7th IAA Planetary Defense Conference

26-30 April 2021, Online Event

Hosted by UNOOSA in collaboration with ESA

Session 5a: NEO Discovery

Chairs: Kelly Fast

Presenters: B. Shustov | S. Urakawa | F. Bernardi | L. Conversi | I. Molotov

System of Observation of Daytime Asteroids (SODA)

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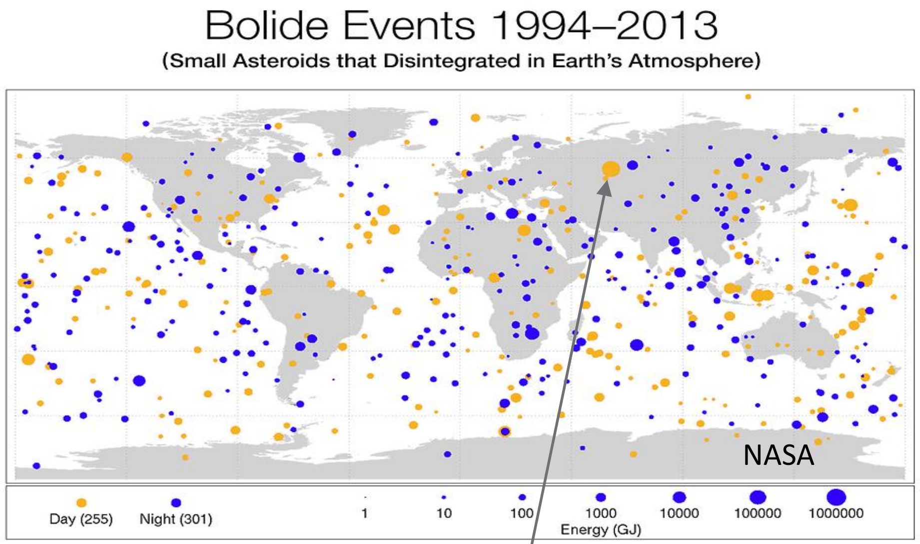
Premises



- Decameter size NEOs (D > 10 m) can be hazardous.
- Nothing could be done to prevent collision of decameter size NEO. Civil defense is the only way to mitigate. Warning in proper time (hours before the collision) is a major action.
- NEOs coming from day sky could not be timely detected by any ground based or near space-based observational facilities. One needs a S/C located far from the Earth.
- There appeared ideas:
  - *Dunham+2013* - to put a 1-m aperture telescope into an orbit around L1 point. The telescope was assumed to survey once per 24 hr an annular region of the celestial sphere around the Earth with an outer radius of about 25 deg.
  - *Shustov+2015, Shugarov+2018* proposed optimized variant of S/C with smaller (30 cm) telescopes and much shorter cadence.

Mission objectives and concept

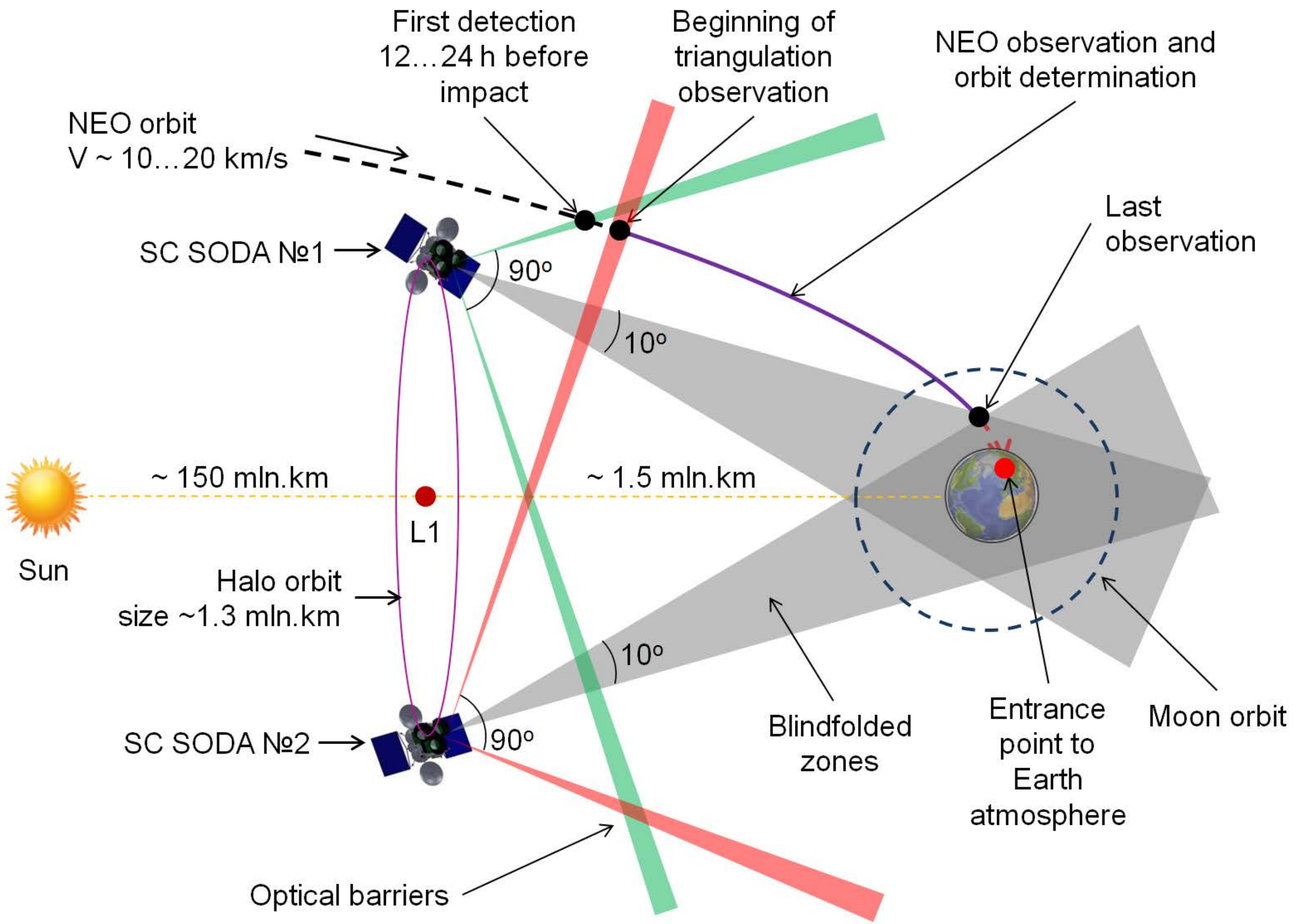
- Detect "all" potentially dangerous bodies >10 m approaching from the Sun.
- Characterize objects of interest:
  - Determine orbit and approach velocity
  - Estimate mass and velocity
- In a collisional case:
  - Determine atmospheric entry point with highest possible accuracy
  - Ensure warning time of 4…10 hours
- Low cost mission at L1 (Sun-Earth).
- 2 S/C variant is optimal, 1 S/C still be quite functional.
- Shared platform with other scientific payload (e.g. Sun, solar wind observation, space weather monitoring, etc.).
- A global network of ground stations ensuring 24/7 regime of operation.

Scheme of operation of the SODA S/C

Two modes of operation:

- detection of asteroids coming from the Sun using the conic barrier technique
- target mode to accurately define orbit of the NEO of interest

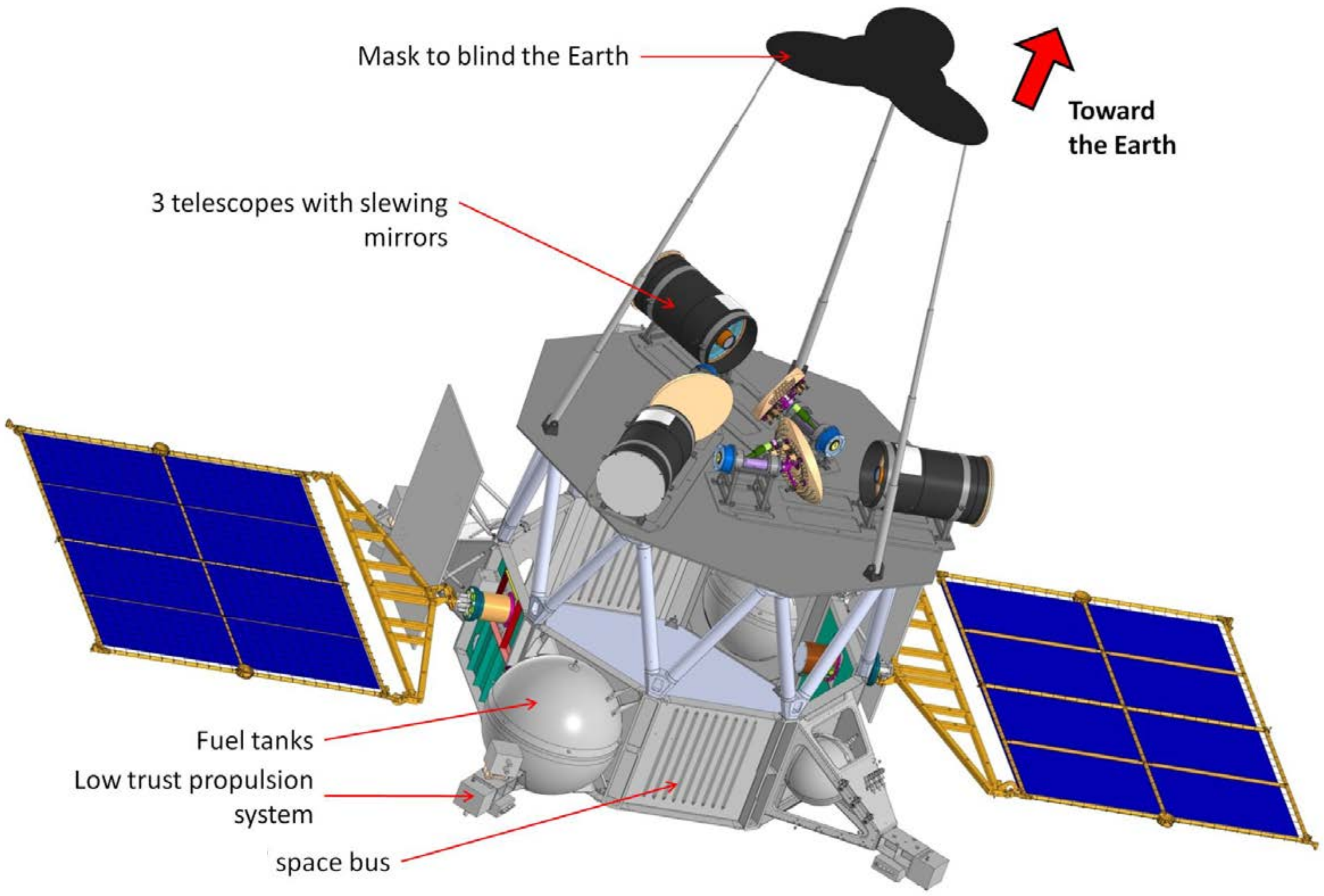
Two S/C variant makes possible a triangulation observation mode, which enables precise orbit determination, helps to avoid missing NEO at close fly-by and provide redundancy.



Spacecraft

Each S/C will be equipped with
≥ 2 telescopes:

- 2 telescope option – minimal variant, no redundancy.
- 3 telescope option – optimal variant: reasonable redundancy.



Telescope with slewing mirror

30 cm aperture optical telescope:

- Sonnefeld camera F:1.5
- 3.75 deg field of view
- 17^m lim. magnitude (4 s exposure)
- 0.5” single observation accuracy
- 2-4 s typical exposure time

CMOS detector:

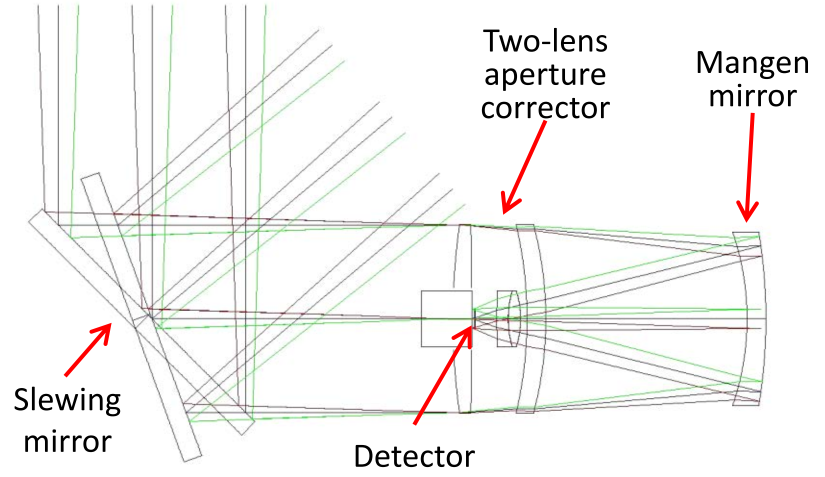
- Size of 30×30 mm
- Format of 6×6 k
- 5 μm pixel

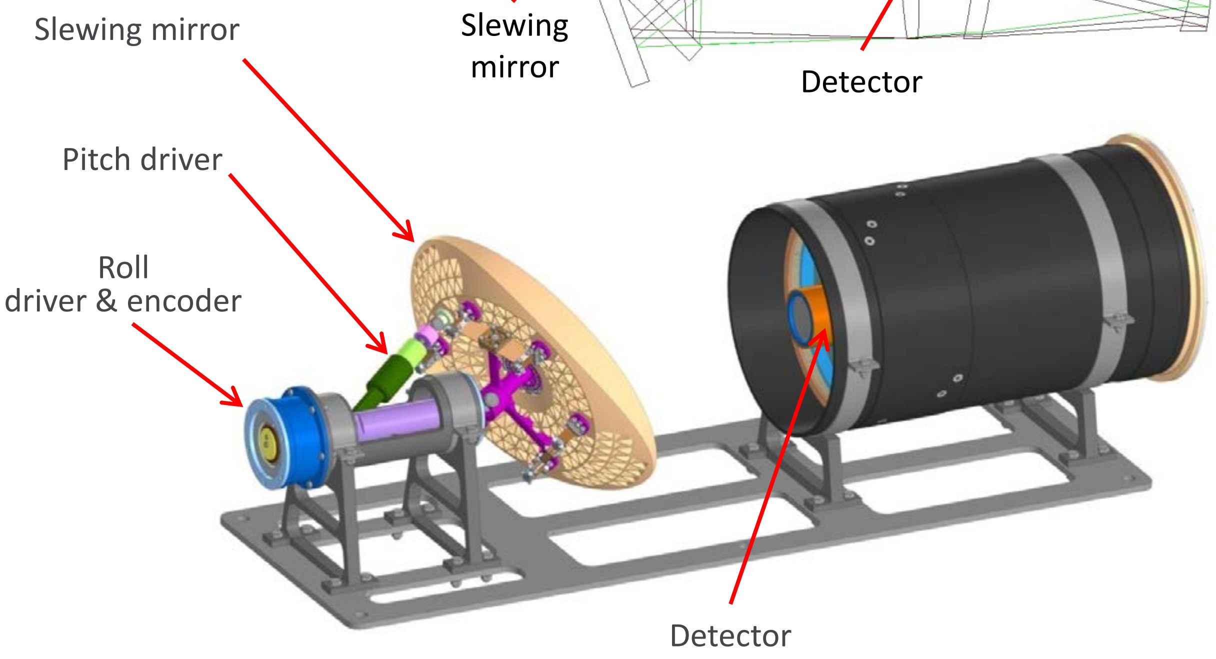
Pre-aperture slewing mirror for fast repointing.

Power consumption: 100 W.

Up to 3.5 min duty cycle of completing optical barrier around the Earth (3 telescopes option).

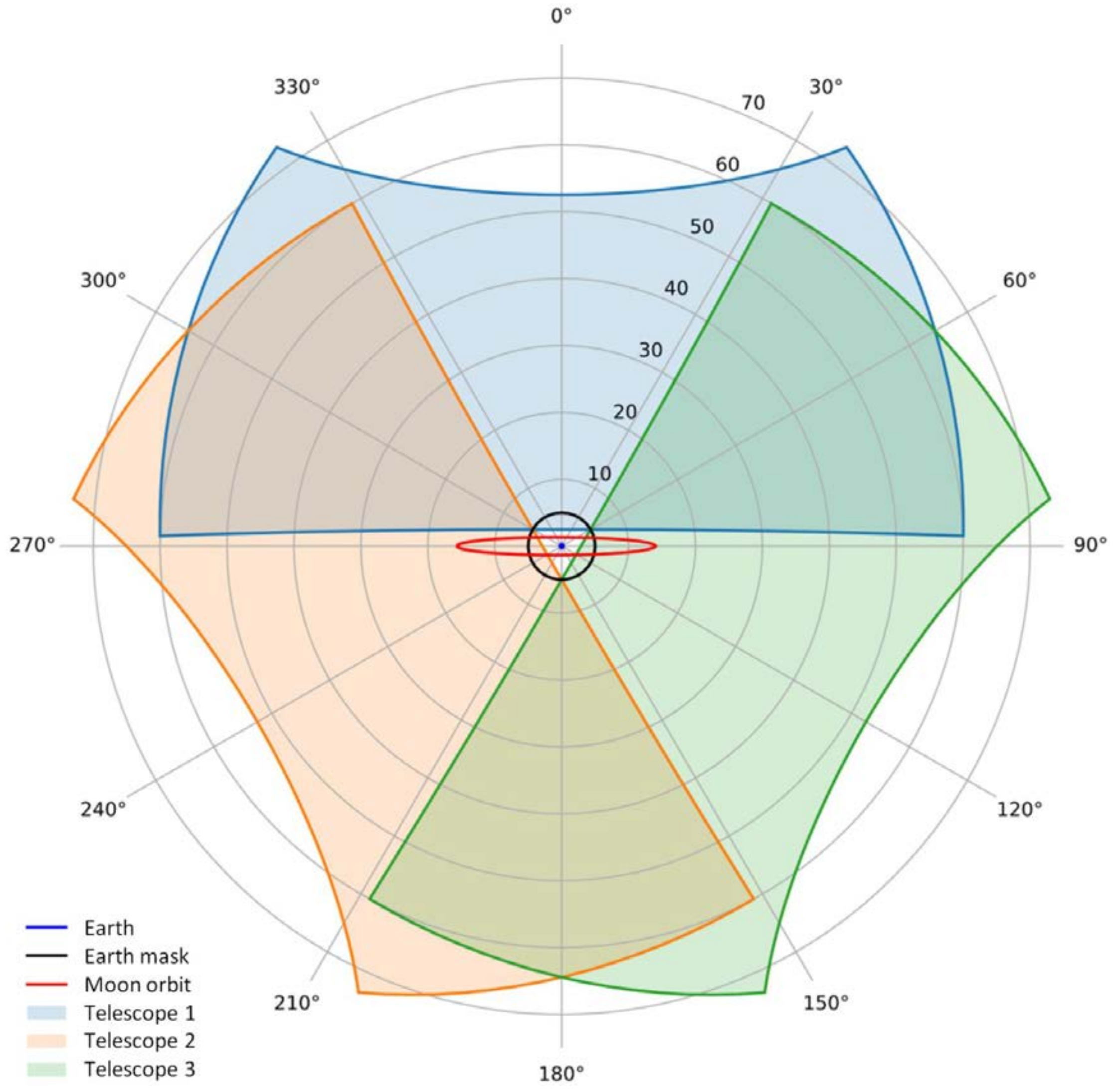
For more details see poster by Shugarov+





Telescope with slewing mirror

- 3 telescope option provides 100...120 deg overlapped area of observation
- 3 telescope option – optimal variant:
  Improved astrometric accuracy.
  50% of the asteroids can be observed simultaneously by two telescopes from one S/C.



