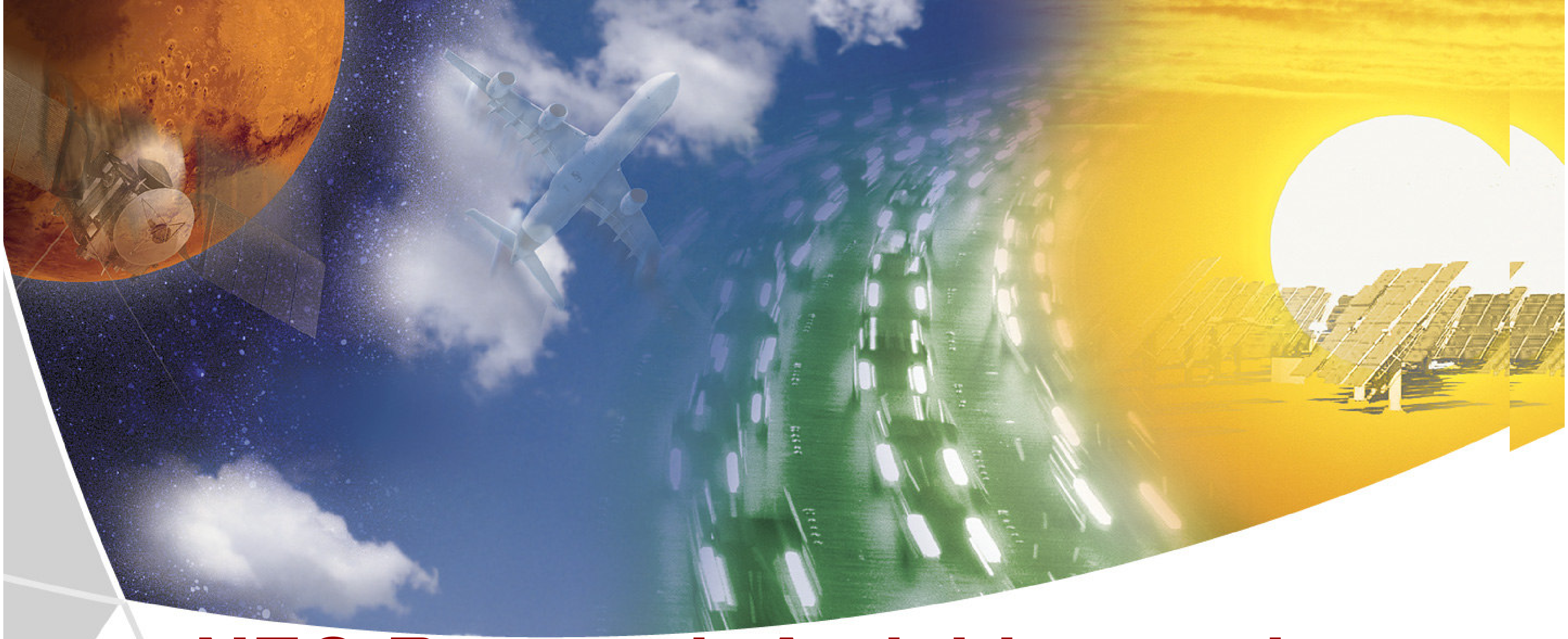

NEO Research Activities at the German Aerospace Center DLR

A Report to the Scientific & Technical Subcommittee of the Committee on Peaceful Uses of Outer Space of the United Nations

45. Session, Vienna 18. 2. 2008

Ekkehard Kührt (DLR)

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V.
in der Helmholtz-Gemeinschaft

Outline

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2. NEO-Research activities 2007
3. AsteroidFinder – a new DLR compact satellite project for INEO search
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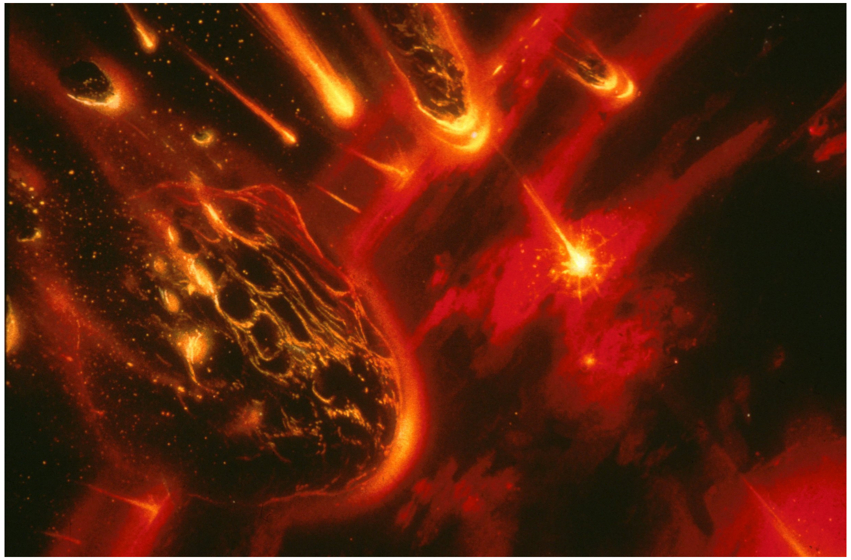


1. Introduction

German Aerospace Center

5.300 employees working in 28 research institutes and facilities

- at 9 sites
- in 7 field offices.

