

# LumiCal displacement measurement present status

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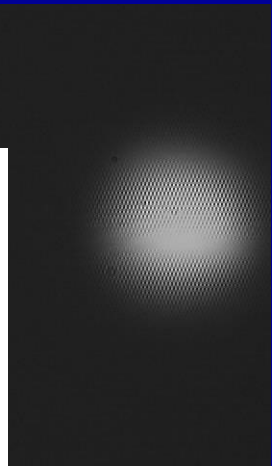
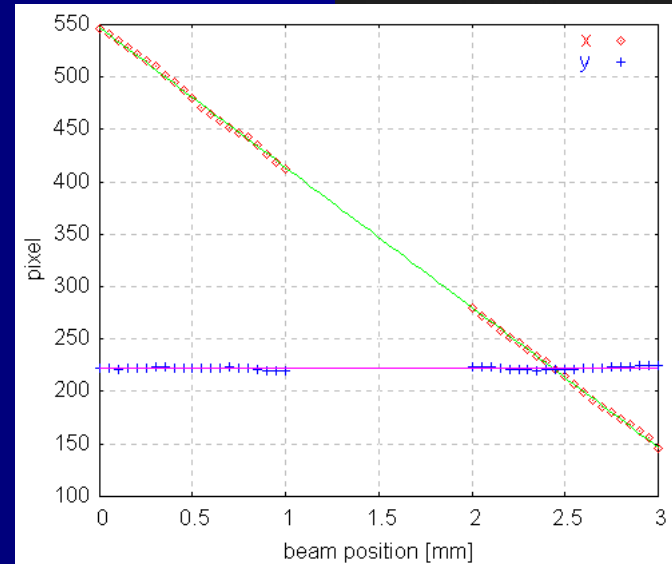
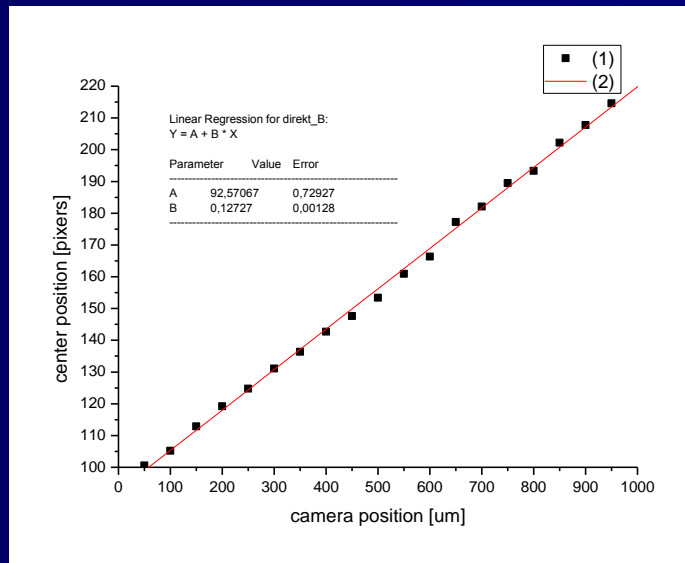
Leszek Zawiejski INP PAS

Krzysztof Oliwa INP PAS

# Previous results

- He-Ne Laser
- Cheap web camera with unknown pixel size
- Old movable table with low precision micrometric screw
- Report can be found:  
<http://www.ifj.edu.pl/reports/1931.pdf?lang=pl>

