Operation manual LMK LabSoft

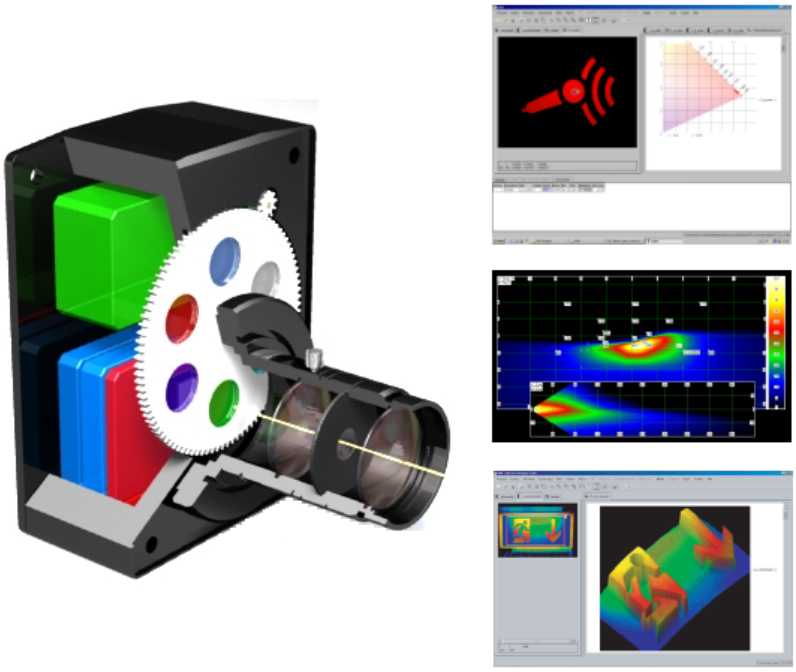

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Table of Contents

1 Comparison of program versions

Function	Simple	Simple Color	Normal	Normal Color
Capturing luminance images	x	x	x	x
Capturing color images		x		x
Live capture			x	x
Measurement series			x	x
Statistic evaluations	x	x	x	x
3D-views of luminance	x	x	x	x
Projective rectification	x	x	x	x
Isolines	x	x	x	x
Coordinate transformation			x	x
Additional evaluation images	1	1+1	N	N
Image processing algorithms			x	x
Use user-defined macros	x	x	x	x
Record user-defined macros			x	x
Calculation of color differences		x		x
Chromaticity diagrams		x		x
Decomposing and composing of color images				x
Data export to MS Word and MS Excel	x	x	x	x
ActiveX programming interface	o	o	o	o
Lenses	1	1	N	N
Movement units			o	o
Photometer			o	o

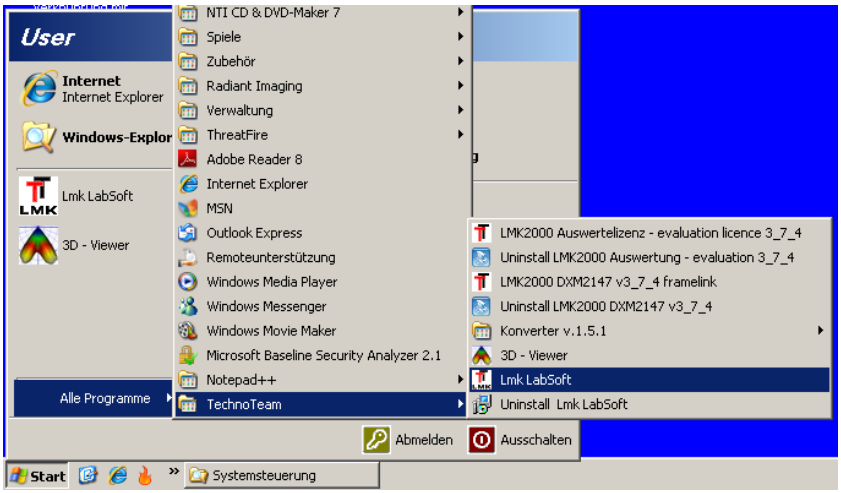
Legend

x	Function is available.
o	Function is optional.
1	One monochrome image image and one lens.
1+1	One monochrome and one color evaluation image.
N	Any number of evaluation images and lenses.

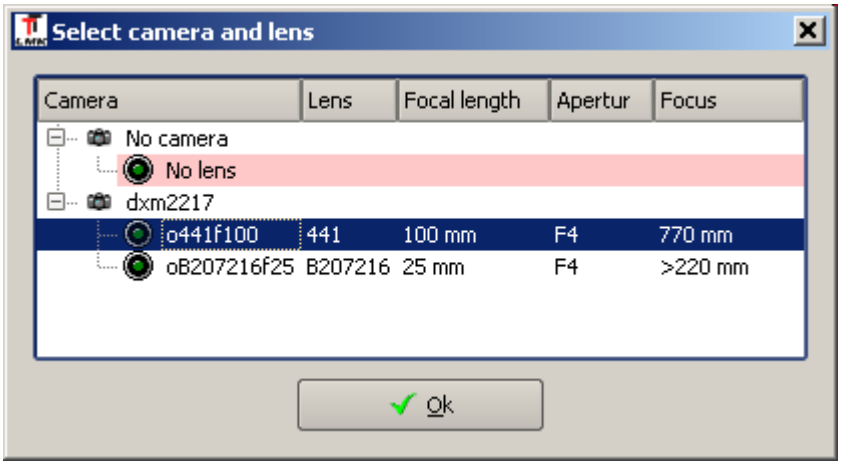
2 Quick lead-in

2.1 How to start-up and quit the program?

The program is opened by the start menu of Windows, in the example by „Start | Program | TechnoTeam | Lmk LabSoft“, or by double-clicking on the relevant start icon.



If a camera is installed on the computer the dialog „Select camera and lens“ is opened when the program is started-up. In this dialog either the camera-lens combination to be used or the evaluation version without the use of hardware can be selected. If there is no camera installed on the computer this dialog does not appear and the software evaluation version is started immediately. See section 4.2 on page 38.



When starting the program it is also possible to restore the settings which existed when the program had been quited. Select „Yes“ when asked „RESTORE LAST SETTINGS?“.

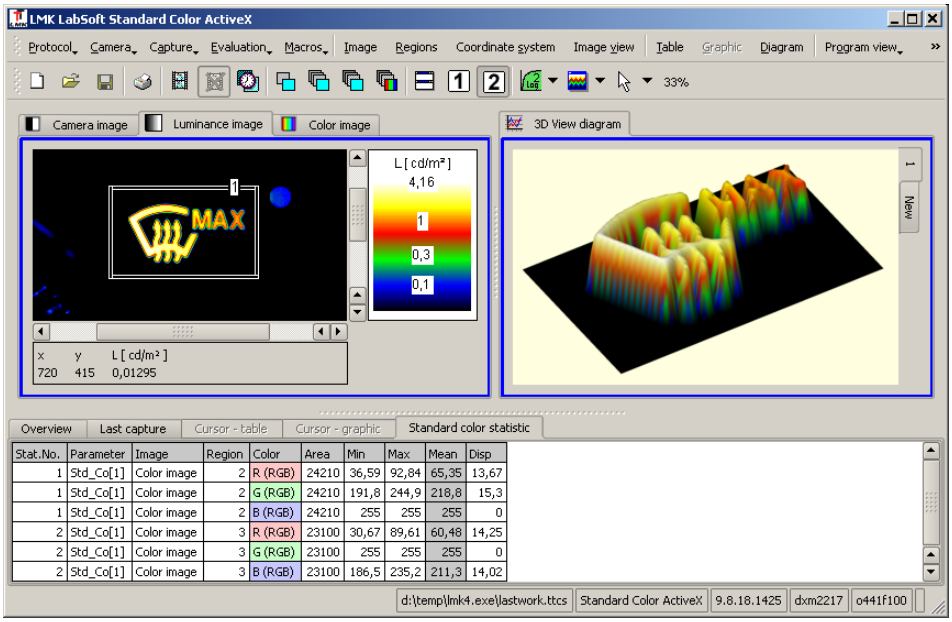
Program start

Program end

To restore the settings they had to be saved at the end of the program. Select „Yes“ when asked „SAVE SETTINGS?“. See also chapter 3 beginning on page 27.

2.2 Where to find the different items?

The program having started and the program settings saved before having possibly been loaded the main window of the application appears. For a more detailed documentation see section 3.3 on page 29.



The main menu contains the menu options which can currently be accessed to:

- The items from „PROTOCOL“ to „ADD-ON“ contain menus which can be used to call up functions such as capturing new images, changing camera parameters or different image processing operations. The appearance and the behavior of the entire program are also influenced by the menus on the right-hand side of the main menu.
- The items from „IMAGE“ to „IMAGE VIEW“ contain menus which can be used to change the image which can currently be seen and this image can for example be saved.

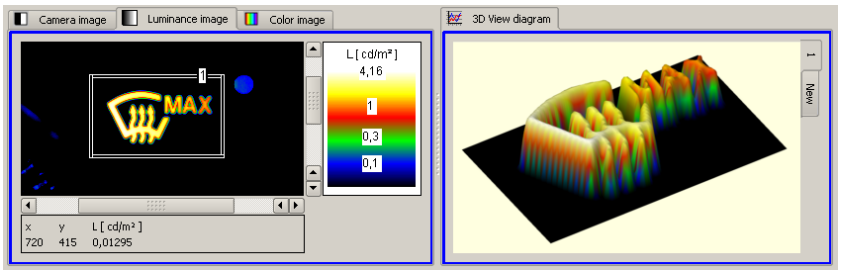
- The menu „TABLE“ can be accessed if there is a table shown in the lower part of the program. This table can for example be saved, it can be copied into the clipboard or it can be printed by means of the options of this menu.
- The same is true with the menu „DIAGRAM“ whose menu items can be used when a diagram such as a luminance sectional view or a histogram is displayed in the lower program area.
- The menu items of the menu „DIAGRAM“ can be accessed when a horseshoe diagram of a color statistic or a three-dimensional view of a monochromatic image are shown. These diagrams are not shown in the lower tab window together with tables and graphics of the statistics. However, they are displayed in the upper tab window together with the images.

Below the main menu there is a button bar containing some of the most important commands of the menu. Thus, they can be accessed directly by a mouse click. If the mouse is moved over one of the buttons a help text of this button is displayed for a short time.

In the middle part of the program window there are all the images which are worked with in the program. There is always a CAMERA IMAGE and a LUMINANCE IMAGE. The COLOR IMAGE only exists if a color evaluation version or a color camera are worked with. Additionally, the user can generate several evaluation images where measuring regions, statistics and image processing operations can be used as well.

In the middle part of the the program window the horseshoe diagrams of the statistic types „HORSESHOE LINE DIAGRAM“, „HORSESHOE AREA DIAGRAM“ and „COLOR SYMBOL OBJECT“ for color images and the „3D VIEW“ for monochromatic images are displayed as well.

To get a better overview, to be able to compare images with each other or to consider an image and a diagram simultaneously there is additionally to the standard one-window view a two-window view available. Here, the images and the diagrams can be assigned at will to the right-hand or left-hand sides.



The tables and diagrams of the statistical evaluations are shown in the tab window at the lower edge of the program. As mentioned above the menus „TABLE“ and „DIAGRAM“ of the main menu are influenced by the view selected here. In addition to the presentation of the statistical results there are:

- The table „OVERVIEW“ containing a list of all statistics generated in the program.
- The views „CURSOR - TABLE“ and „CURSOR - GRAPHIC“ which are operative when a line cursor, a circle cursor or a rectangle cursor are worked with in the current image.

- The table „Last capture“ where the capture parameters and the results of the last luminance or color captures are stored.

Overview | Last capture | Cursor - graphic | Cursor - table | Standard color statistic

Stat.No.	Classificator	Image	Object	Color	Area	Min	Max	Mean	Disp
1	Std_Co[1]	Color image	2	R (RGB)	10190	60,86	133,4	96,63	15
1	Std_Co[1]	Color image	2	G (RGB)	10190	123,3	193,3	160,5	19,21
1	Std_Co[1]	Color image	2	B (RGB)	10190	255	255	255	0
2	Std_Co[1]	Color image	3	R (RGB)	14190	92,52	155,2	124,7	16,6
2	Std_Co[1]	Color image	3	G (RGB)	14190	215	255	243	13,18
2	Std_Co[1]	Color image	3	B (RGB)	14190	229,3	255	249,9	7,85

Information on the program version, the camera and lens used, and also on the last measuring protocol can be found in the status bar of the program.

2.3 How to exchange the camera and the lens in the program?

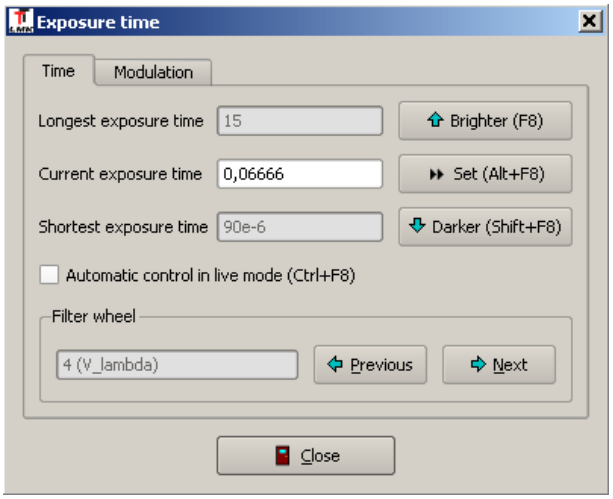
Camera and lens changes are not only possible when the program is started. They can also be exchanged when the program is worked with. When the menu item „Camera | change“ is chosen, the dialog „Selection of camera and lens“ is opened where the new selection can be performed. After an exchange the calibration data required for the relevant camera-lens-combination is loaded. It is possible to change between different cameras and lenses and it is possible to change between a version with and without capturing hardware use as well. If such a case occurs the option „No camera | No lens“ should be selected in the dialog, see also section 4.2 on page 38.

2.4 How to prepare the camera for capturing images?

The cameras and lenses are delivered with the calibration data needed for their later use. Before a capture, however, some adaptations are necessary or recommended at least, e.g.

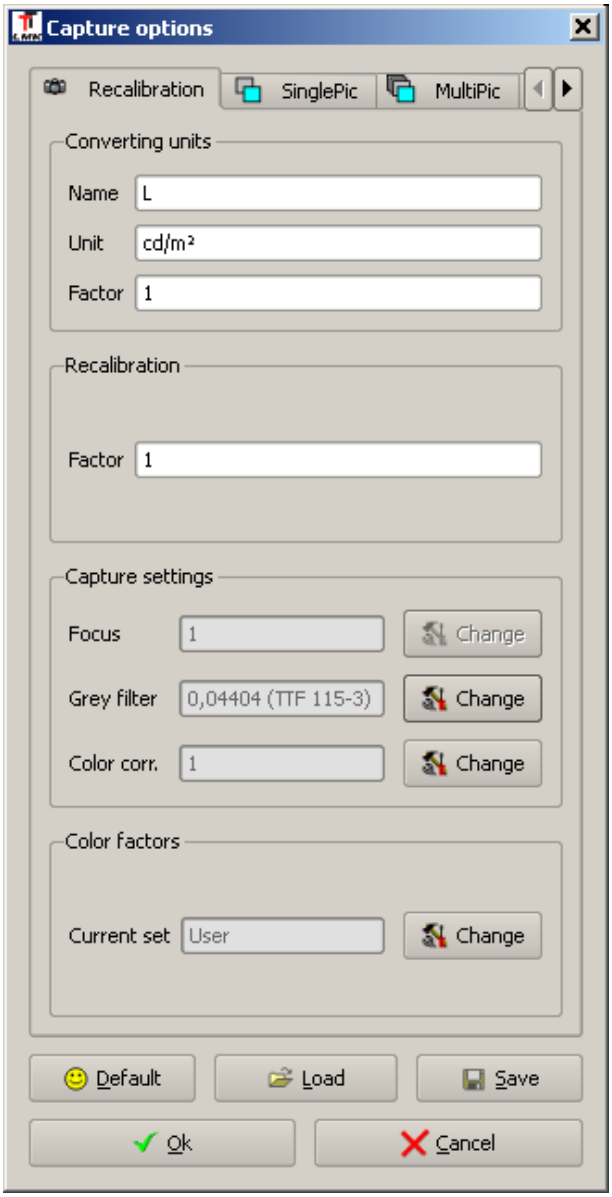
- The adaptation to the brightness of the scene to be captured by selecting a suitable exposure time or a neutral grey filter.
- The use of a lens which can be focused and the selection of the appropriate capturing distance if a non-focusable lens is used, respectively.
- The adaptation of the spectral corrective data of color cameras if narrow-band light sources are to be captured.

To set the most suitable camera exposure time set the camera into the live-mode. When the camera is in this mode it continuously captures and displays images. This mode is started by the menu item „Camera | Live“ or by the relevant quick start button  . In the dialog „Exposure time“ which opens simultaneously the image can be made brighter or darker by selecting a different exposure time. The options possible in this dialog are described in section section 5.1.3 on page 44.



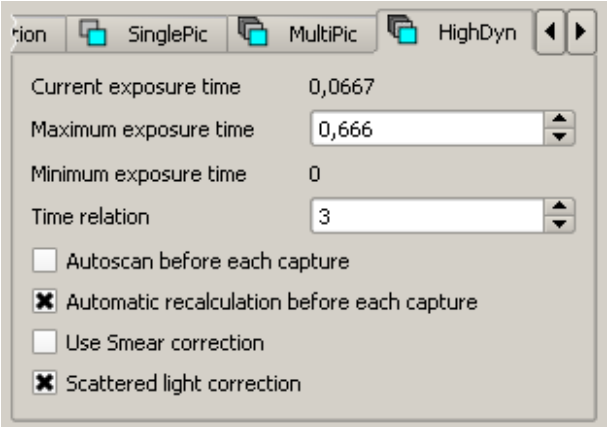
The section FILTER WHEEL only exists when a filter wheel color camera is used. If required, the operating frequency of the light source can be adjusted on the tab sheet MODULATION. The live mode is finished by means of the menu item „CAMERA | FREEZE“ or by the quick start button .

A sharp optical image is of great importance especially if small objects in the image are in the focus of interest. Otherwise, great differences between the data measured and the real photometric and colorimetric data would occur. With focusable lenses the optical properties differ depending on the measuring distance. Thus, the program has to be informed about the focus set before capturing a luminance or color image. The adjustment is performed in the dialog Capture options which can be opened via the menu item „CAPTURE | PROPERTIES“.



In this dialog all settings which are important for capturing luminance and color images can be performed. For a more detailed description of all camera and lens settings available see section 4.3 on page 39.

2.5 How to capture images?



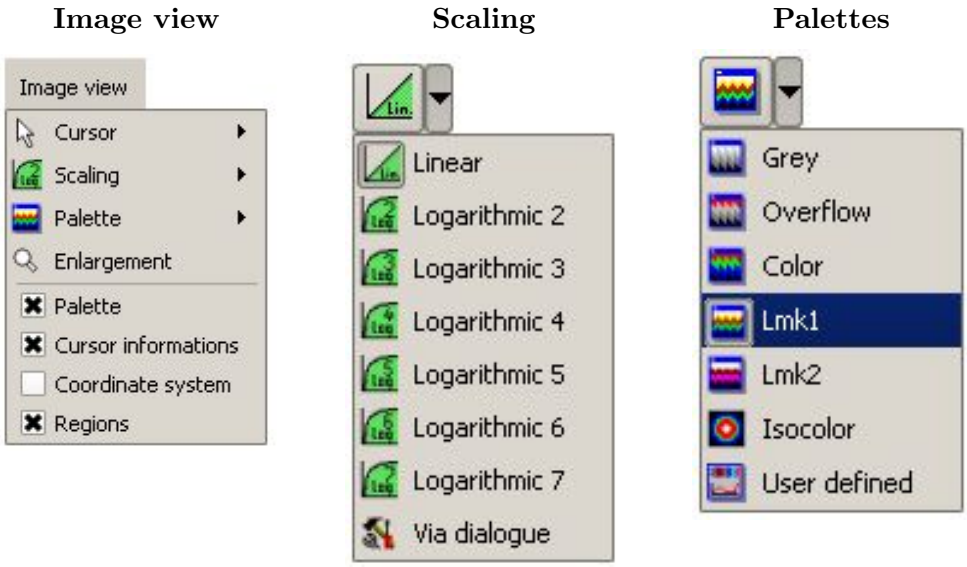
In the previous section we mentioned the dialog CAPTURE OPTIONS.It also contains the tab sheets SINGLEPIC, MULTIPIC and HIGHDYN where the parameters of the different capturing procedures can be set. The settings of the different options of the capture of luminance and color images is described in more detail in section 5.2.2 on page 47. In most applications, however, no changes of the default values are required and a luminance or a color image can be captured by means of one of the four existing procedures immediately after the selection of a suitable exposure time.

- By means of the SINGLEPIC ALGORITHM a camera image is captured and converted into a luminance image. The capture is started via the menu item „CAPTURE | SINGLEPIC“ or the quick start button .
- The algorithm MULTIPIC successively captures several camera images using the same exposure time and produces one common luminance image: Owing to the use of several camera images the noise in the calculated luminance image is reduced. The capture is started via the menu item „CAPTURE | MULTIPIC“ or the quick start button .
- By means of the HIGHDYN algorithm several camera images with different exposure times are converted to one luminance image. The use of different times allows a higher dynamic range of the captured scene. A capture is generated via the menu item „CAPTURE | HIGHDYN“ or the quick start button .
- The algorithm COLORHIGHDYN is only available when a color camera is worked with. When a filter wheel camera is used a lot of camera images with different exposure times and different color filters are converted to one color capture. To start such a capture the menu item „CAPTURE | COLORHIGHDYN“ or the quick start button are used.

2.6 How to change the image display?

All images can be enlarged or reduced in size thus allowing either the total image or the region of interest in an enlarged size to be considered. To select a region of interest is most convenient by means of the mouse.

- The enlargement is set via the scroll wheel. Scrolling up results in a greater enlargement whereas scrolling down leads to a reduction as long as the entire image can be seen again.
- If the complete image does not fit in the display the visible area can be set by means of horizontal and vertical scrollbars.
- Furthermore, it is possible to adjust the enlargement and the visibility of an image section by means of the dialog IMAGE ENLARGEMENT, see section 8.2 on page 80.



The dynamic range of the black-and-white or the color values of an image can be very large so that with a linear scaling the bright and dark image regions of the screen cannot simultaneously be seen with the same quality. In those cases a logarithmic scaling can be used.To change the scaling in a simple way use the relevant button in the button bar. The scaling options are described in section 8.3 on page 81.

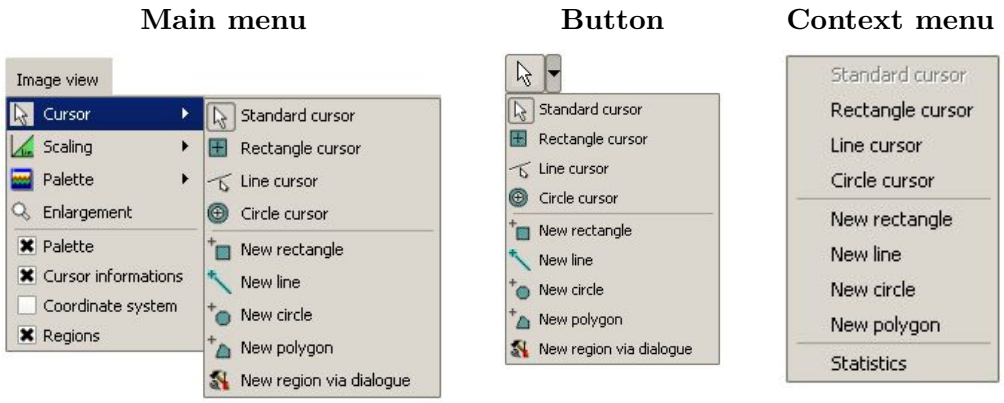
Different color palettes can be assigned to each black-and-white image thus allowing a pseudo-color representation of this image. Along with pre-defined ranges, it is possible to define your own palettes and to define luminance regions with threshold values and colors which may freely be chosen. The palettes may most easily be accessed via the relevant button in the button bar. Color palettes are documented beginning with section 8.4 on page 82.

The visibility of different window components such as the color range, the co-ordinate system and the measuring regions of each image can be changed. These options can be found in the menu „IMAGE VIEW“.

2.7 Cursor options

If the mouse pointer is moved over the image box, in the status line information on the image content or on the regions under the mouse pointer is displayed. The displays of the status line change in the different mouse modes. Several mouse operations and in some additionally opened dialogs can be performed. A change of the mouse mode is done

either in the menu „Image view | Cursor“, by the relevant button or via a right mouse click in the context menu of the image. See also chapter 11 beginning on page 108.



- If the Standard cursor is operative, the image value is displayed in the status line at the place of the mouse pointer. With color images it is displayed in the color space which is set, with black-and-white images in the unit which is valid in this image.

  A region can be marked by clicking on this region by means of the left mouse button. The marking is required for some measuring region operations such as displacing, duplicating, changing, deleting, generating and changing a statistical evaluation. If the mouse pointer is over a marked region, information on this region is displayed in the status line such as position, size etc.

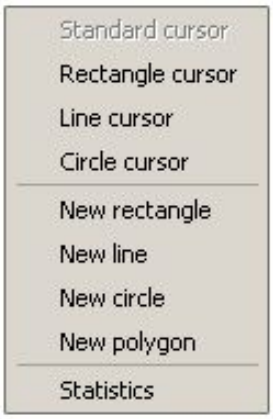
- If the Line cursor is on, a graphical representation of the image values along the cursor line is displayed below the image. The position and length of the line cursor can be defined either by drawing a new line by means of the pressed left mouse button or via a dialog which is opened at the same time when the line cursor is switched on. See section 11.2 on page 110.

- A histogram of the values in a rectangular or circular region around the mouse pointer can be displayed by means of a Rectangle or Circle cursor. And again it is possible to define the size of this region either by dragging with the mouse or by a dialog.

- All the other mouse modes (new rectangle, new line, new circle, new polygon, new region in dialog) are used to generate new measuring regions, see the short description in the next section or the more detailed part in chapter 9 beginning on page 93.

Pressing the right mouse button opens a context menu containing all operations possible at present.

Nothing marked



Marked region

2.8 How to define measuring regions?

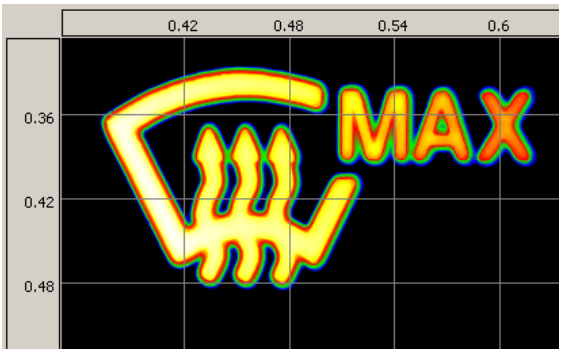
The procedure of drawing regions into the image by switching to the relevant cursor mode was described in the previous section. Measuring regions can be defined in the mouse modes New rectangle, New Line and New Circle by pressing the left mouse button, moving the mouse and releasing the mouse button. The first point of the new region is defined by pressing and the second one by releasing.

Polygons are defined by more than two points. Therefore, dragging the pressed mouse button generates a new side of the polygon. The definition of a polygon is finished by clicking a second time on the last drawn polygon point without moving the mouse or when the mouse mode New polygon is left.

The dialog „List of regions“ which can be opened by the menu item „Regions | properties“ is another option to generate new regions. Here, it is possible to modify the properties of regions already existing. By means of the menu item „Regions | Undo“ it is possible to undo erroneously performed changes in the regions. There is a detailed documentation beginning in chapter 9 beginning on page 93 where all options to generate, change and handle measuring regions.

2.9 How to use coordinate systems?

Geometric information in the image is always displayed in units of a coordinate system. If no special coordinate system is defined, pixels are displayed without explicitly displaying any units. The origin of coordinates is in the upper corner on the left. The x-values grow from left to right, the y-values grow from top to bottom. The settings of coordinate system used can be changed via the menu item „Coordinate system | properties“. It is possible to define another Cartesian or a polar coordinate system. The work with coordinate systems in the program is described in chapter 10 beginning on page 105.

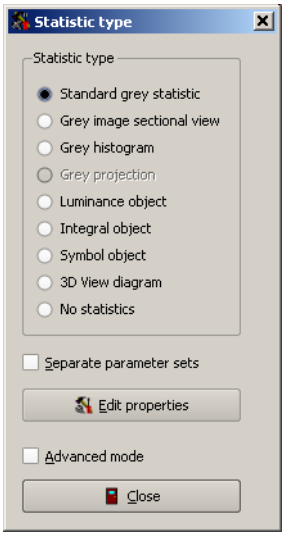


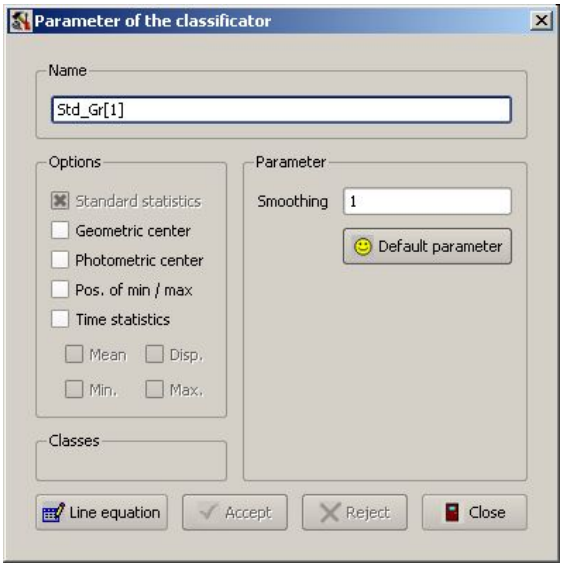
The coordinate system currently used can be displayed via the menu item „Image view | coordinate system“.

2.10 How to define statistical evaluations?

To generate a statistical evaluation first draw measuring regions into an image for the desired evaluation and mark them. After that, either call up the menu item „Statistics“ in the context menu of the image or the menu item „Evaluation | Statistics“ in the main menu of the program. See section 12.1 on page 113.

Select type **Set parameters**





A statistical object is characterized by the 5 properties below:

- Image: A black-and-white or a color image delivers the pixel values.
- Measuring region: The region defined in the image determines the image points the evaluation is used for.
- Type: The type of calculation to be carried out. At present, the following types are implemented in the program: Standard statistic, Sectional view, Histogram, Projection, Luminance object, Integral object, Symbol object,

3D-VIEW DIAGRAM, COLOR SYMBOL OBJECT, HORSESHOE LINE DIAGRAM, HORSESHOE AREA DIAGRAM.

- CALCULATION PARAMETERS: Depending on type different calculation parameters are required.

- VIEWS: The presentation of measuring results can occur in different formats.

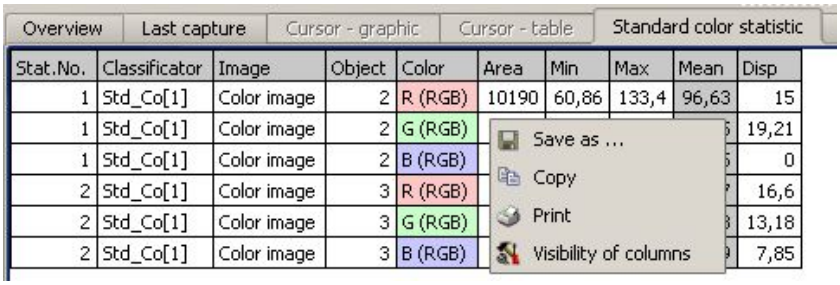
When handling images, measuring regions and statistics there are two main differences between the LMK LABSOFT and the LMK2000:

- When a measuring region has been generated no standard statistic is calculated for the new region.

- For each measuring region only one statistic can be calculated.

The representation of the statistical results is shown in tabular or graphical form. In the default setting not all the views existing for a statistic are displayed. In sectional views and histograms for example the table with the standard statistics (mean value, variance, minimum, maximum) is not displayed but only the measured course of the function in a graph. The visibility settings can be changed for each type of statistic via the menu item „EVALUATION | VISIBILITY OF TABLES AND DIAGRAMS“.

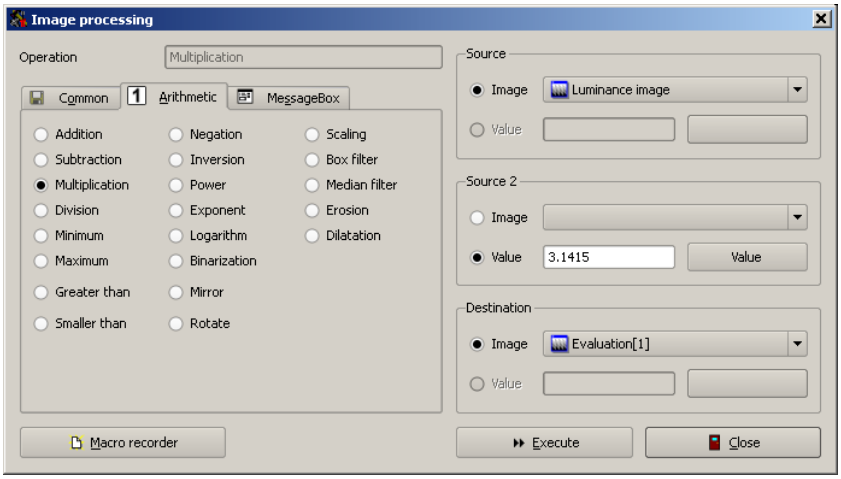
Tabelle Standardfarbstatistik



There is a context menu in all of the views which can be opened by pressing the right mouse button. It contains the same menu items existing in the main menu of the program in the menus „TABLE“, „DIAGRAM“ and „GRAPH“. For more details see section 12.4 on page 140.

2.11 What are the image processing options?

In some applications it is useful to link the values of the different images with arithmetic or logic operations. Contrast, for example, can be calculated by linking two images arithmetically. The options available in the program for that are mainly summarized in the dialog „IMAGE PROCESSING“ which can be called up via the menu item „EVALUATION | IMAGE PROCESSING“. For more detailed information see section 13.8 on page 164.

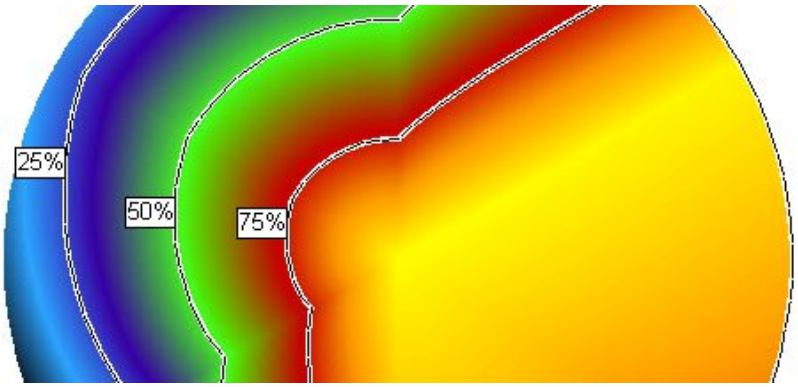


The additional evaluation images required for these operations can be generated via the menu items „Evaluation | generate a new image“ or „Duplicate image“. For more information see section 13.1 on page 155.

There are other image evaluation and processing operations available. They are as follows:

- Projective rectification: Perspective distortions which are produced by an oblique view of the camera on the measuring scene can be corrected. This method is described in section 13.5 on page 158.

- Isolines: Isolines are lines of equal brightness in the image. If there is a continuous course of brightness in the image e.g. bright areas gradually changing to dark, it is possible to mark areas whose brightness is higher or lower than selected threshold values by means of an isoline representation. The representation of isolines is handled in section 13.7 on page 162.



- Transformation of coordinates: The correction of heavy lens distortions and the conversion of images in polar and in sphere coordinate systems are characteristic fields of application. For coordinate transformation see section 13.6 on page 161.

2.12 How to record and replay courses?

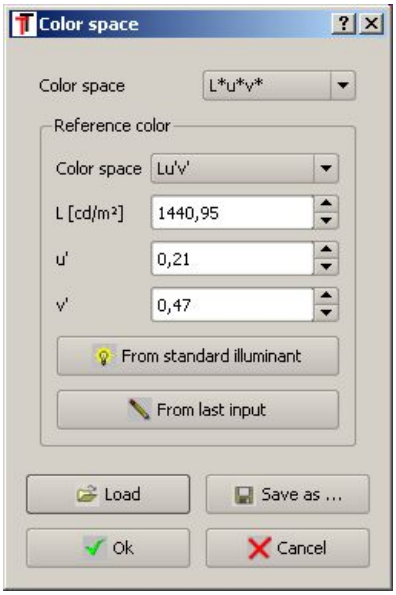
There is a macro recorder in the program which can record a series of user actions and save them as a menu item. If this menu item is called up later, the instruction sequence recorded before is carried out again. The main operations which can be recorded are:

- Capturing luminance or color images
- Generating and deleting evaluation images
- Loading and saving images
- Arithmetic and logic operations on images
- Projective rectification
- Isolines
- Transforming coordinates

The macro recorder can be called up either via the menu item „Macros | Macro-recorder“ or by the button Macro recorder in the dialog „Image processing“. After recording the menu items generated can be found in the menu Macros. The use of the recorder is described in detail in section 13.9 on page 172.

2.13 What color evaluation options do exist?

The measuring values in a color image are displayed in a color space which is set via the menu item „Image | color space“ and where - in case of color spaces with reference color - the parameters can be set in the dialog „Color space“. The handling of the dialog are documented in section 8.5 on page 87.



The color space being changed, the measuring data for this image and the statistical evaluations generated in the selected color space are output.

As for black-and-white images, in color images the Standard statistics (mean values, variance, minimum and maximum), Sectional views and Histograms can be calculated. The statistical objects Color symbol object, Horseshoe line diagram and Horseshoe area diagram are especially suitable for the statistical evaluation of color image regions.

Color distances can be calculated via the menu items „Color | color difference between two images“ and „Color | color difference to one color“. The calculation of color differences is described in section 14.3 on page 177.

A color image can be decomposed into components via the menu item „Color | Decompose into color extracts“ e.g.. into X, Y, Z, L, x, y etc. As a result of the decomposition there are monochromatic images which can be analyzed and handled by image processing methods. If it makes sense to compose the results of the processing to a new image it can be done by means of the menu item „Color | Compose color extracts“. These procedures are described in section 14.1 on page 176.

2.14 How to print or export the results?

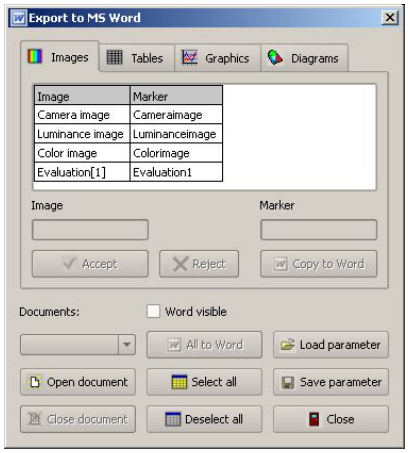
The menus and context menus, respectively of images, tables, graphs and diagrams have the menu items Print, Copy and Export. Short description:

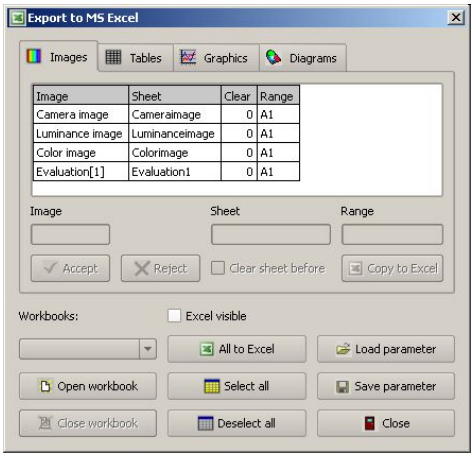
- Print: Direct output of a relevant view to a printer connected.

- Copy: Filing the relevant view into the clipboard thus enabling it to be inserted into a different program. The data format depends on the view, sometimes data is copied into the clipboard in different formats simultaneously. Therefore, the menu item „Insert contents“ or „Insert as“ should be used if available instead of Insert in order to have full control about the format to be inserted.

- Exporting: The results are stored in a file. And again the data format is dependent on the relevant view.

To generate, process and represent reports in a word processing system or in a table calculation the program has export interfaces to „Microsoft Word“ and „Microsoft Excel“. The dialogs for the data export are called via the menu items „Protocol | Export to MS-Word“ and „Protocol | Export to MS Excel“, respectively. A more detailed description of the export options to Word and Excel can be seen in section 15.3 beginning on page 183.





When exporting to Word text markers are used in order to identify the insertion places, when exporting to Excel the names of the tab sheets are used. Hence, it is possible to generate in both programs customer-defined and task-specific source documents where the data is updated by the Lmk software.

2.15 How to store results for a later evaluation?

The current program state can be saved in a protocol file via the menu item „Protocol | Save file“. The state can be restored later via the menu item „Protocol | Load“. The protocol files with the ending *.ttcs (**T**echno**T**eam **C**ompressed **S**tream) contain:

- Images.
- Measuring regions.
- Parameters of all statistical evaluations, thus allowing them to be reconstructed after loading the images and regions.
- Display parameters thus enabling the representation of the measuring results to be set into the state as they were when they were stored.
- Results of the time statistic.

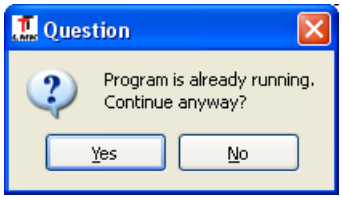
When at the end of the program the software offers to store the current state in order to allow it to be reconstructed when the program is started again thus allowing you to continue work at the same point then storing is performed in the same format. For details see chapter 7 beginning on page 75.

Protocols in HDF5 format as used in the Lmk2000 software can be loaded via the menu item „Protocol | Import HDF5 file“. Storing in this format is not possible.

Images, measuring regions and parameter files of statistics and some image processing operations can be saved in single files and loaded again later. It is, however, not possible to load results again which are calculated by the program automatically such as tables, diagrams, graphs.

2.16 How to exchange data between different measuring records

It is often the case that images or measuring regions saved in a particular measuring record shall be used also for another evaluation. However, when loading a new protocol which contains the data of interest, the data already existing in the program will be overwritten. Now, a second instance of the program can simply be opened to load a second protocol there. When starting another instance of the software, first a security query will have to be answered:



In the second program which is opened, the second protocol can be opened. Now, data can be exchanged between both programs via the clipboard.

Another option is to make sure that, by means of the menu item „UPDATE PROTOCOL“, not all of the already existing data are overwritten, but, for example, only the contents of the images or the kind of the evaluations. See also paragraph 7.2 on page 76.

2.17 How can the program work with other programs?

The export options to the clipboard and the compatibility with Microsoft Word and Microsoft Excel were described in section 2.14 on page 23. Additionally, the program version LABSOFT EXTENDED can be used as ActiveX-Server. A possible application is to write your own Excel application where the LMK functions can be accessed by means of „VISUAL BASIC“. At present, the ActiveX interface is capable of performing the functions below:

- Opening and closing application and camera.
- Capturing camera, luminance and color images.
- Loading and saving images and protocols. They can already have the evaluation images and statistics needed.
- Access to the measuring values of the statistics.
- Handling different menu items. Hence, the user can work with macros of his own.

The ActiveX interface is described in chapter 16 beginning on page 189. If desired, the existing range of functions can be expanded.

2.18 How can the program be reset to the factory settings?

Many settings implemented in the program are saved after the program is finished. When it is restarted later, these settings will be loaded, such as:

- The display of the results of statistical analyses,
- the colored representation of image points for luminance, integral and symbol objects,
- images and parameters used in the image arithmetic functions,
- parameters and settings found in numerous dialogs.

Using the menu item „Program preview | Reset to factory settings“, these entries can be deleted in order to return to that state provided during the original program installation.

After calling this function, the program must be restarted to allow any modifications to become effective.

2.19 Where to get help?

In the program this manual is opened via the menu item „Help | manual“. In case of problems which cannot be solved by reading the manual we recommend you to collect some information on the items listed below before contacting our customer service department:

- What program version is worked with? Use the menu item „Help | On“.
- What hardware is used (number of camera, additional hardware)?
- What function do you want to be informed on, when and where do the problems occur?
- In what section of the manual is the function described? What is wrong and does not work as described in the manual?
- Save the data which cause the problem. We recommend to save the data in a protocol file (menu item „Protocol | save file“). These files contain the complete program state and are a convenient tool for describing the problem.
- Note the step of the process the problem resulted from.

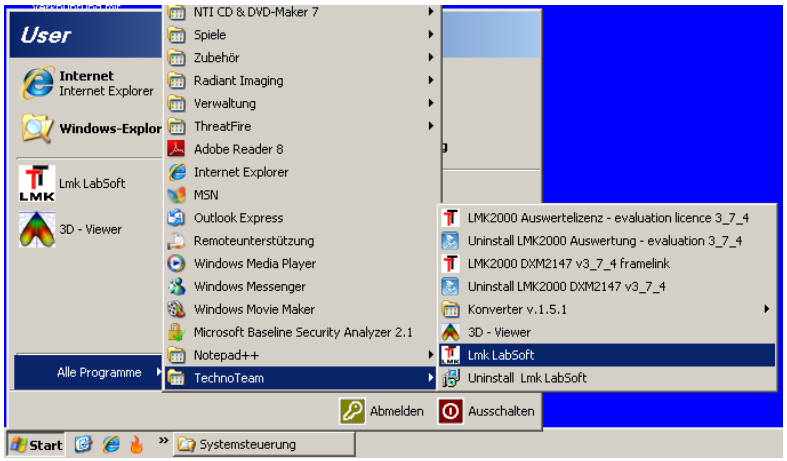
Having collected this information contact the customer service department, please:

labsoft@technoteam.de

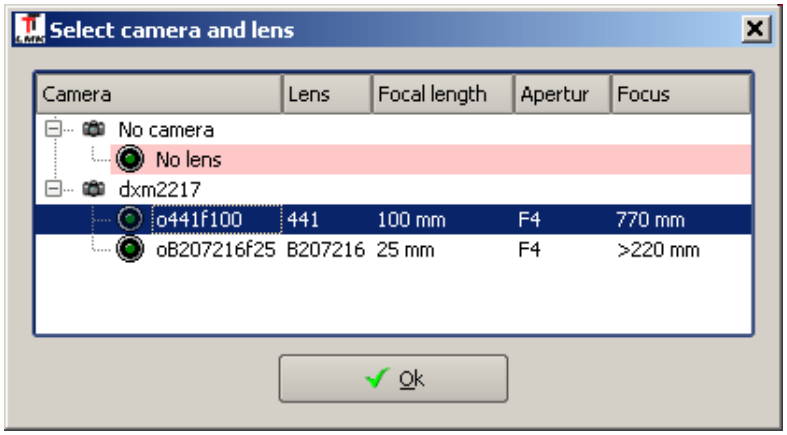
3 Starting and closing the program

3.1 Starting the program

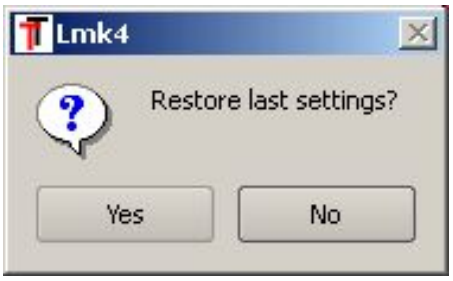
The program is opened by the start menu of Windows, in the example by „Start | Program files | TechnoTeam | Lmk LabSoft“, or by double-clicking on the relevant start icon.



If a camera is installed on the computer the dialog „Select camera and lens“ is opened when the program is started-up. In this dialog either the camera-lens combination to be used or the evaluation version without the use of hardware can be selected. If there is no camera installed on the computer this dialog does not appear and the software evaluation version is started immediately. See section 4.2 on page 38.



If the dialog is left by „CANCEL“ the default settings marked as a red line remain. After „OK“ the hardware desired is initialized. After that, the program will ask you whether you want to load a program state again which had possibly been saved before.



The last program state is saved in the file „LASTWORK.TTCS“. This file and some other temporary files are saved in the temporary user directory in the subdirectory „ /LMK4.EXE/“.

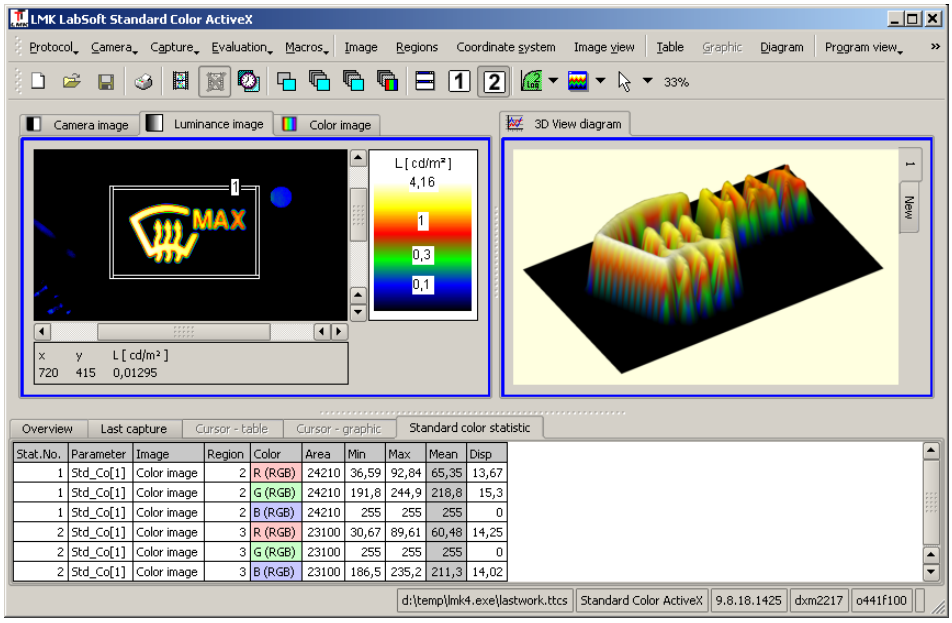
3.2 Closing the program

The program can be closed by the icon CLOSE in the top right-hand corner of the program window, by the menu item „PROTOCOL | CLOSE“ or by the key „ALT-F4“. Then, the user is asked if he wants to save the current state.

As described in the previous section, the saving is performed in the protocol file „LASTWORK.TTCS“. When working with the program other protocols can be loaded or saved. The work with protocol files is described in detail in chapter 7 beginning on page 75.

3.3 The main window of the application

When the program has been started and a program state which had been saved before has been loaded again, you are in the main window of the application.



3.3.1 Main menu

The items of the main menu are divided into groups.

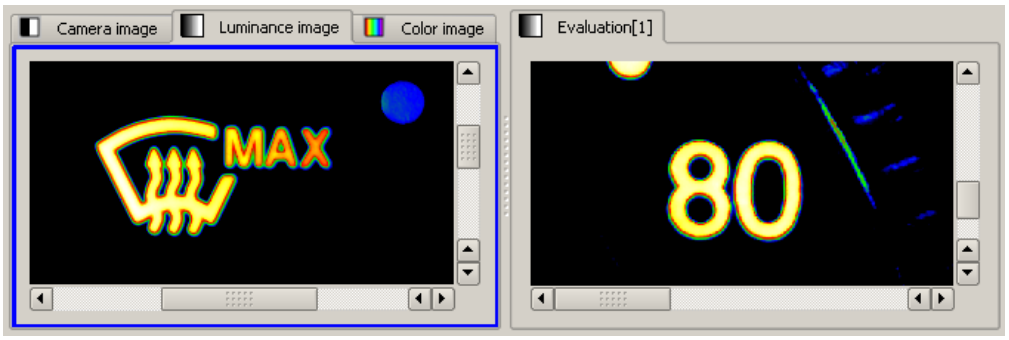
In the first group there are the main menu items.

- The menu PROTOCOL contains the menu items for loading and saving protocols, for importing HDF5 files (protocol format of Lmk2000 software), for changing the language used in the program and for calling up the dialogs for the data export to Microsoft Word and Microsoft Excel.
- The menu items which are used to control the used camera are summarized in the menu CAMERA: Turning on and off the capture mode, selecting the exposure time, recalibrating the camera, exchanging camera and lens.
- The menu items of the menu CAPTURE contain all the menu items needed to capture new luminance and color images and the parameterization of the capturing algorithms as well.
- The functions listed below are summarized in the menu EVALUATION:
  - Accessing the statistical calculations (see chapter 12 beginning on page 111).
  - Creating and deleting evaluation images. Evaluation images are essential for a lot of image processing algorithms (see section 13.1 on page 155).

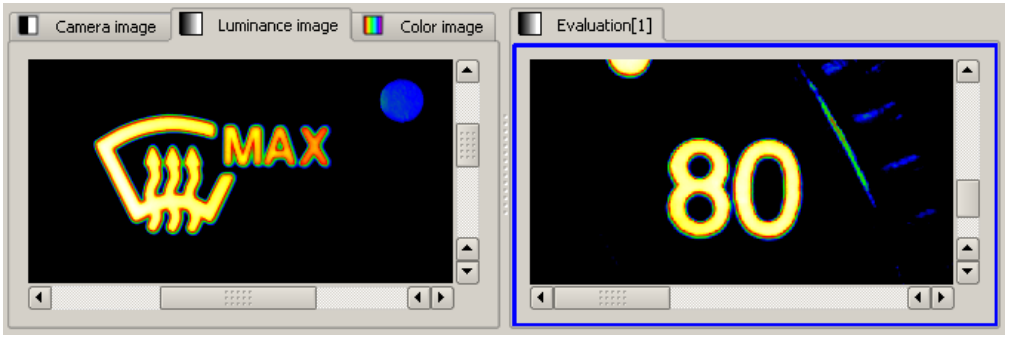
– Assigning lists of regions to images (see section 13.4 on page 157).
– Accessing to the general image processing dialog (see section 13.8 on page 164).
– Calling different image processing operations: projective rectification, transformation of coordinates, calculation of isolines. These operations are described in chapter 13 beginning on page 153.

The image menu items are required for processing the current image. In the one-tab-window view the image displayed is always the current image. In the two-tab-window view either the image on the right-hand side or on the left-hand side can be made active by clicking with the left mouse key on the image desired. Then, the image menu is part of the enabled image.

„Luminance image“ is enabled



„Evaluation[1]“ is enabled

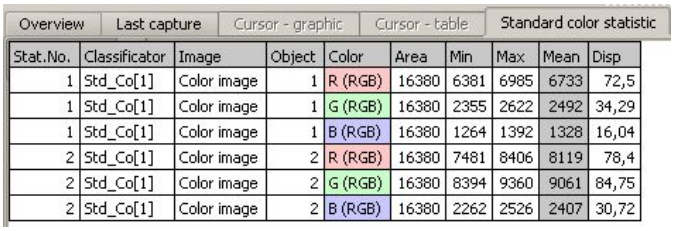


The tasks performed by the image menu items are as follows:

- IMAGE: Loading, saving, printing, duplicating, deleting, copying and pasting images, changing existing image properties. For a more detailed description see chapter 8 beginning on page 78.
- REGIONS: Loading, saving, copying and pasting lists of regions. Creating, deleting and changing regions via dialog. Operations possible with regions can be found in chapter 9 beginning on page 93.
- COORDINATE SYSTEM: Loading, saving, copying and pasting a coordinate system. Changing the coordinate system properties of the current image via a dialog. The coordinate systems are described in detail in chapter 10 beginning on page 105.
- IMAGE VIEW: Changing the image display: scaling, palette, zoom, cursor, status line. For a more detailed description see section 8.2 on page 80.

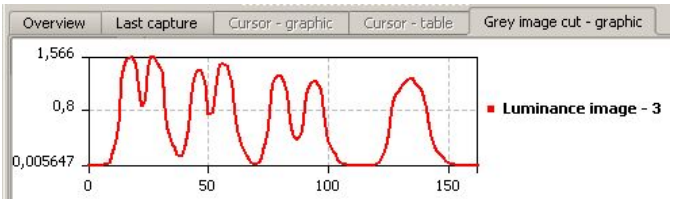
The accessibility of the menu items of the menus TABLE, GRAPHIC or DIAGRAM depends on the existence and the condition of these views in the program.

- The menu TABLE contains the option to save, to copy into the clipboard or to print an existing table. Furthermore, existing columns of a table can be made invisible. The invisible columns are no longer taken into consideration during the saving, copying and printing operations.

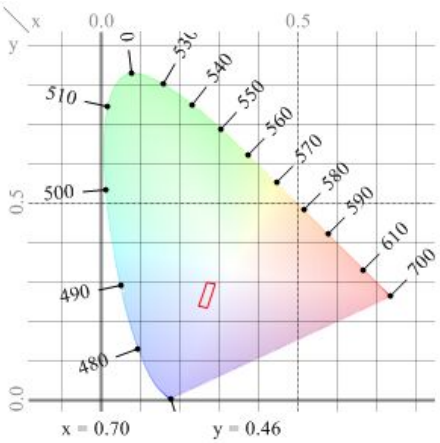


Stat.No.	Classificator	Image	Object	Color	Area	Min	Max	Mean	Disp
1	Std_Co[1]	Color image	1	R (RGB)	16380	6381	6985	6733	72,5
1	Std_Co[1]	Color image	1	G (RGB)	16380	2355	2622	2492	34,29
1	Std_Co[1]	Color image	1	B (RGB)	16380	1264	1392	1328	16,04
2	Std_Co[1]	Color image	2	R (RGB)	16380	7481	8406	8119	78,4
2	Std_Co[1]	Color image	2	G (RGB)	16380	8394	9360	9061	84,75
2	Std_Co[1]	Color image	2	B (RGB)	16380	2262	2526	2407	30,72

- The menu items of the menu GRAPHIC can be used to save, copy or print graphics such as sectional views of luminance or histograms or to change their display properties.



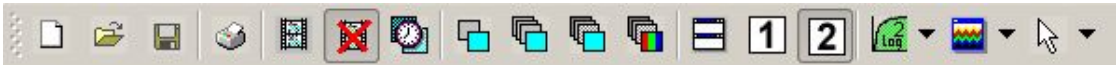
- The menu DIAGRAM contains the possible operations for horseshoe diagrams or 3D-views. The functionality is the same as for graphics.



The total view of the program can be modified in the menu WINDOW. You can select either a one-tab-window or a two-tab-window view or you can decide to display images and diagrams or tables and graphics.

In the menu HELP you can open this operation manual or you can get information on the current program version.

3.3.2 Tool bar



A tool bar below the main menu allows quick access to the most important menu commands. Thus, they can directly be accessed via a mouse click. If the mouse is moved over one of these buttons a help text is shown for a short time.

Protocols and printing


New protocol, deleting all images, tables, graphics and diagrams.


Loading protocol.


Saving protocol.


Printing, i.e.calling up the dialog „EXPORT TO MS WORD“.

For more information on protocols see chapter 7 beginning on page 75. For printing outputs see section 15.3 on page 183.

Camera and capturing

 Live mode, i.e. turning on permanent capture mode.

 Turning off permanent capture mode.

 Opening the dialog „EXPOSURE TIME“.

 Capturing a luminance image by means of the algorithm SINGLEPIC.

 Capturing a luminance image by means of the algorithm MULTIPIC.

 Capturing a luminance image by means of the algorithm HIGHDYN.

 Capturing a color image by means of the algorithm COLORHIGHDYN.

For further information on turning the live mode and the „EXPOSURE TIME“ dialog on and off see section 5.1.1 on page 44. For capturing luminance and color images see section 5.2 on page 46.

Program view

 Restoring the standard distribution of images and tables.

 Switching to the one-tab-window view. In this view the image can be seen in full width.

 Switching to the two-tab-window view . In this view two images are displayed side by side.

The menu items by means of which these displays can also be changed can be found in the menu item WINDOW in the main menu.

Image display

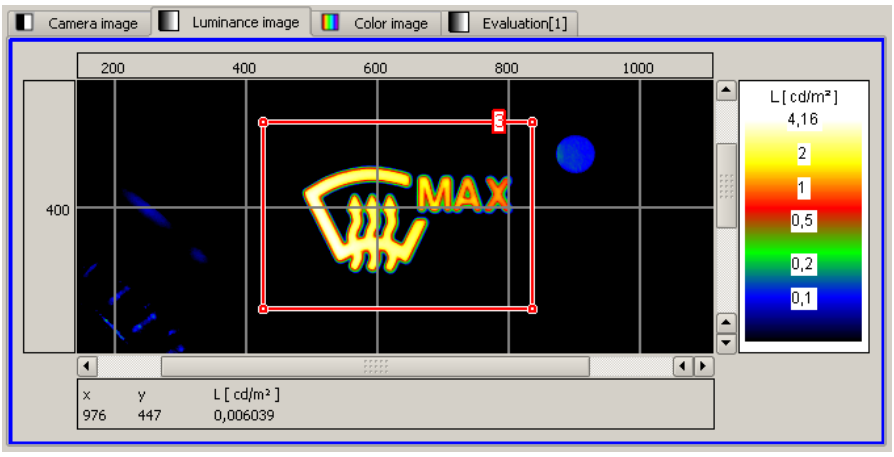
Behind the last 3 buttons of the tool bar there are menus where you can modify the display of the current image. Depending on the current settings also the appearance of the buttons changes. To modify the settings do not click on the button but on the arrow on the right.

 Display of the current scaling and the option to modify it. For more detailed information see section 8.3 on page 81.

 Display of the current color palette and the option to modify it. For more detailed information see section 8.4 on page 82.

 Display of the current cursor and the option to modify it. For more detailed information see chapter 11 beginning on page 108.

3.3.3 Image display



In the center part of the program the images and diagrams are displayed in a tab window. The image or diagram desired can be shown in the foreground by clicking on the tab. After the start of the program there are the „Camera image“ and the „Luminance image“. The „Color image“ only exists if a color camera or the color evaluation version of the program is used.

While working with the program the other tabs were created if desired:

- The „3D View diagram“ is the result view of a statistical evaluation see chapter 12 beginning on page 111.
- The image „Evaluation[1]“ is a monochromatic evaluation image, the image „Evaluation[2]“ is a color evaluation image. For working with evaluation images in image processing see chapter 13 beginning on page 153 and for color evaluation see chapter 14 beginning on page 175.

A part of the luminance image is displayed in the middle. The colors used for the pseudo colorization of the luminance values can be seen in the color palette on the right-hand side of the image. The values in this palette show what luminance appears in what color in the image.

In the top right-hand part of the rectangular measuring region, displayed in the image, you can find its designation „1“. The name of the image and the name of the region allow a distinct relation between the measuring values of the statistics and their measuring places in the image.

The horizontal and vertical auxiliary lines in the image are part of the coordinate system used. The axis marking can be found on the left and on the top edge of the image.

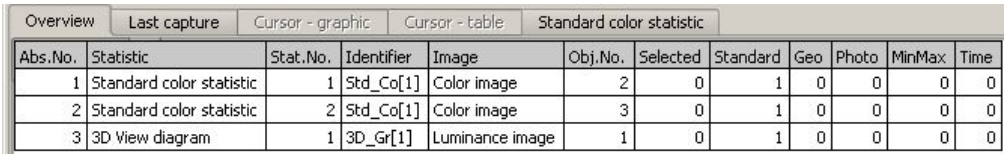
Measuring values belonging to the cursor used in the image are displayed in a box below the image. In the example, a luminance value L in $cd/m^2$was measured at the position (x, y) . The names and units of the geometric position depend on the coordinate system used, see chapter 10 beginning on page 105. Physical parameters and units can be modified via the dialog „Image properties“, see section 8.6.2 on page 90.

The scroll bar next to the right-hand side and the bottom of the image allows to navigate in the image. The enlargement of the image is achieved best by means of the scroll wheel of the mouse.

3.3.4 Tables and graphics

There is a second tab window in the lower part of the program where the results are displayed. Here, the results of the statistical evaluations are represented as tables and graphics. The following information is always displayed there:

- OVERVIEW: This table contains a list of all statistics defined in the program together with their parameters such as type of statistic, image and region the statistic was created for.

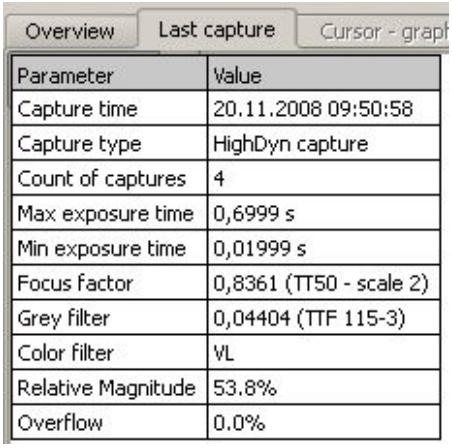


Overview | Last capture | Cursor - graphic | Cursor - table | Standard color statistic

Abs.No.	Statistic	Stat.No.	Identifier	Image	Obj.No.	Selected	Standard	Geo	Photo	MinMax	Time
1	Standard color statistic	1	Std_Co[1]	Color image	2	0	1	0	0	0	0
2	Standard color statistic	2	Std_Co[1]	Color image	3	0	1	0	0	0	0
3	3D View diagram	1	3D_Gr[1]	Luminance image	1	0	1	0	0	0	0

  In the example shown two objects of the „STANDARD COLOR STATISTIC“ type were created in the „COLOR IMAGE“. There is another evaluation of the „3D VIEW DIAGRAM“ type in the „LUMINANCE IMAGE“.

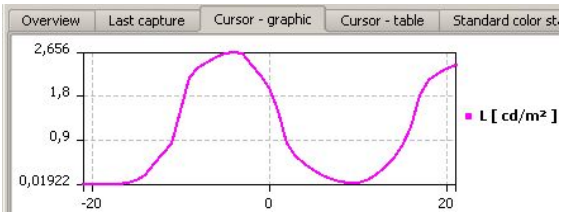
- LAST CAPTURE: This table contains the parameters used after a capture.



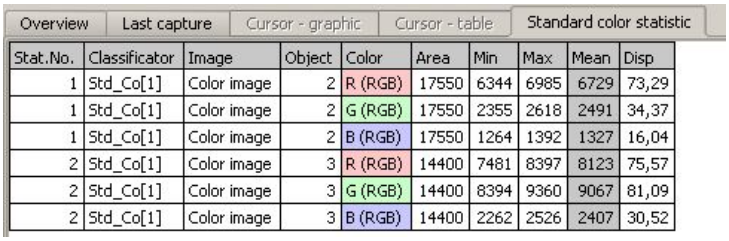
Overview | Last capture | Cursor - graph

Parameter	Value
Capture time	20.11.2008 09:50:58
Capture type	HighDyn capture
Count of captures	4
Max exposure time	0,6999 s
Min exposure time	0,01999 s
Focus factor	0,8361 (TT50 - scale 2)
Grey filter	0,04404 (TTF 115-3)
Color filter	VL
Relative Magnitude	53.8%
Overflow	0.0%

- „CURSOR - GRAPHIC“ and „CURSOR - TABLE“: These two views are only enabled if in the current image a „RECTANGLE“, „CIRCLE“ or „LINE CURSOR“ is used. In those cases the statistical measuring results are represented in table form or graphically at the cursor position. If there is a rectangle or a circle cursor the display contains a histogram of the measuring values within the cursor; if there is a line cursor then a sectional view is shown along the cursor.



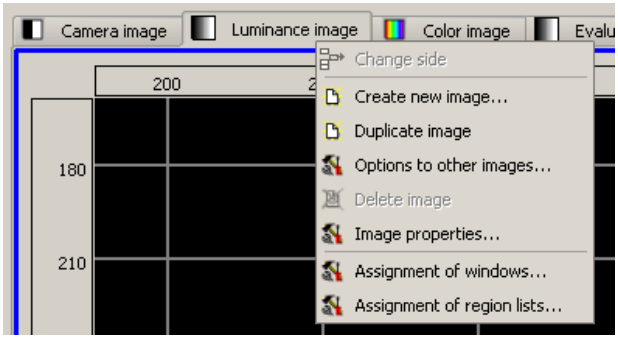
- All the other tables and graphics are created when statistical objects are created and the visibility of the views is desired. Creating, parameterizating and deleting statistical evaluations are described in chapter 12 beginning on page 111.



