NASA
Near-Earth Object Observations (NEOO) Program

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NEO Observations Program

Detection and tracking of natural objects – asteroids and comets – that approach within 28 million miles of Earth's orbit

US component to International Spaceguard Survey effort

Has provided 98% of new detections of NEOs since 1998

Began with NASA commitment to House Committee on Science in May 1998 to find at least 90% of 1 km and larger NEOs

- That goal reached by end of 2010

NASA Authorization Act of 2005 increased scope of objectives:

- Amended National Aeronautics and Space Act of 1958 ("NASA Charter") to add:

  "The Congress declares that the general welfare and security of the United States require that the unique competence of the National Aeronautics and Space Administration be directed to detecting, tracking, cataloguing, and characterizing near-Earth asteroids and comets in order to provide warning and mitigation of the potential hazard of such near-Earth objects to the Earth."

- Made NEO detection, tracking and research 1 of 7 explicit purposes stated for NASA!
- Provided additional direction:

  "…plan, develop, and implement a Near-Earth Object Survey program to detect, track, catalogue, and characterize the physical characteristics of near-Earth objects equal to or greater than 140 meters in diameter in order to assess the threat of such near-Earth objects to the Earth. It shall be the goal of the Survey program to achieve 90 percent completion of its near-Earth object catalogue within 15 years [by 2020]"

Recent National Interest in Asteroid Detection

Congressman Lamar Smith (R-Texas) — Chairman of U.S. House of Representatives Committee on Science, Space, and Technology

"Threats from Space: A Review of U.S. Government Efforts to Track and Mitigate Asteroids and Meteors, Part 1"

Congressional Hearing by the U.S. House of Representatives Committee on Science, Space, and Technology (19 March 2013), post-Chelyabinsk event

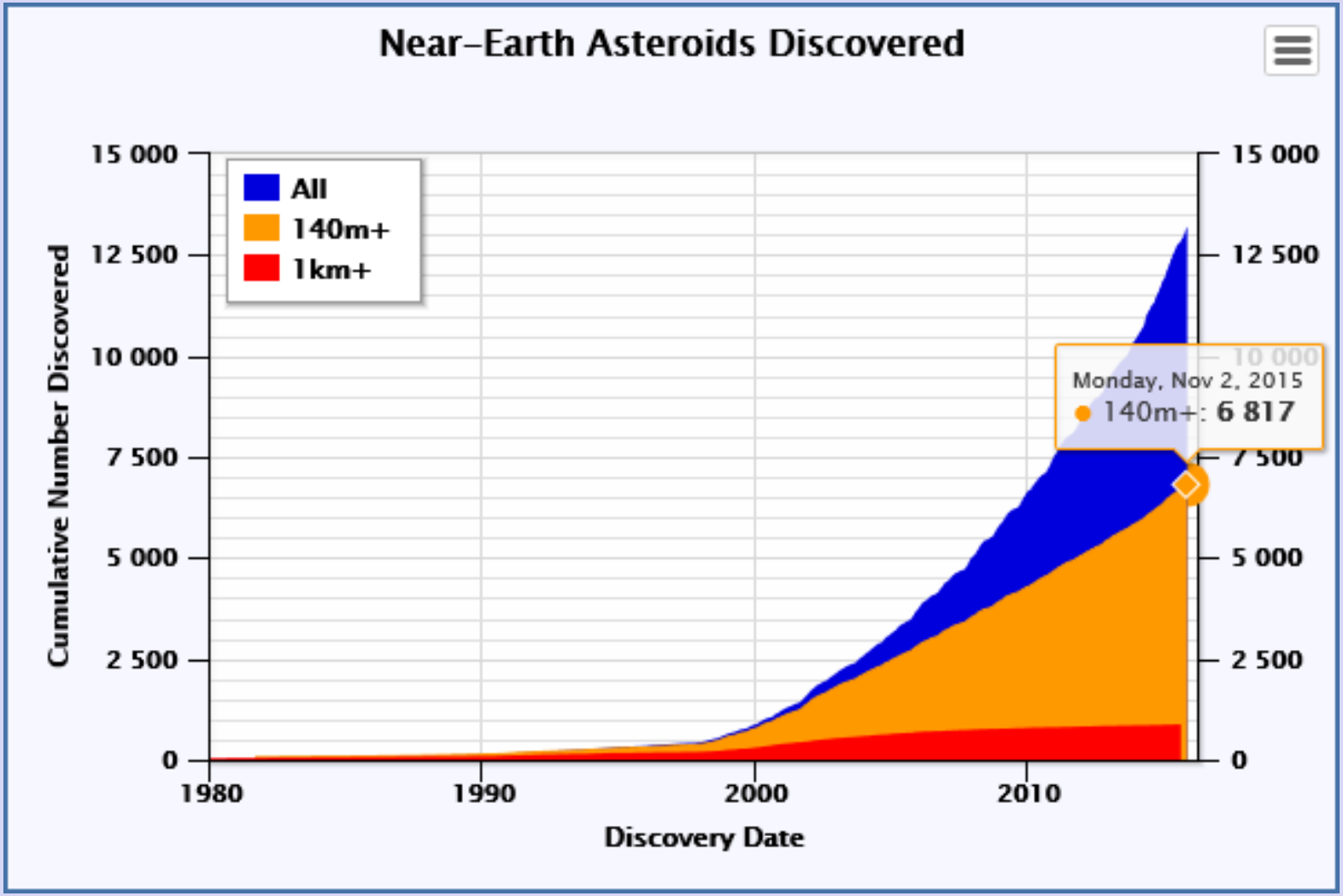
General William Shelton — then-Chief of the U.S. Air Force Space Command

"The Administration places a high priority on tracking asteroids and protecting our planet from them, as evidenced by the five-fold increase in the budget for NASA's NEOO program since 2009. The United States has an effective program for discovering larger NEOs, but we need to improve our capabilities for the identification and characterization of smaller NEOs."

John Holdren, Director, Office of Science and Technology Policy, Science advisor to President Barack Obama

Administration guidance was provided in OSTP Letter to Congress dated 15 October, 2010, as Response to Section 804 of NASA Authorization Act of 2008
https://www.whitehouse.gov/sites/default/files/microsites/ostp/ostp-letter-neo-senate.pdf

