

CHARA Array Operating Procedures

1 Introduction

Introduction to the document, mostly still to be written . . .

This document and all others in the CHARA Array documentation tree can be found in the password-protected user area at: <http://www.chara.gsu.edu/CHARA/data>.

2 Lab Rules

2.1 Lab Rules Intro

The CHARA optics lab is a building within a building and is intended to provide thermal and vibrational stability. The main goal of the CHARA lab is to keep all optics and equipment safe from any hazards. The crucial issue being misalignment of anything. The amount of dust and dander must be kept to a minimum.

2.2 The Laser

A high-powered infrared laser is used for the delay line metrology. This is an eye hazard, so before entering the lab check to make sure the red light above the door is *not* on. If the laser is activated it is a must to put on IR-protective goggles. If you are not sure, wear the goggles.

2.3 Lab Procedure

So please remember that:

Procedures in the lab must be followed closely and failure to follow these rules will result in loss of lab privileges and a blast with the CHARA ray gun. While we hate physical violence, you will grow back . . . the equipment will not.

- Before entering the lab, you must have a reason or tasks at hand.
- Lab booties/shoe covers must be worn by all.
- Proper clothing is also important, loose hanging jackets garments etc will be better left outside of the lab until your finished.
- Please be alert and move slowly and cautiously.
- When entering or exiting the lab make sure to walk across the sticky floor mat. If the mat isn't sticky anymore remove the top layer. If this is close to the final layer please let Bob know so he can order more.
- No more than three people are allowed in the lab at once unless it is 3 to 4 hours before observing time or there is some pressing need. Many bodies can create unwanted atmospheric effects. Besides, with too many people it is too easy to bump into each other, and the equipment.
- If you bump, hit, move or just tap anything in the slightest way, let us know.
- Never touch anything you have not been trained to use. If ever in any doubt, leave it alone and get someone who knows.
- Any unusual sounds, sights, movement of equipment, etc., should be noted.
- If you know the path of the laser beams, metrology or alignment, stay out of their way especially right before observing. If you must go into the lab during this time don't forget to put on IR-protective goggles.
- Access and use of the lab requires training. If a piece of equipment does not appear to be operating properly let us know immediately. Also if you are uncertain about a lab procedure or a step in the alignment sequence contact us before proceeding.

3 Observing Conditions

3.1 Observing Conditions Intro

In opening the CHARA Array, conditions should be, for the most part, ideal. If the weather is questionable, it is best if the sky is 60% to 70% clear and conditions stable before commencing. Delicate optics and electronics make up the majority of the Array and it's better to err on the side of caution. In preparation for observing, the Mount Wilson weather server and web-based weather pages should be consulted. The telescopes can now be closed in about 10 minutes from the control room. With this in mind, don't open up the telescopes to observe if conditions can change for the worse rapidly enough that you don't get 10 minutes or more to close down safely. Weather stations now exist at each bunker and there is a control system software application to display the current conditions. Soon this application will also issue warnings. One can also use the white Radio Shack thermometer/hygrometer outside of the control room. With the Array becoming more fancily automated and weather monitoring technology becoming more robust (weather servers, satellite images, web cams, etc.), almost all weather monitoring can be done seemingly without ever leaving the cozy control room. Unfortunately this is not a good policy and nothing beats going outside for a gander and giving the sky a good old fashioned assessment. Obviously weather variations do exist from telescope to telescope as much as 16% in RH at times. Most of the time this just means something is blowing through and opening is not a good idea. These circumstances need to be dealt with cautiously depending on the given weather conditions. Allowing extra time to close is advised in case of any problems. If any questions or doubts arise contact one of the CHARA staff.

3.2 Humidity

Only observe if the humidity is steady or dropping, at 75% or below. If you are observing merrily with the humidity at about 50%, and you notice the humidity start to rise, you can keep observing, but keep a close eye on the humidity. When it hits 75%, start closing down. 75% is conservative, but we need to be conservative because it takes so long to close down. Other humidity warning signs that you can use are: 1) water dripping off the OPLE building (or wet spots on the asphalt straight down from the eaves); 2) cold, clammy feel to metal objects such as railings; and 3) dew forming on the parked cars (it forms on the white cars first). Important to note that the humidity can rise from 50% to 80% in as little as 10 minutes.

3.3 Dust

Gauging the airborne dust is problematic because you need a bright light and a relatively dark night. In general, you want to look in the bottom 0.5 meter of the light column. There will be a diffuse column lit up by the beam – don't worry about it, just follow the dust glints. If you can count the dust glints, the conditions are safe to observe. If it looks like a blizzard, close up. If any of the dust glints shine with an orange or a peach hue, or the dust glints look abnormally large, the dust is probably ash – close up immediately. Ash seriously degrades bare aluminum coatings. Dust and wind go together. But, just because it is calm, the dust conditions might still be bad. If it was windy a few days earlier, it could have

kicked up a lot of dust, which can take several days to settle. Finally, during late spring to early summer, conifer tree pollen can be problematic. If particulates are borderline please email the CHARA day staff so they can clean the optics as soon as possible.

3.4 Wind

Wind has the effect of degrading the seeing as well as kicking up dust. The wind effects are amplified in the tunnel between the OPLE building and the office building, so look for other places to gauge the wind conditions. The intersection of the road and the trail to the eastern telescopes is a good place to gauge conditions. To be on the safe side, we only observe under calm to light breeze conditions (gusts less than about 10 knots, or 15 kph). Windy conditions we try to avoid. If you can hear the gusts from your desk, it is too windy to observe. If you hear whistling from the light pipe supports, it is too windy to observe. If you hear the signs on the chain banging, it is too windy to observe. Occasionally you will hear the wind rustling the tops of the tall trees, but it is calm at ground level. This is a symptom of chaotic wind conditions, and almost always happens during windy episodes (Santa Anas, onshore flows, etc.), during which you shouldn't observe – the seeing will be bad anyway.

3.5 Snow

Because of the nature of the snow that falls on Mount Wilson, it is usually not a problem. If snow/wind conditions are such that drifting occurs, don't open up. If there is still any snow stuck to the telescope dome itself, don't open up. Otherwise, you are free to observe (assuming the humidity, dust, and wind conditions allow it).

4 Remote Observing

4.1 Modes of Operation

Since many beam combiners run simultaneously at CHARA, remote observing procedures have become intense and involved. On each observing night scheduled there will be allocated a Primary Observer and a Secondary Observer and occasionally a Tertiary. This is taken into account when issues arise and if needs be the Primary Observer will take precedence and everything is done to keep them working, even if it means that the Secondary and Tertiary may have to cease their operations. It is important when instances occur that each observer's tasks are followed correctly and slowly. The Night Observer (or Observing Specialist) running the Array for the evening may be quite busy assessing other situations. When a problem is encountered with remote observations the first task is to check the CHARA Array Software Overview Manual and use it in conjunction with this document. However, if serious situations occur with the OPLE carts or the Telescopes this will require immediate attention and notification on Skype. If there is no response from Skype place an emergency phone call to the CHARA Array.

