Observers Meeting

NEOCC observations with the ESA OGS, VLT, and LBT

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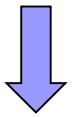
SpaceDyS

European Space Agency

NEO Statistics

~ 13 700 known NEOs
…of which…
~ 510 (4 %) have impact solutions (VIs) in the next century (according to NEODyS and Sentry)

However… of those VIs:
- Only ~2 % have more than one apparition
- ~90 % are lost!

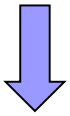


We need to find a way to improve these numbers by:
- Prevent the new ones from being lost
- “Recover” some of the lost ones

How to do it

There are basically three ways to deal with this problem:

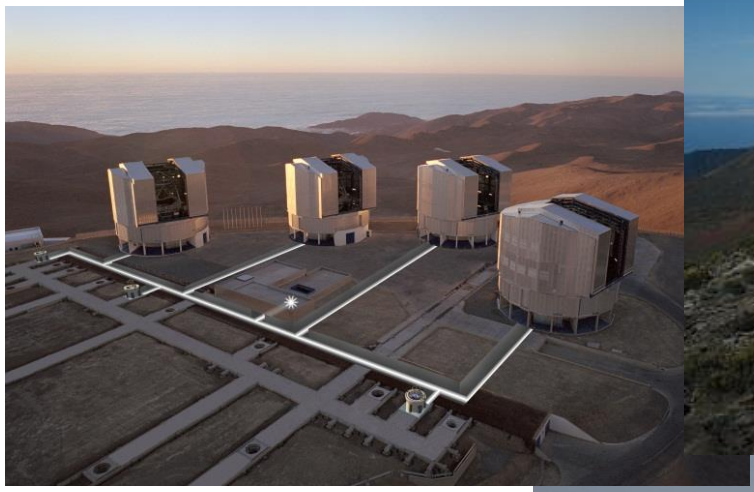
- Extend the observed arc at the discovery apparition
- Attempt wide-field recoveries at the next apparition
- Try to locate precovery observations in existing archives

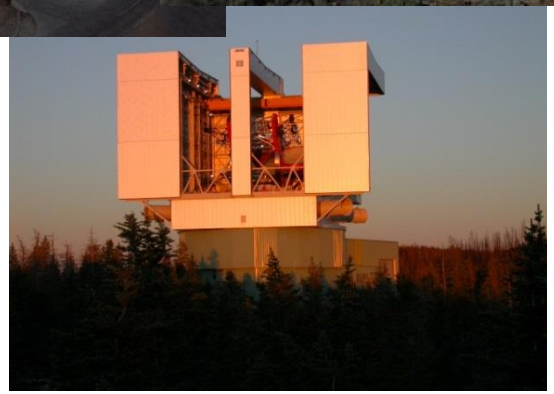


These goals can be achieved using:

- Large aperture telescopes
- Wide-field imagers
- Large repositories of astronomical images

The observational network





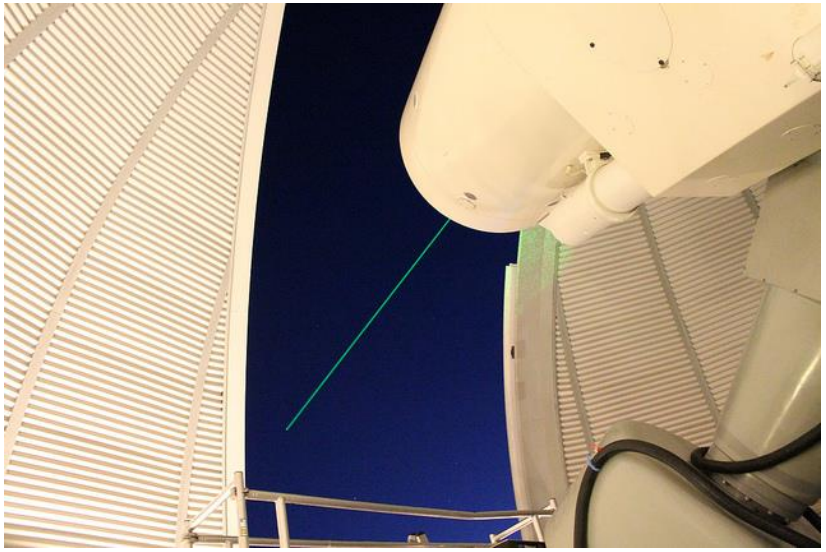
Plus all of you who helped us over the years with your observations
Thank you!

