LOT Operation Cheat-Sheet (2021-Feb-15)

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Sofia camera: FOV–13′.08×13′.08; 0″.39/pixel; CCD counts: <50 k is usable (ideally <30 k)

Versions:
beta: 2021-Feb-15

Starting up (15 mins after sunset [exact sunset time can be checked with google])

Initiating the software environment (skip this step if the applications/software have been launched by the previous observer) **The order is important. Please strictly follow it.**

1. Find "FocusMax" icon in the Windows XP toolbar (looks like a yellow coffee cup with something red inside). Click it.
   In the FocusMax panel, click the "system" tab in the bottom. Then find the "Connect" button in the "Focuser" section and then click it.
2. In the Windows XP toolbar, find the MaxImDL icon (looks like a white telescope next to a moon). Launch it.
3. In the MaxImDL panel, click the "View" tab, and then click "Camera Control Window".
   In the Camera control window panel, click the "Setup" tab, and then click "Connect" on the upper right corner. In the "Coolers" section, click "on".
4. In the MaxImDL panel, click the "View" tab, and then click "Observatory control window".
   In the "Observatory" panel, click the "Setup" tab and then find the "Dome" section, then click "Connect".
5. After going through steps 1–4, the "ACP Observatory Control Software" panel will be launched automatically.
   Click the "Camera" tab and then click "Connect" if it is not yet connected.
   Find the "Script" Section. Click "Select the Script" and choose "AcquireImages.js". Click the other box in the "Script" section and then click "JSscript".
6. In the Windows XP toolbar, find "Lulin.sky" and launch it (looks like s dark blue ball with a "S" on it).
7. In the FocusMax panel, click the "System" tab, in the "Camera" section, choose "MaxImDL" to permit automatically focusing.

If the applications/software have been launched by the (previous) observer:

1. Switch on all monitors (4 in total)
2. Unlock the dome [twist the red button clockwise] (see Figure 1) and then push the "open" button.
3. Unlock the telescope controller [twist the red button clockwise].
4. After the dome is fully opened, on the autoslew panel (see Figure 1), click the "Telescope" tab and open the cover of the telescope.
5. On the autoslew panel (see Figure 2), click the button on the left of the "Earth icon" to enable tracking stars.
6. Create the directory "LOTYYYYMMDD", and then create a "flat" directory under LOTYYYYMMDD. May also create a "PIname" directory (e.g., "hyliu") to store the data taken on the target source(s).

