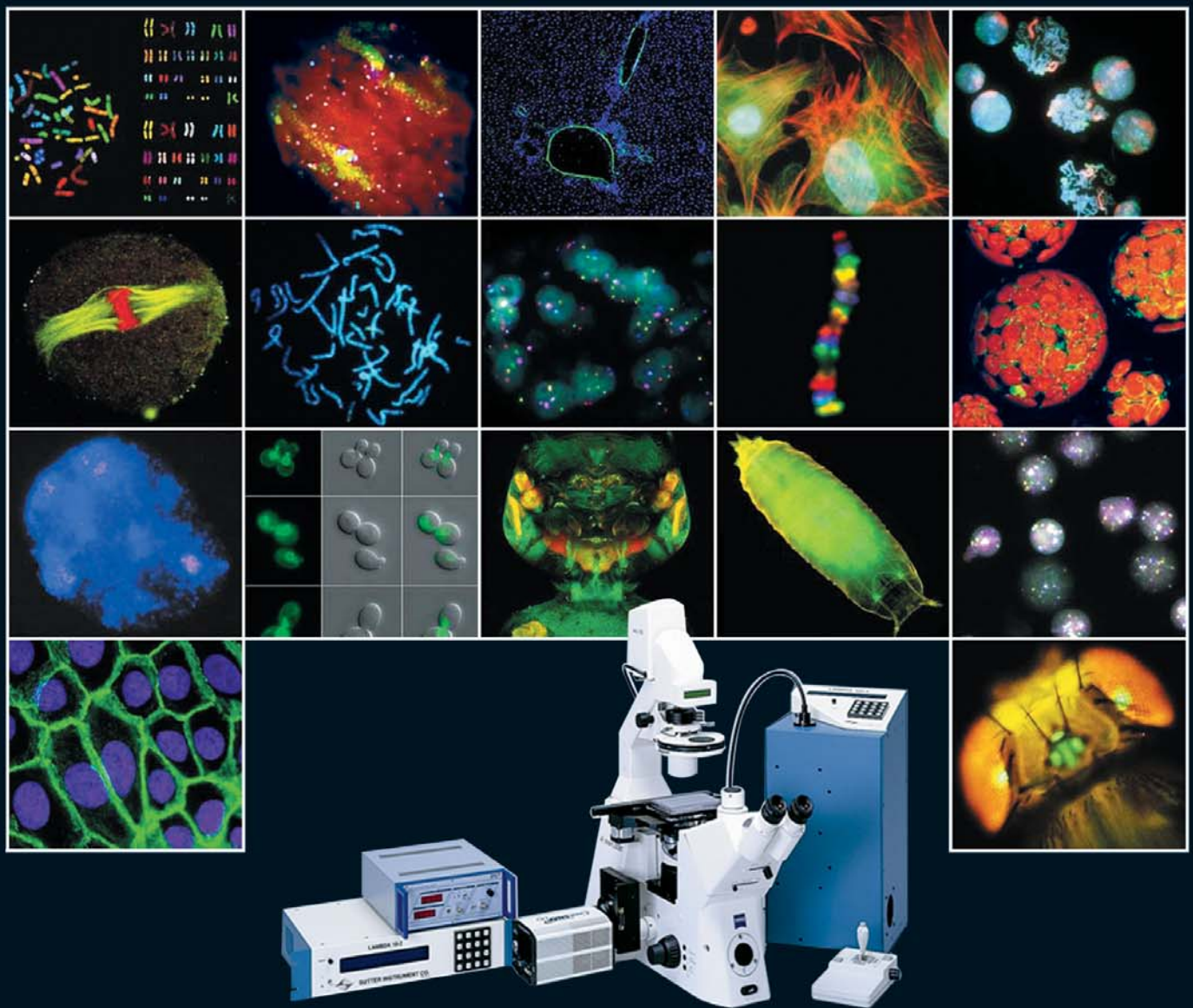
High Performance Solutions For Biology Imaging



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(주)케이오에스
KOS, Inc.

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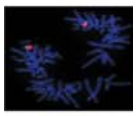
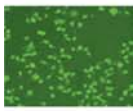
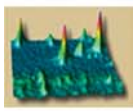
Image Total Solution for Biology Applications!!


- Real-Time Confocal Microscope Imaging System

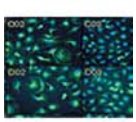

- GFP and FRET Imaging Methods System


- Chemi-Luminescence Imaging System


- Micro-Spectroscopy Imaging System


- Fluorescence in situ Hybridization (FISH) System

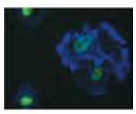

- Atomic Force Microscope Imaging System


- Calcium Ratio Imaging System

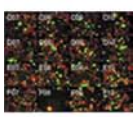
- Single Molecule Fluorescence Imaging System

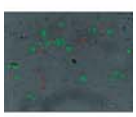
- Chemi-Luminescence Imaging System


- 3D Deconvolution & 3D Recontraction System

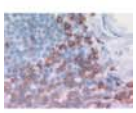

- High Throughput Screen (HTS) System


- Live Cell Time-Lapse Imaging System


- Confocal Image Enhanced System


- Cell Autocounting System


- Fluorescence Immunocytochemistry Imaging System


- Gene Chips & Microarray Imaging System


- MultiWell Plate Imaging System

- Z-Series Imaging System

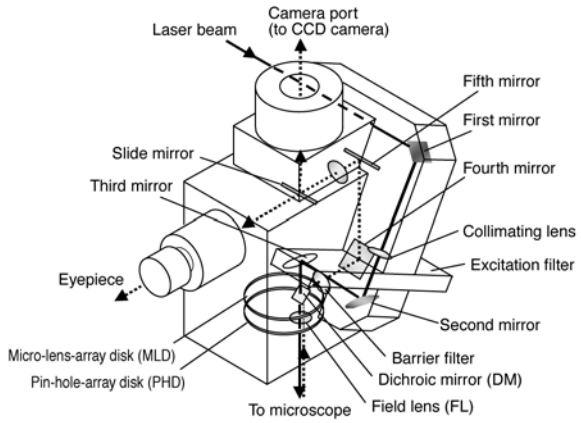
- Motion Analysis & Particle Tracking System

Real-Time Confocal Microscope CSU10/22

Brand-New Confocal Scanner for Fluorescence Microscopy with Innovative Nipkow Disk

- **Fast Scanning Rate at 360 frames/sec.**
- **High-Resolution with High S/N**
- **Direct Viewing of Clear-Cut Confocal Images**
- **Easy Operation Without Computer Control**
- **Mountable on Any Microscopes**

CSU10 revolutionizes the world of Confocal fluorescence microscope.



Internal Structure of CSU10/22

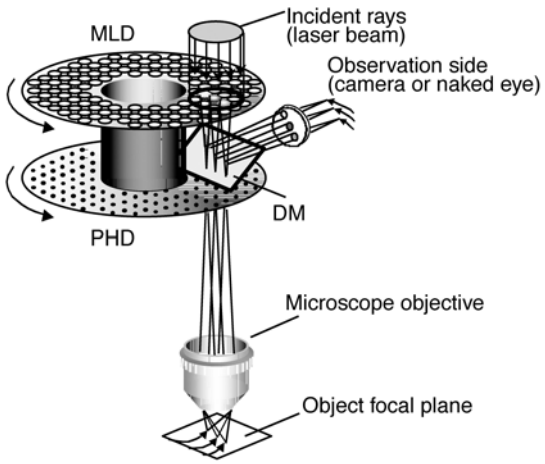
A confocal microscopy has enabled z-axis resolution of a thick specimen by employing pin-point illumination and pin-point detection while both the illumination and detection of a conventional optical microscopy are planar. However, it typically takes around 1 second to produce one confocal image using most of the existing confocal microscope; which is too slow to observe movement of living cells in real time. Now, as fast as 360 frames/sec. Scanning speed and high S/N design of Yokogawa Model CSU10/22 enables direct viewing of clear-cut confocal images of fluorescent specimens in real time at its eyepiece. The confocal images captured by CSU10/22 can be recorded either by a video camera as live images or by a film camera as real-color photographs. Using CSU10/22 is as easy as using regular microscopes: you set it on a microscope, change the light path: that's all. You can mount CSU10/22 on most of the currently used microscopes.

Unique Mechanism

Confocal scanning method of CSU10/22 is based on the Nipkow disk scanner (1884); an optical scanner using rotation of a disk with pinholes to produce an image. While a Nipkow scanner is good at fast scanning, its optical efficiency is too low to capture dark fluorescent image. By placing a microlens array in front of the Nipkow disk, we greatly improved the optical efficiency about two orders. In addition, CSU10/22 is designed to minimize the background inside the system thus realized high S/N.

Fast scanning, high optical efficiency and high S/N in the system: These are the key factors to realize the direct viewing of clear-cut confocal images in CSU10/22

CSU10/22 has two disks; one with about 20,000 microlenses, the other with pinholes arranged in the same pattern as the microlenses. Light incident on the upper disk is focused by the microlenses on corresponding pinholes. The two disks rotate together at 1,800 rpm by an electrical motor, so that the light beams raster-scan the specimen. The light passing through the pinhole is focused by an objective lens on a spot in the specimen. Fluorescent light from the specimen returns along the same path through the objective lens and the pinhole, and reflected by the dichroic mirror through a relay lens to the imaging point in a camera or eye. Both the laser beam and the emitted fluorescent light pass through a pinhole, thus CSU10/22 can produces 2-dimensional confocal images at such high-speed. The pinhole pattern is designed to capture 12 frames per rotation, which means 360 frames per second of confocal images can be captured with CSU10/22.



Scanning in CSU10/22

Best for tracking fast movement/reactions of living cells in real-time, but also good at capturing clear-cut cross section.

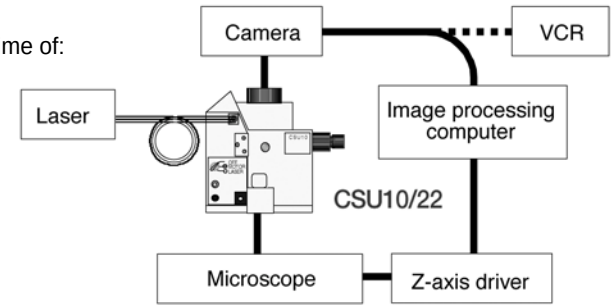
Applications:

Observation and recording of fluorescent images in real-time of:

- Ca^{2+} signals in living cells and/or organs.
- blood circulation in living animals.
- Movement/reactions in microorganisms or plant cells, especially stained with GFP.

Recording clear-cut cross sections of:

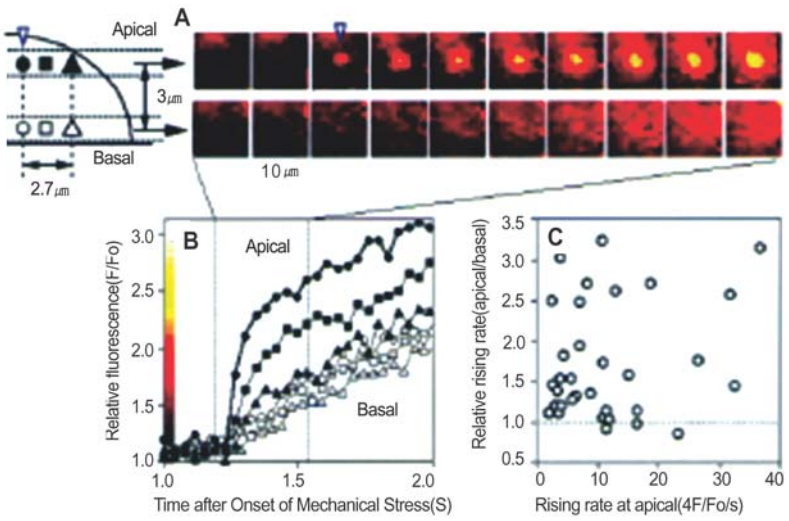
- Whole-mount embryo
- Pathological or histological specimens And MORE!



Scanning in CSU10/22

SYSTEM AND CAMERA

A computer is vital for most conventional confocal laser scanning microscopes since it is required to process the scanning position data and the intensity of the fluorescence signal, scanned by a laser beam with an oscillating mirror and acoustooptic device(s) and detected with a photomultiplier, into an image.
Even with the minimum system using laser scanning, the CSU10/22 allows confocal images to be observed through the eyepiece by the naked eye because it employs high-speed scanning and because of the persistence of human's vision. Nonetheless, since most cases require the observed images to be recorded, a CCD camera is used to record confocal images generated optically by the CSU10/22. This means that the recording performance of the CCD camera used determines the quality of the confocal images.
If the images captured by a CCD camera simply need to be recorded on videotape, a computer for image processing is not required. In most applications, however, an image capture board is installed in a computer, and the computer reads the images through the board, performs noise rejection processing and other image processing such as image enhancement and pseudocolorization. Besides, most digital CCD cameras require a computer with an image capture device, and for Z-axis control for moving along the observation plane and automatic integrated control of the laser beam shielding shutter, even a Nipkow disk type scanner, such as the CSU10/22, requires a computer system with (1) a camera, (2) Z-axis control, (3) shutter control, and (4) image processing configured. Although items (2) to (4) are techniques that are also used for conventional laser scanning confocal microscopes, care must be taken when selecting item (1), the camera, since a two-dimensional sensor, which is not always required for conventional laser scanning confocal microscopes, is a requisite for capturing images with the CSU10/22. Furthermore, the quality of base images is the key determinant of success or failure in computer image processing, therefore the camera must be extremely carefully chosen.
There are numerous factors that discern the performance of a camera including the shooting speed, spatial resolution, sensitivity, noise level, number of gray scale levels, dynamic range, gamma, and color or black and white shooting capability. The users may select cameras having different speeds according to the purpose for use with the CSU10/22, and the spatial resolution, sensitivity, and noise level are often raised as the three common critical factors in actual applications. The spatial resolution is determined by the pixel size of the CCD camera; however, as in the case of noise level, data is rarely obtained under the same measurement conditions and hence the data of different cameras cannot be compared. To solve this, we devised a method of obtaining images shot by cameras under fixed conditions in which thin chromium films formed on a glass substrate in a pattern of repeated lines (four micrometers thick and four micrometers spaces) are shot while being lit from the back.



High speed 3D data

PERFORMANCE EVALUATION MEASUREMENTS FOR CAMERA

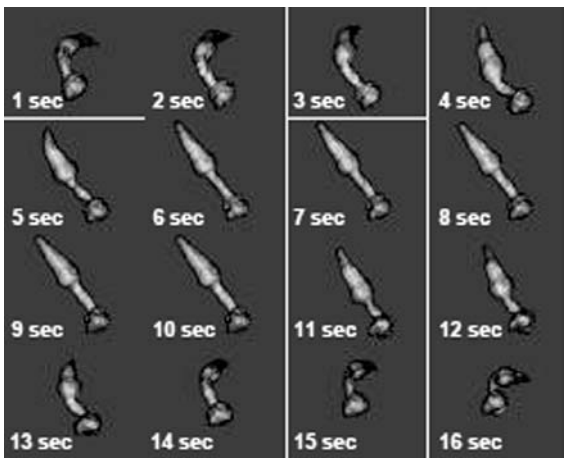
Spatial resolution: Although the pixel size, which is often shown in the catalog of a CCD camera, indicates the spatial resolution of the captured images for a digital camera, if the output from the camera is an analog signal, the spatial resolution also depends on the frame size of the image capture board. To use the CSU10/22 to perform video-rate or faster capture, a CCD camera with an intensifier may need to be used because of the low amount of light per unit time, which imposes a trade-off between sensitivity and resolution.

Sensitivity: Choosing a high-sensitivity camera, with the expectation of obtaining bright confocal images with the CSU10/21, results in images that on the whole, including the background have high brightness. As the greatest benefit of confocal images is an increased contrast, the change in output electric signal level according to the unit change in the amount of incident light, namely the contrast, is also important for the camera. Especially for living samples, the dosage of a fluorescent reagent is limited and the energy of the excitation laser must be kept low to suppress the phototoxic effect from the laser radiation, therefore, the fluorescence signal is generally low in level and a camera with high sensitivity and high contrast is required. On the other hand, these limitations are reduced for non-living fixed samples but the same requirements also apply to camera selection when no treatment is performed to prevent discoloration. In general, moving-subject observations require a fast capture speed and hence the gray scale levels are traded off for higher sensitivity, but for morphologic observations halftones are required.

Noise level: Noise interposing in the obtained images incurs due to various optical and electrical causes, and its level differs depending on the camera's working conditions including the cooling temperature, set sensitivity, exposure time, capture speed, and extraneous noise. However, if these conditions are made constant, calculating the standard deviation of the gray scale distribution in the signals for each of the white and black level portions inside each captured image will enable quantitative comparisons and analyses. Generally speaking, the noise level is less than 1 for cooled CCD cameras, 1 to 5 for non-cooled CCD cameras, and 5 or larger for CCD cameras with an intensifier. The criterion for whether the measured noise level is acceptable should be determined for each application. For example, it may be whether the finestructure of the sample's intended portion (e.g., the axon of a neuron) can be distinguished, or whether the changes in the sample's generating signal (sparks or fluorescence from pH-dependent granular pigments) can be identified and/or quantitatively measured.
There is no camera available that boasts high spatial resolution, high sensitivity, and low noise; hence it is substantial to choose the right camera for the purpose in confocal image observations.

EXAMPLES OF MEASUREMENTS BY CSU10/22

Confocal Images of Nematode through Continuous Z-axis Moves (taken by Professor Ayako Sugimoto, Biochemistry Dept., Science Div., Tokyo University, Japan)



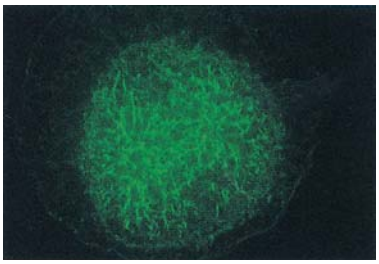
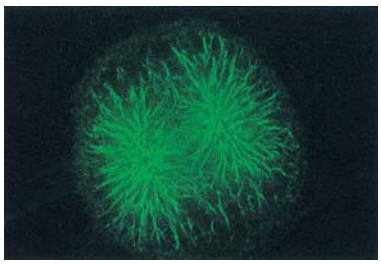
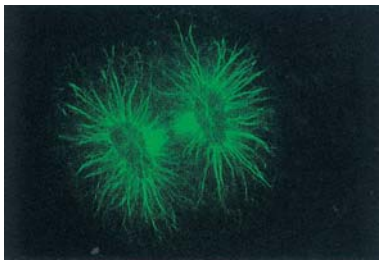
Reconstructured Three-dimensional Stereoscopic Images of Nematode

Figure on the right shows images continuously shot while the microscope objective was moved in one-micrometer pitches. The sample is Caenorhabditis elegans (a nematode) in which a green fluorescent protein-fused pharyngeal protein is manifested. Since the CSU10/22 allows video-rate monitoring, three-dimensional slice data of a slow-moving nematode can be obtained with nearly negligible, spatial displacements. The results from obtaining slice image stacks at one-second intervals for sixteen seconds (namely, obtaining sixteen stacks) and performing three dimentional image restructuring processing for each stack using a computer, are shown in Figure on the left. A CCD camera with an intensifier and an 8-bit image capture board was used.

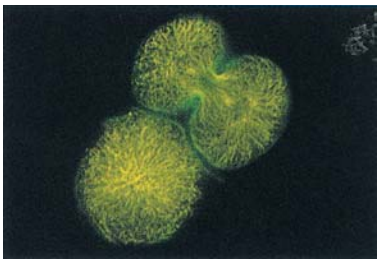
Images of Sea Urchin Embryonic Microtubules at the First Mitotic Stage

(By Courtesy of Dr. I. Uemura et. al., Tokyo Metropolitan Univ., Dept. Biology)

Series of optical sections: (Stained with BODIPY-FL)

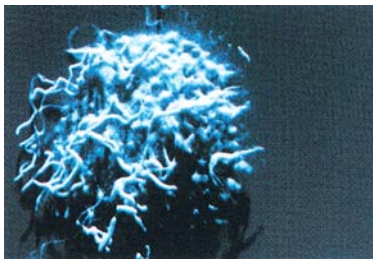




Double Staining



(Microtubules were stained with Phycoerythrin anti tubuline antibody, and actin filamentswere stained with BODIPY-FL Phallacidin)

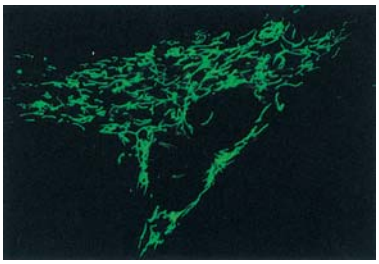
3-D Image Reconstruction



(Reconstructed 3-D image of sea urchin embryonic microtubules at gustrula stage, stained with BODIPY-FL)

Images of Living Cell

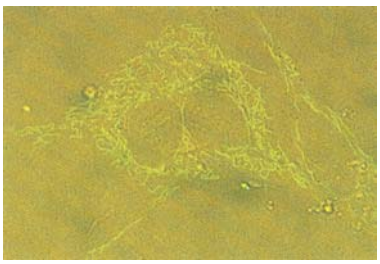
Mitochondria of Mouse Fibroblast



(Stained with Rhodamine 123.)

