

ESA's activities in Planetary Defence

D. Koschny and the ESA Planetary Defence Team

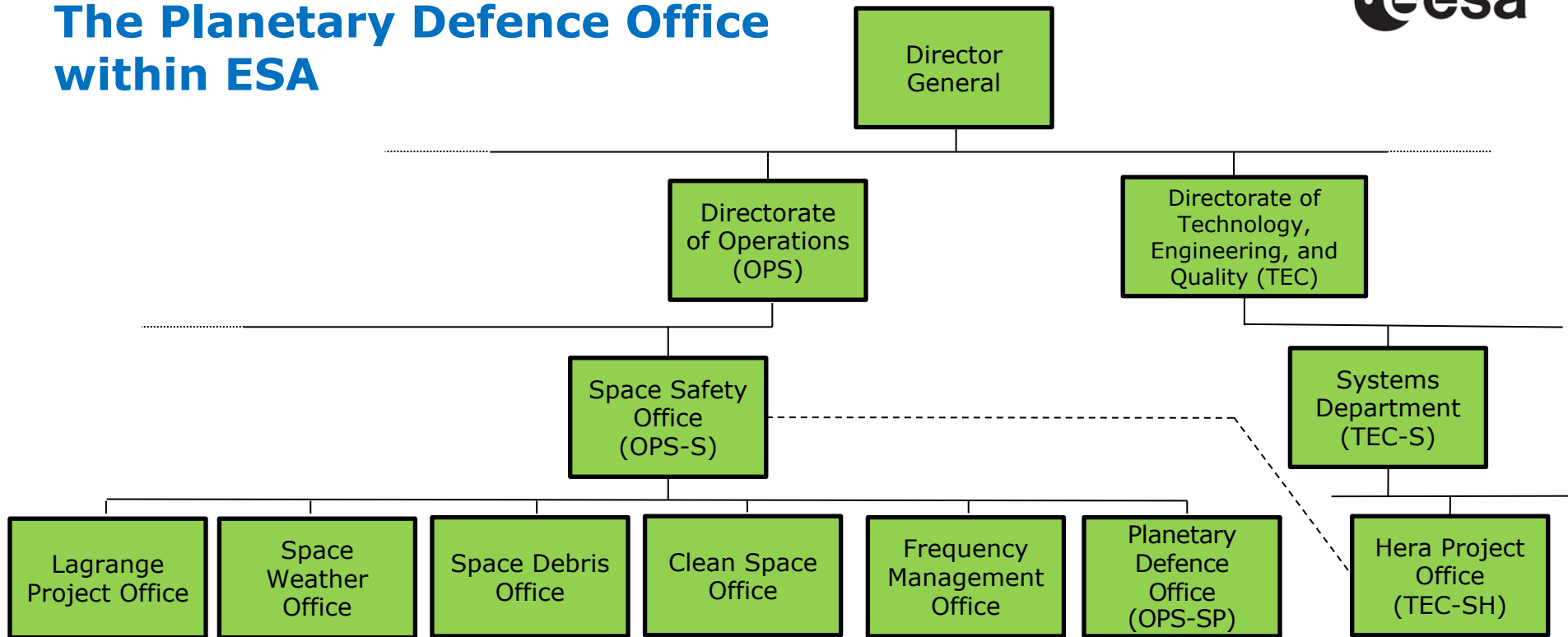
PDC 2021

Image credit: ESA/P. Carril

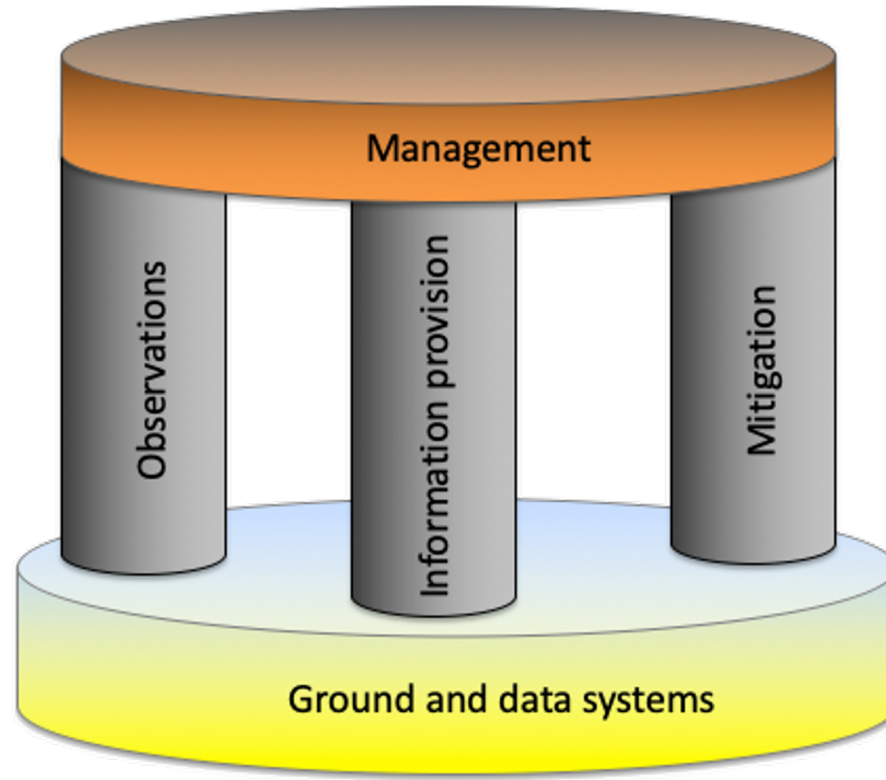
*"The goal of Space Safety is [] **the protection of our planet, humanity and assets in space and on Earth from dangers originating in Space**" (PB-SSA 2018(24))*

- ❑ **To be aware of situation of natural objects in space**
- ❑ **To predict possible impacts and their consequences and inform relevant parties**
- ❑ **To prepare for risk mitigation, by technological developments and on political level**

