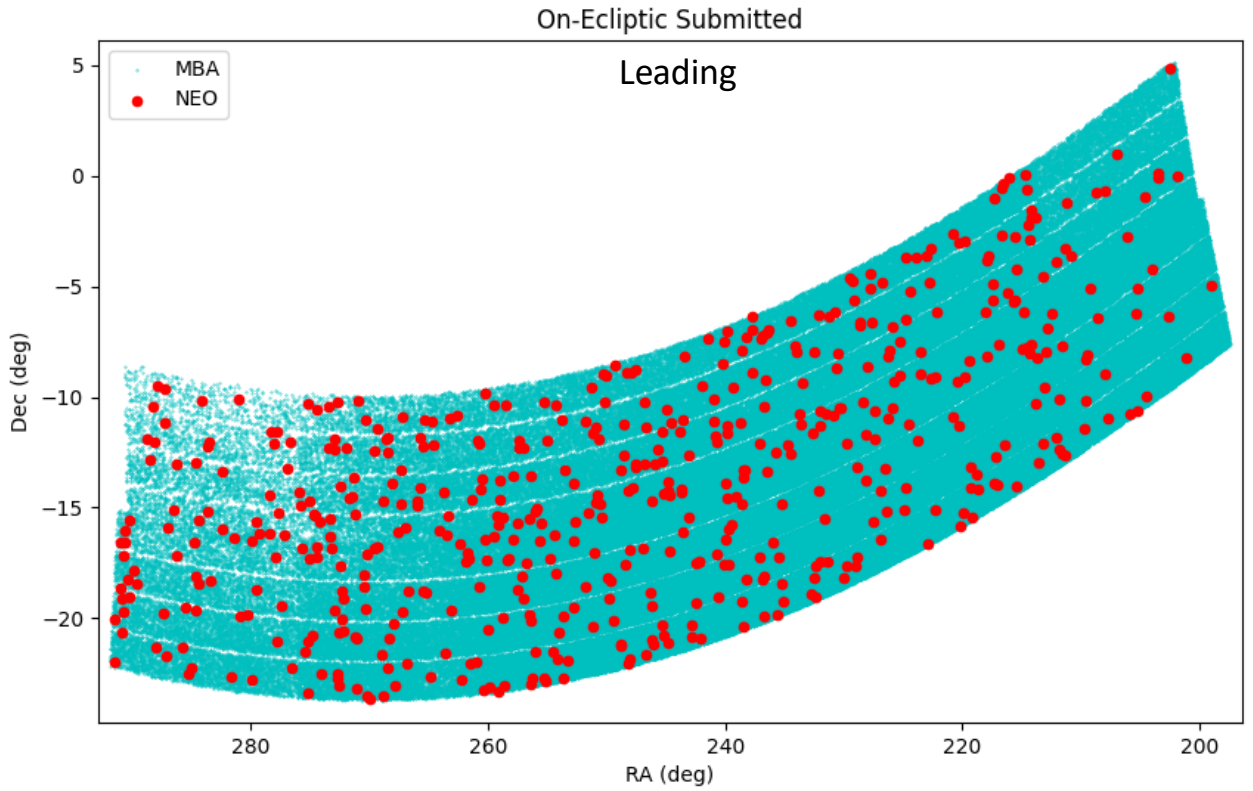
Simulated NEO Surveyor “Quad” Image cutout
0.8°x0.8°
elon,elat=38°,+7°

