

# PC3246: Astrophysics I

## Telescope Setup Guide

### 1 General Observing Rules

When setting up, choose a suitable site that is

- Away from hazardous situations such as ledges, steep slopes, roads and cliffs.
- A safe distance from an adjacent group.
- Away from nasty situations such as anthills and mosquito swamps.
- Reasonably unobstructed so you can see most of the sky.
- On reasonably stable ground such as concrete, asphalt, grass or gravel.
- Suitably close to a source of power (if you need it).
- **Do not set up the telescope on sand.**

While observing, take note of the following:

- **Watch out for wires.** DO NOT let the wires stretch, and **DO NOT let anyone trip over the wires.** In addition to being dangerous, there have been many a group who had their observations interrupted and alignment lost because someone tripped over a wire.
- Keep your observing area neat. Clutter in the dark is a tripping hazard.
- **Always hold on to the telescope before unclamping the right ascension, declination or dovetail clamps.**
- Watch out for rain or thunder. Take cover at the first sign of lightning.
- Keep the cover on the main case at all times. You can use it as a makeshift table for your laptop.
- If you intend to continue observing the next day, remove the optical tube and put a strong waterproof bag over the mount. *Secure the bag by tightening the tripod strap over the bag around the tripod so that the wind does not blow the bag off.*
- Put on the dust plugs and caps when the equipment is not in use. **DO NOT let grass, dirt, sand, insects or critters get into the optical tube.** Points will be taken off if you return equipment with grass, dirt or sand inside the optics or optics boxes, or with the dust plugs missing or in the wrong place.

**DO NOT BORESIGHT THE SUN.** Do not point the telescope to the sun without an appropriate solar filter. Do not install a finderscope when observing the sun.

### 2 The Care and Feeding of Optical Components

**Important points** (Points will be taken off if you break these rules)

- **DO NOT attempt to clean optical components in the field.**
- **NEVER touch an optical surface with your bare hands**
- **NEVER attempt to clean an optical surface without the correct equipment**
- Handle optics with care – These are made of glass.
- Do not let sand, soil, grass, insects or critters in the telescope or cases.

- Do not lose the eyepiece and lens covers. They are there to protect the optics.
- Keep the optical components covered when not in use.
- Do not set up the telescope on sand.

### Cleaning optics

- **NEVER touch an optical surface with your bare hands.** Skin oils will damage the sensitive optical coatings.
- The best way to clean optics is by air: pass dry air over the optical surface using a blower or a can of compressed air.
- **NEVER attempt to clean an optical surface without the correct equipment.** Do not use your shirt or a rag. That is the surest way to get it dirtier and destroy precision optics. **Do not blow on it.**
- Do not attempt to disassemble optical components. Some of these are factory aligned and calibrated, and cannot be reassembled without specialised equipment.

### Condensation and Moisture

- Avoid letting condensation build up on optical elements. While observing, you may need to place a small heat pack on the telescope to avoid condensation.
- Optics should not be stored when wet or moist. (This may happen when condensation builds up)
- After a night of observing, allow optics to dry out before storage. Do not completely close the case, but allow some airflow so that the equipment can dry out.

### Eyepieces and eyepiece accessories

- Eyepieces are attached by a clamped barrel to the telescope. Insert the eyepiece into the attachment and clamp it down to attach it to the telescope.
- When attaching or detaching eyepieces, **do not twist it.** This will cause the barrel to detach, and lens elements to fall out and break.
- When observing, **do not use the eyepiece as a handle.** That will unbalance the telescope and could break something.

### Optical Tubes

- The optical tube attaches to the mount by means of a dovetail rail and clamp. To attach the tube, make sure that the mount is locked into a stable position. Then place the optical tube in the dovetail saddle and **tighten the clamp while holding on to the optical tube.** Get someone to help you if necessary.
- Be sure that the optical tube is tightly secured to the mount before letting go of it.
- When removing the optical tube, hold on to it while the clamps are released. Get someone to help you if necessary. **Do not drop the optical tube!**

### Filters

- Filters should be held by the edges. The window is an optical surface.
- Filters sometimes thread onto the barrel end of an eyepiece. If the thread does not fit and it does not screw on all the way, **DO NOT FORCE IT.**

### Cameras

- Cameras are often attached directly to the telescope. The sensor chip may be exposed.
- The sensor chip is an optical surface. **NEVER touch the sensor chip!** Fingerprints on the sensor chip will get in the way of pictures and give you lousy pictures.
- If you use an interchangeable lens camera on the telescope, **remember to bring along a rear end cap for your camera's regular lens.**

### 3 Telescope Setup Manual

There are 4 different telescope configurations available:

- The iOptron SmartEQ Pro+ with the William Optics Z73II ..... Page 4
- The Celestron Nexstar 5SE ..... Page 25
- The Vixen Porta II with the Vixen R130sf ..... Page 40
- The Telescope-in-a-box Model 2005Mk3 ..... Page 48

Note: Equipment is shared with other modules and may be subject to scheduling constraints.

Each part is an independent setup guide for the recommended configurations. All configurations allow for visual observation. However, there may be some limitations for photography:

**Visual Astronomy:** This is strictly eyepiece-only visual observation

- Best configuration: Telescope-in-a-box Model 2005Mk3
- Best configuration: Vixen R130sf/Porta II
- Good configuration: Celestron Nexstar 5SE
- Ok configuration: SmartEQ Pro+/WO Z73II (complicated to setup, poor light gathering area)

**Planetary/Lunar/Solar Imaging:** This requires the use of a webcam

- Best configuration: Celestron Nexstar 5SE
- Ok configuration: SmartEQ Pro+/WO Z73II(limited resolution)
- Ok configuration: Telescope-in-a-box Model 2005Mk3 (requires manual tracking, no solar imaging)
- Suboptimal configuration: Vixen R130sf/Porta II (requires manual tracking)

**Deep Sky Imaging:** This requires the use of a DSLR

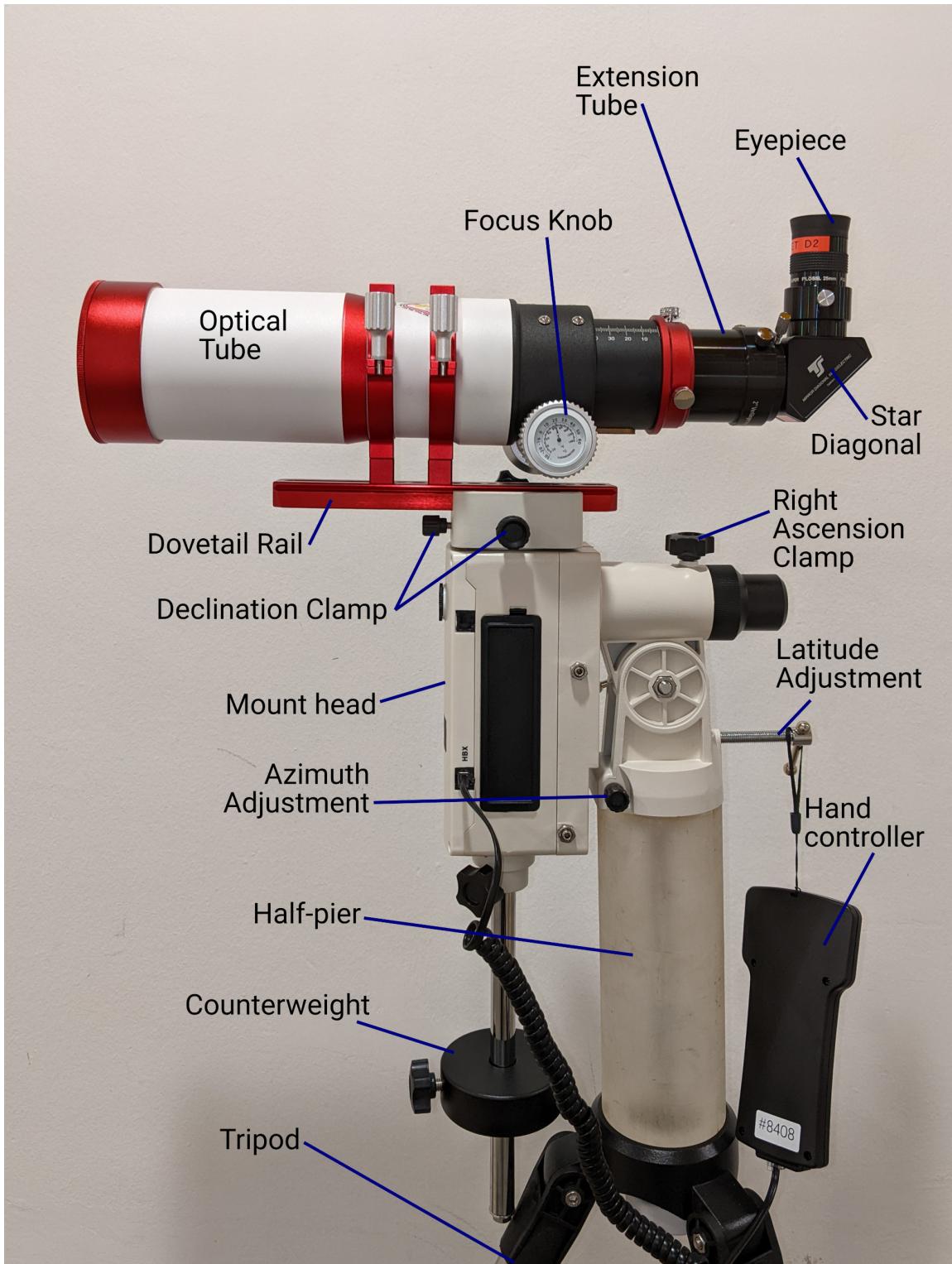
- Best configuration: SmartEQ Pro+/WO Z73II
- Ok configuration: Celestron Nexstar 5SE (will have field rotation)
- Suboptimal configuration: Vixen R130sf/Porta II (requires manual tracking)

**Slitless Spectroscopy:** This requires the use of a grating and camera

- Good configuration: Celestron Nexstar 5SE (will have field rotation)
- Good configuration: SmartEQ Pro+/WO Z73II
- Ok configuration: Vixen R130sf/Porta II (requires manual tracking)

# I The iOptron SmartEQ Pro+ with the William Optics Z73II

## 1 Parts of the Telescope and Mount



The parts and setup procedures will differ slightly from the instructions in the telescope and mount manual because we have made some modifications to the setup for efficiency and geographical location.

## 1.1 The Hand Controller



**MENU Key** Press “MENU” to enter the Main Menu.

**BACK Key** Move back to the previous screen, or end/cancel current operation, such as slew-ing.

**ENTER Key** Confirm an input, go to the next menu, select a choice, or slew the telescope to a selected object.

**Arrow ( $\blacktriangle\triangledown\blacktriangleleft\blacktriangleright$ ) Keys** The arrow keys are used to control the movement of DEC and R.A. axes. Press and hold  $\blacktriangle$ (DEC+), $\blacktriangledown$ (DEC-) buttons to move a telescope along the DEC direction,  $\blacktriangleleft$ (R.A.+),  $\blacktriangleright$ (R.A.-) to move a telescope along the RA direction. They are also used to browse the menu or move the cursor while in the menu. Hold down an arrow key for a fast scrolling.

**Number Keys** Input numerical values. Also used to adjust slewing speeds (1: 1X; 2: 2X; 3: 8X; 4: 16X; 5: 64X; 6: 128X; 7: 256X; 8: 512X; 9: MAX)

**? Key** Identify and display nearby bright stars or objects where the telescope is pointing to.

**0 Key** Stop the mount during GOTO. Also starts and stops tracking.

**HBX (Handbox) port** Connect the hand controller to the SmartEQ mount using a 6 pin 4 wire (6P4C) RJ11 plug.

**Serial port** Connect the hand controller to a computer for remote control.

## 2 Telescope Manuals

- [https://www.ioptron.com/v/Manuals/3200\\_SmartEQProPlus\\_Manual.pdf](https://www.ioptron.com/v/Manuals/3200_SmartEQProPlus_Manual.pdf)

### 3 Basic Setup Instructions

This is a detailed and illustrated step-by-step list of instructions on how to set up the mount.

- 1.** Completely uncoil the power cable from power strip and plug it in. Make sure that your power strip is placed a safe distance from an adjacent group. This marks your tripod setup location. It is **important** that you do this step first or you may not get power.
- 2.** Unfold the tripod and set it up *on top of the power strip*. **Do not extend the tripod legs.**

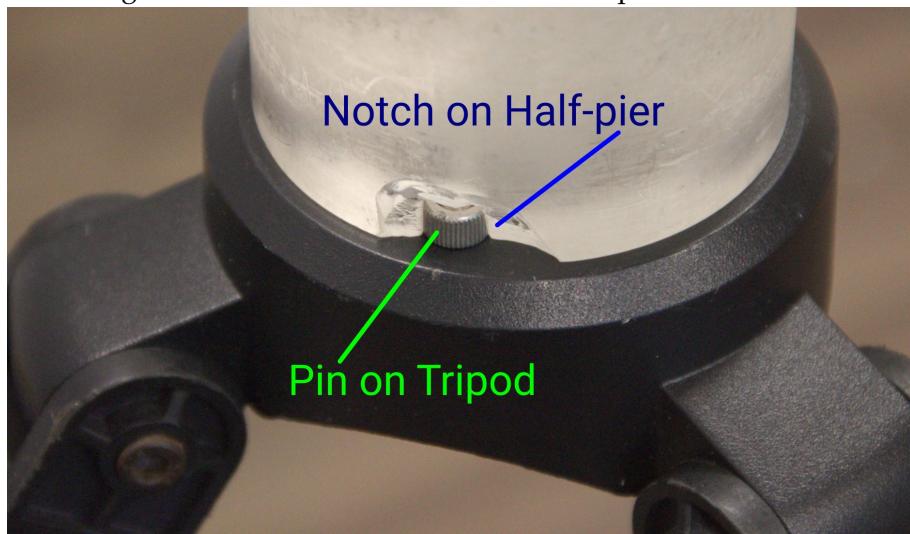


- 3.** Install the accessory tray on the spreader of the tripod, and lock it in place.

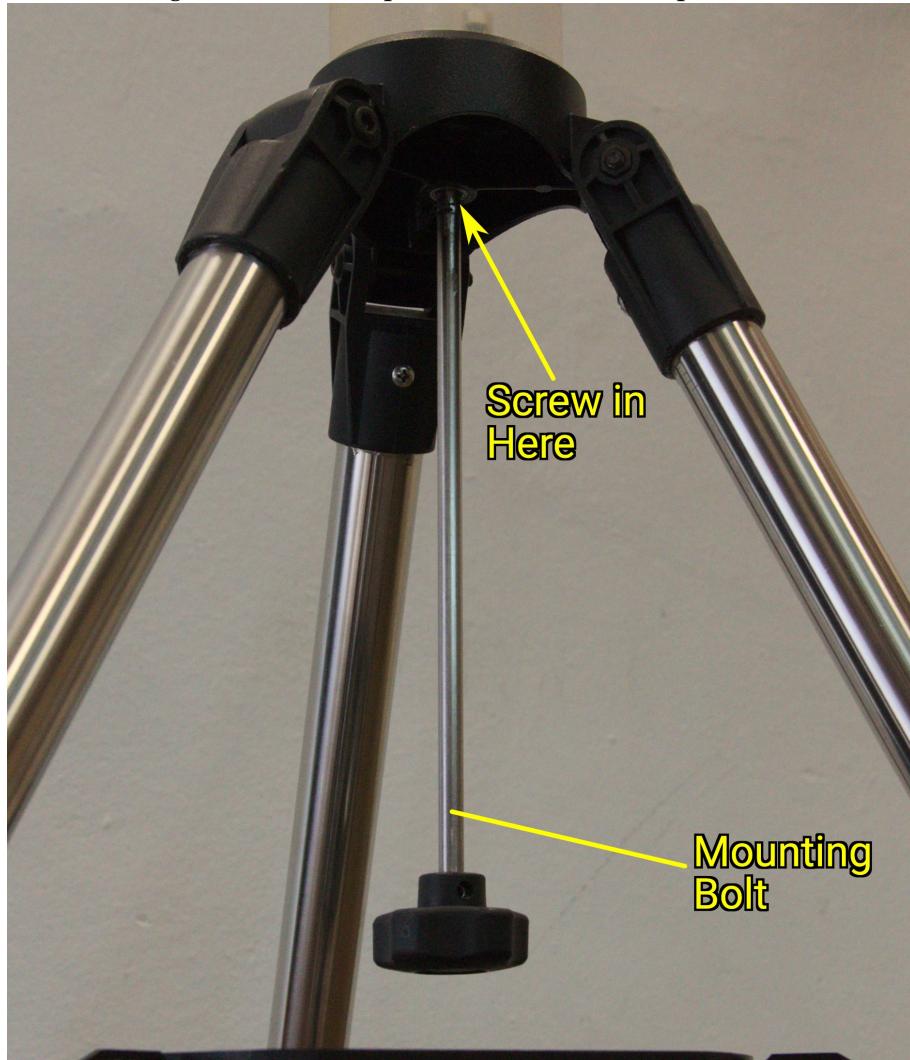


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

4. Install the half-pier on the top of the tripod, and make sure that the pin on the top of the tripod goes in the alignment hole on the bottom of the half-pier.

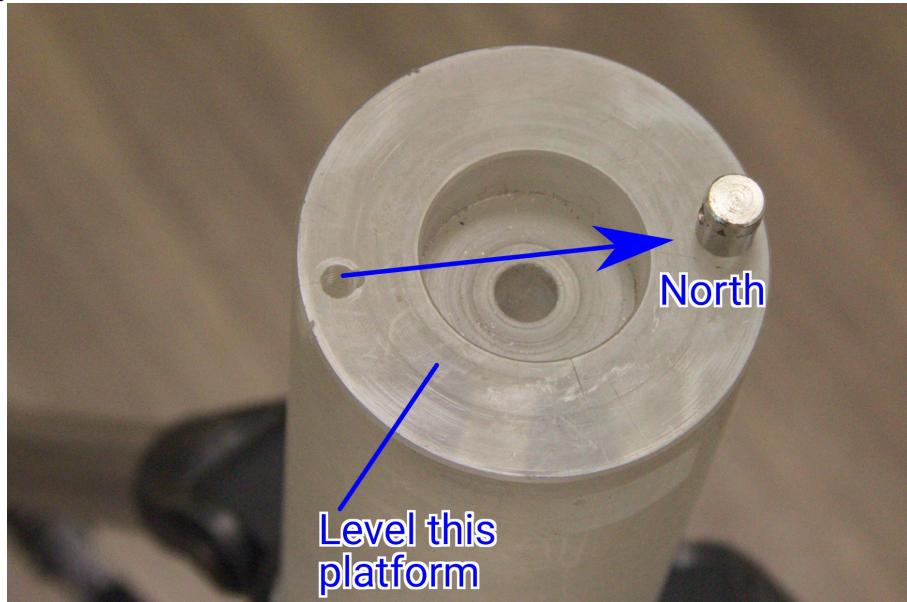


5. Screw the mounting bolt into the tripod from the bottom up.

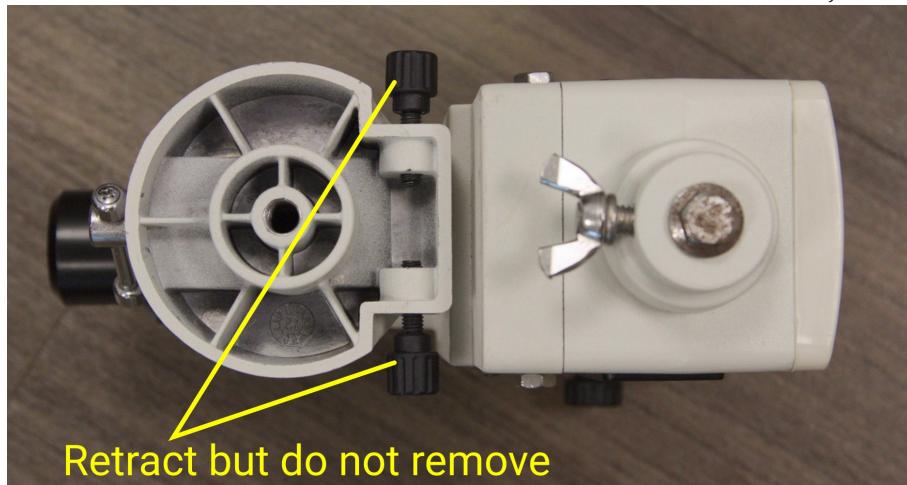


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

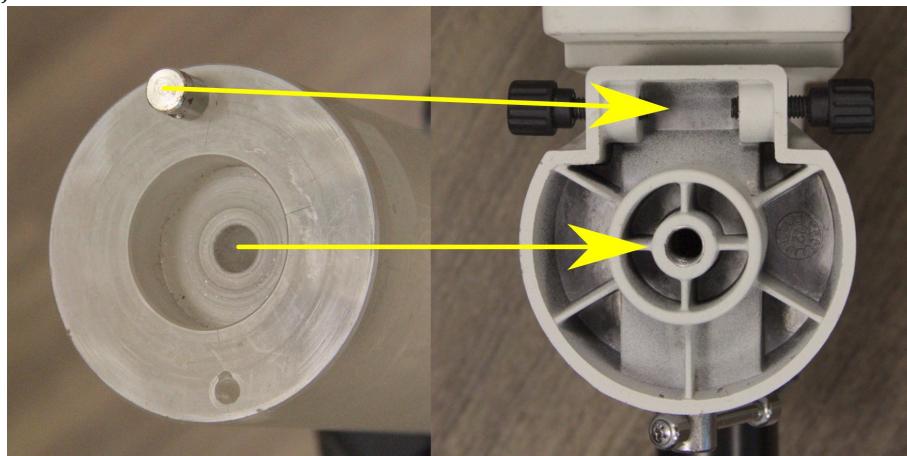
6. Turn the tripod such that the alignment pin on the top of the half-pier faces North (Use a compass). Place a bubble level on the top of the half-pier and adjust the legs such that the top of the half-pier is level.