~ 100 collaborators worldwide

More than a dozen telescopes with various apertures

A wide range of observing techniques (astrometry, lightcurves, visual and IR colors, spectroscopy, polarimetry, …)

ESA Optical Ground Station (OGS)



A 1.0 meter ESA telescope in Tenerife, Canary Islands.

Originally designed for satellite optical communication experiments.

We have 4 to 8 nights per month, around new Moon.

ESA Optical Ground Station (OGS)

Follow-up activities

The OGS is one of the few follow-up facilities that can reach magnitude 22.

In 2015 we have:

Observed ~250 NEO observed (~20 per run)

~10-15 NEO candidates targeted every night (>50 % turn out to be actual NEOs)

Success rate of observations (= target located): ~85 %

2-3 NEO or comet recoveries per month

ESA Optical Ground Station (OGS)

TOTAS survey

We perform ~2 hours of survey per night, coordinated by Matthias Busch

In 2014-2015 we have:

Discovered 11 NEOs in 2014-2015

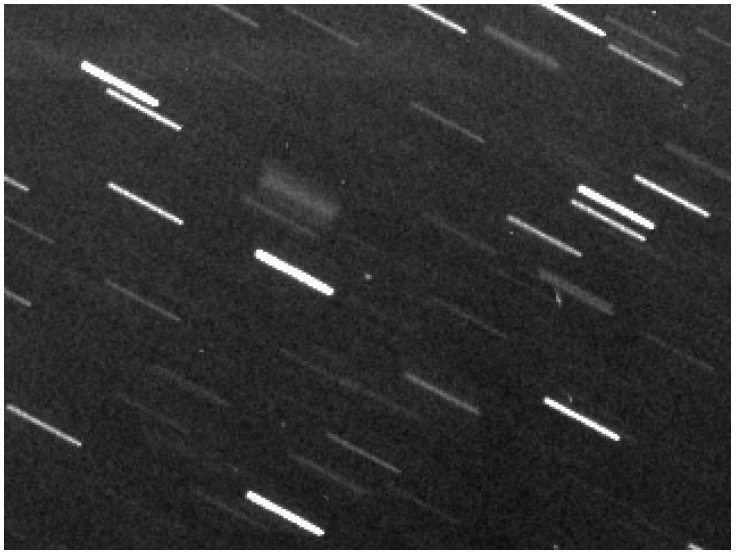
1 current VI discovery:

2014 QN266

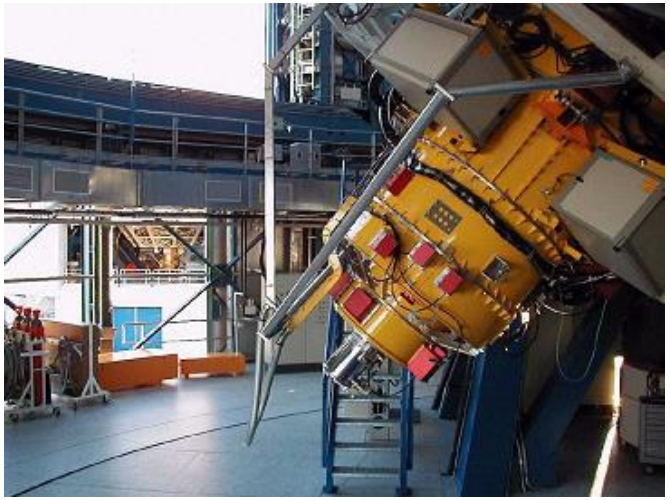
2 comets:

C/2014 C1 (TOTAS)

C/2015 C1 (TOTAS-Gibbs)



ESO Very Large Telescope (VLT)



Four large 8.2 meter telescopes at Cerro Paranal, Chile

We use the FORS2 camera on the first telescope, 7 arcminutes field

We have ~11 hours per semester to observe NEOs from the risk list.
Support by Olivier Hainaut (ESO) is acknowledged.

ESO Very Large Telescope (VLT)

Follow-up

2014 AF16, a dangerous case

Getting fainter fast, unobservable until the time of impact

We observed it in March 2014, V=25, ~5° from the galactic center!

