SWTEST

PROBE TODAY, FOR TOMORROW

2024 CONFERENCE

Probe Heads for Optical Wafer-Level Testing

Keystone photonics

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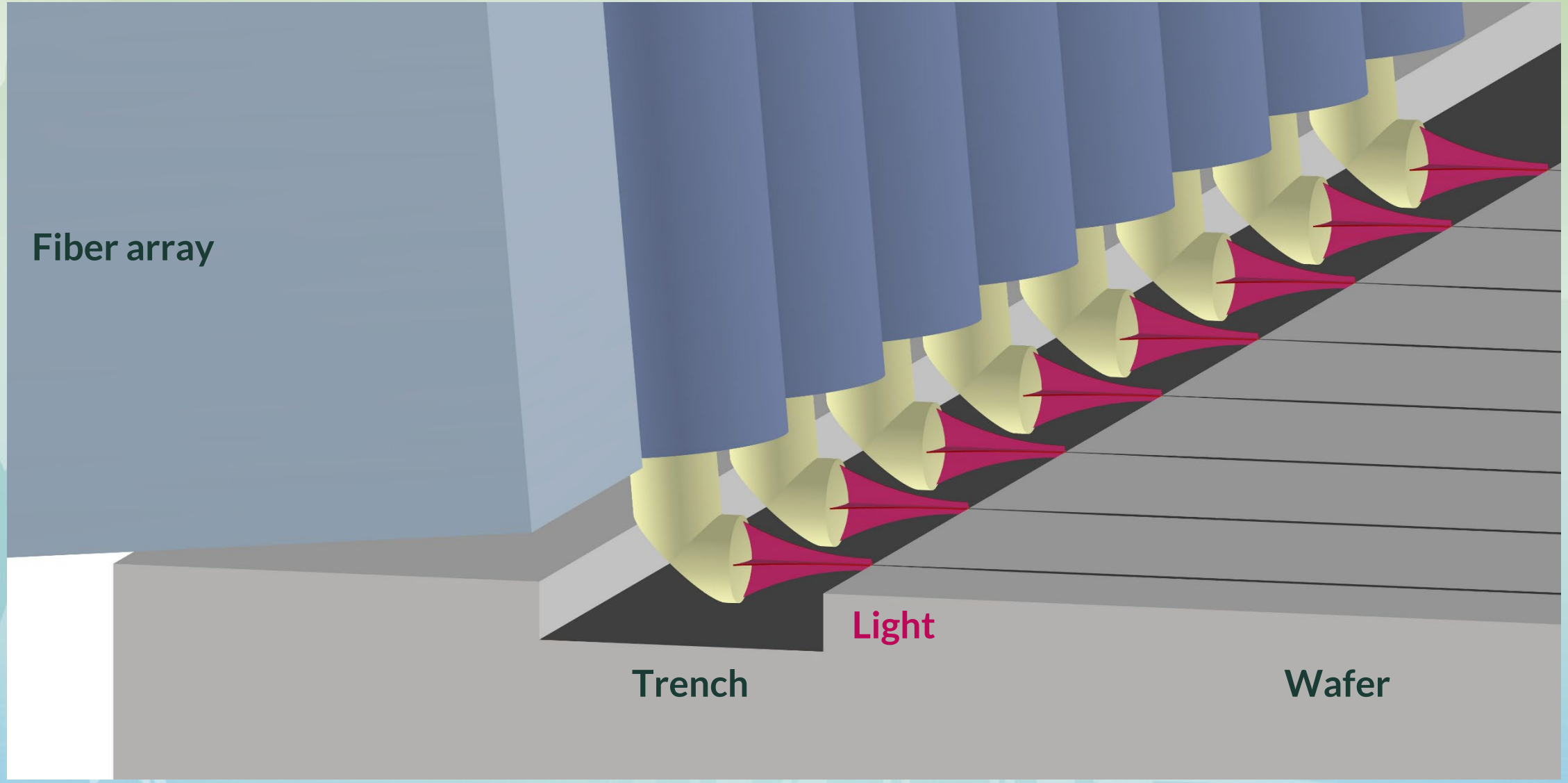
Keystone Photonics GmbH

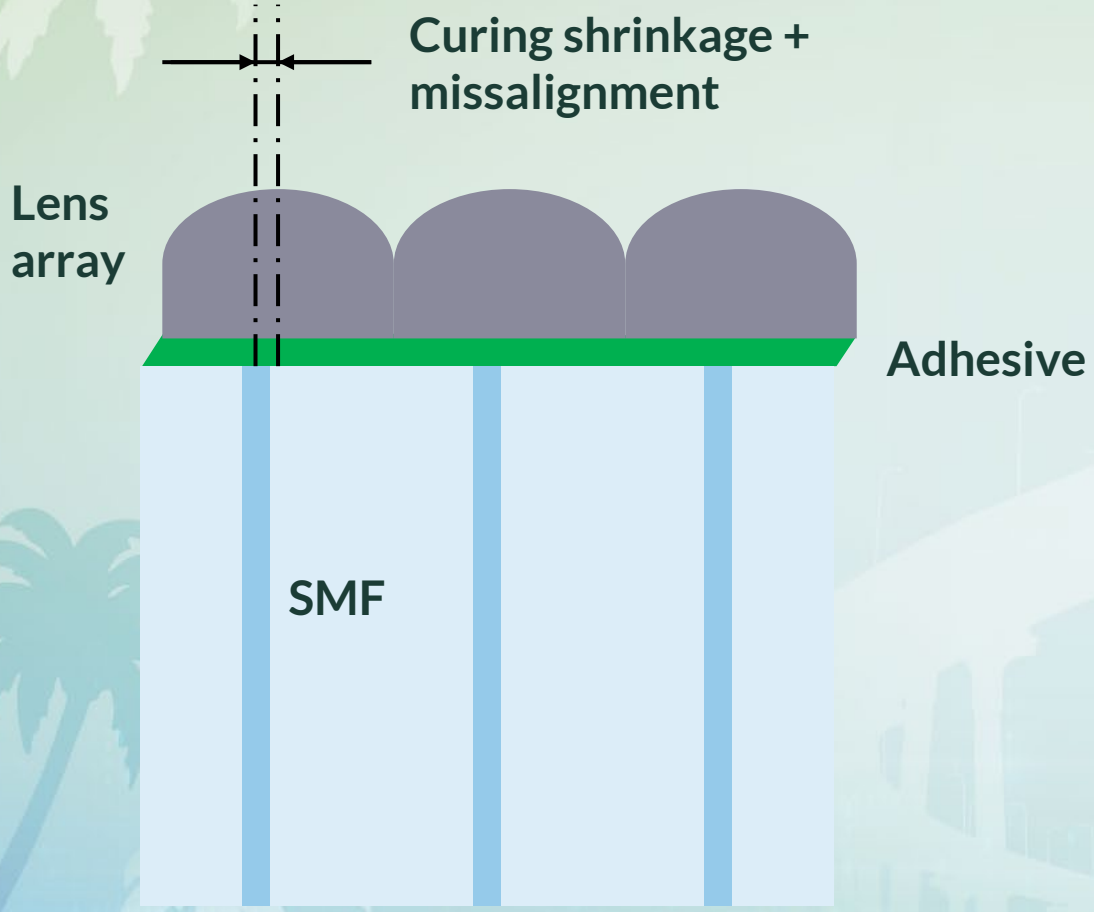
Content

- In-situ fabrication of micro-optics
- Performance and reproducibility
- Optical wafer-level testing
  - Surface coupling
  - Trench coupling
- New developments
  - Ultra dense pitch for AI
  - Integrated sensor functionality for production
  - Cryo and broadband testing for quantum applications

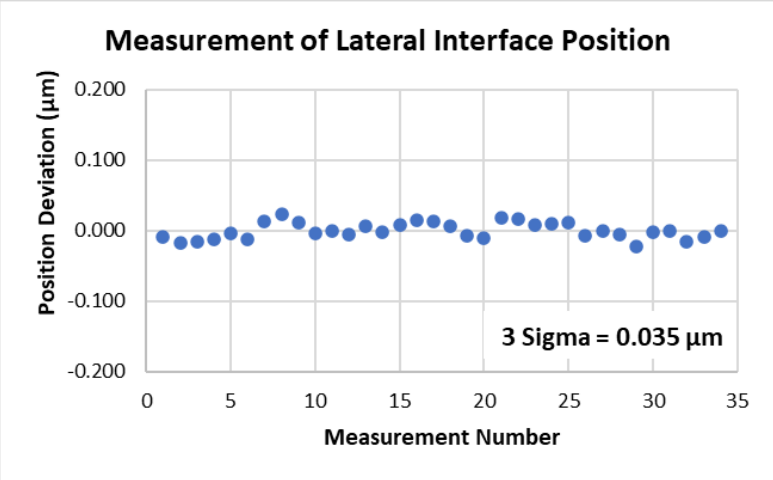
Our solution for optical wafer-level testing

