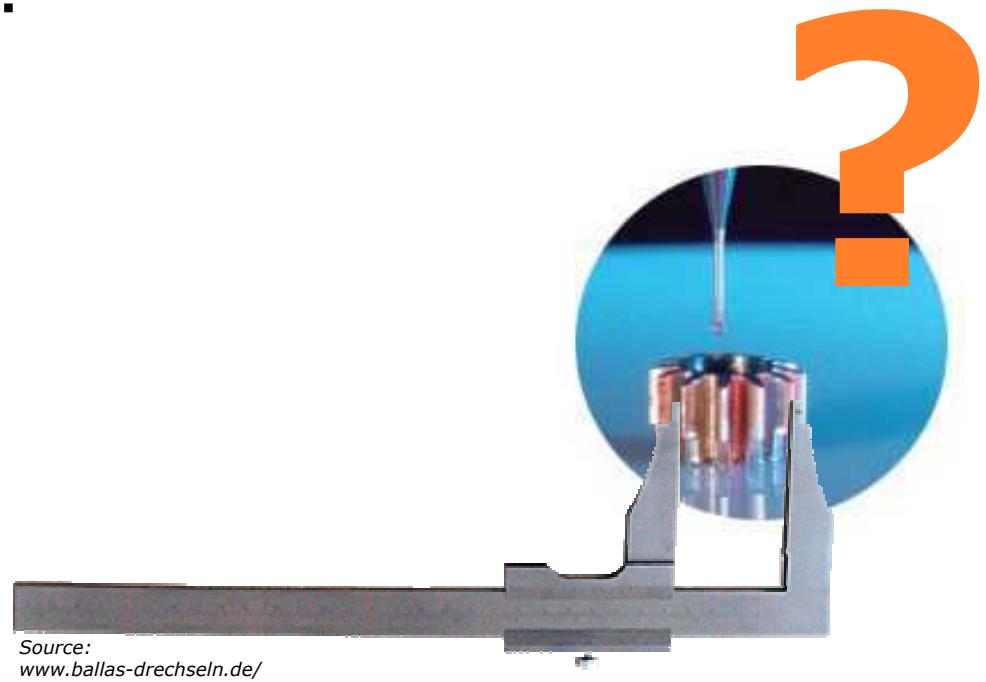
Focus-Variation towards Integrated Micro CMM

Matthias Stroessner, Alicona Germany

20th of April 2010

Why do we need integrated measurements?

Source:
www.lvr.de/Kultur/Museen/industriemuseum/zahnrad_oberhausen_gr.jpg



Source:
www.ballas-drechseln.de/
shop/images/Schublehre.jpg

Source:
www.cemmnt.co.uk

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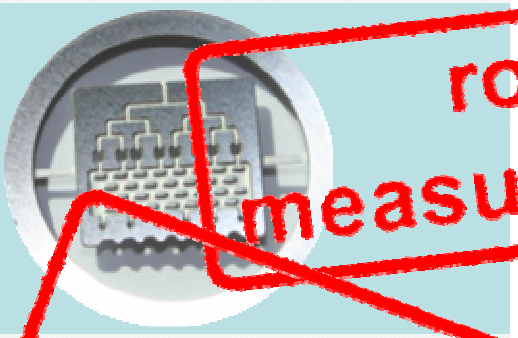
How would you solve this?

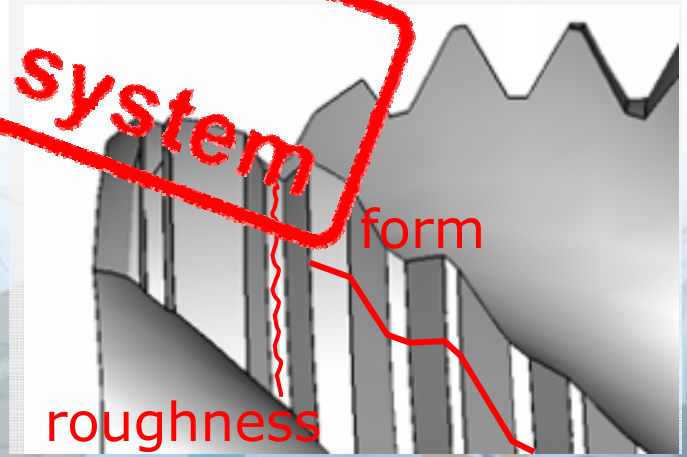
Example micro fluidic



micro fluidic
with etched channels
Source: Precision micro, UK

Example tap

drills, milling cutters…
gates
Source: BASS, DE



roughness measurement system

form measurement system

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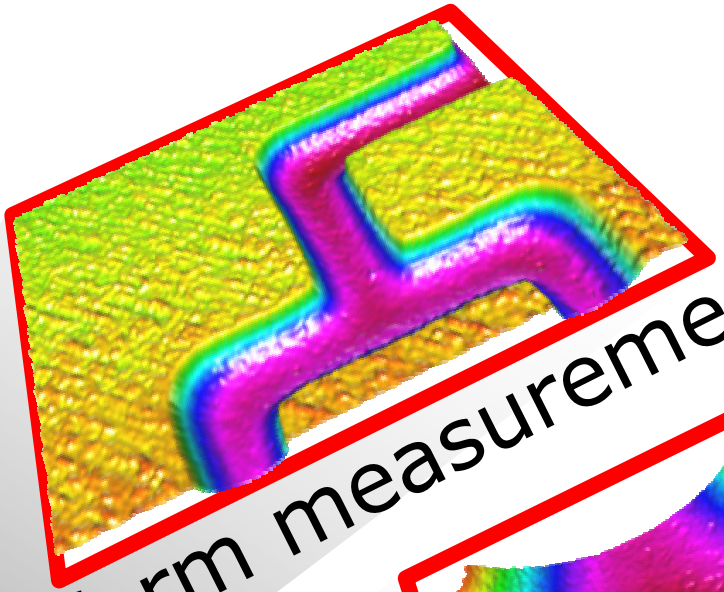
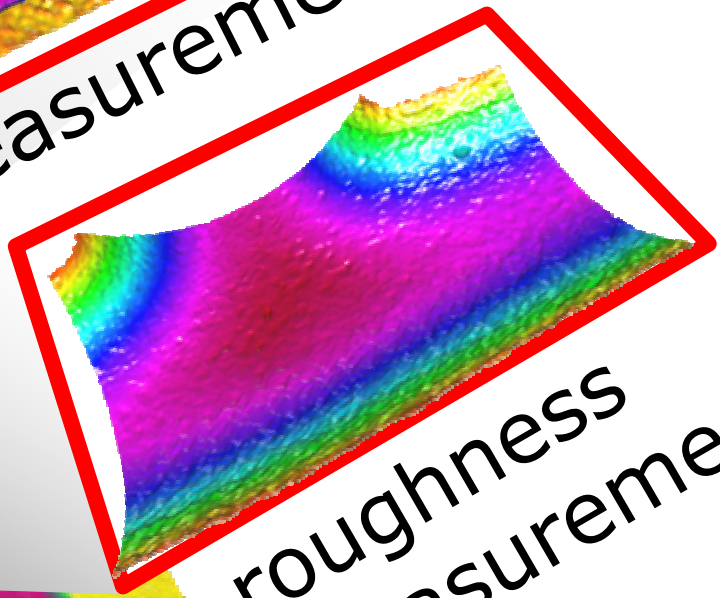
Example: Micro Fluidic



form measurement



roughness measurement

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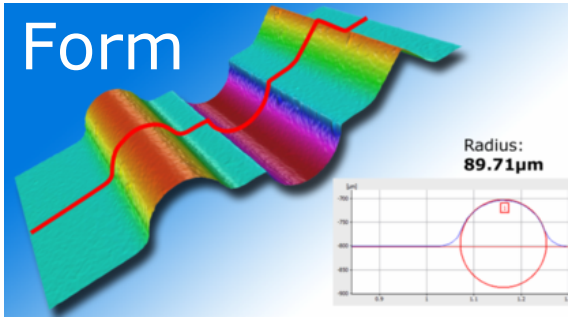
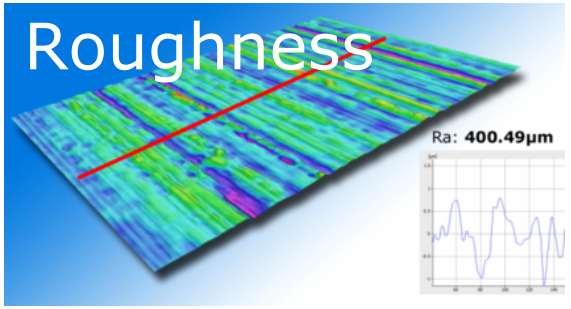
Technology: Focus-Variation





