DXOMARK AUTOMOTIVE/ROBOTICS EVALUATION REPORT

LI-VENUS-ISX031-GMSL2-060H

Automotive RGB camera – Standard report

corp.dxomark.com

P2020 Dynamic Range

Standard compliance

The Dynamic Range measurement is fully compliant with IEEE P2020.

Metric details

The dynamic range measurement is performed on pairs of patches (A, B), with a 2:1 contrast ratio between A and B in the scene

Adjusted CNR (Contrast to Noise Ratio):

$$\mathrm{CNR}(A,B) = \frac{s_A - s_B}{\sqrt{\sigma_A^2 + \sigma_B{}^2}} \cdot \frac{c+1}{c-1} \cdot \frac{1}{\sqrt{2}}$$

With:

- s_A, s_B the mean signal of A and B
- σ_A, σ_B the standard deviation of A and B
- c the contrast between A and B in the scene

TCG (Tonal Contrast Gain) is the transfer function between the scene contrast and the image contrast:

$$\mathrm{TCG}(A,B) = \frac{\log_2\left(L_{A,image}/L_{B,image}\right)}{\log_2\left(L_{A,scene}/L_{B,scene}\right)}$$

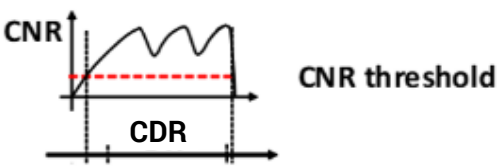
With:

- $L_{A,image}$, $L_{B,image}$ the mean signal of A and B in the image.
- $L_{A,scene}$, $L_{B,scene}$ the luminance of A and B in the scene.

CDR (Contrast Detection Ratio) is the dynamic range measured from CNR:

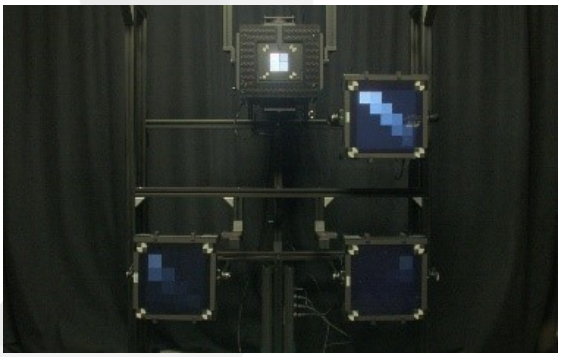
$$\mathrm{CDR}_{dB} = 20\log_{10}\left(\frac{L_{max}[\mathrm{CNR}>1]}{L_{min}[\mathrm{CNR}>1]}\right)$$

With $L_{max}[CNR>1]$, $L_{min}[CNR>1]$ the maximum and minimum luminance values that verify $CNR>1$.



Measurement setup specifications

The dynamic range setup is an assembly of 4 light panels and charts, delivering 25 patches that can reach 170dB dynamic.



SFR

Standard compliance

The SFR measurement is fully compliant with the standard ISO 12233.

Metric details

SFR is computed in a linearized image

Metrics are computed in 15 different field positions.

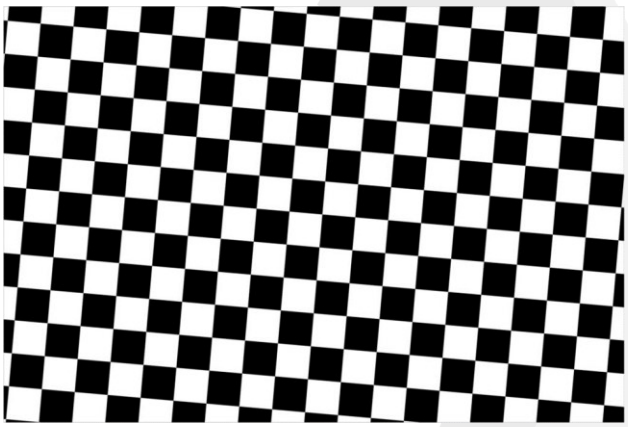
SFR measurement compensates the target printer MTF. The target MTF is measured compared to a true cutter target, and it is then taken into account during the camera MTF measurement

- **MTF** curve with frequency in cycles/pixels
- **MTF10** and **MTF50**: (raw images only) frequency (in cycles/pixel) corresponding to MTF=10% and 50%
- **MTF@Nyq/2** and **MTF@Nyq/16**: (raw images only) MTF value at frequency = 1/2 and 1/16 of Nyquist frequency

Measurement setup specifications

High contrast checkerboard chart

Through focus method is used to find the best focus.



SFR at Infinity

Standard compliance

The SFR measurement is fully compliant with the standard ISO 12233.

Metric details

A slanted edge is backlit with a collimated light source. This allows the SFR measurement to be performed on devices focused at infinity.

SFR is computed in a linearized image

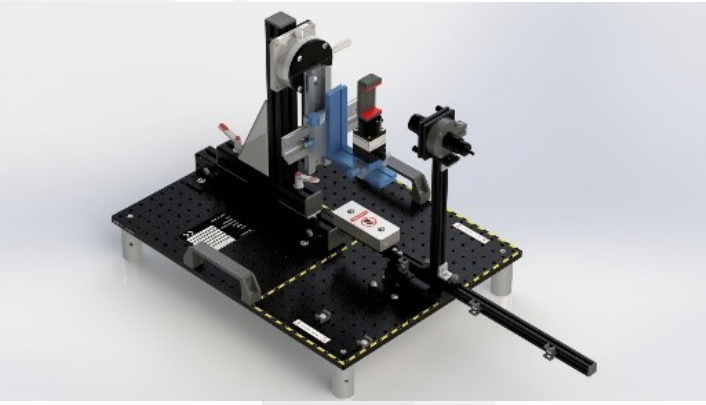
Metrics are computed in 15 different field positions.

SFR measurement compensates for the collimator reticle MTF during the camera MTF measurement. The collimator reticle MTF is measured compared to a true cutter target.

- **MTF profile:** MTF curve for each field position, with frequency in cycles/pixels
- **Acutance in the field:** acutance values for all tested positions

Measurement setup specifications
COMPASS bench with collimator:

- Focal length: 50 mm
- External diameter: 30 mm
- Reticle: Slanted edge 12 mm
- Aperture: f/2.8
- Motorized arm for rotating the slanted edge between -160° and +160°



Texture Preservation

Standard compliance

The Texture measurement is fully compliant with IEEE CPIQ 1858.

Metric details

The measurement is performed on a display-referred linearized image

Acutance

- **Texture acutance:** acutance measured on the textured patch
- **Edge acutance:** acutance measured on slanted edges

Visual Noise

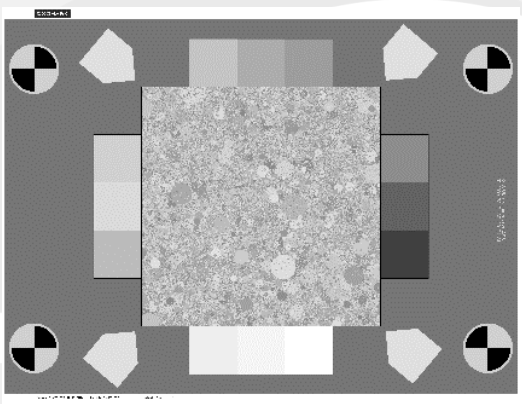
$$\text{Visual Noise} = 6.87 \cdot \log_{10}\left(1 + \sigma_{L^*}^2 + \sigma_{a^*}^2 + \sigma_{b^*}^2\right)$$

measured for $L^* = 50$

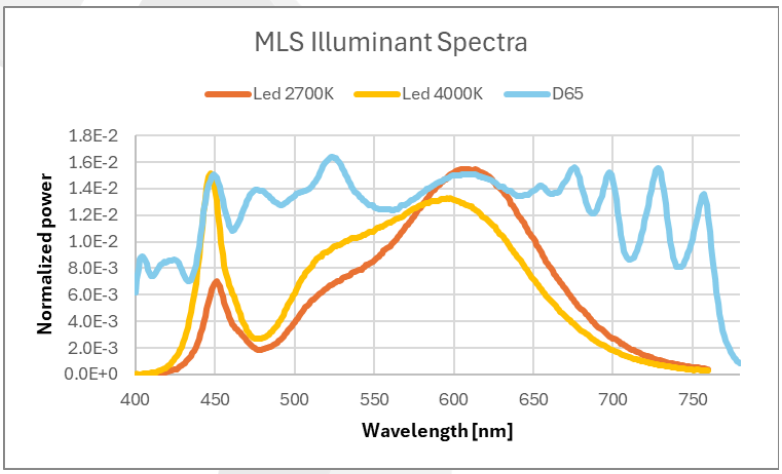
Reference article: *F. Cao, F. Guichard, and H. Hornung. "Dead leaves model for measuring texture quality on a digital camera." Digital Photography VI. Vol. 7537. SPIE, 2010.*

Measurement setup specifications

Texture chart



The MLS allows to reproduce precisely the spectra of the different use cases.



SNR

Metric details

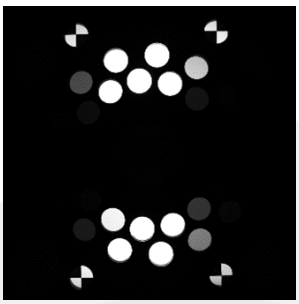
- **Mean signal** and **noise standard** deviation are computed for each patch
- **Signal-to-noise ratio (SNR)**, computed as:

$$\mathrm{SNR}_{dB} = 20 \cdot \log_{10}\left(\frac{\mu}{\sigma}\right)$$

with μ the mean signal and σ the standard deviation

Measurement setup specifications

DXOMARK HDRNoise target (for manual exposure devices), or calibrite ColorChecker target



Color Fidelity

Standard compliance

The Color Fidelity measurement is fully compliant with ISO 17321-1:2012, and uses the colors spaces and Euclidean distances defined in the CIELAB specifications emanated in ISO 11664-4:2019.

Metric details

CIELAB is a color space designed to be hue-linear and perceptually uniform. The color fidelity measurement converts the measured image into this color space and compares measured values to the CIELAB ground truth.

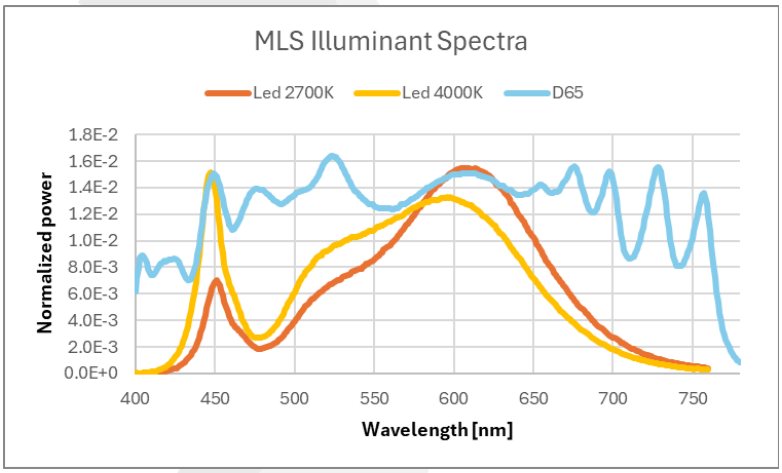
Metrics are computed without exposure or white balance correction

- **Color rendering:** average $\Delta a^* b^*$ value on all colored patches
- **White balance accuracy:** average $\Delta a^* b^*$ value on the 4 gray patches (excluding black and white patches)
- **Color rendering map:** the squares represent the CIELAB reference values for each colored patch. The end of the arrows represent the corresponding measured $\Delta a^* b^*$ value

Measurement setup specifications

24 patches calibrite ColorChercker chart

The MLS allows to reproduce precisely the spectra of the different use cases.



P2020 Flicker Mitigation

Standard compliance

The flicker mitigation measurement is fully compliant with IEEE P2020.

Metric details

Flicker Modulation Index (FMI):

$$FMI = 100 \times \frac{s_{max} - s_{min}}{s_{max} + s_{min}}$$

With s_{max} and s_{min} the maximum and minimum values of the measured signal for the considered time-range of the video.

Flicker Detection Index (FDI):

$$FDI = P\left[\frac{s(t) - s_{off}}{s_{off}} \geq \text{th}\right]$$

Where:

- P[x] is the probability of x.
- $s(t)$ is the measured signal.
- s_{off} is the measured signal when the PMW signal is off.
- th is a minimum threshold above which the LED is considered visible.

Modulation Mitigation Probability (MMP):

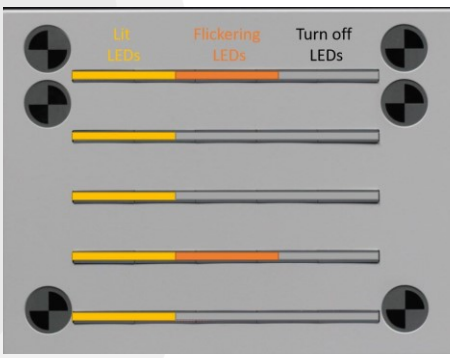
$$MMP = P\left[\overline{s_{ref}}(1-\delta) < s(t) < \overline{s_{ref}}(1+\delta)\right]$$

Where:

- P[x] is the probability of x.
- $s(t)$ is the measured signal.
- $\overline{s_{ref}}$ is the expected signal.
- δ is a parameter defining the lower and upper bounds of the signal interval in which the device is considered as able to successfully mitigate the LED flickering.

Measurement setup specifications

Flicker is generated by the DXOMARK LED Universal Timer. This device provides a light modulated by a square signal with frequency in range [50, 2000] Hz, adjustable duty cycle, phase and intensity.