Program Directorates

- Aeronautics
- Space
- Transport
- Energy

NEO activities at DLR are concentrated in the Institute of Planetary Research in Berlin.

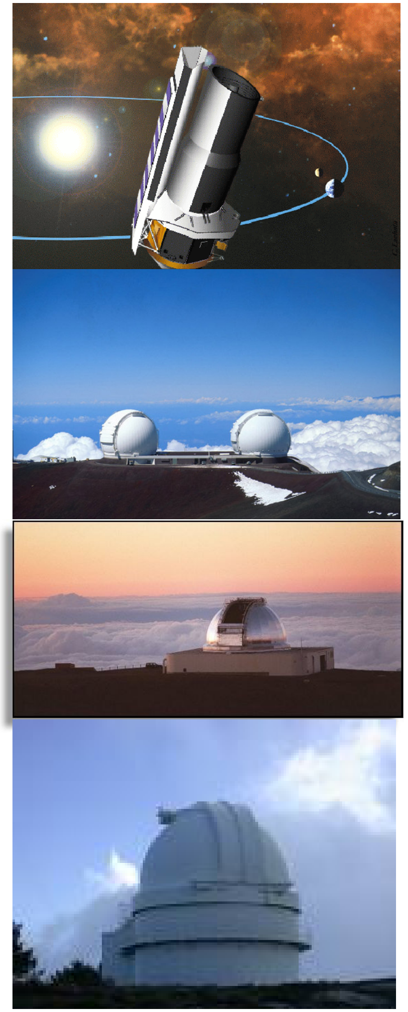
2. NEO Research Activities 2007

Observation programs

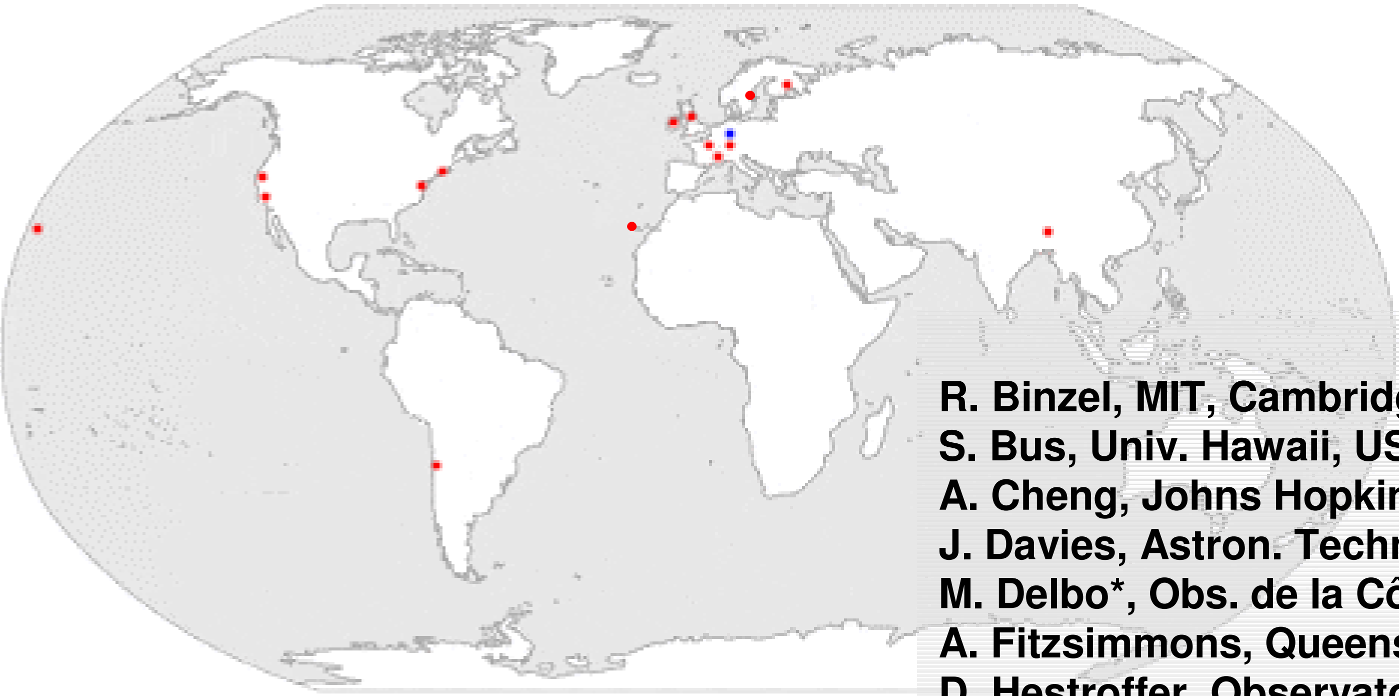
- With Spitzer, IRTF and UK-Infrared-Telescope in the Thermal Infrared
- Nordic Optical Telescope La Palma (in cooperation with the Nordic Group for Small Planetary Bodies).
- Calar Alto 1.2 m telescope (remotely controlled).
- European Fireball Network together with amateurs and Czech colleagues from Astronomical Institute.