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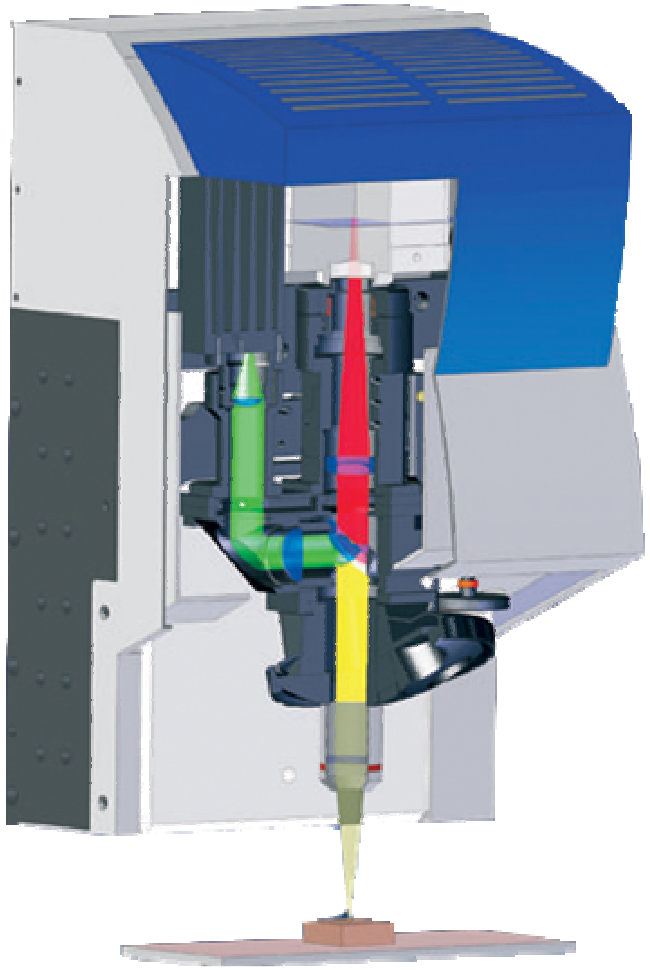
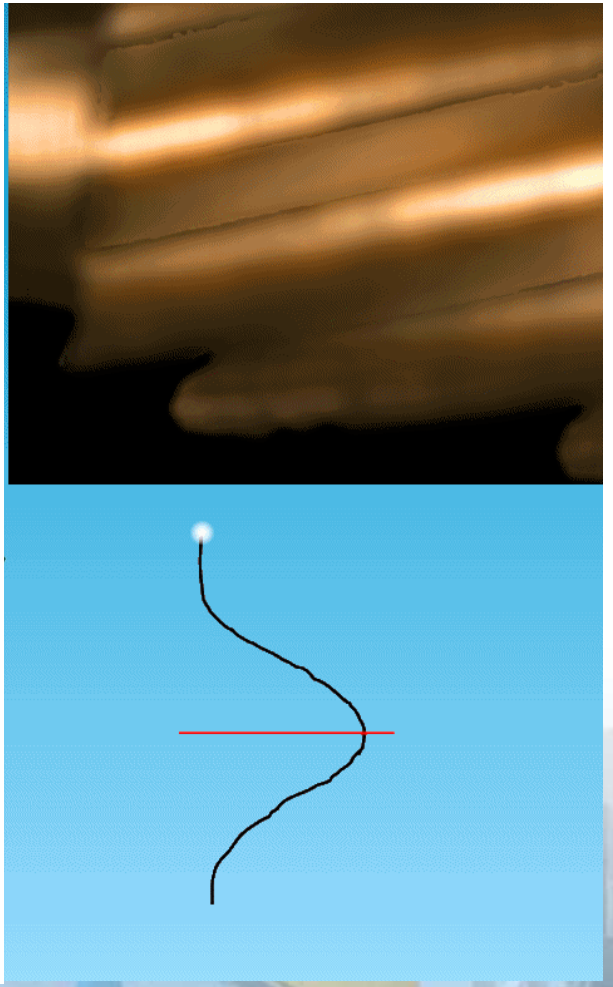
How does Focus-Variation work?





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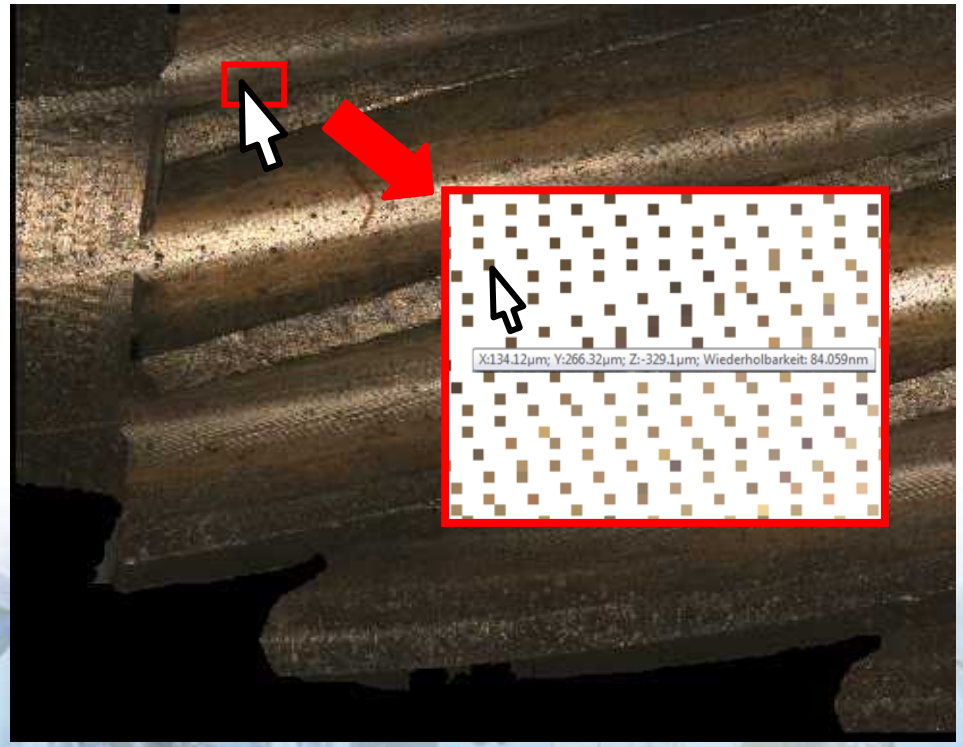
Result of a 3D Focus-Variation Measurement:



2.3 million measurement points in one shot, each with

- **3D position x, y and z**
- **Color for every single measurement point**
- **Repeatability for every single measurement point**

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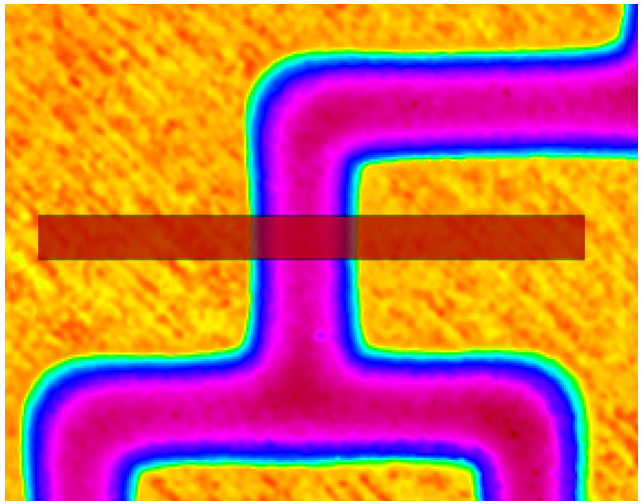
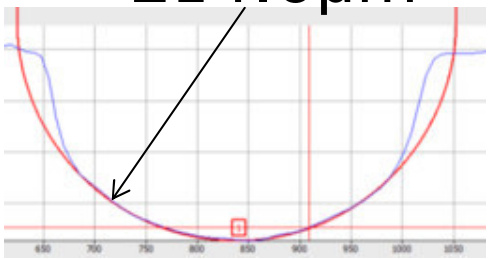
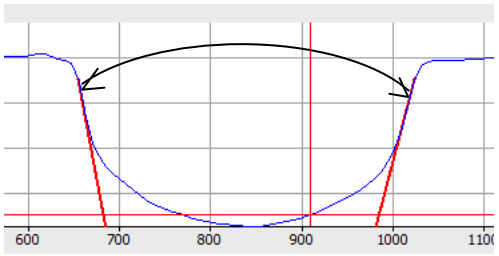
Form Measurement Micro Fluidic

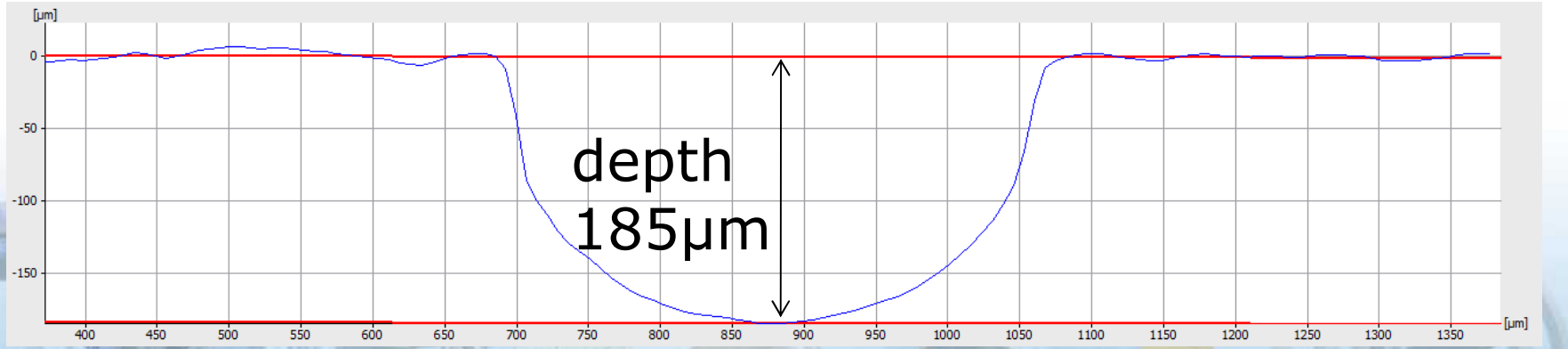


radius
214.6µm



flank angle
25.1°





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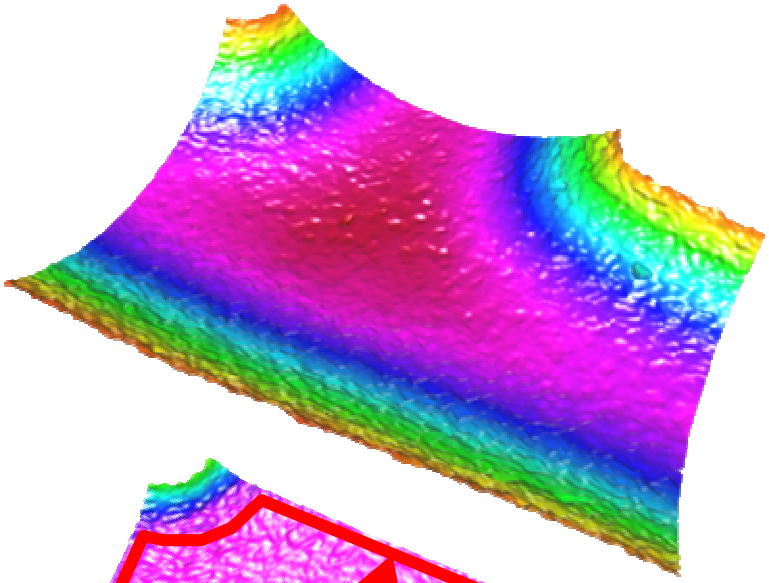
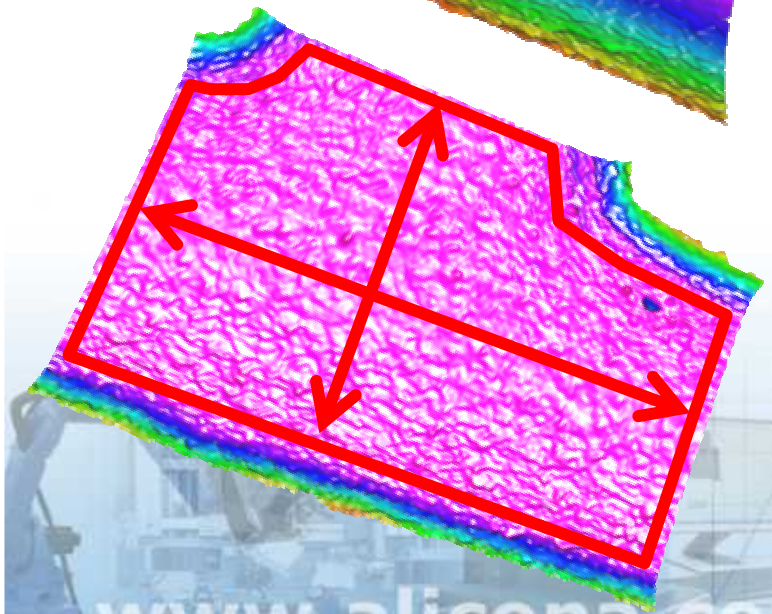
Roughness Measurement Micro Fluidic





