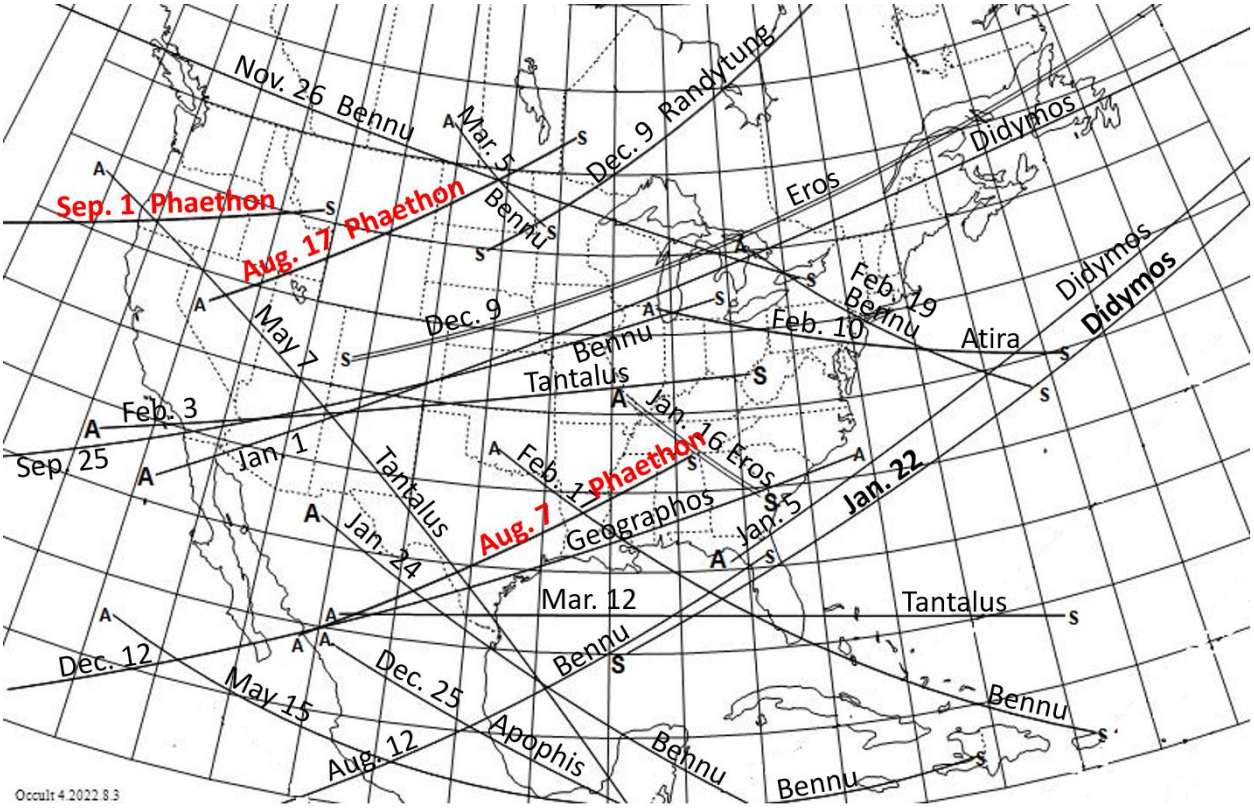
2023 Occultations by Near-Earth Asteroids

More information can be found on IOTA's page for 2023 North American Near-Earth Asteroid (NEA) occultations at **https://occultations.org/publications/rasc/2023/nam23NEAoccs.htm** . Also there for specific occultations, when appropriate, are finder charts, maps, links to other resources, and cloud cover forecast maps. Interactive (zoomable) maps that show event U.T. and circumstances when clicking on a specific location, Aladin zoomable photographic star charts, and different path statistics can be found on the OW cloud page for an event available with Occult Watcher (OW) for events generally less than two months in the future. When using OW for these events, you need to set the size and rank limits to small values to get the events to show up. For example, for the (98943) 2001 CC21 campaigns, the object is only 600m in diameter and with current 1-sigma errors of about 3 path-widths, the rank of the events are around 8, so a size limit of 0 km and rank limit of 5 are recommended in your OW configuration. For a specific event, you might select a site (from the General tab) near the path you want with a small (such as 100 km) distance, to add that event to your OW list, without cluttering OW with dozens of inappropriate events, which would likely happen if you selected a large-enough distance with your home location.

