Optical Functionality Simulation Based in Traceable Characterization of Optical Components

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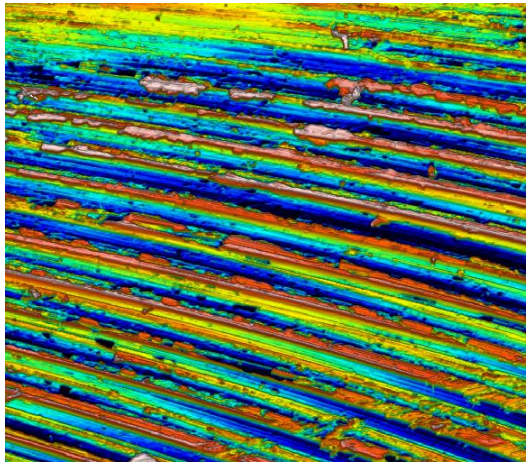
Tekniker
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

CONTACT
Jesús Paredes
jesus.paredes@tekniker.es

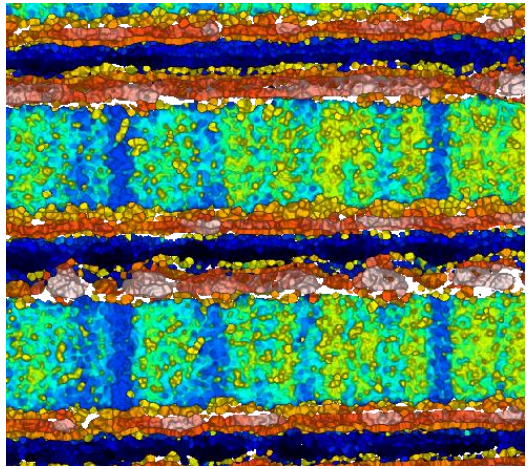
Materials & Methods

SNEOX

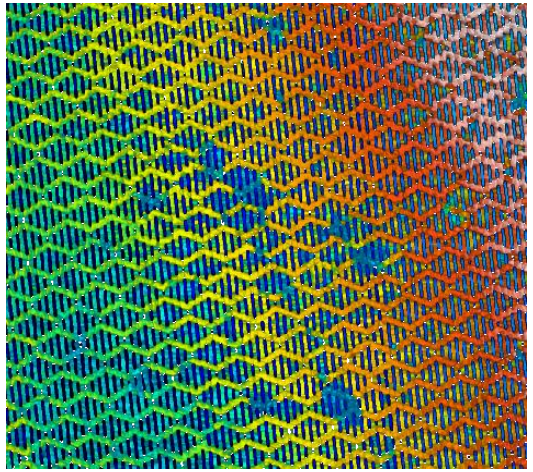
SENSOFAR® METROLOGY



Confocal Microscopy



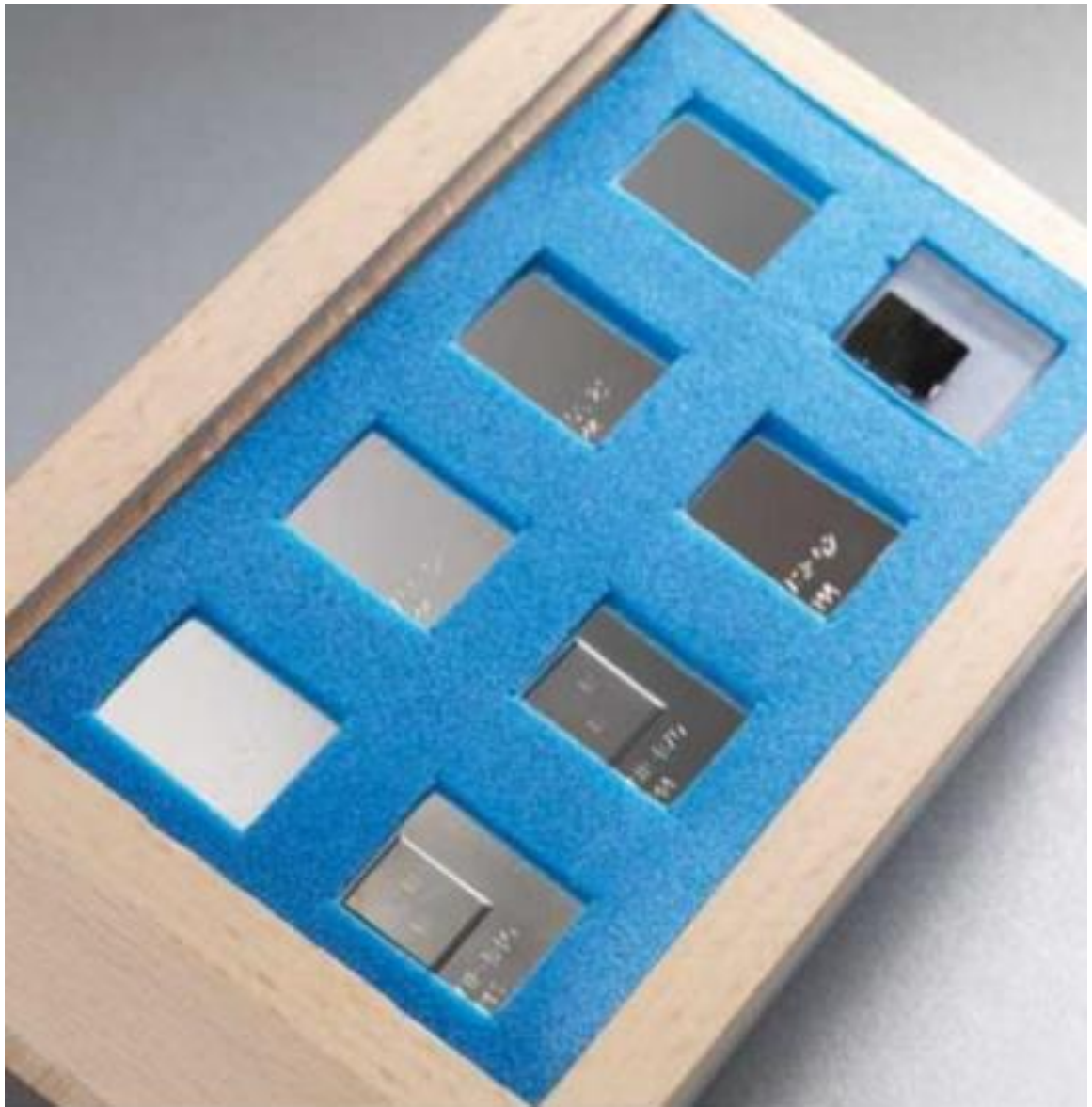
Focus Variation



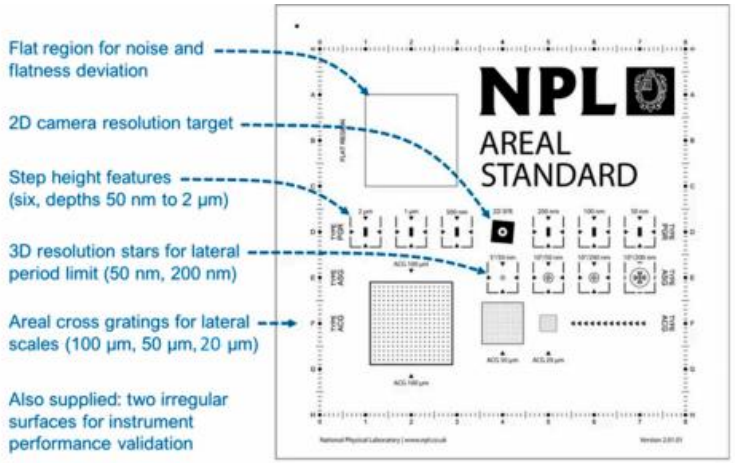