Known Near Earth Asteroid Population



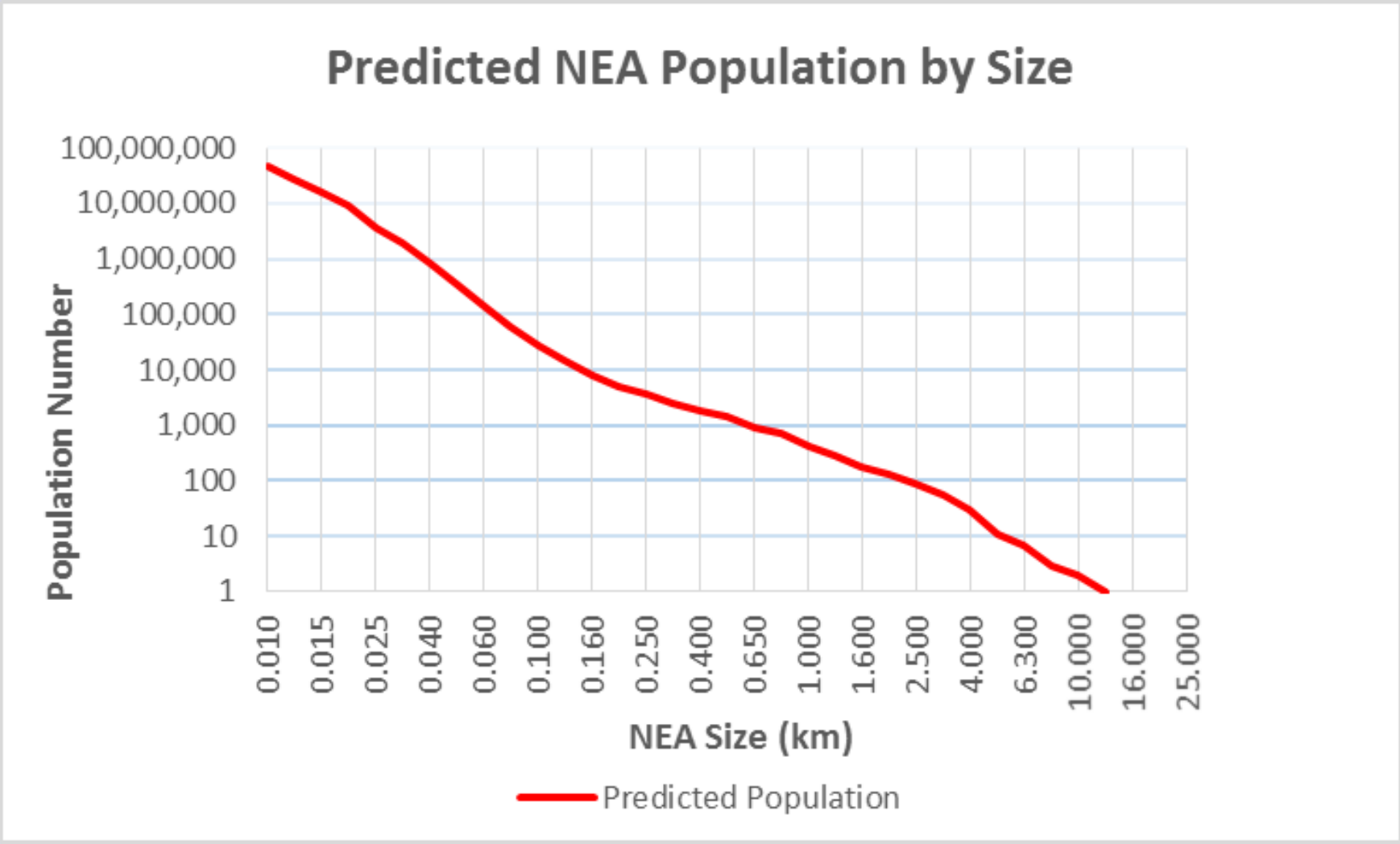
As of 11/03/15
13,206

Also 104 comets

1639 Potentially Hazardous Asteroids
Come within 5 million miles of Earth orbit

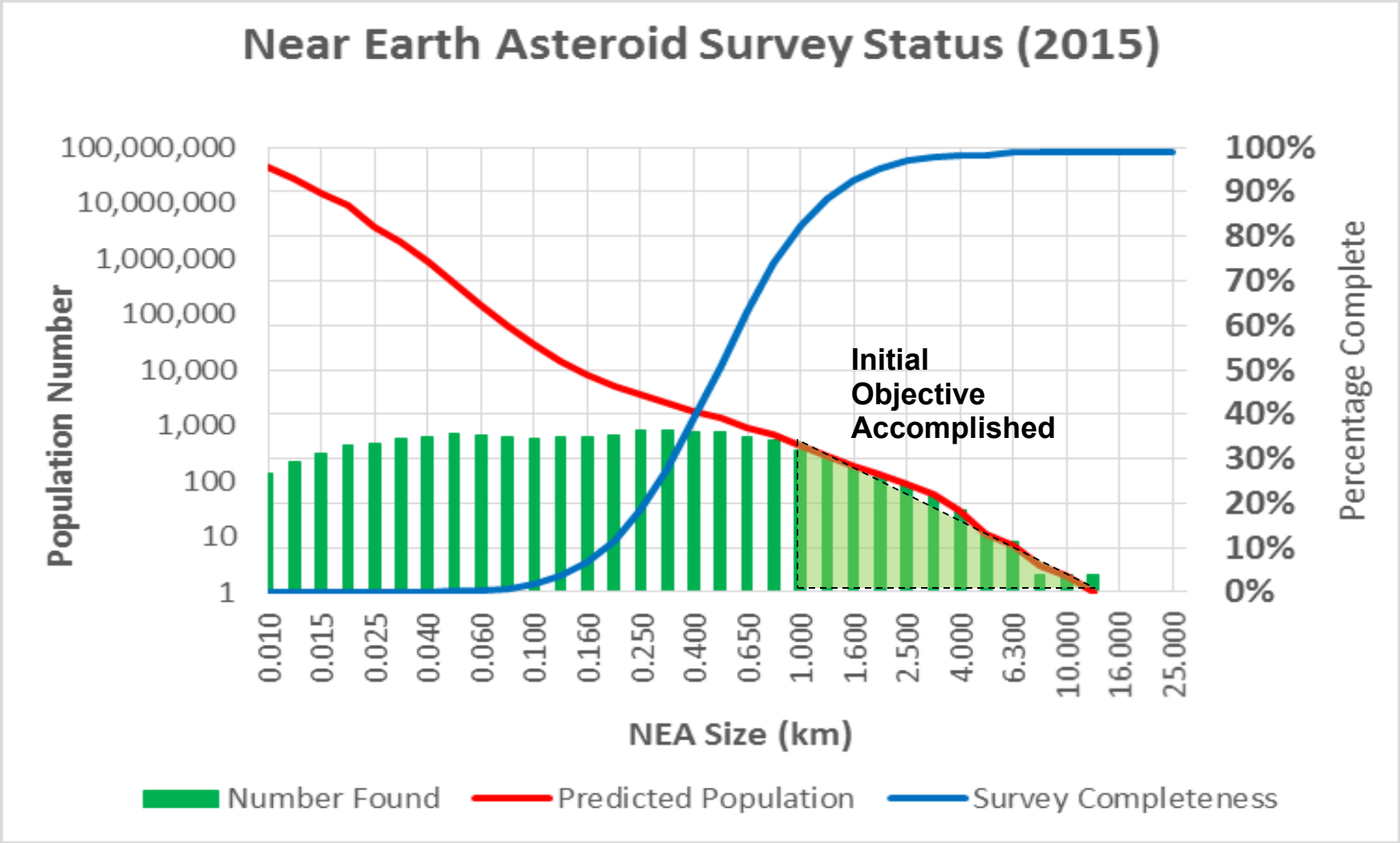
876
153 PHAs

Near Earth Asteroid Survey Status

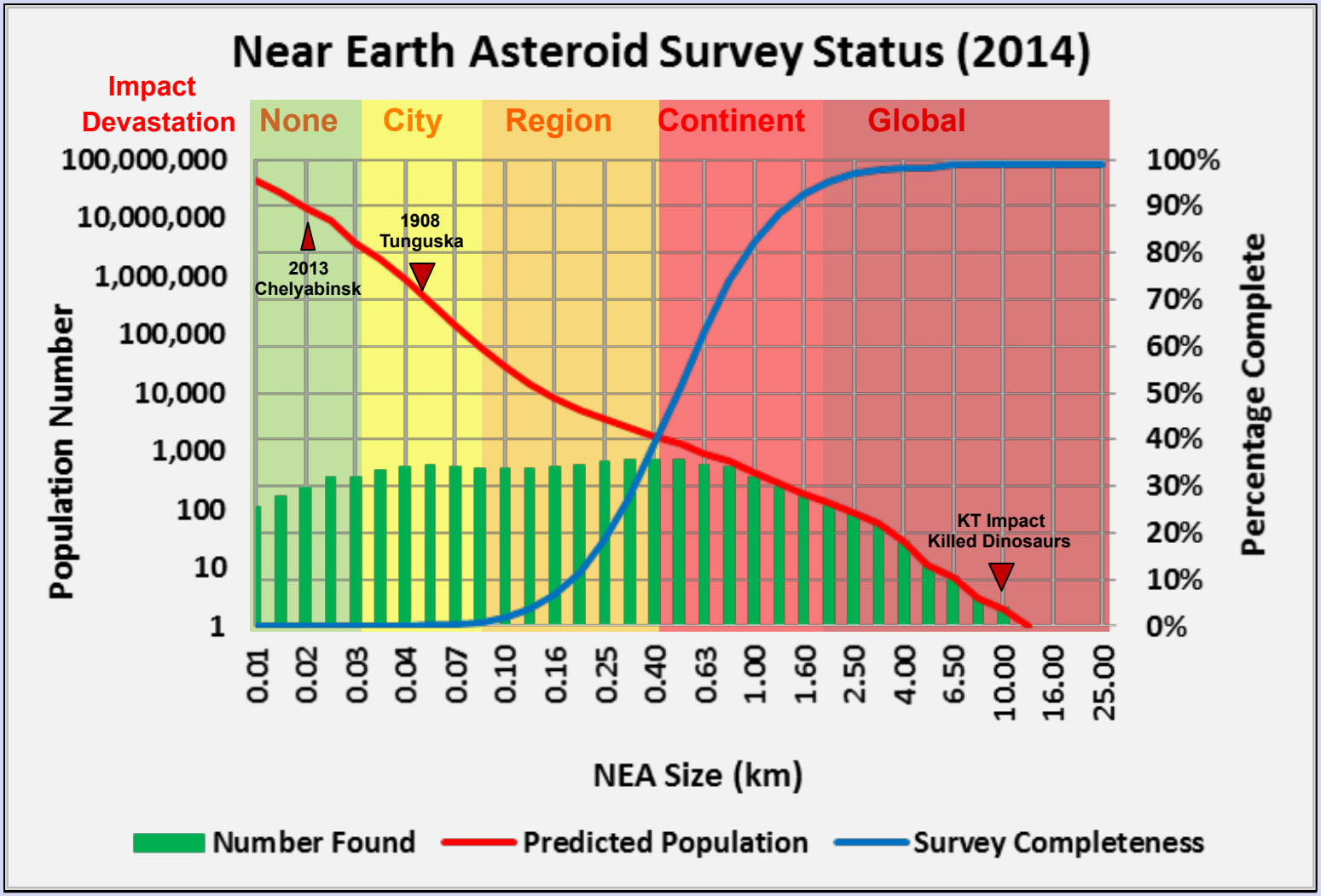