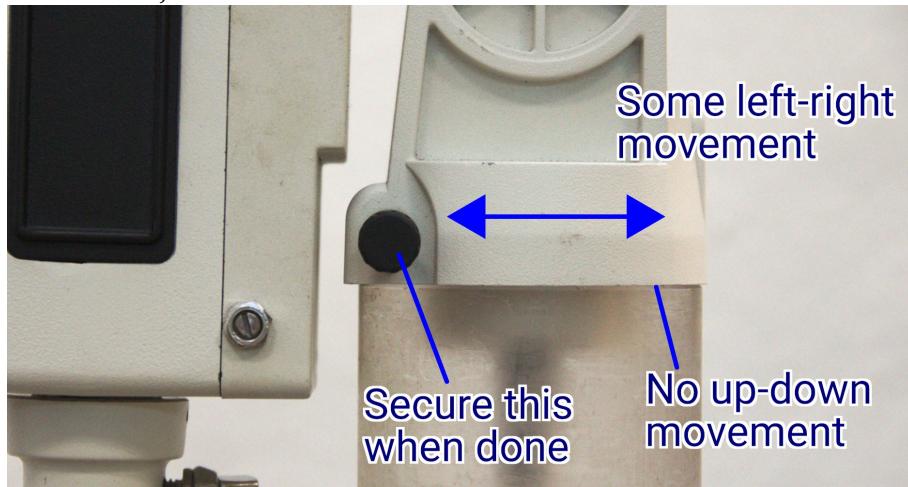
7. Unpack the mount head and retract but do not remove the azimuth adjustment screws.



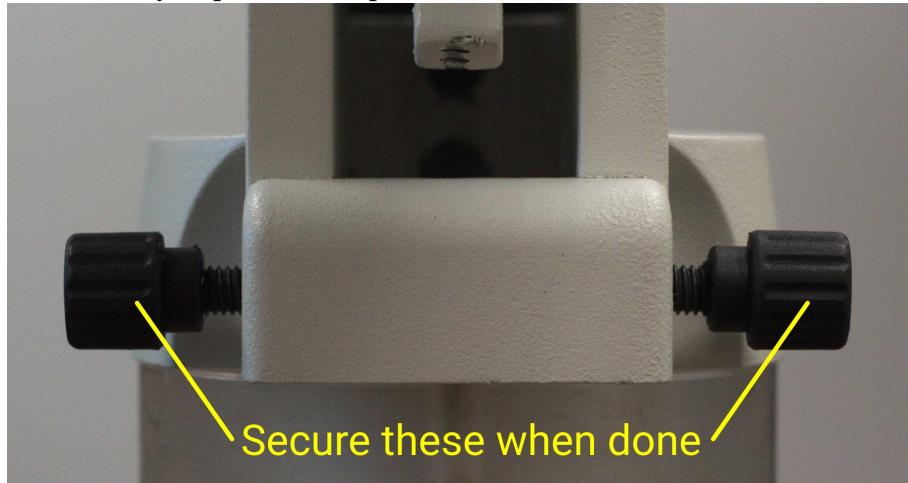
8. Place the mount head on top of the half-pier such that the alignment pin is between the azimuth adjustment screws.



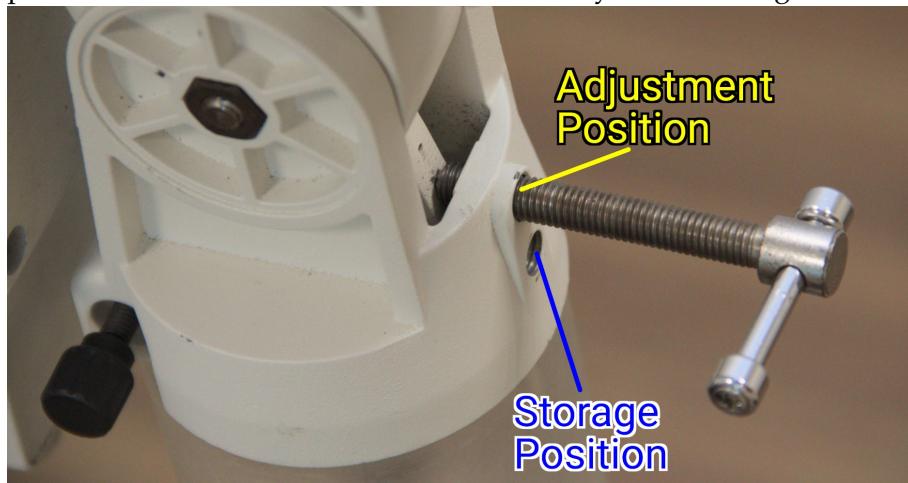
- 9.** Screw in the mounting bolt to secure the mount head to the half-pier. Tighten it enough that the mount head has no up-down movement but allow some side-to-side movement of the mount head for later adjustment.



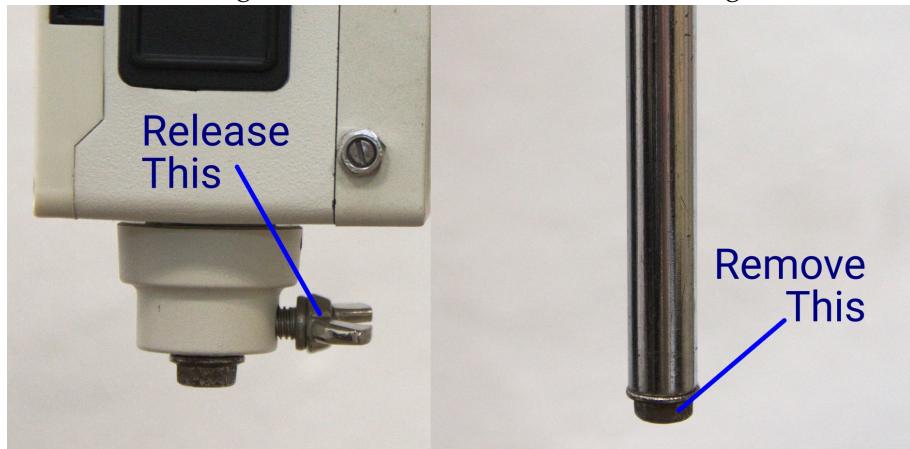
- 10.** Then secure the azimuth adjustment screws. This keeps the mount head steady so that it does not move when you put on the optics.



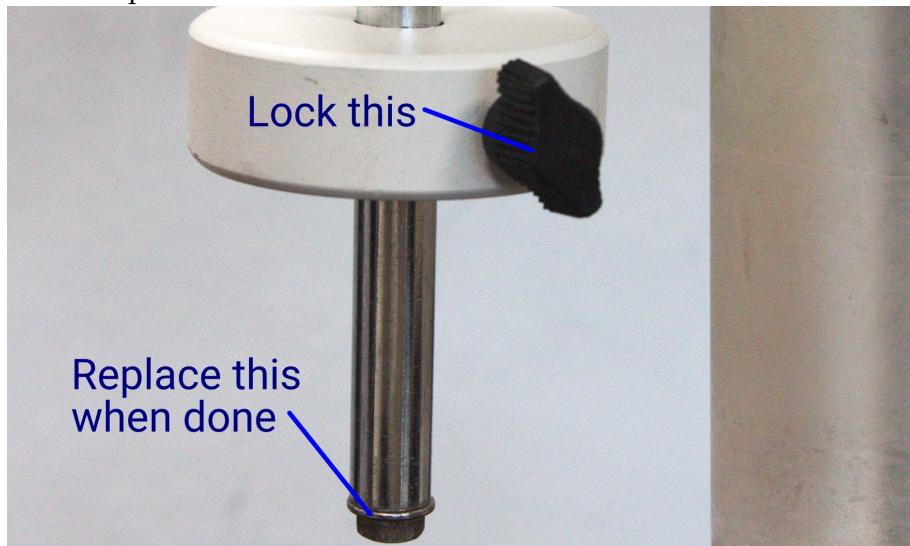
- 11.** Move the the latitude adjustment screw from the lower storage position to the upper adjustment position and set the latitude to the latitude of your observing site.



- 12.** Release the counterweight shaft lock and remove the retaining bolt.

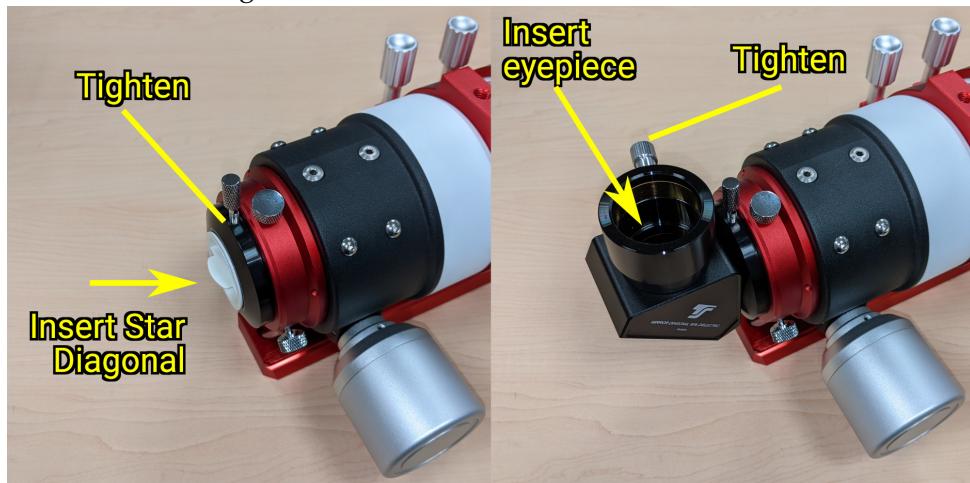


- 13.** Slide a counterweight onto the counterweight shaft and tighten it. If you are using a heavier setup (guidescope or a heavy camera), you may need a second counterweight. Put back the retaining bolt so that the counterweight will not fall off the shaft. Lock the counterweight shaft in the retracted position.



- 14.** If you are attaching a camera, skip this step and use the instructions in section 3.2 instead.

Attach the star diagonal to the back end and secure it with the lock screw. Then attach the 26 mm eyepiece to the star diagonal.



**15.** This step is optional if you already know the balance point. Alternatively, you may perform this step in advance and mark out the balance point prior to setting up.

Attach all accessories that go on the optical tube (replace the eyepiece with a camera if you plan to use a camera most of the session). Then place the optical tube (black rail down) on a pencil. Make sure that the pencil is on a stable, flat surface like a table.



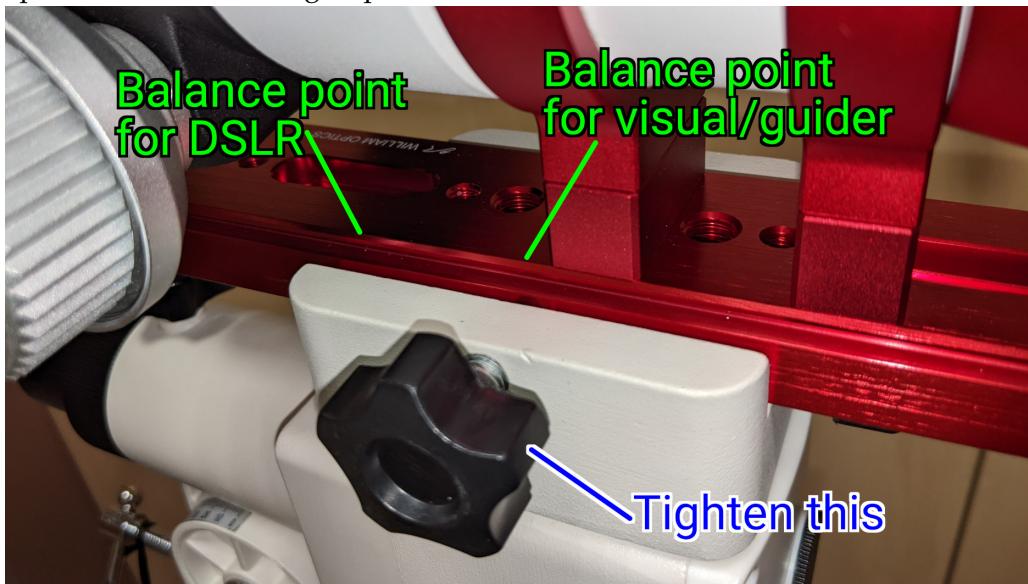
Then move the rail along the pencil until you can locate a point where the optical tube feels balanced. The final position of the pencil is the balance point.

**16.** Release the dovetail clamp on the mount platform but do not remove it. Ensure that all other clamps on the mount are tightened.



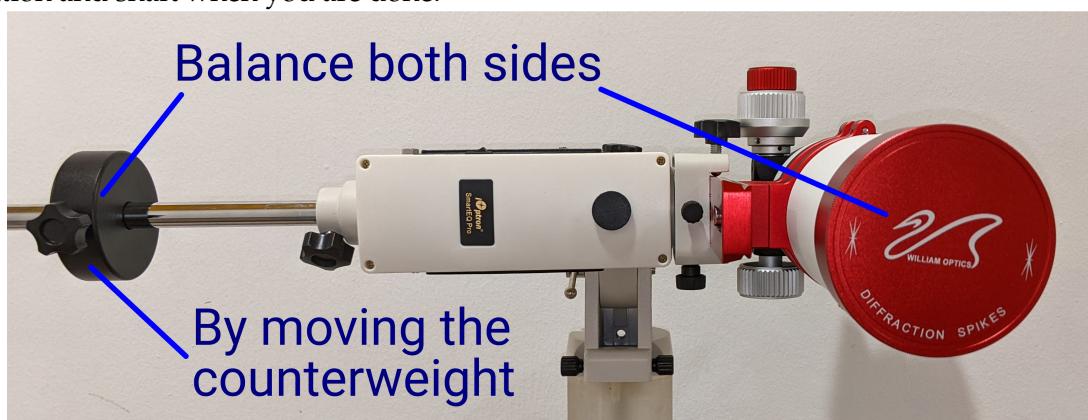
- 17.** Slide the optical tube on the mount. Tighten the dovetail clamp to lock the optical tube onto the mount head.

The position where the dovetail clamp screw touches the black rail on the optical tube should be at the centre of gravity (balance point) of the observing setup. For visual observing (eyepiece), this is at the back of the rear mounting plate. For a midrange DSLR without the guider, this is a few cm behind the rear mounting plate. For all other setups, you should find out the balance point beforehand using step 15.

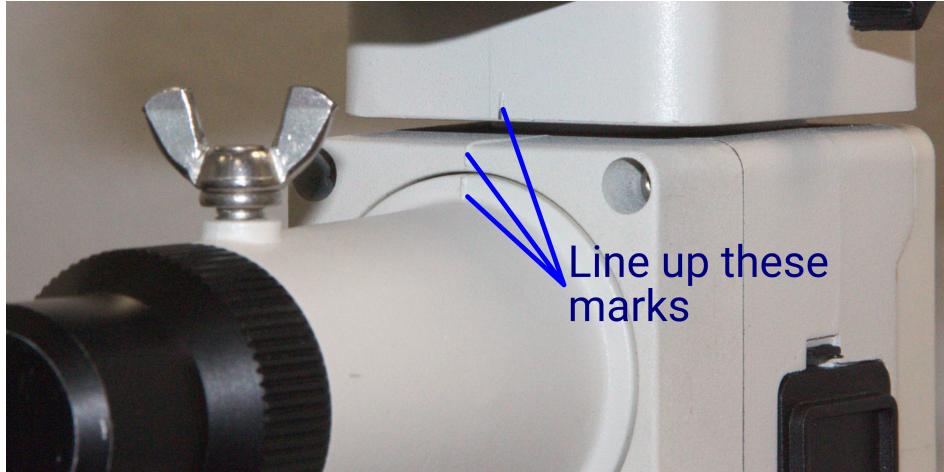


- 18.** Attach all accessories that go on the optical tube. This includes a finder or guider if you plan to use one, and a star diagonal and eyepiece or a camera (depending on observing plan). At this point you want the weight of the optical tube section to be as close to your observing configuration before you start to balance it.

- 19.** Release the right ascension clamp and adjust the counterweight position such that the counterweight can balance the weight of the optical tube accessories. The balance does not need to be perfect, but try to balance as best as you can. However, the mount is known to have tracking problems if the right ascension axis is not properly balanced. Lock the counterweight position and shaft when you are done.



- 20.** Release the axis clamps and manually bring both axes to the zero position by lining up the marks on the mount. Tighten all clamps after that. You should try to tighten the right ascension clamp as much as possible.



- 21.** Connect the power supply to the mount and plug it in to the power strip.  
**22.** Connect the hand controller to the mount on the port marked HBX.

If you have followed all the steps correctly, the mount should be correctly set up and approximately polar aligned.

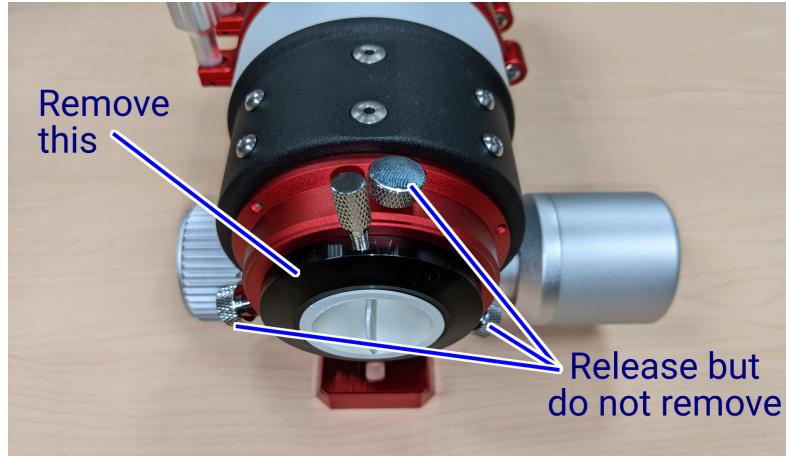
### 3.1 During Observing

- While observing, keep the cover on the main box and keep the tripod bag neatly folded up. This will prevent unexpected surprises from getting into the boxes.
- Place the main box reasonably close to the tripod, or with your group. You may use this as a makeshift table for your laptop.

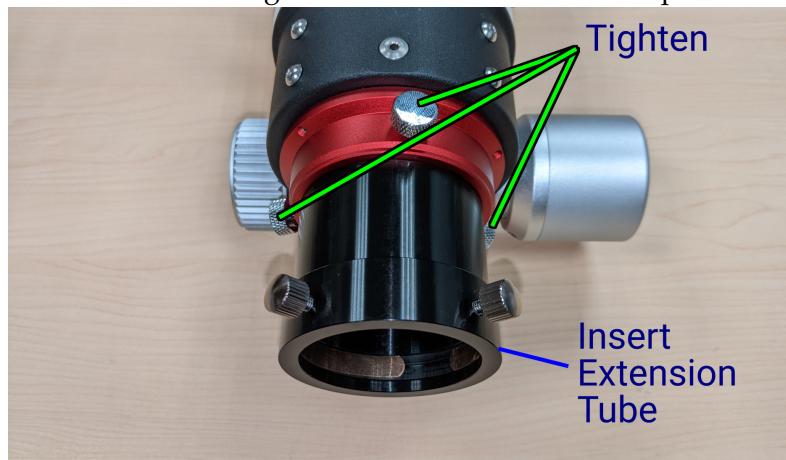
### 3.2 Attaching a Camera

To attach a DSLR or an interchangeable lens camera, you will need an appropriate T-ring for the camera. This will generally depend on the brand and model of the camera. The instructions here apply for most cameras (excluding webcams and the TinyMOS Tiny1).

- 1.** Remove the 2"-1.25" adaptor from the end of the focuser by releasing the two screws on top (do NOT remove these screws). Place the 2"-1.25" adaptor in the optics box when not in use.



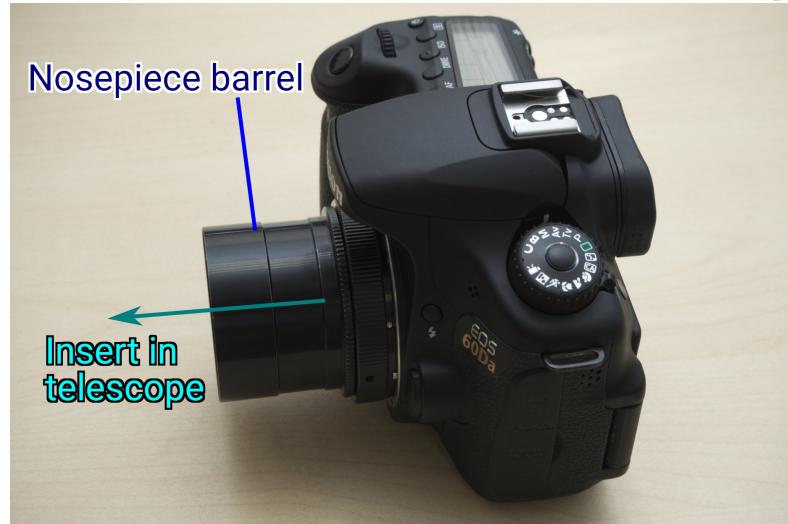
- 2.** Insert the extension tube and tighten the screws on the telescope side



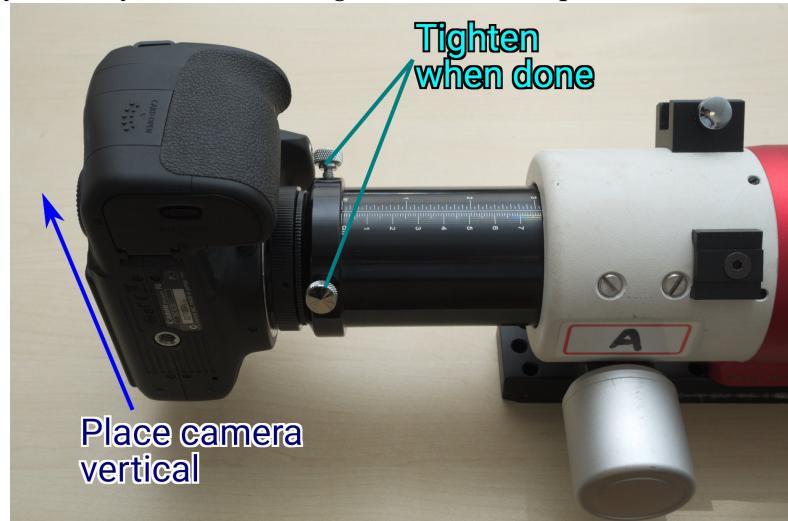
- 3.** Screw on the T-ring to the 2"-T adaptor



4. Remove the lens from the camera. Then attach the camera to the T-adaptor assembly.



5. Attach the camera to the focuser like an eyepiece. It is recommended that you orient the camera vertically so that you can see along the side of the optical tube for boresighting.



