International Cooperation and Collaboration: The MPC Perspective

Presentation to
International Asteroid Warning Network
Steering Committee

Timothy Spahr
Director, Minor Planet Center
Smithsonian Astrophysical Observatory
14 January 2014

Overview and Outline

--Making the case for cooperation and collaboration for surveying for NEOs

--The necessity for cooperation in follow-up selection

--Existing MPC resources to aid in collaboration

--Real-world examples of cooperation in action

--Needs as the survey and follow-up teams increase and increase capabilities. Don’t forget physical follow-up as well!

The Need for Cooperation

Finite survey and follow-up capabilities necessitate distribution of effort

Direct duplication of effort has negative consequences, especially for the largest survey instruments

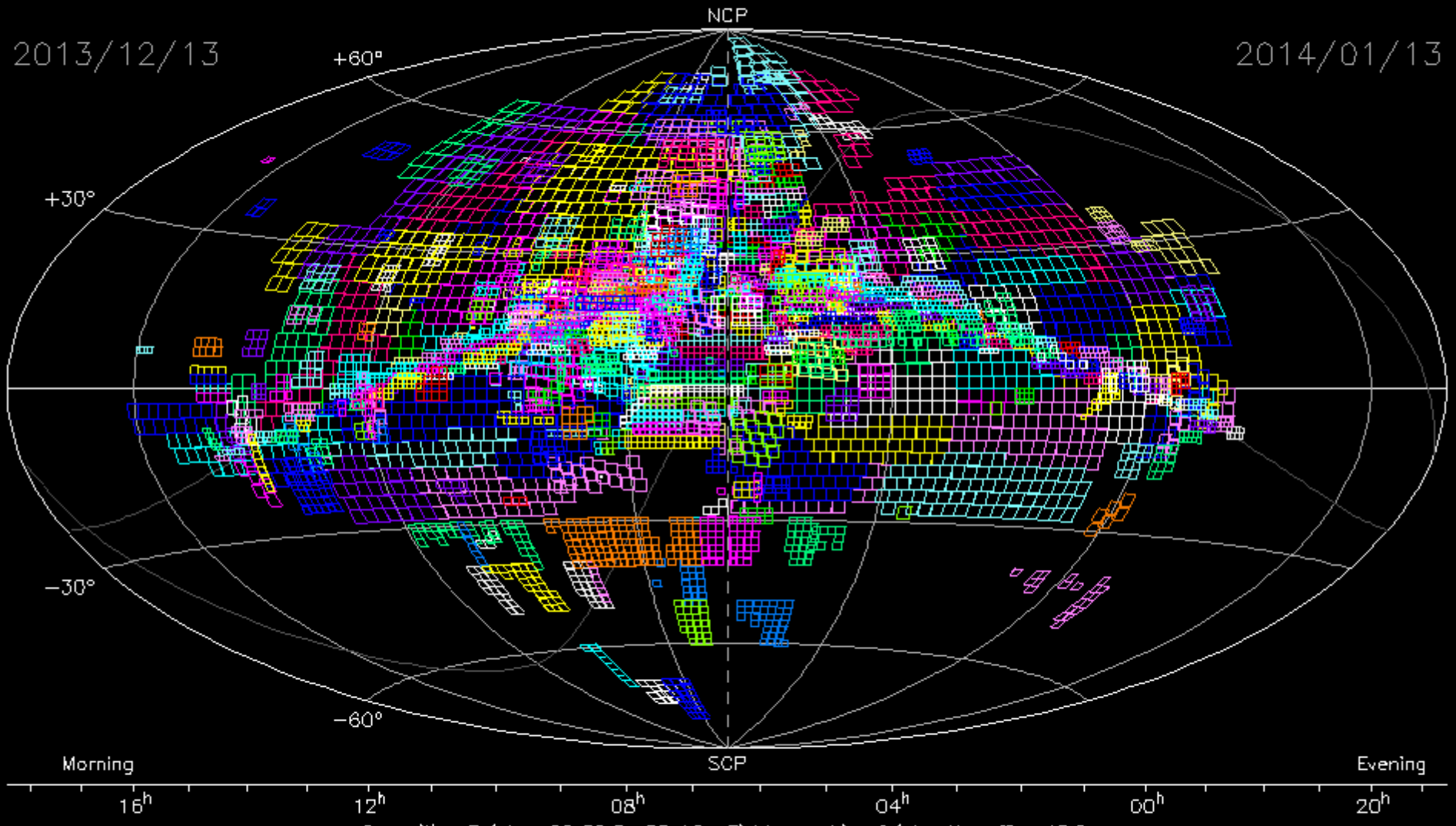
On any given day there can be 100 unconfirmed NEOs in need of targeted follow-up; cooperation there essential as well

Designated NEOs need orbit improvement for tracking purposes and impact probabilities

Don’t forget physical follow-up coordination!

