Imaging System Guide
SBIG ST-10XME

By: Dave Samuels and Ron Dammann

Revision History:

Vers	Revised by	Date	Reasons
1.5	Dave Samuels	2009.04.16	Add table of contents and information regarding the test lens that Ron made.
1.4	Dave Samuels	2009.03.23	Added new instructions based on final installation of wiring harness and drive corrector cabinet.

Table of Contents

1 - Preface

The purpose of this document is to provide some guidelines for proper use and care of the imaging system. With proper care, this system will provide FPOA and Hartnell College years of use as a scientific data gathering instrument.

The imaging system consists of a specialized dual-sensor camera, the SBIG ST10XME, along with its accessories, mainly the SBIG CFW9 filter wheel and the SBIG AO8 adaptive optics module.

Following these instructions and guidelines, you will be able to safely connect the equipment to the Challenger telescope and perform basic imaging tasks. Instructions for more advanced tasks will follow with their own papers, manuals, and guidelines.

Before you begin:

- The main objective of using this equipment is to not let the camera hit the floor.
- You should become familiar with the operation of the SBIG ST-10XME camera, guiding with the internal guiding sensor, AO8 operation, and CFW9 filter wheel operation.
- This camera is an expensive unit.
- You should become familiar with the operation of the software the will be used for the imaging and data gathering
- You should become familiar with the concepts of image calibration (dark frames, flat field calibration, bias frames, camera noise, signal to noise ratio, etc). See the appendix for a glossary of terms.
- You should become familiar with the field of view of the camera on the telescope - not just for the main imaging sensor, but also for the internal guiding sensor and how to determine, through camera rotation, the camera angle needed for acquiring a suitable guide star.
- Be sure that you understand the concept of "binning". We will attempt to briefly explain it where it becomes necessary or useful to use it
- Learn to master the setting circles for the Challenger.

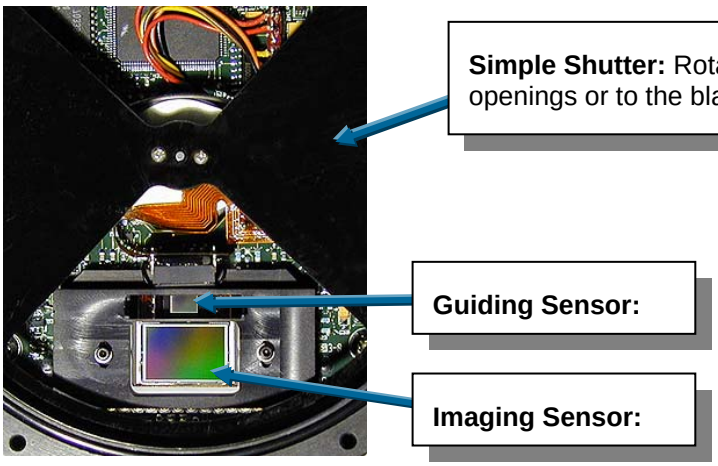
Another document will eventually be created to provide some background about digital cameras, like taking darks/flats, etc. That kind of information is not contained in this document.

2 - Camera Handling Precautions

It is essential that the camera is handled gently and care is taken to ensure that it is never dropped and all care is taken to avoid the introduction of dust into the system.

Before you begin:

- SBIG Camera model ST-10XME is stored in its waterproof Pelican case.
- Keep the camera in the plastic bag as long as possible to prevent contamination from any dust, critters, insects, etc.
- Keep the black 2" adapter cover on until you connect the camera to the scope. It is a good idea to keep the 2" adapter pointing downward whenever the adapter cover is removed in order to lessen the amount of dust that can enter the system.
- The sensor is covered by a window that seals the sensor from the elements, but we want to avoid having to clean the dust from this window as much as possible.
- Whenever moving the camera, be sure to take extra caution that the cables do not catch on anything and jerk the camera from your hand.
- Always hold the camera firmly by the handles.
- You shouldn't need to remove the AO and Filter Wheel cable connectors from the camera at any time.
- The filter wheel should only be changed by authorized persons.
- The camera uses thermal-electric cooling (TEC) to limit thermal noise and to stabilize all images to the same calibration levels. We'll be storing banks of darks at different temperatures (0C, -5C, -10C, and -25C). The TEC will only cool to about 45C below ambient temperature. Select a starting temperature where the power to stably maintain that temperature is below 90%. 75% is recommended by the manufacturer, but the temperature often decreases as the night goes on, so you can choose a temp a little higher if you expect the ambient temperature to decrease.
- The camera has a 12 VDC power connection, ST-4 guiding output, and USB 1.1 computer interface.
- The ST-4 guiding output port cable connects to the SBIG Relay Adaptor Box. This box converts the normal ST-4 guiding signals to relays that close switches identical to how the drive corrector hand paddle works.
- Never make adjustments to the camera (like rotating the orientation angle, etc) unless the telescope is in the home/setup position (scope on the west side of mount and sitting on the horizontal). The sound of the huge bang when the camera hits the primary mirror will indicate that your imaging session is over.

