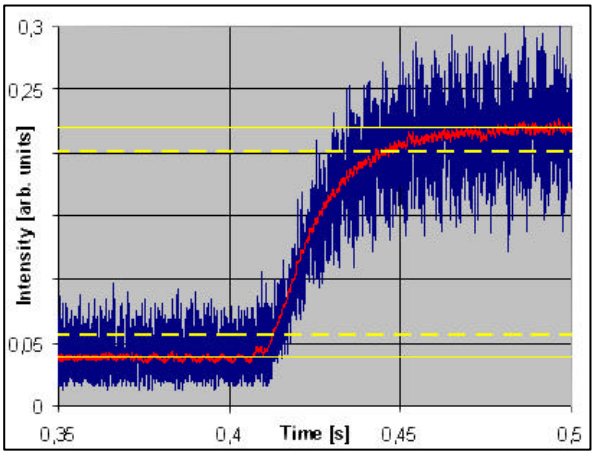
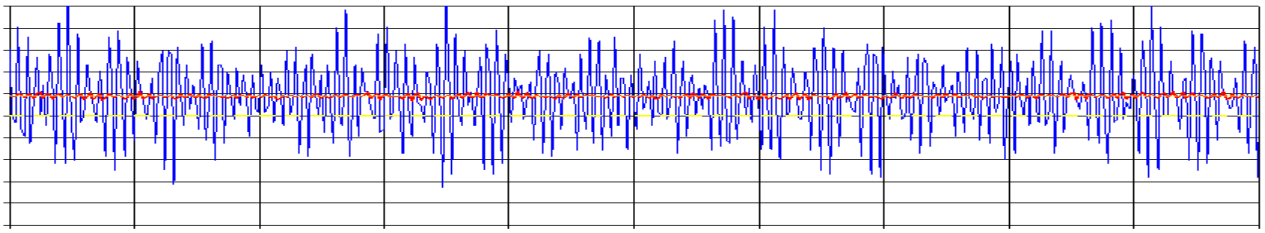


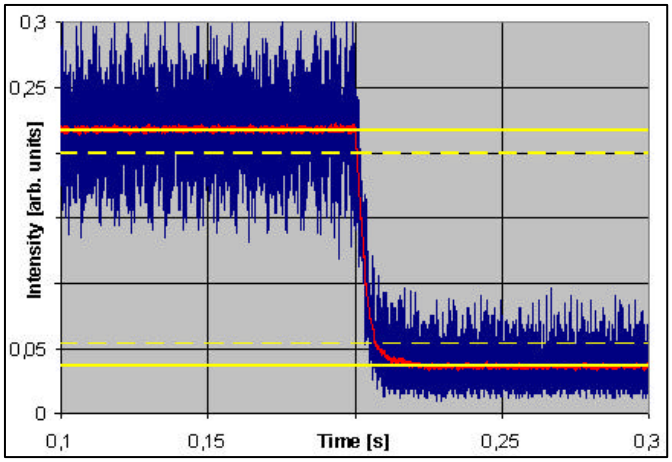
OTR-3™

Optical Transient Recorder



Features

version 6-02/08



Display-Metrology & Systems
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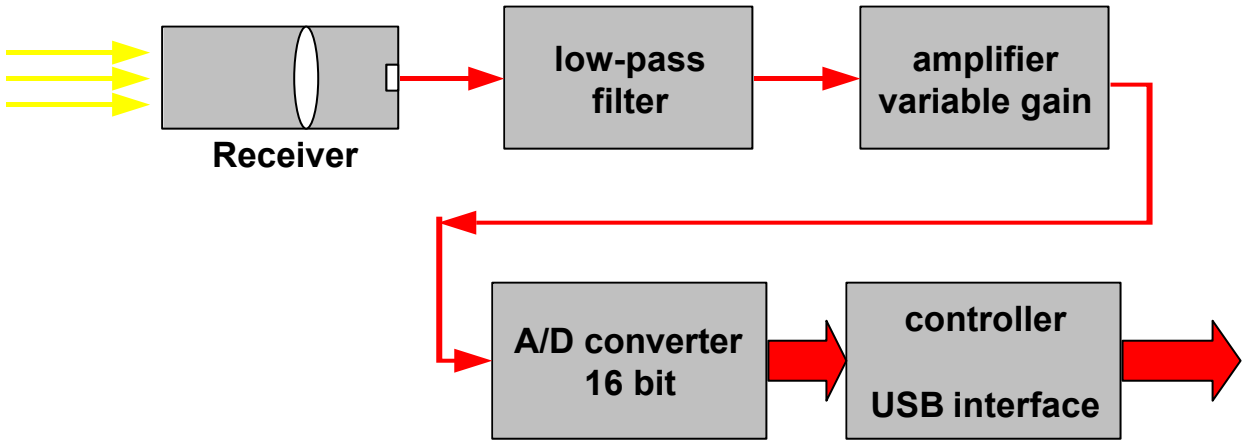
Optical Transient Recorder OTR-3

