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FocusVariation
Optical 3D-Measurement

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www.alicona.com

Company

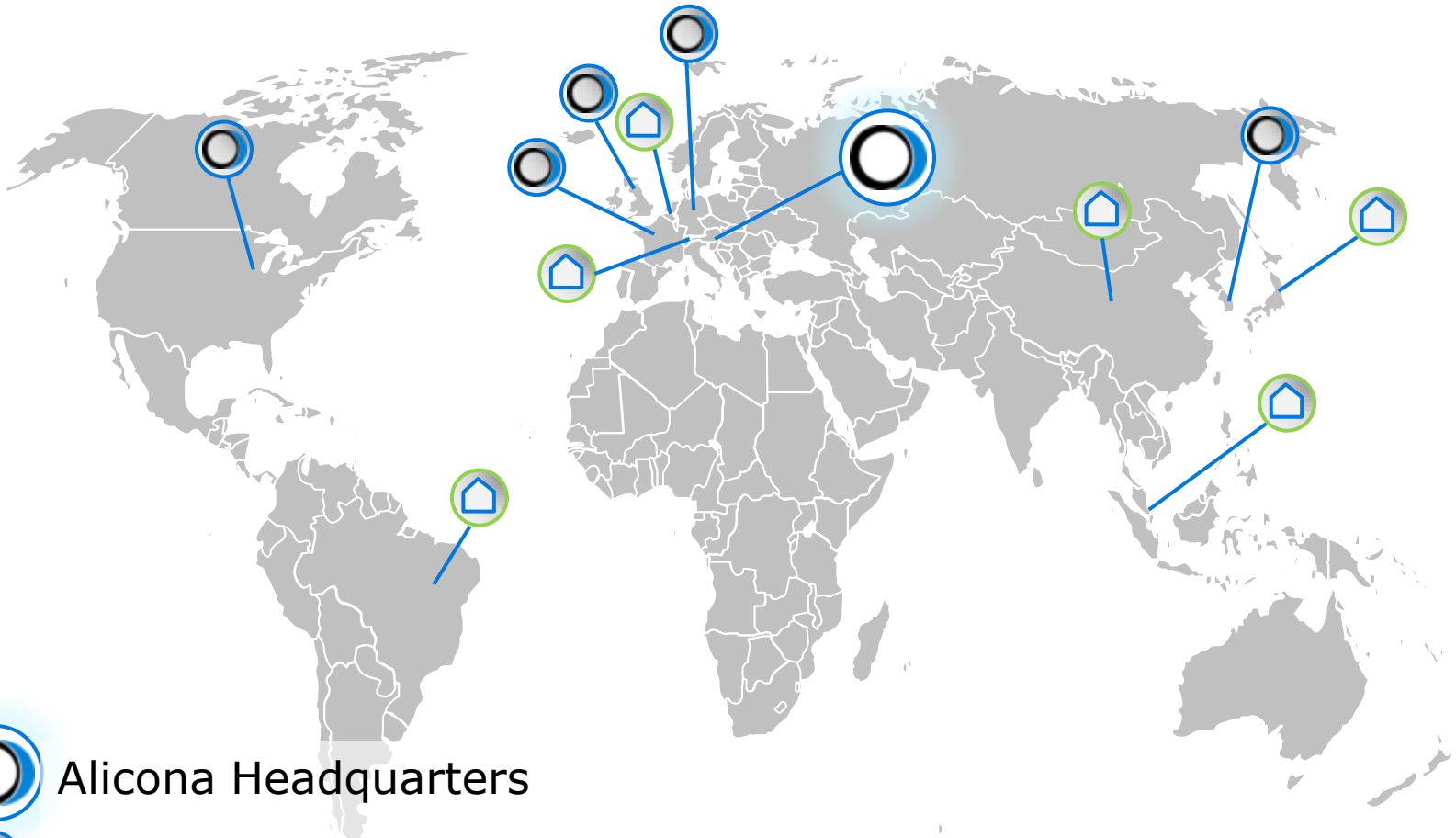
Alicona – what we do

- **high resolution optical 3D measurement**
- Supply systems based on Focus-Variation
- Open up new perspectives for optical measurement in lab and production
- Driving force for traceable optical roughness measurement
- International cooperations

Milestones

2001	Foundation of Alicona Austria and Germany
2004	Foundation Alicona USA
2005	Foundation Alicona UK
2007	Foundation Alicona Asia
2010	Foundation Alicona France
	Application Lab USA

Alicona Sites



Alicona Headquarters

Alicona Subsidiaries

Certified Alicona Distributors

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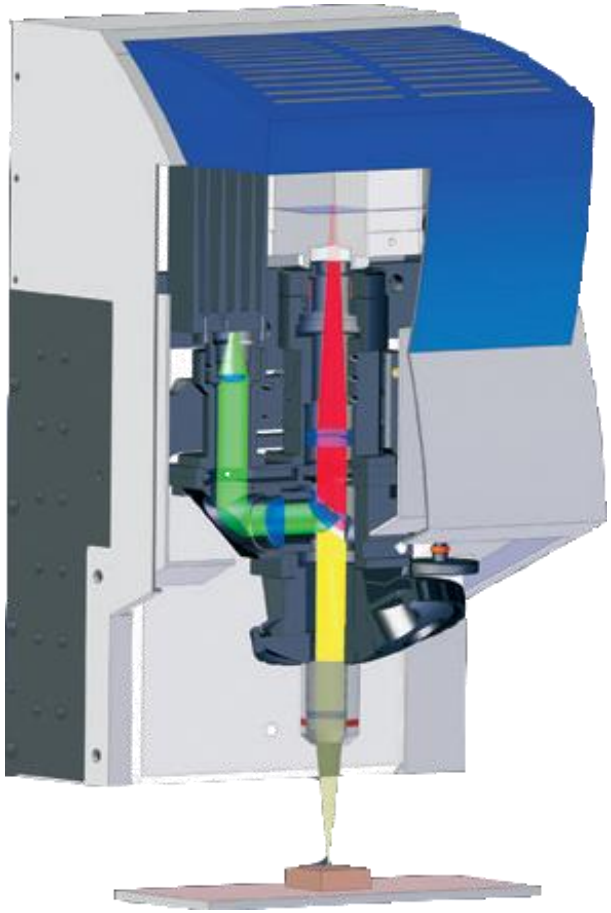
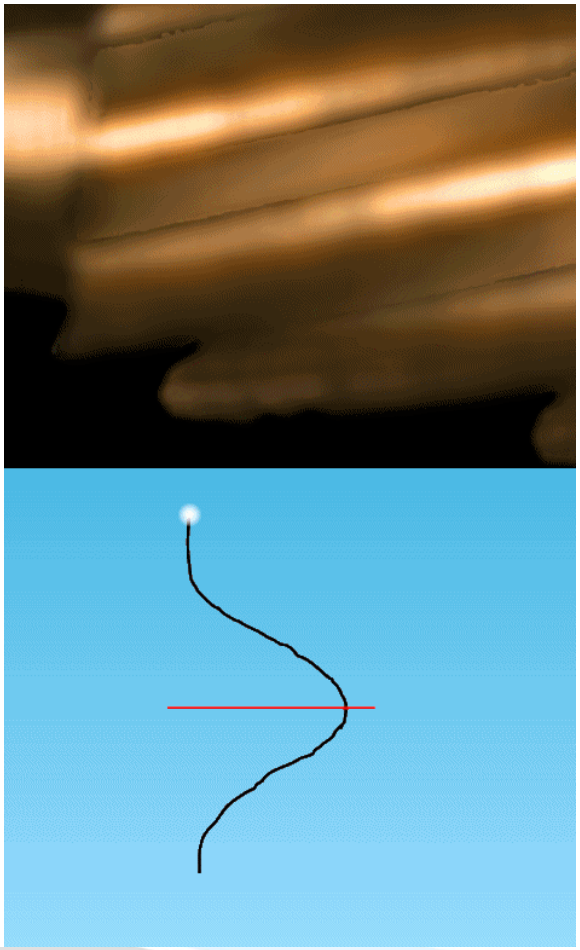
Product Overview

Technology

Focus-Variation as Measurement Technique





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Focus-Variation Technical Specifications

Optical 3D-surface metrology
based on a color focus sensor

Vertical resolution	**>10nm**
Lateral resolution	**>400nm**
Scan height	**<22mm**
Scan area	**100mm x 100mm**

Surface measurements in less than 16 sec.
(2 million measurement points)

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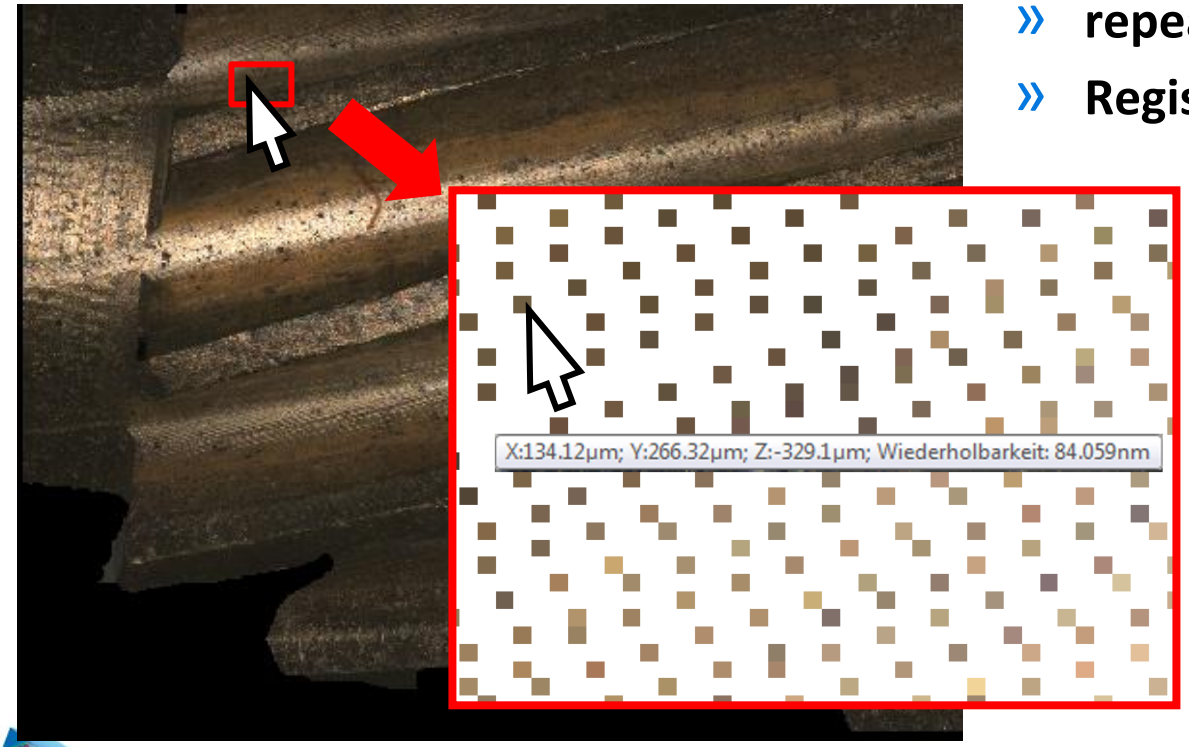
Information of a Measurement

- 3D-position (x, y, z)
- repeatability
- Registered true color



Optical 3D-Measurement - WHY?

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References

esa
BOSCH
AMD
EPFL
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE
JOHNSON CONTROLS
SIEMENS
ExxonMobil
oerlikon
esec
gsk
GlaxoSmithKline
Bundeswehr
SWAROVSKI
Roche
Arjo Wiggins
fine papers · papiers fins
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich
AIRBUS
Pfizer
HYDRO
ARJOWIGGINS
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Forever New Frontiers
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BASS
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What makes a cellphone sexy?

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How does the rhino get on the cellphone?

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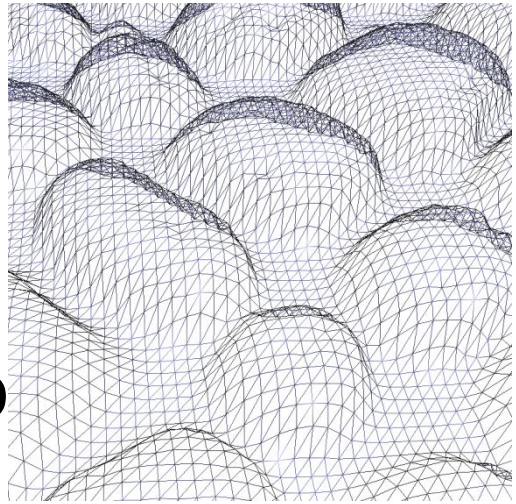
One stop shopping for customers

