## Setting up Agile from the Observing Specialist's Point of View

This document describes how to mount and unmount Agile from the NA2 port of the 3.5 m telescope at Apache Point Observatory, after it has been connected and setup on the cart. I include guidelines for instrument operation from the observing specialist's point of view, such as mounting a filter or setting up to take bias and dark frames. I also include instructions on adjusting the bias level if needed. If you have any other additions or suggestions on how to improve this document, I would really appreciate the feedback.

–Anjum Mukadam

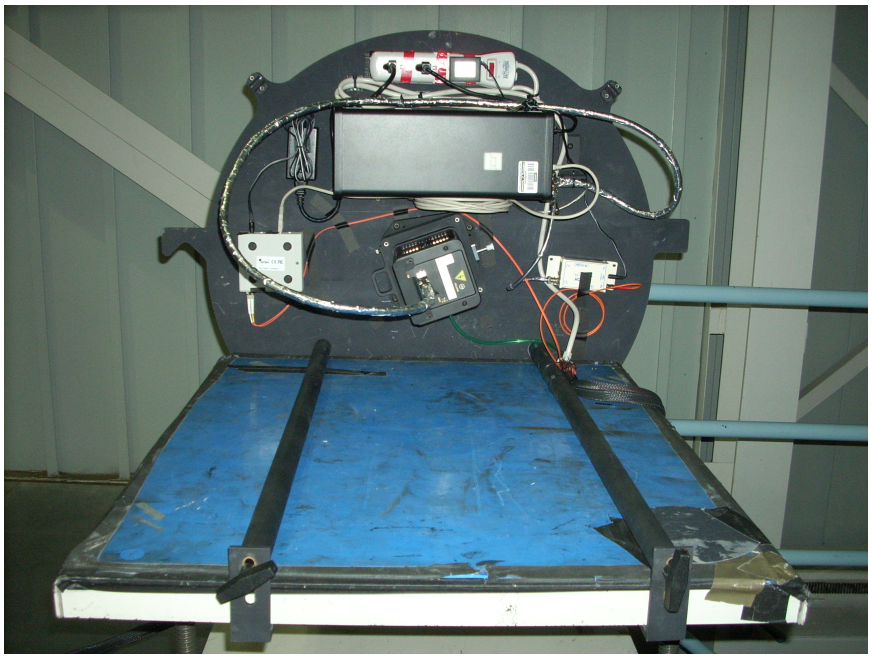

Figure 1: Agile on its cart: The CCD camera is attached to an assembly at the center of the mounting plate. On top of the CCD camera and attached to it with a triple-shielded analog cable is the electronics controller.

# 1 Starting Point for the Observing Specialist

Please ensure that the CCD camera and electronics controller are attached to the mounting plate (see Figure 1). Please ensure that the big mounting plate is vertical and hanging off the edge of the cart. If the plate is lying flat on the cart, two people are required to lift it, bring it to the edge of the cart in a vertical position, and secure it to the cart with clamps. This must be done by engineers in the daytime. Please ask Nick MacDonald for assistance, as he is well versed with this procedure. I would like to make a policy that one person is not allowed to change the position of the mounting plate on their own, even if the person has been or is a weight lifting champion.

Agile is thermo-electrically cooled, and takes no more than a few minutes to cool down to -40 C. There is absolutely no need for the CCD camera to be kept running all the time when not

in use. The power to the camera should be switched on or off using the switch on the controller itself and the switch on the power strip, placed just above the controller (see Figure 2). ACCIDENTALLY DISCONNECTING THE CAMERA WHEN IT IS POWERED ON CAN FRY THE CCD; this is not covered by warranty. Dave Woods has kindly replaced the camera cable slide locks with screws; you can no longer accidentally disconnect the camera. Hence there is no need to unplug the power chord any more when moving Agile around.

