ANALYZER *by DXOMARK*

This Module includes essential hardware and software to perform a suite of measurements on the camera performance under High Dynamic Range (HDR) . Users can analyze the contrast, color, and texture preservation simultaneously of tone mapping performance in an HDR image using composite chart (up to 15 EV). Users can also analyze noise, dynamic and tonal range, tone curve (OECF), dark signal, and ISO sensitivity using HDR noise chart Moreover, perceptual analysis on natural scene chart provides complementary evaluation to objective measurements. This module is compatible with all HDR technologies. Multiple measurements can be done from a single image of the chart.
The high dynamic of the chart (120 dB) allows for measuring HDR cameras.

Key features

- Delivers color, contrast and texture preservation measurements in up to 15EV HDR condition.
- Delivers image quality metrics available using the HDR Noise chart : noise, dynamic and tonal range, tone curve (OECF), dark signal, and ISO sensitivity. All measurements are performed in one go from one image of the test chart
- Provide repeatable HDR test scene in lab for perceptual evaluation of artifacts.
- Includes high-quality test chart(s), recommended lab equipment, in-depth documentation, and the analysis software in one package
- Automatically detects relevant test chart patterns and reports results with no operator intervention
- Performs measurements on RGB (.jpeg, .tiff, etc.) or RAW images
- Can measure cameras with resolutions from VGA to 50Mpix, and fields of view up to 120°

Application across many markets

The HDR Module is compatible with cameras designed for many applications and markets: photography (DSCs and DSLRs), mobile (smartphone camera modules), automotive (cameras for ADAS systems), surveillance (IP cameras, CCTV), medical, drones, wearables, etc.
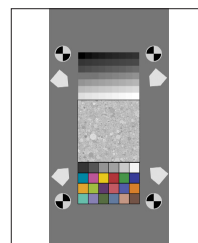
Available HDR Module measurements

HDR Module measurements are performed on several charts adapted to the measured phenomenon. The respective measurements are listed in the following table :
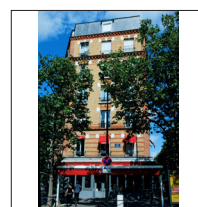
HDR NOISE CHART
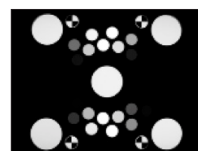
- Contrast
- Noise
- Dynamic range / Tonal range
- Tone curve (OECF)
- Dark signal
- ISO sensitivity

COMPOSITE CHART

- Contrast preservation
- Texture preservation
- Color consistency
- Noise

NATURAL SCENE CHART

- Texture loss
- Color shift
- Moiré
- Aliasing
- Other artifacts

HDR MODULE MEASUREMENT HARDWARE

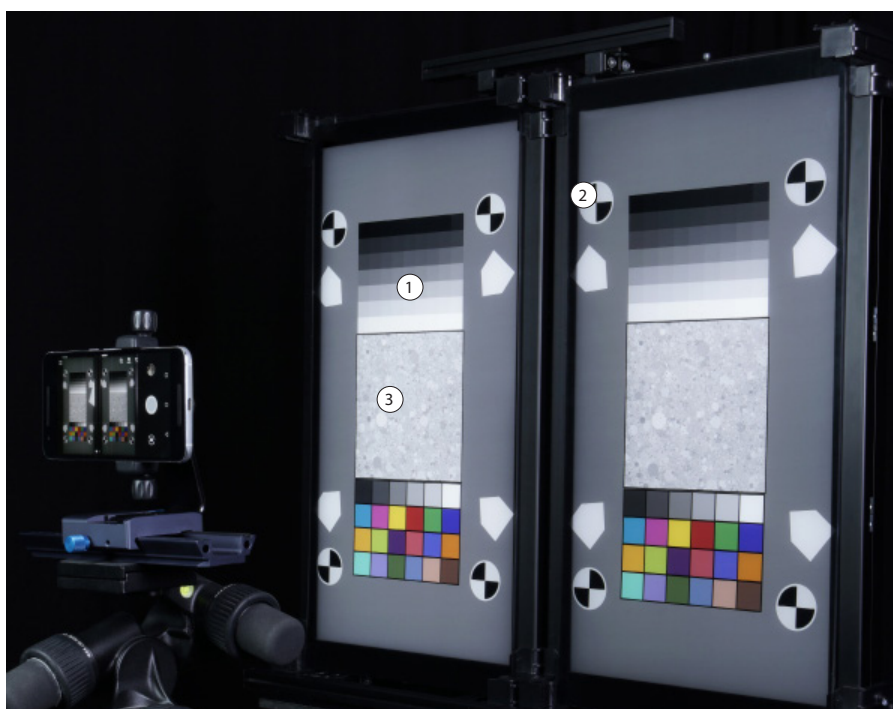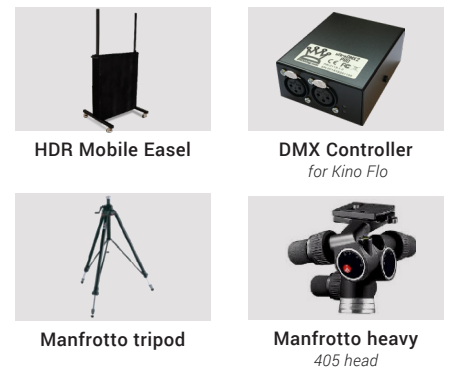## Recommended lab environment