Occultations by Near-Earth Asteroids (NEAs) is an exciting new endeavor that contributes to planetary defense by refining the orbits of these small but possibly dangerous objects. IOTA's first success with NEA events was with (3200) Phaethon in 2019, but more spectacularly with (99942) Apophis in 2021, and finally with Didymos late last year; much information about the occultations, their value, and how they helped retire the threat of Apophis, is given in a paper presented at the 7th Planetary Defense Conference (PDC) that you can obtain at **http://iota.jhuapl.edu/NEOoccultationsDunham.pdf** . An 8th PDC was held this year with an update NEAs occultations presentations that you can get from IOTA's NEA occultations Web page. There are several opportunities in 2023 shown on the map and table on the next page, similar to those described for bright main-belt occultations at **https://occultations.org/publications/rasc/2023/nam23MBoccs.htm** **.** Especially important earlier this year were occultations by (65803) Didymos and its small moon Dimorphos, the target of NASA's DART planetary defense demonstration mission (see **https://www.nasa.gov/planetarydefense/dart**). Unfortunately, no observations of occultations by either Didymos or Dimorphos were obtained before the successful DART impact on 2022 Sept. 26, but shortly after that, Goldstone radar and radiometric tracking data of DART resulted in a good-enough improvement of Didymos' orbit that the first ever occultation by Didymos was recorded by Roger Venable on Oct. 15, and several more have been observed since then. Occultations by Dimorphos were observed by Roger Venable in Florida on Oct. 19 and by Robert Jones in California on Nov. 12; we want to obtain a few more Dimorphos events before its occultations become too short to record with video around 2023 March. Dimorphos orbits Didymos in a virtually circular orbit 3 Didymos diameters away in a period just under 12 hours. The JPL orbit, #201, fit well all occultation observations made through 2022 Dec. 23, is virtually as good as the latest orbit #204, so #201 is still fine for checking for later events. During January, the Didymos occultation durations increased to even 0.7s, allowing Dimorphos occultation possibilities with video, in spite of their being only 1/5th the duration of the Didymos events. By 2023 March, the opportunities decreased considerably as Didymos travels farther from Earth (so shorter occultation durations) and farther from the star-rich Milky Way.

Although it will be virtually possible to observe Didymos occultations during the rest of 2023, there are other important NEA opportunities described and mapped below. Since the paths for these events are all very narrow, one must travel to the paths with mobile equipment to observe them, rather like grazing occultations of stars by the Moon.

The best occultations of stars by NEA's in North America during 2023



Date	UT	Occulting Body		Star		Mag.	RA (2000) h m s	Dec ° ′ ″	ΔMag.	Dur. s	Path
Jan. 1	**01:41**	**65803**	**Didymos**	**HIP**	**37693**	**9.0**	**07 43 59.0**	**+29 24 22**	**7.4**	**0.20**	**NL-Baja**
Jan. 5	**23:47**	**65803**	**Didymos**	**TYC**	**2453-00085-1**	**11.4**	**07 35 47.5**	**+30 04 10**	**5.1**	**0.26**	**FL**
Jan. 16	11:30	433	Eros	UCAC4	301-121701	11.6	17 13 08.6	–29 56 10	2.6	0.41	IL-GA
Jan. 22	**00:16**	**65803**	**Didymos**	**TYC**	**2451-01892-1**	**9.1**	**07 16 02.8**	**+30 50 49**	**8.3**	**0.41**	**FL**
Jan. 24	10:50	101955	Bennu	TYC	6813-00643-1	11.3	16 47 08.2	–25 09 32	12.5	0.01	Mex
Feb. 3	11:29	2102	Tantalus	TYC	1592-00588-1	11.1	18 55 49.6	+19 17 25	7.2	0.09	CA-WV
Feb. 10	10:12	163693	Atira	UCAC4	398-105724	10.5	18 58 07.3	–10 30 17	7.9	0.06	IL-NJ
Feb. 17	10:13	101955	Bennu	TYC	6850-01892-1	9.0	18 02 49.1	–27 22 21	14.8	0.05	OK-PR
Feb. 19	10:08	101955	Bennu	UCAC4	313-159522	12.0	18 09 08.2	–27 27 23	11.8	0.01	ON-NY
Mar. 5	12:01	101955	Bennu	TYC	6868-01265-1	10.7	18 53 34.2	–27 36 47	13.0	0.01	SK-MN
Mar. 12	09:43	2102	Tantalus	TYC	1072-01065-1	11.0	20 06 50.9	+08 58 57	7.6	0.10	Mex-BS
May 7	10:14	2102	Tantalus	HIP	106281	8.4	21 31 35.0	–11 56 18	10.0	0.11	OR-Mex
May 15	09:26	101955	Bennu	TYC	6388-00279-1	11.1	22 29 26.9	–17 59 53	12.0	0.01	Mex-HT
Aug. 7	09:53	3200	Phaethon	UCAC4	587-029902	12.9	06 27 01.2	+27 17 38	5.1	0.13	Mex-AL
Aug. 12	10:01	101955	Bennu	TYC	1253-00686-1	10.3	03 53 35.9	+17 04 52	11.6	0.02	Mex-FL
Aug. 17	09:36	3200	Phaethon	UCAC4	582-034437	12.6	06 55 59.8	+26 13 24	5.1	0.12	NV-ON
Sep. 1	11:40	3200	Phaethon	UCAC4	567-040387	12.6	07 47 40.0	+23 19 16	4.6	0.11	OR-MT
Sep. 25	10:27	101955	Bennu	UCAC4	582-040467	11.4	07 58 18.8	+26 13 27	10.8	0.02	CA-MI
Nov. 26	11:08	101955	Bennu	TYC	287-00022-1	11.0	12 14 54.7	+05 44 37	11.5	0.01	BC-NY
Dec. 9	00:12	29886	Randytung	UCAC4	396-133733	11.1	22 20 24.9	–10 51 06	9.4	0.13	SD-QC
Dec. 9	00:49	433	Eros	TYC	5211-00132-1	11.3	21 54 44.7	–01 46 28	2.5	0.74	CO-NL
Dec. 12	02:28	1620	Geographos	UCAC4	398-133629	11.2	21 18 14.5	–10 25 25	7.1	0.07	Baja-SC
Dec. 25	11:24	99942	Apophis	TYC	6195-00365-1	11.1	15 54 06.7	–20 07 58	10.3	0.01	Mex