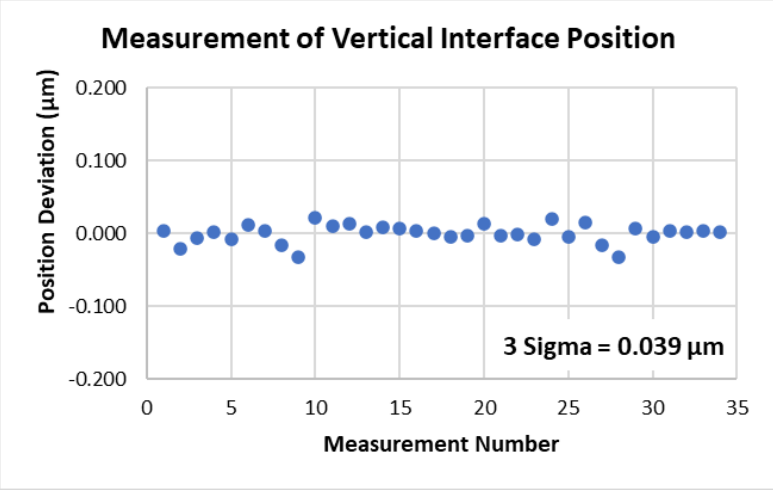


Conventional lens array alignment

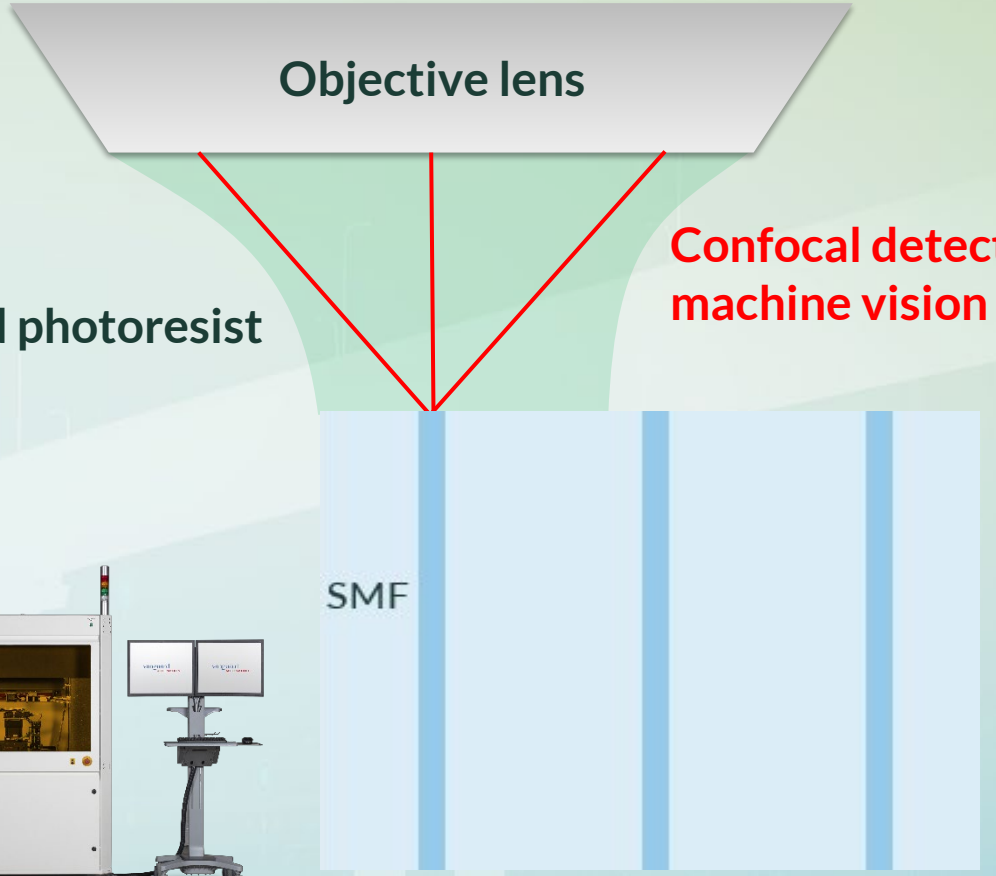


In-situ fabrication



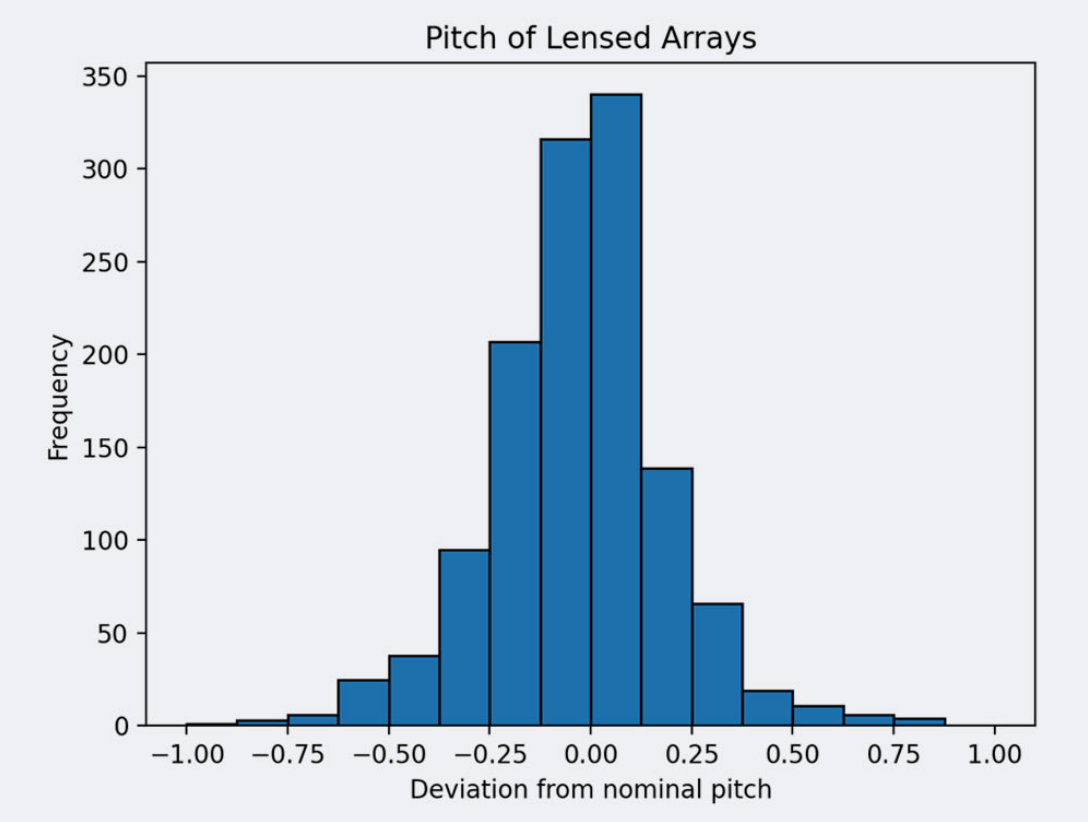


Data: Vanguard Automation



Sonata1000

In-situ fabrication



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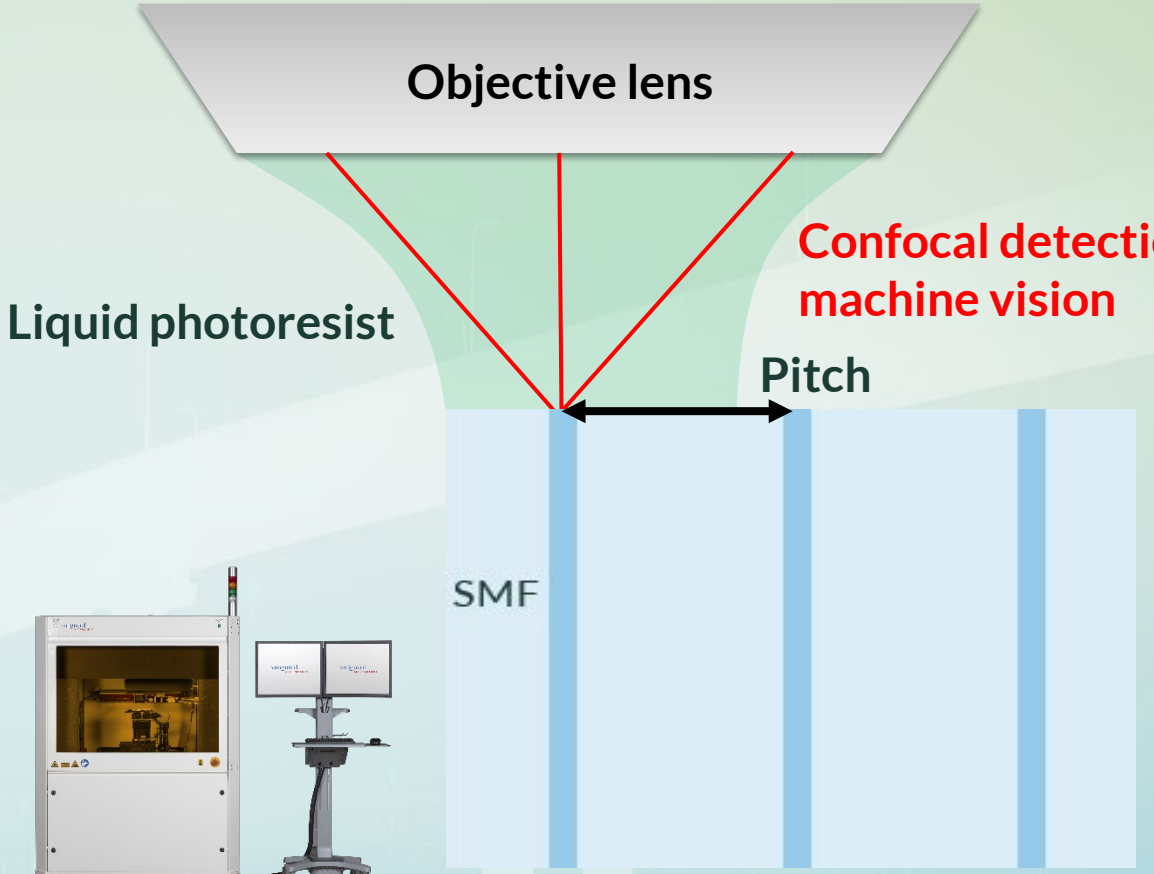
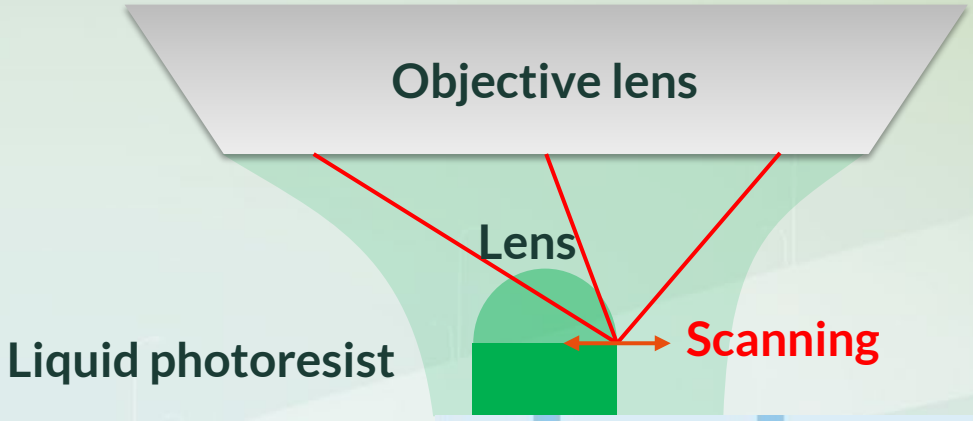


Sonata1000

In-situ fabrication

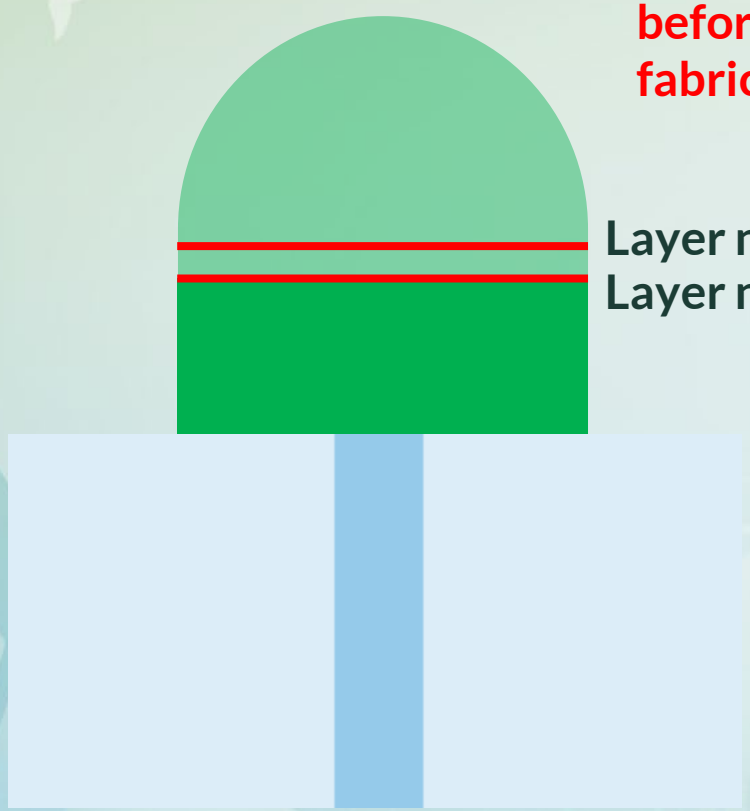


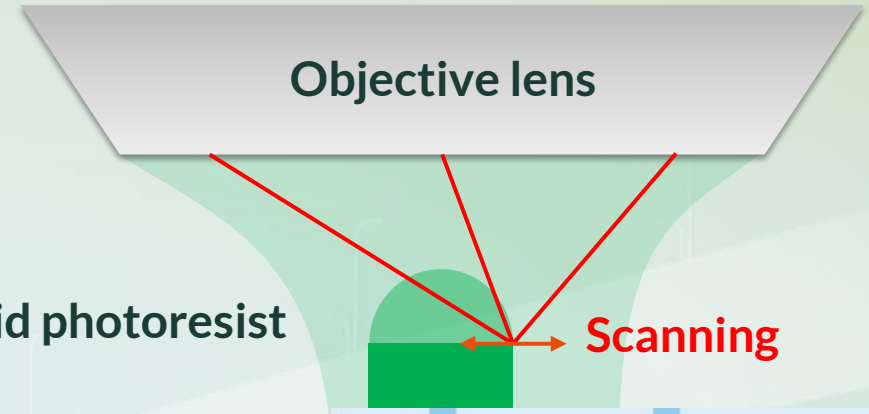
Sonata1000

Very same laser => detection missalignment and fabrication missalignment cancel out!

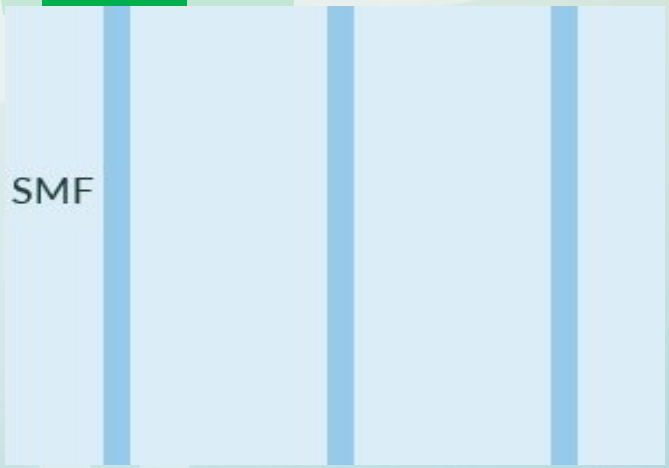
What about curing shrinkage?

Layer n is cured and shrunken before layer n + is fabricated!

