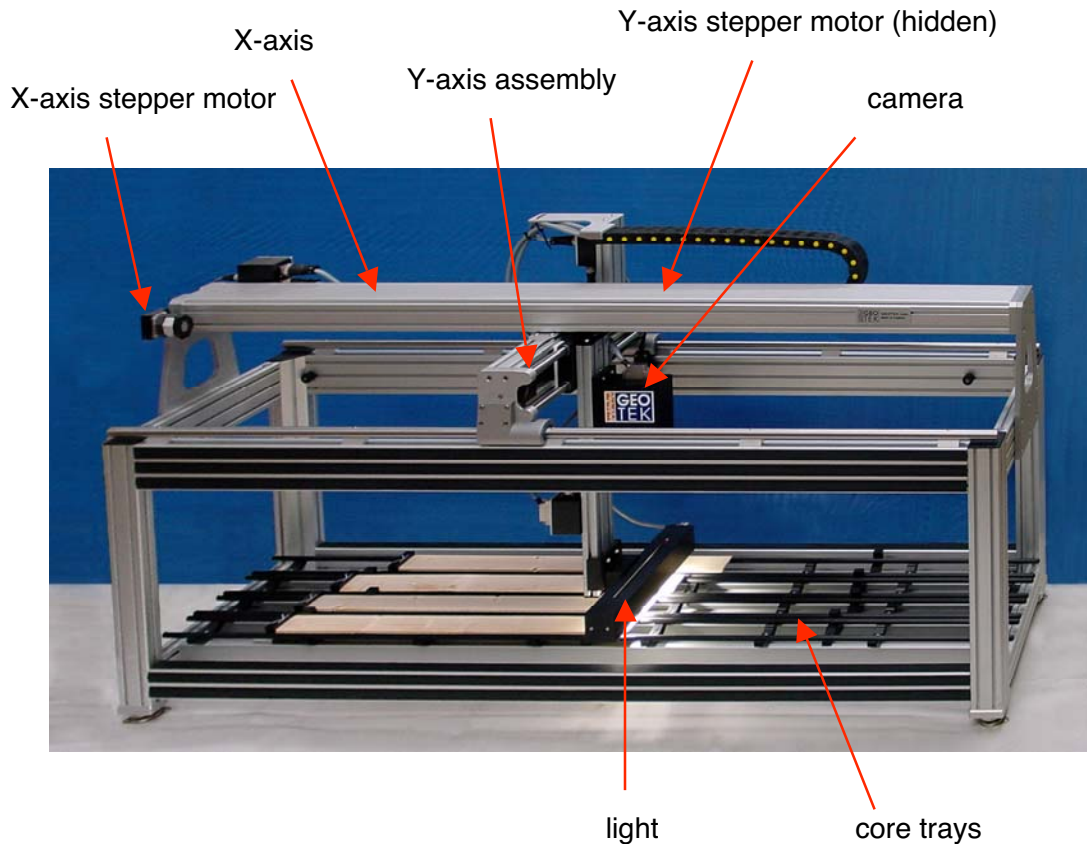


# Digital Imaging System Cookbook

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# I. Introduction

## The Geotek X-Y Imaging System



The Geotek X-Y Imaging System is a means of obtaining high-quality color linescan images. Linescan images are superior to standard two-dimensional photos as there is minimal distortion. As configured for the Ocean Drilling Program, the Geotek X-Y Imaging System takes linescan images of core sections, four to five of which can be loaded into the core tray at once for computer-controlled imaging. The imaging length (X) is 180 cm and the image width (Y) is fixed by the camera height and lens (standard width (Y) in original configuration is 9 cm). At this camera height, the horizontal (Y) resolution of the image is 100 dots per cm. The vertical (X) resolution is user-controllable, but in the system's original configuration, the vertical resolution of the image is also 100 dots per cm.

The Geotek X-Y imaging system is a direct descendent of the Geotek Geoscan imaging system, developed in response to the scientific community's need for an imaging system that would provide scientific colour data as well as being used to obtain colour images that looked accurate to the naked eye. Good scientific imaging requires accurate RGB images with minimal overlap of the wavebands in the 3 channels (RG&B) providing true RGB colour analysis. As there were no camera systems on the market that matched

these requirements, we developed and built our own camera. We can not only provide high quality digital colour images but we can also obtain true RGB 2-dimensional colour analysis with spatial resolutions of less than 0.1 mm. In other words, the Geoscan camera is a 2-dimensional, 3 channel, imaging spectrophotometer; a quantitative tool far more valuable than an imaging camera alone. Scientific colour analysis requires calibration protocols that are common between users. The Geotek imaging system and accompanying colour calibration protocols allow scientists from different institutions around the world to confidently compare their data with each other.

## Camera, Light Source, & Image Acquisition

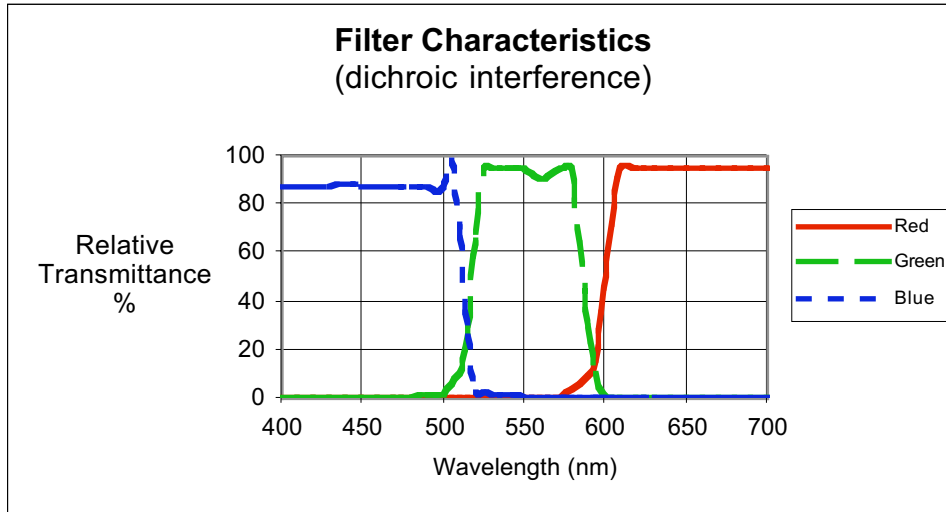
The Geoscan color line scan camera is a 3 CCD device using 3 \* 1024 pixel CCD arrays. A standard Pentax K-mount lens fitting is used which enables the user to easily purchase and change lenses depending on the exact imaging requirements. This is an important consideration when considering focusing and depth of field issues. Light from the object passes through the lens and is split into 3 paths by the beam splitter before passing through red, green and blue filters and falling onto the CCD detectors.



Geotek Geoscan camera shown mounted in the X-Y Imaging System

All CCD detectors are sensitive to light in the 400 to 950 nm waveband. However, they are relatively insensitive to light at shorter wavelengths (400-500 nm - the blue end of the spectrum) than to light at the longer wavelengths in the visible spectrum wavelengths (600-700nm - the red end of the spectrum). Consequently the beam splitter is designed to direct 50% of the light towards the blue detector while 25% each is directed at the red and the green sensors.

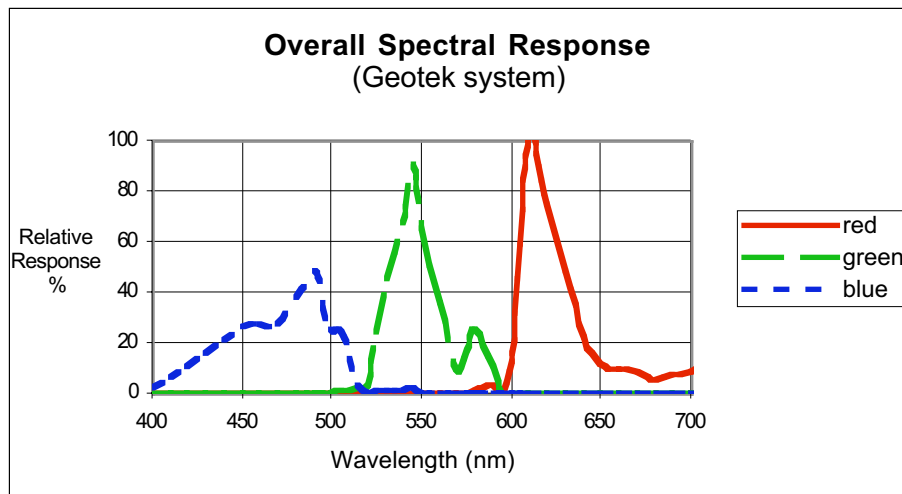
To ensure that there is minimal overlap between the wavebands in the 3 channels (RG&B) for scientific applications, the light leaving each exit face of the splitter passes through a dichroic color interference filter before falling on the detectors which is located at the focal plane of the lens. The



transmission characteristics of the filters used are shown above, which clearly shows how the filters ensure true color separation.

The overall system response is also a function of the spectrum of the light used to illuminate the object. For normal RGB imaging the Geoscan system uses high frequency fluorescent lamps which produce light in 3 main wavebands corresponding to the red, green and blue parts of the spectrum. The light unit uses 2 fluorescent tubes that illuminate the core evenly from both sides of the image line. This provides a flooded illumination that minimises any shadow effects that could be caused from microtopographic effects. The camera is arranged directly above the light and “looks” through a slot in the top surface of the light unit. Spurious reflections are eliminated by black anodising both the camera and light units.

The combined effect of all the elements in the camera and lighting unit produces an overall system response as shown below.