On the top of the previous page is the map of 2023 NEA occultations that's on p. 247 of the *Observer's Handbook 2023* of the Royal Astronomical Society of Canada (but the map here is corrected with the right date for the Jan. 22nd Didymos event, and using red font to emphasize the important Phaethon events noted below), and the corresponding table of information about each of the plotted occultations. The orbital elements are all from the NASA JPL Horizons Web site at **https://ssd.jpl.nasa.gov/horizons.cgi** and the stellar data are from the Early third release (EDR3) of the European Space Agency's Gaia mission, as implemented with UCAC4, Tycho, and Hipparcos catalog identifiers with IOTA's free *Occult* software.

Like for lunar grazes, it is necessary to adjust the location for elevation above sea level. John Irwin in the UK has helped IOTA with this by supplying special Google Earth files that take elevation into account. His were important for also showing the paths of Dimorphos events, but for other NEA's, thanks to Dave Herald's updates, we can now generate those files with Occult4.

The successive columns in the table list: (1) the date and time of the event for a location near the center of the path on the map; (2) the name of the occulting body; (3) the catalogue and number of the occulted star; (4) the star's apparent visual magnitude; (5) the star's right ascension and (6) declination; (7) the expected magnitude change from the combined brightness; (8) the predicted maximum duration of the occultation in seconds; and, (9) the path location specified by the lands crossed by the eastern and western ends of the path shown on the map. The two-letter abbreviations for the US States and Canadian Provinces are given, with the order indicating the direction of motion of the shadow. "Baja" is Baja California, either Norte or Sur, while "Mex" denotes the rest of Mexico. Note that for any specific location in North America, the event time can be a few minutes earlier or later. As noted above for Didymos, when a NEA occultation is first observed, it generally must be done by a large team of observers to cover the relatively large uncertainty zone. But after one occultation is observed, that data can refine the orbit to allow more accurate prediction of future events that can then be covered by only a few observers.

Some information about the occulting NEAs portrayed above is given below:
(433) Eros: Observations are useful to improve the post-NEAR-Shoemaker orbit of Eros.
(1620) Geographos: Radar observations show the asteroid to be the most elongated object in the Solar System.
(1866) Sisyphus: Observations of occultations by this large NEA are valuable since Sisyphus is out of radar range for at least the next 20 years. Due to the important Didymos campaigns, IOTA did not conduct a large effort to observe a reasonable Sisyphus event on 2022 Nov. 26 as originally planned, but Steve Messner travelled to the latest predicted path, which had been updated by Steve Preston with smaller errors than before, and Messner recorded the occultation, with a duration of 0.3s. Although there are no Sisyphus events on our N. America map or table, there are several Sisyphus events around the world, and some in N. America fainter than mag. 12, and Messner showed that the current orbit is good, having real errors an order of magnitude less than the current formal ones.
(2102) Tantalus: This 1.4km potentially hazardous asteroid is in an orbit inclined 64° to the ecliptic, and will be out of radar range until its next close approach in 2038. The brightest NEA event of 2023 was by Tantalus, on Jan. 30, but only really observable from n. Greenland. The star was 4.1-mag. 110 Herculis = SAO 86406, spectral type F5. A more accessible event with 8th-mag. SAO 164452 occurred on May 7; it was successfully observed in NM. See the IOTA NEA Web page for a link to an article about it. Like Sisyphus, the prediction was spot on, again showing that the real errors are much less than the formal ones.
(3122) Florence: 2017 radar observations found two Florence moons, one about 200m across and about 5 km away, while the other is a little more than 300m across and about 10 km away. Although there are no events by Florence in N. America brighter than our mag. 12 limit for non-Phaethon NEA's for our map, there are several Florence events around the world, and some in N. America fainter than mag. 12.

(3200) Phaethon: The paths should be quite accurate, with the orbit well-determined from the 2019, 2020, and 2022 occultations. But more observations are desired, to check for variations in Phaethon's non-gravitational forces caused by mass shedding (Geminid meteoroids) from its extreme thermal environment. A significant shift was found by a large expedition in Japan for an event in 2022 October, possibly due to shedding of a sizeable object during its 2022 May perihelion passage (see our paper for PDC 2023 linked to from the IOTA NEA occultations page for details), so we plan significant efforts for the remaining Phaethon events in the USA, stressed in red (a 4th Phaethon event, on Sep. 25, is on another map on a following page). It is JAXA's DESTINY+ mission target.

(29886) Randytung: This may be a 2nd target of ESA's Hera mission to Didymos, so ACROSS is interested.

