CLIO2 Manual

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1. Introduction

Clio is a 1-5 micron imager, coronagraph, and low spectral resolution spectrometer built to exploit the unique sensitivity and resolution of deformable secondary AO systems. It was used from 2006-2011 on the MMT. In 2012, it was moved to Magellan, to be used with the MagAO system. The camera is currently available only with MagAO.

This manual is primarily an online document. Please have a look at http://zero.as.arizona.edu/groups/clio2usermanual/ for the most up-to-date information.

Questions about Clio should be directed to Phil Hinz or Katie Morzinski.

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Edited Apr 13, 2014 6:18 PM by Alycia Weinberger…

Beginning of the Night Checklist

Log in to Clio computer

1. IF there is not already a Terminal logged into clio1, then use ssh to remotely log into the clio computer:

    ssh obs@clio1.lco.cl -YC

2. If you are already running clio, you have the option of killing it. In the Terminal window in which you are logged onto Clio, type

    [obs@clio1]$ killclio

3. At the prompt in the clio1 Terminal, run the script to start up all of the Clio programs.

- [obs@clio1]$ runclio

This will start up ~9 windows to allow control and monitoring of Clio. It also sets the directory name on clio1 to be the UT date for 5 hr after the current date.

Note: If you didn't do a runclio command, then you need to set the directory name in the Clio Camera Control Program. The directory should be of the form /home/obs/Data/nyymmdd where the dd is the UT day of most of the night (not UT at start).

4. Press the "Star Nudger" Button on the "Reset Clio Component" GUI to start the star nudger GUI

5. If you want to do flats at Ks, you will need to get on the sky 30 min before sunset, and your integration times (in the Narrow camera) will be approx 60 s.

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Edited Apr 15, 2014 9:13 PM by Katie Morzinski...

Camera Operation

Camera Operation

1. Choice of array / subarray size:

Format	Array Size	Minimum Integr. (and readout time)	Max Coadds
Full array	(1024x512)	280 ms	20
Strip	(1024x300)	164 ms	40
Stamp	(400x200)	43 ms	100
Substamp	(100x50)	3 ms	??

Strip is composed of the full width (1024 pix) and the top 300 pixels of the array.

Stamp is composed of two 200x200 square sets of pixels, located in the upper left of each half of the detector, which are saved together as a 400x200 pixel image.

SubStamp is composed of two 50x50 square sets of pixels, located in upper left of each half of the detector, which are saved together as a 100x50 pixel image.

2. Software / GUI Descriptions

I) Clio Camera Control Program GUI

This is the main GUI for setting the observation parameters. To set up an imaging sequence, select an integration time (must be greater than the minimum time for the selected read-out format), number of coadds, number of images per nod, and number of nod cycles. **After entering values in the boxes, press <RETURN>.**

Integration time per nod [ms] = Integration [ms] * Coadds * Images per Nod

No changes may be made to any of the values in this GUI while data taking is in progress. To make changes, you must first press the "Stop" button and wait for the current image to complete.

Startup Buttons:

- **Reset**: resets Clio2 electronics
- **Init**: [done automatically at startup] Allows GUI to interact with the instrument

Detector:

- **Format**: Choose read-out format for detector (Full, strip, stamp, substamp)

Taking Data:

- **Take Back.**: Saves a sky image with current values of integration time and coadds

There are two way of taking continuous unsaved images (useful for acquiring/centering target and setting integration times)

- **Video**: Uses current values (integration and coadds) and takes continuous unsaved images
- **Quick Video**: sets integration to minimum for the read-out format and coadds to 1, then takes continuous unsaved images. Stop button will return time parameters to previous values.

There are three buttons for taking data that will be saved:

- **Take Images**: At the current position, takes the number of images set by "Images per Nod" where each image is taken with the current values of integration time and number of coadds
- **Take Images (Nod AB)**: Executes two sets of images. Nod A will be the current position of the target on the detector. Nod B will be xnod,ynod arcseconds away. In each position, "Images per Nod" will be saved, where each image is taken with the current values of integration time and number of coadds. After the nod, Clio will wait to take data until the AO loop closes.
- **Take Images (Nod ABBA)**: Executes four sets of images starting at the current position of the target on the detector. Nod B will be xnod,ynod arcseconds away. In each position, "Images per Nod" will be saved, where each image is taken with the current values of integration time and number of coadds. After each nod, Clio will wait to take data until the AO loop closes.

All three types of Take Images are repeated "Nod cycles" times.

To end data acquisition:

- Stop: button appears after starting data acquisition (either video, taking images or a script); stops video mode or imaging (including aborting a script)

Check Boxes:

- Use Back: In Video and Imaging mode, subtract the saved sky image before displaying
- Save Data in Cubes: save every coadd in naxis3 of a single output FITS file instead of saving each coadd in its own FITS file
- Take Cal. Frame: after every nod, save an image (called Prefix_calxxxxxx.fit) with the minimum integration time and current value of coadds (useful for getting unsaturated images of a target once every nod)
- Tel. info in header: THIS SHOULD ALWAYS BE CHECKED WHEN CLIO IS AT THE TELESCOPE. It puts the TCS information (e.g. RA, DEC) in the Clio FITS headers

File Saving Boxes:

- Set Directory: choses output directory for image FITS files [note that this is done automatically for you when you start Clio, setting the directory to the current UT date, with the prefix "n"].
- Set Prefix: sets the file name prefix; names will be of the form Prefixnnnnn.fit and will be numbered sequentially starting with 1 for every unique Prefix, and the ns are 0s (ie, StarName00001.fit is the first file saved).
- Next Image Number: used for setting the next image number by hand instead of letting the Clio2 software use the next sequential number

Nod Parameter Boxes:
The current values of the nod distance are shown and may be set in the boxes:

- xnod (arsec)
- ynod (arsec)

NOTE: -x moves the star to the right on the detector; -y moves the star up on the detector
NOTE2: This is NOT the same sign convention as in the Star nudger!

Script:

Pushing the green Script button brings up the buttons for selecting and executing a .tcl observing script

II) Star Nudger GUI

This is the GUI for moving the telescope. There are currently two ways to use it:

1. left/right or up/down: enter the distance (in arcsec) into the box and press the appropriate button. The button indicates the way the **target** moves, not the way the telescope moves.
2. AutoStar: Waits for two mouse clicks in the ds9 display. The first mouse click is on the current position of the target (and displays a green circle) and the second mouse click is on the desired location of the target (and displays a blue circle). The GUI calculates the offset and presents it to the user. Then the green "Move" button will execute the offset. NOTE: +x is right on the detector and +y is up on the detector (not the same as the Nod vector convention)
3. Go to focus button: sets focus to the entered value

III) CLIO Motor Control GUI

This is the GUI for selecting the camera plate scale, filter, and pupil mask. The boxes turn yellow while the wheels are turning and become green when done moving. The status bar at the bottom of the GUI is also yellow when things are moving. It's fine to move multiple wheels at once, though once you click on "Move motors", all other buttons become disabled until the movements are done.

1. Select a camera: Hit the "Align Wide Camera" or "Align Narrow Camera" button. This will get you very close to being aligned, but extra tweeking may be necessary. See Section Observation Guidelines for instructions on how to complete the alignment.

- The align button will automatically choose the camera (pupil plane) and corresponding Scale. After all the wheels move, you will be left in pupil imaging mode.
- When you are done aligning, to return to regular imaging, click "Next CW" on wheel 5 (Camera Lens) until you reach your desired camera (f/37.7 for narrow or f/21.5 for wide). **NOTE: Do not select the "Scale" from the button menu because that will ruin your alignment.**

- When you click "Align ...", a window will pop up that will ask you if you're sure you want to Align.
- If you change the camera by hand in the "Pupil Plane" menu, the wheel will not move until you press "Move motors". You also then need to align by hand (see "Observation Guidelines").

2. To change filters, choose the "wavelength" button and select the desired filter. Then press "Move motors." Note: If the "Auto Focus" button is checked, this should move to the correct focus as well (but sometimes it will not if AO is not accepting bayside commands). Check the focus!

3. Focus button: Sets the focus to the correct value for the current filter

IV) Quick Analysis (cliocurrentstats GUI)

This Matlab tool uses the image currently displayed in ds9 and computes and display some statistics.

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Edited Apr 13, 2014 6:50 PM by Alycia Weinberger…

Using Clio Cookbook

This Cookbook assumes you've already started all the Clio GUIs (see Beginning of the Night Checklist), slewed to your target of interest, and the AO is locked. Before the AO is locked, you won't be allowed to nod the camera and you won't be able to tell what integration time you want, but you can check the background level in your filter of interest.

Note: In the afternoon, you should have selected the camera you wanted (i.e. the pixel scale). The pupil stop is not repeatable, so once you have it aligned, you want to leave it there. If you absolutely must change it during the night, you will have to realign (see camera details).

Follow this 7 step checklist to observe.

