

# Microscopy Effects on Images

## Detectors:

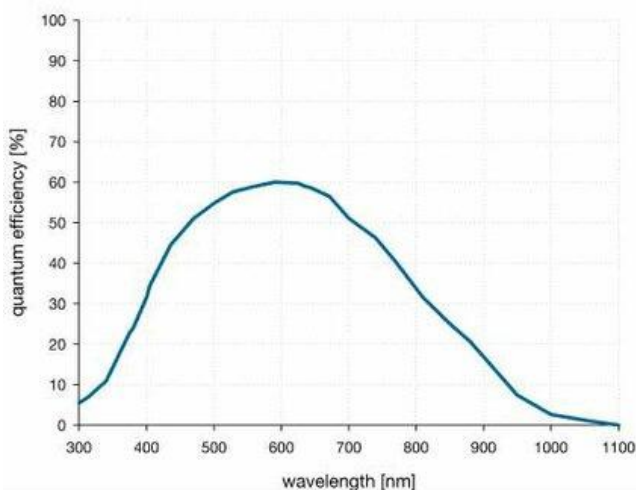
### Array Detectors

## Cameras, CCD's EMCCD's Back thinned CCD's, CMOS, sCMOS

These detectors measure photons and produce electrons in each pixel. The pixels are then readout as a serial list of values representing the photon intensity at each location.

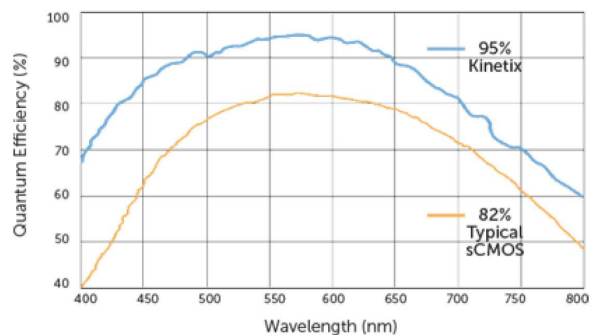
### Quantum Efficiency

The quantum efficiency is a ratio between the number of photons hitting a pixel to the number of electrons in the well



PCO edge 5.5 sCMOS

IXon CCD



Kinetix sCMOS

## Noise

- **Read Noise:**
- Errors in reading elections in wells. Read noise is independent of ingratiation time and effects low light level imaging.
- **Shot noise:**
- statistical differences in the number of photons hitting the pixel
- **Dark noise:**
- Is the accumulation of electrons when no photons are hitting the pixel
- **Hot Pixels/ Dead Pixels:**
- Pixels with Higher or lower dark noise

## Pixel Size

Use magnification and Nyquist theorem

### Point Detectors

## PMT's APD's

## Quantum Efficiency

## Noise

## other Info

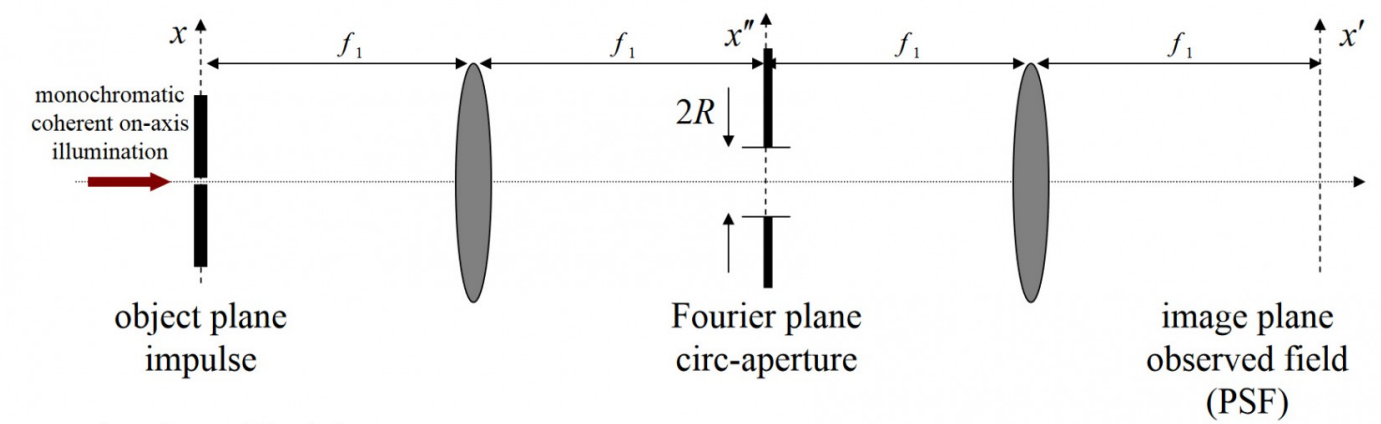
## more stuff

## even more stuff

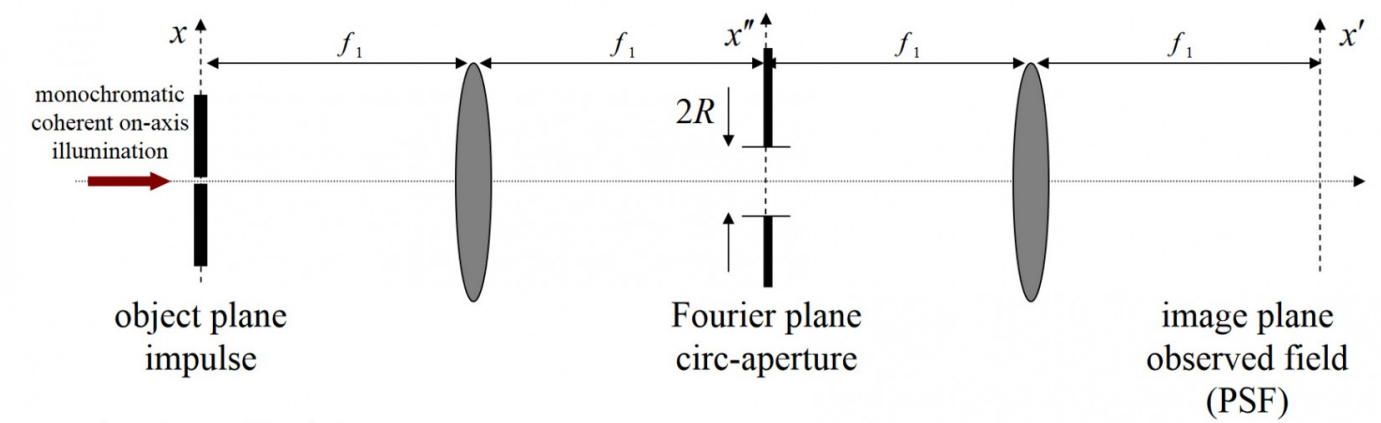
**Point Spread Function**

A microscope is a 4f system as shown

**PSF vs NA**



**PSF vs NA**



The objective is the first lens and col

**Objectives**

<https://www.microscopyu.com/digital-imaging/introduction-to-charge-coupled-devices-ccds>

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