(65803) Didymos: The occultations by Didymos had the highest priority since NASA's DART mission planned to impact Dimorphos, Didymos' 160m moon that is 1.2 km away, on September 26, 2022. Once a first occultation was observed, the following ones were predicted more accurately; then, especially valuable were observations of occultations by Dimorphos as well as by Didymos, to help measure the effect of the DART impact. The 6.6-km/sec impact changed the orbital period of Dimorphos around Didymos by many minutes. The 9.1-mag. Jan. 22nd event occurred earlier (Jan. 21st UT) over northern India, Turkey, Italy, and southern France. Unfortunately, it was overcast along the path over Florida, but great observations of the event were obtained from France and Italy. More about the Didymos efforts are given in a Sky and Telescope article by Damya Souami at **https://skyandtelescope.org/astronomy-news/how-citizen-scientists-are-monitoring-the-dart-impact/** .

(98943) 2001 CC21: This estimated 600m NEA is a flyby target of the Hayabusa2 extended mission (the flyby will occur in July 2026) that hopes to rendezvous with the 30m Apollo-orbit NEA 1998 KY26 in 2031. The Japanese space agency JAXA is interested in characterizing 2001 CC21 that is currently occulting many stars. Six large expeditions have already been mounted in Japan this year; 2 were clouded out and the others had 10 and 12 stations that all had no occultation, except that one in early March secured one positive chord. However, it did not help because the 10th-mag. star had a high Gaia RUWE and its Gaia position had larger-than-expected errors. So although it was used to update the orbit anyway, it caused all 12 stations for the 5.1-mag. 6 Persei occultation on Mar. 26 in s. Japan to have no occultation. See their Web site at **http://hal-astro-lab.com/asteroid/2303_2001CC21_index.html** (Google translate does a pretty good job translating this to English). Page 5 has a map and table that includes the better remaining 2001 CC21 events in North America.

(99942) Apophis: Unfortunately, all of the occultations by Apophis in 2023 are very short, lasting only 0.01s; systems that can record faster than video rate will be needed, and even then, the event will be quite difficult due to Fresnel diffraction smearing. As Apophis recedes farther from Earth next year, the events become virtually impossible, and we will likely not be able to observe them again until 2028, or maybe 2027, as Apophis approaches its close Earth flyby in April 2029.

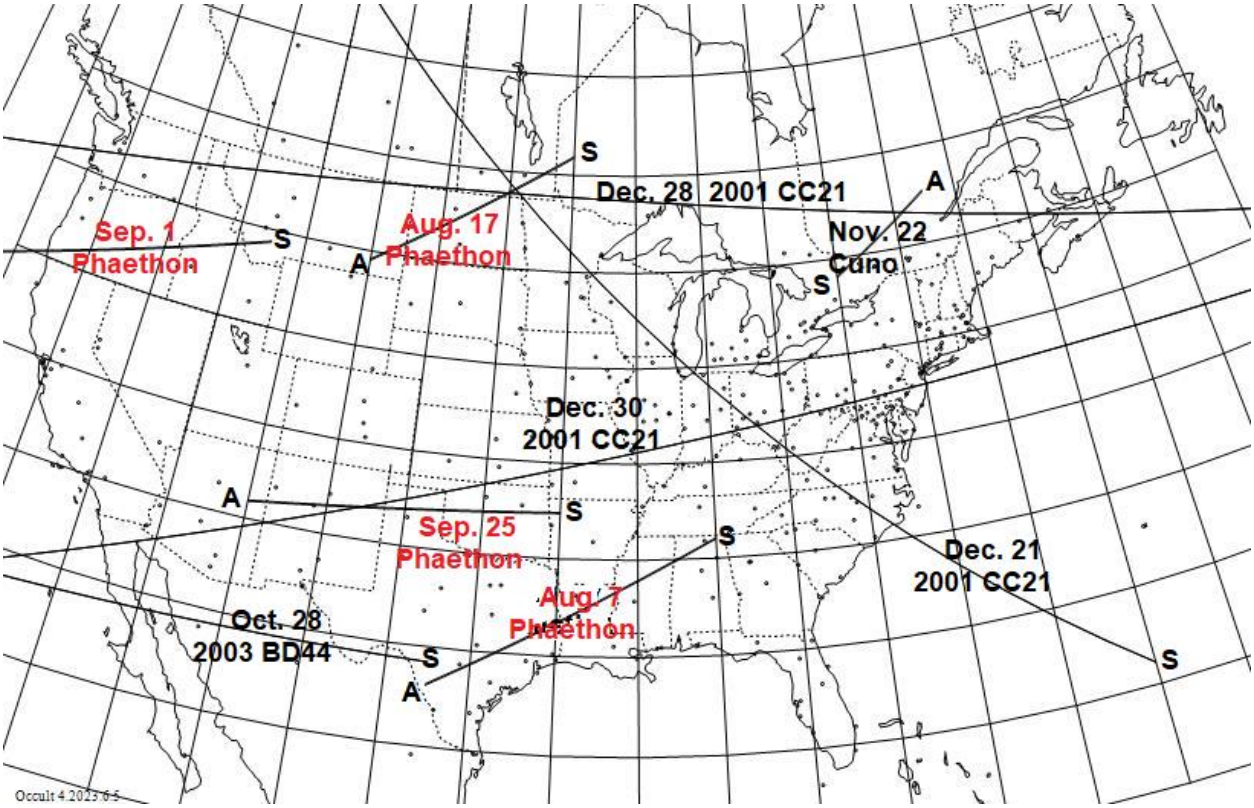
(101955) Bennu: This is NASA's OSIRIS-Rex's target asteroid, but the 2023 events are all too short to record with video; I regret now that I included them.

