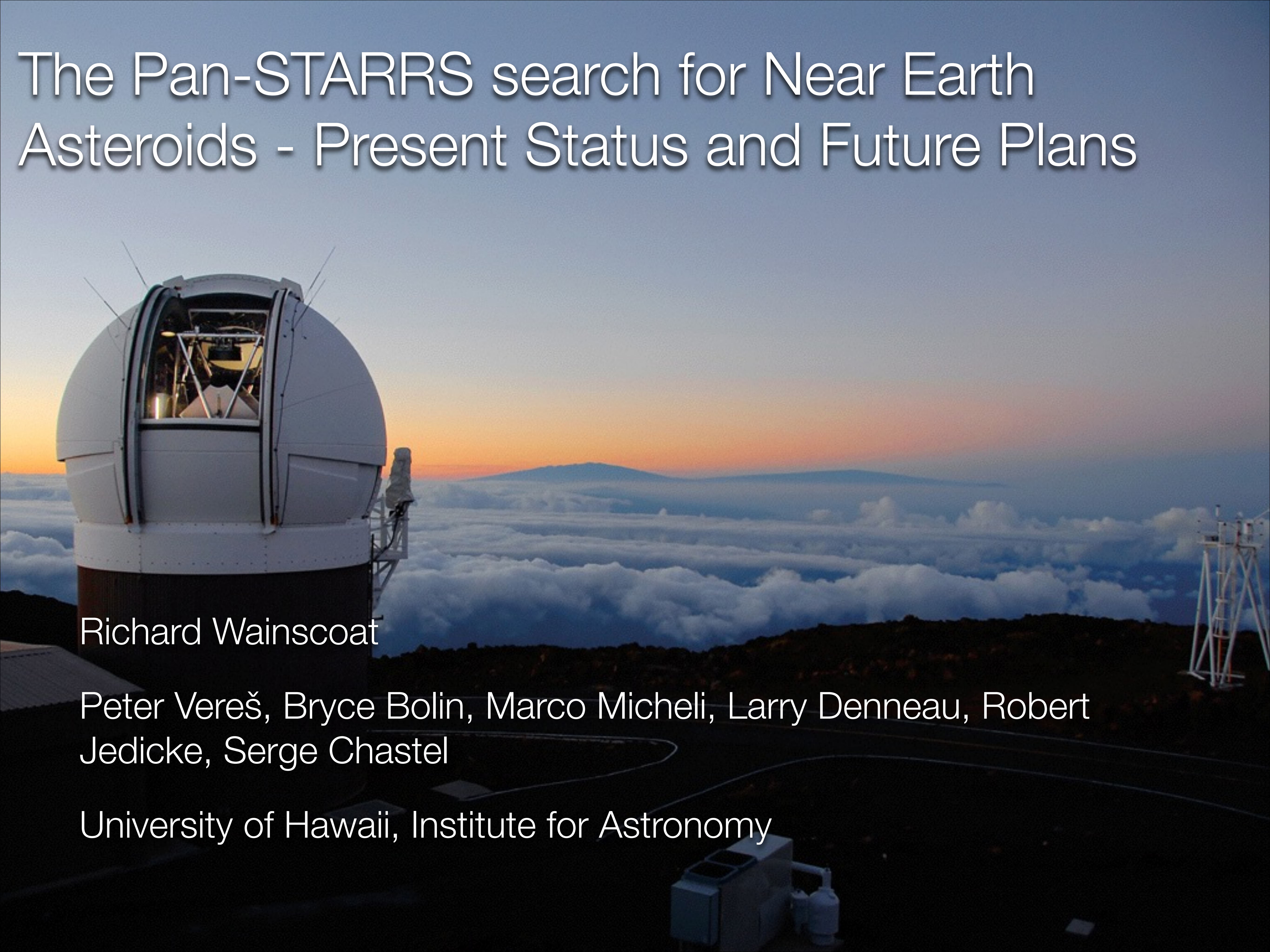
The Pan-STARRS search for Near Earth Asteroids - Present Status and Future Plans



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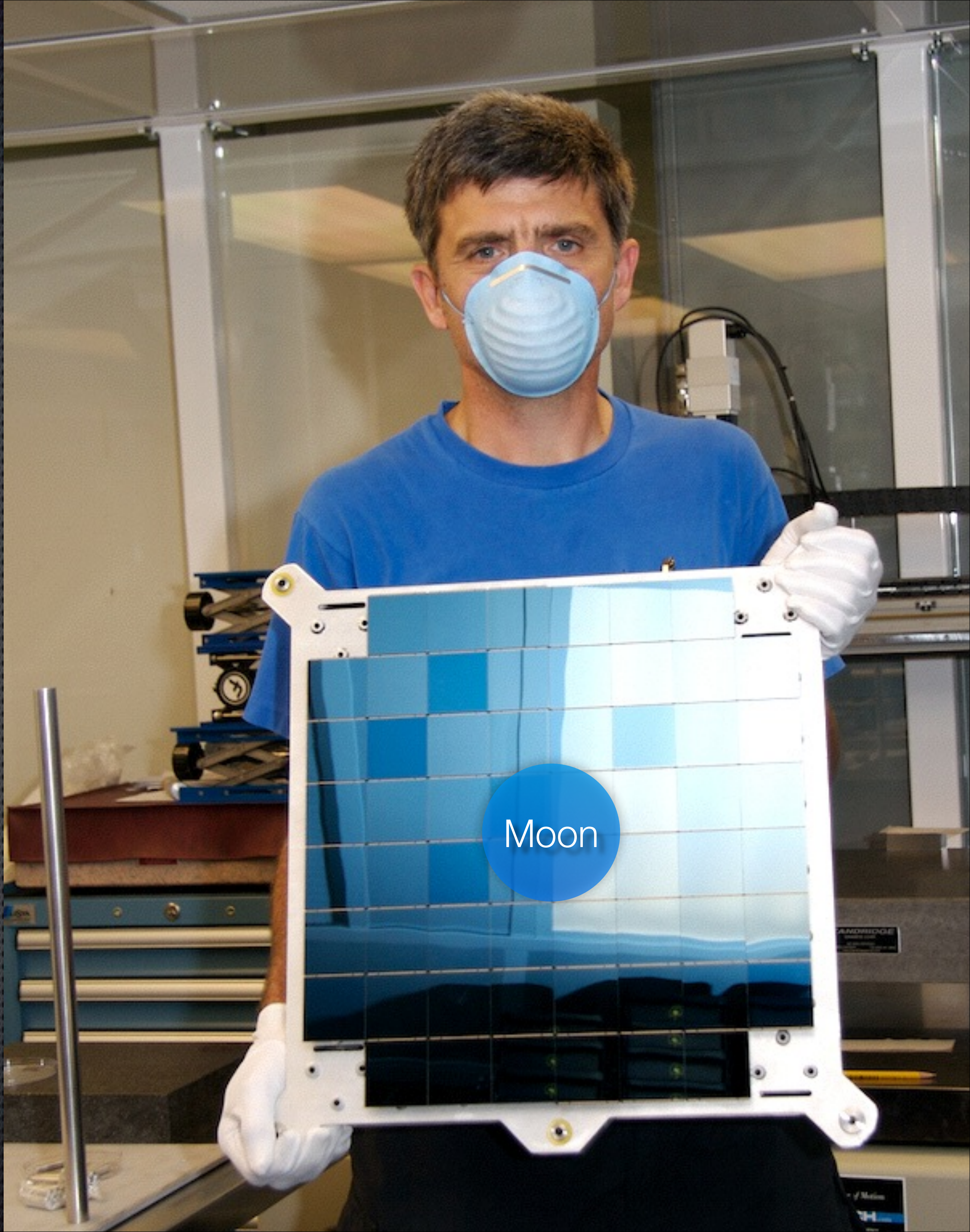
The Pan-STARRS telescopes

- Pan-STARRS1 is a 1.8-meter diameter telescope at Haleakala observatory in Maui (PS1)
- A second telescope (PS2) is being built adjacent to PS1
- PS1 has the largest digital camera in the world
  - 60 CCDs, each with 4800x4800 pixels, arranged in an 8x8 grid of 600x600 pixels

Gigapixel camera

- 1,382,400,000 pixels
- 7 square degree field-of-view
- Read time 12 sec
- Some CCDs are cosmetically poor
  - 70% fill factor