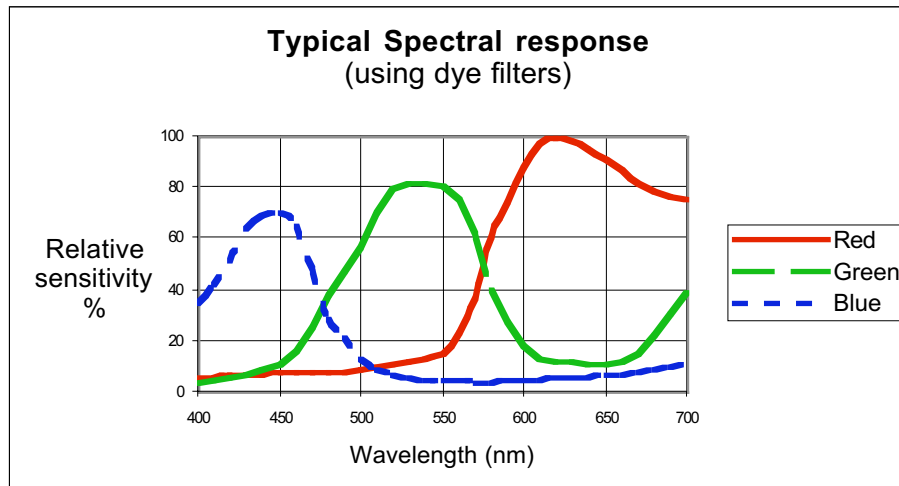
This illustration clearly shows that with the Geotek system we have almost achieved complete separation of the data into the R, G and B wavelength bands. Compare this with a typical system response from a 3 CCD camera where normal dye filters are used.

Whilst the latter system response may give perfectly good images for viewing they will not enable any rigorous colour analysis to be performed because of the lack of true color separation. This is a particularly important point for the wide range of scientific studies that ODP images will be subjected to.

The 3 CCD sensors used have 1024 active elements each. A set of dark reference pixels are used which are electrically identical to the active pixels, but have been fabricated with an opaque layer over them. They are used to compensate for electrical drift within the sensor due to temperature variations. Each pixel is  $14\mu\text{m}$  square with a total active array length of 14.4 mm. The digitised data from the 3 sensors is 8 bit and is multiplexed and transmitted differentially to the interface electronics providing the 24 bit colour.

Synchronisation between the camera and the track is achieved by using the stepper motor pulses to trigger the line acquisition of the camera. Since each motor pulse corresponds to a fixed amount of track movement it can be seen that the camera images a line across the core at precise spatial intervals down the core. This means that there is no optical distortion from the lens or variation in lighting in the down-core direction, a very important factor for high-resolution studies. Compare this with a frame camera that must stitch images together and resolve any problems associated with variable lighting. No matter how well lights are adjusted or picture frames are stitched together, they will never match the consistency of using a line scan philosophy. Motor speed defines the time between pulses and hence the integration period (exposure time). The software-controlled pulse divider allows the distance between scans, i.e. down-core resolution, to be defined. Camera data is de-multiplexed in the interface box, and 24-bit data is transmitted differentially to the PC interface card. Once in the PC the data is corrected for convergence, gain and offset.

A software convergence routine applies a correction that compensates for any minor mechanical differences between the 3 sensor arrays. This feature is particularly valuable when assessing the performance of the camera. In the event that the camera is subjected to excessive mechanical shock (it gets dropped!) the convergence routine would enable the user to assess the extent of any damage that had been sustained and, within limits, apply a software correction to the data. Offset correction ensures that the 3 channels are referenced to a true black level. This is achieved by measuring the signal level of the black



reference pixel for each sensor. Gain correction compensates for pixel-to-pixel response variation, uneven lighting, and lens effects. Lenses tend to darken the edges of the field of view, an effect which becomes more pronounced with increasing aperture. To correct for all of these the camera images a white tile and a software gain correction is calculated for each pixel. This correction is then applied to subsequently acquired image data. The corrected data is stored in a TIFF format (for ODP) with appended depth and calibration information that can then be read by the image replay software.

## **Mechanical & Control Systems**

The tracking system is constructed from anodized aluminum extruded sections in an open frame arrangement mounted on vibration limiting feet. The open frame allows core sections to be easily loaded from the front or side even when the system is in operation (important for a bench-mounted system). The complete Y-axis assembly is driven the length of the frame (X-axis) with a single center-mounted ball screw and stepper motor; the camera and light arm are moved across the width of the frame (Y-axis) with a similar system. The camera and light assemblies are mounted on a vertical slide so their height above the imaging surface can be adjusted manually.

The Y-axis cable chain carries a power cable to the light and a single power/signal cable to the camera. The X-axis cable chain in addition carries a power /signal lead to the Y-axis stepper motor. Flexible, cable chain management systems are used to accommodate power and signal cables. The core trays are moveable.

The electronics and computer system resides in an integrated 19" rack and consists of a microprocessor track control system, an interface, control and power supply unit, and a computer. The computer, as requested, is a single processor 1GHz Pentium III, with 512 MB RAM, 2 20GB hard drives, a CD drive, a CD/RW drive, a network card, a video card with minimum 8MB Video RAM, and is installed with the Windows 2000 operating system. All systems are designed for shipboard use, with vibration-mounted hard drives.

## II. Imaging Cookbook

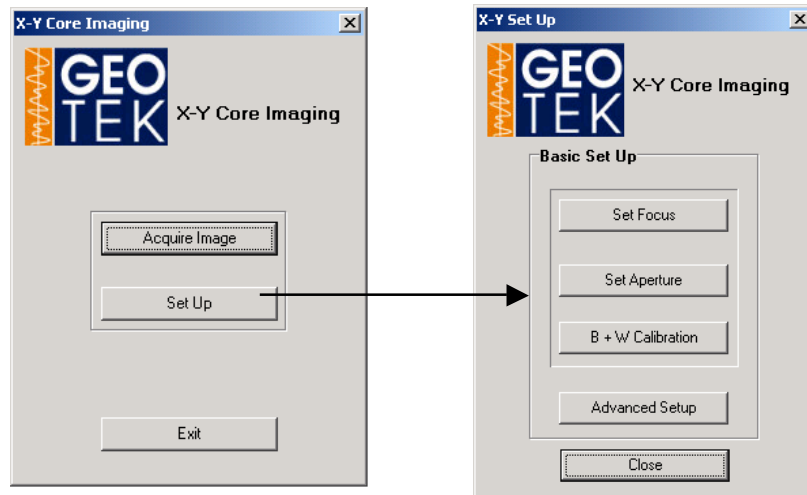
This section contains step-by-step instructions for standard imaging of core sections. It is designed for inexperienced users, provided that the system has been set up and is being maintained by a knowledgeable operator. For more detail on calibration procedures or imaging, refer to the next chapter.

### Setting Up the System

**Make sure the power has been on** to the system for at least one hour.

**Make sure that the camera-light assembly is completely unobstructed.** The light is only 1 cm above the core surface and also sticks out of the left and right sides of the frame by about 10 cm.

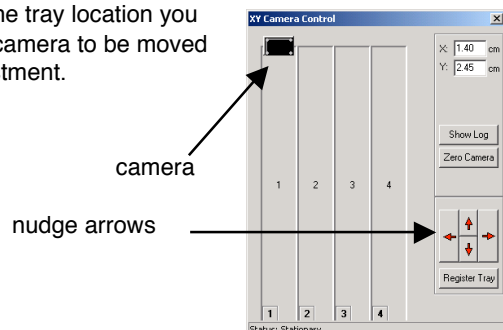
**Select Set Up** to adjust the camera to provide the best image. Focusing, setting aperture, and black & white calibration should be done at the beginning of each session. During a imaging session, refocusing will only be necessary if the height of the core changes significantly (uneven splitting, rocks). Aperture should be rechecked if the cores lighten or darken significantly. Calibrations should be redone on a schedule determined by the main camera operators.



## Set Focus

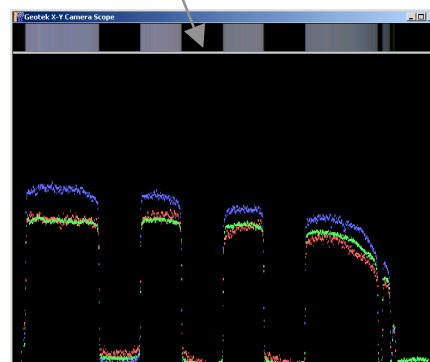
**Find a subject to focus on.** This can be anything with sharp edges that is at the correct height. Good objects to focus on include a core section (focus on the edge of the core liner) or a Geotek calibration card mounted at the same height as a split core (focus on the black and white squares).

**Drag the camera** in the camera control window over the tray location you will use to focus the camera. Shift-drag allows the camera to be moved in the X direction. Use **nudge arrows** for fine adjustment.



**Focus camera** by moving the **focus ring** on the

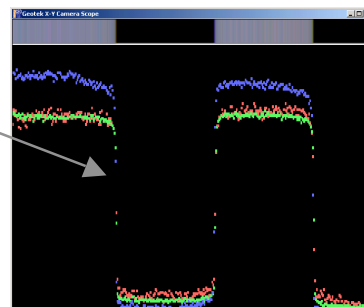
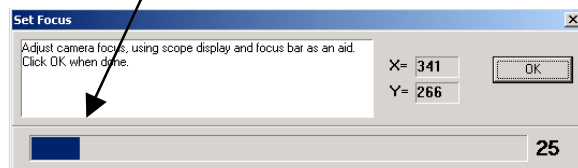
camera lens until the **linescan view** at top of scope window is in focus.



**Click OK.**

Focusing Hints:

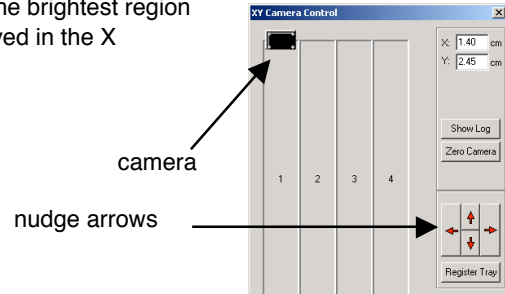
- Drag the bottom of the linescan view down to make the view larger.
- Use the scope to help focus. Zoom in on an edge (select area on scope and click) and use Large Pixels (in scope, right-click and select Large Pixels). Make the edge of the transition as sharp as possible.
- Maximize **bar** in focus window.



# Set Aperture

Select lightest core section to be imaged and place on core tray.

