Recent Planetary Defence Activities at ESA's Planetary Defence Office

Francisco Ocaña on behalf of PDO team

ESA NEO Coordination Centre,
Planetary Defence Office

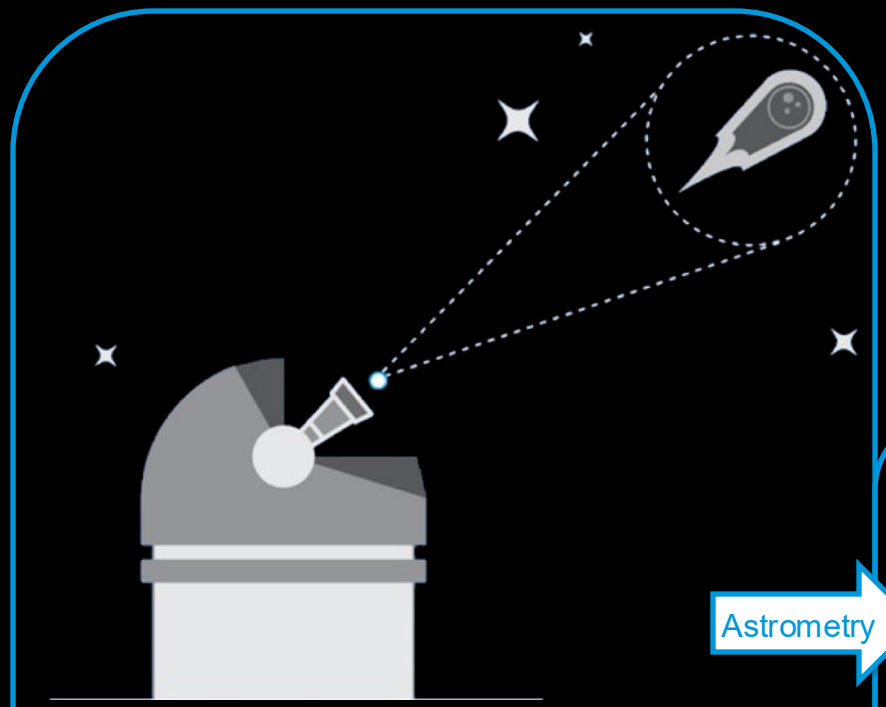
IMC 2025

ESA Planetary Defence Office

"The goal of Space Safety is [...] ***the protection of our planet, humanity and assets in space and on Earth from dangers originating in Space"***

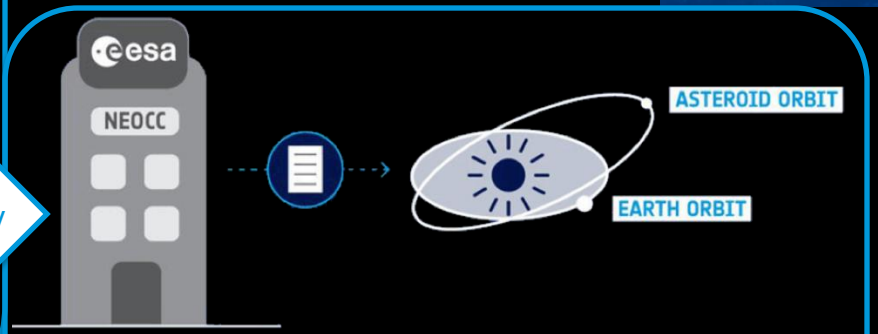
- ***Detection*** of Near-Earth Objects, determining their dynamic and physical properties
- ***Assessment*** and prediction of impact risk, warning decision makers and disaster relief forces in case of threats
- Risk ***mitigation*** through potential reconnaissance and/or deflection missions