*Harris & D'Abramo, "The population of near-Earth asteroids", Icarus 257 (2015) 302–312, http://dx.doi.org/10.1016/j.icarus.2015.05.004

Near Earth Asteroid Survey Status



Near Earth Asteroid Survey Status



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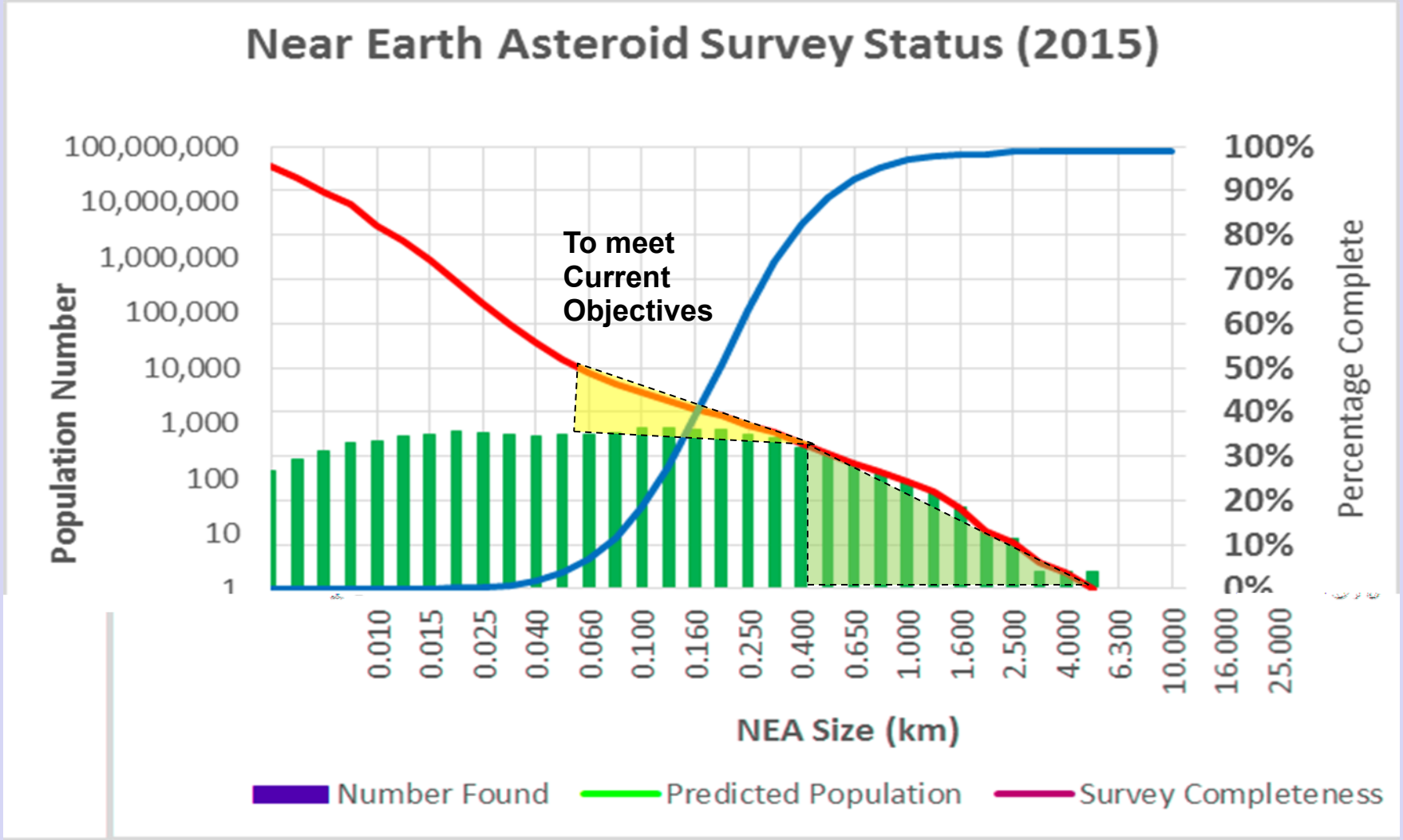
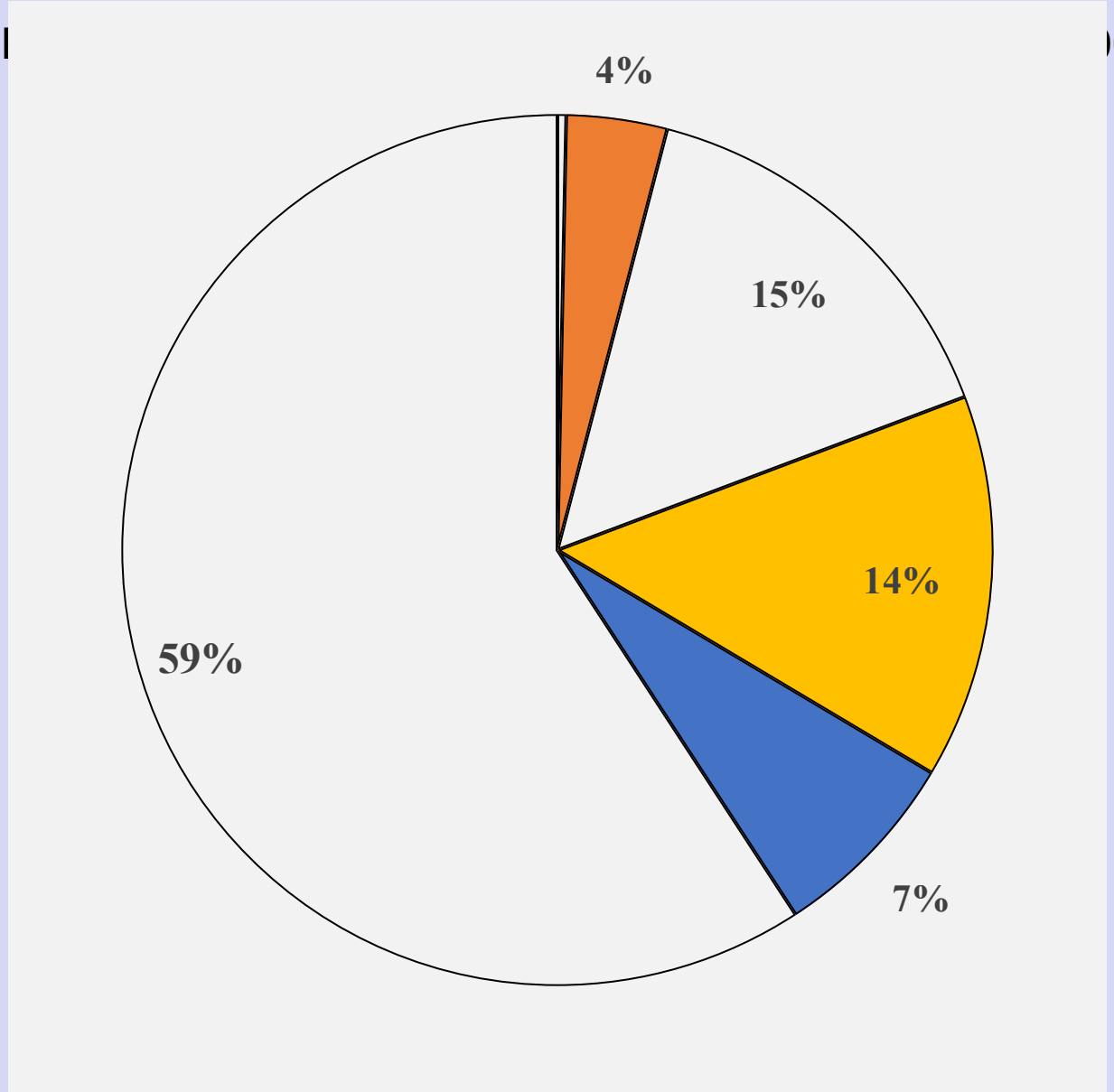