Interferometry

Calibration
NPL **Standards**

NPL BentoBox

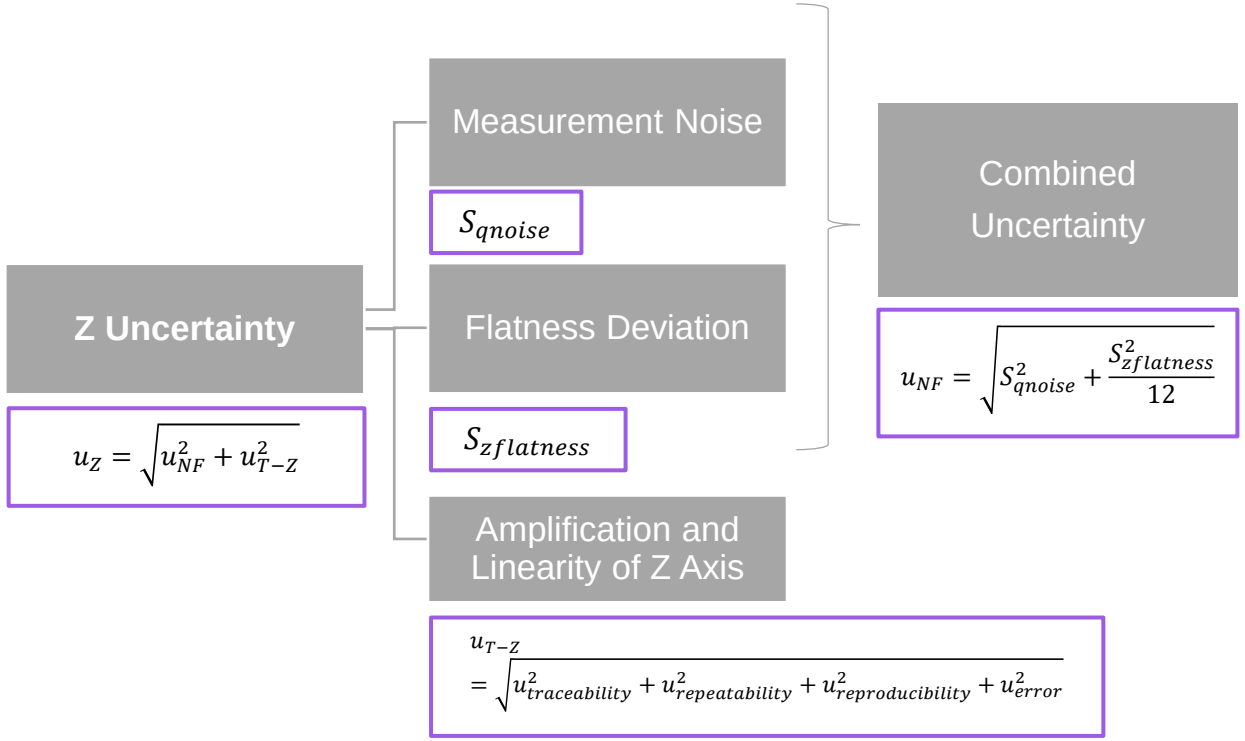


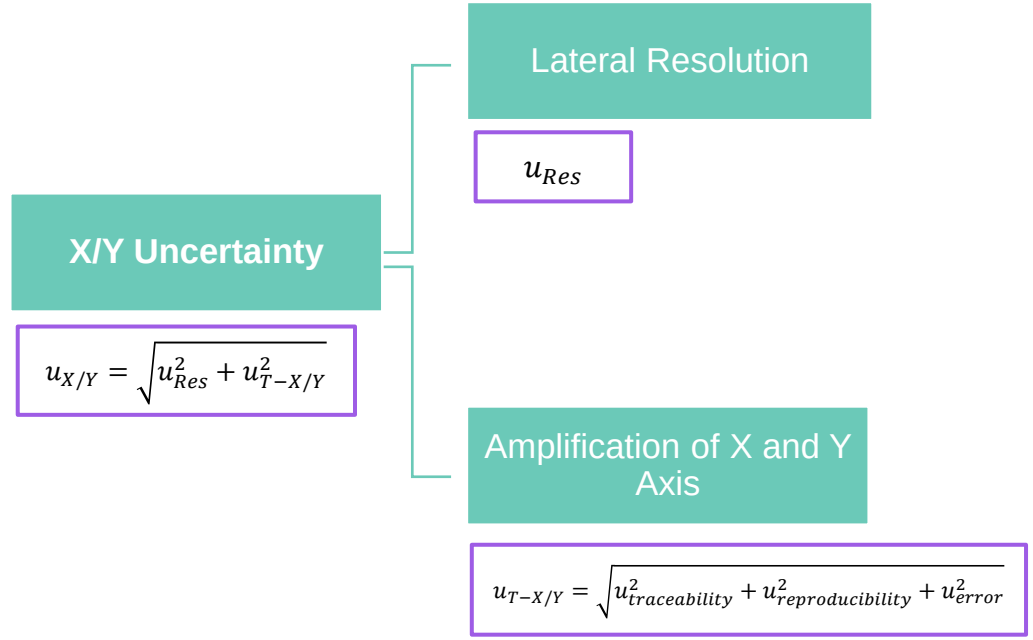
NPL Areal Standard



Calibration

Uncertainty evaluation method for X Y and Z axes

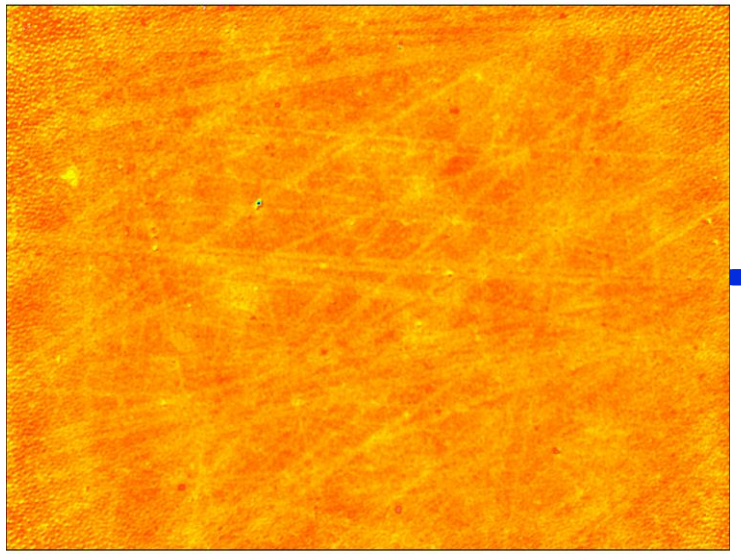




Good Practice Guide Nº128

Calibration of the metrological characteristics of Imaging Confocal Microscopes

Calibration of Z axis

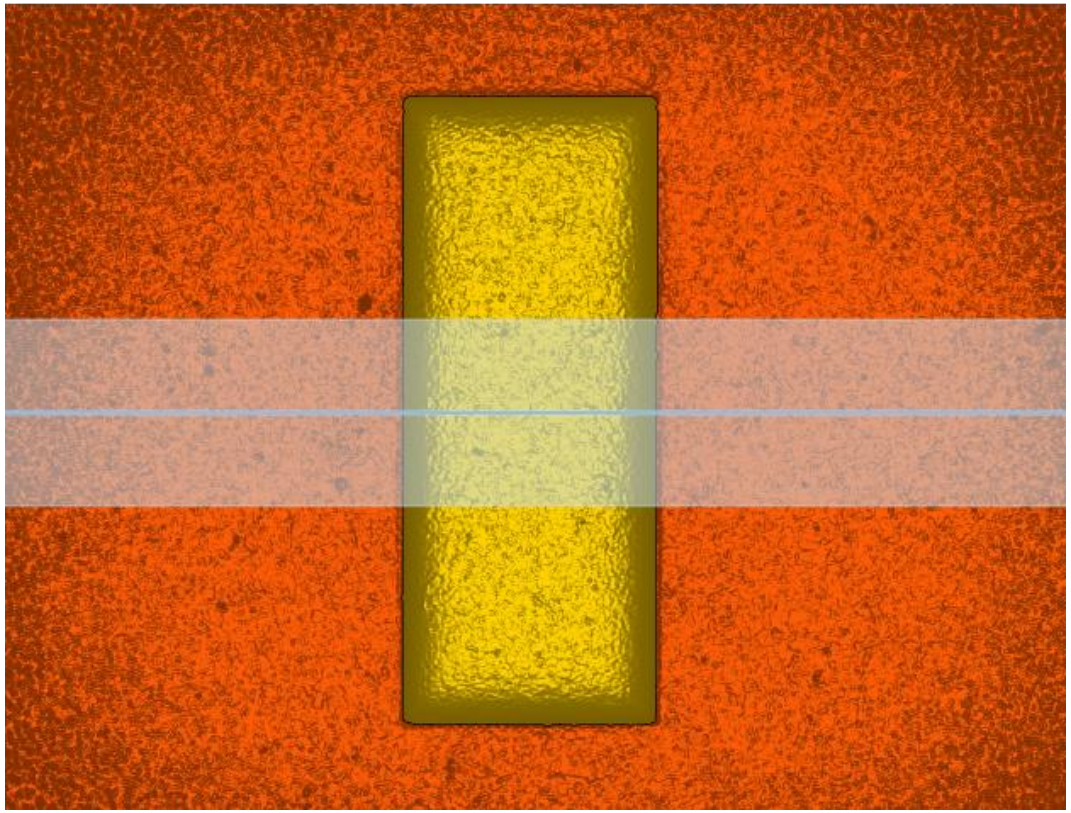


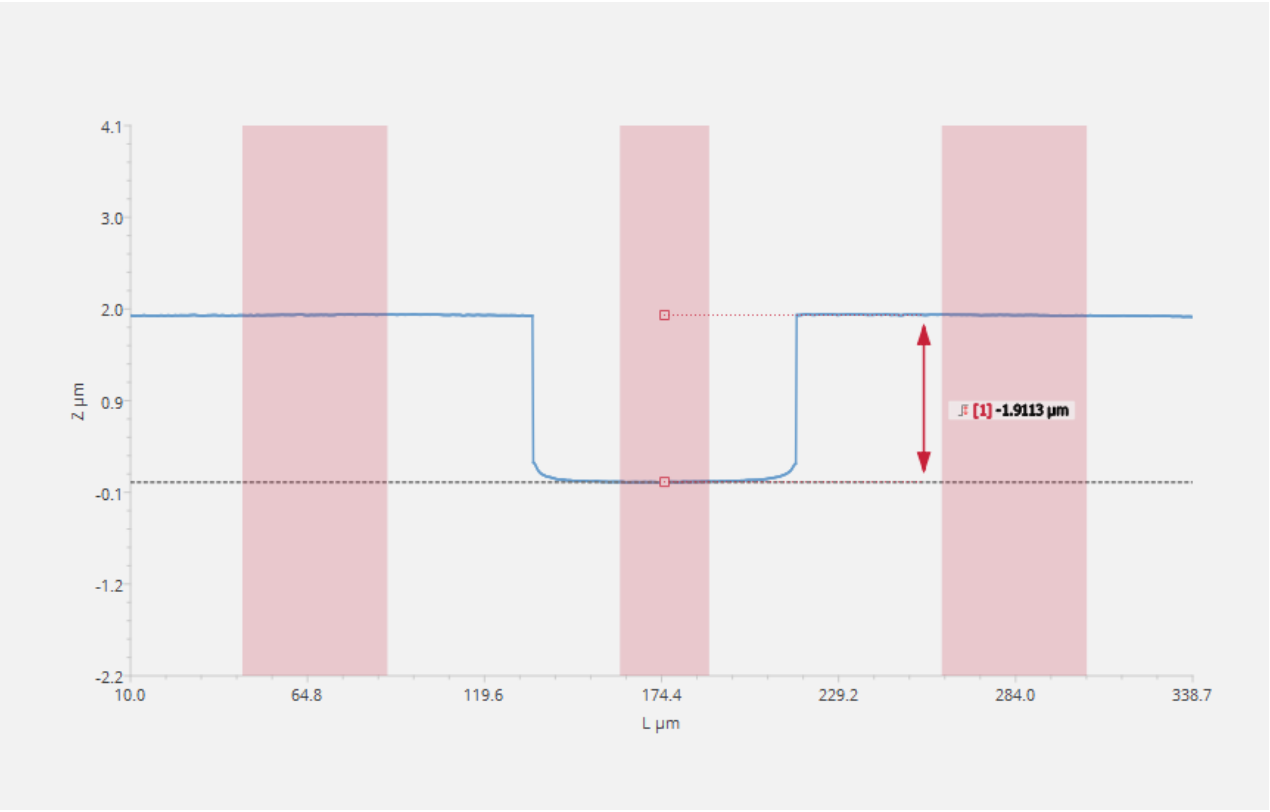
AFL
Noise and Flatness

