

Improving the overall system efficiency from detection, through orbit determination and consolidation

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Physical Characterization

Dynamical Characterization

Discovery





• We want to reduce the time from discovery to the time when the orbit is well constrained, such that physical observations are possible.





- The new fast-moving detections must be submitted to MPC as soon as possible:
 - Automatic detection
 - Fast validation
 - Fast submission
 - Time from detection to submission, ideally, within 20-30 min
- Fast follow-up, even before the NEOCP publication, is welcome:
 - Collaborating observers
 - Automatic alert (via telegram, whatsapp, emails, ...)
 - Catalina is a good example for fast follow-up through its telescopes' network



MPC-NEOCP posting

- The NEOCP posting for new candidates seems quite fast, (within minutes?)
- Automation is a key issue
- ...but also data quality check
- Both NEOScan and JPL-Scout are scanning the NEOCP web page very quickly



- NEOScan is the service, available at NEODyS, which performs the imminent impactors scanning: <u>https://newton.spacedys.com//neodys2/NEOScan/</u>
- It scans on a frequency of **2 minutes**
- As soon as new data are available from NEOCP, it uses data in ADES format directly from the MPC database replica @NEODyS: ADES has more information, in particular the expected measurements rms performance provided directly by the observer (or measurer)



- NEOScan monitors the possible imminent impactors within the next month
- Typical computation times: from few minutes to few tens of minutes
- Results of imminent impactors are posted on the NEOScan Risk Page: <u>https://newton.spacedys.com//neodys2/NEOScan/index_risk.html</u>



- Imminent impactors alerts are automatically sent to major players:
 - MPC, JPL, NEOCC, Big Surveys, Tim Spahr, Bill Gray, follow-up observers,...
 - Alerts are sent via email when the significance is good (when the observed arc is long enough) and the impact flag ≥3 (depending upon the impact probability)
 - Email alerts include the impact location map plot
 - Comparison with JPL-Scout results



NEOScan weak points

- Single run depending upon backlog runs
- If the foreseen impact is happening very soon (in few hours) and the data flow from observers is rapidly increasing, the computation might be not fast enough to catch up
- Room for improvements: this data processing issue can be fixed and the output release timing improved



- During the NEOROCKS project (<u>https://www.neorocks.eu</u>, EU grant n. 870403), we developed some tools and services to support the follow-up observers:
 - Observation prediction tools
 - NEOCP Priority List
 - NEOs' Priority Lists (after MPECed)
 - E-mailing service for tailored priority lists
 - Follow-up observers ranking



SpaceDyS

Observer tools in NEOScan

NEOScan	Sponsored by	SpaceDys	yyyy - mm - dd 💌 MJD
Near Earth Objects - Dynamic Site		UNIVERSITÀ DI PISA	2021-04-14 12:25:18 UTC 59318 MJD
Home NEOCP Scan Risk Page Observa	ational tools NEODyS		
EPHEMERIDES /	AND OBSERVATION PREDI	CTION	
		Object selection: P11ekJ2	•
MOV obs	ervation prediction		Nominal ephemerides
This tool provides the user with the observation prediction at a given by the MOV sampling.	given time for the selected object, based on the unc	ertainty representation This tool provide and given time s	s the user with the ephemerides of the orbit with minimum χ among the orbits of the MOV sampling, for the selected object van and time step.
Observatory Code 500 Prediction time (UTC) 2021 04 Maximum sigma 3.0 FoV Width (E-W) 0.0 arcmin FoV Width (N-S) 0.0 arcmin	- 14 12 : 00 n in	C	Deservatory Code 500 Initial time (UTC) 2021 04 14 12 00 Final time (UTC) 2021 04 15 12 00 Step 1.0 hours • • •
COMP This tool may require se	PUTE RESET		

Fixed time, full uncertainty

Time range, only nominal



Observation Prediction output at a fixed time

- Users can select a field of view box
- Output gives uncertainty with an associated magnitude color code
- It is possible to show NEO classes (Aten, Apollo,...)
- It can also show impactors (if any) to allow to focus on the most critical part of the sky



NEOCP Priority List

SpaceDyS

Home NEOCP Scan Risk Page NEOCP Priority List Observational tools NEODyS

Priority class

RA

Priority value

NEOCP PRIORITY LIST

NEOCP Priority List Withdrawn from NEOCP

 V mag.
 ΔV mag.
 Uncertainty
 Sun elong.

