The background of the slide is a dark space filled with stars. On the left, a large, detailed image of Earth is shown, displaying continents and clouds. In the center and right, there are several asteroids of varying sizes and textures, some appearing to be in motion or orbiting. The overall scene is a representation of the near-Earth object environment.

The Near-Earth Object Segment of ESA's Space Situational Awareness programme (SSA-NEO)

Overview

Detlef Koschny, Gerhard Drolshagen

The SSA-NEO segment shall provide information about the impact threat of near-Earth objects (NEOs). To be able to do this, it shall be aware of the positions and physical properties of NEOs. It shall assess their impact probabilities, effects, and possible mitigation activities.

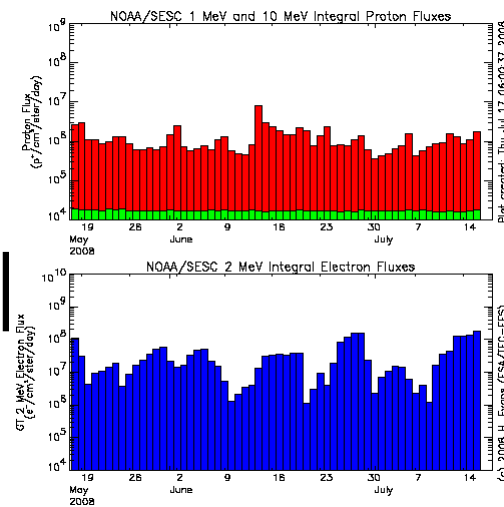
Presented 18 Feb 2013

The European SSA Programme



■ Three 'segments':

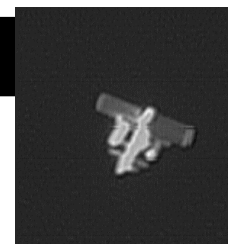
- Space Weather
- Near-Earth Objects = "SSA-NEO"
- Space Surveillance and Tracking (of satellites and space debris)



← Proton and electron fluxes (NOAA)



© Robert Schwanz, 2003

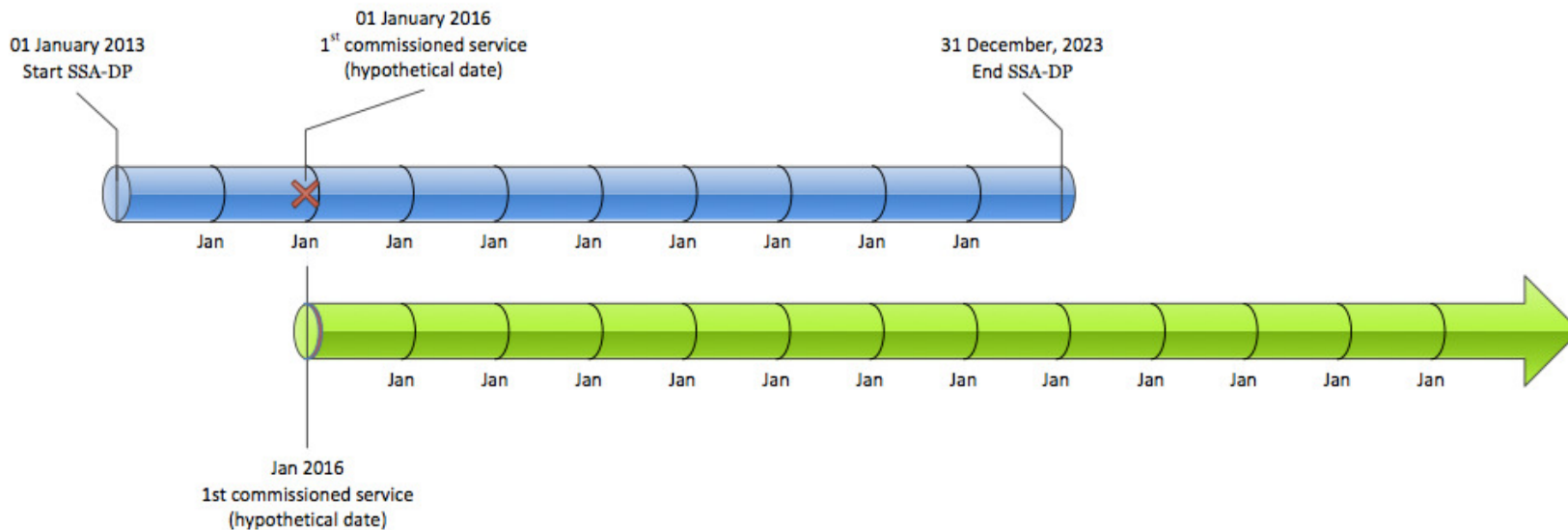


ISS Station from 400 km,
VSW Munich, 80 cm aperture

The European SSA Programme



- ESA's council meeting on ministerial level approved SSA as an optional programme in Nov 2008
- 2009 – 2012: Preparatory phase
- After confirmation at ESA's council meeting on ministerial level in Nov 2012: now in 'Phase 2'
- Moving over into operations as services are implemented



