General: Nonsidereal Starlist Generator

Author	Date	Comment
jlyke	2008 May 20	Original
Calvarez	2016 May24	Mac ^M line end character
Jlyke	2016 Nov 07	New –ao option
Calvarez	2020 Dec 11	Link to new JPL Horizons App. Adapt procedure to new app.

Purpose: Easily convert JPL Horizons-generated non-sidereal coordinate list into Keck format

Method: Download list from the web, use csh script nonsidereal to convert

Procedure:

1. If you need the name of an observable non-sidereal target, use this web form: https://ssd.jpl.nasa.gov/tools/sbwobs.html#/ , and set your time, location, and constraints.
2. Go to the JPL Horizons web form: https://ssd.jpl.nasa.gov/horizons/app.html#/ and select the following:
    a. Ephemeris Type: **Observer Table**
    b. Target Body: **Your target**
    c. Observer Location: **568 (Mauna Kea)**
    d. Time Specification: (times are UT, *e.g.*):
        i. Start Time: `2021-12-21 05:00`
        ii. Stop Time: `2021-12-21 15:00`
        iii. Step size: **10-30 minutes** depending on non-sidereal rates
    e. Table Settings:
        i. Observer quantities: **1, 3, 4, 8, 9**
        ii. Additional Table Settings:
            1. Reference frame: **ICRF**
            2. Date/time format: **calendar format**
            3. Time digits: **HH:MM**
            4. Angle format: **sexagesimal format**
            5. Refraction model: **no refraction (airless)**
        iii. Click on **Use Specified Settings**
3. Click on **Generate Ephemeris**.
4. Click on **Download Results**. This will download the file to your directory (default name is *horizons_results.txt*)
5. If you have access to a Keck computer, run ***~kics/instr/bin/nonsidereal horizons_results.txt [object_name]***. Otherwise, you can ask your SA to provide the **csh** script ***nonsiderial*** to you, and run it on your local computer. Once you make the script executable, it should run on any Mac or Linux PC terminal.
    a. Note: object_name is optional. If no name is given, target will be called "movintarg".

   b. Note: If object_name is longer than 9 characters, it will be truncated; if object_name is shorter than 9 characters, "_" will be appended to the name.
   c. Note: This script does not verify that the target has positive elevation
   d. Note: Use option **–ao** for AO lists to skip dra and ddec values: ***~kics/instr/bin/nonsidereal horizons_results.txt [object_name] -ao***
6. Verify output looks reasonable (see appendix)
7. Run ***~kics/instr/bin/nonsidereal horizons_results.txt [object_name]*** >> ***newfile.list***
8. Copy ***newfile.list*** to ***/kroot/starlists/your_directory/***, or upload the file to the Keck system using the **target management tool** available in your **Keck Observer page** (https://www2.keck.hawaii.edu/inst/PILogin/login.php).

Appendix: (Sample input and output)

