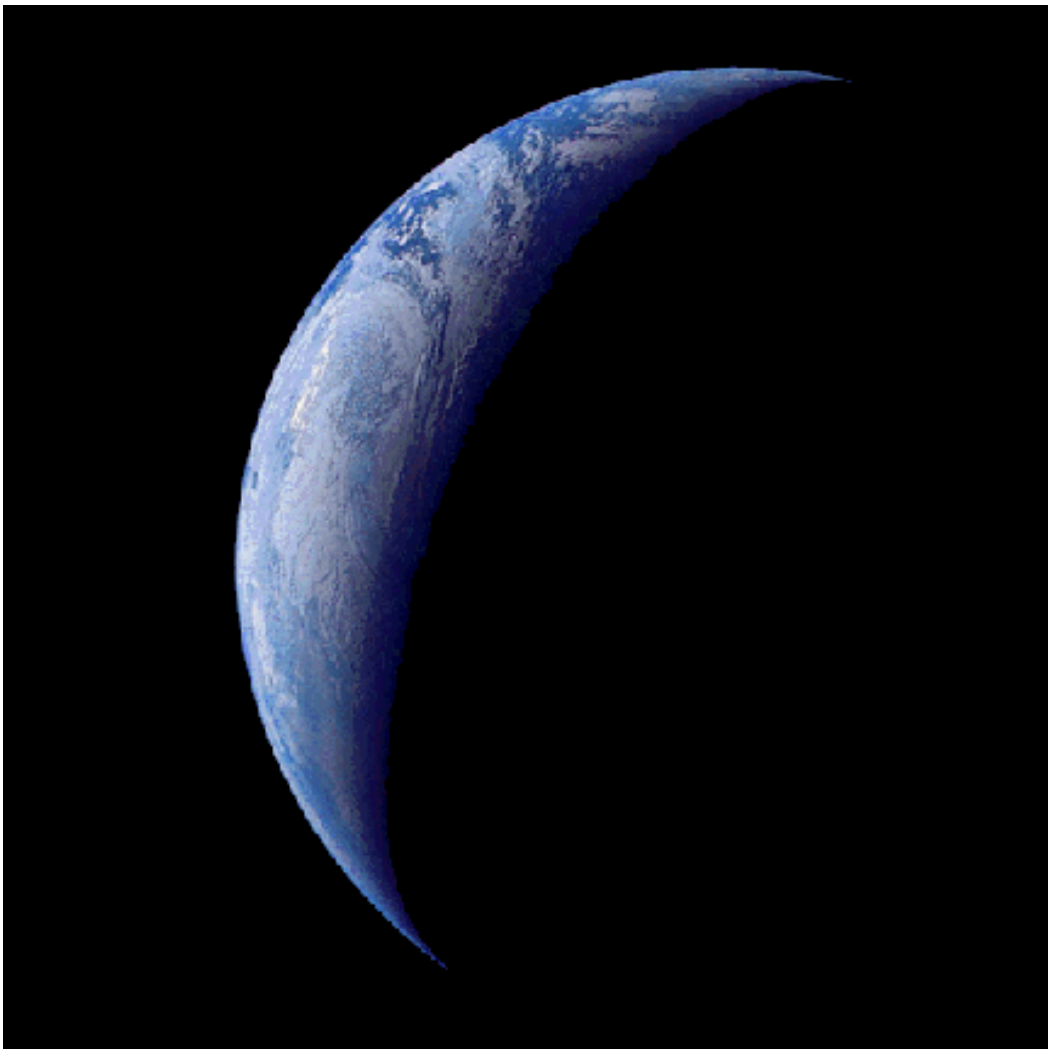


Retriever Technology

Operating Manual for

Voodoo 1.71



4/1/2005

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Quick Start

This is a summary of software steps to be taken to begin generating images. It is assumed that the user has already installed Voodoo, and it is properly connected via fiber optic cabling to the camera controller. For installation please refer to Installation section.

The outlined steps are

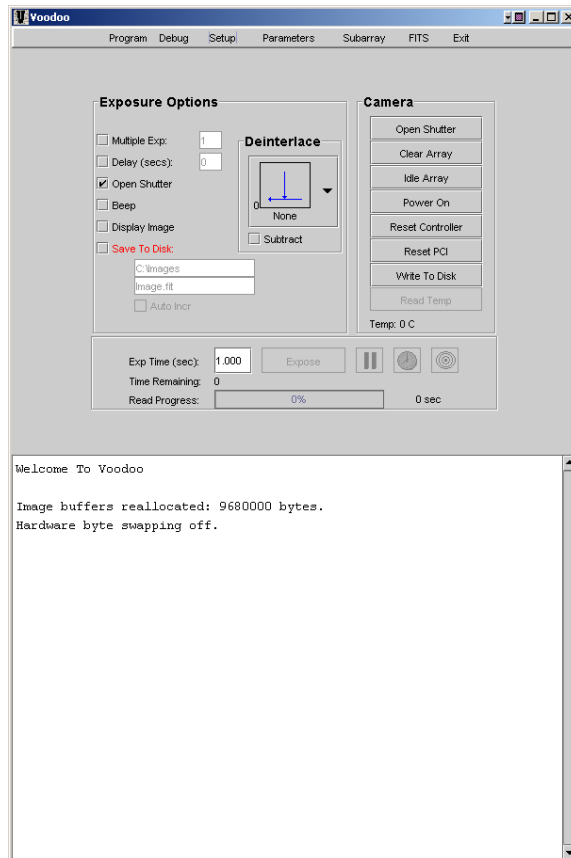
- 1- Start Voodoo
- 2- Apply Controller Setup files
- 3- Save Setup files
- 4- Set startup for automatic loading of Controller Setup files
- 5- Acquire and Save and images

1- Start Voodoo.

Simply double click on the Voodoo shortcut icon. Alternatively, double click on the "Voodoo.bat" file located in the installation directory.

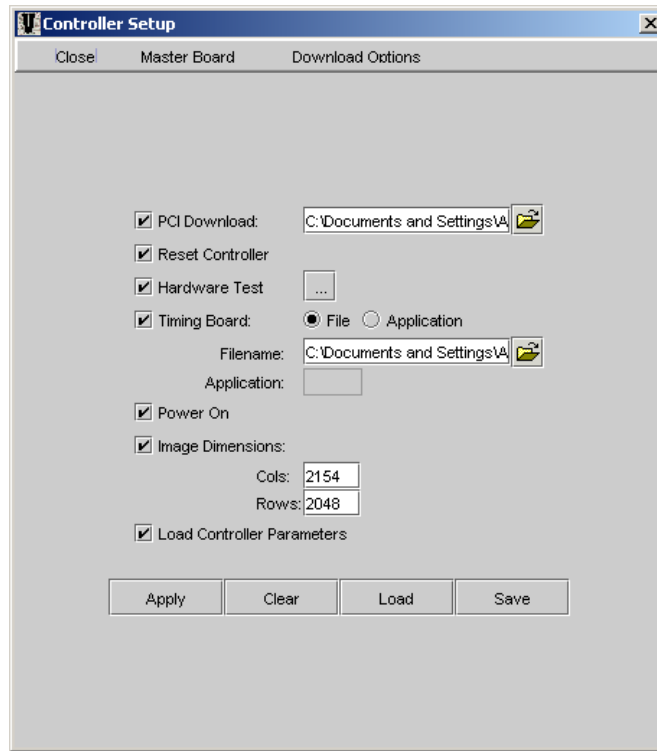
2- Apply Controller Setup Files

After startup, the main Voodoo menu will appear.



Select "Setup." The Setup menu item directs the loading of timing (tim.lod) and PCI (pci.lod) files. These files control nearly all aspects of CCD behavior, and are necessary for camera operation. In addition, image dimensions and other miscellaneous functions, including the saving and

automatic loading of Setup files upon Voodoo startup, are controlled in the Setup window.



PCI Download

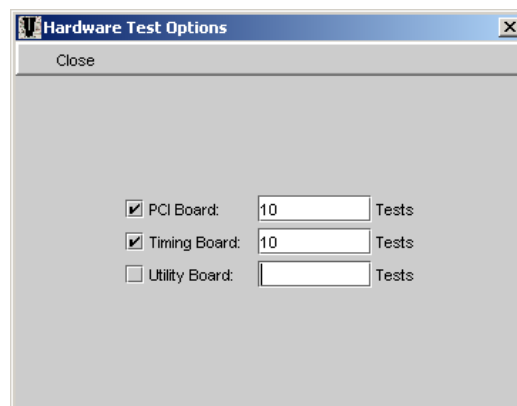
A pci.lod file is supplied with all Retriever Technology cameras. This file is relatively invariant, and as such a user will almost always have only a single pci.lod file to choose from. Check the box, and browse for the current location of the pci.lod file, which then is shown in the text window.

Reset Controller

This should be checked. Resetting the controller is a useful function to be performed every time Voodoo is started.

Hardware Test

This should be checked. Test settings can be modified by clicking on the box to the right. Doing so pulls up the following submenu:



Check the appropriate boards. The PCI Board and the Timing board should always be

checked but only check the Utility board if you have one. Utility boards are options and you will only have one if you requested it. Any number of tests can be performed; 10 is the default.

Timing Board

A tim.lod file is supplied with all Retriever Technology cameras. Unlike the pci.lod file, a user may have a number of tim.lod files. Examples of different tim.lod file functions can include: differing default STM modes, alternate timing methods, and even different CCD chips altogether. Nevertheless, most cameras are delivered with a single tim.lod file. For more details contact Retriever Technology. To load, check the box, and browse for the current location of the tim.lod file, which then is shown in the text window. Note that the name of the file can be whatever the user chooses, as long as the .lod extension is preserved.

Power On

Always check this box to turn on controller power.

Image Dimensions

Put in appropriate image dimensions. Make certain that the Image Buffer size, set under "Program" is at least as large as the image dimensions in this Setup.

For example for a system with e2V™ 4240 chip, it is recommended that the following settings to be used:

Columns = 2048
Rows = 2048

Load Controller Parameters

Checking this box allows for saving and automatic loading of "Parameter" settings. For settings details see "Parameters" section.

Master Board

The Timing Board should always be selected as the Master Board.

Download Options

Check 'Perform Download Check'. It is not necessary to select "Stop Download on Error."

Apply

After all desired Controller Setup values are entered, click the "Apply" button. A successful loading of controller values will be indicated in the main Voodoo window by a step-by-step confirmation of each value.