# Simple laser – CCD camera position measurements

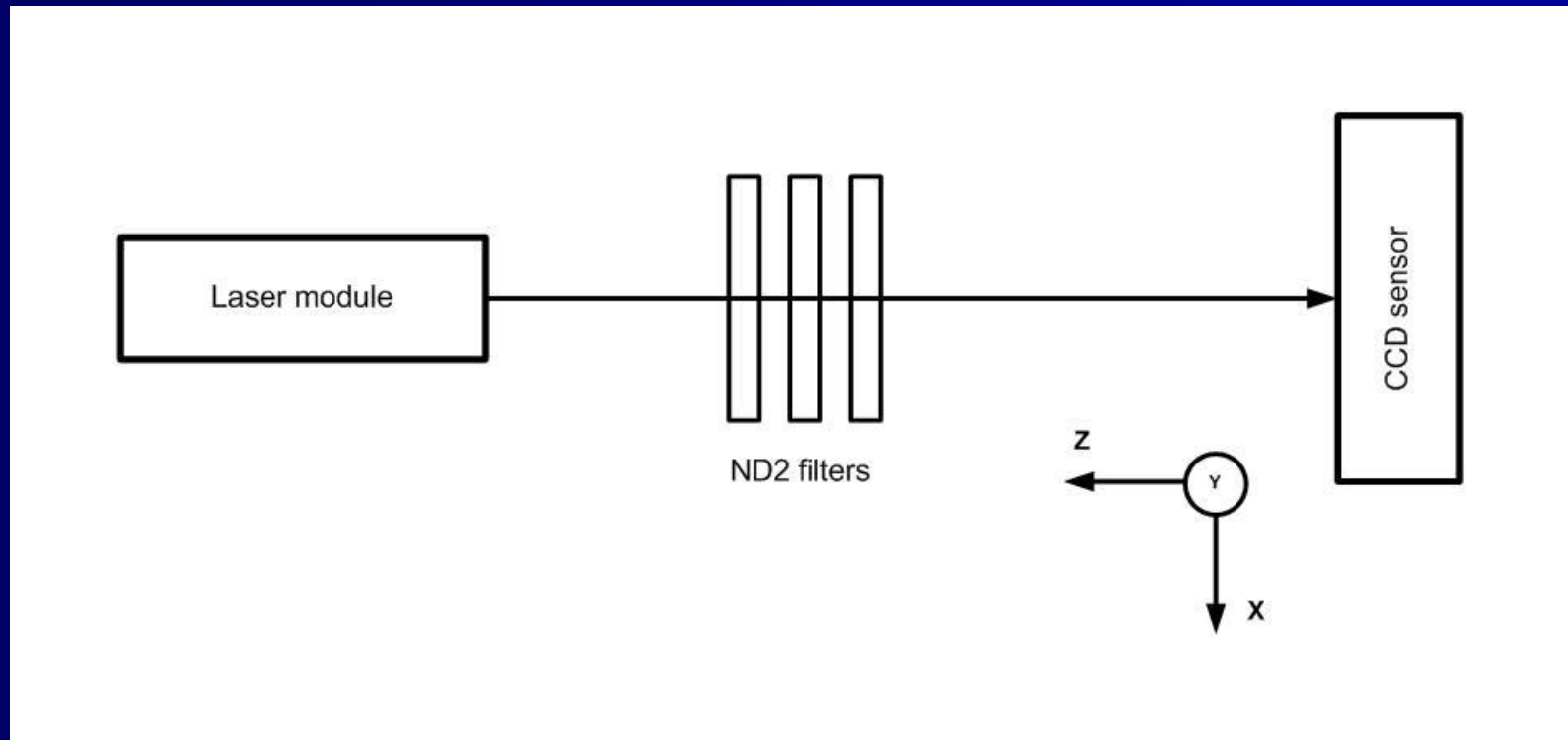


Resolution  $1\mu\text{m}$  if the accuracy of determination of the centre of the light spot is better than  $0.1\text{pixel}$

