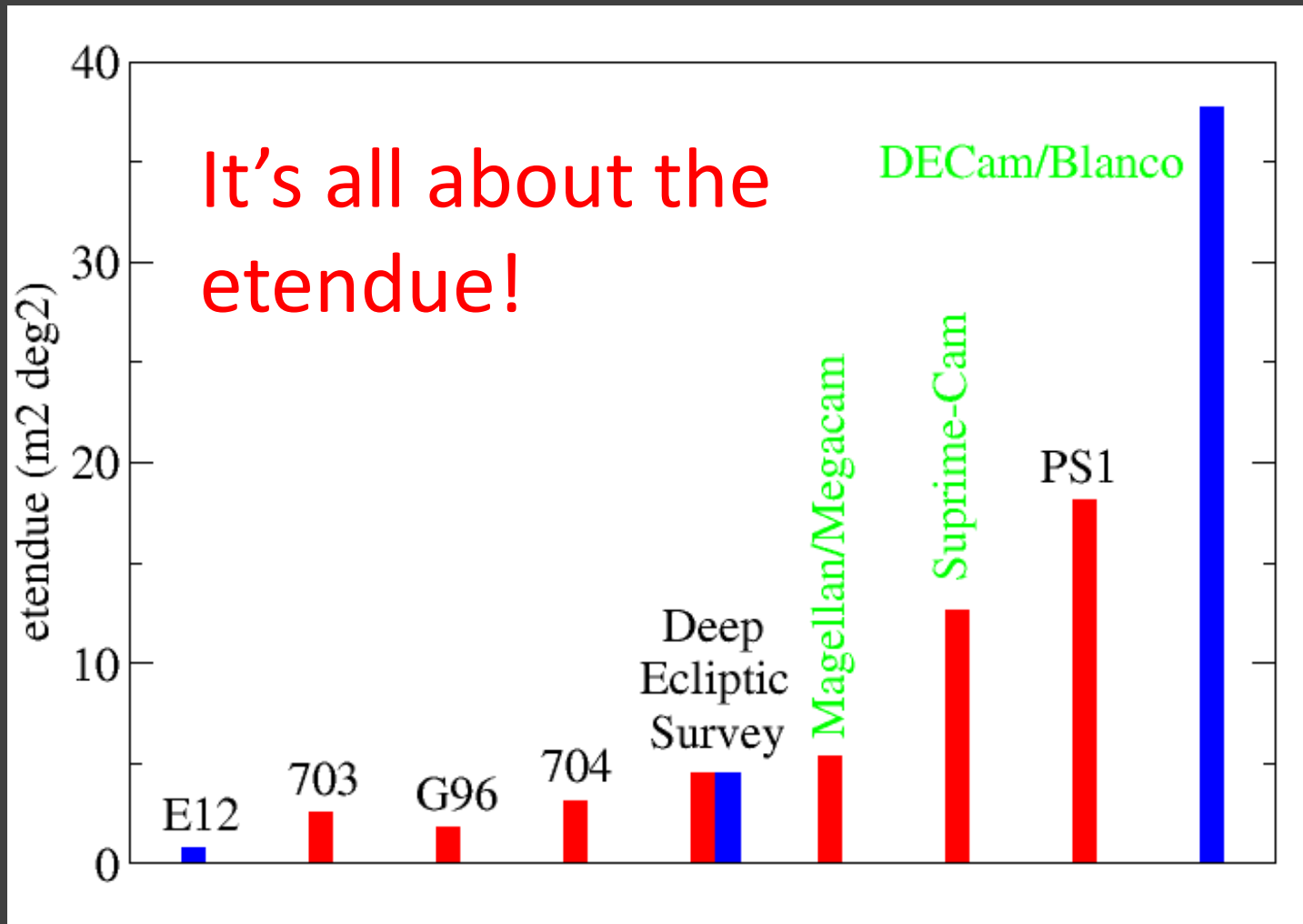


The DECam view of the Solar System

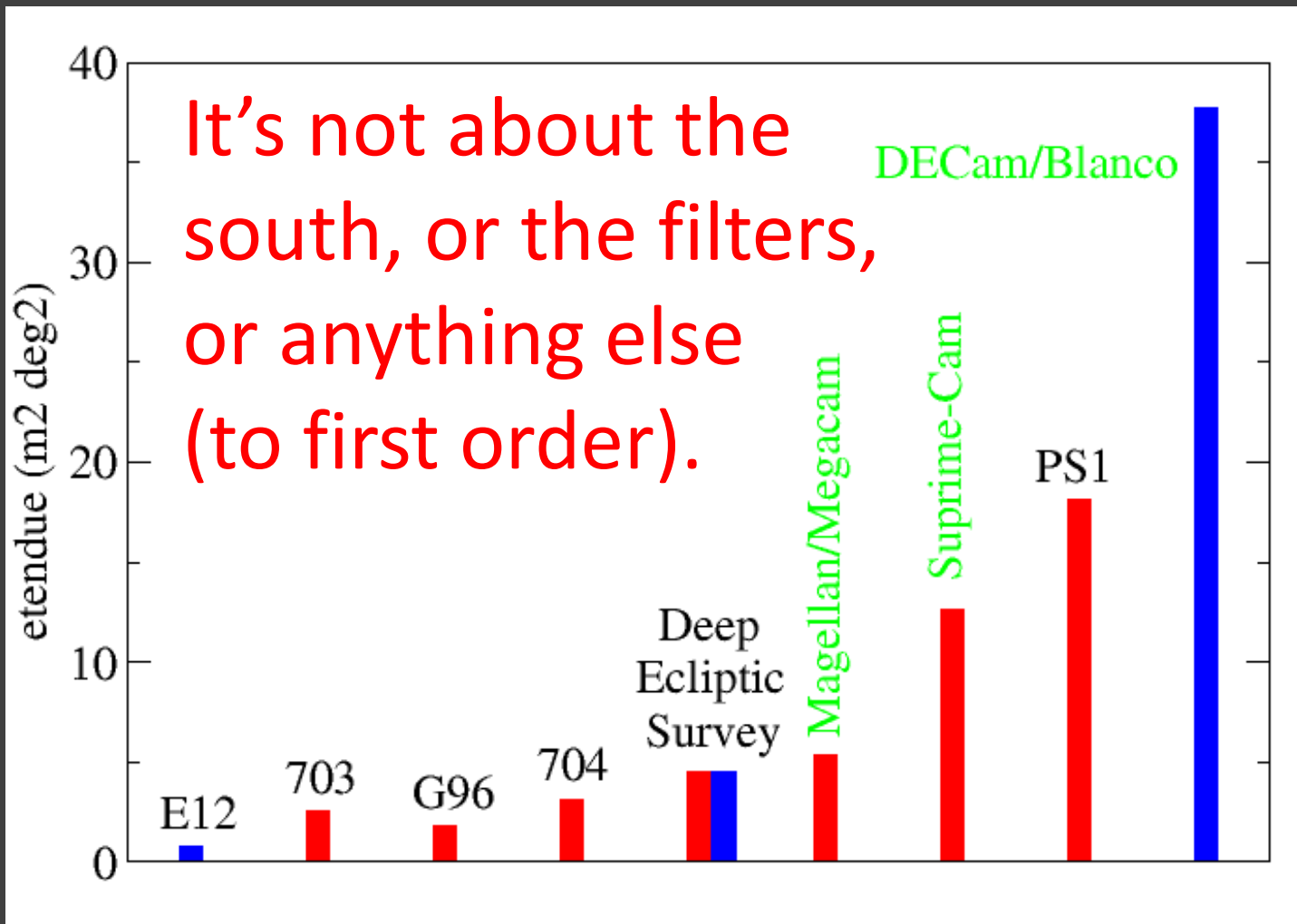
David E. Trilling (NAU)

Why is DECam interesting for Solar
System science?

Why is DECam interesting for Solar System science?



Why is DECam interesting for Solar System science?

