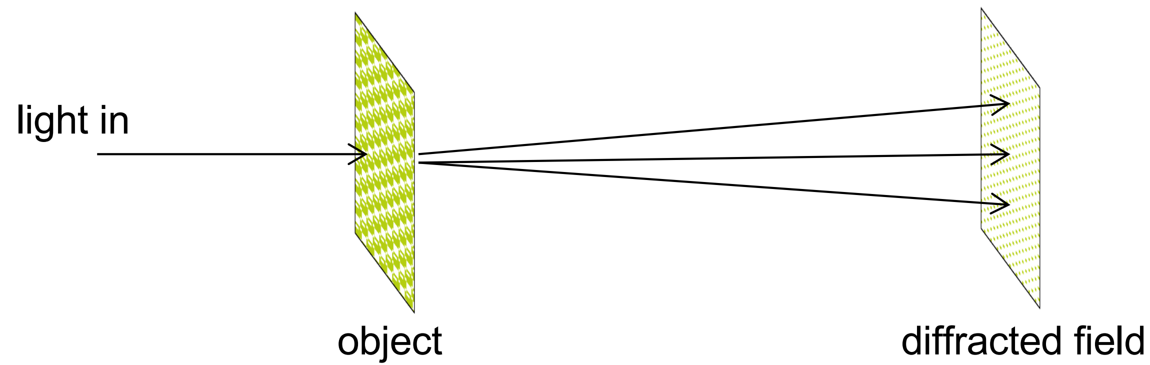
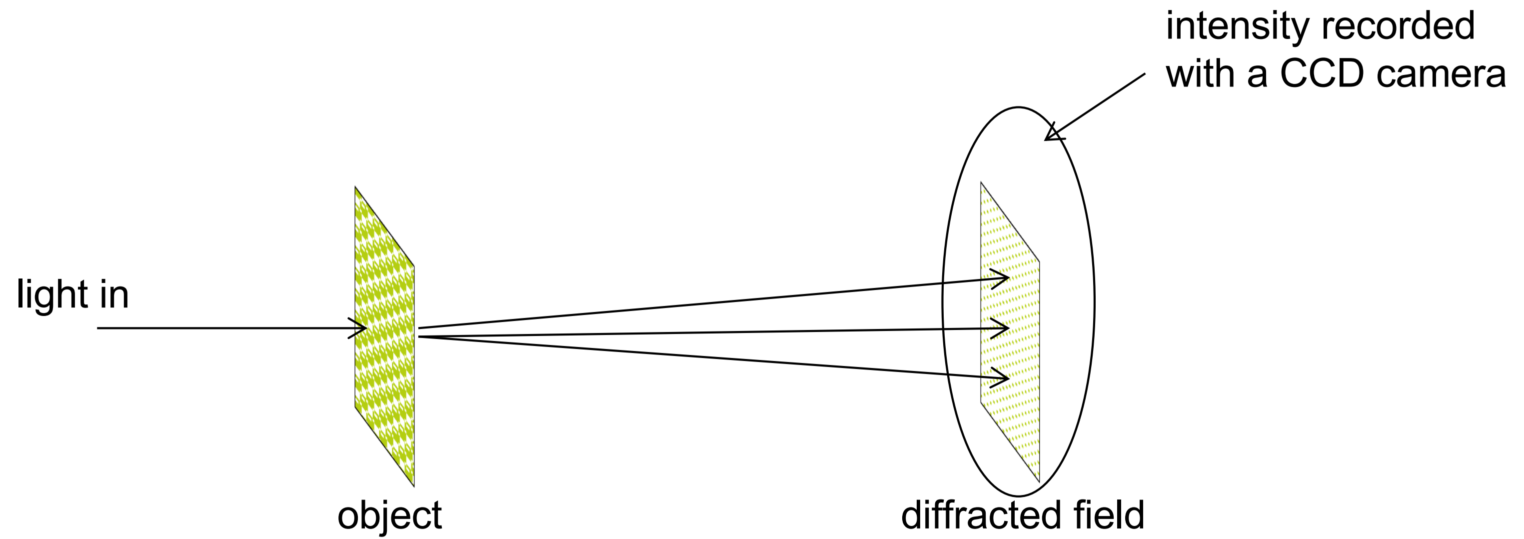
Applications

