Document Name:	***Machine Calibration & Maintenance***
Document ID:	FLN-79056-TI
WISE:	***xxxxxA***

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File Name:	FLN-79056-TI				
				REV.	*A*

Machine Calibration and Maintenance

Documentation Control

REV.	*Description*	*E.C.O*	*Date*	*Written*	*Author*	*Approv.*
A	*Product Release*					

25.11.2005	Advanced Brightness Adjustment for integration and service with additional camera saturation check.
9.12.2005	Additional Integration Tests for setting up the machine.
14.12.2005	New function for the 'Flash Gauss Test' to trace the brightness of the flashes over a long period.
10.05.2006	Service and Maintenance Panel: new/changed functions Added new function to 'Target Selection/Center Cross' Camera Alignment: changed instruction Line Projector Alignment: New measurements added Report Generator: New functions added Maintenance intervals changed Grid: Added new calibration height check Adapter Calibration: Reference Width Setup removed New Hardware Wizard

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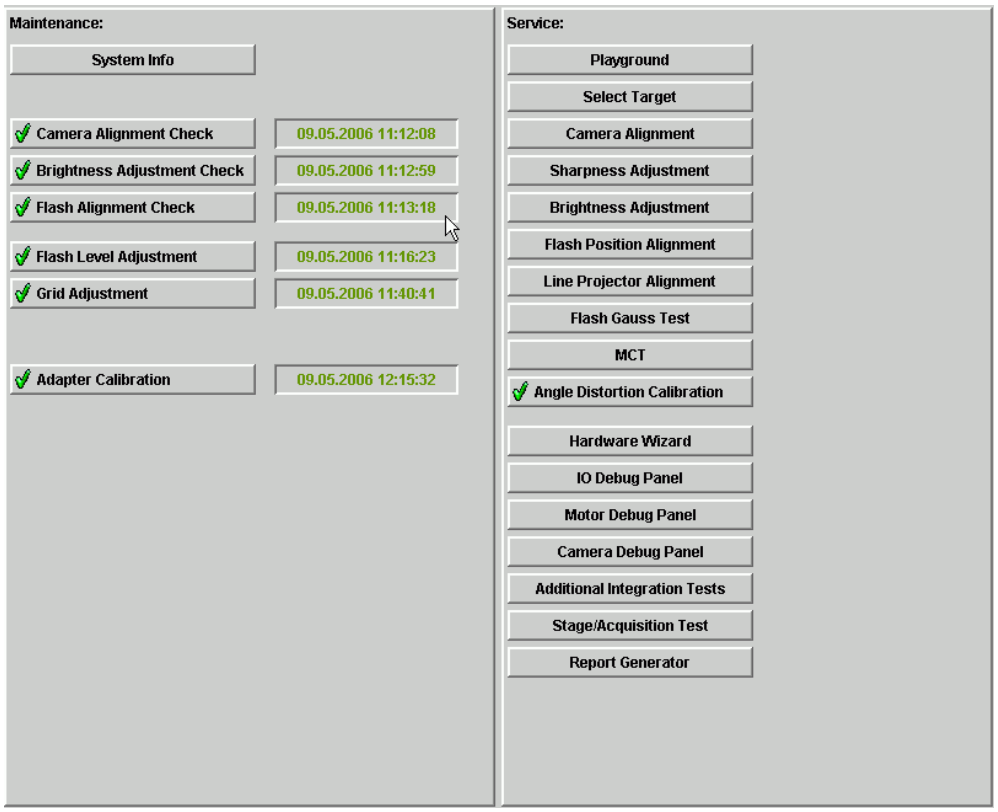
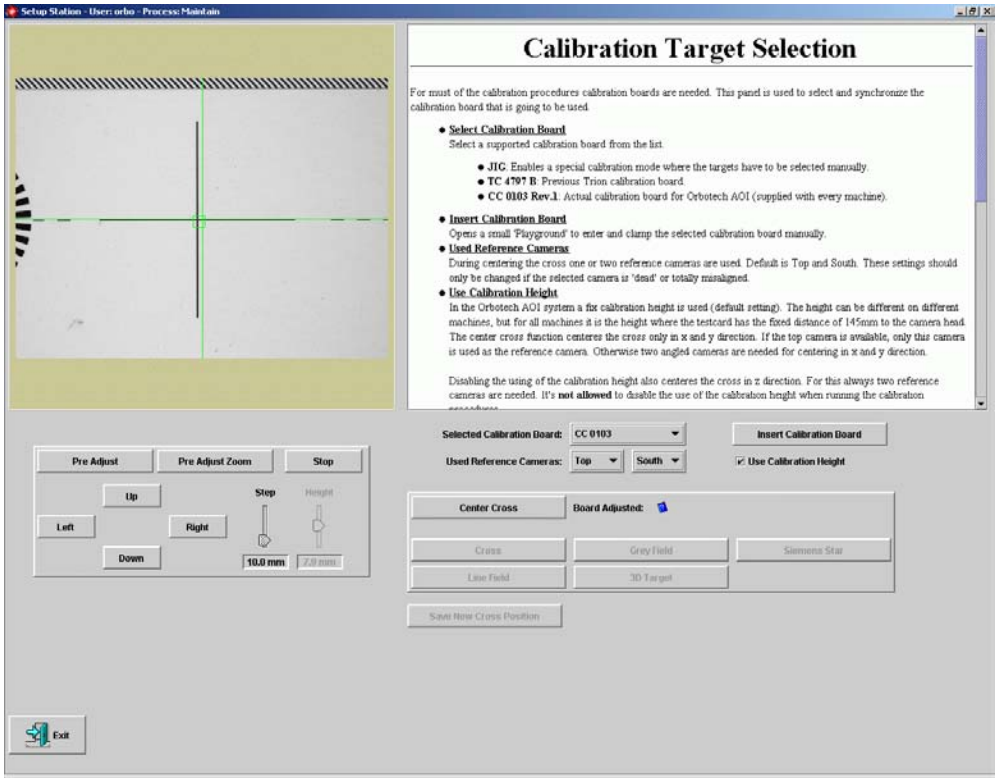
1 Service and Maintenance Panel



1.1 Service Tools

This panel contains calibration and test panels for more experienced persons.

1.1.1 Calibration Target Selection



For most of the calibration procedures calibration boards are needed. This panel is used to select and synchronize the calibration board that is going to be used.

- **<u>Select Calibration Board</u>**
  Select a supported calibration board from the list.
  - **JIG**: Enables a special calibration mode where the targets have to be selected manually.
  - **TC 4797 B**: Previous Trion calibration board.
  - **CC 0103 Rev.1**: Current calibration board for Symbion S3x (supplied with every machine).
- **<u>Insert Calibration Board</u>**
  Opens a small 'Playground' to enter and clamp the selected calibration board manually.
- **<u>Used Reference Cameras</u>**
  While centering the cross, one or two reference cameras are used. Default is Top and South. These settings should only be changed if the selected camera is 'dead' or totally misaligned.

- **Use Calibration Height**
  In a Symbion system, a fix calibration height is used (default setting). The height can be different on different machines, but for all machines it is the height where the test card has the fixed distance of 145mm to the camera head. The centre cross function centres the cross only in x and y direction. If the top camera is available, only this camera is used as the reference camera. Otherwise two angled cameras are needed for centring in x and y direction.

  Disabling the use of the calibration height also centres the cross in z direction. For this two reference cameras are always needed. It is **not permitted** to disable the use of the calibration height when running the calibration procedures.

  Pre-Adjustment of the calibration board.