To:

- Determine sizes, rotation periods, albedos and thermal inertias of NEOs (risk assessment, statistics, classification).
- Refine orbit parameters by astrometric measurements.
- Derive strength and orbits of fireballs.



Cooperation



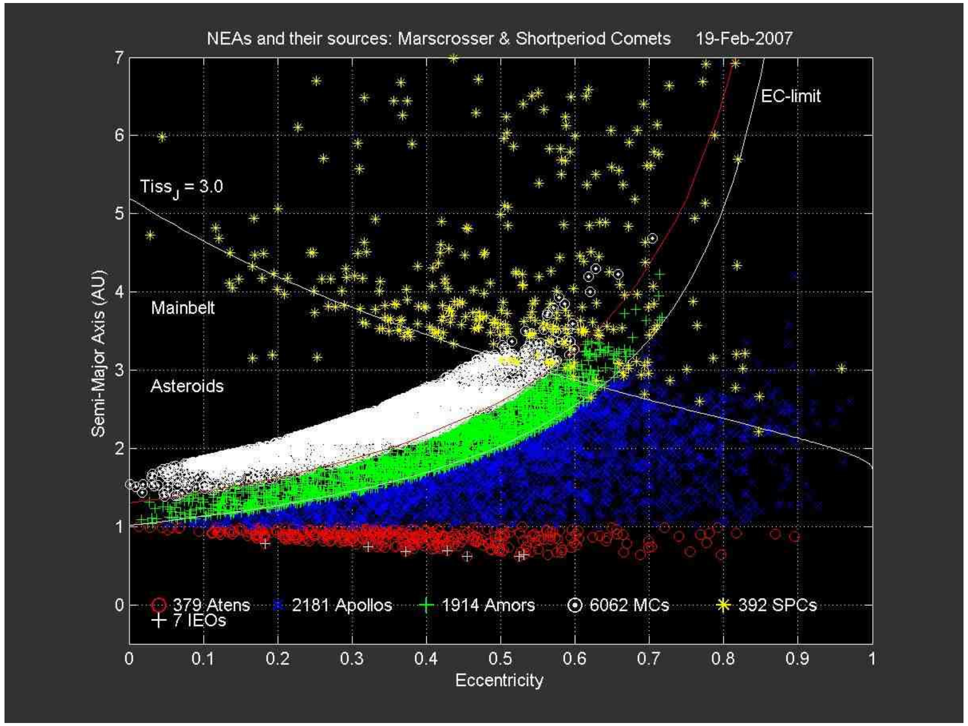
R. Binzel, MIT, Cambridge, USA
S. Bus, Univ. Hawaii, USA
A. Cheng, Johns Hopkins Univ., Baltimore, USA
J. Davies, Astron. Techn. Centre, Edinburgh, UK
M. Delbo*, Obs. de la Côte d’Azur, Nice, France
A. Fitzsimmons, Queens Univ., Belfast, UK
D. Hestroffer, Observatoire de Paris, France
M. Hicks, JPL, Pasadena, USA
M. Kaasalainen, Univ. Helsinki, Finland
C. Lisse, Johns Hopkins Univ., Baltimore, USA
F. Marchis, UC Berkeley, USA
D. Osip, Las Campanas Observatory, Chile
P. Pravec, Ondrejov Observatory, Czech Rep.
A. Sen, Univ. Assam, India
University Uppsala

Data base of physical properties of NEAs

We maintain and update a database of physical physical properties of all known NEAs

666 entries

- 179 asteroids with H values
- 337 asteroids with albedo or diameter
- 399 asteroids with taxonomic types
- 436 asteroids with rotational periods
- 56 asteroids with colors determined
- 30 binary asteroids
- 212 asteroids with radar observations obtained