Transmission chart with 120 dB (1/1,000,000) luminance range
(HDR Noise chart), coupled with uniform LED lighting
Kino Flo Celeb 250

① Chart & Lightboxes, ② Camera, ③ Tripod

Recommended equipment

Composite Chart CT001

Natural Scene Chart

HDR Noise Chart

Kino Flo Celeb 250

FRAMING & ACCESSORIES

HDR Mobile Easel

DMX Controller *for Kino Flo*

Manfrotto tripod

Manfrotto heavy *405 head*

① Transmission scene : Composite chart CT001
Flexible scene simulation : 2-chart configuration
24 color patches
80 grayscale patches (6.66 EV dynamic)
Texture/Dead Leaves patch
Markers for automated processing

② Lighting: Kino Flo Celeb 250 (LED)
2-panel configuration
Computer-controlled and programmable (DMX)
Emittance tunable from 7 to 26,800 cd/m2,
Up to 12 ΔEV between two panels

③ Setup
Maximum grayscale dynamic range: 15.04 EV
Automatic workflow using Digital Trigger and Sequencer
Camera
Tripod

MEASUREMENT SAMPLES

Analyzer software processes the image files

Measurements of all purchased modules are available in this interface, and can be accessed from their chart.

Results are displayed in the interface after processing, and can be exported in html, spreadsheet, or pdf formats.
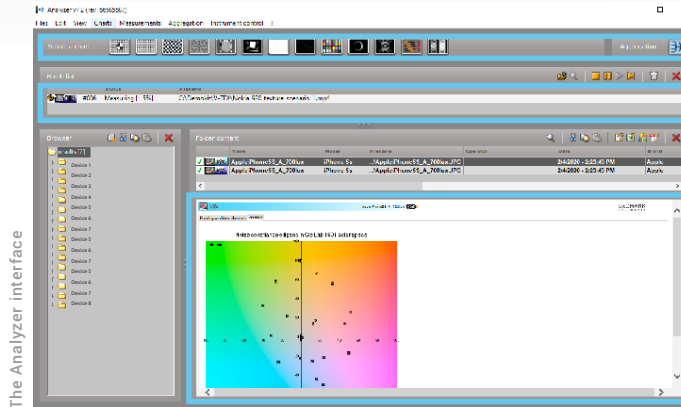
The Analyzer interface

> Select chart to launch a new measurement

> Batch processing of photos and videos

> Results are available in datasheets

1 Select chart to launch a new measurement

2 Batch processing of photos and videos

3 Results are available in datasheets

↓ Here are examples of Analyzer results for all the available measurements of the HDR Module

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Noise

SNR, grain size, grain coloration, and autocorrelation function are computed on the different grey levels of the HDR Noise chart.

