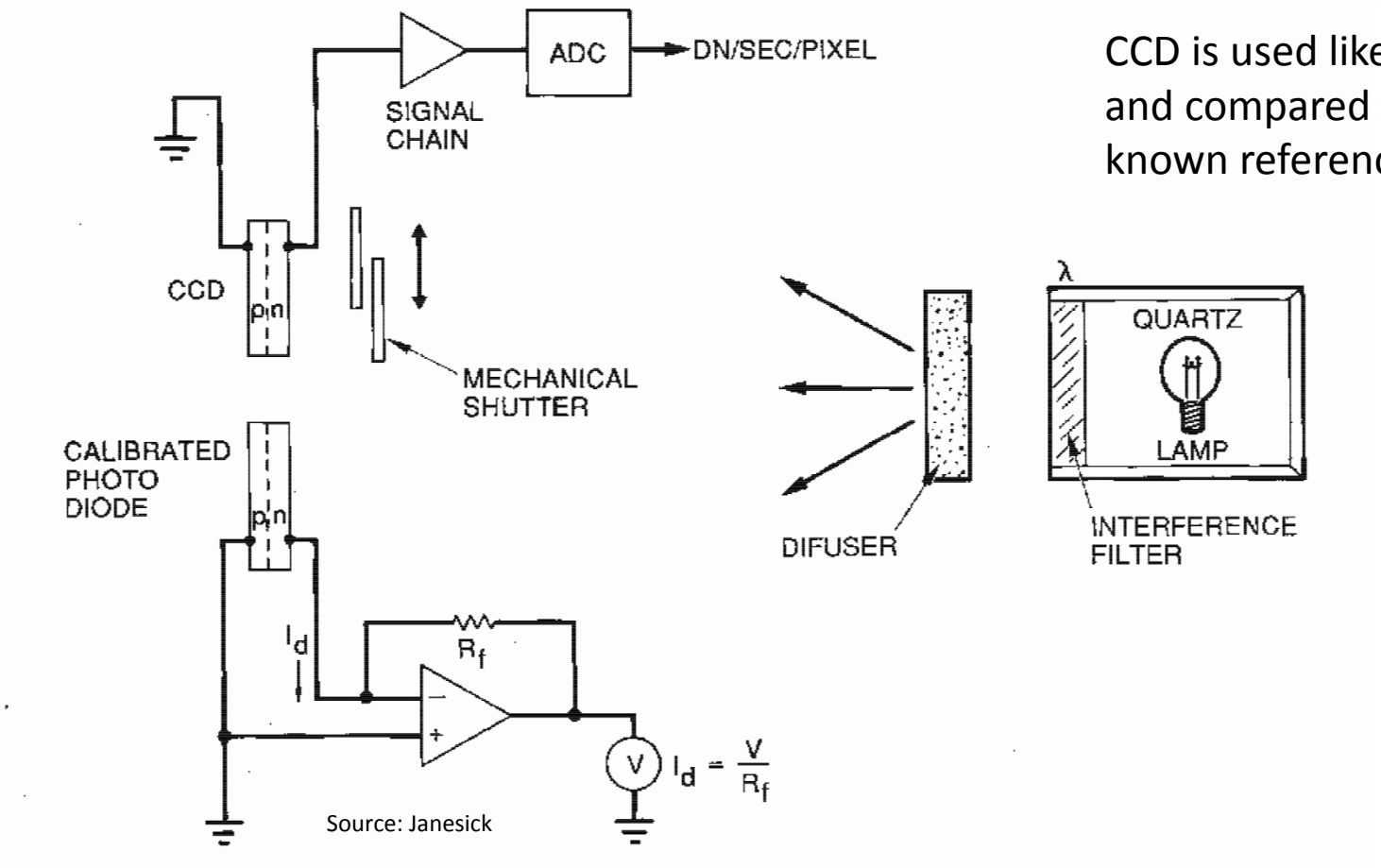
QE, MTF and Backside Illumination

QE Measurement



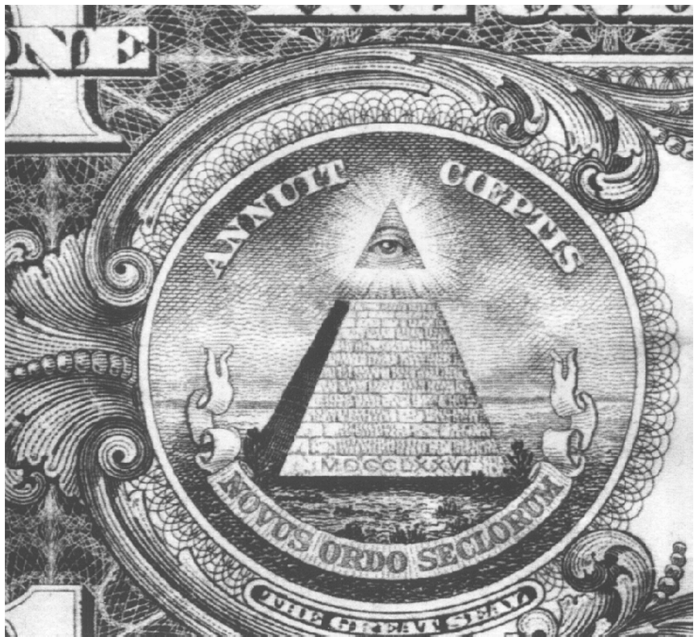
Source: Janesick

CCD is used like a “solar cell” and compared against a known reference diode

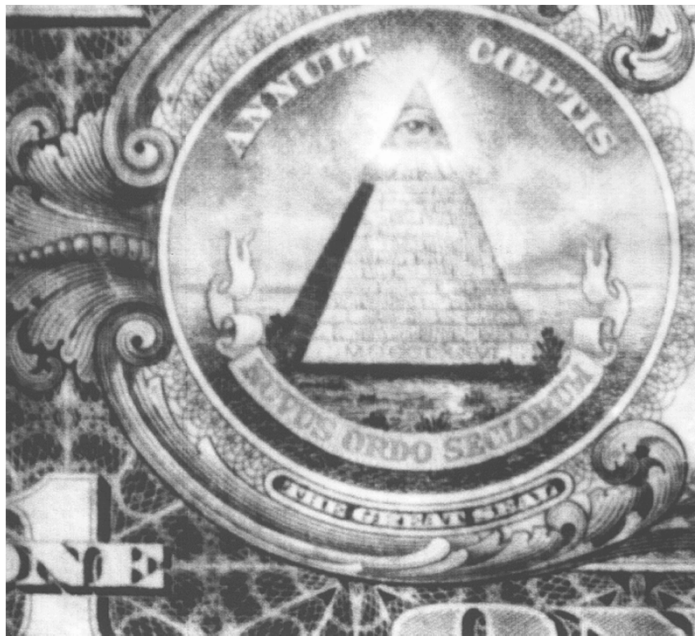
QE doesn’t tell the whole story

- The entire CCD is used as a single light collector for measuring QE
- If the photoelectrons are collected in the wrong pixels, it makes no difference in the QE value measured
- This can happen when NIR light is used for a CCD

