Color Line Scan System user manual V.1.3
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Introduction

A line scan camera and a linear light source are available as an option on the XRF Core Scanner. High resolution color images can rapidly be obtained and due to individual CCD pixel calibration accurate color data in RGB and CIE-lab units becomes available.
An user friendly control program with state of the art graphical user interface makes the camera system easy to operate.

The Line Scan Program runs on a personal computer with a WIN32 based operating system, like WinXP and Win2000. To be able to capture images from a Jai CV-L107 line scan camera a Dalsa-Coreco X64-CL-iPro-Lite frame grabber board must be installed. The Line Scan Program uses the Stemmer Common Vision Blox (CVB) platform to acquire and process color images. The CVB platform contains the drivers for the X64-CL-iPro frame grabber board, SaperaLT libraries and the Image Manager to control the image acquisition and processing.

The camera system contains a 3-CCD camera with beam-splitter and a manual controlled Pentax 50mm lens. The image resolution is appr. 150 pixels per cm in cross-core and down-core direction. With a shutter time of 5 ms a scan speed of 2 minutes per meter can be achieved. The image coverage in cross-core direction is appr. 13 cm and in down-core direction maximum 155 cm.

Launch Program

The Line Scan Program appears like this:
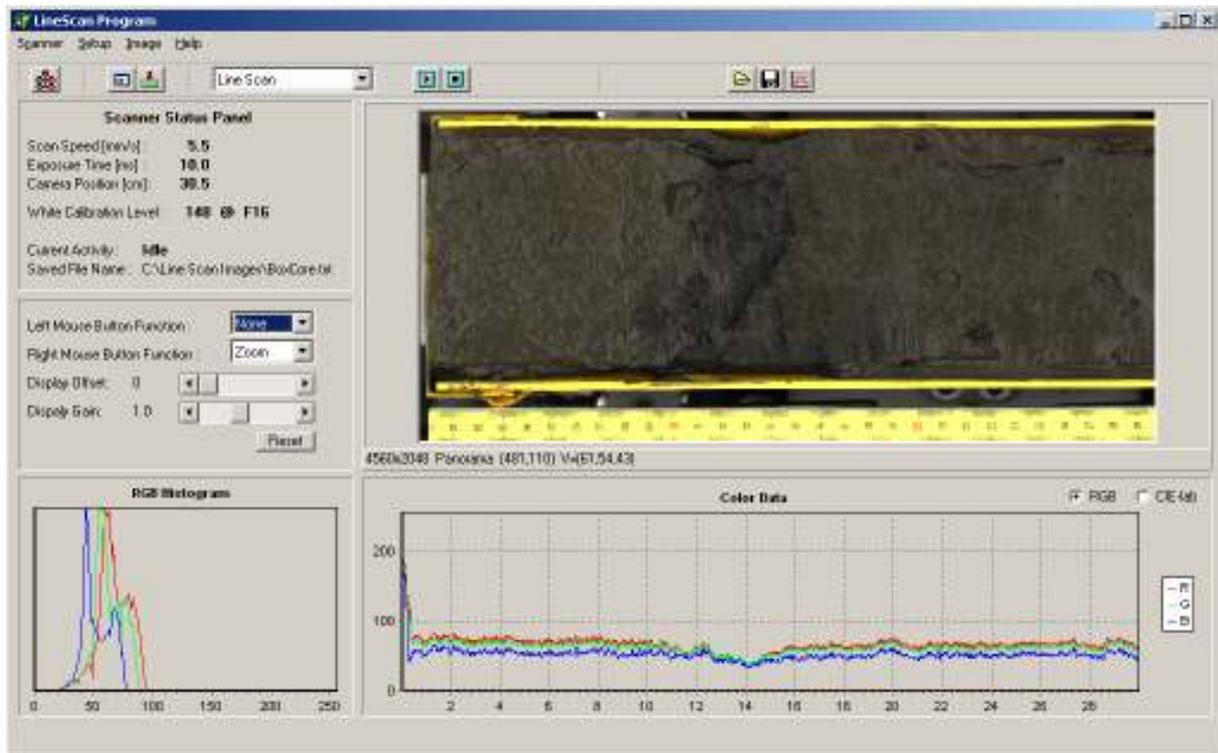
At the top of the window there is a menu and an application toolbar. On the left there are three panels. The upper panel shows the status of the camera system. The middle panel contains various mouse functions and image display controls. The lower panel shows the distribution of pixel intensities of a selected area of the image.
The biggest panel is the image panel. With various left and right mouse button functions the image can magnified and scrolled in the image panel.
The lowest panel shows the color data in RGB or CIE-lab units.
An specific area can be selected on the image panel. The color data and RGB histograms are calculated from this area. Color data is obtained by averaging pixels in cross-core direction.

User Interface

The commonly used controls are located on the application toolbar.
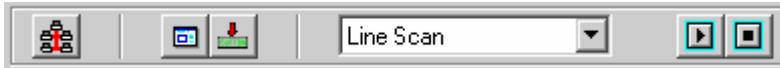
The XRF Core Scanner must be switched on and operate in Remote mode. The Line Scan Program will connect to the camera and scanner by clicking the button.

The connection screen will appear.
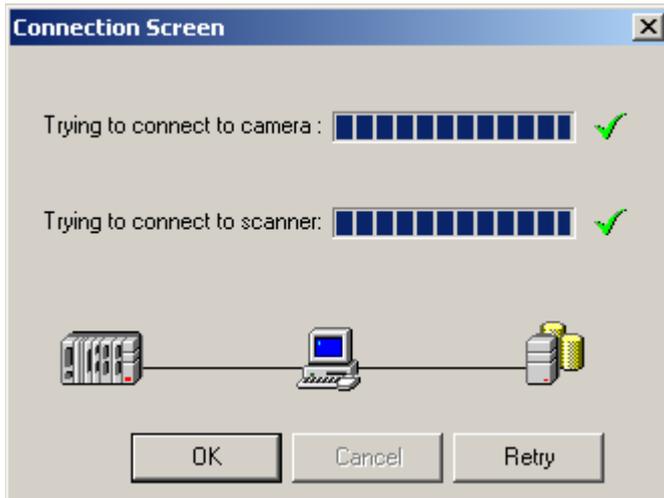
When the connection has been established the remaining toolbar buttons become active. The instrument settings button opens a window that contains the instrument related settings and the measurement setup button opens a window that contains the measurement related settings like sample name and length.