SNR versus grey level

Autocorrelation at a given grey level

> RED   > GREEN

> BLUE
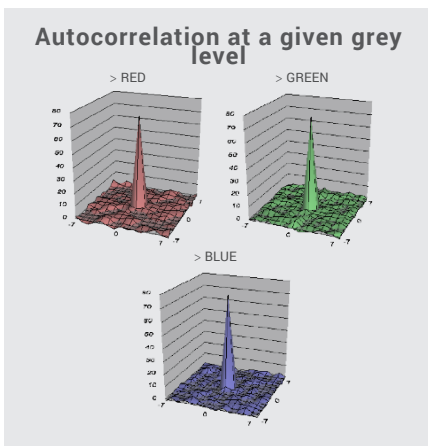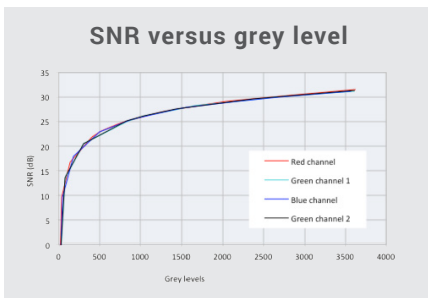
Dynamic range / Tonal range

Dynamic range is the ratio between the largest luminance and the lowest luminance that a camera can capture. Tonal range is the effective number of grey levels of the system, taking noise into account. Here are the results for the same camera, with HDR mode activated or not :

HDR mode not activated

	Dynamic range	Dynamic range (Ev, stop)	Tonal range (steps)	Tonal range (bits)
R	702.37	9.46	220.87	7.79
G	462.02	8.85	223.66	7.81
B	320.66	8.32	219.05	7.78
Y	412.08	8.69	224.80	7.81
Contrast dynamic range		65.01		6.02 EV

> Scale of grey levels

HDR mode activated

|	Dynamic range	Dynamic range (Ev, stop)	Tonal range (steps)	Tonal range (bits)
R	26913.75	14.72	213.38	7.74
G	17089.29	14.06	226.25	7.82
B	10338.62	13.34	220.01	7.78
Y	22738.62	14.47	228.36	7.84
Contrast dynamic range		1875.58		10.87 EV

> Scale of grey levels

Tone Curve

The tone curve is a non-linear function applied to the input luminance values to convert them into grey levels. It can vary with the selected mode of the camera.
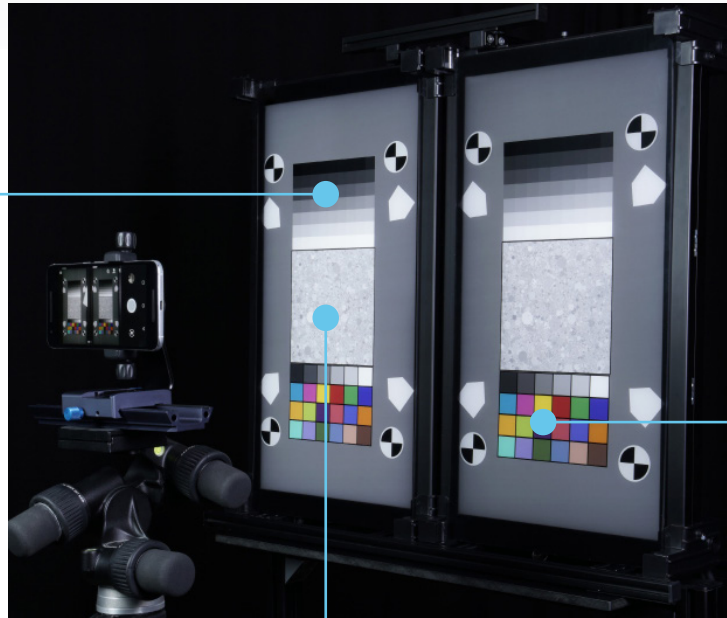
HDR MODE NOT ACTIVATED

Tone curve profile

HDR MODE ACTIVATED

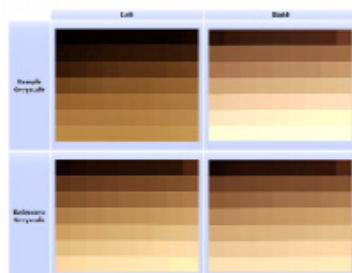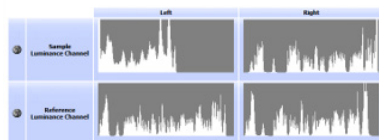#### Tone curve profile
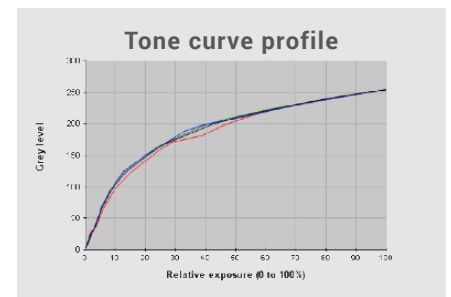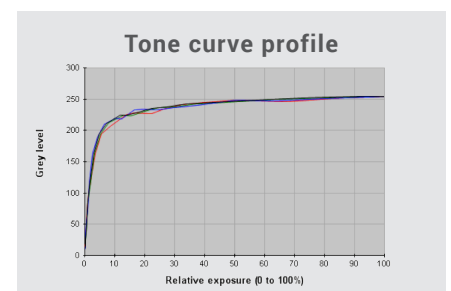
Contrast preservation

