Master thesis

Portable Low-Cost Confocal Microscope Based on Pinhole Array and Smartphone

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Collaborator:

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Introduction

Advantage

- **Optical sectioning**.
- High resolution.
- Blocking defocused.
- Scattered light.
- Depth imaging.

Disadvantage

- **Bulky system**.
- **High cost**.

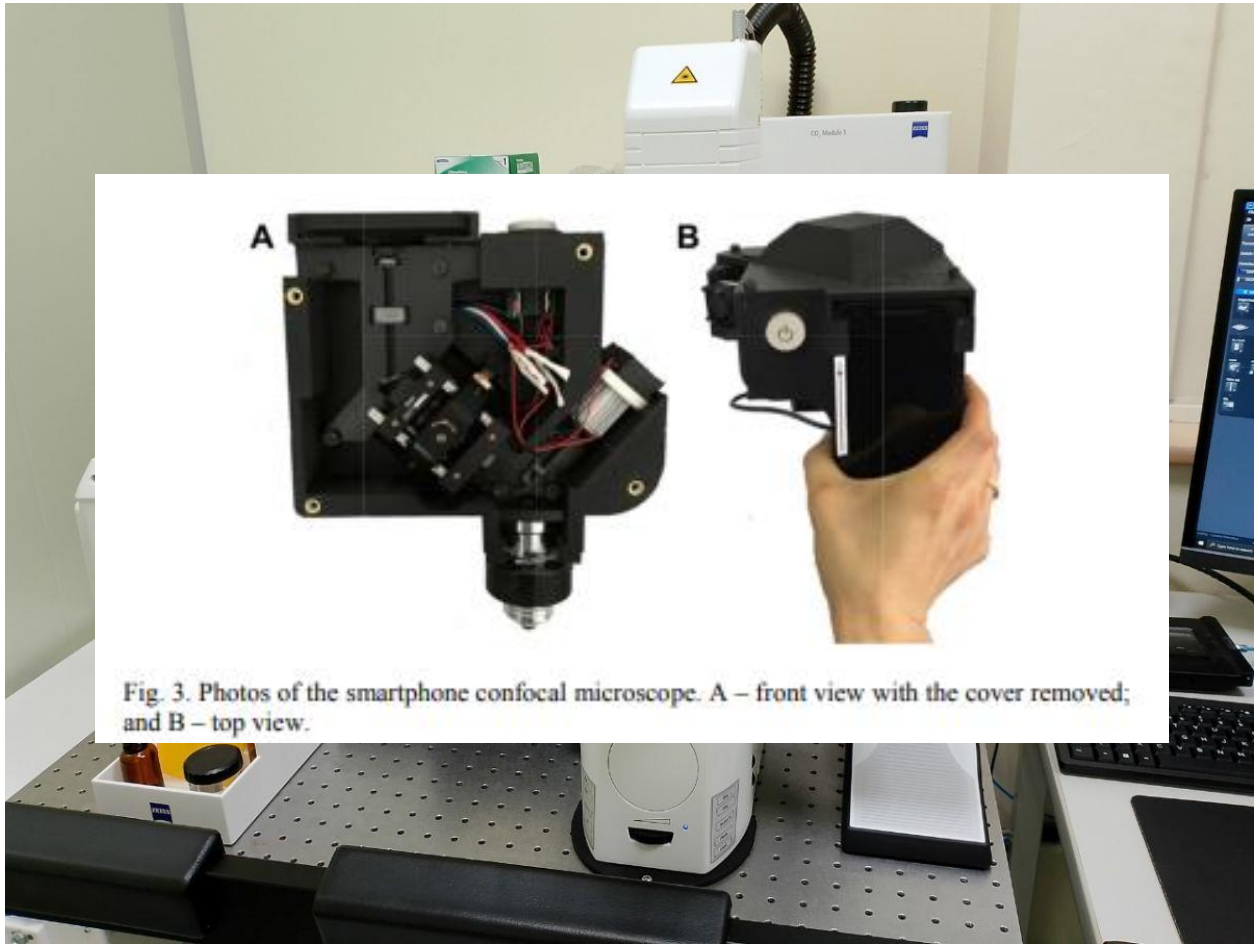


Fig. 3. Photos of the smartphone confocal microscope. A – front view with the cover removed; and B – top view.