The telescope-camera connection is a passive mechanical connection. This means the camera will not recognise any lens, and **cannot autofocus**. The f-stop is fixed at f/5.9 for the William Optics Z73 and will not be recorded in your pictures.

- Some Sony cameras must be set to release the shutter without a lens.
- Nikon cameras will only function in manual (M) mode.

## 4 Align the mount

Now that the mount is set up, you may further align the mount. The first step is to use the mount's internal database to improve your approximate polar alignment.

### 4.1 GOTO Alignment

The iOptron SmartEQ Pro+ (and other modern telescope mounts) have a computer-controlled finding procedure known as GOTO. However, this is not always perfect, and requires that your initial polar alignment is reasonably close to correct. The GOTO system has been known

to fail (sometimes in the middle of observing), in which case you will have to fall back on the traditional finding chart. For the purposes of this module, you may use the GOTO system, but you should still prepare your finding charts and instructions. **Do not solely rely on the GOTO system for finding objects! It is not perfect.**

**You should only proceed with GOTO alignment when you are confident in setting up the mount.**

To setup the telescope for GOTO operation,

1. You will need to ensure that the mount is approximately polar aligned – You will want to make sure that you are approximately facing the correct direction.
  - Also ensure that **both axes are at zero position** (see step 20). This starts the mount from a known position from which the system takes its reference.
  - Reset the mount by turning off power, then turning it on.
2. Make sure that all the axis clamps are locked down tight. If you release any axis or if the mount slips, the controller will have to be aligned again. *All subsequent movement must done using the motors:*
  - The arrow buttons move the mount.
  - The number buttons control the speed (1: slowest, 9: fastest).
  - The '0' button starts and stops tracking and movement.
  - The '?' button tells you what the mount thinks it is pointing to.

When the mount is moving, be sure to watch it. **DO NOT let any part of the optical tube, dovetail rail or counterweight assembly hit the half-pier or tripod.** Stop the slew or switch off the mount if you have to.

3. Set up time and location: You need to manually enter the time and site information before the mount can precisely go to an object.
  - Press MENU button, from the main menu, scroll down and select "Set Up Controller"
  - Select "Set Up Time and Site"
  - Set time:  
Use the ▲ or ▼ key to move the cursor and use number keys to change the numbers.  
Use the ▲ or ▼ button to set "N" for no Daylight Saving Time. Hold on the arrow key to fast forward or rewind the cursor.  
Press ▲ or ▼ key to move to the second line and enter the local time zone (480 Min. ahead of UT for Singapore).
  - Set location: The bottom two lines display the longitude and latitude coordinates, respectively. "W/E" means western/eastern hemisphere; "N/S" means northern/southern hemisphere; "d" means degree; "m" means minute; and "s" means second.

The coordinates of our observing sites are as follows:

**NUS Field:** E103d46m46s N01d17m54s Northern

**Frontier Green:** E103d46m51s N01d17m47s Northern

**Engineering Bridge:** E103d46m23s N01d17m51s Northern

**U-Town Green:** E103d46m23s N01d18m18s Northern

For other locations, get the coordinates from a suitable GPS app.

Press ▲ or ▼ key to move the cursor and using ▲ or ▼ key to toggle between "W" and "E", "N" and "S", using number key to change the numbers.

- If the polar axis is aligned to North Celestial Pole, then set the mount to Northern Hemisphere. If the polar axis is pointing to South Celestial Pole, set the mount to Southern Hemisphere. Press **◀** or **▶** key to move the cursor and using **▲** or **▼** key to toggle between “Northern Hemisphere” and “Southern Hemisphere”.
  - **Your time and location must be set correctly of the GOTO system will not work.**
4. Now that the mount is set up, you can tell it to go to something.
    - Press MENU and select “Select and Slew”.
    - Select a naked-eye star and press ENTER. The telescope will slew to it.
    - If you have done drift alignment, the telescope should be quite accurate as long as the clamps are tight enough. If not, it will most likely be off.
  5. After slewing, the mount should be close to your selected star. We can now improve your polar alignment.
    - If the date, time and location is correctly set, the telescope should be pointing in the general direction of the selected star.
    - Get the star in the centre of the eyepiece (boresight if you have to) by adjusting the *latitude and azimuth adjustment bolts*.
    - Once you have done this, the mount should be approximately polar aligned and the GOTO system should work as expected.
    - If the GOTO system does not work as expected, you have have centred on the wrong star. Reset the mount and try again with a different star.

A mount that has been set up correctly will track better. **Do not unclamp the RA or Dec once the GOTO system has been set up.**

**Do not rely on the GOTO system for finding objects!**  
It is not perfect and has been known to fail.

Following the GOTO alignment, there are two further methods of alignment which have their pros and cons, and complement each other. **In many cases, you may not need to perform these procedures.**

**3-star alignment** This is a procedure that aligns the mount’s internal computer to correct for slight inaccuracies in the setup. It is NOT perfect, and it is known to fail. In particular, it requires a reasonably good initial polar alignment. **You will need at least 2-3 widely-spaced bright stars to do this.**

**Drift alignment** This is a manual alignment method and will take some time, practice and patience. This also requires rather good skies because of its requirement for alignment stars. **You will need a number of alignment stars on the celestial equator to do drift alignment.** Drift alignment can also be followed by 3-star alignment to help the mount track better.

**The alignment procedures here are optional, especially if you are observing only naked-eye objects visually or by webcam.**

## 4.2 3-Star Alignment

The 3-star alignment procedure aligns the mount to the sky using 3 or more reference stars. This can sometimes (but not always!) compensate for small errors in polar alignment, but is no substitute for drift alignment.

If you have time, you can do a 3-star alignment for better tracking. The time and site setup gives the mount computer an approximate location, but a star alignment confirms the location.

**You are to skip 3-star alignment if any of the following applies**

- This is your first time observing and setting up the mount.
- Skies are not very good and you cannot find 3 widely-separated bright stars that you can boresight.
- **You are short of time.**

To do 3-star alignment,

- Make sure that the date, time and GPS location have been correctly entered in the hand controller.
- Press MENU and select “Alignment”.
- Select “Three Star Align” and follow the instructions on the hand controller.
- When selecting stars, try to select stars that are far apart. This is where the need for good weather comes in. **If half the sky is cloudy, you should not bother with 3-star alignment.**

**The three star align procedure should only be done in good weather or when you have time.** Skip doing three-star alignment unless you really need it or can spare the time.

### 4.3 Drift Alignment

*Drift alignment is an optional step* that allows you to adjust the mount for better alignment.

**You are to skip drift alignment if any of the following applies**

- This is your first time observing and setting up the mount.
- Skies are not very good and you cannot find enough stars on the celestial equator.
- **You are short of time.**
- **You are not doing long exposure imaging.**

To do drift alignment, you will need an eyepiece with crosshairs, or use virtual crosshairs on a live webcam video. Also ensure that the top of the pier is levelled before starting drift alignment.

1. **Initial setup:** Drift alignment must be done with only sidereal tracking, which is the initial mode that the mount starts in. If you have done 3-star alignment or used the sync function, switch off the mount to reset it, or clear the alignment data.

- To ensure that the mount is in sidereal mode, switch it off and on. Do not enter the date, time or location, and do not align it to any stars. Press the ‘0’ button to start or stop tracking.
- Find a star *near the meridian and celestial equator*. This can be any star as long as you can see it through the eyepiece or webcam view.
- Centre the star in the field of view using the hand controller.
- Slightly slew the telescope north (the objective should move towards the north celestial pole) and watch where the star drifts in the field of view. That direction is south.

- Slightly slew the telescope west (the objective should move towards the western horizon) and watch where the star drifts in the field of view. That direction is east.
- Keeping the star in the FOV, rotate the crosshairs so that a crosshair is aligned with the east-west direction, then secure it. It may help to move the telescope back and forth along the east-west direction.

**2. Adjust the azimuth position:**

- Place the star on the east-west crosshair and watch where it drifts with only sidereal tracking on. If the mount is not perfectly polar aligned, there will be a slow drift in the north-south position.
- Adjust the azimuth position of the mount until the star does not drift off the crosshairs. To do this, slightly release the appropriate azimuth adjustment screw and turn the mount head in the correct direction.
  - If the star drifts south, move the mount towards the west.
  - If the star drifts north, move the mount towards the east.
- Slew the telescope to get the star back on the crosshairs and repeat these steps until you cannot detect a drift for about 30 seconds.

**3. Adjust the altitude position:**

- Make sure that the latitude position is unlocked and the mount rests on the latitude adjustment screw.
- Find and slew to a star on the celestial equator *close to the horizon*. This part is to adjust the altitude position.
- Place the star on the east-west crosshair and watch where it drifts with only sidereal tracking on. If the mount is not perfectly polar aligned, there will be a slow drift in the north-south position.
- Adjust the latitude position of the mount using the latitude adjustment screw until the star does not drift off the crosshairs.
  - If the star is in the west and it drifts south, move the mount down.
  - If the star is in the west and it drifts north, move the mount up.
  - If the star is in the east and it drifts south, move the mount up.
  - If the star is in the east and it drifts north, move the mount down.
- Slew the telescope to get the star back on the crosshairs. Repeat these steps until you cannot detect a drift for about 30 seconds.

**4. Finalize the alignment:**

- Secure the azimuth alignment screws by lightly turning until you meet resistance. Do not over-tighten the screws. Tighten the mounting bolt if you have to.
- Secure the latitude position by locking the latitude position on the side of the mount head.
- Finally, reinitialize the GOTO system by switching off the mount and manually moving it to the zero position. You can then follow up with a 3 star alignment.

**Drift alignment should only be done in good weather or when you have time.** Skip doing drift alignment unless you really need it or can spare the time.

## 5 PC Control

The GOTO system can also be controlled by suitable software on a laptop. In this mode, you can select and slew to objects directly from your laptop. The hand controller is still required,

as it translates the RA and Dec positions into the low level motor control commands that are required to move the telescope.

PC control should only be done when you are confident of your alignment.  
**Do not use PC control if this is your first time setting up the mount.**

Before connecting the hand controller to a laptop,

- Ensure that the mount's internal date, time and location are correct.
- Perform any of the following: GOTO alignment, 3-star alignment or drift alignment.
- Connect the hand controller to the laptop using the serial cable and the USB adaptor.

The steps to get PC control working will vary with operating system and are highly specific to the operating system and software. The following instructions are only a suggestion of the possible software packages that you could use.

## 5.1 Windows

You will need the following software:

- The ASCOM platform with drivers for the iOptron 8408 (SmartEQ Pro+/CEM25) hand controller
- A planetarium software package that is compatible with ASCOM, such as SkyChart or World Wide Telescope.

To control the iOptron SmartEQ Pro from a Windows version of Stellarium, you will need to use the INDI server for Windows (<http://www.cloudmakers.eu/windi/>) to translate ASCOM commands to a form that Stellarium can understand.

## 5.2 MacOS X

You will need the following software:

- A sufficiently recent version of the INDIGO libraries and servers.
- A suitable INDIGO or INDI client such as stellarium, kstars or xephem.
- Your user should have write access to the serial port from the USB adaptor.

The software may be downloaded from <http://indigo-astronomy.org/downloads.html>

## 5.3 Linux

You will need the following software:

- A sufficiently recent version of the INDI libraries and servers.
- A suitable INDI client such as stellarium, kstars or xephem.
- Your user should be a member of the dialout group or have write access to the serial port from the USB adaptor.

## 6 Packing Up

Before packing up, ensure that

- All boxes are dry and clean.
- All dust caps and plugs are present and accounted for.
- All screws, nuts and bolts are present and accounted for. In particular, make sure that you have the following:
  - The dovetail clamp screw
  - The right ascension lock hex key
  - The latitude adjustment bolt
  - The latitude lock nut
  - The counterweight shaft retaining bolt
  - The focuser lock screw (if applicable)
  - Eyepiece clamp screws from the optical tube, 2"-1.25" adaptor and star diagonal

When packing up, take note of the following:

- **All optical items must be covered by a dust plug and/or cap.**
- **Do not let grass, dirt, sand, insects or animals into the boxes or bags.**
- All wires must be neatly coiled. Keep electrical plugs stowed carefully.
- The dovetail bar of the optical tube must be stowed facing up.
- Place the optical accessories in a separate box from the non-optical accessories.
- The tripod and half-pier must be folded up neatly.

Before returning equipment,

- Make sure that all optical items are covered by a dust plug and/or cap.
- Ensure that there is no grass, dirt or sand in any of the boxes.
- **Points may be taken off if you return equipment that is uncovered or is missing dust caps or dust plugs, or if you return equipment with grass, dirt or sand in any of the boxes.**
- Ensure that all items are packed as seen in the examples.

### 6.1 Packing examples

The following pictures show how equipment should be packed. This is to minimise transport damage and to ensure that the equipment is easily carried around. The packing order is also designed to have the most-used items placed on top. A penalty may be applied to improperly packed equipment.

Tripod bundle:



NOTE: Place the mounting bolt in the half-pier. The counterweights are in the larger side compartment, the power adaptor is in the smaller side compartment

## SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

Accessories box:



NOTE: The hand controller cable is under the hand controller. **Do not coil the hand controller cable around the hand controller.**

Main box:



NOTE: The accessories box is placed on top of the mount head.

## 7 Checklist

This is a list of all the parts present in the standard set.

In the tripod bag:

- Tripod (with index screw)
- Half-pier (with index pin)
- Mounting bolt
- Velcro strap for tripod
- 2 counterweights with lock screw
- 12V AC-DC adaptor

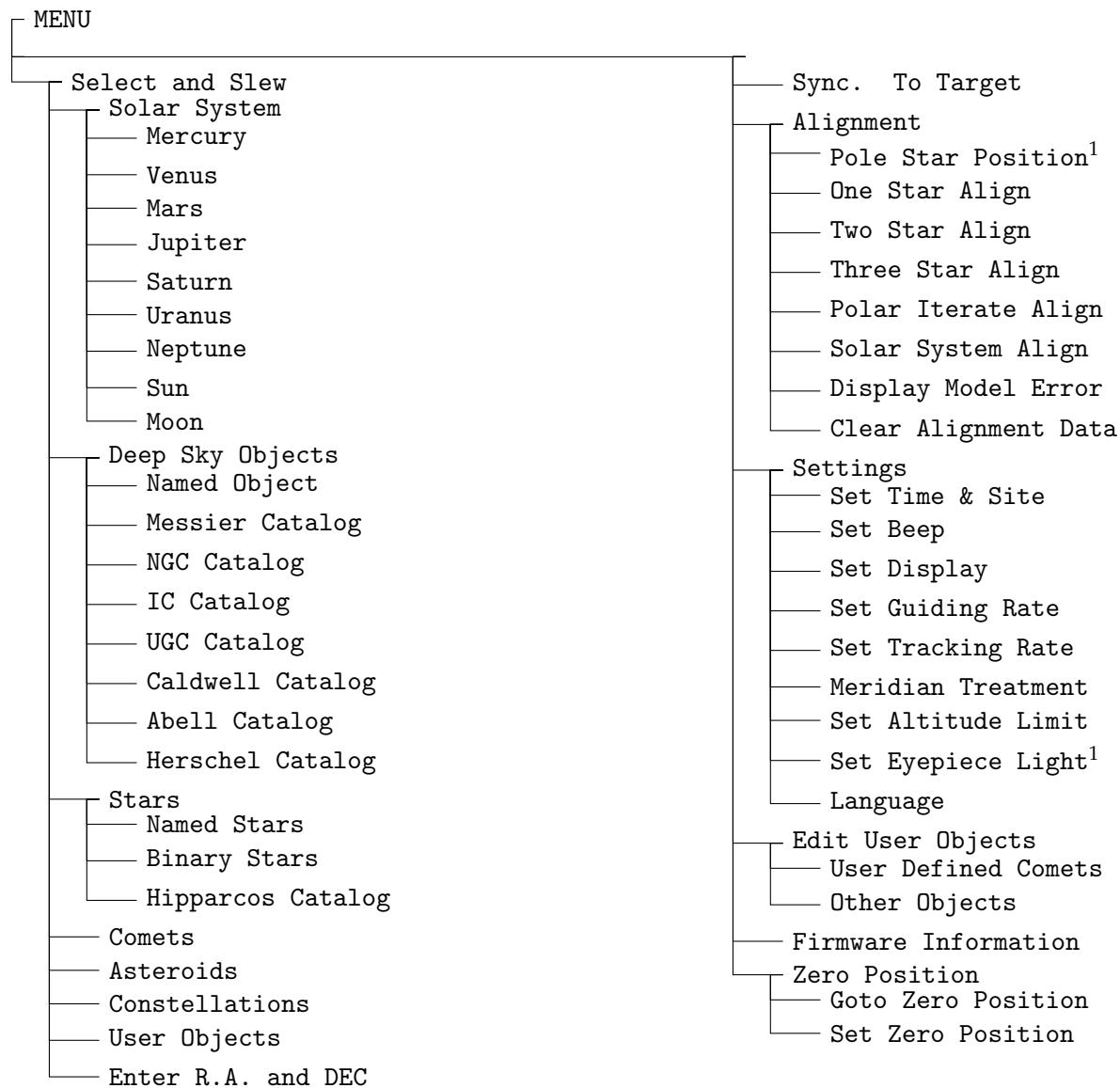
In the main box:

- Foam padding
- Eyepiece tray
- Optical tube assembly, consisting of
  - William Optics Z73 optical tube
  - Dovetail rail
  - 2"-1.25" eyepiece adaptor
  - 3 Eyepiece clamp screws (2 on main focuser body, 1 on eyepiece adaptor)
  - Focuser screw-on cap
  - Guidescope/Finderscope mounting screw
  - Telescope objective cover
  - Telescope Bahtinov mask cover (screw-on)
  - Telescope rear end cap (1.25", white)
- Mount head assembly, consisting of
  - iOptron SmartEQ Pro+ mount head
  - Polar scope cap
  - 2 Battery compartment covers (1 on each side)
  - Counterweight safety screw
  - Counterweight shaft lock screw
  - Dovetail clamp screw
  - 2 Declination lock screws
  - Right ascension lock screw
  - Latitude lock screw and nut
  - Latitude adjustment screw (in storage position)
  - 2 Azimuth adjustment screws (1 on each side)
- Accessories box, containing
  - 25mm Plössl eyepiece with 2 dust caps
  - Svбony 10mm UltraFlat eyepiece with 2 black dust caps
- Star diagonal with 2 dust caps and 1 lock screw
- 50 mm focuser extension tube
- T-mount to 2" adaptor
- Hand controller
- Hand controller cable

Additional special request items not placed with the main box:

- Autoguider set (ZWO), comprising of
  - 30 mm guidescope (with objective cover)
  - ASI120MM Mini Autoguider
  - USB A-C cable for autoguider
  - ST-4 cable for autoguider
  - Accessory mounting rail
  - T-mount to camera adaptor
  - Focuser lock screw
  - Polar Scope set

## 8 Hand Controller Menu Items




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<sup>1</sup>Not used in this class

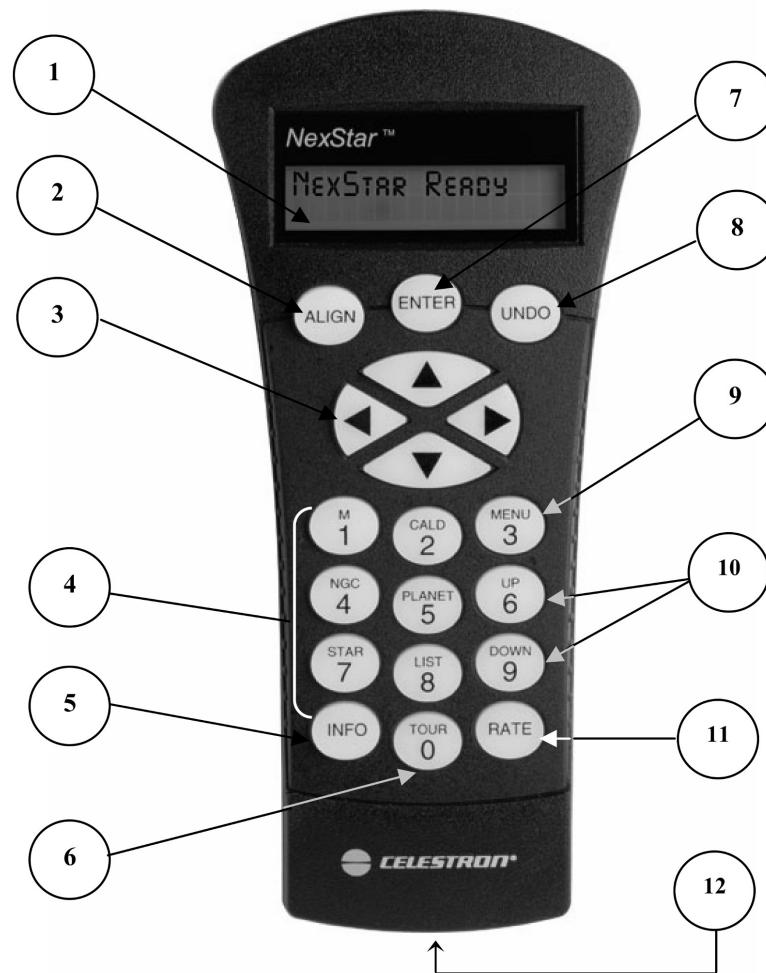
## II The Celestron Nexstar 5SE

### 1 Parts of the Telescope and Mount



The parts and setup procedures may differ slightly from the instructions in the telescope and mount manual because we have made some modifications to the setup for efficiency and geographical location.