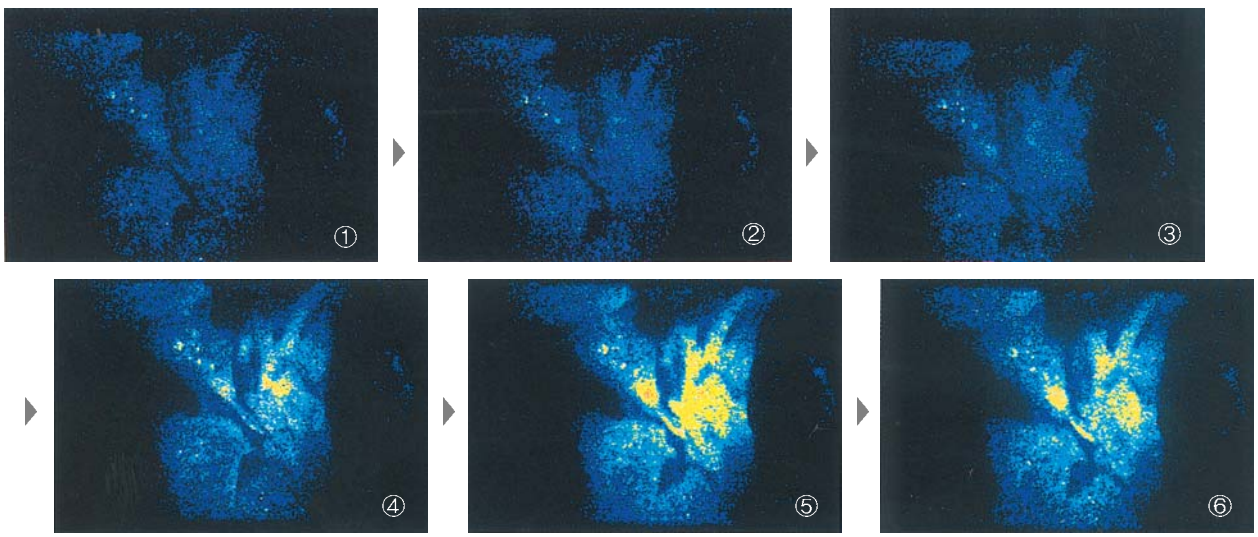
Overlap of Confocal and Bright Field Images

(By Courtesy of Dr. Ishida, Tokai Univ., School of Medicine)

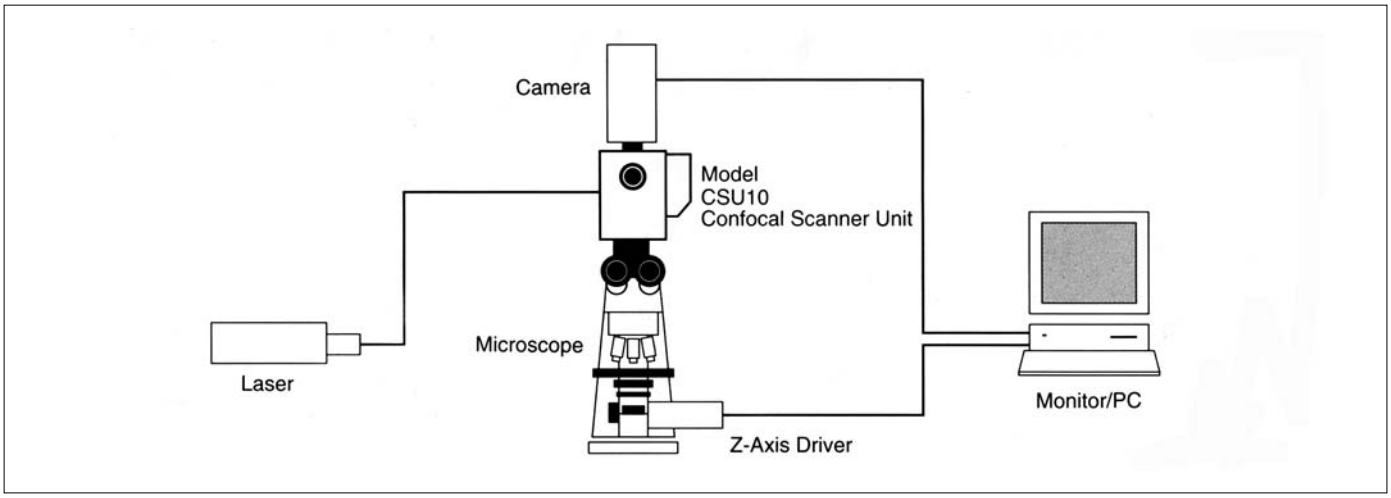


Real-Time Observation of Calcium Signals in a Mouse Cardiac Muscle Cell

(By Courtesy of Dr. Ishida, Tokai Univ., School of Medicine)
(Rapid changes in the Calcium level following spontaneous beating in a mouse cardiac muscle cells were recorded with an ICCD camera at video rate. Calcium stained with Fluo-3)



Combination with Microscopes and Cameras



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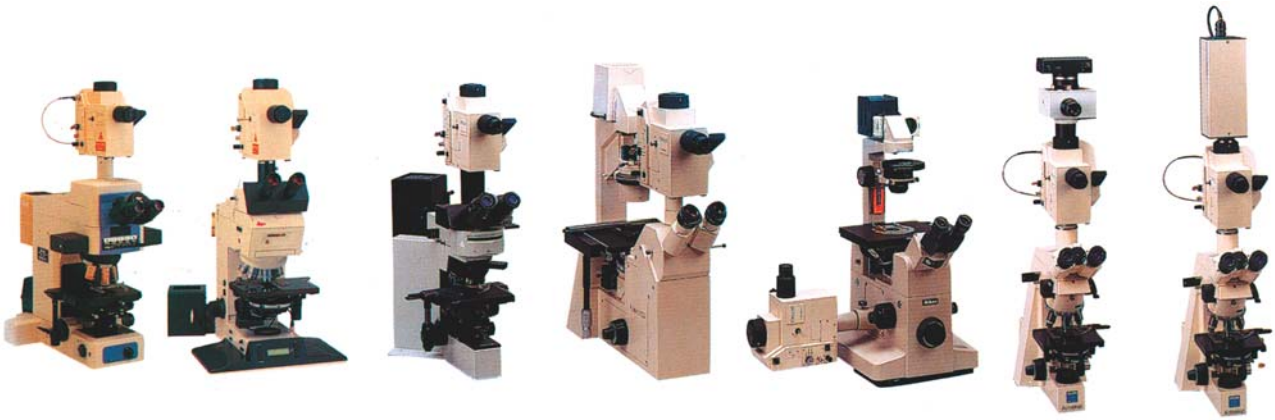


Nikon Leica Olympus Zeiss Nikon Film Camera CCD Camera

Specifications

scanning speed	360 frames/sec.(rotation at 1,800 rpm)
excitation	473nm, 488nm, 568nm, 647nm, (532nm)
electrical shutter	Remote or safety lock
installation	Set at the camera port of a microscope with a direct-C mount
optical fiber connector	FC-connector
power supply	100/120 VAC or 200/240 VAC. 50 or 60 Hz
power consumption	20 VA
size(mm)	150(W) x 210(L) x 210(H)
weight	5 Kg

ROPER SCIENTIFIC® ChemiPro™

The "Whole" Solution

Roper Scientific® ChemiPro™ system is a state-of-the-art laboratory instrument engineered for chemiluminescence imaging of whole plants or whole animals. This unique, fully integrated system incorporates a high-performance CCD camera, a ultrablack dark box, and simple-to-use software in order to provide a streamlined research solution for a number of challenging chemiluminescence imaging applications.

Chemi-Luminescence Image System

ChemiPro supports a broad range of experiments:

- **Gene expression in plants**
- **Brightfield/high-resolution DIC microscopy**
- **Tissue-specific gene expression in animals**
- **Fluorescence in fixed samples**
- **Gene expression in isolated-cell preparations**
- **Particle tracking**
- **Spray imaging**
- **Medical imaging**

At the heart of the ChemiPro system is a cryogenically cooled, back-illuminated CCD that boasts excellent quantum efficiency across the visible spectrum. This outstanding QE, combined with the very low readout noise of the camera's slow analog-to-digital converter, yields maximum sensitivity.

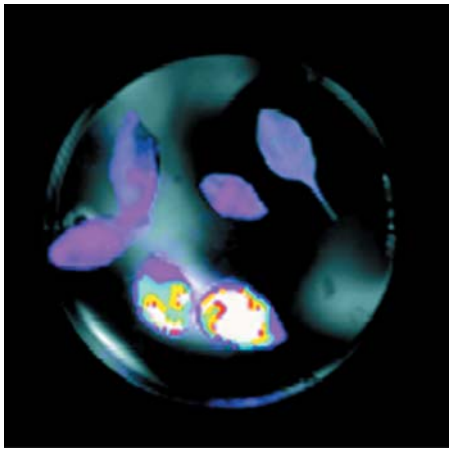
In addition to high-sensitivity image acquisition, the ChemiPro system's dual speed readout capability provides a faster operation mode for quick camera setup and focusing. User-programmable gain levels afford even greater detection versatility.

The ChemiPro system includes either a USB 2.0 interface or a high-speed PCI card, as well as all required cables and a camera lens adapter nose (F-mount style). A downward-looking dewar (available with an optional "liquid nitrogen autofill" system) is provided as the standard configuration. Alternatively, an all-directional camera model allows the detector to be mounted on any microscope port, given the appropriate microscope adapter.

LN Cooled CCD Camera

Dark Box

The ChemiPro system's dark box has been designed to provide a light-tight environment for imaging chemiluminescent samples. The ultrablack box, which features an externally adjustable stage and a "camera-to-dark box" adapter nose, lets samples be observed with negligible background-light contamination. With the ChemiPro system, there's no need to waste an undue amount of time repeatedly opening and closing the dark box to fine tune the setup of an experiment. For ease of use, the ChemiPro box has interior lights that are externally controllable, making it simple to acquire a brightfield reference image. Focusing is also aided by conveniently located external controls. For collection of the greatest number of photons emitted from the sample, an ultrafast Nikkor 50-mm f/1.2 lens is included.

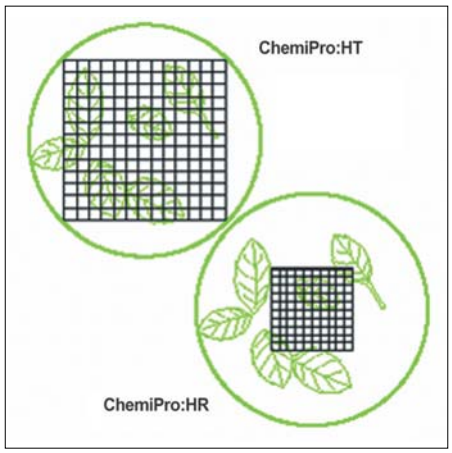


Powerful Software

The ChemiPro system includes imaging software that offers reliable acquisition, processing, and archiving. This full-function package enables the optimization of data collection via on-chip binning, various subregion-readout methods, and the ability to set exposure times anywhere from milliseconds to an hour.

The feature-rich software boasts a comprehensive suite of mathematical functions, allowing researchers to add, subtract, multiply, and divide in order to derive image corrections. The resultant 16-bit data can be saved as a standard TIFF file for export or formatting for publication.

The ChemiPro system is PVCAM® compatible as well. Roper Scientific's exclusive PVCAM application programming interface facilitates the acquisition, processing, and printing of images using dozens of popular third-party packages.



Versatile performance

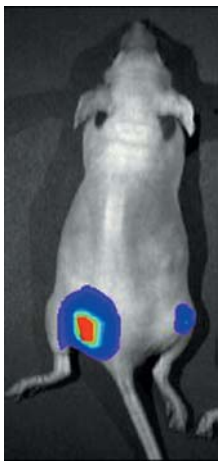
Each ChemiPro system is tailored for either high-throughput (large field of view) or high-resolution (high pixel density) performance. Both models deliver superb ultra-low-light sensitivity at luciferin's emission wavelength.

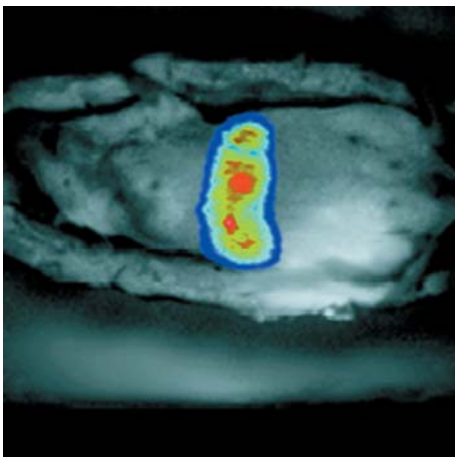
High Throughput ··· ChemiPro:HT

- Large field of view for high-density sample evaluation
- High-efficiency light collection
- High intrascene dynamic range for measurement of heterogeneous samples

High Resolution ··· ChemiPro:HR

- Excellent resolution attributable to high pixel density
- High intrascene dynamic range for measurement of heterogeneous samples





Superior Support

Purchasing an instrument from the world's largest manufacturer of scientificperformance CCD cameras has distinct advantages. Each ChemiPro system comes from the factory fully tested and guaranteed to perform according to specification. In addition, an optional on-site installation with a one-day, hands-on training session helps making system setup and usage a breeze. Of course, Roper Scientific imaging experts are always glad to answer any instrumentation questions, as well as help assess suitability for specific laboratory applications. With Roper Scientific facilities and personnel spanning the globe, all ChemiPro users can count on responsive, knowledgeable, local support.

model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise	dark current
ChemiPro:HT	1340 x 1300	20 x 20	1 MHz 100 kHz 50 kHz	5 e- rms @ 100 kHz or 50 kHz 12 e- rms @ 1 MHz	<1 e-/p/s @ -110 °C
ChemiPro:HR	1024 x 1024	13 x 13	1 MHz 100 kHz 50 kHz	5 e- rms @ 100 kHz or 50 kHz 10 e- rms @ 1 MHz	<1 e-/p/s @ -110 °C

Intracellular Ion Image Measurement System

Introduction

Designed for single or dual wavelength intra-cellular ion measurements, IonFluor supports FURA-2, BCECF, INDO-1, FRET and other common ratiometric indicators.
IonFluor provides simultaneous display of the original wavelengths, the ratio images, graphs of intensities, ratios, and ion concentrations, and a non-ratiometric image such as a bright field or phase contrast image.
Two different ratiometric indicators can be imaged and measured at the same time.

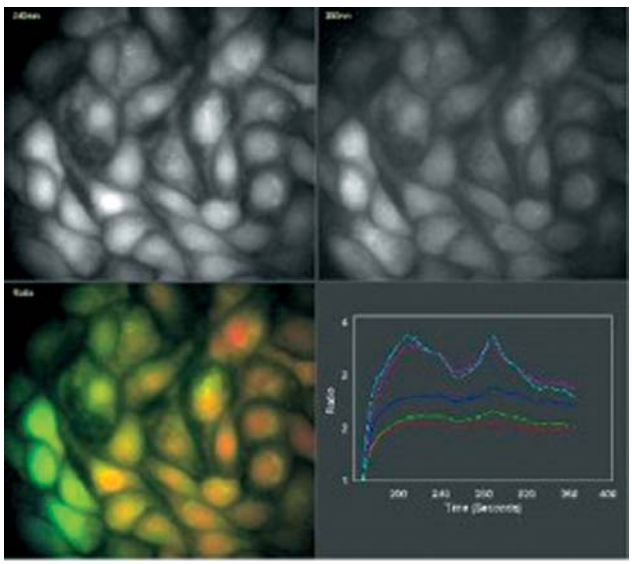
Ion Image Measurement System

Calibrations

- Calibrate using the standard Grynkiewicz equation.
- Titration calibrations with choice of curve fits.
- Generate calibration maps to directly display pH, calcium or other ion concentrations.

Image Analysis

- Generate up to two Ratios per cycle from wavelength images
- Log data to text files or to Microsoft Excel or other applications
- Analyze multiple regions of interest; measure intensity, integrated intensity, threshold area, ratios, or calibrated ion concentrations for each region over time
- Thousands of regions, of standard shapes or free-form
- Four graphs display any selection of measured values
- Event Marks, Notepad, and Image Annotation serve to document the experiment
- IMD, pseudo color, and monochrome display modes
- Save images using standard TIFF files
- Make movies, saving them in standard AVI files



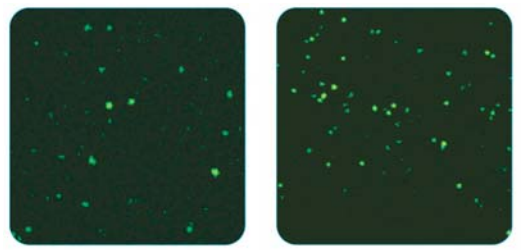
MDCK cells loaded with fura-2 AM

Automation

- Drives multiple shutters, filter wheels, monochromators, and other wavelength- changing devices
- Trigger external devices such as pumps, valves, strobes, or flash lamps using TTL outputs
- Receives triggers from other computers or devices
- Send or receive data through standard serial ports
- Sequence journals to run at specific times during the experiment acquisition cycle
- Automatically run journals every time an acquisition or other task occurs
- Timelapse

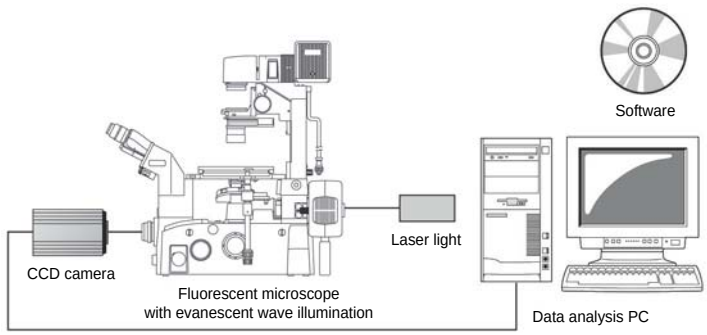
SMF Single Molecule Fluorescence Imaging

The technique for imaging single-molecule fluorescence inside a cell has beenapplied to various samples recently by many researchers. Required for the single-molecule fluorescence imaging is the detection capability of photons at an extremely low level. Hence, the cameras have to possess the performance of high sensitivity and a high S/N ratio for SMF imaging.
As the ideal cameras for imaging extremely weak single-molecule fluorescence,Roper Scientific offers the Cascade series, the CCD cameras with on-chip multiplication gain, and the PI-MAX, the ICCD camera with the enhanced sensitivity by the image intensifier. Both types have the sensitivity of the highest level to achieve the single-photon detection capability.



Single-Molecule Fluorescence Image

System Specification



Dual Cam Simultaneous dual-wavelength imaging unit

The unique beamsplitter is integrated into the unit in a compact manner to guide the light to the two output ports where two CCD cameras are mounted to acquire images without compromising the resolution. With the two absorption filters installed inside, this unit is ideal for the simultaneous, dual-wavelength imaging applications as typified by FRET and fluorescence ratio imaging.

Specifications

- Attachment thread C-mount for all input and output ports, or C-mount for input port and F-mount for output ports
- Wavelength sensitivity : 350 nm to 2.2 mm

Systems Specification

SMF Single-Molecule Fluorescence Imaging (single wavelength image acquisition)
Best for noiseless single-molecule imaging with its high-speed framing

Camera	: Cascade 512B Single Amplifier Cooled Digital CCD Camera
Software	: RS Image Pro Imaging Software or any equivalent StreamPix-PVCAM Recording Software
Analysis Functions	: Brightness, Area, Object tracking, etc.
Data Acquisition Speed	: 27 fps @ 512 x 512, Long Time Recording to HDD
Data analysis PC	: RS-PC (Windows XP)

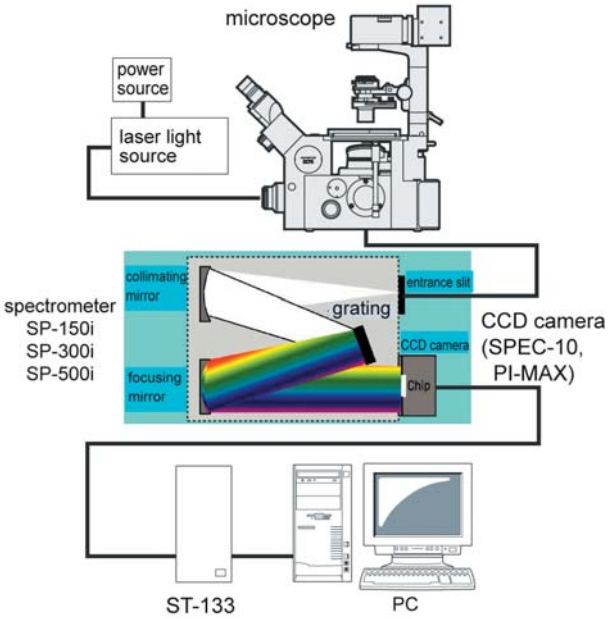
SMF-FDV Single-Molecule Fluorescence Imaging (dual wavelength acquisition)
Acquisition of dual-wavelength single-molecule images with one camera

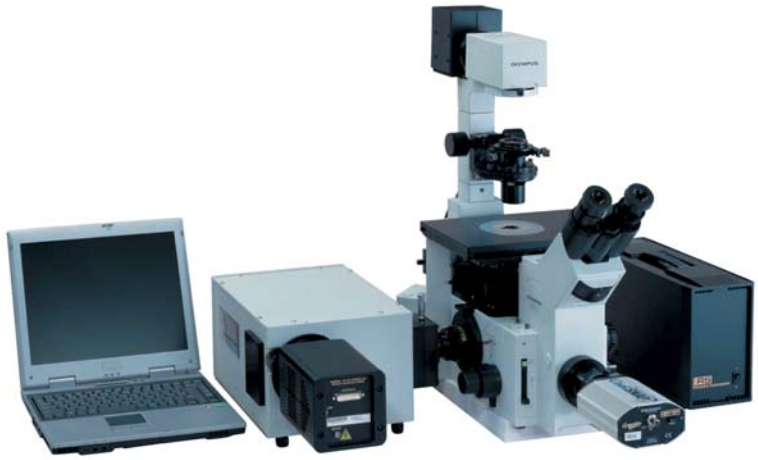
Camera	: Cascade 512B Single Amplifier Cooled Digital CCD Camera
Software	: RS Image Pro Imaging Software or any equivalent StreamPix-PVCAM Recording Software
Wavelength-based beamsplitting optics	: Dual View (FITC/T.Red Filter Mounted)
Analysis Functions	: Brightness, Area, Object tracking, etc.
Data Acquisition Speed	: 27 fps @ 512 x 512, Long Time Recording to HDD
Data analysis PC	: RS-PC (Windows XP)

- Recommended cameras: Cascade 650, Cascade 512B, Cascade 512F, PI-MAX

Micro Spectroscopy Imaging System

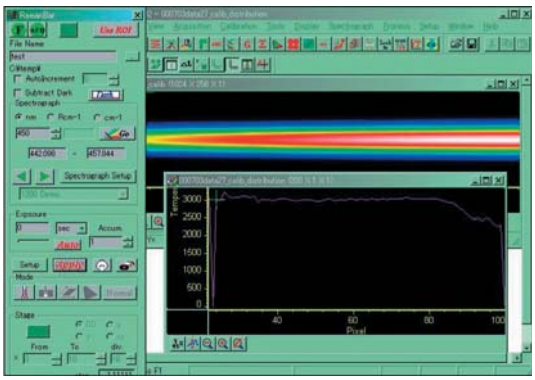
The purpose of mcro spectroscopy is being able to provide spectroscopic analysis of more minute part of object while physical properties of a sample material are featured by the standard spectroscopy. Roper Scientific CCD spectroscopic systems can be connected with various types of microscope to build up specified micro spectroscopic systems. Nippon Roper supplies embedded software SnapIn on WinSpec/32 to control the exciting light shutler, the sample stsge and so on for the micro spectroscopy. By use of the software, the spectra can be analyzed automatically scanning the sample on the motorized stage, And it is possible to produce mapping images of noliced information including peak value of the spectra, bandwidth, and peak intensity picking up from the captured data.

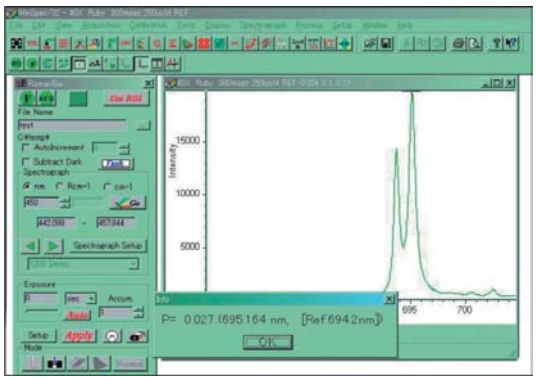




Measurement of Pressure and temperature in Diamond Anvil Cell

Diamond Anvil Cell (DAC) is used as a most appropriate tool for the measurement of samples under a high pressure as it is compact and lightweight enabling to generate high pressure. Roper supplies spectroscopic sysems and software for the analysis using DAC. The pressure data at DAC can be captured in real time by ruby fluorescence method taking spectra using a Roper Scientific CCD spectroscopic system. In these years it is interested in taking material properties under high pressure and high temperature. For the purpose it is possible to measure the temperature from the emissive spectrum.



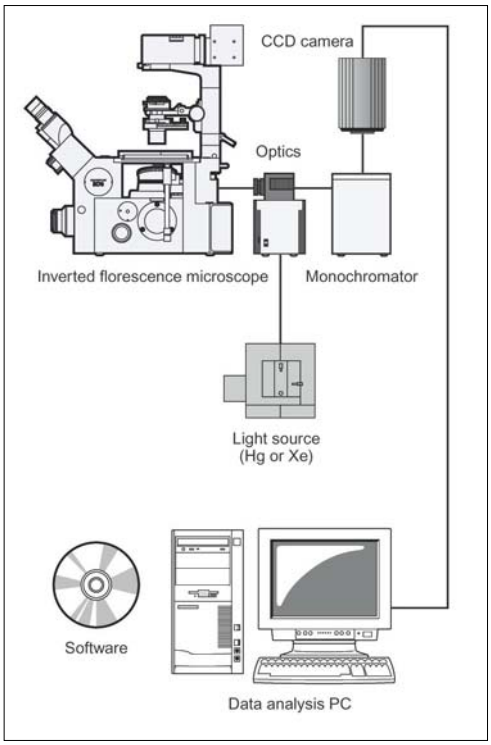


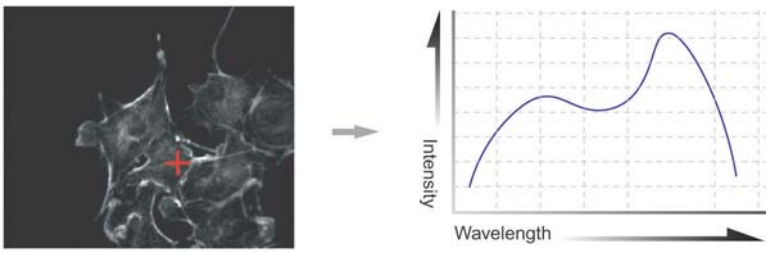
MSI Multi-Spectral Imaging

PATPEND

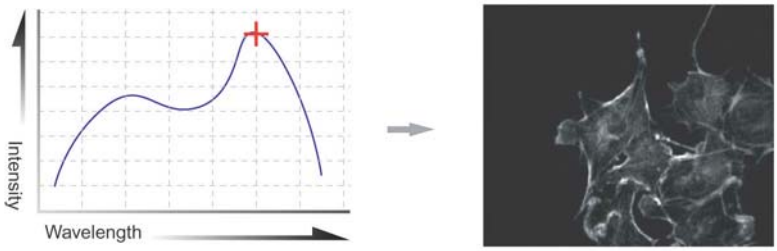
The multi-spectral imaging system, MSI can simultaneously acquire an image of biological samples such as cells, the wavelength at each point in the image and the time-varying wavelength - image information.
Biological samples are often prepared in solutions and the demand for analyzing them in vivo has been rising recently. This system provides the information on colors and shapes of the sample through the microscope, and at the same time, all points of the microscope image are spectrally resolved and even time-resolved.
The sample, stained in advance, is placed under the microscope and illuminated by the excitation light. Then the florescence the sample generates is collected through the objective lens and imaging optics to form the sample image on the slit located at the entrance of the monochromator.
This image is spectrally resolved by the aberration-corrected monochromator and digitized by the highly sensitive 2D digital optical sensor. The digitized image data is stored in the PC.
The image formed on the slit of the monochromator is converted by the 2D optical sensor to the optical intensity as a function of wavelength.
When the sample is translated in the direction perpendicular to the slit during the data acquisition, the information on both the wavelength and the image is simultaneously acquired.