SKY COVERAGE

Plot prepared 2014/01/11.959 by the Minor Planet Center

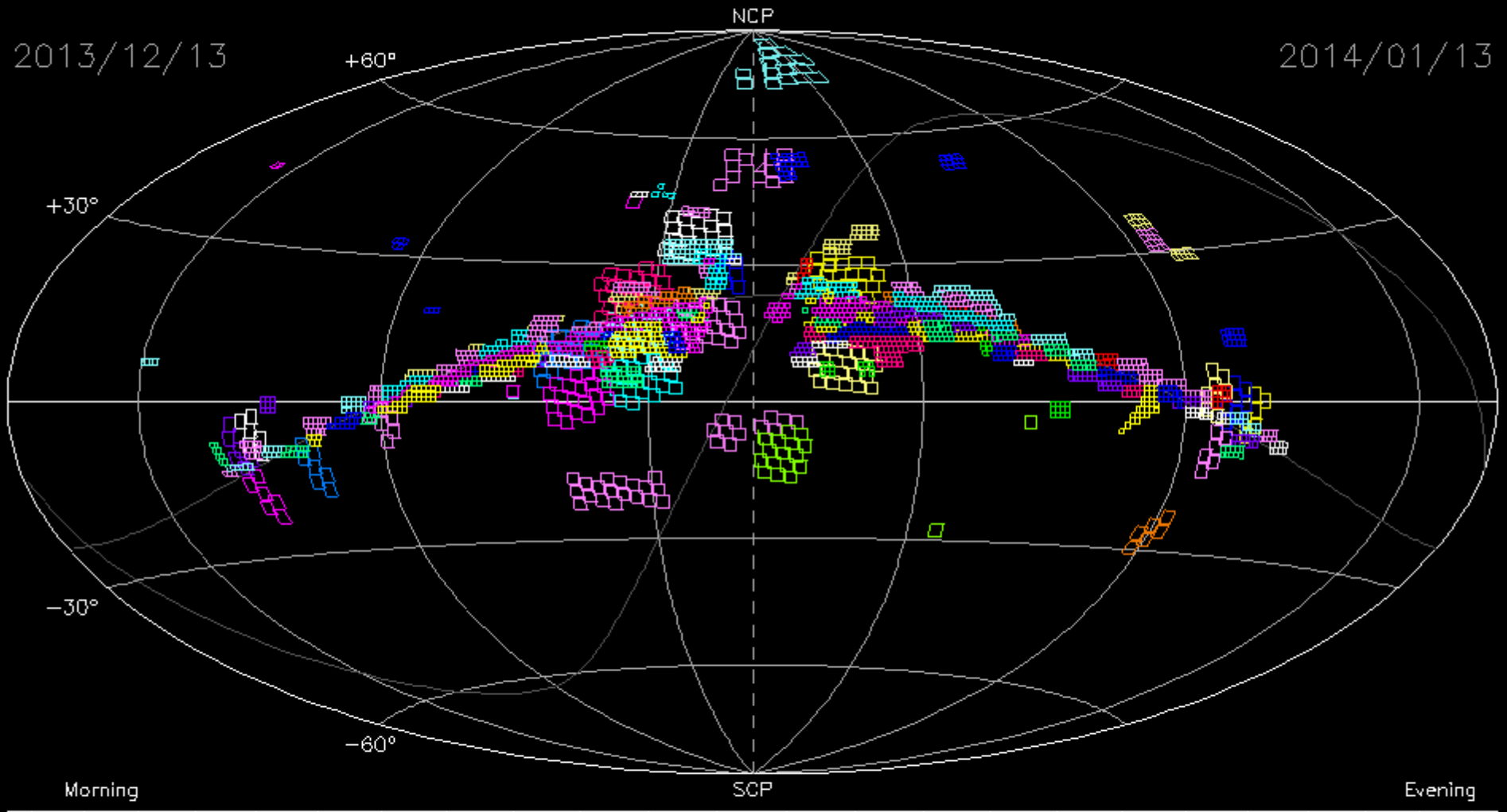


Opposition Point = 06 29.3,+23 16. Fields reaching fainter than V = 18.0.

