

AxioCam HR

Success Through Performance



**The flexible high-end camera for
digital documentation and image analysis**



We make it visible.

Superior performance for research and routine work – brilliant quality documentation

Increasingly complex applications in pathology, developmental biology and material science demand microscope systems and camera technologies that reach the very limits of what is physically possible. A Carl Zeiss camera that meets even the highest demands of digital documentation has established itself in high-end microscopy. The monochrome version is, ideally suited to Live Cell Imaging – even at high speeds. The color variant can be used universally: in fields ranging from materials sciences and the materials industry, pathology, cytology, hematology and histology through to botany, zoology, forensics and pharmacology.

High-resolution for lossless digital microscopy

Documenting with the AxioCam HR means seeing what the microscope sees – in full microscope resolution without interpolated image information. Different resolutions can be set depending on the application: from 1388 x 1040 up to 4164 x 3120, corresponding to 13 megapixels per color channel.

Outstanding image quality even with weak fluorescence

With a dynamic range of 1 : 2500 (at 12.5 MHz) and a 14 bit gray level range, the monochrome version of the AxioCam HR produces high-contrast images even when it comes to demanding applications in fluorescence microscopy. The Peltier-cooled camera offers exposure times ranging from milliseconds up to several minutes. The advantage: high-quality images, even when signals are extremely weak.

Selectable read-out modes for more flexibility

The option of selecting from two different read-out speeds (12.5 MHz and 25 MHz), as required, makes the AxioCam HR impressively versatile in terms of the range of applications it can perform. With the fast read-out mode of 25 MHz, live images of between 12 images/s (full resolution) and 33 images/s (reduced resolution) can be achieved. The advantages this offers are simple adjustment of the sample and ergonomic focusing in all situations. In conjunction with the AxioVision Digital High Speed Recorder module or the





Axio Observer



SteREO Discovery



Axio Imager

Systems with Carl Zeiss quality:
the complete solution with microscope,
camera and software

Cell Observer® HS, fast time lapse or multidimensional imaging is also possible with up to 48 images/s using 5x5 binning, e.g. for the observation of extremely fast processes. Optimized fast acquisition of scanned resolutions can also be performed. All in all, this means that the right setting is available for every application.

Maximum convenience in a compact format

Very small dimensions and no external control box: the Zeiss Blue can be integrated as a compact solution into any laboratory or working environment and will not restrict your freedom of movement. As the AxioCam HR does not have rotating fans, it works without any vibrations and transfers the digital image data directly to your computer without interference.

Perfect interaction in the overall system

Carl Zeiss offers a wide range of components that complement each other perfectly and, when combined as an overall system, offer your applications optimum support. The AxioCam HR can be connected to any Carl Zeiss microscope that has a

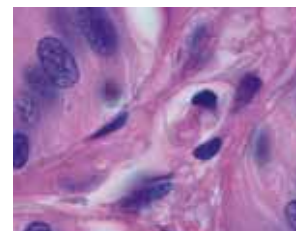
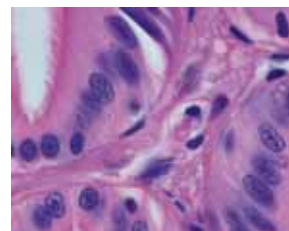
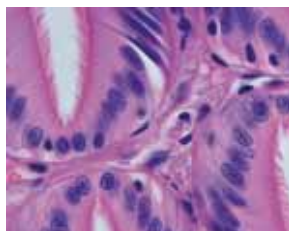
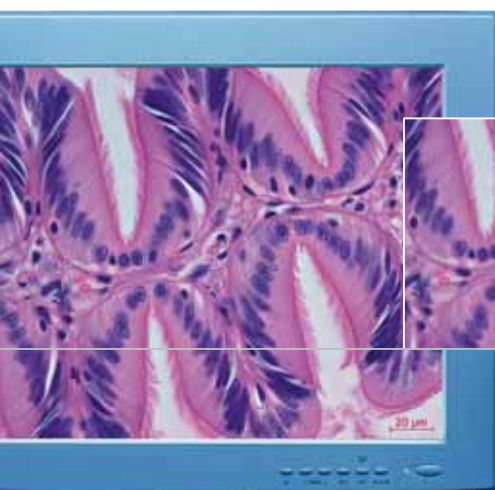
phototube or TV output. When combined with the Axio Imager or Axio Observer research microscopes and the AxioVision imaging software, you will have a high-performance system with a high degree of automation – for reliable, reproducible results.