The Three Pillars Of ESA Planetary Defence



Observations

Astrometry

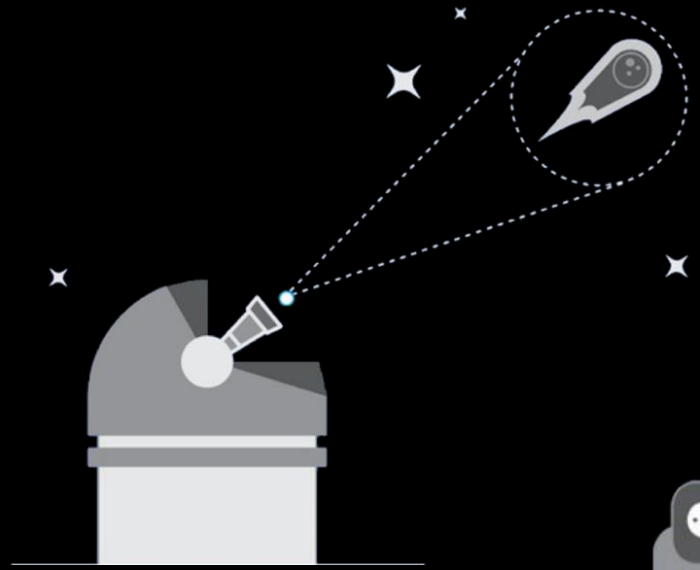


Assessment

Mitigation

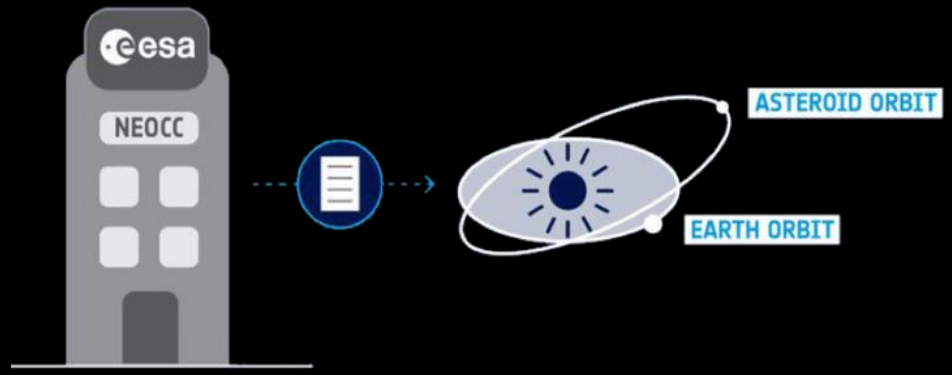
Provide Information

ESA's Planetary Defence Plans for the Future

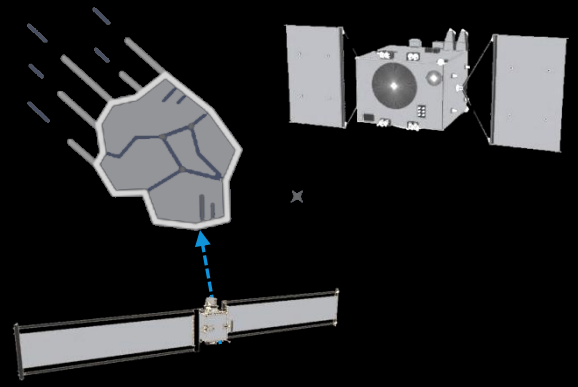


Closing observational gaps

Strengthen international collaboration and networking



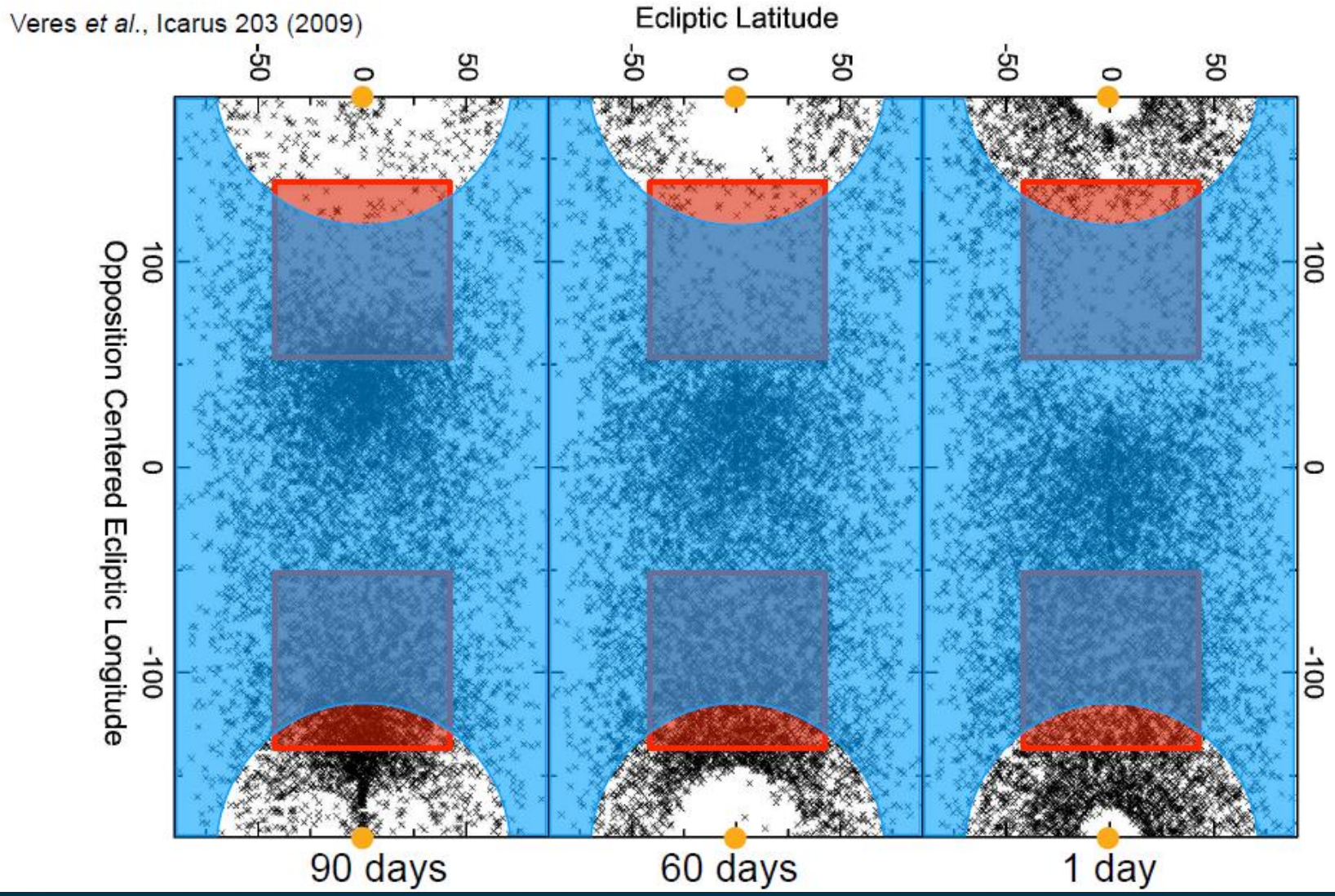
Enhancement and upgrade of capabilities



Fast Asteroid Reconnaissance and deflection

