Near-Earth Asteroid Observations with the Arecibo Planetary Radar

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Observatory and Radar Group Status

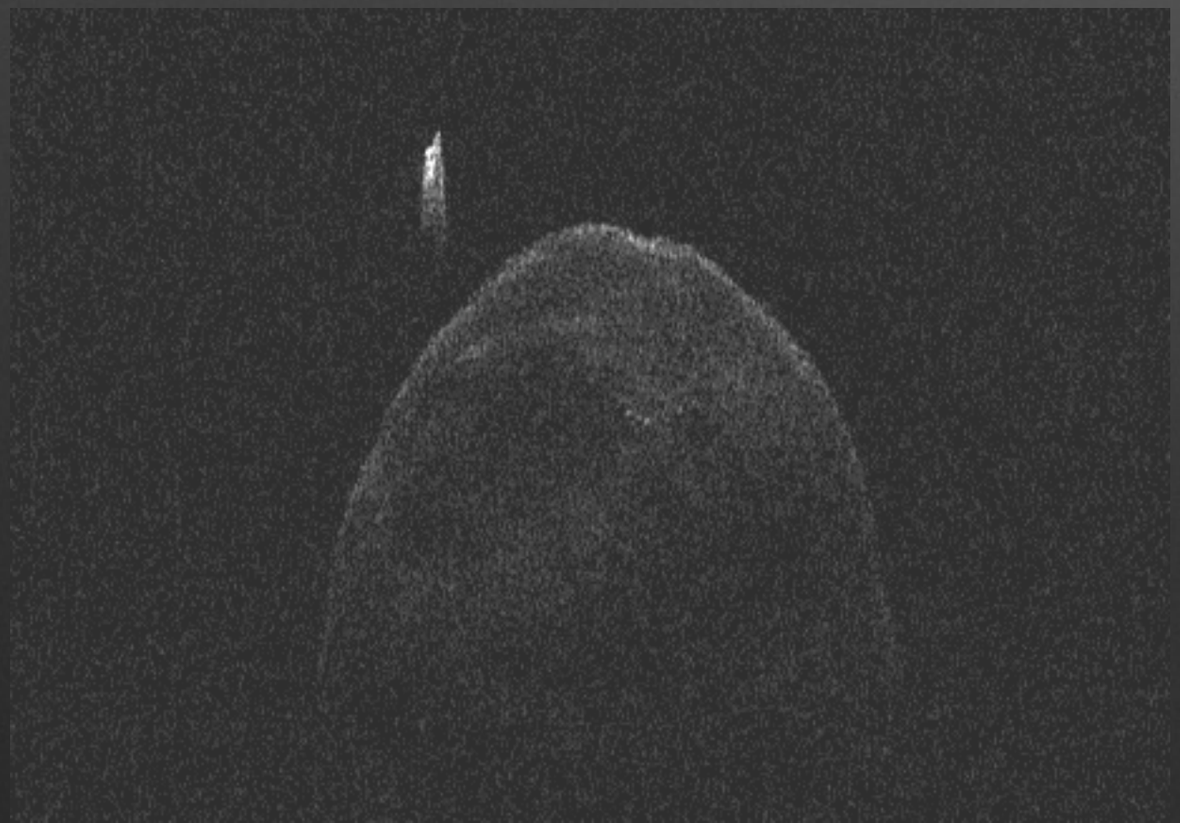
- Arecibo Observatory is a facility of the NSF currently managed by SRI, USRA, and UMet
- Reduced NSF funding for the observatory requires the radar program to rely entirely on outside support
- NASA NEOO funding supports the radar program:
  - $2M/year through September 2016 intended to fund basic telescope operations to observe at the traditional level of 20-30 objects per year

Observatory and Radar Group Status

- October 2013: Additional NASA NEOO funds allow for a 50% increase in telescope time (up to ~800 hr/yr)
  - Hired two new staff members and one new data analyst, and will hire two technicians soon
- December 2013: “Dear Colleague Letter” NSF 14-022 suggests continued decline in support for Arecibo from NSF Astronomy, but no concrete news
- NASA NEOO support of the radar program cannot support the observatory as a whole