2014/01/13 (2014 013)	2014/01/12 (2014 012)	2014/01/11 (2014 011)	2014/01/10 (2014 010)	2014/01/09 (2014 009)
2014/01/08 (2014 008)	2014/01/07 (2014 007)	2014/01/06 (2014 006)	2014/01/05 (2014 005)	2014/01/04 (2014 004)
2014/01/03 (2014 003)	2014/01/02 (2014 002)	2014/01/01 (2014 001)	2013/12/31 (2013 365)	2013/12/30 (2013 364)
2013/12/29 (2013 363)	2013/12/28 (2013 362)	2013/12/27 (2013 361)	2013/12/26 (2013 360)	2013/12/25 (2013 359)
2013/12/24 (2013 358)	2013/12/23 (2013 357)	2013/12/22 (2013 358)	2013/12/21 (2013 355)	2013/12/20 (2013 354)
2013/12/19 (2013 353)	2013/12/18 (2013 352)	2013/12/17 (2013 351)	2013/12/16 (2013 350)	2013/12/15 (2013 349)

SKY COVERAGE

Plot prepared 2014/01/11.956 by the Minor Planet Center



Opposition Point = 06 29.3,+23 16. Fields reaching fainter than V = 18.0.

2014/01/13 (2014 013)	2014/01/12 (2014 012)	2014/01/11 (2014 011)	2014/01/10 (2014 010)	2014/01/09 (2014 009)
2014/01/08 (2014 008)	2014/01/07 (2014 007)	2014/01/06 (2014 006)	2014/01/05 (2014 005)	2014/01/04 (2014 004)
2014/01/03 (2014 003)	2014/01/02 (2014 002)	2014/01/01 (2014 001)	2013/12/31 (2013 365)	2013/12/30 (2013 364)
2013/12/29 (2013 363)	2013/12/28 (2013 362)	2013/12/27 (2013 361)	2013/12/26 (2013 360)	2013/12/25 (2013 359)
2013/12/24 (2013 358)	2013/12/23 (2013 357)	2013/12/22 (2013 358)	2013/12/21 (2013 355)	2013/12/20 (2013 354)
2013/12/19 (2013 353)	2013/12/18 (2013 352)	2013/12/17 (2013 351)	2013/12/16 (2013 350)	2013/12/15 (2013 349)