## 1.1 The Hand Controller



1. **LCD Window:** Has a dual-line, 16 character display screen that is backlit for comfortable viewing of telescope information and scrolling text.
2. **Align:** Instructs the NexStar to use a selected star or object as an alignment position.
3. **Direction Keys:** Allows complete control of the NexStar in any direction. Use the direction keys to center objects in the eyepiece.
4. **Catalog Keys:** The NexStar has a key on the hand control to allow direct access to each of the catalogs in its 40,000 object database. The NexStar contains the following catalogs in its database:

**Messier** Complete list of all Messier objects.

**NGC** Select list of all the deep-sky objects in the Revised New General Catalog.

**Caldwell** A combination of the best NGC and IC objects.

**Planets** All 8 planets in our Solar System plus the Moon.

**Stars** A compiled list of the brightest stars from the SAO catalog.

**List** For quick access, all of the best and most popular objects in the NexStar database have been broken down into lists based on their type and/or common name:

**Named Stars** Common name listing of the brightest stars in the sky.

**Named Objects** Alphabetical listing of over 50 of the most popular deep sky objects.

**Double Stars** Numeric-alphabetical listing of the most visually stunning double, triple and quadruple stars in the sky.

**Variable Stars** Select list of the brightest variable stars with the shortest period of changing magnitude.

**Asterisms** A unique list of some of the most recognizable star patterns in the sky.

5. **Info:** Displays coordinates and useful information about objects selected from the NexStar database.
6. **Tour:** Activates the tour mode, which seeks out all the best objects for a given month and automatically slews the NexStar to those objects.
7. **Enter:** Pressing Enter allows you to select any of the NexStar functions, accept entered parameters and slew the telescope to displayed objects.
8. **Undo:** Undo will take you out of the current menu and display the previous level of the menu path. Press Undo repeatedly to get back to a main menu or use it to erase data entered by mistake.
9. **Menu:** Displays the many setup and utilities functions such as tracking rate and user defined objects and many others.
10. **Scroll Keys:** Used to scroll up and down within any of the menu lists. A double arrow symbol on the right side of the LCD indicates that the scroll keys can be used to view additional information.
11. **Rate:** Instantly changes the rate of speed of the motors when the direction buttons are pressed.
12. **USB Port:** Allows you to interface with a computer and control the NexStar remotely.

## 2 Telescope Manuals

- [https://s3.amazonaws.com/celestion-site-support-files/support\\_files/1152119805\\_11036manual.pdf](https://s3.amazonaws.com/celestion-site-support-files/support_files/1152119805_11036manual.pdf)

### 3 Basic Setup Instructions

This is a detailed and illustrated step-by-step list of instructions on how to set up the mount.

**1.** Completely uncoil the power cable from power strip and plug it in. Make sure that your power strip is placed a safe distance from an adjacent group. This marks your tripod setup location. It is **important** that you do this step first or you may not get power.

**2.** Unfold the tripod and set it up *on top of the power strip*. **Do not extend the tripod legs, do not raise the tilt plate.**



**3.** Install the spreader plate and lock it in place using the lock nut. **Ensure that the flat side of the plate is on top.**



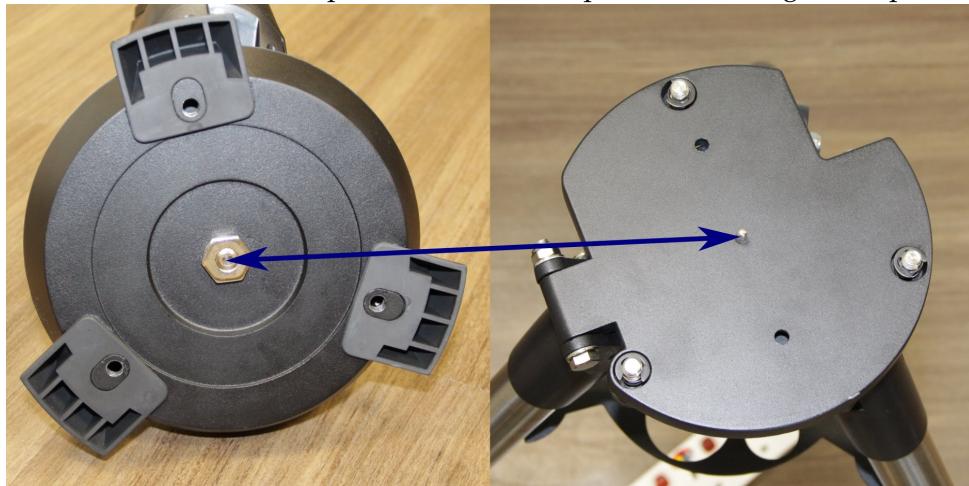
SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

4. Place a bubble level on top of the tripod and adjust the legs such that the platform is level.

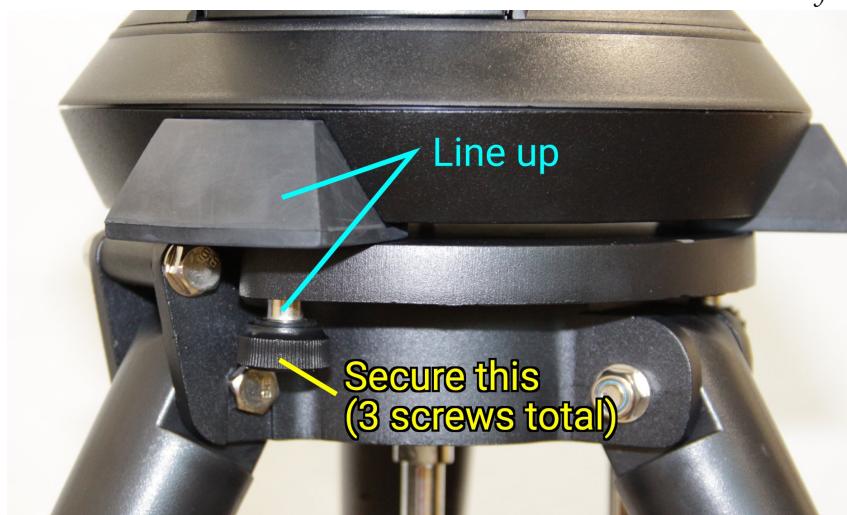


5. Before removing the mount from the case, check that the optical tube is securely attached to the mount. You do not need to remove it beforehand. Note that the objective cover or hand controller may fall off.

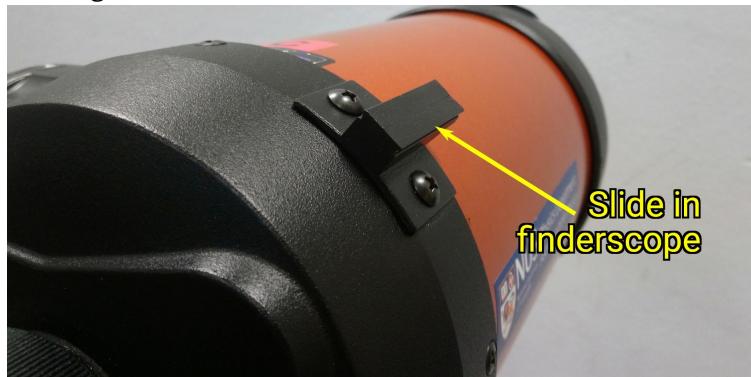
6. Place the mount head on the platform, and line up the central alignment pin.



7. Rotate the mount base such that the rubber legs are over the locking bolts. There may be a slight click as the screws engage the holes. Then secure the mount head to the tripod using the 3 mounting screws around the sides. *Ensure that all 3 screws do not move when you tap on them.*



- 8.** Attach the finderscope to the black attachment near the back of the optical tube. **Skip this step if you are observing the sun.**



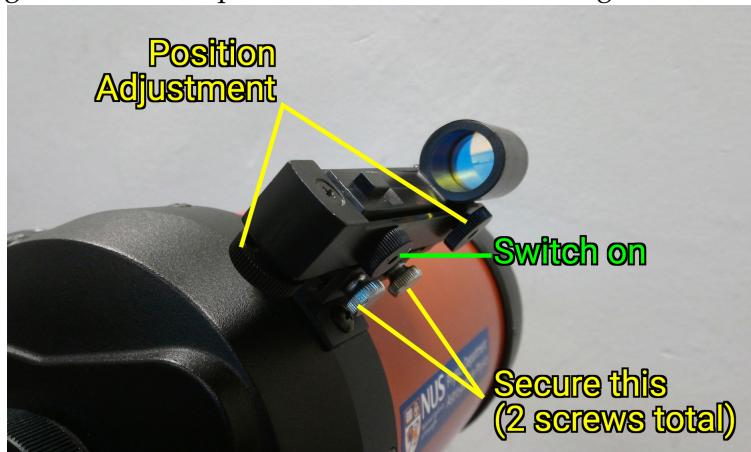
- 9.** If you are attaching a camera, skip this step and use the instructions in section 3.2 instead.

If you are attaching an eyepiece, attach the star diagonal to the visual back and secure it with the lock screw. Then attach the 25 mm eyepiece to the star diagonal. It is recommended to have the star diagonal pointing outwards.



- 10.** Connect the power supply to the mount and plug it in to the power strip. The mount does not require polar alignment. **However, the mount will not track until GOTO setup is completed** (see section 4.1).

- 11.** Turn on the finderscope. Boresight a faraway object at least 1 km away, or a star, moon or planet, and get the object centered in the main eyepiece. Then adjust the finderscope positioning screws to get the finderscope red dot centered on the target.



### 3.1 During Observing

- While observing, keep the telescope case closed and keep the tripod bag neatly folded up. This will prevent unexpected surprises from getting into the boxes.
- Place the main case reasonably close to the tripod, or with your group. You may use this as a makeshift table for your laptop.

### 3.2 Attaching a Camera

To attach a DSLR or an interchangeable lens camera, you will need an appropriate T-ring for the camera. This will generally depend on the brand and model of the camera. The instructions here apply for most cameras (excluding webcams and the TinyMOS Tiny1).

1. Remove the visual back from the end of the focuser by unscrewing the retaining ring at the bottom. Place the visual back in the optics section when not in use.



2. Screw on the T-ring to the SCT-T adaptor



- 3.** Screw on the SCT-T adaptor to the telescope by placing it on the SCT section and screwing on the retaining ring. Do not tighten the retaining ring, but leave it loose so that the T-ring can rotate.



- 4.** Remove the lens from the camera. Then attach the camera to the T-ring. You may have to turn the camera around to find the correct position.



- 5.** When the camera is securely mounted on the T-ring, turn the camera such that the focus knob is below the camera. Then tighten the retaining ring to lock the position of the camera.

- 6.** Note that you will need to refocus when attaching a camera. However, the focus position for a camera should be close to the focus position for an eyepiece *with the star diagonal*.

The telescope-camera connection is a passive mechanical connection. This means the camera will not recognise any lens, and **cannot autofocus**. The f-stop is fixed at f/10 for the Celestron Nexstar 5SE and will not be recorded in your pictures.

- Some Sony cameras must be set to release the shutter without a lens.
- Nikon cameras will only function in manual (M) mode.

## 4 Align the mount

Now that the mount is set up, you will need to align the mount using a reference star or planet.

### 4.1 GOTO Alignment

The Celestron Nexstar 5SE (and other modern telescope mounts) have computer-controlled motors required for 2-axis tracking. This needs to be set up by aligning the telescope to a celestial object and **a correctly set-up system is required for the telescope to track an object**. In addition, the telescope mount has a feature known as GOTO which may aid in finding objects. However, the GOTO system is not perfect and has been known to fail (sometimes in the middle of observing), in which case you will have to fall back on the traditional finding chart. For the purposes of this module, you may use the GOTO system, but you should still prepare your finding charts and instructions. **Do not solely rely on the GOTO system for finding objects! It is not perfect.**

To setup the telescope for tracking,

1. Identify a bright object, either a named star, a planet or the moon.
2. *All movement must done using the motors:*
  - The arrow buttons move the mount.
  - The 6 and 9 buttons control scrolling in the menus.
  - To set the movement speed, press the motor speed button (bottom right), then a number for the speed (1: slowest, 9: fastest).
  - Note that the controls may move in opposite directions for rates 7, 8 and 9

When the telescope is moving, be sure to watch it. **DO NOT let any part of the optical tube, camera or other accessories hit the mount base or tripod.** Stop the slew or switch off the mount if you have to.

3. Set up the controller:
  - Switch on the mount, and wait for the hand controller to start.
  - Select an alignment mode:
    - If your alignment object is a planet or the moon, select “Solar System Align”
    - If your alignment object is a named star, select “One-star Align”
    - **Do not use Skymount** (It is unlikely to work with Singapore’s light pollution)
  - The hand controller will display the location. Press enter if it is correct or undo to set the location. **A correct location is required for proper alignment.**

The coordinates of our observing sites are as follows:

**NUS Field:** E103d46m46s N01d17m54s Northern

**Frontier Green:** E103d46m51s N01d17m47s Northern

**Engineering Bridge:** E103d46m23s N01d17m51s Northern

**U-Town Green:** E103d46m23s N01d18m18s Northern

For other locations, get the coordinates from a suitable GPS app.

- Set the date and time. **A correct date and time is required for proper alignment. Also note that the date needs to be in MM/DD/YYYY format.**
- **Your time and location must be set correctly of the GOTO system will not work.**
- The SELECT STAR 1 or SELECT OBJECT message will appear in the top row of the display. Use the Up and Down scroll keys to select the star you wish to use for the first alignment star. Press ENTER.

When raising the telescope, ensure that both **the dovetail release knob and focuser knob are below**. The telescope will not track properly if either or both are on top.

- NexStar then asks you to center in the eyepiece the alignment star you selected. Boresight the alignment object. Press ENTER when you have found the object in the main eyepiece.
  - Then, bring the object to the centre of the main eyepiece. When doing so, **ensure that your final approach to the centre is done by using only the right and up buttons**. This is so that the gears can engage in a consistent way during alignment. When you are done press ALIGN.
  - Once in position, the NexStar will model the sky based on this information and display Align Successful.
4. Now that the mount is set up, you can tell it to go to something.
    - Choose a catalog from the buttons (M, CALD, NGC, PLANET, or STAR) and select an object. Press enter to slew to the object.
  5. After slewing, the mount should be close to your selected star. If it is off, you will have to manually slew to it (boresight if necessary).
  6. To improve GOTO accuracy, you have the following options:
    - Before slewing to a faint object, slew to and centre a *nearby* bright star in the eyepiece. Then press undo to get to the main menu. At the main menu, press align and select "sync" to update the telescope's position.
    - The precise goto feature ("Menu" → "Precise Goto") combines the sync step and the slew step.
    - You may add or replace an alignment star. Slew to and centre a bright star in the eyepiece. Then press UNDO to get to the main menu. At the main menu, press ALIGN and select "Alignment stars" to update the telescope's system. **Only replace alignment stars when necessary** (if you know you have made a mistake).

If the GOTO system does not work as expected, your alignment stars may be wrong. Reset the mount and try again with a different star. Note that a mount that has been set up correctly will track better.

**Do not rely on the GOTO system for finding objects!**  
It is not perfect and has been known to fail.

## 5 PC Control

The GOTO system can also be controlled by suitable software on a laptop. In this mode, you can select and slew to objects directly from your laptop. The hand controller is still required, as it translates the RA and Dec positions into the low level motor control commands that are required to move the telescope.

PC control should only be done when you are confident of your alignment.  
**Do not use PC control if this is your first time setting up the mount.**

Before connecting the hand controller to a laptop,

- Ensure that the mount's internal date, time and location are correct.

- Set up the mount with GOTO alignment.
- Connect the hand controller to the laptop using the serial cable and the USB adaptor.

The steps to get PC control working will vary with operating system and are highly specific to the operating system and software. The following instructions are only a suggestion of the possible software packages that you could use.

## 5.1 Windows

You will need the following software:

- The ASCOM platform with drivers for the Celestron Nexstar+ hand controller
- A planetarium software package that is compatible with ASCOM, such as SkyChart or World Wide Telescope.

Alternatively, you may control the Celestron Nexstar 5SE directly from Stellarium.

## 5.2 MacOS X

You will need the following software:

- A sufficiently recent version of the INDIGO libraries and servers.
- A suitable INDIGO or INDI client such as stellarium, kstars or xephem.
- Your user should have write access to the serial port from the USB interface.

The software may be downloaded from <http://indigo-astronomy.org/downloads.html>

Alternatively, you may control the Celestron Nexstar 5SE directly from Stellarium. For later versions of MacOS X, you may also need drivers for the USB interface (PL-2303).

## 5.3 Linux

You will need the following software:

- A sufficiently recent version of the INDI libraries and servers.
- A suitable INDI client such as stellarium, kstars or xephem.
- Your user should be a member of the dialout group or have write access to the serial port from the USB interface.

Alternatively, you may control the Celestron Nexstar 5SE directly from Stellarium.

## 6 Packing Up

Before packing up, ensure that

- All boxes are dry and clean.
- All dust caps and plugs are present and accounted for.
- All screws, nuts and bolts are present and accounted for. In particular, make sure that you have the eyepiece clamp screws from the optical tube and star diagonal.

When packing up, take note of the following:

- All optical items must be covered by a dust plug and/or cap.
- Do not let grass, dirt, sand, insects or animals into the boxes or bags.
- All wires must be neatly coiled. Keep electrical plugs stowed carefully.
- Place the optical accessories in a separate section from the non-optical accessories.
- The tripod must be folded up neatly.

Before returning equipment,

- Make sure that all optical items are covered by a dust plug and/or cap.
- Ensure that there is no grass, dirt or sand in any of the boxes.
- Points may be taken off if you return equipment that is uncovered or is missing dust caps or dust plugs, or if you return equipment with grass, dirt or sand in any of the boxes.
- Ensure that all items are packed as seen in the examples.

## 6.1 Packing examples

The following pictures show how equipment should be packed. This is to minimise transport damage and to ensure that the equipment is easily carried around. The packing order is also designed to have the most-used items placed on top. A penalty may be applied to improperly packed equipment.

Tripod bag:



## SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

Accessories:



Main section:



## 7 Checklist

This is a list of all the parts present in the standard set.

In the tripod bag:

- Tripod with spreader support nut
- Tripod spreader
- Velcro strap for tripod

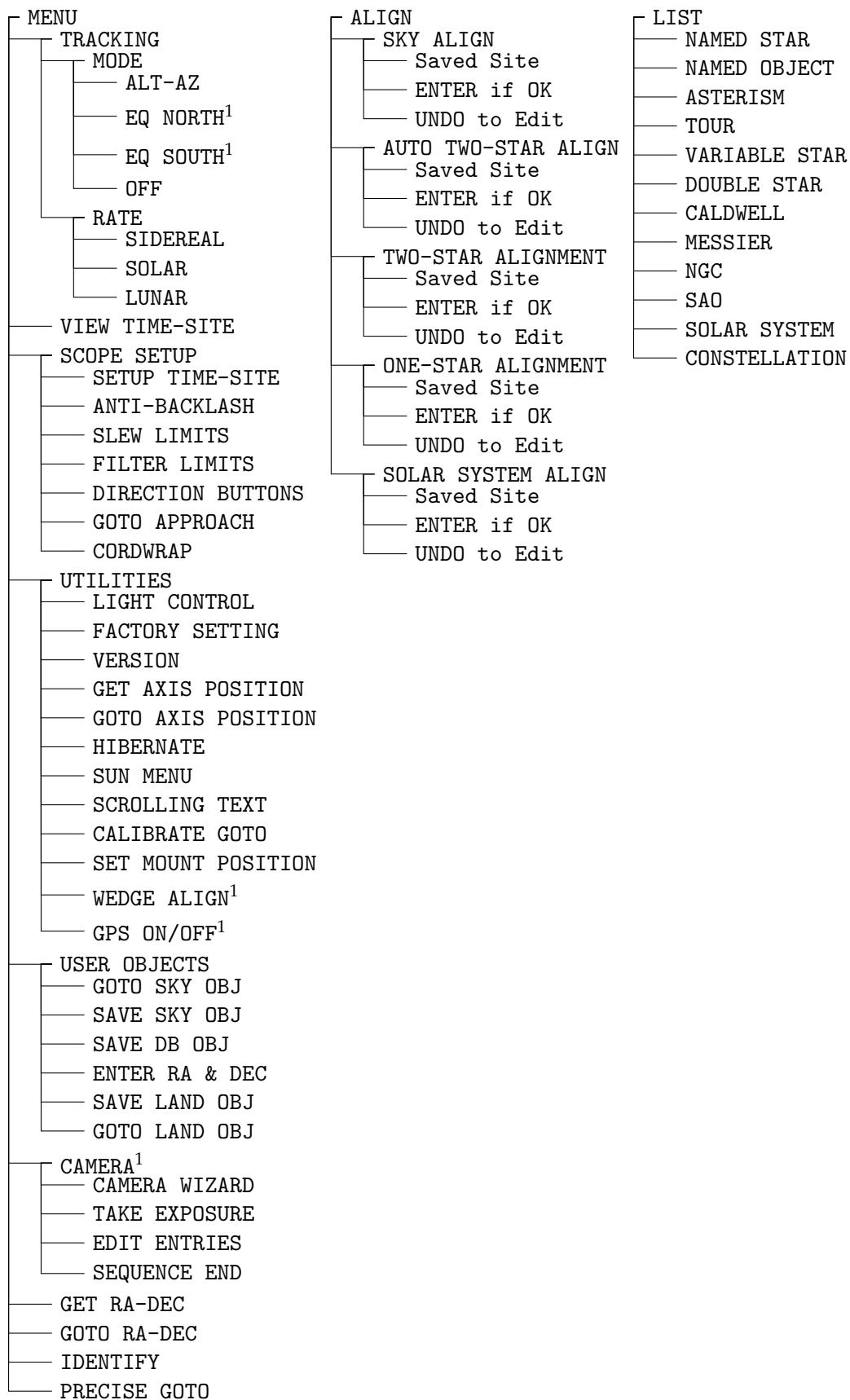
In the main case:

- Foam padding (black)
- Optical tube assembly, consisting of
  - Celestron C5 optical tube
  - SCT-1.25" eyepiece adaptor with 1 eyepiece clamp screw
  - Telescope objective cover
  - Telescope rear end cap
- Mount assembly, consisting of
  - Celestron Nexstar 5SE mount head
  - Battery compartment cover
  - Hand controller with cable
- In the optics section:
  - Celestron 25mm Plössl eyepiece with 2 black dust caps
  - Celestron 9mm Xcel-LX eyepiece (in bolt case, with 2 dust caps)
  - Star diagonal with 2 dust caps and 1 eyepiece clamp screw
  - Webcam set comprising of:
    - \* QHY5III-462C with IR cut filter and dust cap
    - \* USB3 A-B cable for webcam
- In the electronics section:
  - 12V AC-DC adaptor with power cable
  - USB A-mini B cable for mount
  - Red flashlight
  - Red dot finder

Additional special request items not placed with the main case:

- SCT-T-mount adaptor
- T-mount to camera adaptor
- Solar filter
- Power Strip
- Car power adaptor

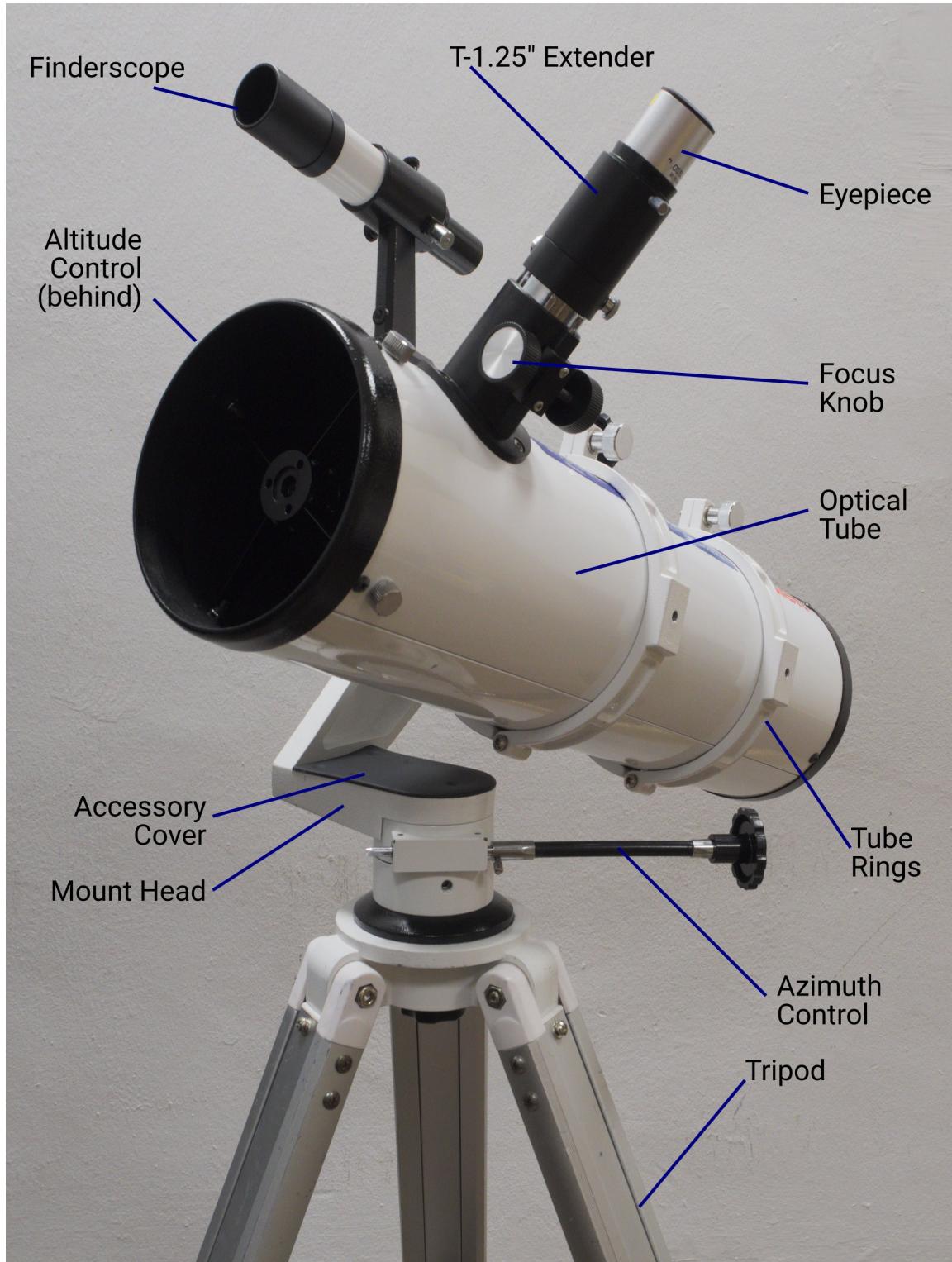
## 8 Hand Controller Menu Items



<sup>1</sup>Not used in this class

### III The Vixen Porta II with the Vixen R130sf

#### 1 Parts of the Telescope and Mount



The parts and setup procedures will differ slightly from the instructions in the telescope and mount manual because we have made some modifications to the setup for efficiency and geographical location.

## 2 Telescope Manuals

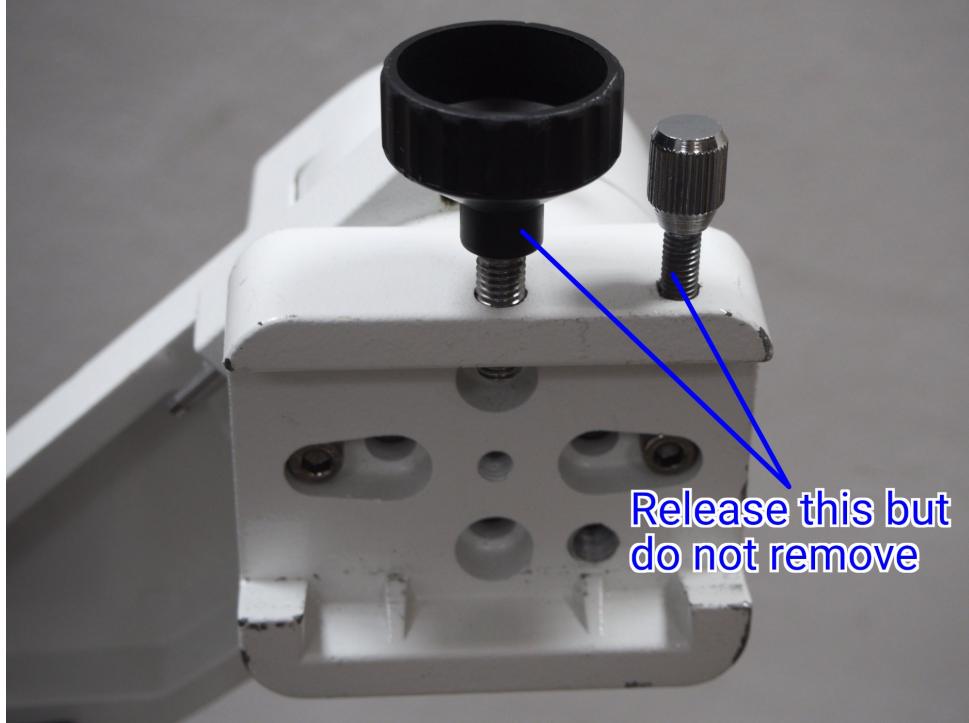
- [http://vixenoptics.com/v/vspfiles/images/PortaMount\\_Manual.pdf](http://vixenoptics.com/v/vspfiles/images/PortaMount_Manual.pdf)
- [http://vixenoptics.com/v/vspfiles/images/a70sF\\_a80sF\\_r130s%20manual.pdf](http://vixenoptics.com/v/vspfiles/images/a70sF_a80sF_r130s%20manual.pdf)

## 3 Basic Setup Instructions

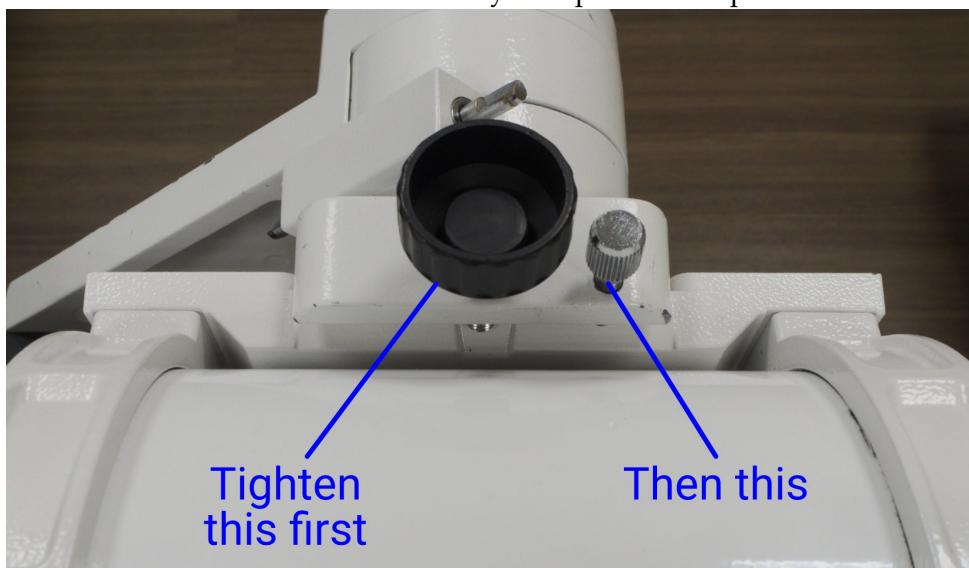
This is a detailed and illustrated step-by-step list of instructions on how to set up the mount.

1. Unfold the tripod and set it up. This setup is relatively lightweight so you may extend the tripod legs to raise the telescope to a comfortable height.

2. Release the dovetail clamp and secondary on the dovetail holder but do not remove it.



3. Install the optical tube on the mount. Tighten the large dovetail clamp to lock the optical tube onto the mount head. Secure the secondary clamp after the optical tube is secure.



SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

4. Attach the finderscope to the black attachment near the front of the optical tube. **Skip this step if you are observing the sun.**



5. Attach the fine control handles to the altitude and azimuth axes.



SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

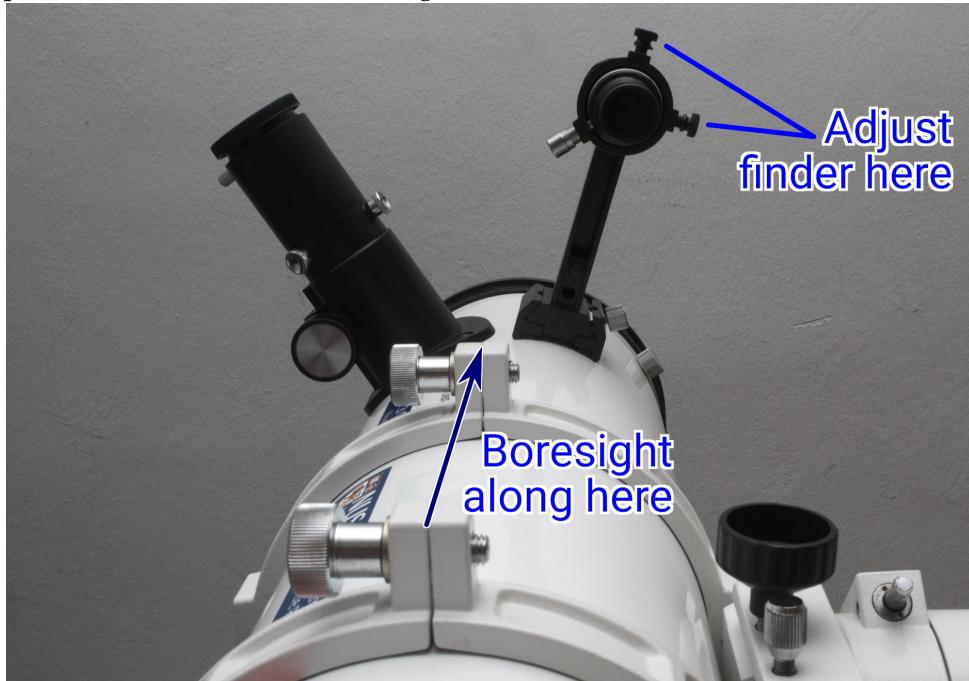
6. Attach an eyepiece to the focuser.



7. For bright moon observations, you may uncover the smaller hole in the objective cover. Otherwise remove the full objective cover.



- 8.** Boresight a faraway object at least 1 km away, or a star, moon or planet, and get the object centered in the main eyepiece. Then adjust the finderscope positioning screws to get the finderscope crosshairs centered on the target.



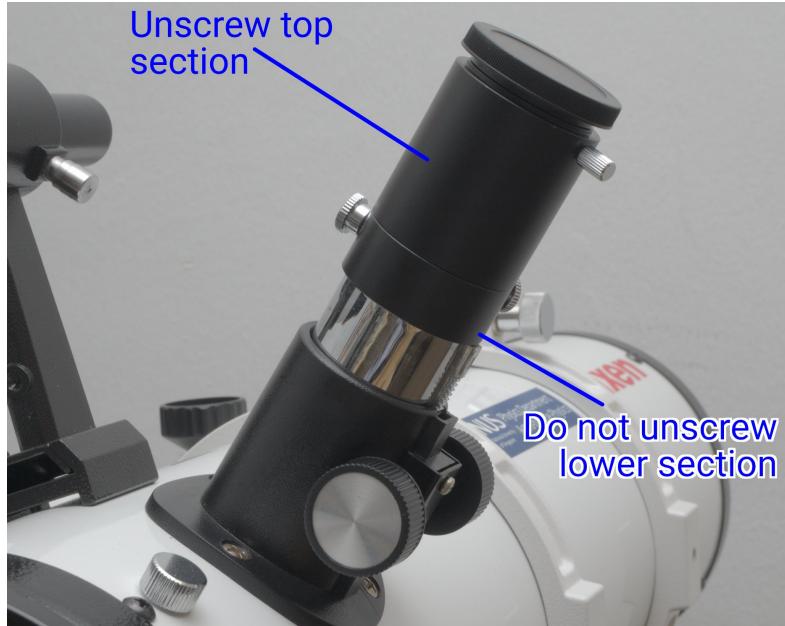
### 3.1 During Observing

- **The mount is fully manual with no tracking.** When observing an object for an extended period of time, you will have to regularly adjust the pointing of the telescope. Use the fine control handles for this. If the object has drifted out of the field of view, it may still be visible in the finderscope.
- **While observing, keep the cover on the main box and keep the tripod bag neatly folded up.** This will prevent unexpected surprises from getting into the boxes.
- Place the main box reasonably close to the tripod, or with your group. You may use this as a makeshift table for your laptop.

### 3.2 Attaching a Camera

To attach a DSLR or an interchangeable lens camera, you will need an appropriate T-ring for the camera. This will generally depend on the brand and model of the camera. The instructions here apply for most cameras (excluding webcams and the TinyMOS Tiny1).

- 1.** Unscrew the T-1.25" adaptor from the top of the focuser. Place the T-1.25" adaptor in the optics box when not in use.



- 2.** Screw on the T-ring to the top of the focuser. Note the position of the index mark



## SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

- 3.** Remove the lens from the camera. Then attach the camera to the T-ring. You may have to turn the camera around to find the correct position.



- 4.** The camera may end up in an odd angle. This is normal, and you will have to correct for the rotation in software.



The telescope-camera connection is a passive mechanical connection. This means the camera will not recognise any lens, and **cannot autofocus**. The f-stop is fixed at f/5 for the Vixen R130sf and will not be recorded in your pictures.

- Some Sony cameras must be set to release the shutter without a lens.
- Nikon cameras will only function in manual (M) mode.

## 4 Packing Up

Before packing up, ensure that

- All boxes are dry and clean.
- All dust caps and plugs are present and accounted for.
- All screws, nuts and bolts are present and accounted for. In particular, make sure that you have the following:
  - The dovetail clamp screws
  - Eyepiece clamp screws from the optical tube and T-1.25" adaptor

When packing up, take note of the following:

- **All optical items must be covered by a dust plug and/or cap.**
- **Do not let grass, dirt, sand, insects or animals into the boxes or bags.**
- The eyepieces go in the small box.

Before returning equipment,

- Make sure that all optical items are covered by a dust plug and/or cap.
- Ensure that there is no grass, dirt or sand in any of the boxes.
- **Points may be taken off if you return equipment that is uncovered or is missing dust caps or dust plugs, or if you return equipment with grass, dirt or sand in any of the boxes.**

## 5 Checklist

This is a list of all the parts present in the standard set.

As a single module:

- Tripod
- Porta II mount head
- Rubber accessory cover
- 4 mm hex key (below accessory cover)
- 3/16" hex key (below accessory cover)

In the main box:

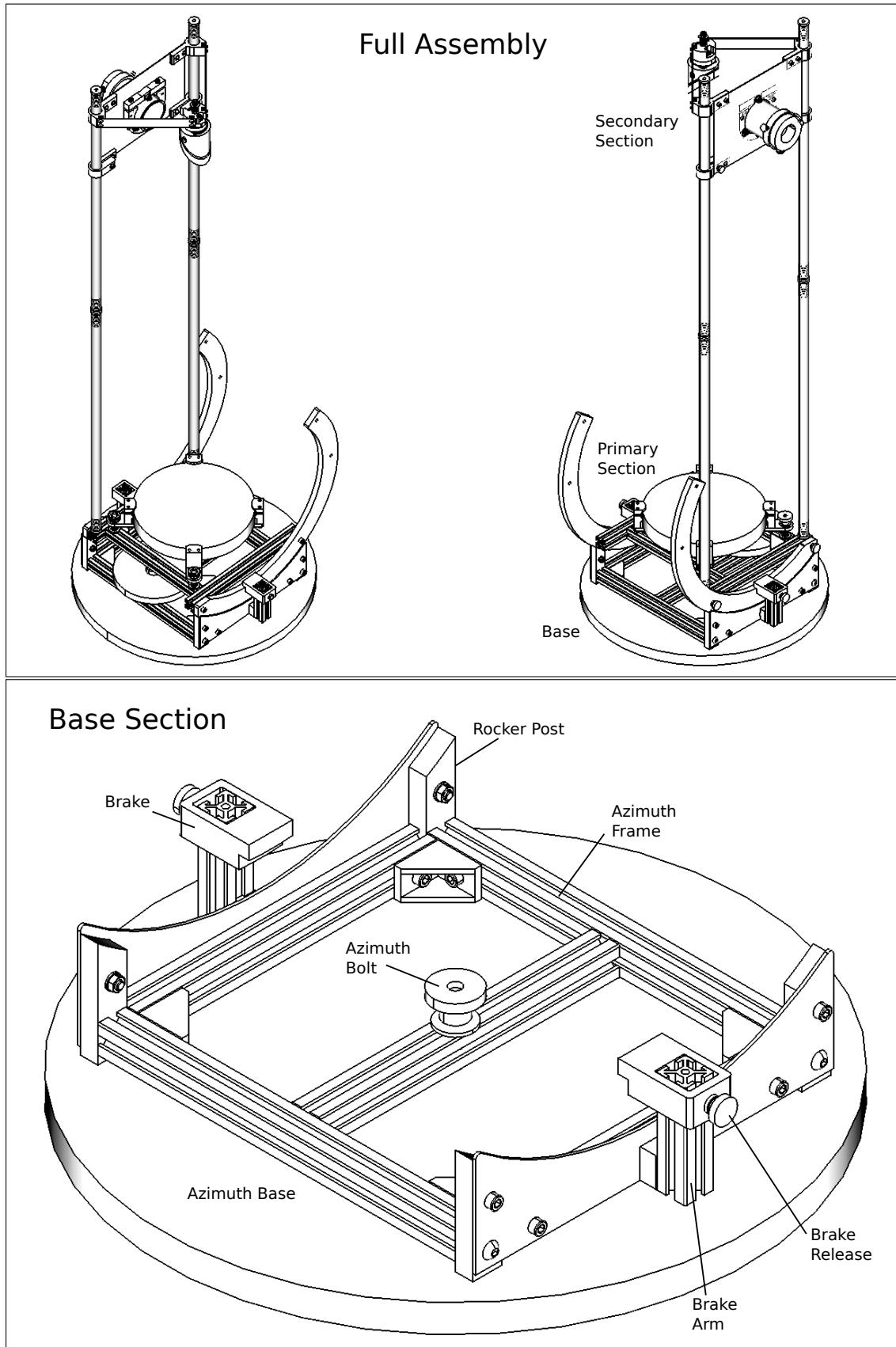
- Foam padding
- Optical tube assembly, consisting of
  - Vixen R130sf optical tube
  - Tube rings
  - T-1.25" extension tube (with eyepiece clamp screw and dust plug)
  - Guidescope mounting screw
  - Telescope objective cover with sub-aperture cover
- Finderscope assembly, consisting of
  - 6x30 finderscope
  - Finderscope mounting arm
  - Alignment screws
- Optics box, containing
  - Vixen 20mm Plössl eyepiece with 2 dust caps
  - Celestron 10mm SMA eyepiece with 1 yellow dust cap
  - Vixen 6.3mm Plössl eyepiece with 1 clear dust cap