Repeated measurements on the same area → **Noise Parameter** S_{qnoise}

Repeated measurements on different areas → **Flatness Parameter** $S_{zflatness}$

Calibration of Z axis

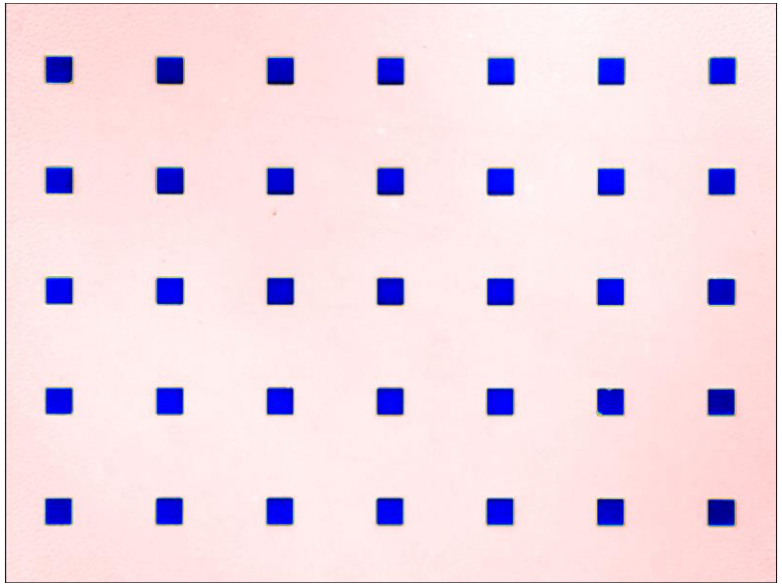




PRG
Amplification and Linearity

Certified Height
= 1915,0 ± 5,9 nm

Calibration of X and Y axes



ACG
Amplification and Perpendicularity

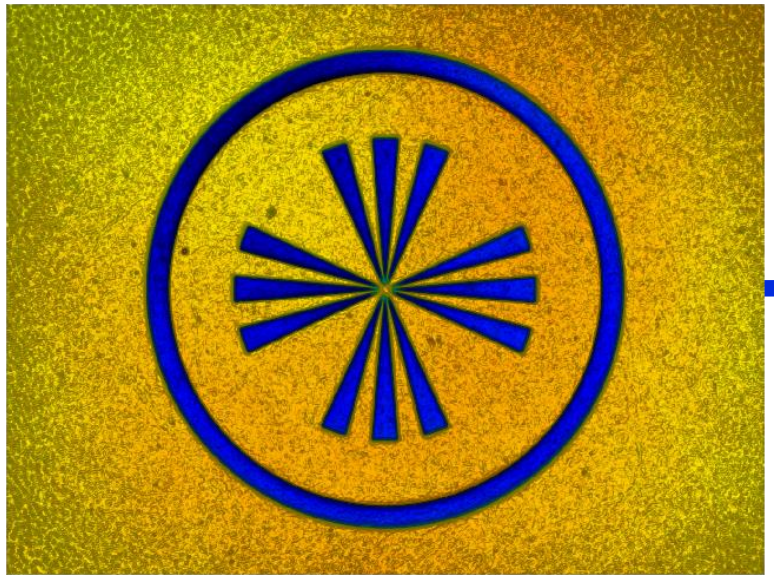
NPL
Areal Lateral Calibration Software

Statistic study of the differences

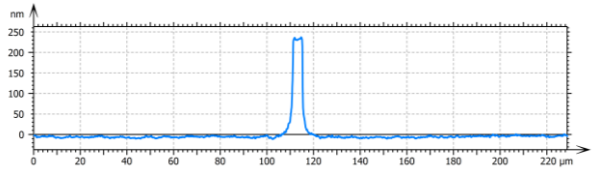
Amplification and Perpendicularity Parameter