A wide telescope network

Observational gap at low elongation



NASA's NEOSM aims at finding NEOs when they are *distant*.

However, due to survey strategy revisit time, it may miss the *smaller* ones (below 100 m) - only observable when *closer*, thus *faster*.

NEOSM Coverage

Ground Coverage

NEOMIR (2032+)

IR observatory at Earth-Sun L1

Mass: ~1.6 t

Launch: Ariane 6-2 in ~2032-2033

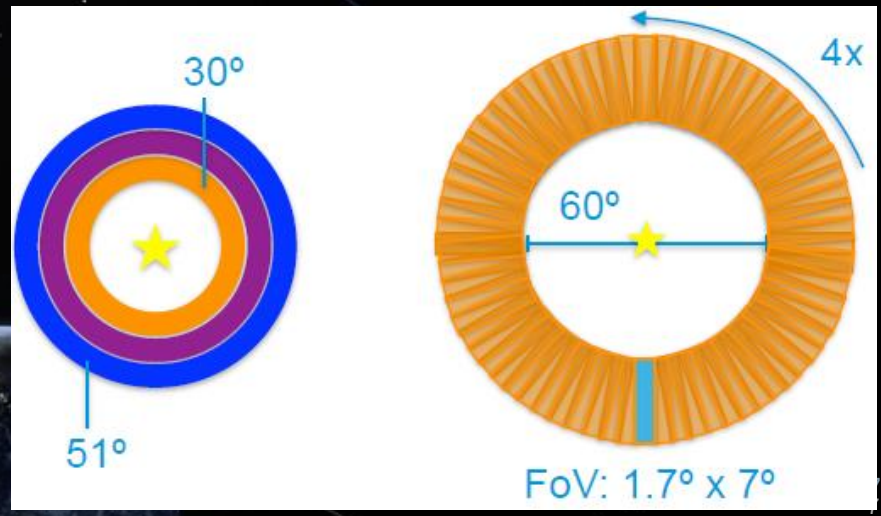
Field of Regard ~30° - 70° solar elongation