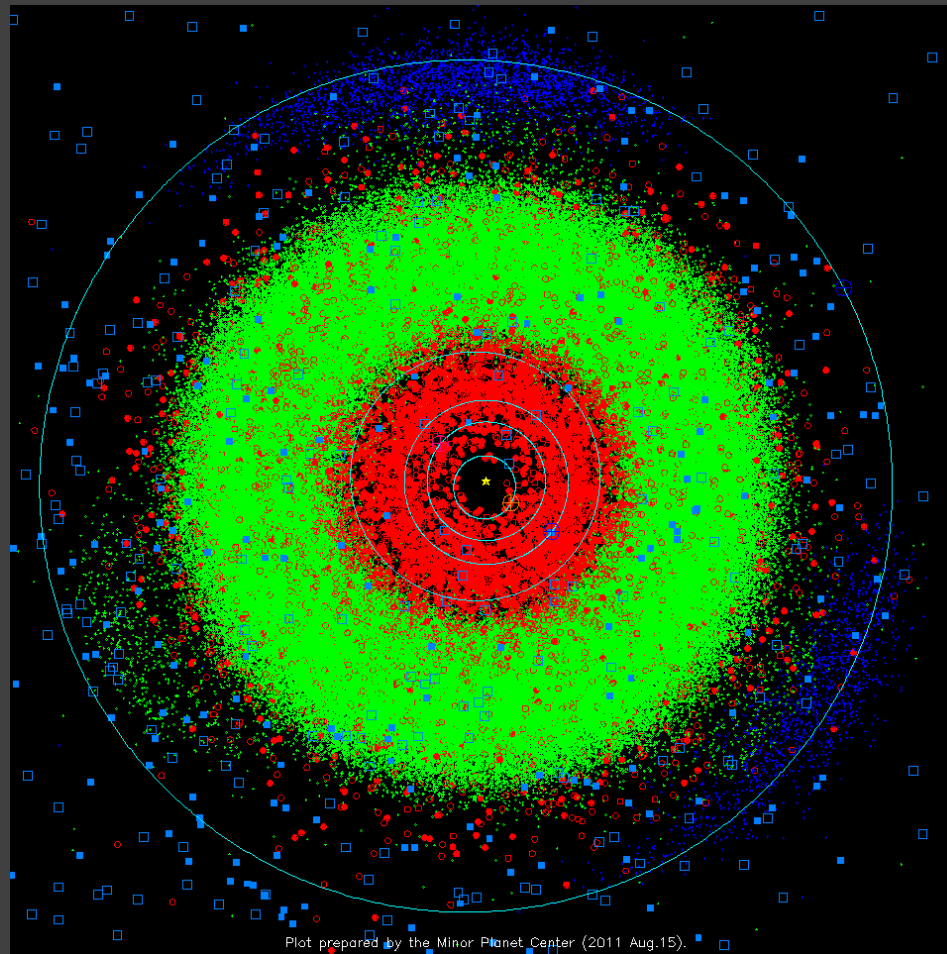


What is DECam?

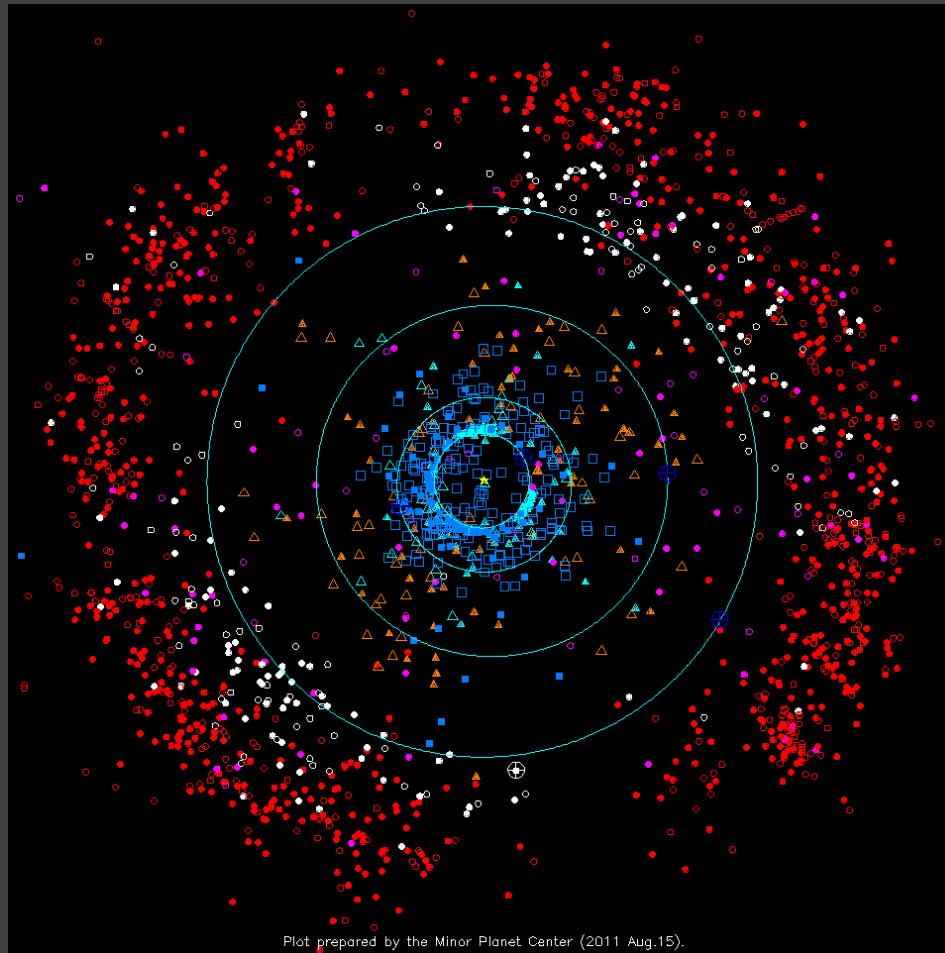
- 3 deg² imager for NOAO/CTIO 4m
- R~24 in ~60 sec
- R~25 in ~6 min
- R~26 in ~1 hr
- R~27 in ~1 night



What is the Solar System?



What is the Solar System?

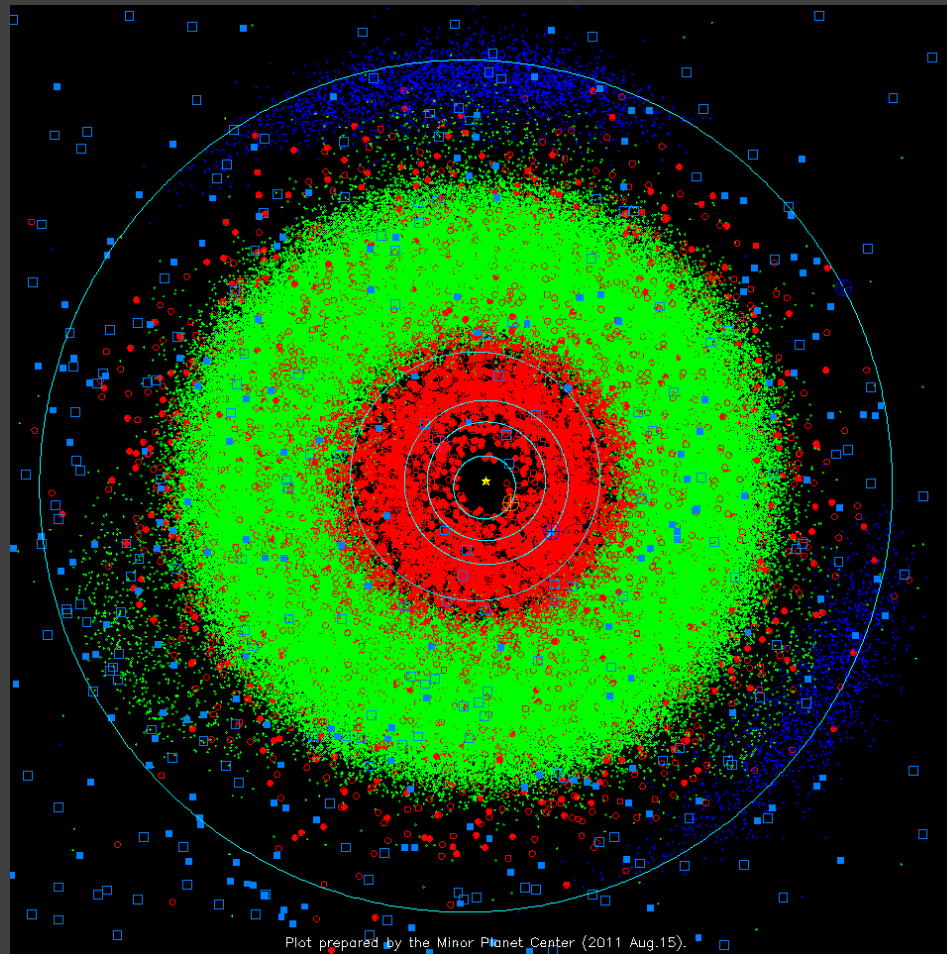


Some current Solar System topics

- Near Earth Objects (NEOs)
- Trojan asteroids (Earth, Mars, Neptune)
- Irregular satellites of giant planets
- Kuiper Belt Objects (KBOs)

- ... plus many others (comets? 1000s of asteroids? you name it)

Near Earth Objects (NEOs)



Near Earth Objects (NEOs)

- What is the population of NEOs?
 - Size distribution, orbital distribution
 - Evolution of near-Earth space
- What is the impact risk?