- 

You can see that when you take darks for one sensor, you can't take lights with the other and visa versa. Consequently, AO guiding is disabled while taking darks on the main sensor. Also, while taking darks for the AO, the imaging sensor is also covered. You need to remember this and bank darks. Try not to use autodarks after you've focused, framed, etc. What will happen is that the guider will loose track of the guide star while taking darks.

3 - Setup Checklist

This checklist will serve as the main procedure for properly connecting the imaging system to the Challenger.

3.1. **Prepare the Challenger telescope as normal for regular use.**

By this, it is meant that the covers are removed from the finders, etc. Also, it is a good practice to **calibrate the setting circles** before installing the camera, but it is not necessary.

3.1.1. Calibrate the setting circles

3.2. **Connect the Lumicon Drive Corrector and wiring harness:**

The Lumicon Drive Corrector is a device that will permit slow motion movement (at guide speed) of the Challenger telescope in East/West and North/South directions. There is no real Up/Down/Left/Right since these directions would be relative to the meridian flip of the telescope and rotation angle of the camera. The camera connects to the drive corrector and allows the software to send commands to the move the scope by small amounts.

Don't try to use the drive corrector to "drive" the scope. This can wear out the transistors which are difficult to replace. The drive corrector should mainly be used for guiding corrections and small framing corrections. Also remember that the DEC corrections have a limit to how far the tangent arm can be used. You should always be sure that the tangent arm gear is in the center of its travel before starting for the night. There is no such restriction on the RA drive.

3.2.1. The drive corrector is stored in the drive corrector cabinet located at the base of the scope.

Picture of the Drive Corrector Cabinet

3.2.2. Open the **drive corrector cabinet** and remove the **hand controller** for the drive corrector. You can place it on top of the cabinet for now.

3.2.3. Make sure that the drive corrector is set to **Sidereal tracking** and not on Solar or Lunar tracking modes. Unless, of course, your target is the moon. Under no circumstances do you ever point the Challenger telescope at the sun, therefore, you will never need the Solar tracking mode.

3.2.4. Connect the **black A/C power cord** of the RA drive directly to the A/C outlet on the side of the drive corrector cabinet.

3.2.5. Connect the **white drive corrector cabinet cable** to the A/C wall outlet. At this time the drive corrector's power light turns on and you should be able to hear the normal operation of the RA tracking motor running.

3.2.6. Perform a **test** with the **drive corrector hand paddle** to ensure that the unit is indeed controlling the RA and DEC.

3.2.6.1. Pressing the **East/West buttons** on the hand paddle will cause the RA motor to change pitch ever so slightly. Drive corrections to the East will almost sound like the motor stops altogether, while corrections toward the West sound like the motor is speeding up.

3.2.6.2. Pressing the **North/South buttons** will activate the motor on the tangent arm. It is sufficient that you hear that the tangent arm motor is operating. The direction of the movement should never be an issue. If you don't hear the tangent arm motor engage, try re-checking the connection to the DEC cable at the back of the drive corrector box.

3.2.6.3. **Center the tangent arm gear** in its range of travel by manually engaging the N/S buttons on the hand paddle until it is centered.

3.2.7. **Unplug the black A/C cord** of the RA gear from the drive corrector cabinet until after you have installed the camera.

3.3. **Prepare the Challenger scope:**

3.3.1. **Disengage the RA drive motor** while installing the camera. The scope will be resting on a chair for safety reasons and there is no sense in having to drive the scope against the chair.

3.3.2. Place a **chair** under the front end of the Challenger so that, in case you accidentally lean on the system or in case the extra weight of the system is not quite balanced, the tangent arm will not touch the RA drive gear and damage the gears.

3.3.3. Drop the front end of the Challenger so that it **rests on the chair**.

Picture of scope with chair

3.3.4. Using care not to touch the secondary mirror (keep your fingerprints off the secondary), **rotate the secondary so that the mirror is facing down**. This will protect the surface of the mirror in case any loose cable ends, screws, dust, etc. fall through the focuser hole and onto the secondary.

3.3.5. Never place any loose items on the focuser mounting plate. This is not a table. Doing so, you risk the danger of forgetting about them and they will surely fall onto the primary or secondary mirrors when the scope is moved.

3.3.6. Place the **step ladder to next to the scope** so that you can comfortably place the camera into the drawtube, tighten the knobs, and connect all the cables.

Picture of scope with step ladder

3.3.7. For counter-weighting and various other reasons, the camera will only be used in **focuser #3**. This is the focuser that is facing up when the scope is on the West side of the pier and the nose sitting on the chair. A side benefit of this is that it is easy to achieve a non-flipped correct orientation, upright "north is up, west is to the right" image if the camera is not rotated.

3.3.8. **Do not remove the counterweight until the camera is installed**. Otherwise, the scope will drift northward.

3.4. **Preparing the Drawtube:**

3.4.1. If there isn't a **drawtube** already in **focuser port #3**, remove the drawtube from port #2 (the one facing the floor) and place it in port #3.

