ESA's Planetary Defence Office Contributions to IAWN

D. Koschny, Planetary Defence Office

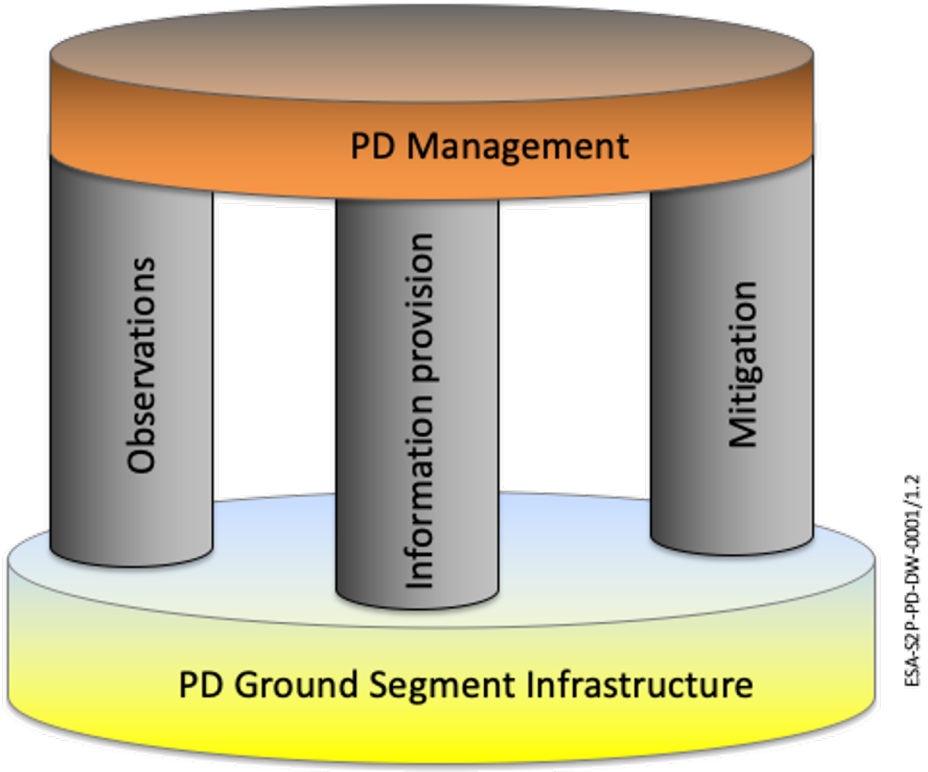
23 Sep 2020, IAWN meeting

With: Juan-Luis Cano, Ramona Cennamo, Luca Conversi, Laura Faggioli, Angelo Foglietta, Dario Oliviero, Rainer Kresken, Marco Micheli, Richard Moissl, Pablo Ramirez, Regina Rudawska, Michael Frühauf/Elisabeta Petrescu

Image credit: ESA/P. Carril

The Planetary Defence Office (PDO)

- **Part of the Space Safety Programme (with Space Weather, Space Debris, missions like Lagrange, Hera)**
- **12 people (observers, orbit experts, operators) + 1 trainee**
- **Main location: ESRIN, Frascati Italy**
- **External contracts for s/w and h/w developments, observational activites**
- **Support from other parts of ESA**



The NEO Coordination Centre (NEOCC)