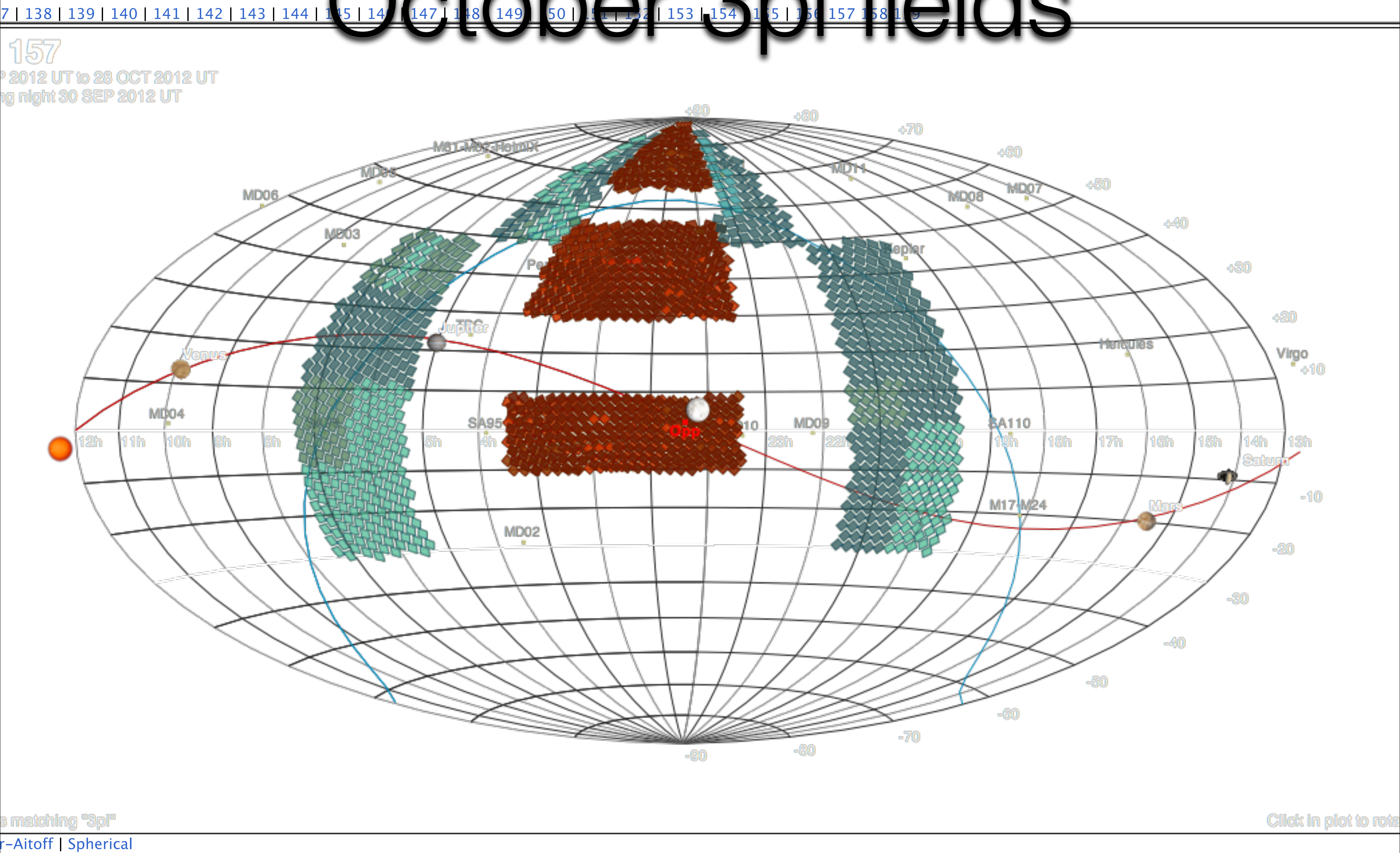
Pan-STARRS1 mission

- The observations that Pan-STARRS1 is obtaining are designed for many different scientific goals, including the solar system, brown dwarfs, Galactic structure, supernovae and other transients, and cosmology
- Nearly all observations that Pan-STARRS 1 obtains are executed in a manner that allows them to be searched for Near Earth Objects
- NASA is funding the NEO search with PS1
- Astrometry from PS1 is excellent, and in most cases is better than 0.15 arcsec

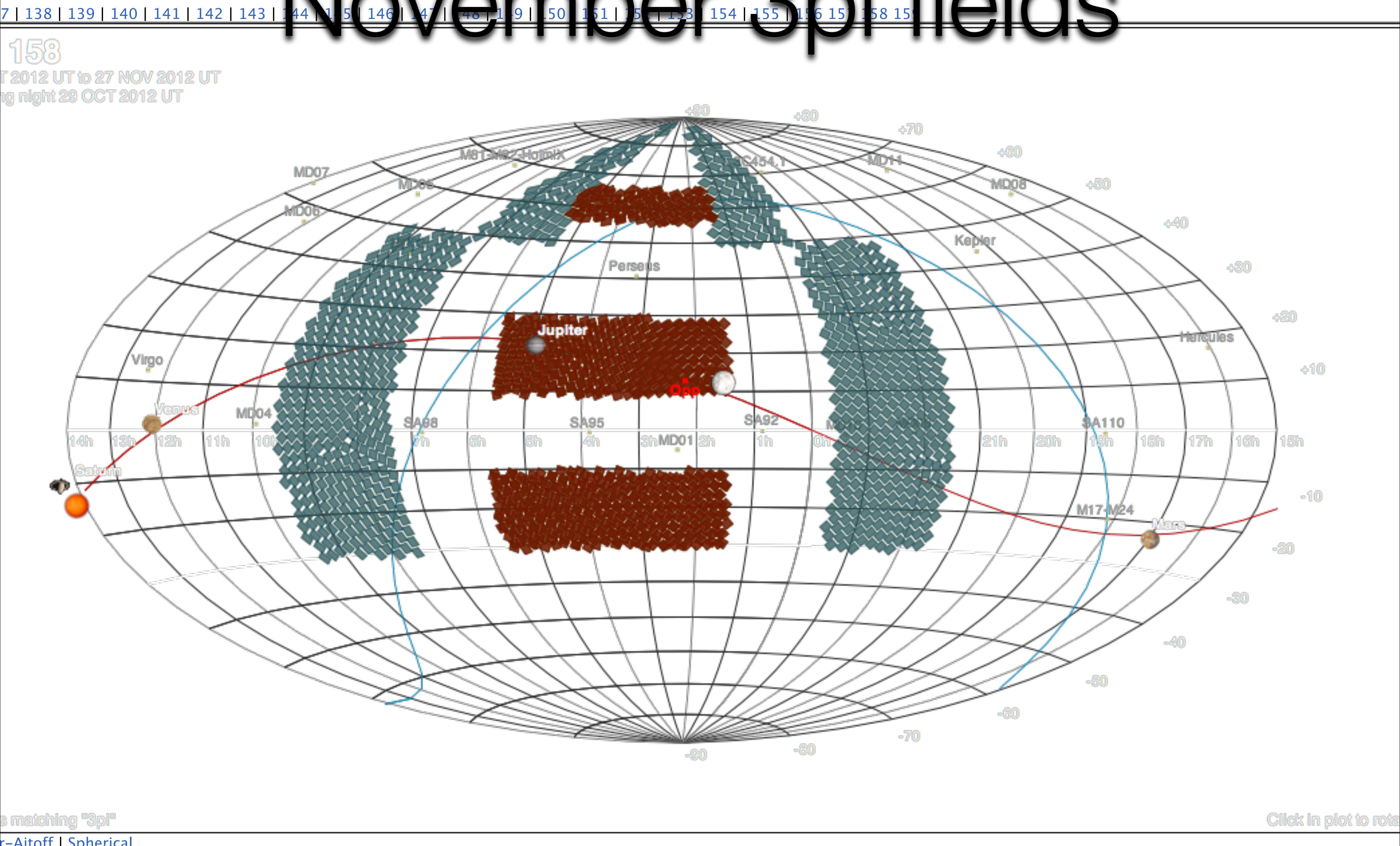
3pi survey

- Entire sky north of –30 surveyed every year
- 2,500 square degrees observed every month using 56% of the observing time
- Two pairs in each of g, r, and i (12 observations total)
- Each pair separated by approximately 20 minutes
- The entire area is observed at least once as a quad (four observations each spaced 20 minutes apart)
- 239 NEOs discovered to date including 24 PHAs