 DEC (deg)
 (deg)
 (deg)
 (deg)

Moon elong.

Gal. lat. Numb. of

Last Updated (UTC)

Last Update: 2022-07-11 09:43 UTC

\$	\$	¢	\$	¢	\$	\$	\$	\$	\$	\$	\$	\$	tools
N00k930	VERY LIRGENT	34.216	01:42	1"54"	20.69	0.43	2 28479	84.6	-126.4	-58.5	5	2022-07-02-07-32	
C7YI 242	VERY URGENT	3/ 138	17-27	42°05'	20.68	1.95	0.53660	-110.5	-67.4	32.8	4	2022-07-11 08:56	
xkos049	VERY URGENT	32.518	18:47	-76°15'	19.23	1.00	1 38472	-125.7	-52.8	-26.1	12	2022-07-10 09:17	
xkos051	VERY URGENT	32.138	10:56	-77'25'	19.09	1.12	1 42652	-124.5	-56.2	-30.0		2022-07-10-01:18	
XKOBOD1		32.130	10.00	-11 25	19.09	1.12	1.42002	-124.5	-502	-30.0		2022-07-10 01.10	
HKmNK01	VERY URGENT	27.307	23:31	1'34'	20.14	1.03	0.03147	114.8	-97.1	-55.5	15	2022-07-11 06:07	••
xkos053	VERY URGENT	25.124	23:17	-78°13'	19.54	0.35	0.46944	117.8	-66.2	-37.8	7	2022-07-10 02:10	••
P21vfVB	URGENT	24.470	22:27	-3°55'	21.76	0.06	0.00138	131.5	-80.3	-48.6	6	2022-07-11 07:52	••
P21vfVE	URGENT	11.319	22:36	-1°55'	22.00	0.06	0.00214	128.6	-83.2	-49.0	5	2022-07-11 08:12	••
P21vfVy	NECESSARY	8.677	22:18	1°12'	22.12	0.02	0.00162	131.0	-80.5	-43.6	7	2022-07-11 09:20	••
P21vg5M	NECESSARY	8.641	22:13	0°40'	22.13	0.02	0.00150	132.4	-79.1	-43.0	10	2022-07-11 08:38	••
P21vf7P	NECESSARY	8.571	22:54	7°30'	21.81	0.02	0.00155	120.1	-91.3	-45.3	12	2022-07-11 08:45	••
C7YKR52	NECESSARY	8.461	23:48	39°04'	21.46	0.02	0.00132	92.7	-114.0	-22.2	16	2022-07-11 07:42	••
C7YKQR2	NECESSARY	8.156	22:47	36°40'	21.48	0.01	0.00045	103.8	-101.8	-19.9	14	2022-07-11 08:33	••
P21vfVx	NECESSARY	7.091	22:09	-7°39'	21.13	0.02	0.00370	137.1	-74.7	-47.1	10	2022-07-11 07:32	••
P21vf7N	NECESSARY	6.722	22:33	0°27'	21.19	0.01	0.00111	128.1	-83.6	-47.0	9	2022-07-11 09:40	**
С7ҮКV32	NECESSARY	5.950	22:35	14°06'	20.58	0.01	0.00242	120.3	-89.9	-37.2	14	2022-07-11 08:01	••
P21veQu	NECESSARY	5.581	21:23	-2°43'	20.82	0.01	0.00031	144.7	-66.4	-34.7	19	2022-07-11 08:39	••
X78240	NECESSARY	4.570	19:36	-15°27'	19.74	0.02	0.00093	172.5	-37.1	-16.8	13	2022-07-10 11:34	••
xkos033	NECESSARY	3.858	18:07	-22"52	18.56	0.01	0.00071	-162.7	-14.8	-1.1	53	2022-07-11 00:07	