A possible scenario of Chelyabinsk event if SODA worked

Chelyabinsk event:

- February 15, 2013
- 17 m size
- 18 km/s

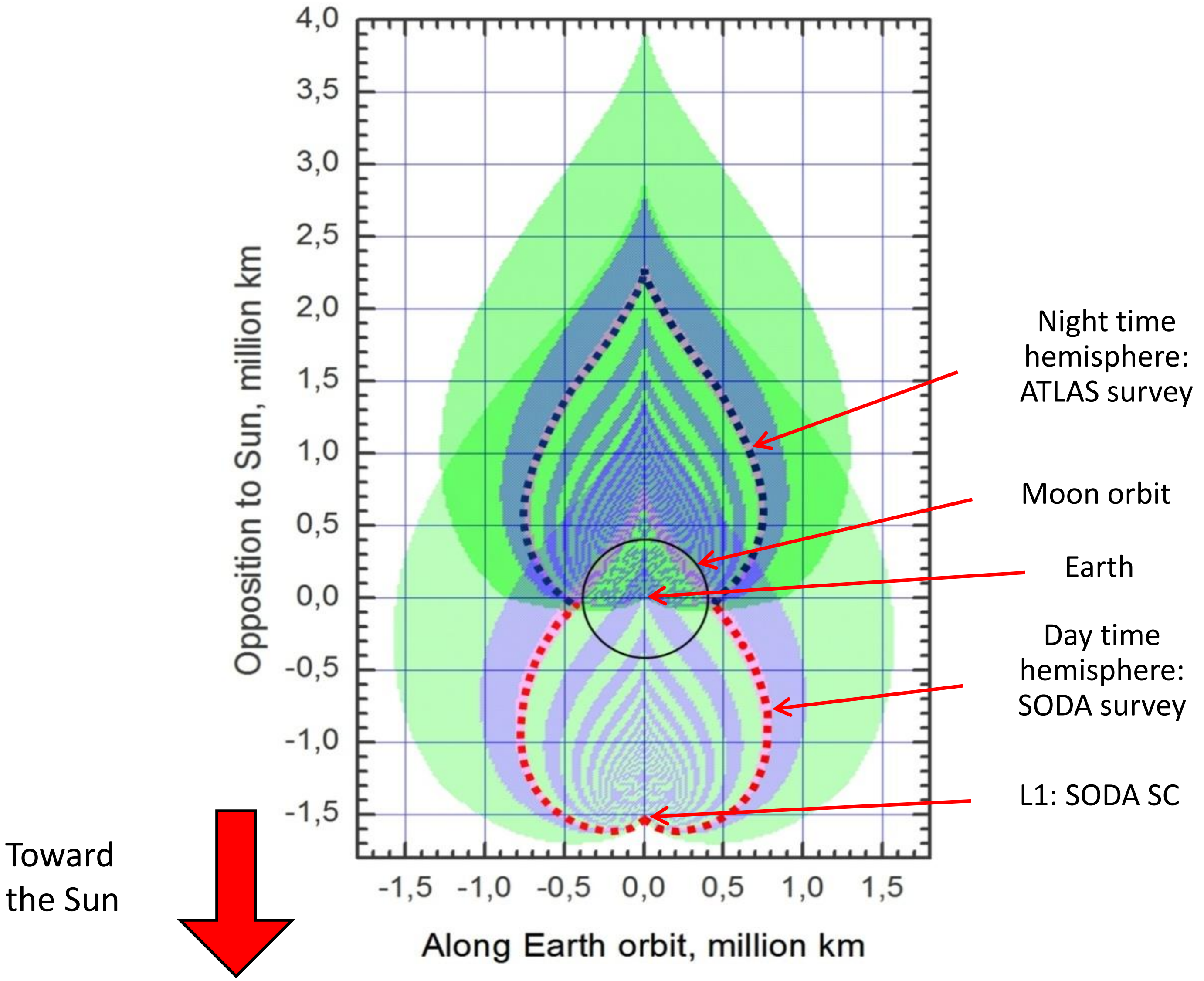
Simulation input:

- 2 SODA spacecraft option
- 0.5 arcsec astrometric accuracy
- Observation every 5 minutes after detection

Time to impact, hours	Accuracy of atmospheric entry point, km	Action
-19	-	First detection of Chelyabinsk's asteroid. Preliminary orbit determination. Data transfer (permanently) to the MPC.
-18	2E4	Start of observation with second S/C in a triangulation mode. First release about possible collision.
-17	5E3×400	First release on the impact region: Russia or Kazakhstan (includes estimated mass of the object).
-16	2E3×200	Updating the forecast: Chelyabinskaya, Kurganskaya, Tumenskaya, Kostanaiskaya region.
-15	5E2× 0	Release of an alert for civil defense of Chelyabinskaya region.
-11	2E2×30	Updated release for civil defense of Chelyabinskaya region.
-4	1E2×20	Final observation and final release.

Cooperation with other survey systems

- A combination of SODA and ground-based survey telescopes (e.g. ATLAS) is a way to provide an efficient all-sky system of detection decameter size NEOs in proper time.
- Combined zone of detection of 10 m body with ground-based telescope (19^m lim. mag.) and the SODA (17^m lim. mag.) is shown in the plot.
- The SNR is marked by color (green and glue) isophotes with 3 unit increments. Blue and pink dotted lines show SNR = 9 (quite reliable detection) for ground-based and SODA telescopes respectively.



Conclusions

- The only realistic way to timely detect daytime asteroids is to use a system of space born telescopes located relatively far from the Earth (e.g. SODA).
- Some years ago, we presented the SODA pre-Phase A study (feasibility and definition).
- Substantial improvements of optical features of the SODA project were made since that. These include a new optical design of the telescope, pre-aperture slewing mirror and new detector.
- SODA uses existing technologies, it is a relatively low-cost project.
- A request for funding for Phase A was submitted to ROSCOSMOS.
- International collaboration is welcome as well as cooperation with other ground-based and/or space projects focused on the detection of 10 m class NEOs.

IAA-PDC-21-5a-02

Development of asteroid detection application “COIAS” for the Subaru HSC data

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[1]Japan Spaceguard Association, [2]Tokyo Institute of Technology, [3]Kobe University, [4]National Astronomical Observatory of Japan, [5]Hokkaido University of Education, [6]The University of Aizu

Background
Subaru Telescope HSC (Hyper Suprime-Cam) and the archived data

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- HSC: Super wide field camera mounted with the prime focus of 8.2 m Subaru telescope. FoV is 1.5 degree in diameter.
- SSP (Subaru Strategic Survey) :A deep multi-band survey of 1400 deg^2 of the sky.
- For small solar system bodies: Some ecliptic plane surveys were also conducted without the SSP.
- HSC archive data: All the HSC data are archived and opened a year and half later from the observation.

Problem

- A large number of asteroids (including NEOs) with diameters smaller than 300 m will be imaged in HSC archived data.
- The coordination and brightness of these asteroids were not reported effectively to the MPC.
- There was no useful application system which can conduct the detection, measuring coordinates, photometry, and reporting to the MPC for asteroid.

COIAS (COmmon! Impacting ASteroid)

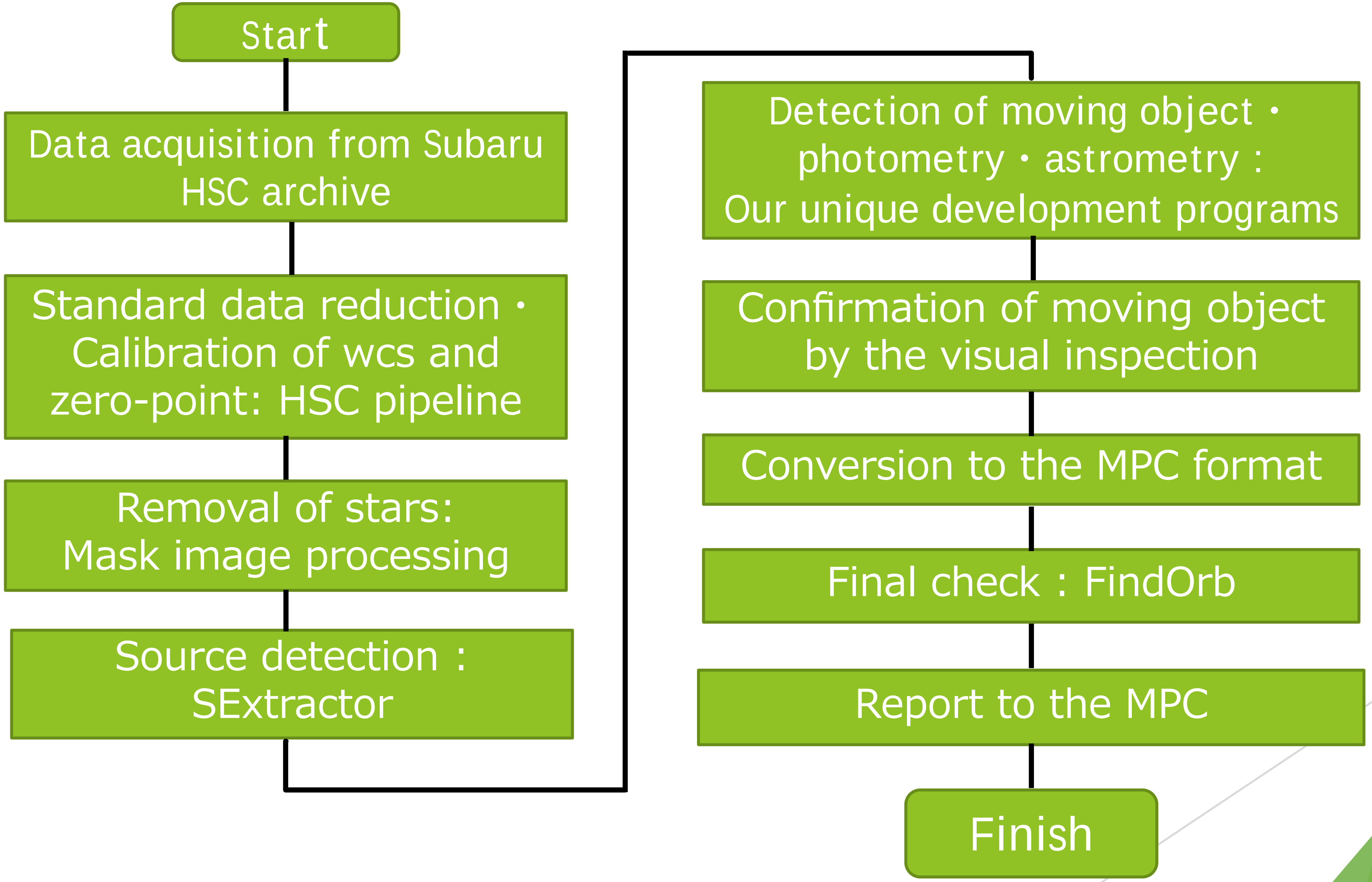
COIAS: An application system for detecting, measuring coordinates, photometry, and reporting to the MPC.
COIAS is composed of our developed programs and the relevant system.

Why COIAS?

The name COIAS comes from a Japanese animation, K(C)oisuru Asteroid (its abbreviated name is K(C)oias), the English title is “Asteroid in Love”. This animation is a story of high school students who try to discover asteroids.

We have a plan to use COIAS for education. We adopted this animation title for our application name considering the educational and public relations effect.

Flowchart of COIAS



Why do we use the visual inspection?

- The HSC data were obtained under a variety of conditions, such as exposure time, filter, and survey area. The machine learning algorithms has a potential to increase detection efficiency in the future, however it is difficult to be applied for the variety of conditions in the current situation.
- The other reason is the educational effect by using GUI (Graphical User Interface). The visual inspection gives citizens and students the delight of asteroid discovery and is expected to have a high educational effect.

Asteroid detection test

- Observation date: 26, January 2015
- Survey area: Jupiter Trojan region that is located around opposition on the ecliptic plane. (PI. F. Yoshida, Co-author, T. Terai, and S. Urakawa)
- Exposure time: 240 sec
- Filter: *g*,*r*
- Number of images : 5 images for the same area at appropriate time interval.
- The candidate of moving object is defined as the source that is detected more than four times.

An example of COIAS

Input personal number of moving objects

OutPut Button: Conversion to the MPC format

Moving object candidates

Noise

An example of COIAS

Input personal number of moving objects

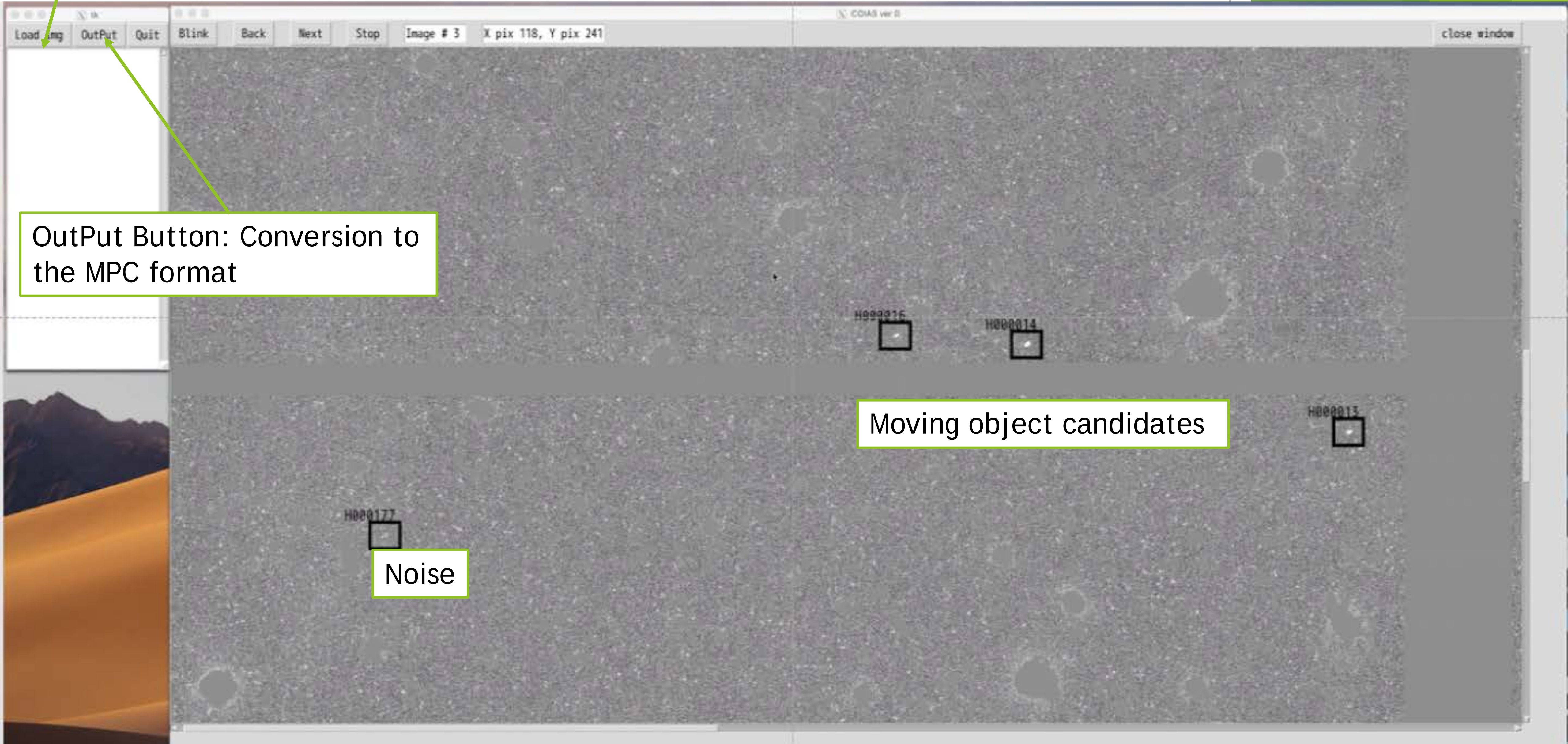
An example of COIAS

Input personal number of moving objects

OutPut Button: Conversion to the MPC format

Moving object candidates

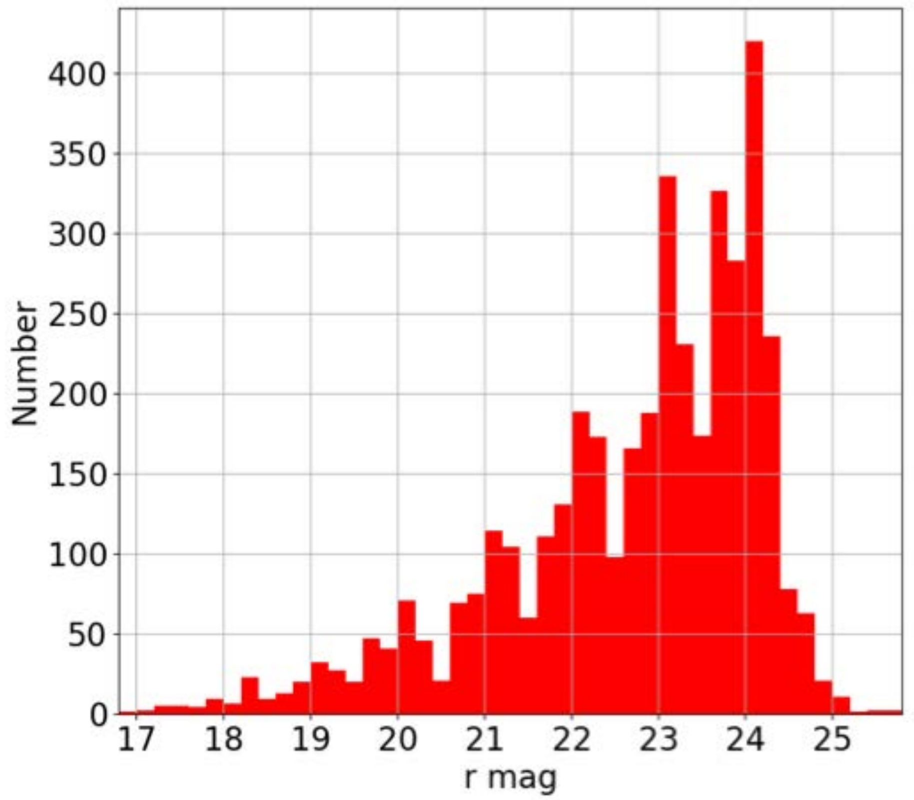
Noise



Test results

- Detection of 4141 unknow object and 874 known objects from the area of 16 deg^2
- Main-belt asteroid candidates: About 90%
- Hungaria group candidates: 7-8 %
- Near-earth asteroid candidates: 2-3 %

- Asteroids up to about 24.2 mag have been detected validly. Assuming the albedo of 0.1 and the semi-major axis of 2.5 au, the brightness of 24.2 mag roughly corresponds to 200 m in diameter.