Sample horizons_results.txt

```
*******************************************************************************
JPL/HORIZONS                         5 Astraea               2008-May-17 22:40:52
Rec #:     5 (+COV)   Soln.date: 2008-Apr-23_14:14:53   # obs: 1721 (1845-2008)

FK5/J2000.0 helio. ecliptic osc. elements (AU, DAYS, DEG, period=Julian yrs):

  EPOCH=  2449241.5 ! 1993-Sep-11.00 (CT)         Residual RMS= .32652
    EC= .1913495556883082  QR= 2.082302091450191  TP= 2449863.052818913
    OM= 141.788005893536   W= 356.354827816858    IN= 5.357532388549395
    A= 2.575033633008893   MA= 211.7455439878357  ADIST= 3.067765174567595
    PER= 4.13221           N= .238522699          ANGMOM= .027093987
    DAN= 2.08298           DDN= 3.0663            L= 138.1587152
    B= -.3401235                                  TP= 1995-May-25.5528189

Physical parameters (KM, SEC, rotational period in hours):
    GM= n.a.               RAD= 59.535            ROTPER= 16.8
    H= 6.8888              G= .150                B-V= .826
                           ALBEDO= .2268          STYP= S

ASTEROID comments:
1: soln ref.= JPL#52, OCC=0
2: source=ORB
*******************************************************************************


*******************************************************************************
Ephemeris / WWW_USER Sat May 17 22:40:52 2008  Pasadena, USA     / Horizons
*******************************************************************************
Target body name: 5 Astraea                       {source: JPL#52}
Center body name: Earth (399)                     {source: DE405}
Center-site name: Mauna Kea
*******************************************************************************
Start time      : A.D. 2008-May-18 05:00:00.0000 UT
Stop  time      : A.D. 2008-May-18 15:00:00.0000 UT
Step-size       : 20 minutes
*******************************************************************************
Target pole/equ : No model available
Target radii    : 59.5 km
Center geodetic : 204.527800,19.8261152,4.2078485 {E-lon(deg),Lat(deg),Alt(km)}
Center cylindric: 204.527800,6006.35451,2151.0229 {E-lon(deg),Dxy(km),Dz(km)}
Center pole/equ : High-precision EOP model        {East-longitude +}
Center radii    : 6378.1 x 6378.1 x 6356.8 km     {Equator, meridian, pole}
Target primary  : Sun                             {source: DE405}
Interfering body: MOON (Req= 1737.400) km         {source: DE405}
Deflecting body : Sun, EARTH                      {source: DE405}
Deflecting GMs  : 1.3271E+11, 3.9860E+05 km^3/s^2
Small perturbers: Ceres, Pallas, Vesta            {source: SB405-CPV-2}
Small body GMs  : 6.32E+01, 1.43E+01, 1.78E+01 km^3/s^2
Atmos refraction: NO (AIRLESS)
RA format       : HMS
Time format     : CAL
RTS-only print  : NO
EOP file        : eop.080516.p080807
EOP coverage    : DATA-BASED 1962-JAN-20 TO 2008-MAY-16. PREDICTS-> 2008-AUG-06
Units conversion: 1 AU= 149597870.691 km, c= 299792.458 km/s, 1 day= 86400.0 s
Table cut-offs 1: Elevation (-90.0deg=NO ),Airmass (>38.000=NO), Daylight (NO )
Table cut-offs 2: Solar Elongation (  0.0,180.0=NO )
*******************************************************************************
Initial FK5/J2000.0 heliocentric ecliptic osculating elements (AU, DAYS, DEG):
  EPOCH=  2449241.5 ! 1993-Sep-11.00 (CT)         Residual RMS= .32652
    EC= .1913495556883082  QR= 2.082302091450191  TP= 2449863.052818913
    OM= 141.788005893536   W= 356.354827816858    IN= 5.357532388549395
```

Asteroid physical parameters (KM, SEC, rotational period in hours):

