

Study of the Disturbance Influences on Optical Coordinate Measuring Machines

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Overview

- Introduction
- Different probes
- Disturbance influences
- Accuracy
- Conclusions
- Questions

Introduction

- Optical CMM's often misused
 - Cf. pma
 - Cf. cirp hole plate
- How measure correctly?
- What are important parameters?

Different probes

Touch Trigger Probe



Tactile Scanprobe



Laser Stripe Scanner



Triangulation Scanner



CCD-Camera Vision System

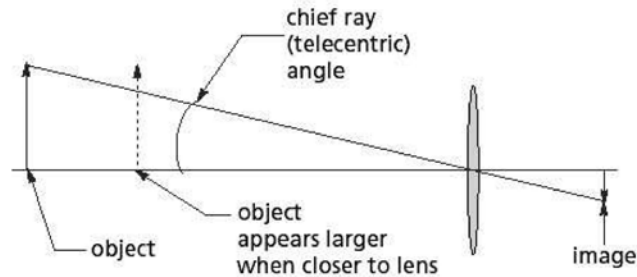
Vision systems

- Principle
 - CCD Precision Camera
 - Measures Contrasts
- Advantages
 - Contactless
 - Very Quick
 - Many points
- Disadvantages
 - Settings of Measurement Parameters Crucial
 - 3D difficult (autofocus)

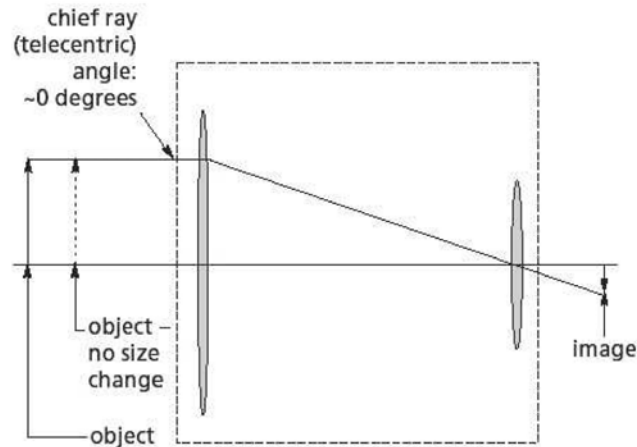


Vision systems

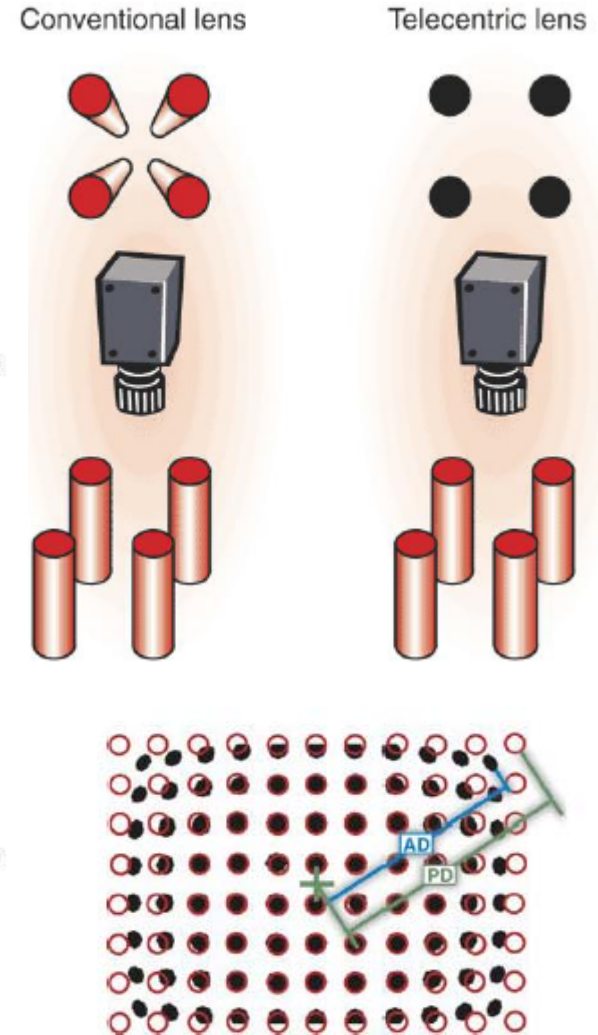
- Lens:
 - Telecentricity
 - Distortion
- Camera
- Light:
 - Back light
 - Coaxial light
 - Ring light
- Software



