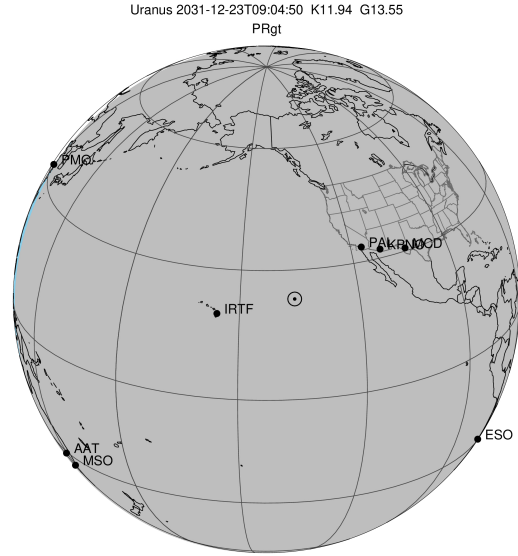


target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:04:50.390  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451

ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s

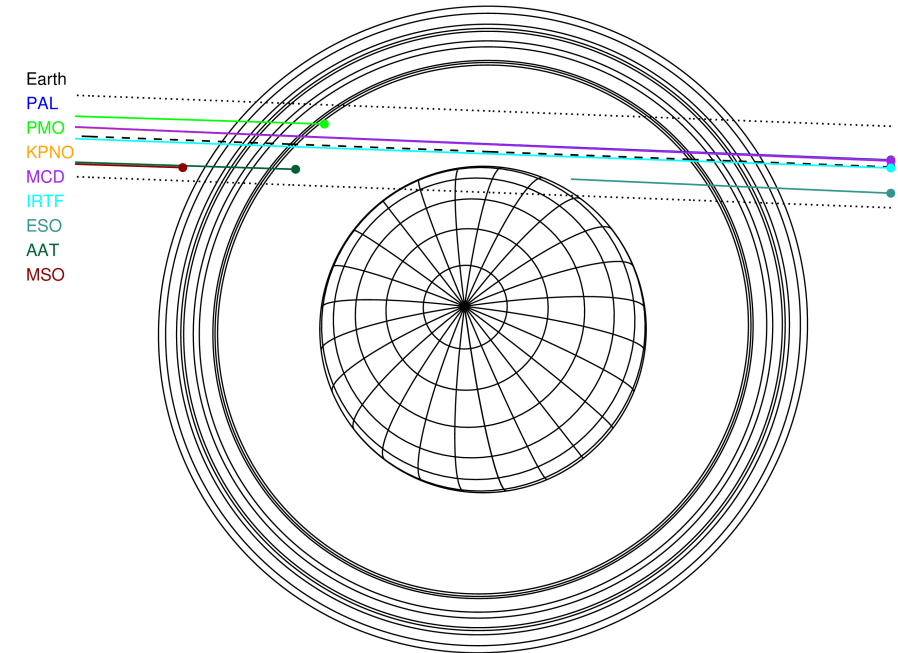
RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 54.52  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49

| #  | a(km)   | ring    |
|----|---------|---------|
| 1  | 41837.2 | 6       |
| 2  | 42235.0 | 5       |
| 3  | 42571.2 | 4       |
| 4  | 44718.5 | alpha   |
| 5  | 45661.1 | beta    |
| 6  | 47176.1 | eta     |
| 7  | 47626.3 | gamma   |
| 8  | 48300.3 | delta   |
| 9  | 50026.7 | lambda  |
| 10 | 51149.4 | epsilon |



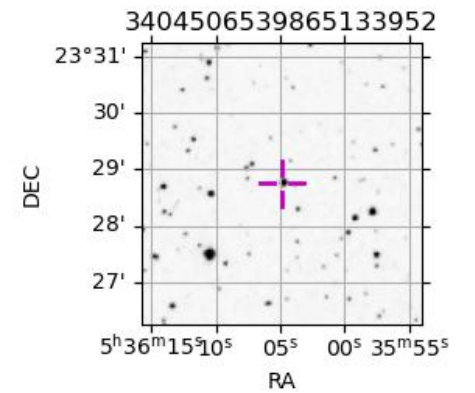
2031-12-23T09:04:50.3900 ra: 05 36 04.86355 s: +23 28 45.035 C/A 2.128° PA 177.82 deg v\_sky -23.25 km/s D 18.11 AU  
 Credit: Styled after SORA/Lucky Star

Uranus 2031-12-23T09:04:50 K11.94 G13.55 PRgt

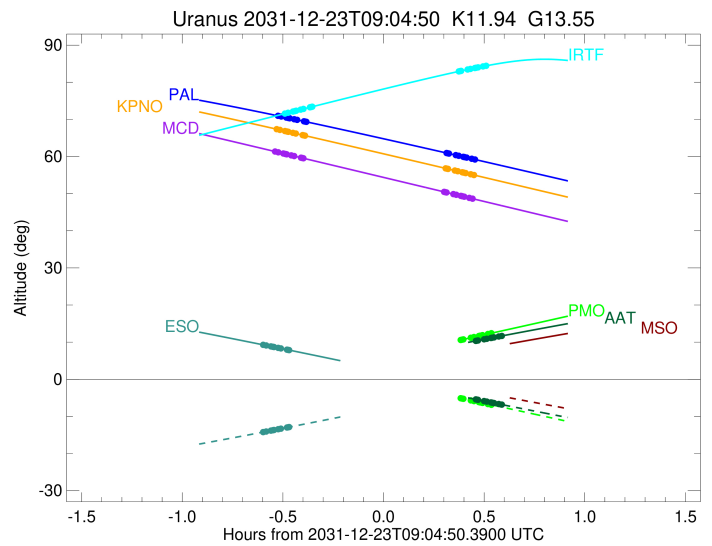
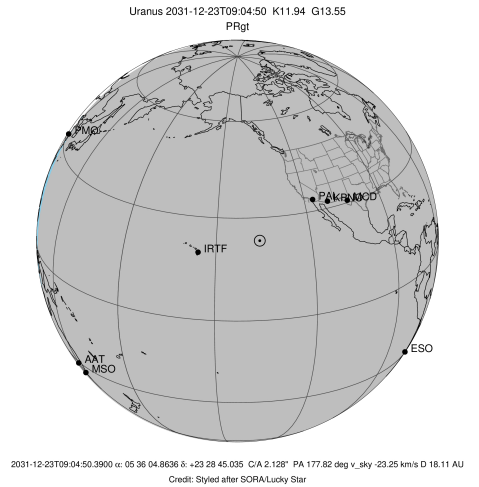