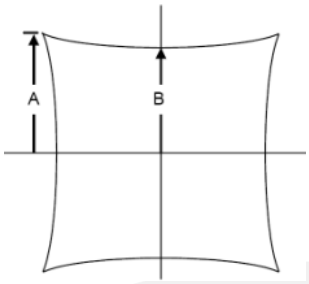
Distortion and lateral chromatic aberration

Standard compliance

The lens distortion measurement is fully compliant with ISO 17850, and the chromatic aberration measurement is fully compliant with ISO 19084.

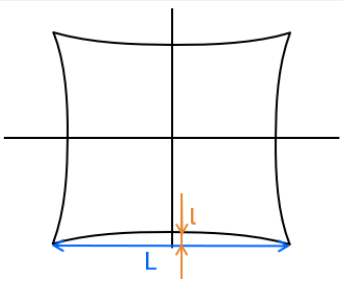
Metric details

TV distortion: $100 \cdot \frac{(A-B)}{B}$, with A and B defined on the following figure:

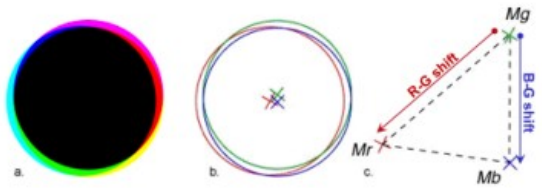


Distortion model reprojection error in pixels and ‰ of of image width, showing the precision of the distortion model.

Geometric distortion: $100 \cdot \frac{l}{L}$, with l and L defined on the following figure:



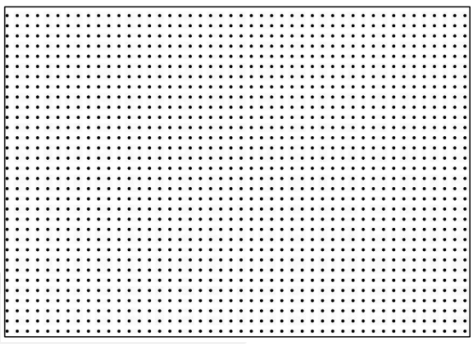
Chromatic aberrations: shift between R and G, and between B and G



Definition of chromatic aberration profiles

Measurement setup specifications

Glass-supported dot chart, offering a very flat surface: less than 1mm planarity difference between the center and the corners of the chart.



Vignetting and Color Lens Shading

Standard compliance

The Vignetting/Color Lens Shading measurement is fully compliant with the standard ISO 17957.

Metric details

Vignetting:
- **Vignetting Profile:** gray level value divided by the gray level value at the vignetting center, for each radial field position and each color channel.
- **Max attenuation:** $\max(1 - \text{VignettingProfile}) \times 100$
- **Max amplification:** $\max(\text{VignettingProfile} - 1) \times 100$

Color Vignetting:
- **Color Vignetting Profile:** each channel vignetting divided by green (average of G1 and G2 channels for raw images).
- **Max Attenuation:** $\max(1 - \text{ColorVignettingProfile}) \times 100$
- **Max Amplification:** $\max(\text{ColorVignettingProfile} - 1) \times 100$
- **Green Imbalance** (raw images only): maps of the relative difference between G1 and G2 channels.

Measurement setup specifications

Litepanels Gemini LED panel or Integrating sphere RO-LIS-3CR80

Chip total size	53x25x25 mm
Pixel size	3 µm
Max resolution	1920x1536
Full frame rate	60 fps
Lens FOV (H)	60°
Sensor format	1/2.42"
Shutter control	Rolling shutter

Testing Conditions

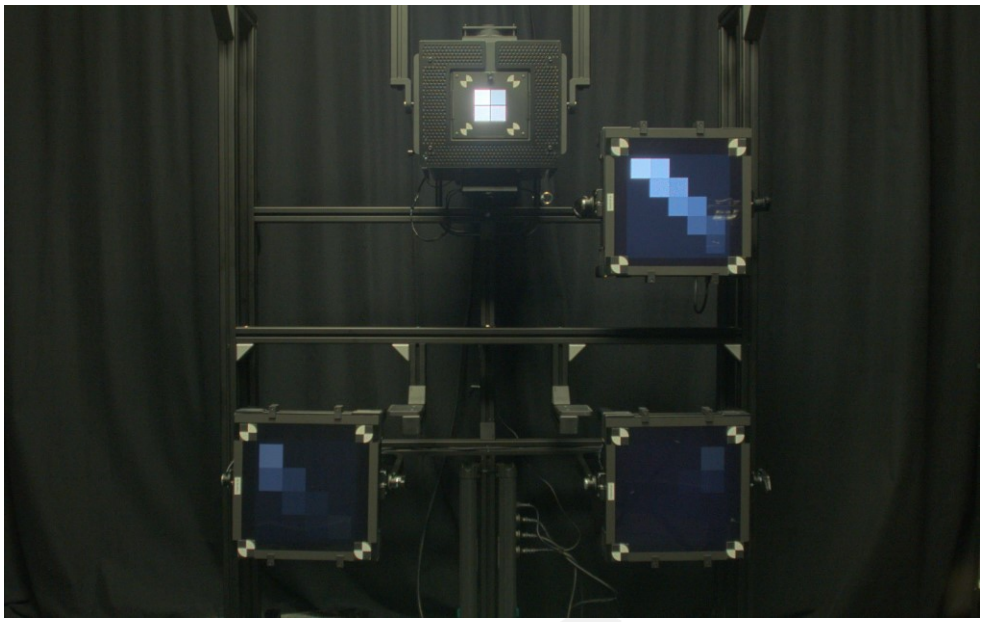
Mode sensor	HDR&LFM
Frame Grabber	LI-GMSL2-USB
SW version	ISX031_STD_v3.45_V3027_3M_30_M4_YUV_ESOW_Int_SYNC
Output	RGB

Framerate	30 fps
Image resolution	1920x1536
Exposure	Auto-exposure

Overall Performance

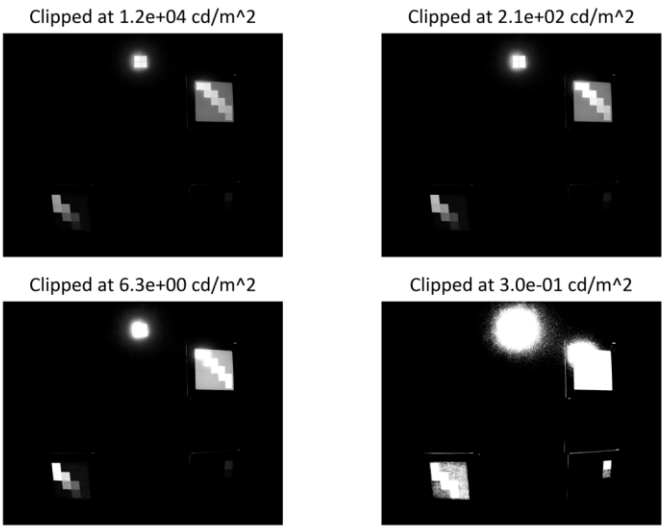
Center acutance	78%
Corner acutance	52%
Max vignetting amplification	23%
TV distortion	-13%
Chromatic aberrations	< 0.5 pixel

DR P2020 (140 dB setup)	133 dB
Half-dynamic SNR (D65 100 lux)	40 dB
Visual Noise (D65 100 lux)	13.5
Color rendering Δa*b* (D65 100 lux)	9.8

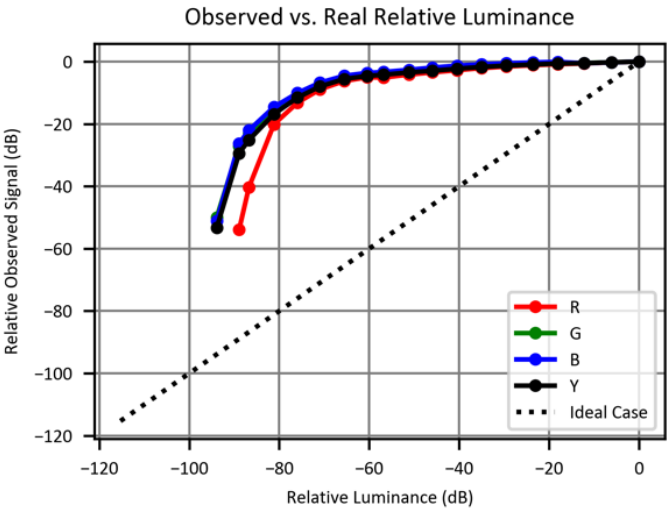


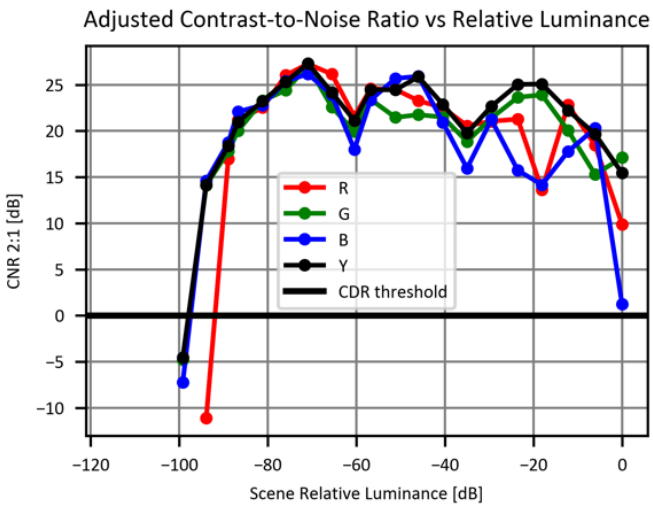
- **Measurement conditions**
  - 4 lighting conditions:
    - patch luminance from 0.012 cd/m² to 12400 cd/m² (120 dB)
    - patch luminance from 0.012 cd/m² to 43100 cd/m² (131 dB)
    - patch luminance from 0.012 cd/m² to 133500 cd/m² (141 dB)
    - patch luminance from 0.012 cd/m² to 517500 cd/m² (153 dB)
- **Results**
  - Maximum measured dynamic range: 132 dB (observed for 141dB configuration)
  - In the 153dB configuration, dynamic range is reduced by tone compression

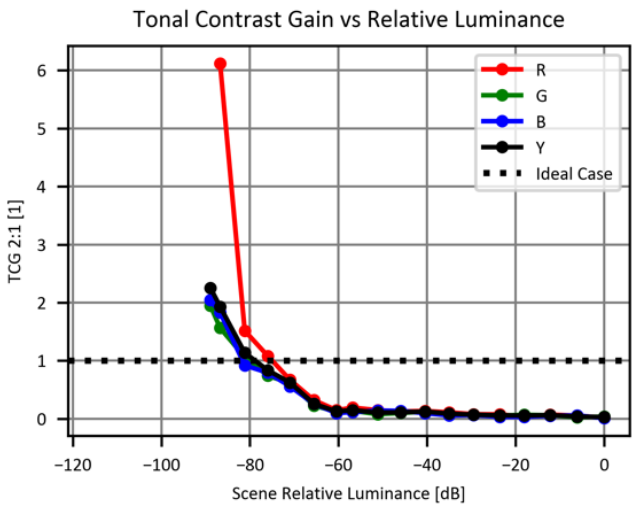
Image preview with different amplification factors



120 dB setup with maximum scene luminance 12400 cd/m²



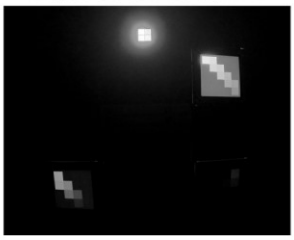




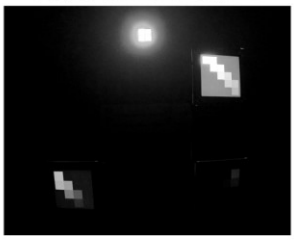
	R	G	B	Y
CDR (dB)	91.9	97.9	97.4	97.9
Lmin (cd/m^2)	2.2e-01	1.1e-01	1.2e-01	1.1e-01
Lmax (cd/m^2)	8.8e+03	8.8e+03	8.8e+03	8.8e+03