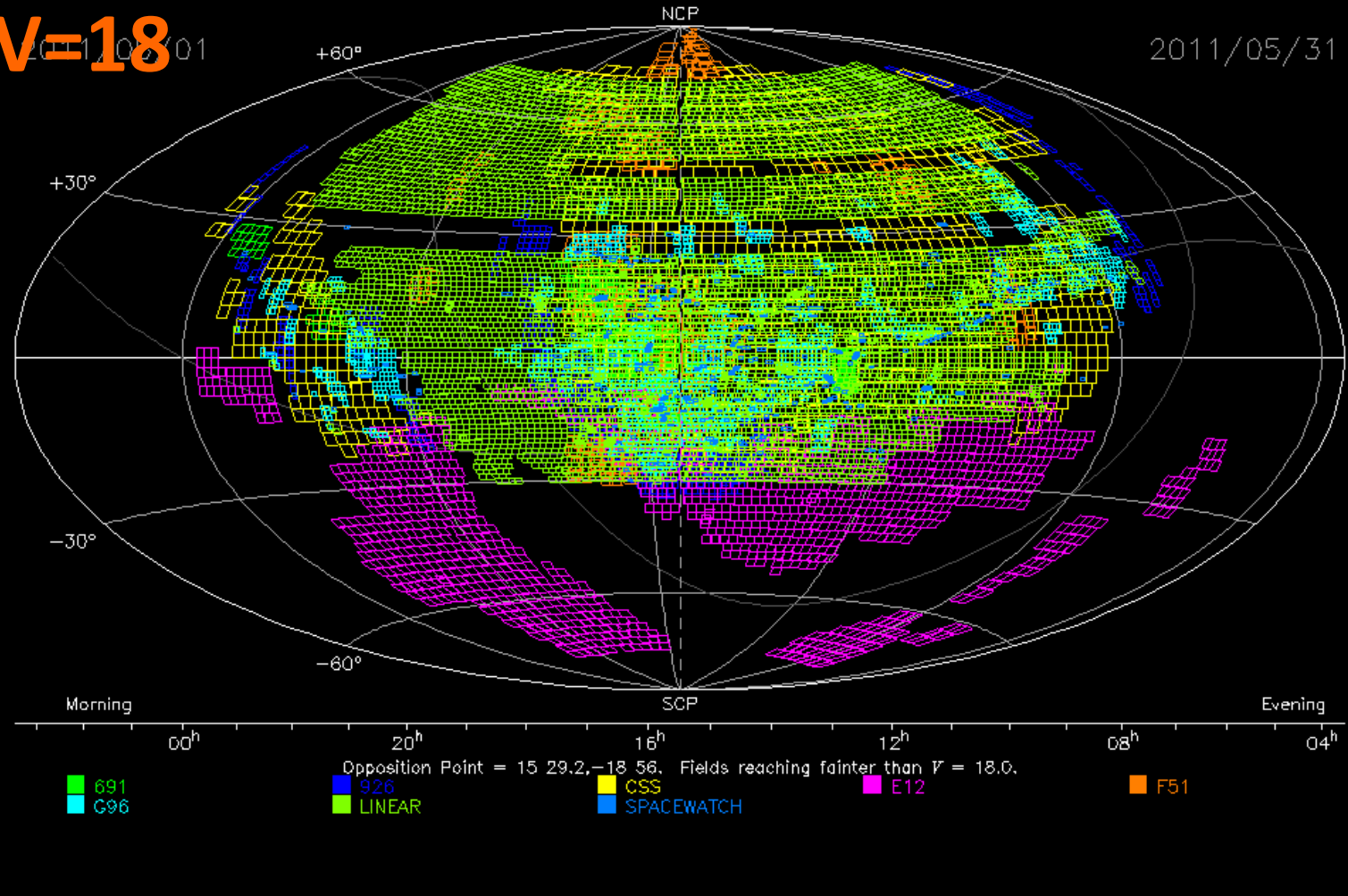
Both are addressed by a **WIDE, DEEP** search