Observable events with sun below -5 deg and altitude above 5 deg unblocked by planet

| Obs  | Location              | lat   | Elon  | Rings I | Planet | Rings E | Observed Events Interval    | OEcode |
|------|-----------------------|-------|-------|---------|--------|---------|-----------------------------|--------|
| PIC  | Pic du Midi           | 42.9  | 0.1   |         |        |         |                             | PnnRnn |
| PAL  | Palomar Mt (200")     | 33.4  | 243.1 | +++++   |        | +++++   | DEC 23 08:33 - DEC 23 09:31 | PnnRie |
| PMO  | Purple Mtn Obs. Nanki | 32.1  | 118.8 |         |        | +++++   | DEC 23 09:27 - DEC 23 09:36 | PnnRne |
| KPNO | Kitt Peak Natl Obs    | 32.0  | 248.4 | +++++   |        | +++++   | DEC 23 08:32 - DEC 23 09:31 | PnnRie |
| MCD  | McDonald Obs. 2.7m    | 30.7  | 256.0 | +++++   |        | +++++   | DEC 23 08:32 - DEC 23 09:31 | PnnRie |
| TEN  | Teide Obs./Tenerife   | 28.3  | 343.5 |         |        | +++++   |                             | PnnRnn |
| IRTF | Mauna Kea/IRTF        | 19.8  | 204.5 | +++++   |        | +++++   | DEC 23 08:35 - DEC 23 09:35 | PnnRie |
| KAV  | Kavalur Observatory   | 12.6  | 78.8  |         |        |         |                             | PnnRnn |
| RIO  | Rio de Janeiro        | -22.9 | 316.8 |         |        |         |                             | PnnRnn |
| ESO  | European Southern Obs | -29.3 | 289.3 | +++++   |        |         | DEC 23 08:28 - DEC 23 08:36 | PnnRin |
| AAT  | Siding Spring (AAT)   | -31.3 | 149.1 |         |        | +++++   | DEC 23 09:32 - DEC 23 09:39 | PnnRne |
| SAAO | So. Afr. Astro. Obs.  | -32.4 | 20.8  |         |        |         |                             | PnnRnn |
| MSO  | Mt. Stromlo Observato | -35.3 | 149.0 |         |        |         |                             | PnnRnn |



target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:03:04.570  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Observer code : PAL  
 Location : Palomar Mt (200")  
 Latitude (deg) : 33.35622  
 E. Longitude (deg) : 243.13601  
 Altitude (km) : 1.706  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451  
 ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s  
 RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 55.42  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49  
 Pole direction: RA (deg): 257.31100  
 Dec (deg): -15.17500  
 C/A sky separation (") : 2.213  
 C/A sky separation (km) : 29064.2  
 NAIF SPICE kernels : RAJobs\_U111+rgf15.spk  
 URKALLvl.spk  
 ura111.bsp  
 IAU\_URANUS\_for\_RINGFIT.tpc  
 vgr2.ura111.bsp  
 ura161.bsp  
 vgr2.ura161.bsp  
 peph.ura160.bsp  
 earthstns\_itr93\_040916.bsp  
 earth\_720101\_070426.bpc  
 earth\_200101\_990628\_predict.bpc  
 pg3f0000r.bsp  
 pg490000r.bsp  
 naif0012.tls  
 earth\_flat\_IAU.spk

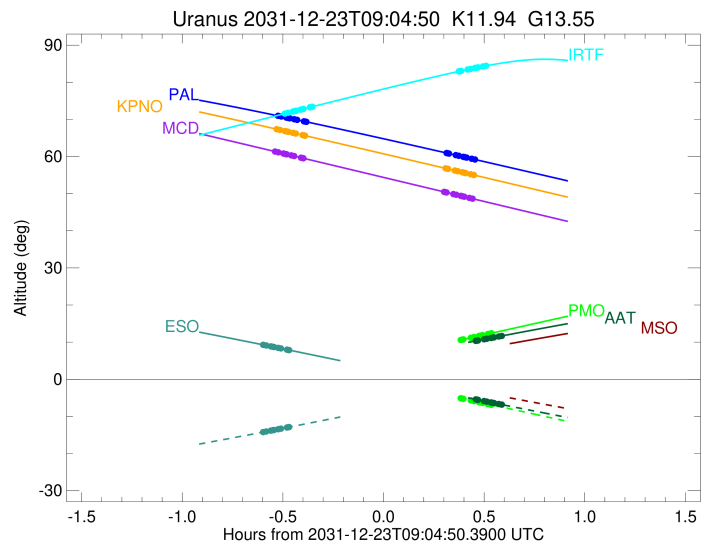
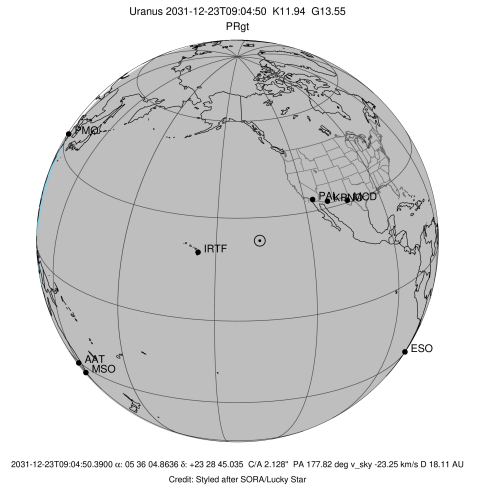


| Ring    | I/E | UTC                     | b? | alt   | alt-sun | radius   | r-dot  | lat-geo | lat-geodetic |
|---------|-----|-------------------------|----|-------|---------|----------|--------|---------|--------------|
| epsilon | I   | 2031-12-23T08:33:17.947 |    | 70.98 | -75.81  | 51264.17 | -19.40 |         |              |
| lambda  | I   | 2031-12-23T08:34:21.768 |    | 70.78 | -75.64  | 50026.71 | -19.27 |         |              |
| delta   | I   | 2031-12-23T08:35:52.226 |    | 70.50 | -75.39  | 48300.35 | -18.89 |         |              |
| gamma   | I   | 2031-12-23T08:36:27.880 |    | 70.38 | -75.30  | 47629.47 | -18.74 |         |              |
| eta     | I   | 2031-12-23T08:36:52.148 |    | 70.31 | -75.23  | 47176.12 | -18.63 |         |              |
| beta    | I   | 2031-12-23T08:38:13.435 |    | 70.05 | -75.00  | 45678.00 | -18.22 |         |              |
| alpha   | I   | 2031-12-23T08:39:05.972 |    | 69.88 | -74.86  | 44727.61 | -17.94 |         |              |
| 4       | I   | 2031-12-23T08:41:07.079 |    | 69.49 | -74.52  | 42595.88 | -17.25 |         |              |
| 5       | I   | 2031-12-23T08:41:31.130 |    | 69.41 | -74.45  | 42183.21 | -17.11 |         |              |
| 6       | I   | 2031-12-23T08:41:53.581 |    | 69.34 | -74.39  | 41800.86 | -16.93 |         |              |