Stat.No.	Classificator	Image	Object	Color	Area	Min	Max	Mean	Disp
1	Std_Co[1]	Color image	2	R (RGB)	17550	6344	6985	6729	73,29
1	Std_Co[1]	Color image	2	G (RGB)	17550	2355	2618	2491	34,37
1	Std_Co[1]	Color image	2	B (RGB)	17550	1264	1392	1327	16,04
2	Std_Co[1]	Color image	3	R (RGB)	14400	7481	8397	8123	75,57
2	Std_Co[1]	Color image	3	G (RGB)	14400	8394	9360	9067	81,09
2	Std_Co[1]	Color image	3	B (RGB)	14400	2262	2526	2407	30,52

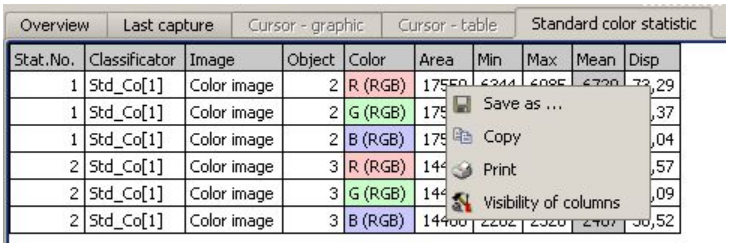
3.3.5 Context menus

In several views of the program there are context menus available. They can be opened by pressing the right mouse key. Some of them have the same menu items as you can find for these views in the main menu. Others, however, contain additional options relating to the current state of the relevant view.

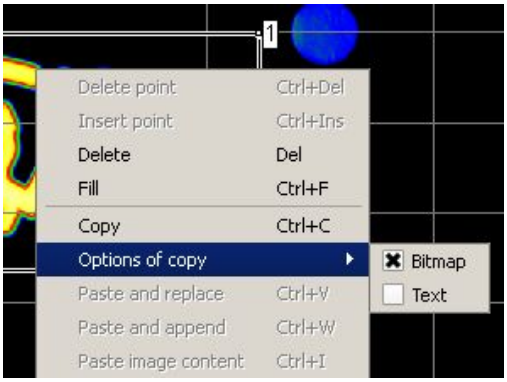


The context menu of the image tab window contains menu items which can also be found in the menu „Evaluation“ of the main menu. In contrast to user-defined evaluation images, the „Luminance image“ as a permanently existing image cannot be deleted. Therefore, the menu item „Delete current image“ is not enabled.

The menu item „Change side“ can only be used when working in the two-tab window mode. An image can be displaced from the tab window on the left to the one on the right by means of this menu item without using the dialog „Evaluation | Assigning the windows“.



The context menus in the displays of the tables and graphics in the lower part of the program are identical to the corresponding menu items in the main menu when TABLE and GRAPHIC are used.

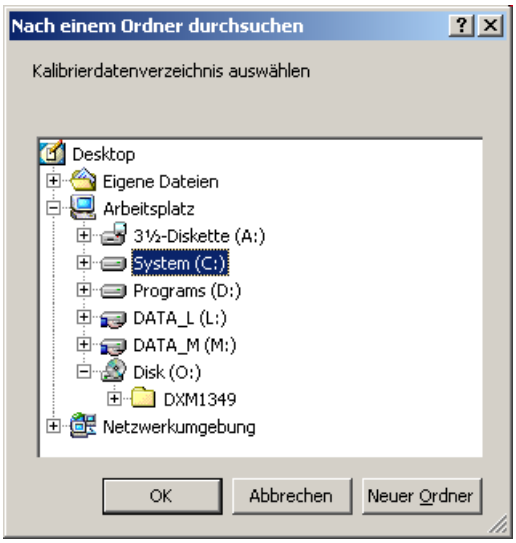


The menu items in the context menu of an image are different depending on the existence of no marked region, one marked region or two marked regions. Furthermore, not all operations are possible with all region types. For example, when working with rectangular regions it is not possible to delete or insert contour points.

4 Camera, lens and recalibration

4.1 1 Installing new calibration data

After the installation of the program the calibration data for the camera and its lenses to be used does still not exist. They can be engaged via the menu item „Camera | New calibration data“. A directory dialog is opened allowing the directory (usually on a CD) which contains the data needed to be selected.



The selected directory with the calibration data is automatically copied into the subdirectory Camera of the existing program installation.

There is a security query before existing data is overwritten during an update operation. After the copying step the new data is immediately available and can be used without a new program start.

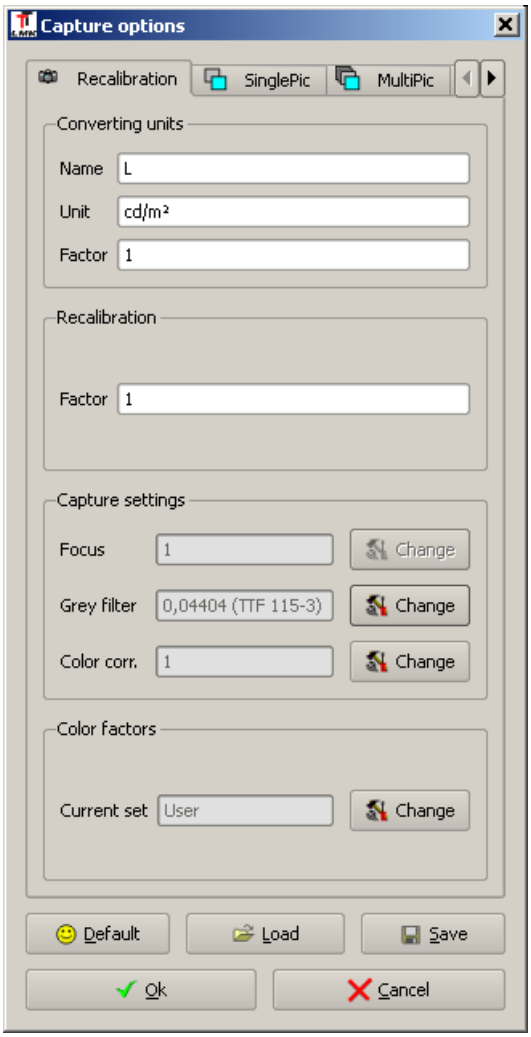
4.2 Selecting camera and lens

If there is some calibration data available when the program is started, a dialog for the selection of a camera-lens combination opens automatically. If required this dialog can manually be opened by calling up the menu item „Camera | change“. Hence, you can change to a different camera, to a different lens or to the evaluation version of the program without using hardware.

If the dialog is left by Cancel the current settings marked as a red line remain. Using Ok the hardware desired is initialized.

4.3 Setting camera and lens properties

The dialog „Capture options“ can be opened by selecting the menu item „Camera | recalibration“. The dialog contains the page Recalibration. Here, the calibration data loaded by selecting the camera-lens-combination can be complemented.



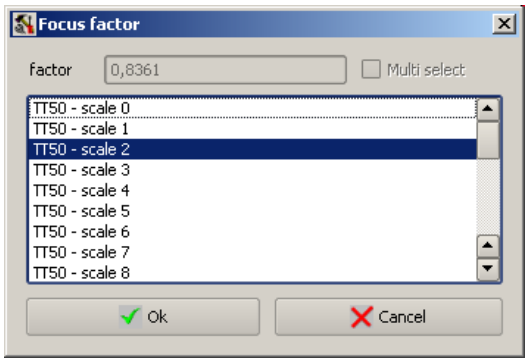
The unit and the conversion factor for the luminance calculation are defined in the section „Converting units“. The TechnoTeam cameras for luminance measurements are calibrated in „cd/m^2“ and the conversion factor is „1“. If a result output in for example Footlambert is desired, the unit „fL“ and the conversion factor 3.4262591 have to be entered.

If there is a deviation of the measured luminance from the calibration standards of the company, it can be corrected by entering a factor in the section Recalibration.

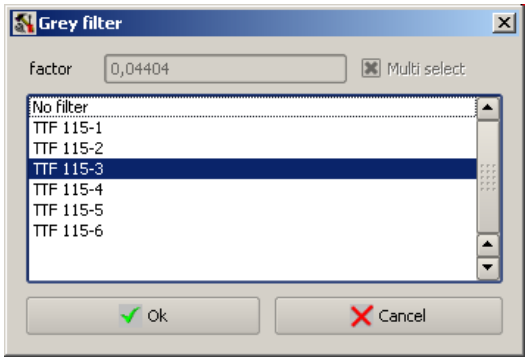
The corrections possible in the section „Capture settings“ are as follows:

- When working with a focusable lens a calibration factor changes depending on the distance settings of the lens. In such a case the scale value has to be read from the

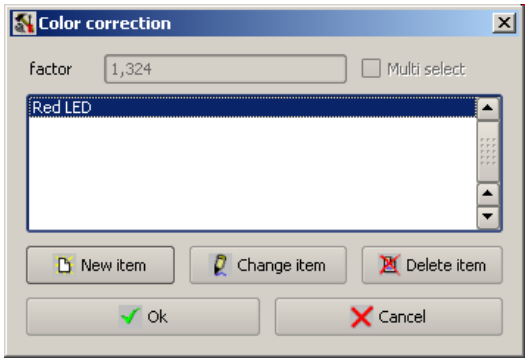
lens, the button CHANGE in the line FOCUS has to be used and the focus value desired has to be selected in the dialog:



- If neutral grey filters or other filters are used and if there are the corresponding factors available in the calibration data, the used filters can be entered into the line „GREY FILTER“ after having selected the button CHANGE. Several filters can be selected simultaneously by keeping the Ctrl.-key in the dialog „GREY FILTER“ pressed. For them a common correction factor is calculated then.



- The luminance calibration of the camera is performed with „STANDARD LIGHT TYPE A“. When measuring narrow-band light sources, some deviations of the measured luminance are possible. Therefore, in the line „COLOR CORRECTION“ you can define your own calibration factors where deviations in always repeating measuring tasks with known light sources of this type can be corrected.



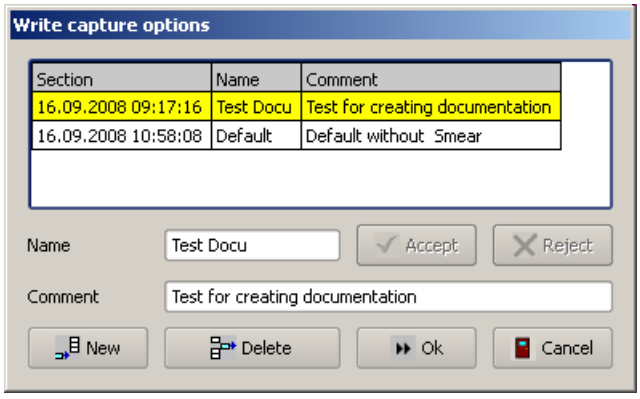
In contrast to the dialogs for the selection of a focus factor and of a neutral grey filter, the list for the color correction factors is usually empty when the program is delivered. By means of the button „New item“ a new correction factor can be defined and a value can be entered. Existing entries can be edited via „Change item“ and removed again via „Delete item“.

When working with a color camera the color matrixing can be modified by means of the button Change in the section „Color factors“. This option is described in section 4.3.1 on page 41.

All settings of the dialog are reset to the standard settings after using the button Default:

- Luminance measurement in cd/m^2.
- Recalibration factor = 1.
- No focus factor, no neutral grey filter, no color correction factor.
- The use of standard color factors when using color filters.

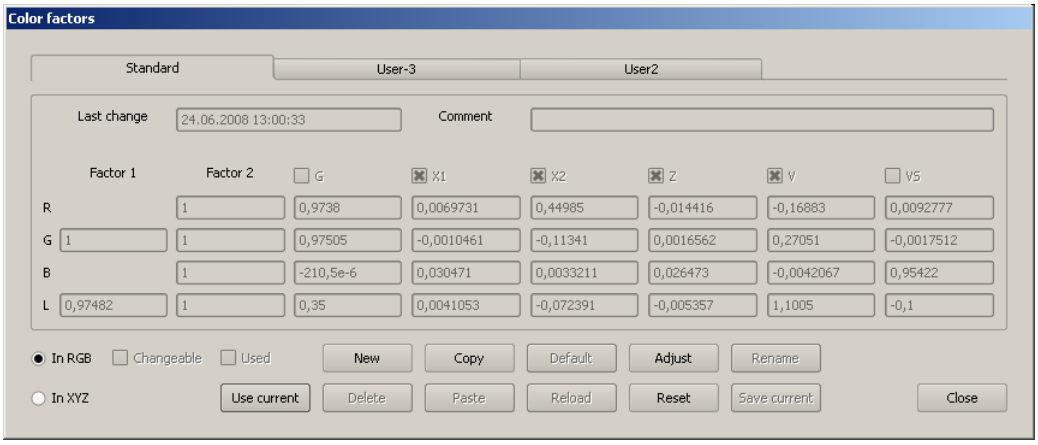
User-defined calibration data records can be managed via the buttons Load and Save. The dialogs „Save capture options“ or „Load capture options“ are opened:



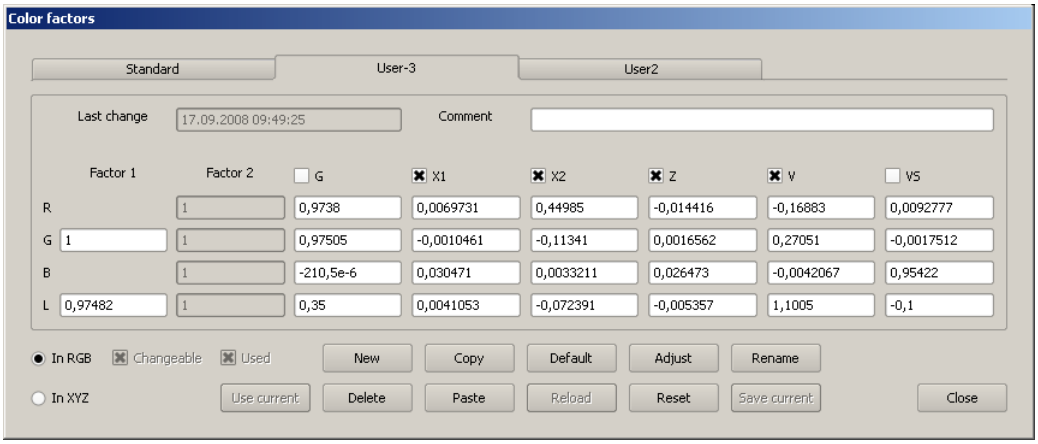
When saving options by means of the button New a new data record with capture options can be created in these dialogs. When a data record has been changed data is accepted by means of Accept, by Reject the changes are canceled. When the dialog is called up the data from the recalibration dialog is accepted in the program or written into a file.

4.3.1 Color factors

When a filter wheel color camera is used, the company-based color matrixing can be replaced by a user-defined matrixing in order to achieve a better adaptation of the measured color values to the measuring tasks desired. Changing the color matrixing can be performed as described in the previous section via the capture option dialog.



Company-based matrixing



User-defined matrixing

In the upper part of the dialog there is a tab with the matrixing existing in the program. In the middle of the dialog there is the following information for a matrixing:

- Last change: Time of the last change of the color factor set.
- Comment: Here, remarks with respect to matrixing can be entered.
- By means of the six check boxes arranged side by side you can select which of the 6 filters in the filter wheel are to be used for a luminance or color capture, respectively.
- Factor 1: A prefactor for the color image and another one for the black-and-white image.
- Factor 2: A prefactor per color channel.
- 4x6 field with factors for the weighting of a color filter in the corresponding result image.

The lower part of the dialog contains the following functions:

- The view in the dialog changes depending on whether the corresponding view had been selected via the radio buttons „In RGB“ or „In XYZ“. The factors are displayed in the corresponding color space.
- The check box Changeable shows whether the data record coefficients may be changed by the user. In the default settings the first data record Standard is write-protected. The default parameters are accepted for other user-defined data records.
- The check box Used shows if the next color images can be calculated by means of the parameters currently displayed. One data record can exactly be in this state. If it is not set the data record displayed can be transformed into the record which is used by means of the button „Use current“.
- A new data record can be created by the button New. In a dialog you first have to give the name of the new data record, then the new data record is displayed in the tab window. During the creation the parameters of the Standard data record are entered.
- The data record displayed can be deleted by means of the button Delete. All data records designated as Changeable can be deleted. The first standard data record cannot be deleted.
- The two buttons Copy and Paste allow the factors to be exchanged between data records via the clipboard. Name, comment and the flags Used and Changeable are not copied.
- The data of the Standard data record is transferred to the current record by means of the button Default.
- If the changes made in the dialog have not been saved the previous state can be reconstructed via the button Reload.
- The color space transformation can be adapted to the measuring value of a reference device (Lxy) by means of the button Adjust. For that, simultaneous measurements with the Lmk and the reference device are required.
- By means of the button Reset the factors in the column „Factor 2“ are set to 1 (only visible in the view „In XYZ“).
- A new name for the new data record can be entered by means of the button Rename. The program does not allow a name to be used twice.
- Changes of the current data record can be accepted by using the button „Save current“.

If the parameter changes have been performed they are available in the program only and are not permanently saved in the calibration data. Thus a corresponding query when the dialog is left by the button Close.

5 Capturing images

5.1 Capturing camera images

A single camera image with the current exposure time is captured via the menu item „Camera | grab“.

One or more camera images are captured via the menu item „Capture | Autoscan“. After each capture the brightness of the image is checked. If the brightest parts of an image are not overdriven yet this image is said to have its optimal brightness. The program corrects the exposure time automatically taking further shots as long as the optimal brightness has been achieved.

5.1.1 Turning on the permanent capture mode (live mode)

The permanent capture mode by the camera is turned on either by means of the button or via the menu item „Camera | Live“. At the same time, the view of the program is changed so that the camera image can also be seen. For that, the camera image is made the active window in the tab window. The dialog „Exposure time“ is simultaneously opened at the beginning of the live mode in order to set the exposure to light.

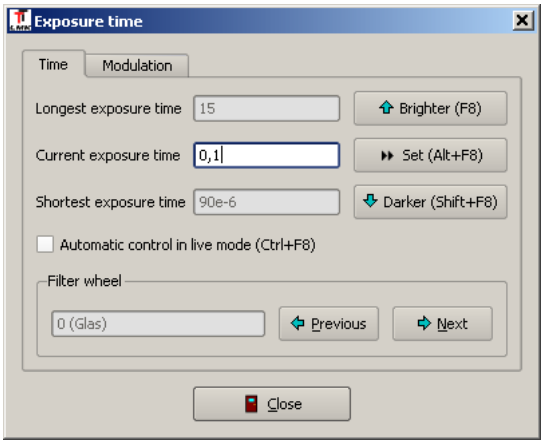
5.1.2 Turning off the permanent capture mode (freeze mode)

The permanent capture mode of the camera can be closed by the button  or via the menu item „Camera | Freeze“. The exposure time dialog possibly still open is closed at the same time.

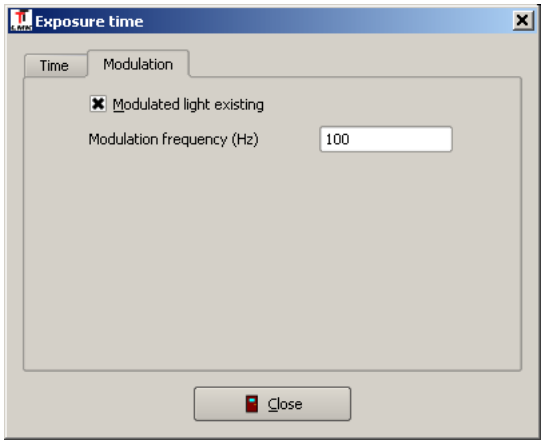
5.1.3 Modifying the capture mode properties

Together with the previous menu items the exposure time setting dialog is opened simultaneously and then closed again. However it can also be opened whenever you want by means of the menu item „Camera | Exposure time“ or by the button in order to be informed about the parameters currently set or in order to modify them.

The dialog contains the two pages Time and Modulation. The appearance of the page Time depends on working with a filter wheel color camera or a black-and-white camera. The section „Filter wheel“ only exists if a filter wheel camera is used.



Page „Time“



Page „Modulation“

Current exposure time

The exposure time currently used by the camera is displayed in the entry field „Current exposure time“ where it can also be changed by the user. All entries have to be terminated either by the enter key or by the button Set. The region allowing user-defined entries contains information on the longest and on the shortest exposure times. In contrast to numerical entries, it is also possible to use the buttons Brighter or Darker or the function keys F8 or Shift-F8 if a different exposure time has to be selected.

In applications where the objects to be measured contain the brightest image regions a suitable exposure time is selected by the program itself. The option „Automatic control in live mode“ is available for this purpose. After the capture of every single camera image the algorithm implemented checks for overdriving and carries out relevant corrections of the exposure time.

Filter wheel

If a filter wheel camera is worked with the filter used can be changed in the section „Filter wheel“. With this filter the next capture of a monochromatic image with the algorithms SinglePic, MultiPic or HighDyn is shot, see the following sections. The capture of a color image with the algorithm ColorHighDyn is not influenced by the selection of the filter in the dialog. For the use of filters for capturing color images see section 4.3.1 on page 41.

Modulation

If the light sources are operated by alternating voltage the light emitted is modulated. To avoid modulation-caused measuring errors it is recommended to use exposure times which are integer multiples of the cycle duration of the modulation. On the page Modulation the modulation frequency can be entered and the program can be instructed by the option „Modulated light existing“ to use suitable times only.

With alternating voltage, usually double the frequency can be entered since the light is modulated with the doubled frequency.

The modulation frequency entered into the dialog „Exposure time“ is equal to the one used in the dialog „Capture options“ on the page Modulation, see section 5.2.2 on page 47.

Please, note that with enabled modulation option exposure times shorter than the duration of one cycle are impossible.

5.2 Capturing luminance and color images

The capture commands are available in the menu Capture and in the relevant buttons of the bar, respectively. (The option for capturing measurement series is available in chapter 6 beginning on page 60.)

5.2.1 Capturing algoritms

The capturing of luminance images is possible with the menu items „Capture | SinglePic“, „Capture | MultiPic“ and „Capture | HighDyn“ and via the corresponding buttons of the bar.

If a color camera is used, the filter wheel is not newly positioned for monochromatic captures. Therefore, it is possible to generate one-channel captures with an optional filter existing in the filter wheel. The filter wheel can be positioned by means of the dialog „Exposure time“ which can be retrieved via the menu item „Camera | Exposure time“. It was described in the previous section.

True luminance images are captured with a filter wheel camera using a $V(\lambda)$ filter. This filter is set automatically by the program:

- after each program start
- after each color image shot

„SinglePic“ captures

By means of the algorithm SinglePic a camera image is captured and converted into a luminance image. A capture is started via the menu item „Capture | SinglePic“ or via the quick start button  .

„MultiPic“ captures

By means of the algorithm MultiPic several camera images are captured one after another using the same exposure time and are converted into one common luminance image. The use of several camera images results in a noise reduction in the luminance image calculated. A capture is started via the menu item „Capture | MultiPic“ or via the quick start button  .

„HighDyn“ captures

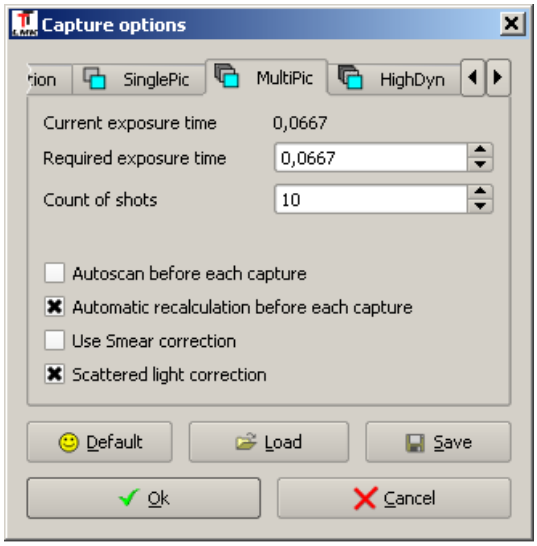
By means of the algorithm HighDyn several camera images with different exposure times are shot and converted into a luminance image. The use of different exposure times allows a higher dynamic range in the captured scene. A capture is generated via the menu item „Capture | HighDyn“ or via the quick start button .

„ColorHighDyn“ captures

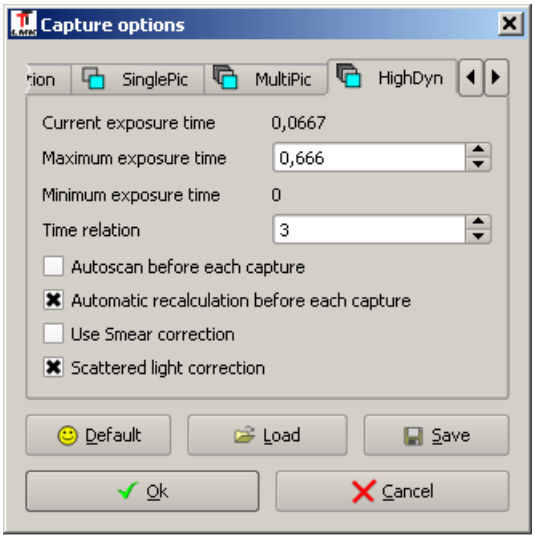
The algorithm ColorHighDyn is only available when a filter wheel color camera is used. When this camera type is used a lot of camera images with different exposure times and with different color filters are converted into one color image. To start such a capture the menu item „Capture | ColorHighDyn“ or the quick start button can be used.

5.2.2 Capture parameterization

The parameters for the 3 capturing methods can be inspected and changed by means of the menu item „Capture | Properties“. For that a dialog is opened where the parameters for each of the 3 methods can be set separately.



Page „MultiPic“



Page „HighDyn“

The count of shots is the only parameter that makes the difference between the pages SinglePic and MultiPic resulting from the fact that in the algorithm SinglePic only one camera shot is used.

Apart from the parameters of the three capturing methods there are other pages available in the dialog:

- Recalibration: Into this page recalibration factors, focus, grey filter and color factors may be entered and modified. This page was described in connection with the camera recalibration options in section 4.3 on page 39.

- Modulation: On this page the frequency of a modulated light source can be set. For these options see section 5.1.3 on page 44.
- Last capture: The parameters and results of the last monochromatic or color capture performed in the program are entered into this page.

Parameters existing for each capturing method

- In the top line the currently set exposure time of the camera is displayed. It can be modified via the exposure time dialog being described in section 5.1.3 on page 44.
- If the option „Autoscan before each capture“ is on, then the exposure time of the camera is automatically determined before each capture by the autoscan algorithm. In the case of a color capture the autoscan algorithm is applied to each color filter separately.
- If the option „Automatic recalculation before each capture“ is on, the times for the capture algorithms are adapted when the camera exposure time is modified via the dialog „Exposure time“: enlargements or reductions of the exposure times automatically result in enlargements or reductions of the times used in the capture methods.

  If, however, the option is off, the times entered into the „Capture options“ dialog are used for the shots, independently of a possible camera exposure time modification in live mode.
- Smear is an effect which may occur when very high luminance is captured. There are vertical white stripes in the images which do not exist in the measuring scene. These stripes are removed by switching on the option Smear.
- If data available for the „Scattered light correction“ then this option can be switched on or off in the dialog.

Single parameters of the capturing methods

- Required exposure time: In the methods SinglePic and MultiPic the camera images are captured with this exposure time. If the option „Automatic recalculation before each capture“ is enabled, the program modifies these times interactively depending on the camera exposure time. If this option is not enabled, the time which had been entered is used.
- Count of shots: In the MultiPic method the count of camera images is captured one after the other and converted into a luminance image.
- Maximum exposure time: In the HighDyn method the camera begins with this maximum exposure time. The exposure time is reduced for the next shot and this is continued as long as there are no more overdriven pixels in the image.
- Time relation: In the HighDyn method this parameter defines the rate of exposure time reduction for each successive camera image. This parameter should usually not be changed.

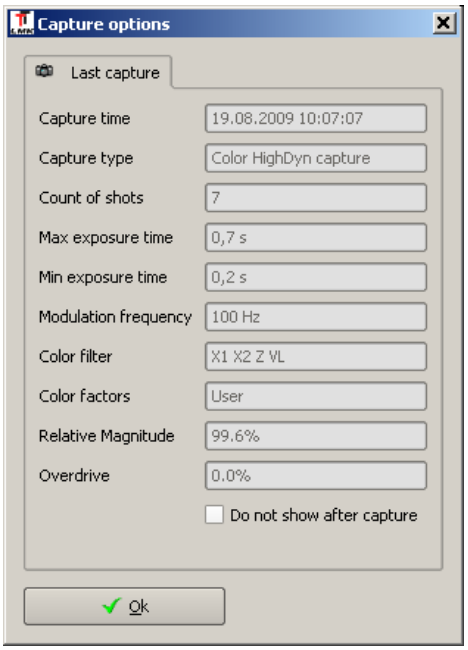
Loading and saving capture parameters

As described in section 4.3 on page 39, a data record generated in the „Capture options“ dialog can be saved and reloaded later. Thus, it is not necessary to enter the parameters required for a certain measuring task again and again. For this task there are the buttons Load and Save in the dialog.

5.2.3 Capturing images

It can be defined to darken the monitor during the shot via the menu item „Capture | Darkening during capture“. Hence, the results of the measuring scene are not negatively influenced by the light emitted by the monitor.

The parameters and the results of the shot are displayed after capturing a luminance or color image:



The display of the results can be disabled for successive captures by means of the option „Do not show after capture“. This option can be enabled again later since the page „Last capture“ also exists in the dialog „Capture options“ (menu item „Capture | Properties“). In the lower part of the program the same information is displayed in the table „Last capture“ independently of the dialog.

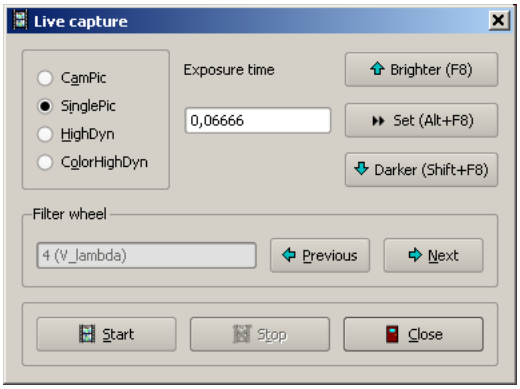
The line „Relative magnitude“ shows the magnitude in the camera images in per cent. The accuracy of the luminance values of the image is the better the modulation approaches to 100%. If the values are very low the shot should be repeated with longer exposure times. If the values are higher than 100% there is an overdrive in the camera image. In this case the percentage in the line Overflow shows the relative count of overdriven pixels in the image. For overdriven pixels the luminance calculated is incorrect.

Overview | Last capture | Cursor - graphi

Parameter	Value
Capture time	28.11.2008 14:48:57
Capture type	Color HighDyn capture
Count of captures	15
Max exposure time	1,1 s
Min exposure time	0,009982 s
Modulation frequency	100 Hz
Focus factor	0,9739 (TT25-F02)
Color correction	1,324 (Red LED)
Color filter	X1 X2 Z VL
Color factors	User
Relative Magnitude	99.7%
Overflow	0.0%

5.2.4 Live capture

The dialog „Live capture“ which can be opened via the menu item „Evaluation | Live capture“ is mainly used for setting purposes.



Having pressed the button „Start“ the consecutive capture of luminance or color images is started. These captures can be finished by pressing the button „Stop“.

On the right-hand side of the dialog different exposure times can be set. This is accomplished either by the buttons „Brighter“ and „Darker“ or by entering the desired time into the input box and using the button „Set“.

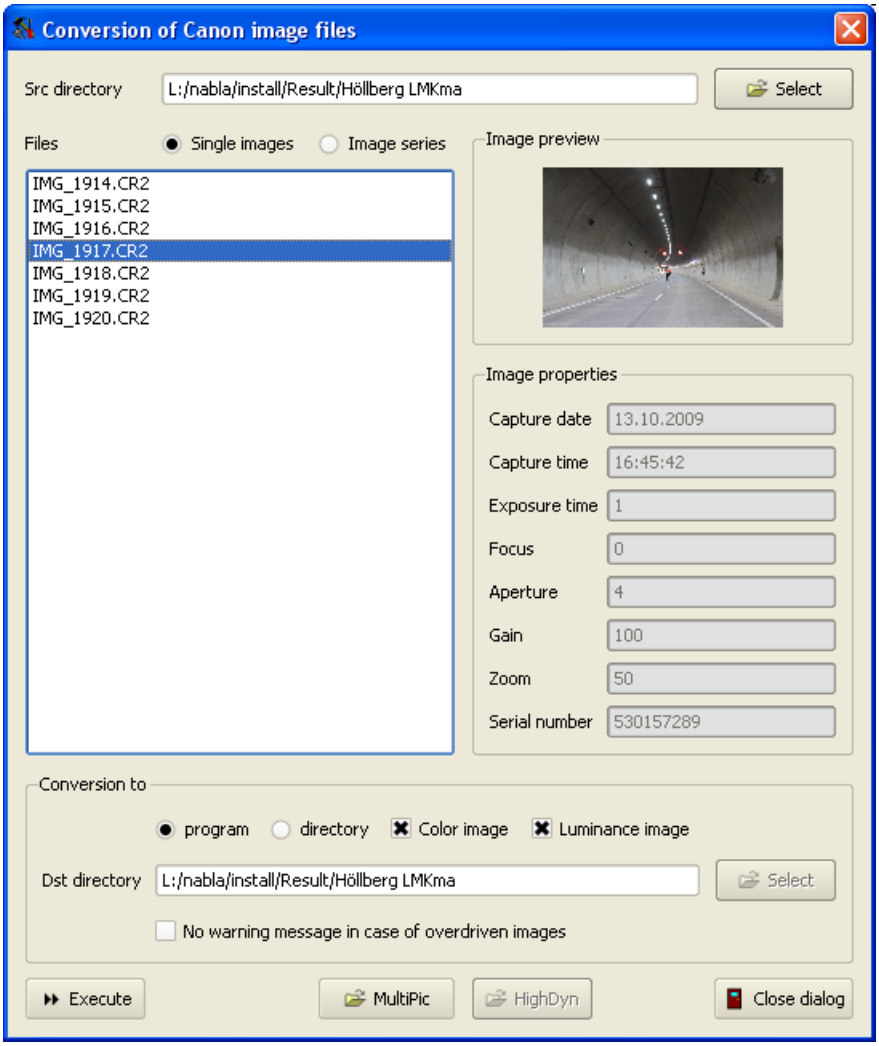
If a filter wheel camera is used, the filter to be used for capturing monochrome images can be set in the section „Filter wheel“.

5.3 Captures made with the LMK mobile advanced

If an „LMK MOBILE ADVANCED“ is employed (Canon EOS 350D or also Canon EOS 450D), the camera images captured and saved on the hard disk can be converted into luminance or also color images.

The options concerning the operation of the camera, the image capture and the copying of image files are described in detail in the documentation „LMK MOBILE ADVANCED“. In the following, only the conversion of the image files is described, allowing the user to further process the images captured by means of the program „LMK LABSOFT“.

After loading the calibration data for the camera using the menu item „CAMERA | CHANGE“, the menu item „CANON FILES“ is available in the menu „CAPTURE“. Via this item, the dialog „CONVERTING CANON IMAGE FILES“ is opened.

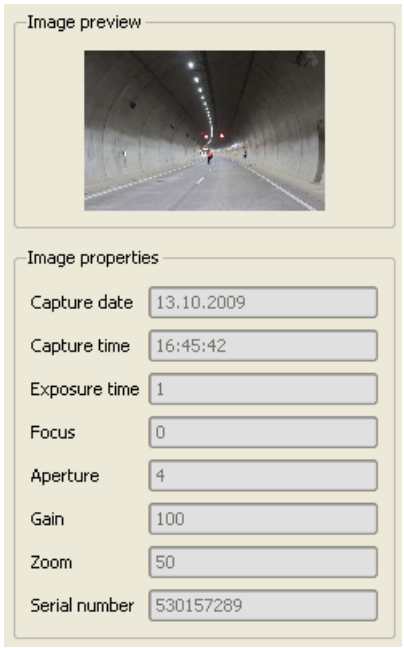


When pressing the button „SELECT“, a directory selection dialog is displayed where that directory can be selected which contains the image data to be converted in the *.cr2-format. After this, a list of the images in this directory is displayed.

Using the two buttons „Single shots“ or also „Image series“, you can toggle between the displays of the files in the dialog. Using the view „Image series“, the captures made at one and the same time are displayed in one and the same line, too.

At the same time, the view selected in this way determines the manner in which the images concerned will be converted later. In the preview „Image series“, those camera images which are together in one line are calculated together into a color Highdyn or also luminance Highdyn image.

By clicking with the mouse, lines in the list of files can be marked. If the control button is kept depressed while clicking with the mouse, several lines can be marked simultaneously. Using the buttons in the lower part of the dialog, only the files marked are processed in each case. If only one line in the list is marked, both a preview and some information about the image captured are displayed on the right-hand side of the dialog:

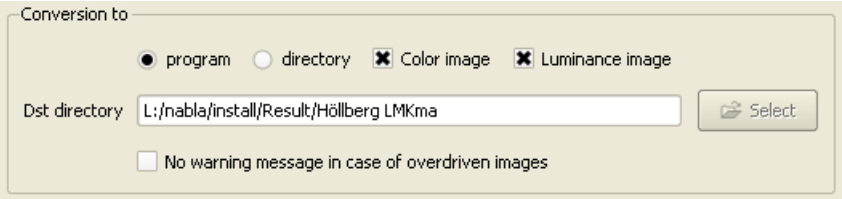


In the paragraph „Converting to“, conversion parameters are fixed:

If the option „Program“ is selected, the camera images are converted into the luminance image and the color image. (The conversion into a color image can be effected only in a program version which allows color evaluations.)

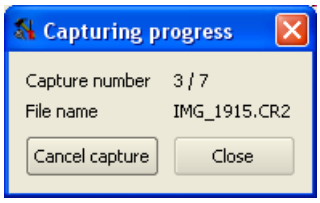
If the option „Directory“ is selected, the images calculated can be saved in a directory. Using the two option switches „Luminance image“ and „Color image“, it is possible

to fix those images which are to be calculated and saved. Upon pressing the button „SELECT“, the target directory can be determined in a directory selection dialog.



The file names are formed on the basis of the names of the converted camera files. In doing so, „-0“ is attached in the case of those camera images which are not overdriven, and „-1“ in the case of those camera images which are overdriven. The ending of the file name is determined by the image type. For color images, it is „.pcf“, whereas for black and white images, it is „.pf“.

The conversion of all marked files in the list is started by pressing the button „EXECUTE“. After conversion, the image loaded last of the Canon camera can be seen in the „CAMERA IMAGE“. The luminance or also the color image contains the results of the last conversion. A progress dialog is displayed during conversion:



The two buttons on the bottom side of the dialog can be used for testing purposes or also for converting single files:

- The button „MULTIPIC“ allows several image files presenting the same capture parameters (exposure time, zoom, aperture, focus) to be converted into a common luminance or color image.
- Using the button „HIGHDYN“, several images captured at different exposure times can be converted into a common image. However, in order to be able to do this, all other capture parameters such as zoom, aperture and focus must be the same.

The buttons are activated only if some corresponding files have been selected in the list of files.

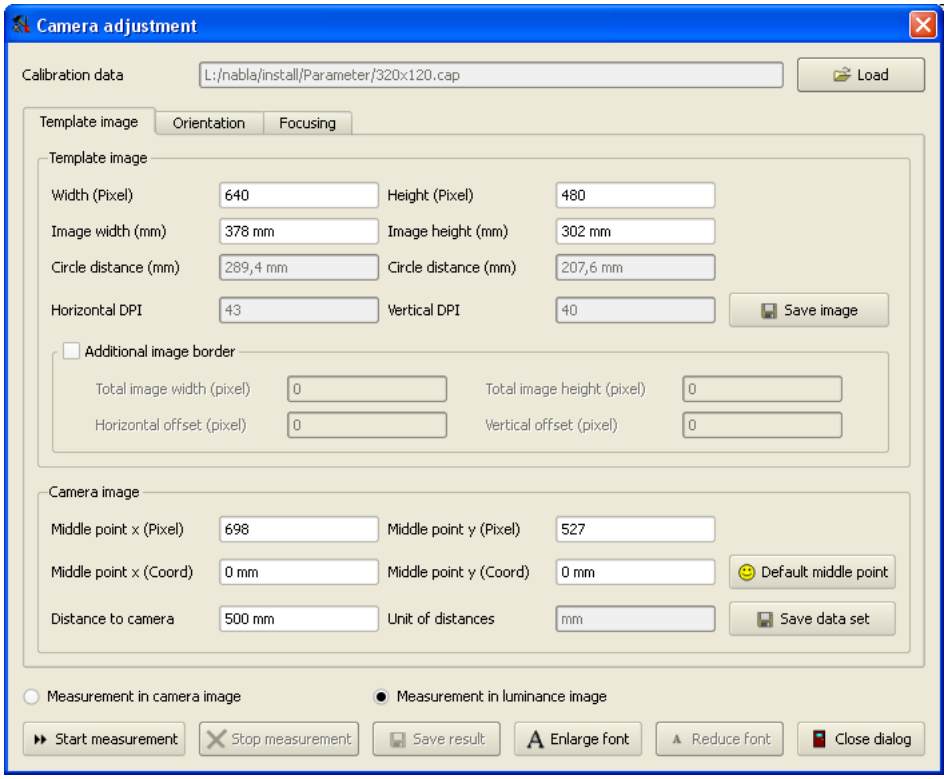
5.4 Kameraeinrichtung (Orientierung, Fokussierung)

Mit dem Menüpunkt „Kamera | Kameraeinrichtungsdialog“ wird der Dialog „Kameraeinrichtung“ geöffnet werden. Dieser Dialog kann in einigen Anwendungsfällen Hilfe bei der Einrichtung eines Messplatzes bieten. Im Dialog gibt es die Möglichkeiten:

- Erzeugung eines Vorlagenbildes, das später entweder ausgedruckt oder im Fall der Displayvermessung als Testbild auf das Display geladen werden kann.
- Bestimmung der Lage der Kamera bezüglich des Vorlagenbildes, das dazu anstelle des späteren Messobjekts aufgenommen wird.
- Bestimmung der Fokussierung der Kamera, indem die Schärfe des Kamerabildes anhand von Strukturen im aufgenommenen Vorlagenbild beurteilt wird.

Für diese drei Aufgaben gibt es im Dialog die drei Seiten „Templatebild“, „Orientierung“ und „Fokussierung“.

5.4.1 Dialogseite „Templatebild“

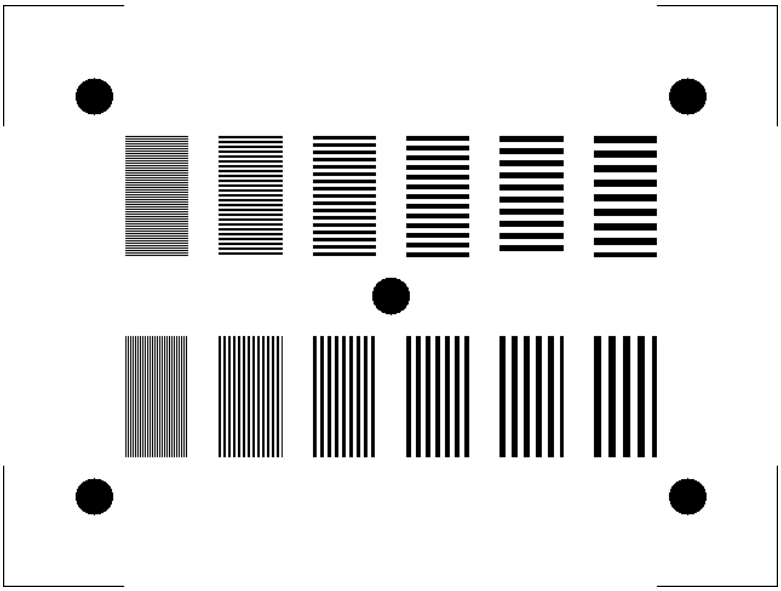


Auf der Seite „Templatebild“ können im Abschnitt „Templatebild“ die Parameter des Testbildes festgelegt werden. Dazu werden die Angaben zur Bildgröße sowohl in Pixeln als auch in Millimetern benötigt. Daraus berechnet das Programm die Bildauflösung in DPI (Dots per inch), die von Druckern benötigt wird, wenn sie das Bild in der richtigen Größe ausdrucken sollen.

Achtung: Viele Drucker unterstützen keine unterschiedliche Bildauflösung in x- und y-Richtung.

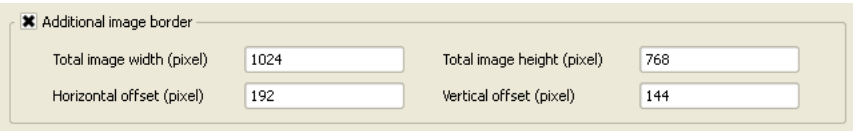
Nachdem die Angaben zur Bildgröße eingegeben worden sind, kann das Bild durch Drücken des Knopfs „Bild speichern“ und der Angabe des gewünschten Dateinamens gesichert werden. Die Speicherung erfolgt im Tiff-Format. Werden andere Bildformate benötigt, kann eine Umwandlung mit einem externen Grafikprogramm erfolgen.

Im folgenden Beispielbild wurden aus drucktechnischen Gründen die Farben invertiert. In einem abgedunkelten Messraum ist jedoch die Verwendung heller Objekte vor einem dunklen Hintergrund zu bevorzugen. Die Einrichtung kann aber sowohl mit schwarzen Objekten vor weißem als auch mit weißen Objekten vor schwarzem Hintergrund erfolgen.



Der Aufbau des Testbilds ist unabhängig von seiner Bildgröße immer gleich:

- Mit Hilfe der fünf Kreise wird die Orientierung der Kamera bezüglich der Vorlage bestimmt.
- Mit Hilfe der waagerechten und senkrechten Streifenstrukturen kann die Fokussierung der Kamera gemessen werden.

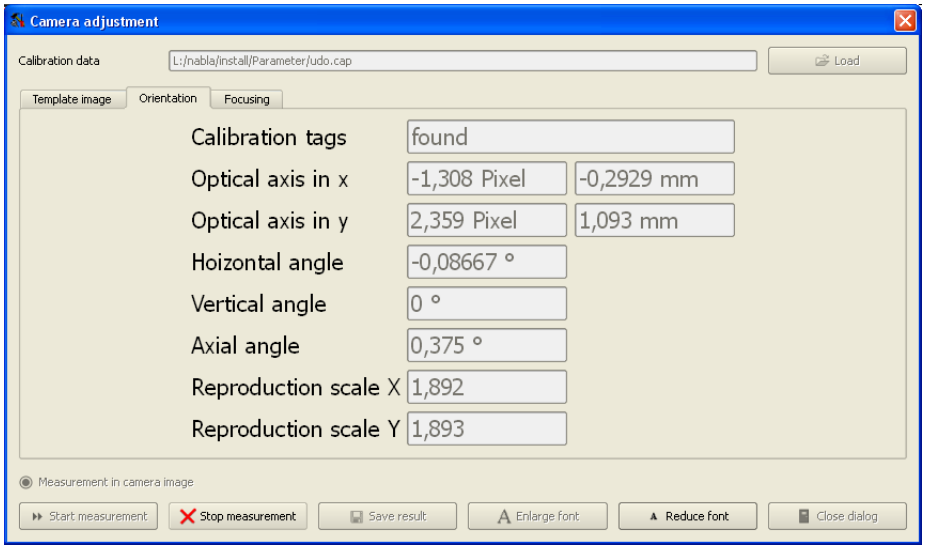


In einigen besonderen Anwendungsfällen soll die zu speichernde Bilddatei größer sein als der sichtbare Bereich. Das ist von Vorteil, wenn im eingebauten Zustand nicht alle Bildpunkte des zu vermessenden Displays sichtbar sind. In diesem Fall kann die Option „Zusätzlicher Bildrand“ eingeschaltet werden. Danach kann in den Eingabefeldern „Absolute Bildbreite“ und „Absolute Bildhöhe“ ein größeres Bild eingestellt werden. Mit den Angaben in „Horizontaler Offset“ und „Vertikaler Offset“ wird das kleinere Templatebild in diesem größeren zu speichernden Bild positioniert.

Im Abschnitt „Kamerabild“ auf der Seite „Templatebild“ können die Angaben zum Kamerabild ergänzt werden. Durch Drücken auf den Knopf „Vorgabemittelpunkt“ wird in den beiden Eingabefeldern „Mittelpunkt (Pixel)“ der Bildmittelpunkt des Kamerabildes eingetragen. Außerdem wird in den beiden Eingabefeldern „Mittelpunkt (Koord.)“ jeweils eine Null eingetragen. Mit dieser Vorgabeeinstellung wird so der Koordinatenursprung des Kamerakoordinatensystems bezüglich des Vorlagebilds auf die Bildmitte gelegt, d.h. auf den Ort des mittleren Kreises im aufgenommenen Testbild.

Mit dem Knopf „Datensatz speichern“ werden alle Eingaben auf dieser Seite zuzüglich einiger weiterer Angaben, die für die Algorithmen zur Aufnahme des Vorlagenbildes benötigt werden, in einer Datei gespeichert. Der Aufbau dieser Datei wird am Ende des Kaptitels ausführlich dokumentiert.

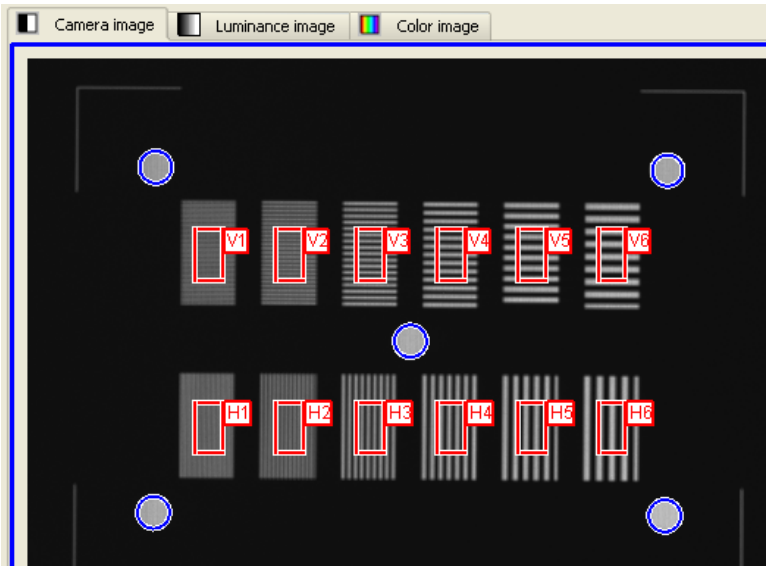
5.4.2 Dialogseite „Orientierung“



Um Messobjekt und Kamera zueinander ausrichten zu können, muss ein Datensatz mit der Beschreibung der geometrischen Parameter geladen werden. Dieser Datensatz konnte auf der Dialogseite „Templatebild“ erstellt werden. Zur Auswahl einer bereits vorhandenen Datei kann der Knopf „Laden“ rechts oben im Dialog verwendet werden. In der oberen Zeile wird danach der aktuell verwendete Datensatz angezeigt. Zum genauen Aufbau dieser Datei siehe am Ende des Kapitels den Abschnitt 5.4.4.

Die Messung der Orientierung und Fokussierung der Kamera wird mit dem Drücken des Knopfs „Messung starten“ begonnen. Zugleich müssen mit der Kamera Bilder aufgenommen werden, in denen das Vorlagebild zu sehen ist. Am einfachsten schaltet man die Kamera mit „Kamera | Live“ in den Livemode.

Im Kamerabild werden die fünf Kreise der Vorlage gesucht. Konnten sie gefunden werden, werden sie im Bild durch blaue Rechtecke umrahmt. Aus ihrer Lage können zusammen mit den Vorgabewerten in der Initialiserungsdatei die Verdrehung und die Verschiebung der Kamera und des Messobjekts zueinander berechnet und im Dialog angezeigt werden.



Zusätzlich werden die berechneten Werten mit Sollwerten verglichen, die in der Datei angegeben sind und die nicht überschritten werden dürfen. Eine Überschreitung dieser Sollwerte wird im Dialog dadurch angezeigt, dass die betreffenden Felder gelb markiert werden.

In den beiden Feldern „Optische Achse in X/Y“ wird eine Verschiebung der Kamera bzw. des Messobjekts in waagerechter bzw. senkrechter Richtung angezeigt. Hierzu wird die Lage des Kreises in der Bildmitte mit der Festlegung „Mittelpunkt x/y“ von der Dialogseite „Templatebild“ verglichen.

Für die Berechnung einer möglichen Verdrehung von Kamera und Messobjekt zueinander werden die Informationen der vier äußeren Kreise verwendet. Eine Verdrehung zwischen beiden in horizontaler Richtung bedeutet zum Beispiel, dass die Abstände der linken und der rechten Objektseite zur Kamera unterschiedlich sind. In diesem Fall verändert sich der Abstand zwischen den beiden übereinander liegenden Kreisen auf der linken und rechten Seite. Aus dieser Abstandsänderung kann bei bekannten Abbildungsverhältnissen der Verdrehungswinkel berechnet werden.

Analoge Überlegungen gelten für eine Verdrehung in vertikaler Richtung. Eine Verdrehung in axialer Richtung bemerkt man sehr leicht im Bild, weil dann waagerechte bzw. senkrechte Objektkanten nicht mehr waagerecht oder senkrecht sind.

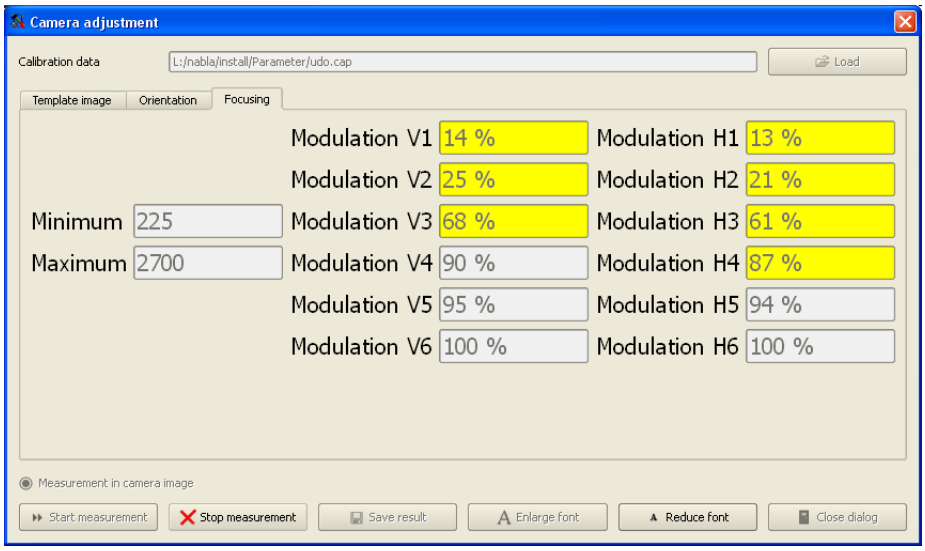
In den beiden Feldern „Abbildungsmassstab X“ und „Abbildungsmassstab Y“ wird das Verhältnis zwischen den Abständen in Pixeln im Kamerabild und im Vorlagenbild berechnet. Der horizontale und der vertikale Abbildungsmaßstab können unterschiedlich sein, wenn ein Vorlagenbild mit unterschiedlichen Auflösungen (siehe „Horizontal DPI“ und „Vertikal DPI“ auf der Dialogseite „Templatebild“ verwendet wird. Die Bildpunkte der Kamera sind hingegen in guter Näherung quadratisch.

Die roten Linien in den 12 Rechtecken mit horizontalen bzw. vertikalen Streifenmustern geben die Messregionen an, in denen die Messungen zur Fokussierung der Kamera vorgenommen werden, siehe dazu den folgenden Abschnitt.

5.4.3 Dialogseite „Fokussierung“

Nachdem mit Hilfe der Dialogseite „Orientierung“ die Lage der Kamera bzgl. des Messobjekts korrigiert worden ist (alle Anzeigefelder nicht mehr gelb), kann auf einer weiteren Dialogseite „Fokussierung“ das Objektiv scharf gestellt werden. In einigen Anwendungsfällen ist unter Umständen auch eine gezielte Defokussierung notwendig.

Für die Messung des Fokuszustandes enthält das Vorgabebild außer den fünf Kreisen für die Ausrichtung der Lage auch 12 Rechtecke mit waagerechten bzw. senkrechten Streifenmustern. Von links nach rechts steigt der Abstand und die Breite der Streifen jeweils um einen Bildpunkt. In jedes der Rechtecke ist eine rot markierte Messregion eingezeichnet. Die Bezeichnungen dieser Messregionen sind oben V1 bis V6 und unten H1 bis H6. „V“ steht für vertikal, „H“ für horizontal, die Ziffern 1 bis 6 geben den Streifenabstand an. Dieselben Regionenbezeichnungen werden auch im Dialog verwendet.



Die Modulationstiefe M in einer Region berechnet sich zu:

$$M = 100\% \frac{Max_R - Min_R}{Max_B - Min_B}$$

Dabei bedeutet „Min“ das Minimum, „Max“ das Maximum, „R“ steht für Region und „B“ für Bild. Je größer der angegebene Wert für eine Modulationstiefe ist, umso schärfer ist das Objektiv eingestellt. Naturgemäß sinken die Modulationstiefen zuerst in feinen Streifenmustern ab.

Auch für die Modulationstiefen kann in der Initialisierungsdatei ein Grenzwert vorgegeben und vom Programm geprüft werden. Nicht diese Vorgabe erfüllende Werte werden im Dialog gelb markiert.

Nach der Einrichtung der Kamera kann die Arbeit mit „Messung beenden“ abgeschlossen werden.

Die Messdaten und die zu ihrer Gewinnung verwendeten Parameter können nach dem Drücken des Knopfs „Ergebnis speichern“ in eine Datei gesichert werden. Diese Ergebnisdatei kann zur Parametrierung eines Koordinatensystems verwendet werden, indem diese Datei als Koordinatensystemdatei mit dem Menüpunkt „Koordinatensystem | Laden“ in ein beliebiges Bild geladen wird, siehe Kapitel 10 ab Seite 105. Außerdem wird die Datei zur Erstellung eines BlackMura-Projektes benötigt, siehe den Abschnitt 17.2 ab Seite 214.

5.4.4 Aufbau der Initialisierungsdatei

```
[Image]
Lines=600
Columns=800
Height=96
Width=128

[OpticalAxis]
MiddleXPixel=600
MiddleYPixel=500
MiddleXCoord=0
MiddleYCoord=0
Distance=500

[Limits]
MiddleXPixel=5
MiddleYPixel=5
AngleHorizontal=1
AngleVertical=1
AngleAxial=1
Modulation=0.9
```

Im Abschnitt „Image“ stehen die Parameter des aktuellen Vorlagenbildes. „Lines“ und „Columns“ geben die Größe dieses Bildes in Pixeln an, „Height“ und „Width“ in Millimetern. Diese Angaben konnten im Dialog auf der Seite „Templatebild“ im Abschnitt „Templatebild“ eingegeben werden, bevor ein Templatebild der entsprechenden Größe gespeichert wurde.

Die Angaben im Abschnitt „OpticalAxis“ werden verwendet, um die Parameter auf der Seite „Orientierung“ zu berechnen. Die Abweichung des mittleren Kreise des aufgenommenen Templates im Kamerabild werden bezüglich „MiddleXPixel“ und „MiddleYPixel“ gemessen.

Die Angaben in „MiddleXCoord“ und „MiddleYCoord“ geben an, welche Koordinatenwerte diesem Pixel für das Bildkoordinatensystem zugewiesen werden sollen. Die übrigen für das Koordinatensystem notwendigen Angaben kann das Programm aus der Höhe und Breite des Templatebildes berechnen, die es aus dem Abschnitt „Images“ entnimmt.

Da die Parameter beider Abschnitte im Dialog „Kameraeinrichtung“ eingegeben werden können, ist ihre Bearbeitung direkt in der Datei nicht notwendig!

Mit den Parametern im Abschnitt „Limits“ werden die Grenzwerte festgelegt, bei deren Überschreitung die entsprechenden Messwerte im Dialog gelb markiert werden. „MiddleXPixel“ und „MiddleYPixel“ geben die maximale Abweichung des Orts des mittleren Kreises von den Vorgaben im Abschnitt „OpticalAxis“ an. „AngleHorzontal“, „AngleVertical“ und „AngleAxial“ sind die Grenzwerte bei der Messung der Winkelabweichtungen vom Soll. „Modulation“ ist der Schwellwert bei der Messung der Modulation (0.9 bedeutet 90%).

6 Measurement series

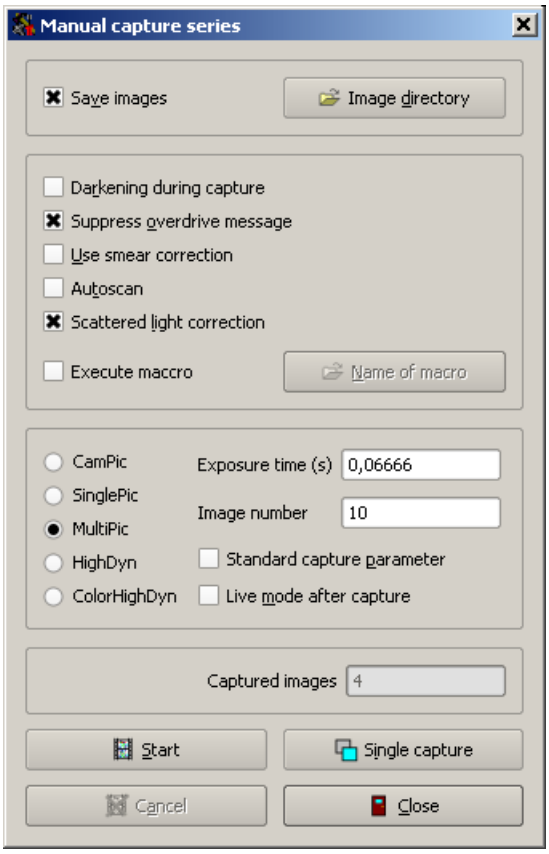
All options to capture several images one after the other and to process them are summarized in the menu „Capture | Measurement series“:

- A dialog is opened via „Capture | Measurement series | Manual“ where a new image is captured and added to a sequence of images either successively or via pressing a key.
- Using „Capture | Measurement series | Time-controlled“ allows image sequences with strictly defined times and parameters to be generated.
- Using „Capture | Measurement series | Mechanics-controlled“, there is the option to generate sequences of images from captures taken at different places. For this, the LMK camera must be connected to suitable hardware.
- Using „Capture | Measurement series | File-controlled“ allows images already captured and saved to be reloaded again and to be automatically evaluated.
- Using „Capture | Measurement series | Composing images“ allows all images of a measurement series captured before to be composed to one common result image. In this image all evaluations can be commonly carried out.
- Using „Capture | Measurement series | Image converter“ a dialog is opened where the following options are available:
  - Reducing the image size of an image sequence by adapting the size of all images to a desired amount.
  - Multiplying all images of an image sequence by a constant factor.
  - Converting all images to BMP or JPG files.
  - Generating an AVI file based on all images of an image sequence.
- Using „Capture | Measurement series | Image directory“ a dialog opens where the directory for saving the captured images is defined or where images already existing can be reloaded again.
- Using „Capture | Measurement series | Time list“ allows the times and capturing parameters which are used for time-controlled capture series to be modified.
- Using „Capture | Measurement series | Position list“ allows the positions and capturing parameters which are used for mechanics-controlled capture series to be modified.

6.1 Capturing a measurement series

6.1.1 Manual capture series

A dialog is opened via the menu item „Capture | Measurement series | Manual“ where a new image is captured and added to an image sequence either successively or by means of a key:



If the option „Save images“ is set the images captured are saved in a directory. A dialog is opened via the button „Image directory“ where the directory and other parameters of the save operation are defined. This dialog is described in section 6.2.1 on page 66.

Using „Darkening while capturing“ the screen is darkened during the capture.

Using „Suppress overdrive message“ the message window can be made to fade out. As a standard, this window displays a message indicating an overdrive occurring during the capture of the images. It is advantageous to select this option if greater attention is paid to darker parts of the image and overdriven image parts are not in the focus of interest.

The option „Use smear correction“ is only available when the camera used is equipped with this function. For more detailed information on this topic see section 5.2.2 on page 47.

By means of the option „Autoscan“ a appropriate exposure time is determined before each capture with the „autoscan algorithm“. In the case of color captures this is

done for each color filter separately. If „AUTOSCAN“ is switched on, the number in the field „EXPOSURE TIME“ is ignored.

If there are data available for the „SCATTERED LIGHT CORRECTION“, this option can be switched on or off too.

If the selection box „EXECUTE MACRO“ is set, the macro which had been selected after pressing the button „NAME OF MACRO“ is executed after each capture. This macro can contain task-specific routines. Macros can be generated either by the TechnoTeam company on request or by the user via the recording routines. See section 13.9 on page 172.

The capturing parameters will be defined in the section below. You can select one of the following capture types:

- CAMPIC: A single camera image is captured using the integration time set.
- SINGLEPIC, MULTIPIC, HIGHDYN: A luminance image is captured with the method desired and the parameters set.
- COLORHIGHDYN: This option is available with color cameras only. A ColorHighDyn image is calculated.

If the option „STANDARD CAPTURE PARAMETER“ is on, the two input boxes „EXPOSURE TIME“ and „IMAGE NUMBER“ are not visible. The program uses the settings for the capturing of images which had been set in the dialog „CAPTURE OPTIONS“. See section section 5.2.2 on page 47.

If the option „LIVE MODE AFTER CAPTURE“ is set, the permanent capture mode is turned on after every single capture. This makes sense if the automatic exposure control is used or if the image is to be watched after each capture.

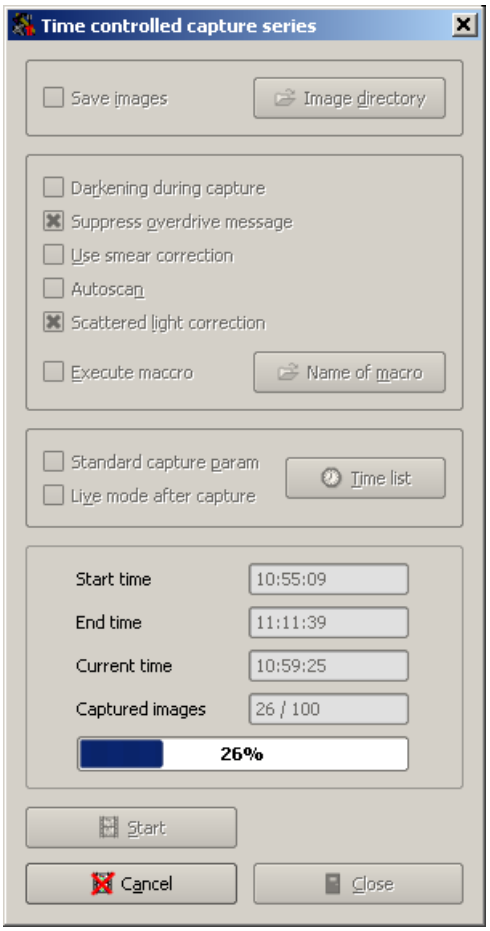
The capture of an image according to the parameters set is started via the button „SINGLE CAPTURE“.

The continuous capture of images according to the parameters set is started via the button „START“. This series can be stopped via the button „CANCEL“.