US350,000=NTD10,000,000

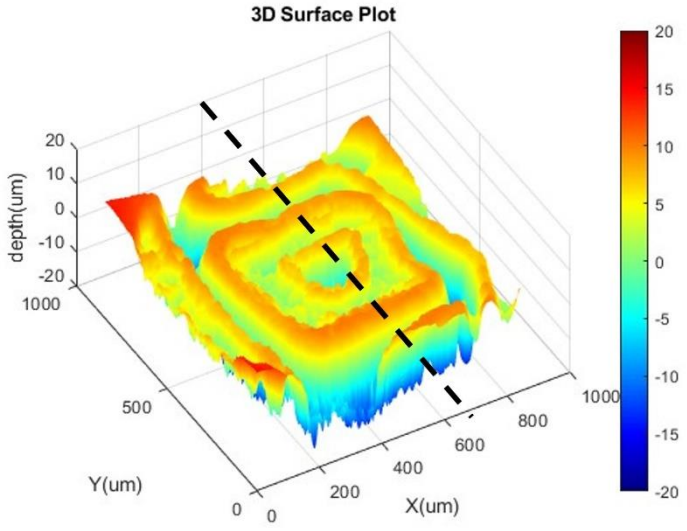
Conclusion

limitation

The cost is approximately NTD 60,000 .

- Without ambient light
- Image need to be aligned
- Two smartphone

Components	NTD
Lens*4	2870
DMLP567	6000
FGL495	1300
EBS1	1150
Optomechanical components	22000
Smartphone*2	10600
Objective lens	14420
Total	58340



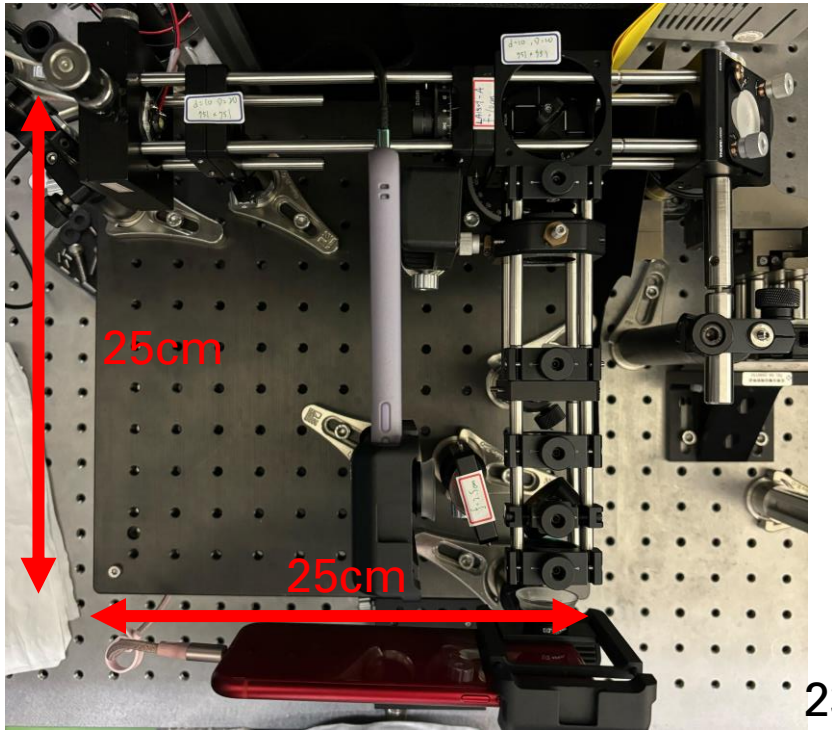
Resolution

Horizontal Resolution of 20X is 2.19 um.

Theoretical Resolution of 20X is 1.99 um.