(163693) Atira: Radar data show Atira has a ~1-km moon orbiting about 6 km from the 5-km primary.

– – – – –

On the next page is a map and table of only a few of the most important NEA occultations during the rest of 2023 in North America. A new Phaethon event on Sept. 25 was found that was missed in our searches last year for the main map and table on p. 2. Two of the occultations are by asteroids that could threaten Earth in the next 1000 years; they are from a list of 20 NEA's given in an abstract for a talk at next week's Asteroids, Comets, Meteors (ACM) Conference in Flagstaff. See more about ACM 2023 on the Web page, where you can also obtain the Occult input dataset for the asteroids considered that can be used to generate predictions for all events down to mag. 14.0 in your region. Please try to get others to join you, especially for the brighter events.

The more important NEA events in North America during the 2nd half of 2023



2023

Date m	d	U.T. h	m	Diam km	Dur sec	Star mag.	drop	Elon o	Star No.	d	RUWE <1.4	Asteroid No	Name	Moon Dist	ill	R.A. (J2000) h	m	s	Dec. o	'	"	Path
Aug	7	9	53	5.0	0.13	12.9	5.2	39	UCAC4 587-029902		0.95	3200	Phaethon	64	61	6	27	1.234	27	17	37.77	TX-AL
Aug	17	9	36	5.0	0.12	12.6	5.2	41	UCAC4 582-034437		1.15	3200	Phaethon	52	1	6	55	59.803	26	13	24.10	MT-ON
Sep	1	11	40	5.0	0.11	12.6	4.7	44	UCAC4 567-040387		1.00	3200	Phaethon	116	97	7	47	39.991	23	19	16.02	OR-MT
Sep	25	11	9	5.0	0.08	12.8	3.5	37	UCAC4 512-048208		1.25	3200	Phaethon	162	79	9	44	52.207	12	13	45.31	AZ-AR
Oct	28	12	2	1.4	0.15	10.2	11.5	129	UCAC4 551-016864	s	1.20	143404	2003 BD44	55	100	5	38	18.361	20	0	57.98	TX-Mex
Nov	22	22	43	3.4	0.09	10.9	8.1	46	UCAC4 343-184000	s	0.95	4183	Cuno	78	77	19	7	14.750	-21	32	38.70	ON-QC
Dec	21	10	27	0.6	0.09	8.4	8.4	174	TYC 1889-00569-1	s	0.95	98943	2001 CC21	71	68	6	8	23.762	28	58	36.15	NC-SK
Dec	28	4	1	0.6	0.09	10.1	6.9	168	UCAC4 604-023464		1.05	98943	2001 CC21	23	98	5	42	21.443	30	36	57.80	NS-WA
Dec	30	1	57	0.6	0.09	9.5	7.6	165	UCAC4 605-022488	d	badPM	98943	2001 CC21	48	91	5	34	53.984	30	59	41.00	NJ-Baja

The above map and table are similar in form to those for the map and table of the best of all NEA occultations on p. 2, but there are some additional columns in the table above, some of which are described at the bottom of p. 2 and the top of p.3 of **https://occultations.org/publications/rasc/2023/nam23MBoccs.pdf** . The Phaethon event's fonts are red to emphasize their importance, as explained above. The events with tan font are other events for which observational efforts are planned; if you are interested in participating in any of these campaigns, contact us at the email address at the end of this document, and read more about them at **https://occultations.org/publications/rasc/2023/nam23NEAoccs.htm** . The Jan. 23rd and 29th events were new, found in a recent search; *'s follow their dates. Since I invested much work already labeling the map, I added them with straight lines; more accurate Occult maps showing their paths are given later. IR satellite imagery shows that all of the early January occultations were completely or mostly cloudy along their entire mapped path, with some exceptions noted on the next page.

Notes about the Didymos occultations shown on the previous page; the Occult maps of past Didymos occultations have been removed from this document, but can be found on a page for past Didymos occultations at **https://occultations.org/publications/rasc/2023/PastDidymosEvents.htm** . **Skip to the last page of this document for information about the Occult datasets and how to use them.**