4.2 Remote Observing Protocol

The current CHARA protocol is that if Remote Observation time is allocated, the Remote Observer must first be trained and fluent in Array operations. We insist and will check that Astronomers have observational experience and once again are acquainted with the software manuals. CHARA will decide if observing qualifications have been met. Also required for first time observers is a visit to Mount Wilson for an accompanying observing run at the CHARA Array to learn observing techniques firsthand. Learning over Skype or running things with just a few nights practice is not sufficient and will not qualify for remote observations. On evenings of extreme error recovery there are many things that take time and go unnoticed to the Remote Observer. If your observing specialist feels that sufficient training requirements have not been met, the run may be rescheduled or canceled for the evening until proper observing procedures can insure safe use of the instrument. It is a must to also proceed cautiously in the remote observing environment. Without further ado, here is an attempt to explain running The CHARA Array.

Crucial Tools

- Take Notes
- Weather GUI
- Sockman
- Patience

4.3 Pre-Run Assessments

Due to the nature of remote observing before the evening's run it is absolutely necessary to assess a few things. First would be the weather. There are any number of circumstances the remote observer might not be able to fully assess. It's important to determine what past nights conditions have been and what the night will have in store. Everything from the

NOAA WX page, The Clear Sky Clock and the Jet Stream need to be checked. Although the Observing Specialist on Mount Wilson will be responsible for these assessments, with multiple instruments running the remote observer needs to be checking as well. This will assist in knowing when to open and or close up critical things like the Domes and Enclosures. Secondly, during the day many changes may have taken place with the instrument so check for instrument updates via email and the Array status from the observing specialist and/or CHARA staff on Mount Wilson. The policy is that nothing is to be opened remotely unless it is cleared through the observing specialist at Mount Wilson. The bottom line is the Observing Specialist will tell the astronomer how best to proceed and these orders should be carried out, regardless of other intentions.

Essential Observing Links

- 150-Foot Solar Tower Current TowerCam Image (<http://www.astro.ucla.edu/~obs/towercam.htm>)
- Official U.S. Time (<http://www.time.gov/timezone.cgi?UTC/s/0/java>)
- National Weather Service (<http://www.wrh.noaa.gov/lox/>)
- California Regional Weather Server (<http://squall.sfsu.edu/>)
- Clear Sky Clock (<http://cleardarksky.com/c/MtWilsonOBCAkey.html>)

4.4 Remote Observing Setup

The observing specialist on Mount Wilson will run all the servers locally. Before setting up, contact the mountain observing specialist to make sure the instrument is stable and ready. At this time nothing by the Remote Observer should ever be turned on unless an "All Clear" has been given by the observing specialist. The first order is to set up the remote observing station monitors and or control panel. This is done with a background click to bring up the menu options and drop down choices for the various clients and GUI'S that will be used for the nights observing session. The clients that we will use are:

- TELESCOPE GUI's (There are two telescope GUIs to be used. After the first GUI pops up, then click CONTROL on that GUI which is located towards the bottom right and this will bring up the second GUI the observer will use.)
- GPS
- OPLE_PRIMARY or OPLE_SECONDARY (Dependent on Observing Schedule – Ask the Observing Specialist)
- METROL
- TIPTILT
- SHUTTERS
- LASER_FILTER_WHEEL
- NUTRAL DENSITY
- POWER
- SOCKET MANAGER
- WEATHER
- CLASSIC/CLIMB (Dependent on beam combiner use)

NOTE: If a Client does not appear this means that the server is not yet running. Ask the Observing Specialist or standby for more information.

Each GUI has a STATUS button. The Status gives the observer the current status of what is going on with that particular system. Since the servers are all run from the Mountain, it is essential that the STATUS GUI be run on the following systems that have a STATUS GUI option to use. A STATUS GUI should be used for the following:

- OPLE
- TIPTILT
- The TELESCOPES
- GPS
- CLASSIC (or Beam combiner choice)

4.5 The Grand Wazoo

The Grand Wazoo is the main sequencer or control panel for the Array. This is what we use to execute the commands to observe and collect data. The Grand Wazoo also gives the necessary information needed for observational targets. Inputting the stars designated number then hitting the corresponding catalog number next to the the star (for example HD, HR, SAO, IRC), and clicking WHEN, will give the AL & EL plus sky availability and the hour angle in the GW display window. The remote observer will use The Grand Wazoo as a control station to observe. It also will list information about the observing session. For example, when going to a star it will give the status of the acquisition procedure and also any error messages. Pay attention to those error messages. The Grand Wazoo will guide you along through the observing run and its tasks.

Grand Wazoo Setup

- To set up the Grand Wazoo, click on the background (or the Applications menu bar on GNOME environments) and, depending on which observing slot you fall into, click ‘Grand Wazoo->Primary’, ‘Grand Wazoo->Secondary’, or ‘Grand Wazoo->Tertiary’. There will be a slight delay upon start-up.
- Once the Grand Wazoo comes up, there will be two smaller pop-up windows that arrive with it. One is to set ‘ACTIVE SCOPES’ and the other for ‘BEAMS’, ‘POPS’, and the ‘REFERENCE’ cart. If lab alignments are done and the lab is clear, the beams and PoPs should be set correctly as they read their positions from the servers that run them.
- Check with the observing specialist about the reference cart selection.
- Next, check and choose the SCOPES or Telescopes, Beams and PoPs that you will use, *if* they are not set already. Make sure the Telescopes, Beams and PoPs are correct, even for those are that not being used by the remote observer.
- If none of this is correct, check with the observing specialist. These choices can also be made and checked using the ‘CONFIG’ and ‘SCOPES’ button on the Grand Wazoo and may be needed later if there is a baseline change.
- Next, if there are multiple beam combiners running, unclick the ‘BL SOL’ button. This collects baseline solution data when only one combiner is running.
- Choose the beam combiner by using the ‘BEAM COMBINER’ pull-down menu; pick the instrument you will use for the evening’s observing session.

TipTilt Comms

- The Beam order for the TIPTILT server needs to be checked and possibly selected.
- Check the TIPTILT STATUS GUI. If it reads that the selected beams are correct for the combiner you're using, then all is well.
- If not, run the TIPTILT COMM sequence. TIPTILT COMM is a Grand Wazoo button labelled, 'TT COMMS'. When selected, the Grand Wazoo will put 7 items in the job queue and then run them. If the communication is established there will be message in the status window of the Grand Wazoo indicating whether communication is established with the chosen telescopes.