GM= n.a.	RAD= 59.535	ROTPER= 16.8
H= 6.8888	G= .150	B-V= .826
	ALBEDO= .2268	STYP= S

Date__(UT)__HR:MN	R.A._(ICRF/J2000.0)_DEC	dRA*cosD	d(DEC)/dt	Azi_(a-appr)_Elev	a-mass	APmag	S-brt
$$SOE							
2008-May-18 05:00 Cm	12 49 59.95 +02 53 14.0	-3.22	-3.96	110.5581 50.2503	1.299	10.59	5.46
2008-May-18 05:20 Nm	12 49 59.87 +02 53 12.7	-3.27	-3.98	114.6165 54.6063	1.226	10.59	5.46
2008-May-18 05:40 Nm	12 49 59.80 +02 53 11.3	-3.32	-3.99	119.5932 58.8069	1.168	10.59	5.47
2008-May-18 06:00 Am	12 49 59.73 +02 53 10.0	-3.36	-4.00	125.8604 62.7784	1.124	10.59	5.47
2008-May-18 06:20 m	12 49 59.65 +02 53 08.7	-3.39	-4.01	133.9383 66.4030	1.091	10.59	5.47
2008-May-18 06:40 m	12 49 59.58 +02 53 07.3	-3.40	-4.03	144.4692 69.4946	1.067	10.59	5.47
2008-May-18 07:00 m	12 49 59.50 +02 53 06.0	-3.41	-4.04	157.9613 71.7785	1.052	10.59	5.47
2008-May-18 07:20 m	12 49 59.42 +02 53 04.6	-3.41	-4.05	174.0969 72.9266	1.046	10.59	5.47
2008-May-18 07:40 t	12 49 59.35 +02 53 03.3	-3.39	-4.07	191.0912 72.7107	1.047	10.59	5.47
2008-May-18 08:00 m	12 49 59.27 +02 53 01.9	-3.36	-4.08	206.5287 71.1778	1.056	10.59	5.47
2008-May-18 08:20 m	12 49 59.20 +02 53 00.6	-3.33	-4.09	219.0815 68.6095	1.073	10.59	5.47
2008-May-18 08:40 m	12 49 59.12 +02 52 59.2	-3.28	-4.10	228.7835 65.3278	1.100	10.59	5.47
2008-May-18 09:00 m	12 49 59.05 +02 52 57.8	-3.22	-4.12	236.2361 61.5797	1.136	10.59	5.47
2008-May-18 09:20 m	12 49 58.98 +02 52 56.4	-3.15	-4.13	242.0555 57.5271	1.184	10.59	5.47
2008-May-18 09:40 m	12 49 58.91 +02 52 55.1	-3.07	-4.14	246.7143 53.2720	1.246	10.59	5.47
2008-May-18 10:00 m	12 49 58.84 +02 52 53.7	-2.99	-4.15	250.5448 48.8784	1.326	10.59	5.47
2008-May-18 10:20 m	12 49 58.78 +02 52 52.3	-2.89	-4.17	253.7764 44.3878	1.427	10.59	5.47
2008-May-18 10:40 m	12 49 58.72 +02 52 50.9	-2.79	-4.18	256.5690 39.8277	1.558	10.59	5.47
2008-May-18 11:00 m	12 49 58.66 +02 52 49.5	-2.68	-4.19	259.0358 35.2172	1.730	10.59	5.47
2008-May-18 11:20 m	12 49 58.60 +02 52 48.1	-2.56	-4.20	261.2592 30.5700	1.959	10.60	5.47
2008-May-18 11:40 m	12 49 58.54 +02 52 46.7	-2.44	-4.21	263.3007 25.8960	2.278	10.60	5.47
2008-May-18 12:00 m	12 49 58.49 +02 52 45.3	-2.31	-4.22	265.2077 21.2029	2.743	10.60	5.47
2008-May-18 12:20 m	12 49 58.44 +02 52 43.9	-2.18	-4.23	267.0181 16.4971	3.473	10.60	5.47
2008-May-18 12:40 m	12 49 58.39 +02 52 42.5	-2.04	-4.23	268.7630 11.7836	4.761	10.60	5.47
2008-May-18 13:00 m	12 49 58.35 +02 52 41.1	-1.90	-4.24	270.4693 7.0671	7.547	10.60	5.47
2008-May-18 13:20 m	12 49 58.31 +02 52 39.7	-1.77	-4.25	272.1615 2.3517	16.592	10.60	5.47
2008-May-18 13:40 s	12 49 58.27 +02 52 38.3	-1.63	-4.26	273.8627 -2.3584	n.a.	10.60	5.47
2008-May-18 14:00 m	12 49 58.24 +02 52 36.8	-1.49	-4.26	275.5958 -7.0590	n.a.	10.60	5.47

```
 2008-May-18 14:20  m  12 49 58.20 +02 52 35.4    -1.35     -4.27 277.3853 -11.7454
n.a.  10.60   5.47
 2008-May-18 14:40 A   12 49 58.17 +02 52 34.0    -1.22     -4.27 279.2577 -16.4124
n.a.  10.60   5.47
 2008-May-18 15:00 N   12 49 58.15 +02 52 32.6    -1.09     -4.28 281.2436 -21.0538
n.a.  10.60   5.47
$$EOE
*******************************************************************************************
***************
Column meaning:

TIME

  Prior to 1962, times are UT1. Dates thereafter are UTC. Any 'b' symbol in
the 1st-column denotes a B.C. date. First-column blank (" ") denotes an A.D.