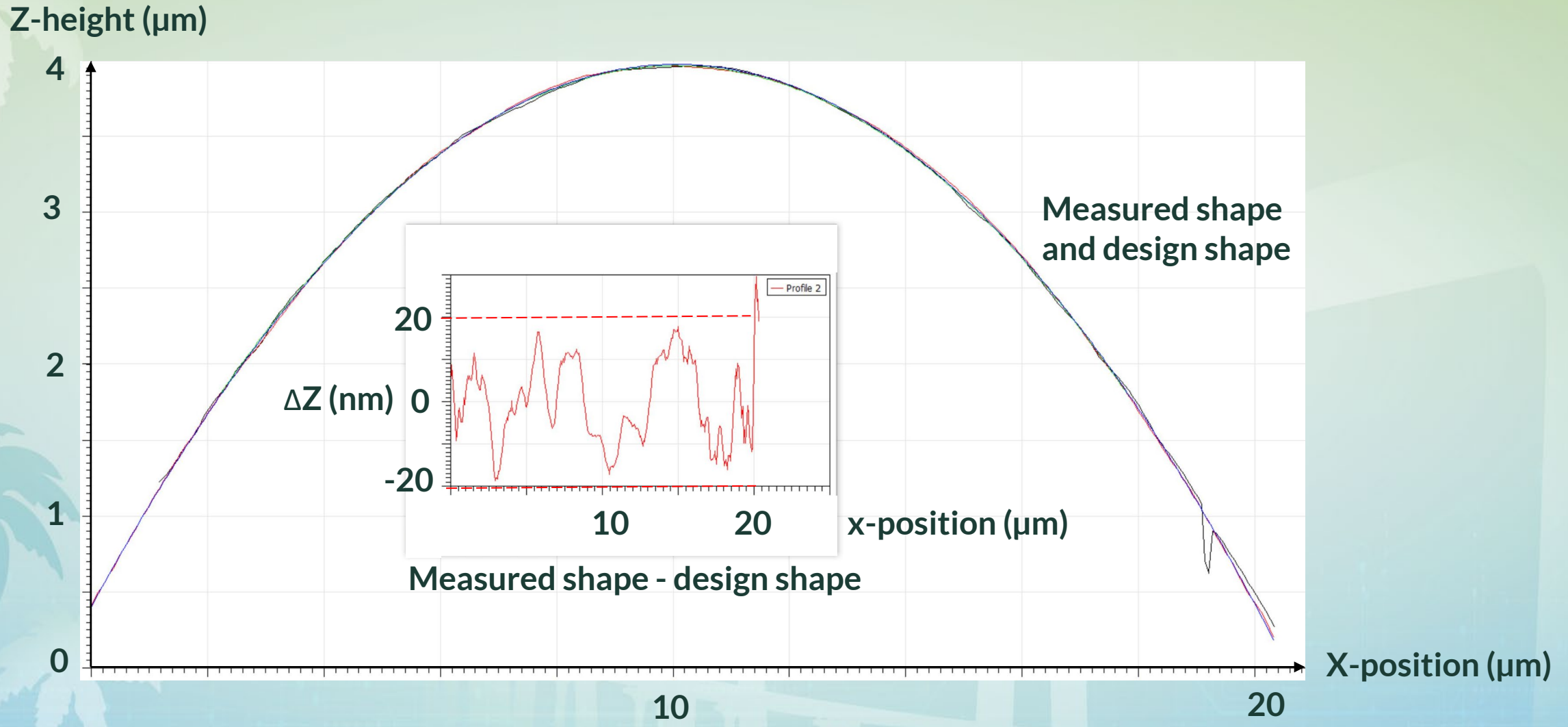




Sonata1000



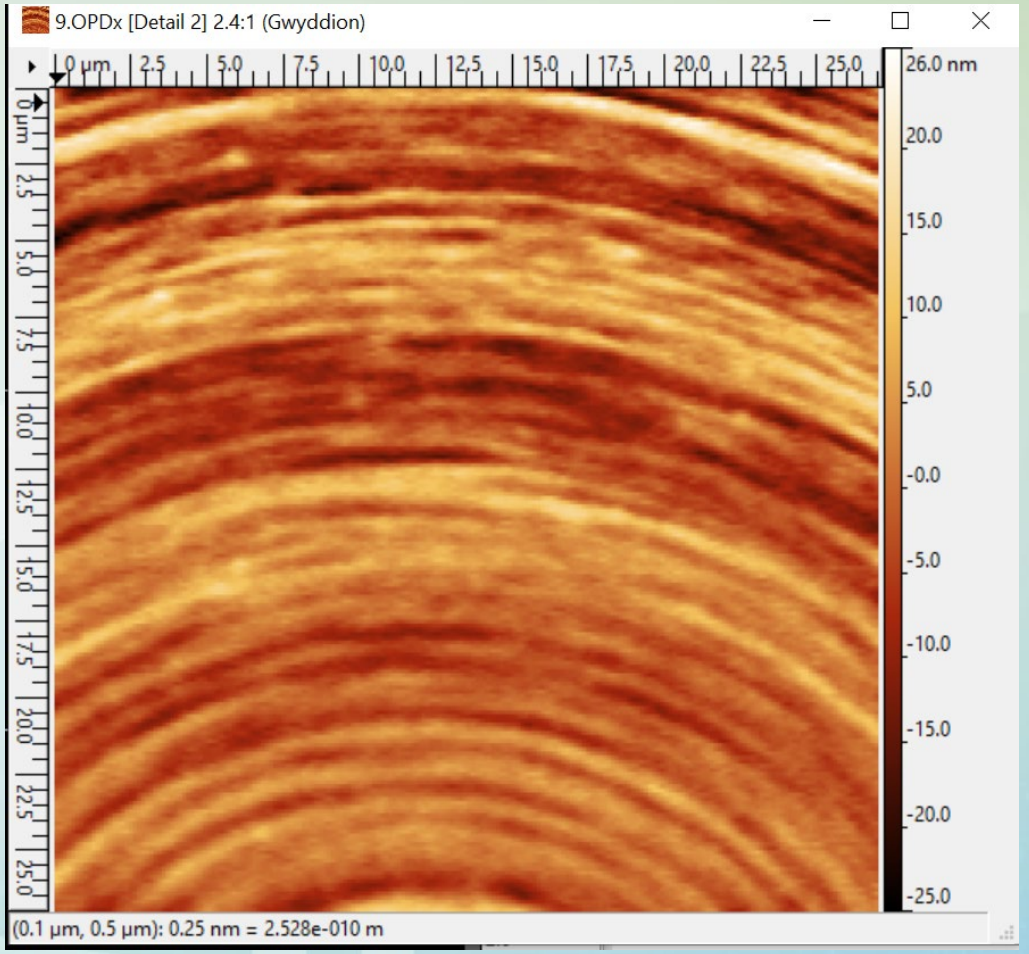
Fabrication accuracy



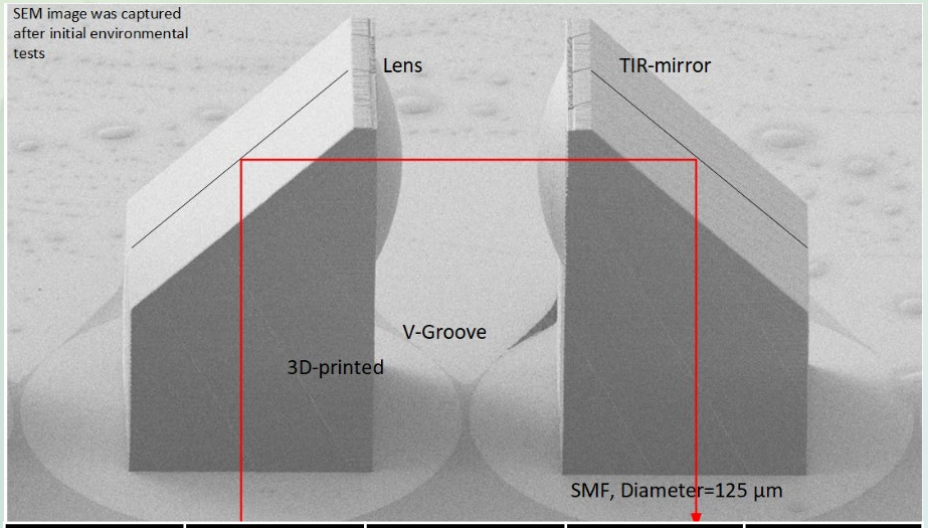
Roughness

10 nm RMS

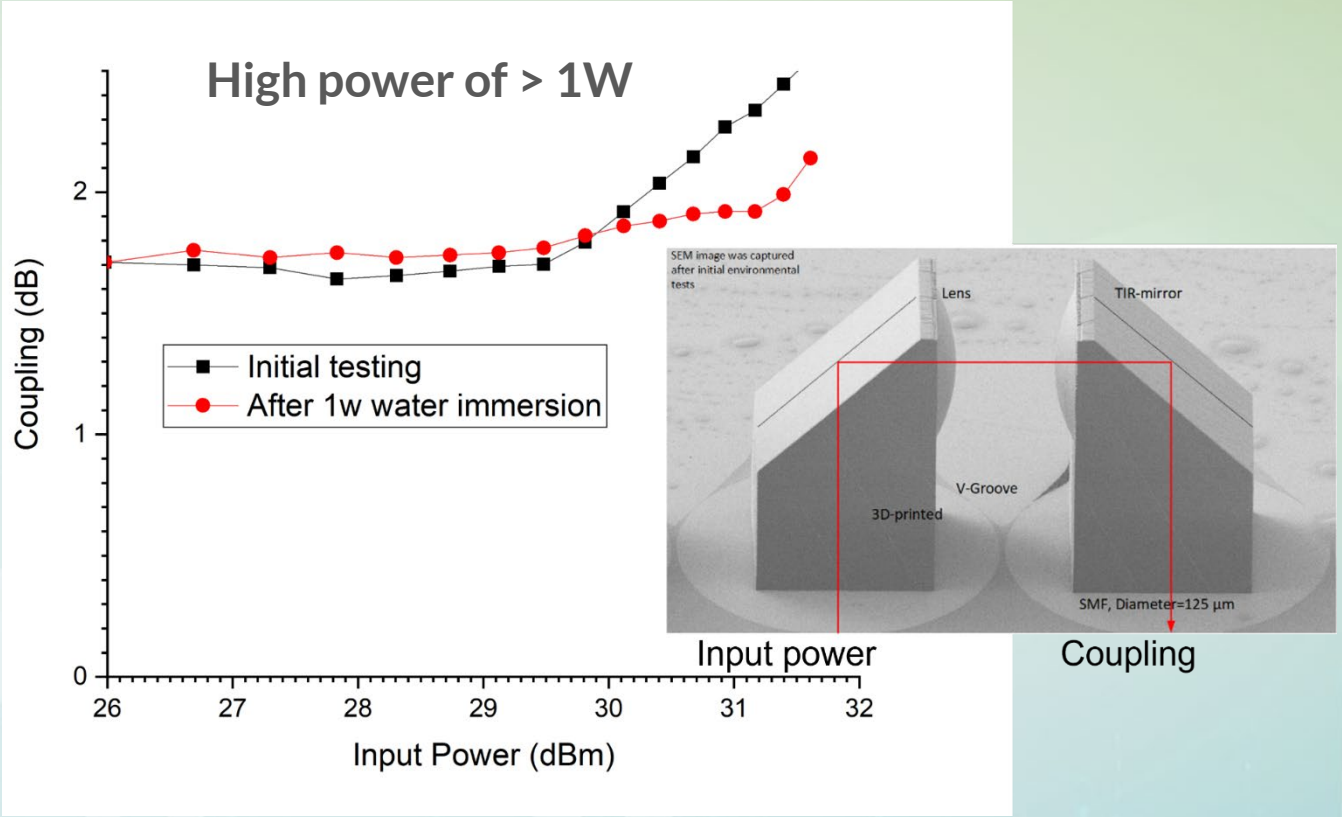
- Measured with Bruker ContourX-100
- USI mode and NA=0.8
- AFM measures 12 nm RMS



