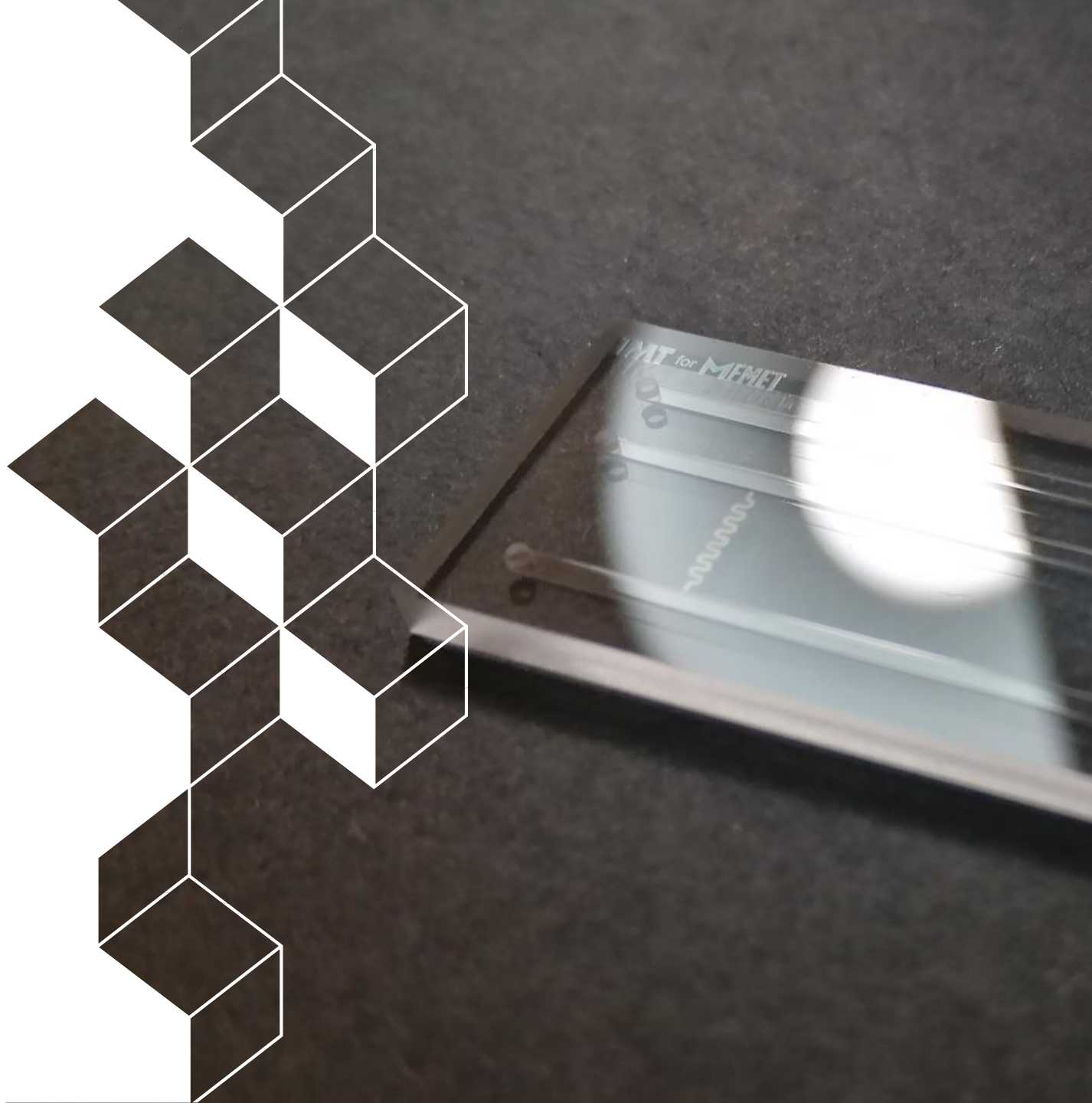

“I prefer to take the train.”
Joris Kaal (a week ago)
MONFRAGÜE
renfe