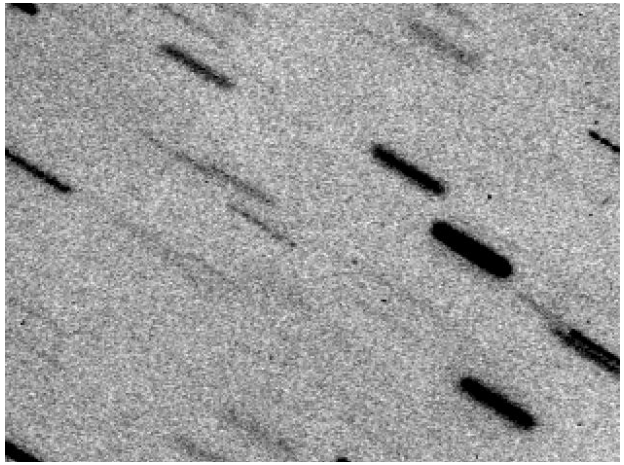
Thanks to these observations, the 2026 VI was removed

2014 WF5, extremely faint follow-up

V=~~26.5~~ 27.1, ~~the faintest NEO ever seen~~

Still on the risk list, but

- Much lower impact probability
- Now recoverable this year



ESO Very Large Telescope (VLT)

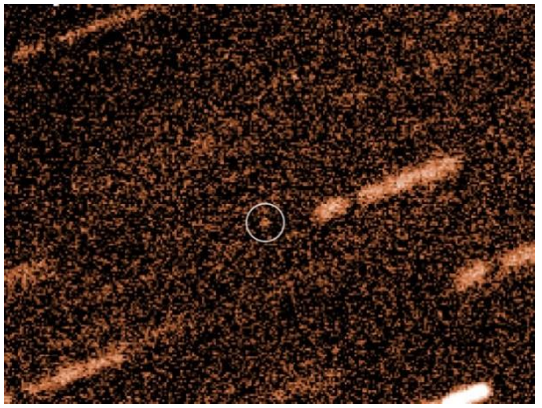
Recoveries

2009 FD, one of the top-rated NEOs

We recovered it in November 2013, when it was V=25.5

The impact probability actually went up! (1/400)

Lowered a bit in most recent analyses (1/700)