The scan mode selector offers a choice between a Line Scan, Quick Scan, Focus Scan, Black Calibration and White Calibration.

Both start and stop buttons controls the selected scan or calibration action.

The Scanner Status Panel shows the actual system settings.
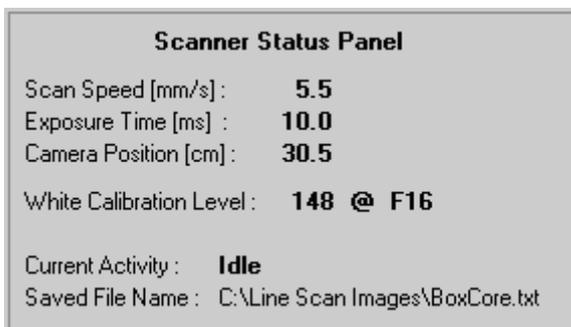
The Scan Speed depends on the camera Exposure Time and the down-core image resolution. The Camera Position is the actual position of the camera. The White

Calibration Level indicates the level [0…255] to whom the three primary colors (RGB) are adjusted after the last white calibration on the calibration tile. It can be used to monitor the long-term behavior of the camera and light source.

Mouse button behavior and image display settings can be controlled from the panel :
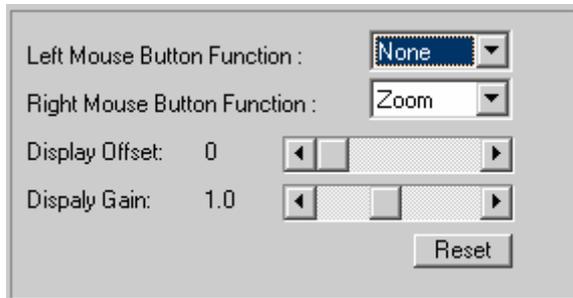
The left mouse button functions are :   None, Rubber, Frame, Area
The right mouse button functions are :   None, Zoom, Menu

The display offset and gain can be adjusted to manipulate the image on the display. These adjustments are only applied to the display and NOT to the image file. The image file can never be changed by these controls.
The reset button restores the original display settings.

The color histogram panel is a very useful tool to observe the intensity of the three primary colors. Peaks on the left-hand side indicates low intensity values, peaks on the right-hand side indicates high intensity values. If peaks reach the 255 value it means that pixels are over-exposed and that a smaller aperture (higher aperture number) should be chosen.
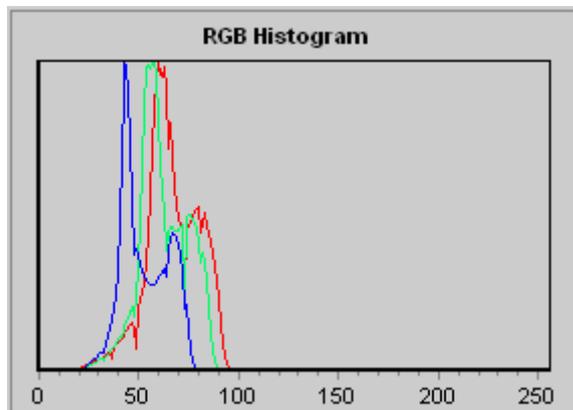
If the left mouse button function is set to Frame, a frame can be drawn on the image. The color histograms are then calculated from that part of the image.

Color data can be calculated from the color image. With the left mouse button a frame can be drawn on the image. The color data are calculated from that part of the image only. All pixels in cross-core direction for each primary color are averaged and plotted for each individual down-core position.
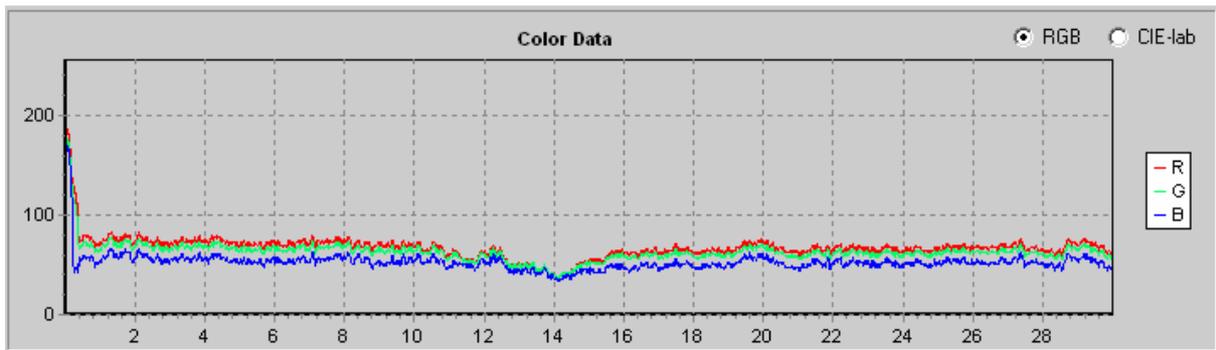
The color data that is automaticaly calculated at the end of a line scan is based on that part of the sample that is used for XRF analysis. The exact pixel numbers in cross-core and down-core direction can be adjusted on the Instrument Settings screen.
The RGB color data can be transformed to the CIE-lab color space by clicking the CIE-lab button.