Reliability



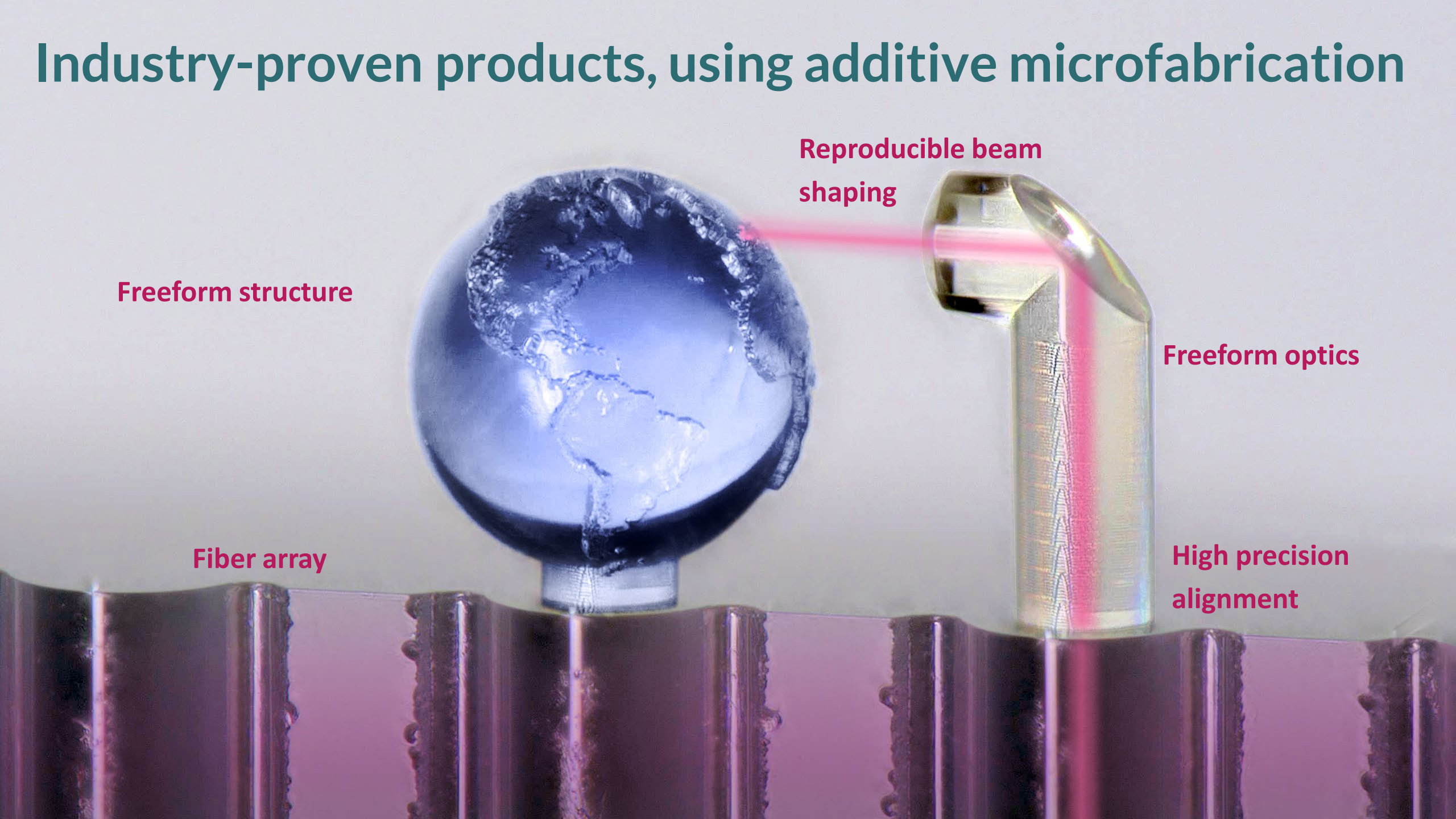
Connection (Lens Pair) #	Initially (dB)	400h 85°C/85 rel. hum. (dB)	1840h 85°C/85 rel. hum. (dB)	3960h 85°C/85 rel hum (dB)
1	1.4	1.4	1.5	1.3
2	1.2	1.2	1.3	1.4
3	1.5	1.6	1.9	1.5
4	1.4	1.6	1.8	1.5
5	1.5	1.6	1.5	1.5



Data: Vanguard Automation, VanCore B

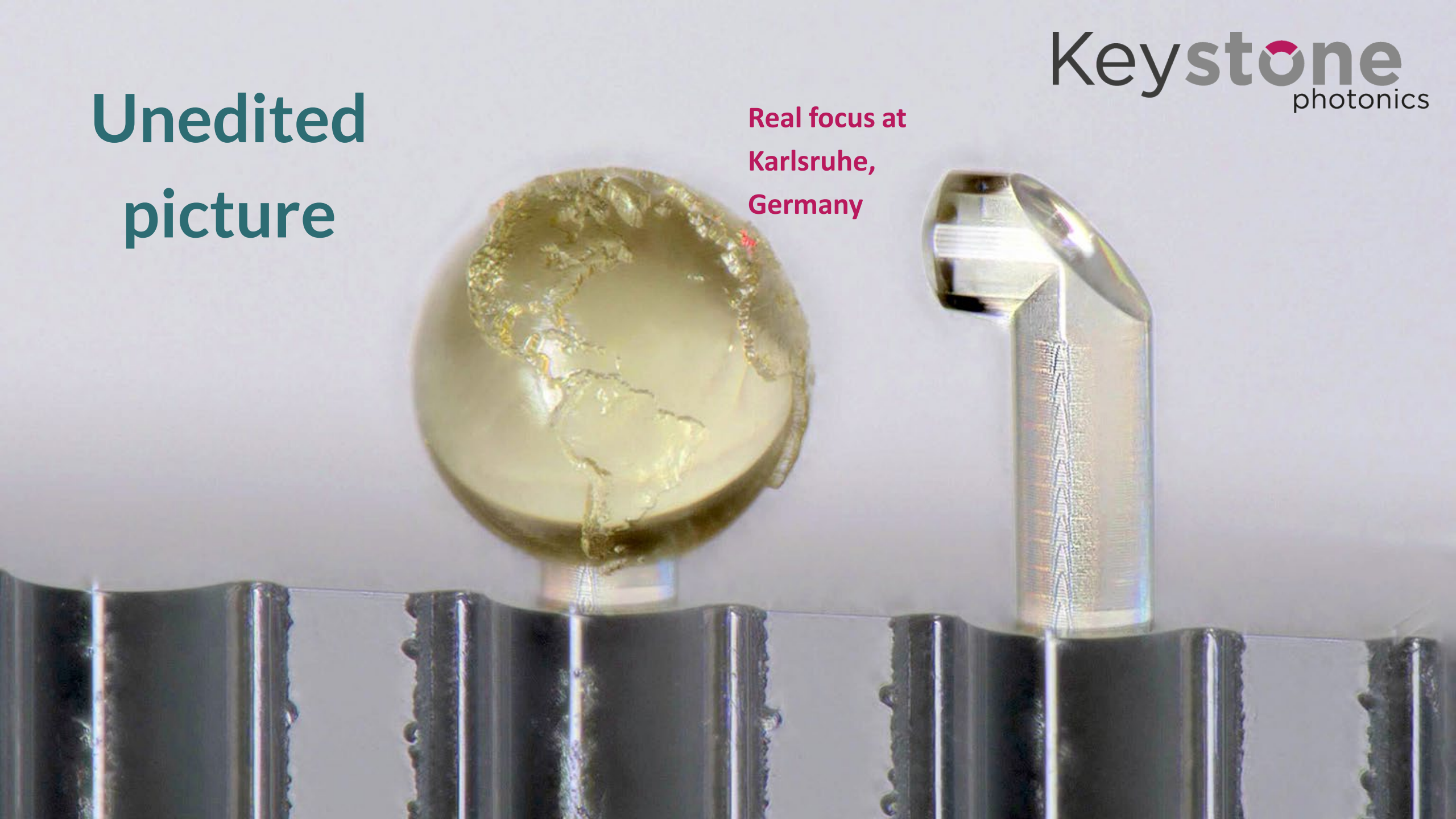
85°C, 85 % rel. hum.; -40/85°C cycle;
10 cycles from -4K to RT, N2 immersion