(a) conventional camera lens

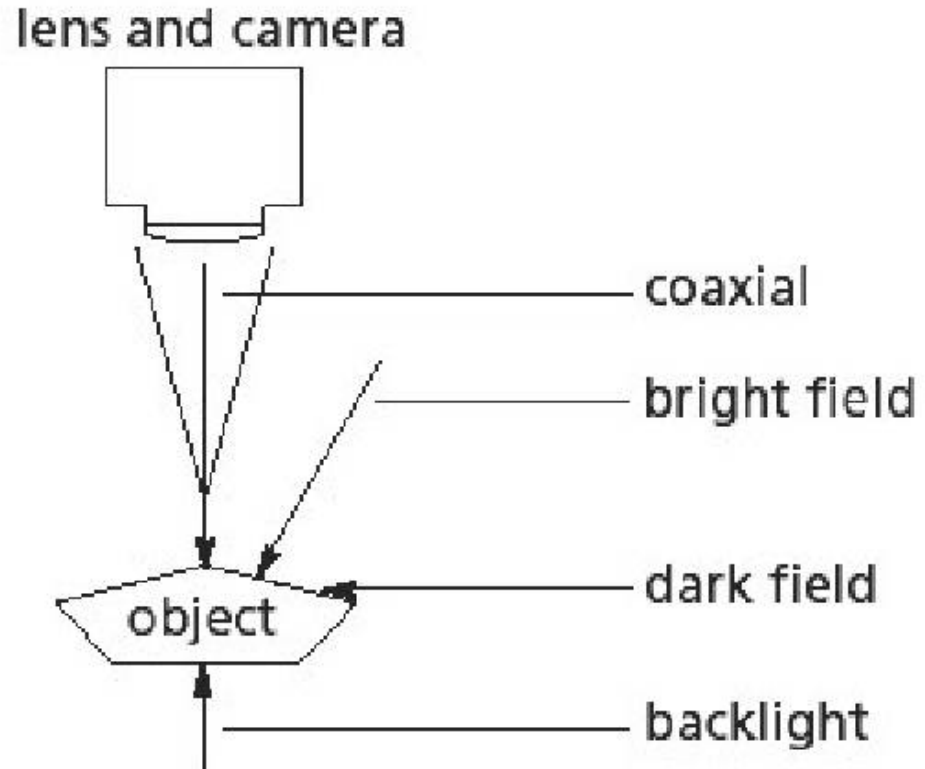


(b) telecentric lens



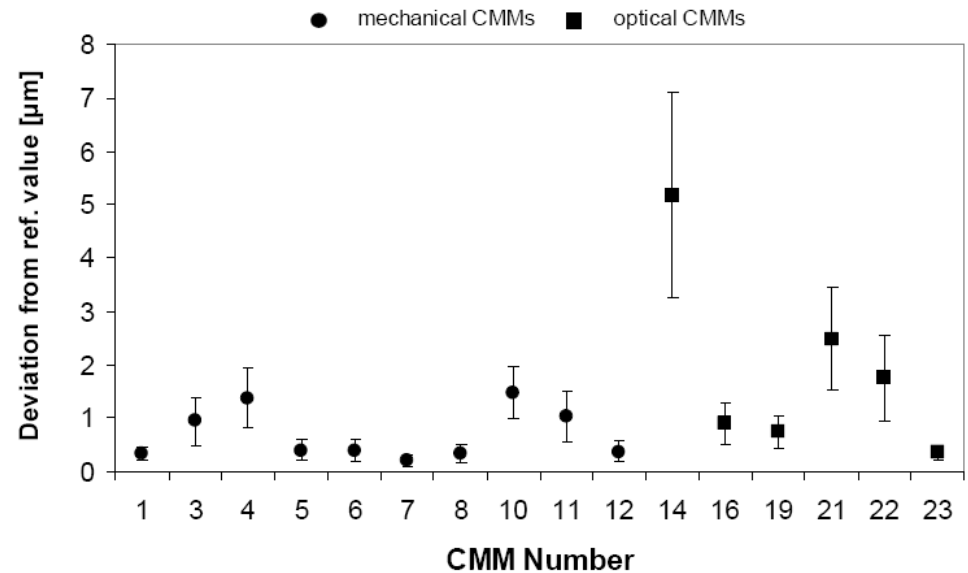
Vision systems

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Test object: Hole Plate

- Hole plate as in CIRP interlaboratory comparison
- Differences between laboratories with optical CMM most probably due to wrong measurement (not less accurate equipment)

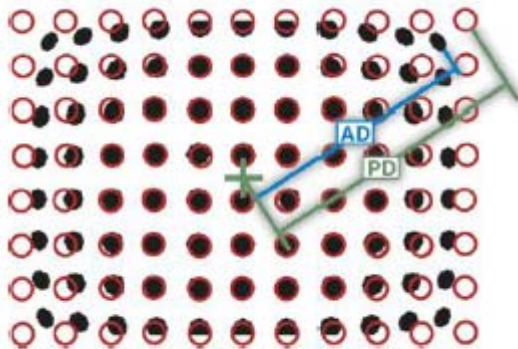


Possible errors

- Machine accuracy ($< 1 \mu\text{m}$)
- Disturbance influences (sometimes very significant):
 - Calibration
 - Distortion
 - Light
 - Fixing
 - Measuring Speed

Disturbance influences: Lens calibration

- Lens is source of errors (distortion)
- Telecentric lens
- Calibration under measuring circumstances: Changes in zoom or light -> new calibration



