



NELIOTA

Ground-based observations of lunar impact flashes

The team: A.Z. Bonanos², M. Xilouris², A. Alikakos², I. Bellas-Velidis², P. Boumis², V. Charmandaris^{2,3}, A. Dapergolas², S. Els⁵, A. Fytilis², A. Liakos², A. Maroussis², A. Noutsopoulos², K. Tsiganis⁴, K. Tsinganos²

From ESA: C. Avdellidou, **D. Koschny**, V. Navarro

²IAASARS, National Observatory of Athens, GR-15236 Penteli, Greece

³Dept. of Physics, University of Crete, Heraklion, Greece

⁴Dept. of Physics, Aristotle University of Thessaloniki, Thessaloniki, Greece

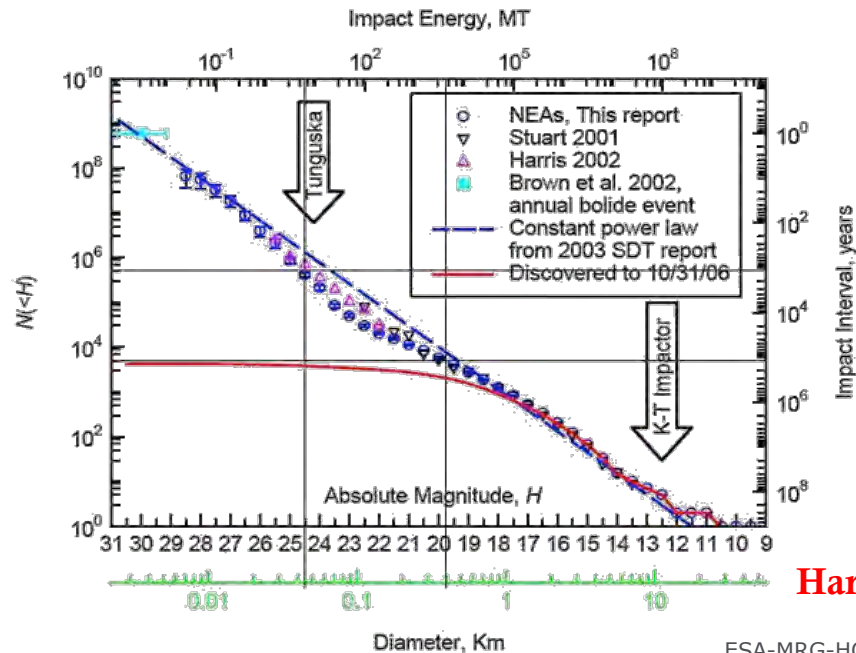
⁵Gulf Solutions Group (SD), PO 500033 Dubai, United Arab Emirate

And: European Space Agency, ESTEC, Keplerlaan 1, 2201 AZ Noordwijk, The Netherlands;

ESAC, Villafrance del Castillo, 28692 Villanueva de la Canada, Madrid, Spain. Email: Detlef.Koschny@esa.int

□ Flux densities of asteroids/meteoroids in the mass range of kg is not very well constrained.

The knowledge of small impactors is important for space assets.