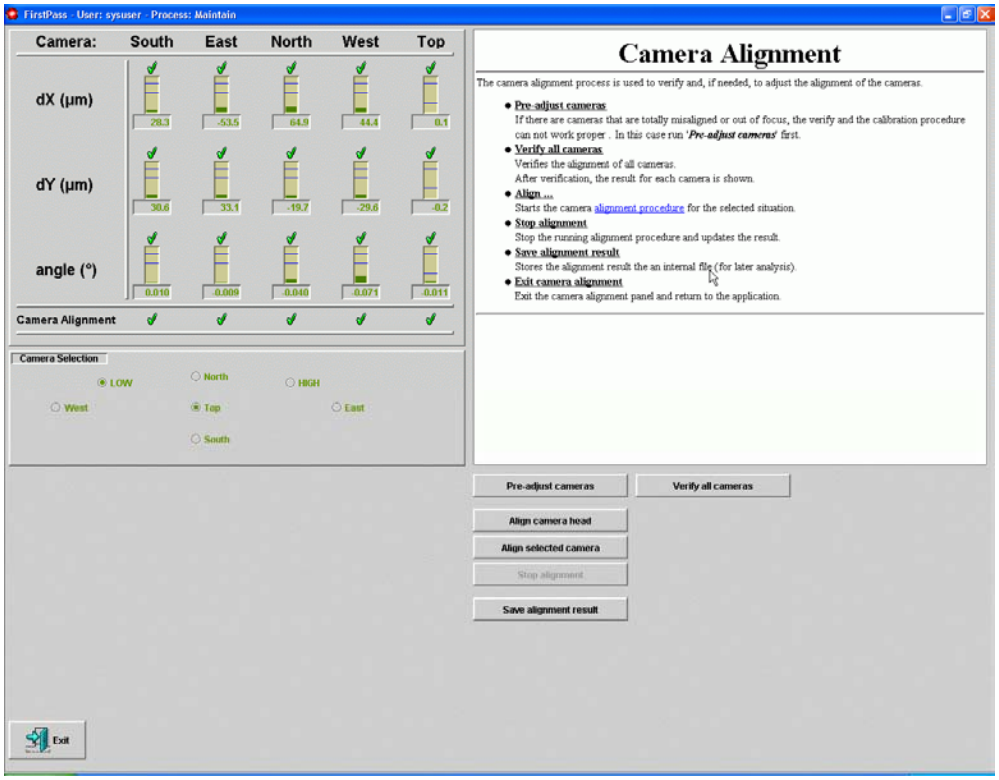
  - **Pre Adjust**
    Starts the normal pre-adjustment mode (without zoom). The window will be updated periodically. The movement buttons (***Up, Down, Left, Right***) can be used to roughly position the main calibration cross in the middle of the window.
  - **Pre Adjust Zoom**
    Starts the zoomed pre-adjustment mode. The window will be updated periodically. The movement buttons can be used to roughly position the main calibration cross in the middle of the zoomed window.
  - **Stop**
    Stops the pre-adjustment mode. The image will no longer be updated automatically.
  - **Step**
    With this, the step size of the stage can be changed (if needed) when using the movement buttons.
  - **Height**
    This function is available only when 'Use Calibration Height' is disabled.

  It is also possible to pre-adjust the board by clicking with the mouse to a point inside the displayed image. This point will be centred afterwards.

- **Center Cross**
  Starts the centre cross function. If the procedure finishes successfully the calibration board is adjusted and the 'Board Adjusted' icon appears ✓.
  Now the calibration procedures are able to run.
  After centring the cross, there is an additional new test that checks the orientation and order of the cameras.

- **Target Selection**
  Using the target selection buttons (***Cross, Grey Field, Siemens Star, Line Field***) different targets are can be displayed.
- **Save New Cross Position**
  If the calibration board is adjusted and the new centre position is different from the previous one, this button is enabled to save the new position. This is especially important for running the grid and flash calibration.
- **Exit**
  Closes the Target Selection menu and returns you to the main application.

1.1.2 Camera Alignment



To cut out the same field of view for each camera, the cameras have to be adjusted in a way that they look at the same point. The rough adjustment has to be done manually with the help of the Camera Alignment tool.
Later the fine-tuning is done automatically when the grid is performed.

1.1.2.1 Function Description

The camera alignment process is used to verify and, if needed, to adjust the alignment of the cameras.

- **Pre-adjust cameras**
  If there are cameras that are totally misaligned or out of focus, the verify- and calibration procedure cannot work properly. In this case, run '***Pre-adjust cameras***' first.
  Pre-adjust cameras tool displays an image of all 5 cameras. The images will be updated in a loop and you have a chance to pre-adjust the sharpness and the position of each camera.
- **Verify all cameras**
  Verifies the alignment of all cameras.
  After verification, the result for each camera is shown.

- **Align ...**
  Starts the camera alignment procedure for the selected situation.
  - **Align Top Camera**
    To adjust the angle and position of the top camera when using a JIG. The top camera is the reference camera. Changing the alignment and also changing the sharpness of the top camera will effect the alignment of all other cameras. After adjusting the alignment of the top camera it is recommended that you also adjust the sharpness of this camera, before going on with the alignment of the angled cameras.
  - **Align Camera Head**
    This function is used to align the angle of the camera head when assembling the head to the machine. The position can be ignored.
  - **Align selected camera**
    Use this function to adjust the angled cameras.
- **Stop alignment**
  Stops the alignment procedure and updates the result.
- **Save alignment result**
  Stores the alignment result to an internal file (for later analysis). The actual alignment result is stored automatically, so this function is only needed if you want to store additional alignment results.
- **Exit camera alignment**
  Exit the Camera Alignment panel and return to the application.

1.1.2.2 Alignment Procedure

Verify All Cameras shows if any camera needs to be aligned. Step by step all misaligned cameras have to be adjusted.
If a camera is totally misaligned or out of focus, run '***Pre-adjust cameras***' first.
With the **Camera Selection** panel you can choose a camera that you want to adjust. To start the alignment procedure press the corresponding '***Align ...***' button.

! When running the camera alignment on a machine the target cross will be moved to the edges of the cut out image (region of interest ROI). This is done to check if the cut out image is inside the (bigger) captured image, and this is also done to measure the real angle of the camera to the x-axis of the stage. A frame marks the cut out image. If the frame is green, the ROI is inside the captured image.
If it is red, the measurement failed because some edges of the cut out image are outside of the captured image. In this case the angle is not correct. The camera module has to be pre-adjusted as best as possible. When this is done, stop and start the alignment procedure again. Now it should be possible to measure the edges of the cut out image (the displayed frame must be green and also the measurement of the angle must be right). Finally adjust the camera module. !

After the calibration procedure is started, a display will appear showing the actual image from the selected camera. It also shows the alignment result.

- Horizontal Shift (µm)
- Vertical Shift (µm)
- Rotation (degree)

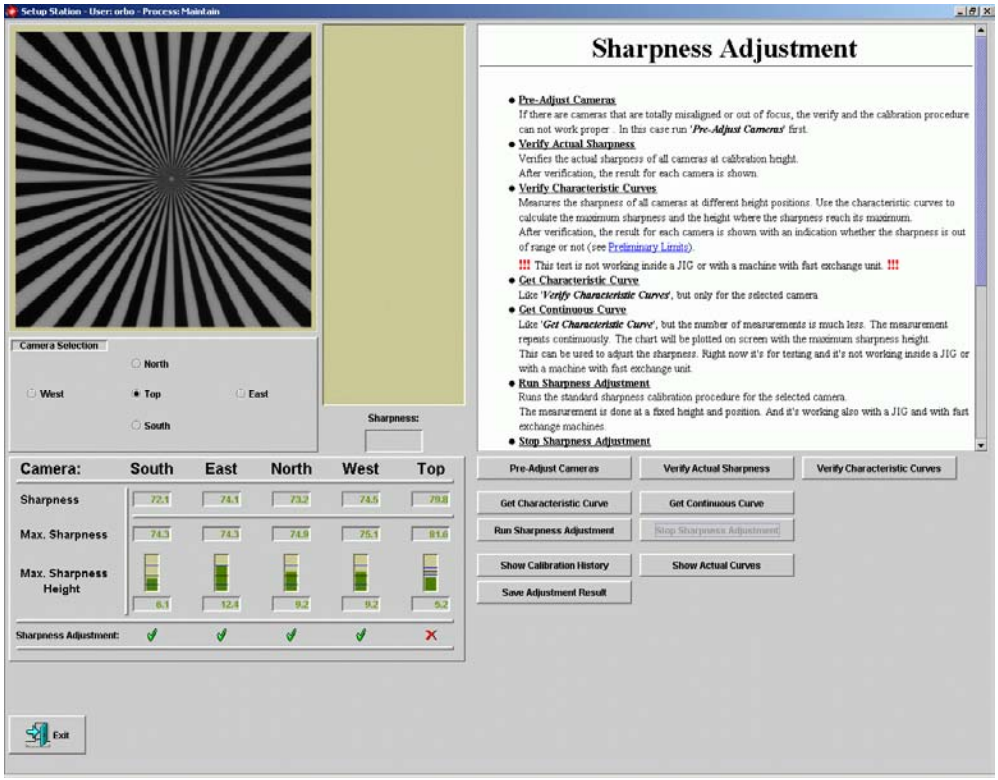
You will see some of the following Icons. These can be used to move and turn the camera module that you have to adjust.

