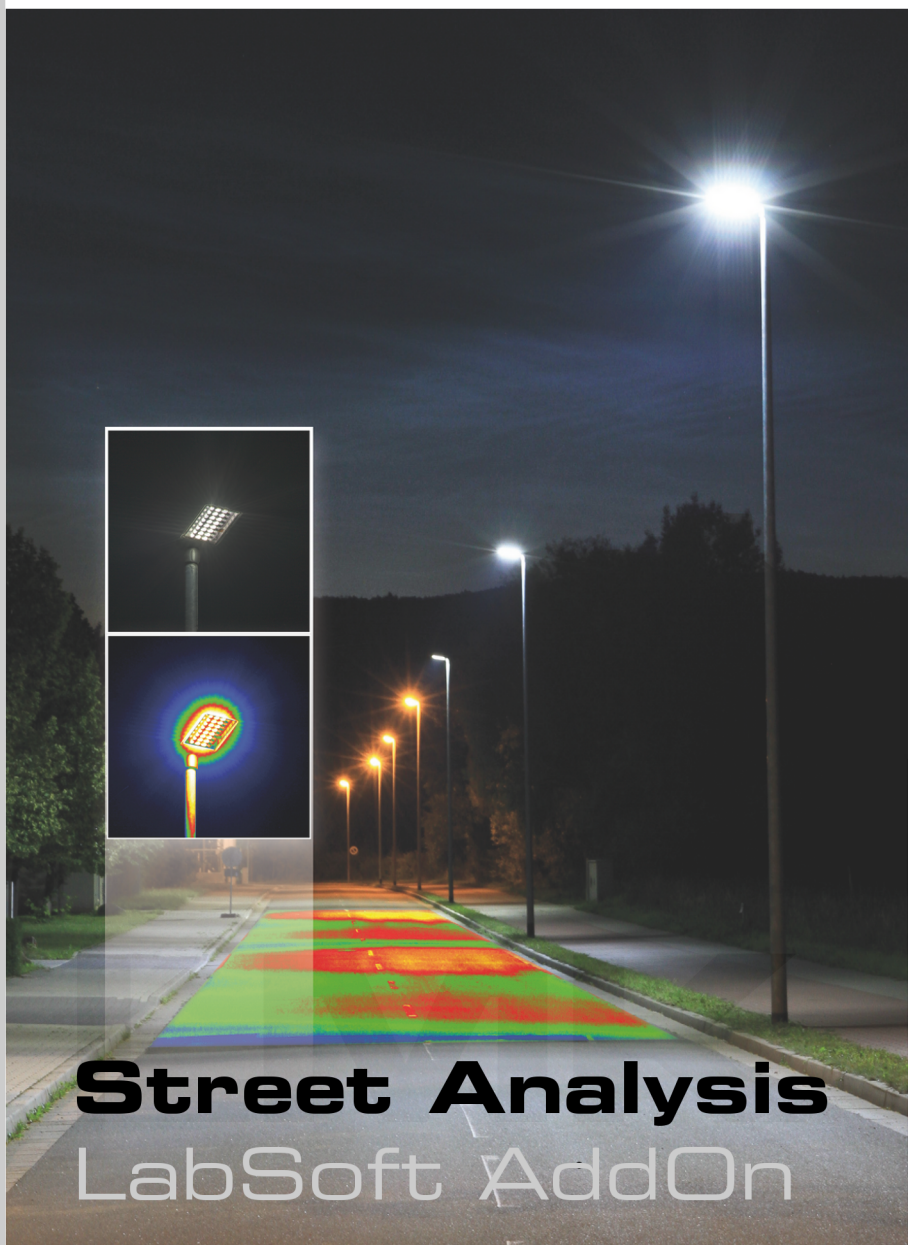**TechnoTeam**
Bildverarbeitung GmbH

MANUAL

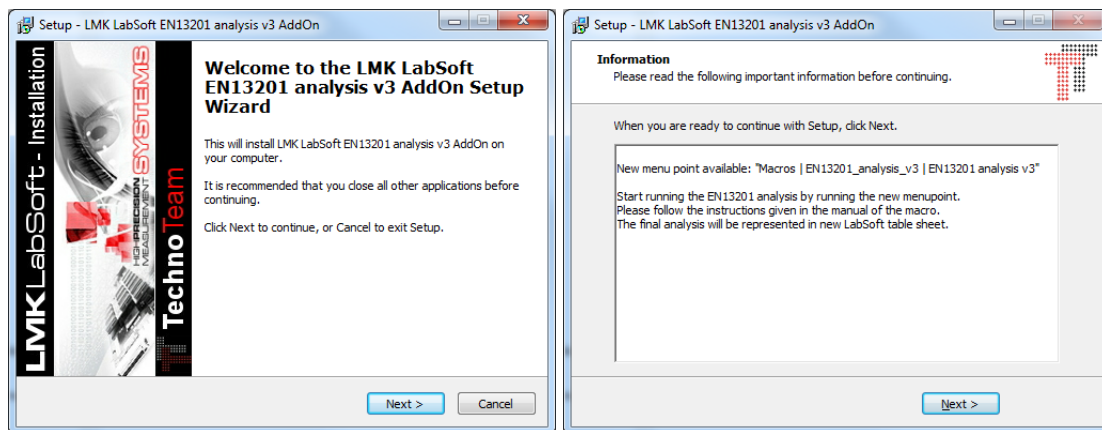EN 13201

Street Analysis
LabSoft AddOn

Table of Contents

1 Starting the program

1.1 Installation of the program

For running the installation wizard of the program **EN13201 street analysis** the program file **21_LMK_LabSoft_EN13201_Street_Analysis_AddOn.exe** must be started. Precondition for a successful installation is an already installed standard version of the **LMK LabSoft** software with a release number above 13.11.6.

You can find the installation program file **21_LMK_LabSoft_EN13201_Street-_Analysis_AddOn.exe** on the supplied LMK software data carrier or download it from our **TECHNOTEAM** webserver: http://www2.technoteam.de/LMK_LabSoft/.

1.2 Starting the program

After successful installation you can find the analysis program under the main menu item „MACROS | EN13201 STREET ANALYSIS". When clicking on the menu the main dialog of the **EN13201 street analysis** software is opened. Furthermore, the last settings of the **Measuring grid**, the **Viewing direction** and the applied coordinate system will be loaded in the luminance image (refer to section 3 on page 9).