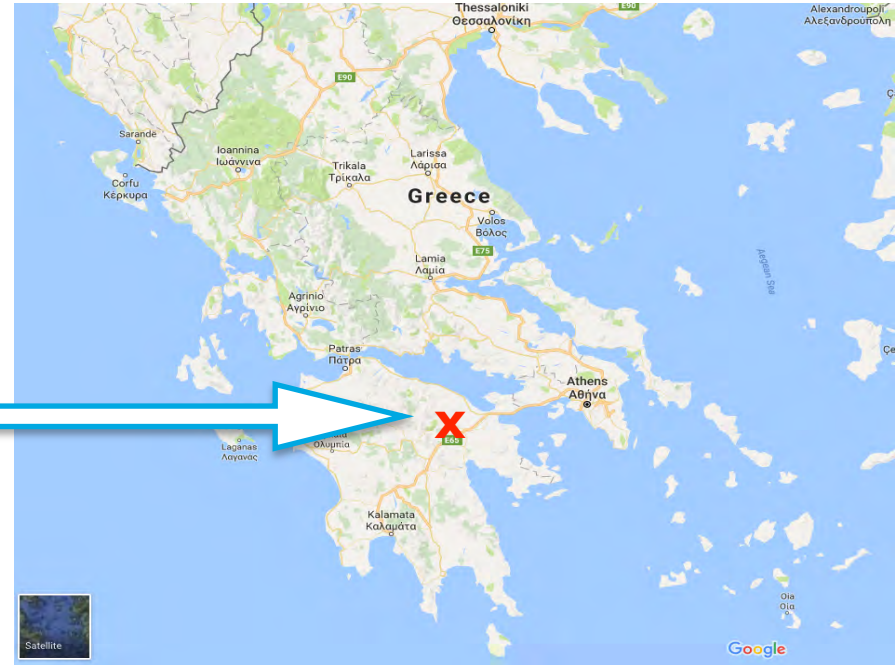
Harris+ 2015

Idea

- Characterise the impactor from the flash
- Use the Moon as the detector to monitor the flashes.

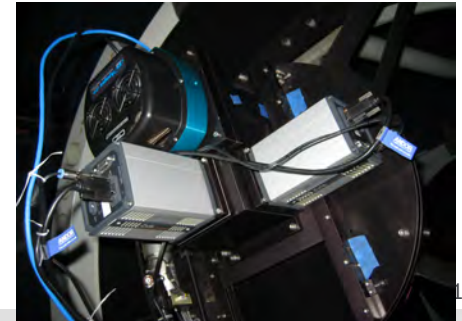
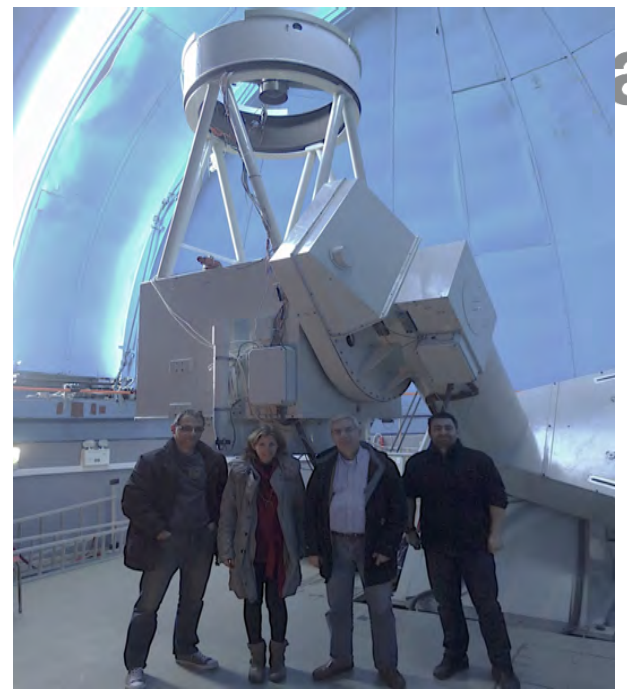
Suggs et al. (2014), Madiedo et al. (2010), Ortiz et al. (1990/2000), and more