1. Choose your filter
    1. Press "Wavelength" button on CLIO motor control GUI
    2. Press "Move Motors" button on CLIO motor control GUI
2. Choose Clio Camera Format (Full, Strip or Stamp) in Clio Camera Control Program NOTE: After AO lock, target should appear in Narrow camera, Full field at approx. pixel (200,300)
3. Take "Video" images to check the exposure time
    1. Set a short Integration time, e.g. 0 s to get shortest, and press return (NOTE 1)
    2. Set Coadds = 1 <PRESS RETURN>
    3. Press "Video" in the Clio Camera Control Program
    4. Stop video and change Integration time as needed (PRESS RETURN), then restart video
    5. Stop video to set final integration times (PRESS RETURN), coadds (be sure to check the maximum coadds for your detector format), and images per nod (NOTE 2)
4. Set Filename Prefix in "Set Prefix" window and PRESS RETURN
5. Put your target where you want it on the array using "Star nudger MagAO GUI"
    1. Press "AutoStar" – click on current location of target (blue circle appears) and then new location for target (green circle appears)
    2. Check with the AO operator that it is ok to nod, then press "Move"
6. Set up nod vector using "Star Nudger MagAO GUI"
    1. Press "AutoStar" – click on current location of target (A nod) and then where

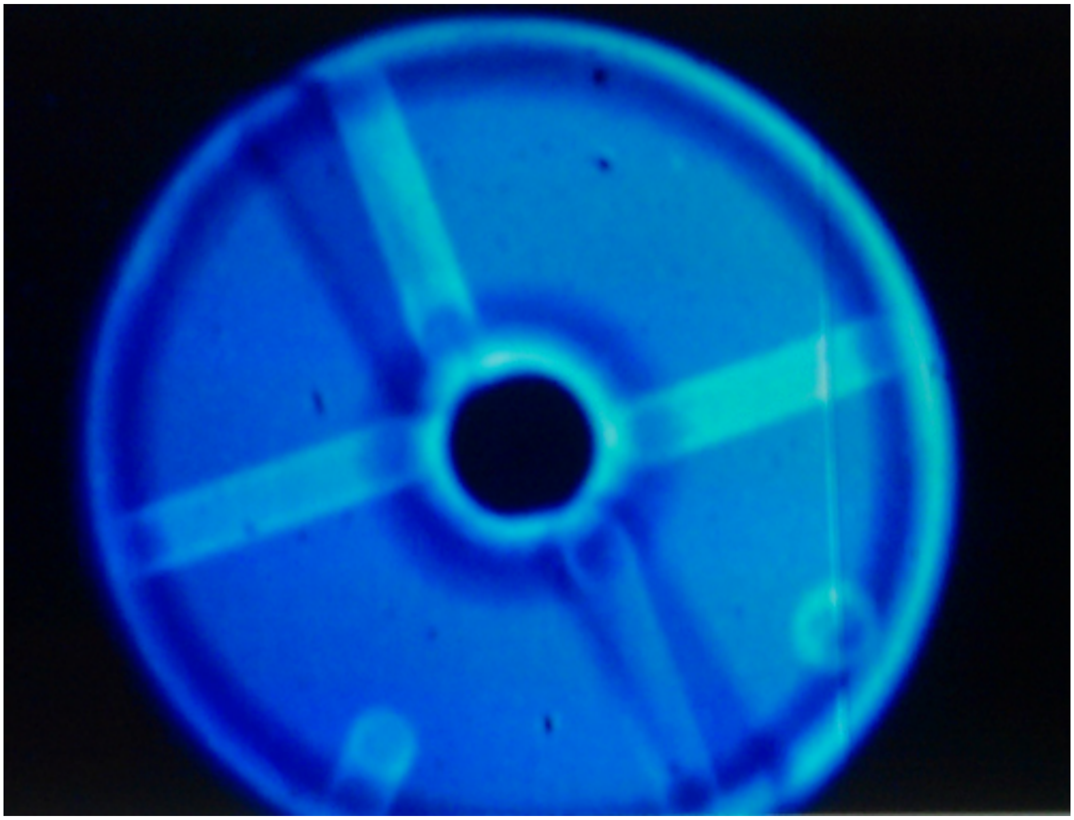
you want B nod
    2. Click "Update Nod Vector" NOTE: for this to work, image taking must be stopped first (i.e. stop video)
7. Take Images
    1. Choose "Nod AB" or "Nod ABBA"
    2. Check Focus - a warning dialog box will come up, if focus is ok, press "yes" otherwise press"no" and click the Focus button on the CLIO Motor Control GUI

For more sophisticated use, you can write a script. See the Observing Scripts page for instructions.

NOTE 1. If you are saturating in the minimum exposure time in your detector format, you can switch to a smaller format
NOTE 2: Normally, we nod on Clio to remove the sky. A typical time between nods is 3 min. On-sky integration time = Integration * coadds * images/nod * Nnods (were Nnods =4 for ABBA).

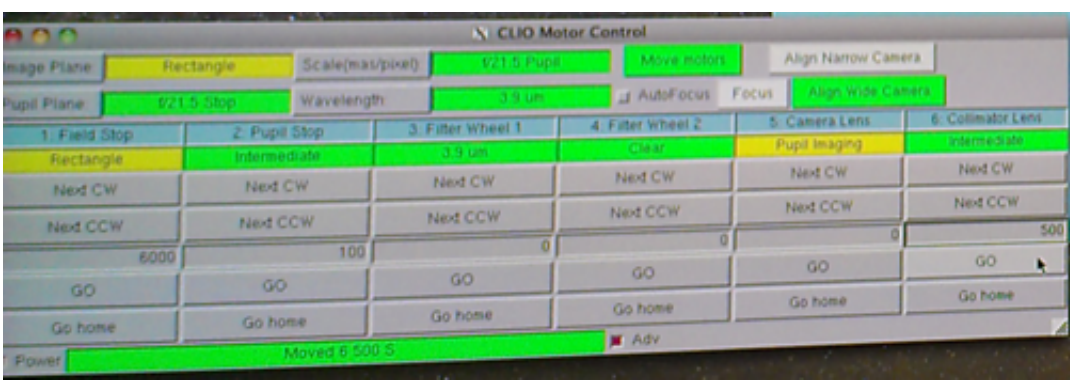
Tags
Edited Nov 17, 2014 7:18 PM by Katie Morzinski...

Aligning Wide and Narrow Cameras



Successfully aligned wide camera pupil image, 3.9um, with the field stop in Open, from 2014/04/21. The pupil image is sharper with the rectangle in, but with the field stop Open we can center up the dark and light patterns better. And since imaging will be with the field stop Open, this is the more valid alignment. It also gives less vignetting. (Click for full-size image)

How to Align the Wide or the Narrow Camera



Where you move the motors to align the camera. (Click for full-size image)

- Hit the appropriate "Align" Button ("Align Wide Camera" or "Align Narrow Camera")

in the CLIO Motor Control Basic GUI -- Say "Yes" to the yes/no pop-up question.
  - This will change the Pupil Plane, Wavelength, Image Plane, and Scale wheels automatically (takes a couple minutes because it moves the motors one at a time)
  - Then put Wheel 1 (Field Stop) from Rectangle to Home to -> Move CW to Open (because we used to put the Rectangle in, but when we did it with open it took out the vignetting in the Wide camera)
- Put the camera into quick video mode
- Put the camera control into Strip mode for Wide cam -- Full frame works for Narrow cam
- Set the ds9 scale to MinMax
- Put a ds9 cursor circle at:
  - *OLD: Aligning Narrow Camera: [681.3, 354.8] with radius 25 pixels in Full frame (Put ds9 Scale -> Log, Zmax).*
  - NEWER2: Aligning Narrow Camera: [664.83, 354.8] with radius 25.1 pixels in Full frame (Put ds9 Scale -> Log, Zmax).
  - NEW WITH OPEN NOT RECTANGLE: Aligning Narrow Camera: [695.42, 145.15] with radius 16.28 pixels in Strip Mode (Put ds9 Scale -> Linear, MinMax).
  - NEW WITH RECTANGLE: Aligning Narrow Camera: [684.83, 357.15, 23.9] in Full Mode (ds9 Scale -> Log, Zmax). 2014/11/16
  - 2014/11/17 Narrow Rectangle [684.83, 355.97, 26.41]
  - Aligning Wide Camera: [401.9, 129.0] with radius 30 pixels in Strip mode (Put ds9 Scale -> Linear, MinMax).
  - *WIDE CAM [416.02,127.82,23.55]*
  - *WIDE CAM [411.82,128.71,23.14]*
  - *WIDE CAM (OPEN FIELD STOP, STRIP MODE) 2014/11/17: [407.11, 127.53, 23.95]*
- This is approx where the pupil stop goes. Then you align the collimator lens to match it, with the field stop in Open.