No planet occultations

|         |   |                         |  |       |        |          |       |  |  |
|---------|---|-------------------------|--|-------|--------|----------|-------|--|--|
| 6       | E | 2031-12-23T09:23:36.333 |  | 60.96 | -66.55 | 41815.69 | 16.91 |  |  |
| 5       | E | 2031-12-23T09:24:04.400 |  | 60.86 | -66.46 | 42297.90 | 17.08 |  |  |
| 4       | E | 2031-12-23T09:24:23.155 |  | 60.80 | -66.40 | 42608.00 | 17.23 |  |  |
| alpha   | E | 2031-12-23T09:26:21.146 |  | 60.39 | -66.01 | 44684.92 | 17.91 |  |  |
| beta    | E | 2031-12-23T09:27:14.469 |  | 60.21 | -65.83 | 45647.49 | 18.20 |  |  |
| eta     | E | 2031-12-23T09:28:37.529 |  | 59.92 | -65.55 | 47176.12 | 18.59 |  |  |
| gamma   | E | 2031-12-23T09:29:01.846 |  | 59.84 | -65.47 | 47629.62 | 18.71 |  |  |
| delta   | E | 2031-12-23T09:29:37.554 |  | 59.72 | -65.35 | 48300.35 | 18.86 |  |  |
| lambda  | E | 2031-12-23T09:31:08.175 |  | 59.41 | -65.05 | 50026.71 | 19.23 |  |  |
| epsilon | E | 2031-12-23T09:31:45.333 |  | 59.28 | -64.92 | 50743.98 | 19.37 |  |  |

target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:08:45.340  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Observer code : PMO  
 Location : Purple Mtn Obs. Nanking  
 Latitude (deg) : 32.06667  
 E. Longitude (deg) : 118.82089  
 Altitude (km) : 0.364  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451  
 ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s  
 RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 54.14  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49  
 Pole direction: RA (deg): 257.31100  
 Dec (deg): -15.17500  
 C/A sky separation (") : 2.390  
 C/A sky separation (km) : 31383.6  
 NAIF SPICE kernels : RAJobs\_U111+rgf15.spk  
 URKALLvl.spk  
 ura111.bsp  
 IAU\_URANUS\_for\_RINGFIT.tpc  
 vgr2.ura111.bsp  
 ura161.bsp  
 vgr2.ura161.bsp  
 peph.ura160.bsp  
 earthstns\_itr93\_040916.bsp  
 earth\_720101\_070426.bpc  
 earth\_200101\_990628\_predict.bpc  
 pg3f0000r.bsp  
 pg490000r.bsp  
 naif0012.tls  
 earth\_flat\_IAU.spk

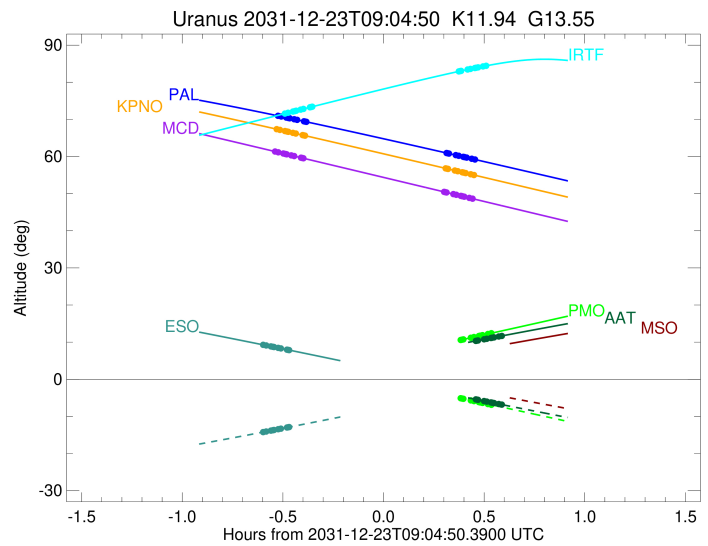
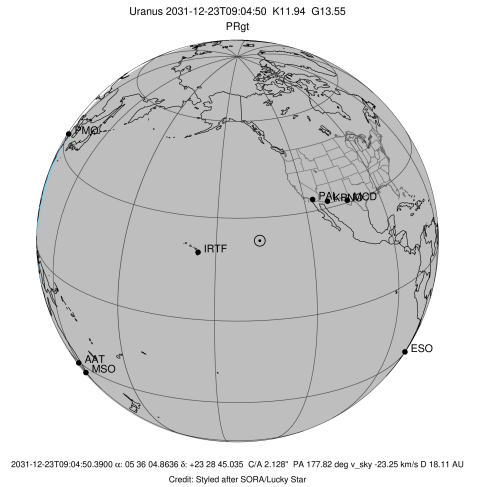


| Ring    | I/E | UTC                     | b?    | alt   | alt-sun  | radius | r-dot | lat-geo | lat-geodetic |
|---------|-----|-------------------------|-------|-------|----------|--------|-------|---------|--------------|
| epsilon | I   | 2031-12-23T08:39:38.425 | 1.22x | 3.95x | 51238.25 | -18.20 |       |         |              |
| lambda  | I   | 2031-12-23T08:40:45.086 | 1.43x | 3.75x | 50026.71 | -18.03 |       |         |              |
| delta   | I   | 2031-12-23T08:42:21.990 | 1.74x | 3.45x | 48300.35 | -17.59 |       |         |              |
| gamma   | I   | 2031-12-23T08:43:00.320 | 1.86x | 3.34x | 47629.76 | -17.40 |       |         |              |
| eta     | I   | 2031-12-23T08:43:26.491 | 1.94x | 3.26x | 47176.12 | -17.27 |       |         |              |
| beta    | I   | 2031-12-23T08:44:54.513 | 2.22x | 2.99x | 45677.10 | -16.78 |       |         |              |
| alpha   | I   | 2031-12-23T08:45:51.794 | 2.40x | 2.81x | 44724.96 | -16.44 |       |         |              |
| 4       | I   | 2031-12-23T08:48:04.473 | 2.83x | 2.41x | 42599.11 | -15.59 |       |         |              |
| 5       | I   | 2031-12-23T08:48:30.989 | 2.91x | 2.33x | 42188.85 | -15.41 |       |         |              |
| 6       | I   | 2031-12-23T08:48:56.390 | 2.99x | 2.25x | 41799.02 | -15.19 |       |         |              |