Fresnel Diffraction Effects for NEA Occultations

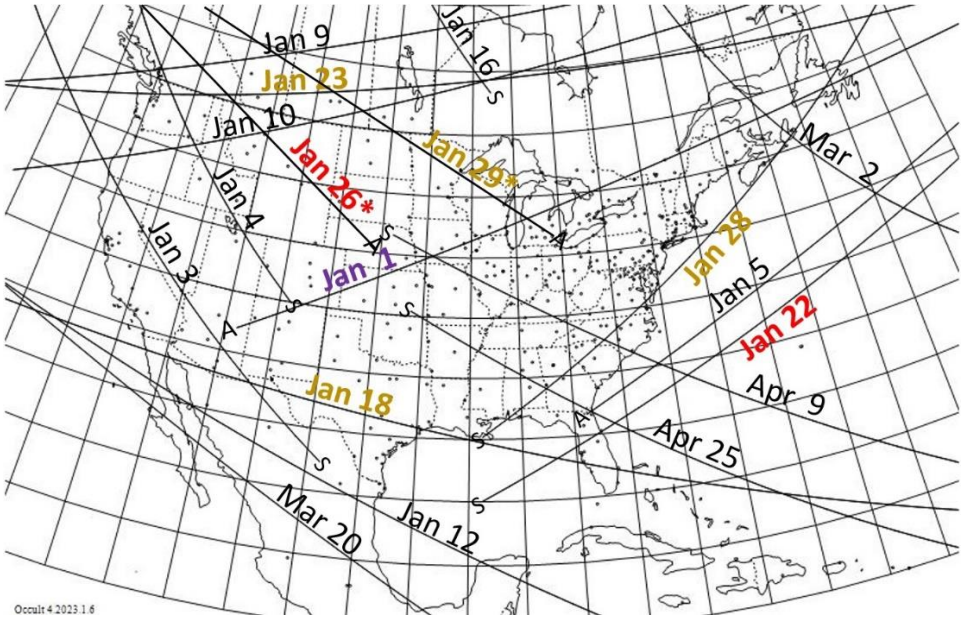
IOTA's page for North American NEA occultations includes a section, "Limiting Distance when Fresnel Diffraction Smearing is Significant", relying heavily on a presentation about NEA occultation light curves given by Roger Venable at the 2022 IOTA meeting. These give formulae for the Fresnel Length, FL, that depends on the object's distance and the wavelength of light. A factor "rho" is found by dividing the object's radius by FL; previous studies show that Fresnel diffraction smearing becomes a significant problem, especially for low S/N events, when rho is ≤0.88. This happens at the following distances for:

Dimorphos (radius r = 80m), 0.18 AU; **Apophis** (r = 169m), 0.82 AU; **2001 CC21** (r = 300m), 2.59 AU; and **Didymos** (r = 400m), 4.60 AU. Beyond these distances, the object becomes "diffracted out", unless the star is bright enough to provide a high S/N. Didymos and 2001 CC21 only have significant diffraction problems when they are farthest from Earth and near the aphelia of their orbits.

– – – – –

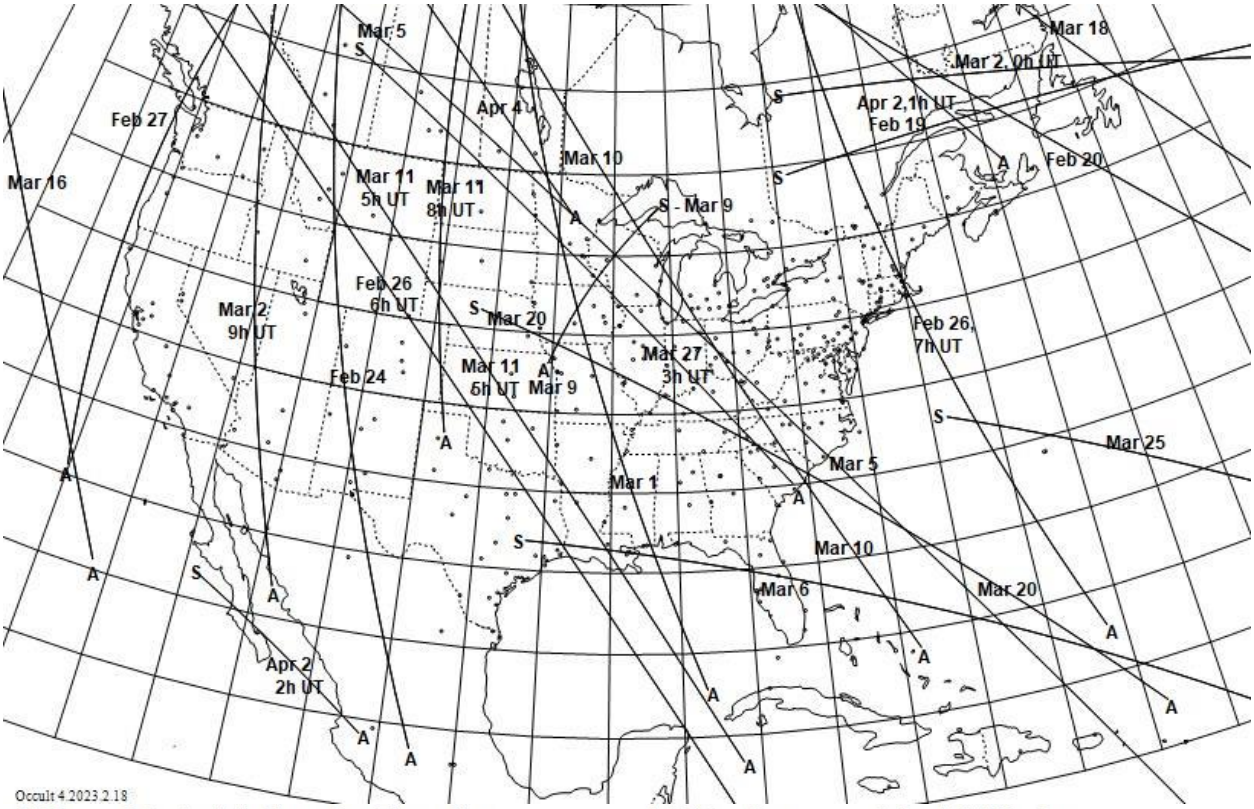
The maps and data below are only kept to summarize and document past events presented in earlier versions of this document; skip to the end for the Occult input datasets and information about using them.