System Configuration





You can measure the spectrum of the particular portion of the sample, and also see the image formed by the selected wavelength.

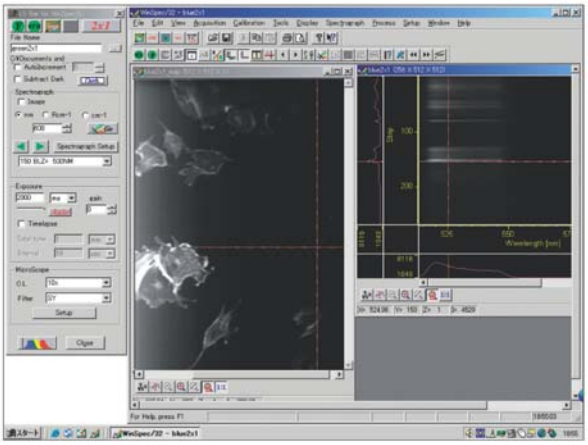


Specifications

Imaging pixel x wavelength pixel		512 x 512	256 x 256	128 x 128
Pixel size (for binned readout)		16 μm x 16 μm	32 μm x 32 μm	64 μm x 64 μm
Measured	300 G/mm (spectral resolution)	78.6 nm (0.15 nm)	78.6 nm (0.3 nm)	78.6 nm (0.6 nm)
wavelength	150 G/mm (spectral resolution)	157 nm (0.3 nm)	157 nm (0.6 nm)	157 nm (1.2 nm)
region	120 G/mm (spectral resolution)	190 nm (0.37 nm)	190 nm (0.74 nm)	190 nm (1.48 nm)
Acquired field of view		320 nm	320 nm	320 nm
Time lapse rate (sec/spectrally resolved image)		50.2	10.9	3.8
Spatial resolution (x 20 magnification) (mm/pix)		0.8	1.6	3.2

User-friendly software

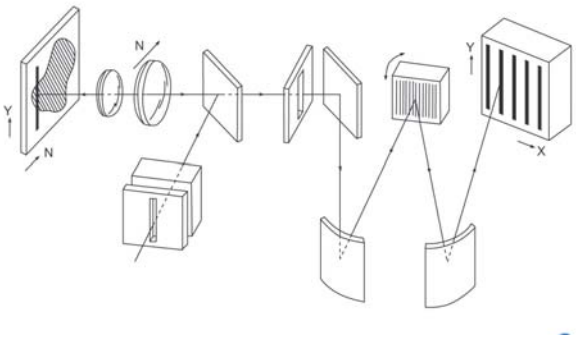
The multi-spectral imaging software developed by Roper Scientific allows for the acquisition of an image composed of any arbitrary wavelength. After setting the exposure time, it performs high-speed sampling of the image signals and the wavelength- intensity information at each point on the image.
The software can also measure the time lapse of these data if necessary. The acquired data can be utilized by the software to display an image of any wavelength and the optical intensity as a function of wavelength at any point of the image.



WinSpec32 Software
WinSpec32 Software can acquire, display and process spectrum-image data on its own as well.

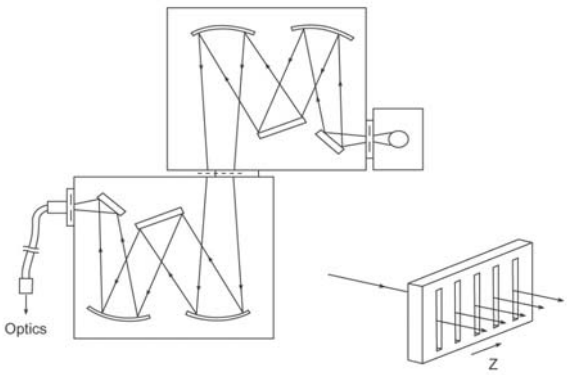
Cutting-edge technology

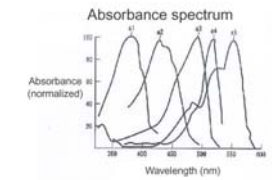
Since driving the sample or the objective lens causes the displacement of the sample in the solution, resulting in low-precision image data, the method of scanning the imaging lens in a precise and rapid manner is employed.
The unique optics of this system excites no other part of
the sample than the spots of measurement so that fluorescence fading is avoided. The incident light to the monochromator and the excitation light to the sample are aligned perfectly on the same optical axis with the slits installed on both the monochromator and the excitation source, thus the imaged and excited spots being exactly the same point of the sample.

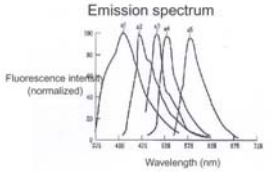


Multi-wavelength illuminator

As for the excitation light source, the multi-wavelength illuminator can simultaneously excite the samples with multi-wavelength lights. Optical filters, with their limitation to the number of selected excitation wavelengths, cannot deal with multiply stained samples, which sometimes need more than 5 excitation wavelengths. In the case of using a white optical source for the excitation, detection capability is severely affected by the white light that interferes with the sample's fluorescence wavelength. Therefore, there has been an increasing demand for the light sources that can emit multi-wavelength lights that are selectable depending on the sample.
The multi-wavelength illuminator of Roper Scientific is the solution to all of these problems.





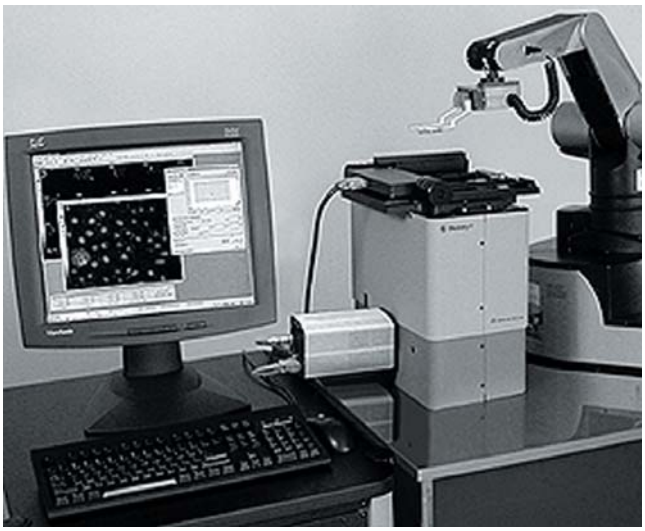


Systems Specification

Camera	: Cascade 512B Single Amplifier Cooled Digital CCD Camera
Microscope	: Inverted, fluorescence microscope
Excitation source	: simultaneous multi-wavelength excitation illuminator
Optics	: image scanning unit
Monochromator	: image correction type with the focal length of 30cm
Data analysis system	: Windows PC
Software	: manufactured by Roper Scientific

• Recommended cameras: Cascade 512B, Cascade 512F, PI-MAX512(5MHz)

Discovery-1



HIGH CONTENT SCREENING SYSTEM

Drug discovery requires specific information about how compounds affect biological mechanisms. Data gathered with image analysis techniques offer new insights into these interactions and can reduce or eliminate bottlenecks during the discovery process.

The Discovery-1 High Content Screening System from Molecular Devices accelerates the discovery process with advanced imaging technology that provides high levels of detail about cell-based assays. The system's intuitive and robust software includes turn-key analysis routines to simplify the task of identifying protein locations, translocation, and expression.

The Discovery-1 has unmatched flexibility and open architecture for developing custom analysis routines. By fully automating image acquisition and analysis, the Discovery-1 brings increased throughput with improved speed and efficiency.

FLEXIBLE AUTOMATED IMAGING

The Discovery-1 is the only system to offer both simplicity and convenient flexibility for image-based high content screening applications. Select a standard image analysis routine, or develop custom protocols using the system' s intuitive software. Implement high throughput strategies by leveraging the system' s scalable architecture.

ROBUST ANALYSIS

- Visualize and analyze cell populations
- Identify sub-cellular protein localization
- Perform multi-parameter analysis

SUPERIOR AUTOMATION

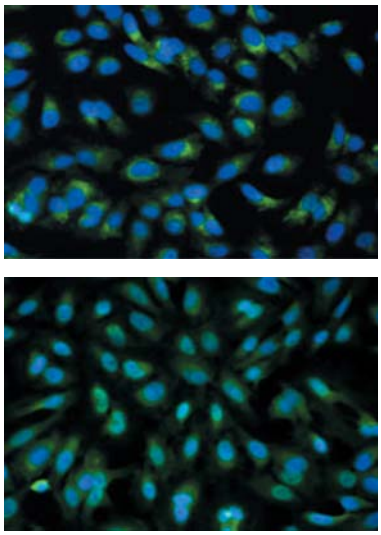
- Rapid acquisition of high content screening data
- Open, scalable architecture for higher throughput and easy integration with robotics
- High-speed laser auto-focus
- Up to eight different fluorophores per assay
- A wide range of acquisition configurations with six objectives
- Quick and easy data archiving

SCALABILITY

The scalable architecture of the Discovery-1 enables easy integration of several optical imagers and robotics systems into a single platform for high throughput, high content screening.
PlateExchange software enables automated plate loading, barcode scanning, and multiple assays with unattended operation. A generic robotics interface provides the flexibility required for integrating one or more Discovery-1 systems into an existing automation platform.

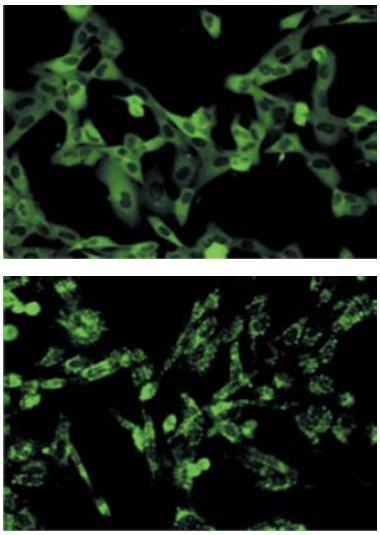
Standard set of analytical routines

protein translocation



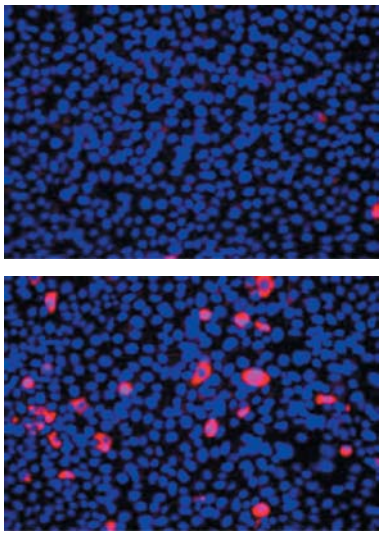
quantification and localization
of protein movement

G protein-coupled receptors



unstimulated (top)
stimulated (bottom)

protein-fragment complementation



Odyssey Thera, USA is using protein-fragment complementation assays (PCA) to map cell signaling pathways. The Discovery-1 system enables screening of tens of thousands of potential interactions to identify novel targets for drug discovery.

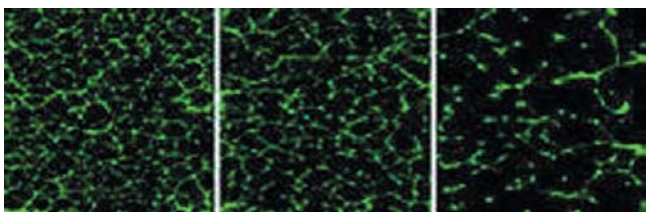
A comprehensive set of analytical routines is standard with the Discovery-1 system.

- Neurite outgrowth
- Angiogenesis
- Cell viability/apoptosis
- Adipogenesis
- Endocytosis/Exocytosis
- Motility
- Molecular translocation
- Receptor internalization for GPCRs
- Proliferation
- Cytoskeletal reorganization
- Protein synthesis, degradation, and localization
- Kinetics

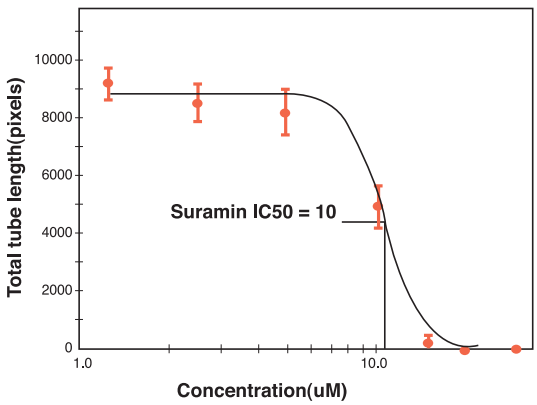
angiogenesis assay

inhibition of HMEC-1 tube formation by suramin

BD BioCoat™ Angiogenesis System



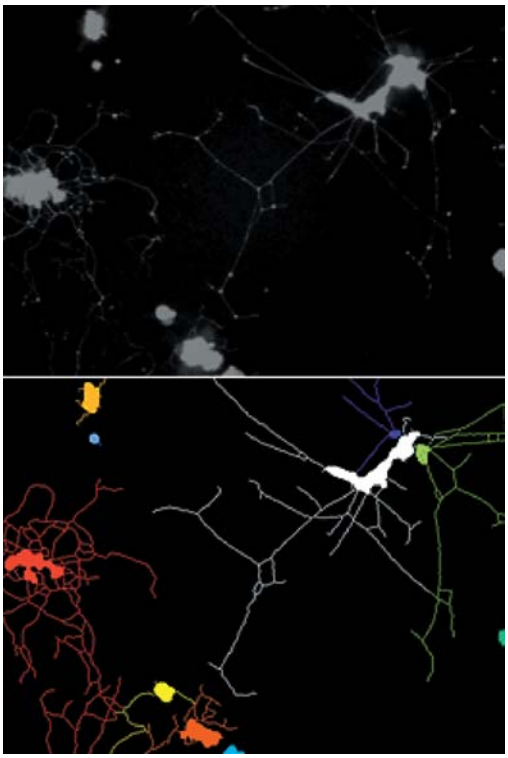
data courtesy of BD Biosciences



ADVANTAGES OF DISCOVERY-1

- Ability to acquire multiple images throughout the depth of sample
- Better quality results due to ability to collapse multiple planes into one image, resulting in an in-focus image for analysis
- More complete analysis, including measurements such as tube length, number of branch points, and more

neurite outgrowth assay



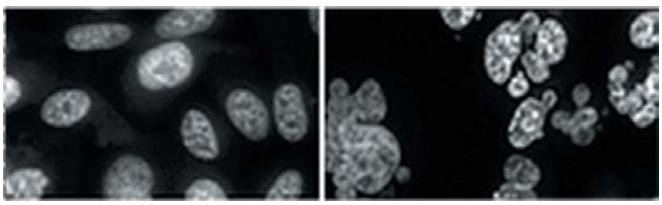
	A	B
1	Cells	DF
2	Number of Cells	10
3	Total Outgrowth	7633.72
4	Mean Outgrowth Per Cell	763.372
5	Total Processes	69
6	Mean Processes Per Cell	6.9
7	Total Branches	238
8	Mean Branches Per Cell	23.8
9	Total Cell Body Area	12725
10	Mean Cell Body Area	1272.5
11	Straightness	0.8926
12	Cells Significant Growth	10
13	% Cells Significant Growth	100
14		

Top: DF cells, courtesy of Rinat Neuroscience Corporation
Bottom: DF cells skeletonized

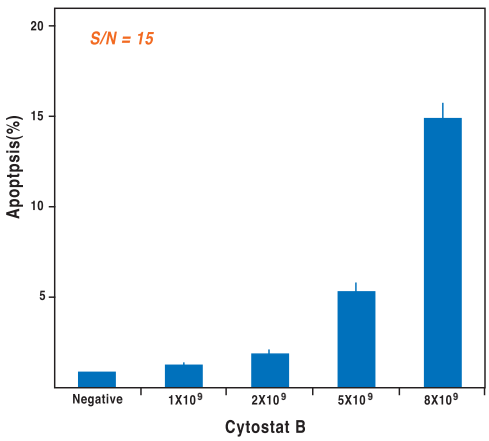
ADVANTAGES OF DISCOVERY-1

- Ability to measure individual cells as well as entire population
- More complete analysis such as measurement of total neurite outgrowth, total branches, straightness, and more

apoptosis assay



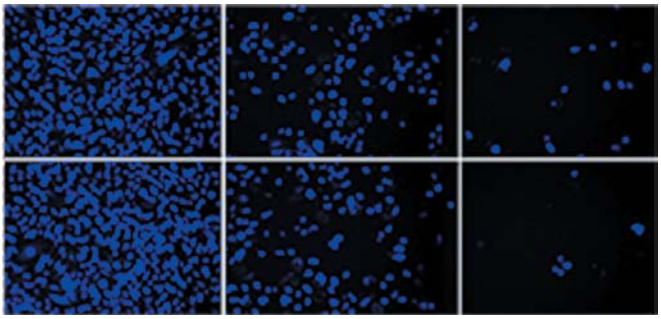
Top: HeLa cells. Left: no apoptosis, right: apoptosis.
Bottom: Discovery-1 TUNEL assay.
Data courtesy of Stefan Prechtl, Schering AG, Berlin.

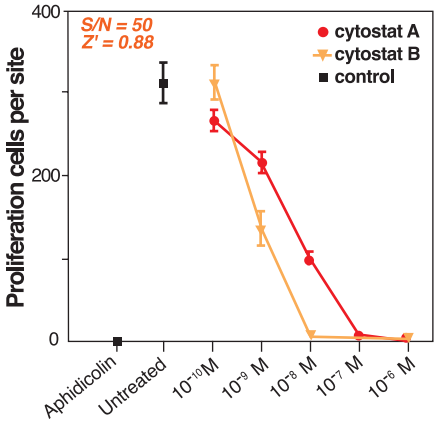


ADVANTAGES OF DISCOVERY-1

- Measurement of apoptosis at the single cell level or whole population
- Increased dynamic range; better signal-tonoise ratio (S/N)
- Greater sensitivity

proliferation assay of PC3 cells





Top: Left to right: increase concentration of cytostat - PC3 cells (prostate carcinoma cell line).
Bottom: Discovery-1 proliferation assay with BrdU.
Data courtesy of Stefan Prechtl, Schering AG, Berlin.

ADVANTAGES OF DISCOVERY-1

- Increased dynamic range; better signal-tonoise ratio (S/N)
- No radioactive material
- Sensitivity is more than eight times better

features

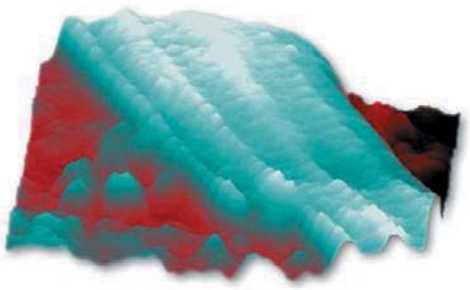
SPECIFICATIONS	• Proprietary optical platform with 14-inch footprint • Fully integrated imaging software • Laser auto-focus • High-speed 5-position dichroic wheel • Optimized 10-position filter wheels (excitation, emission, and neutral density) • Filter sets for most standard assays • Fully automated 6-position objective turret (2x, 4x, 10x, 20x, 40x) • High intensity arc lamp for fluorescence excitation • High-speed scientific grade CCD camera • Microsoft® SQL and ORACLE® database archiving and retrieval • One day of acquisition training and two days of analysis training • One-year warranty
OPTIONS	• Additional filter sets • Additional objectives • Transmitted light • Extended service contracts • Image server • Analysis workstations
ROBOTIC OPTIONS	• Thermo CRS CataLyst Express™ • Hudson Control PlateCrane™ • PlateExchange software • Generic robotics interface • Barcode reader

Molecular Imaging

Atomic Force Microscope

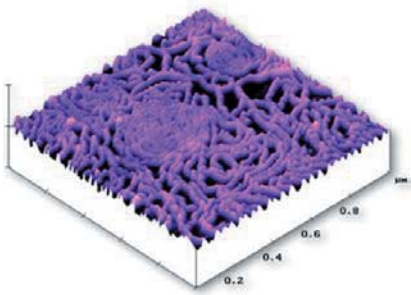
Designed for life science researchers who want to use both optical spectroscopy and high-resolution AFM to study their samples, BioScan combines the power of optical microscopy with high-resolution imaging capability of PicoSPM or PicoSPM II. Mode and temperature control allow BioScan users to image soft biological samples under physiological conditions and obtain optical spectroscopy data, for example, fluorescence spectroscopy, at the same time. BioScan is the best solution for cell biologists or those biologists who would like to see a big picture with an inverted microscope.

For molecular biologists or others who don't need an inverted microscope, a stand-alone PicoPlus or PicoSPM system may be the best choice. A critical component of this system is MAC Mode, which offers gentle high-resolution imaging of soft biological samples both in air and in fluid, plus complete options of temperature and environment control.



MAC Mode image of microtuble in buffer

MAC Mode image of Ferritin in water



MAC Mode image of pUC 19 DNA

PicoSPM II

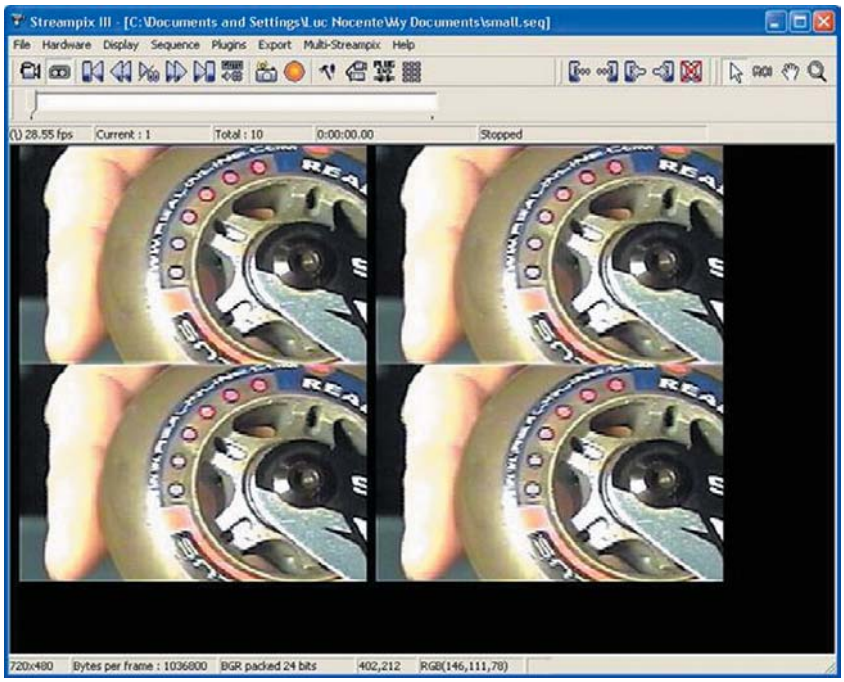
The new scanning probe microscope, PicoSPM II, retains the unique features of PicoSPM, such as top-down scanning and environmental control while offering maximum flexibility and modularity in a completely new design with key new features. The universal microscope base permits easy integration with an environmental chamber or an inverted optical microscope. An open-top allows an unobstructed optical view of the cantilever and the sample without sacrificing sample handling. A modular "nose-cone" on the scanner makes a change of imaging modes a cinch! Three independent stepper motors provide vertical approach and keep sample stage perfectly level at all times.

Modular scanner

One modular scanner does all imaging modes on PicoPlus. The novel design is an interchangeable nose-cone module at the end of each scanner. Different imaging modes use different nose-cones. The standard nose-cone does contact mode AFM and LFM. Other imaging modes, such as MAC Mode AFM, acoustic AC (AAC) mode AFM, current sensing AFM (CSAFM), and STM are accomplished by simply changing to the appropriate nose-cones. Each scanner has an open top, allowing unobstructed view from a video microscope.

