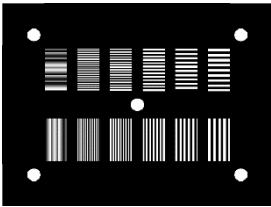


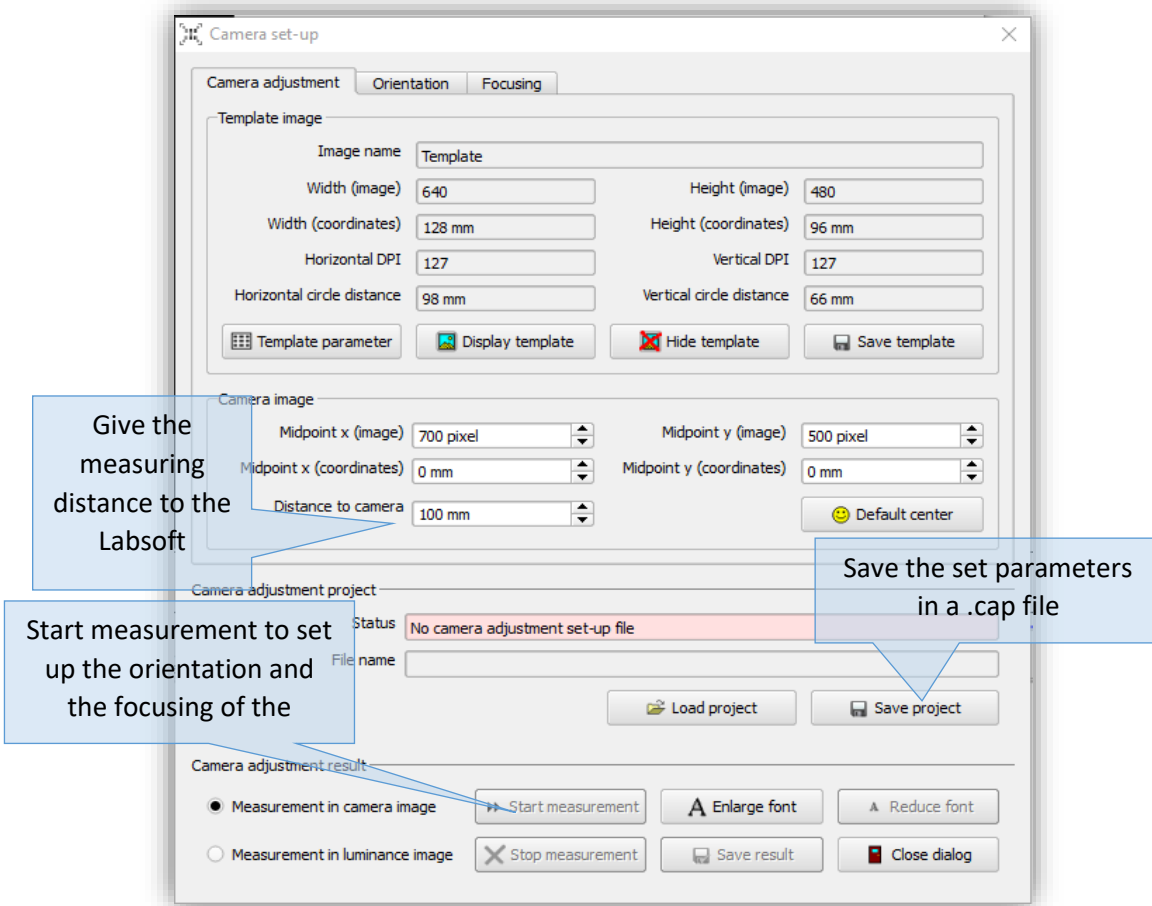
# LabSoft AddOn BlackMURA

- Install the '14\_Lmk\_LabSoft\_blackmura\_AddOn\_YYYY\_MM\_DD.exe' after installing a LMK LabSoft standard version package.
- A new Icon 'BM' and the new submenu entry 'BlackMura application' in the Main menu 'Evaluation' was created.
- Consider the following measurement conditions to receive valid and reproducible results:

Room	temperature	25°C / 77°F
Display	backlight	Set the maximum brightness level (to reduce the influence of PWM) If possible the internal PWM should be set to 100%.
		No pixel defects!
	Luminance (White)	>300 cd/m <sup>2</sup>
	Contrast L <sub>White</sub> /L <sub>Black</sub>	>500:1
Camera	properties	The resolution of the camera sensor must be higher than the display resolution
	position	Choose the focal length of the lens and set the measuring distance so that the whole image of the display shall be as large as possible on the image sensor (employs maximum number of pixels of the sensor)  To enable the border detection of the display around the display area at least 10 camera pixel should be left.
		The display image has to be centred within the camera image (in relation to the optical axis of the lens)
		Align the display orientation in relation to the camera position – each tilt angle has to be less than 0.5° in each axis (you can use the 'Camera set-up' dialog in combination with the alignment picture on the display)
	 <ul style="list-style-type: none"> <li>• Use Main menu 'Camera set-up   Camera adjustment   Template image   Template parameter' Select the register 'Adjustment   Camera adjustment')</li> <li>• Ensure, that the right display target with the right display parameters is selected on top of the 'Template image generator' dialog)</li> </ul>	
	focus	Avoid aliasing effects (set a slight de-focus with a modulation depth of > 50% for V4 x H4 grid patterns of the adjustment image)

## Starting with the camera adjustment

- Open the 'Camera|Camera set-up dialog ...'. It is important to enter correct values for receiving valid properties and results for the measurement. Set up the integration time using the Auto-scan function in Live-mode so that all parts of the Adjustment pattern has good saturation.

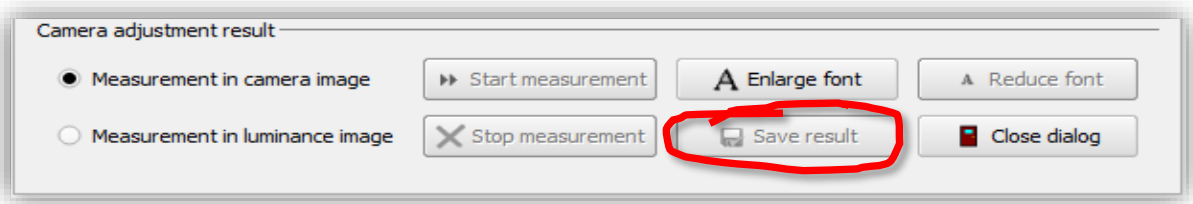


- After entering all parameter to the 'Template image' and 'Camera image' press the 'Save project' button and store a \*.cap file (camera adjustment project). Please

Note: This file can be used as a parameter template file for coming measurements using the same measuring setup.

- Check the measurement results in tab sheet 'Orientation' and 'Focusing'.
- Set the Focus of the LMK so that the following modulation parameters are adjusted. First of all create a sharp image. In the next steps change the focus (the direction is not important) until no aliasing (esp. in homogenous white areas) is visible anymore. The 4x4 modulation measurement (V4, H4) should be in the range of 50-95% in this case. Beware that changes to the lens focus setting has to be applied as new focus factor within the Capture settings of the LMK LabSoft.