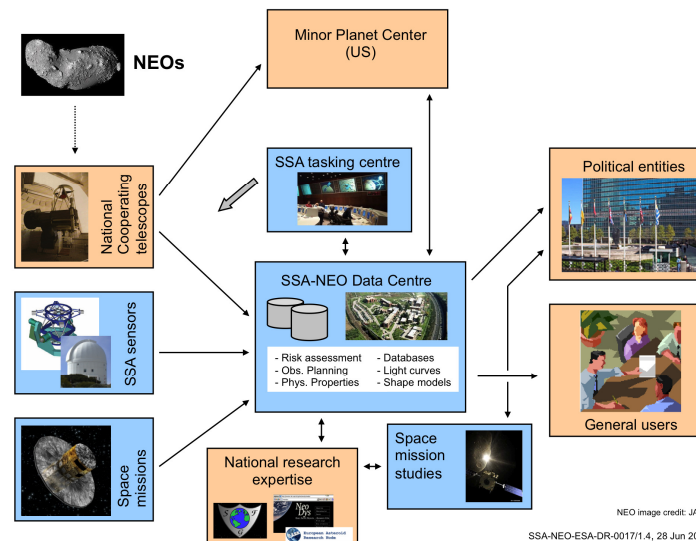
- **SSA is designed using a service-based architecture**
- **NEO services are (*):**
 - (S1) *Issue NEO impact warnings and news releases.*
 - (S2) *Provide direct access to data in the NEO database.*
 - (S3) *Provide access to data in the NEO database via registration (e.g. applicable for downloading image datasets).*
 - (S4) *Perform additional observations.*
 - *Survey goal: Discover all Tunguska-sized objects (40 – 50 m in size) or larger visible in the night sky with a warning time of 3 weeks*
 - (S5) *Provide high priority information.*
 - (S6) *Provide educational and PR material.*
 - (S7) *Provide user tools.*

(*) as defined in the System Requirements Document

Precursor phase achievements



- Focus on S1, S2, S4: Impact warnings, database, observations
- Bottom-up: Precursor services have been set up
- Data centre at ESA/ESRIN in Italy has been installed
- Top-down: Architectural design of the three SSA segments is being finalized
- Have performed studies for sensor networks (including a design for a NEO Survey Telescope)
- Technical support studies (e.g. Demonstrator for Robotic Telescope)



<http://neo.ssa.esa.int>

- Built up by an industrial consortium in Europe
- With involvement of
 - Univ. Pisa (I)
 - INAF Rome (I)
 - DLR Berlin (D)



The screenshot shows the SSA-NEO web portal interface. At the top, there is a blue header with the ESA logo and the text "space situational awareness" and "European Space Agency". Below the header is a navigation bar with tabs for "ESA", "SSA", "SST", "SWE", and "NEO". The main content area is titled "NEO Data Centre" and "Precursor services". It displays two statistics: "Current number of known NEOs: 9618" and "Current number of NEOs in risk list: 361". Below this is a "Headline News" section with the title "STRANGER IN THE NIGHT: SPACE ROCK TO MAKE CLOSE EARTH FLYBY" and a date of "7 February 2013". An image shows an artist's impression of an asteroid passing Earth. On the right side, there is a "Sign In" form with fields for "Screen Name" (admin) and "Password" (masked with dots), and a "Sign In" button. Below the form are links for "Create Account" and "Forgot Password". A left sidebar contains a menu with categories like "NEO Home", "Additional Information", and "Services Administration".

Precursor services provide...