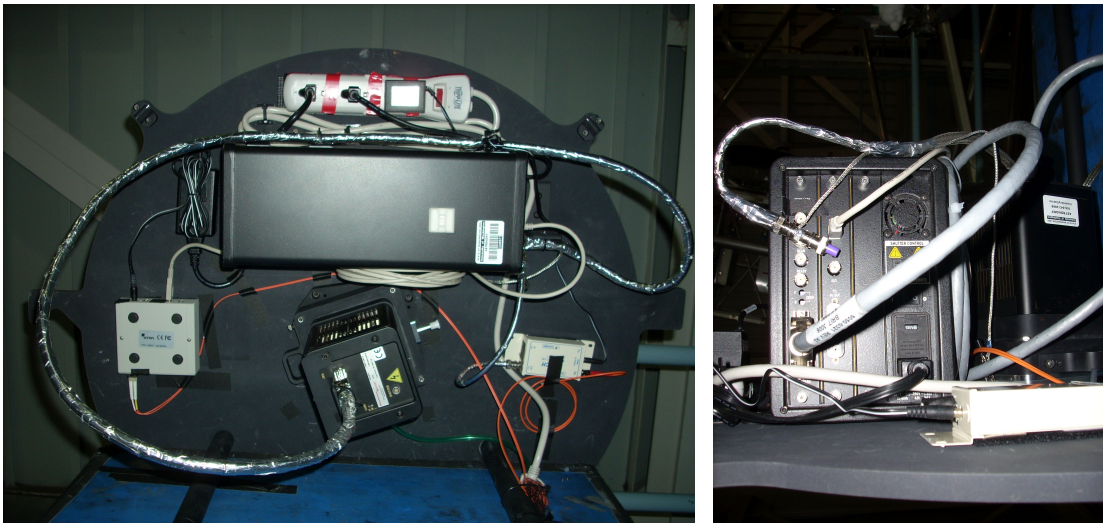

Figure 2: The triple-shielded analog cable covered with aluminium tape connects the camera to the electronics controller. Digital CCD images travel via a USB 2.0 cable into a media converter (visible to the left of the camera), that transmits these images through the orange duplex fiber-optic cable to the computer nimble. Exposures are controlled directly by GPS-synchronized pulses that travel through a separate fiber-optic cable into another media converter (visible to the right of the camera). These pulses then traverse via a foot long co-axial cable (also covered with aluminium tape) into the BNC connector marked as “Ext Sync” on the electronics controller after suitable termination by a 50 ohm resistance.

## 1.1 Agile: Mounted & Connected

The triple-shielded analog cable connects the camera to the electronics controller (left panel, Figure 2). It is important that this cable be securely fastened; should the connectors at either end appear loose, please take a few minutes to tighten the connection. Please ensure that the power is turned off when attempting to tighten or tweak the camera cable connections. Any noise visible in CCD images is likely to have been picked up by this cable because the signal is still in analog form, which is why we have covered it with aluminium tape, grounded this additional third shield, and laid out the cable as straight as possible to eliminate coils entirely.

After digitization within the controller, the CCD images travel via a USB 2.0 cable into an ICRON media converter unit to the left of the camera. The images are converted into an optical signal, and then travel through a duplex fiber-optic cable to the intermediate level. A duplex LC-LC

adaptor helps connect this short 75 ft long cable between the instrument and the intermediate level to a longer 330 ft cable between the intermediate level and the computer room. Another ICRON media converter in the computer room transmits the images through a USB 2.0 cable to the data acquisition computer Nimble.

Nimble receives IRIGB pulses from the new GPS clock; these pulses arrive at a BNC connector on the Brandywine PCI timing card housed within the computer. Also connected to this PCI card is a custom-built unit with aluminium housing that has two BNC connectors marked "IN" and "OUT". The GPS-synchronized pulses that provide exposure control commence from the BNC connector marked as "OUT" and travel to the instrument via another fiber-optic cable; these pulses initiate the frame transfer operation and serve to end the ongoing exposure and start a new exposure. Agile does not have a mechanical shutter; the frame transfer operation serves as an electronic shutter. These pulses are converted into an electrical signal by a SI Tech media converter on the right of the camera and then traverse via a co-axial cable into the BNC connector marked as "Ext Sync" on the electronics controller (see Figure 2). It is necessary to terminate these pulses using a 50 ohm resistance, otherwise the exposure timing will be affected.