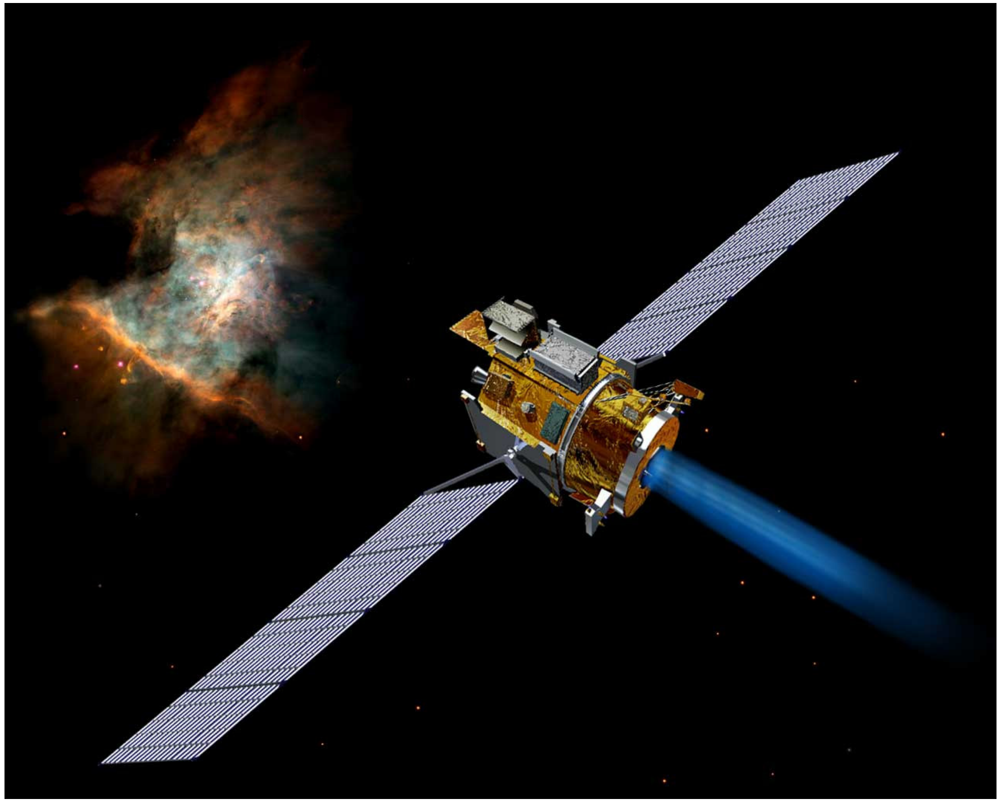


http://earn.dlr.de/nea

ASTEX (Phase A study)

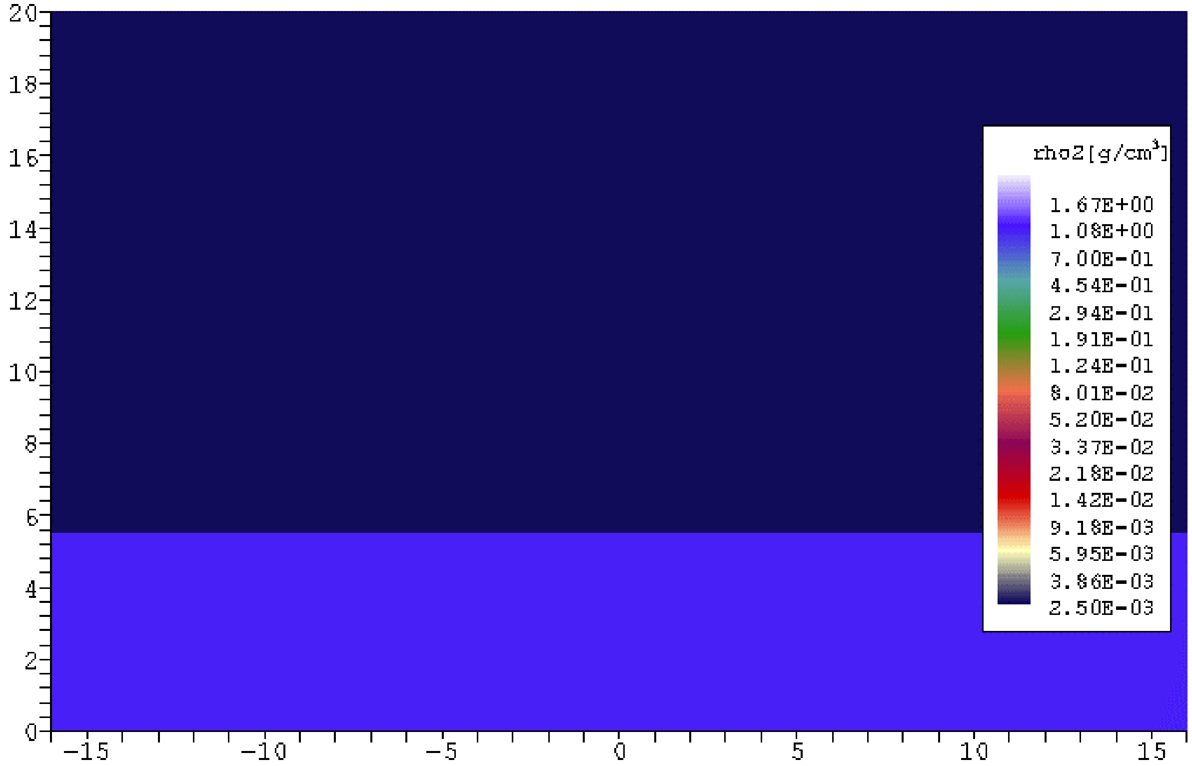
(together with Max-Planck-Society and other German institutes)

- In situ investigation of two NEAs with orbiter and lander
  - Physical and chemical properties
  - Structure of NEOs
  - Important for risk
  - mitigation strategies



Impact Simulation Tools

- Improved sophisticated and 2D multi-material hydrocodes
- to analyze high-energy impacts onto a continent and impacts into the ocean.