Conventional lens

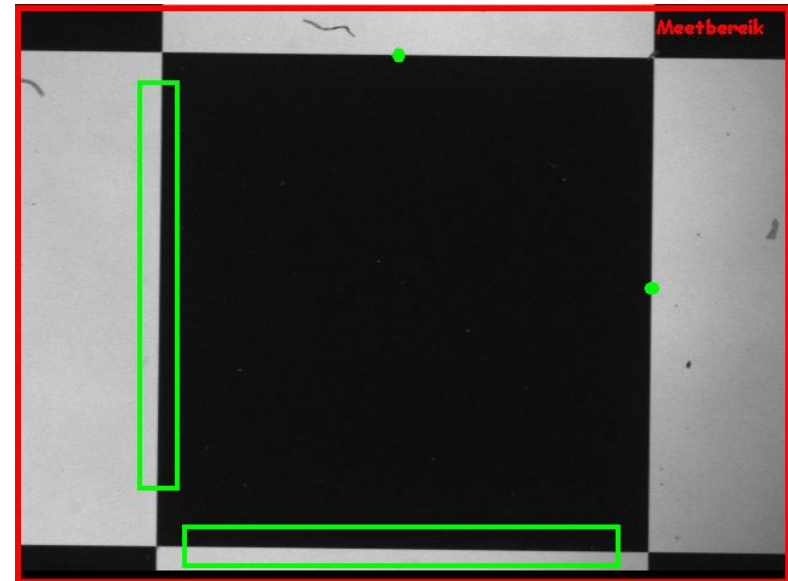


Telecentric lens



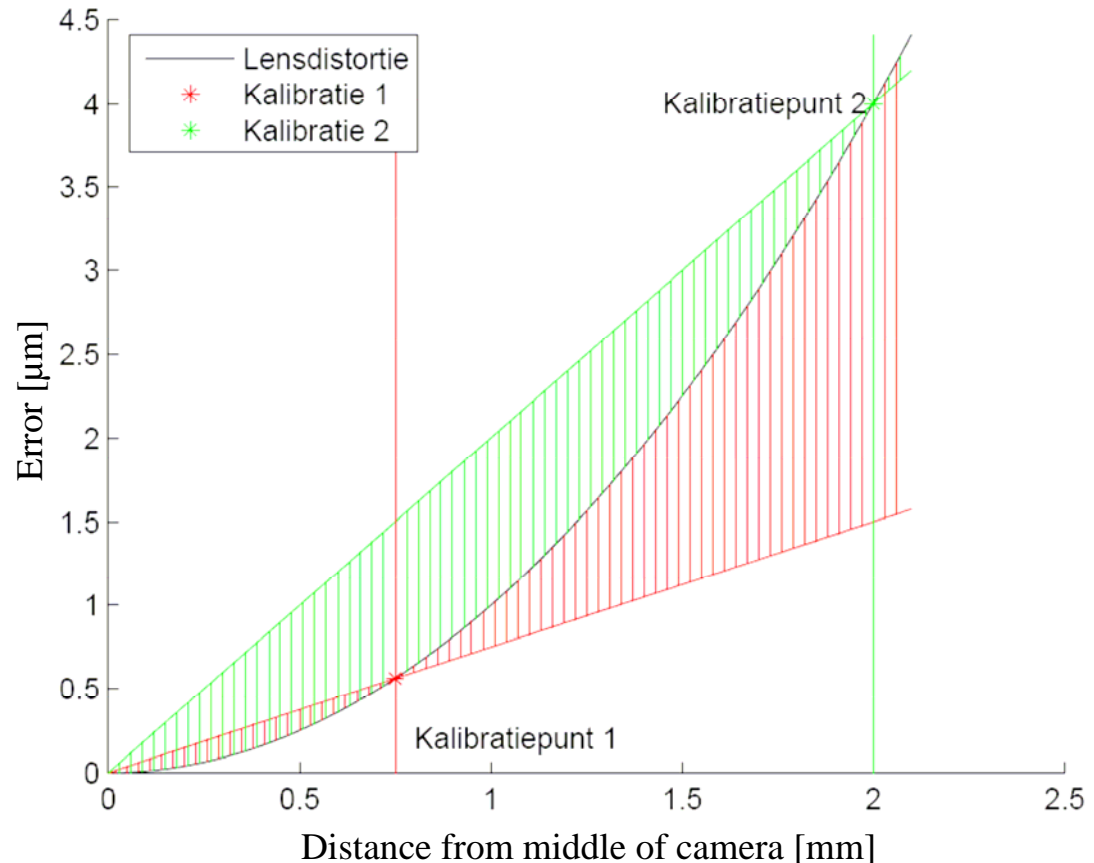
Disturbance influences: Lens calibration

- Calibration of CCD camera, NOT axis (frequent error)
- Measure lines and points
- Repeat calibration if other magnification is used



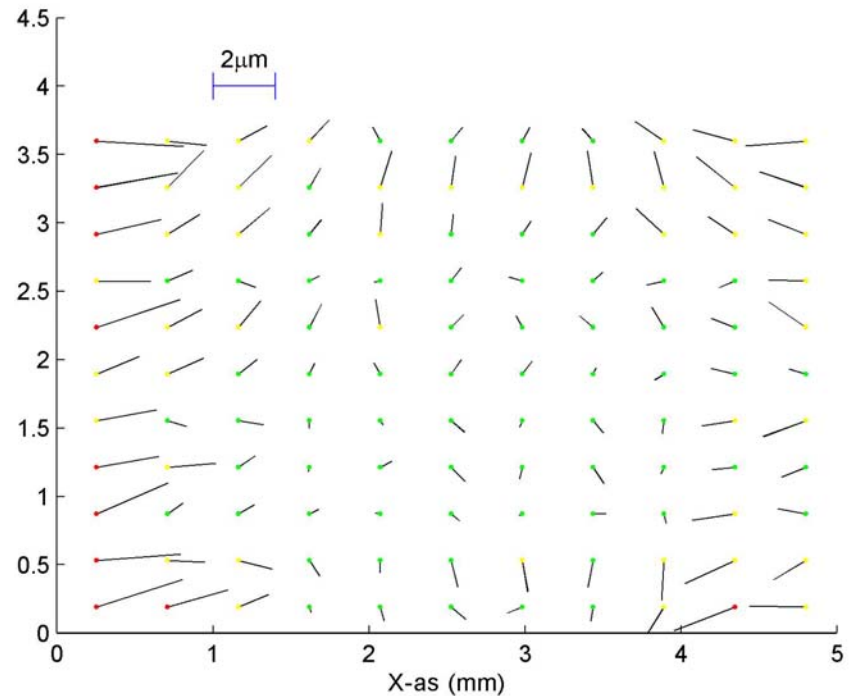
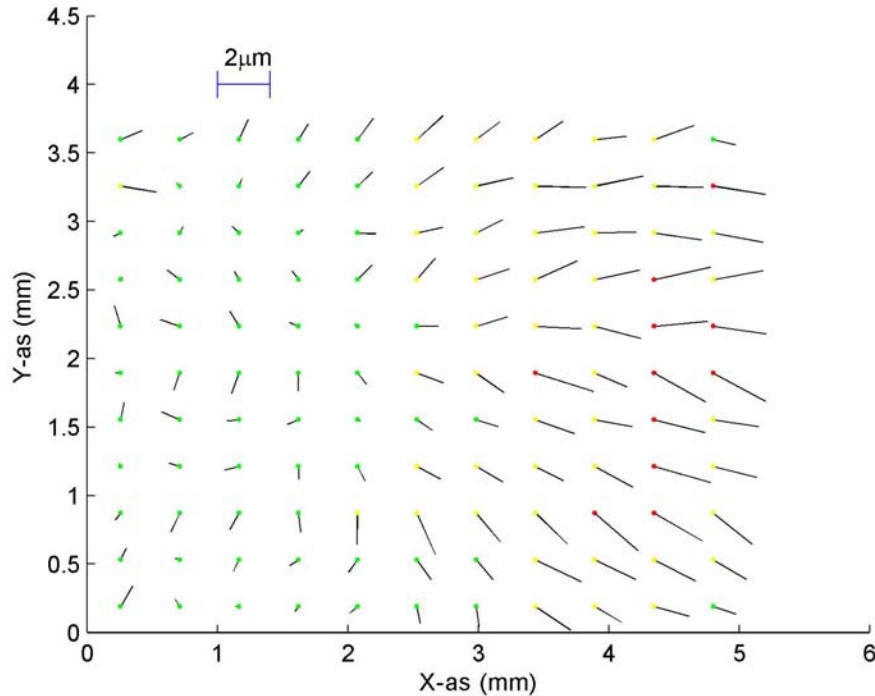
Disturbance influences: Distortion