Instrument Settings

The instrument settings are divided into four categories and are accessible by clicking the corresponding tab.
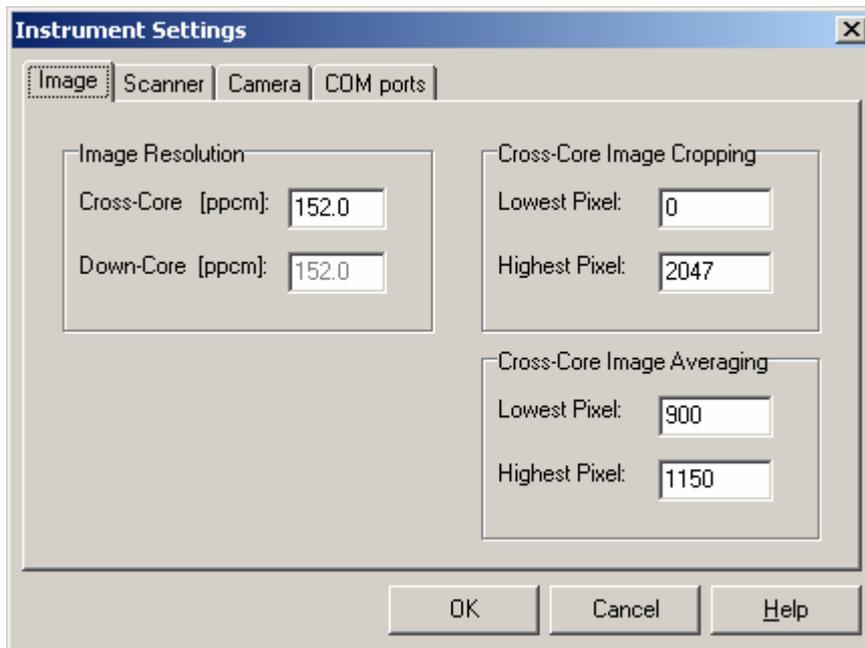
In order to know the exact size of the details on the image it is necessary to know the cross-core image resolution. The height of the camera above the sample and the lens type are important factors.
The best way to measure the image resolution is to scan an object with known sizes.
The down-core resolution can not be adjusted on this tab. Since the camera is a line scan type the down-core resolution is controlled by the scanner movement and therefore adjustable on the Scanner tab.
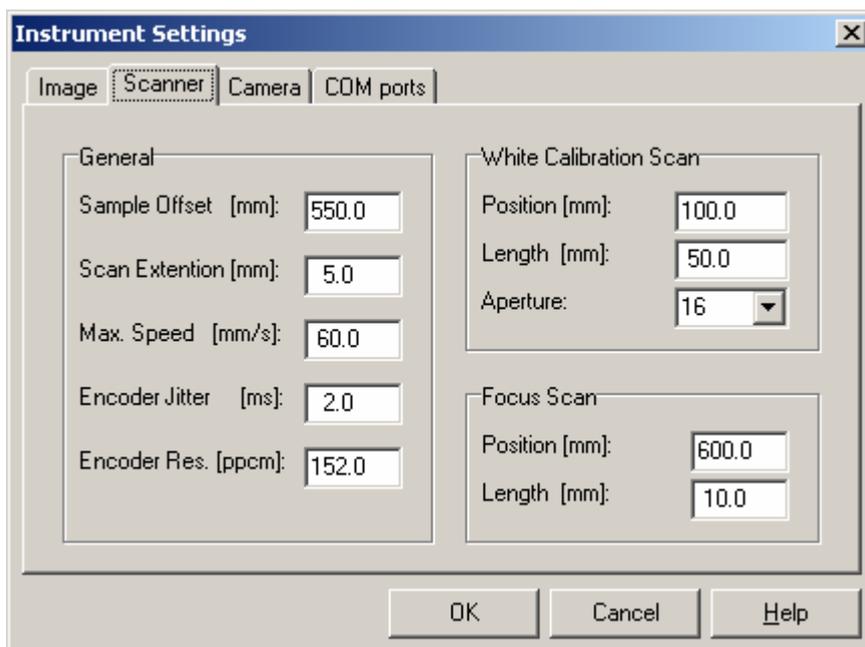
A general scanner setting is Sample Offset. This is the distance between the homing switch and the location where the sample is located. Before each line scan the camera and light source are positioned at this location.

The Scan Extension is the distance that is added to the scan length to avoid producing images with missing lines. Max. Speed is the maximum scanner speed of the scanner and should never be changed. Encoder Jitter is a time that is added to the camera exposure time before calculating the correct scan speed. This is to be sure that each line exposure has ended before reaching the next position.

The Encoder Resolution is known for each individual scanner and should never be changed. This setting corresponds with the down-core image resolution.

The following settings control the white calibration of the camera system. Position is the location where the white calibration starts on the white tile. Length is the distance the camera moves over the white tile during the calibration, to avoid that dust particles disturb the white calibration. Since the lens has a manually controlled aperture the user will be remembered at the start of a white calibration to set the aperture to the Aperture value on this tab.

In order to set the manual focus of the lens a focus scan can be applied. During a focus scan the camera and light source are positioned to location Position and continuously lines will be acquired of this same position. It is recommended to put an object on this location with strong contrast in cross-core direction.
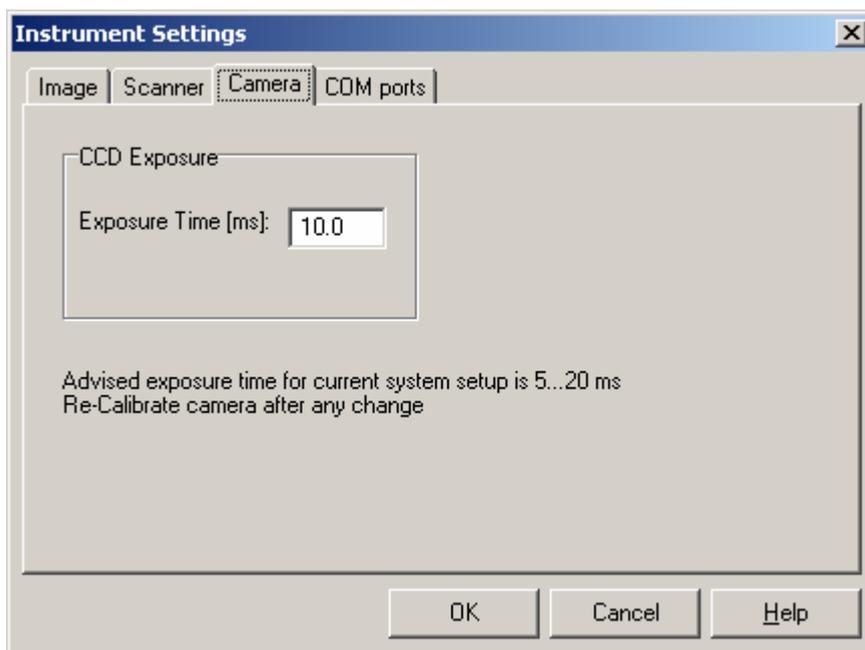
On the camera tab the camera Exposure Time can be set. The exposure time for each line is a critical parameter that controls the actual scan speed and the required aperture setting and therefore the field of depth.