If an alignment result is printed in **red**, this means it still needs to be adjusted. **Green** means the value is inside the Limits.
After you have finished your adjustment and the screws of the camera module are tight (and all values are **green**), press the 'spacebar' on the keyboard.
Choose the next camera for adjustment and repeat the described calibration steps.

1.1.2.3 **Limits** (preliminary)

	x shift	y shift	rotation
Calibration Angled:	**±200.0µm**	**±200.0µm**	**±0.200°**
Verification Angled:	**±300.0µm**	**±300.0µm**	**±0.300°**
Calibration Top:	**±100.0µm**	**±100.0µm**	**±0.100°**
Verification Top:	**±300.0µm**	**±300.0µm**	**±0.300°**

1.1.3 Sharpness Adjustment



Right now we have no algorithm for calculating absolute sharpness.
Our standard sharpness adjustment procedure (executed by 'Run Sharpness Adjustment') calculates a relative value. The objective is to adjust the sharpness in a way to achieve a maximum value. But because this value is very sensitive to fluctuations in the flashes, it is a little bit tricky to find the maximum.
Another disadvantage is that you don't know if you have the maximum sharpness until you touch the lens and change the focus.

If the calibration is done in a machine, we have some new functions for measuring the maximum sharpness height of the z-axis without changing the focus. These functions can be used to verify the sharpness more accurately. They can also be used to iteratively adjust the sharpness (change focus, verify height, change focus, verify height, change focus, verify height, and so on) until you get the maximum sharpness at zero height. But this procedure takes more time.

- **Pre-Adjust Cameras**
  If there are cameras that are totally misaligned or out of focus, the verify and the calibration procedure cannot work properly. In this case run '***Pre-Adjust Cameras***' first.

- **Verify Actual Sharpness**
  Verifies the actual sharpness of all cameras at calibration height.
  After verification, the result for each camera is shown.

  ! This value doesn't show if the sharpness is good or if it can be better.

- **Verify Characteristic Curves**
  Measures the sharpness of all cameras at different height positions. Use the characteristic curves to calculate the maximum sharpness and the height where the sharpness reach its maximum. After verification, the result for each camera is shown with an indication whether the sharpness is out of range or not.
  This measurement takes more time, but at the end you know if your cameras have a good sharpness without changing the focus.

  ! This test does not work inside a JIG or in a machine with a fast exchange unit fitted.

- **Get Characteristic Curve**
  Like '***Verify Characteristic Curves***', but only for the selected camera.

- **Get Continuous Curve**
  Similar to '***Get Characteristic Curve***', but the number of measurements is much less to get a faster result. The measurement repeats continuously. The chart will be plotted on screen with the maximum sharpness height.
  This can be used to adjust the sharpness while the test is running and updating the result, but at present it is only for testing and the result is not exact.

- **Run Sharpness Adjustment**
  Runs the standard sharpness calibration procedure for the selected camera.
  The measurement is done at a fixed height and position. It works also with a JIG and with fast exchange machines.
  After starting this function, it does some initialization steps and then starts to continuously measure and update the actual sharpness. The target is to achieve a maximum value by adjusting the focus.
  As an aid, the result is plotted on a graph that shows the actual sharpness (left bar) with a black line that captures the maximum sharpness and a zoom graph around the maximum (right bar).

  ! If the image becomes dark while you are adjusting the focus, maybe because your hand was placed in front of the lens, the measurement produces a wrong value and sets the maximum to 100%. In this case, stop the adjustment and start it again.

- **Stop Sharpness Adjustment**
  When you have finished the adjustment, press 'Stop Sharpness Adjustment'.
  While stopping, the contrast is recalibrated and the finally sharpness value is measured.

i It is also possible to switch to a different camera module during sharpness adjustment. In this case, stopping the actual measurement and starting the new one is done automatically.

! Don't switch to different camera module in quick succession. Each switching process takes some time and should not be interrupted.

- **Show Calibration History**
  Opens a panel with the previously stored sharpness calibration results from the machine and the actual ones. It is also possible to have a look at the characteristic curve of a camera if this information was gathered with '***Verify Characteristic Curves***' or '***Get Characteristic Curve***'.

- **Show Actual Curves**
  Opens a panel with the actual sharpness calibration results of the machine. It is possible to have a look at the characteristic curve of a camera if this information was gathered with '***Verify Characteristic Curves***' or '***Get Characteristic Curve***'.

- **Save Adjustment Result**
  Stores the sharpness adjustment result (not the characteristic curves) to the internal sharpness result history file. This is currently only for debugging.

- **Exit**
  Exit the sharpness adjustment panel and return to the application.

1.1.3.1 !!! Changed Sharpness Measurement !!!

1.1.3.1.1 Actual Situation

When running 'Verify Characteristic Curves' or 'Get Characteristic Curve' the actual sharpness is measured for different heights (the result can be verified with 'Show Actual Curves'). The target is to find the height where the sharpness reaches the maximum. Because of fluctuations in the sharpness measurement this is not that easy, especially if the procedure is running automatically.

To solve this problem, a mathematical approximation of the actual curve is calculated.

original sharpness curve
approximated curve

The approximated mathematical curve is used to calculate the z-axis height where we have the maximum sharpness. This is the result of the sharpness measurement that decides if the sharpness is inside the allowed limits or not.

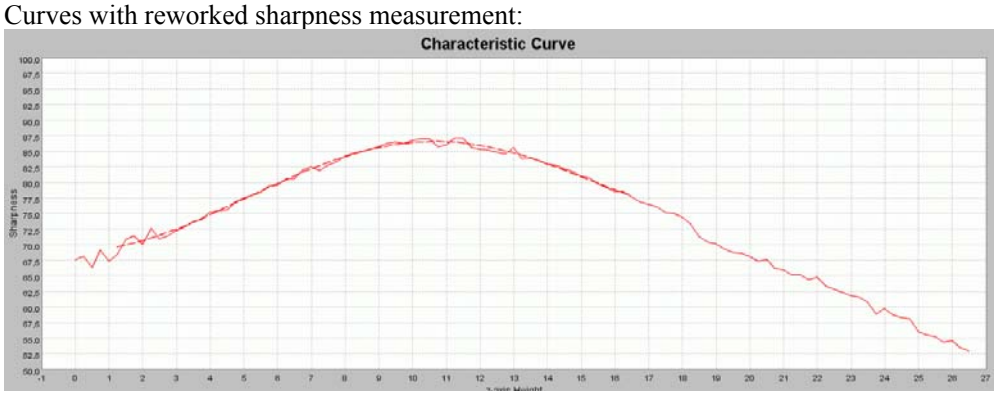
But as you see from the image above, the approximated curve is, as it is said, only an approximation to the original (and sometimes uneven) sharpness curve.
This leads sometimes to different results (see image above):

- The calculated max sharpness height from the example is **9.9** mm
- If the max sharpness height is manually defined from the original curve, it would be about **11.0** mm.

1.1.3.1.2 Changed Sharpness Measurement

Because of this difference between the original and the approximated curve, the sharpness measurement has been reworked.

Curves with reworked sharpness measurement:



Now the approximation is much better.
The calculated max. sharpness is now **10.67** mm.

! From Version 1.08 on, this new sharpness measurement is used because of the better approximation.

1.1.3.1.3 What does this mean for machines calibrated with the previous method?

Well, as we have seen the new sharpness result can be slightly different from the previous one because it is more accurate.
For cameras that are calibrated close to a limit or especially for the top camera with it's smaller limits, it is possible that they are now out of range with the new method.

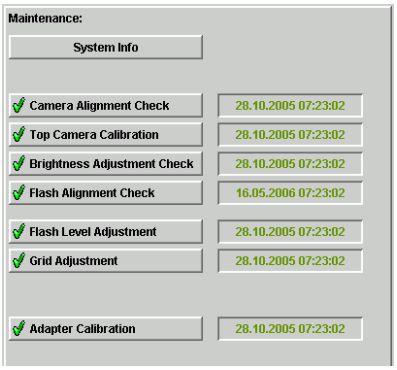
Camera:	South	East	North	West	Top
Sharpness	74.6	74.2	74.7	74.1	83.7
Max. Sharpness	74.7	74.5	74.7	74.1	85.3
Max. Sharpness Height	9.3	6.6	8.0	10.6	12.0
Sharpness Adjustment:	✓	✓	✓	✓	✗

In this case do not worry. Check the image quality first. Only if the image is not sharp do you need to recalibrate the machine. Otherwise it is recommended to wait with the calibration until there is time to do it (especially if the top camera is affected, because this can cause a recalibration of the camera alignment of the angled cameras).

