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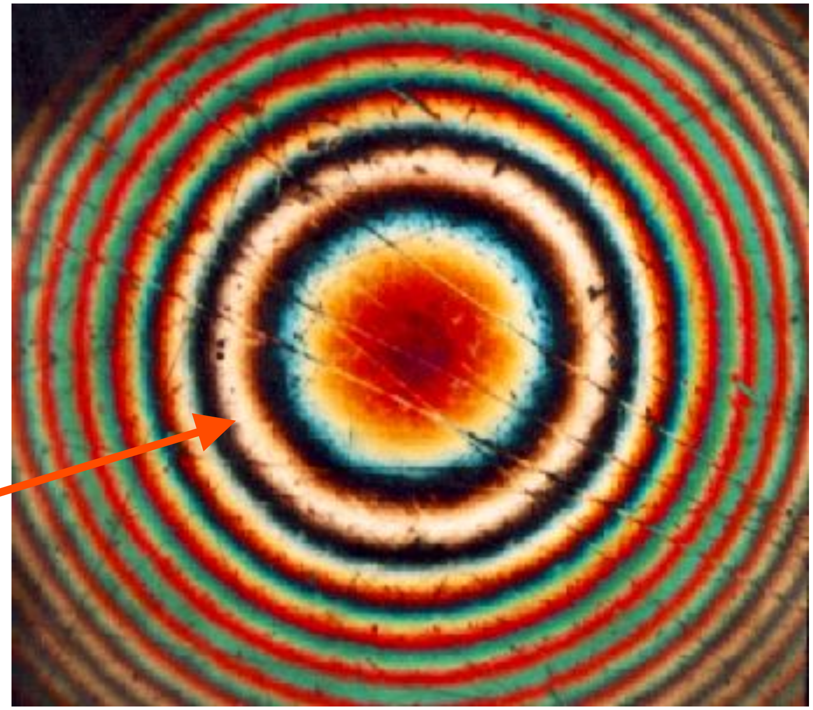
College of Optical Sciences

5.8 Vertical Scanning (Coherence Probe) Techniques

White Light Interference Fringes

- **Fringes form bands of contour of equal height on the surface with respect to the reference surface.**
- **Fringe contrast will be greatest at point of equal path length or "best focus."**



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White Light Interferometry

- Eliminates coherence noise (spurious fringes and speckle) present when using coherent laser source
- Eliminates ambiguities in heights present with monochromatic interferometry
- Techniques old, but use of modern electronics and computers enhance capabilities and applications

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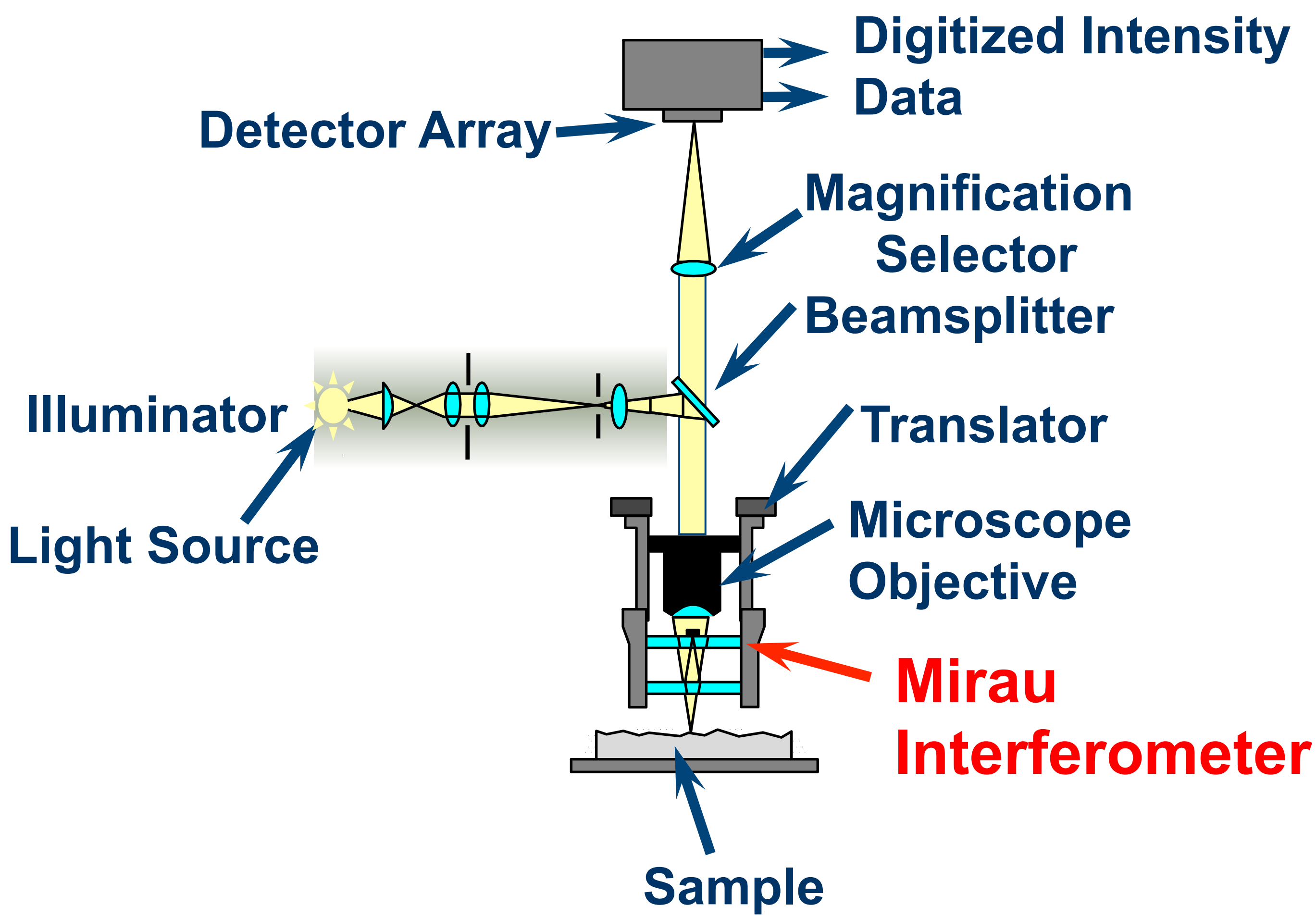
Principles of Vertical Scanning Interferometry

- A difference between the reference and test optical paths causes a difference in phase.
- Best fringe contrast corresponds to zero optical path difference.
- Best focus corresponds to zero optical path difference.