Follow-up capability all NEOs

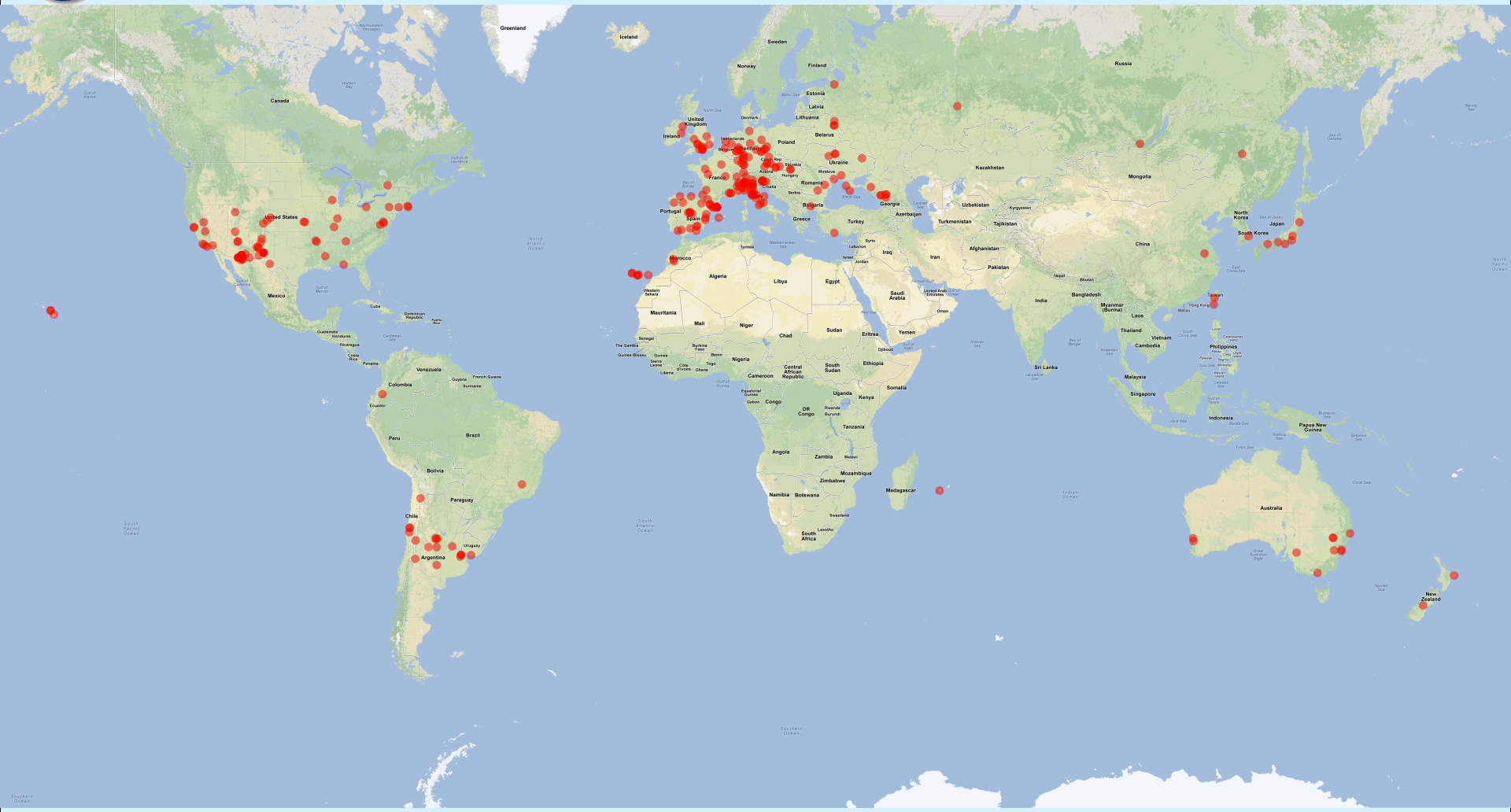
Code	Total Obs.	NEO Obs.	NEOs	NEO Nights	Site
-ALL-	8915349	113697	2430	19539	All sites
H21	20852	13949	1174	3732	Astron. Res. Obs., Westfield
807	12341	9964	910	2411	Cerro Tololo Obs., La Serena
291	9141	5876	824	2038	LPL/Spacewatch II
703	1713454	7265	755	1539	Catalina Sky Survey
F51	2070656	4860	941	1537	Pan-STARRS 1, Haleakala
G96	1921549	6899	829	1330	Mt. Lemmon Survey
A24	17126	4688	255	1033	New Millennium Obs., Mozzate
204	3431	2192	647	814	Schiaparelli Obs.
H45	10903	5455	210	757	Arkansas Sky Obs., Petit Jean Mtn. South
704	802599	3589	330	756	Lincoln Lab. ETS, New Mexico
160	3043	1918	117	601	Castelmartini

Follow-up capability all NEOs V > 20

2012-06-01 – 2013-06-01

Code	NEO Obs.	NEOs	NEO Nights	Site
-ALL-	29190	1965	7111	All sites
291	4648	682	1633	LPL/Spacewatch II
H21	4327	656	1373	Astron. Research Obs., Westfield
807	4170	592	1057	Cerro Tololo Obs., La Serena
G96	4128	514	786	Mt. Lemmon Survey
F51	2617	602	772	Pan-STARRS 1, Haleakala
568	960	236	325	Mauna Kea
H01	1217	205	298	Magdalena Ridge Obs., Socorro
204	511	210	233	Schiaparelli Obs.
691	562	126	187	Steward Obs., Kitt Peak - Spacewatch
H36	532	144	181	Sandlot Obs., Scranton

