RETROCAM User's Guide
Version 2.2
2017December07

RETROCAM Overview

RETROCAM is a science-quality optical CCD camera installed on the 2.4m telescope Multiple Instrument System (MIS). It is available for use with all of the observatory's primary instruments. A detailed description of RETROCAM can be found in Morgan et al. (2005, AJ, 129, 2504). Papers using data acquired with RETROCAM should cite this paper.

RETROCAM Specifications:

CCD Detector:	E2V CCD 55-20 1152×770 22.5µm pixels
Pixel Scale	0.259 arcsec pixel−1
Field of View:	4.97×3.32 arcminutes
Gain:	3.0 e⁻/DN
Readout Noise:	13.4 e⁻ pixel⁻¹
Dark Current:	2.5 e⁻ sec⁻¹ pixel⁻¹ at −20°C
Readout Time:	6 seconds
Cooling:	3-stage thermoelectric (−20±1°C)
Filters:	SDSS g, r, i and z + 1 open position

RETROCAM uses the MIS finder mirror (now renamed **RETROCAM**), which obscures the science field of the primary instrument. Thus, while RETROCAM can be used with most primary instruments, the two cannot be used simultaneously. The finder mirror has been resized such that a ~100 arcmin² horseshoe-shaped guide field is available around the perimeter of the MIS aperture.

RETROCAM is configured to be confocal with the CCDS. Operation with the Mark III, Modspec or TIFKAM spectrographs or any of the direct imaging cameras requires a small telescope focus offset, given in the table below (see "Observing with RETROCAM").

Typical uses for RETROCAM include
* An imager for targets of opportunity (SNe, GRBs, microlensing events, etc.)
* Imager for long-term episodic monitoring (QSO lenses, long-term variables, etc.)
* Contemporaneous photometry of spectroscopic targets
* As a finder Camera for the MDM 2.4m for alignment, pointing map generation, etc.

RETROCAM Startup

Before you begin, make sure that the tcsBridge and xmis2 programs are running and initialized.

From either mdm24ws1 or mdm24ws2, ssh to **hiltner** as the "obs24m" user.

Before starting the RETROCAM control program, verify that another RETROCAM session is not already running by typing:

    ps −x

and search the process table for instances of "retrocam" and/or "ds9".

Start the RETROCAM control GUI by typing '**start_retrocam**' in an xterm on hiltner.
- Multiple windows will open during system startup.
- System startup is complete when the ds9 window, RETROCAM control panel, the Observing Session Setup window, and the original xterm are the only open windows.
- The diagnostic xterm may be iconified while using RETROCAM, but can contain useful information if there are problems, so don't logout or delete the window.

The RETROCAM control panel will start by launching the Observing Session Startup window
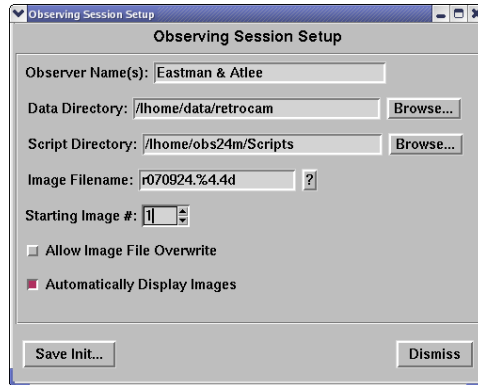
Make sure that the Observer Names, Data Directory, Script Directory, and Image Filename pattern are correct for your observing session. We recommend that you **not** change the default data and script directories without very good reason or great care. You also have the option of allowing RETROCAM to overwrite image files with the same name. This can be dangerous and has led to lost data when carelessly used! If you're unsure, disable this feature, and RETROCAM will prompt you for a new filename if a new image will overwrite an old one. You may also elect to disable automatic display of images in ds9, although this is rarely done and we recommend you always keep this enabled. This option is primarily for engineering work.

