AxioCam HR
Success Through Performance

The high-resolution camera
for digital documentation
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. With needle-sharp images and brilliant color quality. Not to mention a good name: AxioCam HR – the Zeiss Blue.

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 2200 : 1 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.
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 Axiovert 200 research microscopes and the AxioVision imaging software, you will have a high-performance system with a high degree of automation – for reliable, reproduceable 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.

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 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
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.
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. 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).

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

Color co-site Sampling

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).

Microscanning
AxioCam HR: Data and Facts

Max. camera resolution 4164 x 3120 = 13 megapixels
CCD basic resolution 1388 x 1040 = 1.4 megapixels
Pixel size 6.45 µm (H) x 6.45 µm (V)
Sensor size 8.9 mm x 6.7 mm, equivalent to 2/3" [2]
Spectral sensitivity HRc: approx. 400 up to 700 nm with BG 40 IR blocking filter; Bayer color filter mask
HRm: approx. 300 up to 1000 nm with BK 7 protective cover glass (BG 40 can be inserted)

NIR-Modus (AxioCam HRm) Mode for higher sensitivity in near IR
Dynamic range Typical > 2000 : 1
Full well capacity Typical 17 ke
Readout noise Typical 8 e-
Dark current Typical 3.7 e/pixels
Readout clock speed 10 MHz

Resolutions (B/W and RGB)
<table>
<thead>
<tr>
<th>Horizontal x Vertical</th>
<th>Binning 1</th>
<th>Binning 2</th>
<th>Binning 3</th>
<th>Binning 4</th>
<th>Binning 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>276 x 208</td>
<td>276 x 208</td>
<td>276 x 208</td>
<td>276 x 208</td>
<td>276 x 208</td>
<td></td>
</tr>
<tr>
<td>346 x 260</td>
<td>346 x 260</td>
<td>346 x 260</td>
<td>346 x 260</td>
<td>346 x 260</td>
<td></td>
</tr>
<tr>
<td>462 x 346</td>
<td>462 x 346</td>
<td>462 x 346</td>
<td>462 x 346</td>
<td>462 x 346</td>
<td></td>
</tr>
<tr>
<td>694 x 520</td>
<td>694 x 520</td>
<td>694 x 520</td>
<td>694 x 520</td>
<td>694 x 520</td>
<td></td>
</tr>
<tr>
<td>1388 x 1040</td>
<td>1388 x 1040</td>
<td>1388 x 1040</td>
<td>1388 x 1040</td>
<td>1388 x 1040</td>
<td></td>
</tr>
</tbody>
</table>

Frame rates
<table>
<thead>
<tr>
<th>Frame rate</th>
<th>Binning factor</th>
<th>Horizontal x Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>AxioCam HRc</td>
<td>5 frames/s</td>
<td>1 / slow</td>
</tr>
<tr>
<td>AxioCam HRm</td>
<td>5 frames/s</td>
<td>1 / slow</td>
</tr>
<tr>
<td>AxioCam HRm</td>
<td>11 frames/s</td>
<td>2 / medium</td>
</tr>
<tr>
<td>AxioCam HRm</td>
<td>15 frames/s</td>
<td>3 / fast</td>
</tr>
</tbody>
</table>

Sensor area readout (ROI) Free adjustable
Raw data rate Max. 20 MB/s (appropriate PC main memory capacity required)
Exposure times From 1 ms up to several minutes
Optimum color reproduction 3200 K standard value at color version
Digitization 14 bit / 10 MHz pixel clock
Interface PCI interface board for data and control lines

Housing Aluminum, blue anodized, cooling fins, 11 cm x 8 cm x 6.5 cm, 500 g, 1/4" screw thread in housing
Free back focal depth Max. 5 mm
Protective cover glass BK 7 for HRm, annealed; IR-Filter BG 40 for HRc, annealed respectively
CCD cooling Single stage thermoelectrical cooling (Peltier) for decrease of dark current and thermal decoupling of the sensor, heat dissipation by means of the housing, no fan required

Dark current compensation Adaptive compensation algorithm in camera driver
Max. file size per image Ca. 78 MB at 4164 x 3120 at 3 x 14 bit (color)
Operating system Microsoft® Windows 2000 Professional
Product types Color and monochrome
Certificates CE, cUL
Power supply 12 V DC, 1 A, 230 V / 110 V
Environmental conditions +5° up to +35° Celsius, max. 80% air humidity, non condensing, free air circulation required

Comment: Technical data applies to the AxioCam HR Rev. 2. Above frame rates are supported by the camera electronics at 20 ms exposure time. Computer hardware, operating system and application software may decrease the frame rates.