$u_{T-X/Y}$

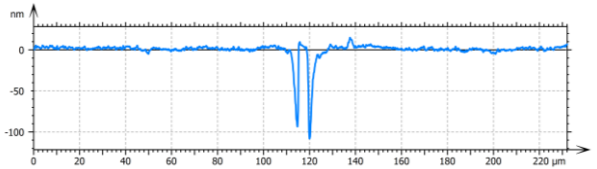
Calibration of X and Y axes



ASG
Lateral Resolution

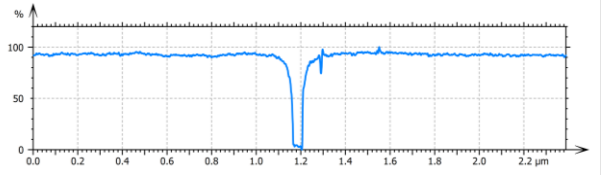


Extracted prodiles of two adjacent petals



Laretal Resolution Parameter

u_{res}



Subtracted profiles

Beam Characterization

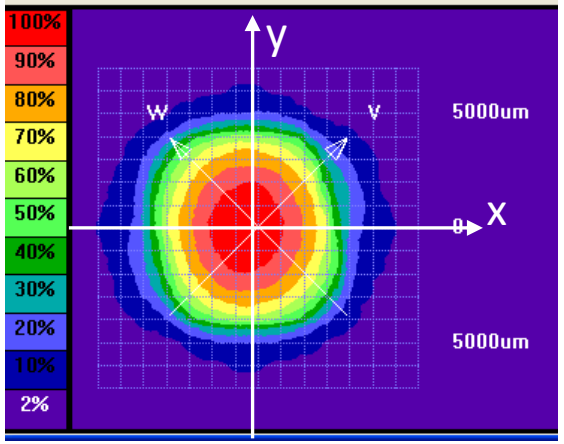
Beam **Master**

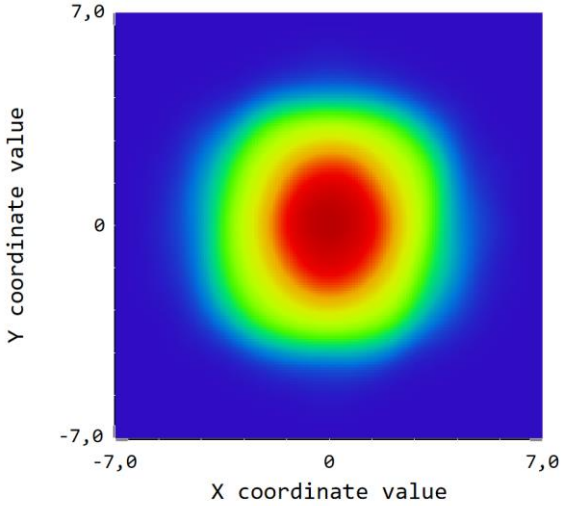
LED Source Modeling

Experimental Results

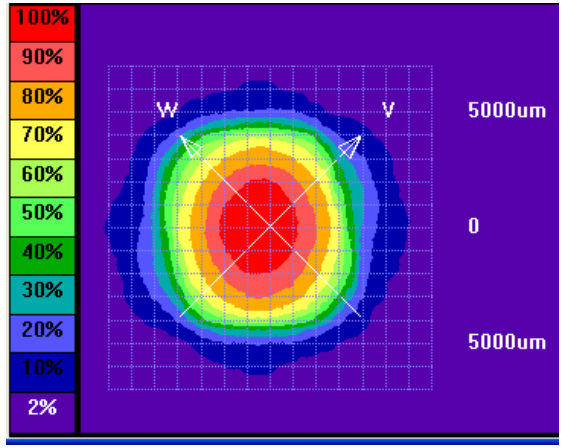
Zemax Results