As with the CCD imaging fiber-optics, the fiber-optic cable that carries the GPS-synchronized pulses from the computer room runs only up to the intermediate level. We have another short stretch of a 75 ft long fiber-optic cable between the intermediate level and the instrument. Should either of the fiber-optic cables between the intermediate level and the instrument be damaged, they can be replaced with spare cables kept in the Agile cabinet. Please read the relevant section in the troubleshooting guide to learn how to do so. Thanks to Dave Woods and Nick MacDonald, the fiber-optic cables are now enclosed in a hard plastic braid that should protect them in case someone steps on the cable braid.

Please ensure that there are thus three cables emanating from the cable braid attached to the instrument, one of which is a power chord that helps connect the power strip just above the controller and the remaining two are fiber-optic cables connected as described above. We have found it necessary to also shield the foot-long co-axial cable. You may notice a grounding wire attached to one of the clamping grooves, that would allow the shielding of the co-axial cable (and the analog imaging cable) to be at the same potential as the telescope when mounted at the NA2 port, thus eliminating possible ground loops. Such an arrangement should drastically reduce or eliminate any noise pick up in the co-axial cable that carries the sync pulses to the controller. Uneven exposures could have been caused by noise picked up by the co-axial cable; please report the incidence of any uneven exposures along with the configuration of the instrument at the time to Anjum or Russell right away.

# 2 Adjusting the Bias

The CCD bias can change abruptly once in a year or so by as much as 50 counts. If the bias drops to an extremely low value of 20 to 30 counts for 2x2 binning, it is time to adjust the bias setting. Please power down the camera and using a tiny flat head screw driver, tune the tiny potentiometers on the elctronics controller shown in Figure 3 so that the bias value is within the range of 150 to 250 counts for 2x2 binning. Turning the potentiometers clockwise increases the bias level and turning them anti-clockwise decreases the bias. The fast potentiometer labeled as F is meant for large adjustments and the slow potentiometer labeled as S is meant for fine-tuning.

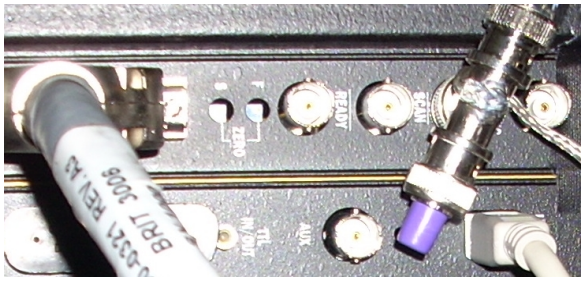

Figure 3: Adjusting the bias: The bias can be increased (or decreased) by gently turning clockwise (or anti-clockwise) either one of the potentiometers F or S on the electronics controller shown in the figure when the camera is powered down. The fast potentiometer labeled as F may not require more than a quarter of a turn, while the slow potentiometer labeled as S may require a complete turn or more to adjust the bias to a suitable value.

After each adjustment which must be carried out when the camera is powered down, you will have to power the camera back up, type the word “pvparam” on Nimble to commence the CCD cooling, and wait for a few minutes till the CCD has cooled to -40 C before you can acquire a bias frame to determine the new bias level. A high bias value is not harmful, but a low bias value may cause the loss of low level data. If the bias jumps to a high value even beyond the range given above, there is no need to waste telescope time to reduce the bias to an optimal setting. But you may have to do so if the bias jumps to a low value. This adjustment must be done gently as the potentiometers are held in place by the strength of the soldering connection, and not robustly by screws and nuts. Should you manage to break one of the potentiometers, simply use the other one to set the bias value and conduct your observations, and please send Dave Woods an email to solder the potentiometer back the next day. I don’t know the consequences of breaking both potentiometers simultaneously, and let us hope we never have to find out.

For different values of binning, the bias level will be different for a given adjustment. When the bias is set to a value of 100 for 2x2 binning, it maybe too low for 3x3 or 4x4 binning. Hence a higher bias setting between 150 and 250 counts for 2x2 binning is preferable rather than a lower value. Most observers will probably acquire data with 2x2 binning with the focal reducer, as that would yield the most optimal PSF sampling at an arcsecond seeing.