Industry-proven products, using additive microfabrication

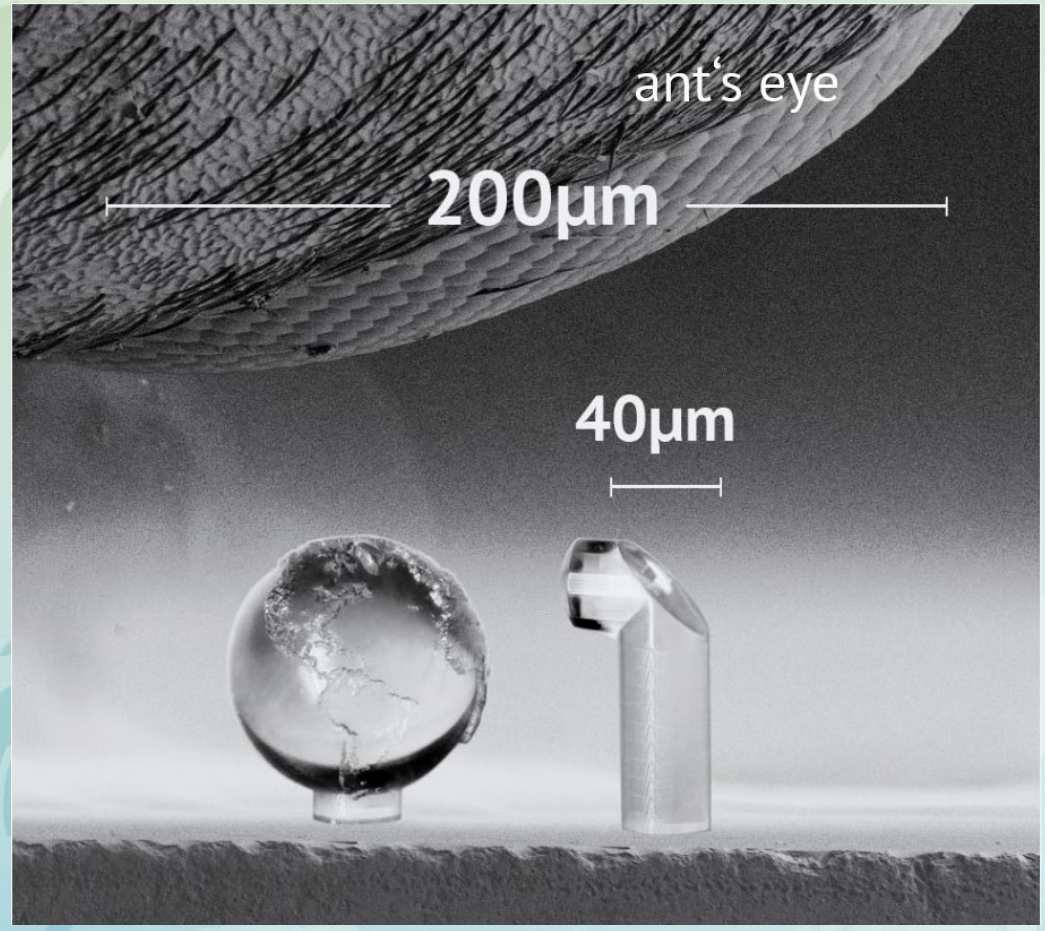


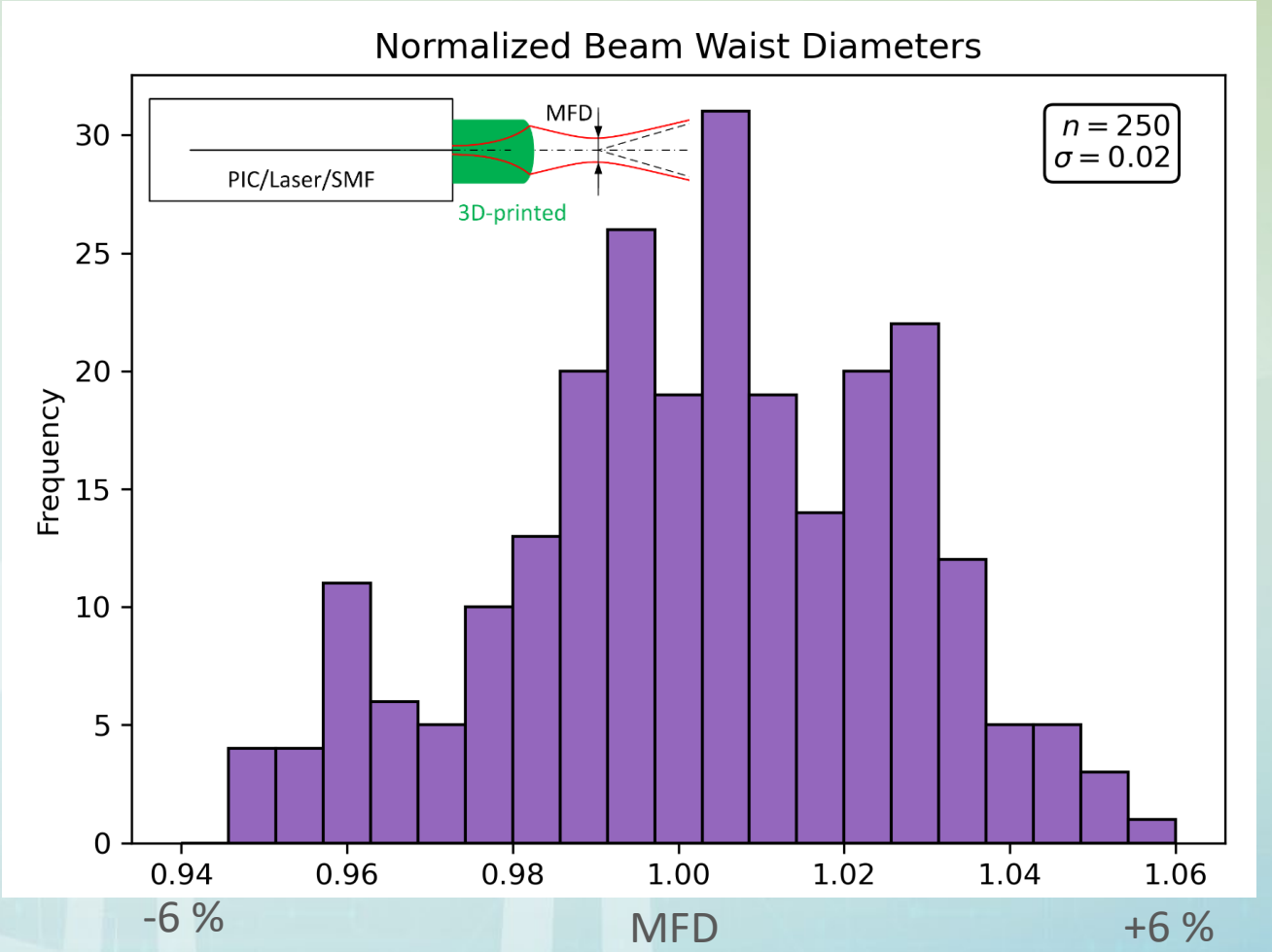
Unedited picture

Real focus at Karlsruhe, Germany

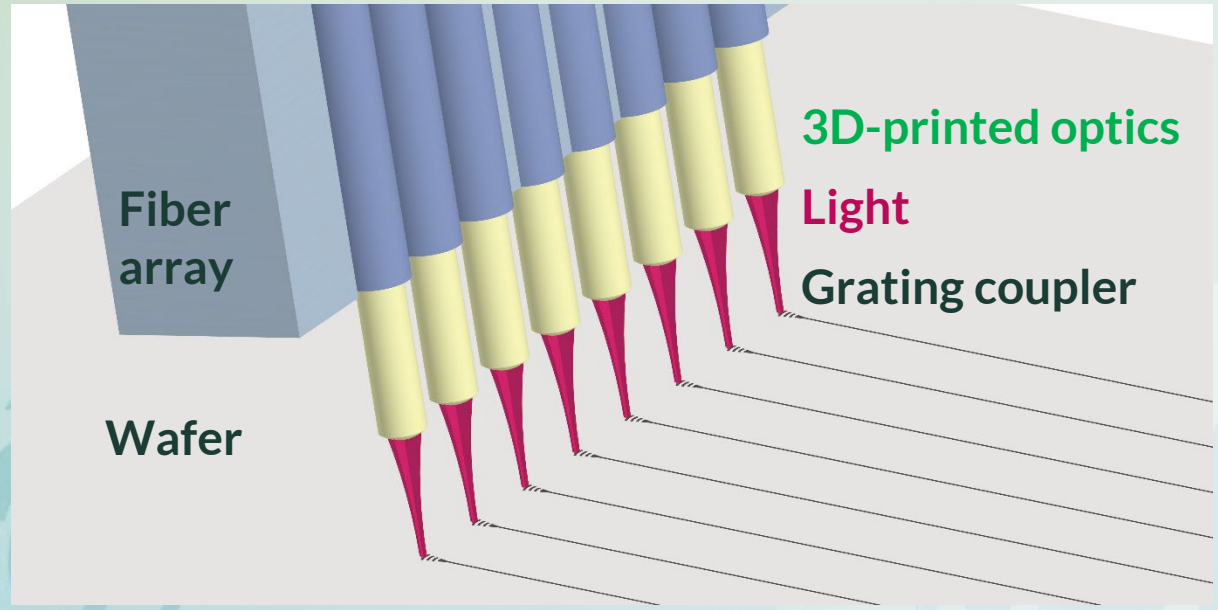


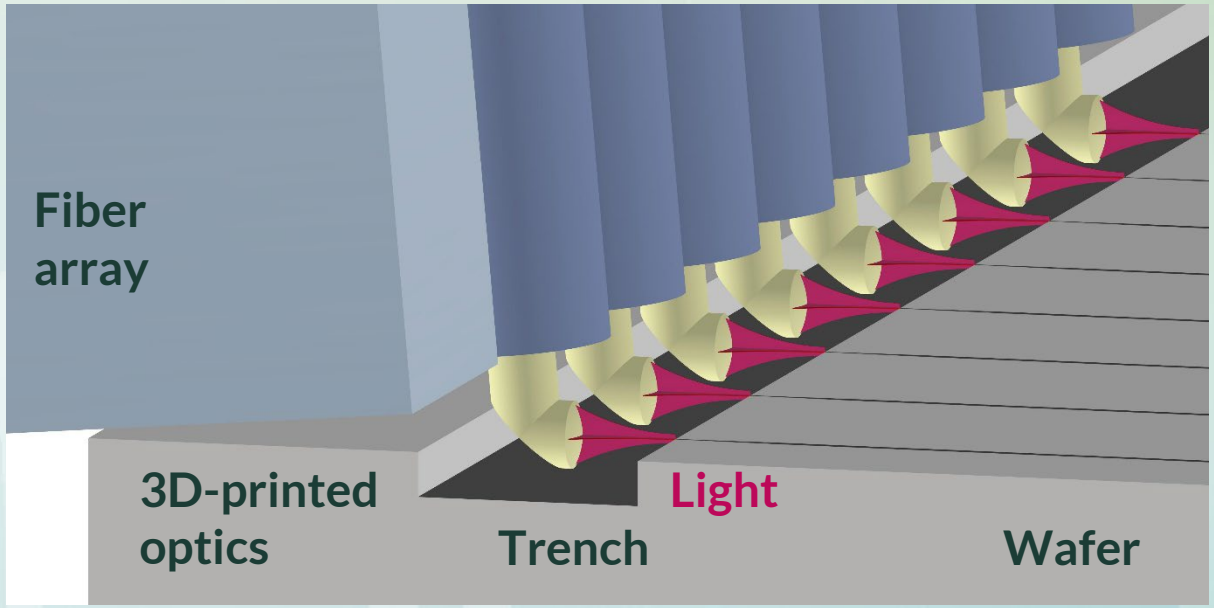
Small & precise



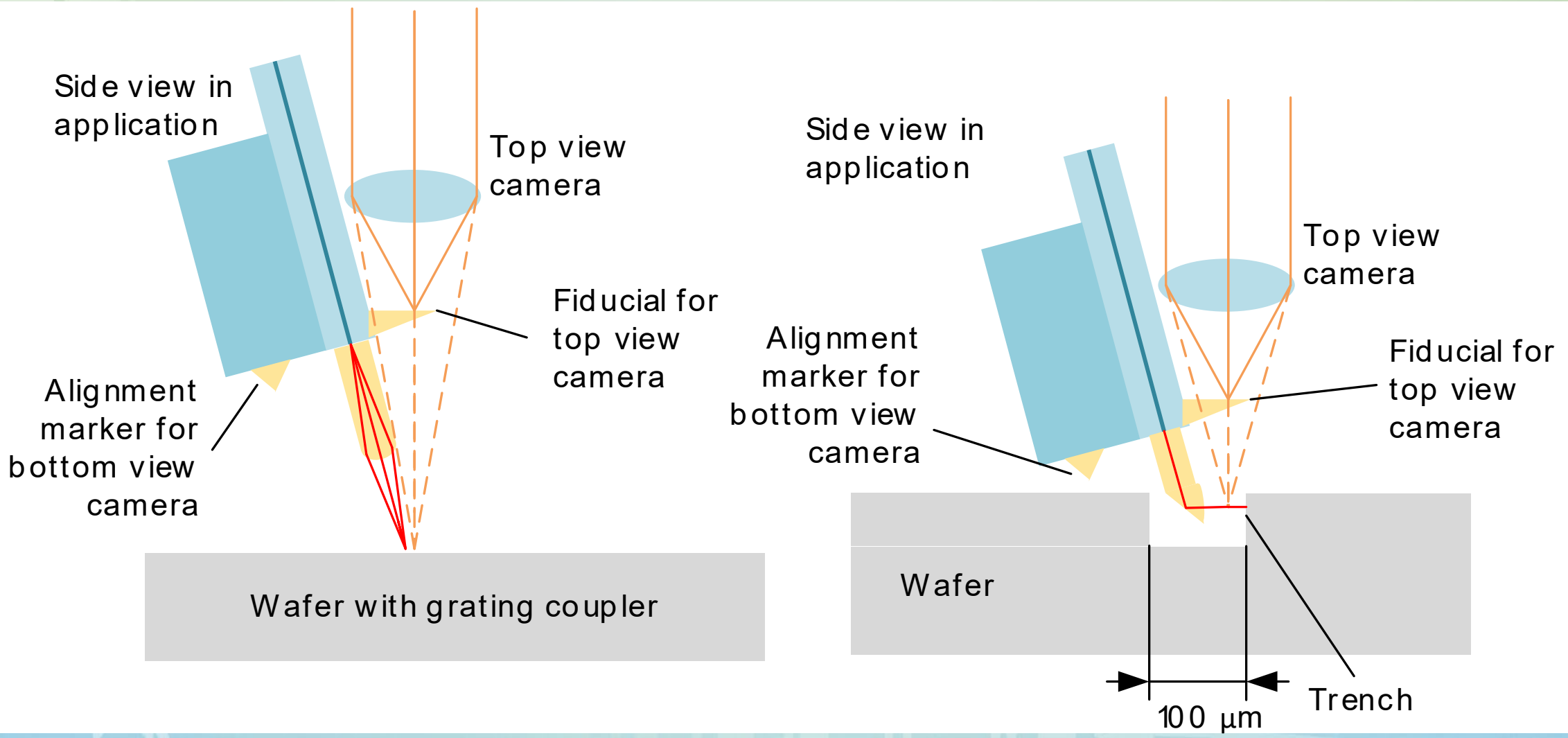


Application: Wafer-level testing in manufacturing

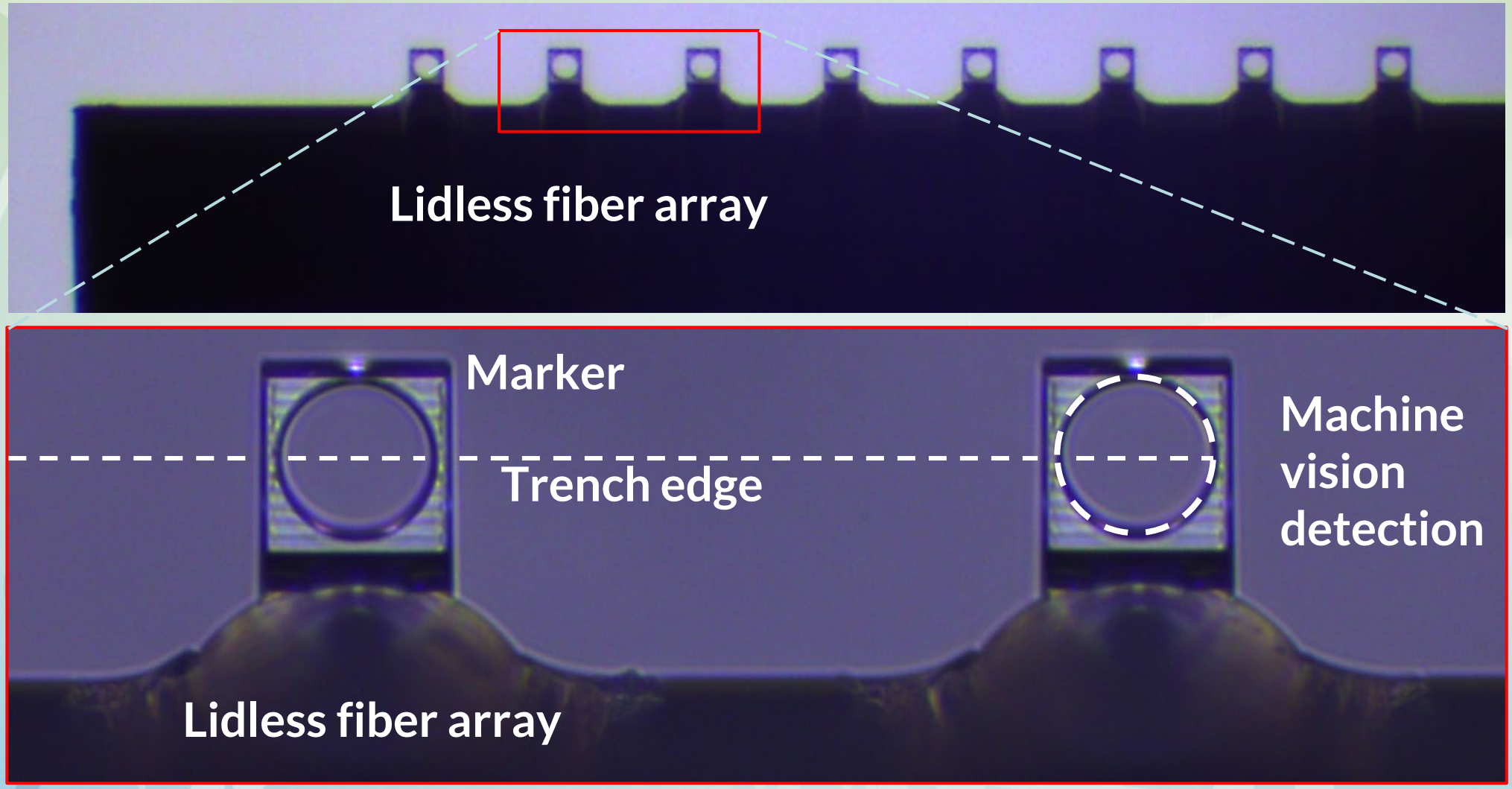




Integration in wafer level tester



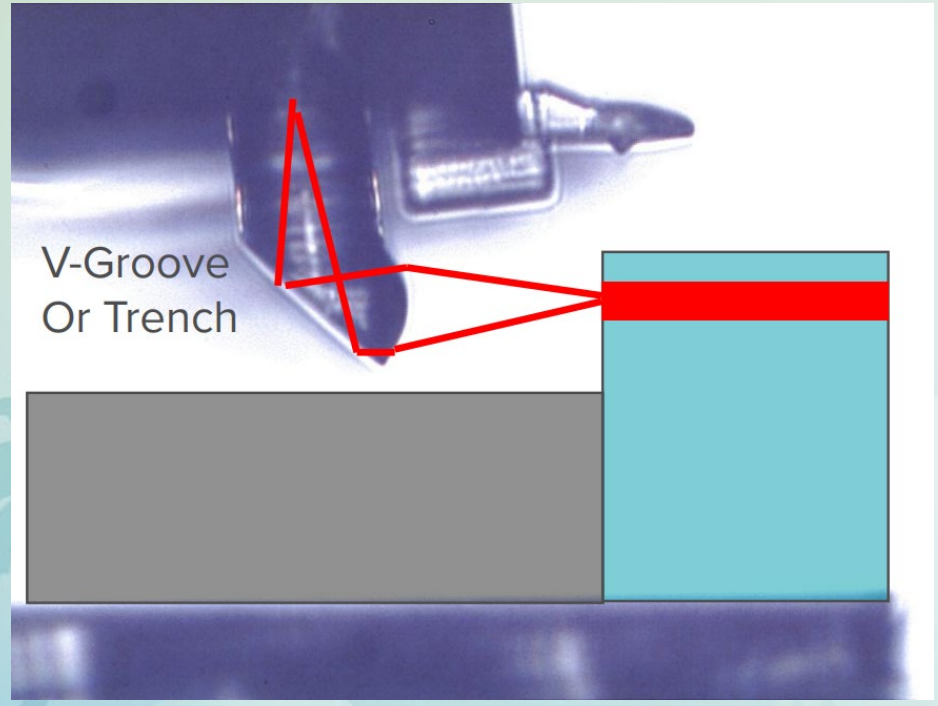
Marker structure for alignment



Top-view camera perspective

Formfactor's Pharos Probes

WD=5um (Cleave fiber array)
coupling loss is 4.25 dB/facet
WD=38um (Pharos Lens)
coupling loss is 1.47dB/facet

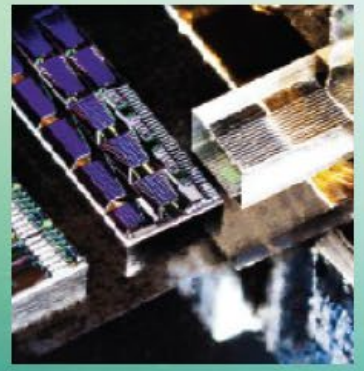


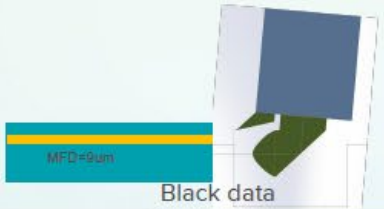
https://www.formfactor.com/download/fully-automated-integrated-silicon-photonic-wafer-test/?wpdmdl=82376