Histogram
Entropy

Entropy is a metric measuring the quantity of information contained in the grayscale patches , given in bits. Maximum possible value of entropy for jpeg output is 8 bits. The formula for determining entropy of the 80 grayscale patches is :

$$Entropy_{gs} = \sum_k hist_{gs}(k) \log \frac{1}{hist_{gs}(k)}$$
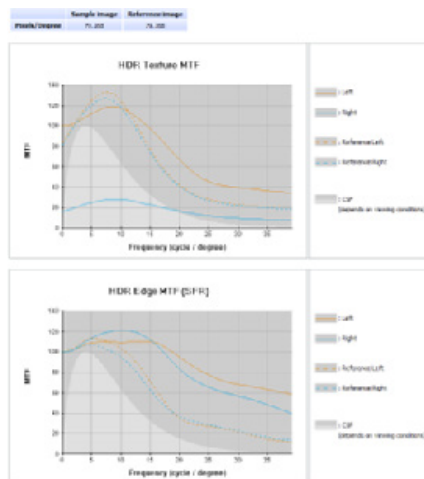

Texture preservation

Texture MTF and acutance
Edge MTF and acutance
Visual noise at 50%
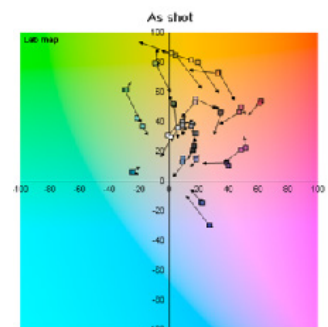Exposure (grey level at 18%)

Color consistency

Color fidelity
White balance
Metrics: ΔL, Δa, Δb, Δab, ΔE, ΔC, ΔH

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Loss of detail and texture of cloud

Loss of color on the roof

Cyan shift in the sky

Color of the building is completely saturated

Loss of detail of the building

The red store turned orange
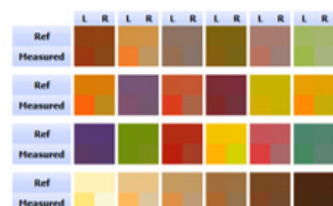
The shadow is underexposed, loss of detail

Evaluation

A wider range of color and details for analyzing texture loss, color shift and other artifacts Sharpness, moiré, and aliasing analysis using geometric objects and details of the scene

Scene and lighting complexities challenge the most advanced HDR technologies

«Perceptual analysis performed by your image quality engineer, following Analyzer guideline.»

Measurement accuracy

NOISE

The accuracy of the noise intensity is ± 0.2 grey level on the measured standard deviation.
Accuracy of the strength of noise coloration is ± 0.5 grey level.
Accuracy of the grain size is ± 0.5 pixel.

ISO SENSITIVITY

Repeatability of the measurement is ± 2% for the same aperture.
Changing the exposure time and the aperture may lead to an error up to 20%, due to the inaccuracy of the aperture in EXIF.

DYNAMIC RANGE / TONAL RANGE

The accuracy of the Tonal Range is ± 0.3 bits.
The accuracy of the Dynamic Range is ± 0.5 Ev.

COMPOSITE CHART

The accuracy of the entropy measurement is ±0.2.
The repeatability of the texture acutance measurement is ±0.04.
Repeatability of the Visual Noise measurement is ±0.6 if visual noise result is higher than 1. Else it is ±0.3.
The accuracy of the color fidelity error computed on Δab is ±5%.

TONE CURVE / DARK SIGNAL

Repeatability of the tone curve measurement, with the same normalization, is ±1.5 grey levels.
The dark signal measurement accuracy is ± 1%.