- Measuring error vs. distance from middle of camera
- Non-linear error
- Linear compensation
- Remaining errors depend on calibration length



Disturbance influences: Distortion

- Measure line intersection on different spots in the window
- Calibration should be done in total range of window
- Parabolic distortion
- Measure holes point by point or in one image

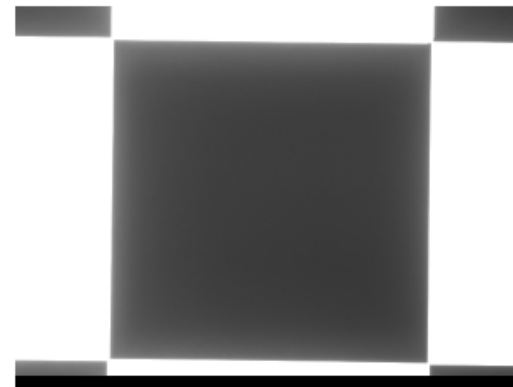
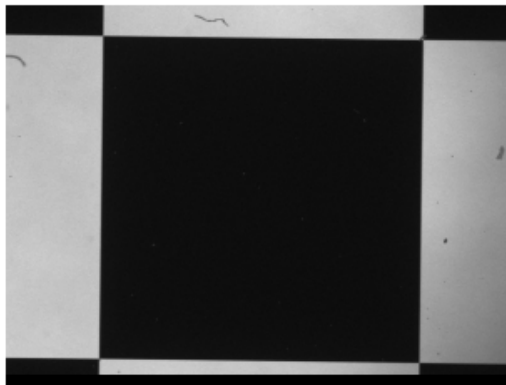


Disturbance influences: Light

- Optimal: Contrast as high as possible with as less light as possible
- Different types of Light
 - Back light (!)
 - Coaxial light
 - Ring light
- Important! Wrong light conditions gives large errors

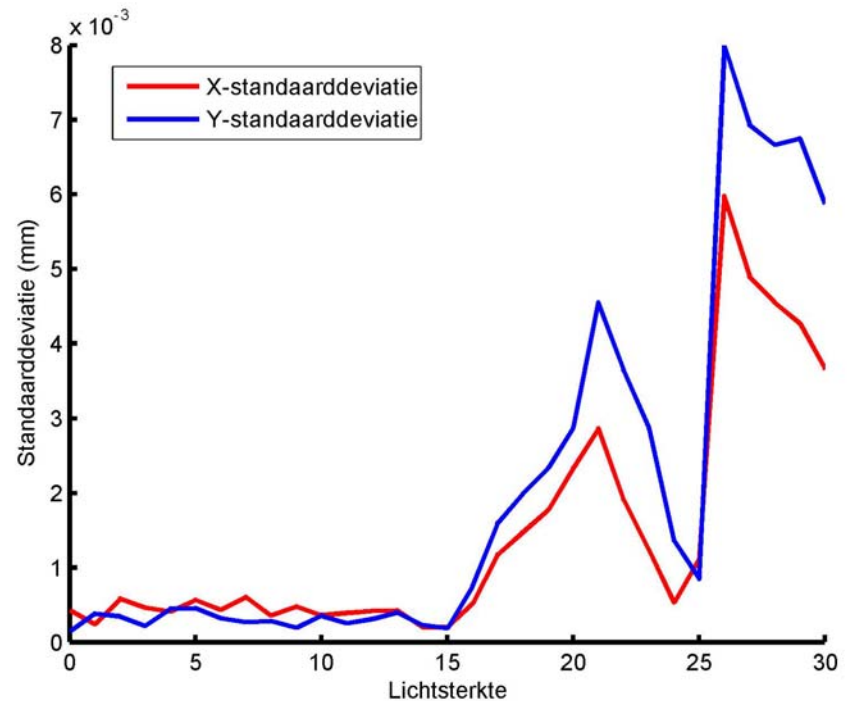
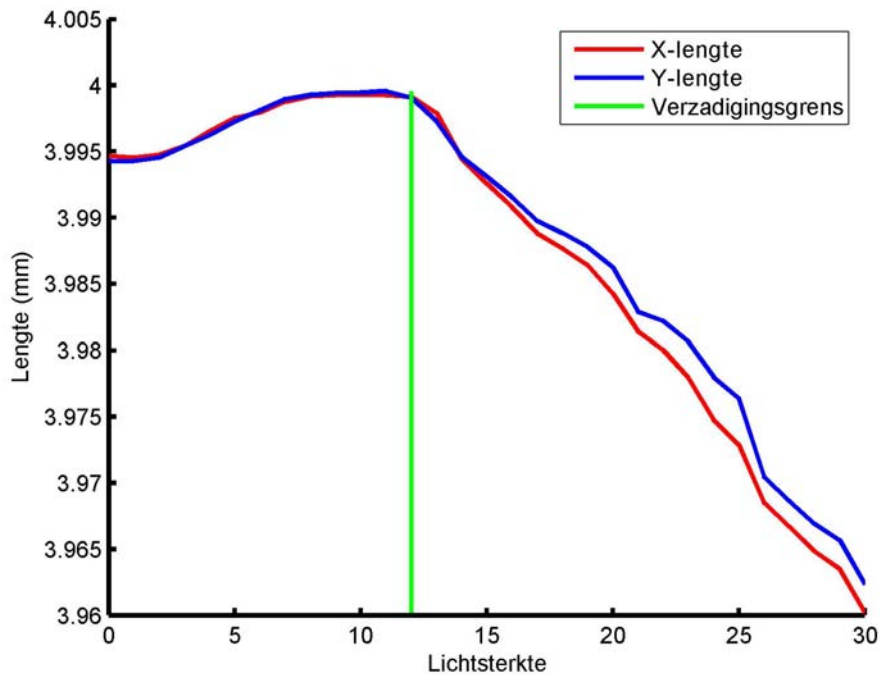
Disturbance influences: Light

