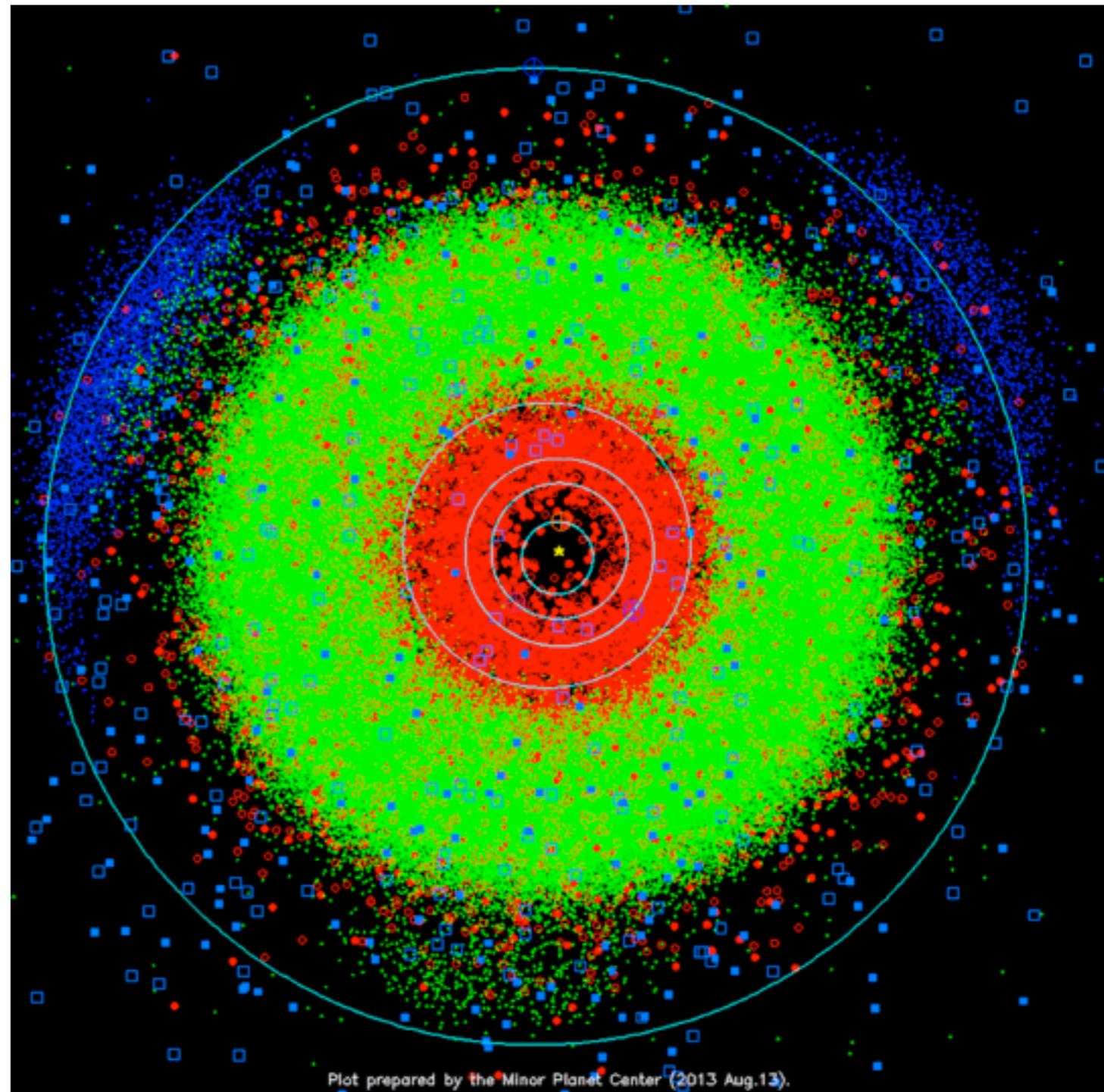


# Solar System Science with a GWEM optical facility

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Assume:

- Solar-System is a driver for regular non-GWEM operations (cadence, depth).
- Current/planned Near-Earth Object surveys for 2017 timeframe are operational.
- ATLAS-like capabilities  
 $V_{lim} \approx 20$



# Moving Object Processing System



The screenshot shows a web browser window displaying the MOPS interface. The browser address bar shows the URL: `mopshq2.ifa.hawaii.edu/czar/psmops_ps1_mdrm152/tracklets.htm?nn=56214&sort=d&maxv=20&minv=0.1&sm=157.OSS.F&min_dets=3&min...`. The page title is "157.OSS.F TJD 6215, 301-400". The interface displays a table of objects with columns for TJD, magnitude, object name, proper motion, position angle, distance, and tracklet ID. To the right of the table, there are small images showing the tracklets of the objects, with red lines indicating the path of the object across the field of view.

