DEEP-SOUTH: Round-the-Clock Physical Characterization of NEOs in the Southern Hemisphere

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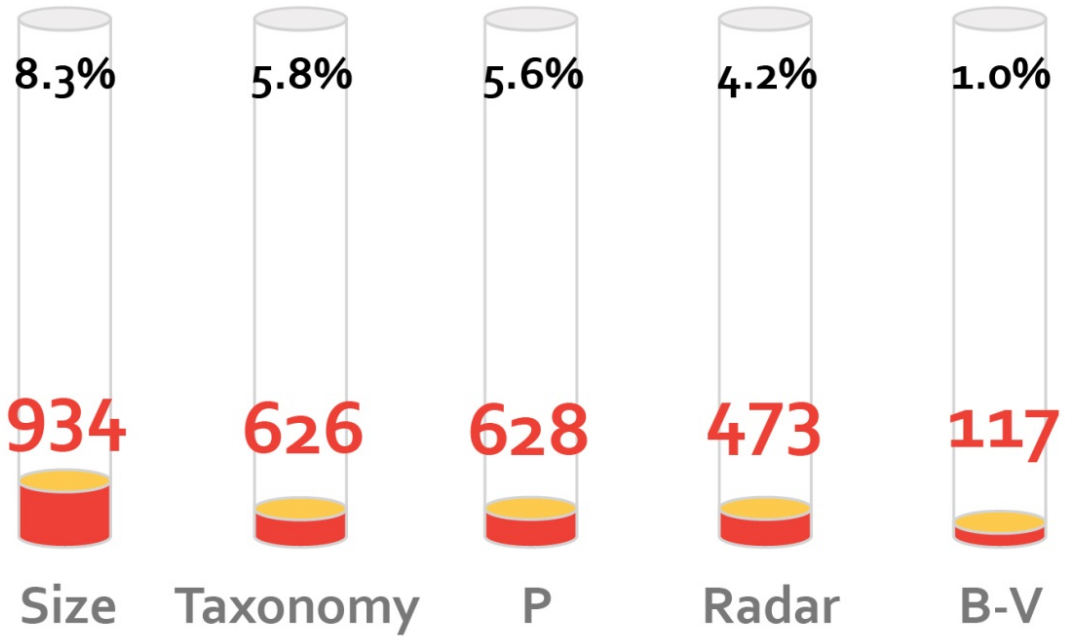
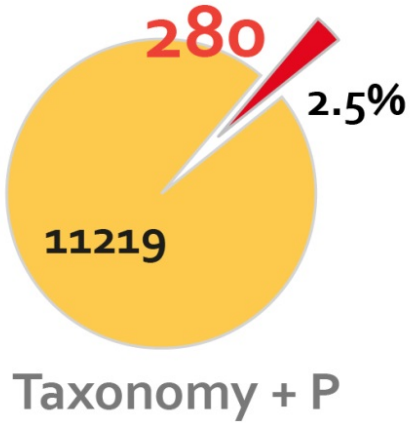
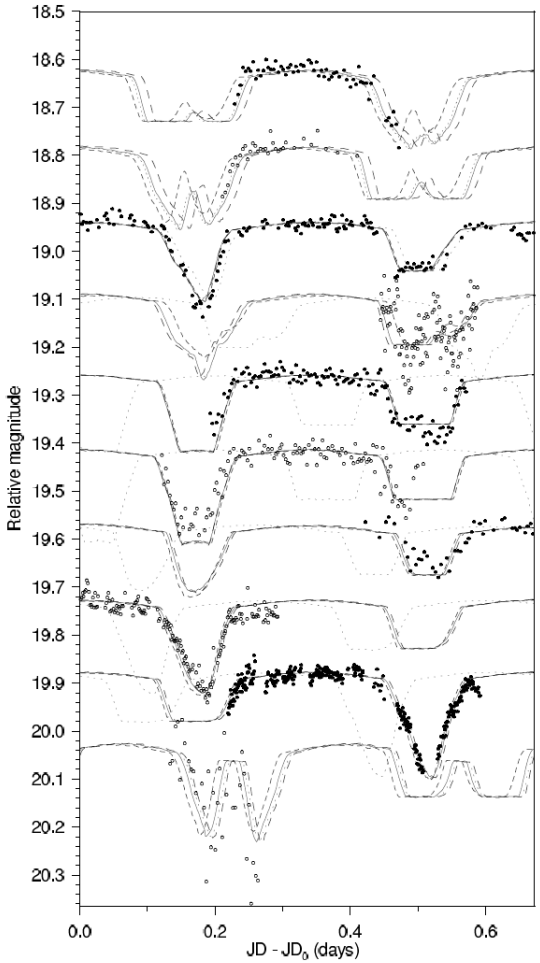
We know very little about physical characteristics of NEAs

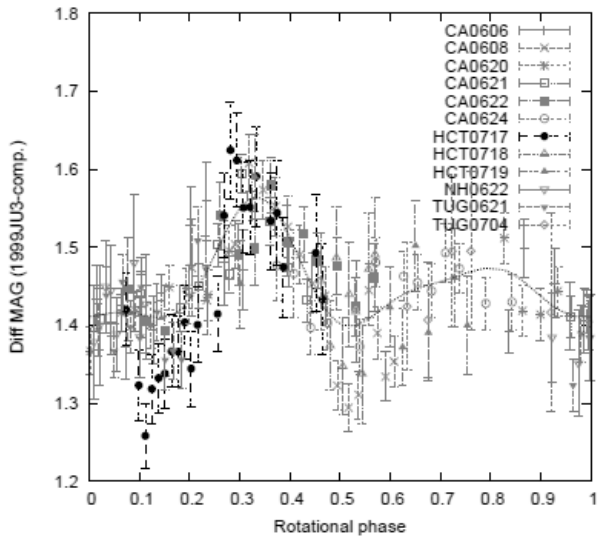




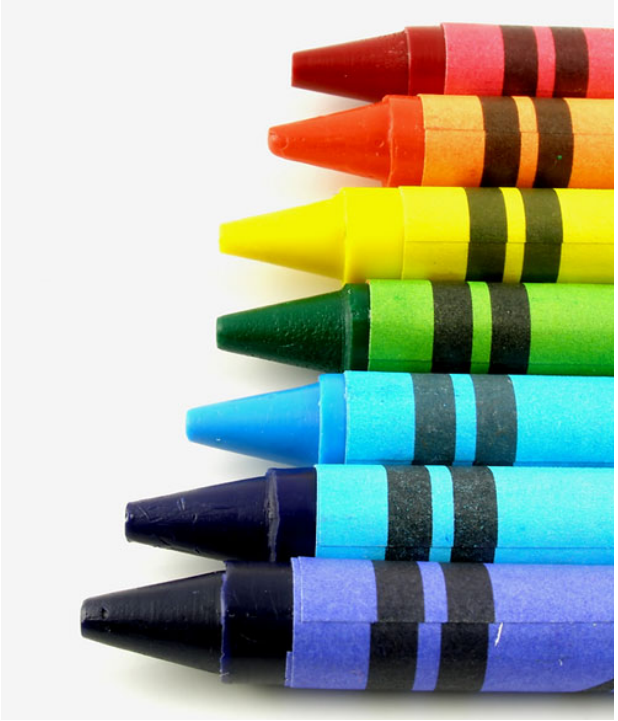
NEA Discovery data, Minor Planet Center (July 10, 2014)
Database of Physical and Dynamical Properties of NEOs, Deutsches Zentrum für Luft-und Raumfahrt (July 9, 2014)