Lost objects on NEOCP

Object name	Numb. of obs.	Last Updated (UTC)	Obs. tools
A10I5MI	8	2022-07-06 22:46	••
C7YKRN2		2022-07-08 12:00	**
C7YKWX2		2022-07-10 11:29	••
HKmMc01	5	2022-06-30 09:49	••

Priority based upon:

• Impact Probability and End of Visibility determined by: Sky uncertainty, Visual Magnitude, Solar Elongation, Moon (phase and target lunar elongation) and Galactic Latitude

SpaceDyS

New Priority List General Layout

NEODYS Near Earth Objects - Dy	-2			Sponsored by	UNIVERSITÀ E	Space	ceDyS												Go	to NEA 🕨	
Home Objects	Observatories	Sea Priorit	ty Lists Riv	age NEA	elements	NEOScan	Related	sites Ir	nfo & Credit	s											
			LIST																		[Help] 🗔
New Priority List New Faint Objects Priority											Download	ASCII file									
List										Last	Update: 2022	-07-10 19:54	JTC								
									Current M	loon phase: 39.3	deg. Phase p	ercentage (10	0% is Full Moo	on): 88.69%							
										Epoch of ephe	merides: CA	L 2022/07/11 0	0:00:00 UTC								
										Numt	er of NEOs	currently in list:	127								
		Object	Deiesite aless	Priority	Risk	Max PS	н	PHA	Num.	End of	Days to	RA	DEC	V mag	Uncertainty	Sun elong.	Moon elong.	Gal. latitude	Next		
		name	Priority class	value	List	value			Opp.	Visibility	EoV	(hh:mm)	(deg)		(arcmin)	(deg)	(deg)	(deg)	App.	Reason	
		\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	for EoV	
		2022NH	URGENT	27.390	No		26.2	No	0	2022-07-16	5	19:24	-58° 31'	17.8	0.149	-143.6	-46.8	-27.0	0	Mag	
		2013XG22	URGENT	11.960	No		20.4	No	0	2022-07-12	1	00:06	46° 54'	21.9	0.004	85.7	-123.3	-15.3	0	LGL	
		2022NE1	URGENT	10.549	No		26.2	No	0	2022-07-12	1	21:00	-06° 17'	20.4	0.040	151.1	-67.1	-31.3	0	Moon	
		2022NY	URGENT	6.954	No	4.00	25.7	No	0	2022-07-13	2	13:48	27° 22'	21.0	0.239	-85.9	63.8	77.4	0	LSE	
		2022NH1	URGENT	5.455	No	-4.02	20.8	No	0	2022-07-10	5	23:28	110 42	21.3	0.017	103.0	-112.7	-33.2	1	Moon	
		2022ND	URGENT	5.288	No		23.3	No	0	2022-07-13	2	22:29	-49° 36'	20.9	0.011	133.0	-72.5	-24.5	1	Moon	
		2022MZ1	URGENT	4.409	No		21.9	No	0	2022-07-14	3	17:21	77° 29'	21.5	0.009	78.8	-101.2	31.3	0	LSE	
		2022NQ	NECESSARY	3.379	No		25.8	No	0	2022-07-14	3	22:28	-10° 27'	20.8	0.007	133.4	-85.9	-52.5	0	Moon	
		2022MS	NECESSARY	3.285	No		25.6	No	0	2022-07-14	3	23:26	-38° 54'	20.6	0.006	125.4	-85.9	-68.7	0	Moon	
		2020KD2	NECESSARY	3.274	No		21.0	No	0	2022-07-13	2	22:03	-81° 08'	21.7	0.002	-118.8	-65.9	-33.5	1	Moon	
		2022MY	NECESSARY	3.210	No		25.6	No	0	2022-07-14	3	22:01	13º 22'	20.6	0.008	126.8	-89.2	-32.2	0	Moon	
		2022MM3	NECESSARY	3.047	No		24.4	No	0	2022-07-15	4	22:10	21º 32'	21.3	0.017	119.7	-94.4	-27.6	0	Moon	
		2022JZ	NECESSARY	3.014	No		21.7	No	0	2022-07-17	6	15:56	47° 09'	21.9	0.005	-97.0	70.9	48.8	0	Mag	
		2022MB	NECESSARY	2.941	No		24.1	No	0	2022-07-16	5	19:05	51° 25'	21.6	0.008	106.3	-82.4	18.8	0	LGL	
		2022MK3	NECESSARY	2.764	No		23.5	No	0	2022-07-12	1	21:39	-37° 37'	20.6	0.015	146.4	-66.5	-48.5	1	Moon	
NEOD-C + D-C - N- N-		2022LN3	NECESSARY	2.556	NO		22.2	NO	0	2022-07-12	1	22:14	-31" 32"	21.3	0.016	139.7	-13.2	-55.4	1	Moon	
NEODyS Priority List																					Contact »