Pharos Low Loss Lens Performance for Edge Coupling

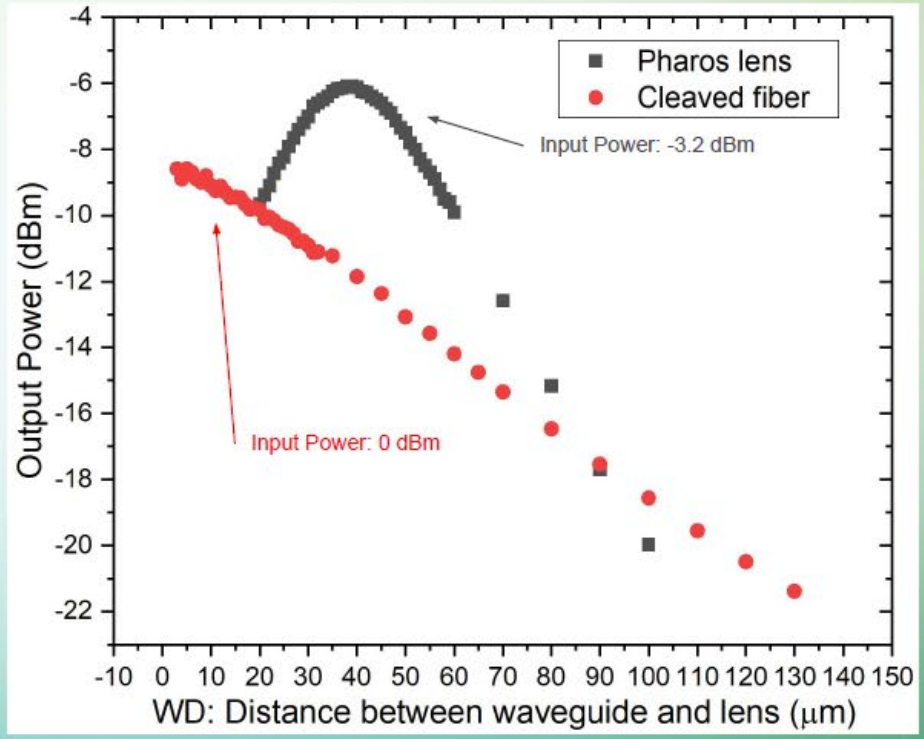
Singulated Chip:	Chip1 MFD = 9 um
FF Pharos Lens:	MFD = 6.0um
Structure:	Loopbacks Edge Facet
Best coupling:	WD=5um (Cleave fiber array) Power =-8.5 dBm
	Coupling loss is 4.25 dB/facet
	WD=38um (**Pharos Lens**) Power= 6.01-3.2 dBm
	Coupling loss is **1.47dB/facet**

Red data



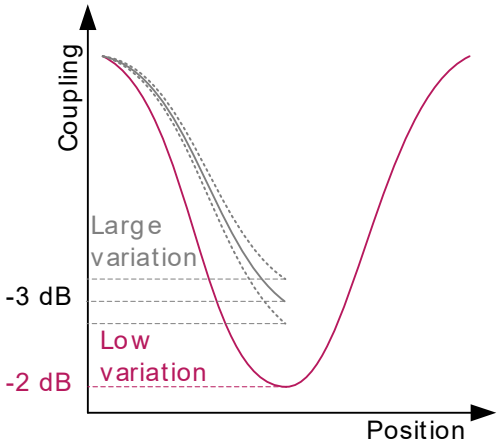


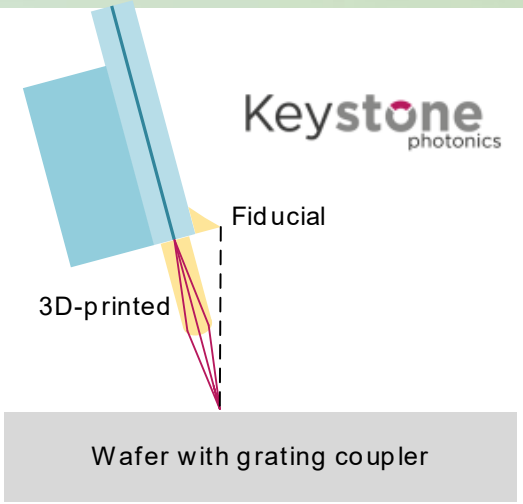
Black data

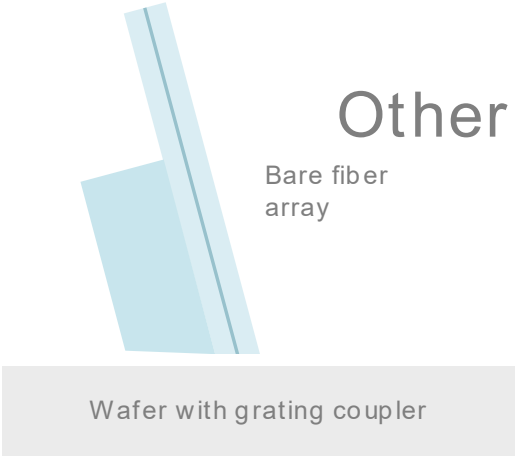


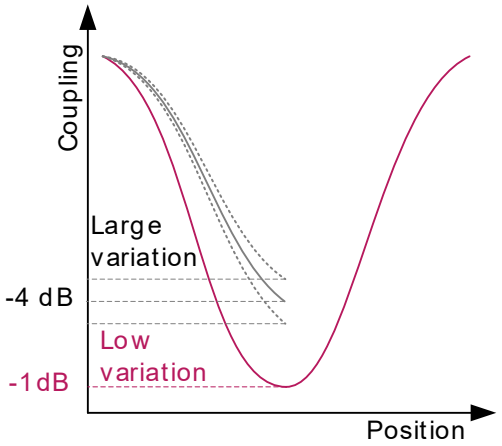
Comparison with conventional technology

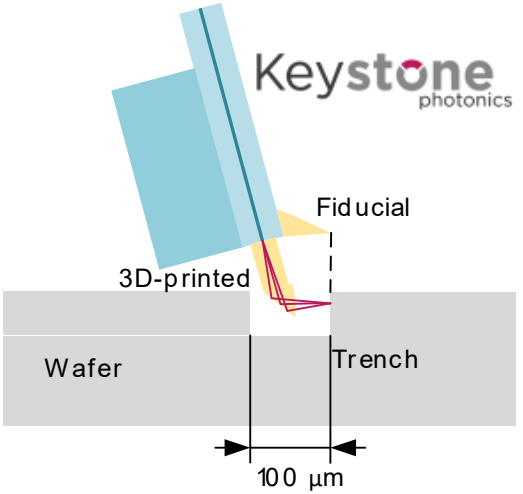
Keystone probes	advantage
reproducible	detect device variation
multi channel	fast
good coupling	BER testing
fiducial	simple alignment
PM-option	no PM alignment
large working distance	robust testing method

