WFIRST and Solar System Science

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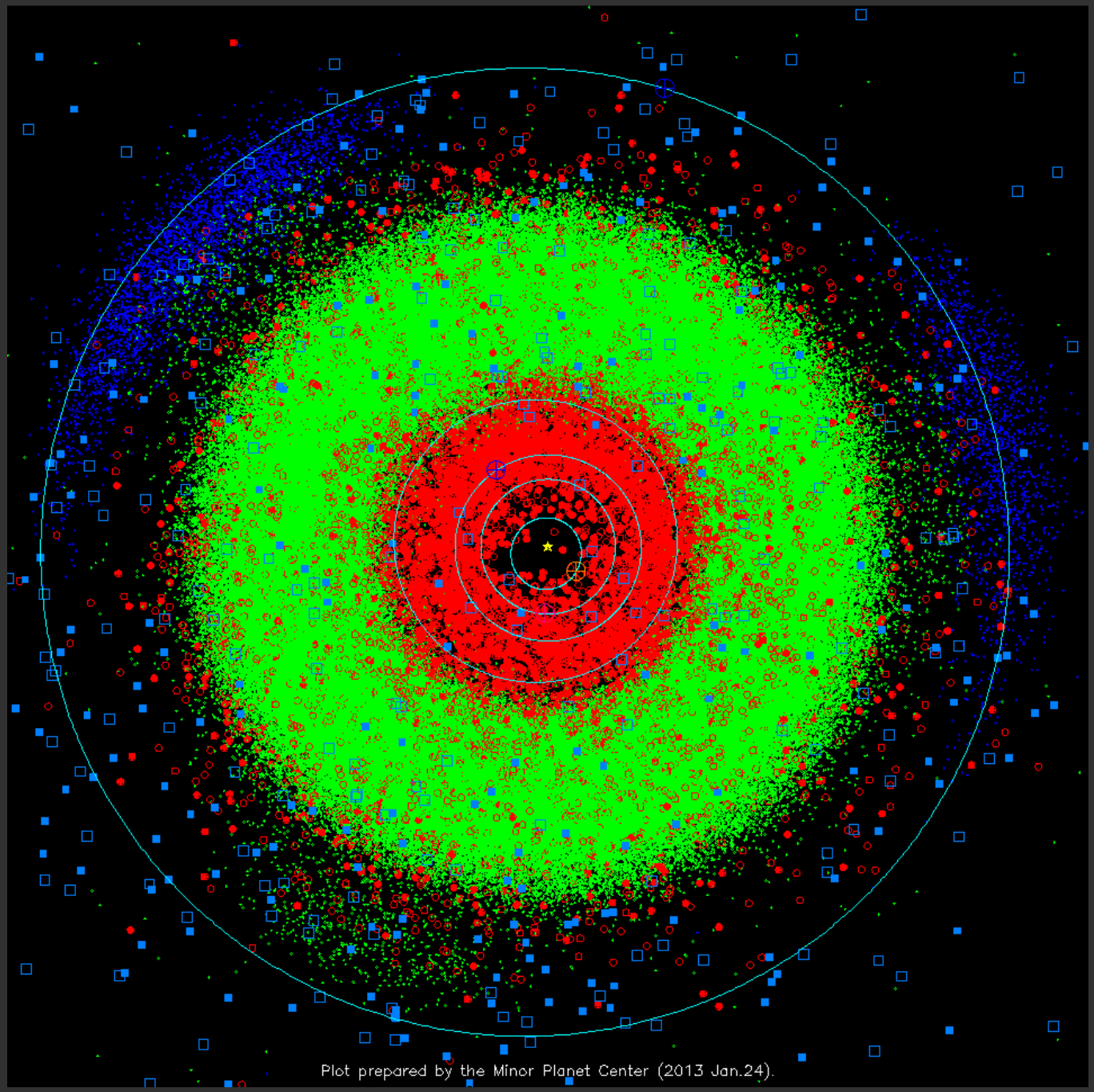
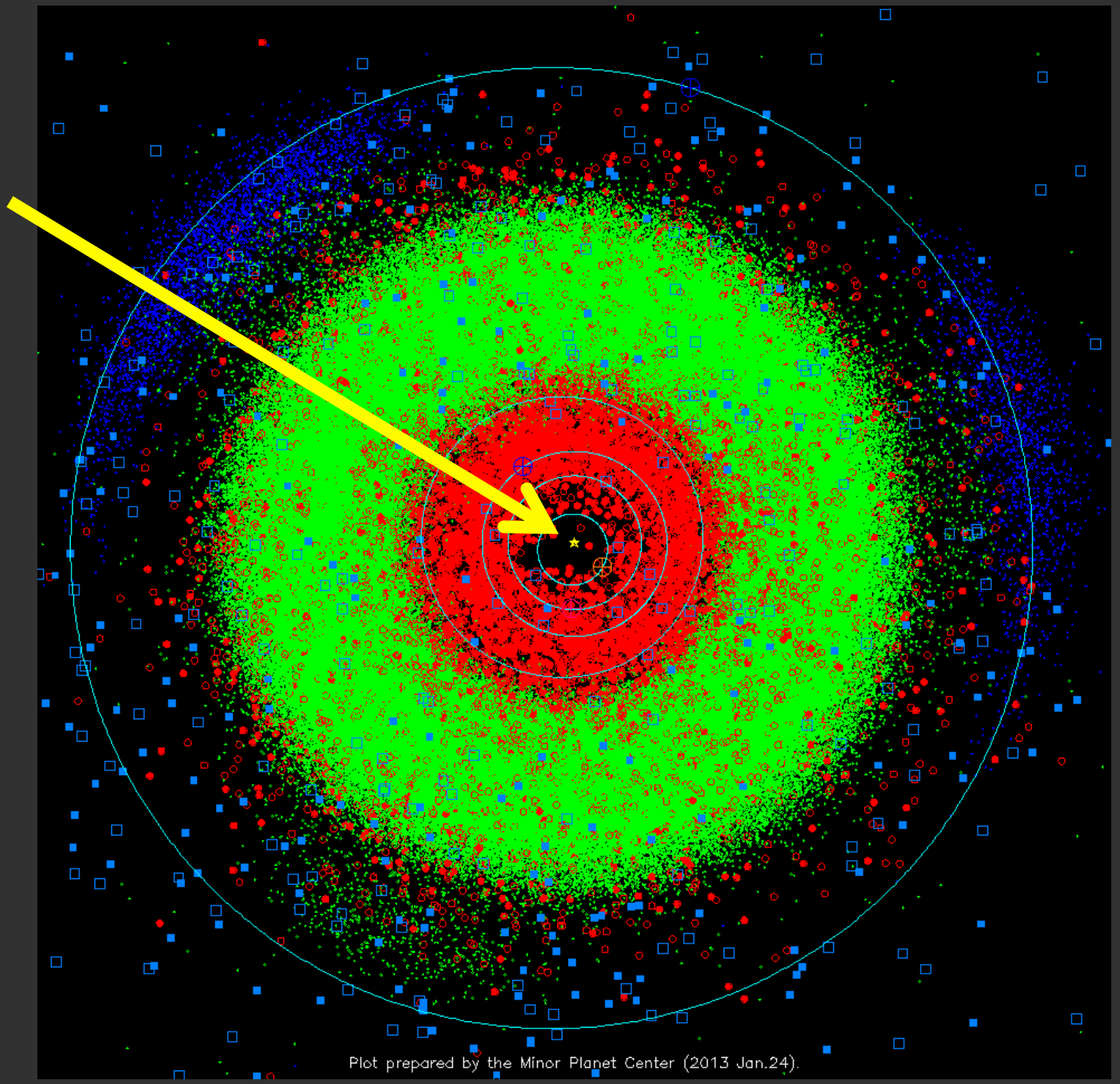
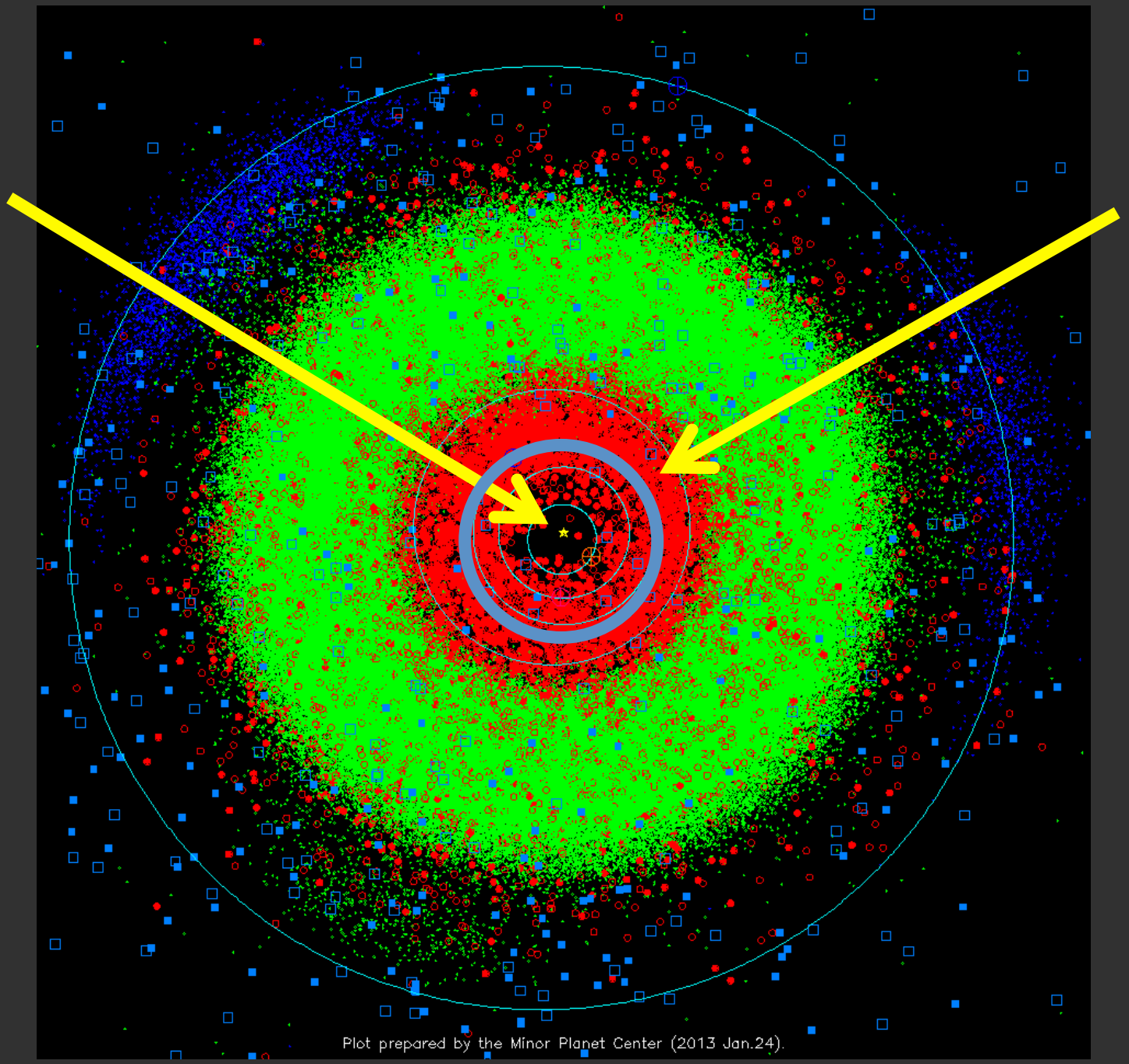
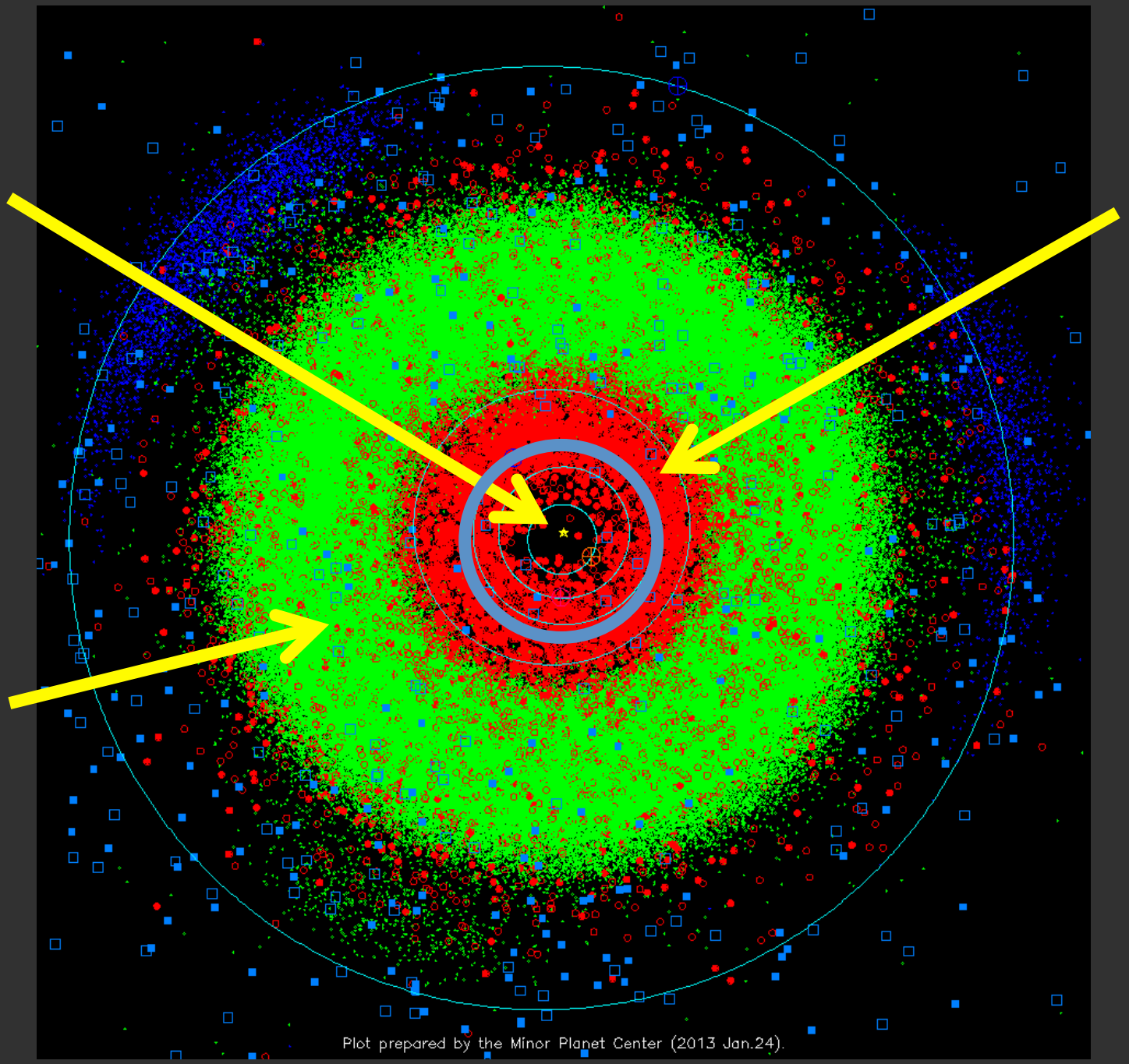
Intro to the Solar System