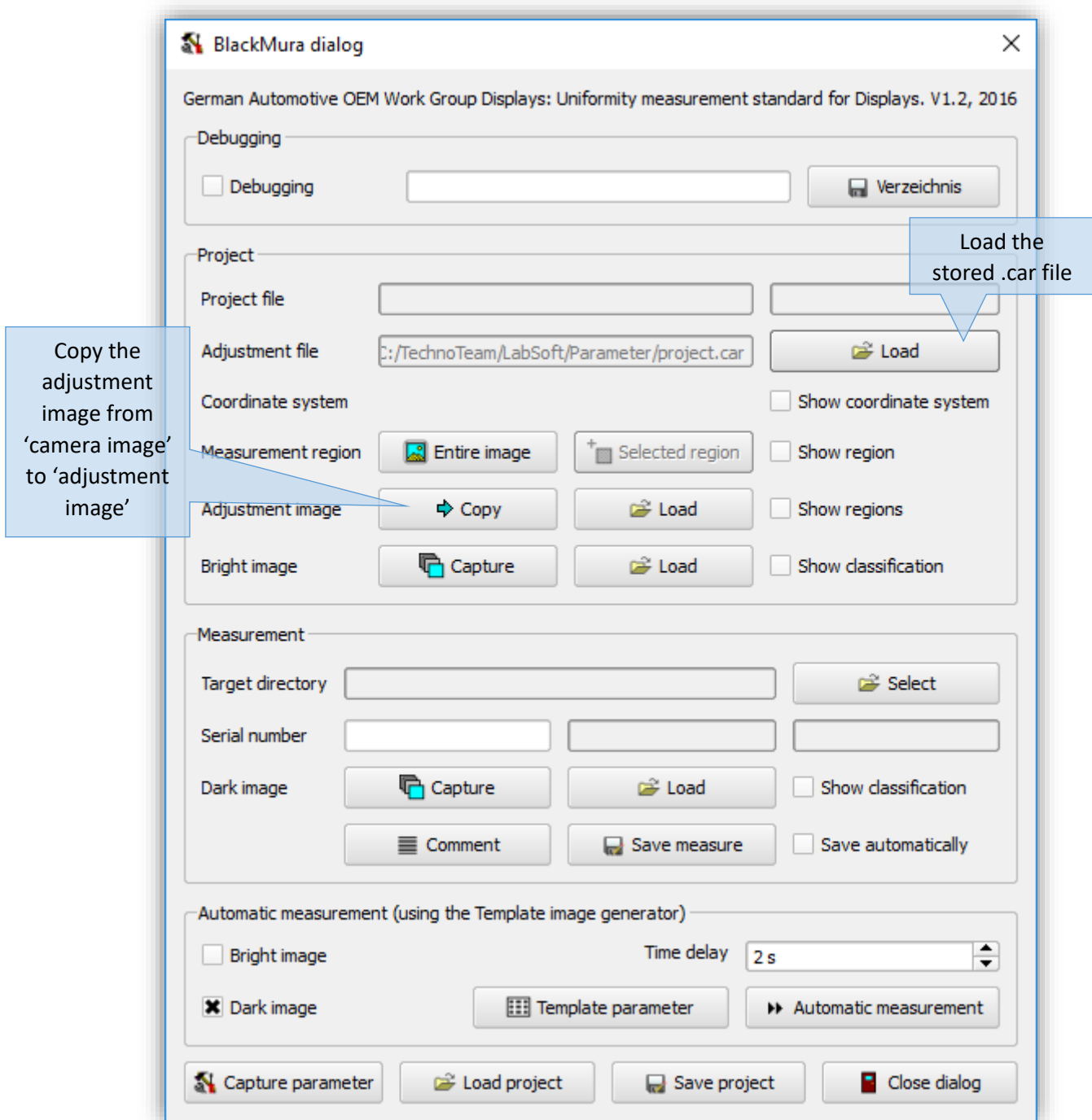
V4 x H4 > 50%



- When the adjustment has finished save the received parameter set for ongoing use with the BlackMURA -analysis as \*.car file (camera adjustment results).
- Close the 'Camera set-up' dialog.