The dialog for the capture of manual series is closed by means of the button „CLOSE“.

6.1.2 Time-controlled capture series

Using „Capture | Measurement series | Time-controlled“ allows image sequences to be created at certain times and with fixed capturing parameters.



The two upper parts of the dialog are equal to those described in the previous section on „manual capture series“.

In contrast to the manual series, in a time-controlled capture series the capturing parameters are defined in a list which can be edited, loaded and saved in a separate dialog. This dialog will be opened by pressing the button „Time list“. The dialog will be described in section 6.2.2 on page 67.

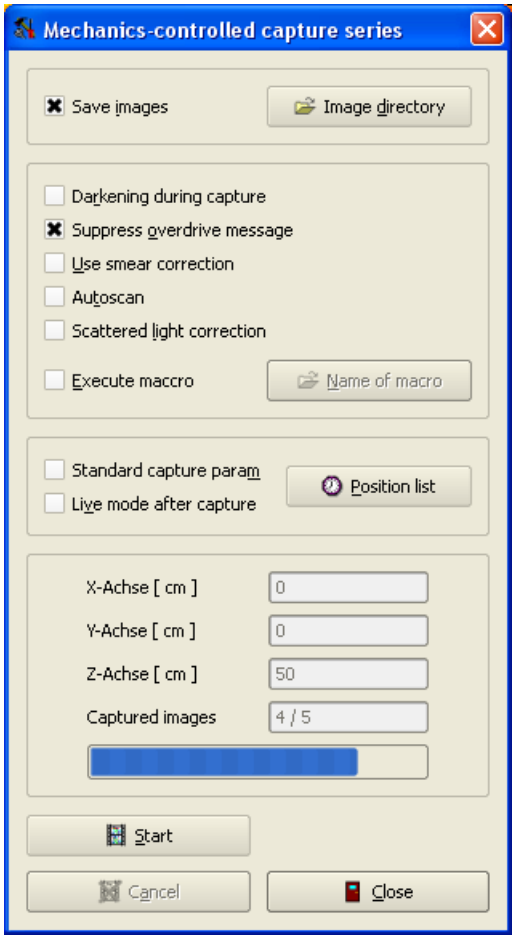
The capture series will be started by means of the button „Start“. While the series is running, the progress of the captures will be displayed in a separate part of the dialog i.e. in „Start time“, „End time“, „Current time“, „Captured images“ and by means of a progress bar.

By means of „Cancel“ a running series will be stopped prior to its completion, via „Close“ the dialog will be closed.

6.1.3 Mechanics-controlled capture series

The option of generating mechanically controlled capture series is only available if a travelling unit is connected to the computer and if the corresponding software components have been loaded into the LMK software. Please initialize the traveling unit first, see chapter 17.1 on page 211.

When selecting the menu item „Capture | Measurement series | mechanics-controlled“, the dialog „Mechanics-controlled capture series“ is opened.



The two upper parts of the dialog are equal to those described in the previous section on „manual capture series“.

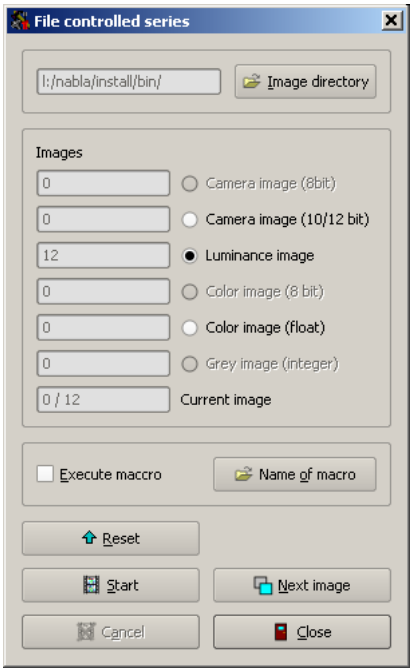
In contrast to the manual series, in a mechanics-controlled capture series the capturing parameters are defined in a list which can be edited, loaded and saved in a separate dialog. This dialog will be opened by pressing the button „Position list“. The dialog will be described in section 6.2.3 on page 70.

The capture series will be started by means of the button „Start“. While the series is running, the progress of the captures will be displayed in the lower part of the dialog .

By means of „Cancel“ a running series will be stopped prior to its completion, via „Close“ the dialog will be closed.

6.1.4 File-controlled capture series

By means of „Capture | Measurement series | File-controlled“ images already captured and saved can be loaded again and automated evaluations can be performed with them.



By pressing the button „Image directory“ a dialog is opened where the place of the images saved can be entered. This dialog is described in section 6.2.1 on page 66.

Since in a directory on a hard disk images of different types can be saved, the user can select in the section below the image type he wants to work with. Camera images are loaded into the „Camera image“, luminance images are loaded into the „Luminance image“ and color images when working with a program version which supports color images are loaded into the „Color image“.

If the selection box „Execute macro“ is set, the macro is executed after each image is loaded which had been selected before by pressing the button „Name of macro“. It can contain task-specific routines. On request, macros can be generated by TechnoTeam or they can be generated by the user via recording routines. See section 13.9 on page 172.

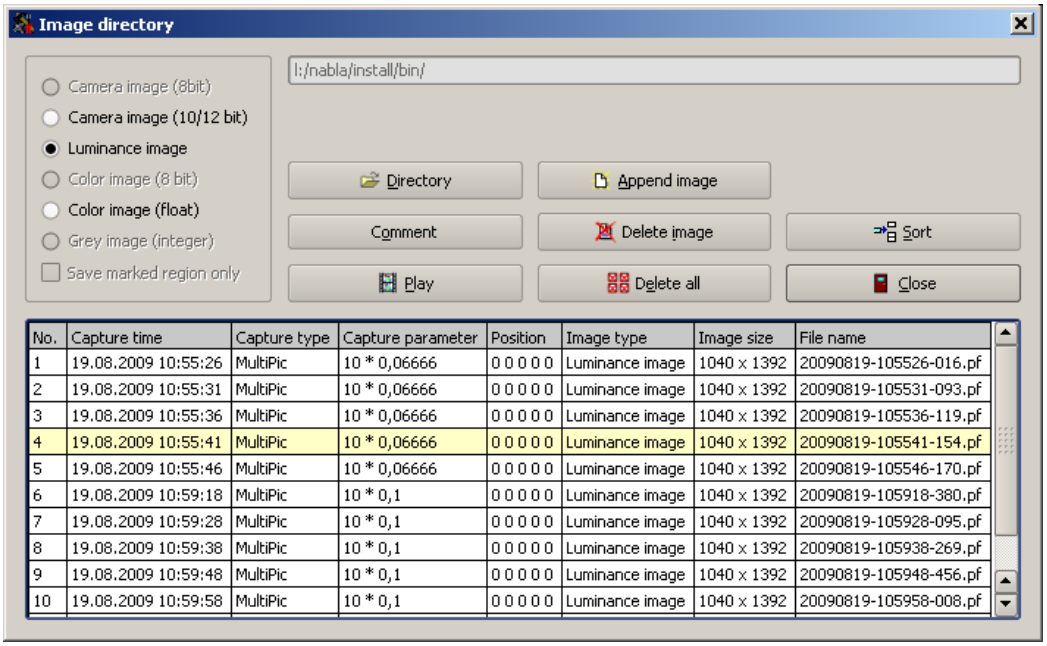
When an image series, which had been generated by means of a manual or time-controlled capture series, is processed, the images are loaded as fast as possible, during the calculations in the program, however, the time intervals between the different images are taken into account. Therefore, it is possible to create a time statistics with these images later, as described in chapter 12 beginning on page 111.

By means of „Start“ the automatic loading of images is started. The loading of the images can be stopped by means of „Cancel“. Selecting the button „Reset“ allows the user to return to the first image of the list. The dialog can be exited by pressing the button „Close“.

6.2 Parameters of measurement series

6.2.1 Image directory

In the manual and time-controlled capture series the images created can be saved in a directory. In a file-controlled measurement series the images of a directory can be reloaded and processed one after the other. In all these methods a dialog is used to load and save images. Independently of the three methods previously described the dialog for processing the image directories can be used separately by means of the menu item „Capture | Measurement series | Image directory“.



No.	Capture time	Capture type	Capture parameter	Position	Image type	Image size	File name
1	19.08.2009 10:55:26	MultiPic	10 * 0,06666	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105526-016.pf
2	19.08.2009 10:55:31	MultiPic	10 * 0,06666	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105531-093.pf
3	19.08.2009 10:55:36	MultiPic	10 * 0,06666	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105536-119.pf
4	19.08.2009 10:55:41	MultiPic	10 * 0,06666	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105541-154.pf
5	19.08.2009 10:55:46	MultiPic	10 * 0,06666	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105546-170.pf
6	19.08.2009 10:59:18	MultiPic	10 * 0,1	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105918-380.pf
7	19.08.2009 10:59:28	MultiPic	10 * 0,1	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105928-095.pf
8	19.08.2009 10:59:38	MultiPic	10 * 0,1	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105938-269.pf
9	19.08.2009 10:59:48	MultiPic	10 * 0,1	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105948-456.pf
10	19.08.2009 10:59:58	MultiPic	10 * 0,1	0 0 0 0 0	Luminance image	1040 x 1392	20090819-105958-008.pf

On the top left-hand side the image types which can be managed in the dialog are displayed. The options are dependent on the program version used. The user can define which images are intended to be saved by clicking on the corresponding buttons.

Before starting a capture series the user has to set the correct image type. If the capture method CamPic *is used, camera images have to be selected. Having selected one of the methods* SinglePic, MultiPic *or* HighDyn *luminance images can be saved. If* ColorHighDyn *is used, color images can be saved.*

On request, it is possible to define in the selection box „Save marked region only“ that the contents of one image region only is to be saved. A single rectangular region has to be marked in the image in order to allow this option to be used. Tailoring can also be done later by means of the image converter, see section 6.3.2 on page 73.

Using the button „Directory“ the user can define the directory on the hard disk where the images are expected to be saved and where they are loaded from. The directory is displayed in the text line above the buttons. Having selected a new directory the list of images standing beneath is updated in this directory.

Clicking on a line of the list the corresponding image is loaded into the program. The destination image is dependent on the type of the image:

- Camera images are loaded into „Camera image“.
- Luminance images are loaded into „Luminance image“.
- Color images (float) are loaded into „Color image“.

When the button „Delete image“ is pressed, the image marked is deleted from the list without any further query, the program automatically loads the next image from the list into the display.

When the button „Delete all“ is pressed the program displays a safety query whether all images existing are really to be deleted. The directory on the hard disk, however, which contained the images will not be deleted at all.

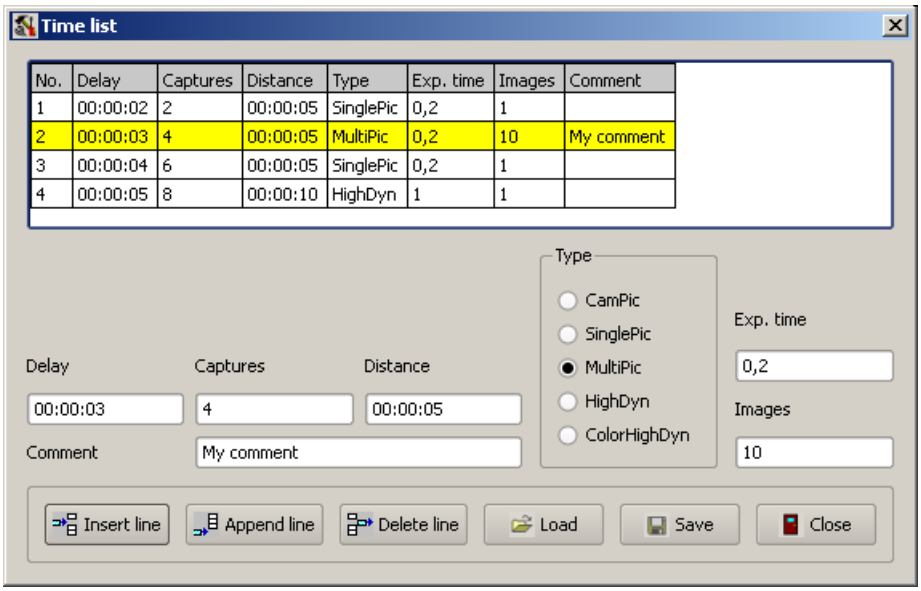
When the „Play“ button is pressed, the dialog loads all images saved, one after the other into the program at an interval of 1 second. Loading starts with the image currently marked in the list.

A dialog window is opened by pressing the button „Comment“ where a comment can be generated which is as HTML file in the directory concerned. The comment is automatically safeguarded when the comment window is closed.

6.2.2 Time list

The dialog „Time list“ can be opened in different ways:

- By selecting the menu item „Capture | Measurement series | Time list“.
- Via the button „Time list“ in the dialog „Time-controlled capture series“.



In the upper half of the dialog there is a list available containing the capture times and parameters. The single columns refer to:

- DELAY: In this time, the program does not make any captures.
- CAPTURES: The number of images desired is captured.
- DISTANCE: The time interval indicated between the single shots is kept.
- TYPE: The possible capture types from CAMPIC to COLORHIGHDYN.
- EXP. TIME: Exposure time for all camera images and for the first camera image when HIGHDYN captures are shot, respectively.
- IMAGES: Number of images for a MULTIPIC capture. For the other capture options this parameter is of no importance.
- COMMENT: Each of the entries can have a single comment.

If a line in the list has been marked by a mouse click, the parameters concerned can be edited in the text fields „DELAY“ up to „IMAGES“standing below the list.

In the two fields „DELAY“ and „DISTANCE BETWEEN TWO CAPTURES“, times can be entered in the following formats:

- XXX: The entry is interpreted as time in seconds.
- XX:XX: The time is read as entry in minutes and seconds.
- XX:XX:XX: The program accepts a time entry in the form of hours, minutes and seconds.

A new entry is pasted in front of the currently marked line via the button „INSERT LINE“. By means of the button „APPEND LINE“ a new entry is attached to the end of the list. When using the button „DELETE LINE“ the line currently marked is removed from the list.

The two buttons „LOAD“ and „SAVE“, respectively allow an edited list to be saved and used again later. The text file format used by the program is structured as follows (the example corresponds to the contents of the dialog already shown):

```
4
2.00e+000   5.00e+000   1.00e+001   0   2.00e-001
3.00e+000   5.00e+000   2.00e+001   1   2.00e-001   10          "My comment"
4.00e+000   5.00e+000   3.00e+001   0   2.00e-001
5.00e+000   1.00e+001   8.00e+001   2   1.00e+000   0.00e+000   2.10e+000
```

- The first line of the file contains the number of the lines which follow (data records).
- In the first column there is the start delay in seconds.
- The second column contains the time interval between two captures in seconds.
- The third column shows the total time calculated for the captures of this list entry. If this time is divided by the time interval between two captures, the number of captures is obtained.

- In the following column the capture algorithm is encoded:

  0 SinglePic

  1 MultiPic

  2 HighDyn

  3 CamPic

  4 ColorHighDyn

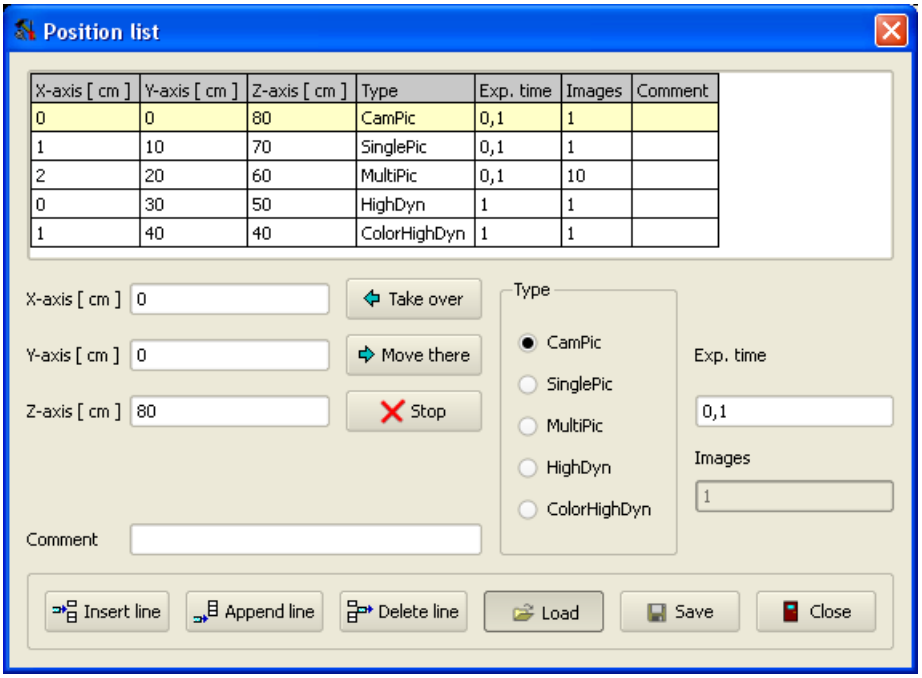
- In the next column there is the integration time to be used in seconds.
- The contents of the possibly following columns are dependent on the capture algorithms:
  - For the capture algorithms CamPic and SinglePic no further parameters are needed.
  - For the algorithm MultiPic the number of the camera images to be captured for one luminance image each is given.
  - For the HighDyn algorithm the minimum integration time and the time factor between two subsequent camera images are given. These two parameters have only been indicated because of downward compatibility reasons to older program versions. Here, the program default settings should not be modified.
  - Behind the capture parameters each line can contain a comment, which has to be included in the file in inverted commas.

It is possible to generate a time list within the program and to modify in a text editor only the numbers which are in the file.

6.2.3 Position list

The dialog „Position list“ can be opened in different ways:

- by selecting the menu item „Capture | Measuring series | Position list“,
- in the dialog „Mechanics-controlled series“ by pressing the button „Position list“.



In the upper half of the dialog, a list containing the capture positions and parameters can be found, the following columns „Capture type, Exp.time“ and „Images“ represent the parameters of the image captures in these different positions.

- X-axis, ..., Z-axis: The first columns contain the desired position of capture. The number just as the designation of these columns depend on the concrete unit of movement. One to five axes are possible.
- Type: The possible types of captures „CamPic“ ... „ColorHighDyn“ have already been described in detail in Section „Manual capture series“.
- Exp.time: Exposure time for all camera images or also for the first one (in the case of the HighDyn-variants).
- Images: Number of images for a MultiPic-capture. For the other capture options, this parameter is not important.
- Comment: The user can write a comment, which belongs to the currrent line of parameters.

Using the button „Take over“, the current position parameters of the motor control are taken over into the data record. Using the button „Move there“, the control can be moved to that position the parameters of which are displayed in the current data record. The button „Stop“ can be pressed in order to stop the motors in motion immediately.

Using the button „Insert line“, a new entry is inserted before the line currently marked. Using the button „Append line“, a new entry is attached to the end of the list. When pressing the button „Delete line“, the line currently marked is deleted.

By means of the two buttons „Load“ or also „Save“, an edited list can be saved and used again for later purposes. The text file format used by the program has the following structure (the example corresponds to the contents of the dialog already shown):

```
5
1.0e+01   2.0e+01   8.0e+01   0.0e+00   0.0e+00   3   1.0e-01
2.0e+01   2.0e+01   7.0e+01   0.0e+00   1.0e+01   0   1.0e-01
3.0e+01   2.0e+01   6.0e+01   0.0e+00   2.0e+01   1   1.0e-01   10
4.0e+01   2.0e+01   5.0e+01   0.0e+00   3.0e+01   2   1.0e+00   0.0e+00   2.10e+00
5.0e+01   2.0e+01   4.0e+01   0.0e+00   4.0e+01   4   1.0e+00   0.0e+00   2.10e+00
```

- The first line of the file contains the number of the subsequent lines (data records).
- The first five columns contain the desired position of the motors at the moment of capture. If there are fewer axes, these positions are not relevant and can be set to zero.
- In the subsequent column, the capture algorithm is encoded:

  0 SinglePic

  1 MultiPic

  2 HighDyn

  3 CamPic

  4 ColorHighDyn

- The next column contains the exposure time in seconds to be used.
- The contents of the possibly following columns depend on the capture algorithm:
  - For the capture algorithms „CamPic“ and „SinglePic“, no further parameters are necessary.
  - For the „MultiPic-algorithm“, the number of the camera images to be captured for one luminance image each are given.
  - For the „HighDyn-algorithm“, the minimum exposure time and the time factor between two subsequent camera images are shown. These two parameters have only be indicated for downward compatibility reasons to older program versions. Here, the default settings of the program should not be changed.

The simplest solution for an external processing of the capture parameters is to draw up a position list within the program and to modify, in the external text editor, only the numbers contained in the text file.

6.3 Evaluating a measurement series

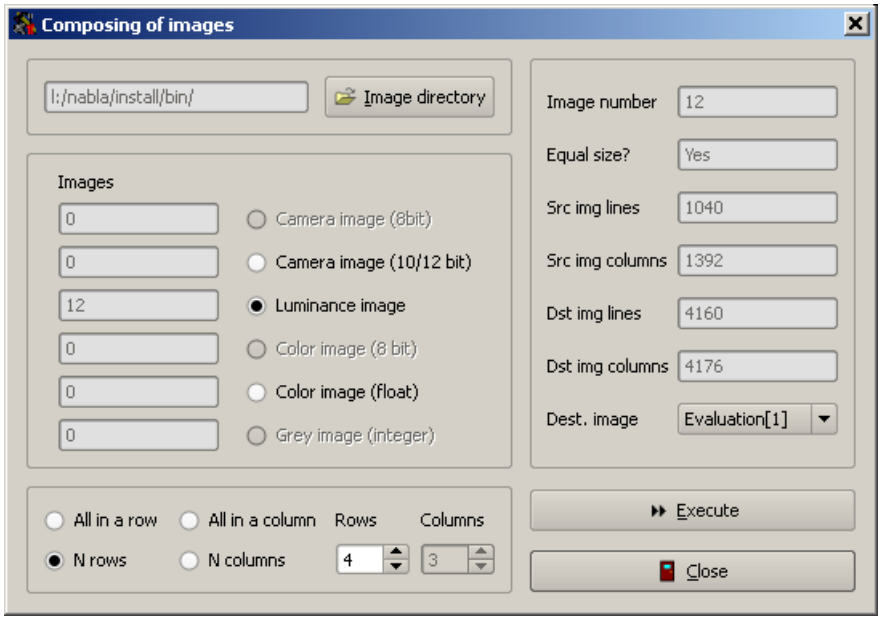
Saving the captured images during a manual or time-controlled capture series is optional, since a lot of evaluation tasks can be solved directly after the capture of the image:

- If there are any measuring regions drawn in the image captured and if for these regions statistical evaluation objects have been created (see chapter 12 beginning on page 111), the results of these statistics are updated before the capture of a new image is started. If, for example, the time behavior of statistical parameters is to be protocoled, this can be done by means of a time statistic of the measurement objects which can be saved as a graphic or a table as well.
- After the capture of each image a macro can be called by means of which user-specific operations in the image captured can be carried out.
- If the images had been saved, both methods - the calculation of a time statistic and the processing of the images by means of a macro - can be used even later by means of a file-controlled capture series.

Options of evaluation, requiring the existence of a capture series in the form of a file, are the composition of all images to one single image and the conversion of the images captured into other formats. See the sections below.

6.3.1 Composing images

A dialog can be called via the menu item „Capture | Measurement series | Composing images“ where several images can be composed to one image.



First, the directory has to be selected via the button „Image directory“ where the images saved have to be read from. An image directory can contain images of different types. Hence, the user has to define the image type to be used. For this image type,

the number of images found will be displayed in the box. Furthermore, the program will check the size of the images found (box „Equal size?“) and show the size of the source image and the possible destination image.

When composing images the storage capacity needed of the memory and the hard disk will have to be taken into account. In the example shown the target image will have 3093 lines and 8226 columns i.e. more than 100 MByte. Options to reduce the storage capacity will be listed below:

- While capturing and saving the source images only a small region of the total image is saved. For this option see section 6.2.1 on page 66, the part „Save marked region only“.
- By means of an image converter described in the next section a small region of the images of a sequence will be cut out later and saved as a new image sequence.

In the lower part of the dialog you can define the composition of the result image. If the image is expected to be composed of a pre-defined number of lines or columns these values can be edited. The other size will be calculated by the program. If all images are expected to be arranged in one line and one column, respectively, no further input will be needed.

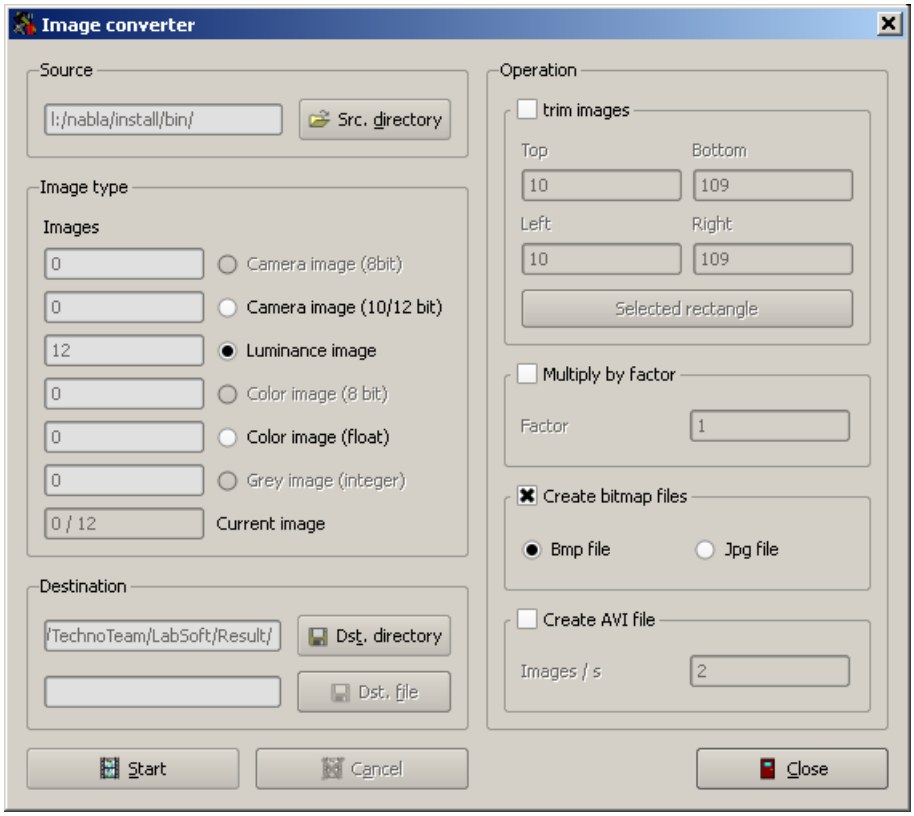
Loading the images of an image sequence is done depending on the image type via „Camera image“, „Luminance image“ or „Color image“. Therefore, the composed destination image cannot be any of these images. In the selection box „Dest. image“ the image desired can be entered, its size will automatically be adapted.

After pressing the button „Execute“ the calculation of the target image will be started. The dialog is closed via the button „Close“.

6.3.2 Image converter

A dialog can be called up via the menu item „Capture | Measurement series | Image converter“ having several conversion options of image sequences into different formats:

- Converting the images into a rectangular region and saving the images reduced in size as a new image sequence.
- Multiplying all the images by a constant factor.
- Calculating bitmap files.
- Creating a video in AVI format.



Having selected a source directory and defined the image type to be used on the left-hand side of the dialog the user can select one of the four conversion options.

While tailoring the images and multiplying them by a constant factor new image sequences of the same type as the source images are generated.

While creating bitmap files or an AVI video the images are sent to the corresponding output files as they are represented in the image display. Thus, it is possible to set the scaling, the type of color palette and the visibility of the palette, of measuring regions and image sections as desired before the conversion is carried out.

Tailoring, multiplying by a factor and creating bitmap files results in several files which need a target directory. When, however, converting into an AVI file just the name of a target file has to be given. The AVI file is not compressed and can be processed later, if necessary, with third-party programs.

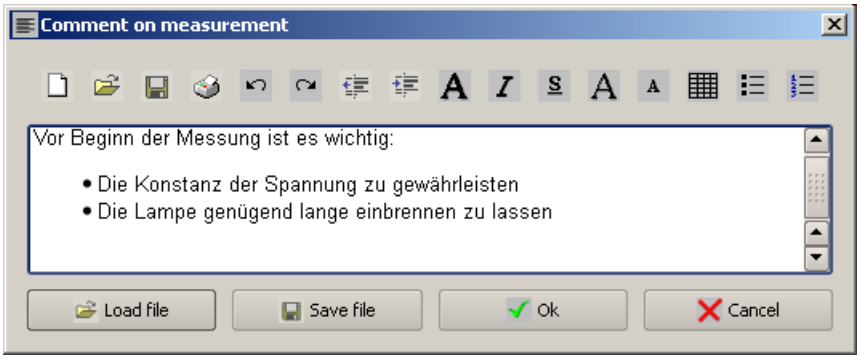
The conversion is started via the button „Start“. The dialog can be left via the button „Close“.

7 Protocols

7.1 Read and write

In protocols the complete processing state at a certain time can be saved. Contents of the protocol:

- All images used in the program are saved: „Camera image“, „Luminance image“, „Color image“ and all user-generated evaluation images.
- „Measuring regions“: The regions drawn in the different images and the assignment of the region lists to the images. It is possible to use the same region list in several images, see section 9.6 on page 103.
- „Statistics“: The protocol contains the statistical evaluations incl. the results of the time statistics.
- „Display parameters“: Scalings and color palettes of the images, formattings of the tables, graphics and diagrams.
- „Comment“: By means of the menu item „Protocol | Comment on measurement“ a dialog is opened where user-specific notes can be generated. This text is saved in the protocol in HTML format.



- „Last capture“: Information on the last camera, luminance or color capture is also saved and reconstructed in the table „Last capture“ when loading the protocol.

Saving a measurement protocol is performed via the menu command „Protocol | Save as“ and via the quick start button, respectively. Loading a protocol is done via „Protocol | Load“.

Reading in protocol files in HDF5 format as used in the Lmk2000 software is possible. The menu item „Protocol | Import HDF5 protocol“ is used for this purpose.

7.2 Update protocol

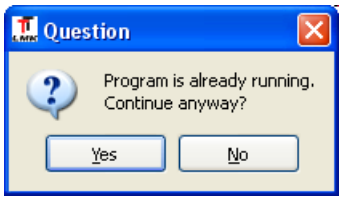
In some cases, it is useful to execute either the same statistical evaluations with different images or different evaluations with the same images. For this, the menu item „Protocol | Update“ is available. A dialog will be opened after selecting this item.

After pressing the button „Load file“, a file selection dialog is opened where the file out of which the information of interest shall be read can be selected. By pressing the button „Close dialog“, the dialog is quited without changing the current program state. Before a protocol is loaded, however, the loading process can be influenced using the specifications given in the dialog:

- By selecting the option „Images“, the contents of the images of a protocol will be loaded from the hard disk into the program. Here, the following selection possibilities are additionally available:
  - „Quantity and unit“: The physical quantities and units of the images saved overwrite the specifications given in the program.
  - „Coordinate system“: The coordinate systems saved in the file replace the specifications given in the program.
  - „Color space“: For color images, the specifications made in the program will thus be replaced by the specifications made in the protocol file.
  - „Delete unnecessary images“: By selecting this option, those images which are available in the program but not in the file will be deleted.
  - „Generate needed images“: If necessary, images which are available in the file will also be laid in the program in order to enable the user to read them from the file.
- When selecting the option „Statistics“, the lists of regions and the statistical evaluations connected with them will be taken over from the protocol file into the program. Any evaluations which have already been available there will be deleted.
- The option „Comment“ allows the comment on the measurement (laid in using the menu item „Protocol | Comment on measurement“) to be overwritten with the text from the protocol file.

7.3 Several program instances

It is often the case that images or measuring regions saved in a particular measuring record shall be used also for another evaluation. However, when loading a new protocol which contains the data of interest, the data already existing in the program will be overwritten. Now, a second instance of the program can simply be opened to load a second protocol there. When starting another instance of the software, first a security query will have to be answered:



In the second program which is opened, the second protocol can be opened. Now, data can be exchanged between both programs via the clipboard. This option can be used, for example, for images, measuring regions and coordinate systems using the menu items „Copy“ and „Paste“ available in the respective menus.

8 Images

8.1 Input and output

8.1.1 Loading and saving

By means of the menu commands „Image | Save as“ and „Image | Open“ images can be saved and loaded again later. There are different file formats available for the different image types:

1. 8Bit camera image when working with an 8Bit camera:
   Picture-Unsigned-Char images (*.puc), text format images (*.txt), 8Bit tiff images (*.tif)
2. 10/12Bit camera image when using a 10 or 12 Bit camera:
   Picture-Unsigned-Short images (*.pus), text format images (*.txt), Unsigned short tix images (*.tix), Unsigned short tiff images (*.tif), PCO images (*.b16)
3. Luminance image and monochromatic evaluation images:
   Picture-Float images (*.pf), text format images (*.txt), Float-Tix images (*.tix)
4. Color image and color evaluation images:
   Picture-Color-Float images (*.pcf), text format images (*.txt), color space text format images (*.cos)

To save and load quickly within the program we recommend the use of the TechnoTeam formats *.puc, *.pus, *.pf and *.pcf.

Text format images *.txt are suitable for a data exchange with other programs if the corresponding program is capable of reading and writing text files, respectively. Possibly, only a few modifications of the file header are necessary to allow a data exchange.

When reading and writing tiff files (*.tif, *.tix) it should be taken into account that the tiff standard includes more options than implemented in the program.

For a description of all file formats see section 18.1 on page 220.

8.1.2 Capture parameters

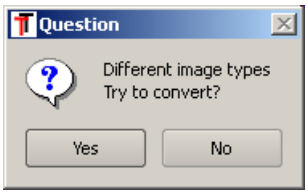
By means of the menu command „Image | Capture parameters...“ the capturing parameters of an image can be shown. These informations are saved in the image and protocol files together with the image content and the associated coordinate system. After reloading the image files into the program these informations can be shown again.

Via duplicating an image or copying and pasting via the clipboard the capturing parameters are copied to the destination images too.

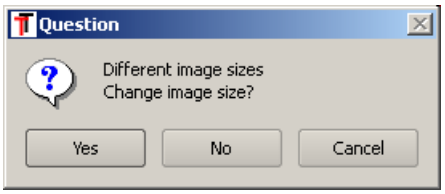
8.1.3 Copying and pasting

The current image is copied in different formats into the clipboard via the menu item „Image | Copy“:

- The current image detail is saved as bitmap. The bitmap can be pasted into other programs (graphics programs, word processing programs), which are capable of reading images from the clipboard. (e.g. in Microsoft Word via „Edit | Paste“.)
- The whole image is saved in binary format in the clipboard, thus allowing image contents to be exchanged between the luminance image and the evaluation images. When pasting into an image of a different size or of a different type the user will be informed about that:



Bildtyp ändern



Bildgröße ändern

- In order to allow the image to be copied into the clipboard even in text format this option has to be activated before via the menu item „Image | Options while copying | Text“. As a standard, it is not activated because it requires a lot of computing time and storage capacity.

Image contents that had been pasted into the clipboard before can be taken over into the current image by means of the menu item „Image | Paste“.

Using the menu item „Image | Copy bitmap with palette“ a bitmap of the current image detail together with the color palette standing next to the right-hand side of the image contents will be copied into the clipboard. From there it can be pasted into a different program as bitmap. This option is not available for color images because for them a color palette is not displayed.

For copying and pasting the contents of image regions into other images see section 9.4 on page 100.

8.1.4 Printing

The current image can be output by a printer via the menu item „Image | Print“. The view will correspond to the current one in the program i.e. the image details shown there, the measuring regions, the coordinate system and the color palette will be output. These options can be modified before printing via the menu items of the menu „Image view“.

For more detailed options concerning the configuration of print reports see chapter 15 beginning on page 181.

8.2 Enlarging the display

The scroll wheel of the mouse is a convenient tool to enlarge or reduce the size of the image display. If possible, the area around the mouse pointer is enlarged or reduced. The visible region within the image can be moved by means of the scrollbars at the edges at the bottom and the right-hand side of the image.

If required, the enlargement and visible areas can be adjusted via a dialog. The dialog can be opened using the menu item „Image view | Enlargement“.

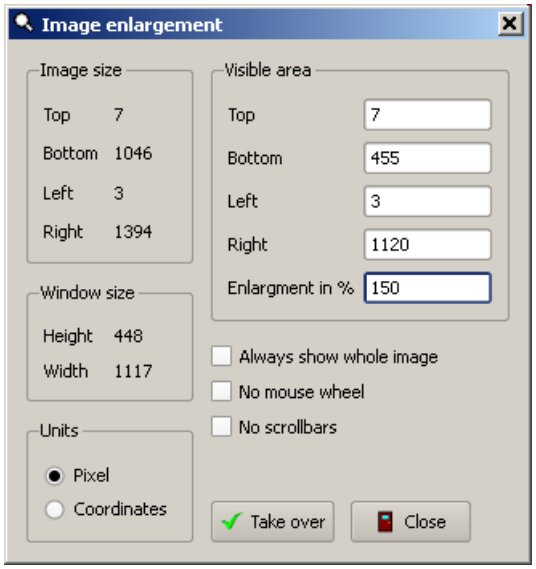
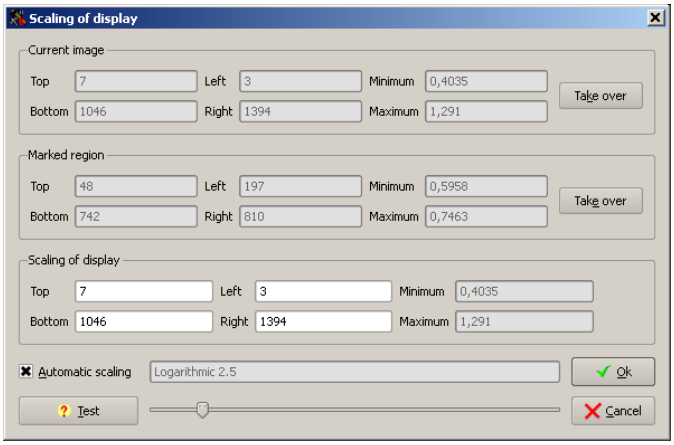


Image and window size are fixed when the dialog is opened, whereas the visible area and the enlargement factor can be selected. In some applications the options in the lower part of the dialog may be of some interest:

- Using the option „Always show whole image“ the image size is automatically adapted while the image is enlarged or reduced.
- The two options „No mouse wheel“ and „No scrollbars“ are used to prevent the user from modifying the display.

8.3 Scaling the display

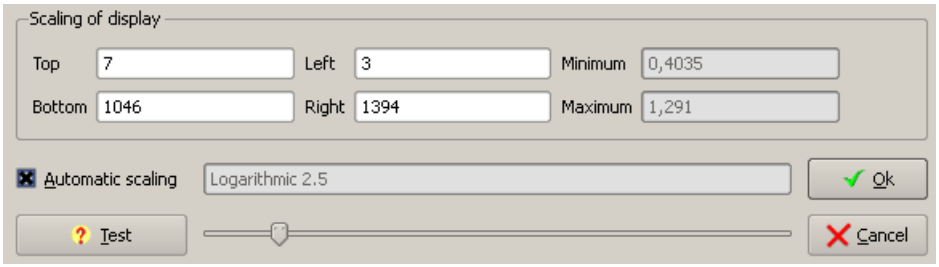
By means of the menu „Image view | Scaling“ and the corresponding quick button, respectively the user can toggle between different scalings: Linear, from Logarithmic2 to Logarithmic7 and „In dialog“. In the first options, a linear and a logarithmic scaling, respectively of the pixel values of the whole image based on a predefined scale takes place. Using the menu item „Image view | Scaling | Via dialog“ a dialog with further options is opened:



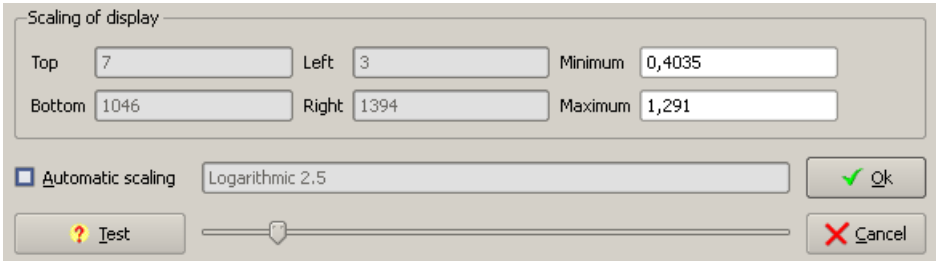
In this dialog, the threshold values (minimum, maximum) can be set where the linear scaling is carried out. For the logarithmic scaling only the upper threshold (maximum) is used. In color images, the absolute minimum or maximum from the three color channels red, green and blue is displayed.

The dialog consists of three parts:

- In the upper part of the dialog „Current image“ the image size and the minimum and maximum luminance values in the image are displayed.
- If a rectangular region was marked before opening the dialog, the middle part of the dialog „Marked region“ contains the size and the measuring values of this image region.
- In the lower part of the dialog „Scaling of display“ the current image scaling values are shown first. Depending on the settings in the option „Automatic scaling“ user-defined modifications can be made:
  - The region limits, minimum and maximum, displayed there can be taken over in the section Scaling of display by means of the buttons „Take over“ in the sections „Current image“ and „Marked region“.
  - If „Automatic scaling“ is turned on, then, in „Scaling of display“, the part of the image (top, bottom, left, right) can be defined where the highest and the smallest values are to be measured and used as scaling threshold values for the whole image.

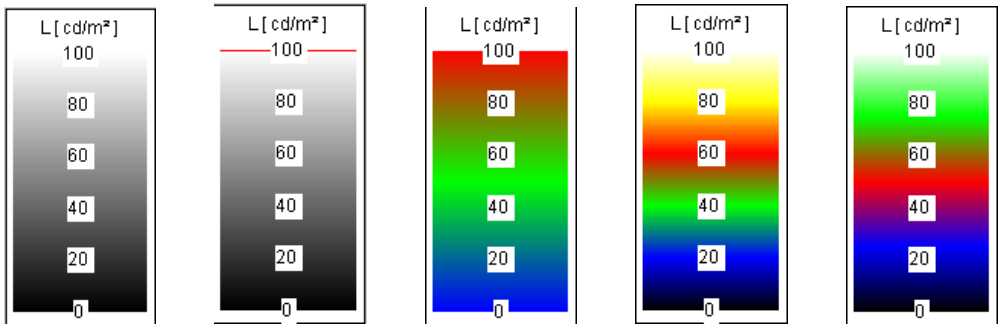


– If „Automatic Scaling“ is not activated, the geometric area is not of any importance, the two limits Minimum or Maximum can firmly be selected.



8.4 Color palettes for black-and-white images

Monochromatic images can be pseudocolored often resulting in an easier interpretation of the measuring results. The color palettes for the current image are assigned in the menu „Image view | Palette“ or by the corresponding button.



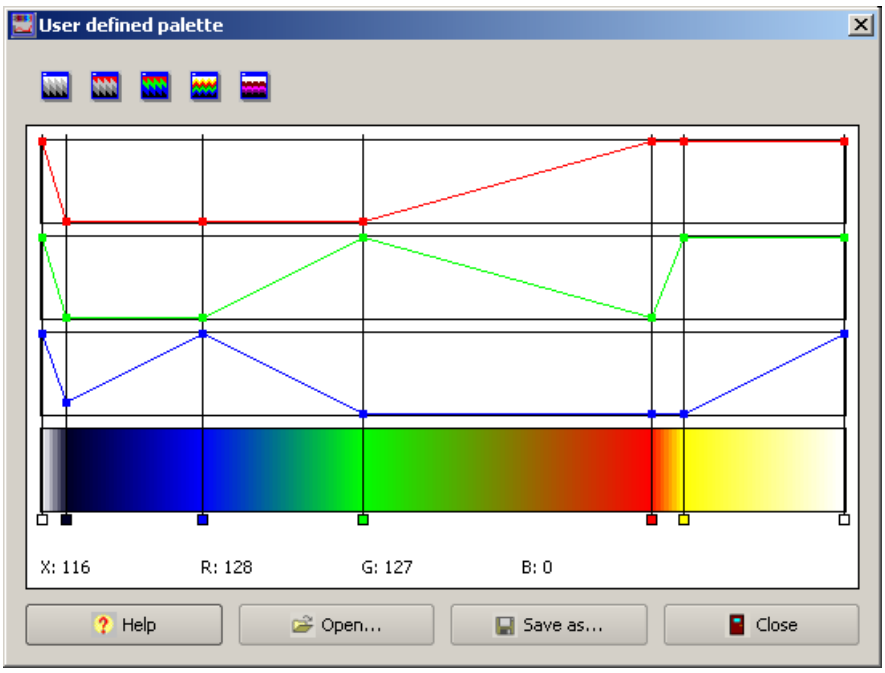
Apart from the predefined color palettes Gray, Overflow, Color, Lmk1 and Lmk2 there are two further options to create color palettes:

- By means of a user-defined palette you can create your own continuous color palette transitions.
- Equal colors can be assigned to different brightness ranges by means of isocolor palettes.

These options are documented in the two paragraphs below.

8.4.1 User-defined palette

Using the menu item „Image view | Palette | User-defined“ or also by means of the corresponding button the user can switch over to the display of a color palette which can be modified by the user himself. The dialog User-defined palette will be opened.

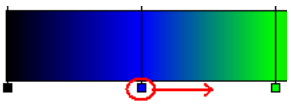


In the dialog, the last user-defined palette known to the program for the current image will be displayed. The color transitions for the three colors Red, Green and Blue constituting this palette will be represented in three curves. When opening the dialog the image display is switched over to this color palette at the same time.

The predefined palettes (Gray, ..., Lmk2) can be set by means of the buttons. A newly created or modified color palette can be saved in a file via the button „Save as“. The button „Open“ causes a palette created and saved before to be loaded and used again. The dialog is closed via the button „Close“.

When modifying a color palette the following operations should be taken into account:

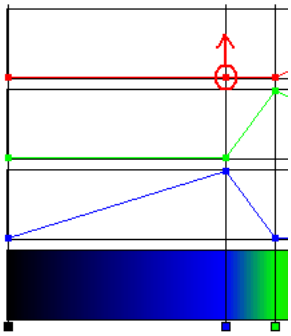
1. Fixing the point where the palette is modified.
For that, one of the vertical splitters has to be grabbed by means of the mouse and dragged to the point desired, with the left mouse button being pressed.



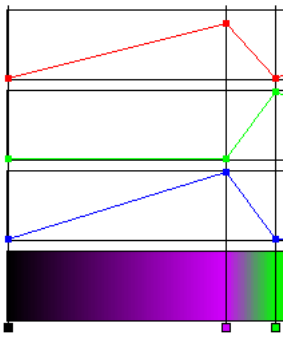
Before

After

2. Fixing the color values for these points.
For that, in one of the three color curves one of the controllers is to be grabbed by the mouse and dragged to the top or bottom.



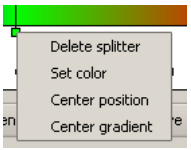
Before



After

By means of the button HELP a help text is opened giving some information on the existence of two context menus. The first context menu is opened after pressing the right-hand mouse button if the mouse is in the color palette. The second context menu is opened if the mouse is over one of the square controllers pressing the right-hand mouse button.

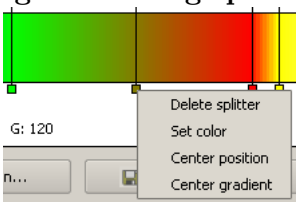
Context menu 1



Context menu 2

All the other operations will be performed by means of these two context menus:

3. Deleting an existing splitter.

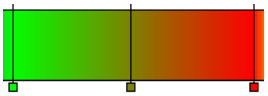


Before deleting

After deleting

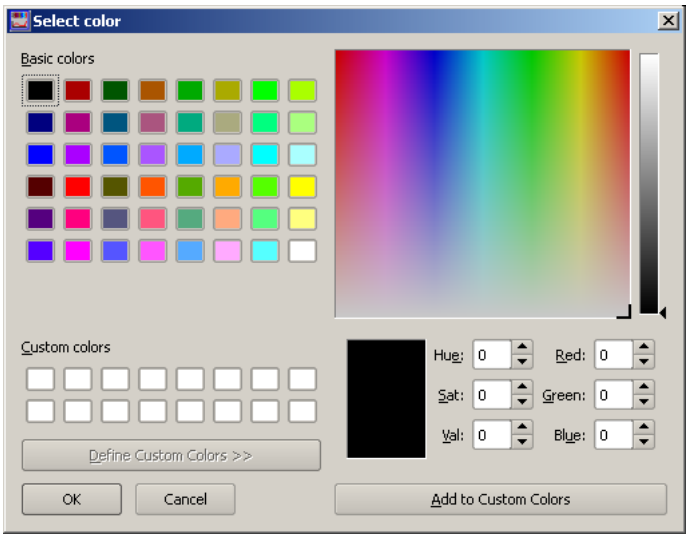
4. Pasting a new splitter

Before pasting

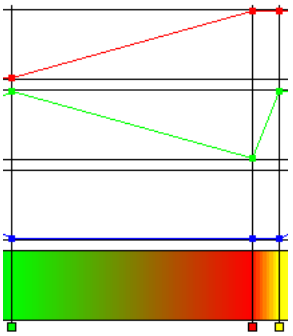


After pasting

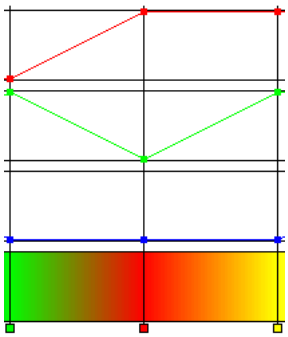
5. Selecting color via dialog
In the context menu 2 there is the menu item „Select color“. Using this menu item the color for a splitter can be selected via a standard color dialog:



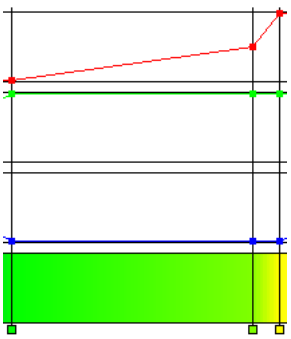
6. Centering the position, 7. Centering the gradient
The two menu items in the context menu 2 which have not been documented so far, „Center position“ and „Center gradient“, normalize either the position or the color of a splitter with respect to its two neighboring splitters:



Before modification



Centering position

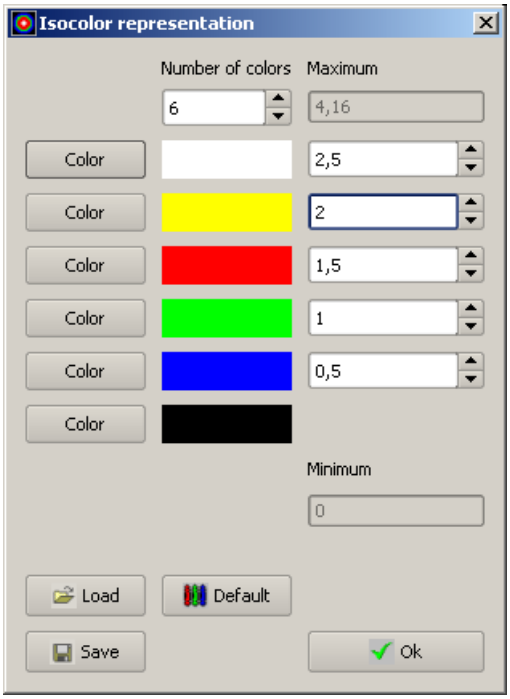


Centering gradient

8.4.2 Isocolor palette

By means of an isocolor representation luminance ranges can be marked in terms of color.

The dialog for the assignment of luminance ranges to colors can be opened via the menu item „Image view | Palette | Isocolors“ or via the corresponding button.



In the box „Number of colors“ the number of colors between 2 and 10 can be set. In each line of the dialog, after pressing the button „Color“, a standard color dialog is opened to select a predefined color or to enter your own color. On the right-hand side of the isocolor dialog the corresponding threshold value can be set, where the change from one color to the other is expected to be carried out.

After pressing the button „Standard“ the predefined settings of the program are used:

- Working with 6 colors and 5 threshold values.
- The threshold values are in equal distance between the minimum and the maximum in the image.
- The 6 colors are white, yellow, red, green, blue and black.

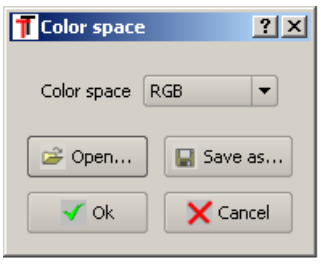
Using the buttons „Open“ and „Save as“ the threshold values and colors defined can be saved in a file or loaded from there.

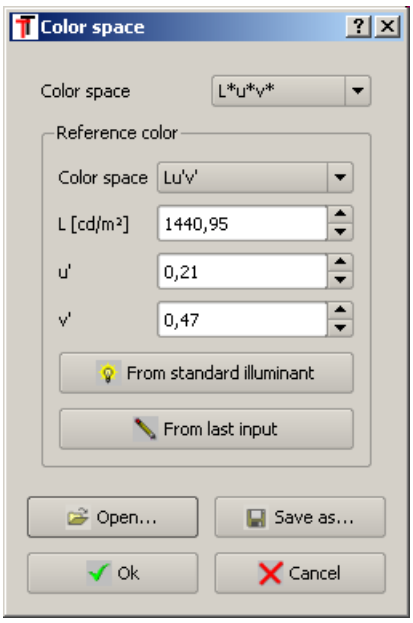
The isoline representation which can be called via the menu item „Evaluation | Isolines“ is another option to separate luminance ranges from each other, see section 13.7 on page 162.

8.5 Color spaces for color images

Depending on the application of the color images captured, the results have to be represented in different color spaces. An overview of the spaces implemented in the program and the relations among them is shown in chapter 19 beginning on page 228 „Color metric“.

Using the menu item „Image | Color space“ the dialog „Color space“ is opened.





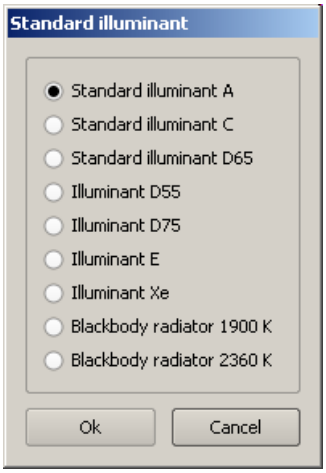
In this dialog, the color space desired can be selected from a list. If a reference color („white point“), is necessary for the color space selected, it can also be entered in the dialog. For entering a reference color the middle part of the dialog is faded in.

The reference color can only be entered in a color space which does not need a reference color itself. To facilitate the input the buttons „From standard illuminant“, „From last input“ and „From marked rectangle“ are available.

By means of the button „From last input“ an input of color coordinates previously used in another image can be used again.

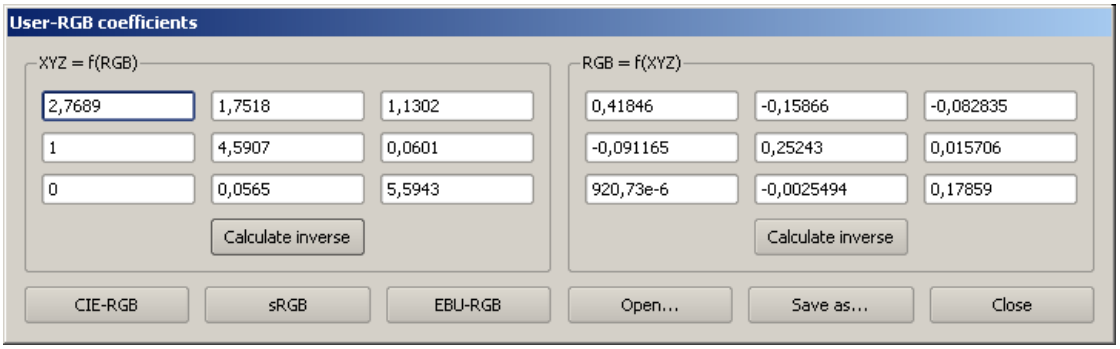
The button „From marked rectangle“ is only available if an exactly rectangular region had been marked in the image. In this case, the mean value of this region is used as reference color.

Pressing the button „From standard illuminant“ another dialog is opened offering some options to select from different standard illuminant types.



The color space „User-RGB“ is a special feature. For this color space, the users can enter coefficients of their own and load and save them as a parameter set under a certain name. Therefore, it is also possible to switch between several different user RGB color spaces.

The dialog „User-RGB coefficients“ is opened via the button „Coefficients“. In the default settings, the dialog contains the coefficient matrices for converting between the XYZ- and the CIE-RGB color space, i.e. the default values for the User-RGB coefficients are the CIE-RGB coefficients.

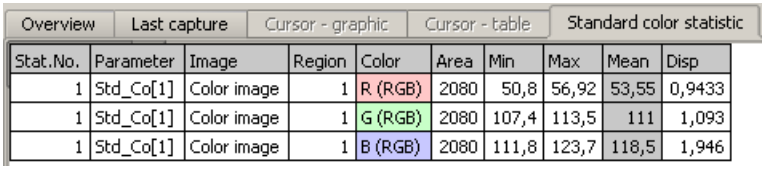


The user only has to enter one of the two coefficient matrices *XYZ = f(RGB)* or *RGB = f(XYZ)* and can then have the inverse transformation generated via one of the two

buttons „Calculate inverse“. The automatic generation is better than the use of coefficients from technical documentations because there they are often given with only a low number of digits after the point.

The coefficients of known RGB color spaces are loaded into the dialog by means of the buttons „CIE-RGB“, „sRGB“ and „EBU-RGB“. The buttons „Open“ and „Save as“ are used to file the coefficients entered and calculated. The work with the dialog is finished by means of the button „Close“.

After switching over to the new color space of the image all further displays in the status line, in the special cursors (line, rectangle, circle), in the statistical tables and graphics are carried out in the color space selected.



Stat.No.	Parameter	Image	Region	Color	Area	Min	Max	Mean	Disp
1	Std_Co[1]	Color image	1	R (RGB)	2080	50,8	56,92	53,55	0,9433
1	Std_Co[1]	Color image	1	G (RGB)	2080	107,4	113,5	111	1,093
1	Std_Co[1]	Color image	1	B (RGB)	2080	111,8	123,7	118,5	1,946

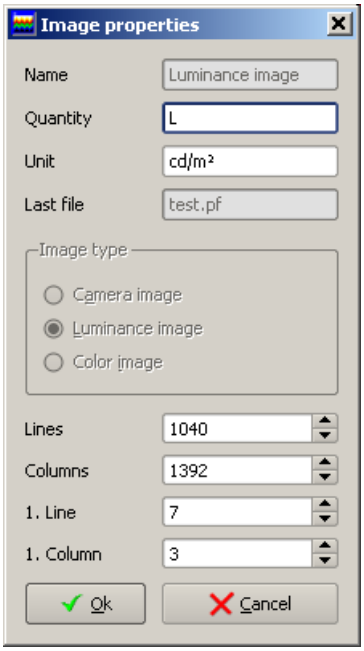
8.6 Further options

8.6.1 Duplicating and filling

A new evaluation image which has the same contents as the current image can be generated by means of the menu item „Image | Duplicate“. The properties of the current image are also taken over into the new image. Using the menu item „Image | Fill“ the complete image can be assigned a constant value. This option is often necessary if the image is to be used during image processing operations for arithmetic operations, see chapter 13 beginning on page 153.

8.6.2 Image properties

Using the menu item „Image | Properties“ a dialog is opened where some image properties can be looked at or modified.



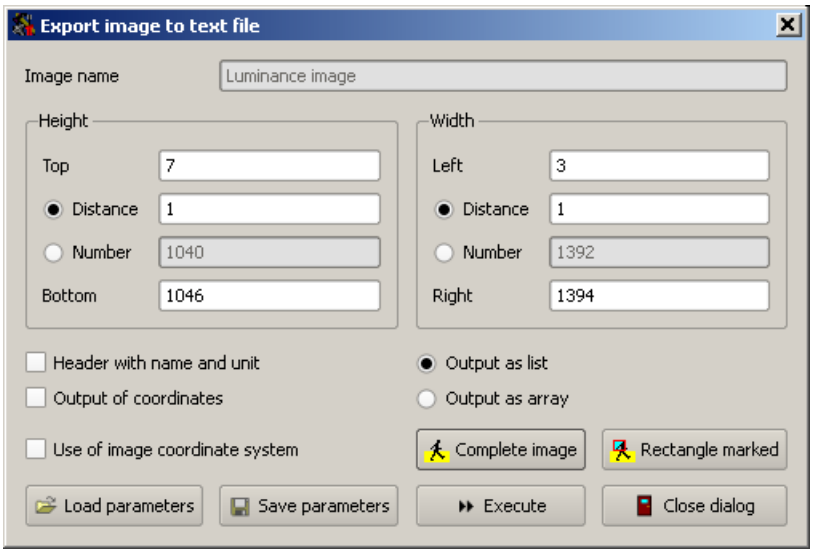
The type of the image is displayed in the middle part of the dialog. It is defined when the image is generated and cannot be modified later. See section 13.1 on page 155 for the creation of evaluation images.

The name of the images, their physical quantity and unit are displayed in the upper part of the dialog. They can also be modified there. These quantities are used in some displays in the program e.g. when the measuring results obtained in the image are displayed.

In the lower part of the dialog the image size can be modified. In a lot of image processing operations it is required for the images used to have the same size, as all pixels of the source image and the target image are to be connected to each other. Therefore, new evaluation images are created with the same size as the images already existing. If an image with a different size is required, it can be modified later via the image properties dialog.

8.6.3 Exporting an image to text file

For simply saving an image in text format, the menu item „Image | Save as“ and the file type *.txt can be selected, see section 8.1.1 on page 78. For further export options the menu item „Image | Export to text file“ can be used.



In the dialog „Export image to text file“ the options below are available:

- An output grid can be selected (not each pixel is used).
- The output is performed in the coordinate system used in the image.
- Two different output formats are available (one-dimensional data list, two-dimensional data field).
- The appertaining image coordinates and the units can be output together with data.

In the boxes „Height“ and „Width“ the size of the image range to be output and the distance between the output points or their number can be entered. To facilitate the input of the image range there are the two switches „Complete image“ and „Marked rectangle“ in the lower part of the dialog. Using the button „Complete image“ the size of the image selected can be entered in the input boxes Top, Bottom, Left and Right. If a rectangular region had been marked before opening the dialog, then the switch „Rectangle marked“ is available. By means of this switch the size of the marked rectangle can be taken over into the corresponding input boxes.

In the two boxes „Height“ and „Width“ either the distance or the number of the points of support in the image section to be output can be selected. As the number of the points of support is determined by the distance between them, and vice versa, it is possible to enter only one of the parameters, the other one will be calculated automatically.

In the lower part of the dialog, there is the selection box „Use of the image coordinate system“. If this option is engaged, all entries in the boxes Top, Bottom, Left, Right and Distance are made in the units of the coordinate system selected. For color images, the output is carried out in the color space set for this image. (The color space

of each color image can be set and parameterized via the menu item „Image | Color space“.)

By means of the two alternatives „Output as list“ and „Output as array“ and the selection boxes „Header with name and unit“ and „Output of coordinates“ the format of the text file generated is influenced.

If different parameter records are needed because data with different settings has to be exported, the parameter records can be saved in a parameter file (file ending *.ini) after pressing the button „Save parameters“ and, on request, be used again by means of the button „Load parameters“.

After using the button „Execute“ the file name of the export file to be generated is asked for and the data export is started. The dialog is closed by means of the button „Close dialog“.

Text file examples generated in this way can be seen in section 18.1.4 on page 224.

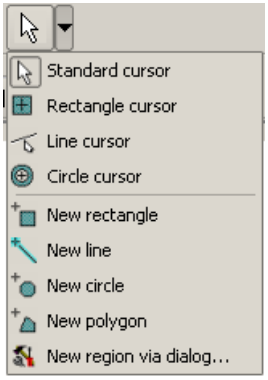
9 Measuring regions

It is necessary for most statistical evaluations to select not only the image where the evaluation is expected to be performed but also a region of the image. The types of regions available are: rectangle, circle, polygon and line. A measuring region can be generated by drawing it in the image concerned or by entering it via a dialog. These two options will be described in the sections below.

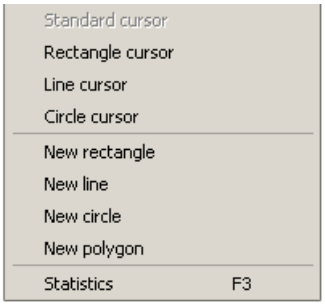
9.1 Processing measuring regions via mouse

9.1.1 Generating a region

To generate a region by means of a mouse the cursor in the current image has to be switched over to a suitable mode. The switching options can be found in the menu items „Regions | New“, „Image view | Cursor“, in a quick start button and in the context menu of the image.



Menus, quick start button



Context menu

- Having switched over to the cursor mode „New rectangle“ the first point of a rectangular region can be defined by pressing the left-hand mouse button. After that, the rectangle is drawn by shifting the mouse keeping the mouse button pressed and then the opposite corner of the rectangle is defined by releasing the mouse button.
- In the cursor mode „New line“, the beginning of a line is defined by pressing the left-hand mouse button, whereas releasing it means its end.
- In the cursor mode „New circle“, circles can be drawn. The central point of the circle is defined by pressing the mouse button, whereas releasing the button results in a point on the circumference of the circle.

- Polygons are generated by more than two points. Therefore, each drawing and keeping the mouse button pressed leads to a new side of the polygon. The generation of a polygon is finished when the point which had been drawn in last is clicked on a second time without shifting the mouse or if the cursor mode „NEW POLYGON“ is left.

9.1.2 Marking regions

To mark, modify or delete existing regions you have to be in the standard cursor mode. This is effected via the menu item „STANDARD CURSOR“.

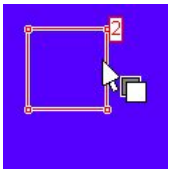
The marking of regions can be modified by:

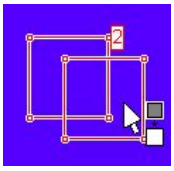
- Mouse click: The region below the cursor will be marked. All regions previously marked will no longer remain marked.
- Shift mouse click: The marking state of the region below the cursor will be modified, i.e. a region marked previously will be demarcated, a region which had not been marked before will be marked. All regions marked previously will remain marked.
- Drawing a circumscribing rectangle around the regions to be marked, i.e. pressing the left-hand mouse button, drawing a rectangle, releasing the mouse button.
  - If the circumscribed rectangle is drawn from top left to bottom right, all regions completely contained in the drawn rectangle will be marked.
  - If the circumscribed rectangle is drawn from bottom right to top left, all regions touched by the drawn rectangle will be marked.

To change a region it must be marked (exception: Undoing a change). Possible changes of measuring regions are:

- Shifting, duplicating or deleting regions
- Shifting, pasting or deleting corners of a region

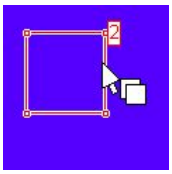
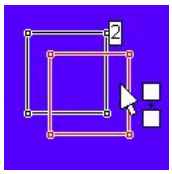
9.1.3 Shifting regions





If the cursor is over a marked region and if the „SHIFT-CURSOR“ is displayed, the marked regions can be shifted. For this, the marked regions are drawn to the position desired, with the left-hand mouse button being pressed.

9.1.4 Duplicating regions

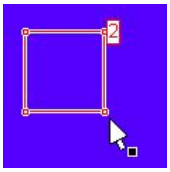
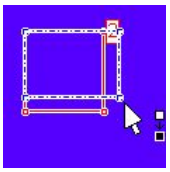
To duplicate marked regions proceed as in case of shifting. At the same time, the CTRL.-key must be kept pressed. (If this key is kept pressed, the changed mode can be recognized by the COPY-cursor.)