Intelligent control with AxioVision

AxioVision from Carl Zeiss is the software for all requirements in digital imaging. It allows you to control all the functions of both the camera and microscope. Acquisition and processing, analysis and archiving – all your work procedures combined in a single platform. AxioVision is practice-oriented, intuitive in terms of operation and easily adapted to your individual requirements. In addition, you can also present your image data in a meaningful way: the Unsharp Masking option allows even the finest details to be displayed in high contrast on the monitor.

**Highest image quality using microscanning
Acquisition time at short exposure times:**

Resolution	AxioCam HRc	AxioCam HRm
1388 x 1040	0.3 s	-
2776 x 2080	1.4 s	0.4 s
4164 x 3120	2.6 s	0.9 s
4164 x 3120 (Fast Scan)	0.6 s	-



*Loligo Pealei (squid), liver,
Stain: hematoxylin eosin,
David Patterson, Marine Biological Laboratory,
Woods Hole, Massachusetts, USA*

Flexibility for every application: color and monochrome

Color or monochrome: always the right choice

Routine tasks or individual applications – the AxioCam HR from Carl Zeiss is the camera of choice for the complete range of applications. Whether you use it as a versatile color camera or in the monochrome variant with optional RGB filter modules – the AxioCam HR delivers color images in extremely high resolution, for every application.

Color co-site Sampling for excellent color brilliance

Accurate color images of even the finest structures without color moiré: the large CCD sensor of the AxioCam HRc ensures perfect color accuracy. By scanning all the red, green and blue components of the image, the patented Color co-site Sampling technique achieves a color brilliance that can otherwise only be achieved using 3 sensors. It guarantees you complete color information for every pixel – no “approximated” interpolated colors.

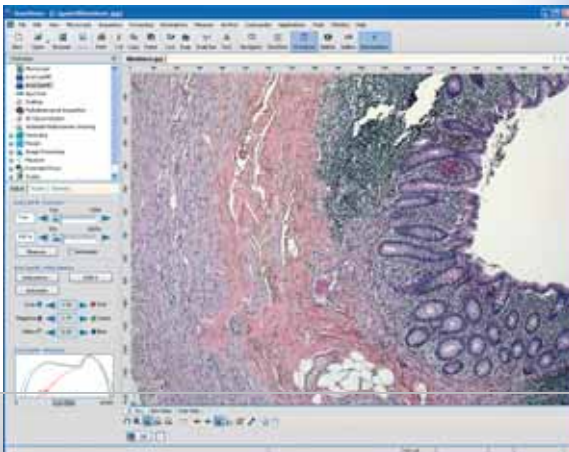
High performance at low light intensities

The extremely high sensitivity of the large 2/3" sensor, an outstanding signal to noise ratio and Peltier cooling for long exposure times – these are the qualities that allow the AxioCam HR to make high-quality imaging possible, even under the most challenging lighting conditions.

Monochrome CCD for fluorescence imaging

Sensitive, weakly fluorescing specimens or contrast and acquisition procedures in several dimensions require maximum resolution with exposure times that are as short as possible. The monochrome version of the AxioCam HR has been specially developed with an enhanced sensitivity range to cope with these demanding tasks.