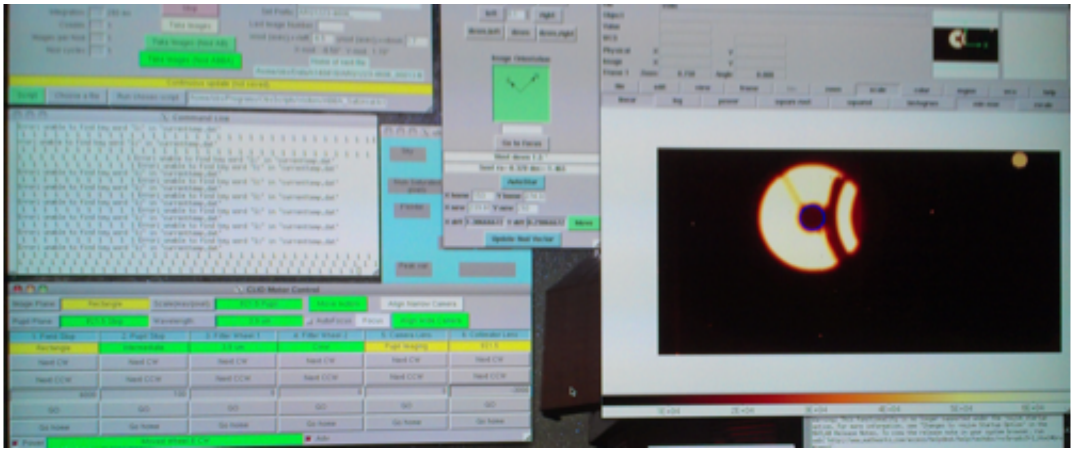
- When the motors are finished moving, the camera will be close to aligned but you have to fine tune it by hand.
  - You will adjust the Pupil Stop (Wheel 2) and the Collimator Lens (Wheel 6).
  - You move the Pupil Stop and the Collimator Lens by typing numbers in the box below "Next CCW", and by hitting "GO" after you type it.
  - Wait for the guide probe to be out to align the Collimator Lens.

NOTE: For small changes (<1000), be prepared for having to hit the motor move button several (maybe 7) times before it starts to move. Once it starts to move, it will respond accurately and immediately to the step command. If you switch directions, you will once again have to hit it multiple times before it responds.

1. Start with Wheel 2 (Pupil Stop): **Positive** numbers move it **left**
    1. Move in units of 100-200 steps to start. There is back-lash so it's easier if you start from one side and always come in from that side -- go back if you go too far, and start again with larger steps, then go to smaller steps, if you mess up.
    2. Move Wheel 2 until the Pupil Stop (dark circle with spiders) is at the circle you drew on ds9.
2. Move Wheel 6 (Collimator Lens) to catch up with Pupil Stop.

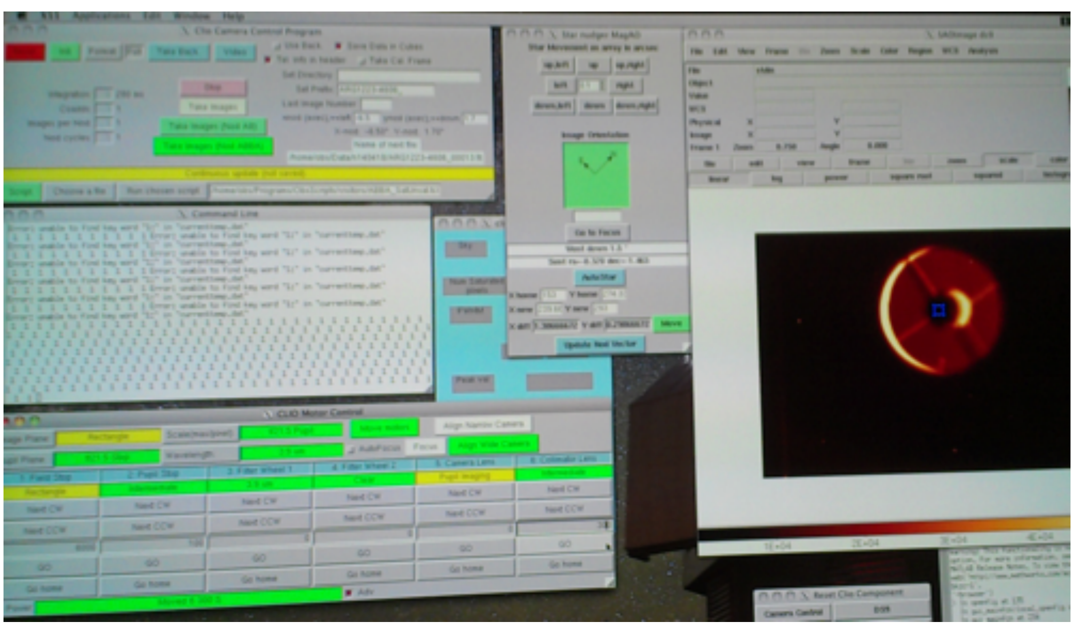
- Leave pupil alignment mode and go to camera imaging with the following steps
    - Move Camera Lens (Wheel 5) CW to the correct camera, by hitting "Home" then "Next CW"
    - Warning: Do not move the motors any other way, because they will "Home" and you will lose your fine-tuning.
        - You want: Camera Lens =
            - f37.7 = Narrow camera
            - f21.5 = Wide camera
    - Then get ready for your observations:
        - Change Image Plane -> Open
        - Choose desired Filter (and check AutoFocus if desired)
        - Hit "Move Motors"

Note: Clio must be looking at sky in order to see the alignment. So, you can not align while the telescope's Shack Hartmann guide probe is in. (Well, you can align the Pupil Stop, but not the Collimator Lens)



How it looks while you're aligning. These images show the Collimator Lens being moved to line up with the Pupil Stop. (Click for full-size image)

How it looks while you're aligning. These images show the Collimator Lens being moved to line up with the Pupil Stop. (Click for full-size image)



How it looks while you're aligning. These images show the Collimator Lens being moved to line up with the Pupil Stop. (Click for full-size image)

To align the APP or NRM by hand

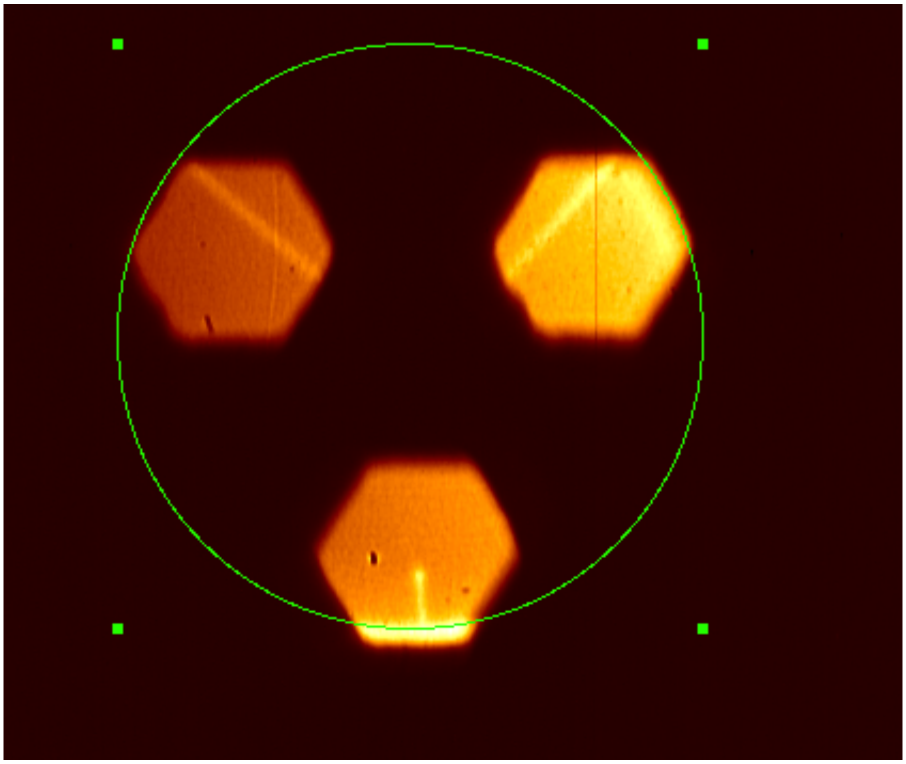
- Select the pupil imaging lens for your desired plate scale in the Scale menu.
- Select the desired pupil mask (cold stop, APP, or NRM) in the Pupil Plane menu. For regular imaging, use the cold stop for the desired plate scale.
- Select the Rectangle field stop in the Image Plane menu.
- Select a thermal wavelength, preferably a narrowband such as 3.4 or 3.9um;