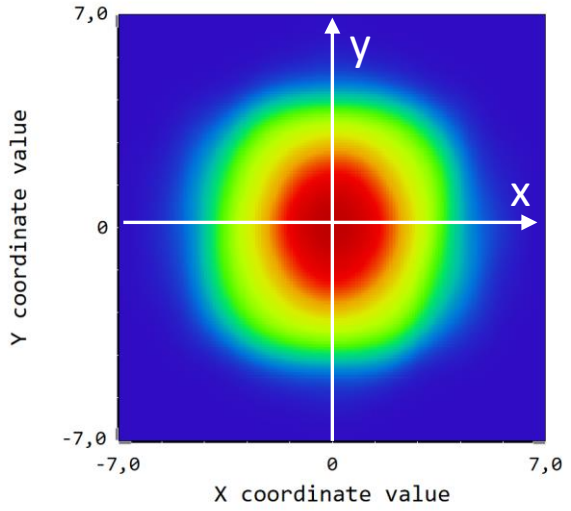
LED source

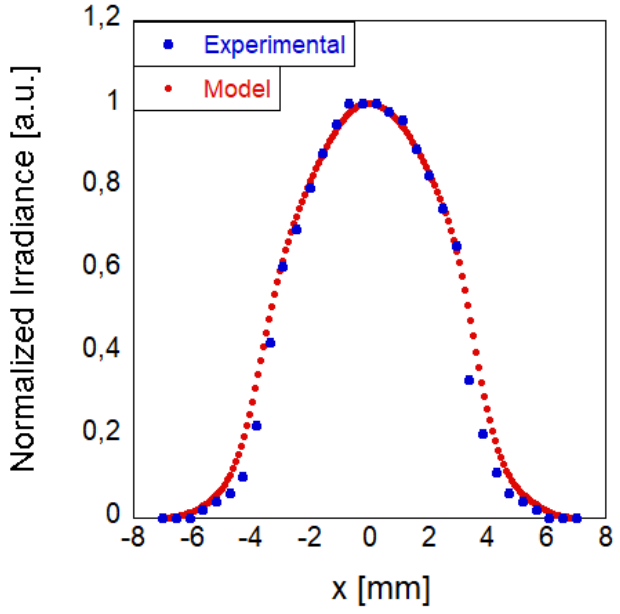


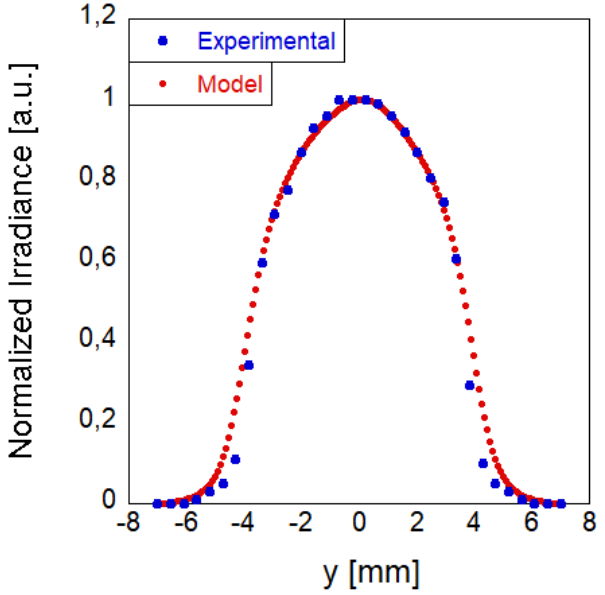


LED source + 11 cm



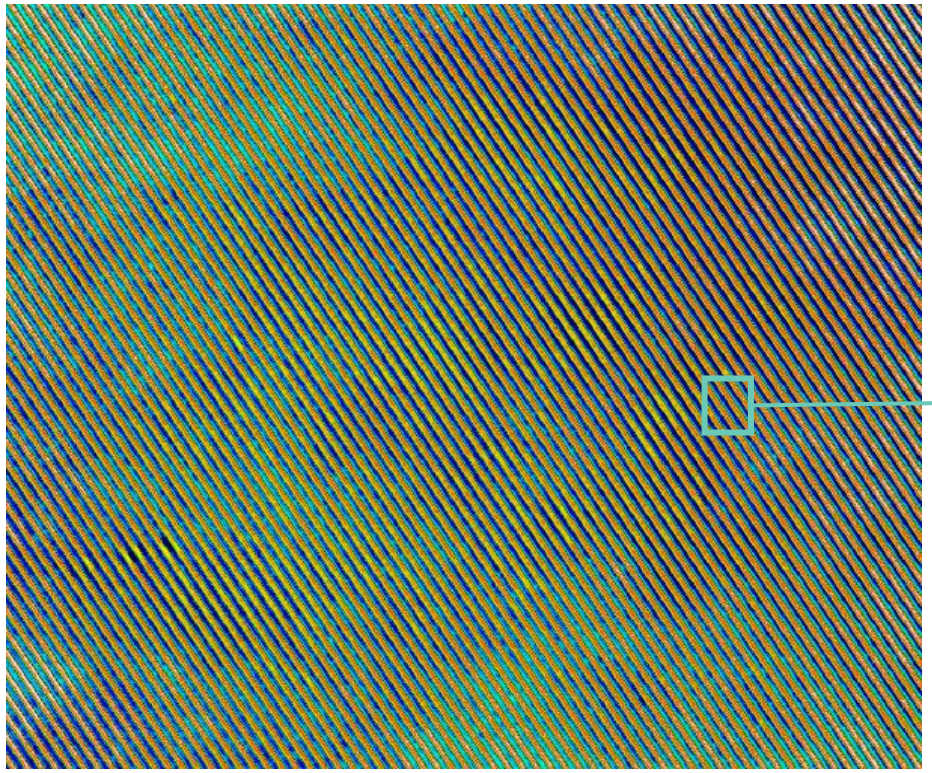


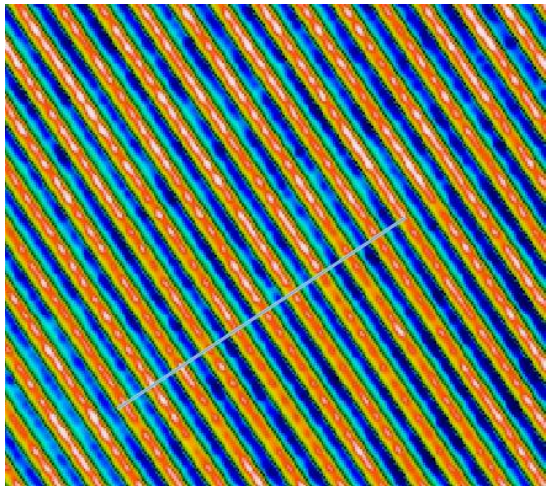




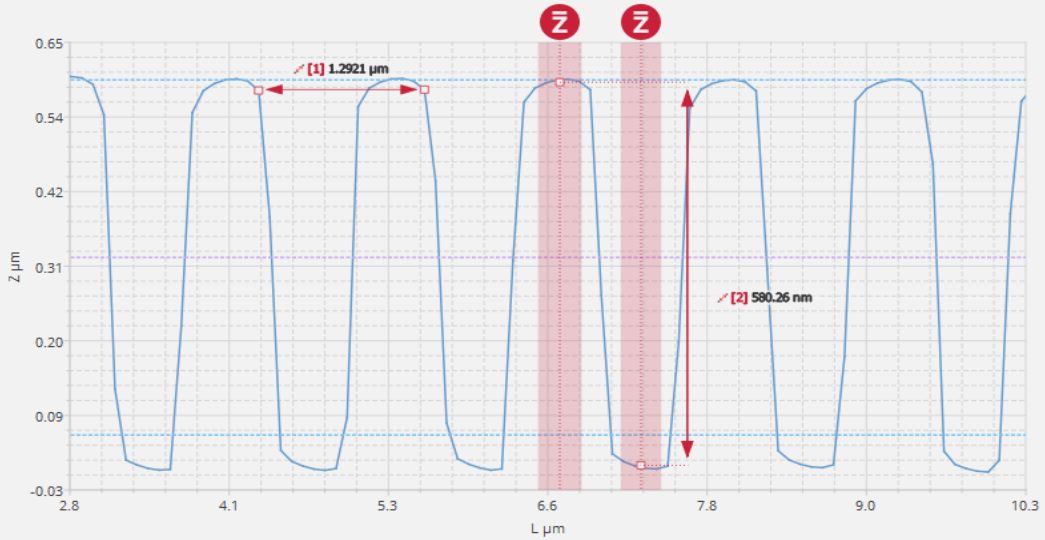
Beam Characterization

Diffuser Characterization



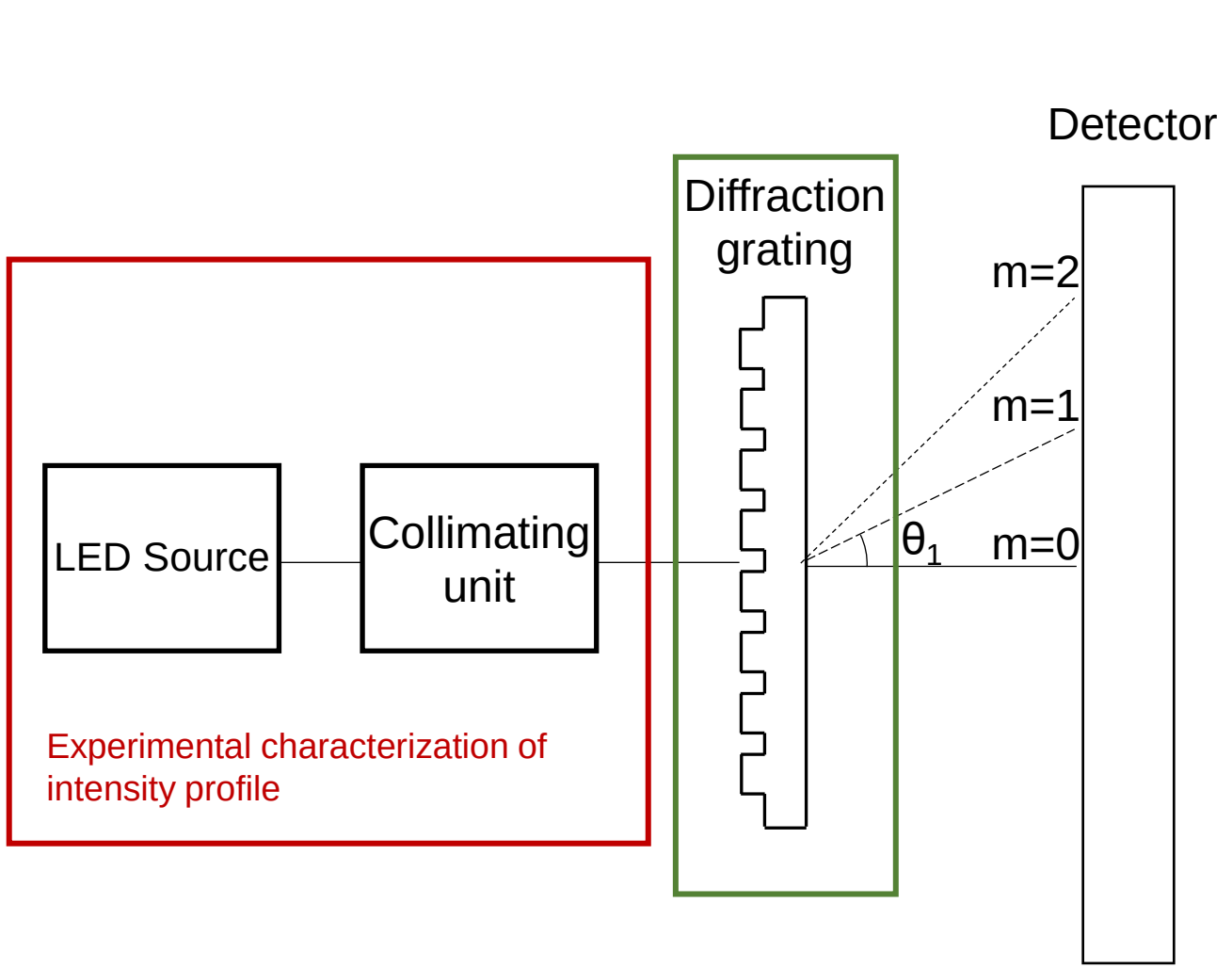


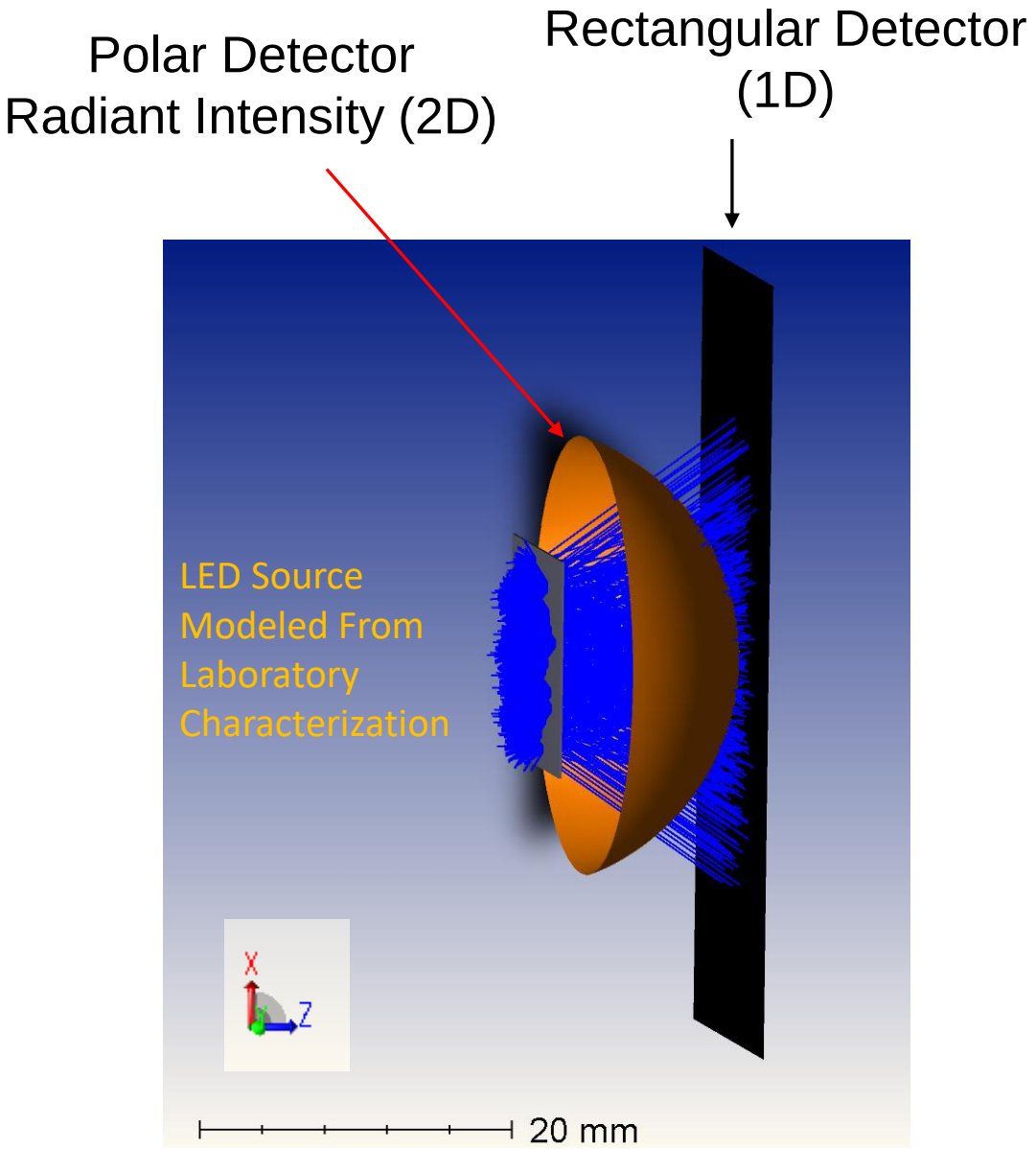
Nominal Pitch = **1,28 µm**
Nominal Height = **610 nm**