Medicine

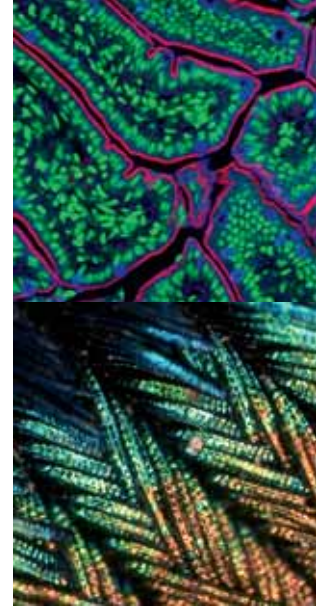


Appendix, Prof. Dr. Joachim Diebold,
Institute of Pathology at the University of Munich,
Germany



Applications

*Peacock feather,
Martin Distel, Reinhard Köster,
GSF, Institute of Developmental Genetics,
Neuherberg, Germany*



Superior performance without color filters

Crucial for your results when working at the limits of visibility: clear advantages in resolution and sensitivity thanks to a CCD sensor without light-reducing color filters.

- The spectrum of detectable light is extended into the otherwise invisible near infrared.
- Even in the basic resolution of 1388 x 1040 pixels, images are acquired without the interpolation of a color sensor and the compromises associated with this.
- Images are scanned 4 x faster than with the color camera.
- The size of the file is reduced to a third compared with the AxioCam HRc color camera.

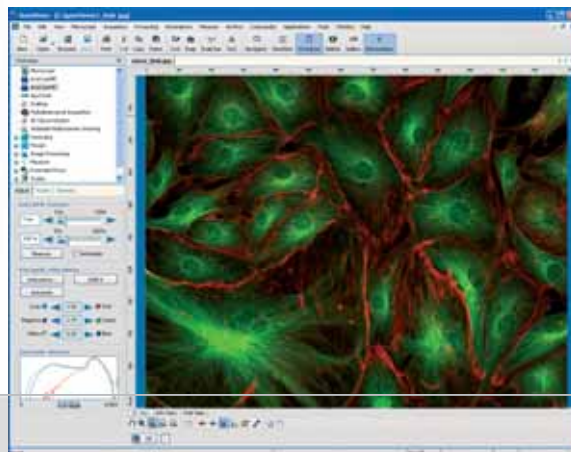
Full-strength signals

With the monochrome AxioCam HRm, no optical elements such as color or infrared filters stand in the way of the light. This means that even fluorochromes that emit in the near infrared are detected by the AxioCam HRm.

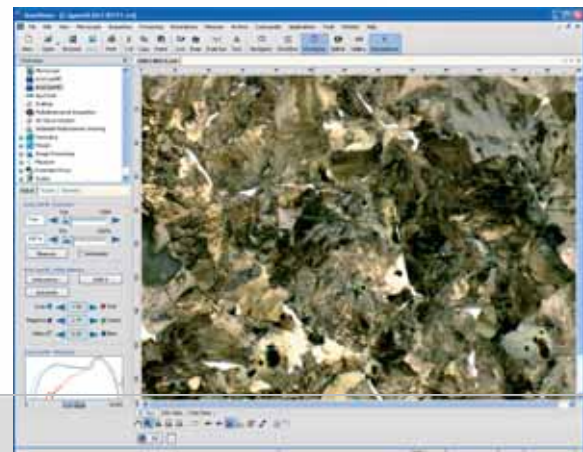
Maximum performance for live cell applications

A unique feature of the AxioCam HR is the possibility of adjusting microscanning and the read-out speed. This combination means that the AxioCam HR can be used with a high degree of versatility – making it an economical and individually adaptable solution that is particularly attractive to research institutes which carry out many different live cell applications. It is only in combination with the Cell Observer® system, however, that you can fully exploit the possibilities of the camera – especially those offered by the monochrome version. Integration into AxioVision enables you to perform every conceivable application in Live Cell Imaging – from extremely fast, one-dimensional time lapse imaging and individual images in multi-channel fluorescence applications through to the combination of fast time lapse images with multi-dimensional acquisition – all with just one camera.

Biology



Materials Analysis





Brilliantly sharp color images thanks to Color co-site Sampling

With ordinary 1-chip digital cameras, color images are acquired with a sensor. Each pixel of this sensor is sensitive to just one of the three basic colors. As only one image is acquired, each sensor pixel receives only the color information for red, green or blue at any one point in the image. However, as all three color channels are required simultaneously at a single point in the image in order to display a pixel in color, the missing color channels are determined by means of interpolation from the nearest neighboring pixels. This approximation results in the generation of imperfect images which display disruptive color fringes and distorted colors at fine image structures and edges.