NEOCC inauguration
May 2013

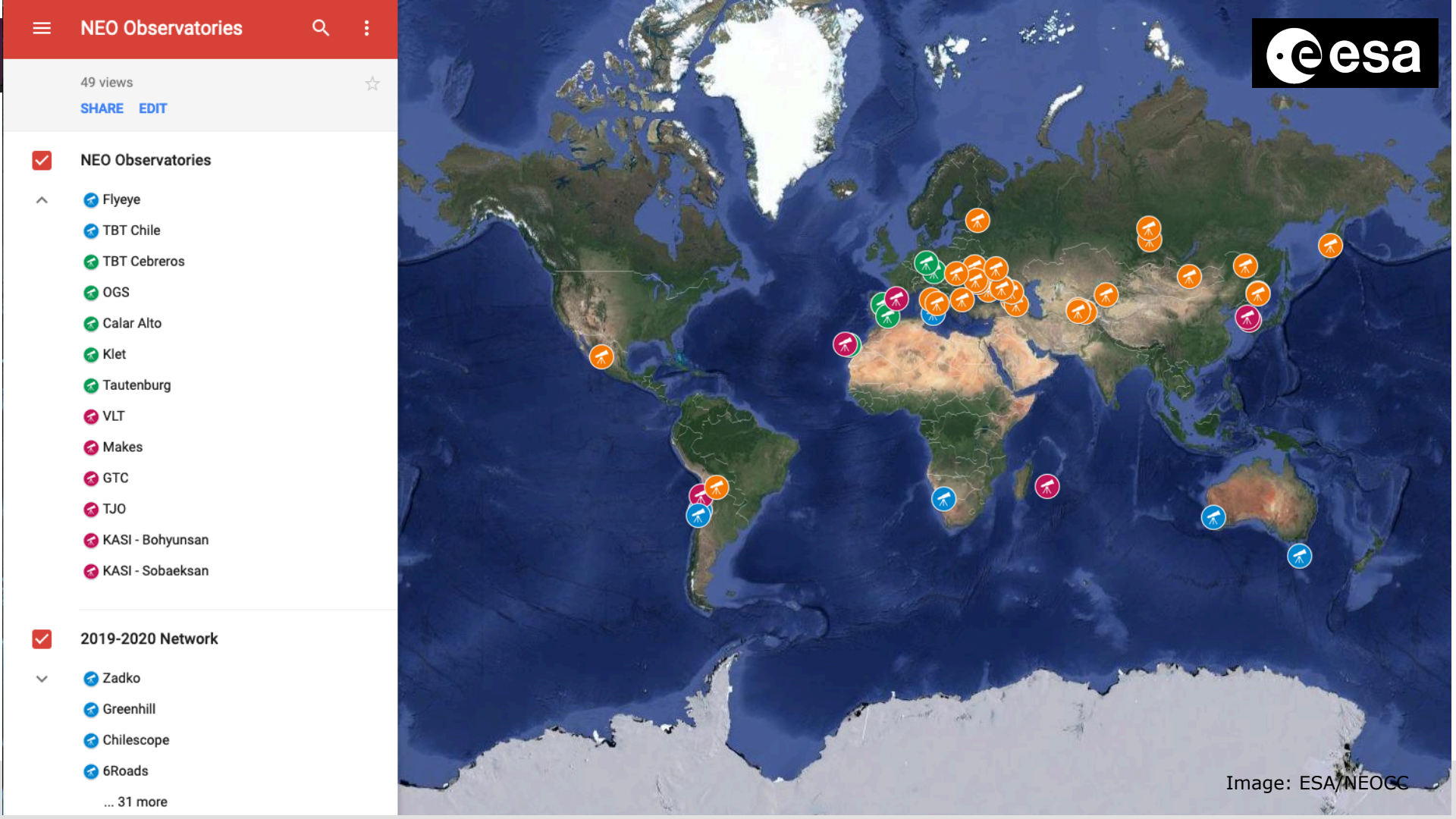
NEOCC Aug 2020

Images credit: L. Conversi

Observations #1

- **Follow-up**
  - **Optical Ground Station (1 m, 0.7 x 0.7 deg^2) – 4 nights per month**
  - **80 cm Calar Alto (CAHA) Schmidt – fully available**
  - **Test-Bed Telescope - #1 in use close to Madrid, #2 'under installation' on La Silla (on hold due to CoViD19)**
  - **Access to other telescopes for follow-up, including ESO's VLT**
- **Physical properties**
  - **Very limited – left to European Union projects**
  - **Radar capabilities are being analysed**
- **Survey**
  - **Still only short test phases, using our 1 m Optical Ground Station and CAHA Schmidt (e.g.: information about pointing is now sent to MPC)**
  - **Flyeye telescope progressing**

Images are made available via our web portal (>400 000), searchable via the Canadian Astronomy Data Centre https://www.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/en/ssois/


NEO Observatories
49 views
SHARE
EDIT
NEO Observatories
Flyeye
TBT Chile
TBT Cebreros
OGS
Calar Alto
Klet
Tautenburg
VLT
Makes
GTC
TJO
KASI - Bohyunsan
KASI - Sobaeksan
2019-2020 Network
Zadko
Greenhill
Chilescope
6Roads
... 31 more
esa
Image: ESA/NEOCC

Observations #3

Examples: BepiColombo Earth flyby

- **Can be used as a proxy for a Chelyabinsk-like impactor when reversing the timeline (Micheli et al., submitted to Icarus)**

