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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^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 x 210 μm 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 3¼ 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:

[1] H. Tanaka *et al*., Proc. 67th Annual Meeting of the Japanese Society of Microscopy, 16Apm_I1-3 (2011) p.8
[2] T. Hashimoto *et al*., Proceedings M&M2012, Phoenix (2012) p. 1280.
[3] W.G. Janssen, H.H. Hanson and B.L. Armbruster, Proceedings M&M2014, Hartford (2014) p. 1104.

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

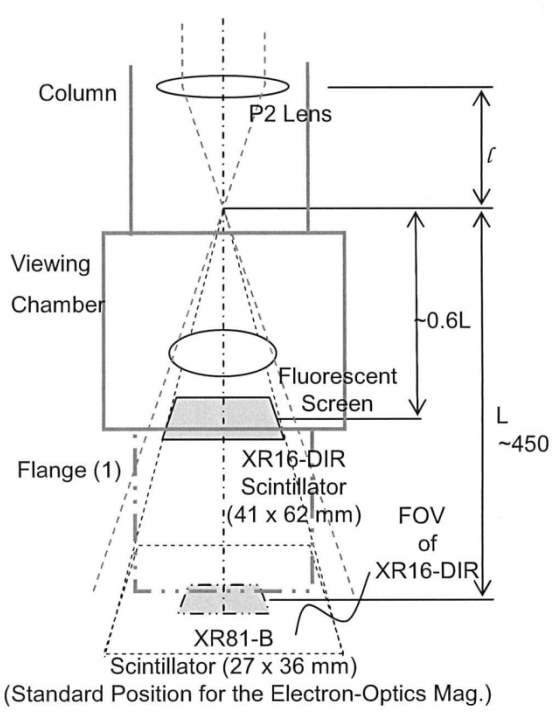
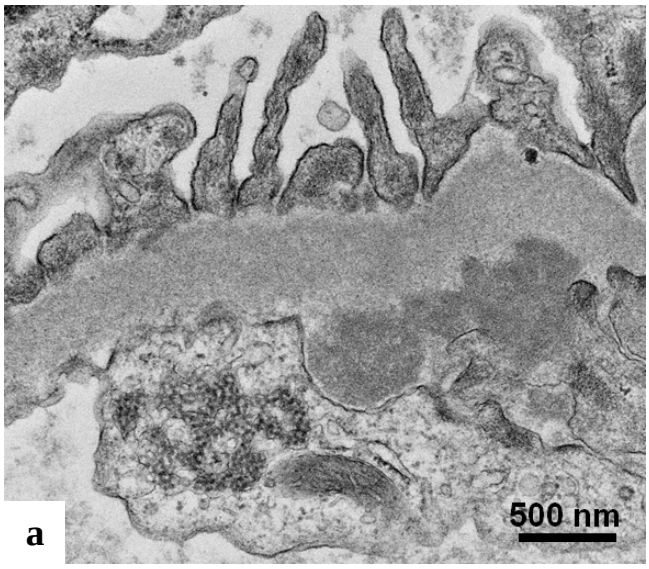


Figure 2. A FOV comparison of XR16-DIR and XR81-B cameras at different column positions.



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

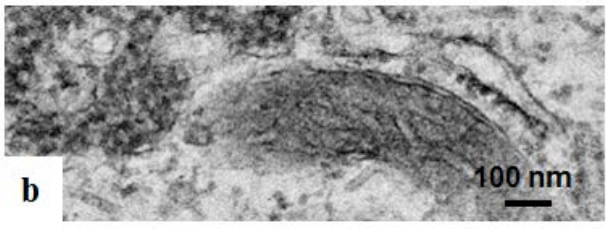


Figure 3. a) Characteristic ultrastructural features of Lupus nephritis including subendothelial deposits and tuboreticular inclusions were imaged on the HT7700 by means of the XR16-DIR camera, b) a sub-area of (a) enlarged 4 times. Main specifications for the XR16-DIR camera are included above.