TJD	Mag	Obj Name	PM ("/day)	PA (°)	Dist (AU)	Tracklet ID
7701583	81.0	157.OSS.F.Q.w	0.128	16.0	-114.2	(2357)
7699508	81.0	157.OSS.F.Q.w	0.130	19.6	-110.6	(117446)
7696693	81.0	157.OSS.F.Q.w	0.170	19.3	-111.7	(90704)
7705159	81.0	157.OSS.F.Q.w	0.134	19.8	-108.1	(256505)
7701207	81.0	157.OSS.F.Q.w	0.127	19.7	-112.2	(117423)
7705106	81.0	157.OSS.F.Q.w	0.220	21.9	-27.1	N/A
7705758	80.0	157.OSS.F.Q.w	0.130	19.6	-110.6	(117446)
7705849	79.0	157.OSS.F.Q.w	0.613	20.0	-158.9	N/A
7704604	79.0	157.OSS.F.Q.w	0.825	20.8	-51.1	N/A

MOPS developed for PS1 system, used by TALCS, WISE, ATLAS. (Denneau et al. 2013),

Takes transient detections, links them to produce “tracklets” of individual objects.

Automatic identification of known objects and estimation of detection efficiencies.

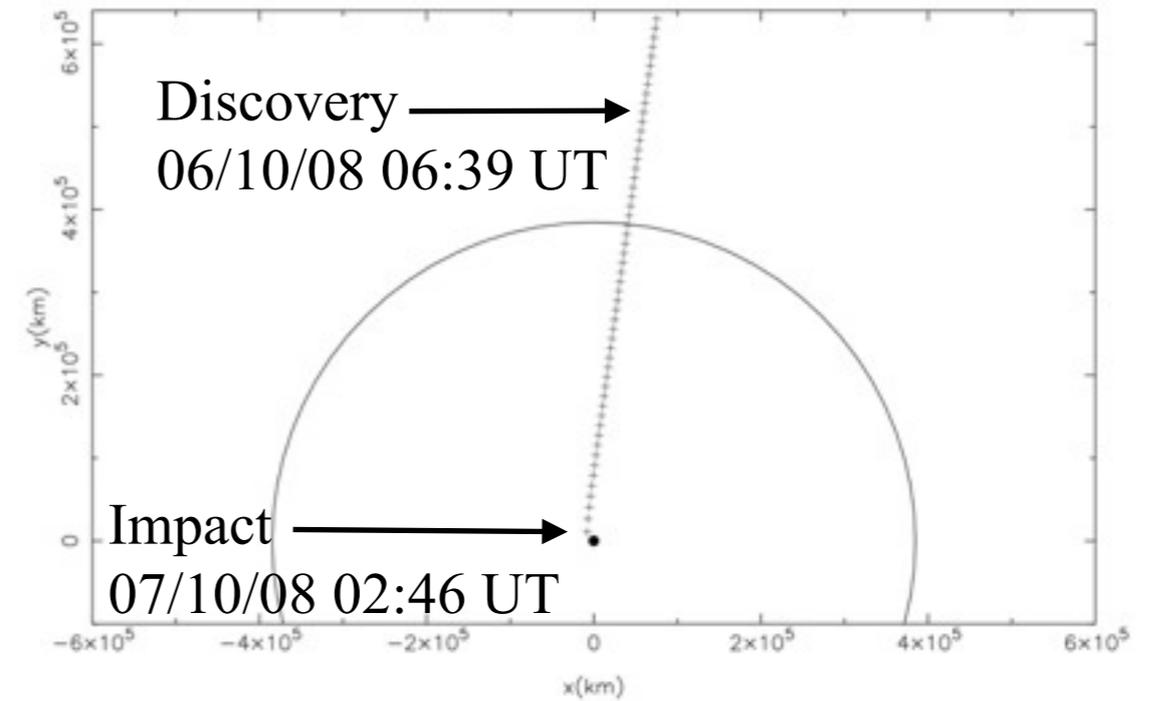
For unknowns estimates likely class of object and provides initial orbit determination.

