NEO Segment Precursor Service Operations

SN-V+CCN

final presentation

18 November 2014 ESRIN

SN-V NEO Segment Precursor Service Operations

- OVERVIEW

ettore perozzi

- NEO SYSTEM

barbara borgia

- OBSERVING CAMPAIGNS

marco micheli

- CONCLUSIONS

ettore perozzi

- ACNOWLEDGMENTS

OVERVIEW
NEO Segment: a little history

- 2009-10: Enabling Technologies
  design the NEO Segment
  SBDC, Collaborating Observatories, Wide Survey

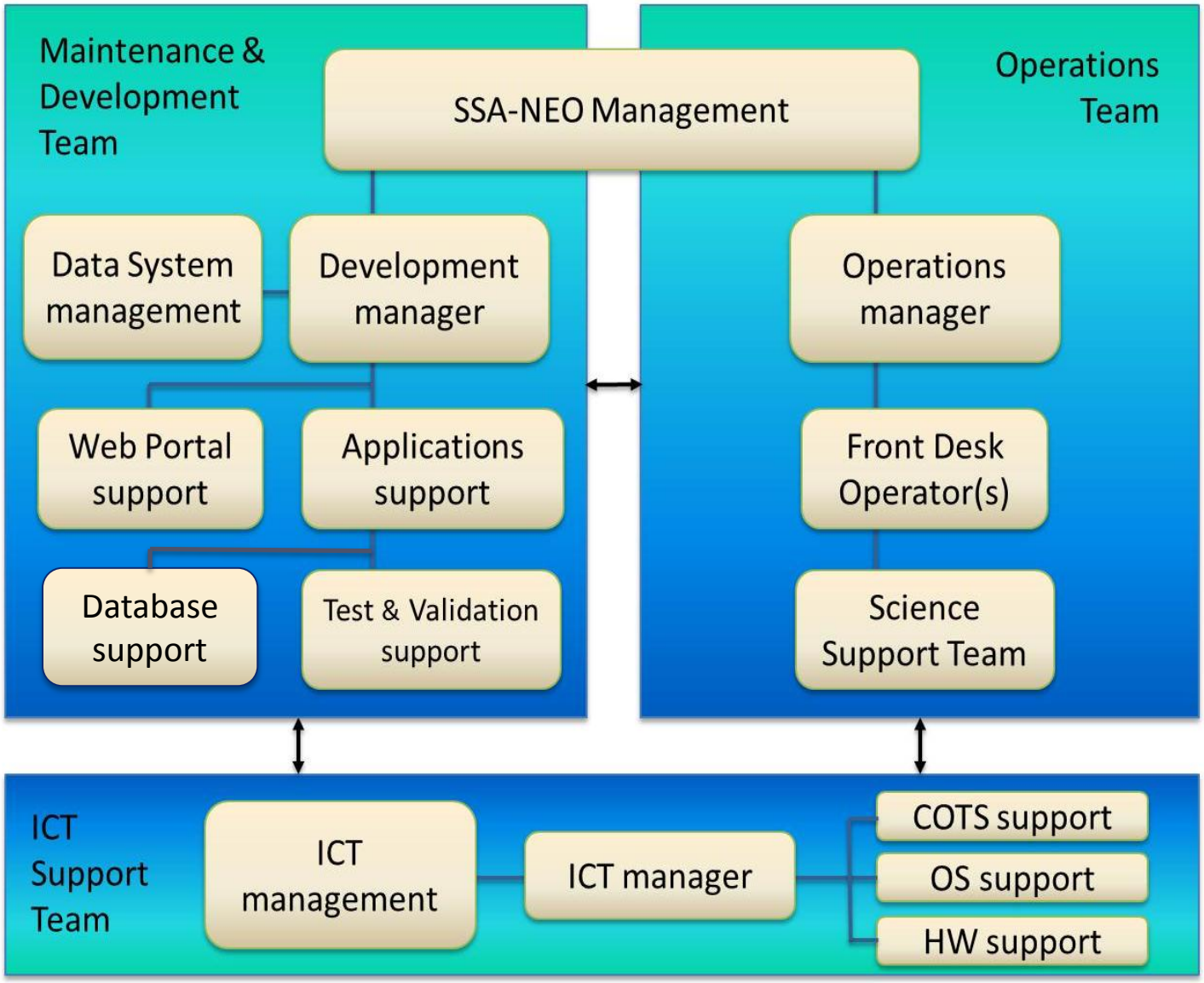
- 2011-12: SN-III Precursor Services
  establish the NEO System
  Web Portal, Database, ESRIN Office

- 2013-14: SN-V Precursor Services Operations
  operate the NEOCC
  System Maintenance & Improvement, Astronomical Observations, NEO Ops

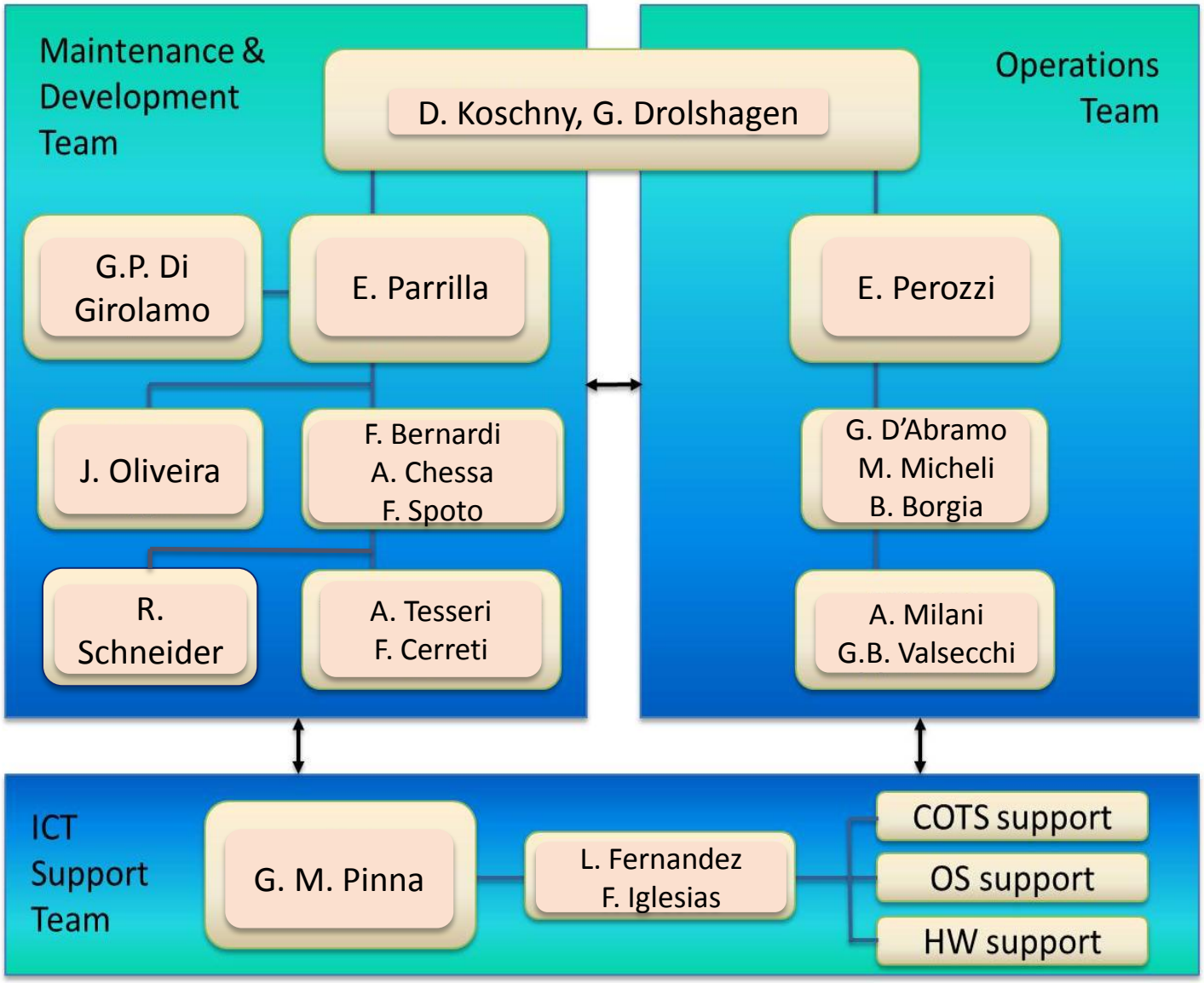
OVERVIEW
Precursor Service Operation goals

- Carry out NEO Segment Precursor Service Operations
- Maintain and improve the NEO System web portal and database
- Contribute to NEO observations
- Establish the NEO Coordination Centre as an authoritative entity

OVERVIEW
Operations Concept



OVERVIEW
NEO Team



OVERVIEW
NEO System Activities

MAINTENANCE | UPGRADE | UPDATE | IMPROVEMENT

backups

Bugs fixing

SW upgrades

improved performances

additional functionalities

new services

database consistency

openAM authentication

comets catalogue

web portal consistency

enhanced layout

discovery statistics

perturbed orbits

Engineering coordination

education and outreach

NEODyS interface

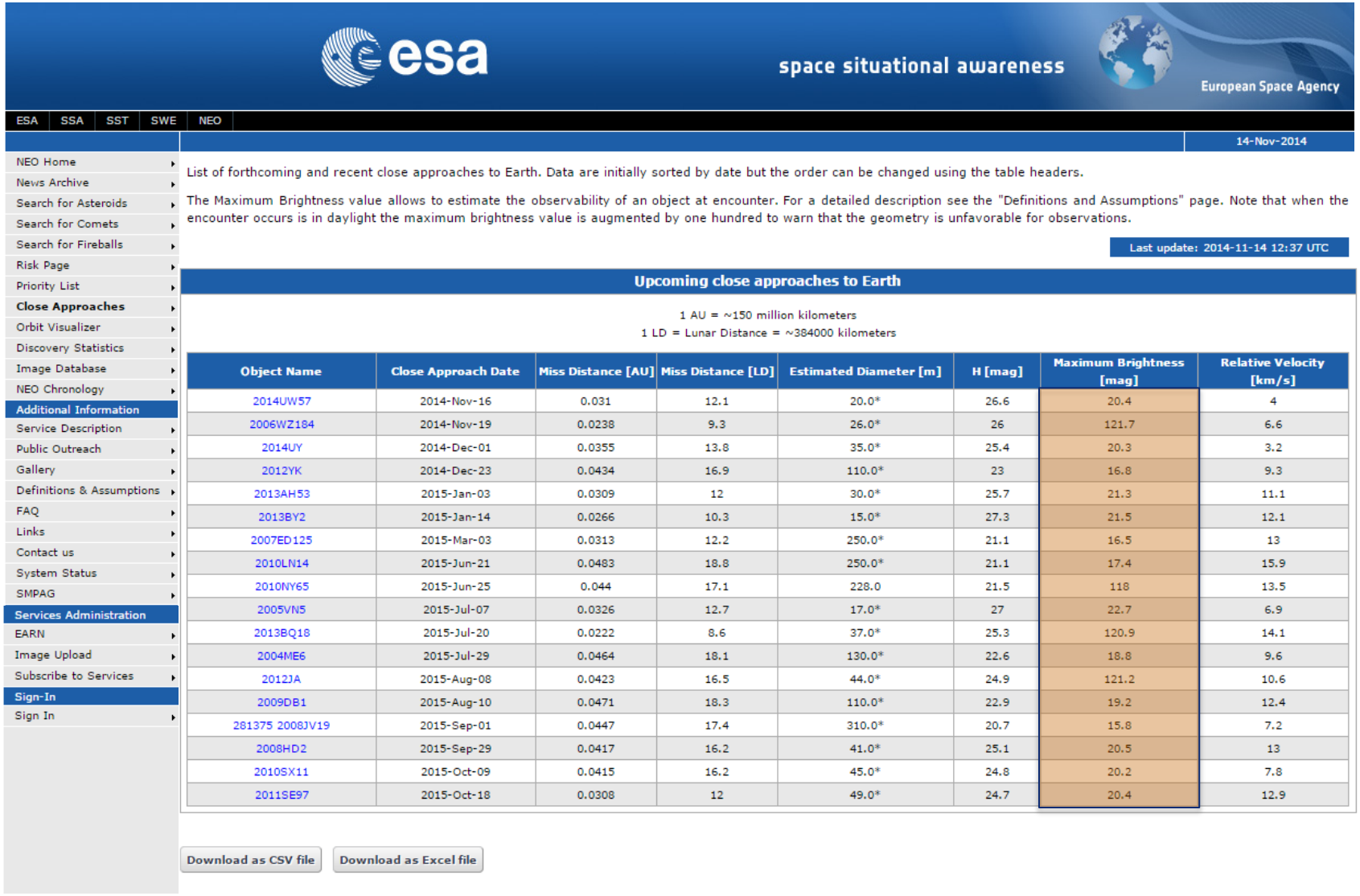
advanced algorithms

Front Desk Operators

training and selection

incremental testing

ADVANCED ALGORITHMS
Maximum Brightness at Close Approach



esa space situational awareness European Space Agency

ESA | SSA | SST | SWE | NEO

14-Nov-2014

- NEO Home
- News Archive
- Search for Asteroids
- Search for Comets
- Search for Fireballs
- Risk Page
- Priority List
- **Close Approaches**
- Orbit Visualizer
- Discovery Statistics
- Image Database
- NEO Chronology
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- Sign-In
- Sign In

List of forthcoming and recent close approaches to Earth. Data are initially sorted by date but the order can be changed using the table headers.

The Maximum Brightness value allows to estimate the observability of an object at encounter. For a detailed description see the "Definitions and Assumptions" page. Note that when the encounter occurs is in daylight the maximum brightness value is augmented by one hundred to warn that the geometry is unfavorable for observations.