## 2.1 Installing a Filter

Even when an observer does not require a filter, please ensure that the empty filter slide is present in the mount, as it will prevent scattered light from finding a way in. We are able to mount a 3x3 filter held within the standard plastic filter holders found at APO. The plastic 2x2 filter holder is thicker than the 3x3 filter holder; a filter slide with a standard 2x2 filter holder on a 3x3 adaptor plate does NOT fit in the cavity. My present workaround is chopping off the middle portion of the plastic 2x2 filter holder using a pair of scissors, and then re-assembling the top and bottom pieces with the filter in between using double sided teflon tape. The filter within its plastic mount should not stand above the edges of the filter slide. I used smaller screws and nuts for this assembly by design.

Installing such a (3x3 filter in the standard mount or a 2x2 filter in the trimmed mount attached

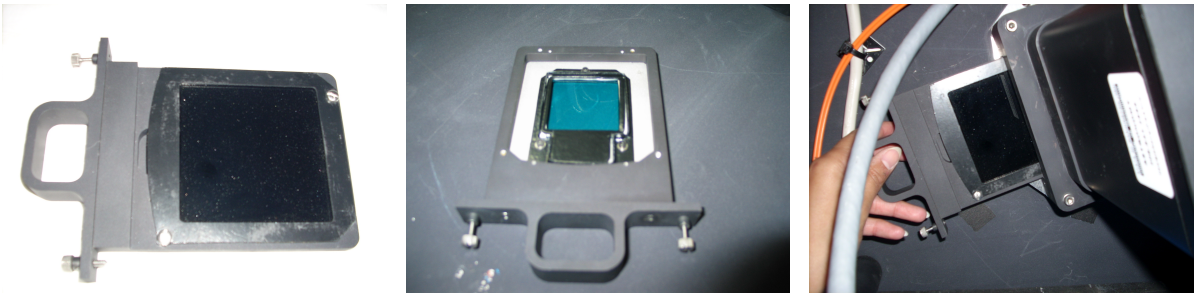

Figure 4: Filter Slide: The left panel shows how a 3x3 filter can be mounted on the filter slide, while the middle panel shows a mounted 2x2 filter holder with a 2x2 BG40 filter, attached to a 3x3 adaptor plate. The right panel shows where the filter slide fits into the hardware mount. It is easier to mount the filter slide with the orientation shown, although it should fit in both ways.

to a 3x3 adaptor plate) mounted filter within the slide should only require affixing two screws (see Figure 4). The filter slide can then be slid into its slot; this is easier with the filter mount on the side towards the camera as shown in the lower panels of Figure 4, although it is possible to mount the filter facing either side.

# 3 Mounting Agile on the NA2 port

Please follow these steps to mount Agile on the NA2 port from the starting point described earlier.

1. Nick MacDonald has graciously made a proper lens cover for the focal reducer. Please remove this hard plastic cover attached to the focal reducer on the rear side of the big mounting plate.

2. Roll the cart with Agile close to the NA2 port. Raise the cart using the crank on the rear side of the cart till the big mounting plate mates appropriately with the NA2 port. Clamp the big mounting plate to the NA2 port, so that the clamps fit in the grooves.

3. Once the mounting plate is securely fastened to the NA2 port, unscrew the black plastic end-caps on the two long aluminium rods. Once the plastic end-caps are out of the way, please remove the aluminium L-shaped brackets that allow the rods to hold to the cart. These rods help balance the big mounting plate hanging off the edge of the cart.

4. The cables emanating from Agile are wrapped around one of the rods and fastened using a tie-wrap. The rods comprise of two parts, a short half that is attached to the big mounting plate, and a longer component. Please unscrew the longer component for both rods. This will leave the two short halves on the mounting plate.

5. Please switch on the power strip and also flip the switch on the controller just above the power chord connection to turn it on. When you do so, you should hear the noise of the fan.

6. Please pull out the dark slide. On the right hand side of the camera, you will find a thin steel rod with a white plastic cap, as shown in Figure 5. This rod manipulates the position of a black piece of plastic that protects the CCD when the camera is not in use. With the dark slide "in" as shown in the left panel of Figure 5, the CCD is covered and no light is incident on it. With the dark slide pulled "out", as the right panel demonstrates, the CCD is exposed.