NEO search comparison

NEO surveys
to $V=18$

SKY COVERAGE

Plot prepared 2011/08/15.600 by the Minor Planet Center

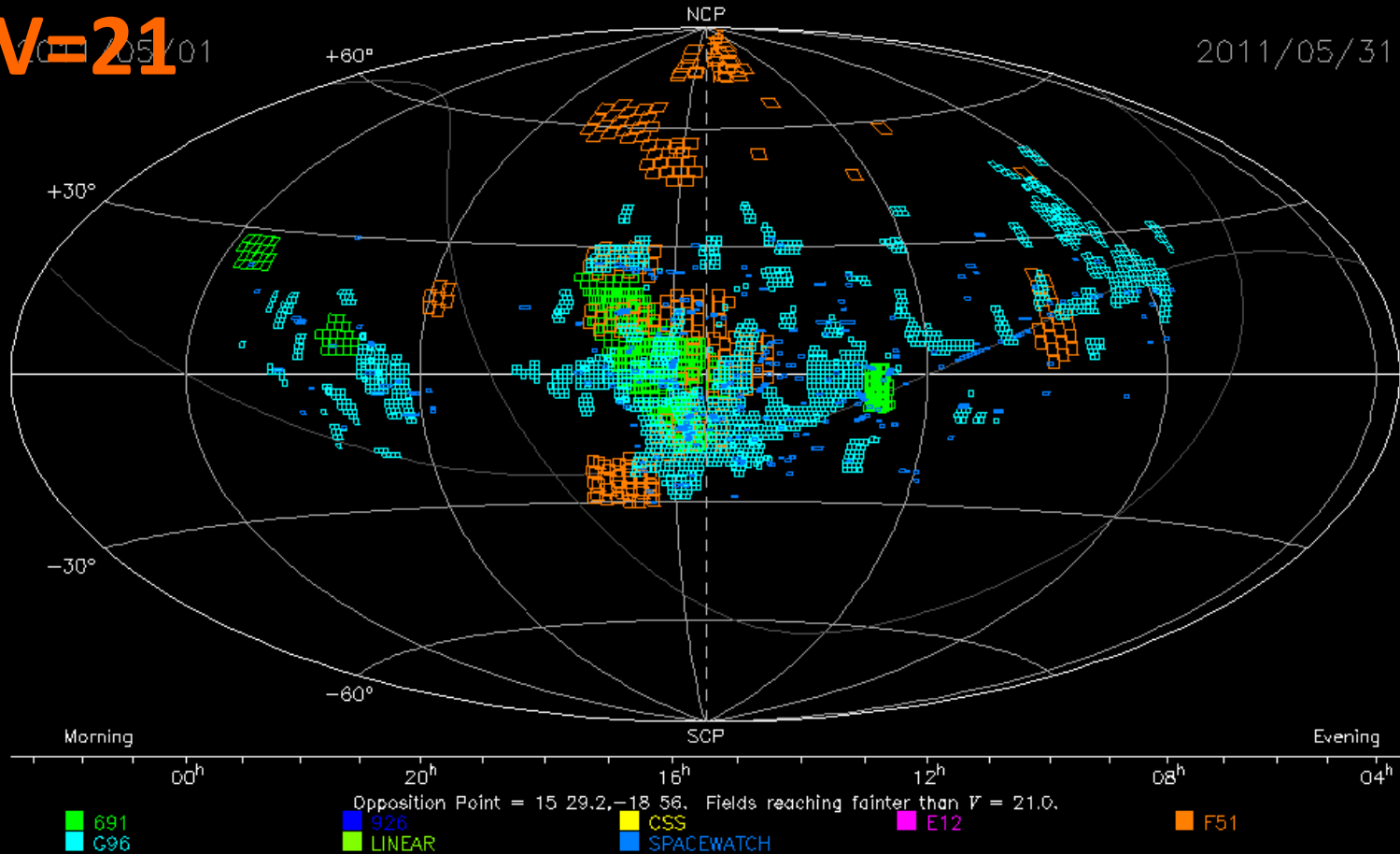


NEO search comparison

NEO surveys
to $V=21$

SKY COVERAGE

Plot prepared 2011/08/15.600 by the Minor Planet Center



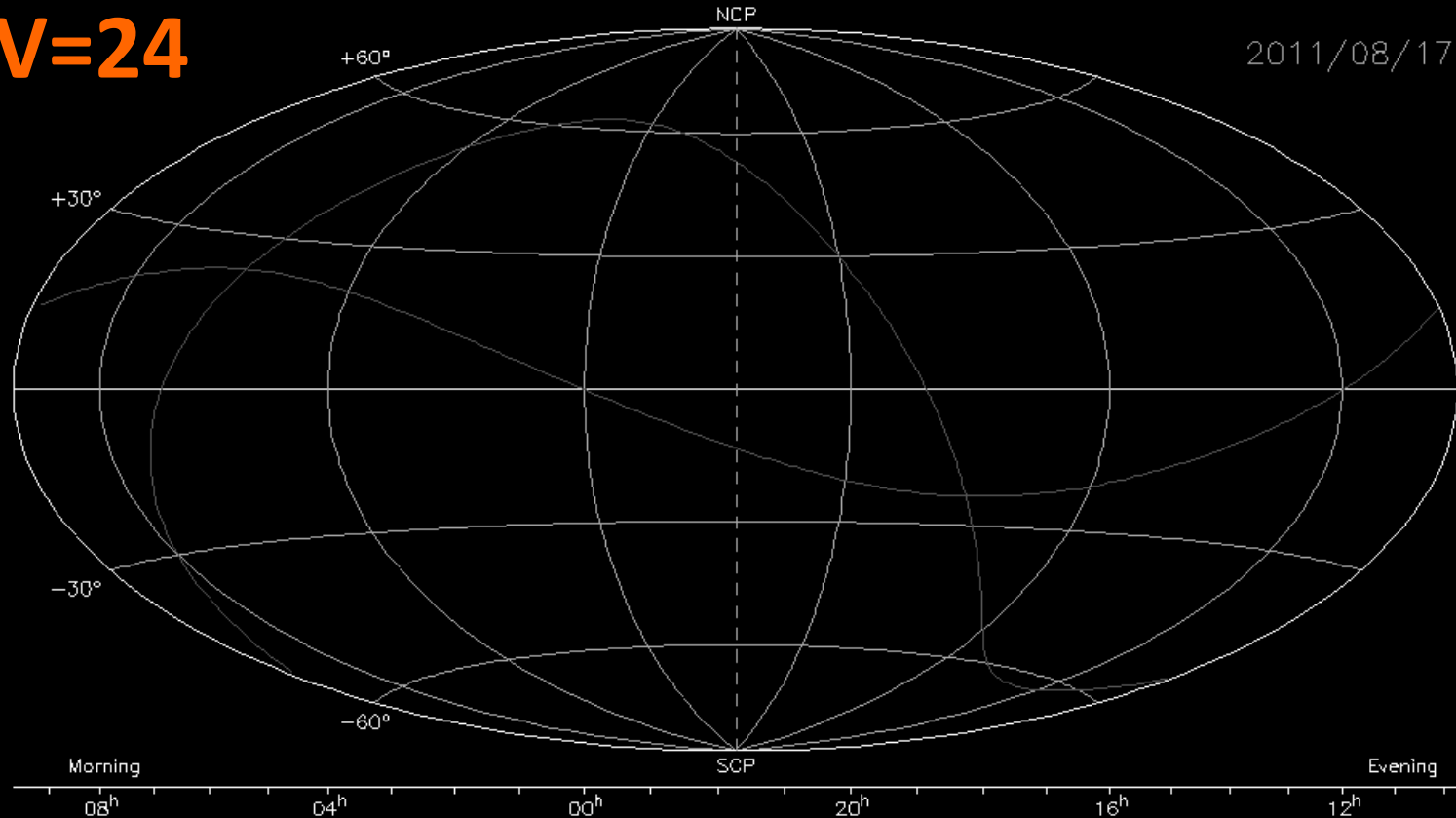
NEO search comparison

NEO surveys
to $V=24$

SKY COVERAGE

Plot prepared 2011/08/15.731 by the Minor Planet Center

2011/08/17



Opposition Point = 21 43.7, -13 39. Fields reaching fainter than $V = 21.0$.