- Saturation of CCD camera: Corners separate
- Measuring of calibration plate under different light circumstances



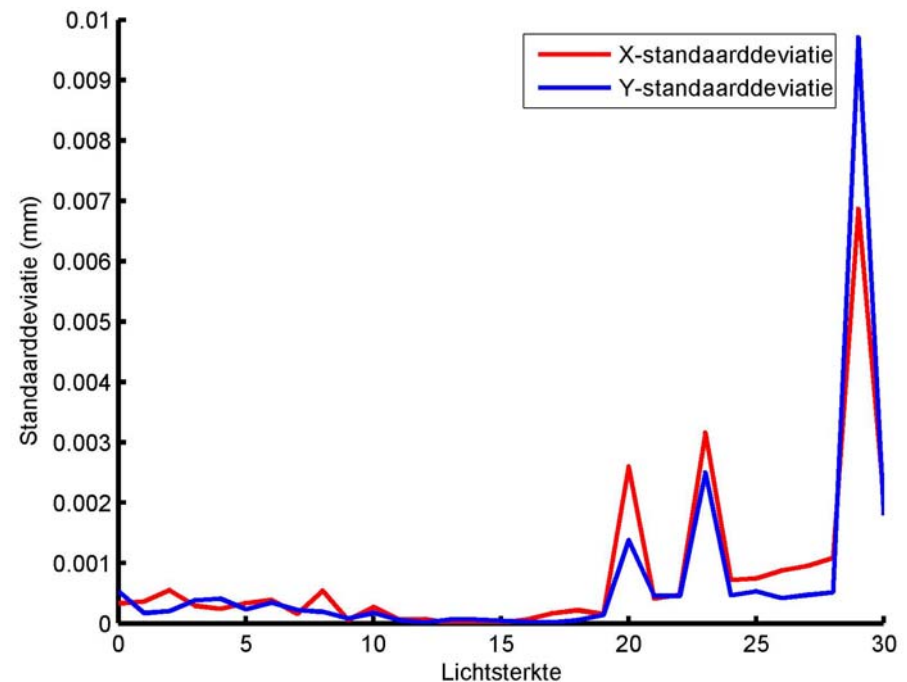
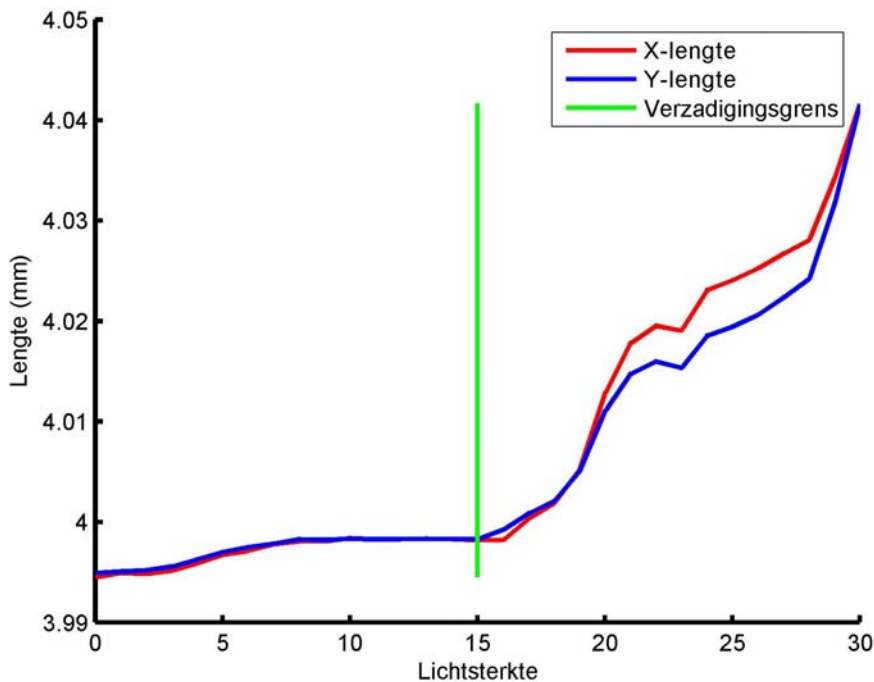
Disturbance influences: Back light

- Lightintensity-accuracy has maximum
- Standard deviation-accuracy becomes instable
- Higher than optimal intensity gives measuring error
- Lower than optimal intensity gives measuring error (!)



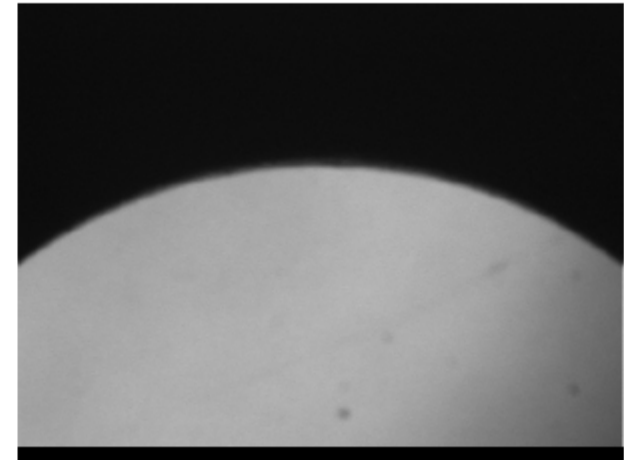
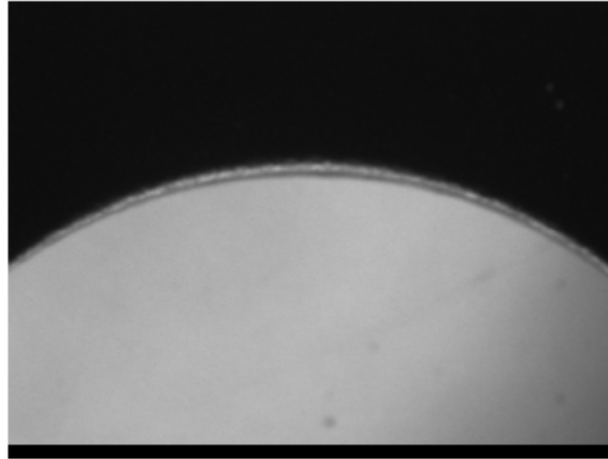
Disturbance influences: Back light