Synchronizing the Clocks

Synchronizing the clocks can be tricky. The observing specialist will do this for you, on the mountain, before your observing session starts.

- The Chara Time on the GPS STATUS GUI should match the hours, minutes, and seconds of the Official U.S. Time (<http://www.time.gov/timezone.cgi?UTC/s/0/java>) website.
- If it does not, then just press the 'SYNC ME' button on the Grand Wazoo and notify the observer on the mountain.
- Due to running many instruments at once, the time is crucial, synchronizing the clocks at the wrong moment may cost loss of data. It is best if the remote observer just sticks to checking the clocks and notifying the mountain if anything occurs.
- Periodically check the time during the night and make sure on the Telescopes, Ople, and operating Beam combiner STATUS windows list the correct time.

At this point, the Remote Observer's station has been set up it is time to notify the mountain that all is ready at the remote end. Be patient. The remote observer might want to recheck the weather status. Once the observing specialist has been contacted and all systems are running, it is time to power things up and slew to a target for some system alignments.

4.6 M10 Alignment

M10 is the mirror in the light pipes that directs the beam into the PoPs correctly. The observing specialist will have most likely done this task before the run. Instances where remote observers are not familiar, below is the procedure.

- Verify with the observing specialist that the Tip/Tilt cover is on, that the corner cubes are out, and that the periscope covers are off in the Lab.
- Make sure the LASER shutter is open.
- Next be sure the Laser_Filter wheel is on 0.
- Under ACQUISITION on the scope GUI Click M10AL.
- The TV should show a large circular light pattern.
- If you see no light recheck light sources and check the TV ADJUST GUI and click DIMSTAR.
- Launch the PICO_2 GUI.

- Now select the telescope that will be used for the evening’s observations by setting the PICO_2 scroll down menu to the telescope M10 in question – for example, ‘S1M10’.
- Yet another GUI will pop up allowing one to click in the directions needed to align with the spot.

4.7 System Check

The observing specialist on the mountain will have opened up the telescope enclosures, dome slits, and optics covers, as well as have things powered up. Anytime the telescopes are open and used it is important to keep a watchful eye. Weather conditions may change and, on occasion, telescopes may move in unexpected ways. The Remote Observer should ALWAYS remain at the control station while the telescopes are slewing. Also, keep an eye on the azimuth and elevation of the telescopes while they are in motion. The telescopes can be watched visually by using Spycam 1 (‘SPY1’) to make sure things are moving correctly on the first slew. The declination should never go below 15 degrees. If a situation arises and one must leave the control room for other issues, make sure the scopes will not track into the ground during this time. Once the confirmation has been given from the observing specialist, you can begin to acquire the first star.

First, make sure that all telescope optics covers are open. Visually check the ones you can by using ‘SPY1’ and ‘SPY2’.

- M1 OPEN
- M3 OPEN
- M5 OPEN
- FINDER OPEN

Next, make sure the telescopes being used are in their parked positions. Check by referring to the telescope STATUS GUI AZ and EL positions. For each telescope, the elevation should read 90.0, and ‘SPY1’ should show the end ring of the telescope framing the top of the open dome. The azimuth values should read the following:

Scope	Azimuth
S1	172.0
S2	172.0
E1	55.9
E2	55.9
W1	99.3
W2	99.3

Finally, check the POWER GUI to make sure that the AZ and EL power is on, denoted by the color green. It is suggested that one double check the Grand Wazoo Setup steps (see [Grand Wazoo Setup], page 7). If any of these steps do not make sense do not turn anything on and contact the observing specialist for assistance.

4.8 Slewing with the Grand Wazoo

- Find a bright star to initialize the telescopes by using the INIT button.
- Enter Calibrator 1, Object, and Calibrator 2 (if used) on the Grand Wazoo. Enter the target by filling in the blank next to the ‘NUM’, ‘IRC’, ‘HR’, ‘HD’, or ‘SAO’ and pressing the corresponding button.

- Check that the azimuth and elevation of the star are correct.
- Now you are ready to go to the star using the Grand Wazoo. Click 'OBJECT'.
- Verify that the telescopes are moving by checking the azimuth and elevation feedback in the telescope GUI status window, and viewing the 'SPY1' camera. The telescopes will go to the elevation of the target first.
- Two TV windows will pop up so one can view this task.
- Click 'STOP JOB QUEUE'. This will not stop the telescopes. Since this is the first star, we do not need the job queue to finish. We need to do alignments first.
- Click 'FIND' under the ACQUISITION heading of the telescope GUI. This has a larger field of view than the acquisition camera (chosen by selecting 'IN').
- The Stars should appear in both TV's and stop.
- Click 'GRAB' under the TV TRACKING heading of the telescope GUI. When the star is centered in the cross hairs, click 'OFF'.
- Then Click 'IN', under the ACQUISITION heading of the telescope GUI. This moves the acquisition mirror into the telescope beam, allowing one to see the star in the acquisition field.

Acquisition Laser Alignment

- Check availability of VIS BEAMS with Observing specialist.
- Put the Neutral Density Filter on ND 3.
- Make sure the Tip/Tilt shutters for the corresponding beams are closed so that the laser does not blast the TipTilt CCD.
- Click 'ALIGN ACQ B5' on the Grand Wazoo, which should show a laser spot in the field. If not, check the TV ADJUST GUI, SHUTTERS, or LASER_FILTER settings.
- On the telescope GUI, Click 'ADJ' under the TV TRACKING heading. This will bring up a box to align things. Move the ticks to line up with the laser position in both the vertical and horizontal directions. **NOTE:** Verify it is the laser and not the star.
- If the laser is difficult to see use the TV ADJ. Visually, brightness may vary from beam to beam.
- Click 'ALIGN ACQ B6' for the other beam.
- Close the laser and open the corresponding TipTilt shutters.
- This should be checked throughout the night. If the laser spot is moving around significantly, it could mean other things need to be looked at and this should be noted.

Reacquire the star with The Grand Wazoo

- Click 'START JOB QUEUE'. The Grand Wazoo will now go to the target star, grab it, center the star in the cross hairs, and lock the TipTilt servo. The Grand Wazoo will list errors, if they happen, in the text window at the bottom.
- The TVs will disappear upon completion.
- If an error comes, up click 'STOP JOB-QUEUE' on the Grand Wazoo and notify the observing specialist.
- If a star does not follow the sequence, the acquisition will have to be done manually. The job queue can be restarted if it was not cleared.