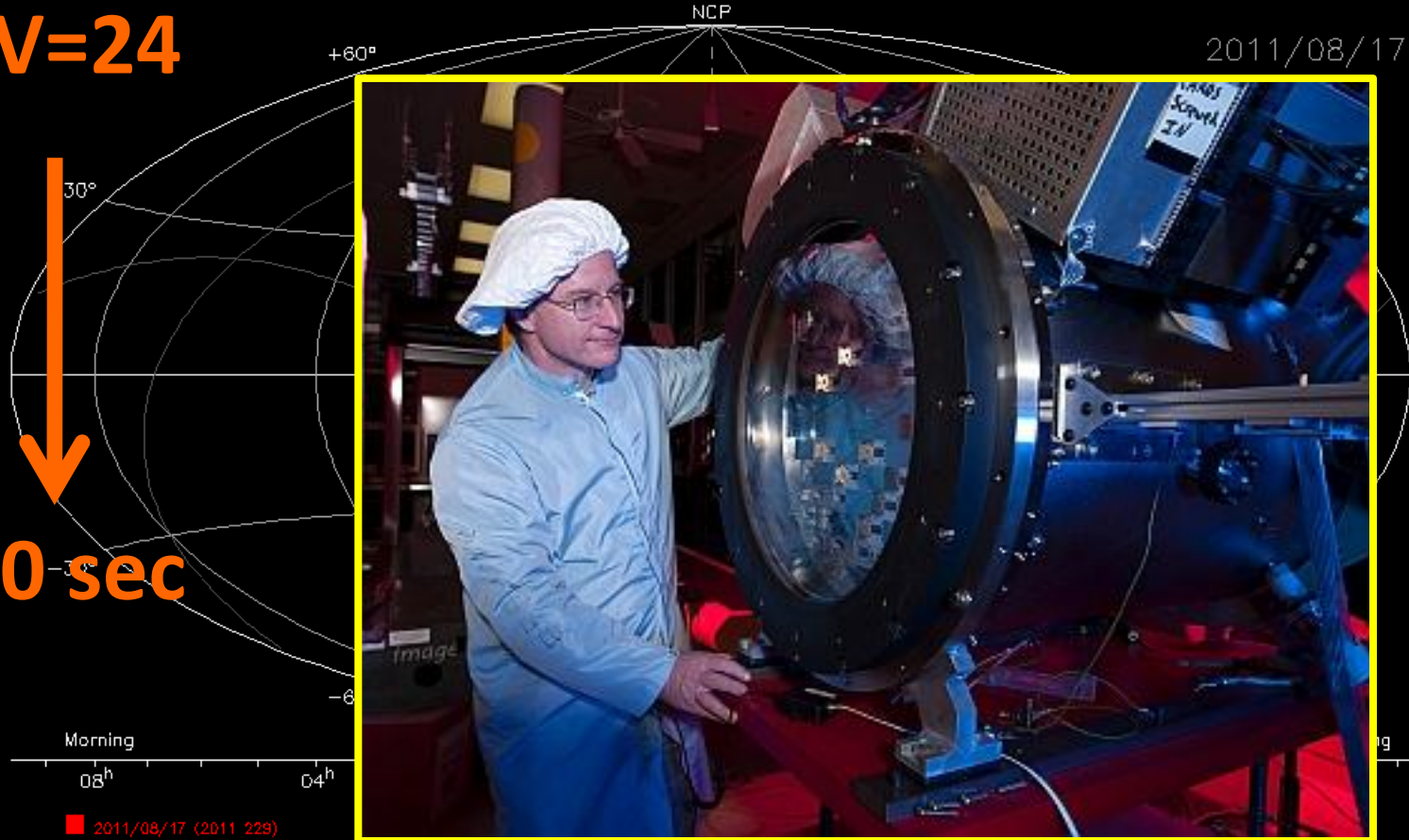
NEO search comparison

NEO surveys
to $V=24$

SKY COVERAGE

Plot prepared 2011/08/15.731 by the Minor Planet Center

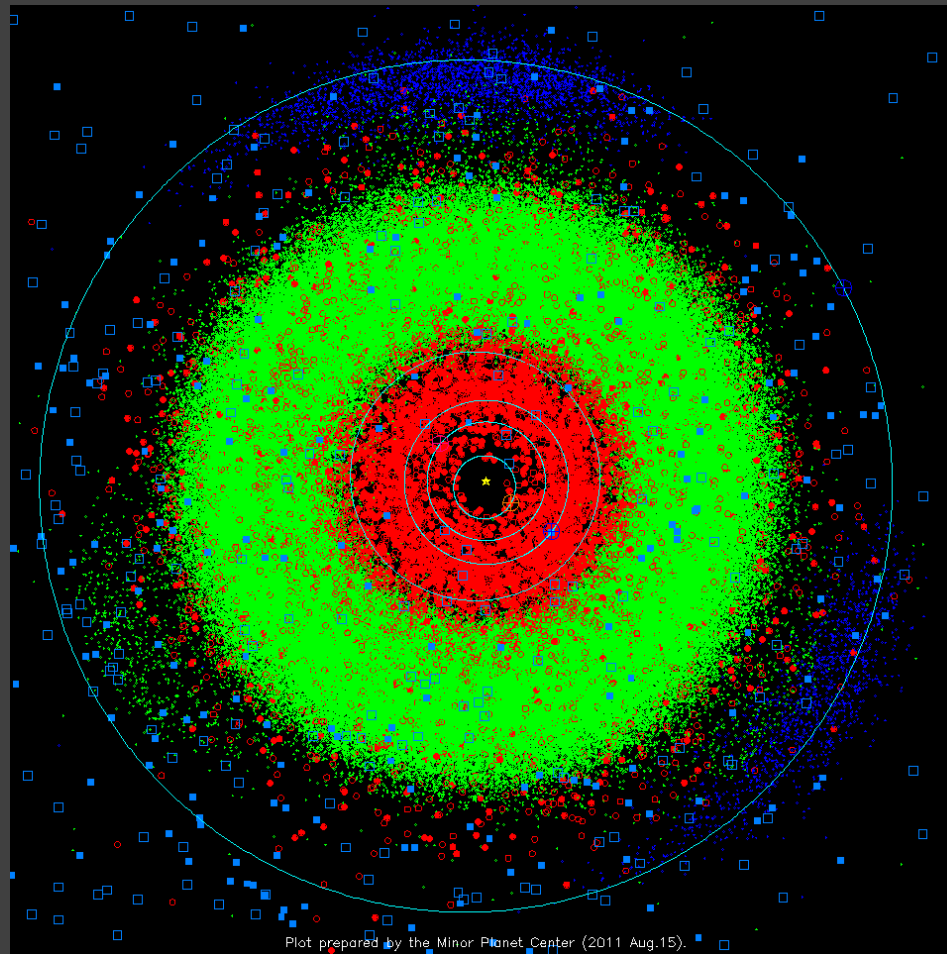
2011/08/17



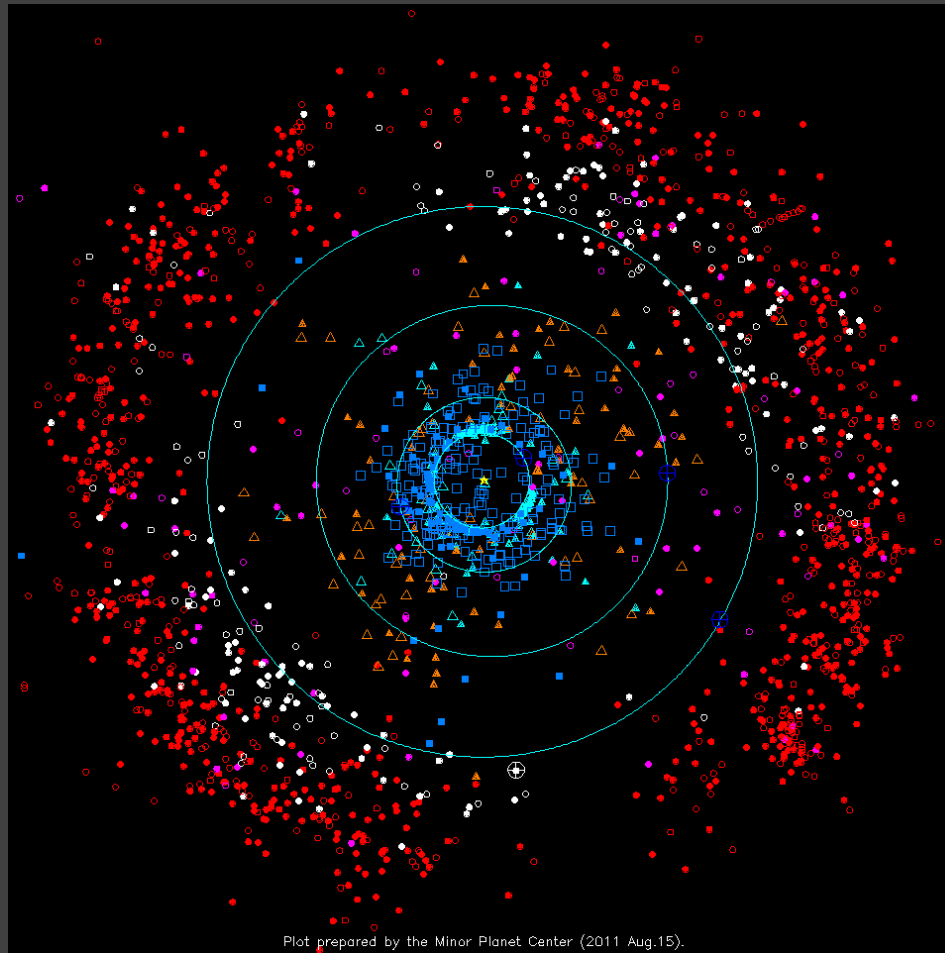
NEO search

- Discover many 100s of NEOs in a single night.
- A few night run gives you 10% percent of all known NEOs.
- More than 80% of DECam NEO discoveries will be fainter than any other survey would discover
- Capability to discover NEOs smaller than 50 m

Trojan asteroids



Trojan asteroids



Trojan asteroids

- Orbit +/-60 degrees from their planet
- Stable over 4.5 billion years
- Probe the early Solar System
- Jupiter, Neptune, Mars ...
- ... and now Earth



Trojan asteroids

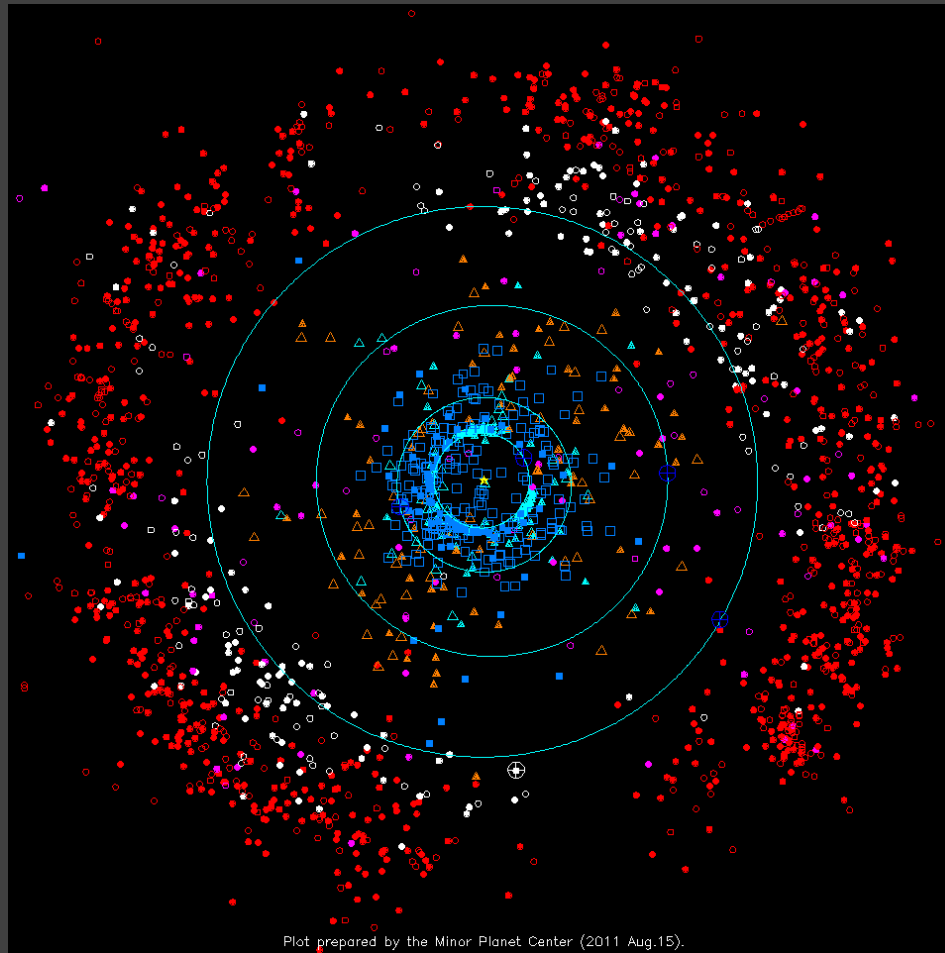
- Thousands of known Jupiter Trojans
- 8 known Neptune Trojans
- ~4 known Mars Trojans
- 1(?) known Earth Trojan

- To use Trojans as probes of Solar System history, you need a **DEEP, WIDE** search

Trojan asteroids

- Biggest survey for Neptune Trojans to date (Sheppard & Trujillo 2010) covered 49 deg² to $R \sim 25.7$ over six years.
- DECam could do this in a single ~ 4 night run.
- Difficult to search for Earth Trojans, but **wide** and **deep** certainly helps.