The Planetary Defence Office within ESA

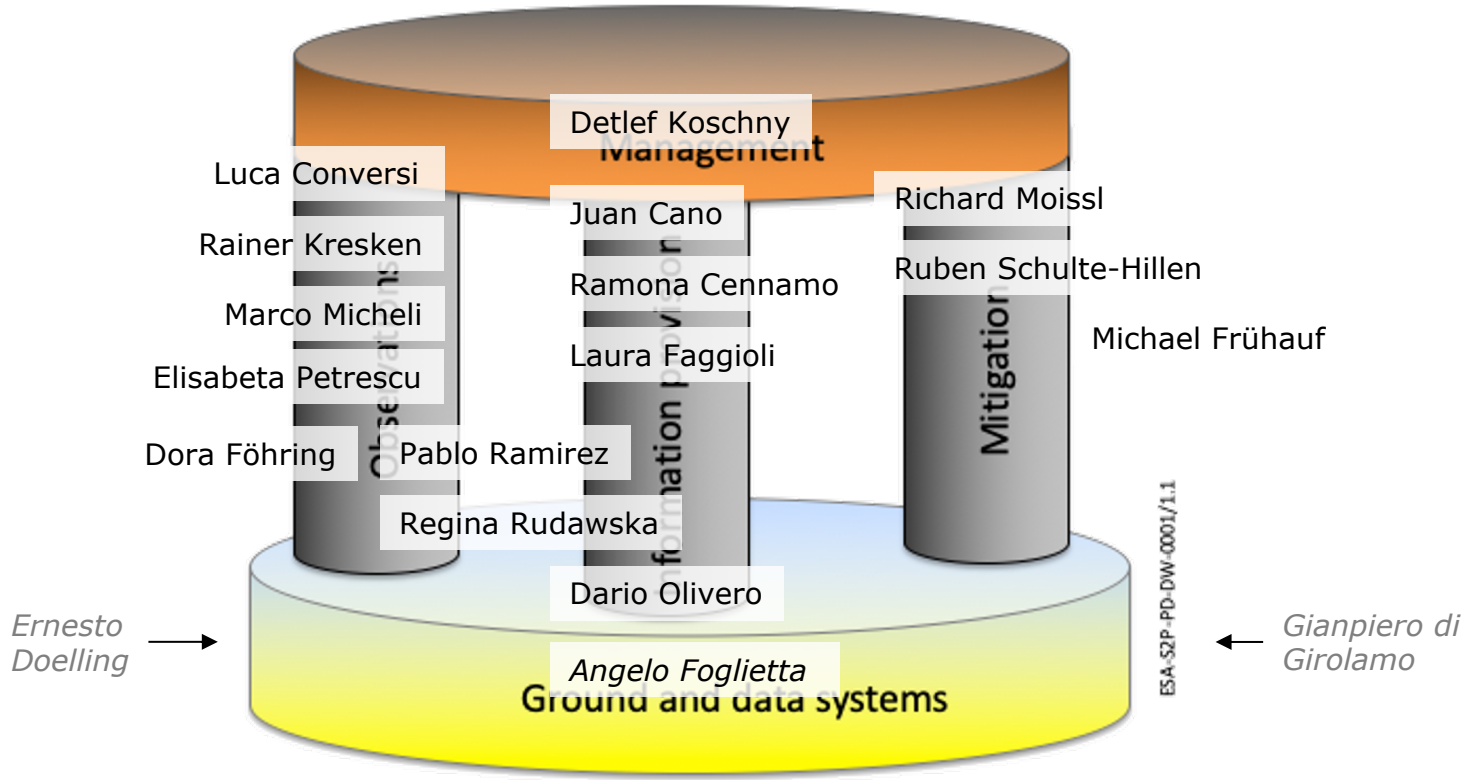


The setup of the Planetary Defence Office



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ESA's Planetary Defence team



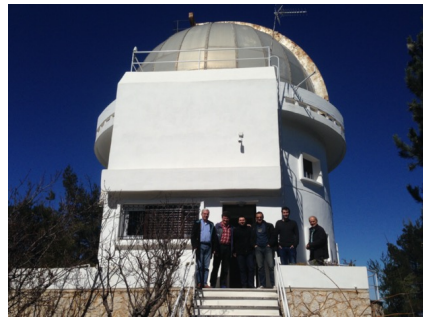
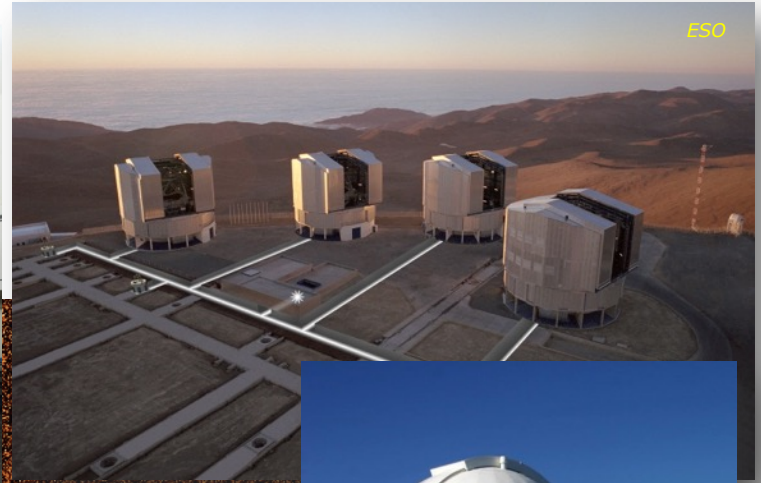
The NEO Coordination Centre

- ❑ The 'instantiation' of the Planetary Defence team – a building at ESA's location ESRIN in Frascati close to Rome, Italy. About half of our team is located there. Computing h/w in separate building.



Images: ESA/NEOCC

Observations



Some of the observatories we work with

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- ❑ **Conversi et al. 'ESA's NEO Coordination Centre observational network'**
- ❑ **Micheli et al. 'Recent observational highlights from ESA's NEO Coordination Centre'**
- ❑ **Perozzi et al. 'An efficient deployment strategy for the first ESA Flyeye NEO survey telescope'**
- ❑ **Rudawska et al. 'FITS image archive at ESA's NEO Coordination Centre'**

Also check out:

- ❑ **Zolnowski et al. '6ROADS – Highly precise optical observations of NEO, fast-moving satellites and Space Debris from a worldwide telescope network'**

Information provision



Information distribution via web portal – risk list, orbits, physical properties, Close-Encounter Fact Sheets....