# 1. Detection of Final-trajectory NEOs

Carancas 2007



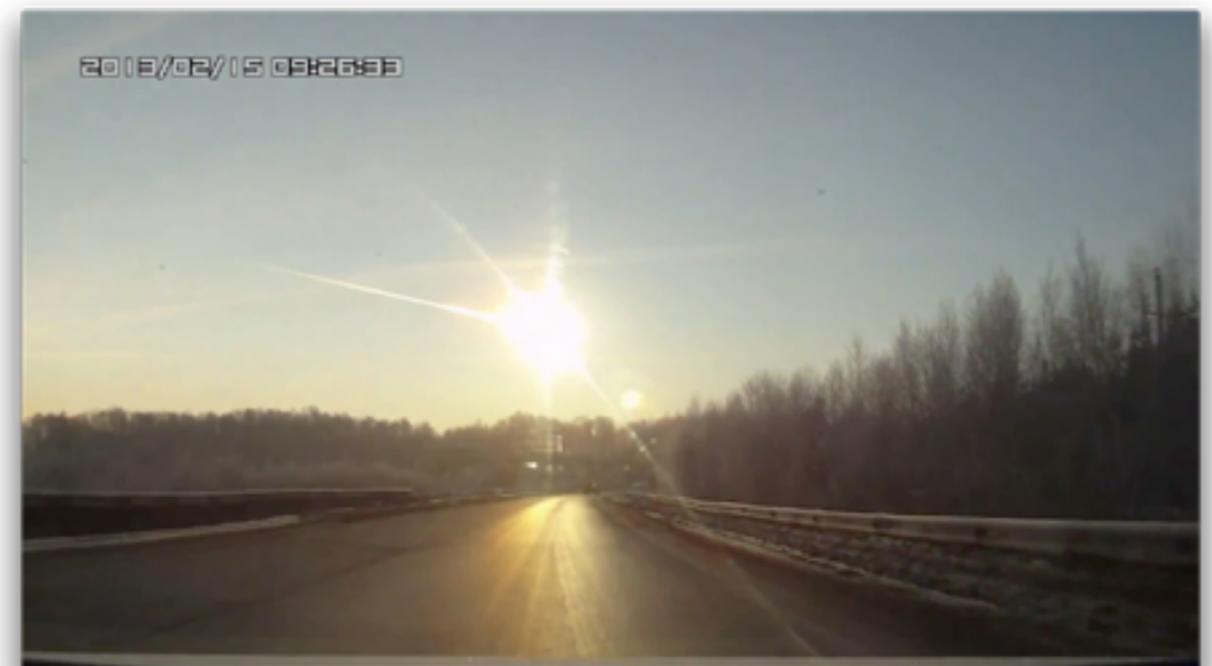
2008 TC3



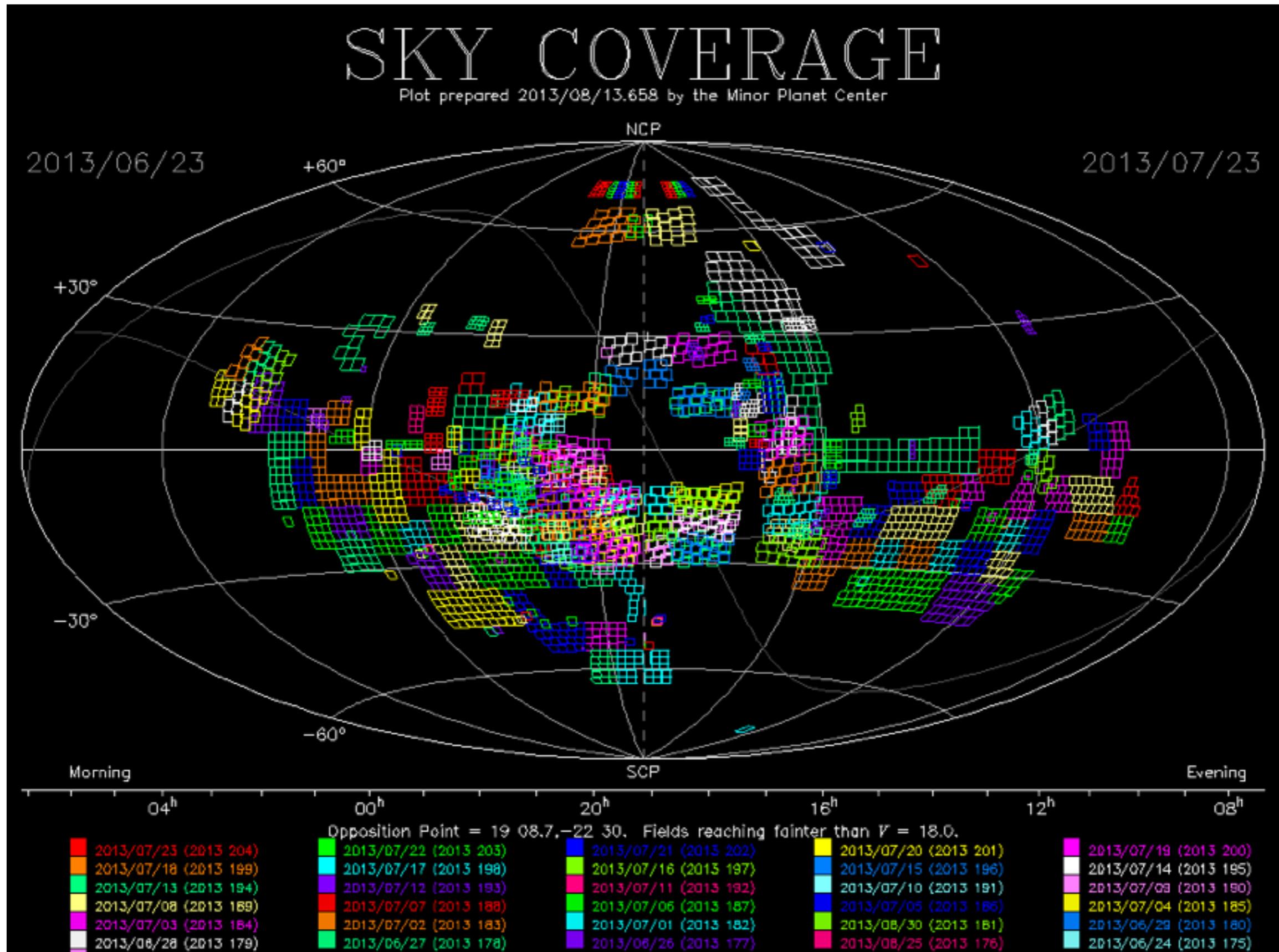
Indonesia 2009



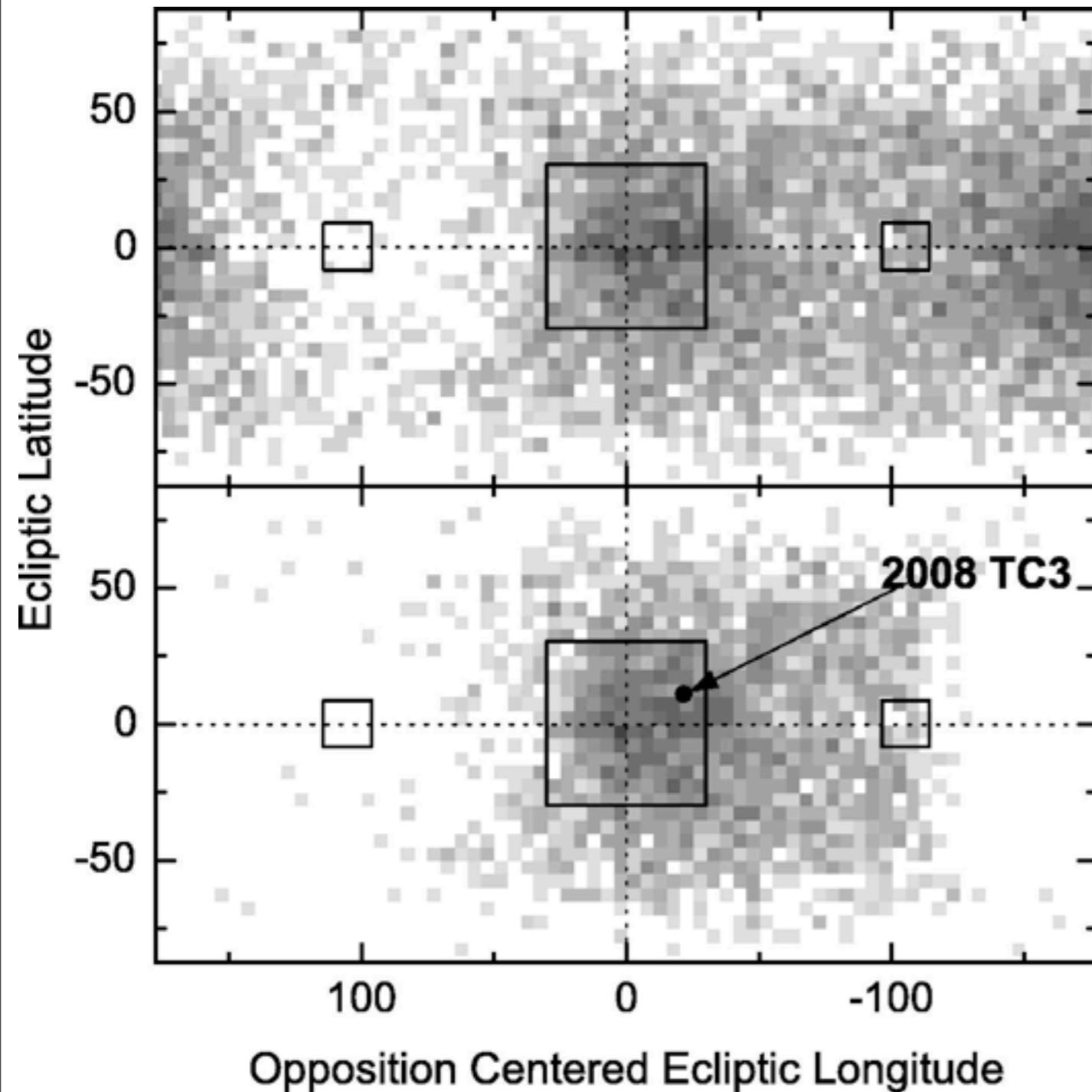
Chelyabinsk 2015



# 1. Detection of Final-trajectory NEOs



# 1. Detection of Final-trajectory NEOs



All-sky coverage is necessary to detect NEOs within  $\sim 1$  Lunar Distance.

A UK GWEM facility would add longitude coverage to ATLAS, discovering  $\sim 1\text{m}$ - $20\text{m}$  NEOs and allowing orbit refinement for new objects.