Clear

All entered Controller Setup values will be erased if the "Clear" button is clicked.

Load

Select 'Load' to load a previously saved *.setup file, if one exists.

3- Save Controller Setup Files

One the desired Controller Setup files are entered, the entire setup can be saved. Select "Save" and choose a name and location for the file. Note: It is not necessary to add the *.setup extension to the Setup file name, but is recommended to make future searching for files easier.

In order to select any given Controller Setup file to automatically load when Voodoo is started, the user needs to select this file under Program -> Global Setup, and input the desired Controller Setup file and select "Save Settings" to save it to the VoodooChild.curse file. Voodoo automatically creates this file and accesses it upon startup. The VoodooChild.curse file can be deleted or moved at any time to start Voodoo without applying any preexisting setup files.

4- Set startup for automatic loading of Controller Setup files

Once a valid *.setup file is created, Voodoo can be instructed to automatically load this file whenever Voodoo is started.

- 1) Select "Program".
- 2) Select "Global Settings".
- 3) Browse and select the desired Controller Setup file.
- 4) Select "Save Settings".

The VoodooChild.curse file is created and will automatically load on startup. The VoodooChild.curse file is automatically placed in the same location where the Voodoo shortcut icon is located.

5- Acquire and Save Images

If your camera is delivered with a timing file whose default trigger setting requires an external TTL signal to initiate the exposure sequence, be certain to connect the appropriate TTL source signal. You can always bypass this requirement. For more information refer to Debug section.

Select the desired exposure time, image name and saving location. Click on the "Expose" button. A progress bar indicates when readout is complete.

Installation Procedure

Voodoo requires a JAVA 2 runtime environment to function. We currently use JDK1.5.
The order of installation is as follows:

- 1) Install JRE 2
- 2) Install PCI card.
- 3) Install Voodoo software
- 4) Install V++ software
- 5) Check Classpaths and Paths
- 6) Modify registry to support large buffer
- 7) Restart computer

1) Installation Instructions for Java Runtime Environment (JRE).

These instructions apply to:

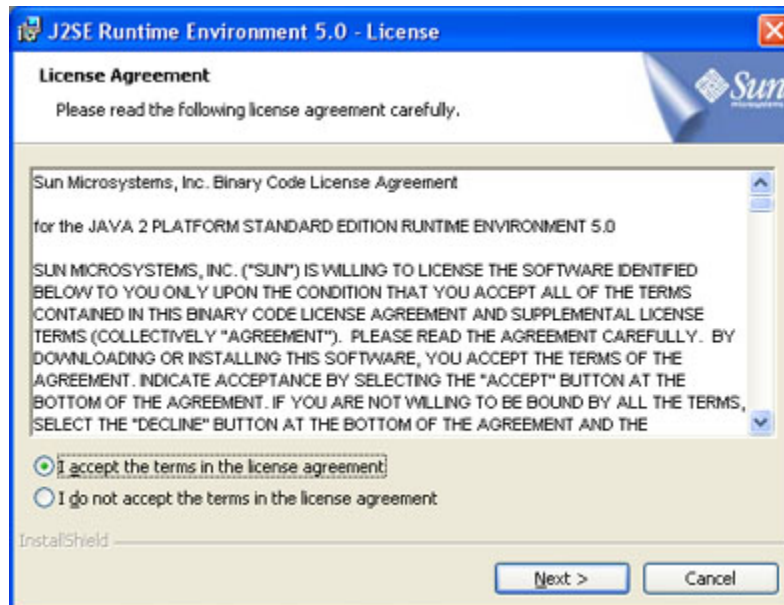
Platform(s): Windows 98, Windows ME, Windows 2000 (SP4+), Windows XP (SP1 SP2),
Windows 2003

Browser(s): Internet Explorer 5.5, Internet Explorer 6.x, Netscape 6.2x, Netscape 7, Mozilla 1.4+,
Firefox

JRE version(s): 1.5.0

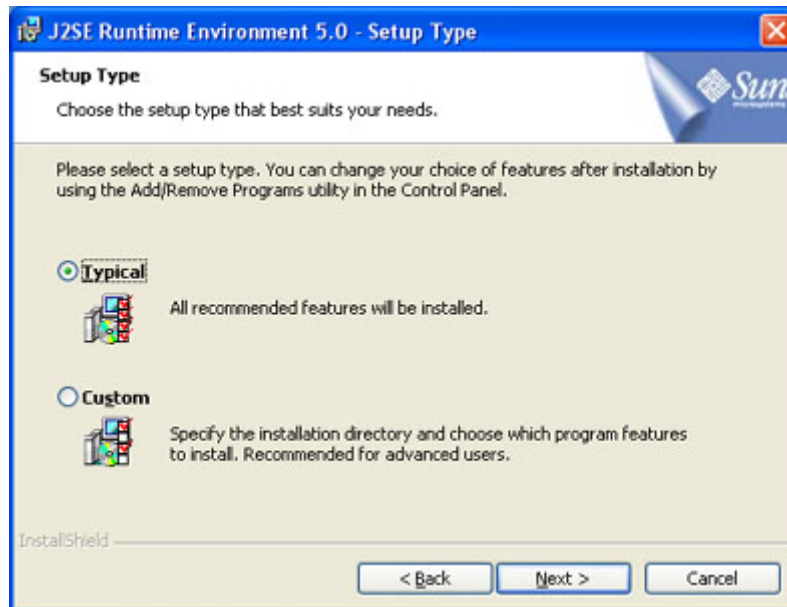
Double-click on the file icon labeled "jre-1_5_0_02-windows-i586-p" to start the installation process.

The installer "unpacks" the files needed to continue. A dialog box tracks this process, which takes less than a minute. After briefly displaying a logo splash screen, the installer presents the license agreement.



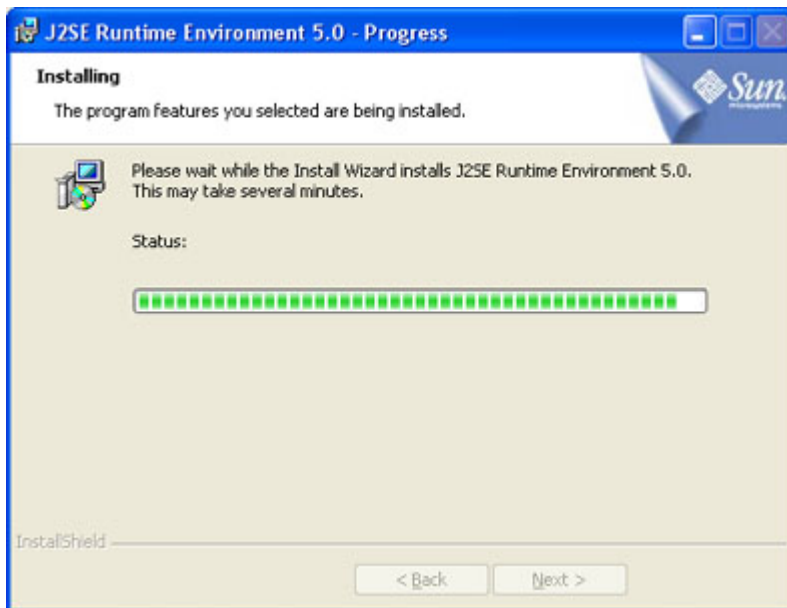
After reading the agreement, click the I accept the terms in the license agreement button to accept its terms and click Next to continue with the installation.

The installer then displays a Setup Type screen that allows you to choose either a typical or custom setup. We recommend that you choose the Typical option (the default selection) unless you are an advanced user who wants more precise control over the components that will be installed.



After ensuring that the Typical setup is selected, click the Next button to continue with the installation.

Now that you have given the installer all of the information it needs to proceed, progress boxes track the installation process.



A few brief dialogs confirm the last steps of the installation process, and a concluding message appears with the confirmation "Installation Completed OK."

2) Install PCI Card

Carefully open your computer's protective cover and install the PCI card into an available PCI slot. Make sure to take precaution against static damage.



Warning: Wear a properly grounded wrist strap when handling the PCI card. Permanent damage to the card may result from improper ESD precautions.

After installing the PCI card restart the computer and allow your operating system to detect it. Once detected direct the browser to the location of your "AstroPCIV1.7" files, which are included with your startup disc or can be downloaded from:

<http://www.retrievertech.com/Product/New%20Products%20Frame%20v1.htm>.

The operating software will then install the hardware for your new PCI card.

Note: If the Installation Wizard cannot readily locate the files "astropci.sys" and "astropci.inf" simply copy them to the desktop where they are easily found and loaded.

After the PCI card installation, connect the PCI card to the controller using the provided fiber optic cables. A 50' fiber optic cable is supplied with the controller. Remove the protective end caps and connect the cables at one end to the PCI card, and the other end to the back of the controller at the connections labeled "Fiber Optic 1/2". The cables have to be installed with I/O ports matched up. If they are not matched up properly, the red fault light on the PCI card will be illuminated when the controller is powered up. (Note that the red fault light will also be illuminated when the controller is off, regardless of fiber optic matching.)

3) Installing the Voodoo Software

After installing the hardware you will need to install the Voodoo software for operating the camera. You do this by simply double clicking the Voodoo.exe icon on the installation disc. The latest version of the software can be downloaded from:

<http://www.retrievertech.com/Product/New%20Products%20Frame%20v1.htm> . After completing this step you should see the Voodoo icon on your desktop.

4) Installing the V++ Software

V++ can be directly downloaded from:

<http://www.digitaloptics.co.nz/download/vpp.htm>

Simply follow the instructions for proper installation. Alternately, install using the V++ CD provided with your camera¹. IMPORTANT: If you install V++ for the first time using the downloaded installer, then ensure that you have also installed the Security Key System Driver. This is available at <http://www.digitaloptics.co.nz/download/system.htm>.

5) Make sure that the correct paths are available for Voodoo to communicate with the Java software. Sometimes when loading Java the software does not properly include the paths and you need to do it manually. This is a simple step. You do this by going to: Control Panels System. This will take you to "System properties". Under "System Properties" open the "Advanced" tab and click on the "Environment Variable" button. At this location you will need to check on "CLASSPATH" and the "PATH" to make sure that they are pointing to the Java "\bin\" directory. You can check this by highlighting the "CLASSPATH" and clicking on the edit button. Then scroll in the path and make sure that you see a path to the \bin\. This path depends on the location where you installed the Java software. For example it could be at: C:\Program Files\Java\j2re1.4.0_01\bin\. You can determine the correct location by using the "file explorer" and finding the correct location for the file in your computer. Once located note the location and enter it in both the "CLASSPATH" and "PATH". Save your work.

