

Product Documentation

Zone Plates

Project XR369

April 20, 2026

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Technical responsible: Damien ESCHIMESE

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1 Design specifications

Zone plate specifications:

- Quantity: 3 chips, 8 ZPs per chips
- 2 ZP designs: Spitzbuebe and Vermicelles
- 4 diameters: 140, 170, 200, and 250 μm
- Contrast material: Iridium
- Conformal ALD deposition: 35 nm
- Resist template CD: HSQ 25nm
- Thickness: 500 nm minimum
- Central stops thickness: 9 μm minimum

Substrate specifications:

- Membrane material: silicon nitride (SiN)
- Membrane thickness: 1000 nm
- Membrane area: 1.2 mm \times 1.2 mm
- Frame material: Si
- Frame dimensions: 3 mm \times 3 mm \times 0.25 mm
- Coating: 5 nm Cr for HSQ adhesion, followed by 35 nm of Iridium

Layout:

- Provided by the customer
- Sample analysis by scanning electron microscopy (SEM) using a Hitachi Regulus 8230 and optical microscopy using a Keyence VHX-7000.

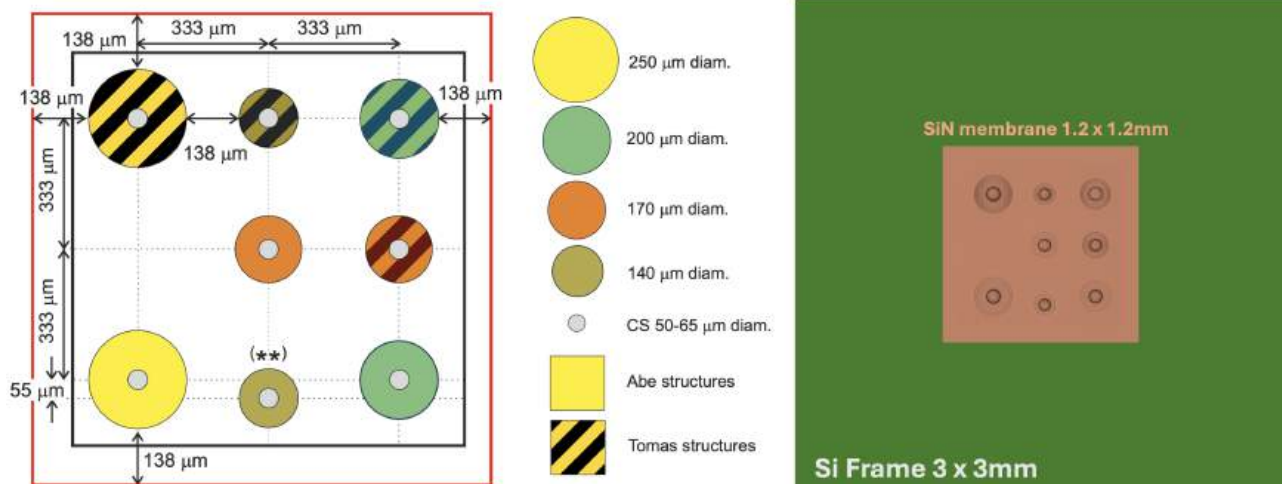


Figure 1: Left: design layout. Right: schematic of the ZPs on the substrate.

2 Inspection results

ZP type	Diameter (μm)	CS (μm)	CD(nm)	height (nm)
Spitzbuebe	140	75	23.8	782
	170	80	23.8	682
	200	85	23.8	730
	250	90	23.8	810
Vermicelles	140	75	25.8	630
	170	80	25.8	654
	200	85	25.8	638
	250	90	25.8	678

Table 1: SEM-based measurements data table

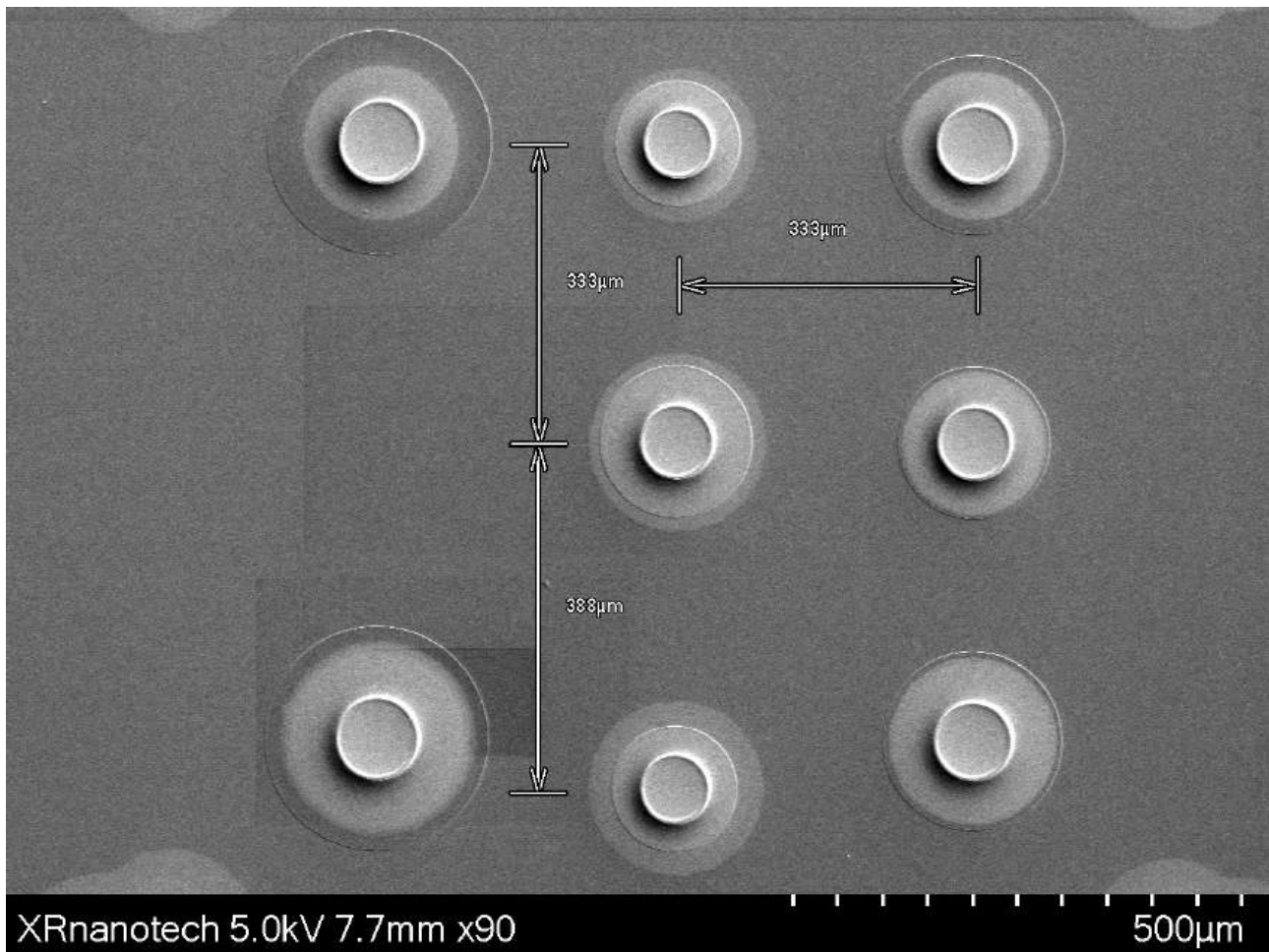


Figure 2: SEM overview of the fabricated ZPs

3 Product analysis

3.1 Spitzbuebe 140 μm

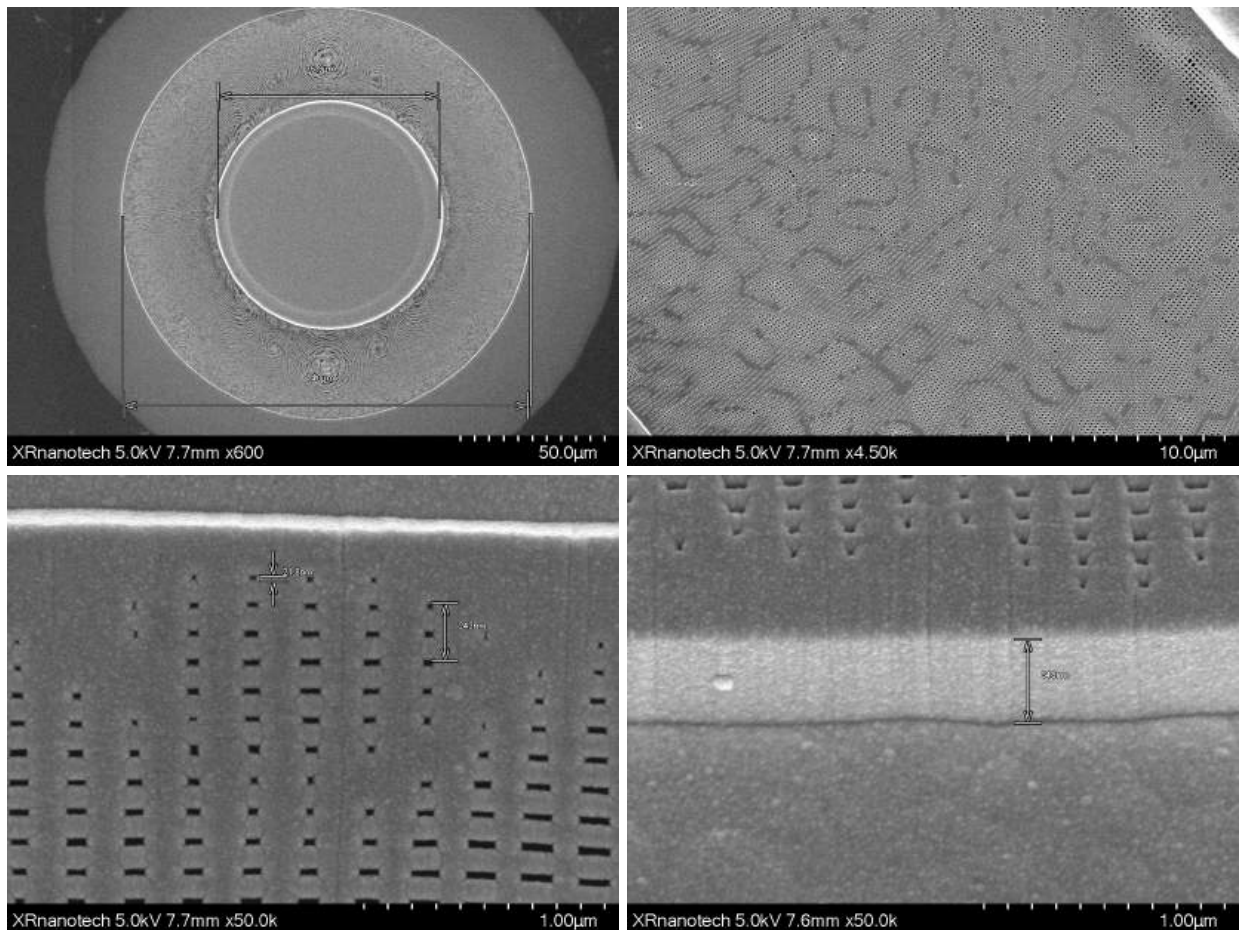


Figure 3: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.2 Vermicelles 140 μm