4.6 microns
4.6+8 microns
8 microns

Testing from image simulation to MPC delivery

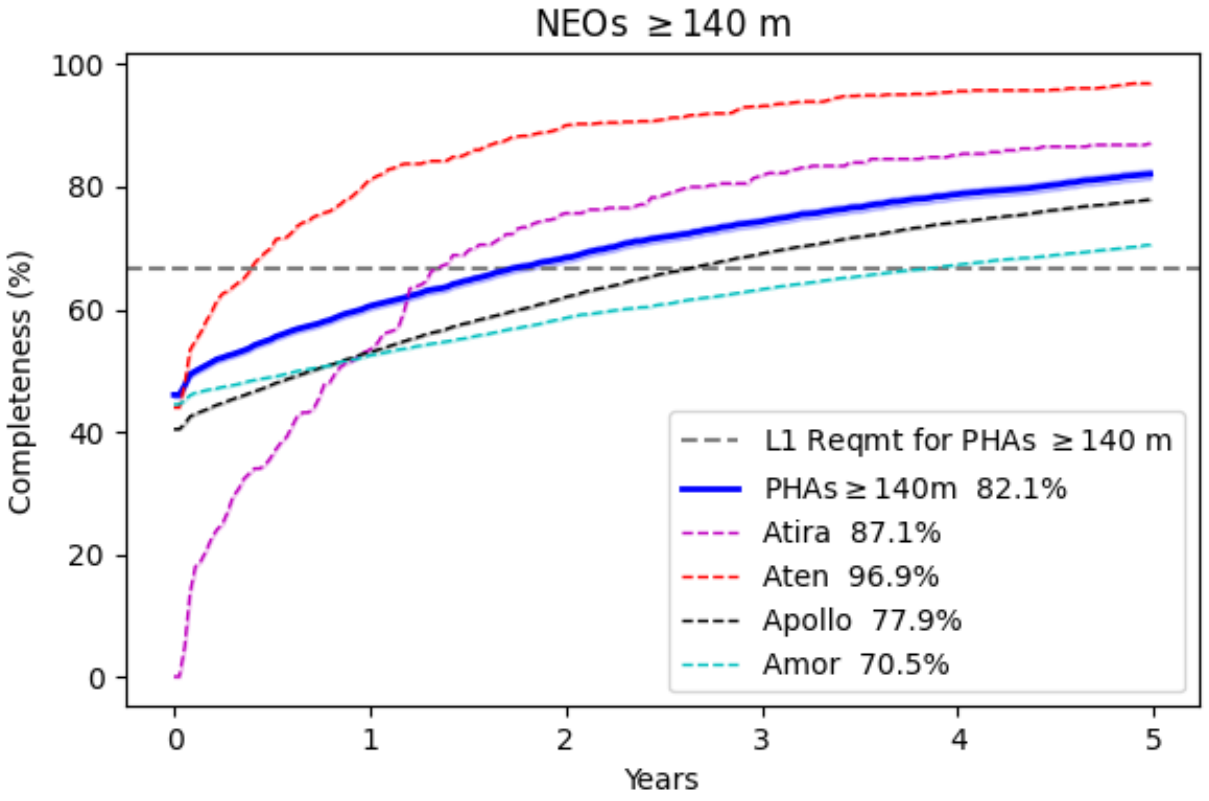
- Simulated images are run through the Survey Data System at IPAC, from image processing to source detection to generation of tracklets
- Example test data from 3 passes of 3 Quads off-ecliptic (left) and on-ecliptic (right) have been submitted to MPC for processing, linking, and orbit determination testing
- NEO sky density is ~flat in NEO Surveyor field of regard, but MBA density peaks strongly toward the ecliptic