The ***optical transient recorder*** (OTR) is designed for acquisition, recording, storage and evaluation of temporal variations of light intensity (*luminance*). The recorded variations can be evaluated to yield the following characteristics:

- image-formation time (ISO 9241-300),
- gray-level transitions times (ISO 9241-305),
- flicker components (ISO 9241-305),
- others.

The OTR comprises the following components:

- opto-electrical transducer (detector),
- low-pass filter (variable cut-off frequency),
- amplifer (variable gain),
- controller and
- USB-interface.



Block diagram of the Optical Transient Recorder, OTR

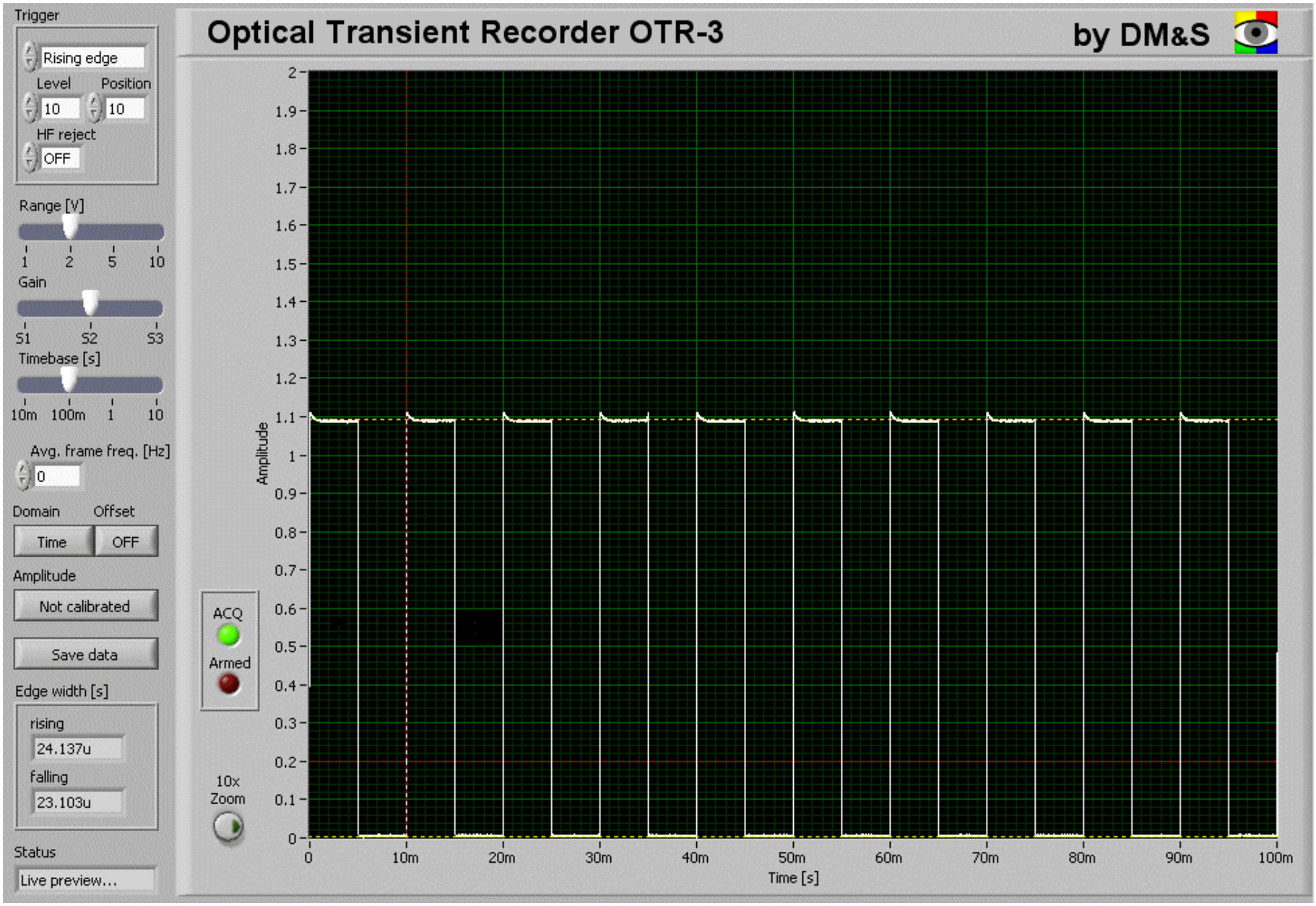
Receiver

The receiver combines a collimating lens for imaging of the spot of measurement with an electro-optical transducer ("light detector"). The diameter of the circular field of measurement is continuously adjustable with an iris between 25 mm diameter and completely closed (this setting can be used for *offset measurement*).