No planet occultations

|         |   |                         |       |       |          |       |  |  |  |
|---------|---|-------------------------|-------|-------|----------|-------|--|--|--|
| 6       | E | 2031-12-23T09:27:48.658 | 10.58 | -5.10 | 41813.07 | 15.24 |  |  |  |
| 5       | E | 2031-12-23T09:28:19.615 | 10.68 | -5.20 | 42294.19 | 15.46 |  |  |  |
| 4       | E | 2031-12-23T09:28:40.665 | 10.75 | -5.27 | 42609.76 | 15.64 |  |  |  |
| alpha   | E | 2031-12-23T09:30:49.615 | 11.17 | -5.68 | 44685.28 | 16.49 |  |  |  |
| beta    | E | 2031-12-23T09:31:47.407 | 11.37 | -5.87 | 45648.39 | 16.84 |  |  |  |
| eta     | E | 2031-12-23T09:33:16.785 | 11.66 | -6.16 | 47176.12 | 17.33 |  |  |  |
| gamma   | E | 2031-12-23T09:33:42.867 | 11.75 | -6.24 | 47629.84 | 17.47 |  |  |  |
| delta   | E | 2031-12-23T09:34:21.050 | 11.88 | -6.37 | 48300.35 | 17.66 |  |  |  |
| lambda  | E | 2031-12-23T09:35:57.579 | 12.20 | -6.68 | 50026.71 | 18.11 |  |  |  |
| epsilon | E | 2031-12-23T09:36:36.983 | 12.33 | -6.81 | 50743.51 | 18.28 |  |  |  |

target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:02:43.880  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Observer code : KPNO  
 Location : Kitt Peak Natl Obs  
 Latitude (deg) : 31.96333  
 E. Longitude (deg) : 248.40000  
 Altitude (km) : 2.120  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451  
 ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s  
 RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 55.44  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49  
 Pole direction: RA (deg): 257.31100  
 Dec (deg): -15.17500  
 C/A sky separation (") : 2.208  
 C/A sky separation (km) : 28992.8  
 NAIF SPICE kernels : RAJobs\_U111+rgf15.spk  
 URKALLvl.spk  
 ura111.bsp  
 IAU\_URANUS\_for\_RINGFIT.tpc  
 vgr2.ura111.bsp  
 ura161.bsp  
 vgr2.ura161.bsp  
 peph.ura160.bsp  
 earthstns\_itr93\_040916.bsp  
 earth\_720101\_070426.bpc  
 earth\_200101\_990628\_predict.bpc  
 pg3f0000r.bsp  
 pg490000r.bsp  
 naif0012.tls  
 earth\_flat\_IAU.spk

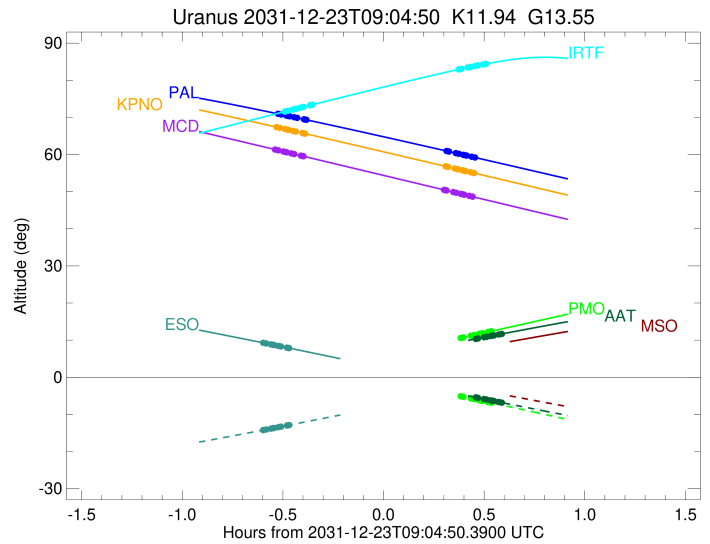
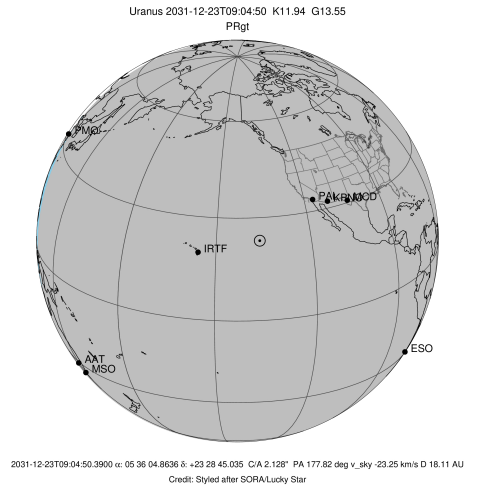


| Ring    | I/E | UTC                     | b? | alt   | alt-sun | radius   | r-dot  | lat-geo | lat-geodetic |
|---------|-----|-------------------------|----|-------|---------|----------|--------|---------|--------------|
| epsilon | I   | 2031-12-23T08:32:54.478 |    | 67.39 | -72.87  | 51265.07 | -19.42 |         |              |
| lambda  | I   | 2031-12-23T08:33:58.284 |    | 67.17 | -72.67  | 50026.71 | -19.29 |         |              |
| delta   | I   | 2031-12-23T08:35:28.645 |    | 66.86 | -72.38  | 48300.35 | -18.92 |         |              |
| gamma   | I   | 2031-12-23T08:36:04.257 |    | 66.74 | -72.26  | 47629.45 | -18.76 |         |              |
| eta     | I   | 2031-12-23T08:36:28.494 |    | 66.66 | -72.18  | 47176.12 | -18.65 |         |              |
| beta    | I   | 2031-12-23T08:37:49.671 |    | 66.38 | -71.92  | 45678.03 | -18.25 |         |              |
| alpha   | I   | 2031-12-23T08:38:42.127 |    | 66.20 | -71.75  | 44727.70 | -17.97 |         |              |
| 4       | I   | 2031-12-23T08:40:43.038 |    | 65.78 | -71.35  | 42595.77 | -17.28 |         |              |
| 5       | I   | 2031-12-23T08:41:07.046 |    | 65.70 | -71.27  | 42183.03 | -17.14 |         |              |
| 6       | I   | 2031-12-23T08:41:29.439 |    | 65.62 | -71.20  | 41800.93 | -16.96 |         |              |

