

## 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, stigmatism 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].

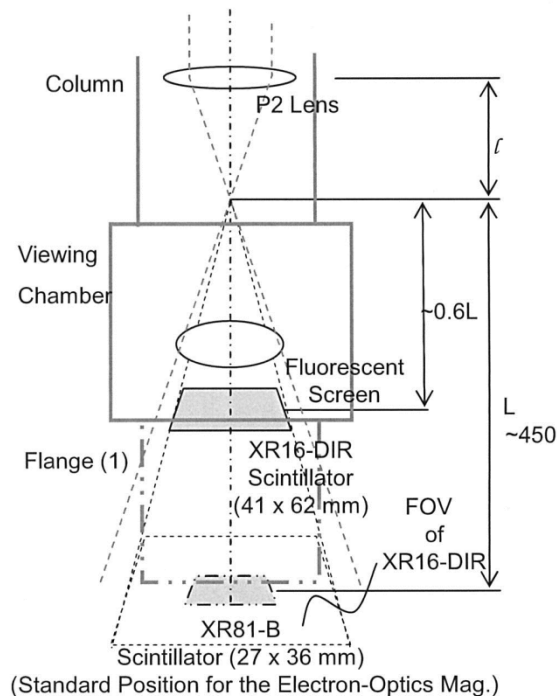
AMT's XR16-DIR (Figure 1) was developed to address specific application fields such as pathology, histology, or anatomy that can require both a wider FOV than provided by conventional bottom-mounted cameras and finer image definition. The XR16-DIR camera exploits a 16M pixel CCD and a custom-made, finite conjugate lens to utilize a 41 by 62 mm<sup>2</sup> 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:

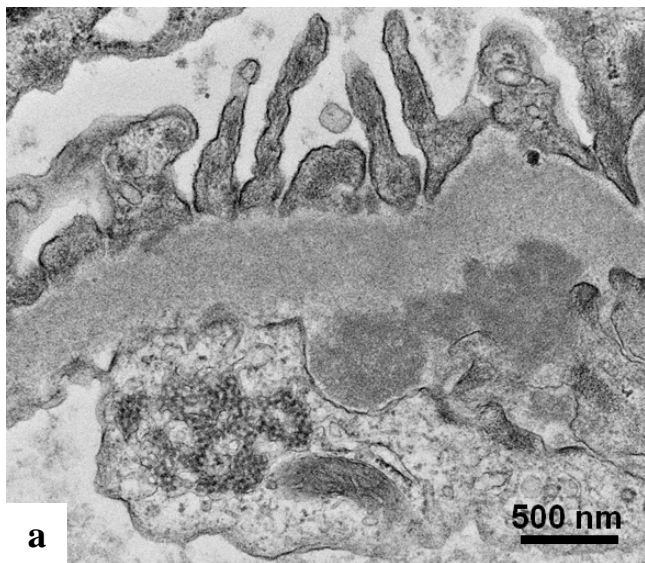
- [1] H. Tanaka *et al.*, Proc. 67<sup>th</sup> Annual Meeting of the Japanese Society of Microscopy, 16Apm\_I1-3 (2011) p.8
- [2] T. Hashimoto *et al.*, Proceedings M&M2012, Phoenix (2012) p. 1280.
- [3] W.G. Janssen, H.H. Hanson and B.L. Armbruster, Proceedings M&M2014, Hartford (2014) p. 1104.



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

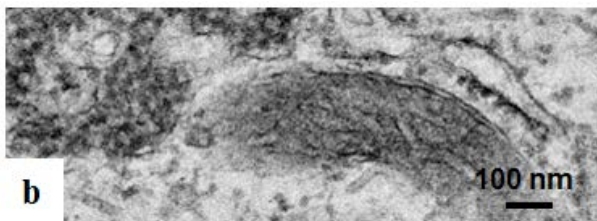


**Figure 2.** A FOV comparison of XR16-DIR and XR81-B cameras at different column positions.



**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.