Recommended Values:

Data Directory:	/lhome/data/retrocam
Script Directory:	/lhome/obs24m/Scripts
Image Filename:	rYYMMDD.%4.4d (YYMMDD=Year, Month, Day).
Image File Overwrite:	DISABLED
Automatic Image Display:	ENABLED

When you have entered your settings for the RETROCAM session, first click on "Save Init..." to save the settings to disk so that they'll be the defaults if RETROCAM is restarted, then click on "Dismiss" to make the setup window go away. You can always revisit your session setup by using the "Setup" then "Observing Session..." menus on the menu bar across the top of the RETROCAM control panel.

You are now ready to start using RETROCAM.

Observing with RETROCAM

1. Insert the RETROCAM pickoff mirror using the xmis2 control panel.

2. Select the focus offset appropriate for the primary instrument in use:

Instrument	Telescope Focus Offset* (Secondary Mirror Encoder Units)
CCDS	0
TIFKAM	+250
MODSPEC	+640
Mark III	+855
Direct Imagers (Templeton, Echelle, etc.)	-75[+]

*These numbers are preliminary. In late 2017, the 2.4m TCS was updated, including the encoder for focus position. It appears that this has introduced a multiplicative factor of ~5x in raw encoder counts relative to the old system. This may be confirmed after RETROCAM is utilized with varying instrumentation. There is also a chance that ± signage has changed (TBD).

[+]This value was measured using the RETROCAM 'r' filter and the Johnson-Cousins 'R' filter with Echelle. Focus offsets between other filters have not yet been measured and are likely to be different.

3. Set the telescope focus to the RETROCAM position using the TCS user program.

   Example: If Mark III is in use and the current focus is 3174:
   3174+855=4029

4. Fill in the Object Name, type of image (Object, Flat, Bias, or Dark).

5. Set the desired Exposure Time in seconds and the Number of Images to acquire.

6. Verify that the data directory, filename pattern, file sequence number, and overwrite permission is set correctly for your needs.

7. Move the guide probe away from the center of the field until guide stars come into view. Note that the guider may need to be focused if a large telescope focus offset was used in Step 2.

8. Setup the autoguider on a guide star in the usual way.

9. Select the desired filter by clicking its button on the RETROCAM Control Panel. **Wait for the button to turn green** (indicating the filter wheel motion is complete) before proceeding.

10. Click the 'GO' button on the RETROCAM Control Panel to start the exposure(s).

11. Once CCD readout is complete, the image will be displayed in the open ds9 window.

12. To resume observing with the primary instrument after using RETROCAM:

   a) Using **xmis2**, move the **RETROCAM** (Finder) mirror to the '**Out**' position
   b) Restore the telescope focus to its original setting using the TCS
   c) Restore the guider focus to its initial setting

The RETROCAM Control Panel

This is the GUI used to control RETROCAM functions for routine observing. You can do more complex observations with RETROCAM using the RETROCAM ScriptTool. See the separate *RETROCAM Command Scripts* document for details.

The RETROCAM Control Panel

The following observation parameters are set using the RETROCAM Control Panel.
- Target Name
- Image Type (Object, Dark, etc.)
- Exposure Time in seconds
- Number of Images to acquire in a multi-image sequence
- Filename (see additional guidance under "Filename" below)
- File sequence number (automatically resets to '1' with each new filename)

Filters are selected by clicking on the appropriate filter button using the mouse. The button will appear yellow while filter wheel is in motion, and then turn green when the selected filter is in front of the CCD.

With RETROCAM v2, the Control Panel communicates with the TCS and MIS to get telescope pointing information, time, and MIS configuration into the image FITS headers. You can view the current TCS status by clicking on the "Update TCS" button in the panel at the lower right. The UTC time the TCS info was last updated is displayed in this panel. If for some reason the TCS link is down or broken, the "Update TCS" button will be disabled. Use the "Setup" then "TCS Link..." menus (menu bar across the top) to bring up the TCS Interface setup window.
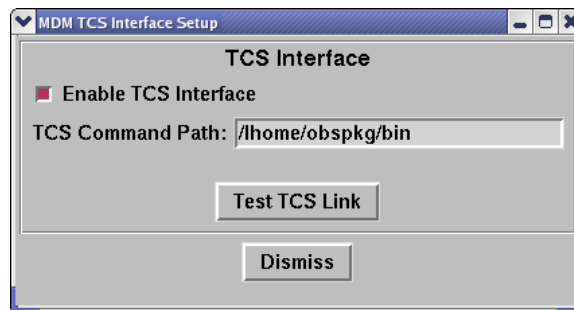
Make sure the interface is enabled, and then test it by pressing the "Test TCS Link" button. If all works well, you'll see good TCS info on the Control panel. Press "Dismiss" to make this setup window go away. You should never change the TCS Command Path (**/lhome/obspkg/bin**).