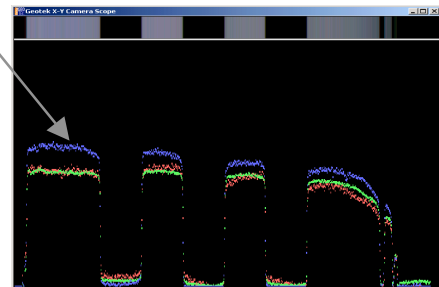
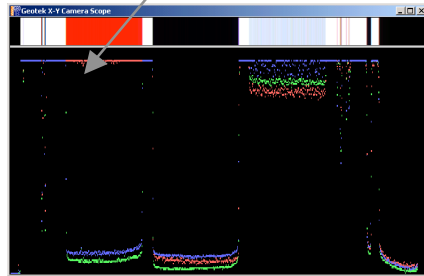
Drag the camera in the camera control window over the brightest region of the core. Shift-drag allows the camera to be moved in the X direction. Use nudge arrows for fine adjustment.



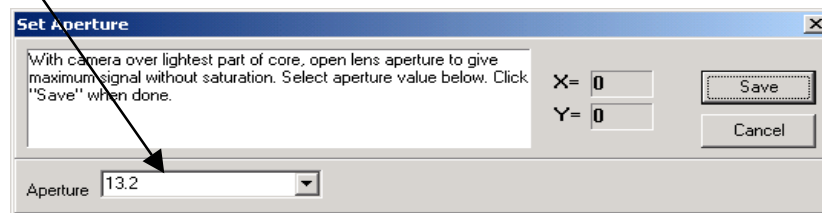
Adjust Aperture to optimum with the Aperture ring on the camera lens. The Aperture value is read at the red line (the Aperture value in this figure is 13.2). Turn the ring to smaller values (larger aperture) until saturation is reached; close the Aperture slowly (click by click) until the scope shows that the camera is no longer saturated.



Flattening of maximum values indicates saturation.



Select Aperture value from pulldown menu.



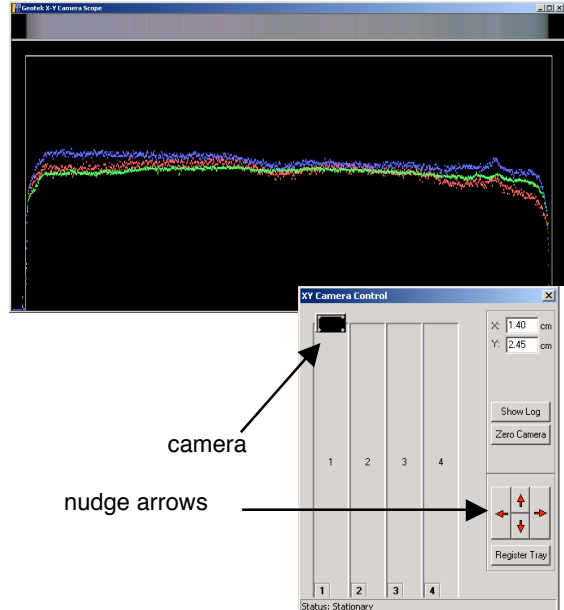
Click Save.

# Calibrate Camera

**Camera moves** automatically to last location of white calibration tile.

**Check that camera is over white calibration tile.** The white tile should be visible all the way across the width of the scope.

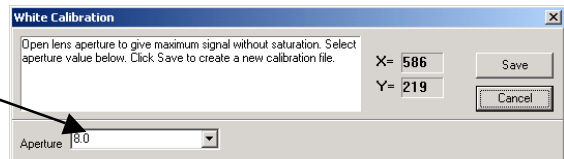
**Drag the camera** if necessary to center it on white calibration tile.. Shift-drag allows the camera to be moved in the X direction. Use **nudge arrows** for fine adjustment.



**Note current Aperture setting.** You will need to reset it to this value.

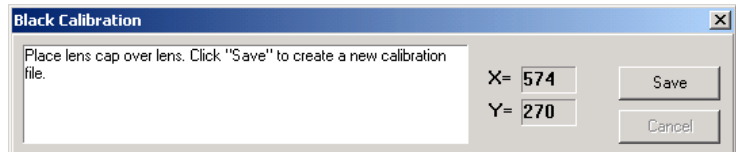
**Adjust Aperture to white calibration optimum** by moving the Aperture ring on the camera lens until the scope shows maximum amplitude without saturation (see **Set Aperture** on previous page).

**Select Aperture value** from pulldown menu.



**Click Save.**

**Place lens cap over lens.**



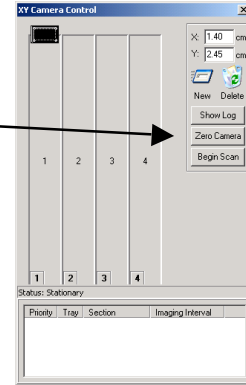
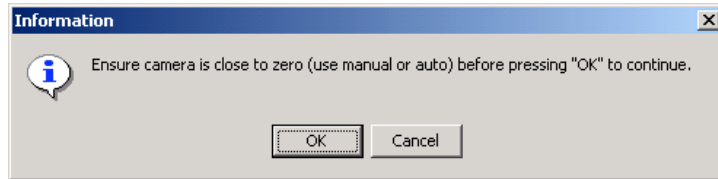
**Click Save.**

**Reset previous Aperture setting** on the camera lens. (If you forgot it, go back and repeat **Set Aperture** procedure.)

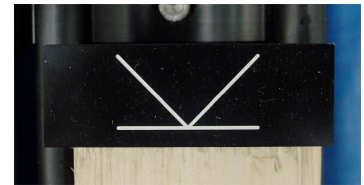
# Imaging Core Sections

Click on **Acquire Image** in the main menu.

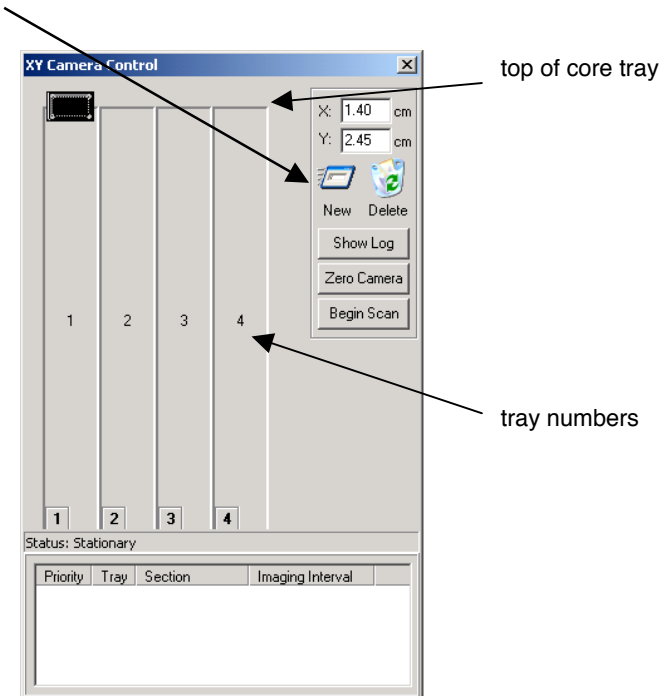
**Zero camera.** Using the Camera control panel, shift-drag the camera to the top left corner. Look at the real camera and check that it is actually over the top left corner of the core tray. Click on Zero Camera, and click OK.



**Place a core section in a tray.** Make sure that top of core section is up against top stop (black with white centering "V").

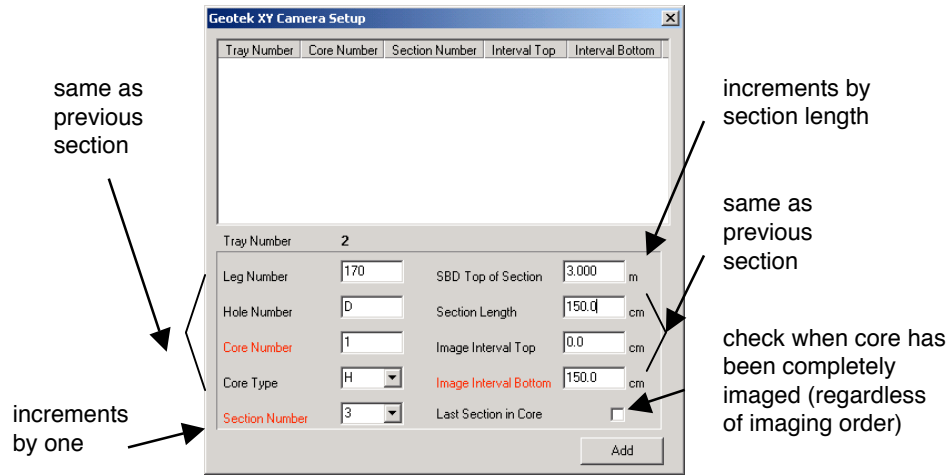


Click **New** and drag to tray corresponding to new section.

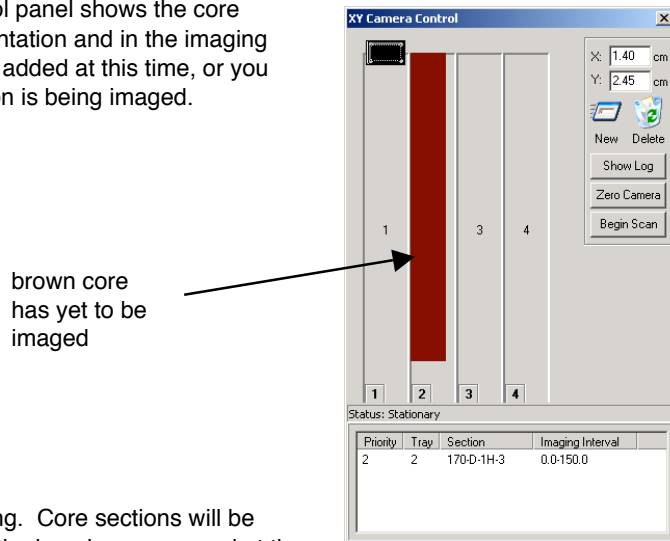




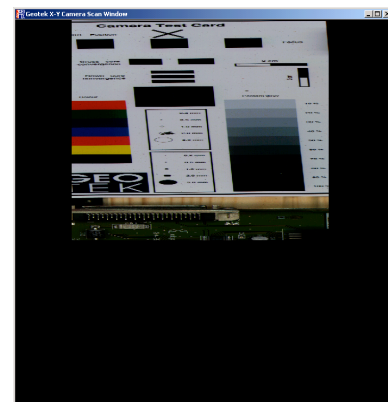
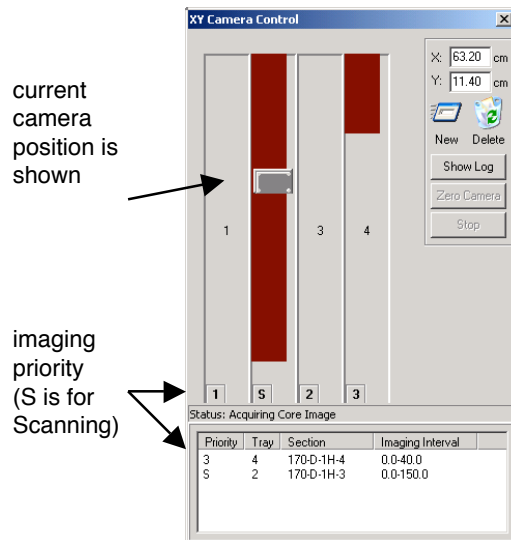
**Enter core section information.** Some information remains the same from new section to new section, and some increments. **Red** information is most likely to be different.



