Contrast measurements on displays using conoscopic lens and LMK videophotometer

Luminance of different directions is imaged to different pixels on the CCD matrix of the LMK videophotometer if the cononscopic lens is used.

The light bundle of different directions is obtained from a defined small spot if the lens is adjusted at the correct measurement distance. The spot size is approximately 5mm in diameter.

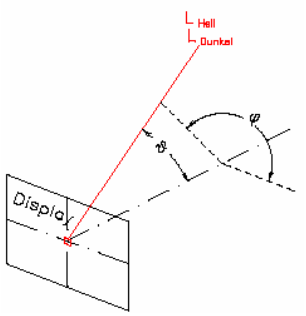


Image 1: Definition of angles

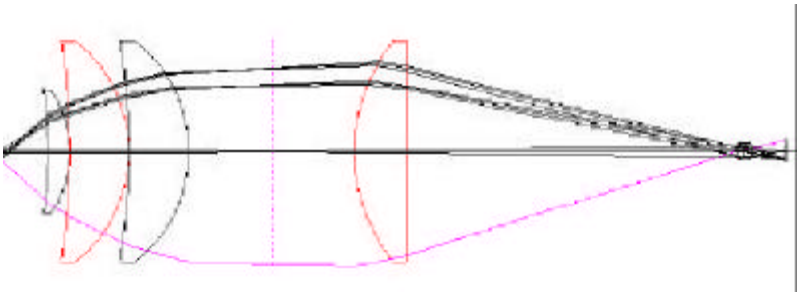
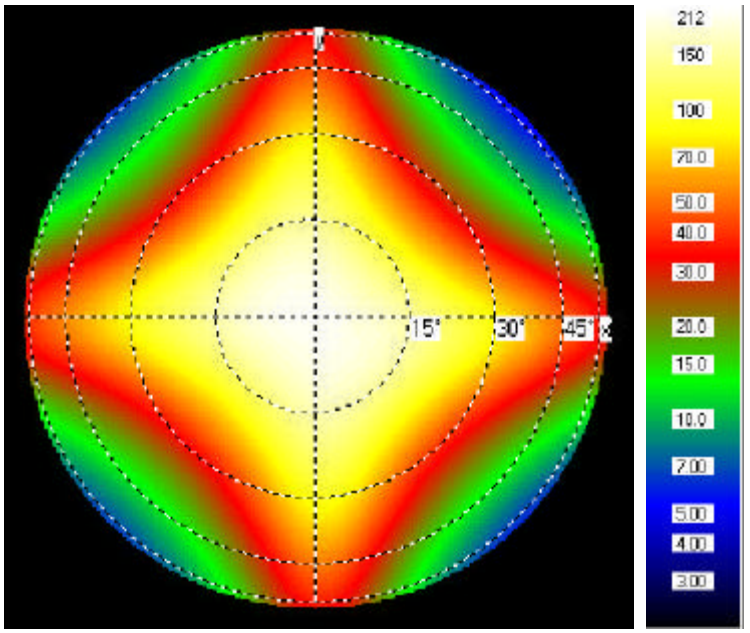


Image 2: Throuput of rays in the conoscopic lens

The contrast is calculated by the division of the results of two luminance captures (display bright and dark) which are obtained using the conoscopic lens.



The calculation can be done very easily using the LMK 2000 Software. The example is showing the results of a display “x152f” (image 3).

A pseudo colouring and a logarithmic scaling is used.

Image 3 Contrast C = L(bright) / L(dark)

Other graphical presentations are sectional vies f(φ) for θ = const. or sectional views f(θ) for φ = const.. These presentations can be reported using the LMK 2000 software functionality. The Windows clipboard is also supported to enable the export into third party software like MS Word or Excel. Other contrast equations, e.g.
C = (L(bright) – L(dark))/(L(bright) +L(dark)) can be easily applied using the LMK 2000 Software.