Occultations by (65803) Didymos in North America, 2023 to mag. 14.0



2023 m d	U.T. h m	Diameter km	"	Durn sec	Star mag	Mag-Drop V	R *	Elon o	Star No.	d	RUWE <1.4	Moon Dist	ill	R.A. (J2000) h m s	Dec. o ' "	Path
Jan 1	1 41	0.80	0.004	0.25	9.0	7.5	7.7	165	HIP 37693	s	1.25	91	60	7 43 58.987	29 24 21.68	NL-Baja
Jan 3	12 37	0.80	0.004	0.25	13.7	2.8	2.8	168	UCAC4 599-041974		1.00	47	90	7 39 45.491	29 46 2.82	Mex-OR
Jan 4	13 17	0.80	0.004	0.25	13.7	2.8	2.9†	169	UCAC4 600-042691		0.95	34	95	7 38 3.811	29 53 56.25	NM-BC
Jan 5	23 47	0.80	0.004	0.26	11.4	5.1	5.4	170	TYC 2453-00085-1		0.95	6	100	7 35 47.509	30 4 10.41	FL
Jan 9	3 21	0.80	0.004	0.27	12.9	3.8	4.0	171	UCAC4 602-041020		1.00	22	96	7 30 55.512	30 22 34.89	ON-BC
Jan 10	2 45	0.80	0.004	0.27	13.6	3.1	3.1	171	UCAC4 603-042004		1.00	34	91	7 29 30.153	30 27 16.55	NL-OR
Jan 12	8 35	0.80	0.003	0.28	13.1	3.7	3.8	171	UCAC4 604-040522		0.90	62	76	7 26 21.532	30 36 30.43	Mex-Baja
Jan 16	12 40	0.80	0.003	0.32	11.6	5.5	5.8	168	TYC 2452-01843-1		0.90	116	35	7 21 14.576	30 46 49.44	ON-MB
Jan 18	6 53	0.80	0.003	0.34	13.1	4.1	4.1	166	UCAC4 605-040083		1.00	141	18	7 19 23.049	30 49 31.16	FL-Baja
Jan 22	0 16	0.80	0.003	0.41	9.1	8.4	8.1	163	TYC 2451-01892-1		1.10	163	0	7 16 2.844	30 50 49.06	FL
Jan 23	4 55	0.80	0.003	0.44	12.4	5.1	5.1	161	TYC 2451-02251-1		1.05	144	3	7 15 7.630	30 50 16.39	NL-WA
Jan 26*	12 24	0.80	0.003	0.57	10.6	7.1	7.2	158	TYC 2451-02141-1		1.10	95	28	7 13 3.603	30 46 43.34	NE-BC
Jan 28	23 25	0.80	0.003	0.71	13.4	4.5	4.3	155	UCAC4 604-039160		10.5	63	53	7 11 59.798	30 42 28.07	NL-LA
Jan 29*	11 25	0.80	0.003	0.76	12.2	5.8	5.9	155	TYC 2438-00969-1		1.00	56	59	7 11 48.045	30 41 22.65	MI-BC
Mar 2	6 11	0.80	0.001	0.15	12.1	7.7	8.0	127	UCAC4 593-040703		0.85	5	77	7 25 19.872	28 32 5.65	QC-NS
Mar 20	4 13	0.80	0.001	0.08	13.7	6.9	6.9	114	UCAC4 585-040450		0.95	136	4	7 47 9.494	26 49 25.74	Baja-Mex
Apr 9	2 15	0.80	0.001	0.06	14.0	7.3	7.3	102	UCAC4 573-043875		1.10	113	91	8 17 3.131	24 35 24.62	NE-NC
Apr 25	2 13	0.80	0.001	0.04	13.7	8.0	8.2	93	UCAC4 563-046290		0.95	33	24	8 43 12.265	22 32 13.77	KS-FL