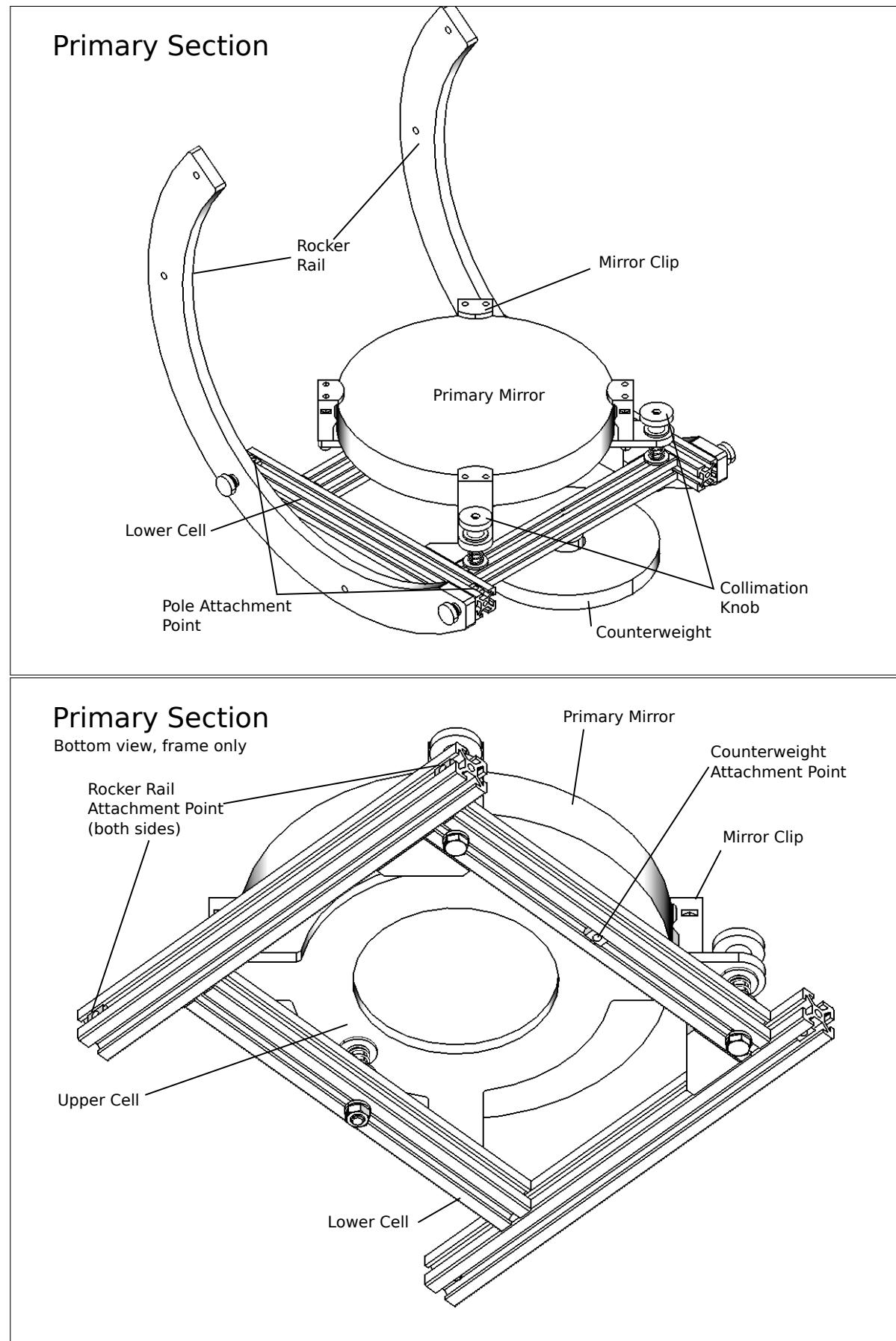
Additional special request items not placed with the main case:

- Spare fine control handles (with lock screw)
- T-mount to camera adaptor
- Solar filter

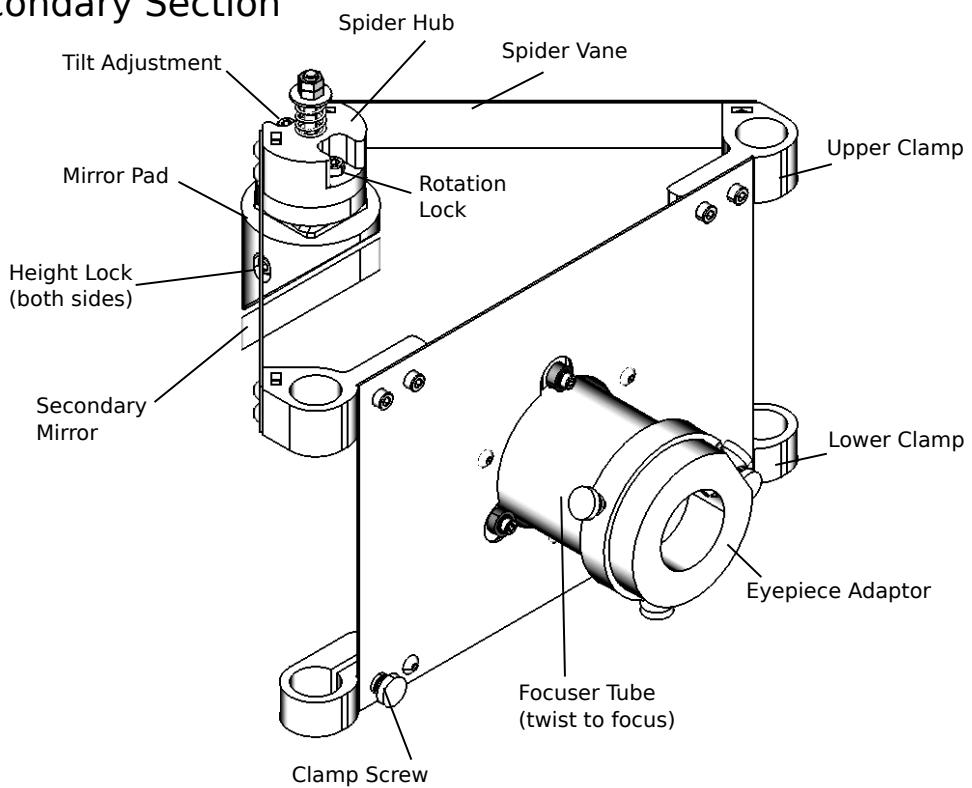
## IV The Telescope-in-a-box Model 2005Mk3

### 1 Parts of the Telescope and Mount



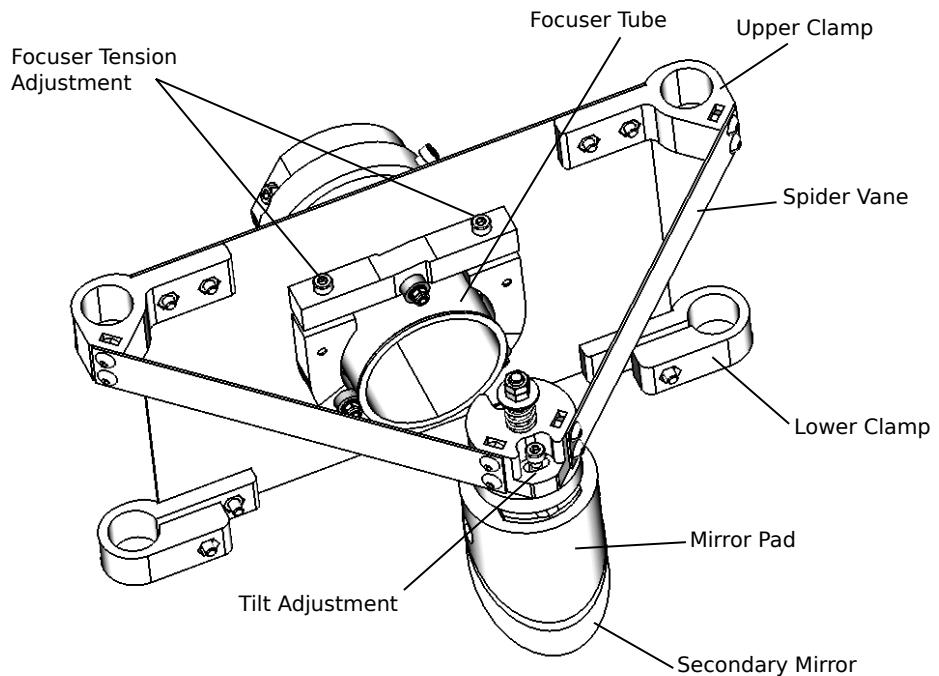


### Secondary Section



### Secondary Section

Top View



## 2 Assembly

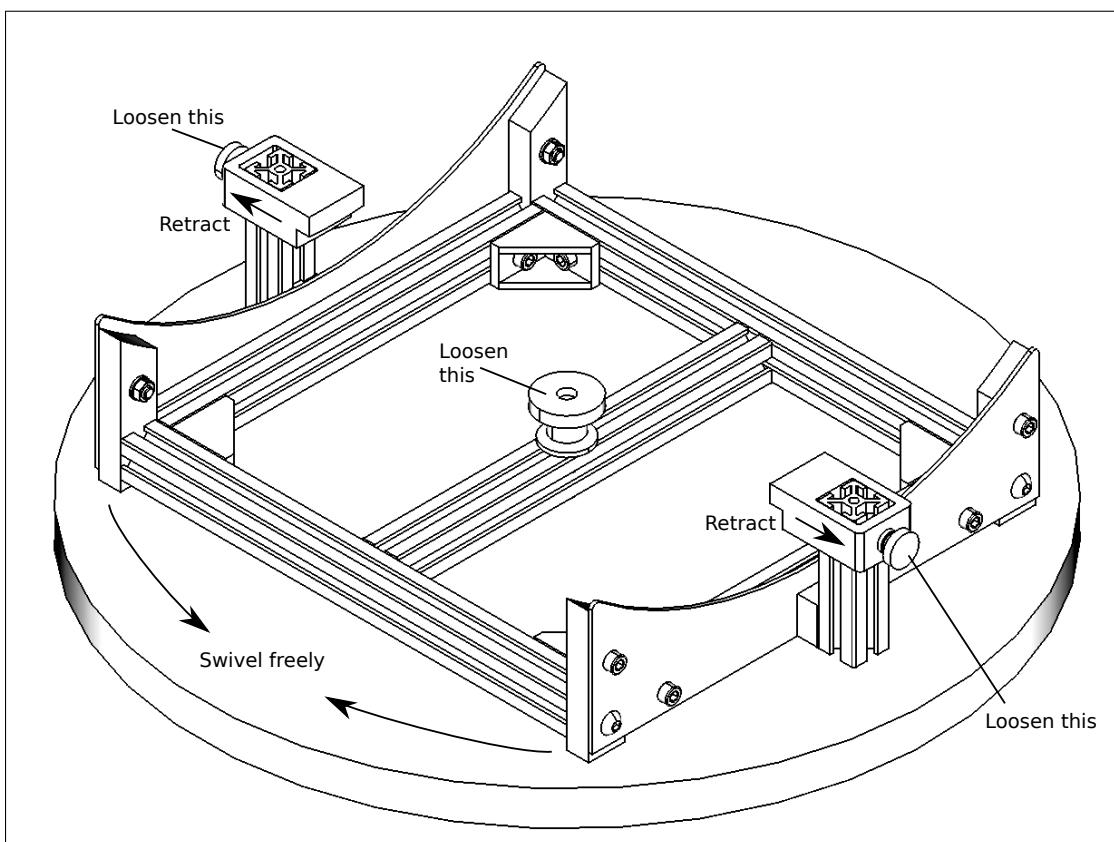
The following instructions are for assembling the telescope from the major modules.

### Required tools:

- 3mm hex key

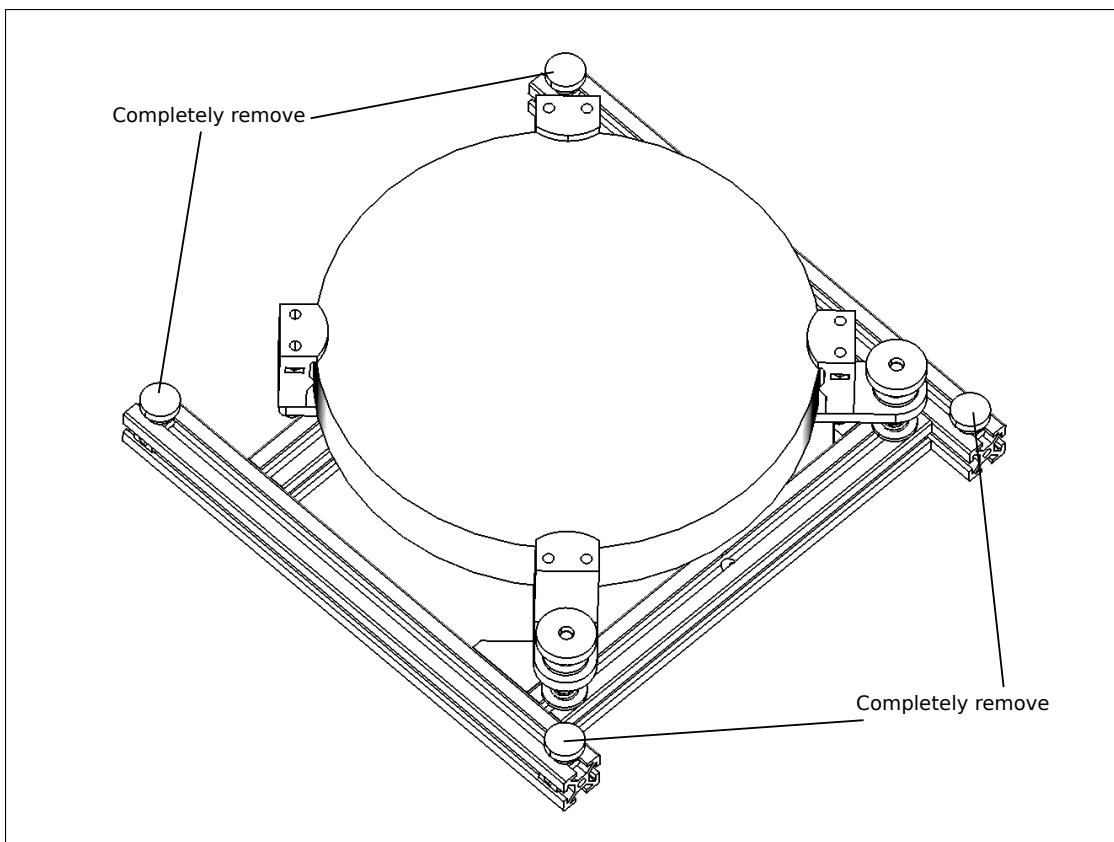
### Steps:

1. On the base section, release the azimuth bolt such that the azimuth frame can rotate freely on the azimuth base. Ensure that the flat bearing is between the bolt and frame.
2. On the base section, release the brake on both sides such that the brake is in the most outward position.

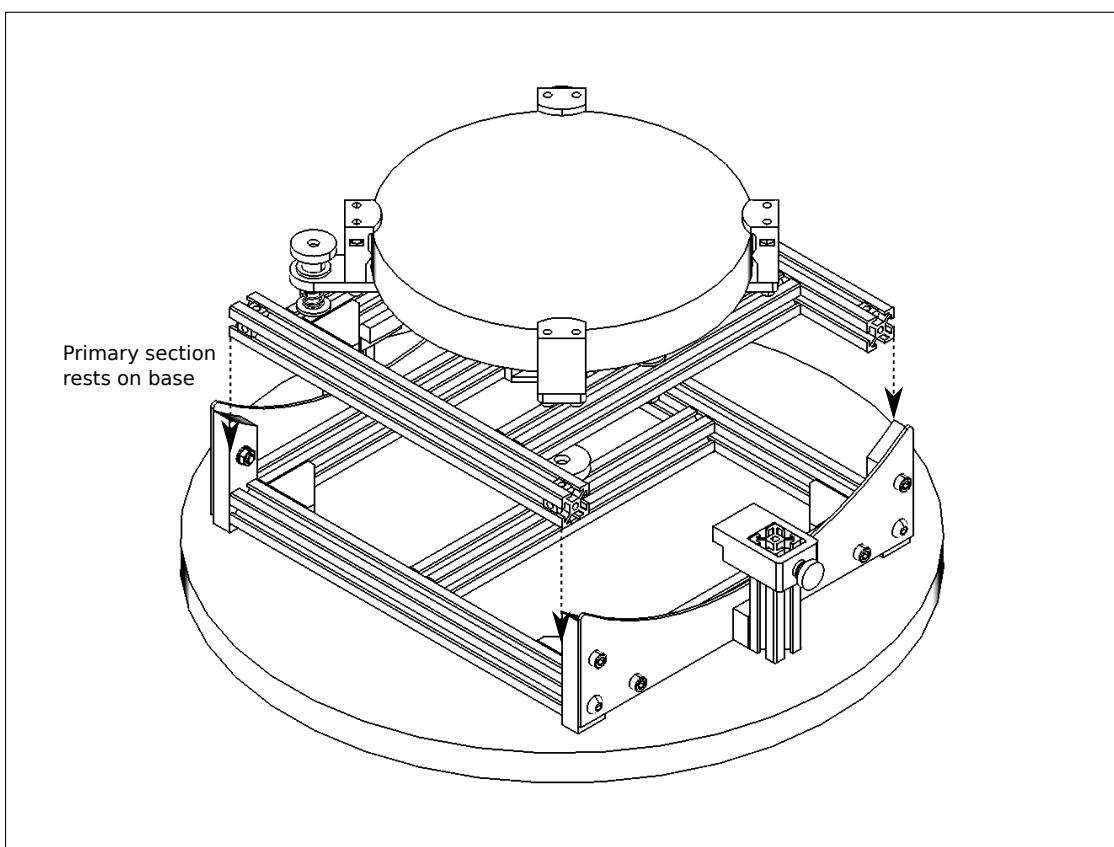


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

3. Remove the 4 M5 thumb screws from the corners of the primary section.

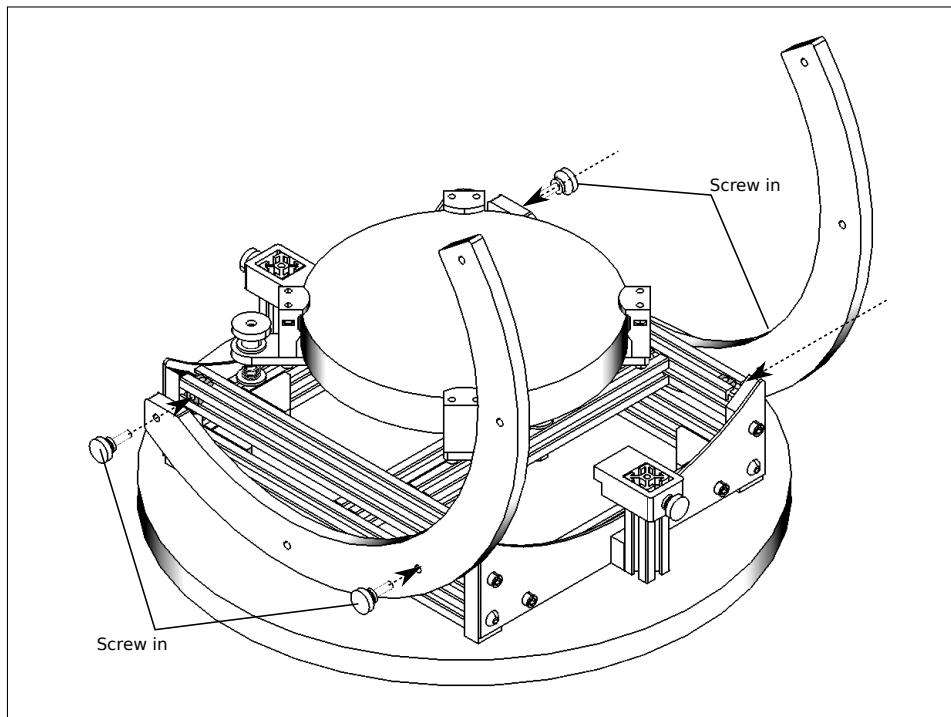


4. Place the primary section crosswise on the base.

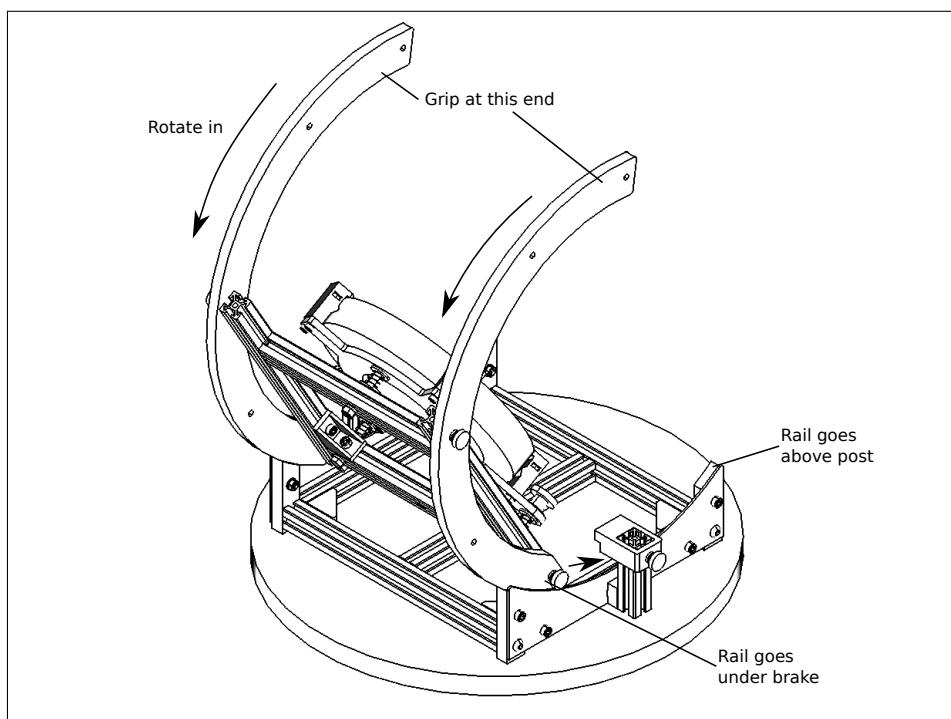


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

5. On one side of the primary section attach the rocker rail to the primary section using 2 of the M5 thumb screws. The arc should curve up at the side that is opposite from the collimation bolts. Ensure that the rocker rail is firmly locked in place with no play.
6. Repeat step 5 for the other side.