- Different saturation-intensity when translucent square is measured
- Higher threshold because CCD camera 'sees' more light

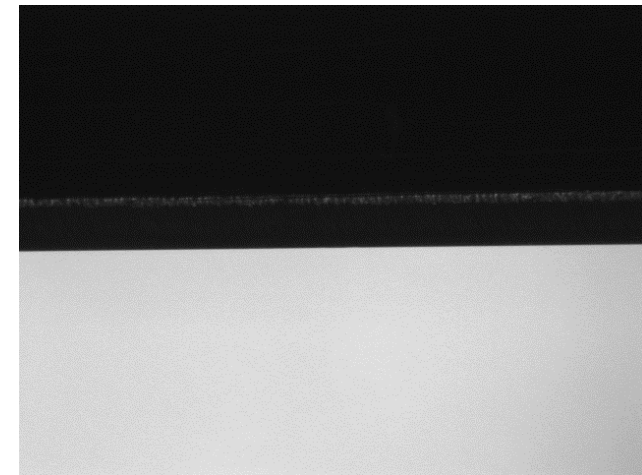
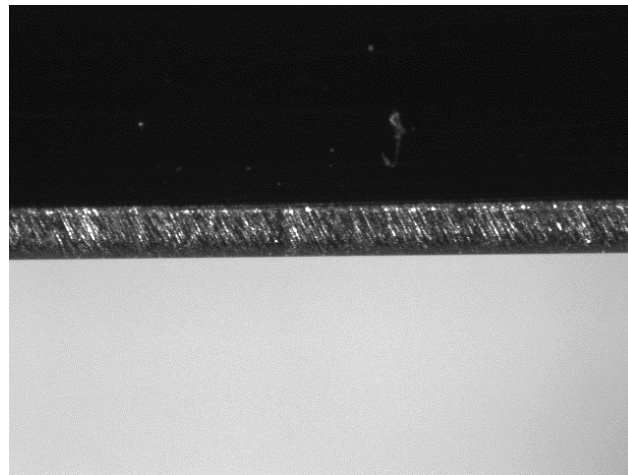


Disturbance influences: Disturbance light

Circles of the
hole plate

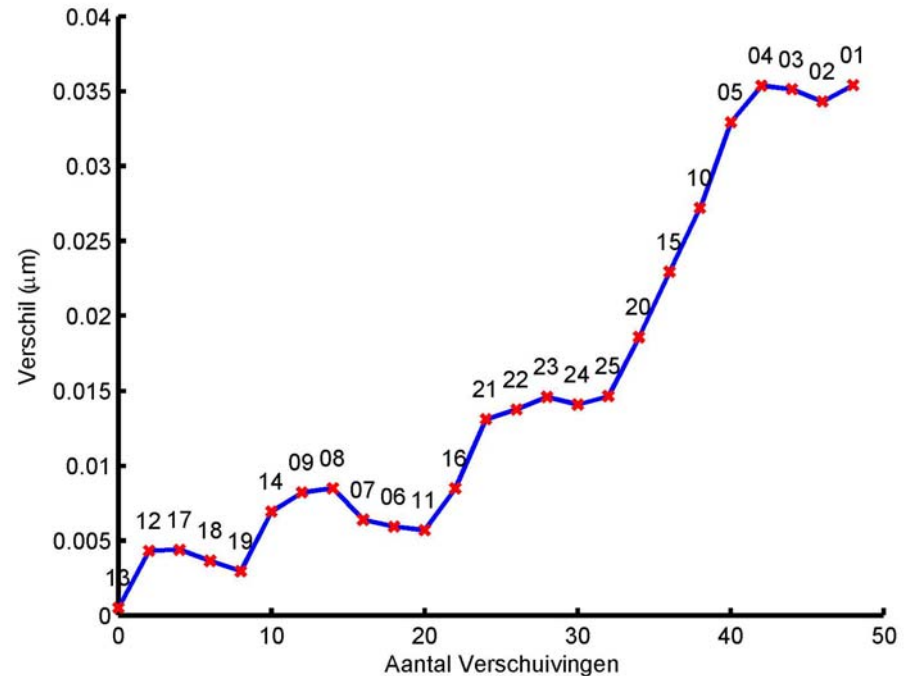
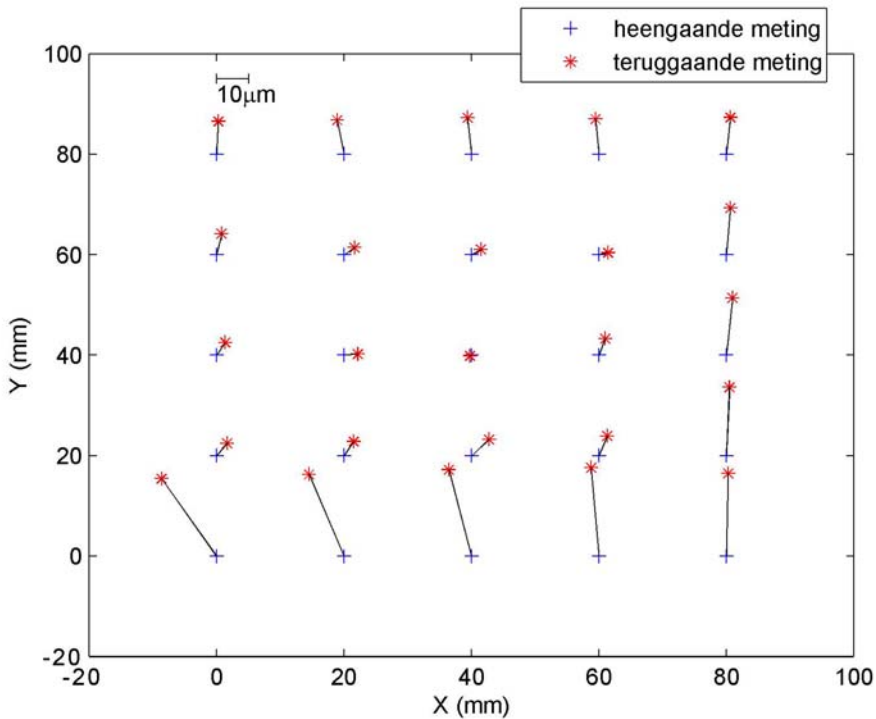


