



University of Antwerp
| EMAT | Electron Microscopy
for Materials Science



Practical: Electron Detection

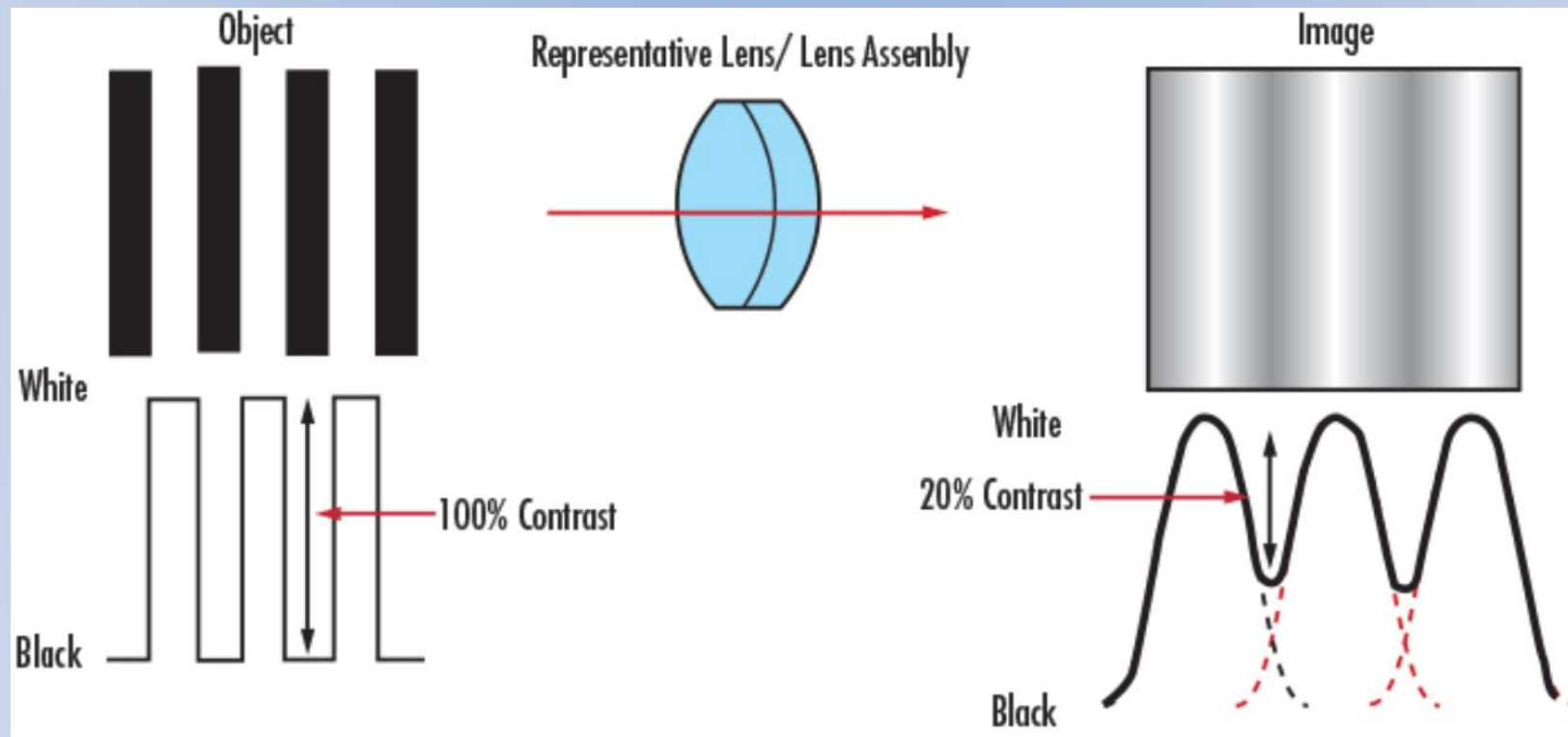
Armand Béché

13-14th May 2025

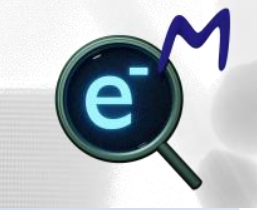
MTF - Definition



- The MTF (Modulation Transfer Function) describes how an object is imaged by an optic system.
➡ How properly high frequencies are sampled by the sensor