Prompt solution:
Time-domain **Multi**-color Census



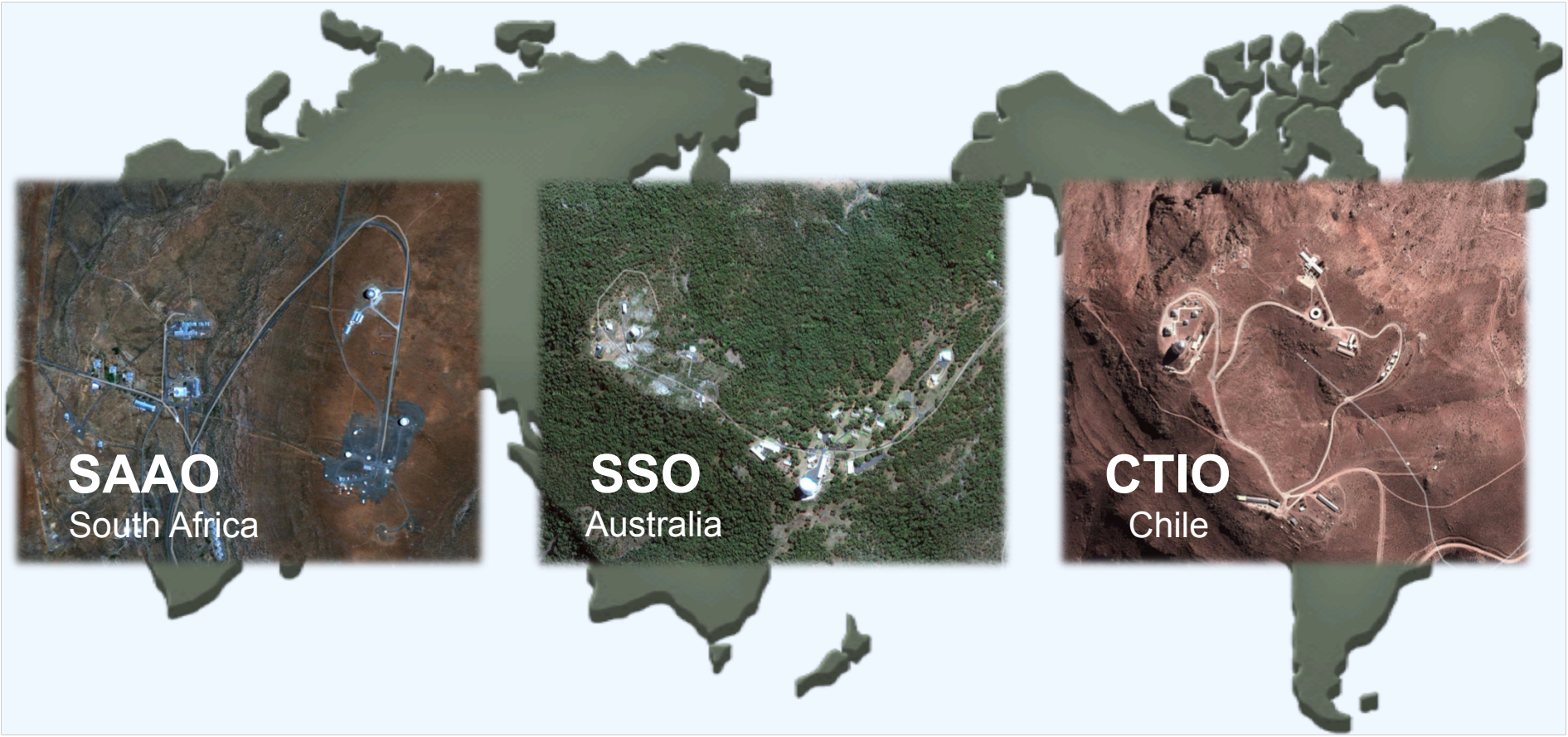


Kim et al. 2013
Scheirich et al. 2014



There is **NO** **dedicated** teles copes in the **Southern** Hemi sphere

A network of telescopes in the Southern hemisphere!



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The DEEP-SOUTH:
Deep Ecliptic Patrol of th
e Southern sky

Factsheet: KMTNet

D: 1.6 m prime focus

CCD: 18k × 18k mosaic

Plate scale: 0".4 /pixel

FOV: 4 □°

Filters: Cousins *BVRI*, SDSS *griz*

Image quality: 1".0 FWHM

@ 0".75 seeing; V-, I- bands

Factsheet: **DEEP-SOUTH**

PI institute: Korea Astron. and Space Sci. Inst.

Goal: Characterization of km-sized NEAs

Period: 2014 ~ 2018

Time awarded: 45 full nights /telescope/yr

=135 full nights /network/yr

Cadence: ~30-100 sec (incl. readout)

Follow-up: under discussion

Organization

PI: Hong-Kyu Moon (HM)[1]
Co-I: Young-Jun Choi (YC)[1]

Myung-Jin Kim (MK)[1,2], Young-Ho Bae (YB)[1], Hong-Suh Yim (HY) [1], Masateru Ishiguro (MI)[3], Amy Mainzer (AM)[4], James Bauer (JB)[4], Yong-Ik Byun (YB)[3], Stephen Larson (SL)[5] and Charles Alcock (CA)[6] (+ students)

[1] Korea Astronomy and Space Science Institute
[2] Yonsei University
[3] Seoul National University
[4] Jet Propulsion Laboratory
[5] Lunar and Planetary Laboratory, University of Arizona
[6] Center for Astrophysics