- **Single entry point to key European NEO services**
- **Federating NEODyS⁽¹⁾, EARN⁽²⁾, SCN⁽³⁾ priority list**
- **Risk list** →
- **Close approaches list**
- **Search capability for physical properties of asteroids**
- **Orbit visualization tool**

The screenshot shows the ESA Space Situational Awareness website interface. At the top, there is a navigation bar with tabs for ESA, SSA, SST, SWE, and NEO. The current date is 17-Feb-2013, and the last update is 2013-02-17 09:01 UTC. A sidebar on the left contains a menu with options like 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, and Subscribe to Services. The main content area features a box stating 'Current number of NEOs in risk list: 361'. Below this is a 'Risk List' table with columns for Object Name, Size [m], Date/Time, IP, PS, TS, Vel. [km/s], In list since [days], IT, PP, and OV. The table lists several objects with their respective data points.

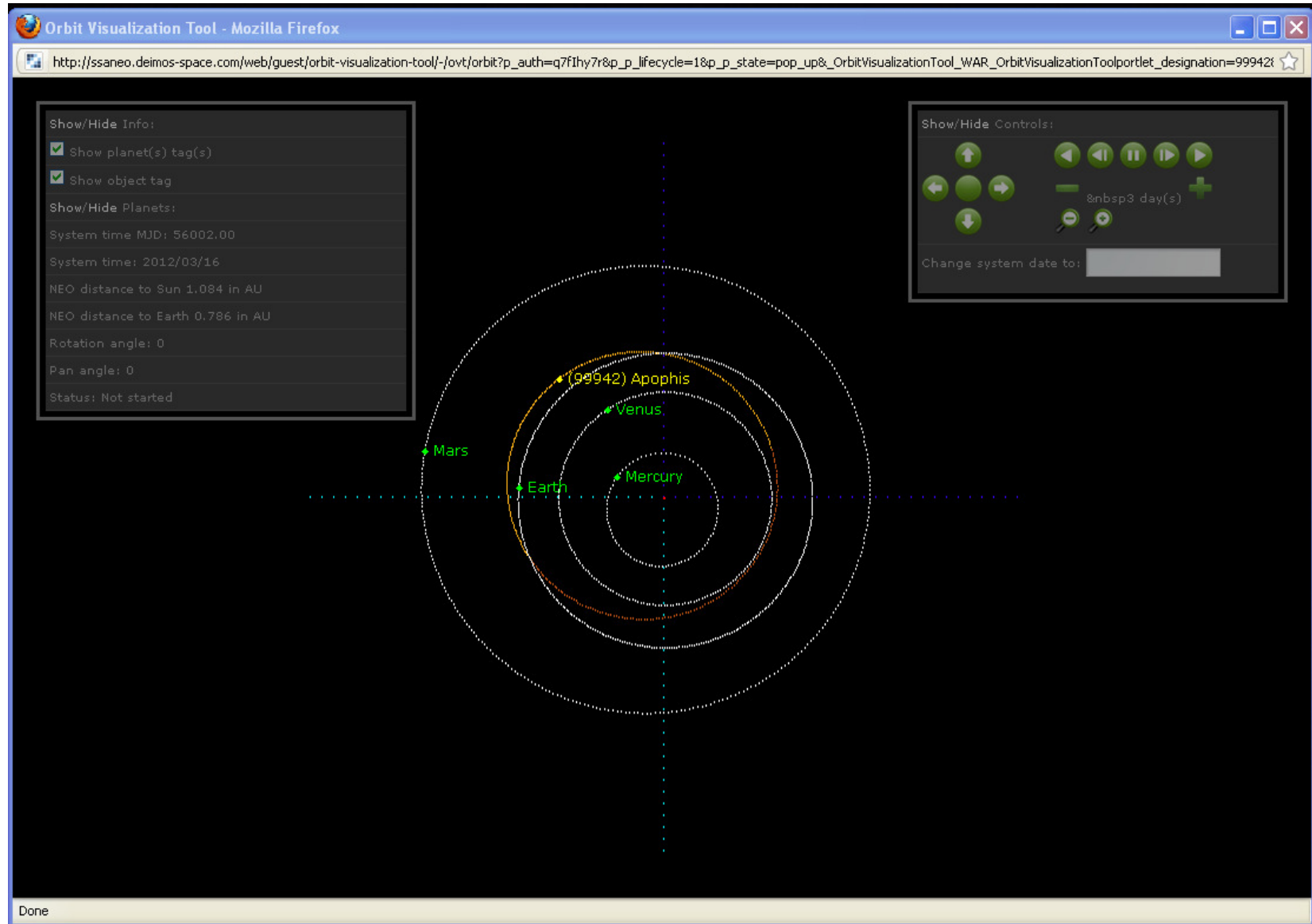
Object Name	Size [m]	Date/Time	IP	PS	TS	Vel. [km/s]	In list since [days]	IT	PP	OV
101955 1999RQ36	200.0	2182-09-24 22:20	1/3623	-1.52	n/a	12.86	1484	→	→	→
2007VK184	170.0*	2048-06-03 02:08	1/1801	-1.61	1	19.21	1919	→	→	→
2009FD	160.0*	2185-03-29 18:06	1/694	-1.9	n/a	19.39	814	→	→	→
2013BP73	390.0*	2093-12-11 13:58	1/104493	-2.65	0	23.51	16	→	→	→
2008CK70	38.0*	2030-02-14 15:56	1/2762	-3.07	0	18.94	1830	→	→	→
2010RF12	9.0*	2095-09-05 23:50	1/11	-3.11	0	12.29	892	→	→	→
1979XB	830.0*	2056-12-12 21:39	1/3.7E6	-3.23	0	27.54	12115	→	→	→
2010MZ112	470.0*	2041-02-17 04:52	1/552486	-3.27	0	11.31	951	→	→	→