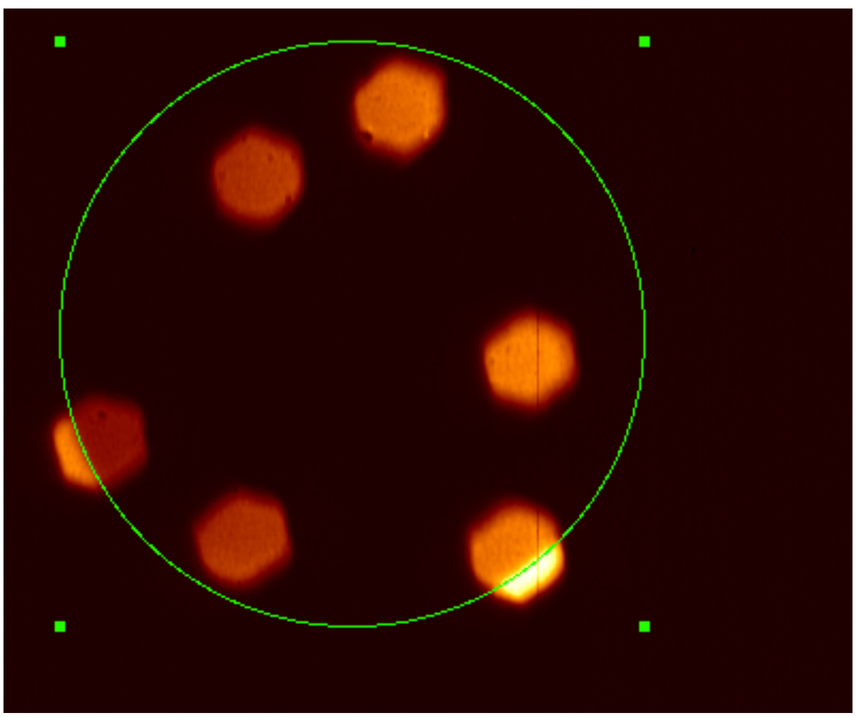
In the Advanced GUI (available by checking the Adv box in the lower right)

- Turn on the power to the motors by checking the Power button.
- Adjust the Pupil Stop (Wheel 2) and Collimator Lens (Wheel 6) left and right. Move by steps of 500-1000 until they're overlapped with the pupil mask central obscuration covering the pupil image central obscuration (ie: aligned both horizontally and vertically). Note that if there is a vertical misalignment, adjust the CL and PS left/right together. Both optics are on filter wheels, so their paths are curved.
- If you've adjusted the collimator lens, DO NOT use the Basic GUI Scale menu to go back to imaging mode, because it homes the collimator lens. Instead, return to imaging mode by using the "Next CW" button for the Cameral Lens in the Advanced GUI.

To decrease detector noise, turn off the power to the motors, if it's not off already.

Aligned NRM pictures:





Tags
Edited Nov 6, 2014 7:32 PM by Katie Morzinski...

PSF Stars

How to do fast Star (i.e. PSF) Switching to Acquire PSF Stars

This procedure is meant for times when you slew a small distance (< few degrees) to a comparison star.

1. Observe your first target.
2. When finished, ask the AO operator to PAUSE the AO loop.
3. BEFORE moving the telescope to the new star, have the TO put the guide probe in and mark the location of the star in the guider field.
4. Slew to the new star, and ask the TO to put it on the marked location and then take out the guide probe.
5. Resume the AO loop (if the new star is a significantly different brightness than the first, AO changes will be necessary).
6. Tip: for good PSF subtraction, set the coadds for the PSF star = 1, so you get more images of the PSF. This will be useful for good PSF subtraction algorithms like PCA, where the more images you have in your library, the better the PSF matching.

PSF switching directions for TO

1. After the AO loop is paused, put in the guide probe. DO NOT MOVE THE TELESCOPE YET.
2. Move the box to the star location and mark the position.
3. Slew to the new target star.
4. Put the new star in the box/at the marked position.
5. Park the guider.
6. The AO operator can now resume the loop.

–modified 2014/11/06 Katie Morzinski

Tags
Edited Nov 15, 2014 6:00 PM by Katie Morzinski...

Observing Scripts

It can be useful to use a script, for example, to take multiple nod sets with dithers in between or even take a nod set, change filter, take a nod set, dither, etc. Scripts for Clio are written in TCL.

Sample observing scripts are on clio1.lco.cl in the directory /home/obs/Programs/ObsScripts.

- ditherscript.tcl – a simple script you can use as a template. Here is what it does:
    - set filename prefix with *set previxtext "name"* [set to "obj_" in the template]
    - set integration time with *set intent <inttime>* [set to 1500 ms in template]
    - set number of coadds [10 in template]
    - set number of images per nod [10 in template]
    - set number of nod cycles [1 in template]
    - set dither size (in arc sec) [0.3 in template]
    - Loop n times [1 time in template], taking ABBA nods and dithering after each nod

Script header

#!/usr/bin/wish
##The line above must always be the first line. Even though it starts with a "#", it is NOT a comment.
##The line below declares ALL the variables you may want to use in a script. No harm in declaring them all.
global calon coaddtext darkon datacubeon impernod_stored impernod inttest movestatus prefixtext queryaoon step timeout video xnodset ynodset

Change filter

##
1. Select filter (choose one below)

######### Blocked ########

```
send CLIOMOTORS definepos 3 1
######### J + PK50 ########
send CLIOMOTORS definepos 3 2
######### H + PK50 ########
send CLIOMOTORS definepos 3 3
######### Ks + PK50 ########
send CLIOMOTORS definepos 3 4
######### 3.1 um ########
send CLIOMOTORS definepos 3 5
######### 3.3 um ########
send CLIOMOTORS definepos 3 6
######### 3.9 um ########
send CLIOMOTORS definepos 3 7
######### L' ########
send CLIOMOTORS definepos 3 8
######### M' ########
send CLIOMOTORS definepos 3 9
######### Lspec+Clear #######
send CLIOMOTORS definepos 3 10
######### Prism+Lspec #######
send CLIOMOTORS definepos 3 11
######### Open ########
send CLIOMOTORS definepos 3 12


##########################################################################
## 2. Move to selected filter
send CLIOMOTORS movemotors


##########################################################################
# 3. Focus in the selected filter
# Check the focus, and update if not in focus
exec echo all | nc magadsecsup.lco.cl 7102 | grep BAYSIDE_Z > /tmp/tmpfocus.txt
set fi [open "/tmp/tmpfocus.txt"]
set focusinfo [gets $fi]
```

```
set currentfocus [lindex $focusinfo 1]
set newfocus [send CLIOMOTORS checkfocus]
set focusdiff [expr {$currentfocus - $newfocus}]
if {$focusdiff != 0} {
send CLIOMOTORS dofocus
after 5000
}
######################################################################
#######
```

Select file name

```
######################################################################
#######
## FITS files named:
set prefixtext "Achernar"
UpdatePrefix
```

Select integration time, coadds, cubes, cal

```
######################################################################
#######
## Integration time, coadds, and cubes, and cal frames
set inttext 0
UpdateInt

set coaddtext 1
UpdateCoadd

## 0 = No Cube (Data Co-added like normal Coadds)
## 1 = Cube (Coadds saved as frames in 3-d cube)
set useCube 0
if {$useCube != $datacubeon} {CubeOn}
## (It's actually a toggle)
```

0 = No Cal frames (Just the integration times you asked for)
1 = Cal frames (Will save a 0-second 1-coadd file at each new Nod position)
set useCal 0
if {$useCal != $calon} {CalOn}

Choose how many images to take at each position

```
##############################################################################
## How many images do you want to take in each position?
set impernod 5
UpdateImperNod
```

Set up the nod/dither vector

```
##############################################################################
## Set up the nod vector
## Positive X makes the star move to the Left on the detector
## Positive Y makes the star move Down on the detector
## xy nod/dither sizes in arcseconds
set xsize -1.1
set ysize 0.4
set xnodset $xsize
set ynodset $ysize
UpdateNodVector
```

Send moves to the Bayside stages

```
##############################################################################
## set dither .5
## Left & right moves the Y stage
## right2 moves the star to the Right
#send MOVEBAYSIDES right2 $dither
```

```
#send MOVEBAYSIDES left2 $dither
## Up & down moves the X stage:
#send MOVEBAYSIDES up2 $dither
#send MOVEBAYSIDES down2 $dither
```

Take data

```
####################################################################
#######
## Take data
## NImg = Take data here without moving
#NImg
## NNod = AB
#NNod
## NNod_ABBA = ABBA
#NNod_abba
```

-Alycia Weinberger, 2014/04/13
-Katie Morzinski, 2014/10/31

Tags
Edited Jun 28, 2012 3:25 AM by Phil Hinz...

Detector Information

Detector

The detector for Clio as of April 2010 is a HAWAII-1 HgCdTe array. We use two quadrants of the array to give a 512×1024 FOV. Pixels are 18.5 microns on a side.

Operational Parameters

Read Noise & Dark Current (as of June 2012)

Images were taken on 6/21/2012, with MBE detector temperature at 56 K. Images were taken with exposure times of 1s, 3s, 10s, 30s, and 100s. From the 1s images, the read noise was estimated as follows:
-subtract two successive images from each other.
-in a good region of the detector (away from stationary artifacts), place a 10x10 pixel box and calculate the standard deviation of the difference image inside the box.
-divide the result by sqrt(2)
-repeat for each consecutive pair of images taken.
-the read noise was measured to be 10 DN (49 e-) from the median of all of these values.