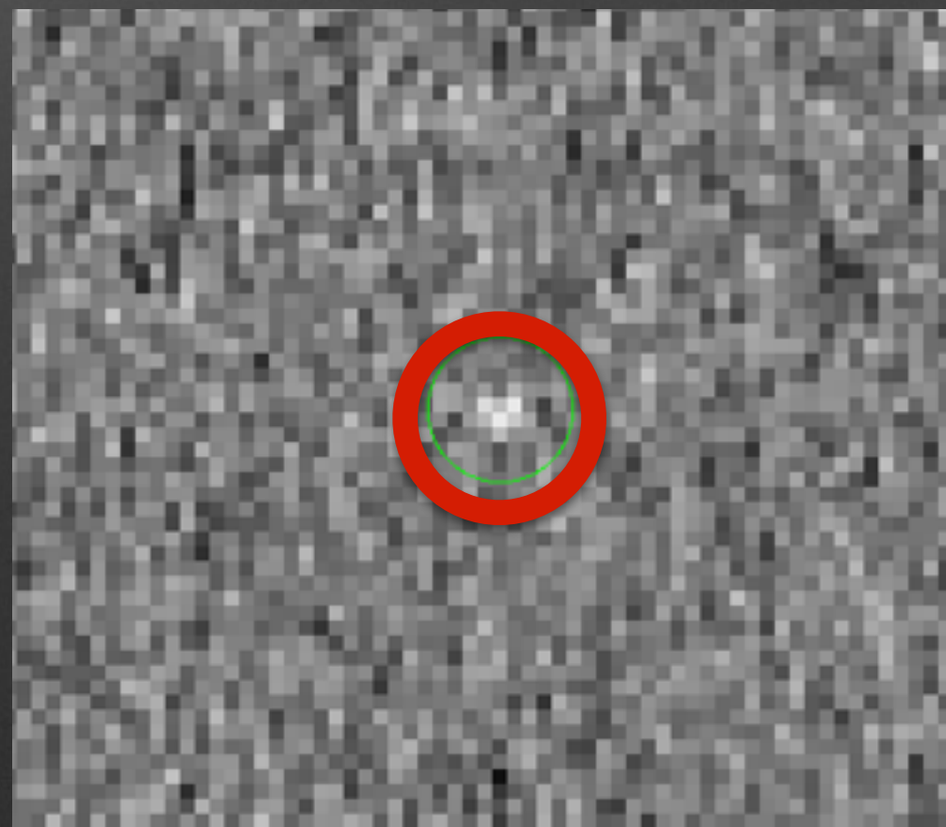
What Do We Measure with Radar?

- Line-of-sight distance and velocity —> Astrometry
- Object depth —> Size and shape
- Velocity dispersion —> Spin state
- Scattering properties —> Surface roughness, composition