¹ V++ is available as an optional software package. Contact Retriever Technology if you would like this option.

6) Modify the registry to support a large image buffer. This MUST be done.
WARNING: Incorrectly modifying registry values can cause your machine to stop working.

a. Run regedit from Start->Run.

b. In the registry, modify HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Memory Management\NonPagedPoolSize to be a value larger than the buffer you want to use. DO NOT make the value more than 80% of your total RAM. For example, to set aside 32M of nonpaged memory, set the value to 0x2000000.

7) Restart the computer.

Installation Issues

Despite the easy installation, errors may still occur and the most common are:

1. I get an Error 31 after installing the Windows 2000 driver?

•The `astropci.sys` file is in the wrong directory. Move it from `C:\WINNT` to `C:\WINNT\System32\drivers`.

2. The result of running Voodoo on Windows 2000 is:

```
java -Xrs Voodoo C:\Voodoo\Voodoo ARCPNP1
java.lang.IllegalArgumentException: Signal already used by VM: SIGINT
at sun.misc.Signal.handle(Unknown Source)
at java.lang.Terminator.setup(Unknown Source)
at java.lang.Shutdown.add(Unknown Source)
at java.lang.Runtime.addShutdownHook(Unknown Source)
at sun.awt.windows.WToolkit.run(Unknown Source)
at java.lang.Thread.run(Unknown Source)
```

Try removing the "-Xrs" from the "voodoo.bat" file. Or try changing ARCPNP1 to astropci1.

3. When I run Voodoo I get an "Unsatisfied Link Error"?

This means the path to Voodoo's C library is not set.

On Windows 2000, make sure your "path" environment variable contains the following:

```
$install_dir/Voodoo/Clib/win2k/lib
```

4. When I run Voodoo I get "CLASSPATH not found"?

This means the path to the Voodoo classes is not properly set.

On Windows 2000, make sure you create an environment variable called CLASSPATH that contains the following:

```
$install_dir/Voodoo/classes;$install_dir/packages
```

**This section Provides
Information on Controller
Setup and
Operation**

Controller Setup and Operation

Attaching controller cable



Warning: Do not attach the camera controller cable to the controller while the controller is powered up. Severe damage to the camera can result.



Warning: Always wear a properly grounded wrist strap when connecting the camera to the cable. Damage to the camera may result.



Warning: Never connect the camera to the cable when the controller has power. Damage to the camera may result.



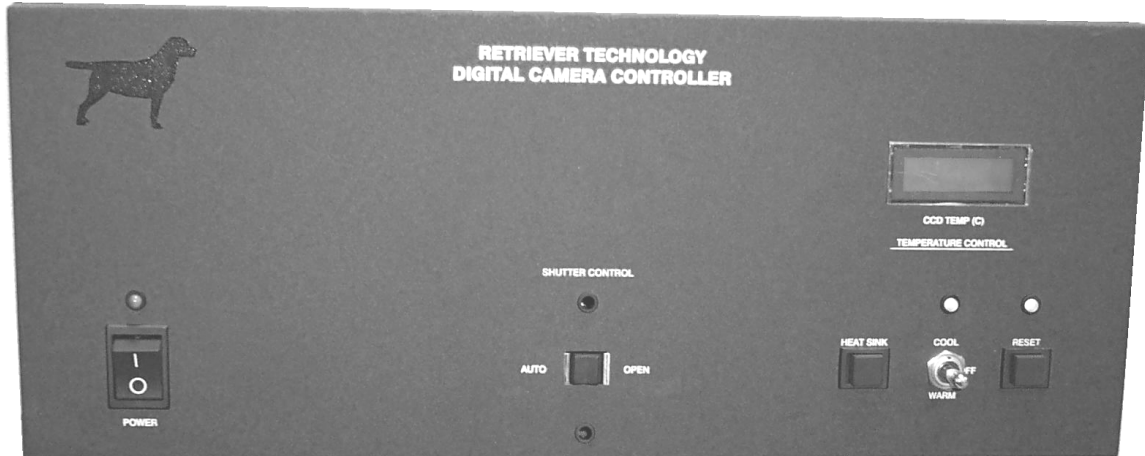
Warning: Never touch the exposed contact pins on the camera. Damage to the camera may result.

A cable connects the camera controller to the controller itself. Typically, the cable is 4 meters long and is fully shielded and grounded. Depending upon the camera, the controller end of the cable will either be a “d-sub” or “MIL-C” style cylindrical connectors. The camera end will always have a MIL-C styled connector. Connect both ends of the cable to the camera and controller, respectively, making sure to utilize the locking and/or stress relief mechanisms.

Connecting AC Power - Retriever Technology controllers are delivered with standard 120 VAC power receptacles. Use a standard power cord to connect the controller to a filtered and surge-protected power source. Other input voltages can be used; contact Retriever Technology for details.

Controller Front Panel Description (Typical)





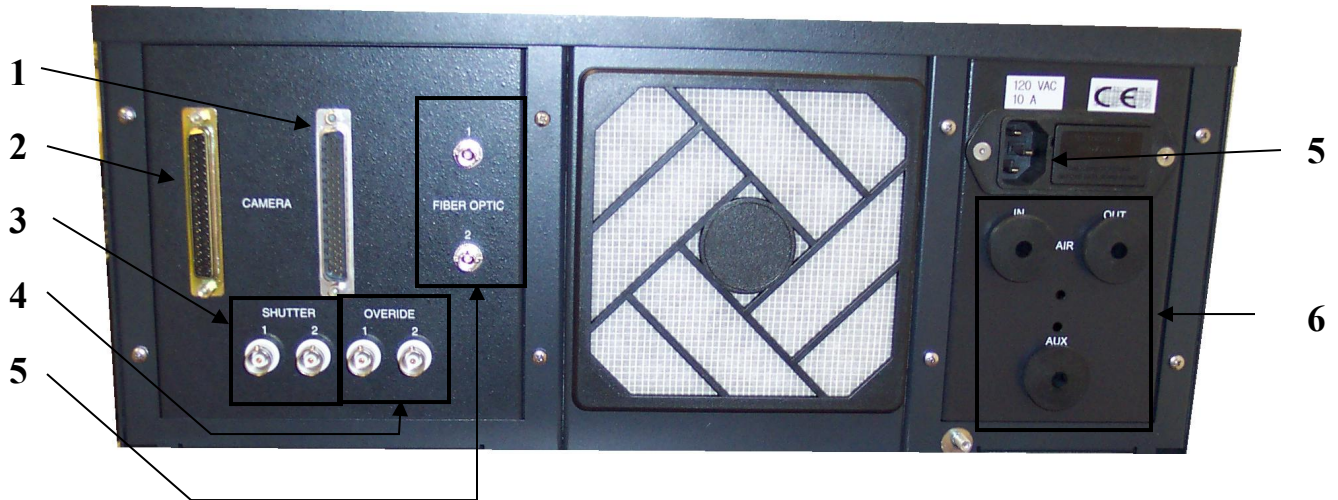
- 1- On/Off Switch. Green indicator light illuminates when power is on.
- 2- Shutter Control. These features are currently not enabled. (Note: External shutter control is done through the Controller Back Panel, see below and Voodoo manual.)
- 3- Temperature Indicator. Indicates hot or cold side TEC temperatures. Only available on TEC-cooled cameras.
- 4- Heat Sink. Depressing this momentary action switch displays TEC hot side temperature. Otherwise, the Temperature Indicator displays TEC cold side temperature. Only available on TEC-cooled cameras
- 5- Cool/Warm. Toggle switch for TEC operation. Normal operation is "Cool" which cools the CCD element. Neutral position of toggle sends no power to TEC. "Warm" position reverses the current flow to TEC and heats the CCD side. Only available on TEC-cooled cameras.



Warning: Do not use the "Warm" setting without prior consultation with Retriever Technology. Damage to the camera may result.

- 6- Reset. Upon controller startup, the LED indicator above "Reset" will illuminate yellow indicating TEC cooler is disabled. Pressing the momentary "Reset" button enables the TEC for normal operation, and indicator light will go out.

Description of Back Panel (Typical)



- 1- Camera cable. This 62-pin d-sub connector accepts the camera cable. Some cameras may have MIL-C connectors on the controller end.
- 2- Camera cable. This 37-pin d-sub connector is not enabled.
- 3- Shutter 1 and 2. "Shutter 1" is a BNC connector that accepts incoming control TTL signals. "Shutter 2" is a BNC connector that provides output TTL signals to control external devices such as a shutter. Contact Retriever Technology for signal details and functionality.
- 4- Override 1 and 2. These BNC connectors are not enabled.
- 5- Line In. 120 VAC line power connects here. Contact Retriever Technology for alternative input power options.
- 6- In/Out/Aux. These functions are not enabled.

Grounding Plug

A grounding plug is supplied with all CCD cameras. When not connected to the controller cable, the camera connection should always be grounded with the grounding plug.