## Running the BlackMURA measuring procedure

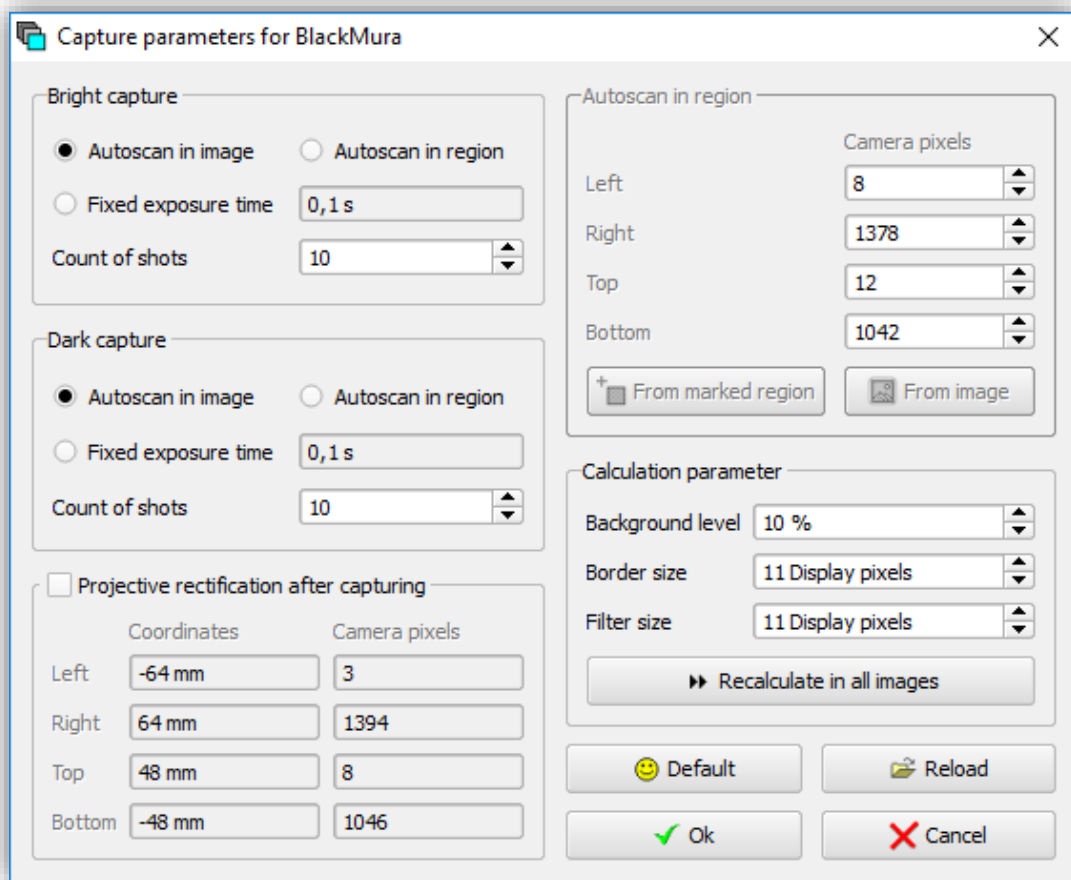
- Start the 'BlackMURA' dialog using the 'BM' icon in the short start list or the Menu item



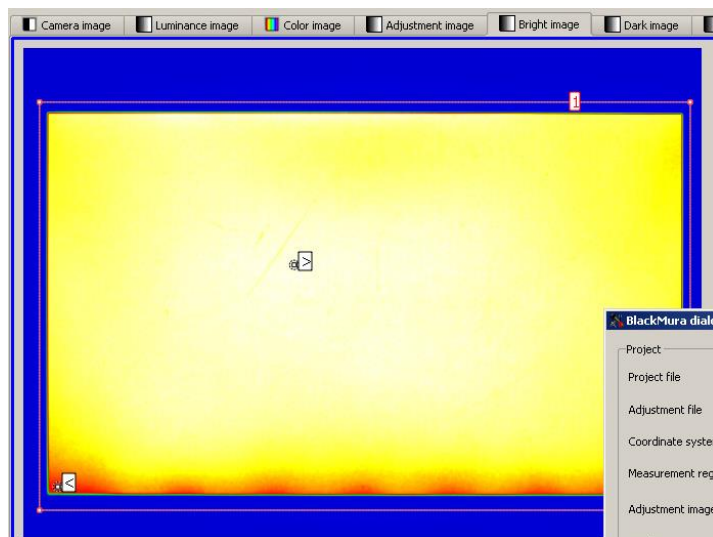
'Evaluation | Blackmura application'. The tab sheets ADJUSTMENT IMAGE, BRIGHT IMAGE, DARK IMAGE, GRADIENT IMAGE AND TEMPLATE are generated.

- Adjusting Capturing properties and Analysis parameter is available with 'Capture parameter' button. - Note that the capture parameters can be set for dark and bright image separately. It also can be set, whether the Autoscan should be done over the whole image or a selected region.

Furthermore, the calculation parameters can be adapted. After changing the parameter, with the recalculate button a new evaluation of all images can be done.