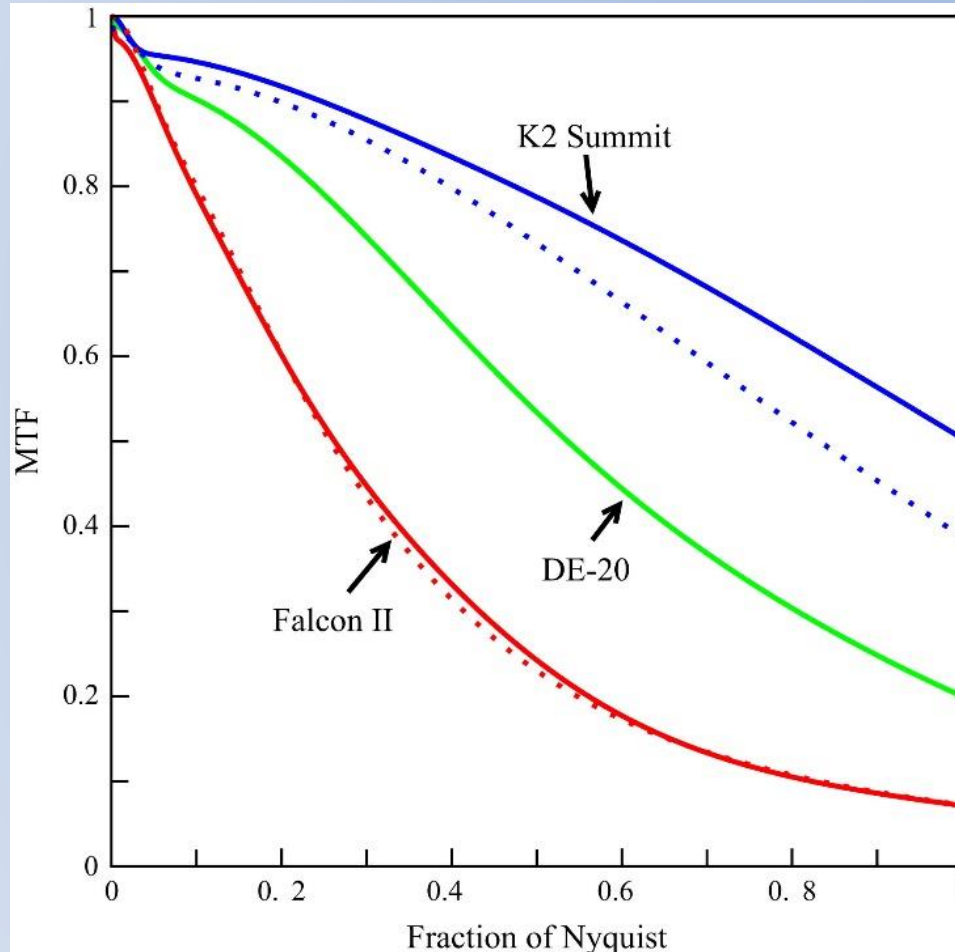


<https://www.edmundoptics.eu/knowledge-center/application-notes/optics/introduction-to-modulation-transfer-function/>



MTF – Typical shape

- Typical MTF of direct electron detector



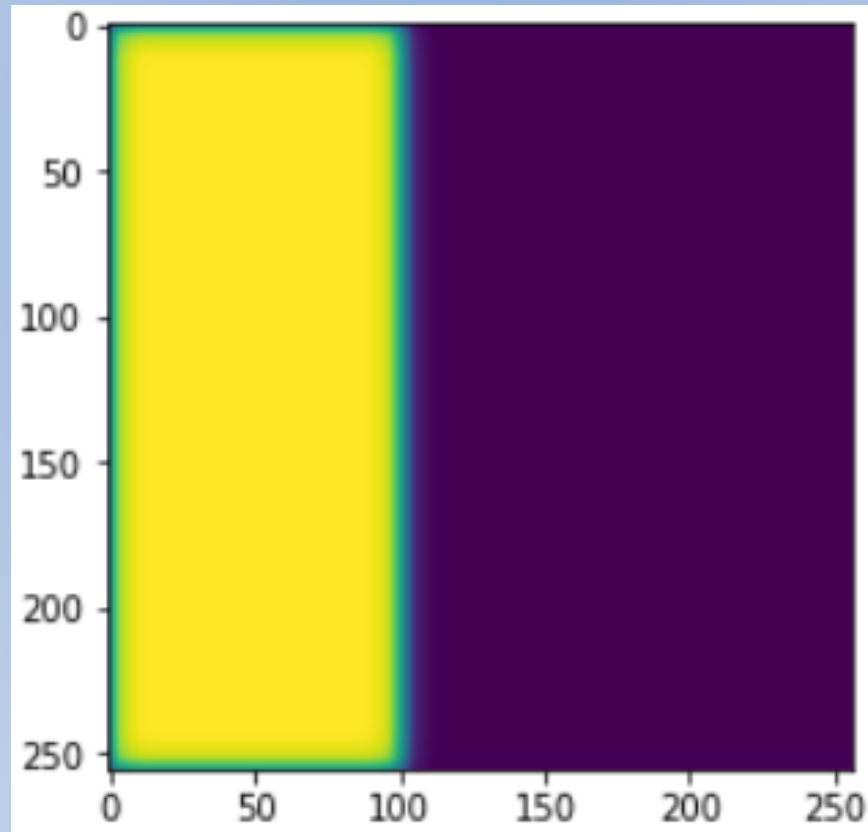
Nyquist frequency corresponds to the highest frequency in a line of pixel