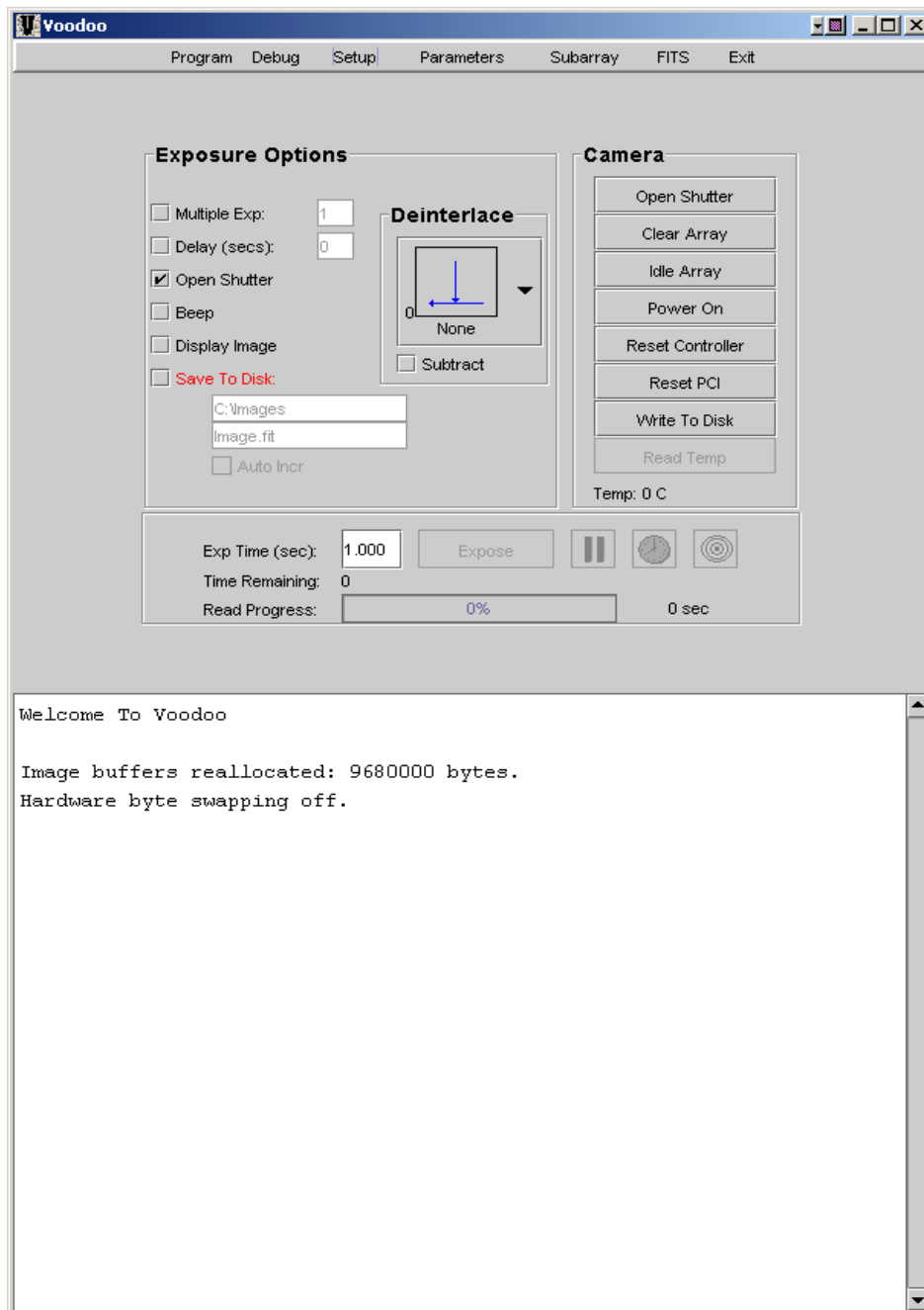
Warning: Storage of the CCD camera without the grounding plug installed may damage the CCD camera.



**This section provides a
Step by Step
Explanation of Voodoo menu items**

Main Window

Power up the controller. After initial installation, a Voodoo shortcut icon is available on the computer desktop. Double click the icon to start Voodoo. The main Voodoo menu will appear.



Exposure Options

Multiple Exp.

This allows the user to select unlimited number of automatic exposures. Select the checkbox and the number of exposures desired. Exposure conditions will be as

selected under the rest of the "Exposure Conditions," as well as any other relevant camera settings. See the sections on "Setup" and "Parameters."

Delay

Select this checkbox to allow a preset delay between initiation of exposure sequence and actual exposure and readout of the camera. Decimal values are allowed. There is no practical limit on the delay; however, for long delays the user may have to override certain timeouts. See "Debug" section.

Open Shutter

This procedure is available on those camera controller units enabled to output controlling TTL signals to a slave shutter. Please contact Retriever Technology to verify your camera controller's configuration. If the feature exists and the checkbox is selected, a TTL active low/high signal (User specified. Contact Retriever Technology for signal details.) is outputted from the 'Shutter 2' BNC connector at the back of the camera controller for the duration of the exposure.

Beep

Activates a computer chime at the beginning and end of the exposure sequence.

Display Image

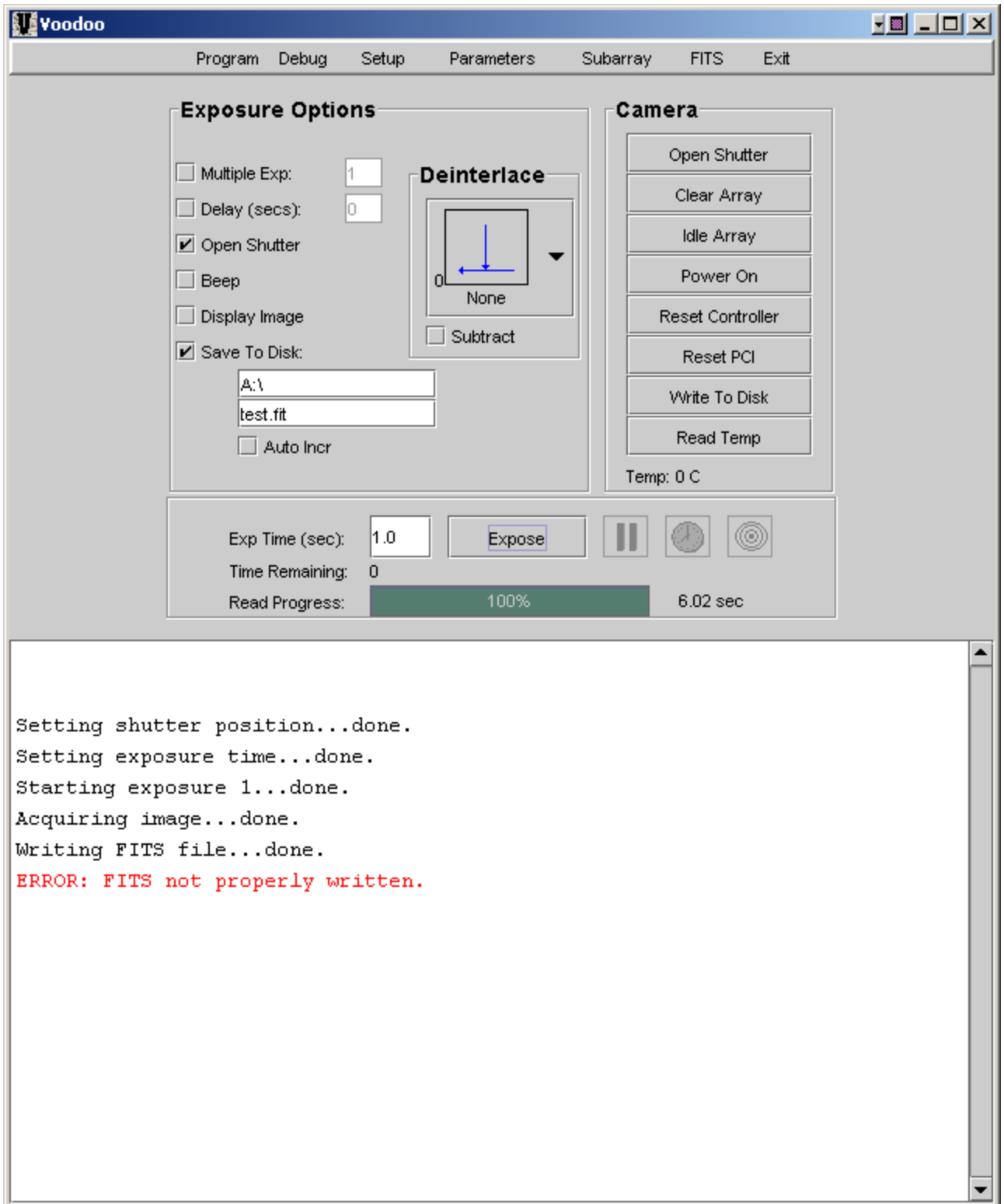
Voodoo comes with an image viewer for basic image viewing needs. Selecting this checkbox and "Use Voodoo Display" under "Program" opens a display window at the end of the exposure sequence. See the "Program" section for viewer details.

Save to Disk

At the end of the exposure sequence the image will automatically be saved to disk when this option is checked. The location and image name are inputted in the two field boxes immediately below. See the "Setup" section for saving default names and locations. Voodoo outputs data in the FITS format. (.tif format is available upon request.) All image names must have the *.fit extension in order to write properly.

If the destination directory is full, an error message will appear in the Information Window:

ERROR: FITS not properly written.



At this point the user should select an alternate directory and click on "Write To Disk" to save the most recently acquired image. Note that this error message does not need to be cleared in order for Voodoo to continue acquiring images. It is recommended that destination directory status is checked for space limitation before acquiring images, particularly when Multiple Exposures are to be automatically captured.

Auto Increment

If this box is checked, Voodoo will automatically increment the image name. For example, an image named test.fit will have successive images named test0.fit, test1.fit, etc.

Exp. Time

Exposure times from 0 to 162,000 seconds can be inputted. Note that for shuttered systems actual exposure time may be limited by shutter speeds. See the "Debug" section for extremely long exposures in which timeout overrides may have to be selected.

Expose

Click on "Expose" to take an image after all appropriate imaging conditions have been selected. Some important exposure options are as follows:

Controller as slave -- The controller has a default configuration of exposing only when an external TTL signal (active High/low) has been received at the "Shutter 1" BNC connector at the back of the controller. Clicking on "Exposure" will prepare the camera for exposure upon receipt of the external controlling TTL signal. For delays over 5 seconds on the TTL signal, the user should select Debug → "Disable Readout Timeout." This allows the camera to wait indefinitely for a controlling TTL signal.

Note: After starting the exposure, the "Expose" button changes to "Abort". The exposure may be aborted at any time by clicking on "Abort." **However, prior to any subsequent exposure the Setup files must be reapplied.** See the "Setup" section.

Time Remaining

For exposures greater than approximately two seconds, the time remaining on the exposure will be indicated, after a slight initial delay.

Read Progress

This indicates the elapsed read time in seconds, as well as a percentage of readout completed in a progress meter. Read time is a function of readout rate and number of output nodes selected on the CCD. See the "Debug → SPT" and "Parameters" sections, respectively.

Deinterlace

Selects the appropriate deinterlace option for the selected CCD readout mode. CCD readout mode is set under "Parameters," and the deinterlace mode is automatically matched to this mode.

Subtract

This feature is generally used by IR cameras and can remain unchecked for normal operation. But if selected, the final image will be the result of subtracting the first rows/2 pixels from the remaining image buffer pixels. In other words, the upper half of the image

buffer is subtracted from the lower half. Generally, for IR cameras the image buffer will consist of two images; this is correlated double sampling for IR cameras.

