

Risk Assessment Pillar at ESA's Planetary Defence Office



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Introduction

One of the main goals of ESA's NEO Coordination Centre (NEOCC) is the accurate computation of the orbits of near-Earth asteroids (NEAs) and their probability of impact with the Earth. These activities are carried out by the Risk Assessment Pillar, one of the three pillars of ESA's Planetary Defence Office [1]. To this purpose, the NEOCC operates two automated systems: (1) the Aegis Orbit Determination and Impact Monitoring System and (2) the Meerkat Asteroid Guard. The Aegis system is a software developed by SpaceDyS s.r.l. through industrial contracts from ESA and it processes data about NEAs. The Meerkat Asteroid Guard is a system that processes unconfirmed objects, searching for imminent impactors.

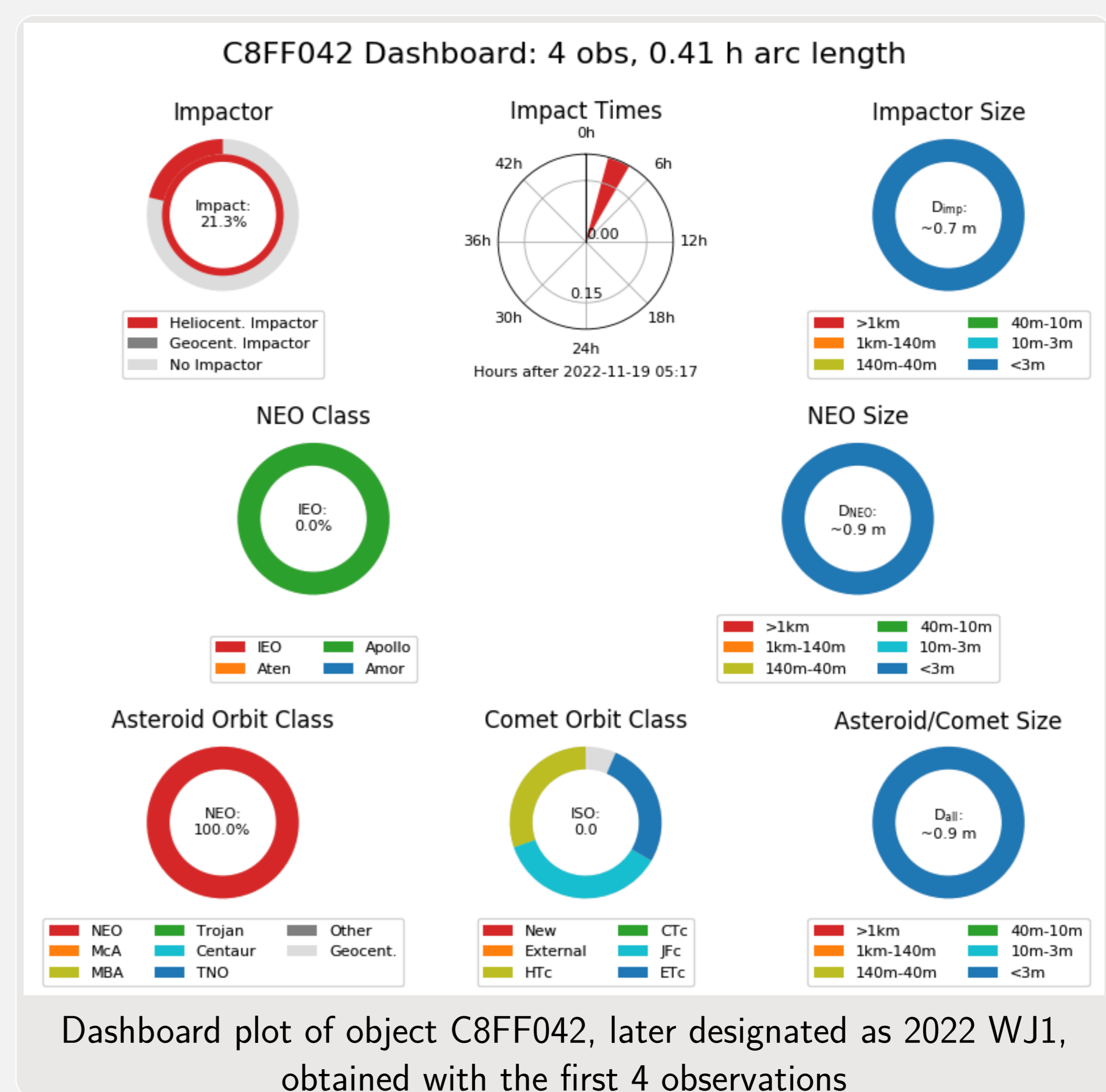
Aegis: Orbit Determination and Impact Monitoring system