The dark current rate was measured by placing the same 10x10 box on all of the images taken (up to 100s exposure). the average pixel value in the box was then calculated, and plotted as a function of exposure time. the dark current rate, measured as the slope of the fitted line, was 5.9 DN/s (29 e-/s). the plot is shown below:

Clio2DarkCurrent.eps

Bad regions of the detector:

The image below shows the regions to be avoided in the detector when taking low flux data. the regions marked in red are high in dark current rate (up to ~25 DN/s); the regions in blue are low (~ 6 DN/s).

badregions.png

Detector Parameters

The detector gain is 4.9 e-/dn.

At the MMT, the temperature settles to 75.6 K on the detector, and the bias is 3700 dn (measured 101021).

The approximate saturation level is 55,000 dn.

This indicates that the full well capacity of the array is 51,000 dn or 250,000 e-

Bad pixel mask

This is a minimal mask that rejects the nonsensitive areas of the Clio2 detector.

Clio2mask101020.fits

Minimum Integration Time

The minimum integration times are the following:

Format	Array Size	Minimum	Max Coadds
Full array	(512×1024)	280 ms	20
Strip	(300×1024)	164 ms	40
Stamp	(200×400)	43 ms	100

Duty Cycle

The dead time for an exposure is approximately 262 msec. This would give an expected efficiency of 50% for a minimum integration time of 262.

Tags
Edited Jul 18, 2014 2:35 PM by Katie Morzinski...

Readout Efficiency

Readout Efficiency Tests

For the Key Project we are interested in temporal sampling of the PSF. So here we did some efficiency tests of the various combinations of Integration time, Coadds, and Cubes to see which mode to use to jointly optimize temporal sampling and efficiency. First let's explain the different options in ways to save Coadds and Cubes.

Clio Data Sequence Options:

Between Coadds, Nimgs, and Cubes, there are a few options for temporal sampling and resultant image size for how to take a sequence of Clio data. If you are using Cubes, then the Coadds are not added but are saved as individual frames within a 3-dimensional data cube. The Cube will be saved as a single .fit file and so it will have only 1 FITS header. Thus, while the temporal sampling of the data is higher, the temporal sampling of the FITS header (not listed here) is per .fit written. Also, the FITS header will state the # of Coadds only if they are added, so if you are saving in Cubes, asking for "10 coadds saved in cubes" gives you 1 coadd in 10 frames in a data cube.

The Table explains it with an example:

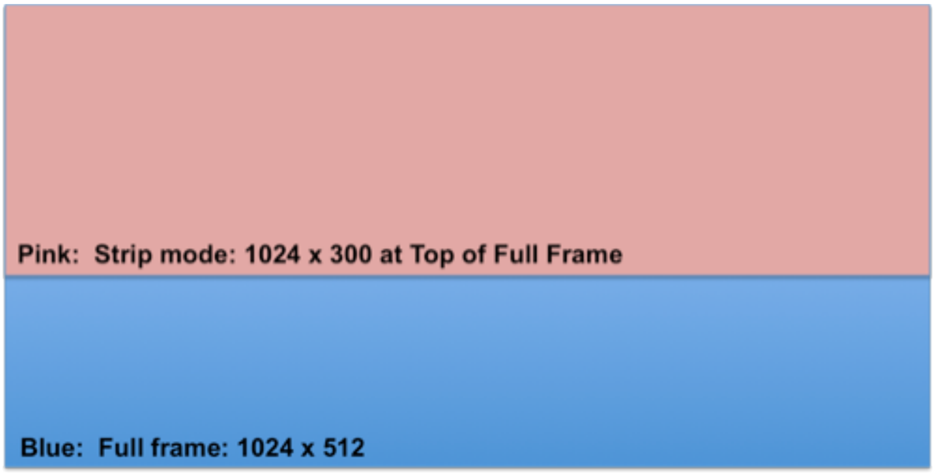
Nimgs	Integration Time [ms]	Coadds	Cubes	What Will the FITS Header Say for # of Coadds	Result	FITS dimensions (Example for Full Frame)	Total Integration Time [sec] = Nimg x IntTime x Coadds	Temporal Sampling of Images [sec]
10	1000	1	No	1	10 2-d FITS files, no coadds	1024 x 512	10	1
10	1000	10	No	10	10 2-d FITS files, each with 10 frames coadded (the total duration is 10x longer than the above line)	1024 x 512	100	10

10	1000	1	Yes	1	10 "3-d" FITS files, with the coadds saved in cubes except that since there is only 1 coadd, the 3rd dimension has nothing in it	1024 x 512 x 1	10	1
10	1000	10	Yes	1	10 3-d FITS files, each with 10 frames in a 3-d Cube	1024 x 512 x 10	100	1

And here are the readout efficiency tests:

(Also a quick note about taking data at a very high temporal sampling. To save computer processing speed, you may want to stop the Transfer Files program (hit the X in upper left corner of window) during the data taking. Restart it when resuming normal observations by going to Restart Clio Components -> FileBackup)

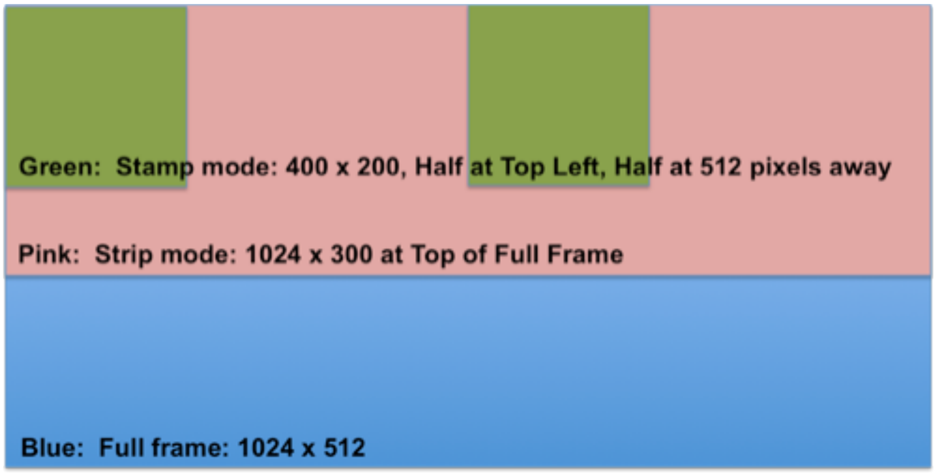
Strip Mode Tests:



Strip Mode

Integration time [ms]	# Coadds	Cubes or 2-d FITS?	# Frames	Images ID	Total Clock Time Elapsed [min:sec] / [sec]	Total Integration [sec]	% Efficiency = 100 x Total Integration / Clock Time Elapsed	Temporal Sampling of Images [sec]
164	40	Cubes	15	n140410 test 1-15	3:39.5 / 219.5	98.4	44.8 %	0.164
164	40	2-d FITS	15	n140410 test 16-30	3:33.3 / 213.3	98.4	46.1 %	6.56
164	1	2-d FITS	600	n140410 test 31-630	6:30.0 / 390.0	98.4	25.2 %	0.164
164	6	Cubes	100	n140410 test 631-730	4:10.8 / 250.8	98.4	39.2 %	0.164

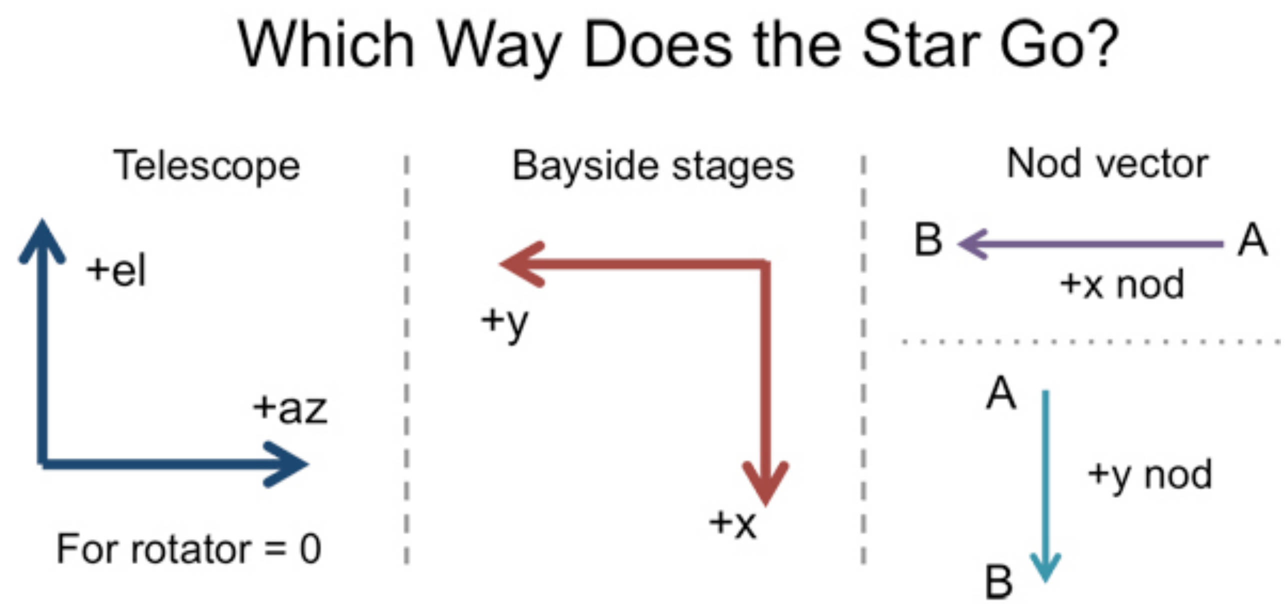
Stamp Mode Tests:



Stamp Mode

Integration time [ms]	**# Coadds**	**Cubes or 2-d FITS?**	**# Frames**	**Images ID**	**Total Clock Time Elapsed [min:sec] / [sec]**	**Total Integration [sec]**	**% Efficiency = 100 x Total Integration / Clock Time Elapsed**	**Temporal Sampling of Images [sec]**
1000	10	2-d FITS	10	n140406 AlphaCen 1-10	2:14.2 / 134.2	100	74.5 %	10
10000	1	2-d FITS	10	n140406 AlphaCen 11-20	1:47.8 / 107.8	100	92.8 %	10
1000	1	2-d FITS	100	n140406 AlphaCen 21-120	2:50.0 / 170.0	100	58.8 %	1
43	100	2-d FITS	10	n140406 AlphaCen 121-130	1:47.4 / 107.4	43	40.0 %	4.3
43	10	2-d FITS	100	n140406 AlphaCen 131-230	2:08.6 / 128.6	43	33.4 %	0.43
43	25	2-d FITS	40	n140407 AlphaCenTest 1-40	1:57.4 / 117.4	43	36.6 %	1.075

-Katie Morzinski, 2014/07/17, tested 2014/04/06-10



Orientation of telescope az/el, bayside x/y, and nod x/y on the Clio chip (as displayed in ds9), and which way the star will go when you move the paddle

Filter Wheel Positions

These are set by choosing "Wavelength" in the CLIO Motor Control GUI. However, if you want to script a filter change, you need these wheel positions. When you move wheel 3 to change the filter, wheel 4 will move to the appropriate location automatically. Don't know if these are right as of the new filters on 2014A (April).

Filter	**Wheel**	**Position**
J	3	2
H	3	3
Ks	3	4
3.1	3	5
3.3	3	6
L'	3	8

Tags
Edited Apr 21, 2014 5:20 AM by Katie Morzinski...

Filters

Filter Wheels

There are two filter wheels in Clio placed just after the pupil stop. Each wheel is capable of holding 8 one inch filters. As of April 2014 the filter wheels contain the following filters. Listings below are listed in clockwise order from the home position, as seen from filter wheel 1.

Wheel 1 (motor 3)

1. Open (Home)
2. MKO M'
3. 3.3 um filter (JDSU W03311-6E passband 3.12-3.53 um)
4. Direct vision prism (narrow edge toward cold plate)
5. 3.1 um filter (JDSU N03095-8E)
6. MKO L'
7. 3.9 micron filter (JDSU N039042-8E)
8. PK50 long-wavelength (<2 um) blocker

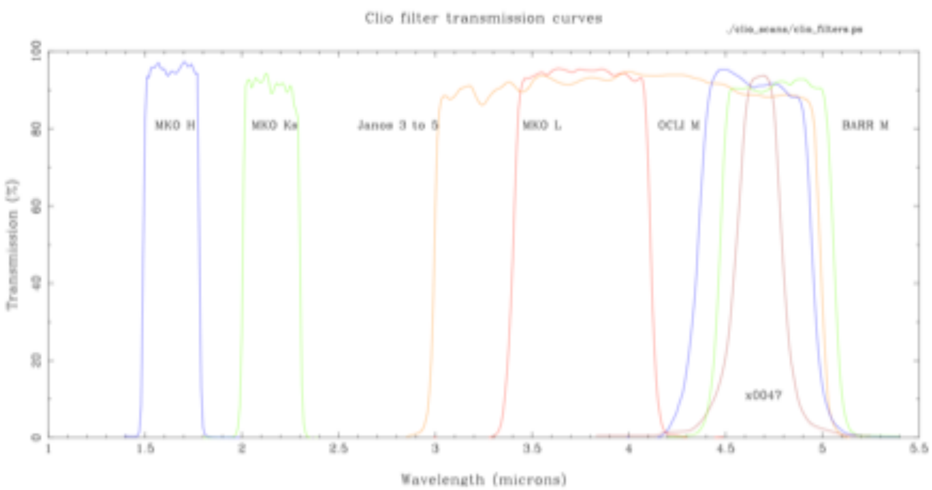
Wheel 2 (motor 4)

1. MKO J (Home)
2. ND2 -- 0.1% transmissive ND (Janostech P/N FX90-0099)
3. ND3 -- ~"4.4%" transmissive ND (Janostech P/N FX90-0098)
4. Open
5. Lspec (2.8-4.2um pass filter, for use with Prism)
6. Blocked
7. Barr Ks
8. "MKO" H (from Asahi)

3.4 micron filter (JDSU N03401-6E) was removed 2014-03-27 and placed in storage in LCO clean room. BK7 windows also removed from JHKs slots 2014-03-27, so instead use JHKs with PK50 from 2014A on.

Field Stop	Pupil Stop	FW1	FW2	Camera Lens	Collimator Lens
50um Pinhole	f/21.5	Open	MKO J	f/21.5	3/37.7
Open	M APP	MKO M'	0.1% ND2	Pupil Imaging	f/21.5

Narrow Slit	L APP	3.3um	4% ND3	f/37.7	
Medium Slit	f/37.7	Prism	Open		
Wide Slit	3 hole NRM	3.1um	Lspec		
Rectrangle	6 hole NRM	MKO L'	Blocked		
		3.9um	Barr Ks		
		PK50	"MKO" H		

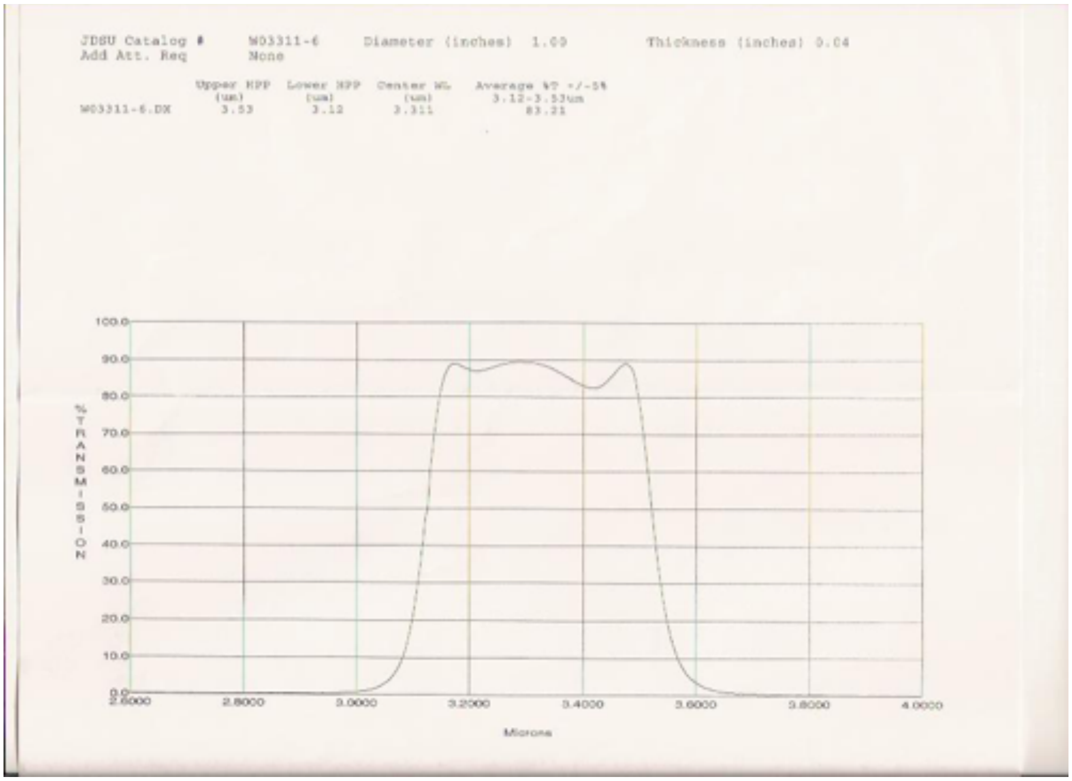


Click for full-size image

The associated text files for the filter transmission curves are in this tarball:

clio_filters_v3.tar.gz

In Fall 2008, a 3.1-3.5 micron filter was added:



Click for full-size image

Around the same time, an Ice band filter was added:

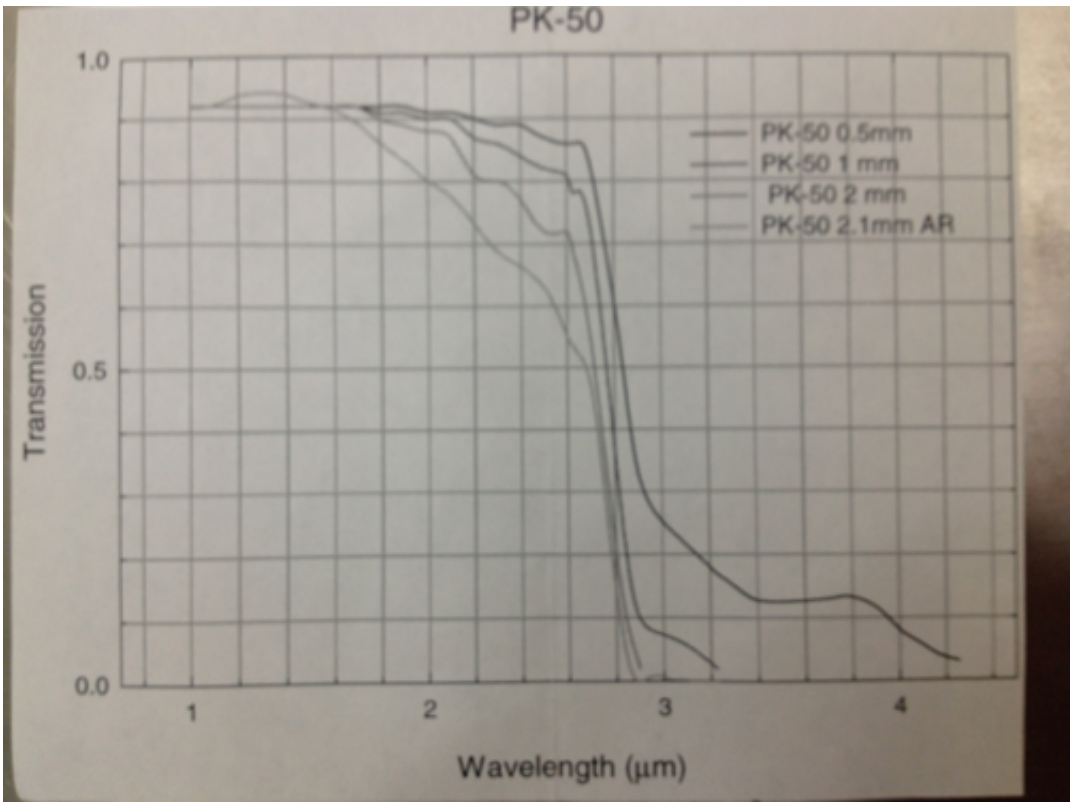
Click for full-size image

New H-band filter as of 2014/03/14: (From Asahi Spectra)

Clio2_H_2014.png

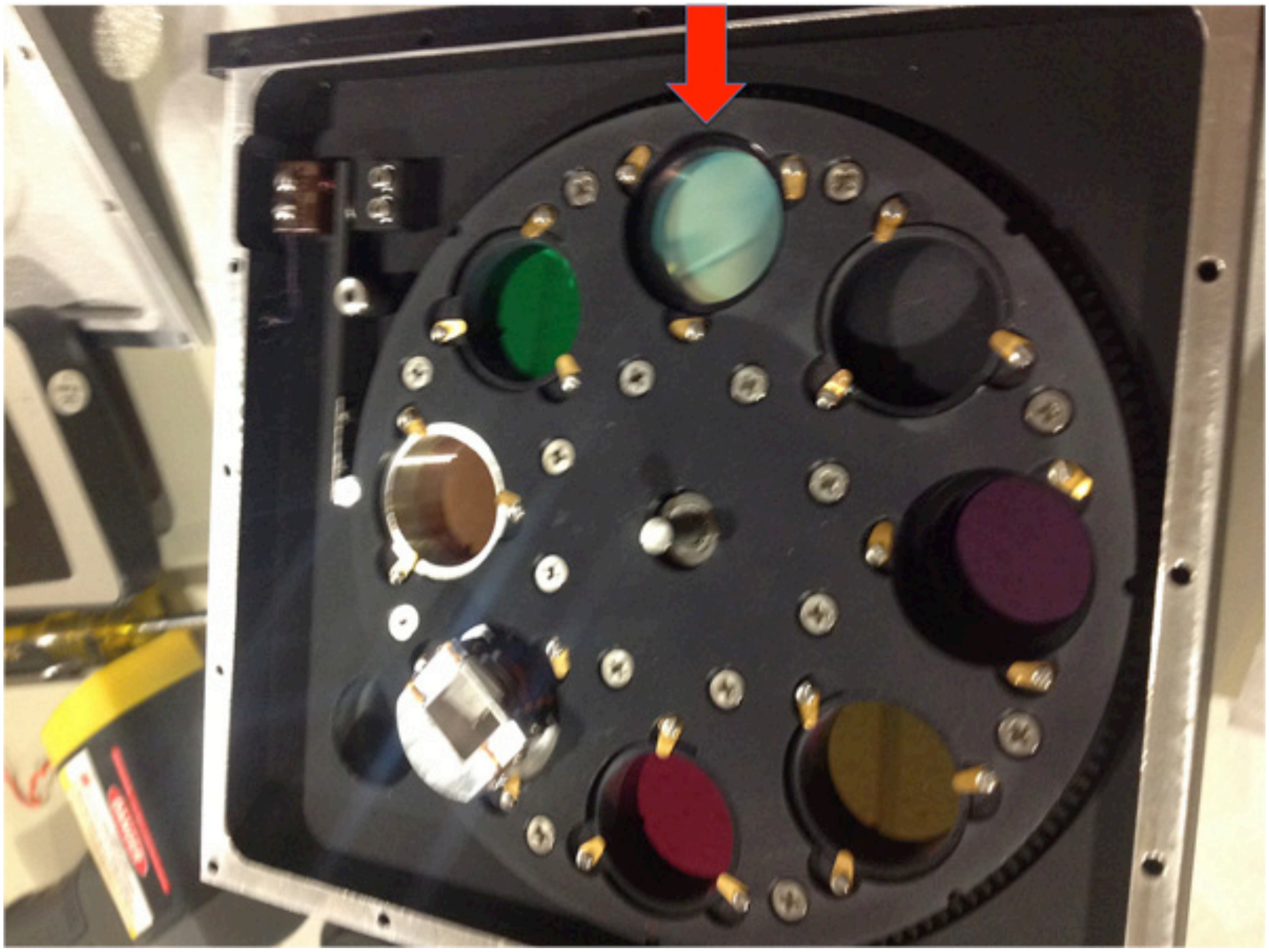
Data: H filter.xls

New PK-50 long-wavelength blocker as of 2014/03/25: We believe we have the 2-mm one. This filter curve is in the box of Clio filters spares in the LCO clean room.



Click for full-size image

Photo of Filter Wheel 1 as of 2012/08/22:



Clockwise from red arrow: MKO J, Blocked (for darks), Open (home), MKO M', Barr M, Direct vision prism, 3.1um, Barr L'.

Dated Summer 2012.

Historical Filter Information: Comm1 (2012B) and Comm2 (2013A) :

Wheel 1

1. Open (home)
2. MKO M’

3. Barr M
4. Direct vision prism (narrow edge toward cold plate)
5. 3.1 um filter (JDSU N03095-8E)
6. MKO L’
7. MKO J +uncoated 5mm thick BK7 window
8. Blocked

Wheel 2

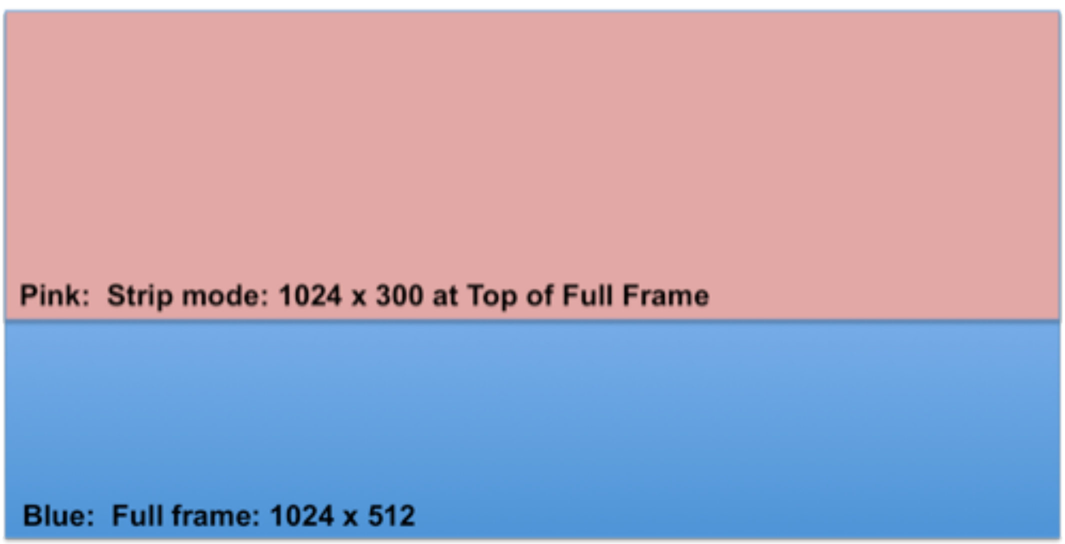
1. 3.3 um filter (JDSU W03311-6E passband 3.12-3.53 um)
2. 0.1% transmissive ND (Janostech P/N FX90-0099)
3. ~1% transmissive ND (Janostech P/N FX90-0098)
4. Open
5. 3.4 micron filter (JDSU N03401-6E)
6. 3.9 micron filter (JDSU N039042-8E)
7. Barr Ks+uncoated 5mm thick BK7 window
8. Barr H + Thorlabs AR-coated 5mm thick BK7 window

Tags
Edited Jul 16, 2014 5:20 PM by Katie Morzinski...