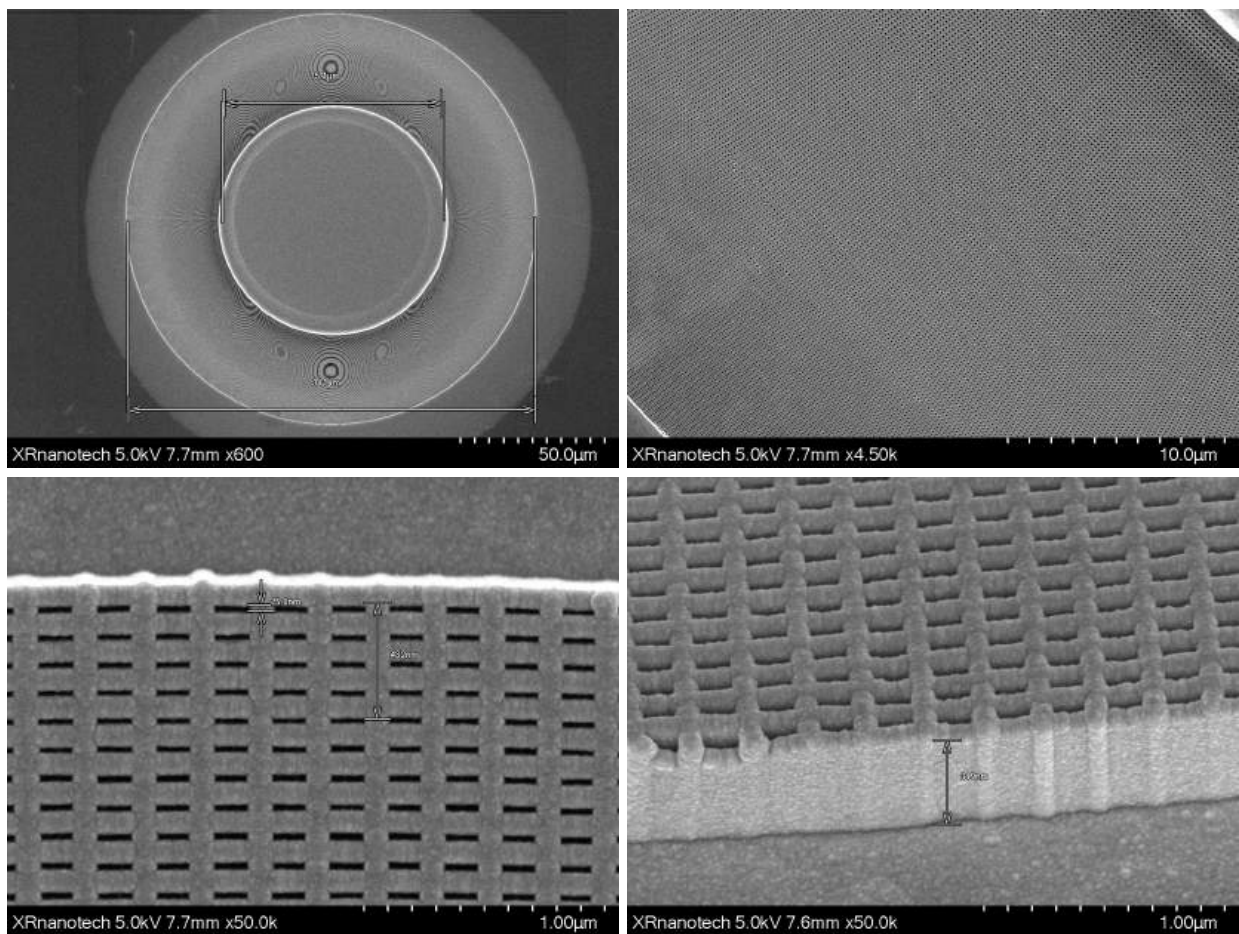


Figure 4: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.3 Spitzbuebe 170 μm

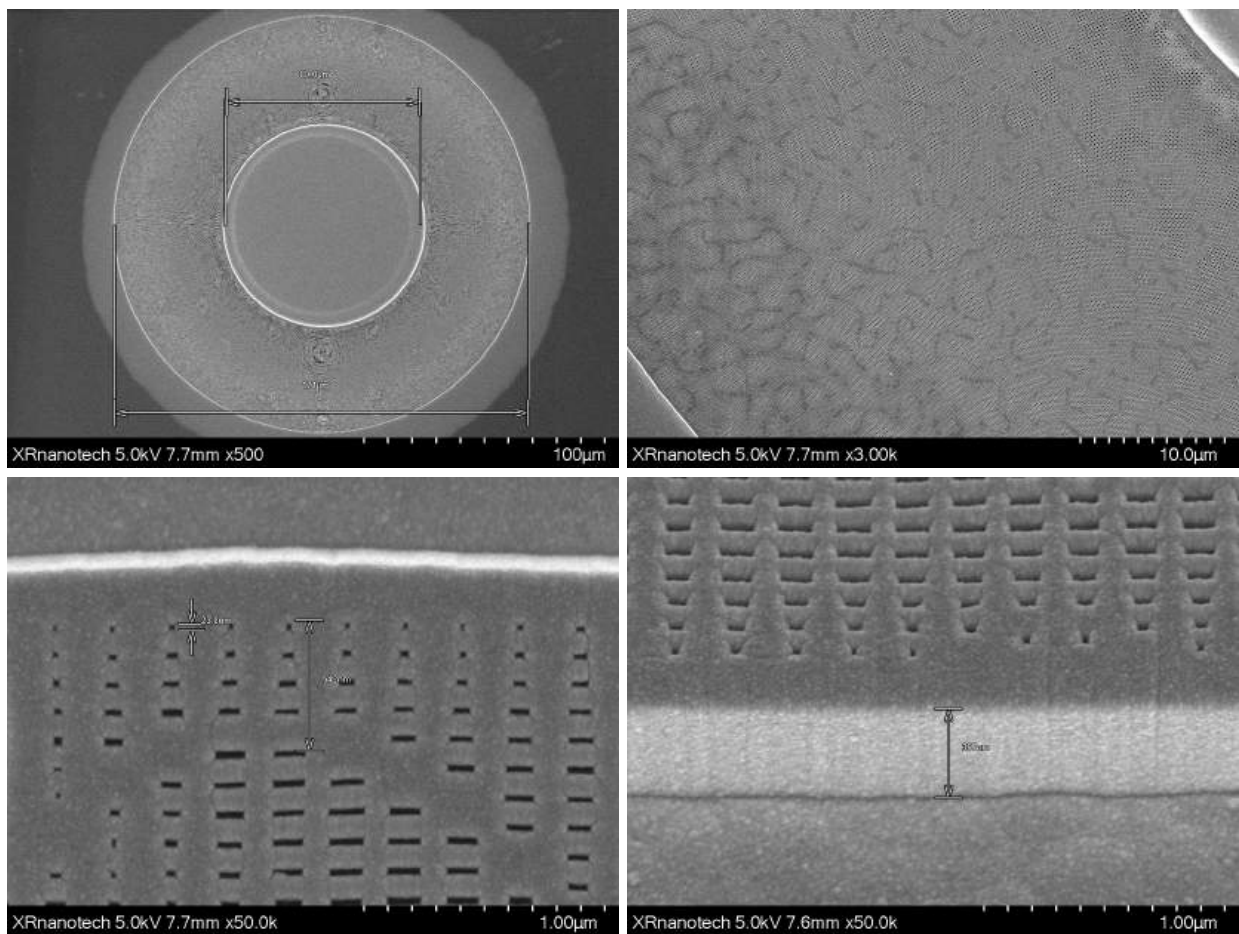


Figure 5: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.4 Vermicelles 170 μm

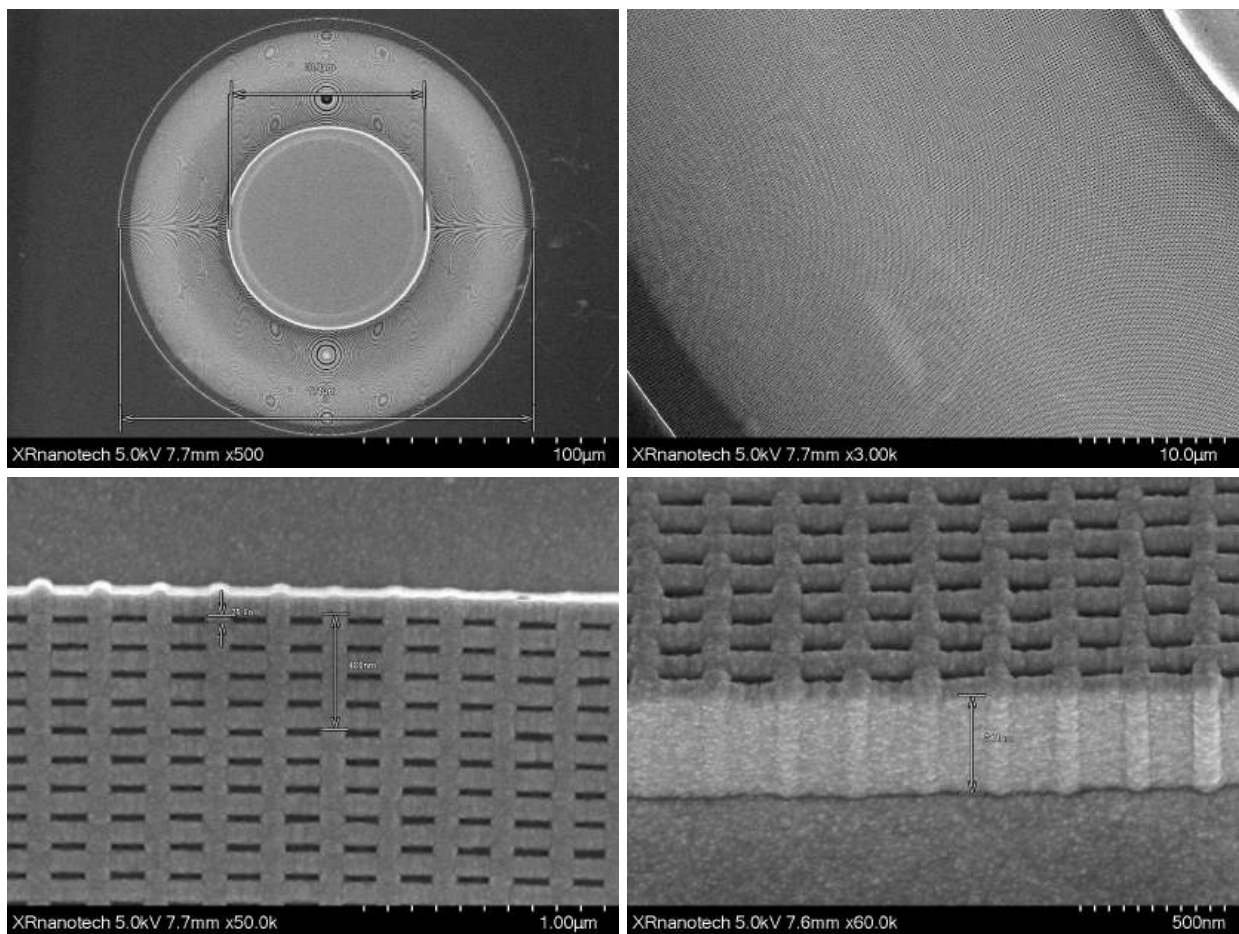


Figure 6: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.5 Spitzbuebe 200 μm