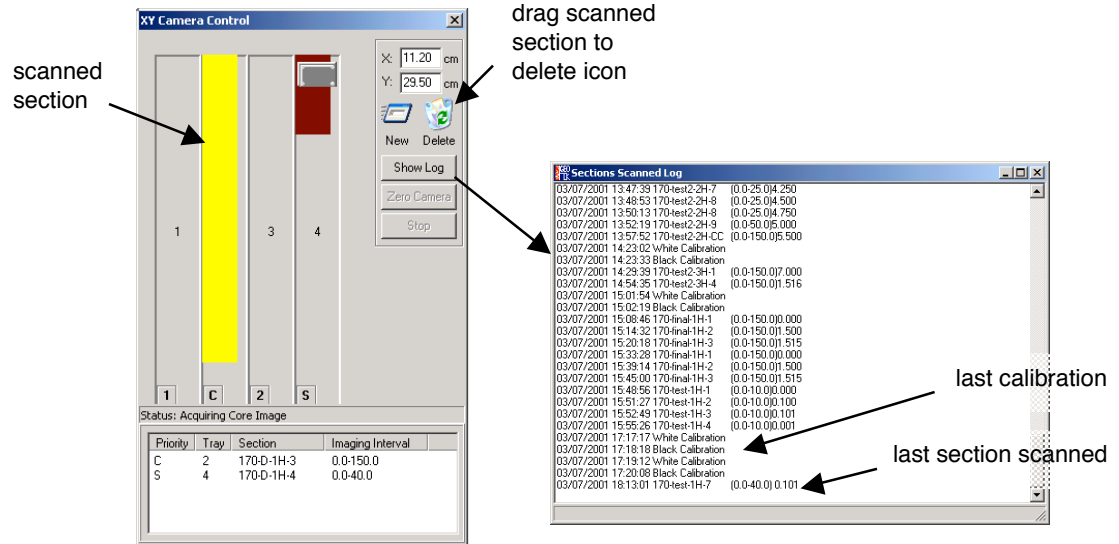
**Click Add.** Now the camera control panel shows the core section in the graphic representation and in the imaging queue. More sections can be added at this time, or you can add them while this section is being imaged.



**Click Begin Scan** to start imaging. Core sections will be imaged in the order shown in the imaging queue and at the bottom of the core tray representation. Change core imaging order if necessary by dragging priority numbers at bottom of core tray representation. Image progress window appears.



**Scanned sections become yellow** and can be removed by dragging to the delete icon. Scanned sections go into the log, which also includes calibrations.



### Actions possible while imaging

- New core sections can be added (drag **new** icon to tray).
- Imaged core sections can be removed (drag to **delete** icon).
- Unimaged core sections can be removed (drag to **delete** icon).
- Core sections to be imaged can be reprioritized (drag numbers at bottom of core trays).
- Log of all core sections imaged can be shown (click **show log**).
- Look at the image of the core being scanned.

**To stop imaging**, remove all sections remaining in the image queue. Imaging will stop when the current section is finished.

**Imaging cannot be stopped in the middle of a core section.** Currently, the program must finish a section once it has started; however, sections not yet imaged can be removed from the queue.

# III. System Manual

## Power-On Procedure

The camera system can remain powered up continuously. If the system has been switched off, the camera (black controller box) should be switched on first. The camera should be allowed to warm up for at least one hour before calibrating or collecting images. The software, XY Camera.exe, can be found in the Geotek folder or on the Start menu under Programs/Geotek/Geotek XY Camera 1.0.

## Main Menu

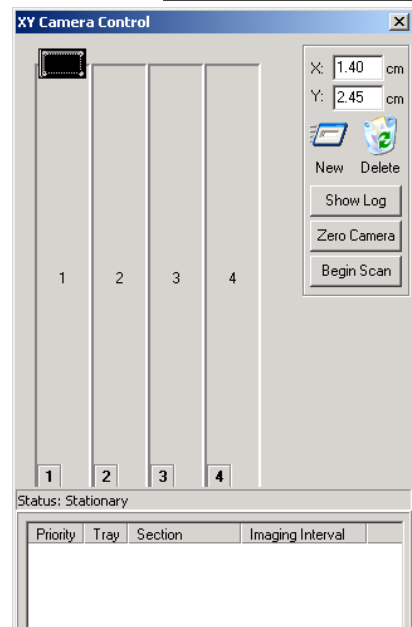
Contains three options: Acquire Image (1), Set Up (2), and Exit, which quits the program.



## 1. Acquire Image

Potential actions: New Core Section (1.1), Delete Core Section(1.2), Show Log (1.3), Zero Camera (1.4), and Begin Scan (1.5). Click Close Box (x) in corner to exit.

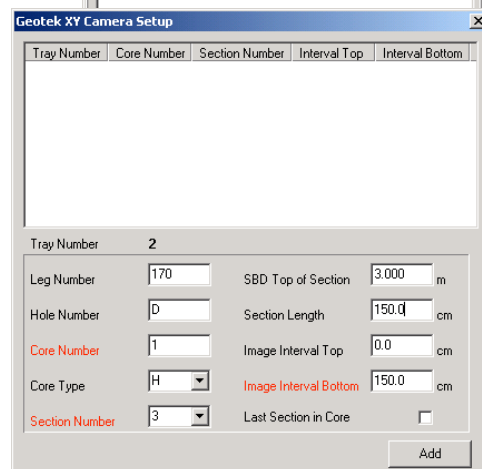
This camera control panel works the same way as the control panel accessible in the Camera Utility (2.4.1). In addition, it shows an imaging queue at the bottom, where all core sections currently on the core trays are show. Priority column contains numbers corresponding to imaging order; numbers not shown are skipped. **S** is for scanning and **C** is for complete. Priority is also show at the bottom of the core tray representation and these numbers can be moved with the mouse to reprioritize the imaging of the core sections loaded on trays.



## 1.1 New Core Section

Adds a new core to the imaging queue. Click on New and drag to a core tray to add a core section; the Add Core window appears. Cores can be added at any time during the imaging process.

The top of the window contains the current imaging queue. The information at the bottom of the window must be filled in by the user. Most fields default to the last entry. Section Number defaults to the last entry plus one, and SBD (subbottom depth) Top of Section defaults to the last entry plus the length of this core section. Last section in core should be checked when imaging the final section of core (regardless of the order imaged). For instance, if the sections have been imaged out of order because section 3 has been undergoing



detailed analyses elsewhere, when section 3 is finally returned and imaged, the box should be checked. Checking this box creates thumbnail pictures of the entire core; this can also be done later using the Create Thumbnails option (2.4.6).

Also see Imaging Core Sections in the Imaging Cookbook (previous chapter).

## 1.2 Delete Core Section

Removes core sections from the imaging queue. Click on a core section representation and drag it to the Delete icon to remove it. If the core section has been imaged (is yellow) this happens immediately. If the core section has not been imaged (is brown) the user is prompted to make sure that this is the desired action.

Also see Imaging Core Sections in the Imaging Cookbook (previous chapter).

## 1.3 Show Log

Shows the entire log of imaged core sections and calibrations. Also see Imaging Core Sections in the Imaging Cookbook (previous chapter).

## 1.4 Zero Camera

Re-registers the camera at its zero position, half a centimeter from the top and half a centimeter from the left of the edge of the core tray (see Register Tray Positions, 2.4.2). Before selecting Zero Camera, either drag the camera to the top left using the Camera Control Panel or turn the camera control to manual on the controller box and use the manual controls to place the camera in the top left corner. Once the camera is within 5 cm of the top left corner, click zero camera. The camera then attempts to move 5 cm up and 5 cm to the left, crashing into the limit switches. It then moves half a centimeter down and to the right to its zero position. If the camera is "zeroed" more than 5 cm away from either the top or left edges, the final position of the camera will be incorrect.

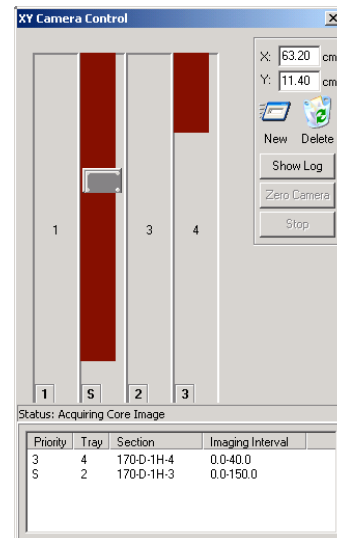
Also see Imaging Core Sections in the Imaging Cookbook (previous chapter).

## 1.5 Begin Scan

Start camera moving and collecting images. Image collection is tied to stepper motor pulses (see Introduction). Imaging of a section must be completed once begun, but imaging can be halted once a section is finished by removing all other sections in the imaging queue. While scanning, core sections can be added, deleted, and reprioritized, and the Log can be shown.

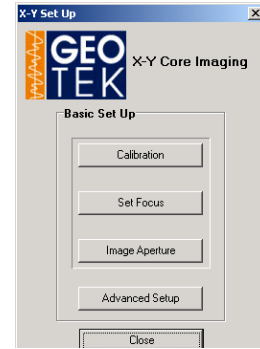
An image of the core section being scanned is shown in a companion window. This image is scaled to the screen and is used for monitoring progress.