Image preview with different amplification factors

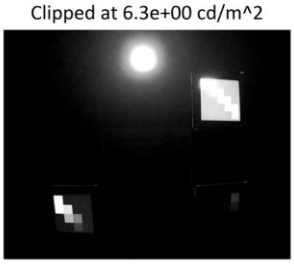
Clipped at 4.3e+04 cd/m^2



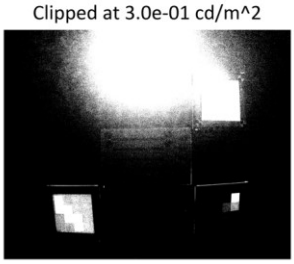
Clipped at 2.1e+02 cd/m^2



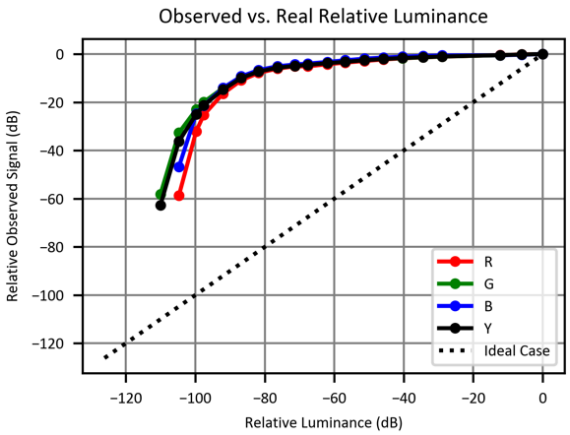
Clipped at 6.3e+00 cd/m^2

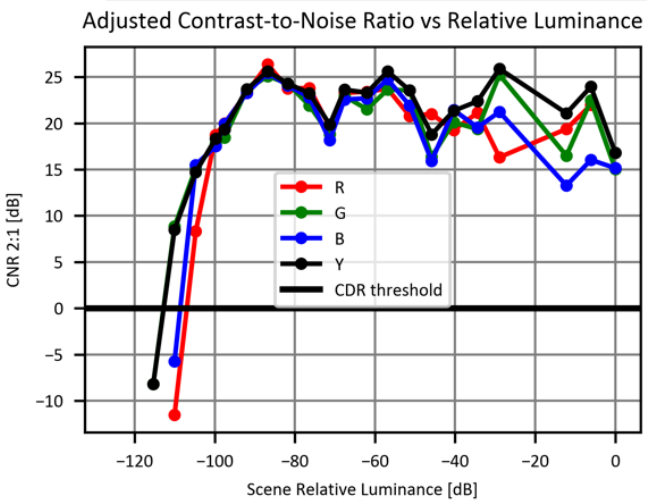


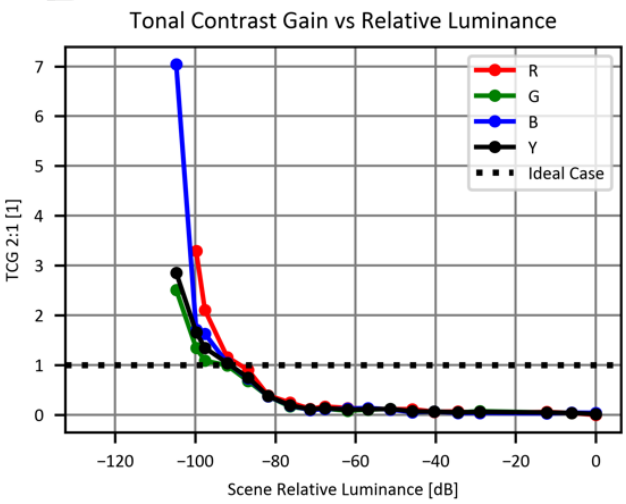
Clipped at 3.0e-01 cd/m^2



131 dB setup with maximum scene luminance 43100 cd/m²



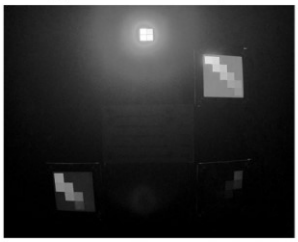




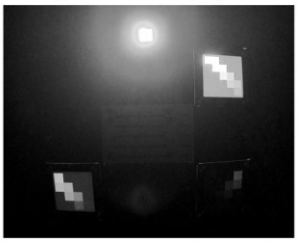
	R	G	B	Y
CDR (dB)	100.9	112.8	108.6	112.7
Lmin (cd/m^2)	1.4e-01	7.0e-02	1.1e-01	7.1e-02
Lmax (cd/m^2)	1.5e+04	3.1e+04	3.1e+04	3.1e+04

Image preview with different amplification factors

Clipped at 1.3e+05 cd/m^2



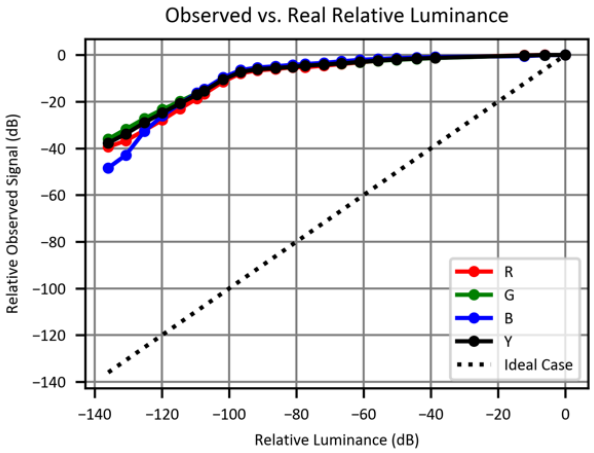
Clipped at 2.1e+02 cd/m^2

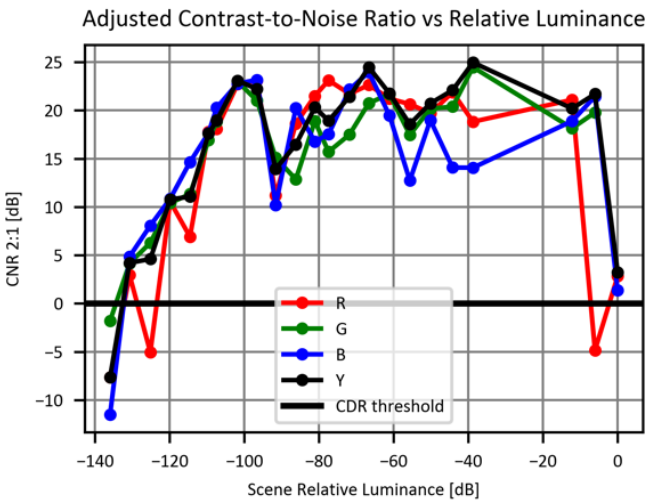


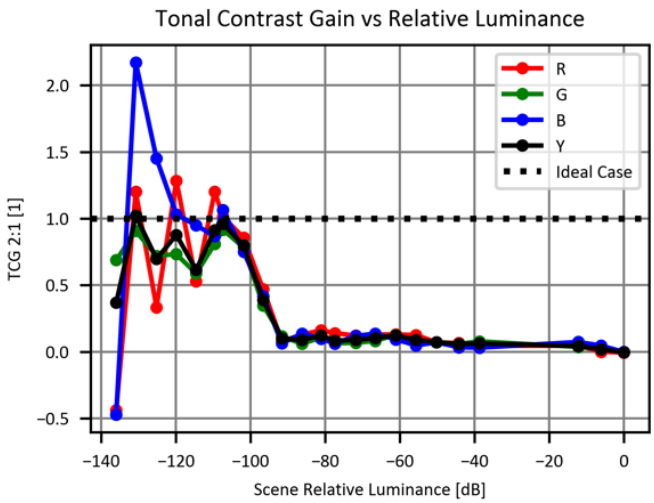
Clipped at 6.3e+00 cd/m^2

Clipped at 3.0e-01 cd/m^2

141 dB setup with maximum scene luminance 133500 cd/m²



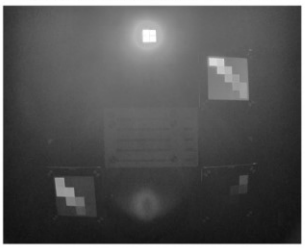




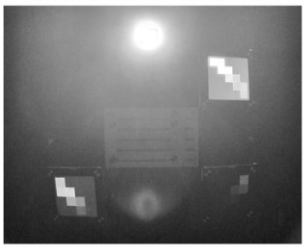
	R	G	B	Y
CDR (dB)	116.2	128.3	132.3	132.6
Lmin (cd/m^2)	6.4e-02	1.8e-02	2.3e-02	2.2e-02
Lmax (cd/m^2)	4.1e+04	4.7e+04	9.5e+04	9.5e+04

Image preview with different amplification factors

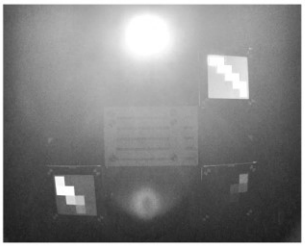
Clipped at 5.2e+05 cd/m^2



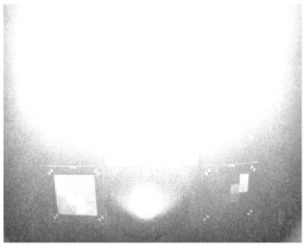
Clipped at 2.1e+02 cd/m^2



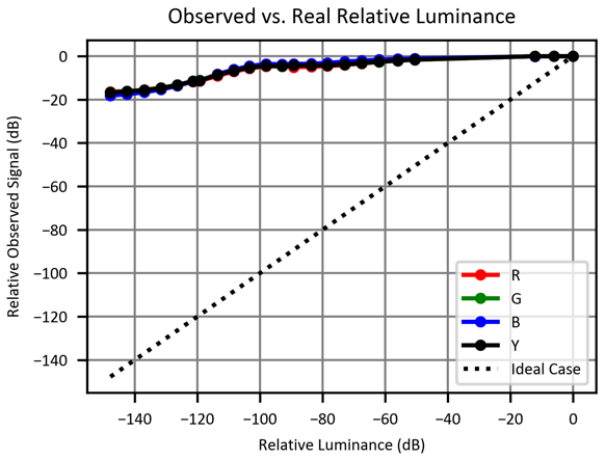
Clipped at 6.3e+00 cd/m^2

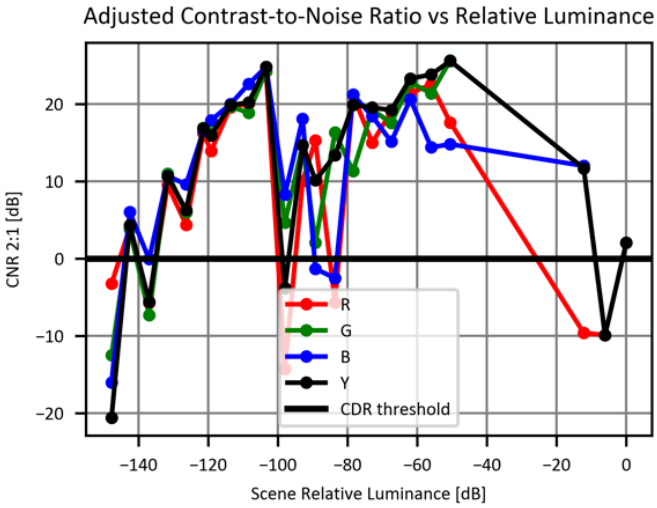


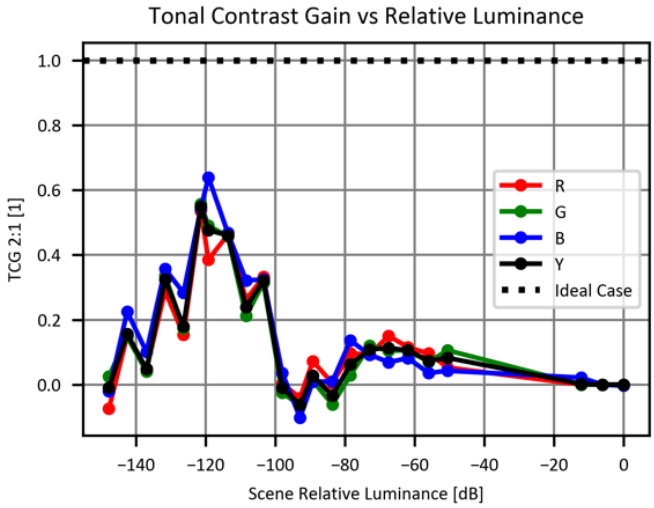
Clipped at 3.0e-01 cd/m^2



153 dB setup with maximum scene luminance 517500 cd/m²



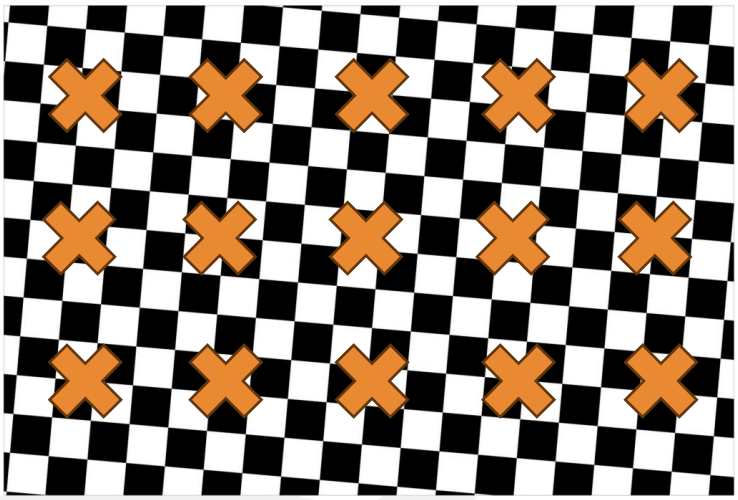




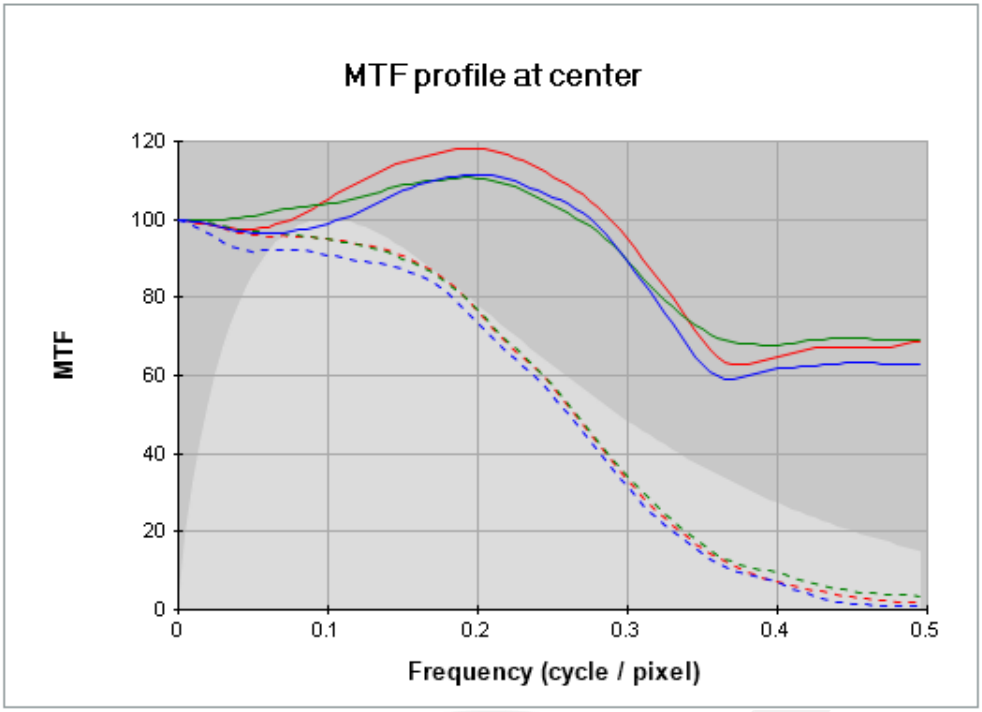
	R	G	B	Y
CDR (dB)	56.8	84.3	70.8	88.0
Lmin (cd/m^2)	2.8e+01	6.7e-02	2.6e+01	5.2e+00
Lmax (cd/m^2)	1.9e+04	1.1e+03	9.0e+04	1.3e+05