Magnitude distributions in the *r* band.

Summary and future work

- We started to develop the asteroid detection application COIAS for Subaru HSC data.
- COIAS is in an early phase of development. The detection of moving object takes about 15 minutes per 10 % of the field of view (= $0.17deg^2$). The visual inspection requires around 15 minutes for the same area.
- We cannot say that the usability of the present GUI is user-friendly because some processes run by command line interface.
- We launch a new effort to improve the usability of COIAS by collaborating with the private corporation. In parallel, we will continue to improve the programs and increase the efficiency of the automatic asteroid detection.
- HSC archive data will continue to increase in the future. COIAS will contribute to the discovery of asteroids, including NEOs.

Thank you for your attention.

Background
Small asteroid population

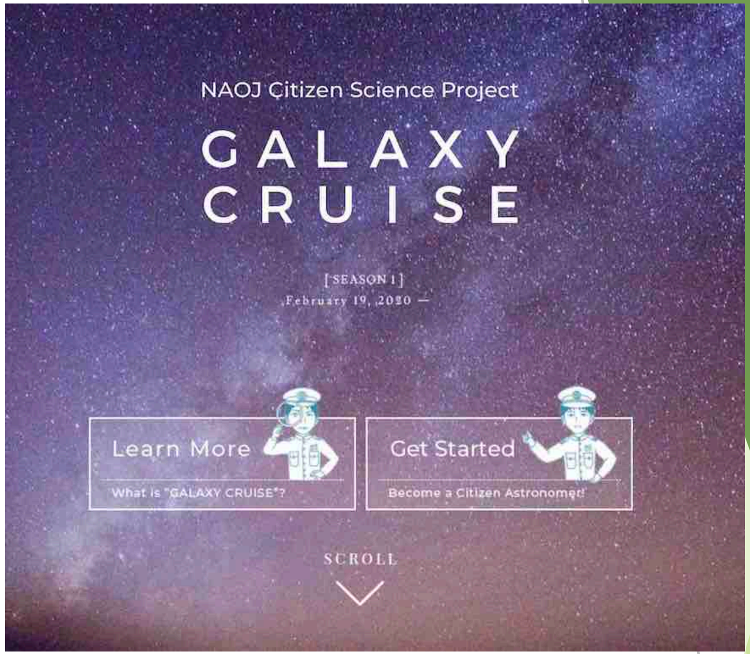
Small asteroid population

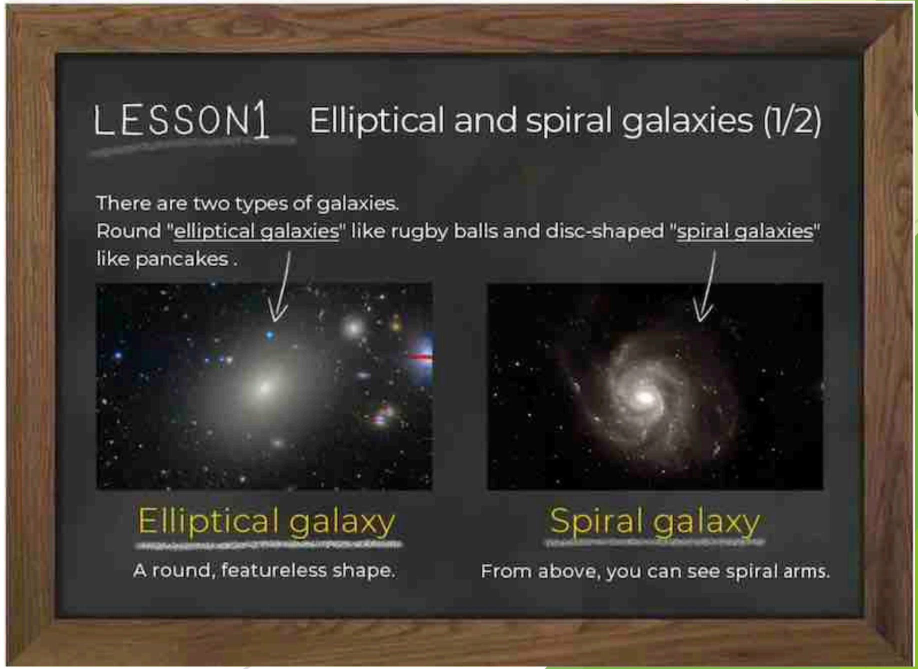
- Most of the discovered asteroids in the main-belt region have diameters larger than 1 km. The orbital distributions of asteroids cover the range of 300 m in diameter have not been clarified.
- Small asteroid population is a key information to understand the formation of asteroid family, and the Yarkovsky effect.

Citizen Astronomy

- GALAXY CRUISE: Citizen astronomy project by using Subaru HSC data
- Developments an application system like GALAXY CRUISE for asteroid discovery

=> Educational effect





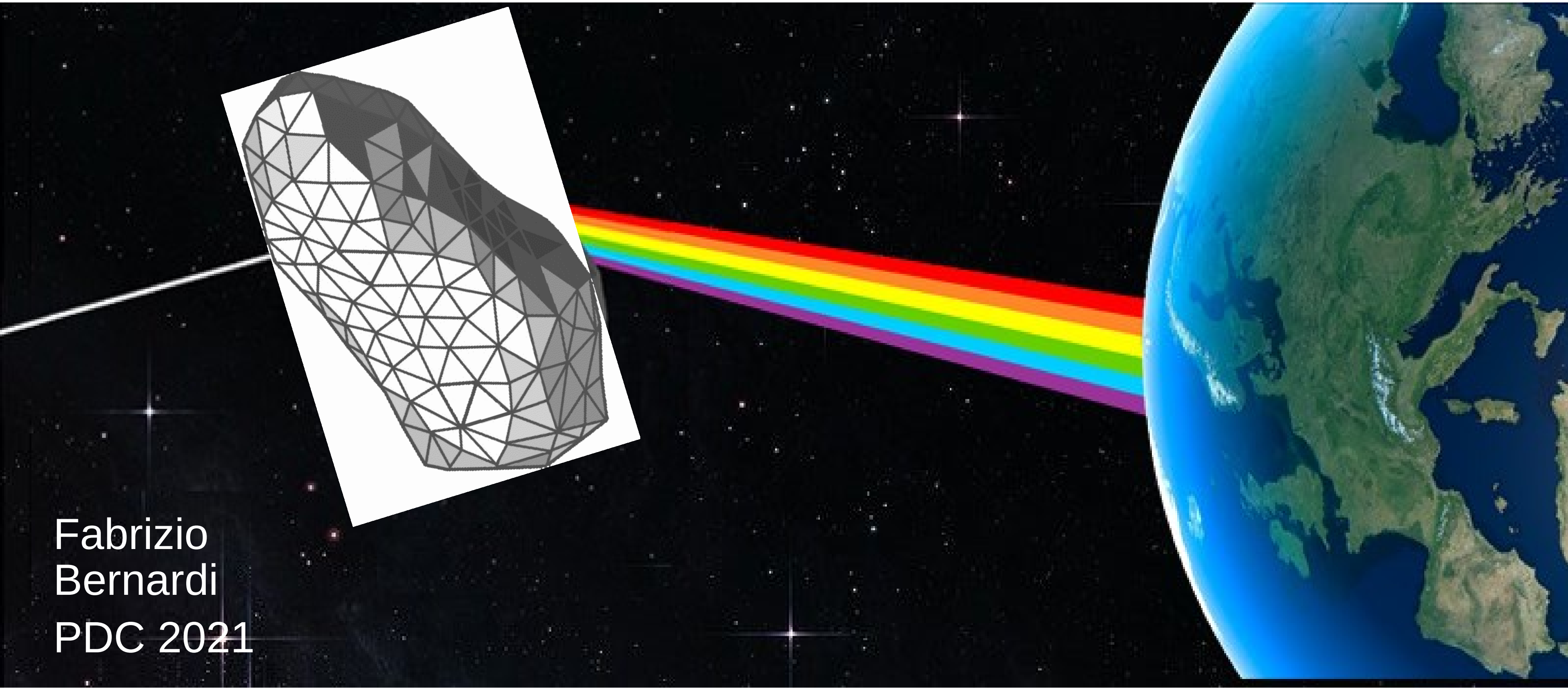
How to detect moving objects

1. Source detection in the first image at the time of t1. The coordinate is expressed as $[x_{1(}t_1), y_1(t_1)]$.
2. Calculation of moving velocity between the first image and the second image. The moving velocity is written in $\Delta x = (x_2(t_2) - x_1(t_1))/(t_2 - t_1)$, $\Delta y = (y_2(t_2) - y_1(t_1))/(t_2 - t_1)$.
3. The estimated coordinate in the third image is described $x_3 = x_2 + \Delta x(t_3 - t_2)$, $y_3 = y_2 + \Delta y(t_3 - t_2)$
4. Search for a point source within 3.6 arcsec around the estimated coordinates.
5. The same procedure is applied for the fourth image and fifth image. The candidate of moving object is defined as the source that is detected more than four times.

NEO ROCKS

Near Earth Object Rapid Observation, Characterization and Key Simulations

New NEODyS Tools for the EU funded NEOROCKS Project: Observations support and Priority Lists



Fabrizio Bernardi

PDC 2021

NEOROCKS stands for:

THE NEO RAPID OBSERVATION, CHARACTERIZATION AND KEY SIMULATIONS

EU funded project

Please, see the e-lightning talk: NEOROCKS: An innovative and pragmatic approach to planetary defense – E. Dotto et al.

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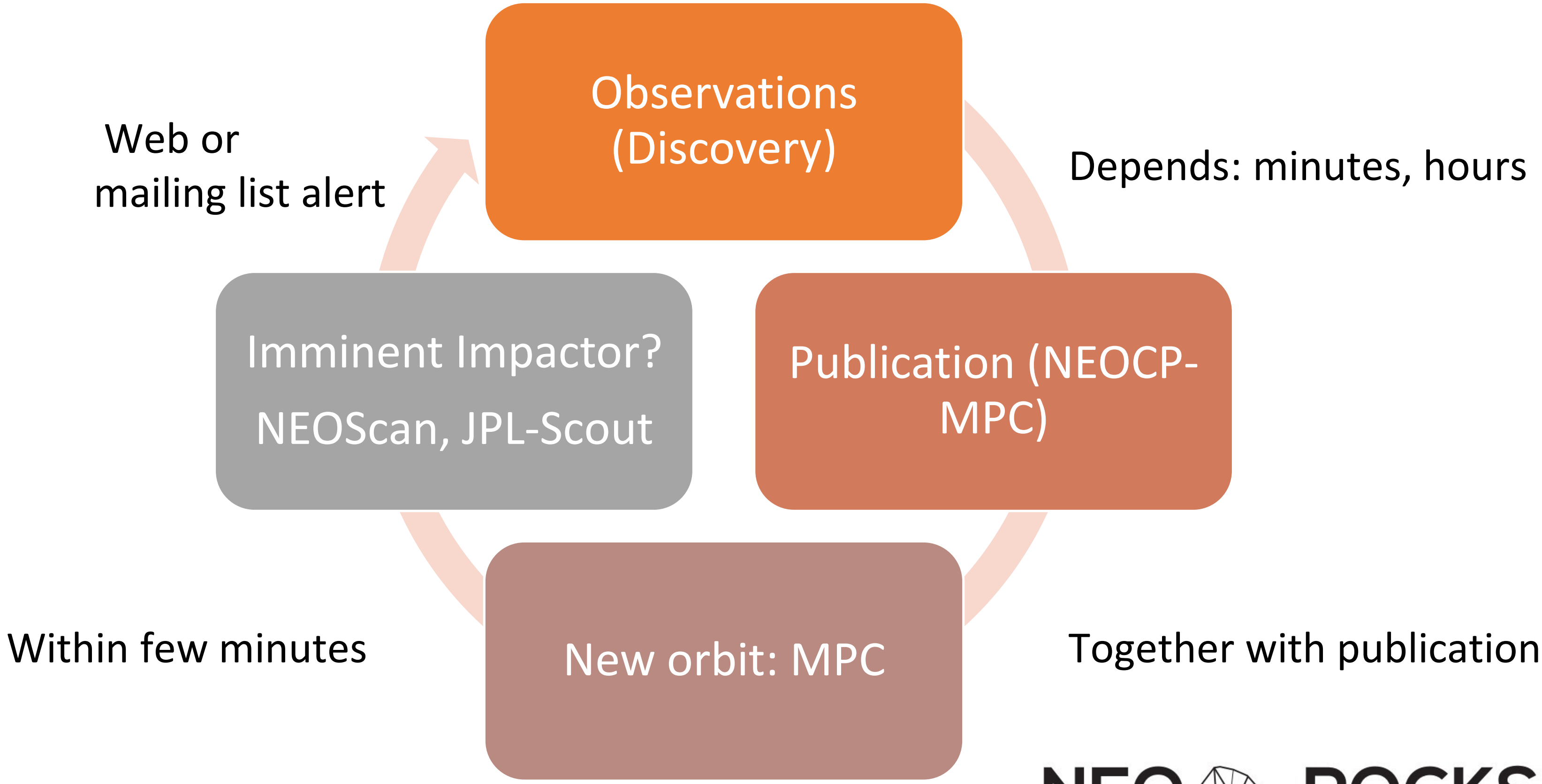
Key point: Speed

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



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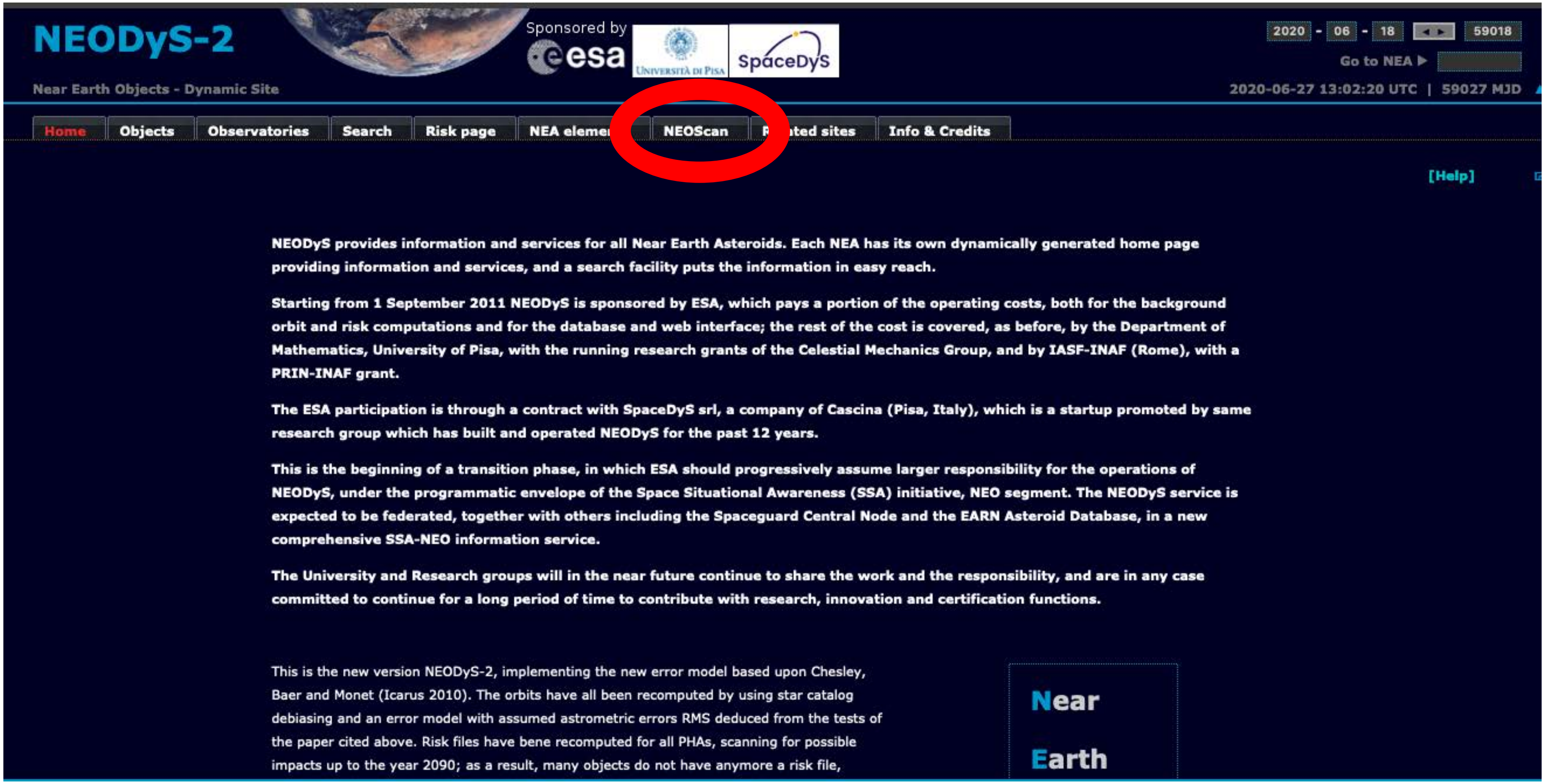
NEOScan

- Since a few years the service **NEOScan** is available at NEODyS: https://newton.spacedys.com/neodys2/NEOScan/