Dimensional characterization of microfluidic chips

What we can and can’t do

Joris Kaal, CEA-Leti



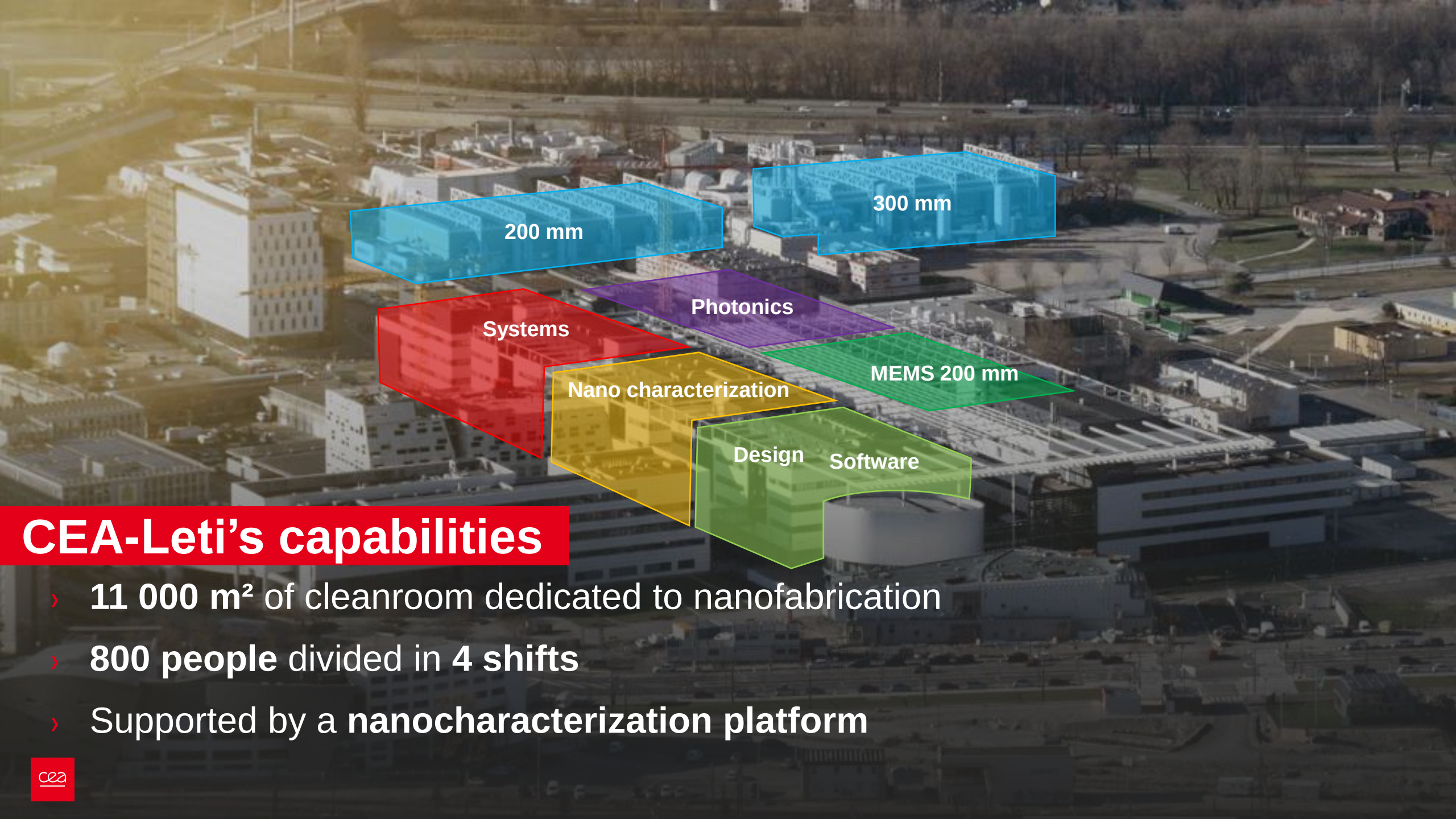
Why?