$V \approx 20$  allows:

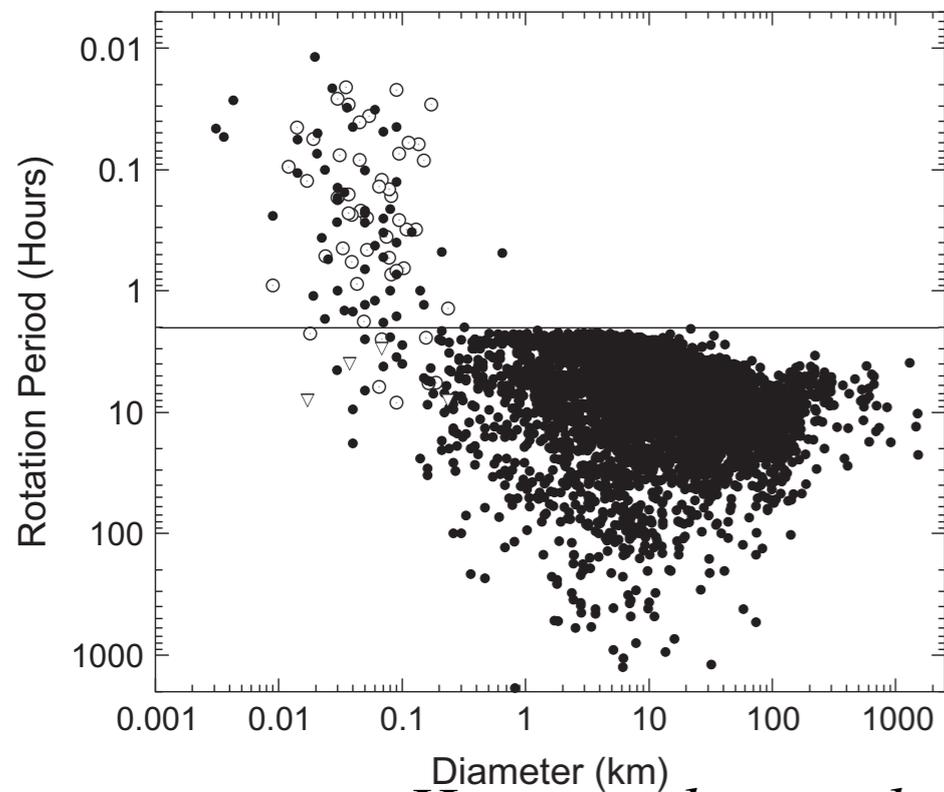
$D = 10\text{m} \leq 2$  days impact warning

$D = 50\text{m} \leq 12$  days impact warning

Top: Simulated positions of objects 1 day from impact

Bottom: 3-m objects with  $V < 22.7$  (Veres et al. 2009)

## 2. Asteroid Lightcurves - Binaries, Spin-up and Collisions

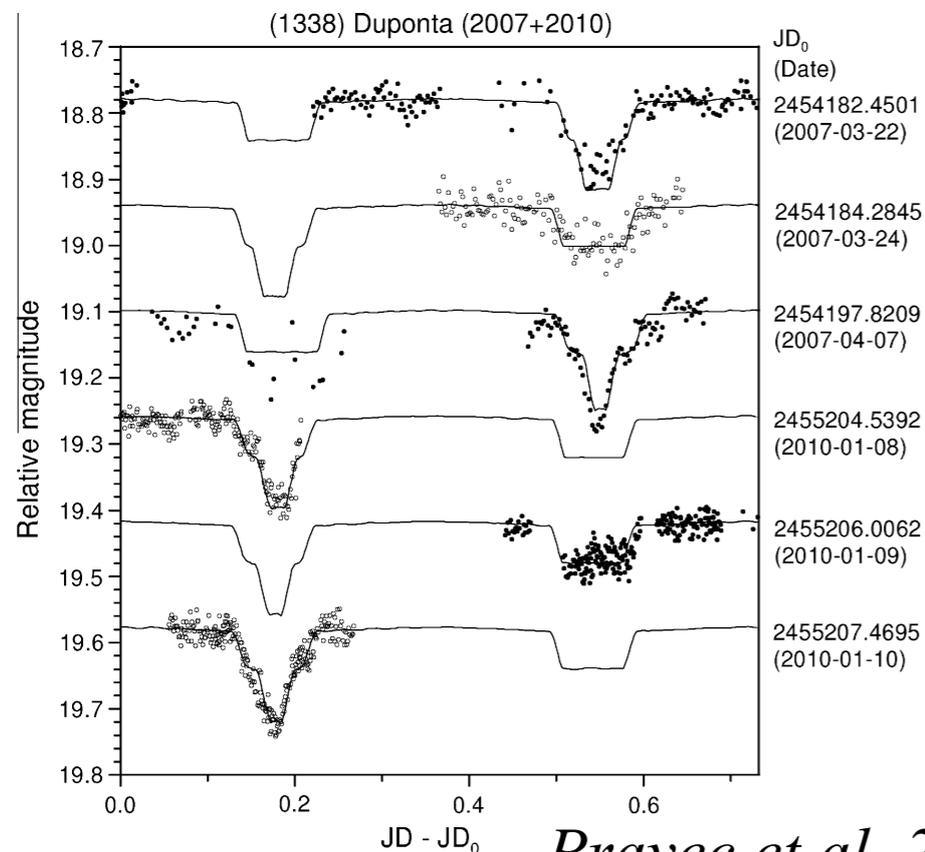


*Hergenrother et al. 2012*

~4500 asteroids with lightcurves to date.

Science to be done depends on cadence + sky coverage.

Requires near-ecliptic fields.