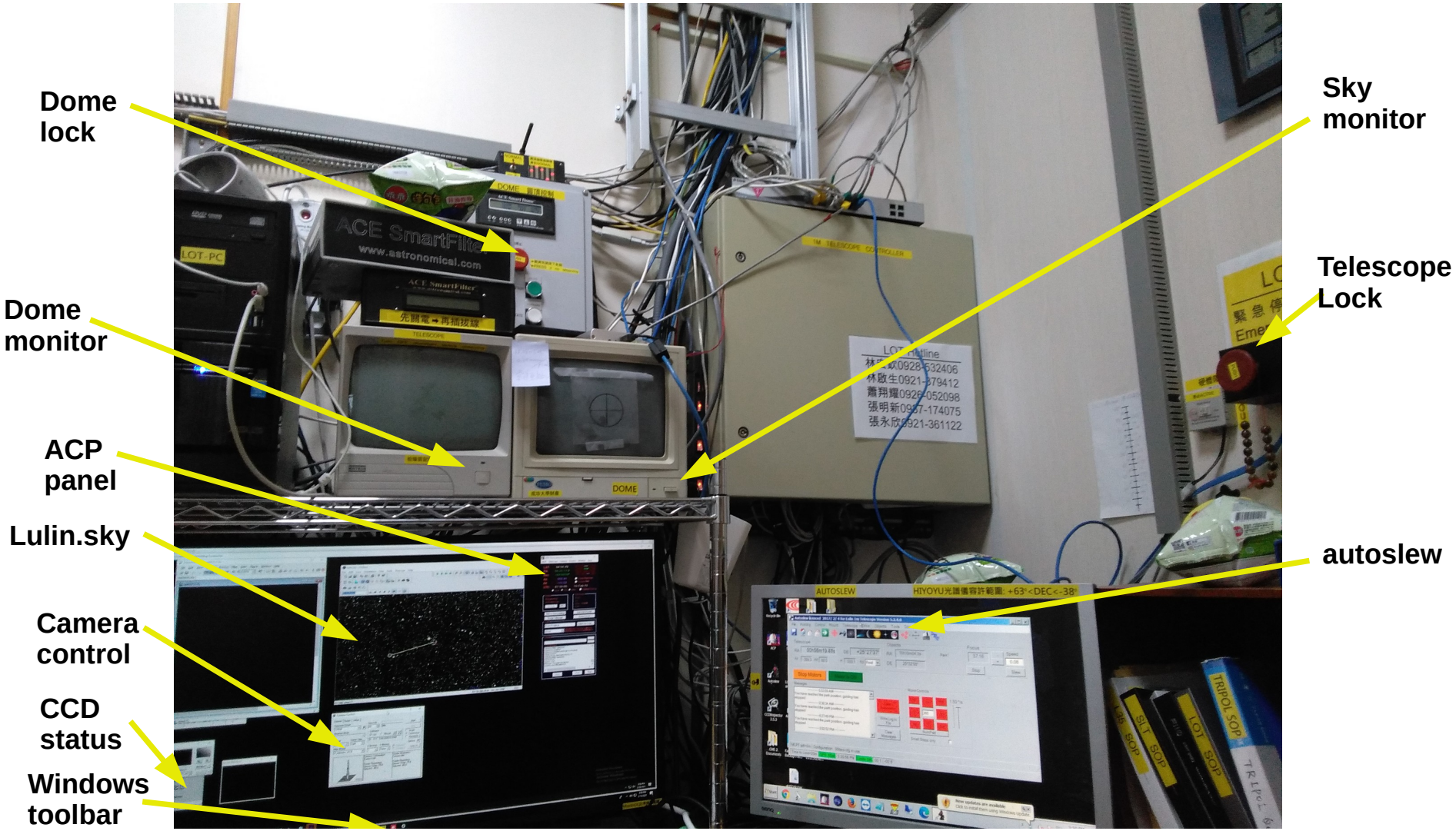

Figure 1: LOT control room configuration.

Flat field [take sky flat as far as the weather allows]

Sky flat during sunset

Starting from the band with low quantum efficiency, and then gradually move to those which are more sensitive (e.g., U− >Hα− >B− >V− >R− >I). During the sunrise, the order opposite to that for the sunset.

1 On the camera control panel, check "continuous" to start testing the integration time (usually it is set to 5-10 seconds).

2 Once the count fall to the range of 10k–30k (for I band, slightly higher than 30k is acceptable), check "autosave" and then set to take 5–10 flat field images for each band. Then click "start".

When each integration is finished, click the "W" button on the autoslew panel to offset the telescope pointing a bit, to avoid having some stars always at the same locations in the flat field images.

3 Remember to book-keep (on your own notebook) the integration time used for the flat field images. We need to take the corresponding dark images.

4 Move on to calibrate focus.

Sky flat during sunrise

Starting from the band with high quantum efficiency, and then gradually move to those which are less sensitive (I− >R− >V− >B− >Hα− >U). During the sunset, the order opposite to that for the sunrise. We can start taking the flat field about 1 hour before sunrise (i.e. about 30 min after the twilight).

1 Make preparations

- Move the telescope to a little west from the zenith using the Lulin.sky (i.e. azimuth: ∼70–80 deg, direction: west) because sunlight comes from the east.
- Set telescope-moving to a higher speed in the Move-Controles on the autoslew panel to allow shifting the telescope pointing with sufficient angular offset when the taking sky-flat field (Usual: ∼0.01°/s?, Sky flat: ∼0.15°/s).
- Prepare Autosave Setup (it is recommended to prepare several slots with different exposure times (e.g. 5, 15, 60 seconds)).

2 On the camera control panel, check "Continuous" to start testing the integration time (e.g. 60 seconds).

3 Once the count becomes more than 1000 ADU, check autosave (use prepared autosave setup) and click start.

When each integration is finished, click the "W" button on the autoslew panel to offset the telescope pointing a bit, to avoid having some stars always at the same locations in the flat field images.

- It is recommended to start from long exposure time and then decrease the exposure time as the CCD counts increase.
- It is also recommended to take many data even if the CCD counts are low (∼ 1k) or large (∼ 40k), just in case. We can remove the data which has too low or too large CCD counts during post-processing.

Autosave Setup

We can save and load the Autosave Setup in the Camera Control. It is useful for taking flat field, dark, and bias.

1 Click "Autosave" on the Camera Control panel to set parameters (e.g. Autosave Filenames, Type, Filter, Suffix, Exposure time, Binning, Repeat).

- Can not use the same Suffix in the sequence.
- If check "Same Repeat Count for All" in the "option", the number of repeats becomes the same for all slots.
- if check "Group by slot" in the "option", move to the next slot after all observations of the previous slot are finished (i.e. finish all repeat).