StreamPix Digital Video Recording Software

StreamPix is a digital video recording software that allows you to grab live uncompressed or compressed video directly from IEEE fire wire, analog, high speed or high resolution digital cameras to your hard disk drive or RAM memory.

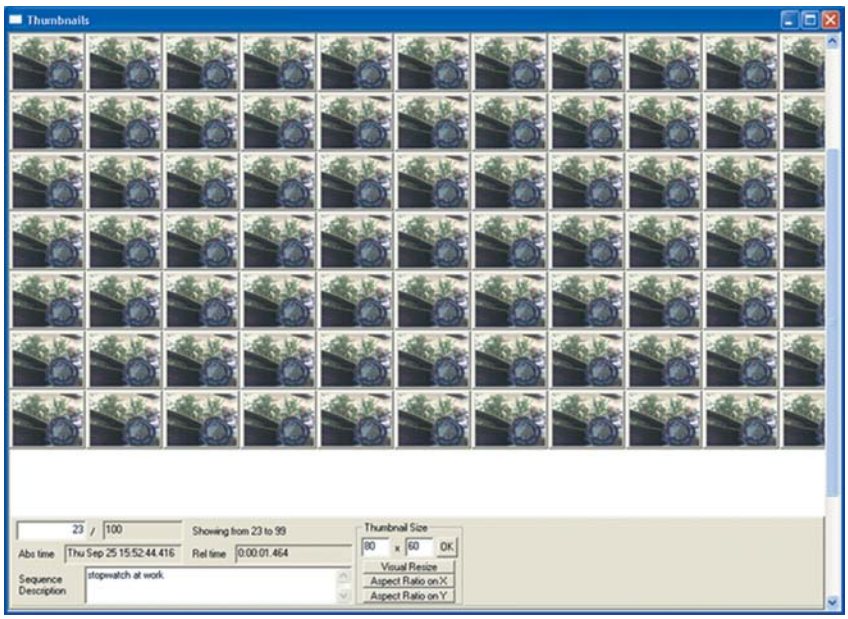


Applications:

- Motion Analysis
- Image archiving
- Flow Analysis
- Medical imaging
- Web inspection
- 120f/s High Speed

Features:

- Acquire from Color RGB, NTSC, monochrome RS170 or high resolution cameras at up to 60 Mbytes/second
- Acquire images as AVI compressed or uncompressed movies*
- Export images as BMP, TIFF, JPEG or AVI
- VCR style controls: Record, Play, Rewind, Fast Forward, Step and Pause
- Supports various frame grabbers and cameras
- For Windows 2000 and XPTM
  - Depending on hardware configuration



StreamPix: Thumbnail viewer

Supported cameras:

- Standard RS-170/CCIR, NTSC/PAL
- Color RGB and high resolution digital cameras
- Monochrome 8 to 16 bit
- Qimaging, Vitana PixelLink, Optronics using Firewire IEEE1394
- Pulnix, RedLake, Dalsa

Supported frame grabbers:

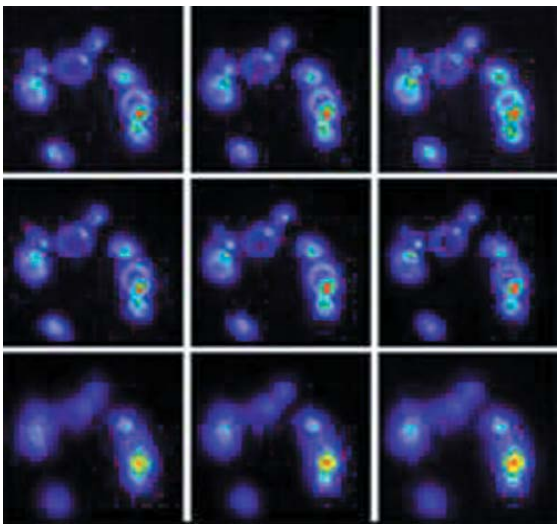
- Matrox
- Coreco, Integral Technologies, Bitflow, EDT.

Camera and frame grabber support updated continually. Contact NorPix to request support for your camera and frame grabber.

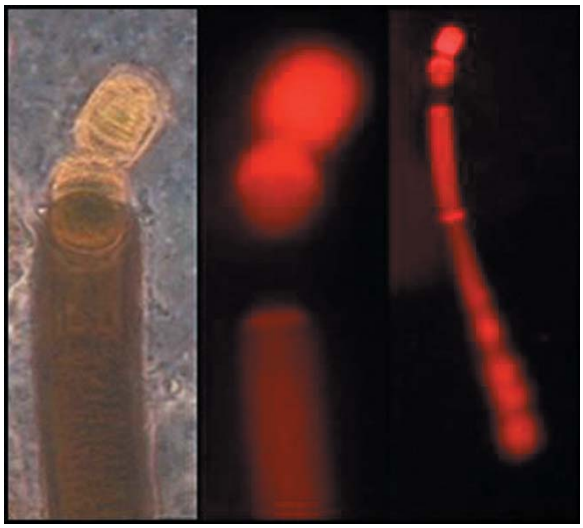
MetaMorph Sofware for Morphometry

Automated Image Processing and Analysis

The MetaMorph system is especially valuable in biological studies that involve live cell imaging, multi-label fluorescence image acquisition, confocal image analysis, motion analysis, colocalization studies, morphometry analysis, FISH, FRET, FRAP, and live/dead cell assays, among others.
Developed in conjunction with leading bioscience researchers, the system offers a variety of image acquisition device controls and analysis tools, providing the researcher flexibility in analytical capability.
The MetaMorph system can also acquire images from a variety of monochrome and color cameras, as well as TWAIN compliant devices.



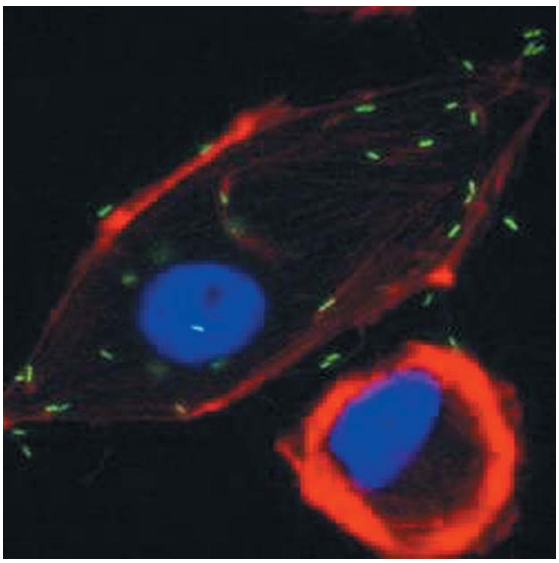
Z-series/time-series images of yeast containing wtGFP-tub3. Images were taken using a Roper Scientific (Princeton Instruments) camera, 100 (1.4NA) x 2.5 magnification on Zeiss Axiovert 100TV. Courtesy of Jan Carmminati and Dr. J. Spudich. Vertical=depth, Horizontal=time



Cyanobacteria shown via transmitted light and fluorescence. Courtesy of Microbial Diversity course, Woods Hole, MBL.

Image Acquisition

Acquire Time Lapse and Z-Series, Multiple Wavelengths, and/or Multiple Stage Positions



Scientists, striving for excellence, know the importance of building a strong foundation of research fundamentals. The MetaMorph Imaging System delivers excellence with a reliable foundation of tools for image acquisition.
A MetaMorph system can acquire images over a defined period of time, a range of Z-axis focal distances (Z-series), multifluorescence wavelengths, multiple sites with a motorized stage, or any combination of these four dimensions.
Using one or all of these acquisition methods, users can then graph intensity levels over time, deconvolve images and create 3D reconstructions, color combine multifluorescence images, or batch process and measure images in a variety of ways.

PtK2 cell infected with listeria and three different acquisitions. Green bacteria, blue nuclei and red F-actin are visible in the host cell. Courtesy of Darren E. Higgins, Ph.D., Assistant Professor, Department of Microbiology and Molecular Genetics, Harvard Medical School.

Stream Acquisition

In Stream Acquisition mode, the MetaMorph system transmits image data at top speed, directly from a camera into the computer' s RAM. This provides the fastest possible multi-image capture capability giving you the ability to view and analyze rapid cellular dynamics and events.
Video images can be acquired at 30 fps. Digital camera images can be acquired at rates exceeding 100 fps (camera and acquisition region limited).
By combining the Stream Acquisition mode with high performance hardware like a Piezo electric focusing device, the MetaMorph system can acquire stacks of Z-distance images and stream them directly into RAM at very fast rates.
This specialized type of Z-streaming application dramatically reduces experimentation time and may allow you to visualize a cellular dynamic through multiple focal planes that another imaging system would be too slow to capture.

Green fluorescent protein and DIC image overlay.
Image was recorded during the Advanced In Situ Hybridization Course at Cold Spring Harbor Laboratory

Device Control & System Automation

Device Control

MetaMorph includes standard interfaces for illumination, stage and Z-motor devices, and it provides digital I/O to communicate with unique devices. Journaling and device controls can:

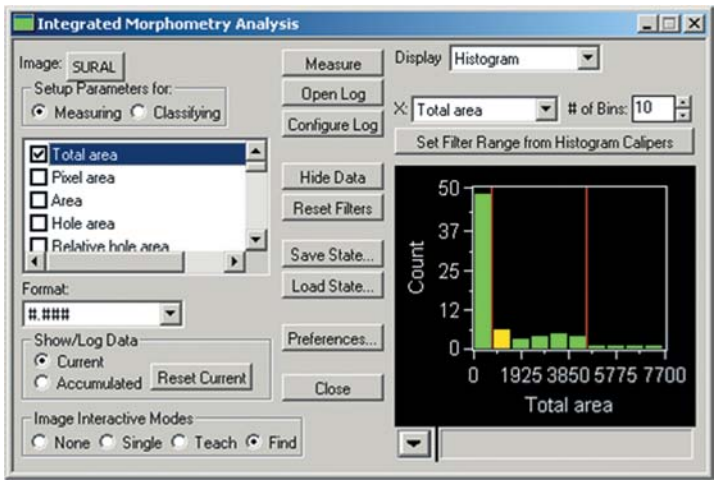
- Control the illumination wavelength by employing filter wheels, shutters, liquid crystal tunable filters, monochromators or other wavelength selectors
- Synchronize image acquisition and analysis with the opening and closing of shutters
- Scan slides or multi-well plates with a motorized stage
- Acquire images of a through-focus Z-series for subsequent deblurring, deconvolution, and 3D reconstruction
- Control custom devices that accept commands through a serial or parallel port connection
- Auto focus at multiple stage positions or at specific intervals in a time lapse environment

Automated microscope controls can:

- Rotate objectives, change filter cube settings, open and close the shutter, switch the illumination lamp on or off, and change the lower and upper prism positions
- Control the X, Y, and Z-axis positioning of a stage, move the stage and store the positions for future use
- Control automated stages to image multiple locations in a sample or multiple samples, including dishes and multi-well plates
- Use focus motors to collect Z-series or through-focal image sets
- Acquire images using eight different groups of settings for wavelength, intensity, and exposure duration
- Acquire a spectral scan in a range of excitation or emission wavelengths
- Capture a time lapse series of images at specified intervals and durations

Extensive Analytical Functions

Once a set of interesting images has been acquired, the researcher can use the MetaMorph Imaging System's extensive analytical functions to measure areas and distances, count objects or cells, and measure or graph intensity and optical densities.
Spatial parameters like area, distance, diameter, perimeter, object counts, and over 30 other variables are measured and logged via two basic methods: 1) interactive region measurements where the user creates line or area regions and MetaMorph displays spatial or intensity data based on those regions, or 2) automated multiple object measurements utilizing an intensity threshold.



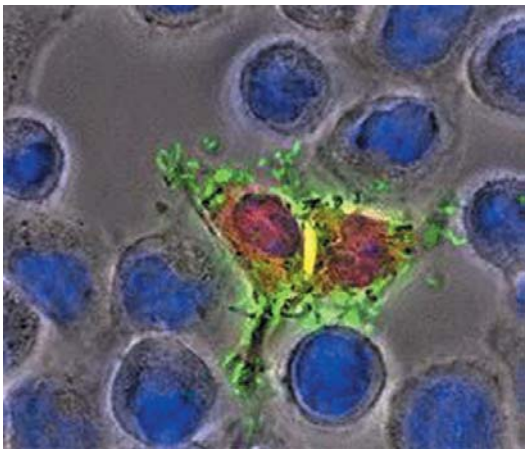
Integrated Morphometry Analysis(IMA) dialog box shows histogram of total area.

Morphometry Analysis

The Integrated Morphometry Analysis (IMA) function uses an advanced point-and-click interface to make classification of objects easy. Employing binary image operations such as threshholding, erosion, and dilation, the user can prepare an image for subsequent morphometric analysis. Objects can be measured within the image and separated into user-definable classes with any combination of morphometric parameters.
IMA measurement parameters include: area, hole area, standard area count, perimeter, centroid X and Y, Z-position, width, length and height, orientation, breadth, fiber length, fiber breadth, shape factor, elongated form factor, inner radius, outer radius, mean radius, equivalent radius, equivalent spheroid volume, equivalent prolate volume, equivalent oblate volume, equivalent sphere surface area, average gray value, total gray value, optical integrated density (OD), integrated OD, intensity center X and Y, radial dispersion, texture difference moment, texture inverse difference moment, OD variance, OD relative low/medium or high areas, OD relative low/medium or high amounts, OD relative low/medium or high distances, and others including over 30 elliptical Fourier parameters to assist in defining shape analysis patterns.

Multi-Dimensional Imaging

Live cell studies often involve acquiring images of multiple wavelengths, over time, and from various stage positions. Managing the many devices that provide this degree of flexibility is the strength of the MetaMorph system's multi-dimensional imaging functions. Unlike other imaging systems, macros or programming are not required to coordinate image acquisition. The two modules that support MetaMorph's multi-dimensional capability contain the Multi-Dimensional Acquisition interface and the Review Multi-Dimensional Data interface. These new tools enable simple and quick acquisition of any combination of image dimensions, and they provide an easy and structured method for reviewing the collected images.
Multi-Dimensional Imaging and other MetaMorph system tools can:



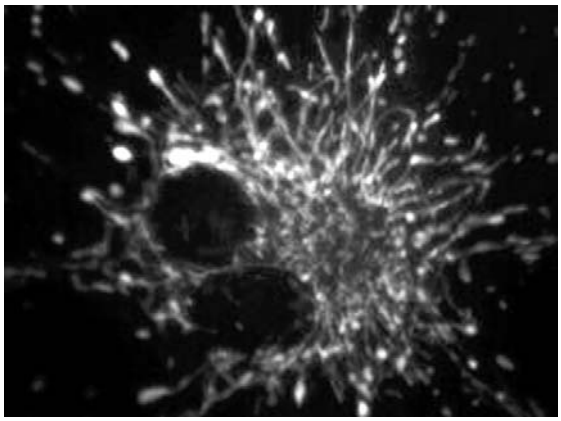
- Align images within the stack
- Create and play a movie
- Render a 3D reconstruction
- Create a montage
- Save the stack to disk
- Measure through all planes automatically
- Enhance any or all of the images
- Deblur the images
- Create topographic surface maps
- Perform arithmetic operations
- View orthogonal planes
- Select a plane or planes
- Equalize light

GFP-Listeria infected macrophages that have been stained with Cell Tracker Orange. These cells are surrounded by L2 (fibroblast) cells used to examine the spread of bacteria from the macrophages. Blue nuclei in the L2 cells and red nuclei in the macrophages result from the cell tracker stain. The experiment was conducted live in temperature controlled environmental chamber.

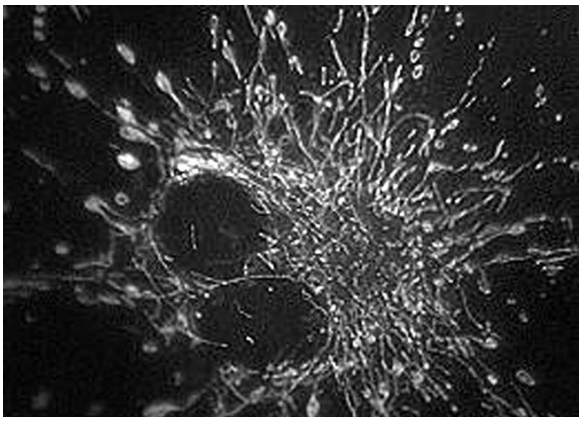
Image Processing

Image Enhancement

The MetaMorph system's processing functions bring out characteristics which may not be clear in the original image, making subsequent analysis and presentation more informative.



Mitochondrial image from fluo cells. Triple labeled fibroblasts from Molecular Probes Image was acquired using (a prototype Varispec liquid crystal tunable filter and Chrome multipass beamsplitter with) a Roper Scientific (Princeton Instruments) MicroMaxTM 0400 cooled CCD camera.



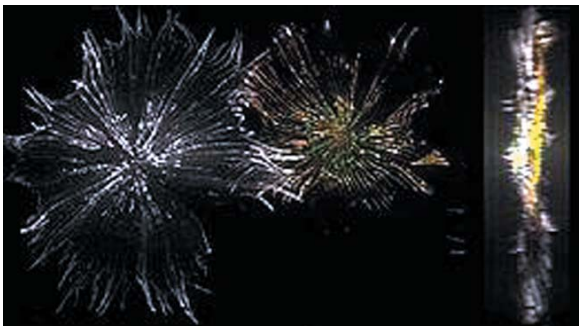
Original image with a 50% homomorphic filter applied using Fast Fourier Transform.

Deconvolution & 3D Reconstruction

Deconvolution

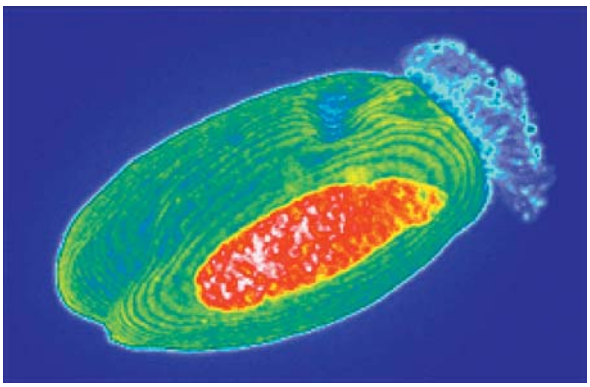
The MetaMorph Imaging System can improve experiment performance and image appearance by mathematically removing the out-of-focus effects common to optical light microscopes.
In most microscopes, the lens aperture causes light from a point source to spread out or diffract, and light from out-of-focus planes can result in image contamination. This is caused by the optical system's Point Spread Function (PSF) and is most often seen with thick sample preparations.
Two deconvolution commands in MetaMorph can be employed to offset these undesirable out-of-focus effects. The first command, called Nearest Neighbors, uses an estimation of the three-dimensional PSF to compute the contributions from adjacent out-of-focus planes, and then removes this data from the original information to create a sharper resulting image.
The researcher may enter experimental settings that help specify the PSF such as wavelength, numerical aperture, and index of refraction.
Secondly, the No Neighbors command, uses an unsharp mask operator to blur an image plane, thereby subtracting the undesired out-of-focus information. This function is often used to improve an image's appearance when only one image is acquired instead of a Z-series of images.

Silver berry scaly hair shown as acquired. Top and side view before blur removal.



After 2D deconvolution

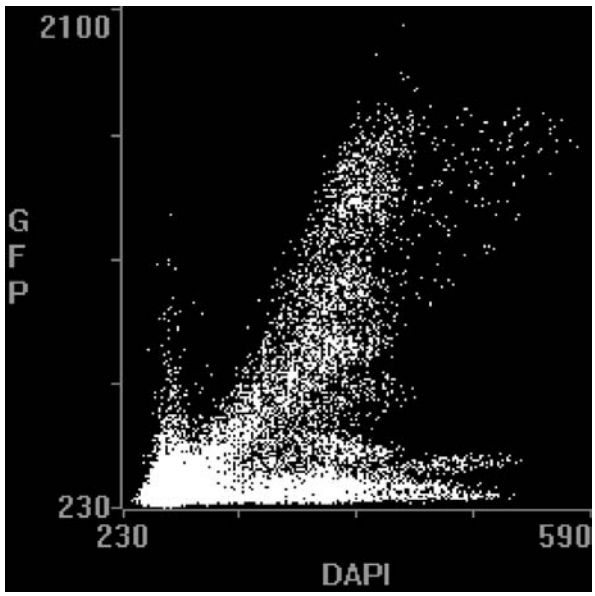
3D Reconstruction



Experimental effects and outcomes are not always apparent when viewing images in two dimensions. The MetaMorph system helps to reveal more detail with its tools for 3D reconstruction.
This command is used when the researcher wants to create a 3D model consisting of rotated views from a stack of images.
Using a stack of planes from a through-focus set of images (Z-series), the user configures the 3D Reconstruction dialog box to set the angle, orientation, Z-axis distance, and reconstruction type for the model. The result is viewed with the MetaMorph system's Movie command.
With images now enhanced, sharpened and reconstructed, researchers can see details and create a new perspective of their sample that they couldn't visualize through the oculars of their microscope.

Advanced Applications

Motion Analysis and Particle Tracking



Correlation plot sample

These commands enable users to follow the movement of tagged particles, such as fluorescently-labeled cell surface molecules, microtubules, nucleic acids, lipids, and other objects with sub-pixel resolution.
Researchers can measure X and Y coordinates, velocity, mean displacement, mean vector length, and more. These measurements can be displayed in a printable graph that the user configures.
Motion analysis works very well when used with Differential Interference Contrast (DIC) microscopy images because the tracking region can be made to encompass both the white and black spots produced by DIC.
Researchers will thus have twice as many pixels to track, which leads to a proportional increase in the tracking position accuracy.

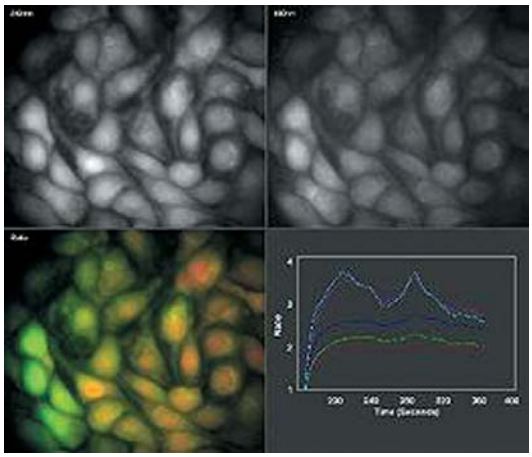
Measure Colocalization

While good experimental data can be obtained by analyzing a single fluorescent probe, researchers often get better results by examining more complex interactions. The MetaMorph system's Measure Colocalization function provides a higher level of detail, with quantitative data regarding regions of overlap between two fluorescent probes.
Users can measure the area, average gray scale intensity, and integrated gray scale intensity in the region of overlap and log this data to a spreadsheet or a separate text file. The correlation between probes can be graphically represented by a correlation plot.

Overlay Fluorescence

Greater levels of detail are also revealed by the Overlay Fluorescence function. This tool enables researchers to overlay up to six fluorescence probe images over a background DIC or Phase Contrast image.
The information available in the background image is visible through the fluorescence image. This can just as easily be done with a set of images from one time point as a set of images from multiple time points, creating a full color multi-fluorescence time lapse movie.

MetaFluor Software for Ratio Imaging

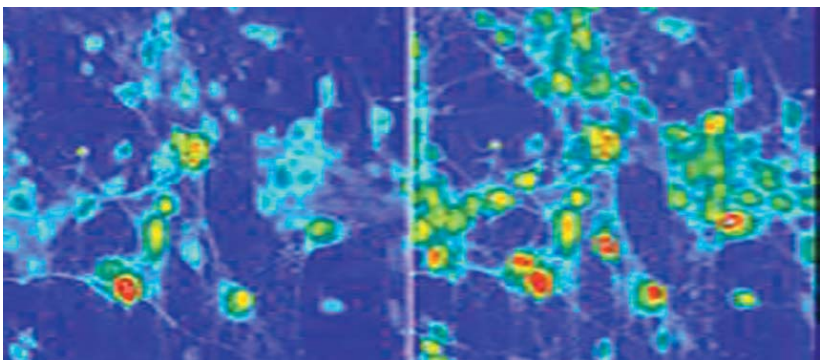


MDCK cells loaded with fura-2 AM. Imaged at the AQLM course in Woods Hole, MA. Upper right and left quadrant are 340nm and 380nm excitation images; lower left is a ratio map using IMD display. Lower right is a graph of selected cell ratio changes measured over time.