No planet occultations

|         |   |                         |  |       |        |          |       |  |  |
|---------|---|-------------------------|--|-------|--------|----------|-------|--|--|
| 6       | E | 2031-12-23T09:23:19.352 |  | 56.82 | -62.65 | 41815.76 | 16.94 |  |  |
| 5       | E | 2031-12-23T09:23:47.373 |  | 56.72 | -62.55 | 42297.99 | 17.11 |  |  |
| 4       | E | 2031-12-23T09:24:06.089 |  | 56.66 | -62.49 | 42607.96 | 17.26 |  |  |
| alpha   | E | 2031-12-23T09:26:03.914 |  | 56.24 | -62.08 | 44684.92 | 17.93 |  |  |
| beta    | E | 2031-12-23T09:26:57.174 |  | 56.05 | -61.89 | 45647.46 | 18.22 |  |  |
| eta     | E | 2031-12-23T09:28:20.151 |  | 55.76 | -61.60 | 47176.12 | 18.61 |  |  |
| gamma   | E | 2031-12-23T09:28:44.446 |  | 55.67 | -61.51 | 47629.62 | 18.72 |  |  |
| delta   | E | 2031-12-23T09:29:20.124 |  | 55.54 | -61.39 | 48300.35 | 18.88 |  |  |
| lambda  | E | 2031-12-23T09:30:50.680 |  | 55.22 | -61.07 | 50026.71 | 19.24 |  |  |
| epsilon | E | 2031-12-23T09:31:27.817 |  | 55.09 | -60.94 | 50744.00 | 19.38 |  |  |

target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:02:16.010  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Observer code : MCD  
 Location : McDonald Obs. 2.7m  
 Latitude (deg) : 30.67158  
 E. Longitude (deg) : 255.97844  
 Altitude (km) : 2.075  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451  
 ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s  
 RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 55.44  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49  
 Pole direction: RA (deg): 257.31100  
 Dec (deg): -15.17500  
 C/A sky separation (") : 2.208  
 C/A sky separation (km) : 28997.3  
 NAIF SPICE kernels : RAJobs\_U111+rgf15.spk  
 URKALLvl.spk  
 ura111.bsp  
 IAU\_URANUS\_for\_RINGFIT.tpc  
 vgr2.ura111.bsp  
 ura161.bsp  
 vgr2.ura161.bsp  
 peph.ura160.bsp  
 earthstns\_itr93\_040916.bsp  
 earth\_720101\_070426.bpc  
 earth\_200101\_990628\_predict.bpc  
 pg3f0000r.bsp  
 pg490000r.bsp  
 naif0012.tls  
 earth\_flat\_IAU.spk

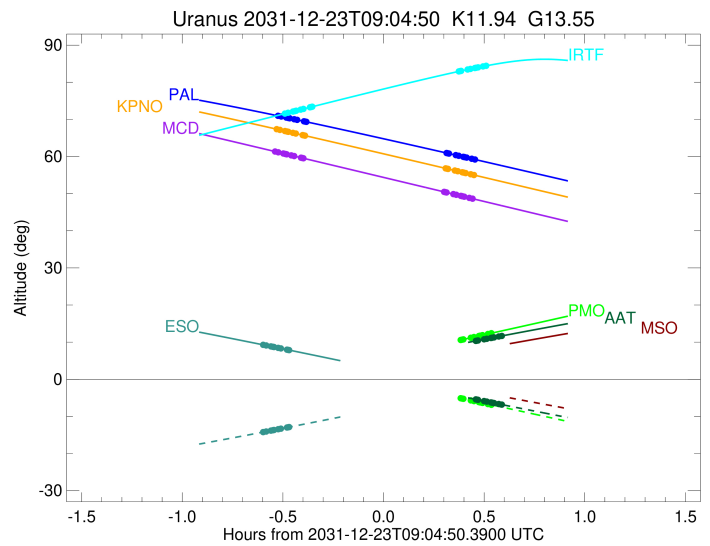
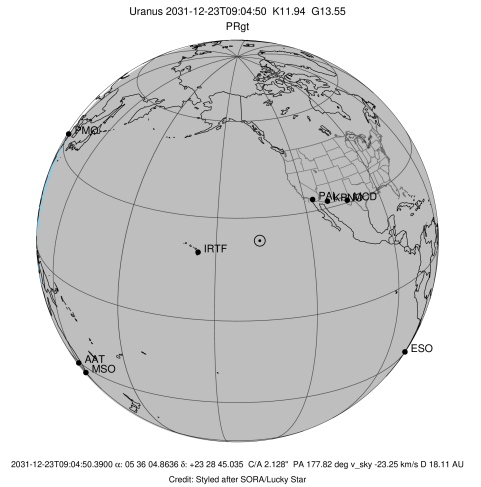


| Ring    | I/E | UTC                     | b? | alt   | alt-sun | radius   | r-dot  | lat-geo | lat-geodetic |
|---------|-----|-------------------------|----|-------|---------|----------|--------|---------|--------------|
| epsilon | I   | 2031-12-23T08:32:25.075 |    | 61.37 | -67.22  | 51265.36 | -19.41 |         |              |
| lambda  | I   | 2031-12-23T08:33:28.949 |    | 61.14 | -66.99  | 50026.71 | -19.27 |         |              |
| delta   | I   | 2031-12-23T08:34:59.388 |    | 60.81 | -66.68  | 48300.35 | -18.90 |         |              |
| gamma   | I   | 2031-12-23T08:35:35.033 |    | 60.69 | -66.55  | 47629.45 | -18.74 |         |              |
| eta     | I   | 2031-12-23T08:35:59.291 |    | 60.60 | -66.46  | 47176.12 | -18.63 |         |              |
| beta    | I   | 2031-12-23T08:37:20.541 |    | 60.31 | -66.18  | 45678.04 | -18.23 |         |              |
| alpha   | I   | 2031-12-23T08:38:13.045 |    | 60.12 | -65.99  | 44727.72 | -17.95 |         |              |
| 4       | I   | 2031-12-23T08:40:14.073 |    | 59.69 | -65.57  | 42595.75 | -17.27 |         |              |
| 5       | I   | 2031-12-23T08:40:38.106 |    | 59.60 | -65.48  | 42182.98 | -17.12 |         |              |
| 6       | I   | 2031-12-23T08:41:00.518 |    | 59.52 | -65.40  | 41800.94 | -16.95 |         |              |