2 Click "Apply" => "OK" on the Autosave Setup.

3 We can save the sequence using "Save Sequence As..." in the "option" (It is useful for taking the flat field, dark, and bias).

We can load the saved sequence file from "Load Sequences..." in the "option".

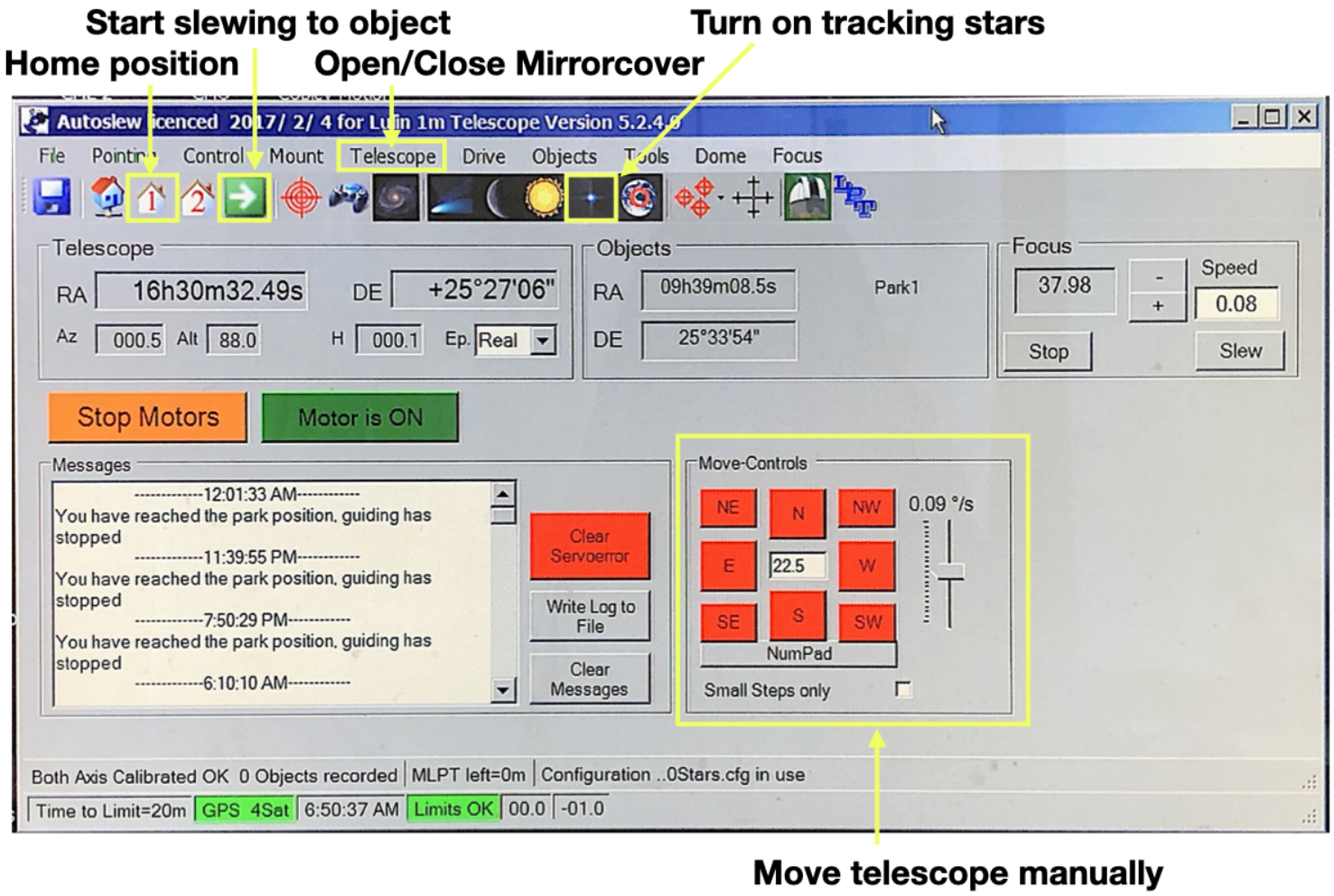

Figure 2: The Autoslew panel.