3.4.1.1. In the future, the drawtube will be labeled. This is so that the **focusing templates** can be used with the same drawtube each time.

3.4.2. Be sure that the **knob** for tightening the camera is accessible and **facing Northward**, toward the primary mirror. (If the knob is under the AO8 side, it is too close to the AO8 to get your hand under it)

3.4.3. Ensure that the 2" eyepiece adapter **knob on the drawtube is loosened** enough so that you can't feel the set screw protruding into the 2" adapter path. If the set screw is protruding into the adapter hole, it will prevent the camera from easily sliding into the drawtube, forcing you to adjust it while holding onto the camera with one hand.

- Don't loosen it so much that the setscrew falls out.
- Just slide your finger into the drawtube and keep turning the knob until the setscrew is just flush with the inside of the drawtube.

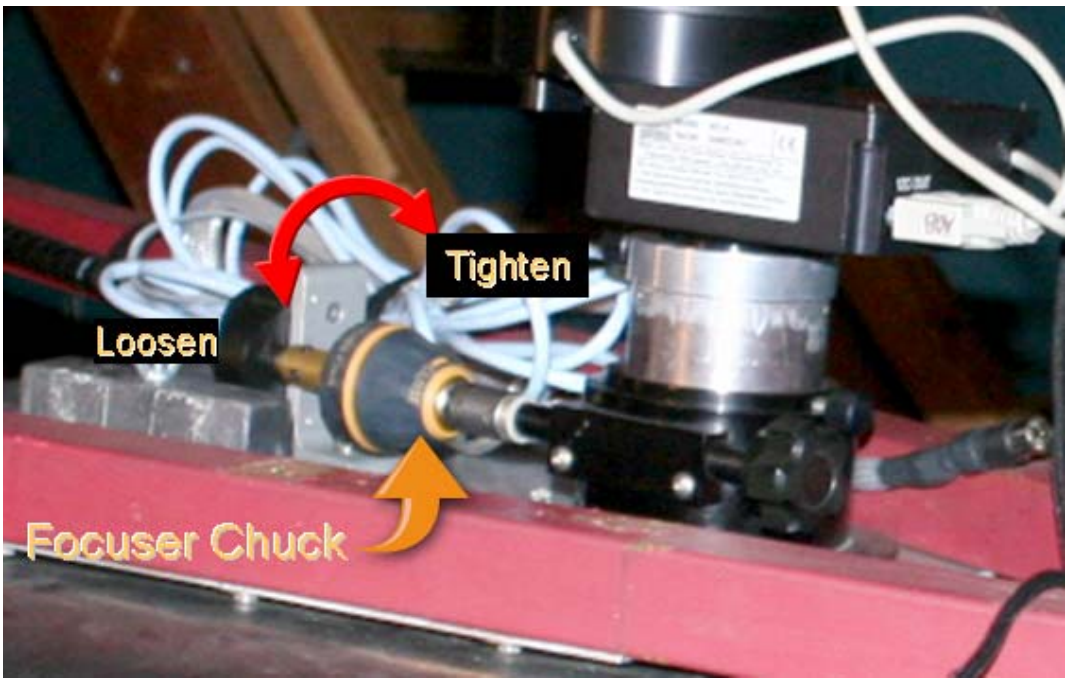
3.4.4. Using the **drawtube focus calibration spacer** (that we plan to make), adjust the drawtube in the focuser at the calibrated amount and firmly tighten the drawtube setscrew. This will ensure that the drawtube is within the range of travel for you to be able to reach focus with the electronic focuser.

3.4.4.1. If the spacer isn't available, use the table in the appendix "B" for the measured spacing for different configurations. (Probably about 1.25" of spacing with the default settings (AO8 + CFW8 + ST10)

3.4.4.2. **Firmly test the drawtube to ensure that it will not slip out**.

3.5. **Set the focuser depth:**

3.5.1. Loosen the **focuser chuck**:



Focuser Chuck

3.5.1.1. With your left hand, hold the outer ring of the chuck. With your right hand, rotate the cone-shaped end of the chuck (clockwise to tighten, counter-clockwise to loosen).

Warning: Do not rotate the top ring of the chuck. Doing so applies pressure to the focuser motor.

3.5.2. Set the **focuser** such that it is in the **middle of its range of travel**. It only has about 3/4 inch of travel.

3.5.2.1. We plan to create a template that will make this as simple as adjusting the focuser knobs until the focuser is flush with the template.

3.5.3. **Tighten the focuser tension**, but not too much. It should still allow the focuser knob to be able to turn and adjust the focus.

3.5.4. **Tighten the focuser chuck**. (As a courtesy to subsequent visual users, you will need to remember to loosen the focuser chuck before you leave).

3.6. **Installing the camera:**

3.6.1. While maintaining a firm grip on at least one of the camera handles, and while resting the camera on the foam packing of the Pelican case, **remove the camera from the plastic bag**.

3.6.2. While pointing the camera downward to avoid dust from falling on the camera window, **remove the 2" adapter cover** from the camera.

3.6.3. **Slide the camera into the drawtube** and orient the camera such that it is in its **"North is up" position**.