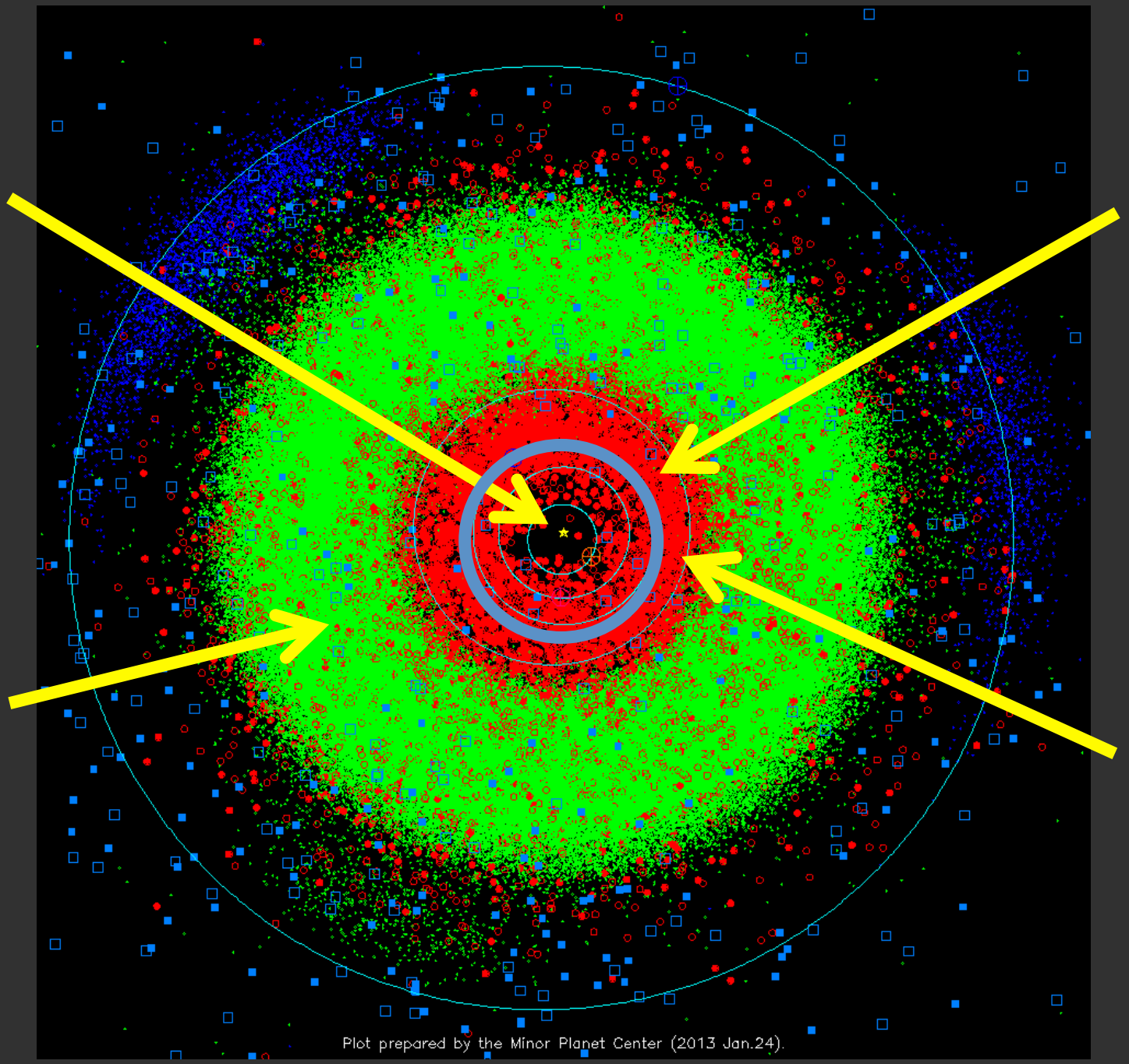
The formation and evolution of the Solar System can be learned from studying the properties of millions of small bodies