Silvania Pereira

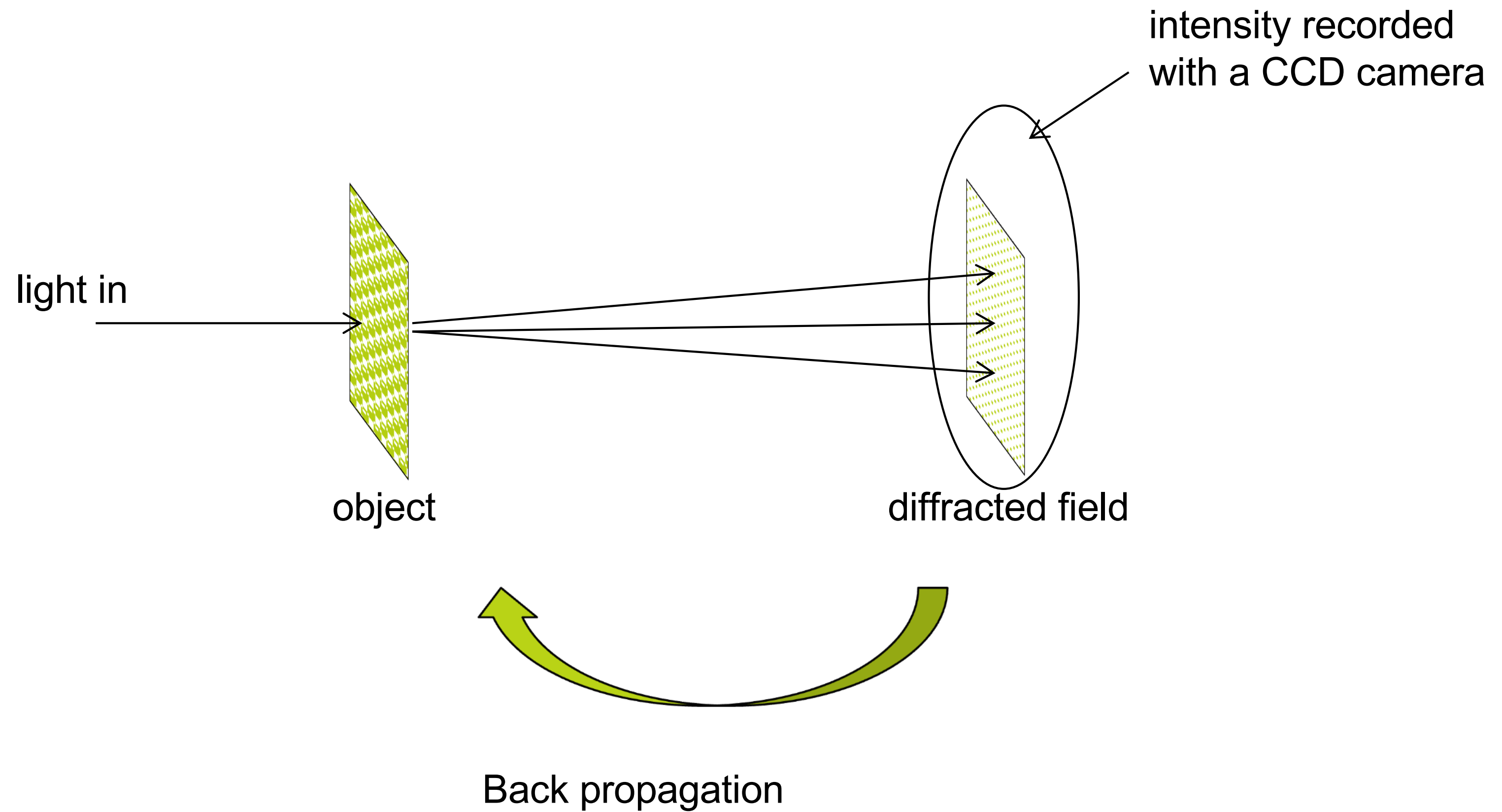
Lensless imaging



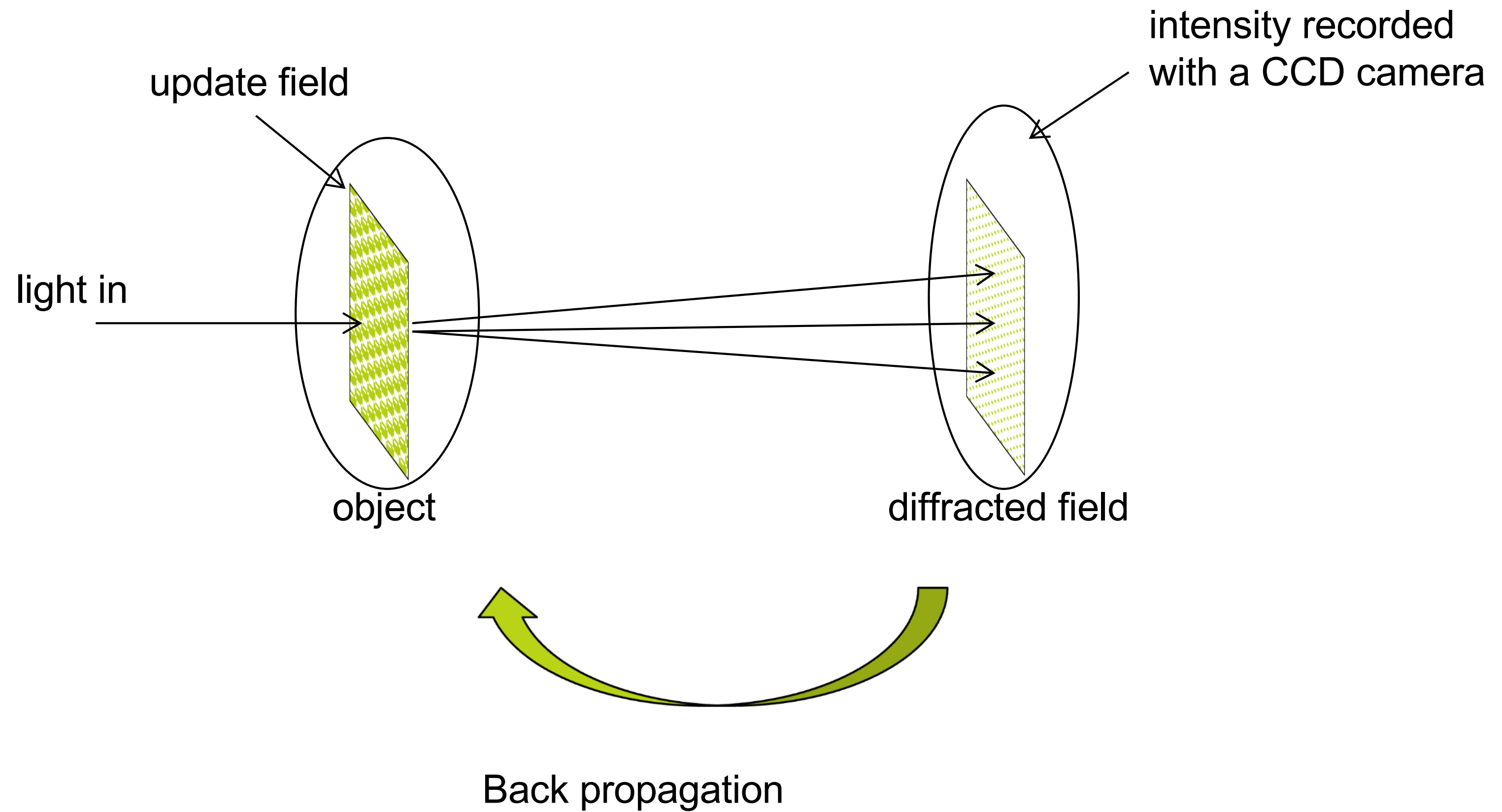
Lensless imaging



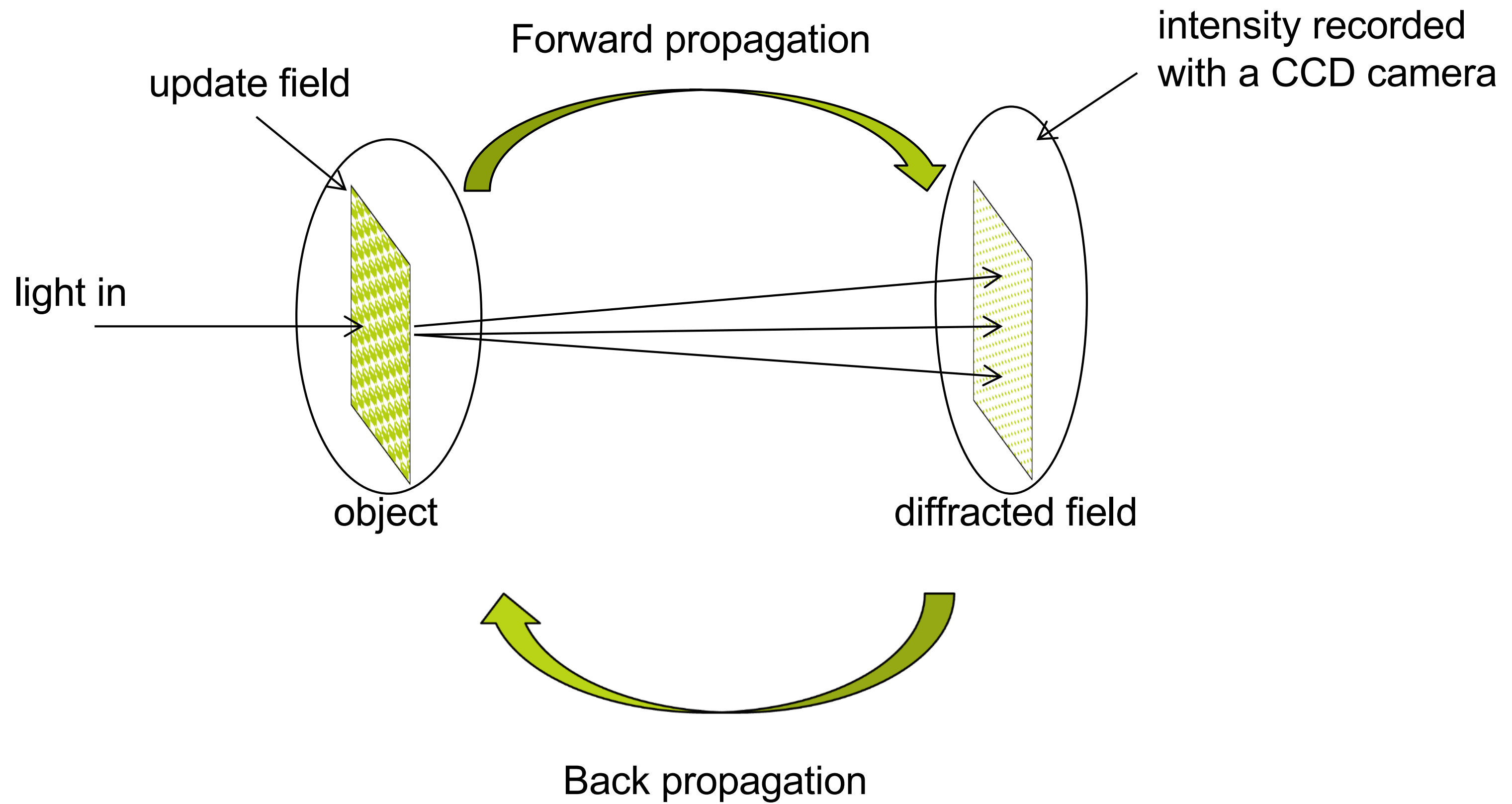
Lensless imaging



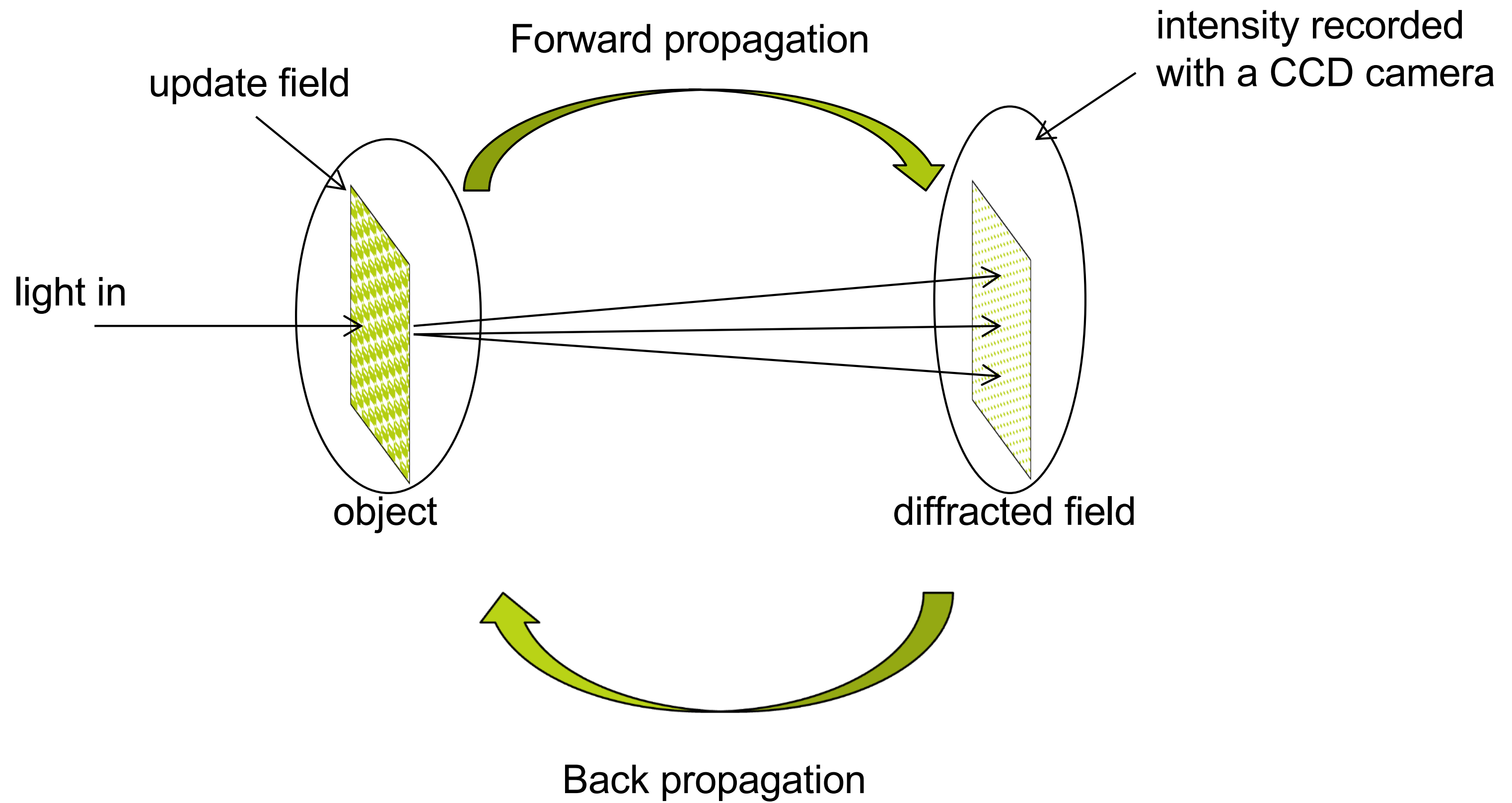
Lensless imaging



Lensless imaging

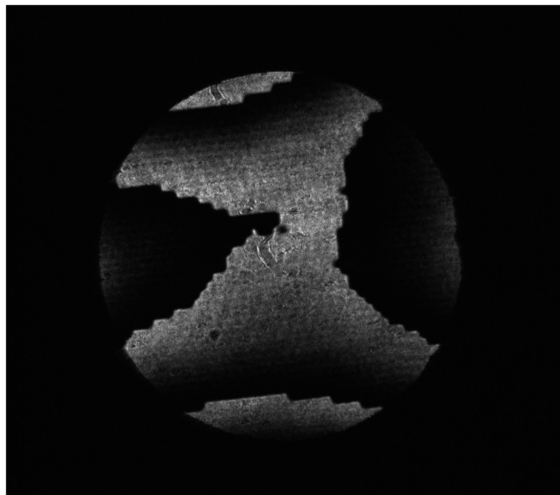


Lensless imaging

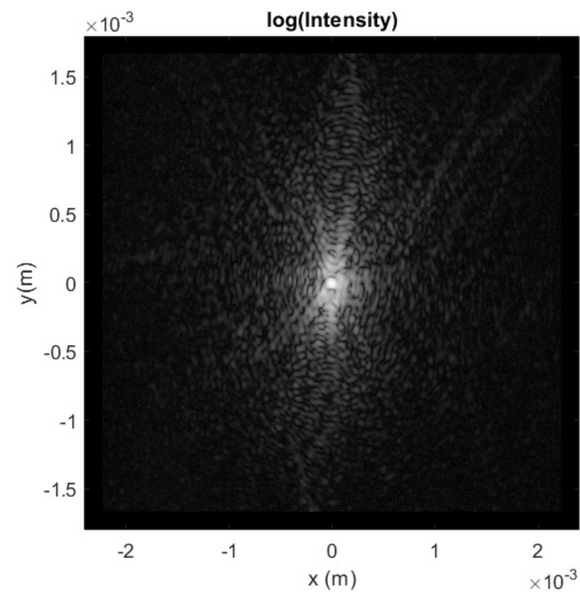


Object reconstruction