Observation **Mode**

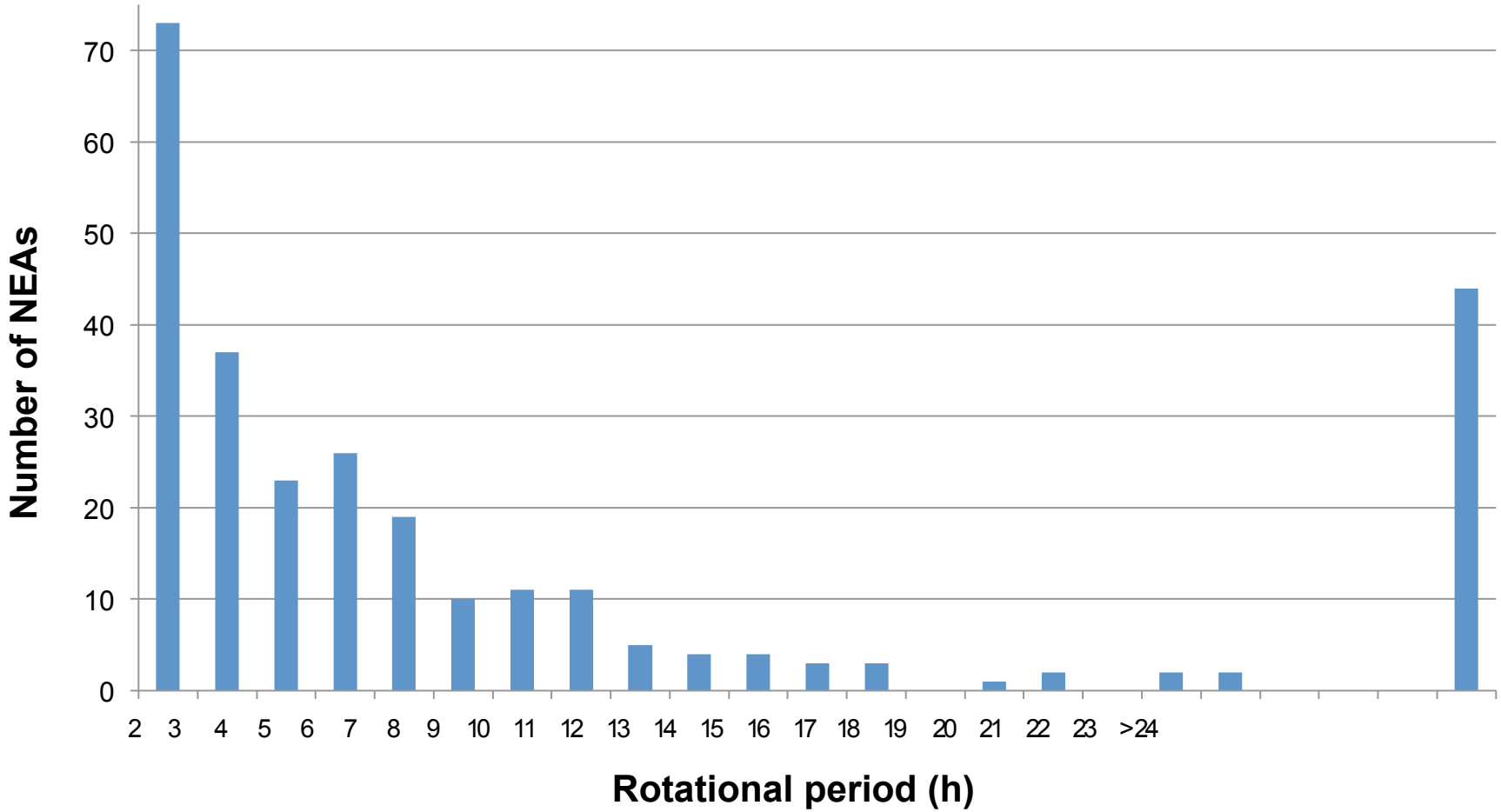
Table 1 DEEP-SOUTH Observation fields and time of each observation mode

mode	fields	filters	observation time
OC	λ: opposition ±10° β: ecliptic ±30°	*BVRI (griz)*	3 hours/night/site
SsS	λ: opposition ± (120°±2°) β: ecliptic ±20°	*R (i)*; no filter	(astronomical twilight ±30 min at dawn and dusk)/night/site
TO	-	mostly *R (i)*	< 15 minutes/night/site

- Each observing run will be scheduled by "OBSPLANNER", which updates minor planet catalogs, generates ephemerides and prepares target lists for each site on a daily basis.
- A suite of scripts will be sent to site operators.

Small body sciences of the **DEEP-SOUTH** project: a couple of examples

P-distribution: 280/862

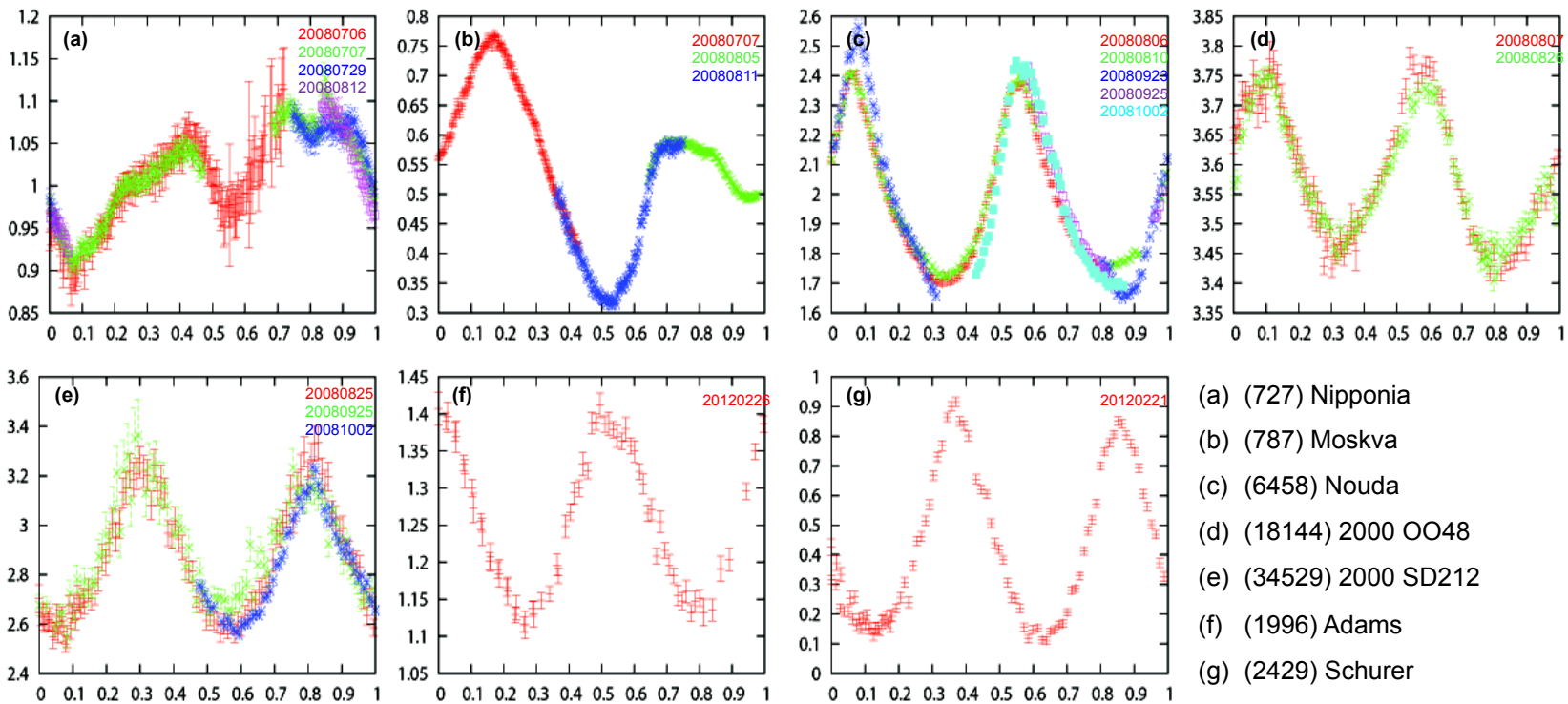


Asteroid Lightcurve Database (accessed: July 15 2014)

Census & survey of asteroids: Physical characterization

- Little is known for object with P≥ 8 - 10 h; non-aliased data on longer timescales
- *SsS* : **sparsely**-sampled long-duration LC
  OC : more **densely**-sampled LC
- Spin states & shape models: unusual obj to be flagged for follow-up
- Color variations: **inhomogeneity** on surface or any evid ence for collisions in the recent past