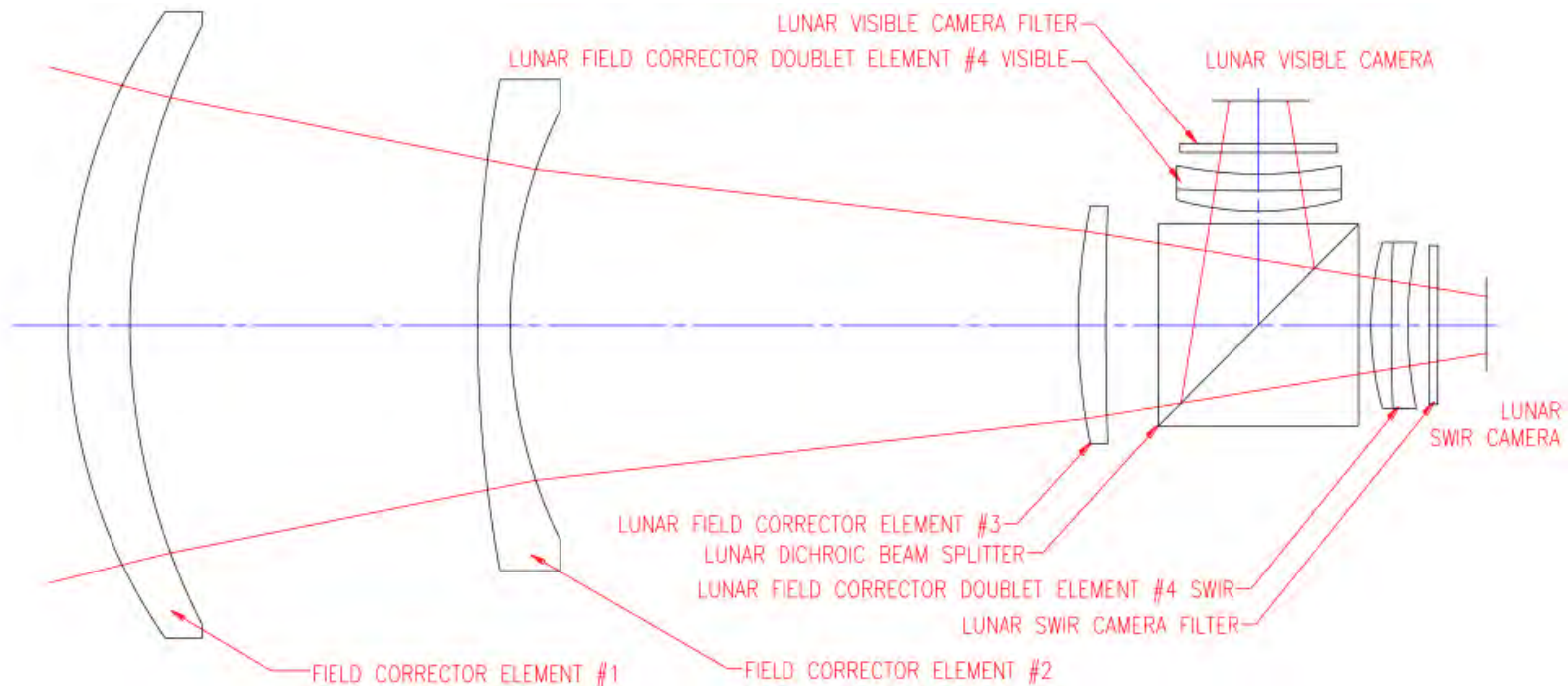
NELIOTA project in Greece developed within an ESA project
NEO Lunar Impacts & Optical TrAnsients



NELIOTA: Technical setup

- ❑ 1.2-m Kryoneri telescope at 930 m above mean sea level (National Observatory Athens)
- ❑ Dichroic beam-splitter
- ❑ Two Zyla sCMOS cameras at 2560 x 2160 pixels, 0.4" / pixel
- ❑ 30 to 40 fps
- ❑ Total FoV: 16.6 arcmin x 14.0 arcmin
- ❑ R and I filters





Specialised software is developed



I.Observation Plan

- science frames
- standard stars
- calibration frames (flat/dark)



Data obtained & stored



II. Data processing

- reduction
- subtraction of moon
- detection of events



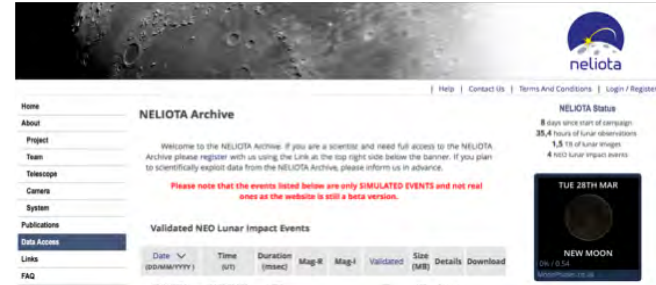
III. Archiving & validation

Operation of 22 months
(started 08 March 2017)

IV. Public Data

<http://neliota.astro.noa.gr>

- Time of event
- Approximate magnitude
- Location on the Moon
- Published within 24 h



The screenshot shows the Neliota Archive website interface. At the top, there is a navigation bar with links for Home, About, Project, Team, Telescope, Camera, System, Publications, Data Access, Links, and FAQ. The main content area is titled 'NELIOTA Archive' and contains a welcome message, a 'Please note' warning about simulated events, and a table of 'Validated NEO Lunar Impact Events'. The table has columns for Date, Time, Duration, Mag #, Mag L, Validated, Size (MB), Details, and Download. On the right side, there is a 'NELIOTA Status' section with statistics and a 'NEW MOON' graphic.