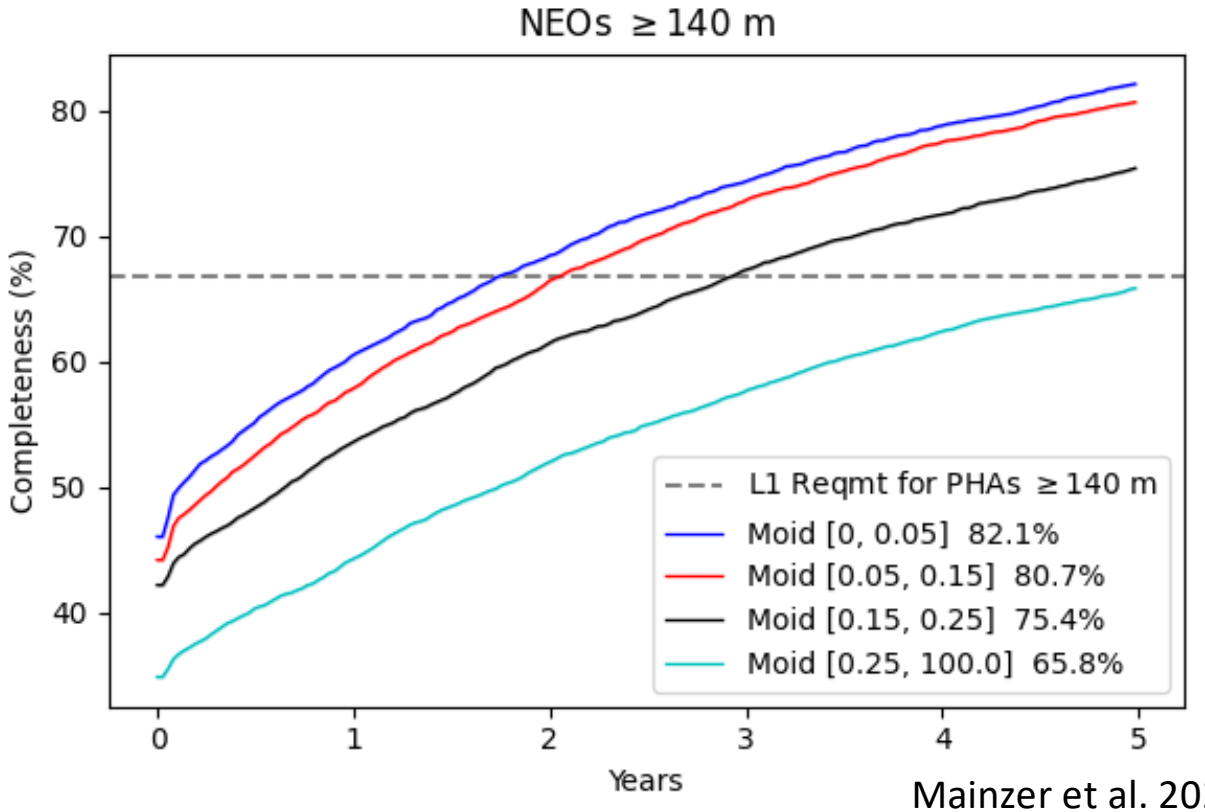




Survey Completeness vs. MOID & vs. Object Type

- NEOS will meet its baseline objectives within its 5-year nominal mission.
- It will reach >90% survey completeness for potentially hazardous asteroids >140 m in 10-12 years.
  - Survey is particularly effective at finding PHAs (MOID < 0.05 au), Atens, and Atiras.





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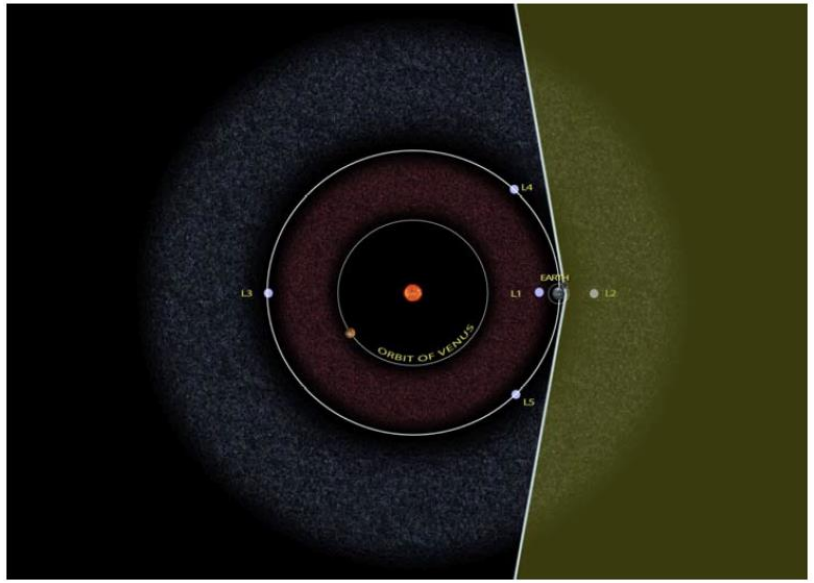
Synergy Between Surveys

- **Vera Rubin and NEO Surveyor cover complementary regions of near-Earth space as shown in the two images to the right**
- **Rubin's LSST survey (yellow shaded region) is most sensitive to NEOs outside the Earth's orbit (blue points)**
- **NEO Surveyor's area of regard (pink shaded region) is most sensitive to NEOs along or inside the Earth's orbit.**
- **Combined, these two systems will provide regular monitoring of objects over the majority of their orbit, constraining complementary physical properties that are needed for impact hazard assessment.**