Near Earth Asteroid Survey Status Alternative Graphic



NASA's NEO Search Program

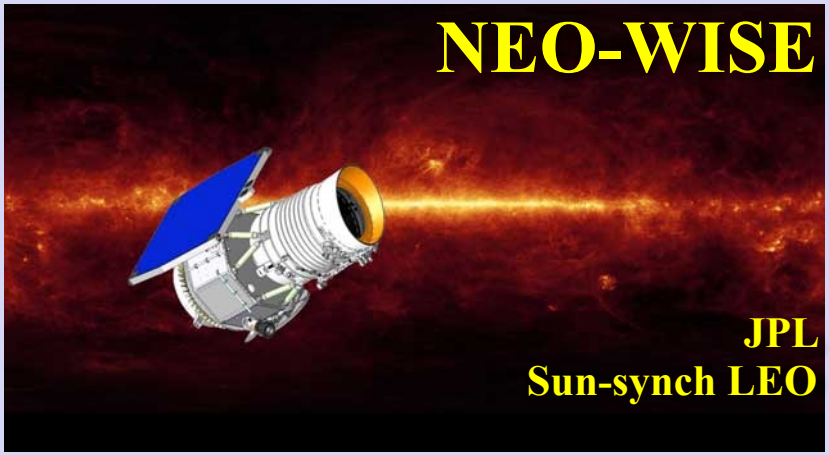
(Current Survey Systems)

Minor Planet Center (MPC)
- IAU sanctioned
- Int'l observation database
- Initial orbit determination

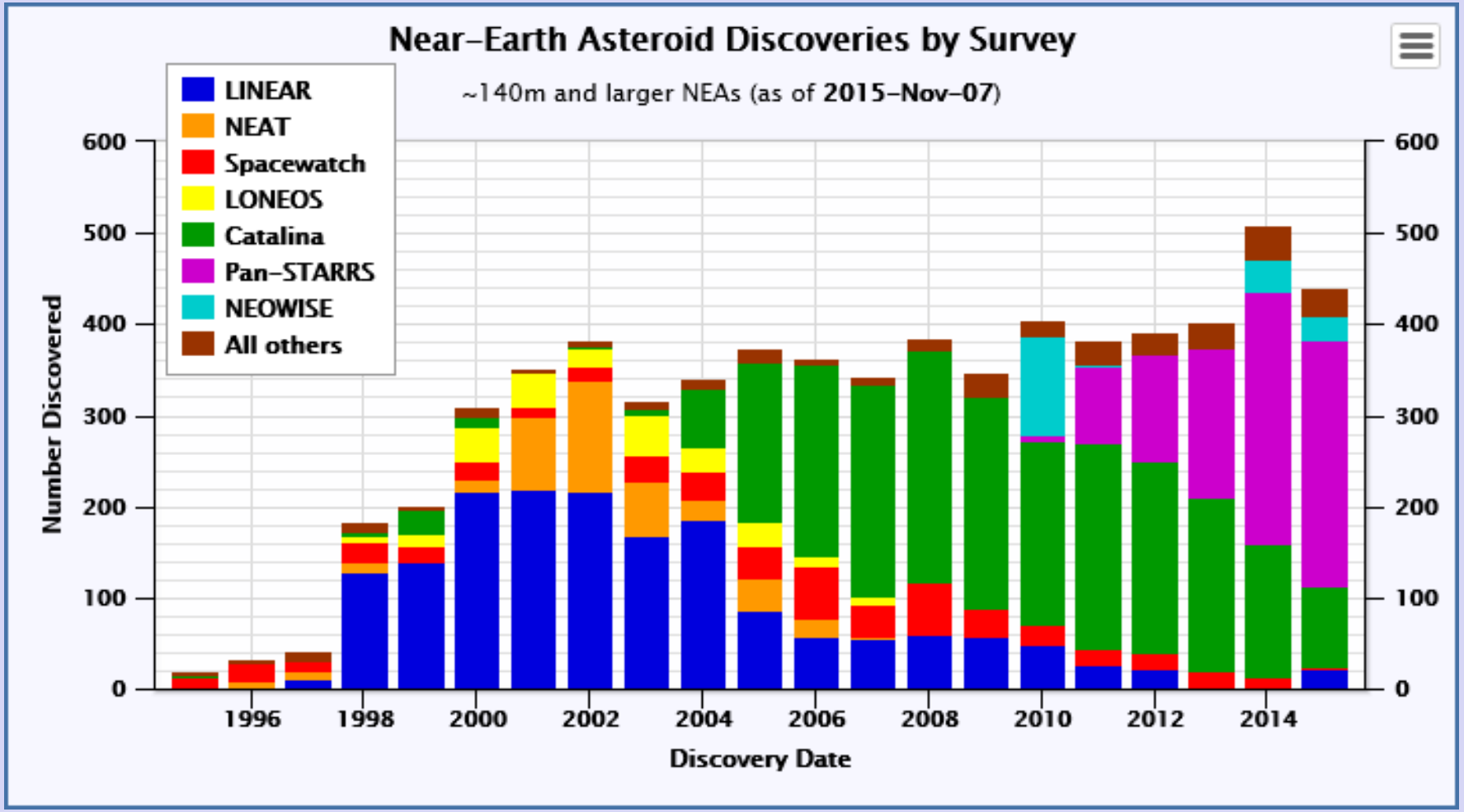
http://minorplanetcenter.net/

Center for NEO Studies @ JPL
- Program coordination
- Precision orbit determination
- Automated SENTRY