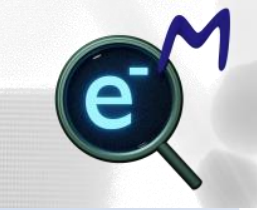
→ Period of 2 pixels



MTF Calculation – Sharp edge image

- Experimental image with sharp edge features
➡ Visualization of blurring from the detector only





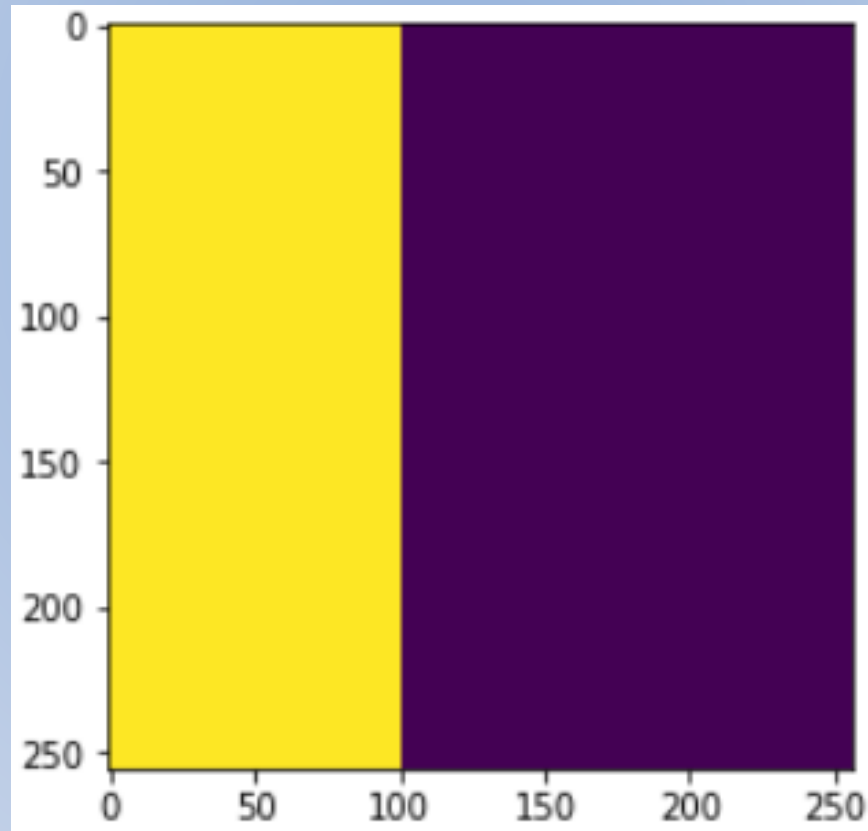
MTF Calculation – Measure of the PSF

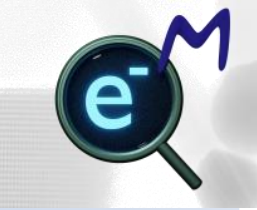
- Point Spread Function (PSF) = how a point appears on the detector
- Several possibilities:
 - Averaging of the experimental sharp edge image
 ➡ Requires a knife edge sample
 - Fitting the experimental sharp edge image with an ad-hoc model
 ➡ Sum of Gaussians (good for CCD's)
 3x3, 5x5... Kernel (better for DED)