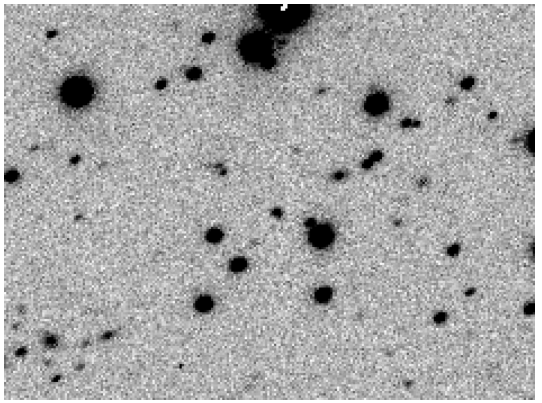


2012 HP13, a faint recovery

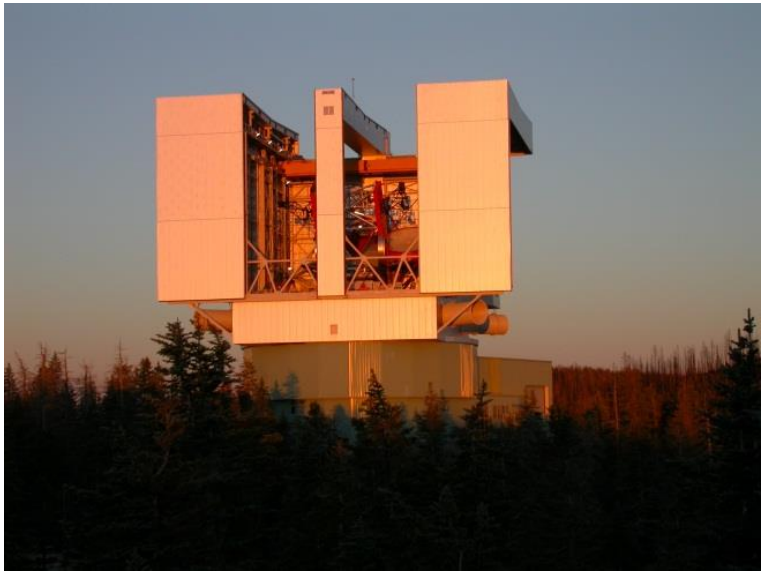
Observed for only 5 days in 2012

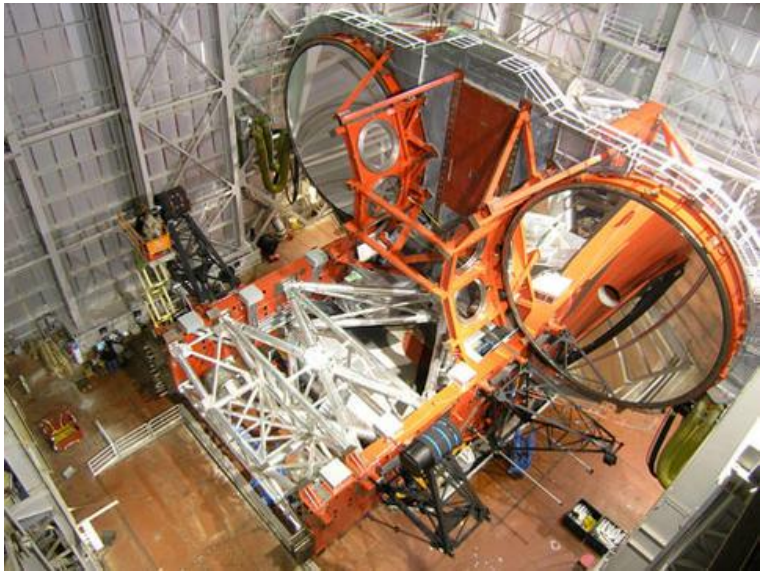
Recovered at V=24 in 2014

All impact solutions were removed



Large Binocular Telescope (LBT)





Two twin comounted 8.4 meter telescopes

Two wide field cameras, 27 arcminutes field, different sensitivities

We are developing an agreement with the Italian partnership (INAF, Observatory of Rome, Adriano Fontana) for DDT time

Large Binocular Telescope (LBT)

Faint large-uncertainty NEOs

We can use LBT for wide field faint recoveries

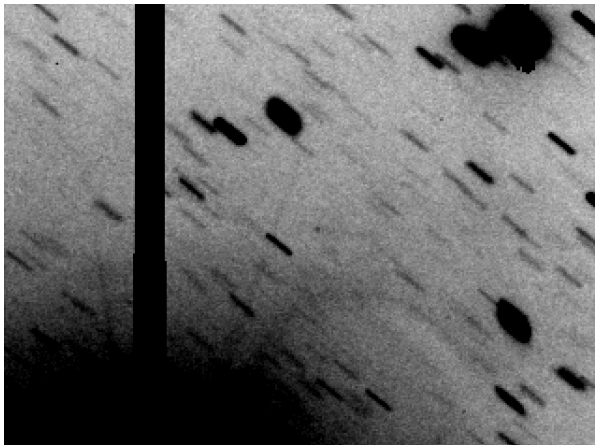
2014 KC46, one of the faintest NEOs ever seen!

We recovered it in October 2014

V=26, uncertainty spanning the whole field

First-ever NEO observation with LBT

All impact solutions were removed



The two sides allow for simultaneous color observations

Precoveries

What can we do if the object is already gone, and lost?

We can search for precoveries in existing data.

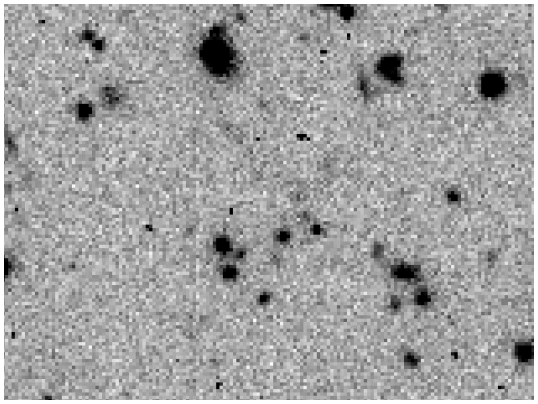
Main sources:

- Archives from large telescopes (e.g. CFHT, DECam)
- Archives from asteroid surveys (e.g. Pan-STARRS)
- Internal archive from cooperating observatories

We need a tool to locate moving objects in these data:

- Existing web tools (e.g. CADC SSOIS, SkyMorph)
- Survey-specific tools

Examples of precoveries



2008 CK70, top-10 in the list of VI

5-day arc, would have been effectively lost

We found precovery images in CFHT

V=24.5, one month before discovery (arc greatly extended)