http://neo.jpl.nasa.gov/



Growth in Capability



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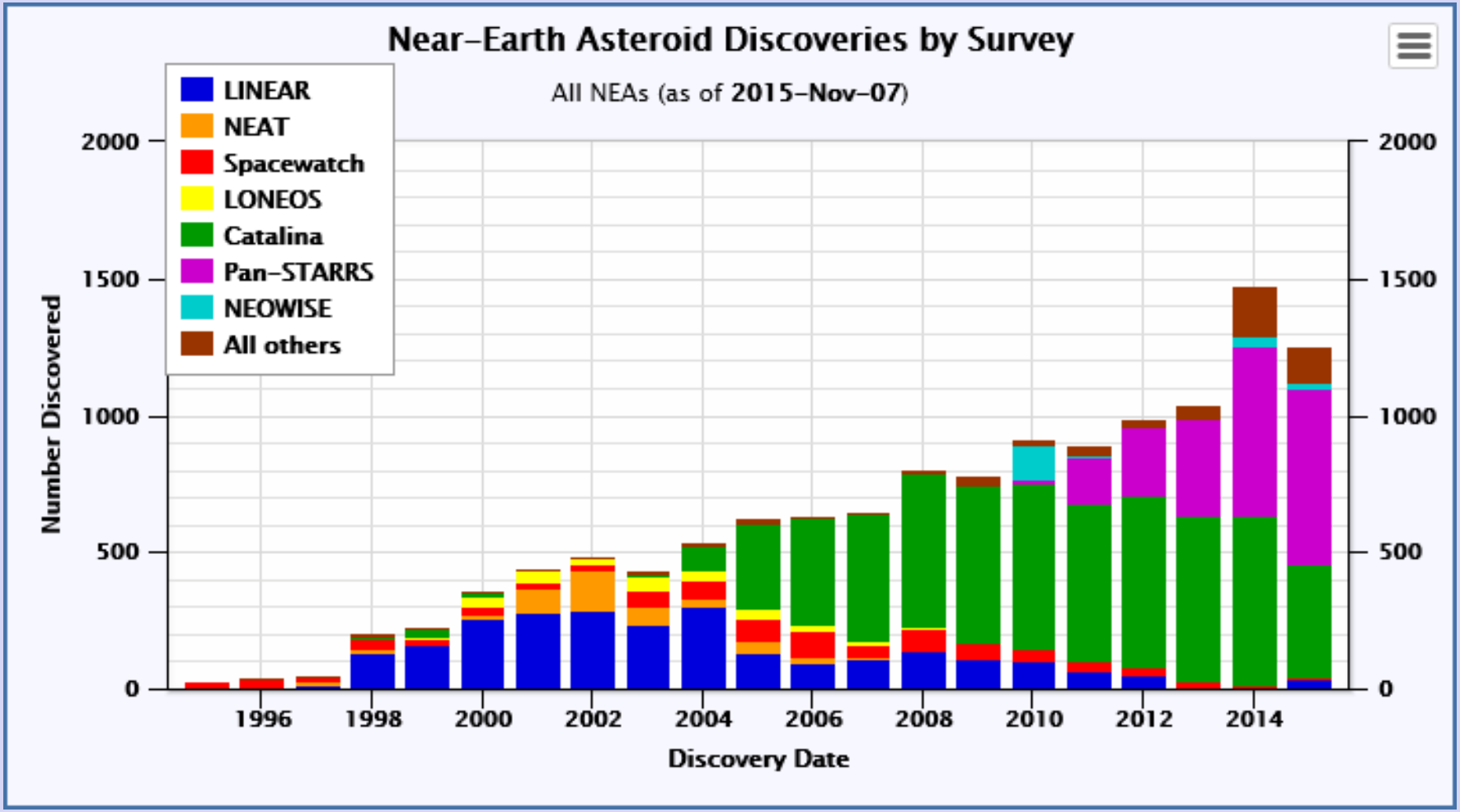