The scanner is connected to the personal computer with a RS232 serial port. The Line Scan Program needs to know which serial is used for the connection. The only important port is the Scanner port. The Camera port is not used.
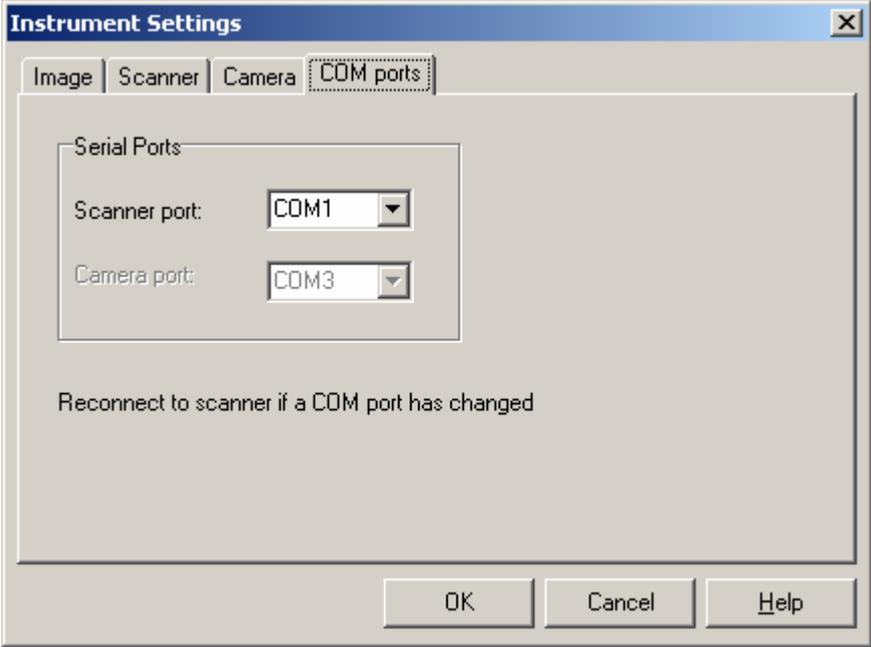
Measurement Setup

The basic sample related parameters are Sample Name and Sample Length. The sample name is also used as file name of the image. The Data Directory is the location where the image and color data files are stored.
Image files can be stored as BMP, TIF and JPG. Color data file are stored as comma separated ASCII files with a TXT file extension.
The Lens Aperture setting should correspond with the actual used aperture value. The setting selected on this screen however is only used for archiving in the color data file.
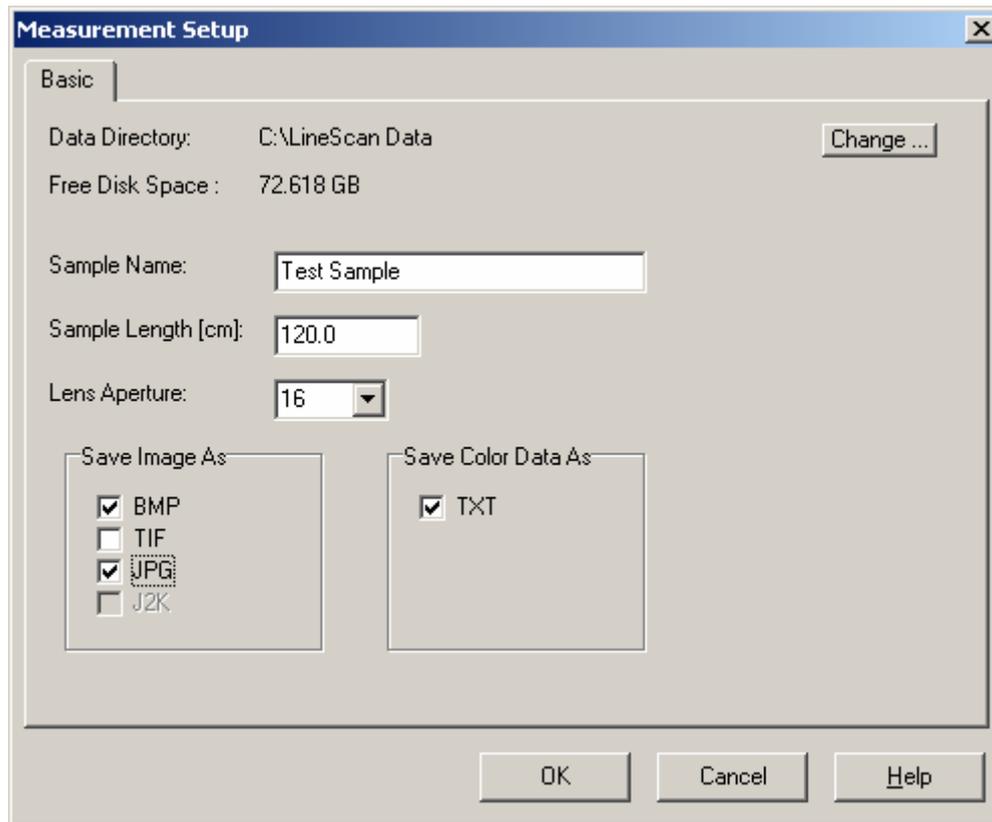
A color data file can easy be imported in MS Excel. Position, RGB and CIE-lab data becomes available. Also the down-core and cross-core image resolution as well as the pixel coordinates of the image area from which the color data was taken are available. Pixel (0,0) is the upper-left pixel of the image.

How to …   Switch on the camera system

The MAIN Switch should be switched to position "ON". Wait some seconds and press the RESET EMERGENCY STOP button. The scanner and line scan camera are now powered. Press the LIGHT CAMERA button to activate the linear light source.
Both line scan camera and linear light source should be powered at least 15 minutes before they are stabilized and ready for use.

Be sure that the scanner is set to "REMOTE" control.
This can be done at the Main Menu screen on the touch panel.
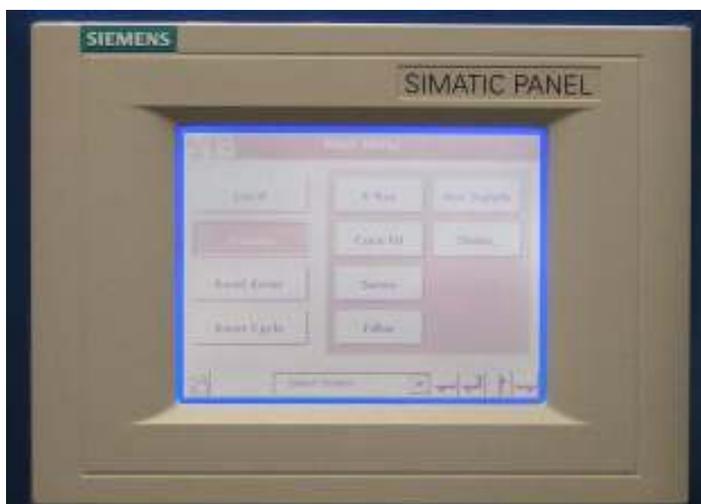
How to ...   Connect to camera system

Switch on the scanner and linear light source.