Survey pattern

- FOV: 1.7° x 7°
- Concentric rings
- 4 revisitations per pointing

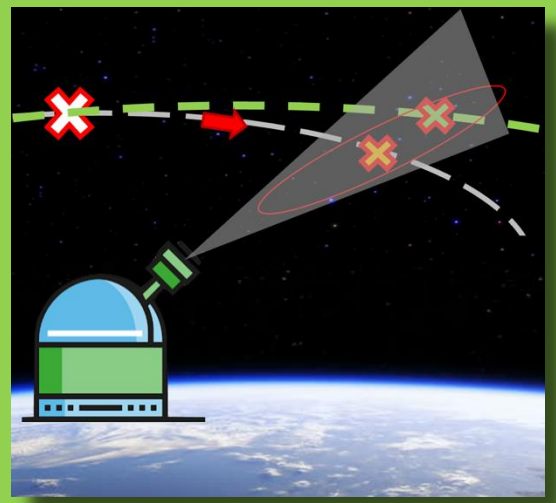
High data volume ~1.4 Gbit/day

High performance detectors

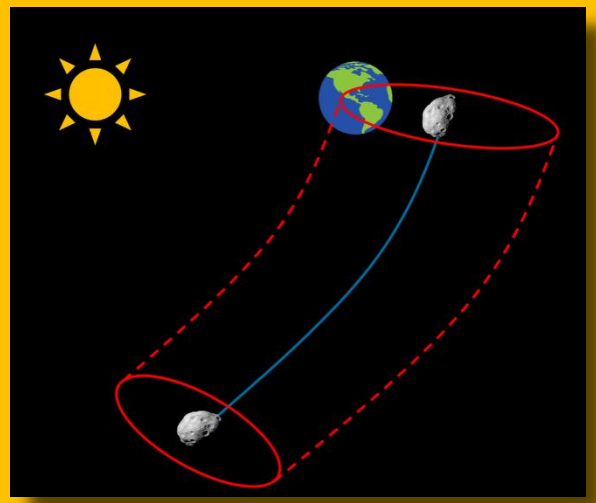


Assessment

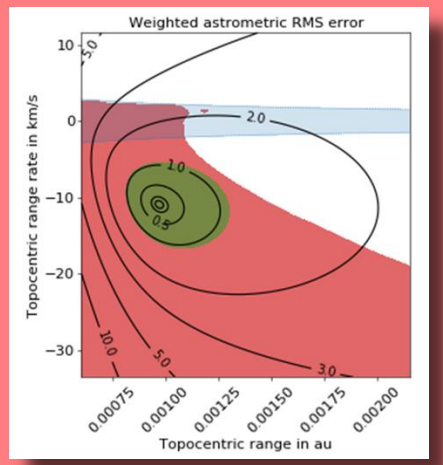
Orbit Determination



Impact Monitoring



Imminent Impactors Warning



Orbit Determination and IM

The main end goal of the NEO discovery process for planetary defence purposes is of course the assessment of the impact threat posed by each known NEO.

- Orbit determination:
  - Mostly a well-defined process nowadays.
  - More attention to astrometric weights, biases, and timing uncertainties.
- Impact monitoring:
  - New better algorithms being developed.
  - Increased computational load due to the much larger number of known objects.

→ RISK LIST help

Last update: 2025-07-07 13:53 UTC

The Risk List is a catalogue of all objects for which a non-zero impact probability has been computed. Each entry contains details on the particular Earth approach which poses the highest risk of impact (as expressed by the Palermo Scale). It includes its date, size, velocity and probability. Impact history data can be selected in tabular and graphical form. Links to the impactor table are also given. In most cases, the size presented in the table is estimated indirectly from the absolute magnitude, and flagged with an asterisk (*). In this case the size uncertainty could be large. When a better measurement is available in the literature, it replaces the estimated value. By default, entries are sorted by the maximum Palermo Scale value; the sorting can be changed by clicking on the table headers.