As more capable telescopes are added, discoveries include more <140m NEOs

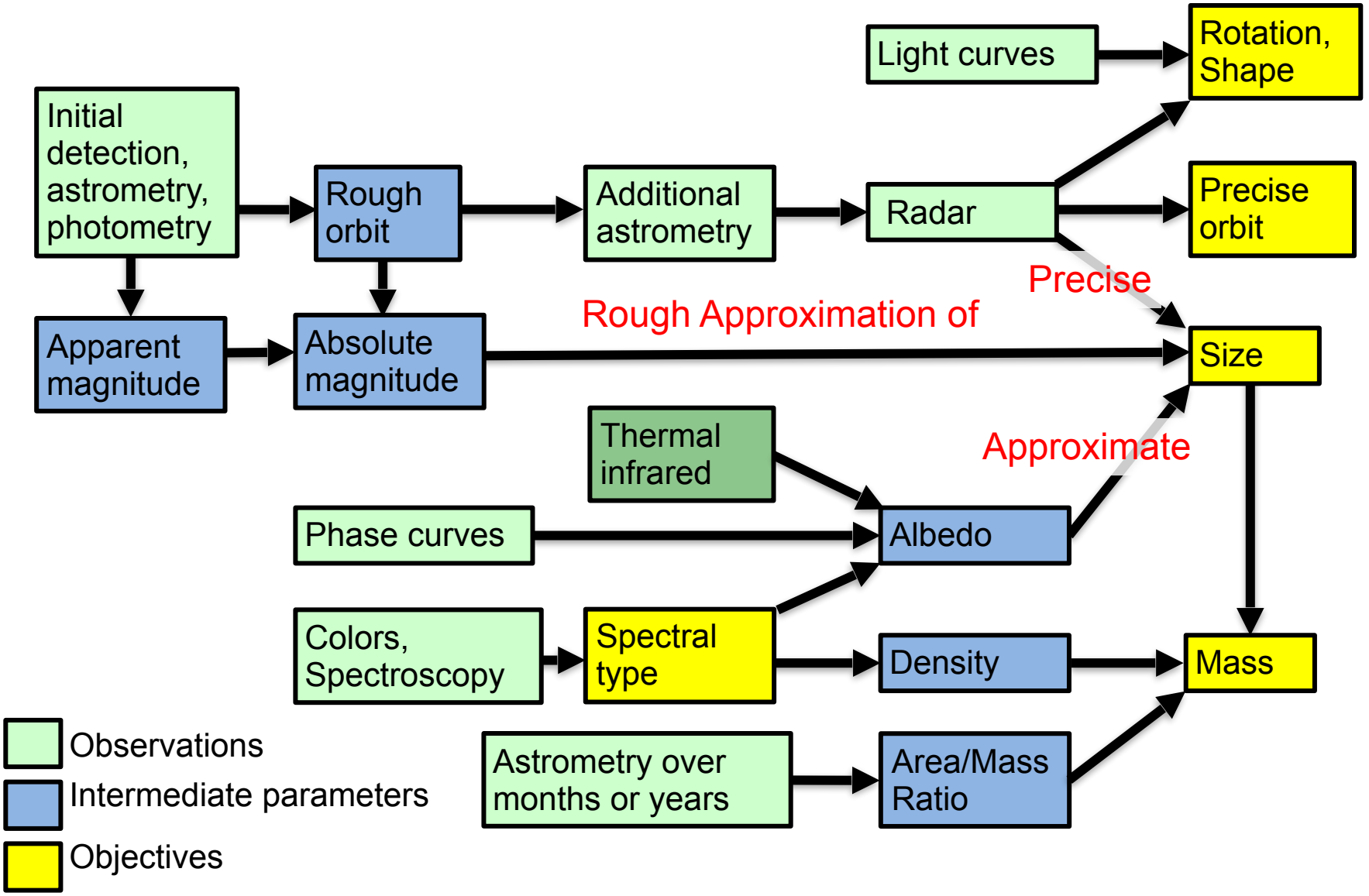
Physical Characterization of NEAs

- **Radar** is essential for obtaining an accurate estimate of size and shape to within ~2 m, as well as rotation state.
- Ground-based and space-based **IR** measurements are important for estimating albedo and spectral class, and from these an approximate density can be inferred.
- **Light curves** are important to estimate shape and rotation state.
- **Long-arc high-precision astrometry** is important for determining the area-to-mass ratio.
- Mass is estimated from size and shape using an inferred or assumed density, and it should be constrained by the estimate of the area-to-mass ratio. Even so, mass may only be known to within a factor of 3 or 4.
- Composition can only be roughly assessed via analogy to spectral class.

Assumed albedo
ρ = 0.04

Assumed albedo
ρ = 0.34

Characterization Process



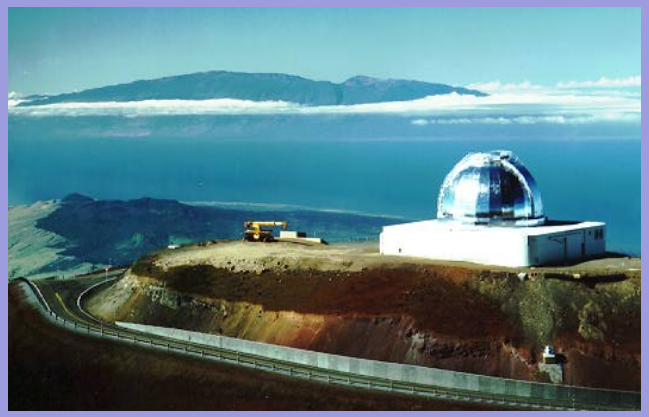
Primary NEO Characterization Assets and Enhancements

Radar (Goldstone and Arecibo)

- Increased time for NEO observations
- Streamlining Rapid Response capabilities
- Increased resolution (~4 meters)
- Improve maintainability


Goldstone Radar


Arecibo Observatory



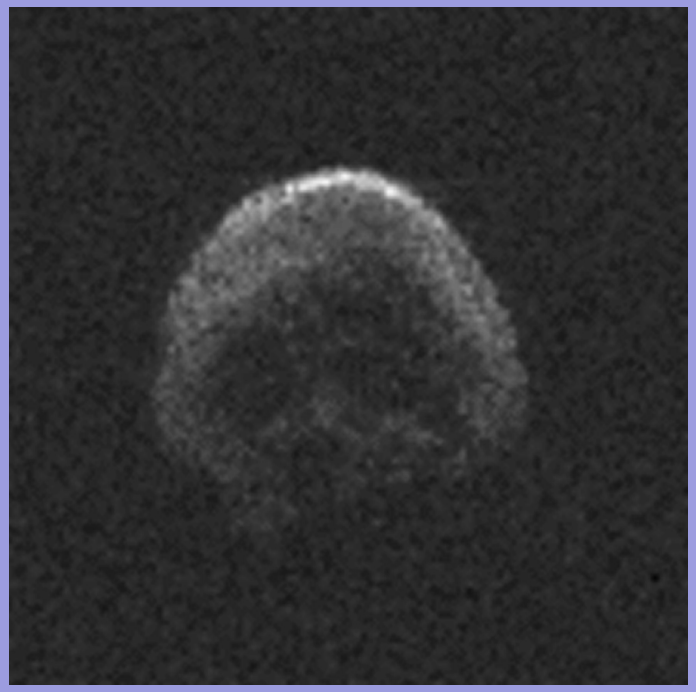
NASA InfraRed Telescope Facility (IRTF)

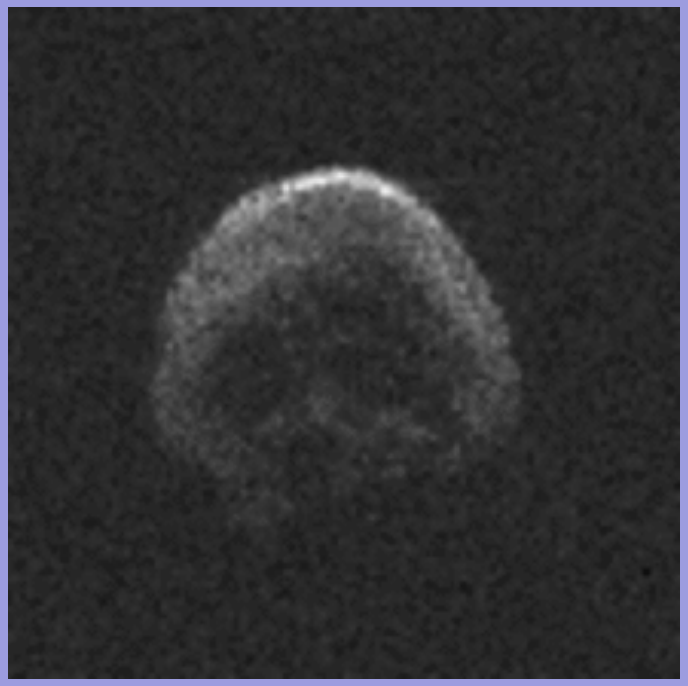
- Increased call-up for Rapid Response
- Improving operability/maintainability
- Improve Instrumentation for Spectroscopy and Thermal Signatures

Spitzer Infrared Space Telescope

- Orbit about Sun, ~176 million km trailing Earth
- In extended Warm-phase mission
- Characterization of Comets and Asteroids
- Thermal Signatures, Albedo/Sizes of NEOs
- Longer time needed for scheduling

2015 TB145 - Halloween Asteroid Fly-by "The Great Pumpkin"





- Discovered by Pan-STARRS on October 10
- Close Approach of 1.3 LD predicted for October 31
- Immediately drew some media attention – "Discovered only 3 weeks before it may hit"
- IRTF observations determined object is likely a dead comet that has shed volatiles