Camera

Typically, these settings manually operate certain standard camera operations. They are not usually necessary for normal operation.

Open Shutter

Clicking on this sends a controlling TTL signal out "Shutter 2" of the controller (for those controllers so configured). Clicking it a second time deactivates the transmitted TTL signal. The TTL signal can be configured to be either active high or low. Contact Retriever Technology for details.

Clear Array

Selecting this manually clears the CCD array. When the camera is powered up and proper Setup files applied, the camera is constantly cleaning the array at a 6-microsecond/pixel rate.

IDLE/Non-IDLE Array Button

Puts the detector array in IDLE/non-IDLE mode. In IDLE mode, when the CCD is not being read out or being exposed it will be continuously clocked exactly as if it is being read out except there is no data transfer. In STOP there is no clocking of the CCD if it is not being read out.

Power On

Resets or turns the controller power on/off. This switches the controller analog power supplies (+/-16.5, +/- 6.5 and +36 volts) from the power control board to the controller backplane, and is there for diagnostic purposes. Generally, the controller will come on when you go through your setup procedures. After the controller power is on a column of LED lights in the inside of the controller will be on indicating that the controller is ready.

Reset Controller

Selecting this resets and turns the controller power off and loads the DSP boot code from ROM. This does not load any DSP application code, and effectively prevents any application code that was there from executing. After performing this operation, the Setup file must be reapplied for the camera to function.

Reset PCI

This resets the PCI board's DSP internal program counter back to 0. This is useful if the PCI board should become "corrupt" for some reason and it is not typically used to address software resets, but can be used to test communication with the PCI card. The code instructs the PCI card to reset its program counter (PC) back to its initial position, thus "restarting" the DSP firmware on the PCI board.

Write to Disk

If an image is taken but the "Save to Disk" option is not checked, the image resides in RAM until the next exposure. The user may manually save this image by selecting the "Write to Disk" option. The name and location of the file will be whatever has already been inputted in the name and location text entry boxes. (In order to change the name and/or location, first check the "Save to Disk" option, which activates the name and location text entry boxes. This can be done after the image has been taken, so no data will ever be lost.)

Read Temp/ Temp

This function is currently not enabled. The temperature is displayed on the controller for TEC cooled cameras.

VOODOO MENU ITEMS

Program

Global Setup

Global Setup saves most camera settings that are required for normal camera operation. This includes, for example, CCD dimension, timing files, readout mode, exposure time and others. After inputting the desired Controller Setup and Developer Parameter files, they are saved as a VoodooChild.curse file, which automatically loads every time Voodoo is started. To save these settings:

- 1) Select "Program".
- 2) Select "Global Settings".
- 3) Browse and select the desired Controller Setup and Developer Parameter files.
- 4) Select "Save Settings".

The VoodooChild.curse file is created and will automatically load on startup. The VoodooChild.curse file is automatically placed in the same location where the Voodoo shortcut icon is located.

Window Properties can also be saved under Global Settings. This command alters the on-screen size of the various Voodoo submenus. Under "Window Properties" select the submenu window of interest, enter the desired Width and Height, and click "Apply Window Size." Select "Save Settings" to save window sizes in the VoodooChild.curse file. (Window sizes are limited by monitor screen area settings.)

Image Buffers

Voodoo has default image buffer dimensions of 2200x2200 pixels. This value can be customized for the duration of the program via the Image Buffers Window. To have Voodoo automatically modify the image buffer dimensions at startup, the user should save a Global Setup File under Program → Global Settings → Save Settings after setting the desired dimensions.

- On Windows 2000, two values limit the maximum image buffer size that can be allocated by Voodoo.
 1. The device driver has a hard-coded maximum image buffer size of 4200x4200 pixels. This value can only be changed by modifying the device driver and re-compiling.
 2. The device driver modifies the registry value "NonPagedPoolSize" to be approximately 35Mb, which is large enough to hold a 4200x4200 pixel image. If this value exceeds 60% of your total RAM your machine may become unstable.
- LINUX users must manually set aside RAM for Voodoo to use. This is accomplished by adding the line: "append=mem=100M" to the file /etc/lilo.conf. The 100M is the amount of RAM you do not want to use for an image buffer. So this would allow a 28Mb image buffer on a 128Mb RAM machine.

Example:

1. Become superuser/root.
2. Edit /etc/lilo.conf to have the append="mem=xxxM" line:

```
image=/boot/vmlinuz-2.4.2-2
label=linux
read-only
root=/dev/hda5
append="mem=100M"
```

3. From a tcsh, execute the command: lilo -v
4. Reboot the computer.

Auto Clear Info Window

This option causes Voodoo to clear all the text in the info status window after every 2000 characters. The info status window is the white text pane at the bottom of the main window. If you don't use this option and run Voodoo for extended periods of time, you will eventually run out of RAM as the text string continues to grow.

Use Voodoo Display

Voodoo comes with an image viewer for basic image needs. Selecting this checkbox and "Display Image" on the main Voodoo window automatically opens a display window at the end of the exposure sequence. Selecting the checkbox (or not) then selecting "Save Settings" under Program → Global Settings will save this setting during subsequent starts of Voodoo. See the "Program" → "Viewer" section for viewer details.

Viewer

Voodoo displays images in its default viewer when the display option is selected.

Auto Scale

Selecting Auto Scale after the first image is acquired will automatically scale subsequent images with an automatically scaled contrast and brightness setting. It is a linear scale with the minimum and maximum values used for the lower and upper values.

Zoom

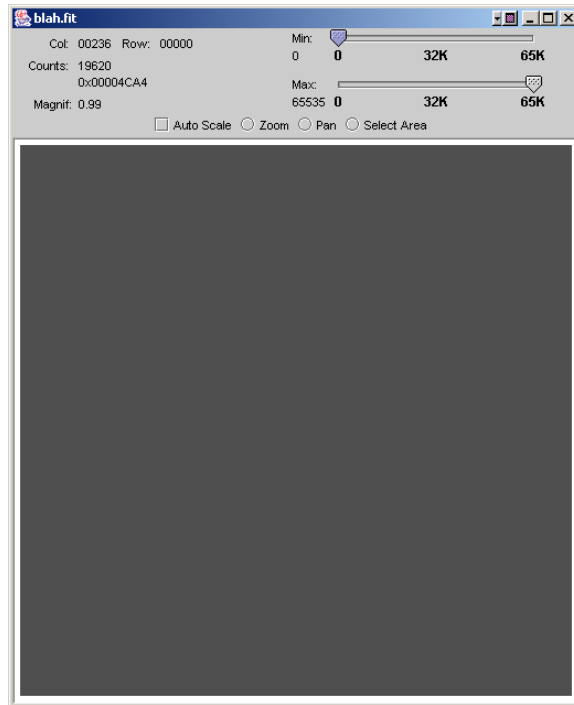
When selected, left-clicking the mouse will zoom in, and right-clicking will zoom out. The magnification level is displayed in the viewer window.

Pan

Selecting this and right clicking while dragging allows for panning around the image.

Select Area

This is primarily meant for auto focusing. You can remove the box by placing the mouse pointer over it and hitting delete on the keyboard.



Min./Max.

They represent the upper and lower values for the linear scaling of the image.

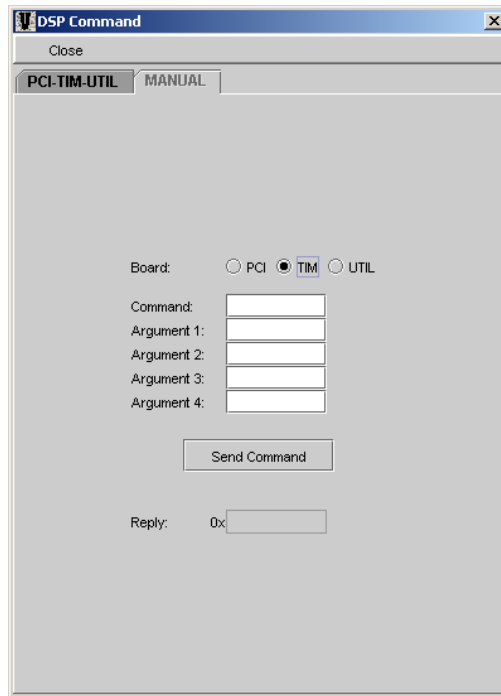
Col/Row/Counts

Displays the column, row and pixel count (in ADUs) where the cursor is currently pointing.

Debug

The Debug menu item has a number of useful features allowing complete user customization of camera operation. Many of these commands operate at the board level and are not recommended to be altered except by experienced users. As such, most of the features are beyond the scope of this manual. With the exception of the topics discussed in the remainder of this section, the camera has been configured to operate at an optimal performance level. Contact Retriever Technology for additional information.

DSP Commands



Two important DSP commands that are readily available to the user are: STM and SPT.

STM (Setting External Trigger Mode)

This allows the camera to wait, or not, for an external trigger before beginning the exposure sequence. Upon loading the timing file (tim.lod), the default value is STM = 1. In this configuration the controller waits for an external TTL signal, active low before beginning the exposure sequence. To override this and allow the camera to immediately begin the exposure sequence when the "Expose" button is clicked, select: Debug → DSP Commands → Manual. Select the "TIM" radio button. Under "Command" type in STM. Under "Argument 1" enter "0" then select "Send Command." If successful the Reply will indicate "DON". **Note: The Controller Setup File needs to be applied first, before sending this DSP command. Aborting an exposure requires the Controller Setup File to be reapplied, after which the STM command needs to be resent.**

SPT (Setting Readout Speed)

The SPT command allows the user to modify readout speeds from the CCD. Read noise depends upon readout speeds, varying in approximate proportion with the square root of the speed. Lower read noise and therefore higher dynamic range can be obtained from lower readout speeds. It should be noted that extremely slow readout speeds may result in significant amounts of dark noise; therefore, the user should evaluate tradeoffs between readout speed and dark noise.

To set readout speed, go to Debug → DSP Commands → Manual. Select the "TIM" radio button. Under "Command" type in SPT. Under "Argument 1: enter a valid number 'n', where 'n' is in hexadecimal notation, with valid values of $4 \leq n \leq 125$ (values in hex from 4 to 7D)" then select "Send Command." If successful the Reply will indicate "DON".

Note: The Controller Setup File needs to be applied first, before sending this DSP command. Aborting an exposure requires the Controller Setup File to be reapplied, after which the SPT command needs to be resent.