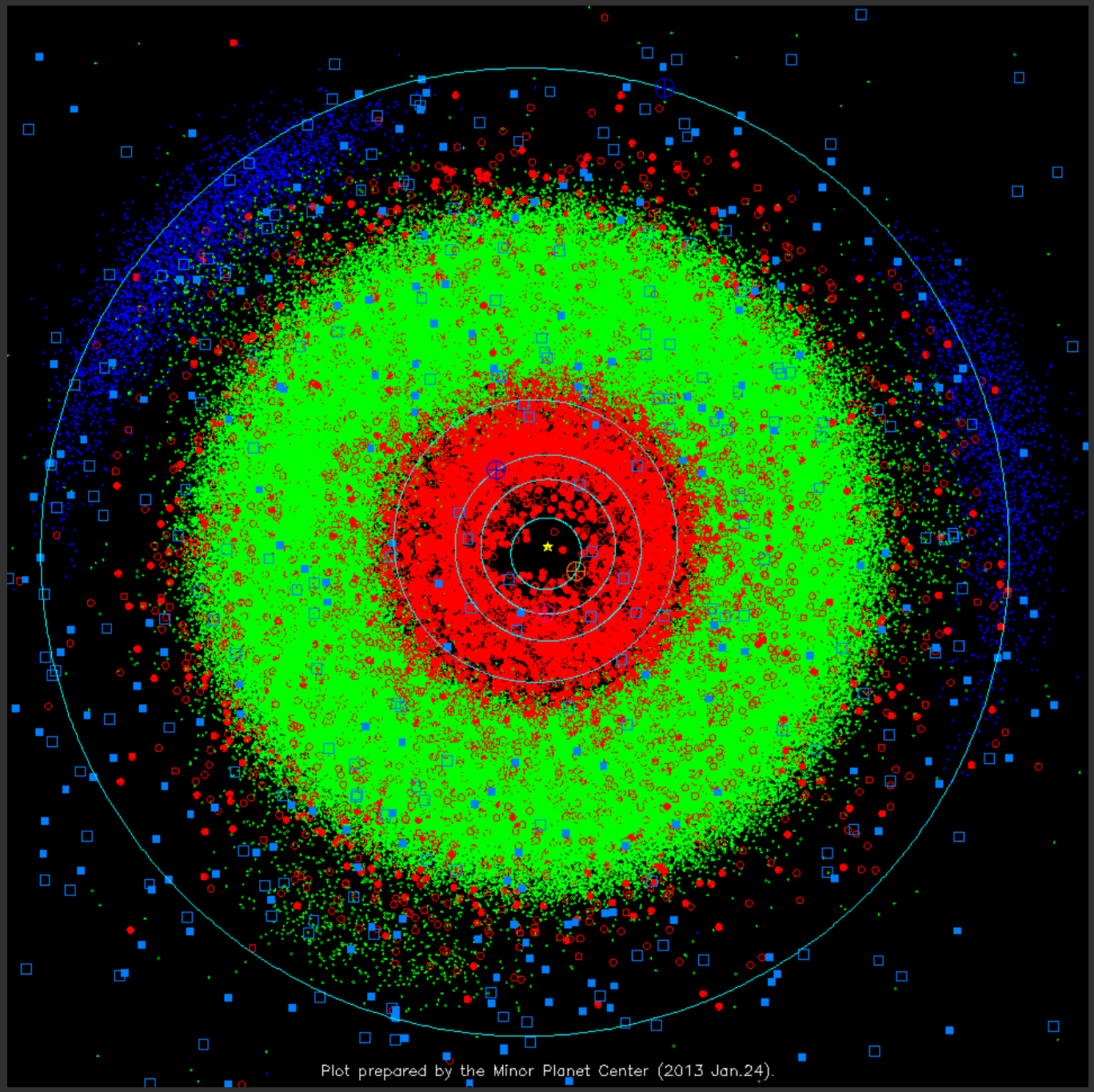

Plot prepared by the Minor Planet Center (2013 Jan.24).


Sun
Plot prepared by the Minor Planet Center (2013 Jan.24).


Sun
Earth's orbit
Plot prepared by the Minor Planet Center (2013 Jan.24).


Sun
Earth's orbit
Main belt asteroids
Plot prepared by the Minor Planet Center (2013 Jan.24).