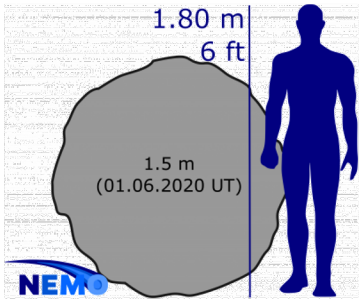
Element	Our optical measurements	ESA Flight Dynamics measurements	Delta (all smaller than 1 σ)
Flyby distance	(10064.016 +/- 0.180) km	(10063.905 +/- 0.001) km	~100 m
Flyby time	04:26:06.418 +/- 0.033 s	04:26:06.399 +/- 0.001 s	~20 ms
Area-to-Mass Ratio	(16.2 +/- 1.6) 10^{-3} m^2 / kg	15.3 10^{-3} m^2 / kg	~1·10^{-3} m^2 / kg

Observations #4

Examples: Fireballs

- **After alerts from our social media scanning system NEMO: Infrasound data is regularly checked (Univ Oldenburg)**
  - **Publication on website of International Meteor Organisation**
- **Fireball Information System: Long-term archive for DLR fireball data of the 'European Network', contains data from 2006 to 2020 Q1**

The extraterrestrial object that entered the Earth's atmosphere could also be measured by infrasound. One station of the International Monitoring System of the Comprehensive Nuclear-Test-Ban Treaty Organisation was almost 1150 km away from the event but in its waveforms a signature of the fireball could be identified. We were able to calculate a source energy of the entering asteroid of about 150 t TNT. With the velocity of 15 km/s computed by SonatoCo and an assumed density of 3000 kg/m^3 the size would be around 1.5 m diameter, with a mass of about 5.5 t!

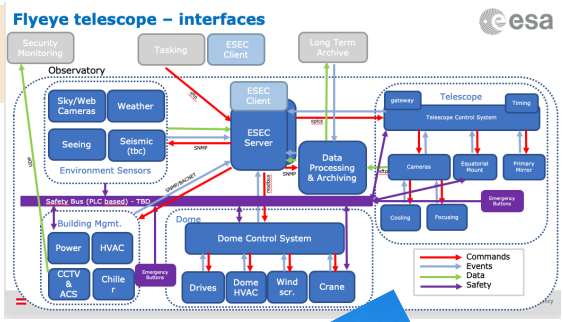


Size of the entering object that caused the fireball (1.5 m)

From: https://www.imo.net/bright-fireball-over-italy/
Published 03 Jul 2020, updated 14 Jul 2020
Ott et al. (2020), Acta Astronautica 177, 172-181
Ott et al. (2019), Planet. Space Sci., 179, 104715

Observations #5

- **Flyeye**
  - **Site loan agreement being negotiated**
  - **Dome and infrastructure design being finalized**
  - **Tasking software and data processing chain close to final**
  - **Telescope: sub-optimal PSF currently being investigated**
  - **16 cameras being manufactured**



Images: Google Earth

Image: ESA/OHB-1


Image: EIE

Information provision

- Updated orbit s/w (evolved from NEODyS) running at the NEOCC
  - Still working on the alignment with JPL data
  - Rebuilding the risk history
  - Expect switch from NEODyS to NEOCC s/w before the end of the year
- Web portal is being renewed – scheduled to be online within the next few weeks
- "Meerkat" ready – a s/w tool to take MPC tracklets for objects on the NEOCP and uses systematic ranging to identify imminent impactors; web-based dashboard, sends emails (right now only ESA internal)
- One upcoming relevant point: ArtSat database development

The new face of http://neo.ssa.esa.int

near-earth objects coordination centre

esa

NEOCC Home
About NEOCC

MAIN SERVICES
Risk List
Close Approaches List
Priority List
Newsletters Archive
CAFS Archive
News Archive

SEARCH
Asteroids
Comets
FITS Images
Fireballs

TOOLS
Orbit Visualiser
NEO Population Generator
NEO Propagator

OUTREACH
NEO Chronology
Discovery Statistics
NEOCC Riddles
Gallery
Public Outreach
Definitions & Assumptions
FAQ

EXTERNAL LINKS

The NEOCC is ESA's centre for computing asteroid and comet orbits and their probabilities of Earth impact.