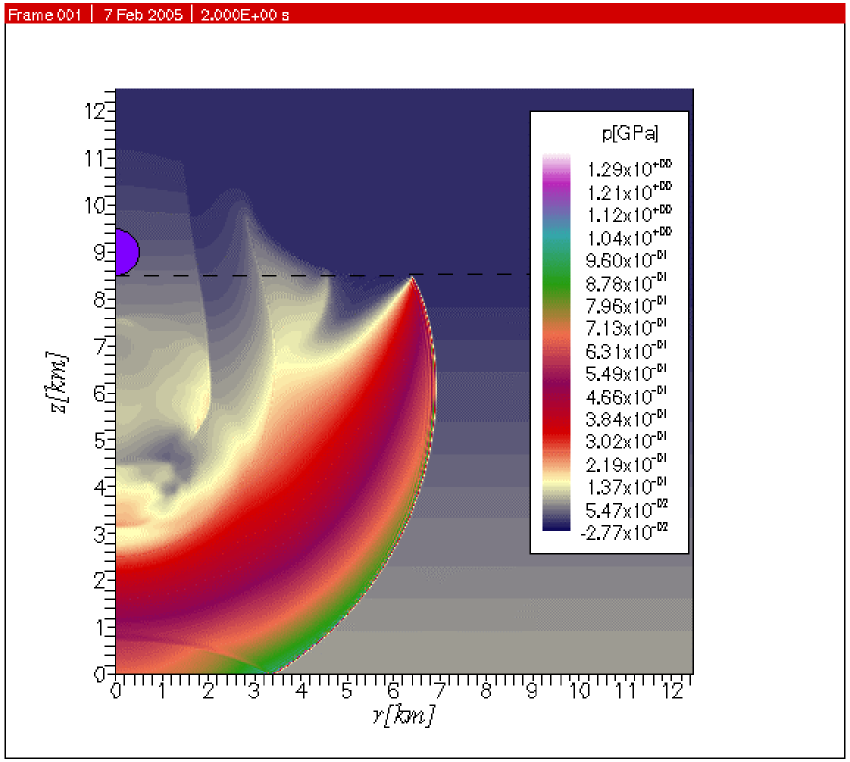
1 km impactor

v = 20 km/s

ocean depth = 5.5 km

To simulate:

- density, pressure, and velocity distributions of the impactor and the ground material up to several hundreds of seconds after the impact.
- range of ejecta in giant Chicxulub type impact (ejecta are distributed over wide ranges, several 1000 km, by ballistic transport but not around the world).
- chemical state of recondensed matter

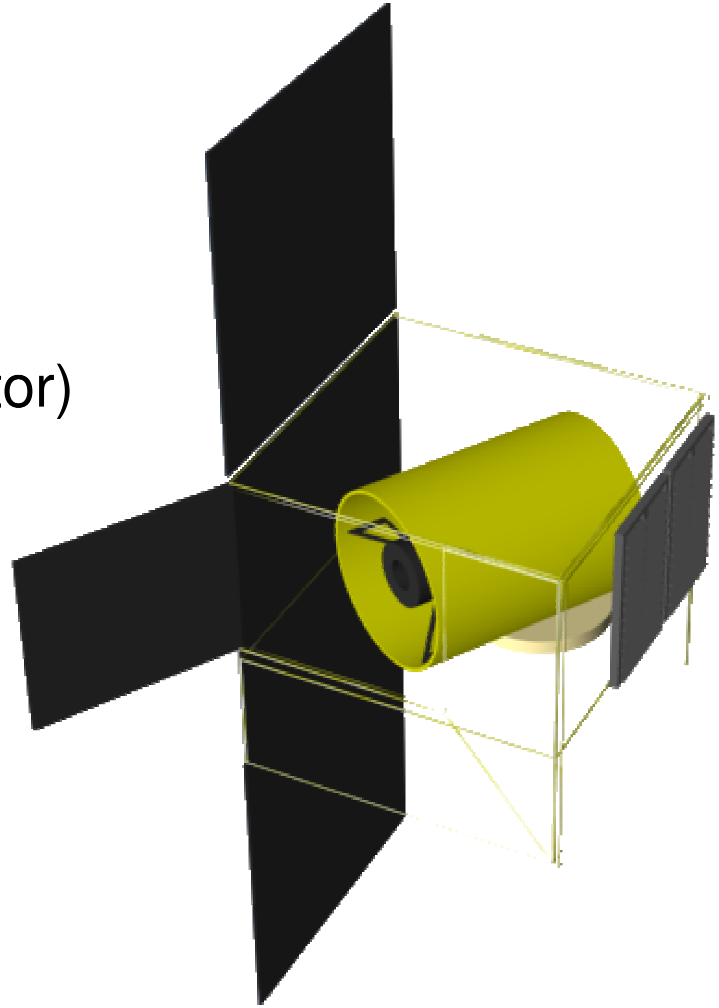


3. AsteroidFinder – a new DLR compact satellite project

Basic data:

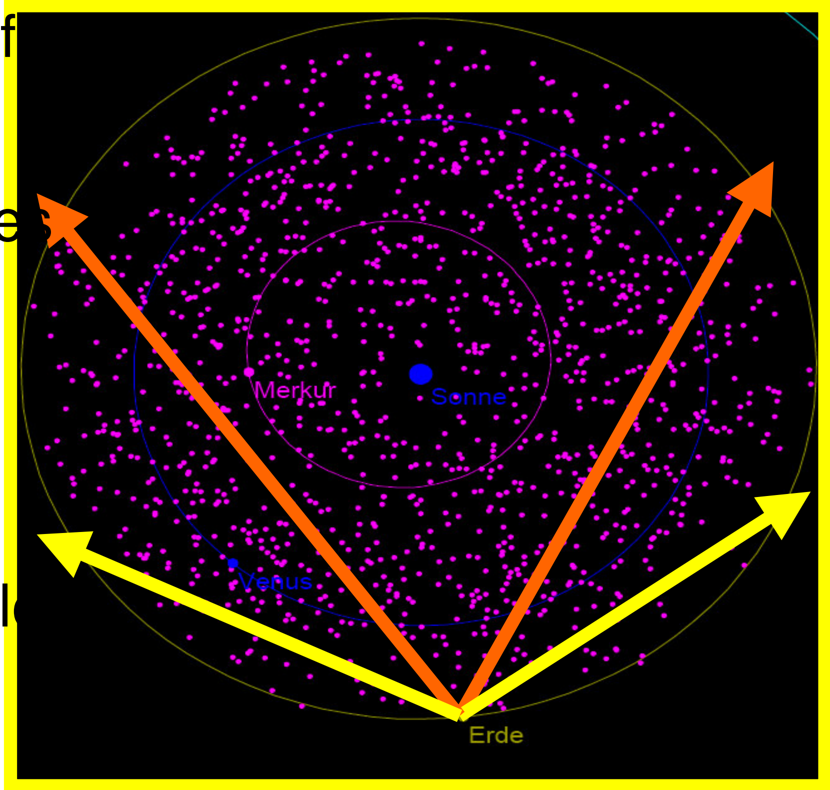
- Launch: 2012
- Orbit: Earth orbit, ca. 600 km altitude (along terminator)
- Limiting magnitude: 18.7

albedo	0.5	0.25	0.05
diameter	370	530	1200



Mission goals

- Detection of Inner Earth Objects (IEOs) with orbits < 1 AU that are hardly to observe from ground (only 8 objects have been identified so far)
- Orbit and size determination
  - Understanding the dynamical development of the planetary system
  - Simulation of the source regions of
  - Assessment of the impact hazard
- Secondary goal: detection of space debrie



Advantages from Earth orbit

- look closer to Sun (region below orange arrows compared to accessible region bel yellow arrows from ground)
- 24 h duty cycle (no eclipse)

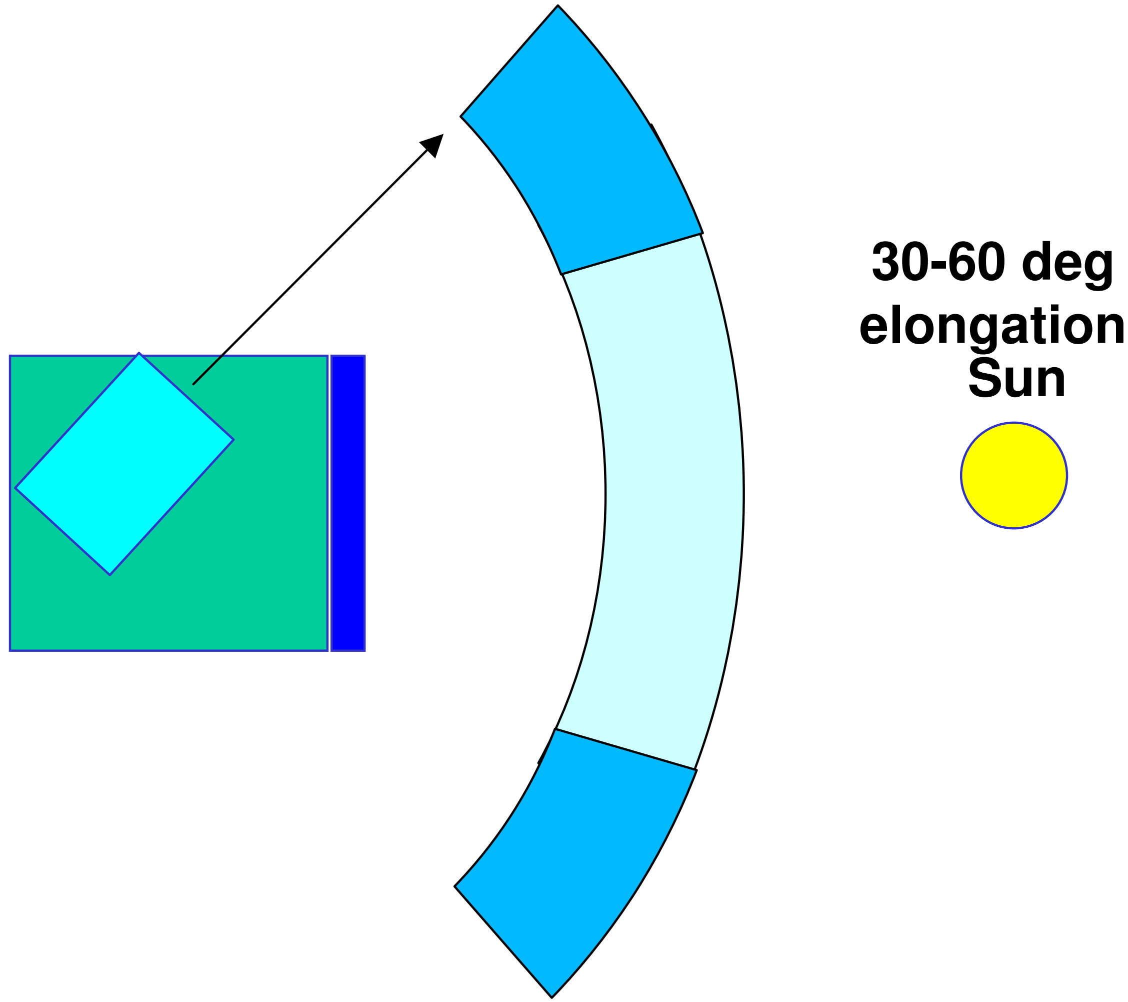
Observational strategy and basic requirements