Specifications

Camera-under-test specifications

Min resolution : Full HD (1080p) ; Minimum resolution is doubled for RAW
Max resolution : up to 50Mpix
FOV : up to 120°
Focal length : 12 mm in 35 mm format
Spectral sensitivity : measurements have been designed for visible spectrum cameras
Sensor : Bayer filter sensor
File formats :
Images : jpeg, bmp, png, tif, and many RAW formats (latest release notes provides a list of supported RAW formats)

Platform requirements

PC-type computer with the following minimum configuration :
Intel Pentium IV® processor or higher Operating systems :
- Windows 10

2 GB of RAM or more
At least 3 Go of free disk space to operate the software
A video card with 3D driver, compatible with DirectX 9c
Screen display resolution : 1024 x 768 or more

At least one USB port
It is possible to run Analyzer on a virtual computer (to run on a Mac platform, for instance), or to control it remotely. Depending on the selected remote OS, some graphics may not be generated.

Laboratory requirements

Laboratory minimum size : 4.5 x 5 m
RAL9005 mat for walls and ceiling
Dark grey antistatic carpet on the floor
Temperature : 23°C ± 2°C (ISO 554:1976)
Humidity : 50% ± 20% (ISO 554:1976)

This Module is an extension of the Optics Module. It includes essential hardware and software for analyzing MTF (Modulation Transfer Function) in the whole image field for fisheye lenses.

The Module configuration is flexible so as to address a wide range of customer needs. It ranges from the simplest software + chart package to a comprehensive package that includes our lab system and automated lighting system.

Key features

- **Delivers the relevant metrics of sharpness quality:** acutance, MTF curves, limiting resolution, ringing intensity. **Performs all measurements in one go using several images on the test chart**

- **Includes high-quality test chart(s), recommended lab equipment, in-depth documentation, and the analysis software in one package**

- **Automatically detects relevant test chart patterns and reports results** with no operator intervention

- **Performs measurements on RGB (.jpeg, .tiff, etc.) or on RAW images**

- **Can measure cameras with resolutions from 800 x 600 to 50 Mpix,** and fields of view up to 190°

Available Fisheye measurements

At present, the Fisheye Module includes only the MTF measurement:
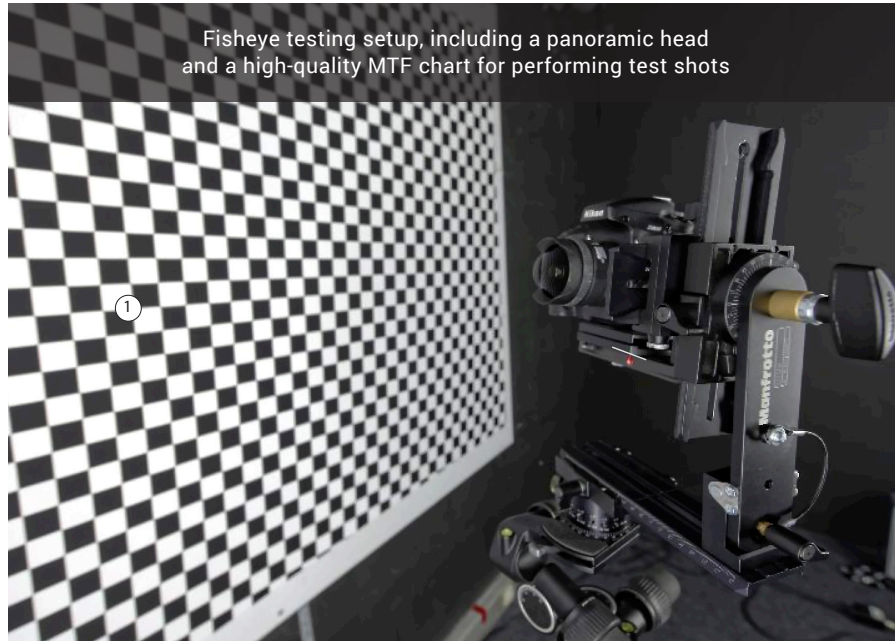
MTF CHART
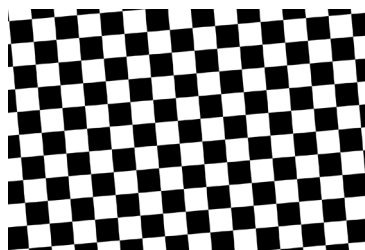
Application across many markets

The Fisheye Module is compatible with cameras designed for many applications and markets: photography (DSC and DSLRs), mobile (smartphone camera modules), automotive (camera for ADAS system), surveillance (IP Camera, CCTV), medical, drones, wearables, etc.