(1) for orbit computation in collaboration with JPL

(2) NEO database of the European Asteroid Research Node at DLR Berlin (D)

(3) Spaceguard Central Node (INAF, I) – providing information on which NEOs are in need of observation

SSA-NEO web portal – orbit visualisation



Observations



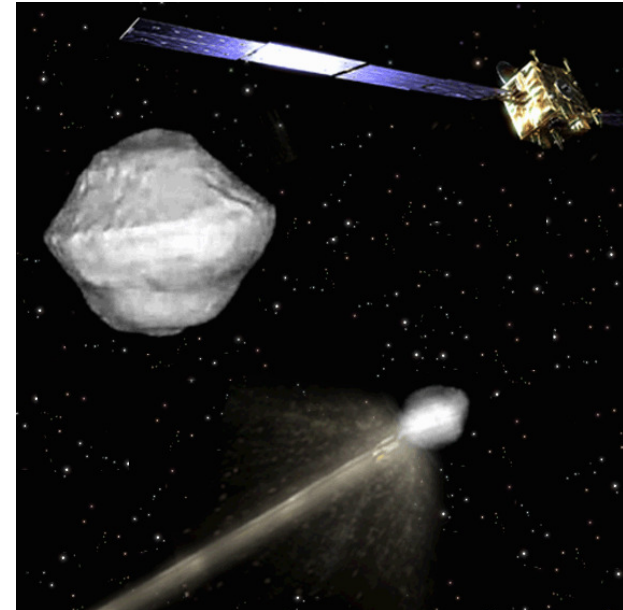
- **Support to existing observatories, e.g. the La Sagra Sky Survey**
- **Use of ESA's 1-m telescope on Tenerife (Optical Ground Station = OGS)**
 - **Used for testing observational strategies**
 - **Provides high-accuracy astrometry of asteroids to Minor Planet Center**
 - **During surveys (ca. 300 hours): more than 1000 asteroids with new designation, 4 new NEOs**
 - **1318 position measurements of ca. 400 NEOs**
 - **In 2012: 36643 measurements of 9008 asteroids**



Space missions, impact effects



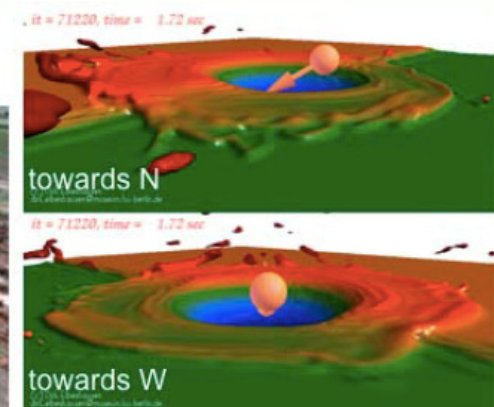
- Close interaction with ESA's General Studies Programme (e.g. the US-European Asteroid Impact and Deflection mission (AIDA) study)
- Close interaction with science programme which studies MarcoPolo-R, an asteroid sample return mission for its Cosmic Vision programme
- Coordination with EU-funded NEOShield project
- Workshop in May 2013 to develop roadmap for work on both impact mitigation and effects



Upper right: Artist impression of the AIDA mission (ESA)

Lower right: iSale model of the Carancas crater, Peru 2007 (Museum fur Naturkunde, Berlin)