October 3pi fields



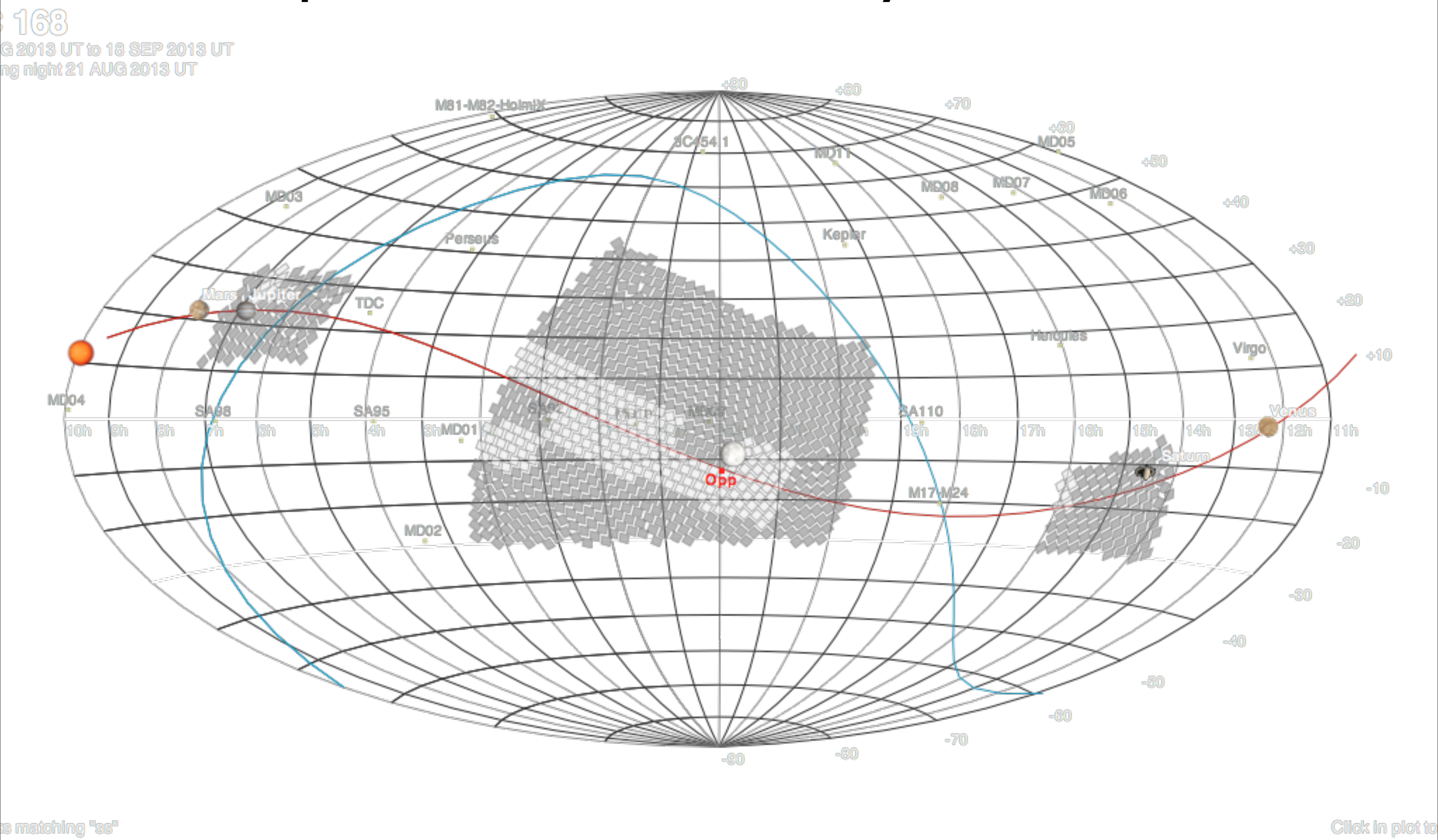
November 3pi fields



NEO Optimized survey

- We use a broad w-band filter (g+r+i) to increase sensitivity and have 11% of the observing time
- Four 45 second exposures separated by 20 minutes in the opposition direction or 7 minutes in the low solar elongation sweet spot directions, using wide filter
- Opposition search has yielded 536 NEO discoveries, including 41 PHAs
- Sweet spot search has yielded 28 NEO discoveries, including 11 PHAs

September 2013 solar system fields



The need for followup observations

- Pan-STARRS NEO candidates are submitted to the Minor Planet Center
  - Pan-STARRS does not followup its own NEO candidates
  - We follow up some NEO candidates with CFHT
- PS1 is extremely dependent on other people to followup candidates to produce discoveries

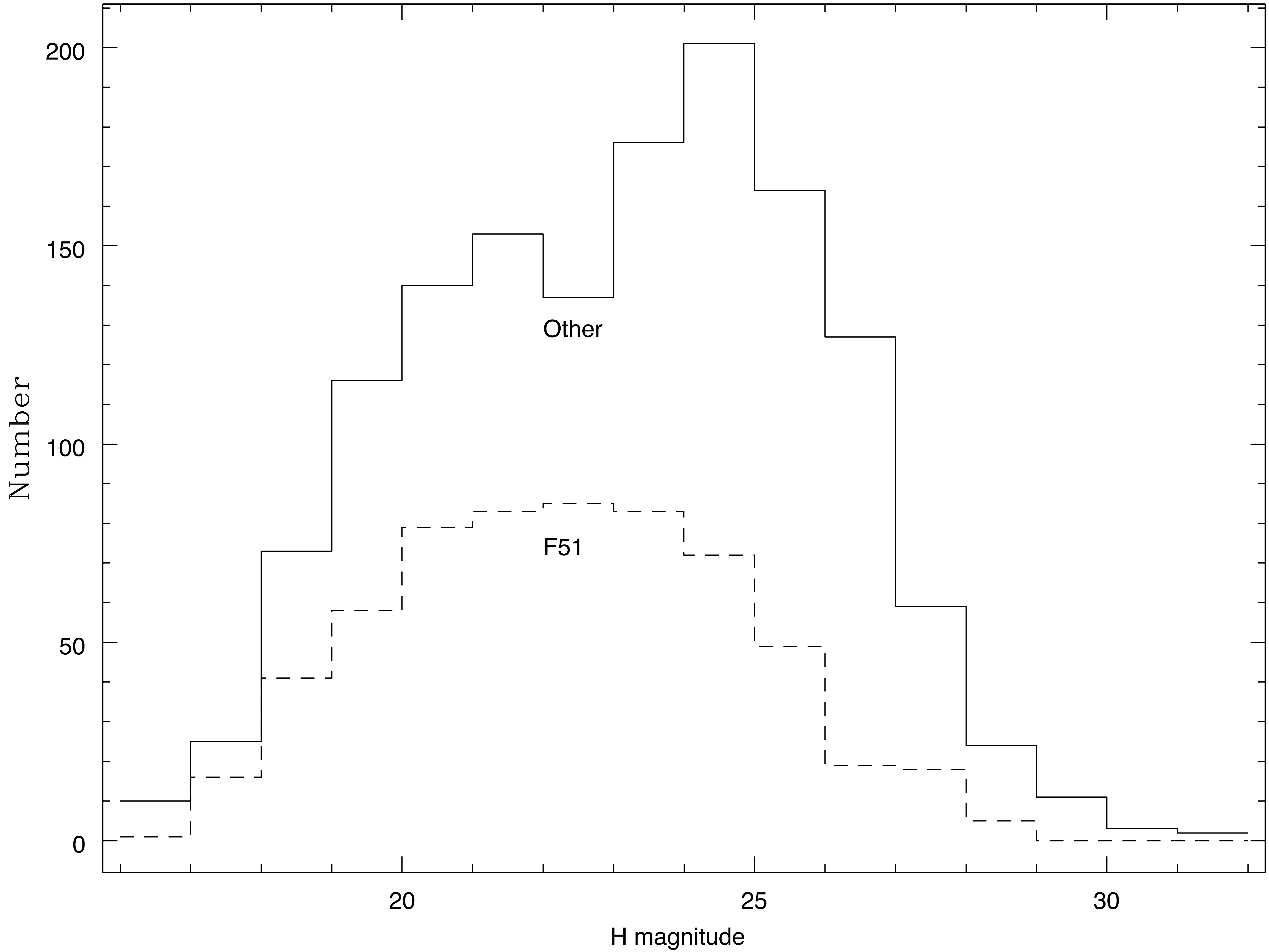
Submissions to MPC

- 2,279,348 asteroid tracklets reported to date
- 7,223,594 detections
- 563,836 distinct asteroids
- 40,357 asteroid discoveries
- 3,000–6,000 asteroids submitted per night