- Systematically perform image scans of a large area of sky at small solar elongation (30 to 60 deg)

- Exposure times of 60 s needed to reach the required limiting magnitude of 18.7

- Astrometric accuracy

  ~ 1”-1.5”

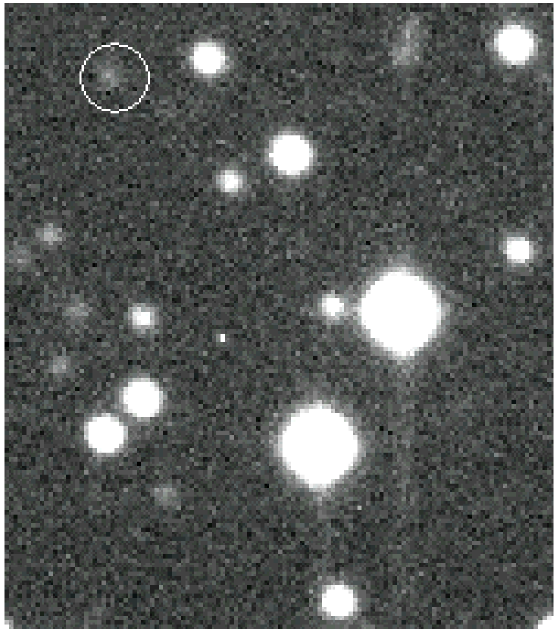


Innovative payload concept

Problem:
Astrometric accuracy requirement and long exposure times demand much higher pointing stability than compact satellite class platforms can provide (> 30''/s).

Solution:
Autonomous image stabilization system on instrument level.

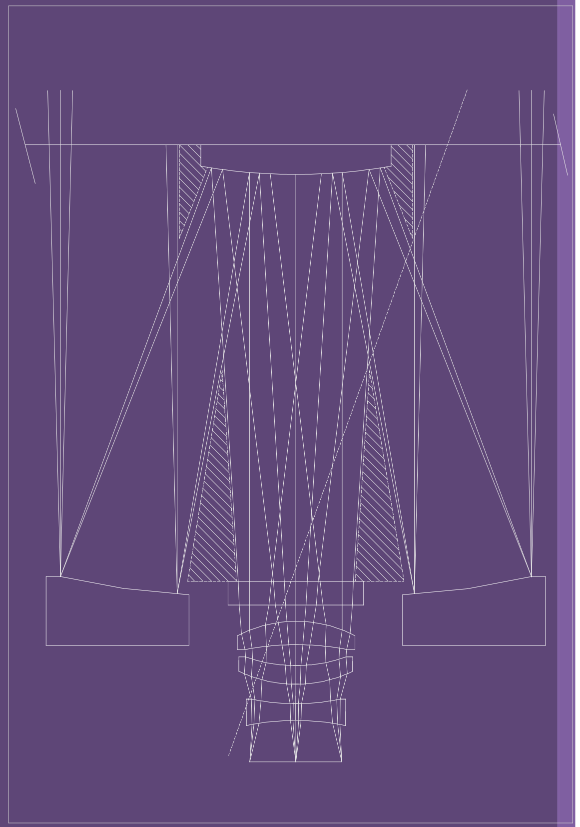
<u>Baseline:</u>
Summing up several hundreds matched images with exposure times (0.1 s) using innovative L3CCD with electron multiplier to reach a adequate signal/noise ratio even at short exposures.