The Aegis system updates astrometric data of asteroids released by the Minor Planet Center (MPC) on a daily basis, and provides a catalogue of NEAs which comprises: orbits with their uncertainties, some physical properties, observations and residuals, close approaches in the last and in the next 100 years and ephemerides. More importantly, it also computes the impact probabilities of NEAs with the Earth in the next 100 years, and all the NEAs with a non-zero impact probability are collected in the **NEOCC Risk List**.

The NEOCC portal offers the users an ephemerides request service, available through an HTTPS API, and Aegis is used to take care of the computations requested. Aegis computes data also for the ESA NEO Toolkit, a new set of services for orbit visualization and observation scheduling [2]. A new Orbit Visualization Tool (OVT), a Flyby Visualization Tool (FBVT) and a Observation Planning Tool (OPT) are now available.

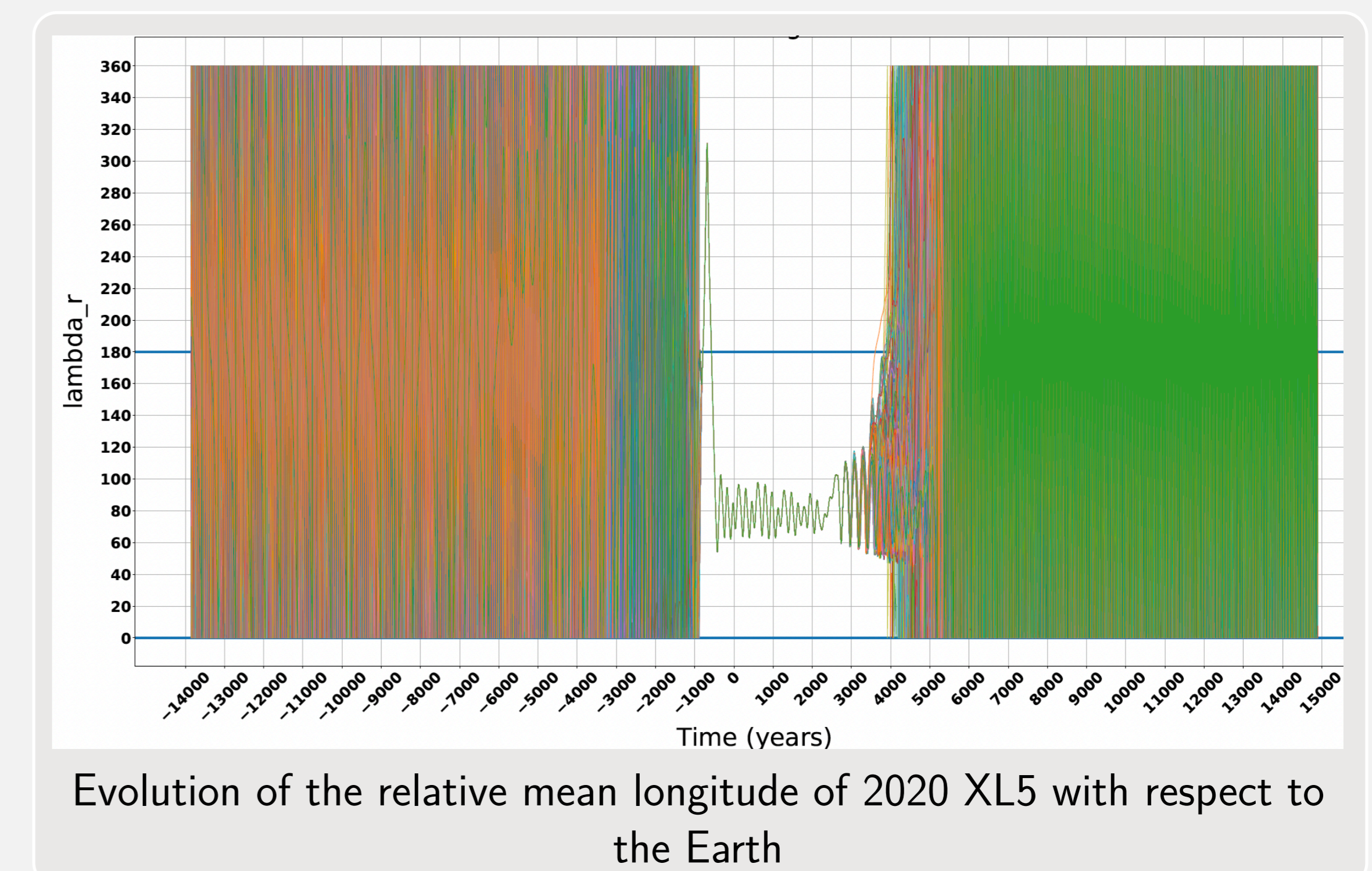
Meerkat: imminent impactors warning service