MTF Calculation – Sharp edge image

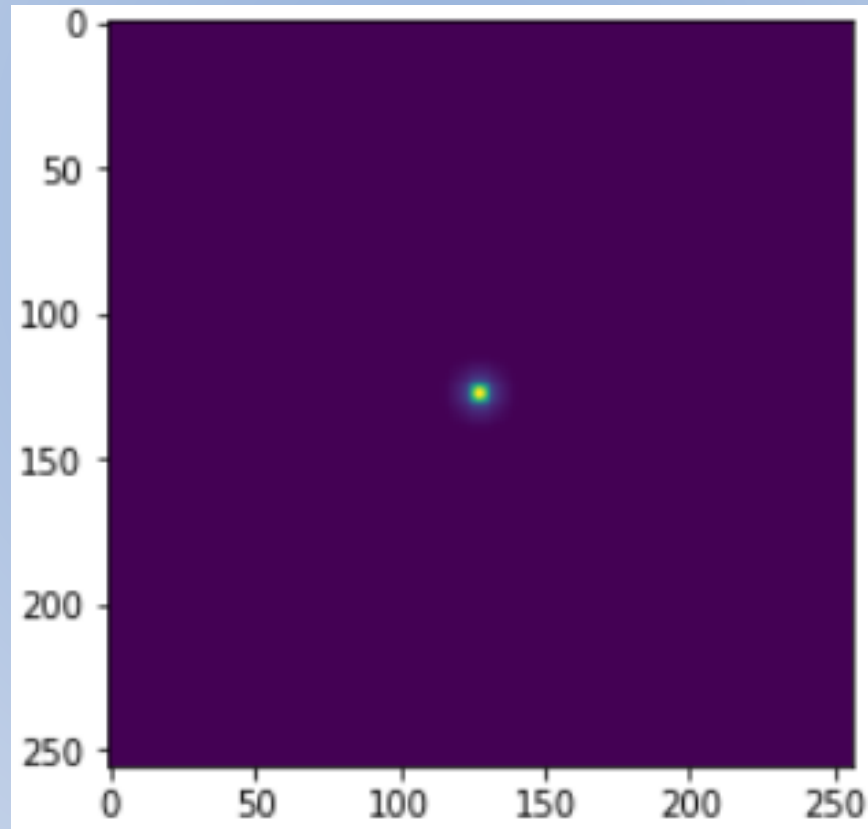
- Fitting:
 - Thresholding of original image to assess the object shape without effect from the detector

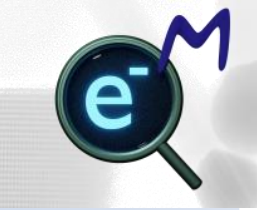




MTF Calculation – PSF model

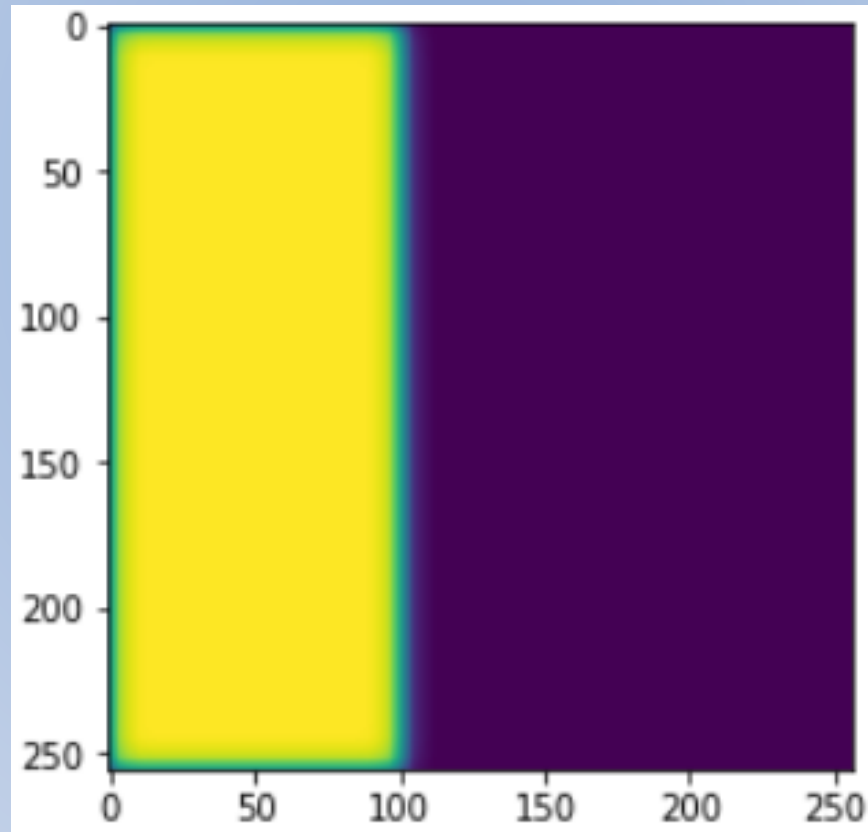
- Fitting:
 - Creation of a parametric model for the PSF