Interference Microscope Diagram



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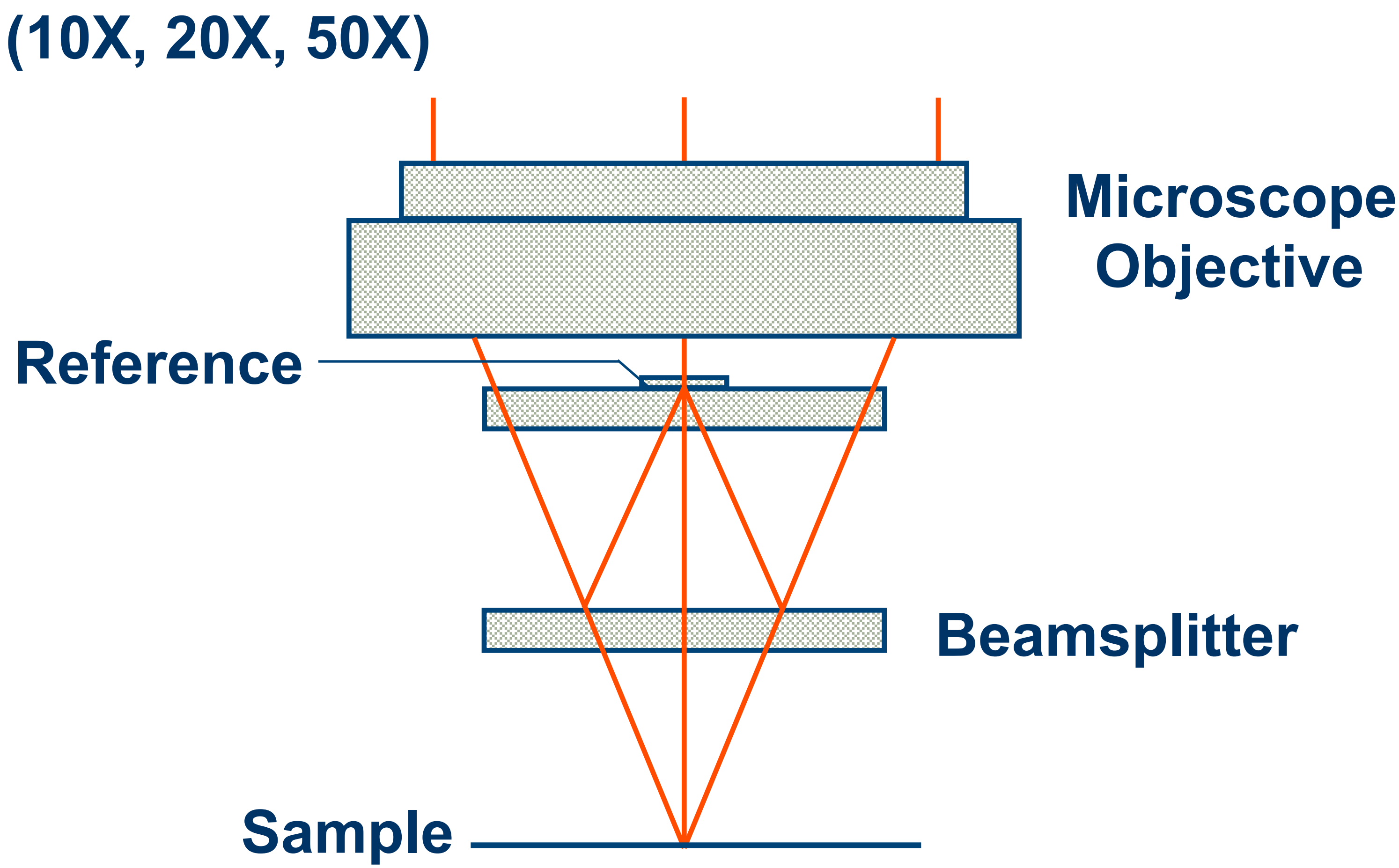
Mirau Interferometer