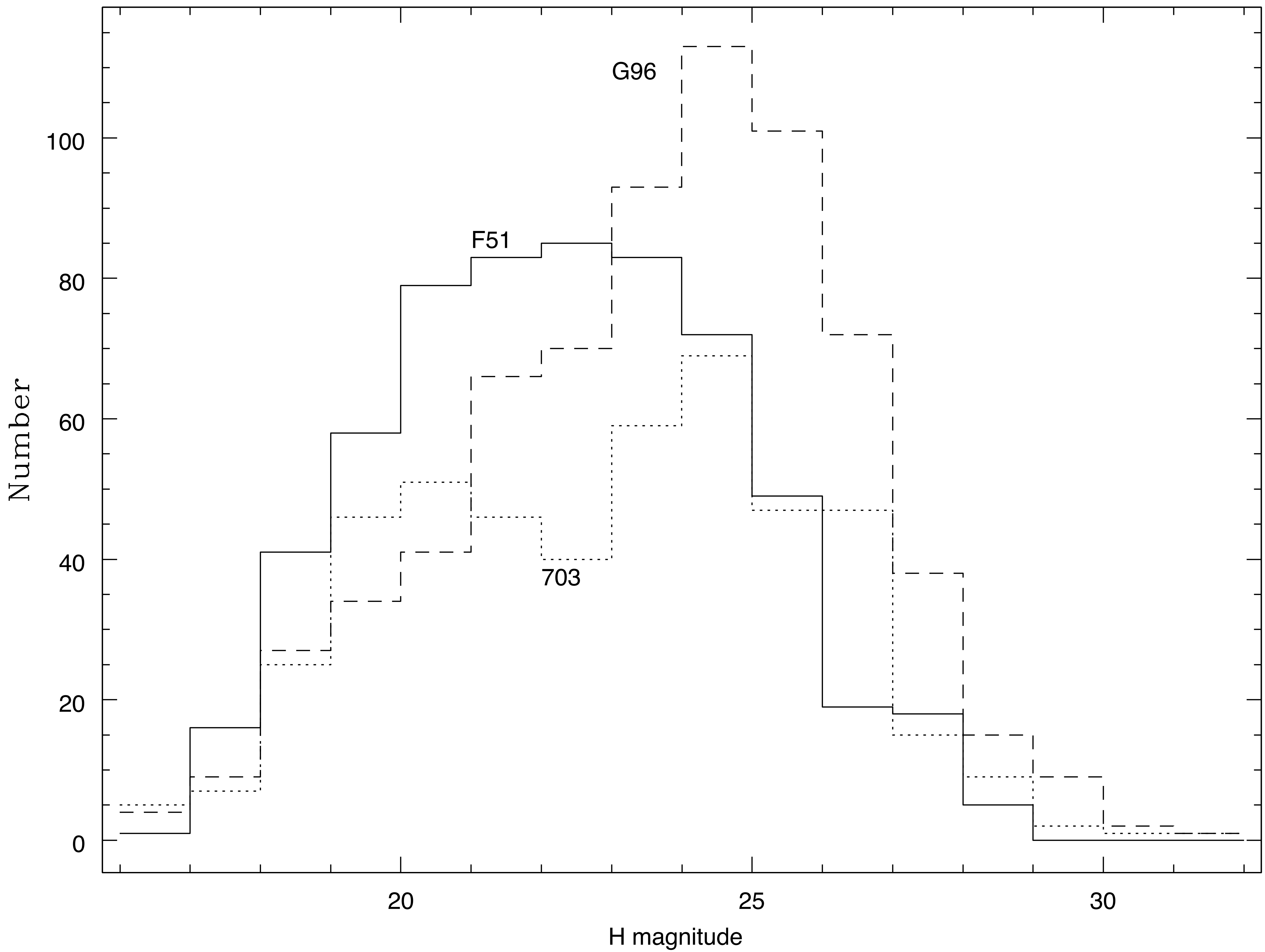
Discovery rate

- PS1 discovers over 50 NEOs per month when the weather is good
- The median H magnitude for PS1 NEO discoveries for 2012 and 2013 is 22.4
  - Other NEO discoveries (mostly from the Catalina Sky Survey) have median H=23.4
- Pan-STARRS is good at finding larger undiscovered NEOs that are distant and faint, but less efficient at finding smaller fast-moving nearby NEOs