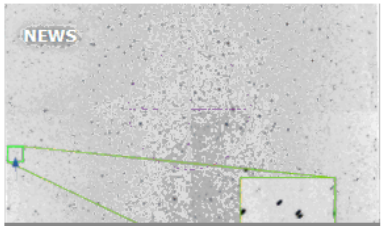
→ NEOCC DATABASE STATISTICS

Last update: 2020-09-01 00:50:00 UTC

NEAs in Risk List	Current NEAs	Current NECs
1077 objects	23424 objects	111 objects

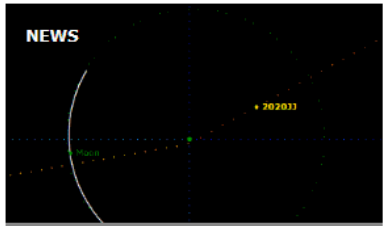
→ NEWS / NEWSLETTERS / CAFS

All news



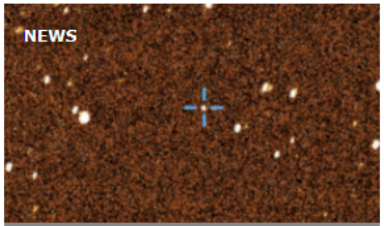
2020 QG, the closest close approach

The fly-by of 2020 QG asteroid



An even closer unexpected approach

The fly-by of 2020 JJ asteroid



An unexpected very close approach

The fly-by of 2020 HS7 asteroid

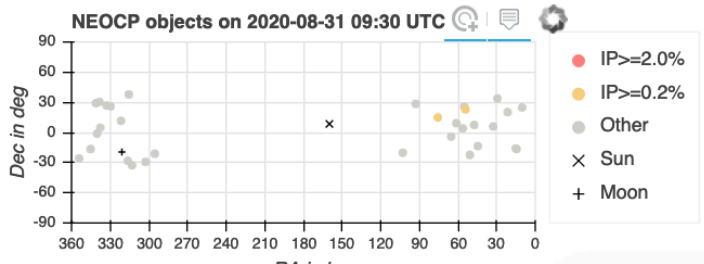
45	2020-08-31 04:03	2020-08-31 09:14
Number of NEOCP objects	Last NEOCP Input in UTC	Last Backend Connection in UTC

0	2	1.16%
Number of Objects IP≥2.0%	Number of Objects IP≥0.2%	Highest Impact Probability

Meerkat Analysis Timeline

COMP. DATE	TEMP. DESIG.	N. OBS.	IMP. PROB.	NEO PROB.	ISO SCORE	IEO PROB.	MIN. WRMSE
2020-08-31 04:06	ZTF0ERB	5	0	0.99999	0.00008	0	0.06
2020-08-30 18:03	C33U392	16	0	0	0.00391	0	0.51
2020-08-29 18:56	A10pPol	5	0.00018	0.76839	0.00007	0	0.52
2020-08-29 17:53	C33U392	12	0	0.05471	0.00216	0	0.47
2020-08-29 17:48	P114Xrm	3	0	0.38102	0.00002	0	0.55
2020-08-29 17:44	P214XyT	4	0	0.75348	0.00004	0	0.06
2020-08-29 17:41	P214XIA	4	0.00012	0.87336	0.00005	0	0.48

Sky Map



Highest Impact Probabilites

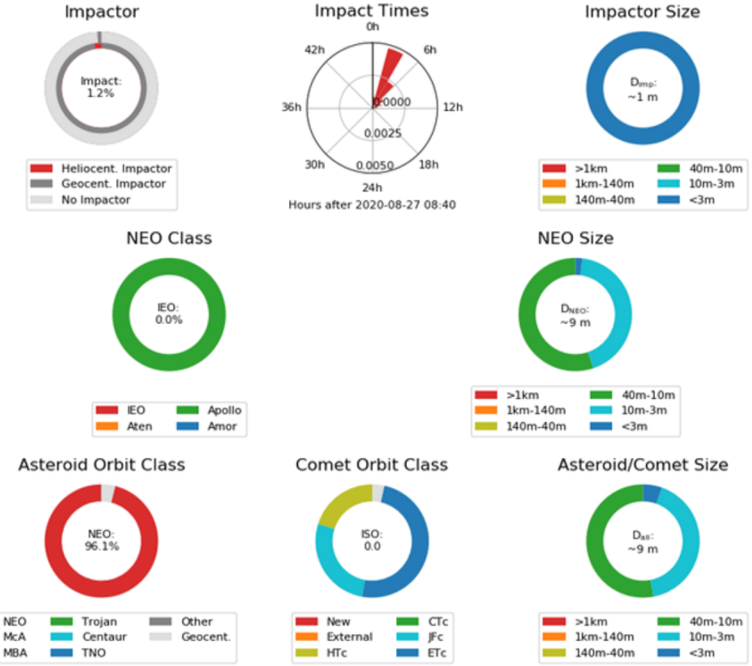
TEMP. DESIG.	N. OBS.	IMP. PROB.	GEO. IMP. PROB.	VIS. MAG.	RA	DEC	UNC
ZTF0EK3	4	0.01164	0.01136	23.1	54.31	22.95	3475
ZTF0EJr	4	0.00467	0.0022	23.4	75.69	14.88	4465
C31KCU2	4	0.00136	0	21.2	65.34	-4.15	178
ZTF0ENm	4	0.00103	0.00039	20.1	316.26	-28.13	974
C33ZZN2	6	0.00087	0	20.8	56.18	4.14	4
C340EH2	4	0.0004	0	21.6	61.17	9.21	11

