Optimized Solutions for the Arrangement of Digital Imaging Detectors

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The Hitachi HT7700 120kV TEM is based on a product concept that allows all observation and image recording procedures to be done in daylight with fully digitized image acquisition devices [1]. A wide-angle 1 megapixel camera monitors at 15 fps a fluorescent screen in an observation chamber positioned just below the projector lens. The live images are displayed in a window within Hitachi’s system control GUI. A second window displays the image from the main image recording camera, imaging from a phosphor located in a traditional bottom-mount configuration. This camera can be an 8 megapixel CCD camera, XR81-B, or an optional high-sensitivity 4 megapixel scientific CMOS camera, XR401L-B. The bottom-mount camera is used for image recording and for automation functions [2], such as auto-focusing, stigmation and alignment, drift correction, stage translation and image acquisition for montaging, and sequential specimen tilting and image acquisition for electron tomography. Excellent high contrast at low magnification with a wide field of view (FOV) is also crucial to identify features of interest in correlative light/electron microscopy experiments [3].

AMT’s XR16-DIR (Figure 1) was developed to address specific application fields such as pathology, histology, or anatomy that can require both a wider FOV than provided by conventional bottom-mounted cameras and finer image definition. The XR16-DIR camera exploits a 16M pixel CCD and a custom-made, finite conjugate lens to utilize a 41 by 62 mm\textsuperscript{2} area of the CCD scintillator, which is optimized for high contrast observation at 80kV. Figure 2 depicts the camera layout on the TEM column. To ensure a wider FOV, the XR16-DIR is mounted directly under the HT7700 viewing chamber, “Flange (1)” as shown in Figure 2. Calculated practical image magnifications for the camera are about 60\% of nominal magnifications displayed on the HT7700 monitor. The estimated image size of the XR16-DIR camera for the HT7700 at 500 times nominal magnification is about 140 \times 210 \mu m on the specimen. It is almost 3 x 3 times wider than the area taken with a standard XR81-B camera single frame image and equivalent to the FOV of a 3½ x 4” sheet of photographic film. Due to the larger number of pixels, the frame rate without binning is slower than that of the XR81-B. Thus auto focusing must be done with binned sub-areas. Such operational conditions are necessary to obtain higher quality images with a reduced noise component. Finally, in addition to a greatly expanded FOV, viewers experience brighter images for a given set of column conditions. Usability improves for application fields such as renal pathology, as exemplified in Figure 3.

References:

Figure 1. XR16-DIR camera configured to mount to the HT7700 column at Flange (1).

AMT XR16-DIR Specification

Number of pixels……………..3,248 × 4,864 pixels
Frame rate…………………8 frame/s (4×4 binning)
FOV range………………..41.44 × 62.06 mm (on scintillator)
Pixel size on CCD……………….7.4 × 7.4 µm
Pixel size on specimen at 10 k×…2.111 ×2.111 nm
(Estimated, 1.083 × 1.083 nm if camera is XR81-B)
Coupling………………………….Optical lens
Scintillator………………….Phosphor optimized for 80 kV

Figure 2. A FOV comparison of XR16-DIR and XR81-B cameras at different column positions.

Figure 3. a) Characteristic ultrastructural features of Lupus nephritis including subendothelial deposits and tuboreticular inclusions were imaged on the HT7700 by means of the XR16-DIR camera, b) a sub-area of (a) enlarged 4 times. Main specifications for the XR16-DIR camera are included above.