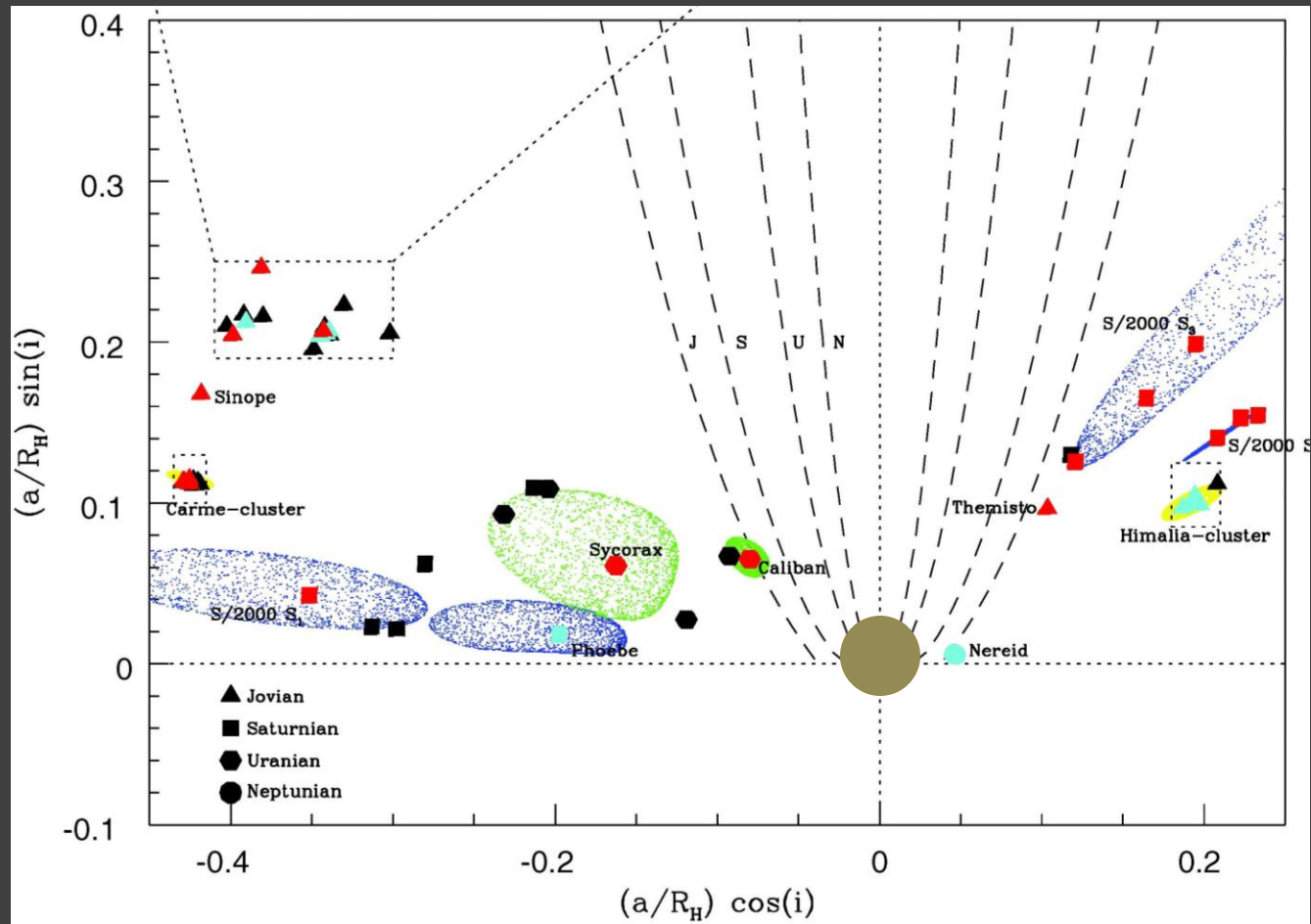
Irregular satellites



Irregular satellites

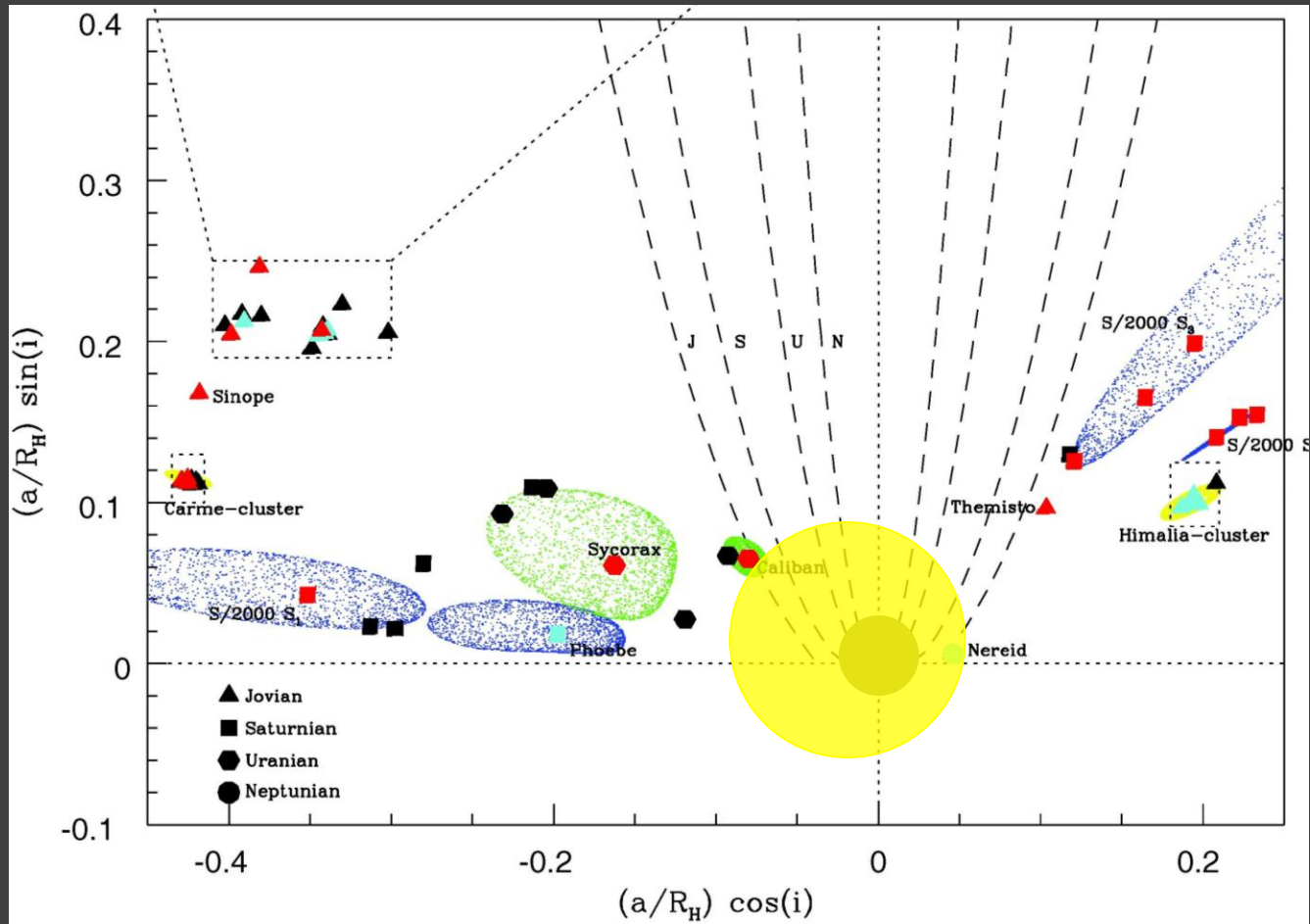
- Irregular satellites are small (~ 10 s km) bodies that orbit giant planets in very distant orbits
- Captured asteroids/comets
- Usually exist in families
- Constrain dynamics in outer Solar System
- Constrain compositions of asteroids/comets