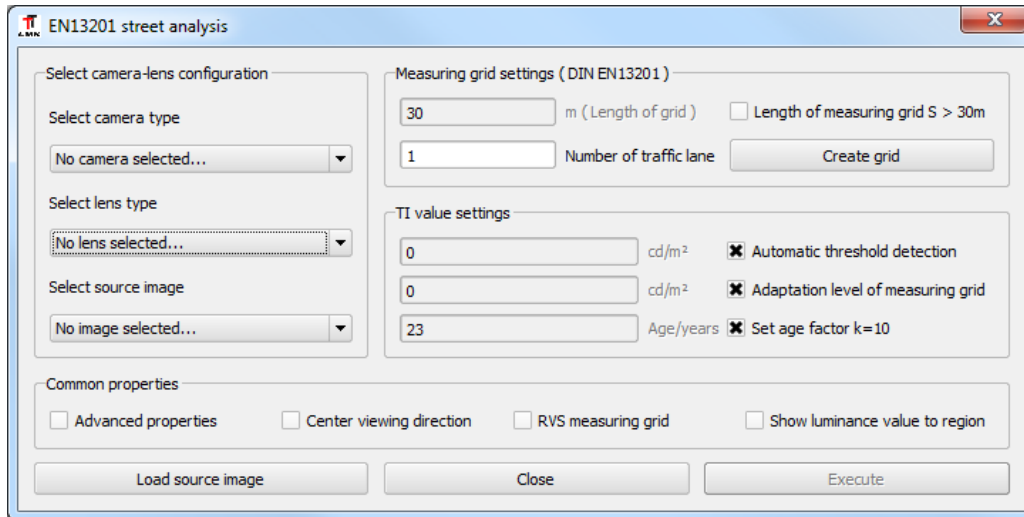
All necessary parameters, settings and adjustments to be made are summarized and shown in group boxes, one for each step in the program execution order. There meaning and service in functionality are explained in the following chapters, named according to the group boxes names.

- Select camera-lens configuration
- Measuring grid settings
- TI value settings
- Common properties

Functional comprehensive handling and operation will be highlighted by text references to the corresponding page and section.

1.3 Control button: Load source image

The control button **Load source image** opens a file browser dialog for loading the luminance image to be analyzed. Thus two standard **TECHNOTEAM** luminance image data file formats (*.pf; *.tix) are set as default. This functionality is for subsequent loading of luminance images if no LMK camera type is connected or no luminance image to be analyzed was loaded, before starting the program.