Start the Line Scan Program and press the 🔲 button.

The connection screen will appear.
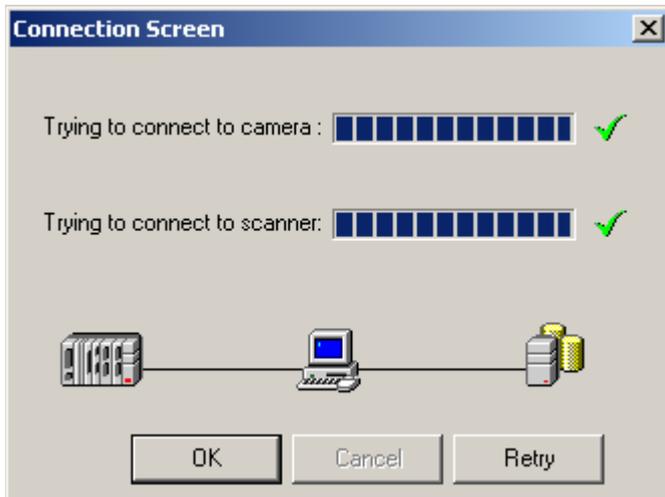
When the connection has been established the remaining toolbar buttons become active.

How to …   Start a Quick Scan

Scanner and linear light source should be switched on.
The Line Scan Program should be "connected" to activate the toolbar buttons.

Open the measurement setup screen by clicking the ![button] button.
Fill in an appropriate Sample Length.

Select a Quick Scan with the scan mode selector and press the ![button] button.
A Quick Scan will perform a line scan at maximum scan speed in order to check the
correct camera lens aperture setting for this sample.
The aspect-ratio of the image will be incorrect. The obtained image will not be saved on
the computer.
In order to check the aperture setting draw a frame on the image of the area of interest
with the left mouse button.
Observe the histogram graphs to check for correct light intensity distribution.
Repeat a Quick Scan with different aperture settings to find the correct setting.
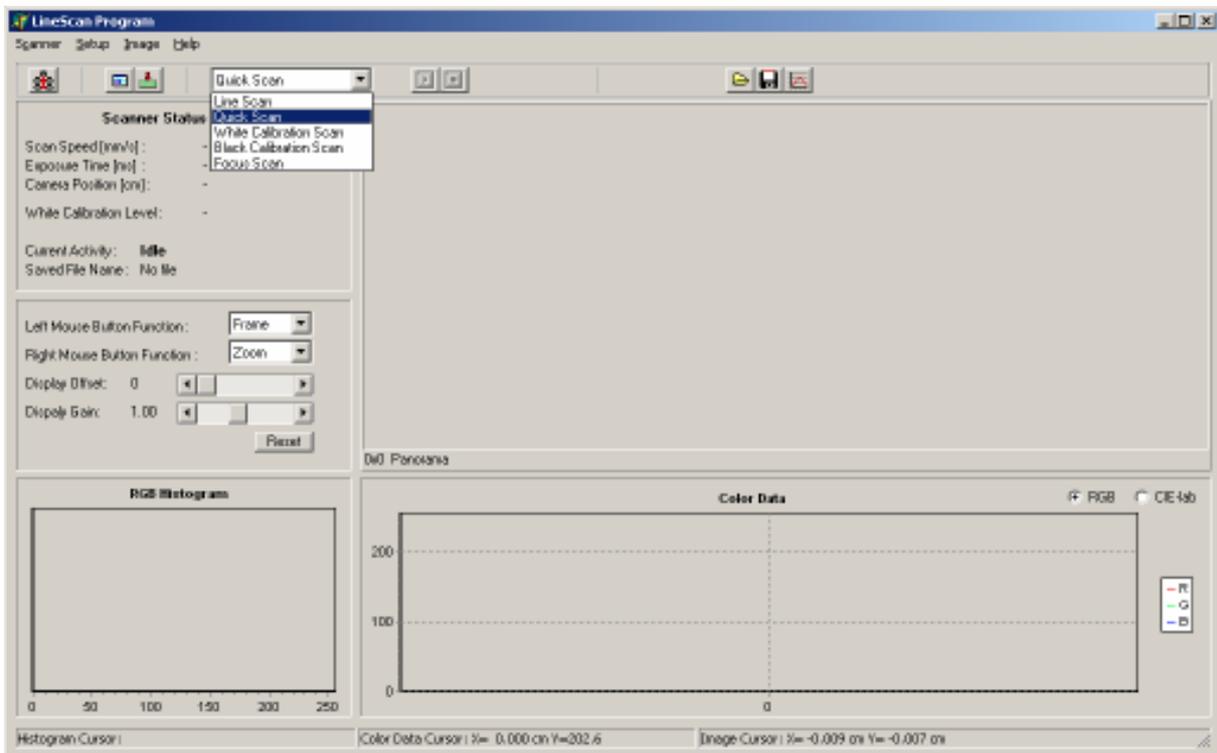
How to …   Start a Line Scan

Scanner and linear light source should be switched on.
The Line Scan Program should be "connected" to activate the toolbar buttons.

Open the measurement setup screen by clicking the [button image] button.
Fill in an appropriate Data Directory, Sample Name, Sample Length and Lens Aperture.
Select the desired image formats.
Be sure the actual aperture corresponds with the Lens Aperture setting on this screen.

Select a Line Scan with the scan mode selector and press the [button image] button.