3.6.3.1. There will be a **compass rose** on the focuser mounting plate and a clearly visible index mark that should point to the camera orientation angle.

3.6.3.2. Make sure that the setscrew is easily accessible as you rotate the camera so that you can tighten it securely. Rotate the drawtube as necessary to achieve this. (When the set screw is on the wrong side, under the AO8 unit, it is difficult to access with your hand)

3.6.3.3. At this time, if you know the **position angle of your first target**, you can position the camera orientation angle in the drawtube to point to the rotation angle indicated on the compass rose. This should be done by rotating the drawtube and not just the camera. The reason for this is because you can't get to the knob if the AO8 is over it.

3.6.3.4. The following image depicts the zero angle (north is up) orientation angle (power connector is on the north side):

Hint: the USB and power connectors are facing north (toward the primary mirror) for the index position (north is up). The AO8 cable is facing south.

3.6.4. **Firmly tighten the setscrew knob**. **Jiggle the camera and tighten** until the camera is firmly in place and you can **guarantee that the camera will not fall out when the camera is upside down** (when the scope is on the other side of the pier, usually pointing West of the meridian).

3.6.5. Immediately attach the **safety "*Oops* strap**" . **This is a hard and fast rule. The camera will always be used with a safety strap to protect both the camera and the scope.**

3.6.6. Connect the following cables to the camera:

3.6.6.1. Connect the large **shielded Power cable to the camera POWER** port. A silver index mark on the plug should mate with the silver mark on the socket.

3.6.6.2. Connect the 9-pin plug labeled **AO/CFW/SCOPE to the camera port labeled AO/CFW/SCOPE**. Do NOT secure with a screw driver.

3.6.6.3. Connect the USB extender labeled **"USB 1370 USB Extension of CAT5" to the blue CAT5 cable labeled "B - Ethernet"** (It might be labeled "USB Extension").

3.6.6.4. Connect the **female end of the USB 1370 to the supplied short USB** cable and the other end to the camera's USB port.

3.6.7. Connect the **Robofocus cable** to the **Robofocus motor** and secure it to the tangent arm with a **Velcro strap**.

3.6.8. **Remove the counterweight from the focuser plate** and **replace the wing nut** such that it will not come lose during the night. (We don't want this falling onto the primary mirror). You need to remember to replace this counterweight at the end of each imaging session as a courtesy for subsequent users).

3.6.9. In the drive corrector cabinet, **plug the SBIG power supply DC cable to the shielded cable connector**. Note: there are silver alignment index marks on both connectors.

3.6.10. **Connect the A/C end of the SBIG power supply to the A/C outlet inside the cabinet**. You should be able to turn the power supply on with the switch on the power supply. When you do, the green light on the power supply should light up and you should hear the AO8 on the camera activate briefly, and possibly also the cooling fan. When you do this, your computer's Plug-n-Play might ask you to install the two SBIG drivers if you have already connected the cables at the desk to the computer.

3.7. **Computer Desk:**

It is important to ensure that the cables are always connected to the same port. This minimizes how often you have to reinstall the drivers.

3.7.1. **Unwrap the cables** and lay them on top of the desk.

3.7.2. Connect the blue **CAT5 cable labeled "B"** to the female end of the USB extender labeled "**USB 1370 Extension over CAT5**".

3.7.3. **Connect the other end of the USB extend to the Kensington USB hub - to port labeled "3"**.

3.7.4. The **Robofocus cable** (gray phone cord) should **connect to the USB to RS323** adapter and **then to the Kensington USB hub port labeled "4"**.

3.7.5. **Plug the USB hub's power adapter** into the USB hub and plug the other end into an AC outlet. You need to be sure to power the hub before connecting the hub to your computer.

3.7.6. **Connect the hub to the same port on your computer that you used previously**. On the Observatory computer, use the following port: _____.

If this is the first time, connect to a port that makes it easy for you to add additional USB devices without disconnecting the hub. (For example: the lowest port allows you to easily use a thumb drive or mouse later)

3.8. **Installing Software Drivers**

When you connect the hub to the comptuer, your computer's Plug-n-Play might ask you to install two SBIG drivers: (sbiguldr and sbigusbe) Sometimes it does this and sometimes it does not. (See the section on "*Installing the Software Drivers*")

3.8.1. If you need to - re-install the two drivers, refer to the **"Installing the Software Drivers**" section.

3.8.2. You should now be able to control the camera and take pictures. (You can test that now):

3.8.2.1. **Set the camera cooling temp to 0C**.

3.8.2.2. **Take a focus shot** with the **main imaging sensor**

3.8.2.3. **Take a focus shot** with the **guider**

3.8.2.4. One of the screens in CCDSoft can be used to **test the computer control of the North/South/East/West drive corrector**. You can test this with the roof closed (just be sure that the scope will not bump into the chair or step ladder)

3.9. **Double-check the balance of the scope before removing the chair.**

3.9.1. **Loosen the DEC clutch**.