Last update: 2014-11-14 12:37 UTC

Upcoming close approaches to Earth

1 AU = ~150 million kilometers
1 LD = Lunar Distance = ~384000 kilometers

Object Name	Close Approach Date	Miss Distance [AU]	Miss Distance [LD]	Estimated Diameter [m]	H [mag]	Maximum Brightness [mag]	Relative Velocity [km/s]
2014UW57	2014-Nov-16	0.031	12.1	20.0*	26.6	20.4	4
2006WZ184	2014-Nov-19	0.0238	9.3	26.0*	26	121.7	6.6
2014UY	2014-Dec-01	0.0355	13.8	35.0*	25.4	20.3	3.2
2012YK	2014-Dec-23	0.0434	16.9	110.0*	23	16.8	9.3
2013AH53	2015-Jan-03	0.0309	12	30.0*	25.7	21.3	11.1
2013BY2	2015-Jan-14	0.0266	10.3	15.0*	27.3	21.5	12.1
2007ED125	2015-Mar-03	0.0313	12.2	250.0*	21.1	16.5	13
2010LN14	2015-Jun-21	0.0483	18.8	250.0*	21.1	17.4	15.9
2010NY65	2015-Jun-25	0.044	17.1	228.0	21.5	118	13.5
2005VN5	2015-Jul-07	0.0326	12.7	17.0*	27	22.7	6.9
2013BQ18	2015-Jul-20	0.0222	8.6	37.0*	25.3	120.9	14.1
2004ME6	2015-Jul-29	0.0464	18.1	130.0*	22.6	18.8	9.6
2012JA	2015-Aug-08	0.0423	16.5	44.0*	24.9	121.2	10.6
2009DB1	2015-Aug-10	0.0471	18.3	110.0*	22.9	19.2	12.4
281375 2008JV19	2015-Sep-01	0.0447	17.4	310.0*	20.7	15.8	7.2
2008HD2	2015-Sep-29	0.0417	16.2	41.0*	25.1	20.5	13
2010SX11	2015-Oct-09	0.0415	16.2	45.0*	24.8	20.2	7.8
2011SE97	2015-Oct-18	0.0308	12	49.0*	24.7	20.4	12.9

Download as CSV file | Download as Excel file

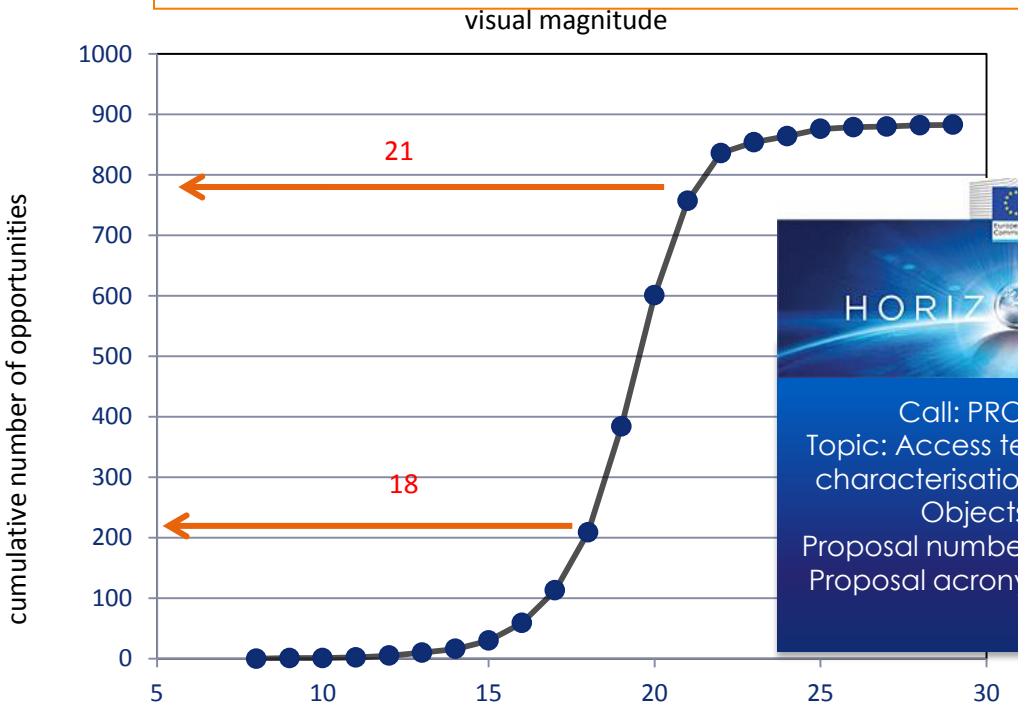
ADVANCED ALGORITHMS
Maximum Brightness at Close Approach

cumulative distribution of 2012 close approachers observation opportunities as a function of their visual magnitude

present discovery rate dominated by small Earth approachers

V=21 is the typical magnitude limit for physical characterization from a 4m class telescope

V=18 is the typical magnitude limit for physical characterization from a 1m class telescope



HORIZON 2020

Call: PROTEC-2014
Topic: Access technologies and characterisation for Near Earth Objects (NEOs)
Proposal number: SEP-210130790
Proposal acronym: NEOShield-2

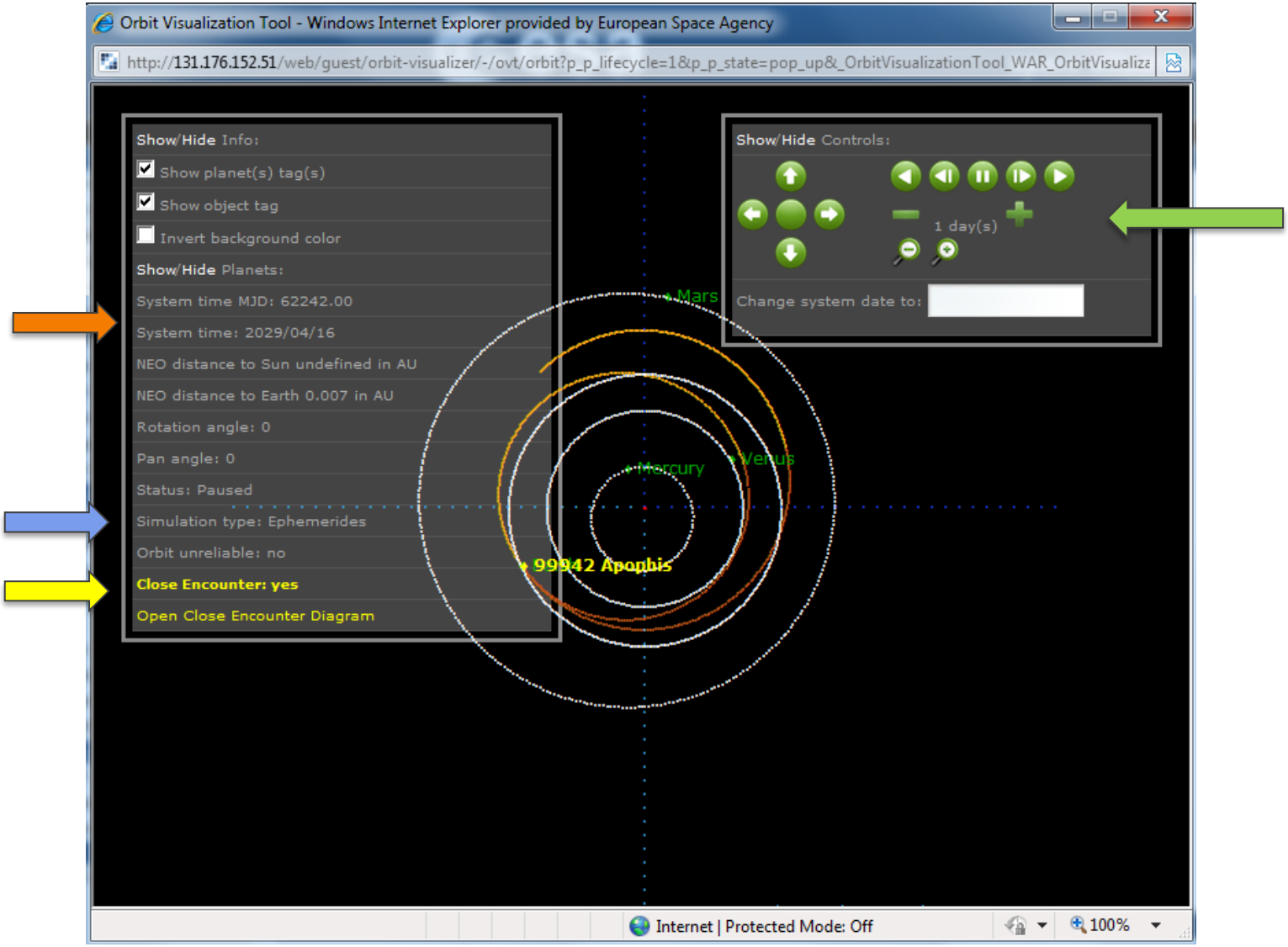
the possibility of pushing the limiting magnitude to 21 allows to encompass the vast majority of the 2012 Earth approachers population