- Once the stars are locked in TipTilt and the flux values look good, everything should be set.
- While the Grand Wazoo instructs the telescopes to acquire the star, it also starts ASTROLIB and instructs the OPLE server to slew the carts to the proper position.

4.9 OPLE Cart Operation

While operating the OPLE carts, the remote observer should keep an eye on the delay lines as much as possible. Do not change the direction of the carts too quickly. When moving them, click STOP, wait, and then restart them. Also watch for warnings on the OPLE server STATUS display. If the FH= Front Hard or BH = Back Hard lights up it means the hard limit switch has been contacted by the cart, and the observer needs to notify the Observing Specialist and turn the carts OFF. If you suspect that the carts aren't moving, or are stuck, or are not moving at the correct speed, IMMEDIATELY stop and notify the mountain staff.

Checking the Cart Positions

- Make sure to click CONTROL on OPLE GUI to bring up the cart control box.
- Make sure the OPLE STATUS GUI is up.
- Check the OPLE server and look at the TARGET Position for the moving cart that Astrolib has set.
- Click HOME on all carts in use by you, and make sure they are moving at the correct pace. When they are home an 'X' will light up under the HOME sensor position.
- Now click 'TRACK' on both carts and the errors should go down and an 'X' HM sensor should light up and stay on.
- It is ok to turn the carts off now.

OPLE Delay Line Cart Initialization

- The reference cart is stationary. Astrolib will give a TARGET position of where the Ref cart should be. When this position is set the other cart should come into range leaving plenty of delay space to slew through. If not, recheck or reset the REF position.
- For example, Astrolib gives a TARGET position of 30 Meters. The reference cart should be set to that position give or take. The moving cart then needs to be placed to allow room for it to slew between 0-44m. If the moving cart is out of this range, change the reference cart position to accommodate the moving cart.
- On the Grand Wazoo, type in the reference position in the empty field next to the 'REF' input. The empty space next to this is for controlling the speed of reference cart, which we shall leave alone for now.
- The position that was just set will register in about 10 seconds on the OPLE server STATUS display under 'Target'.
- Once the REF position has registered, the carts can go into place by clicking TRACK on the OPLE GUI.
- Once each cart has reached its position and the ERRORS are low, everything is set.
- Also once the carts are tracking, uncheck the 'MAN' button for the reference cart and uncheck the 'MAN' and 'OL' button for the moving cart.

- **Note:** On the East-West Baselines the carts move fast. Make sure the OPLE clock is synced with GPS. There is a button on the OPLE GUI called ‘OPLESYNC’ that should be tried if the usual time syncing sequence does not work.

4.10 Routine Observing

Settle Down to Routine Observing

It is at this time that you can settle down to the standard, and sometimes mundane, part of observing. Not to be taken for granted, data means WINNING!!! As the carts are tracking and the Tip Tilt beams are locked the Remote Observer can start taking data. Remember the Array is made up of many systems and at anytime one could falter. As Array Observers, it is most pertinent that we keep watch 100% of the time. If problems occur notify the Mountain Staff. When trouble arises proceed slowly and carefully. Don't forget to check the CHARA Array Control Software Manual or in the worst case scenario call the CHARA Mount Wilson location.

Nightly Observing Report

Please stick to the following format for the nightly observing reports emailed to charaobs@chara-array.org.

- Program
- Observers
- Baseline
- Seeing
- Weather
- Targets
- Notes

If you have other information to send out that is not related to the nightly observing runs, use our other lists that pertain to the subject at hand.

5 Shutdown Checklist

5.1 Shutdown Checklist Intro

Simple as it seems each night, it is important that all gets closed up, covered up, and shutdown. Each day many employees are working on various systems from any number of different locations around the Array. Any CHARA equipment left on or exposed, can cause damage to other systems or be damaged itself. The Array is a sensitive system and it is critical that some consistency be used when shutting down. Listed below is a closing schedule. Please make sure that the Array is secure at the end of the night. Feel free to double and triple check – always a good policy!!!

5.2 Central Scrutinizer

At the end of each observing session, the first task is to check the metrology. This is done by turning on tracking to each of the OPLE carts in use, turning off the manual targets on each OPLE cart, and opening up the tracking loops. Each cart should find its home sensor. Wait for this to happen (or not) before going on to anything else. Next, clean all jobs in the queue. At this point, press the *End Night* button on CENTRAL_SCRUTINIZER (the GUI). This will close all the shutters, stow each telescope, close the primary and M3 mirror covers, send the OPLE carts to home, close the OPLE socket, and archive all the night's accumulated data. To finish up in the control room, execute the following list:

- The Metrology Laser, METLAS GUI
 - LAASZER POWER, click off
- LABPOW GUI, click the following off:
 - T/T Comms
 - Ref CCD
 - T/T Power
- Dither off
 - Clicking on *STATUS* in the IRIMAGE GUI should show the Dither as off at bottom.
- Spycams off; on telescope GUI, TV off.
- Quit CENTRAL_SCRUTINIZER (the GUI) when finished.

5.3 Telescopes

Verify that each telescope is in the following state:

- Telescope Enclosures
 - Upper closed.
 - Lower closed.
 - Dome slit and lower drop-out closed.
- Telescope Optics
 - Mirrors covered.
 - Primary closed.

- M3 covered.
- Acquisition cover slid closed.
- Finder covered.
- Acquisition mirror out
- Telescope Power GUI
 - TIP/TILT off
 - COMMS off
 - TEL AZ off (make sure telescope has stowed before doing this)
 - TEL EL off (make sure telescope has stowed before doing this)

5.4 The Lab

- Outside of the Lab
 - Vacuum valves closed (valve handle turned perpendicular to tube)
- Computer Area, OPLE Hardware and Software Racks off
 - Burleigh amplifiers/drivers off
 - Techron amplifiers off
 - Plain aluminum faceplate racks off
 - Tripp Lite noise filter off
 - Main rack OPLE off
 - Oscilloscope off
 - Dither toggle switch off (red light off)
 - If white light source is on, turn power down to 0 watts; power off
- Inside of the Lab
 - NIRO
 - + Silver box off
 - + Black box off
 - + Exit multread program - Click "x"
 - + Tower computer off
 - + Plastic pill bottle top covering open aperture
 - + Fill NIRO if needed (NOTE: Make sure covers are on before filling); enter date & time of filling in notebook
 - HeNe laser cover slid closed
 - Pico Box #3 off
 - Metrology filter boxes off
 - Metrology laser box off, key taken out & set on top of box
 - Pico Box #1 off
 - Pico Box #2 off
 - Periscope covers on
 - Laptop computers closed
 - Note lab temperature in observers notebook (optional)