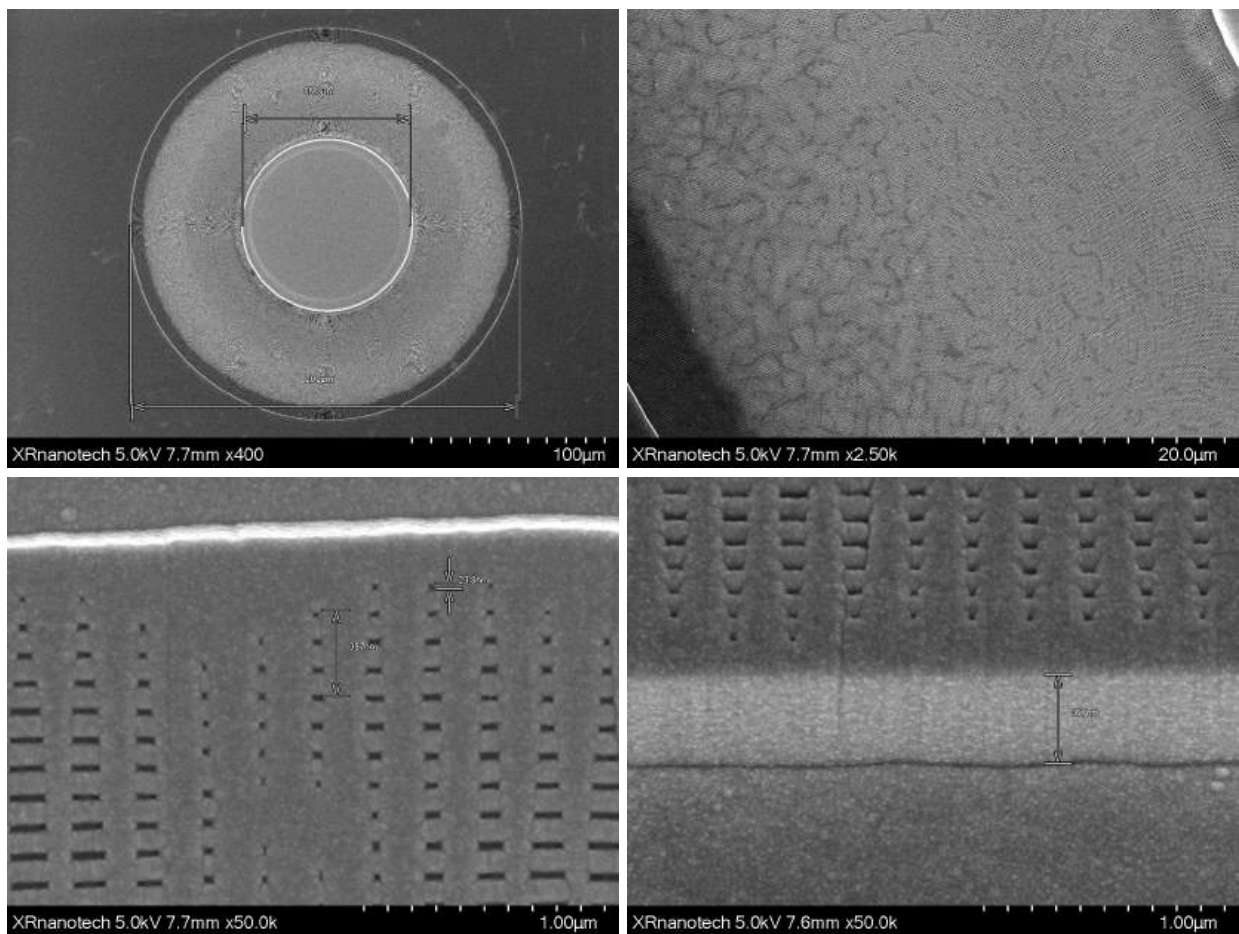


Figure 7: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.6 Vermicelles 200 μm

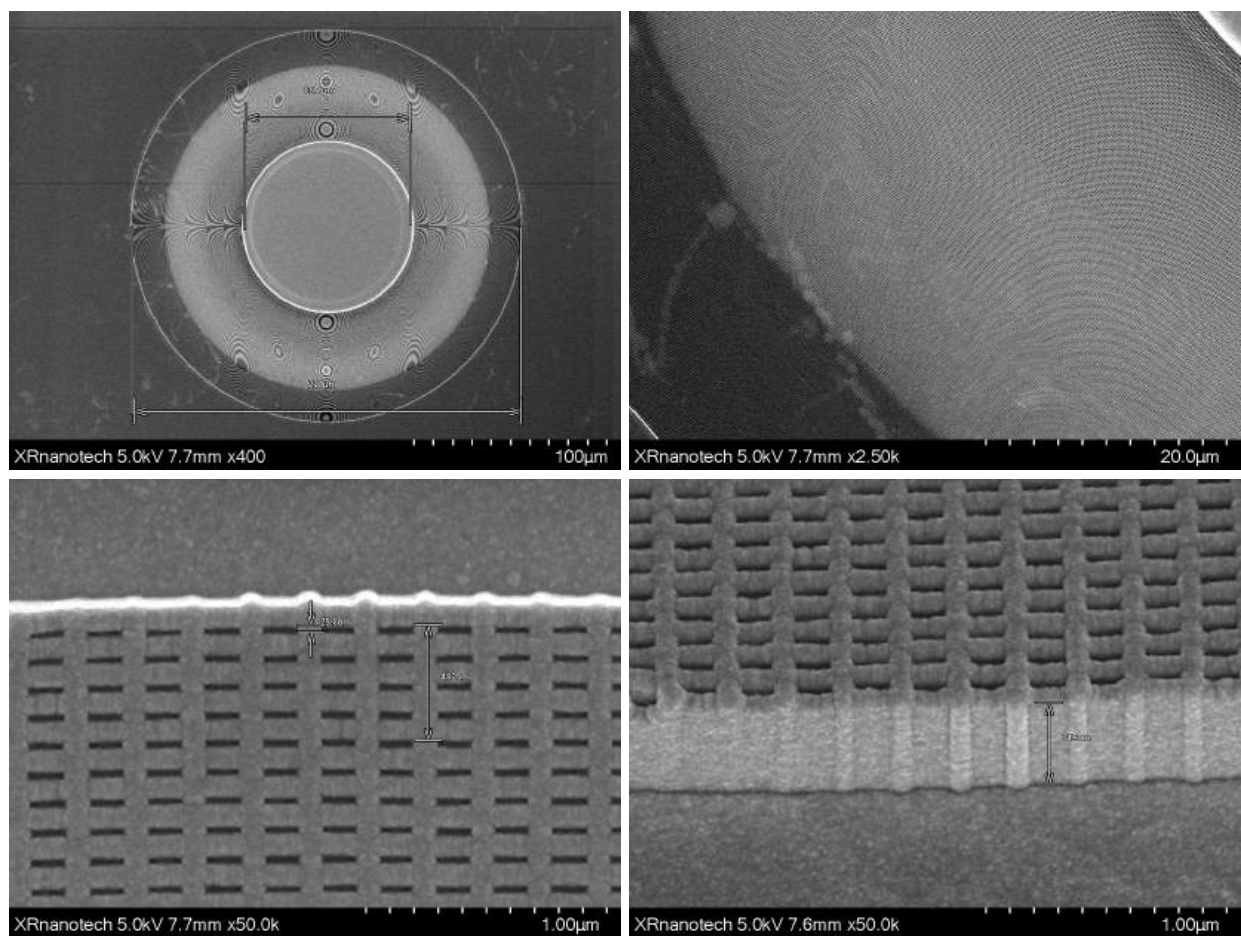


Figure 8: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.7 Spitzbuebe 250 μm

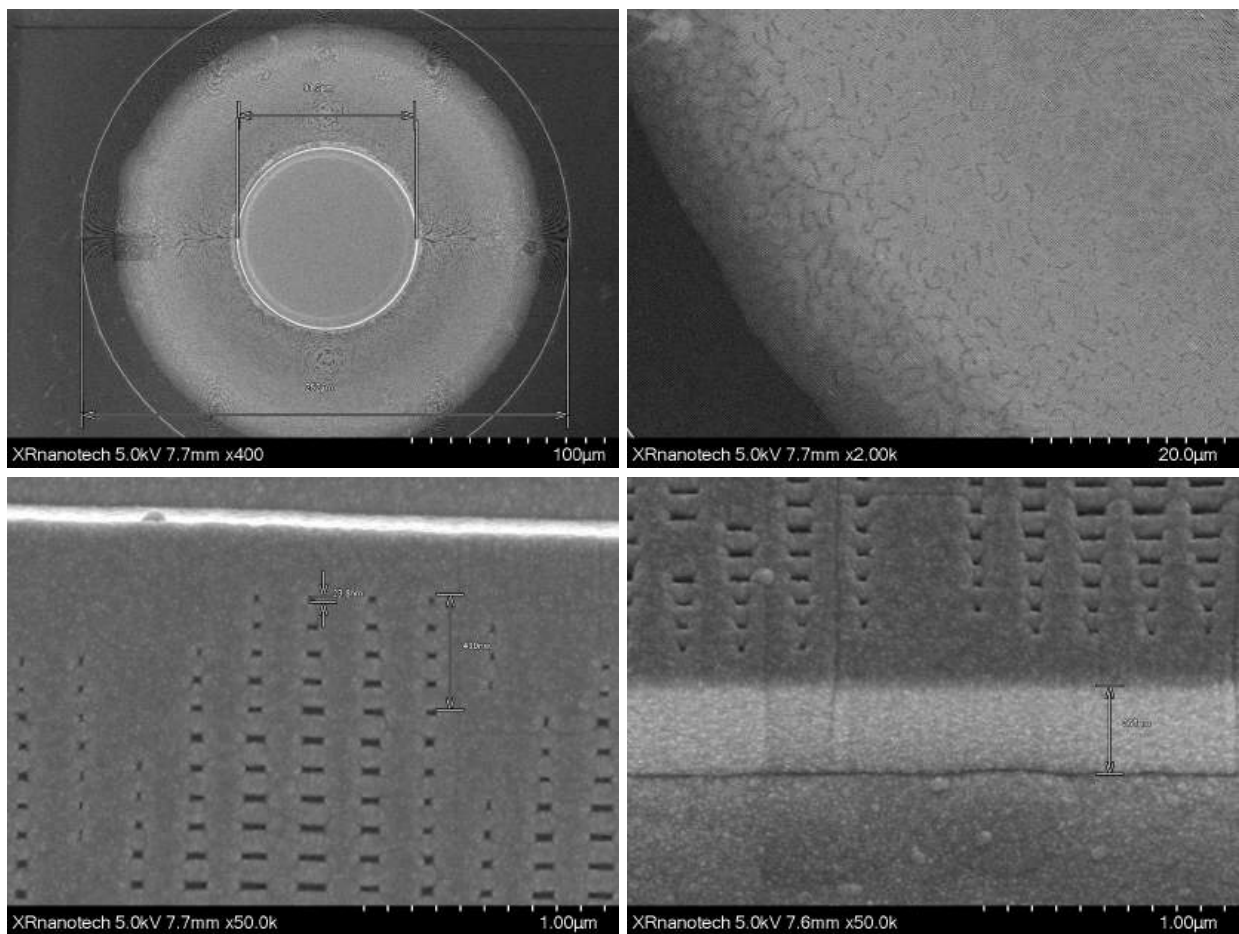


Figure 9: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.8 Vermicelles 250 μm