Also see Imaging Core Sections in the Imaging Cookbook (previous chapter).



## 2. Basic Set Up Menu

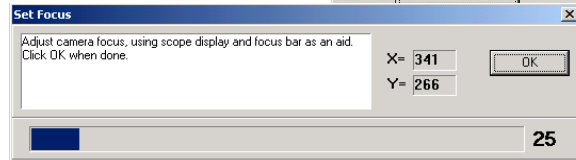
Contains five options: Set Focus (2.1), Set Aperture (2.2), B & W Calibration (2.3), Advanced Set Up (2.4), and Close, which returns to the Main Menu.



### 2.1 Set Focus

Assists the user in focusing the camera in the plane of the split core surface using a focus bar (shown at bottom of window) and the RGB Scope window (see 2.4.1). Focusing should take place on a subject

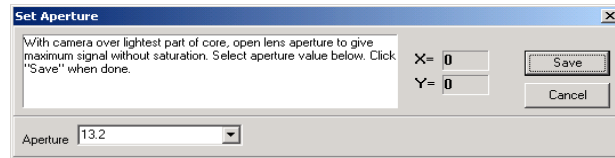
that is in the same plane as core sections to be imaged and has sharp transitions (edges). Aperture (see 2.2) will affect the depth of field and the need for refocusing. Also see Set Focus in the Imaging Cookbook (previous chapter).



### 2.2 Set Aperture

Writes the chosen Aperture value to the settings (.ini) file: see Settings (next chapter). Aperture should be selected using the output of the RGB Scope (see 2.4.1) such that the scope output is as large as possible without flattening at the upper values, indicating saturation of the CCD.

Also see Set Aperture in the Imaging Cookbook (previous chapter).

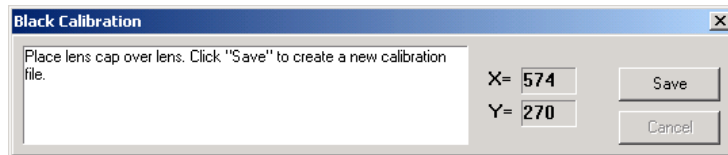
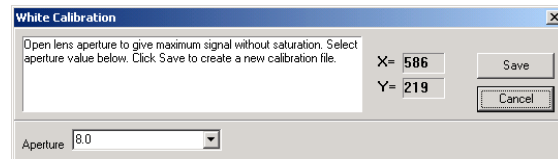


### 2.3 B & W Calibration

Writes calibration files containing the black and white calibrations for each element in the CCD. This ensures that all CCD pixels are scaled to the same black (minimum) and white (maximum) values. Also see B & W Calibration in the Imaging Cookbook (previous chapter).

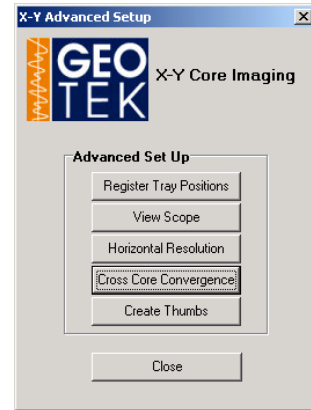
White calibrations are performed on a special white ceramic tile and integrated for an amount of time. The camera can be allowed to travel a distance across the tile (see Settings, next chapter) to remove the effects of dust or dirt on the tile. This white calibration will be a function of Aperture and scan speed. White calibration Aperture does not have to be the same as the scanning aperture, but both of these apertures are very important to the accurate replay of the images and must be accurately noted by the user using the pulldown menus in the White Calibration and Set Aperture (see 2.2) dialogs.

Black calibrations are performed with the lens cap on. Data is collected for an amount of time and averaged.



## 2.4 Advanced Set Up Menu

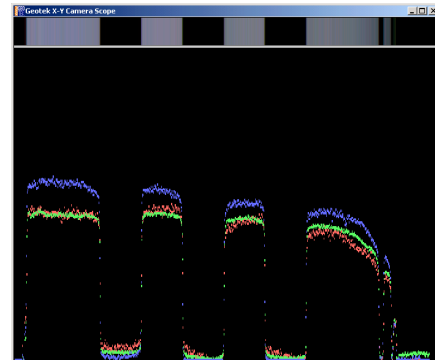
Contains six options: Camera Utility (2.4.1), Register Core Trays (2.4.2), Horizontal Resolution (2.4.3), Cross-core Convergence (2.4.4), Create Thumbnails (2.4.5), and Close, which returns to the Basic Set Up Menu (2).



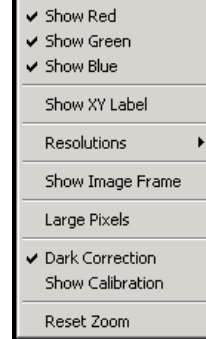
### 2.4.1 Camera Utility

The Camera Utility provides direct access to two useful tools: the RGB Scope and the Camera Control Panel. Both of these tools are also displayed in most of the set up and calibration screens where their function is essentially the same.

**The RGB scope** monitors the output of all 1024 elements of each of the 3 CCDs (red, green, and blue). The window shows the output of the red, green, and blue channels on the bottom and the linescan image (repeated for better visibility) at the top. The scope can be resized at will (bottom righthand corner). The proportion of the window devoted to scope and linescan view can be changed by dragging the horizontal boundary. Portions of the scope and corresponding linescan view can be enlarged by selecting an area on the scope and clicking inside it.



A pop-up menu accessed by the right mouse button allows customization of the scope.



All Colors: displays red, blue, and green channels.

Show Red (Green, Blue): toggles individual channels

Show XY Label: displays the X position (1-1024) and value (0-255) of any location on the scope.

Resolutions: (obsolete; leave set on highest)

Show Image Frame: shows yellow frame corresponding, in the horizontal, to the edges of the image (removing the permanently dark pixels at the left) and in the vertical to 0 and 255.

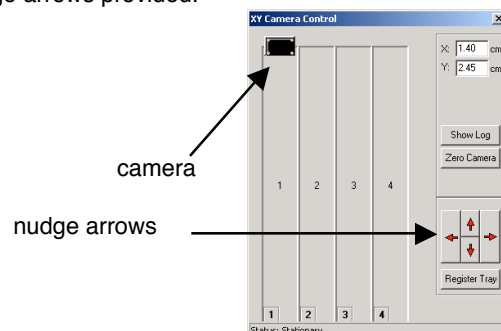
Large Pixels: doubles the size of the scope pixels on the screen for easy viewing.

Dark Correction: toggles the correction applied from the permanently dark CCD pixels to compensate for thermal noise and other environmental effects (also see Camera & Light in the Introduction).

B & W Calibration: toggles the corrections applied to each pixel from the Black and White Calibration files.

Reset Zoom: returns the scope to full view. Areas can be enlarged by selecting and clicking. Maximum zoom is 20x in either dimension; if this value is exceeded zoom will not proceed.

**The Camera Control Panel** allows the operator to move the camera within the software by either dragging the camera to the desired location or using the nudge arrows provided.

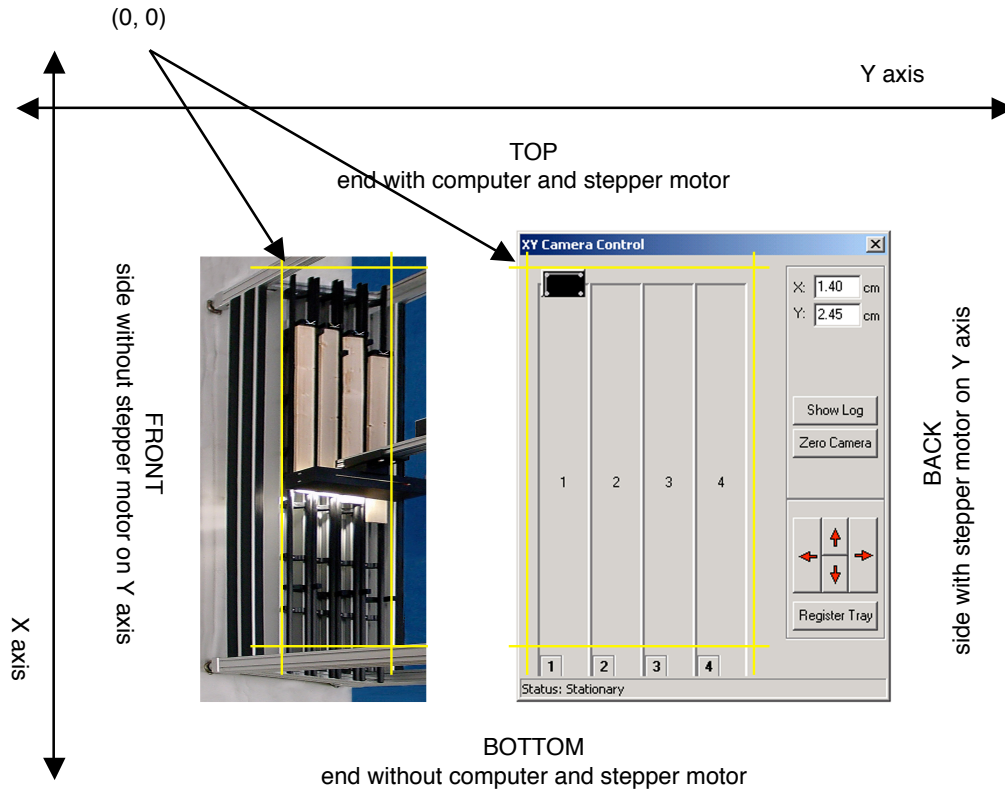




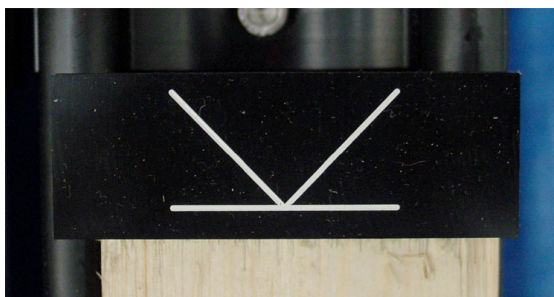
## 2.4.2 Register Tray Positions

Register Core Trays puts the exact coordinates of the top center of each tray in the Settings file (see Settings, next chapter). The coordinate system that the system uses is seen below, both on the real core tray and the software representation. The X axis is the long axis of the machine, along the axis of the core sections. The Y axis runs across the core sections. (0, 0) is in the top right corner and represents the farthest the camera can move up and right. The top of each tray is defined relative to this zero position.