The images will be loaded into the **Luminance image** tab, thus replacing the existing one. Alternatively, it is possible to capture a new image or to convert a ***.cr2** raw data image (by using connected LMK video model or LMK mobile advanced) as new luminance image.

Anyway, it is absolutely necessary for the program execution to go on, that the above listbox **Select source image** will display **Luminance image**. In our case, the listbox **Select source image** will switch automatically when using the control button.

1.4 Placement of the measuring grid polygon

When starting the program two measuring regions will be plotted in the **Luminance image**. The positioning and size of both depends on the luminance scenario shown in the image. The last used settings for the position and size will be used as preset .

The region named **Measuring grid** is a 4-corner polygon used as perspective road surface measuring grid. The top-left edge has the index „0". The indexing of the other edges follows clockwise. **This orientation is absolutely necessary and shall <u>not</u> be changed when making any changes to the position of the edges. This has an influence on the projective rectification and causes tilting, or mirroring effects.**

Later on the **Measuring grid** will be used to calculate the luminance uniformity on the road surface. Additionally, the average of the luminance will be used as adaption level for the calculation of the threshold increment (TI) (refer to page 13).
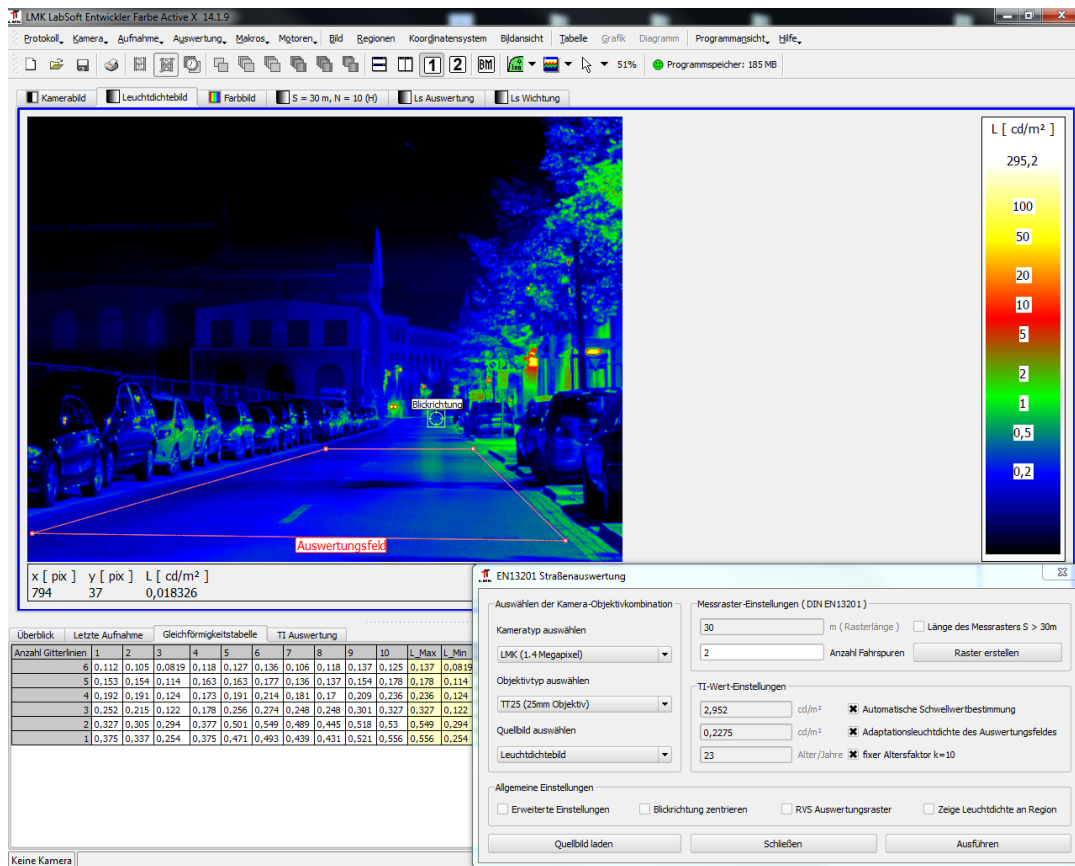

1.5 Specifying the viewing direction

The small cross-hair in the **Luminance image** must be used for defining the **Viewing direction** of the associated observer. By redefining the **Viewing direction** the viewing angles for the glare sources and, furthermore, the result of the TI calculation will change.