9.1.5 Deleting regions

Marked regions are deleted by:

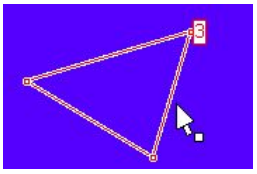
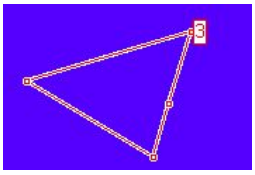
- Clicking the right-hand mouse button and selecting the menu item DELETE in the context menu or
- Pressing the key combination CTRL+DEL on the keyboard.

9.1.6 Shifting a contour point

If the cursor is over a corner of a marked region, the „SHIFT-POINT“ cursor is displayed. Now, the point can be shifted to another place. It is drawn to its new position by keeping the left-hand mouse button pressed.

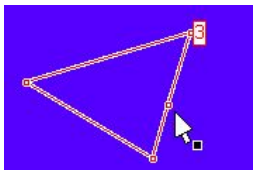
9.1.7 Inserting a contour point

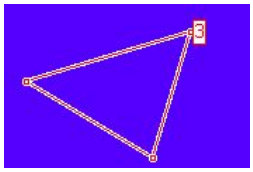



This operation is allowed for polygons only. If the mouse pointer is over an edge of a marked polygon, the „PASTE-POINT“ cursor is displayed. At this position, another contour point can be inserted:

- Use the right-hand mouse button and select the menu item „PASTE“ in the context menu or
- Press the key combination „CTRL+INS“ on the keyboard.

9.1.8 Deleting a contour point





This operation is allowed for polygons only. If the mouse pointer is over a contour point of a marked polygon, and if the polygon still has more than three corners, and if the „SHIFT-POINT“ cursor is displayed, the corresponding point can be deleted. It can be deleted by:

- Clicking the right-hand mouse button and selecting the menu item „DELETE POINT“ in the context menu or
- Pressing the key combination „ALT+DEL“ on the keyboard.

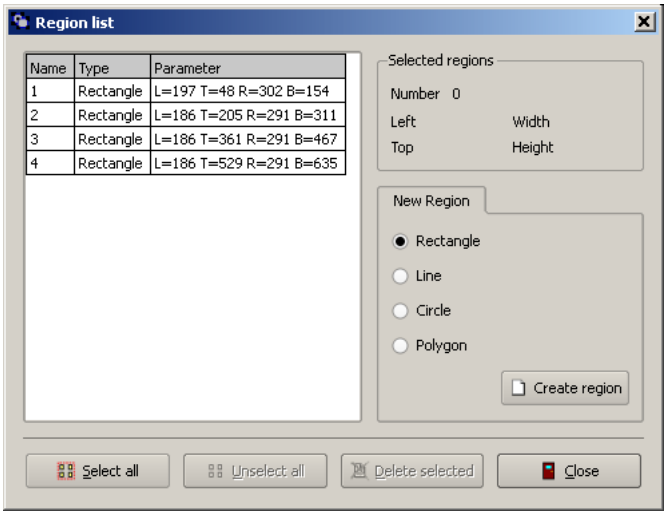
9.1.9 Undoing changes

Using the menu item „REGIONS | UNDO“ any changes in the regions can gradually be undone.

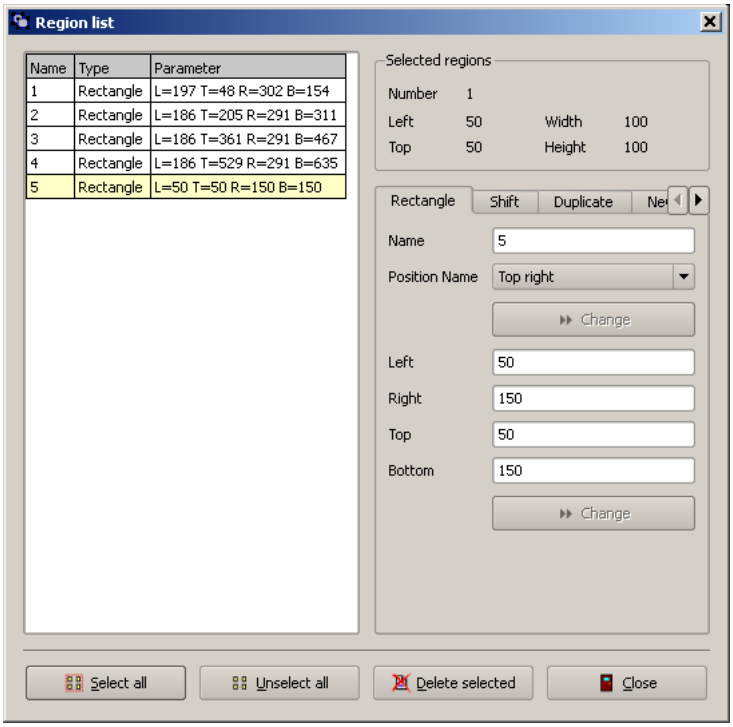
Using the menu item „REGIONS | REDO“ the undoing operation itself can be undone again.

9.2 Editing measuring regions via dialog

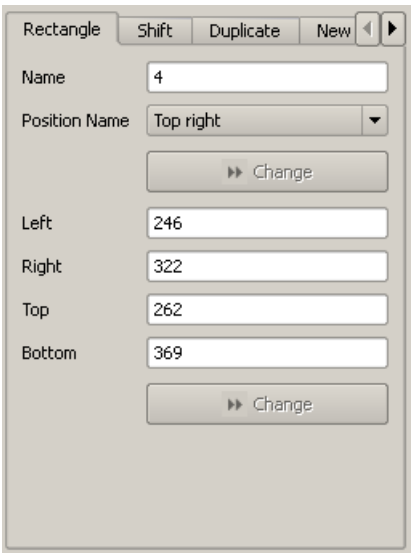
In the previous paragraphs, options of editing measuring regions by means of cursor functions were described. However, measuring regions can be created, modified or deleted by means of a dialog as well. Using the menu item „Regions | Properties“ the dialog „Region list“ is opened. If there is no region marked in the image, new regions can be created by means of the dialog:

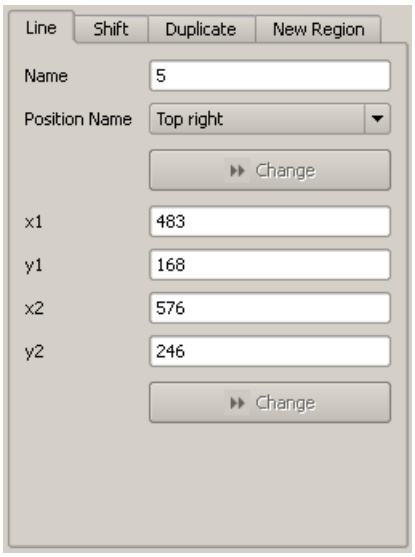


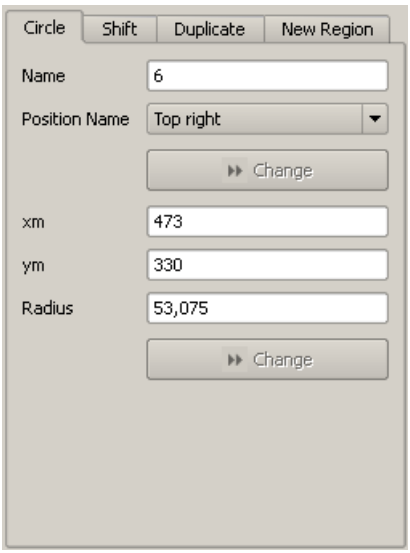
A new region of the type desired is created, drawn in the image and marked by pressing the button „Create region“. As on the right-hand side of the dialog the properties of marked regions are displayed, the modification of their properties can be started immediately:

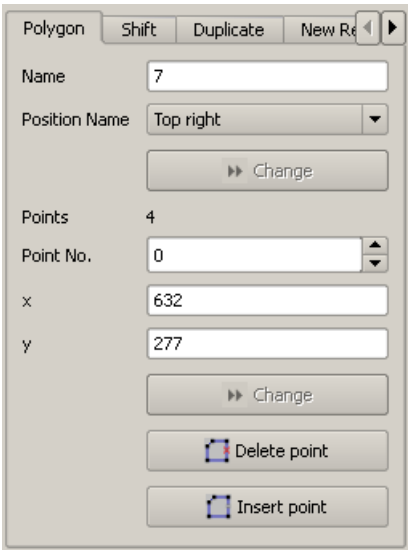


The data on the property page of a region is dependent on the type of the region:



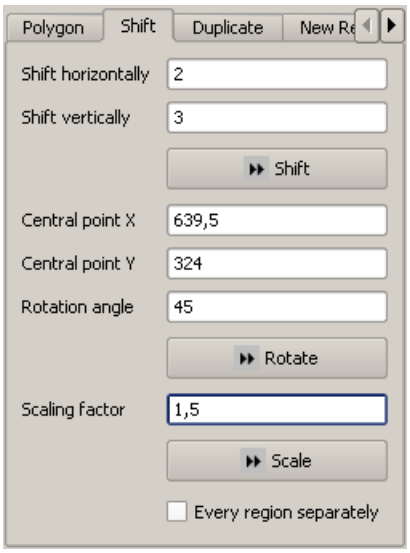


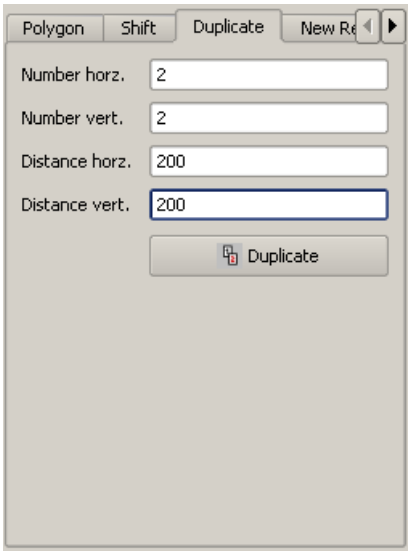




In the upper part of the dialog, the name of each region and its position can be defined. In the lower part, the corner points of the regions can be changed. For polygons it is possible to insert corner points or to delete them. Modifications of the names or of the coordinates by dialog are first transferred to the region list and become visible in the image when they have been taken over by pressing the button CHANGE.

All data of position in the dialog is shown in the unit of the coordinate system used in the image, see chapter 10 beginning on page 105.





Another option available in the dialog is to shift, to rotate, to change in size or to duplicate one or more marked regions.

In these operations, too the actions desired are carried out in the region list and in the image when the buttons SHIFT, ROTATE, SCALE or DUPLICATE are pressed after having entered the values.

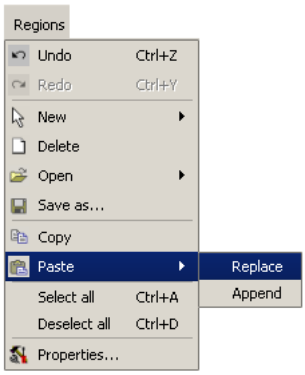
Rotating and scaling are influenced by the option „EVERY REGION SEPARATELY“ on the page SHIFT. If the option is not turned on, the regions are commonly rotated around their central point or they are scaled with respect to their common central point. If the option is turned on, each region is rotated around its own central point and scaled, respectively.

All data on position in the dialog are in the unit of the coordinate system used in the image, see chapter 10 beginning on page 105.

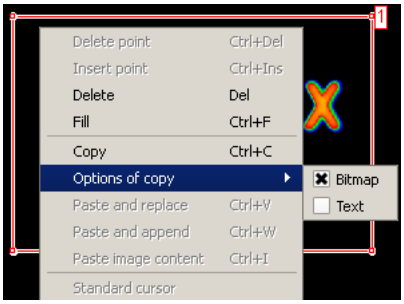
9.3 Loading and saving

A region list can be saved in a file by means of the menu item „REGIONS | SAVE“. Later, this list can be read in the program again. While reading in you can decide whether to overwrite the regions existing (menu item „REGIONS | LOAD | REPLACE“ or to add the new regions to the ones already existing (menu item „REGIONS | LOAD | APPEND“).

9.4 Copying and pasting



Main menu



Context menu

In these operations data is transferred via the clipboard. Please note:

- Using the menu items of the main menu Regions („Regions | Copy“, „Regions | Paste“ actions with the complete region list are performed.
- Using the menu items in the context menu of the image („Copy“, „Paste and Replace“, „Paste and append“, „Paste image content“) the marking of the regions in the current image is additionally taken into account. Therefore, some more cases have to be looked at:
  - No region is marked.
  - Exactly one rectangle is marked.
  - Several regions are marked or the only region marked is not a rectangle.

9.4.1 Copying and pasting the whole region list

Using the menu command „Regions | Copy“ the whole region list of an image will be saved in the clipboard. If another image will be used afterwards, the regions from the clipboard can be taken over via the commands „Regions | Paste | Append“ or „Regions | Paste | Replace“. Depending on the option selected, the regions existing in this image will stay there or they will be replaced by new ones.

As the regions of the source image have been copied to the target image, later modifications of the regions in one of the two images do not influence the regions in the other one. If a common region list is desired to be used in several images, another option is available - the menu item „Program view | Assignment of region lists“ can be selected, see section 9.6 on page 103.

9.4.2 Copying and pasting several marked regions

If one or more image regions had been marked, the menu item COPY is available in the context menu of the image. By means of this item, the marked regions can be copied into the clipboard as a separate region list. They can be taken over into the region list of a different image via the main menu items „REGIONS | PASTE | APPEND“ and „REGIONS | PASTE | REPLACE“ in the same way as if the whole region list of an image were in the clipboard.

9.4.3 Copying and pasting a marked rectangle

If only one rectangular region is marked in the image, the menu items in the context menu of an image for copying and pasting get an additional meaning. Now, not only the regions but also the content of the image can be copied from a rectangular region of an image and pasted into a rectangular region of the same or a different image.

When copying exactly one marked rectangular region the information below will be saved in the clipboard:

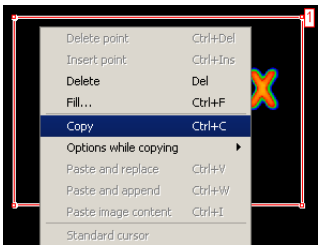
- A region list containing the position and the size of the rectangular region.
- The image content of this rectangular region.
- Optionally, a bitmap of the image content of this region. For that, the option „OPTIONS WHILE COPYING | BITMAP“ in the context menu has to be engaged.
- Optionally, the image content as a text array. For that, the option „OPTIONS WHILE COPYING | TEXT“ in the context menu has to be engaged.

The last two options can be used for data export to other programs (word processing, table calculation).

The first two options can be used for copying and pasting image contents into other images or a different range of the same image. For that, the following operations are necessary:

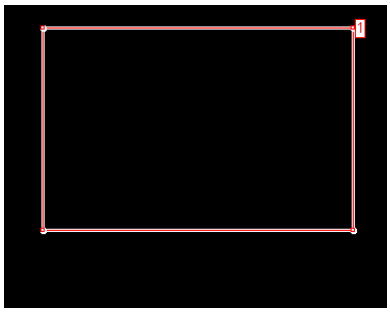
1. Marking a rectangular region in an image.
2. Selecting the menu item COPY in the context menu.

Marking



Copying

3. Switching over to a different image.
4. Selecting the menu item „Regions | Paste | Append“ in the main menu or „Paste and replace“ or „Paste and append“ in the context menu. Thus, a marked region which is, however, still empty will be pasted into another image.
5. Placing the new marked tectangular region to the position desired.
6. Selecting the menu item „Paste image content“ in the context menu. Thus, the image content will be pasted into the region.



Pasting a region

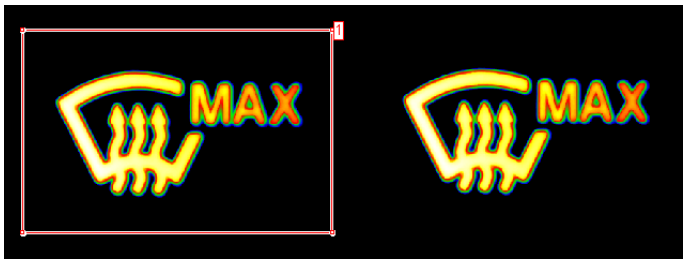
Pasting an image content

7. Shifting the marked region to the position desired.
8. Deselecting the region. Only now the image content will permanently be copied into the target image.

Shifting

Deselecting

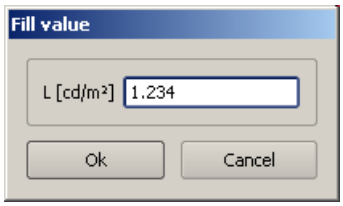
The steps mentioned above can be repeated, i.e. shifting the newly marked region to another position, selecting the menu item „Paste image content“ in the context menu and demarking the region.



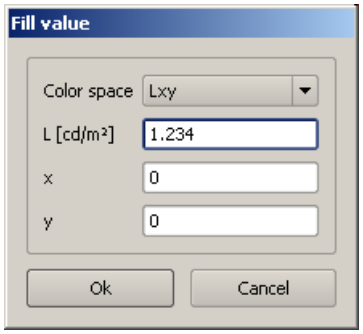
After repeating

9.5 Filling regions

The marked regions can be filled with a constant value by means of the menu item FILL in the context menu. The dialog for entering a fill value in color images allows the value to be entered in different color spaces.



Monochrome images



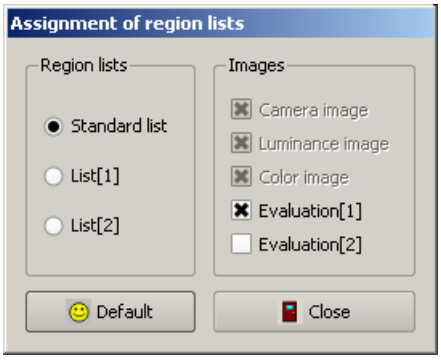
Color images

9.6 Equal region lists in different images

To define measuring regions a new region list is automatically assigned to each newly generated evaluation image. Therefore, measuring regions can be generated, modified or deleted in the single images without other images being modified.

In some applications, however, it is quite useful to use the same measuring regions in different images. Such a comparison of measuring data can, for example, be performed between the desired image and the current image, with the same measuring regions being defined in both images.

Using the menu item „PROGRAM VIEW | ASSIGNMENT OF REGION LISTS“ the dialog „ASSIGNMENT OF REGION LISTS“ can be opened and the user can ger information on the current assignment there and can modify it.



In the Camera image, the Luminance image and in the Color image a common list is used. In the dialog, this list is called „STANDARD LIST“. The assignment of the standard list to the images always existing cannot be changed by the user. For the images generated by the user himself the assignment can freely be selected.

In the example shown, the standard list is used in the image „EVALUATION[1]“, too. On the left-hand side of the dialog the region list is selected. On the right-hand side its assignment to images is displayed and can be modified. In each image only one region list can be used.

By means of the button DEFAULT the user-defined assignments will be undone.

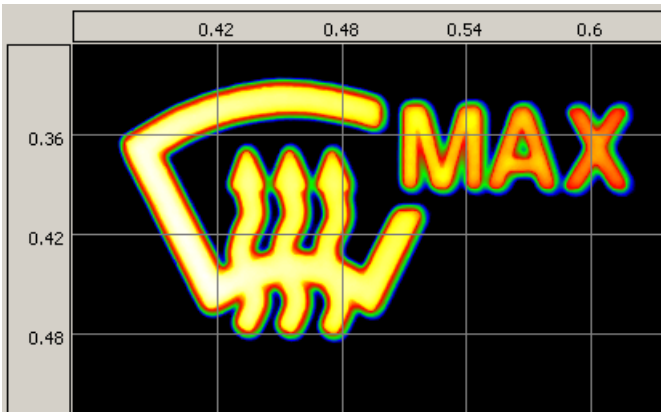
10 Coordinate systems

Geometrical information in an image is always displayed in the units of a coordinate system. If there is no special coordinate system defined, it is displayed in pixel, without a unit being explicitly indicated. The origin of the coordinates is on the top left-hand side. The x-values increase to the right, whereas the y-values increase to the bottom.

Using the menu items „Coordinate system | Save“ or „Coordinate system | Load“ the current data can be saved in a file or loaded from such a file.

The menu items „Coordinate system | Copy“ and „Coordinate system | Paste“ can be used to transfer the parameters of an image coordinate system to another image.

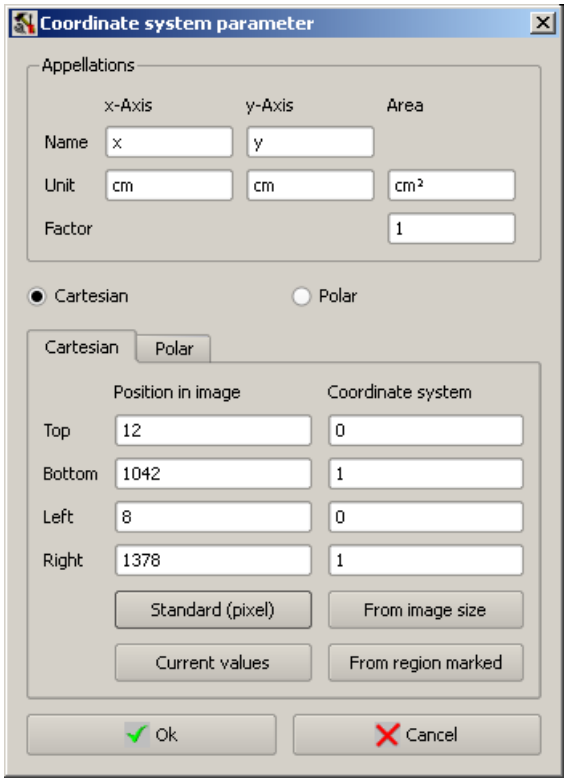
Using the menu item „Ïmage view | Coordinate system“ the coordinate system currently used in the image can be displayed.



By means of the menu item „Coordinate system | Properties“ the settings of the coordinate system used can be modified. It is possible to define another Cartesian or a polar coordinate system. The positions, the heights, widths, lengths and areas are displayed in the quantities and units of the coordinate system used.

In the upper part of the dialog, names and units of the axes of the coordinate system defined can be entered.

10.1 Cartesian coordinate system



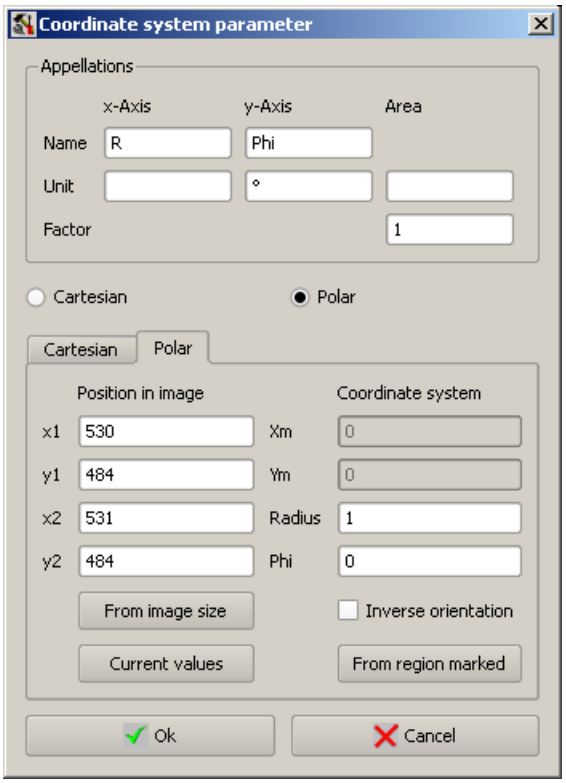
If the option CARTESIAN is selected in the coordinate system dialog, the properties of this system can be edited on the corresponding page.

In the four input boxes on the left-hand side, four coordinate values in the image can be entered in pixel coordinates. In the four boxes on the right-hand side, four coordinate values in the coordinate system desired are assigned to these four values. Based on this data the program calculates the conversion between the pixel values to those of the coordinate system.

The four buttons below the input boxes are used to facilitate the parameter determination of the coordinate transformation:

- „STANDARD (PIXEL)“: Using this button the coordinate system will be reset to pixel coordinates.
- „FROM IMAGE SIZE“: The size of the image will be entered into the four input boxes.
- „CURRENT VALUES“: The eight input boxes will be reset to the state before the dialog was opened (Undo-function).
- „FROM REGION MARKED“: If exactly one rectangle is marked in the image, the coordinates of the marked rectangle will be entered into these four input boxes on the left-hand side.

10.2 Polar coordinate system



If the option POLAR is selected in the coordinate system dialog, the properties of the coordinate system can be edited on the corresponding page.

On the left-hand side of the dialog, the coordinates of two points can be defined. The zero-point of the polar coordinate system is defined by the first of the two points. The values for the second point in the coordinate system can be entered on the right-hand side.

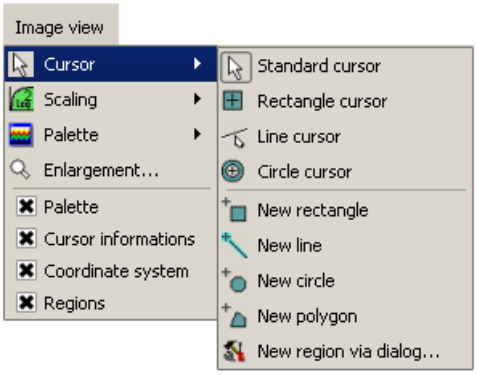
The option Inverse orientation allows the direction of rotation of the angle to be inverted. The parameters of the conversion from pixel to polar coordinates are distinctly determined by this data.

The three buttons below the input boxes are used to facilitate the parameter determination of the coordinate transformation:

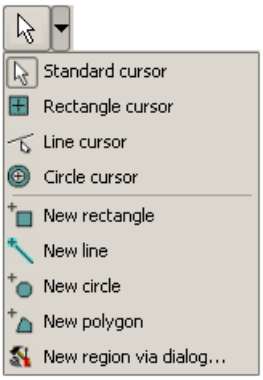
- „FROM IMAGE SIZE“: The size of the image will be entered into the four input boxes on the right-hand side.
- „CURRENT VALUES“: The input boxes will be reset to the state before the dialog was opened (Undo-function).
- „FROM REGION MARKED“: If exactly one circle is marked in the image, the parameters of the central point and of a second point which is on the right-hand side on the circumference will be entered.

11 Cursors

If the mouse pointer is moved across the image, information on the image content or on the regions under the mouse pointer will be displayed in the status line. The data in the status line differ in the different mouse modes, several operations with the mouse and in some dialogs which are additionally opened can be carried out. Changing the mouse mode is effected either in the menu „Image view | Cursor“ or via the corresponding button.



Menu



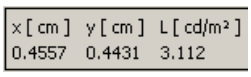
Button

11.1 Cursor types

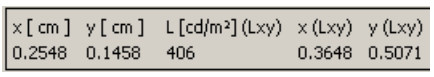
The cursor types „New rectangle“, „New line“, „New circle“ and „New polygon“ are used to generate new measuring regions and have already been described in detail in section 9.1 on page 93.

11.1.1 Standard cursor

If the „Standard cursor“ is turned on, the image value at the position of the mouse pointer is displayed in the status line. When working with color images it is displayed in the color space set, when black-and-white images are used it is shown in the unit valid in this image. If a coordinate system had been agreed upon for the image, the geometrical parameters in the coordinate system are displayed.



Monochrome image



Color image

Clicking with the left-hand mouse button on a region or drawing an enclosing rectangle around the regions they can be marked, see section 9.1.2 on page 94. The marking is needed for some operations with measuring regions such as shifting, duplicating, changing, deleting, generating and changing a statistical evaluation.

If the mouse pointer is over a marked region, information about this region is displayed in the status line. The display changes depending on whether the pointer is within the region, on its contour or on one of its corners.

Object	Type	Points	Area	Circumference
1	Rectangle	4	0.01403	0.4738

Area

Object	Type	Line	Length	Angle
1	Rectangle	2	0.1193	180

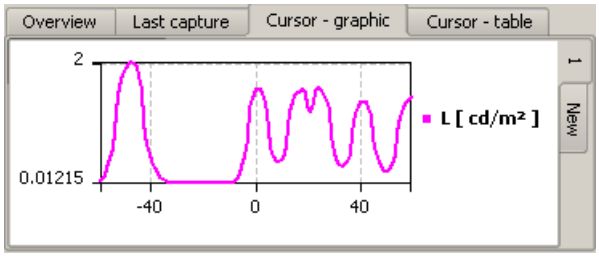
Contour

Object	Type	Point	x [cm]	y [cm]
1	Rectangle	3	0.4319	0.5219

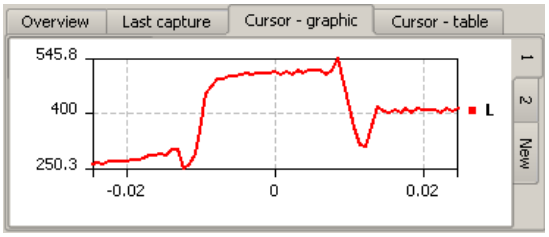
Corner

11.1.2 Line cursor

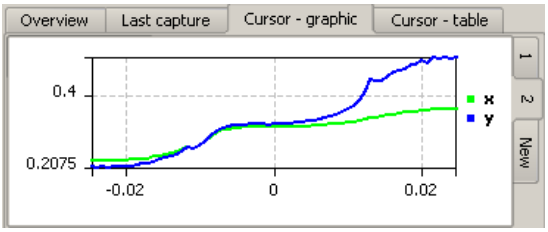
If the „LINE CURSOR“ is turned on, a luminance or a color sectional view is displayed in a window below the current image.



Display in a monochrome image



Display 1 in a color image

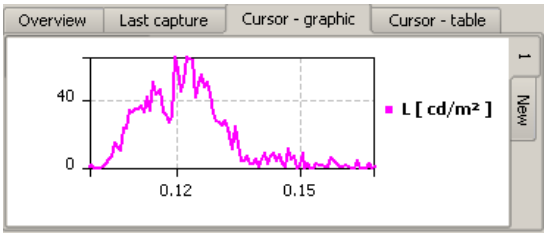


Display 2 in a color image

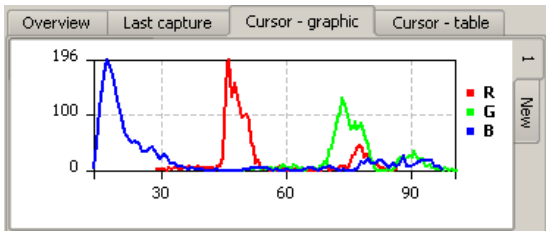
Since the output of the measuring values for a color image was selected in the color space LUV, the cursor display is also in this color space. The curves for L and for x,y, respectively are on two different pages of the graphics display since the value ranges for the luminance L and the color u,v are very different.

11.1.3 Rectangle and circle cursor

A histogram can be displayed in a window below the current image by means of a RECTANGLE or a CIRCLE cursor. As it can be seen from the name of the cursor, a rectangular and a circular cursor region respectively are used.



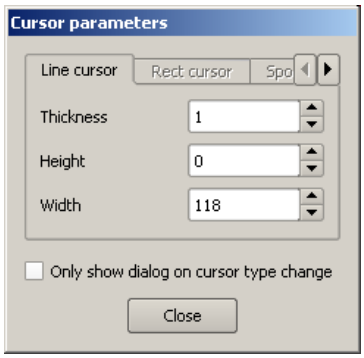
Display in a monochrome image



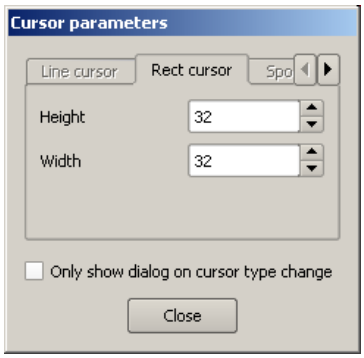
Display in a color image

11.2 Cursor parameterization

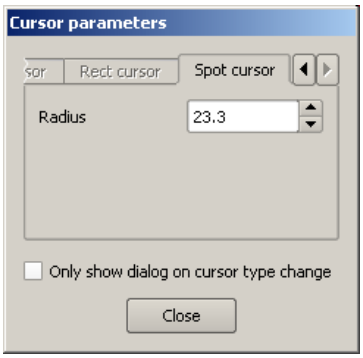
When switching over to one of the three special cursors - „Line cursor“, „Rectangle cursor“ or „Circle cursor“ - a dialog will automatically be opened where the cursor parameters are displayed and where they can be modified. The displays and the values of this dialog are in the units of the current coordinate system.



Line cursor



Rectangle cursor



Circle cursor

To modify the size of a cursor two different options are available:

- Pressing the left-hand mouse button it is possible - depending on the cursor type set - to draw a line, a rectangle or a circle. If the mouse button is released, the drawing is finished and the new cursor size is defined. The parameters modified are displayed in the dialog.
- Entering the cursor size into the dialog.

The parameter Thickness in the parameter dialog for a line cursor results in a smoothing of the sectional view displayed. The luminance and the color values, respectively in the neighborhood of the sectional line are averaged.

If the dialog is left via the button Close, it is opened again when the size of the cursor is intended to be modified by the mouse again in order to display the new cursor size. This behavior can be changed by means of the option „Only show dialog on cursor type change“. Then, the dialog will only be opened if, for example, it is switched over from a rectangle to a line cursor.

12 Statistic evaluations

After the capture and calculation of a luminance and a color image, respectively by means of a capture method implemented in the software result images are available showing a luminance or chromaticity value for each pixel. Very often, however, it is not the measuring values of single pixels that are in the focus of interest but statements on the objects captured by the camera. For more complex tasks, some algorithms are available to compose the measuring values of several pixels in one region of the image to joint resulting values. Some quantities can be found by means of the cursor functions presented in chapter 11 beginning on page 108. All cursors supply photometric and colorimetric statements on mean value, variance, minimum and maximum in the cursor area. The luminance and the chromaticity profile along a line can be determined by means of a line cursor. The use of plane cursors such as rectangle cursors results in histogram statistics of luminance and chromaticity in the cursor area. The cursor results are, however, „momentary“ because they are dependent on the movement of the mouse pointer.

The methods presented in this chapter can calculate measuring results from regions defined in the image by the user. The measuring values remain unchanged as long as a new image is captured or the measuring regions or the parameters of the evaluation method are changed. The values calculated can be saved, printed or exported in different formats to other programs. As already described in chapter 9 beginning on page 93, lines, rectangles, circles and polygons are available as geometric measuring regions. Some of the evaluation methods described below (luminance, integral and symbol objects) allow not only a geometric object definition based on the contour of the measuring region but also a photometric determination of a measuring object. An object can, for example, be separated from the background by fixing a luminance threshold, if it is brighter or darker than its surroundings. Thus, even elaborately shaped measuring objects can be defined.

There are photometric and colorimetric as well as geometric values available as measuring results:

- PHOTOMETRIC, COLORIMETRIC: mean value, variance, minimum, maximum, number of pixels, photometric center of area.
- GEOMETRIC: geometric center of area, area, position of minimums and maximums.
- USER-DEFINED: Furthermore, it is possible to calculate user-defined values from the measuring results available. The user can, for example, make a contrast definition suitable for his special problem which is based on the mean value, the minimum and the maximum.

A statistic object is characterized by five properties listed below:

- Image: A black-and-white or a color image provides the pixel values.
- Measuring region: The region defined in the image determines the pixels where the evaluation is to be performed.
- Type: The type of calculation to be carried out. These are the types implemented in the program: Standard statistics, Sectional view, Histogram, Projection, Luminance object, Integral object, Symbol object, 3D-view diagram, Color symbol object, Chromaticity line diagram, Chromaticity area diagram.
- Calculation parameters: Depending on the type, different parameters are required to perform the calculations.
- Views: The presentation of the measuring results can be effected in different formats.

To generate a statistic evaluation first measuring regions have to be drawn in the image for the evaluations desired and they have to be marked. After that, either the menu item „Statistics“ in the context menu or the menu item „Evaluation | Statistics“ in the main menu of the program have to be selected. See the paragraphs below. Please note:

- When a measuring region has been generated, a statistic for this region is not calculated automatically.
- Furthermore, for each measuring region only one statistic can be calculated and displayed.

The statistic results are represented as tables or graphics. These different views are documented in section 12.4 on page 140. In the default settings, not all the views existing for a statistic are displayed. When, for example, sectional views or histograms are used, the table containing the standard statistic (mean value, variance, minimum, maximum) is not displayed but only the measured function behavior in a graphic. The visibility settings can be modified for each statistic type either by means of the menu item „Evaluation | Visibility of tables and diagrams“ or directly in the context menu of tables and graphics.

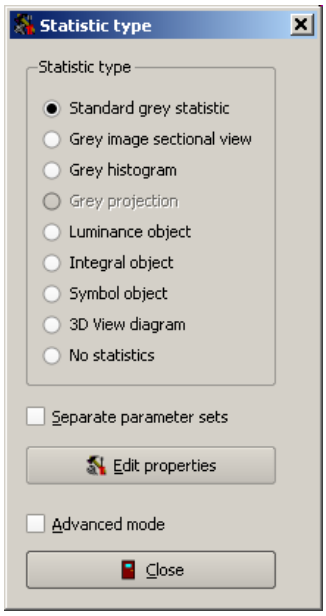
In each of the views there is a context menu which can be opened by pressing the right-hand mouse button. The menu items are equal to those of the main menu of the program in the pop-up menus „Table“, „Diagram“ and „Graphic“. For more details see section 12.4 on page 140.

12.1 Generating and parameterizing a statistic

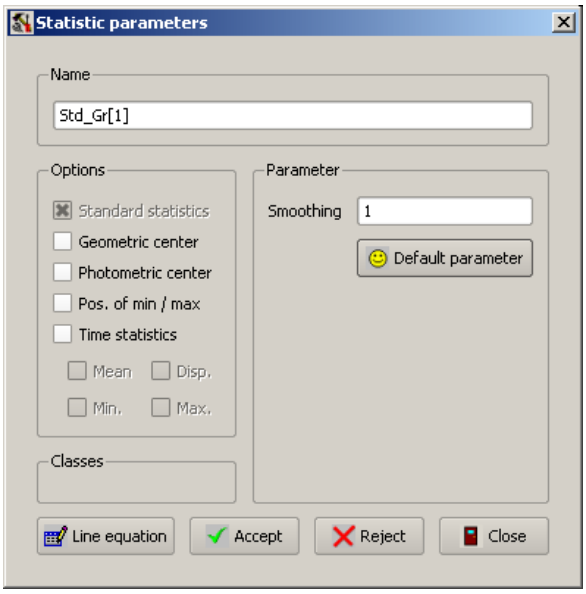
12.1.1 Standard statistics

In a standard statistic, the mean value, the variance, minimum and maximum are calculated for all pixels of a region. Additionally, the geometric and the photometric center of the region and the positions of minimum or maximum can be calculated. It is possible to generate a time statistic based on all these values, i.e. for example to record the modified statistic measuring values after capturing an image.

To generate a standard statistic the desired measuring region in the image has to be marked and to be selected in the dialog „STATISTIC TYPE“ - depending on the image type - either „STANDARD GREY STATISTIC“ or „STANDARD COLOR STATISTIC“. This dialog can be opened either in the context menu of the image via the menu item „STATISTICS“ or in the main menu via „EVALUATION | STATISTICS“.



Statistic type



Statistic parameters

In the dialog „STATISTIC TYPE“, the dialog „STATISTIC PARAMETERS“ can be opened by pressing the button „EDIT PROPERTIES“ where calculation parameters can be modified.

The enlarged parameter „SMOOTHING“ results in a noise reduction probably existing in the images. The measured minimum is enlarged, whereas maximum and variance are reduced. All the other options of both dialogs are described in detail in section 12.2 on page 130.

Overview | Last capture | Cursor - graphic | Cursor - table | Standard grey statistic

Stat.No.	Parameter	Image	Region	Area	Min	Max	Mean	Disp
1	Std_Gr[1]	Luminance image	1	1089	0.05034	3.83	2.372	1.085
2	Std_Gr[1]	Luminance image	2	667	0.03937	2.906	1.966	1.013
3	Std_Gr[1]	Luminance image	3	999	0.03141	1.759	0.9317	0.4825

Standard statistic in a luminance image

Overview | Last capture | Cursor - graphic | Cursor - table | Standard color statistic

Stat.No.	Parameter	Image	Region	Color	Area	Mean
1	Std_Co[1]	Color image	2	L [cd/m²] (Lxy)	667	9305
1	Std_Co[1]	Color image	2	x (Lxy)	667	0.3608
1	Std_Co[1]	Color image	2	y (Lxy)	667	0.3657
2	Std_Co[1]	Color image	3	L [cd/m²] (Lxy)	999	18330
2	Std_Co[1]	Color image	3	x (Lxy)	999	0.4869
2	Std_Co[1]	Color image	3	y (Lxy)	999	0.3629

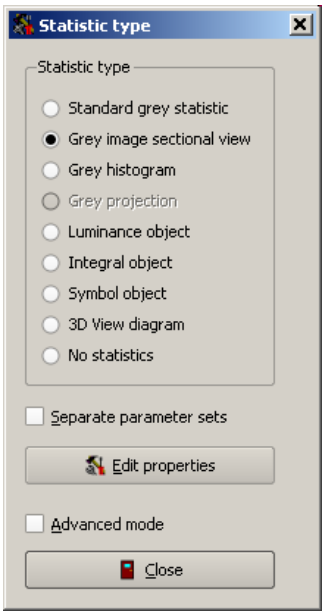
Standard statistic in a color image

For all the other statistic object types, the results of the standard statistic (mean value, variance, minimum, maximum) are also calculated. In most cases, however, the table with the standard results is not displayed in the default settings. If the indication of the results is additionally needed, it can be turned on via the dialog „Visibility of tables and diagrams“. This dialog is opened by the menu item „Evaluation | Visibility of tables and diagrams“.

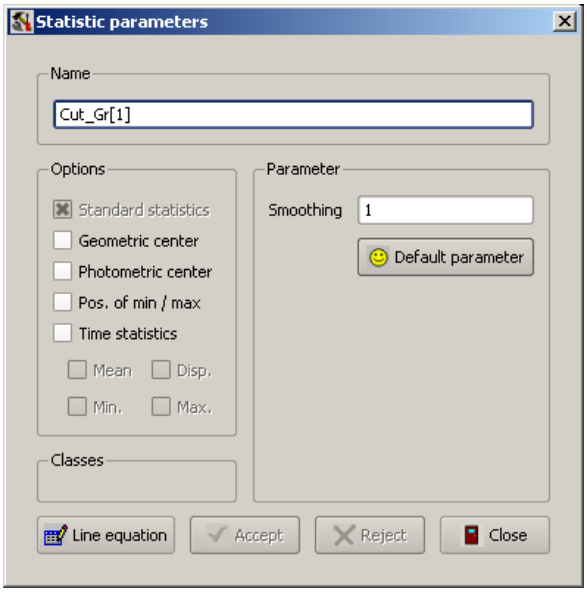
12.1.2 Sectional views

The brightness profile along a line can be represented by sectional views. In general, a line measuring region will be used to assess the profile along this line. The plane measuring regions rectangle, circle and polygon can be used as well. The sectional view is effected along the contour line.

To generate a sectional view the desired measuring region in the image has to be marked and, depending on the image type, the options „Grey sectional view“ or „Color sectional view“ in the dialog „Statistic type“ have to be selected. This dialog can be opened either in the context menu via the menu item „Statistics“ or in the main menu by means of „Evaluation | Statistics“.



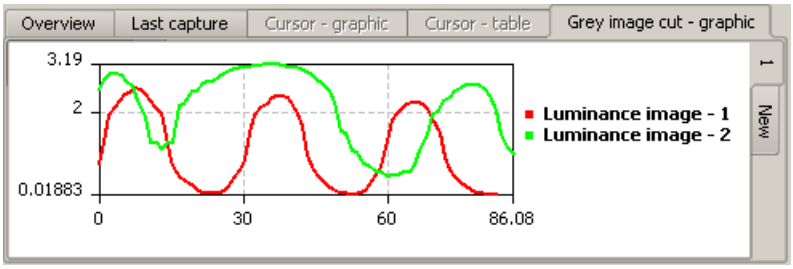
Statistic type



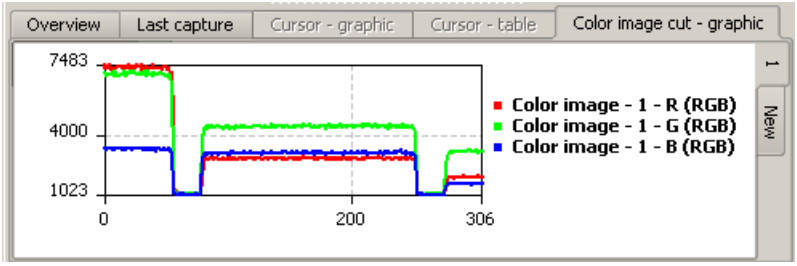
Statistic parameters

Using the button „EDIT PROPERTIES“ in the dialog „STATISTIC TYPE“ the dialog „STATISTIC PARAMETERS““can be opened where calculation parameters can be modified. Both dialogs are described in detail in section 12.2 on page 130.

- The enlarged parameter „SMOOTHING“ results in a noise reduction probably existing in the images. Hence, the curve in the graphical representation will be smoothed. The minimum measured is enlarged, whereas maximum and variance are reduced.
- All other options of both dialogs are described in detailed form in section 12.2 on page 130.

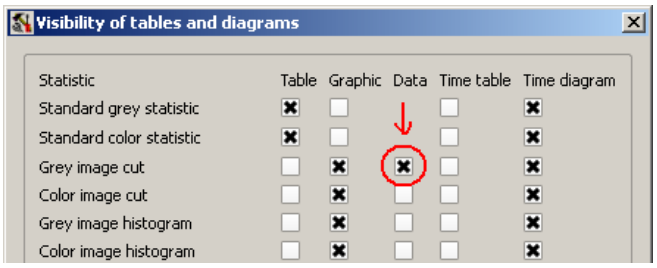


Sectional view in a luminance image



Sectional view in a color image

If the measuring values along the line are needed, the corresponding result view „DATA“ in the dialog „VISIBILITY OF TABLES AND DIAGRAMS“ has to be turned on:



Turning on visibility

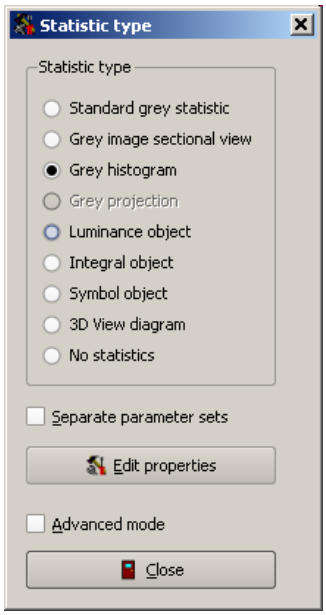
No.	x[1]	y[1]	V[1]
1	550	454	0.5183
2	551	454	0.4002
3	552	454	0.2594
4	553	454	0.2594
5	554	454	0.4028
6	555	454	0.5301
7	556	454	0.7838

Data view

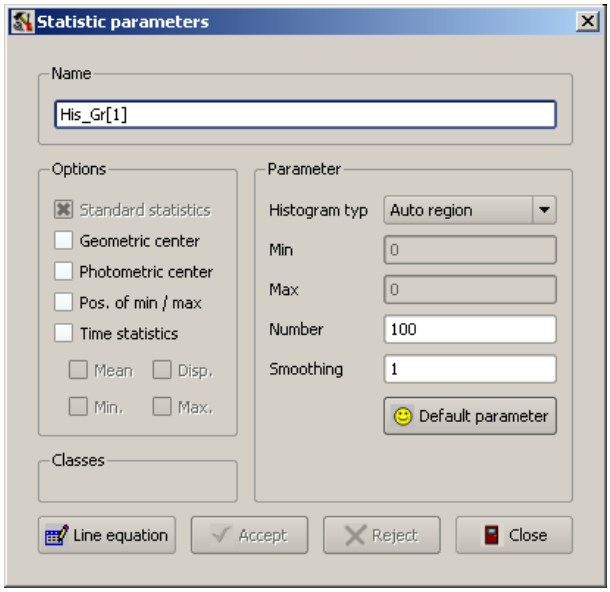
12.1.3 Histograms

Histograms represent the frequency distribution of luminance or chromaticity in a measuring region. In general, plane measuring regions such as rectangles, circles or polygons are worked with. As a default setting, only the graphical display is active.

To generate a histogram the desired measuring region in the image has to be marked and depending on the image type, the options „GREY HISTOGRAM“ or „COLOR HISTOGRAM“ in the dialog „STATISTIC TYPE“ have to be selected. This dialog can be opened either in the context menu of the image via the menu item „STATISTICS“ or in the main menu by means of „EVALUATION | STATISTICS“.



Statistic type

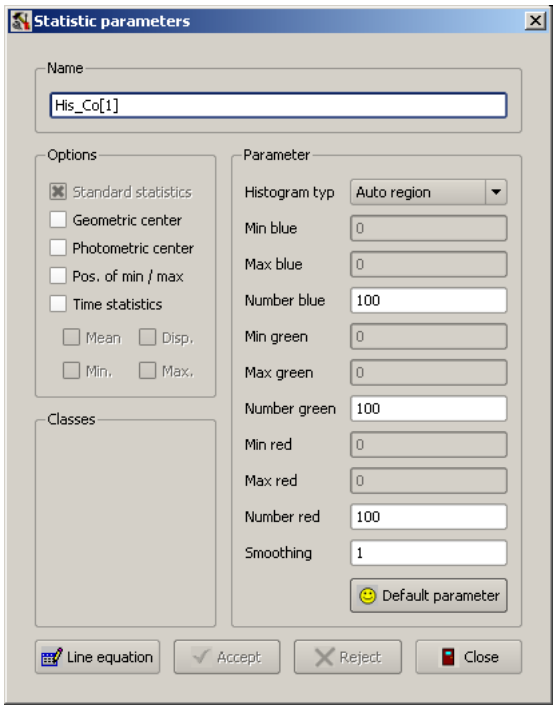


Statistic parameters

Using the button „EDIT PROPERTIES“ in the dialog Statistic type the dialog „STATISTIC PARAMETERS“ can be opened where calculation parameters can be modified.

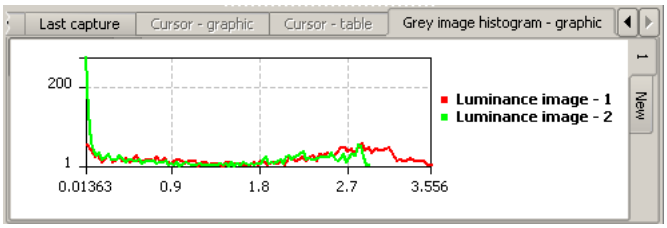
- The parameter NUMBER determines the number of intervals the area between the minimum and the maximum is to be divided in.
- MINIMUM and MAXIMUM are influenced by the „HISTOGRAM TYPE“:
  - „AUTO. REGION“: The minimum and the maximum are determined by luminance or chromaticity, respectively within the measuring regions. Therefore, the input boxes for minimum and maximum are disabled as a default setting.
  - „AUTO. IMAGE“: The minimum and the maximum are determined by luminance or chromaticity, respectively within the image. Therefore, the input boxes for minimum and maximum are disabled.
  - „MANUAL“: The user can enter fixed threshold values into the input boxes for minimum and maximum.
- MIN, MAX: If MANUAL had been selected as histogram type, the fixed threshold values desired can be entered into the input boxes.

- If color images are used, the parameters NUMBER, MIN and MAX for each of the three colors can be entered.

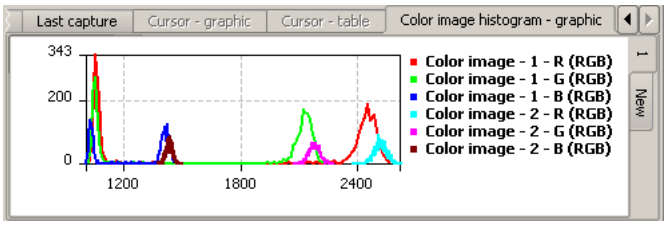


Parameters of a color histogram

If the parameter SMOOTHING is enlarged, the noise probably existing in the images will be reduced. The curve in the graphical representation will be smoothed. The minimum measured will be enlarged, maximum and variance will be reduced. All the other dialog options are described in detail in section 12.2 on page 130.

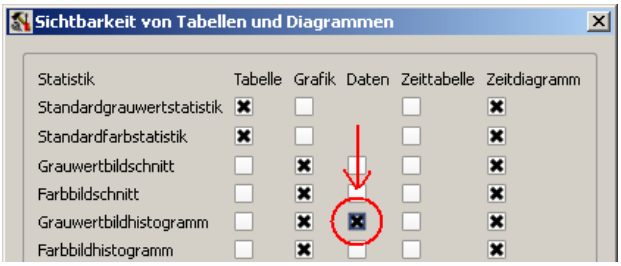


Histogram in a luminance image



Histogram in a color image

If the measuring values of the histogram are needed, the corresponding result view DATA in the dialog „VISIBILITY OF TABLES AND DIAGRAMS“ has to be turned on:



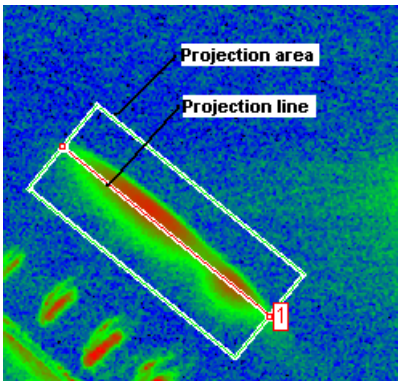
Turning on visibility

No.	R[1]	N(R)[1]	G[1]
1	1027	9	1021
2	1042	115	1033
3	1058	343	1045
4	1073	202	1058
5	1089	44	1070
6	1104	22	1082

Data view

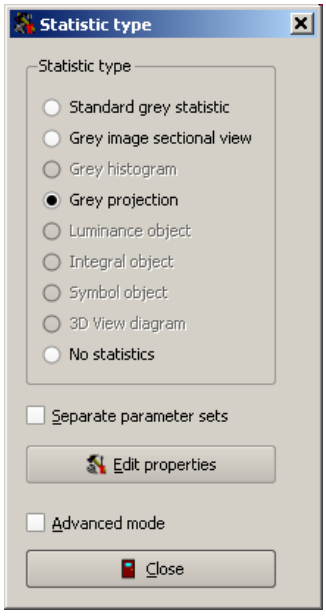
12.1.4 Projections

It is the purpose of a projection to project the profile of the pixel values within a region of a black-and-white or a color image on a line. The line and the maximum distance of the pixels to be projected from the line are defined by the user. The line and the maximum distance result in a rectangular area drawn in the image for information purposes.

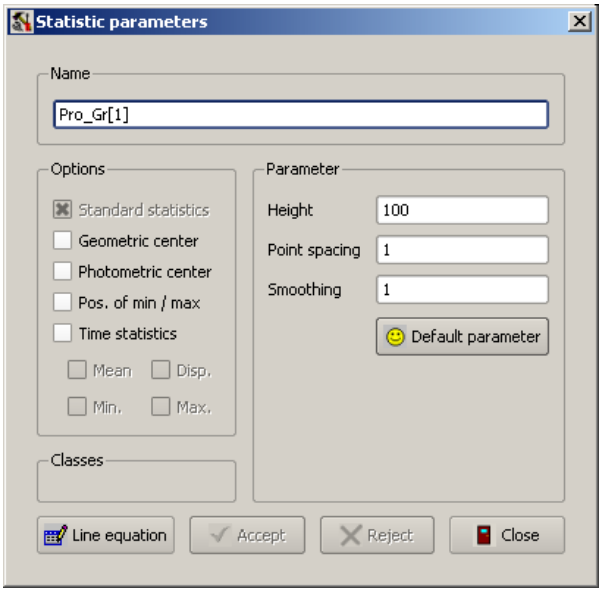


Measuring region of the projection

To create a projection the measuring line desired in the image has to be marked and depending on the image type either „Grey image projection“ or „Color image projection“ have to be selected in the dialog „Statistic type“. This dialog can be opened either in the context menu of the image via the menu item „Statistics“ or in the main menu by means of „Evaluation | Statistics“.

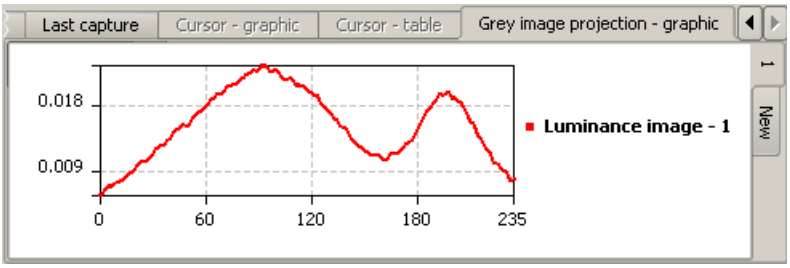


Statistic type



Statistic parameters

Using the button „Edit properties“ in the dialog „Statistic type“ the dialog „Statistic parameters“ can be opened where calculation parameters can be modified. Both dialogs are described in detail in section 12.2 on page 130.



Curve of results of a projection

If the measuring values of the projection are needed, the corresponding result view „DATA“ in the dialog „VISIBILITY OF TABLES AND DIAGRAMS“ has to be turned on as already described for sectional views and histograms in the sections concerned.

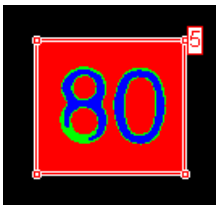
12.1.5 Luminance objects

A statistic of the type „LUMINANCE OBJECT“ is characterized by two luminance thresholds. By means of these threshold values, all pixels of the measuring region can be assigned to one of the three luminance areas having developed:

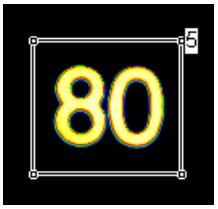
- Dark area: smaller than the lower luminance threshold
- Intermediate area: greater than the lower but smaller than the upper luminance threshold
- Bright area: greater than the upper luminance threshold.

The determination of the statistic parameters such as mean value and variance is separately performed for each of the three luminance areas. In the image, the luminance areas are indicated in terms of color if the measuring region is marked:

- Dark area: Red
- Intermediate area: Green
- Bright area: Blue



Marked region



Not marked

In the table, the lines with the measuring results of the three areas are also indicated in terms of color (blue, green or red) in the column „CLASS“.

Overview | Last capture | Cursor - graphic | Cursor - table | Luminance object

Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp
1	Lum_Gr[1]	Luminance image	5	Bright	3933	2.54	3.811	3.012	0.2611
1	Lum_Gr[1]	Luminance image	5	Intermediate	2142	1.271	2.54	2.034	0.3647
1	Lum_Gr[1]	Luminance image	5	Dark	24820	398e-6	1.27	0.07396	0.1928

Table with measurement results

To create a luminance object the desired measuring region in the image is to be marked and in the dialog „Statistic type“ „Luminance object“ has to be selected. This dialog can be opened either in the context menu of the image via the menu item „Statistics“ or in the main menu by means of „Evaluation | Statistics“.

As the pixel classes have been defined by luminance thresholds the statistic results calculated are dependent on these threshold values. A bright region, for example, has been separated from the background by a luminance threshold. All pixels above the threshold value belong to the foreground region. If the luminance threshold is lowered, the calculated statistic parameters are automatically modified: The number of pixels is enlarged, the mean value is reduced. The variance can become greater or smaller.

12.1.6 Integral objects

The measurement of objects by means of a luminance object (previous chapter) provides steady and sufficiently correct results for the mean luminance of bright objects if these are big enough (sufficient number of pixels). If small bright objects are used, it should be taken into account that blurred light-dark edges could develop owing to the image formation by the lens. That means, light from the object is scattered areas beyond the object. Therefore, the integral object has been implemented and it is based on the main ideas below:

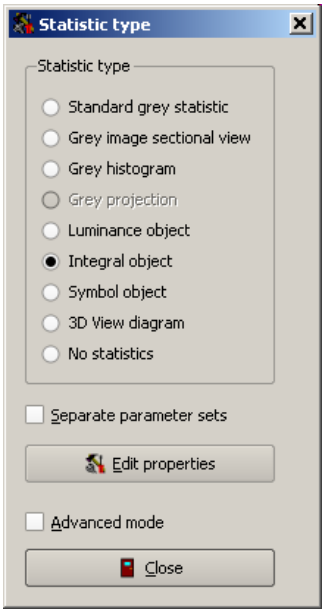
1. Using a low luminance threshold all light coming from the object is collected (integrated).
2. Using a second luminance threshold, the pixels which belong to the object are determined. This threshold is adaptively matched to the actual luminance distribution within the object. For this, the maximum luminance is determined for each pixel in its neighborhood (height * width). The decision whether the pixel belongs to the object or not is taken by comparing its luminance with the product of a factor and the maximum luminance in its surroundings. Thus, the second luminance threshold is given as a factor.
3. The measuring value for the mean luminance of the object results from the quotient of the light collected according to (1) and the object size estimated according to (2).

Object to be measured

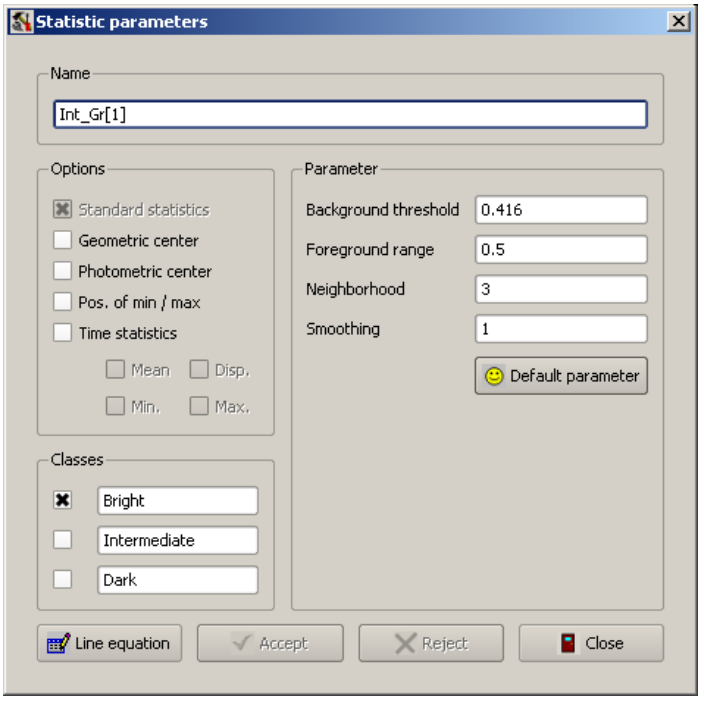
Integral object

In the image section, the object to be measured can be seen. The structure width is only a few pixels so that a larger portion of the light of the object has been scattered to the boundary area. By means of the integral object the light and the surface of the object are separately determined. The size of the measuring object is defined by the blue pixels. The blue and the green pixels contribute to the luminance of the object.

To generate an integral object the desired measuring region in the image has to marked and then the type „Integral object“ has to be selected in the dialog „Statistic type“. This dialog can be opened either in the context menu of the image via the menu item „Statistics“ or in the main menu by „Evaluation | Statistics“.



Statistic type



Statistic parameters

- All pixels having a lower luminance than the „Background threshold“ are assigned to the background (pixel class „Dark“).
- „Foreground range“: A factor is determined by means of which a pixel is compared with the maximum luminance of its neighborhood. The value 0.5 (default value) for example determines that the pixel belongs to the object if its luminance is at least 50% of the maximum luminance of the brightest pixel in its neighborhood.

All pixels brighter than 50% of the maximum luminance in their neighborhood are assigned to the pixel class „BRIGHT“. All the other pixels which belong neither to „BRIGHT“ nor to „DARK“ automatically belong to „INTERMEDIATE“.

- „NEIGHBORHOOD“: Determines the search area around the pixel. In this area, the maximum luminance used for the pixel is determined.
- Since the algorithm for the integral object has especially been developed to measure bright symbols, only the measuring results of the bright pixels are displayed in the default settings.

Overview | Last capture | Cursor - graphic | Cursor - table | Integral object

Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp
1	Int_Gr[1]	Luminance image	1	Bright	17220	0.416	4.16	1.843	0.9734

Measuring results

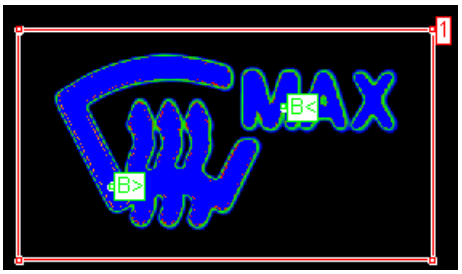
This default settings can be modified in the section Classes of the dialog „STATISTIC PARAMETERS“.

- An enlarged parameter „SMOOTHING“ reduces the noise probably existing in the images. The minimum measured is enlarged whereas the maximum and the variance are reduced.

Based on the experience of TechnoTeam, the two parameters „NEIGHBORHOOD“ and „FOREGROUND RANGE“ should not be modified by the user. The default values have been optimized during a large number of measurements. Just the parameter „BACKGROUND THRESHOLD“ has to be adapted to the current measuring scenario. It is recommended first to measure the luminance in the background beyond the object and then to use a slightly greater luminance as background threshold.

12.1.7 Symbol objects in luminance images

When characterizing symbols with background light not only the mean luminance but often the minimum and the maximum as well and their positions are in the focus of interest. To record these measuring values the symbol object has been implemented. The symbol object is based on the integral object. The algorithms for the determination of the object and the mean luminance are equal in both cases.



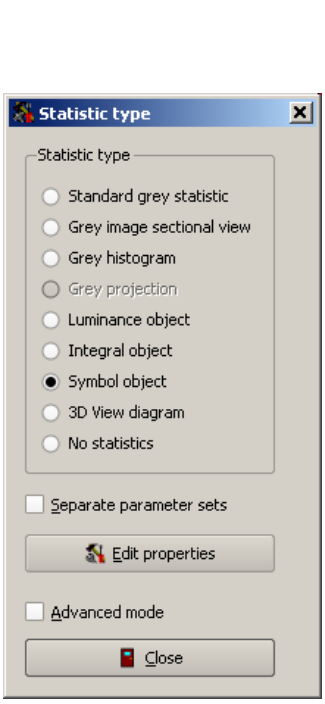
The minimum and the maximum in the bright object are additionally searched for. Similar to the use of a luminance meter working point by point the object is scanned by a circular spot. The pixels within the circle are put together to a local mean value. The

minimum and the maximum of all local mean values, together with their positions, are available as additional measuring values. The size of the spot can be adjusted.

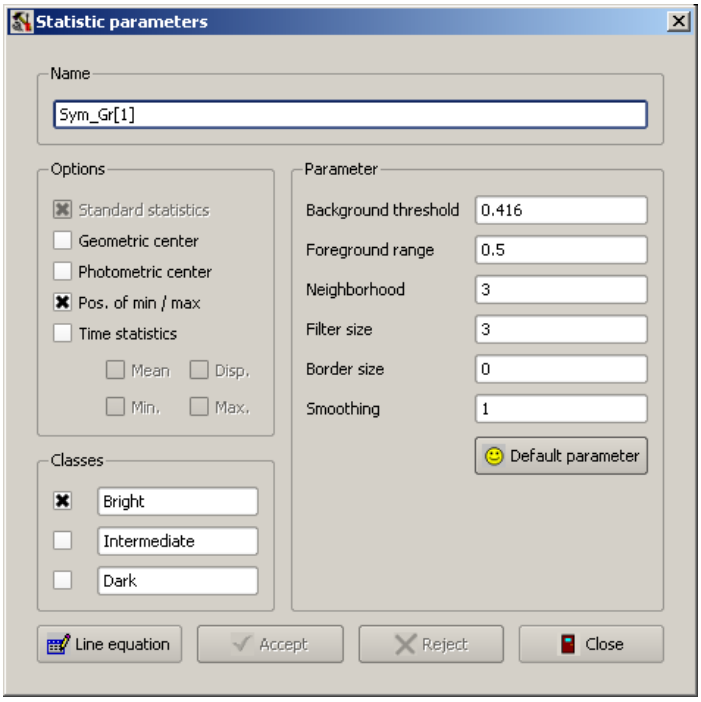
To generate a symbol object the measuring region desired is to be marked in the image and the type „Symbol object“ is to be selected in the dialog „Statistic type“. This dialog can be opened either in the context menu via the item „Statistics“ or in the main menu by means of „Evaluation | Statistics“.