+GF+ AgieCharmilles & alicona

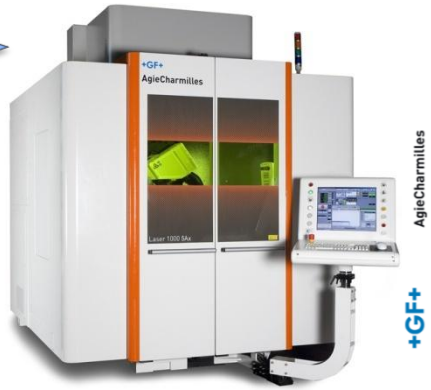
Real surface

Digitizing of the surface

CAD



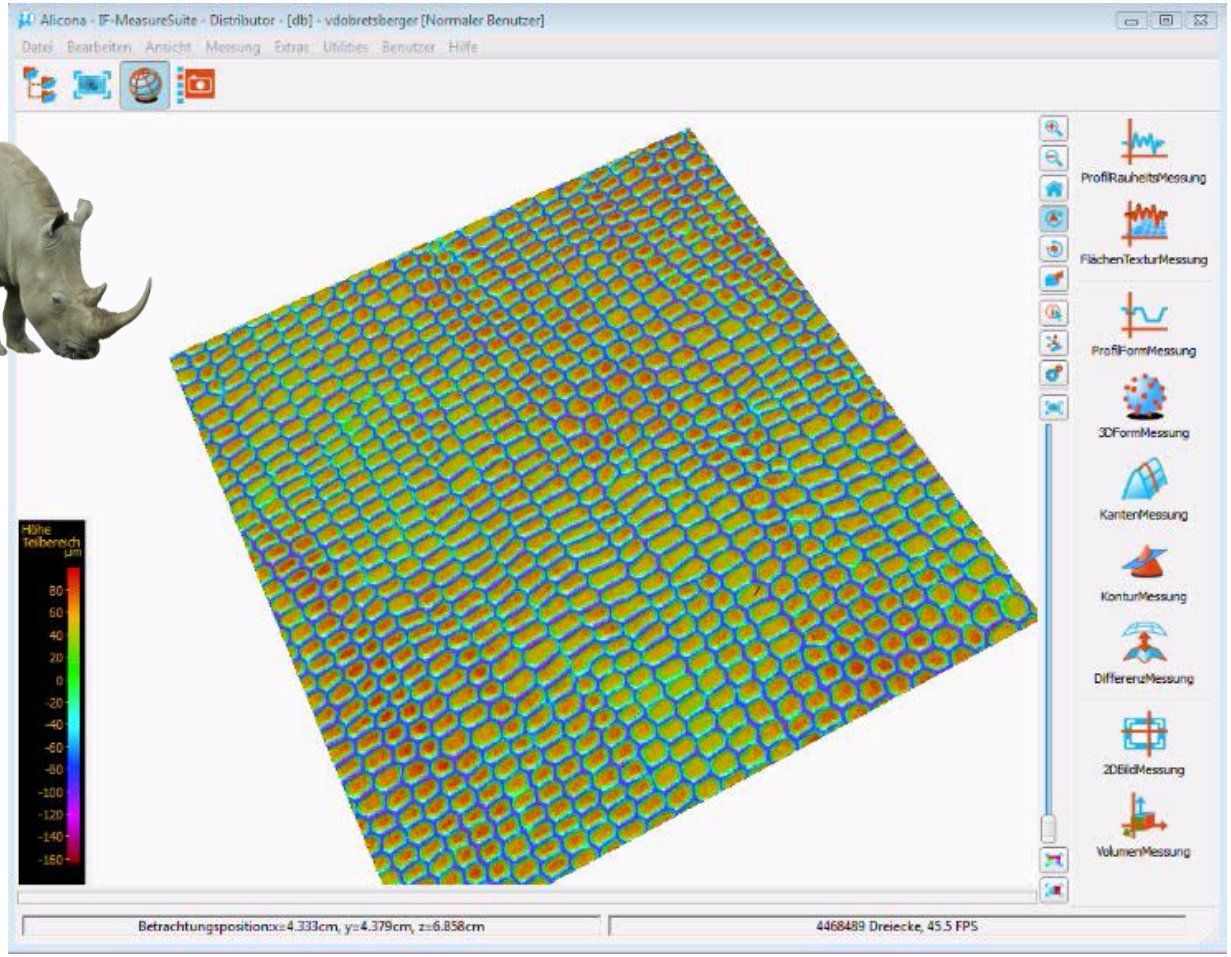
Quality proof of AgieCharmilles machine



Production

Produced Surface

3D-Datasets for the Subsequent Laser Manufacturing



Roughness-Measurement

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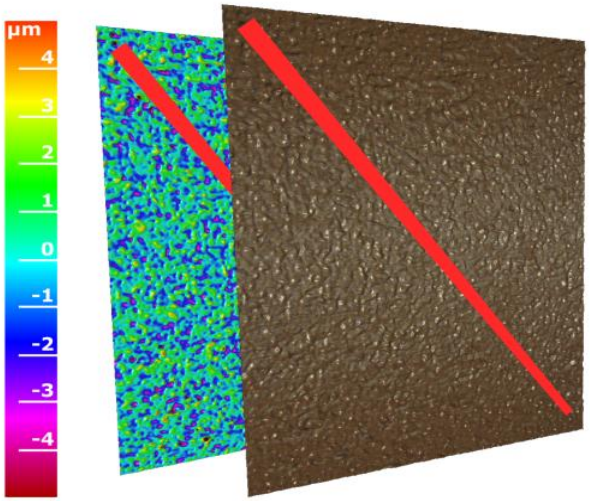
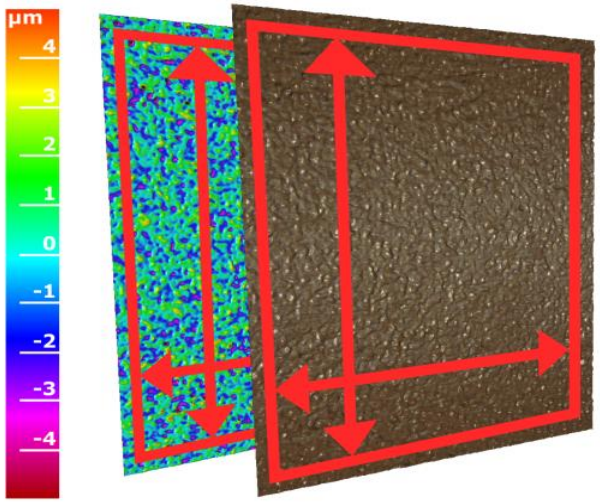
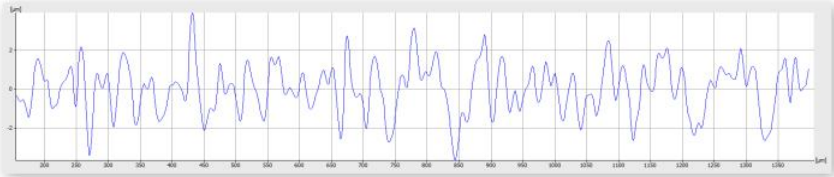
Roughness

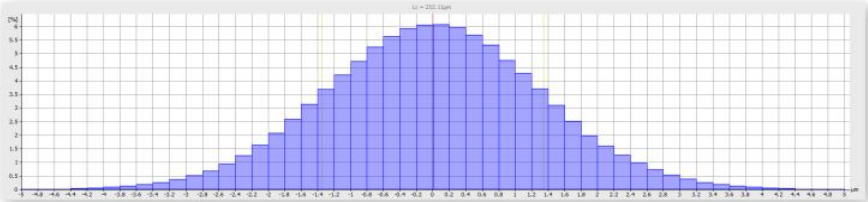
Measure Roughness Profile- and Area Based







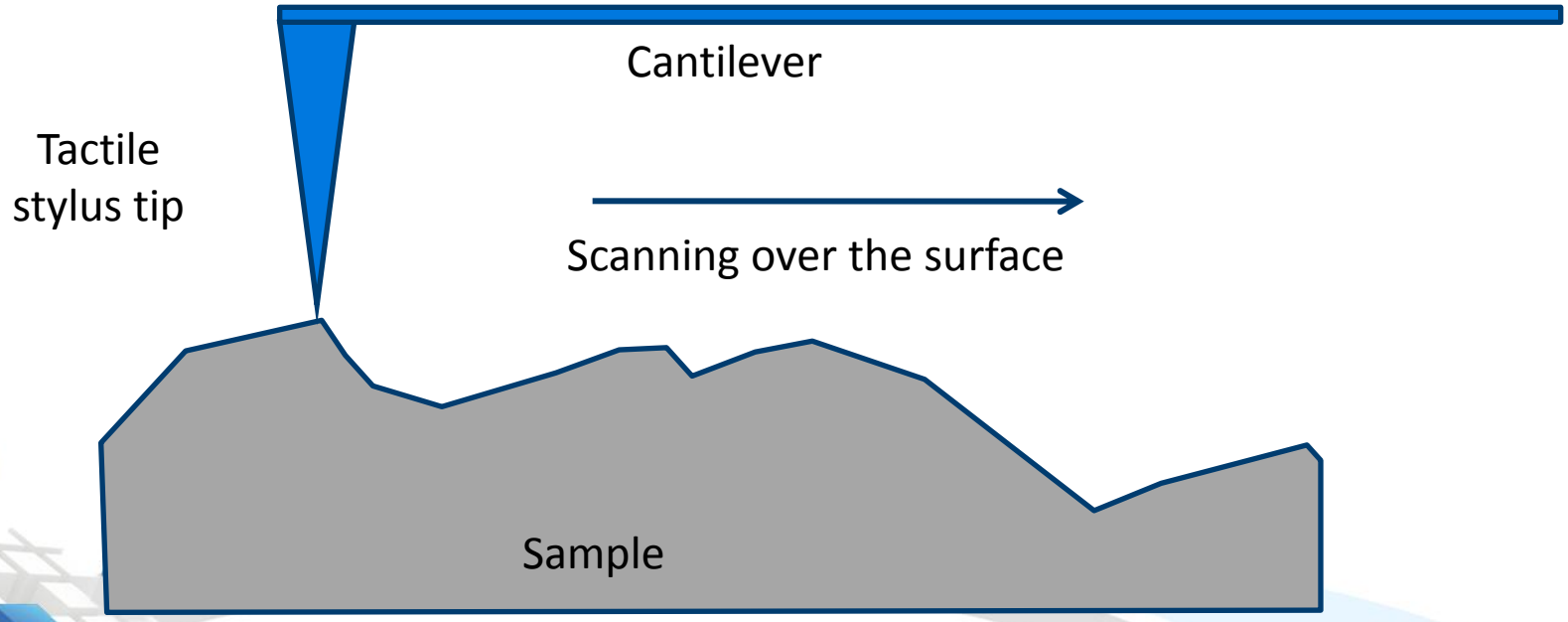
Ra 0.99µm **Rq** 1.24µm **Rz** 5.64µm



Sa 1.06µm **Sq** 1.35µm **Sz** 26.6µm

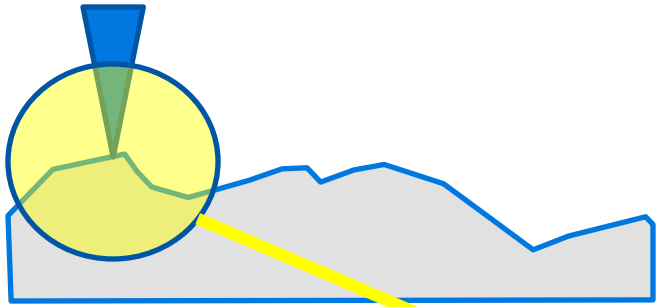
Introduction to Tactile Instruments

A tactile instrument measures the contact between the tactile tip and the specimen surface. Through moving the tip over the surface a profile or area is measured.

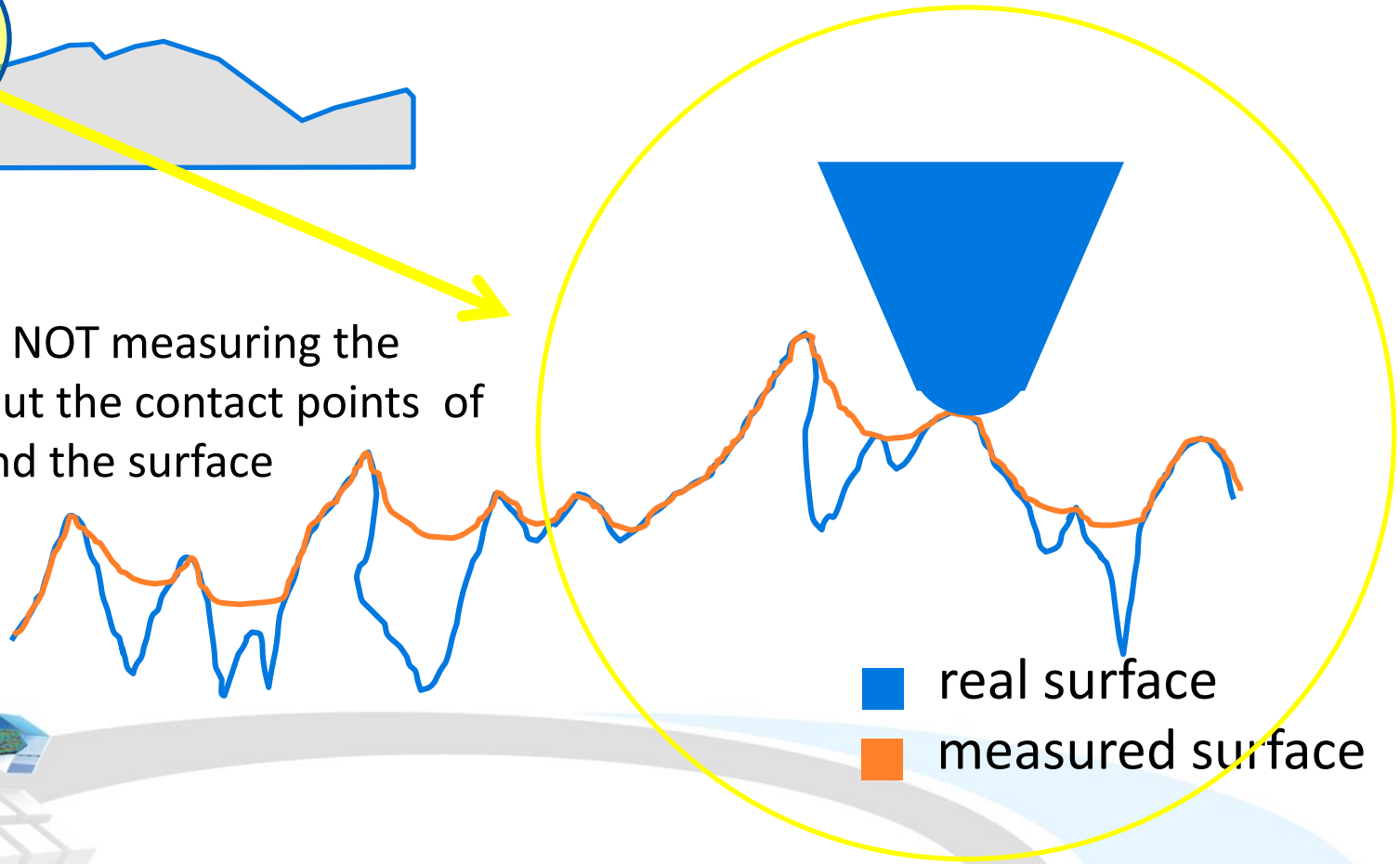


Introduction to Tactile Instruments

The stylus tip is not sharp but round:



The tip is NOT measuring the surface but the contact points of the tip and the surface



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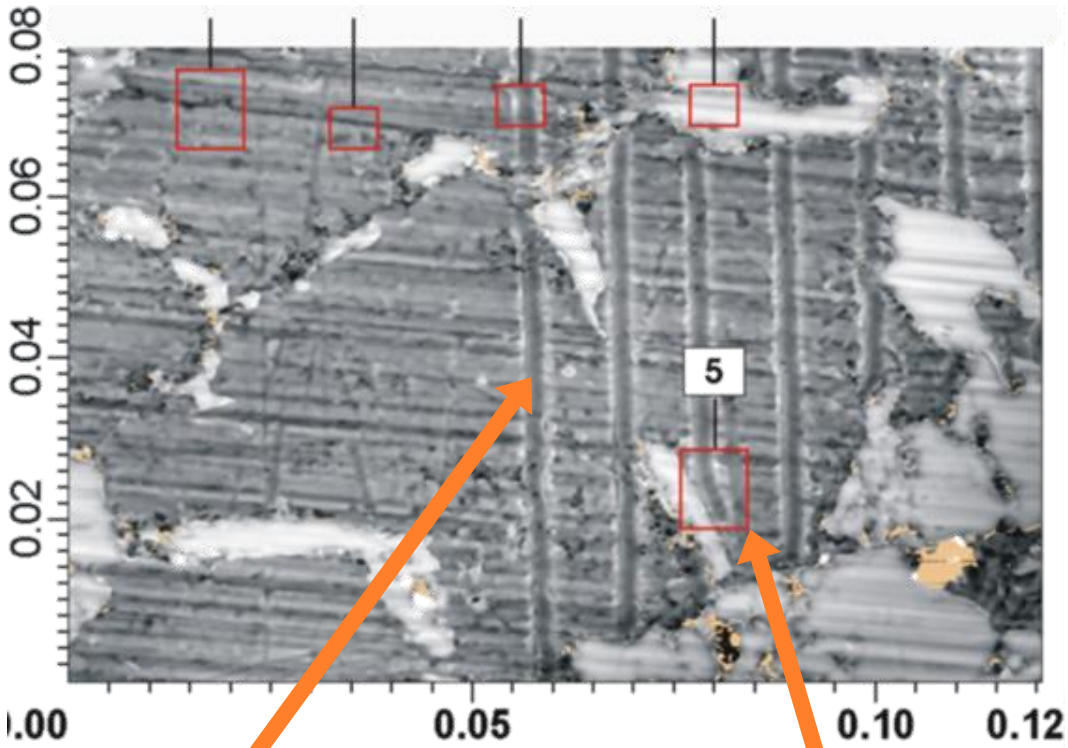
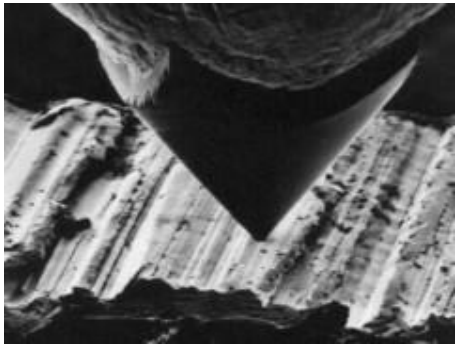
Limitation of Tactile Systems