Dome flat with a illuminated screen

1) Use two small light sources (Source A1, Source A2; see Figure 3)
   1. Walk up to the dome and switch on the Source A1 and A2 (Figure 3).
      - Source A1: We can adjust the light intensity (The intensity should be minimum (labeling, minimum: E, maximum: F) when the light is turned on and off).
      - Source A2: on/off only.
      - Shed light on the floor (Do not shed light on the screen for domeflat).
   2. Walk back to the control room and slew the telescope to the domeflat position (the position of telescope faced the screen) manually, using Move-Controls on the autoslew panel (check by our eyes in the sky monitor, e.g. Figure 4).
   3. On the camera control panel, check "Single" to start testing the integration (exposure) time.
      - Typical exposure time is 5 – 60 sec ??
      - If we want to keep the error of about 1%, please keep the CCD counts of 10-30k.
      - If it is difficult to adjust the time, go to the dome and adjust the light intensity of Source 1.
   4. On the control panel, check "autosave", set to take 5–10 flat field with the adjusted exposure time (do not forget to click "Apply" => "OK" after the setting), and then click "start".
   5. Remember to book-keep the exposure time used for the flat field images. We need to take the corresponding dark images.
   6. Move on to calibrate focus.

2) Use one big light source (Source B)
   1. Slew the telescope to the domeflat position (Az: 92.7, El: 21.0). First, use Lulin.sky to slew the telescope around the position roughly. Second, use Move-Controls to slew the telescope to the position correctly. Finally, lock the telescope.
   2. Walk up to the dome taking with the black remote controller (Figure 5) and prepare the Source B (Figures 3, 6).
      2.1 Change the plug (white -> blue) of the socket of the Source B (Figure 6).
      2.2 Turn on the compact monitor (plug in the socket-> press the A1 button of the remote controller, Figure 5).
      2.3 Hung a rope of the Source B down (Figure 6).
      2.4 Turn on the switch (switch 1 and 2) and adjust the height of the Source B using the up-down switch (Figure 7).
         * When adjusting the height, please check the compact monitor (adjust the height to the white circle be in the center of the compact monitor, Figure 5).
   3. Walk back to the control room.
   4. On the camera control panel, check "Single" to start testing the integration (exposure) time.
      - Use the black remote controller to adjust the light intensity (e.g. Table 1)
      - If we want to keep the error of about 1%, please keep the CCD counts of 10–30k.
   5. On the control panel, check "autosave", set to take 5–10 flat field with the adjusted exposure time (do not forget to click "Apply" => "OK" after the setting), and then click "start".
   6. Remember to book-keep the exposure time used for the flat field images. We need to take the corresponding dark images.
   7. Move on to calibrate focus.