Sun
Main belt asteroids
Earth's orbit
Near Earth asteroids
Plot prepared by the Minor Planet Center (2013 Jan.24).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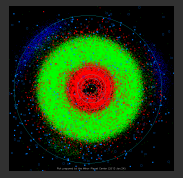
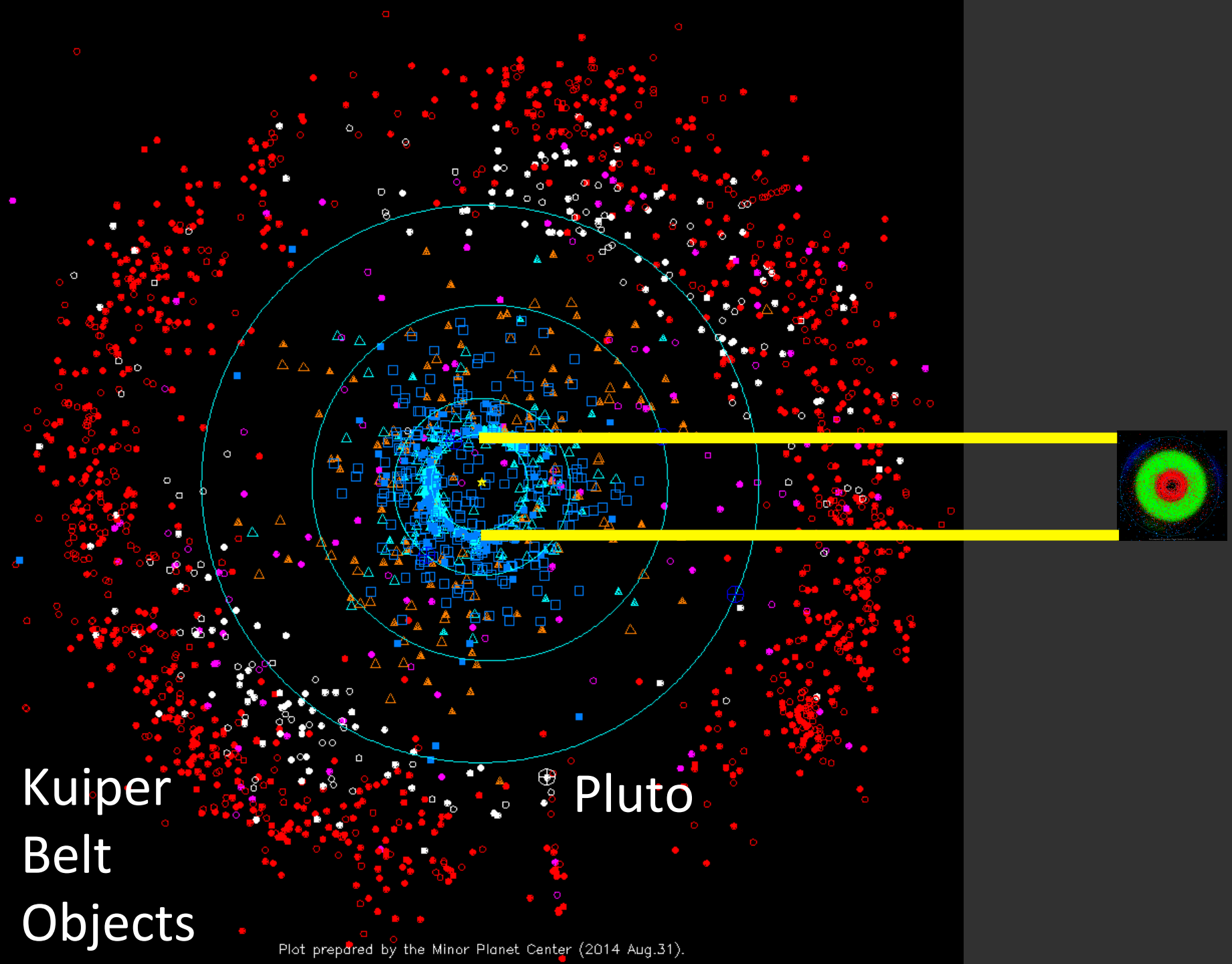
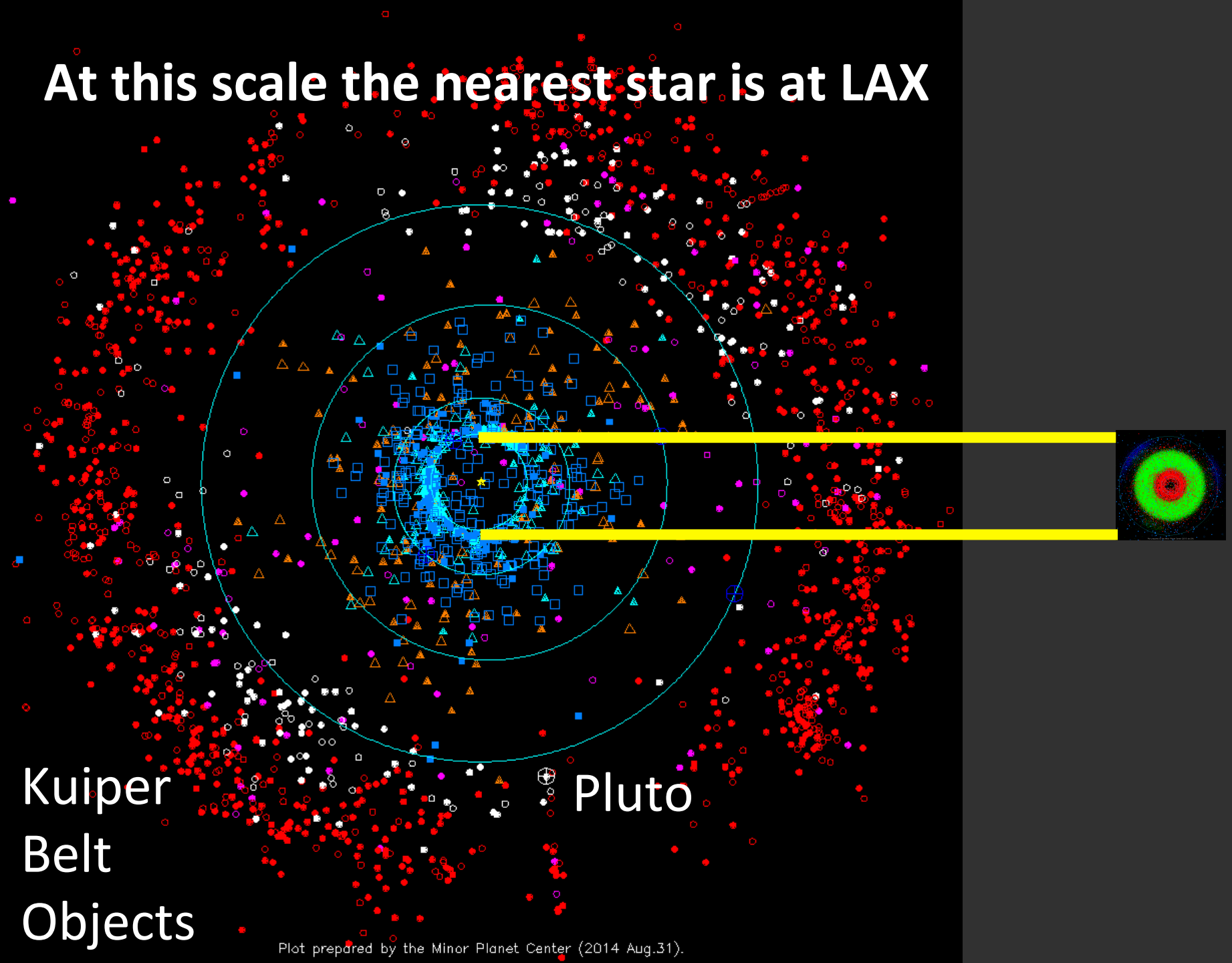



Kuiper Belt Objects
Pluto
Plot prepared by the Minor Planet Center (2014 Aug.31).

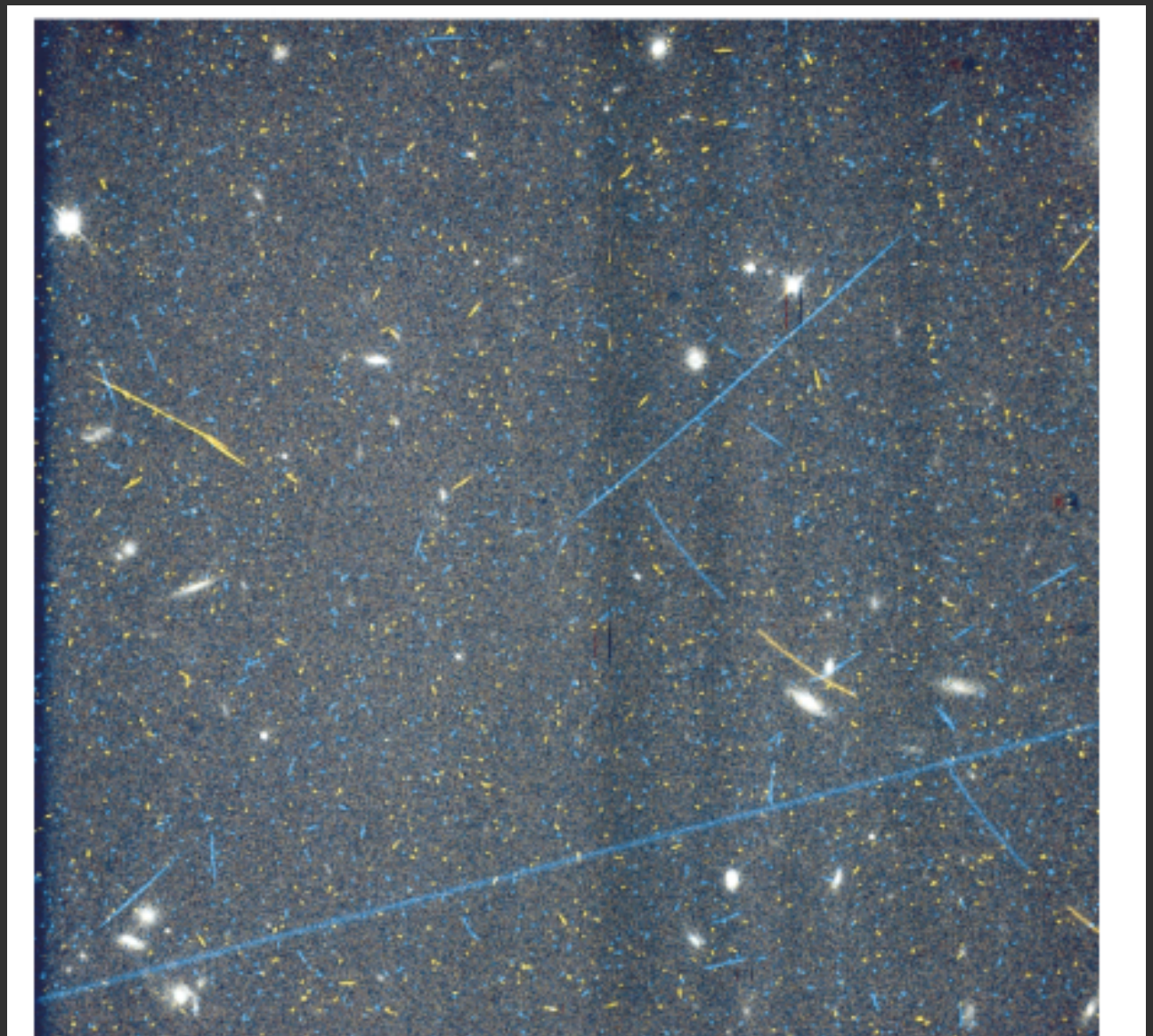
At this scale the nearest star is at LAX