The parameter dialog values „Background threshold“, „Foreground range“, „Neighborhood“ and „Smoothing“ have the same meaning as for the integral object the symbol object has been derived from. New parameters are:

- „Filter size“: Here, the size of the „point sensor“ can be set. Depending on the size selected the data on the minimum and the maximum change in the measuring value table and in displaying minimum and maximum in the image.
- „Border width“: Using this parameter an additional distance of the point sensor to the border of the symbol object can be generated. And again, the position and the size of the minimum and the maximum are changed. If, for example, the structure width of the symbol to be measured is too small for the border width, the minimum and the maximum for this position cannot be determined.



Statistic type



Statistic parameters

In addition to the measuring results of the bright region, the positions and the values of minimum and maximum are displayed in the table of results.

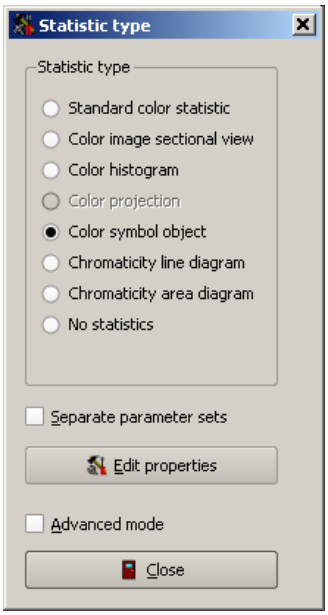
Overview | Last capture | Cursor - graphic | Cursor - table | Symbol object

Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp	MinX	MinY	MinVal	MaxX	MaxY	MaxVal
1	Sym_Gr[1]	Luminance image	1	Bright	17220	0.451	4.124	1.843	0.9734	702	387	0.451	541	461	4.124

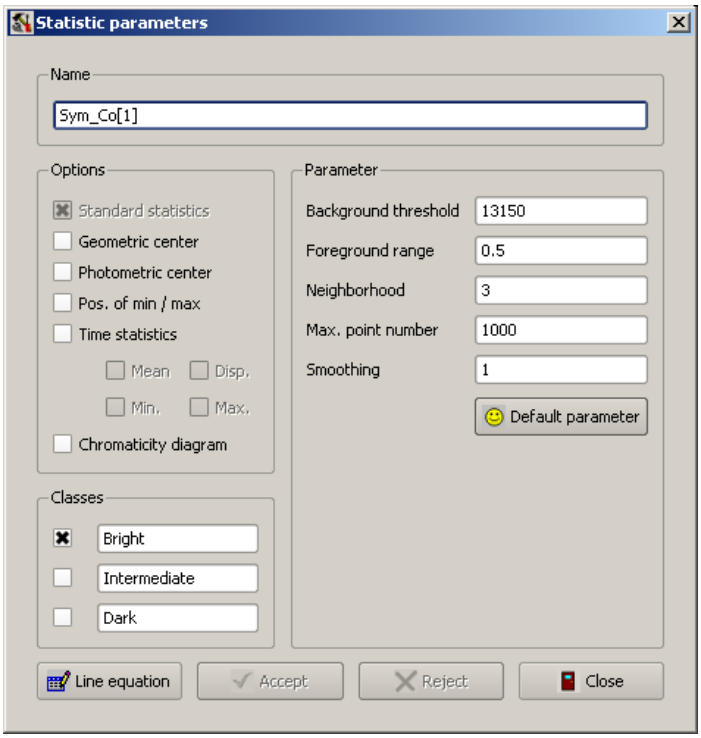
12.1.8 Symbol objects in color images

In contrast to the symbol object for luminance images, symbols with background light can be analyzed by color symbol objects in color images. To divide the pixels in a color image into the three classes BRIGHT, INTERMEDIATE and DARK the pixel luminance is used. According to the classification of the pixels, the statistic values are calculated separately for each color. The output of the measuring values is effected in the color space selected for the corresponding image.

To generate a color symbol object the measuring region desired has to be marked in the image and the „COLOR SYMBOL OBJECT“ has to be selected in the dialog „STATISTIC TYPE“. This dialog can be opened either in the context menu of the image via the menu item „STATISTICS“ or in the main menu by means of „EVALUATION — STATISTICS“.



Statistic type



Statistic parameters

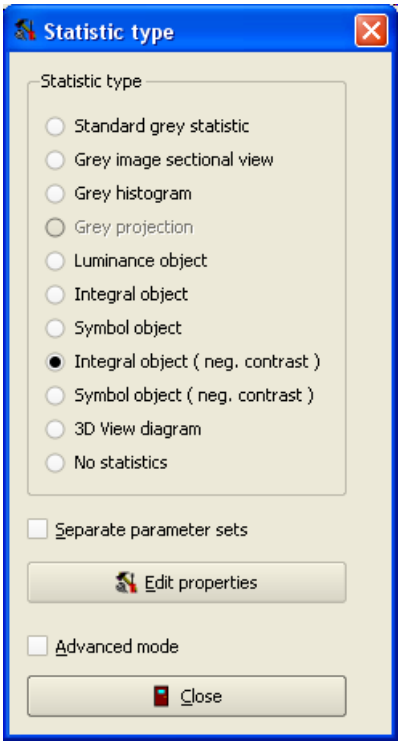
- The effect of the parameters „BACKGROUND THRESHOLD“, „FOREGROUND RANGE“, „NEIGHBORHOOD“and „SMOOTHING“ has already been documented for the integral object for luminance images, see section 12.1.6 on page 121. As described in the introduction to the color symbol object, a minimum luminance value is indicated by the background threshold which has to be met by the pixels in order to be accepted as part of the symbol to be measured.
- In the section „OPTIONS“, the option „CHROMATICITY DIAGRAM“ can be selected. If so, a corresponding diagram „SYMBOL OBJECT CHROMATICITY“ is calculated showing the xy-chromaticity values for bright pixels belonging to the symbol.
- If a chromaticity diagram is displayed, the item „MAX. POINT NUMBER“ on the right- hand side of the dialog in the part „PARAMETERS“ is of some importance.

Smaller values result in an accelerated calculation of the chromaticity diagram on slow computers.

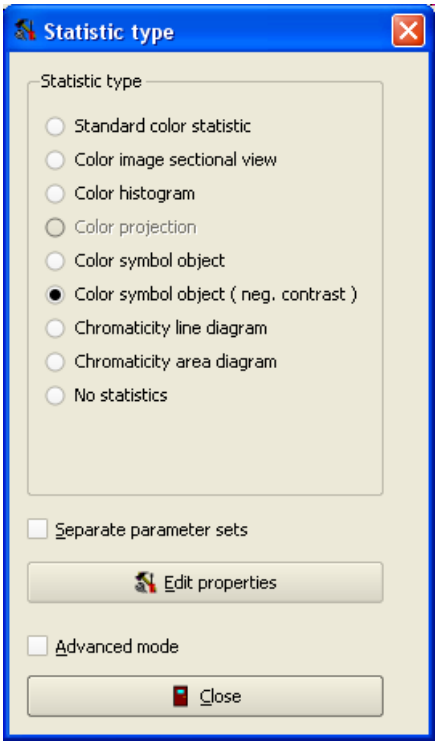
12.1.9 Evaluation in the case of negative contrast

The evaluations described so far using integral objects and symbol objects in luminance or also color images can be employed for bright objects in the image on a dark background. For the statistical evaluation of dark objects on a bright background, however, these approaches are not suitable. For such a case, the three methods described so far have been modified. Thus, three new types of evaluation methods are available:

- For luminance images:
  - Integral object (negative contrast)
  - Symbol object (negative contrast)
- For color images:
  - Color symbol object (negative contrast)



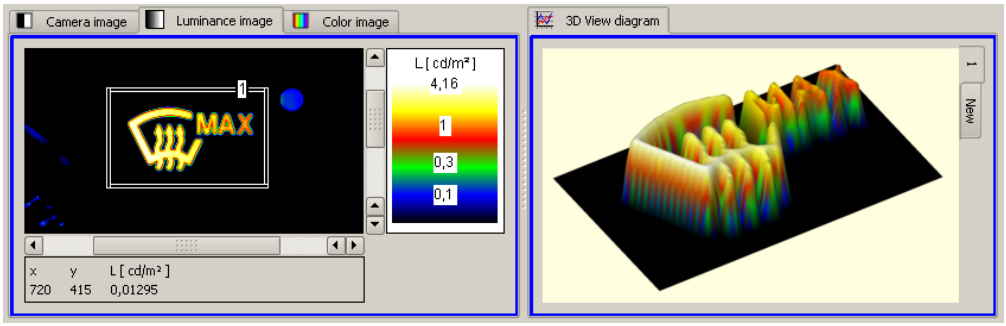
in luminance image



in color image

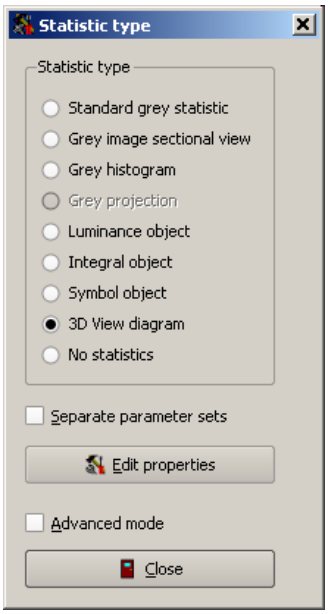
For the user, the only visible difference is that the evaluation for the dark object is carried out in the area of the measuring region. The parameters of the algorithms in the respective parameter dialogs have remained unchanged compared with those for bright objects on a dark background. Therefore, no further explanation concerning parametrization will be given.

12.1.10 Three-dimensional views

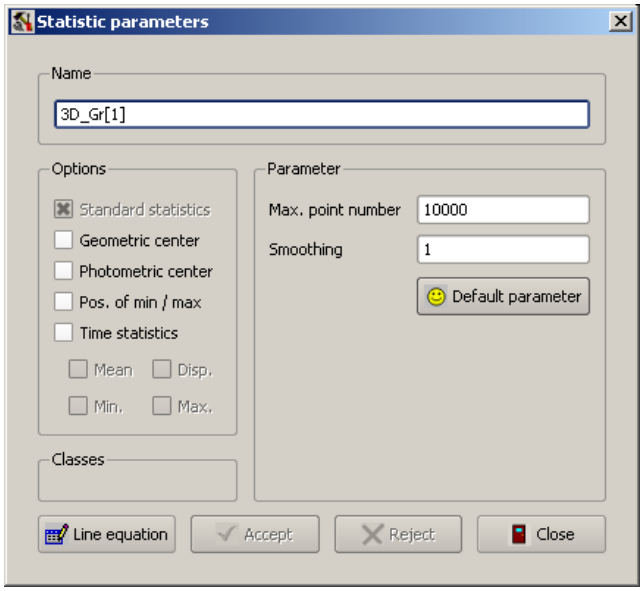


A three-dimensional luminance representation in a rectangular region can be calculated and displayed by this statistic type.

To generate a 3D-view the rectangular measuring region desired is to be marked and the item „3D-VIEW DIAGRAM“ in the dialog „STATISTIC TYPE“ is to be selected. This dialog can be opened either in the context menu of the image via the menu item „STATISTICS“ or in the main menu via „EVALUATION | STATISTICS“.



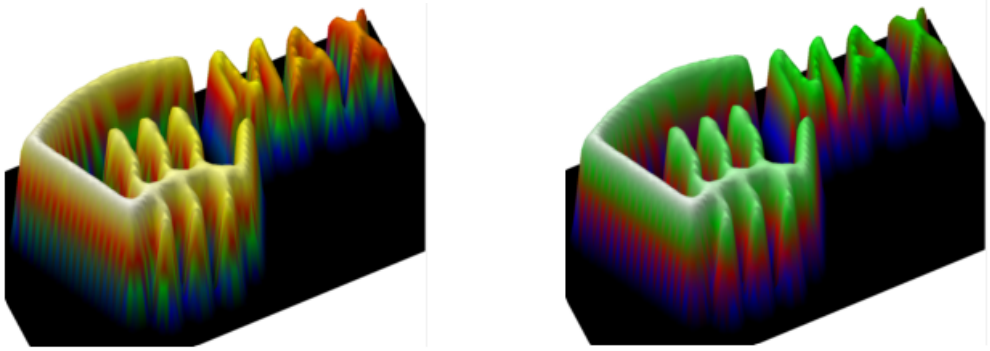
Statistic type



Statistic parameters

- A reduction of the property „MAXIMUM NUMBER OF POINTS“ in the dialog „STATISTIC PARAMETERS“ is only required if slow computers are used to allow the calculation and drawing of the object to be accelerated.
- The enlargement of the parameter „SMOOTHING“ results in a noise reduction probably existing in the images and, if requested, in a slightly smoothed graphical representation.

The representation in the diagram is influenced by the settings of the display. Depending on the scaling selected in the image (linear or logarithmic) the appearance of the mountains changes. The colors used in the diagram correspond to the pixels in the image.



Further changes of displaying the object can be performed by means of the mouse. To enable the scroll wheel to be used the object has to be clicked on by the mouse before thus activating the diagram. After that, the options below are available:

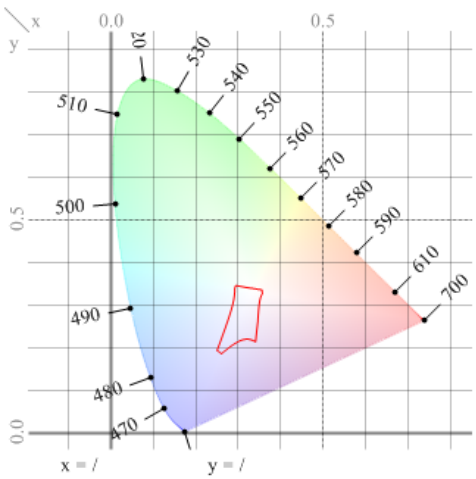
- The object can be enlarged or reduced by means of the scroll wheel of the mouse.
- The object can be turned by moving the mouse holding the left-hand mouse button pressed.
- If the Shift-key is pressed and the mouse is moved simultaneously with the left-hand mouse button being pressed, the object is not turned but it can be moved.

Other display properties such as the height of the mountains and the color of the background can be changed via the dialog which can be opened by the menu item „Diagram | Options“. To enable the menu item to be used the 3D-object has to be clicked on by the mouse before thus activating the diagram.

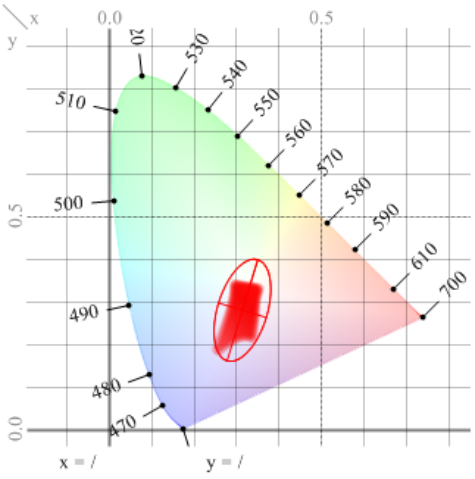
12.1.11 Chromaticity diagrams

The chromaticity rate of an image can be graphically represented by a chromaticity diagram. Two different diagram types are implemented:

- The chromaticity behavior along a line or the contour of a plane region can be graphically represented by a chromaticity line diagram.
- A two-dimensional histogram of the chromaticity rate of all image pixels within a plane region (rectangle, circle, polygon) is displayed in a chromaticity area diagram.

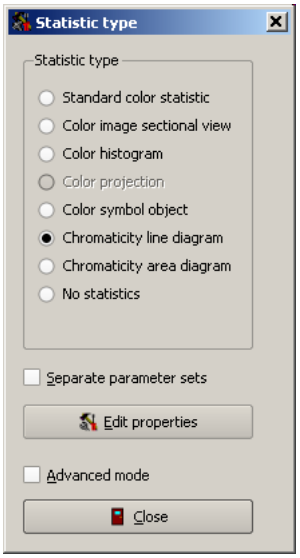


Chromaticity line diagram

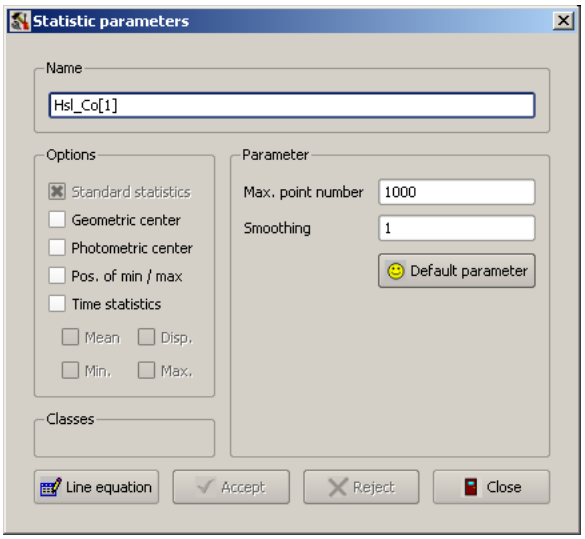


Chromaticity area diagram

To generate a chromaticity diagram the measuring region desired is to be marked in the image and either the option „Chromaticity line diagram“ or „Chromaticity area diagram“ have to be selected in the dialog „Statistic type“. This dialog can be opened either in the context menu of the image via the menu item „Statistics“ or in the main menu by means of „Evaluation | Statistics“”.



Statistic type



Statistic parameters

The parameter dialogs of both diagram types are equal.

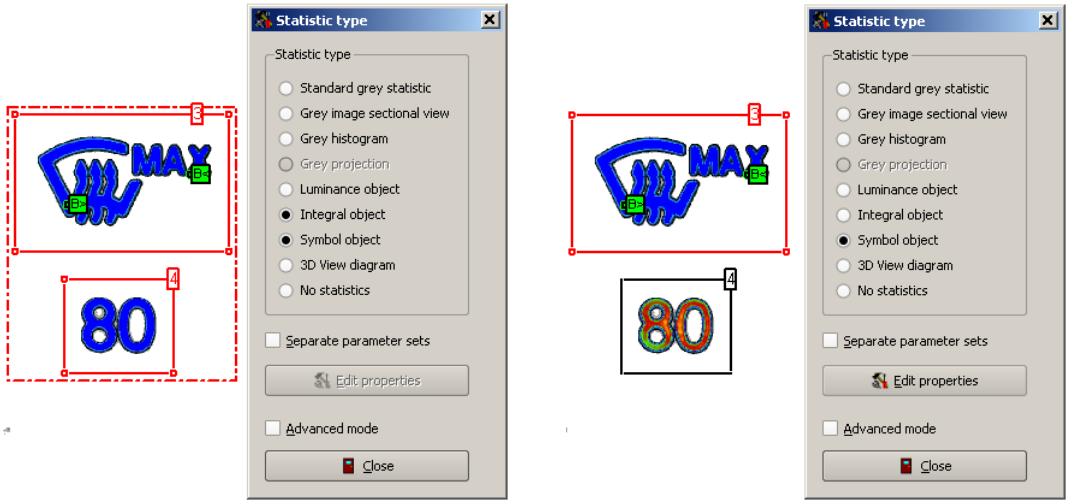
- A reduction of the property „Maximum number of points“ in the dialog „Statistic parameters“ is only required if slow computers are used to allow the calculation and drawing of the object to be accelerated.
- The enlargement of the parameter „Smoothing“ results in a noise reduction probably existing in the images and, if requested, in a slightly smoothed graphical representation.

12.2 The dialog „Statistic type“

If the option „Separate parameter sets“ is on, every statistic object is created with its own parameter set (for example with separate luminance thresholds). In the default case this option is switched off and every object of the same type is created with the same parameter set.

Simple mode

In the previous sections where the creation and the parameterization of statistic objects were handled, the use of the dialog „Statistic type“ has also been described. The radio buttons in this dialog show the existence of statistic objects in the current image and allow those objects to be generated, modified or deleted for the marked regions.



Two marked regions **One marked region**

In the example on the left-hand side, two regions in the image are marked which two different statistic evaluations had been created for. Therefore, two radio buttons are marked in the dialog. The button „Edit properties“ is not active because the two objects are of different types and have, therefore, different parameters.

By clicking on the radio button „Standard grey statistic“ ... „No statistic“ an evaluation of the same type for both regions can be generated. Due to this operation, the two existing evaluations of the types „Integral object“ or „Symbol object“ will be deleted because for each region only one evaluation is permitted.

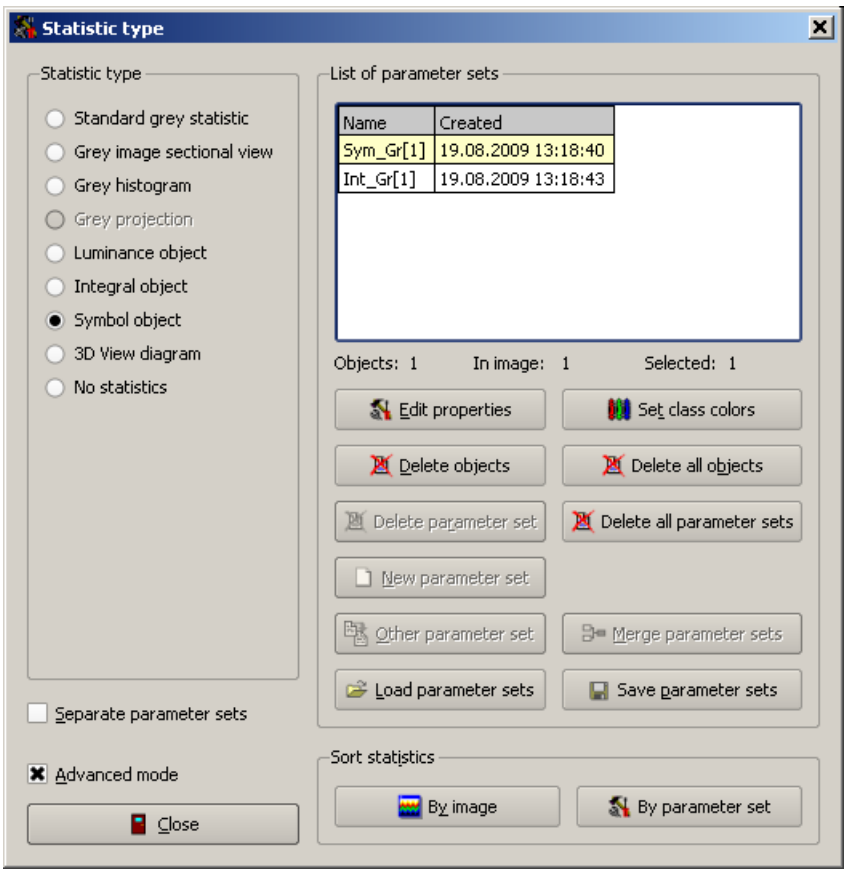
In the example on the right-hand side, only one region is marked. Using the button „Edit properties“ the parameters for this object can be modified.

Advanced mode

In all examples described so far the statistic type dialog in the simple mode has been used. This mode is sufficient if the same parameters are used for all statistic objects of one type. It is, for example, possible to create several symbol objects for different regions

in different images. If the calculation parameters in the statistic parameter dialog, which can be opened via the button „EDIT PROPERTIES“, are changed, all the other symbol objects in all the other images are influenced by them.

If it is required to calculate symbol objects with different parameters, the statistic type dialog has to be switched over by selecting the option „ADVANCED MODE“.



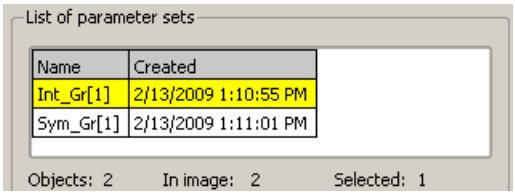
The left-hand side of this dialog largely corresponds to the simple mode. The function of this side of the dialog does not change in the advanced mode: By changing the displayed and marked radio buttons when the current image is changed or when changing the marking of regions the user is informed about the existence of the statistic evaluations for these regions and which of them had been selected. New evaluations for measuring regions can be created or existing evaluations can be deleted by pressing the radio buttons.

Down left, there is the option switch „ADVANCED MODE“, which can be used if the advanced options are not needed. If this option is switched off, the simplified dialog version is displayed again.

On the right-hand side of the dialog, there are the additional options of the advanced mode. Top right, a list is displayed containing all the parameter sets existing in the program. Selected data records are marked yellow. This marking can be changed as follows:

- The user can mark regions in the image and create statistic evaluations for them using the radio buttons on the left. In this case, the corresponding parameter set is marked in the list on the right.
- Using the mouse the user can select one or more of these data records from the list of parameter sets on the right. Exactly one of the data records is selected by a simple mouse click. Holding the Shift-key pressed a mouse click leads to a change of the marking state of a line and allows the selection of no, one ore more data records at the same time. Some of the operations described below require one or more parameter sets to be marked.

The line below the list offers some information on the use of the current parameter set:

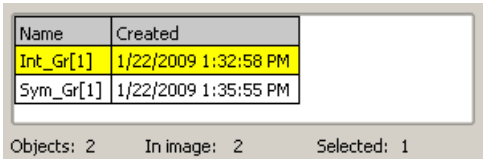


In the example shown, the same parameter set is used by two statistic objects. Both objects have been created in the image displayed in the current program. One of the two measuring regions used is marked in the image.

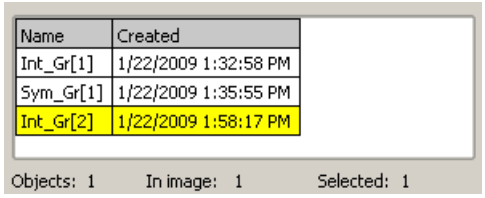
The buttons below this display are used to create new parameter sets, to edit their properties and to delete parameter sets which are no longer needed. The activation and deactivation of the buttons is dependent upon what image regions or what parameter sets are marked:

- „Edit properties“: This button can be used when exactly one item in the list of parameter sets is marked. The statistic parameter dialog which has already been described in the sections on creating statistic objects and which will be described in detail in section 12.3 on page 135 is opened by pressing this button.
- „Delete objects“: When this button is pressed all statistic objects using the parameter sets marked in the list will be deleted. The parameter sets and the measuring regions marked in the images remain unchanged.
- „Delete all objects“: All statistic objects in the program are deleted by this button independently of the marking state of the regions in the image and the parameter sets in the list. The parameter sets and the measuring regions marked in the images remain unchanged.
- „Delete parameter set“: This button can only be used if there are no statistic objects using the parameter sets currently marked in the list. The parameter sets marked are removed from the list by this operation.
- „Delete all parameter sets“: All parameter sets in the list are deleted by means of this button independently of their marking state in the list. As statistic evaluations are not possible without any parameters, all statistic evaluations are removed from the program during this operation. The measuring regions drawn in the image are not influenced by this operation.

- „New parameter set“: This button can be used when the number of the marked objects using a parameter set is smaller than the total number of objects using this parameter set:

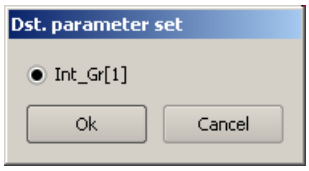


  A new parameter set for the regions marked is created by pressing the button:

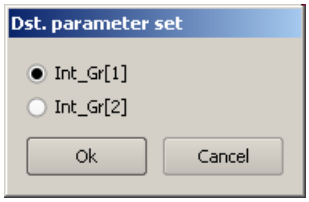


  The properties of the new parameter set are like a copy of the one used before. The new set having been created, other parameters can be assigned by means of the statistic parameter dialog. This dialog can be selected via the button Edit properties.

- „Change parameter set“: If there are more data records available for a statistic type, the objects of one type can be assigned a different data record. Using this button a dialog with a list containing all the other parameter sets is displayed which can be changed to with the objects marked:



- „Merge parameter sets“: If there are more data records of the same statistic type marked in the list, the objects can be assigned a joint parameter set. The desired one can be selected in a selection list:

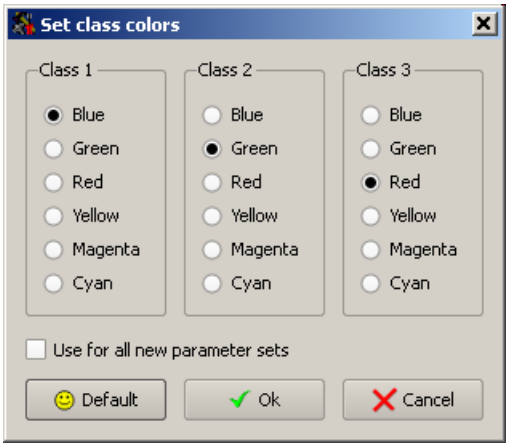


- „Save parameter sets“: Using this button the existing parameter sets can be saved in a file. The target can be defined via a file selection dialog.

- „Load parameter sets“: Parameter sets saved before can be read into the program again by means of this operation. While reading the program ensures names

of parameter sets not to be used twice. The parameter sets and the statistic objects already existing remain unchanged while loading.

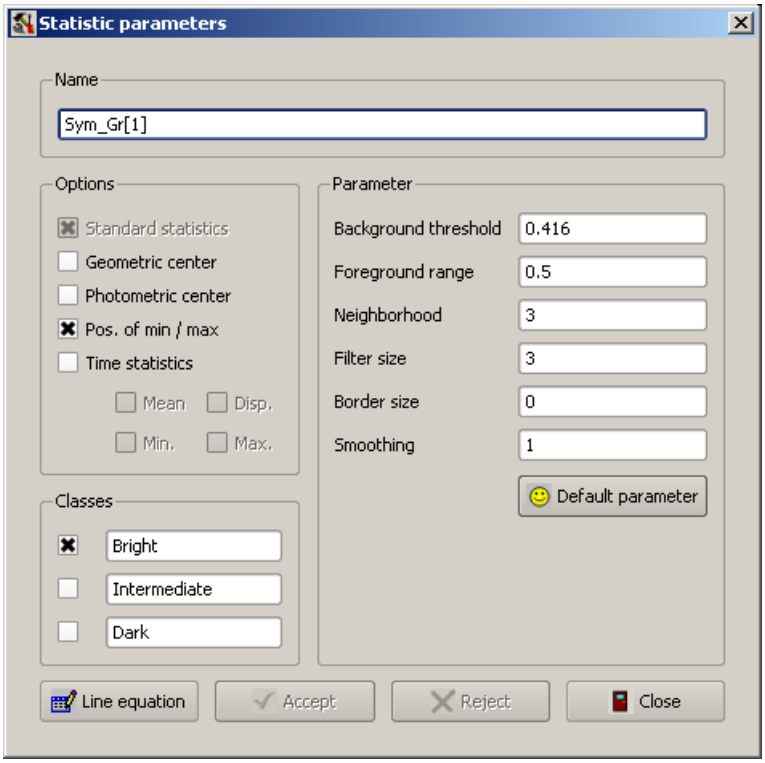
- Set class colors: Opens a dialog, in which the color marking of the pixels can be changed. Afterwards both the color marking in the images and in the result tables is changed. If „Use for all new parameter sets“ is checked, this colorization is used for all parameter sets created later.



- The sequence of the items in the statistic tables can be modified by the two items „For all images“ and „By parameter set“ in the section „Sort statistics“.

12.3 Statistic parameter dialog

Using the button „Edit properties“ the dialog „Statistic parameters“ in the dialog „Statistic type“ described in the previous section can be opened where the parameters of a parameter set can be adjusted.



Name

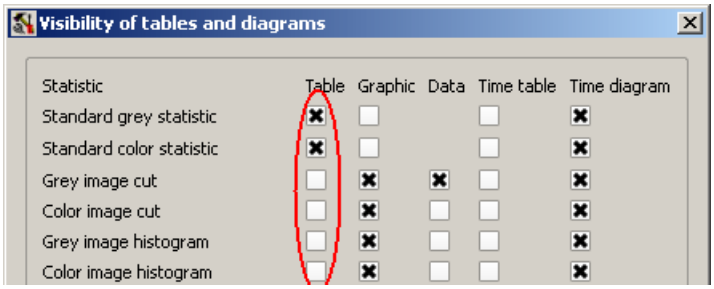
In the section „Name“ the parameter set can be given a significant designation. Having created a parameter set each data record is automatically given a name which is derived from the English designation of the corresponding statistic type. In the example, „Sym Gr[1]“ has been formed since it is the first parameter set for a Symbol object in a Grey image.

Parameters

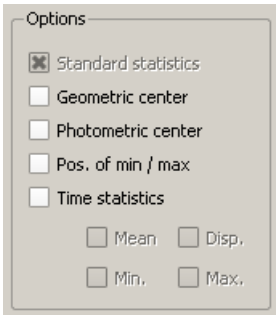
The input boxes in this section of the dialog are dependent on the statistic type. These type-specific inputs have already been described in section 12.1 on page 113 in connection with the creation of statistic objects of different types. In the example above, the parameters of a symbol object in a luminance image are shown.

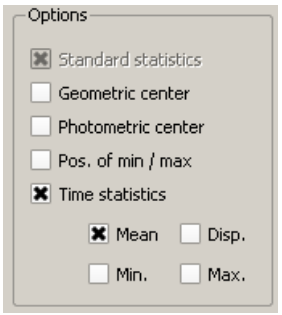
Options

In this section, different options can be turned on or off. For all statistic types, a standard statistic is always calculated as well. In many applications, however, the corresponding display of these results is faded out. The result table with mean value, variance, minimum and maximum can be turned on in the dialog „Visibility of tables and diagrams“. This dialog is opened when selecting the menu item „Evaluation | Visibility of tables and diagrams“.

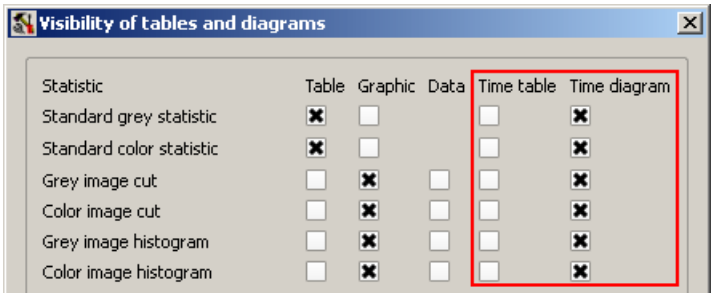


As shown in the example, the table for the „Standard statistics“ is turned on in the default settings whereas „Sectional views“ and „Histograms“ are turned off.



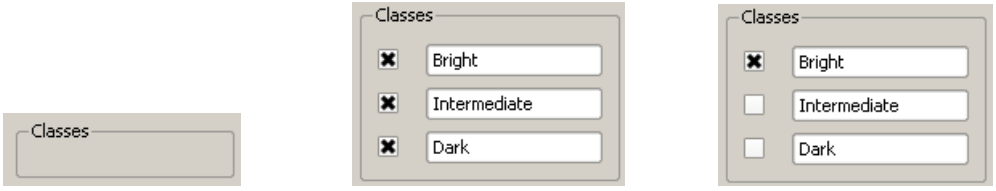


If the option „Time statistics“ is turned on, it can be additionally selected for which of the results the mean value, variance, minimum and maximum a time statistic is expected to be calculated.



In the default settings, the time statistic is only shown as as a graphical representation. A table with the measuring values of a time statistic can be turned on via the dialog „Visibility of tables and diagrams“.

Classes



Standard statistic **Luminance object** **Symbol object**

Depending on the statistic type, the display in the section „Classes“ differs. In case of a standard statistic, a sectional view or a histogram there are not any further subdivisions of the pixels of a region. In case of types with a photometric assignment of the pixels the designation and the visibility of the pixel classes calculated can be defined there.

As a default setting, all three pixel classes are displayed for the luminance object which can be formed by subdividing by means of two luminance thresholds. There are three items for each measuring object in the corresponding result tables as well:

Overview | Last capture | Cursor - graphic | Cursor - table | Luminance object

Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp
1	Lum_Gr[1]	Luminance image	1	Bright	3169	2.774	4.16	3.325	0.4014
1	Lum_Gr[1]	Luminance image	1	Intermediate	7249	1.387	2.773	2.117	0.3988
1	Lum_Gr[1]	Luminance image	1	Dark	73390	10.75e-6	1.387	0.1143	0.2715

In this example, the measuring results for one object are shown for the dark, the intermediate and the bright regions.

The calculation algorithm for integral and symbol objects, however, was specially aimed at the bright pixels within a measuring region. Therefore, in the default settings only the measuring values of the pixels classified as „bright“ are displayed in the corresponding table of measuring values:

Overview | Last capture | Cursor - graphic | Cursor - table | Symbol object

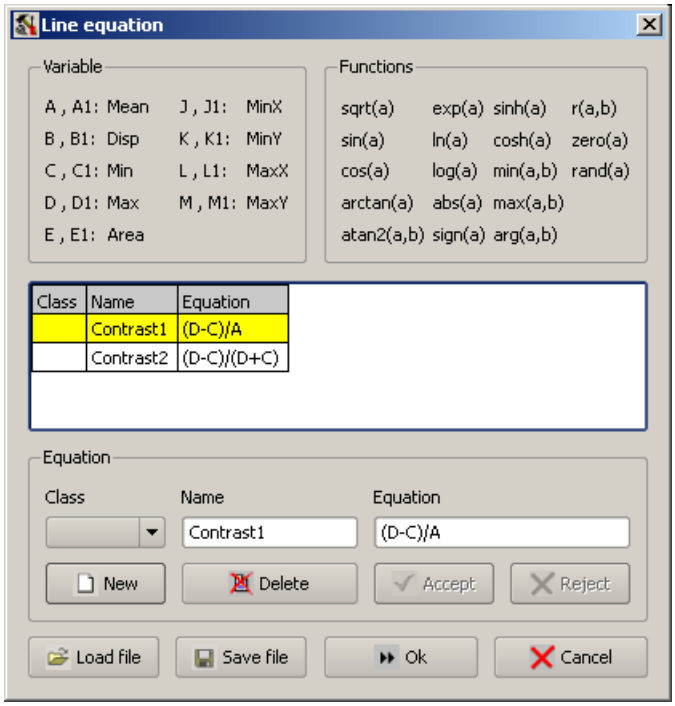
Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp	MinX	MinY	MinVal	MaxX	MaxY	MaxVal
1	Sym_Gr[1]	Luminance image	1	Bright	17220	0.451	4.124	1.843	0.9734	702	387	0.451	541	461	4.124
2	Sym_Gr[1]	Luminance image	2	Bright	6762	0.6761	3.777	2.479	0.7727	674	622	0.6761	650	667	3.777

In the example, only the results of the bright region for three measuring objects have been displayed. As it is a symbol object, not only the statistic parameters of the bright region are shown in the default settings but also the minimums, the maximums and their positions in the image.

Line equation

In section 15.4 on page 187, it has been shown how to export measuring value tables to Microsoft Excel. There, quite a lot of complex calculations with the data measured can be done. For simple evaluations, it is possible to perform arithmetic calculations within the program joining several data columns. A contrast definition is a characteristic

example. The dialog to input one or more line equations is opened via the button „Line equation“:

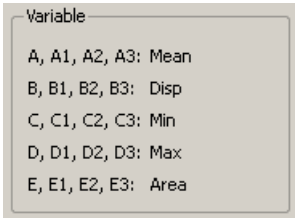


In the example shown, two different contrast definitions have been created which are displayed in two additional columns of the result table:

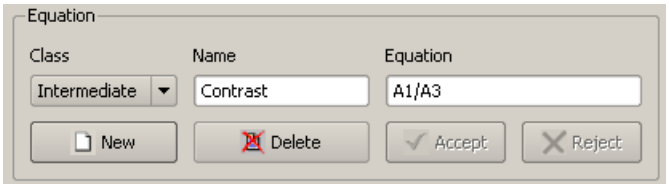
Overview | Last capture | Cursor - graphic | Cursor - table | Symbol object

Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp	Contrast1	Contrast2
1	Sym_Gr[1]	Luminance image	1	Bright	17220	0.451	4.124	1.843	0.9734	1.993	0.8028
2	Sym_Gr[1]	Luminance image	2	Bright	6762	0.6761	3.777	2.479	0.7727	1.251	0.6963

The variables available for the calculation are dependent on the type of the statistic, the options set there and the visibility of the measuring results of the statistic:



In case of a luminance object for a monochrome image or for a standard statistic in a color image, three lines with measuring results of an object are displayed in the table as a default setting. For the luminance object they are the results of the bright, intermediate and the dark pixels, in the color image they are the three components in the corresponding color space. In these cases, in a line equation not only class-dependent results can be accessed to (A, B, C, D, E) but the results of single classes can be used directly (A1, ..., E3).



In this example, the contrast has been calculated as the quotient of the mean value of the bright and the dark regions and it is to be displayed in the line with the intermediate pixel class. The result is in the table of the measuring results:

Overview | Last capture | Cursor - graphic | Cursor - table | Luminance object

Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp	Contrast
1	Lum_Gr[1]	Luminance image	1	Bright	3169	2.774	4.16	3.325	0.4014	
1	Lum_Gr[1]	Luminance image	1	Intermediate	7249	1.387	2.773	2.117	0.3988	29.1
1	Lum_Gr[1]	Luminance image	1	Dark	73390	10.75e-6	1.387	0.1143	0.2715	

Using the button „Save file“ in the line equation dialog it is possible to save the equations used in a file. By means of „Load file“ equations saved in this way can be loaded and used again. The availability of the variables used in the equations of the corresponding statistic has to be taken into account.

12.4 Result views of a statistic

The measuring results of statistic evaluations can be displayed in different formats:

- Standard tables: These tables contain the standard statistic values mean value, variance, minimum and maximum. If the calculation of the geometric or photometric center or the indication of the positions of minimums and maximums has been selected in the options of the statistic, these results can also be found in these tables.

  If the time statistic is turned on, the time mean values of the recorded values are also displayed in the tables. In the default settings, the tables are displayed for the standard statistic, the luminance, the integral and the symbol objects. For all the other statistic types these tables are usually not visible and they have to be turned on via the menu item „Evaluation | Visibility of tables and diagrams“.

  This switching option of visibility is true for all the other tables, diagrams and graphics that will be described below.

- Value tables of the curve behavior of sectional views, histograms and projections and of time statistics as well: In the tables for sectional views and projections, the measuring values are numerically represented as functions of position. In histograms the function behavior can be found depending on the luminance or the color. The tables of the time statistics contain a list with the values measured over time.

  In the default settings, all value tables are turned off.

- Graphics of the standard statistic: These graphics can be displayed for standard grey and standard color statistics. Mean values, variance, minimums and maximums are graphically represented. In the default settings, these graphics are not visible.

- Graphics of the curve behaviors of sectional views, histograms and projections: In these graphics, the behaviors of the corresponding functions are graphically represented. They are the default settings for sectional views, histograms and projections in monochrome and color images.

- Graphics of time statistics: In these graphics, the time behaviors of the measuring values to be recorded are displayed as curves. In the default settings, the graphics are visible.

- Chromaticity diagrams: Chromaticity diagrams are displayed for the statistic types chromaticity area diagram, chromaticity line diagram and as a special option for the color symbol object. If these statistics are calculated, the corresponding diagrams are always displayed as well.

- 3D views: The 3D view diagram is the output for the statistic object of the same name. It can also not be turned off when the corresponding statistic is calculated.

12.4.1 Standard tables

A table is available for each statistic type containing the values of the standard statistic and, if the options are active, geometric and photometric centers, mean values of the time statistics and possibly the results of the user-defined line equations. Depending on the statistic type and the classes set, the measuring values of an object occupy one to three lines of the table. Some examples of tables of this type are shown below:

Overview | Last capture | Cursor - graphic | Cursor - table | Standard grey statistic

Stat.No.	Parameter	Image	Region	Area	Min	Max	Mean	Disp
1	Std_Gr[1]	Luminance image	1	1089	0.05034	3.83	2.372	1.085
2	Std_Gr[1]	Luminance image	2	667	0.03937	2.906	1.966	1.013
3	Std_Gr[1]	Luminance image	3	999	0.03141	1.759	0.9317	0.4825

Standard statistic in a luminance image

Overview | Last capture | Cursor - graphic | Cursor - table | Standard color statistic

Stat.No.	Parameter	Image	Region	Color	Area	Mean
1	Std_Co[1]	Color image	2	L [cd/m²] (Lxy)	667	9305
1	Std_Co[1]	Color image	2	x (Lxy)	667	0.3608
1	Std_Co[1]	Color image	2	y (Lxy)	667	0.3657
2	Std_Co[1]	Color image	3	L [cd/m²] (Lxy)	999	18330
2	Std_Co[1]	Color image	3	x (Lxy)	999	0.4869
2	Std_Co[1]	Color image	3	y (Lxy)	999	0.3629

Standard statistic in a color image

Overview | Last capture | Cursor - graphic | Cursor - table | Integral object

Stat.No.	Parameter	Image	Region	Class	Area	Min	Max	Mean	Disp
1	Int_Gr[1]	Luminance image	1	Bright	17220	0.416	4.16	1.843	0.9734

Integral object in a luminance image

The tables can have the columns below:

- STAT.NO.: Consecutive numbering of the measuring values of this statistic.
- PARAMETERS: Name of the parameter set used for the calculation of this statistic.
- IMAGE: Name of the image where the measuring object is arranged. All results of one statistic type are displayed in a table, even if the measuring objects are arranged in different images.
- REGION: Name or number of the region in the image concerned.
- CLASS: For statistic types where the pixels of a region can be divided into several pixel classes the name of the corresponding class is shown here.
- COLOR: For statistics of color images the name of the color component is displayed here.
- AREA, MIN, MAX, MEAN VALUE, VARIANCE: Results of the standard statistic. The area is displayed in the units of the coordinate system used in the image. This is also true for all the other geometric data. In color images, the variance is only indicated if the RGB color space is used in the image concerned.

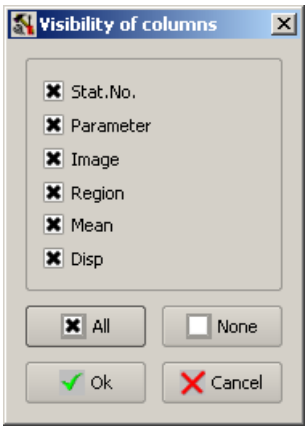
- GeoX, GeoY: If the calculation of the geometric center of a region is turned on, it will be displayed here.
- PhotoX, PhotoY: If the calculation of the photometric center of a region is turned on, it will be displayed here.
- MinX, MinY, MinVal, MaxX, MaxY, MaxVal: If the calculation of the geometric position of minimum and maximum is turned on, it will be displayed here.
- Time number: If a time statistic for the measuring object is turned on, the number of the measuring values will be displayed in this column independently of the desired measuring results of the time statistic.
- min(MW), max(MW), mean value(MW), variance(MW), min(Strg), max(Strg), mean value(Strg), variance(Strg), min(Min), max(Min), mean value(Min), variance(Min), min(Max), max(Max), mean value(Max), variance(Max): For the calculation of the time statistic the values of minimum, maximum, mean value and variance can be recorded independently from each other. In the corresponding standard table only the standard statistic of the list of time values will be displayed. If, for example, the mean value is time-recorded, the standard table will contain a summary of this value list:
  - min(MW): The minimum of the items in the mean value list.
  - max(MW): The maximum of the items in the mean value list.
  - Mean value(MW): The mean value of the items in the mean value list.
  - Variance(MW): The variance of the items in the mean value list.

  The same is true if the variance, the minimum and the maximum are recorded. The list of the actual values as a function of time can be found in a separate value table, see the section below.
- User-defined columns if user-defined line equations are used: As described on page 126, the user can define equations of his own whose results are displayed in these columns.

If a standard table is displayed in the lower tab window, a context menu can be opened in the table by pressing the right-hand mouse button. The menu can also be opened via the main menu bar by means of the menu item „Table“. The following menu items are available:

- Save as: Allows the measuring results of the table to be filed in a text file. Reading in those files into the program again is not planned because all data used here is automatically calculated.
- Copy: The table is copied into the clipboard. It can be pasted into other programs from there.
- Print: The table is immediately output by a printer. If requested, the table is turned or the columns are wrapped, respectively. For further options of copying and printing according to Microsoft Word and Microsoft Excel see chapter 15 beginning on page 181.

- Visibility of columns: In some applications, not all the colums of the table have to be output. If so, some of them can be faded out. If this menu item has been selected, the dialog "Visibility of columns"will be displayed. In the dialog, all the columns currently available in the table are displayed. Their visibility can individually be turned on or off.



Although the standard tables exist for all statistic types, for some of them they are not displayed in the default settings. For sectional views, histograms, projections, chromaticity diagrams and 3D views the focus is on the graphical representation of the measuring values. Invisible tables can be displayed via the menu item „Evaluation | Visibility of tables and diagrams".

Objects in the tables can be marked by clicking them on with the mouse. The marking can be changed by a click, with the Shift-key being pressed. Therefore, it is also possible to mark several objects at the same time. The regions belonging to the objects in the table are also marked or demarcated in their images.

12.4.2 Value tables

Value tables are other tables used in the program. They are used as follows:

- for the numerical representation of the measuring values in sectional views, histograms and projections,
- as a list of the measuring values of a time statistic.

In contrast to the standard tables where information on a measuring object consists of one or more lines, in the value tables one or more columns belong to each object. If, for example, sectional views are of different lengths, or if the time statistic contains a different number of times, the table will have a different number of lines for each measuring object. See the examples below:

1:Time	1:Mean	2:Time	2:Mean
0:00:00 AM	160.8	0:00:00 AM	159.1
0:00:02 AM	162.1	0:00:02 AM	160.4
0:00:04 AM	162.5	0:00:04 AM	160.8
0:00:06 AM	161.8	0:00:06 AM	160.1
0:00:08 AM	161.9	0:00:08 AM	160.2
0:00:11 AM	162.7	0:00:11 AM	161

Time statistic

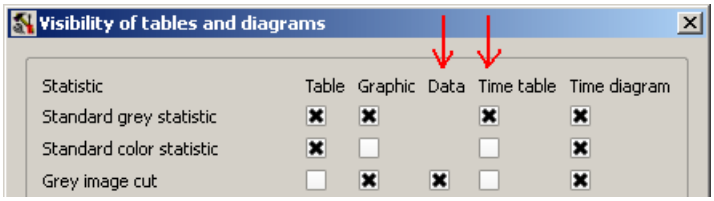
No.	x[1]	y[1]	V[1]
1	446	304	161.4
2	447	304	161.8
3	448	304	161.7
4	449	304	161.3
5	450	304	161.1
6	451	304	161

Sectional view

In the time statistic table on the left-hand side, the mean values of the standard statistic of two regions have been recorded. In the table on the right-hand side, the values of a sectional view together with the position coordinates of each value can be seen.

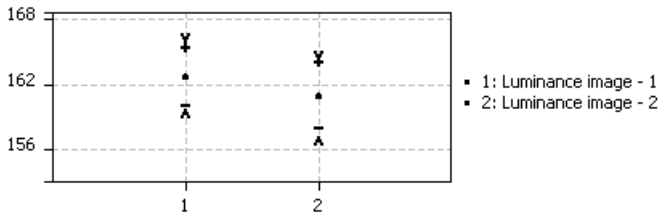
The context menu available in the value tables and the menu items available in the main menu under „TABLE“ can be compared to those of the standard tables. For a detailed description see the previous section.

In the default settings, all value tables are invisible. They can be turned on via the menu item „EVALUATION | VISIBILITY OF TABLES AND DIAGRAMS“. For sectional views, histograms and projections the option in the column DATA is to be used and for time statistics the option in the column TIME TABLE.



12.4.3 Graphics of a standard statistic

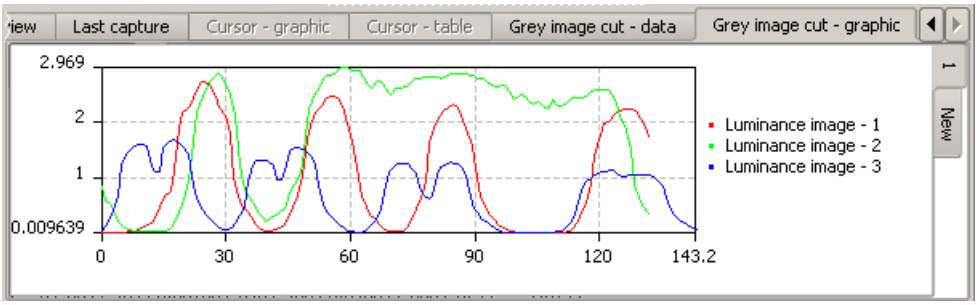
For the standard statistics in grey and color images a special graphical representation of the measuring values mean value, variance, minimum and maximum is available.



In these graphics, „•“ stands for the mean value, „∨“ for the maximum and „∧“ for the minimum. Between „+“ and „−“ there is the 3σ-area around the mean value.

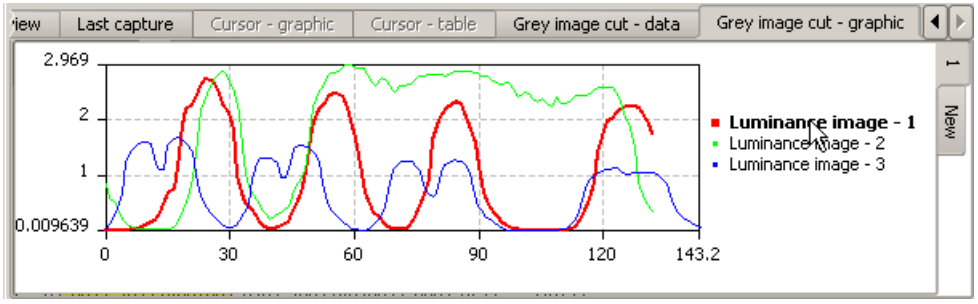
All options of working with graphics (distributing values to several graphic sheets, enlarging, context menu) will be described below since there is no difference between them and the graphics of the curve progressions presented there.

12.4.4 Graphics of the curve progressions

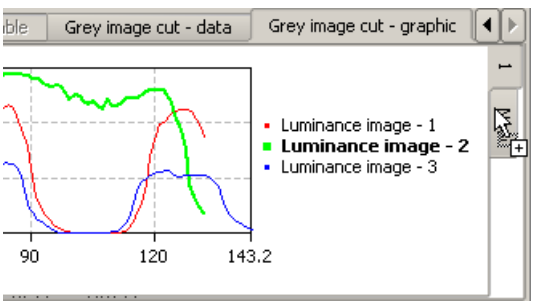


Next to the right-hand side of the graphical representation, there is a legend of the curves represented. The names of the image and of the region are displayed there. A small rectangle in front of the name is in the color of the curve belonging to it.

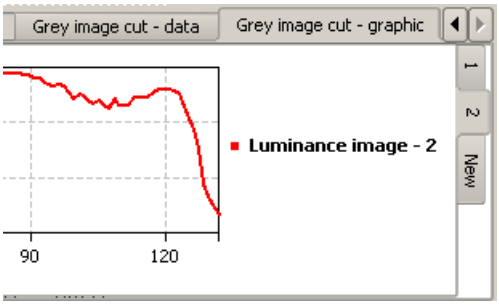
If the corresponding region is marked, the name will change from standard to bold type. In this case, even the curve will be highlighted. The marking of the region can be effected either in the image or in the graphical representation by clicking on the name concerned. When clicking and holding the Shift-key pressed, an existing marking state can be modified, thus allowing several curves to be marked at the same time.



The curves can also be distributed to several sheets. On the one hand, this is performed automatically by the program if the number of curves is too large for a good representation on one single sheet. On the other hand, the user can manually change this distribution. For that, a curve identifier has to be clicked on and drawn onto another tab window marker with the left-hand mouse button being pressed:



While moving



After moving

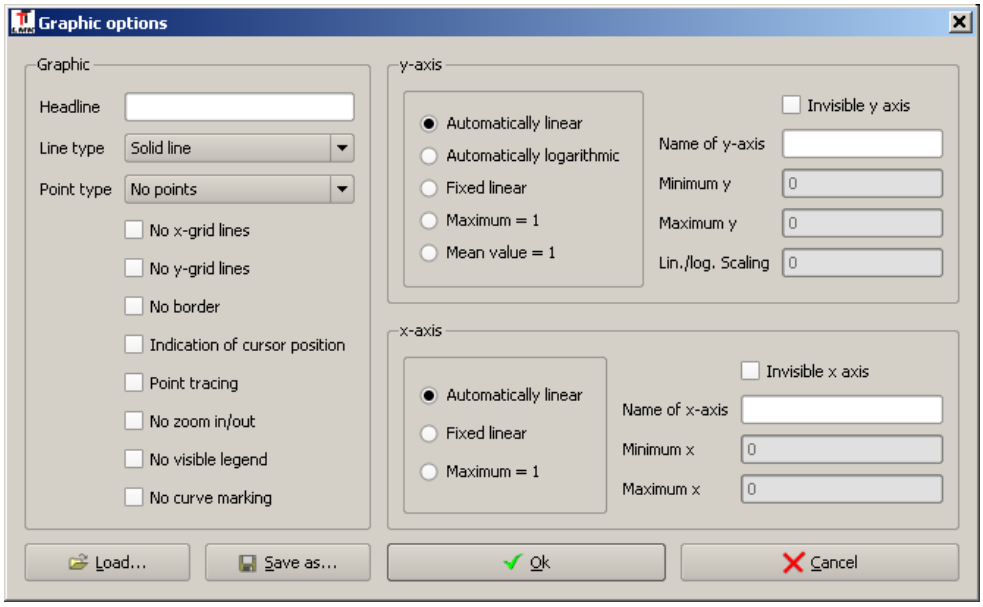
In this example the curve „Luminance image - 2“ was drawn on the tab window marker New. Therefore, the program produced a new sheet „2“ containing the moved curve only.

The graphic can be zoomed in or out by means of the scroll wheel. If the representation is enlarged, the section can be moved by means of the pressed left-hand mouse button.

If a graphic is shown in the lower tab window, a context menu can be opened by pressing the right-hand mouse button in the graphic. The same menu can be opened by means of the main menu bar via the menu item „Graphic“. The menu items available are as follows:

- Save as: If this item is selected, the file dialog where a file name can be selected the current graphic is expected to be filed under will be opened. The formats available are BMP and JPG. The graphic will be saved as currently represented on the screen. Thus, for example, enlarging or reducing the display window results in a corresponding enlargement or reduction of the bitmap file.
- Copy: The graphic can be copied as bitmap into the clipboard by means of this item. The copy will be influenced by the current display.
- Print and Print all graphics: If the first item is used, only the current graphic will be output to the printer, the second item causes all graphics of the corresponding statistic to be output on one or more sheets. And again, the output can be influenced by the size of the indication window.
- Options and Options for all graphics: In both cases, the dialog „Graphic options“ will be opened. If the first command is used, settings performed there will apply for the current graphic, if the second is used, the settings will apply for all the graphics of this statistic type.

Graphic option dialog



In the section GRAPHIC on the left-hand side of the dialog, the following options are available:

- HEADLINE: A name entered here will be shown in the graphic above the curves.
- LINE TYPE: The points of the measuring values are connected by lines. The choices available are „SOLID LINE“, „DOTTED LINE“, „DASHED LINE“ and „NO LINE“. The default setting is a solid line.
- POINT TYPE: Points represent the positions of the measuring values. The options available are as follows „NO POINTS“, „RECTANGULAR“, „CIRCLE“, „CROSS“, „HORIZONTAL LINE“, „ARROW UP“ and „ARROW DOWN“. The default setting is „NO POINTS“.
- NO X-GRID LINES: The vertical auxiliary lines in the graphic are not displayed.
- NO Y-GRID LINES: The horizontal auxiliary lines in the graphic are not displayed.
- NO BORDER: No rectangular border around the graphic.
- INDICATION OF CURSOR POSITION: If this option is active, the coordinates of the mouse pointer in the graphic will be faded in next to the pointer.
- POINT TRACING: This option is preferably used for the graphical representation of sectional views. If it is turned on, a vertical line will be drawn into the graphic. At the same time, a small point will be drawn in at the position of the region for all marked objects of this statistic on this graphic sheet in the corresponding image, with the point containing the value of the graphic at the position of the mouse.
- NO ZOOM IN/OUT: If this option is on, it will be impossible to enlarge or reduce the graphic by means of the scroll wheel or via drawing a rectangle. The enlargement set before the opening of the dialog will remain unchanged.
- NO VISIBLE LEGEND: The legend located as default setting on the right-hand side next to the graphic and assigning the names to the colors of the curves will be faded out.
- NO CURVE MARKING: The objects in the legend cannot be marked or demarcated by a mouse click. Thus, moving to other sheets is also not permitted. The marking of the corresponding objects by marking the regions in the image, however, is possible.

There are further formatting options in the sections X-AXIS and Y-AXIS on the right-hand side of the dialog:

- INVISIBLE AXIS: By means of this option the corresponding axis in the graphic can be faded out.
- NAME OF THE AXIS: Here, the name of the axis can be changed.
- Scaling options:
  - „AUTOMATICALLY LINEAR“: The curve for the axis concerned will be linearly scaled between the greatest and the smallest value.
  - „AUTOMATICALLY LOGARITHMIC“: The scaling will be between zero and the maximum of the curve.

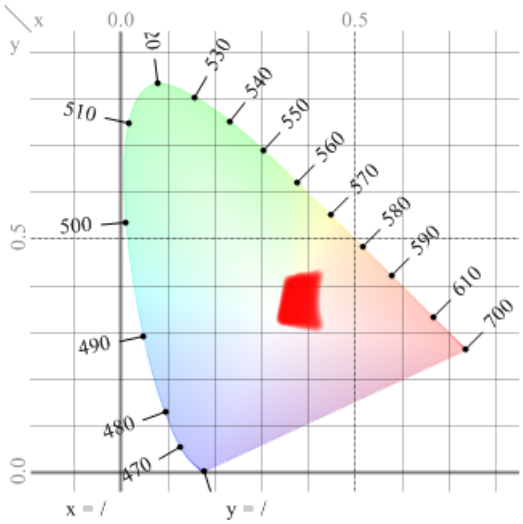
- „Fixed linear“: The limitation of the value span can be entered into the input boxes minimum and maximum.
- „Maximum = 1“: The curve will be linearly scaled so that the maximum is one.
- „Mean value = 1“: The values will be adapted so that the mean value is one.

By means of the buttons Save or Load a parameter set can be copied into a file or taken over from there for later use.

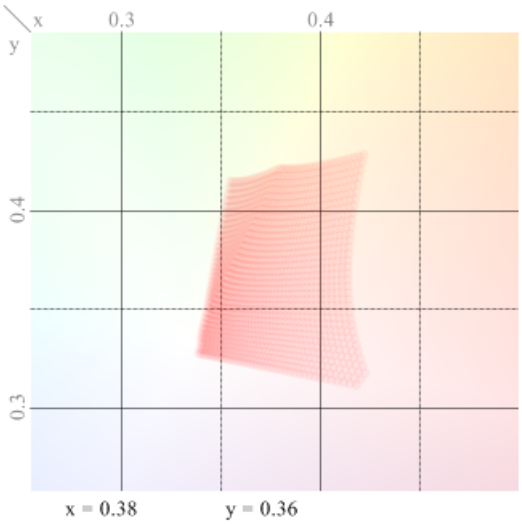
Using the button Ok the modified settings will become effective in the graphic. Using Cancel the current state of the graphic will remain unchanged.

12.4.5 Chromaticity diagrams

A chromaticity diagram is calculated and displayed for the statistic types „Chromaticity line diagram“ and „Chromaticity area diagram“ and if the option „Chromaticity diagram“ is turned on for the „Color symbol object“ as well. In contrast to the graphics documented in the previous chapters, the chromaticity diagrams are displayed in the same tab window as the images, i.e. in the upper part of the main window of the application. Thus, a simultaneous representation of the image and the results as well is not possible in the One-window view and therefore we recommend to switch over to the Two-window view. See section 13.3 on page 156. There it is possible, for example, to show the image with the measuring region on the left-hand side and the calculated chromaticity diagram on the right-hand side.



Total view



Enlarged segment

In the diagram, the color values of the measuring objects are displayed in two color coordinates. In case of a chromaticity line diagram as a line of the color values along the measuring line. In case of a chromaticity area diagram or a color symbol object as a scatter plot of the measuring points within the region or the pixel class. In horizontal direction the first color component will be shown, in vertical direction the second one.

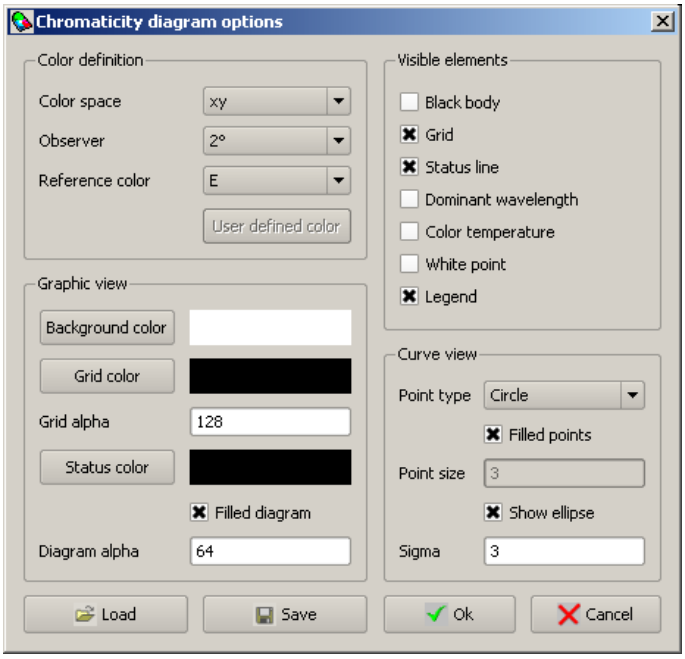
The inscription at the edge of the diagram shows the wavelengths in nanometer. Below the diagram there is a steadily changing display „x=… y=…“. These are the color coordinates at the current position of the mouse.

The diagram can be zoomed by means of the scroll wheel of the mouse. Keeping the left-hand mouse button pressed the visible segment can be moved. In the context menu, there are the menu items „Adapt zoom“ and „Zoom reset“ which are also used to enlarge or reduce the representation.

The main menu of the program contains the submenu „Diagram“. (If it is deactivated, please click once into the chromaticity diagram in order to make the menu active.) The options of this menu are as follows:

- Save as: Using this menu item a file dialog will be opened where a file name can be selected under which the current diagram is to be filed. The formats available are BMP and JPG. The diagram is saved in the same form as currently represented on the screen. Hence, enlarging or reducing the display window results in a corresponding enlargement or reduction of the bitmap file.
- Copy: Using this menu item the diagram can be copied as bitmap into the clipboard. And again, the current display will influence the appearance of the copy.
- Print: The current diagram will be output to the printer. And again, the size of the display window can influence the output.
- Options and Options for all graphics: In both cases, the dialog „Options of chromaticity diagrams“ will be opened. When the first menu command is used the settings done there are only effective for the current graphic, in the second case, however, for all diagrams of this statistic type.

Dialog for chromaticity diagram options



In the section „Color definition“, the properties of the color space are defined where the indications are expected to be done.

- Color space: The color spaces *xy*, *uv*, *u'v'*, *u*v**, *a*b** and *rg* are available. Depending on the color space selected here the graphical representation of the diagram is changed since the limiting spectral color value in these color spaces has always a different profile.
- Observer: Here, a change between a 2° and a 10° observer is possible.
- Reference color: The standard illuminants E, A, C, D55, D65, D75, 1900K, 2300K and User-defined are available. Using the button „User-defined color“ the reference color desired can be entered.