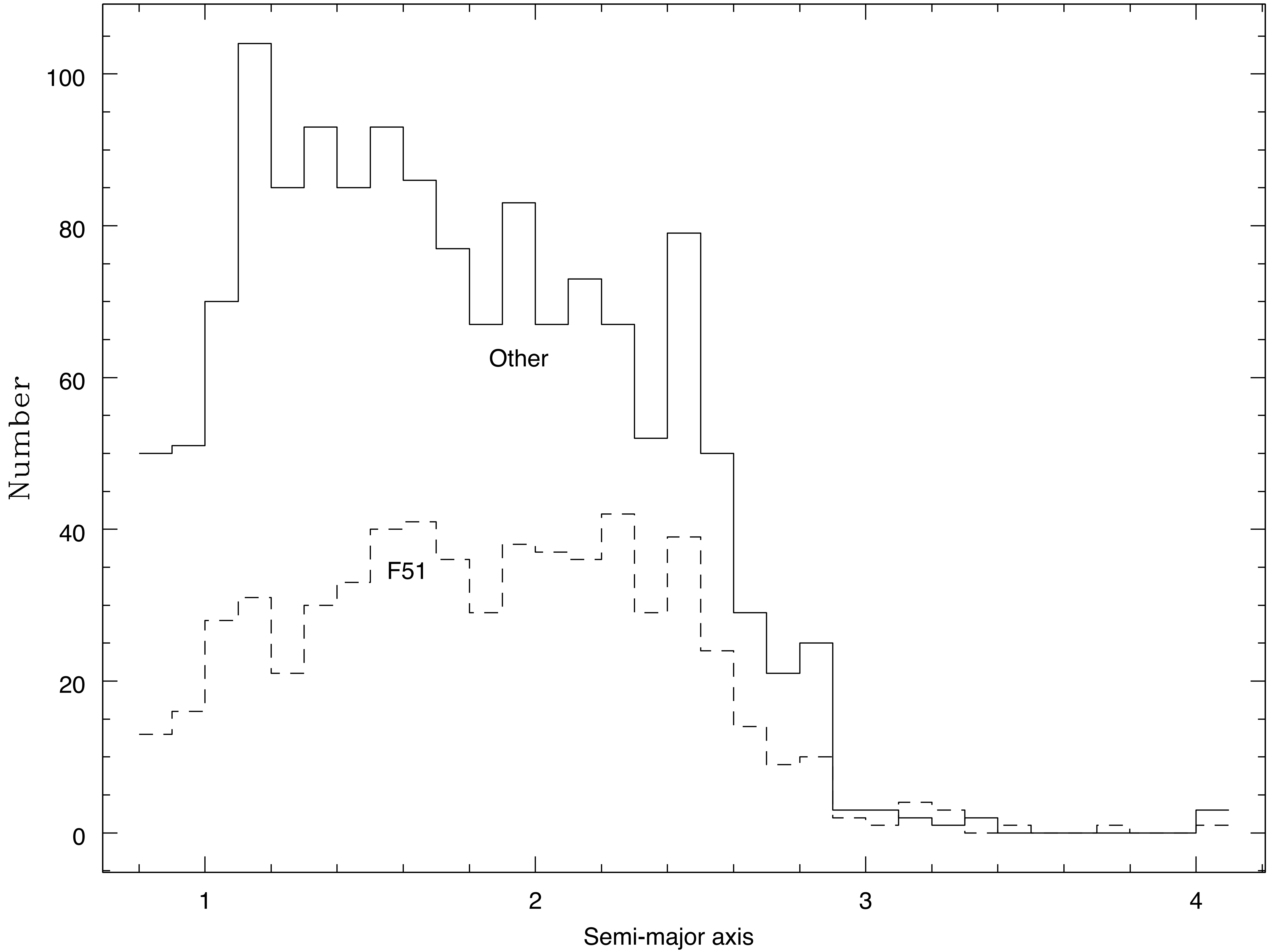
2012 and 2013 NEO discoveries



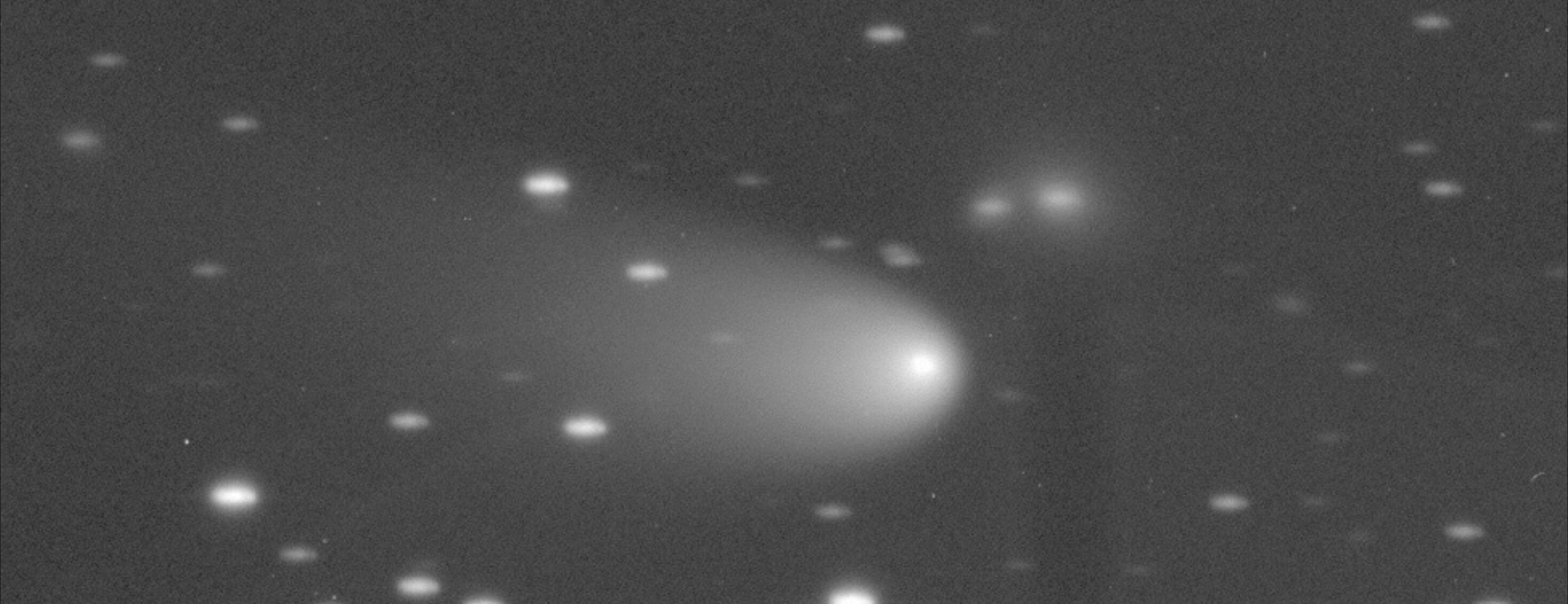
2012 and 2013 NEO discoveries



2012 and 2013 NEO discoveries



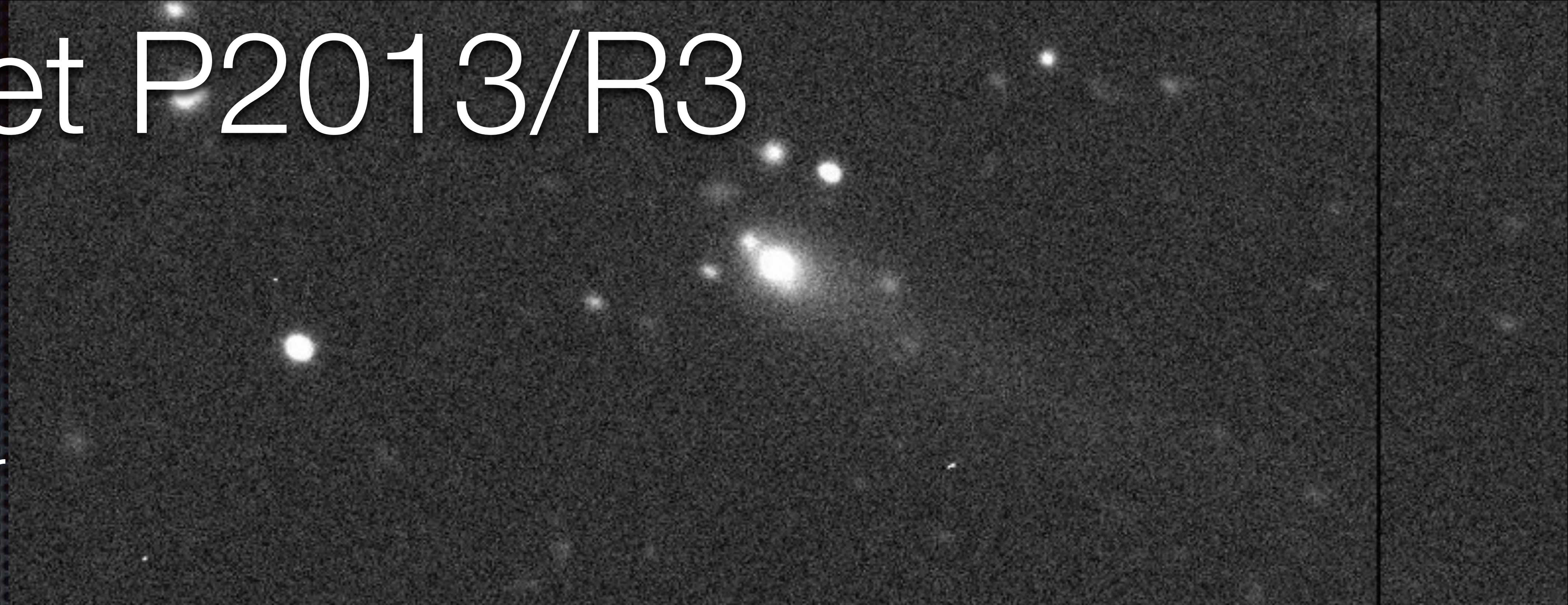
Comets



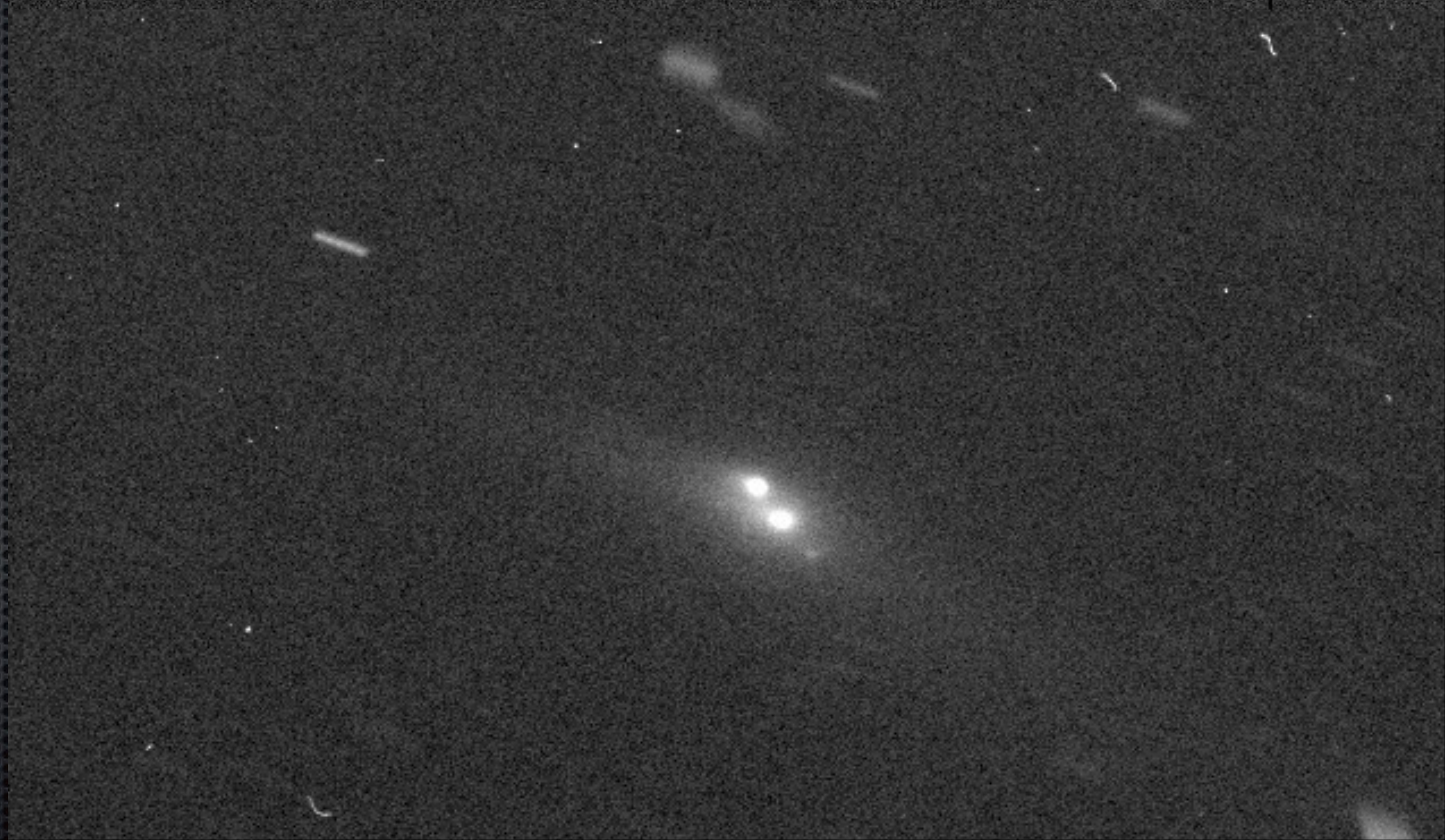
- Pan-STARRS has discovered many comets and is efficient at discovering low levels of activity
- Five Main Belt Comets have been discovered to date