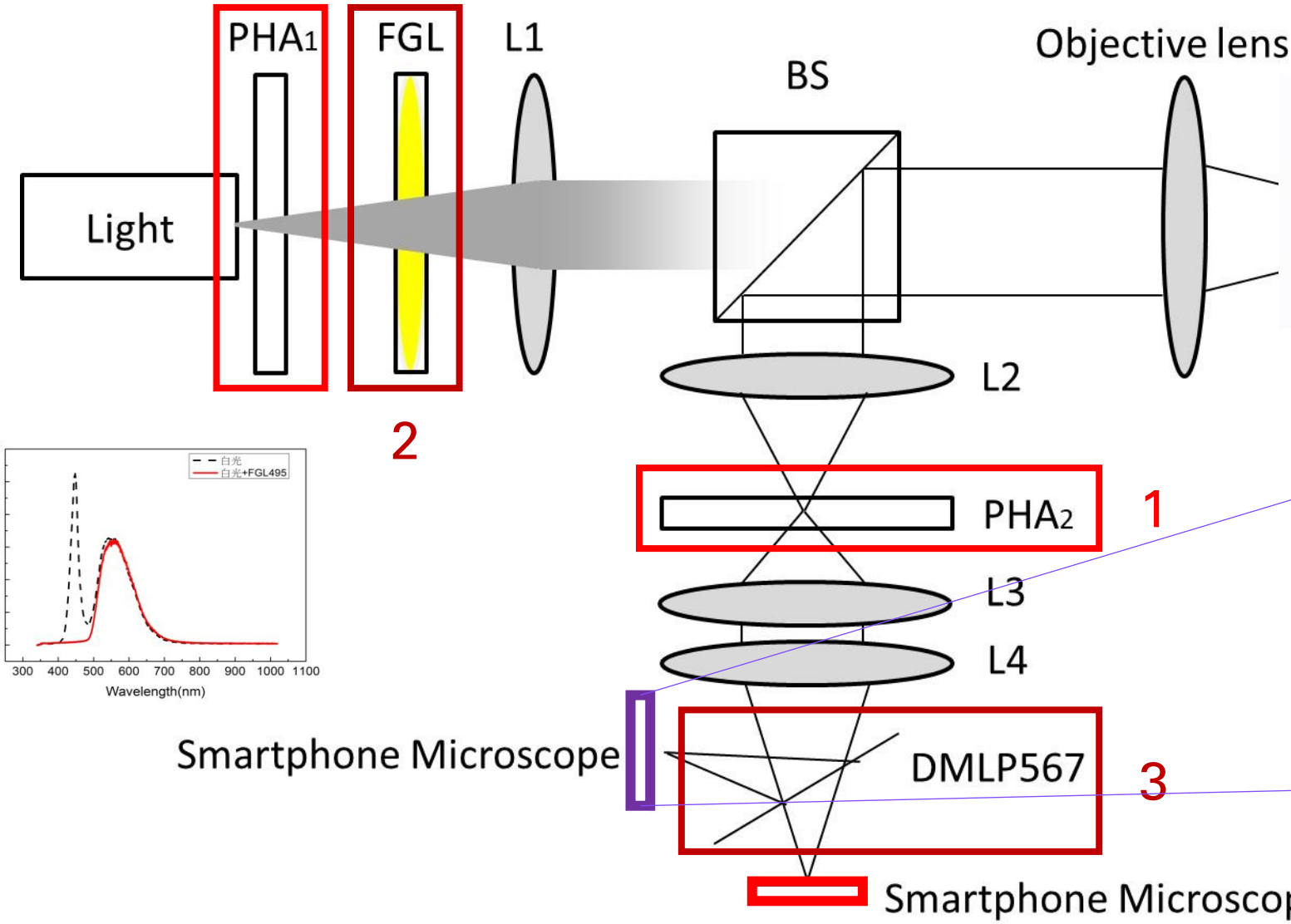
Vertical sensitivity of 20X is 0.5 um.

