CLASSIC and CLIMB Observing Manual

Introduction

The CLIMB and CLASSIC beam combiners operate at 1.3μm, 1.6μm and 2.2μm wavelengths in the J, H and K bands. CLIMB combines the light from three telescopes while CLASSIC combines the light from only two telescopes. There are two sets of redundant optics for CLIMB on the beam combining table. CLIMB 1 uses beams 1-3 where it often serves as a fringe tracker for VEGA. CLIMB 2 uses beams 4-6 and can run at the same time as PAVO or other program using beams 1-3. CLASSIC is only run on beams 5-6 and is the most sensitive program for dim objects. All three combiners were built by GSU and use the NIRO camera, which is the first camera used on the CHARA Array.
You may find more detailed information about the combiners, observing proposals, and data reduction on the CLASSIC/CLIMB instrument page:
http://www.chara.gsu.edu/instrumentation/classic-and-climb
and in this link to recorded seminars:
http://www.chara.gsu.edu/workshops/chara-summer-seminar-2020

Cooling Down the NIRO Camera

The NIRO Camera is cooled with twice daily fillings of liquid nitrogen after it has been pumped down to 10 E-7 or lower pressure. Since it is usually pumped down at the start of the observing season, only filling with LN2 is necessary during normal operations. The night observer is responsible for filling NIRO each evening before observing. The LN2 is kept in a 35 liter dewar in the optical lab and the camera is filled using a one liter thermos type flask, cryogenic gloves and safety glasses. About half a flask is poured into the inner chamber of the camera with a funnel and stainless tube and a full flask is poured into the outer chamber. The chambers are filled until LN2 bubbles out of the top ports. Log your filling of the camera in the logbook with the time and your initials. Note also the MIRCX pressure reading. Let the

site manager know if the 35 liter dewar is running out of LN2.

Aligning to NIRO in the lab

The alignment to the NIRO camera is usually done by day staff. On weekends or any time there is no day staff to do these alignments, the night observer is responsible for aligning in the lab. The alignments in the lab are covered in the wiki under **Preparations in the Lab Prior to Observing, Sections 2.3 to 2.6**. The alignments on the IR table are stable night to night and the basic IR alignments to the IR target are all that is needed each night. If CLIMB or CLASSIC is used after a longer period of non use, a more precise alignment to the camera can be performed using the white light source in the lab. Before leaving the lab, the NIRO camera electronics need to be turned on. Turn on the black box above the NIRO computer, and then turn on the silver box below it on the same cart. Remove the lens cover on the camera.

Setting up for Remote Observing

With COVID restrictions in place, remote observing will be the standard protocol for PI's and scientists until in-person observations return to the mountain. Use this page to establish the remote connection and set up your desktop.
http://www.chara.gsu.edu/observers/remote-observing

Setting up in the Control Room

Turn on the power to the NIRO CPU in the POWER gui. Also turn on the power to the CLIMB 1 (beams 1-3) dithers or CLIMB 2/CLASSIC (beams 4-6) dithers on the RACK_3 RPC. The CLIMB and CLASSIC programs are run by the CLIMB_1, CLIMB_2, or CLASSIC servers. They can be opened from the server menu icon on the toolbar on the upper left monitor. Open the corresponding gui from the icons on the lower right monitor. The set up can be found on the **Observing Procedures page, Setting up Computer in the Control Room, Chapter 3, Section 3.2.**

Going on sky with CLIMB or CLASSIC

Telescope preparations

After the domes and covers have been opened, carts have been homed, the check, calibrators and science stars have been chosen, the configuration has been set in Cosmic Debris (CD), and telescopes have been slewed to a check star, alignment star, or bright target or cal, the telescope AO and labao alignment procedures (beacon alignments) can be performed. The night observer will inform the PI when these have been done and the camera is ready for alignment.

Aligning NIRO

Once you have locked on a star, the NIRO camera will then be aligned to center the star light on the read out pixels. Open the PICO7 gui from the icon at the right side of the lower right monitor. Select the program from the 3 choices in the PICO 7 gui, CLIMB1, CLIMB2. or CLASSIC. The windows you will use to align each pixel will pop up and you will need to tile them on the right edge of the lower right monitor. CLIMB programs use 5 windows and CLASSIC uses 3. Take each window and set them from lowest first to topmost, starting about 3 inches above the bottom corner of the screen. This will put them above the alignment windows that pop up giving you a view of the NIRO camera pixels you will align.

Make sure you are locked on a sufficiently bright star, Kmag 2-4 is typical, before aligning the first time. Dim stars or poor seeing can make this process difficult so having plenty of light is essential to getting a good alignment at the start of your night. Also make sure the carts have been homed and that they are tracking to the correct positions with no errors on OPLE. The alignment is better when the carts are in place instead of moving them after aligning.