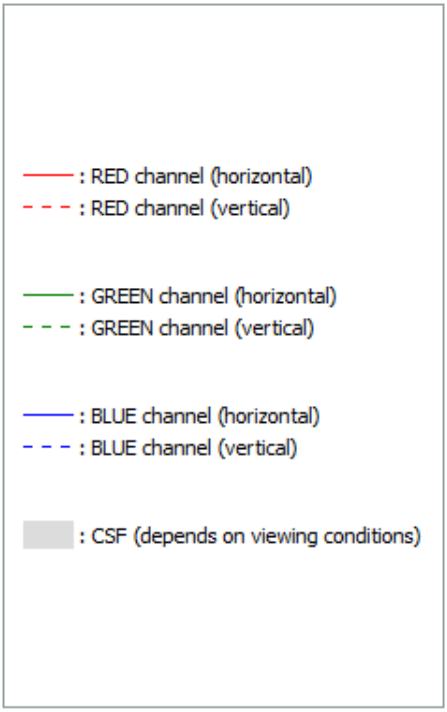
- **Sharpness is evaluated with 4 different measurements:**
  - Edge acutance in the field of view on a high contrast chart
  - Edge acutance in the field of view at infinity
  - Edge acutance in different lighting conditions on a low contrast chart
  - Texture acutance in different lighting conditions on a textured patch
- **Results**
  - The high contrast chart shows strong over-sharpening.
  - Sharpening is inconsistent across horizontal and vertical directions, which is generally not wanted.
  - Sharpness is reduced in the corners, which means that the sharpening process does not compensate for optical loss of sharpness in the corners.
  - Flare on the collimator image reduces measured sharpness.
  - Sharpening depends on lighting conditions: more sharpening is done in bright light.

The measurement is performed for different positions in the field of view of the device:



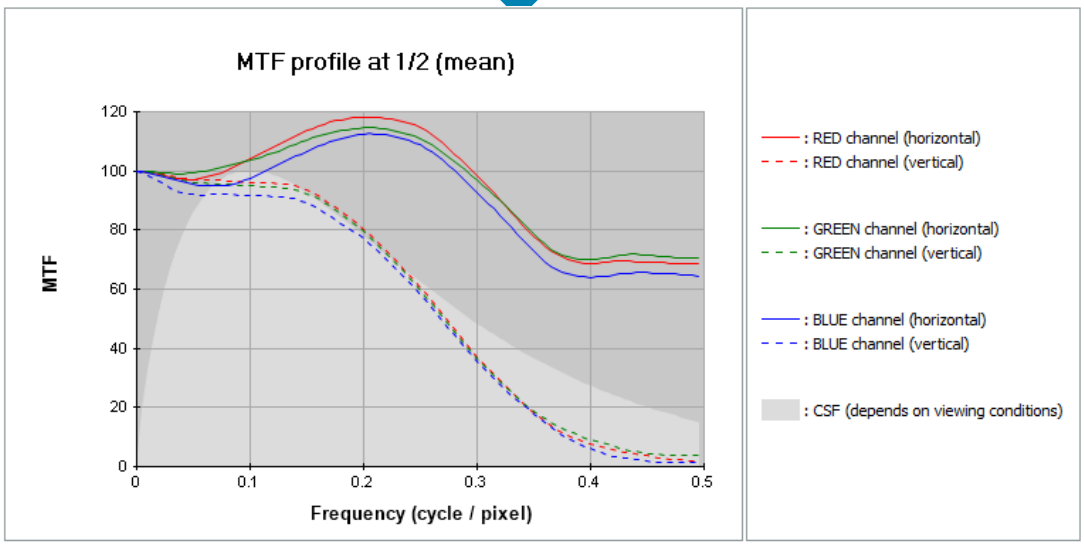
- **Measurement conditions:**
  - Illumination: D65 1000lux
  - Through focus to find the position with best sharpness in the center:
    - DUT to chart distance: 65cm
  - Viewing condition for acutance computation:
    - Distance: 600mm
    - Pixel pitch: 0.254mm

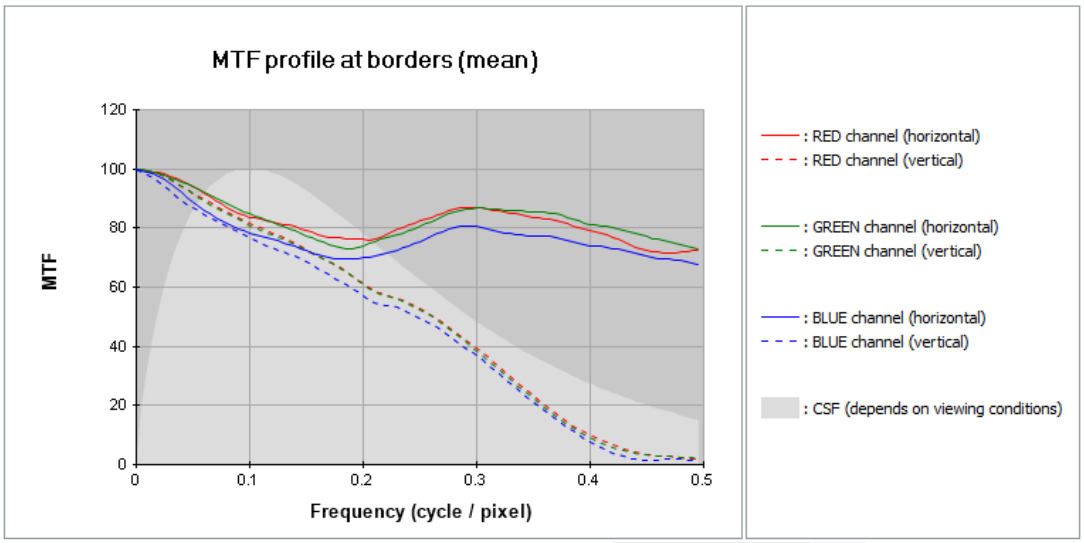


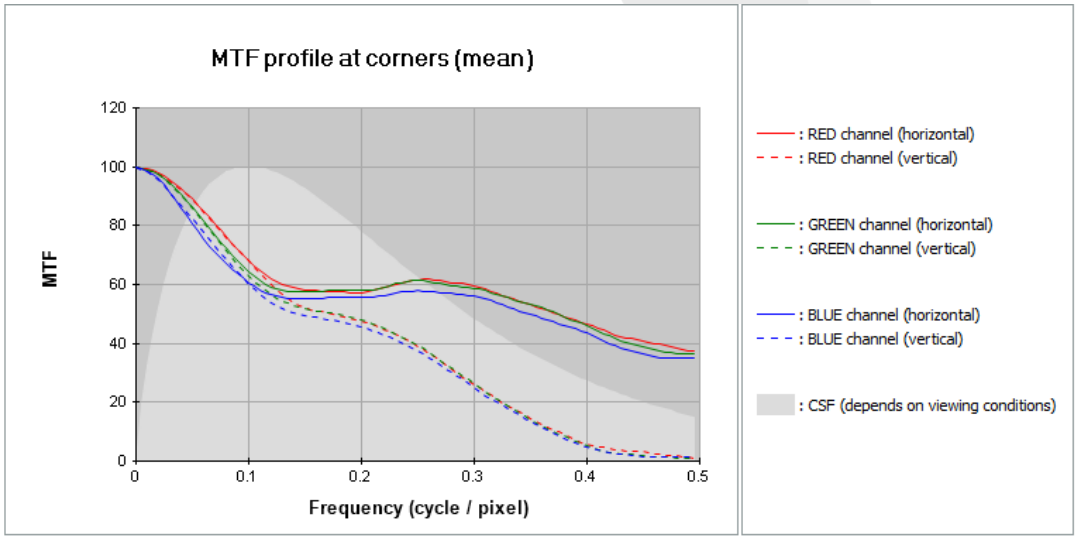


	Center			All corners (mean)		
	R	G	B	R	G	B
Acutance (%)	79	78	75	53	52	50

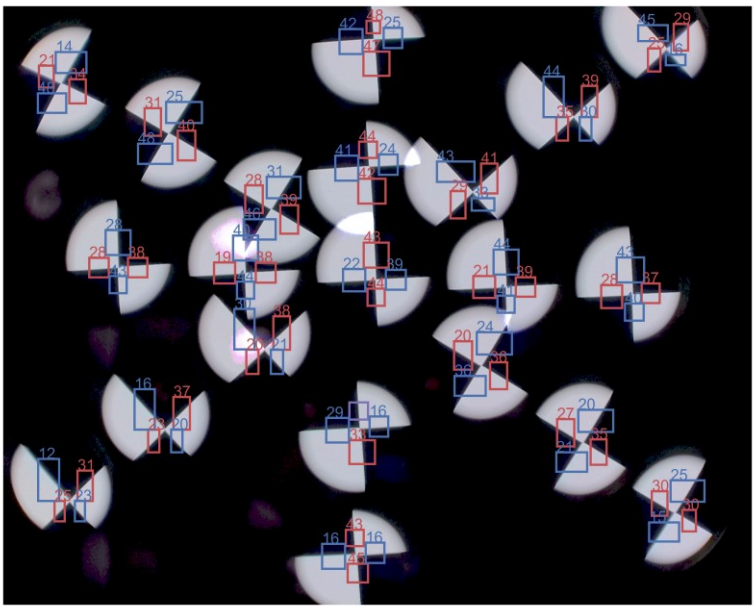
Conversion factor between cycles/pixels and cycles/degrees	
Pixel/Degree	40.212


MTF profile at 1/2 (mean)
MTF
120
100
80
60
40
20
0
0
0.1
0.2
0.3
0.4
0.5
Frequency (cycle / pixel)
: RED channel (horizontal)
: RED channel (vertical)
: GREEN channel (horizontal)
: GREEN channel (vertical)
: BLUE channel (horizontal)
: BLUE channel (vertical)
: CSF (depends on viewing conditions)

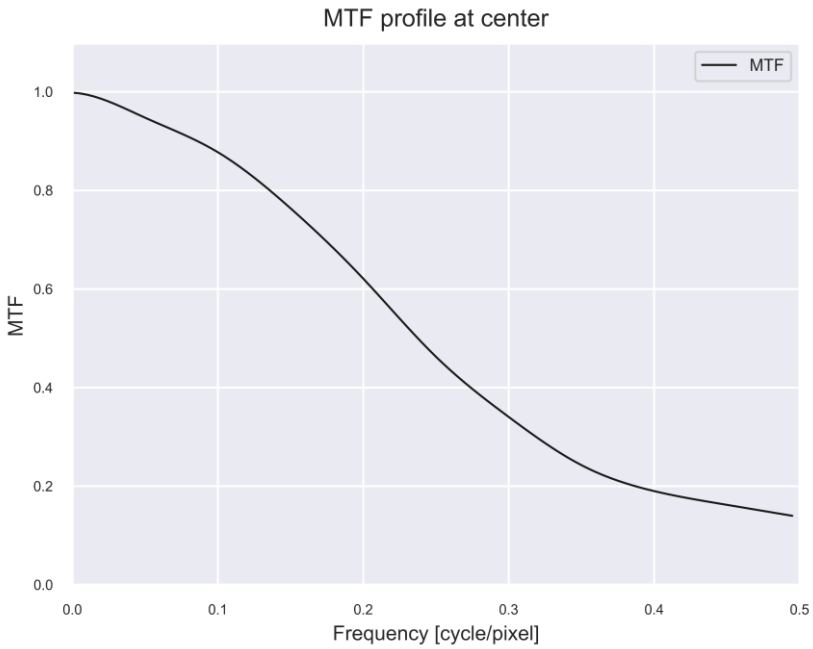

MTF profile at borders (mean)
MTF
120
100
80
60
40
20
0
0
0.1
0.2
0.3
0.4
0.5
Frequency (cycle / pixel)
: RED channel (horizontal)
: RED channel (vertical)
: GREEN channel (horizontal)
: GREEN channel (vertical)
: BLUE channel (horizontal)
: BLUE channel (vertical)
: CSF (depends on viewing conditions)

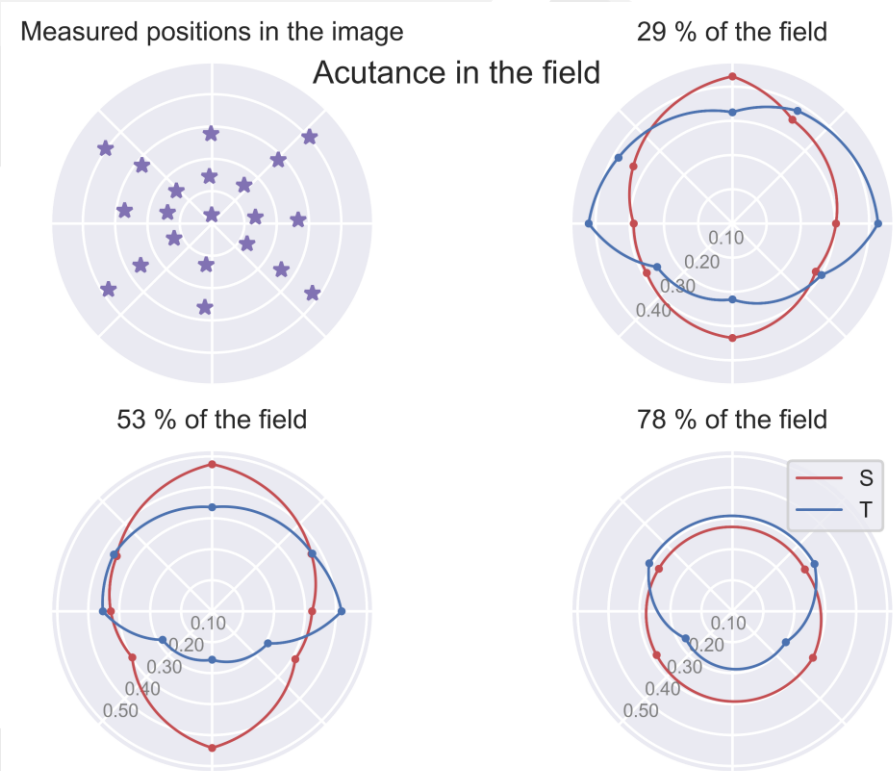

MTF profile at corners (mean)
MTF
120
100
80
60
40
20
0
0
0.1
0.2
0.3
0.4
0.5
Frequency (cycle / pixel)
: RED channel (horizontal)
: RED channel (vertical)
: GREEN channel (horizontal)
: GREEN channel (vertical)
: BLUE channel (horizontal)
: BLUE channel (vertical)
: CSF (depends on viewing conditions)