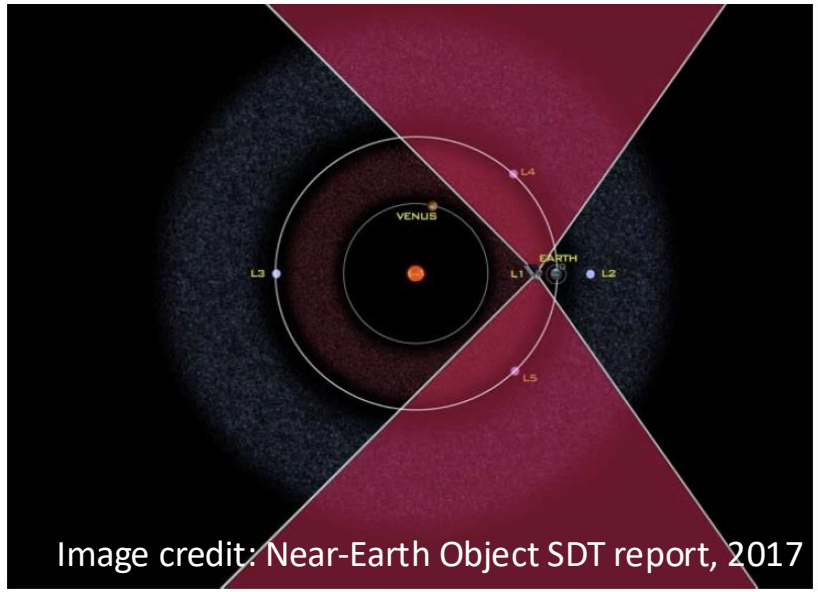
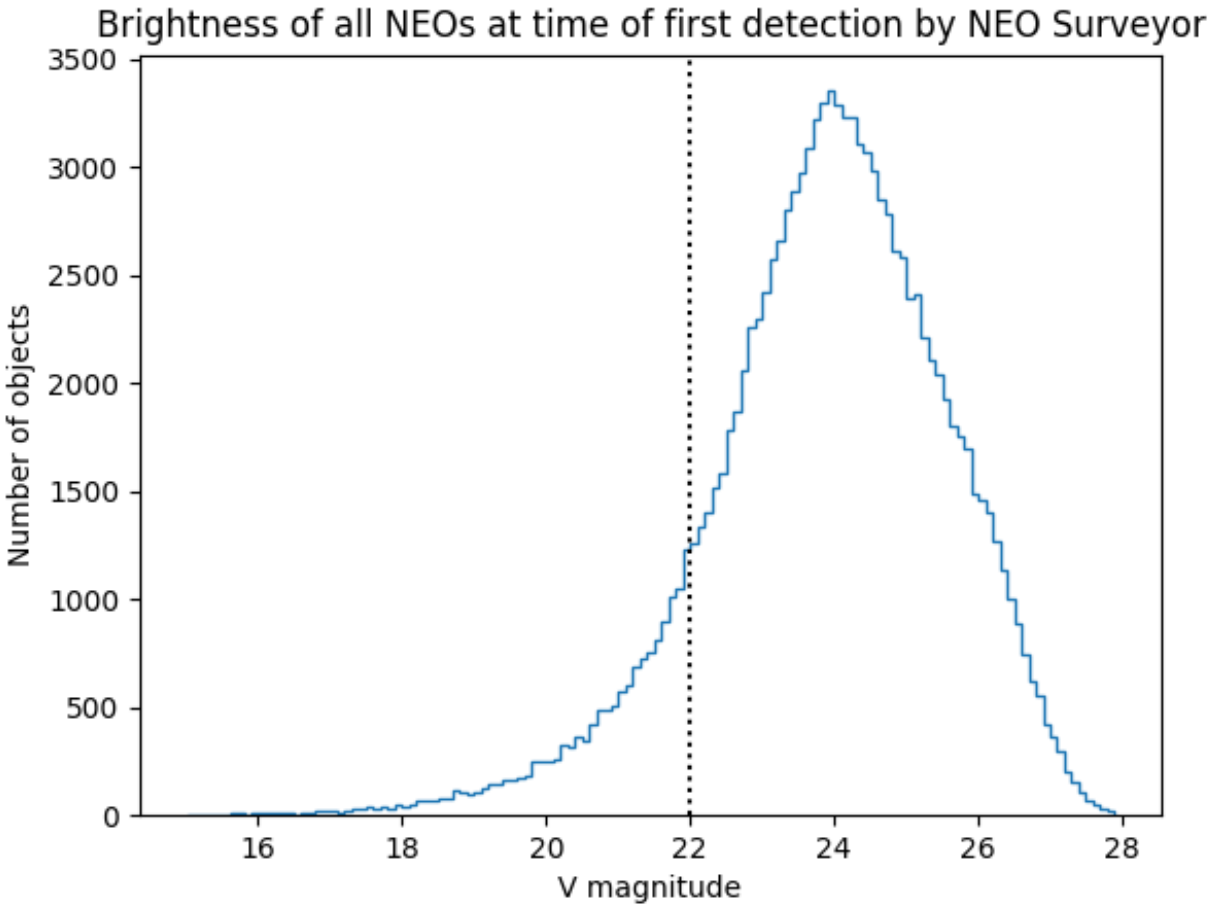