The thermoelectric cooler (TEC) controls can be found in the "Temperature" menu. The TEC is automatically set to maintain -20±1°C upon startup. Additional adjustments should not be necessary. The most recent temperature is shown in the "RETROCAM+TCS Status" panel on the right-hand side of the RETROCAM control panel. The temperature readout is only queried when an image is acquired or when "Update TCS" is pressed.

Filenames

RETROCAM uses a C-like filename convention, as shown in the RETROCAM Control Panel screenshot. The '%4.4d' suffix is a formatting statement that will append a four-digit file sequence number (SeqNo) to each image created. For example, if Filename=r170814.%4.4d, and SeqNo=1, then the next file written by RETROCAM would be named r170814.0001.fits. The sequence number is automatically incremented with each exposure, so continuing with our example, after writing r170814.0001.fits the next image file will be named r170814.0002.fits.

Changing the filename formatting string to '%3.3d' would instead use a 3-digit sequence number (.001.fits, .002.fits, etc.).

> **NOTE: The file sequence number (SeqNo) is automatically reset to '1' when the filename is changed, but it can then be manually set to any number. This means you should change Filename then SeqNo in that order.**

Where are my Images?

From mdm24ws1 or ws2, your images will be in **/data/hiltner/retrocam/**. Note, however, that while logged into hiltner this directory is named /lhome/data/retrocam/, which is the data directory path you should use in the RETROCAM control program (each computer at MDM has a local home disk named /lhome/ within which /lhome/data/ gets mapped to /data/<hostname>/ when automounted by another computer).

To keep this directory manageable, we recommend moving your images into a subdirectory (usually with the same rootname, e.g., r170924) after your night of observing is done. Any random files found in /data/hiltner/retrocam/ not in named subdirectories are fair game for deletion by the next observer.

RETROCAM Shutdown

Under the 'Session' menu on the RETROCAM control panel, select 'Exit'. You will be asked if you want to save the current RETROCAM configuration. If you are shutting down normally, the correct answer is always "YES". You should only answer "NO" if there is some anomaly and you wish to avoid that condition getting preserved in the startup configuration file.

Troubleshooting

1. The CCD temperature is too high.

> The TEC 'ON/OFF' indication is located on the 'CCD Temp:' line in the status panel of the RETROCAM Control Panel. Verify that 'ON' is displayed in green. If not, turn on the TEC by selecting 'Cooler ON' in the 'Temperature' menu. It takes about 20-30 minutes to reach operating temperature from ambient. You can monitor the cool down progress by occasionally pressing the "Update TCS" button.

2. No stars appear in the image following CCD readout.
> Verify that **RETROCAM** is in the 'In' position on the **xmis2** control panel.

3. Images are out of focus.
> Ensure that you have entered the appropriate focus offset for the primary instrument in use. See Step 2 of "Observing with RETROCAM" for details.

4. IRAF is reporting some inscrutable errors when I am attempting to display images in ds9
> The RETROCAM ds9 window can cause conflicts with another IRAF ds9 window. We recommend that you not run IRAF on **hiltner**, and instead perform data analysis using mdm24ws1 or mdm2ws2 (the retrocam disks are automounted by both computers). A restart of the RETROCAM software may be necessary to fix things. Exit normally as described above.

5. I can't find any guide stars.
> The RETROCAM mirror occults the central region of the guide field.   Approximately 100 arcmin^2 of unvignetted guide field is available in an annular region around the center. The guide probe may be in the shadow of the finder mirror.
> Attempt to focus the guider. Inserting a telescope focus offset will put the guider out of focus, and refocusing may be necessary to resolve guide stars on the guider display.

6. RETROCAM is completely locked up; I can't operate the GUI at all.
> Close the RETROCAM and ds9 windows.
> Open the diagnostic xterm – a prompt should be available.
> Restart RETROCAM