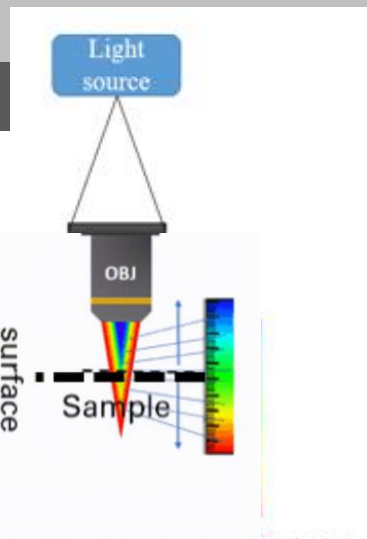
Portable Confocal Microscope

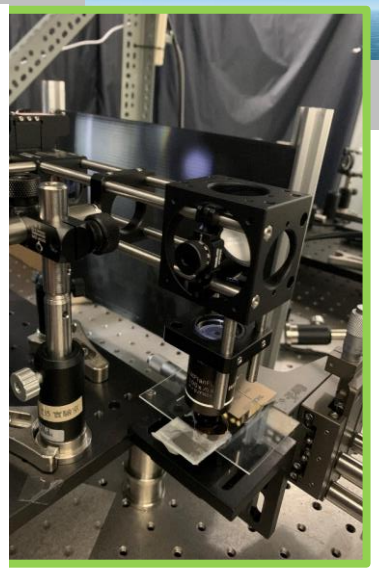


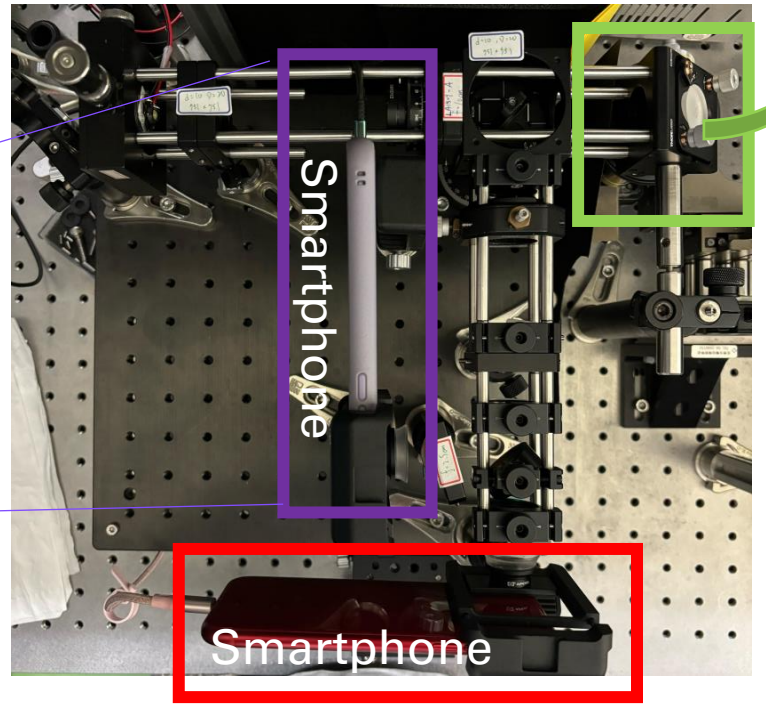
Confocal microscopy theory

Pinhole array confocal microscope









Master thesis Outline

- Introduction & Conclusion
- Theory
- Experimental process
- Results

Experimental process

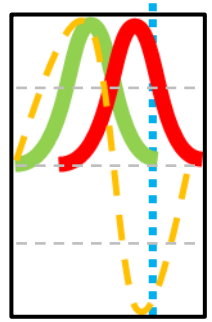
Part1:Image process

Obtain a 2D image stack.

Align the transmission and reflection image stacks.

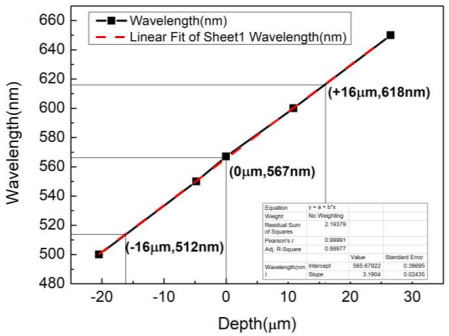
Select the region where the pinhole is clear, plot the z-axis curve to obtain the 1D longitudinal response curve.

Normalize each image stack, then subtract them to obtain the slope of the linear region.

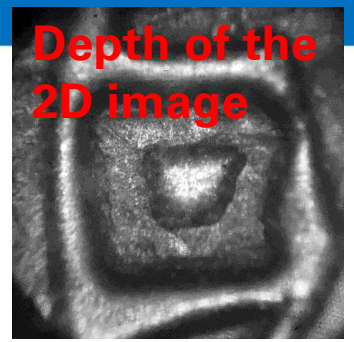


Part2:

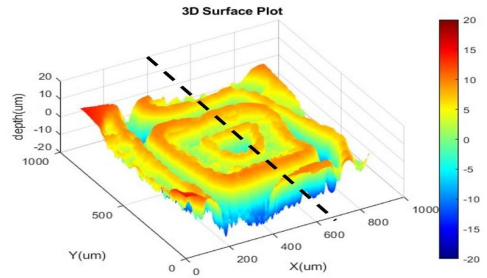
Establish a calibration curve.