The detector can be a *photodiode* or a *photo-multiplier-tube* (PMT) depending on the requirements with respect to speed and sensitivity (order option).

The electrical signal from the detector is first low-pass filtered to remove high-frequency noise components and then amplified with an adjustable gain (S1 – S3).

The digitized detector signal is transmitted to the host computer for storage, evaluation and graphical representation.


Trigger
Rising edge
Level
Position
10
10
HF reject
OFF
Range [V]
1
2
5
10
Gain
S1
S2
S3
Timebase [s]
10m
100m
1
10
Avg. frame freq. [Hz]
0
Domain
Offset
Time
OFF
Amplitude
Not calibrated
Save data
Edge width [s]
rising
24.137u
falling
23.103u
Status
Live preview...
Optical Transient Recorder OTR-3
by DM&S
ACQ
Armed
10x
Zoom
Amplitude
Time [s]
0
10m
20m
30m
40m
50m
60m
70m
80m
90m
100m
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2

Operation of the OTR

The OTR-3 is operated just like an oscilloscope. The remote receiver head of the OTR-3 transforms temporal luminance variations into temporal voltage variations which are then measured, displayed, stored and evaluated.

With each single measurement a set of 10 000 individual values is taken and their temporal variation is shown on the screen of the OTR. The OTR identifies the first pulse and displays the width of both edges (rising, falling) in the result window.

Controls of the OTR

- **Trigger** (OFF, rising edge, falling edge)
  The OTR can be triggered with a rising or a falling edge of the input signal.
  - Level (in % of the chosen amplitude range, y-axis)
  - Position (in % of the chosen time range, x-axis)
  - HF reject (OFF, 1, 2 and 3) for improved triggering

- **HF reject**
  The trigger stability of noisy input signals can be improved by selection of one of the high-frequency rejection ranges (HF reject 3 > HF reject 2 > HF reject 1).

- **Range (V)**
  The input voltage ranges are 1V, 2V 5V and 10V. They have to be selected according to the electrical signal provided by the receiver.

- **Gain**
  The gain of the receiver can be set to 3 different values (S1, S2, and S3). With increasing sensitivity of the receiver (S3 > S2 > S1) the rise-time decreases. S3 ≈ 10*S2 ≈ 10*S1

- **Time base**
  The time base of the OTR can be set to four values (10ms, 100ms, 1s and 10s).

- **Averaging frame frequency**
  Numerical smoothing of the measured signal (e.g. for removal of temporal frame-response modulations) is available with an *averaging window*. The width of that window is given by the reciprocal value of the frame frequency (e.g. 16.666 ms for 60Hz)

- **Domain**
  The OTR has two modes of operation:
  - **Time domain**
    The time domain operation is used for measurement of transient responses.
  - **Frequency domain**
    The frequency domain operation is used for measurement of the frequency components of a stationary input signal.

- **Offset**
  The receiver can be manually closed for measurement of the signal of the dark state which then can then be subtracted from the measured signals.

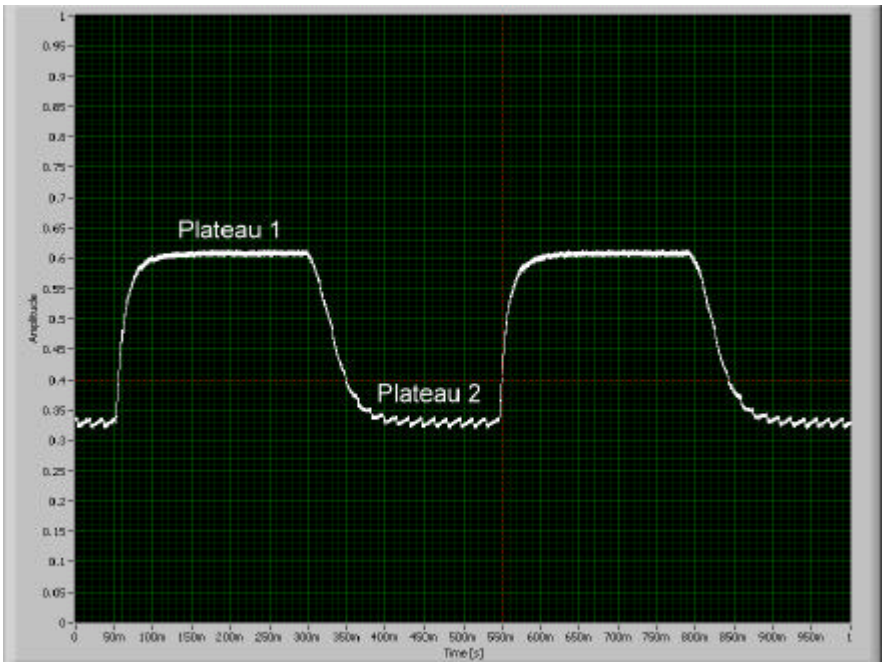
- **Amplitude calibration**
  The OTR can be calibrated in absolute luminance units (cd/m^2) when a reference sample with known luminance is available.