150X Objective
Measurement

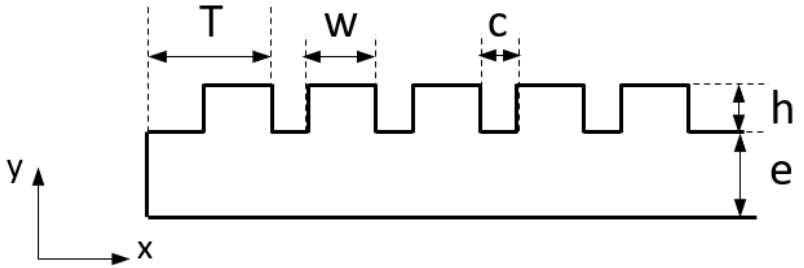
Functionality Simulation (Zemax)





Sample Configurations

Ref	T [µm]	c [µm]
1	1.28	0.73
2	1.28	0.73 + Δ
3	1.28	0.73 – Δ
4	1.28 + Δ	0.73
5	1.28 + Δ	0.73 + Δ
6	1.28 + Δ	0.73 – Δ
7	1.28 – Δ	0.73
8	1.28 – Δ	0.73 + Δ
9	1.28 – Δ	0.73 – Δ



T → Grating period
w → Wall width
c → Channel width
h → Height

$\Delta = u_{X/Y}$

Ref	T [µm]	c [µm]
1	1.28	0.73
2	1.28	0.73 + Δ
3	1.28	0.73 – Δ
4	1.28 + Δ	0.73
7	1.28 – Δ	0.73