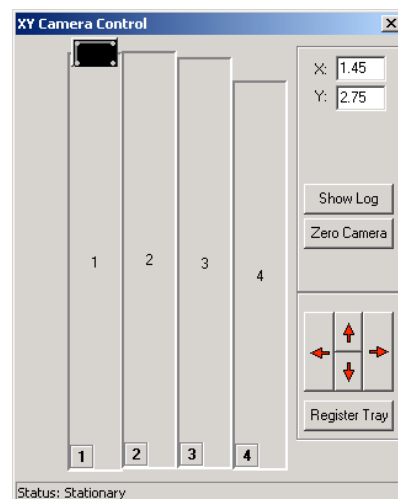
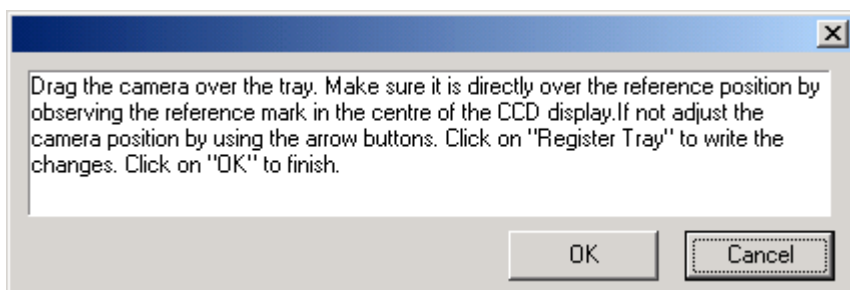
Looking closely at the top of the core trays..... and even more closely at the top of each tray.







- The tops of the core trays have underlined white "V"s for centering and alignment.
- When to do this--every how often or if the block that indicates the top of the section( with white registration vee) has been moved
- White marks have been put on the registration blocks to aid in tray registration.
- Move camera so that diagonals of vee can be seen in scope
- Center Y axis so that diagonals are equidistant from center of image (yellow line on scope)
- Move camera down in X --diagonals will converge to a point and then the white horizontal line will be visible.
- Click register core tray, and do it again for any others that need it.



### 2.4.3 Horizontal Resolution

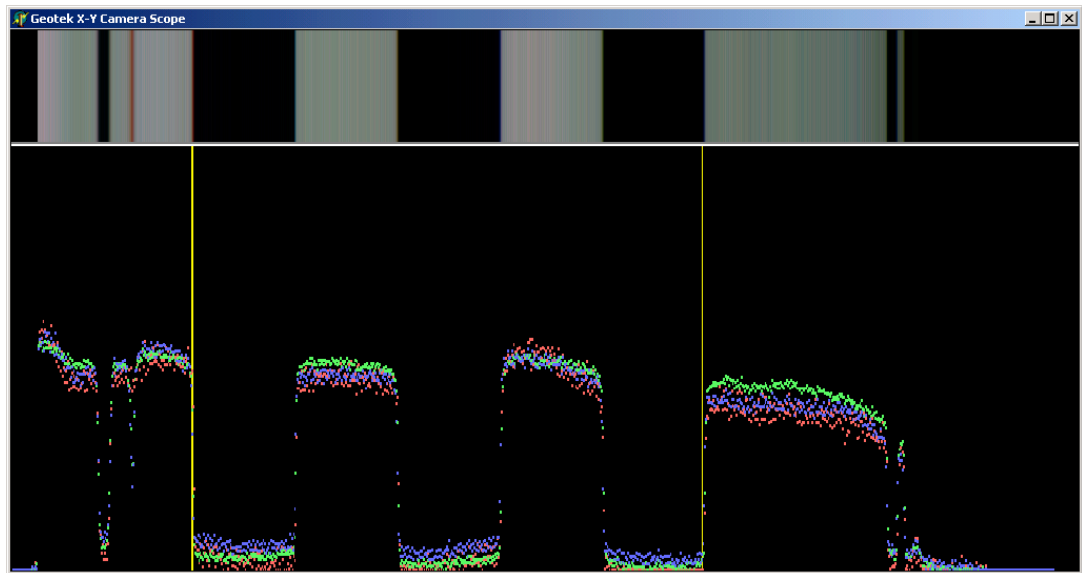
The down-core resolution is a function of a number of parameters but is controlled by the line acquisition rate as synchronised to the stepper motor. Consequently it is not a continuous variable but is a multiple of the smallest step distance. This is currently 0.01 mm (2540 dpi) which means that in theory the down-core resolution could be any multiple of 0.01 mm. In the standard operational mode the down core resolution will be set at 0.1mm (254 dpi). The cross core resolution is controlled by the lens and the height of the camera above the object but of course is limited to 1000 pixels wide. If the full width were used then the cross-core resolution on a 9 cm wide core would be 0.09 mm (282.2 dpi). To reduce the cross core resolution to match that of the down-core resolution the user simply has to raise the height of the camera so that it is imaging a full 10cm providing the 254 dpi cross core resolution. The software will contain a feature to crop the additional image on either side of the core.

When a higher resolution image is required the lens on the camera is changed and the camera height is adjusted to set the new cross core resolution. The down core resolution can be set from the software.

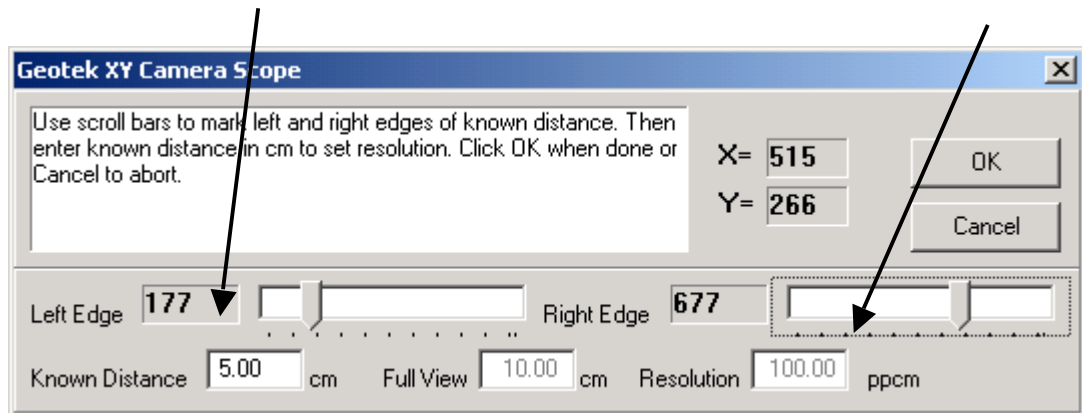
This puts the resolution of the linescan in the ini file. Since the pixels per inch in the CCD is fixed, the resolution will depend on the distance between the camera and the object imaged, or practically, the camera height. The resolution is determined by placing something of known dimension under the camera at the height of the core surface and marking the distance for the program.

Find an appropriate subject for setting the resolution. Anything flat with sharp edges that is less than 9 cm across can be used. Measure it and lay the measured dimension across the Y axis of a core section (or something of equivalent height). Alternatively, use the core section itself as the subject (liner edges are relatively sharp).

Use the sliders and arrow keys to move the left and right yellow lines on the scope to the measured edges. Zooming in on the scope window can be helpful.



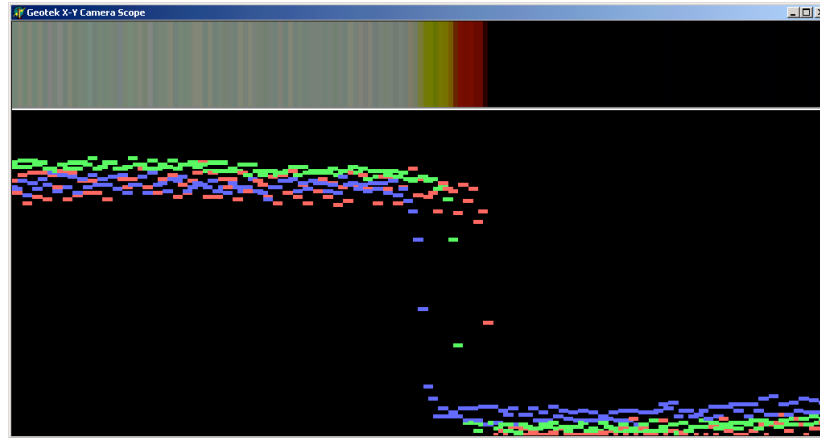
Type in the measured distance (in cm). The software will calculate the resolution



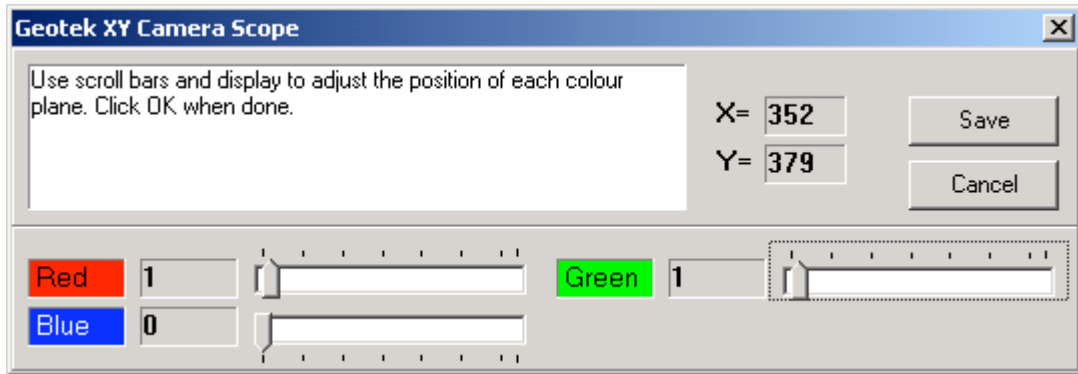
## 2.4.4 Cross-Core Convergence

what is cross core convergence? how can the color planes be misregistered?  
empirical--do it by eye, not perfect, can be slightly different from one side of the linescan to another  
how often will it likely need to be done?