NELIOTA: First Results

Commissioning phase: 01 Feb – 08 Mar 2017



Validated/Suspected NEO Lunar Impact Events

UT Date (DD/MM/YYYY)	UT Time	Duration (sec)	R (mag)	I (mag)	Validated	Size (MB)	Details	Download
27/08/2017	17:29:42.997	0.033	-	10.3 ± 0.0	<input type="checkbox"/>	92	See >>	+ Add to Cart
18/08/2017	02:03:08.317	0.066	9.9 ± 0.0	8.8 ± 0.0	<input checked="" type="checkbox"/>	93	See >>	+ Add to Cart
18/08/2017	02:02:21.417	0.066	10.5 ± 0.0	9.0 ± 0.0	<input checked="" type="checkbox"/>	93	See >>	+ Add to Cart
16/08/2017	02:41:15.113	0.066	10.3 ± 0.0	8.9 ± 0.0	<input type="checkbox"/>	100	See >>	+ Add to Cart
16/08/2017	02:15:58.813	0.066	9.6 ± 0.1	8.8 ± 0.0	<input checked="" type="checkbox"/>	100	See >>	+ Add to Cart
16/08/2017	01:05:46.763	0.033	9.5 ± 0.1	9.1 ± 0.0	<input checked="" type="checkbox"/>	100	See >>	+ Add to Cart
28/07/2017	19:17:18.307	0.132	8.2 ± 0.0	6.4 ± 0.0	<input checked="" type="checkbox"/>	121	See >>	+ Add to Cart
28/07/2017	18:51:41.683	0.033	10.3 ± 0.0	9.6 ± 0.0	<input checked="" type="checkbox"/>	97	See >>	+ Add to Cart
28/07/2017	18:42:58.027	0.033	10.3 ± 0.0	9.5 ± 0.0	<input checked="" type="checkbox"/>	96	See >>	+ Add to Cart
28/07/2017	18:21:44.850	0.066	-	9.1 ± 0.0	<input type="checkbox"/>	101	See >>	+ Add to Cart
27/07/2017	18:31:06.720	0.033	-	9.3 ± 0.0	<input type="checkbox"/>	92	See >>	+ Add to Cart
19/07/2017	02:00:36.453	0.033	-	9.2 ± 0.0	<input type="checkbox"/>	92	See >>	+ Add to Cart
28/06/2017	18:45:25.803	0.033	10.0 ± 0.0	9.4 ± 0.0	<input type="checkbox"/>	93	See >>	+ Add to Cart
27/06/2017	18:58:26.680	0.066	10.3 ± 0.0	9.2 ± 0.0	<input checked="" type="checkbox"/>	87	See >>	+ Add to Cart
19/06/2017	02:39:13.590	0.033	-	10.1 ± 0.1	<input type="checkbox"/>	97	See >>	+ Add to Cart