FISHEYE MODULE MEASUREMENTS HARDWARE

Recommended lab configuration

Fisheye testing setup, including a panoramic head and a high-quality MTF chart for performing test shots

①

Use of a baffle to manage auto-exposure adjustment

Required equipment

MTF Chart
(2000 mm x 1350 mm)

Manfrotto
Spherical Head

Recommended equipment

LAB STRUCTURE AND CHART FRAMING

ITEM Framing Structure
(3m x 3m x 2.5m)

Baffle

REFLECTION LIGHTING

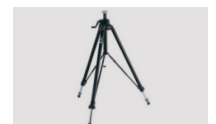**Kino Flo LED Celeb 250** *(2 units)*

Automated Lighting System (2 units)
+ with control software and auto-regulation setup

ACCESSORIES

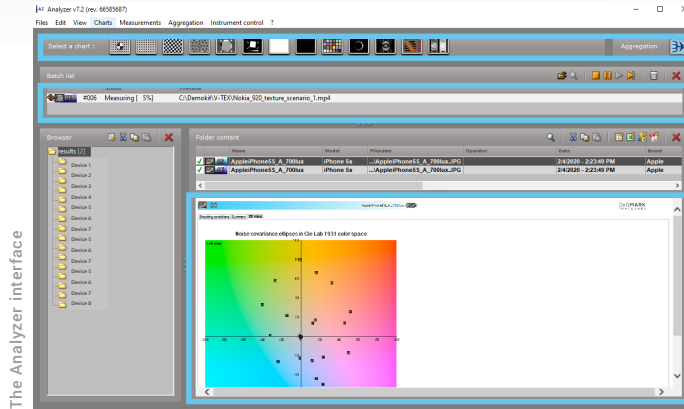**LEICA Laser Telemeter**

Manfrotto Tripod

Gossen Luxmeter - Mavolux 5032B
+ luminance attachment
+ certificate

Analyzer software processes test images automatically

Measurements provided by all purchased modules are available in this interface, and can be accessed from their respective charts.

The results are displayed in the interface after processing, and can be exported in html, spreadsheet, or pdf formats.

1 Select chart to launch a new measurement

2 Batch processing of photos and videos

3 Results are available in datasheets

The Analyzer interface
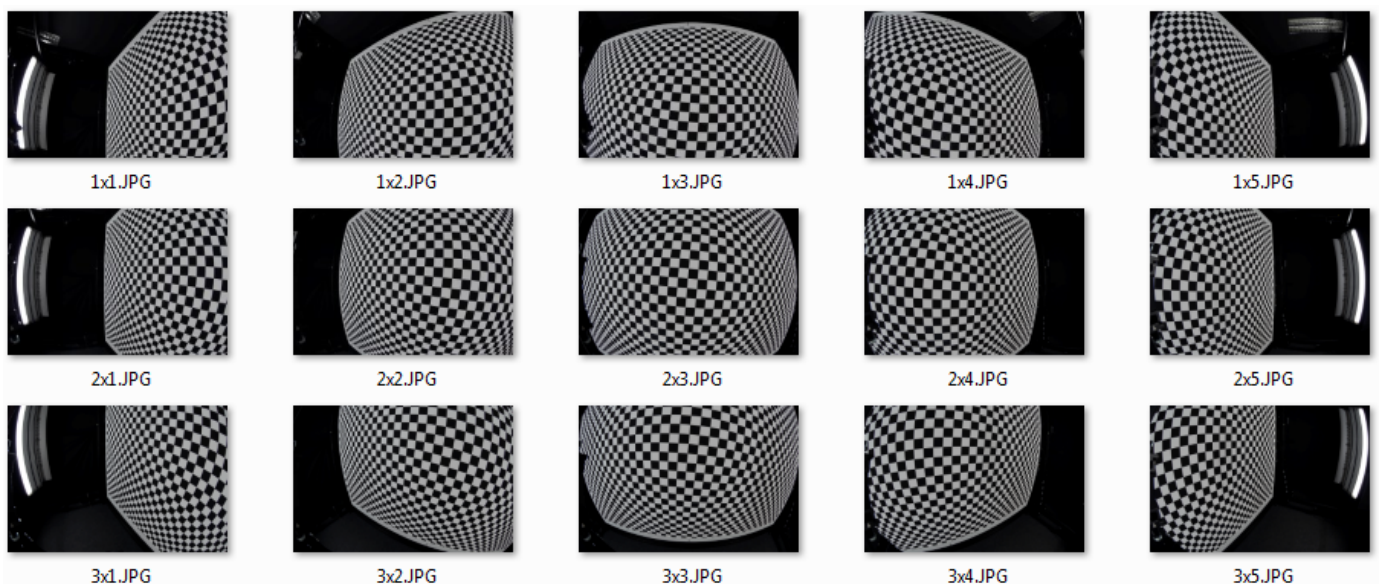
Select chart to launch a new measurement