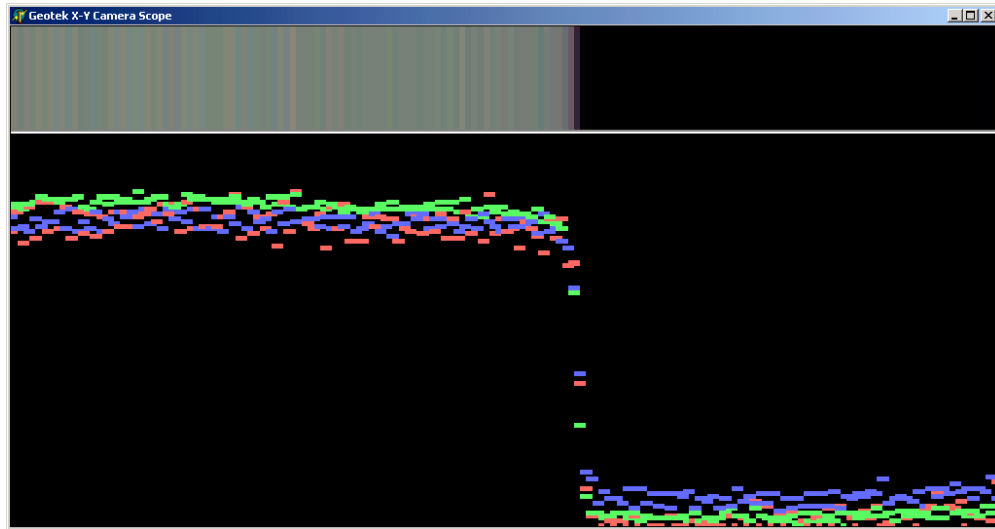
what to do: look at the scope and see if at boundaries there are sharp and all three colors are together--  
zoom in on a black & white boundary  
this is an example where the colors aren't together... color fringing here



so need to move the colors using the sliders



so they all line up together like this



#### Colour Calibration

Geotek has initiated a procedure based on standard 'white' calibration tiles and this protocol has been adopted by all our users and has proved to be rugged. This involves adjusting the RGB channels so that they all produce a reading of 255 on the white tile. The same adjustment is made on the core data and hence the image is always referenced to white. Of course it is important to image the white tile under exactly the same lighting conditions as for the core. To ensure that the image retains the maximum dynamic range the core image is collected at the maximum aperture (without saturation occurring) and referenced to the white tile by storing the aperture information in the image file footer. The colour calibration feature is built into the software.

### 2.4.5 Create Thumbnails

## IV. Settings

```
# Camera type
Camera=1
SerialPort=2
# Save Directory
ImagePath=c:\geotek\
# Last entered section
LegNumber=169
HoleNumber=1036B
CoreNumber=1
CoreType=H
SectionNumber=6
SBD=600.0
SectionLength=60.0
IntervalTop=0.0
IntervalBottom=60.0
ImageAperture=13.2
# Calibration Parameters
CalibrationAperture=8.0
CalibrationX=0
CalibrationY=29.6
CalibrationDistance=4
CalibrationTime=7
# Current Camera Position
CameraX=0.00
CameraY=0.00
CrossCoreResolution= 100.00

# Convergence parameters
[RedConvergence]
X=1
YLow=0
YMed=0
YHigh=0
YMax=0

[GreenConvergence]
X=1
YLow=0
YMed=0
YHigh=0
YMax=0

[BlueConvergence]
X=0
YLow=0
YMed=0
YHigh=0
YMax=0

# Table parameters
[Table]
# Length and width refers to actual camera travel
Length=190
Width=47
# X and Y Border represent camera travel + borders of physical table
XBorder=5
YBorder=10
# Tray Offset is distance from white marker to top of core
TrayOffset=-0.2
```

```

# Image Offset is distance from centre of tray to imaging centre
ImageOffset=0
# Where the camera is allowed to move
XLimit=177
YLimit=32

# Each Tray in the format Tray1..Tray10
[Tray1]
# Y is the centre of the tray from Camera's zero position
Y=2.75
# X is the position of white marker
X=1.45
# Length and Width of the actual tray
Length=170.35
Width=9
# How wide the core is.
CoreWidth=7

[Tray2]
Y=11.70
X=1.60
Length=170
Width=9
CoreWidth=7

[Tray3]
Y=20.65
X=3.90
Length=167.7
Width=9
CoreWidth=7

[Tray4]
Y=29.60
X=13.15
Length=158.55
Width=9
CoreWidth=7

# Sections are filled in the Core Entry Dialog Box
[Sections]
1=1
2=2
3=3
4=4
5=5
6=6
7=7
8=8
9=9
CC=10
# Core Types are filled in the Core Entry Dialog Box
[CoreTypes]
H=APC
X=XCB
R=RCB
D=DCB
N=MDCB
P=PCS
T=TRB

```

Quotes from RFQ Attachment I "Award Criteria"	Comments
<p>1. Pricing</p> <p>2. How well the vendor's response meets or exceeds the specifications</p> <p>3. Data quality (resolution, range, digital artefacts).....</p> <p>4. Ease of operation</p> <p>5. Delivery Date</p> <p>6. Maintenance - need for supplies/spares</p> <p>7. Experience/References</p>	<p>A \$40,000 special discount has been applied.</p> <p>The proposed system meets or exceeds by far all of ODP's specifications.</p> <p>The data quality is probably unique in that contains true scientific colour at resolutions up to 1000 dpi.</p> <p>The mechanical and software design is made as simple as practically possible. In addition many of the scientific users will be familiar with the style of Geotek systems because they use them in their own laboratories.</p> <p>1st March 2001 if the order is placed by 8th January or 10 weeks.</p> <p>Very low maintenance - Need spare bulbs for light. With over 50 core loggers and 17 digital imaging systems around the world we know which parts go wrong and we have already fixed them.</p> <p>With many combined years of experience with ODP and with over 50 core loggers made we understand the needs of the scientific logging community and have the experience required. Any of our customers can be used as references and we can do no better than quote from the experienced JOIDES Scientific Measurements Panel "The GEOTEK line scan digital imaging system suggested by SCIMP is the system of choice".</p>



## V. Core Imaging Instructions

If the Geotek Program is already running, start here. If not, see "**Starting the Program**" below.

**1. Loading Trays.** Load core sections in ascending order in trays 1-4 making sure that the cores are all the way up against the black endpieces, the core faces are flat and the rulers are clean and aligned. Place bar code labels with gray scale chip on the mounts at the end of each section.

**2. Setting the Aperture.** Go to the "Calibrate Camera" section, "Set Aperture" window. Move the camera by holding down the shift key and dragging the camera over the lightest part of the core (this area will require the smallest aperture). Manually adjust the aperture (the top ring on the camera) down to the smallest setting (22) and then open it step by step until you get the desired amount of light. The light spectra should come up as high as possible on the computer screen without going off scale (overexposure). Note the aperture setting, and then manually adjust to smallest setting (22) again, and open incrementally until you reach this setting. Enter the aperture setting into the box provided and press Save.

**Notes:** Try not to move the bottom dial, as this is for setting the focus, which is set each day by the technicians and will have to be reset if it is moved. Avoid overexposure at all costs. It is better to have the image be too dark than too light.

**3. Entering Section Info.** Click and drag the New icon to tray 1. The Geotek XY Camera Setup window will appear. Scan lower barcode with scanning gun. In box "SBD Top of section" enter the depth of the top of the core for section 1 of each core (Get depth from Core Tracking Sheet). Then enter section length from the ruler and include the IW space if applicable. The program will automatically add 9 cm to the section length to account for the foam mounts, and it will enter this number into the "image interval bottom" box. When finished, click Add. Tray 1 in the window will display the core section in red. When finished scanning, Tray 1 will turn yellow. For the other sections, the program automatically increments the section number by 1 and increases the depth of the top of the section by the length of the previous section. You can either enter all 4 trays right from the start (if they require the same aperture setting) or you can do individual trays at a time (if they require different aperture settings), but note that if you enter all four at once, the computer will scan all four without stopping.

**4. Scanning.** When all of the trays to be imaged have been entered you are ready to start scanning. Click the Begin Scan button. It will take a moment before the camera begins to move. The camera will scan all sections entered taking about 5 minutes for a 150 cm section. A compressed image of the core section will appear on the screen as the section is being scanned. When the section is completed, the section will turn yellow in the Camera Control window.

**5. Finishing Up.** When scanning is completed, remove the yellow sections from the trays in the Camera Control window by dragging them to the Remove icon. Remove core sections from the imaging table. Load trays with new cores and repeat steps 1-5.

## 6. What if you notice a mistake after you begin the scan?

Click Pause Scan. Remove the remaining unscanned sections (red sections) in the Camera Control window by dragging them to the Remove icon. The camera will then stop after it has completely scanned the section it was on. Remove the yellow sections as in step 4. Reenter the correct section information and begin the scan again. (Please see a Lab Tech if you have questions).

### Starting the Program

- A. Login (if necessary) 1<sup>st</sup> login (Netware): guest/no password 2<sup>nd</sup> login: camera/camera
- B. Open MrSID Workgroup Encoder 1.1, **turn it on** then minimize it to keep it running in the background. (Start menu/Programs/LizardTech/MrSID Workgroup Encoder 1.1, **Turn On**).
- C. Open Geotek XY Camera Program using either the shortcut on the desktop or under the Start menu/Programs/Geotek MSCL/Geotek Digital Camera System.
- D. Click Acquire Image. The Camera Control window will open. The four columns on the left represent the four trays on the scanning table.
- E. Zero Camera. Click the Zero Camera button and follow the directions given. (See a Lab Tech for assistance).

If you mistakenly adjust the focus knob on the camera, see a tech for help. You may need to redo the black and white calibration and reset the focus. To redo a black and white calibration, go to the “Calibrate Camera” section of the imaging cookbook (black binder that says “ODP Digital Imaging System”). To reset the focus, go to the “Set Focus” section of the imaging cookbook.

To zero the camera (which is also usually done by the techs), you can go to the “Imaging Core Sections” portion of the imaging cookbook, and find directions.