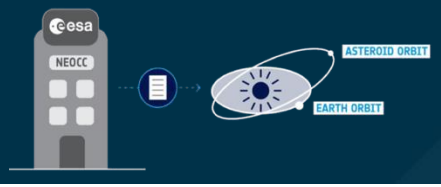
Current number of NEAs in risk list: **1794**

→ OPEN INTERACTIVE RISK PLOT

Risk List

No.	Object designation	Diameter in m	Impact date/ time in UTC	IP max	PS max	TS	Years	IP cum	PS cum	Vel. in km/s	In list since in d	History data	History plot	IT	LOVV
1	2023VD3	11 - 24*	2034-11-08 17:08	1/425	-2.67	0	2034-2039	1/425	-2.67	21.01	607				
2	2008JL3	23 - 50*	2027-05-01 09:05	1/6711	-2.73	0	2027-2122	1/6211	-2.73	14.01	6110				
3	1979XB	400 - 900*	2056-12-12 21:38	1/4.27E6	-2.82	0	2056-2113	1/1.36E6	-2.70	27.54	6110				
4	2000SG344	27 - 60*	2071-09-16 00:54	1/1117	-3.18	0	2069-2122	1/354	-2.77	11.27	6110				
5	2025LK	11 - 25*	2052-06-08 14:51	1/499	-3.36	0	2052-2113	1/495	-3.36	14.90	31				
6	2005QK76	27 - 60*	2030-02-26 08:15	1/33222	-3.39	0	2030-2108	1/15576	-3.26	22.66	6110				
7	2007KE4	24 - 50*	2029-05-26 00:18	1/23419	-3.47	0	2026-2115	1/22883	-3.47	15.03	6110				
8	2021GX9	24 - 50*	2032-04-16 21:51	1/19880	-3.49	0	2032	1/19880	-3.49	20.17	1544				
9	2025JU	60 - 140*	2074-10-02 08:27	1/33333	-3.50	0	2074-2108	1/23041	-3.34	18.93	64				

The end-result is the publication of "risk lists" of objects with a non-zero impact probability.



And much more in our Portal

Orbit Visualisation Tool

Display collections of asteroids and the Keplerian and perturbed orbits of NEOs in a 3D environment of the Solar System.

Flyby Visualisation Tool

Produce high-precision simulations of NEOs in their close approach to Earth.

Sky Chart Display Tool

Locate the path in the sky followed by your objects of interest as observed from any coordinates in the world.

Observation Planning Tool

Calculate observational conditions and precise ephemerides to optimise the scheduling of your observations.

Synodic Orbit Visualisation Tool

Display Keplerian and perturbed orbits of NEOs in a rotating Sun-centered reference frame in 3D and check for their observability.