Divide the image's light intensity by the slope of the linear region to convert it into depth information.



Use MATLAB for 3D rendering to visualize the data and calculation results for analysis and interpretation.



Experimental process

Part1

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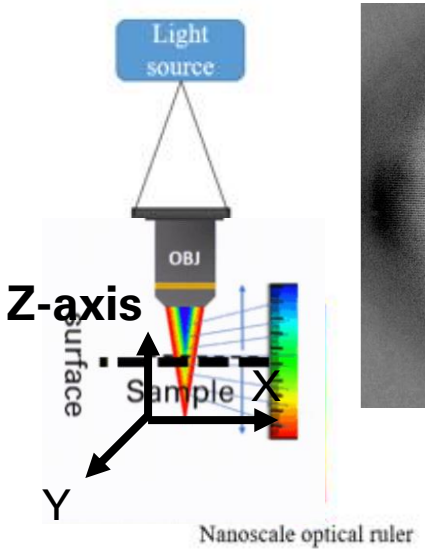
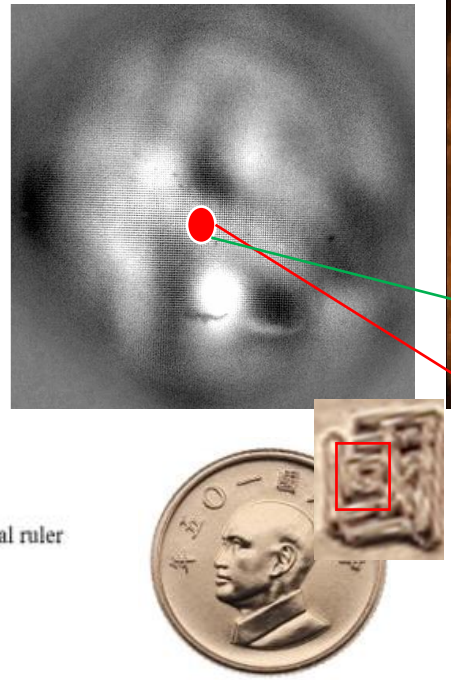
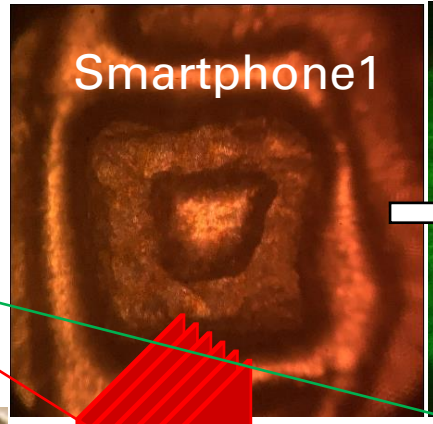
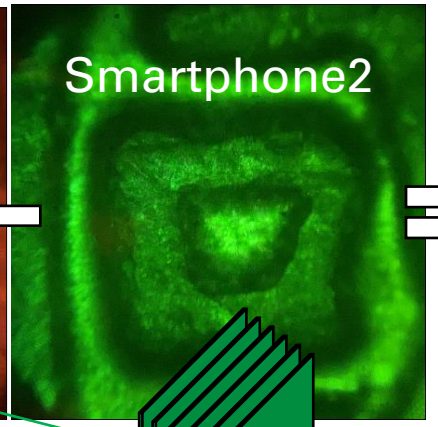
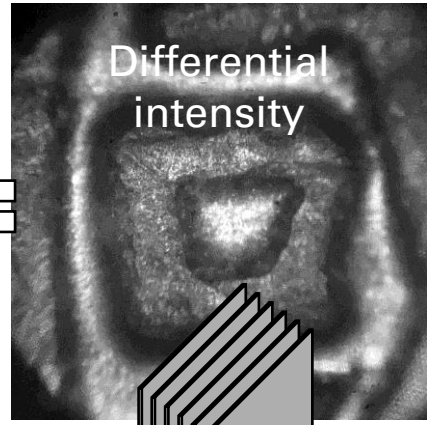