Results

Calibration of Z axis

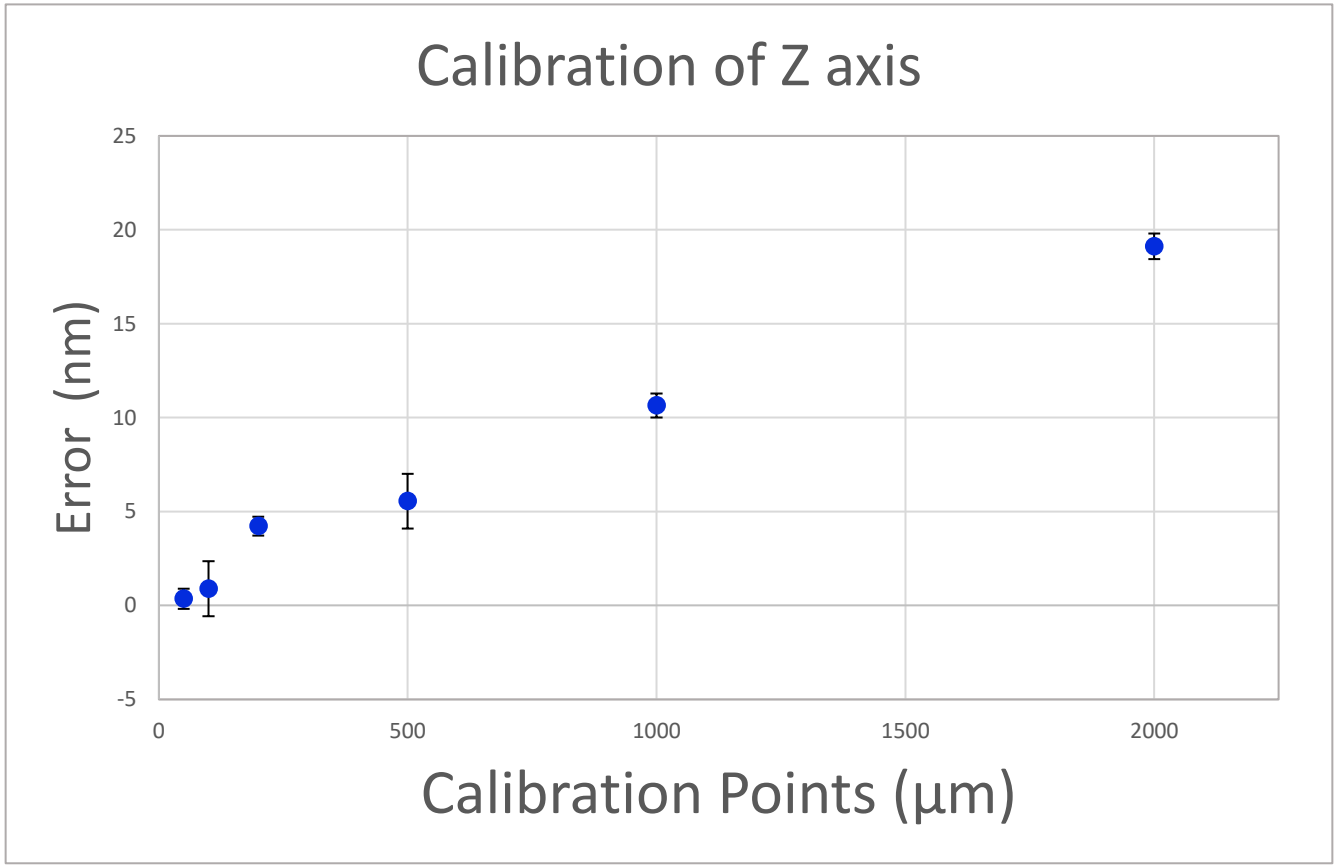
Noise Contribution

S_{qnoise} 150x (nm)
0.675

Flatness Deviation

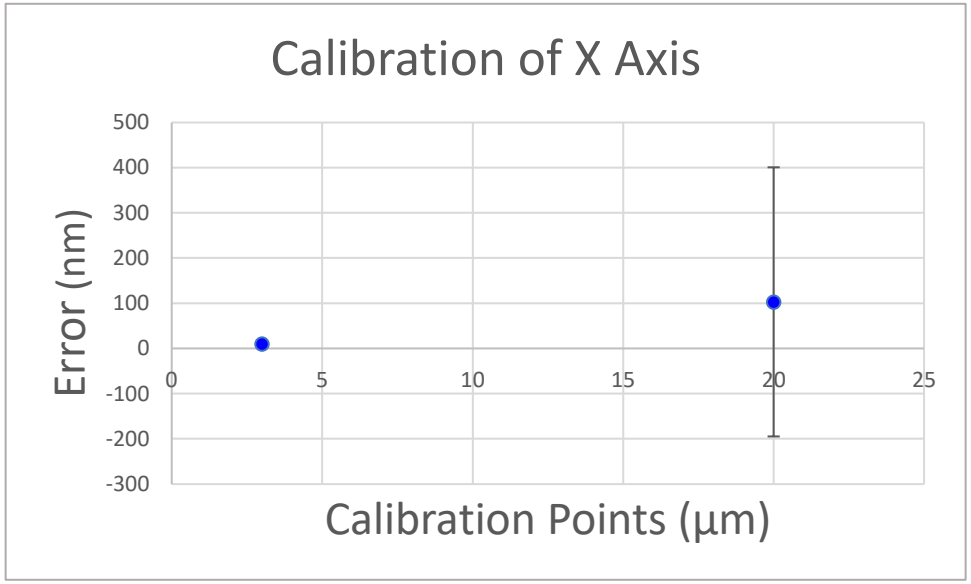
$S_{zflatness}$ 150x (nm)
102.685

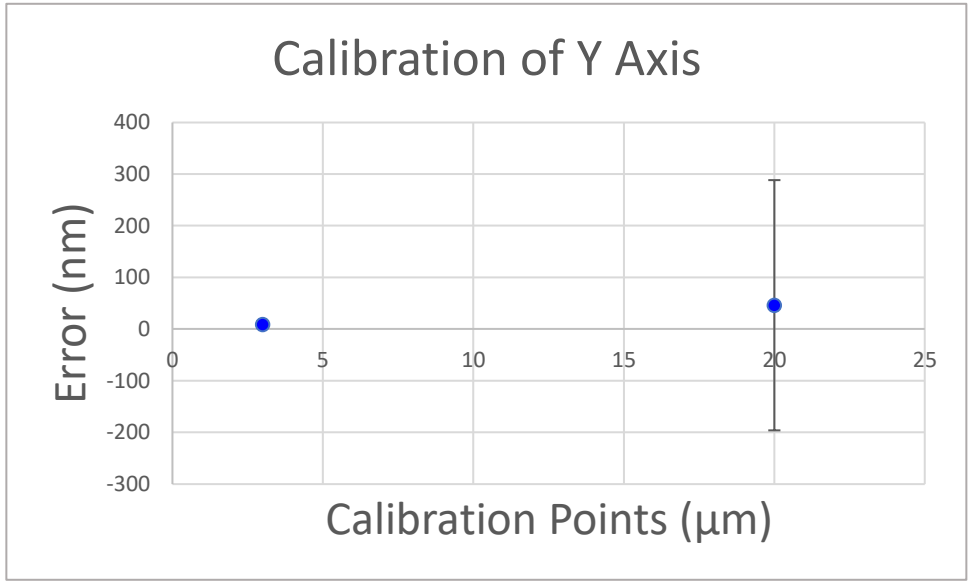
Amplification and Perpendicularity



Calibration of X and Y axes

Amplification and Perpendicularity





Lateral Resolution

u_{res} **150x (µm)**
0.391

Calibration Results for 150X Confocal Objective

Z Uncertainty

$$u_{NF} = \sqrt{S_{qnoise}^2 + \frac{S_{zflatness}^2}{12}}$$

$$u_Z = \sqrt{u_{NF}^2 + u_{T-Z}^2}$$

X/Y Uncertainty

$$u_{T-X/Y} = \sqrt{u_{traceability}^2 + u_{reproducibility}^2 + u_{error}^2}$$

$$u_X = \sqrt{u_{Res}^2 + u_{T-X}^2}$$

$$u_Y = \sqrt{u_{Res}^2 + u_{T-Y}^2}$$

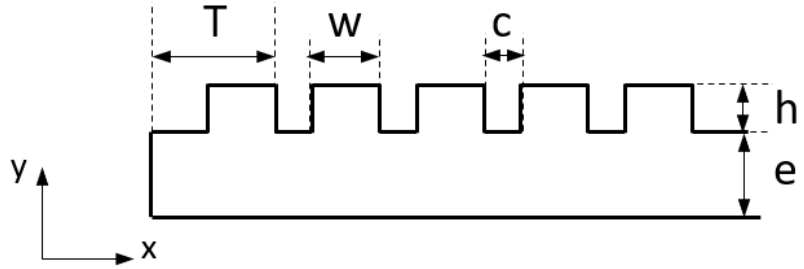
$u_X = 0.392\ \mu m$

$u_Y = 0.395\ \mu m$

$u_Z = 36.049\ nm$

Functionality Simulation

$$\Delta = 0.395\ \mu m$$



T → Grating period
w → Wall width
c → Channel width
h → Height

Ref	T [µm]	c [µm]	θ [º]		I [%]	
			m1	m2	m1	m2
1	1.28	0.73	20	44	52	1.77
2	1.28	0.73 + Δ = 1.125	20.6	44.68	95	82.2
3	1.28	0.73 – Δ = 0.335	20.6	44.68	9.98	4.6
4	1.28 + Δ = 1.675	0.73	15.6	32.5	30.6	1.2
7	1.28 – Δ= 0.885	0.73	30.6	-	90.4	-