Make sure you have selected one of the CLIMB or CLASSIC programs

in Cosmic Debris by checking one of the boxes and that you have selected 2 telescopes for CLASSIC or 3 telescopes for CLIMB in the CONFIG tab on Cosmic Debris. The NIRO alignment is started by clicking the NIRO ALIGN button on Cosmic Debris. It will start a sequence that takes about 5-10 seconds and will open a small window showing the first pixel to be aligned. Use the top gui from the 3 or 5 that you opened earlier to move the light into the center pixel. Follow the directions in Cosmic Debris as to which way each button moves the light. The directions are not usually as listed, ie. UP is not always UP. The TOG BLUR button on the ALIGN tab on the CLASSIC or CLIMB gui can be used to stack 10 images and this will slow down the bouncing light and make aligning much easier. Click Start Job Queue on CD after each pixel alignment to move to the next step. Complete each alignment step and then click Start Job Queue to see the chip alignment in CLIMB or to end the procedure in CLASSIC. All instructions for aligning are given in the message window on Cosmic Debris.

Searching for Fringes

Searching for fringes the first time in a new observing run, in a new part of the sky or with a new set of telescopes usually means using a check star to find the fringe offsets more easily than can be done with some targets and calibrators. This check star may be the alignment star or one nearby to the science target or first calibrator. Check stars that are west of the first cal or object work better as you will track into that part of the sky instead of away.

Ensure that the carts have been homed and that they are tracking to the correct positions with no errors and on the right star on OPLE.

Setting the scan length, frequency, mode and baseline

Once you are aligned, you can set up the camera settings using Cosmic Debris (CD). Set the scan length (short = 90 µm, medium = 120 µm, long = 150 µm), the frequency (250, 500, 750, 1000 Hz) and

the mode (Destructive, NonDestructive) before scanning. Medium scan length is typical, 750Hz for brighter check stars and Destructive mode to prevent saturating is also typical. Choose which baseline you will scan first if using CLIMB 1or 2. You can choose baseline 1-2/4-5, 2-3/5-6, or 3-1/6-4. Usually the shorter baseline will find fringes more easily and is a good start to ensure the system is running correctly. Be aware of which cart is the reference cart (ref cart) when making this selection. For example, if the ref cart is on Beam 2, you will scan beams 1-2 and 2-3. If the ref cart is beam 3, you will scan beams 1-3 and 2-3. You may scan the baseline with the cross fringe, but you will not be able to put a cart in that position because it's offset is not given in relation to the ref cart.

Scanning

The default scan position is centered on 0.0m and the scan range using CLIMB or CLASSIC is 0.005m (+-5mm) before and after 0.0m. This can be changed if the offset is known to be somewhere outside of this range or if you want to go directly to the known offset from previous observing. Press the SCAN FRINGES button on CD to start the scan sequence. A new set of windows will pop up to show the current fringe scan segment, the best scan segment with highest signal and the flux. Most frames will display noise, but when a fringe is found, the signal will rise above the noise and will usually be saved by the second window. Hit HOLD and SEND on the CLIMB or CLASSIC gui to send the saved offset to CD. After a fringe is found, CD will save the position for later when you have both offsets and are ready to begin recording. Scan the other baseline if using CLIMB and when you have both, it is time to go to the record sequence.

Some tips for scanning:

If you see a fringe that is not detected by CLIMB or CLASSIC, the EDGE button on the OPLE gui can reverse the cart and go back to the position where you saw it. If you hit EDGE again, it will only scan between the two points where you hit EDGE. This can be useful for a

very faint fringe where scanning over the position many times is needed to get a fringe strong enough to be obvious. It is important to watch the OPLE offset closely or this function is not useful.

The INCREASE button on the OPLE gui adds scan length by .5mm on either side of the scan range. You can use it if the EDGE function has defined too narrow a range and you need to expand it again. You can add as many increments as needed to expand the range.

It is a good idea to watch the OPLE gui for the cart offset during the scan to see where the fringe was when detected. Cosmic Debris can often display an incorrect position from where the cart actually was when the fringe was found if HOLD and SEND are not hit soon after seeing the fringe or if the EDGE button was used. This error can be several millimeters to several centimeters off, so do not open a new Record sequence with a bad offset because the carts will be put to the wrong position. Perform another scan to get a correct offset. These errors most often occur when using the EDGE function so always watch OPLE for the actual offsets when scanning.

If a fringe is found on the first pass from -5mm to +5mm, the offset will record a little late. The fringe will be slightly negative of the recorded position. Just click to the left (negative) when you are in the record sequence to find the fringe. The opposite is true when scanning from positive to negative. The fringe will be slightly positive of the recorded position in Cosmic Debris.

If you have an offset from previous observing, you can enter the offset in CD and make the scan range 0.001m. It will scan 1mm around the position you define as the known offset and can pick up a fringe quickly that was known from before. Use the INCREASE button on OPLE to expand the range if it does not find it right away. Just remember that Cosmic Debris uses meters as its units.