The default value of 'n' corresponds approximately to 833 kHz readout speed (per channel), with each increment of 'n' increasing the pixel time by 80 nanoseconds up to a maximum pixel time of about 11 microseconds, or about 90 kHz.

n	Approximate Readout Rate per Channel
Default (=4)	833 kHz
5	780 kHz
6	735 kHz
8	660 kHz
A	525 kHz
E	500 kHz
10	460 kHz
11	440 kHz
1a	335 kHz

Note: Decreasing readout speed leads to an decrease in system gain, in other words the number of electrons per ADU decreases with longer readout times. At some pixel speed this will lead to the dynamic range being limited by the controller's A/D converters. In order to operate the system with dynamic range being correctly limited by full well of the CCD, the controller's video gain can be adjusted. Please see the section, Debug → Development → Gain for instructions on adjusting and optimizing video gain.

PTC

The PTC plots image signal level (mean counts in ADUs) against the variance (in ADUs) measured between pairs of flat field images of identical exposure times. One of each pair serves as a flat field correction for the other image. The conversion gain is also calculated and is determined from the following equation for total noise:

$$\sigma_i^2 = \sigma_r^2 + k (N_i)$$

where σ_i is the variance, σ_r the Poisson readout noise, N_i the number of ADUs detected and $1/k$ the conversion gain in e-/ADU. The variance is measured as the root mean square of the number of ADUs in the corrected image divided by $\sqrt{2}$ to account for the noise introduced by flat fielding. The conversion gain is obtained from the slope of a linear least squares fit to the plotted data points (full well turn-over points are not included in the calculation). The full well of the device's pixels is determined from the ADU value where the plot deviates from linear behavior.

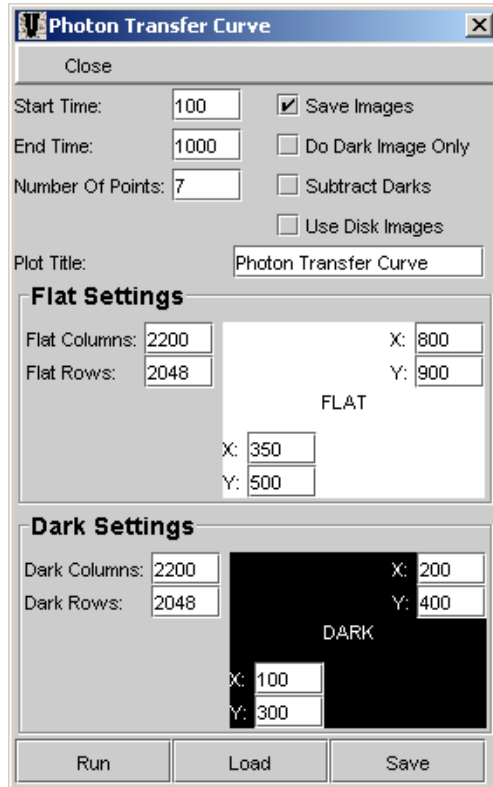
PTC WINDOW

The "Start" and "End" times are the exposure times for the first and last flat field images, respectively. The exposure time for the intermediate flat field images is determined by the "Number of Points" to be plotted:

$$\text{Exposure Time} = (\text{End Time} - \text{Start Time}) \div (\text{Number of Points} - 1)$$

The dark image exposure time is set to 0 seconds. The number of flat field exposures taken is just two times the specified "Number of Points" to be plotted. If "Save Images" is checked, then all images will be saved to the local directory. These images can later be used to re-generate the PTC plot by checking the "Use Disk Images" checkbox. If "Do Dark Image Only" is checked, no flat field images will be taken, which is useful if you only

want bias statistics. The “Subtract Darks” checkbox causes two dark images to be taken and the average mean calculated (instead of the mean for a single dark image). The “Flat” and “Dark” settings specify the size of the images and the location on the images where the statistics will be calculated. The “Flat/Dark Columns and Rows” specify the size of the images in pixels. The “X” and “Y” positions mark the lower left and upper right coordinates of the region on the image from where the statistics will be calculated. This region can be anywhere within the image. The “Save” and “Load” buttons allow all values and options to be saved and re-loaded for reuse.



In the above figure, points will be plotted from 14 images of 2048x2200, with points being generated from the calculations on the 450x400 pixel region located at ((350,500),(800,900)). The situation is similar for the dark image. The flat image exposures will start at 100 ms and end at 1 sec with all intermediate exposures being 212 ms, 424 ms, ...

Because read noise is best calculated from sampling only the read amplifiers, it is best to select a dark region using 'fictitious' pixels, i.e. those with column values greater than 2100. In practice, however, PTCs are generated from relatively short exposure times where dark noise is not significant. The user should take care in selecting appropriate PTC values.

Development

The primary user function of this submenu is the manipulation of camera gain values. However, complete control of CCD clock driver and DC bias voltages is available through the Clock Driver and ARC-45 submenus.



Warning: Adjustment of the clock driver and bias voltages should only be done under consultation with Retriever Technology. Changing these values will lead to changes and possible significant degradation of camera performance.

Gain

The gain adjustment submenu allows the user to adjust camera gain (electrons/ADU) in order to maximize performance of the system. Low light applications may utilize higher gain values to allow for greater sensitivity. Because lower readout speed changes system gain, the user may wish to adjust video gain and/or integrator speed to optimize camera performance.



The default settings are
Video Gain = 2.0
Integrator Speed = Fast

System gain is changed according to the following trends. Increasing Video Gain decreases camera gain, i.e. fewer electrons per ADU. Increasing Integrator Speed decreases camera gain, i.e. fewer electrons per ADU.

Clock Driver



Warning: Adjustment of the clock driver voltages should only be done under consultation with Retriever Technology. Changing these values will lead to changes and possible significant degradation of camera performance.

ARC-45



Warning: Adjustment of the bias voltages should only be done under consultation with Retriever Technology. Changing these values will lead to changes and possible significant degradation of camera performance.

Disable Read Elapsed Exp. Time

This checkbox will prevent Voodoo from sending commands to read the controller's elapsed exposure time. This will not prevent Voodoo from reading the image, it will only prevent reading of the elapsed time.

Disable Exposure Timeout

This checkbox will prevent Voodoo from timing out if it cannot read the elapsed exposure time from the controller.

Disable Readout Timeout

This checkbox will prevent Voodoo from timing out if the current pixel count cannot be read from the controller. Voodoo will never come out of expose mode if this box is checked and the controller fails to finish image readout. The current pixel count is the number of pixel that have been transferred to the host computer.

Disable Readout Progress

This checkbox will prevent Voodoo from reading the current pixel count. The current pixel count is the number of pixel that have been transferred to the host computer.

Synthetic Image Mode

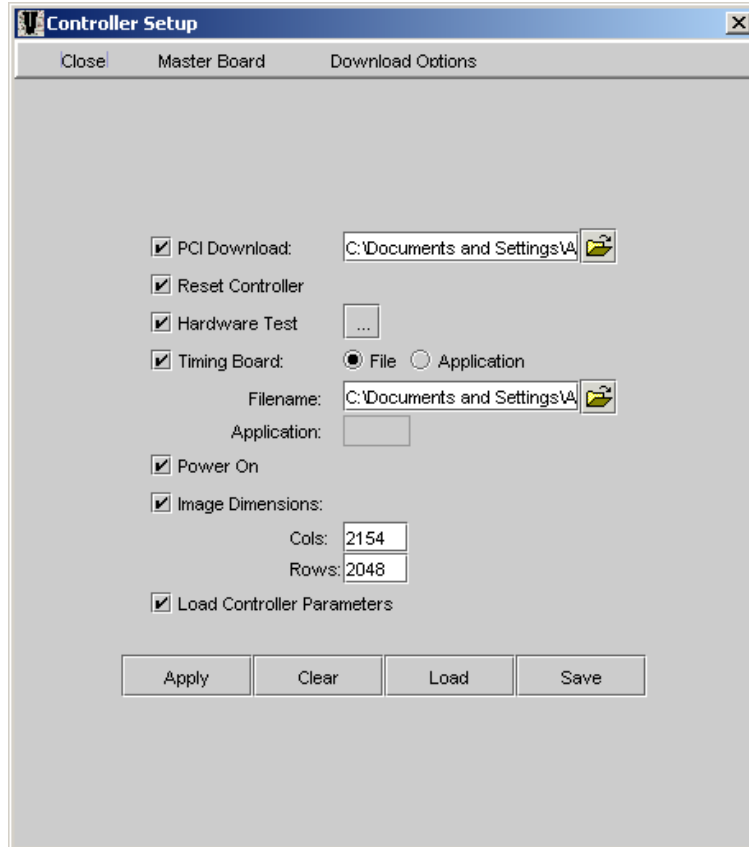
Synthetic Image Mode is used to verify image readout. Selecting this Mode will cause the controller, and in particular the timing board, to generate a preset image on exposure. This allows users to determine if the controller is properly reading out. For example, if no image or an incorrect image is returned from an array on expose, then using synthetic image mode will allow users to know that there may be a problem with the array readout code. Exposure time has no effect on the appearance of synthetic image. The dimensions of the synthetic image will be equal to the set image dimensions. Also, the number of gradients will depend on the set image dimensions. The larger the image, the more gradients there will be. It is important to note that this is a test of the controller and not the computer or Voodoo. Also, it is possible that your controller may not contain the DSP code required to generate the synthetic image.

Show Commands

This will display the details of every command as it is sent. This will display the command, header, parameter and reply values for every command sent.

Setup

The Setup menu item directs the loading of timing (tim.lod) and PCI (pci.lod) files. These files control nearly all aspects of CCD behavior, and are necessary for camera operation. In addition, image dimensions and other miscellaneous functions, including the saving and automatic loading of Setup files upon Voodoo startup, are controlled in the Setup window.