Fluorescence ratio imaging involves the introduction of a fluorescent indicator into living cells to allow the monitoring of these cells through a microscope using a photodetector. In imaging, the detector is a sensitive digital or video camera.
Indicator dyes have been designed which shift their fluorescence excitation or emission spectrum upon binding the ions of interest. Images are obtained at two appropriate wavelengths, typically matching the absorption maxima at the high and low binding conditions.
By ratioing the intensities in the image at corresponding picture elements, a map can be constructed showing the local ion concentrations throughout the field of view. Since the monitoring process is nondestructive, image acquisition can be repeated frequently to trace out the time course of cellular responses.
MetaFluor supports a variety of image storage devices for archiving original image data, facilitating post-experiment processing and analysis or the use of an auxiliary, analysis-only workstation.

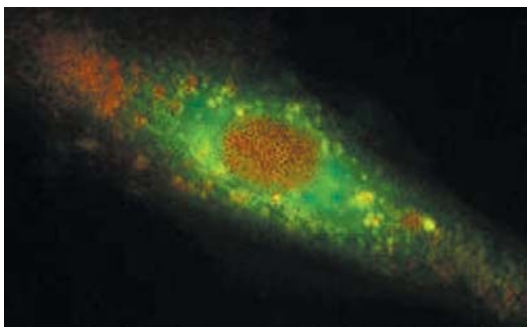
Introduction to MetaFluor

Designed for single or dual wavelength intracellular ion measurements, MetaFluor supports FURA-2, BCECF, INDO-1 and other common ratiometric indicators. For easy viewing and analysis, MetaFluor provides simultaneous display of the original wavelengths, the ratio images, graphs of intensities, ratios, and ion concentrations, and a non-ratiometric image such as a brightfield or phase-contrast image. Two different ratiometric indicators can be imaged and measured at the same time. Computer controlled shutters minimize cellular exposure to the excitation illumination, reducing photo damage to your sample.



Fluo-3 labeled cells before and after stimulus.

Easy To Use

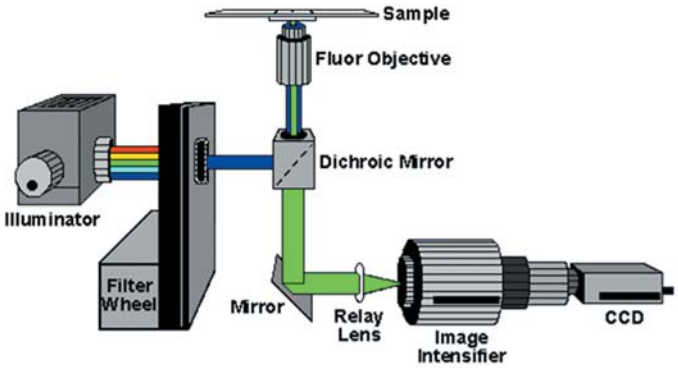


With MetaFluor, you set the controls up once, then let the experiment run by itself. After specifying what images to acquire, how to control the hardware, the acquisition frequency, where to save the data, and what measurements to make, you just have to press the "start" button and the system will run unattended.
You can collect a large amount of data online, and then easily process it offline, with either MetaFluor or an offline analysis-only copy of the software.

A calcium map. Each pixel of the original ratio image was calibrated to represent its calcium concentration. Courtesy of Dr. M. Borin, University of Maryland School of Medicine, Baltimore, MD.

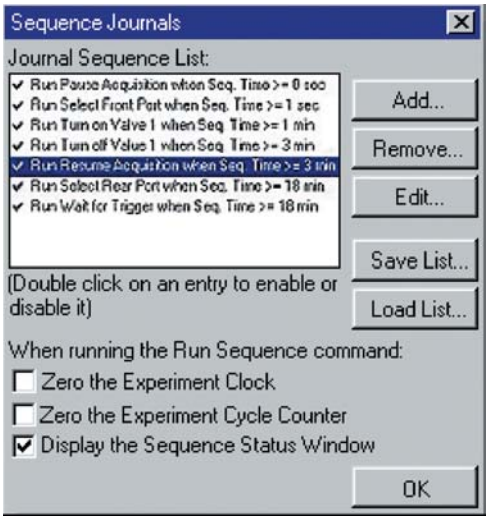
Hardware Support

MetaFluor can work with any microscope that has an epi-fluorescence illumination and fluorescence objectives and lenses, and has a camera mount. Typically an inverted microscope is used when working with live cells (because they can be kept in a dish) whereas an upright may be used with fixed preparations.



Inverted microscope configured for fluorescence ratio imaging.

Device Control & System Automation



Use the Sequence Journals dialog box to run a set commands in the order you choose.

Journaling

Journals are sophisticated macros that can do many tasks without requiring you to know any programming language or use a special program editor. MetaFluor's journal system and integrated Journal Editor allows you to create functions which simplify system operation, automate acquisition and device control, and automatically sequence events.
You can also create journals that set MetaFluor variables, such as the timelapse rate or whether background substraction is to be enabled. Journals are sophisticated macros that can do many tasks without requiring you to know any programming language or use a special program editor

Sequencing

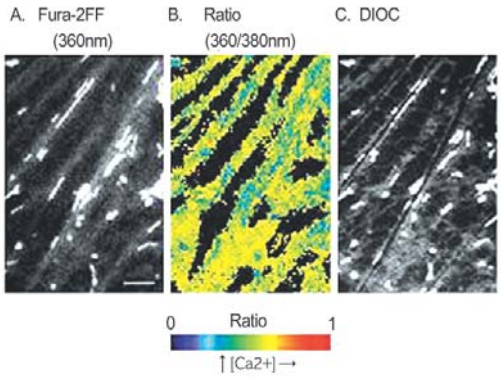
A novel feature of the system is the ability to set up "sequences" of commands. Using the Sequence Journals command, it is easy to tell the system to run a set of commands at a given time in the acquisition sequence.
For instance, you can have the system acquire images with a long timelapse when your preparation is in a steady state. This can serve as a baseline measurement.
Then, after running that for a few seconds, the system can send a pulse out to a flash lamp to uncage a molecule, and then you can switch to a fast acquisition which will acquire the dynamic events. This sequence can easily be looped so that many uncaging experiments can take place.

Real-Time Processing

Many applications require real time image processing. With a real time processing board, MetaFluor can perform frame averaging and background subtraction on the video image. Interactive controls allow quick and easy contrast enhancements to further improve image quality.

Real Time Processing at Full Resolution

With the appropriate hardware, MetaFluor can accept live video from RS-170 and CCIR video sources as well as a variety of non-standard imaging devices. This gives you a wide selection of acquisition options. Images can be acquired and saved using industry standard TIFF image formats. In addition, MetaFluor can load saved images using a variety of other image formats, including sequences acquired with MetaMorph or with several confocal instruments.
This selection of image formats provides compatibility with your favorite programs for subsequent manipulation and presentation.



Dynamic changes in [Ca^{2+}]M & [Ca^{2+}]S-ER in intact, nonpermeabilized rat astrocytes. From V. Golovina and Dr. Mordecai P. Blaustein, University of Maryland School of Medicine, Baltimore, MD., in Science, Vol. 275, March 14, 1997, p. 1646.

Image Averaging, Background Subtraction and Shading Correction

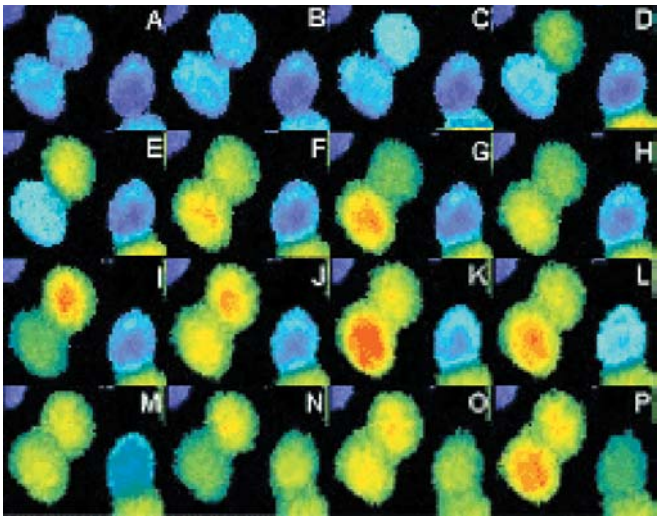
When acquiring from video sources, MetaFluor can average up to 256 images, significantly reducing random image noise. Background subtraction is also used to improve accuracy by correcting for stray light, camera settings and autofluorescence. In addition, MetaFluor can use a shading reference image to correct for non-uniform illumination. This is critical when using certain illumination and camera systems.

Analog Adjustment

MetaFluor provides separate analog contrast settings for each video channel, permitting pre-acquisition normalization of intensities for each wavelength. This is particularly important because of the wide differences in brightness that may be present between images in the two ratio wavelengths. In addition, MetaFluor can control cameras with multiple gain settings, such as those offered by Roper Scientific, Inc., Hamamatsu Corporation and others.

Digital Camera Control

Digital cooled CCD cameras represent the state of the art in image acquisition. When acquiring with a digital camera, up to 16 bits of data per pixel can be obtained. This wide dynamic range allows the camera to capture information in both dark and bright areas of the scene.
There is no need to use neutral density filters when using a digital camera; if the image is too bright, you simply expose for a shorter period of time. Many cooled CCD's have exposure times that are as short as 1 millisecond.



A representation of images acquired in a "stream". Single or dual wavelength images can be transferred directly from the camera into the computer's memory at a high rate of speed, subject to the capabilities of the camera and the size of the image being acquired. In this example, a montage of 16 frames show ratio changes over time. With a Princeton Instruments PentaMAX Intensified Frame Transfer cooled CCD camera using the EEV-512 chip and 8x binning, and exposing for 10ms per frame, imaging rates of 100 frames per second can be achieved.

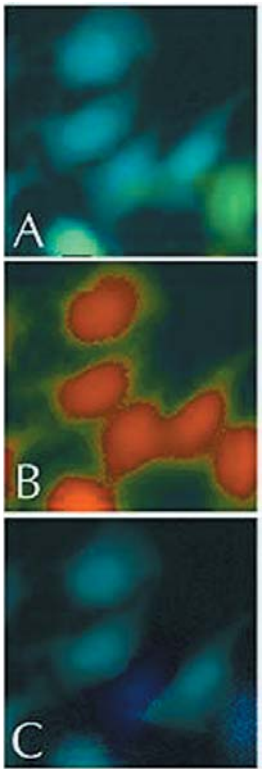
Quantitative Fluorescence

Ratio Imaging

MetaFluor can acquire five wavelengths at each time point. These are then grouped into two pairs of ratiometric wavelengths, and one isosbestic or transmitted-light image. With this arrangement, it is possible to monitor two indicators, such as BCEcf (for pH) and fura-2 (for calcium) while also obtaining a phase image of the cell structure. Of course, each wavelength can be turned off, so that at the minimum you can acquire just one wavelength per time point, which is suitable for basic intensity-over-time measurements, or for monitoring a non-ratiometric dye such as fluo3.

Making Measurements

Regions of interest of any size or shape can be placed on any of the source images or the ratio image to monitor image intensity, ratio value, or ion concentration. Measurements can be made simultaneously on all the regions of interest, and can be updated continuously on a scrolling graph allowing you to follow changes as they occur in your living samples. In addition, images can be zoomed to assist in the selection and creation of regions of interest. Different region tools, such as ellipses, boxes, and an auto-tracer, make region definition easy.
After each acquisition and ratio, MetaFluor measures and plots the data for each region. A flexible system of four graphs lets you choose what gets graphed where. Commonly, intensity data for all regions and all wavelengths will be shown on one graph, while ratio traces for each ratio will appear on their own graph.



In situ calibration of fura-2 in HeLa cells. Cells after loading are shown in Figure A. Figure B shows the R maximum after the perfusion of 10uM ionomycin. R minimum after the perfusion of 2uM EGTA is shown in Figure C. Courtesy of Dr. Randi Silver, Cornell University Medical College, New York, NY

Calibration

MetaFluor can be calibrated using the Grynkiewicz equation, resulting in a direct display of ion concentrations. Calibrations can then be stored on disk for future use.
You can also calibrate MetaFluor using a series of titration calibration references. After measuring the ratios of several solutions of known calcium concentration (or other ion values), MetaFluor will calibrate the system to convert between measured ratios and actual concentrations. MetaFluor supports a variety of curve-fitting modes letting you choose the one best suited to your application.
With both methods, it is possible to calibrate the images on a pixel-by-pixel basis, or to calibrate using a generalized set of constants applied to the whole image. The former method is preferable when measuring the calibration images in situ, because it allows for cell compartments to have their own calibrations. The latter case is recommended for in vitro calibrations, typically done with a standard solutions kit.

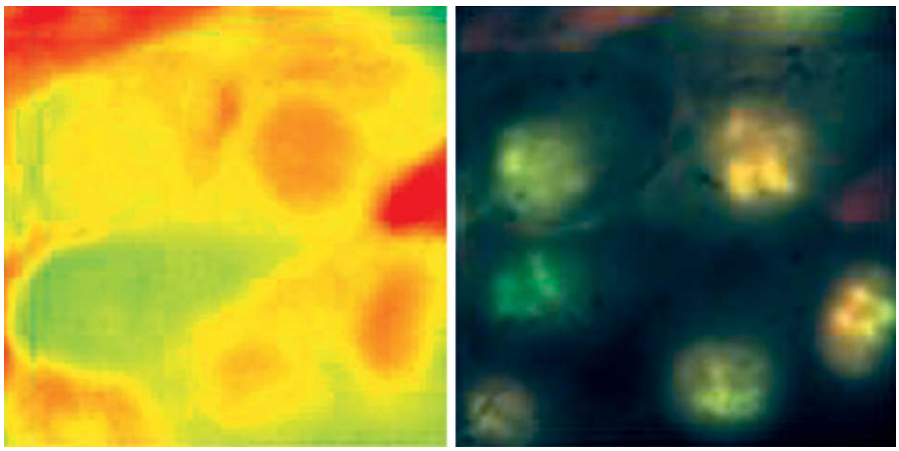
Data Analysis

Dynamic Data Exchange

MetaFluor optionally logs all measurements to either a text file (using standard ASCII file format) or, via Windows DDE, to a spreadsheet program. Supported programs include Microsoft Excel and other applications.
The data file stores columns of data including the time stamp of each measurement, and a user-defined selection of wavelength average and integrated intensities, thresholded region area, ratio values, and calibrated concentrations.

Event Marks

In an experiment, the Event Mark function can be used to record where drugs were added, experimental conditions changed, triggers were received or sent, or other events occurred. You can pre-enter any number of events.
An additional collection of shortcuts grants you fingertip access to the first 10 events in your list. Of course, if an event occurs to you that was not pre-entered, you can always type it in directly.
You can associate a timer and an alarm bell to each event. This unique feature can serve as a handy way to jog the memory for example, if you know that you need to wash your cells for 30 seconds before infusing a drug, you can define an event called "Wash" that has a 30 second countdown timer and an alarm associated with it; 30 seconds after you start washing, the alarm will start beeping. Then you can open the stopcock for the drug you need to infuse, and press the "Drug" event mark button, which will turn off the alarm and indicate that the perfusion has started.



A comparison of Pseudocolor vs. Intensity Modulated Display mode. The traditional pseudocolor loses image definition of cells and cell structures. The same image data, displayed with the IMD representation, pulls cells out from the background without the need for thresholding.

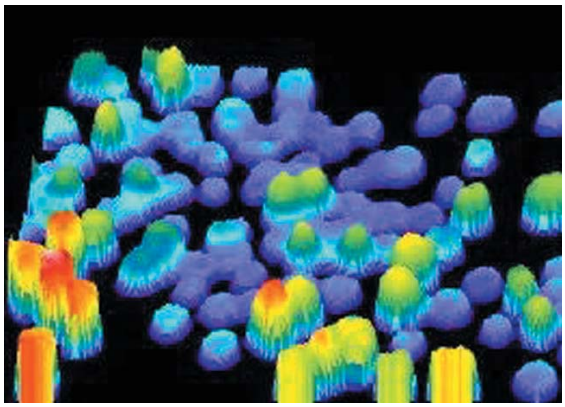
Versatile

Presentation and Publication

Images in MetaFluor can be displayed in monochrome, pseudocolor, or using a variety of user-defined Look Up Tables (LUTs). Ratio Images can also be displayed using a special display mode called Intensity Modulated Display, or IMD.
With the IMD mode, color is used to represent the relative ratio value, while the intensity or brightness of the color is used to represent whether the source images were bright or dim at that location. This technique helps automate the process of extracting spatial information from the background, by automatically eliminating background fluorescence from the scene.

Compatible with MetaMorph

Because MetaFluor saves images in the TIFF file format, it is possible to import them into another program such as MetaMorph for annotation, post-processing, and further refinement.
For example, images can be loaded in MetaMorph and an intensity profile can be generated. The profile is a useful way to compare rates of ratio or ion change in a field of cells. After you have loaded the images into MetaMorph, you can make spatial measurements, measure line scans, count objects, draw text labels and arrows, and analyze your data further.



An intensity profile created with MetaMorph. Profile shows a 3D perspective view of cell ratios. Height and color indicate increasing calcium concentration.

Interactive Graphs

By clicking on graph traces, you can display a readout of the time and data value for the region nearest to the click. When playing back an experiment, clicking on the graph will rewind or fast-forward the experiment to show the images that correspond to that location on the graph.
The measurement graphs scroll so that you can get a sense of the history of the experiment while you are collecting new data or playing back a stored experiment. MetaFluor graphs feature X and Y ranges that you can configure, as well as tick marks and color information. Graphs can be printed or copied to the clipboard.

Improved for FRET Experiments

MetaFluor excels at experiments involving Fluorescence Resonance Energy Transfer (FRET). Using this technique, an investigator can determine the exact time and place of colocalization.
FRET involves the non-radiative transfer of energy from a fluorophore in an excited state to a nearby acceptor fluorophore. For example, FITC is excited with blue light and the transfer results in red light from Rhodamine.
Several features make MetaFluor a powerful platform for FRET imaging. First, FRET takes place at extremely low light levels and depends on the detector for most signal amplification so dark current noise must be minimized. MetaFluor supports highly sensitive cooled CCD cameras with high quantum efficiency (less noise) and fast readout rates - ideal tools for this application.
Second, FRET images are taken at different wavelengths, making alignment a very important factor. MetaFluor supports acquisition of up to five wavelengths with automated wavelength changers and its tools make it easy to automatically align multiple images.
Finally, speed is a prime ingredient in FRET experiments and MetaFluor meets this challenge with its support for multi-wavelength streaming using appropriate devices.

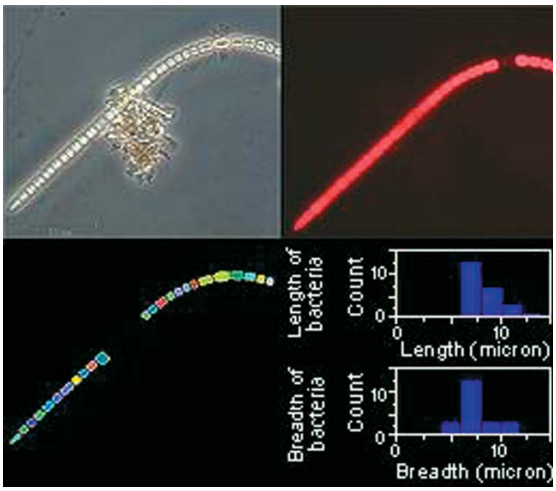
MetaVue

Meta Imaging Series - The Market Standard for BioImaging

Scientists worldwide look to Universal Imaging Corporation's Meta Imaging Series software as the industry standard for bioimaging applications. The MetaVue Imaging System is the newest addition to this distinguished product line.
MetaVue is the cost effective solution for basic imaging applications. Many applications do not require a huge toolbox of tools but instead can be solved with commands tailored to common research imaging tasks. MetaVue was designed to accommodate these basic research needs.
Image stacks, a way of grouping related images into one window, make it easy to apply a processing or measurement operation to the entire collection of images in one easy step.
Expand MetaVue over time with a set of advanced device controls and image processing modules. With the "dropin" architecture, expanding the software is simple and allows the system to grow as your imaging needs change.
MetaVue is tailored for specific applications. These include:

- Time lapse
- Digital photography
- Morphometric analysis
- Simple image analysis

Automate your laboratory! MetaVue's advanced device control capabilities offer the opportunity to drive motorized microscopes, filter wheels, shutters, monochromators, liquid crystal filters, x-y microscope stages, focus motors, and more.
Turn repetitive tasks into one-button clicks with MetaVue's easy-to-use Journaling system. With Journals, you can record your own personal set of commonly used imaging steps, and then repeat these steps over and over again by just pressing a button on your very own customized toolbar. Simplify imaging tasks by using the wizards, toolbars, and clearly arranged menus and dialog boxes offered in MetaVue.

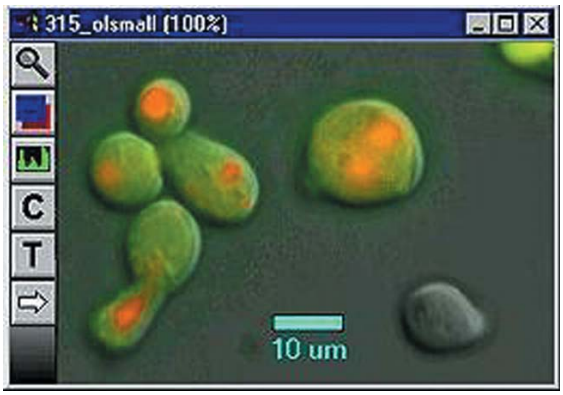


Cyanobacteria Montage. Courtesy of Microbial Diversity Course, Marine Biological Laboratory, Woods Hole, MA.

Digital Photography

The MetaVue System allows acquisition with monochrome and color cooled CCD cameras, as well as monochrome and color video cameras.
With MetaVue, you will have a simple, cost-effective system for:

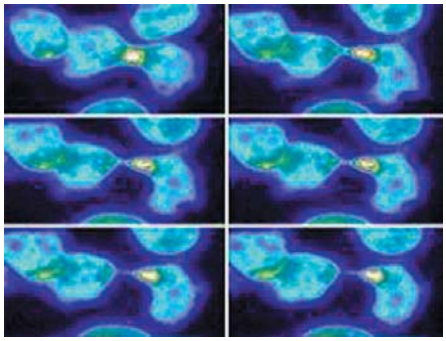
- Acquiring and processing images
- Performing graphics functions such as adding text and arrows, and
- Archiving and retrieving images through the Find File and Find Image properties



Overlay of fluorescence on transmitted light image with distance stamp.

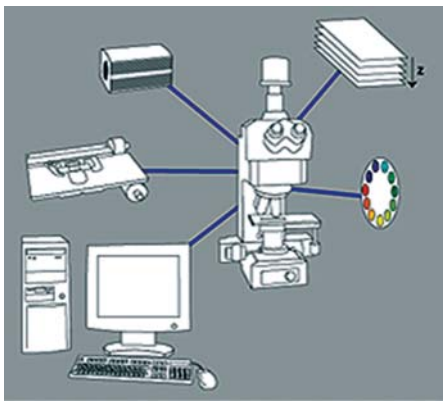
Time Lapse

Save time and money by setting up a dedicated MetaVue time-lapse acquisition workstation at your microscope.
Use the low-cost MetaVue system, with its extensive device control library and automation, to sequence and acquire live cell images over time. Double your lab's productivity by having a MetaVue time-lapse acquisition station and an off-line analysis station. While today's images are being acquired with MetaVue, you can analyze previous experiments with an off-line analysis station in your office. Because of MetaVue's compatibility with the Meta Imaging Series from Universal Imaging Corporation, any one of the products in this lineup, such as MetaMorph or MetaFluor can be used for off line analysis. Accomplish a wide range of experimental protocols with MetaVue and the appropriate options. For fluorescence imaging, prevent photobleaching by synchronizing an epi-illumination shutter with your camera.