Anyway, if there is any problem with this new sharpness measurement (e.g. the new sharpness is totally different from the previous one, or if the measured curves don't look reasonable), press the 'Save Adjustment Result' button after 'Verify Characteristic Curves' and send us the calibration results.

1.1.3.1.4 How to send the calibration results?

Before collecting the calibration result data, please verify all the calibration items in the Maintenance panel.



One additional step when you are checking the brightness the first time after using the new Version 1.08 or higher:
During 'Brightness Adjustment Check', **Run** the brightness adjustment, even if the brightness values are alright. This will store additional information in the calibration result history.

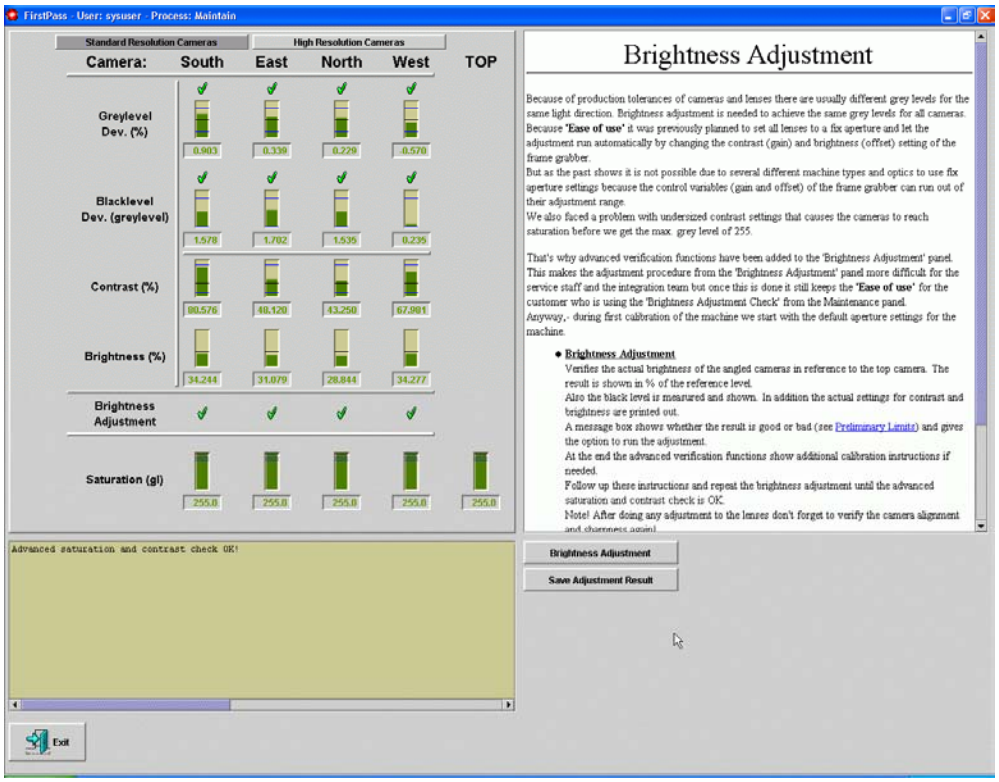
Finally, you need to generate the DiagnosticInfo.zip file that includes the calibration result (go to the panel 'Report Generator' and press the button 'Collect Diagnostic Information'), and send us this file.
Additional information about the 'Report Generator' and how to generate the DiagnosticInfo.zip file and where to find it, you can find here.

1.1.3.2 Limits (preliminary)

The maximum sharpness height should be close to the calibration height (zero height) ± a specified range.

Angled Cameras:	**±5.0mm**
Top Camera:	**±1.5mm**

1.1.4 Brightness Adjustment



Because of production tolerances of cameras and lenses, there are usually different grey levels for the same light direction. Brightness adjustment is needed to achieve the same grey levels for all cameras.
For **'Ease of use'** it was previously planned to set all lenses to a fixed aperture and let the adjustment routine run automatically by changing the contrast (gain) and brightness (offset) setting of the frame grabber.
But from past experience, this is not possible due to the several different system types and optics. Fixed aperture settings cannot be used because the control variables (gain and offset) from the frame grabber can exceed their adjustment range.
We also faced a problem with contrast settings fallen below that caused the cameras to reach saturation before we got the max. grey level of 255.

This is why advanced verification functions have been added to the 'Brightness Adjustment' panel.
This makes the adjustment procedure from the 'Brightness Adjustment' panel more difficult for the service staff and the integration team. But once this is done, **'Ease of use'** is maintained for the customer who uses the 'Brightness Adjustment Check' from the Maintenance panel.

Anyway, during the first calibration of the machine we start with the default aperture settings for the machine.

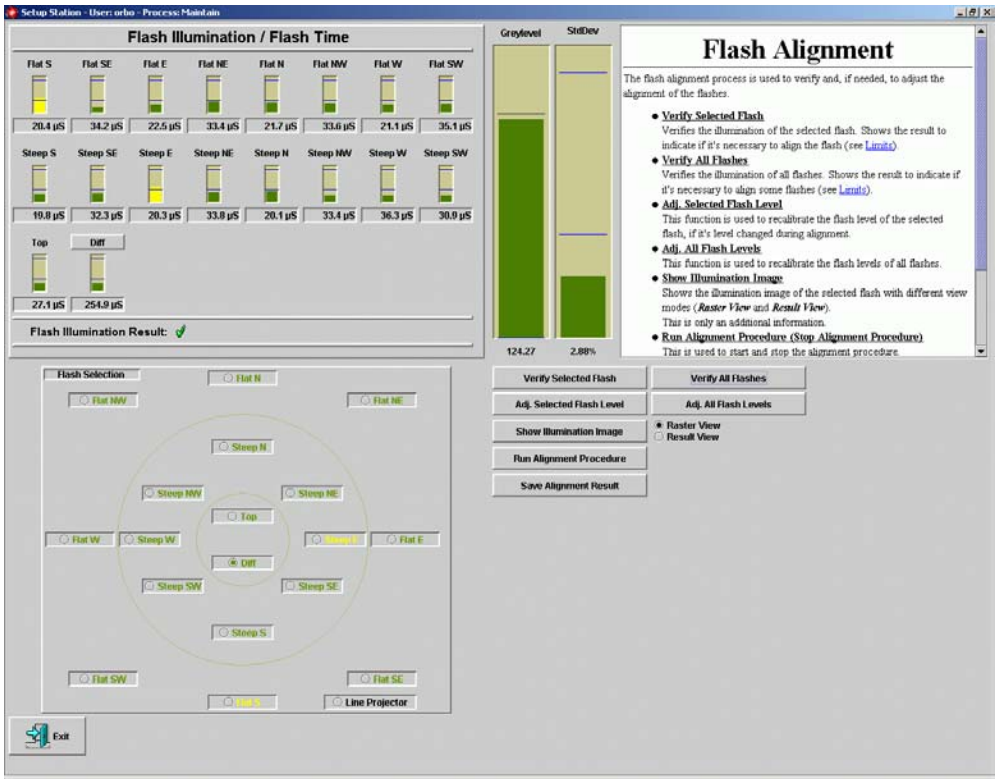
- **Brightness Adjustment**
  Verifies the actual brightness of the angled cameras in reference to the top camera. The result is shown as % of the reference level.
  Also the black level is measured and displayed. Additionally the actual settings for contrast and brightness are printed out.
  A message box shows whether the result is good or bad (see Preliminary Limits) and offers the option to run the adjustment.
  At the end, the advanced verification functions show additional calibration instructions if needed.
  Follow these instructions and repeat the brightness adjustment until the advanced saturation and contrast check is OK.
  Note! After doing any adjustment to the lenses, don't forget to verify the camera alignment and sharpness again!
- **Save Adjustment Result**
  Stores the brightness adjustment result in the internal maintenance result history file.
- **Exit**
  Exit the brightness adjustment panel and return to the application.

If it is absolutely not possible to adjust a camera module, exchanging the complete module and lens is recommended, or as a last resort, the frame grabber!

1.1.4.1 Limits (preliminary)

Grey Level Calibration Deviation:	**± 1 %**
Grey Level Verification Deviation:	**± 2 %**
Black Level Range:	**0 < Black Level < 3**

1.1.5 Flash Alignment



The flash alignment process is used to verify and, if needed, to adjust the alignment of the flashes.

- **Verify Selected Flash**
  Verifies the illumination of the selected flash. Displays the result to indicate if it is necessary to align the flash.
- **Verify All Flashes**
  Verifies the illumination of all flashes. Displays the result to indicate if it is necessary to align some flashes.