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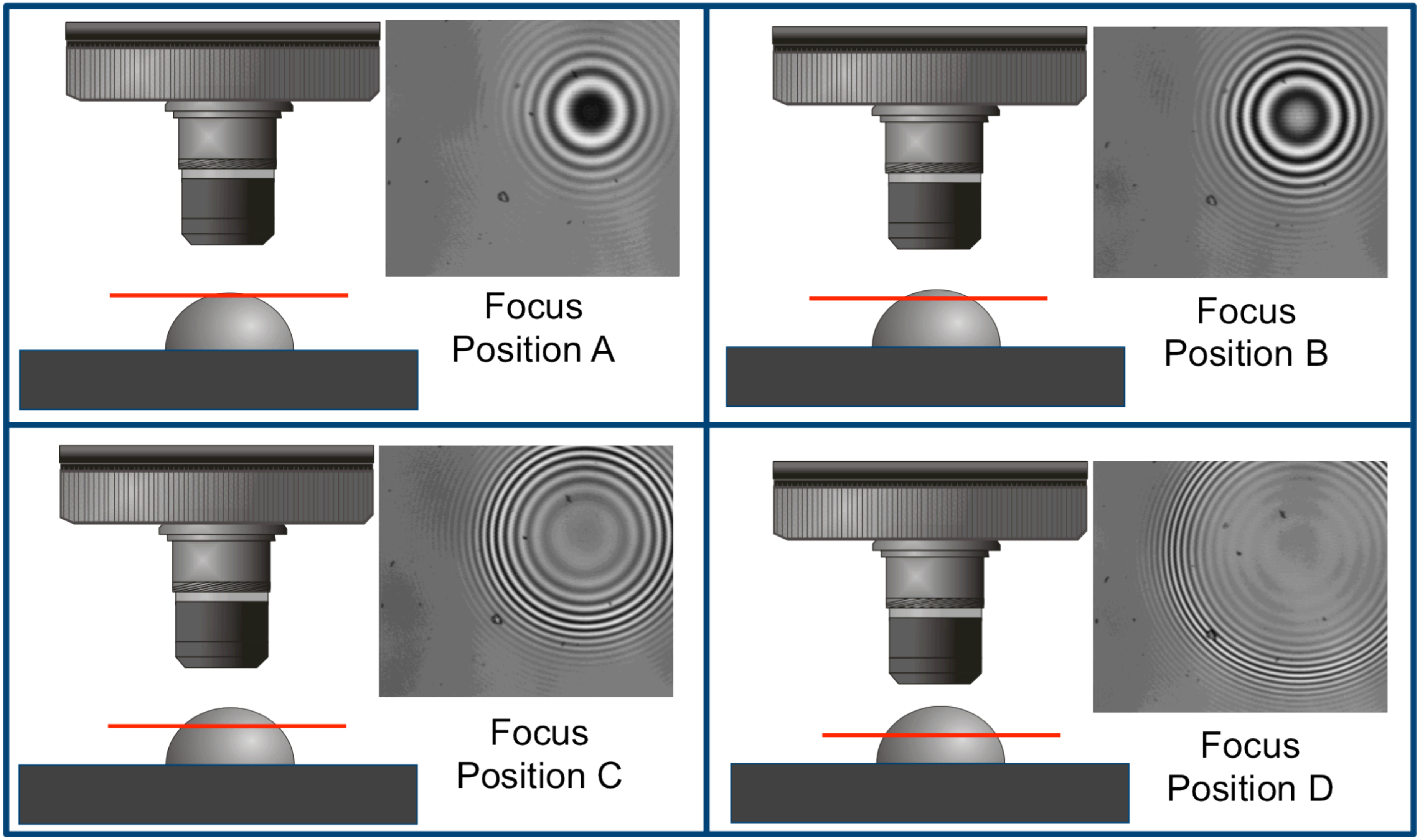
Vertical Scanning Interference Microscope



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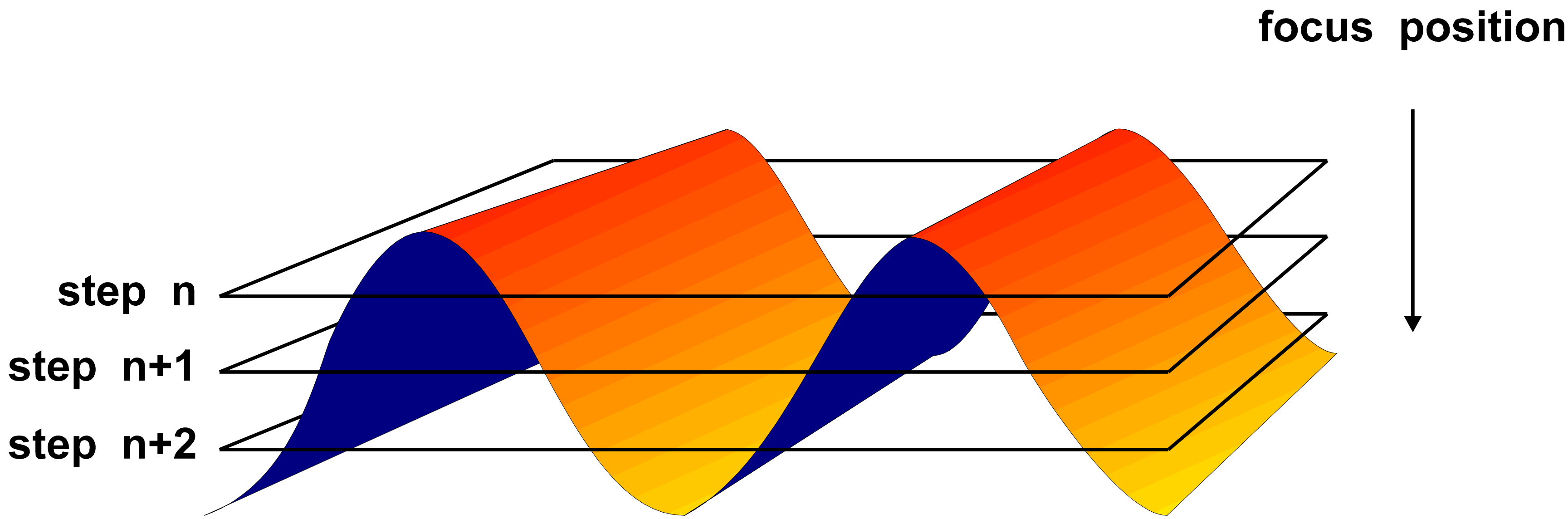
Vertical Scanning Measurement