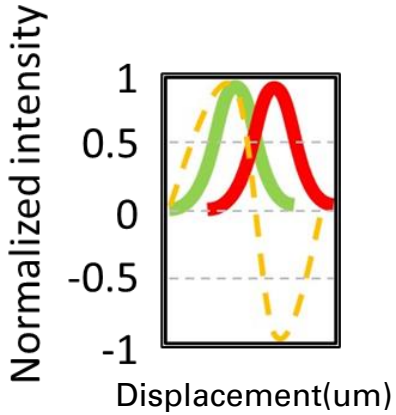








Response curve



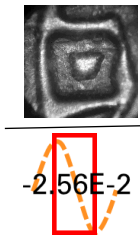
Experimental process

Part2

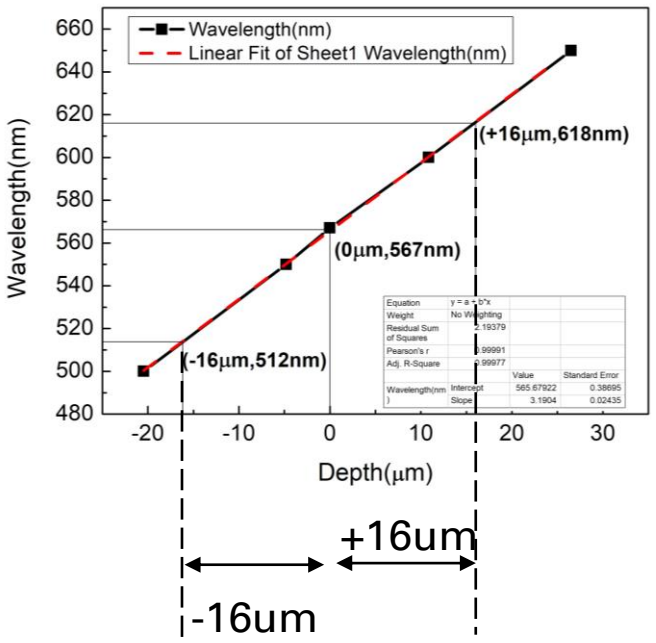
Establish a calibration curve. → Divide the image's light intensity by the slope of the linear region to convert it into depth information. → Use MATLAB for 3D rendering to visualize the data and calculation results for analysis and interpretation.

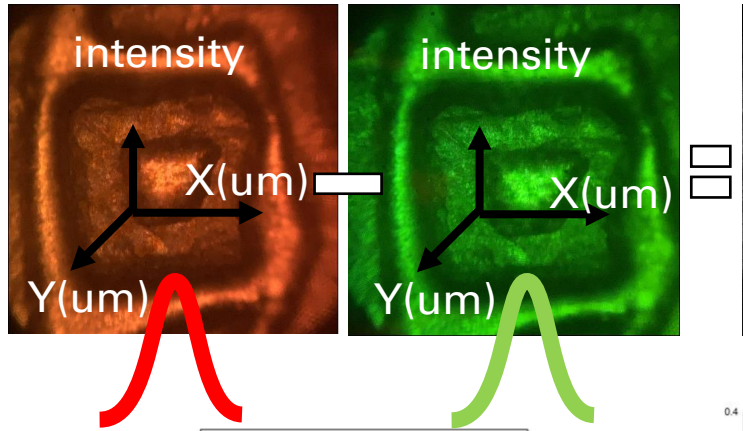
Depth of 2D image:

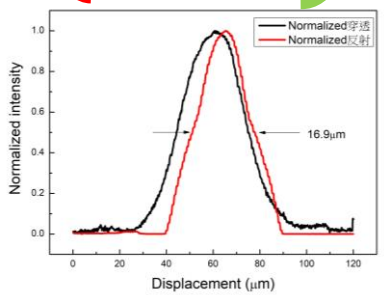
$$\frac{Differential\ intensity}{slope(\frac{Differential\ intensity}{depth})}$$