The object was removed as a possible impactor

2014 BB33, a Main Belt “posing” as an NEO

Discovered by Pan-STARRS, H=17 in a preliminary PHA-like orbit

Five nights of precoveries in the Pan-STARRS database

Arc extended from 2 days to 215 days (chain of precoveries)

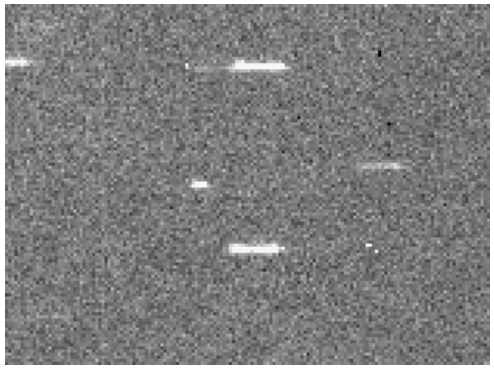
Immediately removed as a VI

Observation campaigns: WT1190F

A peculiar artificial object as a test for an NEO impact

We alerted our collaborators to obtain:

- Astrometric observations (Mauna Kea, Asiago, Loiano, DeSS, Lumezzane, Schiaparelli)
- Precoveries (Pan-STARRS archive)
- Colors (Asiago, Loiano)
- Spectroscopy (Successful DDT at VLT)
- Lightcurve observations (Asiago, Loiano, Schiaparelli, Lumezzane)
- Airborne observation campaign (University of Stuttgart)