Photo of the object



Diffracted field



Reconstructed object

Optical metrology for surface inspection

- Contamination control
- Quality control of printed structures
- Application: inspection of gratings printed on wafers for chip fabrication -> smartphones, computers, ..

In collaboration with ASML

Optical metrology for surface inspection

- Contamination control
- Quality control of printed structures

Why do we use light？

Fast

Noninvasive

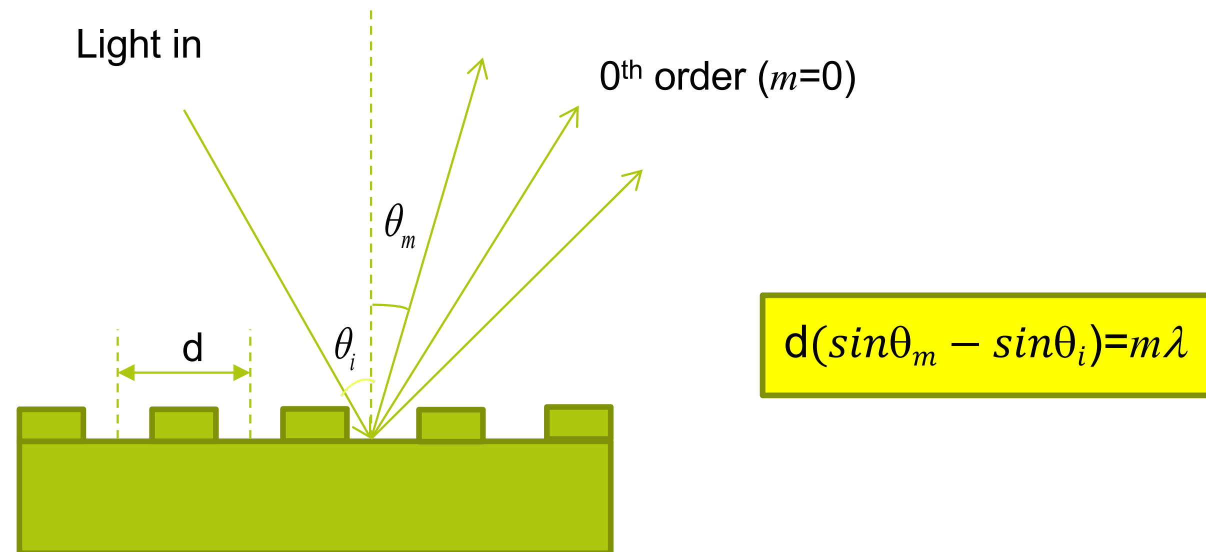
In-situ measurements

required accuracy << wavelength

required accuracy << wavelength

“imaging” is not possible

Quality control of printed structures: diffraction gratings



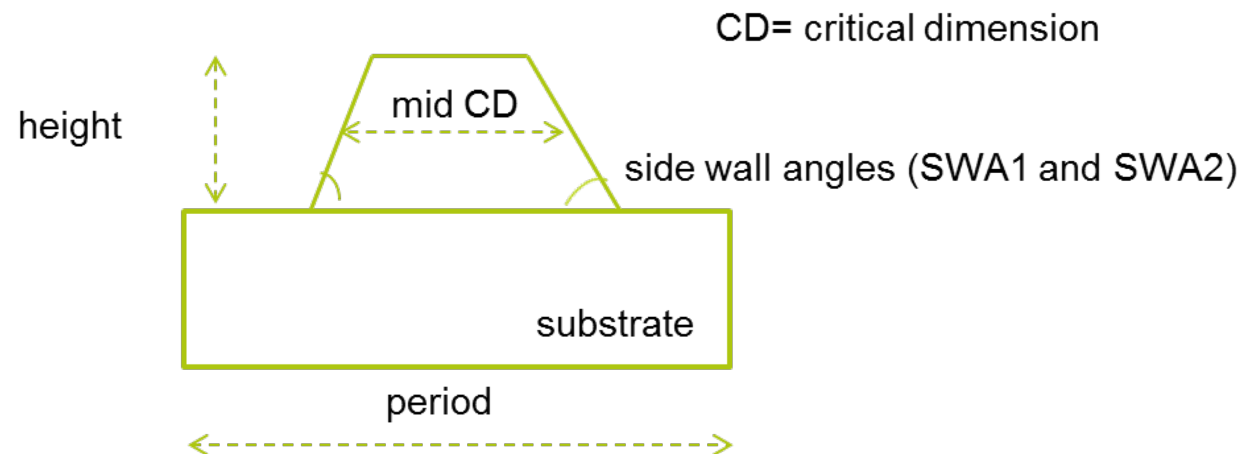
Example: grating under laser illumination: wavelength of the grating << period