- **Save Data**
  The data displayed on the screen can be captured and stored in csv-Format for documentation purposes, for further processing (e.g. with spreadsheet software) evaluation and display according to the special needs of the user.

Data captured on:	1. January 07 17:11:18"
Gain setting:	1
Edge width rising [s]:	3.705385E-5
Edge width falling [s]:	3.869675E-5
Time [s]	Amplitude
1.000000E-6	2.746582E-2

- **Edge Width**
  Temporal (light) intensity or luminance transitions are characterized according to the time required for a change between 10% and 90% of the stationary levels (according to e.g. ISO 14 406-2 *Image Formation Time*)
  - Rising edge
  - Falling edge

NOTE: The operator has to make sure by proper selection of the blinking frequency of the test-object (monitor) and of the OTR time base that the signal reaches a plateau for a sufficient period of time. The plateau levels are taken as 0% and 100% levels for evaluation of the transitions times (edge widths) between the 10% and the 90% level.

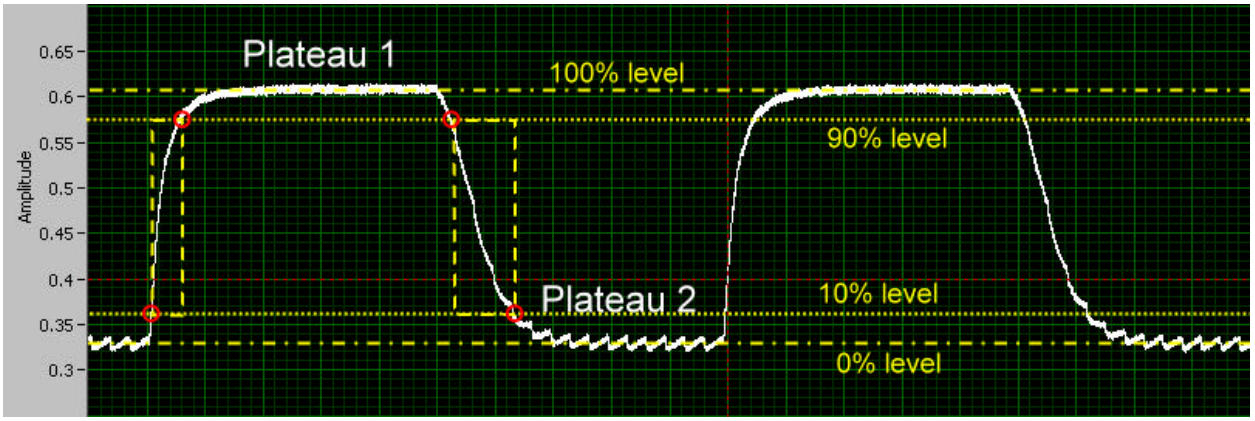


- **Scaling of axes**
  The axes of the diagrams can be scaled directly by entering the maximum value at the respective axes without affecting the data-acquisition timing of the OTR.

Edge width

Temporal intensity transitions are commonly characterized by the time period that elapses during a change of 80% of the amplitude between 10% and 90% reference levels.

In electronic display metrology "image formation time" (e.g. according to ISO 13406-2), "switching times" (e.g. according to IEC 61747-6) and "gray-to-gray transitions times" (e.g. ISO 9241-305) all refer to a change of 80% of the luminance response of the object under measurement (between 10% and 90%).