50x measurement,
100nm vertical resolution

selected area for
roughness analysis
(form removed)

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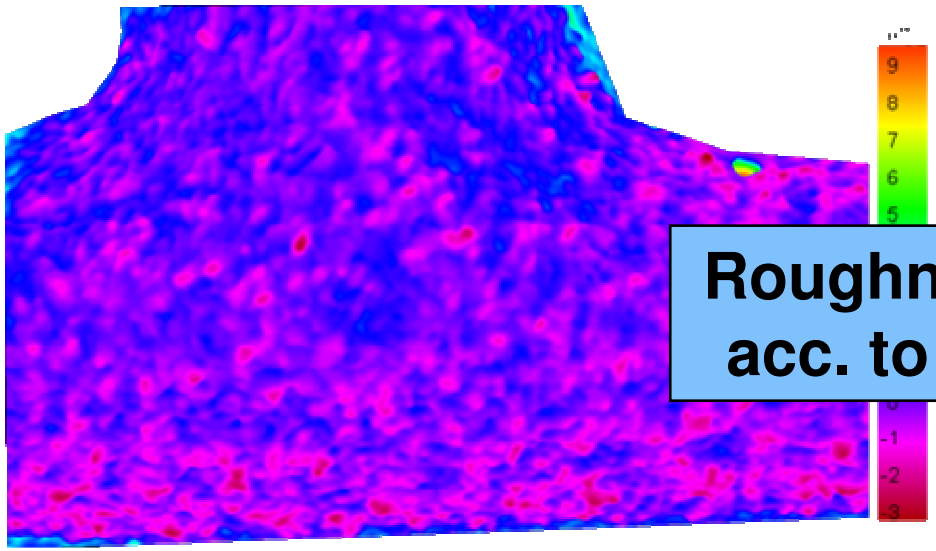
Roughness Measurement Micro Fluidic

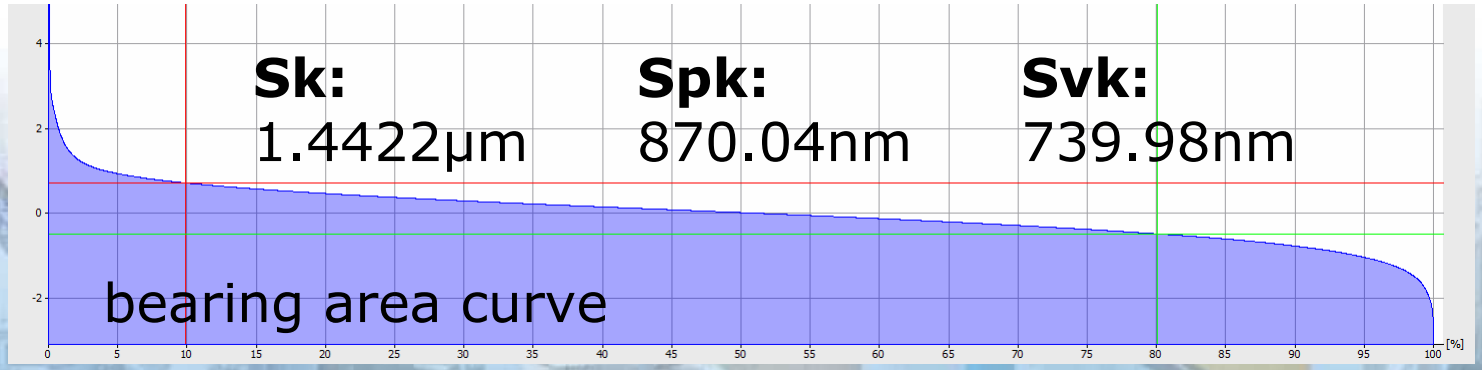
Sa:
478.66nm

Sq:
650.62nm

Sz:
12.66µm



Roughness Analysis acc. to ISO 25178-2



Sk:
1.4422µm

Spk:
870.04nm

Svk:
739.98nm

bearing area curve

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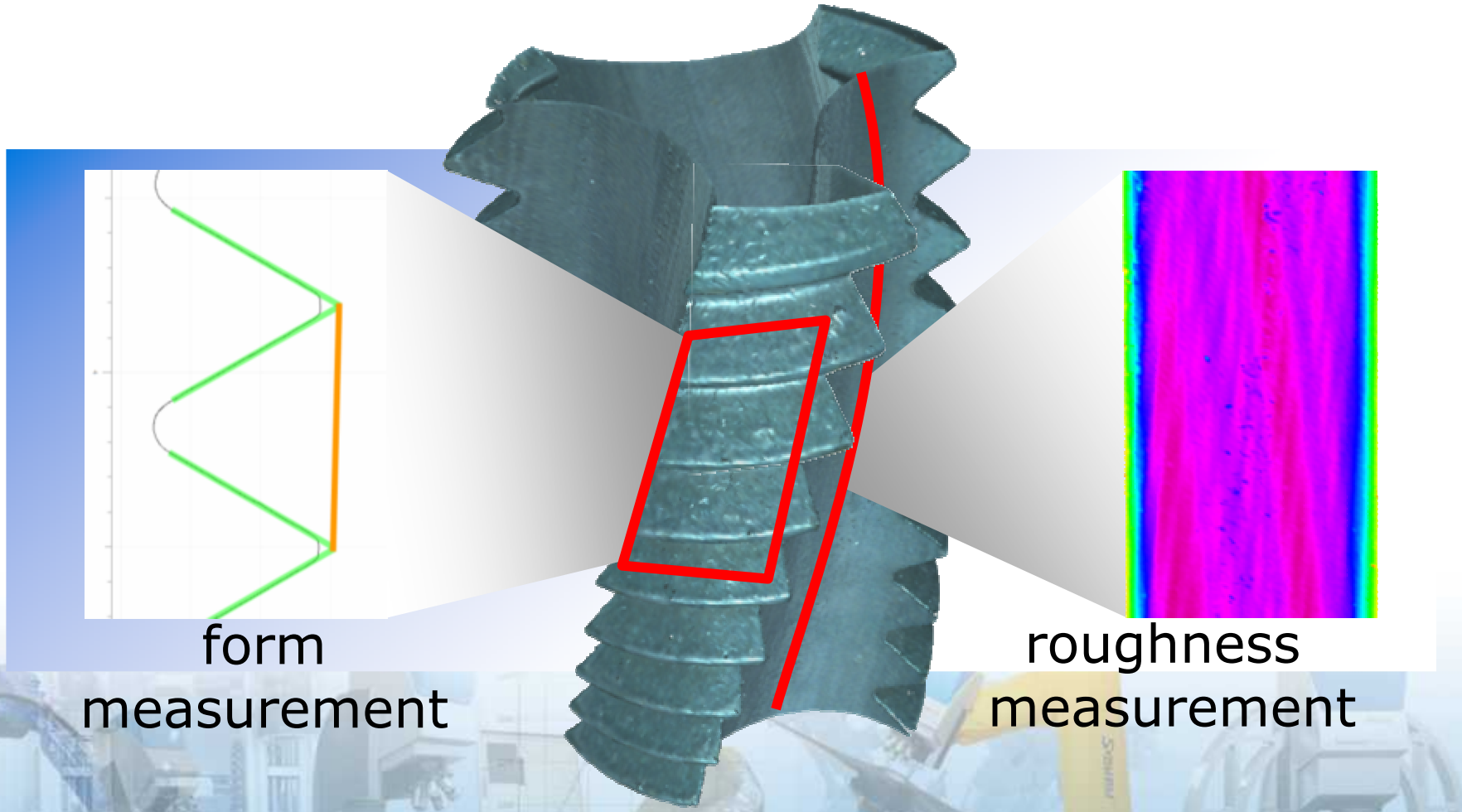
Example Tap



form measurement

roughness measurement

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Focus-Variation provides…

- up to **100 Mil. 3D-measurement points**
- across an area of **100x100mm**
- at a **vertical scan range** of **100mm** at **23mm working distance**
- at **a large variety of materials**
- at a resolution of up to **10nm**
- full **360°** and
- ca. **200.000 measurement points/sec.**

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Integrated measurements include…

- **roughness** measurements
  - Profile based
    ISO 4287, Ra, Rz, …..
  - Area based
    ISO 28178, Sa, Sq, …….
- **Form** measurements
  Diameter, sink hole measurement, roundness…
- **Orientation** measurements
  Distances, geometries,…

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Towards integrated micro CMM

Focus-Variation...