### Step guide:

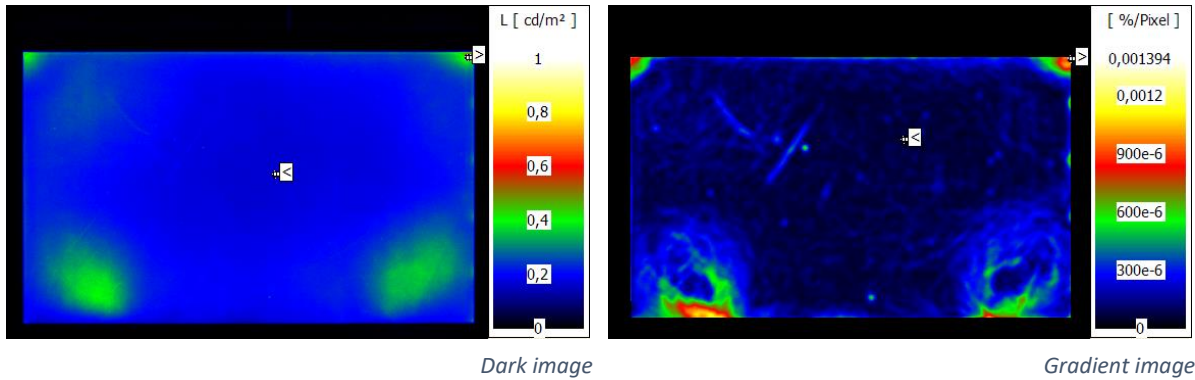


- Capture and evaluate the white display screen with 'Capture' button in the line 'Bright image'. The whole image is used for the evaluation. The algorithms detects the screen surface (for both cases – white and dark image) using an adaptive threshold algorithm.

Note: If there are bright light sources in the surrounding (e.g. while measuring prototypes or displays without external housings) one can use and set rectangle region for marking the

display screen manually within the image to specify the area of interest (AOI). For this press 'Selected region' in the line 'Measurement region' after creation of the rectangle area.

- When clicking the checkbox 'Show classification' in the same line, the part of the image which is used for BlackMURA evaluation will be highlighted.
- Start the capture of the dark display screen with the 'Capture' button in the Line 'Dark image'. Pressing this button the complete BlackMURA evaluation starts automatically



- All results are shown in the table 'BlackMURA results'.

Image	Parameter	Value	Unit
Dark image	Serial number		
Dark image	Mean		
Dark image	Minimum		
Dark image	Maximum		
Dark image	Uniformity		
Gradient image	Maximum W		
Gradient image	Maximum B		
Bright image	Mean		
Bright image	Minimum		
Bright image	Maximum		
Bright image	Uniformity		
Dark image	Minimum x		
Dark image	Minimum y		
Dark image	Maximum x		
Dark image	Maximum y		
Bright image	Minimum x		
Bright image	Minimum y		
Bright image	Maximum x		
Bright image	Maximum y		

- In this table the values of a Standard grey statistic for the bright and the dark image and the Uniformity of both pictures are shown. Furthermore the geometrical dimensions (x,y) of the display size in for the bright and the dark image are given. Finally in this table the maximum gradients relatively to the bright and to the dark image are noted. For more detailed information please refer to section 8.3 of the BlackMURA standard.

- In the table BlackMURA parameter it can be controlled, whether the camera, display and measurement adjustments are correct. If the Labsoft noticed problems (e.g. some parameters are out of the threshold values), the relevant lines of the table would be marked.

- It is possible to store the images produced in serial order in a single directory. In addition, a file is stored in the same directory ending in ".csv" (standing for comma separated value) which will contain all the values measured by the program so that they can be evaluated in an external program such as Excel. Once the "Select" button has been clicked in the "Target directory" line, the name of the existing directory can be entered or a new one created. The file "BlackMura.csv" will immediately be created in the directory, which will capture all the measured values from the ensuring analyses.

*BlackMURA results*

- All steps can be done automatically with the section 'Automatic measurement'. Be sure to set all Parameters in the camera set-up and have the correct settings of the bright image.

Note: If the display is driven by the image pattern generator of the LMK Labsoft, switching between the bright and the dark image has to be done manually. In this case a time delay for

automated measure can be set, the algorithm can be triggered or the measurement must be done twice – once for the bright and once for the dark image.

#### Literature:

German Automotive OEM Work Group Displays: Uniformity measurement standard for Displays.  
V1.15, 2011