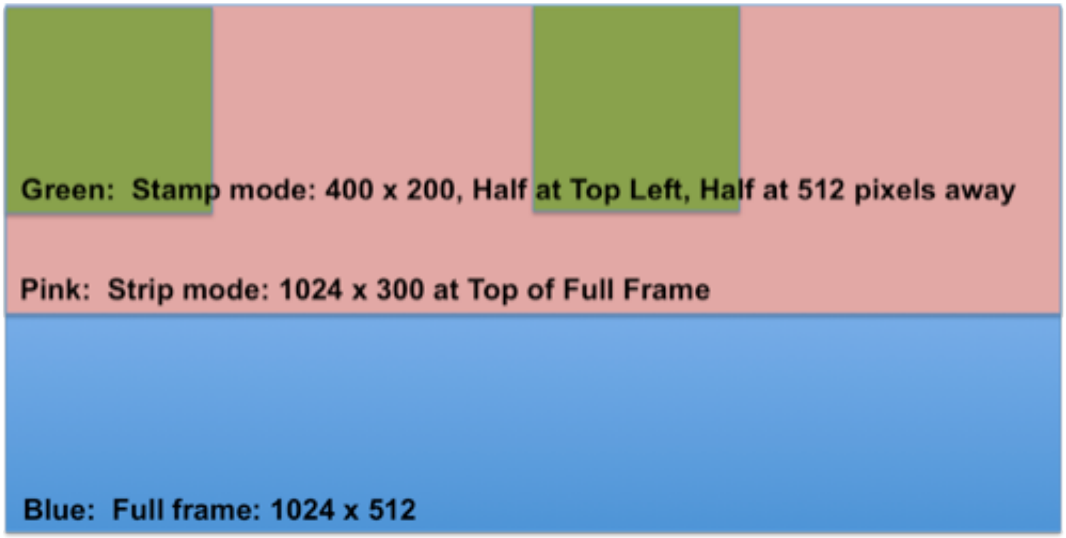
Full Frame and Sub Frame Formats

"Format" is the detector sub-array that is read out during a Clio observation. This page has diagrams to illustrate the exact pixels that fall in the different detector formats: Strip, Stamp, and Substamp, relative to Full Frame.

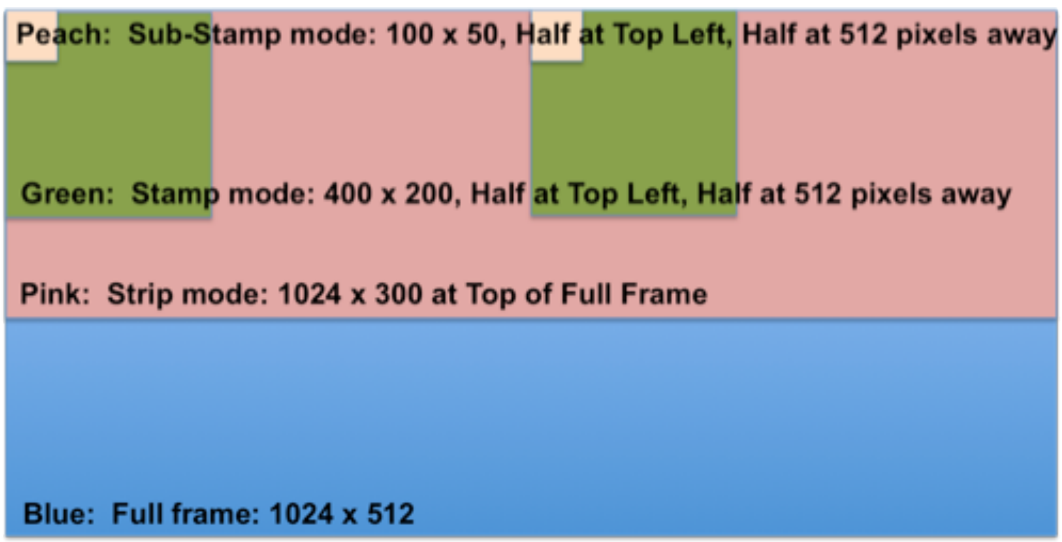
Full Frame



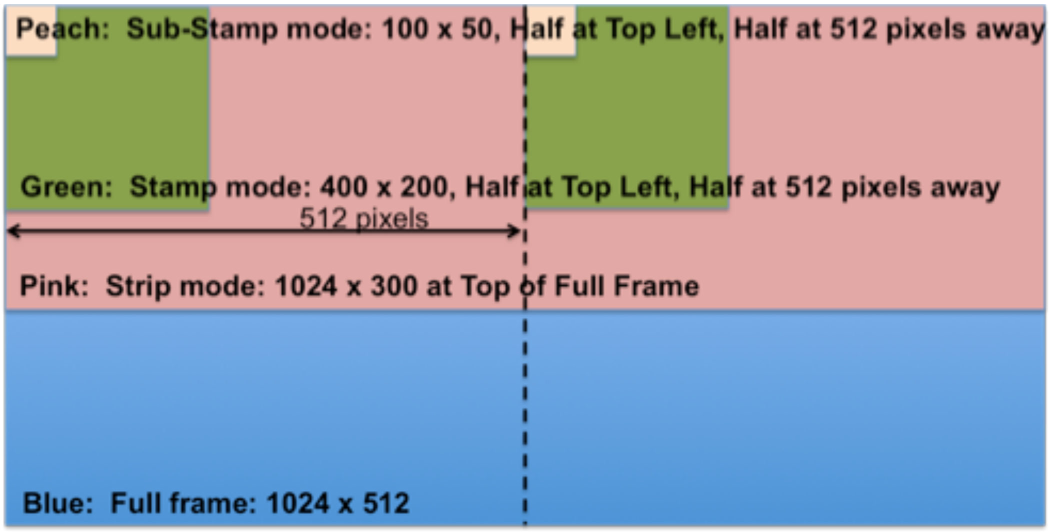
Strip Mode



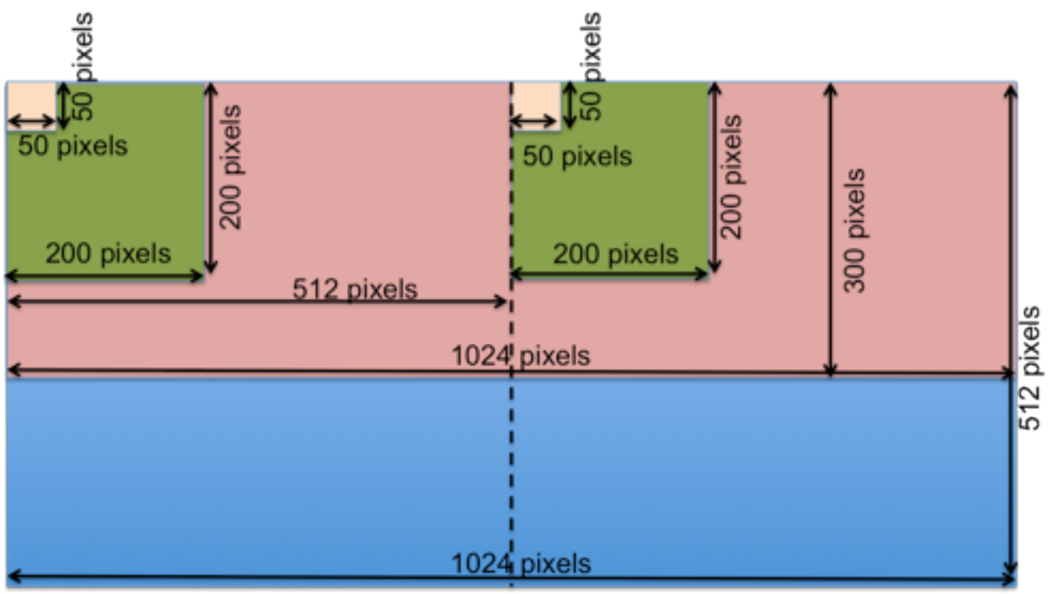
Stamp Mode



Sub-stamp Mode



Half-way Across



Dimensions

IDL (starting from 0) etc.

Coordinates in IDL

IRAF (starting from 1) etc.

Coordinates in IRAF

Created 2014/05/09, Katie Morzinski.