The measurement is performed for different positions in the field of view of the device:

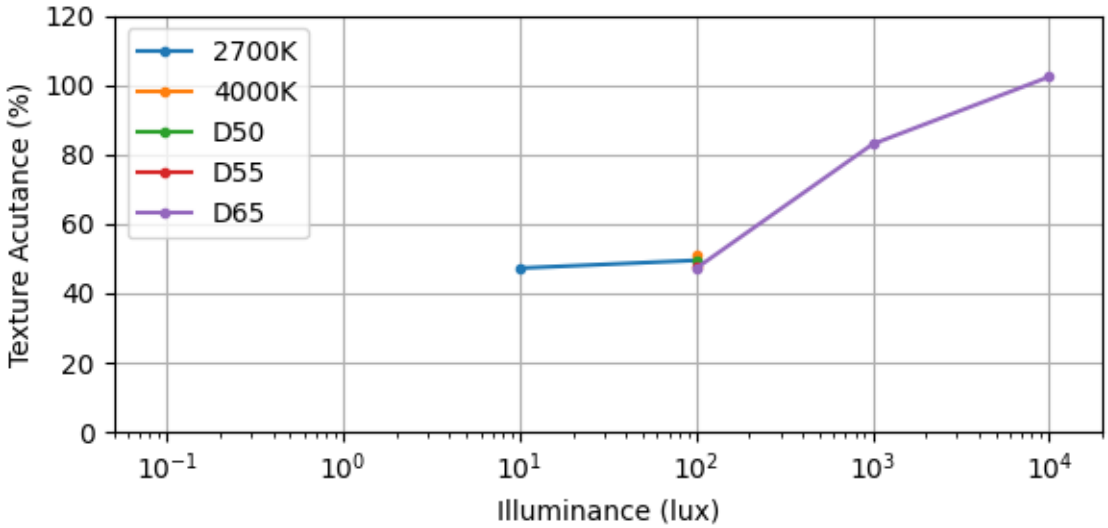


- **Measurement conditions:**
  - Slanted edge at infinity
  - Viewing condition for acutance computation:
    - Distance: 600mm
    - Pixel pitch: 0.254mm


MTF profile at center
MTF
1.0
0.8
0.6
0.4
0.2
0.0
MTF
0.0
0.1
0.2
0.3
0.4
0.5
Frequency [cycle/pixel]


Measured positions in the image
Acutance in the field
29 % of the field
0.10
0.20
0.30
0.40
53 % of the field
0.10
0.20
0.30
0.40
0.50
78 % of the field
S
T
0.10
0.20
0.30
0.40
0.50

- Texture Acutance

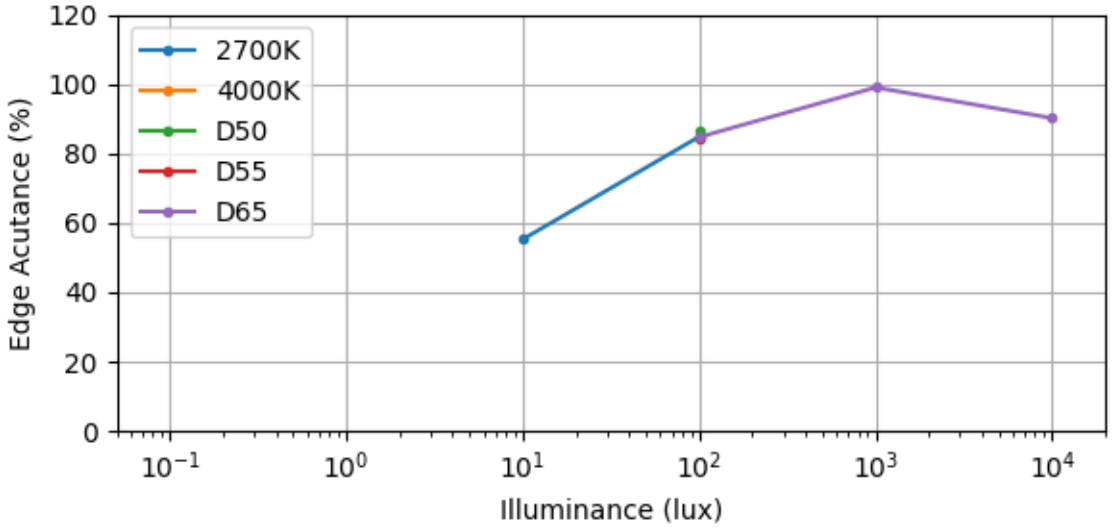


Texture Acutance (%)

	2700K	4000K	D50	D55	D65
0.1 lux		NOK			
1 lux		NOK			
10 lux	47.2				
100 lux	49.5	51.1	49.4	47.6	47.2
1000 lux					82.9
10000 lux					102.3

- Viewing conditions:
  - Distance: 600mm
  - Pixel pitch: 0.254mm
- Underexposed image for 4000K 0.1 lux and 1 lux

- Edge Acutance

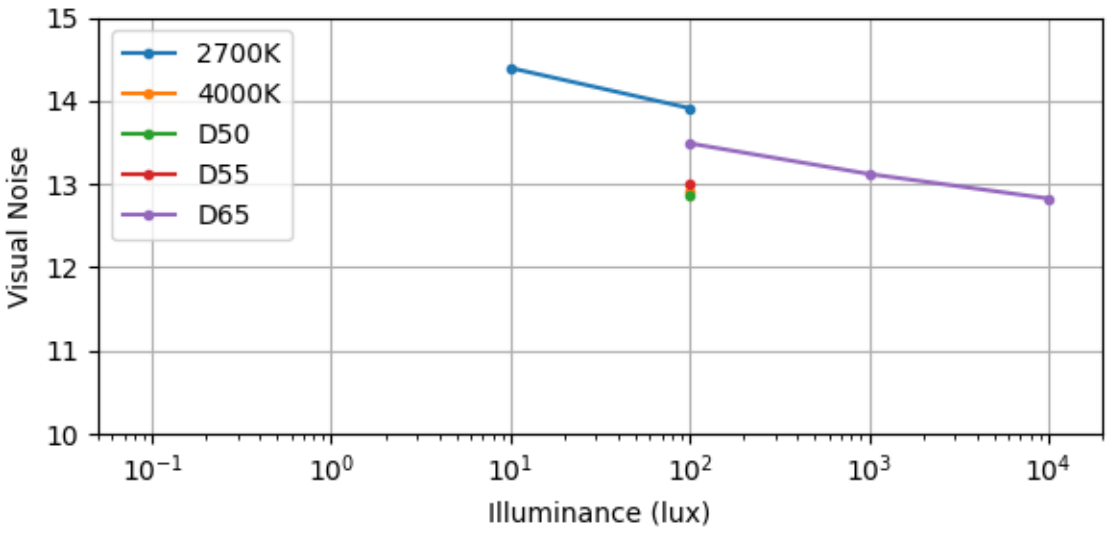


Edge Acutance (%)

	2700K	4000K	D50	D55	D65
0.1 lux		NOK			
1 lux		NOK			
10 lux	55.2				
100 lux	84.8	84.7	86.2	84.4	84.7
1000 lux					99.0
10000 lux					90.1

- Viewing conditions:
  - Distance: 600mm
  - Pixel pitch: 0.254mm
- Underexposed image for 4000K 0.1 lux and 1 lux

- Visual Noise

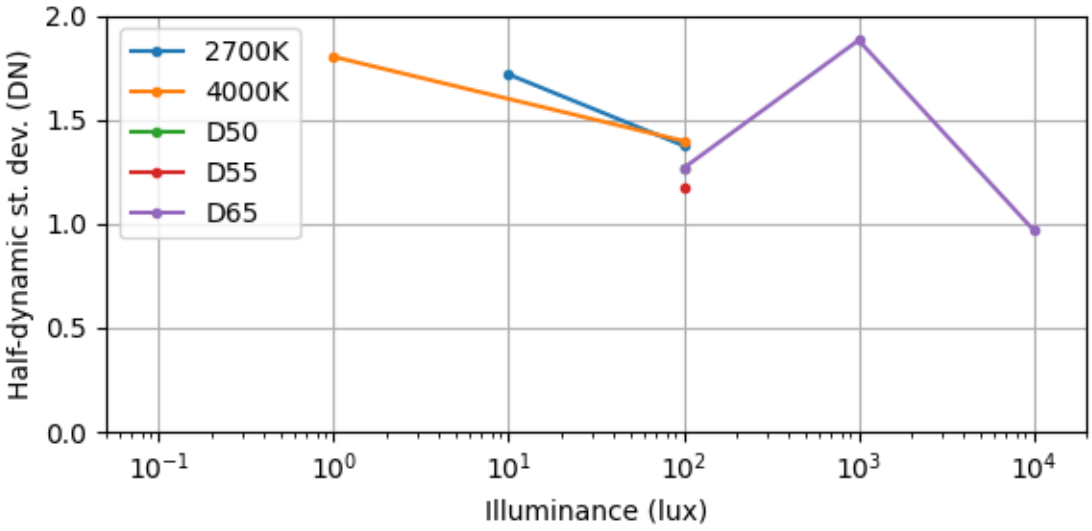


Visual Noise

	2700K	4000K	D50	D55	D65
0.1 lux		NOK			
1 lux		NOK			
10 lux	14.4				
100 lux	13.9	12.9	12.9	13.0	13.5
1000 lux					13.1
10000 lux					12.8

- Viewing conditions:
  - Distance: 600mm
  - Pixel pitch: 0.254mm
- Underexposed image for 4000K 0.1 lux and 1 lux
- Results
  - Significant amount of visual noise across all lighting conditions

- Standard deviation for Grey Level = 128 (interpolated)

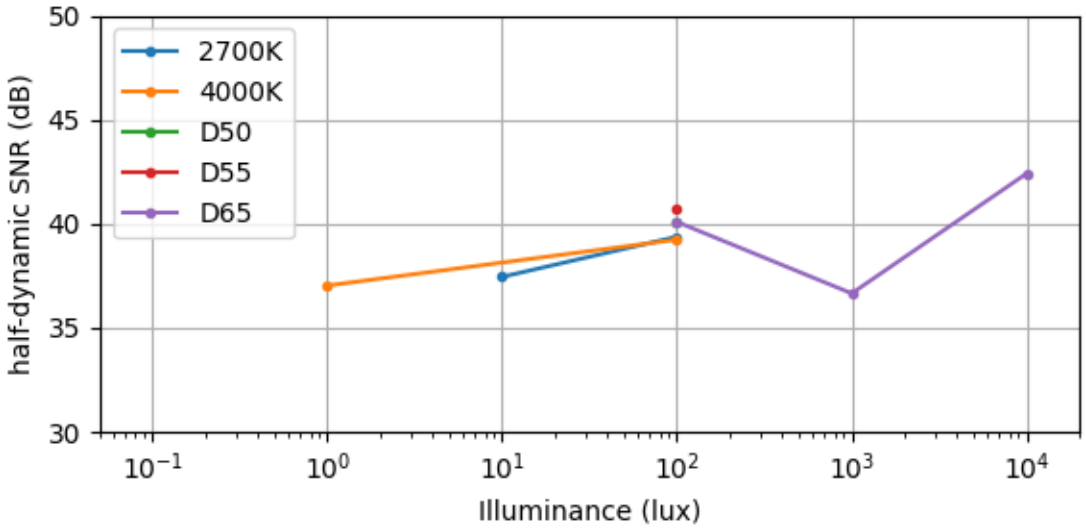


Half-dynamic st. dev. (DN)

	2700K	4000K	D50	D55	D65
0.1 lux		NOK			
1 lux		1.8			
10 lux	1.7				
100 lux	1.4	1.4	1.3	1.2	1.3
1000 lux					1.9
10000 lux					1.0

- Underexposed image for 4000K 0.1 lux
- The behavior of the camera is little unstable across lighting conditions: larger noise st. dev. at 1000 lux compared to 100 lux

- SNR for Grey Level = 128 (interpolated)

