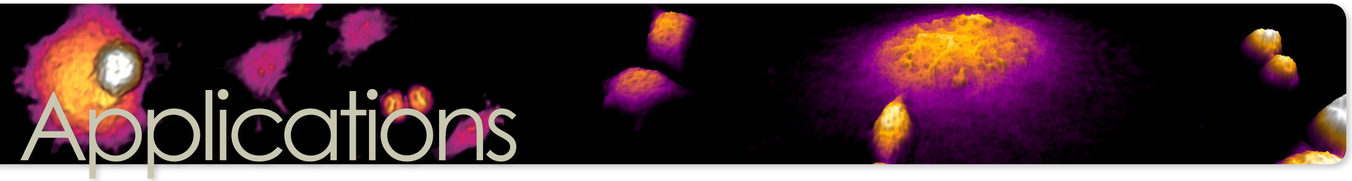
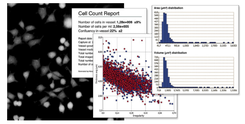
Autoimmune diseases
Cancer research
Stem cell biology
Inflammation Gene therapy
Toxicological studies
Regenerative medicine

Applications



Unprecedented time-lapse imaging minute by minute and day after day

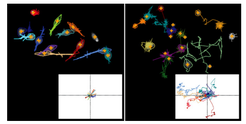


Growth rate data for untreated L929 mouse fibroblasts.

COMPREHENSIVE CELL CULTURE QCA

Instantaneously assess your tissue culture integrity

- Quantitative tissue culture QC metrics within seconds.
- Cellular growth rate and morphological changes simultaneously.
- Cellular population statistics comprise many relevant cell-by-cell measurements (size, optical cell volume, thickness, irregularity, etc).

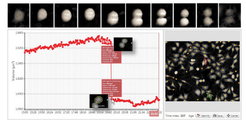


XY spacial movement plots of murine macrophages M1 phenotype and M2 phenotype.

CELL MOTILITY

Monitor cell movement and morphological changes simultaneously

- Robust segmentation and tracking of cells of interest.
- Cell motility speed and cell migration velocity measurements at your fingertips.
- Non-invasive nature allows subsequent cellular staining for further analysis upon conclusion of holographic imaging.

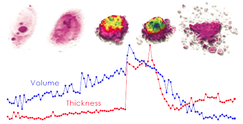


Changes in optical volume over time based on tracking of one cell of interest.

CELL CYCLE KINETICS

Analyze cells through rounds of replication with full confidence

- No perturbation to the natural cell state and function with label-free analysis.
- Robust measurement of mitosis and cytokinesis based on reliable automated segmentation.
- Cytometric data with effortless relationship between images and quantitative data.
- Results comparable to classic cytometric DNA cell cycle studies using fluorescent DNA stains.

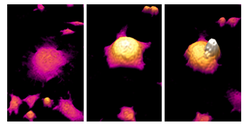


Etoposide-treated DU145 cell line: changes in optical thickness and volume during the death process in one individual cell.

CELL DEATH

Advanced studies with real-time observation of critical events

- Continuous 2D and 3D visual observation of cellular death in second intervals.
- Large portfolio of quantitative morphological parameters: optical cell volume, thickness, area, irregularity, eccentricity and many more.
- Single cell tracking and population data analysis.
- Ideal suitability for studying drug-induced cell death.



L929 mouse fibroblasts: a rare giant budding multinuclear cell.

RARE OR TRANSIENT CELLULAR EVENTS

Visualize previously unseen and analyze formerly undetected

- Unsurpassed temporal resolution with speed of image acquisition of up to 1 image per second.
- Morphological and quantitative tracking of cells of interest over multiple days.
- Cell-by-cell population data analysis.