5.5 North Side of the Beam Combining Facility Outdoors

- North Side of the Beam Combining Facility Outdoors
 - All three HVAC units back on
- Vacuum Pump House
 - Valve turned off perpendicular to tube
 - Vacuum pump switched off
 - Cooling fan off
 - Heater off
 - Club VP locked

5.6 Odds and ends

- Back in the Control Room
 - Please feel free to record any details in the Observers Notebook, the CHARA blog, or an email to specified groups or individual employees
 - Lock front and side doors of Operations Center
 - Lock OPLE building doors; they tend to stick open, please shut tightly

6 Control System Power Down

6.1 Control System Power Down Intro

In the summer of 2006, the CHARA Array experienced a number of extended power outages. This was due to Southern California Edison converting the Mount Wilson main line power from 4 kV to 16 kV in preparation for the higher powered HDTV broadcasts. On several occasions, inexperienced visiting astronomers were on duty when the outages occurred, leading to frustration and scientifically lost nights. While the “horses are out of the barn” at this point, should it be required that less experienced personnel need to power down the computer systems in the Array, this document will help.

6.2 Power Down Order

The CHARA Array control system involves over two dozen computers, four operating systems, four flavors of real-time control system, hundreds of computer-controlled opto-mechanical components, and thousands of meters of cabling – electrical, optical fiber, and network. All of this *doesn't* include the office, trailer, and electronic shop computer network. Needless to say, shutting down the beast is an intricate task.

Since this controlled shutdown may occur while observing (or observing preparations) are underway, one should follow the normal end-of-night shutdown procedures (see Chapter 5 [Shutdown Checklist], page 13). After this is done, one can begin the computer shutdown process. It is best to start with the computers that are least inter-connected and then move up to the “server” class machines, those that all the other machines depend upon. Start by powering down the computers in the bunkers, then the office, trailer, and electronic shop computers, then the non-server computers at the west end of the OPLE building, and finally the servers at the west end of the OPLE building.

6.2.1 Bunker Computers

Each bunker has two computers, a system running a real-time version of Linux, and a system running DOS. Start with the Linux box. Log onto the machine as ‘observe’, and

type the command, *startx*. Look for the RPC GUI. Make sure all of the devices are off except 'TEMA', the bottom one.



This figure shows a typical RPC GUI at a telescope.

Now go back to the DOS computer. Shut down TCS. Use the arrow keys to move over to the far right menu item **shutDown** and select the **Manual** method of shut down. The item is selected if the background is blue. Press **ESC** for all queries except the last, 'Abandon TCS for System?' For that, hit the **ENTER** key.

```

UT DATE: 08/10/2006      UT: 07:09:47.8  LST: 20:32:04  LHA: +00:00:00.00
JD: 2453957.80          UTC: Disabled
ACCESS: NOVICE          RA          DEC          ALTAZ mode
ARF Epoch: J2000.0      20:31:47.28      +34:12:13.1
Commanded:              23:04:00.79  SLEW PERMIT  +06:36:58.7  E1: 90.0
Next:                  23:04:00.79      +06:36:58.7  Az: +99.3
Reference:              : : :                               Secz: 1.00
Offset Vector:          : : :                               PA: +0.0
Wobble Vector:          : : :                               Mag:
δ Difference:           +1105105.8      -99.1        MC: Closed
Bias:                   +0.0000      Joystick     +0.0000      FFoc: -1
δ Guide:                +5.0000      +5.0000      Move: +1.8
δ Drift:                +6.0000      +6.0000      Shut: +0.0
                                     1800

Coordinate Mode: Keyboard      Command File:
Coordinate File:              Current Command:
Coordinate Epoch: 2000.0      MPNAR_p      Command Count:

Shutdown
Auto Alt Z
Manual Alt Q

Runtime Operations Menu
Motion deClare m0ve Position Rates Source Time pARameter

```

This figure shows a typical TCS screen. Note in the lower right that TCS is about to be manually shut down.

The result of this procedure will drop you into the DOS prompt. At this point, perform the “three-fingered salute”, $\langle \text{Ctrl} \rangle\text{-}\langle \text{Alt} \rangle\text{-}\langle \text{Del} \rangle$. When the BIOS screen appears, power off the DOS box. Power off the dome shutter power. This is the switch on the control panel mounted to the wall above the bunker light switch. The dome shutter power switch has a power light on the casing and two protective plates on either side of the switch.

Now go back to the Linux box. Exit ‘X’. Perform the “three-fingered salute”, $\langle \text{Ctrl} \rangle\text{-}\langle \text{Alt} \rangle\text{-}\langle \text{Del} \rangle$. When the BIOS screen appears, power off the Linux box. Now power off the tan ISA expansion chassis. Power off the UPS unit at the bottom of the computer rack. Finally, power off the computer monitor and make sure the clock cable is disconnected from the junction box mounted on the wall.

6.2.2 Office Computers

After shutting down the computers in all six bunkers, move onto the office computers. Currently, not including personal laptops, there are 13 computers in the Operations Center (the main office building), a Mac and a Windows XP machine in Bob Cadman/Steve Golden’s office, an XP machine in Judit Sturmman’s office, another XP machine in Laszlo Sturmman’s office, yet another XP machine (a laptop) in the conference room, a Linux box in Theo ten Brummelaar’s office, two Linux boxes in Nils Turner/Antoine Mérand/PJ Goldfinger’s office, and four Linux boxes and one Mac machine in the control room.

For the Mac computers, shutdown is straightforward. Move the mouse to the upper left corner of the screen and click on the Apple icon. This will activate a menu in which one of the selections is ‘Shut Down’. Select this. You’re done with the Macs.

Next, move onto the XP machines. They are also easy to shut down. Click on the ‘Start’ icon at the lower left of the screen. Select ‘Turn Off Computer’ and confirm it in the pop-up window. You’re done with the XP machines. Make sure you turn off the monitors.

The machines ‘allures’ (in Theo’s office) and ‘lem’ (in Nils’ office) have display managers running. If someone is logged in, log him or her out to get back to the display manager. On the display manager, there will be a button allowing one to shutdown the computer. Do so. ‘candler’ (also in Nils’ office) doesn’t run a display manager. Power it down by logging out whoever is logged on and perform the “three-fingered salute”, `Ctrl-Alt-Del`. When the BIOS screen appears, power off ‘candler’. Make sure you turn off the monitors.