Validated/Suspected NEO Lunar Impact Events

UT Date (DD/MM/YYYY)	UT Time	Duration (sec)	R (mag)	I (mag)	Validated	Size (MB)	Details	Download
19/06/2017	01:51:08.663	0.033	-	10.2 ± 0.1	<input type="checkbox"/>	98	See >>	+ Add to Cart
19/06/2017	01:50:34.560	0.066	9.9 ± 0.1	9.3 ± 0.1	<input type="checkbox"/>	98	See >>	+ Add to Cart
29/05/2017	19:00:05.083	0.033	-	9.6 ± 0.0	<input type="checkbox"/>	89	See >>	+ Add to Cart
20/05/2017	01:58:56.980	0.033	-	9.8 ± 0.0	<input type="checkbox"/>	99	See >>	+ Add to Cart
20/05/2017	01:58:45.080	0.033	-	11.6 ± 0.0	<input type="checkbox"/>	97	See >>	+ Add to Cart
01/05/2017	20:30:58.137	0.066	9.7 ± 0.0	8.5 ± 0.0	<input checked="" type="checkbox"/>	97	See >>	+ Add to Cart
01/04/2017	19:45:51.650	0.033	10.0 ± 0.1	8.7 ± 0.1	<input checked="" type="checkbox"/>	92	See >>	+ Add to Cart
04/03/2017	20:51:31.853	0.033	9.7 ± 0.1	8.8 ± 0.1	<input checked="" type="checkbox"/>	94	See >>	+ Add to Cart
01/03/2017	17:13:17.360	0.033	9.2 ± 0.1	8.1 ± 0.1	<input checked="" type="checkbox"/>	84	See >>	+ Add to Cart
01/03/2017	17:08:46.573	0.132	6.7 ± 0.1	6.0 ± 0.1	<input checked="" type="checkbox"/>	98	See >>	+ Add to Cart
01/02/2017	17:13:57.863	0.033	9.8 ± 0.1	8.9 ± 0.1	<input checked="" type="checkbox"/>	91	See >>	+ Add to Cart

NELIOTA Status



Validated/Suspected NEO Lunar Impact Events

UT Date (DD/MM/YYYY)	UT Time	Duration (sec)	R (mag)	I (mag)	Validated	Size (MB)	Details	Download
27/08/2017	17:29:42.997	0.033	-	10.3 ± 0.0	<input type="checkbox"/>	92	See >>	+ Add to Cart
18/08/2017	02:03:08.317	0.066	9.9 ± 0.0	8.8 ± 0.0	<input checked="" type="checkbox"/>	93	See >>	+ Add to Cart
18/08/2017	02:02:21.417	0.066	10.5 ± 0.0	9.0 ± 0.0	<input checked="" type="checkbox"/>			+ Add to Cart
16/08/2017	02:41:15.113	0.066	10.3 ± 0.0	8.9 ± 0.0				+ Add to Cart
16/08/2017	02:15:58.813	0.066	9.6 ± 0.1					+ Add to Cart
16/08/2017	01:05:46.763	0.033	9.5 ± 0.1					+ Add to Cart
28/07/2017	19:17:18.307	0.132	8.2 ± 0.0					+ Add to Cart
28/07/2017	18:51:41.683	0.033	10.3 ± 0.0					+ Add to Cart
28/07/2017	18:42:58.027	0.033	10.3 ± 0.0	9.5 ± 0.1				+ Add to Cart
28/07/2017	18:21:44.850	0.066	-	9.1 ± 0.1				+ Add to Cart
27/07/2017	18:31:06.720	0.033	-	9.3 ± 0.0				+ Add to Cart
19/07/2017	02:00:36.453	0.033	-	9.2 ± 0.0				+ Add to Cart
28/06/2017	18:45:25.803	0.033	10.0 ± 0.0	9.4 ± 0.0				+ Add to Cart
27/06/2017	18:58:26.680	0.066	10.3 ± 0.0	9.2 ± 0.0	<input checked="" type="checkbox"/>			+ Add to Cart
19/06/2017	02:39:13.590	0.033	-	10.1 ± 0.1	<input type="checkbox"/>			+ Add to Cart

NELIOTA: First Temperature Measurement of Lunar Impact Flashes***

A.Z. Bonanos¹, C. Avdellidou², A. Liakos¹, E.M. Xilouris¹, D. Koschny², I. Bellas-Velidis¹, P. Boumis¹, V. Charmandaris^{1,3}, A. Dapergolas¹, A. Fytisilis¹, A. Marcoussis¹