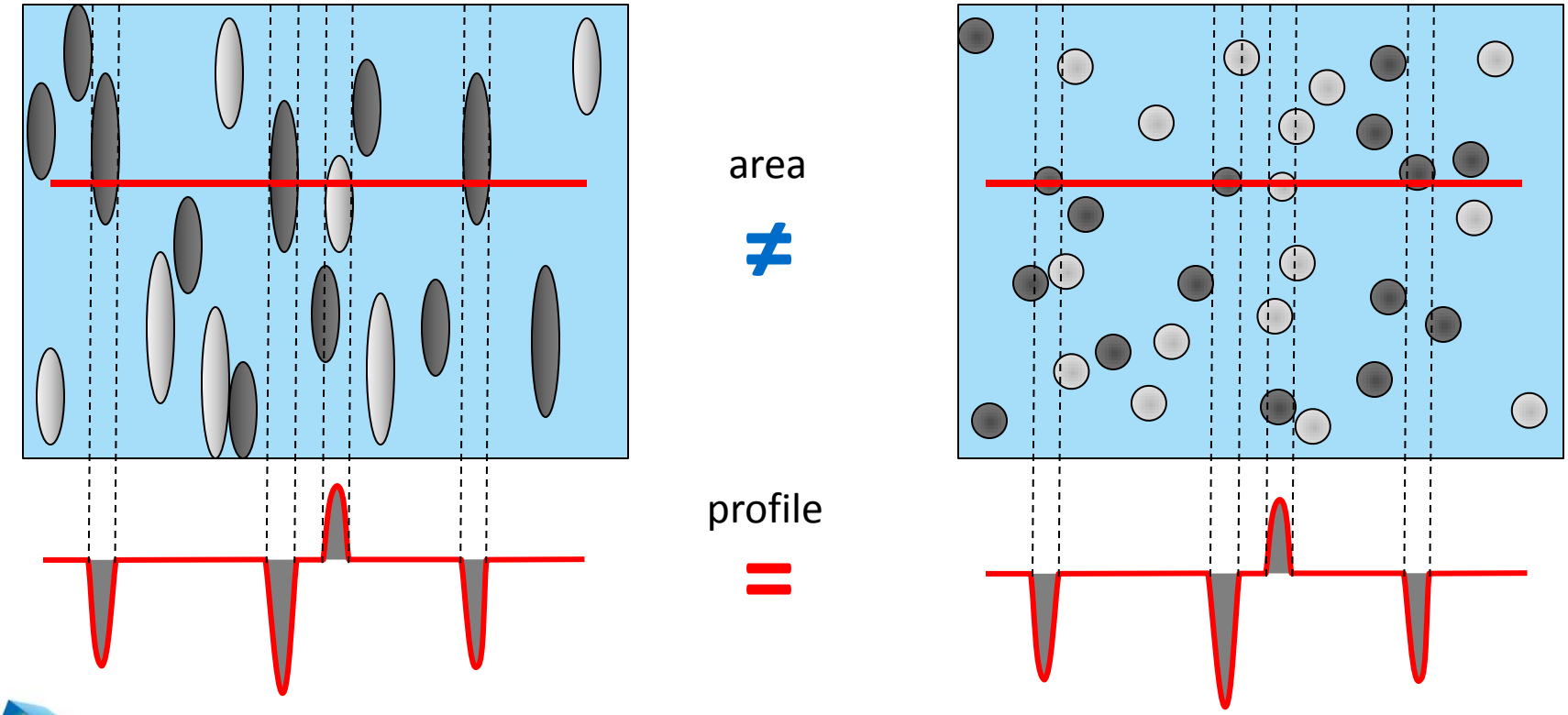


Images courtesy by
Prof. Dr.-Ing. Jörg Seewig,
Techn. Univ. Kaiserslautern, Germany

tip is generating a groove

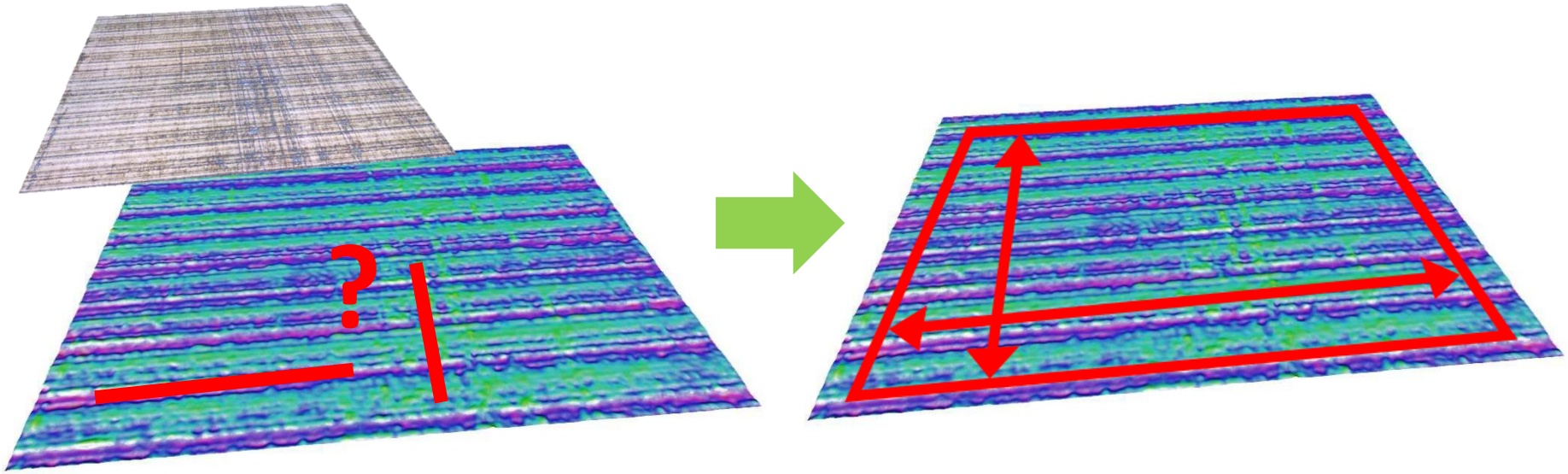
tip is deflected

Area Versus Profile Measurement



Profile measurement gives only limited information
Area measurement allows significant surface characterisation

Ground Surface
Significant Roughness Measurement



Parameters to Describe Surfaces

- **Profile** parameters (Ra, Rq, Rz, ..): ISO 4287, 4288, 13565, ..

- **Areal** surface texture parameters (ISO 25178,..)
  - Height parameters (Sa, Sq, ..)
  - Spatial parameters (Sdq, Sdr, ..)
  - Functional parameters (Sk, Volume parameters, ..)
  - Feature parameters (closed dale area: Sda, ..)
  - Autosurf parameters

- **Form** parameters
  - Edge radius
  - Volume
  - Pit depth

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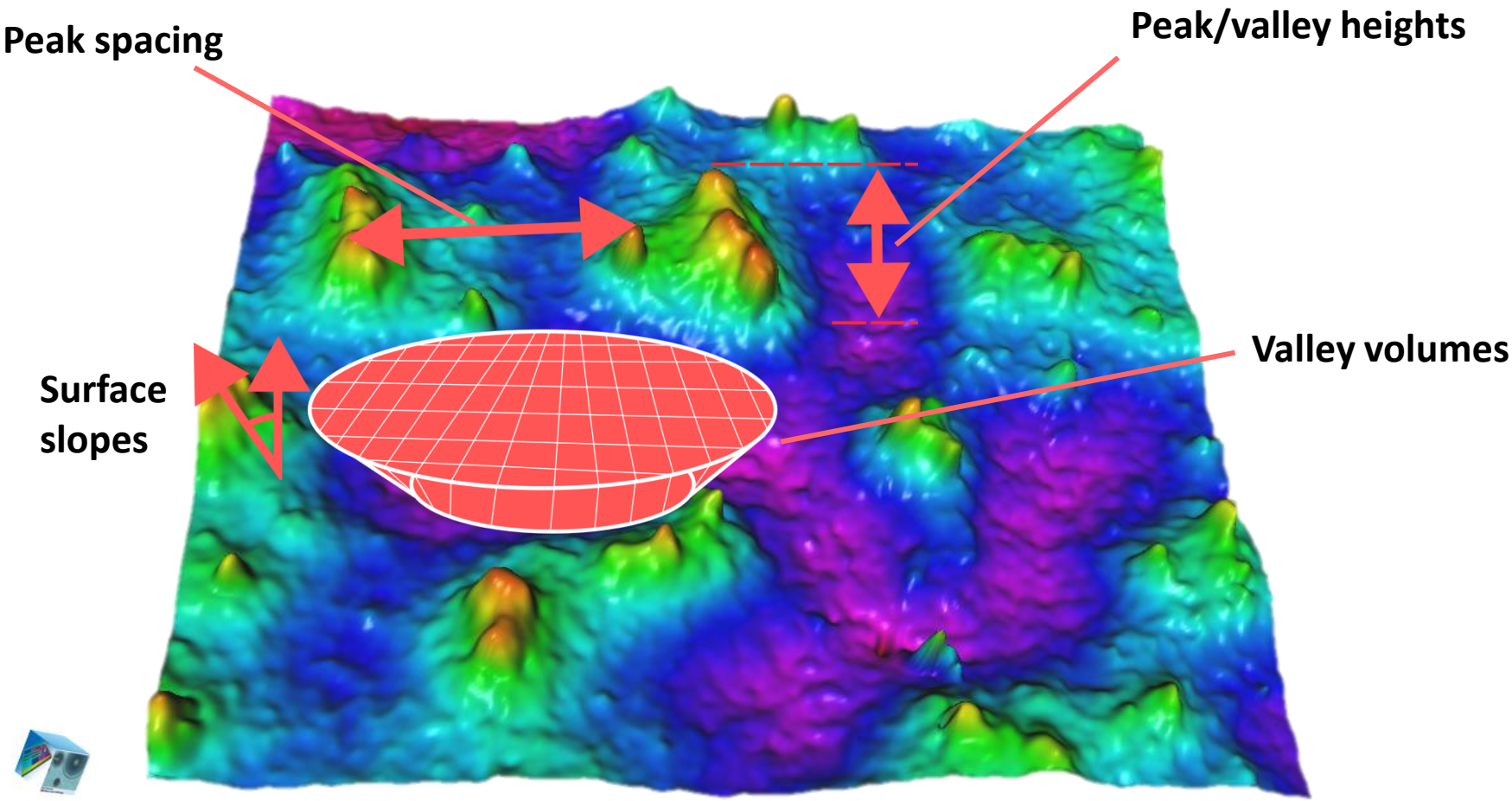
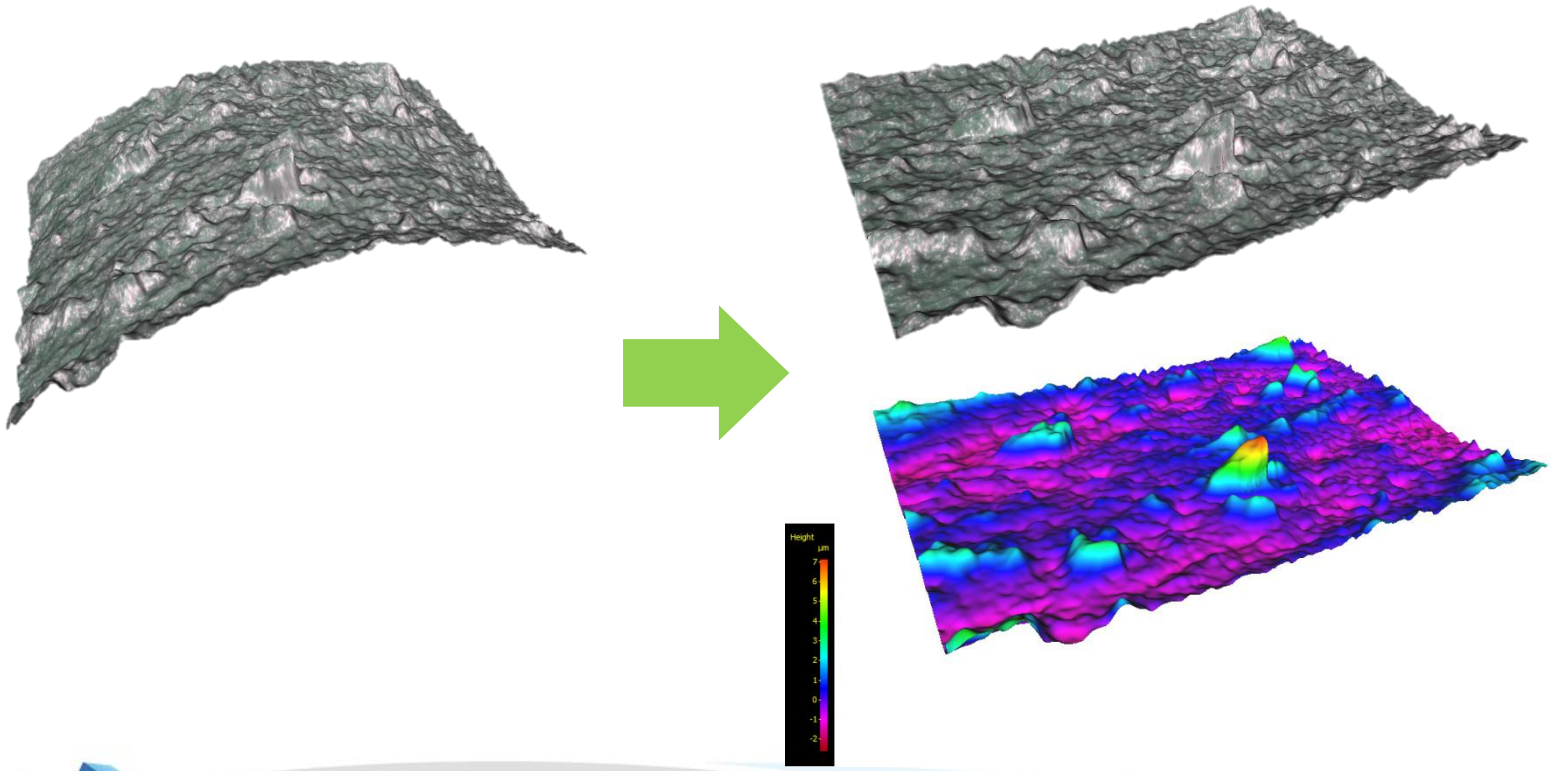
Putting Numbers to a Surface