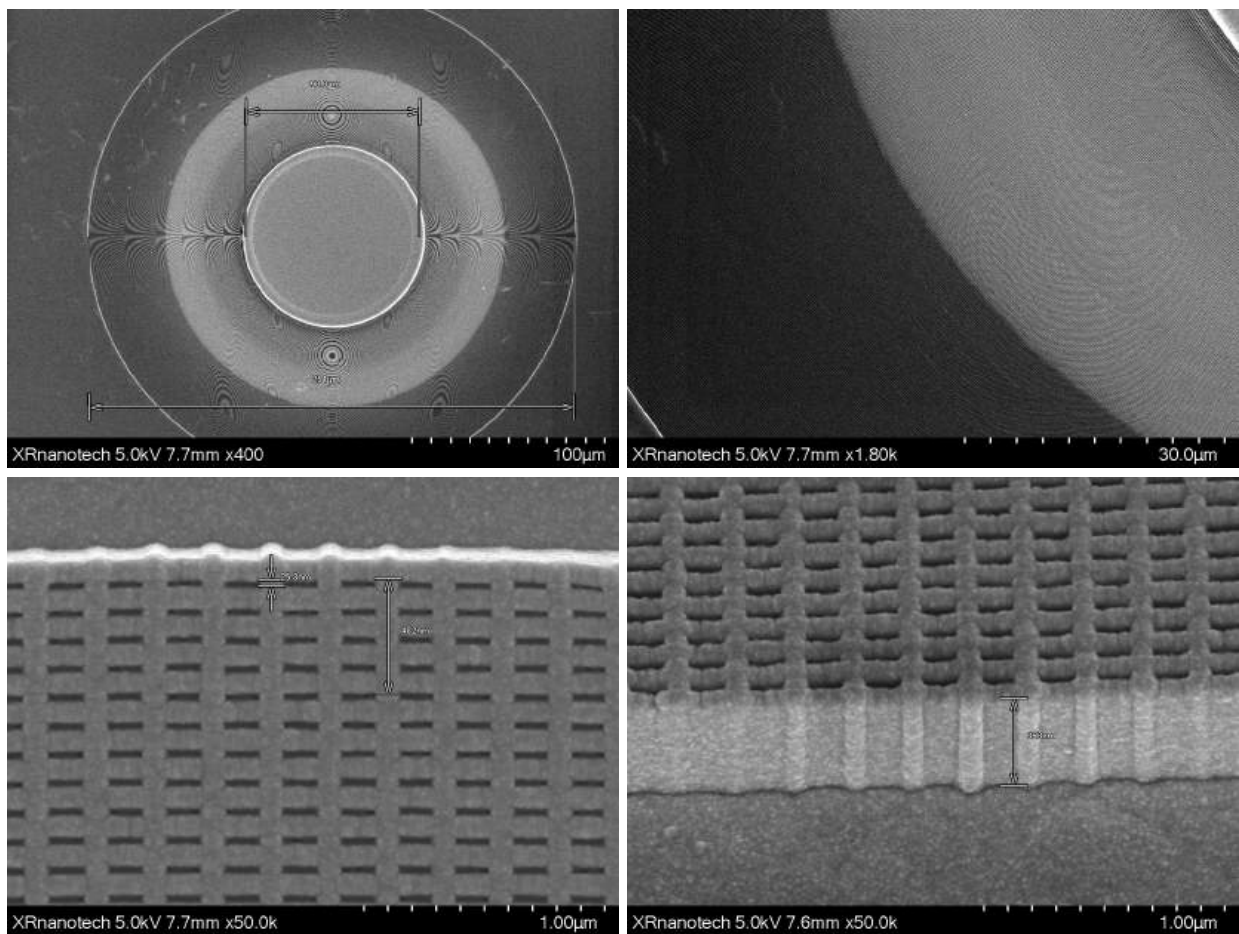


Figure 10: SEM images — From top left to bottom right: overview and diameters measurement, zoom on the zone plate, CD measurement, and height measurement (tilted at 30°, the measured height corresponds to half of the actual height).