The specified viewing direction influences directly the angle-dependent equivalent veiling luminance. The veiling luminance calculation formula starts with the **Viewing direction** as the origin and follows the viewing angle in a rotating symmetry (see text paragraph 5.5 on page 16). After specifying the **Viewing direction**, the **Execute** button can be pressed to calculate of specific TI for each glare source and as a function of the viewing conditions. Also the summary of all TI's is given.
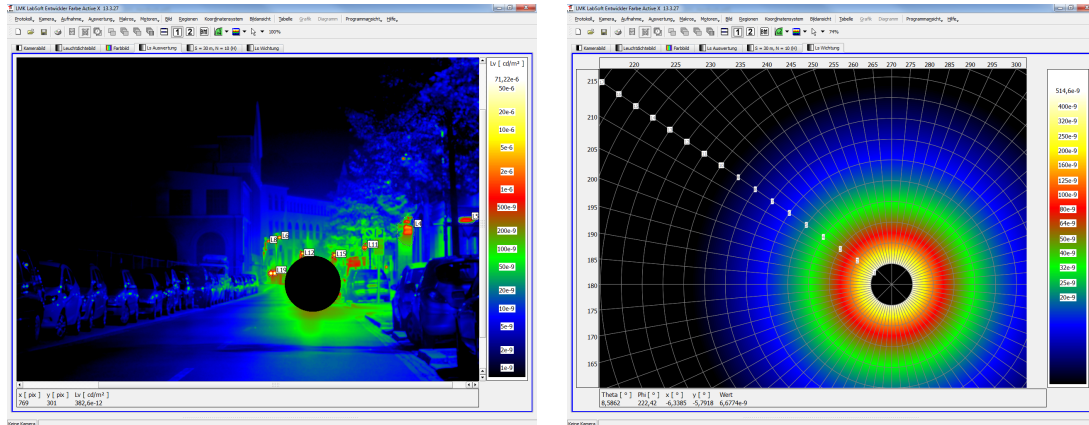
1.6 Control button: Execute

The control button **Execute** starts the program execution of the **EN13201 street analysis** program. All parameters of the main operation dialog will be used. When starting the program the control button **Execute** remains inactive. It will become active when loading a source image (see text paragraph 1.3). If an active camera connection is established (already loaded calibration data also for LMK mobile advanced) the selection of the right camera-lens configuration (see paragraph 2.1 on page 8) activates this button too.

Due to the fact that there is no check for preloaded camera calibration data on startup, one has to select the camera-lens configuration at least once to activate the **Execute** control button.

The first step of the program execution is the analysis of the uniformity parameter of the artificial street lighting (refer to paragraph 1.4). Therefore, the settings of the group box **Measuring grid settings** will be used and an additional evaluation image will be created. Afterwards, a new rectangular measuring grid with a **Standard statistic** will be applied for the new image. After that the projective rectification of the image content of the measuring grid polygon into the new applied image will be carried out.

For the settings of this measuring grid please refer to paragraph 3 and 5 on pages 9 and 14. The resulting data of the measuring grid will be given in a **Uniformity table** shown below. The table additionally presents the results for the **Lengthwise unformity** and the **Overall uniformity**.

Now, the next step of the program execution is to calculate the threshold increment (TI) for the lighting scenario of the **Luminance image**. Therefore, some more evaluation

images were needed and created. The formula image **Ls weighting** includes the formal relation for calculating the equivalent veiling luminance based on the angular relationship for the Camera-Lens configuration used and the adjusted **Viewing direction** (see text paragraph 1.5).

The image **Ls weighting** will be multiplied with the **Luminance image** and the result will be stored in image **Ls analysis**. Also the luminances of the detected glare sources will be marked and shown in this image. Finally, the derived data will be used to calculate the equivalent veiling luminances and the TI for each glare source or the overall lighting glare scenario. The result will be shown in table **TI analysis**.

For setting the input parameters of this operation please refer to paragraph 4 and 5 on pages 11 and 14.

1.7 Control button: Close

The control button **Close** closes the **EN13201 street analysis** software. Settings made in the main dialog will be stored and appear when the program is started again.