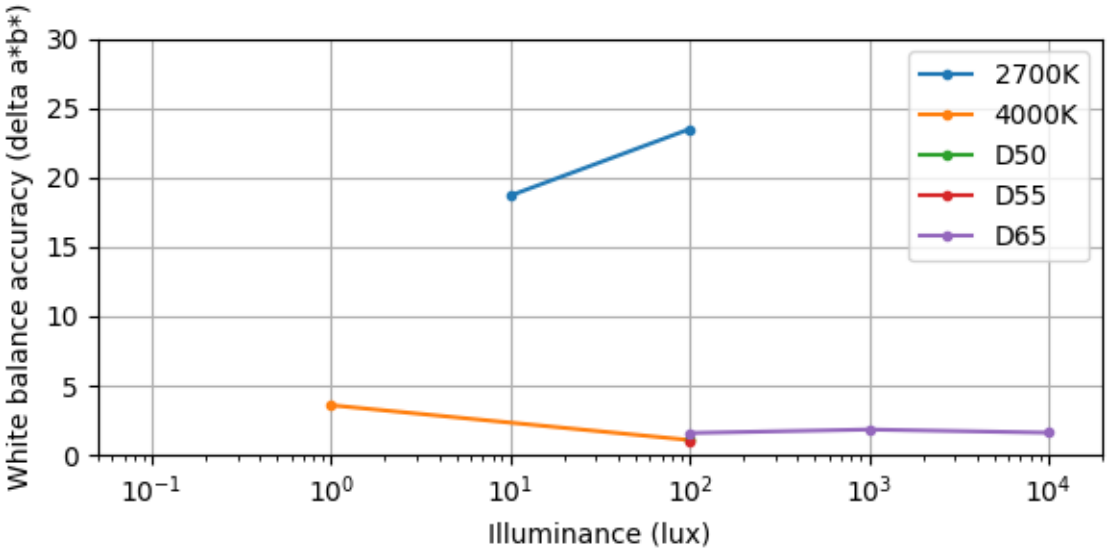


half-dynamic SNR (dB)

	2700K	4000K	D50	D55	D65
0.1 lux		NOK			
1 lux		37.0			
10 lux	37.4				
100 lux	39.4	39.2	40.1	40.7	40.1
1000 lux					36.7
10000 lux					42.4

- Underexposed image for 4000K 0.1 lux
- The behavior of the camera is little unstable across lighting conditions: smaller SNR at 1000 lux compared to 100 lux

- White balance accuracy

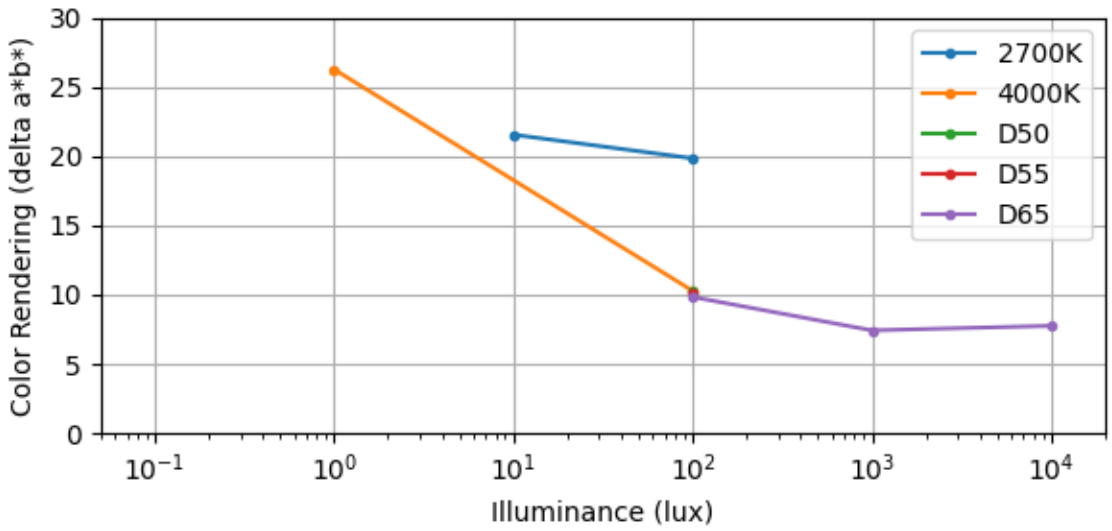


White balance accuracy (delta a*b*)

	2700K	4000K	D50	D55	D65
0.1 lux		NOK			
1 lux		3.6			
10 lux	18.7				
100 lux	23.5	1.1	1.1	1.0	1.6
1000 lux					1.8
10000 lux					1.6

- Underexposed image for 4000K 0.1 lux
- Wrong white balance at 2700 K: color cast
- White balance is very accurate for other lighting conditions

- Color Rendering

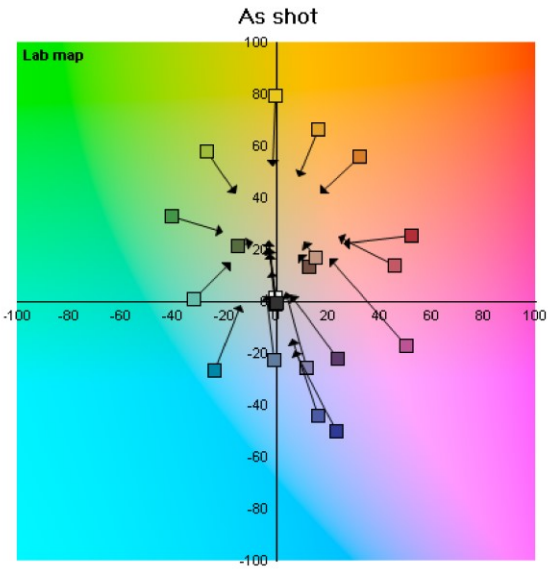


Color Rendering (delta a*b*)

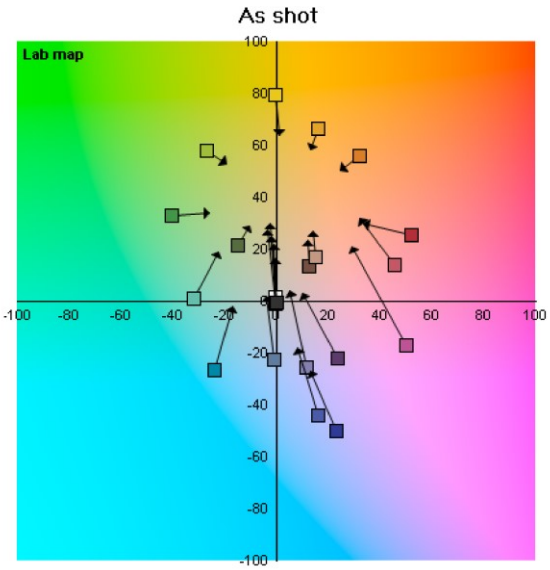
	2700K	4000K	D50	D55	D65
0.1 lux		NOK			
1 lux		26.2			
10 lux	21.5				
100 lux	19.8	10.3	10.2	10.1	9.8
1000 lux					7.4
10000 lux					7.8

- Underexposed image for 4000K 0.1 lux
- Images in low light (1 lux and 10 lux) are underexposed. White balance at 2700K is wrong. This explains the larger color rendering values.
- Good color rendering at 1000 lux and 10000 lux
- For other lighting conditions, colors are different from theoretical colors, but it could be a manufacturer's choice