01

GENERAL NEED MEASUREMENT METHODS

02

DIMENSIONS ARE BASIS OF OTHER MEASUREMENTS



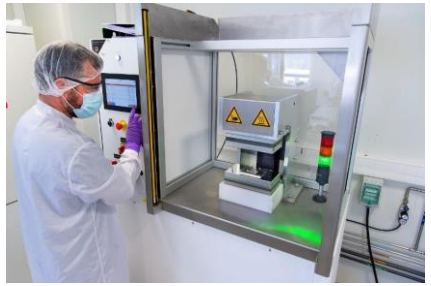
CEA-Leti's capabilities

- **11 000 m²** of cleanroom dedicated to nanofabrication
- **800 people** divided in **4 shifts**
- Supported by a **nanocharacterization platform**

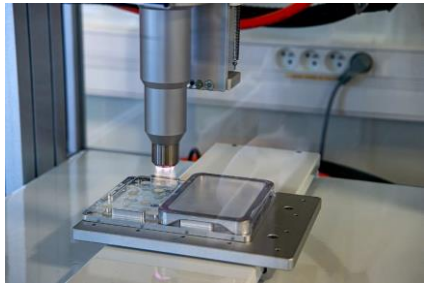
PRISM

Research Platform for Integration, Surface functionalization and Microfabrication

Polymer micro-machining and aluminium moulds



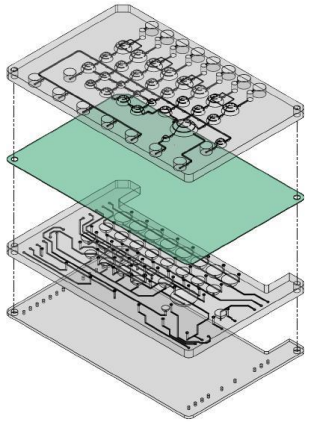
Thermoforming and heat sealing



Atmospheric plasma

Silicone film lamination

Electrochemical sensors and surface functionalisation



Generic library for standardised and ISO-conform building blocks

Cleanroom environment

How are we measuring?

Optical profilometry

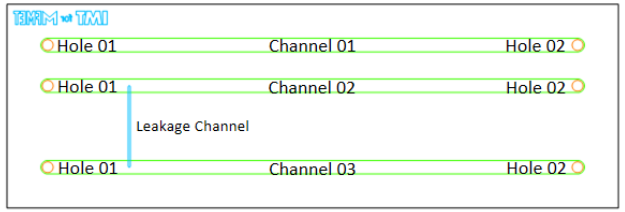
Optical microscopy

Tiled digital imagery

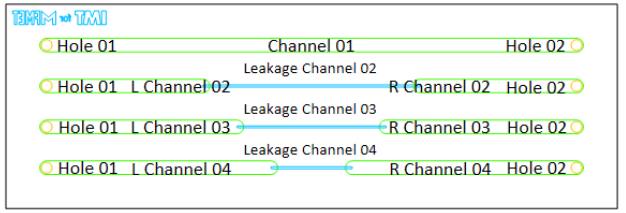
Confocal microscopy

What are we measuring?