Occultations by (98943) 2001 CC21 in North America, early 2023 to mag. 12.0



Occult 4.2023.2.18

2023	U.T.		Centrl	Star	Mag	Elon	Star	d	RUWE	Moon		R.A. (J2000)			Dec.			
m	d	h	m	Durn	mag	Drop	o	No.		<1.4	Dist	ill	h	m	s	o	'	"	Path
Feb	19	23	46	0.13s	11.4	5.2	117	UCAC4 759-037018		1.20	124	0	6	45	12.166	61	41	45.59	NL-QC
Feb	20	3	33	0.13s	8.8	7.8	117	HIP 32227	s	0.85	122	0	6	43	39.639	61	44	45.45	NL-YT
Feb	24	9	33	0.14s	10.2	6.5	109	TYC 4099-00193-1		2.05	67	21	6	3	22.060	62	42	43.57	Mex-AB
Feb	26	6	5	0.14s	11.8	5.1	106	UCAC4 765-036775		1.20	48	39	5	45	54.046	62	53	21.00	LA-BC
Feb	26	7	0	0.14s	10.1	6.7	106	UCAC4 765-036754		3.20	48	40	5	45	31.980	62	52	52.31	MA-QC
Feb	27	11	57	0.14s	12.0	4.9	103	TYC 4085-02251-1		1.35	39	52	5	34	19.116	62	54	25.58	WA-BC
Mar	1	7	59	0.17s	11.0	6.0	100	UCAC4 765-035217	v	1.15	36	69	5	17	27.648	62	50	52.54	MS-MB
Mar	2	0	2	0.15s	11.8	5.2	99	UCAC4 765-034889		1.10	39	75	5	11	31.396	62	48	20.80	NL-QC
Mar	2	9	38	0.15s	10.9	6.1	98	TYC 4083-01683-1	s	1.10	41	78	5	7	51.514	62	45	8.15	Mex-BC
Mar	5	4	18	0.15s	11.5	5.7	93	TYC 4082-00698-1		3.00	64	95	4	43	37.693	62	19	50.04	NC-AB
Mar	6	1	12	0.15s	11.8	5.4	92	UCAC4 761-030107		1.35	73	98	4	36	17.666	62	9	10.62	FL-TX
Mar	9	11	12	0.15s	11.6	5.8	86	TYC 4064-00851-1		0.90	110	96	4	8	31.709	61	9	54.62	KS-MI
Mar	10	5	18	0.15s	11.9	5.6	84	UCAC4 755-031715		1.35	118	93	4	2	30.285	60	54	55.67	SC-MB
Mar	11	5	15	0.15s	11.7	5.8	83	UCAC4 753-033296		0.95	128	87	3	54	48.377	60	32	57.11	LA-BC
Mar	11	8	53	0.15s	11.9	5.6	82	UCAC4 753-033160		1.65	129	86	3	53	41.729	60	28	50.19	TX-SK
Mar	16	7	26	0.15s	11.2	6.7	73	TYC 3714-01143-1		1.05	132	36	3	17	44.045	58	12	13.74	Pac-AK
Mar	18	2	15	0.14s	9.8	8.2	70	TYC 3709-00586-1	s	1.05	112	18	3	5	32.663	57	11	32.02	Lab
Mar	20	1	47	0.14s	11.8	6.4	66	UCAC4 730-026287		0.90	87	4	2	52	28.568	55	57	52.24	SC-NE
Mar	25	23	36	0.13s	9.3	9.6	55	TYC 3306-00413-1	s	1.10	38	31	2	16	29.629	51	30	19.87	Atl
Mar	27	3	1	0.12s	11.7	7.3	53	TYC 3289-00314-1		1.15	39	31	2	10	4.721	50	29	59.38	SC-AB
Apr	2	1	51	0.11s	11.4	8.7	42	UCAC4 673-008337		1.00	100	84	1	39	32.595	44	34	19.29	QC
Apr	2	2	24	0.11s	8.9	11.2	42	UCAC4 673-008326	s	1.10	100	84	1	39	23.479	44	33	20.79	Mex-Baja
Apr	4	3	27	0.11s	11.6	9.0	38	TYC 2822-02147-1		1.00	124	96	1	30	12.994	42	15	51.17	MN-SK

The table above, under the map, follows the same format as the one for Didymos on p. 5, but here, a few events don't cross land on the map, so under path, Atl (Atlantic) or Pac (Pacific) indicate the ocean. Lab is for Labrador, distinguishing it from Newfoundland (NL) Island. During the middle of 2023, 2001 CC21 is too close to the Sun for observing occultations. There will be more occultations during the last quarter of 2023 that are shown on another map and table on p. 5. Our mode now should be to observe all events you can in coordinated efforts like for Didymos, to try to record a first occultation by 2001 CC21; we will coordinate with Japanese observers and others to try to avoid duplication, to optimize the search coverage; smaller efforts can be made after the first detection.

The map and table on the previous page show the better events, but there are more events, especially with 12th-mag. stars, that can be recorded with 8-inch and larger telescopes, so you are encouraged to make your own searches with Occult4 using the worldwide input file for the rest of 2023 of stars down to mag. 14. Vince Sempronio has added worldwide events for the next 60 days on OW as AZfeed events, but beware of your OW filters, as explained in the first paragraph of this document. You can find more events with your own searches.

– – – – –

The Asteroid Collaborative Research via Occultation Systematic Survey **(ACROSS)** project home page is at **https://lagrange.oca.eu/fr/home-across** , and predictions are at **https://lagrange.oca.eu/fr/prediction** . The effort is funded by the European Space Agency (ESA) and is focused on Didymos and other Hera mission NEA possibilities.

The maps were produced with IOTA's free *Occult* software; see **http://www.lunar-occultations.com/iota/occult4.htm** . You can download and use this software and use it to compute your own local lists and information about these and many other occultations. The information for doing this is at **http://www.lunar-occultations.com/iota/2023iotapredictions.pdf** . This describes a prediction input file for planetary and asteroidal files called **All2023.xml**. You can use that file to generate local predictions, but you can replace it with the other files listed at **https://occultations.org/publications/rasc/2023/nam23NEAoccs.htm** to generate predictions for more occultations, of fainter stars than shown on the maps, or for other parts of the world.

This document will seldom be updated; more frequent updates with more timely information will be made at **https://occultations.org/publications/rasc/2023/nam23NEAoccs.htm** . Later in the year, some past-event files will be removed that may result in broken links.

David and Joan Dunham, dunham@starpower.net, 2023 Jan. 6; updated Jan. 16, Feb. 22, and June 17.