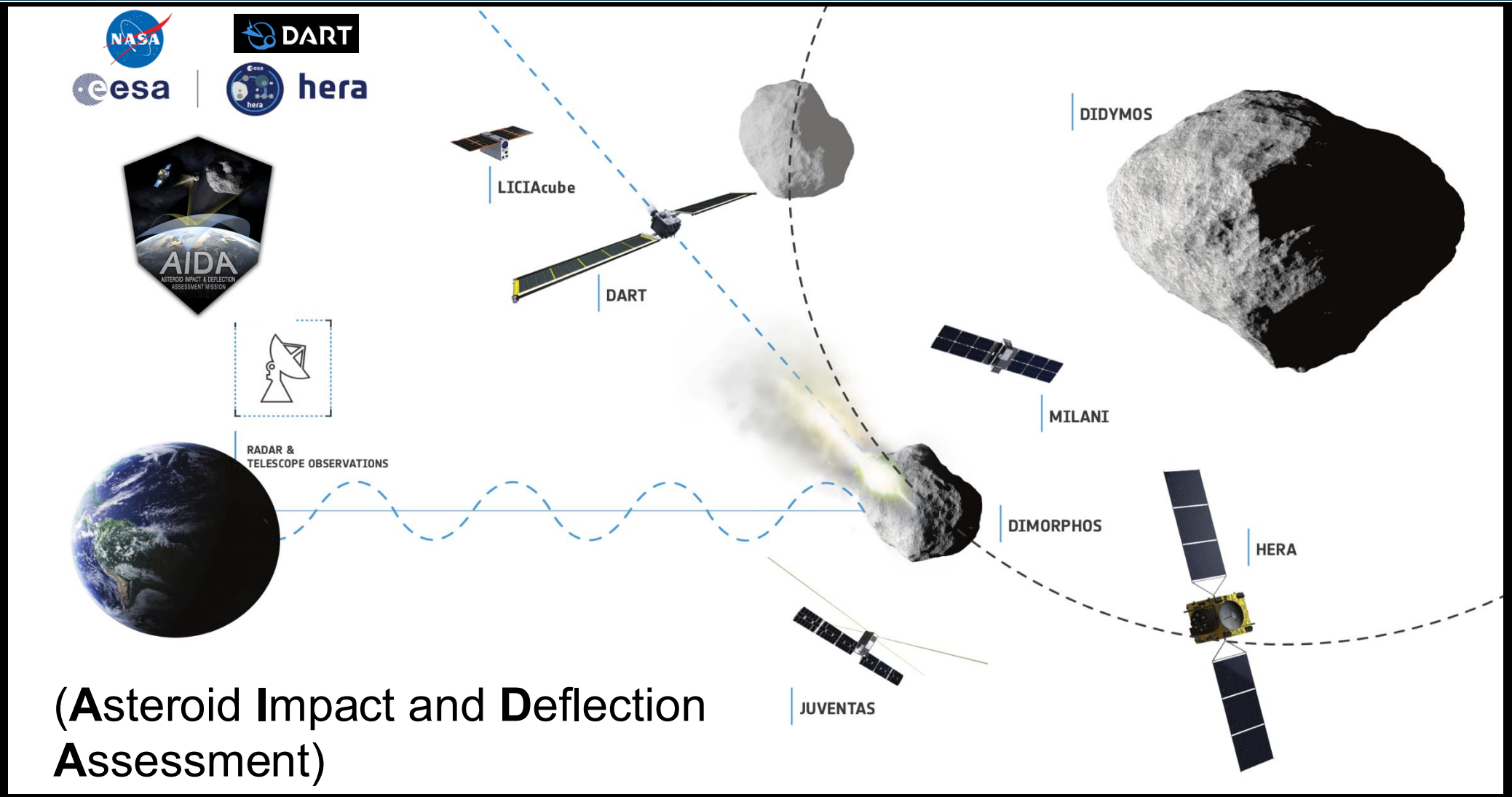
https://neo.ssa.esa.int

Subscribe to our services: newsletter/CAFS/news !

Mitigation

Mitigation

DART + Hera = AIDA



RAMSES

Apophis close approach in 2029

Leverages much of the technology developed for Hera

To be confirmed at CM25 (November)

Other space missions

AIM (Asteroid Inspection Mission)

- Deep-space cubesat mission. Actual scope is being evaluated.

PAN (Precise Asteroid Nudging) IBD-demonstrator

- CDF Study have just started

LUMIO (LUnar Meteoroid Impact Observer)

- ESA's mission – cubesat at L2
- non-PDO mission, but very relevant for PD

Fireball observations

All sky cameras (2 in Spain, 1 in Italy) - Used for PR and data is shared for analysis.

Fireball Information System (FIS)

https://neo.ssa.esa.int/search-for-fireballs

Fireball observations (also from space!)

Lightning Imager data exploitation for fireballs in Meteosat data

- More detail in *Detection of fireballs in the Lightning Imager data* (Kokou, P., MNRAS, 2024)

ESA graduate trainee (EGT) just started to perform a dedicated project to exploit the MTG-LI information

Potential synergy with GOES-East

Horizon Europe activities

Horizon Europe EC entrusted activities

- Physical properties observations, led by INAF (IT) – Focused on the smaller end of asteroid distribution

- Physical properties DB development, scientifically led by OCA (FR)

- Promotion of networking of Member State facilities and research centres
  - 2022 – Imminent impactors (Cano, J.L., PDC 2023)
  - 2023 – Emergency response agencies
  - 2024 – NEO size determination
  - 2025 – Astrometric/radar observations (see next slide)