3.9 Central stops

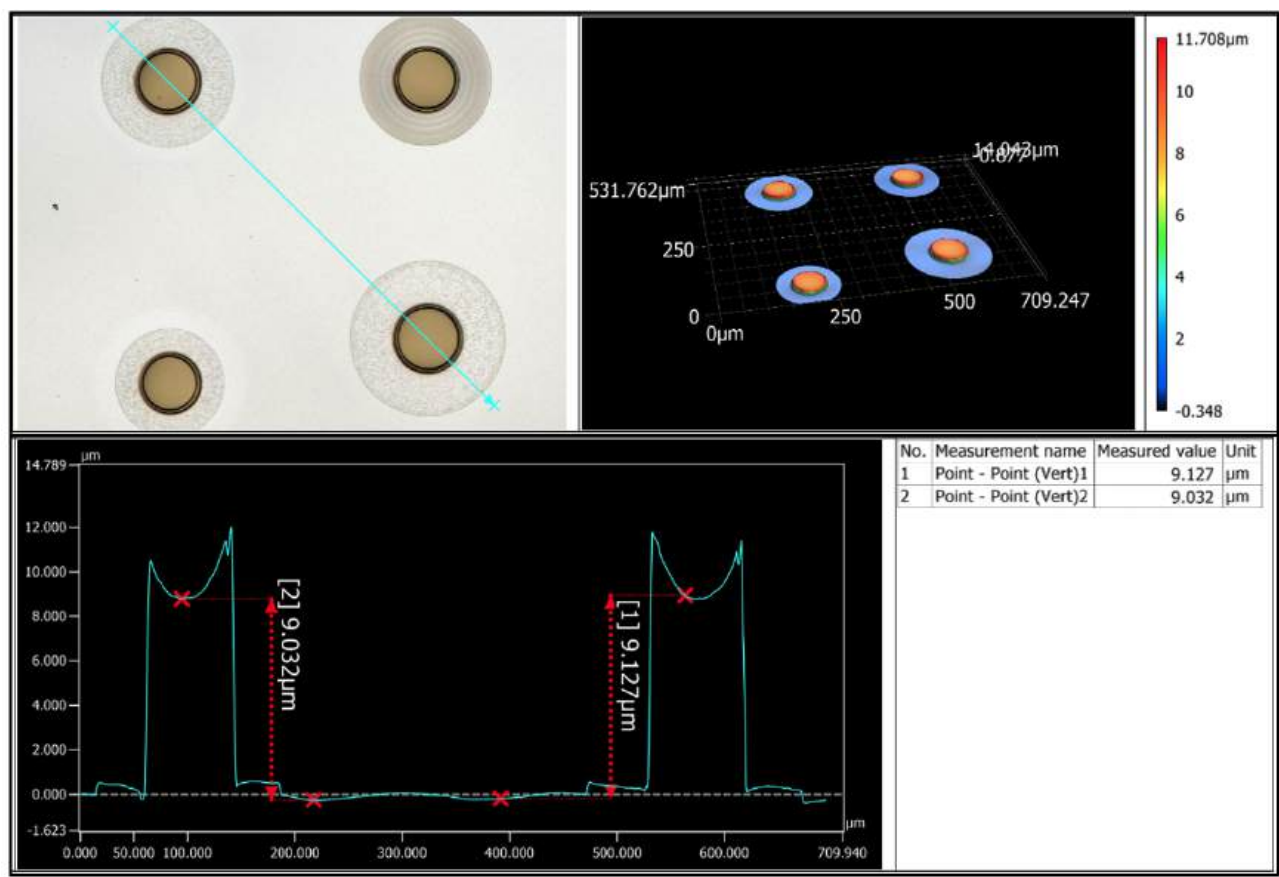


Figure 11: Central Stop thickness measurement

4 Chips overview and packaging

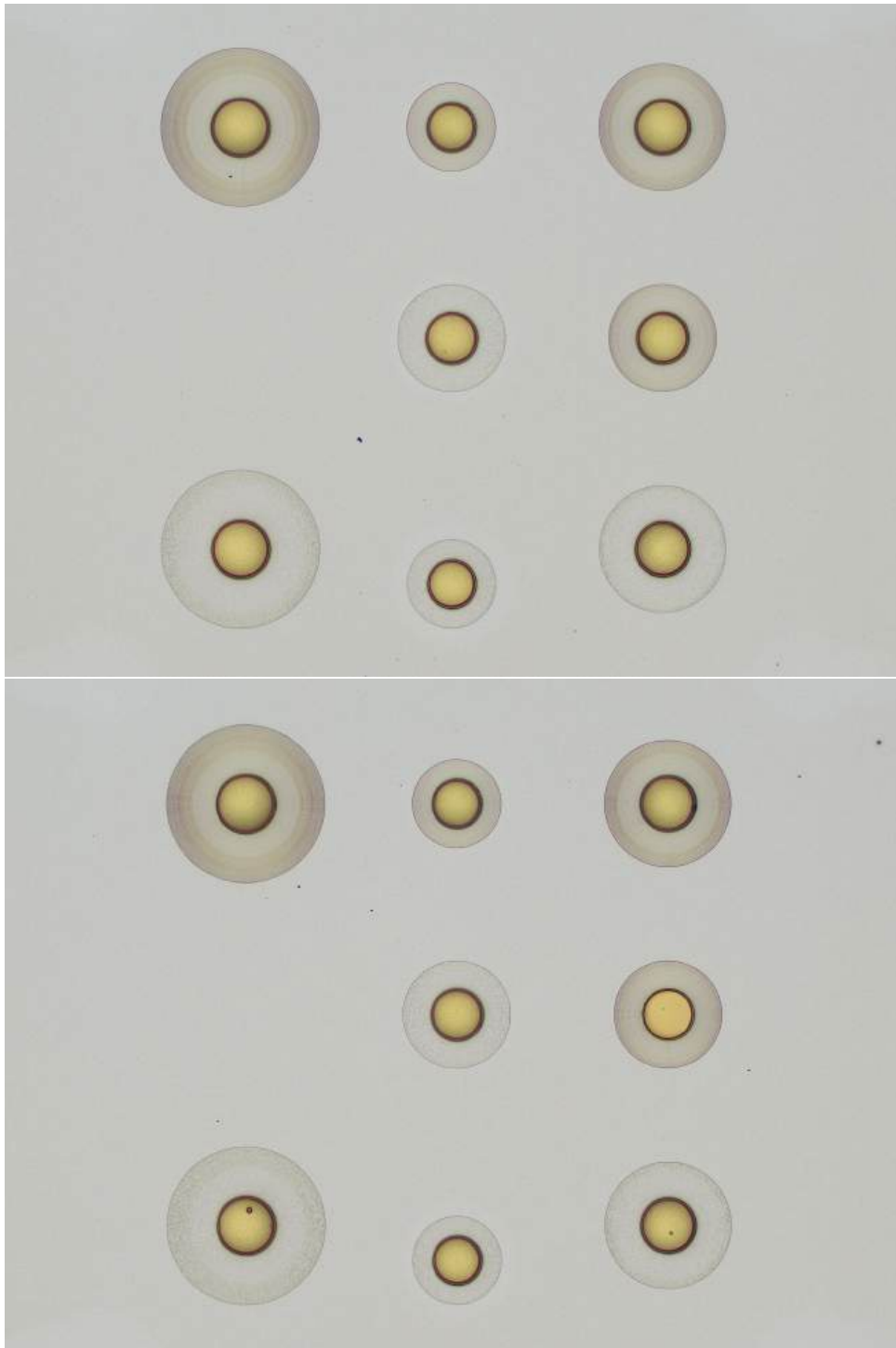


Figure 12: Overview of the chips. top: Chip 1, bottom: Chip 2

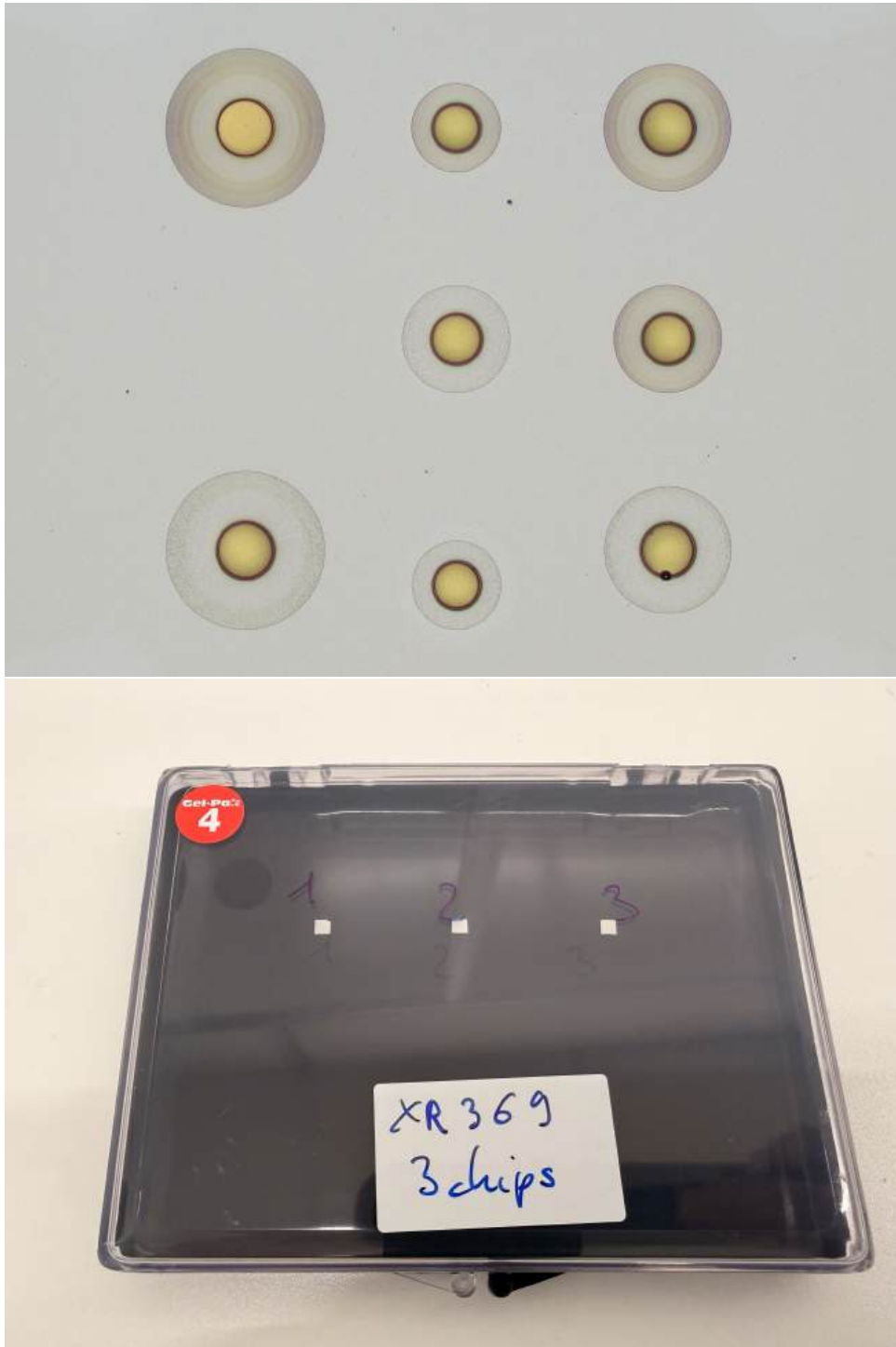


Figure 13: Overview of the chips. top: Chip 3, bottom: Packaged chips.



Abe Levitan :: Postdoc :: Paul Scherrer Institute :: École Polytechnique Fédérale de Lausanne

Final design breakdown for zone plates order XR353, intended for cSAXS beamline of the SLS

August 20, 2025

Overview of fabrication parameters

- Chips: $3 \times 3 \text{ mm}^2$ with $1.2 \times 1.2 \text{ mm}^2$ windows, 1 μm thick SiN
- Outer 0.1 mm region of the window will be used for fabrication alignment markers
- Each chip has 8 optics, with 2 styles across 4 energies
 - Abe-style: “Spitzbuebe”
 - Tomas-style: “Vermicelles”
- Zone-doubled optics with a 30 nm “equivalent” outer zone width
- 35 nm conformal layer of Iridium
- 120 nm outer pitch with a 25 nm minimum feature size in HSQ
- Zone Height: $\geq 500 \text{ nm}$
- 65 μm diameter Au beamstops, $>10 \text{ }\mu\text{m}$ thick
- Design files: <https://drive.switch.ch/index.php/s/i1SVQADZsYePkC3>

Overall Layout:

Abe = Spitzbuebe, Tomas = Vermicelles

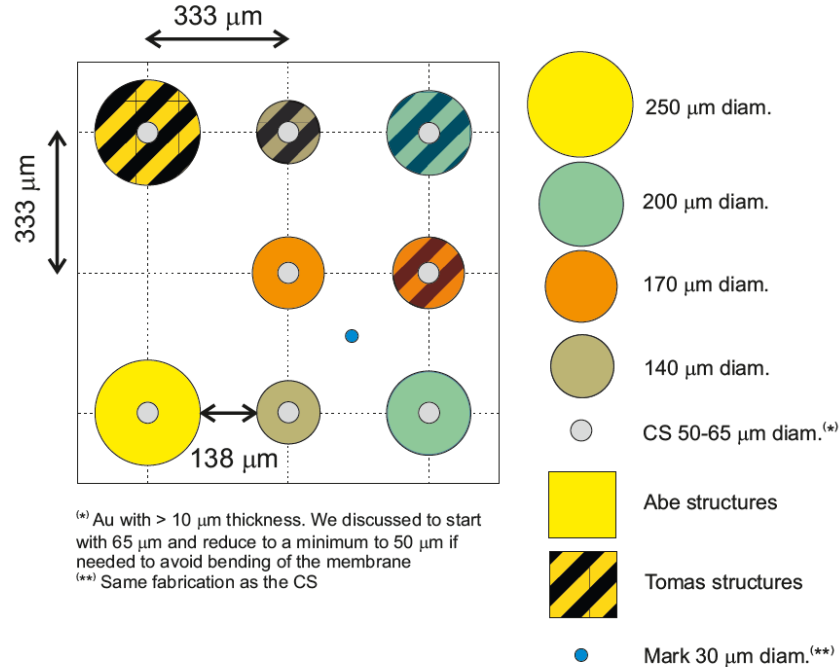


Table of optic parameters (Spitzbuebe)

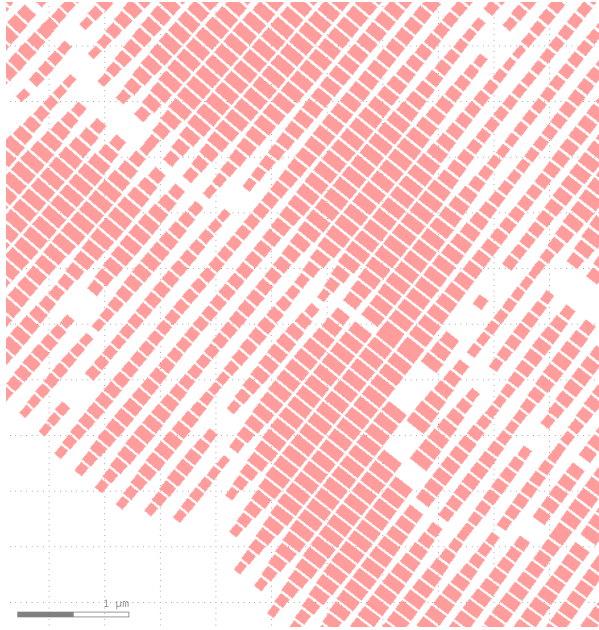
Optic Name	Optic Diameter	Design Energy	Focal Distance	Focal Spot Diameter	Inner Diameter
Spitzbuebe_250	250 μm	6 keV	36.306 mm	7.5 μm	90 μm
Spitzbuebe_200	200 μm	8 keV	38.745 mm	6 μm	85 μm
Spitzbuebe_170	170 μm	10 keV	41.175 mm	4.8 μm	80 μm
Spitzbuebe_140	140 μm	12 keV	40.705 mm	4.05 μm	75 μm

Table of optic parameters (Vermicelles)

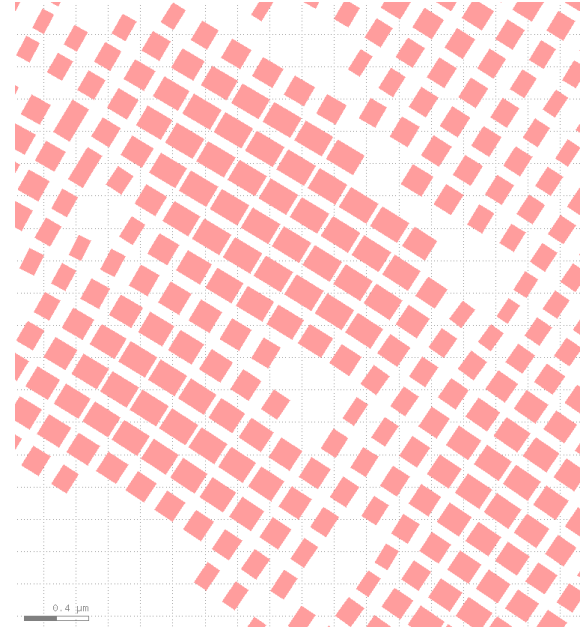
Optic Name	Optic Diameter	Design Energy	Focal Distance	Inner Diameter
Vermicelles_250	250 μm	6 keV	36.306 mm	90 μm
Vermicelles_200	200 μm	8 keV	38.745 mm	85 μm
Vermicelles_170	170 μm	10 keV	41.175 mm	80 μm
Vermicelles_140	140 μm	12 keV	40.705 mm	75 μm