Comet P2013/R3

- September



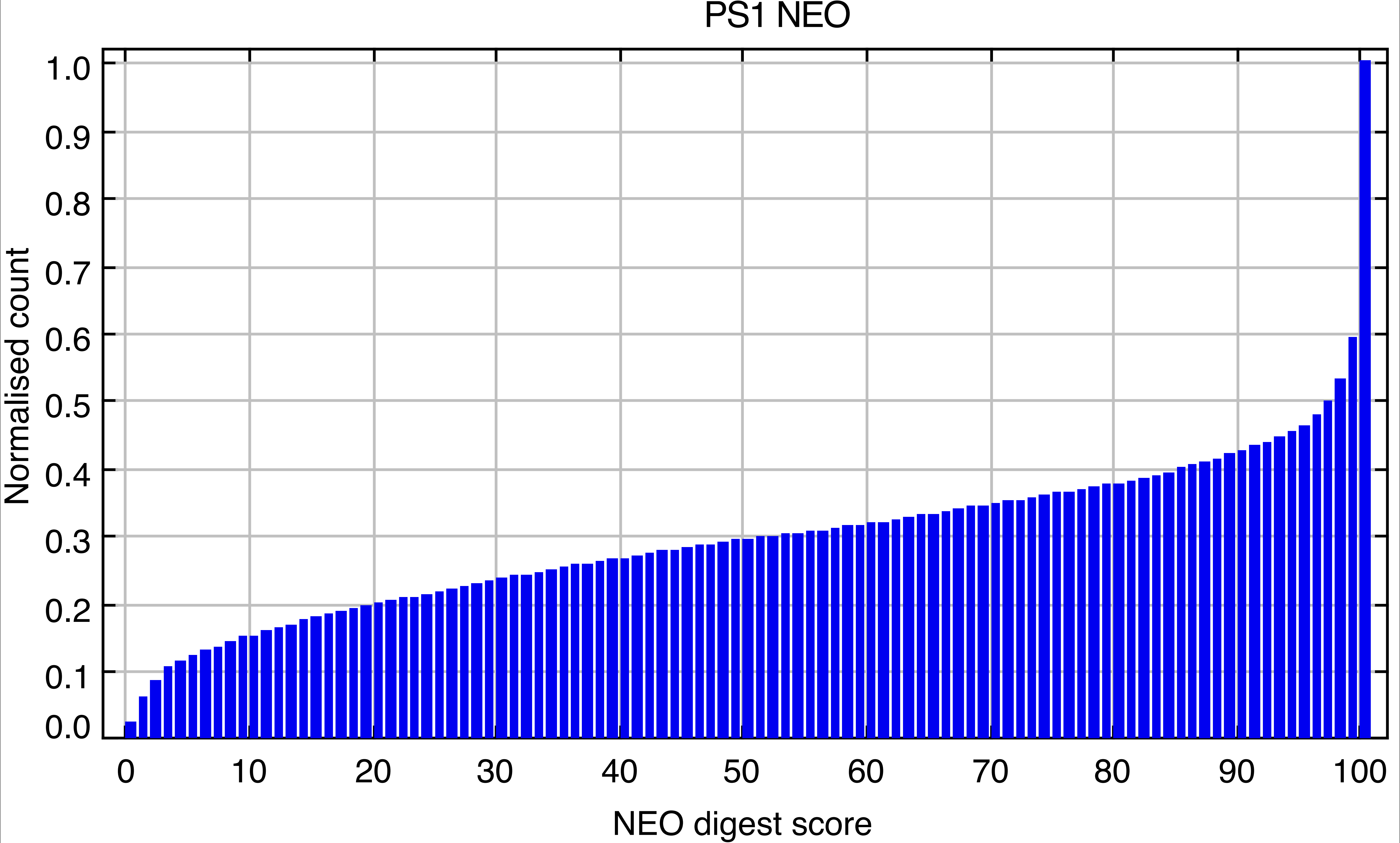
- October



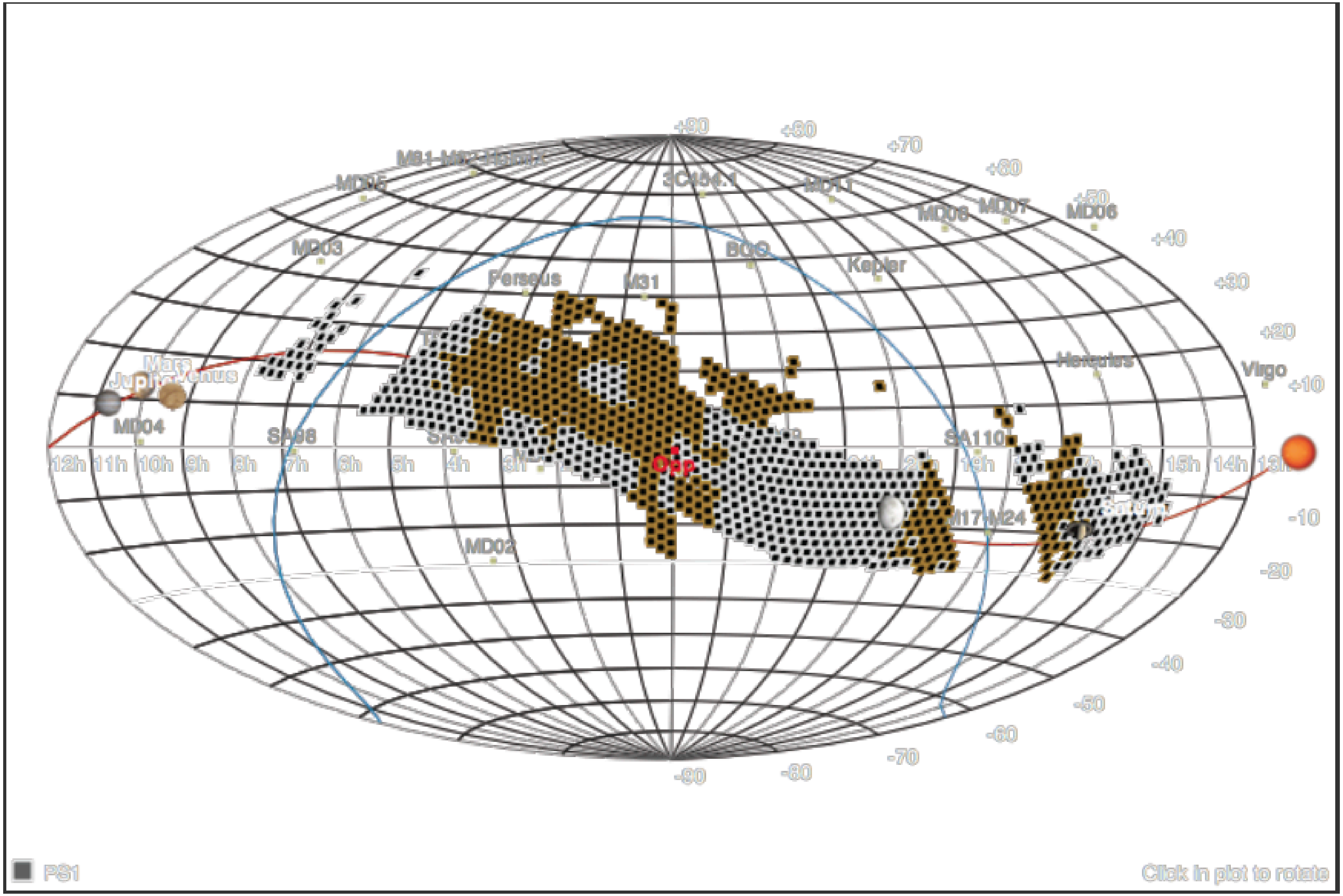
Future plans

- The Pan-STARRS1 Science Consortium survey will finish at the end of February 2014
- We are planning to conduct an NEO optimized survey using 100% of the observing time beginning in March 2014
- This will enable a much larger area of the sky to be surveyed multiple times per month
- We can survey further south, reaching to -40°