The adjust flash level functions can be used to recalibrate the flash levels if they changed during adjustment. These functions are related to the known flash calibration.

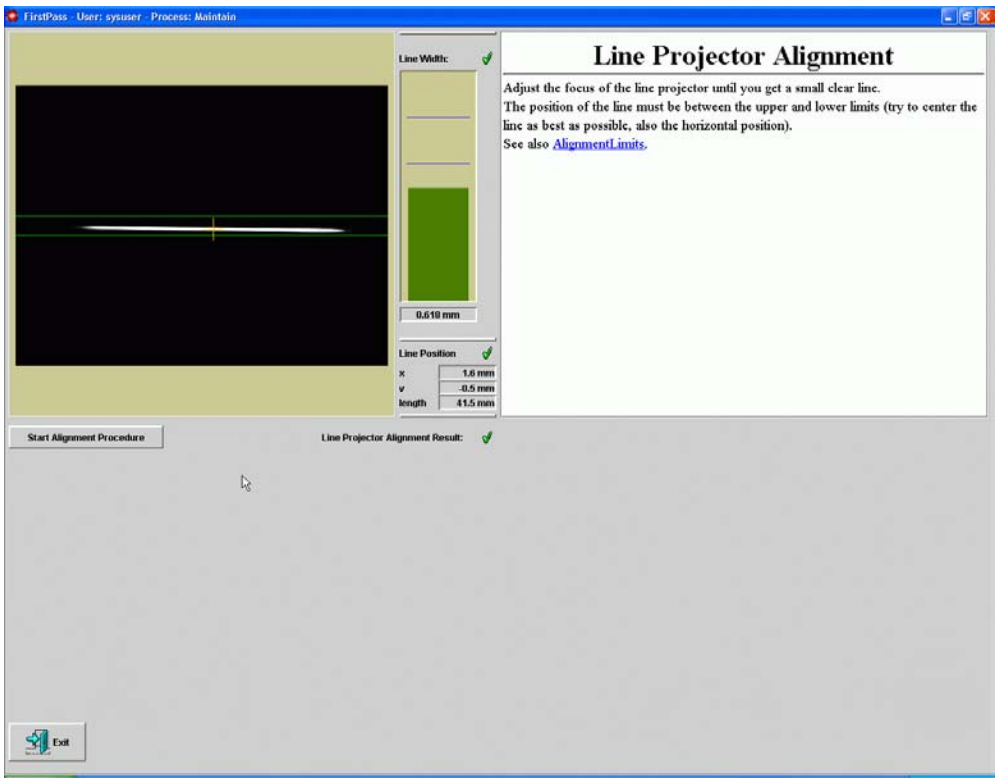
- **Adj. Selected Flash Level**
  Recalibrates the flash level of the selected flash.
- **Adj. All Flash Levels**
  Recalibrates the flash levels of all flashes.

- **Show Illumination Image**
  Shows the illumination image of the selected flash with different view modes (***Raster View*** and ***Result View***).
  This is only additional information.
- **Run Alignment Procedure (Stop Alignment Procedure)**
  This is used to start and stop the alignment procedure.
  When the alignment procedure is running, it is continuously grabbing images and updating the result for the selected flash.
  The goal is to get a low standard deviation (see graphic 'StdDev'). Green and yellow are okay, but try to achieve a value as low as possible.
- **Save Alignment Result**
  Stores the alignment result in an internal file (for later analysis).
- **Exit Flash Alignment**
  Exit the flash alignment panel and return to the application.

1.1.5.1 Limits (preliminary)

Grey Level Distribution:	
Max. StdDev.:	**12.50 % of mean value**

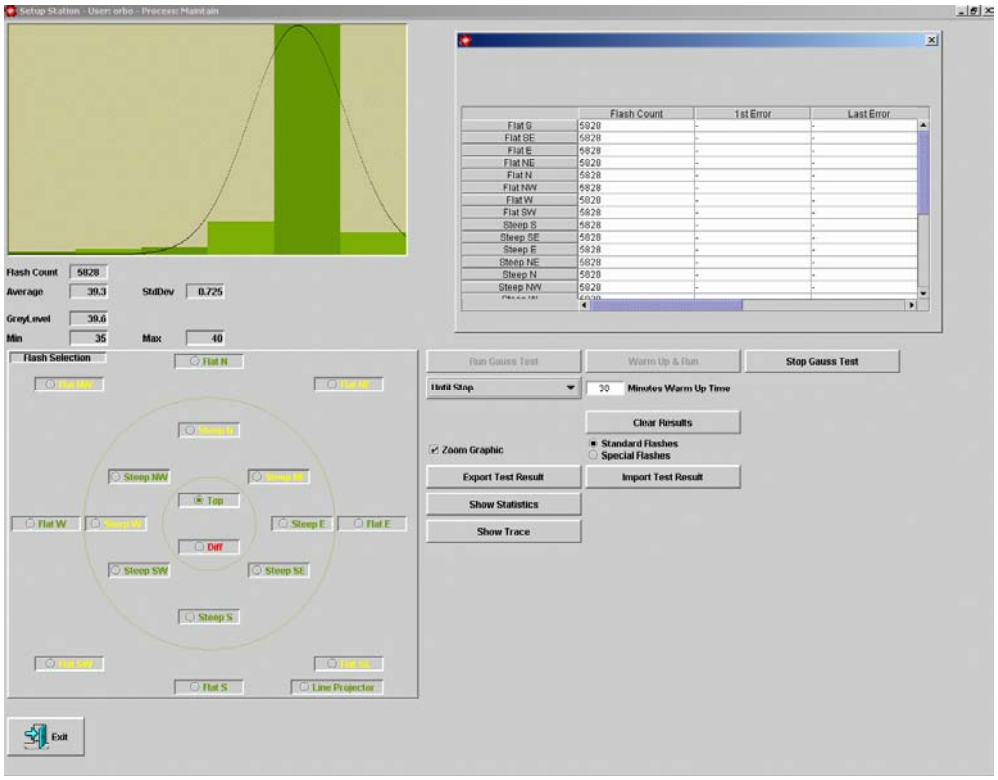
1.1.6 Line Projector Alignment



This tool is used to adjust the position and the sharpness of the line projector.
The image shows the position limits and the actual line. The graph displays the line width and the allowed limits.
The position of the line should be in the centre of the image as far away from the limits as possible. The focus should be adjusted in a way that you get a small clear line (as small as possible).
Also, the x and y position (measured from the centre of the line in reference to the centre of the image) and the line length are displayed. Right now, these values are for information purposes only.

- **Start Alignment Procedure**
  Starts a continuously determination and update of the result.
  This button is also used to stop the procedure.
- **Exit Line Projector Alignment**
  Exit the line projector alignment panel and return to the application.

1.1.7 Gauss Test



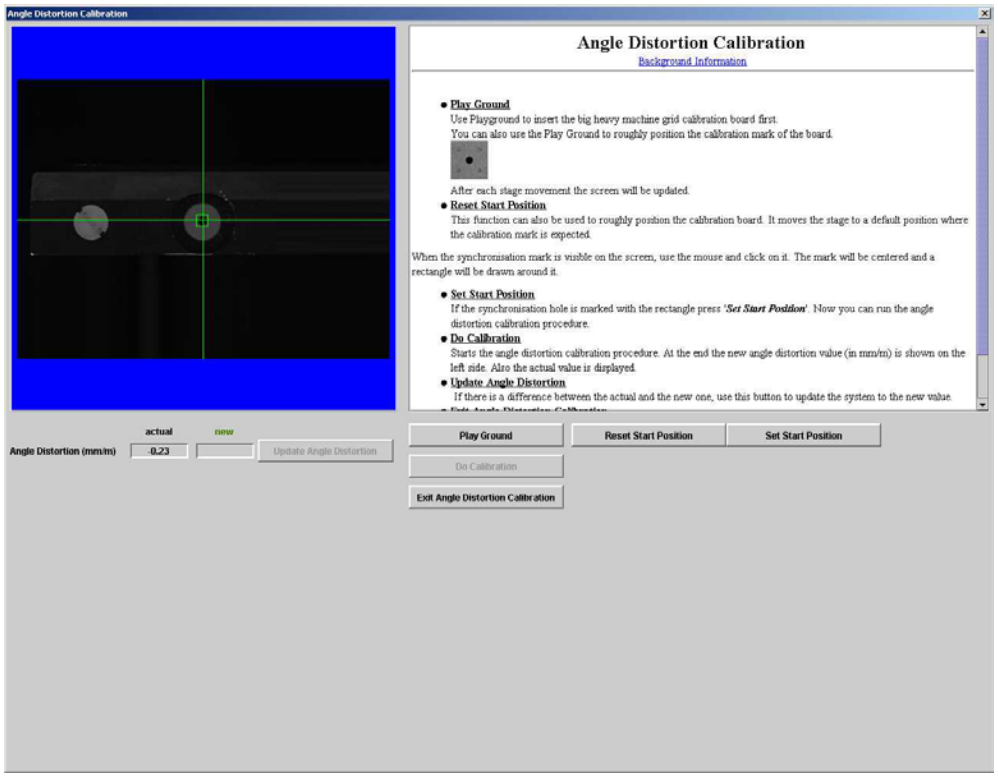
This is a test to verify the stability of the flashes over a longer period of time. The brightness distribution for each flash can be displayed.
Show Statistic was added to get an overview of failing flashes while running the gauss test.
Show Trace: This function displays the brightness traced over time.