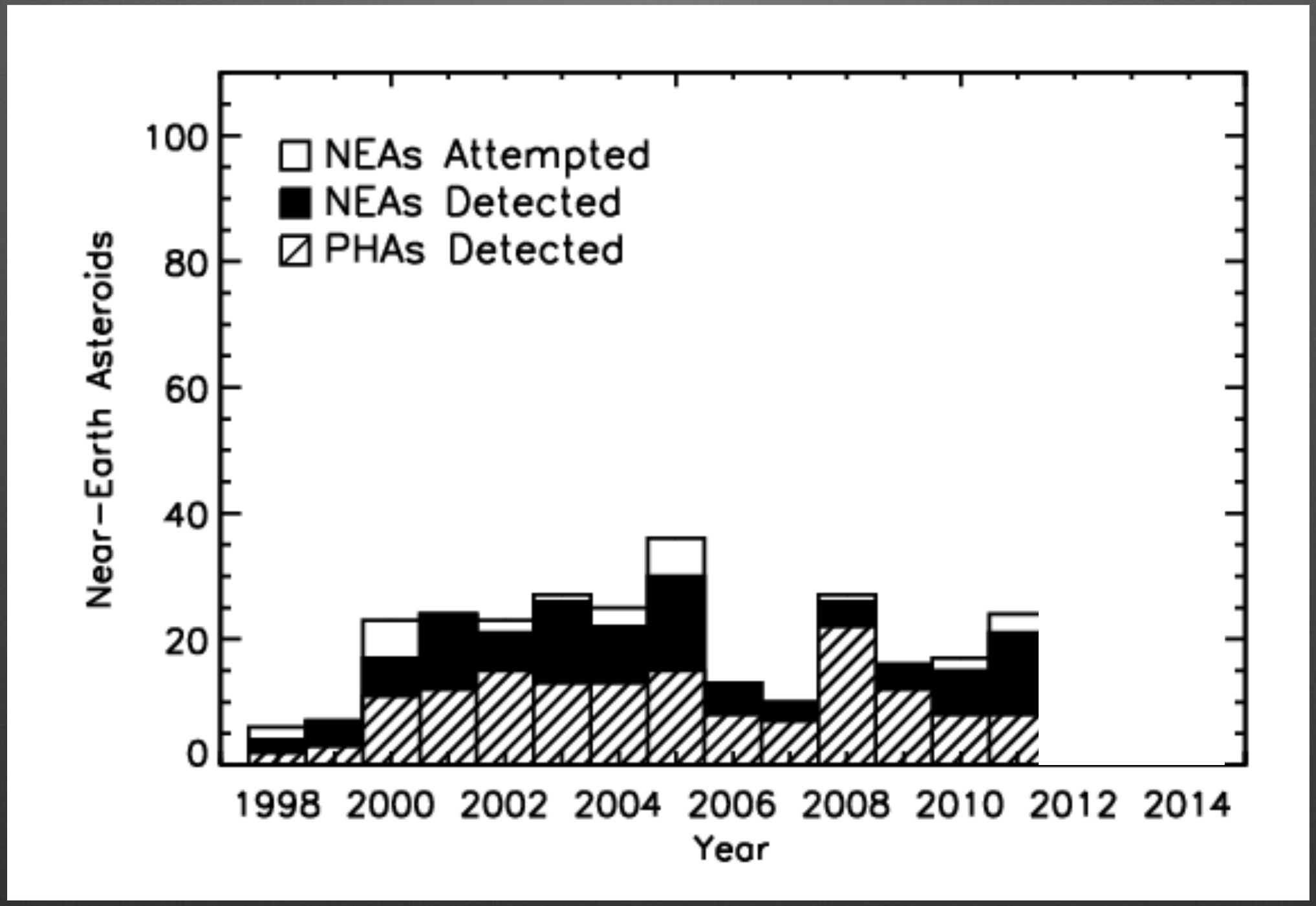


Left:
1998 QE2

Right:
Bennu

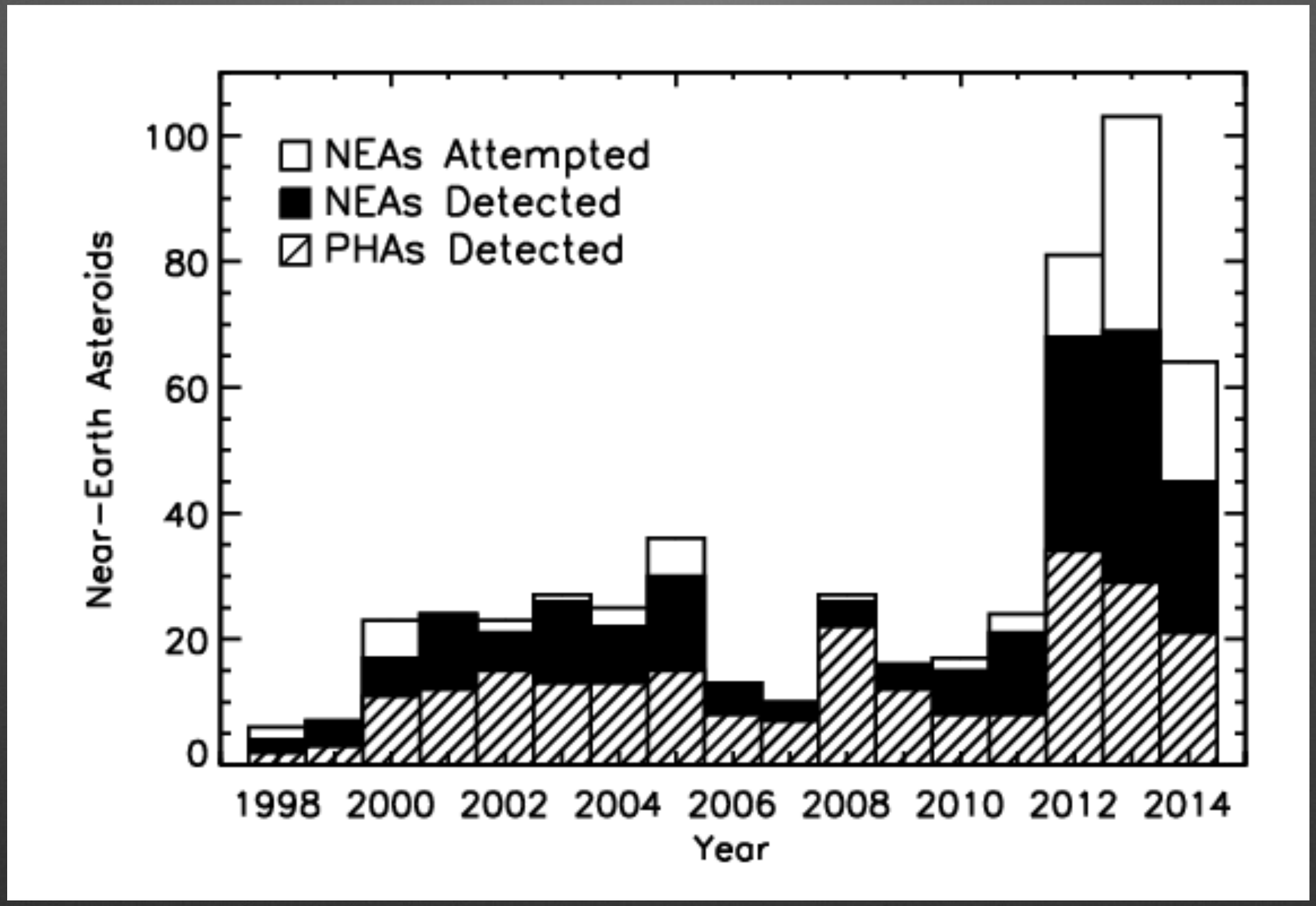