During the Line Scan the image will appear at the image display panel. At the end of the scan the image will be saved to the Data Directory.
Color data will be calculated from that part of the sample that is used for XRF analysis.
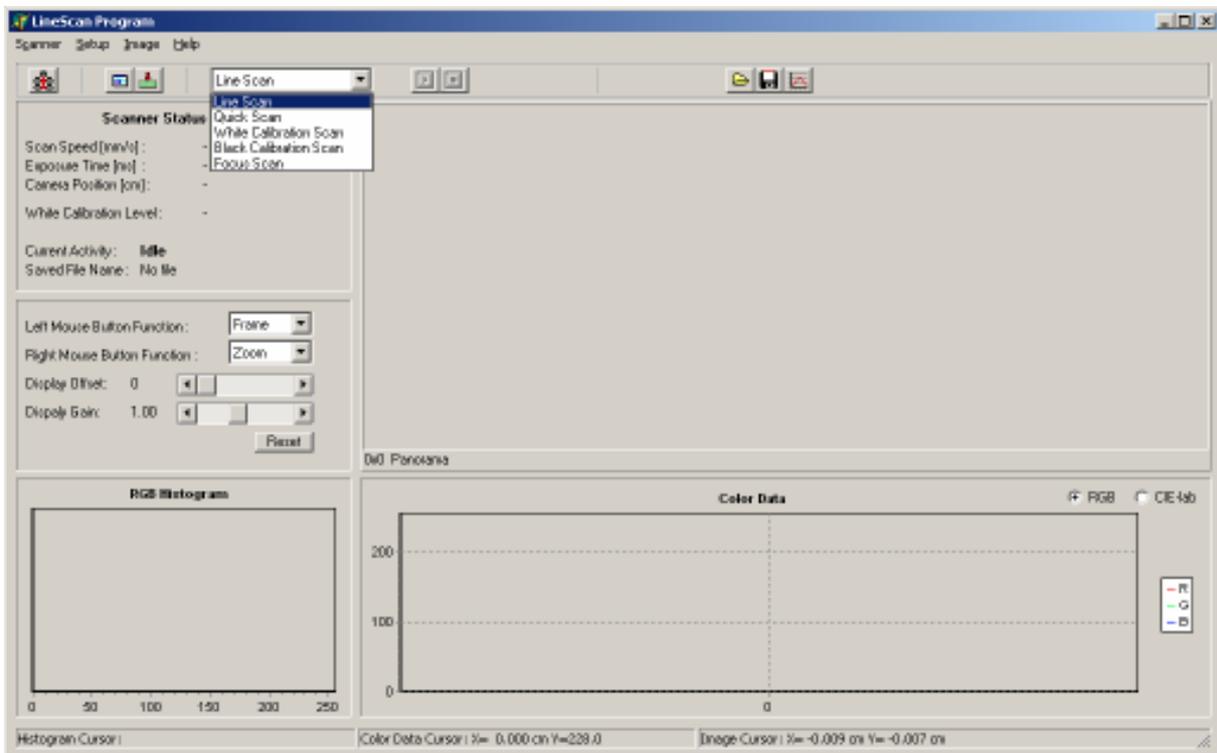
How to ...   Start a White Calibration Scan

Scanner and linear light source should be switched on.
Wait at least 15 minutes to stabilize.
The Line Scan Program should be "connected" to activate the toolbar buttons.

Select a White Calibration Scan with the scan mode selector and press the [▶] button.

A message will be shown that the lens aperture should be set at a certain white calibration position, usually 16. Click OK to start the White Calibration Scan.

A part of the white calibration tile will be scanned. To avoid disturbance from dust particles on the calibration tile all pixels in down-core direction are averaged. Each individual CCD pixel will be calibrated to the dominant light intensity. The value of this light intensity is shown at the Scanner Status Panel and be used as a reference of the long-term stability of camera and linear light source combination.
All the individual pixel calibration coefficients are stored and used during all following line scans until a new White Calibration Scan is performed.
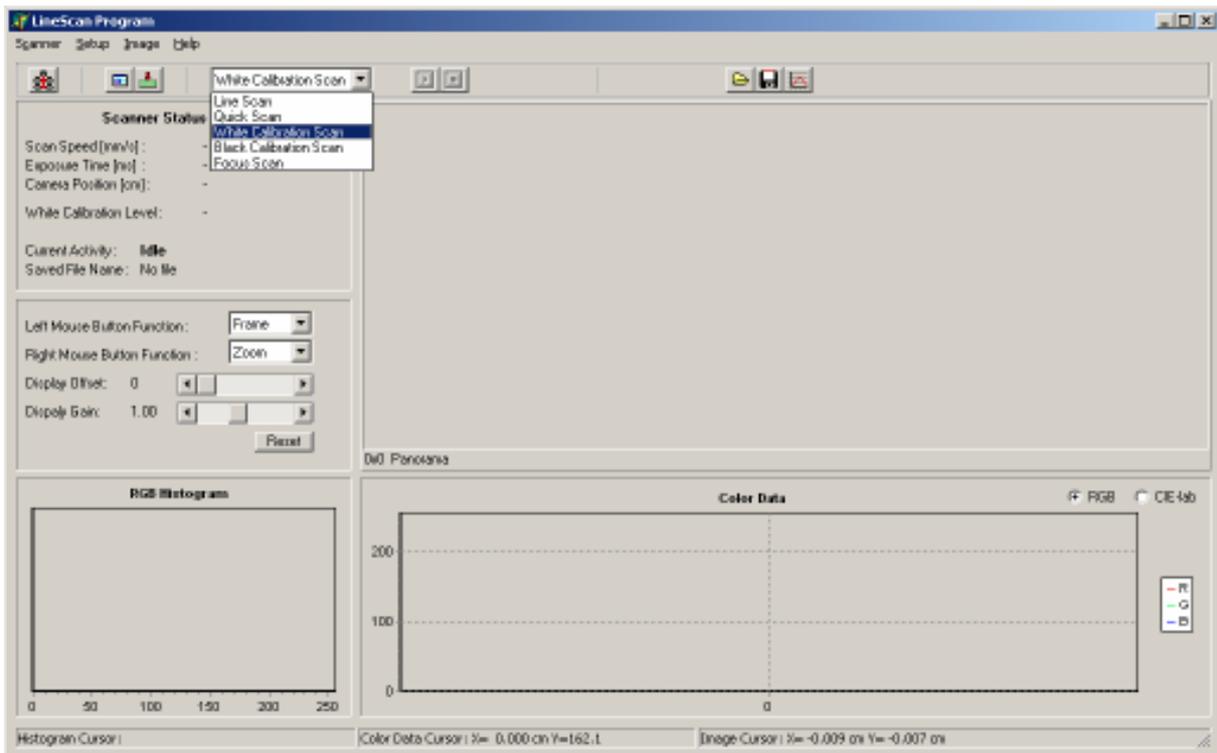
How to ...   Start a Black Calibration Scan

Scanner and linear light source should be switched on.
Wait at least 15 minutes to stabilize.
The Line Scan Program should be "connected" to activate the toolbar buttons.

Select a Black Calibration Scan with the scan mode selector and press the ▶ button.