End gauges



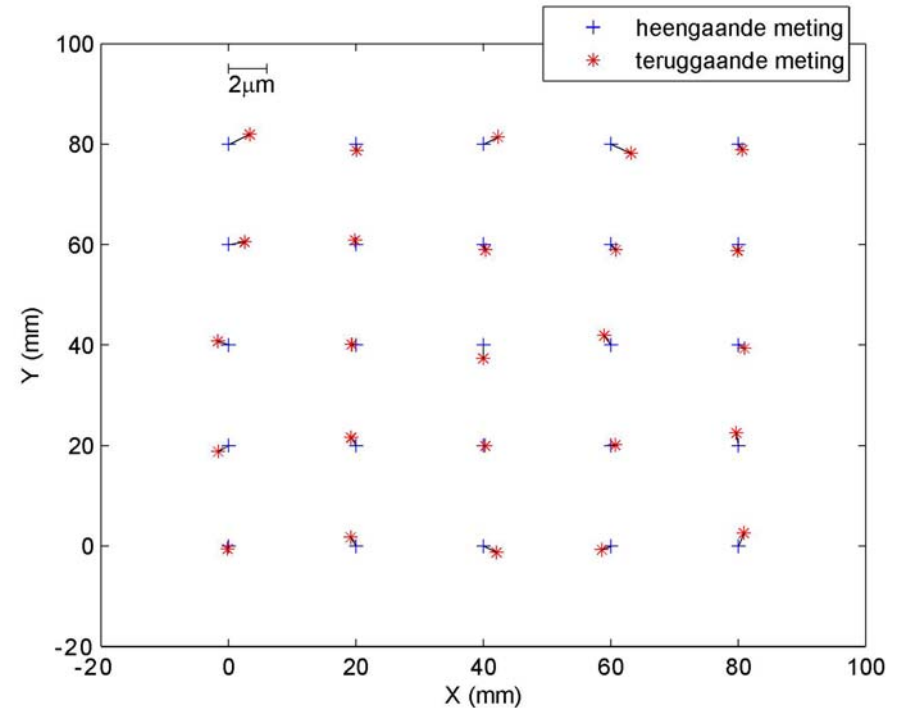
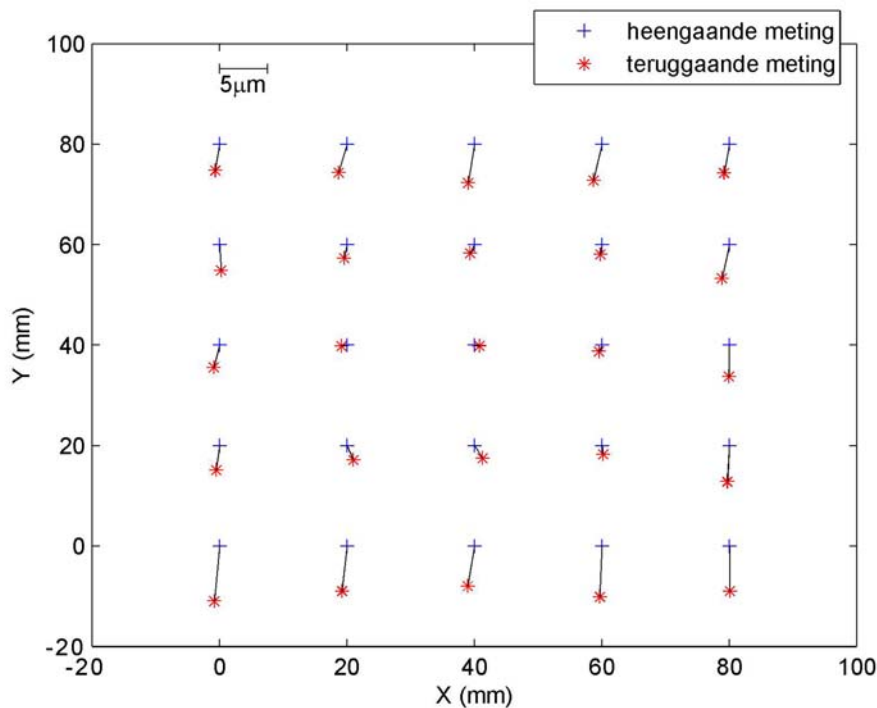
Disturbance influences: Fixing

- No mechanical contact so no fixing
- Deviation without fixing (cf. cirp)