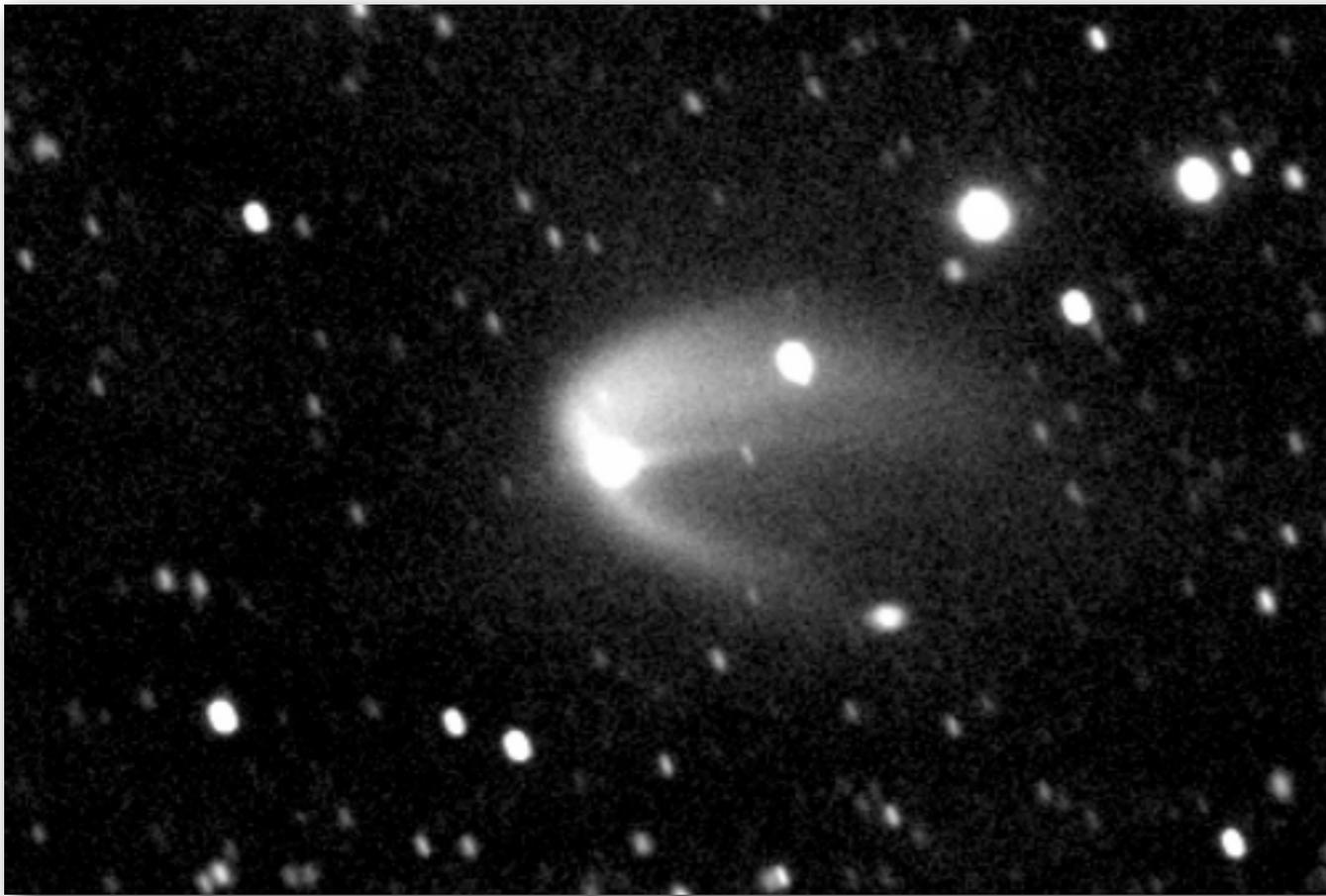


*Pravec et al. 2012*

Lower cadence + all-sky gives sparse lightcurves on  $10^4 - 10^5$  asteroids (ATLAS).