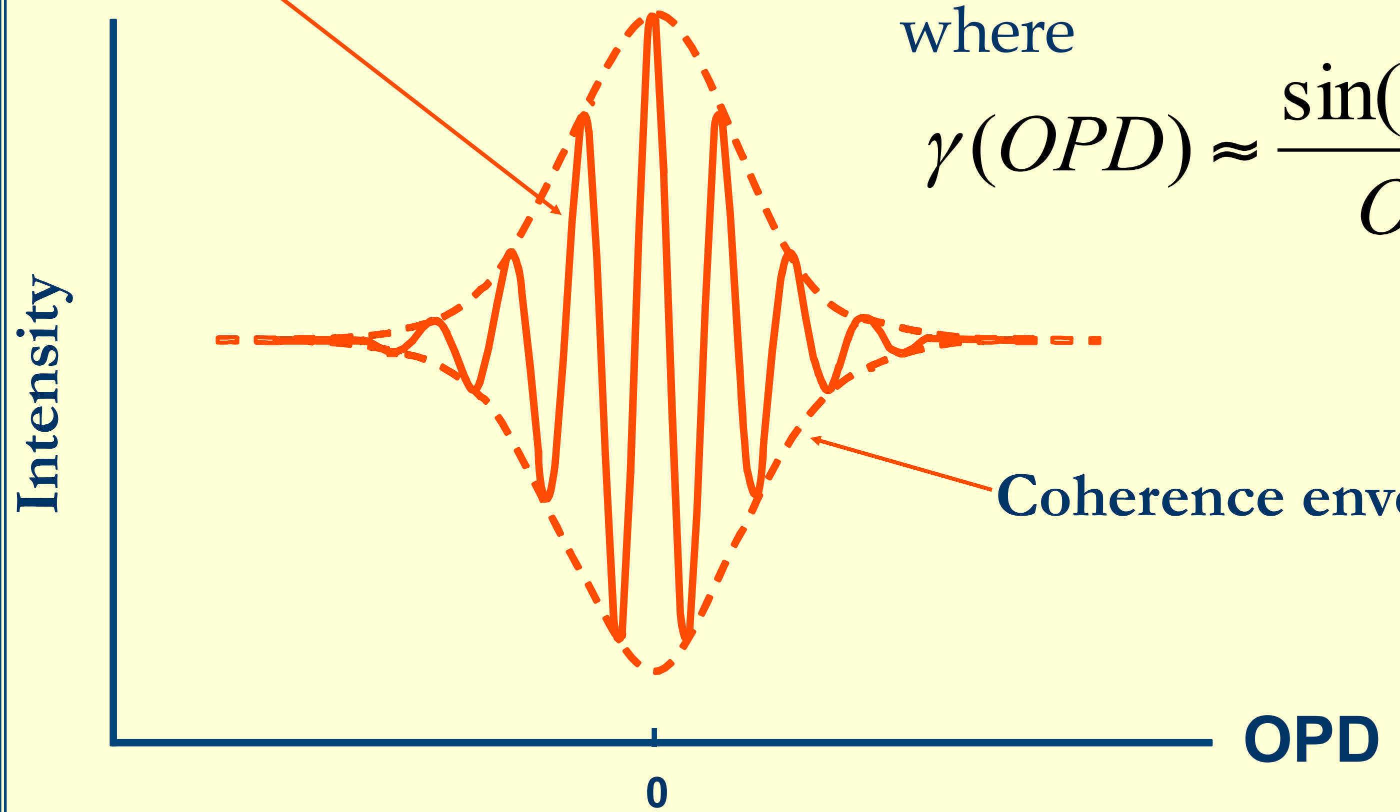


Irradiance Signal Through Focus

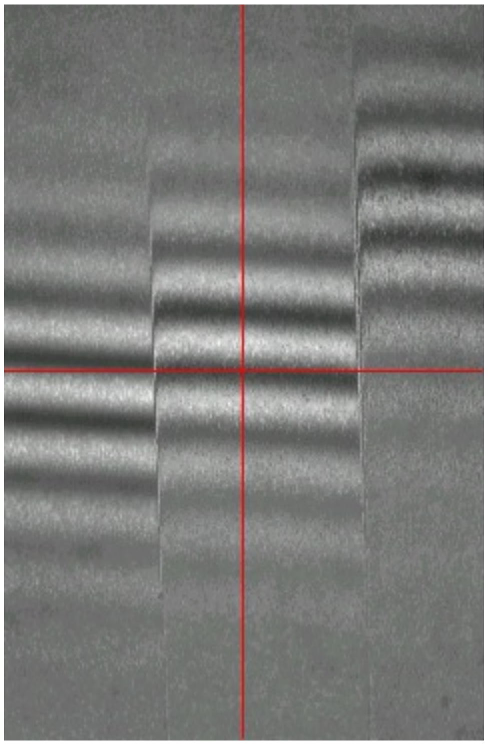
$$I = I_0\left[1 + \gamma(OPD)\cos\left(\phi + \alpha\right)\right]$$

where

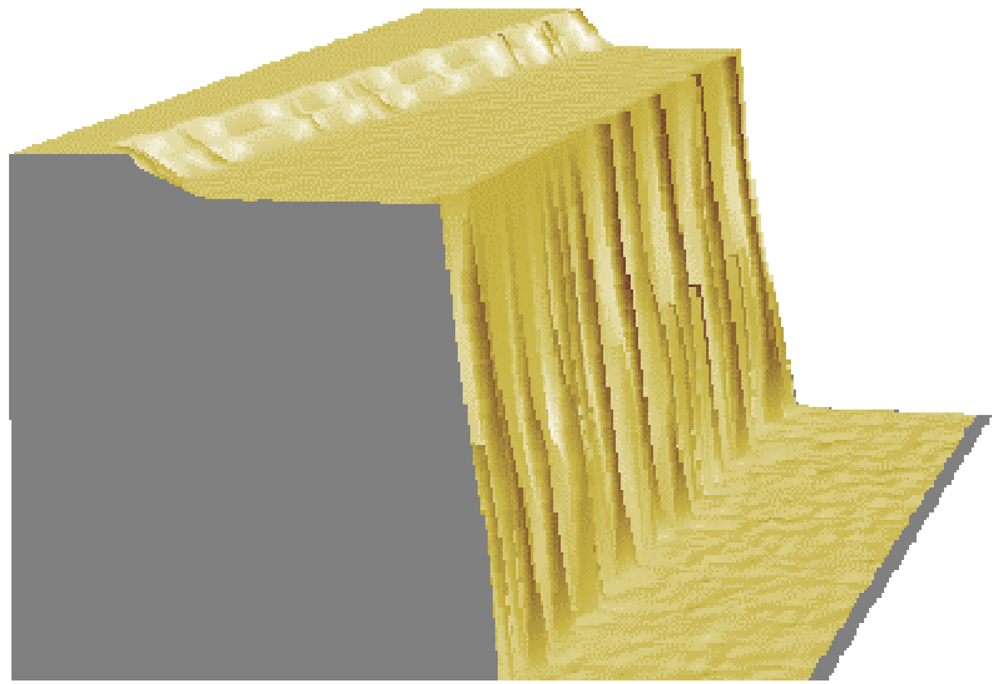
$$\gamma(OPD) \approx \frac{\sin(OPD)}{OPD}$$