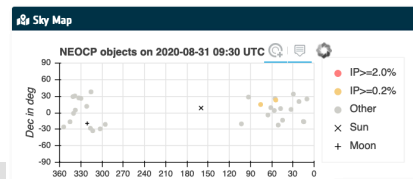
Orbit Determination and Impact Monitoring software

The screenshot shows the NEOCM web portal interface. At the top, it says 'near-earth objects coordination centre' with the ESA logo. Below that, there's a navigation menu with 'EUROPEAN SPACE AGENCY' and 'SPACE SAFETY PROGRAMME'. The main content area features 'The NEOCC is ESA's centre for computing asteroid and comet orbits and their probabilities of Earth impact.' and 'NEOCC DATABASE STATISTICS' with a last update of '2021-04-15 06:55:47 UTC'. There are three main statistics cards: 'NEAs in Risk List' with 1156 objects, 'Current NEAs' with 25553 objects, and 'Current NECs' with 113 objects. Below these are news sections with headlines like 'Apophis removed from the risk list', 'A brand-new face for the NEOCC web portal', and 'Impact monitoring for Apophis computed...'. A sidebar on the left contains various service links like 'Risk List', 'Close Approaches List', and 'Search'.

Many tools and scripts, notification systems...

The screenshot shows the 'Meerkat Asteroid Guard' dashboard. It includes a 'Dashboard' section with a 'Number of NEOCP' of 45 and 'Number of Objects' of 0. Below this is a 'Meerkat Analysis Timeline' table with columns for DATE, TEMP. DESIG., N. OBS., IMP. PROB., NEO PROB., ISO SCORE, IEO PROB., and MIN. WRMSE. To the right of the table is a circular diagram showing the orbits of Earth, Mars, and Mercury, with a specific point labeled '99942 Apophis' near Earth's orbit.

DATE	TEMP. DESIG.	N. OBS.	IMP. PROB.	NEO PROB.	ISO SCORE	IEO PROB.	MIN. WRMSE
8-31 04:06	Z1FOERB	5	0	0.99999	0.00008	0	0.06
8-30 18:03	C3U392	16	0	0	0.00391	0	0.51
8-29 18:56	A10pPol	5	0.00018	0.76639	0.00007	0	0.52
8-29 17:53	C3U392	12	0	0.05471	0.00216	0	0.47
8-29 17:48	P114Xm	3	0	0.38102	0.00002	0	0.55
8-29 17:44	P214yT	4	0	0.75348	0.00004	0	0.06
8-29 17:41	P214XIA	4	0.00012	0.87336	0.00005	0	0.48



TEMP. DESIG.	N. OBS.	IMP. PROB.	GEO. IMP. PROB.	VIS. MAG.	RA	DEC	UNC
Z1FOEK3	4	0.01164	0.01136	23.1	54.31	22.95	3475
Z1FOEjr	4	0.00467	0.0022	23.4	75.69	14.88	4465
C31KCU2	4	0.00136	0	21.2	65.34	-4.15	178
Z1FOENm	4	0.00103	0.00039	20.1	316.26	-28.13	974
C32ZNR2	6	0.00087	0	20.8	56.18	4.14	4
C34GEH2	4	0.0004	0	21.6	61.17	9.21	11



- ❑ **Cano et al. 'Evaluation fo an NEO close approach frequency index for public/media release purposes'**
- ❑ **Cano et al. 'Recent evolutions in ESA's NEO Coordination Centre information system'**
- ❑ **Di Girolamo et al. 'ESA's planetary defence NEO Coordination Centre DevOps model-based operations'**
- ❑ **Frühauf et al. 'Meerkat Asteroid Guard imminent impactor warning service of the European Space Agency'**

Also check out:

- ❑ **Bernardi et al. 'New NEODYs tools for the EU-funded NEOROCKS project'**

space situational awareness

→ NEAR-EARTH OBJECTS

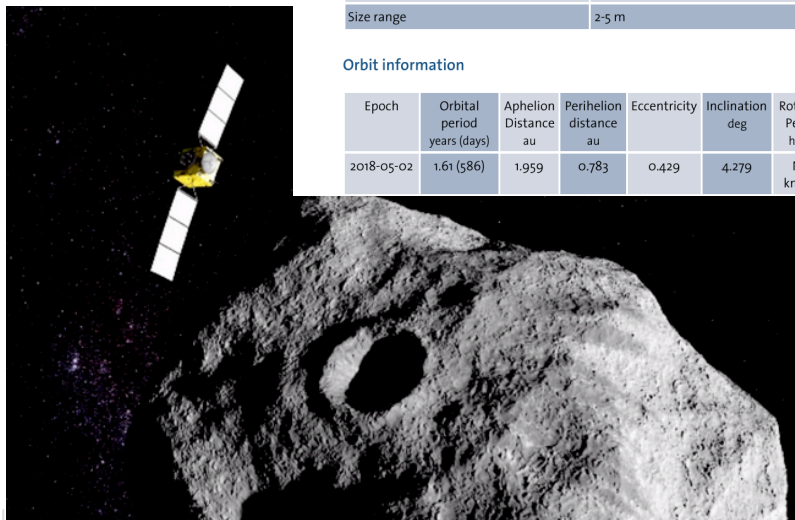
Close approach fact sheet for asteroid 2018 LA

A small asteroid impacted the Earth on 02 June 2018.

Impact date	2018-06-02
Impact time	~ 16:45 UTC
Minimum distance from Earth surface	The object impacted the Earth
Fly-by speed	17.0 km/s
Size range	2-5 m

Orbit information

Epoch	Orbital period years (days)	Aphelion Distance au	Perihelion distance au	Eccentricity	Inclination deg	Rotation Period hours
2018-05-02	1.61 (586)	1.959	0.783	0.429	4.279	Not known



The medium-sized asteroid 2012TC4 had a close approach with the Earth on 12 October 2017. The minimum distance was outside the geostationary ring. This is a special-interest event.

Flyby information:
 Flyby date: 2017-10-12
 Closest approach time: 05:41 UTC +/- 0 s
 Flyby distance from Earth surface: 43632 km +/- 1 km
 Flyby speed: 7.26 km/s
 Size range: 13.0 m to 30.0 m
 Discovery date: 2012-10-04
 Discovery site: Haleakala

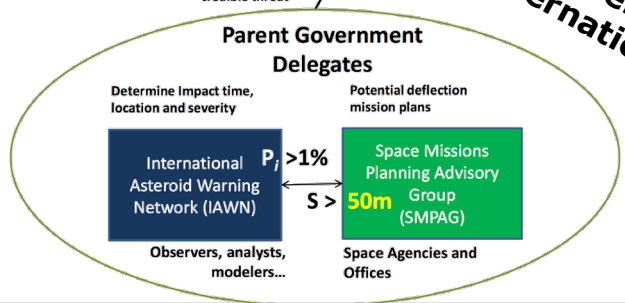
Orbit information:
 The flyby caused a change in the orbit elements.
 Date before and after flyby: Before = 2017-09-12, after = 2017-22-12
 Orbital periods in years/rs/days: Before = 0.885/1.67, after = 0.886/2.06
 Aphelion distances in au: Before = 1.878, after = 2.275
 Perihelion distances in au: Before = 0.934, after = 0.965
 Eccentricities: Before = 0.336, after = 2017-22-12
 Inclinations in deg: Before = 0.857, after = 0.536

Mitigation information:
 No mitigation actions required for this object.
 Days since closest approach: -1203
 Cumulative impact probability: 0
 Composition (Taxonomic type): Unknown
 Rotation period in hours: 0.204

Other information:
 Peak brightness magnitude: 12.7
 Date of previous encounter: 2012-20-12
 Date of next encounter: 2050-10-19
 Encounter peculiarities: An international observation campaign devoted to the very close flyby of 2012TC4 had been organised.

United Nations
COPUOS/OOSA

Inform in case of
credible threat



And there is an international context

- ❑ **Drolshagen et al. 'Scope, objectives and first results of the Space Mission Planning Advisory Group (SMPAG)'**
- ❑ **... and we are preparing our 'Close Approaches Fact Sheet' and the 'Automated Impact and Close Approach Message' as part of the exercise**
- ❑ **And of course look at all the Hera talks**



Image credit: ESA/P. Carril