Solar System objects move

Moving objects move

Moving objects move

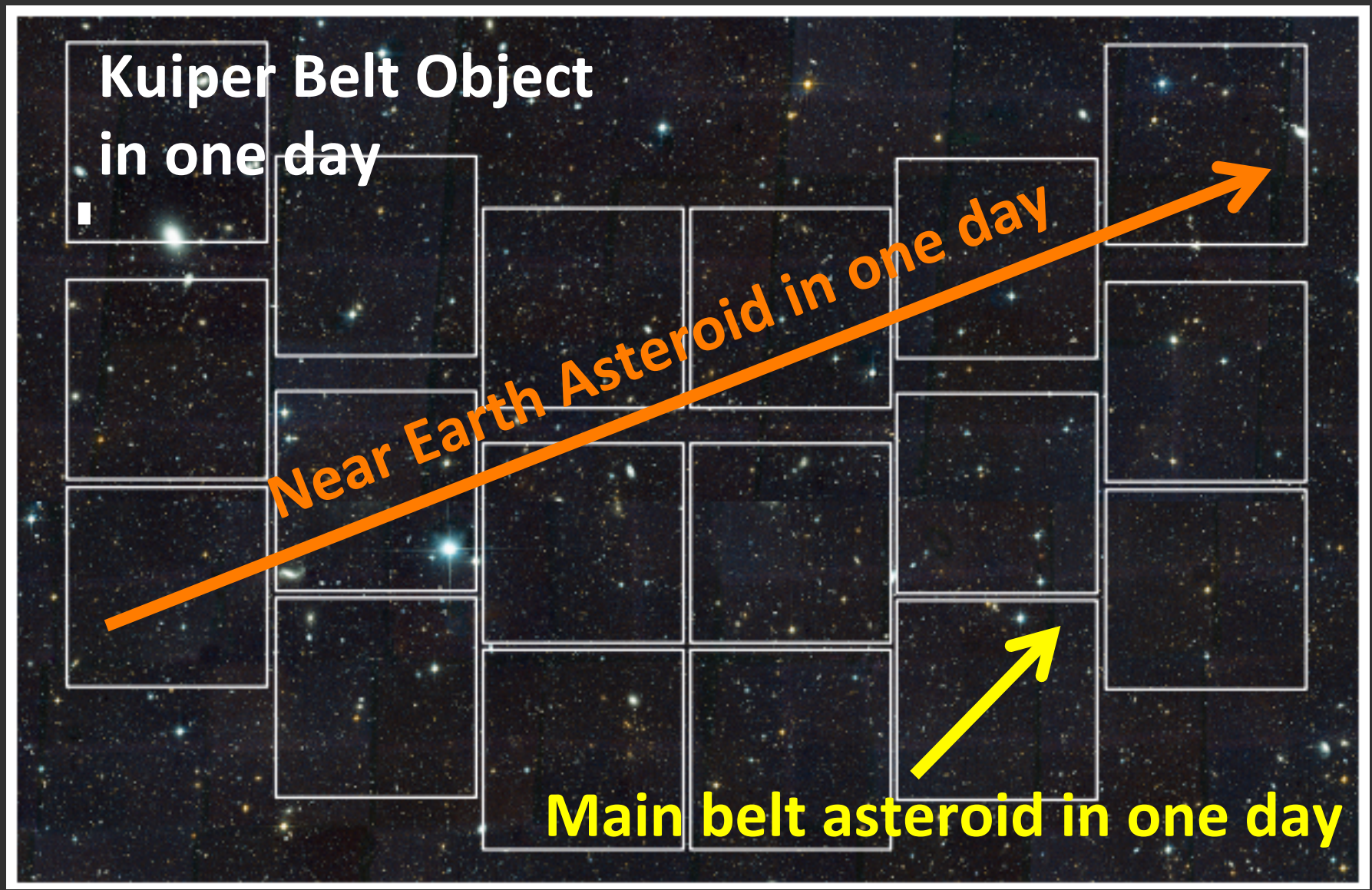


HST/ WFPC2
Evans et al. 1998

Moving objects move

- Rates of motion: From 1—100”/hour
- Impacts both GI and GO science (if there is no non-sidereal observing; more on this later)

Moving objects move



Science investigations

Guest Investigator science

Guest Investigator science

- Archive: only WFI data is going to be useful

Guest Investigator science

If NO repeat:

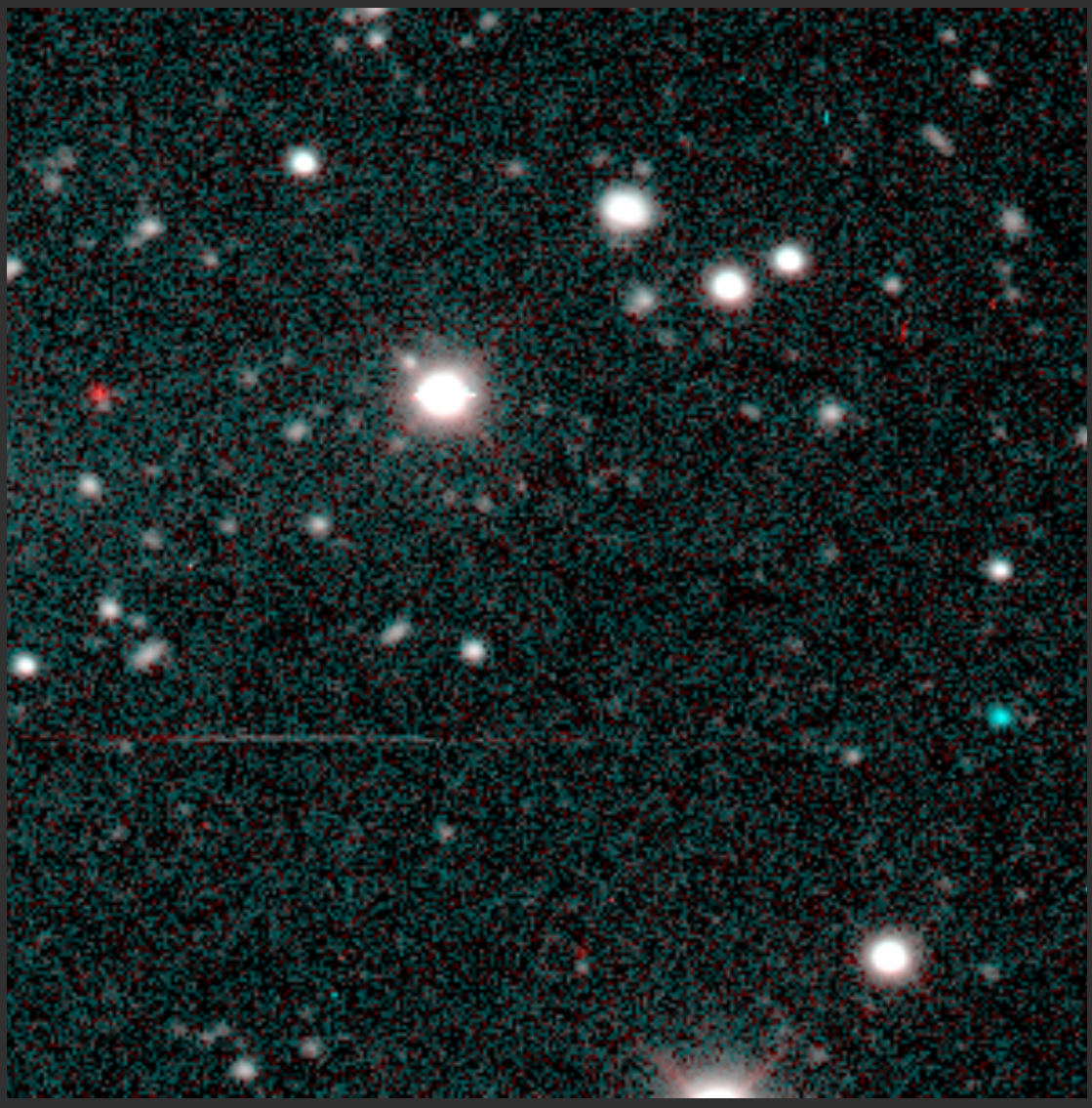
- Only trailed objects (trails up to 30-50 pixels)
- Statistical population properties (how many, how bright) as derived from trails
- Lessons learned from Pan-STARRS (example: Near Earth Asteroid lightcurves measured in the trail)