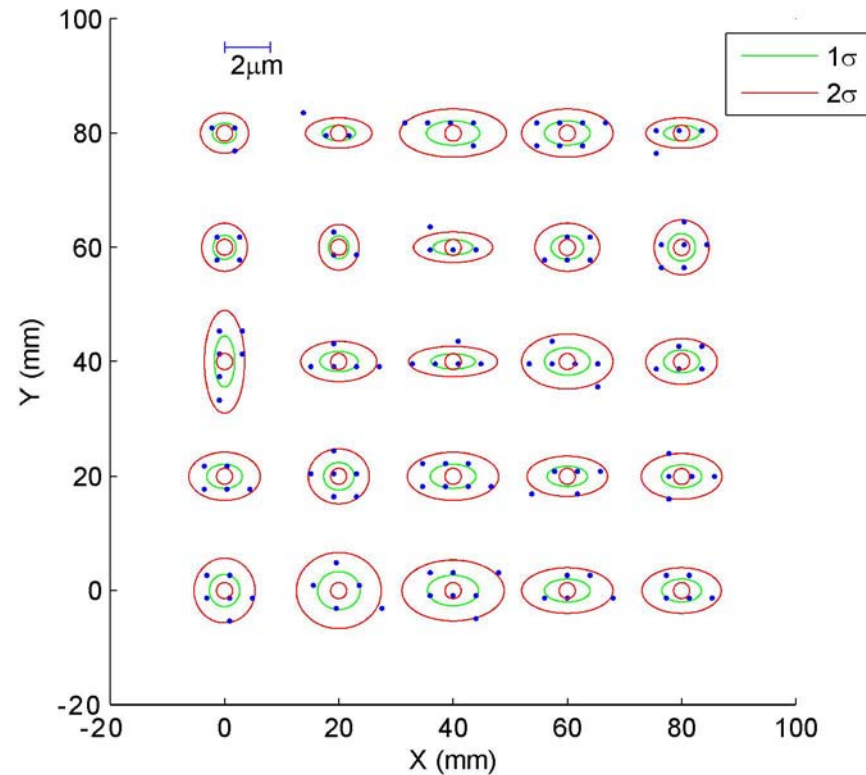


Disturbance influences: Measuring speed

- Problem not completely solved when fixed
- Do not measure at high speed, for accurate results



Repeatability

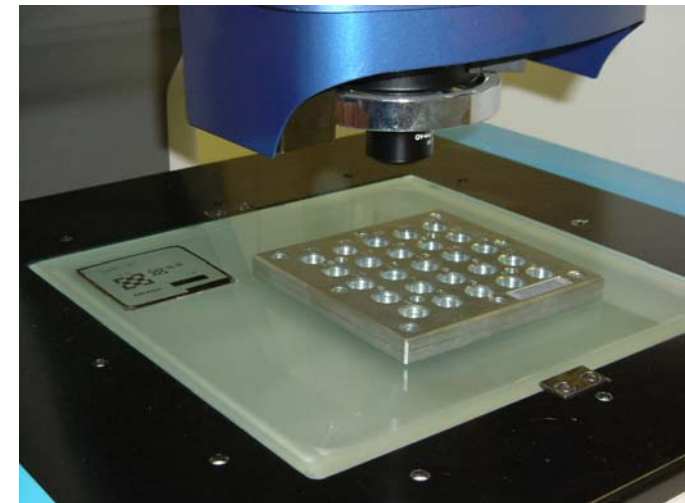
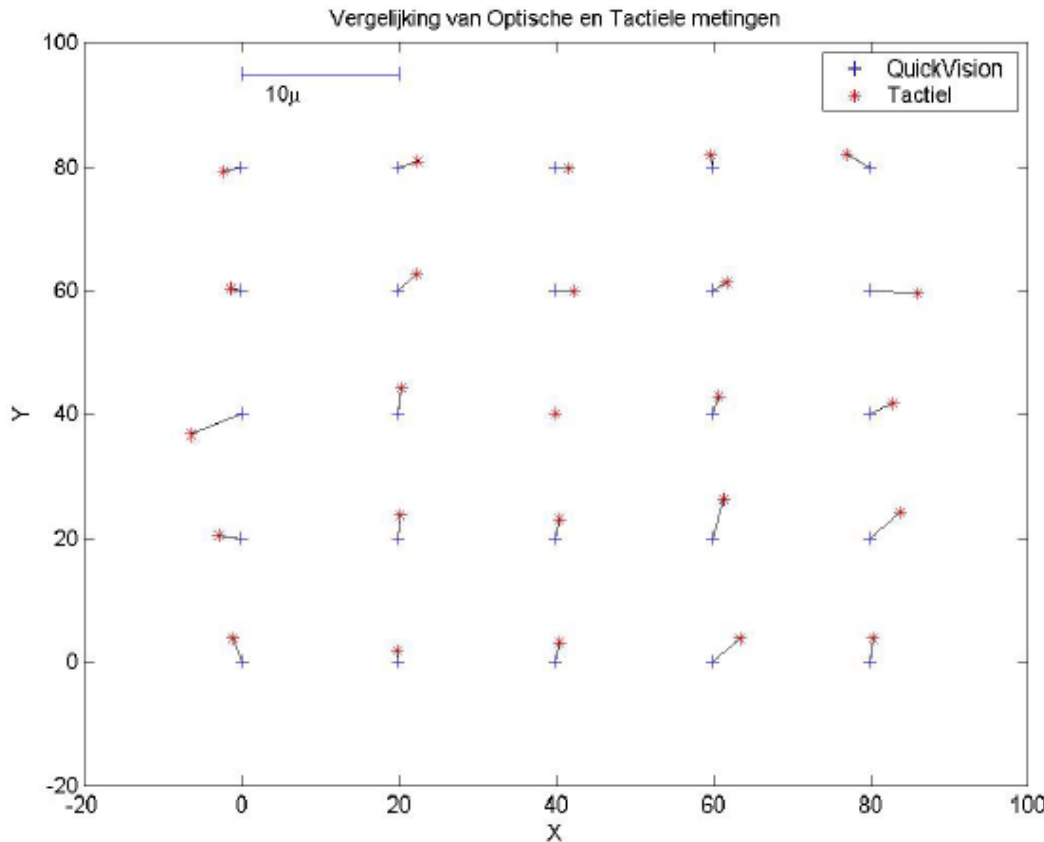


Accuracy

Comparison Tactile – Optical: Measuring a hole plate

Mitutoyo CMM,
touch-trigger probe (KUL-PMA)

Mitutoyo Quick Vision,
CCD camera (KUL-PMA)



10 μm

Conclusions

- Very accurate CMM if used correctly:
 - Calibration
 - Light and disturbance light
 - Speed and fixing