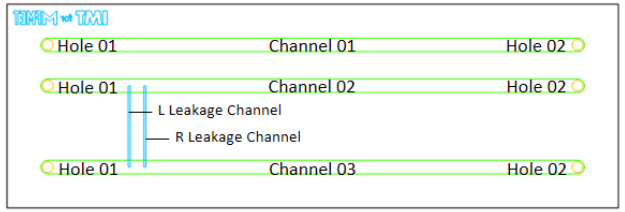
Design 01



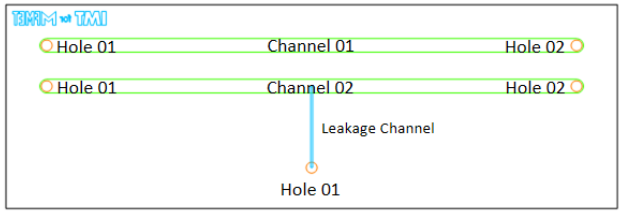
Design 05

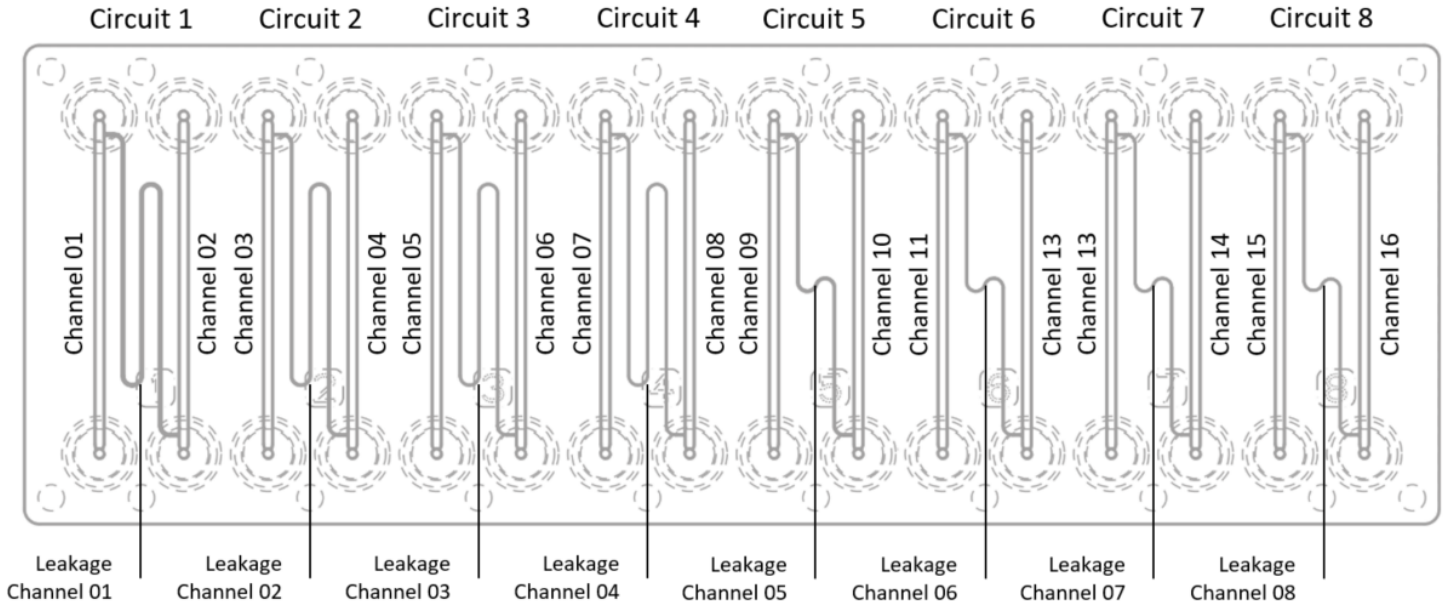


Design 02



Design 06

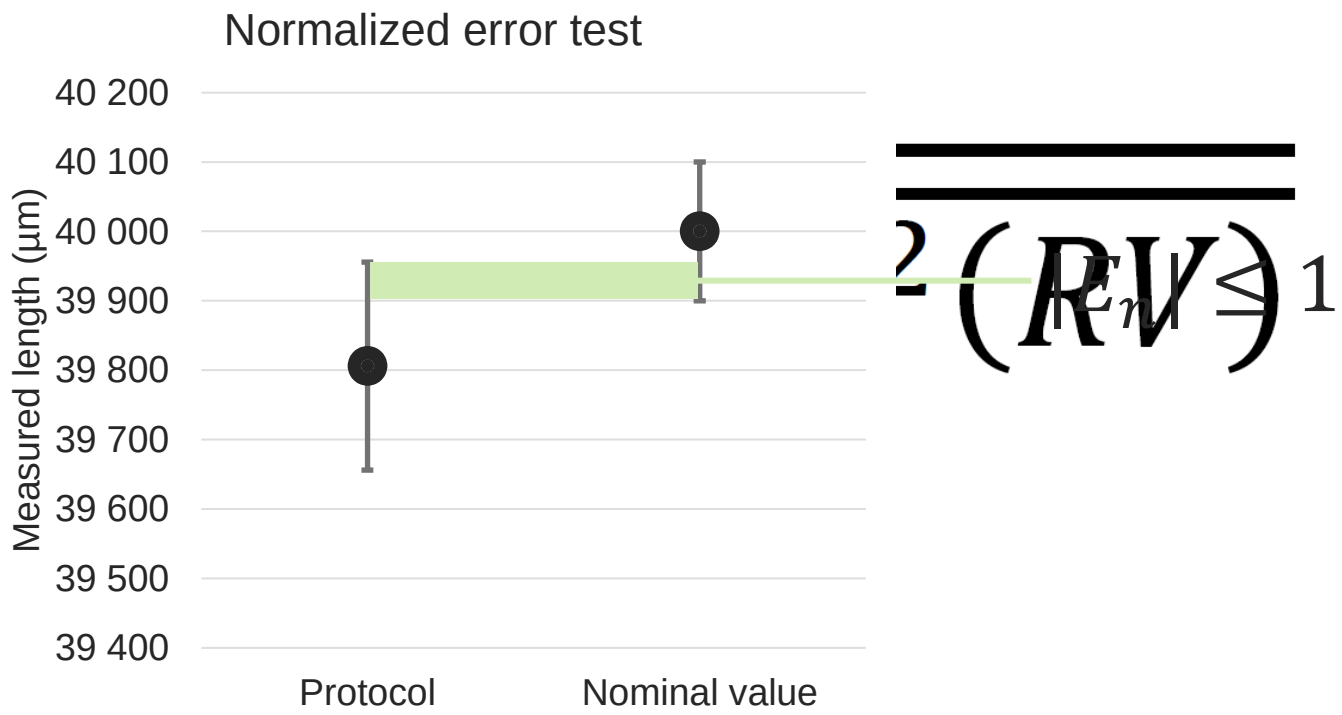




263© Bio glass
TOPAS© COC

How do we compare?

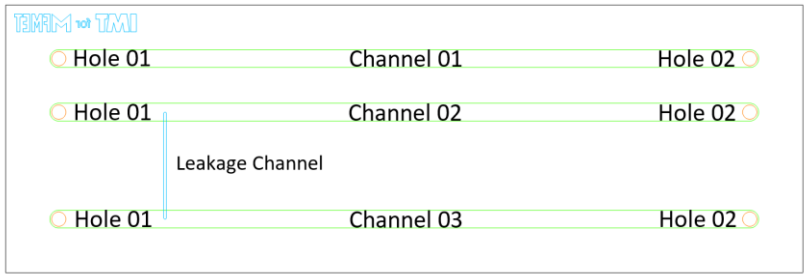
$$E_n = \frac{|x_{lab} - x_{ref}|}{\sqrt{U_{lab}^2 + U_{ref}^2}} \leq 1$$



Normalized error values in glass

	Diameter Hole 01	Diameter Hole 02	Width	Depth	Length
Protocol 1	0.16	0.33	-0.93	-7.81	0.02

Design 01



Material influence (xy-plane)

Optical profilometer on TOPAS© COC

Width

	Average measured	Standard deviation