Existing Worldwide Observing Network



While many observatories, vast majority of the work being done by ~ 10 teams

MPC and Other Remedies & Resources

NEO Confirmation Page & NEO Confirmation Page Blog

Get ephemerides | Reset form

Select object(s) from the current list of objects needing confirmation (NEO desirability score, discovery date, rough current position and ma
given, as well as number of observations, arc and nominal *H*):

All objects with *V* = -30 to 30, with Decl. between -90 ° and +90 °, with an NEO desirability score of 0
100 %

or just the objects selected below: Deselect All | Select All

Temp Desig	Score	Discovery	R.A.	Decl.	V	Updated	Note	NObs	Arc	H
VA3E319	98	2014 01 13.4	10 25.8	-21 18	18.4	Updated Jan. 13.50 UT	*	8	0.06	23.7
d112283	70	2014 01 13.1	09 31.1	+25 59	19.3	Added Jan. 13.46 UT		4	0.03	17.8
VAA5E09	67	2014 01 13.3	11 03.8	+31 42	20.5	Added Jan. 13.41 UT		4	0.01	17.4
VAA5CD6	45	2014 01 13.2	09 08.7	+40 05	19.6	Updated Jan. 13.51 UT		12	0.13	18.2
VAA5CCB	83	2014 01 13.2	09 13.8	+44 49	20.0	Updated Jan. 13.38 UT		8	0.08	17.2
VAA5CB5	71	2014 01 13.2	09 08.8	+41 50	19.8	Updated Jan. 13.40 UT		8	0.08	17.6
VAA5CA2	66	2014 01 13.2	08 37.0	+53 18	20.5	Updated Jan. 13.40 UT		7	0.11	18.8
VAA5C97	83	2014 01 13.2	08 34.8	+55 33	19.8	Updated Jan. 13.40 UT		8	0.12	17.5
VAA5C88	45	2014 01 13.2	08 04.1	+55 43	20.2	Updated Jan. 13.39 UT		7	0.15	18.4
S002239	46	2014 01 12.0	05 49.6	-39 28	17.7	Updated Jan. 13.54 UT		13	1.48	9.2
P109J30	30	2014 01 11.4	09 28.8	-01 26	20.7	Updated Jan. 13.55 UT		5	1.76	18.1
P109J2r	95	2014 01 11.3	07 53.7	+30 32	20.5	Added Jan. 12.49 UT		2	0.01	19.3
VAA5896	42	2014 01 12.2	06 04.5	+55 38	20.3	Updated Jan. 13.22 UT		12	0.94	17.1
VA3E1BA	55	2014 01 12.3	07 48.1	+57 32	19.9	Updated Jan. 13.51 UT		11	0.94	17.6
VAA588C	98	2014 01 12.2	05 41.7	+54 01	20.1	Updated Jan. 13.30 UT		18	0.97	20.6
VAA5803	100	2014 01 12.1	00 48.5	+03 43	21.4	Added Jan. 12.22 UT		4	0.03	20.9
VA3DC02	35	2014 01 11.3	09 25.8	-09 04	19.3	Updated Jan. 12.75 UT		18	1.05	17.1
VA3DE03	85	2014 01 11.4	11 55.1	+02 28	19.5	Updated Jan. 13.45 UT	*	34	1.97	24.9
SW40q4	100	2014 01 10.4	09 21.0	+23 05	21.1	Updated Jan. 12.59 UT		9	1.90	21.0

G96 reported VA3E319

From G96 on Monday, 2014-01-13 12:01 UTC

{ "object": "VA3E319", "status": "reported", "observatory": "G96", "observer": "J. A. Johnson", "date": "2014-01-13", "time": "12:01:11" }

Posted in Follow Up | Leave a response

G96 targeting VA3E319

From G96 on Monday, 2014-01-13 11:54 UTC

{ "object": "VA3E319", "status": "targeting", "observatory": "G96", "observer": "J. A. Johnson", "date": "2014-01-13", "time": "11:54:39" }

Posted in Follow Up | Leave a response

G96 reported VAA5CD6

From G96 on Monday, 2014-01-13 10:23 UTC

{ "object": "VAA5CD6", "status": "reported", "observatory": "G96", "observer": "J. A. Johnson", "date": "2014-01-13", "time": "10:23:34" }

