Targeting Minor Planets with *SPIRIT*

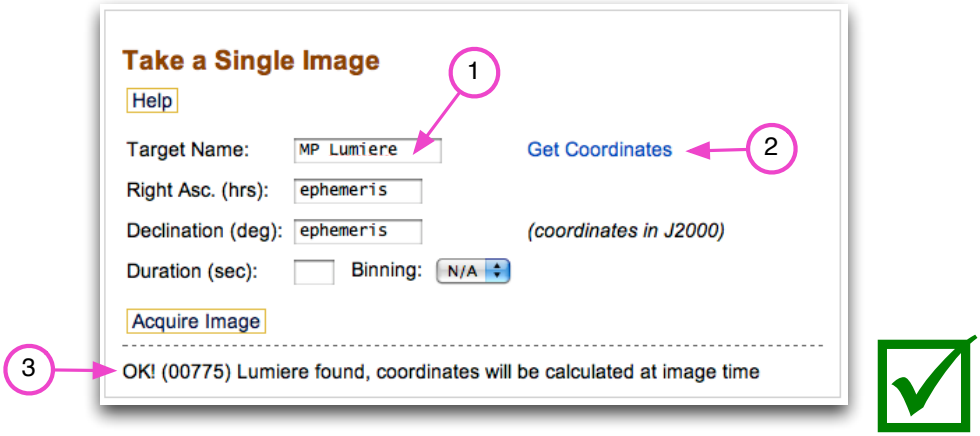
Targeting minor planets (asteroids and comets) is complicated by the fact that RA and Dec coordinates of these objects constantly change.

SPIRIT includes functionality that automatically calculates the precise coordinates (ephemerides) of specified minor planets at the time of imaging.

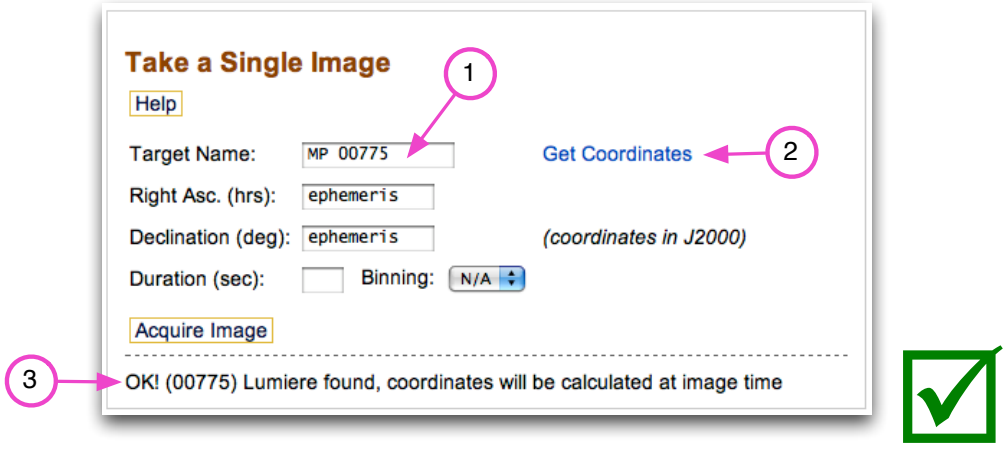
1. Basic imaging

- Specify the minor planet by name or catalogue number preceded by 'MP'. Refer to Appendix B for naming formats.
- Select **Get Coordinates**.
- If the minor planet exists in the database you will see 'ephemeris' appear in the coordinates boxes, and a message will indicate that the object's coordinates will be calculated at image time.

Example 1: Using common name:



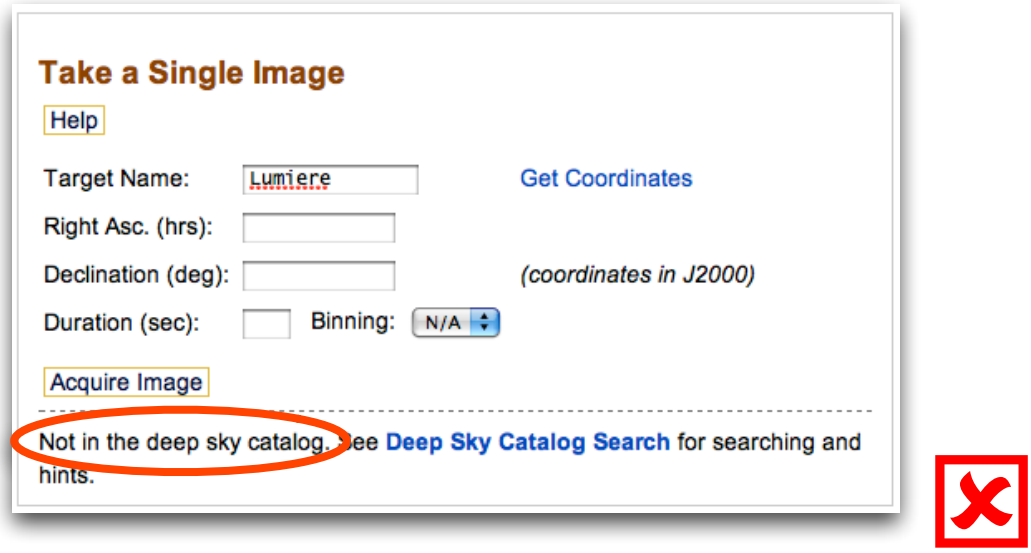
Example 2: Using catalogue number:



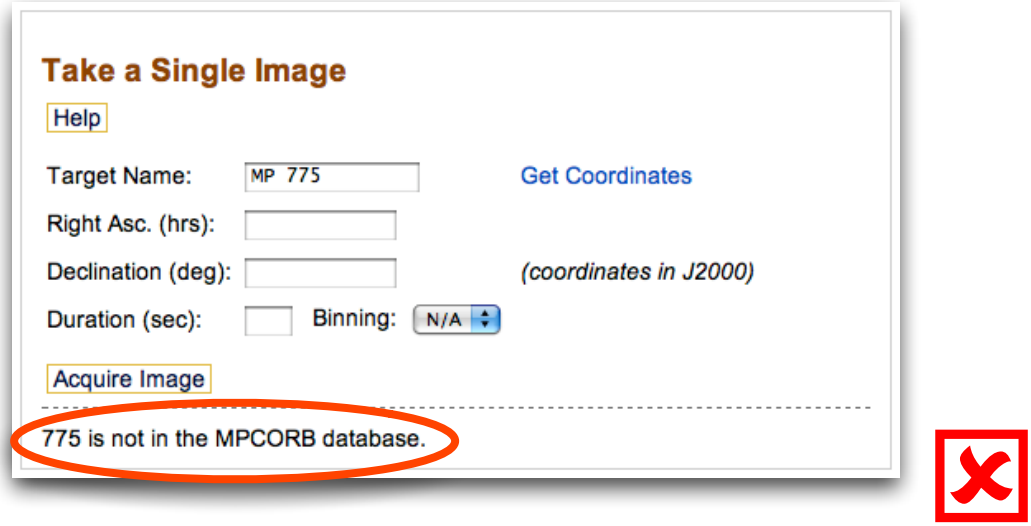
Note: Numbered minor planets must be specified using 5 digits, including leading zeroes if necessary (refer to Appendix B for more information).

Errors

Omitting 'MP' will result in an 'object not found' error when **Get Coordinates** is selected.



Leaving out the leading zeros in a 5 digit numerical designation will result in an 'object not found' error when **Get Coordinates** is selected.