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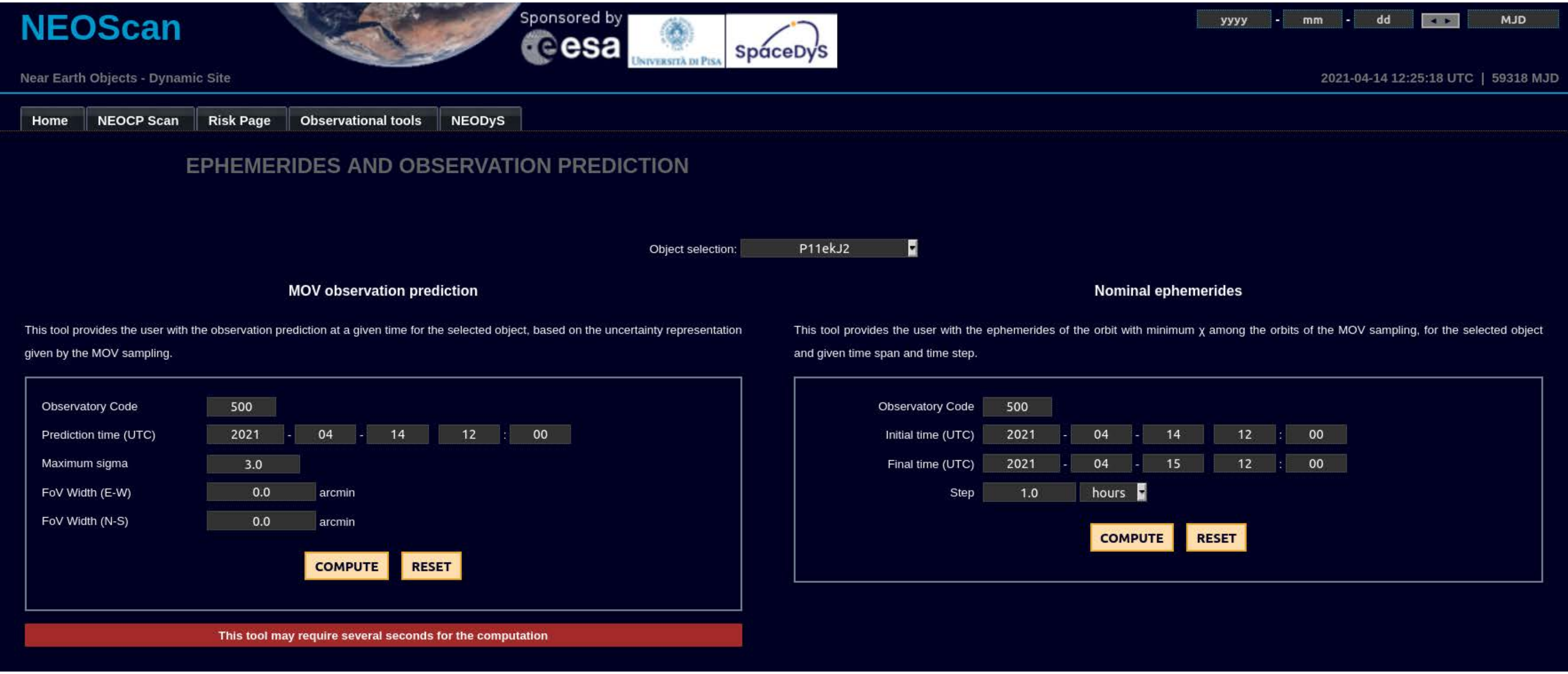
Observer tools in NEOScan



Fixed time, full uncertainty

Time range, only nominal

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Observation Prediction output at a fixed time

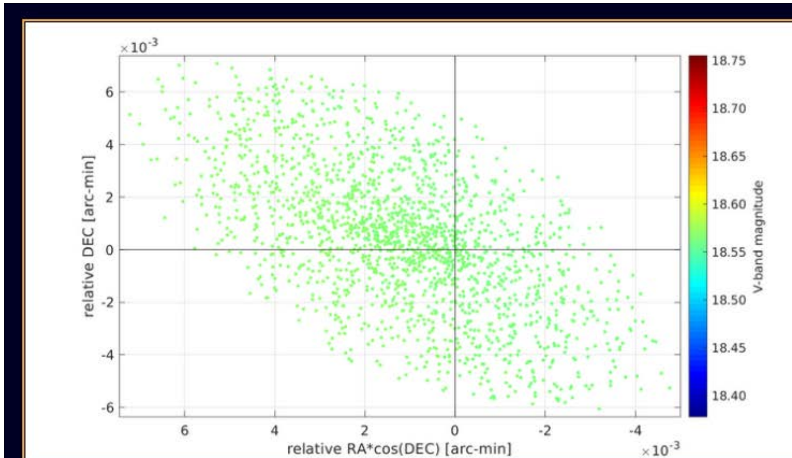
OBSERVATION PREDICTION FOR C18N021

Observation prediction data of the orbit with minimum χ: **ASCII file**

```
Prediction time = 2020/06/03,09:12:00 UTC;  59003.38333 MJD,    Observatory = 0500

RA  = 17:19:23.386 [HH:MM:SS]        4.53519 [deg]
DEC = +39 05 28.37 [deg min sec]     0.68227 [deg]

RA/DEC Apparent motion =    16.660 [arcsec/min]   53.597 [arcsec/min]
Apparent motion =    56.126 [arcsec/min], Position angle =  17.267 [deg]
Visual magnitude = 18.57
Solar elongation =  118.07 [deg], Lunar elongation =  -62.95 [deg], Galactic latitude and longitude =    0.00 [deg]   31.73 [deg]
Elevation =   60.86 [deg], Airmass =   33.887, Phase angle =   63.55 [deg]
```



Plot by colour code

-Select a colour code- PLOT

Plot object classes

-Select a class of objects- PLOT

Plot impacting orbits

-Select an action for impactors- PLOT

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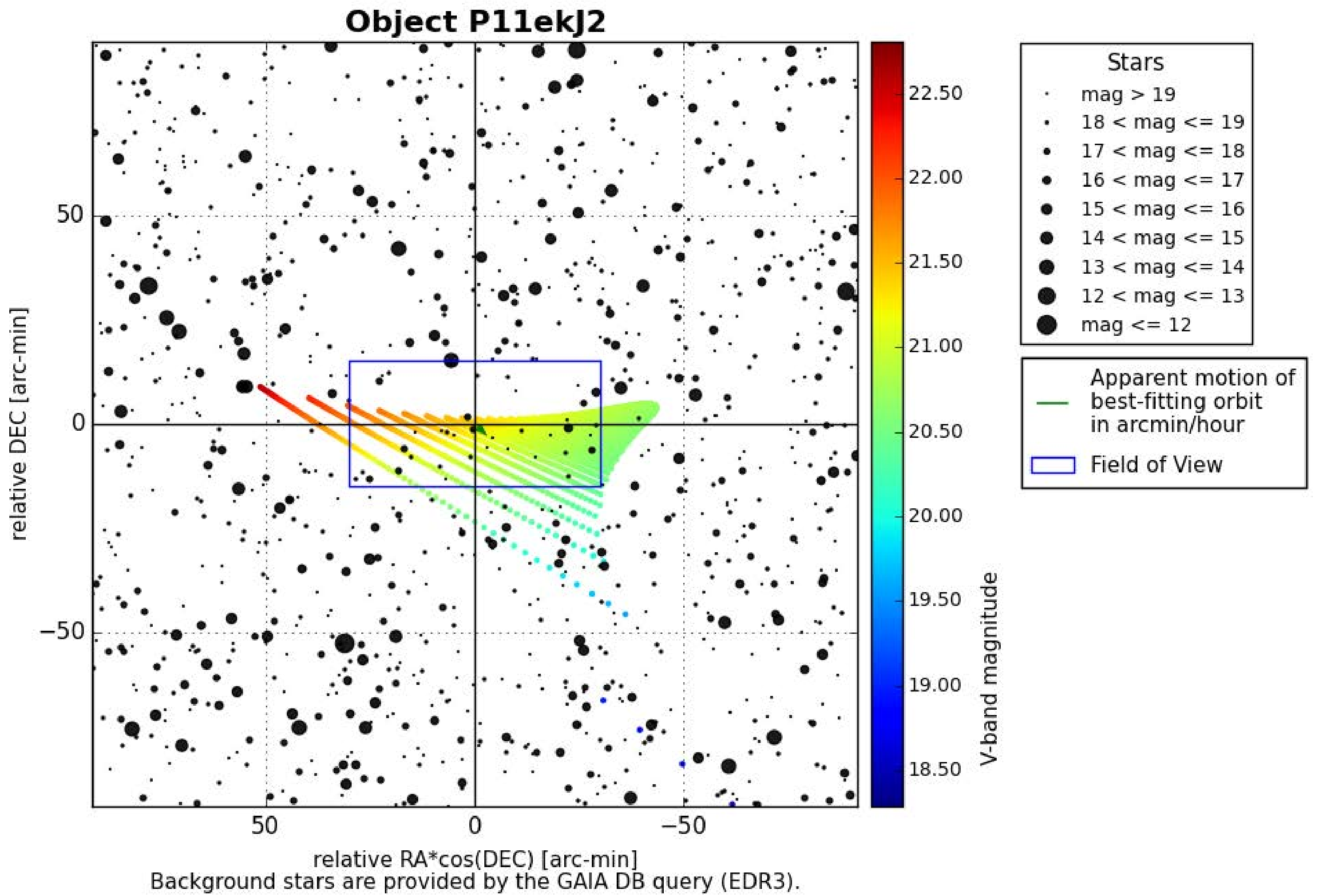
Observation Prediction output at a fixed time



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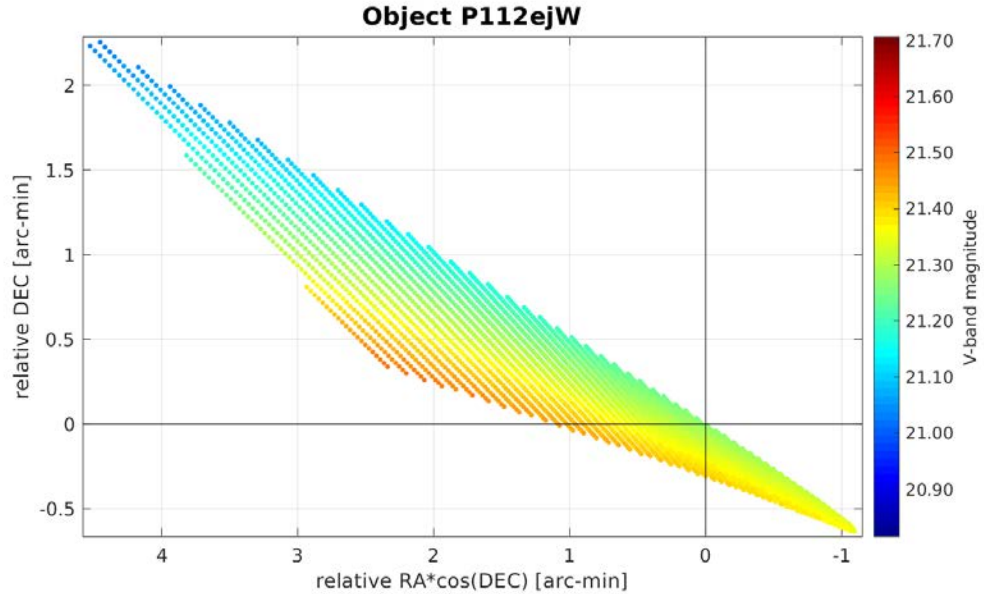
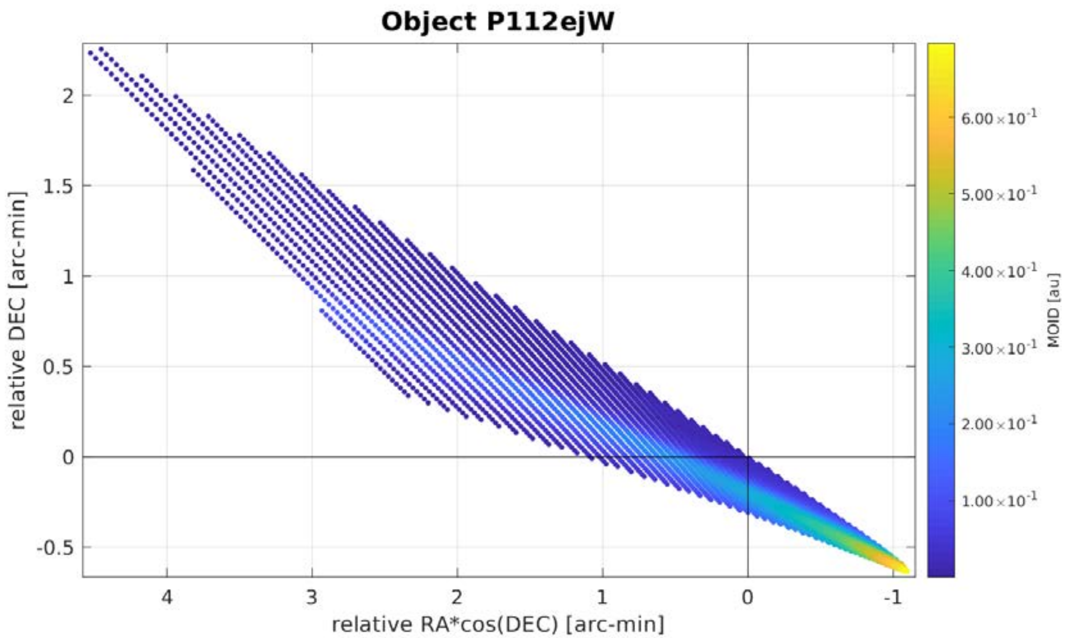
V mag and MOID graphs