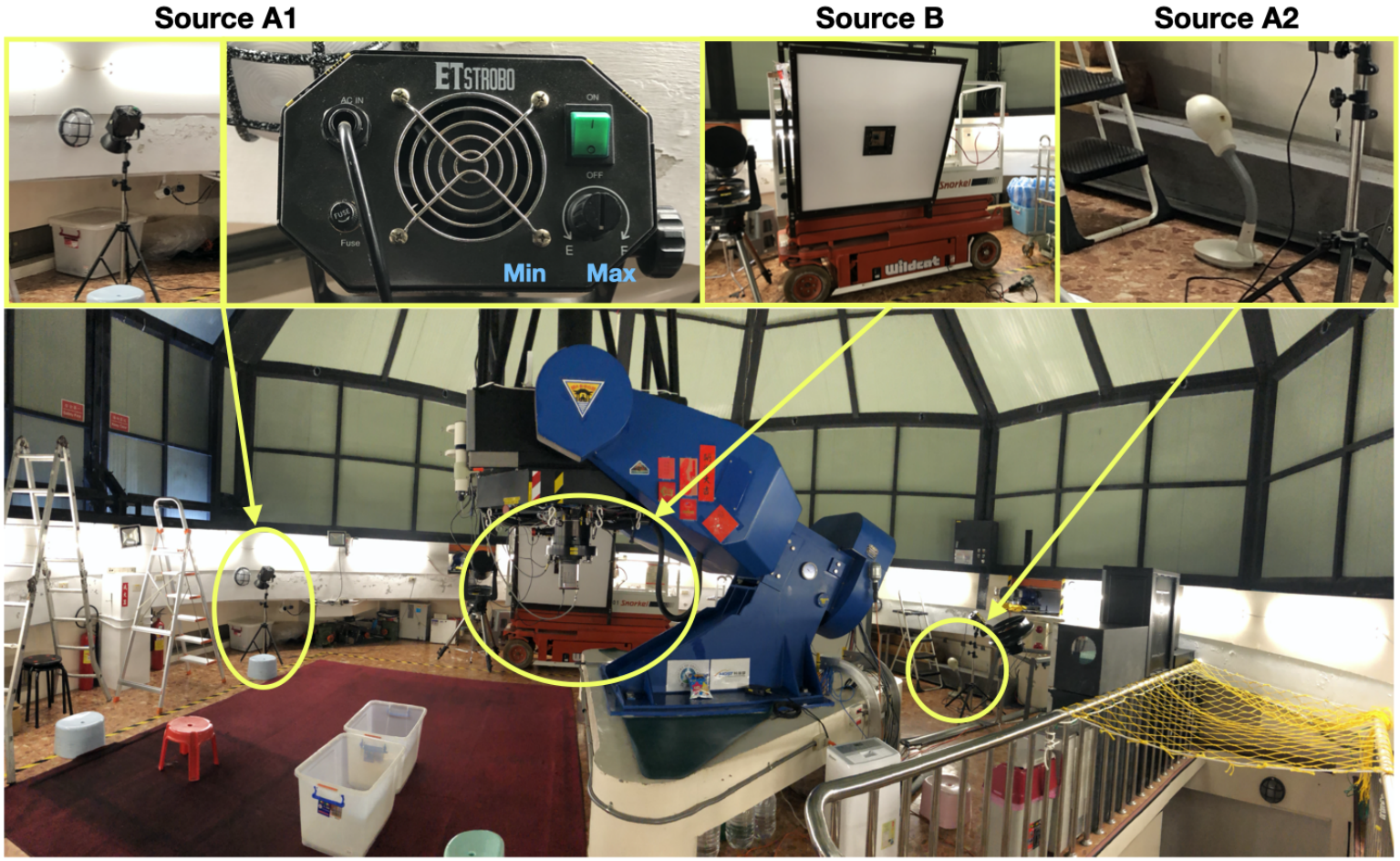

Figure 3: LOT dome configuration.