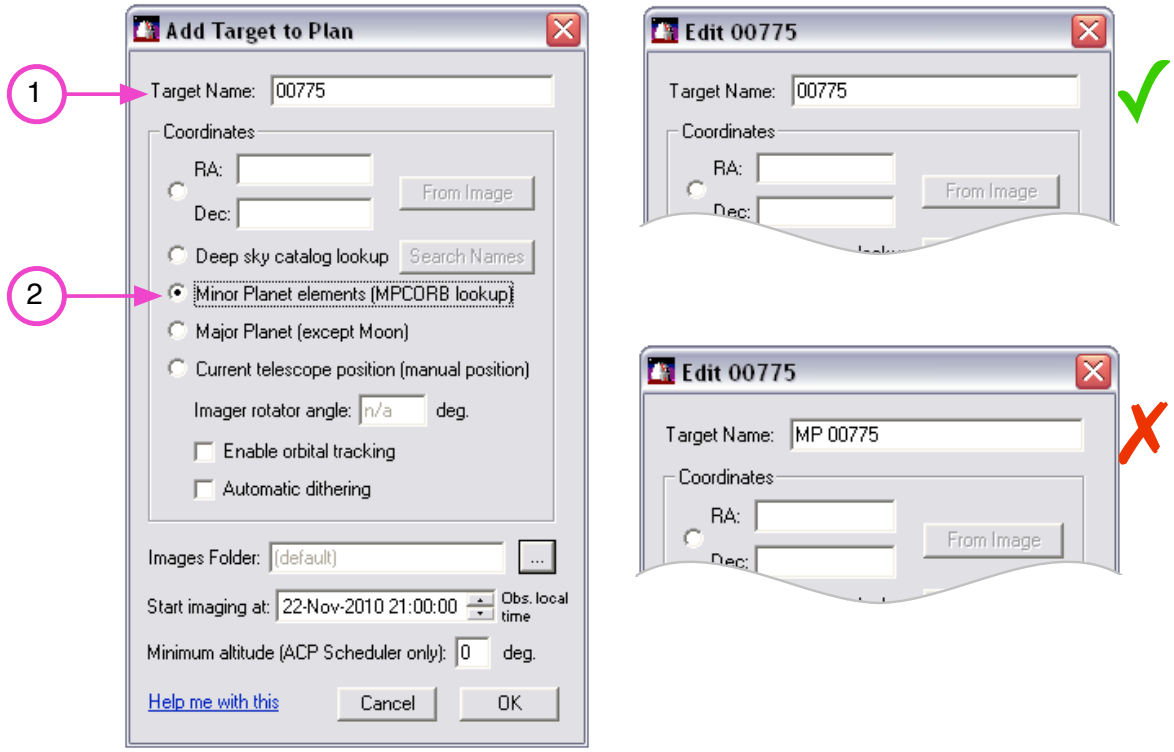


2. Specifying Minor Planets in ACP plans

ACP Planner includes the same provision for automatically calculating the ephemeris of a minor planet at the time of imaging.

IMPORTANT: When adding targets in ACP Planner the preceding 'MP' must be omitted.

- Add the minor planet (by name or number) without the prefix 'MP'.
- Select **Minor Planet elements (MPCORB lookup)**.



Ensure that you set image start time to your pre-determined optimum imaging time (i.e. when the object is in a favourable viewing position for *SPIRIT*).

Examining the plan produced above shows the 'MP' prefix automatically inserted by ACP Planner:

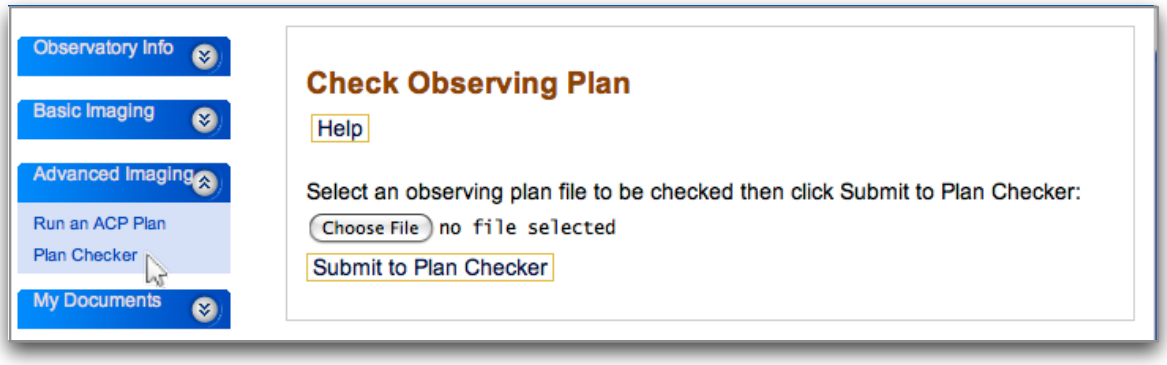
```
;
; === Target 00775 ===
;
#waituntil 1, 13:00:00    ; UTC (21:00:00 local)
#count 1
#filter Clear
#interval 60
#binning 1
MP 00775
;
; -----------
; END OF PLAN
; -----------
;
```