1.1.8 MCT

Machine Capability Test (for debugging only).

! Measurement can fail if the grid calibration was bad.

1.1.9 Angle Distortion Calibration

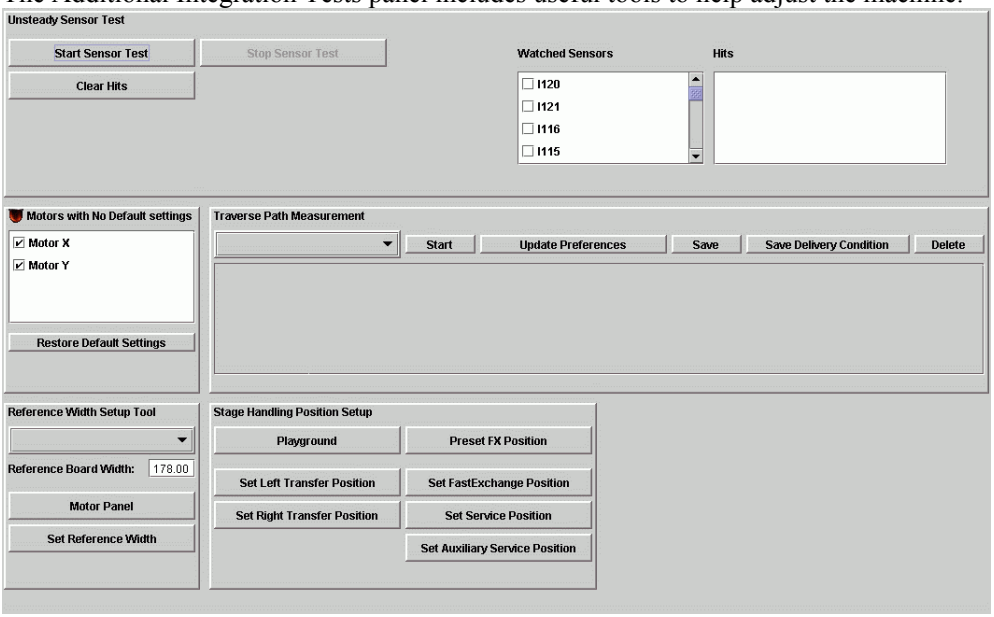


1.1.10 Hardware Wizard

The Hardware Wizard is similar to the Preferences panel, but it should be used to set up the hardware related settings of a system.
Other than the preferences panel, the Hardware Wizard is more clearly arranged. It offers additional tools for setting up the machine, shows differences when changes are made, offers the possibility to import or compare hardware settings from a different system and stores local backups when changes are made.
The Hardware Wizard will be described in a different document.

1.1.11 Additional Integration Tests

The Additional Integration Tests panel includes useful tools to help adjust the machine.

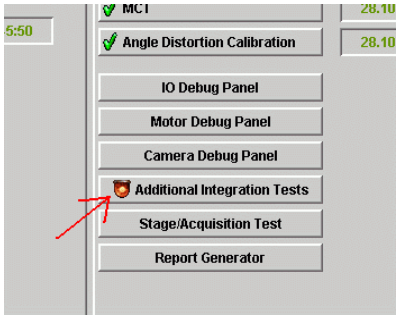


1.1.11.1 Unsteady Sensor Test

This test detects unsteady sensors (especially Board Sensors).
When the test is running, (select 'Start Sensor Test') the motion unit moves continuously to different positions. Also, the width is changed and the belts and clamps are used.
During the procedure, the selected sensors are monitored to see if their state is unsteady i.e. they change their status for no reason.
The standard board sensor I212 is selected by default for monitoring but, any other input can also be monitored if needed.

1.1.11.2 Motors with No Default Settings

Default motor settings can change. Not often but they can if there is a good reason for it. It is also possible that there are machines in the field using different settings than the default ones.
This panel displays all motors with No Default settings. So as not to confuse the operators, it is only active when the integration option is enabled.
In this case, the actual motor settings for the stage (x, y, z, width and the belt, if required) are compared to the default motor settings. Any motor that is not using default settings will be displayed (also an alert icon appears if there is a No Default motor).
For the motors, the default settings can be restored by pressing the button 'Restore Default Settings'.
With the integration option selected, there is also an alert icon visible from the maintenance/service panel in case there is any Default motor.



1.1.11.3 Traverse Path Measurement

This tool is to measure the traverse path of any machine axis. It is used to check and update the maximum travel length and also the fast exchange positions for the x, y and z-axis.

- ***Motor selection:*** Firstly, a motor to measure has to be selected from the list. Any previous measurement result which is available will be displayed.
- **Start:** Starts the measurement. At the end of the procedure, the new actual measurement data will be displayed ('Actual Values').
- **Update Preferences:** This function updates the preferences with the measurement result from the selected motor. The max. travel length, and for some axes also the fast exchange positions, will be updated.
  Always the actual measurement (if there is no actual data then the delivery condition if it is available) will be taken into account for updating.
- **Save:** The actual values are stored automatically every time if they are measured. If there is a need to trace measurements over a longer period, additional data sets can be stored with the save button.
- **Save Delivery Condition:** During the initial start-up of the system, any measurement should also be stored as Delivery Condition for later analysis. This function is only available if the integration option is enabled.
- **Delete:** This will delete any selected data set that previously was stored with "Save'.
  'Actual Values' and 'Delivery Condition' can not be deleted.

1.1.11.4 Reference Width Setup Tool

The reference width is important for adjusting an adapter to the correct width for a board. Because an automatic measurement of the reference width is only possible for the stage adapter (during run Adapter Calibration), this tool was made to help set up the reference width for any attached conveyor and any stage adapter.

- First you need to select an available conveyor from the dropdown list.
- Then you need any board with a known width and you have to insert this width into the field 'Reference Board Width'. The default value is 178mm if you are using the cc0103 calibration board.
- With the 'Motor Panel' button, you can open the motor panel for the selected adapter. Use this motor panel to adjust the width of the conveyor in such a way that you obtain the right size for your board with enough space, so that the board will not stick.
- If the board fits well into the adapter, press 'Set Reference Width'. Now the new reference width is stored in the preferences and will be taken into account for the next width adjustment.

1.1.11.5 Stage Handling Position Setup

For the handling, there are several handling and service positions of importance (e.g. Left Transfer Position or Fast Exchange Position. With this tool, you can set up each of these positions in a simple way.