Roughness of Uneven Surfaces



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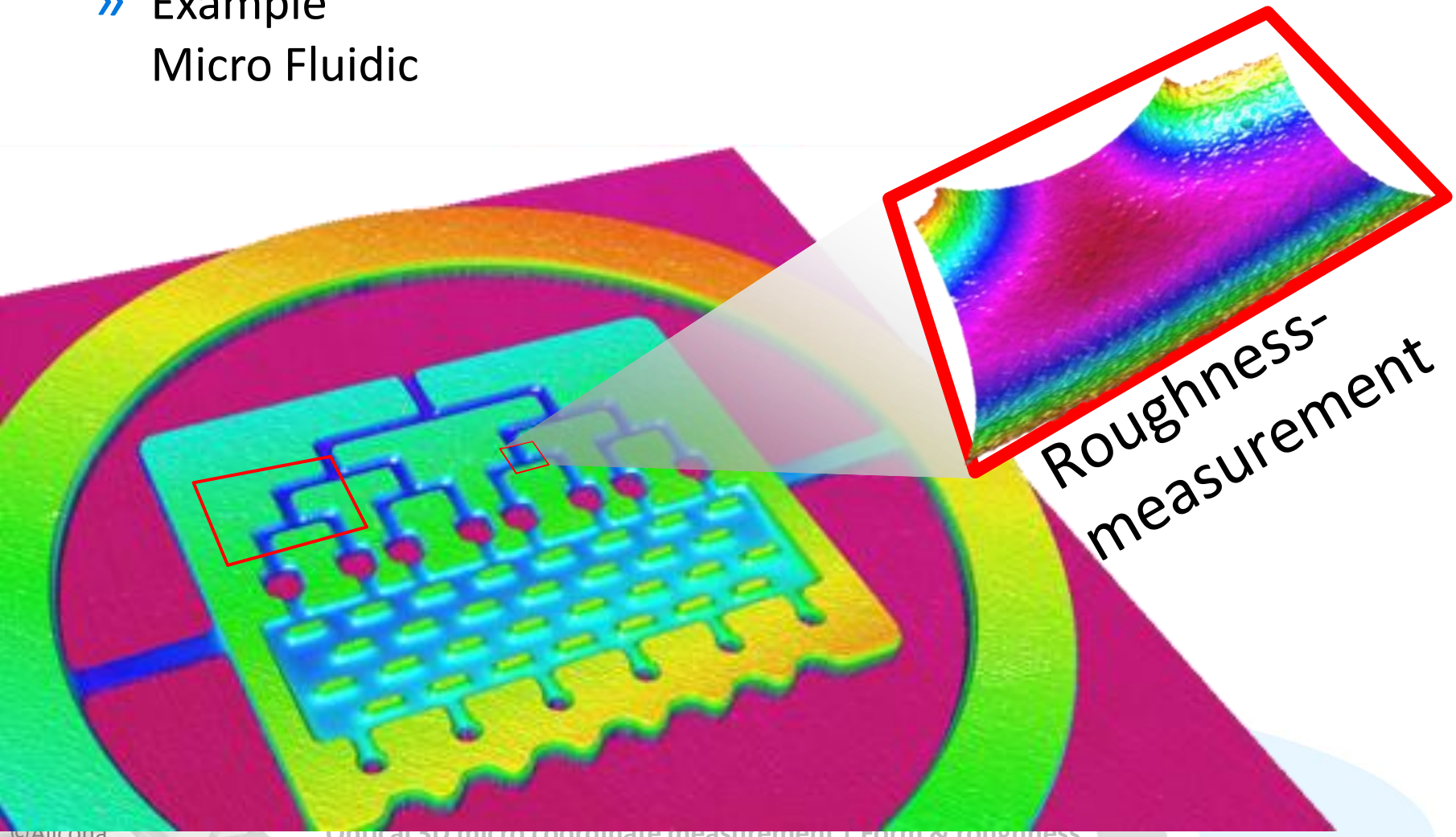
Roughness of Very Small Surfaces

» Example
Micro Fluidic

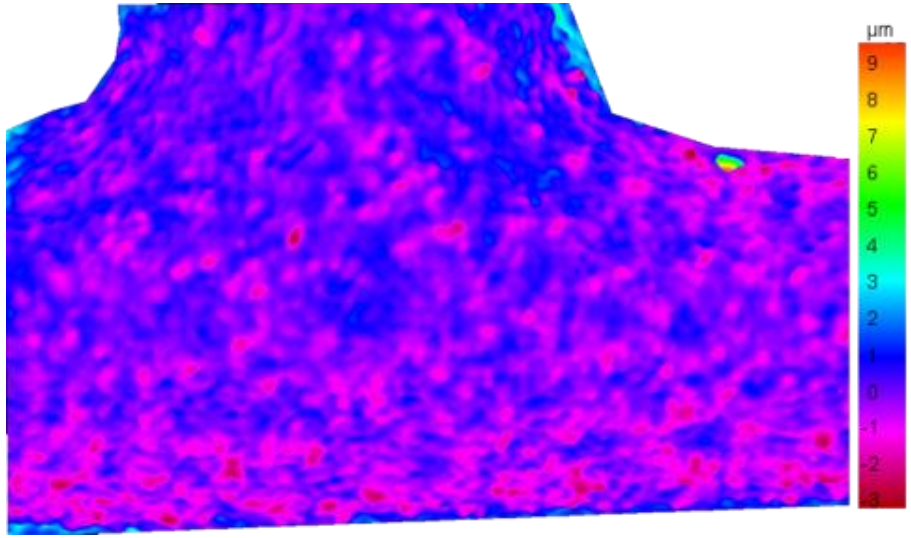


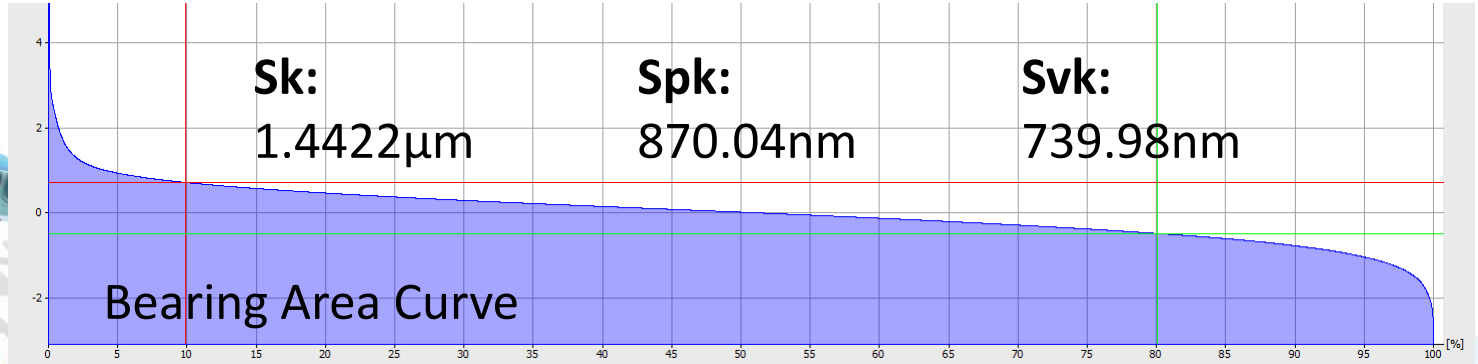
Roughness Measurement Micro Fluidic

Sa:
478.66nm

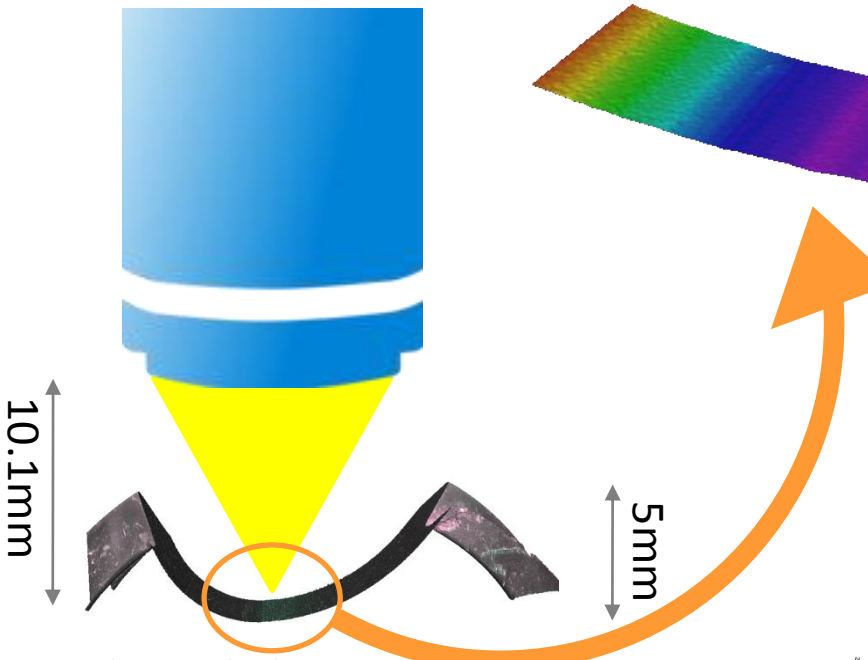
Sq:
650.62nm

Sz:
12.66µm



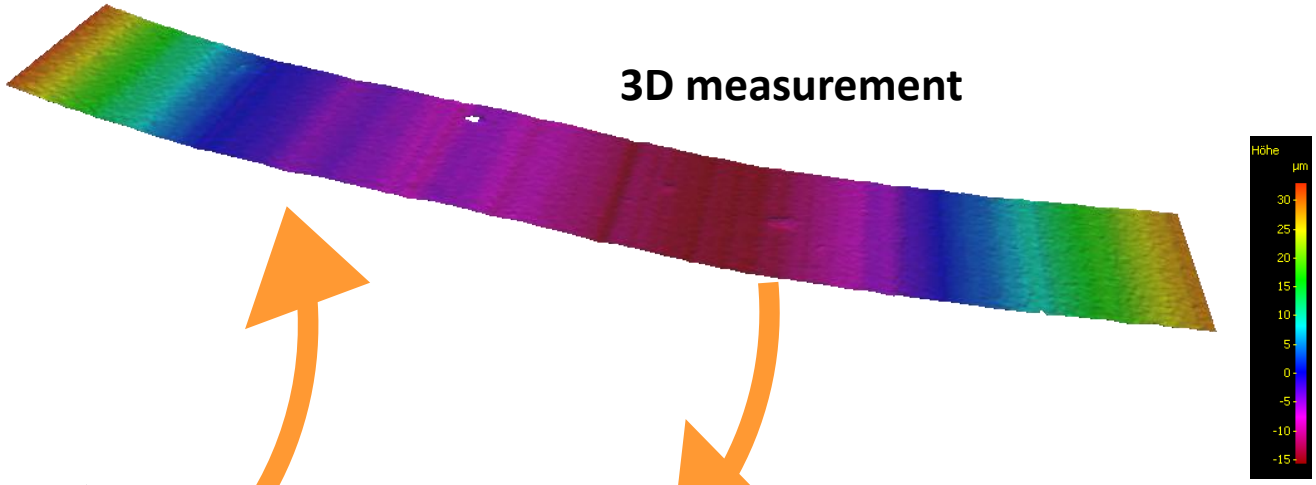


Measurement at the Flute of a Tap

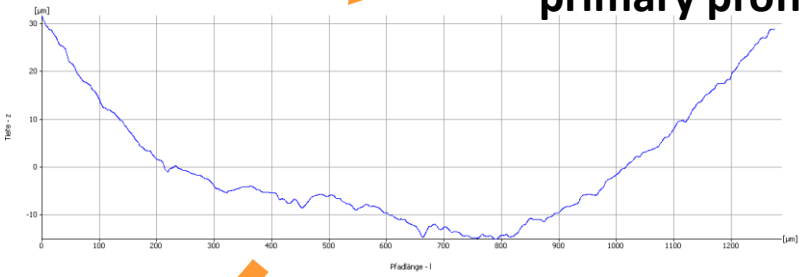


Example 50x objektive: working distance10.1mm

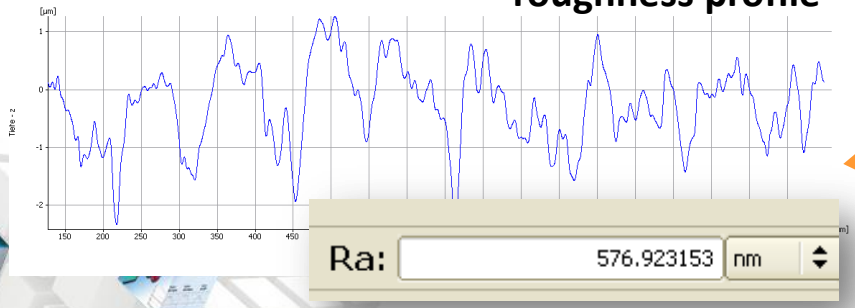
3D measurement



primary profile



roughness profile



Due to the large working distance roughness measurements are possible without collisions.

Working Distances InfiniteFocus

objectives	2,5x	5x	10x	20x	50x	100x
	8.8mm	*23.5mm*	*17.5mm*	*13.0mm*	*10.1mm*	*3.5mm*

working distance

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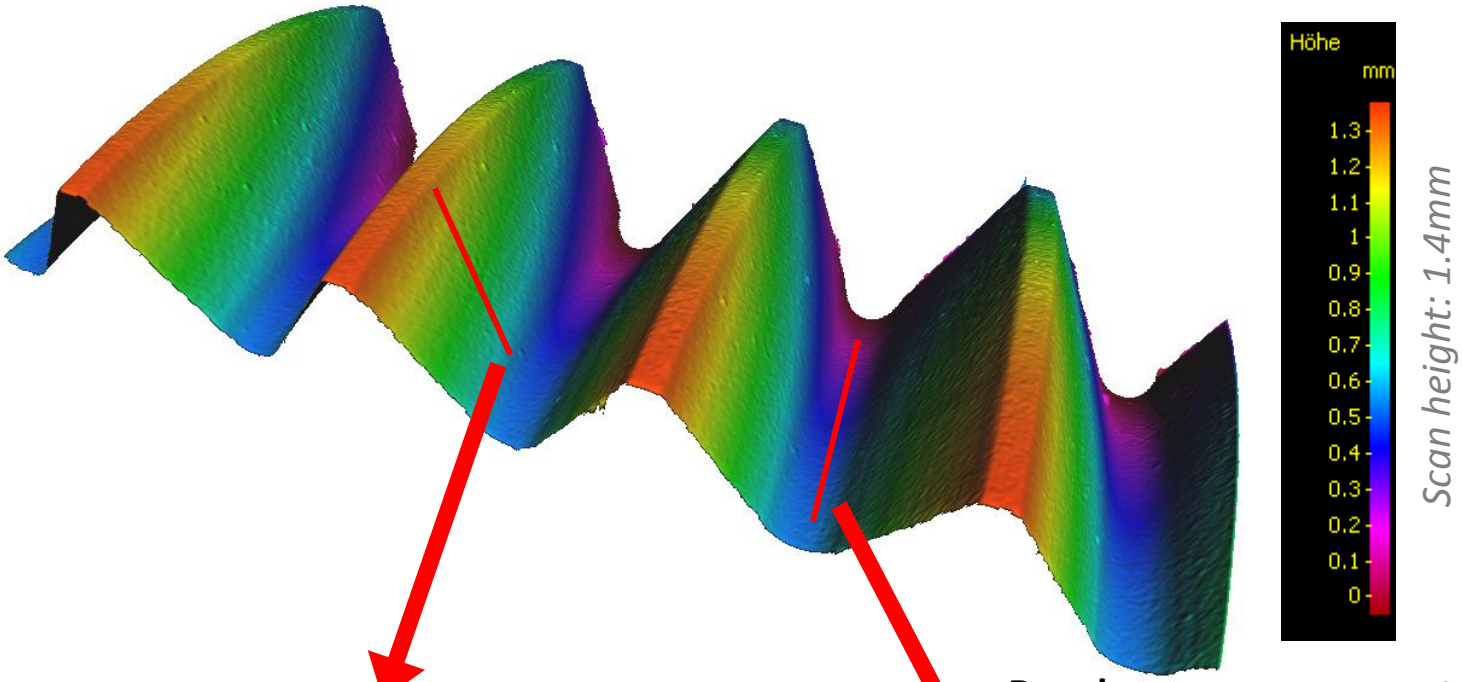
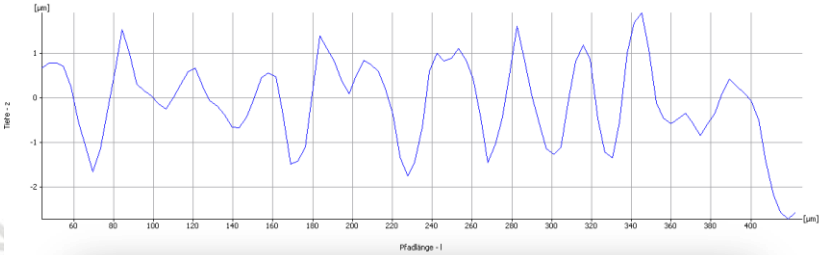
Example: Roughness Measurement of the Thread