Typical zone structures (Spitzbuebe)

Outer edge

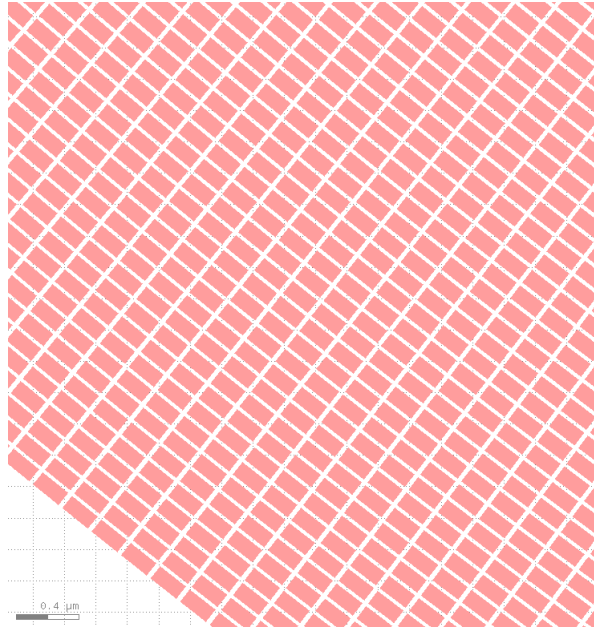


Inner edge

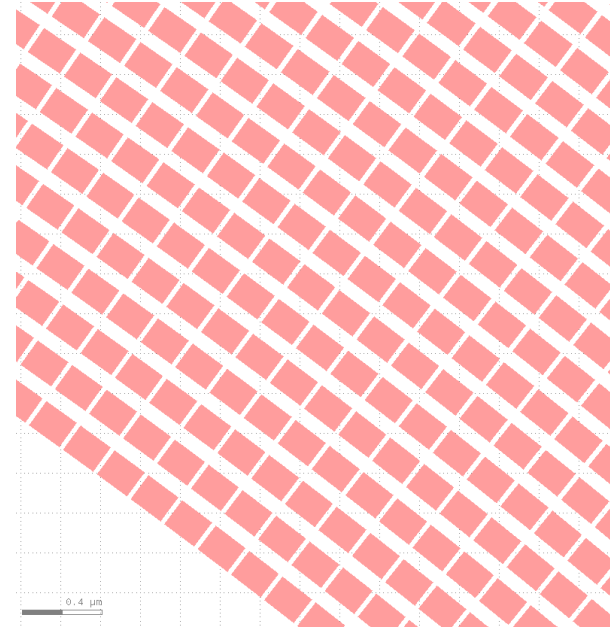


Typical zone structures (Vermicelles)

Outer edge

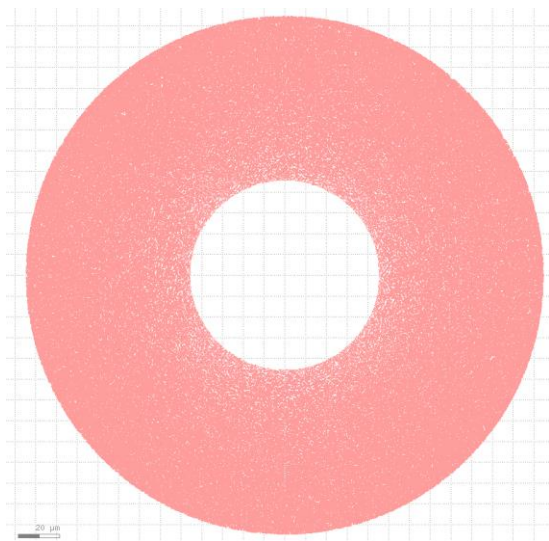


Inner edge

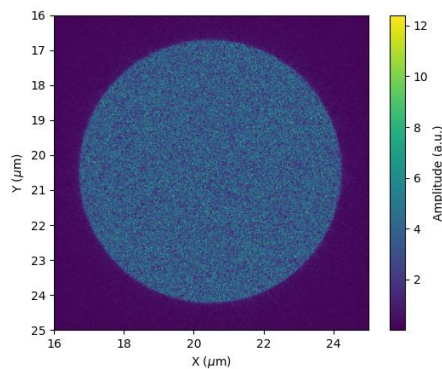


Spitzbuebe_250

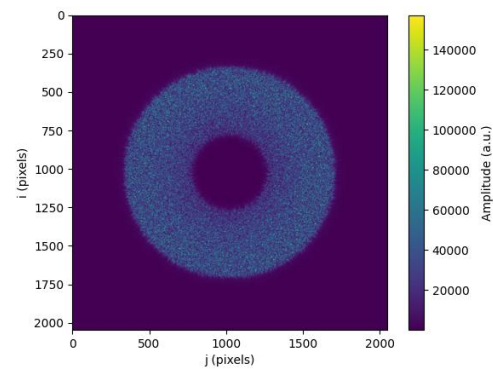
Overview



Focus

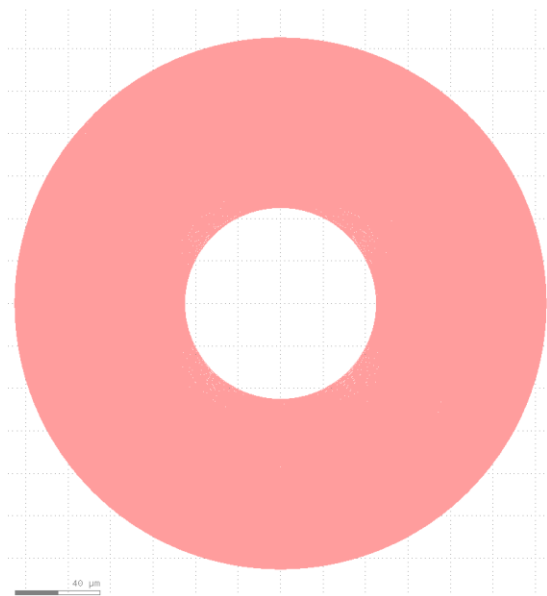


Diffraction Pattern

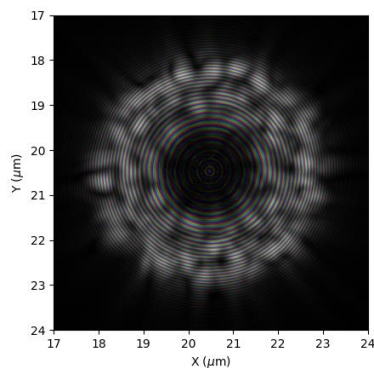


Vermicelles_250

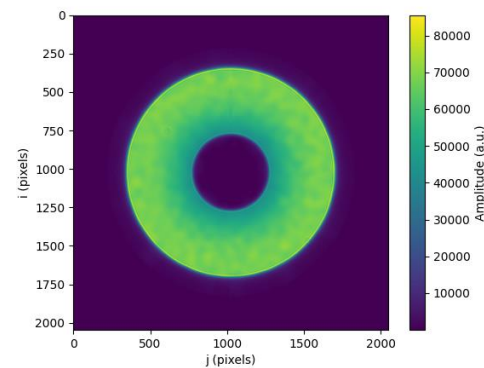
Overview



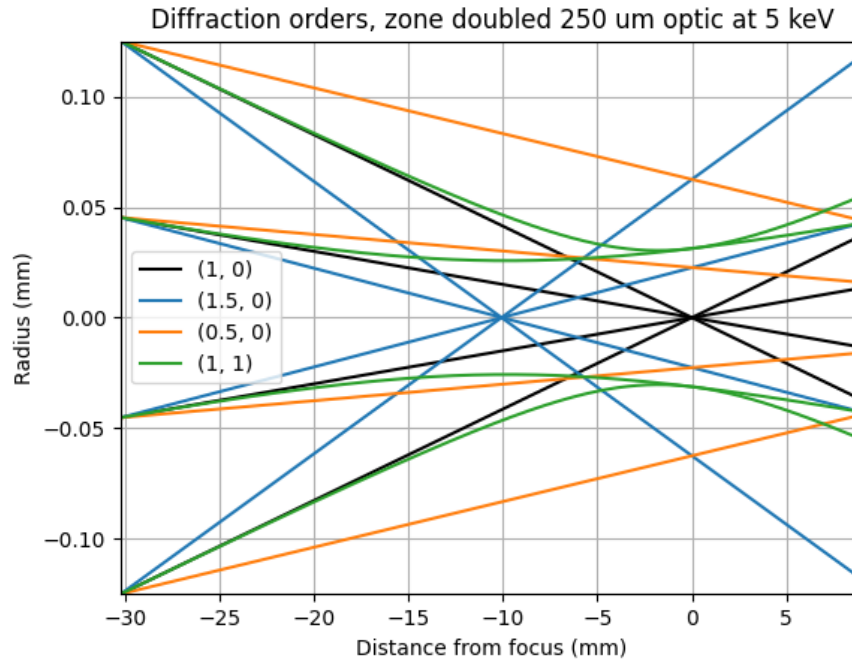
750 μm from focus



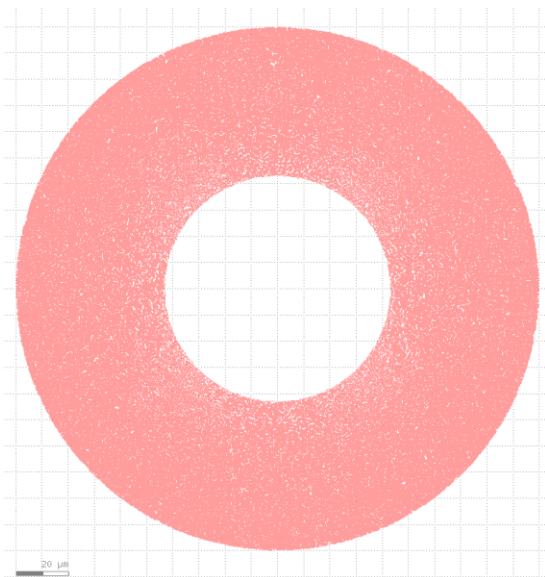
Diffraction Pattern



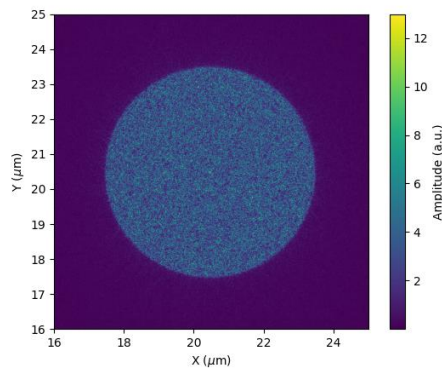
Diffraction order diagram for 250 μm optics