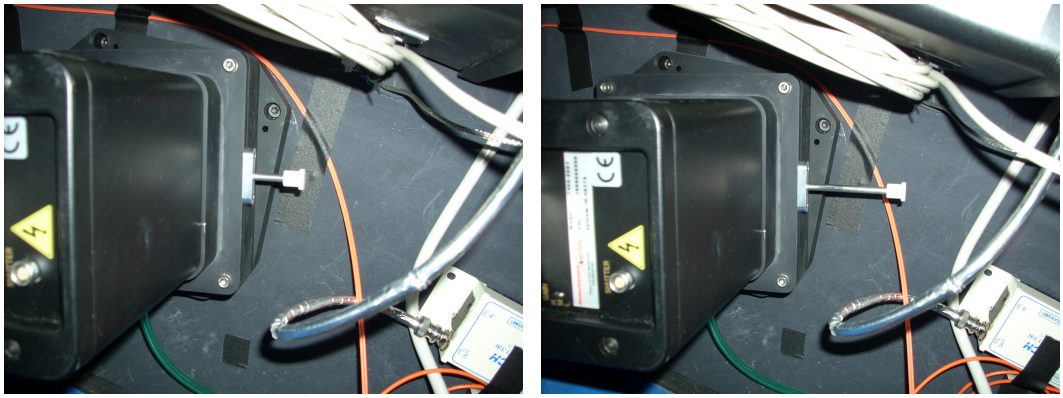

Figure 5: Dark Slide: The left panel shows a closed dark slide, where the CCD is no longer exposed to light. The right panel shows an open dark slide, where the aperture afore the CCD is open for the light beam.

7. Please walk back to the control room, and log onto the data acquisition computer nimble with the username ccd. After launching a new terminal, please type the word "pvparam" and you will see some text scroll by. If the text has the appearance of error codes, see the section on troubleshooting. If not, then this action should have initiated the cooling of the CCD to the set point of -40 C. A silent observer in the dome would have heard a distinct increase in the sound coming from Agile at that time. The CCD should cool in a few minutes, and Agile will be ready for action. This completes the mounting procedure.

# 4 Setting up for calibrations

An observer will probably request bias or dark frames and flats as well. Agile does not have a shutter as it uses the frame transfer operation to end an exposure and start the subsequent one. To setup the observer for bias or dark frames, when the instrument is mounted on the NA2 port, please close the "eyelid" of the port. To setup for flats or to acquire data, please remember to open the eyelid again. There is no special setup for flats pertaining to Agile; it should be the same as for other instruments.

Should the observer request you to set up for bias or dark frames when the instrument is not mounted on the NA2 port, please switch on the power to the controller and then ensure that the dark slide is in. Please log on nimble as the user "ccd", and type the word "pvparam". It should take the CCD a few minutes to cool to -40 C, after which the observer is ready to acquire bias and dark frames. The data acquisition program prints the temperature of the CCD, and the observer should check that the temperature is -40 C before he/she decides to store the acquired images.

# 5 Unmounting Agile from the NA2 port

1. Power off the controller using the switch shown in Figure 2. Please also turn off the switch on the power strip above the controller.

2. Please close the dark slide.

3. Please roll the cart beneath the instrument, so that the crank is on the rear side of the cart. Next fasten back the aluminium rod halves into the short rod halves that were left attached to the big mounting plate. You should now have two long rods attached to the mounting plate, as in Figure 1.

4. Raise the cart using the crank on the rear side of the cart. At a suitable height, attach the L-shaped metal brackets back on the rods, as shown in Figure 1. Fasten the black plastic end-caps. The cart is now capable of supporting the weight of the instrument. Undo the clamps that fix the mounting plate to the NA2 port. The cart with the instrument can now be rolled away safely and tucked in a corner.

5. Please ensure that the fiber-optic cables are tucked out of the way and safe from rolling carts of other instruments.

6. Please attach the hard plastic cover back on the focal reducer.