- can measure steep flanks
- delivers dense datasets
- delivers more than 2 million 3D measurement points in one step including color
- allows a large field of view
- offers a large working distance

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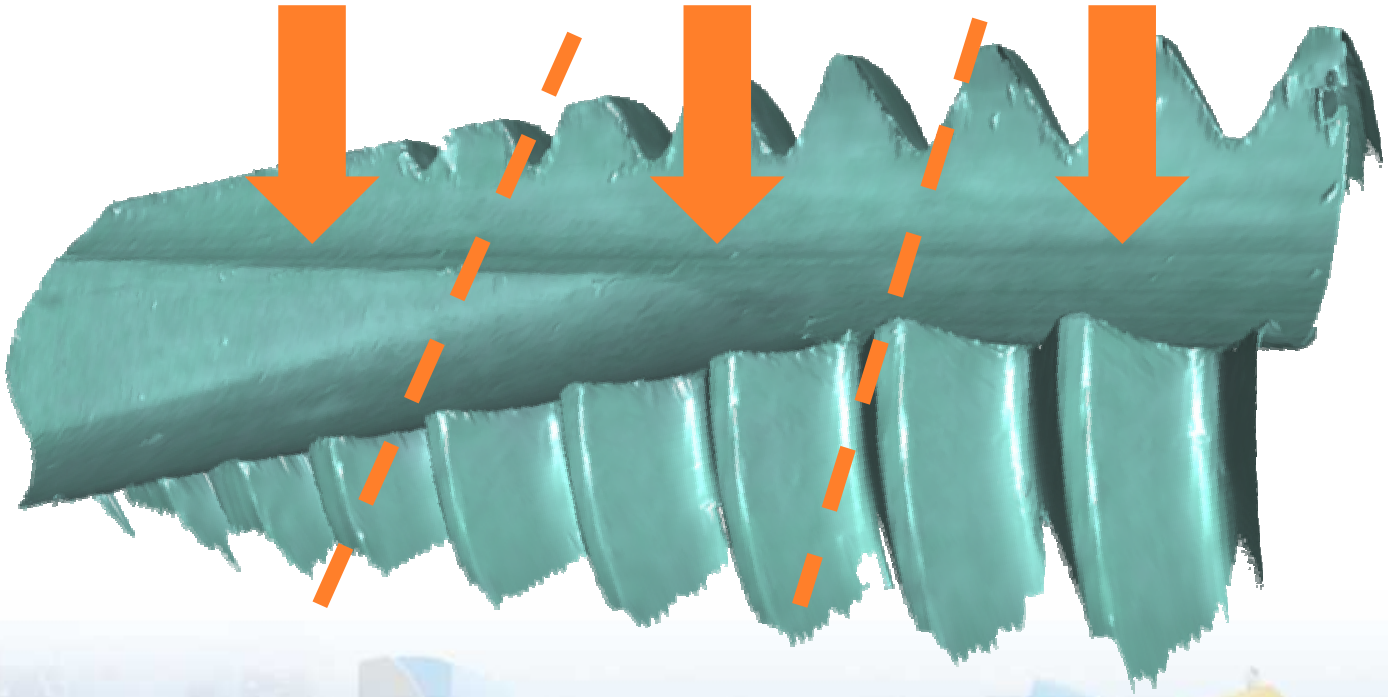
3D dataset measured by FocusVariation



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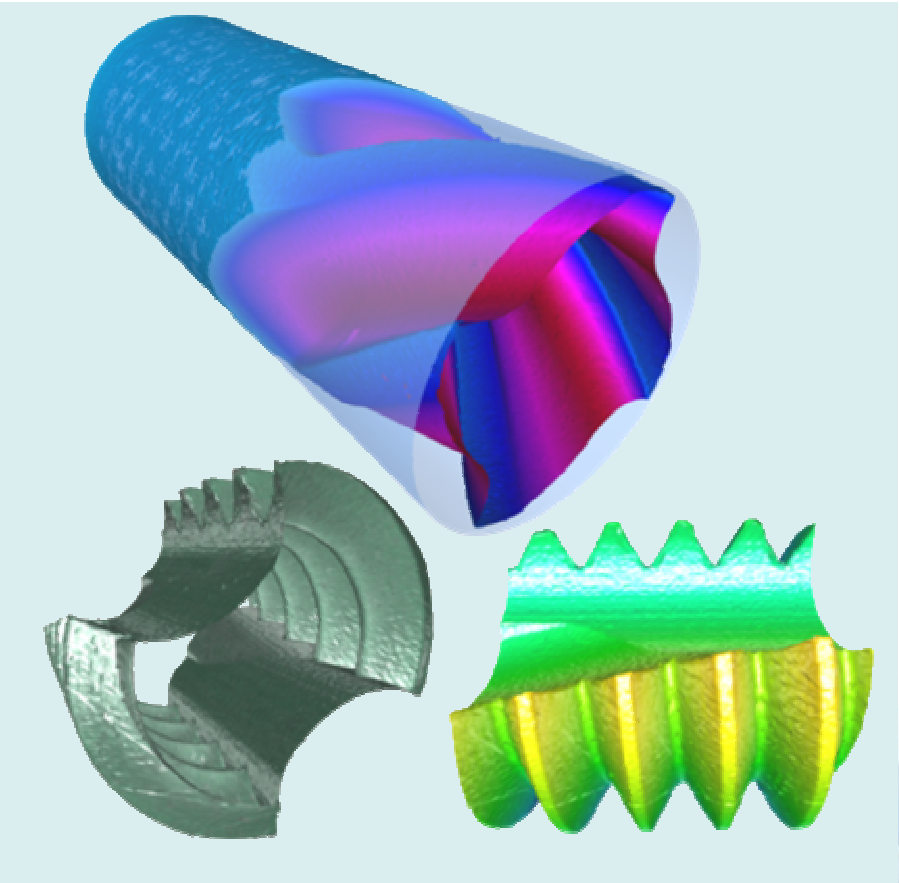
Real3D-Technology



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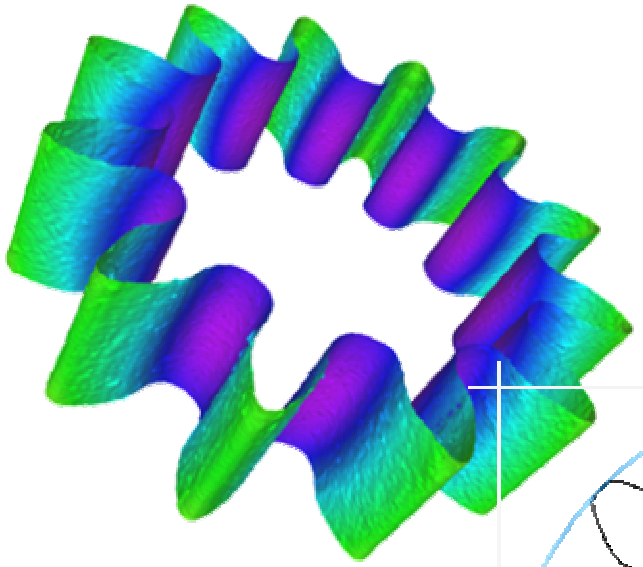
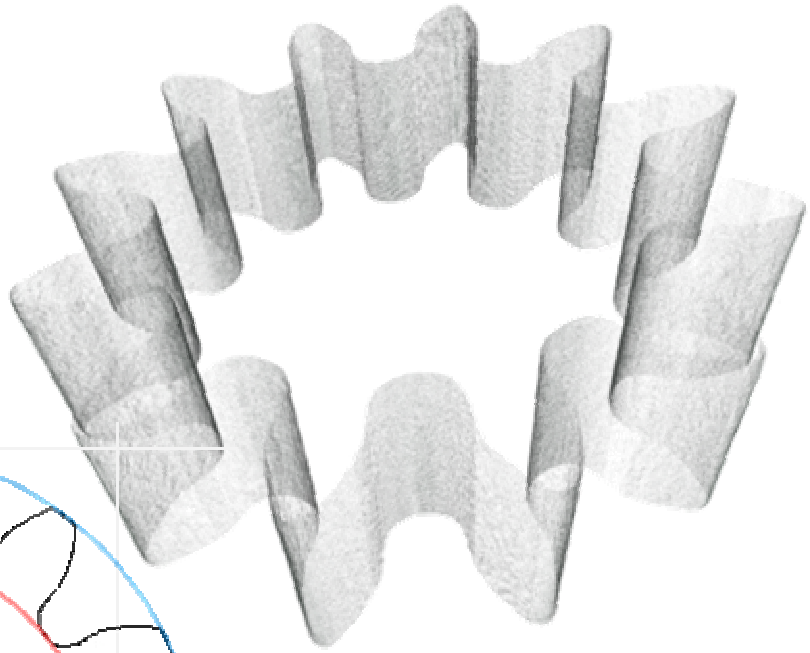
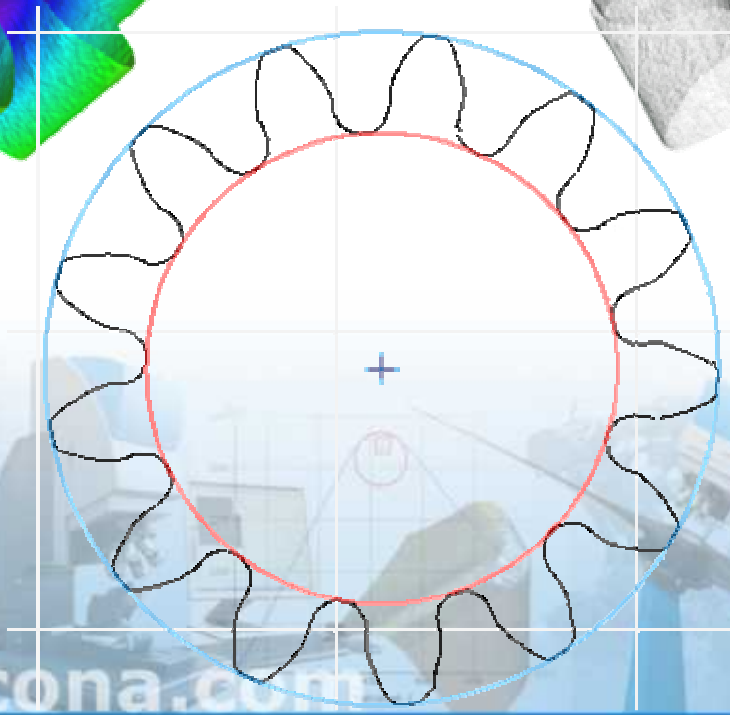
Micro-Gear-Wheel