PCI Download

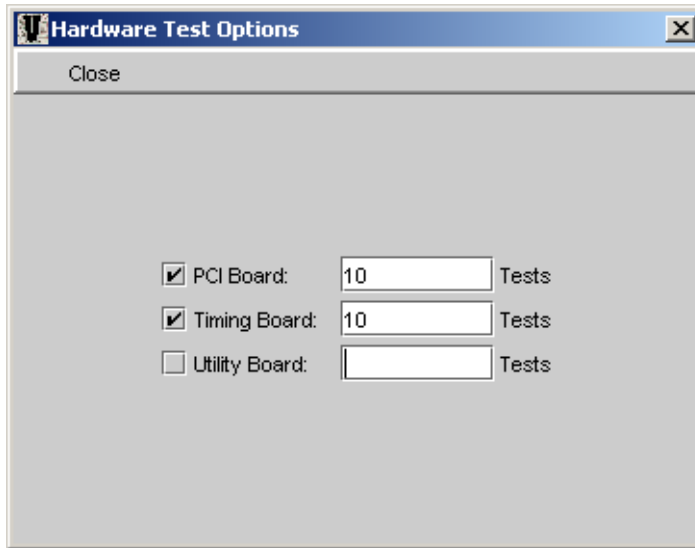
A pci.lod file is supplied with all Retriever Technology cameras. This file is relatively invariant, and as such a user will almost always have only a single pci.lod file to choose from. Check the box, and browse for the current location of the pci.lod file, which then is shown in the text window.

Reset Controller

This should be checked. Resetting the controller is a useful function to be performed every time Voodoo is started.

Hardware Test

This should be checked. Test settings can be modified by clicking on the box to the right. Doing so pulls up the following submenu:



The PCI Board and Timing Board should be checked. Any number of tests can be performed; 10 is the default. The Utility Board does not need to be checked as this system does not have a Utility Board.

Timing Board

A tim.lod file is supplied with all Retriever Technology cameras. Unlike the pci.lod file, a user may have a number of tim.lod files. Examples of different tim.lod file functions can include: differing default STM modes, alternate timing methods, and even different CCD chips altogether. Nevertheless, most cameras are delivered with a single tim.lod file. Contact with Retriever Technology for details. To load, check the box, and browse for the current location of the tim.lod file, which then is shown in the text window.

Power On

Always check this box to turn on controller power.

Image Dimensions

Put in appropriate image dimensions. Make certain that the Image Buffer size, set under "Program" is at least as large as the image dimensions in this Setup.

For 4240 systems, it is recommended that the following settings to be used:

Columns = 2048
Rows = 2048

Load Controller Parameters

Checking this box allows for saving and automatic loading of "Parameter" settings. For setting detail see "Parameters" section.

Master Board

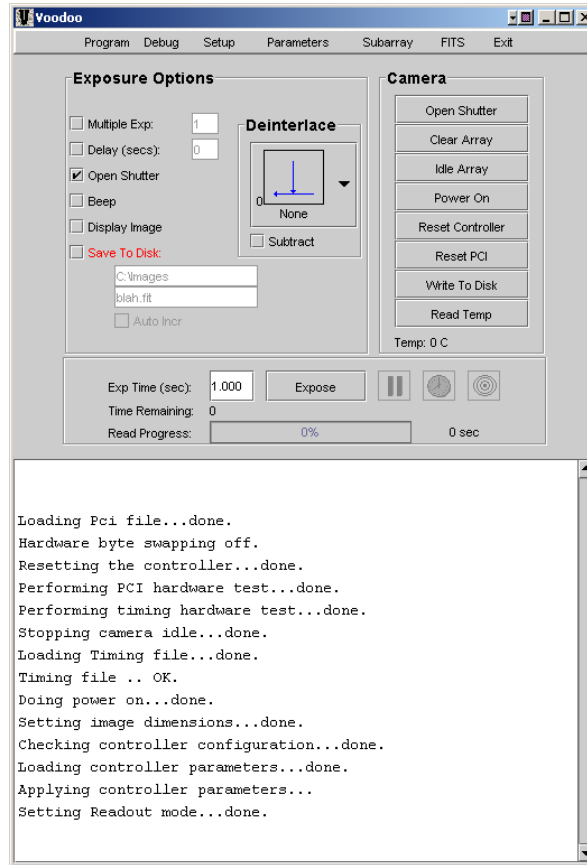
The Timing Board should always be selected as the Master Board.

Download Options

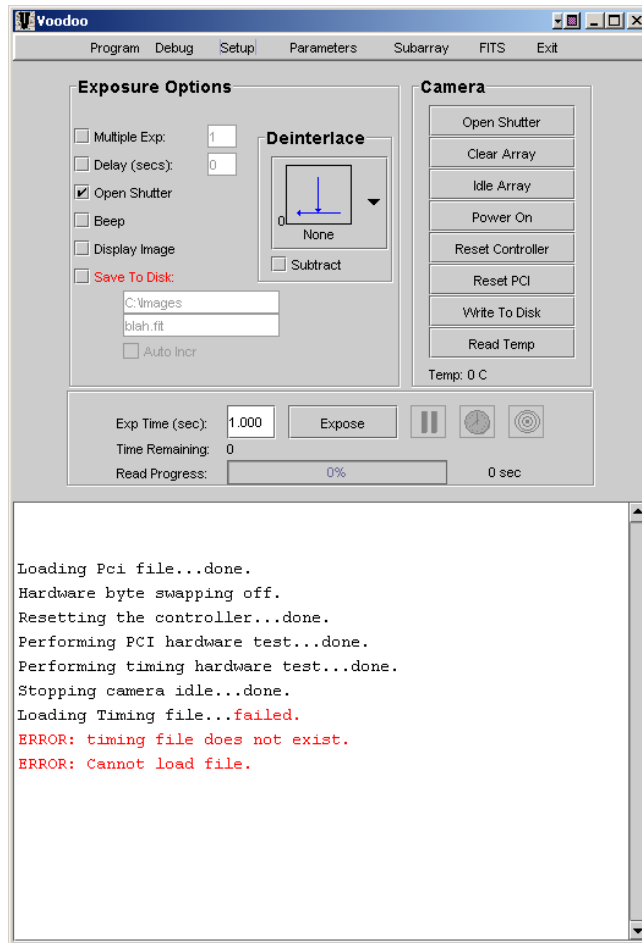
Check 'Perform Download Check'. It is not necessary to select "Stop Download on Error."

Apply

After all desired Controller Setup values are entered, click the "Apply" button. A successful loading of controller values will be indicated in the main Voodoo window by a step-by-step confirmation of each value, as shown in the following typical Info Window display:



An example of an unsuccessful load, in this case caused by a non-existent timing file, could look like the following:



Error messages appear as **red text** in the Info Window.

Clear

All entered Controller Setup values will be erased if the "Clear" button is clicked.

Save

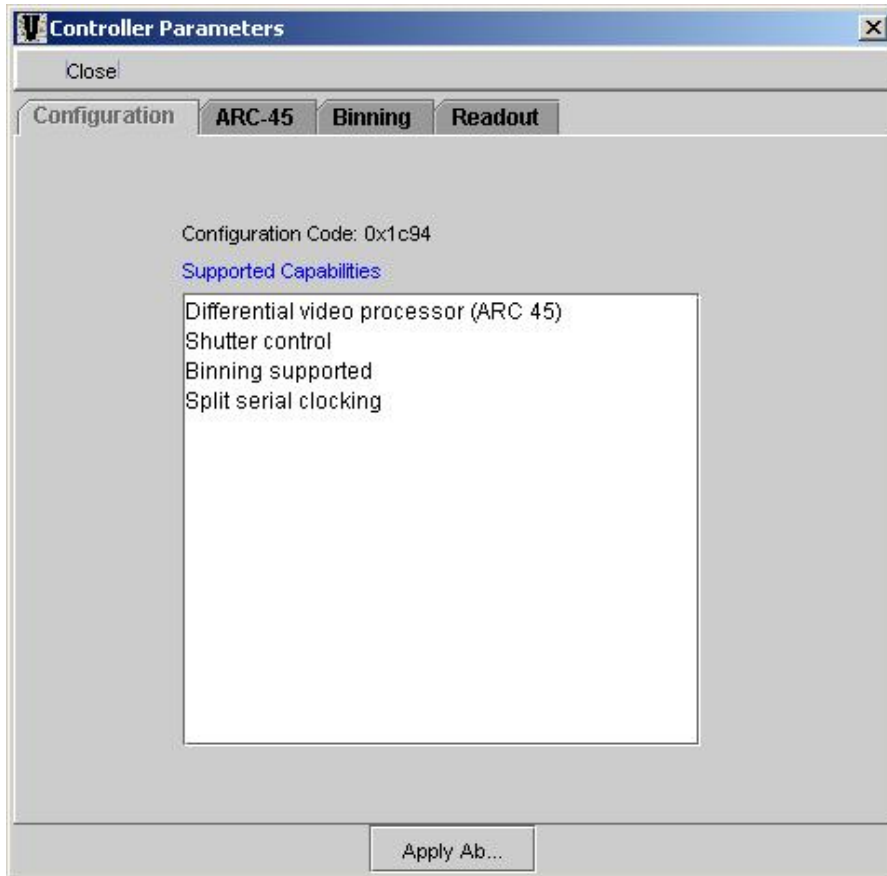
Once the desired Controller Setup files are entered, the entire setup can be saved. Select "Save" and choose a name and location for the file. Note: It is not necessary to add the *.setup extension to the Setup file name, but is recommended to make future searching for files easier.

In order to select any given Controller Setup file to automatically load when Voodoo is started, the user needs to select this file under Program -> Global Setup, and input the desired Controller Setup file and select "Save Settings" to save it to the VoodooChild.curse file.

Load

Select "Load" to load a previously saved *.setup file.