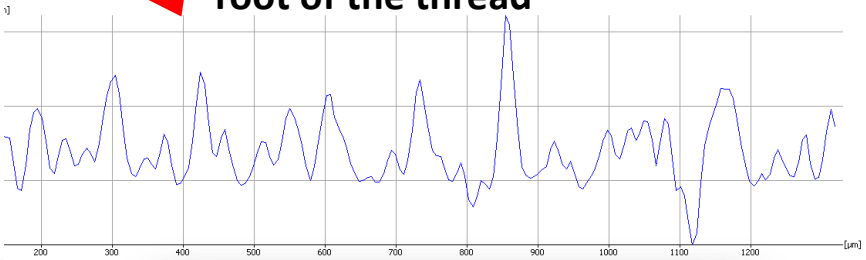
Scan height: 1.4mm

Roughness measurement on the flank



Ra: 766.800946 nm

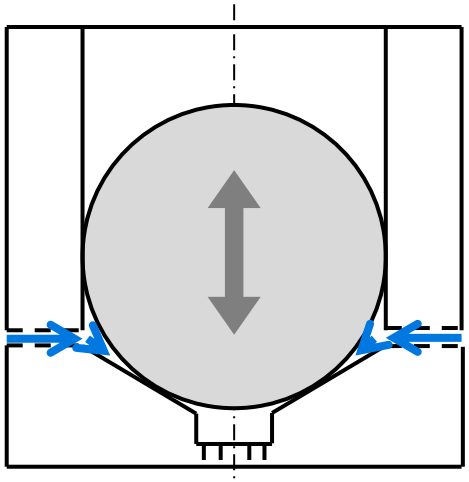
Roughness measurement on the root of the thread



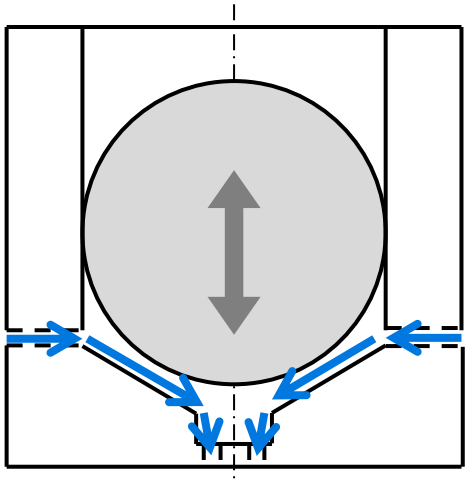
Ra: 449.445505 nm

Measurement Task

valve closed



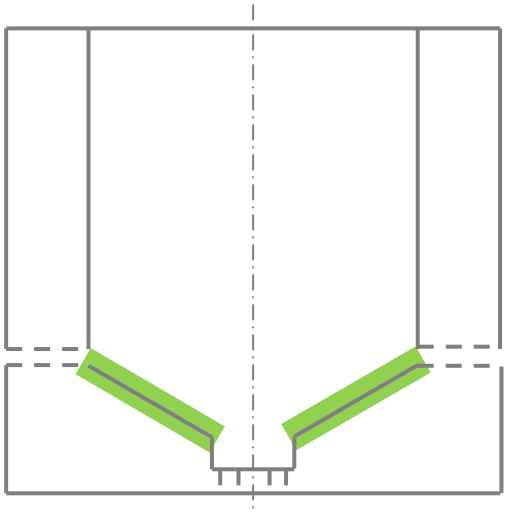
valve open



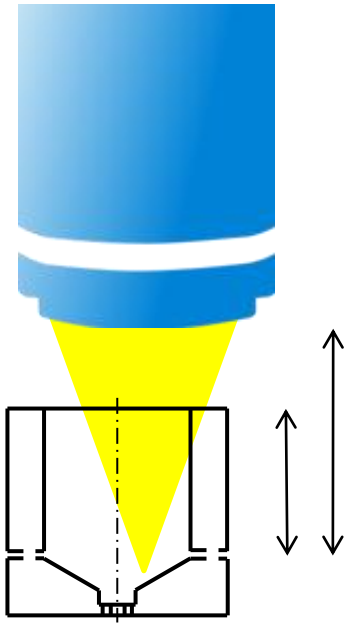
sealed?

Is the fuel supply with closed valve interrupted?
Boundary conditions: multiple injections of lowest quantities, pressures up to 2000bar

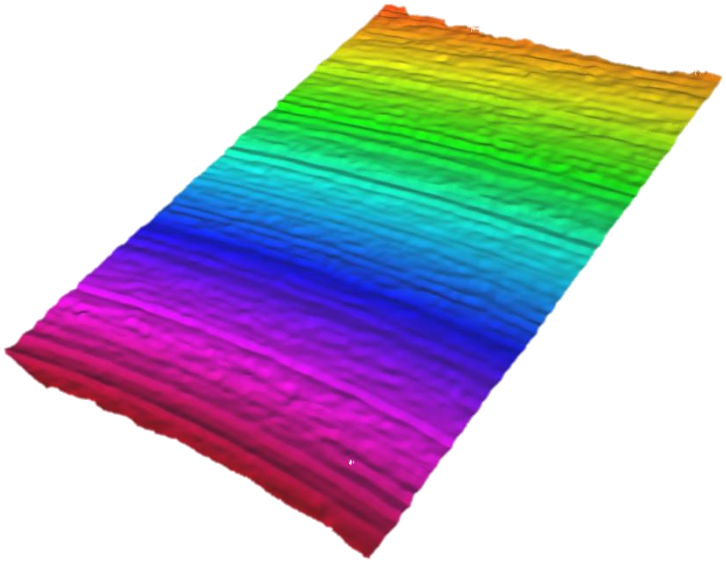
Example 1: Measurement of Injection Nozzles



Sealing surface

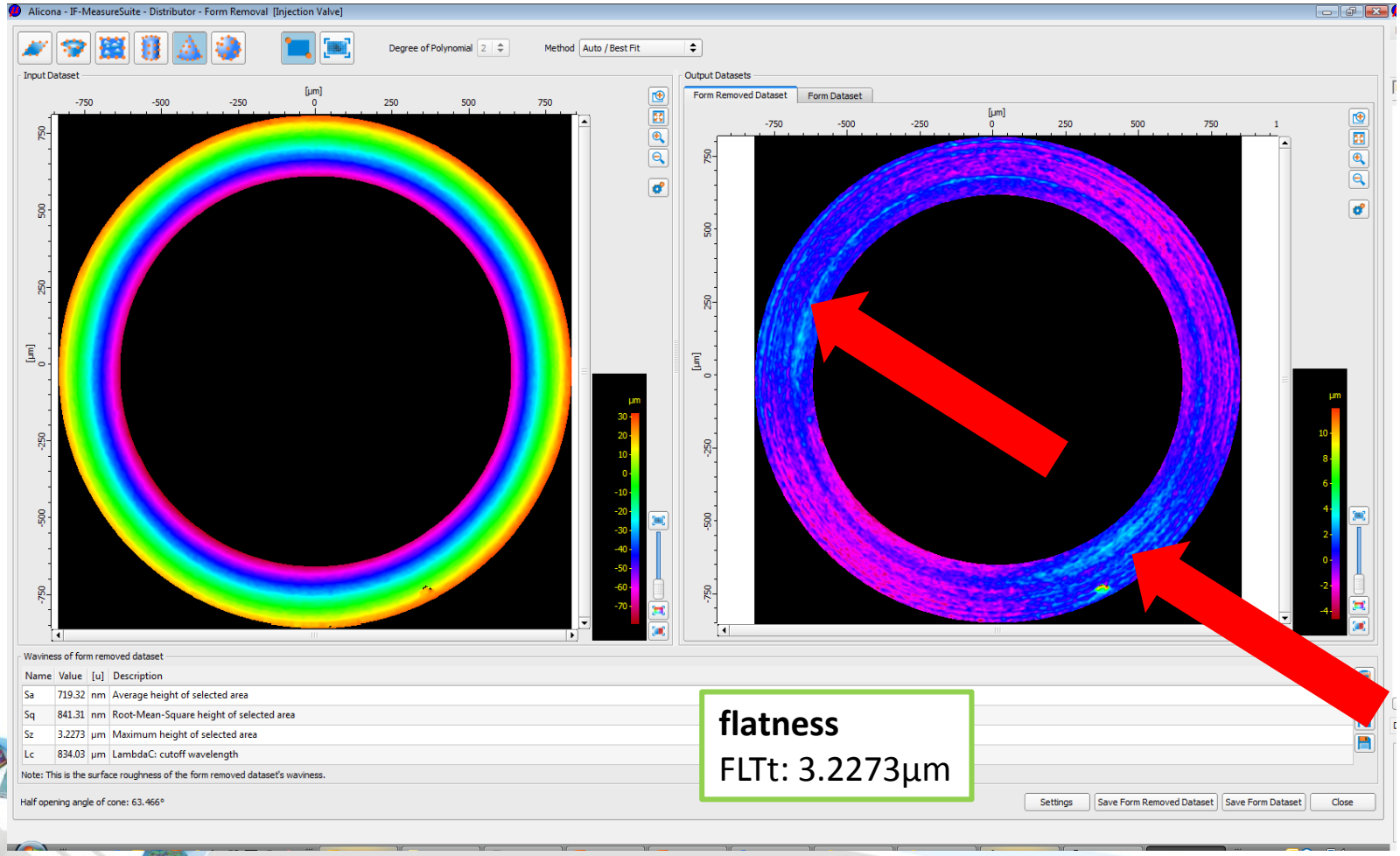


Measurements on the Sealing surface possible

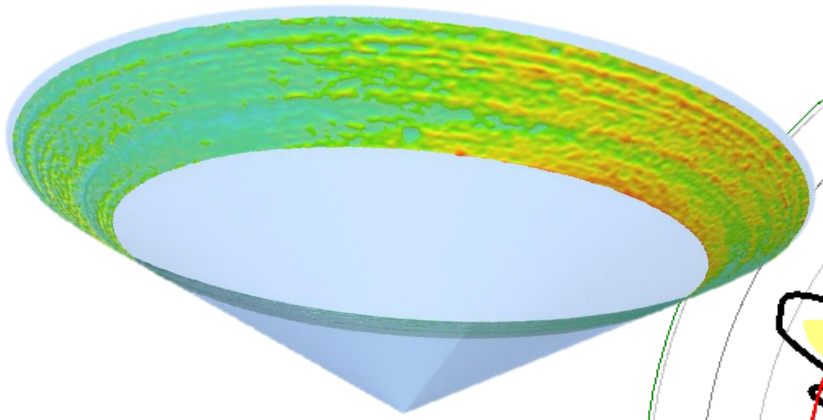


3D measurement of the sealing surface

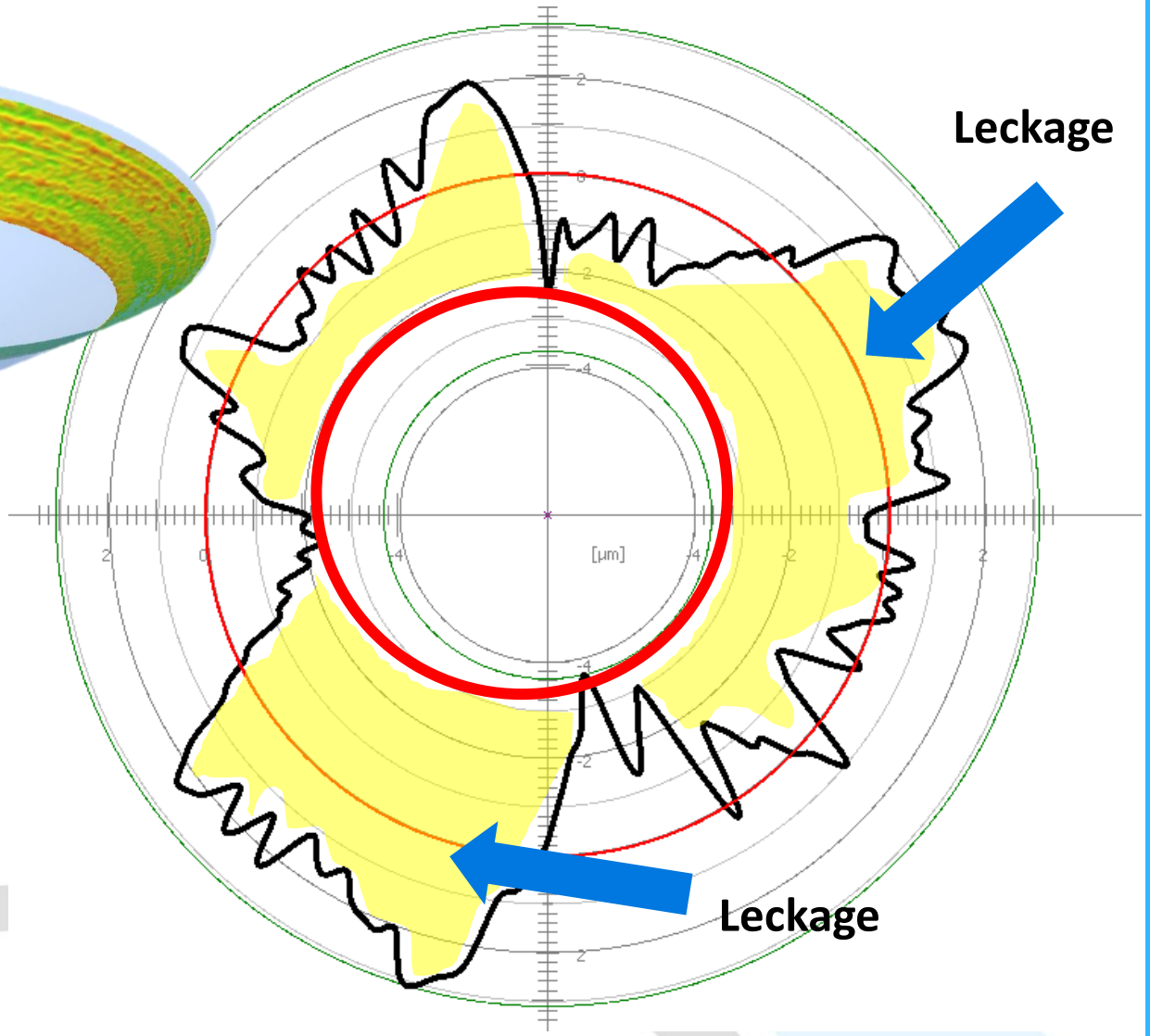
Flatness – Visualized After Form Removal