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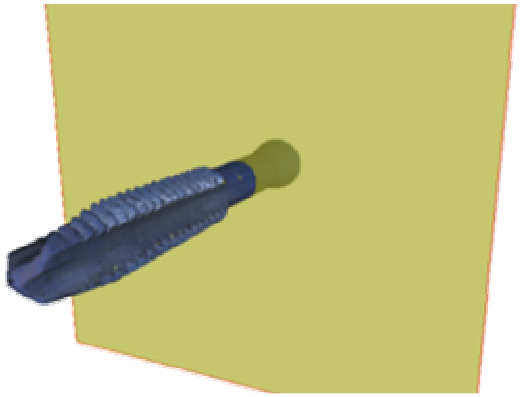
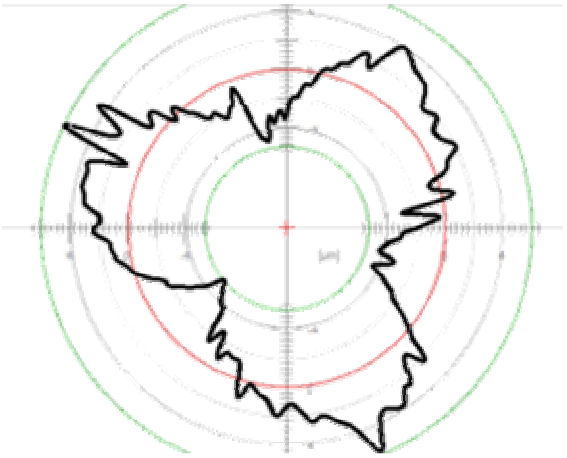
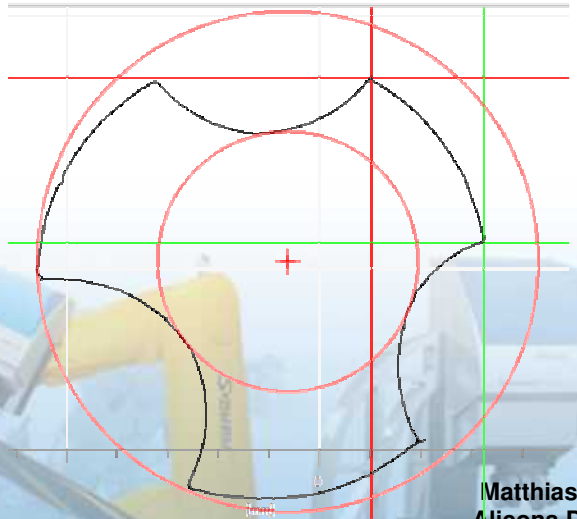
Tap Measurement



Roundness



Contour



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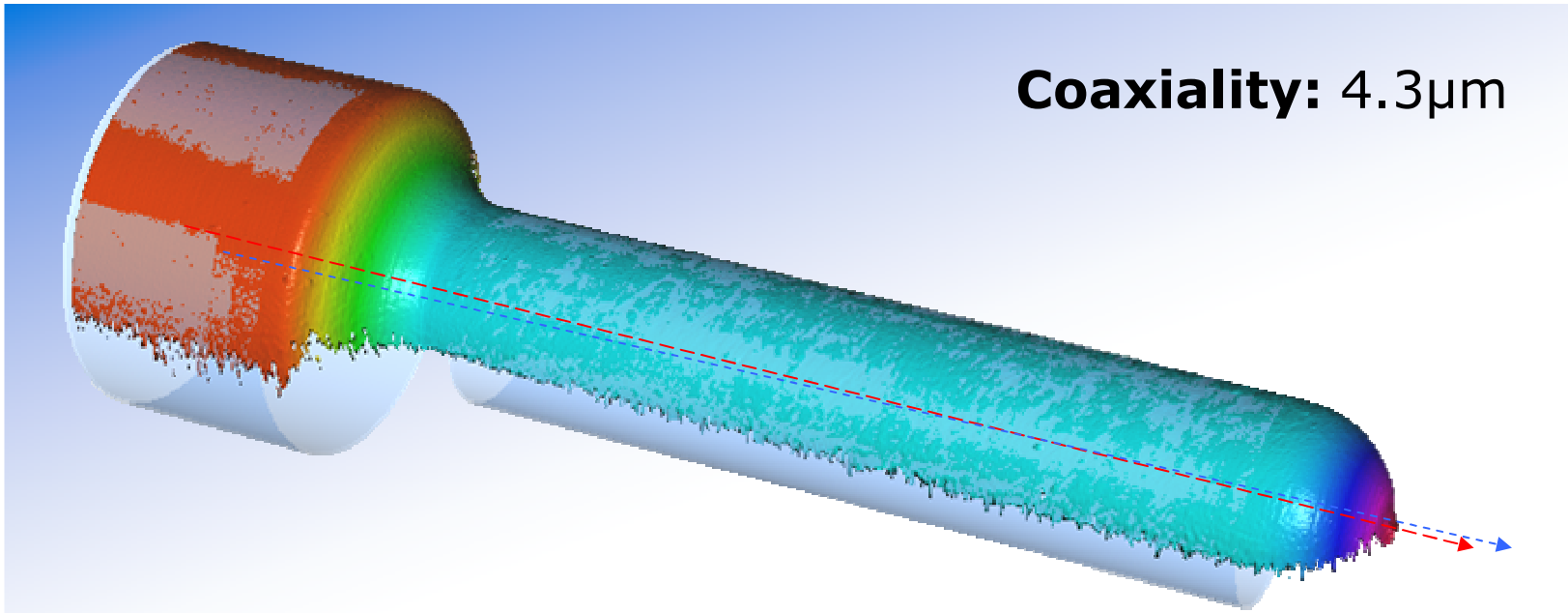
Measurement of Coaxiality



	Visible	Radius [µm]	Azimuth [°]	Zenith [°]	mean Deviation [µm]	min. Deviation [µm]	max. Deviation [µm]	Height [mm]	C.x [mm]
Cylinder 1	☑	511.82	1.4767	88.526	180.51	-477.57	503.03	4.272	2.8009
Cylinder 2	☑	997.98	1.4768	88.597	322.69	-965.28	8.1631	1.2139	-2.3117

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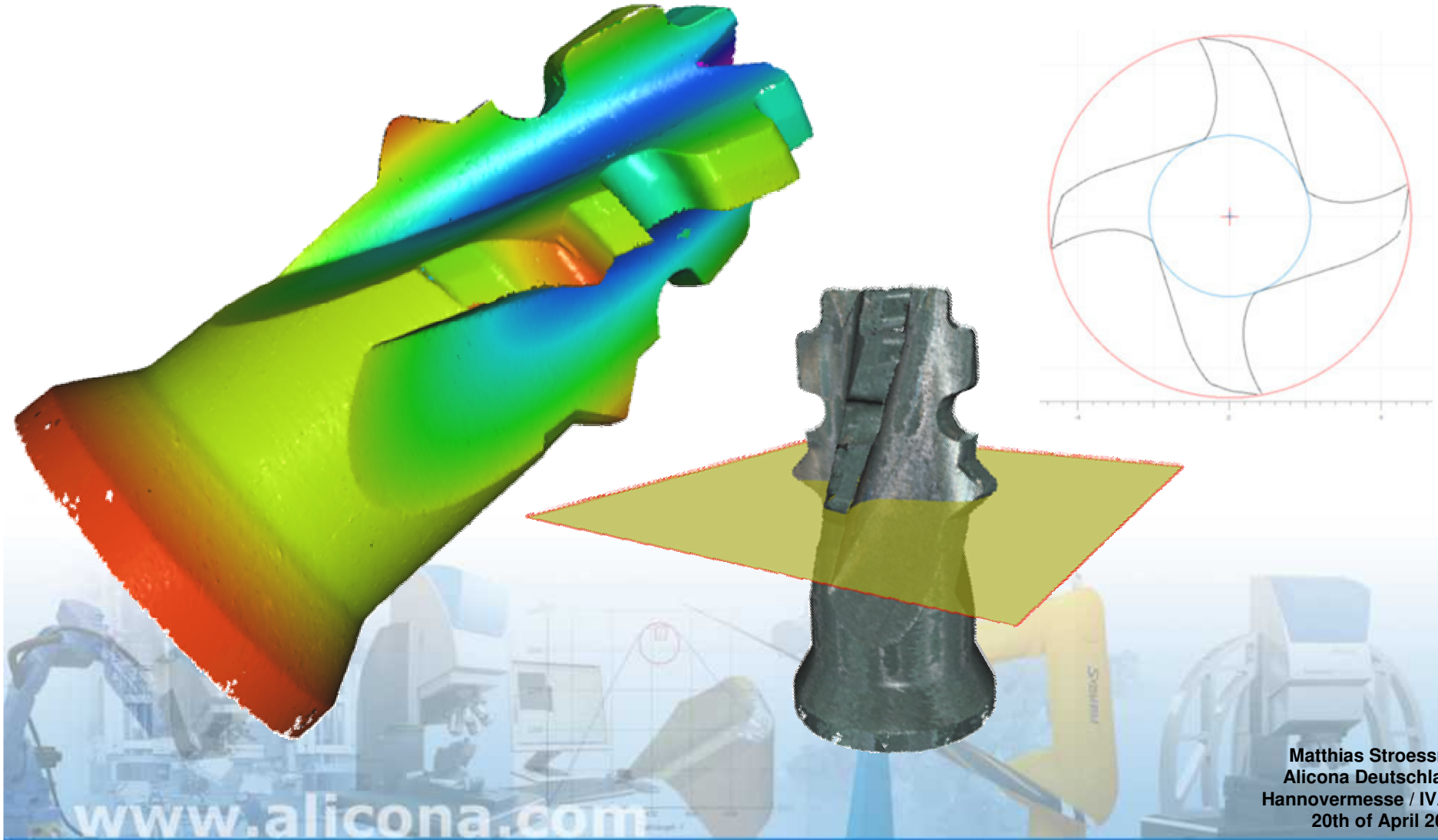
Special Drill – Form Measurement