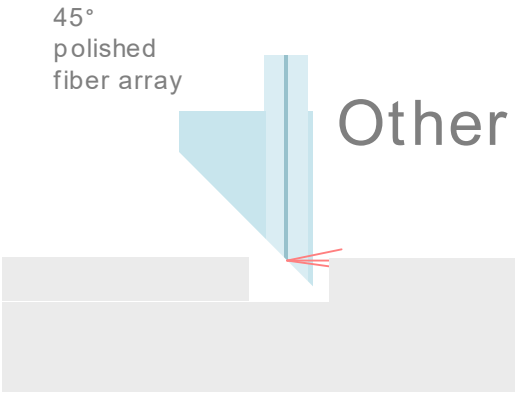




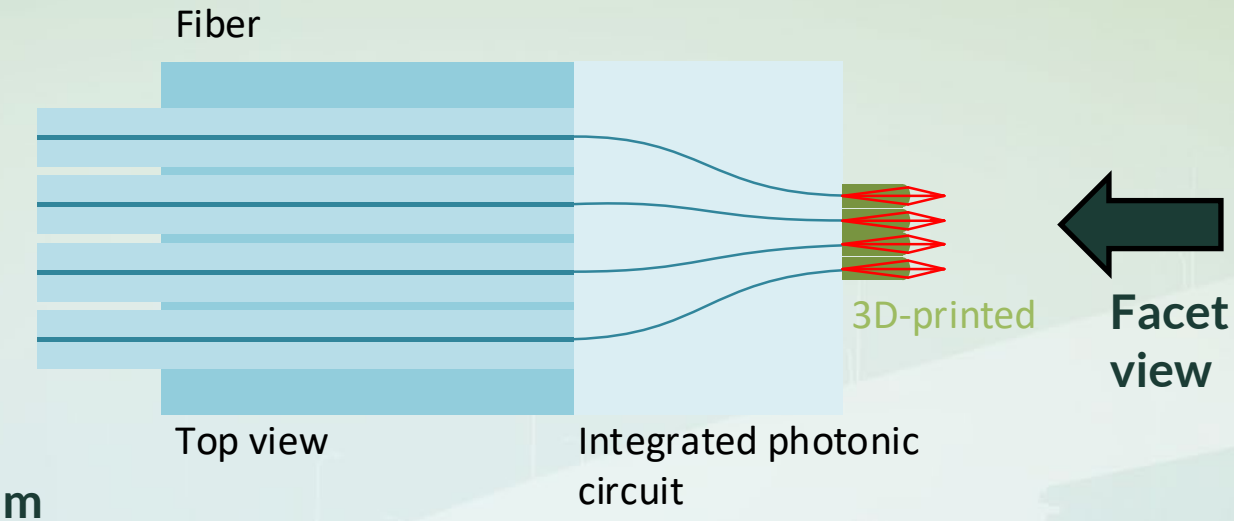


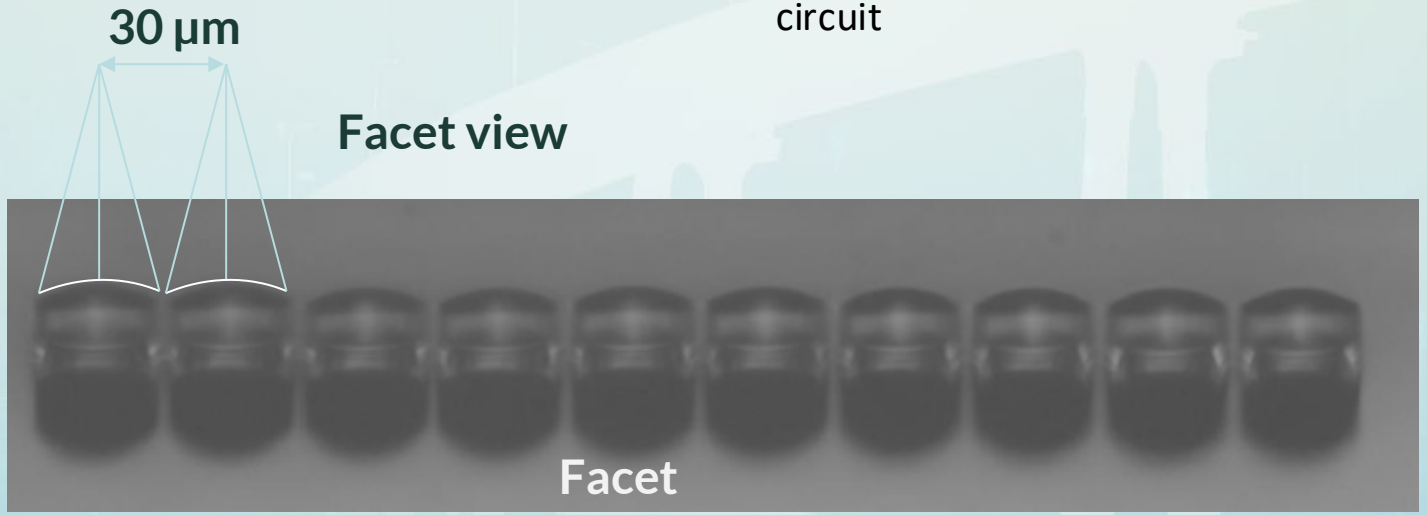




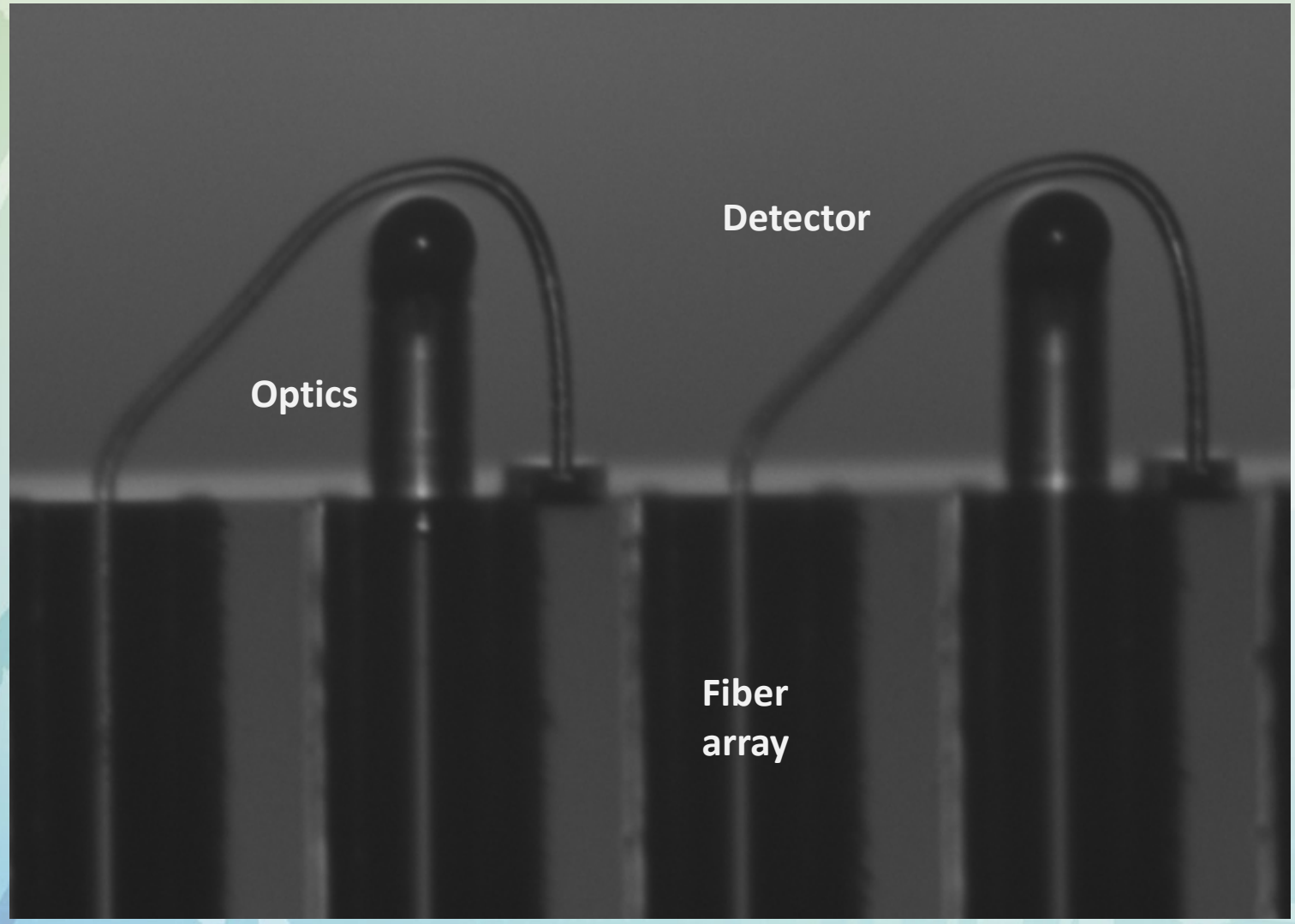


New: Ultra dense pitch testing for AI

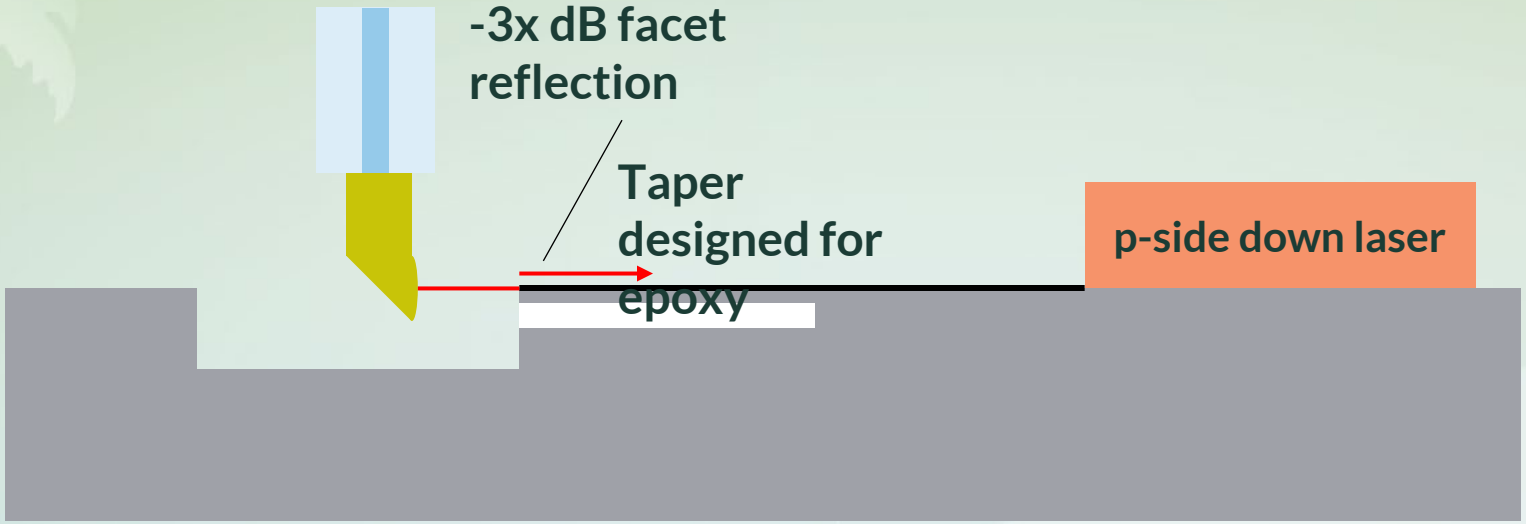




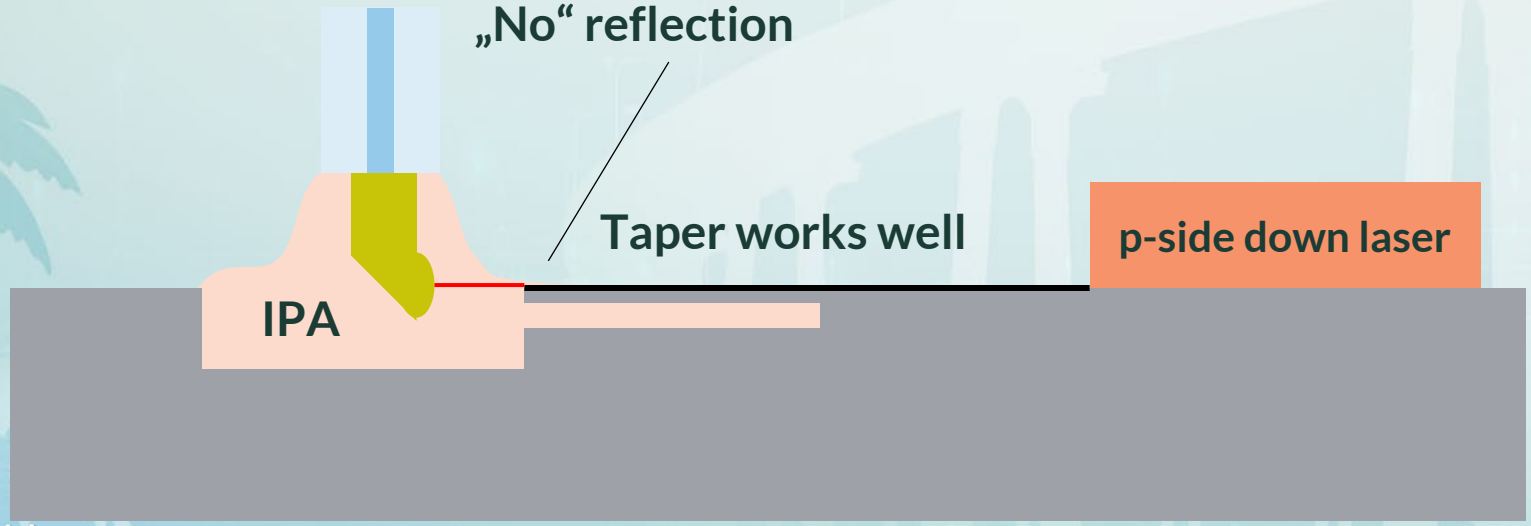
New: sensor functionality for production