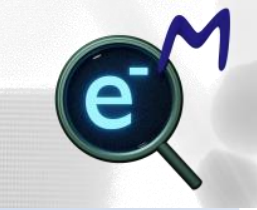




MTF Calculation – Fitting

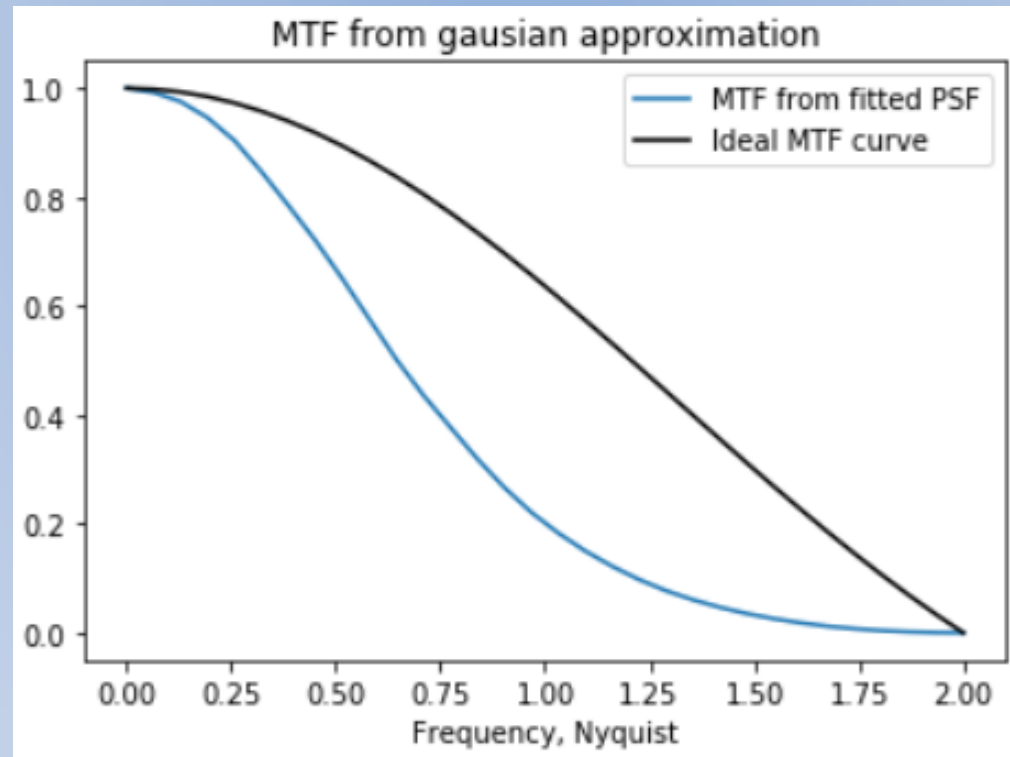
- Fitting:
 - Iterative fitting procedure to find the best parameters for the model which fits the experimental sharp edge image

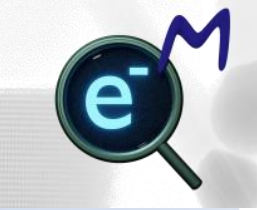




MTF Calculation – MTF

- Rotational average of the PSF and FFT
- Issue with pixelated information: multiplication by a sinc function as it corresponds to the FFT of a top hat function (pixel shape)
- MTF:





MTF Calculation –Script

- File folder: \\Goinfre\Practical Camera
- Script folder: documents\Python script