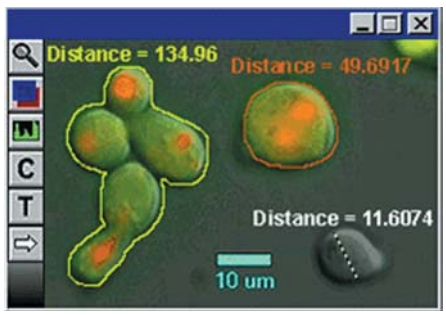


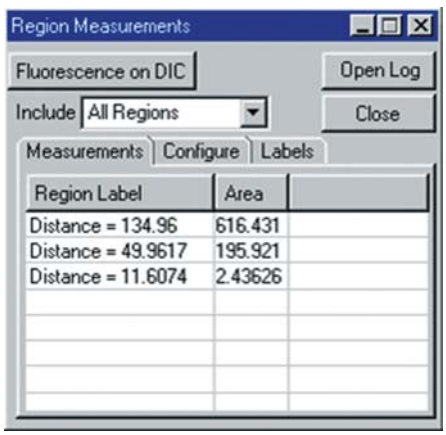
For multi-mode microscopy, MetaVue can sequence the acquisition of multiple fluorescence wavelengths combined with a transmitted light image (typically phase or DIC) over time. Auto-focus at each time interval with the addition of the digital auto-focus option and a Z-motor or acquire images at multiple stage positions over time with a motorized stage.

Distribution of Myosin II after cell division over time. Dictyostelium discoideum containing GFP fused to the N-terminus of the myosin II heavy chain gene. Courtesy of Dr. James Sabry and Spudich.



MetaVue control a variety of microscope peripherals.





Region Measurements. You can collect image statistics with the Region Measurements function, which enables interactive viewing of collected data and stores it in a log file.

Microscope Automation

Like all Meta Imaging Series systems from UIC, MetaVue device drivers support a full range of microscopes and peripherals, including:

AutomatedMicroscopes
- Leica
- Nikon
- Olympus
- Zeiss

MicroscopePeripherals
- Filter wheels
- Shutters
- Z-motors
- Motorized stages
- Monochromators

MetaVue's device control is integrated into high level acquisition tools for:
- Multi-wavelength fluorescence
- Z-series
- Stage montage
- Stage scanning
- Time lapse

Image Analysis

Standard Analysis Features

- Curved and linear distance measurements
- Manual object count
- Area measurements
- Spatial calibration
- Gray level measurements and calibration to standards
- Line intensity scans
- Image histograms
- Position and angle measurements

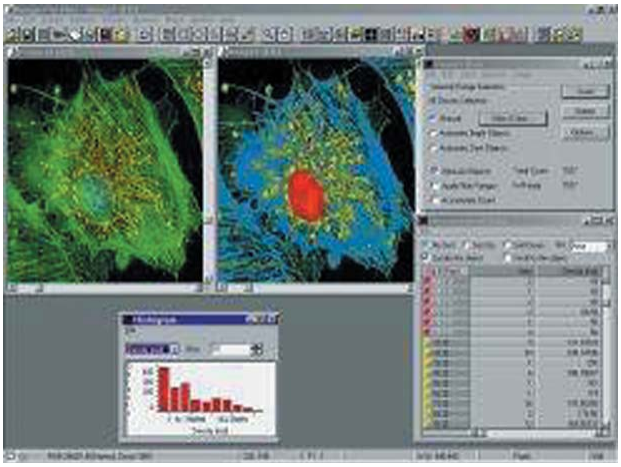
Optional Analysis Features

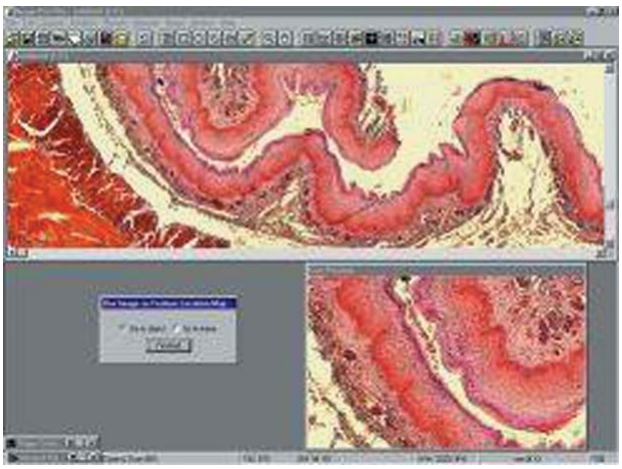
- Integrated Morphometry Analysis (IMA) - Automated object counting and sizing, measure over 100 object parameters
- Graph intensity vs. time, or wavelength from multiple regions of interest on live or stored images
- Manually track objects over time for motion analysis, and include graphing of X-Y coordinates, distance traveled and vectors

Integrated Morphometry Analysis

- Measure over 100 different attributes of objects in your image
- Receive immediate visual feedback on which objects fit your specified classifications
- Look at your measurements in a graph, table, or spreadsheet

RS Image - Pro Plus Software





Automatic microscope control

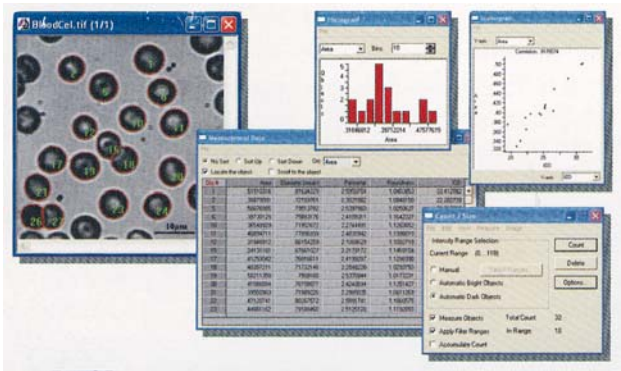


Image-Pro Plus is the proven solution that makes your job easier and you more productive. Whether your job involves failure analysis, analyzing particle distribution of ceramic material, performing live / dead cell assays, analyzing tissue sections, or any of hundreds of other applications where you need to acquire and analyze images, you can count on Image-Pro Plus for the solution to your image analysis needs.

Image-Pro Plus provides an easy way to acquire, process, and analyze images on a single machine or across an entire network. Image-Pro Plus comes complete with point-and-click simplicity, intuitive interface, and the ability to integrate text, data, and graphics into one package. A Visual Basic compatible macro language allows for easy customization of Image-Pro Plus to meet your specific imaging needs. And Image-Pro Plus delivers all the powerful functionality you' ll ever need at a price you can afford.

CAPTURE

Acquire images easily from video, digital cameras, scanners, scientific instruments and image databases. Comprehensive file format and device support, including support for today's most advanced digital cameras, sophisticated image capture cards, TWAIN, Video-for-Windows (VFW), and scanner devices, provide unparalleled compatibility between Image-Pro Plus and other applications and devices.

Capture and process a sequence of images using the sequencer tool. Use the Sequencer to easily acquire, create, and playback a sequence of images. The improved Sequencer contains additional playback options and the ability to delete or add frames anywhere in a sequence. It is fully integrated and supports all Image-Pro Plus Filters.

Use one program for all your color and gray scale imaging needs. Image-Pro provides full support of 8-, 12-, and 16-bit gray scale and 24-, 36-, and 48-bit color images, as well as, 32-bit floating point images.

Work more effectively with color images. Color segmentation tools allow you to interactively separate objects or features from the background based on color characteristics using a new histogram-based tab dialog. In addition, a color-cube based color separation tab dialog allows you to create multiple ranges and select colors for each range. With these tools, you can select and apply multiple color ranges from either the histogram or color-cube dialogs.

PROCESS

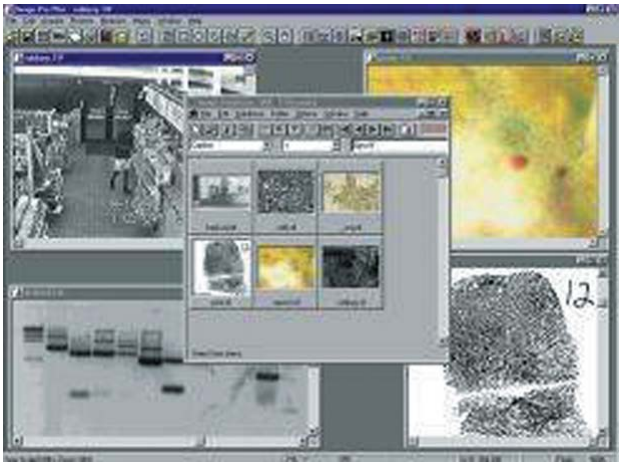
Process images to guarantee high quality, accuracy and reproducible results. Use equalization, background subtraction, correction, and field flattening methods to enhance images. Filtering functions will sharpen, soften, blur, or enhance edges. Separate touching or overlapping objects, and perform morphometric processing. Execute complex image manipulations that are possible only in the frequency domain with high-speed Fast Fourier Transform (FFT) operations.

MEASURE

Use Image-Pro Plus for simple manual measurements to complex automated measurements. Absolute spatial calibration, closely coupled with your image acquisition device, assures the most accurate measurement data.

Advanced filtering and segmentation techniques help separate overlapping objects, complete grain boundaries, and recognize clusters. Once segmented, each grouping can be color-coded for quick visual identification and class verification. You'll be able to easily acquire an image of an object, define features in the sample, and automatically take measurements on selected features such as best-fit arc, best-fit circle, and best-fit line. Unlike manual or other tedious methods, Image-Pro Plus will quickly calculate length, radius, diameter, and distance between feature measurements.

In addition, optional pass/fail measurement routines can be recorded in a macro for future playback. Once these macros are recorded, Image-Pro Plus plays them back whenever needed making it easier and much faster to perform quality assurance testing.



Criminal forensics

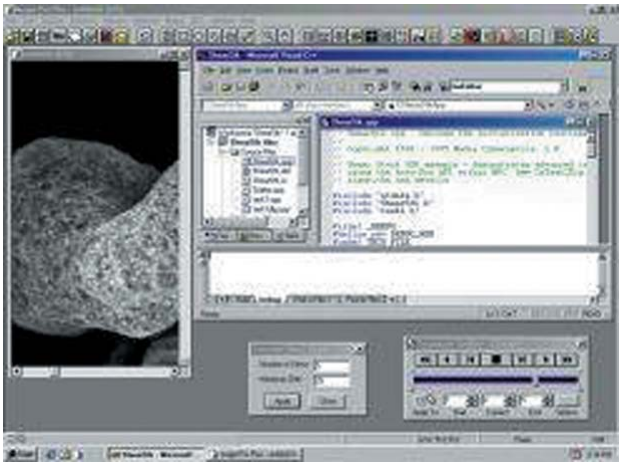
Image-Pro Plus' Caliper tool detects edges, measures distances, and more. The Caliper tool allows you to automatically locate edges along straight or irregular lines and circles. No longer having to rely on manual methods, this tool can automatically detect and measure distances between edges. In addition, the number of edges or spans between edges can be reported, making any changes or defects easily identifiable.

Add densitometry with the click of a mouse. Whether you need absorption or reflection measurements, Image-Pro Plus performs equally well. Our calibration routine takes into account of all your system variables, providing true absolute optical density measurements.

ANALYZE

Tesscattergrams, histograms, line profiles, and psuedocolor. Image-Pro's solutions don't stop there. You can also add, subtract, or mask images with Boolean or arithmetic functions, or use powerful geometric transforms for spatial manipulations. For convenient archiving, documentation and further statistical analyses, send results to Excel or other spreadsheets via Direct Data Export.

View image intensity in 3-D. For improved data visualization, the Surface Plot tool allows you to display image intensity in a full color 3-dimensional plot. With this tool, you can rotate, tilt, colorize, and wireframe the plots to aid in data visualization, and the plot can easily be exported to the Report Generator or your printer.



ARCHIVE

Organize your images and data more efficiently. The built-in Image-Pro Plus Database provides you with a powerful tool for acquiring, organizing, storing, retrieving, and sending your images. The Query Records dialog allows you to perform a search with multiple parameters.

Data entry is easy with the new drop-down choices, which can be pre-defined or expandable by the user. User-defined custom data fields can attach your specific measurement analysis and data to each image, compare and visualize your data for maximum results. Collect and visualize your data using the record. Annotate your image with non-destructive overlays, which can be saved with the image and recalled later.

COMMUNICATE

Let Image-Pro Plus connect you to the rest of the world. Share your images and data with your colleagues on the Internet within the Image-Pro Plus application. Communicate easily and quickly with popular word processors, spreadsheets, publishing environments, and electronic media.

Produce professional documents and research reports. For printed output, the Report Generator allows you to create custom formatted reports with images, data, and text. Images can be inserted into your reports with or without overlay data. In addition, images, data, and text are easily sized and formatted to your specifications.

CUSTOMIZE

Build customized applications and automate functions with the included Auto-Pro macro creation features. These powerful built-in functions let you compress lengthy operational sequences into a single key-stroke or mouse click, so you can complete your projects faster. Record sessions and play them back. Integrate and customize macros with Visual Basic or Visual C++ to build applications to solve your specific imaging needs.
Extend and customize Image-Pro Plus to fit your needs with the freely available SDK. The Image-Pro Plus Software Development Kit (SDK) offers a powerful development environment for OEMs, systems integrators, and end-user/programmers to create tailored versions of the industry standard application for analytical imaging. Unlike programming toolkits, the SDK offers a proven host environment that can be easily and quickly customized to solve specific imaging applications without starting from scratch, thereby reducing development risk and cost.

SPECIALIZED APPLICATIONS

To better serve the needs of specific applications, our packaged products and plug-ins will take you from installation to critical answers in the shortest time possible. These products and plug-ins are written in terms commonly used by actual practitioners and follow typical lab protocols.

Scope-Pro® PLUG-IN
An Image-Pro® Solution

Automate the movement of your Microscope and/or Stage

Scope-Pro® is designed for Image-Pro Plus users who want to control and program the movement of their automated microscope, stage, filter wheels, etc.

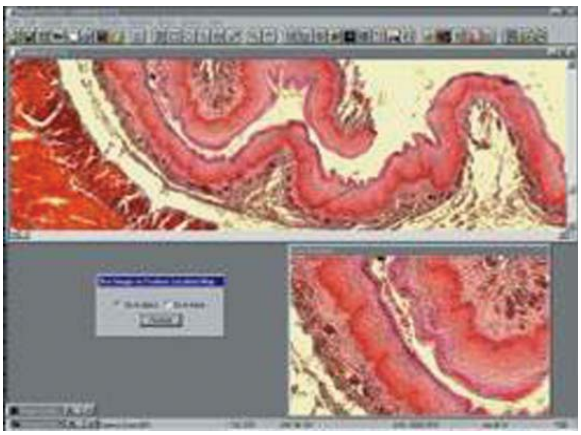
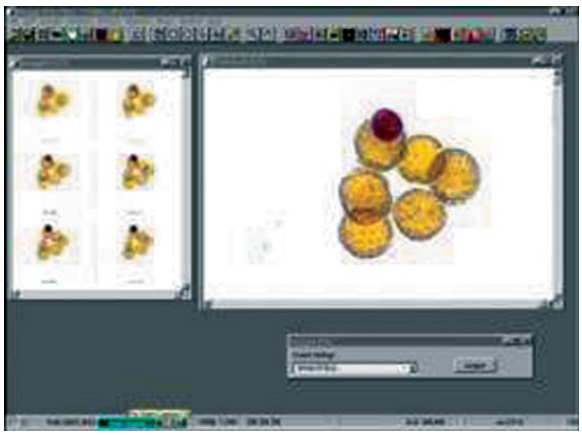
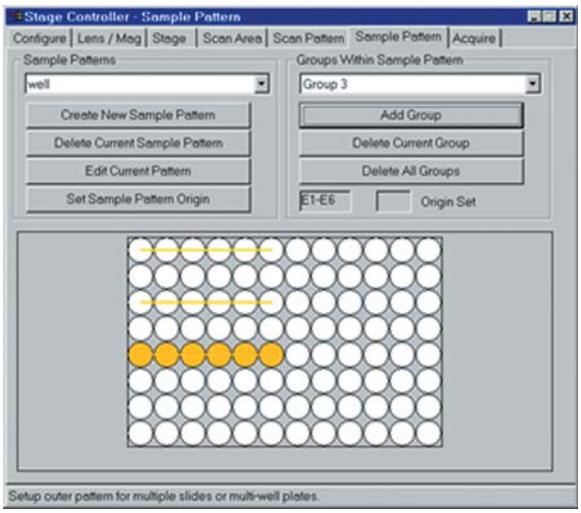


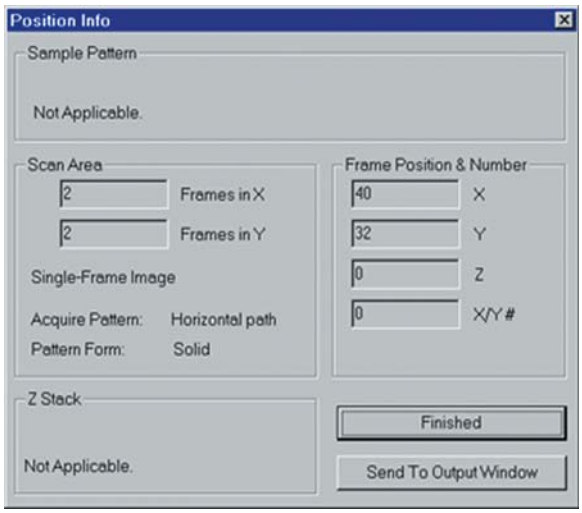
Image Feature Map for locating features of interest



Capture and save Z-stacks of images

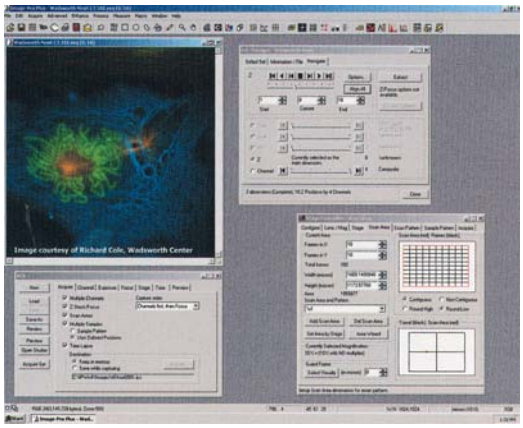


Retain vital image information
when capturing images through Scope-Pro.



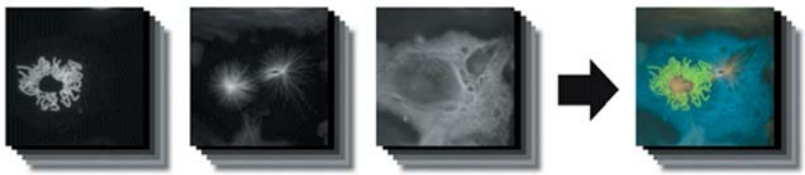
Scope-Pro includes pre-defined multiwell plate patterns for easy set-up.

AFA - Advanced Fluorescence Acquisition Module for Image-Pro Plus



Manage all combinations of acquisition modes and image sets: Time, Channel (wavelength), Focus (Z-stack), and Stage Position
Image courtesy of Richard Cole, Wadsworth Center.

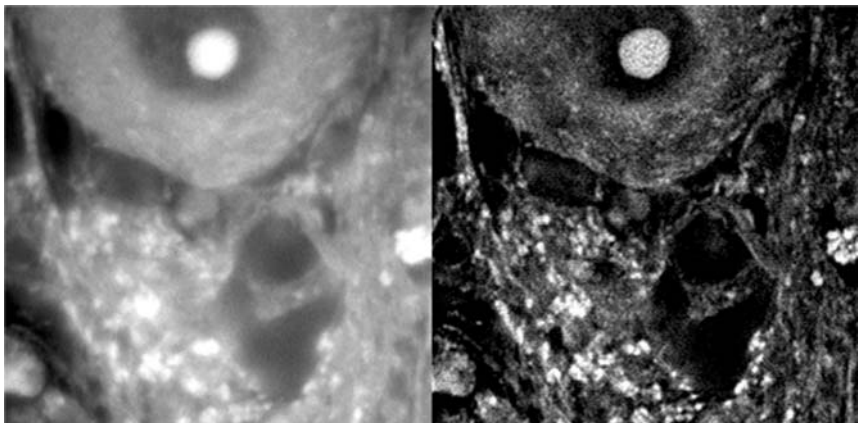
The AFA (Advanced Fluorescence Acquisition) Plug-In module is for research microscopists who need to automate and manage complex acquisition setup parameters, user feedback display, and subsequent sorting into sets for analysis. Unlike other automation products, AFA becomes an integral piece of the analysis process, sharing information.



Example of a composite image derived from 16 Z-stack sets from 3 fluorescent channels using AFA.

The Deconvolution Plug-in Module for Image-Pro Plus

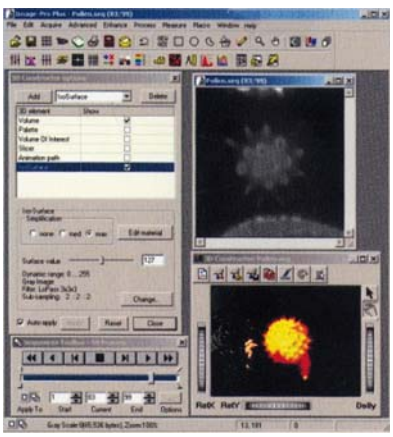
SharpStack® enhances qualitative interpretation through haze removal and deconvolution. It integrates seamlessly with Image-Pro Plus for fast and simple operation.



Pig cerebellum image deconvolved using the inverse filter algorithm.

The 3D Reconstruction, Visualization, and Measurement Plug-in

3D Constructor is for scientific researchers who wish to explore three-dimensional relationships within and among objects. The latest version adds interactive and automatic measurement capabilities in three and four dimensions. Image Z-stacks can be reconstructed and measured within the popular Image-Pro Plus environment.



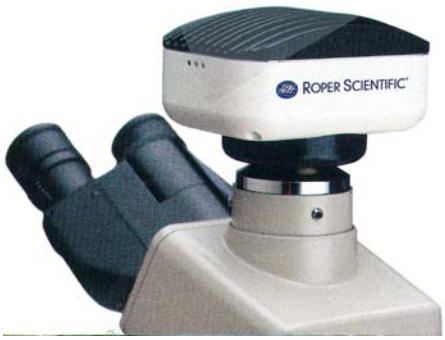
CoolSNAP 5.0M/5.0MC

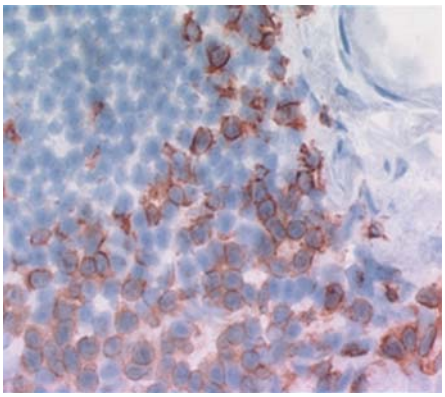
Cooled Digital High Resolution Color CCD Camera

CoolSNAP 5.0M CCD Camera

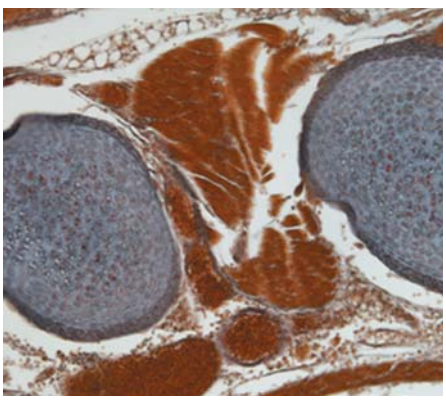
- **Brightfield, Phase Contrast and Dark-field Microscopy**
- **Fluorescence microscopy**
- **Pathology**
- **Histology**
- **Cytology**
- **Hematology**

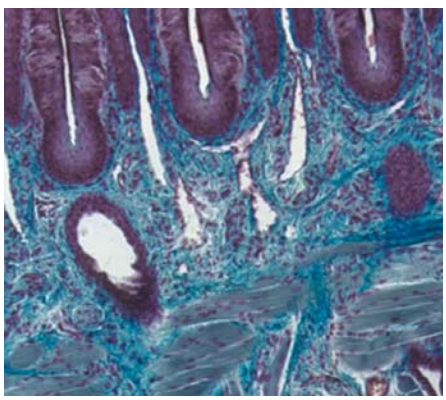
The CoolSNAP 5.0M/5.0MC digital imaging system delivers high resolution color images for microscopy documentation and publication. The 3.3 megapixel CCD sensor and 30-bit color digitization produce high quality color images of brightfield, dark-field and fluorescence work. For demanding low light applications, the CoolSNAP 5.0MC Cooled model minimizes thermal noise during long exposure times for high quality, low light images. The FireWire™ IEEE 1394 digital interface allows ease of use and installation with a single wire connection from the camera to the computer (including laptops) for full computer control of the camera.