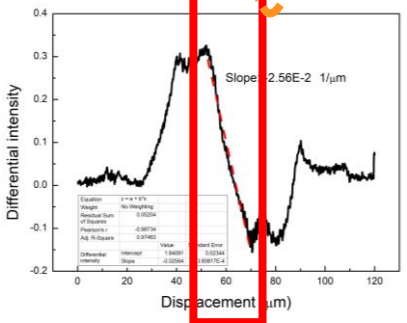
MATLAB

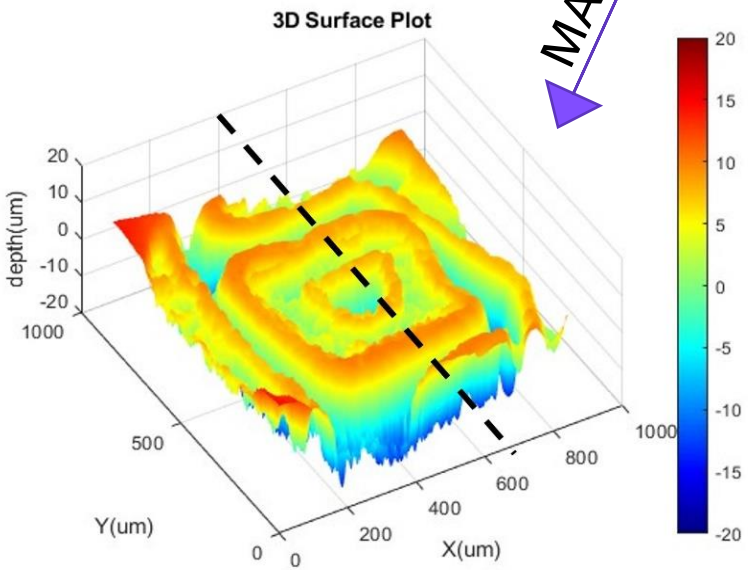






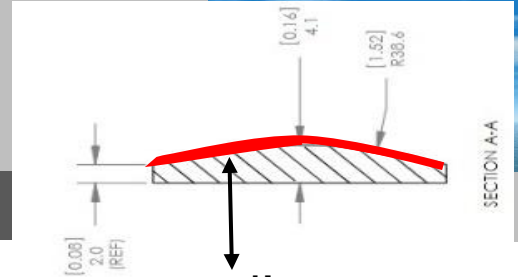
Linear region





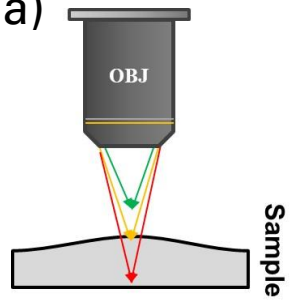
Slope:-2.56E-2
(differential intensity/depth)