New: Probing in Index Matching Liquid



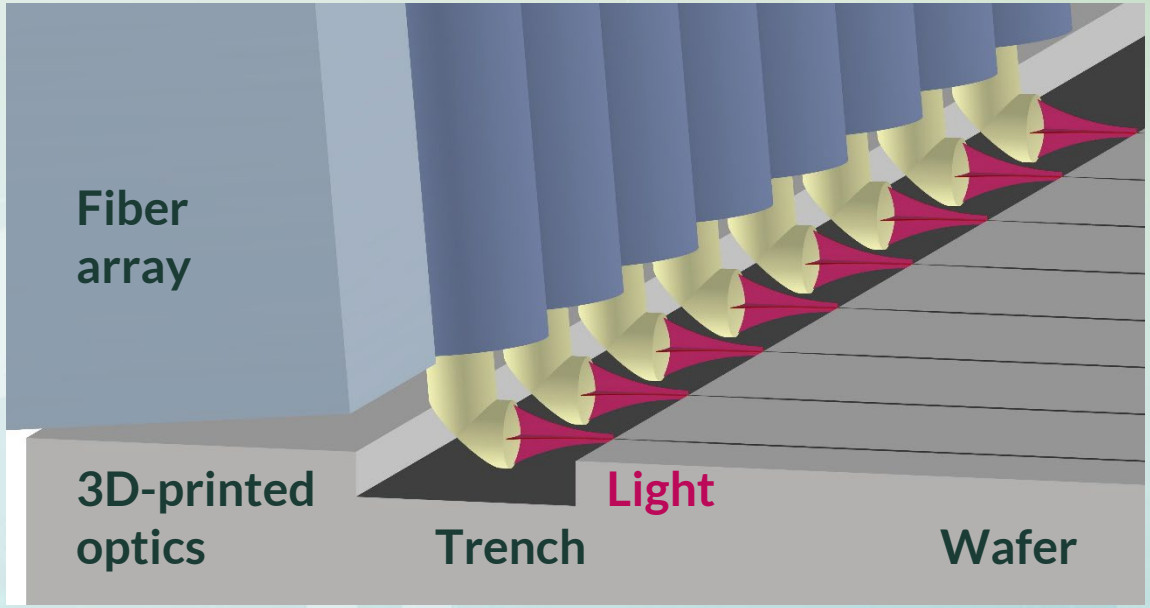
Probing in air



Probing in index matching liquid

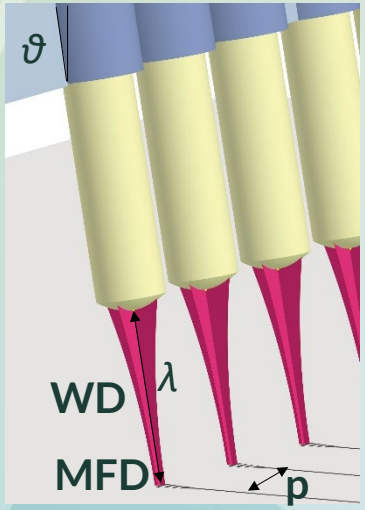
Summary

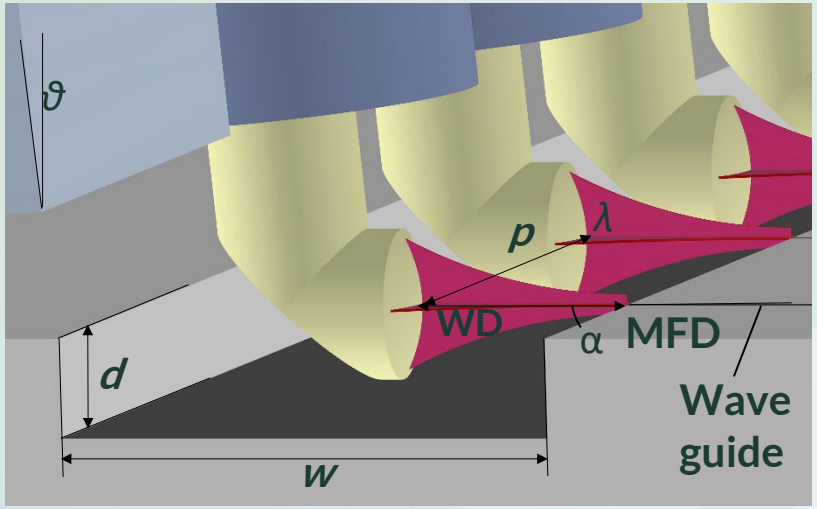
- Universal solution for optical wafer level testing
- Fabrication is precise and reliable
  - No offset between localization and fabrication
  - Technology is used in commercial transceivers
- New developments
  - Narrow pitch
  - In-built detector
  - Testing in liquid



Annex

Parameters





Name		Range	Accuracy
Fiber type		SMF/PMF/MMF/mixed	±5° (PMF)
Fiber array angle	ϑ	from 0 to 12°	
Working distance	WD	15..200 µm	±10%
Mode-field dia.	MFD	2µm…30µm, @1/e²	±5%, 3σ
Pitch	*p*	20µm .. >1mm	±1 µm, 4σ
Wavelength	λ	1.2 to 1.6 µm	-
Min trench depth	*d*	30 µm	-
Min trench width	*w*	100 µm	-
Emission angle**	α	70° to 110°	±0.2°
Coupling*		<-1dB	±0.2 dB,σ
Reflection	-	< -33 dB	
Operation temp.	-	4K to 85°C	-
Acceleration		Shock 500g, vib. 20g	
Max. power		1 W, cw @ 1550nm	
Channel count		Up to 64	

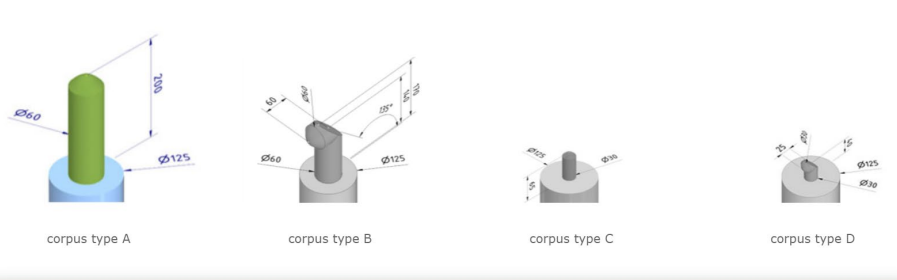
*Depending on PIC mode-field **Emission angle can range from 70° to 110° in plane and 88° (<90° => towards wafer) to 110° out of plane

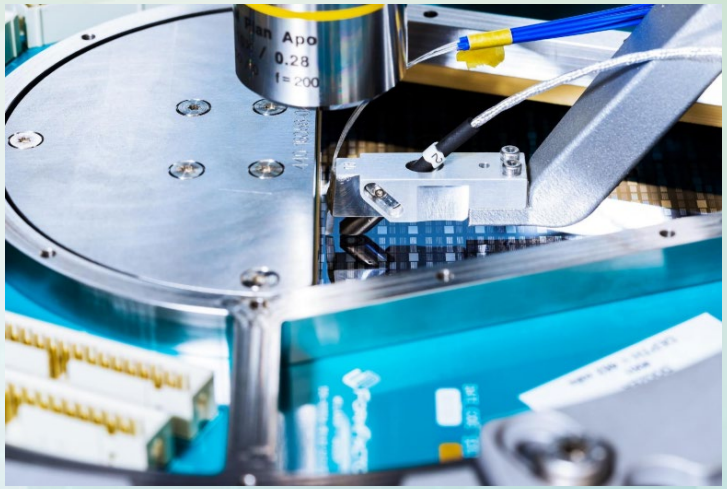
Engagement

Standard products via online configurator

Design and engineering services

OEM components





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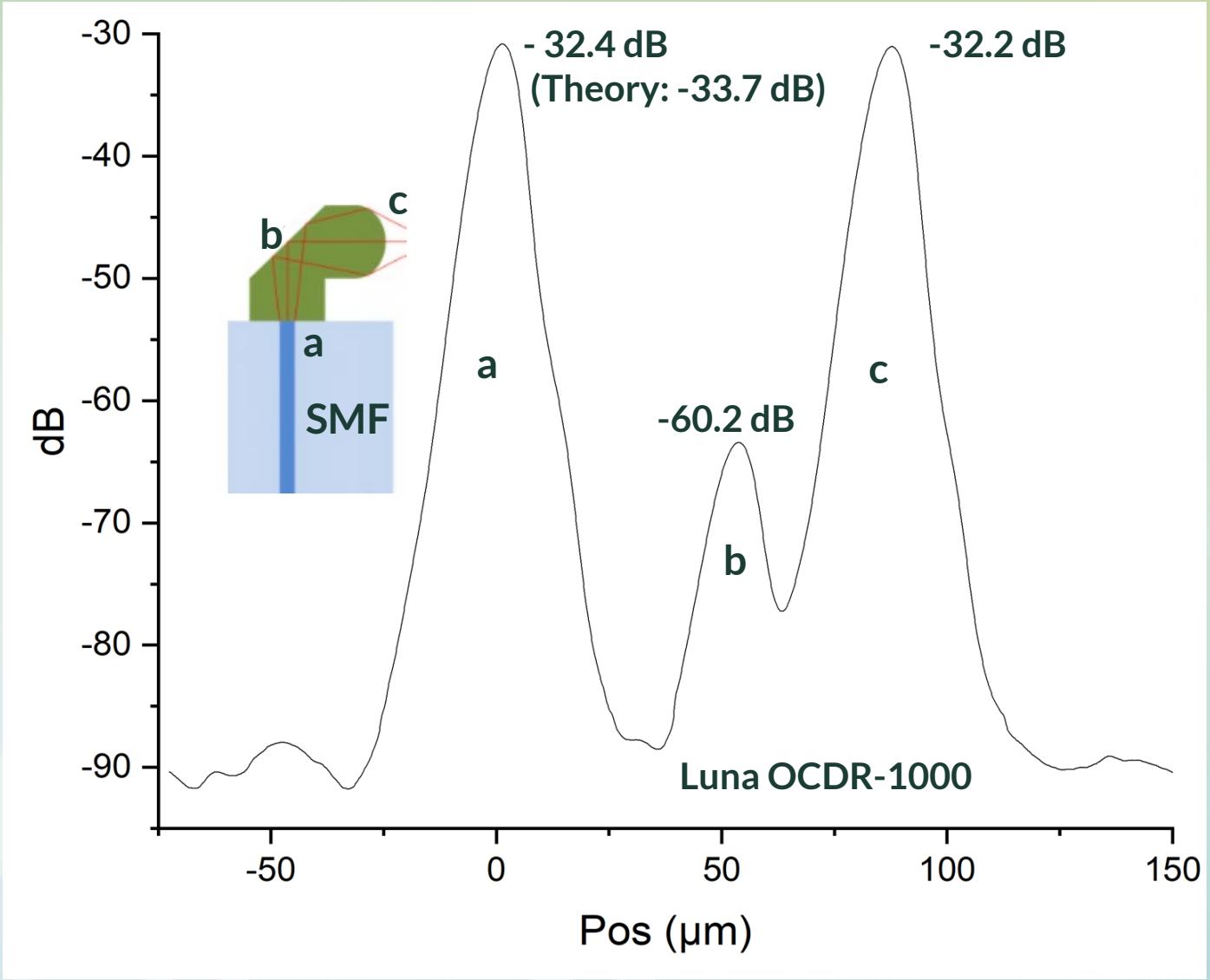
www.keystone-photonics.com

Back reflection



Ready for quantum application @Cryo

image **source**: KIT

- Complete package
  - 3D-printed freeform optics
  - Application specific products
- Suitable for cryogenic temperature
  - Operation at 4K
  - 4K to room temperature (>10 cycles)
  - Stable @ liquid N2 immersion
  - Wavelength 530 nm to > 2000 nm
- What we can do
  - 3D micro-structures for mdB coupling
  - Test & Measurement

sales@keystone-photonics.com

www.keystone-photonics.com

Datasheet photoresist VanCore B*

- compatible components
  - laser (DFB and other)
  - PIN and APD diodes
  - SMF, PMF and MMF fiber arrays
  - PIC: SOI, SiN, InP, LiNb and more
- standard building blocks:
  - lenses with focal length up to centimeters and mode-field diameters of 2.0 µm to 100 µm (@1/e² intensity)
  - total-internal-reflection mirrors
  - 3D-printed mode-size converter
- coupling, depending on laser and chip
  - laser-to-chip: 0.6 to 2.5 dB
  - chip-to-fiber: 1.5 to 2.5 dB,
- alignment tolerances @ 1 dB penalty:
  - ±1.5 µm (single lens on one component) to ±15 µm (beam expander)
- operation range
  - 530 nm to 1650 nm
- reproducibility
  - below σ = 0.2 dB coupling variation
  - below 10% mode-field and focus length variation/deviation
- accuracy
  - below σ = 50 nm detection accuracy
  - below ±100 nm shape accuracy
  - less than 10 nm RMS-roughness
- reliability testing
  - > 4000 h 85°C/85% rel. hum
  - > 250 cycles -40°C to 85°C
  - reflow soldering, 3 cycles, 270°C
  - AuSn 310°C
- shock testing
  - acceleration of up to 1500 g
  - vibration, 20g, all axis
- high power operation
  - >1 W @ 1550 nm
- cryogenic operation
  - > 10 cycles 4K to room temperature

our production solution:
Vanguard Automations
SONATA1000

*by Vanguard Automation GmbH

Printing process of lenses with Sonata1000