Fraunhofer Diffraction

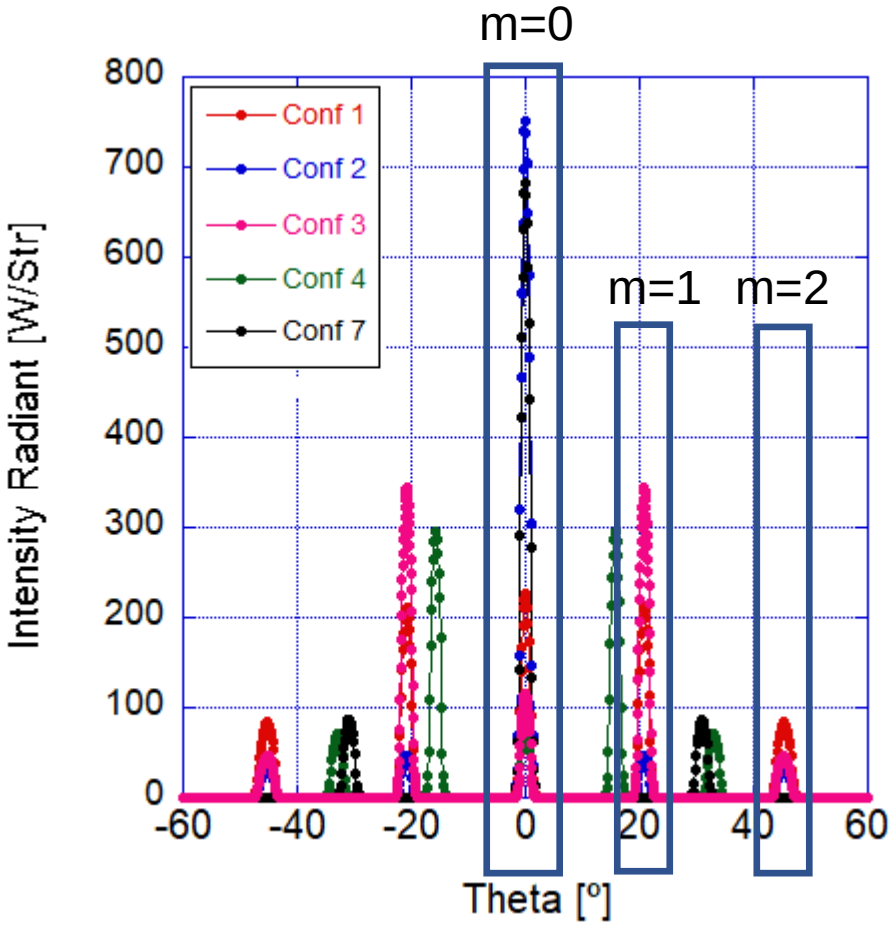
$$I(\theta) = I(0) \cdot \left[\frac{sen\beta}{\beta}\right]^2$$

$$\beta = \frac{2\pi}{\lambda} \cdot \frac{c}{2} \cdot sen\theta$$

$$\theta = asen\left(\frac{m\lambda}{T}\right)$$

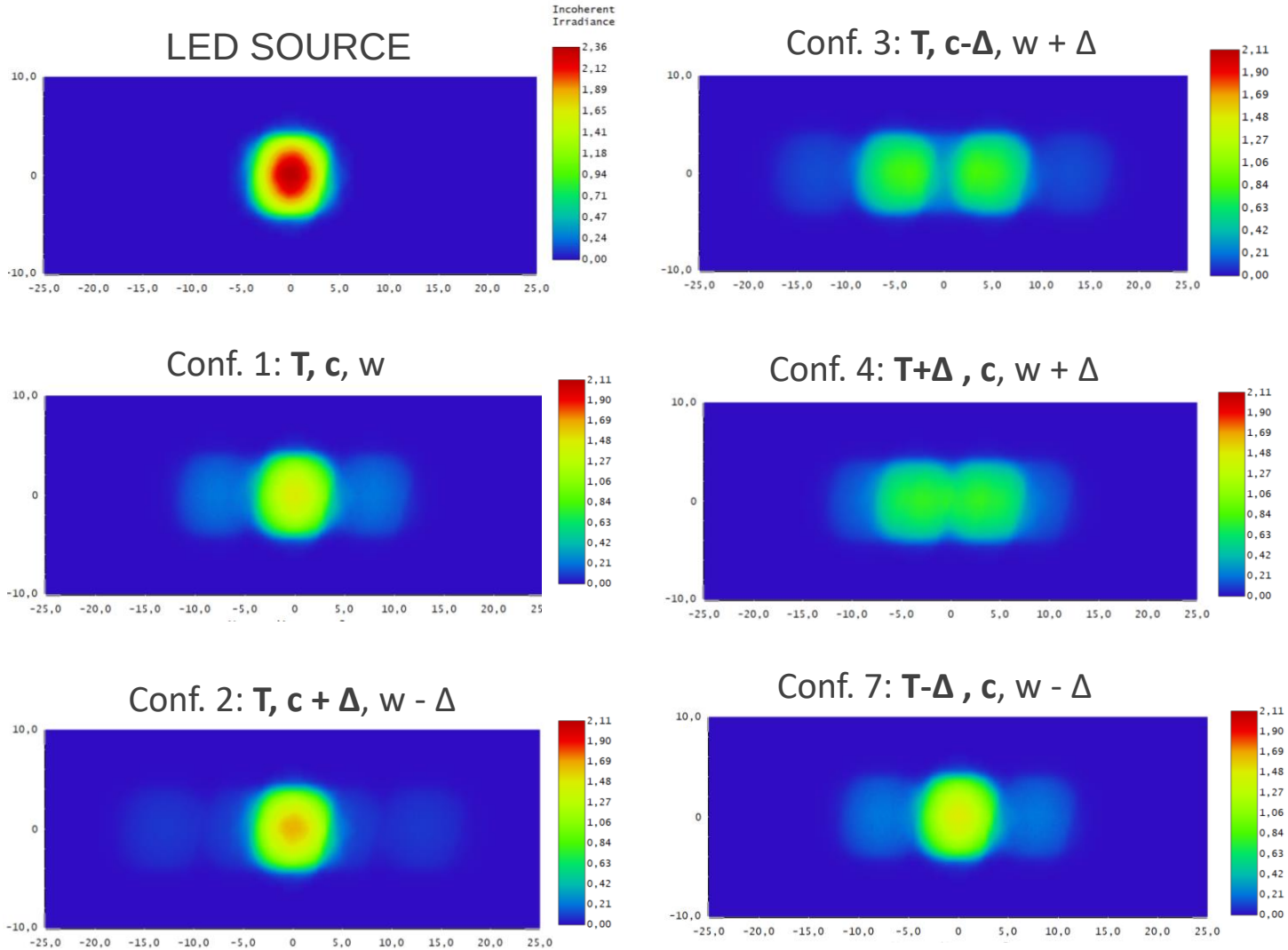
Simulation Results

Rectangular Detector (1D)



Conf. 1, 2 and 3
same diffraction angles

Polar Detector (2D)



Conclusions

Conclusions

- Calibration of Confocal Microscopy 150x Objective has been carried out.
- Optical functionality of surface structured samples has been simulated.
- To have a good estimation of this functionality a real light source has been simulated.
- Variations on the period and channel width of the structures have been proven to produce noticeable changes on the optical functionality of the proposed samples.

Thank you!

Tekniker
Parke Teknologikoa
C/ Iñaki Goenaga, 5
20600 Eibar (Gipuzkoa)
Tel: +34 943 20 67 44

CONTACT
Jesús Paredes
jesus.paredes@tekniker.es