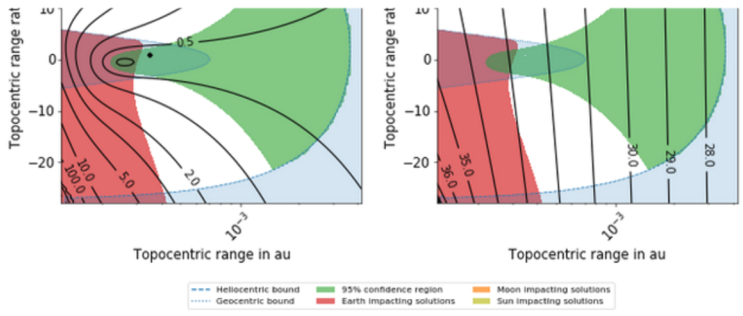
	2020-08-27 22:08 UTC
	33.3 mag
	1.3 m
	28.9 mag
	9.7 m
	29.1 mag
	9.1 m
	34.73 R_{earth}
	2020-08-25 03:51 UTC

NObs:	4
Obs Arc:	0.18305 h
Last Obs:	2020-08-27 08:40 UTC
Last vis. mag:	15.7 mag
Last RA:	-30.227 deg
Last Dec:	-1.958 deg
Discovery Stn:	I41
Discovery Date:	2020-08-27 08:29 UTC

[Score Visualisation] [Systematic Ranging Visualisation] [Station Selector] [Scatter] [Impact]

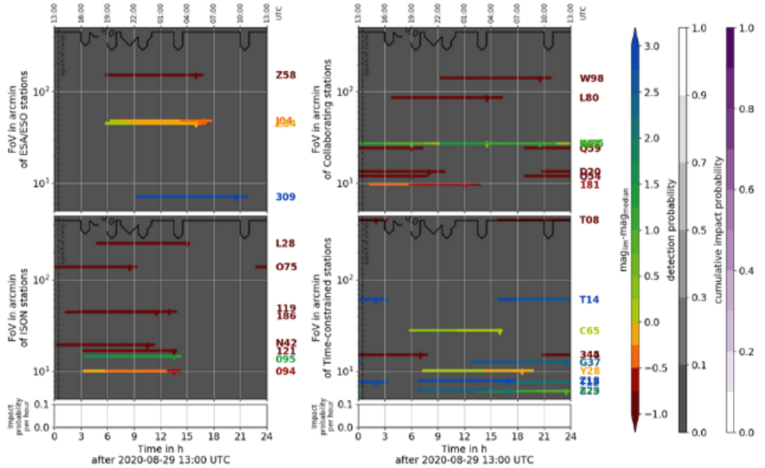
ZTF0EK3 Dashboard: 4 obs, 0.18 h arc length



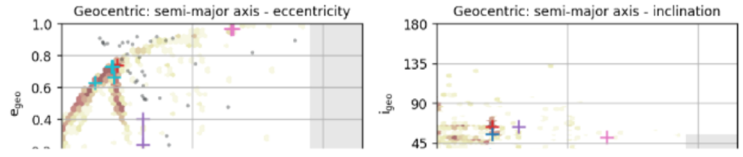


First observation: 2020-08-27 08:29:17, Last observation: 2020-08-27 08:40:16, Number of observations: 4

ZTF0EK3 Detection probability: 4 obs, 0.18 h arc length



ZTF0EK3 Scatter plot: 4 obs, 0.2 h arc length



Mitigation

- Knowledge base for impact effects has been developed, delivery end Sep 2020
- Next step: Operational tool for fast determination of impact effects
- Close-Approach Fact Sheets this year: 1998 OR2; 2020 OY4; 2020 SW
  - Definition of a close approach?
- Preparation of ‘text blocks’ for information messages ongoing
  - Where do we stand within IAWN on this?