Typical White Light Fringes for Stepped Surfaces



Fringes



Phase map

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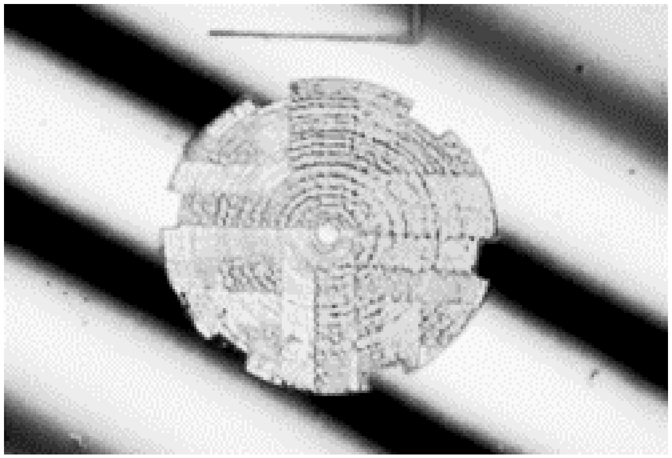
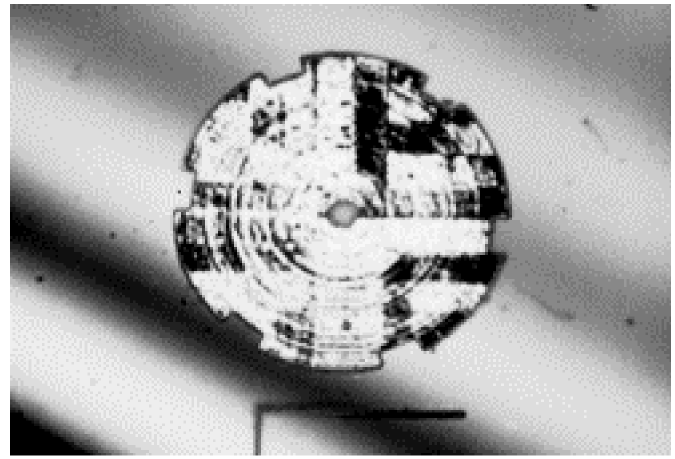
White Light Interferograms



Focus Position A



Focus Position B

As the scan moves different areas of the part being measured come into focus (have zero OPD or maximum contrast between fringes). A determination of the point of maximum contrast and knowledge of the scan position allows a reconstruction of the surface shape.

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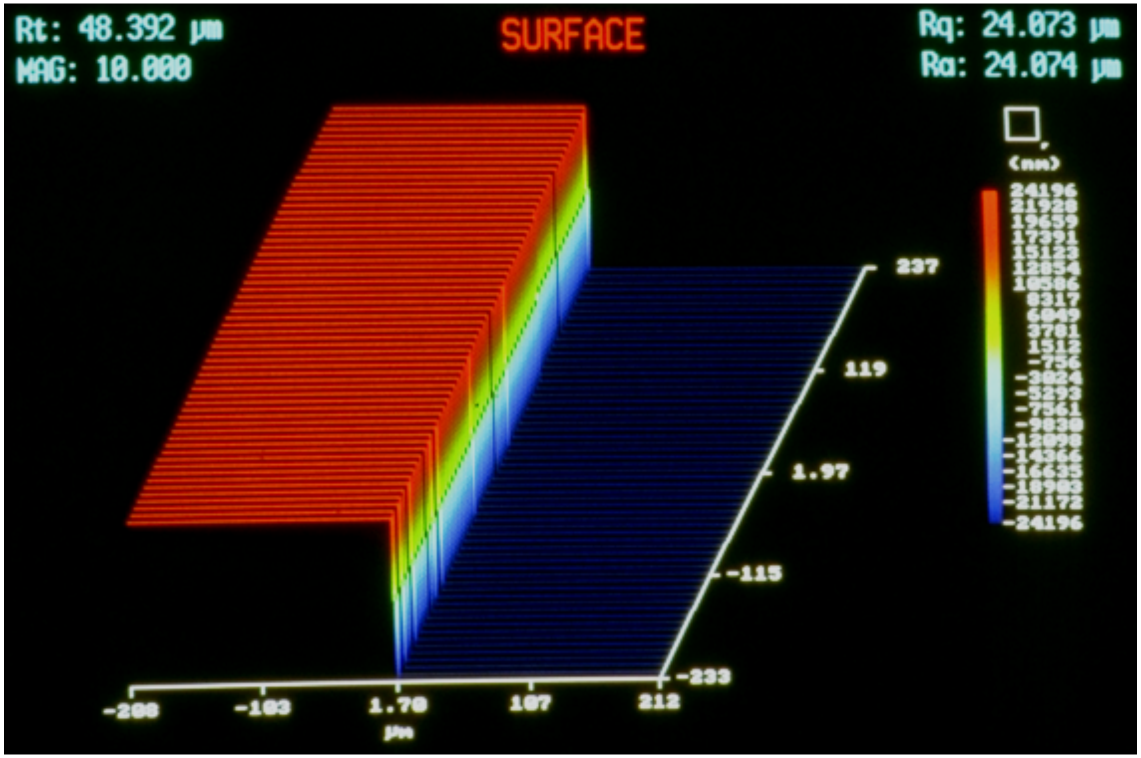
Step Measurement