Experimental results-Tunable lens



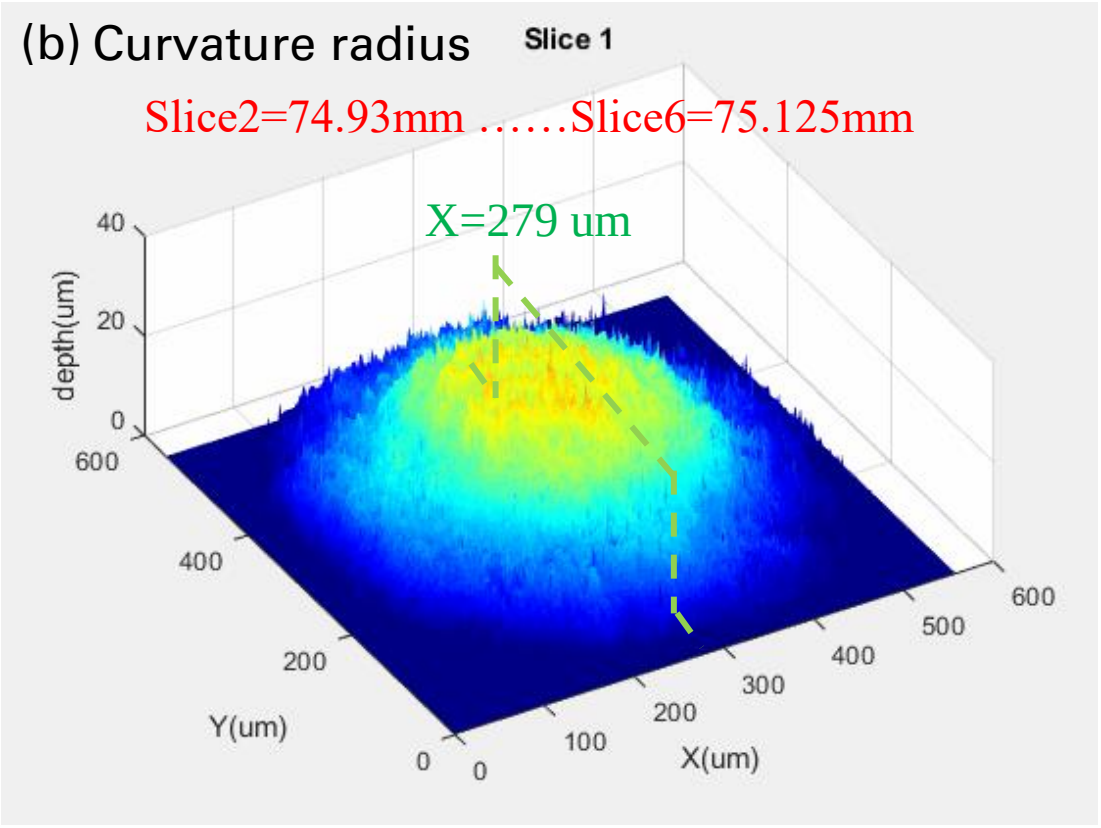
Curvature radius

(a)



I(mA)	111.06	114.88	115.02	115.16	115.3	115.44	119.21
Focal length(mm)	76.49	75.125	75.07	75.02	74.978	74.93	73.65
Surface change(um)	-16.18um (2899.06)	-1.11um (2914.13)	-0.55um (2914.69)	0um (2915.24)	0.55um (2915.79)	1.1um (2916.34)	15.97um (2931.21)

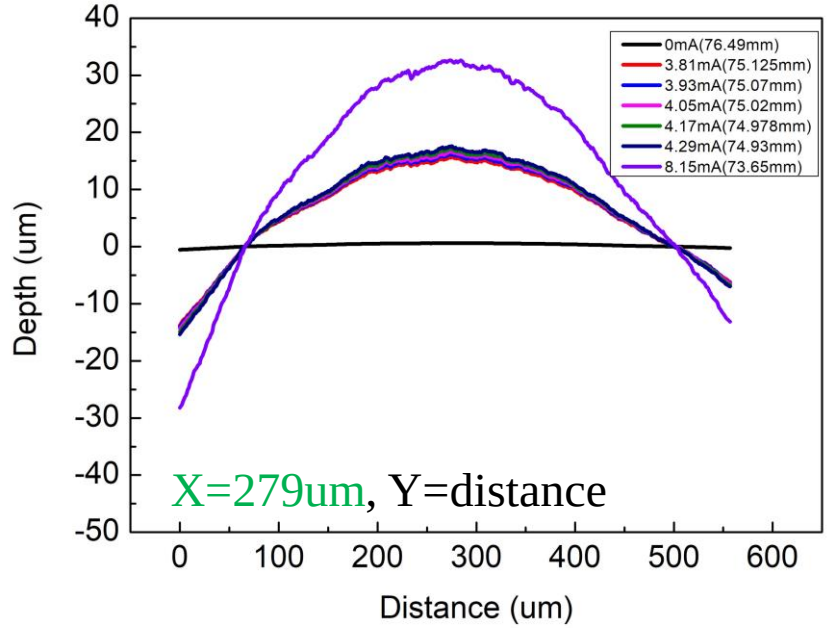
(b) Curvature radius



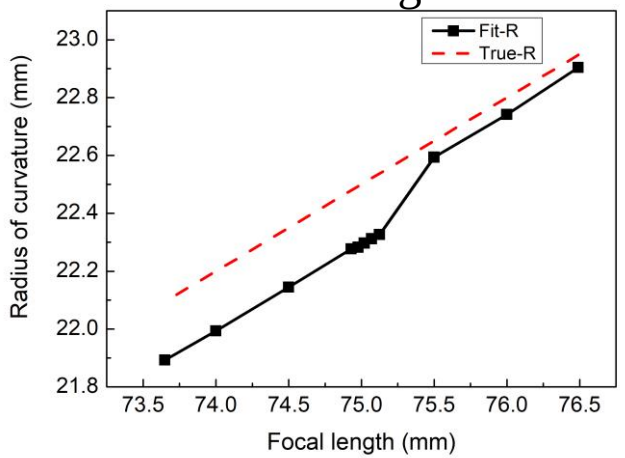
thick lens equation

$f = R/(n-1)$

(c)



Fitting



Residual