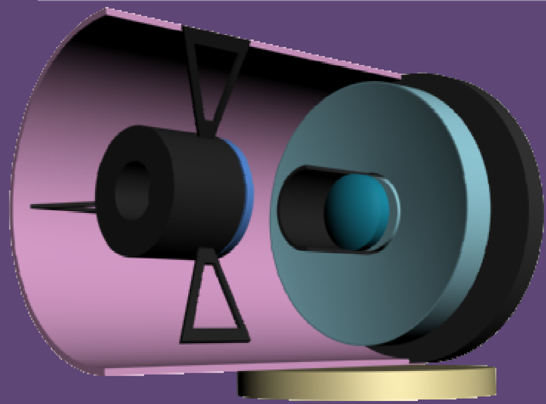


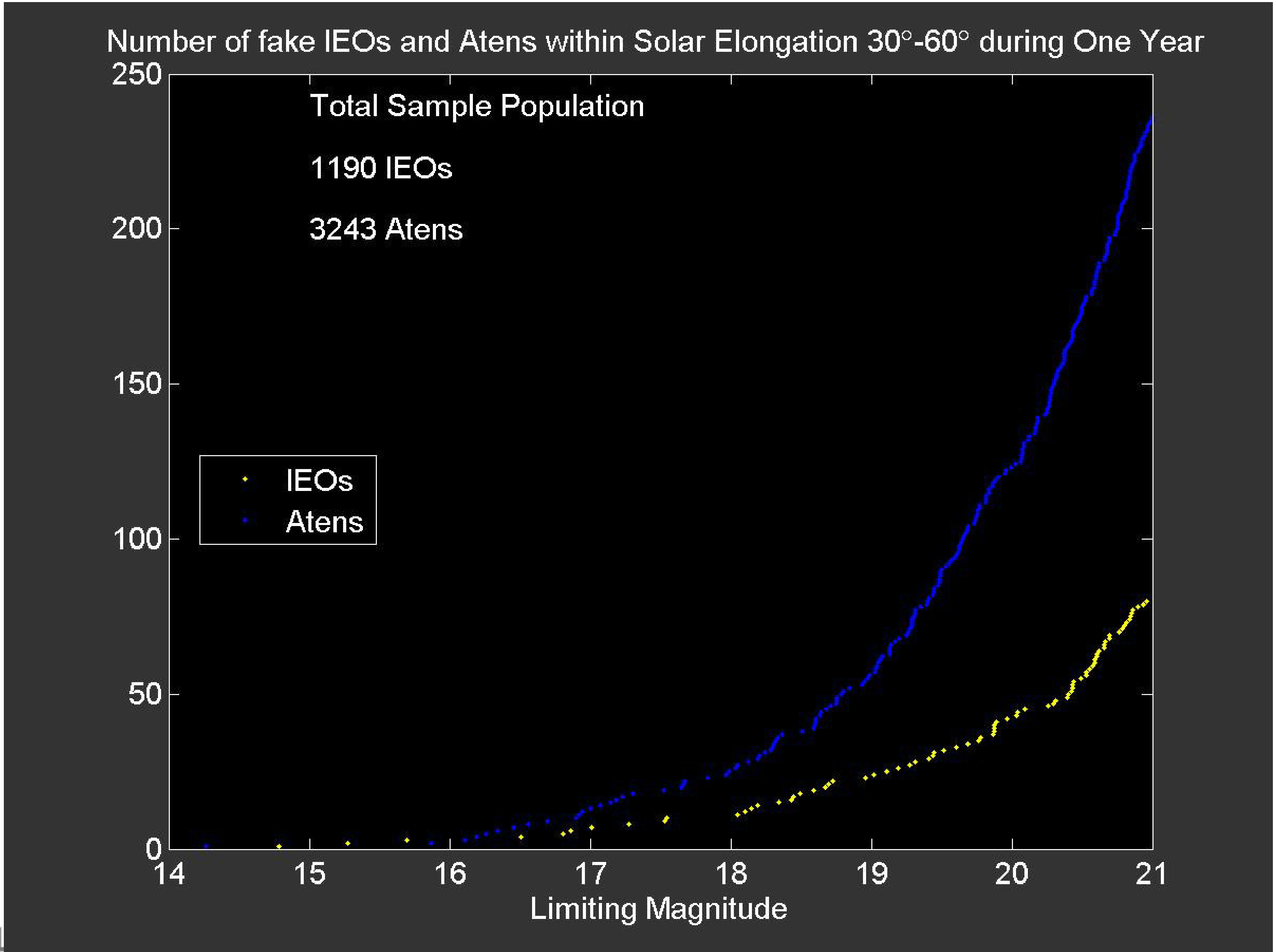
Telescope

Modified Ritchey-Chrétien with focus corrector

Focal length	760 mm
Aperture	250 mm
f ratio	1:3
Pixel size	13 µm
IFOV	3.5”/pix
FOV	2°






Number of fake IEOs and Atens within Solar Elongation 30°-60° during One Year
Total Sample Population
1190 IEOs
3243 Atens
IEOs
Atens
250
200
150
100
50
0
14
15
16
17
18
19
20
21
Limiting Magnitude

4. Conclusions

DLR has continued its efforts in NEO research and is prepared to support international NEO activities.

- Our future activities will include:
  - preparation of the AsteroidFinder mission
  - follow up observations of NEOs to determine their physical and dynamical properties
  - impact simulations

International cooperation in the AsteroidFinder mission is highly welcome!