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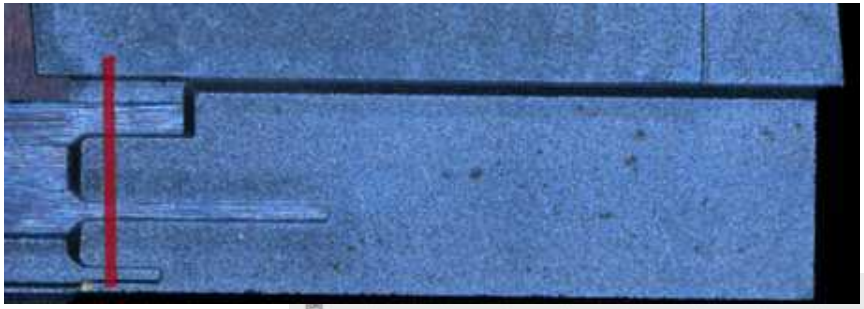
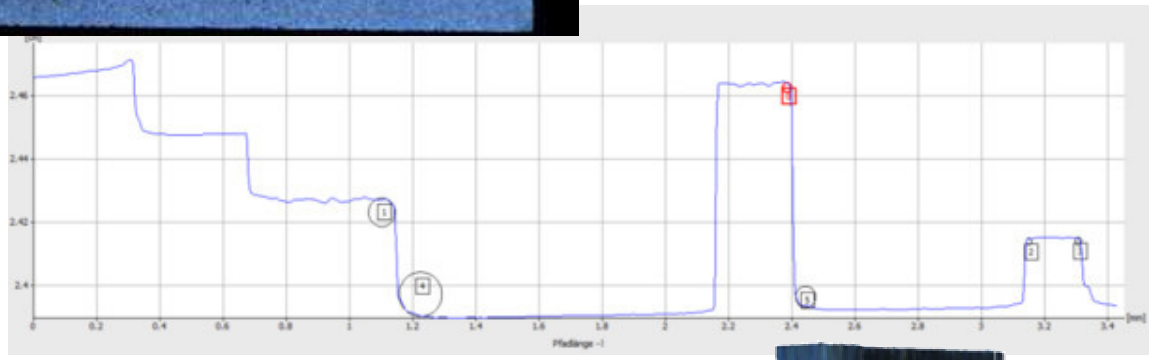
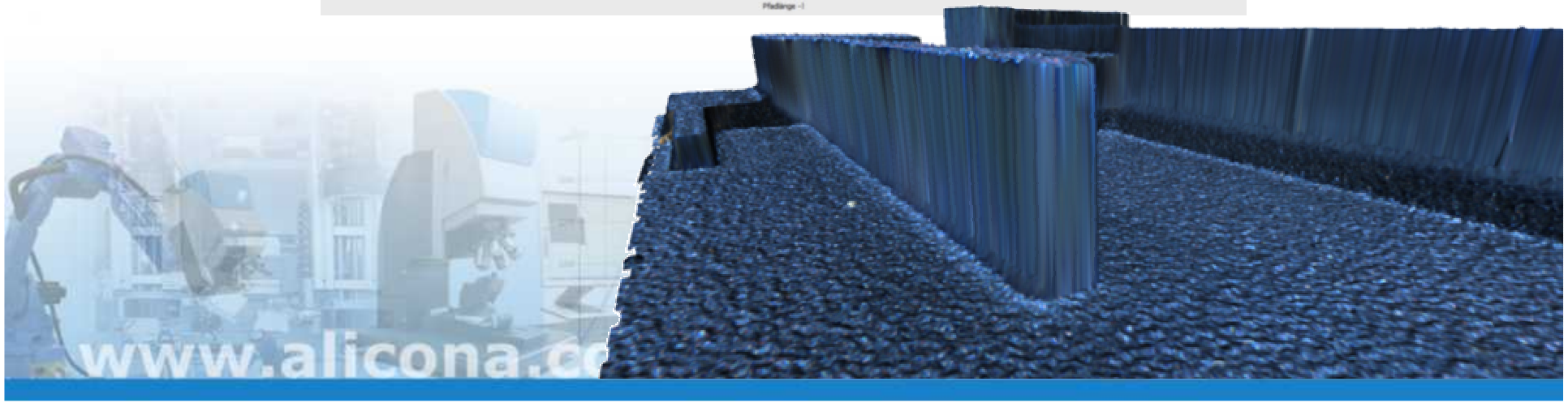
Micro Form Measurement

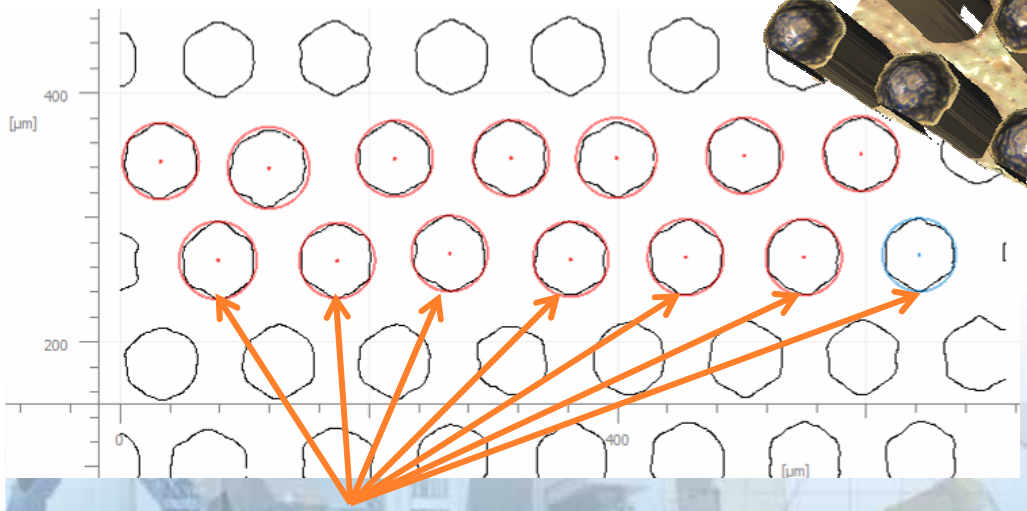


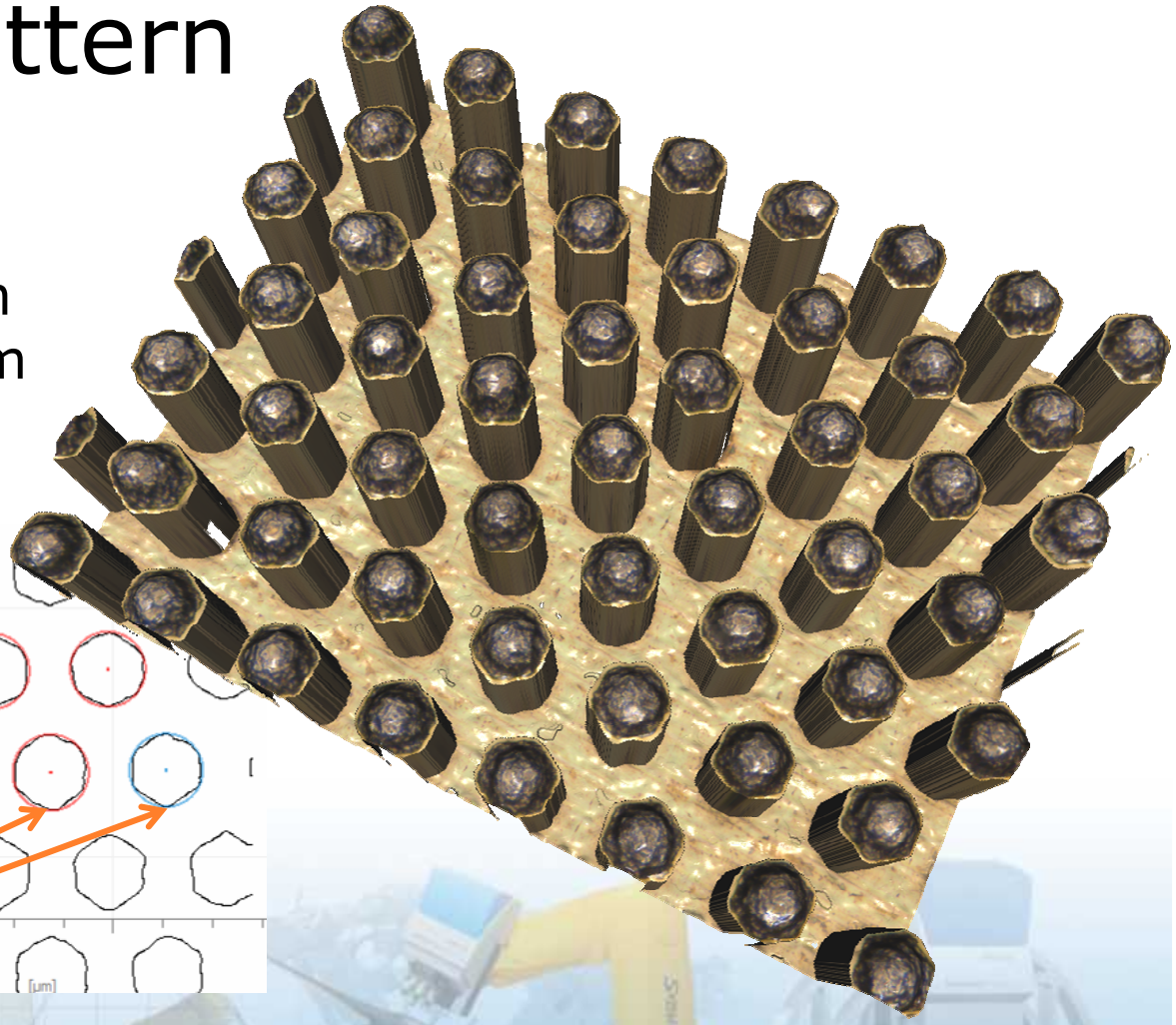




Micro-Hex Pattern

Min. Diameter: 59.02µm
Max. Diameter: 65.57µm





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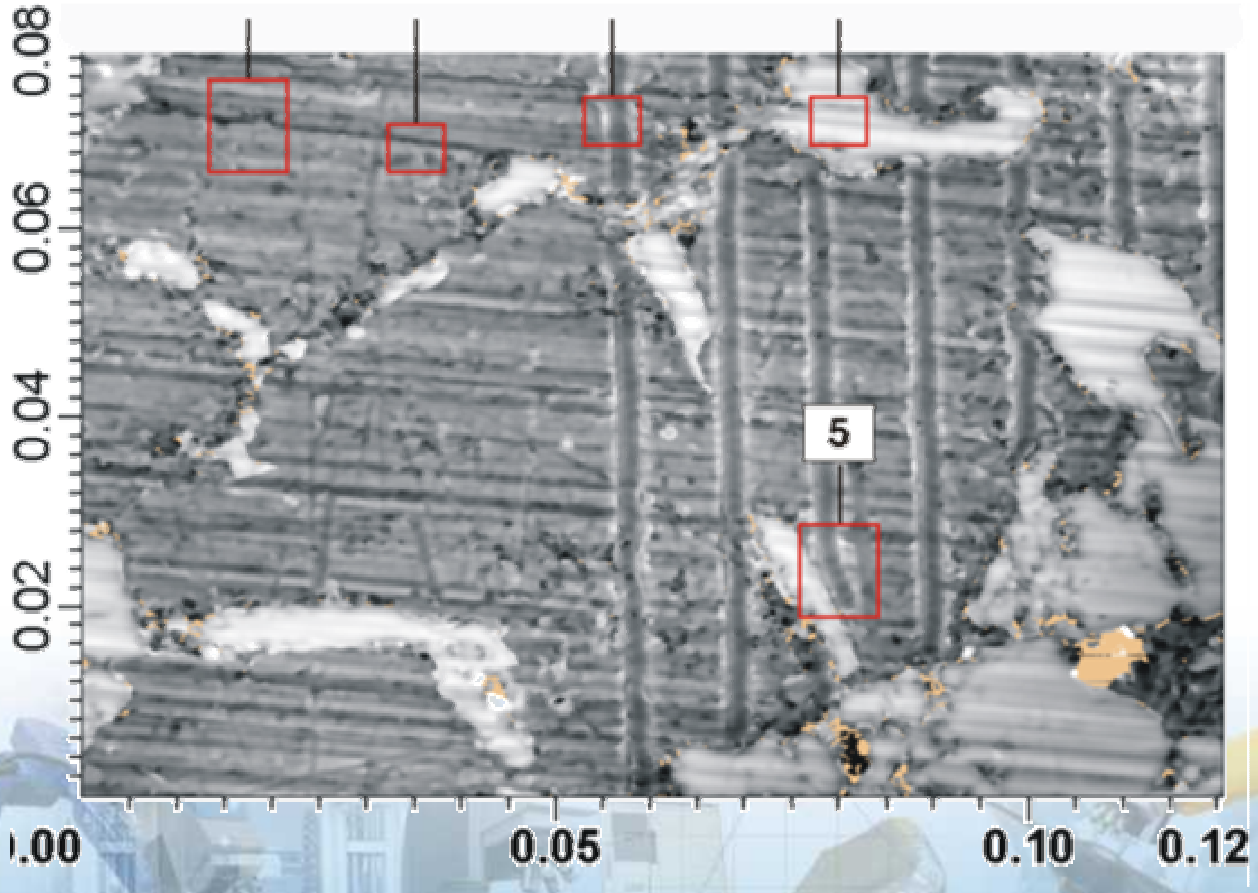
Comparison to Other Roughness Measurement Techniques