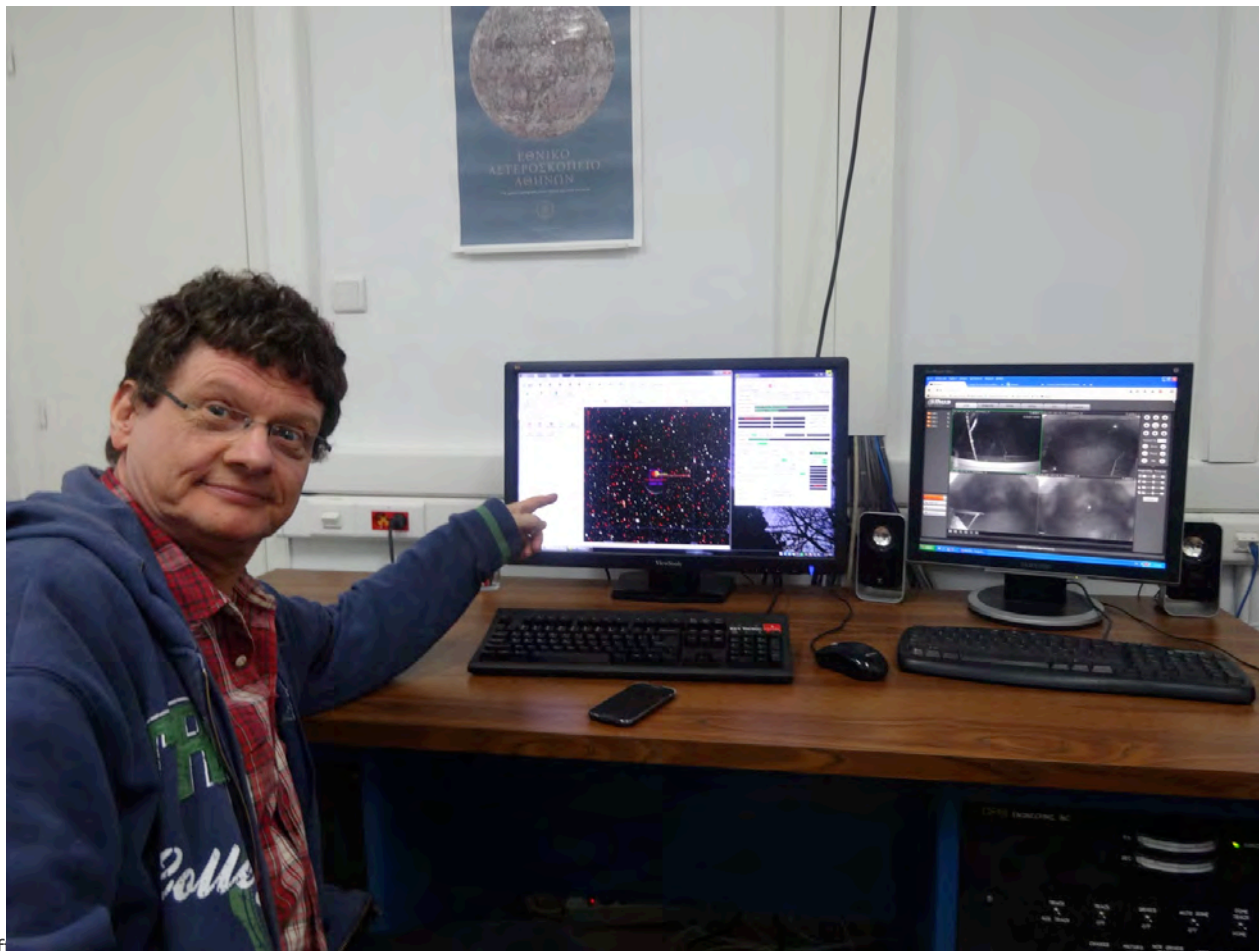
¹ IAASARS, National Observatory of Athens, 15236 Penteli, Greece
² Scientific Support Office, Directorate of Science, European Space Research and Technology Centre (ESA/ESTEC), 2201 AZ Noordwijk, The Netherlands
³ Department of Physics, University of Crete, 71003, Heraklion, Greece

Received; Accepted ???