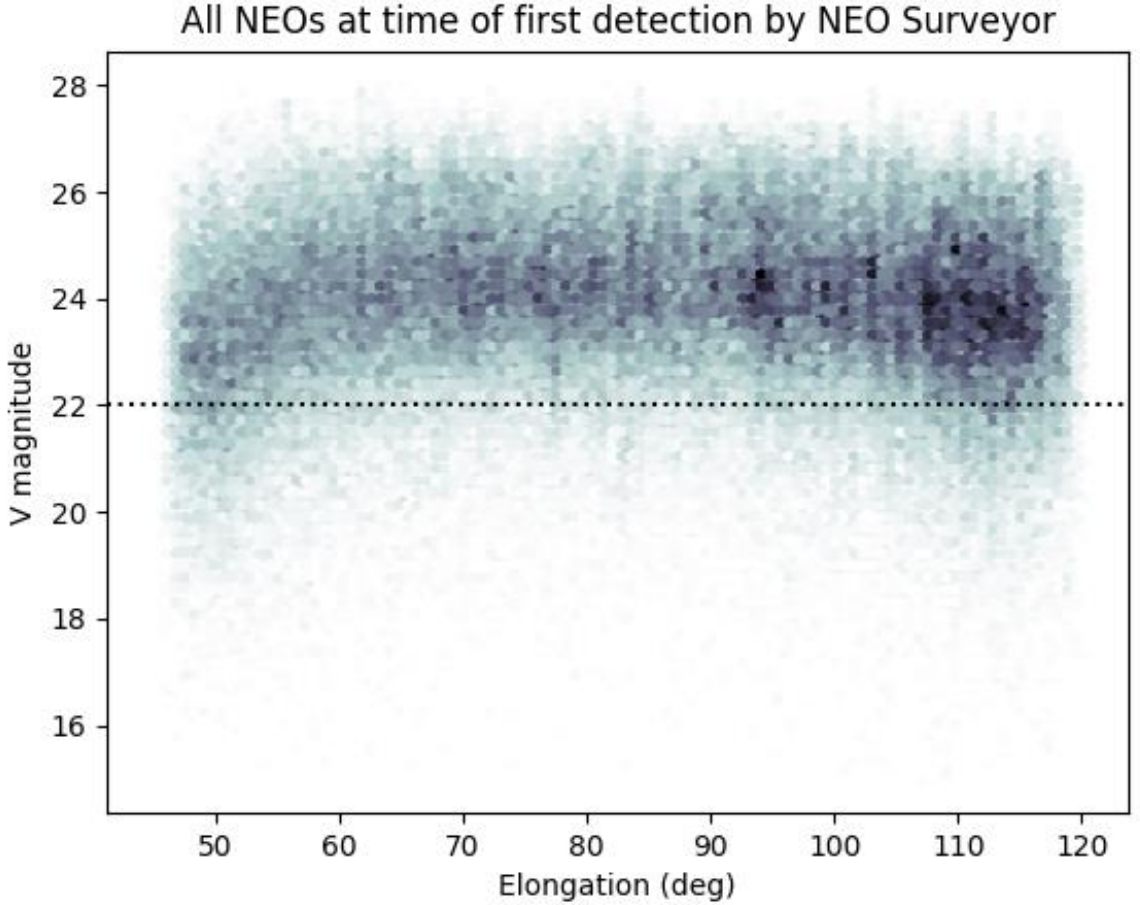