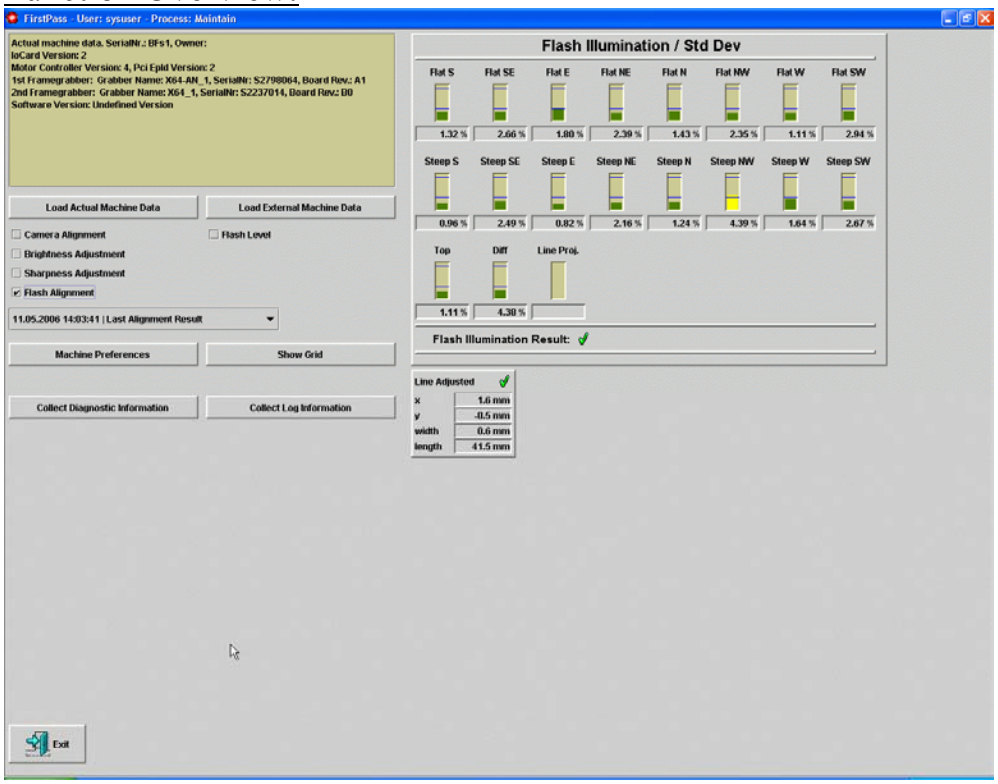
- Use the Playground to drive the stage to the required position.
  Preset FX Position is an additional positioning tool that moves the x and y axis to their fast exchange position if needed.
- When the correct position is set up, press the corresponding Set …. button to store the position.

1.1.12 Report Generator Panel

Purpose

The Report Generator was designed to view all important calibration results and machine information. Actual calibration results and previously collated results can also be verified.
The report generator also includes functions to collect this data and store it in compact, compressed files.
These files are important. Especially if there is a problem with a machine, these files can help analyse what is going on because they include the set up and calibration status.
Here is an overview of some functions of the Report Generator. Because it is currently still in development, there may be changes in the future, but the main functions persist.

Function Overview:



Report Generator Panel (there is an older version of this panel that looks slightly different)

Loading Machine Data

- **Load Actual Machine Data**
  Loads the calibration history and set up information for the actual system.
- **Load External Machine Data**
  Loads the calibration history and set up information from a selected archive file. This file (DiagnosticInfo.zip) is generated when using the function 'Collect Diagnostic Information'.

i There was a previous version where the actual machine data was loaded automatically when opening the panel.

View Machine Data

- **Machine Preferences**
  Displays the preferences of the machine (except Server preferences).
- **Show Grid**
  Displays the last grid calibration result.
- **Calibration Results**
  Select any alignment or adjustment result from the drop down lists and the last selected item will be displayed on the right side.

Collecting Data

- **Collect Diagnostic Information**
  This function collects important calibration and machine information files that are stored at different locations, compresses them and stores the ZIP-file at the following fixed location:
  d:\Orbotech\HardwareStatistics\DiagnosticInfo.zip
  This is the archive file that is needed when using the function 'Load External Machine Data'.
- **Collect Log Information**
  This function collects all the log files. To reduce the data amount, only the actual log files (with the extension *.log) are collected. If a log file is quite new and the size is smaller than 500k (means that it maybe contains not enough information), then the previous one (with the extension *.log.1) is also collected.
  The compressed log information file is stored at the following location:
  d:\Orbotech\HardwareStatistics\LogInfo.zip
  In some cases the log information can be useful to find a problem in a system.

1.2 Periodic Maintenance Tools

Periodic Maintenance contains functions to easily verify if the machine is calibrated well. Some functions include also calibration routines.
The 'good' and 'bad' icons on the left side of the function buttons indicate whether the last check failed or passed. Also the date of the last test execution is displayed. The color of the date shows if a maintenance interval has expired.

Maintenance Intervals **(preliminary)**

Function	Maintenance Interval (days)
Camera Alignment Interval	14
Brightness Adjustment Interval	14
Flash Alignment Interval	14
Flash level Adjustment Interval	14
Run Grid Interval	90
Adapter Calibration Interval	90
Top Camera Calibration	360

If any maintenance function expired or failed, an alert window appears with a reminder.

1.2.1 Camera Alignment Check

Verifies the camera alignment. Shows whether the result was okay or not with the actual test date.
If the procedure fails, you need to run the Camera Alignment.

1.2.2 Brightness Adjustment Check

Check the brightness of all angled cameras with reference to the top camera. Shows the result and ask if you want to run the adjustment routine or not.

1.2.3 Flash Alignment Check

Checks the flash alignment. Shows whether the result was okay or not with the actual test date.
If the result is bad, you need to run the Flash Position Alignment or the Line Projector Alignment form the Service Panel.

1.2.4 Flash Level Adjustment

Flash Level Adjustment is not only for verifying the flash level but also for adjusting the flash timing until every flash reaches it's target.
1st the flash levels of all flashes are checked. The result is shown on the screen. If the result is okay, you are asked if you want to calibrate the flash level anyway.
2nd if the flash level needs to be calibrated or if you are forced to run flash level calibration, you can select special calibration options before starting the adjustment.

- **Warm-up Flashes**: If this function is enabled, the flashes will be warmed up before calibration. At present we have a preliminary warm-up time of 2.5 minutes.

- **Quick Calibration**: If this function is enabled, a quick flash level calibration is performed. In most cases this is enough and you get good results.
  If this option is not enabled a different procedure is selected. This takes more time and the limits are closer. It can happen that it is not possible to adjust some flashes, especially if they are seriously unstable.
- **Start With Default Level**: In general the calibration starts with the actual flash time settings. If for any reason they are totally out of range, the calibration procedures can have problems adjusting the flashes. It is possible to start with default settings for the flash time.
- **OK**: Starts the calibration procedure.
- **Cancel**: Interrupts the calibration process.

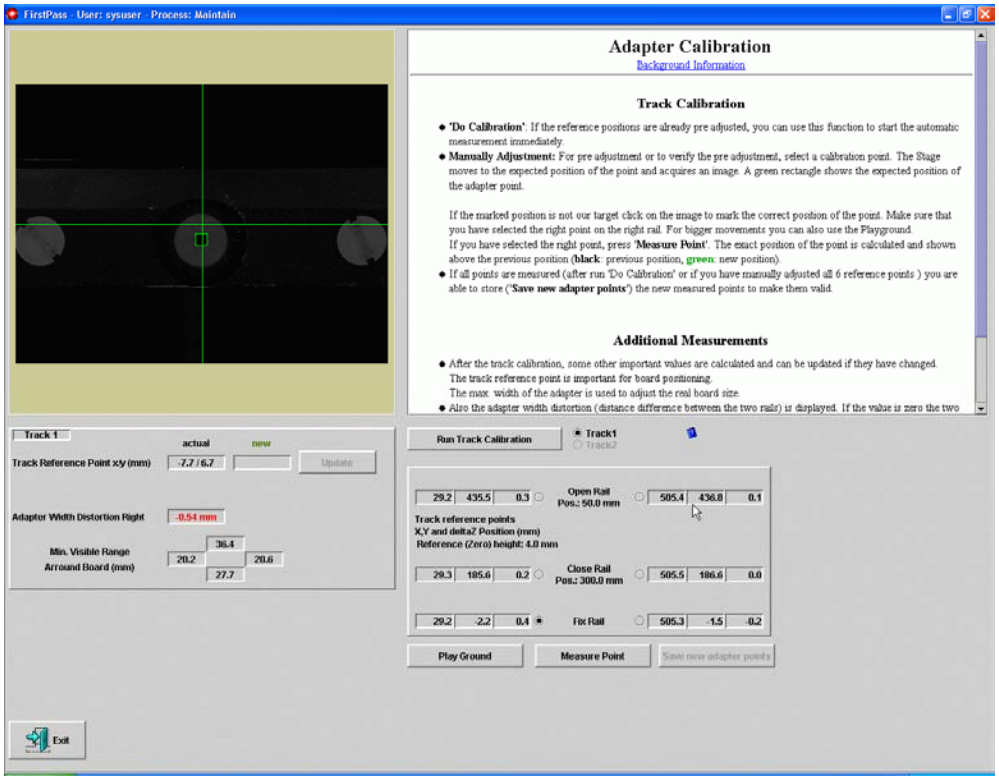
3rd The calibration result is shown if the calibration succeeds. The new flash timing are already stored. Otherwise the previous setting are restored.