The Meerkat Asteroid Guard is an automatic tool that scans the MPC NEO Confirmation Page in order to search for imminent impacting objects. Meerkat provides users with different plots. The Dashboard plot gives a clear overview for threat assessment by visualizing the relevant information as pie charts. The Station Selection plot helps choosing the right observatory for follow-up observations. Finally, the estimated impact corridor gives an indication of the impacting location, with a precision of few kilometres. The computations performed by Meerkat are currently sent to a mailing list opened to people involved in the planetary defence community. Since the beginning of its operations, Meerkat detected three imminent impactors: 2022 EB5, 2022 WJ1, and 2023 CX1.



Other activities supported by the Risk Assessment Pillar

Aegis is used to carry out other activities in NEOs research. Aegis and its predecessor, AstOD, have been used already in several activities: (1) the analysis of the orbital stability of the second Earth Trojan asteroid (614689) 2020 XL5 [4]; (2) the negative observation exercise of 2010 RF12; (3) the development of an automated Yarkovsky effect detection procedure [5]; (4) the update of the risk assessment of (29075) 1950 DA and of (99942) Apophis; (5) the Apophis 2021 campaign exercise.



RISK LIST

Last update: 2023-01-12 16:17 UTC

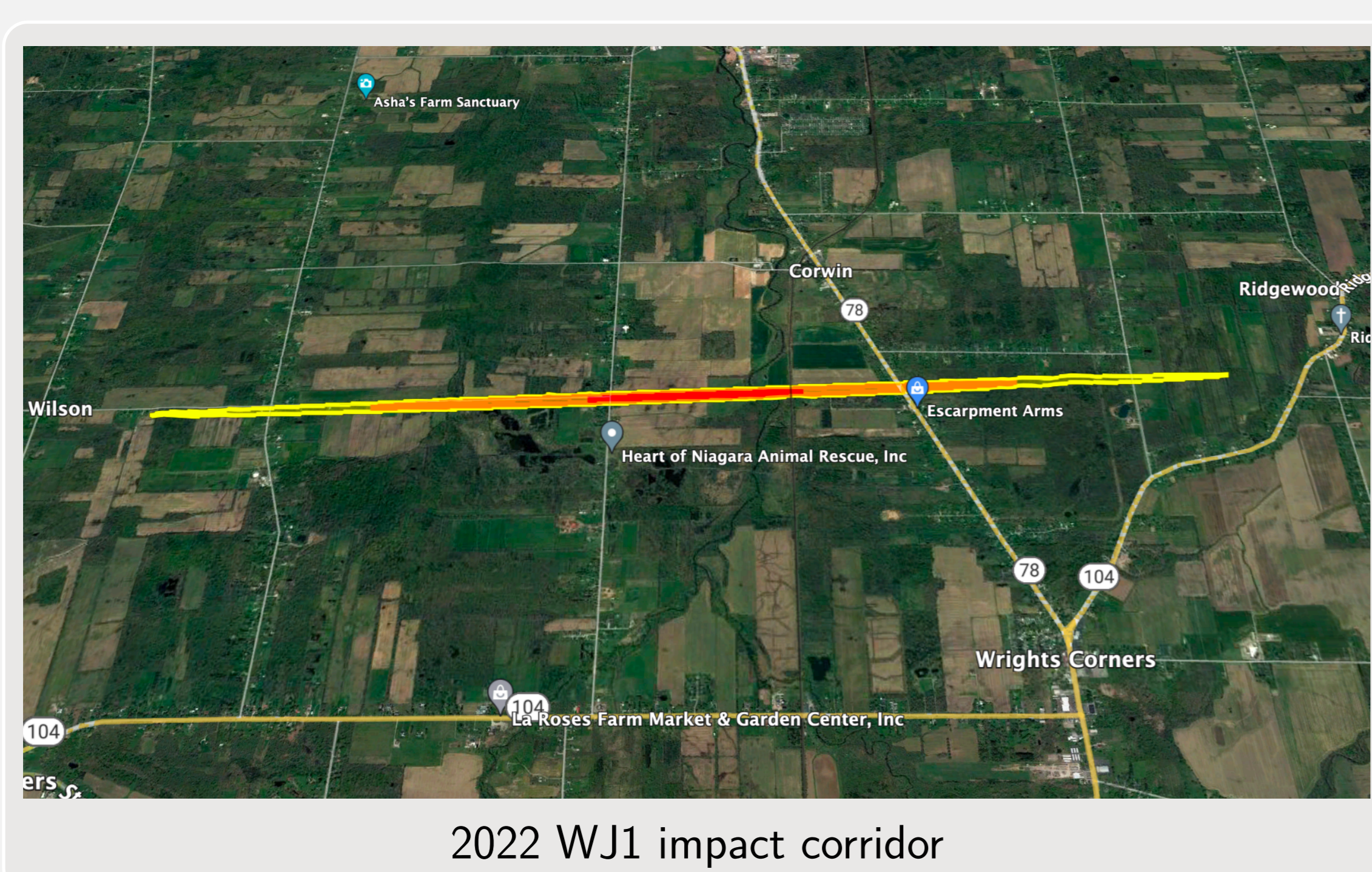
The Risk List is a catalogue of all objects for which a non-zero impact probability has been computed. Each entry contains details on the particular Earth approach which poses the highest risk of impact (as expressed by the Palermo Scale). It includes its date, size, velocity and probability. Impact 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: **1436**