Image credit: Near-Earth Object SDT report, 2017

Predicted V band brightness of newly discovered NEOs





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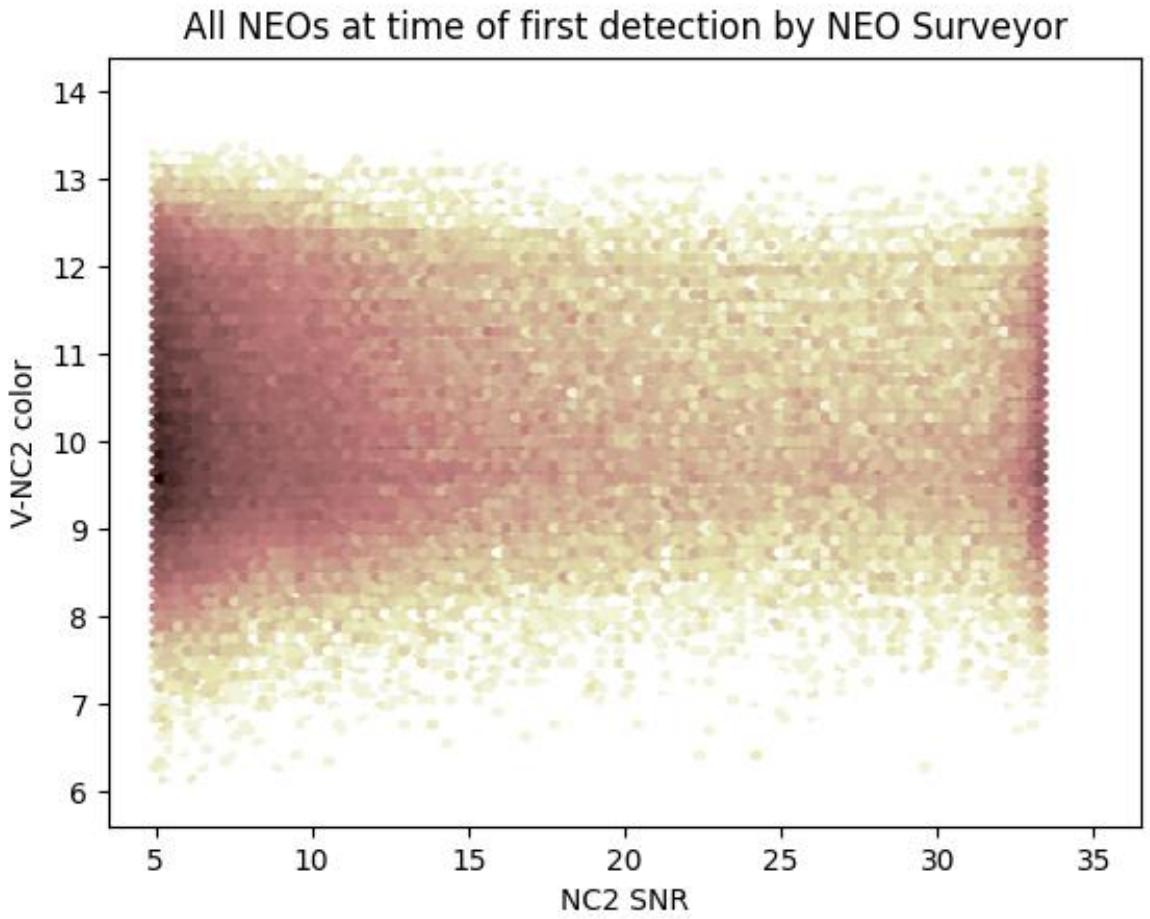
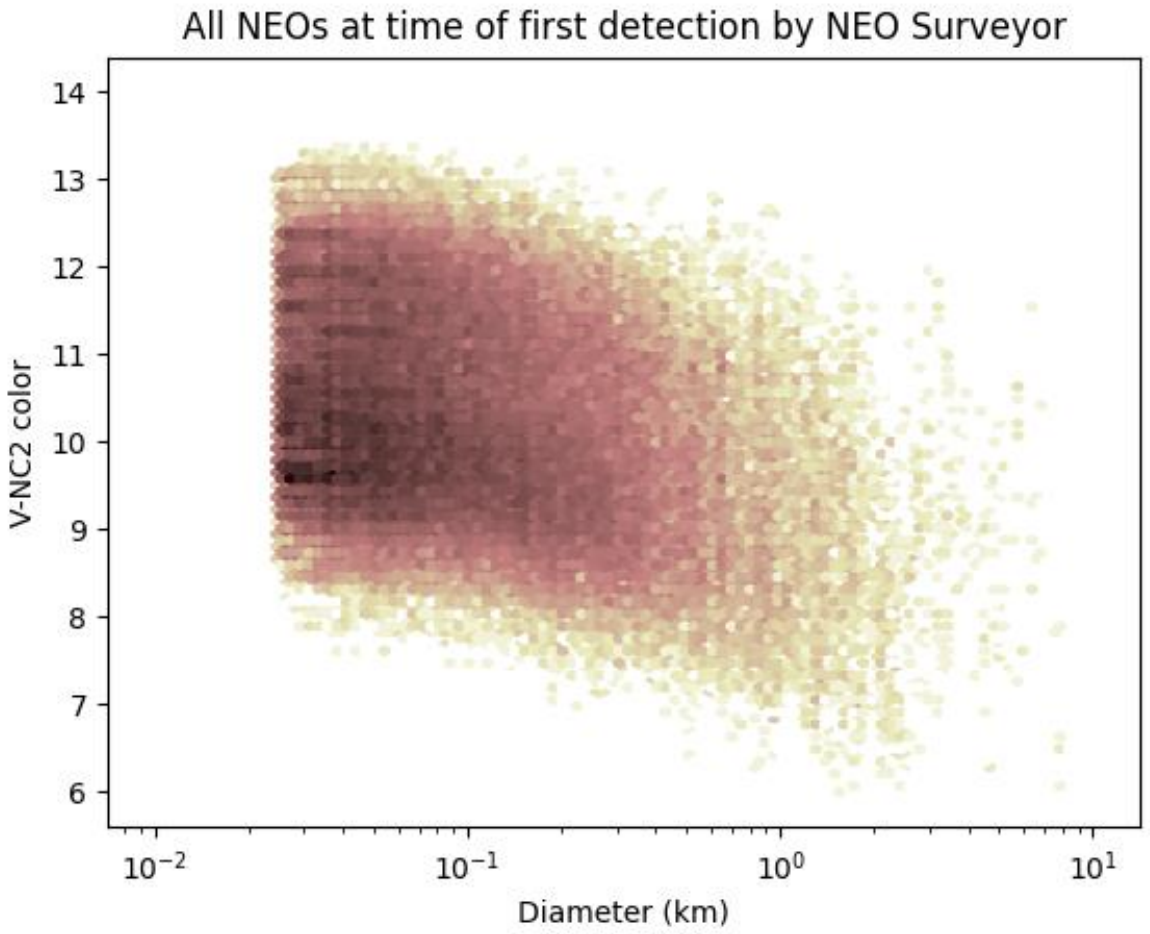
V-NC2 color (log scale binning)