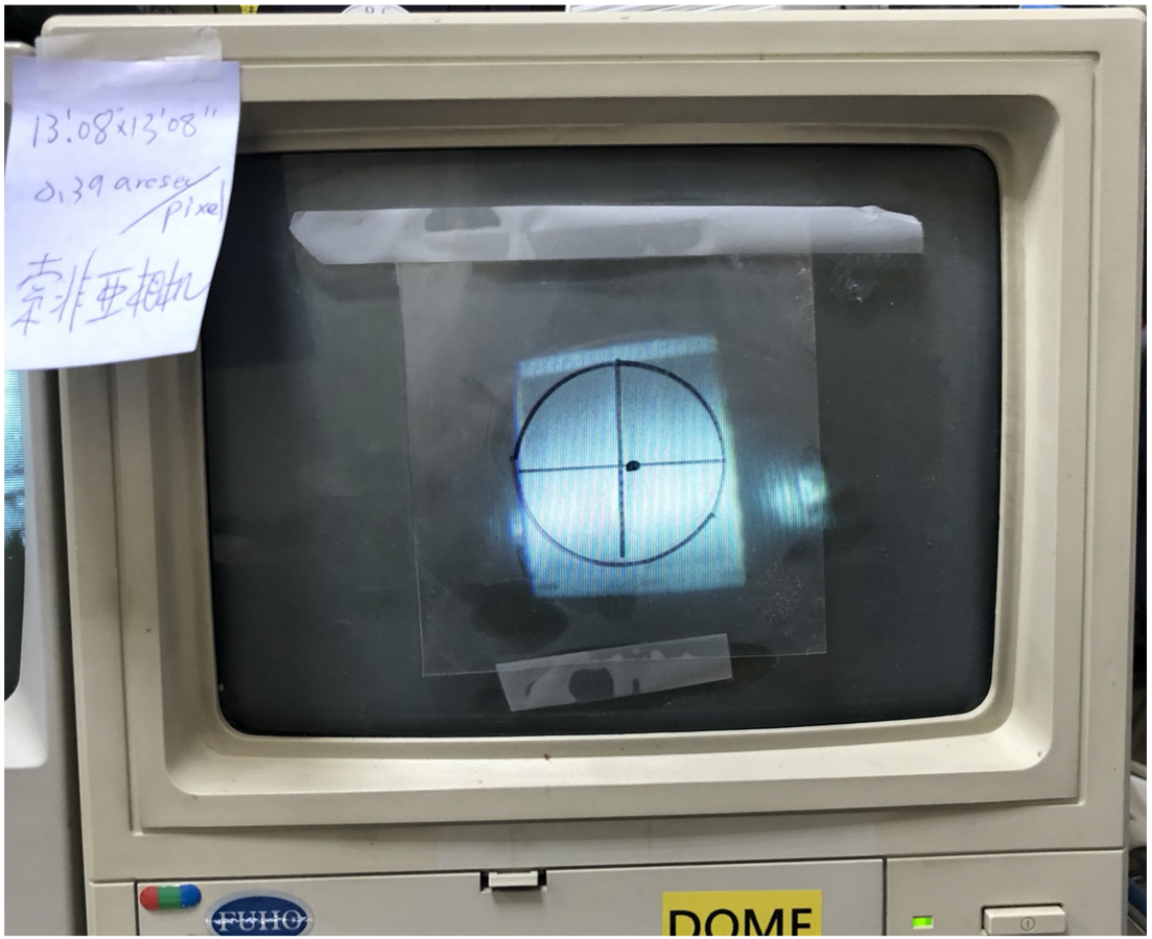

Figure 4: Example of the sky monitor during the observation of the flat (dome) field.

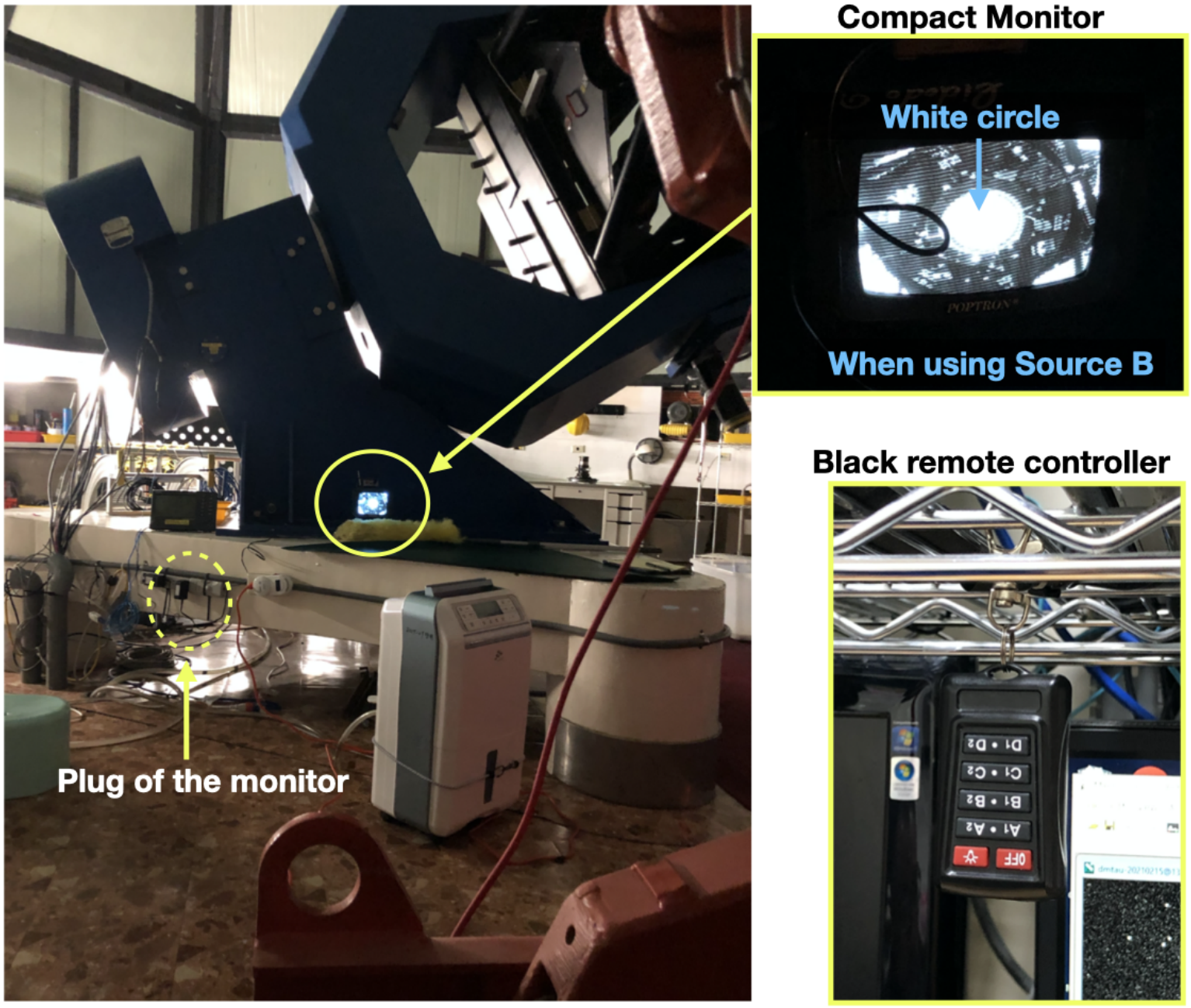

Figure 5: Compact monitor in the dome and black remoto controller

Figure 6: Source B configuration

Table 1: Example of the combination of the button of the remote controller, filter, and exposure time.