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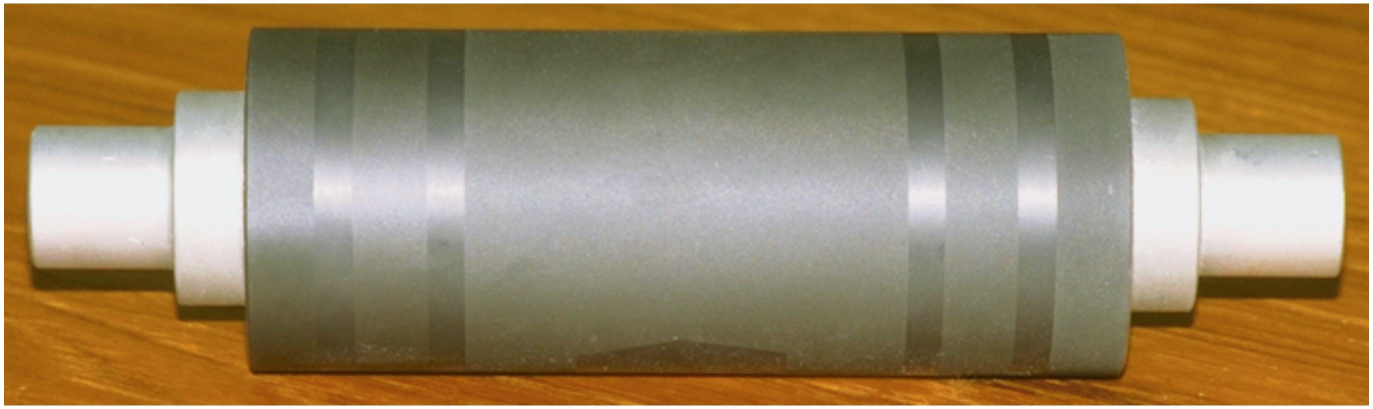
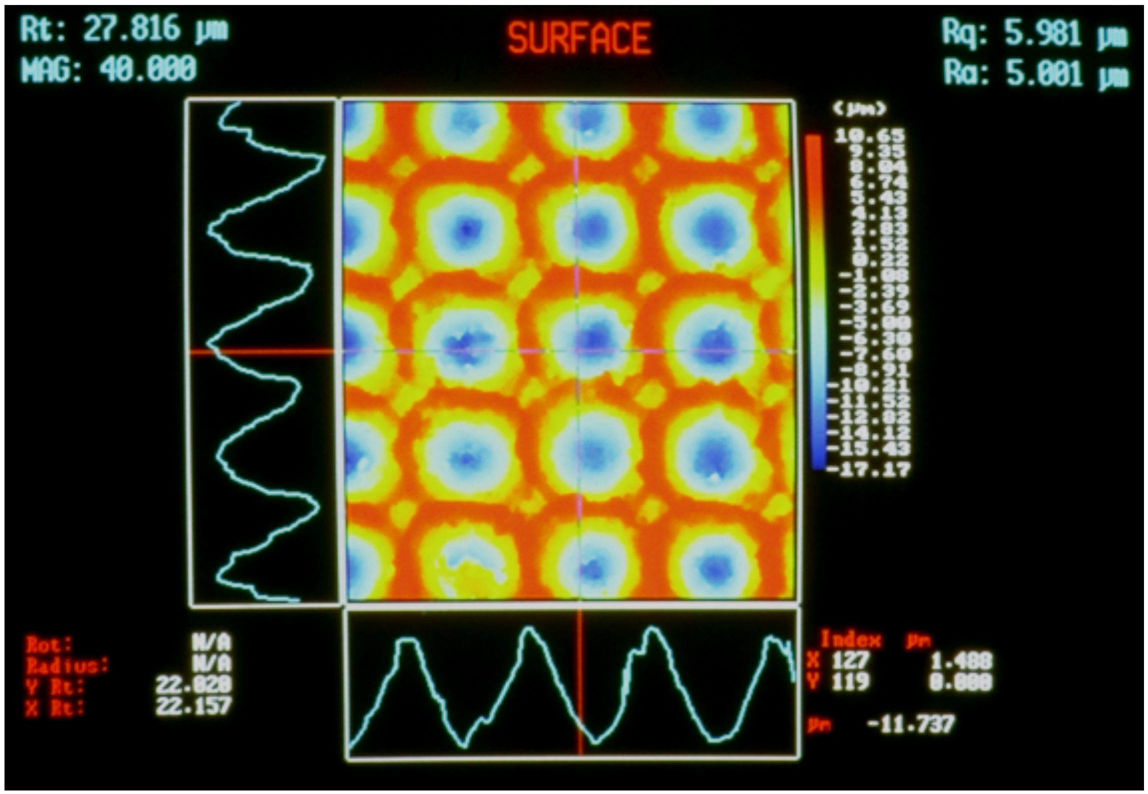
Print Roller