date. Calendar dates prior to 1582-Oct-15 are in the Julian calendar system.
Later calendar dates are in the Gregorian system.

  The uniform Coordinate Time scale is used internally. Conversion between
CT and the selected non-uniform UT output scale has not been determined for
UTC times after the next July or January 1st.  The last known leap-second
is used over any future interval.

  NOTE: "n.a." in output means quantity "not available" at the print-time.

SOLAR PRESENCE (OBSERVING SITE)
  Time tag is followed by a blank, then a solar-presence symbol:

        '*'  Daylight (refracted solar upper-limb on or above apparent horizon)
        'C'  Civil twilight/dawn
        'N'  Nautical twilight/dawn
        'A'  Astronomical twilight/dawn
        ' '  Night OR geocentric ephemeris

LUNAR PRESENCE WITH TARGET RISE/TRANSIT/SET MARKER (OBSERVING SITE)
  The solar-presence symbol is immediately followed by another marker symbol:

        'm'  Refracted upper-limb of Moon on or above apparent horizon
        ' '  Refracted upper-limb of Moon below apparent horizon OR geocentric
        'r'  Rise    (target body on or above cut-off RTS elevation)
        't'  Transit (target body at or past local maximum RTS elevation)
        's'  Set     (target body on or below cut-off RTS elevation)

RTS MARKERS (TVH)
  Rise and set are with respect to the reference ellipsoid true visual horizon
defined by the elevation cut-off angle. Horizon dip and yellow-light refraction
(Earth only) are considered. Accuracy is < or = to twice the requested search
step-size.

 R.A._(ICRF/J2000.0)_DEC =
   J2000.0 astrometric right ascension and declination of target center.
Corrected for light-time. Units: HMS (HH MM SS.ff) and DMS (DD MM SS.f)

 dRA*cosD d(DEC)/dt =
    The rate of change of target center apparent RA and DEC (airless).
d(RA)/dt is multiplied by the cosine of the declination.
    Units: ARCSECONDS PER HOUR

 Azi_(a-appr)_Elev =
   Airless apparent azimuth and elevation of target center. Corrected for
light-time, the gravitational deflection of light, stellar aberration,
precession and nutation. Azimuth measured North(0) -> East(90) -> South(180) ->
West(270) -> North (360). Elevation is with respect to plane perpendicular
to local zenith direction.  TOPOCENTRIC ONLY. Units: DEGREES

 a-mass =
   Relative optical airmass at target center point. Topocentric EARTH sites,
ABOVE HORIZON ONLY.  Unitless.
```

```
 APmag S-brt =
   Asteroid's approximate apparent visual magnitude & surface brightness:
APmag = H + 5*log10(delta) + 5*log10(r) - 2.5*log10((1-G)*phi1 + G*phi2)
In principle, accurate to ~ +/- 0.1 magnitude. For solar phase angles > 90 deg,
the error could exceed 1 magnitude. No values are output for phase angles
greater than 120 degrees, since the errors could be large and unknown.
Units: NONE & VISUAL MAGNITUDES PER SQUARE ARCSECOND


 Computations by ...
     Solar System Dynamics Group, Horizons On-Line Ephemeris System
     4800 Oak Grove Drive, Jet Propulsion Laboratory
     Pasadena, CA  91109   USA
     Information: http://ssd.jpl.nasa.gov/
     Connect    : telnet://ssd.jpl.nasa.gov:6775  (via browser)
                  telnet ssd.jpl.nasa.gov 6775    (via command-line)
     Author     : Jon.Giorgini@jpl.nasa.gov

*******************************************************************************
***************
```