3.9.2. **Lift the front end of the scope** a foot or so off the chair and notice whether it **holds that position**. If it doesn't hold the position, the scope isn't balanced and you will not be able to maintain good tracking and guiding while imaging. You will need to resolve any balance issues at this point.

- Check to ensure that the counterweight is removed.
- You may need to remove heavy eyepieces from the other focuser ports.

3.9.3. **Re-tighten the DEC clutch**, but not too tight.

3.10. **Final scope preparation:**

3.10.1. **Rotate the secondary mirror** so that the mirrored surface faces the camera in port #3.

3.10.2. **Remove the chair** and the **stepladder**.

3.10.3. **Engage the RA drive**.

4 - Shutdown Procedure Checklist

4.1. In the **software**, set the **cooling temperature** to **warm up** to ambient temperature (usually any value greater than 0C, such as **5C is OK)**.

4.2. When the software shows that the **camera has reached ambient temperature**, in the software **disconnect the camera**.

4.3. In the **drive corrector cabinet**, **turn off the SBIG power supply**. The fan should stop.

4.4. While you're there, **unplug the black RA drive A/C cord**.

4.5. **Park the scope on the west side**.

4.6. Put the **front end of the scope** on the **chair**.

4.7. Put the **sock/cover** on the **secondary mirror**.

4.8. **Rotate** the **secondary** so it's **facing down**.

4.9. Move the **step ladder** to the **west side** of the scope.

4.10. At the **camera**, **unplug** the following three cables (Leave the connector labeled I2C-AUX connected):

- **Power**
- **AO/CFW/Scope**
- **USB**.

4.11. **Disconnect** the **security strap** from the strut.

4.12. Replace the **counterweight**.

4.13. With one hand on the camera handle, **loosen the drawtube screw** and **remove the camera**.

4.14. Immediately **cap the 2" adapter** on the camera and **place the camera in the storage bag**.

4.15. Put the **camera in the pelican case**.

4.16. At the base of the scope/drive corrector cabinet, **disconnect** the **SBIG power cable** from the **main harness**.

4.17. **Unplug** the **SBIG power supply** from the **AC** outlet inside the cabinet.

4.18. Put the **SBIG power supply** in the **pelican case**.

4.19. Put the **USB 1370 Extender** adapter at the camera port into the **pelican case**.

4.20. **Secure all the cables at the focuser port** with the **Velcro tie downs**.

4.21. **Loosen the focuser chuck**.

4.22. Stow the **drive corrector hand controller** on top of the drive corrector box **inside the cabinet**.

4.23. **Unplug** the **white drive corrector cabinet A/C cord** from the main power outlet.

4.24. Check that **all the lights of all the devices inside the cabinet are out**.

4.25. **Lock** the **drive corrector cabinet**.

4.26. Back at the **computer desk**:

- 4.26.1. **Shut down the software**.
- 4.26.2. **Unplug** the **Kensington USB hub** from your computer.
- 4.26.3. **Unplug** the **power supply from the Kensington Hub** and **unplug it from the wall**.
- 4.26.4. **Stow the hub and all the desk cables** and adapter in the provided storage case.
- 4.26.5. **Transfer your files** so you can take them with you and **remove any images from the FPOA computer** that you may have added so that we don't fill up the hard drive.

5 - Imaging Tips

Notes:

- For asteroids, comets, and other moving targets, be sure to capture some images with enough time elapsed between them to be able to blink the images to locate a moving object. For NEOs, this could be as frequent as 2-5 minutes between them. For Main belt asteroids, maybe 1/2 hour to several hours. For Keiper belt objects, it might be several days (Pluto registers quite well at about 2+ hours). Too long of an interval will also stump the automated asteroid finders and produce no results when there really are results. This happens when the asteroid has moved too far in the image between shots.

- Capture at minimum of 3 good exposures. Good exposures are those exposures that plate solve to the same RA/DEC for the same star in all the images. Automatic blinking and asteroid detection requires at least 3 images for it to function properly. More is better.

- Try to choose exposures short enough to avoid blooming, but long enough to capture the needed data and enough stars to be able to do plate solves. Sometimes a filter will darken bright objects - just be sure there are 10 or more stars in the image that are unmistakably stars.

- Be sure that the image scale is no less then 0.6 arcsec/pixel so that plate solving is possible. The ST10 on the Challenger binning 1x1 yields a scale of 0.383 arcseconds per pixel. Binning 2x2 produces 0.766 arcsec/pix while at the same time cuts the required exposure in half. 3x3 binning produces 1.149 arcsec/pix and requires only a third of the exposure. So, if your exposure requirement is 30 seconds at 1x1, a 10-second exposure at binning 3x3 would be the same exposure. You'll find that a higher percentage of images are usable at 10 seconds because you're relieving the system from having to compensate for wind gusts and PE (periodic error in the worm gears). The drawback is that the resolution isn't as fine.

    - Do not bin 4x4. It is a selectable setting, but the camera can't do it. Some of the software for controlling the camera blows up when taking 4x4 binned images with this camera.

- As much as possible, set software preferences and settings such that the following settings cause the data to be recorded with the FITS headers in each image:

  Without this information, it is unnecessarily difficult to reduce the data.