Print Roller Measurement



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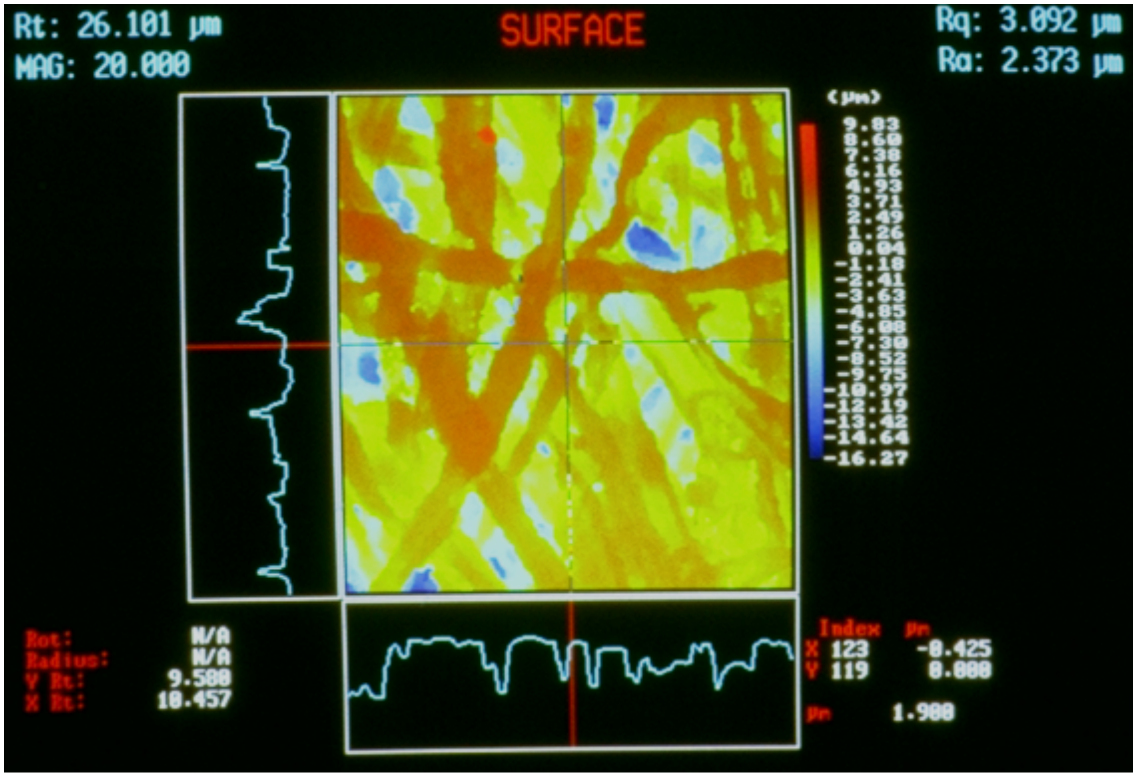
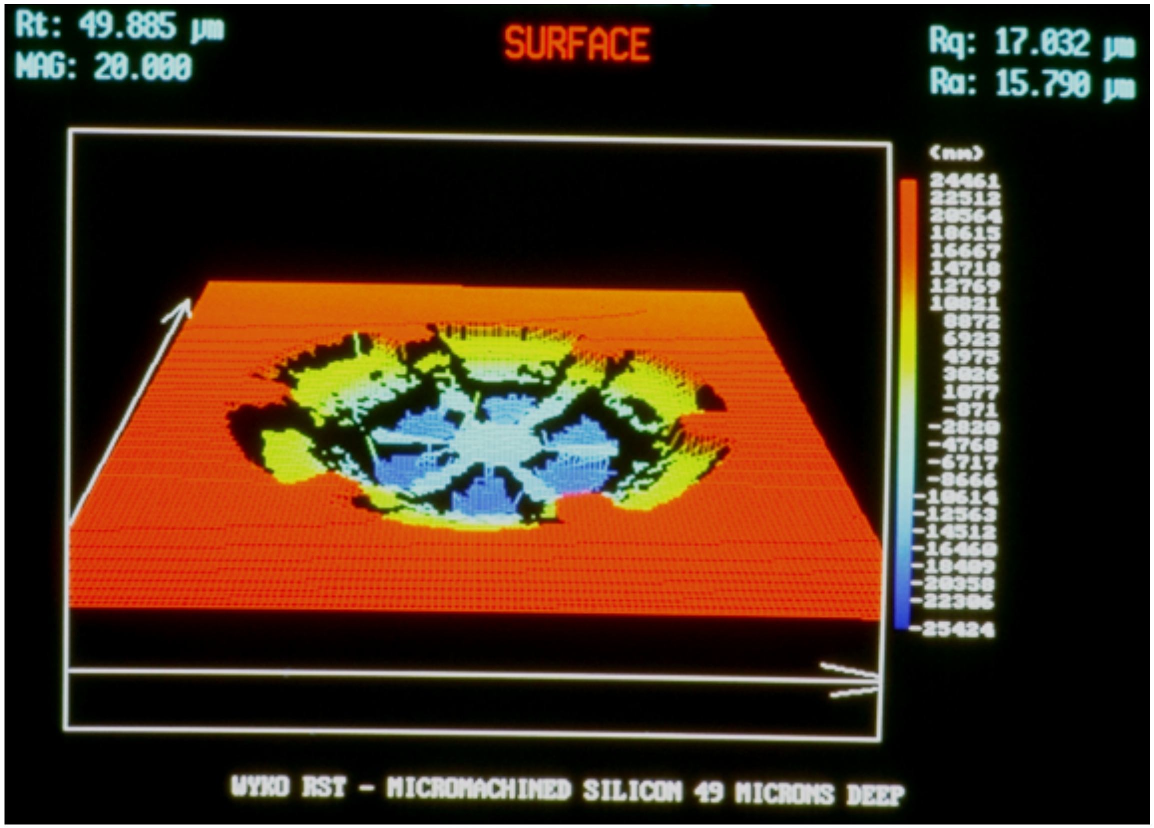
Paper Measurement



Micromachined Silicon Measurement



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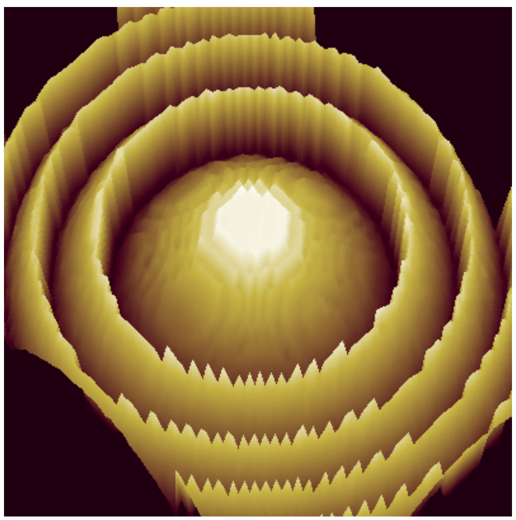
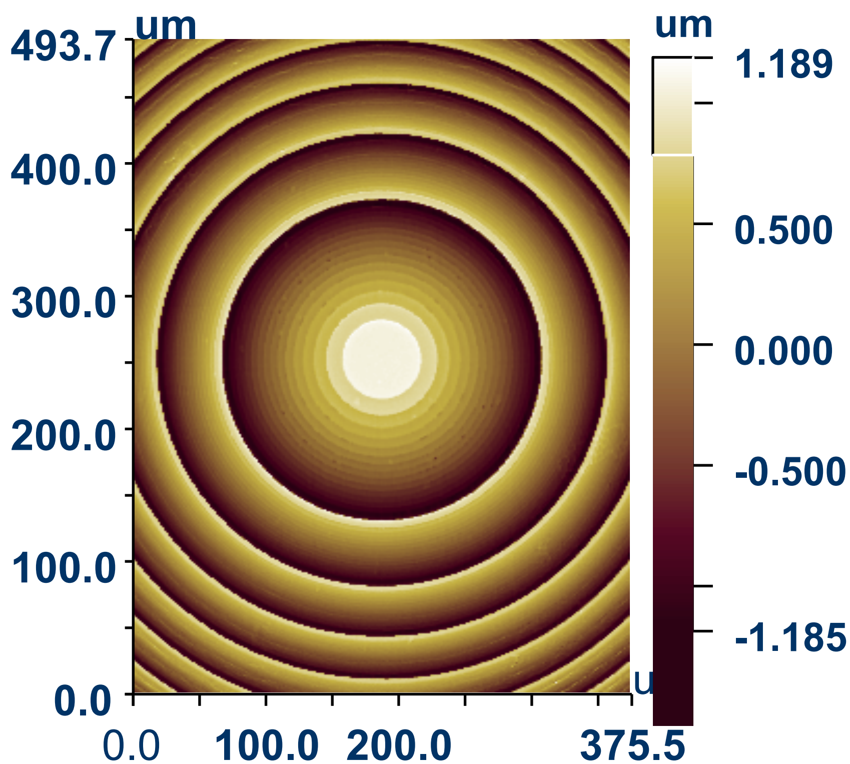
Binary Optic Lens