Photograph of the Carancas crater towards W



NEO data centre – ESRIN, Italy



SSA-NEO data centre – inauguration spring 2013

Image © 2011 GeoEye
© 2011 Tele Atlas
Image © 2011 DigitalGlobe
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
41°50'27.03"N 12°35'09.14"E elev. 177 m

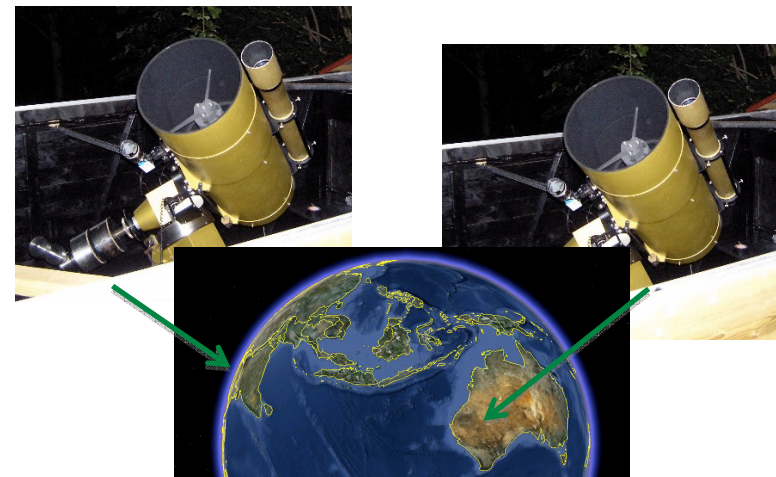
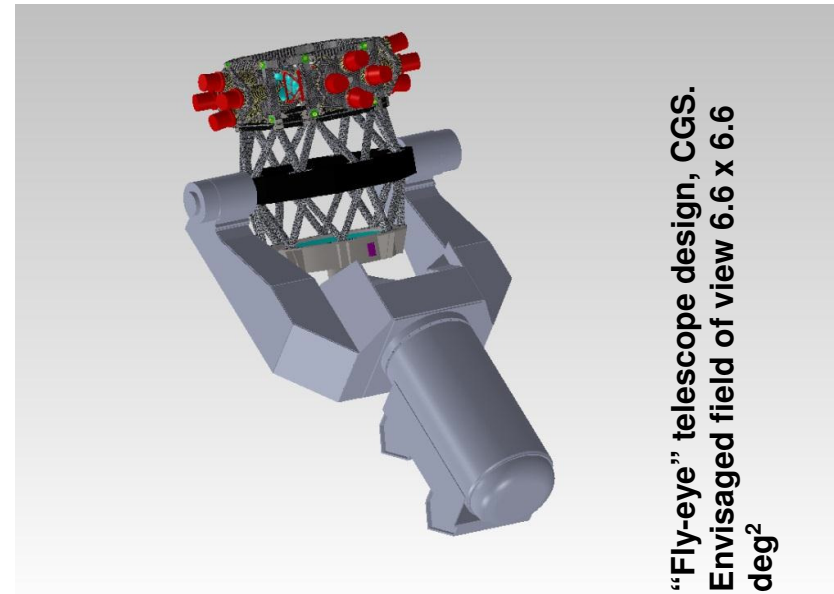
© 2010 Google
Eye alt. 65.98 km

■ NEO Survey Telescope

- Fly-eye telescope concept
- Funding for prototype telescope is available
- For the 'wide survey', 4-6 such telescopes are needed

■ 'Robotic telescope demonstrator' development ongoing

- Focus on software development (schedule and control of multiple telescopes; use for NEOs and Space Debris)
- Part of baseline: Deploy two $\approx 16''$ telescopes in New Norcia (Australia) and Cebreros (Spain)



- **ESA is successfully contributing to the global effort of coping with the NEO impact threat**
- **Federation of existing assets in precursor services**
 - NEODyS (orbit computation, working in close collaboration with JPL)
 - EARN (database for physical properties)
 - SCN priority list (list of NEOs in need of observations)
 - See <http://neo.ssa.esa.int>
- **NEO data centre at ESRIN, Italy, hosts the precursor services**
- **Funding available for further expanding services**
- **Development of a 1-m effective aperture NEO Survey Telescope has started; funding for prototype is available**

Flyby of asteroid 2012 DA14. Courtesy
F.Kugel and J.Caron, Dauban observatory,
IAU A77