Exceptions are the settings of the **Advanced properties** influencing the calculation rule of the disability glare (equivalent veiling luminance) that are not part of the EN13201 standard. Changes made here will be set back to the requirements in normative paragraph 8.5 of the EN 13201:3 standard (refer to section 5.5 on page 16). New evaluation images, measuring regions, statistic operators and tables remain preserved. They will be used again on program restart.

Changing language settings before restarting the program and keeping the existing additonal images and LMK LabSoft settings cause program errors and are not recommended.

2 Select camera-lens configuration

2.1 Select camera and lens type

The group box **Select camera-lens configuration** allows the specification of the LMK model type and the used lens at the time of the luminance image capture to be analyzed by the algorithm. The information is needed to set the size of the additonally used evaluation images. Additionally, the given focal length and the sensor resolution is used to set the angular reproduction scale [°/px].

Determined by the camera-lens configuration used an angular relation for the further program execution will be set. For example, the drawing of the angular coordinate system for the **Luminance image** and the calculation of the veiling luminance formula as input for the TI.

2.2 Listbox: Select source image

The listbox **Select source image** allows the user to chose preloaded images of the current **LMK LabSoft** session for the analysis by the program. Please note that this function copies the selected original image into the **Luminance image** tab, thus overwriting the existing one. It is necessary for th program execution to go on that the listbox **Select source image** will not display **No image selected** (see also paragraph 1.6 on page 6).

3 Measuring grid settings

The group box **Measuring grid settings** includes all settings of the geometry of the measuring grid on the road surface. Current available calculation rules in the program are the standard requirements of the **EN 13201-3:2003** text paragraph 7.1.4 or the Austrian **RVS 09.02.41** text paragraph 9.3.1.

The choice of the standard to be used for the drawing of the measuring grid can be made with checkbox **RVS benchmark grid** in group box **Common properties**. Correspondingly the name of the group box will be changed to the set standard. The preset is the **EN 13201-3:2003** standard. The last used setup will be stored on exit of the program, when pressing the **Close** button.

3.1 Length of measuring grid

As default the measuring grid for a length on the street of $\leq 30m$ will be created. Therefore, 10 or also 7 measuring spots will be plotted in a horizontal line relatively to the overall length according to the **EN** or **RVS** standard. The **RVS** measuring grid is only valid for lengths $\leq 30m$. Thus, the parameter for another length is inactive (refer to paragraph 5.2 on page 14).

TheEN 13201-3:2003 standard also allows the calculation of a measuring grid for longer road surface and measuring fields. Once the checkbox **Length of measuring grid S > 30m** is checked the left-hand placed input box becomes activated and the real length of the road measuring field can be entered in meter.

3.2 Number of traffic lanes

The parameter **Number of traffic lanes** is for the count of traffic lanes on the road surface for which the measuring grid has to be calculated. The whole-number parameter is used as multiplier for three rows of measuring points. All three rows for one traffic lane in lengthwise direction. As default a measuring grid for one traffic line is plotted, i. e. three measuring point rows in lengthwise or also viewing direction. This parameter does not depend on set **EN** or **RVS** standard.

3.3 Control button: Create grid

When pressing the control button the manual entries of the group box **Measuring grid settings** will be confirmed and used. A correspondingly named evaluation image will be created. Thereby any existing evaluation images will be overwritten or also deleted when the given parameters have changed. Once a new source image is loaded or changes to the

Measuring grid in the **Luminance image** are made, new uniformity results based on the applied **Measuring grid settings** will be calculated and shown in the **Uniformity table**. Thus, this button offers a second possibility to recalculate the uniformity values without recalculating the TI (comparing paragraph 1.6 on page 6).

4 TI value settings

The group box **TI value settings** shows all parameters for calculating the Threshold increment (TI). The given settings are independent of the calculation rule. They will be used as input values for all types of calculation (for further information refer to section 5.5 on page 16). As default all settings of the program are set to automatic determination or as fixed standard values.

4.1 Automatic threshold detection

If this checkbox is selected, glare sources in the lighting scenario of the luminance image will be detected and plotted with the help of the 1% method. That means 1% of the maximum luminance in the luminance image will be used as luminance threshold for glare source detection and separation.
If this checkbox is not checked the left-hand placed input box becomes activated for a manually set of any luminance threshold. Once this is done the search, detect and separation algorithm for the glare source is uses this threshold.