Census & survey of asteroids: Physical characterization



(a) (727) Nipponia
(b) (787) Moskva
(c) (6458) Nouda
(d) (18144) 2000 OO48
(e) (34529) 2000 SD212
(f) (1996) Adams
(g) (2429) Schurer

Kim et al. 2014
: Rotational properties of Maria asteroid family

Comet census:

- The comet reservoirs still remain as the least known sources of NEOs
- NICs (LPCs) are almost evenly distributed with respect to the ecliptic (Lamy et al. 2004)
- KMTNet addresses the need for coverage in this significantly undersampled region of phase space
- SPCs distributed at lower ecliptic latitudes will also be accessible

Comet DEEP-SOUTH in the soap on TV "The man from a star"

© 2013 Seoul Broadcasting System

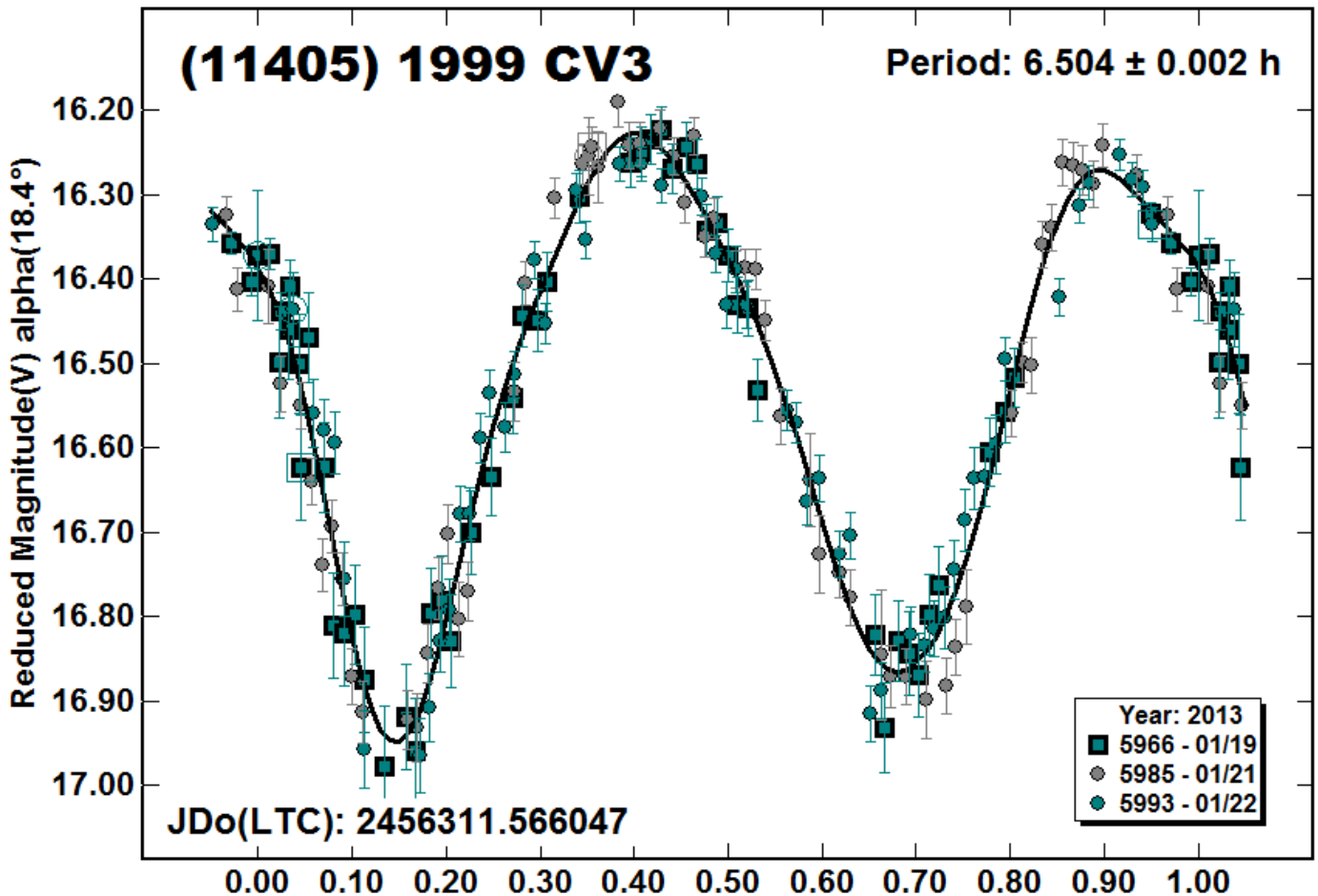
Scheduler and **pipeline**: current status and plans

Targets: 1km-class NEAs

- n(NEA ≥ 1km): 872 (H_{cutoff} =17.7)
- With known period: 280/872= 32%
  - Grade 3: completely unambiguous P
  - Grade 2: incomplete coverage
  - Grade 1: with lower limit

- With pole orientation: 31/280= 11%
  - 31/872~ 3%

Grade 3: 160 NEAs



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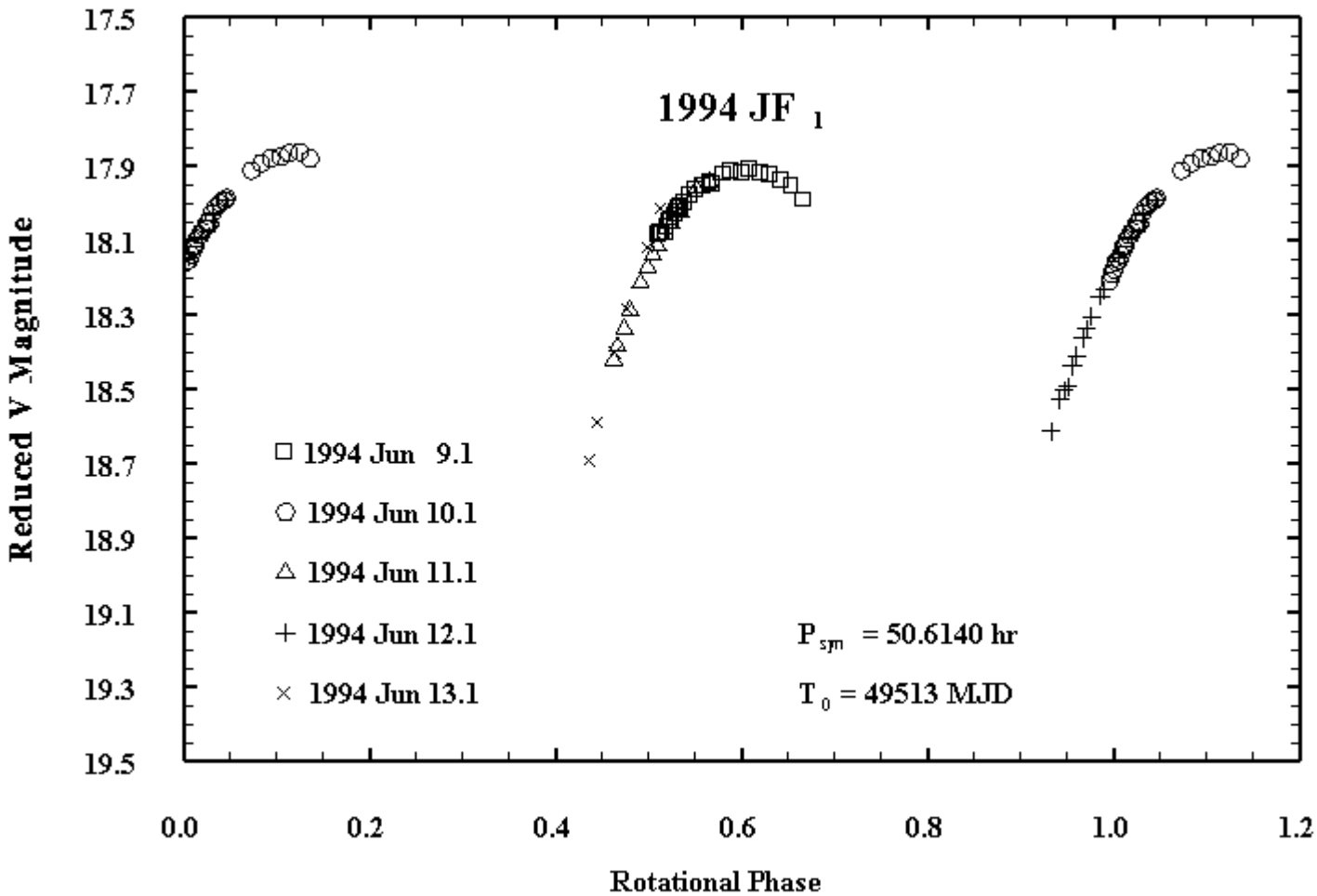
Grade 2: 71 NEAs