NEA Detections with Arecibo



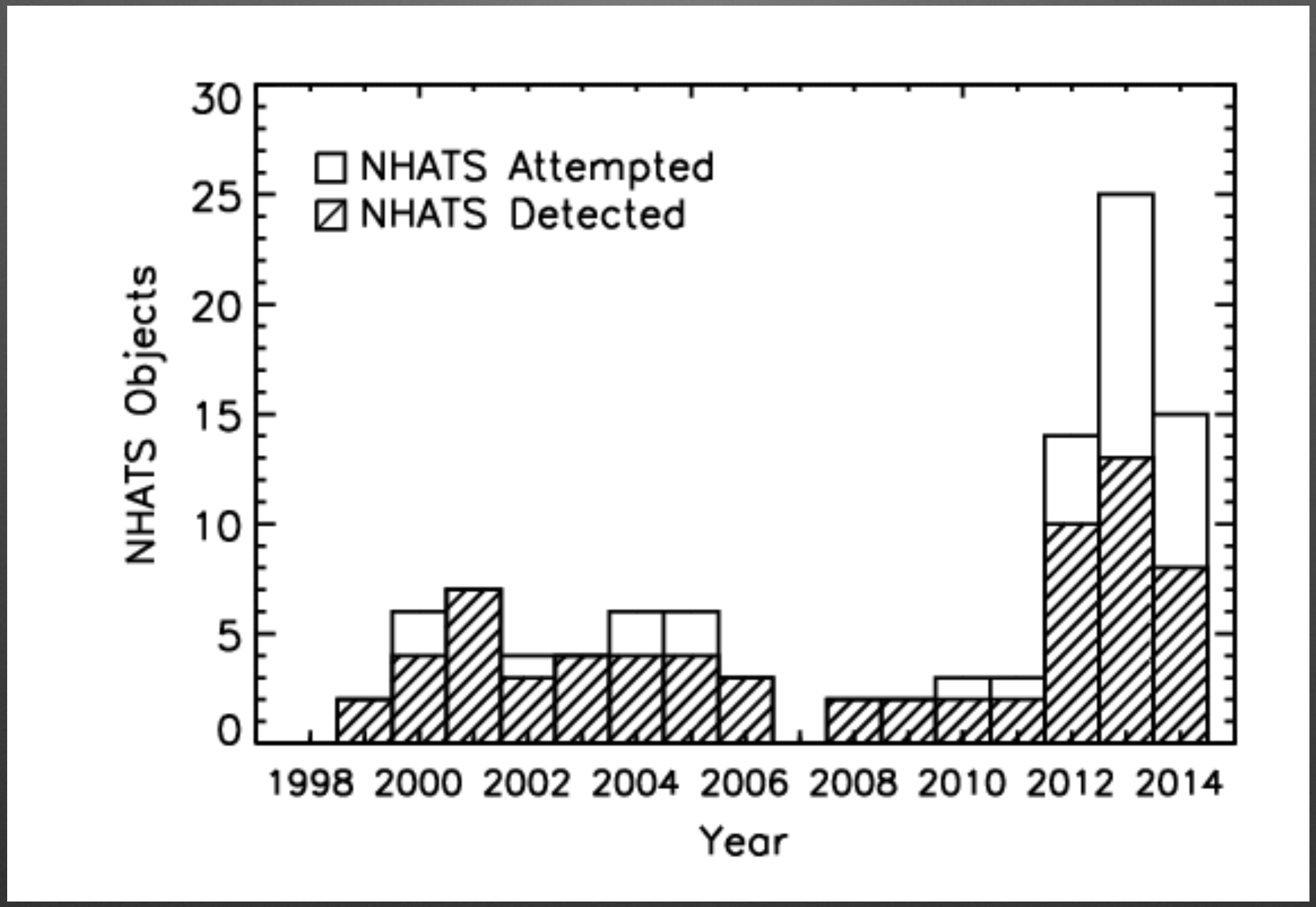
1998-2011: ~20 detections per year, mostly larger targets and PHAs.

NEA Detections with Arecibo



2012-2013: increase by a factor of 3+ in attempts and detections of NEAs.