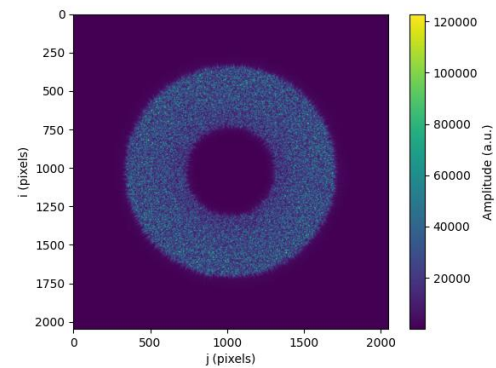
Overview



Focus

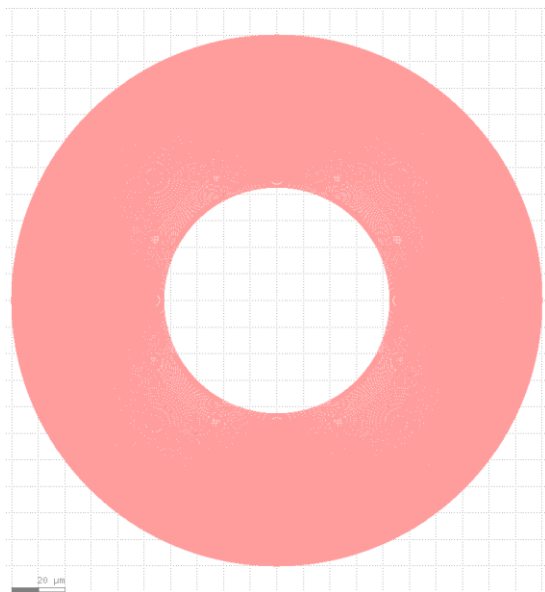


Diffraction Pattern

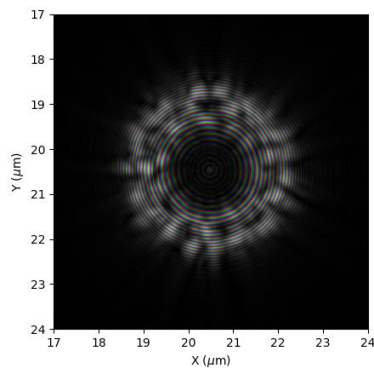


Vermicelles_200

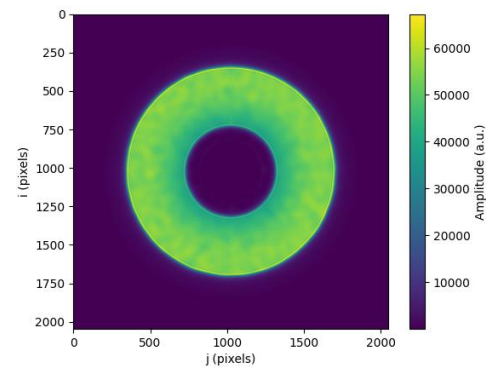
Overview



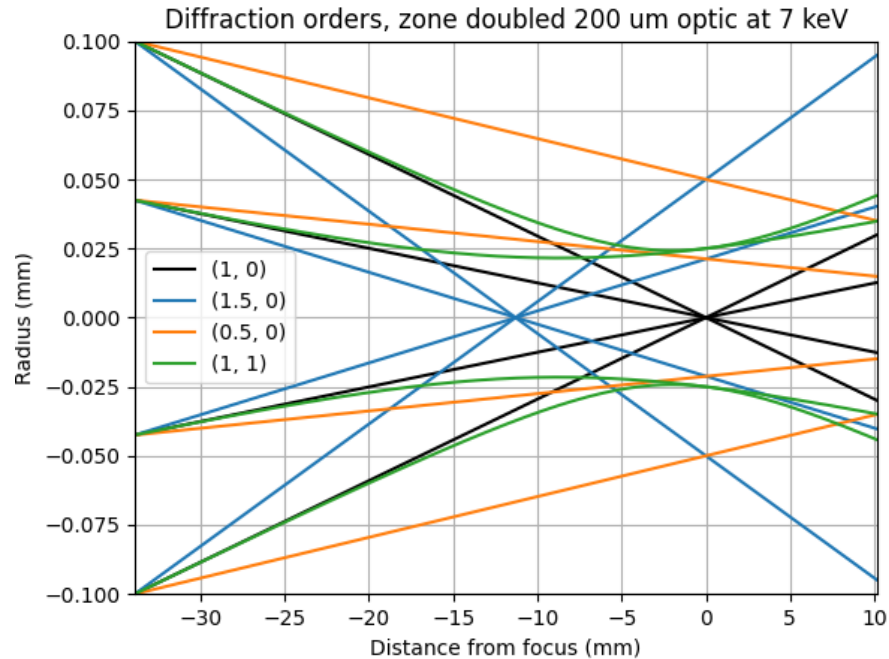
750 μm from focus



Diffraction Pattern

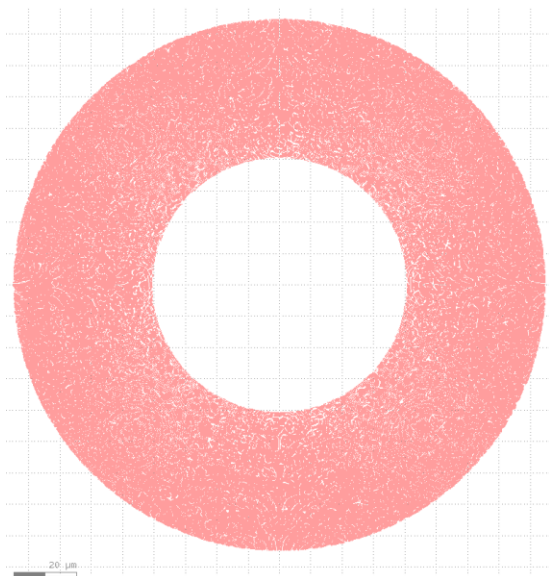


Diffraction order diagram for 200 μm optics

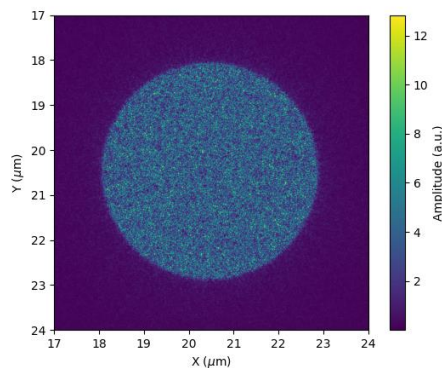


Spitzbuebe_170

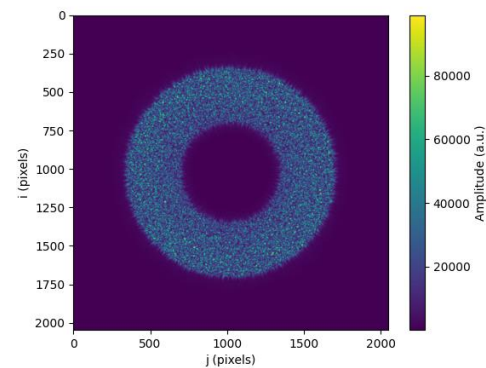
Overview



Focus

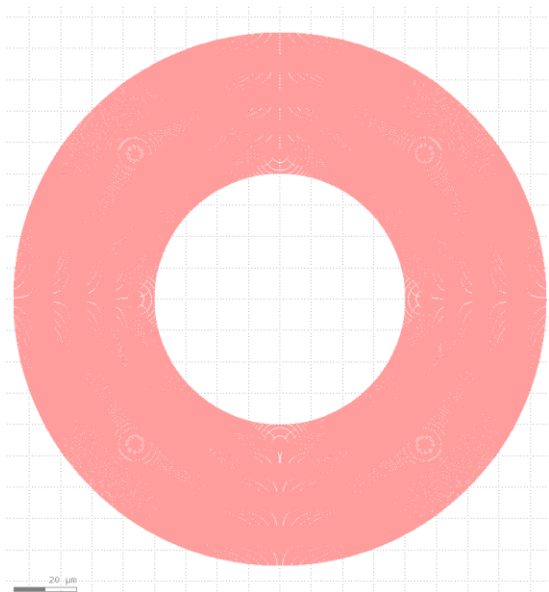


Diffraction Pattern

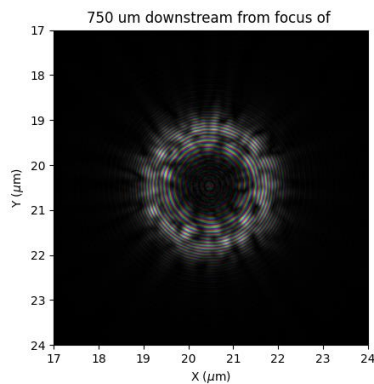


Vermicelles_170

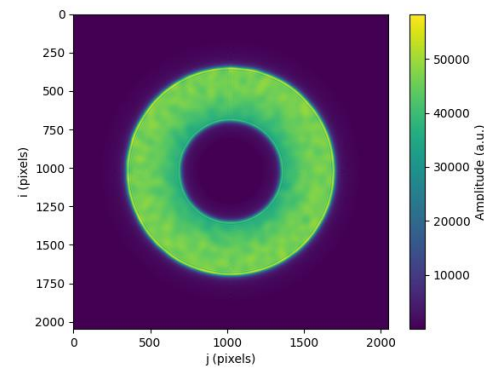
Overview



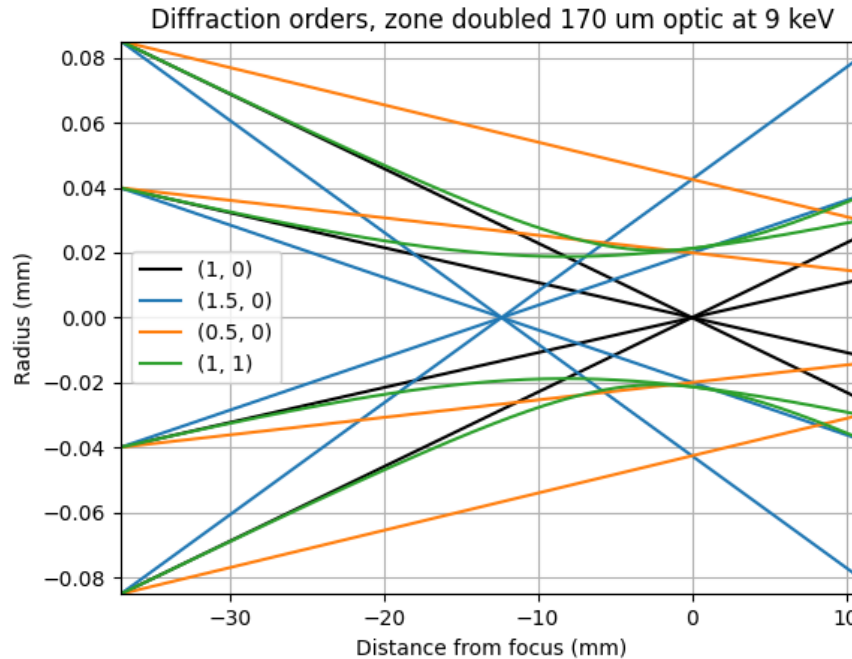
750 μm from focus



Diffraction Pattern

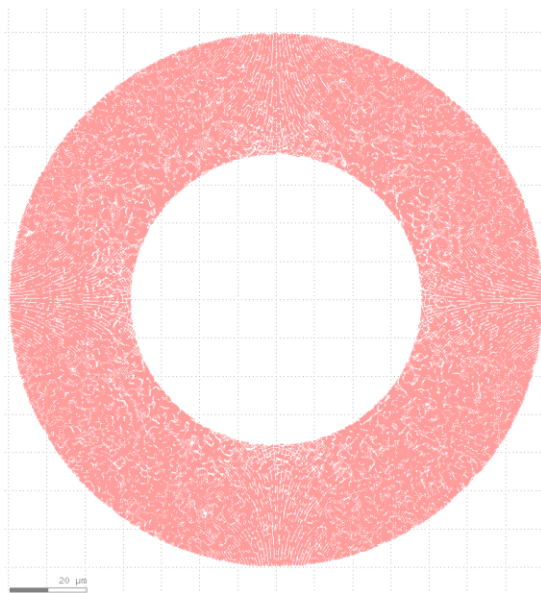


Diffraction order diagram for 170 μm optics