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
1	2001VB	700*	2023-07-23 07:16	1/3.56E8	-2.64	0	2023-2089	1/3.34E8	-2.64	36.76	1211			
2	1979XB	700*	2056-12-12 21:38	1/4.27E6	-2.86	0	2056-2113	1/1.36E6	-2.74	27.54	5203			
3	2008JL3	30*	2027-05-01 09:05	1/6711	-3.08	0	2027-2122	1/6211	-3.08	14.01	5203			
4	2005ED224	60*	2023-03-11 08:25	1/487804	-3.18	0	2023-2064	1/383141	-3.16	27.08	5203			
5	2005GC344	40*	2071-09-16 00:54	1/11117	-3.20	0	2069-2122	1/354	-2.79	11.27	5203			
6	2005QK76	30*	2030-02-26 08:15	1/33222	-3.58	0	2030-2108	1/15576	-3.42	22.66	5203			
7	2021GX9	30*	2032-04-16 21:51	1/19880	-3.63	0	2032	1/19880	-3.63	20.17	637			
8	2007KE4	30*	2029-05-26 00:18	1/23419	-3.67	0	2026-2115	1/22883	-3.67	15.03	5203			
9	2019VB37	40*	2049-04-26 01:30	1/17793	-3.69	0	2041-2088	1/17513	-3.69	18.34	96		n/a	
10	2011DU9	16*	2046-02-23 20:44	1/1466	-3.75	0	2046-2101	1/1455	-3.75	14.21	4285			

The NEOCC Risk List on 12 January 2023

Aegis is used to compute the impact corridor with the Earth in case an impact probability of at least 10^{-3} is found [3]. The impact corridor typically shows three concentric ellipsoids, corresponding to the impact area determined at 1σ , 3σ , and 5σ levels. Since the end of 2022, the tool successfully predicted the impact location of 2022 WJ1 and 2023 CX1, two small NEAs that impacted the Earth respectively on 19th November 2022 and on 13th February 2023, with a precision of few kilometres.



References

- [1] Koschny D., et al. (2021), *7th IAA PDC*
- [2] Oliviero D., et al. (2023), *This conference*
- [3] Dimare L., et al. (2002), *CMDA*, **132**(3)
- [4] Santana-Ros T., et al. (2022), *Nat. Comm.*, **13**(447)
- [5] Fenucci M., et al. (2023), *This conference*



Scan the QR code to go to the NEOCC web portal