4.1.1 Specifying the threshold based glare source detection

When using the 1% of maximum luminance threshold or another threshold value, the glare sources will be detected by mainly using the **Symbol object** statistic operator. For this operator type further parameters are:

- Enlarge regions: 3
- Smoothing contour: 1
- Minimum size: 1
- Maximum size: 250

The search algorithm employed can be found in the **LMK LabSoft** in main menu „Eva-luation | Searching for regions and using them automatically". The luminance threshold and also the other parameters that influence the glare source detection can be changed in this dialog.
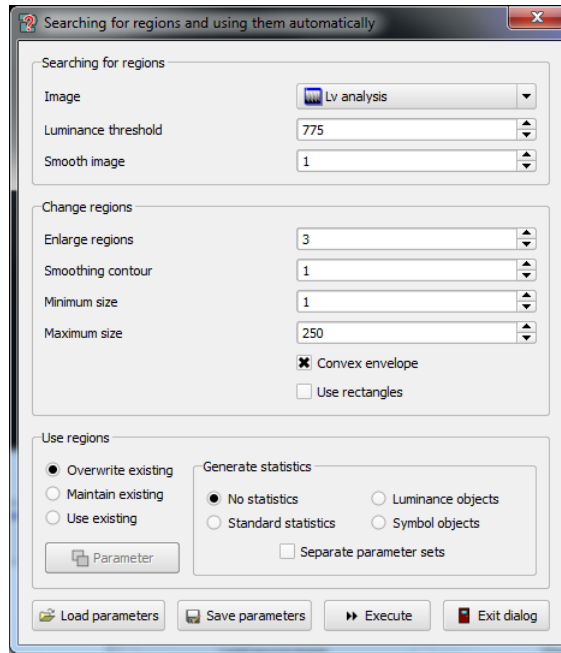
4.1.2 Drawing the glare sources

Each glare source will be visualised by a polygon region in the evaluation image **Lv analysis**. They will be named in the order of detection by indexing as follows:**L1 ... Ln**. These names will also adopted in the table with the results **TI analysis**. Additionally to the indexing names also the average luminance of the glare source can be shown in the region name (refer to paragraph 4.1.3).

4.1.3 Changing the glare sources

After the glare sources have been specified automatically, the polygon regions drawn can later be changed manually by the user. So it is possible to delete, create or change the size and coordinates of regions in the region list.

By pressing the **Execute** button again, the program runs the changes in the region list and calculates new measuring values and a new TI. Thus, manually added or changed glare sources will be newly indexed and named.

If the user modifies the viewing direction in the **Luminance image** or enters another luminance threshold or changes the calculation formula (refer to paragraph 5.5 on page 16) the automatic detection remains activated if the **Execute** button is pressed again.

4.1.4 Luminance threshold of zero

If the inserted value for the luminance threshold is set to 0 cd/m^2 the overall image area will be used for the calculation of the TI. That means that the veiling luminance, an input value for the TI calculation, will be integrated pixel-wise for all luminances in the

image.

4.2 Adaptation luminance of the measuring grid

As preset the luminance of the road surface will be used as adaptation level for the calculation of the TI. For this, the average luminance of the **Measuring grid** in the **Luminance image** will be used automatically. However. it is also possible to enter another value as adaptation level. For this purpose, it is possible to move and or resize the **Measuring grid** region to another part of the **Luminance image**. Furthermore, the value of this level can be entered manually after unchecking the checkbox **Adaptation level of measuring grid**, for example the average road surface luminance calculated in the **Uniformity table**.

Depending on the absolute value of the Adaptation luminance level, different coefficients will be used within the TI calculation formula. If the value is below ≤ 0.05 cd/m^2, the TI is set to „0".

for Adaptation luminances > 5 cd/m^2:

$$TI = L_{(S)} \times \left[\frac{95}{\left(L_{(adapt.)} \right)^{1.05}} \right]$$

for Adaptation luminances $\leq$ 5 cd/m^2:

$$TI - Wert = L_{(S)} \times \left[\frac{65}{\left(L_{(adapt.)} \right)^{0.8}} \right]$$

4.3 Set age factor k=10

The age factor in the calculation rule of the veiling luminance considers the age of the observer, as with increasing age the veiling luminance inside the eye increases, too. However, the age factor is commonly set to 10. Therefore, it is possible to fix this value by checking checkbox **Set age factor k=10**.

Otherwise, if this checkbox is not checked the user can enter an assumed age in years in the input box on the left-hand side. For the subsequent determination of the age factor different calculation rules according to DIN or CIE standards (refer to section 5.5 on page 16) are available.