Channel 01	503.1 µm	0.1 µm (0.0 %)
Leakage Channel 01	108.5 µm	0.1 µm (0.1 %)
Channel 02	508.1 µm	0.1 µm (0.0 %)

vs.

Optical profilometer On D263© Bio glass

Width

	Average measured	Standard deviation
Channel 01	991.3 µm	0.2 µm (0.0 %)
Channel 02	992.1 µm	0.2 µm (0.0 %)
Channel 03	992.4 µm	0.2 µm (0.0 %)
Leakage Channel	143.0 µm	0.5 µm (0.3 %)

Material influence (depth)

Optical profilometer on TOPAS© COC

Depth

	Average measured	Standard deviation
Channel 01	358.0 µm	1.7 µm (0.5 %)
Leakage Channel 01	123.6 µm	1.8 µm (1.4 %)
Channel 02	372.9 µm	2.7 µm (0.7 %)

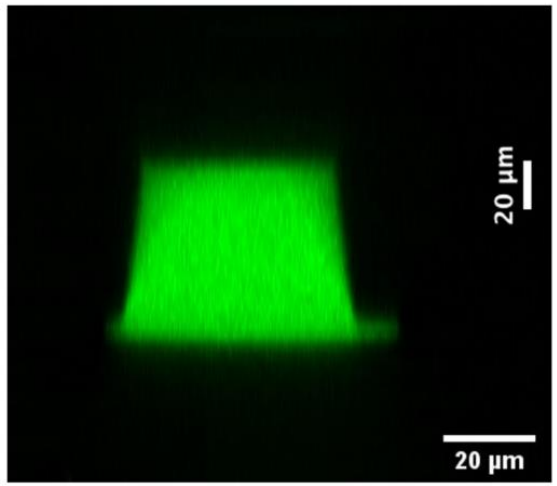
vs.