SpáceDyS

Tailored priority list email for observers



Good Morning,

This email contains the ephemerides for objects in **NEODyS' Priority List**.

Observatory Code: K83

Observatory Name: Beppe Forti Astronomical Observatory, Montelupo

Limiting Magnitude: 20.5

Declination Range: -30 to +90

CAL 2021/	Feb/16 00:	00:00 UTC										
Name	RA	DEC	Vmag Elo.Sun	Ph. El.Moo	Gal.lat	. Mot.	& Dir.	Uncerta	inty Ellipse	Urgency	End of Vis Recov	Ephemerides
	(HH MM SS)	(DD MM SS)	(deg)	(deg) (deg)	(deg)	("/min)	(deg)	(arcmin)	(arcmin) (deg)			
2021CZ7	15 18 44	+ 4 41 17	20.5 100.5	79.0 145.9	48.4	86.2	165.9	1.373	0.043 164.9	URGENT	2021-02-18	2021CZ7 1-day Eph. for K8
2021CL4	15 29 48	+11 51 52	20.5 99.2	79.9 141.5	49.9	51.6	113.9	0.130	0.011 121.0	URGENT	2021-02-17	2021CL4 1-day Eph. for K8
2021CW8	9 49 30	+75 19 1	19.7 -117.1	61.5 -98.0	36.8	62.2	5.0	0.024	0.008 192.4	URGENT	2021-02-18	2021CW8 1-day Eph. for K83
2021CH8	7 54 34	+ 4 4 35	20.0 -148.4	30.0 -102.4	15.9	9.2	327.0	0.606	0.020 148.0	URGENT	2021-02-19	2021CH8 1-day Eph. for K83
2021CU8	10 32 14	+ 5 5 55	20.5 168.8	11.0 -141.4	50.2	21.8	93.0	0.119	0.011 91.5	NECESSARY	2021-02-19	2021CU8 1-day Eph. for K83
2021CX4	7 25 37	+44 57 58	20.3 -134.1	42.7 -92.6	24.6	8.4	308.5	0.019	0.004 136.8	NECESSARY	2021-02-19	2021CX4 1-day Eph. for K83
2021CD2	10 2 49	-14 38 10	19.4 152.9	24.6 -133.3	31.5	9.7	196.9	0.051	0.017 195.9	USEFUL	2021-02-20	2021CD2 1-day Eph. for K83
2021CY5	8 31 8	+ 6 51 52	20.3 -157.9	21.1 -111.3	25.3	8.2	332.5	0.012	0.004 154.3	USEFUL	2021-02-20	2021CY5 1-day Eph. for K83
2021CG8	11 35 31	+15 46 49	20.5 156.1	22.8 -152.0	69.1	13.3	273.5	0.108	0.012 94.1	USEFUL	2021-02-23	2021CG8 1-day Eph. for K8
2001CQ36	4 6 17	+31 0 22	20.5 -98.2	75.1 -52.0	-15.6	4.8	86.8	0.003	0.001 58.8	LOW	2021-02-17	2001CQ36 1-day Eph. for K
2021CM1	11 25 42	-10 17 33	20.4 148.5	30.1 -154.0	47.2	10.7	129.1	0.097	0.011 124.3	LOW	2021-02-27	2021CM1 1-day Eph. for K8
2021CS4	14 17 39	+ 7 36 28	20.2 116.0	59.8 159.5	61.7	17.2	65.2	0.049	0.012 64.4	LOW	2021-02-22	2021CS4 1-day Eph. for K8
2010VU198	4 12 35	+26 23 21	20.4 -98.7	47.7 -51.5	-17.9	1.6	7.2	0.001	0.000 171.5	LOW	2021-02-17	2010VU198 1-day Eph. for H
2017BL31	1 36 21	+34 46 5	19.9 -70.0	86.1 -34.0	-27.2	4.0	256.1	0.002	0.001 68.0	LOW	2021-02-17	2017BL31 1-day Eph. for K8
<u>2021CQ1</u>	9 59 40	+45 3 20	20.5 -147.4	25.6 -117.9	51.5	6.0	351.8	0.007	0.003 190.1	LOW	2021-02-22	2021CQ1 1-day Eph. for K83
<u>2017YZ1</u>	5 14 38	-25 56 2	20.5 -101.2	61.4 -66.3	-31.8	1.7	221.8	0.002	0.001 204.1	LOW	2021-02-19	2017YZ1 1-day Eph. for K8
2021CU5	9 32 50	+10 34 23	19.9 -173.6	6.1 -126.0	40.6	6.2	170.7	0.011	0.005 164.8	LOW	2021-02-22	2021CU5 1-day Eph. for K8