Batch processing of photos and videos

Results are available in datasheets

Examples of Fisheye measurements

A spherical panoramic head is used to shoot as many images as there are desired measurement points. The equivalent of the one-picture measurement for standard lenses is 5x3 shots. With this method, measurements are made roughly at the same position on the chart for all measurement points in the field, and deformations due to distortion are reduced.
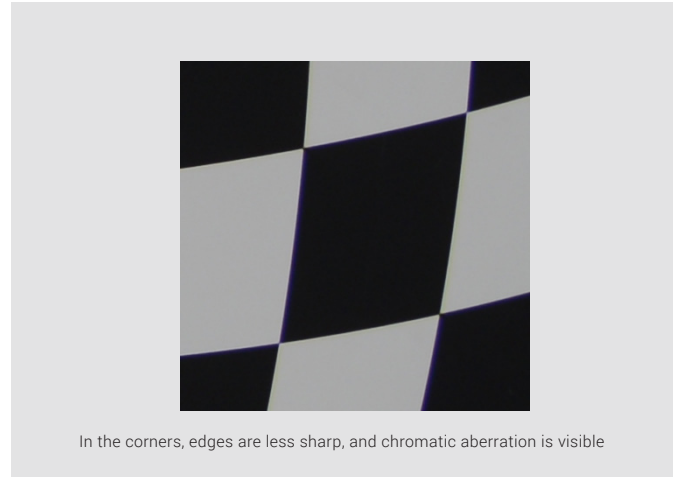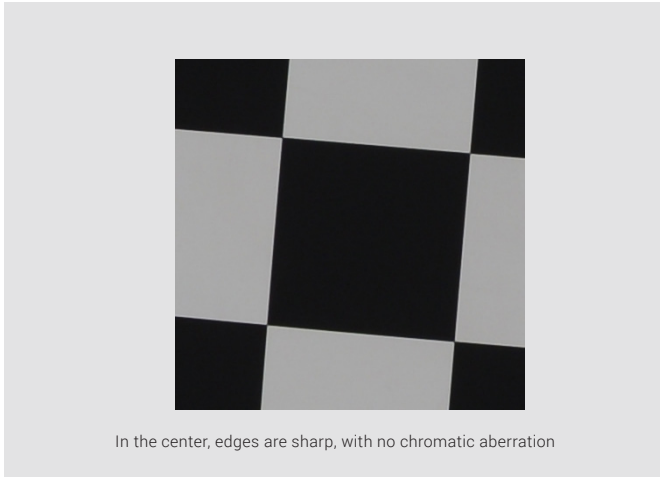
This is also the equivalent of measuring MTF on a spherical chart, with the distance from the chart to the sensor equivalent for all measurement points.

Here is an example of input images for 5x3 measurement points in the field:

1x1.JPG	1x2.JPG	1x3.JPG	1x4.JPG	1x5.JPG
2x1.JPG	2x2.JPG	2x3.JPG	2x4.JPG	2x5.JPG
3x1.JPG	3x2.JPG	3x3.JPG	3x4.JPG	3x5.JPG

ANALYZER
by DXOMARK

MEASUREMENT SAMPLES (NEXT)

Results show a great difference in sharpness between the center and the mean corners, which is clearly visible in the images


In the center, edges are sharp, with no chromatic aberration

In the corners, edges are less sharp, and chromatic aberration is visible

In the measurement result overview, the results are as follows

	Acutance	Limiting resolution (MTF 10%)	MTF 50%	Ringing
		cycles/pixel (lp/mm 24x36mm eq)	cycles/pixel (lp/mm 24x36mm eq)	
CENTER	0.74	0.50 (66.67)	0.35 (46.00)	7%
ALL CORNERS (MEAN)	0.54	0.40 (53.00)	0.22 (29.75)	1%