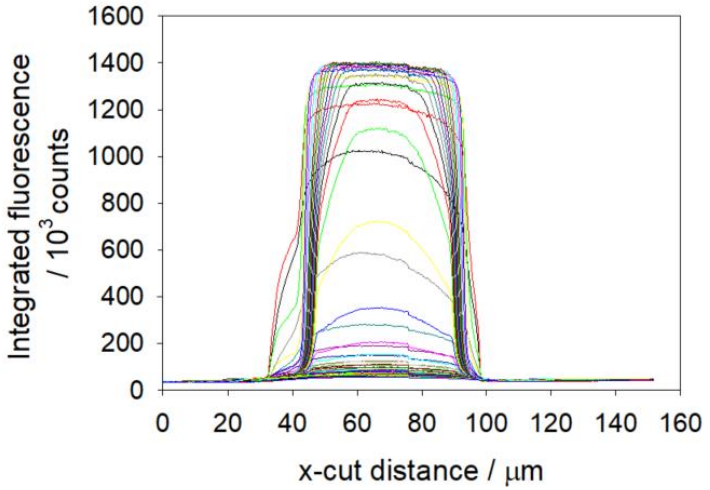
Optical profilometer On D263© Bio glass

Depth

	Average measured	Standard deviation
Channel 01	13.8 µm	4.6 µm (33.0 %)
Channel 02	17.9 µm	1.3 µm (7.6 %)
Channel 03	20.2 µm	3.3 µm (16.3 %)
Leakage Channel	N/A	N/A