Checking for errors in ACP plans

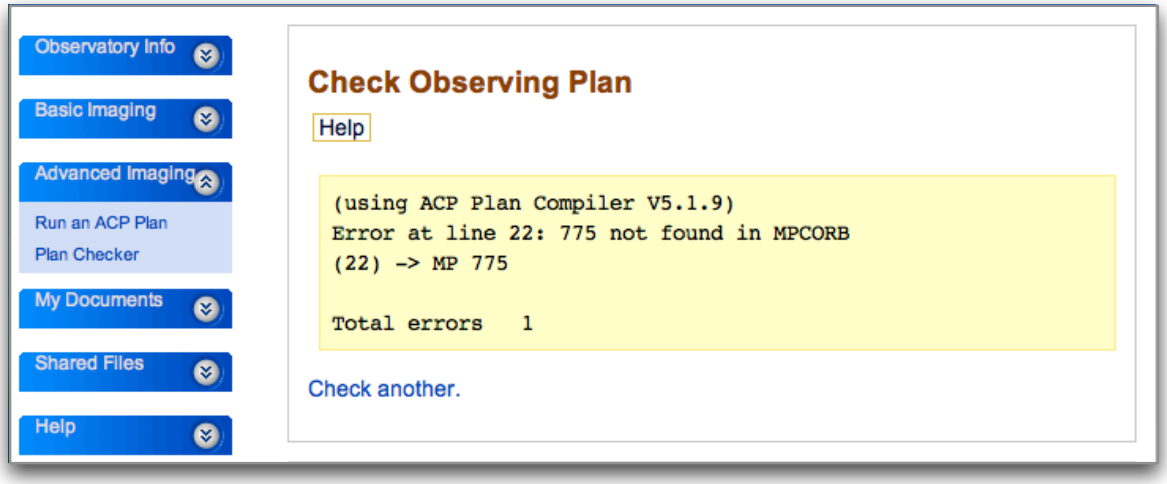
Errors in specifying minor planets in ACP Planner will not become evident until imaging time.

Plans can be checked for errors by selecting **Plan Checker** before uploading the plan to *SPIRIT*:

1. Log into *SPIRIT*
2. Navigate to **Advanced Imaging / Plan Checker.**



3. Choose the plan (stored on your computer) and select **Submit to Plan Checker**.

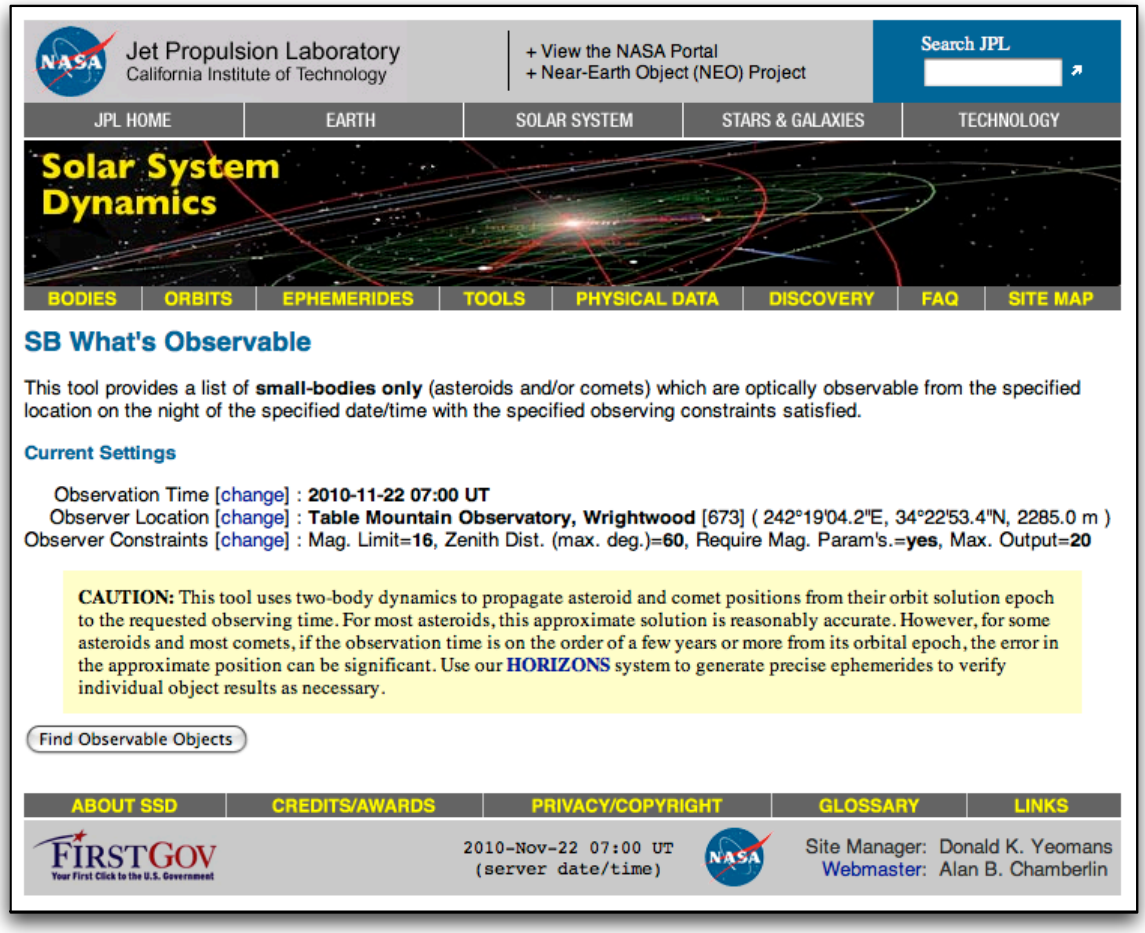


In the above example, the user neglected to include the leading zeros for MP 00775.

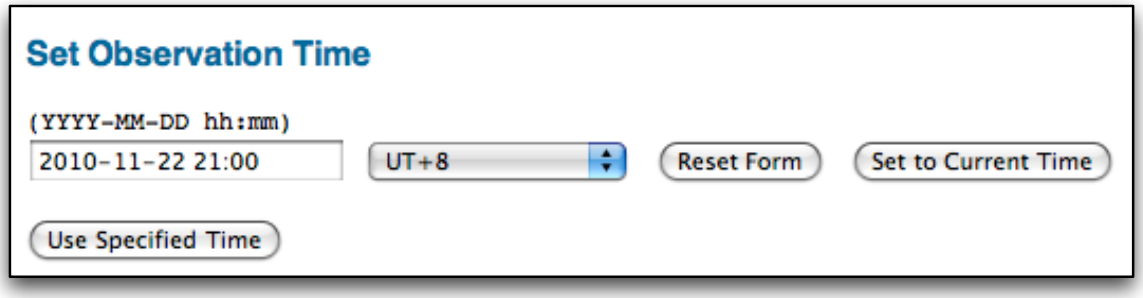
Appendix A: Selecting bright Minor Planets for observation by *SPIRIT*

An easy ways to create a list of bright Minor Planets for imaging is to use the NASA / JPL Small Body Database Browser at http://ssd.jpl.nasa.gov/sbdb.cgi

1. Navigate to the 'On-line Tools / What's Observable' page: http://ssd.jpl.nasa.gov/sbwobs.cgi

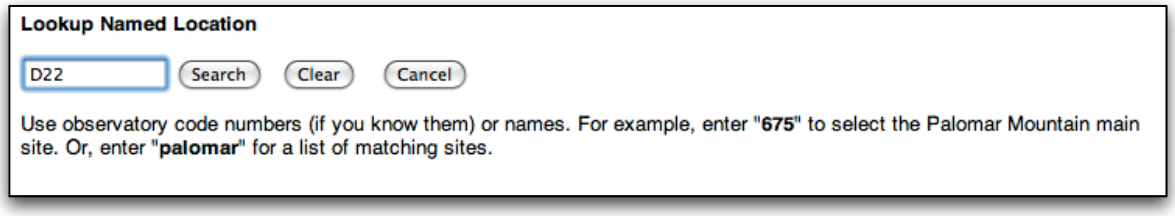


2. Under 'Current Settings', select **Observation Time** to modify the date and time to match your *SPIRIT* booking. Times can be entered in UT or local by selecting the appropriate time zone.