No planet occultations

|         |   |                         |  |       |        |          |       |  |  |
|---------|---|-------------------------|--|-------|--------|----------|-------|--|--|
| 6       | E | 2031-12-23T09:22:52.702 |  | 50.49 | -56.45 | 41815.72 | 16.91 |  |  |
| 5       | E | 2031-12-23T09:23:20.760 |  | 50.38 | -56.35 | 42297.95 | 17.09 |  |  |
| 4       | E | 2031-12-23T09:23:39.506 |  | 50.32 | -56.28 | 42607.98 | 17.23 |  |  |
| alpha   | E | 2031-12-23T09:25:37.488 |  | 49.89 | -55.86 | 44684.92 | 17.91 |  |  |
| beta    | E | 2031-12-23T09:26:30.820 |  | 49.70 | -55.67 | 45647.48 | 18.19 |  |  |
| eta     | E | 2031-12-23T09:27:53.909 |  | 49.40 | -55.37 | 47176.12 | 18.59 |  |  |
| gamma   | E | 2031-12-23T09:28:18.237 |  | 49.31 | -55.28 | 47629.62 | 18.70 |  |  |
| delta   | E | 2031-12-23T09:28:53.963 |  | 49.19 | -55.16 | 48300.35 | 18.85 |  |  |
| lambda  | E | 2031-12-23T09:30:24.641 |  | 48.86 | -54.83 | 50026.71 | 19.22 |  |  |
| epsilon | E | 2031-12-23T09:31:01.827 |  | 48.73 | -54.70 | 50743.99 | 19.35 |  |  |

target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:05:46.330  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Observer code : IRTF  
 Location : Mauna Kea/IRTF  
 Latitude (deg) : 19.82622  
 E. Longitude (deg) : 204.52800  
 Altitude (km) : 4.168  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451  
 ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s  
 RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 55.17  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49  
 Pole direction: RA (deg): 257.31100  
 Dec (deg): -15.17500  
 C/A sky separation (") : 2.096  
 C/A sky separation (km) : 27528.6  
 NAIF SPICE kernels : RAJobs\_U111+rgf15.spk  
 URKALLvl.spk  
 ura111.bsp  
 IAU\_URANUS\_for\_RINGFIT.tpc  
 vgr2.ura111.bsp  
 ura161.bsp  
 vgr2.ura161.bsp  
 peph.ura160.bsp  
 earthstns\_itr93\_040916.bsp  
 earth\_720101\_070426.bpc  
 earth\_200101\_990628\_predict.bpc  
 pg3f0000r.bsp  
 pg490000r.bsp  
 naif0012.tls  
 earth\_flat\_IAU.spk



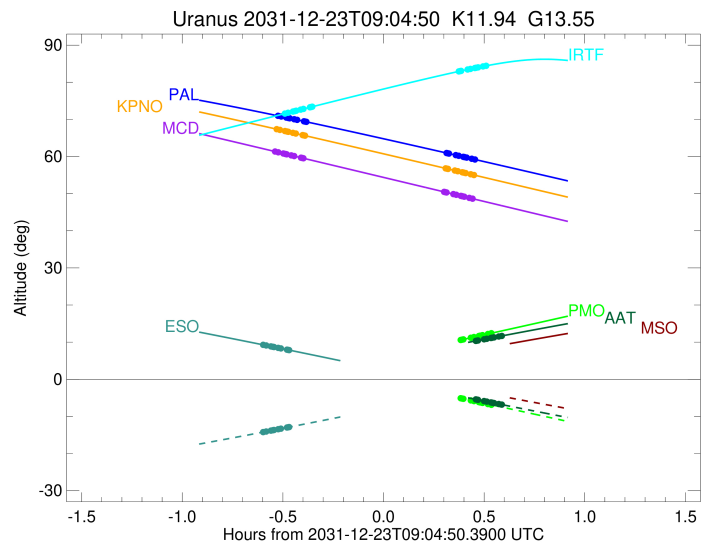
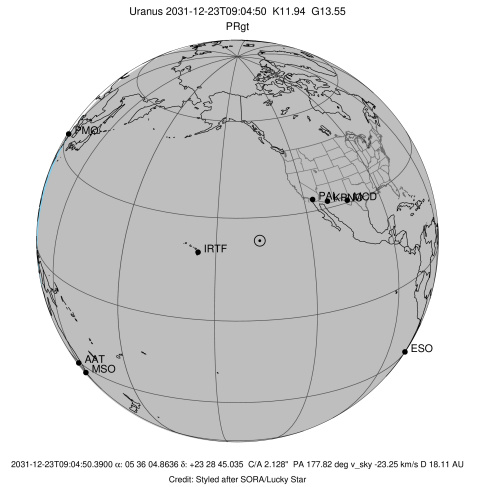
b: ring blocked by planet x: target alt < 5.0 deg or sun > -5.0 deg

| Ring    | I/E | UTC                     | b? | alt   | alt-sun | radius   | r-dot  | lat-geo | lat-geodetic |
|---------|-----|-------------------------|----|-------|---------|----------|--------|---------|--------------|
| epsilon | I   | 2031-12-23T08:35:20.884 |    | 71.55 | -65.25  | 51276.60 | -19.93 |         |              |
| lambda  | I   | 2031-12-23T08:36:23.625 |    | 71.79 | -65.49  | 50026.71 | -19.81 |         |              |
| delta   | I   | 2031-12-23T08:37:51.459 |    | 72.12 | -65.82  | 48300.35 | -19.49 |         |              |
| gamma   | I   | 2031-12-23T08:38:26.010 |    | 72.25 | -65.95  | 47629.31 | -19.35 |         |              |
| eta     | I   | 2031-12-23T08:38:49.487 |    | 72.34 | -66.04  | 47176.12 | -19.26 |         |              |
| beta    | I   | 2031-12-23T08:40:07.957 |    | 72.63 | -66.34  | 45678.42 | -18.91 |         |              |
| alpha   | I   | 2031-12-23T08:40:58.489 |    | 72.83 | -66.53  | 44728.93 | -18.66 |         |              |
| 4       | I   | 2031-12-23T08:42:54.688 |    | 73.27 | -66.98  | 42594.16 | -18.07 |         |              |
| 5       | I   | 2031-12-23T08:43:17.682 |    | 73.35 | -67.06  | 42180.49 | -17.94 |         |              |
| 6       | I   | 2031-12-23T08:43:38.874 |    | 73.43 | -67.14  | 41801.91 | -17.79 |         |              |

