

Biomicroscopy I - Exercise Sheet 13

December 16, 2025

1 Detectors

- A. **Nyquist criterion.** According to the Nyquist sampling theorem preservation of the spatial resolution of the optics requires that the magnified air disk radius should be covered by a minimum of 2 adjacent pixels on the CCD. Define the maximum size of the CCD pixel size required for fulfilling this condition in case you are using water ($n = 1.33$) immersion objective with $NA = 1.2$, magnification M 100x and illumination wavelength $\lambda = 550$ nm.

What is the maximum allowed spatial frequency B in μm^{-1} contained in the upcoming image so that it could be reconstructed perfectly with calculated pixel size?

- B. **Collection yield.** The optical system consists of the objective, lenses, and filters resulting in total transmission efficiency $T_{\text{optics}} = 30\%$ for the emission signal. Sony ICX205AL is utilized as the detector at the system output (see Fig. 1 for quantum efficiency). The numerical aperture of the utilized oil immersion ($n = 1.51$) objective is $NA = 1.3$. Considering that one excites the fluorophore with radiation at $\lambda_{\text{exc}} = 400$ nm and collects fluorescence signal from this fluorophore emitting light isotropically at the wavelength $\lambda = 450$ nm, calculate the total collection yield for such a system.

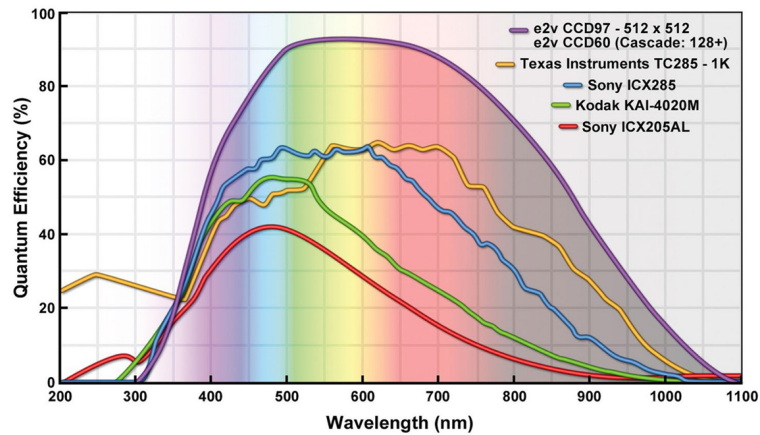


Figure 1: Quantum efficiency of different detectors as a function of wavelength