    - Optics for guider and main scope are set so that focal length and camera pixel size are set (762mm aperture, f/4.8, 3658mm focal length, 6.8 micron pixel size, 2184x1472 pixels, 14.9mm x 10mm, Object (target) name or designation, Site Lat/Long,

    - NAXIS1 = 2184 /fastest changing axis

    - NAXIS2 = 1472 /next to fastest changing axis

- OBJECT = '4179 Toutatis '
- TELESCOP = 'Challenger' / telescope used to acquire this image
- INSTRUME = 'SBIG ST-10 3 CCD Camera w/ AO'
- OBSERVER = 'Dave Samuels' /Example: Dave Samuels, Ron Dammann, Miguel Rodriquez, and Fabian Hernandez
- NOTES = ' '
- DATE-OBS = '2008-07-13T09:09:51' /YYYY-MM-DDThh:mm:ss observation start, UT
- XPIXSZ = 6.8000000000000007 /Pixel Width in microns (after binning)
- YPIXSZ = 6.8000000000000007 /Pixel Height in microns (after binning)
- SITELAT = '36 45 36.84' / Latitude of the imaging location
- SITELONG = '-121 29 55.32' / Longitude of the imaging location
- FOCALLEN = 3658.0000000000000 /Focal length of telescope in mm
- APTDIA = 762.00000000000000 /Aperture diameter of telescope in mm
- APTAREA = 456036.74387812614 /Aperture area of telescope in mm^2
- FLIPSTAT = 'F' /T if scope is on East side of pier pointing Westward
- HISTORY Dark Subtraction (Dark 4, 2184 x 1472, Bin1 x 1, Temp -5C, Exp Time 90s)

6 - Appendix A

7 - Appendix B

ST10XME+CFW9+AO8

- 1/4" focuser
- 1.25" drawtube

8 - Quick Setup Checklist

This checklist will serve as the main procedure for properly connecting the imaging system to the Challenger.

8.1. **Prepare the Challenger telescope as normal for regular use.**

8.1.1. Calibrate the setting circles

8.2. **Connect the Lumicon Drive Corrector and wiring harness:**

8.2.1. **Unlock the drive corrector cabinet** and **remove the hand controller** from for the drive corrector. You can place it on top of the cabinet for now.

8.2.2. Set drive corrector to **Sidereal tracking**.

8.2.3. Connect the **black A/C power cord** of the RA drive directly to the A/**C outlet** on the side of the drive corrector cabinet.

8.2.4. Connect the **white drive corrector cabinet cable** to the **A/C wall outlet**. At this time the drive corrector's power light turns on and you should be able to hear the normal operation of the RA tracking motor running.

8.2.5. Perform a **test with the drive corrector hand paddle** to ensure that the unit is indeed controlling the RA and DEC.

8.2.5.1. **Center the tangent arm gear** in its range of travel by manually engaging the N/S buttons on the hand paddle until it is centered.

8.2.6. **Unplug the black A/C cord** of the RA gear from the drive corrector cabinet until after you have installed the camera.

8.3. **Prepare the Challenger scope:**

8.3.1. **Disengage the RA drive motor** while installing the camera.

8.3.2. Place a **chair under the front end of the Challenger**.

8.3.3. Drop the front end of the **Challenger so that it rests on the chair**.

8.3.4. Rotate the **secondary so that the mirror is facing down**.

8.3.5. Place the **step ladder on the West side** of the scope so that you can comfortably place the camera into the drawtube, tighten the knobs, and connect all the cables.

8.4. **Preparing the Drawtube:**

8.4.1. If there isn't a **drawtube** already in **focuser port #3**, remove the drawtube from port #2 (the one facing the floor) and place it in port #3.

8.4.2. Be sure that the **knob for tightening the camera is accessible and facing Northward**, toward the primary mirror.

8.4.3. Ensure that the **2" eyepiece adapter knob** on the **drawtube is loosened** enough so that you can't feel the set screw protruding into the 2" adapter path. Just slide your finger into the drawtube and keep turning the knob until the setscrew is just flush with the inside of the drawtube.

8.4.4. Using the **drawtube focus calibration spacer** (that we plan to make), adjust the drawtube in the focuser at the calibrated amount and firmly tighten the drawtube setscrew. (probably about 1.25" for the default configuration AO8 + CFW8 + ST10)

8.4.4.1. **Firmly test the drawtube to guarantee that it will not slip out**.

8.5. **Set the focuser depth:**

8.5.1. **Loosen the focuser chuck**:

> **Warning**: Do not rotate the top ring of the chuck. Doing so applies pressure to the focuser motor.

8.5.2. Set the **focuser** such that it is in the **middle of its range of travel**. It only has about 3/4 inch of travel.

8.5.3. Tighten the **focuser tension**, but not too much. It should still allow the focuser knob to be able to turn and adjust the focus.

8.5.4. **Retighten the focuser chuck**.