need of a rapid response network for physical characterization

ORBIT VISUALIZATION TOOL

Apophis: heliocentric perturbed trajectory

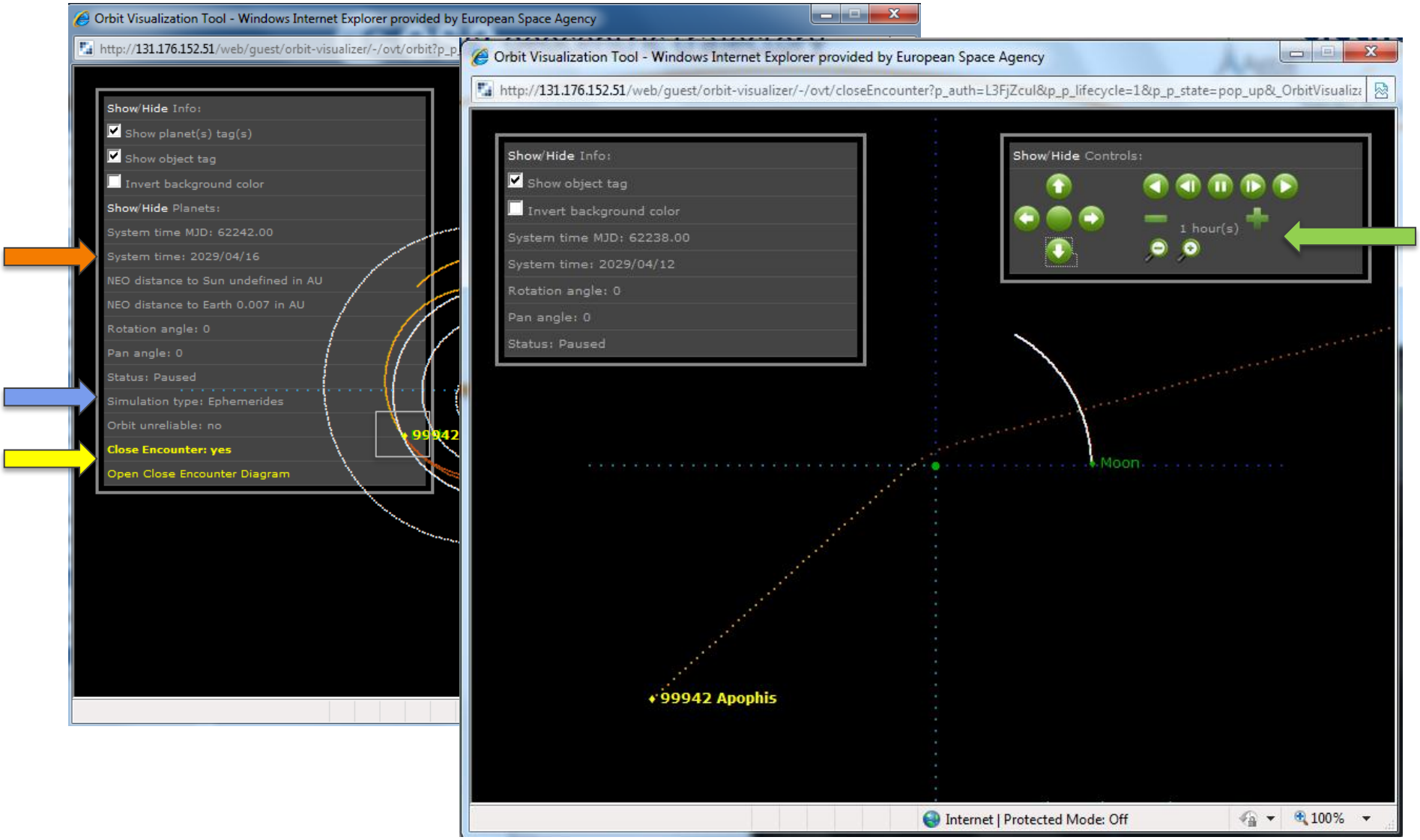
2029 Earth encounter



ORBIT VISUALIZATION TOOL

Apophis: geocentric perturbed trajectory

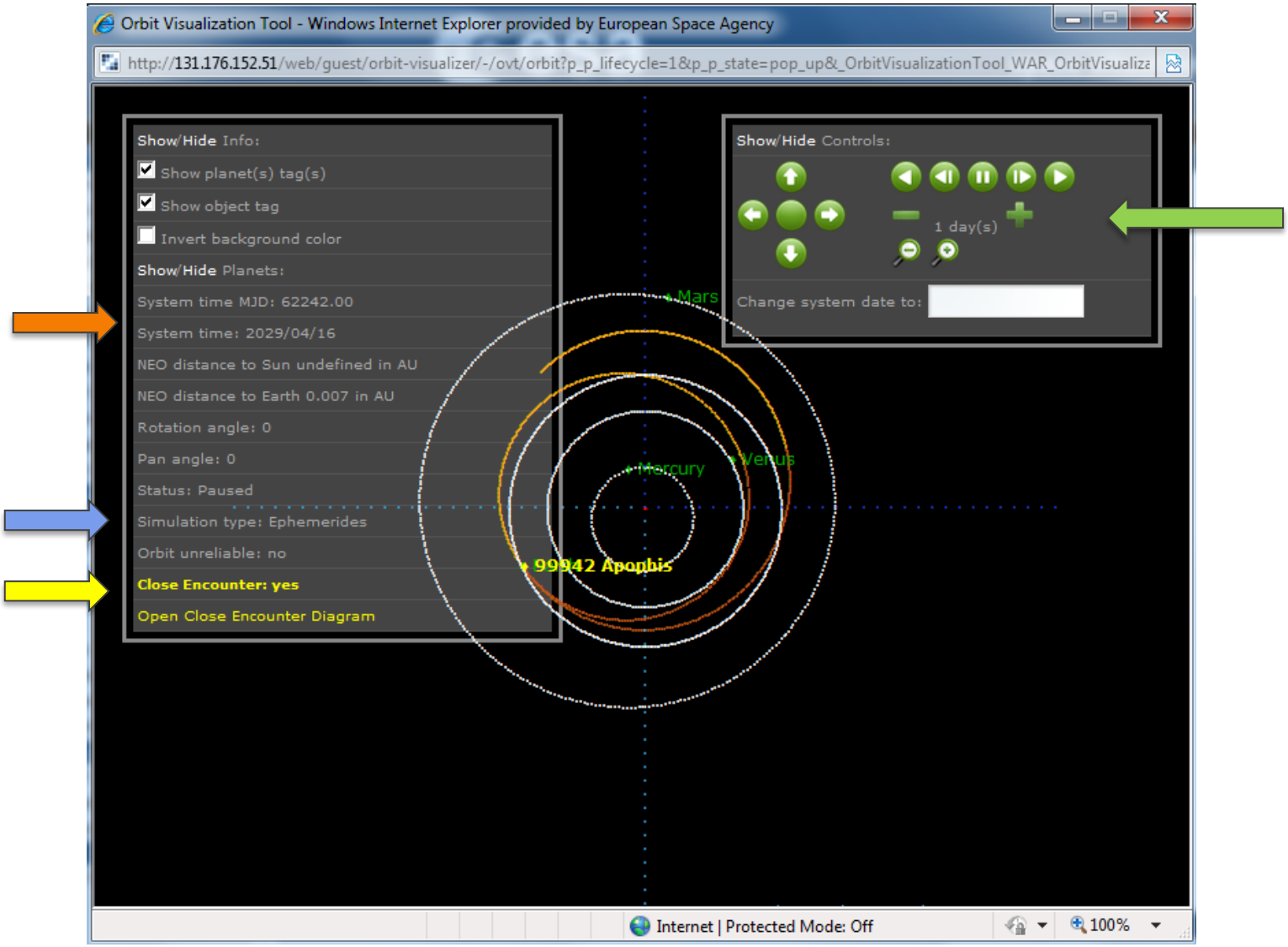
2029 Earth encounter



ORBIT VISUALIZATION TOOL

Apophis: heliocentric perturbed trajectory

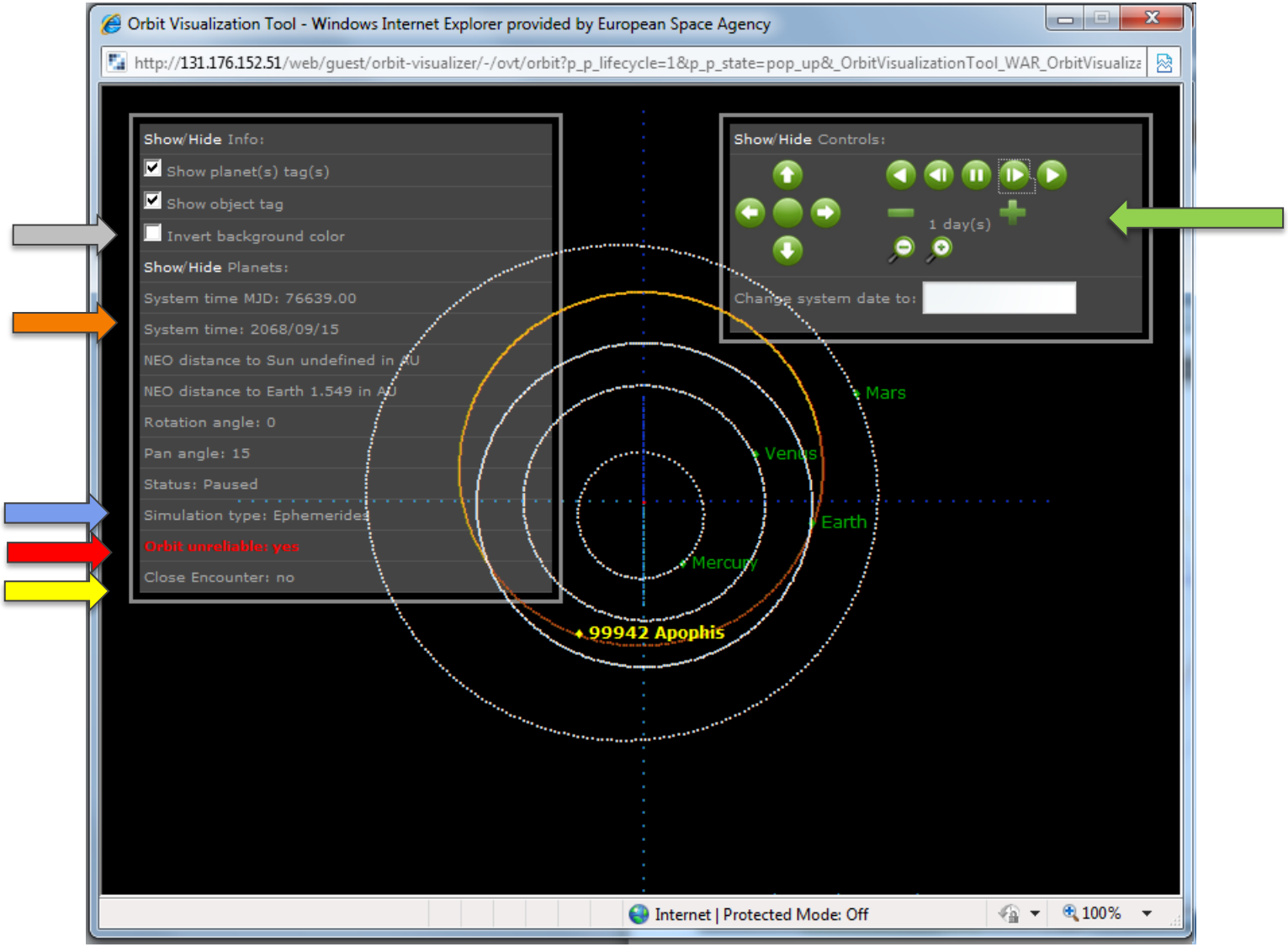
2029 Earth encounter



ORBIT VISUALIZATION TOOL

Apophis: heliocentric perturbed trajectory

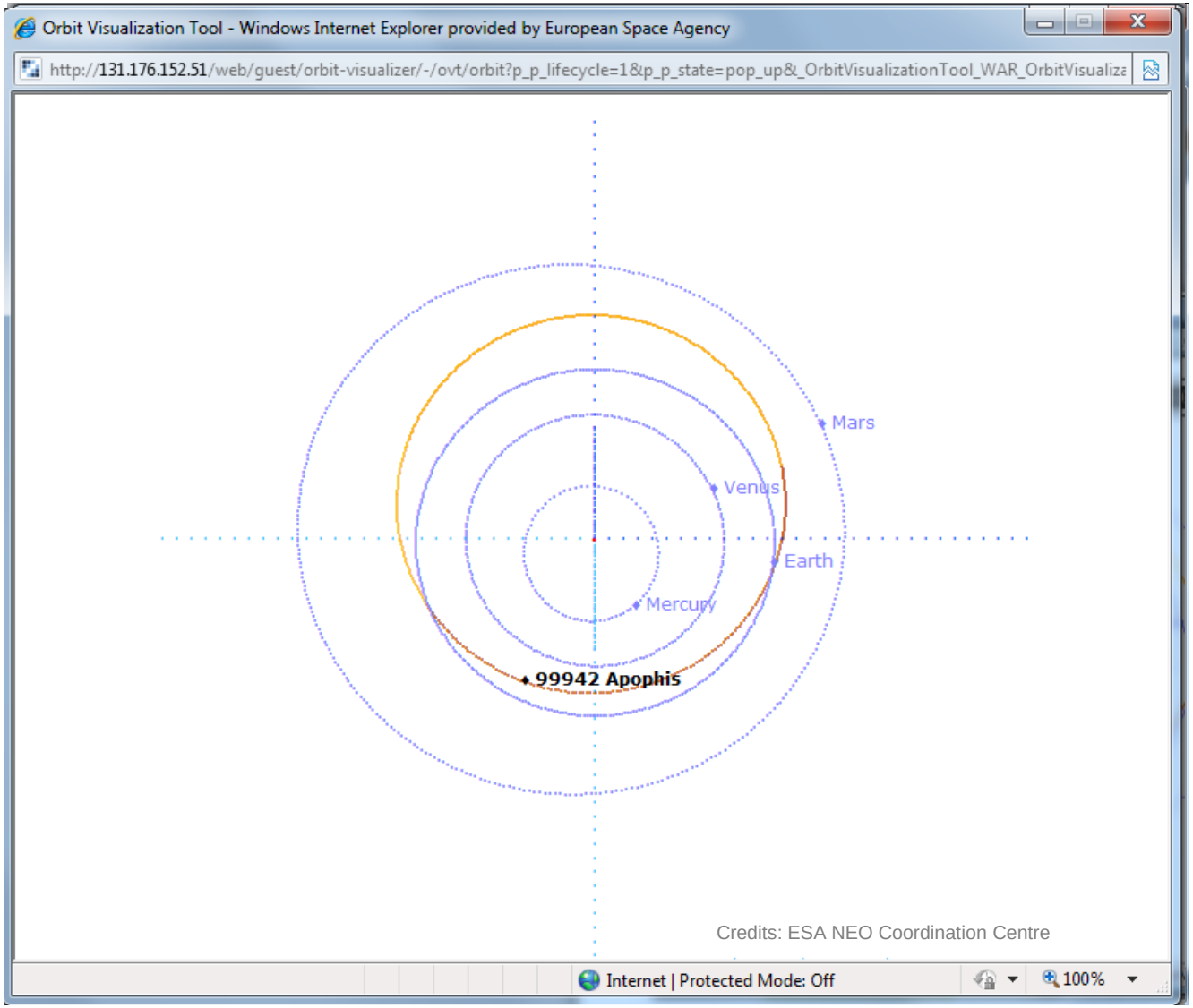
2068



ORBIT VISUALIZATION TOOL

Apophis: heliocentric perturbed trajectory

2068



OVERVIEW
NEOCC Context Diagram

NEOs

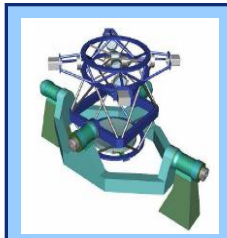
Minor Planet Center (US)

SSA tasking centre

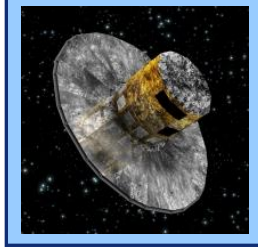
Political entities

Cooperating telescopes

SSA sensors



Space missions



SSA-NEO CC

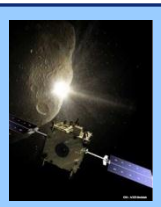
- Risk assessment
- Obs. Planning
- Phys. Properties
- Databases
- Light curves
- Shape models

Front Desk Operator

General users

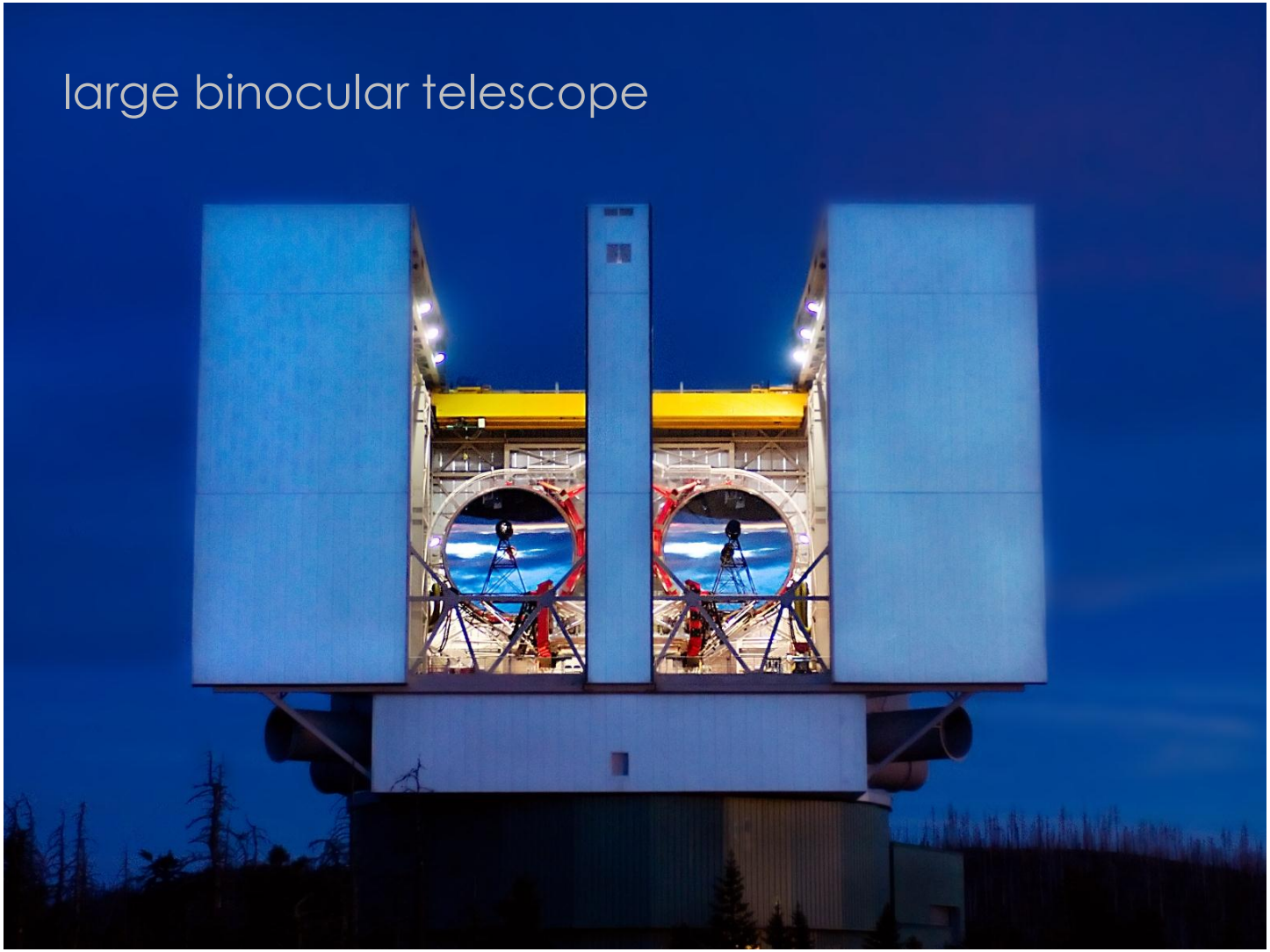
National research expertise

Space mission studies



COLLABORATING TELESCOPES
INAF

COLLABORATING TELESCOPES
INAF



NEOCC Priority List has been used as a Gaia simulator

Telescopes from Gaia-FUN-SSO observed 2002 GT providing photometric and astrometric measurements.