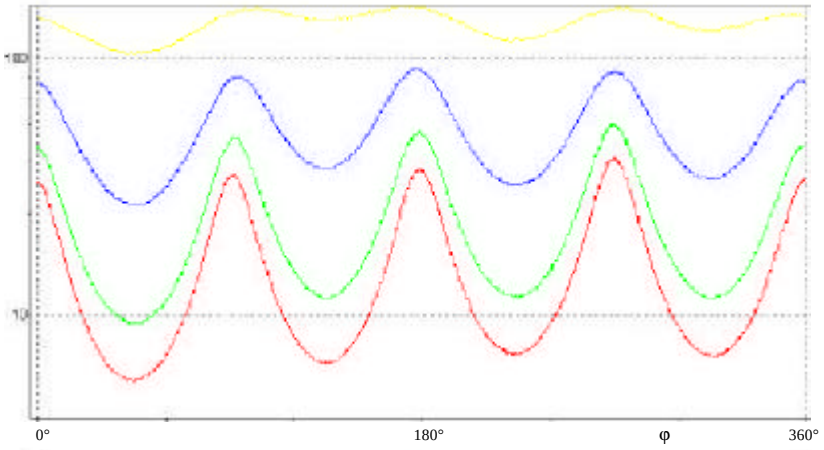


Image 4: Sectional views f(φ) for θ = const

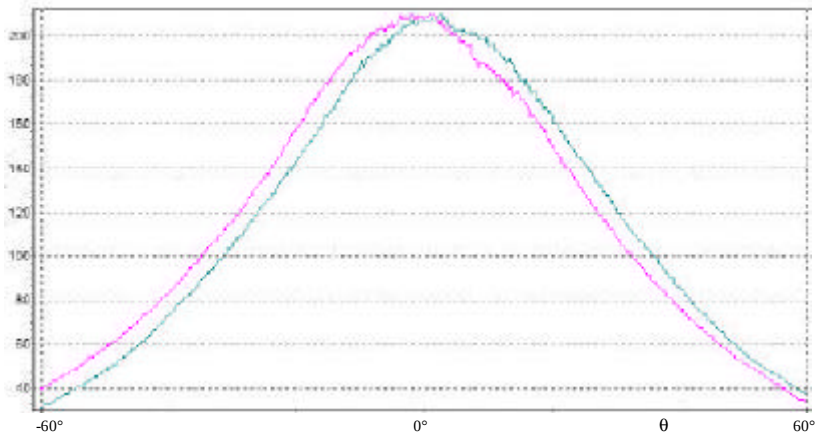


Image 5: Sectional views f(θ) for φ = const

Image 2 is also showing that the ray bundle will have a specific size in the object plane (ca. 5mm). Therefore, some important things have to be considered if the conoscopic lens is used:

1. **Measurement of large areas with uniformity in light distribution.**
   The captured rays are not coming from one and the same position in the object plane (even if the lens is defocused). The measurement is correct only if the light distribution vs. the angle is constant for all location.

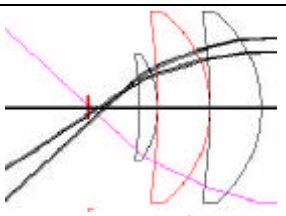


Image 6: Trace of rays used for data acquisition in the object plane

2. **Measurement of large areas with a fine structure (e.g. matrix displays)**
   In the case of fine structures (areas larger than 5mm), The focus must be adjusted exactly to theses structures. This can be realised using the online view. Moire-effects can be obtained caused by the ray tracing shown in image 6. Partial, this problem produces large errors. The problem can be solved using statistic methods. The MultiPic-algorithm (averaging over n images) at simultaneously movements of the object will capture different locations. An averaged distribution of the captured area is the result. This averaged distribution is in most cases the distribution of interest if a display with fine structures (dots on CRT, pixels on LCD) has to be measured. The characteristic of a micro structure is not interesting in such cases. The movement during the capture can be done using swinging mechanics or simply by hand.

3. **Measurement of small objects for there intensity distribution**
   Intensity distributions of small luminous objects require the increasing of the ray bundles which can be captured.

This increasing allows to capture the complete luminous flux which is emitted into a concrete direction. A different lens construction is necessary for this purpose.

The measurement tasks 1,2 can not be done together with task 3 using one and the same lens (caused by different lens constructions).

Using the conoscopic lens function

The menu item „K**onoskop**“ is available in the menu „Extras“ if the consocopic lens is selected as the start option of the LMK 2000 software.

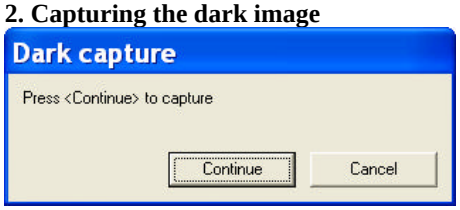
This selection can be done at the start or later on work using the menu item **camera.change lens**.

The following automatic measurement is started if “K**onoskop**” is selcted:

1. Loading of the predefined measurement protocol file konoskop.h5

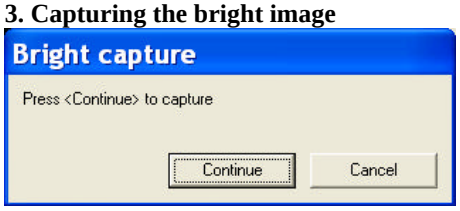
The software is checking the existence of the images which are required for the work with the conoscopic lens: bright capture, dark capture and contrast. The protocol file konoskop.h5 will be loaded if the images are not present at the first time of use. This loading is skipped for the second and following conoscopic measurements.

2. Capturing the dark image



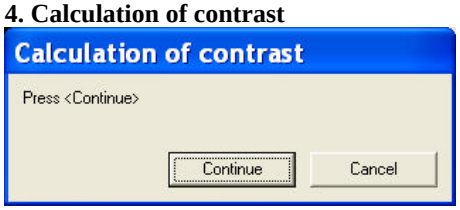
A dialog window is opened before the capture. The user has to press „continue“ if the measurement scene is adjusted correctly. After this, the luminance image is captured using the HighDyn-algorithm (or MultiPic) and the data are copied to the image “dark capture”.

3. Capturing the bright image

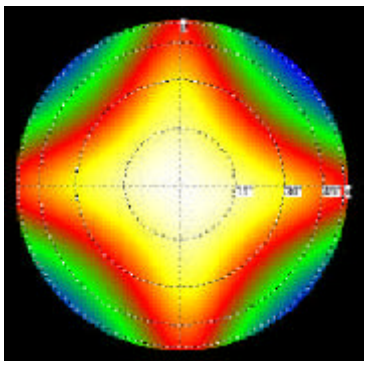


A dialog window is opened before the capture. The user has to press „continue“ if the measurement scene is adjusted correctly. After this, the luminance image is captured using the HighDyn-algorithm (or MultiPic) and the data are copied to the image “bright capture”.

4. Calculation of contrast



After pressing the button “continue”, the quotient of the luminance values of the “bright capture” and of the “dark capture” is calculated and stored into the image “contrast”



The conoscopic measurement is completed with the contrast calculation. The inspector window is showing the statistic results of the measurement regions which are defined in the images. They can be used for further evaluations.