NHATS Detections with Arecibo



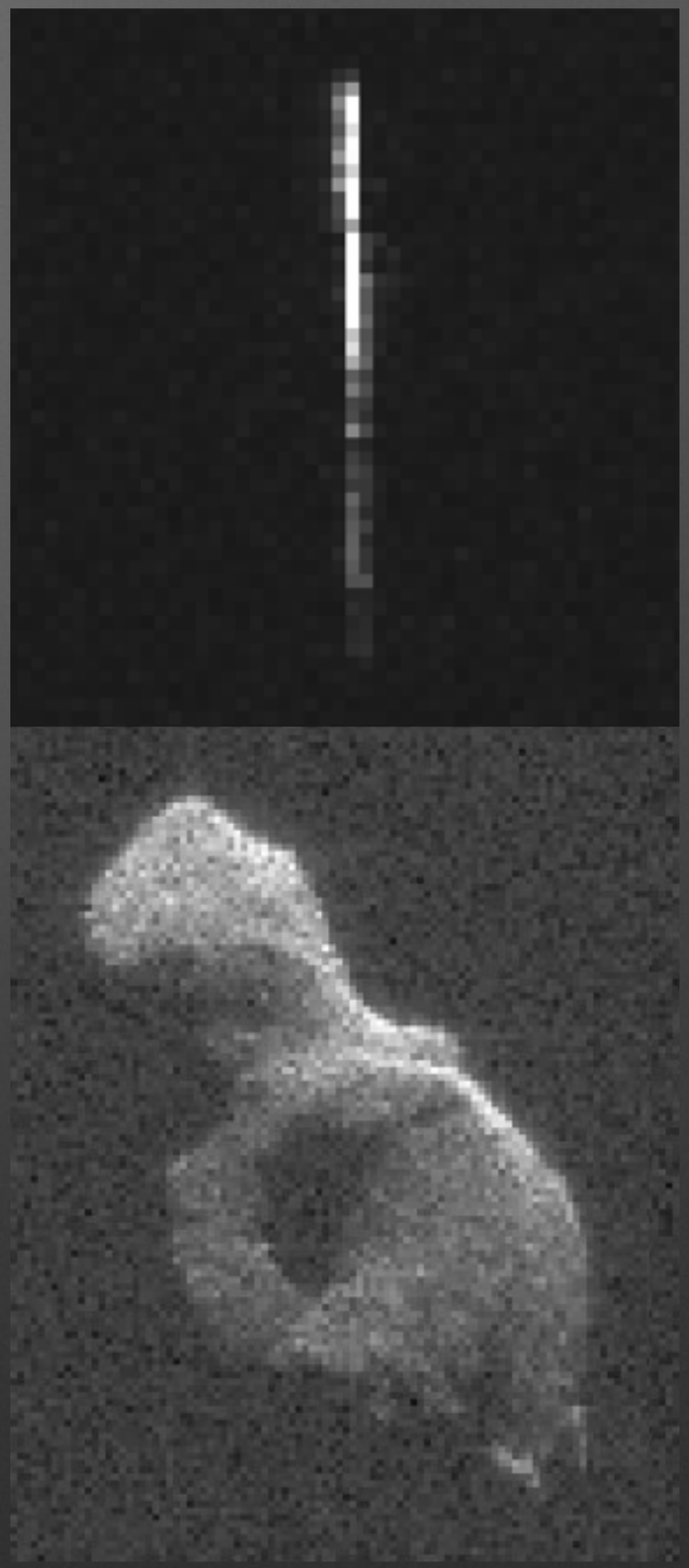
The increase in usage included a push to smaller objects.

Rapid Radar Response

- Since 2013, we responded to seven requests to observe potential NASA mission targets, detecting five of them
  - Astrometry reported for detected objects
- Rapid response to targets of opportunity are attempted on a best-effort basis and are contingent upon:
  - re-scheduling the telescope if necessary
  - having an available transmitter operator and observer
  - having an available observing ephemeris

New Capability: Bistatic X-band Imaging

- Goldstone transmits while Arecibo receives
  - Allows for 3.75-m resolution
  - Allows for frequency-resolved images of very close objects
  - Five times more sensitive than Goldstone monostatic
  - Right: 2014 HQ124 at ~5 lunar distances
    - Top: Arecibo monostatic, 7.5 m x 0.25 Hz
    - Bottom: G—>A bistatic, 3.75 m x 0.0125 Hz



Summary of Arecibo Radar Status

- The radar program at Arecibo is strong and growing: funding increased, telescope usage and detections up and increasing, personnel expanding
- However, continued NSF support to maintain the underlying facility is not assured
- We are sampling the small end of the population, though inherent faintness and (often) rapid rotation makes observations difficult
- We need to work closely with survey/discovery programs and the JPL NEO program office to have telescope time available, both at Arecibo and Goldstone, to rapidly follow up on new, desirable targets while “brightest,” i.e., close to Earth