Mottola et al. 1995

SMART: functions

Scheduler for Measuring Asteroid's RoTation

- Designed to schedule asteroid observation and fol low-up in a timely manner.

  - updates NEA catalogs
  - generates ephemeris
  - prepares target lists, and
  - sends a suite of scripts to site operators
  - flag lightcurve
  - determine additional follow-up

ASAP: functions

Asteroid Spin Analysis Package

- Designed to conduct photometric analysis in a semi-automatic mode;

  - aid to find comparison *s

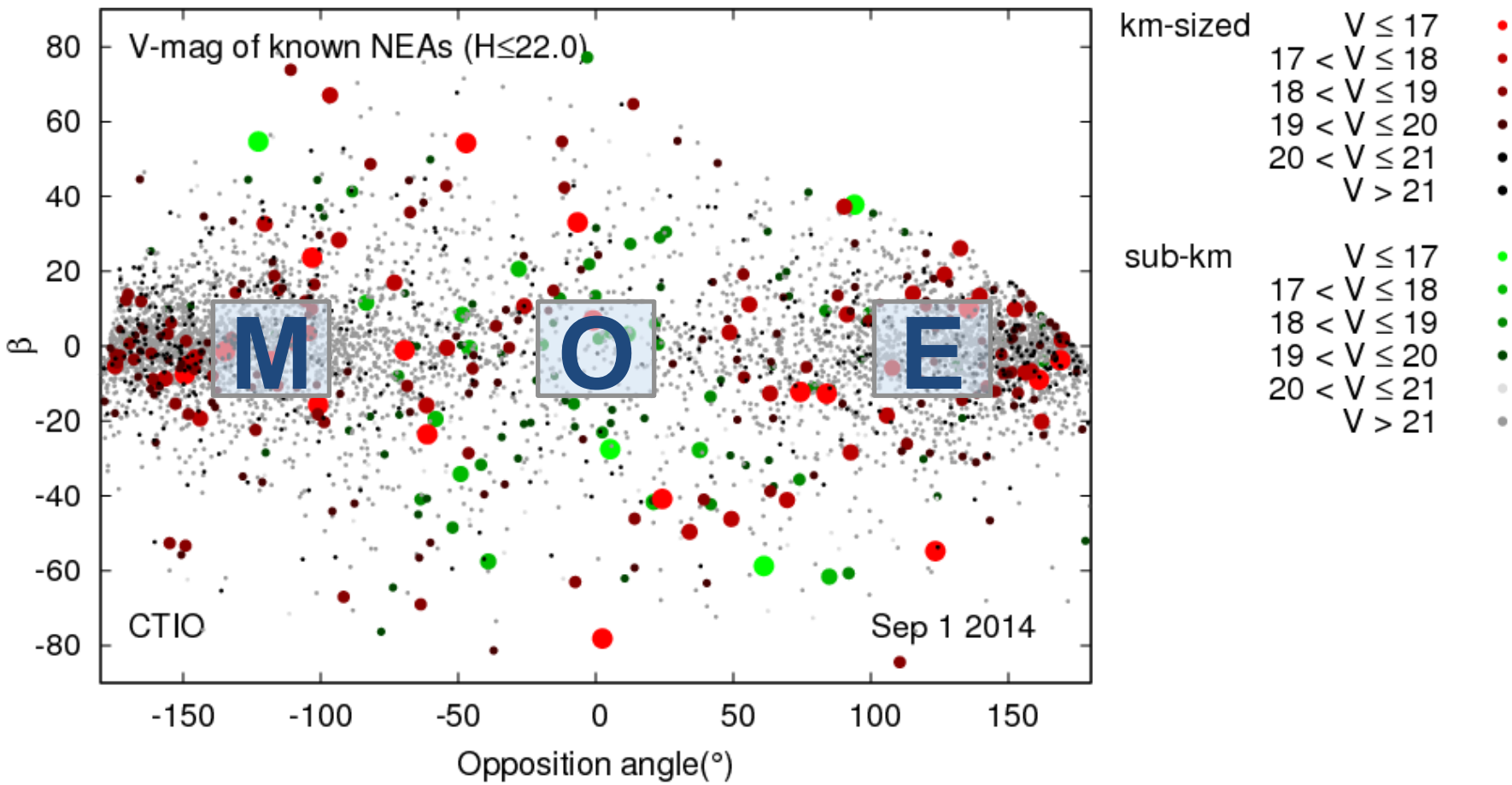
  - derive light curves

  - calculate periods, H-G parameters

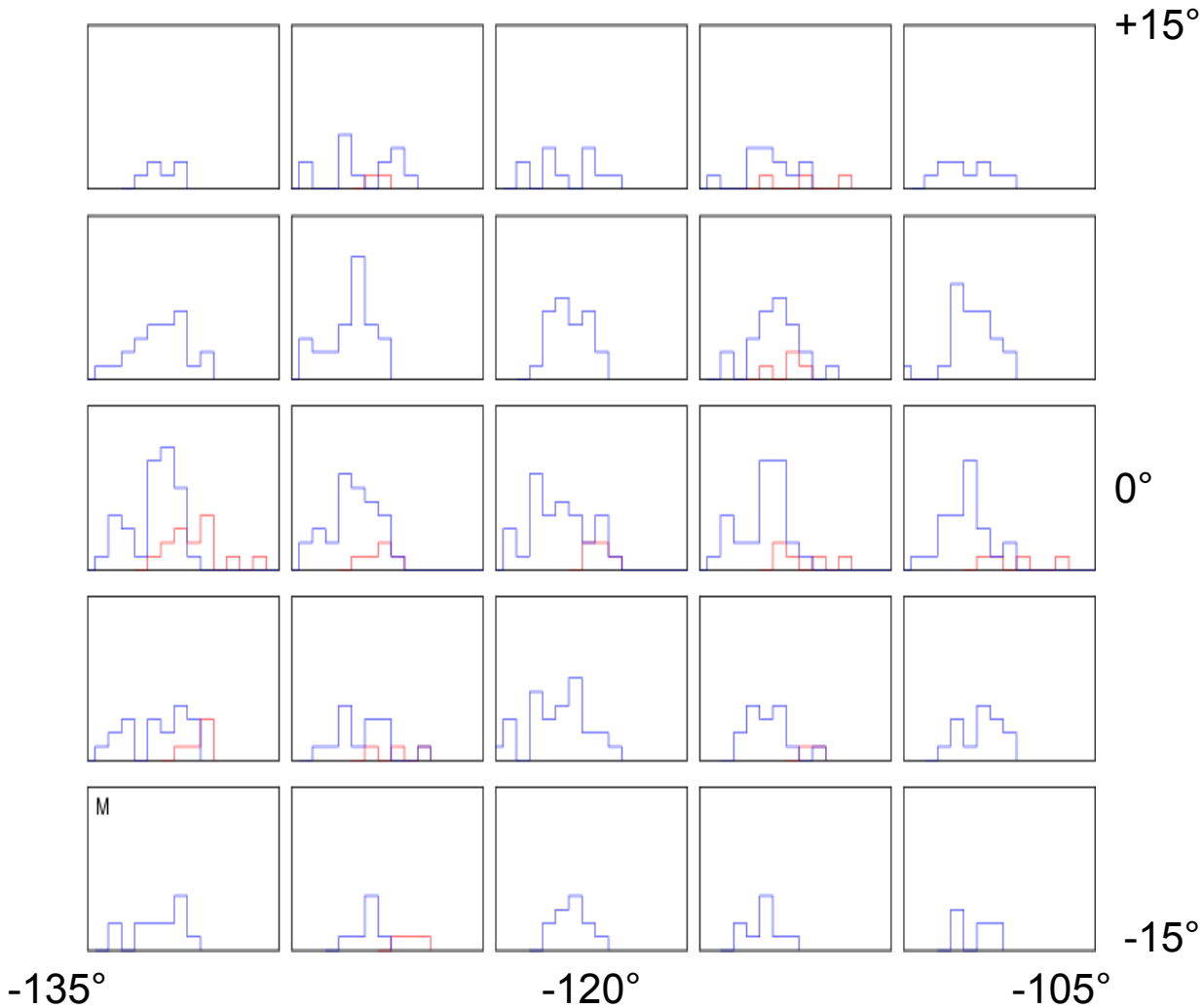
  - spin orientation and shape

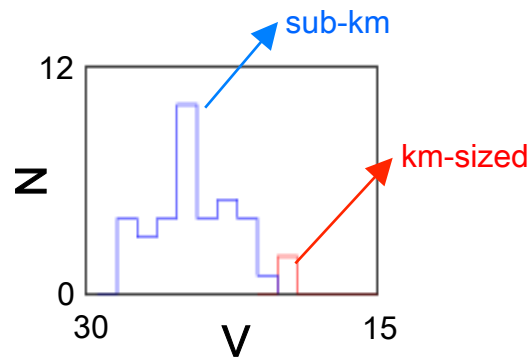
Establishing observation strategy

Count the number of NEAs in **Opposition** & M/E **sweet spots**

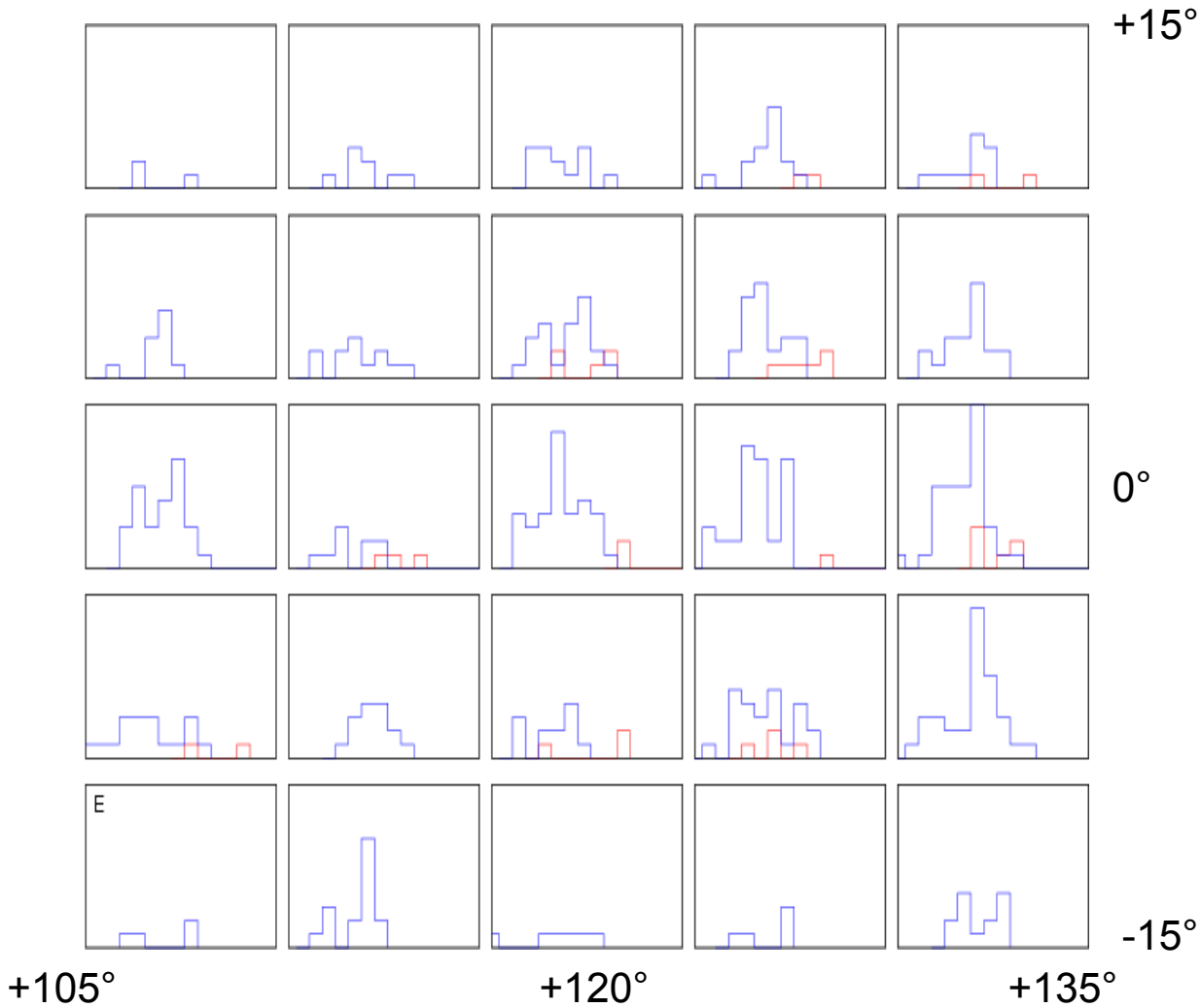


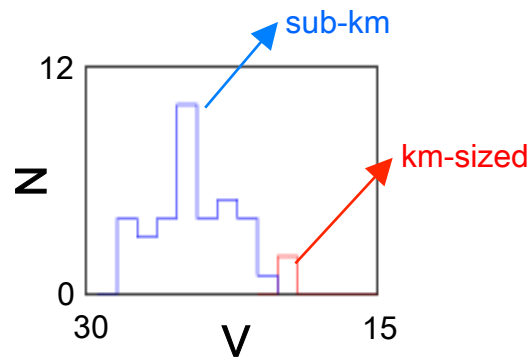
Number of NEAs in the Morning s weet spots