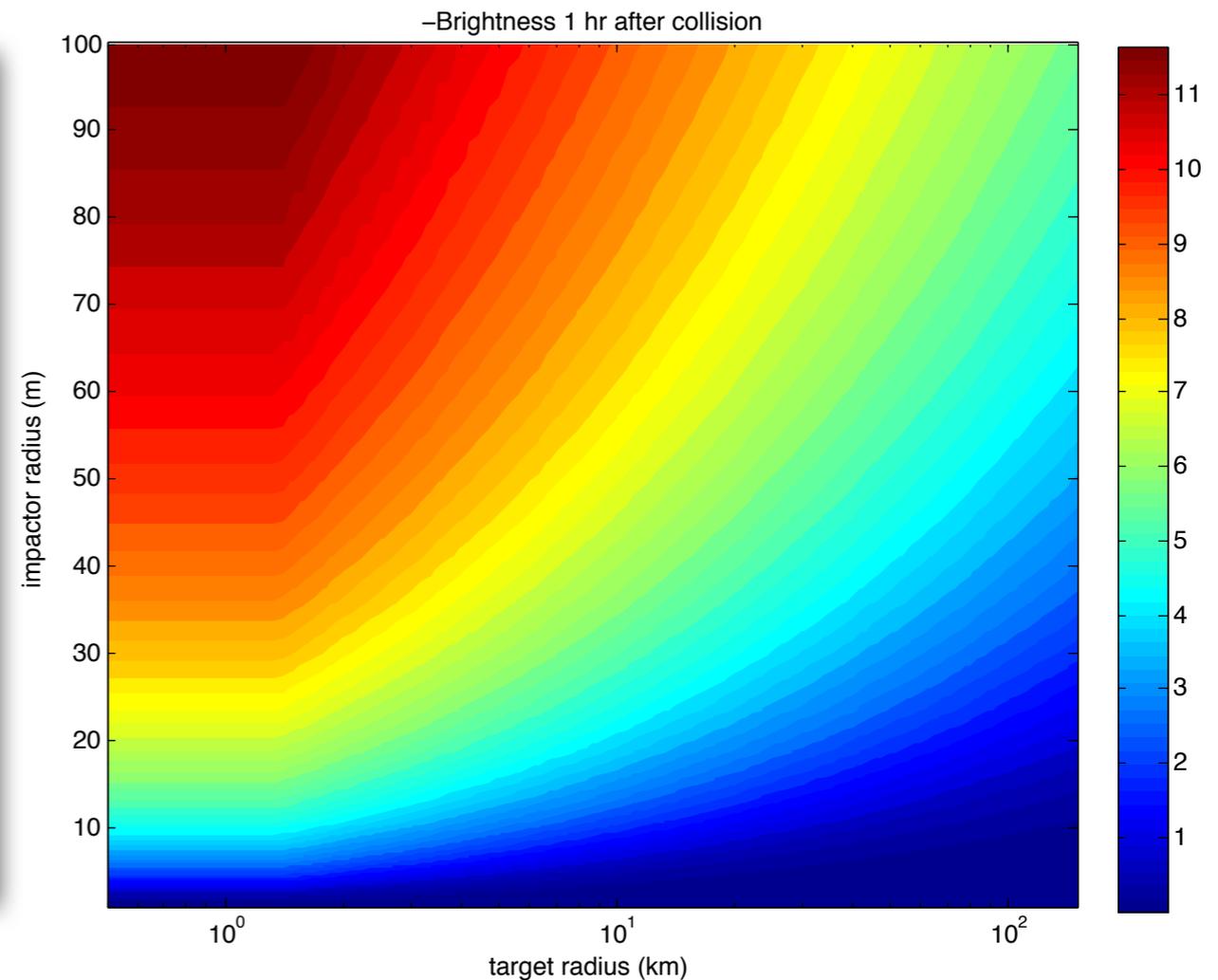
Fast cadence + low coverage gives detailed lightcurves on  $\sim 10^3$  asteroids.