Roundness/Leak Tightness of a Valve



3D measurement of a valve



Geometry-Measurement

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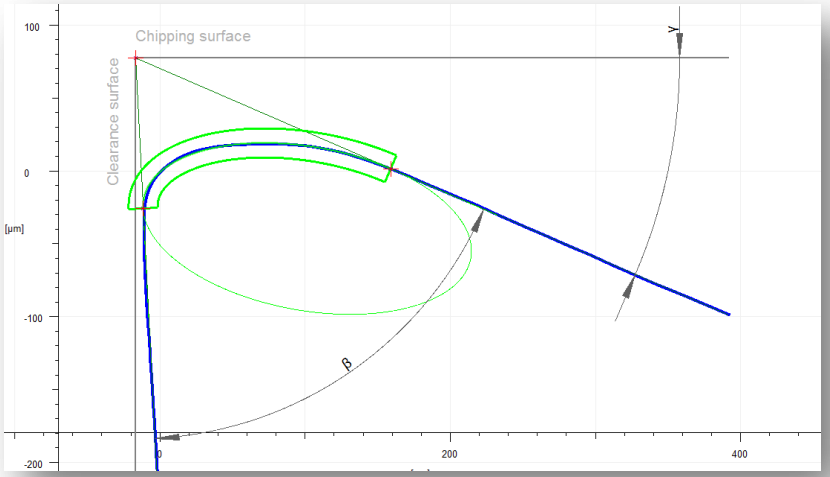
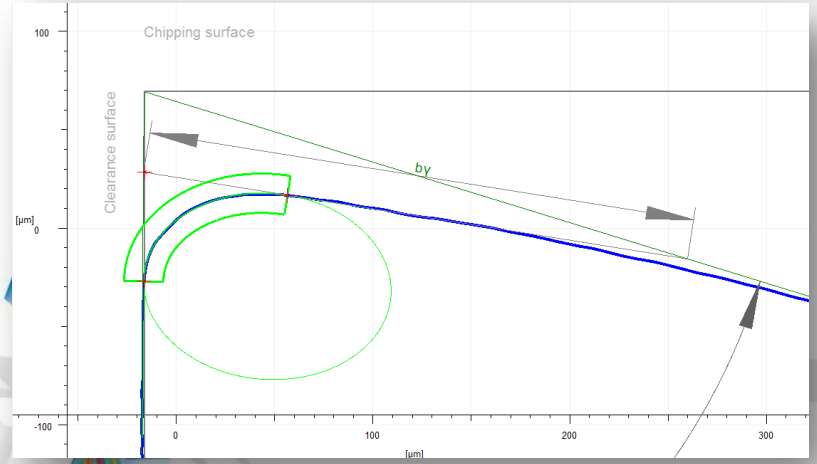
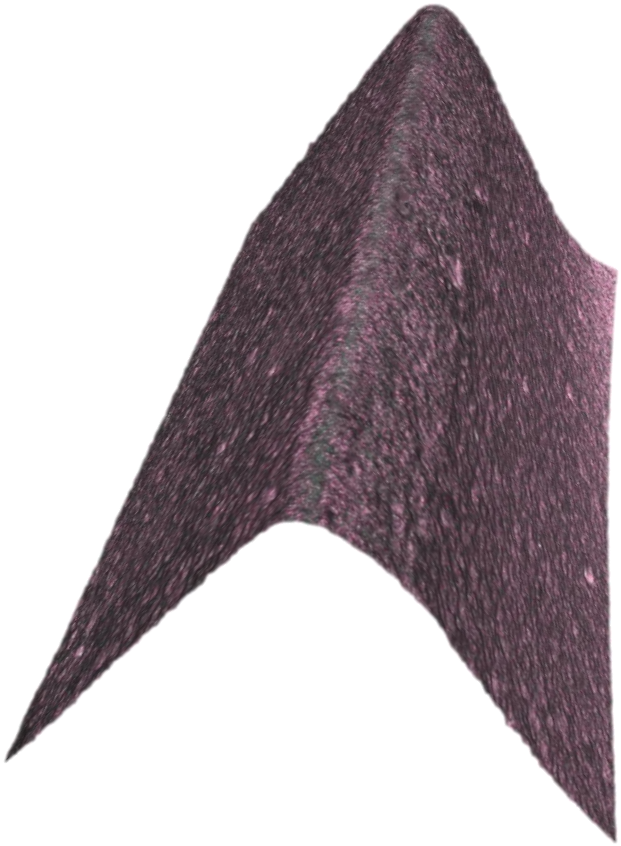
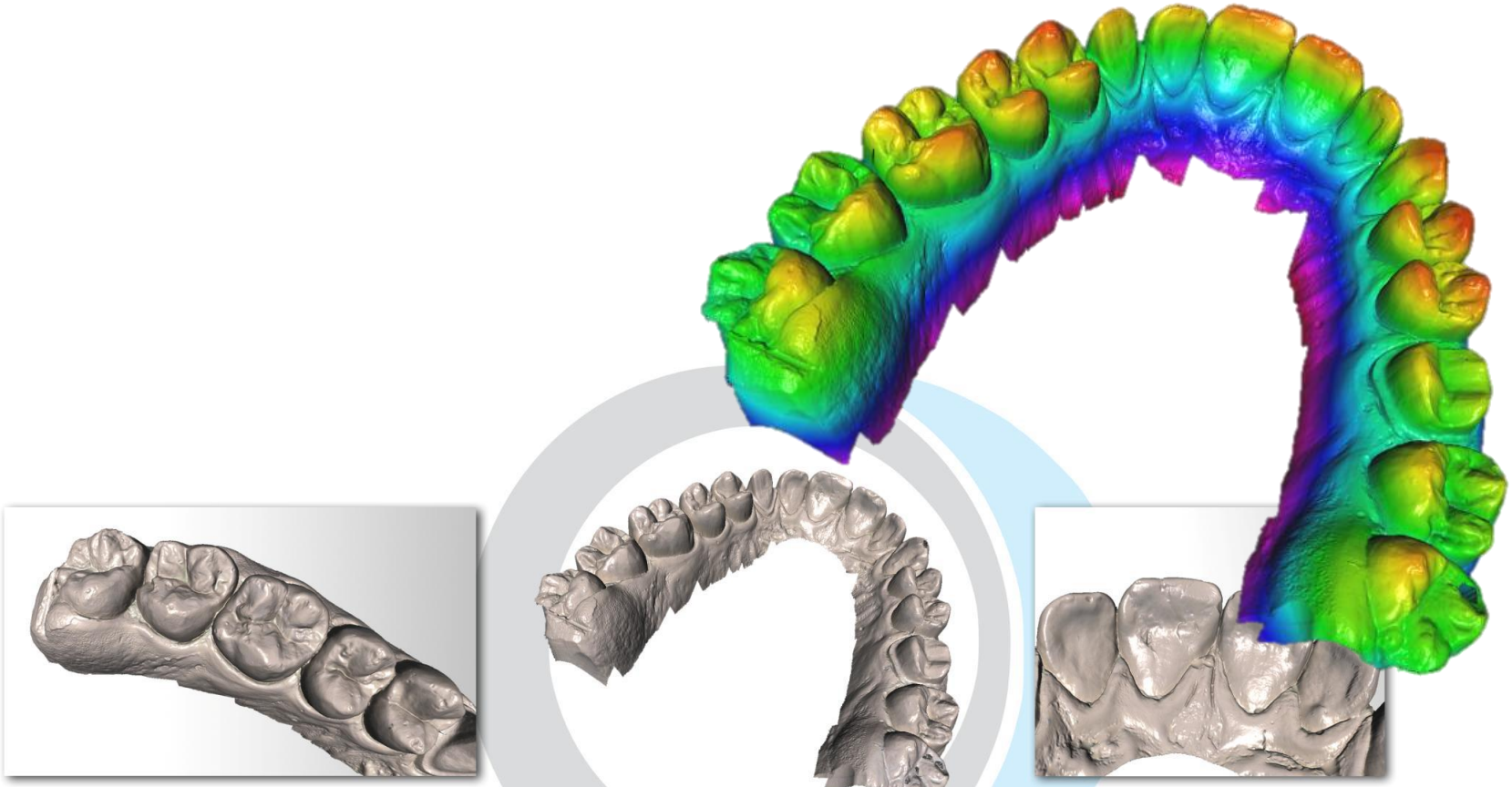
Correct Measurement of Basket Arches by Ellipse Fitting









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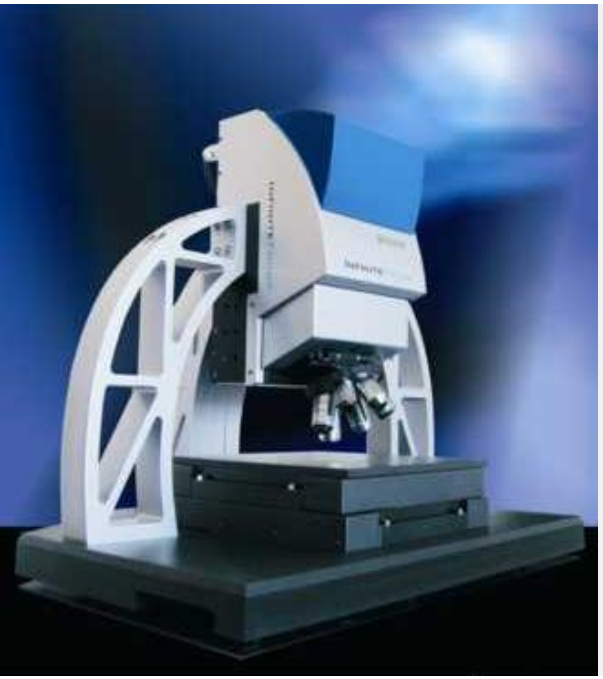
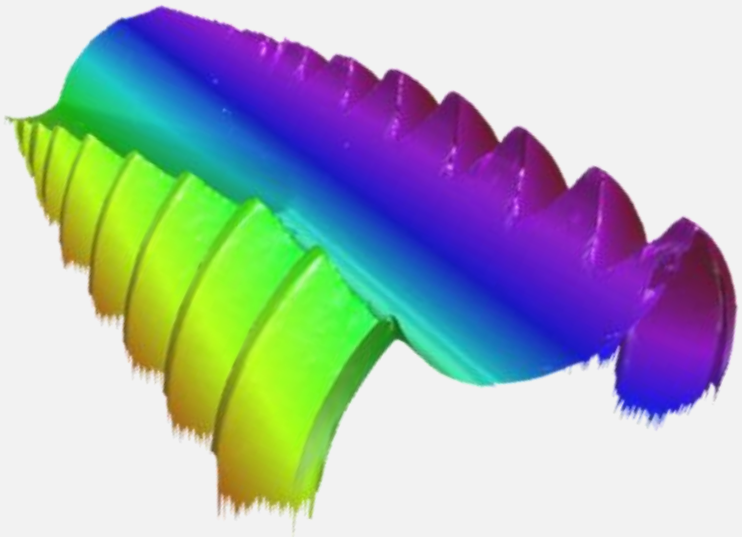
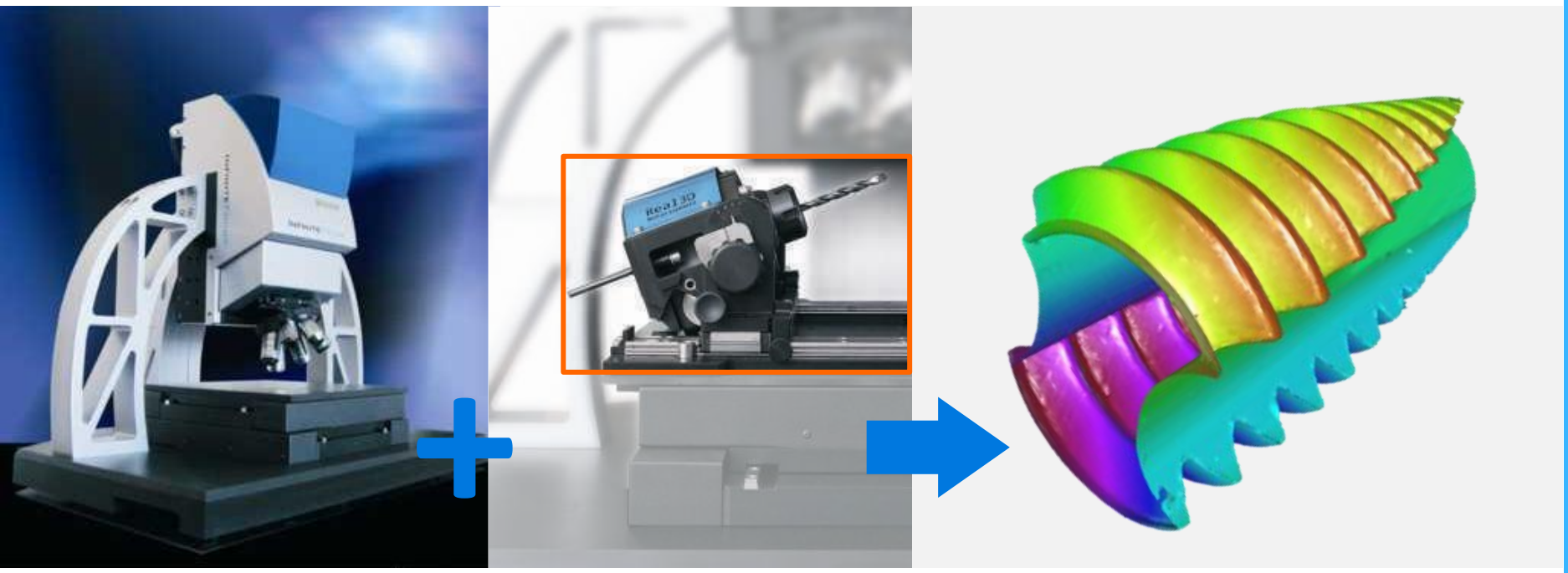
InfiniteFocus Standard Measurement