ABSTRACT

We report the first scientific results from the NELIOTA project (NEO Lunar Impacts and Optical Transients), which has recently begun lunar monitoring observations with the 1.2-m Kryoneri telescope in the Peloponnese, Greece. NELIOTA aims to detect faint impact flashes produced by near-Earth meteoroids and asteroids and thereby help constrain the size-frequency distribution of near-Earth objects in the decimeter to meter range. The NELIOTA setup, consisting of two fast-frame cameras observing simultaneously in the R and I-bands, enables – for the first time – direct analytical calculation of the flash temperatures. We present the first 10 flashes detected, for which we find temperatures ranging between ~1,800 and ~3,000 K. Two of these flashes were detected on multiple frames in both filters and therefore yield the first measurements of the temperature drop for lunar flashes. In addition, we compute the impactor masses, which range between a few hundreds of grams and a few kg.







Occultation observations?

- ❑ Large aperture
- ❑ 30 fps, two colors, sCMOS camera
- ❑ Needs observer
- ❑ Time stamping and synchronisation of cameras under test

march2017_kryoneri.txt

Maximal Distance = 250.0
Maximal Mv = 14.00
Minimal Duration = 0.5s
Maximal Sun Elevation = 0.0
Minimal drop: 0.5
Minimal probability: 0.0
Minimal probability in nearest point: 1.0
Minimal star elevation: 0.0
Time UTC

Date	Time	Number	Asteroid Name	Diam(km)	AMag.	Max Durat(s)	Prob.	Center Prob.	SMag.	Star RA	Star Dec
2017/03/01	20:43:33	889	Erynia	22.6	15.05	1.3	1.8%	9.1%	13.73	5h11m10.890s	18o33'50.439"
2017/03/01	21:18:20	33593	1999 JT47	5.5	19.16	0.6	1.1%	1.4%	13.10	5h39m18.885s	34o06'27.088"
2017/03/02	03:19:39	3705	Hotellasilla	10.5	17.36	0.7	1.7%	3.2%	13.97	11h11m59.119s	5o33'03.756"
2017/03/02	16:23:54	14113	1998 QD32	8.7	18.15	0.5	1.3%	2.3%	13.91	11h03m54.034s	14o24'31.955"
2017/03/02	21:44:41	70992	1999 XU34	5.5	17.72	0.5	1.2%	1.9%	12.78	9h13m30.695s	-2o25'16.777"
2017/03/02	23:05:04	27575	2000 RX29	6.0	17.91	0.8	1.4%	2.2%	13.71	14h54m55.579s	-25o06'54.095"
2017/03/03	02:43:51	7331	Balindblad	14.5	17.35	2.3	3.3%	3.9%	12.74	14h32m15.240s	-15o52'35.320"
2017/03/03	03:27:53	8693	Matsuki	8.3	17.97	0.9	2.8%	2.9%	11.77	15h42m40.773s	-11o10'51.038"
2017/03/03	18:42:03	2613	Plzen	28.2	17.46	0.7	2.7%	5.1%	12.61	0h27m43.588s	13o50'11.469"
2017/03/03	19:02:58	82899	2001 OS90	5.8	18.34	0.6	1.5%	1.6%	13.42	7h22m35.971s	-26o25'53.923"
2017/03/03	19:28:22	311	Claudia	24.1	15.68	1.0	3.0%	6.5%	12.71	3h36m18.345s	19o02'15.479"
2017/03/03	19:55:31	32871	1993 FQ32	5.2	19.17	2.2	1.0%	1.5%	13.75	7h33m03.526s	25o00'27.790"
2017/03/03	20:10:03	102	Miriam	83.0	14.29	5.4	3.6%	27.6%	13.85	5h09m50.811s	17o30'18.424"
2017/03/03	21:39:58	3332	Raksha	16.6	15.13	1.6	5.1%	7.1%	13.78	9h40m51.726s	18o44'03.553"
2017/03/04	00:28:19	71329	2000 AH06	5.0	17.52	0.6	1.5%	1.9%	13.49	11h36m05.865s	1o40'42.568"
2017/03/04	01:59:35	6307	Maiztequi	13.8	17.46	0.5	1.3%	3.7%	13.52	18h04m10.087s	-13o03'10.009"
2017/03/04	03:23:20	1015	Christa	96.9	14.95	17.8	22.4%	25.3%	12.73	15h24m01.971s	-7o14'32.899"
2017/03/04	04:21:09	3721	Widorn	13.8	17.97	0.6	3.1%	3.2%	13.49	17h53m49.688s	-30o58'46.958"