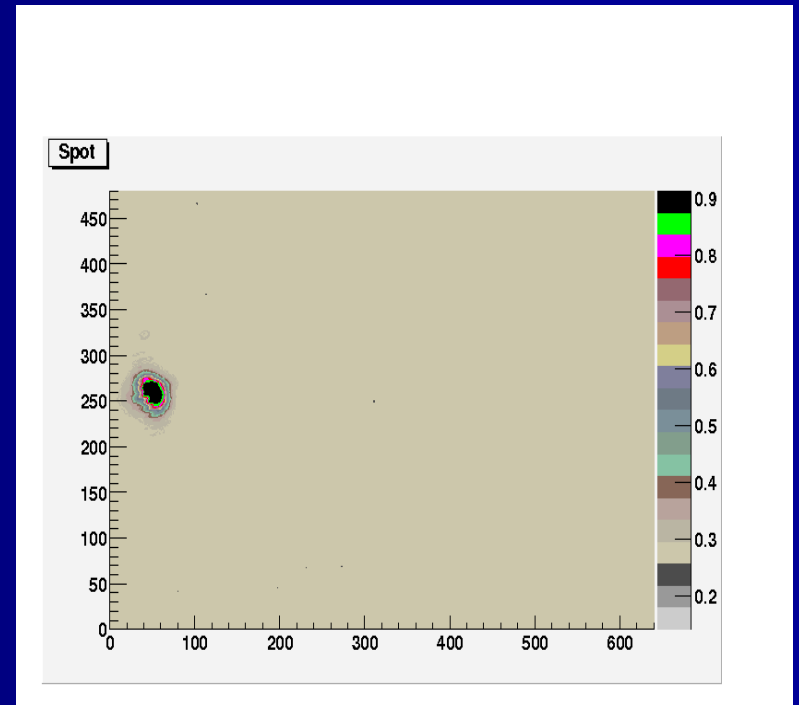
# New setup – single laser beam

- BW camera DX1-1394a from Kappa company 640 x 480 with Sony ICX424AL sensor 7.4  $\mu\text{m}$  x 7.4  $\mu\text{m}$  unit cell size
- Laser module LDM635/1LT from Roithner Lasertechnik
- ThorLabs 1/2" travel translation stage MT3 with micrometers (smallest div. 10  $\mu\text{m}$ )
- Neutral density filters ND2

# Single beam setup layout

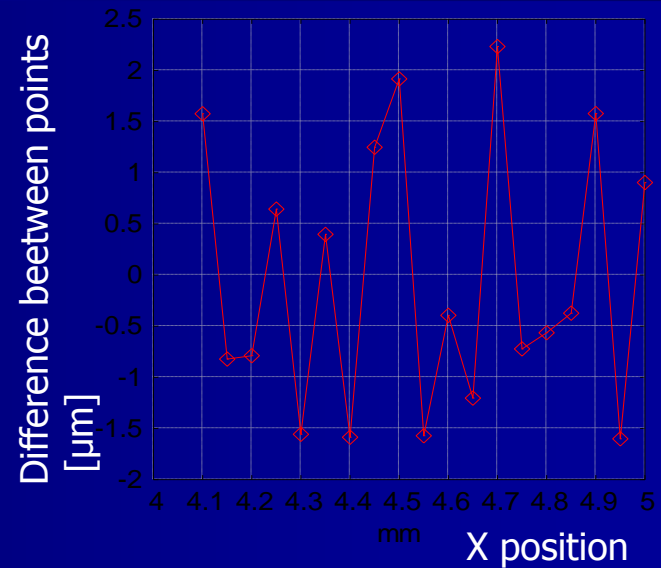
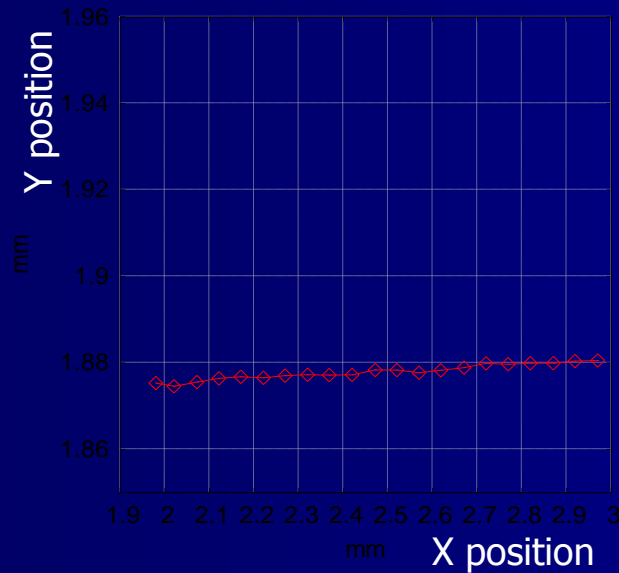