For any concern, please send an email to neodys-help@spacedys.com.

This service has beend developed for the NEOROCKS (NEO Rapid Observation, Characterization And Key Simulation) Project, which has received funding from the European's Horizon 2020 research and innovation programme under grant agreement No 870403.

for K8 for K83 for K8



Automatic daily (or configurable) e-mail to subscribers with some customizations:

Obscode ephemerides, limiting magnitude, declination range,...)



Follow-up ranking system

And Observation Constrained 1 10 Constrained Constrained	NKING	IG ⊳ <u>F</u> C	OLLOW-UP RANKING FOR PRESEN	NT YEAR									[Help
Point Point Point Point Point Point Point Point Point Point Point Name							Last Update: 2022-12-05 12:32	2 ИТС					12
Overal Follow-op Ranking Observatory name (mk to Delta-PL assignment) Cum, PL value (mk to Delta-PL assignment) Cum, PL value (mk to Delta-PL assignment) Discretion (mk to Delta-PL assignment) Discretion (mk to Delta-PL assignment) Cum, PL value (mk to Delta-PL assignm					Fo	llow-u	up Ranking for pre	sent year 2022					
Bank Observatory name (link to Delta-PL assignment) Cum. PL value 1 152 Steward Observatory, Mit. Lemmon Station 235200 2 F52 Pan-STARRS 2, Haleakala 2121465 3 696 ML Lemmon Station 2121465 4 807 Cerro Tololo Observatory, La Serena 109200 5 F16 Pan-STARRS 1, Haleakala 912225 6 V66 Catalina Sky Survey-Kulper 646300 7 03 Karl Schwarzschild Observatory, Westfield 40301 7 03 Karl Schwarzschild Observatory, Westfield 410001 7 V3 Catalina Sky Survey-Kulper 626 7 V3 Karl Schwarzschild Observatory, Westfield 696 7 V3 Catalina Sky Survey 20630 8 H2 Observatory, Westfield 410001 10 V96 Kataleakala 61002 7 V3 Catalina Sky Survey 26613 8 H2 Matronomical Research Observatory, Westfield 7005			Overall Follow-up Ran	ıking							All others Follow-up Ra	anking	
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Purpose: motivate the observers after the MPEC release to continue to follow NEOs Ranking obtained through the Priority List value metrics





- Automation is the key issue: from discoverers, MPC and imminent impactor scanners, but reliable data are needed (quality check)
- Fast alert broadcasting to follow-up observers is welcome: emails, telegram, whatsapp, push communication,... (see NEOROCKS experiment)
- Alerts communicated also to **physical observers** for rapid characterization
- In case of a certain impact event, fast interface with decision makers is needed
- Post-discovery MPEC support to observers for continue monitoring is welcome (notstrictly related to the imminent impactor problem)