Scatterometry on periodic gratings

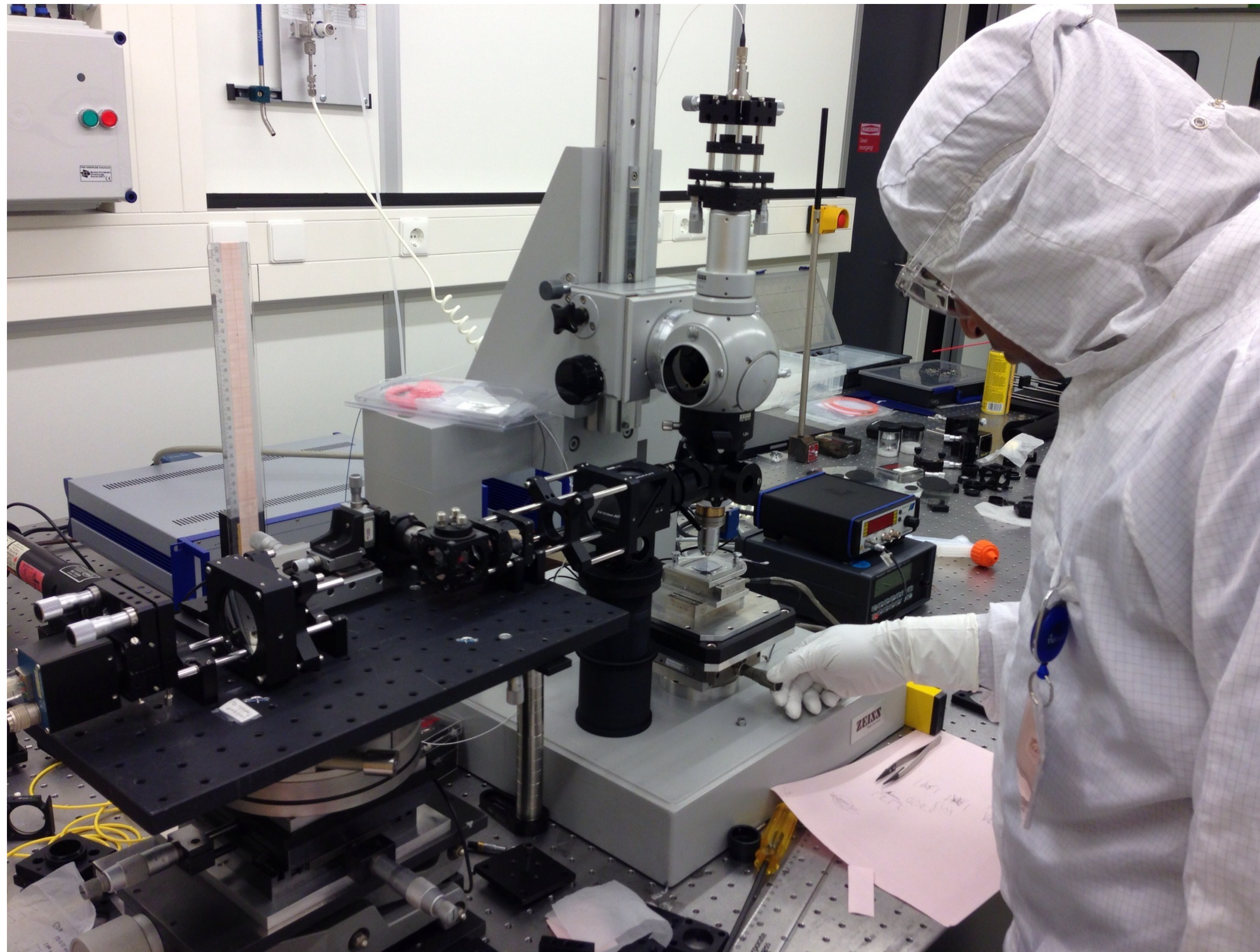
- Reflected signal depends on the incident light properties and physical properties of the grating (structure)
- Light properties: wavelength, angle of incidence, polarisation
- Physical properties of the grating: geometry of the grating (period, height, side wall angle), material

Test gratings

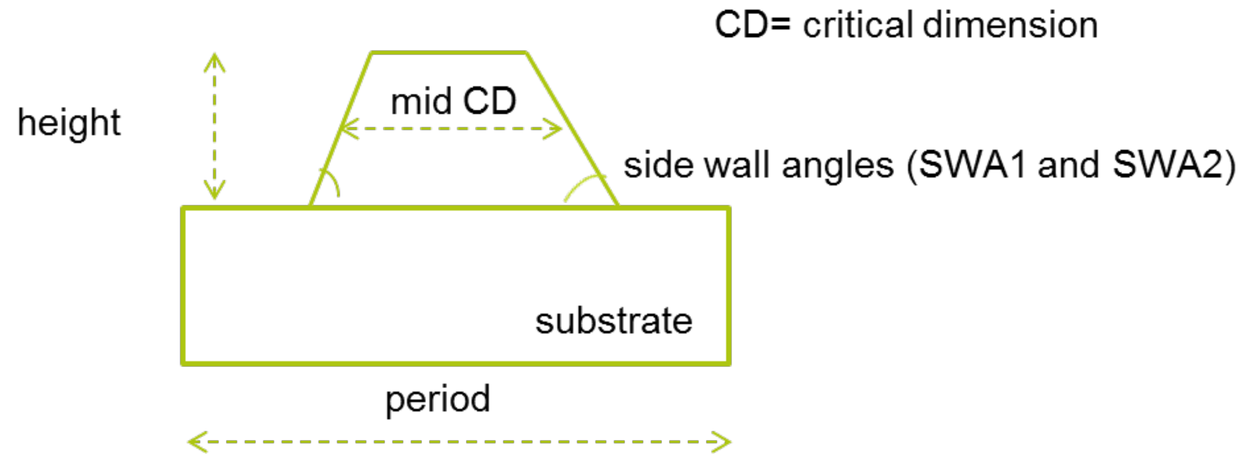
Parameters of the grating:



Coherent Fourier scatterometry: experiment



Grating reconstruction

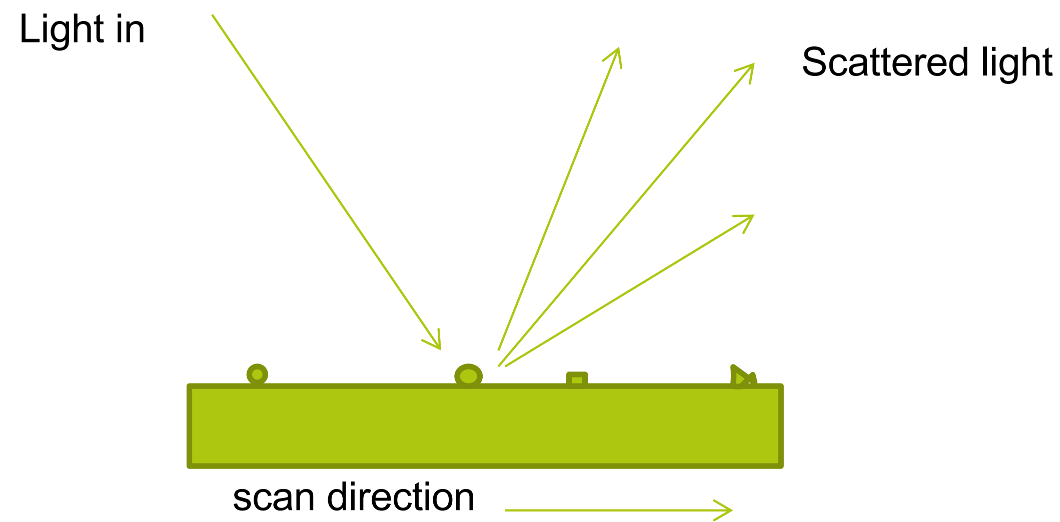


Reconstructed parameters

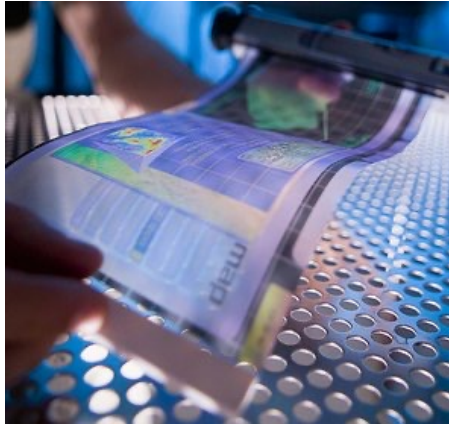
Parameters	CFS	SEM	AFM
MidCD (nm)	563±2	562±4	–
Height (nm)	116±1	–	116±3
SWA(°)	89±3	–	–
Bias (nm)	1190±1	–	–

N. Kumar *et al, Opt. Exp.* **20**, pp 24678-24688 (2014)

Contamination control : scatterometry for non-periodic, isolated structures



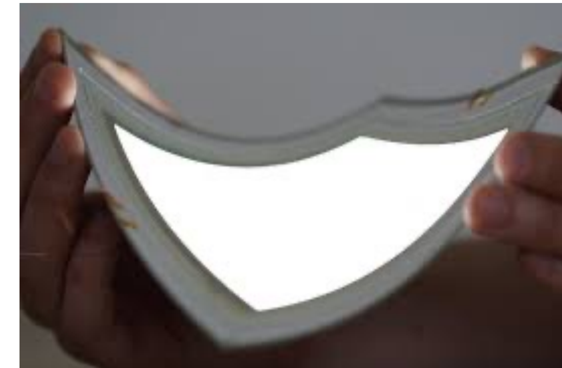
Applications: lithography on wafers and plastic substrates



Plastic electronics

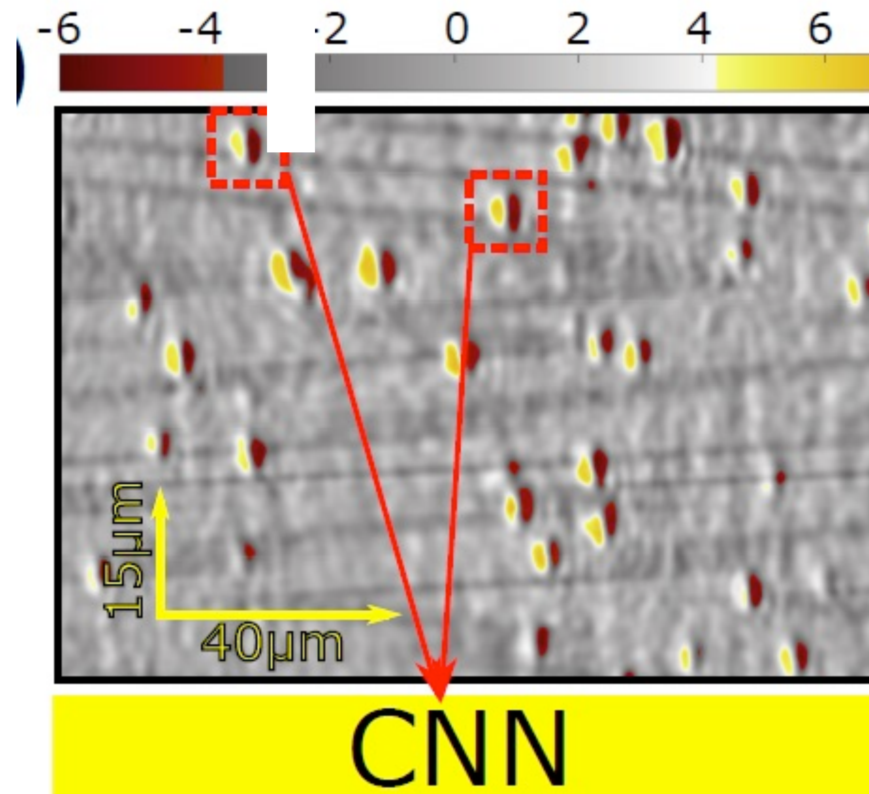
Plastic solar panels

Silicon wafers



Plastic-based OLEDs

Example of detected polystyrene particles on silicon wafer with diameters = 40,50,60 nm