In the section „Graphic view“ the colors in the diagram can be modified. The legend in most cases speaks for itself. The alpha values show the transparency of the corresponding colors. The value range is between 0 (transparent) and 255 (opaque).

In the section „Visible elements“ different display options can be modified:

- Black body: If the option is turned on, a curve is faded into the diagram showing the chromaticity values of black bodies at different temperatures.
- Grid: If the option is turned off, the coordinate axes and the grid will be faded out.
- Status line: If the option is turned off, the chromaticity values at the cursor position will disappear.
- Dominant wavelength: The dominant wavelength of the current cursor position will be displayed in the diagram.
- Legend: If the option is turned off, the names of the measuring objects standing next to the right-hand side of the diagram will be removed by means of which a connection to the colors used for the representation in the diagram could be made.

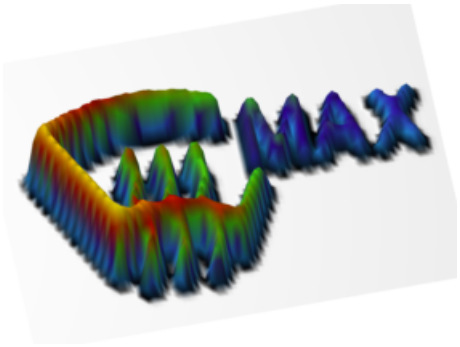
In the section „Curve view“, the indication of the curves can be influenced by the user:

- Point type: The shape of the points shown in the diagram can be modified here. This option is of some importance for chromaticity area diagrams and color symbol objects only.
- Fill points: Here, it can be defined whether the points displayed are expected to be filled or not.
- Point size: Here, the size of the points displayed can be modified.
- Show ellipse: An ellipse can be displayed by using this option showing with its position and size the mean value and the variance of the chromaticity coordinates. The option is of some importance for chromaticity area diagrams and color symbol objects only.
- Sigma: If the option „Display ellipse“ is turned on, the size of the ellipse can be defined in units of variance Sigma.

12.4.6 3D views

Chromaticity diagrams are displayed in the same tab window as the images. The same applies for 3D view diagrams, i.e. in the upper part of the main window of the application. Therefore, it is not possible to simultaneously represent the image and the result display in the ONE-WINDOW VIEW and thus we recommend to change over to the TWO-WINDOW MODE. See section 13.3 on page 156. There, the image with the measuring region can be displayed, for example, on the left-hand side and the calculated 3D view on the right-hand side.

Measuring region in the image



3D view

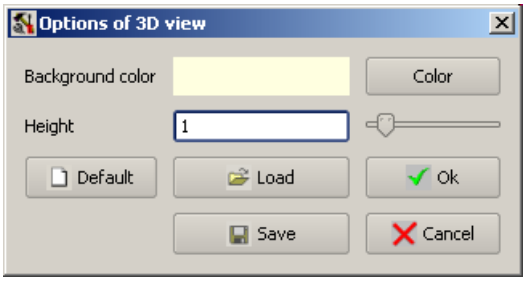
The color representation in a diagram is in accordance with the representation of the corresponding pixels in the image, i.e. if the color palette and the scaling of the image are changed, the indication in the diagram will be changed as well.

Using the scroll wheel of the mouse the representation can be enlarged or reduced. Keeping the left-hand mouse button pressed the 3D mountains can be turned. If the Shift-key is pressed at the same time, the object will not be turned but moved.

The main menu of the program contains the submenu „DIAGRAM“.(If it is not active, click once into the diagram in order to activate it.) The options below are available in this menu:

- SAVE AS: A file dialog will be opened via this menu item where a file name the current diagram is expected to be filed under can be selected. The formats BMP and JPG are available. The diagram will be filed as currently represented on the screen. Thus, if the indication window is, for example, enlarged or reduced, a corresponding enlargement or reduction of the Bitmap file will be the result.
- COPY: By means of this menu item the diagram can be copied into the clipboard as Bitmap. And again, the appearance of the copy will be influenced by the current display.
- PRINT: The current diagram will be output to the printer. And again, the output can be influenced by the size of the indication window.
- OPTIONS and OPTIONS FOR ALL GRAPHICS: In both cases, the dialog „OPTIONS OF 3D VIEWS“ will be opened. Using the first menu command the settings adjusted there apply for the current graphic only. If the second one is used, they apply for all diagrams of this statistic type.

Option dialog for 3D views



Using the button COLOR the background color in the diagram can be selected. In the input box HEIGHT or by means of the scroll bar located next to it, an enlargement factor for the height of the representation in comparison to its width or depth can be selected.

Using DEFAULT the standard settings for 3D diagrams are restored. By means of the buttons SAVE and LOAD selected settings can be saved and reconstructed, respectively.

If the dialog is left via OK, the settings will permanently be taken over. If the dialog is finished via CANCEL, the settings before the opening of the dialog will be reconstructed.

13 Image processing and evaluation images

Having started the program the camera image and the luminance image are available. If a color camera is used, the color image will be displayed additionally. Captures with the camera will be saved in these images:

- The captures with the menu commands „Camera | Live“, „Camera | Grab“ and „Capture | Autoscan“ are written into the camera image.
- Luminance images are captured by means of the menu commands „Capture | SinglePic“, „Capture | MultiPic“ and „Capture | HighDyn“. For these algorithms the capture of camera images is necessary thus changing the content of the camera image as well.
- If a color camera is used, a color image can be captured via „Capture | Color-HighDyn“. The results of this capture are a new color image and a new luminance image.

For many applications, however, these three images are not sufficient. Additional images are needed, for example, to compare image contents to each other, to perform arithmetic calculations with images or to use other image processing algorithms. The menu items available for working with evaluation images are as follows:

- New evaluation images can be created by means of the menu items „Image | New“ and „Image | Duplicate“. An evaluation image which is no longer needed can be deleted via the menu item „Image | Delete“. These operations will be described in the section below.
- Display options of an image can be transferred to another image by means of „Image | Copy options“. See section 13.2 on page 155.
- In the default settings, the program will show one image only - „One-window view““. If two images have to be visually compared to each other, the „Two-window view“ can be selected. This and other options of changing the distribution of windows can be found in the menu „Programm view““. See section 13.3 on page 156.
- In some applications, there are similar image contents in different evaluation images and similar evaluations are to be carried out with these images. Thus, it can be quite helpful to use the same region list in different images thus allowing the measuring regions in the images to be situated at the same positions. The menu item „Program view | Assignment of region lists“ allows the same region list to be assigned to several images. See section 13.4 on page 157.
- The main application of a projective rectification is to correct a perspective distortion in an image. The geometrical connection between the pixels of the source and the destination images is automatically determined by the program from one mar-

ked region in the source image and one in the destination image. These measuring regions can be placed at the right positions by the user.

The rectification task can be solved via the menu item „Evaluation | Projective rectification“. There is a detailed description of this dialog and the algorithm in section 13.5 on page 158.

- As with the projective rectification, a new destination image will be calculated from a source image by means of a coordinate transformation. In contrast to the projective rectification the program needs two pre-calculated index images. If requested, these two index images can be created by the company TechnoTeam. Typical applications, for instance, are the correction of lens distortions or the representation of a light intensity distribution (LID) in a theta-phi coordinate system.

  The menu item to start the corresponding dialog can be found under „Evaluation | Coordinate transformation“. See section 13.6 on page 161 for a more detailed description.

- To separate areas of different brightness from each other by lines the isoline method is available. Having selected the menu item „Evaluation | Isolines“ a dialog is opened, where the parameters desired can be entered and where the desired isoline representation can be calculated. See section 13.7 on page 162.

- There is a great number of additional image processing options available in the dialog „Image processing“ which can be opened by means of the menu command „Evaluation | Image processing“. All operations of this dialog can be recorded for later use as a macro under a user-defined menu item. Amongst others, the algorithms below are available in this dialog:

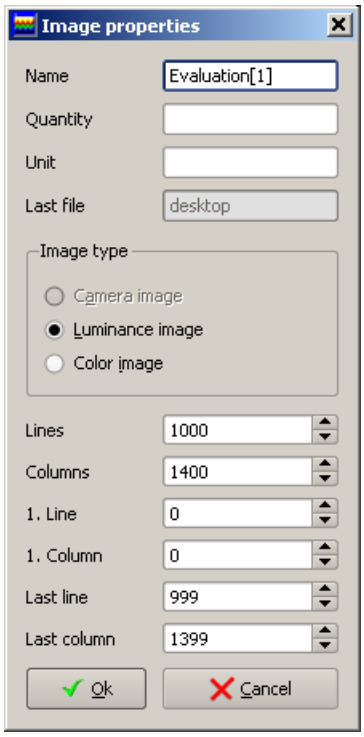
  - Loading and saving images.
  - Projective rectification, coordinate transformation and isoline calculation based on parameter sets which have been created via the parameterization dialogs presented above.
  - Arithmetic connections of images to other images or constants, such as addition ..., inversion.
  - Operations such as mirroring, rotating, enlarging or reducing images.
  - Image filters such as box, erosion and dilatation.
  - Especially for the recording of user-defined macros it is possible to display message boxes between the operations.

- If user-defined macros are recorded, the creation and the deletion of evaluation images, the capture of camera, luminance and color images, the data export to Microsoft Word and Microsoft Excel and the selection of already existing macros can be integrated. For the administration of the user-defined macros there is a special dialog which can be opened by means of the menu item „Macros | Macro recorder“. See section 13.9 on page 172 for details.

The evaluation options of color images will be described in chapter 14 beginning on page 175.

13.1 Using evaluation images

A new evaluation image can be created via the menu item „Image | New“. The dialog „Image properties“ will be opened:



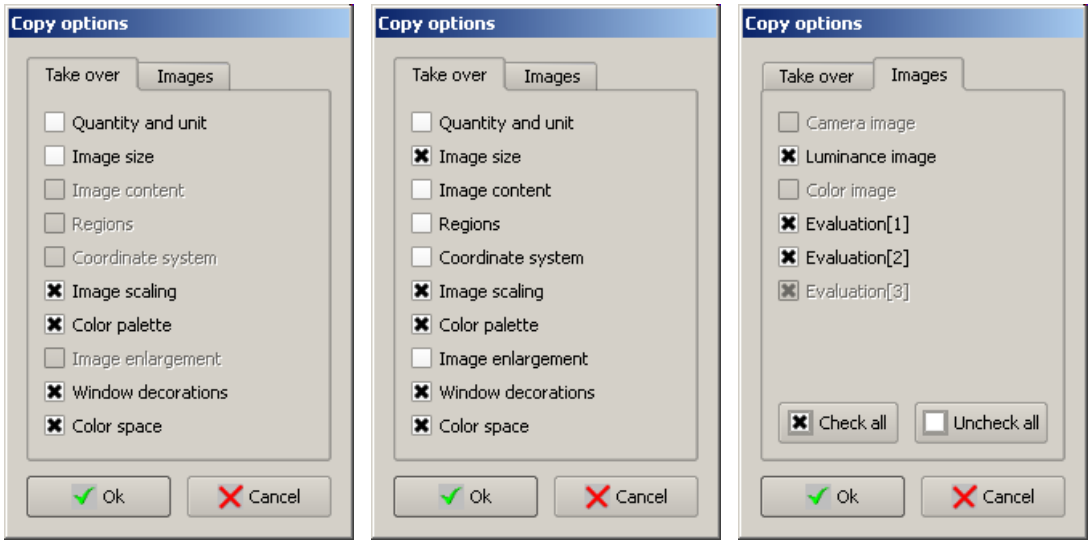
In this dialog, the parameters of the new image can be set: name, physical quantity and unit, image size. If a program version is used which supports color images, this image type can also be selected here. Later, the image type cannot be changed.

A copy of an already existing image can be created by means of the menu item „Image | Duplicate“. It is not only the image content that will be taken over to the new image but the physical quantity and unit, the image scaling and the color palette as well. While duplicating, the image name is automatically created. If requested, modifications can later be performed by means of the menu item „Image | Properties“.

An evaluation image which is no longer needed can be removed via the menu item „Image | Delete“. The images „Camera image“, „Luminance image“ and possibly „Color image“ which always exist cannot be deleted by the user.

13.2 Copying display options to other images

For the visual comparison of several images it could make sense to use the same display settings in several images. A dialog can be opened via the menu item „Image | Copy options“ by means of which the settings of an image can be copied to one or more images.



Without image size **With image size** **Destination images**

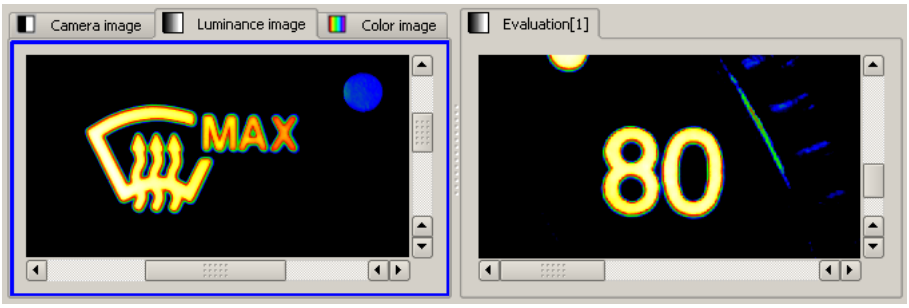
Using „Take over“ it can be defined which image properties are to be copied to other images. In addition to the properties such as physical quantity and unit, image scaling and color palette, the image content itself, the regions drawn in and the coordinate system used can be copied as well. For the take-over of these properties it is, of course, required to match the size of the destination images.

The option „Window decorations“ can be set to take over the display of the regions, the status line, the coordinate system and the color palette to the destination images. (These options will be turned on or off for one image by means of the menu items „Image view | Palette“ to „Image view | Regions“.)

On the second page of the dialog, the images the options are to be copied to can be selected. It is, of course, not possible to take over the options into the source image of the copy operation and the images of a different image type. The buttons „Check all“ and „Uncheck all“ are to facilitate the inputs. The copy operation will be started by „Ok“, the dialog will be left without action via „Cancel“.

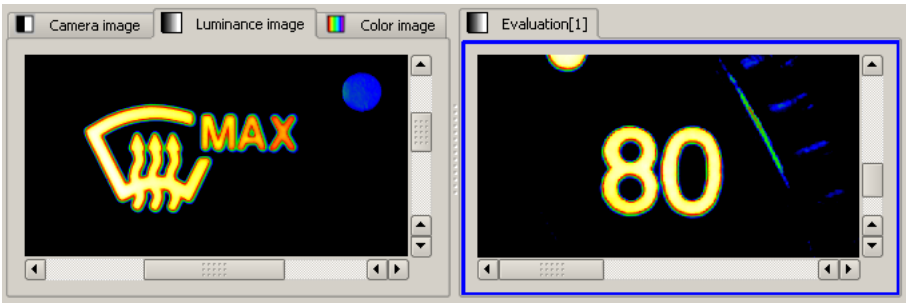
13.3 One- and two-window views

In addition to the one-window view which is set as a standard there is the two-window view making possible a better overview, a comparison between the images or an observation of an image and a diagram. There, the assignment of the images or diagrams to the right or to the left can be freely selected. To switch over the menu items „Program view | One-window representation“ and „Program view | Two-window representation“ can be used. (Furthermore, the menu „Program view“ contains some other menu items to influence the division of the window: The default setting can be restored by means of „Arrange“, by „Display images only“ or „Display tables only“ the other elements will be faded out.)



Two-window view, image on the left active

If the Two-window view is worked with and two images are considered at the same time, it should be taken into account that it is possible to simultaneously consider two images but in the header of the program the menus „IMAGE“, „REGIONS“, „COORDINATE SYSTEM“ and „IMAGE VIEW“ exist only once. These menus will automatically be assigned to that image which is active. An image can be activated by clicking once on it by means of the mouse. The state of activation can be seen by the border around the window concerned.



Two-window view, image on the right active

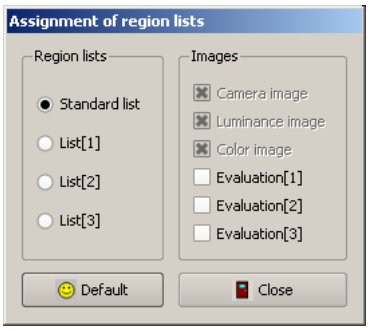
13.4 Assigning region lists

Measuring regions can be drawn, modified and deleted in each image. The region types available are Rectangle, Circle, Line and Polygon. All measuring regions of an image are contained in exactly one list which is assigned to this image. The measuring regions are used, for example, for statistic evaluations, see chapter 12 beginning on page 111. The default settings of the program for the work with the measuring regions are as follows:

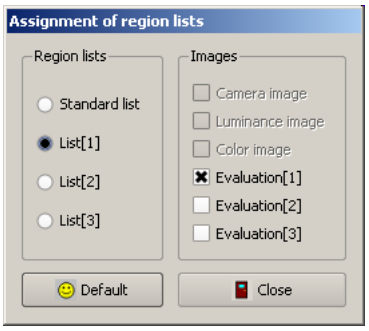
- The measuring regions in the evaluation images do not depend on each other, if regions in one image are modified, the regions in other images will not be influenced.
- A joint region list is used in the camera image, the luminance image and in the color image. If one or more measuring regions in one of these images is modified, the modifications will be effective in the other images as well. The joint list in the three images is called „STANDARD LIST“.

In some applications, there are similar image contents in different evaluation images and similar evaluations are to be performed with these images. So, it could make sense to use the same region list in different images thus allowing the measuring regions to be at

the same positions in the images. The menu item „Program view | Assignment of region lists“ is one way of assigning the same region list to different images. In this dialog, the assignment of region lists to images can be modified:



Standard list

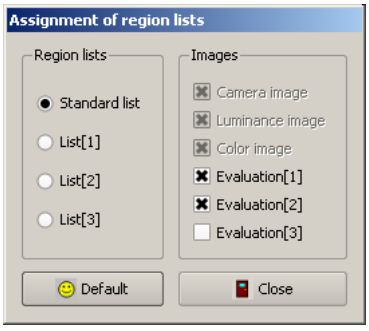


List[1]

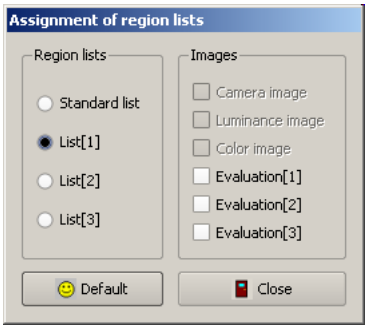
The default setting is displayed in the figures above: The „Standard list“ is used in the camera, luminance and color images. The region list „List[1]“ is used in the image „Evaluation[1]“. The assignment of the corresponding list to images can be shown by clicking on an item on the left. Another image can be assigned to the list by clicking on the right-hand side.

The two figures below show the result of assigning the „Standard list“ to the images „Evaluation[1]“ and „Evaluation[2]“. The „List[1]“ used previously in „Evaluation[1]“ is no longer used.

A modification of the assignment of region lists to images on the right-hand side of the dialog will immediately be carried out. It should be taken into consideration that statistic evaluations in the corresponding image which are an assignment of such an evaluation to an image and a region will automatically be deleted.



Standard list



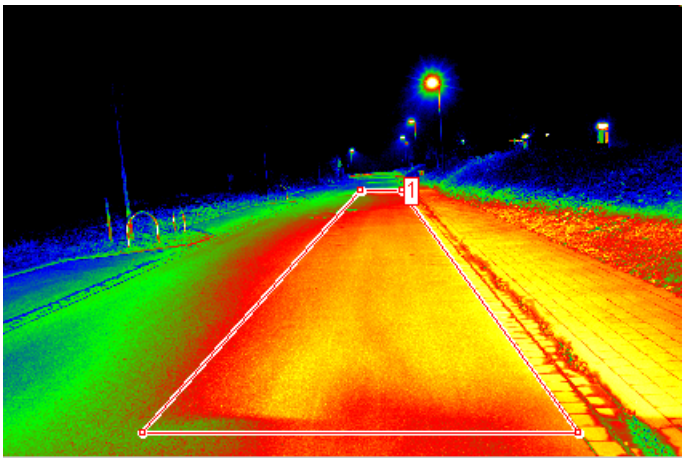
List[1]

Using „Default“ the original assignment of the region lists can be restored.

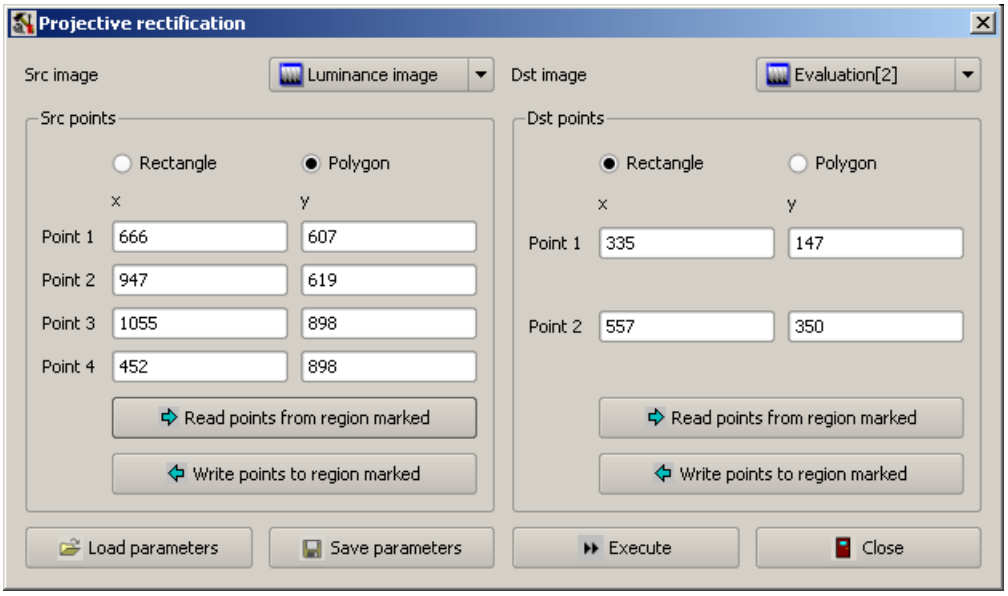
13.5 Projective rectification

There are measuring tasks where the camera is directed at an angle to the measuring scene, but where the evaluation requires an orthogonal view since the measuring points are to be positioned in a fixed grid in the measuring scene. Captures in streets are a

typical application. The camera's direction of view is directed towards the street. Street sections which are farther away will appear perspectively shortened in the image. In such cases the captured images can be perspectively rectified.



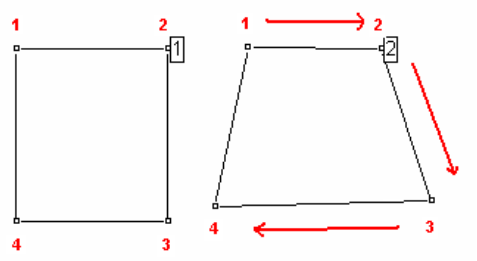
The dialog for the parameterization of a projective rectification is opened via the menu command „Evaluation | Projective rectification“.



In this dialog, first the source image and the destination image of the projective rectification have to be defined. In the example, they are the images „Luminance image“ and „Evaluation[2]“. In order to instruct the rectification algorithm four points are needed in each image where the rectification parameters are calculated from. To facilitate the input of the point coordinates in both images marked regions can be used. The use of rectangles and polygons with four corners is quite convenient.

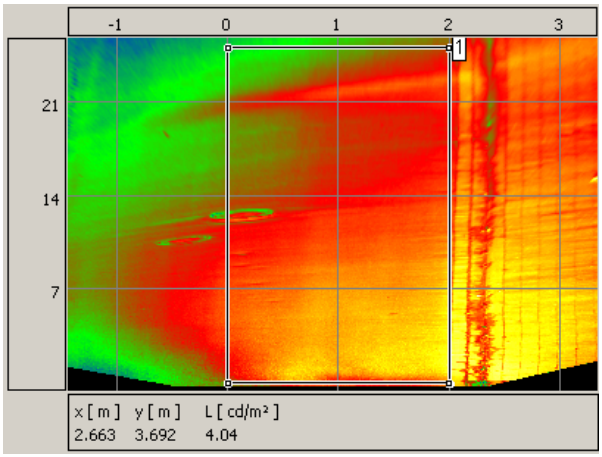
In the standard task „Rectification of captures in streets“ a polygon will be used in the source image, whereas in the destination image a rectangle will be used. As a rectangle is distinctly defined due to two points, in this case only the coordinates of two points (top left and bottom right) have to be defined. In the dialog, there is

the option to take over the coordinates of the regions of the image by using the button „Read points from region marked“. The opposite case is possible as well: Using the button „Write points to region marked“ data entered via dialog are transferred to the marked region in the image.



During the rectification the point of the source image is mapped to the point of the destination image, point2 to point2 etc. When drawing rectangles the corners are always in a specified order: From top left clockwise. If polygons are drawn, the order of the points is determined by the order they are drawn in the image by the mouse. It is recommended to start with the top left point and then to draw the other points clockwise, see also the figure. The fine positioning of the polygon points can be done after finishing the drawing.

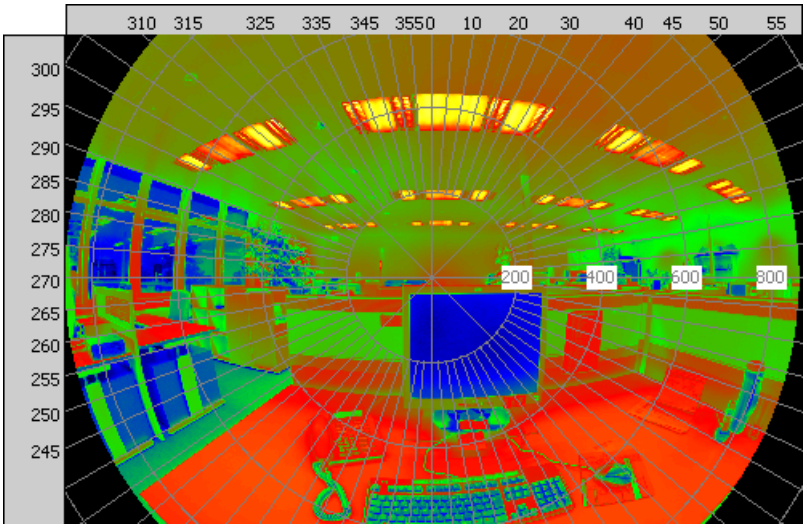
Having finished the definition of the source and the destination regions the rectification can be started via the button „Execute“. In the example of rectifying the street scene it is possible to simultaneously use the marked rectangle in the destination image for the definition of a coordinate system, see section 10.1 on page 106. The figure below shows the result of a rectification, with the coordinate system defined by means of the rectangle being shown as well.



A data record with rectification patameters can be saved in a file for later use by means of the button „Save parameters“. Later, this data record can be retrieved via the button „Load parameters“. Saving a data record is also necessary if the projective rectification is to be used in a self-created macro as a menu item. See page 166.

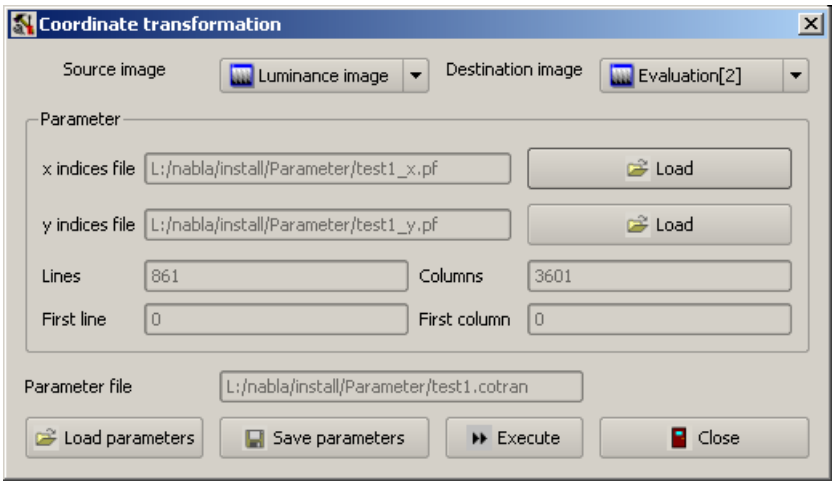
13.6 Coordinate transformation

As with the projective rectification a new destination image is calculated from a source image by means of a coordinate transformation. In contrast to the projective rectification, the program needs two precalculated index images here. If desired, the index images can be created by the company TechnoTeam. Typical applications, for example, are the correction of lens distortions or the representation of light distribution solids (LVK) in a Theta-Phi coordinate system. The figure below shows a capture with a half-space lens. A polar coordinate system is faded into the image display. In this polar coordinate system the radius increases outwardly beginning from the center. The angle Phi increases clockwise from 0 to 360°.



Quellbild

The dialog „Coordinate transformation“ can be opened by means of the menu item „Evaluation | Coordinate transformation“.

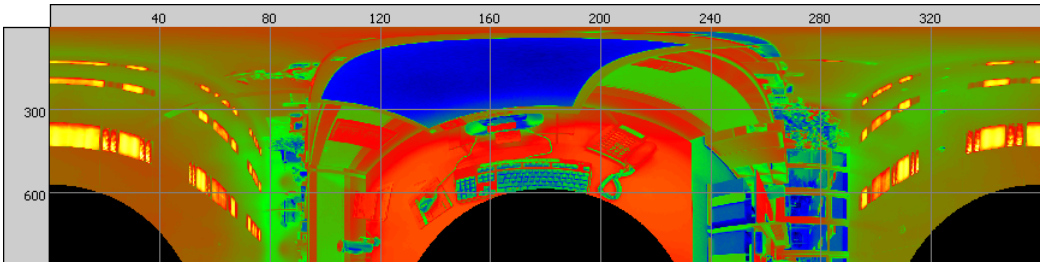


In this dialog the source image and the destination image of the transformation can be selected first. After that, the two index images are to be loaded. The names of the index

images will be displayed and then the image size will be checked. The image size of the destination image is determined by this image size and it is displayed in the dialog. These checks having been successful, the coordinate transformation can be started by means of the button „EXECUTE“.

In the destination image (see figure below) the coordinate system has been drawn in. Here, the angle Phi increases from the left to the right from 0 to 360°. The radius increases from top to bottom.

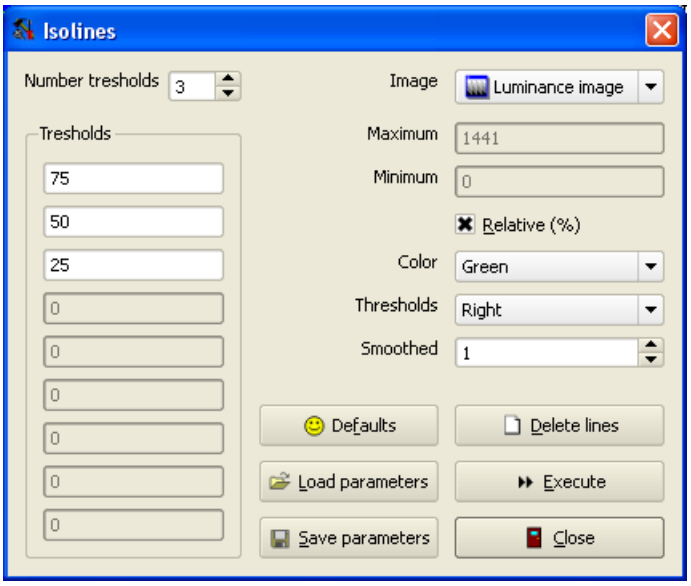
A data record with transformation parameters can be saved for later use in a file by means of the button „SAVE PARAMETERS“. Later, this data record can be retrieved via the button „LOAD PARAMETERS“. It is also necessary to save the data record if the coordinate transformation in a self-created macro is to be used as an independent menu item. See also page 166.



Destination image

13.7 Isoline representation

In order to separate areas of different brightness from each other by lines the isoline method can be used. Having selected the menu item „EVALUATION | ISOLINES“ a dialog is opened where the parameters needed can be entered and where the isoline representation desired can be calculated.



Having selected the image which the isoline representsation is to be calculated for the lowest and the highest luminance values in this image are displayed. These can serve as an orientation for the luminance thresholds which can be entered on the left-hand side. The up-down button on top left is used to determine the number of threshold values. Having pressed the button „Default“ the threshold values are entered into the corresponding input boxes at an equal distance between minimum and maximum.

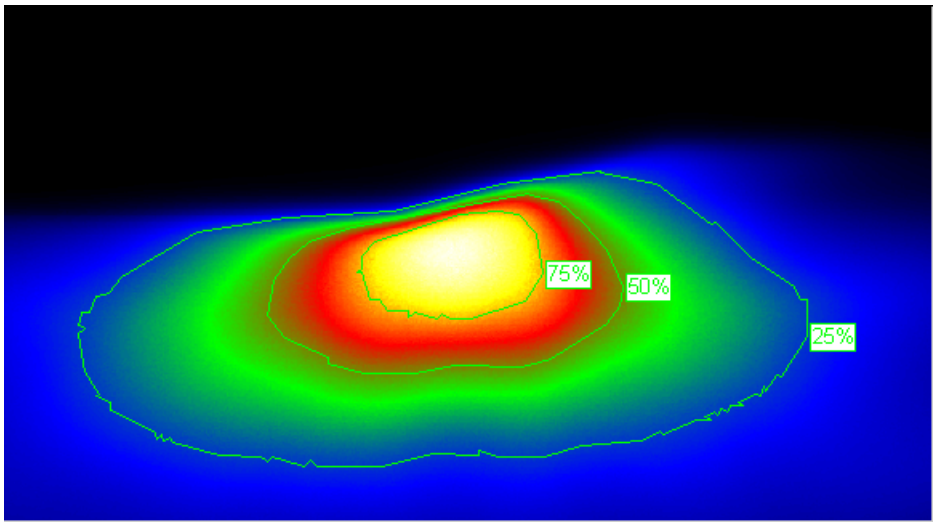
On the right-hand side, some options can be modified which can influence either the calculation or the display of the isolines:

- Turning on the option „Relative (%)“ causes the values for the threshold values into the input boxes on the left are interpreted to be relative.
- In the selection box „Color“ the colors of the markings in the image can be changed.
- In the selection box „Threshold values“ the places in the image can be defined where the threshold values are to be displayed at the lines concerned.
- If the parameter „Smoothing“ is higher, the curves will be more strongly smoothed. Thus, the shape of the curve will be less influenced by noise.

The calculation of the isolines is started via the button „Execute“. Lines visible in the image are removed by means of the button „Delete lines“.

Using the button „Save parameters“ a data record containing calculation parameters can be saved in a file for later use. Later, this record can be retrieved again via the button „Load parameters“. Saving a data record is also necessary if the calculation of isolines in a self-created macro is to be used as an independent menu item. See also page 167.

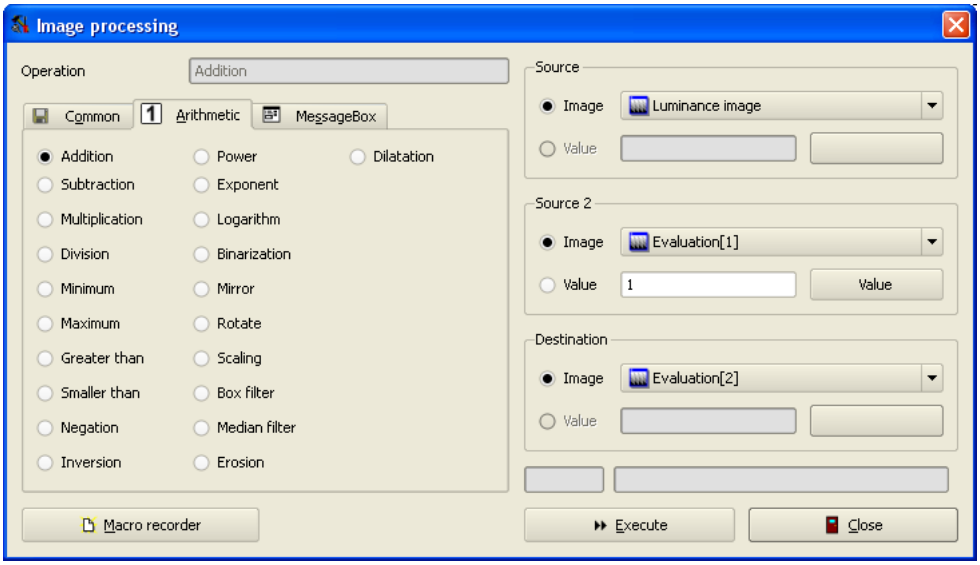
In the figure below, the result of an isoline calculation with the parameters set in the dialog above is shown:



13.8 Image processing

Using the menu item „Evaluation | Image processing“ a dialog with the options below will be opened:

- Arithmetic, logic and filter operations with images can be performed.
- Images needed can be loaded, images calculated can be saved.
- Several successive operations can be recorded in a macro in order to carry them out later several times using a self-defined menu item.
- The operations below can be integrated into the self-defined activities:
  - The menu items „New“ and „Delete“ in the menu „Image“ for creating or deleting evaluation images.
  - The menu items in the menu „Capture“ for capturing luminance or color images.
  - The menu items for processing color images „Decompose into color extracts“ to „Color difference to a color“ in the menu „Evaluation“ can also be integrated into macros.
- Existing parameter sets for the projective rectification, the coordinate transformation and for the calculation of isolines can also be used in order to perform these operations in the dialog or during the creation of macros.



On the left-hand side of the dialog the function desired can be selected by clicking on the corresponding radio button. After that, the parameters needed for this function can be entered on the right-hand side. The data having been completed, the function selected can be started via the button „Execute“.

Using the button „Macro recorder“ another dialog can be opened where the recording of the data can be switched on or off in a user-defined macro, see section section 13.9 on page 172.

In the three sections below the operations implemented in the dialog and their parameters will be described.

13.8.1 Register card „Common“

If the register card „Common“ on the left-hand side of the dialog is clicked on, one of the operations below can be selected by means of the radio buttons. They have become part of the dialog in order to use them in the macros to be captured.

Load image (fixed name)
: In this operation, an image with a fixed file name be loaded into the program. The file name can be entered on the right-hand side in the section „Source“. This name can either be written directly into the input box or it can be defined via the button „File name“ in a file selection dialog.

  In the section „Destination“ the destination image for the loading operation can be defined. Having pressed the button „Execute“ the file desired will be loaded into the destination image.

Load image (file dialog)
: Also in this operation, a file will be loaded into the image. In contrast to the operation above, the selection of the file name is not effected before pressing the button „Execute“ but later. Therefore, the section „Source“ in the dialog is disabled. This difference is of some importance for a use within a macro. In the first option, the image will always be loaded from the same file when the macro is executed. In the second option, a file selection dialog is opened when the macro is executed thus always allowing a different file to be selected.

Save image (to directory)
: An image can be filed in this operation. The image to be saved is displayed in the section „Source“. In the section „Destination“ the directory where the image is to be filed has to be entered. The file name is automatically derived from the date, the time and the image type.

Save image (file dialog)
: In this operation, an image can be saved in a file, too. In contrast to the previous option, the file name will not automatically be defined but only after having pressed the button „Execute“. The difference is of some importance for a use within a macro. In the first option, the image is always saved under a different name in the same directory when the macro is executed. In the second option, a file selection dialog is opened when the macro is executed thus allowing a file name to be interactively selected.

Copy image
: Using this operation the content of an image can be copied to another image. Both images have to be of the same type. The size of the destination image is matched to the size of the source image. The parameters are the names of the source and the destination images.

Convert image
: By means of this operation the image content can be copied to another image. Both

images can be of different types. The size of the destination image is matched to the size of the source image. The parameters are the names of the source and the destination images. If color images are converted to monochrome images, the destination image will contain the luminance of the color image after the conversion. If monochrome images are converted to color images, the color image will have the same luminance as the source image. The color coordinates are x=y=0.3333.

Set image size (other image)
The parameters of this operation are a source image and a destination image. While executing the size of the destination image will be set on the size of the source image.

Set image size (coordinates)
By means of this operation the image size can be set to the entered values.

Move image origin
The coordinates of the upper left corner of the image are changed by means of this operation. The image size and the image content remain unchanged.

Set image (fixed value)
In this operation, an image can be set on a fixed value. This fixed value can either be written directly into the input box or it can be entered via a dialog after having pressed the button „Value“ in the section Source. If color images are used, the data can be input in the dialog in any color space. The entered color value is displayed in the input box in the color space RGB by three digits separated by blanks.

Set image (from marked region)
The value to set in the target image is calculated from the mean value of a rectangular region marked in the source image.

Set image (Input dialog)
Also in this operation, a fixed value can be assigned to an image. In contrast to the previous operation, the value desired is queried only after the button „Execute“ has been pressed. The difference is of some importance for a use within a macro. In the first option, the same predefined value is used for the image when the macro is executed. In the second option, an input dialog is opened thus allowing a different value to be used each time.

Projective rectification
The projective rectification has been described in section 13.5 on page 158. It has also been mentioned that it is possible to save the parameters of the operation in a file. By means of this parameter file a projective rectification can be used in the image processing dialog and integrated into a macro. In the section „Source“ the source image to be rectified is defined. In „Source 2“ the name of the parameter file can be selected. In the section „Destination“ the destination image of the rectification is defined.

Coordinate transformation
The coordinate transformation operation has been described in section 13.6 on page 161. There, it has also been mentioned that it is possible to save the parameters of the operation in a file. By means of this parameter file a coordinate transforma-

tion can be used in the image processing dialog and integrated into the macro. In the section „Source“ the source image to be transformed is defined. In „Source 2“ the name of the parameter file can be selected. In the section „Destination“ the destination image of the transformation is defined.

Isolines

The representation of isolines has been described in section 13.7 on page 162. There, it has also been mentioned that it is possible to file the parameters of the operation. Using this parameter file an isoline representation in the image processing dialog can be used and integrated into a macro. As the isoline representation is calculated and drawn in the same image, the image to be used has only to be defined in the section „Destination“.

13.8.2 Register card „Arithmetic“

In addition to some arithmetic and logic operations with images there are some options for rotating, mirroring and image filtering available in the section „Arithmetic“.

If color images are processed, it should be taken into consideration that all arithmetic and logic operations will be carried out component-by-component in the color space „RGB“. That means that the three color components red, green and blue are processed independently from each other as if they were independent monochrome images. If other operations in other color spaces are necessary, their implementation can be realized as follows:

1. Decomposing the color images in color extracts. See section 14.1 on page 176.
2. Doing the calculations in the monochrome color extracts.
3. Composing the monochrome color extracts to the resulting color image. See section 14.2 on page 177.

All images used must be of the same type. The size of the target image will be matched automatically. If the two source images have different sizes, the operations will be carried out only in those image regions which are available in both of them. For nearly all operations, the same image can be used both as source and also as target image, which makes the use of any additional auxiliary images and the copying the image contents unnecessary.

Addition

In this operation, either two images or one image and one constant can be added and the result can be saved in a destination image. The decision whether a second source image or a constant is added to source image 1 is taken via a radio button in the section „Source 2“. Depending on the decision either the second image is to be selected there or the constant has to be indicated.

If the second source parameter is a constant, it can either directly be written in the input box or the dialog can be used which will be opened after having pressed the button „Value“. If color images are used, the color value can come from any color space. In the input box this constant will always be represented in the color space „RGB“.

Subtraction
The meaning of these parameters can be compared to the addition parameters.

Multiplication
The meaning of these parameters can be compared to the addition parameters.

Division
The meaning of these parameters can be compared to the addition parameters. A division by zero is resolved within the program. The corresponding pixel or the color component is set to zero in the destination image.

Minimum
The meaning of these parameters can be compared to the addition parameters. After the operation, the destination image contains the smallest of the source image values and the second operand which can be either a constant or a second source image.

Maximum
The meaning of these parameters can be compared to the addition parameters. After the operation, the destination image contains the larger of the values of the source image and the second operand which can either be a constant or a second source image.

Greater than
Two images or one image and a constant can be compared to each other. The result will be a new image containing the result of the comparison in terms of pixels with the values „0“ or „1“.

Smaller than
Two images or one image and a constant can be compared to each other. The result will be a new image containing the result of the comparison in terms of pixels with the values „0“ or „1“.

Negation
In this operation, all pixels in the source image which are not zero will be set to zero. All pixels which are zero will be set to one.

Inversion
In this operation, all pixels of the source image will be set to their reciprocals in the destination image. Zero values in the source image will remain unchanged.

Power
In this operation, the values of an image can be potentiated. If there is a power of 2.0, the values of the source image will be squared. If there is a power of 0.5, the square root can be found.

Exponent
In this operation, the exponential function of each pixel of the source image will be calculated.

Logarithm
In this operation, the natural logarithm of a pixel will be calculated. For pixels of zero the resulting value will be set to zero. The calculation of the exponent and of

the logarithm are inverse operations to each other. The logarithm of values which are smaller than or equal to zero will be set to zero.

Binarisation

In this operation, the pixels of the source image will be compared to a predefined threshold. All values greater than or equal to the threshold will be set to one in the destination image. All values below the threshold will be set to zero.

Mirror

In this operation, the source image will be mirrored either at the vertical or the horizontal center line of the image. The direction of mirroring is defined by the second source parameter. If it is zero, it will be mirrored at the vertical center line of the image in horizontal direction. If the parameter is one, it will be mirrored in vertical direction at the horizontal center line.

Rotate

In this operation, the whole image will be rotated. The angle of rotation is defined by the second source parameter. The image content is rotated in a mathematically positive direction. The center point of the image served as the rotation center.

Scaling

In this operation, an image can be enlarged or reduced. The amount of the enlargement or reduction is determined by the second source parameter which has to be a rational number greater than zero. Values smaller than one result in a reduction, values greater than one lead to an enlargement.

Box filter

In this operation, images can be filtered by means of a box filter. A pixel in the destination image is calculated from the mean value calculation of the pixels in the source image in the near neighborhood. This algorithm reduces the noise in the image, it makes, however, the edges of the objects in the image blurred. The second source parameter is the size of the filter to be used. This size should be an odd integral number.

Median filter

In this operation, images can be filtered by means of a median filter. A pixel in the destination image gets the median value of the sorted pixel list in the neighborhood of the pixel. A median filter reduces the noise in the image and does not make the edges of an object in the image blurred. The calculation of median values, however, is slower than the use of a box filter.

The second source parameter is the size of the image range where the list of pixels is set up. This size should be an odd integral number.

Mask filter

There is the possibility to filter an image with an user defined filter. The first source parameter is the name of the source image. The second source parameter is the name of a text file (*.filter), which contains the filter coefficients.

An example of such a file:

```
5   5  10
-1  0  2   0  1
-1  0  2   0  1
-1  0  2   0  1
-1  0  2   0  1
-1  0  2   0  1
```

The first row contains the height and width of the filter (in the example both are 5) and the divisor of every filter coefficient. The following rows contain the filter coefficients themself.

In comparison with other image processing operations the mask filter needs a lot of time.

Erosion

In this operation, a pixel in the destination image gets the smallest value of the sorted pixel list in the neigborhood of the pixel.

The second source parameter is the size of the image range where the list of pixels is set up. This size should be an odd integral number.

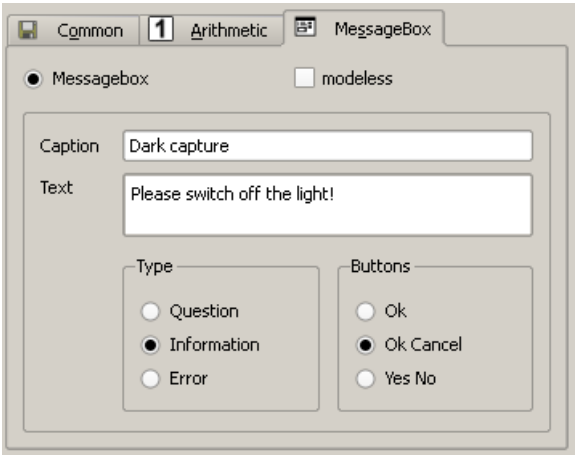
Dilatation

In this operation, a pixel in the destination image gets the greatest value of the sorted pixel list in the neigborhood of the pixel.

The second source parameter is the size of the image range where the list of pixels is set up. This size should be an odd integral number.

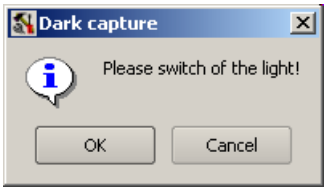
13.8.3 Register card „Message box“

On this side, the display of a message box can be parameterized. These display windows can be used when recording a macro in order to later stop the macro at this position or to cancel it. The break forced in this way in executing the macro can be used, for example, to modify some measuring object settings and then generating some other captures of the scene.



If the radio button „MESSAGEBOX“ is selected, the parameter input on the right-hand side of the dialog will be disabled since all input for the message box desired is done on the left-hand side of the dialog. There, the headline of the window and the text to be displayed can be entered. Furthermore, the type of the message box and the buttons to be shown can be selected. If the two buttons (Ok-Cancel or Yes-No) are used, pressing the first button (Ok or Yes) results in a continuous execution of the macro, pressing the second button (Cancel or No) leads to a termination of the macro. With the option „MODELESS“ the user could decide, whether the message box works in modal or modeless mode.

In the image below, the results of the input into the example above are shown when the message box is tested by means of the button „EXECUTE“.



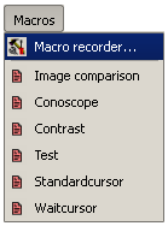
13.9 Recording recurrent operations

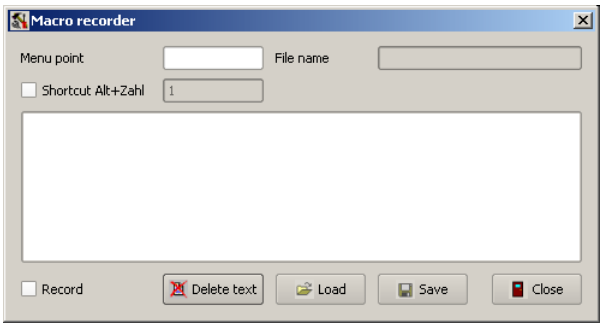
In the previous chapter, we mentioned that it is possible to record user-defined data in a macro, to save this macro as a file and to make it available for the program as a user-defined menu item. The user-defined data to be recorded is as follows:

- Creating, modifying and deleting an evaluation image by means of the menu items „Image | New“, „Image | Properties“ and „Image | Delete“.
- Capturing luminance and color images via the menu items „Capture | SinglePic“, „Capture | MultiPic“, „Capture | HighDyn“ and „Capture | Color HighDyn“.
- All image processing operations initiated in the dialog „Image processing“. This dialog is opened via the menu command „Evaluation | Image processing“. It has been described in detail in the chapters above.
- Evaluating color images by means of the menu items „Evaluation | Decompose into color extracts“, „Evaluation | Compose from color extracts“, „Evaluation | Color difference between images“ and „Evaluation | Color difference to a color“. These options of color image processing will be documented in the chapter below.
- Exporting data to MS Word and MS Excel. To accomplish that, opening and closing Word or Excel documents and transferring images, tables, graphics and diagrams to these two programs are recorded if these operations are carried out in the dialogs „Export to MS Word“ or „Export to MS Excel“. See section 15.3 on page 183 and section 15.4 on page 187.
- Retrieving a macro already existing by the menu item concerned of the menu „Macro“.

The dialog for the recording and processing of user-defined macros can be opened by:

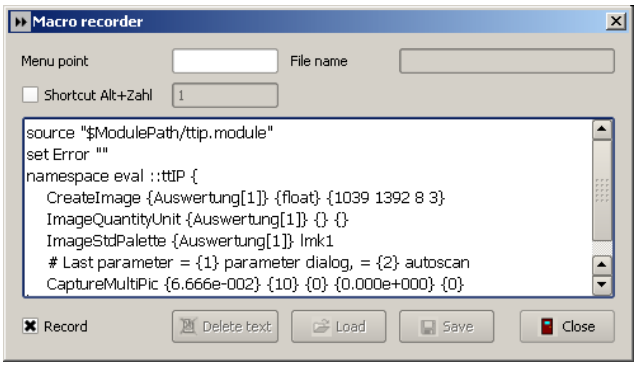
- the button „Macro recorder“ in the dialog „Image processing“.
- the menu item „Macros | Macro recorder“ in the main menu of the program. There, the user-recorded macros are also displayed as a menu item.





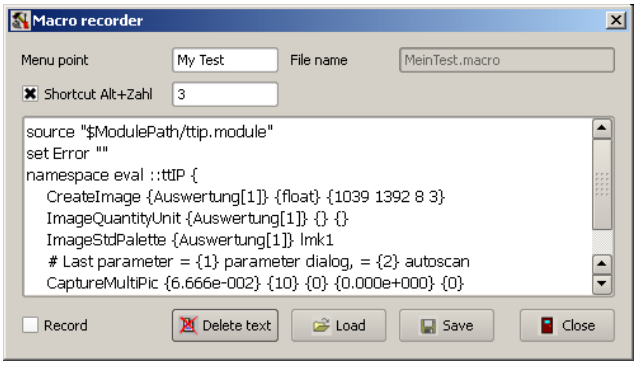
The figure on the left shows the menu „Macros“ with the item „Macro recorder“ and also some user-defined menu items. The dialog „Macro recorder“ is shown in the figure on the right.

The recording of a macro is started by setting the option „RECORD“ in the dialog. After that, the dialog can be closed while recording, and it can be opened again when the finished macro is to be saved as a file and as a new menu item. In the figure below, the dialog state during a recording is shown.



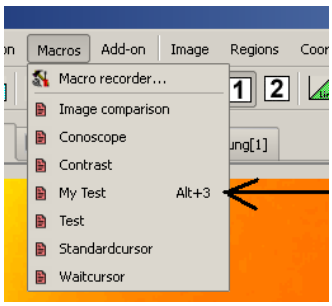
The commands in the text field are commands in the script language „TCL“. For more details on this script language used in the macros see section 16.2 on page 205.

For the recording of macros a detailed knowledge of the script language is not required!



The recording of a macro is finished by turning off the option „RECORD“. Then, the name of the new menu item has to be defined in the input box „MENU ITEM“. In the example, „My test“ has been entered. Additionally a shortcut can be defined. In the example „Alt+3“ is used.

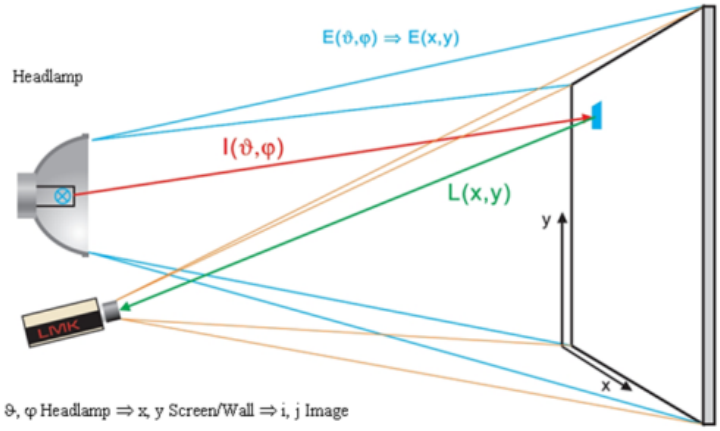
The macro is saved as a file by the button „SAVE“. After that, the dialog „MACRO RECORDER“ can be closed and the macro is available in the program as a new menu item:



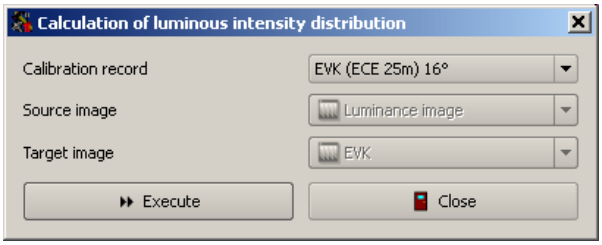
13.10 Calculation of a luminous intensity distribution

In order to be able to calculate a luminous intensity distribution by means of a luminance measuring camera, the following prerequisites must be fulfilled:

- A fixed test set-up must be available:
  - The object to be measured illuminates a projection wall.
  - The camera is firmly installed and captures an image of the projection wall.
- This measuring set-up has been installed and calibrated by the TechnoTeam company.



After adjusting and calibrating, the menu item „Evaluation | LID calculation“ is available. Using this item, the dialogue „Calculation of luminous intensity distribution“ is opened.



In the selection list „Calibration record“, a record can be chosen. It is possible, for example, to calculate from the luminance image a luminous intensity distribution just as an illuminance distribution or, if a color camera is available, to determine similar distributions also for color images.

In the two following boxes of the dialog „Source image“ and „Target image“, the images used for the procedure are displayed. They are firmly determined and cannot be modified. Any target images which are not available will be set up automatically.

Upon pressing the button „Execute“, the calculations are started. When they are over, the display of the coordinate system of the luminous intensity distribution can be switched on using the menu item „View | Coordinate system“.

14 Evaluating color images

In the previous chapters some options of color evaluations have already been presented:

- In the status line of a color image the chromaticity values at the cursor position are displayed. The color space used can be selected via the menu command „Image | Color space“.
- Using a „Line cursor“ a sectional view representation of the color behavior in the neigborhood of the cursor position can be displayed. Plane cusors such as „Rectangle cursor“ and „Circle cursor“ show a histogram of the chromaticity values in the neighborhood of the cursor. See chapter 11 beginning on page 108 for a more detailed description.
- While cursors offer an instable result representation, the sectional views presented in chapter 12 beginning on page 111 (section 12.1.2 on page 114) and histograms (section 12.1.3 on page 116) allow a result output connected to fixed evaluation regions in the image.
- Other statistic evaluation options which can be used for monochrome and color images are „Standard statistics“ (section 12.1.1 on page 113) and „Projections“ (section 12.1.4 on page 119).
- Especially for color images it is possible to calculate „Chromaticity diagrams“, see section 12.1.11 on page 128.
- By means of „Color symbol object“ (section 12.1.8 on page 125) the algorithm of the „Symbol object“ developed for monochrome images can be used for color images as well.
- The algorithms for the projective rectification introduced in chapter 13 beginning on page 153 (section 13.5 on page 158) and for the coordinate transformation (section 13.6 on page 161) can also be used in color images.
- Arithmetic calculations with color images can be carried out by means of evaluation images and the dialog „Image processing“ (section 13.8 on page 164).

Additional methods of evaluating color images will be presented in the chapter below:

- The dialogs for the decomposition of color images or for the later possible composition of the processed color extracts allow monochrome images to be processed also for single color extracts. The options of image arithmetic described in section 13.8 on page 164 are of some interest here.
- Two specialized dialogs allow color differences to be calculated, see section 14.3 on page 177:
  - between two images,

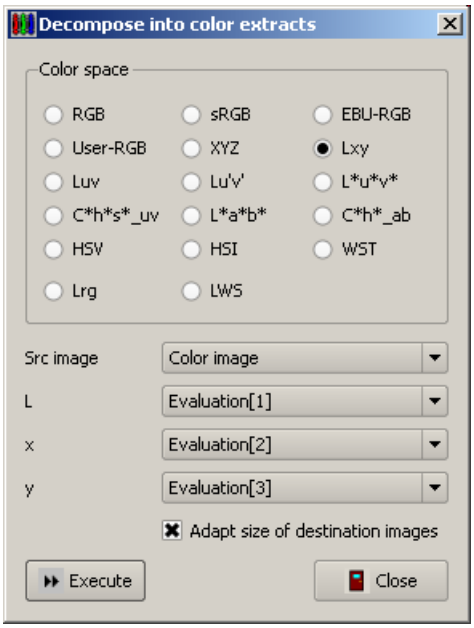
- to a reference color.

The color spaces and color differences implemented in the program will be documented in detail in chapter 19 beginning on page 228.

14.1 Decomposing into color extracts

Using the menu command „Evaluation | Decompose into color extracts“ a dialog will be opened where a color image can be decomposed into one to three monochrome images at maximum. Therefore, each monochrome destination image contains one color component each after the decomposition.

A possible application is the extraction of the luminance and a comparison to the desired standard values in the partial monochrome image for the luminance.



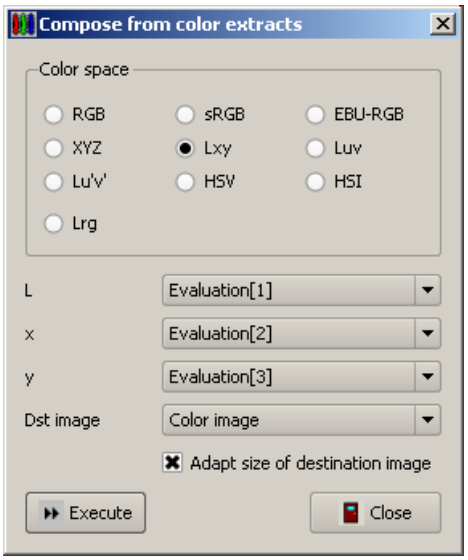
In the section „Color space“ three possible color components are selected which can be created by a decomposition. In the selection box „Src image“ one of the color images existing in the program can be selected. In the three lines below, the possible color component will be displayed on the left, on the right-hand side monochrome destination images can be assigned to these color components. If one component is not needed, the item „No image“ can be selected.

As the destination images can possibly have a different size compared to the source image a modification can be caused via the option „Adapt size of destination images“. The decomposition is started by the button „Execute“. The dialog can be left via „Close“.

14.2 Merging color extracts

Using the menu item „Evaluation | Compose from color extracts“ a color image can be merged from three monochrome images, with each of them supplying a color component. A color image cannot be composed of each color space which is implemented in the program for decomposing into color extracts because some color space transformations are not reversible.

A possible application of this method is the creation of synthetic color patterns from monochrome images or the composition of a color image which had been decomposed before after some image processing algorithms have separately been performed with some color components.



In the section „Color space“ the color space can be selected where the three monochrome source images are to be composed to a color image. On the left-hand side of the three lines below, the color components needed are displayed. On the right-hand side the three source images have to be defined in the selection boxes. The name of a color image existing in the program is required in the line „Dst image“.

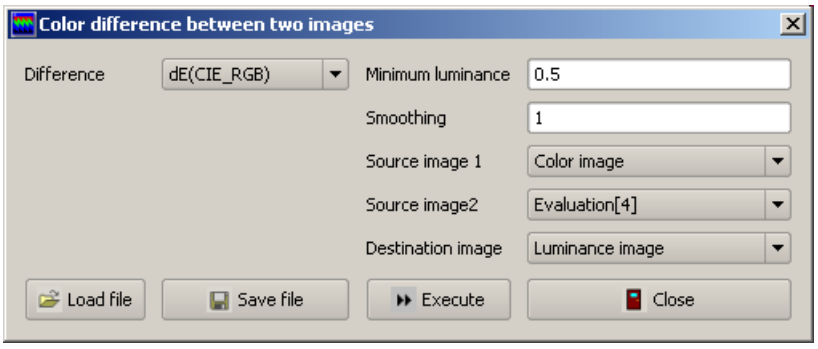
The three source images have to be of the same size, the size of the destination image can be corrected by means of the option „Adapt size of destination image“. Having pressed the button „Execute“ the merging process will be started. The dialog can be left via „Close“.

14.3 Calculating the color difference

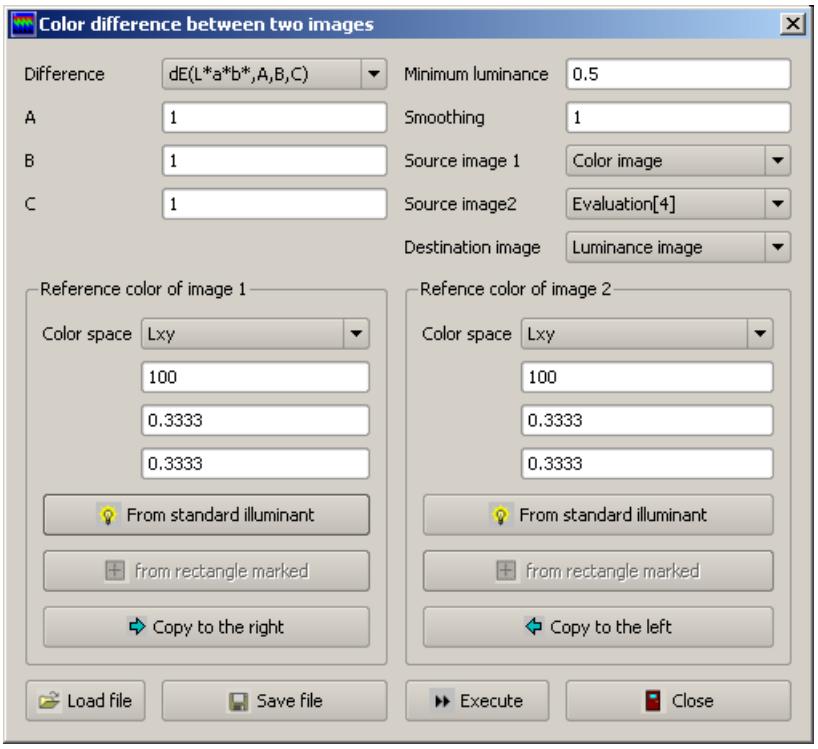
There are two possible applications for the calculation of color differences. In the first case, the colors of two images can be compared to each other point-by-point. A possible application is the capture of the same object at two different times. The second application is the evaluation of an image with respect to a reference color. This option is available via the menu item „Evaluation | Color difference to a color“.

14.3.1 Color difference between two images

To open the dialog „Color difference between two images“ the menu item „Evaluation | Color difference between images“ can be used.



Color difference in a color space without reference color



Color difference in a color space with reference color

On the right-hand side of the dialog, the two color images the color difference has to be calculated for are to be determined in the selection boxes „Source image1“ and „Source image2“. In „Destination image“ a monochrome image has to be defined which is expected to include the result of the operation.

In the selection box on the top left of the dialog the desired difference measure is to be selected. (For the implemented difference measures see section 19.2 on page 234). Depending on the difference measure selected the appearance of the dialog changes:

- If the difference measure is calculated in a color space without a reference color, no other parameters will be needed (see upper figure).
- If a difference measure of two images in a color space with a reference color is to be calculated, the reference colors of both images will be shown in the dialog (see lower figure). The buttons in the section „Reference color“ will facilitate the input and the adjustment of the reference colors of both images:
  - Using the button „From standard light“ a dialog wii be opened where a fixed standard illuminant can be selected as the reference color.
  - The button „From marked rectangle“ is active if a rectangular measuring region is marked in the image concerned. Having pressed the button the mean value of this region will be taken over as the new reference color.
  - The buttons „Copy to the right“ and „Copy to the left“, respectively can be used to take over the reference color of one image to the other one.

In the input box „Minimum luminance“ a threshold value can be defined, under which no difference is to be calculated. (In case of very low brightness the accuracy of the color coordinate determination is worse than in well-illuminated image parts.)

If a value greater than 1 is selected in the input box „Smoothing“, the source images will be filtered by a smoothing filter of a corresponding size before the difference is formed. Thus, the influence of noise can be reduced in both images.

Using the button „Save file“ the data of the dialog can be filed in order to allow them to be used later via the button „Load file“.