InfiniteFocus & Real3DRotationUnit



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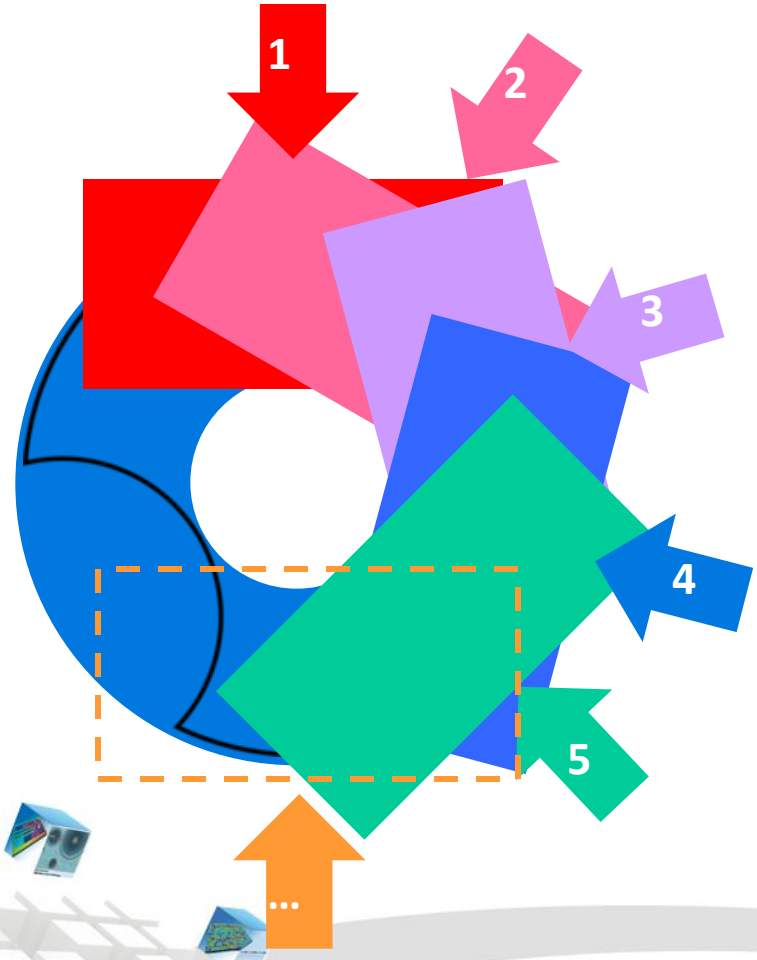
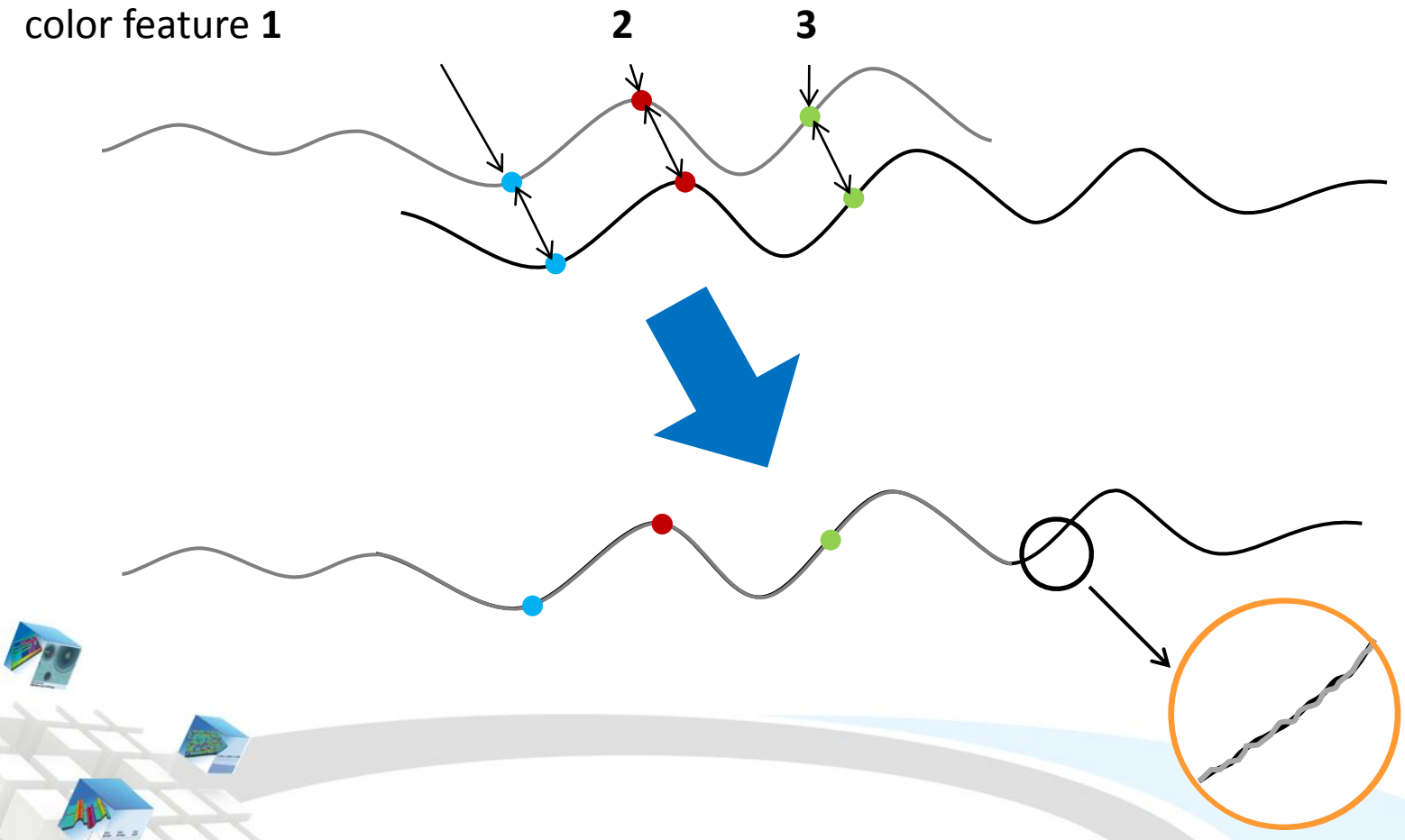
Real3D Measurement

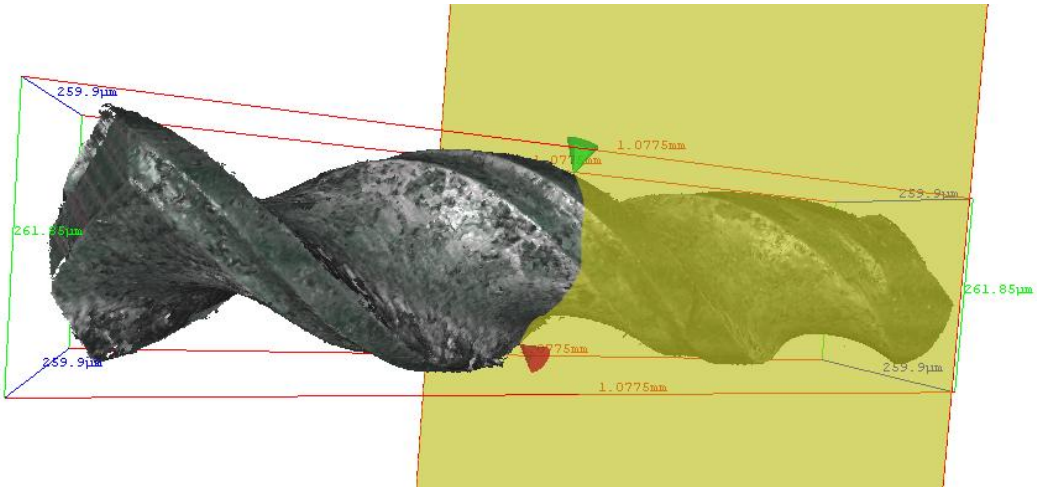


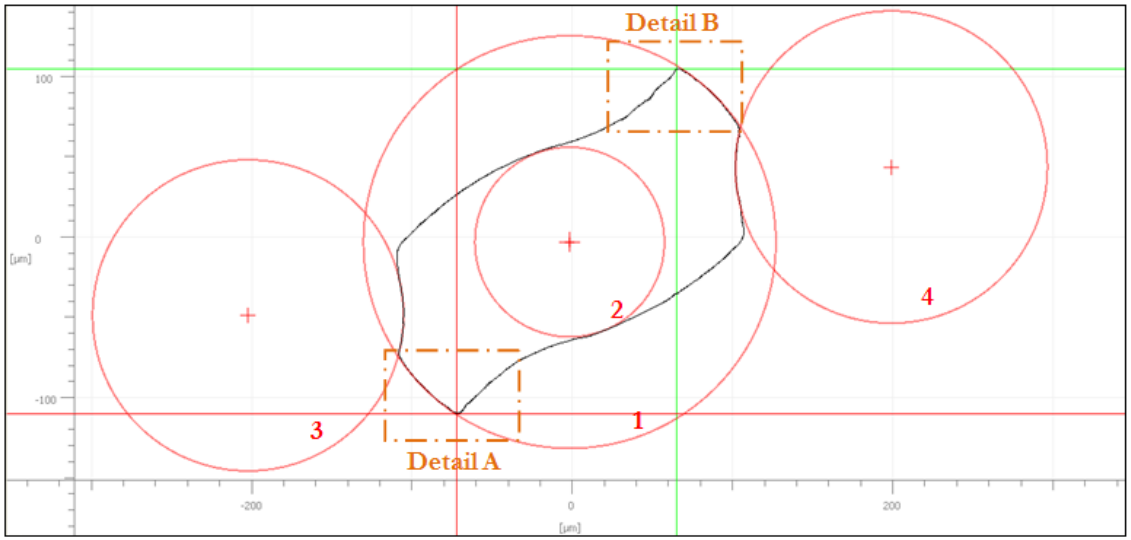
1-… Single measurements that are merged into one dataset.

Alignment of Real3D-Datasets



Geometry Measurement of a Drill



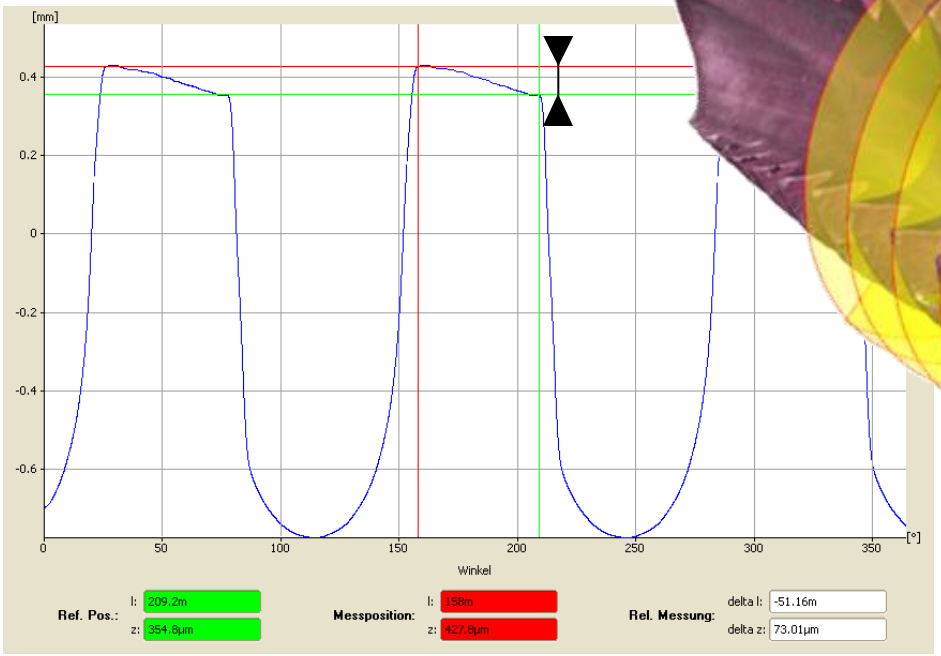


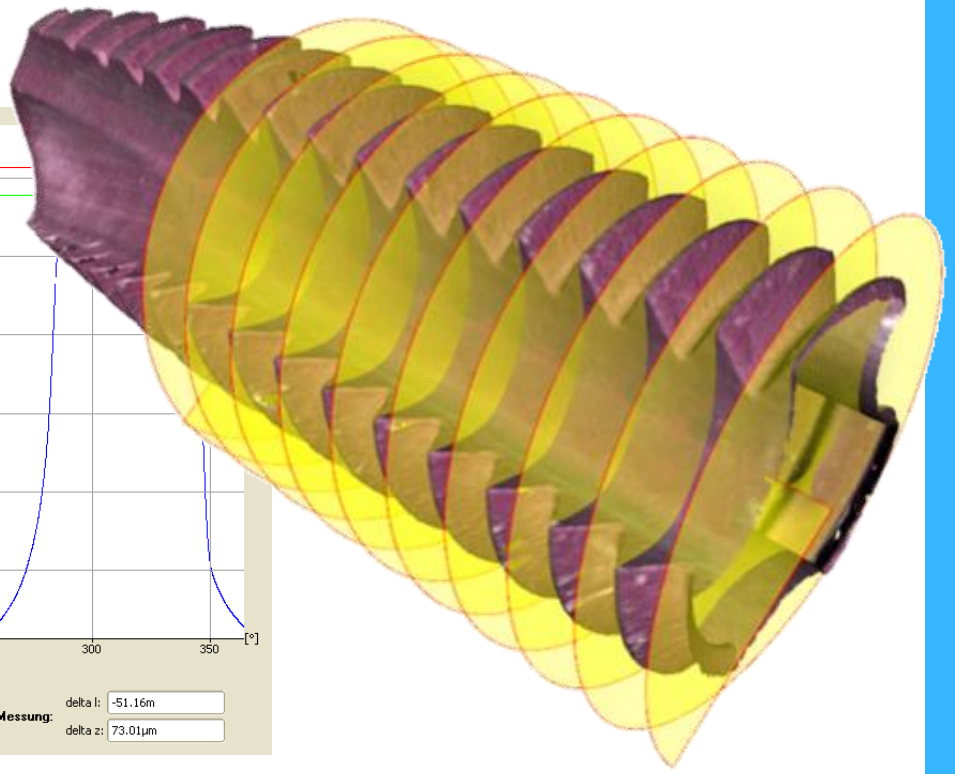
- **major radius** 128.8µm (circle 1)
- **core radius** 59.2µm (circle 2)
- **radius of circle 3** 97.1µm
- **radius of circle 4** 97.4µm