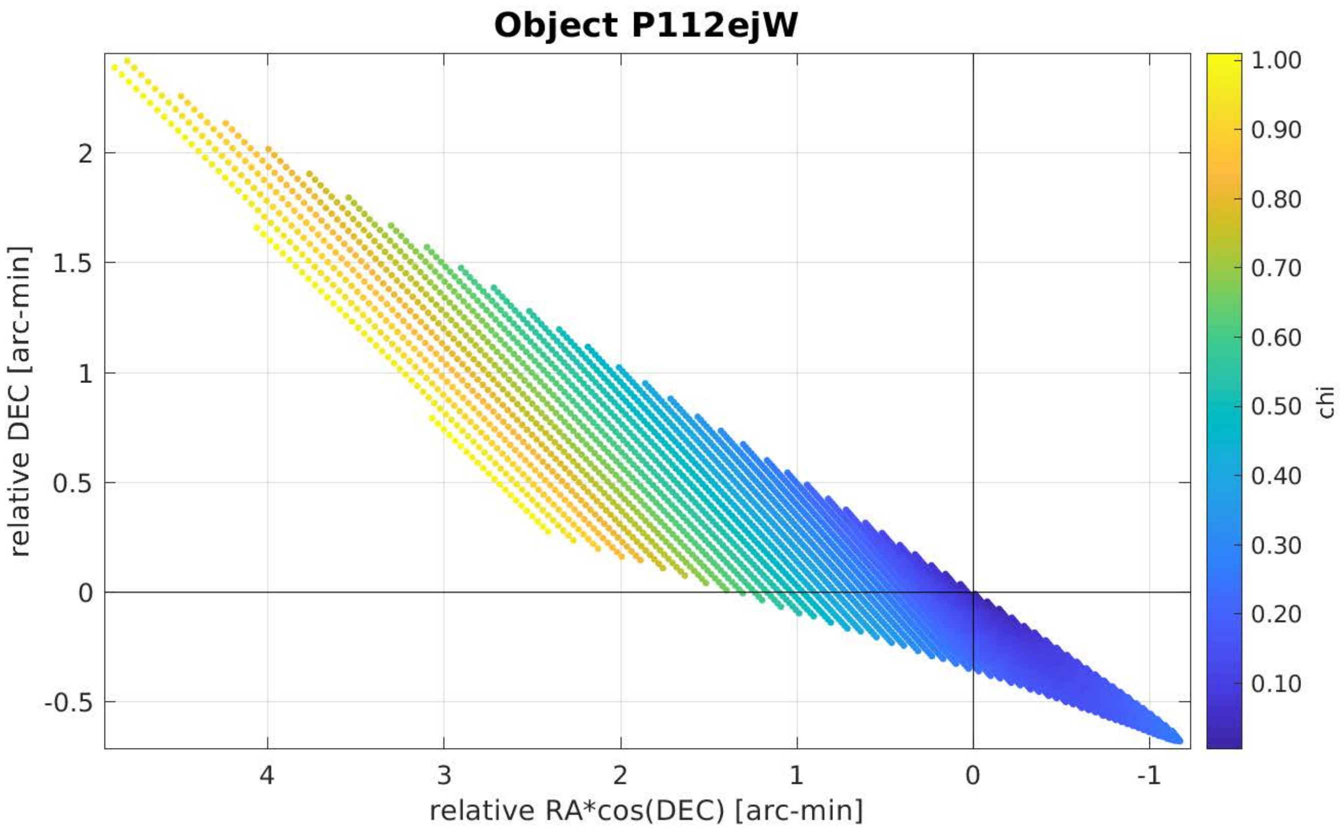
Visual Magnitudes Prediction



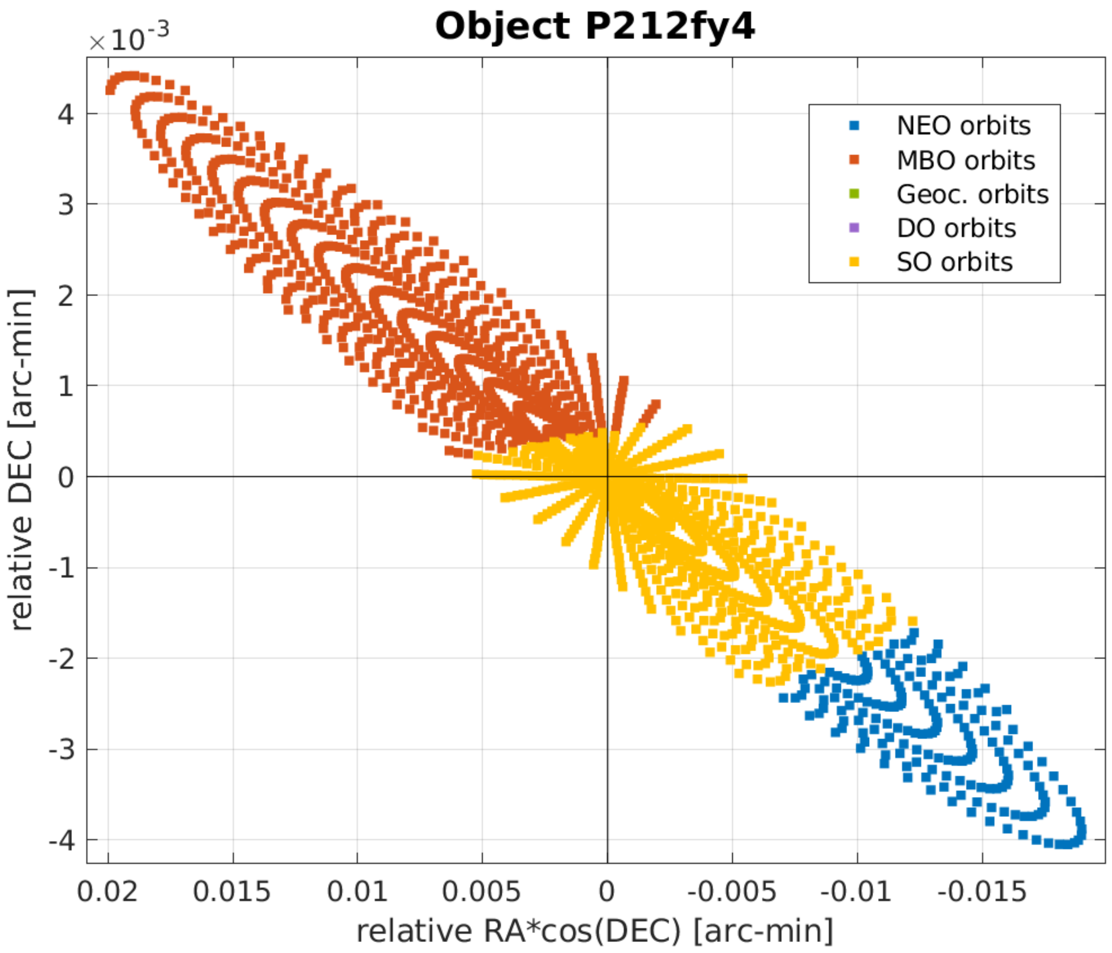


MOID Prediction

Most likely positions



Object classes graph



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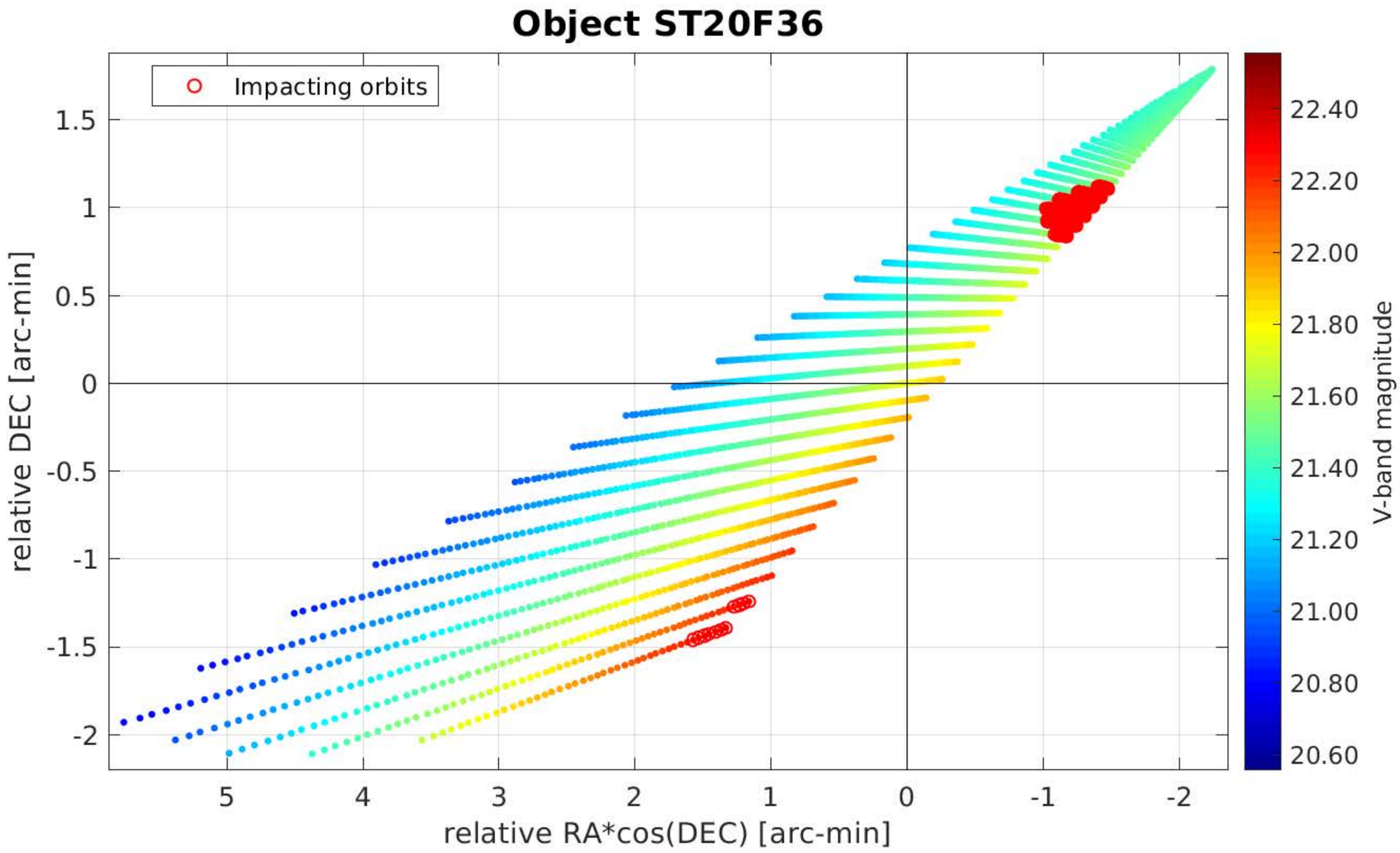
Possible Imminent Impactors Graph



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NEOCP Priority List

NEOScan

Near Earth Objects - Dynamic Site

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Home | NEOCP Scan | Risk Page | Observational tools | NEODyS

NEOSCAN PRIORITY LIST

Last Update: **2021-04-14 09:04 UTC**

NEOCP name	Priority class	Priority value	RA (hh:mm)	DEC (deg)	V mag.	ΔV mag.	Uncertainty (deg)	Sun elong. (deg)	Moon elong. (deg)	Gal. lat. (deg)	Numb. of obs.	Last Updated (UTC)	Obs. tools
P11f0DU	VERY URGENT	43.697	13:49	-7°50'	22.12	4.81	2.53220	175.1	-157.1	52.3	4	2021-04-13 12:48	▶▶
P11f0FA	VERY URGENT	36.667	13:36	-11°47'	22.08	2.63	1.58702	177.3	-155.4	49.5	3	2021-04-13 12:59	▶▶
P11f2XJ	URGENT	24.417	14:18	-21°15'	21.61	1.09	0.24288	163.6	-165.4	37.2	4	2021-04-13 15:52	▶▶
P11ekJ2	URGENT	23.936	11:32	21°19'	21.35	4.14	1.91573	-137.7	-113.5	71.2	4	2021-04-06 12:57	▶▶
P11f35T	URGENT	21.929	16:02	-11°12'	22.28	1.32	0.84148	142.6	167.6	29.8	4	2021-04-13 15:53	▶▶
TMG0044	URGENT	16.968	13:41	-19°14'	21.58	0.02	0.46649	169.9	-157.2	42.1	6	2021-04-11 17:16	▶▶
14D2801	URGENT	14.958	11:50	-22°17'	18.22	0.27	0.14594	-152.8	-131.3	38.4	6	2021-04-14 07:57	▶▶
IJj01lI	URGENT	13.266	13:56	-35°57'	21.20	0.55	0.34024	152.9	-153.5	25.1	18	2021-04-12 14:19	▶▶
P11f2XH	URGENT	10.392	13:49	-17°24'	21.30	0.11	0.04924	170.9	-159.1	43.3	7	2021-04-14 00:27	▶▶
P11f2XG	URGENT	10.052	14:19	-18°57'	20.32	0.55	0.60505	164.9	-166.1	39.2	4	2021-04-13 15:42	▶▶
14B1J01	NECESSARY	8.975	16:08	-49°32'	18.99	0.15	0.39047	128.3	145.1	1.7	12	2021-04-12 15:56	▶▶
C5EG9A2	NECESSARY	8.900	15:30	44°32'	21.88	0.04	0.00785	119.5	119.1	53.8	9	2021-04-13 22:25	▶▶
P11elvl	NECESSARY	8.831	13:17	-27°34'	21.88	0.02	0.02658	161.7	-150.3	34.9	12	2021-04-10 16:27	▶▶
C06DLV5	NECESSARY	8.762	16:55	33°59'	21.93	0.17	0.00429	114.9	124.5	37.8	8	2021-04-14 02:42	▶▶
P11f3VO	NECESSARY	8.612	11:56	0°24'	21.59	0.04	0.01347	-154.8	-128.2	59.4	6	2021-04-14 05:28	▶▶
C5EG992	NECESSARY	8.370	15:13	41°50'	21.82	0.08	0.00529	123.5	-121.8	57.6	12	2021-04-13 23:14	▶▶
C06DL65	NECESSARY	8.267	16:01	38°37'	21.70	0.02	0.00606	120.4	124.0	48.9	12	2021-04-14 03:01	▶▶
P11eSPL	NECESSARY	7.807	13:39	-2°22'	21.84	0.07	0.01092	-172.6	-152.3	58.3	6	2021-04-14 00:02	▶▶
C5EEGT2	NECESSARY	7.683	14:08	55°56'	21.69	0.01	0.00135	-114.1	-106.3	58.0	16	2021-04-13 12:14	▶▶
P21eSue	NECESSARY	7.328	20:46	4°53'	20.68	0.01	0.00091	70.6	95.9	-22.8	16	2021-04-13 11:08	▶▶
P11elvC	NECESSARY	6.239	12:59	-15°51'	21.66	0.01	0.00121	-170.0	-147.1	47.0	24	2021-04-13 23:43	▶▶
A10wotD	NECESSARY	5.353	06:24	-21°24'	19.28	0.03	0.00295	-78.3	-59.5	-15.4	11	2021-04-13 10:22	▶▶
P11f0FB	NECESSARY	5.093	13:32	-14°05'	20.86	0.04	0.00421	175.4	-154.8	47.6	9	2021-04-14 00:01	▶▶
A10wqAF	NECESSARY	3.782	14:00	25°47'	20.07	0.01	0.00156	-144.0	-134.1	74.4	40	2021-04-14 04:07	▶▶

Priority based upon:

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

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Near Earth Object Rapid Observation, Characterization and Key Simulations

New Priority List

- The **(Old) Priority List** is a protocol to provide a list of observable NEO targets to observers according to a priority defined by the observability conditions and dynamical constraints
- The protocol and algorithm were defined in the paper: «A New Protocol for the Astrometric Follow-up of Near Earth Asteroids»; Boattini, D'Abramo, Valsecchi e Carusi; Earth, Moon and Planets, V.100, pp.31-41, 2007
- The priority List has been published since 2000 by the Spaceguard Central Node and since a few years it has been integrated into the ESA portal of the NEO Cordination Centre:
  - http://neo.ssa.esa.int/PSDB-portlet/download?file=esa_priority_neo_list
- After a couple of decades, the algorithm needs necessary a review:
  - Now we observe much smaller objects
  - The algorithm didn't take into account the Moon. Several NEOs have been lost when the Moon is getting full or the lunar elongation is too small
  - The algorithm didn't take into account the galactic latitude. If an asteroid is going to a densely star populated field, the observers usually avoid to observe it.
  - Objects going to negative declinations are more likely to get lost

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NEO ROCKS

Near Earth Object Rapid Observation, Characterization and Key Simulations

New Priority List – Mailing service

- The **New Priority List** will list and sort the objects according to a Priority List Value determined according to observational and dynamical considerations (see later)
- New service:
  - Automatic daily (or configurable) e-mail to subscribers with some customizations:
    - Obscode ephemerides, limiting magnitude, declination range,…)
  - Right now, we have some beta-testers of this service among the Italian amateurs community
  - If you are interested, please contact me: **bernardi@spacedys.com**

SpaceDyS

NEO ROCKS
Near Earth Object Rapid Observation, Characterization and Key Simulations

Priority List Mailing Service layout

NEODyS-2

Near Earth Objects - Dynamic Site

Sponsored by esa, Università di Pisa, SpaceDyS

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 (HH MM SS)	DEC (DD MM SS)	Vmag	Elo.Sun (deg)	Ph. (deg)	El.Moo (deg)	Gal.lat. (deg)	Mot. ("/min)	& Dir. (deg)	Uncertainty Ellipse (arcmin)	(arcmin)	(deg)	Urgency	End of Vis Recov	Ephemerides
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 K83
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 K83
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 K83
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 K83
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 K83
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 K83
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 K83
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 K83
2021CQ1	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
2017YZ1	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 K83
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 K83

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.**

Near Earth Object Rapid Observation, Characterization and Key Simulations

Thanks to this mailing service, a recovery of 2017 FH128 has been done by the Galhassin-Robotic-Telescope which is one of our beta-tester. They are using it already as a standard tool to schedule their observing night

Near Earth Object Rapid Observation, Characterization and Key Simulations

Present New Priority List General Layout

NEODyS-2

Near Earth Objects - Dynamic Site

Sponsored by esa

Go to NEA ▶

2020-09-04 08:16:04 UTC | 59096 MJD

Home | Objects | Observatories | Search | Risk page | NEA elements | NEOScan | Related sites | Info & Credits

PRIORITY LISTS ▷ NEW PRIORITY LIST

[Help]

Priority List

Faint Objects Priority List

Download ASCII file

Last Update: **2020-09-04 08:01 UTC**

Current Moon phase: 31.2 deg. Phase percentage (100% is Full Moon): 92.77%

Epoch of ephemerides: CAL 2020/09/05 00:00:00 UTC

Number of NEOs currently in list: **63**

Object name	Priority class	Priority value	Risk List	Max PS value	H	PHA	Num. Opp.	End of Visibility	Days to EoV	RA (hh:mm)	DEC (deg)	V mag	Uncertainty (arcmin)	Sun elong. (deg)	Moon elong. (deg)	Gal. latitude (deg)	Next App.	Reason for End of Visibility
2020QU	URGENT	15.307	No		23.8	No	1	2020-09-06	1	20:40	-46° 39'	22.0	0.530	-130.7	73.4	-37.6	0	Magnitude
2020QN3	URGENT	6.235	No		21.0	No	1	2020-09-07	2	20:14	03° 25'	21.5	0.055	-138.3	70.8	-16.6	0	Low-Galactic-Latitude
2020PR2	URGENT	5.865	No		22.7	No	1	2020-09-11	6	22:47	-62° 42'	21.2	0.117	-124.1	68.2	-49.0	0	Low-Solar-Elongation
2020PE1	URGENT	5.590	No		23.2	No	1	2020-09-12	7	00:01	-69° 56'	21.0	0.546	-116.0	71.5	-46.6	0	Low-Solar-Elongation
2018FB1	URGENT	5.284	No		19.7	No	1	2020-09-25	20	01:05	-74° 29'	21.7	7.790	-109.8	-75.4	-42.6	5	Moon
2020OG	URGENT	4.919	No		25.8	No	1	2020-09-08	3	20:32	-46° 35'	22.0	0.023	-129.7	74.7	-36.2	0	Magnitude
2020PS4	NECESSARY	3.973	No		21.8	Yes	1	2020-09-14	9	19:59	-36° 05'	21.5	0.128	-130.2	78.1	-28.6	0	Low-Galactic-Latitude
2020QY1	NECESSARY	3.934	No		22.0	No	1	2020-09-08	3	18:48	46° 40'	21.0	0.036	-103.5	90.9	20.0	0	Low-Solar-Elongation
2020MO4	NECESSARY	3.431	No		21.7	No	1	2020-09-23	18	19:49	-25° 06'	21.0	2.678	-131.9	78.6	-23.3	1	Moon
2020LZ1	NECESSARY	2.937	No		22.3	No	1	2020-09-10	5	20:57	-01° 46'	21.8	0.003	-150.0	60.0	-28.6	0	Magnitude
2020ON1	NECESSARY	2.936	No		21.3	No	1	2020-09-10	5	20:42	-13° 38'	21.8	0.005	-146.5	64.8	-30.7	0	Magnitude
2020PR6	NECESSARY	2.584	No		19.4	No	1	2020-10-01	26	04:05	-46° 43'	20.6	1.196	103.7	-62.9	-47.5	1	Moon
2020PY1	NECESSARY	2.503	No		20.7	No	1	2020-09-21	16	20:06	-32° 08'	21.2	0.092	-133.1	76.1	-28.8	0	Moon
2020FW3	NECESSARY	2.229	No		21.1	No	1	2020-09-12	7	20:21	01° 26'	21.7	0.005	-140.4	69.1	-19.1	0	Magnitude
2020QM	NECESSARY	2.035	No		21.0	No	1	2020-09-22	17	20:37	-26° 58'	21.3	0.044	-141.4	68.3	-34.1	0	Low-Solar-Elongation
2020QU4	USEFUL	1.836	No		21.7	No	1	2020-09-22	17	20:15	-13° 07'	21.9	0.050	-140.0	71.2	-24.5	0	Moon
2020QT3	USEFUL	1.663	No		19.6	No	1	2020-09-23	18	21:15	-29° 52'	20.5	0.523	-147.0	61.1	-42.9	0	Moon
2020OT6	USEFUL	1.591	No		20.1	Yes	1	2020-09-24	19	23:02	-64° 59'	20.1	0.754	-121.8	69.1	-48.4	2	Moon
2020GF3	USEFUL	1.289	No		19.9	No	1	2020-09-27	22	03:25	-70° 41'	21.6	0.013	-103.8	-75.6	-41.4	1	Moon

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Near Earth Object Rapid Observation, Characterization and Key Simulations

Present New Priority List Layout

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Last Update: **2020-09-04 08:01 UTC**

Current Moon phase: 31.2 deg. Phase percentage (100% is Full Moon): 92.77%

Epoch of ephemerides: CAL 2020/09/05 00:00:00 UTC

Number of NEOs currently in list: **63**

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Near Earth Object Rapid Observation, Characterization and Key Simulations

New Priority List

- Several data:
  - Name of target
  - Urgency → Urgent, Necessary, Useful, Low Priority
  - PL Value (it will explained later)
  - Presence in Risk list and, in case, PS value
  - Absolute magnitude H
  - If it is a PHA
  - Number of observed oppositions/apparitions (source MPC)
  - End of Visibility at present apparition
  - Remaining days to EoV
  - RA, DEC and Vmag at next midnight UTC
  - Present Sky uncertainty,
  - Sun elongation
  - Moon elongation
  - Galactic Latitude
  - Next Apparitions (number of visibility windows in the next 10000 days – 27.4 ys)
  - Reason for EoV
- All fields are sortable
- RA is sortable starting from present Sun RA (list objects from sunset to sunrise going East)

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Near Earth Object Rapid Observation, Characterization and Key Simulations

New Priority List

- The **Priority List Value**, used to determine the urgency for observations is computed in this way:
  - For each object that is visible today, we compute the **ephemerides for 10000 days** (a bit more than 27 years)
  - An analysis of the visibility windows in this timeframe is performed:
    - If the only visibility window is now, the PL value is very high
    - If there are several more opportunities, the PL value is lower
  - The Visibility Window is determined by:
    - V mag limits
    - Sky uncertainty constraints
    - Solar elongation
    - Lunar elongation and phase
    - Galactic latitude
  - The PL is computed taking into account:
    - Present End of Visibility
    - Visibility during the next 10000 days
    - Presence in Risk List and its PS value
    - MOID
    - Present solar and lunar elongations, uncertainty and V magnitude

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Near Earth Object Rapid Observation, Characterization and Key Simulations

Priority List and Faint Objects Priority List

- We decided to keep a legacy from the original Priority List Service of the SCN
- We implemented two lists: the “main” Priority List and the Faint Objects Priority List
- The differences are the following:
  - Priority List:
    - V mag lim to 22
    - Solar elongation greater than 40 deg
  - Faint Objects Priority List:
    - V mag between 22 and 25
    - Solar elongation greater than 30 deg
    - Lunar brightness less important
- The **Priority List** is tailored for the general observer, from amateur to professional, but with limited telescope resources
- The **Faint Objects Priority List** is tailored only for observers with meter-class telescope and bigger