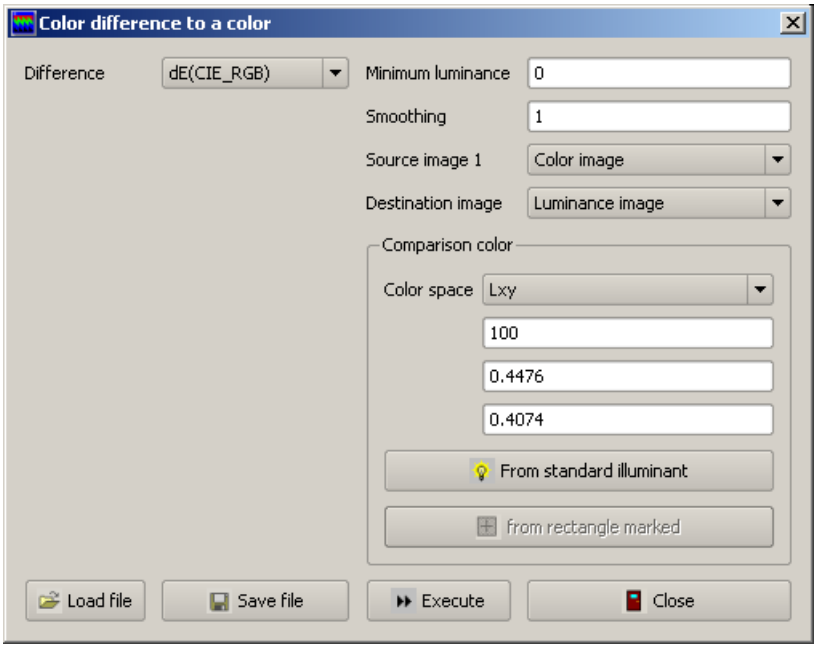
The calculation is started via the button „Execute“. Working on the dialog is finished via the button „Close“.

14.3.2 Color difference to a color

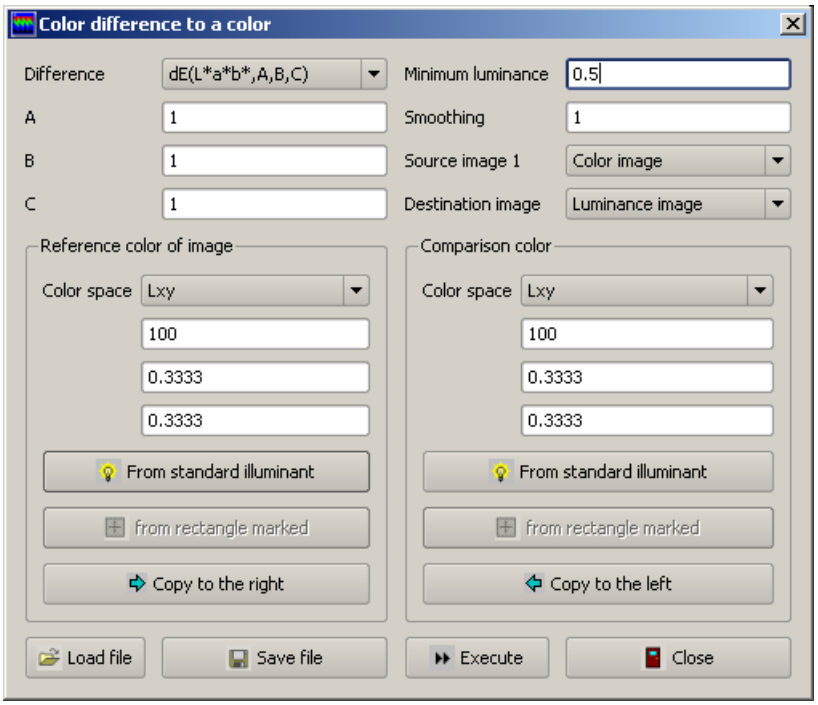
The menu item „Evaluation | Color difference to a color“ can be used to open the dialog „Color difference to a color“.

This dialog is quite similar to the dialog which has just been documented. Instead of a second image, a reference color which is to be compared with all pixels in the source image has to be entered. Therefore, there is an input option for the reference color on the right-hand side of the dialog, whereas on the left-hand side, as in the application above, the reference color of the colored source image can be entered for some color differences.

All the other input elements and buttons show the same behavior in both dialogs.



Color difference in a color space without a reference color



Color difference in a color space with a reference color

15 Printing and exporting

In each of the four result views of the program there are options available to directly output the measuring data to a printer or to copy them into the clipboard.

15.1 Immediately printing images, tables, graphics and diagrams

Bilder

Using the menu item „Image | Print“ the current image is immediately output to the printer. The image printed is equal to the current view in the program:

- Visible image section
- Color palette
- Measuring regions
- Coordinate system

Tables

A table is output to the printer either by the main menu item „Table | Print“ or via the context menu item „Print“. (The context menu will be opened if the mouse pointer is in the table, with the right-hand mouse button being pressed.)

Tables are output to the printer in their current state. If any lines of the table are marked (recognizable by their yellow color), they will also be output in the corresponding color. Tables which are too large for a standard output will either be made up or printed in oblong format.

Graphics

The menu items „Graphic | Print“ and „Graphic | Print all graphics“ are available for the printing operation. The operations can also be initiated in the context menu of the graphic by the menu items „Print“ and „Print all graphics“, respectively.

If „Print“ is used, only the currently visible graphic will be printed. Via „Print all graphics“ several graphics will be printed one below the other if the views of the current statistic are distributed to several tab sheets.

The graphics are output in the same form as currently represented on the screen. Therefore, it could make sense to optimize the representation as desired by, for example, modifying the program or window size.

Diagrams

The current diagram is output to the printer via the menu item „Diagram | Print“. And again, the diagram will be printed in the same form as represented on the screen.

15.2 Copying via clipboard

The four result views (images, tables, graphics and diagrams) can be copied into the clipboard of Windows and pasted into other programs from there.

Images

If the menu item „Image | Copy“ is selected in the main menu, the image can be copied into the clipboard in the formats listed below:

- **Bitmap**: The bitmap of the current image copied into the clipboard is identical to the image representation in the program. For details of the representation see the notes in the previous section.

  To copy the image as bitmap into the clipboard the option „Image | Options while copying | Bitmap“ has to be turned on. This is the default setting.

- **Binary format**: The image is copied into the clipboard in a TechnoTeam-specific data format and can be pasted in this format into other images or image sections:

  – Pasting into another image is accomplished by switching the display to a different image and selecting there the menu item „Image | Paste“.

  – Pasting into another image section is accomplished by marking a rectangular measuring region in the image and selecting the menu item „Paste image content“ in the context menu. See section 9.4 on page 100 for a more detailed description.

- **Text format**: The image is copied into the clipboard in a format that can be read by a word processing program. This option is turned off in the default settings. It can be activated via the menu item „Image | Options while copying | Text“.

  A description of the text format used can be found in section 18.1 on page 220.

The complete image can be copied into the clipboard as bitmap, in binary and text formats, and so can the content of a marked rectangle. The corresponding menu items („Copy“ and „Options while copying“) are in this case in the context menu of the image. See section 9.4 on page 100.

Tables

- As **Text**: The lines of the table are separated from each other by Newline characters whereas the columns are separated by tabulators.
- As **Bitmap**.

In both cases, the copy in the clipboard only contains the columns which are currently displayed in the program. (The visibility of the columns can be modified by the menu item „Table | Visibility of columns“ or by the context menu item „Visibility of columns“.

Graphics

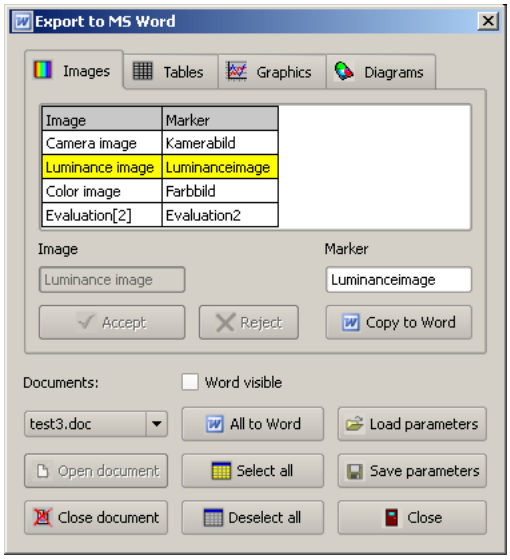
Using the menu item „”Graphic | Copy“ or the context menu item „Copy“ the current graphic will be copied into the clipboard as bitmap. The appearance of the graphic is equal to its representation on the screen. Therefore, it makes sense to optimize the representation as desired by, for example, modifying the program or window size.

Diagrams

The current diagram will be transferred to the clipboard via the menu item „Diagram | Copy“. And again, the copy is the same as visible on the screen.

15.3 Export to Microsoft Word

In the two sections above options have been described to individually print results or to copy them via the clipboard. For the data export to Microsoft Word and (see next section) to Microsoft Excel two specialized dialogs are available providing some more options of creating a report with measuring data.



The dialog for the output of measuring values to Microsoft Word is opened by means of the menu item „Protocol | Export to MS-Word“.

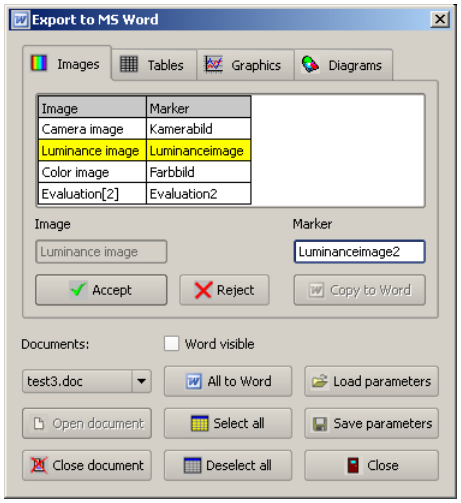
In the upper part of the dialog the different types of results are displayed on four different pages. In the figure, the table „Images“ contains a list with the four images currently existing in the program. In the columns of the table there are:

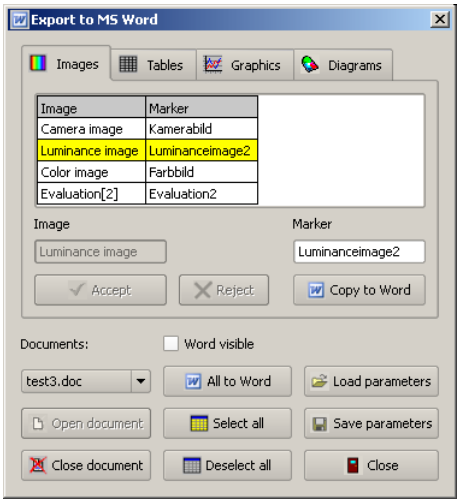
- **Image**: The corresponding image is shown under this name in the program. The same is true on the other pages where the first columns are labeled with „Table“, „Graphic“ or „Diagram“.
- **Marker**: In the Word document opened later the position of the image can be fixed by a text marker. A more detailed description of the work with text markers can be found at the end of this chapter.

Having pressed the button „Open document“ a new or an existing Word document can be selected via a file selection dialog where the measuring results are to be copied to. Later, the work with the document has to be finished by the button „Close document“. The command to Microsoft Word to actually save the document is only given when the document is closed. Using the option „Word visible“ the program can be prompted to display the Word document just processed otherwise all operations would take place in secrecy.

If a Word document is opened, one or more objects can be copied into this document. To accomplish that the objects to be copied have to be marked in the tables. Using the button „Select all“ it will be possible to mark all objects on all four pages of the table. Having pressed the button „Deselect all“ the marking state of all objects will be reset. Using the button „All to Word“ all objects just marked on all four pages will be copied to Word.

The buttons and the input boxes in the upper part of the dialog directly below the table only relate to the marked objects in the table displayed.





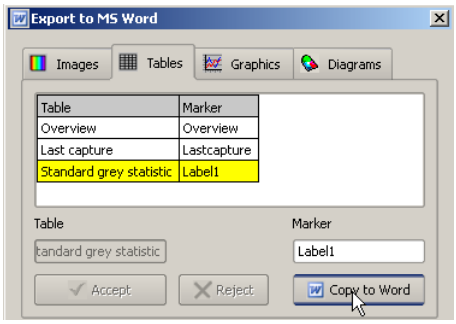
In the figure on the left, a modified name has been entered into the input box „Marker“. Before the corresponding image can be transferred to the indicated text marker, the

modification is either to be accepted by the button „Accept“ or rejected by the button „Reject“. Only then, copying will be possible via the button „Copy to Word“.

If there is a text marker with the same name, the content of this marker will be replaced by the new content. If there is no text marker, such a marker will be created at the end of the document, with the image being written at this position. Thus, it will be possible:

- To replace the content of a prepared document with existing text markers by new data or
- to successively take over new data into the document by means of new text marker names.

And here is an example: First, the table of the standard statistic is copied to a Word document which has already been opened.

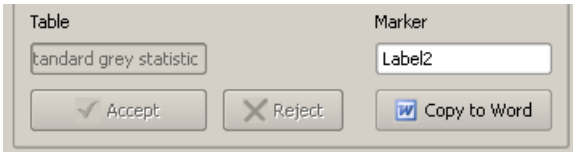


Stat.No.	Parameter	Image	Region	Area	Min	Max	Mean	Disp
1	Std_Gr[1]	Luminance image	1	194	0.006761	0.07092	0.0405	0.01713
2	Std_Gr[1]	Luminance image	2	3685	0.004422	4.16	1.104	1.349
3	Std_Gr[1]	Luminance image	3	4209	0.002909	2.848	0.4793	0.8504
4	Std_Gr[1]	Luminance image	4	4712	0.003493	1.809	0.5576	0.5684

When checking the result we will find out that the information on the parameter set used and on the size of the measuring region is of no importance. Therefore, the visibility of these columns will be switched off by means of the menu item „Table | Visibility of columns“. Copying the table again will lead to the result below:

Stat.No.	Image	Region	Min	Max	Mean	Disp
1	Luminance image	1	0.006761	0.07092	0.0405	0.01713
2	Luminance image	2	0.004422	4.16	1.104	1.349
3	Luminance image	3	0.002909	2.848	0.4793	0.8504
4	Luminance image	4	0.003493	1.809	0.5576	0.5684

After capturing a new luminance image a new table with modified statistic results is to be written into the file. The old table is to remain unchanged. Therefore, the name of the text marker will be changed before the copy operation:



Having copied a second time there will be two tables in the Word file since the new table has been saved under a new text marker:

Stat.No.	Image	Region	Min	Max	Mean	Disp
1	Luminance image	1	0.006761	0.07092	0.0405	0.01713
2	Luminance image	2	0.004422	4.16	1.104	1.349
3	Luminance image	3	0.002909	2.848	0.4793	0.8504
4	Luminance image	4	0.003493	1.809	0.5576	0.5684

Stat.No.	Image	Region	Min	Max	Mean	Disp
1	Luminance image	1	0.006398	0.02284	0.01367	0.003714
2	Luminance image	2	0.002972	2.892	0.17	0.5134
3	Luminance image	3	0.002223	2.848	0.2511	0.6805
4	Luminance image	4	0.004186	1.809	0.602	0.5626

By means of the button „Save parameters“ the state of the dialog can be filed in a parameter file and reconstructed later via the button „Load parameters“. Hence, it is possible to create user-defined reports. The operational procedure required is as follows:

1. Opening a new blank Word document.
2. Copying the data needed to this document.
3. Editing this document, e.g. by adding company-specific information and help texts.
4. Saving and closing the document as a pattern and the parameter file for the data export.

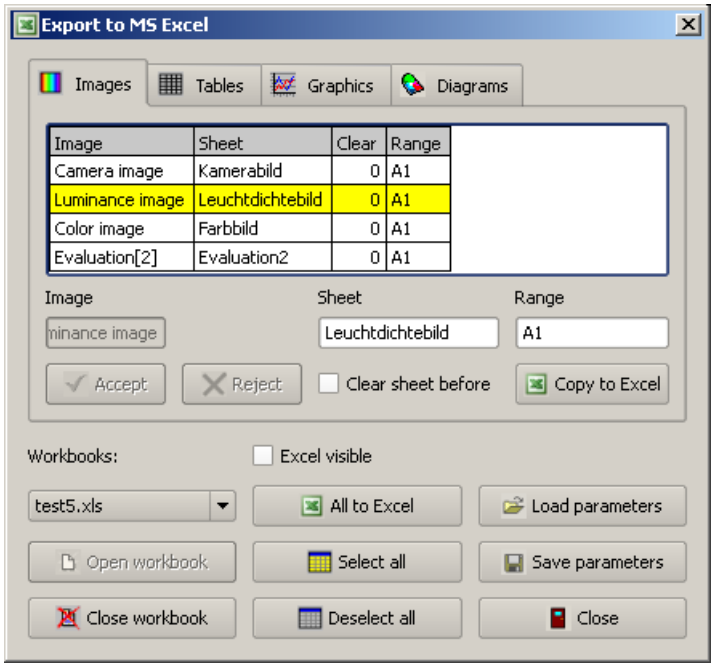
Later, this document can be opened again. The parameter file having loaded, the prepared document can be supplied with updated data by a new data export.

The data entered into the dialog can be recorded in a macro and used as an independent menu item, see section 13.9 on page 172. The recorded data is:

- Opening the Word document.
- Copying some objects (images, tables, graphics and diagrams).
- Closing and saving the Word document.

15.4 Export to Microsoft Excel

Selecting the menu item „Protocol | Export to MS-Excel“ a dialog will be opened which allows masuring values to be output to Microsoft Excel.



As the appearance and the operation of this dialog are similar to a large extent to the dialog for the export to MicrosoftWord, only the differences between the two dialogs will be described below.

In contrast to Microsoft Word, the destination of copying will not be defined by a text marker but by a table sheet and a cell on this sheet (range) defining the position of the top left corner of the object to be copied. Furthermore, it can be defined whether the sheet concerned is to be cleared before copying or not. A general clearing of the sheets concerned can possibly not make sense if there are already some inscriptions, numbers or calculations on the sheet.

- **Image**: the name of the image to be copied. On the three other sheets „Tables“, „Graphics“ and „Diagrams“ the names of these objects concerned can be found.
- **Sheet**: The name of the table sheet where an object is to be copied to.
- **Clear**: A flag showing whether the table sheet concerned is to be cleared before copying or not.
- **Range**: Top left-hand corner of the copy range.

If a line of the table has been marked, the input boxes „Sheet“ and „Range“ and the option field „Clear sheet before“ show the state of the corresponding line of the table. If modifications are performed in the input fields, it can be decided afterwards whether the modifications are to be taken over into the table or not by pressing the buttons „Accept“ or „Reject“.

All the other dialog options are completely equal to those for the export to Microsoft Word:

- Opening a new or an existing file.
- Copying some or all objects to the Excel file.
- Saving and closing the processed file.
- Creating, saving, loading and using parameter files.
- Working with prepared template files.
- Recording user inputs in order to use them as independent menu items.

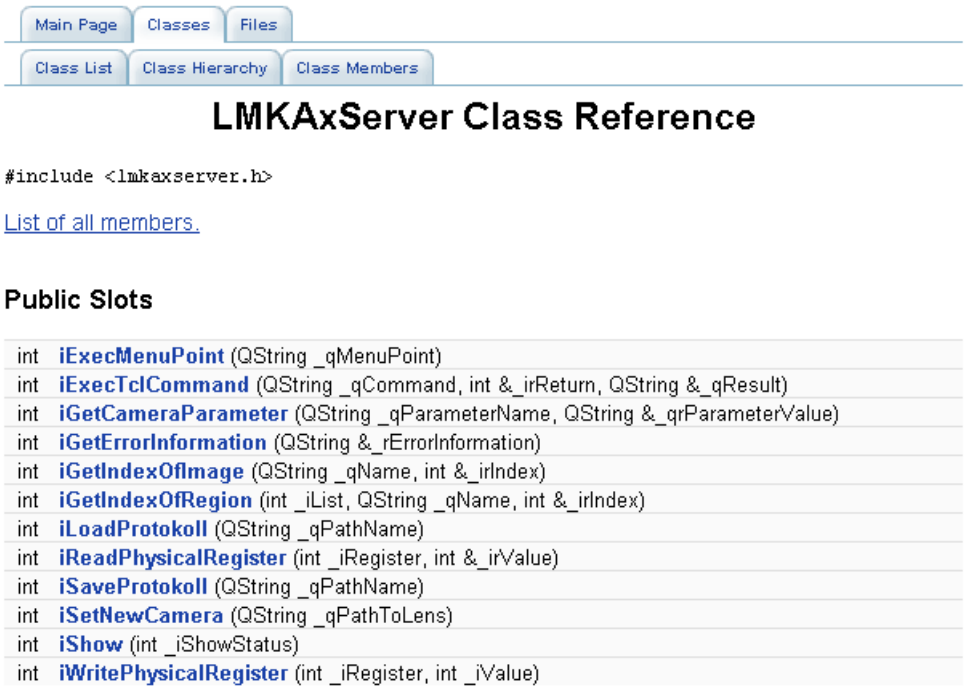
16 External Program Control

16.1 ActiveX-server interface

16.1.1 Introduction

The programming interface of the LMK LabSoft provides an ActiveX server, which allows important functions of the program from other applications having an ActiveX interface (e.g. MS Excel and NI Lab-View) to be controlled. In general, the measurement preparations should always be made interactively with the LMK LabSoft interface. The programming interface will then allow the prepared settings and evaluations which are saved, for example, in a protocol, to be utilized. Thus, the functions of the programming interface are designed for the utilization of already existing structures rather than for setting up images, regions or evaluations. The ActiveX server is automatically registered during the installation of the LMK LabSoft software.

The description of the functions can be found in the subdirectory „doc/Lmkaxserver“ of your installation in HTML format.


Main Page Classes Files

Class List Class Hierarchy Class Members

LMKAxServer Class Reference

#include <lmkaxserver.h>

List of all members.

Public Slots

int iExecMenuPoint (QString _qMenuPoint)
int iExecTclCommand (QString _qCommand, int &_irReturn, QString &_qResult)
int iGetCameraParameter (QString _qParameterName, QString &_qrParameterValue)
int iGetErrorInformation (QString &_rErrorInformation)
int iGetIndexOfImage (QString _qName, int &_irIndex)
int iGetIndexOfRegion (int _iList, QString _qName, int &_irIndex)
int iLoadProtokoll (QString _qPathName)
int iReadPhysicalRegister (int _iRegister, int &_irValue)
int iSaveProtokoll (QString _qPathName)
int iSetNewCamera (QString _qPathToLens)
int iShow (int _iShowStatus)
int iWritePhysicalRegister (int _iRegister, int _iValue)

The information concerning the type of the interface is found in the file „lmk4.tlb“. If necessary, this file is utilized by your software in order to determine the description of the interface.

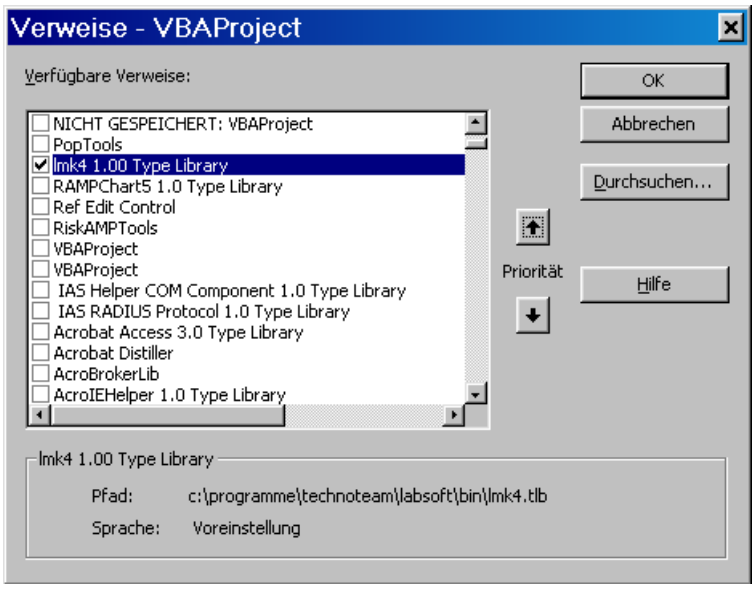
The programming interface provides numerous functions which permit the LMK LabSoft to be included in other programs. Thus, the users can define processes for their applications in a very purposeful way, with these processes including the spatially resolved measurement of luminances and color coordinates. If, for certain cases of application, the functions provided are not sufficient, it will be a pleasure for us to adapt the interface accordingly.

The functions can be classified as follows:

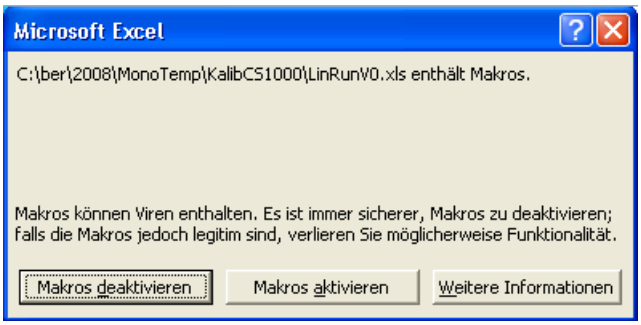
- Using the application
  - Opening and closing
  - Controlling the application
    - Calling up menu items
    - Executing TCL commands
  - Loading and saving protocols
- Features of the camera
  - Starting the camera and loading the calibration data
  - Setting and querying the integration time
  - Accessing the filter wheel of the color camera
- Capturing luminance and color images
  - Controlling the capturing algorithms
  - Querying the features of the capture
- Accessing the results
  - Image data
  - Lists of objects
  - Statistical data

16.1.2 Preparation of MS Excel

After its registration during the installation of the LMK LabSoft, the interface is also available in MS Excel. In the case of problems arising when using the interface or when installing updates, the user should click on „Extras / References“ in the VBA interface of MS Excel and activate the interface (or also disable it first and activate it again). In the figure, the interface is represented through the description „lmk4X.XX Type Library“, with „X.XX“ standing for the respective version of the interface. Clicking on „Browse“, the file „lmk4.tlb“ can be given as the description of the interface.

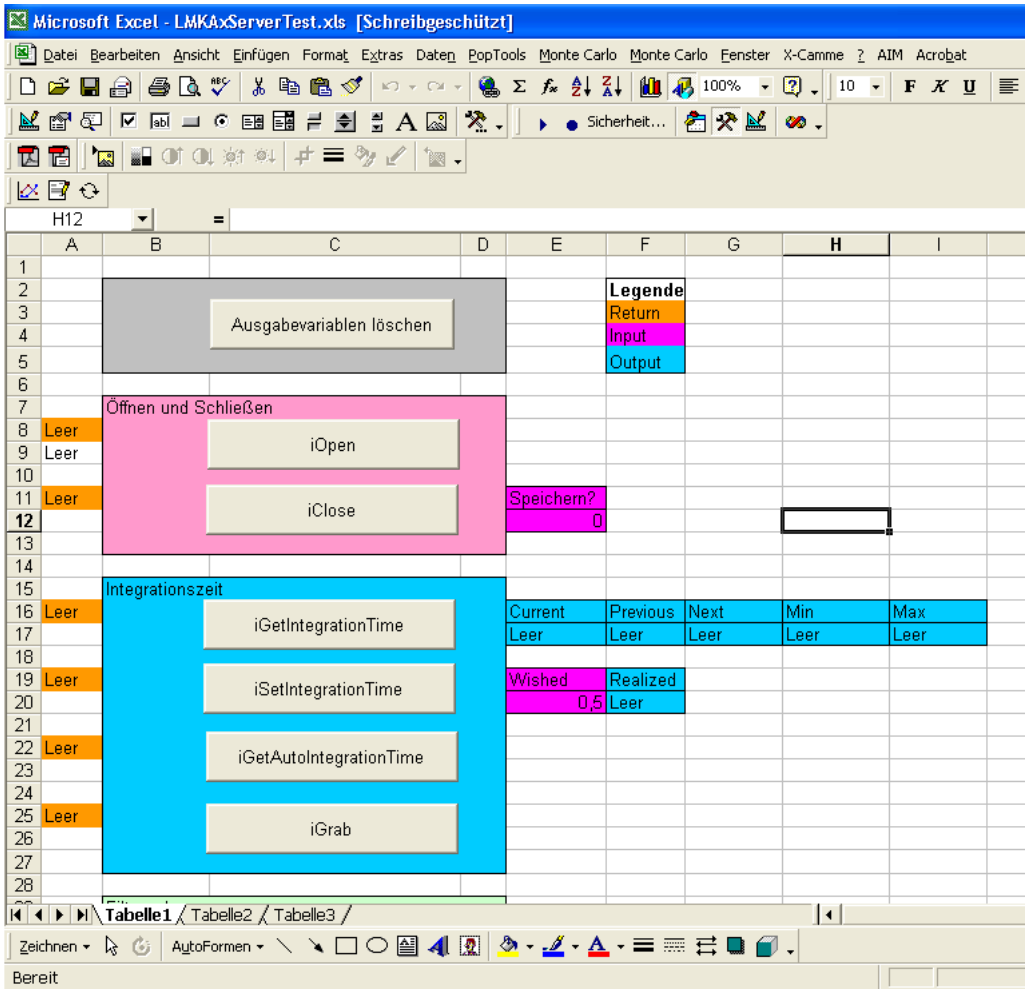


When the examples are loaded, the execution of macros must be activated.



16.1.3 Example 1: Test frame in MS Excel

The file „LMK4AxServerTest.xls“ provides a test frame for all available functions. This file is found in the subdirectory „Examples“ of your installation. Each function can individually be called up by means of a button. To each of the buttons a VBA function is assigned which is called up when pressing it. The parameters just as the return values will be read from the corresponding cells of the XLS files or also entered there.



16.1.4 Example 2: Linearity measurement in MS Excel

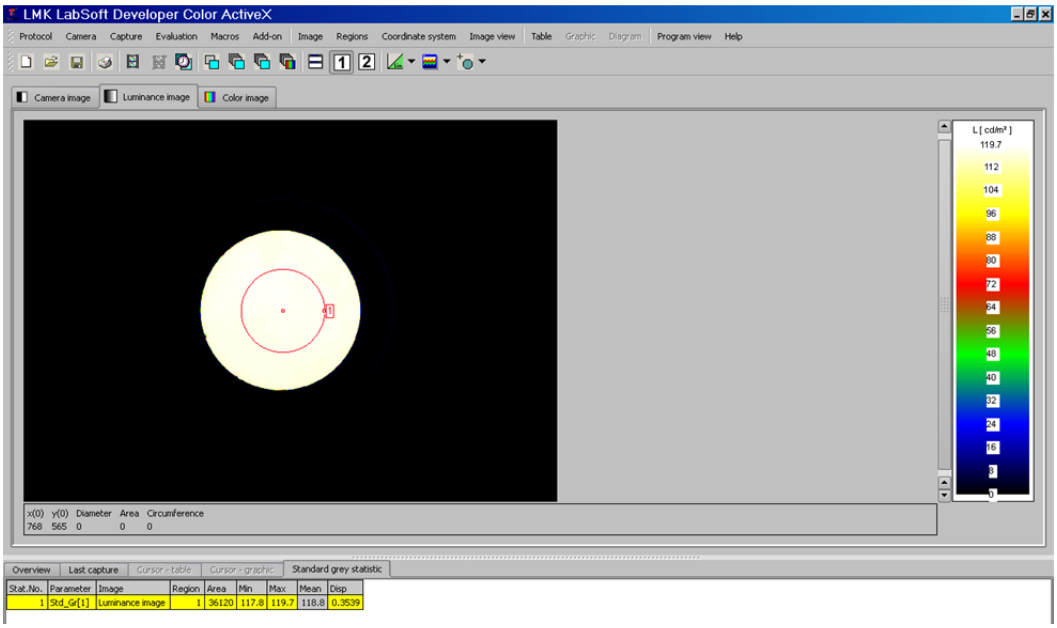
For this example, the file „LMK4AxServerLinRun.XLS“, which is found in the subdirectory „Examples“ of your installation, is used. The linearity measurement is an application originating from the field of the characterization of photometers or image resolved luminance measuring devices. Here, in the simplest case, a constant light source (e.g. a luminance standard) is captured by the camera. For doing this, the luminance is set in such a way that a total of 90% of the full drive range is achieved for a given exposure time.

Then, the linearity measurement is initiated, and the algorithm will reduce the exposure time by a given factor until modulation is less than 1% of the full drive range. After each modification of the exposure time, an image is captured, and the measurement value of a pre-defined region is added to the evaluation table. When the measurements are complete, the data will automatically be represented in the form of a diagram, and the parameter value can be calculated.

Steps:

1. Interactive setting of the LMK LabSoft

- Opening the LMK LabSoft
- Starting with the camera to be used
- Setting the image
- Fixing a region within the luminance standard
- Setting up a set of standard statistics for this region
- Setting up a „LinRun.ttcs“ protocol



2. Entering the application-specific data in the XLS-file (table LMK Setup)

- Place of the LMK installation
- Name and place of installation of the camera used including lens
- Name and place of the protocol to be used („LinRun.ttcs“)

In the red area of the table, entries are made which are then used in the functions for opening and closing the LMK. For this purpose, the red area is labeled with names of variables (LMKDrive, LMKPath, LMKCameraPath, LMKProtocol).

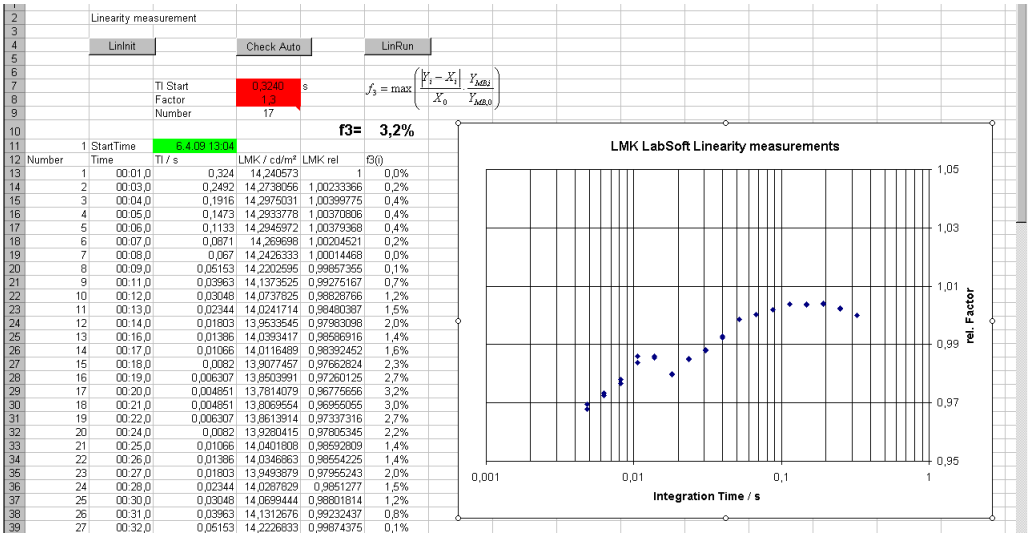
All operations effected with the LMK LabSoft programming interface can be found in the LMK4 module. Here, VBA functions are provided which are necessary for making the measurements, such as:

- „Function lOpenLMK()“: opening the LMK LabSoft
- „Function lCloseLMK()“: closing the software
- „Sub LMKIni()“: opening and loading the camera data
- „Function dCheckAutoScan() As Double“: fixing the integration time; corresponds to menu item „Capture | Auto Scan“
- „Sub MeasureTime(ByRef dIntegrationTimeSet As Double, ByRef dValue As Double)“: making a measurement at fixed integration time and determining the mean luminance of the region fixed

All functions are explained in greater detail in the module.

3. Making the measurement

After opening the LMK (button „LMKOpen“ in the Workbook „LMKSetup“), the function „CheckAuto“ can be called up in the table „LinTest“. This function permits the user to fix the maximum exposure time at which no overdriving occurs, and to enter it at „TI Start“.



Linearity measurement

LinInit | Check Auto | LinRun

TI Start 0,3240 s
Factor 1,3
Number 17

$f_3 = \max\left(\frac{|Y_i - X_i|}{X_0} \cdot \frac{Y_{Kalib}}{Y_{Kalib}}\right)$

f3= 3,2%

1 StartTime 6.4.09 13:04

Number	Time	TI / s	LMK / cd/m²	LMK rel	f3(i)
1	00:01,0	0,324	14,240573	1	0,0%
2	00:03,0	0,2492	14,2738056	1,00233366	0,2%
3	00:04,0	0,1916	14,2975031	1,00399775	0,4%
4	00:05,0	0,1473	14,2933778	1,00370806	0,4%
5	00:06,0	0,1133	14,2945972	1,00379368	0,4%
6	00:07,0	0,0871	14,269698	1,00204521	0,2%
7	00:08,0	0,067	14,2426333	1,00014468	0,0%
8	00:09,0	0,05153	14,2202595	0,99857355	0,1%
9	00:11,0	0,03963	14,1373525	0,99275167	0,7%
10	00:12,0	0,03048	14,0737825	0,98828766	1,2%
11	00:13,0	0,02344	14,0241714	0,98480387	1,5%
12	00:14,0	0,01803	13,9533545	0,97983098	2,0%
13	00:16,0	0,01386	14,0393417	0,98586916	1,4%
14	00:17,0	0,01066	14,0116489	0,98392452	1,6%
15	00:18,0	0,0082	13,9077457	0,97662824	2,3%
16	00:19,0	0,006307	13,8503991	0,97260125	2,7%
17	00:20,0	0,004851	13,7814079	0,96776656	3,2%
18	00:21,0	0,004851	13,8069954	0,96955055	3,0%
19	00:22,0	0,006307	13,8613914	0,97337316	2,7%
20	00:24,0	0,0082	13,9280415	0,97805345	2,2%
21	00:25,0	0,01066	14,0401808	0,98592809	1,4%
22	00:26,0	0,01386	14,0346863	0,98554225	1,4%
23	00:27,0	0,01803	13,9493879	0,97955243	2,0%
24	00:28,0	0,02344	14,0287829	0,9851277	1,5%
25	00:30,0	0,03048	14,0699444	0,98801814	1,2%
26	00:31,0	0,03963	14,1312676	0,99232437	0,8%
27	00:32,0	0,05153	14,2226833	0,99874375	0,1%

Now, the measurement can be made using „LinRun“. Starting from „TI Start“, the integration time is shortened always by the „Factor“, and the constant luminance is measured. The diagram shows the deviation from the first measured value. The maximum of the deviations is called parameter „f3“.

16.1.5 Example 3: Glare evaluation according to the UGR method

For this example application, the Excel file „LMK4AxServerUGR.xls“ is used. You can find it in the subdirectory „Examples“ in your Lmk LabSoft installation. With this example of the glare evaluation of interiors according to the UGR method, some functions for manipulating image data and reading out statistical measuring data of the ActiveX-server interface are presented.

For the evaluation of glare situations according to the UGR method, a number of various steps are necessary to obtain the measuring data for the UGR calculation formula. This formula reads:

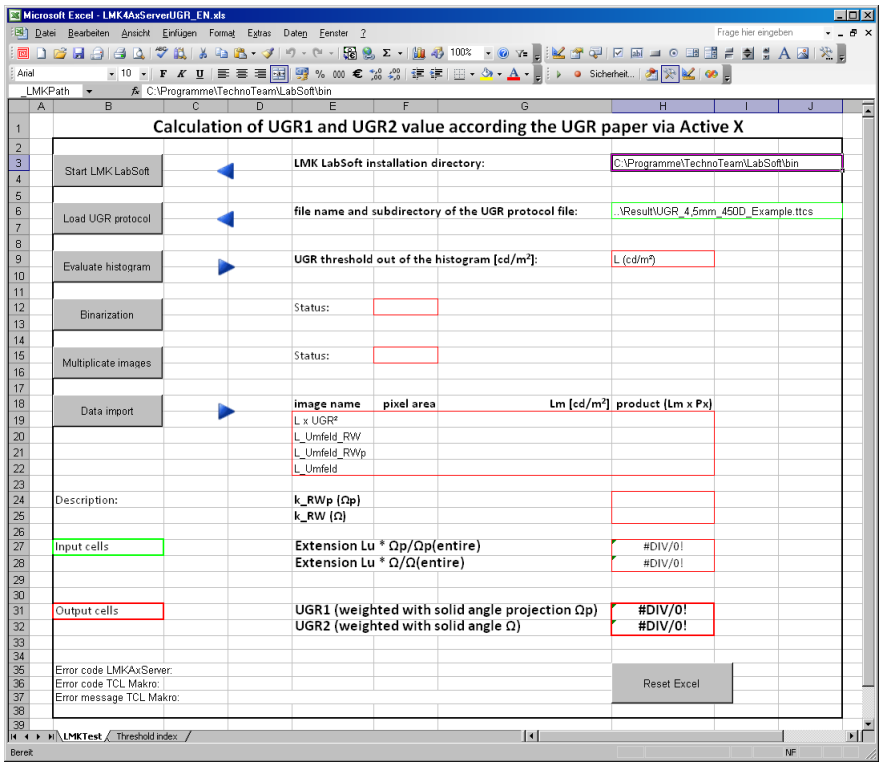
$$UGR = 8 \cdot \log\left(\frac{0{,}25}{L_u} \cdot \sum_i \frac{L_i^2 \cdot \omega_i}{p_i^2}\right)$$

It requires the measurement and determination of photometric and appertaining geometrical quantities:

- mean luminance in the surrounds
- mean luminance of the glare sources
- solid angle at which the glare sources are seen
- position index according to Guth (results from the elevation angle according to table)

Procedure:

1. Starting the Excel worksheet „LMK4AxServerUGR.xls“



2. Calling and starting the LMK LabSoft from this Excel sheet

To do so, the button „Start LMK LabSoft“ in the worksheet must be pressed. The appertaining Visual Basic Source Text:

```
Public Sub OpenLMK()
    Set LMK = New LMKAxServer
    rc = 1
    rc = LMK.iOpen
    If rc = 0 Then
        isLMKOpen = True
    Else
        isLMKOpen = False
    End If
```

3. Loading the protocol

The subdirectory „Examples“ of the Lmk-installation contains the two example protocols „UGR 3.5mm 350D Example.ttcs“ and „ÜGR 4.5mm 450D Example.ttcs“. Before loading a protocol, the path name must be adapted in the Excel sheet accordingly.

```
sLMKProtocol=Worksheets("LMKTest").Range("_LMKProtocol").Value
rc = LMK.iLoadProtokoll(sLMKProtocol)
If rc <> 0 Then
        GetErrorInformation
End If
```

After pressing the button „Load UGR protocol“, the following Visual Basic Source Text is executed:

In the two example protocol files, some calculations are already prepared in the images and the statistical evaluations. Thus, it is possible to refer to the image, statistics and region numbers used there using the following function calls.

4. Loading or capturing the images to be evaluated

The two example protocols are prepared for the use of the cameras Canon D350 and Canon D450. If any images captured are to be evaluated using these cameras, then the example protocol which fits well this camera type must be used. For using an image, it must be loaded into the luminance image via the menu item „Capture | Canon files“.

5. Copying the data of the gray value histogram statistic of the luminance image into the Excel worksheet „Threshold determination“

For this, the button „Evaluate histogram“ in the worksheet must be pressed, which entails the execution of the following Visual Basic Source Text:

```
iObject = 0
rc=LMK.iGetGreyHistogramValues(iObject,irSize,srlX,srlValues)
Worksheets("LMKTest").Range("_RC").Value = rc
If rc <> 0 Then
      GetErrorInformation
End If
```

In the Excel worksheet, a threshold is determined from the data of the histogram statistics. This value separates the glare luminances from the surrounding brightness, and is necessary for making the next steps.

6. Preparing the separation of the luminous glare sources

For preparing the separation of the luminous glare sources from the measuring image data, so-called masks in the form of images must be generated. For this, the corresponding image processing operations „Binarization“ and „Negation“ are called using the TCL command interpreter, and the result data are saved in two predefined evaluation images.

A TCL command is called using the following function:

```
iExecTclCommand(qCommand, iReturn, qValue)
```

For this, however, the TCL class module must explicitly be named before, and also the error variable must globally be defined:

```
'calling the TCL-class modul
qCommand = "source " + Chr(34) + Chr(36)
        + "ModulePath/ttip.module" + Chr(34)
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

'global definition of TCL-error variable
qCommand = "set Error " + Chr(34) + Chr(34)
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue
```

When pressing the button „Binarization“ in the worksheet, the following Visual Basic Source Text is executed:

```
'running the Binarization according the UGR threshold
qCommand = Worksheets("Schwellwertbestimmung")
        .Range("_UGR_Schwelle").Value
qCommand = "::ttIP::Binarization {Binarisierung_HistoSchw.}
        {_LUMPIC_} {" + qCommand + "}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

'running the Negation of the Binarization
qCommand = "::ttIP::Negation {NegBinarisierung_HistoSchw.}
        {Binarisierung_HistoSchw.}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue
If iReturn = 0 Then
        Worksheets("LMKTest").Range("_Bin_Stat").Value = "Ok"
Else
        Worksheets("LMKTest").Range("_Bin_Stat").Value="Fehler"
End If
```

7. Separating the luminous glare sources

The actual separation of the luminous glare sources from the measuring image data is now effected by multiplying the mask images with the measuring image within the LMK LabSoft program. The result images are saved in specially provided evaluation images. In the last section of the source text, the surface-related weighting of the background luminance with the solid angle or also the solid angle projection per pixel is carried out additionally.

By pressing the button „Multiplication“ in the worksheet, the following Visual Basic Source Text is executed:

```
'separating the light sources from the ambient
qCommand = "::ttIP::MulImgImg {Leuchten_sep.} {_LUMPIC_}
        {Binarisierung_HistoSchw.}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

'squaring the light sources
qCommand = "::ttIP::MulImgImg {Leuchten2_sep.(temp)}
        {Leuchten_sep.} {Leuchten_sep.}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

'UGR weighting of the light sources
qCommand = "::ttIP::MulImgImg {L2 x UGR} {Leuchten2_sep.(temp)}
        {UGR}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

'separating the ambient from the light sources
qCommand = "::ttIP::MulImgImg {L_Umfeld_sep.} {_LUMPIC_}
        {NegBinarisierung_HistoSchw.}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

'solid angle weighting of the ambient
qCommand = "::ttIP::MulImgImg {L_Umfeld_RW} {L_Umfeld_sep.}
        {k_RW}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

'solid angle projection weighting of the ambient
qCommand = "::ttIP::MulImgImg {L_Umfeld_RWp} {L_Umfeld_sep.}
        {k_RWp}"
rc = LMK.iExecTclCommand(qCommand, iReturn, qValue)
Worksheets("LMKTest").Range("_ETC_RETURN").Value = iReturn
Worksheets("LMKTest").Range("_ETC_VALUE").Value = qValue

If iReturn = 0 Then
        Worksheets("LMKTest").Range("_Mul_Stat").Value = "Ok"
Else
```

```
        Worksheets("LMKTest").Range("_Mul_Stat").Value = "Fehler"
End If
```

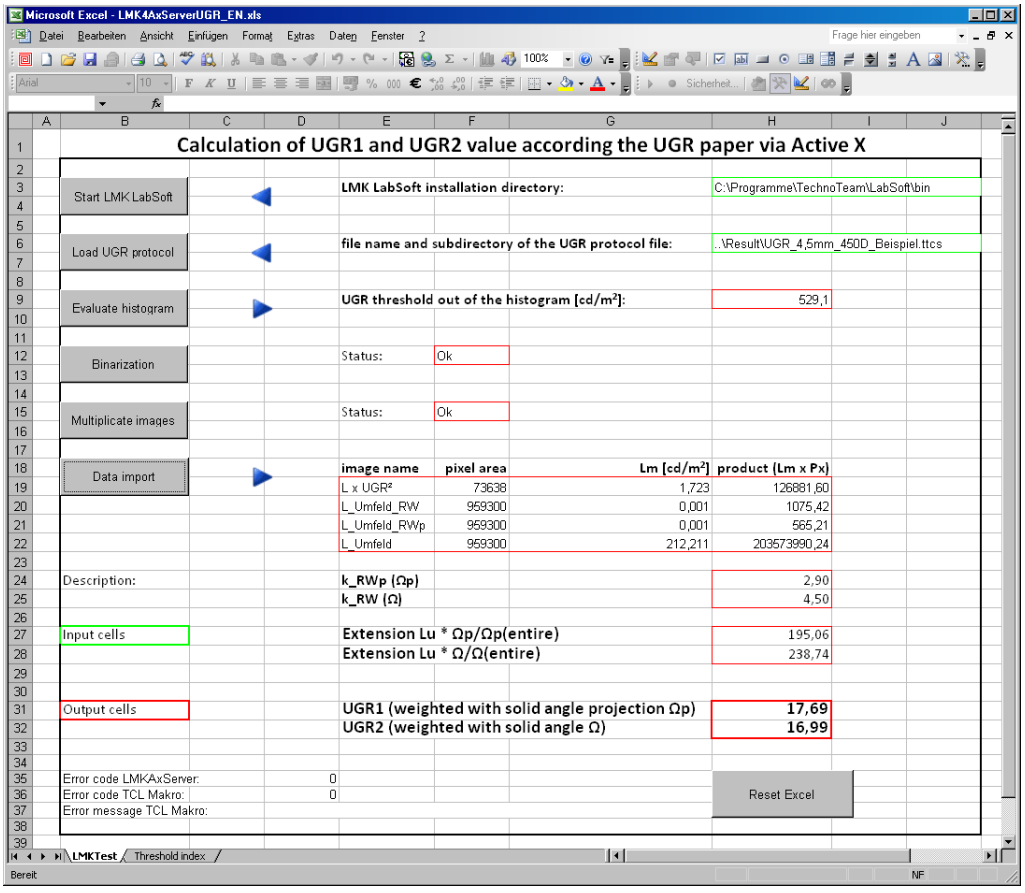
8. Adopting the measurement values

After having carried out steps 4 to 7, the results are available in the luminance object statistic contained in the program. This statistic can now be adopted directly into the Excel worksheet „LMKTest“. Then, the UGR value is calculated from these data according to the UGP method, and displayed in the worksheet.

After pressing the button „Import data“, the following Visual Basic Source Text is executed:

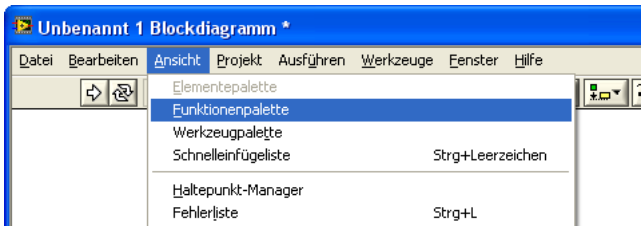
```
rc = LMK.iGetStandardStatistic(iStatistic, iObject, iClass,
        iSize, dMin, dMax, dMean, dVar)
If rc <> 0 Then
        GetErrorInformation
End If
```

The following figure shows the result of the adoption of the calculated values into the Excel sheet:



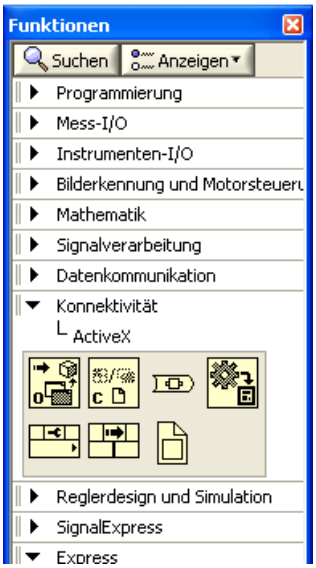
16.1.6 Preparation in NI LabView

After its registration, this interface is also available in "NI LabView". In a block diagram of the current project, an instance of the Lmk-ActiveX-interface can be set up. For doing this, the following menu item must be selected:



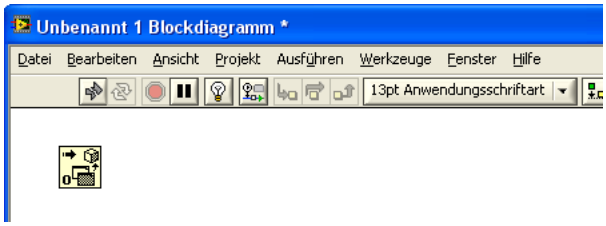
The selection of the menu item opens the tool palette. Here, click on the item „ActivX“ in the folder "Connectivity".

Toolpalette

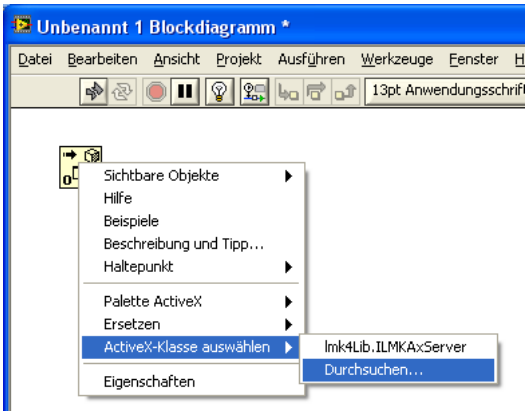


Folder „Connectivity“

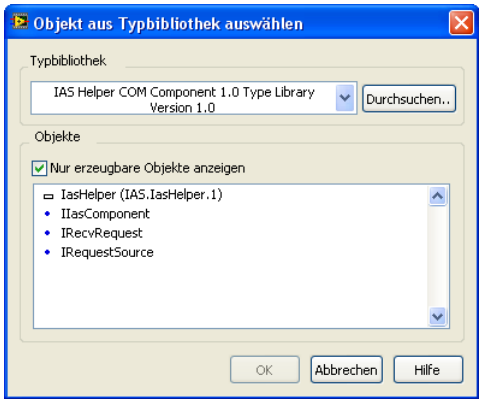
Using the mouse, click on the upper left-hand symbol („Open ActivX object“) and move it to the block diagram using the „Drag and drop“-function.



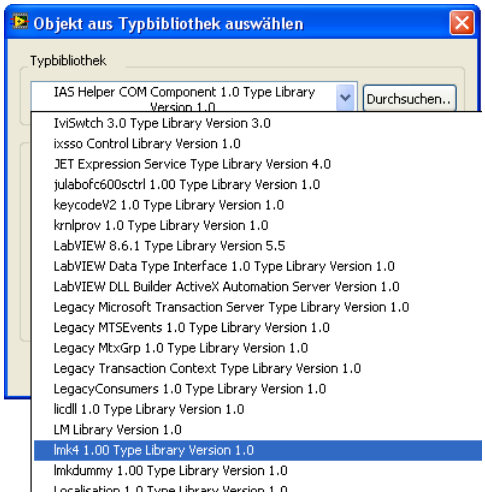
By clicking on the symbol with the right-hand mouse button, the context menu is opened. In order to assign a class to the „Open ActivX Object“-node, select the following entry in this menu:



This opens a dialog in which the type library can be chosen.

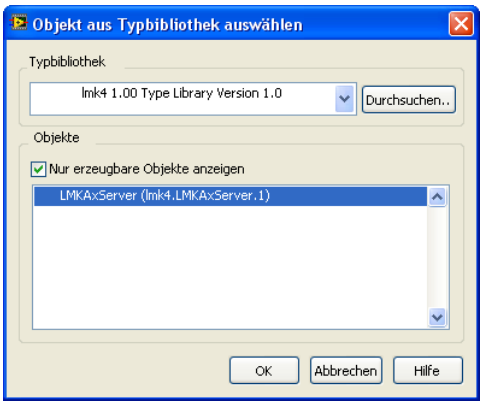


Opened dialog



Selection of type library

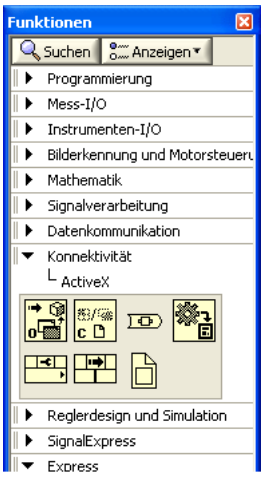
The type library chosen is then displayed in the dialog. In the „Objects“ list, select the entry „LMKAxServer(lmk4.LmkAxServer.1)“ and quit the dialog by clicking on „OK“. The block diagram now displays the new object.



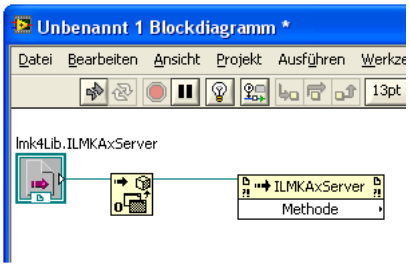
Type library

Block diagram with object

For accessing the methods and features of ActivX-Control, the list already used above must be opened again. Then, a „Method node (ActivX)“ (2nd symbol from the left in the lower row) is moved to the current block diagram by using the „Drag and drop“ function. Afterwards, the output „ActivX(reference) of the Open ActivX object“ symbol is connected with the input „Reference“ of the „Method node (ActivX)“ symbol.

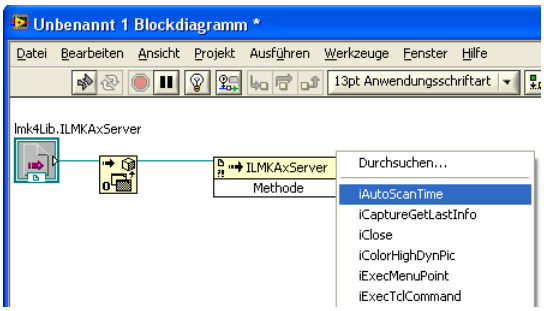


List

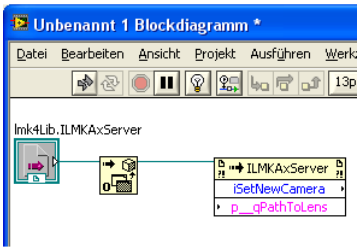


Block diagram

If further methods of an ActivX-instance are to be generated, some more method nodes can be set up. They have to be connected with each other via the „Reference“ inputs and outputs. The method of a node is chosen in the method menu where all available methods are listed. Afterwards, the function arguments are displayed in the form of connecting nodes.



Method menu



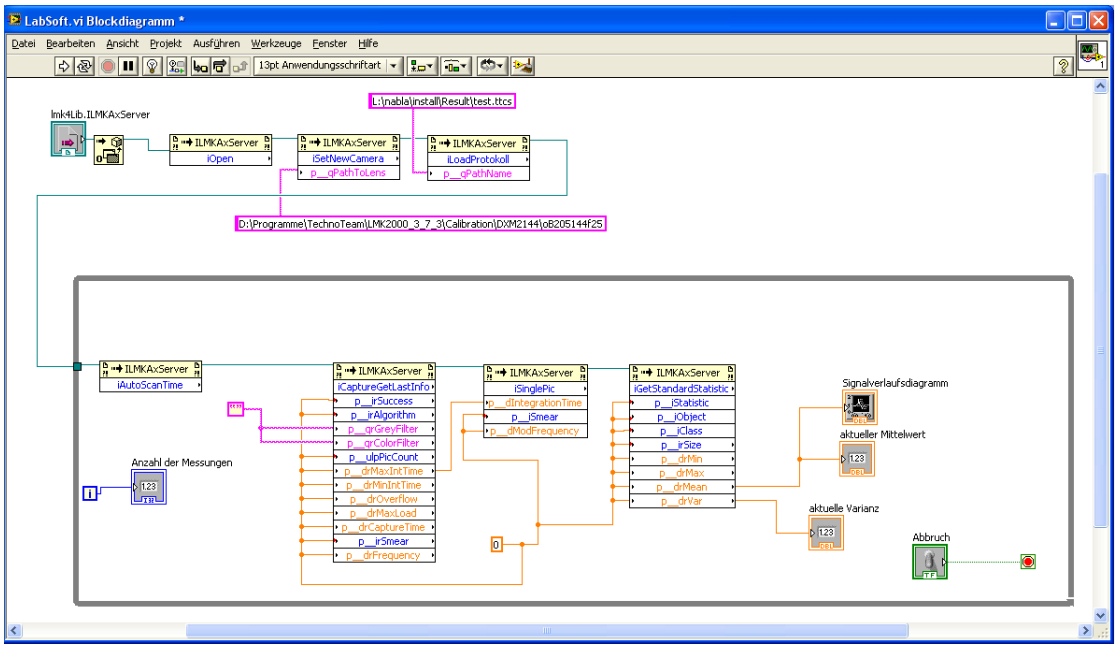
Function arguments

16.1.7 Example 4: Measurement series in LabView

Here, the running-in behavior of a luminance standard shall be measured. You can find the corresponding file „LabSoft.vi“ in the subdirectory „Examples“ of your installation. During measurement, the following procedure must be followed:

- Opening the LMK
- Setting the camera and the lens

- Loading the pre-defined protocol (with a marked region and standard statistics set up)
- Generating endless loop (with abort button)
- Calling up iAutoScanTime()
- Calling up SinglePic()
- Getting the measured value
- Representing the measured value in a time diagram



Block diagram

Front panel

16.2 Tcl as script language

In the program there is a built-in command interpreter based on the open-source-script language Tcl (Tcl is an abbreviation of „Tool command language“). The command interpreter is used in the program in order to allow the recording and playing of macros, see section 13.9 on page 172.

The interpreter allows objects used in the program such as images, regions, coordinate systems, the camera and most of the used algorithms in user-written scripts to be accessed. In the two sections below, some principles of the script language will be presented, its use in software will be shown.

If macros are only to be recorded and used later as self-defined menu items by means of the macro recorder introduced in section 13.9 on page 172, a detailed knowledge of the script language will not be required.

16.2.1 Basics of Tcl

In this section only some language elements used in the program will be presented. For more detailed information and the complete scope of operation of Tcl see the Web links at the end of this section.

A program written in Tcl is composed of commands having their parameters after them. This is called Polish notation. Each line contains exactly one command and its parameters. Example:

```
set a 7
```

„set“ is a command expecting two parameters. „a“ is the name of a variable possibly to be created which the value „7“ is to be assigned to.

```
set b 3
set c [ expr $a +  $b ]
```

There is a second variable „b“ and it is assigned the value „3“. The square brackets in the next line instruct the interpreter to evaluate the term within the brackets. „expr“ is a command for the calculation of numerical expressions, therefore, the following three arguments „$a“, „+“ and „$b“ will be interpreted as numerical expressions. Due to the „$“ characters the values of the variables „a“ and „b“ are used for the calculation. As a result of the evaluation of the term in brackets a number is calculated (a „10“ in the example) and assigned to the variable „c“ by means of the external „set“ command.

```
set d { 3 5 }
```

Character strings in braces form a list. The list is a single argument for the „set“ command which is assigned as a value to the variable „d“. The commands for processing lists are a significant element of the concept of the programming language Tcl because a command and its successive arguments can be seen as a list of character strings.

The „if“ command can be used for conditional branchings expecting two or three parameters. The first parameter is the condition to be checked, the second one is the „then“ branch, the third and optional parameter is the „else“ branch.

```
if { $x > 4 } { set x 0 } { incr x }

if { $x > 4 } then {
        set x 0
} else {
        incr x
}
```

In the first example, the key words „then“ and „else“ have been left. As lists the three parameters had to be included by braces because they contained more than one character string.

The second example is identical to the first one. For clear representation purposes the key words „then“ and „else“ have been written out and the command and its parameters have been distributed over several lines. There, it is necessary that the opening braces are always in the same line as the preceding character string because each command may formally occupy exactly one line.

Analogously to the branching options there are several options of loop formation. One of them is the „for“ command which has four parameters. In the example there are again two different notations:

```
for { set i 1 } { $i < 10 } { incr i } { puts $i }

for { set i 1 } { $i < 10 } { incr i } {
        puts $i
}
```

By the command „proc“ user functions can be defined. An example:

```
proc mult3 { Par1 Par2 Par3 } {
        return [ $Par1 * $Par2 * $Par3 ]
}

set a [ mult3 3 4 5 ]
```

The command „proc“ will expect three parameters. The first one represents the name of the new function, in this example it is „mult3“. The second parameter contains the list of the call parameters, the third one contains the actual definition of the function.

In the subjacent line the new function will be called. The function „mult3“ will multiply the three numbers „3“, „4“ and „5“. The result of the function which has been returned by „return“ will be assigned to the variable „a“ by means of the command 2set“.

Please, contact the web links below for more detailed information:

German Web links

„Einfach Tcl“: http://wiki.tcl.tk/2548
Kommentierte Sprachregeln: http://wiki.tcl.tk/4592
Einführung als PDF: https://www.bg.bib.de/portale/bes/pdf/Einfuehrung_Tcl.pdf
Forum zu Tcl/Tk: http://www.self-tcl.de/
Lernsoftware für Tcl/Tk: http://www.tcl-coach.de/

English Web links

Tcl/Tk main page: http://www.tcl.tk/
Wikibooks: Tcl programming: http://en.wikibooks.org/wiki/Programming:Tcl
Tcl FAQ: http://www.faqs.org/faqs/tcl-faq/
Tcl'ers Wiki & Code examples: http://wiki.tcl.tk/

16.2.2 Using Tcl in LabSoft

For a better understanding of the interpreter operation integrated in the program the concepts below are of great importance:

- When the program is started the interpreter will automatically be extended by some commands allowing program objects such as images, regions, the camera and algorithms to be accessed. An overview of the additional commands will be given at the end of this section.
- If the menu „Macros“ is selected, the subdirectory „Macros“ of the LabSoft installation will be searched for macro files and they will be displayed as independent menu items. The macro files can be created by the user if he makes recordings of his actions by the macro recorder. For recording macros see section 13.9 on page 172.

  It is possible to add self-created macros to the automatically generated ones or to edit existing ones. Therefore, the basic configuration of the macro files will be described in the next section.
- To execute the macros in the macro directory module files are used connecting the macro files and the Tcl commands. These modules are in the subdirectory „Modules“ of the LabSoft installation.

Creating independent or editing existing macro files, modules and Tcl scripts requires a detailed programming knowledge. Before implementing user routines TechnoTeam *should be contacted in order to find a joint optimal solution for the application concerned.*

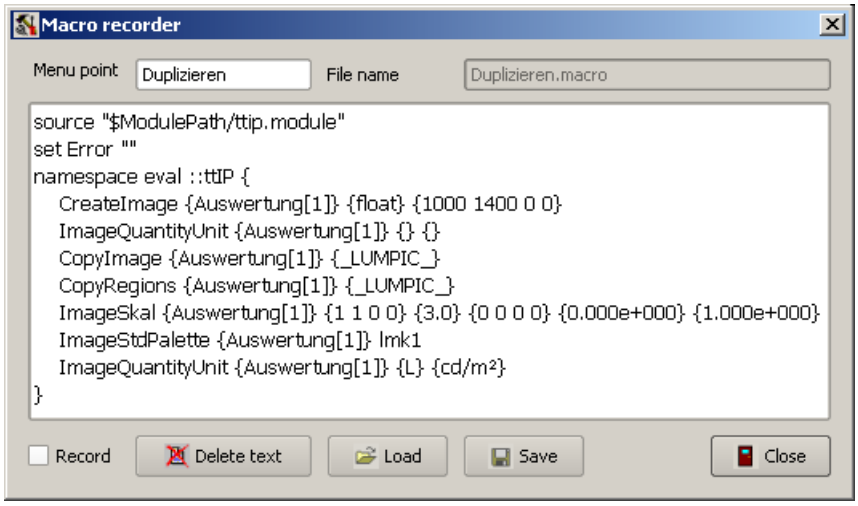
Makros

This is a source text example of a macro file:

```
ï»¿if 0 {
[Macro]
Menu=Duplizieren
}

#Content>
source "$ModulePath/ttip.module"
set Error ""
namespace eval ::ttIP {
        CreateImage {Auswertung[1]} {float} {1000 1400 0 0}
        ImageQuantityUnit {Auswertung[1]} {} {}
        CopyImage {Auswertung[1]} {_LUMPIC_}
        CopyRegions {Auswertung[1]} {_LUMPIC_}
        ImageStdPalette {Auswertung[1]} lmk1
}
#<Content
```

File content



Display in the macro recorder

The file starts with the character string „ï»¿“ which tells the interpreter that the file is UTF8 encoded. All script files are encoded in this way because this makes possible the use of words of any language. For English texts, the UTF8 encoding corresponds to the Ascii character set.

The „if“ command following then is overlooked by the Tcl interpreter as the condition is false (if 0). However, between the opening and the closing brackets it is defined that it is a macro file and the name of the menu item in the example is to be „Duplizieren“.

Between the character strings „#Content>“ and „#<Content“ there is the actual macro text as shown by the macro recorder. Any Tcl commands are allowed here. Therefore,

the macro text may consist of built-in Tcl commands (set Error „“), procedure calls (CreateImage ... ImageStdPalette) and of commands the scope of operation of the TechnoTeam interpreter has been extended by.