A message will be shown that the lens cap should be installed on the lens. Click OK to start the Black Calibration Scan.

Some black lines will be scanned and averaged in down-core direction. The black level of each individual CCD pixel will be measured and saved and used during all following line scans until a new Black Calibration Scan is performed.
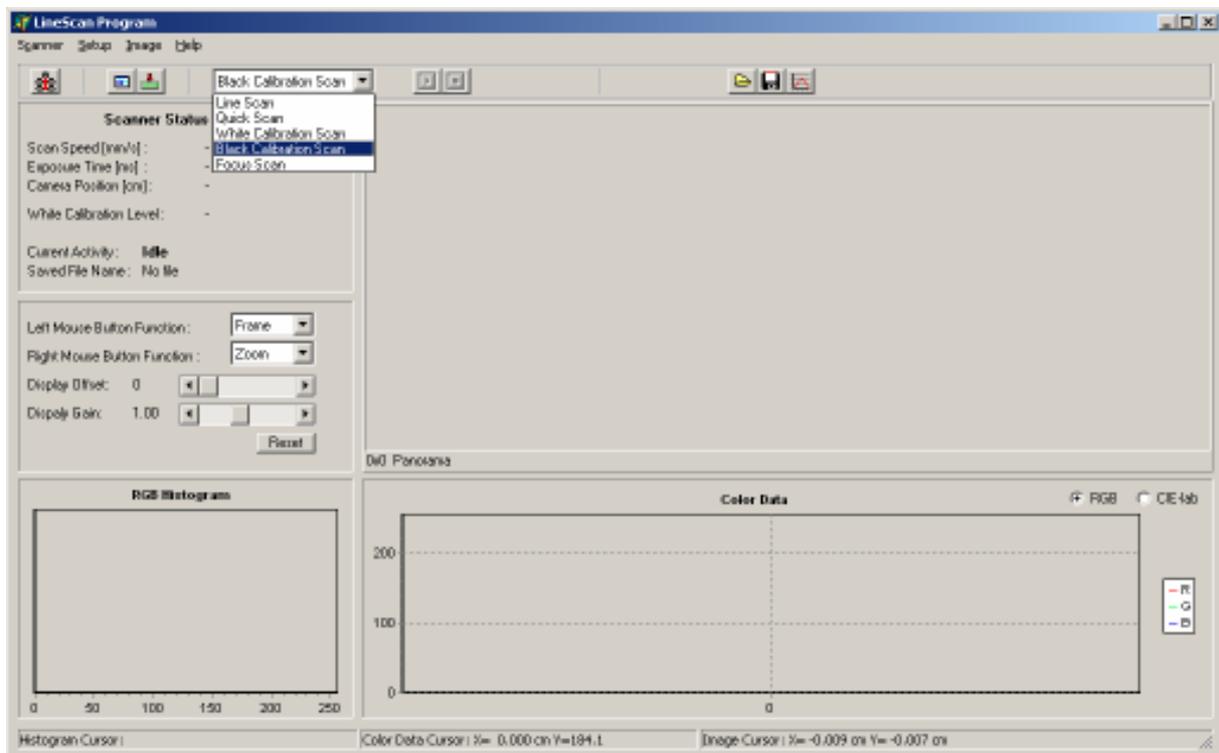
How to … Start a Focus Scan

Scanner and linear light source should be switched on.
Wait at least 15 minutes to stabilize.
The Line Scan Program should be "connected" to activate the toolbar buttons.

Select a Focus Scan with the scan mode selector and press the [▶] button.

During a focus scan the camera and light source are positioned at a specific position and continuously lines will be acquired and displayed on the image display panel. It is recommended to put an object on this location with strong contrast in cross-core direction.
Manually adjust the focus ring of the lens until best results are obtained.
Always lock the focus ring by rotating the fixation screw clock-wise.

Press the [■] button to stop the Focus Scan.
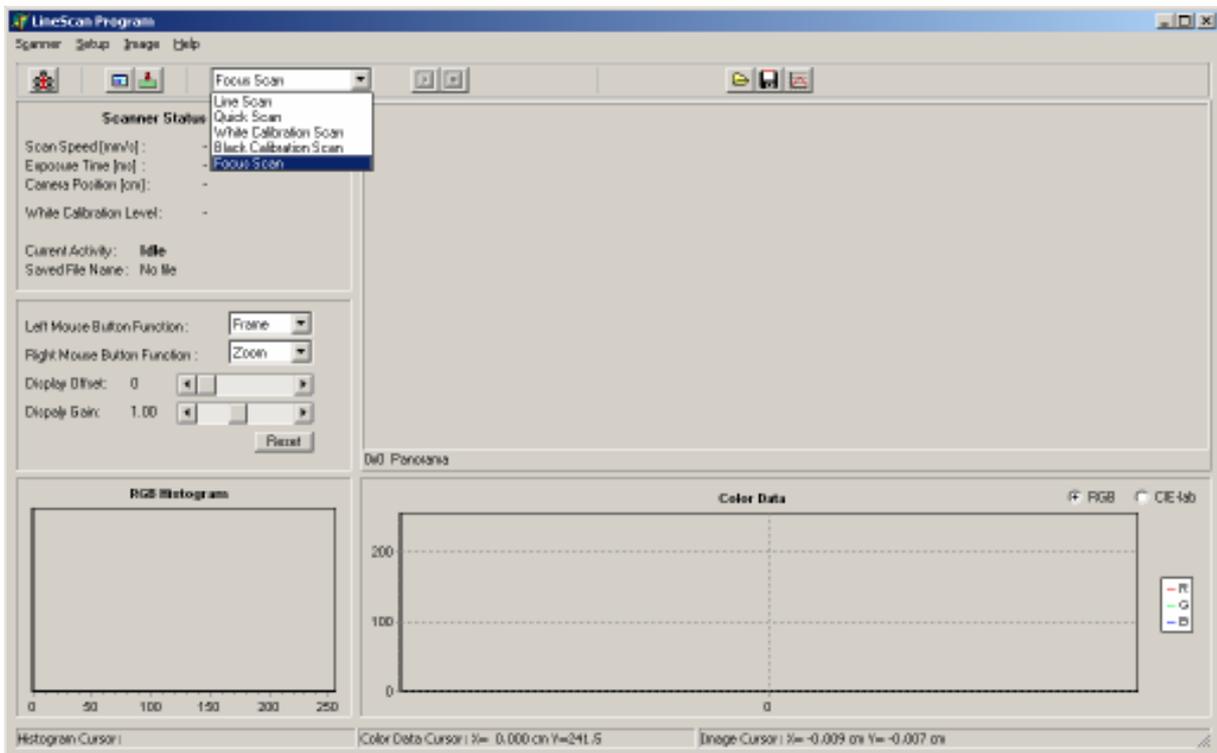
How to …   Calculate color data from specific image area

Perform a Line Scan to acquire a new image or open an existing image from the computer by clicking the [icon] button.