Similar values

Measurement on a Helical Cut

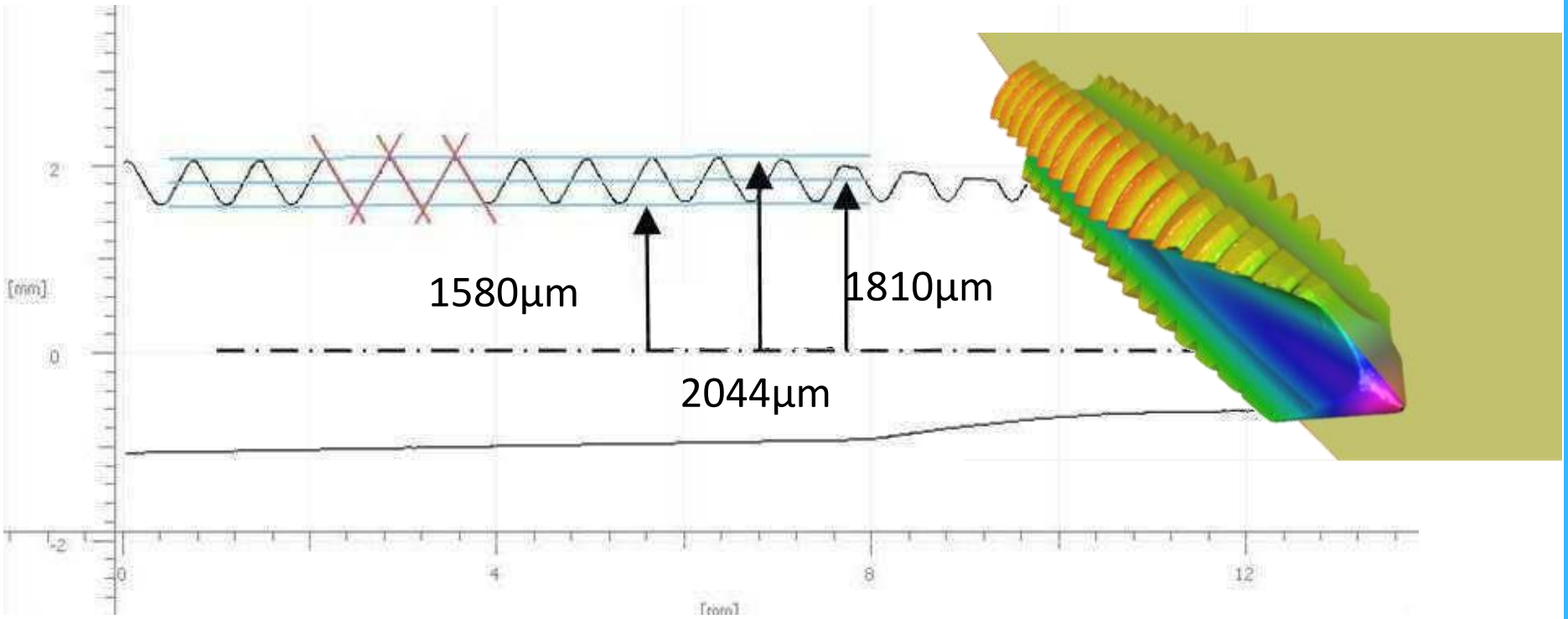
Relief: 73.01µm





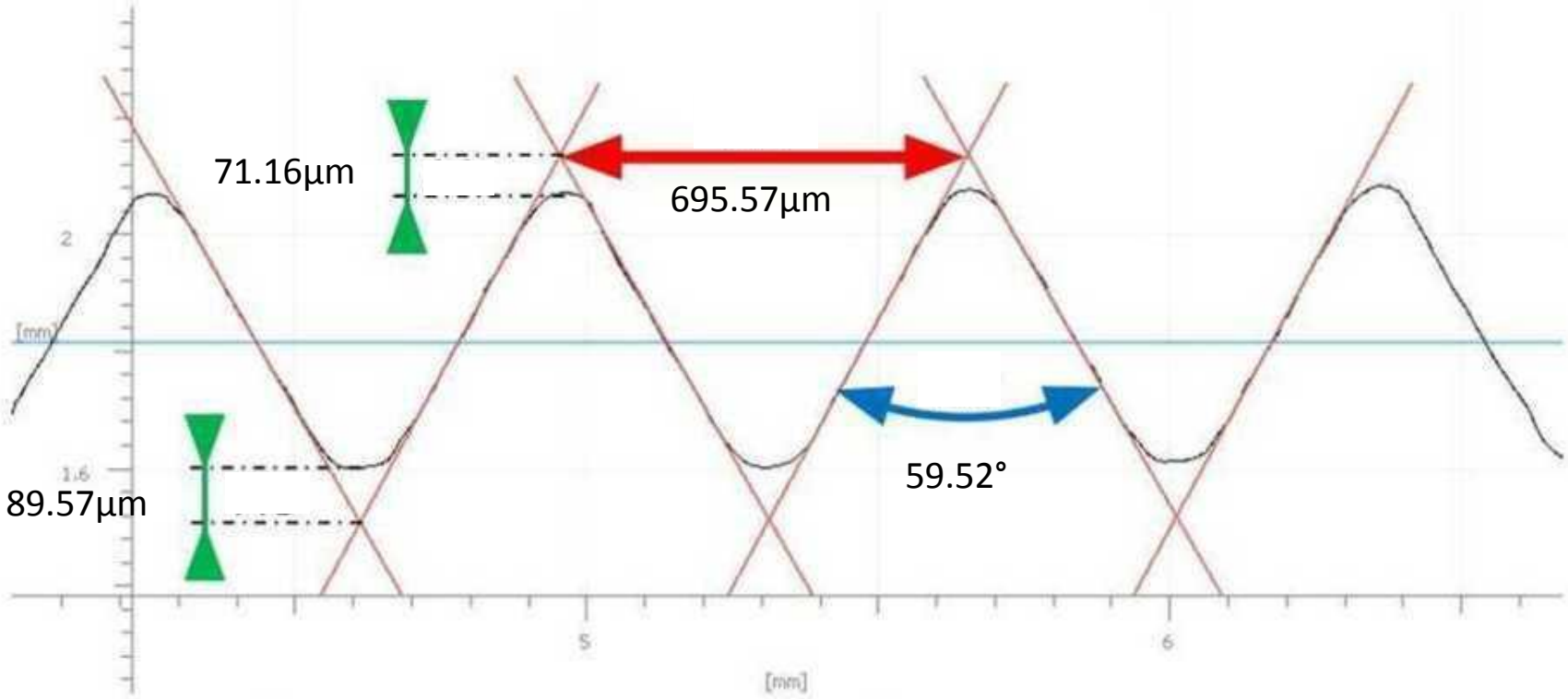
Helical cut simplifies relief measurements

Measurement on the Longitudial Cut of a Tap Tool



These parameters are measured automatically when extracting the contour.

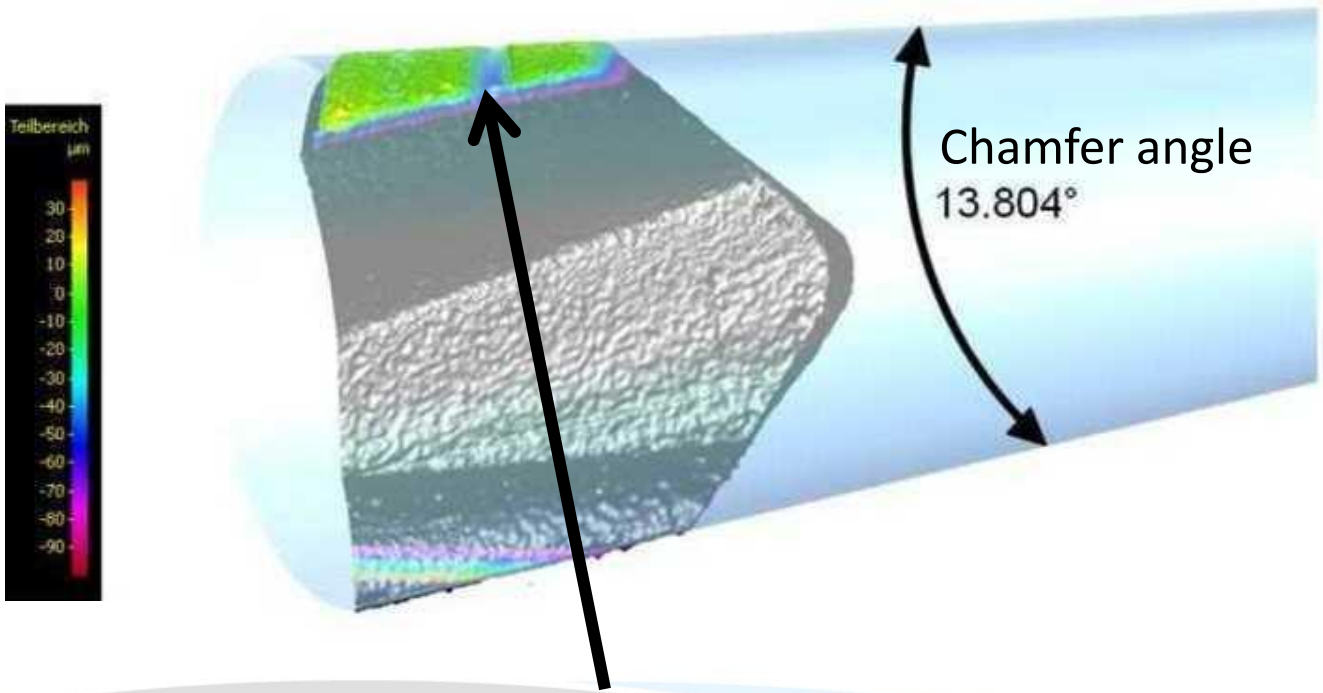
Measurement on the Longitudial Cut of a Tap Tool



- » Thread pitch
- » Flank angle
- » Flattening of the major diameter
- » Flattening of the minor diameter

Form-Measurement on a Tap Tool

Measurement of chamfer angle
via robust cone measurements



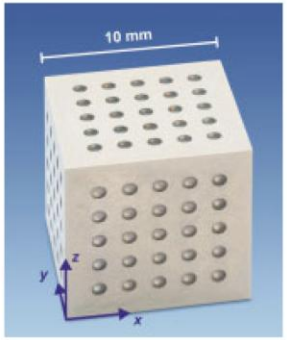
Automatic point selection/deselection

Traceability

Nice, but can I trust the results?

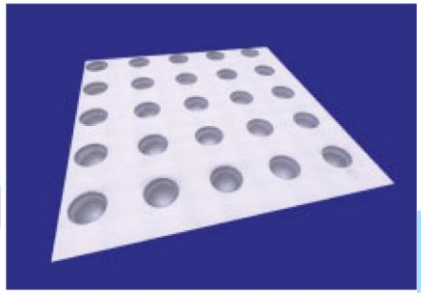
- Focus-Variation is added in the draft for **ISO 25178-6** as **independent technology**
- **PTB** uses **InfiniteFocus for calibrating** computer tomography **standards**

Physikalisch Technische Bundesanstalt
Braunschweig und Berlin



Prüfkörper für optische und taktile Mikromesstechnik

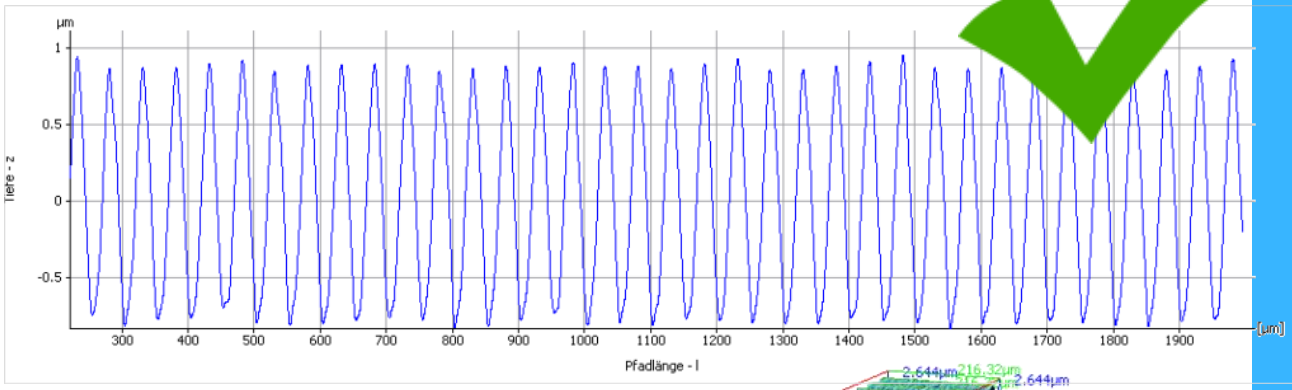
2c. Optische Messung

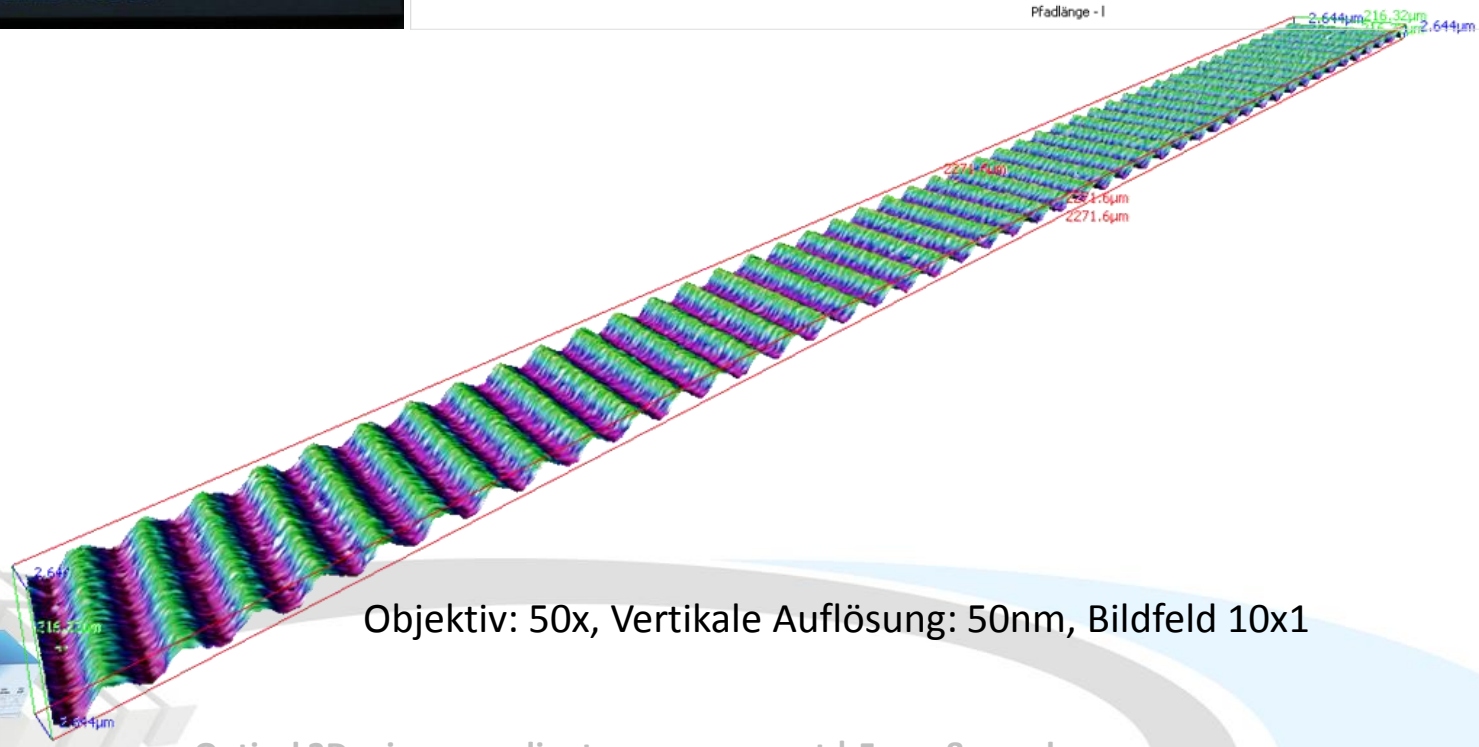


Optische Messung mit InfiniteFocus-Messgerät (www.alicona.com)
Objektiv 10x, Stitchmodus, > 1 000 000 Datenpunkte

PTB

Are optical measurements traceable?





Objektiv: 50x, Vertikale Auflösung: 50nm, Bildfeld 10x1

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Roughness Standards

Calibrated roughness standards

- structure is measured with a reference measurement device
  → roughness value for the certificate
- assures reference to national standards
- assures reproducibility with other measurement devices

Institutions for calibration

- DAkkS (prior DKD)
- PTB
- NIST

Conclusion

Benefits of Focus-Variation

+ Form and roughness in one measurement

- + Rough and smooth surfaces
- + Color information
- + Steep flanks
- + Diversity of materials
- + Large measurement areas

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Thank you for your attention!