Digest scores of NEOs observed by PS1

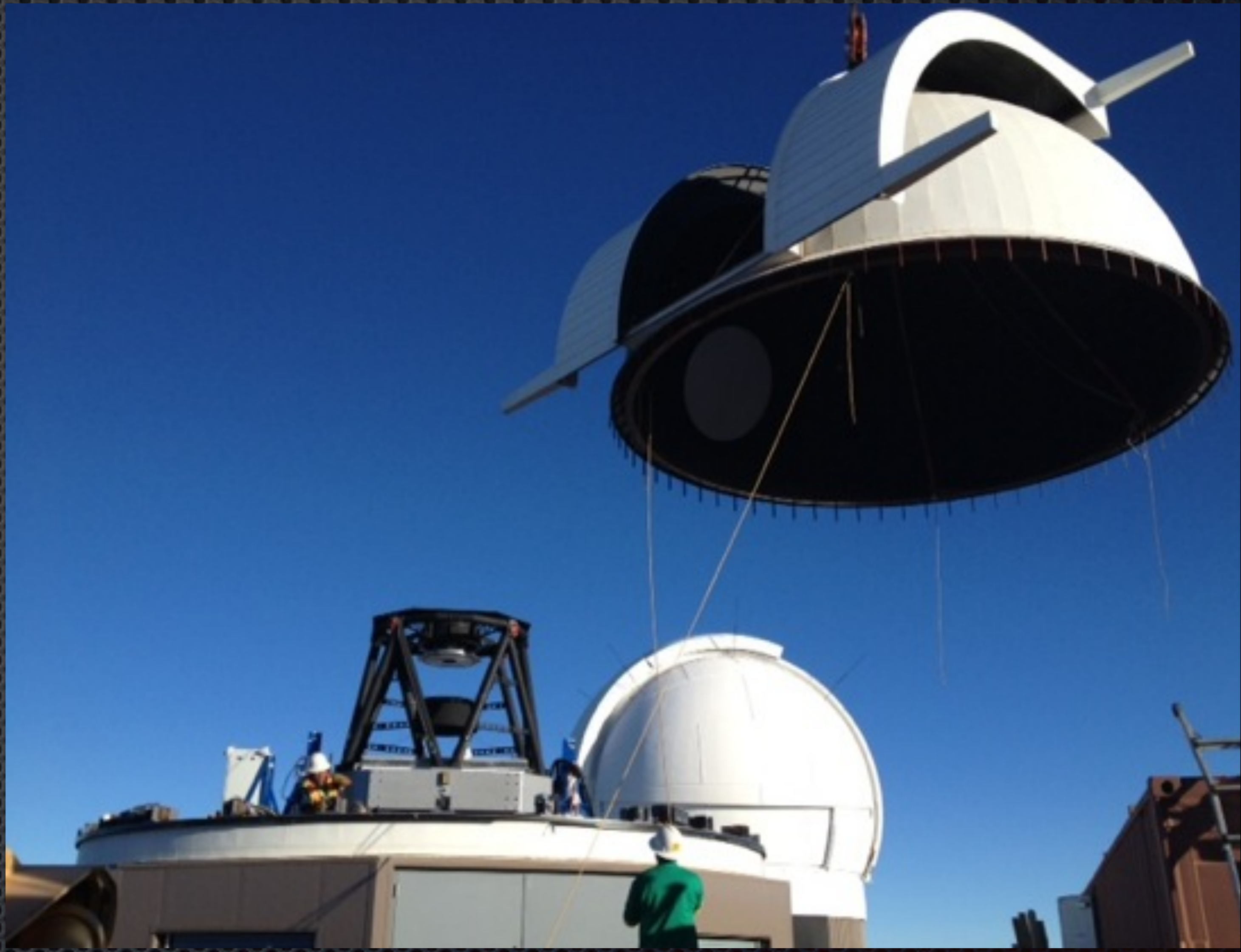


Sky coverage with 100% of Pan-STARRS1



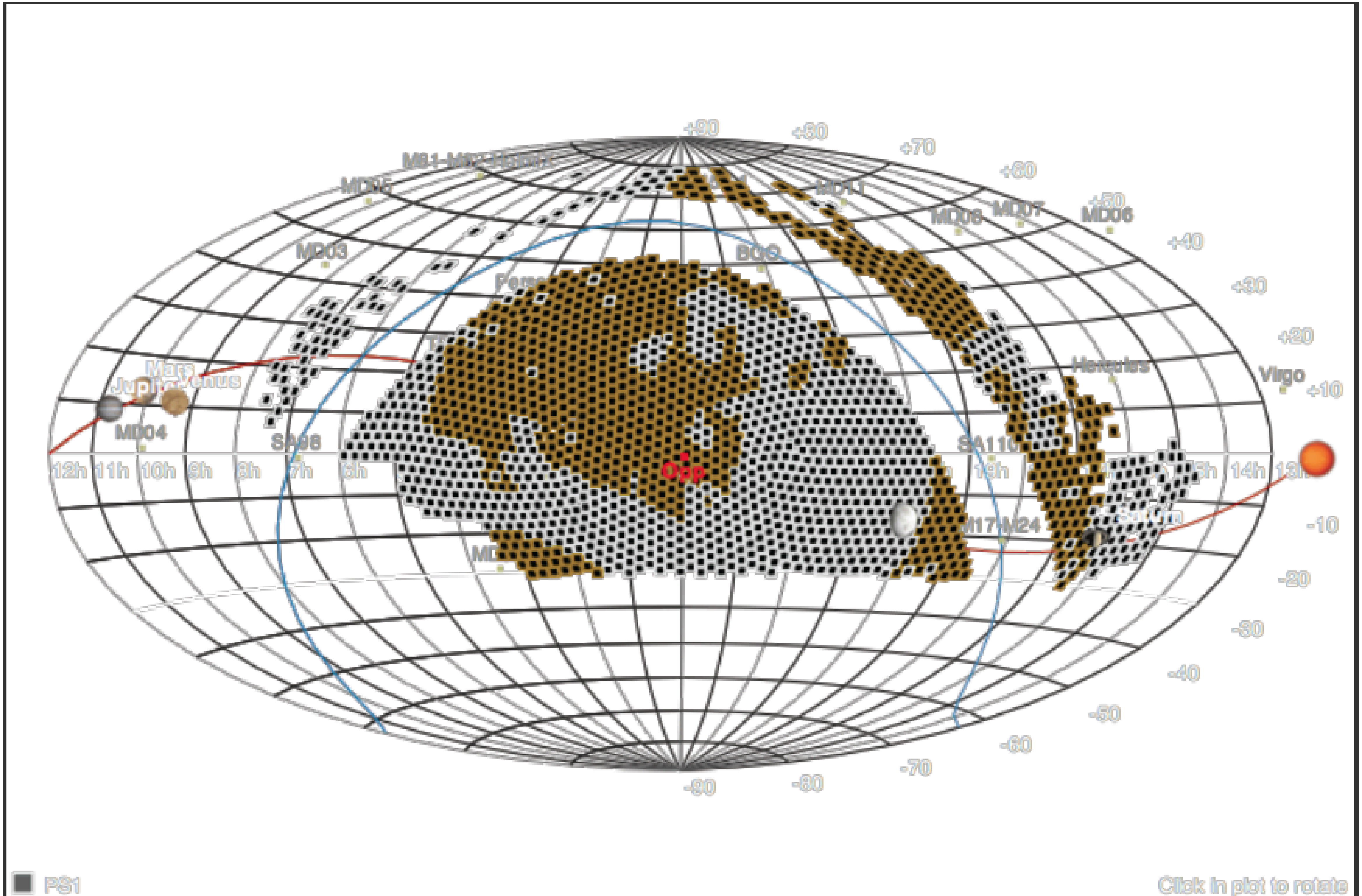
Pan-STARRS2

- Pan-STARRS2 is nearing completion adjacent to PS1
- Adding a second telescope will enable us to survey a large fraction of the sky multiple times each lunation