ESRIN (Rome, Italy) – 6 to 8 October 2025

Horizon Europe activities

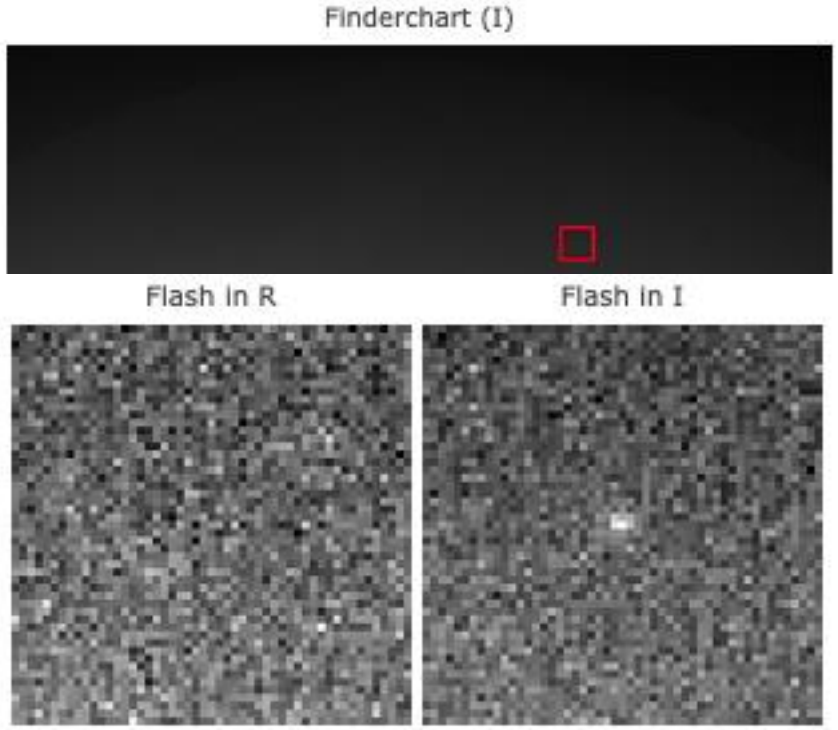
Horizon Europe EC entrusted activities

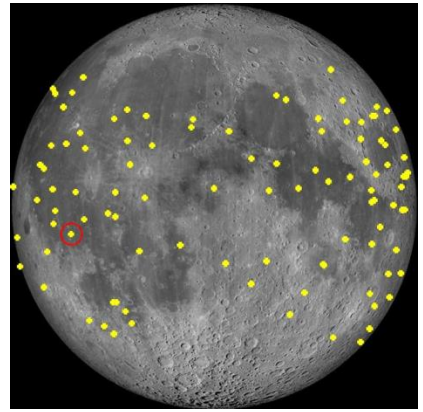
- Lunar impact flashes observations – re-started in August

Detected NEO Lunar Impact Event

ID: 20250817_002847

Moon Position (Topocentric)	
Airmass:	1.93
Altitude (deg):	31.1
Azimuth (deg):	279.9
Event Data	
UT Date (DD/MM/YYYY):	17/08/2025
UT Time:	00:28:47.853
R (mag):	10.3 ± 0.3
I (mag):	9.2 ± 0.1
Lunar Long (deg):	54.6
Lunar Lat (deg):	-7.9
Duration (sec):	0.066
Additional Information	
Number of Cameras:	2





ESA / NELIOTA

Other meteor-related activities

- Taurids 2022 out-of-atmosphere meteoroids search with ESA's 1 m OGS

- We regularly observe spacecraft 'close' approaches as proxies/training:
  - BepiColombo / JUICE / OSIRIS-REx…