Diffusion MTF/Crosstalk



Source: Janesick

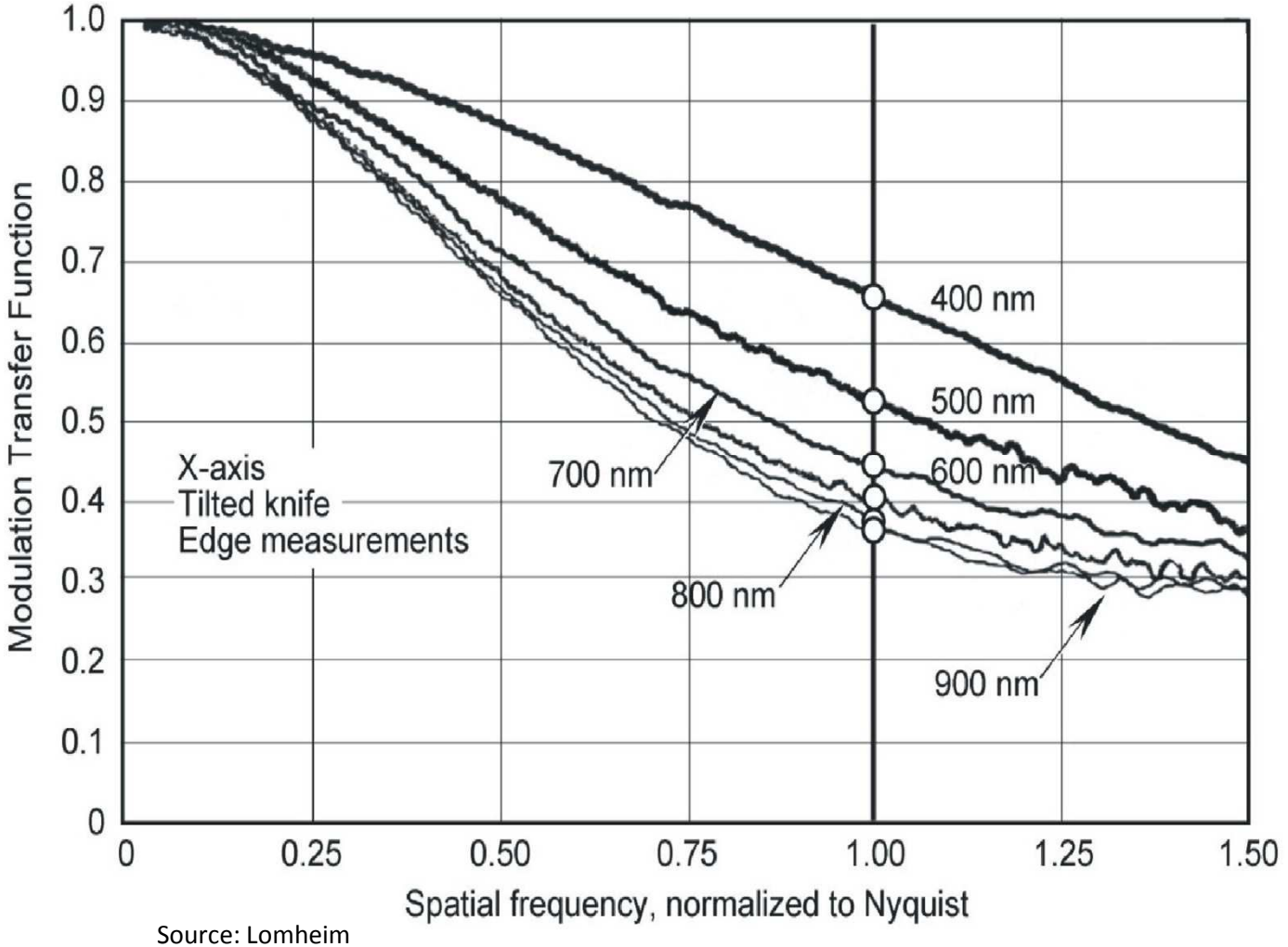


400nm light

900nm light

Longer wavelength light penetrates deeper before liberating photoelectrons / holes
If interaction happens outside potential well, then some charge will be captured by the wrong pixel.
CCDs needed for NIR imaging need careful design / fab process optimization to have good MTF.

MTF vs Wavelength



Source: Lomheim

Very poor response for NIR wavelengths (>700nm)

At 400nm 65% of charge ends up in correct pixel at Nyquist sampling

At 700nm only 40% does and at 900nm only 35% does

NIR images taken with this sensor will have fine detail smeared

Imaging at NIR wavelengths

- Kodak KAF series sensors have degraded MTF at NIR wavelengths
- Even with all-reflective optics (no chromatic aberration), poor sharpness results due to sensor Diffusion MTF/Crosstalk unless sensors *specifically* designed to work at NIR
- QE is only part of the story, MTF is the big issue for NIR
- Sensors designed for NIR imaging use specialized wafer fab processes and may include high substrate bias voltages to ensure good MTF (to prevent photoelectrons from forming outside of pixel potential wells)