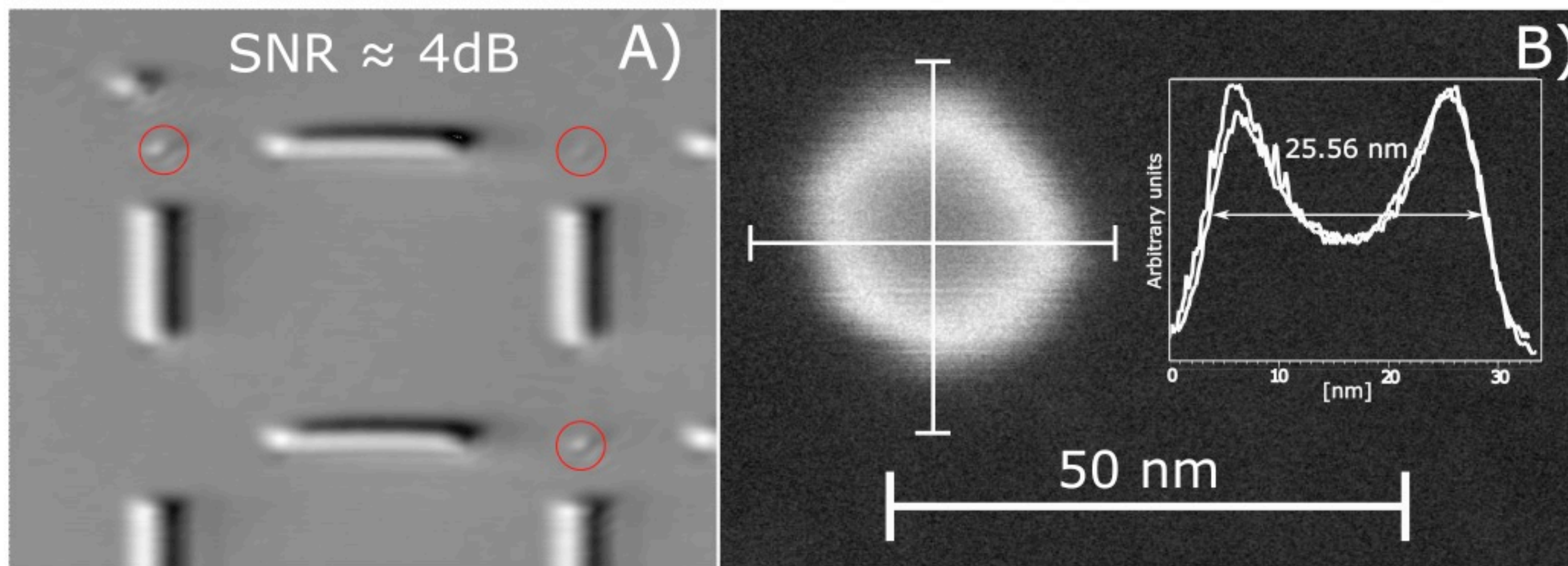


Wavelength 400 nm

Kolenov et al., Appl. Opt. 59 (2020)

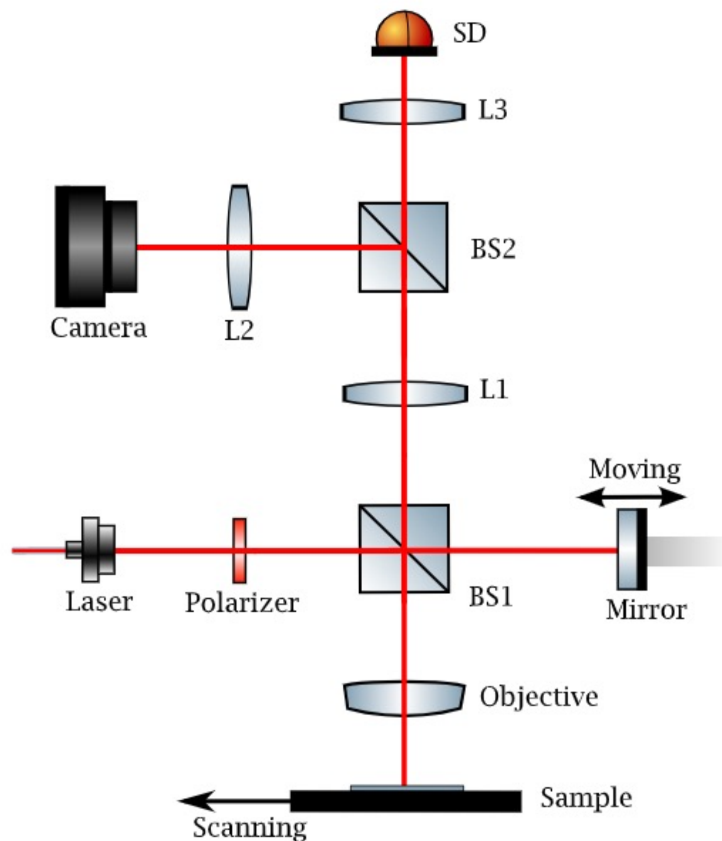
Detection of smaller particles

~25x25x25 nm photoresist cubes fabricated with e-beam on silicon wafer:

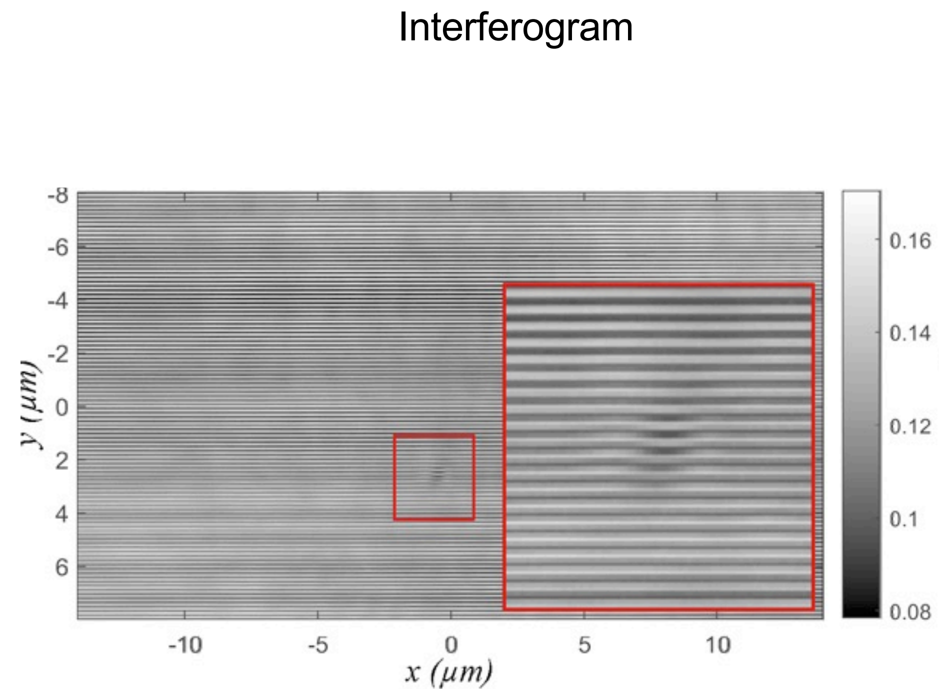


D. Kolenov et al., Opt. Express 29, 16487 (2021)

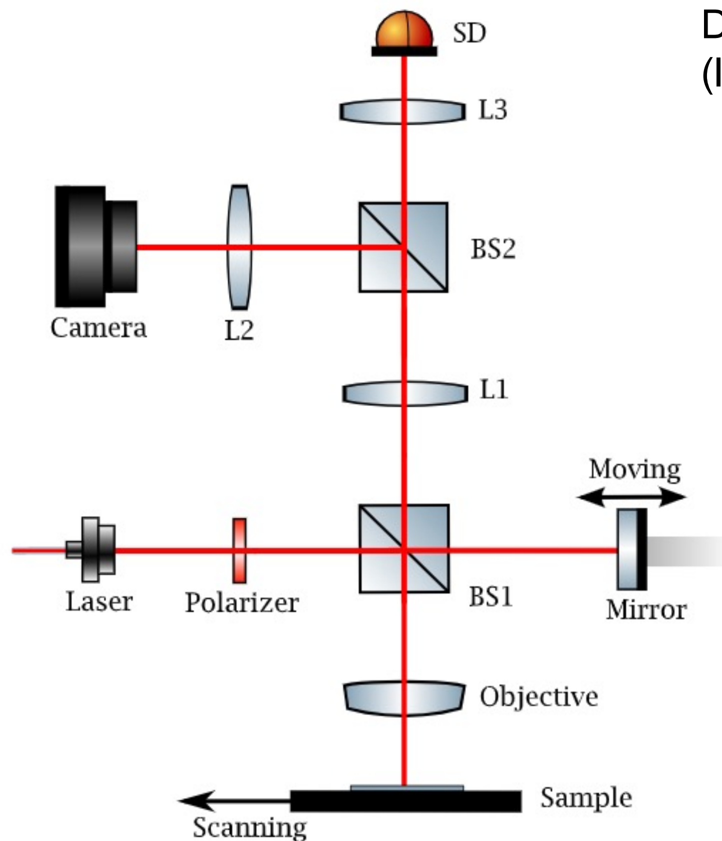
Explore the phase information: synthetic holography



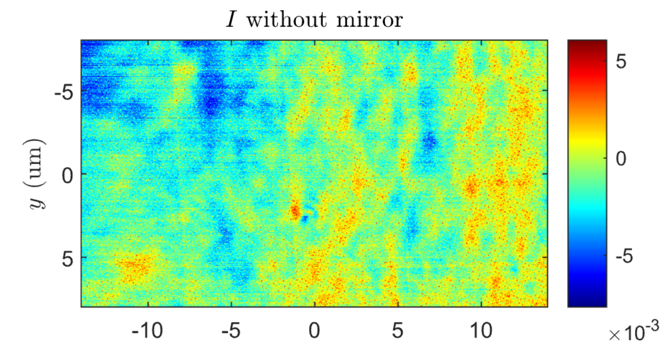
Interferogram

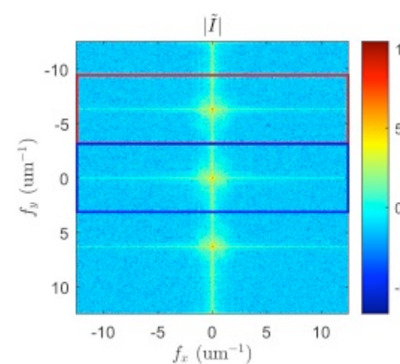


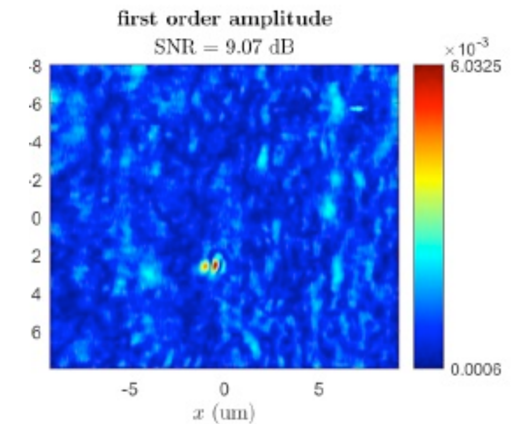
Explore the phase information: synthetic holography



Detection of small particles with low signal to noise ratio (low laser power): ~9 dB improvement in SNR

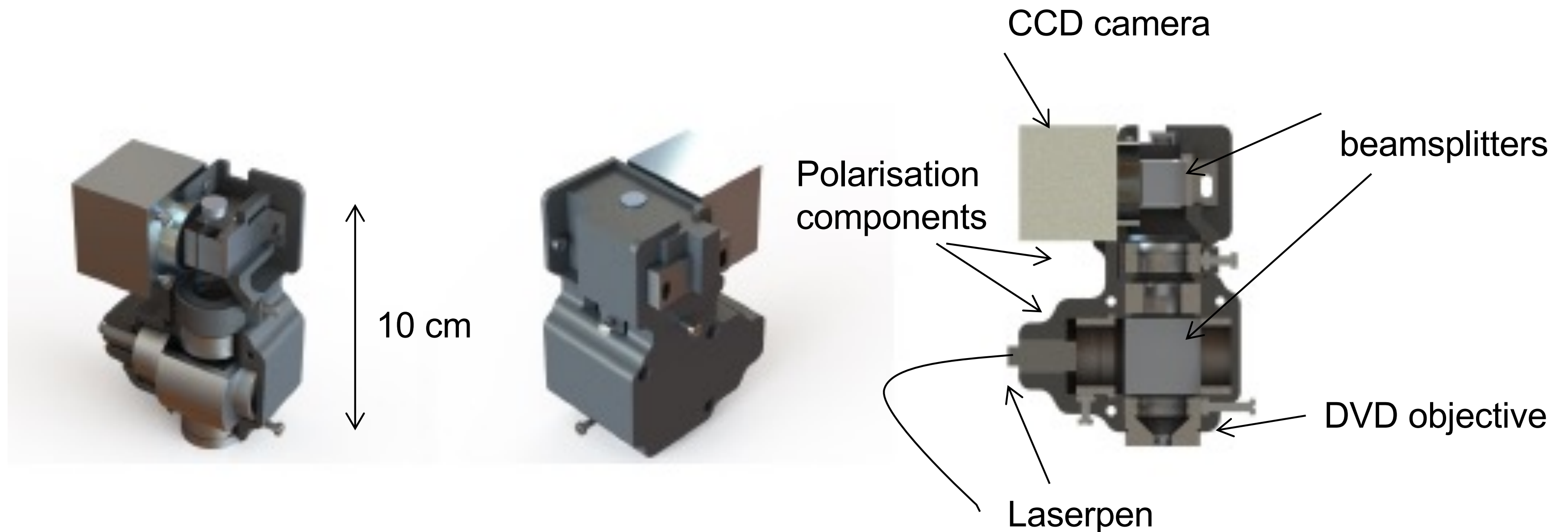






H. Yin, Opt. Lett. 47, 3840 (2022)

Miniaturisation: 3D printed



Designed and built by mechanical engineering students

Other applications

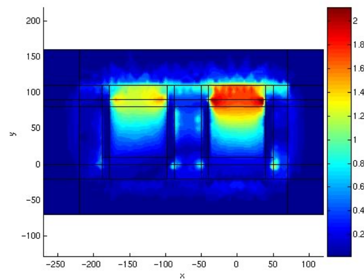
- Detection of smaller isolated particles: current limit is 30 nm PSL particles at wavelength of 400 nm. Applications in biology for detection of virus and bacteria

- Detection of contamination of the air pollution at the level of particles smaller than 100 nm (ultrafine dust)

- Detection of microplastics in sea and river water

More information?

Copies of the articles, open positions for PhD/postdocs, visits



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