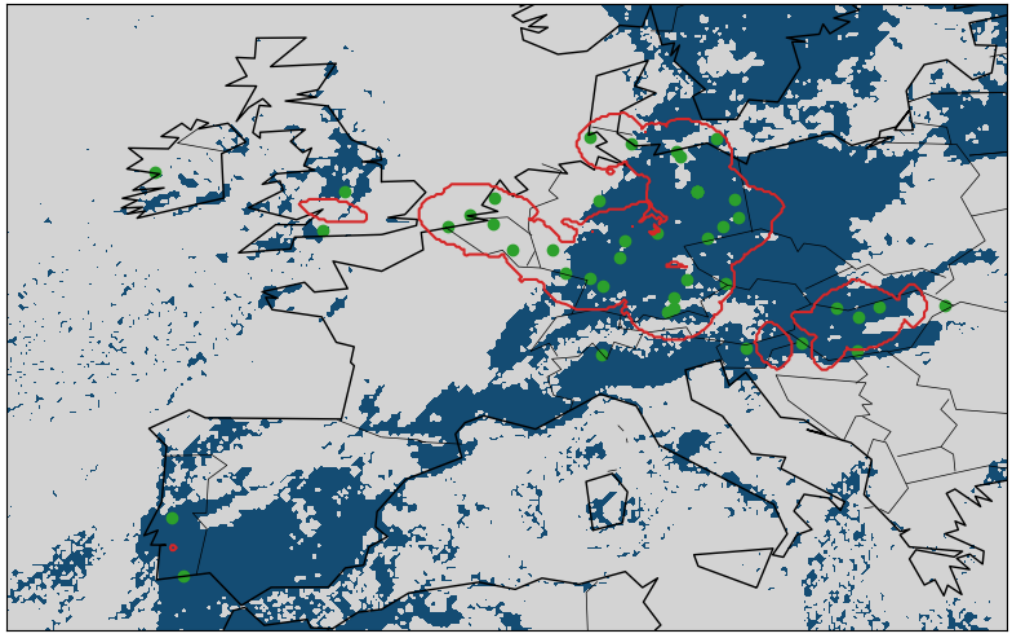
- But some spacecraft in HEO orbits could really become artificial meteors (reentries):

Salsa (CLUSTER FM II) last perigee	41 minutes after	61 arcsec/s (15000 km away)
Salsa (CLUSTER FM II) reentry	39 minutes before	86 arcsec/s (12900 km away)
Quequiao 2 booster reentry	24 minute before (until shadow entry)	390 arcsec/s (3400 km away)

Other meteor-related activities

Constraining the Fireball Flux Density

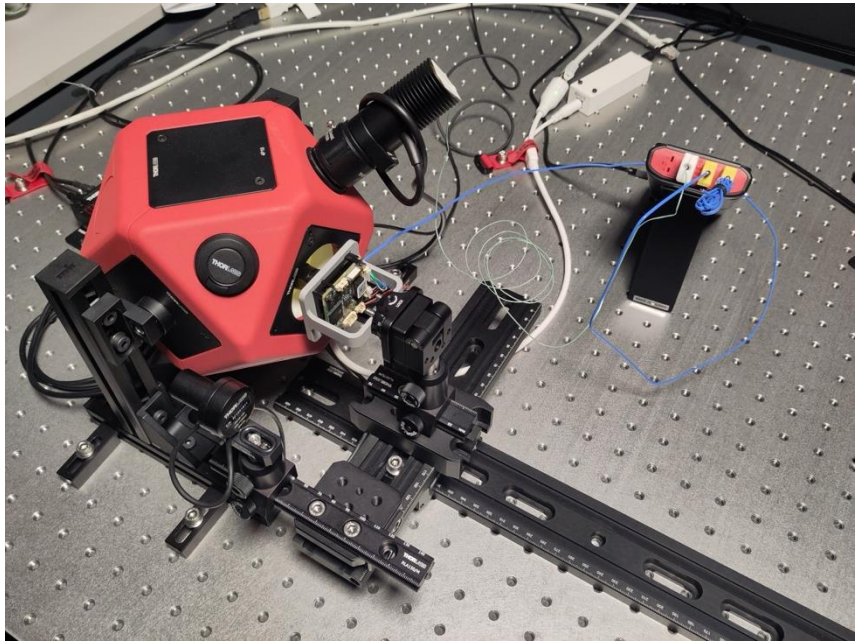
- Data sources: Investigating FRIPON and AllSky7 data
- Observation area: Overlap of FoV of at least two stations
- Estimation of cloud cover: EUMETSAT data



Laboratory experiments with IMX291-based* camera

- Studying the various camera parameters and options
- Creating flat fields using an Integrating Sphere

** used by AllSky7*



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