(Here acutance is given for "computer display" viewing conditions)

Results show a great difference in sharpness between the center and the mean corners, which is clearly visible in the images
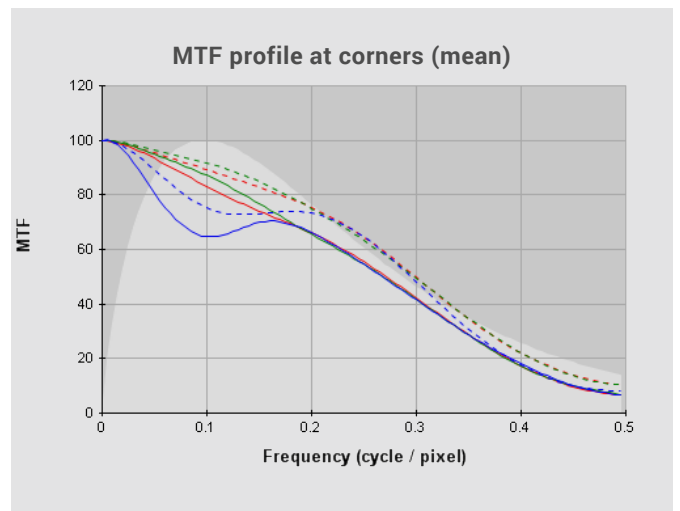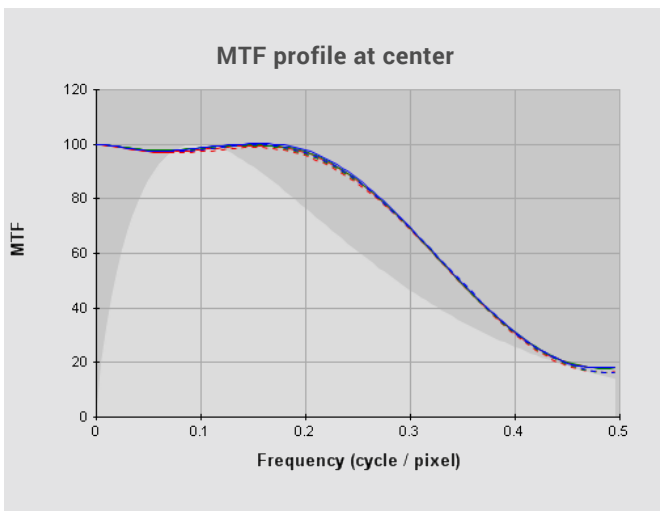
Measurement accuracy

For MTF curves, the measurement repeatability is ± 4% on average, with higher accuracy at lower frequencies, as shown in the table:

Repeatability of acutance measurements is ± 0.04. However, this depends on the measured camera characteristics (autofocus accuracy and repeatability, mechanical vibrations).

Frequency (cy/pixel)	Accuracy (RGB)	Accuracy (RAW)
[0;0.1]	± 2%	± 3%
[0.1;0.3]	± 4%	± 6%
[0.3;0.5]	± 7%	± 10%

Specifications

Camera testing specifications

Min resolution : 800 x 600
Max resolution : up to 50 Mpix
FOV : up to 190° and above, depending of the resolution of the camera (FoV up to 130°: minimum image height = 800 pixels ; FoV up to 190° : image height =1600 pixels)
Spectral sensitivity : measurements have been designed for visible spectrum cameras
Sensor : Bayer filter sensor
File formats : jpeg, bmp, png, tif, and many RAW formats (latest release notes provides a list of supported RAW formats)

Platform requirements

PC-type computer with the following minimum configuration :
Intel Pentium IV ® processor or higher Operating systems :
- Windows 10

2 GB of RAM or more **At least 3 GB of free disk space** to operate the software **A video card with 3D driver**, compatible with DirectX 9c **1024 x 768** or more for screen display resolution
At least one USB port
It is possible to run Analyzer on a virtual computer (on a Mac platform, for instance), or to control it remotely. Depending on the selected remote OS, some graphics may not be generated.

Laboratory requirements

Laboratory minimum size : 4.5 x 5m
RAL9005 mat paint : for walls and ceiling
Dark grey antistatic carpet on the floor
Temperature : 23°C ± 2°C (ISO 554:1976)
Humidity : 50% ± 20% (ISO 554:1976)