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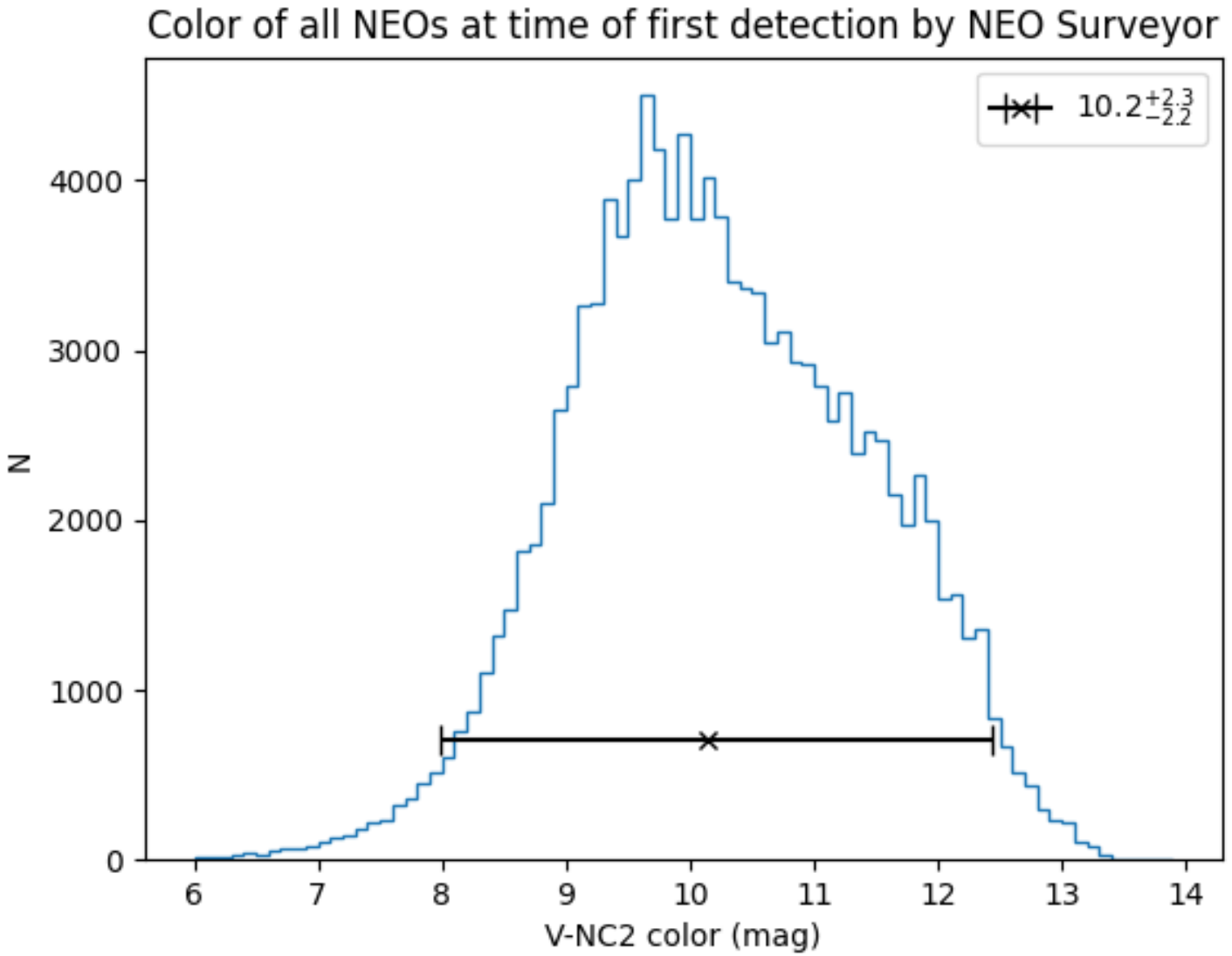
NEO Surveyor mission