Illuminant: 2700K 10 lux



Illuminant: 2700K 100 lux

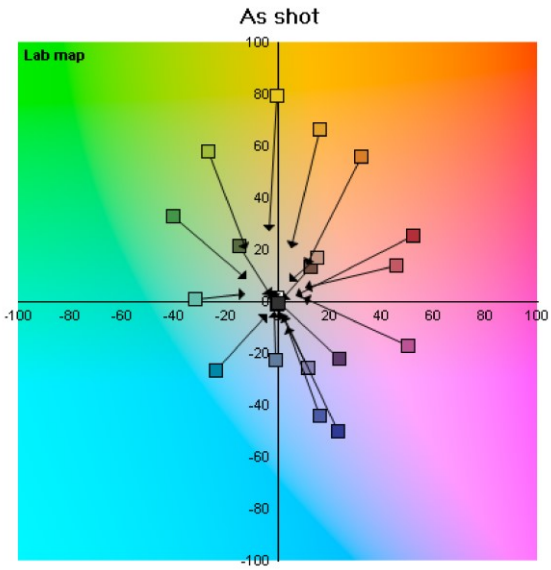


Illuminant: 4000K 0.1 lux

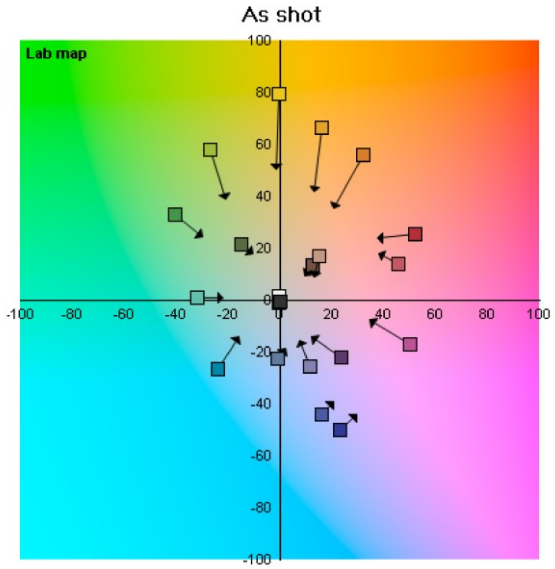
NOK

underexposed

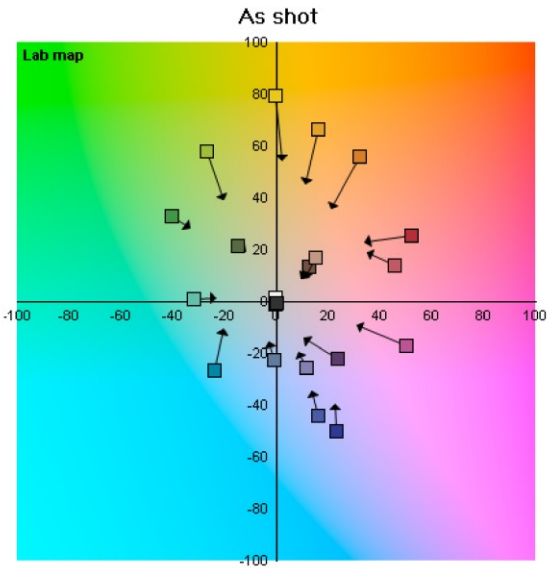
Illuminant: 4000K 1 lux



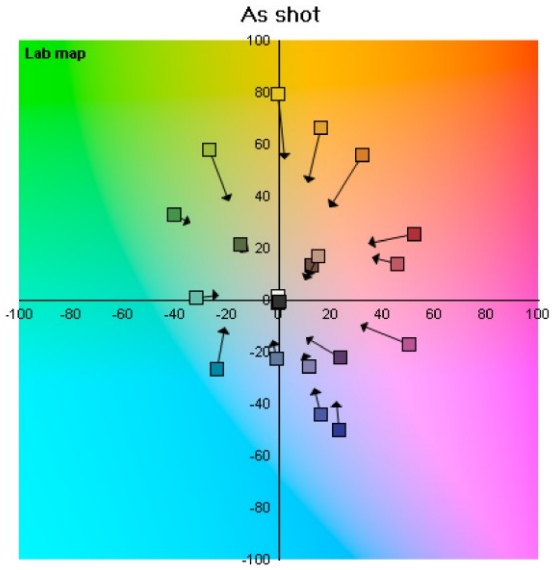
Illuminant: 4000K 100 lux



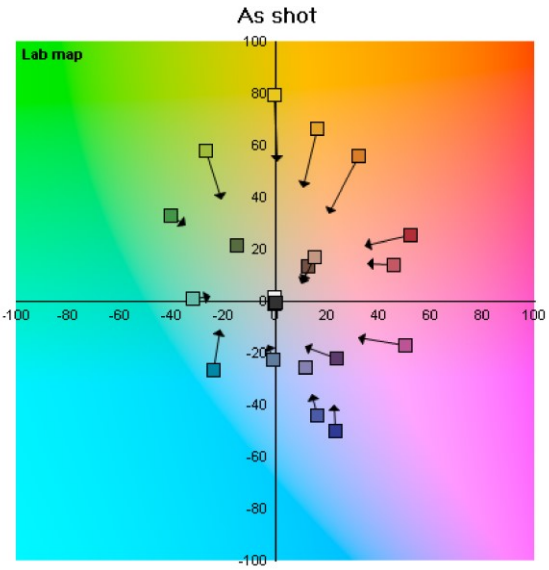
Illuminant: D50 100 lux



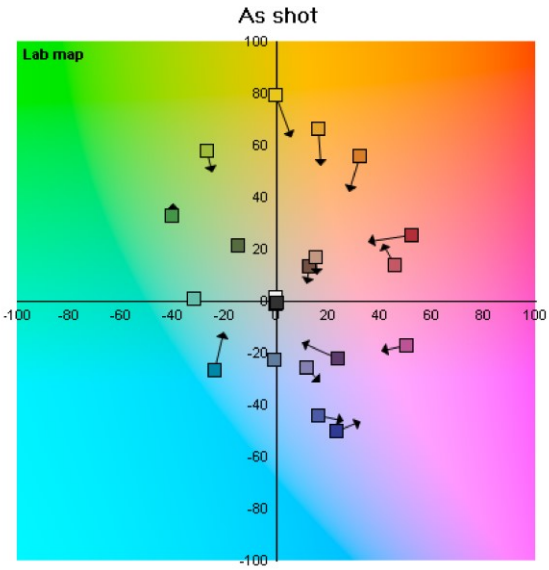
Illuminant: D55 100 lux



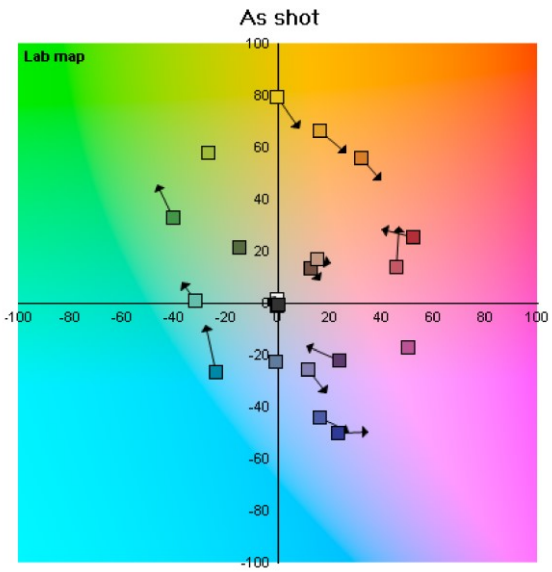
Illuminant: D65 100 lux



Illuminant: D65 1000 lux

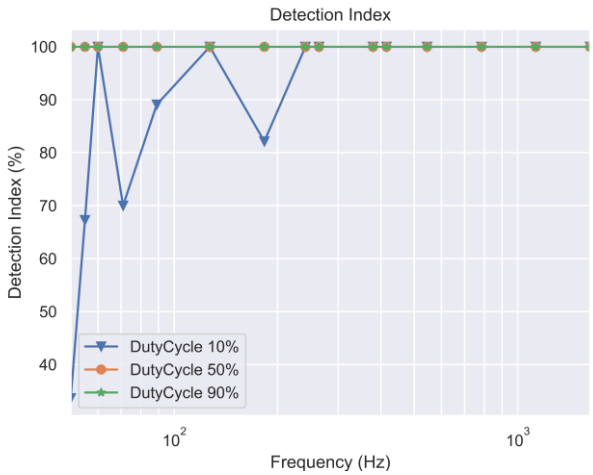


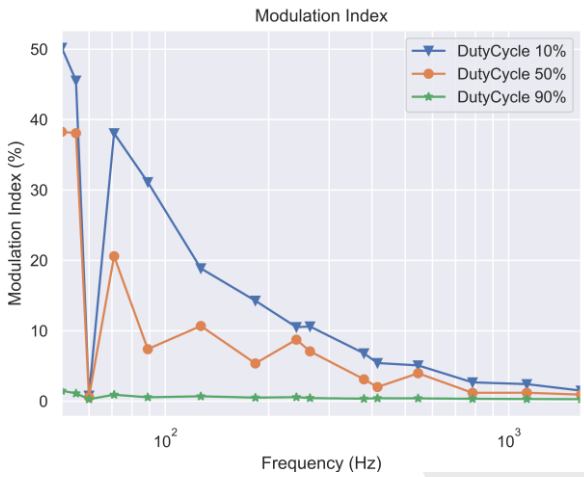
Illuminant: D65 10000 lux

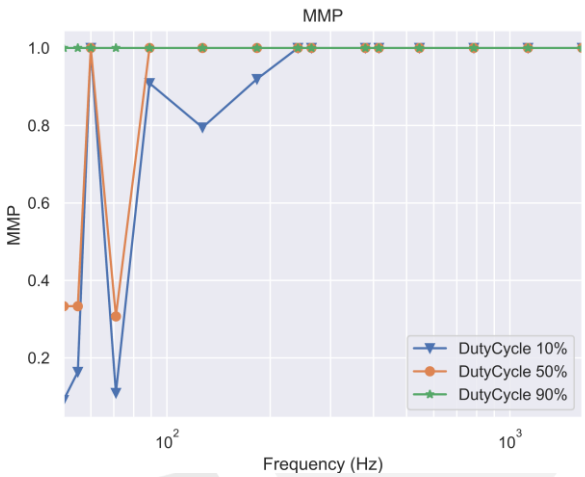


- **Measurement conditions:**
  - 10 LED PWM frequencies in Hz: 50, 55, 60, 71, 89, 127, 183, 241, 264, 379, 415, 545, 785, 1129, 1624
  - 3 LED PWM duty cycles: 10%, 50%, 90%
  - 3 test conditions:
    - Background at 10000 lux, LED light intensity at 6620 cd/m²
    - Background at 1000 lux, LED light intensity at 5300 cd/m²
    - Background at 300 lux, LED light intensity at 4000 cd/m²
  - Results presented for the R channel
- **Results**
  - Good flicker mitigation for frequencies above 100 Hz at 300 lux and 1000 lux
  - Flicker mitigation for frequencies above 300 Hz at 10000 lux

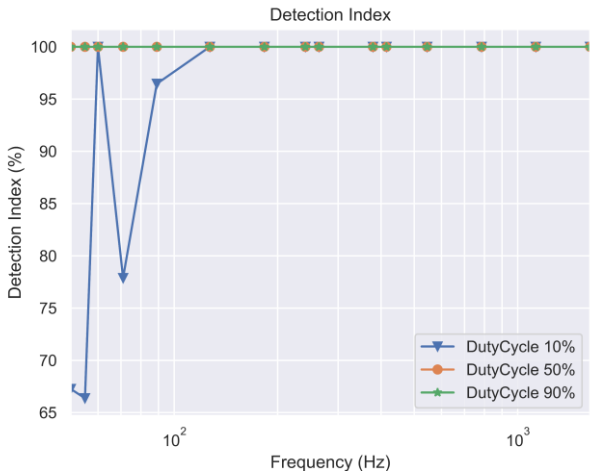
- Background at 10000 lux, LED light intensity at 6620 cd/m²

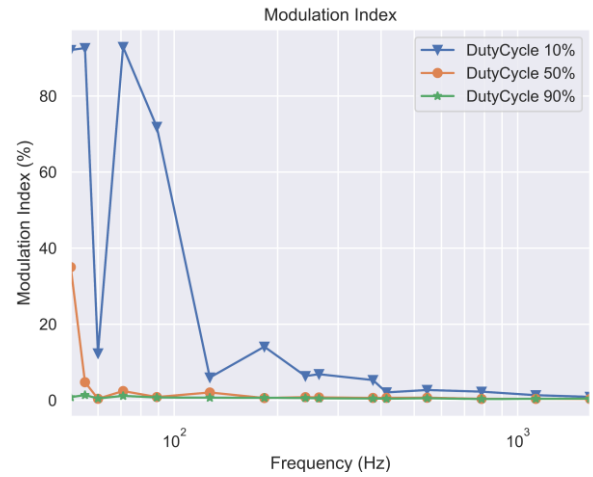


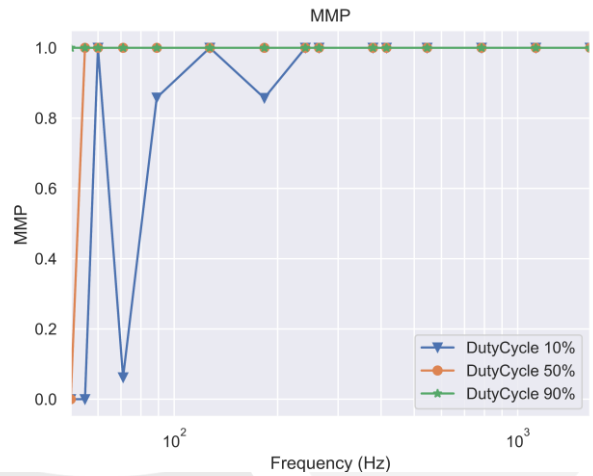




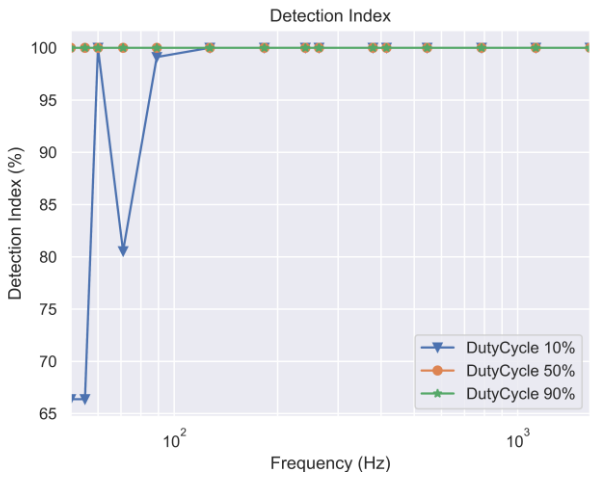
- Background at 1000 lux, LED light intensity at 5300 cd/m²

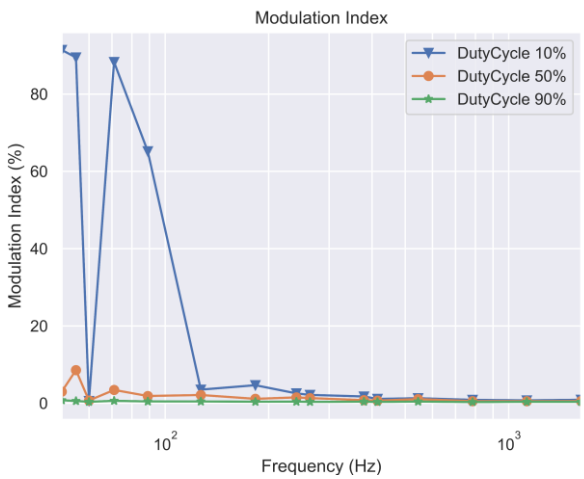


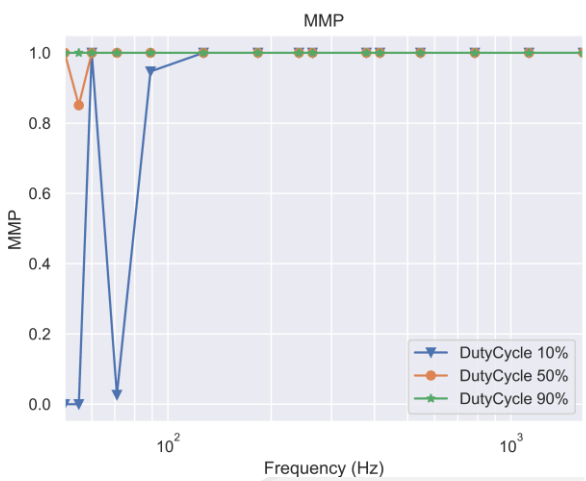


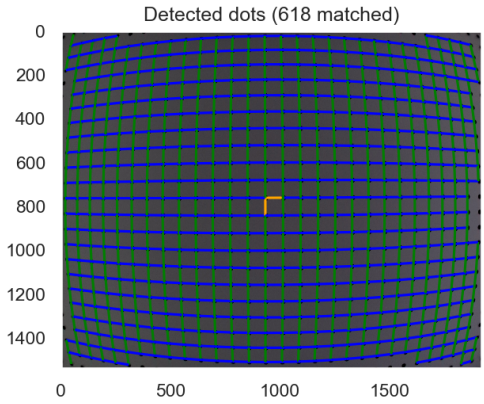


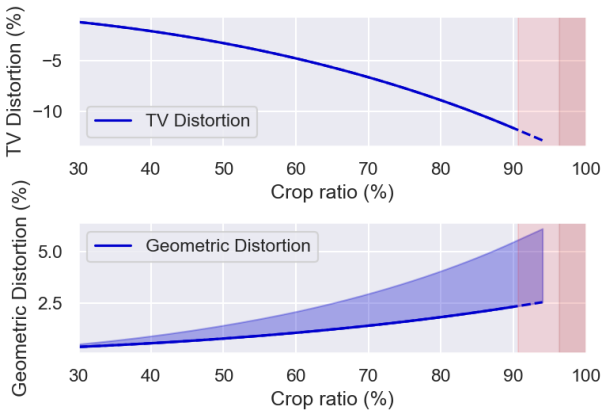
- Background at 300 lux, LED light intensity at 4000 cd/m²