8.6. **Installing the camera:**

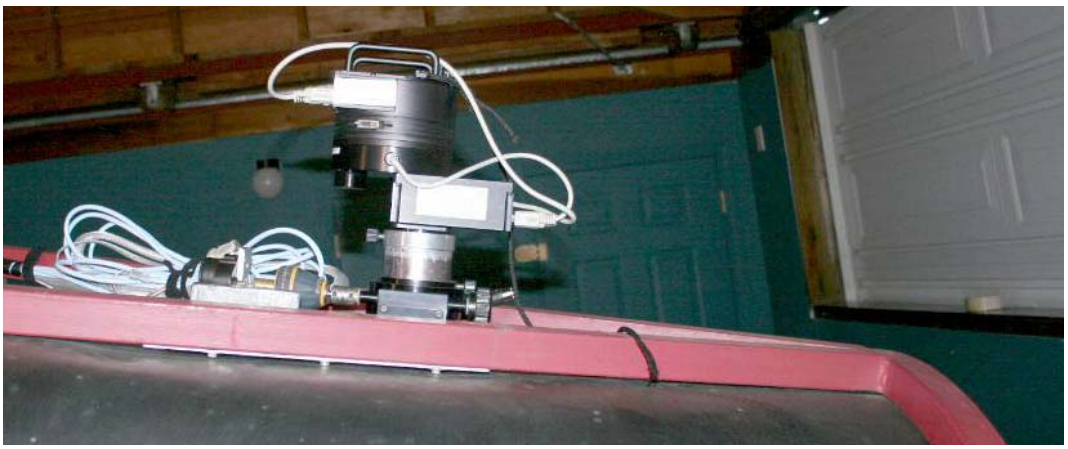
8.6.1. While maintaining a **firm grip** on at least one of the **camera handles**, and while resting the camera on the foam packing of the Pelican case, remove the camera from the **plastic bag**.

8.6.2. While pointing the camera downward to avoid dust from falling on the camera window, **remove the 2" adapter cover** from the camera.

8.6.3. Slide the **camera into the drawtube** and **orient the camera** such that it is in its "**North is up" position**.

8.6.3.1. At this time, if you know the position angle of your first target, you can position the camera orientation angle in the drawtube to point to the rotation angle indicated on the compass rose. This should be done by rotating the drawtube and not just the camera. The reason for this is because you can't get to the knob if the AO8 is over it.

8.6.3.2. The following image depicts the zero angle (north is up) orientation angle (power connector is on the north side):



Hint: the USB and power connectors are facing north (toward the primary mirror) for the index position (north is up). The AO8 cable is facing south.

8.6.4. **Firmly tighten the setscrew knob**. **Jiggle the camera and tighten** until the camera is firmly in place and you can **guarantee that the camera will not fall out when the camera is upside down** (when the scope is on the other side of the pier, usually pointing West of the meridian).

8.6.5. **Immediately attach the safety "Oops strap". This is a hard and fast rule. The camera will always be used with a safety strap to protect both the camera and the scope.**

8.6.6. Connect the following cables to the camera:

8.6.6.1. **Connect the large shielded Power cable to the camera POWER** port. A silver index mark on the plug should mate with the silver mark on the socket.

8.6.6.2. **Connect the 9-pin plug labeled AO/CFW/SCOPE** to the camera port labeled **AO/CFW/SCOPE**. Do NOT secure with a screw driver.

8.6.6.3. Connect the USB extender labeled "**USB 1370 USB Extension of CAT5**" to the **blue CAT5** cable labeled "**B - Ethernet**" (It might be labeled "USB Extension").

8.6.6.4. Connect the **female** end of the **USB 1370** to the supplied **short USB** cable and the **other end to the camera's USB port**.

8.6.7. Connect the **Robofocus cable to the Robofocus motor** and secure it to the tangent arm with a **Velcro strap**.

8.6.8. **Remove the counterweight** from the focuser plate and **replace the wing nut**.

8.6.9. In the drive connector cabinet, **plug the SBIG power supply DC cable to the shielded cable connector**. Note: there are silver alignment index marks on both connectors.

8.6.10. **Connect the A/C end of the SBIG power supply to the A/C outlet inside the cabinet**. You should be able to turn the power supply on with the switch on the power supply. When you do, the green light on the power supply should light up and you should hear the AO8 on the camera activate briefly, and possibly also the cooling fan. When you do this, your computer's Plug-n-Play might ask you to install the two SBIG drivers if you have already connected the cables at the desk to the computer.

8.6.11. You can tuck the SBIG power supply into the cabinet or leave it out.

8.7. **Computer Desk:**

8.7.1. **Unwrap the cables** and lay on top of the desk.

8.7.2. Connect the blue **CAT5 cable labeled "B"** to the female end of the USB extender labeled "**USB 1370 Extension over CAT5**".

8.7.3. Connect the other end of the **USB extend to the Kensington USB hub** - to port l**abeled "3"**.

8.7.4. The **Robofocus cable** (gray phone cord) should **connect to the USB to RS323** adapter and then to the Kensington **USB hub port labeled "4"**.