Irregular satellites



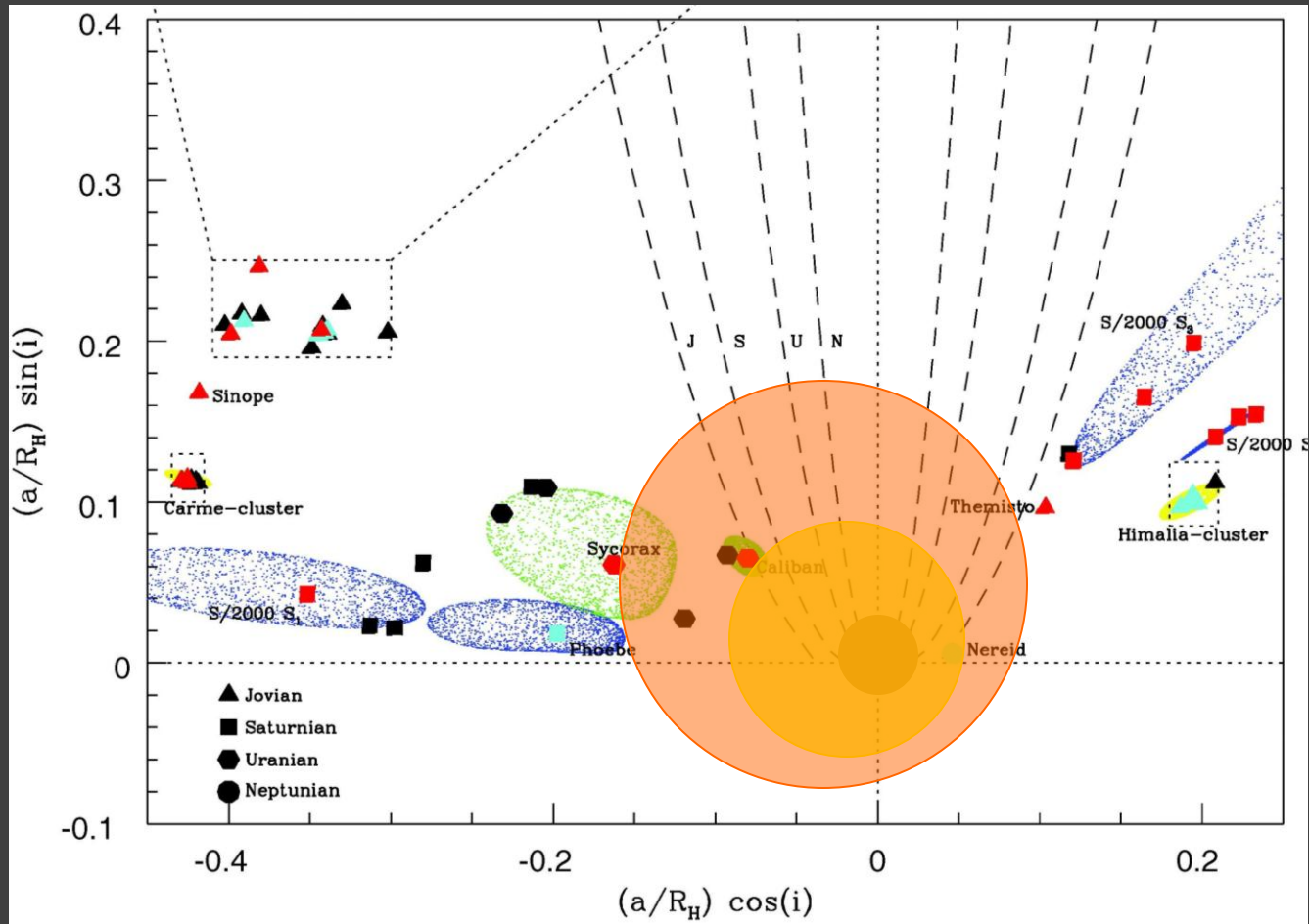
Grav et al. 2003

Irregular satellites



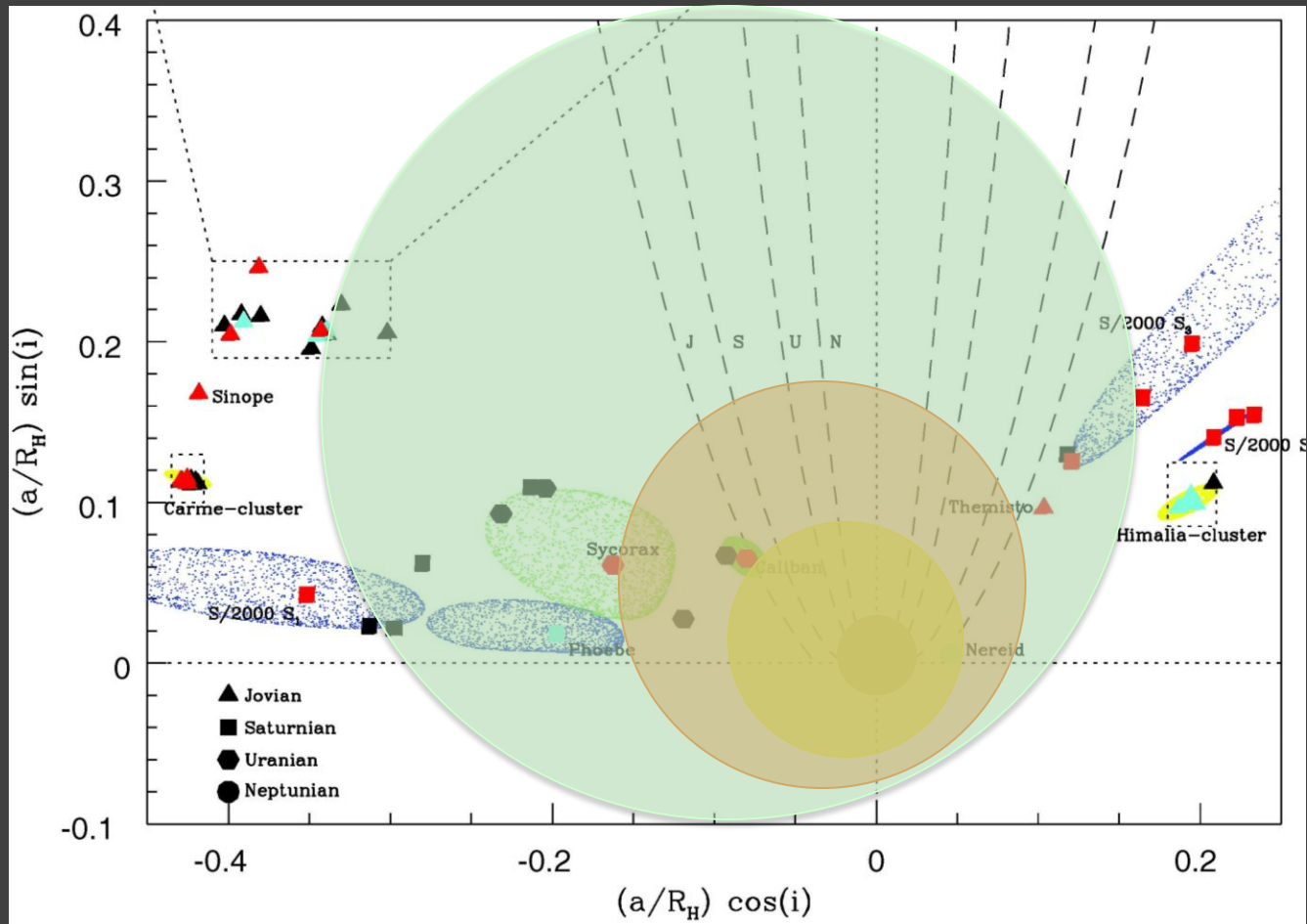
Jupiter

Irregular satellites



Jupiter
Saturn

Irregular satellites



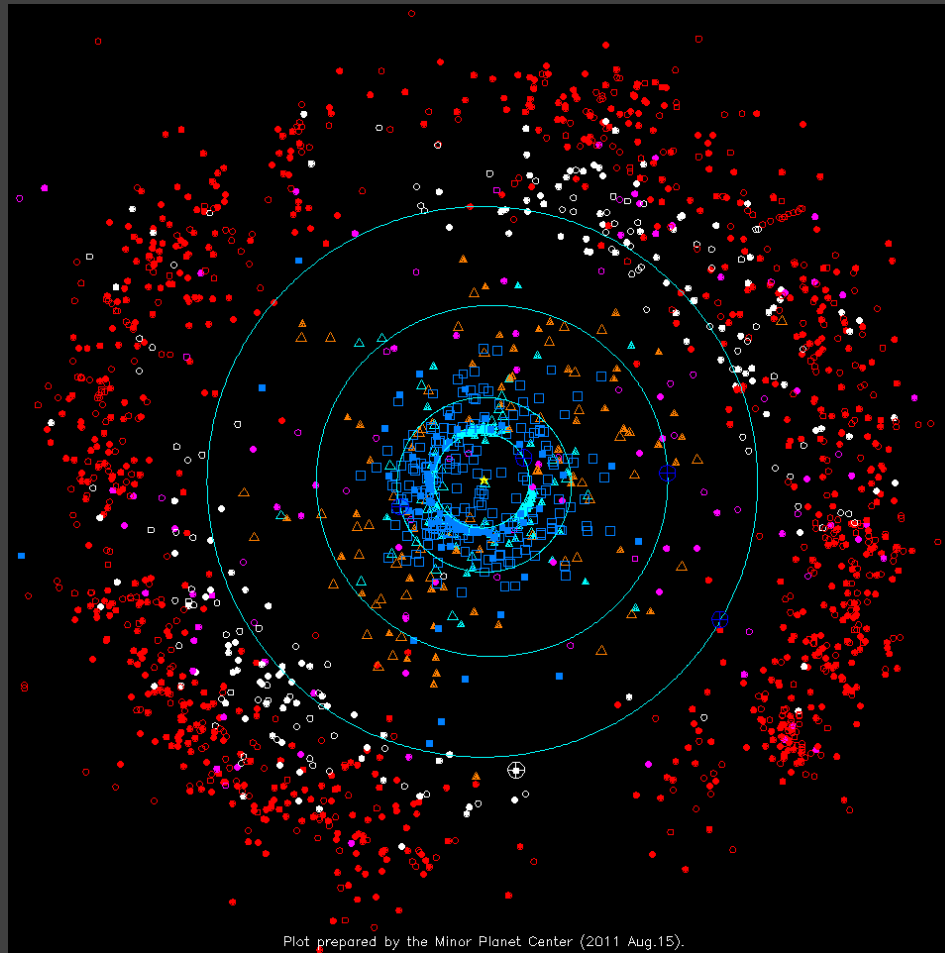
Grav et al. 2003

Jupiter
Saturn
Uranus/
Neptune

Irregular satellites

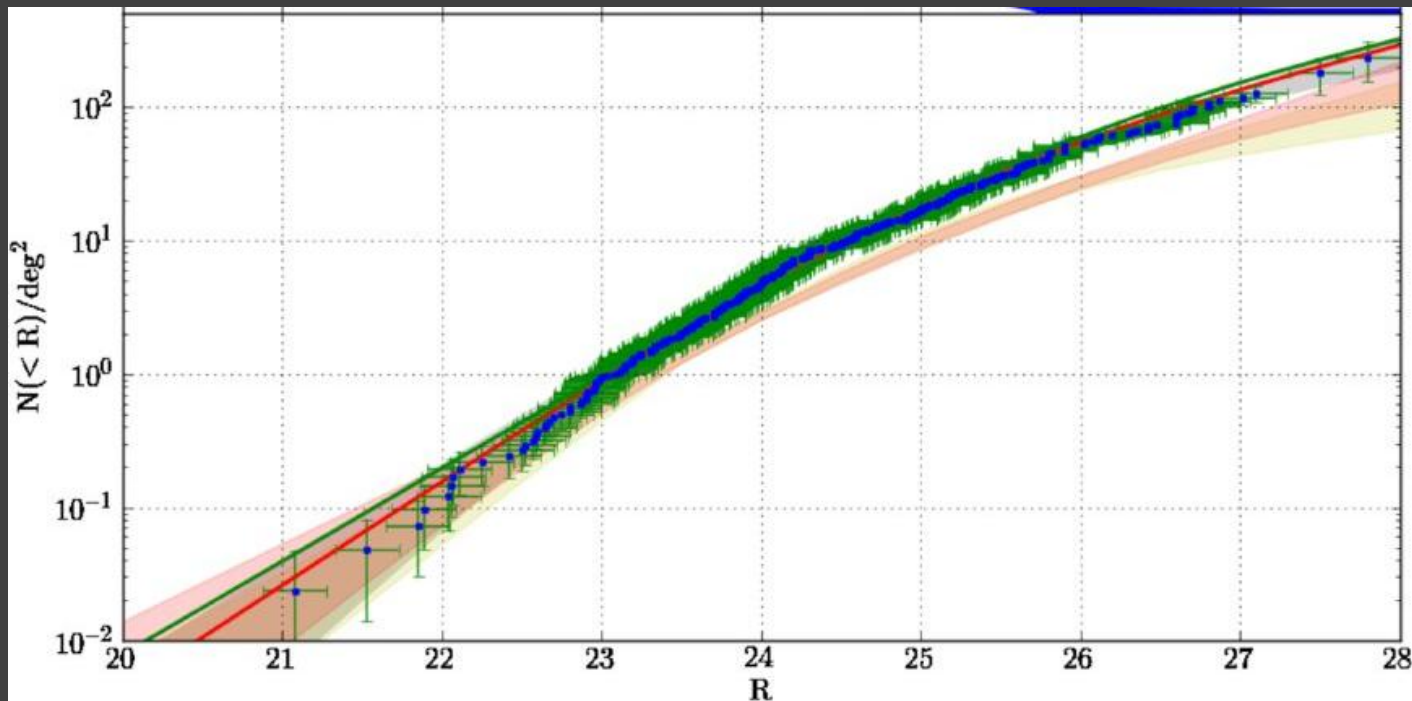
- Typical search: $R \sim 25-26$ (DECam does this in 1 hour)
- Typical search: 5-10 fields to get to several square degrees (DECam does this in a single pointing)
- What has previously been done over several nights can be done with DECam – better, deeper, and wider – in a couple of hours.

Kuiper Belt Objects (KBOs)



Kuiper Belt Objects (KBOs)

Number known: 99 123 107 29 4



Fuentes et al. 2010

1 KBO/sq degree at $R=23$

Kuiper Belt Objects (KBOs)

- KBO searches have been going on for 20 years
- KBOs are primordial: Solar System history
- Some outstanding questions:
 - Size distributions (esp. $R > 24$)
 - High vs. low inclinations
 - Extreme (Sedna-like) objects (very low sky density)

Kuiper Belt Objects (KBOs)

- 15 KBOs/pointing at $R=24$ (1 min). Three visits per field. 500 KBOs at $R=23-24$ in a single night. Compare: 100 known KBOs at $R=23-24$.