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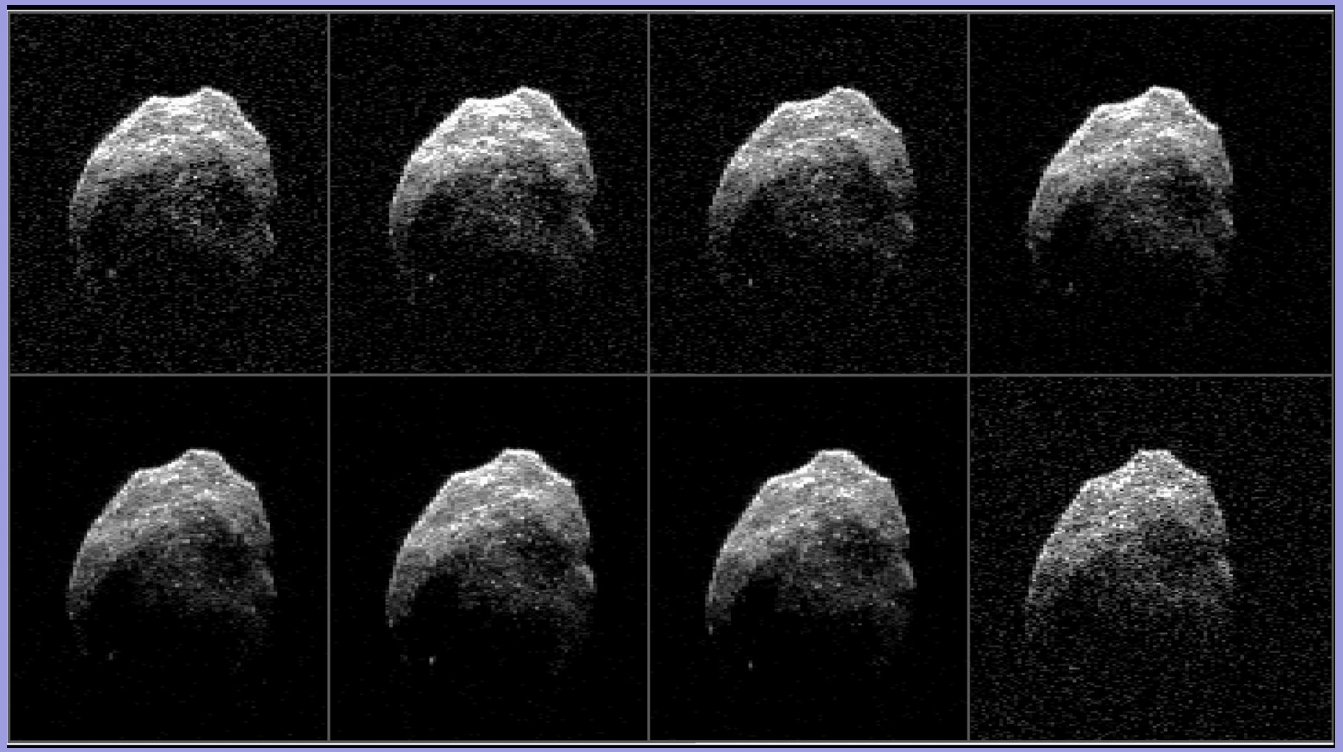

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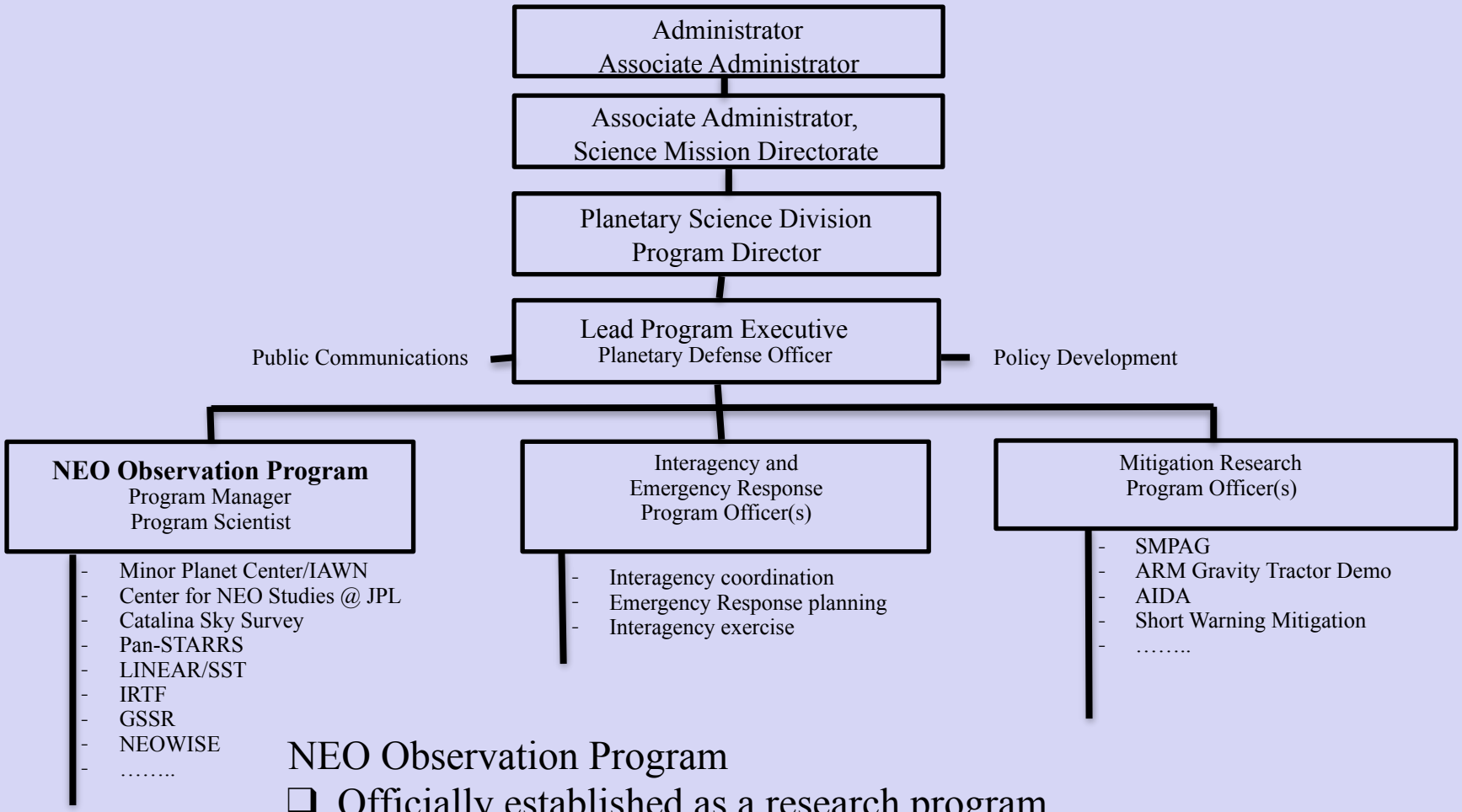
- Immediately drew some media attention – "Discovered only 3 weeks before it may hit"
- IRTF observations determined object is likely a dead comet that has shed volatiles
- Observed by Arecibo and bi-static with Greenbank receiving from Goldstone transmission
- Object is roughly spherical in shape and approximately 2,000 feet (600 meters) in diameter
- Resolution is ~4 meters