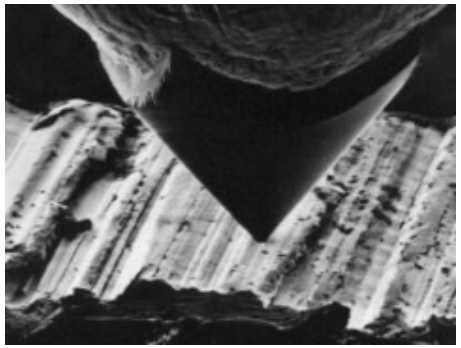
Tactile: widespread and accepted

BUT:

- Touching
- Measures mostly only single profile line
- Suitable only for „flat“ samples

Limitation of Tactile Systems





Images by
Prof. Dr.-Ing. Jörg Seewig,
Techn. Univ. Kaiserslautern,
Germany

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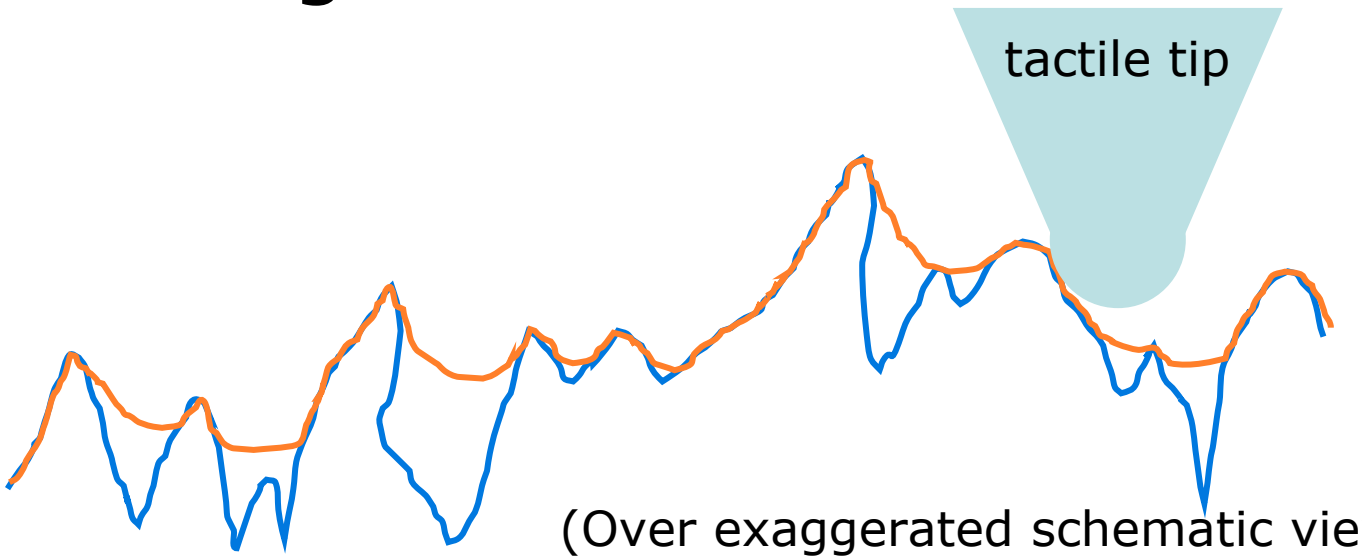
Smoothing Effect



(Over exaggerated schematic view)

- real surface
- measured surface

Deep valleys are filtered out

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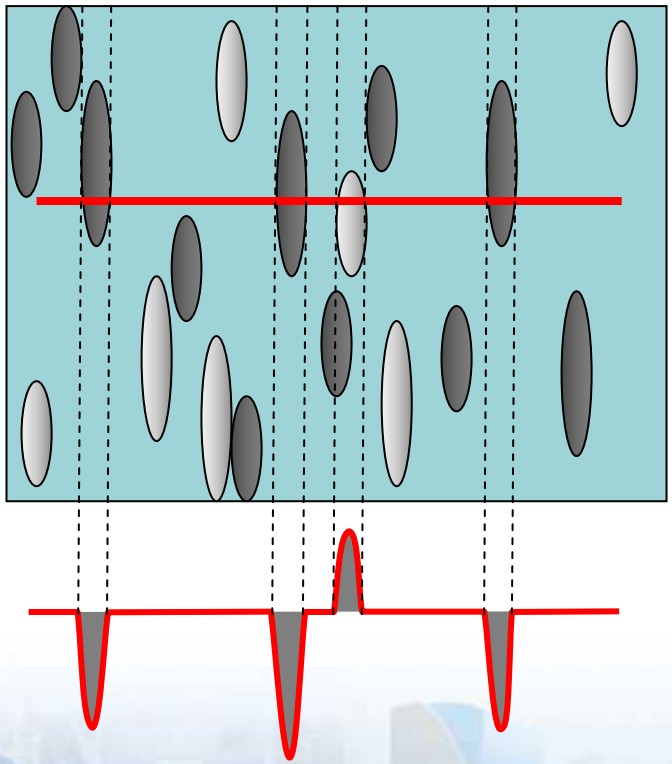
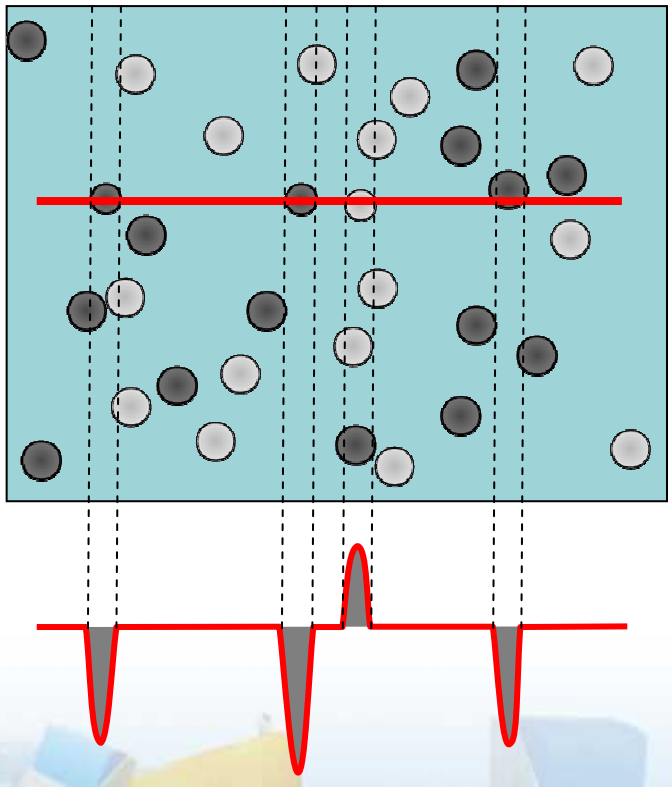
Limitation of a Profile Measurement



area
surface
≠



profile
=

profile measurement, no significant characterization provided

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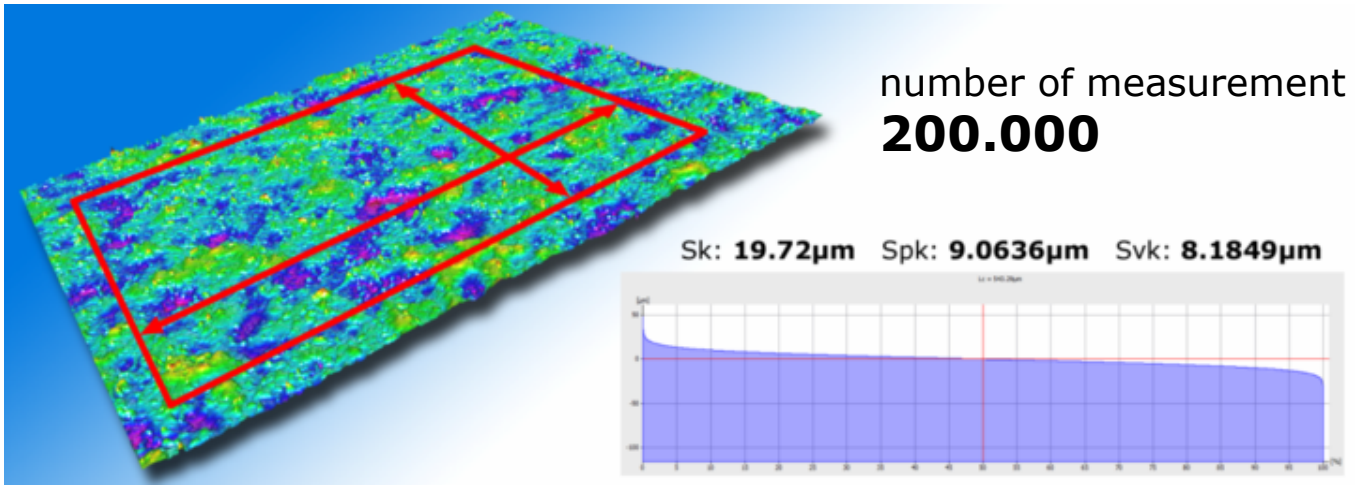
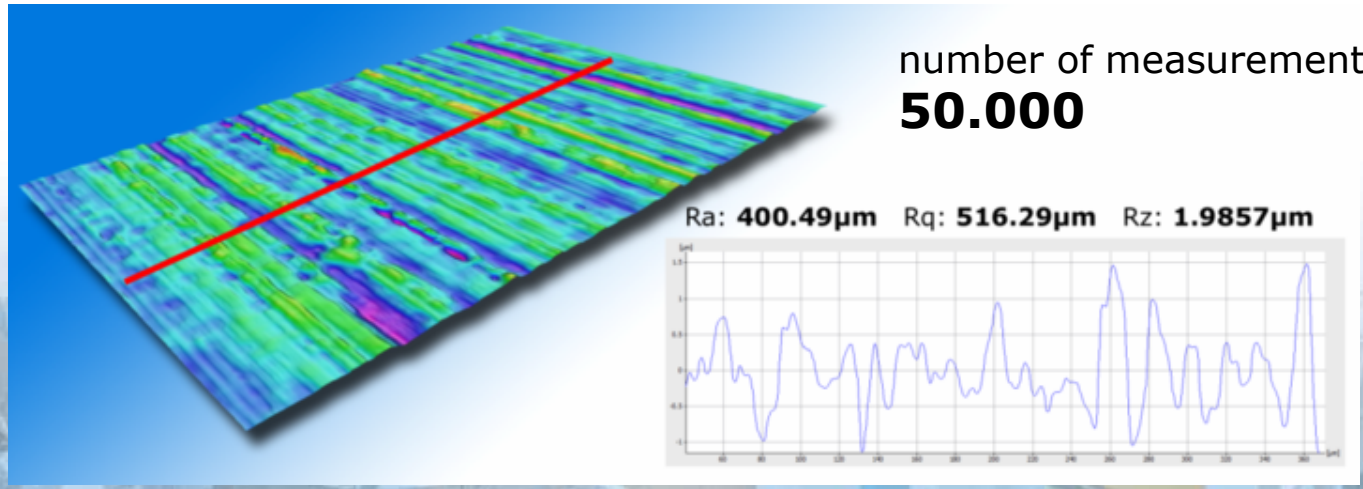
Considerably Higher Significance at Area Based Measurements