New commands

In order to allow objects such as images, regions, statistics, the camera and algorithms to be accessed the scope of operation of Tcl has been extended by self-defined commands. The general syntax of the extension commands is as follows:

```
command subcommand list\_of\_parameters
```

- Command: The name of the new Tcl command. In most cases the command will define an object class.
- Subcommand: In general, the command will be followed by the name of a method of the object class.
- Parameter list: Zero, one or several parameters can follow. The number and the meaning of these parameters will depend on the command and the subcommand.

The example below will illustrate the explanations above:

```
set hImage [ TTIMAGE create float 1400 1000 ]
TTIMAGE readFile $hImage test.pf 1
TTIMAGE delete $hImage
unset hImage
```

In this example, the command „TTIMAGE“ has been used allowing images in scripts to be worked with. Using the subcommand „create“ a new luminance image will be created in the first line having a size of 1000 lines and 1400 columns. The function call will return an instance pointer of the new image as a return value which will be saved in the Tcl variable „hImage“.

In the second line, the content of an existing file „test.pf“ will be loaded into the image „$hImage“ via the subcommand „readFile“.

In the third line, the image „$hImage“ which is no longer needed will be deleted via the subcommand „delete“. As the Tcl variable „hImage“ will not be removed by this call the Tcl command „unset“ is called in the fourth line in order to remove the variable itself.

In the next two tables there is a list of the commands currently implemented and a short description of the objects available in the program. In the first table there are the commands which can also be used indepently of the user interface.

Command	Use
TTIMAGE	Creating, deleting, loading, saving and processing of existing or self-created image.
TTOBJECTLIST	Creating, deleting, loading, saving and processing of existing or self-created region lists.
TTCOORDSYSTEM	Creating, deleting, loading, saving and processing of existing or self-created coordinate systems.
TTOBJSTAT	Creating, deleting, loading, saving and processing of self-created object statistics in images and regions.
TTIMGPROC	Image processing operations such as addition, subtraction etc.
TTPROJEQUAL	Using the projective rectification in scripts.
TTCOORDTRAFO	Using the coordinate transformation in scripts.
TTCOLOR	Different color image algorithms are available.
TTCOLORDIFF	Calculating color differences between images and between an image and a color.
TTIMAGEDIRECTORY	Accessing directories containing some images.

The commands in the second table will access existing objects within the program.

Command	Use
TTLMK4	Accessing the camera, the image capturing methods, the Word and Excel interfaces.
TTDISPLAYIMAGETAB	Accessing the image display windows.
TTDISPLAYIMAGE	Accessing a single image display window, its image content, the regions and the coordinate system used.

The methods implemented as Tcl commands do not provide the complete scope of operation of the total program. The Tcl interface has been completed to only such an extent as necessary for recording and playing the macros. If requested, functions needed may be replenished.

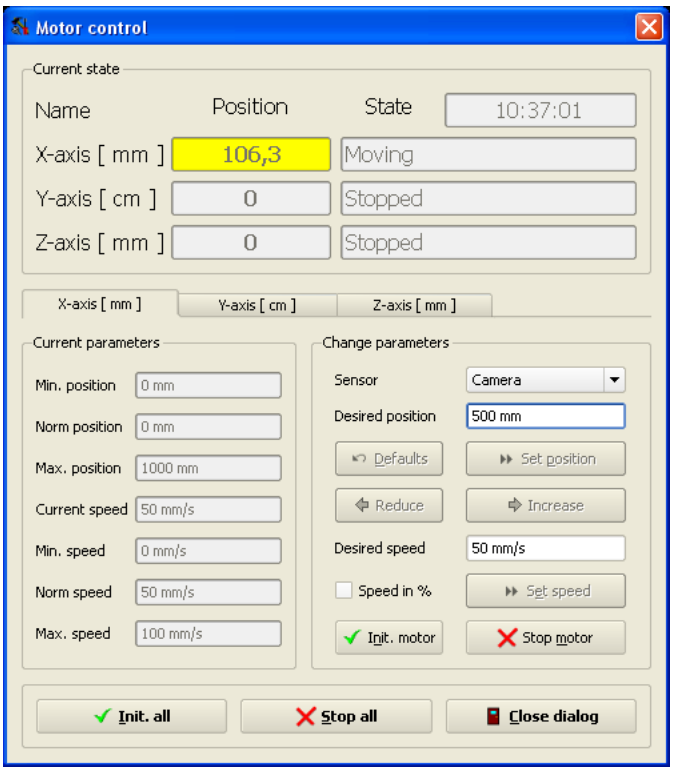
17 Extras

17.1 Motor control

The job of the motor control is to provide the computer-controlled movement of a travelling unit or a goniometer. Depending on the mechanical structure, either the camera or the measuring object can be moved. If the software components necessary for the usage of those mechanics are available, the user will find the menu point „New calibration data“ in the menu „Motors“ after starting the program, to take over the initialization data of the mechanics.

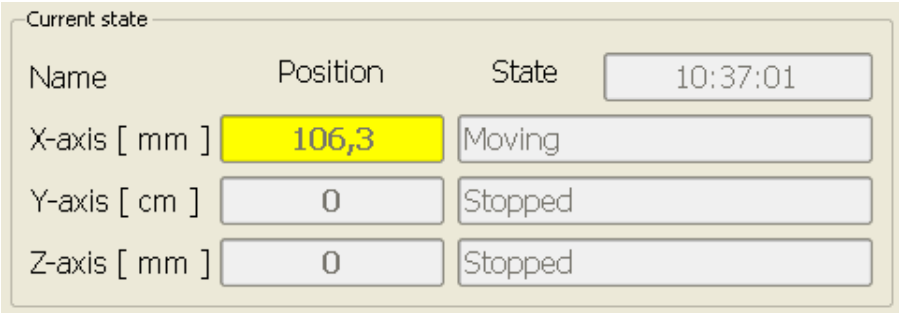
After calling this menu point a dialog is opened to chose the directory with the initialization data of the mechanics. After selecting the directory the files are copied into the program. Afterwards the menu „Motors“ contains one ore more menu points to use a travelling unit or a goniometer.

When selecting a menu item in the menu „Motors“, the dialog „Motor control“ will be opened.

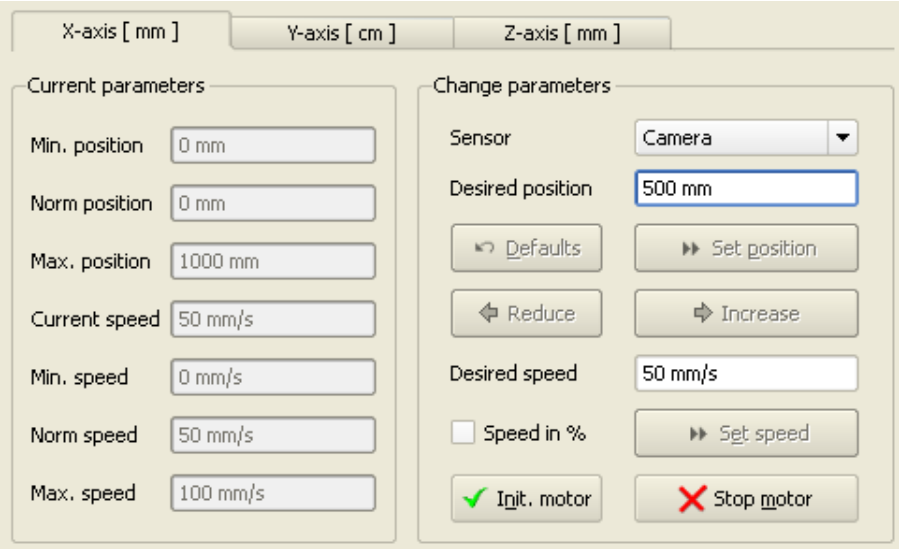


If this dialog is opened for the very first time after starting the program, it is necessary to establish the connection to the mechanism and to initialize it. The easiest way to do this is by pressing the button „INIT. ALL“ in the lower section of the dialog. The button „STOP ALL“ can be found there, too. All axes of the mechanism can be stopped immediately by pressing it.

In the upper section of the dialog, an overview of the states of the available axes, which can be controlled by means of the dialog, is displayed. In the current example, three axes are available, with the „X-AXIS“ being moved right now. The two other axes are standing still.



In the lower section of the dialog, the parameters of the individual axes are displayed on the left-hand side in a tab window. On the right-hand side, options for controlling the axes are offered.



Each axis of the moving unit is characterized by the two limits for possible positions and speeds, by the default values and the currently set values.

On the right-hand side, the current values for the speed at which a certain position is approached just as the position itself can be set:

- If several devices are mounted on the travelling unit, e.g. a photometer or a spectrometer next to the camera, then the selection box „Sensor“ permits the user to select the device which is just being used. This is necessary as the devices are attached to different places and, therefore, have different coordinate systems. For example, the minimum and the maximum positions are slightly different for each device.
- If a position has been entered in the box „Desired position“, the motor control will execute the command upon pressing the input key or the button „Set position“.
- When pressing the button „Default“, the standard speed of the axis is set, and the axis is then moved to the standard position.
- If the button „Reduce“ is kept depressed, the motor control will move the axis towards the „Min. position“ at the currently set speed. There, it will stop either when the button is released or when this position has been reached.
- This procedure is completely analogous when the button „Increase“ is pressed in order to move the axis to „Max. position“.
- If a new value is entered in the box „Desired speed“, this value can be transmitted to the motor control either by pressing the input key or the button „Set speed“.
- The kind of the display and input of a speed depends on the selection of the option „Speed in %“. This option being switched on, all speed values will be displayed in percent referring to the maximum speed.
- The movement of the motor can be stopped by pressing the button „Stop motor“.
- If it turns out to be necessary to initialise again a motor separately from all others, this can be carried out by pressing the button „Init. motor“.

Using the menu item „Close dialog“ a dialog can be quitted. The mechanism will remain active, which means that it can be used immediately again when the dialog is reopened.

Travelling units and goniometers generally contain end-point switches for the protection of the devices against mechanical damages. If positions are reached which activate these switches, with the movement being fully software-controlled, then a malfunction can be assumed as the initialisation data of the software also include end position data. Consequently, the software should allow the travelling unit to approach only those positions which are admitted. Therefore, a new initialisation of the hardware and a restart of the software will have to be carried out after determining and rectifying the causes of reaching the end position, so that the user can go on working.

17.2 Programmpaket „BlackMura“

Mit dem Programmpaket „BlackMura“ wird die Vermessung von Displays unterstützt. Das Paket stellt eine Erweiterung des Funktionsumfangs der „LabSoft“ zur Verfügung. Im Folgenden wird die Kenntnis des Dokuments „BlackMURA_Display_V100.pdf“ (Uniformity measurement standard for Displays) vorausgesetzt und nur auf die Möglichkeiten eingegangen, die das Programmpaket dem Anwender zur Verfügung stellt.

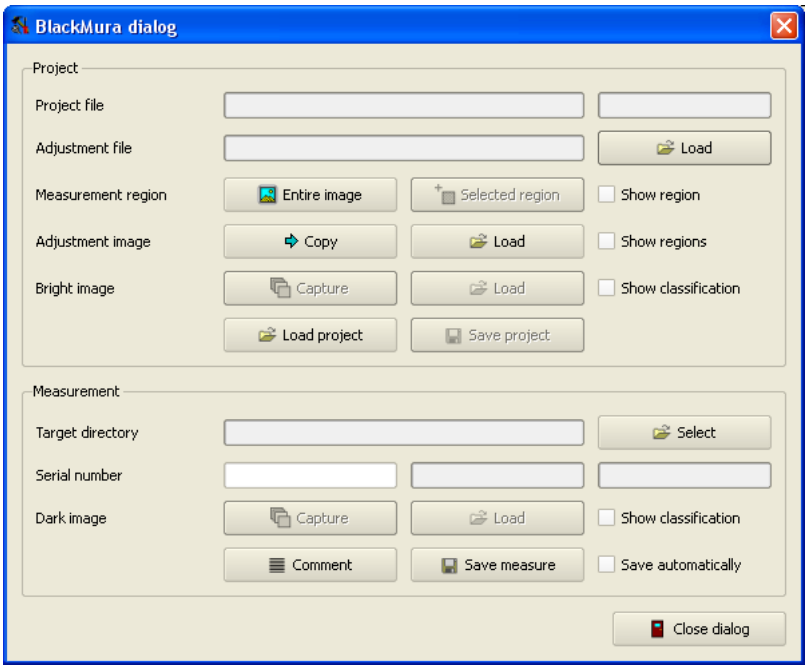
17.2.1 Installation und Aufruf

Zur Einbindung des Pakets ist das Installationsprogramm „14_Lmk_LabSoft_BlackMura_*.exe“ („*“ steht für die Version des Pakets) zu starten. Dieses Programm erwartet vom Benutzer die Angabe des Verzeichnisses einer bereits bestehenden „LabSoft“-Installation, z.B. „C:\Programme\TechnoTeam\LabSoft“.

Beim nächsten Start des Programms steht das Programmpaket in Form des neuen Menüpunkts „Auswertung | BlackMura-Anwendung“ bzw. mit dem Schnellstartknopf BM zur Verfügung. Wählt man diesen Menüpunkt bzw. Knopf aus, werden

- die benötigten Bilder „Einrichtungsbild“, „Helles Bild“, „Dunkles Bild“ und „Gradientenbild“ angelegt, wenn sie noch nicht vorhanden sind,
- ebenso die Tabellen „BlackMura-Parameter“ und „BlackMura-Ergebnisse“.
- der Dialog „BlackMura-Dialog“ geöffnet
- und, wenn möglich, die Daten der letzten Arbeit mit dem Dialog geladen.

Beim ersten Aufruf nach der Installation ist der Dialog leer:



17.2.2 Anlegen einer Projektdatei

Voraussetzung für die lichttechnische Vermessung eines Displays ist, dass der Messplatz mit der Kamera und dem Display bereits eingerichtet ist. Für die geometrische Ausrichtung der beiden Komponenten zueinander und für die Fokussierung des Objektivs auf das Display ist der Dialog „Kameraeinrichtung“ zu verwenden, der im Abschnitt 5.4 ab Seite 54 beschrieben wurde.

Das Ergebnis der Einrichtung der Kamera ist in diesem Dialog mit dem Knopf „Ergebnis speichern“ in eine Datei zu schreiben. Dateien dieses Typs haben die Endung „.car“ (**C**amera **a**djustment **r**esult). Zur Erstellung eines Projekts Im BlackMura-Dialog muss diese Datei mit dem Knopf „Laden“ in der Zeile „Einrichtungsdatei“ geladen werden.

Nach dem Laden dieser Datei werden die relevanten Informationen in der Tabelle „Dark-Mura-Parameter“ angezeigt. Damit die spätere Vermessung eines Displays verwendbare Ergebnisse liefern kann, dürfen die Abweichungen in der Positionierung in horizontaler, vertikaler und axialer Richtung bestimmte Grenzwerte nicht übersteigen. Sind die Abweichungen zu groß, wird das in der Tabelle gelb vermerkt. Weitere Auswirkungen auf den Messablauf hat das aber nicht, man kann also auch mit einem nur ungenau positionierten Display weiterarbeiten.

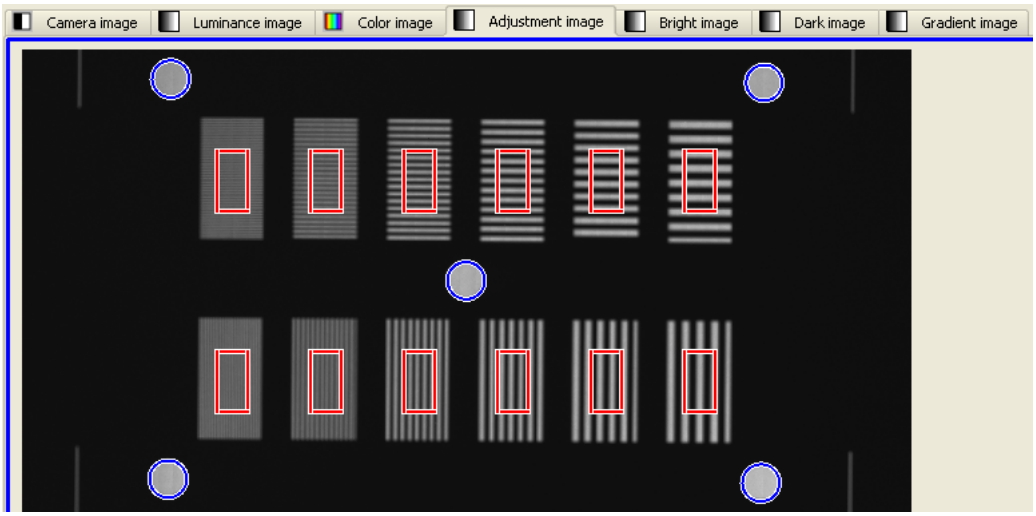
Parameter	Value	Unit
Optical axis X	-0.01956	mm
Optical axis Y	0.2135	mm
Horizontal angle	-0.4805	°
Vertical angle	0.2135	°
Axial angle	0.3802	°
Reproduction scale X	1.892	
Reproduction scale Y	1.893	
Modulation	86.97	%

Parameter sind nicht i.O.

Parameter	Value	Unit
Optical axis X	-0.01956	mm
Optical axis Y	0.2135	mm
Horizontal angle	-0.4805	°
Vertical angle	0.2135	°
Axial angle	0.3802	°
Reproduction scale X	1.892	
Reproduction scale Y	1.893	
Modulation	91.97	%

Parameter sind i.O.

Ist die Kameraeinrichtung unmittelbar zuvor erfolgt, dann befindet sich im Kamerabild noch das Ergebnis der letzten Aufnahme des Templatebildes. Mit dem Knopf „Kopieren“ in der Zeile „Einrichtungsbild“ kann man dieses Bild in das Bild „Einrichtungsbild“ übernehmen.

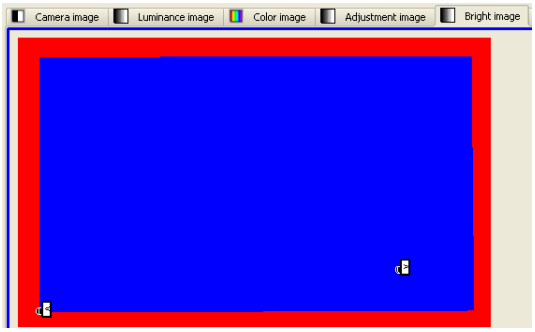


Für die weitere Vermessung ist dieses Bild nicht notwendig, es wird aber später in der Projektdatei gespeichert bzw. von dort geladen, weil es unter Umständen für Dokumentationszwecke sinnvoll ist. Wird zusätzlich die Checkbox „Regionen zeigen“ ausgewählt, dann werden im „Einrichtungsbild“ die 5 gefundenen Kreise zur Bestimmung der geometrischen Lage und die 12 linienhaften Messregionen zur Berechnung der Modulation angezeigt.

Nachdem man das Display hell geschaltet hat, kann man mit dem Knopf „Aufnahme“ in der Zeile „Helles Bild“ eine Aufnahme mit nachfolgender Auswertung starten. Zuerst wird dazu die optimale Belichtungszeit nach dem „Autoscan“-Algorithmus bestimmt und danach mit dem „Multipic“-Algorithmus ein Leuchtdichtebild aufgenommen. Dieses Bild wird in das Bild „Helles Bild“ kopiert, wo die weitere Auswertung erfolgt.

Dort werden die Bildpunkte bestimmt, die zum Display gehören, und in diesem Bildbereich Mittelwert, Minimum und Maximum und die Lage von Minimum und Maximum berechnet. Aus Minimum und Maximum ergibt sich zugleich die Gleichförmigkeit des Displays. Mit dem Knopf „Klassifikation zeigen“ in der Zeile „Helles Bild“ kann man sich zeigen lassen, welche Bildpunkte das Programm dem Display und welche dem Hintergrund zugeordnet hat.

Helles Bild mit Minimum und Maximum



Ergebnis der Bildpunktzuordnung

Gelingt es in einem speziellen Anwendungsfall nicht, die Umgebung des Displays ausreichend dunkel zu gestalten, sodass die optische Trennung des Displays von seinem Hintergrund nicht eindeutig ist, kann man den zu vermessenden Bereich auf eine Bildregion einschränken. Dazu muss man

- im „Leuchtdichtebild“ eine rechteckige Region einzeichnen, die das zu vermessende Display enthält, den störenden Rand aber nicht,
- diese Region markieren und
- im Dialog in der Zeile „Messregion“ den Knopf „Markierte Region“ drücken.
- Danach kann man sich in den Bildern „Einrichtungsbild“, „Helles Bild“, „Dunkles Bild“ und „Gradientenbild“ diese Region anzeigen lassen, indem man die Option „Region anzeigen“ in der Zeile „Messregion“ einschaltet.
- Möchte man zur Arbeitsweise der Auswertung des gesamten Bildes zurückkehren, dann muss man den Knopf „Gesamtes Bild“ in der Zeile „Mesregion“ drücken.

Bei der Speicherung einer Projektdatei werden die Angaben über den zu verwendenden Bildbereich ebenfalls mit vermerkt und für nachfolgende Auswertungen berücksichtigt.

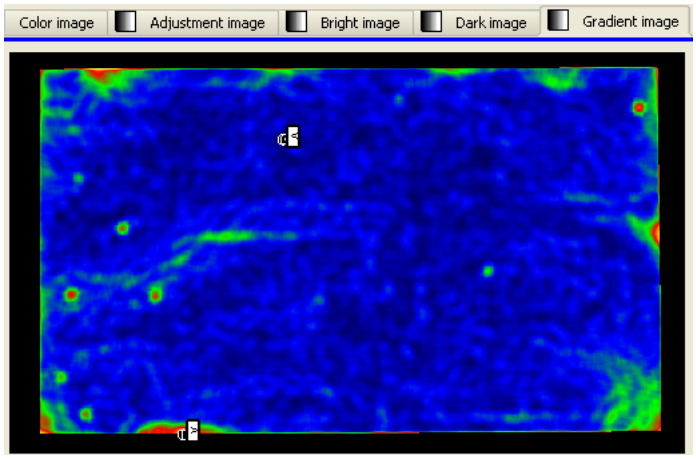
Für eine nachträgliche Auswertung eines bereits aufgenommenen Bildes kann man mit dem Knopf „Laden“ in der Zeile „Helles Bild“ eine gespeicherte Aufnahme aus einer Datei in „Helles Bild“ laden. Danach wird derselbe Algorithmus angewendet, wie er sonst nach der Aufnahme eines Leuchtdichtebildes abläuft.

Die Ergebnisse der Berechnungen für das „Helle Bild“ werden in der Ergebnistabelle angezeigt:

Image	Parameter	Value	Unit
Dark image	Serial number		
Dark image	Mean		
Dark image	Minimum		
Dark image	Maximum		
Dark image	Uniformity		
Gradient image	Maximum		
Bright image	Mean	647.9	cd/m²
Bright image	Minimum	485.4	cd/m²
Bright image	Maximum	714.7	cd/m²
Bright image	Uniformity	67.92	%

Nach der Dunkelschaltung des Displays kann mit dem Knopf „Aufnahme“ in der Zeile „Dunkles Bild“ eine Leuchtdichteaufnahme gestartet werden. Das Ergebnis dieser Aufnahme mit dem „Autoscan“- und dem „Multipic“-Algorithmus wird in das Bild „Dunkles Bild“ kopiert und zuerst derselbe Auswertungsalgorithmus wie für das helle Bild angewendet. D.h. es werden Mittelwert, Minimum und Maximum berechnet, sowie die Lage von Minimum und Maximum und die Gleichförmigkeit.

Danach werden die lokalen Ungleichförmigkeiten in dem aufgenommenen Bild bestimmt und in einem weiteren Bild „Gradientenbild“ dargestellt. Der dabei verwendete Algorithmus wurde in dem Dokument „BlackMURA_Display_V100.pdf“ (Uniformity measurement standard for Displays) beschrieben. In diesem Gradientenbild werden wiederum Minimum und Maximum sowie deren Lagen berechnet und angezeigt. Die Messwerte aus dem dunklen und dem Gradientenbild werden ebenso wie diejenigen des hellen Bildes in die Ergebnistabelle übertragen.



Gradientenbild

Image	Parameter	Value	Unit
Dark image	Serial number	12.34.56	
Dark image	Mean	0.6315	cd/m²
Dark image	Minimum	0.4993	cd/m²
Dark image	Maximum	0.7227	cd/m²
Dark image	Uniformity	69.09	%
Gradient image	Maximum	0.001108	%/Pixel
Bright image	Mean	647.9	cd/m²
Bright image	Minimum	485.4	cd/m²
Bright image	Maximum	714.7	cd/m²
Bright image	Uniformity	67.92	%

Ergebnistabelle

Bevor man eine Projektdatei speichert, kann man mit dem Knopf „Kommentar“ einen erklärenden Text verfassen, der gemeinsam mit den vier Bildern „Einrichtungsbild“, „Dunkles Bild“, „Helles Bild“ und „Gradientenbild“, sowie den Tabellen „Dark-

Mura-Parameter“ und „BlackMura-Ergebnisse“ in der Projektdatei gespeichert wird. Eine Projektdatei wird nach dem Drücken des Knopfs „Projekt sichern“ und der Eingabe eines Dateinamens in einer Datei gespeichert.

Eine zuvor gespeicherte Projektdatei kann mit dem Knopf „Projekt laden“ wieder in das Programm übernommen werden. Dabei wird der Inhalt der vier Bilder „Einrichtungsbild“, „Dunkles Bild“, „Helles Bild“ und „Gradientenbild“, sowie der Tabellen „DarkMura-Parameter“ und „BlackMura-Ergebnisse“ rekonstruiert.

Der wesentliche Sinn einer Projektdatei besteht in der Dokumentation der Parameter, die bei der Einrichtung des Messplatzes für einen bestimmten Displaytyp gewählt wurden, sowie typischer Messergebnisse. Für die eigentliche Vermessung von Displays werden aus den Parametern lediglich die Abbildungsmaßstäbe in beiden Koordinatenrichtungen benötigt (siehe die Tabelle „BlackMura-Parameter“), da aus ihnen sowohl die Messfleckgrößen für die Berechnung der Minima und Maxima und deren Lagen in den verschiedenen Bildern berechnet werden, sowie die Größe des Filters zur Berechnung der Ungleichförmigkeit im Gradientenbild.

17.2.3 Messung und Auswertung

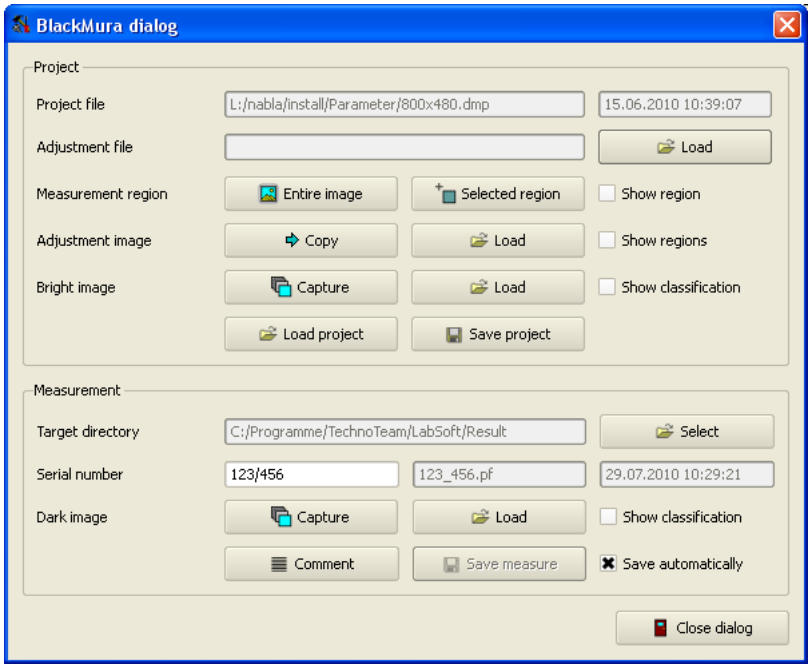
Für die aufeinanderfolgende Vermessung von Displays gibt es die Möglichkeit, die dabei entstehenden Bilder fortlaufend in einem Verzeichnis zu speichern. Zusätzlich wird in diesem Verzeichnis eine Datei mit der Dateiendung „.csv“ (**c**omma **s**eparated **v**alue) angelegt, die alle vom Programm ermittelten Messwerte enthält, um sie in einem externen Programm wie Excel auszuwerten. Die Bilder werden in demselben Format im Verzeichnis gespeichert, wie es auch von den Messreihendialogen verwendet wird. Siehe dazu das Kapitel 6 ab Seite 60.

Nach dem Drücken des Knopfs „Auswählen“ in der Zeile „Zielverzeichnis“ kann man den Namen eines bestehenden Verzeichnisses angeben oder ein neues anlegen. Unmittelbar danach wird in diesem Verzeichnis eine Datei mit dem Namen „BlackMura.csv“ erzeugt, die alle Messergebnisse nachfolgender Messungen aufnehmen wird.

Nach dem Drücken des Knopfs „Aufnahme“ in der Zeile „Dunkles Bild“ wird eine neue Leuchtdichteaufnahme gemacht, das Ergebnis in das Bild „Dunkles Bild“ kopiert, ausgewertet und im Anschluss ebenfalls das „Gradientenbild“ berechnet und ausgewertet.

Mit dem Drücken des Knopfes „Bild speichern“ wird das „Dunkle Bild“ in das angegebene Verzeichnis gespeichert und die Datei „BlackMura.csv“ um eine Zeile mit den Messwerten dieses Bildes ergänzt. Ist im Feld „Seriennummer“ keine Eintragung vorhanden, wird der Dateiname des Bildes automatisch aus Datum und Uhrzeit gebildet, ansonsten wird die angegebene Seriennummer dafür verwendet. Durch die Auswahl der Option „Automatisch speichern“ kann man ein Bildspeichern nach jeder Aufnahme ohne Drücken des Knopfes „Bild speichern“ erzwingen.

Gibt es zum Zeitpunkt des Speicherns einen Kommentar, den man nach dem Drücken des Knopfes „Kommentar“ eingeben konnte, dann wird dieser in einer zusätzlichen Html-Datei ebenfalls mit dem gleichen Namensstamm wie das Bild im Verzeichnis gespeichert.



Dialog nach dem Speichern einer Aufnahme

Das Format der Datei „BlackMura.csv“ ist selbsterklärend. Die Werte einer Messung sind durch Semikolons voneinander getrennt, jede Messung steht in einer separaten Zeile. Die erste Zeile enthält die Namen der Werte der betreffenden Spalte. Enthalten sind sowohl die Messwerte des dunklen Bildes als auch die des Ergebnisbildes als auch die des hellen Bildes.

Name	Größe	Geändert am
123.pf	5.657 KB	11.06.2010 10:37
123.pf.ini	3 KB	11.06.2010 10:37
123_456.pf	5.657 KB	11.06.2010 10:37
123_456.pf.ini	3 KB	11.06.2010 10:37
123_457.pf	5.657 KB	11.06.2010 10:43
123_457.pf.ini	3 KB	11.06.2010 10:43
123_458.pf	5.657 KB	11.06.2010 10:43
123_458.pf.ini	3 KB	11.06.2010 10:43
123_459.html	1 KB	11.06.2010 10:53
123_459.pf	5.657 KB	11.06.2010 10:53
123_459.pf.ini	3 KB	11.06.2010 10:53
DarkMura.csv	3 KB	11.06.2010 10:53

Inhalt eines Verzeichnisses

	A	E	F	G	
1	FileName	DarkMean	DarkMin	DarkMinX	Dark
2	20100610-101249-995.pf	658.263	591.873	1223	
3	20100610-101259-739.pf	720.438	647.373	1222	
4	20100610-101308-699.pf	721.874	648.572	1223	
5	20100610-101320-387.pf	721.874	648.572	1223	
6	20100610-101329-251.pf	723.941	651.093	1223	
7	20100610-101552-409.pf	785.365	700.612	1223	

BlackMura.csv in Excel dargestellt

18 Formats

In this chapter the data formats will be described which can be of some interest with respect to data exchange with other programs. Data formats which are only used in the LabSoft program will not be documented here.

18.1 Images

Images can be saved and read in different formats. In the list below they are sorted according to their file endings the program suggests for saving:

Camera images

For camera images with a pixel resolution of 10 or 12 bits the formats available are:

- *.PUS The abbreviation „PUS“ stands for „PICTURE UNSIGNED SHORT“. This format is a very simply configured binary format developed by TechnoTeam which will be described in section 18.1.1 on page 221.
- *.TIX This data format has been developed by TechnoTeam for internal use, it is based on the Tiff standard.
- *.TXT This format is a simply configured text format developed by TechnoTeam which will be described in section 18.1.2 on page 222.
- *.TIF Some images can be read which have been saved as Tiff images. Since the Tiff format supports many different versions, only those Tiff images can be loaded whose Tiff tags meet the following conditions:
  - BitsPerSample = 16
  - SamplesPerPixel = 1
  - Compression = No compression
- *.B16 These files are images which exist in the PCO image data format for 12Bit images.

Luminance image and monochrome evaluation images

- *.PF The abbreviation „PF“ stands for „PICTURE FLOAT“. This format is a simply configured binary format developed by TechnoTeam which will be described in section 18.1.1 on page 221.
- *.TIX This data format has been developed by TechnoTeam for internal use and is based on the Tiff standard.

- *.TXT This format is a simply configured text format developed by TechnoTeam which will be described in section 18.1.2 on page 222. Images in this format can be saved by the menu item „IMAGE | SAVE AS“ and reloaded into the program via „IMAGE | LOAD“.

  Additionally, the menu item „IMAGE | EXPORT IMAGE TO TEXT FILE“ offers another option of transferring image contents into text files. This export option has been documented in section 8.6.3 on page 91. A description of this format can be found in section 18.1.4 on page 224.

Color image and colored evaluation images

- *.PCF The abbreviation „PCF“ stands for „PICTURE COLOR FLOAT“. It is a simply configured binary format developed by TechnoTeam which will be described in the next section.
- *.TXT This simply configured text format has been developed by TechnoTeam and will be described in section 18.1.2 on page 222. In this format, color images are saved in the color space RGB.
- *.COS The abbreviation „COS“ stands for „COLOR SPACE“. It is a text format developed by TechnoTeam. In contrast to image files in Txt format which are always saved in the RGB color space, the saving operation here is performed in the color space which is set in the image display for this image.

  Not all the images of this type can be loaded again, for this the option of backward conversion from the corresponding color space to RGB is required. Therefore, the main application of this format is the image export to other color information processing programs. The format will be described in section 18.1.3 on page 223.

18.1.1 Binary formats *.pus, *.pf, *.pcf

These images consist of a header and the image content.

Header

The header is a zero terminated string according to the C standard. The entries into the header are separated from each other by 0x0D 0x0A. A program which is capable of reading-in images of this type has to evaluate the five entries below:

```
Typ=Pic98::TPlane<float>
Lines=1000
Columns=1400
FirstLine=3
FirstColumn=8
```

Camera, luminance and color images are different from each other by their type entries:

- Camera images *.pus: Typ=Pic98::TPlane<unsigned short>
- Luminance images *.pf: Typ=Pic98::TPlane<float>
- Color images *.pcf: Typ=Pic98::TPlane<Pic98::TRGBFloatPixel>

A read routine can ignore this type entry as the file content is distinctly characterized by the file ending.

All the other data in the header is of no importance for an external reading program. If an image is created in this format which is then to be read by the Lmk LabSoft, these entries can be neglected.

Image content

The image content begins directly after the header which is terminated by a single zero byte. The pixels follow successively line by line. The pixel interpretation is dependent on the type:

- Camera images *.pus: Two bytes per pixel in the format „unsigned short“.
- Luminance images *.pf: Four bytes per pixel in the format „float“.
- Color images *.pcf: Twelve bytes per pixel. 3 „Float“ values each for the three colors. The chromaticity values in the file are in the order of blue - green - read.

Based on the image size shown in the header and the number of bytes per pixel the reading program can determine the number of bytes which follow the header. That means for the example above: number of bytes = lines * columns * 2 = 2800000.

„FirstLine“ and „FirstColumn“ are of no importance for the reading-in process of the image content. The shift of the origin of the coordinates has only to be taken into consideration if the image content has to be put into relation to a coordinate system and if, for instance, measuring regions have also to be exported to and used in a different program.

18.1.2 Text format *.txt

An example of an image saved in text format:

```
float
204             383             369             499
3.659068e+002   3.676931e+002   3.694770e+002   ...
3.675441e+002   3.693331e+002   3.711197e+002   ...
3.691783e+002   3.709700e+002   3.727594e+002   ...
...
```

The image type is encoded in the first line:

- Camera images: *ushort*
- Luminance images: *float*
- Color images: *rgbfloat*

In the second line the image size is displayed: „FirstLine LastLine FirstColumn LastColumn“. Based on this data the image size can be determined.

Then, starting in line three, the image content follows line by line. Successive pixels of a line are separated from each other by tabulators. The decimal separator depends on the language settings in the operating system. In German-speaking countries a comma is used whereas in a lot of other countries it is the point.

In color images, the three chromaticity values of a pixel in the color space RGB are one after the other. The order of the colors is red - green - blue.

18.1.3 Color image format *.cos

In the previous section a text format for color images has already been introduced. The pixels in these files are always in the RGB format. By means of the cos format images can be saved in the color space in which they are displayed in the program. This option makes sense when the chromaticity values are to be imported into another program. It is not possible to read-in all files in this format as some color spaces are not invertible.

An example file in this format:

```
"ColorSpace"  "L*a*b*"
"RefColor"    "XYZ"     966.3099  1036.17    1689.5899
rgbfloat
8             1039      4         1382
23.848354     118.4457  -26.4505  23.838926  120.026550  ...
23.984262     120.0575  -26.7038  24.087620  119.872787  ...
24.167095     119.6843  -26.7634  24.273176  119.389404  ...
24.316652     119.4463  -26.7805  24.269077  119.919891  ...
...
```

In the first line, the color space is shown after the key word ”ColorSpaceïn which the pixels have been saved in the file. In the example it is the color space $L^*a^*b^*$. In the second line the reference color of the color space is shown after the key word „RefColor“. It consists of the name of the color space of the reference color and the three chromaticity values belonging to it. In the example the chromaticity values of the reference color are in the color space XYZ.

From the third line on, the file configuration corresponds to that of a color image saved in the Txt format. The pixel values, however, are in the color space which is defined in the first line of the file. In the example it is the color space $L^*a^*b^*$.

18.1.4 Export of images in a text format with a coordinate system

In section 8.6.3 on page 91 a method has been described showing how to export image data in a predefined raster in a coordinate system to a text file. The data format generated depends on the parameters used during the export and on the type of the image. Examples of data exports:

Output as list

- Headers with name and unit: off
- Output of coordinates: off
- Use of image coordinate system: off

Black-and-white image: One value of a pixel per image line

```
9.452e+001
8.867e+001
8.479e+001
8.259e+001
8.192e+001
...
```

Color image: One pixel with three chromaticity values per line (in color space Lxy here)

```
1.019e+002  5.832e-001  3.837e-001
1.621e+002  6.108e-001  3.692e-001
6.030e+002  6.513e-001  3.440e-001
1.131e+003  6.069e-001  3.891e-001
1.459e+003  6.005e-001  3.973e-001
...
```

Output as array

- Header with name and unit: off
- Output of coordinates: off
- Use of image coordinate system: off

Black-and-white image: All image pixels of a line per line

```
8.388e+001  8.413e+001  ...
8.233e+001  8.257e+001  ...
8.125e+001  8.149e+001  ...
8.062e+001  8.086e+001  ...
8.042e+001  8.066e+001  ...
...
```

Color image: All image pixels of a line per line, three chromaticity values side by side per pixel

```
1.01e+02  5.83e-01  3.83e-01  1.79e+03  6.39e-01  3.59e-01  ...
9.60e+01  6.36e-01  3.32e-01  1.90e+03  6.49e-01  3.46e-01  ...
1.10e+02  6.11e-01  3.72e-01  1.16e+03  6.17e-01  3.78e-01  ...
1.18e+02  5.74e-01  3.96e-01  6.87e+02  6.61e-01  3.33e-01  ...
1.25e+02  6.07e-01  3.62e-01  1.77e+03  6.10e-01  3.86e-01  ...
...
```

Output as list

- Headers with name and unit: on
- Output of coordinates: on
- Use of image coordinate system: on

Color image: One pixel per line, first its coordinates (X, Y), then the chromaticity values (L, x, y)

```
Y           X           L           x           y
Pixel       Pixel       cd/m2
4.000e+000  7.340e+001  1.621e+002  6.108e-001  3.692e-001
4.000e+000  1.468e+002  6.030e+002  6.513e-001  3.440e-001
4.000e+000  2.202e+002  1.131e+003  6.069e-001  3.891e-001
4.000e+000  2.936e+002  1.459e+003  6.005e-001  3.973e-001
4.000e+000  3.670e+002  2.127e+003  6.176e-001  3.802e-001
...
```

Output as array

- Header with name and unit: on
- Output of coordinates: on
- Use of image coordinate system: on

Black-and-white image: The coordinates are beyond the array

```
            I           I           I
            cd          cd          cd
            1.000e+001  0.000e+000  -1.000e+001  ...
8.042e+001  8.577e+001  8.192e+001  8.577e+001   ...
8.285e+001  8.418e+001  8.040e+001  8.418e+001   ...
8.527e+001  8.308e+001  7.935e+001  8.308e+001   ...
8.770e+001  8.243e+001  7.873e+001  8.243e+001   ...
9.012e+001  8.223e+001  7.854e+001  8.223e+001   ...
...
```

18.2 Region lists

Region lists can be saved by the menu command „Regions | Save as“ and loaded again via „”Regions | Load“”. When loading the regions read can be appended to the ones already existing or the existing ones can be overwritten.

The file formats available are:

- *.csv This file format has been developed by TechnoTeam for internal use.
- *.txt This text format is especially simple and can be used to exchange region lists with other programs. The configuration of this format will be described now.

An example for a file in Txt format:

```
RegionList
4
Rectangle   11   22   33   44
Line        100  100  100  200
Circle      55   66   27
Polygon     3    111  121  111  133  122  133
```

The first line contains the key word „RegionList“, the second one the number of regions. The parameters of each region are saved on a line of their own. The region types are shown at the beginning of each line as a character string. There are four types available and they are followed by the parameters of the corresponding region:

- Rectangle: The key word for a rectangle is followed by the four coordinates x_1, y_1 for the top left-hand corner and x_2, y_2 for the bottom right-hand corner.
- Line: The key word has to be followed by the coordinates of the two end points.
- Circle: A circle is defined by its center point x, y and the radius.
- Polygon: The first parameter of a polygon is the number of corners. It is followed by a list with the xy values of these corners.

18.3 Measuring value tables

Using the menu item „Tabble | Save as“ a measuring value table can be saved as a text file or a bitmap file. In both cases, only the currently visible columns are exported. Reading-in the saved tables in the program again will not be possible.

An example of a measuring value table:

Stat.Nr.	Bild	Region	Mittelwert	Streuung
1	Leuchtdichtebild	1	76.14	32.36
2	Leuchtdichtebild	2	206.6	225.9
3	Leuchtdichtebild	3	283.2	50.72
4	Leuchtdichtebild	4	176.8	40.97
5	Leuchtdichtebild	5	112.2	11.15

A tab character will be used as a column separator.

As in the whole program, the type of the decimal separator will depend on the national default settings of the operating system. In German-speaking countries a comma is used, whereas a point is used in a lot of other countries. When the program is started the corresponding values are taken from the operating system.

19 Color metric

19.1 Color spaces

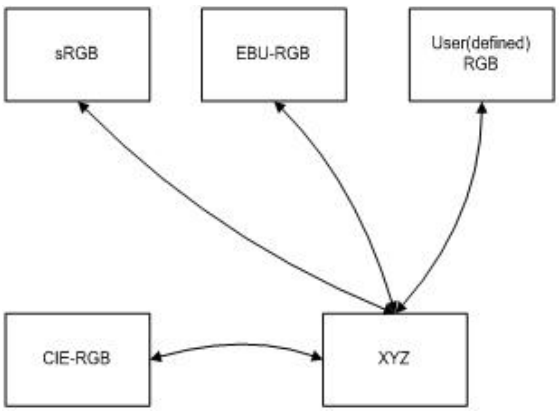
Generally speaking, the color spaces presented in the following relate to different possibilities of displaying the color components of one and the same image in different ways. Therefore, the possible change-over to another color space provided by the program, for example using the menu item „Image | Color space“ or when calculating the color differences (menu item „Color | Color differences“) exerts an influence only on the display of the measuring results, but not on the contents of the images.

The color camera makes the images available in the XYZ color space. Therefore, the connections between the single color spaces are represented in the following graphs always starting from XYZ. For ensuring better openness, the implemented color spaces are arranged in groups in the following graphs.

If required, further color spaces can be realized upon request.

19.1.1 CIE-RGB, sRGB, EBU-RGB, User-RGB

The connection between the RGB-color coordinates and the XYZ-color space is realized via a 3x3-matrix multiplication. For the User-RGB-color space, the coeffients can be set by the users themselves. In the case of the other RGB-color spaces, the coeffients are defined by the program.



RGB - XYZ

$$\begin{pmatrix} X \\ Y \\ Z \end{pmatrix} = \begin{bmatrix} X_R & X_G & X_B \\ Y_R & Y_G & Y_B \\ Z_R & Z_G & Z_B \end{bmatrix} \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{bmatrix} R_X & R_Y & R_Z \\ G_X & G_Y & G_Z \\ B_X & B_Y & B_Z \end{bmatrix} \begin{pmatrix} X \\ Y \\ Z \end{pmatrix}$$

CIE-RGB

$$\begin{bmatrix} X_R & X_G & X_B \\ Y_R & Y_G & Y_B \\ Z_R & Z_G & Z_B \end{bmatrix} = \begin{bmatrix} +2.7689 & +1.7518 & +1.1302 \\ +1.0000 & +4.5907 & +0.0601 \\ +0.0000 & +0.0565 & +5.5943 \end{bmatrix}$$

$$\begin{bmatrix} R_X & R_Y & R_Z \\ G_X & G_Y & G_Z \\ B_X & B_Y & B_Z \end{bmatrix} = \begin{bmatrix} +0.4185 & -0.1587 & -0.0828 \\ -0.0912 & +0.2524 & +0.0157 \\ +0.0009 & -0.0026 & +0.1786 \end{bmatrix}$$

sRGB

$$\begin{bmatrix} X_R & X_G & X_B \\ Y_R & Y_G & Y_B \\ Z_R & Z_G & Z_B \end{bmatrix} = \begin{bmatrix} +0.4124 & +0.3576 & +0.1805 \\ +0.2126 & +0.7152 & +0.0722 \\ +0.0193 & +0.1192 & +0.9505 \end{bmatrix}$$

$$\begin{bmatrix} R_X & R_Y & R_Z \\ G_X & G_Y & G_Z \\ B_X & B_Y & B_Z \end{bmatrix} = \begin{bmatrix} +3.2406 & -1.5372 & -0.4986 \\ --0.9689 & +1.8758 & +0.0415 \\ +0.0557 & -0.2040 & +1.0570 \end{bmatrix}$$

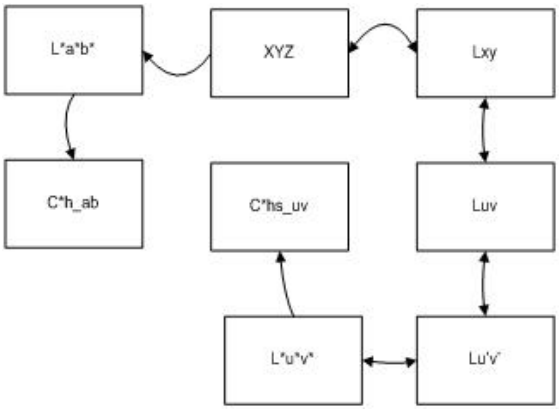
EBU-RGB

$$\begin{bmatrix} X_R & X_G & X_B \\ Y_R & Y_G & Y_B \\ Z_R & Z_G & Z_B \end{bmatrix} = \begin{bmatrix} +0.431 & +0.342 & +0.178 \\ +0.222 & +0.707 & +0.071 \\ +0.020 & +0.130 & +0.939 \end{bmatrix}$$

$$\begin{bmatrix} R_X & R_Y & R_Z \\ G_X & G_Y & G_Z \\ B_X & B_Y & B_Z \end{bmatrix} = \begin{bmatrix} +3.0596 & -1.3927 & -0.4747 \\ -0.9676 & +1.8748 & +0.0417 \\ +0.0688 & -0.2299 & +1.0693 \end{bmatrix}$$

19.1.2 Lxy, Luv, Lu'v', L*u*v*, C*h*s*uv, L*a*b*, C*h*ab

For the color spaces $L^*u^*v^*$ and $L^*a^*b^*$, a reference color (”‘White point”’) is required. $C^*h^*s^*_{uv}$ is not a color space in the real sense, but only a further conversion from the color space $L^*u^*v^*$. The same is true for $C^*h^*_{ab}$, here, two (!) new color coordinates are calculated from $L^*a^*b^*$.



Lxy=f(XYZ)

$$
\begin{aligned}
N_{XYZ} &= X + Y + Z \quad (Hilfsgroesse) \\
L &= Y \quad (Leuchtdichte) \\
x &= \frac{X}{N_{XYZ}} \\
y &= \frac{Y}{N_{XYZ}} \\
z &= \frac{Z}{N_{XYZ}} \quad (redundant)
\end{aligned}
$$

These equations are only useful if $L = Y > 0$ and $X + Y + Z > 0$.

Luv=f(XYZ)

$$
\begin{aligned}
N_{UV}{}' &= 0.5X + 7.5Y + 1.5Z \\
u &= \frac{2X}{N'_{UV}} \\
v &= \frac{3Y}{N'_{UV}} \\
L &= Y
\end{aligned}
$$

Lu'v'=f(XYZ)

$$
\begin{aligned}
N'_{UV} &= 0.5X + 7.5Y + 1.5Z \\
u' &= \frac{2X}{N'_{UV}} \\
v' &= \frac{4.5Y}{N'_{UV}} \\
L &= Y
\end{aligned}
$$

$L^*u^*v^*$=f(Lu'v')

$$
\begin{aligned}
L^* &= \begin{cases} 116\left(\frac{L}{L_{\mathrm{Ref}}}\right)^{\frac{1}{3}} - 16 & fuer\ \frac{L}{L_{\mathrm{Ref}}} > 0.008856 \\ 903.3\frac{L}{L_{\mathrm{Ref}}} & fuer\ \frac{L}{L_{\mathrm{Ref}}} \leq 0.008856 \end{cases} \\
u^* &= 13(L^*)(u' - u'_{\mathrm{Ref}}) \\
v^* &= 13(L^*)(v' - v'_{\mathrm{Ref}})
\end{aligned}
$$

A reference color is required („White point“), this reference color must be available in Lu'v'.

$C^*h^*s^*_{uv}$

$$
\begin{aligned}
C^* &= \left((u^*)^2 + (v^*)^2\right)^{\frac{1}{2}} \\
h^*_{uv} &= \arctan\left(\frac{v^*}{u^*}\right) \\
s^*_{uv} &= \frac{C^*}{L^*}
\end{aligned}
$$

$L^*a^*b^*$

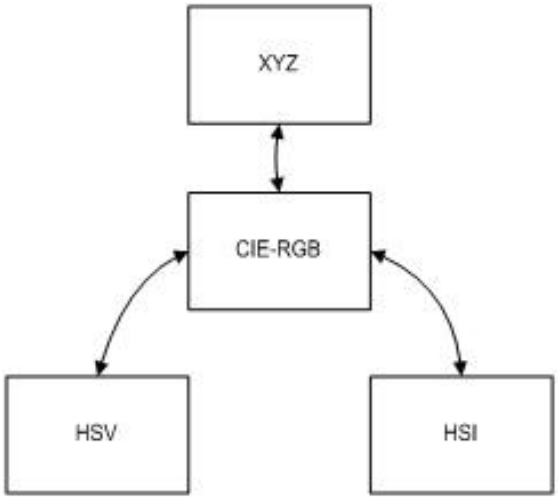
$$
\begin{aligned}
L^* &= \begin{cases} 116\left(\frac{Y}{Y_{\mathrm{Ref}}}\right)^{\frac{1}{3}} - 16 & fuer\ \frac{Y}{Y_{\mathrm{Ref}}} > 0.008856 \\ 903.3\frac{Y}{Y_{\mathrm{Ref}}} & fuer\ \frac{Y}{Y_{\mathrm{Ref}}} \leq 0.008856 \end{cases} \\
a^* &= 500\left(f\left(\frac{X}{X_{\mathrm{Ref}}}\right) - f\left(\frac{Y}{Y_{\mathrm{Ref}}}\right)\right) \\
b^* &= 200\left(f\left(\frac{Y}{Y_{\mathrm{Ref}}}\right) - f\left(\frac{Z}{Z_{\mathrm{Ref}}}\right)\right) \\
mit\ f(t) &= \begin{cases} t^{\frac{1}{3}} & fuer\ t > 0.008856 \\ 7.787 * t + \frac{16}{116} & fuer\ t \leq 0.008856 \end{cases}
\end{aligned}
$$

$C^*h^*_{ab}$

$$
\begin{aligned}
C^* &= \left((a^*)^2 + (b^*)^2\right)^{\frac{1}{2}} \\
h_{ab} &= \arctan\left(\frac{b^*}{a^*}\right)
\end{aligned}
$$

19.1.3 HSL-color spaces such as HSI and HSV

HSL: Hue, Saturation, Lightness
HSV: Hue, Saturation, Value
HSI: Hue, Saturation, Intensity



HSV (Travis)

$$
\begin{aligned}
Max &= \max(R, G, B) \\
Min &= \min(R, G, B) \\
S &= \tfrac{Max - Min}{Max} \\
V &= Max
\end{aligned}
$$

The color value H is indicated as angle between 0° and 360°, which makes its calculation rule slightly more complicated:

$$
\begin{aligned}
N &= Max - Min \\
R' &= \tfrac{Max - R}{N} \\
G' &= \tfrac{Max - G}{N} \\
B' &= \tfrac{Max - B}{N}
\end{aligned}
$$

$$
\begin{aligned}
&(1)\, H = undefined && |\, S = 0 \\
&(2)\, H = 60°(5 + B') && |R = Max, G = Min \\
&(3)\, H = 60°(1 - G') && |R = Max, B = Min \\
&(4)\, H = 60°(R' + 1) && |G = Max, B = Min \\
&(5)\, H = 60°(3 - B') && |G = Max, R = Min \\
&(6)\, H = 60°(3 + G') && |B = Max, R = Min \\
&(7)\, H = 60°(5 - R') && |B = Max, G = Min
\end{aligned}
$$

HSI (Gonzalez, Woods)

$$
\begin{aligned}
RGB &= R + G + B \\
RG &= R - G \\
RB &= R - B \\
GB &= G - B \\
a &= \min(R, G, B)
\end{aligned}
$$

$$
\begin{aligned}
I &= \tfrac{RGB}{3} \\
S &= 1 - \tfrac{3*a}{RGB} \\
H &= \begin{cases} bedeutungslos & S = 0 \\ \arccos \frac{0.5*(RG+RB)}{\sqrt{RG^2+RB*GB}} & S > 0 \cap B < G \\ 360^\circ - \arccos \frac{0.5*(RG+RB)}{\sqrt{RG^2+RB*GB}} & S > 0 \cap B > G \end{cases}
\end{aligned}
$$

19.1.4 WST-color space

Here, the iterative calculation rules for the dominant wavelength „W“ and the saturation „S“ have been combined with the iterative calculation rule for calculating the color temperature „T“ into a „color space“ with three color coordinates. As all three algorithms constitute iterative procedures, it is not possible to give any closed equations.

However, it is important to know that the dominant wavelength and the saturation depend on a reference color in the Lxy-color space, whereas the color temperature is calculated directly from the xy-color coordinates, which means that it does not require a reference color.

Reference literature: Wyszecki, G.; Stiles, W.S.: Color Science: concepts and methods, quantitative data and formulae. Second Edition, Wiley, New York, 1982

19.1.5 LWS-color space

In this color space, the luminance L, the dominant wavelength W and the saturation S are combined.

19.1.6 Lrg-color space

In the color space Lrg the luminance L was combined with the color coordinates r and g. These color coordinates are calculated from the CIE-RGB color space:

$$
\begin{aligned}
L &= 1,0000 * R + 4,5907 * G + 0,0601 * B \\
r &= \tfrac{R}{R+G+B} \\
g &= \tfrac{G}{R+G+B}
\end{aligned}
$$

19.2 Color differences

All color differences are equations which image a color difference between the color coordinates in a certain color space in a scalar number. If required, further color difference measures can be realized upon request.

ΔE(L*u*v*)

$$\Delta E = \sqrt{(L^* - L_R^*)^2 + (u^* - u_R^*)^2 + (v^* - v_R^*)^2}$$

ΔE(L*a*b*)

$$\Delta E = \sqrt{(L^* - L_R^*)^2 + (a^* - a_R^*)^2 + (b^* - b_R^*)^2}$$

ΔE(L*a*b*,A,B,C)

$$\Delta E = \sqrt{A\,(L^* - L_R^*)^2 + B\,(a^* - a_R^*)^2 + C\,(b^* - b_R^*)^2}$$

The „normal“ color difference in the L*a*b*-color space is a special case of this new color difference with A=B=C=1.

ΔE(Lu'v',A,B)

$$\Delta E = \begin{cases} \sqrt{A\,\left((u' - u'_R)^2 + (v' - v'_R)^2\right) + B\,\left(\frac{L - L_R}{L_R}\right)^2} & fuer\ L_R > 0 \\ 0 & sonst \end{cases}$$

L_2(Lxy)

$$L_2 = \sqrt{(x - x_R)^2 + (y - y_R)^2}$$

L_{oo}(Lxy)

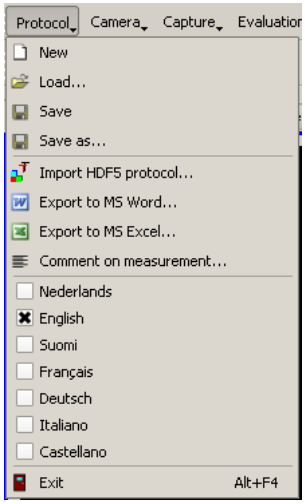
$$L_\infty = \max\left(abs\,(x - x_R)\,, abs\,(y - y_R)\right)$$

20 Shortcuts

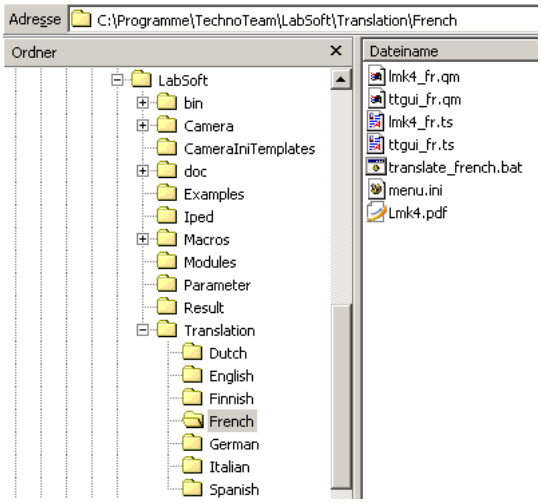
Shortcut	Menu point or function
Ctrl+N	Protocol | New
Ctrl+O	Protocol | Load
Ctrl+S	Protocol | Save as
Alt+F4	Protocol | Exit
F7	Camera | Live
Shift-F7	Camera | Freeze
Alt-F7	Camera | Grab
Ctrl-F7	Camera | Exposure time
F6	Capture | MultiPic
Shift-F6	Capture | HighDyn
Alt-F6	Capture | ColorHighDyn
Ctrl-F6	Capture | Properties
F8	In the Exposure time dialog: Brighter
Shift-F8	In the Exposure time dialog: Darker
F3	Evaluation | Statistics or Image context menu | Statistics
Alt-1 ... Alt-9	Macro | User_defined_macro
Ctrl-Z	Regions | Undo
Ctrl-Y	Regions | Redo
Ctrl-A	Regions | Select all
Ctrl-D	Regions | Deselect all
Ctrl-S	Image view | Scaling | Via dialog
Ctrl-Del	Image context menu | Delete point
Ctrl-Ins	Image context menu | Insert point
Del	Image context menu | Del
Ctrl-F	Image context menu | Fill
Ctrl-C	Bildkontextmenü | Copy
Ctrl-V	Image context menu | Paste and replace
Ctrl-W	Image context menu | Paste and append
Ctrl-I	Image context menu | Paste image content
Esc	Image context menu | Standard cursor
Ctrl-Plus	Enlarge image or graphic
Ctrl-Minus	Reduce image or graphic
Cursor keys	Changes visible area in image
Ctrl-Cursor keys	Move selected regions in image or move graphic In the dialog „ASSIGNMENT OF WINDOWS“ move the selected window
F9	Program view | Arrange
F1	Help | Handbook

21 Translation

After having installed the software it is possible to change the used language in the menu „Protocol“ at any time. The available languages depends on the content of the subdirectory „Translation“ in the software installation directory.



Menu

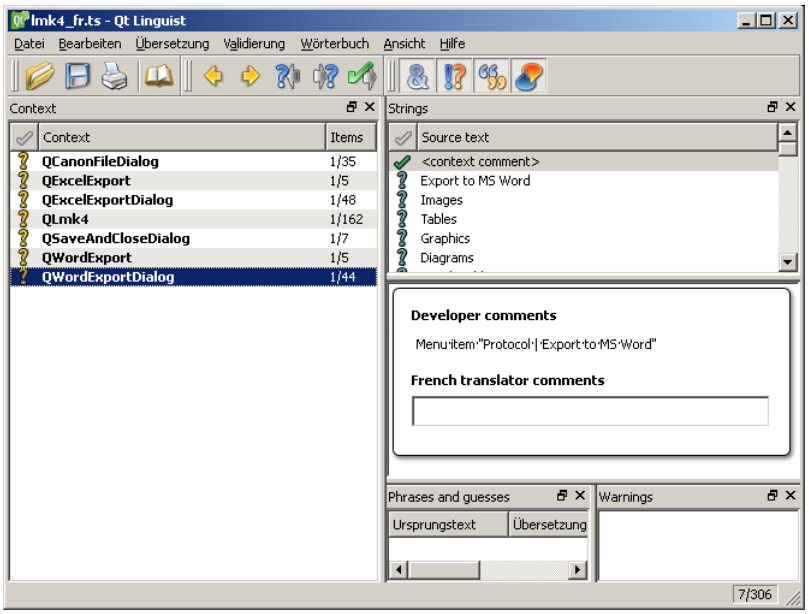


Directory structure

In this example on the right hand side the content of the „French“ directory is shown.

File	Content
lmk4_fr.ts, ttgui_fr.ts	Source files for translation in XML format: English source words and their French translation. See next page for the translation process itself.
lmk4_fr.qm, ttgui_fr.qm	Binary files with the results of the translation process.
translate_french.bat	This Batch file calls the program „Qt Linguist“ for every file to be translated and compiles the completed source files „*.ts“ in the binary file format „*.qm“. See next page.
Menu.ini	This file contains the string used for the language in the program menu. In case of the French language this is „Français“.
Lmk4.pdf	This file is the manual. The manual can be opened within the program with the menu point „Help | Handbook“. Currently the manual is only available in German and English.

The most important task in the translation of the strings of the program is done with the help of the program „Qt Linguist“. (This is a tool for adding translation to Qt applications, Copyright by Nokia Corporation.) If the Batch file „translate_xxx.bat“ is called, this program is opened one time for every *.ts file to be translated.



The list on the left hand side of the program „Qt Linguist“ shows a list with two columns:

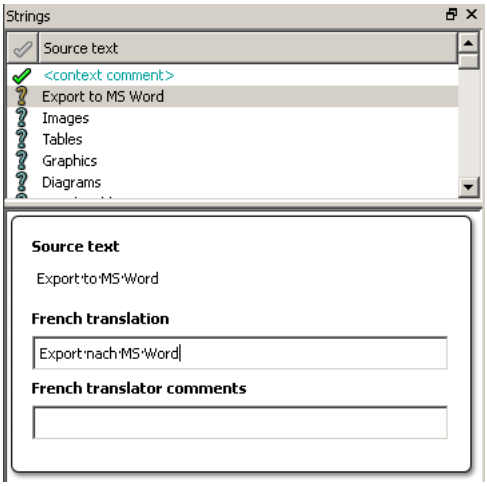
- Context contains the names of dialogs or windows within the „Lmk Labsoft“ program.
- Items contains the number of strings within this contect to be translated.

If a line in this list is selected with mouse click, the strings to be translated are shown on the upper right hand side. In the example above the context „QWordExportDialog“ is marked. Therefore the upper right side contains all strings to be translated within this context.

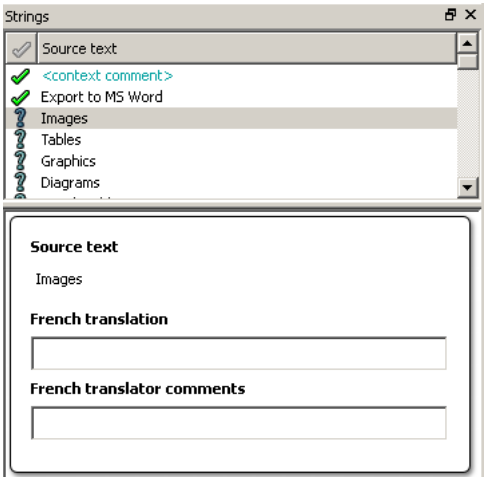
The first string in every context is „<Context comment>“. If this string ist marked on the top of the right hand side the middle part of the right side shows a comment, for example:

If the user has simultaneously opened the „Lmk LabSoft“ program, he can call the menu point „Protocol | Export to MS Word“. There he can find all strings of this context to be translated.

If the the user has selected a string to be translated in the upper right list, he can type in the translation in the edit field below.

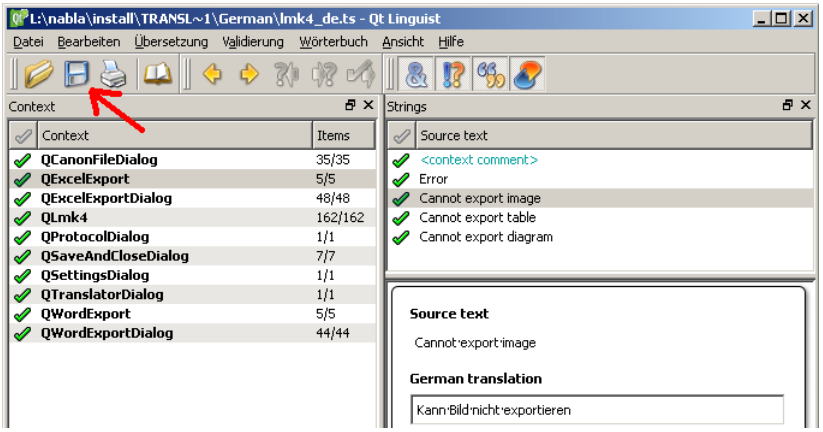


Before translation



After translation

After typing in the input has to be finished with „Ctrl+Enter“. The program takes over the translation and jumps automatically to the next string to be translated. Every not translated string is marked by a question mark, every translated string by a check mark.



If all strings are translated, every context and every string is marked with a check mark. The user has to save his work, see the red arrow above.

It is possible to do parts of the translation at different times:

1. Call the Batch file ones to translate a few dialogs.
2. Open the „Lmk LabSoft“ to view the results of the translation.
3. Recall the Batch file a second time to continue.

After a „Lmk LabSoft“ program update most of the strings are already translated by the previous version. In this case only a few new translations have to be completed.