SN-V NEO Segment Precursor Service Operations

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ettore perozzi

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barbara borgia

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marco micheli

- CONCLUSIONS

ettore perozzi

- ACNOWLEDGMENTS

SSA-NEO Segment Precursor Services – SN-V

NEO SYSTEM

SpaceDyS

Barbara Borgia

Germano D'Abramo

deimos SPACE

Joaquim Oliveira

Esther Parrilla

Astos Solutions

Sven Weikert

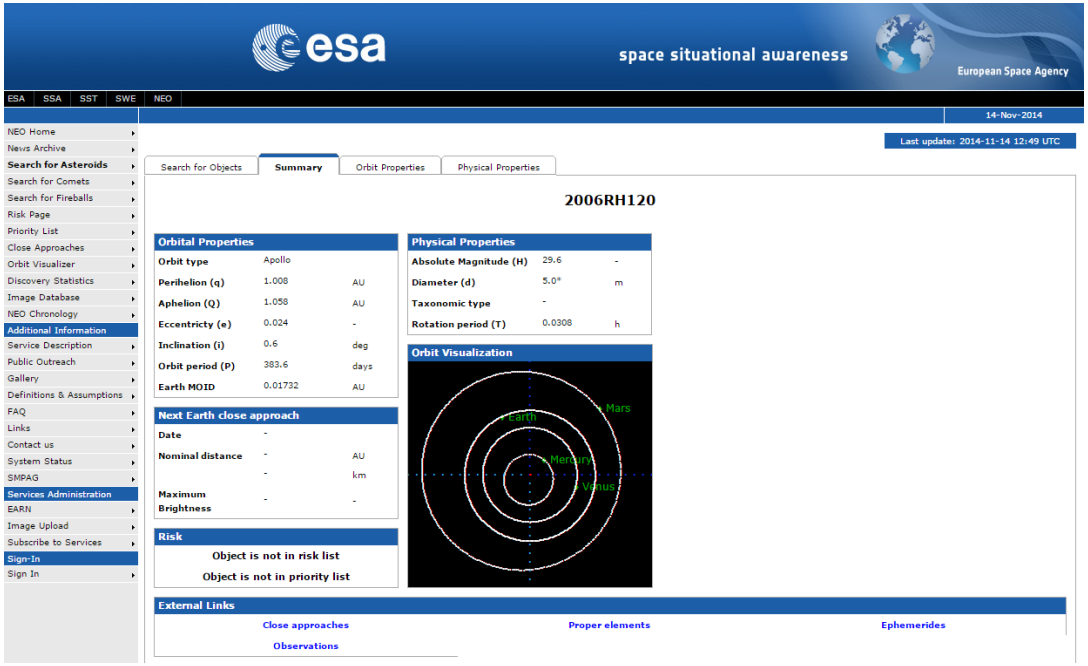
Raphael Schneider

Andrea Tesseri

serco

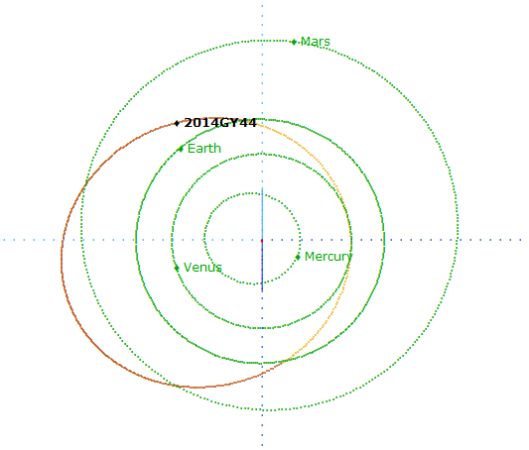
Marco Micheli

Fiammetta Cerreti



History: System Status before SN-V

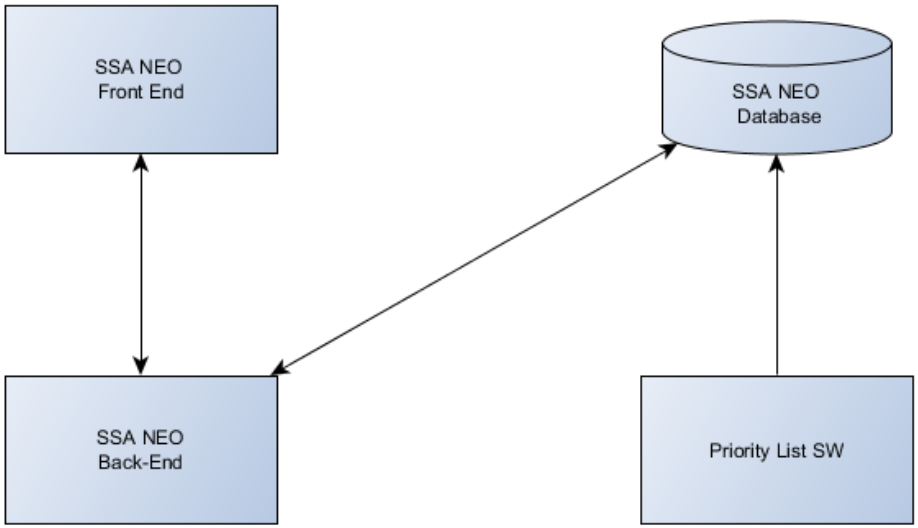
- Orbital data: orbital elements of asteroids in NEODyS and AstDyS
- Impact Monitoring: link to NEODyS impactor tables
- Physical Properties: physical properties from EARN
- Close approaches: date, distance, velocity etc
- Priority List: objects in need of observations
- Orbit Visualization Tool: unperturbed asteroid orbits



Where are we now? SN-V Improvements

- Hardware set-up
  DEV, TST, IRE, OPE
- Advanced algorithms implementation
  Max brightness, close encounter ephemerides computation
- Visualization improvements
  Geocentric OVT, discovery statistics, enhanced graphic layout, news archive, banner rearrangement, new static contents, IAU NEO Chronology
- Bug fixing
  Redmine testing management tool
  80 bugs closed → 20 from SN-III
- Operational procedures
  Failure and recovery procedures

SSA NEO Platforms: DEV, IRE, TST, OPE

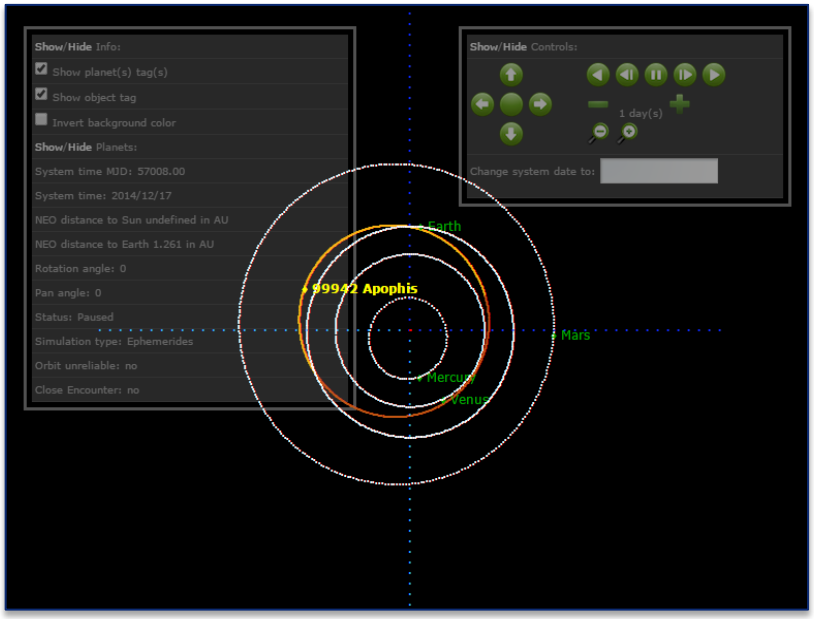


Development → Testing → Security tests → Operations

DEV TST IRE OPE

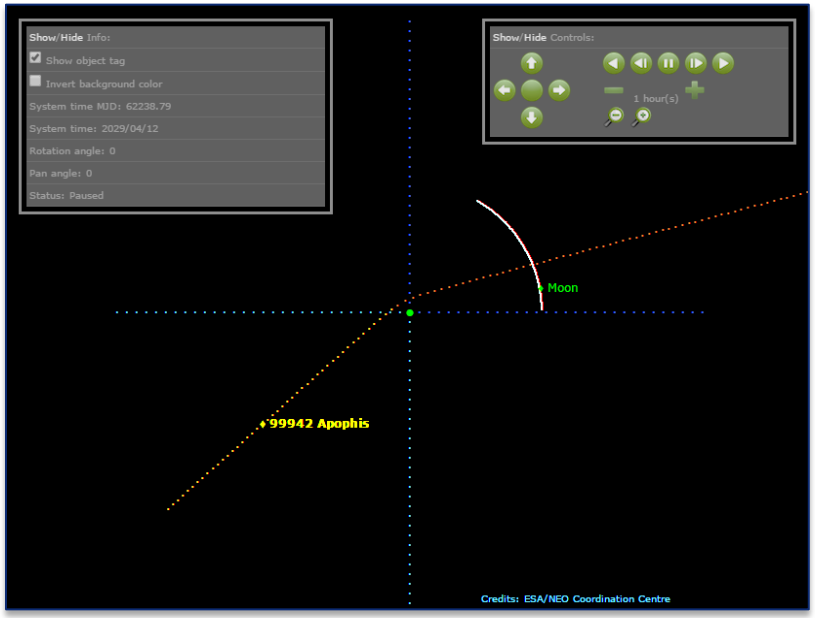
ORBIT VISUALIZATION TOOL
Objects outside close encounters

- Perturbed ephemerides pre-computed by NEODyS (steps of 1 day)
- Heliocentric system

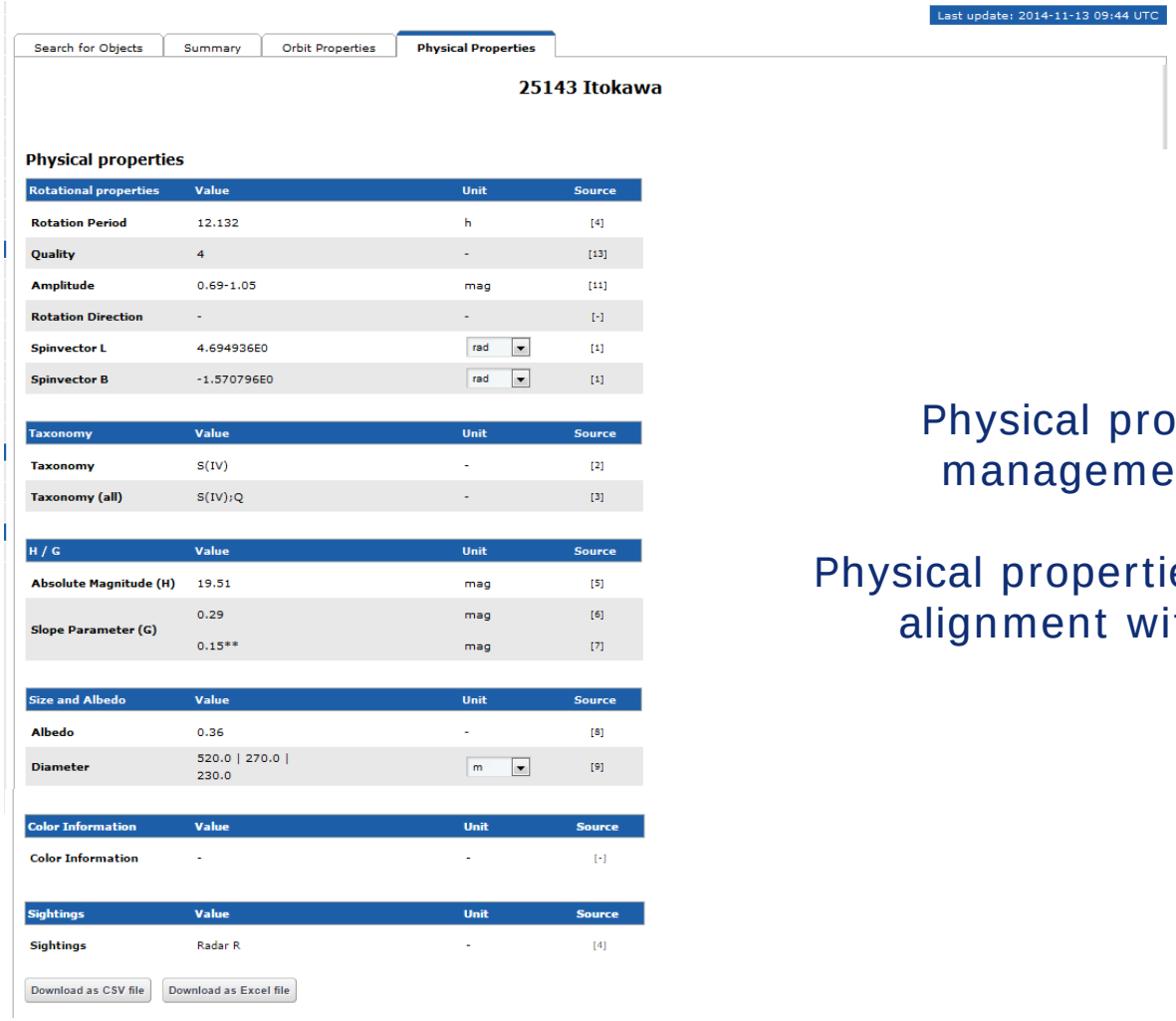


ORBIT VISUALIZATION TOOL
During a close encounter…

- Trajectory based on ephemerides pre-computed by NEODyS (steps of 1 hour)
- Perturbation from Earth and Moon is taken into account
- Geocentric reference frame