With the Color co-site Sampling technique used by the AxioCam HR, several images of a specimen are produced and combined into a sharp resulting image. After the acquisition of each image a piezo mechanism moves the sensor by precisely the

distance of one pixel, meaning that each point is seen by the sensor at least once in all colors. Interpolated color information is therefore not needed. In this way, the complete color information for each detail is obtained in four images and put together to form one image that is identically sharp in all three color channels.

Microscanning for all details

Using the same procedure you can achieve even more, however: by acquiring images at additional positions in the spaces between pixels, the accuracy of the images produced by the AxioCam HR is increased again, also in case of the monochrome camera. With up to three additional positions on the x and y axes, the resolution is increased from 1388 x 1040 by a factor of 9 up to 4164 x 3120 pixels. The Color co-site Sampling used at the same time ensures perfect, color-correct reproduction of the finest structures.

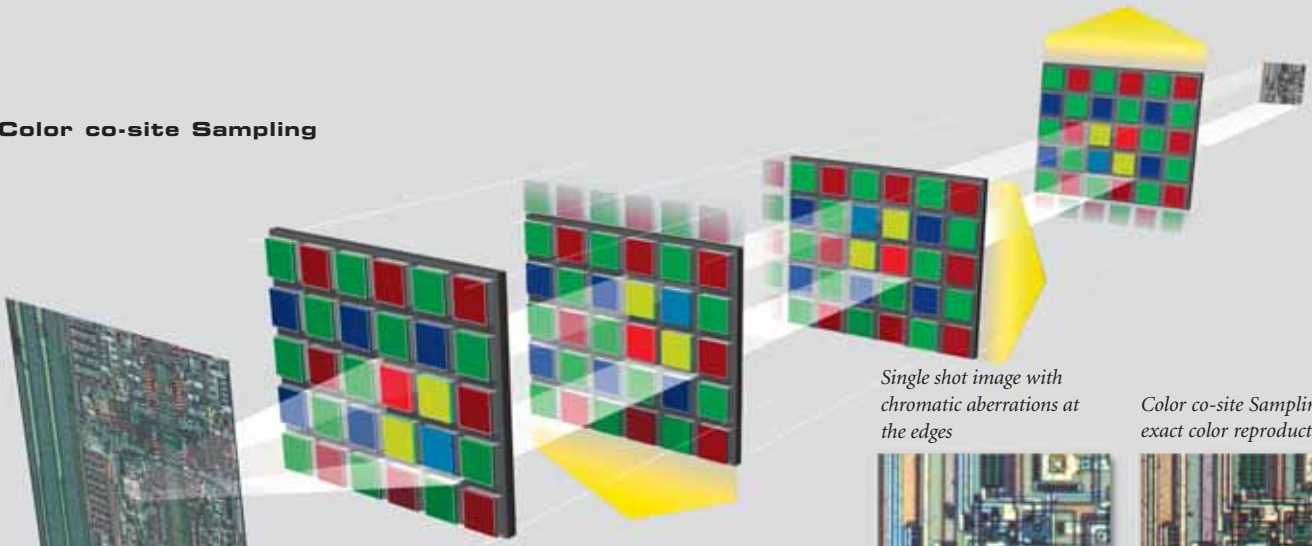
The resolving power of Carl Zeiss objectives in the intermediate image with 0.63x and 1.0x TV adapters in combination with the AxioCam HR's 2/3" CCD sensor (8.5 mm x 6.4 mm).