Posted in Follow Up | Leave a response

G96 targeting VAA492A

From G96 on Monday, 2014-01-13 10:21 UTC

NEO Coordination System

http://spaceguard.iasf-roma.inaf.it/SSystem/NEOCS/NEOCSMain.html

The following table can be sorted by: Object Magnitude

Last update: 2014 Jan 13, 12:22 UT

Priority	Object	Inserted in this categ.	R.A.	Decl.	Elong.	Magn.	Sky Uncert. in arcsec	End of Visibility
			Data for 2014 Jan 13, 23:00 UT					
UR	2013 WV45	2013/12/03	13h 16m	+49.2	110	**21.8**	37	2014 Jan 17
UR	2013 XA22	2013/12/17	06h 29m	+27.7	163	**20.8**	7	2014 Jan 31
UR	2013 XV18	2013/12/23	12h 50m	+82.6	113	**21.8**	35	2014 Jan 16
UR	2013 XY9	2014/01/12	06h 11m	+09.3	155	**21.9**	3	2014 Jan 20
UR	2013 YB48	2014/01/03	05h 24m	+22.7	148	**21.5**	12	2014 Jan 28
UR	2013 YD48	2014/01/01	02h 36m	-33.1	89	**19.3**	0	2014 Jan 17
UR	Objects from the NEO Confirmation Page							
NE	2013 WB44	2013/12/04	05h 54m	+47.0	147	**21.7**	6	2014 Jan 23
NE	2013 XE22	2013/12/18	05h 44m	+23.6	153	**21.9**	1	2014 Jan 23
NE	2013 XG22	2013/12/20	05h 21m	+10.3	145	**21.1**	2	2014 Jan 26
NE	2013 XG4	2013/12/09	06h 25m	+22.6	162	**21.1**	6	2014 Feb 07
NE	2013 XN24	2013/12/25	12h 30m	-26.9	95	**19.7**	1	2014 Apr 30
NE	2013 XW3	2013/12/07	05h 54m	+29.7	154	**21.7**	1	2014 Jan 24
NE	2013 XZ20	2013/12/15	09h 47m	+61.6	134	**21.8**	1	2014 Jan 14
NE	2013 YA38	2014/01/01	05h 24m	+12.6	146	**21.7**	2	2014 Jan 19
NE	2013 YB14	2013/12/29	05h 57m	+24.5	156	**21.2**	1	2014 Jan 22

Survey Cooperation

There's no substitute for different survey personnel discussing survey plans and strategy

Real-world example of Pan-STARRS and Catalina/Mt. Lemmon surveys discussing and implementing joint survey strategies

As the field grows, survey cooperation will become more complicated. I suspect we will need a meeting of the interested parties within the next year.

The MPC is happy to "coordinate the coordination" but always keep in mind the surveys generally know their individual strengths and weaknesses best (know thyself)

Specific and Directed Observing Campaigns

Virtual Impactors (1999 AN_{10}, 99942 (Apophis)

Call for observations of radar or physical observation targets

Observations of potential spacecraft targets

We must be exceedingly careful requesting time on the largest groundbased facilities for Target of Opportunity (ToR) observing

We must also decide that some NEOs don't need follow-up after the discovery arc and initial orbit determination. Amors, non-PHAs, the smallest objects, and so on.

Self-follow-up

At some point self follow-up will be the rule of the day.

LSST and space-based systems require a cadence that acquires many observations over a long arc for many NEOs. To put it plainly, NEOCAM and Sentinel must operate in such a way to provide excellent orbits

Note that MLS and PS1 are approaching some self-follow up strategy already

Brian Marsden recommended for Main Belt Asteroids a simple cadence of a pair of nights at one lunation and a pair at another lunation. I suspect this would still work very well if we had very robust single-night tracklets

Notes and Summary

Perhaps we need to define what our goal is for the database of NEOs? What objects need follow-up, and what objects can we ignore?

Currently existing follow-up structure likely to be swamped by full PS1 and PS2 and upgraded Catalina/Mt. Lemmon

Tools for coordination of follow-up and survey planning exist and teams are communicating

We need someone from the physical observations community involved to help avoid duplication here, but a much knottier issue because this is a science problem