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Pretty pictures

Telescope enclosure in JPL Highbay (10/25/24)

Telescope setup for alignment testing

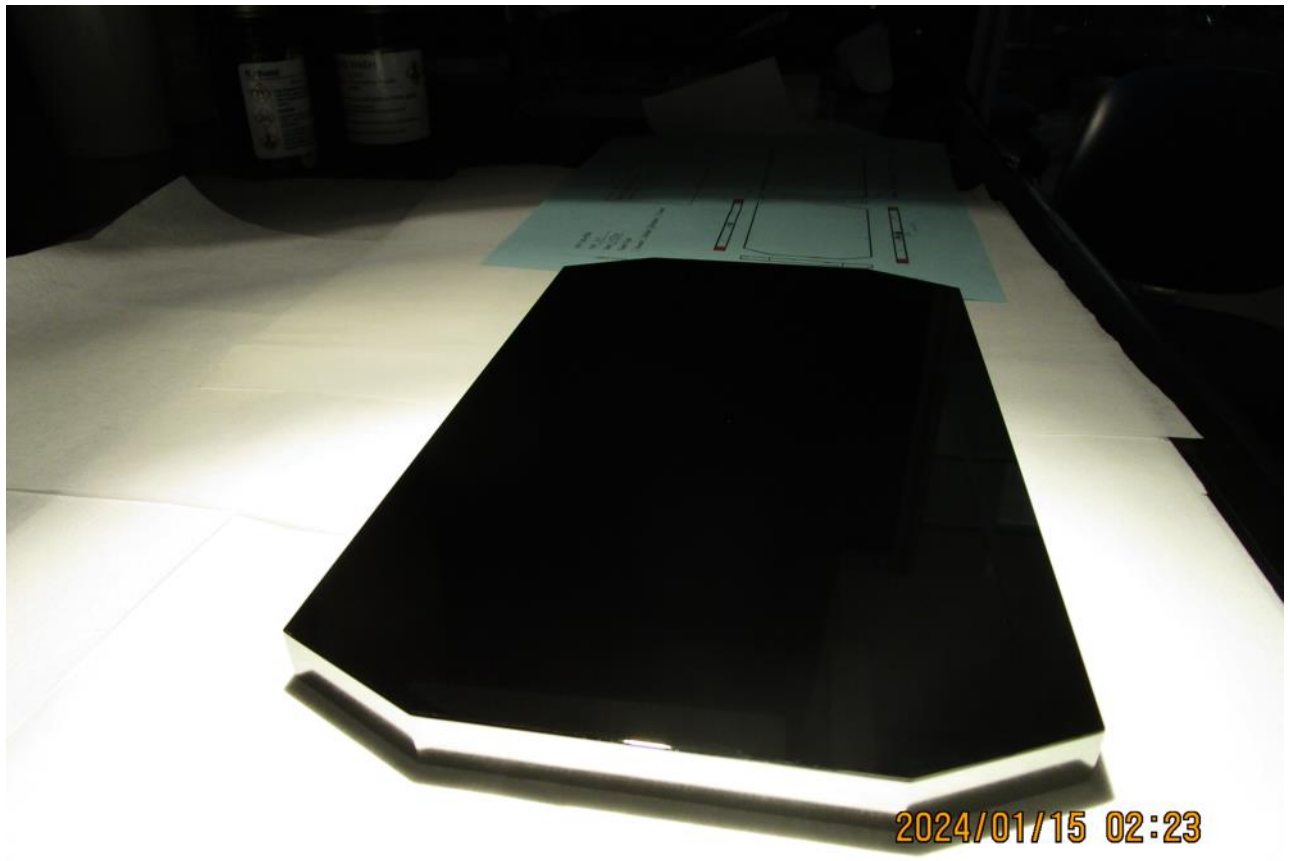
NEOS Telescope Assembly Finished

NEOS Telescope First Light

Technicians installing SMRs on the Telescope and OGSE

(a real human for scale!)

Flight Beamsplitter



Conclusions

- NEO Surveyor will execute a cadence to find and characterize >2/3rds of NEOs in 5 years
- NEO Surveyor will provide orbits and sizes for >100,000 near-Earth objects
- Median Visible magnitude of new NEOs will be V~24
- Mission will provide estimated V magnitudes for newly-discovered objects, but this will have significant uncertainty (~4.5 mags range to cover 95% percent of cases)
- Estimated V mags are important for planning followup characterization observations (e.g. spectra) as well as improve the results from routines like MPC's Digest2