# Single beam spot



Laser beam spot and corresponding histogram

# Single beam measurement results



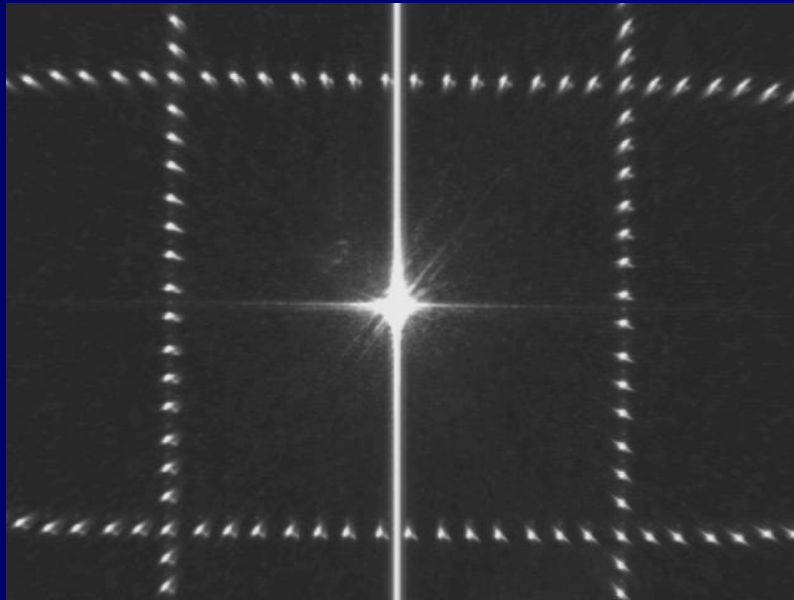
Camera has been translated in  $50 \mu\text{m} \pm 2 \mu\text{m}$  (estimated) steps

# Pattern generator

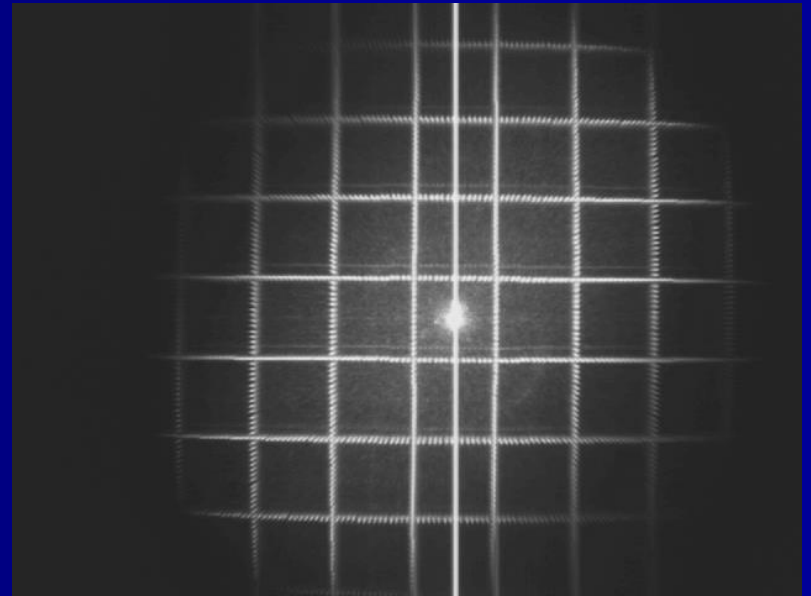
- Laser modul with pattern generator
- Need to use the lenses to focus the grid on CCD sensor
- Simple lens = distorsion (coma)
- We have skipped this solution for future investigations because of sophisticated optical system need