HoloMonitor gives a totally new dimension to our work

Prof. Stina Oredsson, Department of Biology, Lund University, Sweden

TECHNICAL SPECIFICATIONS

HoloMonitor® M4 Base unit

Sample stage	Fixed
Light source	External laser unit, 635 nm
Sample illumination	635 nm, 0.2 mW/cm²
Objective	20×
Lateral resolution	1 µm
Field of view	0.25 mm²
Working distance	0.5 – 2 mm
Autofocusing range	1.5 mm
Maximum image rate	1 image/s
Image size	1024 × 1024 pixel
Dimensions (L × W × H)	250 × 160 × 180 mm
Weight incl. fixed stage	3.9 kg
Cell culture vessels	6-well, 24-well, 96-well, Petri, IBIDI
Software	Hstudio™

Regulatory compliance

Low voltage directive 2006/95/EC, Electromagnetic compatibility 2004/108/EC EN61010-1:2001 EN60825-1:2007

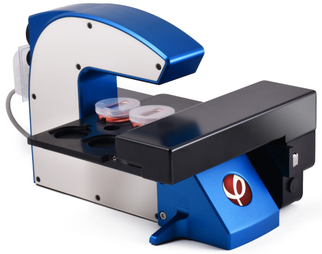
Requirements

Cells	Monolayer of adherent cells
Computer	Windows 10 or higher, for details see Setup and Operation Manual
Incubator	Access port for cabling
Operating temperature	10 – 40° C
Operating humidity	Max 95%

For research use only. Not for use in diagnostic procedures.

Motorized XYZ-stage (optional)

Travel range	100 × 70 × 10 mm
Repeatability	5 µm
Dimensions (L × W × H)	260 × 200 × 180 mm
Weight incl. base unit	5.5 kg
Cell culture vessels	6-well, 24-well, 96-well, Petri, IBIDI



HoloMonitor M4 equipped with optional motorized XYZ-stage

HoloLid™ for superior image quality

HoloLids eliminate image disturbances caused by surface vibrations and condensation inside the cell culture vessel. HoloLids are available for Sarstedt 35 mm Petri dish and multi-well plates.

For additional information see www.phiab.se/products/hololids.

Phase Holographic Imaging PHI AB
HoloMonitor and HoloMetrics are registered trademarks of PHI
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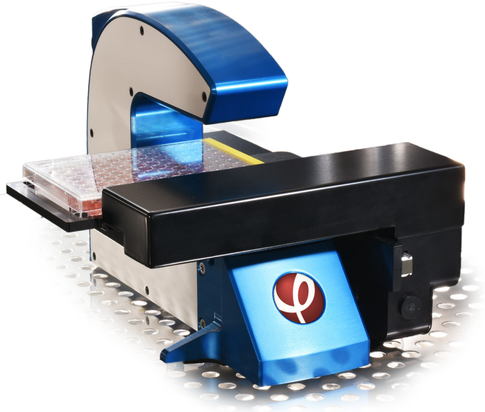
+46 46 38 60 80 | info@phiab.se | www.phiab.se

HoloMonitor® M4



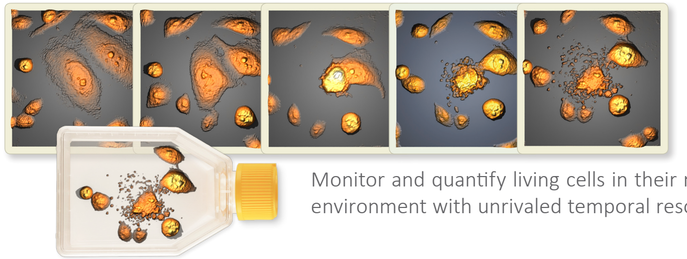
For powerful discoveries in your incubator

HoloMonitor offers unique imaging capabilities that greatly enhance our understanding of cell behavior, previously unachievable by other technologies

Ed Luther, Supervisor of Core Imaging and Cytometry Facility, Northeastern University, Boston, USA

HoloMonitor M4 is a fantastic tool. The spectrum of applications are endless. I am fully convinced that this is the beginning of a new era for research