	CoolSNAP 5.0MC	CoolSNAP 5.0M
Resolution	2580 x 1944	2580 x 1944
Pixel Size	3.4 x 3.44um	34. x 3.44um
Binning Modes	2x2, 3x3, 4x4 in full color	2x2, 3x3, 4x4 in full color
Cooling Type	Peltier thermoelectric cooling	Non cooling
Digital Output	10-bit	10-bit
Exposure/ Integration	1.6ms to 17.9min in 1μs increments	1.6ms to 17.9min in 1μs increments
Digital Interface	IEEE 1394 FireWire	IEEE 1394 FireWire
Shutter Control	Electronic shutter, no moving parts	Electronic shutter, no moving parts
Optical Interface	2/3", C-Mount optical format	2/3", C-Mount optical format
Weight	710g	710g
Computer Operating System	Windows2000/XP Professional & Mac OS 9/OS X	Windows2000/XP Professional & Mac OS 9/OS X





High Resolution Real Color Images

PHOTOMETRICS® CoolSNAP cf™

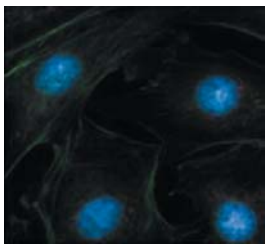
CoolSNAP-cf- Color CCD Camera

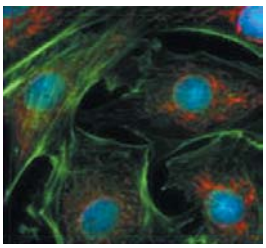
- **Brightfield / DIC image**

CoolSNAP-cf- Monochrome CCD Camera

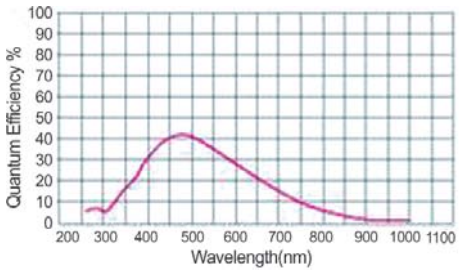
- **FISH**
- **GFP**

The Photometrics® CoolSNAP™ cf Monochrome/Color camera from Roper Scientific® incorporates low-noise electronics and moderate CCD cooling to achieve good low-light sensitivity. A megapixel sensor with small, square elements ensures that each image shows extraordinary detail. This feature, along with a high-speed digitizer, shutterless operation and an interline CCD, makes the CoolSNAP™ cf





Fluorescence Image with Bright Image



model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise
CoolSNAP cf Color	1392 x 1040	4.65 x 4.65	20 MHz	15 e- rms
CoolSNAP cf Mono	1392 x 1040	4.65 x 4.65	20 MHz	15 e- rms

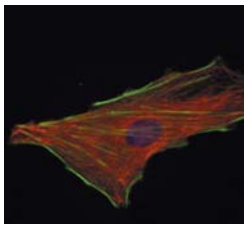
PHOTOMETRICS® CoolSNAP™ ES

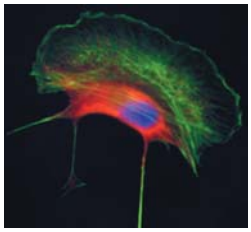
CoolSNAP ES CCD Camera

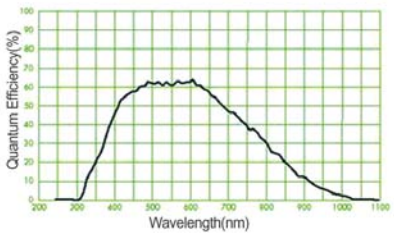
- **FISH**
- **Time Lapse**
- **FRET**
- **3D Deconvolution**
- **GFP**

The Photometrics® CoolSNAP™ ES Monochrome camera is a fast, high-resolution digital camera system designed for low-light scientific and industrial applications. This moderately cooled CCD camera system provides 12-bit digitization at 20 MHz. The fine pitch of the pixels, 6.45 x 6.45 microns, is ideally matched to the resolution of optical microscopes. Mega pixel resolution and small pixels allow imaging of very fine detail, yet the pixels can be easily binned to improve sensitivity. New interline CCD technology provides high quantum efficiency, most notably in the near-infrared (NIR) portion of the spectrum.

model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise
CoolSNAP ES Monochrome	1392 x 1040	6.45 x 6.45	20 MHz	<8 e- rms



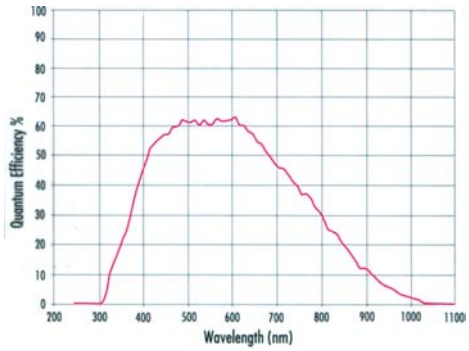




CoolSNAP HQ CCD Camera

- **MULTI COLOR-FISH**
- **6D TIME LAPS**
- **FRET**
- **3D DECONBOLUTION**

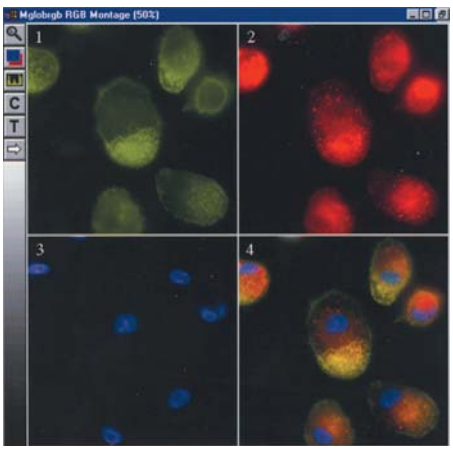
The Photometrics® CoolSNAP™ HQ Monochrome camera is a fast, high-resolution digital camera system designed for low-light scientific and industrial applications. This cooled CCD camera system provides 12-bit digitization at both 10MHz and 20 MHz. The fine pitch of the pixels, 6.45 x 6.45 microns, is ideally matched to the resolution of optical microscopes. Mega pixel resolution and small pixels allow imaging of very fine detail, yet the pixels can be easily binned to improve sensitivity.
New interline CCD technology provides high quantum efficiency, most notably in the near-infrared (NIR) portion of the spectrum.



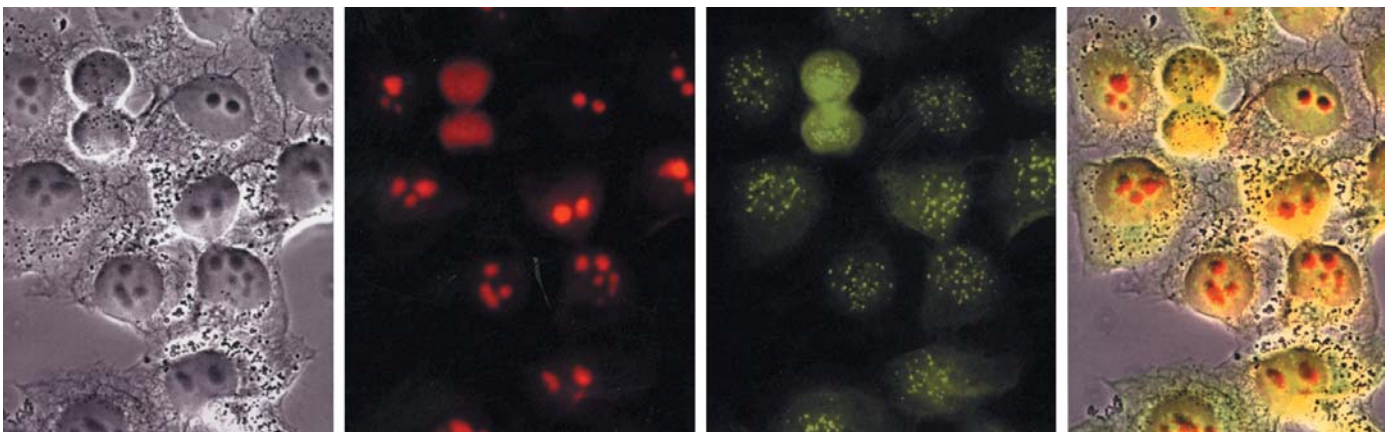
Binning	1392 x 1040	512 x 512	256 x 256
1 x 1	10	19	30
2 x 2	18	30	44
3 x 3	24	38	51
4 x 4	29	43	56

model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise
Monochrome (INT)	1392 x 1040	6.45 x 6.45	10 MHz 20 MHz	6 e- rms @ 10 MHz 8 e- rms @ 20 MHz

- 20 MHz and 10 MHz low noise 12 Bit readout
- CCD offers superior red response
- Dual Clocking Modes
- CCD cooled to -30℃
- On CCD binning and subarray readout
- 1.3 mega-pixel high resolution CCD
- Trigger, 8-bit TTL I/O and dual 8-bit DAC's
- Electronic shuttering eliminates vibration
- Precise timing, synchronizes shutters/filters/stages
- Compact, no external camera controller
- Free PCI interface with Video output



The yellow areas of the montage in panel 4 show colocalization of the green and red images panels 1 and 2. Images courtesy of Philip L. Leopold, Barbara Ferris, and Ronald G. Crystal, Cornell University Medical College.



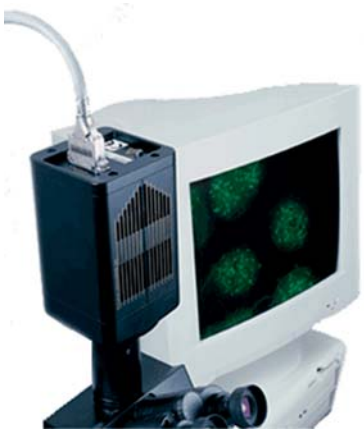
CHO cells shown(l-r) in Phase Contrast, RFP and GFP Channels and Overlay

PRINCETON INSTRUMENTS **MicroMAX**

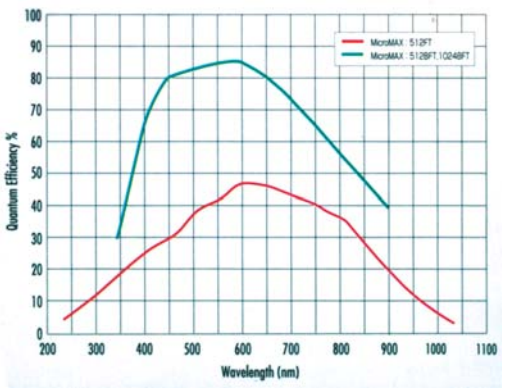
MicroMax CCD Camera

- **GFP imaging**
- **Fluorescence microscopy**
- **Ion imaging**
- **Particle Imaging Velocimetry (PIV)**

The MicroMAX Digital Camera System is an optimal device for use in fluorescence microscopy applications such as high-resolution immunofluorescence, FISH and GFP imaging. One of the advantages of the MicroMAX concept is the large variety of CCD types that are supported within the product line so the user can choose the optimal CCD sensor for his/her application type. Another advantage is the built in video output mode which simplifies setup and focusing on the microscope. In addition, integration into third party software packages is essentially completed after working with one of the system types since the software communicates with the common element of the system, the ST-133 controller. The combination of the MicroMAX system with one of a variety of specialty software packages for use on one of several different computer platforms results in a powerful digital imaging system that can meet most experimental needs.



- High Quantum efficiency throughout the visible spectrum
- Smallest pixel available in a back-illuminated device
- Shutterless frametransfer operation
- Readout versatility
- Support for E2V framtransfer CCDs
- Thermoelectrically cooling



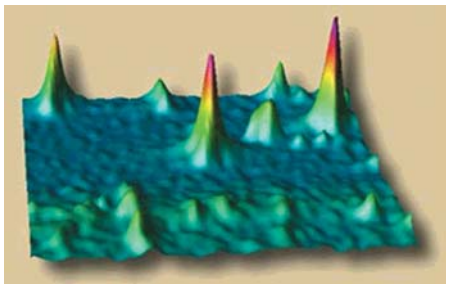
model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise	dark current
512FT(FT)	512 x 512	13 x 13	100 kHz1 MHz	4 e- rms @ 100 kHz 8 e- rms @ 1 MHz	<10 e-/p/s @ -45°C
512BFT(B, FT)	512 x 512	13 x 13	100 kHz1 MHz	4 e- rms @ 100 kHz 8 e- rms @ 1 MHz	<10 e-/p/s @ -45°C
1024F	1024 x 1024	13 x 13	100 kHz1 MHz	4 e- rms @ 100 kHz 8 e- rms @ 1 MHz	<0.5 e-/p/s @ -40°C
1024FT(FT)	1024 x 1024	13 x 13	100 kHz1 MHz	4 e- rms @ 100 kHz 8 e- rms @ 1 MHz	<10 e-/p/s @ -40°C
1024B(B)	1024 x 1024	13 x 13	100 kHz1 MHz	4 e- rms @ 100 kHz 8 e- rms @ 1 MHz	<0.5 e-/p/s @ -40°C
1024BFT(B, FT)	1024 x 1024	13 x 13	100 kHz1 MHz	4 e- rms @ 100 kHz 8 e- rms @ 1 MHz	<10 e-/p/s @ -40°C

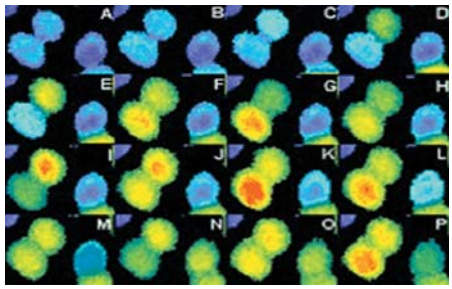
PHOTOMETRICS® Cascade®

HIGH SENSITIVITY- HIGH SPEED HIGH RESOLUTION 16BIT CAMERA

Cascade CCD Camera

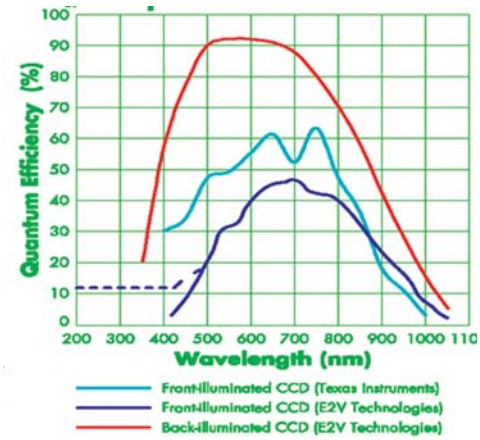
- **Single molecule fluorescence**
- **FRET experiment**
- **High Speed Calcium**
- **ion measurement**





The Photometrics Cascade:650 digital imaging system offers very high sensitivity through the use of on-chip multiplication gain technology. The CCD camera' s 16-bit digitization at 10 MHz provides wide dynamic range at video frame rates and higher, while the fine pitch of the detector' s pixels, 7.4 x 7.4 microns, is ideally matched to the resolution of optical microscopes. The thermoelectrically cooled system represents an excellent solution for low-light-level applications such as single- molecule fluorescence (SMF), intracellular ion imaging, and biological fluid flow measurements.

- Front and back-illuminated (>90% QE) version available with optional UV coating
- On-chip multiplication gain for single photon counting
- Additional 3 conversion gains, quantifies how the resulting electrons are converted into Analog-to-Digital units
- Full 16 Bit digitizer at 10, 5 and 1 MHz readout rate
- DSP controlled multiplication gain lifetime optimization
- Model 512 offers dual amplifiers option for optimized high-sensitivity or wide-dynamic-range performance
- Shutter less frame-transfer CCD, 100% duty cycle to collect continuous data, support for non-overlap, readout
- Single anti-reflective coated input window
- Adjustable C-mount adapter for precise focal depth adjustment
- Negligible readout noise



model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise	dark current
650(FT)	653 x 492	7.4 x 7.4	10 MHz 5 MHz	negligible (<1 e- rms) with on-chip multiplication gain enabled	1e-/p/s@-35°C
512F(FT)	512 x 512	16 x 16	"on-chip multiplication gain" amplifier		1e-/p/s@-30°C
			10 MHz 5 MHz	negligible (<1 e- rms) @ 10 MHz and 5 MHz	
			"traditional" amplifier		
			5 MHz 1 MHz	~15 e- rms @ 5 MHz ~10 e- rms @ 1 MHz	
512B(B, FT)	512 x 512	16 x 16	"on-chip multiplication gain" amplifier		0.5e-/p/s@-30°C
			10 MHz 5 MHz	negligible (<1 e- rms) @ 10 MHz and 5 MHz	
			"traditional" amplifier		
			5 MHz 1 MHz	~15 e- rms @ 5 MHz ~10 e- rms @ 1 MHz	

PHOTOMETRICS® SenSys®

SenSys CCD Camera

- **Brightfield microscopy**
- **Immunofluorescence**
- **FISH**
- **Fluorescence microscopy**

SenSys supports a variety of scientific grade CCD sensors all of which are thermoelectrically cooled to provide accurate and reproducible results. The latest in surface mount technology is used to consolidate all camera electronics within a compact camera head. Analog to digital conversion, AIA parallel digital interfacing, TTL input/output and temperature stabilization circuits are all contained in a unique, single board design. The camera head has a high speed, customer-replaceable shutter that can maintain a 15 frames per second repetition rate. Interchangeable C- and F-mount hardware is available to adapt the camera head to common lenses, microscopes and other analytical compatibility is achieved through a low profile, lightweight design. Patented features make the SenSys ideal for a variety of specialized applications.

model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise	dark current
0402E (ITO)	768 x 512	9 x 9	1.4 MHz	11 e- rms	1 e-/p/s @ +10°C
1401E (ITO)	1317 x 1035	6.8 x 6.8	1.4 MHz	11 e- rms	1 e-/p/s @ +10°C
1602E (ITO)	1536 x 1024	9 x 9	1.4 MHz	11 e- rms	1 e-/p/s @ +10°C
3200E (ITO)	2184 x 1472	6.8 x 6.8	1.4 MHz	8 e- rms	1 e-/p/s @ +10°C
3200ME (ITO, MT)	2184 x 1472	6.8 x 6.8	1.4 MHz	8 e- rms	1 e-/p/s @ +10°C

PHOTOMETRICS® Quantix®

Quantix CCD Camera

- **High-resolution imaging**
- **High-speed imaging**
- **Gel electrophoresis**
- **Gene chip reader**

Quantix supports a variety of scientific grade CCD sensors all of which are thermoelectrically cooled to provide accurate and reproducible results. The latest in surface mount technology is used to consolidate all camera electronics within a compact camera head. Analog to digital conversion, AIA parallel digital interfacing, TTL input/output and temperature stabilization circuits are all contained in a unique, single board design. The camera head has a high speed, long-lifetime shutter that can maintain a 15 frames per second repetition rate. Interchangeable C- and F-mount hardware is available to adapt the camera head to common lenses, microscopes and other analytical instrumentation. Finally, mechanical compatibility is achieved through a low profile, lightweight design. The Quantix's features make it ideal for a variety of specialized applications.

model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise	dark current
57 (B, FT)	535 x 512	13 x 13	1, 2, 3 MHz	15 e- rms @ 1 MHz 15 e- rms @ 3 MHz	29 e-/p/s @ -25°C 18 e-/p/s @ -35°C
1401E (ITO)	1317 x 1035	6.8 x 6.8	1 MHz 5 MHz	18 e- rms @ 1 MHz 18 e- rms @ 5 MHz	0.03 e-/p/s @ -25°C 0.01 e-/p/s @ -35°C
1602E (ITO)	1536 x 1024	9 x 9	1 MHz 5 MHz	16 e- rms @ 1 MHz 16 e- rms @ 5 MHz	0.05 e-/p/s @ -25°C 0.02 e-/p/s @ -35°C
7899	2048 x 2072	14 x 14	3 MHz 5 MHz	20 e- rms @ 3 MHz 30 e- rms @ 5 MHz	3 e-/p/s @ -25°C
6303E (ITO)	3072 x 2048	9 x 9	1 MHz 5 MHz	15 e- rms @ 5 MHz	0.05 e-/p/s @ -25°C 0.04 e-/p/s @ -30°C

PRINCETON INSTRUMENTS PI•MAX®

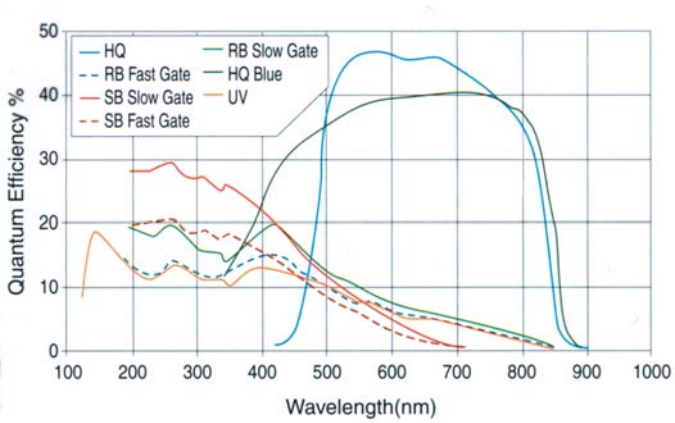
The PI-MAX features high-resolution camera fiber-optically coupled to either a CCD imaging unit or image intensifier developed for very dark spectroscopy and scientific imaging. PI-MAX offers gate widths less than 2 ns by its high-speed shutter. PI-MAX systems employ an integrated digital Timing Generator that allows the user to set all gating parameter for time-resolved applications of many independent lasers, spectrometers, and measuring equipments. An USB 2.0 communications port or another high speed interface is used for seamless connectivity with notebooks and desktops PC applications to control this hardware automatically.