This will leave four computers remaining, all Linux boxes, all in the control room. ‘lothlorien’, the computer in the far right corner when looking at the four-screen control console. That’s a MIRC computer, and we don’t have the root password for that computer, so just push and hold in the power button on the case to shut it down. Make sure the BenQ monitor is powered down. The computers ‘pakyderm’ and ‘elefant’, to the left of ‘lothlorien’, are the archive computers. Neither of them has a keyboard, mouse or monitor. To shut them down, log onto ‘zoot’, the control console computer, as ‘observe’. Open up an ‘xterm’, and in that terminal, type `ssh pakyderm`. Once logged onto ‘pakyderm’, `su` to root and type `poweroff`. If you don’t know the root password on ‘pakyderm’, don’t worry about it. Simply log out of ‘pakyderm’ and just power it off in a way similar to ‘lothlorien’. Shutting down ‘elefant’ is done in a similar fashion to ‘pakyderm’. In the terminal type `ssh pease`. When logged in, type `ssh elefant`. At this point the shutdown is just like that of ‘pakyderm’. At this point, you can log out of ‘zoot’ and perform the “three-fingered salute”, `Ctrl-Alt-Del`. When the BIOS screen appears, power off ‘zoot’. Make sure you turn off all four monitors.

Finally, power down both printers (the HP 4000TN in Bob’s office and the HP 1120c in the control room) and go around to all the offices and shut off the UPS units. In the control room, the UPS units are located on little shelves below the desk top.

6.2.3 Trailer Computers

Currently, there are only two computers in the trailer office annex, ‘decaturn’ and ‘garnett’. Neither runs a display manager, so you shut them down in a manner similar to ‘candler’ (see [candler], page 19). Once these computers are powered down, turn off the monitors, the printer, and the UPS units, one located below the desk housing ‘decaturn’, and one on the desk housing ‘garnett’.

6.2.4 Electronic Shop Computers

There are two computers in the electronics shop, one XP box, one Linux box. The Linux box powers down in a manner similar to ‘candler’ (see [candler], page 19), while the XP machine powers off, well like an XP box (see [powering off an XP machine], page 18). Make sure the monitors are off and the UPS unit has been powered down.

6.2.5 Server Farm

At the east end of the OPLE building, within the storage area, is located a server farm. There are up to eight computers. This is a grab-bag of computers. Some will shut down in a manner similar to ‘allures’ (see [allures], page 18) and some will follow the ‘candler’ procedure (see [candler], page 19). Shut down all these computers, power off the monitors, and power off the outlet strip at the back of the shelf unit.

6.2.6 Computer Room Computers

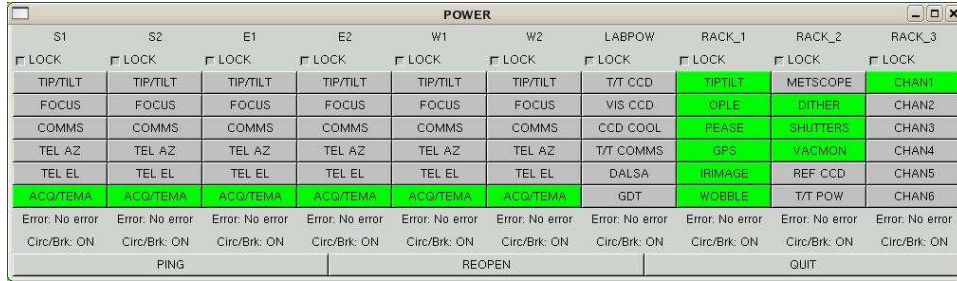
Prior to shutting down the (non-server) computers in the computer room, there are a number of hardware controllers that need to be shut down first. Start with the New Focus 8732 picomotor controllers. There are five of them, and they are all inside the inner enclosure. Units ‘#1’ and ‘#2’ are located just in front (east) of the W1/W2 BRT/beam switcher table. Unit ‘#3’ is above the CHARA Classic beam combiner table. Unit ‘#4’ is at the far eastern end of the inner enclosure, straddling the W1/W2 PoP pipes. Finally, unit ‘#5’ is near the ceiling, just over the W1/W2 periscopes. Simply turning off the units is sufficient.

Next, shut down the Newport ESP units. There are seven of these, four inside the inner enclosure, and three outside. Start with the ones inside. Over the visible fringe tracking table (the 6x8ft table), power down the ‘VIS DITH’ unit. Over the CHARA Classic table (next to picomotor unit ‘#3’), power down the ‘DITH’ unit. Over the W1/W2 periscopes (just below picomotor unit ‘#5’), power down units ‘PERI1’ and ‘PERI2’. Moving outside the inner enclosure, power down the ‘LDC1’, ‘LDC2’, and ‘BS’ units, located on top of the OPLE cart control racks (the far left racks when you look at the racks from the west). Like the picomotor control units, simply turning off the ESP units is sufficient.

There are several laptops in that reside in the BC area. These need to be shut down. Start with ‘lab1’ which lives on the E1/E2 BRT/beam switcher table, near the visible beams target. This is a Linux box. It doesn’t have a display manager running, so follow the same shutdown procedure as ‘candler’ (see [candler], page 19). Next move to ‘wild’ which lives on the CHARA Classic table. It shuts down in the same way. Next are ‘dotty’ and ‘daisy’ which live on the metrology table and light source table, respectively. Both of these run display managers, so following the power down procedure for ‘allures’ (see [allures], page 18) will be the thing to do.

Make sure the metrology laser controller is off, and if so, power down the UPS unit that sits on top of the metrology table. Over at the light source table, make sure the alignment laser is off. The switch for it is a keyed switch on the table cover above the laser. Finally, make sure the paper cup covers the objective to the tip/tilt CCD.

Move back outside of the inner enclosure. At this point you can sit at the console. To the left of the monitors, you will notice an Oriel white-light source power supply. Make sure it is off. The console here controls 8 machines: ‘gps’, ‘irimage’, ‘merrill’, ‘michelson’, ‘ople’, ‘pease’, ‘tip tilt’, and ‘wobble’. You can switch between these machines by typing, in rapid succession, $\overline{\text{Ctrl}}-\overline{\text{Ctrl}}$. The arrow keys will then allow you to select to which machine you wish the keyboard, video display, and mouse to connect. Note that ‘michelson’ and ‘pease’ are not actual machines, but are used to differentiate between the control-side and office-side ‘ctrscrut’ machines. ‘michelson’ is the master machine. It controls the power supply to most of the other machines by means of several RPC units. This is done in order to be able to remotely cycle power on the computer room real-time Linux boxes in case of runaway servers.



This figure shows the full RPC GUI.