Dr. Alain Geloen, National Institute of Applied Sciences, Lyon



Monitor and quantify living cells in their natural environment with unrivaled temporal resolution

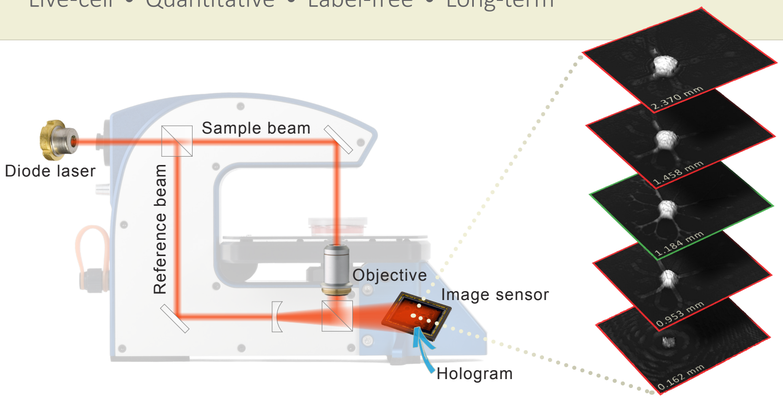
Phase Holographic Imaging

HoloMonitor® M4

Live-cell • Quantitative • Label-free • Long-term

An essential and versatile tool for label-free kinetic cell analysis

Simple workflow • Intuitive user interface • Proprietary software



HOLOGRAPHIC MICROSCOPY

HoloMonitor M4 utilizes the principle of holographic microscopy. A low-power laser beam is split into two, one illuminating the sample and the other providing a reference beam. Laser light passing through the sample is affected by intra-cellular structures causing a phase shift of the illuminating light.

Once combined, the two beams create an interference pattern which is recorded by a digital image sensor. The recorded interference pattern – the hologram – is then processed computationally to produce a holographic image.

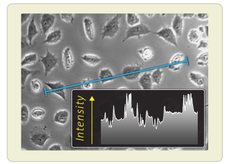
DIGITAL AUTOFOCUS

The fine focusing is done entirely in software, after recording. The digitally recorded interference pattern is computationally processed to create holographic images over a range of focal distances. From this temporary stack of images, HoloMonitor M4 automatically selects the best in focus image to produce the final holographic image. Alternatively, users may manually select the focal distance to focus on a plane of interest.

ROBUST SEGMENTATION

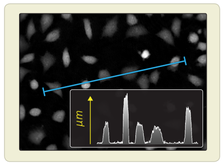
The foundation of quantitative analysis is the ability to identify discrete events for quantification:

PHASE CONTRAST



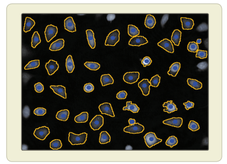
In the line profile of the traditional phase contrast image the background value cannot be accurately determined and a characteristic bright halo around the edge of the cells is present. This type of image does not lend itself for reliable segmentation.

HOLOMONITOR



In contrast, holographic images can be quantified as they reflect the optical thickness of the cell and optical density variations in the specimen. Additionally, holographic images have a background level of zero and the intensity of the events measured as positive values.

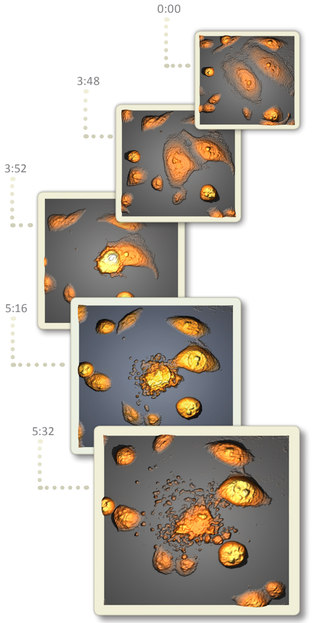
SEGMENTATION



HoloMonitor methodology enables reliable segmentation seen in the image as yellow cellular boundaries defined by a proprietary software algorithm.