New NEO Organization at NASA

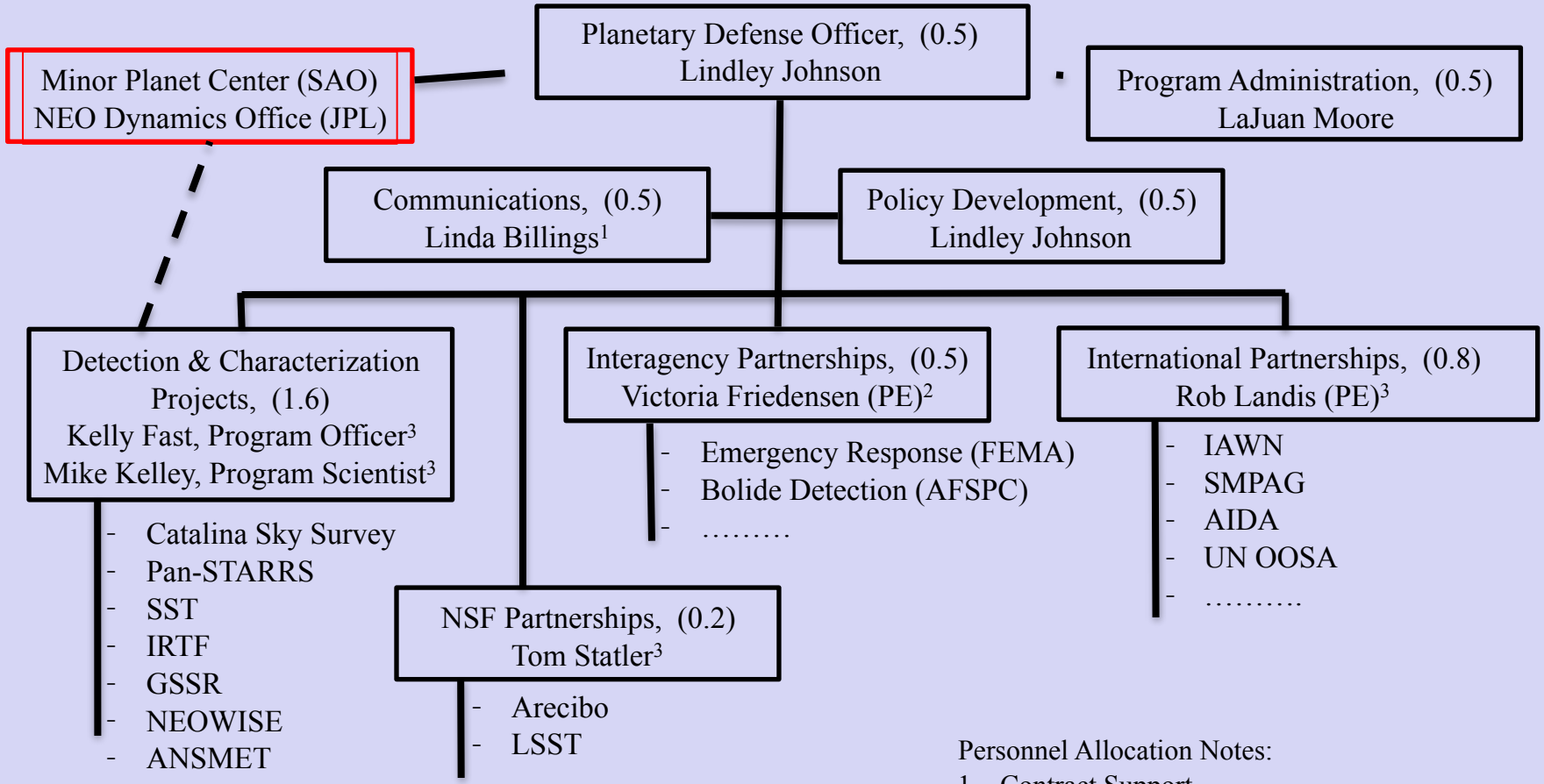
Planetary Defense Coordination Office



NEO Observation Program

- ❑ Officially established as a research program
- ❑ Formalized program documentation
- ❑ PDCO Staffing at ~5.0 FTE

Planetary Defense Coordination Office (PDCO)



Personnel Allocation Notes:

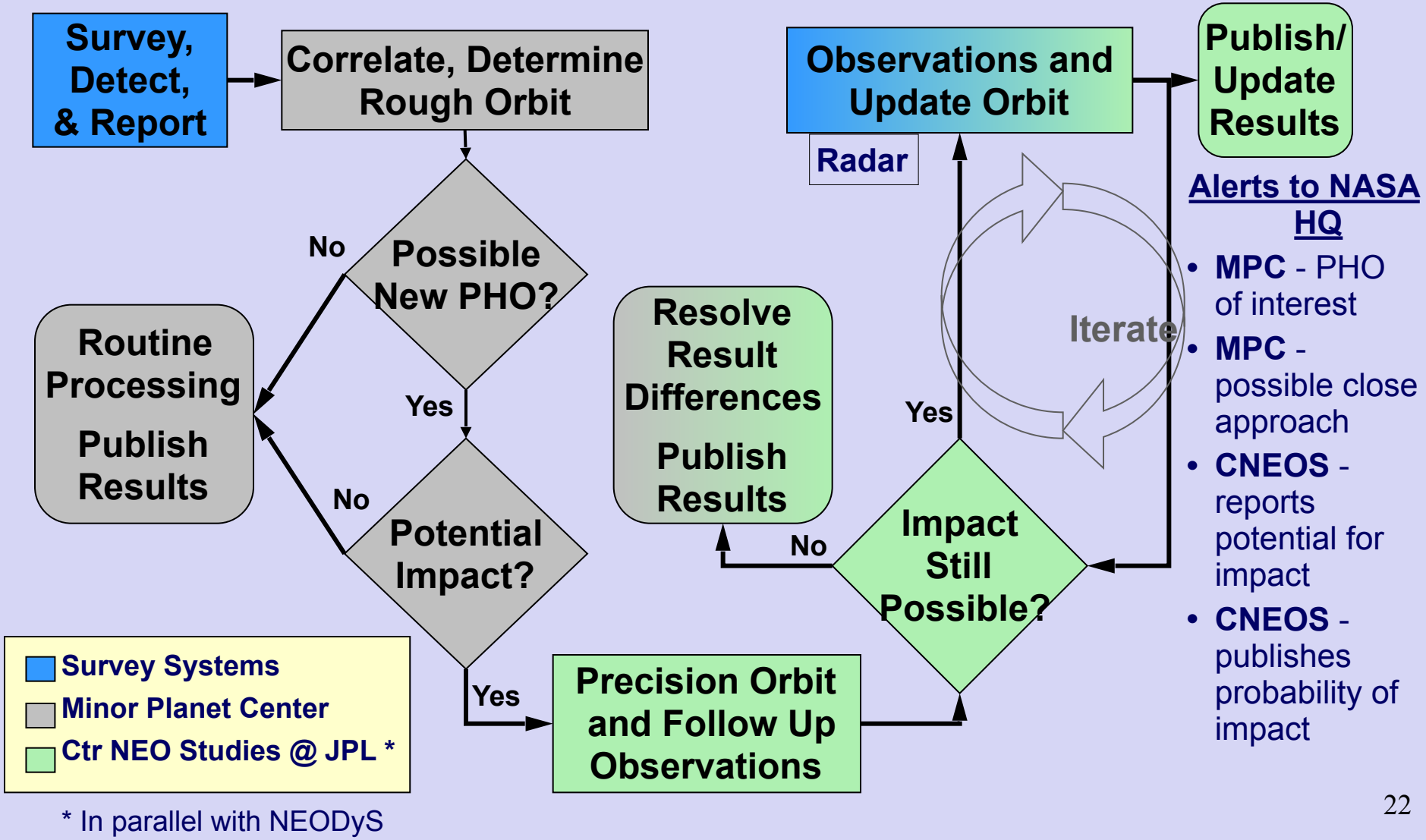
1. Contract Support
2. ½-time Detailee from HEOMD
3. Part-time on other PSD Programs

Planetary Defense Coordination Office Mission Statement:

Lead national and international efforts to:

- Detect any potential for significant impact of planet Earth by natural objects
- Appraise the range of potential effects by any possible impact
- Develop strategies to mitigate impact effects on human welfare

Spaceguard Survey Catalog Program
Current Spaceguard Survey Infrastructure and Process



* In parallel with NEODyS

Planetary Defense Coordination Office
Potential Impact Notification Process