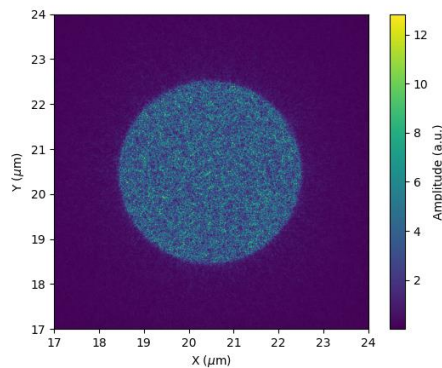


Spitzbuebe_140

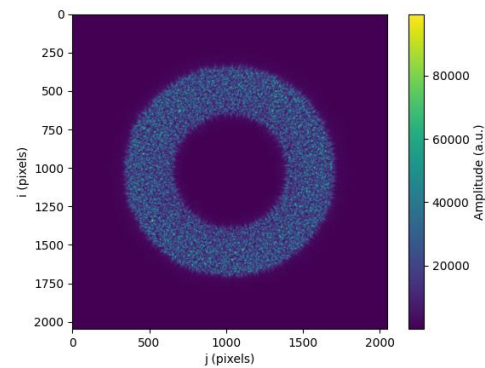
Overview



Focus

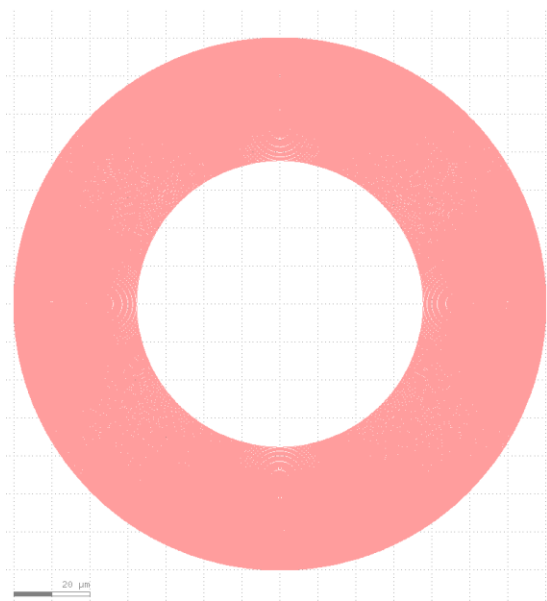


Diffraction Pattern

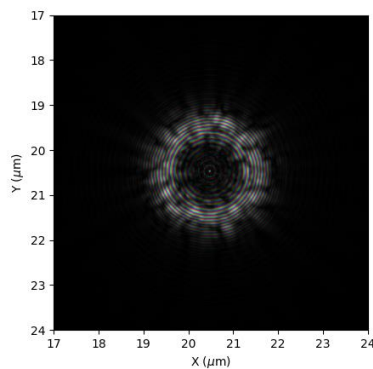


Vermicelles_140

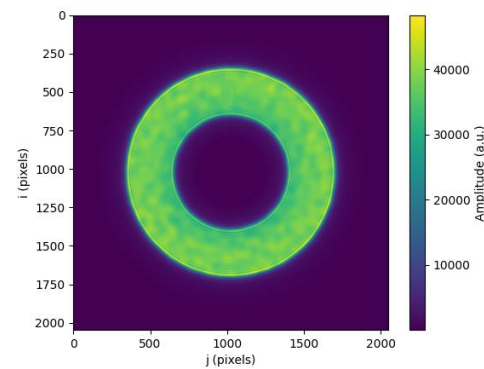
Overview



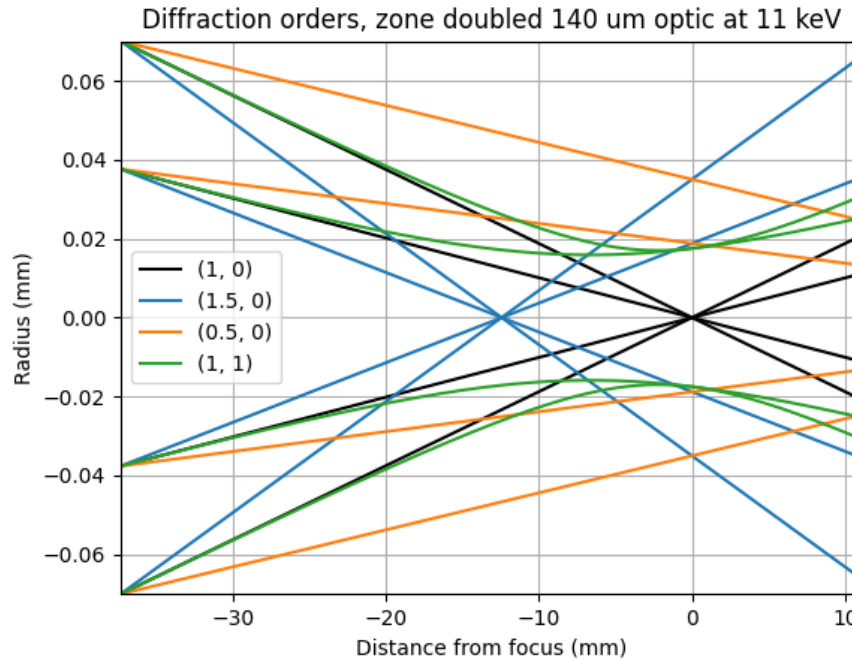
750 μm from focus



Diffraction Pattern

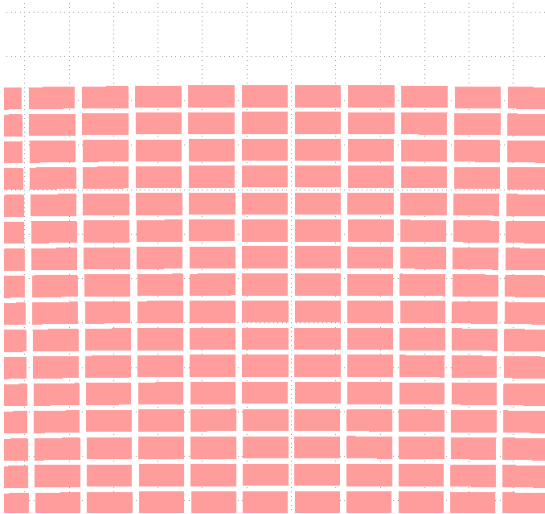


Diffraction order diagram for 140 μm optics

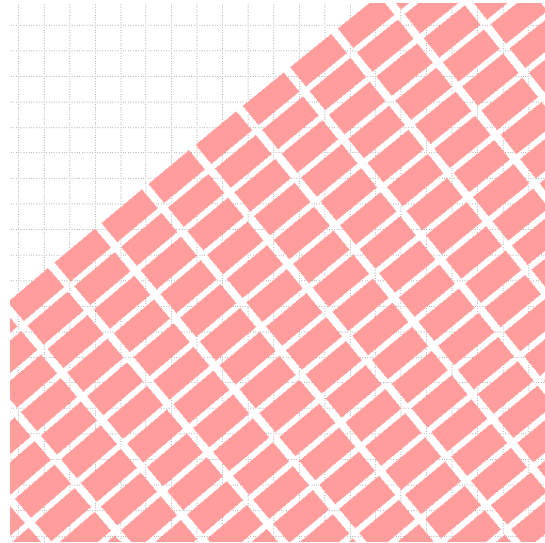


Suggested characterization locations (page 1)

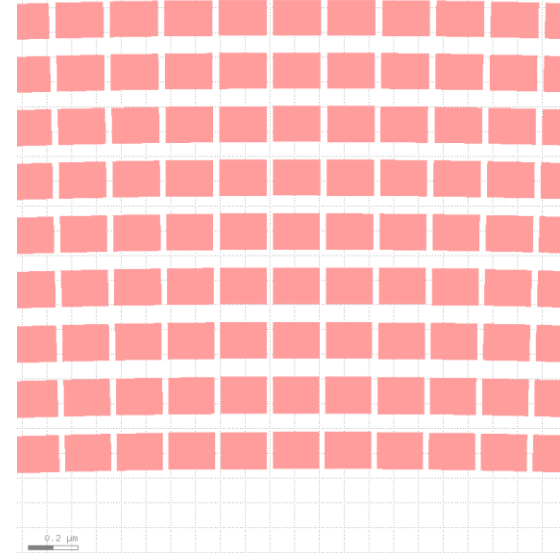
Outer edge (horizontal)



Outer edge (45 deg)

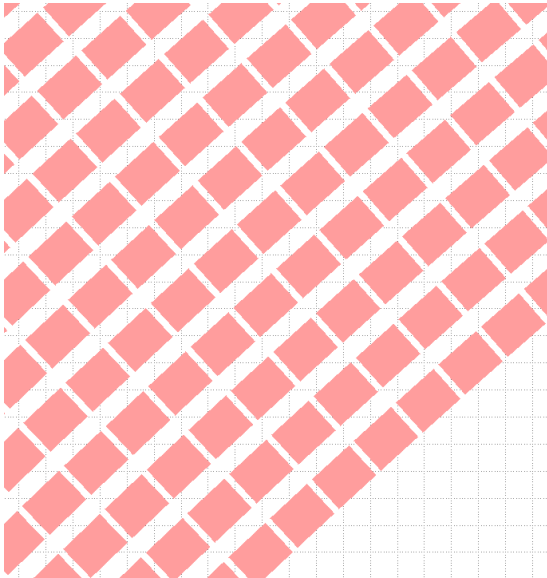


Inner edge (horizontal)

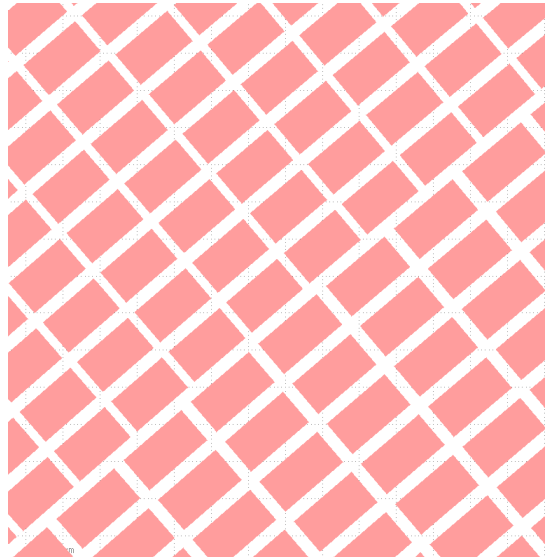


Suggested characterization locations (page 2)

Inner edge (45 degrees)



Buttress jump location



Overview