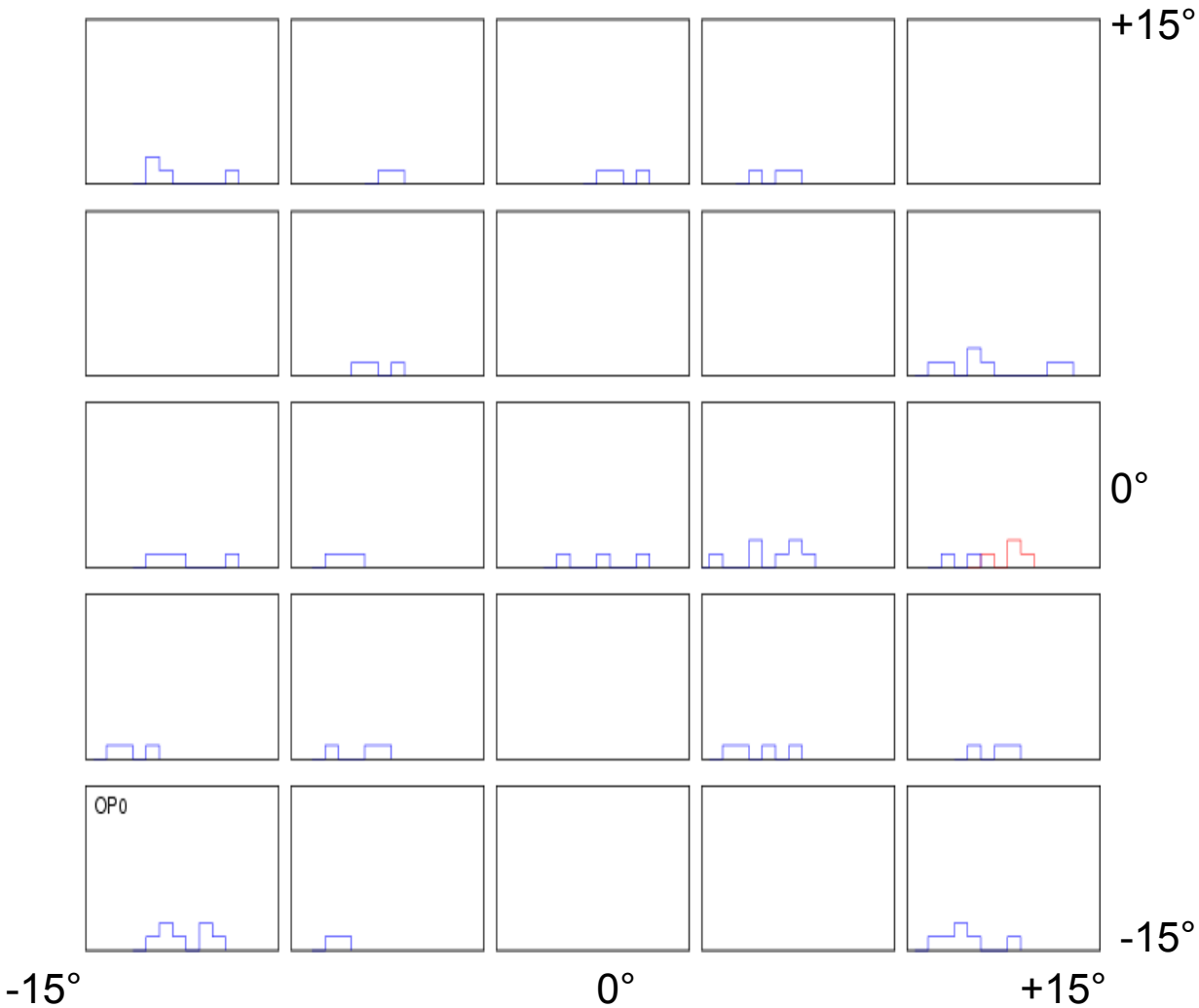


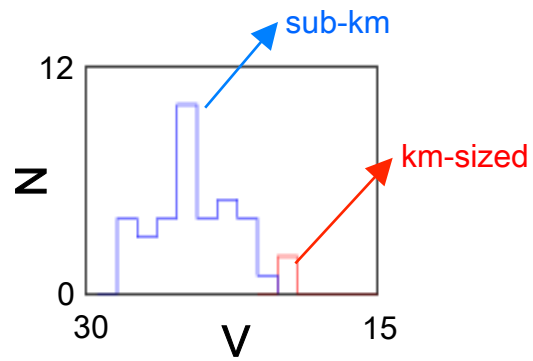
Number of NEAs in the Evening sweet spots