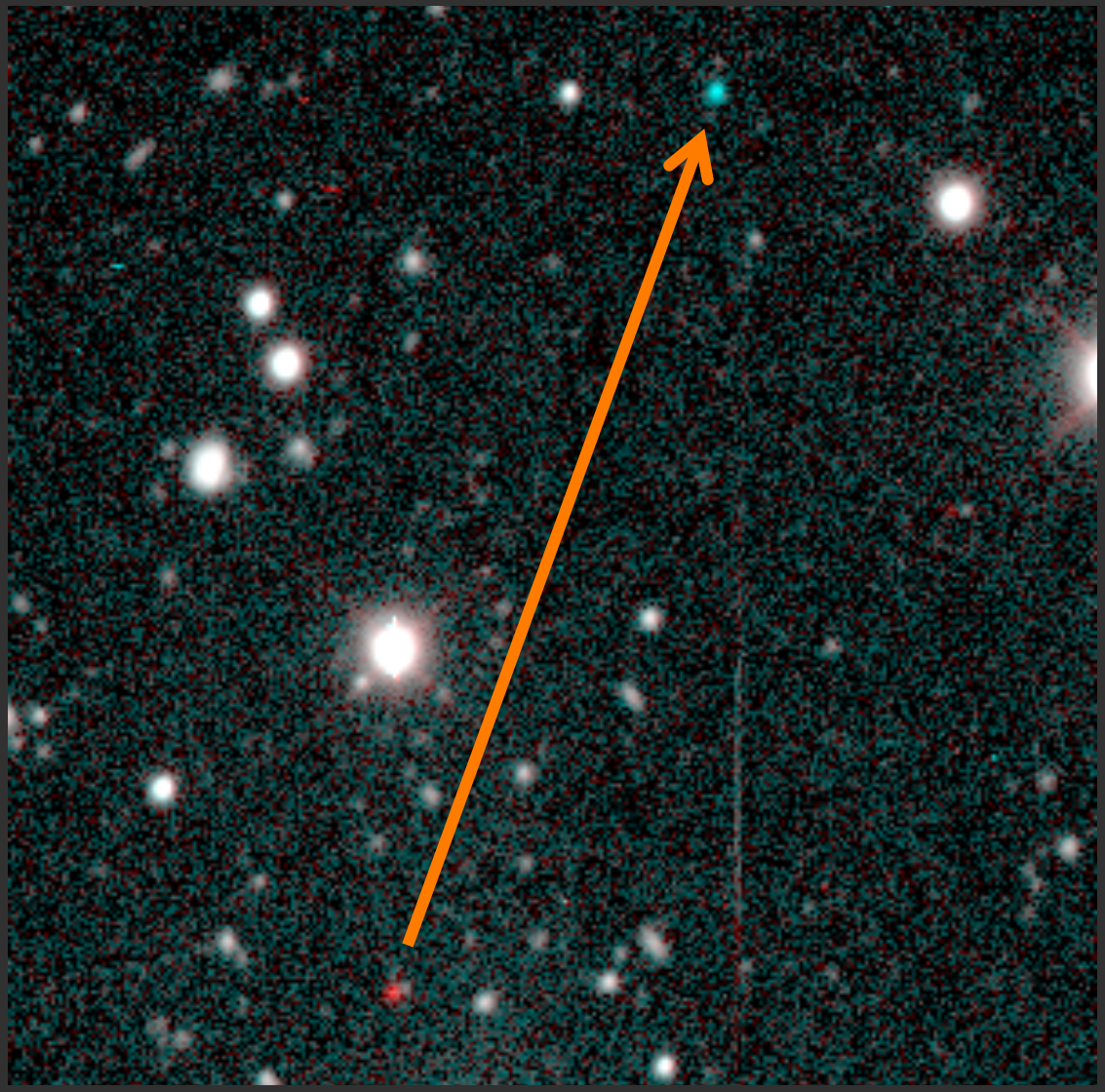
Guest Investigator science

If YES repeat:

- Slow moving outer Solar System objects (connect the dots)
- Individual object properties

1 arcmin x 1 arcmin




1 arcmin x 1 arcmin

Guest Investigator science

Andy Gould (2014):