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www.neorocks.eu

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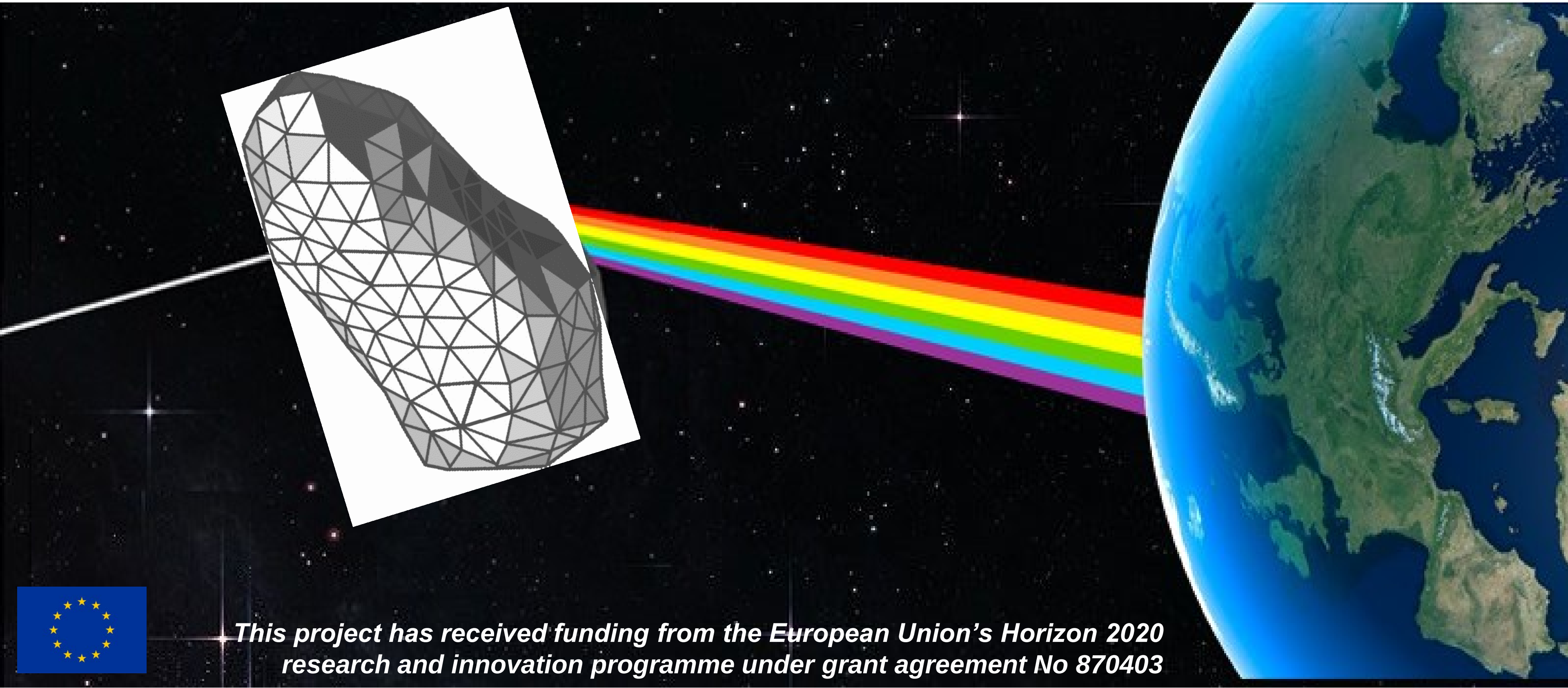
Near Earth Object Rapid Observation, Characterization and Key Simulations

Thanks!



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870403

Extra slides

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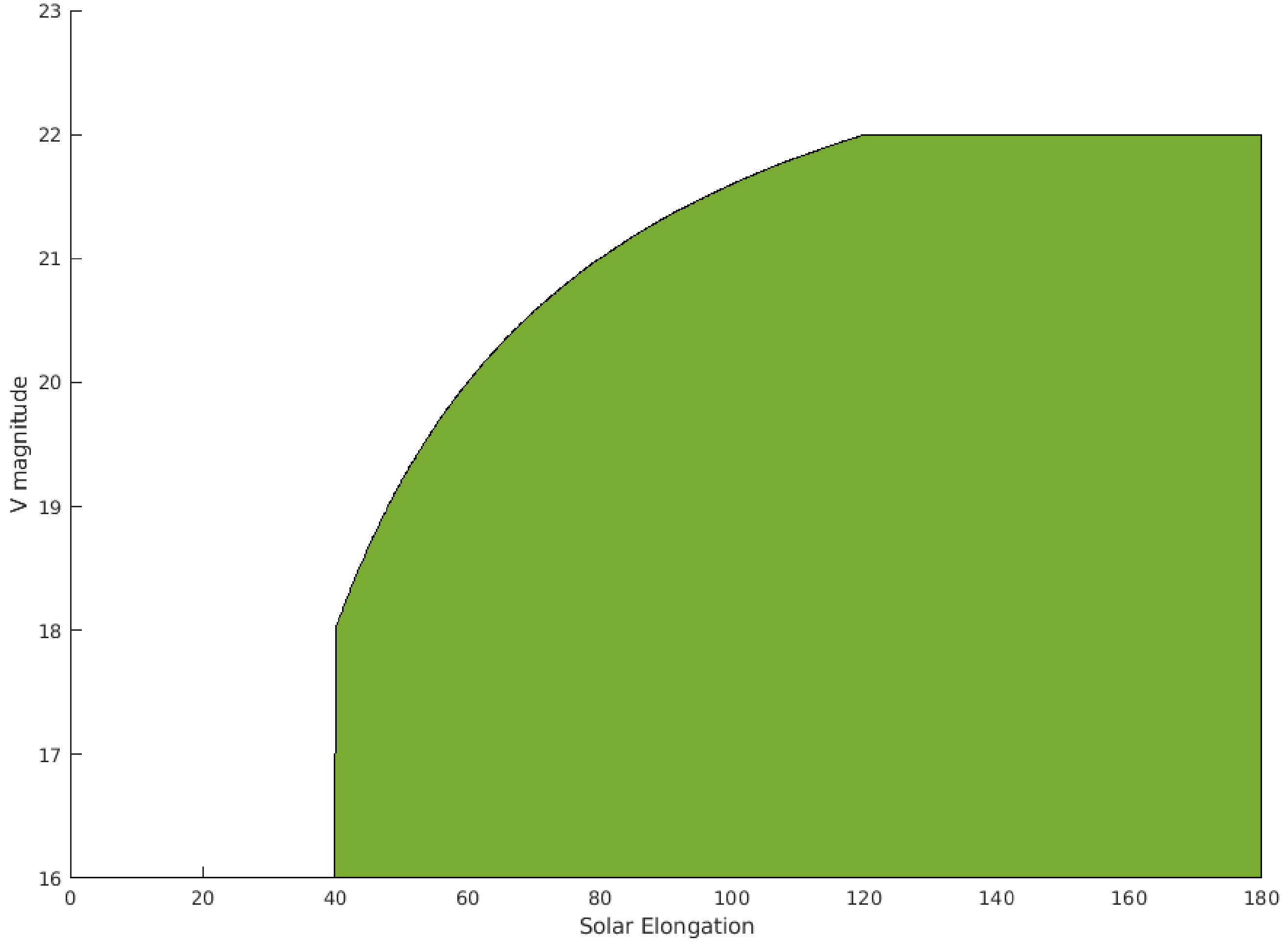
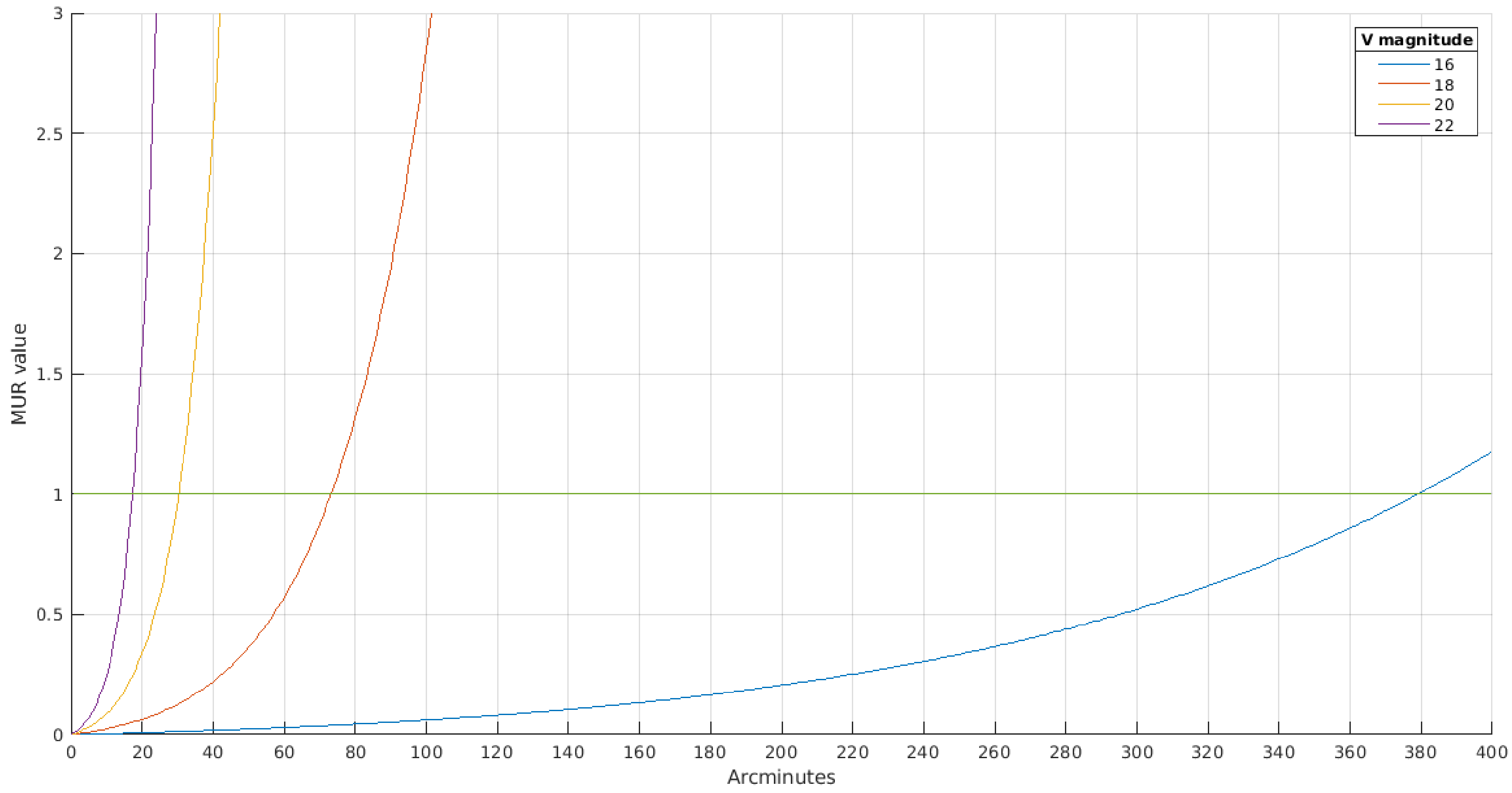
Near Earth Object Rapid Observation, Characterization and Key Simulations

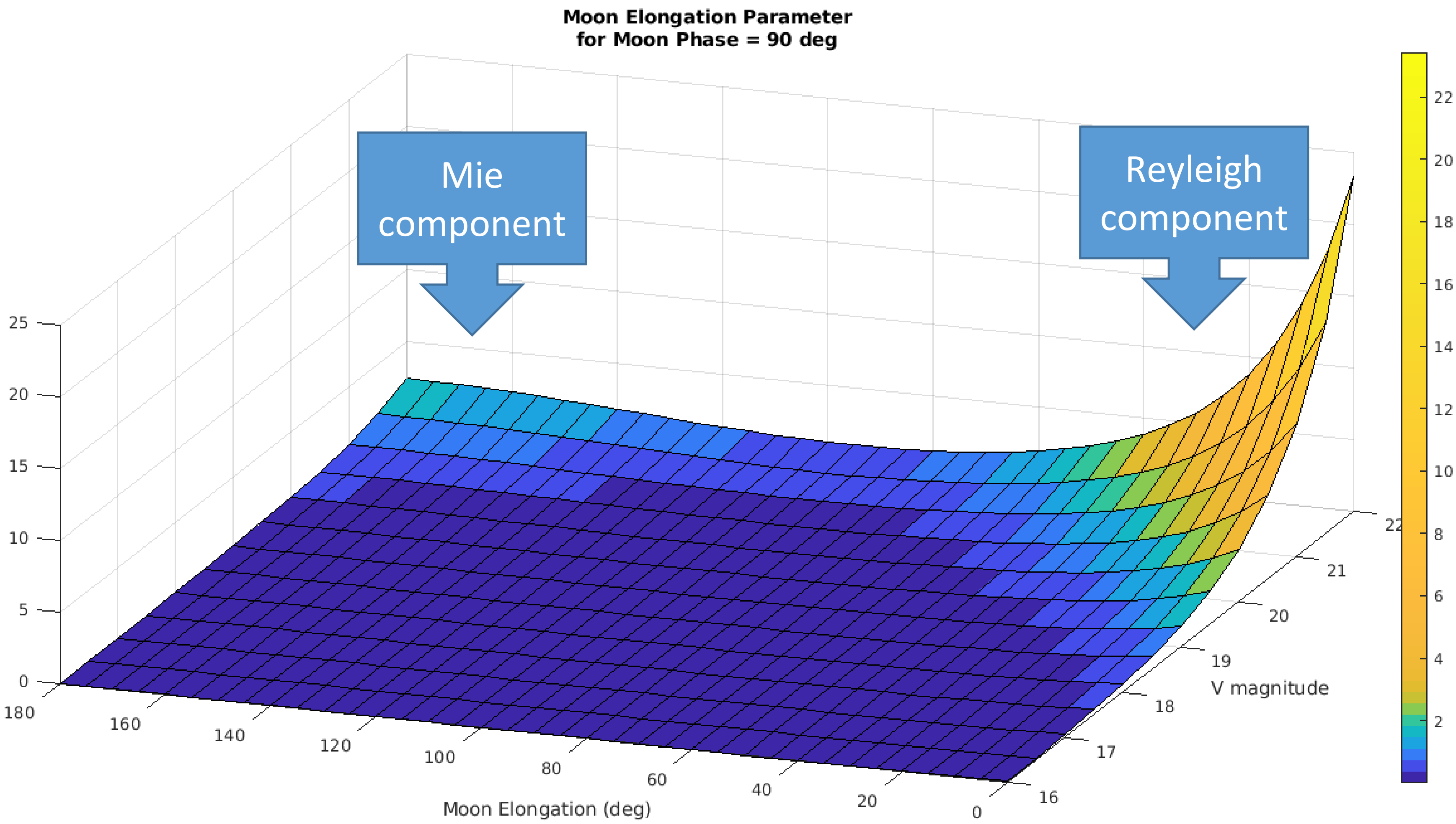
Visibility window depending upon Vmag and Solar Elongation



Visibility window depending upon Sky uncertainty

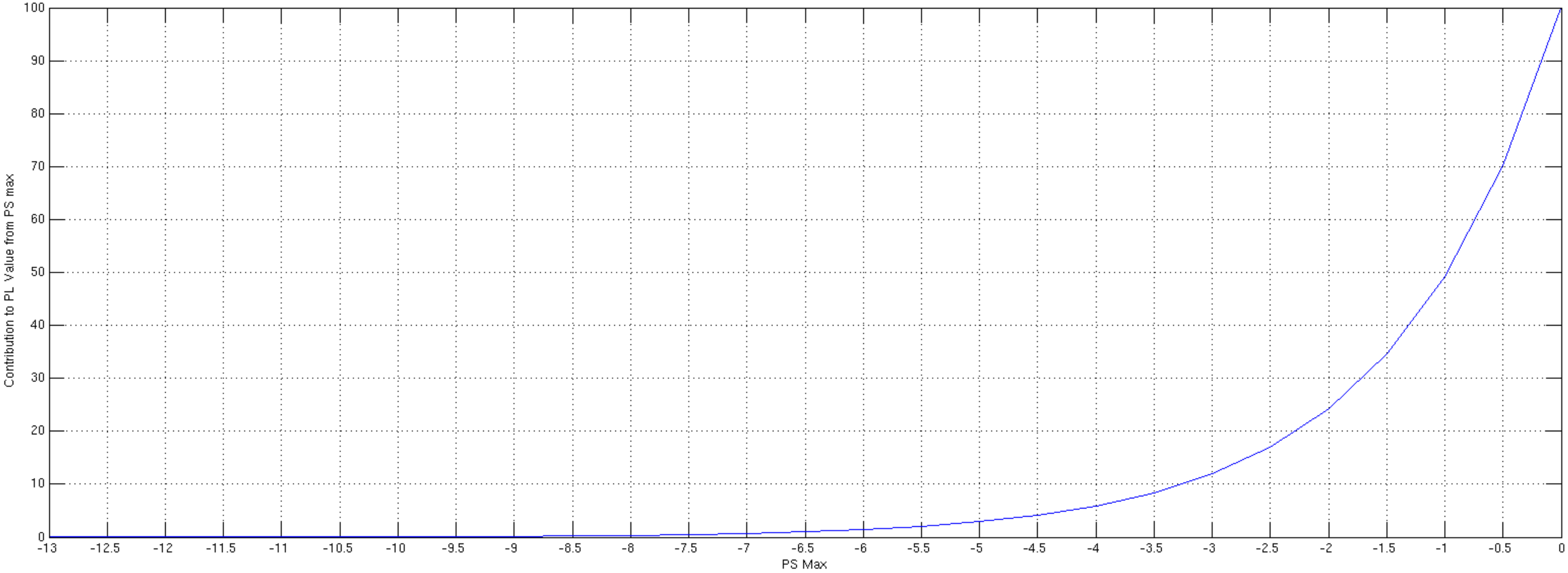


Moon elongation effect



Near Earth Object Rapid Observation, Characterization and Key Simulations

Priority List Value and Palermo Scale dependency



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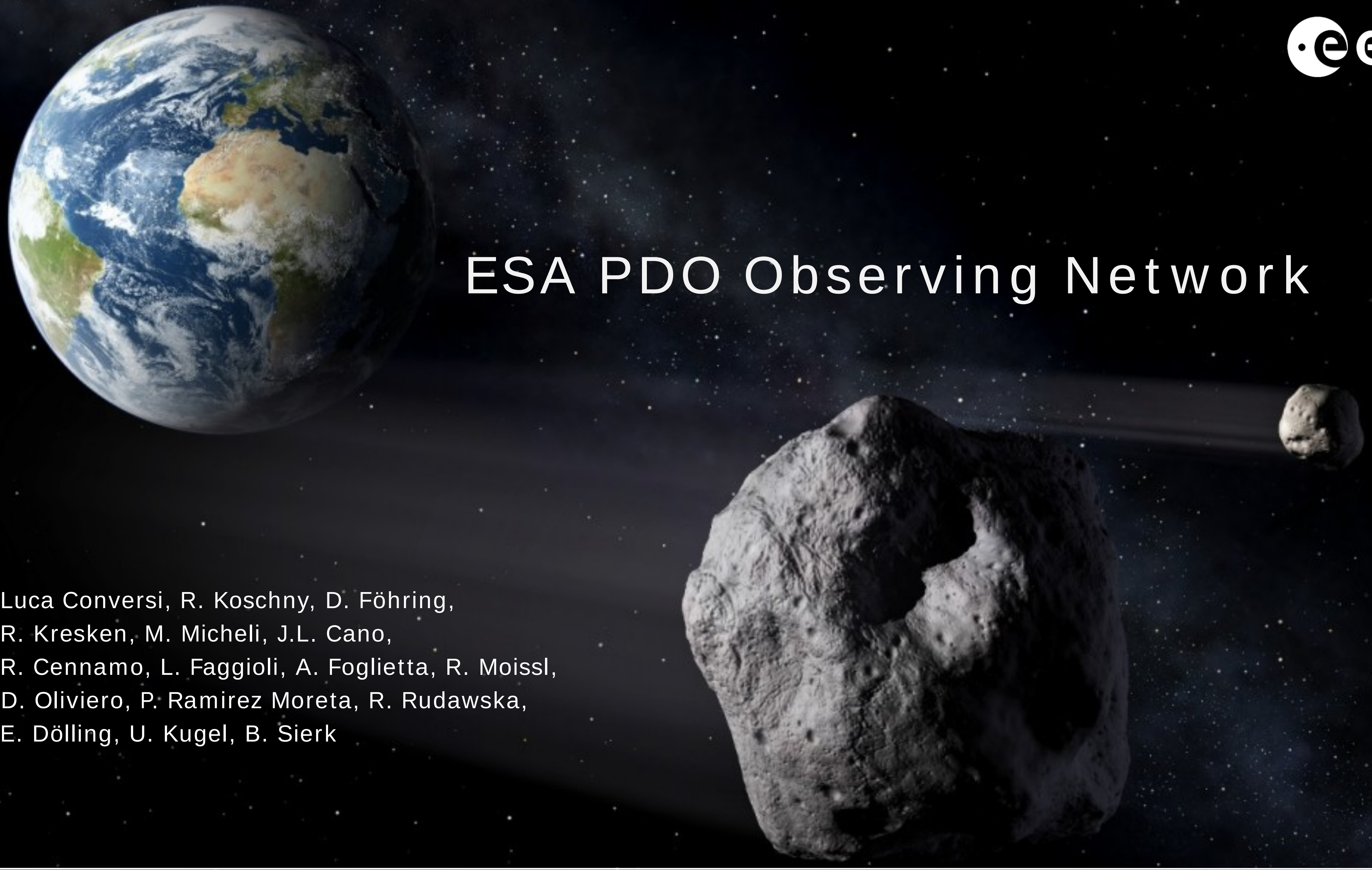
NEO ROCKS