No planet occultations

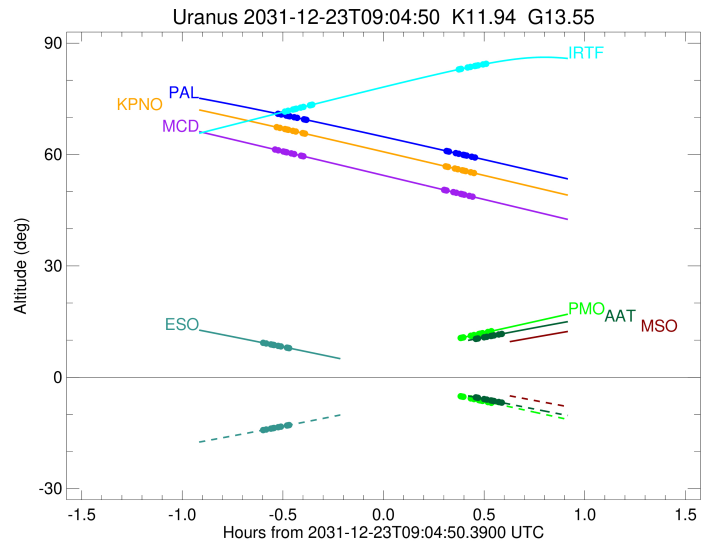
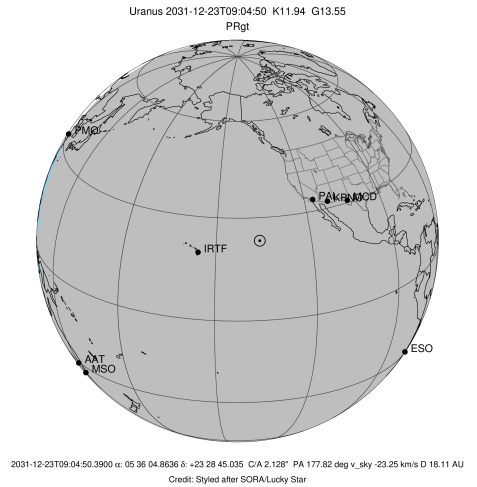
|         |   |                         |  |       |        |          |       |  |  |
|---------|---|-------------------------|--|-------|--------|----------|-------|--|--|
| 6       | E | 2031-12-23T09:27:15.592 |  | 82.93 | -77.02 | 41817.74 | 17.80 |  |  |
| 5       | E | 2031-12-23T09:27:42.331 |  | 83.01 | -77.12 | 42300.51 | 17.96 |  |  |
| 4       | E | 2031-12-23T09:27:59.951 |  | 83.07 | -77.18 | 42606.54 | 18.08 |  |  |
| alpha   | E | 2031-12-23T09:29:52.812 |  | 83.43 | -77.60 | 44684.74 | 18.68 |  |  |
| beta    | E | 2031-12-23T09:30:43.997 |  | 83.59 | -77.79 | 45646.80 | 18.92 |  |  |
| eta     | E | 2031-12-23T09:32:04.036 |  | 83.84 | -78.08 | 47176.12 | 19.27 |  |  |
| gamma   | E | 2031-12-23T09:32:27.499 |  | 83.91 | -78.17 | 47629.43 | 19.37 |  |  |
| delta   | E | 2031-12-23T09:33:02.013 |  | 84.02 | -78.30 | 48300.35 | 19.51 |  |  |
| lambda  | E | 2031-12-23T09:34:29.767 |  | 84.28 | -78.62 | 50026.71 | 19.83 |  |  |
| epsilon | E | 2031-12-23T09:35:05.875 |  | 84.38 | -78.75 | 50745.12 | 19.95 |  |  |

target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:01:01.650  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Observer code : ESO  
 Location : European Southern Obs. (3.6m)  
 Latitude (deg) : -29.26097  
 E. Longitude (deg) : 289.26831  
 Altitude (km) : 2.400  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451  
 ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s  
 RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 55.00  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49  
 Pole direction: RA (deg): 257.31100  
 Dec (deg): -15.17500  
 C/A sky separation (") : 1.838  
 C/A sky separation (km) : 24137.1  
 NAIF SPICE kernels : RAJobs\_U111+rgf15.spk  
 URKALLvl.spk  
 ura111.bsp  
 IAU\_URANUS\_for\_RINGFIT.tpc  
 vgr2.ura111.bsp  
 ura161.bsp  
 vgr2.ura161.bsp  
 peph.ura160.bsp  
 earthstns\_itr93\_040916.bsp  
 earth\_720101\_070426.bpc  
 earth\_200101\_990628\_predict.bpc  
 pg3f0000r.bsp  
 pg490000r.bsp  
 naif0012.tls  
 earth\_flat\_IAU.spk



| Ring    | I/E | UTC                     | b? | alt    | alt-sun | radius   | r-dot  | lat-geo | lat-geodetic |
|---------|-----|-------------------------|----|--------|---------|----------|--------|---------|--------------|
| epsilon | I   | 2031-12-23T08:28:50.666 |    | 9.30   | -14.25  | 51309.59 | -20.69 |         |              |
| lambda  | I   | 2031-12-23T08:29:52.659 |    | 9.11   | -14.07  | 50026.71 | -20.61 |         |              |
| delta   | I   | 2031-12-23T08:31:16.886 |    | 8.85   | -13.83  | 48300.35 | -20.38 |         |              |
| gamma   | I   | 2031-12-23T08:31:49.920 |    | 8.75   | -13.73  | 47628.88 | -20.28 |         |              |
| eta     | I   | 2031-12-23T08:32:12.289 |    | 8.68   | -13.67  | 47176.12 | -20.21 |         |              |
| beta    | I   | 2031-12-23T08:33:26.814 |    | 8.46   | -13.45  | 45679.36 | -19.95 |         |              |
| alpha   | I   | 2031-12-23T08:34:14.495 |    | 8.31   | -13.31  | 44732.19 | -19.78 |         |              |
| 4       | I   | 2031-12-23T08:36:03.953 |    | 7.97   | -12.99  | 42589.72 | -19.36 |         |              |
| 5       | I   | 2031-12-23T08:36:25.485 |    | 7.91   | -12.93  | 42174.26 | -19.27 |         |              |
| 6       | I   | 2031-12-23T08:36:44.763 |    | 7.85   | -12.87  | 41804.81 | -19.16 |         |              |
| Uranus  | I   | 2031-12-23T08:55:22.562 |    | 4.36x  | -9.54   | 25406.99 |        | 5.32    | 5.57         |
| Uranus  | E   | 2031-12-23T09:05:54.897 |    | 2.35x  | -7.61   | 25092.23 |        | 9.44    | 9.87         |
| 6       | E   | 2031-12-23T09:24:47.596 |    | -1.32x | -4.08x  | 41821.48 | 19.09  |         |              |
| 5       | E   | 2031-12-23T09:25:12.645 |    | -1.41x | -4.00x  | 42304.61 | 19.20  |         |              |
| 4       | E   | 2031-12-23T09:25:28.765 |    | -1.46x | -3.95x  | 42603.72 | 19.29  |         |              |
| alpha   | E   | 2031-12-23T09:27:15.323 |    | -1.81x | -3.61x  | 44684.61 | 19.70  |         |              |
| beta    | E   | 2031-12-23T09:28:03.913 |    | -1.97x | -3.46x  | 45645.68 | 19.87  |         |              |
| eta     | E   | 2031-12-23T09:29:20.410 |    | -2.22x | -3.21x  | 47176.12 | 20.12  |         |              |
| gamma   | E   | 2031-12-23T09:29:42.885 |    | -2.29x | -3.14x  | 47629.09 | 20.19  |         |              |
| delta   | E   | 2031-12-23T09:30:16.052 |    | -2.40x | -3.04x  | 48300.35 | 20.29  |         |              |
| lambda  | E   | 2031-12-23T09:31:40.657 |    | -2.68x | -2.77x  | 50026.71 | 20.52  |         |              |
| epsilon | E   | 2031-12-23T09:32:15.763 |    | -2.80x | -2.66x  | 50748.65 | 20.59  |         |              |