Kuiper Belt Objects (KBOs)

- 15 KBOs/pointing at $R=24$ (1 min). Three visits per field. 500 KBOs at $R=23-24$ in a single night. Compare: 100 known KBOs at $R=23-24$.
- 150 KBOs/pointing at $R=26$ (1 hr). Three visits per night. 250 KBOs at $R=25-26$ in a single night. Compare: 107 known with $R=25-26$.

Kuiper Belt Objects (KBOs)

- 15 KBOs/pointing at R=24 (1 min). Three visits per field. 500 KBOs at R=23-24 in a single night. Compare: 100 known KBOs at R=23-24.
- 150 KBOs/pointing at R=26 (1 hr). Three visits per night. 250 KBOs at R=25-26 in a single night. Compare: 107 known with R=25-26.
- 300 KBOs/pointing at R=27 (1 night). Two consecutive nights. 150 KBOs at R=26-27 in two nights. Compare: 29 known KBOs with R=26-27.

Technical issues

- Cadence is essential
- Filters: As wide as possible; red is good
 - Possibility of a very wide (w? V+R?) filter?
- Piggy-back on DES is possible, with constraints

Summary: DECam + Solar System

- DECam for the Solar System: **Wide and deep**
- Orders of magnitude available
 - Near Earth Objects (see also Lori Allen's talk)
 - Trojans (see also Alex Parker's talk)
 - Irregular satellites
 - Kuiper Belt Objects
- No extreme technical challenges
- Piggy-back on DES possible, with constraints