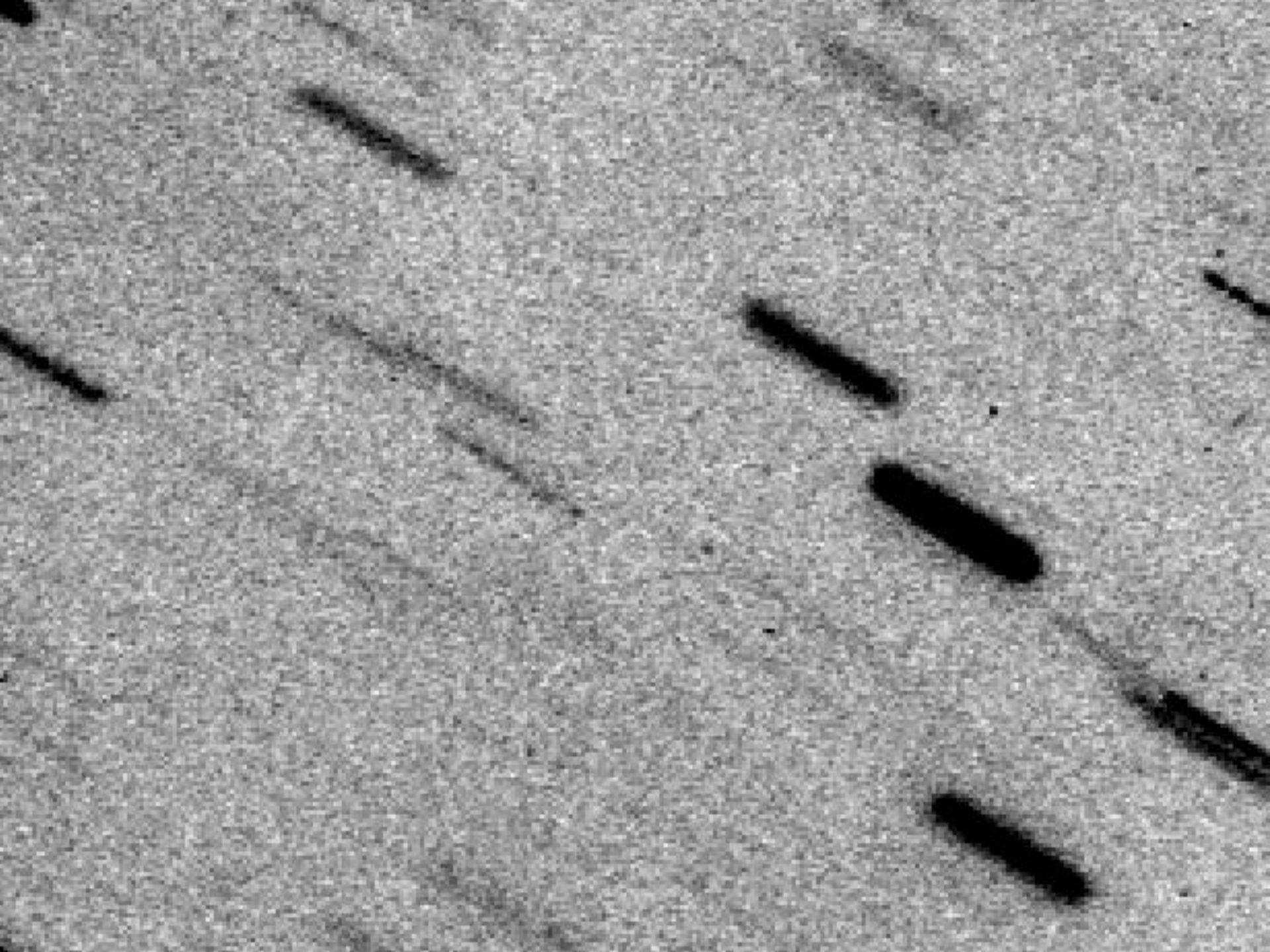
From…  … to 

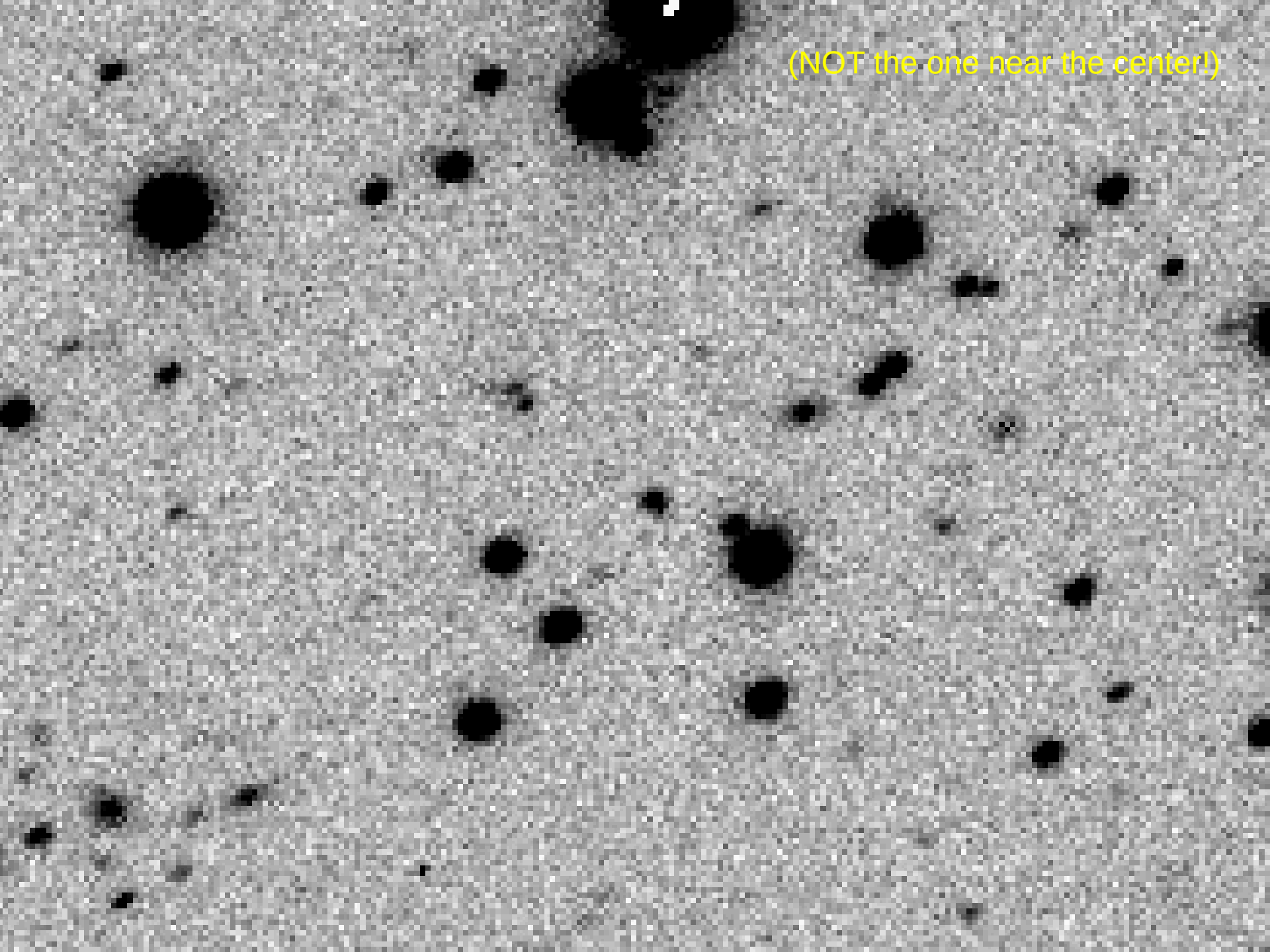
Objects removed from the Risk List

Object	Date	PS0	Telescope	Instrument	People	Archive
2007 UW1	2013-11-28	-3.4	CFHT	MegaCam	M. Micheli, D. J. Tholen	-
2013 XE2	2013-12-10	-4.0	PS1	GPC	M. Micheli, P. Veres, R. J. Wainscoat	PS1
2008 CK70	2013-12-18	-3.1	CFHT	MegaCam	M. Micheli	CADC
2013 BP73	2013-12-20	-3.8	SDSS	SDSS	M. Micheli	CADC
2013 YC	2014-01-22	-2.9	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2014 BD33	2014-01-29	-4.2	PS1	GPC	M. Micheli	PS1
2004 BX159	2014-02-18	-4.5	CFHT	MegaCam	M. Micheli	CADC
2014 AF16	2014-03-11	-2.4	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2012 HP13	2014-04-09	-6.6	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2014 DN112	2014-05-01	-3.6	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2014 HM129	2014-05-22	-4.2	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2014 HM187	2014-05-28	-4.5	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2012 VU76	2014-06-09	-6.1	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2013 YD48	2014-06-30	-4.8	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2014 LU27	2014-07-17	-2.4	PS1	GPC	M. Micheli	PS1
2014 PB58	2014-08-12	-4.5	PS1	GPC	M. Micheli	PS1
2014 QF392	2014-08-14	-8.0	PS1	GPC	M. Micheli	PS1
2014 QJ392	2014-08-14	-6.1	PS1	GPC	M. Micheli	PS1
2014 RC	2014-09-04	-7.0	PS1	GPC	M. Micheli, R. J. Wainscoat	PS1