number of measurement points
200.000

Sk: **19.72µm** Spk: **9.0636µm** Svk: **8.1849µm**



number of measurement points
50.000

Ra: **400.49µm** Rq: **516.29µm** Rz: **1.9857µm**

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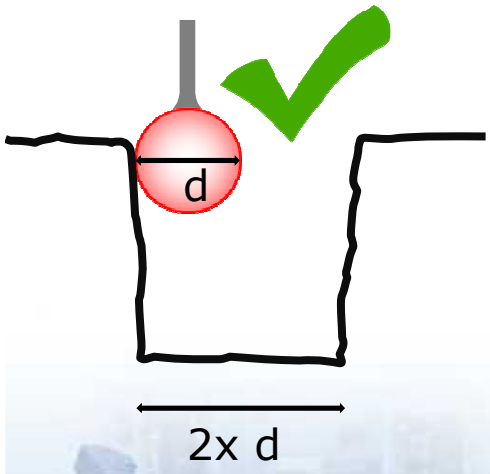
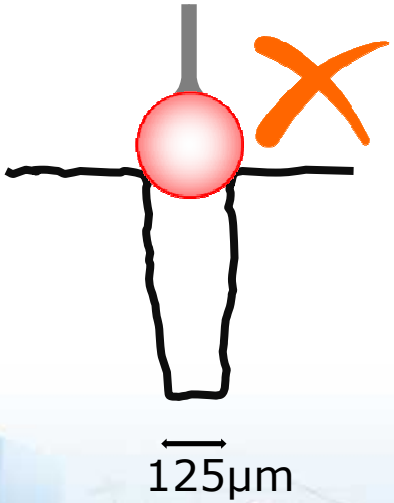
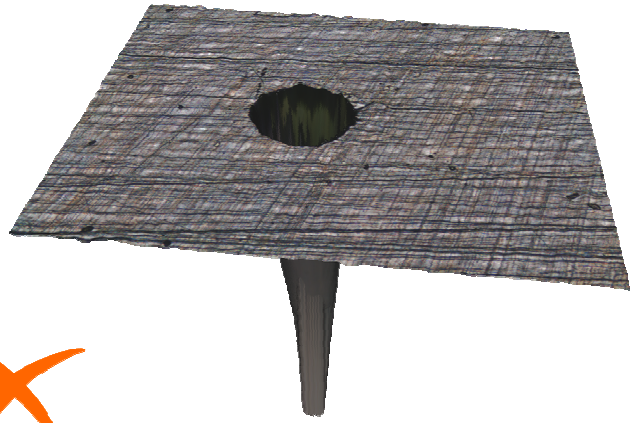
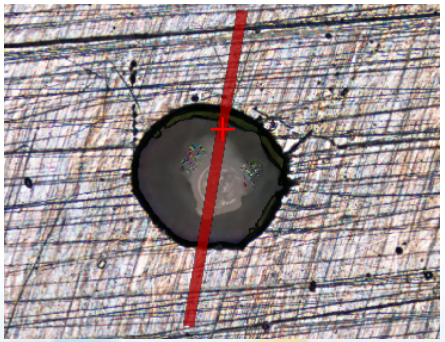
Measurement Problem of tactile Instruments:

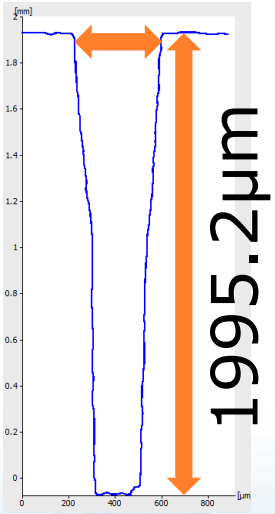






370.34µm





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Comparison to Other Optical Technologies

Focus-Variation

Structured Light

Confocal

Interferometry

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Relevance for modern Manufacturing Methods

long-wave surface structures

- » tactile systems were developed and built for that and perform in a reliable way

new manufacuture methods require a different surface measurement

- » more complex, short-wave structures
- » integrated form and roughness measurement

MICRO → OPTICALLY!

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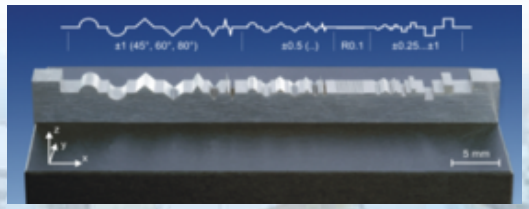
Nice, but can I trust the results?

- Focus-Variation is added in the draft for **ISO 25178-6** as an **independent technology**
- **Extensive tests at PTB**
- Various successful **cooperations with** NPL National Physical Laboratory
- **Comparison with different standards**

Calibration Standard

Verification Standard



Roughness Standard

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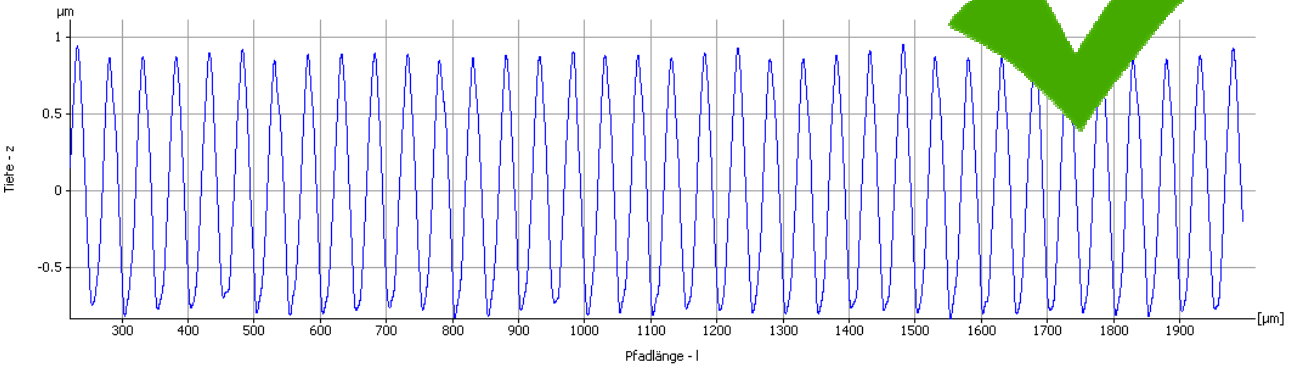
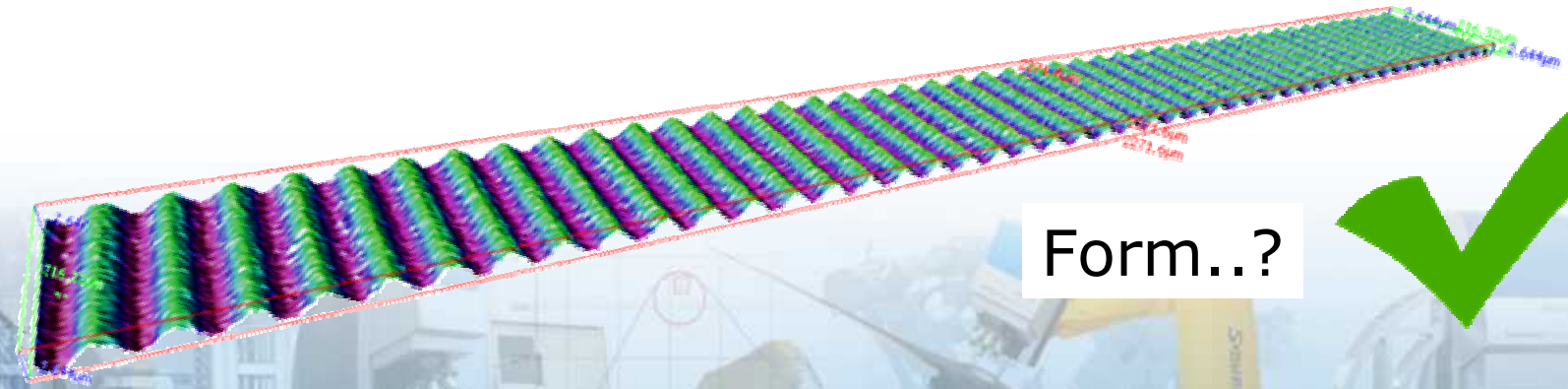
Are optical measurements traceable?

Roughness..?





Form..?

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Conclusion

InfiniteFocus combines the function of a CMM and a surface/roughness measurement system in ONE device.

Optical – contact free - areal - traceable

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Any questions..?!

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