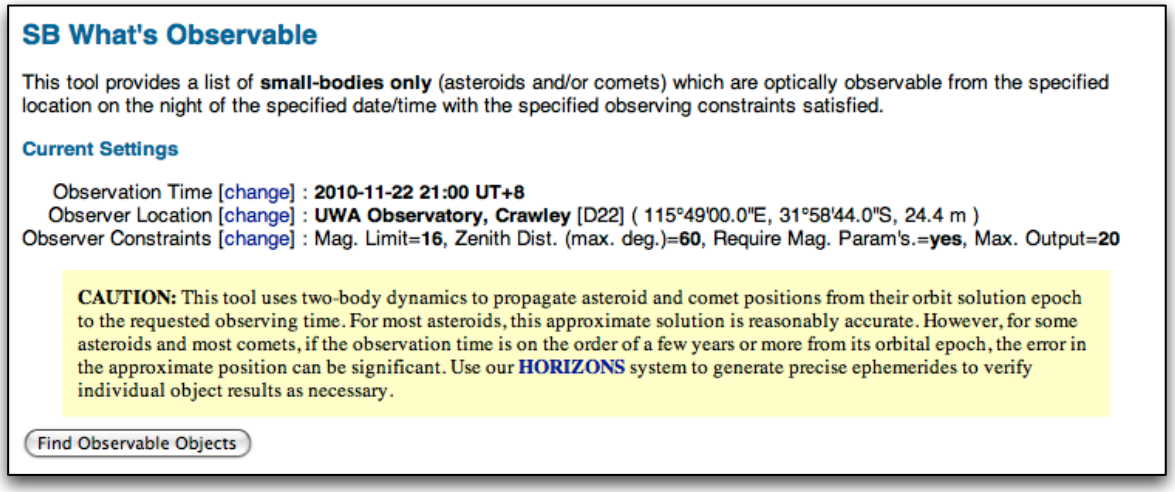


Select **Use Specified Time** when finished.

3. Select **Observer Location**. *SPIRIT* has a unique Minor Planet Centre assigned observatory code, **D22**.



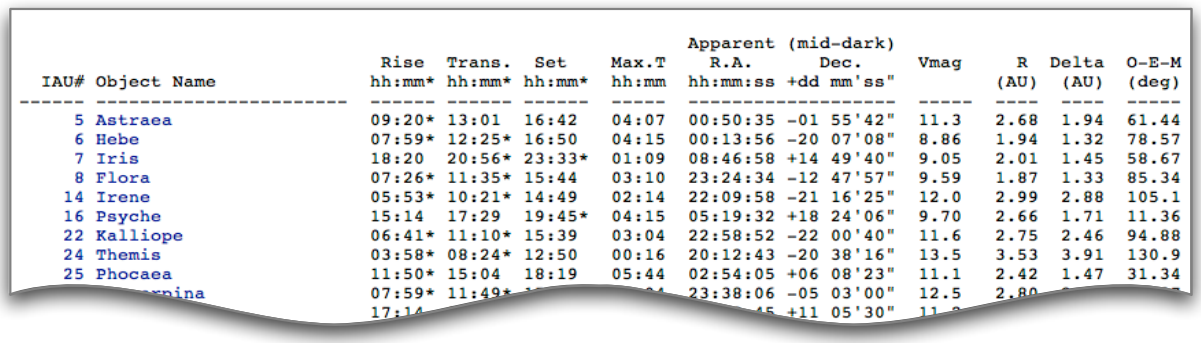
Click on search. This will look up the observatory code, automatically fill in the correct coordinates and return you to the previous page:



A number of observer constraints can be modified, such as limiting magnitude and maximum distance from the zenith. Otherwise, use the default settings.

4. Select **Find Observable Objects**.

A large list of visible minor planets will appear with rise time, transit time and other important information that will assist in choosing targets:



IAU#	Object Name	Rise hh:mm*	Trans. hh:mm*	Set hh:mm*	Max.T hh:mm	Apparent (mid-dark) R.A. hh:mm:ss	Dec. +dd mm'ss"	Vmag	R (AU)	Delta (AU)	O-E-M (deg)
5	Astraea	09:20*	13:01	16:42	04:07	00:50:35	-01 55'42"	11.3	2.68	1.94	61.44
6	Hebe	07:59*	12:25*	16:50	04:15	00:13:56	-20 07'08"	8.86	1.94	1.32	78.57
7	Iris	18:20	20:56*	23:33*	01:09	08:46:58	+14 49'40"	9.05	2.01	1.45	58.67
8	Flora	07:26*	11:35*	15:44	03:10	23:24:34	-12 47'57"	9.59	1.87	1.33	85.34
14	Irene	05:53*	10:21*	14:49	02:14	22:09:58	-21 16'25"	12.0	2.99	2.88	105.1
16	Psyche	15:14	17:29	19:45*	04:15	05:19:32	+18 24'06"	9.70	2.66	1.71	11.36
22	Kalliope	06:41*	11:10*	15:39	03:04	22:58:52	-22 00'40"	11.6	2.75	2.46	94.88
24	Themis	03:58*	08:24*	12:50	00:16	20:12:43	-20 38'16"	13.5	3.53	3.91	130.9
25	Phocaea	11:50*	15:04	18:19	05:44	02:54:05	+06 08'23"	11.1	2.42	1.47	31.34
	[illegible]rpina	07:59*	11:49*	[illegible]	[illegible]	23:38:06	-05 03'00"	12.5	2.80	[illegible]	[illegible]
		17:14	[illegible]	[illegible]	[illegible]	[illegible]:45	+11 05'30"	11.2	[illegible]	[illegible]	[illegible]

Appendix B: Formats for specifying minor planets in *SPIRIT*

SPIRIT accepts minor planet names in a variety of formats.

1. Named minor planets can be specified directly, e.g. 'MP Lumiere'
2. Numbered minor planets are specified using 5 digits, including leading zeros if necessary.

Examples:

- The asteroid 1142 is specified in *SPIRIT* as MP 01142
- Juno can be specified as MP 00003.

In the case of 6 or more digits, a prefix is used according to the following scheme:

A = 10	B = 11	C = 12	D = 13	E = 14
F = 15	G = 16	H = 17	I = 18	J = 19
K = 20	L = 21	M = 22	N = 23	O = 24
P = 25	Q = 26	R = 27	S = 28	T = 29
U = 30	V = 31	W = 32	X = 33	Y = 34
Z = 35				

Some examples:

- The numbered asteroid 100000 is specified as MP A0000
- 131186 is specified as MP D1186
- 235641 is specified as MP N5643

For numbered minor planets over 359999, lower case alphabetic prefixes are used according to the scheme: a = 36.

Examples:

- The numbered minor planet 360000 is specified in ACP as MP a0000
- Minor planet 369956 is specified in ACP as MP a9956

3. Unnumbered Minor Planets can be specified by their provisional designation.

Examples of this include:

- MP 2001 XD175
- MP 2006 UW260

Note: Provisional designations are not used once an asteroid has been named. For example MP 1926 PD does not exist in the SPIRIT database. It is specified as MP 01065 or as MP Amundsenia. The Minor Planet Centre or NASA/JPL small body database browser can be used to cross reference minor planet names and numbers.

Appendix C: Multi-target Minor Planet template

ACP Plans can be created or modified using a text editor, such as 'Windows Note Pad'. This provides a very powerful way to streamline repeated and unattended acquisition of targets, and is particularly useful for creating animations.

The example below provides a template that can be re-used with any list of Minor Planets, provided they exist in the *SPIRIT* database and visible at the specified date and time.

The plan will take 3 *sets* of images one hour apart, starting at 12:30 UT. Each set will contain 2 images of each minor planet.

The first section of the plan contains directives for exposure, count, filter, number of sets and timing.

The second section contains the list of minor planets to be imaged using the predefined directives. The list shows a variety of naming formats.

```
; Minor Planet Plan
; Joe Bloggs
; 25th November, 2010
;
#INTERVAL 45              ; 45 second exposures
#COUNT 2                  ; 2 images of each
#FILTER Clear             ; Using the Clear filter
#SETS 3                   ; 3 sets over the course of the night
#WAITUNTIL 1, 12:30       ; First set starts at 12:30 UT
#WAITUNTIL 2, 13:30       ; Second set starts 60 min later
#WAITUNTIL 3, 14:30       ; Last set starts 60 min after that
MP Titicaca
MP Tiburcio
MP Laputa
MP 1989 TG17
MP Sholokhov
MP Hohensteina
MP 04859
MP 00745
MP Barbarossa
MP Kalinin
;
; End of Plan
```