If the KVM selection is not already at ‘michelson’, perform the $\langle \text{Ctrl} \rangle$ - $\langle \text{Ctrl} \rangle$ sequence and select ‘michelson’. This computer will actually drive both displays. The vacuum monitor server is usually run from this machine. Shut it down by typing *quit* in the server window and following the subsequent directives. At this point, it is safe to shut off the electronics by means of the RPC GUI (‘RACK_2’, ‘VACMON’).

Next, you want to power down the dither mirror. It is important that the dither mirror power not be cut while it is in motion. Verify that the dither status is off by launching the irimage server (left mouse click on the background, follow the ‘Servers’ menu directive, and select ‘IRIMAGE server’). In the server window, 9th line from the top, far right, you will see ‘DITH STS:’. If it reports ‘Off’, you can power down the dither mirror electronics by means of the RPC GUI (‘RACK_2’, ‘DITHER’), and quit out of the irimage server.

If a shutter GUI is not already up, launch one (left mouse click on the background and select ‘Shutters’). Close all of them and power down the shutter electronics by means of the RPC GUI (‘RACK_2’, ‘SHUTTERS’).



This figure shows shutter GUI.

At this point, you can start shutting down machines. Start with ‘wobble’. Perform the $\langle \text{Ctrl} \rangle$ - $\langle \text{Ctrl} \rangle$ sequence and select ‘wobble’. Reboot the machine by typing the “three-fingered salute”, $\langle \text{Ctrl} \rangle$ - $\langle \text{Alt} \rangle$ - $\langle \text{Del} \rangle$. When the BIOS screen appears, perform the $\langle \text{Ctrl} \rangle$ - $\langle \text{Ctrl} \rangle$ sequence and select ‘michelson’. Cut the power to ‘wobble’ by means of the RPC GUI (‘RACK_1’, ‘WOBBLE’). Follow a similar sequence of events to power down ‘irimage’, ‘ople’, ‘tiptilt’, and ‘gdt’ (‘LABPOW’, ‘GDT’).

‘mirkwood’ is a MIRC computer for which we don’t have the root password. Just shut it down by cutting its power from the RPC GUI (‘RACK_3’, ‘CHAN1’). Finally, power down the ‘FLUOR G3’ (see [powering off Macs], page 18).

6.2.7 Computer Room Servers

You're almost done. Power down 'gps'. Perform the **Ctrl**-**Ctrl** sequence and select 'gps'. Reboot the machine by typing the "three-fingered salute", **Ctrl**-**Alt**-**Del**. When the BIOS screen appears, perform the **Ctrl**-**Ctrl** sequence and select 'michelson'. Cut the power to 'gps' by means of the RPC GUI ('RACK_1', 'GPS').

Power down 'pease'. 'pease' runs a display manager, so shut it down in a manner similar to 'allures' (see [allures], page 18). When the BIOS screen appears, perform the **Ctrl**-**Ctrl** sequence and select 'michelson'. Cut the power to 'pease' by means of the RPC GUI ('RACK_1', 'PEASE').

Power down 'michelson'. 'michelson' runs a display manager, so shut it down in a manner similar to 'allures' (see [allures], page 18).

Power down the mail server, 'merrill'. Perform the **Ctrl**-**Ctrl** sequence and select 'merrill'. Reboot the machine by typing the "three-fingered salute", **Ctrl**-**Alt**-**Del**. When the BIOS screen appears, reach over to the computer in the rack and press the power button in the upper right corner of the case. A non-ATX power supply – nostalgic, eh? Finally, shut off the UPS units. There are three large UPS units at the bottom of several of the racks, and one smaller unit near the bottom of the rightmost rack.

Revel in the quiet.

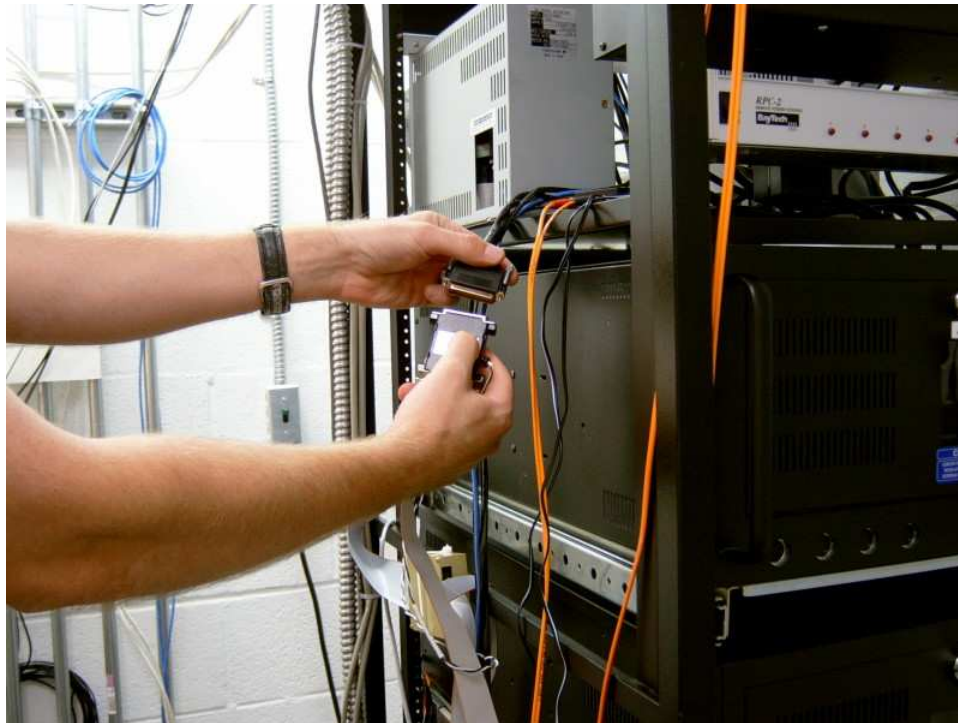
7 TCS Shutdown and Startup

When it comes to the telescope control system (TCS) computers, there are a few tricks of the trade that will minimize pain in shutting them down and starting them back up. This document is designed to pass along that lore.

The TCS computers run PC-TCS, a telescope control software product from Comsoft¹. It runs best under native DOS, but will run in the DOS emulation mode under Windows 95/98. Typically, we run under DOS, but we do make use of the emulation mode under Windows for certain tasks, notably, taking data for a pointing model.

The TCS shutdown technique was described previously, in detail, in the discussion of completely powering down the Array, so it won't be discussed further here. See [TCS Shutdown], page 17, for a description.

Starting TCS back up can be tricky. The two things to watch out for are the hand paddle/drive connector and the dome shutter. The following figure shows you the hand paddle/drive connector.