- Image Intensifiers CCD digital camera
- Gen II, Gen III and ultraviolet image intensifiers
- High-performance response from 120 to 900 nm
- High speed gate response less than 2nano-seconds
- Equipped with 2 sets of ADC (100KHz, 1MHz, 5MHz)
- USB2.0 PC interface
- 16bits dynamic range
- Selectable intensifiers of 18mm or 25mm
- Winspec and Winview softwares
- Wireless connection available (mouth controller)

- **Ultra High Speed Ca++ Image**
- **Time-resolved fluorescence**
- **Single Molecule Fluorescence Imaging**
- **Real Time Confocal Fluorescence**

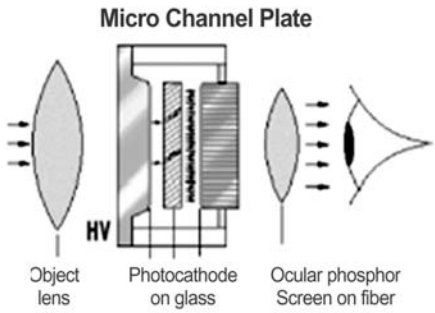
1) Quantum efficiency

PI-MAX supports Gen II and Gen III image intensifiers, covering the entire visible, UV and NIR spectral region



2) Image intensifier

Image intensifier is composed of components such as photoelectric surface, MCP (micro channel plate), and hosphorescent surface. These components are combined and held in a high vacuum chamber to intensify 7,000 or 20,000times the charge of photons received on the photoelectric surface. The amplitude is controllable by changing the voltage applied on the MCP using a PC.



model	intensifier	wavelength range	peak QE	minimum gate time	limitingresolution
NEW 512 Now operates at 5 MHz!	18-mm Gen II I 18-mm Gen II	see RB, SB, UV models (specs vary) see HQ models (specs vary)			45 or 54 lp/mm 64 or 72 lp/mm
1K	18-mm Gen II 18-mm Gen III	see RB, SB, UV models (specs vary) see HQ models (specs vary)			45 or 54 lp/mm 64 or 72 lp/mm
1024RB	18- or 25-mm Gen II	200 to 900 nm	15 to 20%	<2 ns	45 lp/mm
1024SB	18- or 25-mm Gen II	200 to 500 nm	25 to 30%	<2 ns	45 lp/mm
1024UV	18-mm Gen II	120 to 900 nm	15 to 20%	<5 ns	45 lp/mm
1024HQ	18-mm Gen III	400 to 900 nm	40 to 45%	<5 ns	64 lp/mm
MG1024	18-mm Gen II RB 18-mm Gen II SB	200 to 900 nm 200 to 500 nm	15 to 20% 25 to 30%	<9 ns <9 ns	45 lp/mm 45 lp/mm

- **Chemi Luminescence Imaging**
- **In-Vivo GFP/RFP Imaging**

VersArray is a line of high performance digital imaging systems developed for the measurement needs of extremely low-light-level applications. Permanent coatings are available to spread the coverage of wavelength to UV zone keeping the high quantum efficiency of the camera. They are best suited for quite wide applications including high throughput screening, read out of streak tubes, analysis of gels, astronomy, photographing of marks of pressure sensitive paint, and defects analysis of semiconductor elements. It is possible to reduce drastically the dark current of VersArray cameras and systems by cooling the CCD array down to very cold temperature.

model	imaging array (pixels)	pixel size (μm)	readout speed	readout noise	dark current
512F	512 x 512	24 x 24	1 MHz 100 kHz 50 kHz	10 e- rms @ 1 MHz 7 e- rms @ 100 kHz 5 e- rms @ 50 kHz	0.1 e-/p/s @ -45°C 0.5 e-/p/hr @ -120°C
512B(B)	512 x 512	24 x 24	1 MHz 100 kHz 50 kHz	10 e- rms @ 1 MHz 7 e- rms @ 100 kHz 5 e- rms @ 50 kHz	0.2 e-/p/s @ -45°C 0.5 e-/p/hr @ -120°C
1K	1024 x 1024	13 x 13	1 MHz 100 kHz 50 kHz	7.5 e- rms @ 1 Hz 3.6 e- rms @ 100 Hz 2.6 e- rms @ 50 kHz	0.3 e-/p/hr @ -120°C
1KB(B)	1024 x 1024	13 x 13	1 MHz 100 kHz 50 kHz	7.5 e- rms @ 1 MHz 3.6 e- rms @ 100 kHz 2.6 e- rms @ 50 kHz	0.5 e-/p/hr @ -120°C
1300F	1340 x 1300	20 x 20	1 MHz 100 kHz 50 kHz	8 e- rms @ 1 MHz 3 e- rms @ 100 kHz 2.5 e- rms @ 50 kHz	0.03 e-/p/s @ -40°C 0.3 e-/p/hr @ -110°C
1300B(B)	1340 x 1300	20 x 20	1 MHz 100 kHz 50 kHz	8 e- rms @ 1 MHz 3 e- rms @ 100 kHz 2.8 e- rms @ 50 kHz	0.1 e-/p/s @ -40°C 0.5 e-/p/hr @ -110°C
CT1300B(B)	1340 x 1300	20 x 20		Contact us	
2048F	2048 x 2048	13.5 x 13.5	1 MHz 100 kHz 50 kHz	9 e- rms @ 1 MHz 5.5 e- rms @ 100 kHz 3.5 e- rms @ 50 kHz	0.05 e-/p/s @ -40°C 0.3 e-/p/hr @ -110°C
2048B(B)	2048 x 2048	13.5 x 13.5	1 MHz 100 kHz 50 kHz	9 e- rms @ 1 MHz 5.5 e- rms @ 100 kHz 3.5 e- rms @ 50 kHz	0.1 e-/p/s @ -40°C 0.5 e-/p/hr @ -110°C

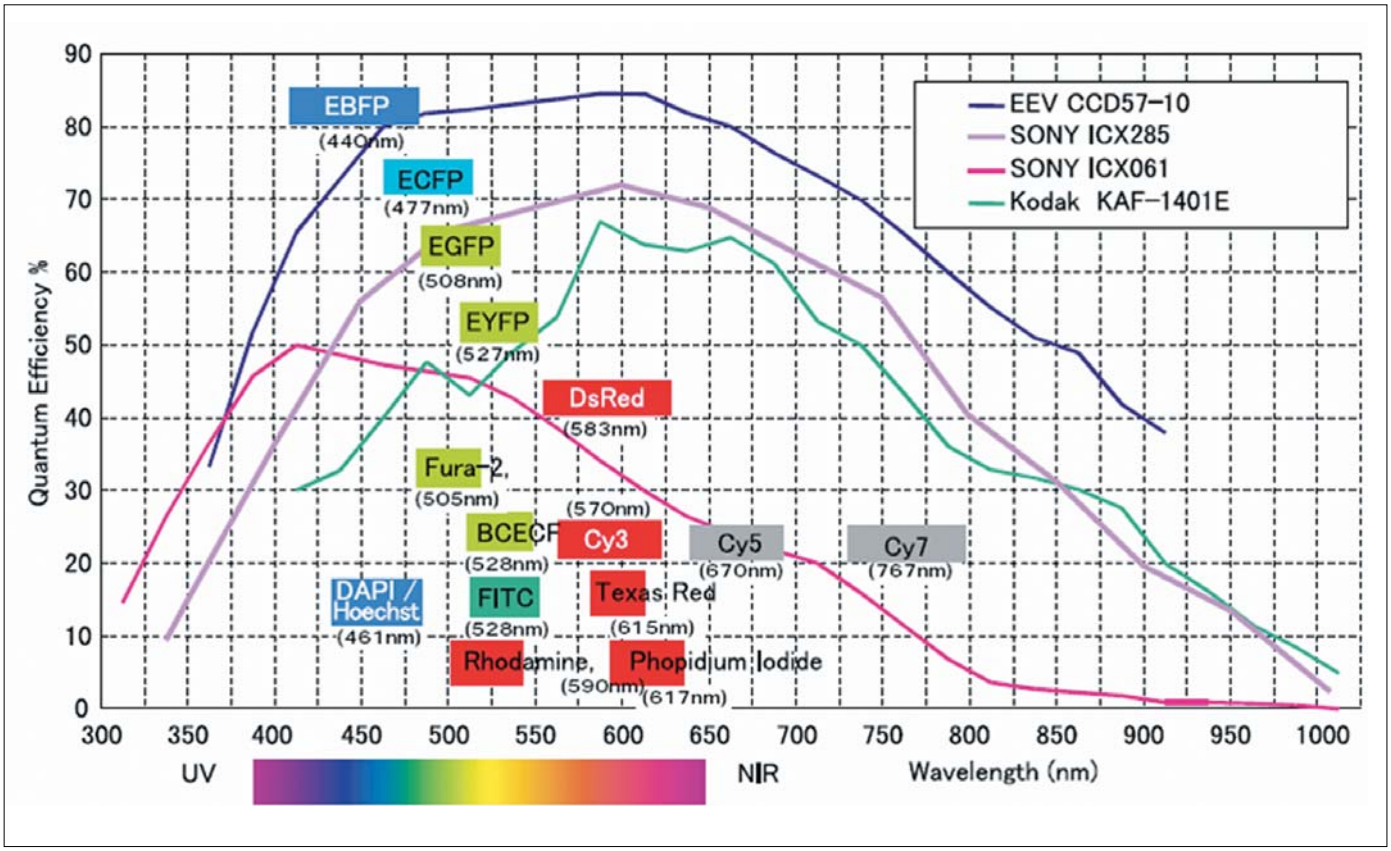
XP series (cooling down to minus 70 degree C by air)

Keeping time of vacuumed has been improved drastically by introduction of a newly developed technology. It is not necessary to re-vacuum at all and possible to chill the elements cooler than before, achieving minus 70 degree C.

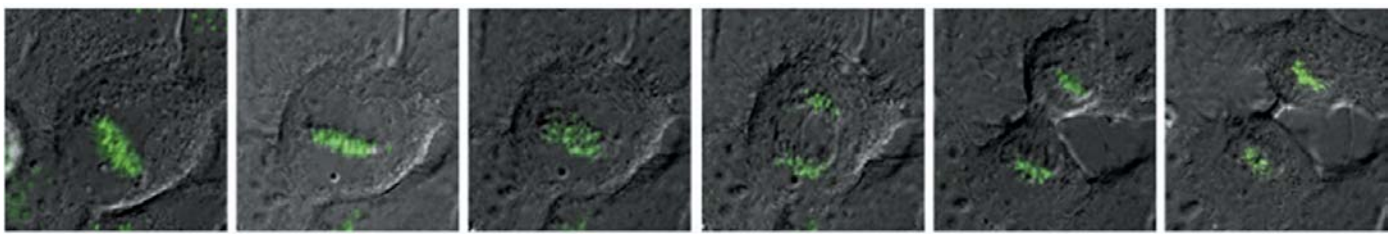
model	imaging array(pixels)	pixel size (μm)	readout noise / speed	dark current
512F	512 x 512	24 x 24	4 e- rms @ 50 kHz 8 e- rms @ 500 kHz 12 e- rms @ 2 MHz	0.002 e-/p/s @ -70°C
512B(B)	512 x 512	24 x 24	4 e- rms @ 50 kHz 8 e- rms @ 500 kHz 12 e- rms @ 2 MHz	0.002 e-/p/s @ -70°C
1K	1024 x 1024	13 x 13	2.6 e- rms @ 50 kHz 6 e- rms @ 500 kHz 9 e- rms @ 2 MHz	0.001 e-/p/s @ -70°C
1KB(B)	1024 x 1024	13 x 13	2.6 e- rms @ 50 kHz 6 e- rms @ 500 kHz 9 e- rms @ 2 MHz	0.001 e-/p/s @ -70°C

Quantum Efficiency Chart

Quantum efficiency (QE) is a measure of the effectiveness of the CCD to produce electronic charge from incident photons. Within the visible spectrum, from 400 to 700 nm, the QE of silicon is always less than unity and varies as a function of wavelength. The spectral range of a front illuminated CCD is limited by the gate structure which absorbs light at wavelengths lower than 400 nm. It is possible to thin the CCD to about 20 microns and focus an image on the back of the device. Since there are no polysilicon gates to absorb incoming light, thinned (Back-illuminated) CCDs exhibits more than 80% quantum efficiency.



GFP(Green Fluorescent Protein) Imaging in Living Cells



Applications of CCD Camera

	General fluorescence	Bright image	DIC image	GFP	FISH	Immunology
CoolSNAP 5.0M/5.0MC		●	●			
CoolSNAP cf color	●	●	●			●
CoolSNAP cf mono	●			●	●	●
CoolSNAP ES	●			●	●	●
CoolSNAP HQ	●			●	●	●
Sensys	●			●	●	●
Quantix				●		
MicroMax				●	●	●
Cascade				●		
PI:MAX						
VersArray						

	FRET imaging	Time lapse imaging	Calcium ratio imaging	Single molecule imaging	Chemi-luminescence	High-throughput screen image
CoolSNAP 5.0M/5.0MC						
CoolSNAP cf color						
CoolSNAP monochrome						
CoolSNAP ES	●	●	●			
CoolSNAP HQ	●	●	●			●
sensys	●					
Quantix	●	●	●			
MicroMax	●	●	●			●
Cascade	●	●	●	●		
PI:MAX			●	●		
VersArray					●	

Automatic Instruments

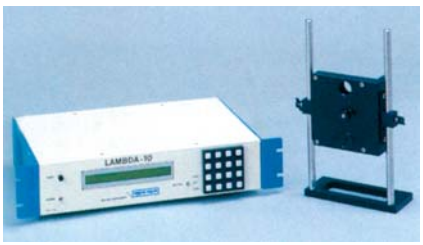
ELECTRO-PROGRAMMABLE SHUTTER

VMM- D1 Single Channel Shutter Driver
For externally timed control, the **VMM-D1** is ideal. In addition to shutter control from the BNC inputs, these inputs can also be controlled via a computer serial port (RS-232C). By selecting the proper address for each unit, a number of devices can be controlled from one serial port. Eight individual addresses are available.

VMM- D3 Three Channel Shutter Driver
The **VMM-D3** is a three-channel shutter driver capable of controlling up to three Vincent shutters independently. The compact design puts three individual shutter drivers in a single streamlined system. Active high-level logic inputs allow independent shutter control. One single input will activate all channels simultaneously. Active low-level logic outputs are available to monitor the status of each individual synchronization system output. One single output is available to monitor when all shutter synchronization system circuits are active.

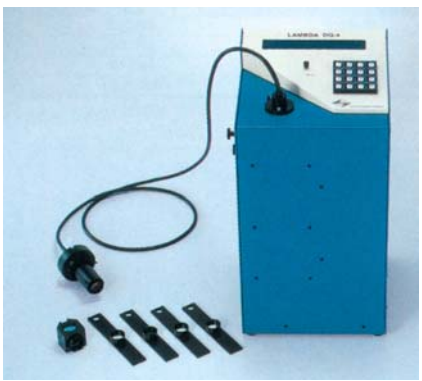
Type	# of Channels	Internal Timing	RS-232 Control
VMM-D1	1	No	Yes
VMM-D3	3	No	Yes
VMM-D4	4	No	No
VMM-T1	1	Yes	Yes

Lambda 10-2 OPTICAL FILTER CHANGER



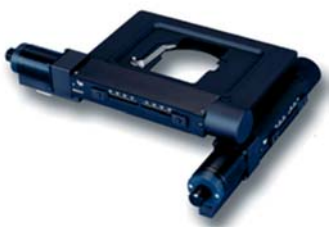
The Lambda 10-2 is a microprocessor controlled, high speed filter wheel. Its impressive speed coupled with exceptionally smooth operation make the Lambda 10-2 ideal for research applications involving fluorescence microscopy, ratio imaging, spectrophotometry, visual physiology, or any application requiring rapid and accurate aperture positioning.

DG-4 ULTRA HIGH SPEED WAVELENGTH SWITCHER



The Lambda DG-4 offers unprecedented speed and versatility for experiments requiring rapid light wavelength switching. It offers all the advantages of interference filter-based systems, yet eliminates the temporal constraints imposed by filter switching devices. Switching between any two wavelengths is achieved in less than the 1.2msec vertical retrace period of a video signal, allowing you to perform real-time video imaging. For dual wavelength ratio imaging studies, the Lambda DG-4 enhances your ability to follow fast changes in ion concentrations by acquiring a ratio pair in two consecutive video frames. For dual wavelength ratio imaging studies, the Lambda DG-4 enhances your ability to follow fast changes in ion concentrations by acquiring a ratio pair in two consecutive video frames.

BioPrecision STAGES



BioPrecision stages are designed for demanding applications where speed, repeatability and accuracy are required. These stages utilize precision ground crossed roller bearing guideways, recirculating ball leadscrews, and precision motors. All components used in these stages are machined with state of the art CNC equipment resulting in the highest stage performance. All stage components are black anodized for durability and long lasting appearance.

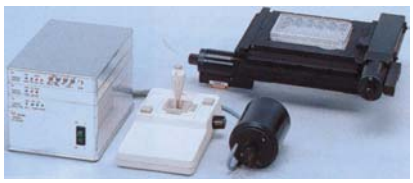
FILTER WHEELS

LEP filter wheels are designed for high performance and long time reliability. Adaptable to most major brands of microscopes with a versatile flange system, integration problems are eliminated.
The MAC 5000 controller drives the filter wheel and provides the host interface for the system. Since the MAC 5000 controller is supported by a large number of imaging software vendors, integration becomes a simple matter of connecting the RS-232 cable.
Eight different filter wheels are available high speed, standard speed, 32 and 25mm filter apertures. The high-speed filter wheel is DC servomotor driven for high performance applications where time critical analysis is required. The standard speed wheel, driven by a stepper motor offers robust performance and compatibility.

Z-MOTER (Auto focus control)

The BioPrecision focus control system provides accurate, high-resolution automated control of the microscope focus.
The focus control systems are available in two versions. The basic focus control system is simply a microstepping motor control that is coupled to the microscope focus drive. The second, more advanced system adds the MAC 5000 video auto focus processor to the basic system to provide video based auto-focus.

MAC-5000 AUTOMATION SYSTEM



All aspects of the MAC 5000 have been designed for simplicity. The stacking module concept, the flexible interfacing, the comprehensive array of component modules all make the MAC 5000 the choice for complete automation.
The ability to unify all the automation into a single controller dramatically simplifies system design, programming, implementation and troubleshooting. There are no boards to install into your computer only a standard RS-232 or USB interface. Each module is configurable either via hardware switches or by software override.
The LEP philosophy makes basic operation and programming of the MAC 5000 system easy. While at the same time sophisticated commands are available that enable an application to fine tune the system for the vital performance edge.
Manual joystick control is always available. While it may seem mundane, this feature can save costs in terms of hardware integration and processing overhead. Each module supports either analog joystick or digital digipot control. In some cases both inputs are simultaneously supported.

Polychrome IV

The **multi-wavelength illumination system** from TILL Photonics is a monochromatising device with an integrated light source.
High Output - unlike other monochromators and wavelength switchers, the Polychrome IV delivers a bright (6-8 mW), evenly illuminated field at the objective with a bandwidth of 15 nm and homogeneity of better than 10%.
High Speed - the Polychrome IV has the ability to jump to any wavelength between 250 and 680 nm in less than 3 ms and provides a remarkable 1.5 ms Fura jump between 340 and 380 nm.
The Polychrome IV is the third generation of a rapidly tunable excitation source from TILL Photonics. It is comprised of a xenon light source, galvanometric scanner mounted grating and mirror optics. The monochromatic light is coupled to specially designed epifluorescence condensers via a solid quartz fiber. These condensers are available for most microscopes and provide optimal illumination

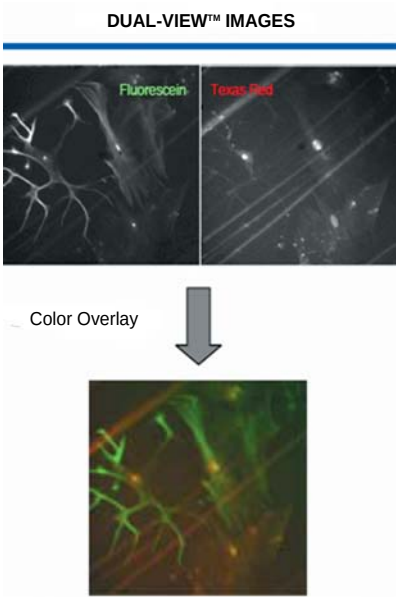
Dual-View™ & Quad-View™ Micro-Imager

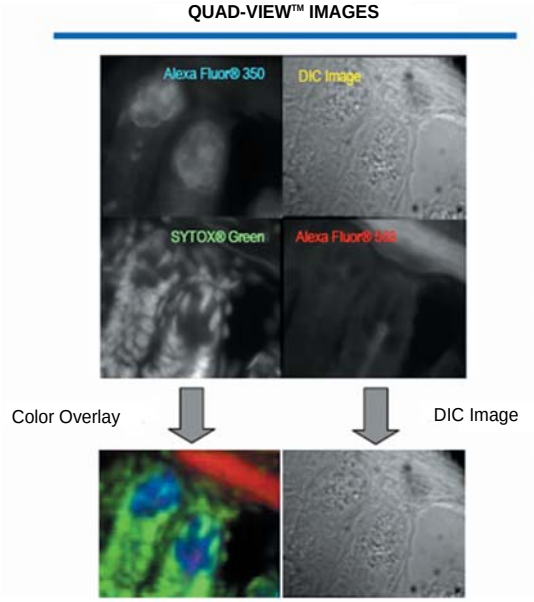
Dual-View™& Quad-View™ (C or F-mount)

- Simultaneous acquisition of 2 to 4 fluorescence emission images in a single snapshot
- Easily mounted to any microscope and CCD
- Uses standard 25mm diameter emission and polarization filters
- Removable filter cube makes configuration for different experiments a snap
- Pass-Thru option means you can leave system in place for full field-of-view imaging

Dual-Cam™/Quad-Cam™ (C or F-mount)

- Simultaneous acquisition of 2 to 4 full field-of-view fluorescence emission images in a single snapshot
- Increase scanning speeds by factor of 2 to 4 without sacrificing resolution
- Easily mounted to any microscope and CCD
- Uses standard 25mm diameter emission and polarization filters
- Filter slider (same as Dual-View) makes configuration for different experiments easy





PIFOC® Z-MOTER CONTROLLER

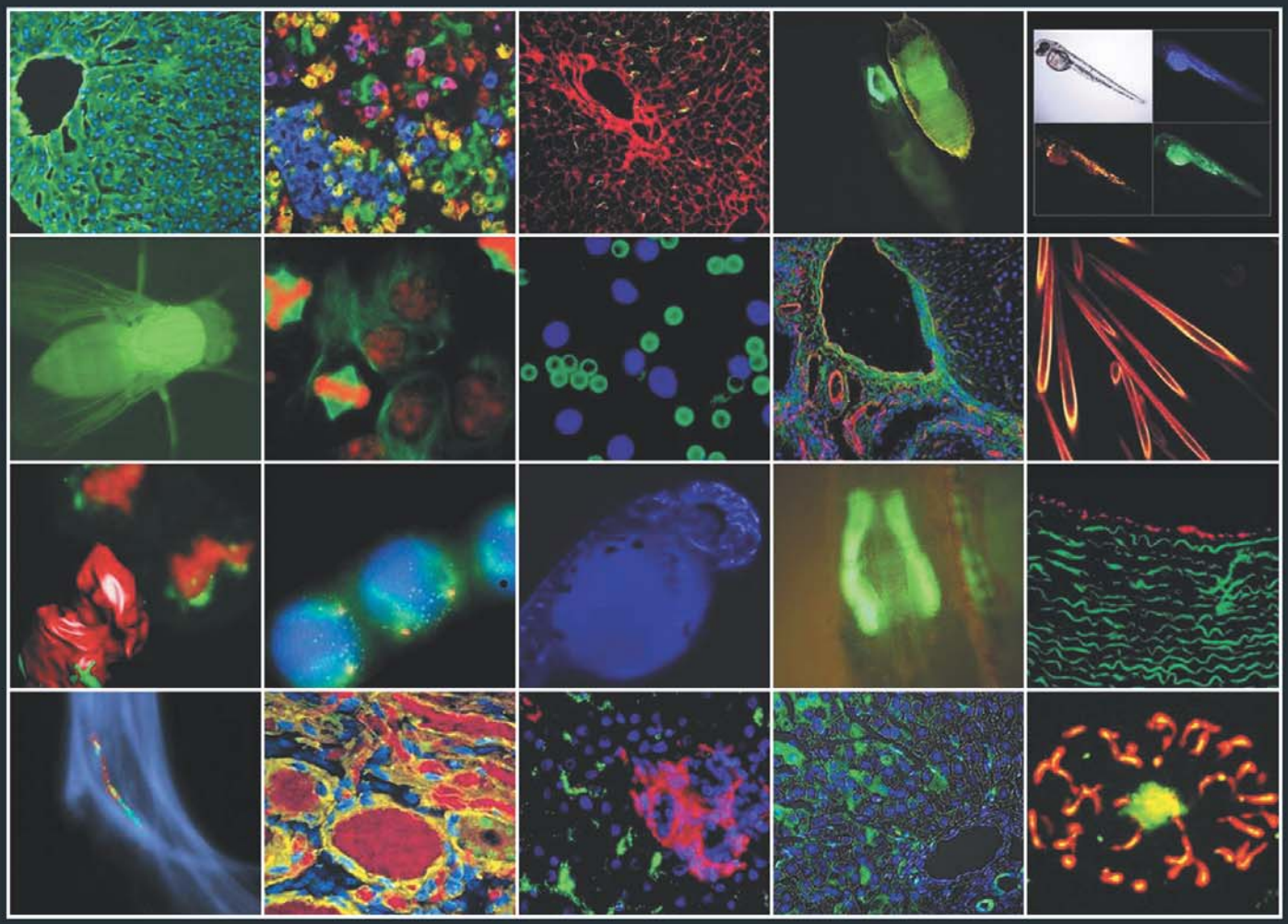
The E-662 is a bench-top, amplifier and position servo-controller with integrated RS-232 computer interface and 12-bit D/A converter for low-voltage PZTs. The amplifier can output and sink a peak current of 360 mA and an average current of 120 mA. The position servo-controller works with either strain gauge sensors or LVDT sensors.

P-725 PIFOC® Microscope Objective Positioners & Scanners with Capacitive Sensors

- Scans and Positions Objectives with Sub-nm Resolution
- High Linearity and Stability with Direct-Measuring Capacitive Sensors
- Travel to 500 µm
- Most-Compact Unit with Direct Metrology
- Enhanced Guiding Precision for Better Focus Stability
- Fast Response & Settling Time
- Compatible with Metamorph® Imaging Software
- QuickLock Adapter for Easy Attachment

Micro*Color™ tunable RGB filters for digital imaging

- High-resolution color images from a monochrome CCD camera
- Better spatial resolution and color accuracy than conventional "painted-pixel" CCD cameras
- Lower cost than triple-CCD cameras and no pixel misregistration issues
- Solid-state liquid crystal technology with no moving parts, no vibration, and no noise



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