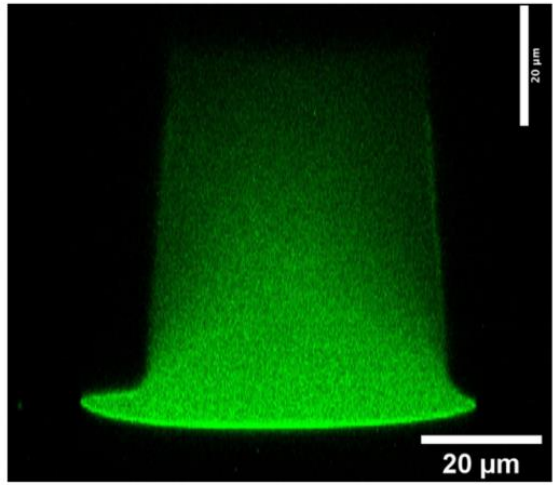
A way to solve depth measurements

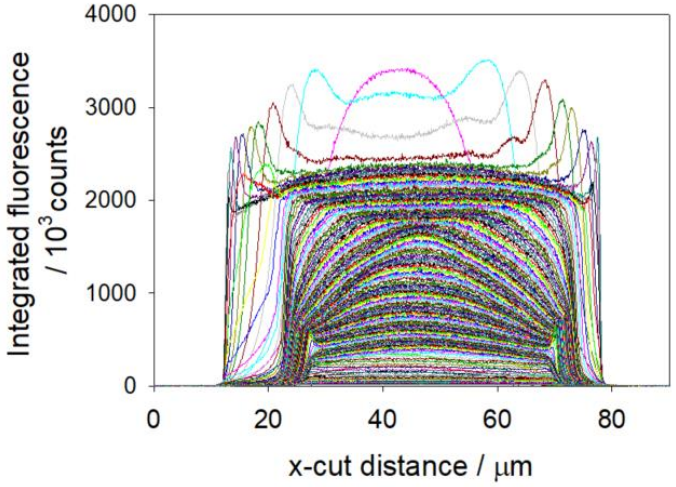




Zeiss LSM 510
x20 NA = 0.5 objective
resolution in Z of 2.07 µm

Estimated channel depth: 74.5 ± 4 µm





Zeiss LSM 510
x100 NA = 1.3 objective
resolution in Z of 0,44 µm

Estimated channel depth: 73.0 ± 0.8 µm

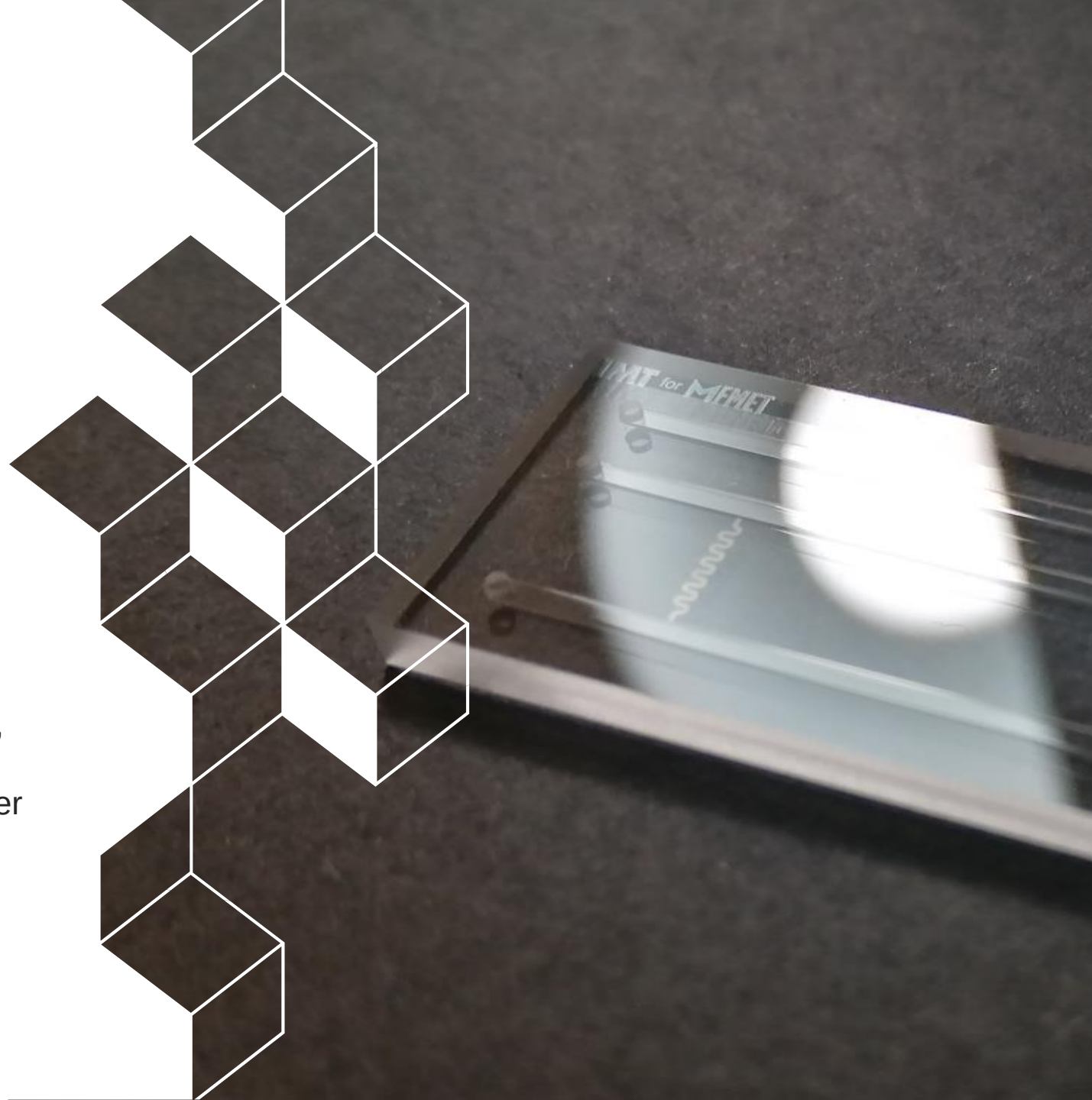
Conclusion

- All protocols are consistent
- D263© Bio glass and TOPAS© COC are comparably compatible with measurements
- Depth measurements are a challenge

Outlook

- How to do depth measurements?
  - Improve optical profilometry?
  - Zeta plane imagery?
  - Confocal microscopy?

- Compare more materials



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MFMET
Establishing Metrology Standards in Microfluidic Devices

EMPIR

EURAMET

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