target : Uranus  
 target radius (km) : 25559.00  
 C/A epoch : 2031-12-23T09:08:38.070  
 Event type : PRgt  
 : Uranus occs: not geocentric or topocentric  
 : Ring occs: geocentric, topocentric  
 Observer code : AAT  
 Location : Siding Spring (AAT)  
 Latitude (deg) : -31.27703  
 E. Longitude (deg) : 149.06608  
 Altitude (km) : 1.164  
 Gaia source ID : 3404506539865133952  
 2Mass ID (if available) : 05360485+2328451  
 ICRS Star Coord at Epoch: 05h 36m 04.86355s +23:28:45.03528s  
 RUWE (>1.4 is poor) : 2.21  
 K magnitude : 11.941  
 G magnitude : 13.554  
 RP magnitude : 13.010  
 BP magnitude : 13.920  
 DUPflag : 0  
 Distance (au) : 18.108  
 f0 (km) : 0.000  
 g0 (km) : 0.000  
 skyplane vel. (km/s) : -23.25  
 Sun-Target sep (deg) : 173.64  
 Sun-Moon sep (deg) : 54.15  
 B (ring opening deg) : 79.56  
 PA of pole (deg) : 38.49  
 Pole direction: RA (deg): 257.31100  
 Dec (deg): -15.17500  
 C/A sky separation (") : 1.839  
 C/A sky separation (km) : 24147.7  
 NAIF SPICE kernels : RAJobs\_U111+rgf15.spk  
 URKALLvl.spk  
 ura111.bsp  
 IAU\_URANUS\_for\_RINGFIT.tpc  
 vgr2.ura111.bsp  
 ura161.bsp  
 vgr2.ura161.bsp  
 peph.ura160.bsp  
 earthstns\_itr93\_040916.bsp  
 earth\_720101\_070426.bpc  
 earth\_200101\_990628\_predict.bpc  
 pg3f0000r.bsp  
 pg490000r.bsp  
 naif0012.tls  
 earth\_flat\_IAU.spk



| Ring    | I/E | UTC                     | b? | alt   | alt-sun | radius   | r-dot  | lat-geo | lat-geodetic |
|---------|-----|-------------------------|----|-------|---------|----------|--------|---------|--------------|
| epsilon | I   | 2031-12-23T08:36:24.568 |    | 0.12x | 5.16x   | 51304.70 | -20.61 |         |              |
| lambda  | I   | 2031-12-23T08:37:26.576 |    | 0.31x | 4.96x   | 50026.71 | -20.53 |         |              |
| delta   | I   | 2031-12-23T08:38:51.130 |    | 0.58x | 4.68x   | 48300.35 | -20.30 |         |              |
| gamma   | I   | 2031-12-23T08:39:24.286 |    | 0.69x | 4.58x   | 47628.94 | -20.20 |         |              |
| eta     | I   | 2031-12-23T08:39:46.741 |    | 0.76x | 4.50x   | 47176.12 | -20.13 |         |              |
| beta    | I   | 2031-12-23T08:41:01.541 |    | 0.99x | 4.26x   | 45679.24 | -19.88 |         |              |
| alpha   | I   | 2031-12-23T08:41:49.402 |    | 1.14x | 4.11x   | 44731.79 | -19.71 |         |              |
| 4       | I   | 2031-12-23T08:43:39.178 |    | 1.49x | 3.75x   | 42590.25 | -19.30 |         |              |
| 5       | I   | 2031-12-23T08:44:00.770 |    | 1.56x | 3.68x   | 42174.95 | -19.21 |         |              |
| 6       | I   | 2031-12-23T08:44:20.158 |    | 1.62x | 3.62x   | 41804.46 | -19.10 |         |              |
| Uranus  | I   | 2031-12-23T09:03:01.573 |    | 5.09  | 0.04x   | 25399.30 |        | 5.45    | 5.71         |
| Uranus  | E   | 2031-12-23T09:13:28.678 |    | 6.99  | -1.93x  | 25087.71 |        | 9.48    | 9.92         |
| 6       | E   | 2031-12-23T09:32:20.328 |    | 10.33 | -5.42   | 41821.96 | 19.16  |         |              |
| 5       | E   | 2031-12-23T09:32:45.292 |    | 10.40 | -5.49   | 42305.09 | 19.27  |         |              |
| 4       | E   | 2031-12-23T09:33:01.302 |    | 10.45 | -5.54   | 42603.33 | 19.36  |         |              |
| alpha   | E   | 2031-12-23T09:34:47.464 |    | 10.76 | -5.86   | 44684.62 | 19.78  |         |              |
| beta    | E   | 2031-12-23T09:35:35.848 |    | 10.90 | -6.01   | 45645.52 | 19.96  |         |              |
| eta     | E   | 2031-12-23T09:36:52.026 |    | 11.12 | -6.24   | 47176.12 | 20.21  |         |              |
| gamma   | E   | 2031-12-23T09:37:14.399 |    | 11.18 | -6.31   | 47629.04 | 20.28  |         |              |
| delta   | E   | 2031-12-23T09:37:47.420 |    | 11.28 | -6.40   | 48300.35 | 20.38  |         |              |
| lambda  | E   | 2031-12-23T09:39:11.633 |    | 11.52 | -6.66   | 50026.71 | 20.62  |         |              |
| epsilon | E   | 2031-12-23T09:39:46.612 |    | 11.62 | -6.76   | 50749.47 | 20.69  |         |              |