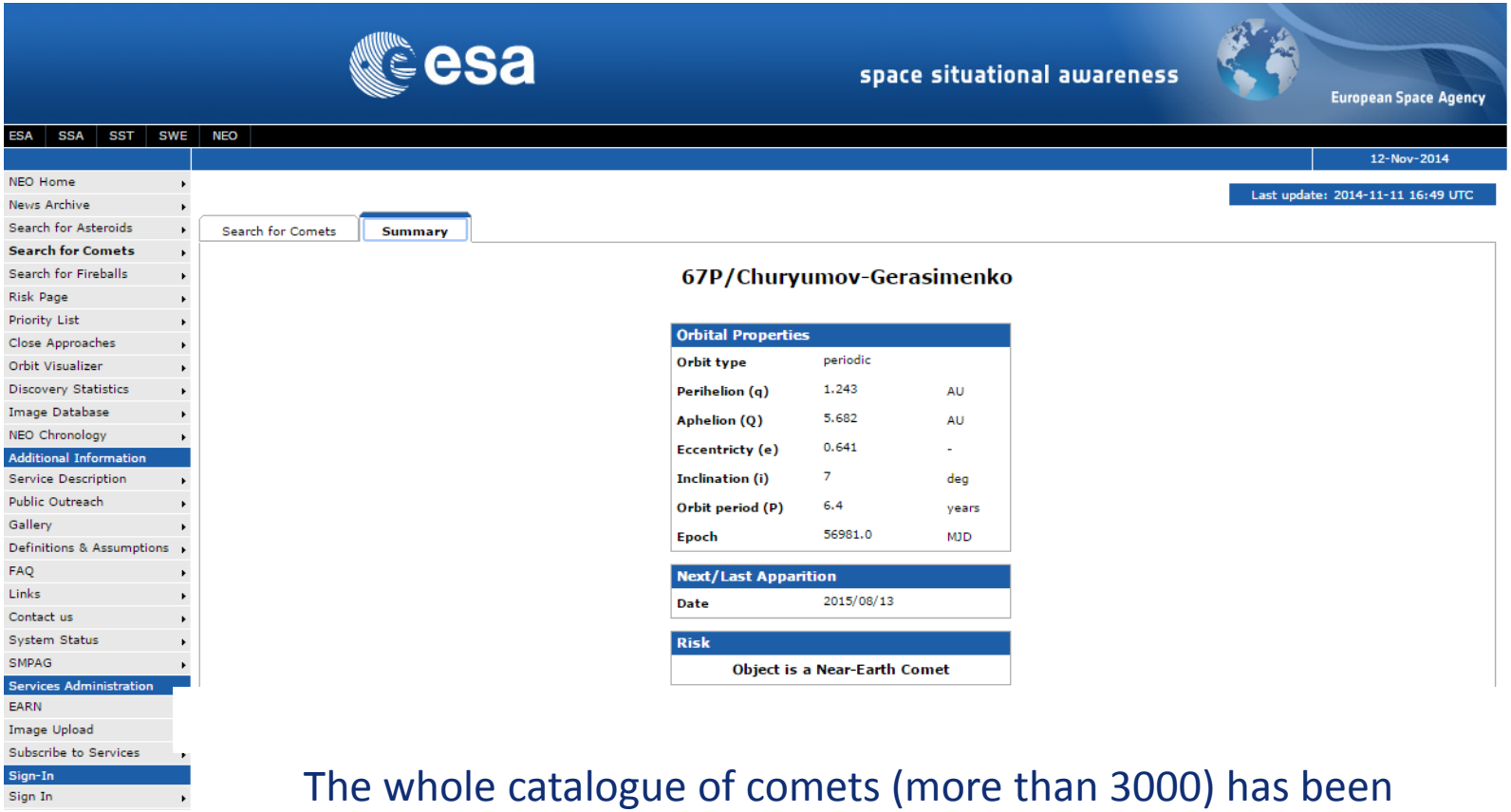
Physical properties upgrade



Physical properties management SW

Physical properties Database alignment with EARN

Comets Data



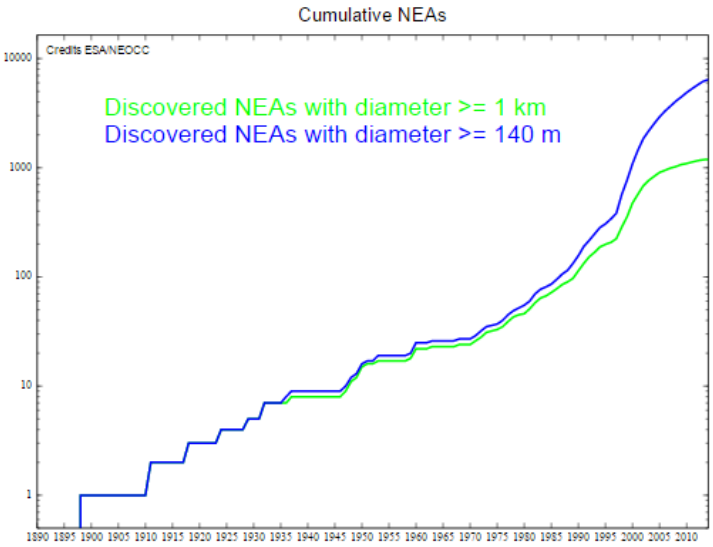
The whole catalogue of comets (more than 3000) has been imported from JPL and regularly updated

http://ssd.jpl.nasa.gov/dat/ELEMENTS.COMET

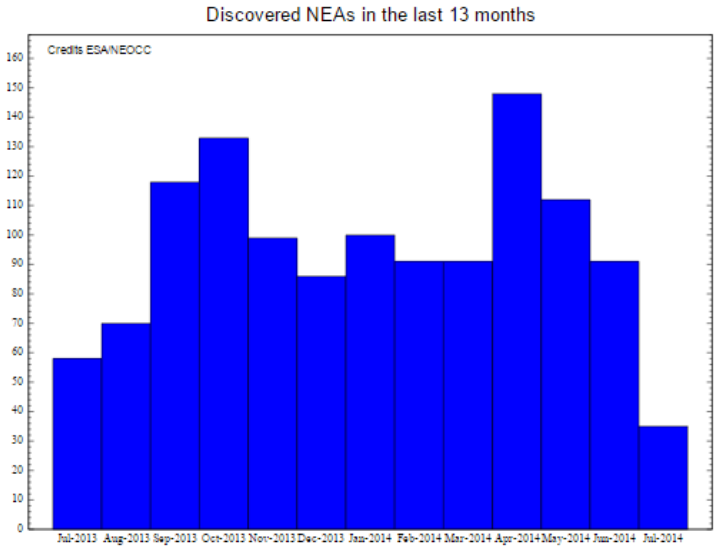
Discovery Statics: Real-time plots

Statistics of NEAs discoveries refreshed daily from MPC data

Cumulative plot #2



Seasonal plot



NEO Chronology page

esa — space situational awareness — European Space Agency

ESA | SSA | SST | SWE | NEO

13-Nov-2014

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- Search for Fireballs
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- Sign In

A Chronology of Milestones

1800 - 2200

7 October 2013 – version 41.0

Introduction

The following chronology lists

1. data of known NEAs with past nominal Earth close approach distances *d* < 1.0 LD;
2. data of known NEAs with future nominal Earth close approach distances *d* < 10.0 LD and minimum close approach distances *d* < 1.0 LD;
3. milestones of NEO/NEA research.

Information on categories *1)* and *2)* is quoted from the NASA JPL NEO Program Close Approach Tables for the period 1900 – 2200 A.D. as of 7 October 2013, available at neo.jpl.nasa.gov/ca/.

By listing in chronological order this broad selection of milestones on NEA research, an impression is offered of what has been done and what is being done in those fields.

For the meaning of the technical terms used, see here

Chronology: 1801 – 2880

1801, Jan 1	First and largest asteroid discovered, **1 Ceres** (*H* = 3.34 mag, *D* = 952 km, main-belt asteroid), by Giuseppe Piazzi (1746 – 1826, Italy) at the Osservatorio Astronomico di Palermo. Asteroid Cerere Ferdinandea was named in honour of King Ferdinand IV of Sicily, and later became known simply as Ceres. Carl Gauss developed the math to determine an accurate orbit for Ceres and published his results in November 1801. Given the definition of planets and dwarf planets accepted by the IAU XXVI General Assembly in 2006, Ceres is considered a dwarf planet rather than an asteroid. See: <1Ceres>. Ref: - G. Piazzi, 1802, Della scoperta del nuovo planeta Cerere Ferdinandea (Palermo: Nella Stamperia Reale). See also: <en.wikipedia.org/wiki/Ceres_(dwarf_planet)>, <www.space.com/12969-giant-asteroid-ceres-telescopes-skywatching.html>.
1803, Apr 26	**L'Aigle Meteorite.** In the early afternoon of 26 April 1803 a meteorite shower of more than 3000 fragments fell upon the town of L'Aigle (Normandy, France). See: <en.wikipedia.org/wiki/L'Aigle_(meteorite)>.
1807, Dec 14	**Weston Meteorite.** At 6:30 on the morning of 14 December 1807, a blazing fireball about two-thirds the size of the Moon was seen traveling southwards by early risers in Vermont and Massachusetts (USA). Three loud explosions were heard over the town of Weston in Fairfield County, Connecticut. Stone fragments fell in at least 6 places. See: <peabody.yale.edu/collections/meteorites-and-planetary-science/weston-meteorite>, <en.wikipedia.org/wiki/Weston_meteorite>.
1840, Jun 12	**Uden Meteorite** (Netherlands). A 600 g meteorite was found. See: <www.dwc.knaw.nl/DL/publications/PU00015500.pdf>, <www.sterrenkunde.nl/index/encyclopedie/meteoren.html>.
1843, Jun 2	**Blauwkapel Meteorite** (Netherlands). Two pieces were found, of 2.7 and 7 kg. See: <www.dwc.knaw.nl/DL/publications/PU00015500.pdf>, <www.sterrenkunde.nl/index/encyclopedie/meteoren.html>.
1859, Nov 15	**New York City Fireball and Airburst** (USA). See: <www.meteoritehistory.info/AJS/S2V1EWS/V30P186.HTM>, <en.wikipedia.org/wiki/List_of_meteor_air_bursts>.
1860, Jul 20	The **Meteor Procession** of 20 July 1860, visible from the Great Lakes to New York State (USA), continuing out over the Atlantic Ocean. Ref: - Walt Whitman, 1859-1860, in *Leaves of Grass*, "Year of Meteors."; - A.G. Pope, 5-1-2010, *Astronomical dating of Edvard Munch's summer sky paintings*, University Honors Program, Texas State University; - R. Sinnott, 2010, *Sky & Telescope*, 7 June 2010, "Walt Whitman's "Meteor-Procession"."

NEOCC now hosts the NEO Chronology page of the IAU (International Astronomical Union)
http://www.iau.org/

NEOCC communication activities

Regular News release on the SSA NEO Web Portal, News Archive, MPML postings

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12-Nov-2014

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NEO Coordination Centre

Precursor services

Please note that all SSA-NEO Services are under development

Current number of known NEAs: **11609**

Current number of NEAs in risk list: **460**

Last update: 2014-11-12 08:12:00 UTC

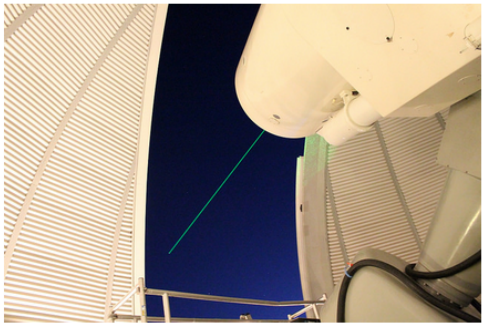
News

Print

Focus on: ESA OGS

30 October 2014

The ESA Optical Ground Station has quickly become a major asset for the NEO Coordination Centre, thanks to the many nights devoted to observing asteroids. It is located at an altitude of 2400 m on the slope of a volcano, in Tenerife, hosted at the Observatorio del Teide - Instituto the Astrofisica de Canarias. The telescope has been originally committed to advanced optical communication experiments on board the ESA geostationary satellite Artemis, and it is therefore equipped with a state-of -the-art laser equipment, still operational. During the SSA social media event on 7 October a spectacular transit of the International Space Station had been organised: a laser link with the ISS was established while the telescope provided incredibly clear images of the Space Station as shown in the *image below* (http://www.iac.es/divulgacion.php?op1=16&id=891, https://www.flickr.com/photos/esa_events/sets/72157648061826537/).



Once the Artemis mission was over, OGS became available for supporting other programs. The Space Debris office of ESA installed a focal reducer and a wide-field CCD camera for observing space debris and satellites. In the meantime, the telescope has turned out extremely useful for fulfilling the ESA Space Situational Awareness observing needs. Over the past few years the SSA-NEO programme has been allocated approximately four nights per month, around new moon, entirely dedicated to asteroid observations. These observations are managed by the NEOCC. As can be seen from the image, laser communication is still part of the activities at the OGS.

The main focus of these activities is to collect follow-up observations of NEOs. A significant fraction of the targets are the so-called "NEOCP objects", recently discovered asteroids whose preliminary ephemerides are posted by the IAU Minor Planet Center on the NEO Confirmation Page (http://www.minorplanetcenter.net/iau/NEO/toconfirm_tabular.html). In most cases these recent discoveries have been observed only for a very short amount of time and it is therefore impossible to determine their orbits and carefully assess if they are indeed dangerous NEOs. In most cases, this same lack of knowledge results in very large positional uncertainties in the sky, thus requiring a telescope with a large field of view to be certain that the object is going to be visible in the image. The OGS, with its 47 arcminutes square field, is ideal for these searches; over the last year, about a dozen candidates per night were successfully targeted and approximately half of them were confirmed to be NEOs thanks to our observations.