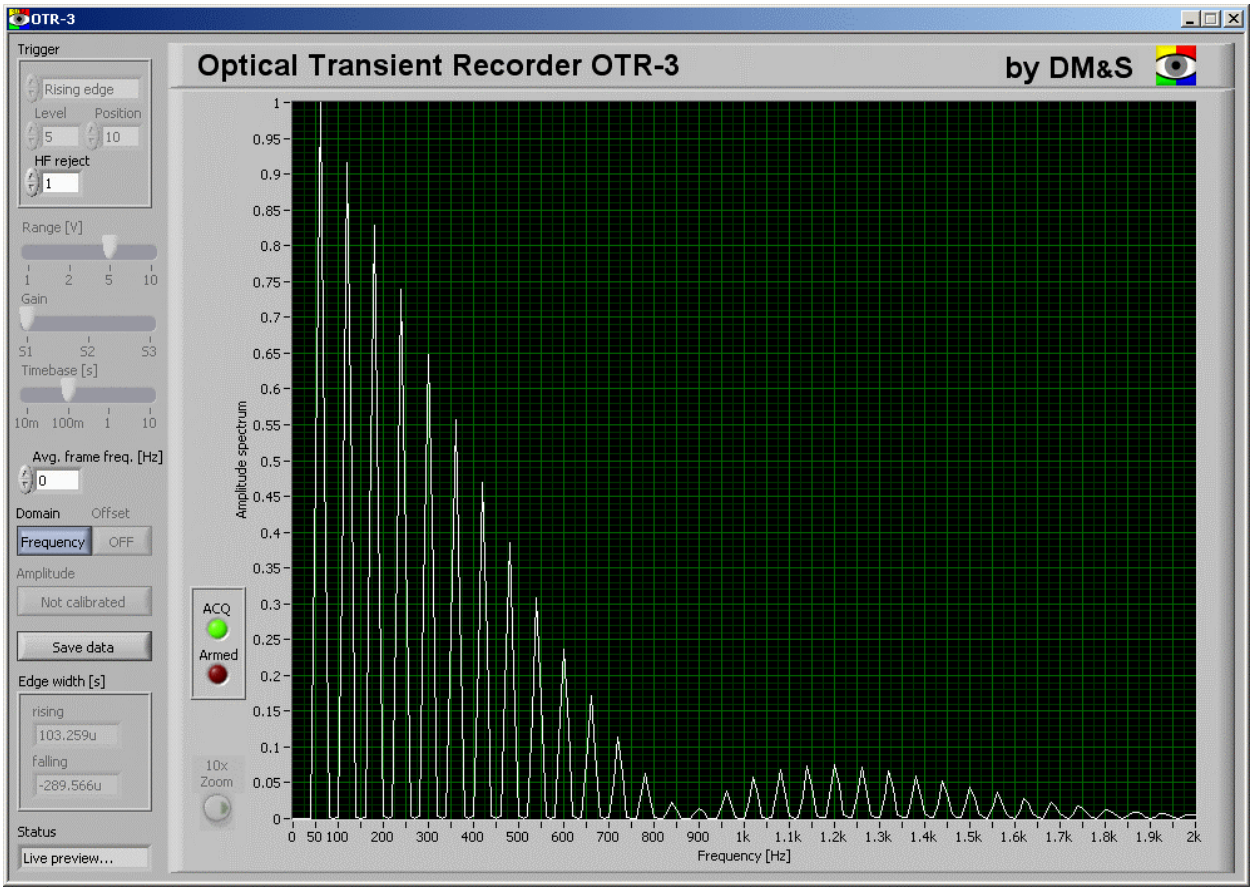
The conventions used for *edge width characterization* are shown in the diagram above. After the transition the signal settles to a steady state called *Plateau 1* and *Plateau 2*. The levels of these plateau regions are taken as 0% and 100% reference values.

The widths of edges (rising, falling) is given by the time difference indicated by the yellow boxes and the red circles.

The OTR identifies the pulse used for evaluation of the displayed edge widths by two blue markers.

OTR-3 PD	**Technical Data**
Data-acquisition	
Detector element:	Si-photodiode, spectral sensitivity V(λ) adapted
Measuring-field diameter	25 mm to zero, adjustment with iris diaphragm
Cut-off frequencies	21 kHz, 8.5 kHz, 1.5 kHz (S1, S2, S3)
A/D conversion	16 bit
local buffer memory	256 k samples
sampling frequency	max. 100 k samples / s
Evaluation	
transient mode	gray-level transition times (t_{10} - t_{90}) image-formation time (ISO 9241-300).
FFT mode	amplitude spectrum of optical input signal
General	
control interface	USB-2.0

OTR-3 electronics box and collimating receiver, measurement field diameter continuously adjustable fromm 25 mm to zero (for measurement of dark-signal).



Graphical user interface of the OTR-3 software shown here in the frequency domain (amlitude spectrum of impulse response of a CRT monitor @ 60 Hz frame frquency)