8.7.5. **Plug the USB hub's power adapter** into the USB hub and plug the other end into an **AC outlet**. You need to be sure to power the hub before connecting the hub to your computer.

8.7.6. **Connect the hub to the same port on your computer that you used previously**. On the Observatory computer, use the following port:

_____.

If this is the first time, connect to a port that makes it easy for you to add additional USB devices without disconnecting the hub. (For example: the lowest port allows you to easily use a thumb drive or mouse later)

8.8. **Install Software Drivers, if necessary**

When you connect the hub to the comptuer, your computer's Plug-n-Play might ask you to install two SBIG drivers: (sbiguldr and sbigusbe) Sometimes it does this and sometimes it does not.

- "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**"

8.8.1.2. Select "**SBIG USB Loader**", Location="**c:\windows\inf\sbigusbe.inf**".

- Navigate to "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**" and select "**sbiguldr.sys**".

8.8.2. The Welcome to the Found New Hardware Wizard dialog should appear a second time, indicating "SBIG USB Camera".

- **Include this location in the search**
  - "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**"

8.8.2.2. Select "**SBIG USB Loader**", Location="**c:\windows\inf\sbigusbe.inf**".

- Navigate to "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**" and select "**sbiguldr.sys**".

8.8.2.3. Click **Finish**. You should hear the camera's fan running.

8.8.2.4. You should now be able to control the camera and take pictures. (You can test that now)

- Set the **camera cooling temp to 0C**.
- Take a **focus shot** with the **main imaging sensor**
- Take a **focus shot** with the **guider**

8.8.2.5. One of the screens in CCDSoft can be used to **test the computer control of the North/South/East/West drive corrector**. You can test this with the roof closed (just be sure that the scope will not bump into the chair or step ladder)

8.9. **Double-check the balance of the scope before removing the chair.**

8.9.1. Loosen the **DEC clutch**.

8.9.2. **Lift the front end of the scope** a foot or so off the chair and notice whether it **holds that position**. If it doesn't hold the position, the scope isn't balanced and you will not be able to maintain good tracking and guiding while imaging. You will need to resolve any balance issues at this point.

- Check to ensure that the counterweight is removed.
- You may need to remove heavy eyepieces from the other focuser ports.

8.9.3. **Re-tighten the DEC clutch**, but not too tight.

8.10. **Final scope preparation:**

8.10.1. **Rotate the secondary mirror** so that the mirrored surface faces the camera in port #3.

8.10.2. **Remove the chair** and the **stepladder**.

8.10.3. **Engage the RA drive**.

9 - Installing Software Drivers

When you connect the hub to the comptuer, your computer's Plug-n-Play might ask you to install two SBIG drivers: (sbiguldr and sbigusbe) Sometimes it does this and sometimes it does not.

9.1. If the "Welcome to the Found New Hardware Wizard" dialog appears, follow these instructions:

9.1.1. **Install from a list or specific location (Advanced)**

9.1.2. Click **Next** >.

9.1.3. Choose the following:

9.1.3.1. **Search for the best driver in these locations**

9.1.3.2. **Include this location in the search**

- "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**"

9.1.4. Click **Next** >.

9.1.5. Select "**SBIG USB Loader**",
Location="**c:\windows\inf\sbigusbe.inf**".

9.1.6. Click **Next** >.

9.1.7. If "**Files Needed**" dialog appears (looking for "sbiguldr.sys"), do this:

- Click B**rowse...**
- Navigate to "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**" and select "**sbiguldr.sys**".
- Click **Open**.
- Click **OK**.

9.1.8. Click **Finish**.

9.2. The Welcome to the Found New Hardware Wizard dialog should appear a second time, indicating "SBIG USB Camera".

9.2.1. Select "**Install from a list or specific location (Advanced)**".

9.2.2. Click **Next** >.

9.2.3. Choose the following:

9.2.3.1. **Search for the best driver in these locations**

9.2.3.2. **Include this location in the search**

- "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**"

9.2.4. Click **Next** >.

9.2.5. Select "**SBIG USB Loader**",
Location="**c:\windows\inf\sbigusbe.inf**".

9.2.6. Click **Next** >.

9.2.7. If "**Files Needed**" dialog appears (looking for "**sbiguldr.sys**"), do this:

- Click **Browse...**
- Navigate to "**C:\Program Files\SBIG\Driver Checker\SBIG Drivers**" and select "**sbiguldr.sys**".
- Click **Open**.
- Click **OK**.

9.2.8. Click **Finish**. You should hear the camera's fan running.

9.3. You should now be able to control the camera and take pictures. (You can test that now)

9.3.1. Set the camera cooling temp to 0C.

9.3.2. Take a focus shot with the main imaging sensor

9.3.3. Take a focus shot with the guider

9.3.4. One of the screens in CCDSoft can be used to test the North/South/East/West drive corrector control. You can test this with the roof closed (just be sure that the scope will not bump into the chair or step ladder)

10 - Troubleshooting

This section will provide some troubleshooting tips.

10.1. Use the test lens that Ron made to ensure that your software is functioning correctly during the daytime.

10.2.