Confirming Fringes with Record sequence

The Record 2 beams or 3 beams sequence will position the carts to the recorded offset for each fringe as found in the scans. Otherwise the offsets will start at zero, or the calculated baseline solution without any corrections. Check to make sure the ref cart is in a good place for lots of delay and that the carts are tracking before starting the record sequence. The OPT DELAY button on CD can be used to find the position of maximum delay for that star. It may not be the best position for the data set as a whole, but if this is the check star, being close is good enough. Start the RECORD sequence to open the windows and find the fringes you located during the scanning. Use the large step size for CLIMB or the - - or ++ buttons to move the carts forward or backwards to verify the fringe positions. When you have a fringe that is not the cross fringe, turn on the SERVO to lock the fringe. When you have the fringes from 2 baselines with the ref cart, the cross fringe (the one not using the ref cart on CLIMB) should also be present. When you have verified and written down the fringe positions for the check star, you can go to your first calibrator.

Slew to the calibrator and lock on the star. Make sure all necessary alignments of the telescope AO or labao are done first. Make sure the ref cart is in a good position for maximum delay for the calibrator, but consider when the science star and cal 2 come into delay as well. If they are not in delay now, will they come into delay before you get to them or will the cart need to be moved to not lose observing time? Your operator can give advice on how to determine this.

Make adjustments to the camera settings based on the brightest and dimmest stars in your Cal-Sci-Cal sequence. Brighter stars use 750-1000Hz for faster scanning and dimmer ones ones use 500 or 250Hz. If all your stars are dimmer than about Kmag 5, you may be able to use Non-destructive mode to gain more counts. Bright science stars and dim calibrators can make this selection difficult as no one setting is best for all of them. Using destructive mode will keep the target from saturating.

If the slew was a short one, the offsets should be very close to the

ones found on the check star. In this case, you can go straight to the record sequence and manually search for fringes there. You can also scan in a very small range around the known positions for each fringe if they do not turn up using the record sequence. Just enter the offset into CD and set the range to 0.001m. Remember that CD uses meters as its units, OPLE scans in centimeters and CLASSIC and CLIMB use microns.

Recording Data

Once you have found the fringes on the first calibrator, lock the servo. The CLIMB or CLASSIC gui will report the servo is ON. Then hit the SAVE button to begin the data recording sequence. The fringes will disappear as the shutters close and dark sequences are recorded for each beam. When the shutters reopen, reacquire any fringes that drifted away. The data recording is set to 200 good frames with fringes on each baseline. Low SNR frames are also saved and will be counted by the gui. In good seeing, the recording will go very quickly and the low SNR frames will be very low or even zero. If the fringes are not very contrasty, the low SNR frames can count up to many hundreds before the 200 good data frames are reached. You can hit STOP to end the data collection and go to the foregrounds and also to end the foregrounds and go to off-star backgrounds. When the sequence is done, the windows will close, CD will report a data line in blue text in the message window and the bell will ring to indicate the data were collected and saved.

Continue the data collecting with a Cal1-Sci-Cal2-Sci-Cal1-Align bracket or similar pattern. Other bracket options are Cal1-Sci-Cal2, Cal1-Sci-Cal2-Align or Cal1-Cal2-Sci-Cal1-Sci-Cal2-Sci-Cal1-Cal2-Align. Perform the telescope AO alignments as needed after each star is locked. After 2-3 brackets as in these examples, it may be time to align NIRO. Keep an eye on the flux counts as reported on the CLASSIC or CLIMB guis and if fringe contrast drops significantly, look at the flux alignment on the pixels with the PICTURE tab and PIXEL AREA button on the CLASSIC or CLIMB gui. Hit the STOP button

when done to close the window. Only do an alignment after a bracket is finished to avoid calibration issues.

There is more information on the wiki here:

Guidelines for selecting CLASSIC settings
Instructions for observing very faint targets with CLASSIC

Troubleshooting

Low or no flux on NIRO

If you have no flux or image on the camera, check

Are the IR shutters open?

Is the lens cap off NIRO? Are the camera control boxes turned on?

Is the IR alignment target still on the table?

Is the star locked and beacons aligned?

Is the star bright enough K or H?

Are telescopes on the right beams after a config change?

No fringes at start of night

Were the carts homed? Are the carts in place with low errors? Is it the right star in OPLE?

Is the metrology signal strong on all delay lines?

Is the star locked? Is it the right star in each telescope? Busy star

fields can cause the wrong star to be locked instead.

Is the clock correct? Was OPLE synced?

No fringes after having them

Did the seeing get worse? Is it a while since the alignment was done? Low flux?

Did the WFS drop the star?

Is the config correct in CD and OPLE after a pop change? Offsets can change by a few mm's after a pop change also.

Is the OPLE clock correct with no errors? Did OPLE or CLIMB have an error or are they lagging?

Is one baseline resolved? Is the target asymmetric? Is the long baseline the one with no fringe? Consult ASPRO for baselines that may be resolved. It is not unusual to have one baseline with a poor or no fringe. This can vary over the course of a few hours or so where the fringe is present, disappears and then reappears.

Norm Vargas May 2020
Stuck at home
COVID-19 Worldwide Lockdown Edition

Revised October 2020
Bobcat Fire Edition