This figure shows the hand paddle/drive connector (the top connector with the 3 round cables coming out of it) disconnected from the pulse generator card (the bottom connector with the flat ribbon cable).

When starting up TCS, it is best to disconnect the hand paddle/drive connector from the ribbon cable connector.

¹ 1552 West Chapala Drive, Tucson AZ 85704, 520-621-3648, comsoft@primenet.com

Next, we have to make sure the dome shutter power is off. The location of the power switch is shown in the following figure.



This figure shows the location of the dome shutter switch.

Frequently, one has to shut down and restart TCS while the dome shutter is open. Ideally, one would close everything up tight and *then* shut down TCS, but the dome shutter takes so long to close and then open back up. With the power off while TCS starts, one doesn't have to worry about the shutter state being in limbo.

To start TCS:

- Make sure the hand paddle/drive connector is disconnected.
- Make sure the dome shutter power is off.
- Power up the TCS computer. Once DOS starts, it will automatically go into TCS.
- Once the TCS command screen comes up, and the menu bar appears along the bottom, reconnect the hand paddle/drive connector to the ribbon cable connector.
- Synchronize the shutter menu entry with the actual state of the shutter (see the description and figure below).
- Restore power to the shutters.
- Home the dome.

Synchronizing the Dome Shutter:

The figure below shows TCS with the 'Motion' menu enabled.

8 Enclosure Cylinder Reinitialization

Each telescope enclosure has 2 cylinders, the upper (sometimes referred to as the *outer*) and the lower (sometimes referred to as the *inner*). Each cylinder is individually controlled by a digital servo motor and amplifier combo, sold as the *Kollmorgen ServoSTAR CD*, where the motor is out at the enclosure while the amplifier is in the bunker. The current state of the system, settings, etc., are kept in the EEPROM and RAM of the amplifier unit. As long as the amplifier power is not cut, the amplifier knows all. However, if there is a power outage . . .

8.1 Hardware

The ServoSTAR CD amps are wired to keep tabs on 3 limit switches: an upper limit, a lower limit, and a home switch. The upper and lower limits work in a “normally closed” mode, i.e., motion of the cylinder is allowed as long as the limit switch circuit is closed. Triggering the limit (or cutting the limit switch wiring) will open the circuit and the amplifier will stop the motion of the cylinder. The home switch operates in a “normally open” mode, with an inverse behavior to the “normally closed” mode. In both the upper and lower cylinders, the home switch is between the upper and lower limits. In the case of the upper cylinders, the home switch is 20-40cm below the upper limit. In the case of the lower cylinders, the home switch is 10-20cm above the lower limit. The system will allow one to “back out” of a limit switch trip without having to disable the limit switches.

When the ServoSTAR CD amps are first powered up, approximately 100kB of information is loaded from the EEPROM to the RAM. This information contains things such as default acceleration rates, velocities, motor voltages, current limits, torque values, etc. The amp also assumes that the cylinder is located at the home switch, so it sets the “motor encoder count” to zero. For information, 6.3 million counts will move a cylinder approximately 1cm.

The ServoSTAR CD amps take their commands from the bunker Linux box. The Linux OS (Red Hat 6.2) starts a server at boot time which controls both cylinders via 3 serial ports and the joystick port. When a client makes a request of the server to move a cylinder, the server queries the amp for its current position. If the server is told that the cylinder is near zero, it checks whether the home switch is closed. If the home switch is still open, the server assumes that amp has lost its way, and it issues a homing command. By default, the lower cylinders home by moving up, and the upper cylinders by moving down. Once the homing is complete, the server will honor the clients motion request. This is how things are supposed to work. Sometimes, the situation gets gnarled. We have found this gnarling happens most often when there are several clients open on various machines, each with conflicting commands in their buffers. Sometimes, one has to resort to manual homing, described in the following section.

8.2 Manual Homing Procedure

8.2.1 Error Codes

These observations need to be verified.

- In an upper cylinder, ‘L2’ indicates that the CW limit has been tripped. This happens if the upper cylinder goes into its *closed* limit. It can be moved off of the limit by

incrementally moving the cylinder in a *negative* direction. There's no need to disable the limits.

- In a lower cylinder, 'L1' indicates that the CCW limit has been tripped. This happens if the lower cylinder goes into its *closed* limit. It can be moved off of the limit by incrementally moving the cylinder in a *positive* direction. There's no need to disable the limits.

8.2.2 Serial Ports

The lower cylinder is controlled by serial port '/dev/ttyC3', while the upper cylinder is controlled by '/dev/ttyC4'. The comm parameters are 9600-8-N-1. '/dev/ttyC5' controls the Practical Instruments DIO port which does I/O for the alarm, emergency stop, and joystick key control.

8.2.3 Kollmorgen Terminal Mode

The following table lists the basic commands that will be needed in manually homing the cylinders.

'STOP'	Stop the motion of the motor, with the appropriate deceleration.
'MH'	Perform the homing procedure, starting in the default direction.
'HOMESTATE'	Report on the status of the homing procedure. Important here is the value '10', which indicates that the homing is complete.
'MA <pos> <vel>'	Move to the absolute motor encoder position represented by '<pos>', at a velocity represented by '<vel>'.
'MI <pos> <vel>'	Move, incrementally, '<pos>' motor encoder counts from the current position, at a velocity represented by '<vel>'.
'PFB'	Print the current motor encoder position.
'LIMDIS'	Indicate the status of <i>all</i> the end-of-travel limit switches. '0' indicates that the limit switches are enabled, while '1' indicates that they are disabled. In addition, disabled switches will make their status know by blinking the LED dot on the segmented display of the amplifier.
'LIMDIS 1'	Disable all end-of-travel limit switches. The LED dot on the segmented display of the amplifier will blink.
'LIMDIS 0'	Enable all end-of-travel limit switches.

8.2.4 Procedure

- Make sure you are at the telescope bunker of the telescope in question before performing a manual homing procedure.
- Disable the `enclD` server by issuing the command (as root), '`service enclD stop`'.
- Depending on whether the cylinder in question is an upper or a lower, issue the command (as user `observe`), '`minicom upper`' or '`minicom lower`'. Press enter a few times until you get the '->' prompt.

- Move incrementally ('MI' command) in 4 million step increments (about 5 mm actual cylinder motion) *away* from the limit (see [Error Codes], page 26 for information on the correct direction to move) until the LED indicator on the drive unit shows '8.' (the LED dot should be steady).
- Issue the command, 'MH'.
- You can monitor the homing progress with the command, 'HOMESTATE'.
- Once the homing is done, exit `minicom` with the key sequence, 'C-a; x; <ENTER>'.
- Reenable the `enclD` server by issuing the command (as root), '`service enclD start`'.