- KBO orbits
- Binary KBOs
- Occultations

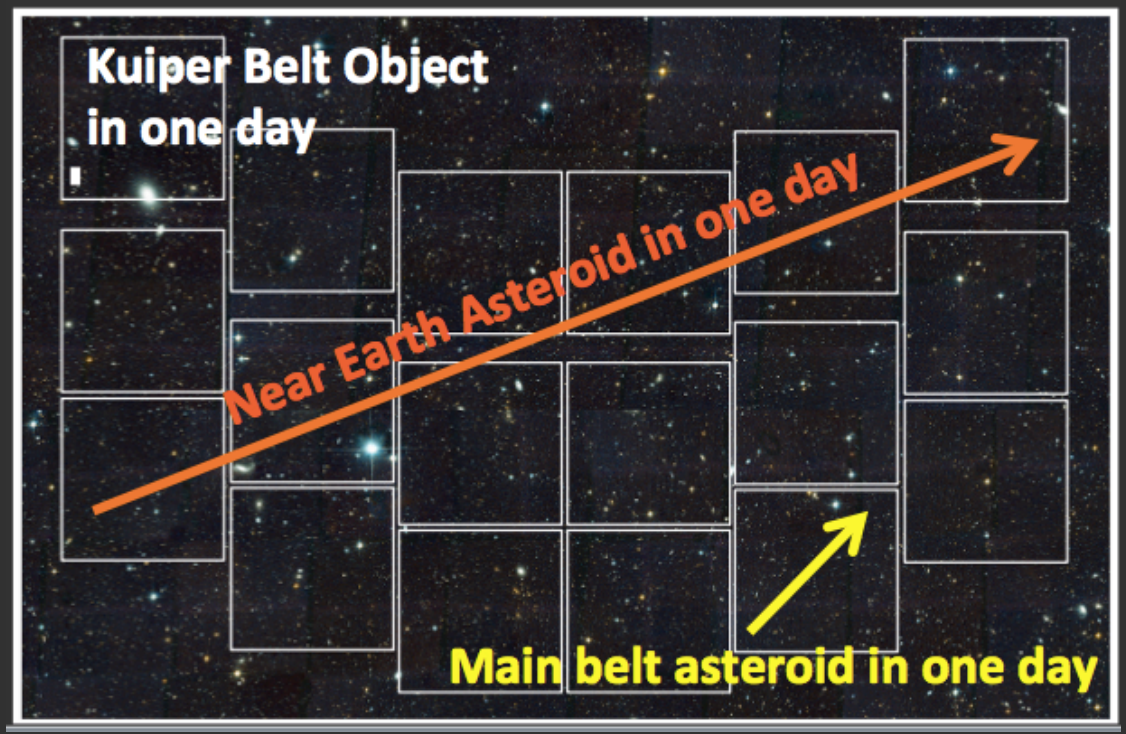
Guest Observer science

Guest Observer science

- Without non-sidereal observing, only WFI will be useful

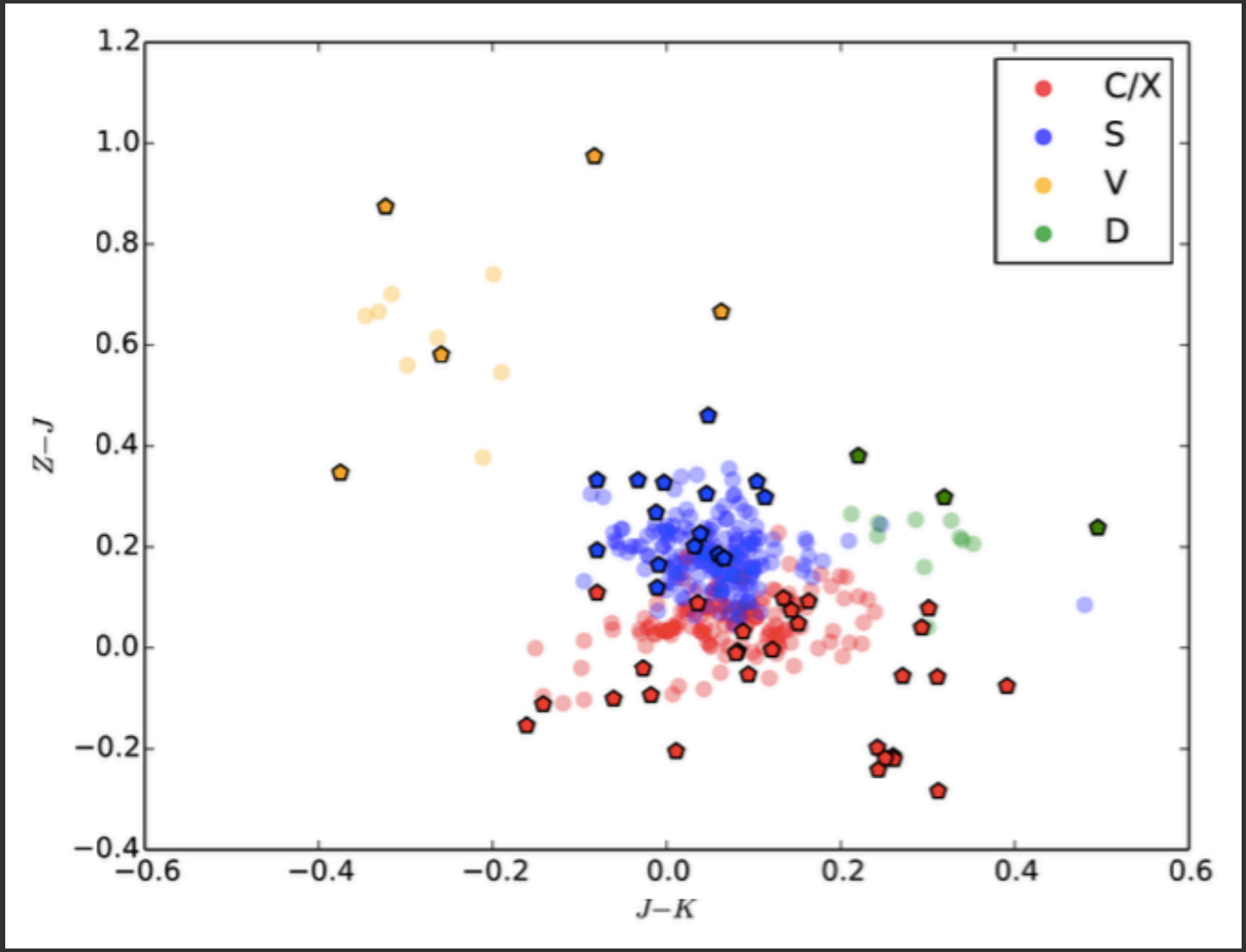
Guest Observer science: WFI

- Near Earth Asteroids (10 sec exposures)
- Main Belt Asteroids (30 sec exposures)
- Kuiper Belt Objects (270 sec exposures)



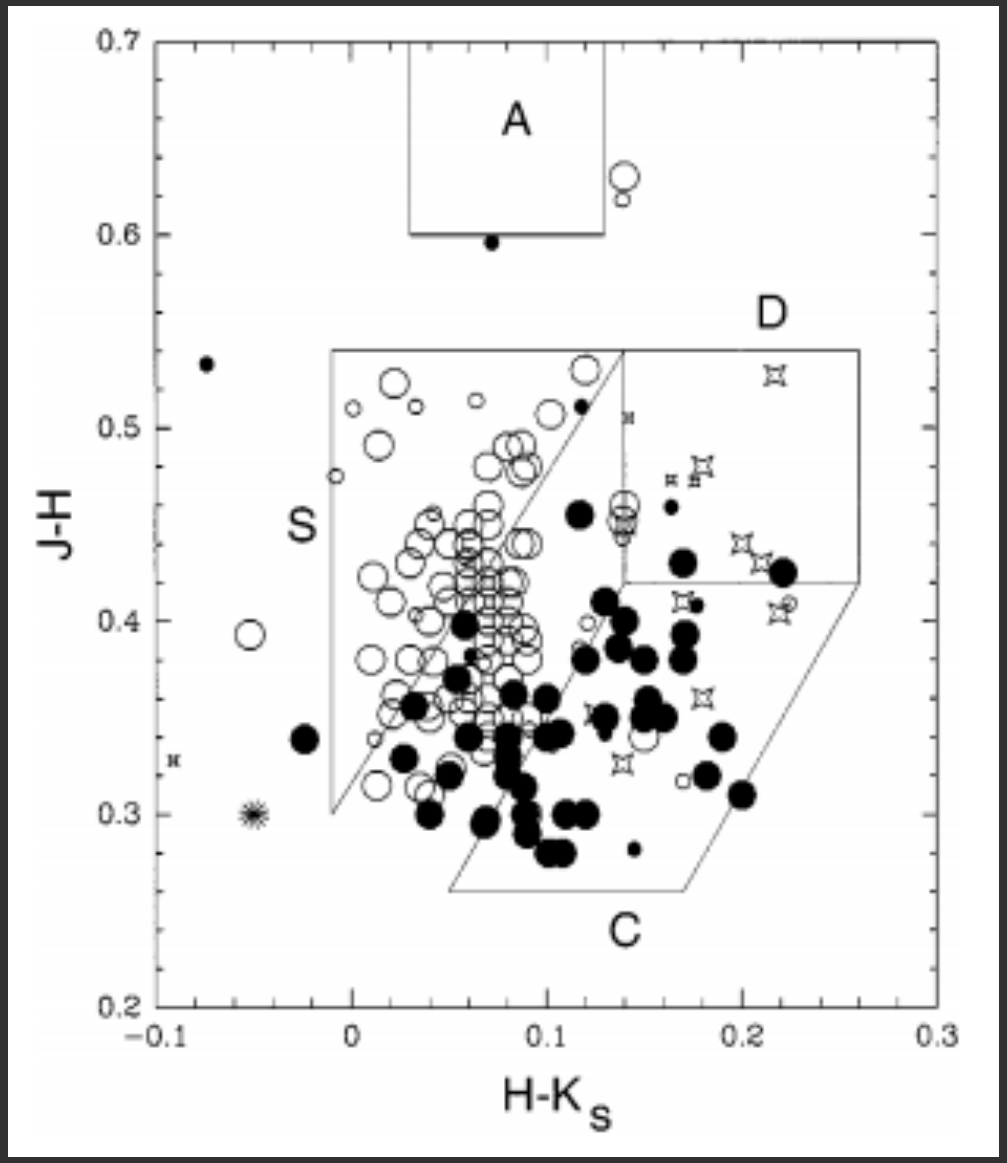
Guest Observer science: WFI

Near Earth Asteroids: UKIRT Mommert et al.