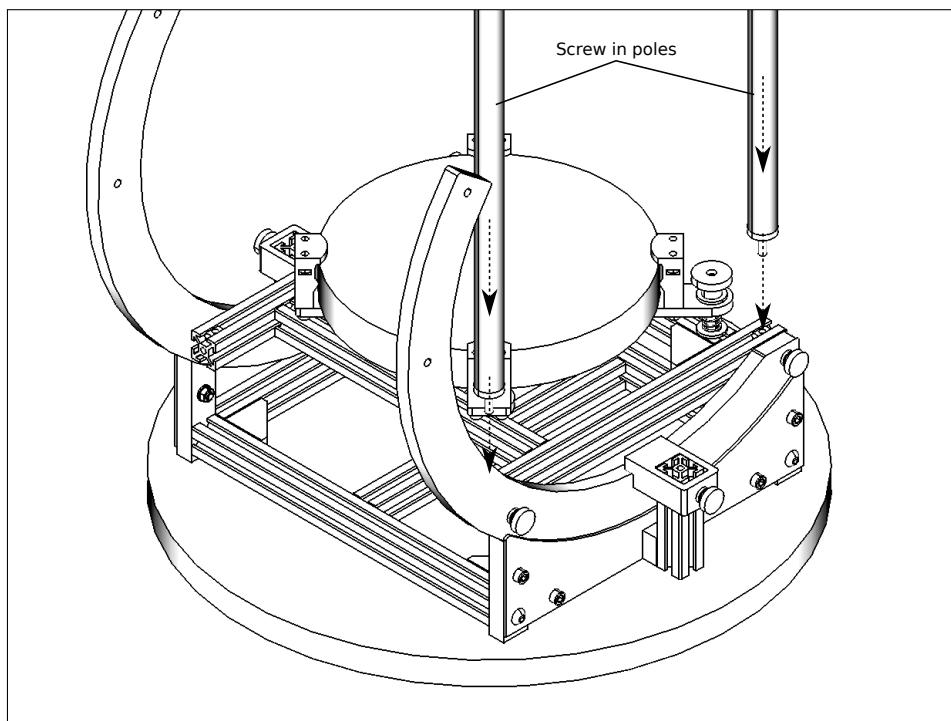


7. Lift the primary section from the base.
8. Slide the primary section over the base such that the rocker rail goes in between the rocker post and armbrake. This is best done by holding the primary section by the ends of the rocker rail and sliding the other end into the base section.
9. Then turn the primary section such that the mirror points at the zenith.

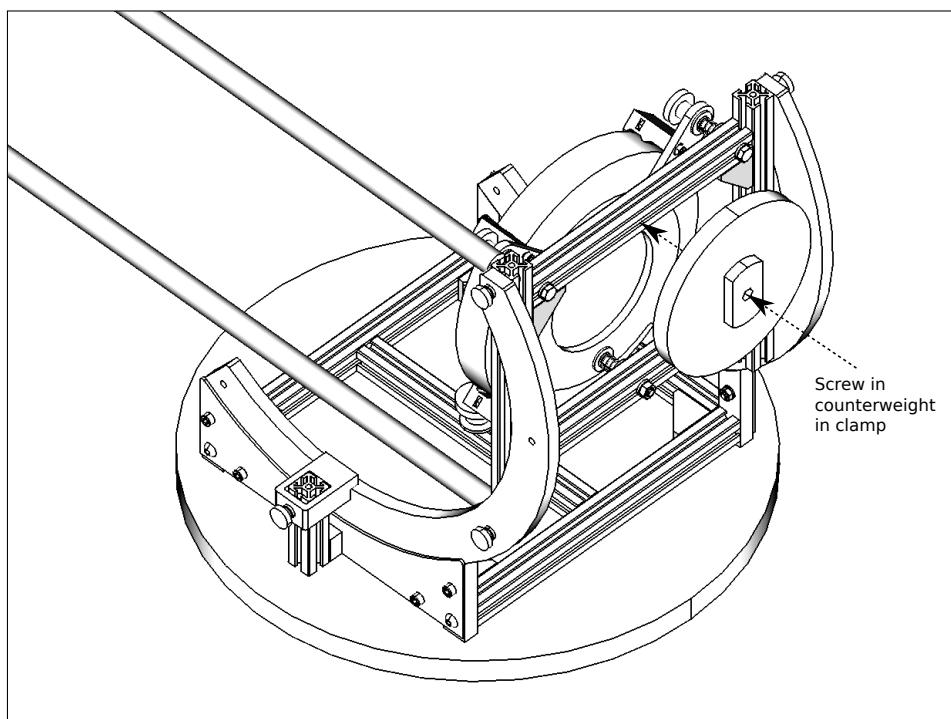


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

10. Connect both sets of upper and lower poles and attach the poles to the primary section using the screw thread on the base. Both poles must be on the same side.

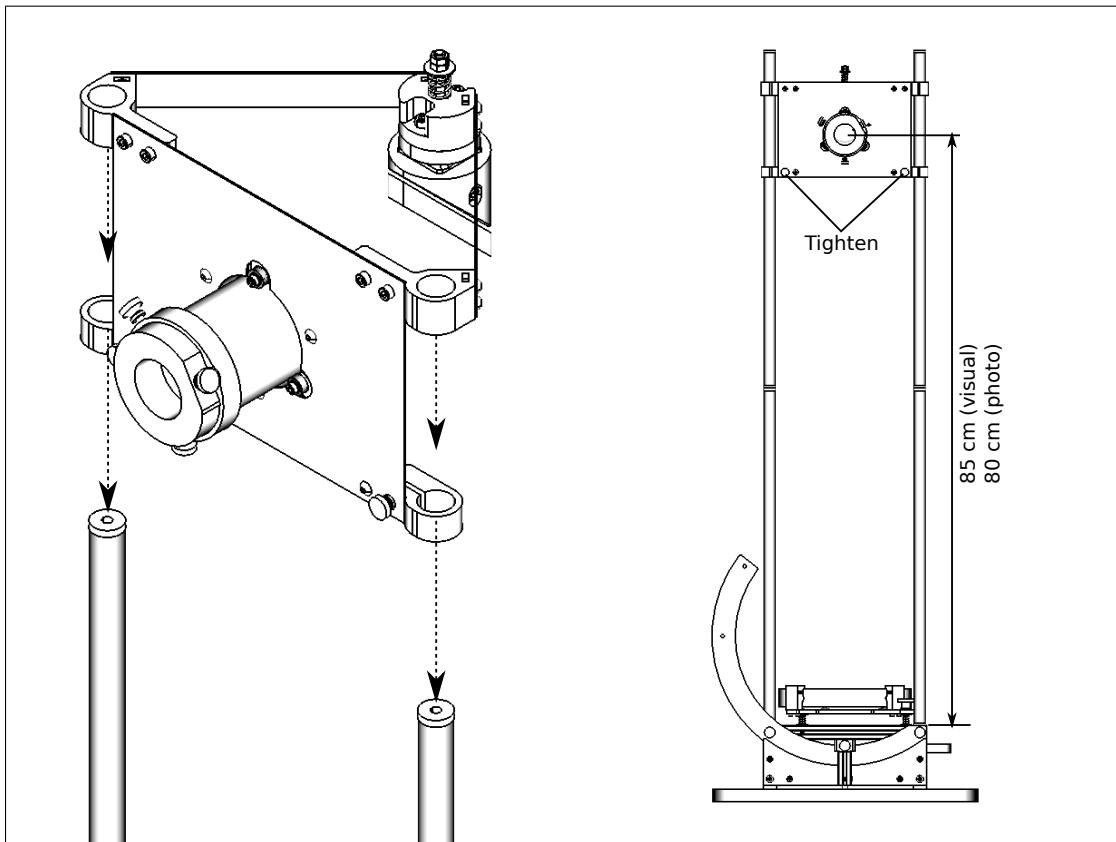


11. Rotate the primary section so that the primary mirror points in the horizontal direction. This will expose the bottom of the primary section. Attach the counterweight using the screw thread at the end of the counterweight clamp to the counterweight attachment point on the primary section.

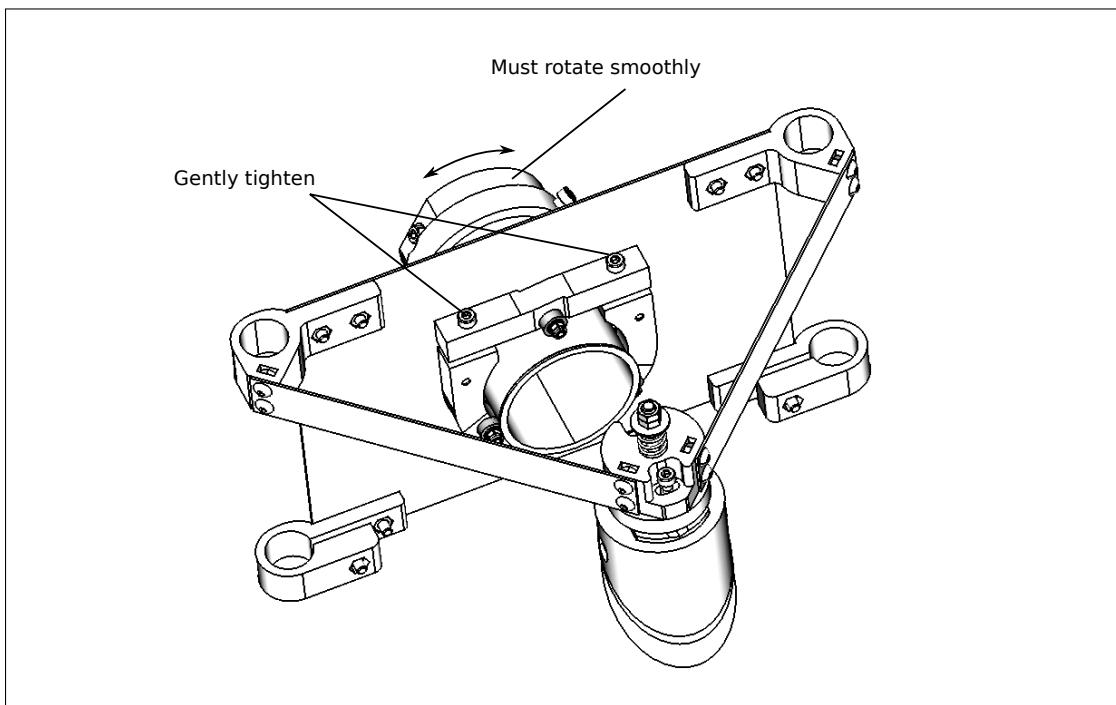


12. Turn the primary section such that the primary mirror points to the zenith.
13. Remove the cover from the secondary mirror.

14. Slide the secondary section over the poles, and lock it in position by tightening the clamp screws on the lower part of the secondary section. The centre of the focuser should be about 85 cm from the base of the pole (80 cm if attaching a DSLR). Note that these distances are approximate and you may still have to move the secondary assembly to reach focus.



15. Set the focuser tension by gently tightening the focuser tension adjustment screws on the focuser. The focuser should stay firm when pulled out, but should rotate smoothly.



16. Remove the cover from the primary mirror.

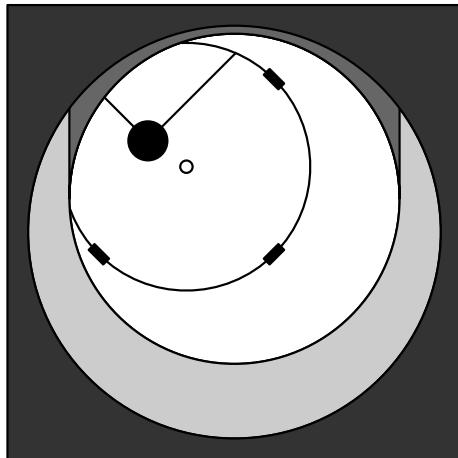
17. Insert the collimation cap in the eyepiece adaptor and collimate the system.

Looking through the pinhole in the collimation cap,

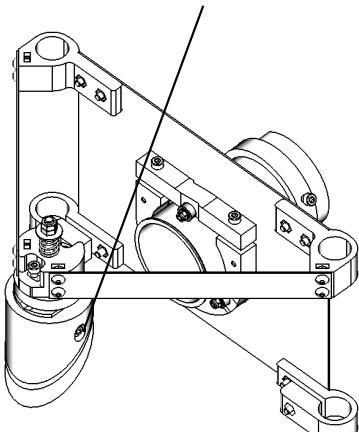
- Adjust the height of the secondary mirror such that it is centered in the focuser. To do so, loosen the height lock on both sides of the mirror pad, adjust the height and tighten the height lock while holding the mirror pad in place.
- Adjust the rotation and tilt of the secondary mirror. To adjust the rotation, loosen the rotation lock and adjust rotation, then tighten the rotation lock while holding the mirror pad in place.

(a)

Place the secondary mirror in the centre of the collimation cap sight tube.

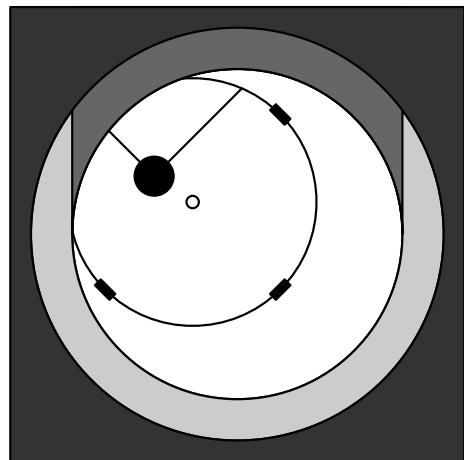


Release this (both sides) to adjust secondary mirror height

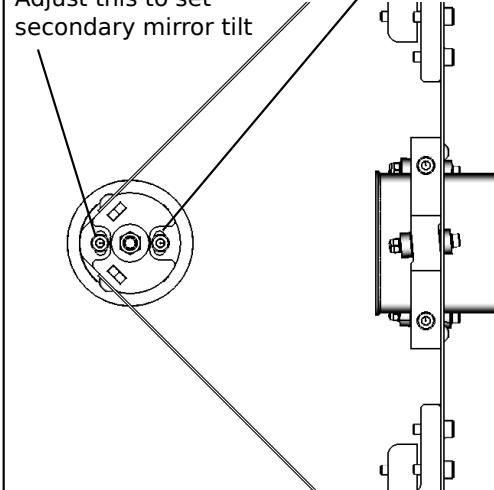


(b)

Adjust the rotation and tilt of the secondary mirror to place the image of the primary in the centre.



Release this to adjust secondary mirror rotation  
Adjust this to set secondary mirror tilt

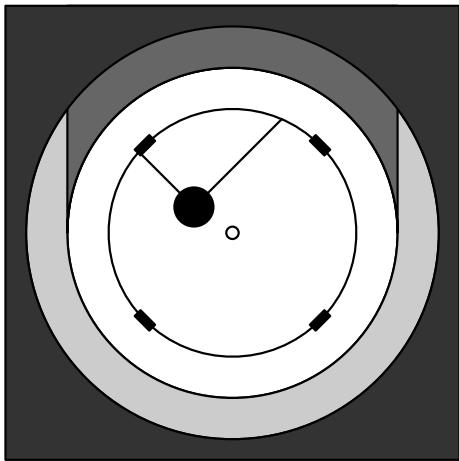


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

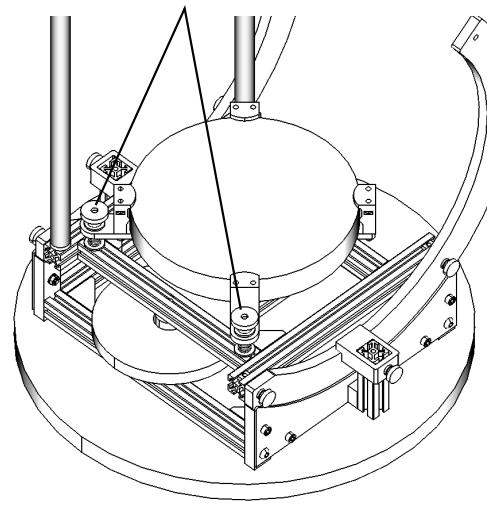
- (c) Adjust the collimation bolts on the primary section so that the centre dot on the primary mirror is lined up with the reflection of the centre of the collimation cap.
- (d) The telescope is collimated when the centre dot on the primary lines up with the centre of the secondary in the middle of the sight tube.

(c)

Adjust the tilt of the primary mirror to place the image of the secondary in the centre.

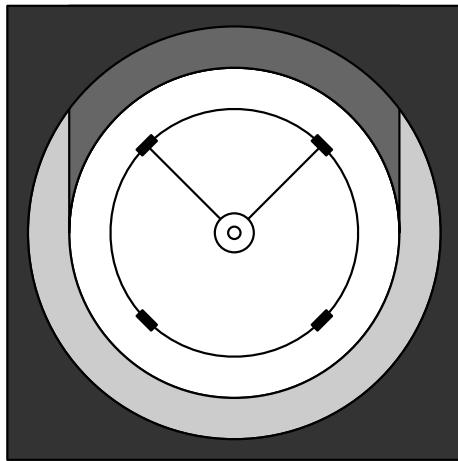


Adjust these to set primary mirror tilt

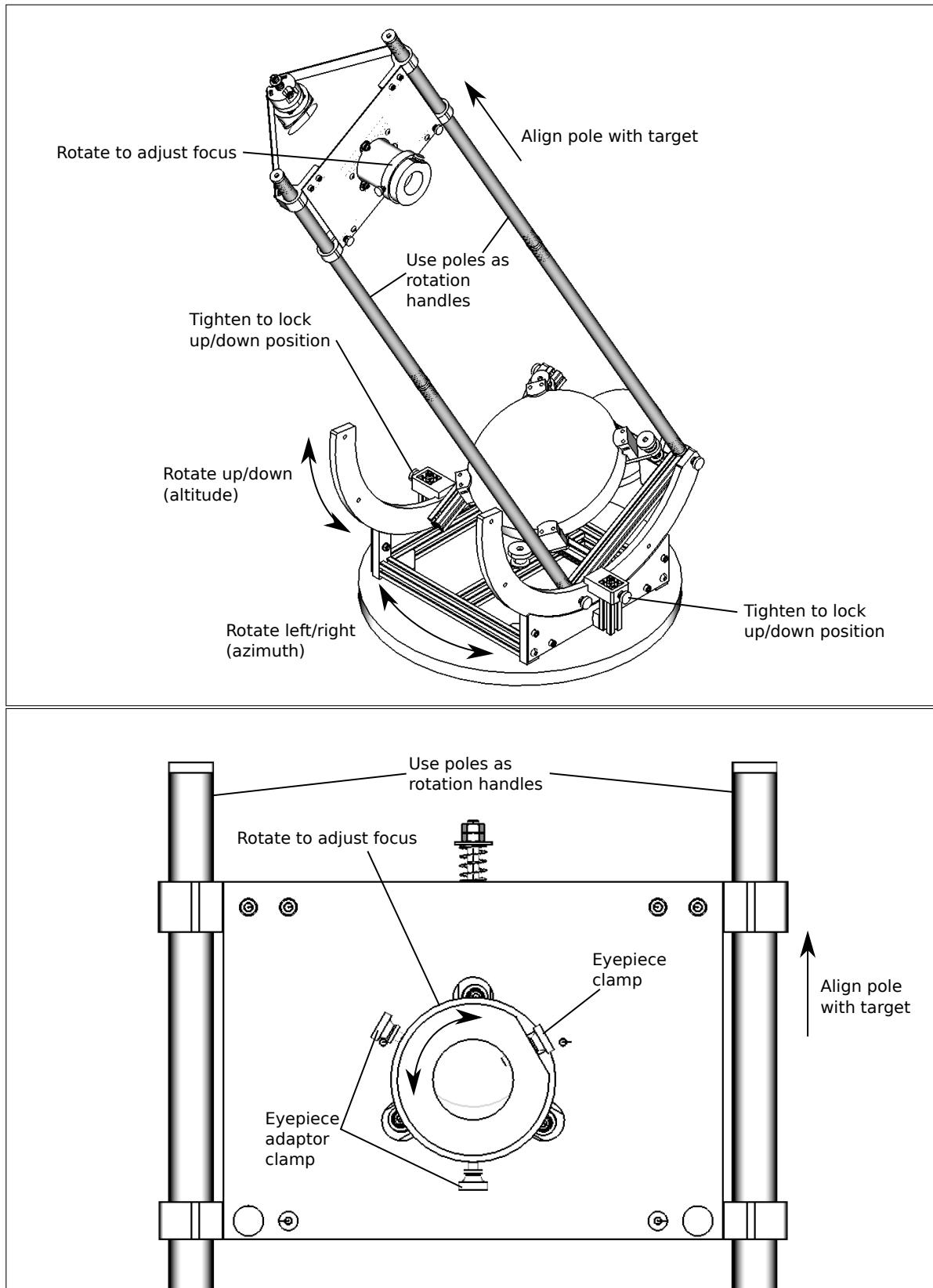


(d)

Collimated system



## 2.1 During Observing



### Usage Notes

- **The mount is fully manual with no tracking.** When observing an object for an extended period of time, you will have to regularly adjust the pointing of the telescope. Use the fine control handles for this. If the object has drifted out of the field of view, it may still be visible in the finderscope.
- **While observing, keep the cover on the main box and keep the tripod bag neatly folded up.** This will prevent unexpected surprises from getting into the boxes.
- Place the main box reasonably close to the tripod, or with your group. You may use this as a makeshift table for your laptop.

The focuser accepts standard 1.25" and 2" optical accessories.

- To attach a 1.25" eyepiece or camera: Release the eyepiece clamp, insert the eyepiece/camera and tighten the clamp.
- To attach a 2" eyepiece or camera: Release the eyepiece adaptor clamps, remove the eyepiece adaptor, insert the eyepiece/camera and tighten the clamps.

To focus the telescope, rotate the focuser tube by holding it at the flange with the eyepiece adaptor clamps.

- If you cannot reach focus at all, you may have to move the secondary assembly up or down the pole as necessary.
- You will have to check collimation each time you move the secondary assembly.

The telescope can rotate left/right (azimuth) and up/down (altitude). To point the telescope,

- Use the poles as handles and line up one pole with the target.
- When you have found the target, gently hold on to the pole to damp out vibrations.

The telescope is reasonably well-balanced to hold its position with a 1kg counterweight in place.

- To lock the up/down position, tighten the brake clamps. Under normal observing circumstances this should not be necessary.
- If you are attaching a heavy camera or eyepiece, you may opt to use a heavier counterweight. The counterweight is a standard 1 inch bore weight plate, available at most sporting goods suppliers.