# Pictures with pattern generator

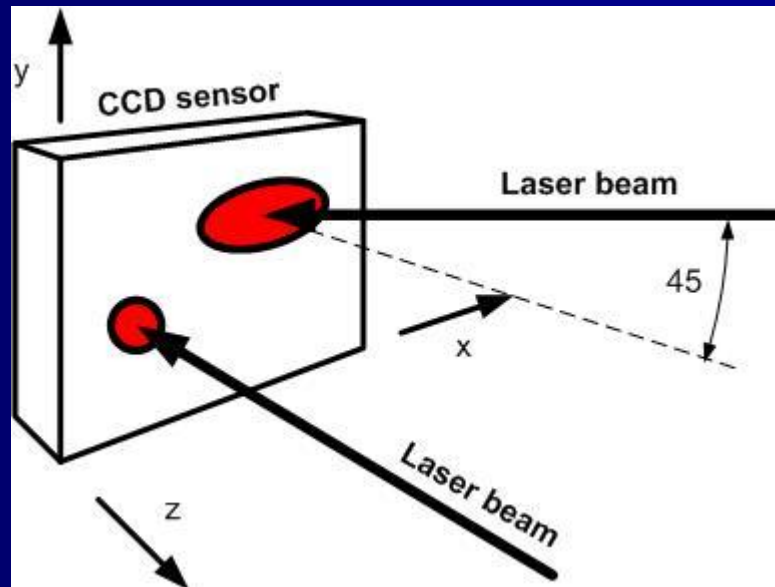


Single lens  $\sim 20\text{mm}$  FL on laser



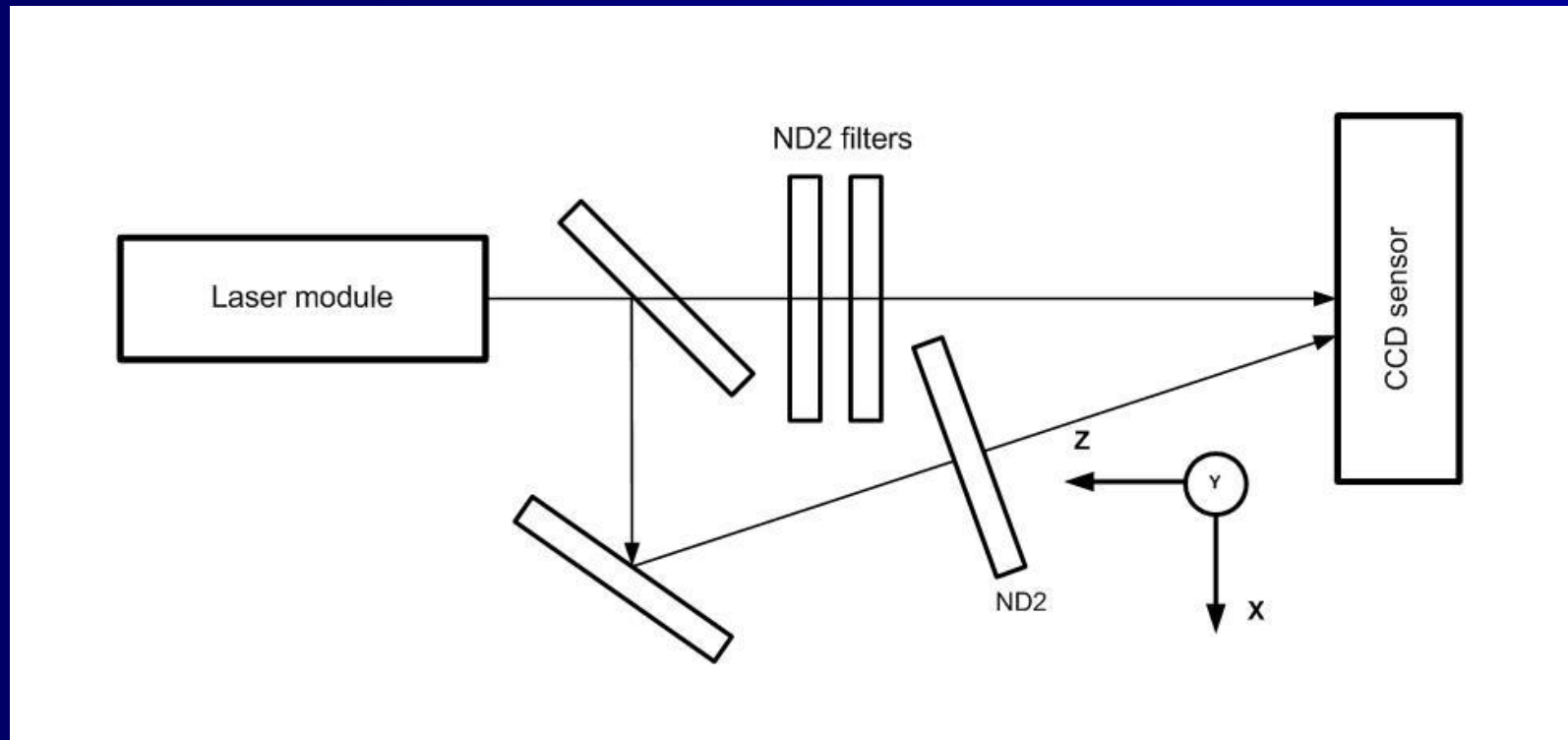
Factory lenses 6 mm FL on camera

# XYZ displacement measurement with two beams

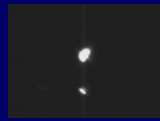


Two laser beams (one not perpendicular to the sensor) allows us to measure XYZ translation in one sensor

# Setup with two beams



# Z translation of the camera



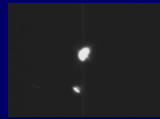
Z = 0  $\mu\text{m}$

X and Y position are constant



Z = 250  $\mu\text{m}$

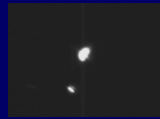
The angle between two beams is  $\sim 30^\circ$



Z = 500  $\mu\text{m}$



Z = 750  $\mu\text{m}$



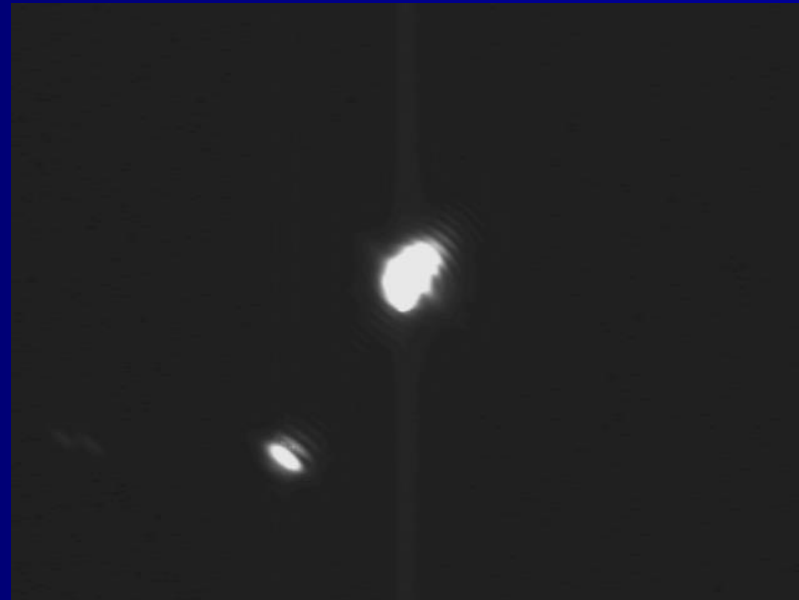
Z = 1000  $\mu\text{m}$



Z = 1250  $\mu\text{m}$



Z = 1500  $\mu\text{m}$



# Conclusions

- The XY position measurement method with single beam has the accuracy better than a few mikrometers
- The XYZ position measurement with two beams looks promising, but to determine the center of two spots a new algorithm has to be developed
- The XYZ Position measurement with a pattern generator needs a sophisticated optics and probably will be expensive

# Next steps

- Solid state diode pumped laser – better spot
- LED with collimator instead of laser?
- Beam splitter with halftransparent mirror
- Algorithm to determine centre of two spots
- Discussion on possible errors
- More compact prototype
- Independent measurement of XYZ translations
- Stability tests