Objective	Magnification	NA	Lp/mm (TV-Cpl 1.0x)	Necessary camera resolution	Lp/mm (TV-Cpl 0.63x)	Necessary camera resolution
1. EC Plan-NEOFLUAR	1.25	0.035	96	1632 x 1229	152	2584 x 1946
2. FLUAR	2.5	0.12	144	2448 x 1843	229	3893 x 2931
3. EC Plan-NEOFLUAR	5	0.15	90	1530 x 1152	143	2431 x 1830
4. ACHROPLAN/N-ACHROPLAN	10	0.25	75	1275 x 960	119	2023 x 1523
5. FLUAR	10	0.5	150	2550 x 1920	238	4046 x 3046
6. EC Plan-NEOFLUAR	20	0.5	75	1275 x 960	119	2023 x 1523
7. Plan-APOCHROMAT	20	0.75	113	1921 x 1446	179	3040 x 2291
8. LCI Plan-NEOFLUAR	25	0.80	96	1632 x 1229	152	2584 x 1946
9. EC Plan-NEOFLUAR	40	0.75	56	952 x 717	89	1513 x 1139
10. EC Plan-NEOFLUAR	40	1.3	98	1666 x 1254	155	2635 x 1984
11. Plan-APOCHROMAT	63	1.4	67	1139 x 858	106	1802 x 1357
12. EC Epiplan-NEOFLUAR	100	0.9	27	459 x 346	43	731 x 550
13. Plan-APOCHROMAT	100	1.4	42	714 x 538	67	1139 x 858

Technology

View through the C-mount connection and the infrared barrier filter on the high-resolution CCD sensor

Color co-site Sampling



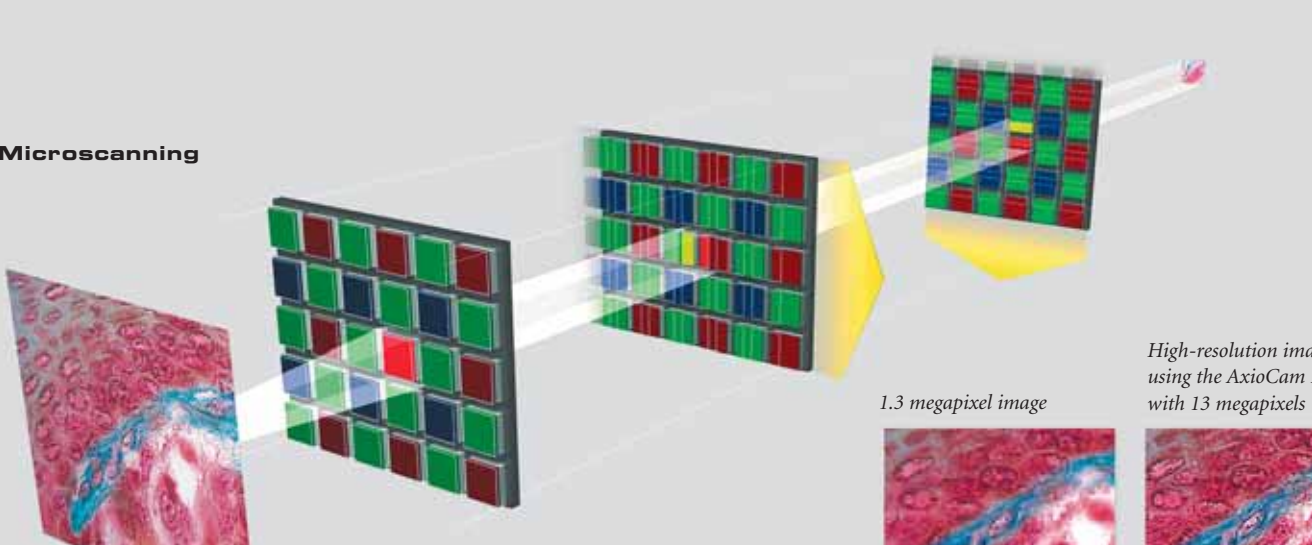
The diagram illustrates the color co-site sampling process. It shows a sequence of four sensor positions as they move across a scene. Each sensor position is represented by a grid of colored squares (red, green, blue, yellow) corresponding to the color filter array. A yellow cone represents the light source or lens. The scene being captured is a detailed image of a circuit board. The first image shows the sensor at a certain position, capturing a portion of the scene. The second image shows the sensor moved by one pixel, capturing a different portion. The third image shows the sensor moved by another pixel, and the fourth image shows the sensor moved by a third pixel. The final result is a high-resolution image with exact color reproduction.