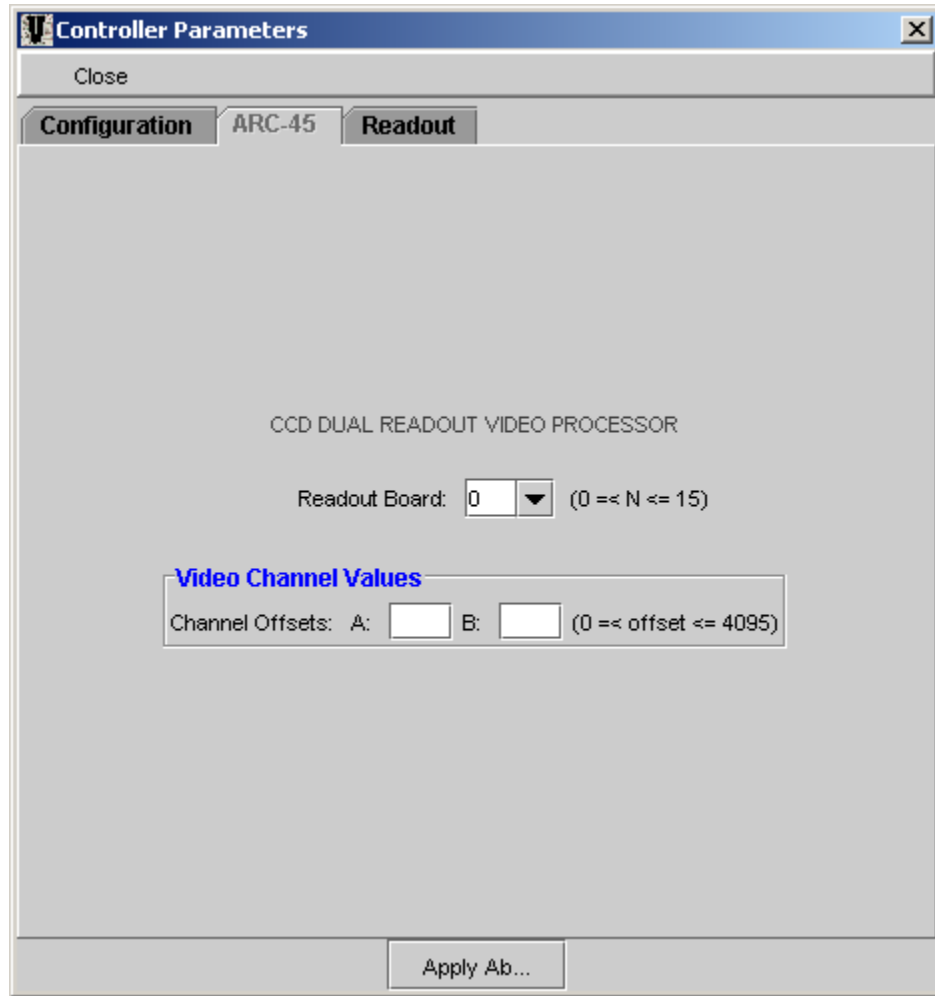
Parameters



Readout

There are three readout options for the 4240: Left, Right and Left/Right, corresponding to readout out of either or both of the on-chip ports. Select the desired readout mode, noting that Split Serial/Split Parallel option is automatically set. Once selected, click on "Apply" and the readout mode will automatically be applied. Once selected, the "Deinterlace" mode in the main Voodoo window is also automatically selected.

ARC-45



Readout Board

The default setting of this is 0, and should not be altered. You can have up to 16 video processor boards (32 channels) with Voodoo Software. Board 0 is the default and is the board number in single video processor board systems.

Video Channel Values

The video offsets affect the video signal by subtracting the user specified video offset from the analog video signal. The 4240 camera system allows the user to select video offset values appropriate to their needs. Default values are zero, corresponding to a relatively high bias offset. The boxes labeled "Channel Offsets: A: and B:" are for entering values between 0 and 4095 that will generate a voltage that will be subtracted from the video signal. A and B represent the two channels (A/D) per board. Channel A is the left readout and Channel B: is the right readout in your system. Enter some trial values, hit "Apply Above", and "Expose" to see what happens to the bias counts. Note that it is easy to obtain zero pixel values when using a higher value for the offset.



Always select a value that gives a bias offset of at least 100 ADU.

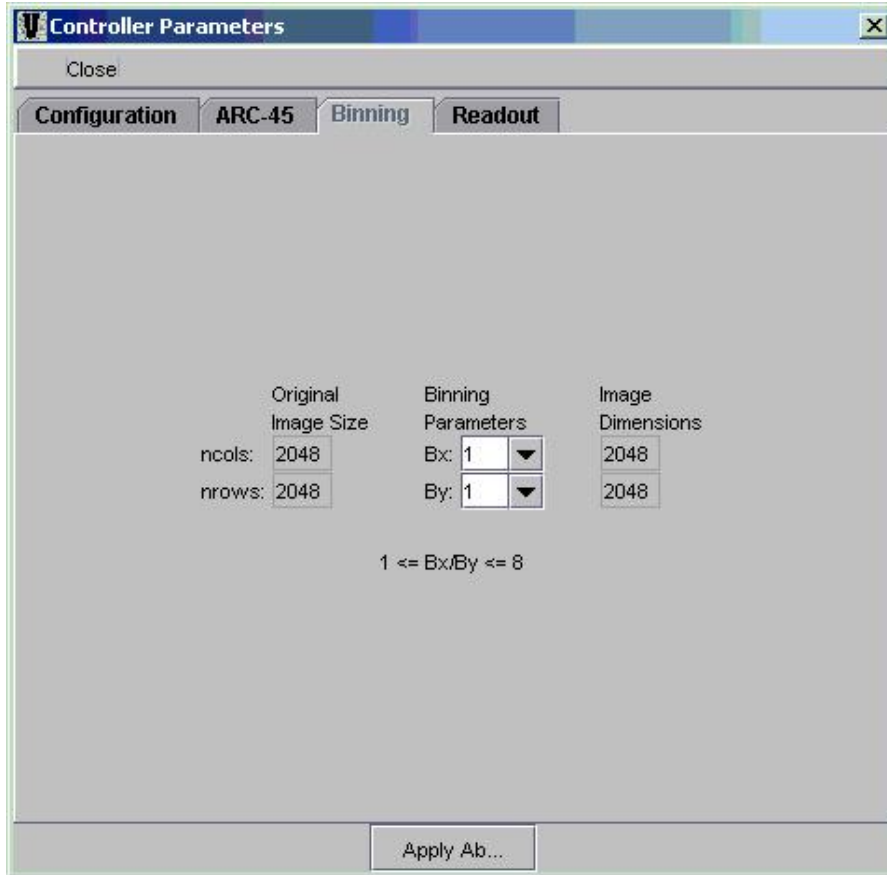
To save the offsets, go to "Setup" and check "Load Controller Parameters" and then "Save" the contents of the window into an appropriate *.setup file. The video offsets you

last entered before the save will be loaded into the controller whenever you "Load" and "Apply" this setup file. See the "CCD Video Processor" manual for more info.

Configuration

This is an information window with no user-selectable features.

Binning



Binning of pixels is available in the following configurations:

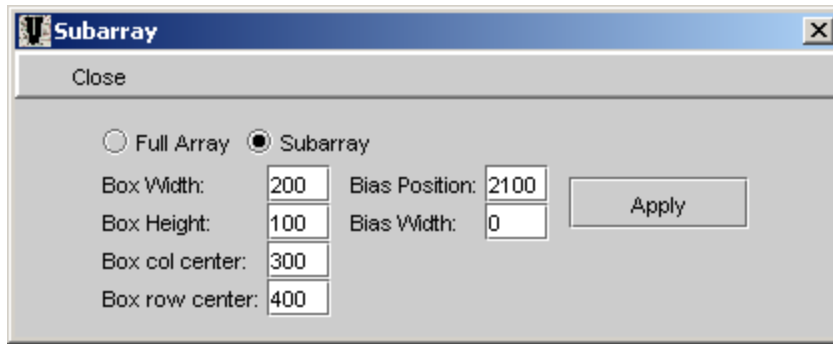
1x1, 1x2, 1x4, 1x8, 2x2, 2x4, 2x8, 4x4, 4x8, and 8x8.

Select a binning value that is suitable for your experimental needs. Note that binning increases the signal in the binned 'super pixel' by an amount proportional to the binning factor. Saturation of the serial registers can easily take place for bright signals, and as such appropriate exposure times should be selected.



Care must be taken when working with Binning and Subarray in conjunction. The binning values must be set first, followed by subarray ROI size. Otherwise, a software fault will occur, possibly requiring program restart.

Subarray



Subarray allows a user to take an image using only a portion of the full array. The box width and height specify the size of the sub-image in pixels. The position of the subarray in the full CCD array is specified in the "Box Column/Row Center" . Bias Position and Bias Width are typically used for diagnostic purposes. It is recommended that these be set and left at:

Bias Width = 0
Bias Position = 2,100

To use the subarray function, select the "Subarray" radio button, input the desired subarray size and click "Apply". The full array option allows the user to set the image dimensions back to what they were before the subarray dimensions were applied. Select the "Full Array" radio button and click "Apply".

FITS FILE CONTROL WINDOW

The "FITS" menu item allows the user to input information that will be associated with the image and stored in the header. Many of the data fields represent astronomical-type entries, but can be used to store any information the user wishes to input. Date, Time and Exposure Time are automatically updated for all images. Some of these fields are explained in more detail below:

FITS

This window allows the FITS header information to be set for images. Changes do not take effect until the "Apply" button is pushed. It is important to note that each text field will allow an unlimited number of characters to be written, but only the first 20 will be stored in the FITS header. Pushing "Apply" will truncate all text fields to 20 characters and redisplay the results.

Simple

Always the letter "T", which means the file conforms to the FITS standard.

Bitpix

The number of bits per pixel. This value may be either 16 or 32, depending on the image resolution chosen by user in the Controller Setup Window.

Naxis

The number of dimensions in the data. In our case, this value is always 2.

Naxis1

The number of columns in the image.

Naxis2

The number of rows in the image.

Date

Initially, the current date is read from the computer when voodoo is started. The date is automatically updated each time the "Apply" button is pushed or when an exposure is taken and the "Save To Disk" checkbox is checked. So it is not necessary to push "Apply" to update the date for each image.

Time

Initially, the current time is read from the computer when Voodoo is started. The time is automatically updated each time the "Apply" button is pushed or when an exposure is taken and the "Save To Disk" checkbox is checked. So it is not necessary to push "Apply" to update the time for each image.

Location

Location from which the observation was made.

Local Siderial Time

The local siderial time of the observation. In the format of hh:mm:ss.ss.

Epoch

The current epoch. Default value is 2000.

Exposure Time

The exposure time for the image. The value is automatically updated when an exposure is taken.

Image Type

The current type of image exposure. Typically "Dark" or "Image".

Telescope

The device from which the observation/experiment is made.

Instrument

The instrument used to make the observation/experiment.

Filter

A list of any filter(s) used. Default value is "None".

Object

The object being images . Default value is "None".

Right Ascension

The right ascension of the observed object. In the format of hh:mm:ss.ss.

Declination

The declination of the observed object. In the format of hh:mm:ss.ss.

Observer

The person who is to take credit for the observation. Default value is "None".

Comment 1, 2, 3, and 4

These four fields are for any comments or notes you wish to have with the observation/experiment. Default value is "None" for all four fields.

Exit

Clicking on the "Exit" menu item will immediately close Voodoo.

June 19, 2003