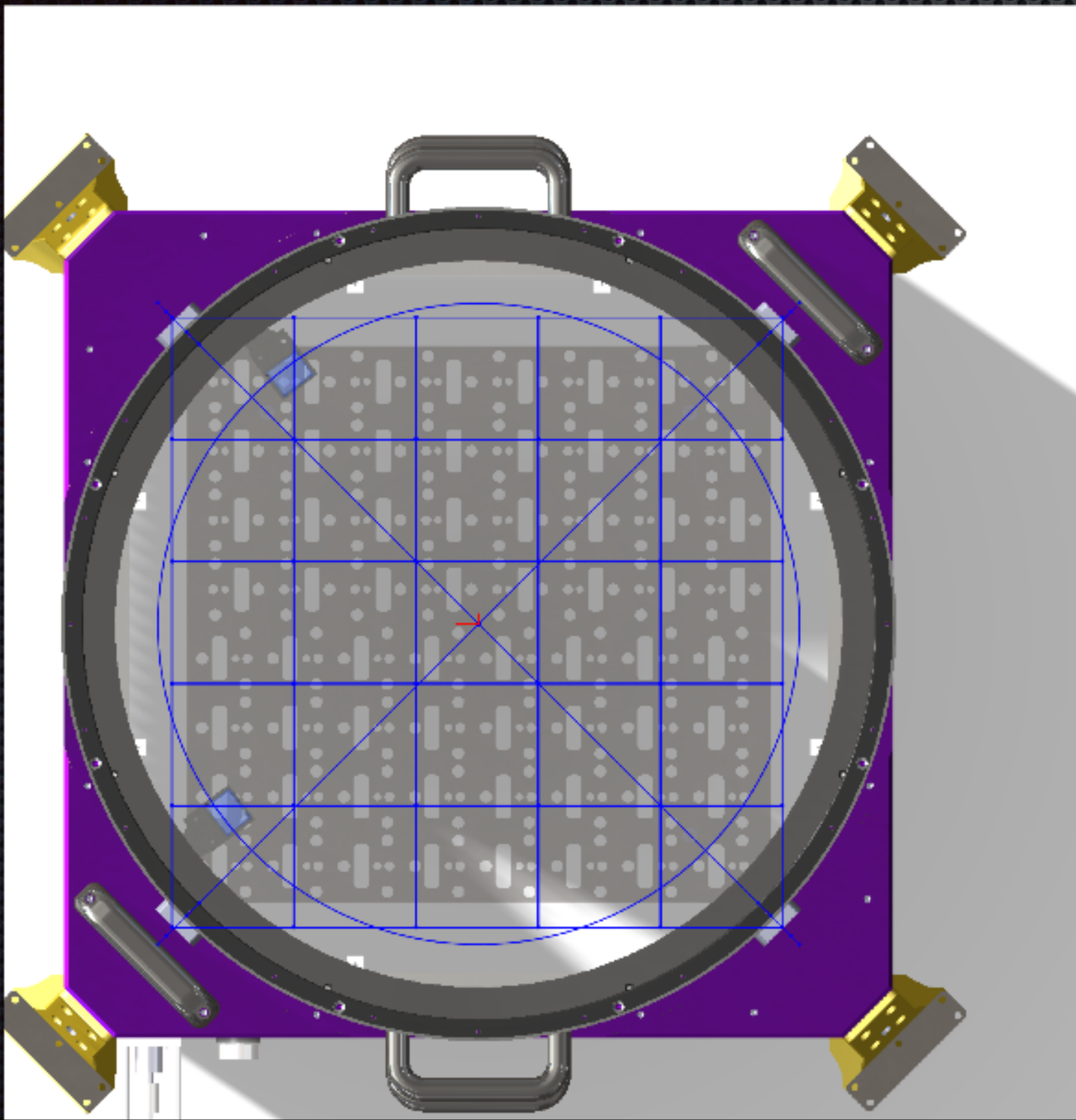


PS2 image of the Crab Nebula

Sky coverage with 100% of Pan-STARRS1&2



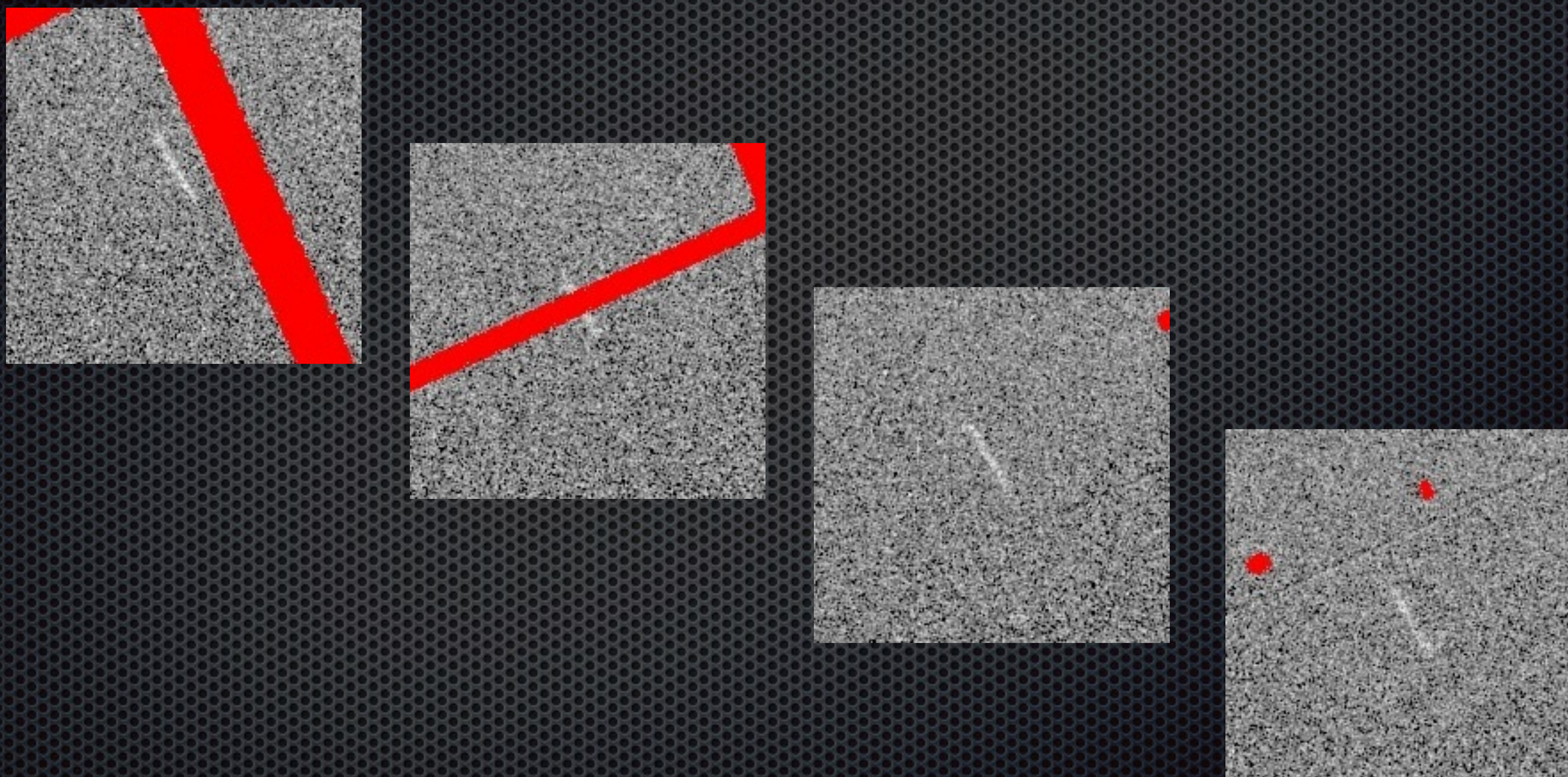
Camera retrofit



The CCDs in the Pan-STARRS telescopes are not ideal

- Cosmetic quality of some devices is poor
- Cell structure in CCDs hinders discovery of faster moving NEOs

Example of fast moving asteroid detection compromised by cell gaps



Camera retrofit

- Better CCDs would increase our discovery rate by a factor of almost 2

Photo by Rob Ratkowski © 2010 PS1 Science Consortium.