5 Common properties

In group box **Common properties** initially three commonly-valid parameters can be set.

5.1 Center viewing direction

Checking this checkbox automatically centers the drawing of the **Viewing direction** in the **Luminance image** to the central point of the image. This means when pressing the **Execute** button the calculated angular coordinate system and all following angular-based calculation steps refer to this observation position.

## 5.2 Uniformity measurement

Alternatively, checking checkbox **RVS measuring grid** enables the calculation rule for the uniformity values measuring grid according to the RVS guidelines (Austrian standard). The preset is the DIN/EN standard. Both are based on requirements of the standard **DIN EN 13201-3:2003** section 7.1.4 and **RVS 09.02.41** section 9.3.1., respectively.
The currently set rule is also displayed in the title of the main dialog group box: **Measuring grid settings (...)**.
In the DIN/EN standard it is possible to calculate a measuring grid > 30m on demand. By optionally checking Checkbox **Length of measuring grid S > 30m** the input box on the left-hand side becomes activated. The value entry is in meter.

5.3 Displaying the luminance

By checking Checkbox **Show luminance value to region** the display of average luminance values [cd/m^2] inside region names for the additional measuring grid image, and the **Ls analysis** image can be activated.
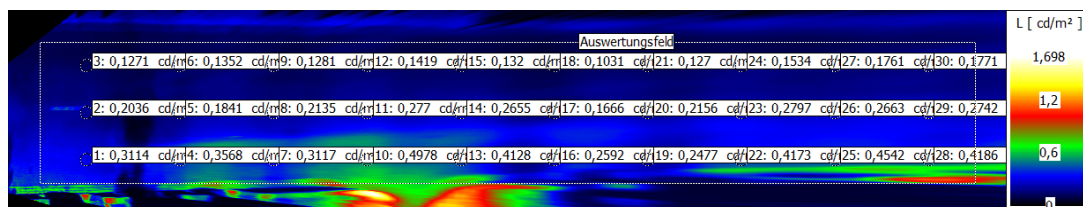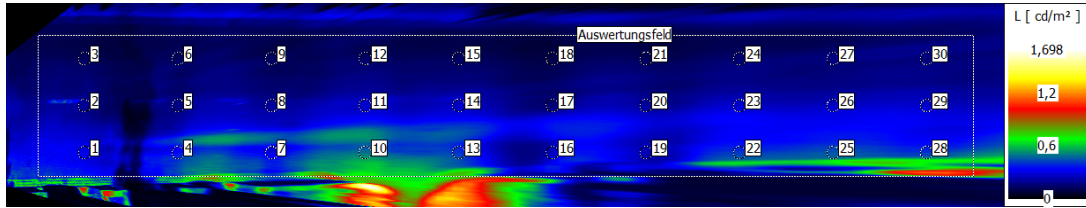
5.4 Advanced properties

By checking the Checkbox **Advanced properties** more advanced parameters and settings become available in group box **Common properties**. Using these optional settings allows the user to change the calculation rule of the TI and offers additional evaluation tools. The optional settings are not basically necessary for the standard program use.