The second main focus of follow-up activities is guided by the Priority List published on the NEOCC website. At any given time, the list highlights about a dozen objects in urgent need of observations, plus many lower priority ones. We therefore try to observe as many of them as possible down to at least a visual magnitude of 22, which is the practical limit of the instrument. This activity is essential in order to prevent most of these targets from being lost because of a

TESTING

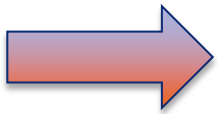
Compliance against requirements: SN-III + new functionalities

System level testing

Iterative→ set of processes at system level
Recursive→ successive levels of system

Verification performed on the TST platform (FAT)

Validation on the OPE platform (OSAT)



Verification Methods

- Inspection
- Analysis
- Demonstration
- Test
- Review

Operational Procedures in case of system failure

STUDY CASE

ISSUE: Number of NEOs not updated, Search unavailable

FDOs: New bodies present in the DB but not on-line (TST and then OPE)

ICT: MySQL and server logs analysis→ system restart is necessary

ESA: authorization to restart the TST and OPE systems

SSA NEO TEAM: System functionality back to normal

Enhanced portal ready for future entries

SN-III

- **NEO Home**
- Risk Page
- Search for Objects
- Priority List
- Close Approaches
- Orbit Visualizer
- Physical Properties
- Comets
- Discovery Statistics
- Image Database
- Fireball Database
- **Additional Information**
- Service Description
- Public Outreach
- Gallery
- Definitions & Assumptions
- FAQ
- Links
- Contact us
- System Status
- **Services Administration**
- EARN
- Image Upload
- Subscribe to Services
- SMPAG

SN-V

- NEO Home
- News Archive
- Search for Asteroids
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- **Sign-In**
- Sign In

Fireball database

Population model

openAM authentication

SN-V NEO Segment Precursor Service Operations

- OVERVIEW

ettore perozzi

- NEO SYSTEM

barbara borgia

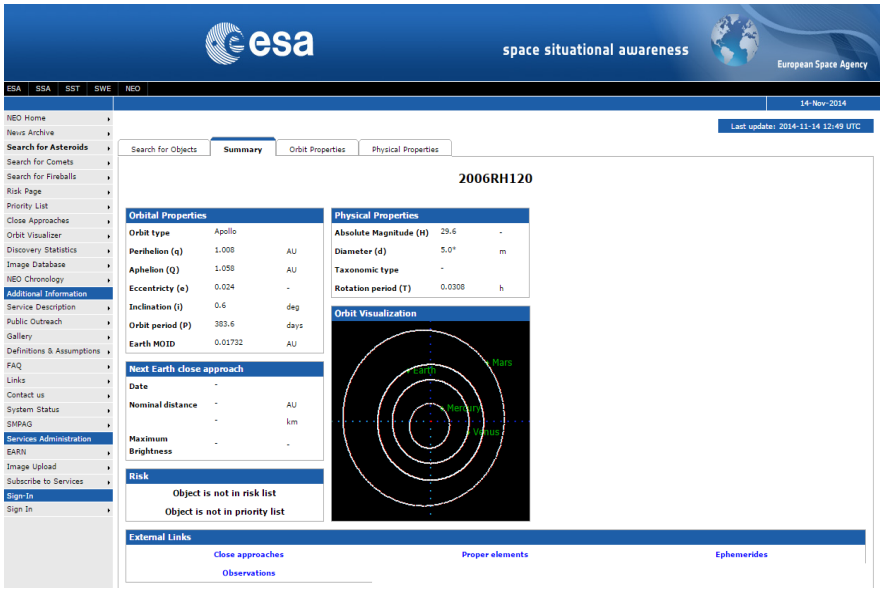
- OBSERVING CAMPAIGNS

marco micheli

- CONCLUSIONS

ettore perozzi

- ACNOWLEDGMENTS



SSA-NEO Segment Precursor Services - SNV

Observing Campaigns

Marco Micheli

Detlef Koschny

Fabrizio Bernardi

~ 11 600 known NEOs

…of which…

~ 460 (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

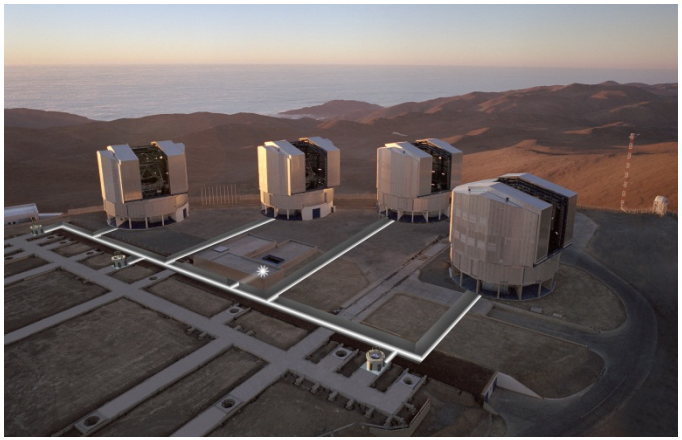
There are basically three ways to deal with this problem:

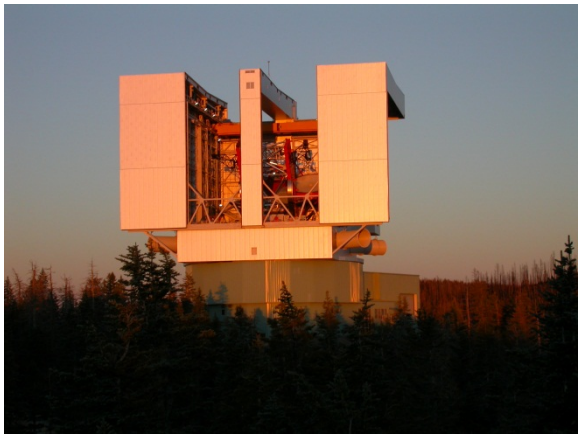
- Extend the observed arc at the discovery apparition
- Attempt wide-field recoveries at the next apparition
- Try to locate precovery observations in existing archives

These goals can be achieved using:

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

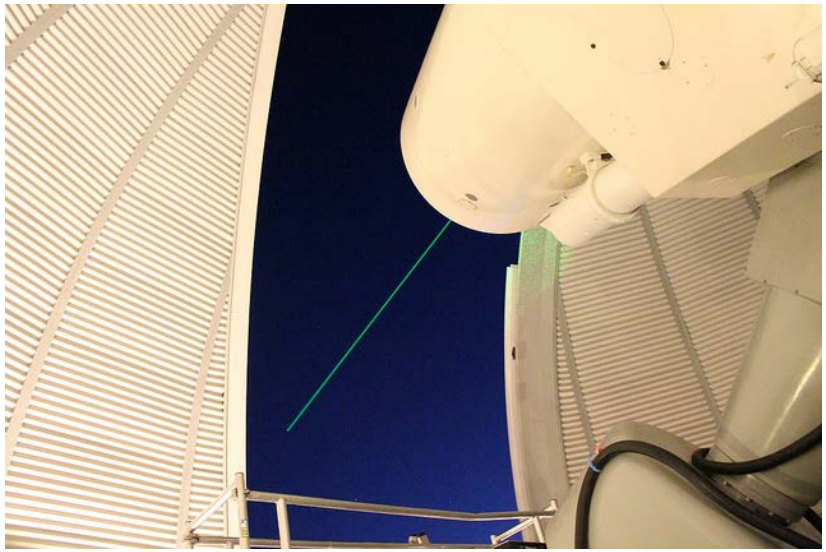
The observational network





Plus many other European and International collaborations…

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

Follow-up activities

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

In 2014 we have:

Almost 200 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 %

1-2 NEO or comet recoveries per month

TOTAS survey

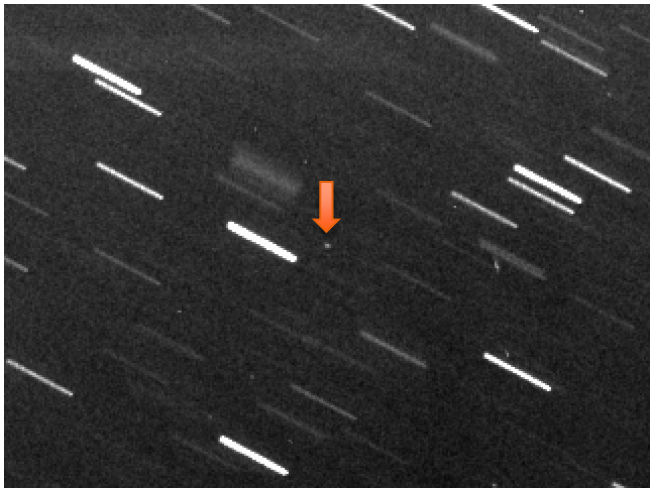
We perform ~2 hours of survey per night, coordinated by Matthias Busch

In 2014 we have:

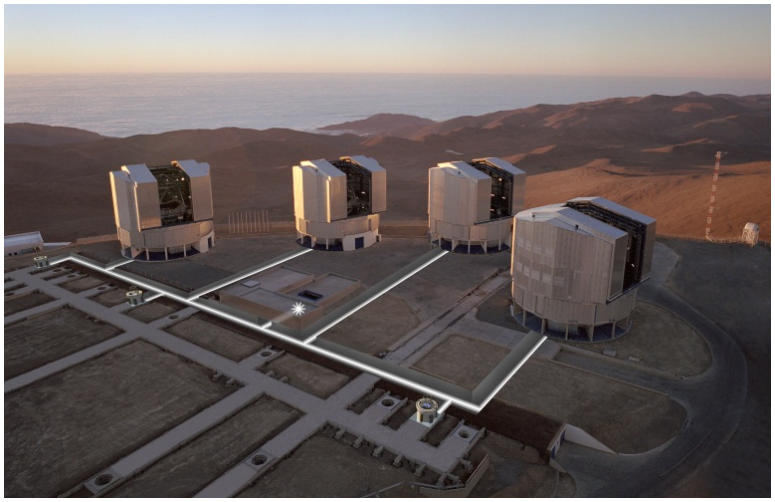
Discovered 5 NEOs (10th most successful discovery station in 2014)

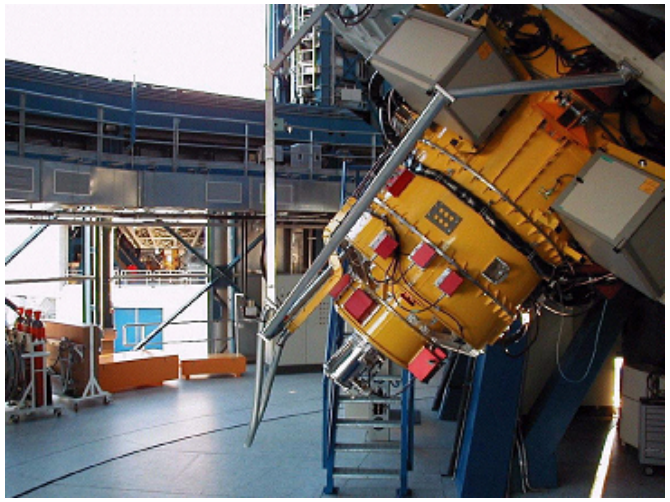
1 current VI discovery: 2014 QN266

1 comet discovered in 2014: P/2014 C1 (TOTAS)



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 Virtual Impactors, thanks to an agreement with ESO

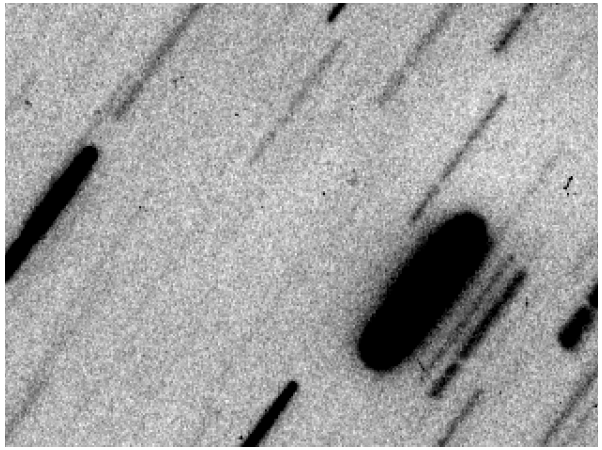
Follow-up

2014 AF16, a dangerous case

- Getting fainter fast, unobservable until the time of impact!
- Observed in March 2014, V=25, ~5° from the galactic center!
- Thanks to these observations, the 2026 VI was removed

2014 GY44, one of the faintest

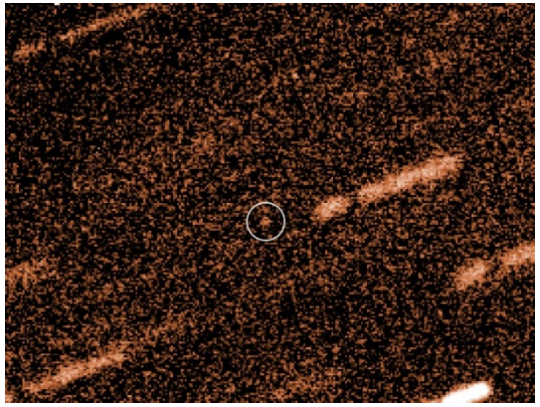
- Very faint object, lost if not reobserved
- IP went up, but now recoverable



Recoveries

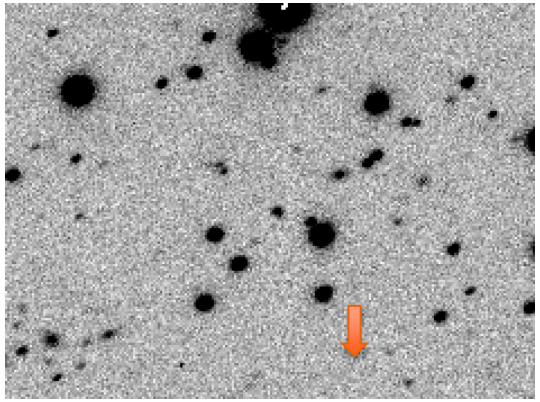
2009 FD, the most dangerous NEO

- We recovered it in November 2013,
- Very faint (V=25.5) and close to the Sun
- The impact probability went up! (1/400)



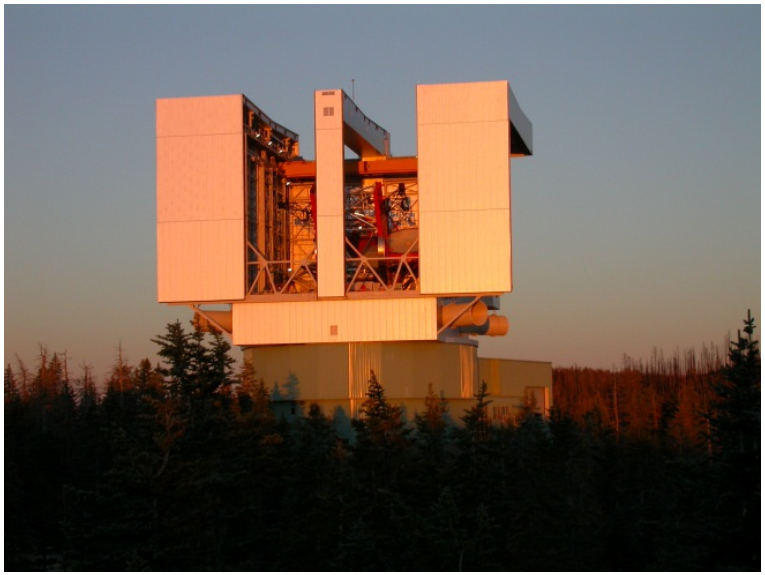
2012 HP13, a faint recovery

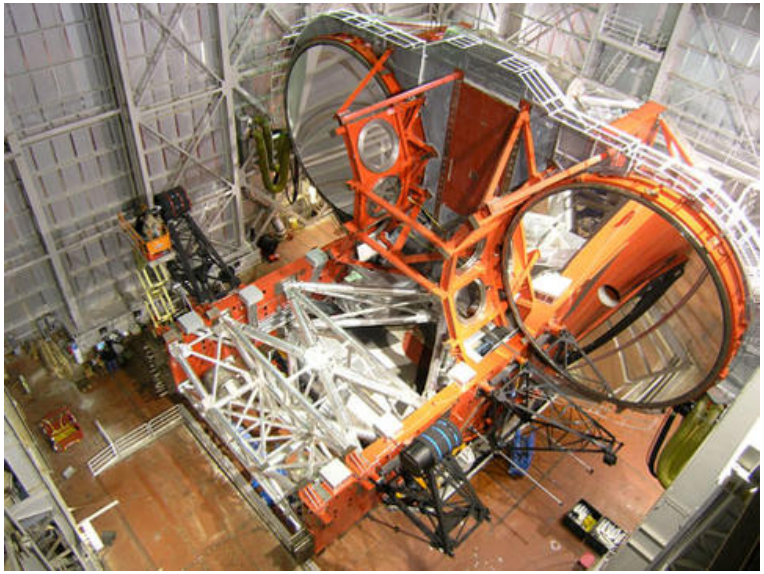
- Observed for only 5 days in 2012
- Recovered at V=24 in 2014
- Published on MPEC 2014-J53
- All impact solutions were removed



(NOT the one near the center!)