→ CAFS FOR 2020 OY4

ESA's NEO Coordination Centre

Close approach fact sheet for asteroid 2020 OY4

A tiny asteroid will have a close approach with the Earth on 28 July.

Fly-by date	2020-07-28
Closest approach time	05:31 UTC (± 2 min)
Fly-by distance from Earth surface	35 170 km, 0.091 Lunar Distances (± 50 km)
Fly-by speed	12.4 km/s
Size range	2-5 m
Discovery date	2020-07-26
Discovery site	Mt. Lemmon Survey

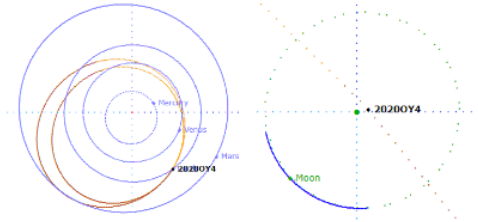
All error bars quoted in this table correspond to one standard deviation.

Orbit information

As the approach distance of the nominal trajectory to the Earth is relatively small, changes in its orbital elements due to the Earth gravity are noticeable.

Date before and after fly-by	Orbital period (years / days)	Aphelion distance au	Perihelion distance au	Eccentricity	Inclination deg
2020-06-28	1.19 / 436	1.561	0.688	0.389	2.112
2020-08-28	1.03 / 376	1.413	0.625	0.387	3.592

All orbital elements in this table are referred to the ecliptic at the epoch of J2000.0.



CLOSE APPROACH FACT SHEET: Asteroid 2020 OY4. Release 1 (2020 July 27 16:00 UTC)

esa

NEO

European Space Agency

Physical and mitigation information

Days to closest approach	Cumulative impact probability	Composition	Rotation period (hours)
1	Not applicable	Not known	Not known

Observational information

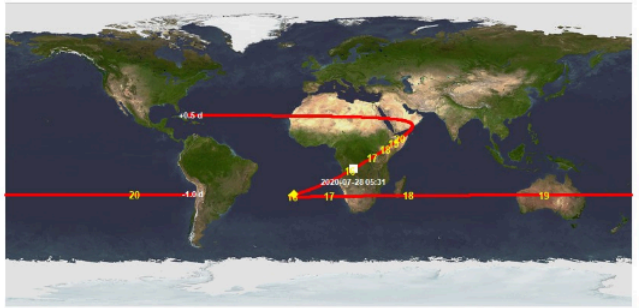
Peak brightness	Visual Observability	Geometric observability
~15	Too faint to observe visually.	Located at slightly Southern declinations before close approach. Unobservable due to low elongation after close approach.

Other information

Encounter peculiarities	Previous encounter	Next encounter
None	None	2021-07-26

Asteroid ground track

The asteroid ground track is provided below, starting one day before the closest approach, and extending for 1.5 days. The curve represents the movement of the sub-asteroid point over the Earth along the mentioned time interval. The asteroid is predominantly a Southern object during the incoming phase, while it gets brighter and closer to Earth. The formal time of maximum brightness (yellow diamond) is located over the Southern Atlantic. After that, the object rapidly heads to is closest approach (white square), and then recedes towards the Sun, becoming unobservable due to the low elongation, the high phase and consequently the extremely faint magnitude.



Links

NEO information:
http://neo.ssa.esa.int/search-for-asteroids?sum=1&des=2020OY4

Orbit visualiser:
https://tinyurl.com/yyyj7ryo

Close approaches page:
http://neo.ssa.esa.int/close-approaches

neo.ssa.esa.int
For further information please send an email to neocc@ssa.esa.int

Summary

- ESA is providing support to IAWN – observations, computations, mitigation – via the Planetary Defence Office
- Part of the Space Safety programme period 1 (2020 – 2022)
- Tight budget – wrapping up things that were started earlier
- New budget expected starting Jan 2023
- And of course there is also Hera!