5.4.1 TI image

By checking checkbox **TI image** an additional evaluation image **TI analysis** presenting the pixelwise TI will be created.
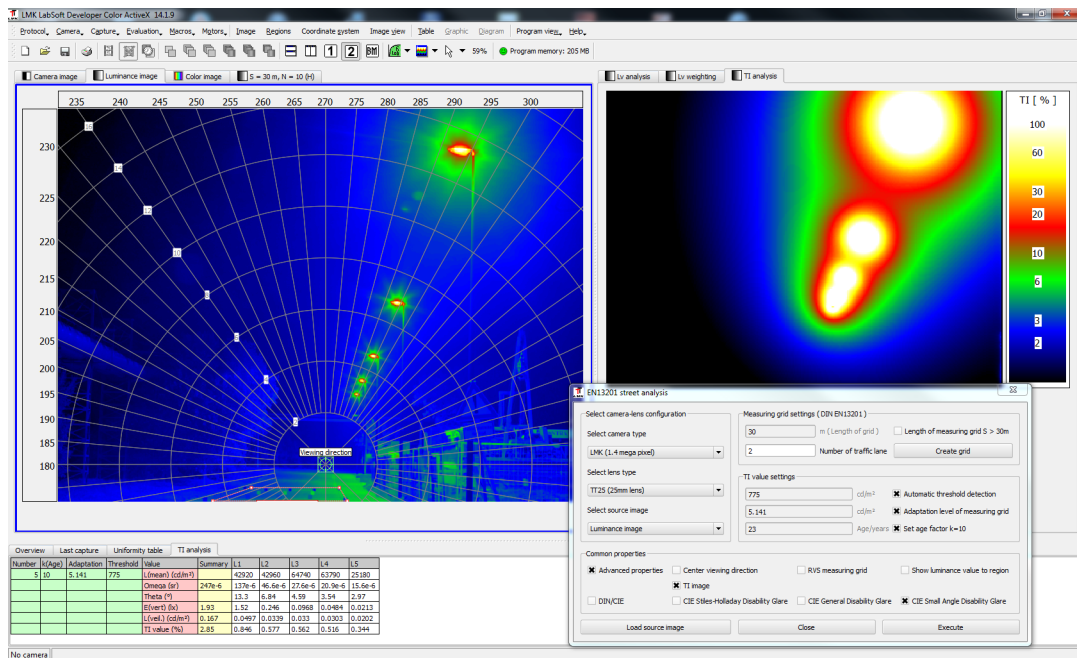
In this image every pixel represents an own viewing direction. For each viewing direction the resulting TI for the complete lighting scenario will be calculated and stored as value for this pixel. Thus this **TI image** is suitable to determine the expected range of values of the TI for many more observation scenarios of the imaged scenario of the original luminance image.

The contribution of each single glare source to the TI will be evaluated by the observing-angle dependent analysis with one pre-defined viewing direction (refer to section 1.6 on page 6).

5.5 Setting of the TI calculation

5.5.1 DIN calculation rules

Besides the recommendation of the CIE for the determination of the extend of the Disability glare and the Age factor a calculation rule is defined in **DIN EN 13201:3 in paragraph 8.5**. This calculation rule corresponds to the basic default values of the program for calculating the TI.

DIN application of the Disability glare
(for $1.5° \leq \theta \leq 60°$):

$$L_{(S)} = Agefactor \times \left[\frac{E_{vert}}{\theta^2}\right]$$

Age factor (DIN):

$$Agefactor = 9.86 \times \left(1 + \left[\frac{age}{66.4}\right]^4\right)$$

By unchecking Checkbox **DIN/CIE** it is possible to deactivate the basic default values. If so, alternatively the calculation rules according to CIE publication 146:2002 can be selected by checking the checkboxes **CIE Stiles-Holladay Disability Glare**, **CIE General Disability Glare** or **CIE Small Angle Disability Glare** (refer to section 5.5.2 on page 16).

5.5.2 CIE calculation rules

A number of different studies concerning the discomfort glare inside the CIE have been conducted. They mainly differ in the span of the considered viewing angle (see CIE publication 146:2002). Thus, newer results exist besides the studies of **Stiles - Holladay** carried out in the middle of the last century. They are concerned with the **CIE General Disability Glare** (for viewing angles of $0.1° \leq \theta \leq 100°$) and for the origin of the viewing angle (of $1° \leq \theta \leq 30°$) in the so called **CIE Small Angle Disability Glare** equation.

Disability glare according to Stiles-Holladay
(for $1° \leq \theta \leq 30°$):

$$L_{(S)} = Agegfactor \times \left[10 \times \frac{E_{vert}}{\theta^2}\right]$$

Disability glare according to CIE
(General calculation for 0.1° ≤ θ ≤ 100° and Pigmenting factor p =0.97):

$$L_{(S)} = \left(10 \times \frac{E_{vert}}{\theta^3}\right) + Agefactor \times \left[\left(5 \times \frac{E_{vert}}{\theta^2}\right) + \left(0.1 \times \frac{p}{\theta}\right)\right] + 0.0025 \times p$$

Disability glare according to CIE
(Small angle calculation for 0.1° ≤ θ ≤ 30°):

$$L_{(S)} = \left(10 \times \frac{E_{vert}}{\theta^3}\right) + Agefactor \times \left[5 \times \frac{E_{vert}}{\theta^2}\right]$$

As well as for the Disability glare several equations for the Age factor based on different studies exist.

Age factor (Stiles-Holladay):

$$Agefactor = 1 + \left[\frac{Age}{70}\right]^4$$

Age factor (CIE):

$$Agefactor = 1 + \left[\frac{Age}{62.5}\right]^4$$