## DIS BASICS

- MrSid and Geotek Digital Camera Program should be open, in acquire image screen (if not look at the more detailed cookbook under the mouse)
- Place core sections in trays, flush against top, aligned with rulers, with scraped surfaces horizontal. Place gray color standard and foam against base of core
- Set aperture manually by adjusting top ring on camera. Initially, decrease to smallest aperture setting (22), increasing incrementally until you reach the desired lightness. Enter the new aperture setting into computer and SAVE.
- Click on New, drag to tray 1. Scan lower bar code, Core info appears in dialog box. Place label with bar code on foam beneath gray color standard.

In dialog box:

Fill in: SBD Top of Section: \_\_\_\_\_ (enter core depth for section 1 of each core)  
Section length: \_\_\_\_\_ (to base of core, including IW space when applicable)

The program will automatically add 9 cm

For sections 2-7, the program will automatically increment the depth upwards by adding the core length. Double check that for each new core, you enter a new Top of section and do not just keep adding on to the previous section.

- Click Add
- Add each section in succession. Only add sections that can be scanned at same aperture setting (that is to say, with similar lightness)
- Scan

# **DIS APPENDIX**

## **DIS Checklist**

- 1 Fill out Log Sheet with section lengths. Make note of rescans or aperture changes.**
- 2 Set Aperture for entire core (if necessary).**
- 3 Place barcode labels on foam next to gray cards. Place the foam at the end of each section with plastic cover over the label.**
- ✓ Use barcode reader to enter section information.**
- 5 Enter the depth of the core in “SBD Top of Section.” (Get depth from Core Tracking Sheet)**

# ODP Leg 202 Installation Report

## Digital Imaging System (DIS)

### Summary

- The DIS scanned approx. 7000 meters of core this Leg. Considering the short period of time the instrument have been in service for ODP and the large workload this Leg it has performed well.
- A lot of experiments have been carried out to monitor the effects of ambient light and it's implication in the scanned images. Shiny and light rulers seem to be a bad idea since they have an influence on the scanned images and RGB files. The images seemed lighter towards the bottom end of the sections both in the images and in the RGB files.
- The new Generic Uploader for the RGB files worked well but more has to be done about the statistical ways of retrieving the actual data.

### Problems Encountered

#### Linear artifacts on scanned images

Immediately upon scanning the first core sections of Leg 202 bright linear lines were discovered in the horizontal plan of the images. These are seen both in the TIFF and MrSID output files. The frequency of the lines appears very systematic with 5-mm intervals in most images and in some denser with a frequency of 1-mm. All images scanned in tray #1 only show's linear lines at a frequency of 30-cm and are therefore positioned at 30-cm, 60-cm, 90-cm, 120-cm, and 150-cm down through the scanned section.

Scientists and technicians have suggested several explanations and possible solutions for this problem. These includes possible problems with the power supply, track, motors and motion controls, software, memory download from camera to PC, image offset, cropping of images, calibration of camera, light bulbs, aperture settings, horizontal resolution, and brightness and saturation of rulers.

The numerous parameters involved and possible causes of the recently discovered problem are discussed and verified/discarded in the following.

Calibration of camera

I calibrated the camera and zeroed the track. Didn't help.

### **Power supply**

The ship's unstable electricity (e.g., phase shifts & frequency fluctuations) could cause interference when acquiring images on the DIS. With help from the ODP Electronics Technicians it was confirmed that there are some problems with the stability of the ship's power supply. It was tested by hooking an oscilloscope to the mains and it showed that there do appear to be some problems. John Davis the MCS installed an APC 1400 UPS between the DIS and mains in hopes of filtering such noise/variations. However, the problem persists.

### **The track and motors**

The track makes a lot of noise and is a bit unsteady. To stabilize it a thin coat of silicone lubricant was applied to the motion guides/rails and bearings on the track. Pieter Pretorius the ET inspected the two motors moving the camera in the Y and X directions on the track. They were tested with a diagnostic software utility that was buried in the Geotek DIS folder. His most notable discovery was that the motors pause (*very, very briefly*) at 30-cm intervals where there are very pronounced lines in the digital images as mentioned above. This is a very "stable" pause of the motor suggesting that it's software related rather than mechanically/electronically. This tells us that there is a direct connection between the 30-cm frequencies of the lines in the images and the motors and therefore the software. We found out that this problem is not a recent one because they occur in images from previous leg's! They were never discovered previously. More about this under "**Aperture settings and light bulbs**".

Another problem associated with the motion controls is that the camera will "freeze" at the end of a run. It normally happens while the camera is dumping the memory to the PC. It happens 1 to 5 times per shift with a constant core flow. Every time it freezes up, you will have to log out and start up the PC again. Then zero the camera and rescan the last scanned section. I haven't been able to come up with a long time solution or explanation for this problem yet!

### **Memory download from camera to PC**

Peter Blum remembered that when he was introduced to the system by Geotek approx. 2 years ago, it could only scan 30-cm intervals per run. The limiting factor seems to be the memory card on the camera. It needs to dump the data every 30-cm and somehow this interferes with the motion controls. We haven't found any solution to this problem yet. Maybe closing the shutter on the camera for that brief period when it dumps the data would help? Or install a memory card with more memory.

### **Rulers**

I was suspecting that the ruler to the left of a tray was causing some kind of interference because the 5-mm and 1-mm lines wasn't appearing in scanned sections from tray #1 but in the remaining tray's. I moved all the rulers and test scan's showed that all the horizontal linear lines were gone. Except for the 30-cm interval ones. When I then put a ruler only on the right side of a tray it still didn't show any lines. The tick marks on the left ruler are pointing towards the section being scanned and away on the right ruler. I then turned the right ruler upside down with the tick marks pointing towards the section

and still no lines. Closing the aperture to approx. 8.0 will make the lines disappear but then you will be compromising with the resolution of the dark cores. Different types of rulers shiny or matte showed the same results as above. It hasn't been possible to find/construct a ruler that doesn't get saturated when having the aperture wide opened (4.0, 4.7, 5.6, 6.7).

In short it's only the left ruler that is affecting the images and only when it's saturated because we need to open the aperture up in order to optimise the resolution when scanning dark cores. We received this information from Geotek:

*The Line CCDs have some reference pixels (I think 3) at their left hand end that are coated in an opaque (black) substance in order to give the camera a zero value for calibration.*

*Your camera is seeing the edge of the ruler from the tray to the left. You have opened the aperture to make the grey aluminium of the ruler appear white and on your sample image it is actually at a digital value of 255 and so is saturated. The first normal pixel (adjacent to the black reference pixels) is seeing a change from saturation to almost black as it scans past the ruler on the left hand side. Because the white value is at saturation, some light and/or electrical energy is spilling over to the black reference pixels inside the camera. When this happens, the black reference value changes, causing the calibration to shift, hence the lighter scan lines.*

*Saturation is a bad thing, and the ruler to the right may also be having some effect on the image because it too is saturating. Even though the CCD's are specified as having "anti-blooming" channels where excess charge is taken away from the CCD, we are not convinced that such systems are 100% effective and excess charge on the CCD could still cause trouble.*

*If this model is right then you may not see this effect on images obtained from Tray number 1, however as I said above, saturation anywhere on an image could cause problems so I am not absolutely sure what you should see on Tray 1. We have not seen this effect before because we do not set the camera up so that saturation occurs.*

*IF our model is correct you have two potential solutions:*

- 1. Reduce the aperture so that the ruler is not saturating.*
- 2. Attenuate the aluminum of the ruler so that it has a much lower dynamic range.... lacquer it with some brown varnish or darken it in some way perhaps?*

*I realize that you are trying to get the optimum dynamic range on dark cores and obviously you need to open the aperture. But when you do this you should take care to prevent any saturation in the image.*



### **Image offset and cropping images**

Cropping the left ruler out of the image doesn't help because the image seen by the camera before cropping is not affected and therefore the left ruler remains in the initial scanned image. I needed to move the camera itself physically. The \*.ini file shows that the offset of the camera is 1-cm to the right of an image already. It's set like that in order to center the image over both tray and ruler. I set this to 1.35-cm to the right so the camera is not scanning the ruler to the left of tray 2, 3 and 4. This immediately solved the problem and the horizontal lines were gone.

This also means that the camera is not centered over the core. In fact the left side of the core liner is now to the very left of the scanned image (instead of the left ruler). In theory the only thing this will have and affect on is the focus. But the affect, with the camera relative far from the scanned surface, should be insignificant.

One thing that remains is that it would be better to have a standard color to the left of an image instead of the edge of a dirty core liner edge. This way the reference pixels for each horizontal line would have a constant reference color. This standard could be incorporated in a ruler were the right side of the rulers didn't have ticks or numbers but simply one standard color that doesn't over saturate.

### **Aperture settings and light bulbs**

So why didn't this problem occur before? This is the first leg I have been on, where we have been opening up the aperture to values of only 4.7. This was done in order to increase the quality/resolution of the images because of dark cores. This means that the rulers are strongly over saturated because more light are let in through the aperture. I also changed the light bulbs before first site and this really made a difference to the quality of the test images. The old lights were yellow and weak compared to the new ones. I suggest we change them at least every leg. I'm no expert so ask somebody else. This Leg they have been changed twice at the beginning and in the middle of the Leg.

Opening the aperture let's too much light in even if the motor stops for just a split second. We found the 30-cm lines in images from previous leg's too though. They were very weak though because of the more closed aperture settings.

### **Inventory**

One old set of light bulbs were taken out in the Chile port call and two new sets of light bulbs have been used this leg. This leaves 18 light bulbs (9 sets) on inventory. The light bulbs brand are: SYLVANIA FM8/841, Subminiature 8w.

### **Final remarks**

The combination of bright light and the wide-open aperture haven't been done on the DIS system out here before now. It resulted in horizontal lines because of the bright tick marks on the rulers. What can be done? Get new rulers with a standard on the right side. The standard doesn't have to be more than 3-4-5-mm wide.

When the data is downloaded from the camera to the PC every 30-cm, the camera stops for a split second. This is seen as a white horizontal line on the images. How to avoid that. Have the camera dump all it's data after an entire run or have the shutter closed for that split second.

Version: 202

Reviewed by: Mads Radsted