Draw a frame on the image of the area of interest with the left mouse button. Color data will be calculated and displayed on the screen. The color data can be displayed in RGB or CIE-lab color space.

To save the color data to a comma separated ASCII file press the [icon] button.
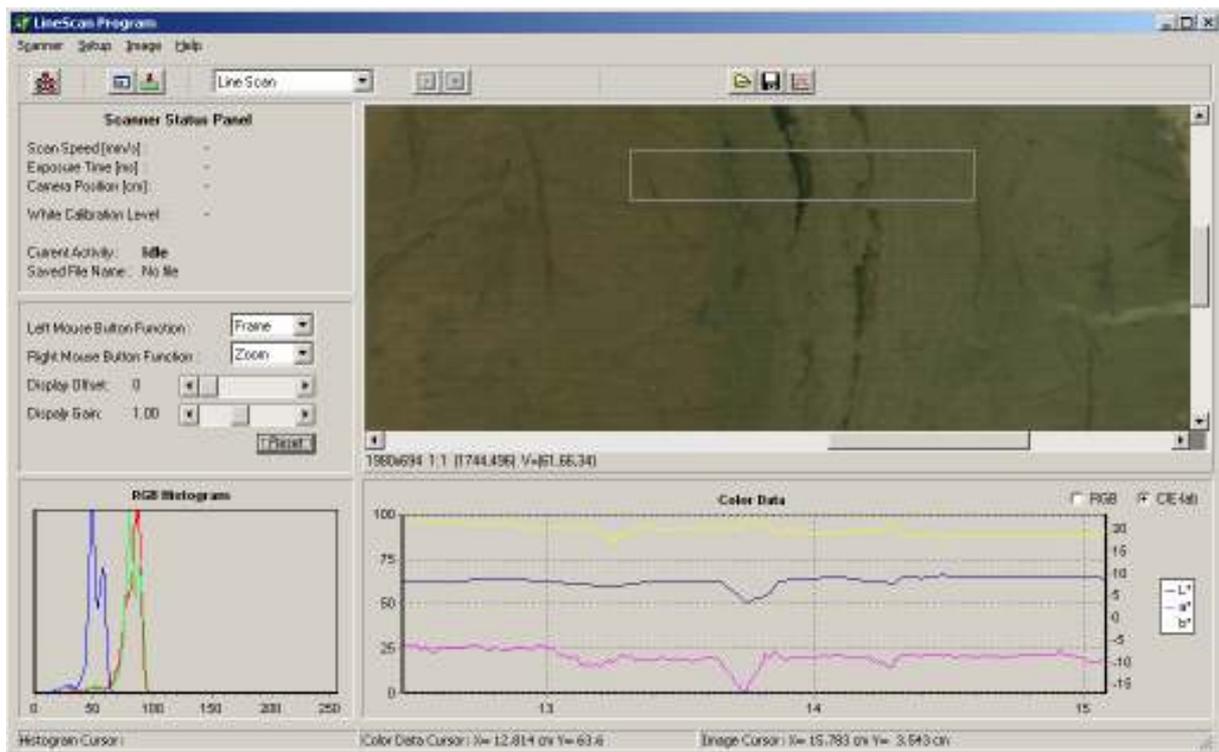
How to ...   Reset a scanner error on the touch screen

If any serious failure in the scanner is detected like emergency stop, low air-pressure etc.
the system stopped and an error symbol at the top of the touch screen will appear.
When the cause of the error has been found and eliminated the system should be re-
activated again.
To recover from an emergency stop pull the red emergency stop button out and press
the blue RESET EMERGENCY STOP button.

In any case press always the RESET ERROR and RESET CYCLE buttons at the touch
screen. These buttons are available on the Main Menu Screen.
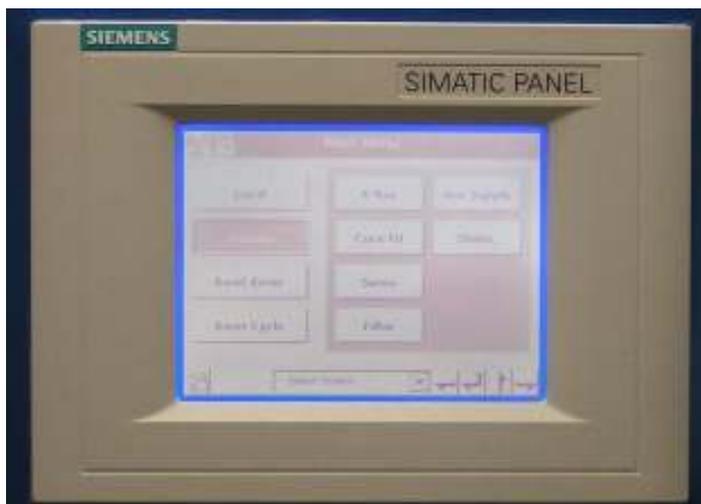
Specifications

Camera system :

Jai 3CCD High Speed Color Line Scan Camera CV-L107
-   3x 2048 line scan sensors mounted on a RGB prism
-   Operating temperature -5 to +45 C
-   Wavelengths: Red: 630nm, Green: 535nm, Blue: 450nm
-   RS-232 controlled setup functions

Cosmicar YF5028 50mm F2.8-22 Manual lens, Nikon mount

Dalsa-Coreco X64-CL-iPro Line scan frame grabber, PCI board

Linear Light Source :

2x Osram Dulux-L, Lumilux de Luxe, 4000 K, 940, 36 Watt, 1900 Lumen
1x Osram High Frequency Ballast, Quicktronic Multiwatt QTM-2-2632

System Specification:

Scan Speed:	up to 2 minutes per meter @ 5ms shutter time
Image Resolution:	± 150 pixels per cm, in cross-core and down-core direction
Color Sampling:	8 bits
Image Coverage:	13cm cross-core, 155cm down-core
White Calibration:	individual pixel calibration on white reference tile