Single shot image with chromatic aberrations at the edges

Color co-site Sampling with exact color reproduction

During acquisition, the sensor is moved by the distance of one pixel. As a result of this every pixel is scanned at least once in all colors and the sharpness is therefore identical in all three color channels

Microscanning



The diagram illustrates the microscanning process. It shows a sequence of four sensor positions as they move across a scene. Each sensor position is represented by a grid of colored squares (red, green, blue, yellow) corresponding to the color filter array. A yellow cone represents the light source or lens. The scene being captured is a detailed image of a biological specimen. The first image shows the sensor at a certain position, capturing a portion of the scene. The second image shows the sensor moved by one pixel, capturing a different portion. The third image shows the sensor moved by another pixel, and the fourth image shows the sensor moved by a third pixel. The final result is a high-resolution image with 13 megapixels.

1.3 megapixel image

High-resolution image using the AxioCam HR with 13 megapixels

Moving the sensor along the vertical and horizontal axes supplies additional information about image details. The basic resolution increases as a result up to 4164 x 3120 pixels (13 megapixels)

You will find an animated version of this illustration on our internet site.

AxioCam HR: Data and Facts

The data and facts apply equally to the AxioCam HRm and AxioCam HRC. Where different data apply, this will be pointed out.

Sensor	AxioCam HRm and AxioCam HRC: Sony ICX 285, progressive readout, AxioCam HRC with RGB filter mask		
Maximum camera resolution	4164 x 3120		
CCD basic resolution	1388 x 1040 = 1.4 megapixels		
Pixel size	6.45 µm (h) x 6.45 µm (v)		
Sensor size	Chip area 8.9 mm x 6.7 mm, equivalent 2/3"		
Spectral sensitivity	AxioCam HRm: approx. 350 nm-1000 nm with BK 7 protection glass AxioCam HRC: approx. 400 nm-700 nm with BG 40 IR barrier filter		
Dynamic range	Typical > 1: 2200 at 25 Mhz at < 7.7 e readout noise Typical > 1: 2500 at 12.5 Mhz at < 6.8 e readout noise		
Full well	Typical 17.000 e		
Dark current	Typical 0.7 e/pixels/s, dark current compensation for maximum low light performance at long exposure times		
Resolution improvement	Microscanning technology enables a configurable image resolution beyond the basic sensor resolution		
Selectable resolution	H x V	H x V (Microscanning Mode)	
AxioCam HRm	276 x 208 Binning 5 x 5 346 x 260 Binning 4 x 4 462 x 346 Binning 3 x 3 694 x 520 Binning 2 x 2 1388 x 1040, Single Shot	2776 x 2080 4164 x 3120	
Selectable resolution	H x V	H x V (Microscanning Mode)	
AxioCam HRC	276 x 208 Binning 5 x 5, RGB 346 x 260 Binning 4 x 4, B/W 462 x 346 Binning 3 x 3, RGB 694 x 520 Binning 2 x 2, B/W 1388 x 1040, Single Shot	1388 x 1040 Color co-site Sampling 2776 x 2080 Color co-site Sampling 4164 x 3120 Color co-site Sampling 4164 x 3120 Fast Scan	
Live image frame rates	H x V	Mode/Binning	Max. frame rate (25 MHz)*
AxioCam HRm	1388 x 1040 694 x 520 462 x 346	Slow/1 Middle/2 Fast/3	12 images/s 21 images/s 31 images/s
Live image frame rates	H x V	Mode/Binning	Max. frame rate (25 MHz)*
AxioCam HRC	1388 x 1040 460 x 344 276 x 208	Slow/1 Middle/3 Fast/5	12 images/s 26 images/s 33 images/s (Binning in color)
Fast readout modes in AxioVision module	<ul style="list-style-type: none"> Five preloadable exposure time parameters in camera head enable especially high speed multichannel acquisition 		
Fast Acquisition	<ul style="list-style-type: none"> Continuous mode enables fast time lapse acquisition Overlapping exposure and readout enables maximum frame rates for time lapse images and minimizes acquisition time for microscanning imaging 		