1.2.5 Grid Adjustment

Firstly, the actual cross height is measured and compared to the calibration height. If the difference is more than 1 mm, the following error message will appear:

In this case, you need to check the calibration height and the camera and sharpness alignment (and so on) again.
If the initial calibration height check is fine, the grid calibration procedure starts (this will take about 15-30 minutes (at he time)). At the end, you will receive a message if the grid went well or not, and also a result screen opens up that shows where the grid points have been found.
If the grid failed you have to check the previously calibration of the machine.
If the grid procedure succeed you have to restart the software to get the changes active.

1.2.6 Adapter Calibration



Measures the height of the adapter at different measurement points. This procedure is also used to calculate a track reference point (used for board positioning) and to calculate the maximum track width.

- **Run Track Calibration**: Starts the track calibration at the previously stored positions and updates the result display. The new positions (green) are displayed above the old (actual stored) position of each reference point.
- Manual Calibration: For pre-adjustment or to verify the pre-adjustment, select a reference point. The stage moves to the expected position of the point and acquires an image. A green rectangle shows the expected position of the adapter point.
  If the marked position is not our target point, click on the image to mark the correct position of the point. Make sure that you have selected the right point on the right rail. For greater distances you can also use the Playground. If you have selected the right point, press 'Measure Point'. The exact position of the point is calculated and shown above the previous position (black: previous position, green: new position).

  ❗ Measurement can fail if the grid calibration was bad.

If the measurement fails, the software asks to store an h5 image file that can be used (in the future) by R&D to debug the problem (the file size can be very big (up to 125MBytes)).

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If all points are measured (after '**Run Track Calibration'** or if you have manually adjusted all 6 reference points) you are then able to store ('Save new adapter points') the new measured points to make them valid. **If you don't store them, the calibration procedure is not finished and you will lose any changes!**

- **Result Display**: After you have stored the reference points, additional measurements are done and shown on the left side.
  - **Track Reference Point:** This point is the stage position (x and y) where the lower left corner of the track is centred under the top camera. This is important for board positioning. The actual value is displayed and if there is a difference, you update the config with the new value by dint of a button.
  - **Adapter Width Distortion Right: A**dditionally you are provided with the adapter width distortion that shows if the track rails are parallel (value = 0).
  - **Max Visible Range:** The visible range around the adapter is shown to see if all points of the board inside the adapter (track) can be inspected.

  The setting '**Track max. width:'** has been removed from this panel. The reference width set up can now be done from the 'Additional Integration Tests' panel.

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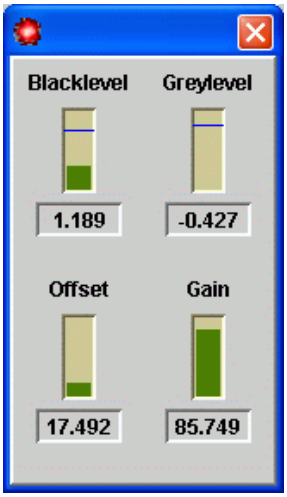
If you have a double track (dual lane) system, then you have to run the track calibration for each track.

1.2.7 Top Camera Calibration

This module is available for systems with a 4M camera and is used to calibrate the black level for the 4MegaPixel top camera.

When starting this function, the actual settings are verified and the result is shown. A message shows whether the result is okay or not and asks if you want to run calibration.



The calibration procedure automatically adjusts the offset setting for the camera to achieve the required black level value. At the end, the new result is shown.
The calibration fails if the offset setting reaches 0% or 100%. This means that the desired values are out of range.

i A wrong aperture setting for a camera can be the reason why the adjustment routine fails.

! After changing the offset for the top camera, the brightness adjustment for the angled cameras is no longer valid. This is why you have to run Brightness Adjustment Check after top camera calibration. !

2 Practical Usage and Information

2.1 Calibration Flow (for experienced persons)

2.1.1 Zero Height *(see Preferences/Hardware/Stage)*

The calibration height is used for calibration of the machine and it is also the zero test height.
Once a value is entered and the machine is calibrated with this height, then the value should not be changed anymore.
Before calibrating a system, this value has to be measured and set up manually.

Measuring the calibration height
To do this, place the calibration board into the system and move the board manually (with the Play Ground) to a position where you can measure the distance between the calibration board (upper edge) and the camera head (lower edge). Make sure that you really measure the distance to the camera head's lower edge and not the distance to any mounting material of the flashes or other parts that are mounted under the camera head. Change the height of the z-axes in such a way that your measured distance from the calibration board to the camera head is about 145mm.

If this is okay then set up the ‘Calibration Height’ with the actual height of the z-axis. From now on, this is the calibration and zero test height for the system and should not be changed.

When do I have to check or change the calibration height?

- During the first start up and calibration of the system, the calibration height must to be measured and set before starting the calibration of the camera head.
- If the calibration (especially the camera alignment) is suddenly bad for all cameras (don’t forget to verify the camera sharpness). **Possible reason:** Someone accidentally overwrote the default FlashConfig with a different one from another machine.

When should I leave the calibration height as it is?
If the calibration height was previously measured incorrectly (distance between calibration board and camera head is not 145mm), and the calibration of the machine is OK and the sharpness of all the cameras is also good, then it makes no sense to change the calibration height because you would then have to recalibrate the machine. If in this case the wrong calibration height is no problem during testing and handling, then leave it as it is!

If you have to change this value, you need to recalibrate the complete camera head.

2.1.2 Pre-Adjust Sharpness

Before starting any adjustment of the cameras, it is recommended to pre-adjust the sharpness and position of the cameras. The pre-adjustment function is included in the camera alignment and the sharpness adjustment panel.

2.1.3 Align Top Camera (Camera Head)

The x and y shift of the top camera is not that important at this stage because the top is the reference camera and it will be centred always before. For the top camera, only the angle to the x-axis has to be adjusted as close to zero as possible.

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Select the top camera and run 'Align Selected Camera'. If the pre-adjustment was ok (all edges of the cut out image have to be visible, the frame of the cut out image **is green**) you can go on with adjusting the angle. If the frame of the cut out image **is red**, the measured angle is **not** the angle to the x-axis. It is the relative angle of the cross on the calibration board. In this case, you need to pre-adjust the angle and stop and start the alignment procedure again. This has to be repeated until you see the green frame of the cut out image. Now you can go on with adjusting the angle.

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2.1.4 Adjust Sharpness of Top Camera

2.1.5 Verify Alignment and Sharpness of Top Camera

If one of these tests fails go back to the previous steps.

2.1.6 Adjust Sharpness of Angled Cameras

2.1.7 Align Angled Cameras

2.1.8 Verify Alignment and Sharpness of Angled Cameras

If one of these tests fails go back to the previous steps.

2.1.9 Run Brightness Adjustment

If the brightness adjustment fails you can try to repeat it. But if the brightness and contrast settings of a camera module reach their limits (0% or 100%), the procedure can't adjust the brightness automatically.
In this case please check the aperture of the lenses.

- If all angled cameras are more or less out of range, then the aperture or the gain of the top camera **can** be wrong.
- If only one angled camera is out of range, this **can** be an indication that the aperture of its lens is wrong or there is something bad with the camera.
- If the east camera is bad, make sure that the line projector does not shadow the image.

2.1.10 Flash Alignment

Before running the flash alignment it is recommended that a flash level adjustment for all flashes is done first. It is also possible to do this directly from the flash alignment panel.

2.1.11 Line Projector Alignment

2.1.12 Go on with 'Flash Level Adjustment' and the following Items.

2.2 Periodic Maintenance Flow

The functions for the periodic maintenance **DO NOT** include the sharpness test for the following reasons:

- The test is more complicated and needs the assistance of experienced persons.
- An automatic sharpness test that returns a good or bad value is not available for all machines (especially fast exchange machines cannot run this automatic test).
- Even the system can measure the characteristic curve of a camera. An experienced person should validate the result and make sure that the curve is correct.

So be sure that the sharpness is okay before using the periodic maintenance functions.

To update the calibration state of the machine, run the verification and calibration functions on the periodic maintenance panel.

2.2.1 Camera Alignment Check

2.2.2 Brightness Adjustment Check

2.2.3 Flash Alignment Check

2.2.4 Flash Level Adjustment

2.2.5 Grid Adjustment

Restart Software !!!
At present it is strongly recommended to restart the software (Remote AOI Server and Symbion application) after finishing the grid procedure.

2.2.6 Adapter Calibration

Adapter calibration only runs with a successfully performed grid adjustment, otherwise it can fail.