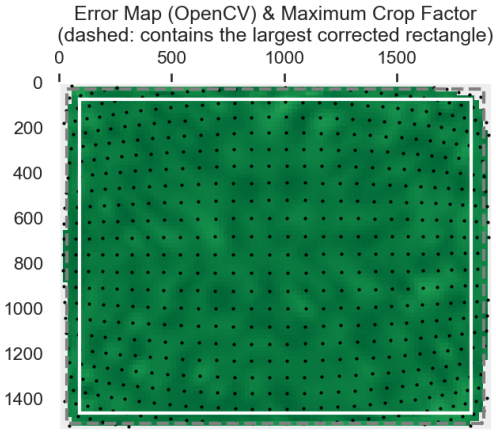


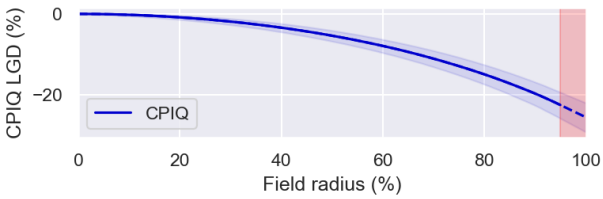


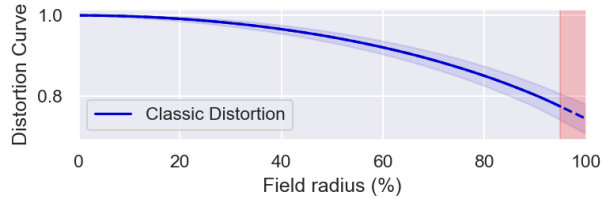


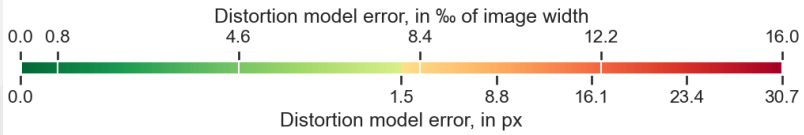






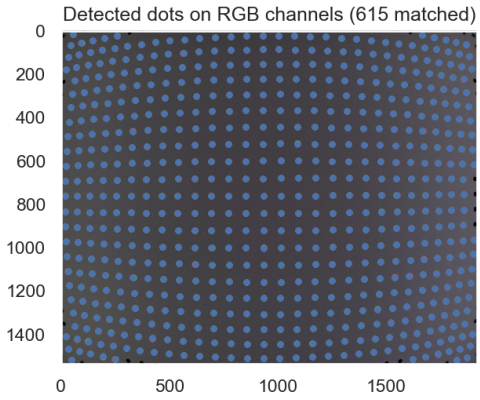


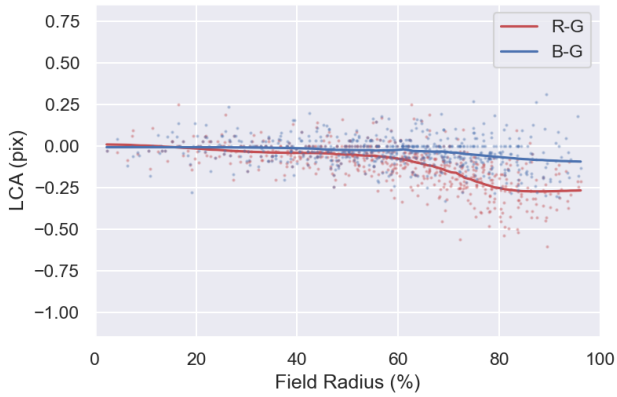


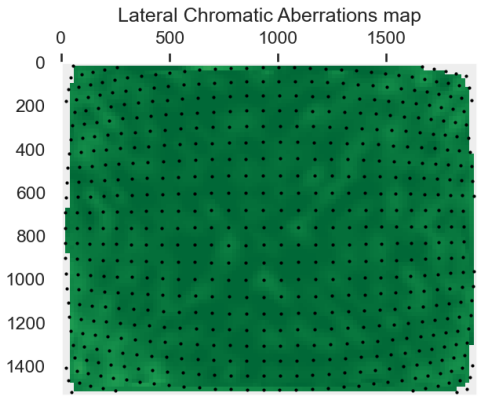


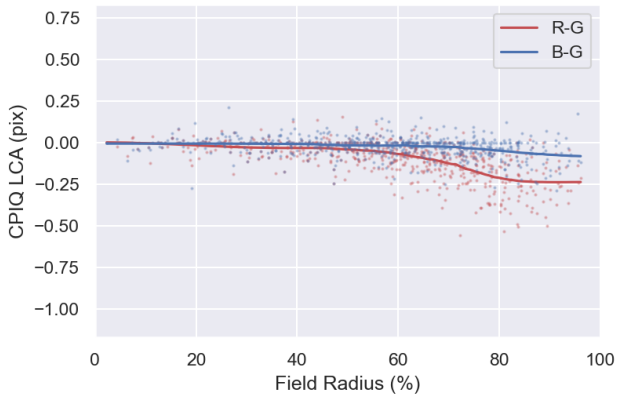
	Results	Results (non extrapolated)
TV Distortion	-12.9%	-11.8%
Geometric Distortion (avg)	+2.6%	+2.36%
Geometric Distortion (Max)	+6.1%	+5.6%

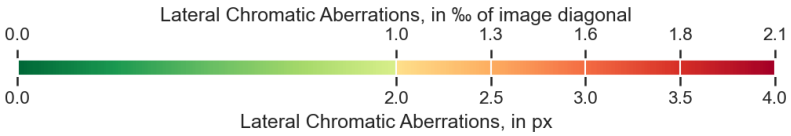
Strong distortion for a 60° HFOV lens
Good fitting of the distortion model (small reprojection error)









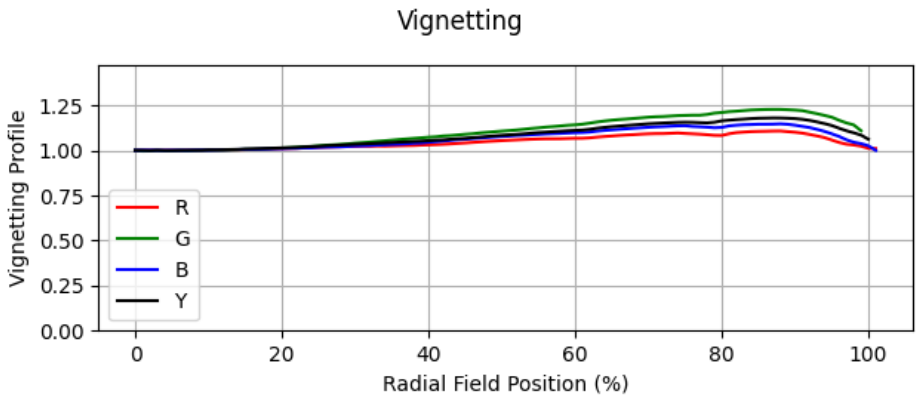


CPIQ Max LCA (Pixels)	-0.24 px
CPIQ Max LCA (Percent)	-0.01 %
CPIQ Max LCA (JND)	0.00

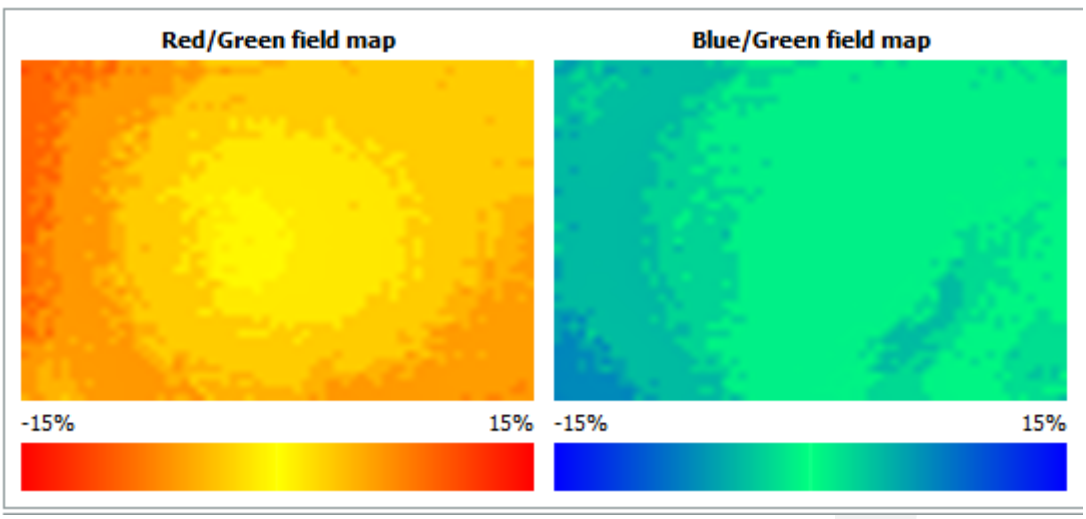
Chromatic Aberrations are negligible (less than 0.5 pixel in the full measurement area)

- **Measurement conditions**
  - 3 lighting conditions:
    - 6000K 5000 cd/m²
    - 6000K 11600 cd/m²
    - 6000K 19000 cd/m²
- **Results**
  - Vignetting is over-corrected:
    - Almost no vignetting attenuation
    - Up to 20% max amplification
  - Significant color lens shading (CLS), in particular at 5000cd/m².
    - up to 11% attenuation
    - Color lens shading is non-radial

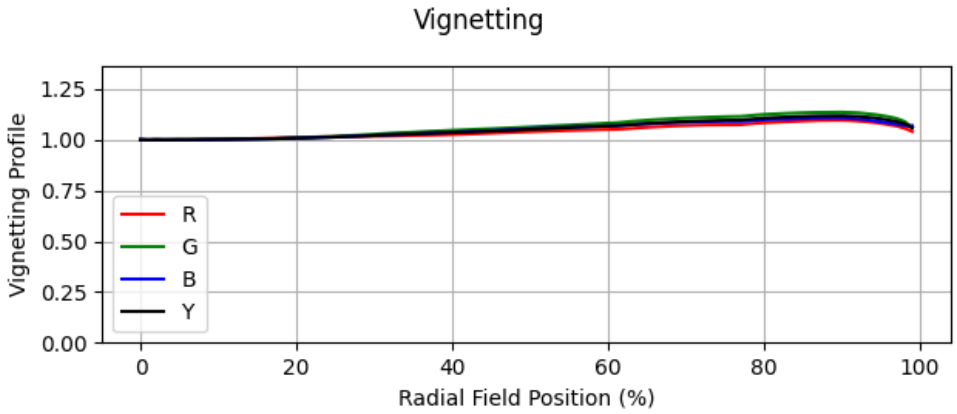
  Significant CLS is generally not wanted, in particular when it is non-radial. Non-radial CLS is more visible and more difficult to correct.



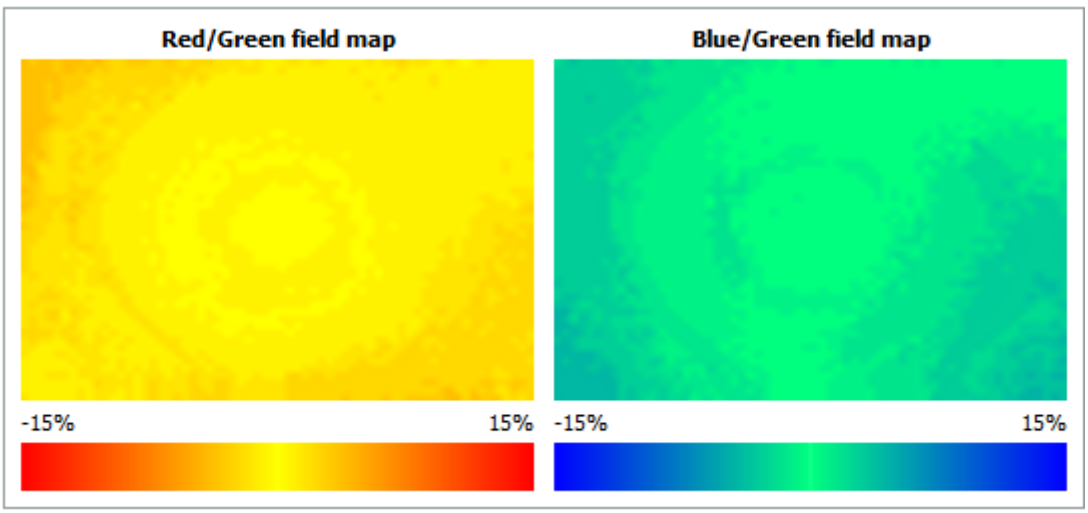
	R	G	B	Y
Max Attenuation	0.1 %	0.4 %	0.0 %	0.1 %
Max Amplification	10.7 %	22.7 %	14.7 %	18.0 %



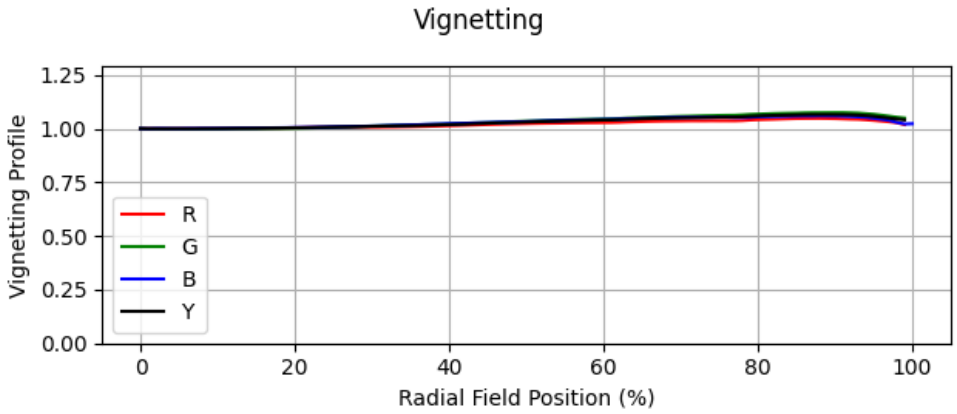
	R	B
Max Attenuation	10.6 %	7.3 %
Max Amplification	0.5 %	4.0 %



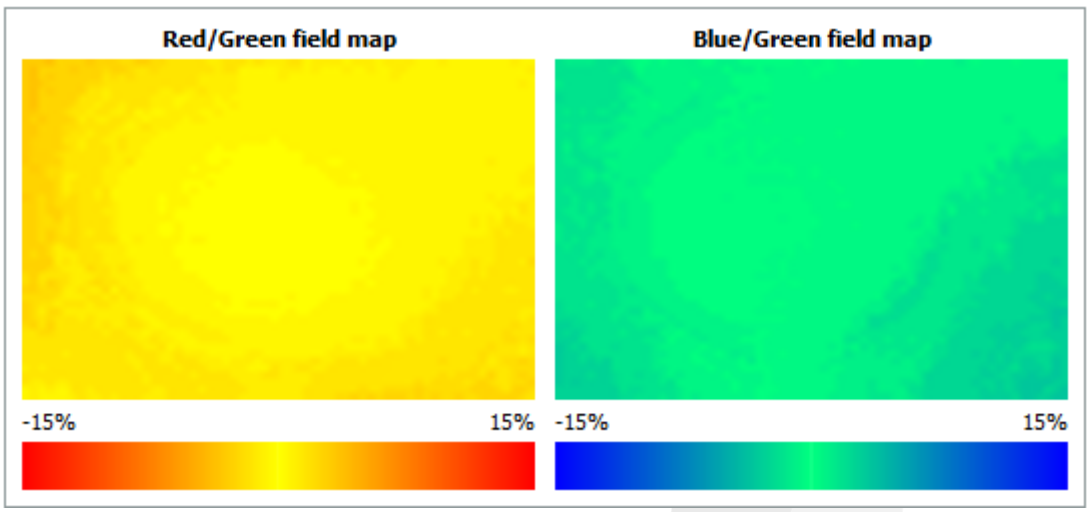
	R	G	B	Y
Max Attenuation	0.2 %	0.1 %	0.1 %	0.2 %
Max Amplification	9.5 %	13.5 %	10.7 %	11.8 %



	R	B
Max Attenuation	3.7 %	4.3 %
Max Amplification	0.8 %	4.5 %



	R	G	B	Y
Max Attenuation	0.1 %	0.2 %	0.1 %	0.1 %
Max Amplification	4.8 %	7.5 %	6.0 %	6.6 %



	R	B
Max Attenuation	3.5 %	3.1 %
Max Amplification	0.0 %	3.4 %

24-26, quai Alphonse le Gallo
92100 Boulogne-Billancourt - France

corp.dxomark.com