Hard disk recording	Inline recording of image data directly to hard disk at all speeds with AxioVision modul Fast Acquisition available
Readout of sub frames (ROI)	Random definition of regions of interest (ROI) on the sensor enables further increase of achievable frame rates
Signal amplification	Analog: 2x, digital 32x
Digitization	Two switchable readout speeds offer different depth of digitization High Quality: 14 bit/12.5 Mhz and High Speed: 12 bit/25 Mhz
CCD cooling	Single stage Peltier cooling, regulated
Interface	FireWire IEEE 1394a (400 megabits/s)
Range of integration time	1 ms up to 600 s
Signal output connectors	2x TTL-Out: exposure time, readout time (i.e. for driving external electric shutters), 1x Trigger-In to start an acquisition
Optical interface	C-Mount, max. 5 mm free back focal depth
Max. file size per image	Approx. 78 MB with 4164 x 3100 pixels at 14 bit (monochrom) and 3 x 14 bits (color)
Operating system	Microsoft® Windows 2000 Professional SP4, Microsoft® Windows XP Professional SP2, Microsoft® Windows Vista Ultimate
Housing	Blue anodized aluminum, with cooling fins, 1/4" connection for tripod mount, 11 cm x 8 cm x 6.5 cm, 500 g
Registration	CE, cUL
Power supply	10-33 V, DC, 5W, power supply provided by FireWire bus (external power supply only for Notebook operation required)
Ambient conditions (operation)	+5° ... +35° Celsius, 10% ... 80% relative humidity, no condensation, free air circulation required
Ambient conditions (storage)	-15° ... +60° Celsius, 90% relative humidity at 40° Celsius, 80% relative humidity at +20° Celsius, no condensation
Order number	AxioCam HRm: 426511-9901-000 AxioCam HRC: 426510-9901-000

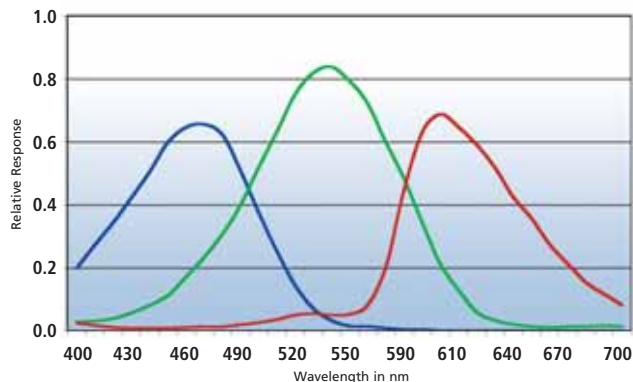
All specifications are subject to change without notice.

* Frame rates depend on exposure time, readout mode and PC hardware

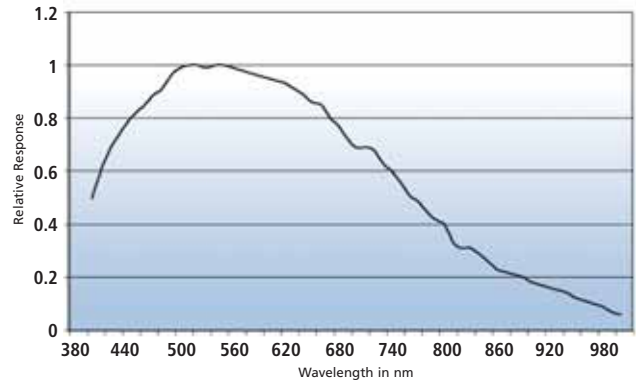
Using Microscanning it is possible to generate high-resolution images by combining several individual images for which the sensor has been shifted by extremely small distances (subpixel dimensions) in each case.

Color co-site Sampling allows optically identical resolution in each of the three RGB color channels. Color interpolation does not take place.

Relative Spectral Sensitivity AxioCam HRC with BG 40 IR-Filter



Relative Spectral Sensitivity AxioCam HRm



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