Sample output

puakea{jlyke}590: nonsidereal horizons_results.txt object_name

```
record divider  00 00 00.00 +00 00 00.0 2000.0 ####################
object_na 05-00 12 49 59.95 +02 53 14.0 2000.0 dra=-0.214667 ddec=-3.96 vmag=10.59
object_na 05-20 12 49 59.87 +02 53 12.7 2000.0 dra=-0.218 ddec=-3.98 vmag=10.59
object_na 05-40 12 49 59.80 +02 53 11.3 2000.0 dra=-0.221333 ddec=-3.99 vmag=10.59
object_na 06-00 12 49 59.73 +02 53 10.0 2000.0 dra=-0.224 ddec=-4.00 vmag=10.59
object_na 06-20 12 49 59.65 +02 53 08.7 2000.0 dra=-0.226 ddec=-4.01 vmag=10.59
object_na 06-40 12 49 59.58 +02 53 07.3 2000.0 dra=-0.226667 ddec=-4.03 vmag=10.59
object_na 07-00 12 49 59.50 +02 53 06.0 2000.0 dra=-0.227333 ddec=-4.04 vmag=10.59
object_na 07-20 12 49 59.42 +02 53 04.6 2000.0 dra=-0.227333 ddec=-4.05 vmag=10.59
object_na 07-40 12 49 59.35 +02 53 03.3 2000.0 dra=-0.226 ddec=-4.07 vmag=10.59
object_na 08-00 12 49 59.27 +02 53 01.9 2000.0 dra=-0.224 ddec=-4.08 vmag=10.59
object_na 08-20 12 49 59.20 +02 53 00.6 2000.0 dra=-0.222 ddec=-4.09 vmag=10.59
object_na 08-40 12 49 59.12 +02 52 59.2 2000.0 dra=-0.218667 ddec=-4.10 vmag=10.59
object_na 09-00 12 49 59.05 +02 52 57.8 2000.0 dra=-0.214667 ddec=-4.12 vmag=10.59
object_na 09-20 12 49 58.98 +02 52 56.4 2000.0 dra=-0.21 ddec=-4.13 vmag=10.59
object_na 09-40 12 49 58.91 +02 52 55.1 2000.0 dra=-0.204667 ddec=-4.14 vmag=10.59
object_na 10-00 12 49 58.84 +02 52 53.7 2000.0 dra=-0.199333 ddec=-4.15 vmag=10.59
object_na 10-20 12 49 58.78 +02 52 52.3 2000.0 dra=-0.192667 ddec=-4.17 vmag=10.59
object_na 10-40 12 49 58.72 +02 52 50.9 2000.0 dra=-0.186 ddec=-4.18 vmag=10.59
object_na 11-00 12 49 58.66 +02 52 49.5 2000.0 dra=-0.178667 ddec=-4.19 vmag=10.59
object_na 11-20 12 49 58.60 +02 52 48.1 2000.0 dra=-0.170667 ddec=-4.20 vmag=10.60
object_na 11-40 12 49 58.54 +02 52 46.7 2000.0 dra=-0.162667 ddec=-4.21 vmag=10.60
object_na 12-00 12 49 58.49 +02 52 45.3 2000.0 dra=-0.154 ddec=-4.22 vmag=10.60
object_na 12-20 12 49 58.44 +02 52 43.9 2000.0 dra=-0.145333 ddec=-4.23 vmag=10.60
object_na 12-40 12 49 58.39 +02 52 42.5 2000.0 dra=-0.136 ddec=-4.23 vmag=10.60
object_na 13-00 12 49 58.35 +02 52 41.1 2000.0 dra=-0.126667 ddec=-4.24 vmag=10.60
object_na 13-20 12 49 58.31 +02 52 39.7 2000.0 dra=-0.118 ddec=-4.25 vmag=10.60
object_na 13-40 12 49 58.27 +02 52 38.3 2000.0 dra=-0.108667 ddec=-4.26 vmag=10.60
object_na 14-00 12 49 58.24 +02 52 36.8 2000.0 dra=-0.0993333 ddec=-4.26 vmag=10.60
object_na 14-20 12 49 58.20 +02 52 35.4 2000.0 dra=-0.09 ddec=-4.27 vmag=10.60
object_na 14-40 12 49 58.17 +02 52 34.0 2000.0 dra=-0.0813333 ddec=-4.27 vmag=10.60
object_na 15-00 12 49 58.15 +02 52 32.6 2000.0 dra=-0.0726667 ddec=-4.28 vmag=10.60
```

puakea{jlyke}591:

Sample output for AO-style lists:

```
kapoho{jlyke}318: nonsidereal io_test.txt Io
record divider  00 00 00.00 +00 00 00.0 2000.0 ####################
Io_______ 05-00 12 46 43.15 -03 47 05.8 2000.0 dra=1.10639 ddec=-5.92400 vmag=6.28
Io_______ 06-00 12 46 44.23 -03 47 11.6 2000.0 dra=1.0624 ddec=-5.68431 vmag=6.28
Io_______ 07-00 12 46 45.28 -03 47 17.3 2000.0 dra=1.034 ddec=-5.56655 vmag=6.28
Io_______ 08-00 12 46 46.31 -03 47 22.8 2000.0 dra=1.02166 ddec=-5.57294 vmag=6.28
Io_______ 09-00 12 46 47.33 -03 47 28.5 2000.0 dra=1.02562 ddec=-5.70310 vmag=6.28
Io_______ 10-00 12 46 48.37 -03 47 34.3 2000.0 dra=1.04585 ddec=-5.95405 vmag=6.28
Io_______ 11-00 12 46 49.44 -03 47 40.4 2000.0 dra=1.08204 ddec=-6.32029 vmag=6.28
Io_______ 12-00 12 46 50.54 -03 47 47.0 2000.0 dra=1.13363 ddec=-6.79389 vmag=6.28
Io_______ 13-00 12 46 51.71 -03 47 54.1 2000.0 dra=1.19975 ddec=-7.36471 vmag=6.28
Io_______ 14-00 12 46 52.95 -03 48 01.7 2000.0 dra=1.27927 ddec=-8.02050 vmag=6.28
Io_______ 15-00 12 46 54.28 -03 48 10.1 2000.0 dra=1.37081 ddec=-8.74723 vmag=6.28
kapoho{jlyke}319: nonsidereal io_test.txt Io -ao
Io_______ 05-00 12 46 43.15 -03 47 05.8 2000.0 vmag=6.28 b-v=0.6
Io_______ 06-00 12 46 44.23 -03 47 11.6 2000.0 vmag=6.28 b-v=0.6
Io_______ 07-00 12 46 45.28 -03 47 17.3 2000.0 vmag=6.28 b-v=0.6
Io_______ 08-00 12 46 46.31 -03 47 22.8 2000.0 vmag=6.28 b-v=0.6
Io_______ 09-00 12 46 47.33 -03 47 28.5 2000.0 vmag=6.28 b-v=0.6
Io_______ 10-00 12 46 48.37 -03 47 34.3 2000.0 vmag=6.28 b-v=0.6
Io_______ 11-00 12 46 49.44 -03 47 40.4 2000.0 vmag=6.28 b-v=0.6
Io_______ 12-00 12 46 50.54 -03 47 47.0 2000.0 vmag=6.28 b-v=0.6
Io_______ 13-00 12 46 51.71 -03 47 54.1 2000.0 vmag=6.28 b-v=0.6
Io_______ 14-00 12 46 52.95 -03 48 01.7 2000.0 vmag=6.28 b-v=0.6
Io_______ 15-00 12 46 54.28 -03 48 10.1 2000.0 vmag=6.28 b-v=0.6
kapoho{jlyke}320: nonsidereal -ao io_test.txt Io
Io_______ 05-00 12 46 43.15 -03 47 05.8 2000.0 vmag=6.28 b-v=0.6
Io_______ 06-00 12 46 44.23 -03 47 11.6 2000.0 vmag=6.28 b-v=0.6
Io_______ 07-00 12 46 45.28 -03 47 17.3 2000.0 vmag=6.28 b-v=0.6
Io_______ 08-00 12 46 46.31 -03 47 22.8 2000.0 vmag=6.28 b-v=0.6
Io_______ 09-00 12 46 47.33 -03 47 28.5 2000.0 vmag=6.28 b-v=0.6
Io_______ 10-00 12 46 48.37 -03 47 34.3 2000.0 vmag=6.28 b-v=0.6
Io_______ 11-00 12 46 49.44 -03 47 40.4 2000.0 vmag=6.28 b-v=0.6
Io_______ 12-00 12 46 50.54 -03 47 47.0 2000.0 vmag=6.28 b-v=0.6
Io_______ 13-00 12 46 51.71 -03 47 54.1 2000.0 vmag=6.28 b-v=0.6
Io_______ 14-00 12 46 52.95 -03 48 01.7 2000.0 vmag=6.28 b-v=0.6
Io_______ 15-00 12 46 54.28 -03 48 10.1 2000.0 vmag=6.28 b-v=0.6
kapoho{jlyke}321: nonsidereal -ao -f io_test.txt -t Io
Io_______ 05-00 12 46 43.15 -03 47 05.8 2000.0 vmag=6.28 b-v=0.6
Io_______ 06-00 12 46 44.23 -03 47 11.6 2000.0 vmag=6.28 b-v=0.6
Io_______ 07-00 12 46 45.28 -03 47 17.3 2000.0 vmag=6.28 b-v=0.6
Io_______ 08-00 12 46 46.31 -03 47 22.8 2000.0 vmag=6.28 b-v=0.6
Io_______ 09-00 12 46 47.33 -03 47 28.5 2000.0 vmag=6.28 b-v=0.6
Io_______ 10-00 12 46 48.37 -03 47 34.3 2000.0 vmag=6.28 b-v=0.6
Io_______ 11-00 12 46 49.44 -03 47 40.4 2000.0 vmag=6.28 b-v=0.6
Io_______ 12-00 12 46 50.54 -03 47 47.0 2000.0 vmag=6.28 b-v=0.6
Io_______ 13-00 12 46 51.71 -03 47 54.1 2000.0 vmag=6.28 b-v=0.6
Io_______ 14-00 12 46 52.95 -03 48 01.7 2000.0 vmag=6.28 b-v=0.6
Io_______ 15-00 12 46 54.28 -03 48 10.1 2000.0 vmag=6.28 b-v=0.6
```