Near Earth Object Rapid Observation, Characterization and Key Simulations



ESA PDO Observing Network

Luca Conversi, R. Koschny, D. Föhring,
R. Kresken, M. Micheli, J.L. Cano,
R. Cennamo, L. Faggioli, A. Foglietta, R. Moissl,
D. Oliviero, P. Ramirez Moreta, R. Rudawska,
E. Dölling, U. Kugel, B. Sierk

PDO Telescope Network in 2019

PDO Telescope Network in 2020

PDO Telescope Network in 2021

PDO Observations in 2019-2020

Scheduled and/or operated by PDO

- OGS:
  - 3/4 nights per Moon cycle (50 nights per year)
  - Follow-up + (small) survey: TOTAS
- CAHA:
  - Fully dedicated to PDO activities
  - Used 150 nights in 2020 for: follow-up, comets, light curves & ArtSat
  - Setting up dedicated survey (CAHAS)
- VLT: 26 hours per year for PDO activities

Observations on request by PDO:

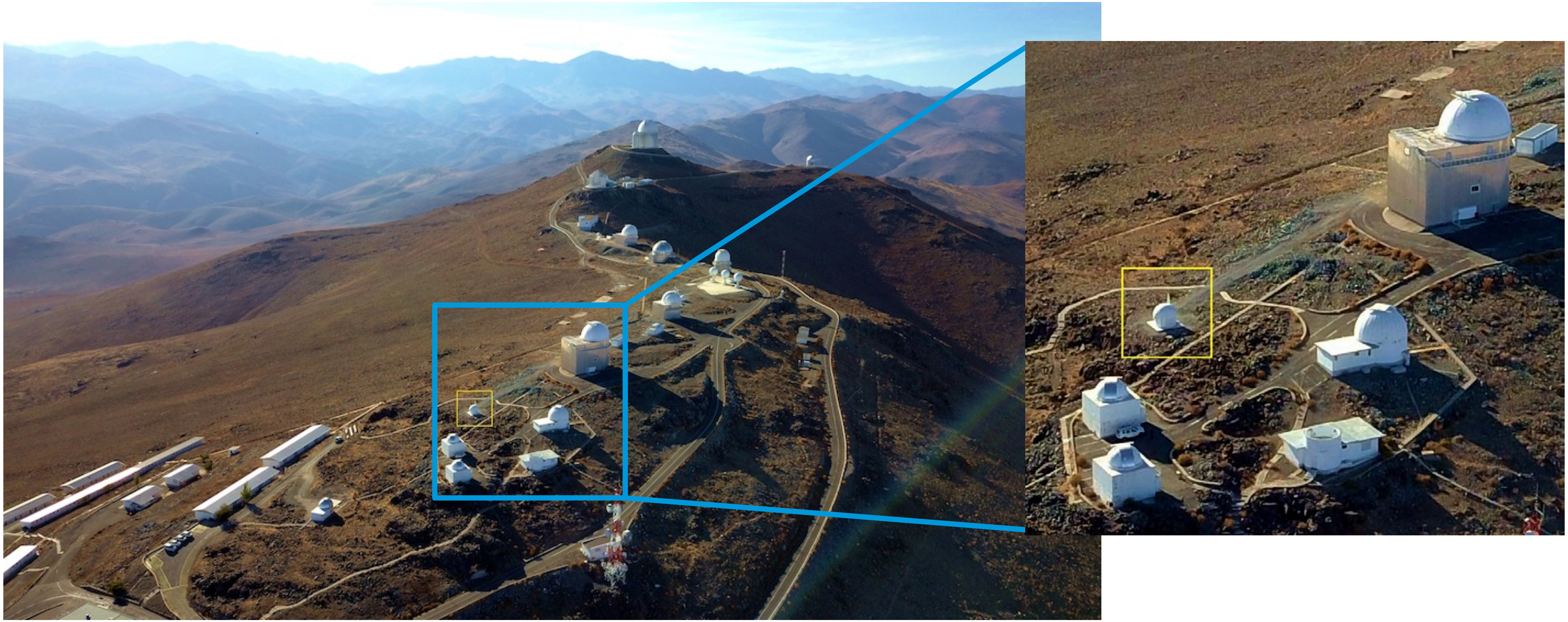
- 6ROADS: coordination of observatories in the Southern Hemisphere
- ISON (former collaboration): participated in 1999 KW4 IWAN (2019) and BepiColombo (2020) campaigns, as well as urgent targets

Autonomous observations but financed by PDO: Klet & Tautenburg

Observatory / Network	Number of Observations
OGS	1289
CAHA	396
VLT	60
6ROADS	94
ISON	40
Tautenburg	8034
Klet	4416

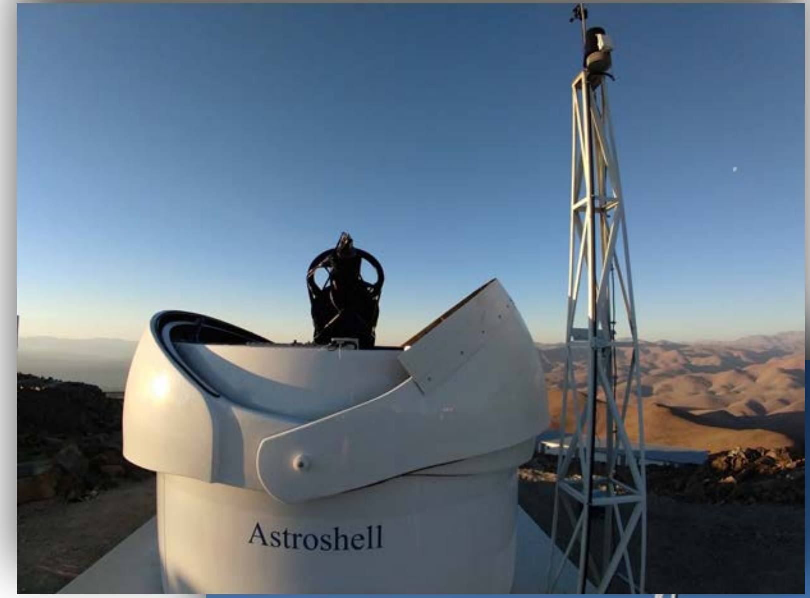
Test-Bed-Telescope 2 - Location

La Silla, Chile



Test-Bed-Telescope 2 - Deployment

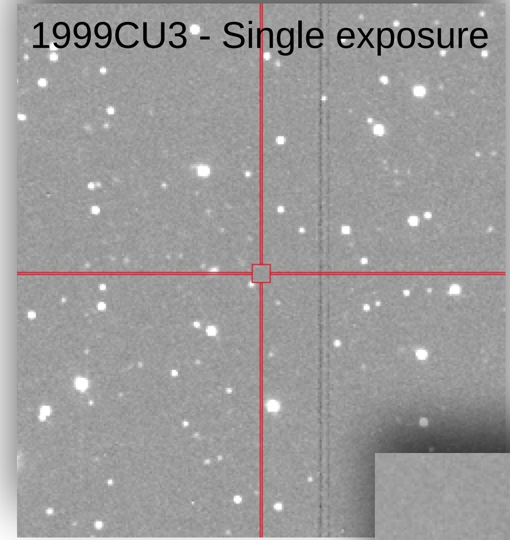
- Activities finally resumed after 14 months (Dec. 2019)
- Telescope unpacked after 4 years of storage.
- Most of the integration and preliminary testing was completed.
- Commissioning to be resumed during next mission.
- ‘Limited’ Remote operations possible.

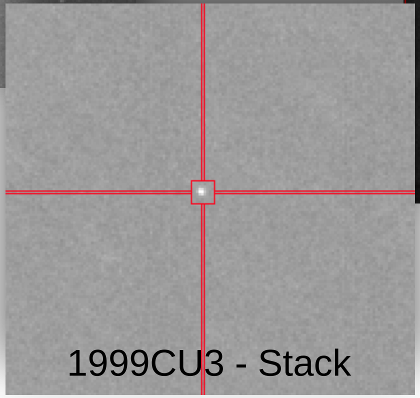


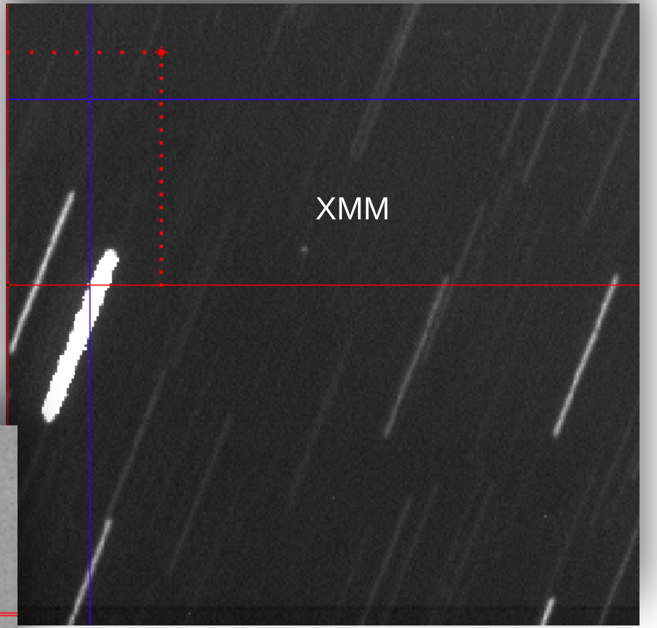
Test-Bed-Telescope 2 - Imaging Tests

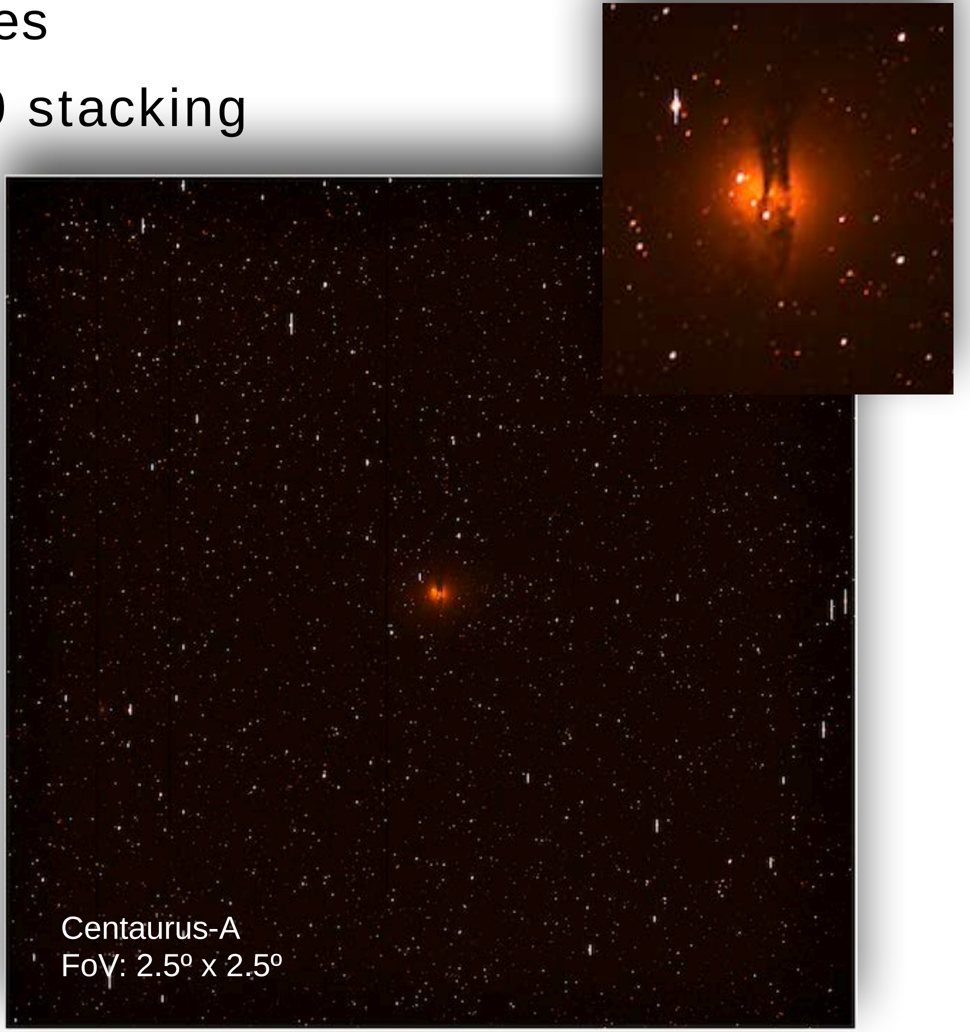
Images taken during the alignment/calibration activities

Able to reach limiting magnitude of 20.2 in 120s; 21.0 stacking









Flyeye 1 - Overview

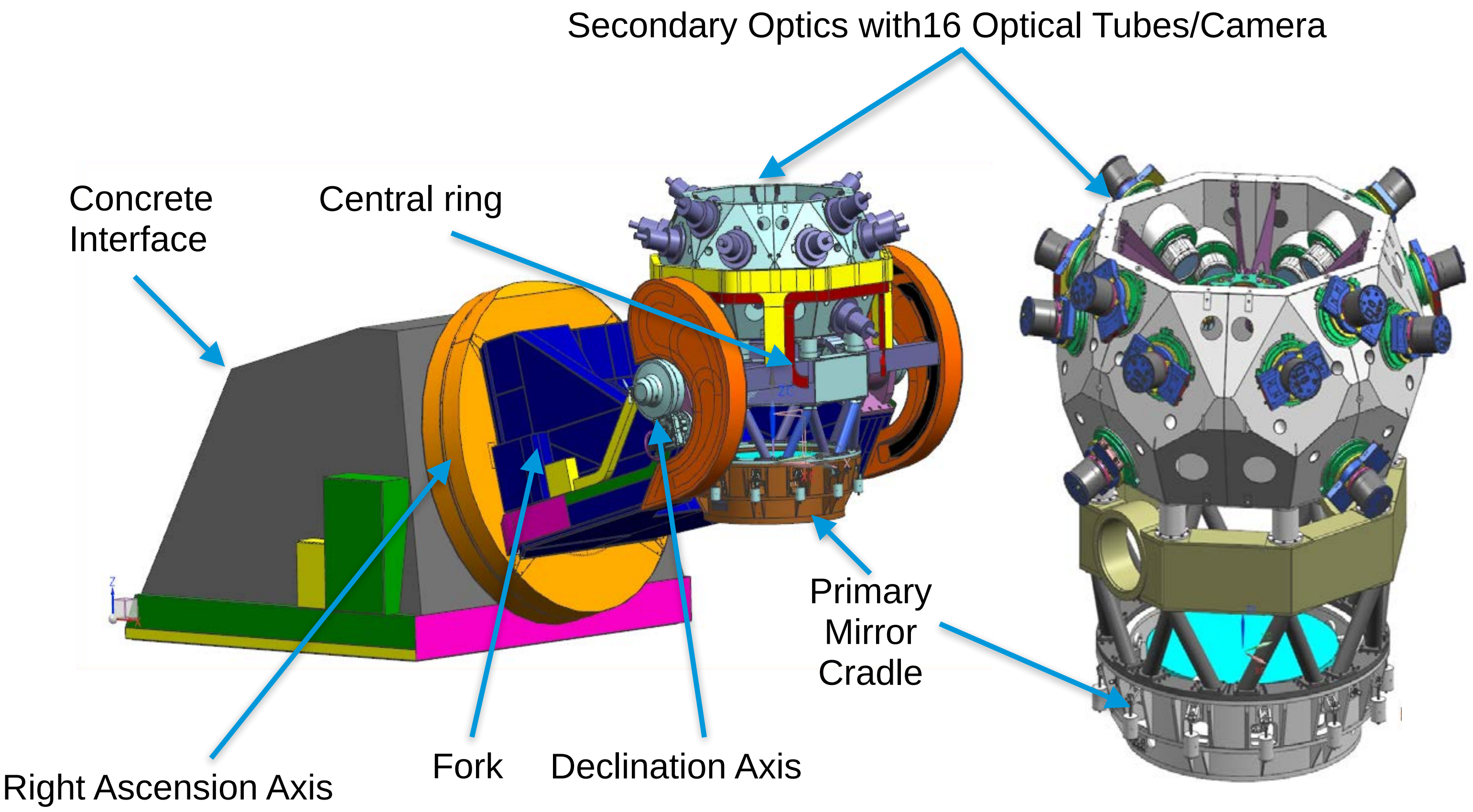
1-m class telescope with 6.7º x 6.7º FoV split into 16 different cameras (fly-eye design)

Equatorial mount, telescope structure, primary mirror and beam splitter ready.