## 2. Asteroid Lightcurves - Binaries, Spin-up and Collisions



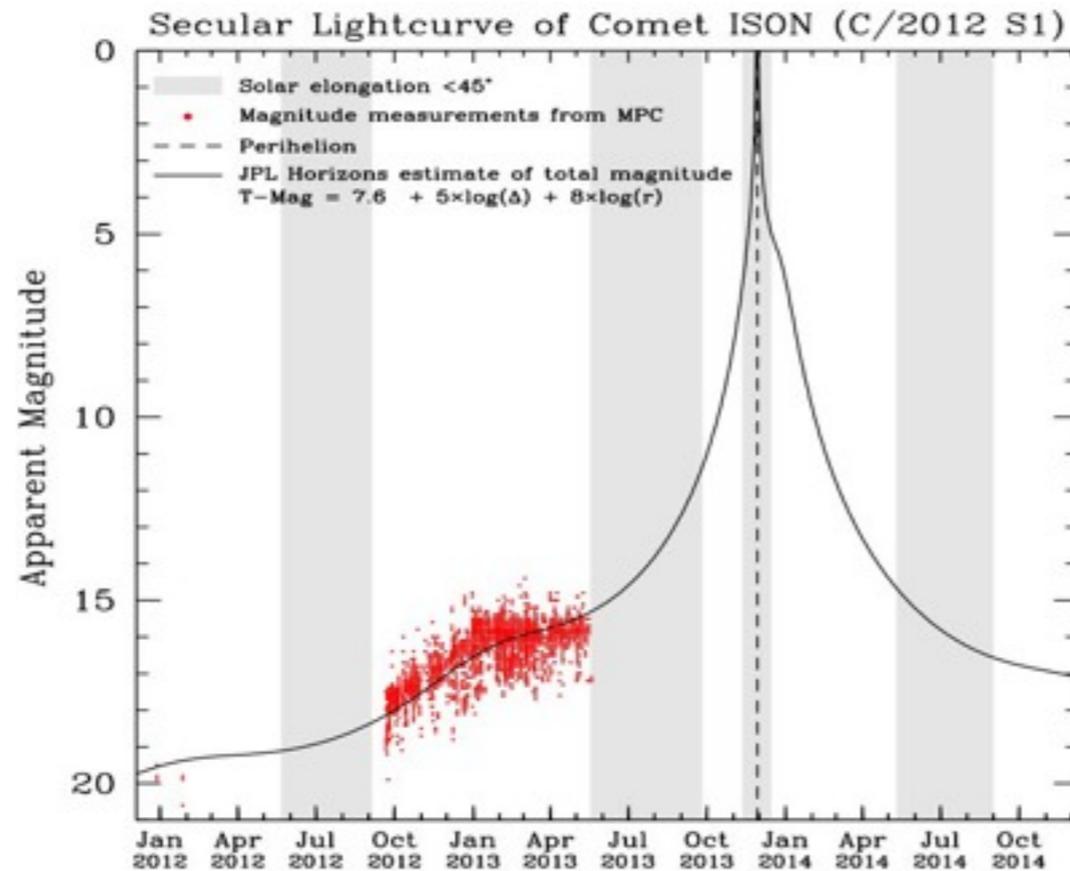
*Larson et al. 2010*

(596) Scheila ~1 week after collision.



Predicted magnitude increase 1 hour after impact by small asteroid.

# 3. Comet Lightcurves - Lifetimes and Outbursts

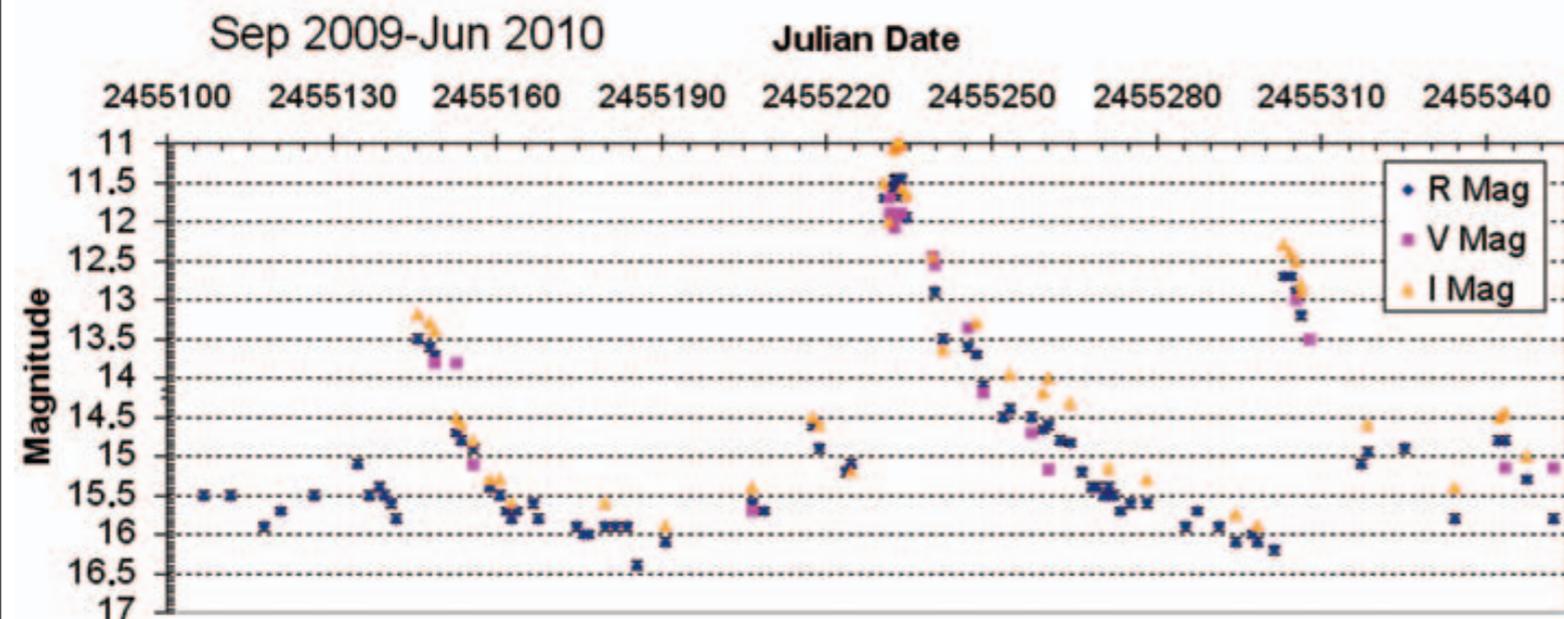


Battams 2013 (<http://sungrazer.nrl.navy.mil>)

> 30 comets/night

Accurate mass-loss estimates of active comets throughout the Solar System.

Possible ~daily monitoring around the orbit.



29P: Trigo-Rodríguez et al. 2010

What fraction of comets suffer regular significant outbursts, and how do these correlate with orbit and evolution?

# Solar System Science with a GWEM optical facility

Software already exists for moving object detection (MOPS), being optimised for ATLAS.

Possible science programmes include:

1. Discovery and tracking of cis-lunar and sub-lunar small NEOs.
2. Discovery of binary asteroids, YORP targets and collisions via lightcurve measurements of  $>10^3 - 10^4$  asteroids.
3. Activity monitoring of  $\sim 10^2$  comets, outburst fractions and accurate sublimation profiles.