Large Binocular Telescope (LBT)

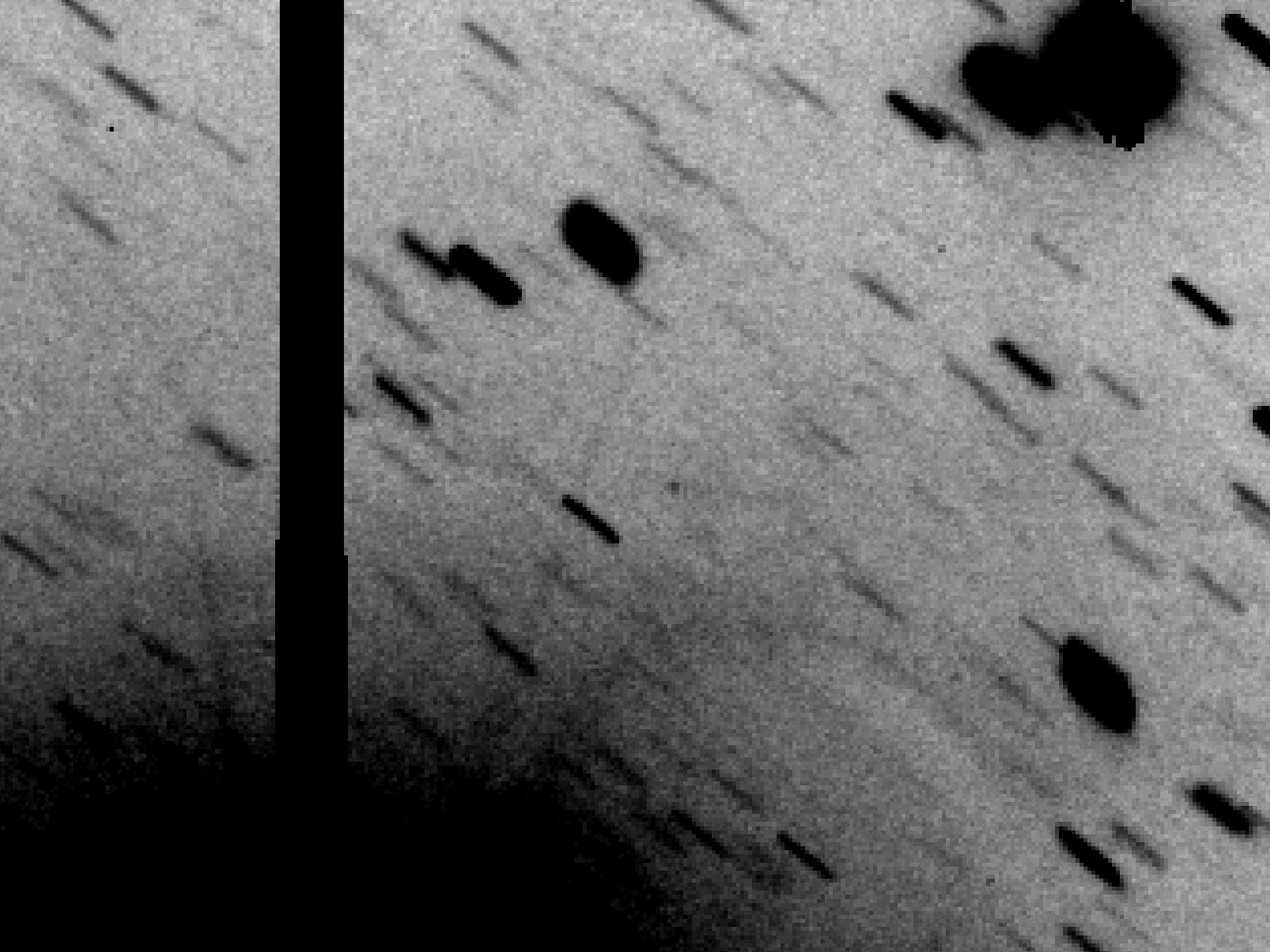




Two twin comounted 8.4 meter telescopes

Two wide field cameras, 27 arcminutes field, different sensitivities

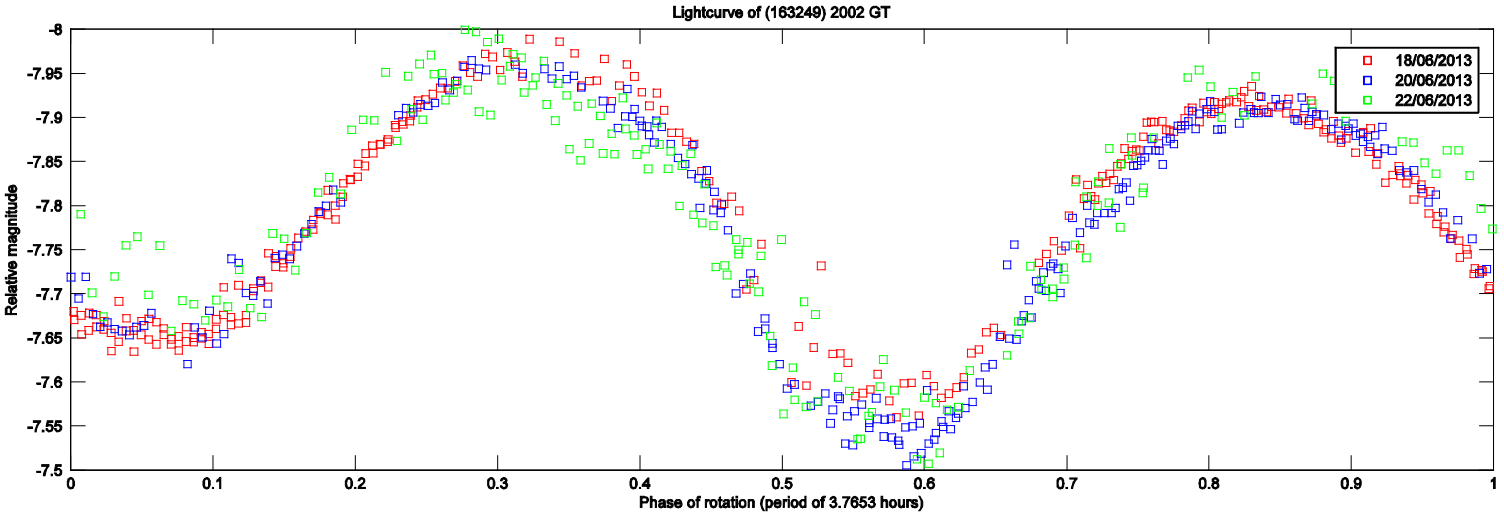
We are developing an agreement with the Italian partnership (INAF) for DDT time



Collaborations started during SN-V

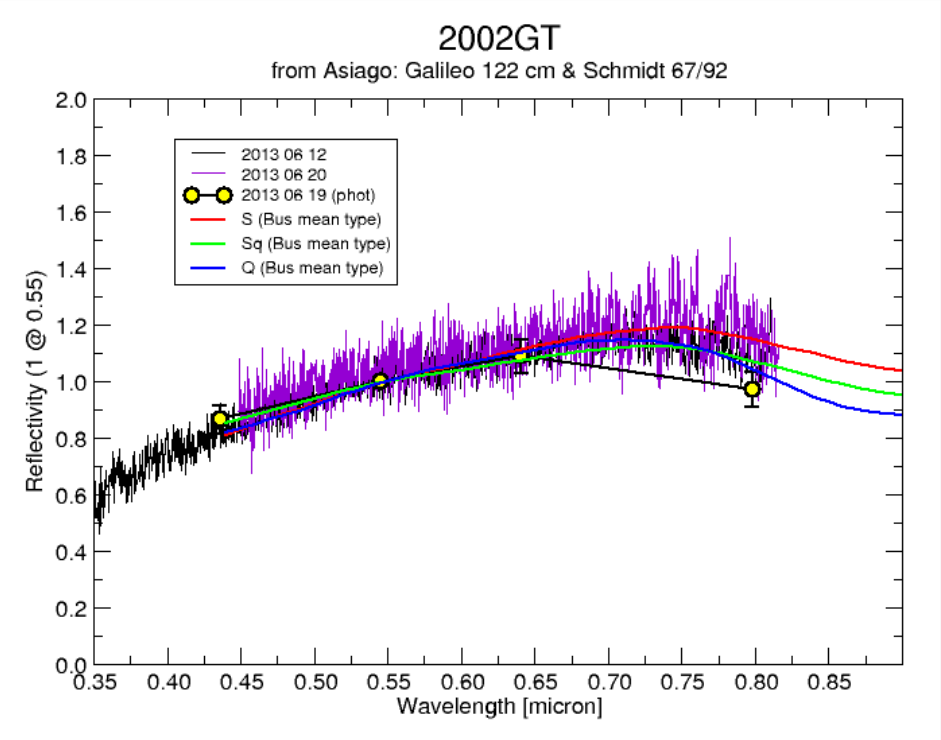
- Campo Imperatore, Italy
- Asiago Observatory, Italy
- Mauna Kea Observatories, Hawaii, USA
- Observatoire de la Cote d'Azur, France
- EURONEAR network
- GAIA FUN-SSO network
- LCOGT network
- La Sagra Observatory, Spain (SLA)
- …and many others

EPOXI target 2002 GT

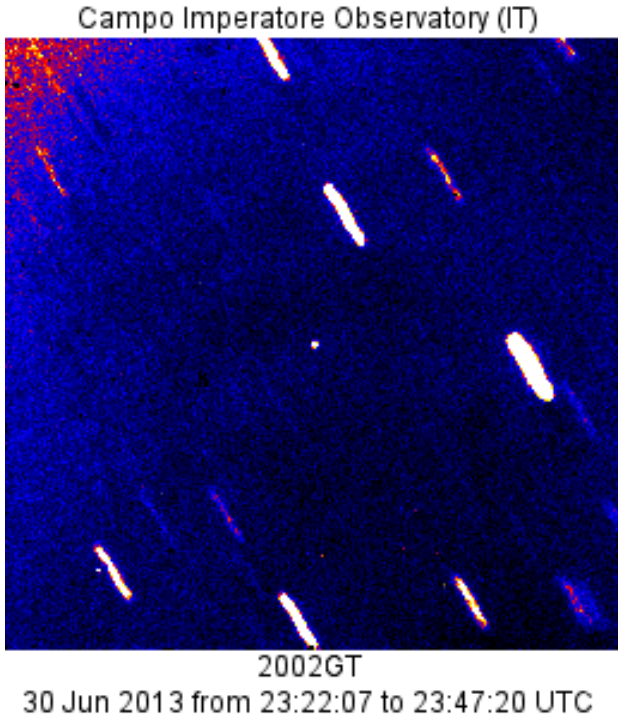


Photometry and light-curve data from the 1 meter diameter C2PU telescope at the Observatoire de la Cote d'Azur allowed determination of the rotation period (3.77 hours).

EPOXI target 2002 GT

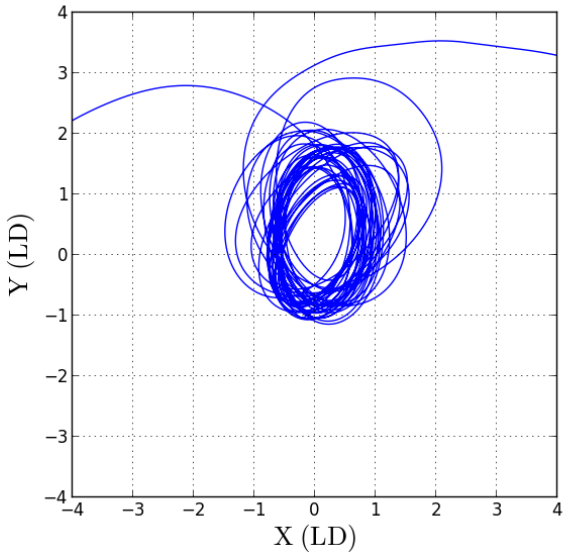


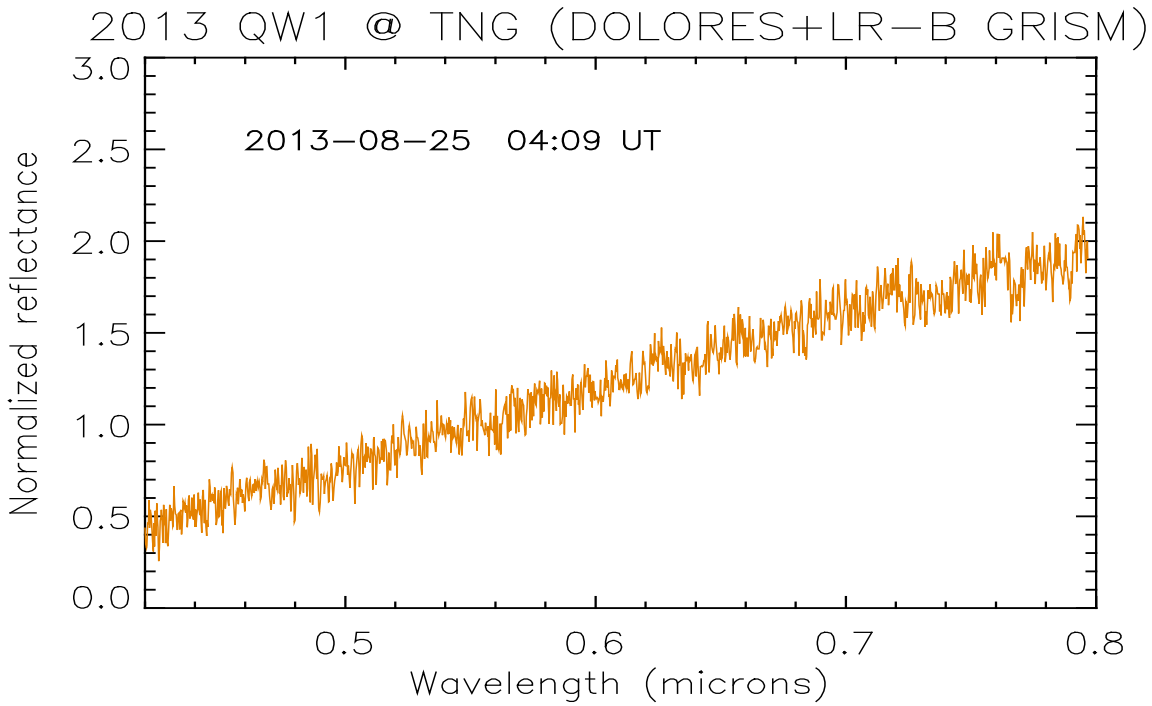
Spectra from Asiago Observatory (University of Padova and Observatory of Padova) allowed determination of the asteroid type (Sq)



Infrared observations from the Campo Imperatore Station of the INAF OAR

2013 QW1: Natural or artificial?





The outcome does not resemble an asteroid spectrum, and provided evidence of the artificial nature of 2013 QW1.