2014 KC46	2014-10-30	-4.1	LBT	LBC	M. Micheli, E. Dotto, E. Perozzi et al.	-
2014 WV363	2014-12-01	-3.4	PS1	GPC	M. Micheli	PS1
2014 XL7	2015-01-15	-3.0	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2003 LN6	2015-01-23	-5.2	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2015 BU92	2015-01-27	-2.9	LCOGT FTN	Spectral	M. Micheli, J. D. Armstrong	-
2014 XM7	2015-02-09	-6.5	PS1	GPC	M. Micheli	PS1
2015 DA54	2015-02-26	-5.4	PS1	GPC	M. Micheli	PS1
2015 DF198	2015-02-26	-5.4	PS1	GPC	M. Micheli	PS1
2014 NG65	2015-03-25	-4.5	PS1	GPC	M. Micheli	PS1
2014 WP362	2015-04-10	-4.8	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2008 LG2	2015-06-16	-5.8	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2015 KL157	2015-07-13	-3.9	OGS	SDC	M. Micheli, D. Abreu, et al.	
2015 OL35	2015-08-02	-3.9	PS1	GPC	M. Micheli	PS1
2015 PR228	2015-08-18	-3.6	PS1	GPC	M. Micheli, B. Borgia	PS1
2015 PK57	2015-08-18	-9.7	PS1	GPC	M. Micheli	PS1
2000 UK11	2015-08-26	-5.6	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-
2015 RA36	2015-09-14	-4.5	OASI	-	M. Micheli, D. Lazzaro, J. S. Silva, F. Monteiro, et al.	-
2011 SE191	2015-12-14	-8.5	PS1	GPC	M. Micheli, A. Chessa	PS1
2011 HP4	2015-12-14	-7.6	PS1	GPC	M. Micheli, A. Chessa	PS1
2006 XP4	2015-12-14	-7.3	VLT (UT1)	FORS2	M. Micheli, O. R. Hainaut, D. V. Koschny	-

…plus almost 100 additional objects observed, with significant changes in their impact probabilities

Thank you!




(NOT the one near the center!)