Button	Filter	Exposure time	CCD counts
B1	B	10 sec	$\sim$ 12-13 k
	V	5 sec	$\sim$ 25 k
	R	5 sec	$\sim$ 35 k
	gp	5 sec	$\sim$ 21 k
	rp	5 sec	$\sim$ 20 k
B1+C1	zp	90 sec	$\sim$ 14 k
C1	ip	2 sec	$\sim$ 30 k

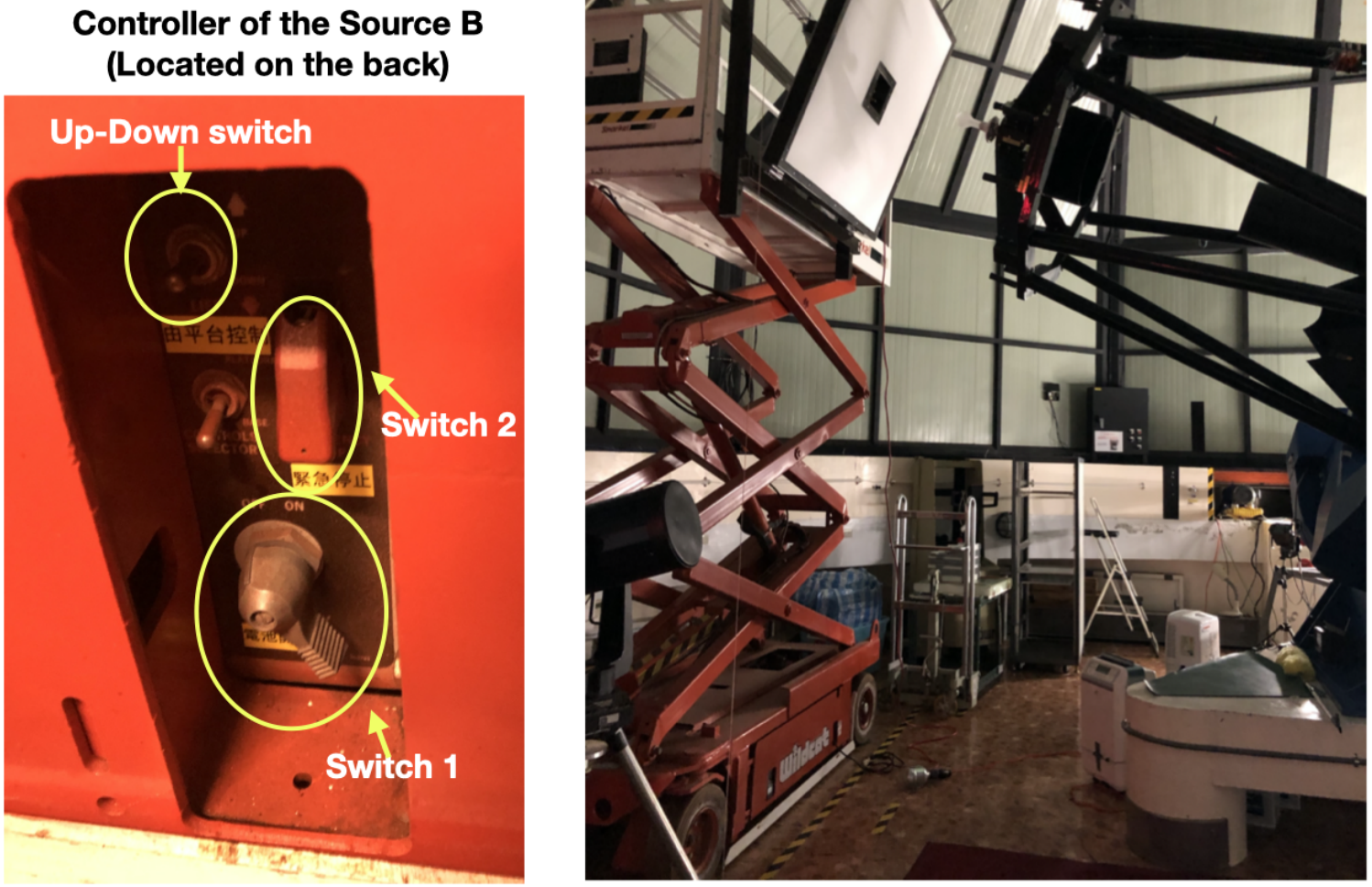

Figure 7: Controller of the Source B and example of the adjusted height of the Source B.