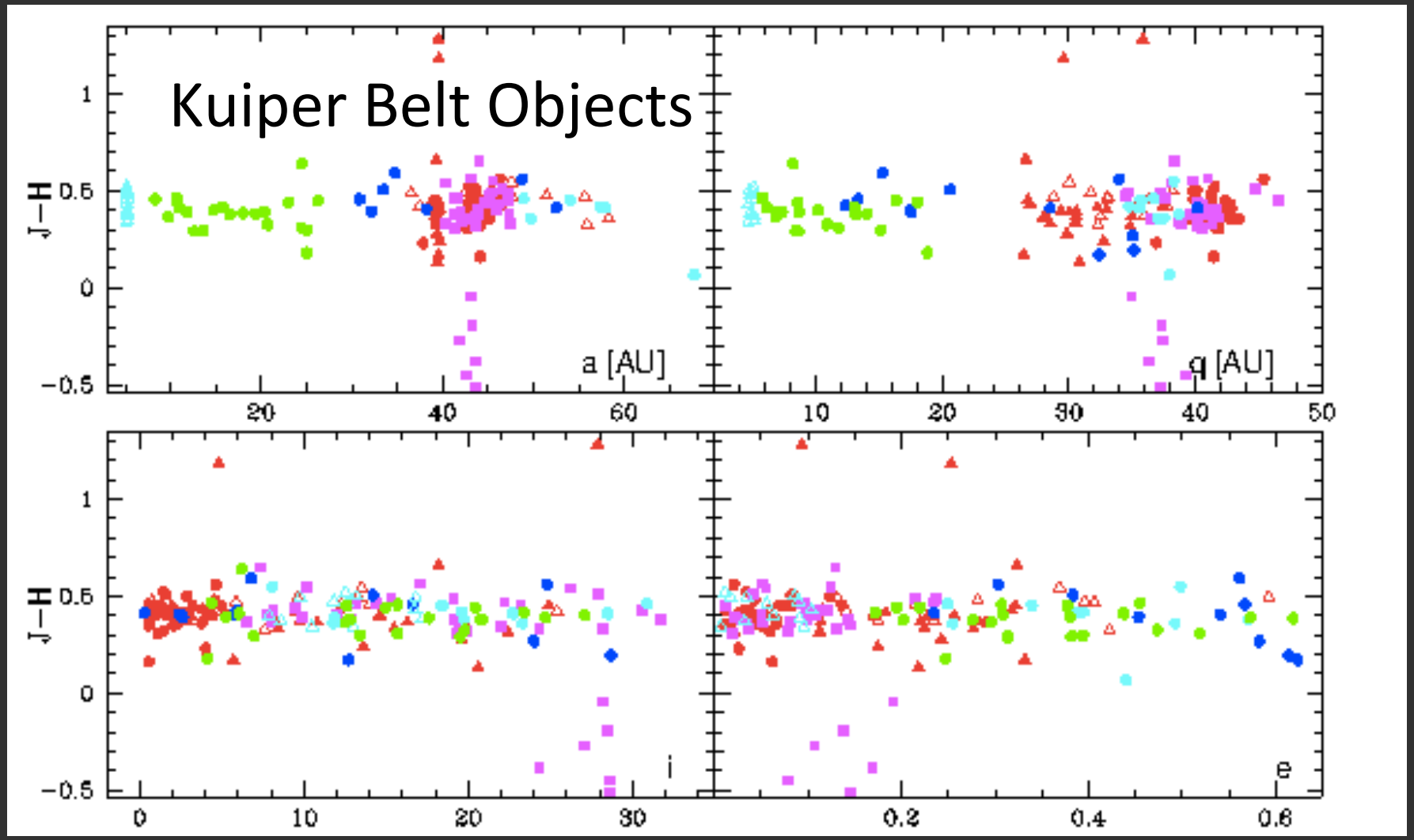


Guest Observer science: WFI

Main Belt Asteroids: 2MASS Sykes et al.



Guest Observer science: WFI



Hainaut et al.

Non-sidereal observing

Non-sidereal observing

- Opens a whole new world for dedicated studies

Non-sidereal observing

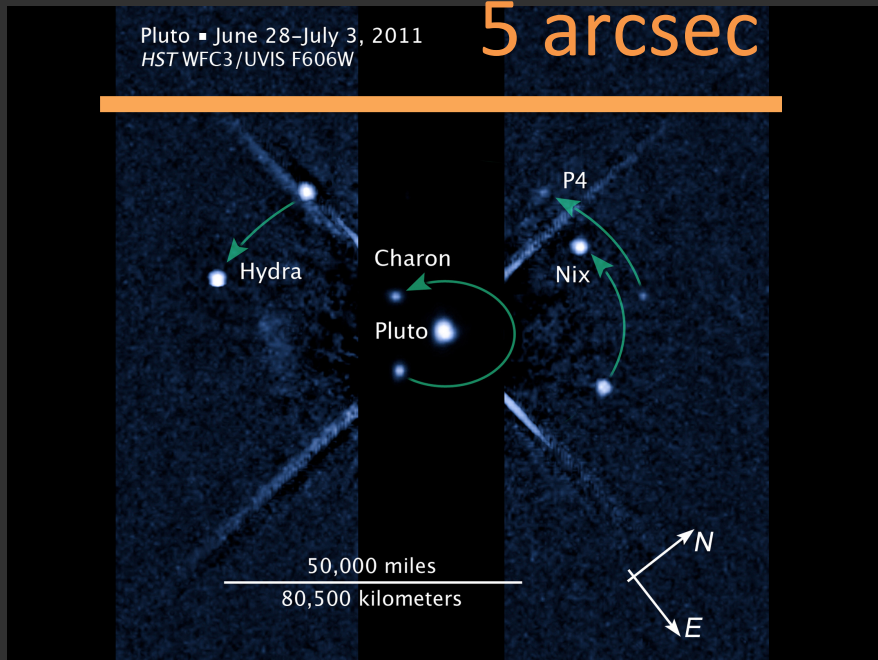
- Opens a whole new world for dedicated studies
- WFI:
  - Characterization of (very) faint objects through long integrations
  - Every known Kuiper Belt Object
  - Almost every known Near Earth Asteroid

Non-sidereal observing

- Opens a whole new world for dedicated studies
- IFU:
  - Spectra of (very small) Near Earth Asteroids
  - Separate spectra of binary components
  - Ice compositions in the outer Solar System

Non-sidereal observing

- Opens a whole new world for dedicated studies
- Coronagraphy:
  - Satellites of Kuiper Belt Objects
  - Active asteroids



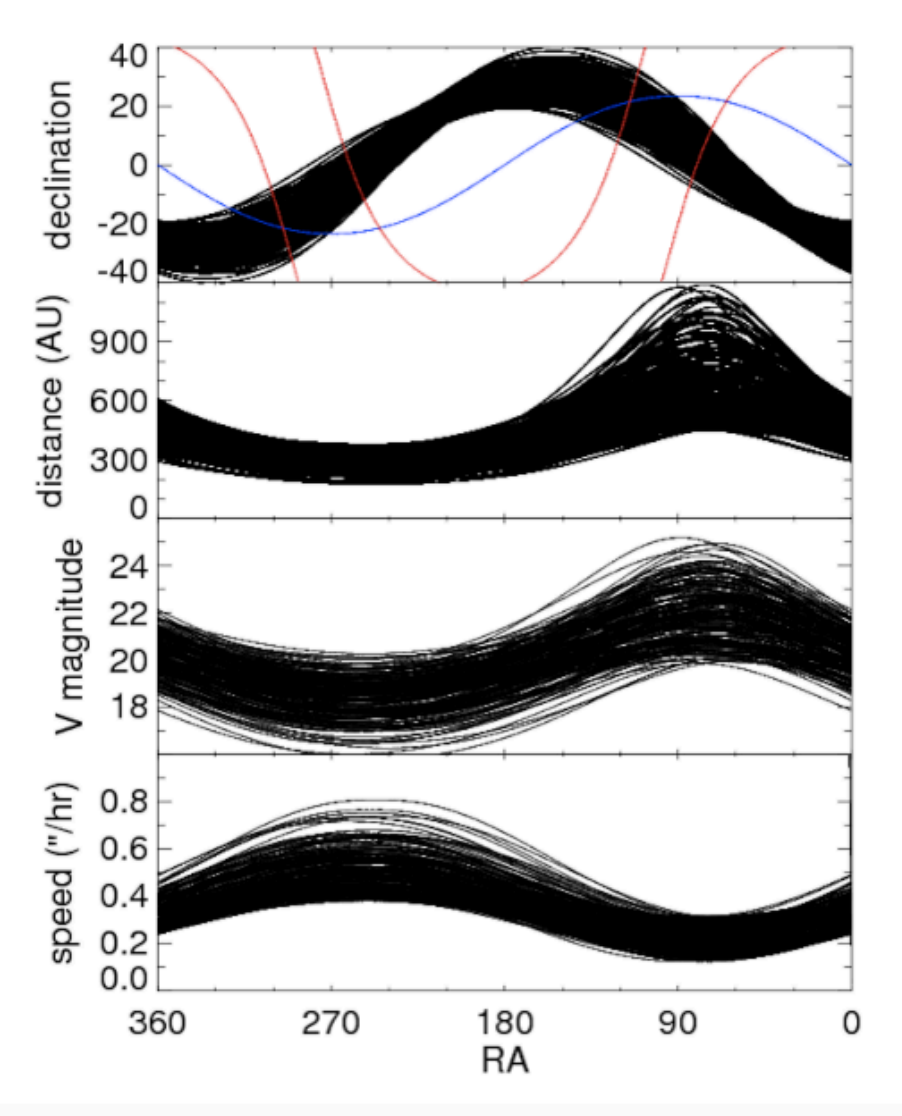
Non-sidereal observing

- Opens a whole new world for dedicated studies
- Could say much more, but trying to stay “high level”

Planet Nine

Planet Nine

Recently predicted Neptune-sized object at ~500 AU



Planet Nine

- WFI: Search for Planet Nine
- WFI/IFU: Characterize atmosphere
- Cor.: Search for moons, rings, ….

Other assets

Other assets

- JWST: Highly complementary
- LSST asteroids in WFIRST FOV will be strongly detected (and further characterized)
- NEOCam (proposed Discovery mission): Add NIR characterization to thermal IR discovery (but overlap might be small because of orbits)

Conclusions

Conclusions

- Use WFIRST to study small Solar System bodies
- WFI/GI: KBOs, also Near Earth Asteroids
- WFI/GO: KBOs, asteroid characterization

If non-sidereal observing is possible

- Many additional projects (WFI, Cor.)

Other assets

- Highly complementary to LSST, JWST; less so for NEOCam