Now identified with 2010-050B.

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

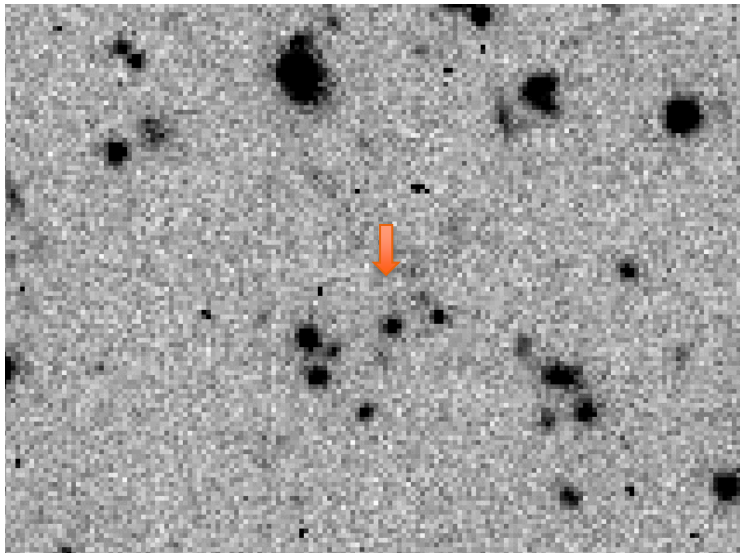
We need a tool to locate moving objects in these data:

- 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 lost
- We found precovery images in CFHT
- One month before (arc extension)
- The impactor was removed



2014 BB33, a Main Belt asteroid “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

One year of objects removed from the Risk List

Object	Date	PS_0	Telescope	Instrument	Archive
2007 UW1	2013-11-28	-3.4	CFHT	MegaCam	-
2013 XE2	2013-12-10	-4.0	PS1	GPC	PS1
2008 CK70	2013-12-18	-3.1	CFHT	MegaCam	CADC
2013 BP73	2013-12-20	-3.8	SDSS	SDSS	CADC
2013 YC	2014-01-22	-2.9	VLT (UT1)	FORS2	-
2014 BD33	2014-01-29	-4.2	PS1	GPC	PS1
2004 BX159	2014-02-18	-4.5	CFHT	MegaCam	CADC
2014 AF16	2014-03-11	-2.4	VLT (UT1)	FORS2	-
2012 HP13	2014-04-09	-6.6	VLT (UT1)	FORS2	-
2014 DN112	2014-05-01	-3.6	VLT (UT1)	FORS2	-
2014 HM129	2014-05-22	-4.2	VLT (UT1)	FORS2	-
2014 HM187	2014-05-28	-4.5	VLT (UT1)	FORS2	-
2012 VU76	2014-06-09	-6.1	VLT (UT1)	FORS2	-
2013 YD48	2014-06-30	-4.8	VLT (UT1)	FORS2	-
2014 LU27	2014-07-17	-2.4	PS1	GPC	PS1
2014 PB58	2014-08-12	-4.5	PS1	GPC	PS1
2014 QF392	2014-08-14	-8.0	PS1	GPC	PS1
2014 QJ392	2014-08-14	-6.1	PS1	GPC	PS1
2014 RC	2014-09-04	-7.0	PS1	GPC	PS1
2014 KC46	2014-10-30	-4.1	LBT	LBC	-

20 objects
in less than one year

and counting…

SN-V NEO Segment Precursor Service Operations

- OVERVIEW

ettore perozzi

- NEO SYSTEM

barbara borgia

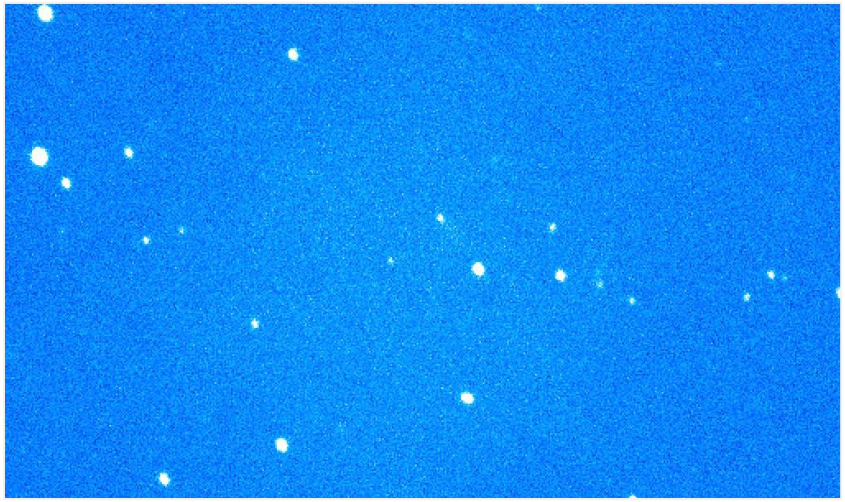
- OBSERVING CAMPAIGNS

marco micheli

- CONCLUSIONS

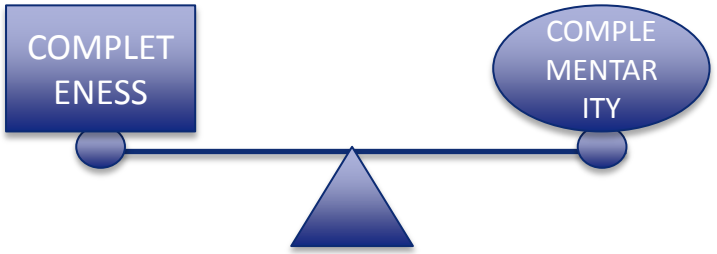
ettore perozzi

- ACNOWLEDGMENTS



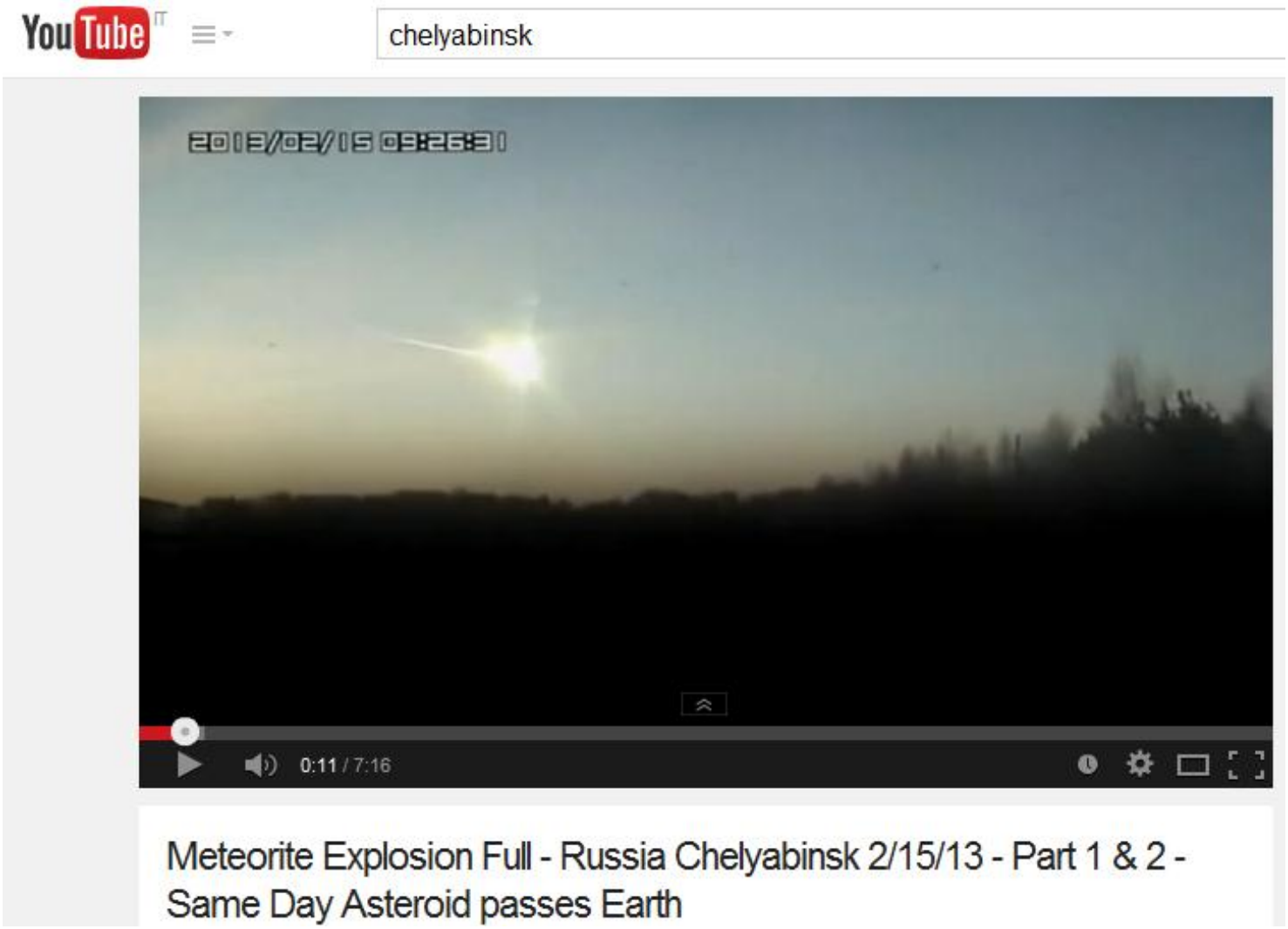
CONCLUSIONS
Precursor Service Operation achievements

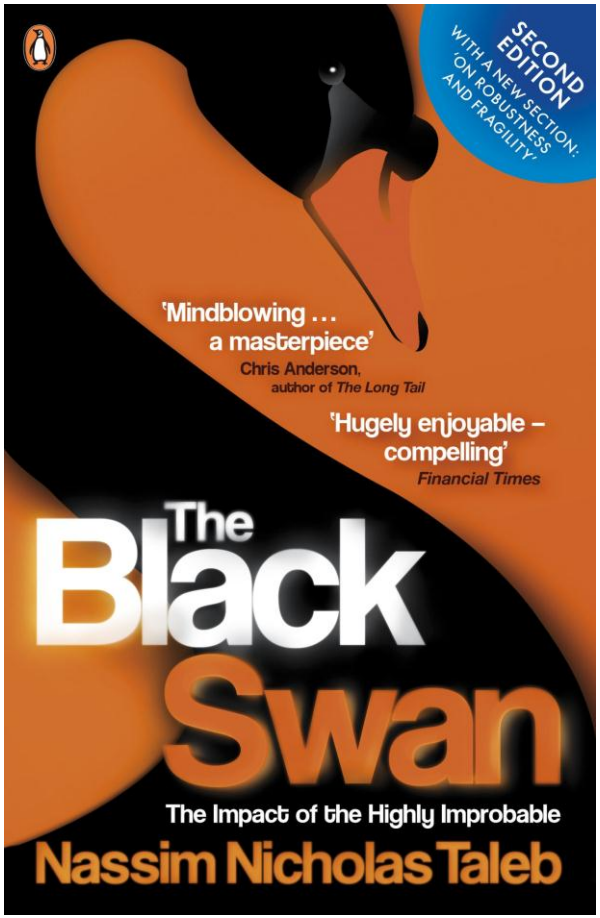
- Carry out NEO Segment Precursor Service Operations
  - regular news posting
  - Chelyabinsk event coverage
  - operational concept and procedures definition
  - Reassessment of the documentation: release 1.0 in esa format
  - Project management, engineerning coordination and team building
- Maintain and improve the NEO System web portal and database
  - OVT extended to pertutbed orbits and geocentric frame
  - Maximum brightness at close approach
  - Dynamically updated discovery statistics
  - IAU NEO Chronology page migration
  - Catalogue of Cometary orbits
  - OpenAM authentication
  - Enhanced web portal layout
  - System Installation package



- Contribute to NEO observations
  - ESA OGS (Tenerife)
  - INAF (Asiago, Campo Imperatore, TNG, LBT)
  - ESO VLT (Chile)
  - Gaia FUN-SSO
- Establish the NEO Coordination Centre as an authoritative entity
  - MPML posting
  - JPL NEO Program interface
  - EU connection through NEOShield-2 (H2020) and Stardust (Marie Curie)
  - PDC 2015 organization
  - Scientific publications, presentations, press releases
  - Education and Public Outreach
  - **Risk Communication**

CONCLUSIONS
Risk Communication





THE EXPERTS PROBLEM

THEY DO NOT KNOW

WHAT THEY DO NOT KNOW

THE NEO EXPERTS PROBLEM

THEY DO NOT KNOW

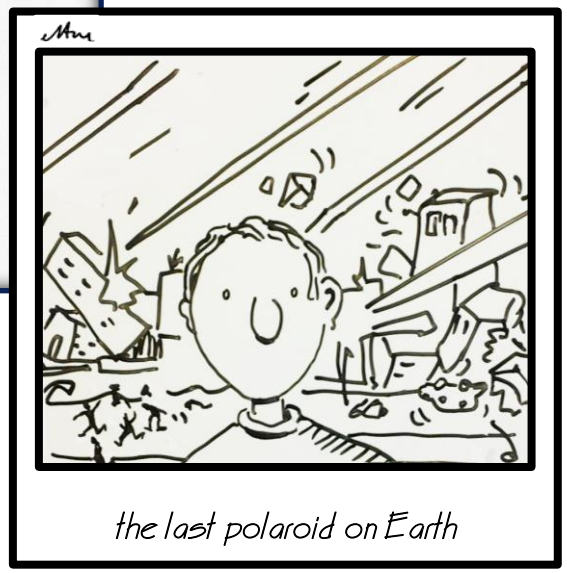
HOW TO SAY

WHAT THEY DO NOT KNOW

LESSONS LEARNED

WHAT **NOT** TO DO:

BE OVEROPTIMISTIC



WHAT **NOT** TO DO:

BE OVERPESSIMISTIC

WHAT TO DO:

KEEP ON ROCKING

thank you!