Observing target source with a script

On the ACP panel, click "RUN" and choose the script for a certain project.

Remember to book-keep the integration time used for all bands for all target sources. We need to take the corresponding dark images.

We can in principle analyze the stars observed with less than 50k counts. But we should keep track of the counts on the major target source, and try to make it around or less than 30k. Otherwise, it may saturates (>50k) once the seeing is improved. We need to abort the script and edit the integration time if the source is saturating.

The system can dynamically solve and calibrate the pointing, which however can cost very significant overhead. Given the large FOV of the Sofia camera, if the science case is only for one single star, it might not be worthy of doing this. To **disable** this function, find the ACP panel and click the "preference" tab. Then click "disable autocenter".

We can manually, roughly calibrate the pointing with the following steps:

1 On the camera control panel, set 1 second integration time with Binning×4.

2 On the Lulin.sky panel, click the location where we are going to correct to, and then click the "green telescope" icon to slew to it. Iterate this a few times until the target source is very close to the center of the field.

3 On the Lulin.sky panel, click again on the target source star. On the "Object information" panel, click "sync".

4 On the autoslew panel, click the "Mount" tab, and then click "set new home position".

We always need to make WCS correction in the post-processing.

Focus Do this before any target source observations

For observing target source with a scrip:

1 Start running the script first, wait for the system to slew the telescope to the target source and finish switching to the first filter.

2 "Abort" the script.

3 On the Lulin.sky panel, look for a star which is in between 9 to 10 magnitudes (cannot use brighter stars to avoid saturation), and then click the "green-telescope" icon to manually slew to it.

4 Click the Windows XP toolbar, find and click the focus-icon, which looks like a coffee cup.

5 In the popped-up panel, click "focus" to allow calibrating focus automatically. Under typical observing condition, we may achieve a FWHM of 1″–1.5″.

For manually observing the target source:

1 On the Lulin.sky panel, click the "orientation" tab, enter the coordinate of the target source and then click "slew" to slew to it.

2 On the camera control panel, pick a filter.

3 Following the steps [3]-[5] for the observations (on target sources) using scripts.

Finishing up (can take flat field before doing this)

1. On the autoslew panel, click the [1] and [=>] icons. *NEVER click the [2] and [home] icons.
2. On the autoslew panel, click the "Telescope" tab and close the telescope cover. Wait for 30 seconds (i.e., until the cover of the telescope is fully closed to avoid dust and water drops from the dome).
3. Push the red buttons to lock the dome and telescope controls.
4. Move on the take "dark" images [Need to go through all the integration times which have been used for the flat and science observations].

An example of target source script (a TXT file with arbitrary filename)

*lines start with ";" are comment lines, which will be ignored by the interpreter.

This script will loop over the target source "DM Tau", a nearby reference position "ref", and another reference position "Terada" which cover some brighter comparison stars (saturate easily). It is switching between the B, V, and I bands. The "ref" field is observed as often as the "DM Tau" field using exactly the same integration time, while the "Terada" field is observed less frequently and with reduced integration time. The line "#SETS 1000" will make the loop repeated 1000 times.

In the lines specifying the observing fields, the source name, R.A., and Decl. needs to be separated by <tab> instead of <space>. Be careful with this!

```
#DIR D:\LOTdata\LOT20210209\hyliu
; interval used (book keep): 120, 60, 30, 20, 15, 10, 5

; times to repeat the loop (set to an arbitrary large number)
#SETS 1000

; Below is one full loop
#COUNT 1
#BINNING 1
#FILTER B_319144
#INTERVAL 120
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#INTERVAL 20
terada  04:33:19.12     18:10:43.9

#COUNT 1
#BINNING 1
#FILTER V_319142
#INTERVAL 30
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#INTERVAL 5
terada  04:33:19.12     18:10:43.9

#COUNT 1
#BINNING 1
#FILTER I_10349
#INTERVAL 10
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#INTERVAL 5
terada  04:33:19.12     18:10:43.9


#COUNT 1
#BINNING 1
#FILTER B_319144
#INTERVAL 120
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#COUNT 1
#BINNING 1
#FILTER V_319142
#INTERVAL 30
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700

#COUNT 1
#BINNING 1
#FILTER I_10349
#INTERVAL 10
dmtau   04:33:48.734    18:10:09.974
ref     04:34:12.0985   18:18:49.700
```