### 3 Disassembly

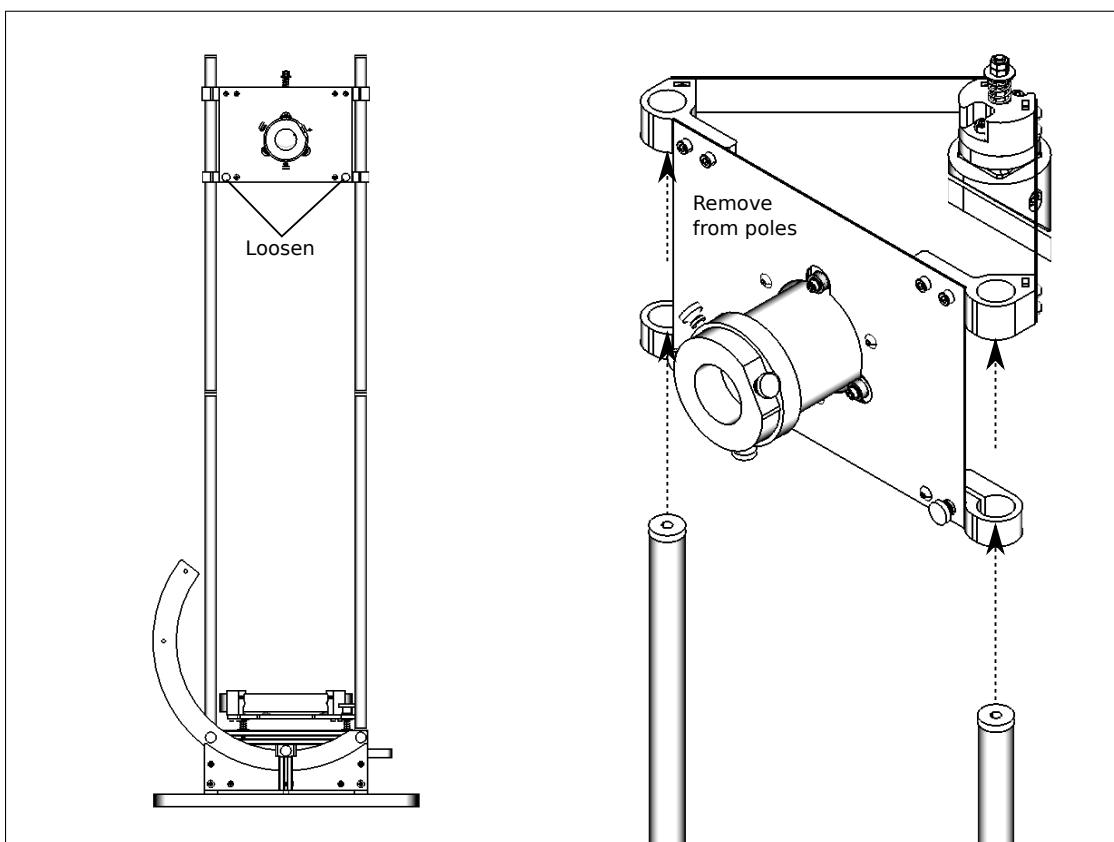
The following instructions are for disassembling the telescope to the major modules for packing/transport.

#### Required tools:

- 3mm hex key

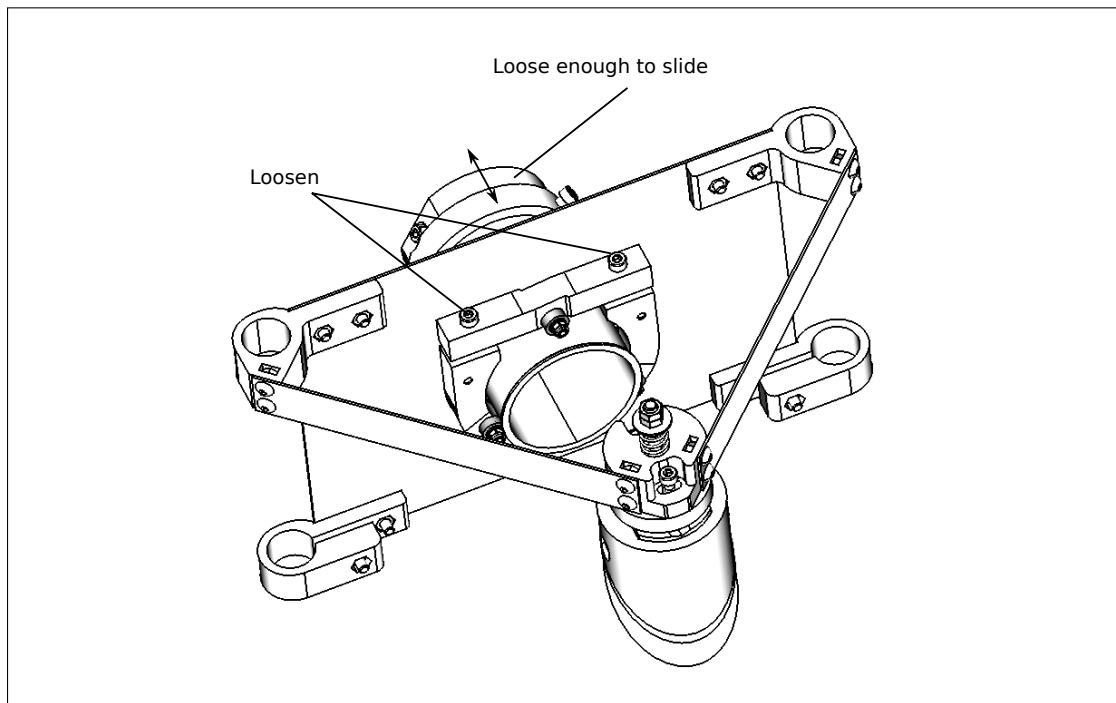
#### Steps:

1. Release the secondary section by releasing the clamp screws on the lower part of the secondary section.
2. Remove the secondary section.

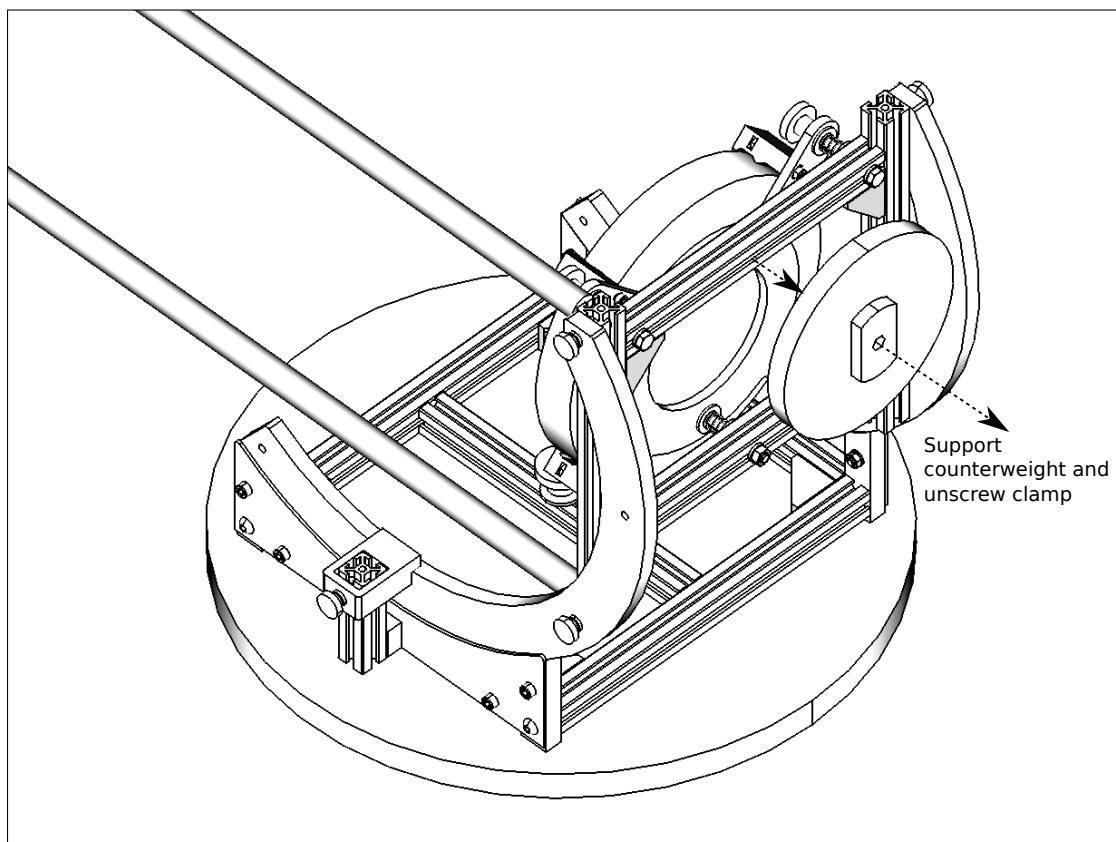


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

3. On the secondary section, release focuser tension by loosening the focuser tension adjustment screws. The focuser tube should be allowed to slide. Do not remove the top bar of the focuser assembly or the focuser tube may fall out.

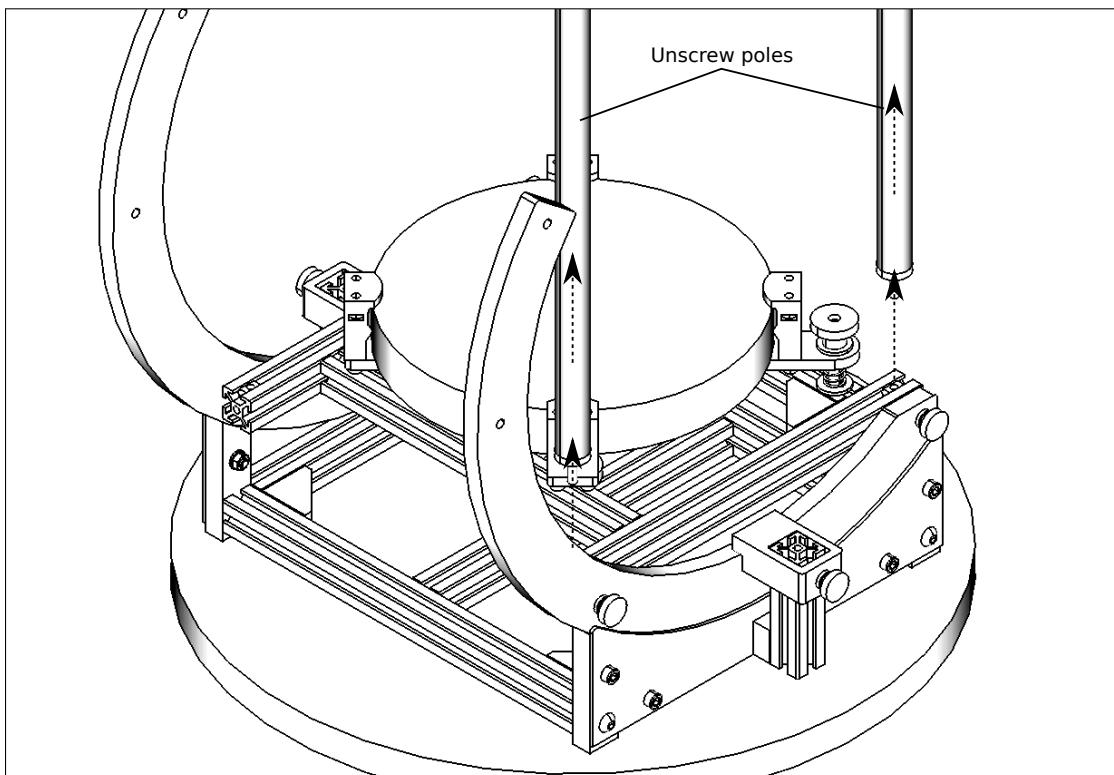


4. Place the secondary mirror in the mirror container and cover it.
5. Place the cover on the primary mirror.
6. Rotate the primary section so that the primary mirror points in a horizontal direction.
7. Remove the counterweight by unscrewing the clamp.

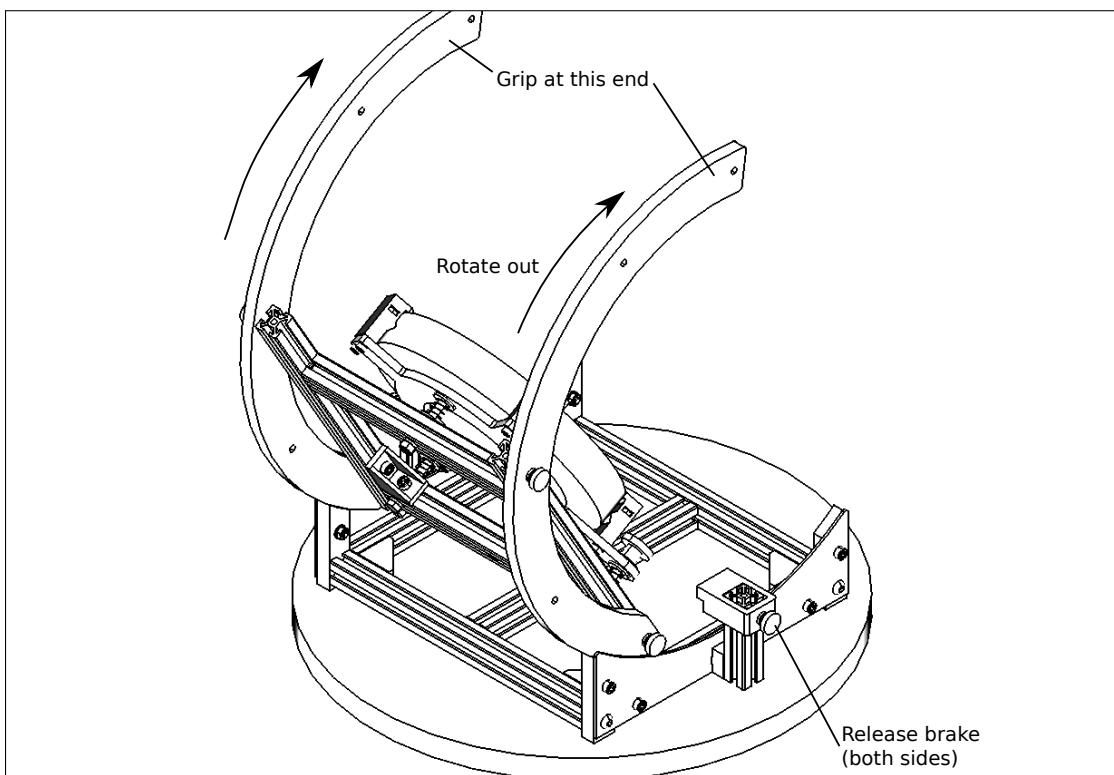


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

8. Rotate the primary section such that the primary mirror points to the zenith.
9. Unscrew the poles from the primary section and disconnect the upper and lower sections.

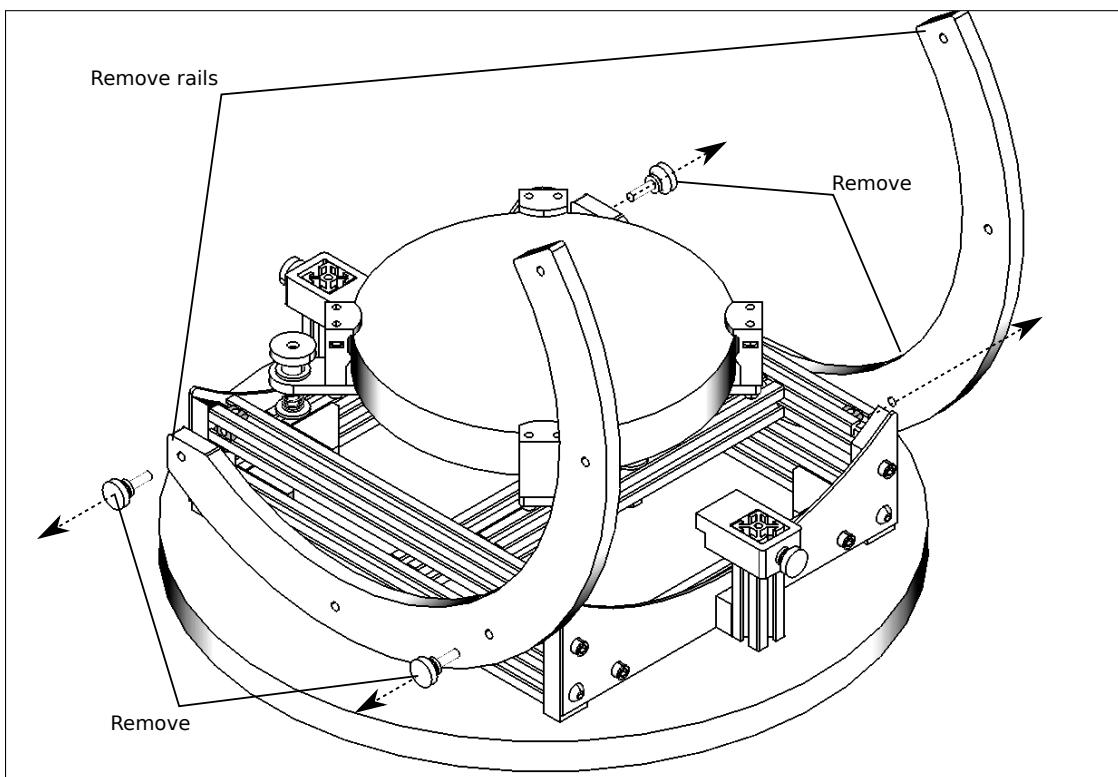


10. Hold the arms of the rocker rail and rotate the primary section such that the rocker rails clear the brake. Lift the primary section off when the rails clear the brake.

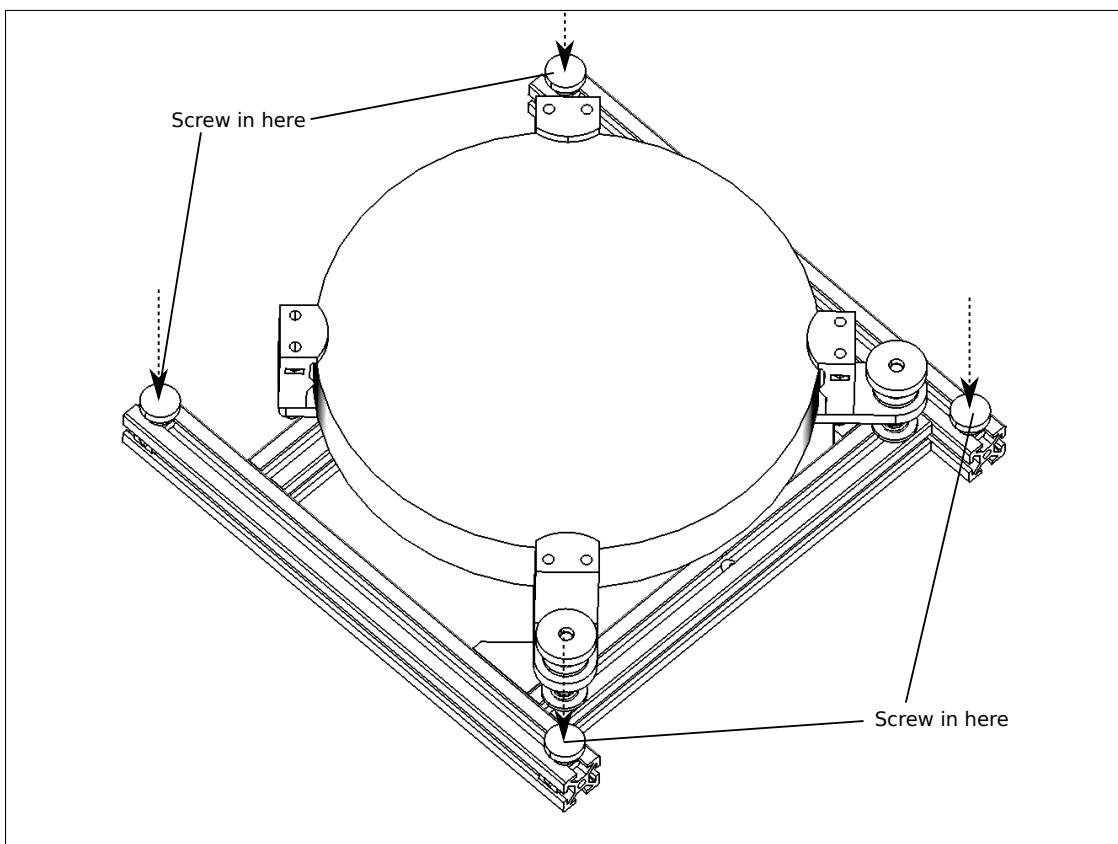


SUPPLEMENTARY HANDOUT: TELESCOPE SETUP GUIDE

11. Place the primary section crosswise on the base.
12. Remove the rocker rails from the primary frame.



13. Screw in the thumbscrews at the pole attachment points.



## 4 Packing Up

Before packing up, ensure that

- All boxes are dry and clean.
- All dust caps and plugs are present and accounted for.
- All screws, nuts and bolts are present and accounted for. In particular, make sure that you have the following:
  - 3mm hex key
  - Rocker rail mounting screws
  - Azimuth base joint bearing
  - The counterweight retaining screw
  - Eyepiece clamp screws from the focuser and T-1.25" adaptor

When packing up, take note of the following:

- **All optical items must be covered by a dust plug and/or cap.**
- **Do not let grass, dirt, sand, insects or animals into the boxes or bags.**
- The eyepieces go in the small box.

Before returning equipment,

- Make sure that all optical items are covered by a dust plug and/or cap.
- Ensure that there is no grass, dirt or sand in any of the boxes.
- **Points may be taken off if you return equipment that is uncovered or is missing dust caps or dust plugs, or if you return equipment with grass, dirt or sand in any of the boxes.**

## 5 Checklist

This is a list of all the parts present in the standard set.

- Eyepiece case consisting of
  - 25mm eyepiece
  - 10mm eyepiece
  - 3mm hex key
  - Counterweight clamp
  - Base pivot bolt assembly
- Secondary assembly with secondary mirror can
- Primary assembly with objective cover
- Base assembly with side brake arms
- 2 Rocker Rails
- 2 lower poles
- 2 upper poles
- 1kg weight plate
- Foam padding
- Azimuth base

Additional special request items:

- T-mount to camera adaptor
- Tensioning string