HIGH TEMPORAL RESOLUTION

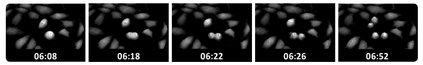
Label-free cell cultures are continuously monitored and analyzed in their natural environment. With the ability to acquire one image per second, both short-term monitoring of transient events in second intervals, and multi-day studies with images captured at user-defined intervals, are possible.



HOLOMETRICS®

Quantitative phase shift measurements are translated by sophisticated software algorithms into morphological parameters – optical cell volume, thickness, texture and many more.

LABEL-FREE SAMPLES

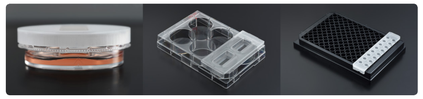


As samples are analyzed unstained, no sample preparation is required, and most importantly, cellular function is not altered by toxic stains.

LONG-TERM EVALUATION

The incubator-tolerant design makes HoloMonitor M4 especially well-suited for long-term kinetic cellular analysis. The low intensity, single wavelength laser generates no heat and reduces the risk of photo-damage to an absolute minimum.

SUPPORTED SAMPLE VESSELS

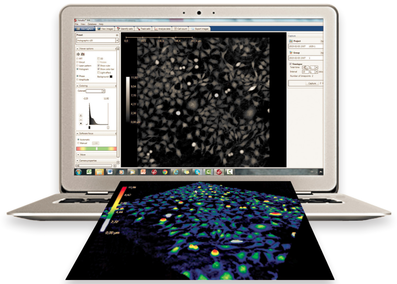


MOTORIZED STAGE

HoloMonitor M4 may optionally be equipped with a motorized stage. The high precision stage allows HoloMonitor M4 to record time-lapse movies at multiple locations, in parallel. Sample locations may be within the same culture or in different cultures. The stage control software is fully integrated in the HoloMonitor software. After sample locations have been graphically programed, time-lapse movies will be automatically recorded at each location.

RELIABLE AND COST-EFFECTIVE OPERATION

A new and innovative mechanical design together with intuitive software interface makes HoloMonitor M4 operation simple and reliable.

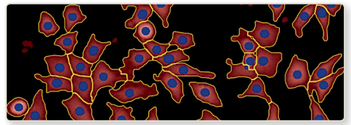


RECORD TIME-LAPSE

Position the vessel on the mechanical stage and record a time-lapse. The total recording time and time interval between image captures are operator-determined.

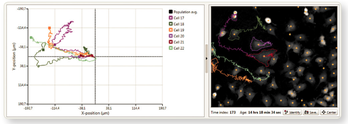
VIEW IMAGES

View images and time-lapse movies in gray scale and color, 2D and 3D. Color variations represent differences in optical thickness. Adjusting threshold allows digital filtering of cells of interest.



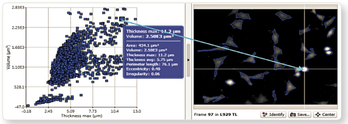
SEGMENT CELLS

Choose one of many available segmentation strategies and fine-tune by adjusting background threshold and cell size.



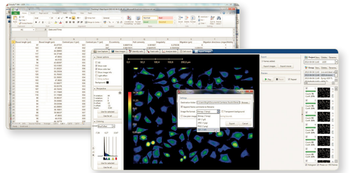
TRACK CELLS

Select individual cells to simultaneously track cell movement and changes in cell morphology over time. Individual cell movements are displayed in spatial plots with related quantitative parameters.



ANALYZE AND DISPLAY DATA

Perform comprehensive automated analysis with options to display quantitative and morphometric features in two dimensional histograms and scattergrams. Data verification is done based on images (example mitotic cells).



EXPORT

The time-lapse movies can be viewed and effortlessly exported. The acquired images can be easily saved in common image file formats. Additionally, data can be exported as XML, to Excel or easily processed in multiple freeware programs.