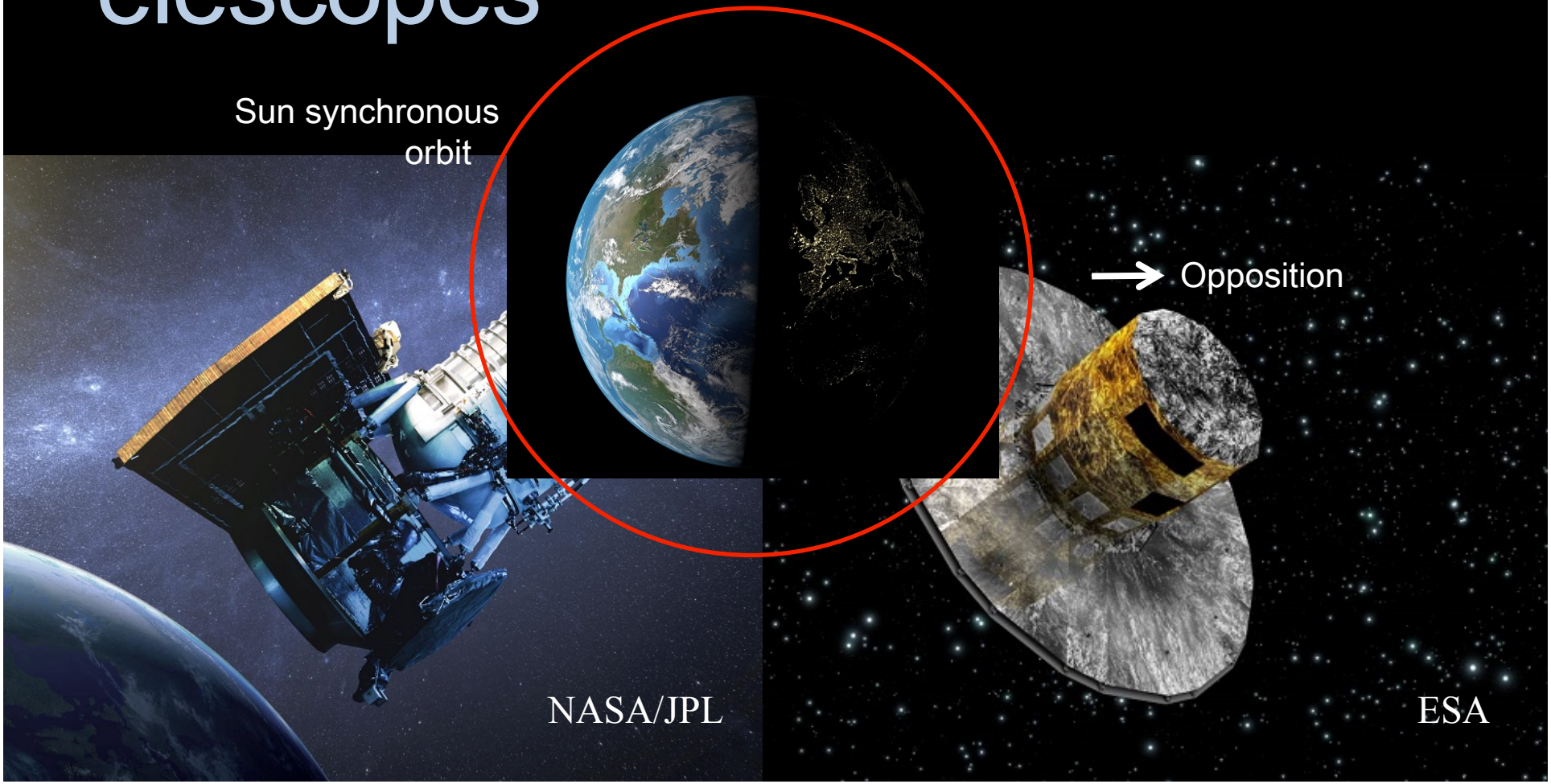


Number of NEAs in Opposition at CTIO on Sep 1, 2014





An additional issue:
Follow-up is crucial for Space telescopes



The SUPERTRAMP:

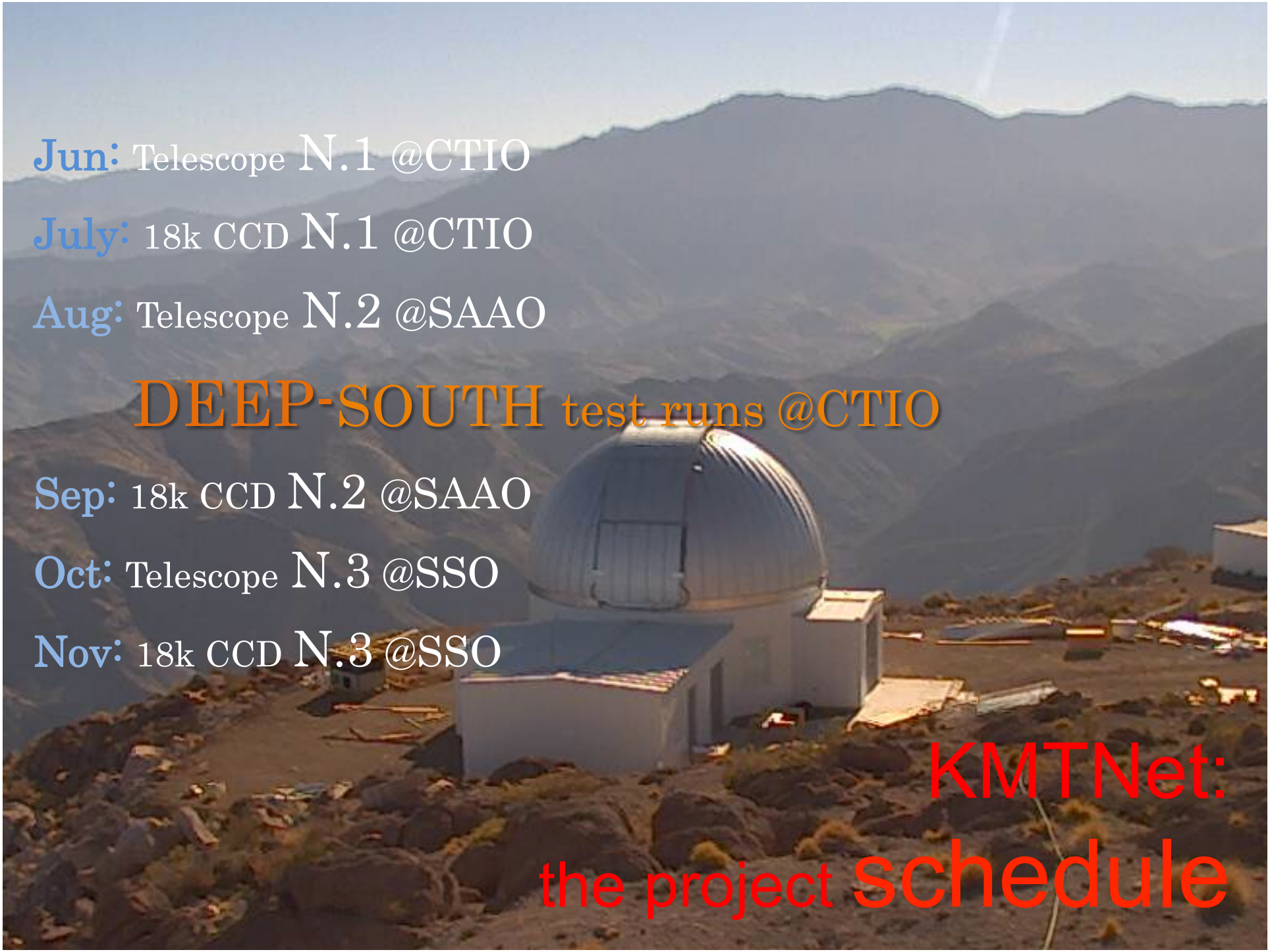
SoUthern hemisPhERe TRAcklet Mining Project

Summary: Characterization of sm all bodies in the Southern sky

- During the "Off-season" for exoplanet search we investigate bulk properties of km-sized NEAs, MBAs and comets.

  - Orbit, “optical” size
  - approximate **Surface mineralogy**
  - Spin state and Shape
  - **Transport, evolution & population**

- Characterization is required for Science, Risk ass essment, human Exploration & Utilization.


Jun: Telescope N.1 @CTIO
July: 18k CCD N.1 @CTIO
Aug: Telescope N.2 @SAAO
DEEP-SOUTH test runs @CTIO
Sep: 18k CCD N.2 @SAAO
Oct: Telescope N.3 @SSO
Nov: 18k CCD N.3 @SSO
KMTNet:
the project schedule