Production of cameras ongoing:

- 7 already qualified,
  4 mounted on telescope.
- Finalisation of all 16 cameras expected by June 2021.

Autofocus software functionality under development.

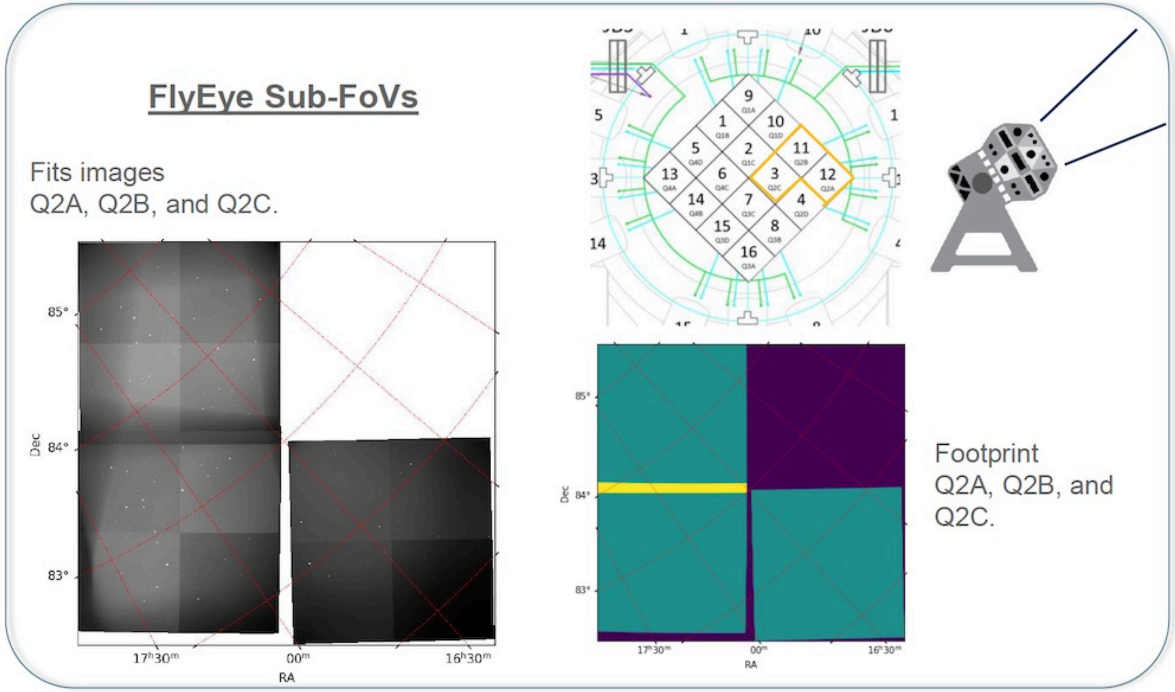


Flyeye 1 - Real Sky Tests

First on-sky alignment exercise with 3 cameras @Turate/Milan - poor seeing.

Focus on completing factory acceptance functional tests, and move to Matera (ASI site) before end of 2021.

Integration and 'on-sky' performance tests to resume @Matera, under better site conditions.

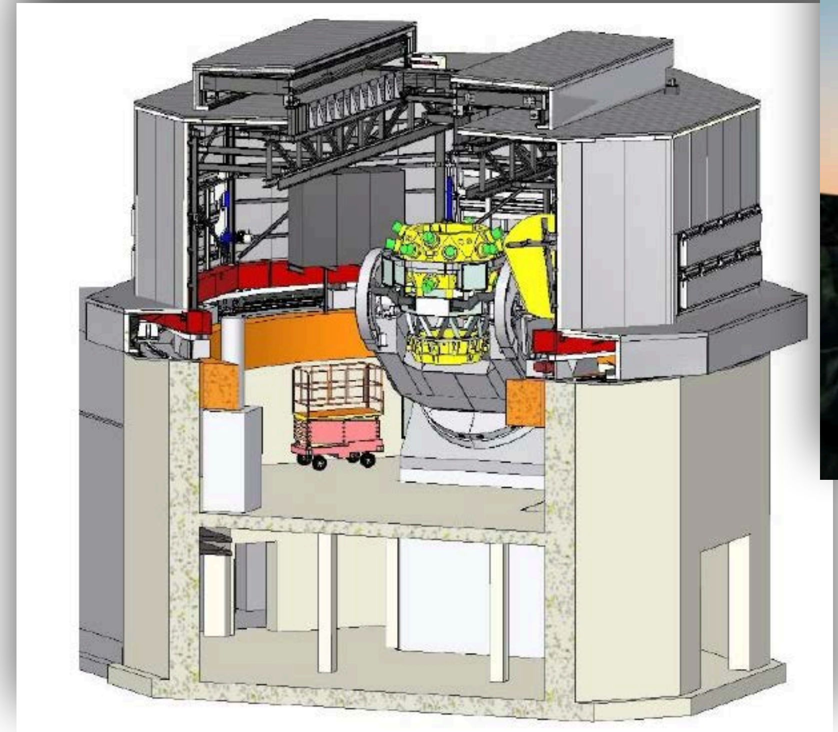


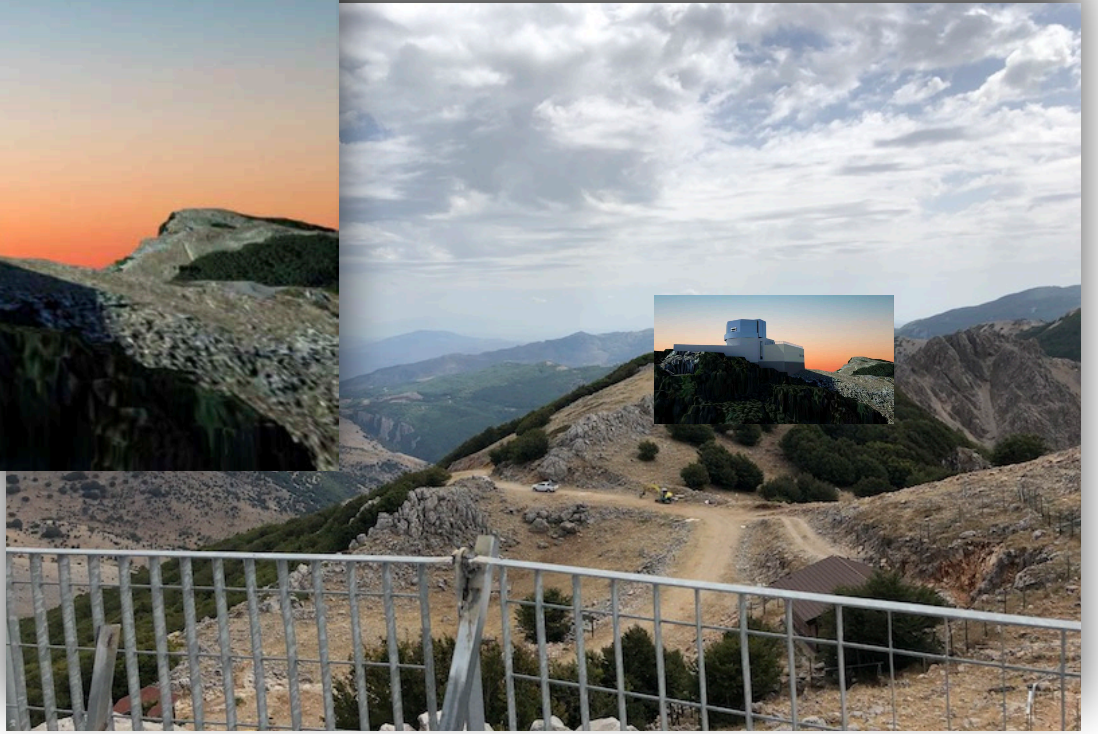
Flyeye 1 - Observatory

Design phase completed - Construction phase under negotiation.

Site readiness and begin of telescope installation expected by end of 2022/beg. 2023.

Synergies between Flyeye and the Wide Mufara Telescope (WMT) under exploration.





See Also

Presentations by ESA's Planetary Defence team:

- Micheli et al. - *Recent observational highlights from ESA's NEO Coordnation Centre*
- Rudawska et al. - *FITS image archive at ESA's NEO Coordination Centre*

Presentations by collaborators:

- Perozzi et al. - *An efficient deployment strategy for the first ESA Flyeye NEO survey telescope*
- Zolnowski et al. - *6ROADS: Highly precise optical observations of NEO, fast-moving satellites and Space Debris from a worldwide telescope network*

ESA-ESO TBT La Silla first light press release

Asteroid survey and follow up observations with small telescopes in framework of ISON network

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26 - 30 April 2021

International Scientific Optical Network (ISON)

Å ISON that have been started in 2004 is an open international project developed to be an independent source of data about natural and artificial space objects for scientific and applied purposes

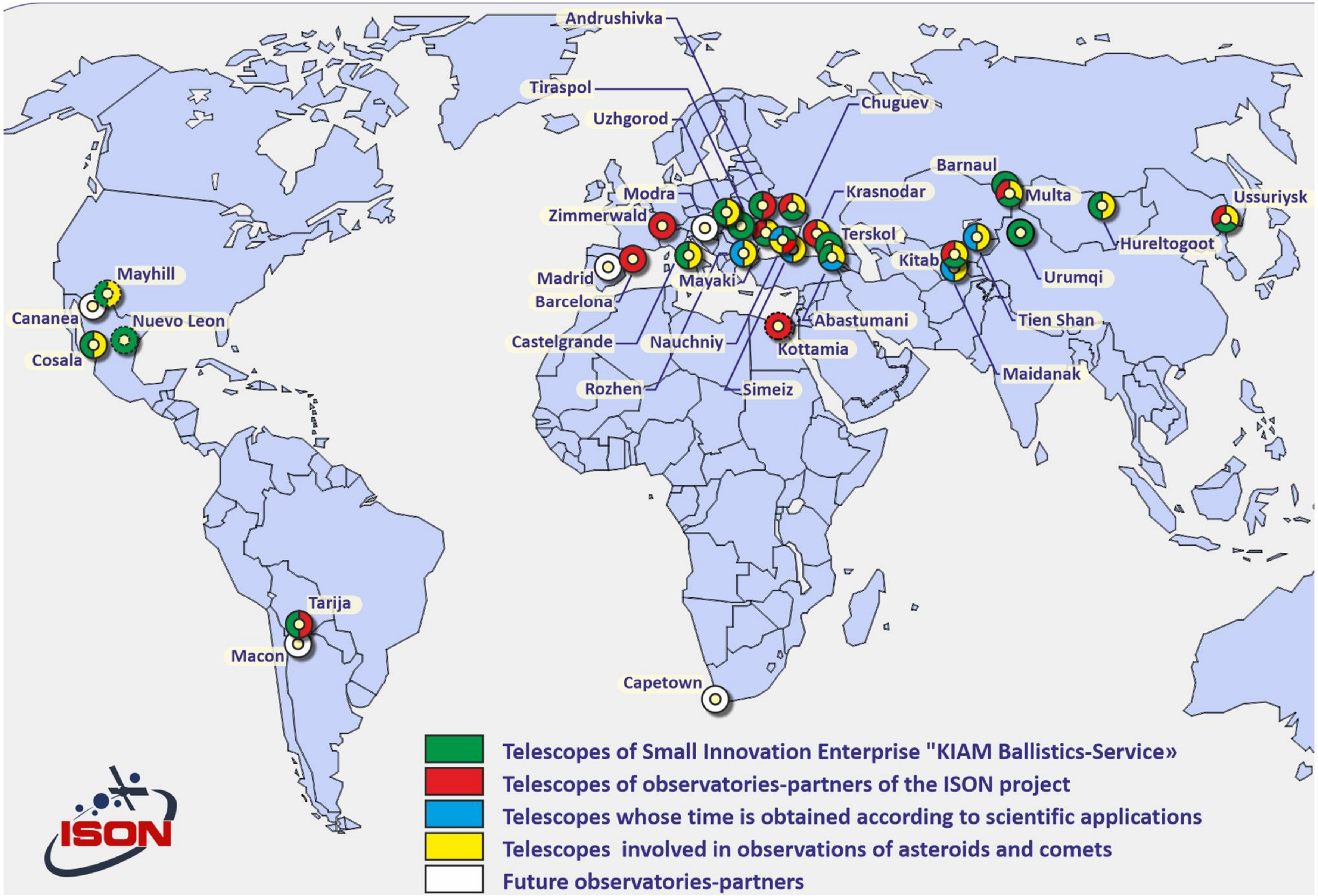
Å Main observation topics: space debris, asteroids, Gamma-Ray Bursts afterglows

Å Core of ISON network is 30 own telescopes (mainly 20-cm – 40 cm apertures) installed in 18 observation points

Å 12 telescopes (more 50 cm apertures) in 9 observatories-partners that have signed agreements on participation in ISON project

Å 10 telescopes (60-cm to 2.6 m apertures) in 8 observatories allocate an observation time based on consideration of the annual scientific applications

Map of observatories collaborating with ISON



Asteroid activities of the ISON project

International cooperation:

Å Cooperation of observatories (Abastumani, **Georgia**; Terskol, Simeiz and Multa, **Russia**; Chuguev and Mayaki, **Ukrain**e; Rozhen, **Bulgari**a; Tien-Shan, **Kazakhstan**, Maidanak and Kitab, **Uzbekistan**, Hureltogoot, **Mongolia**)

Å ESA network of follow-up telescopes => UN IAWN project

Å Chinese Near-Earth Object Survey Telescope, NAOC, **China**

Observations:

Å Dedicated asteroid surveys (temporarily suspended in 2019), survey method with small telescopes with big FOV;

Å Discovery of NEA as by product of space debris observations;

Å Follow up (astrometric measurements) of new NEAs;

Å Photometry of asteroids to measure the lightcurves:

- **studying physical properties of PHA, comets and radar targets;**
- **searching and investigation of binary NEAs, asteroids with the YORP and BYORP effect**

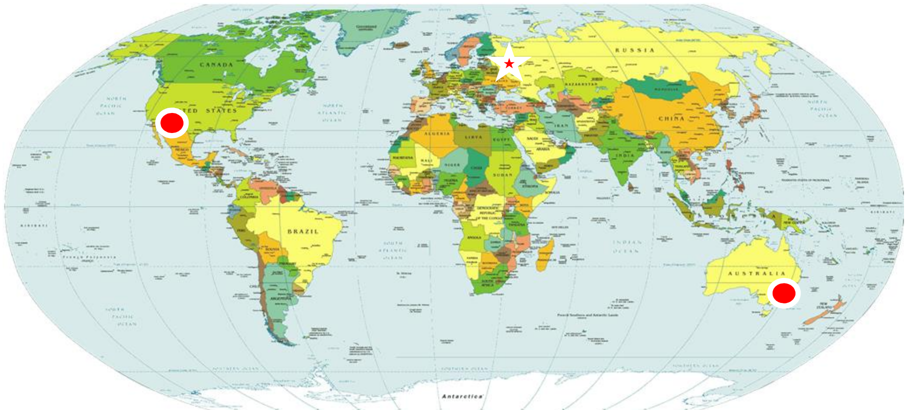
ISON dedicated asteroid surveys

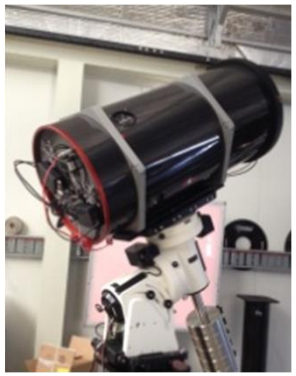
Å Two surveys with 40 cm telescopes in New Mexico (H15), USA (**1.76x1.76 degree**) and Siding Spring (Q60), Australia (**2x2 degree**) (joint project with AIUB team) were scheduled, controlled and processed in KIAM, that made it possible adjust technique and software, which were stopped at end of 2018

Å Both 40 cm telescopes covered 900 square degrees per night with a **limiting magnitude up to 20.5 m**

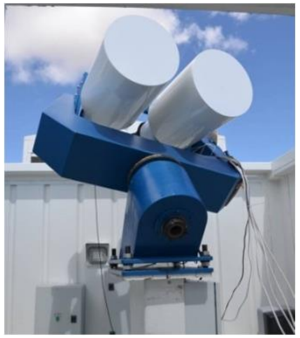
Å Measured 1 230 500 astrometric positions

Å Discovered **17 NEAs, 8 comets**, 20 Trojans of Jupiter, 4 objects from the family of Hilda, 4 Centaurs, **1605 main belt** asteroids.





Discovery of NEA as by product of space debris survey observations




- There are four two-tube 19.2 cm system with FOV 9x7 deg and four-tube system with FOV 9x14 deg of ROSCOSMOS which provide surveys of GEO and regularly (appr. 1 time per two weeks) detect new NEAs. Good example is NEA 2019 VS4.
- Problems – MPC-codes exist for two observatories only and the astrometry have not enough precision due the large FOV.
- Proposal – to arrange with ISON telescopes having MPC-code and good astrometry accuracy will be supplied by urgent follow up observations of the discovered NEAs.

New ISON subsystem for follow up NEAs





Å 40 cm ChV-400 at Uzhgorod (K99) , 36-cm RC-360 at Kitab (186), *ORI-40 at Khuraltogote* (O75), 40-cm Santel-400 at Multa (N82), 50-cm ORI-50 at Andrushivka (A50) + telescope of photometry network

Å Follow up by requests of ESA for IWAN (2018 -2020)

Å Follow up by requests from Chinese Near-Earth Object Survey Telescope (2020-2021)

Å Follow up from NEOCP up to V=20 - 21 mag

Å 1062 NEAs, 4972 astrometric measurements, 984 MPEC

ISON photometry observation campaigns

Å 10 telescopes (2.6 m ZTSh at Nauchniy, 1 m Zeiss-1000 at Simeiz and Tien-Shan, 2 m Zeiss-2000 at Rozhen and Terskol, 70 cm at Abastumani and Kharkiv, 1.5 m and 60 cm at Maidanak, etc.) participate in ISON photometric monitoring of asteroids

Å Every year, 200 - 250 nights observations of 50 - 70 NEAs are carried out to determine or clarify periods of rotation, sizes and shapes, properties of the surface of these bodies, as well as to study binary asteroids, radar and space mission targets

Å With ISON data, the YORP-effect was discovered for (1620) Geographos, (3103) Eger, and (1685) Toro, the BYORP-effect was first detected for the binary NEA (88710) 2001 SL9

Å Smaller ISON telescopes participate in observation campaigns of bright NEAs passing close to the Earth. In 2020, the campaigns were organized for NEAs 2020 SW in September, and for 2000 TU28 and 2020 UA in October

Outlook

Significant outcomes in asteroid research were obtained with 40-cm class telescopes within ISON project

Development of ISON asteroid survey is connected with 40-cm telescope (first in Multa) with FOV 4x5.5 degree and 28-cm telescopes with FOV 6x6 degree (first will be installed in Mexico in this year).

7th IAA Planetary Defense Conference

26-30 April 2021, Online Event

Hosted by UNOOSA in collaboration with ESA

Q&A

Session 5a: NEO Discovery

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Break

Up next: Session 6a - NEO Characterization