Surface Stats:

RMS: 561.30 nm
PV: 2.37 um





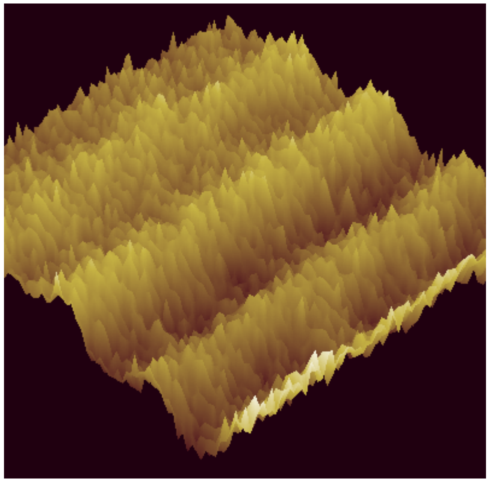
Chatter Seen on Camshaft

Surface Stats:

Rq: 872.06 nm
Ra: 693.90 nm
Rt: 7.47 um

Terms Removed:

Cylinder & Tilt



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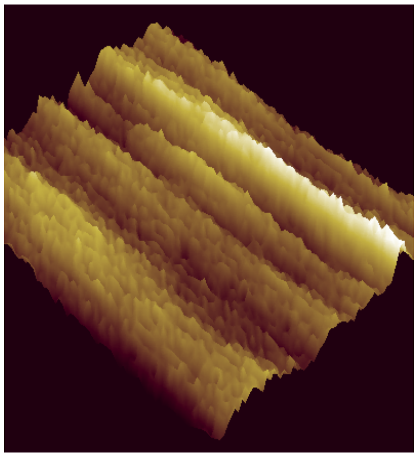
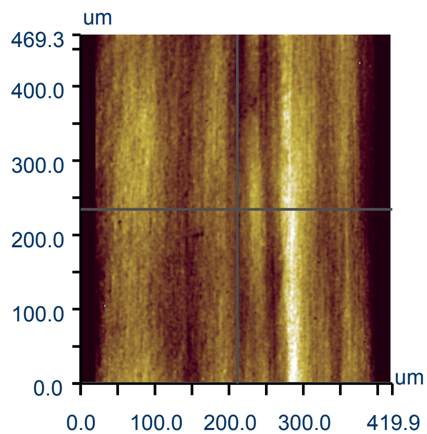
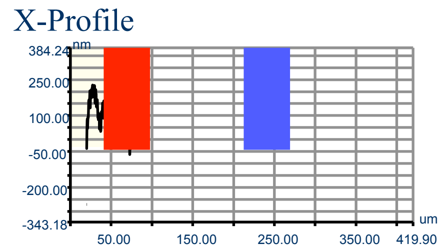
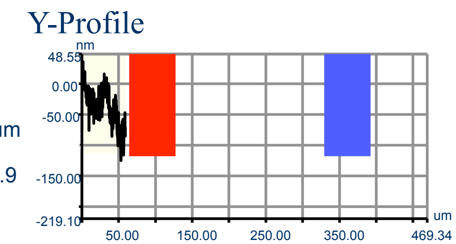
Heart Valve







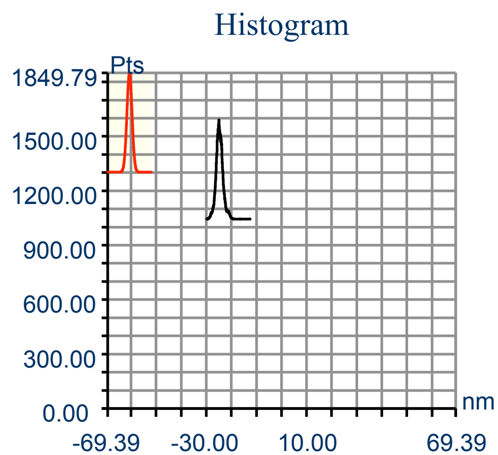


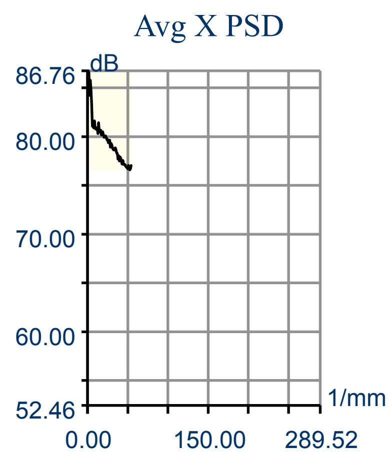
Data Statistics

Rt: 1.419 um

Ra: 87.391 nm

Rq: 113.942 nm



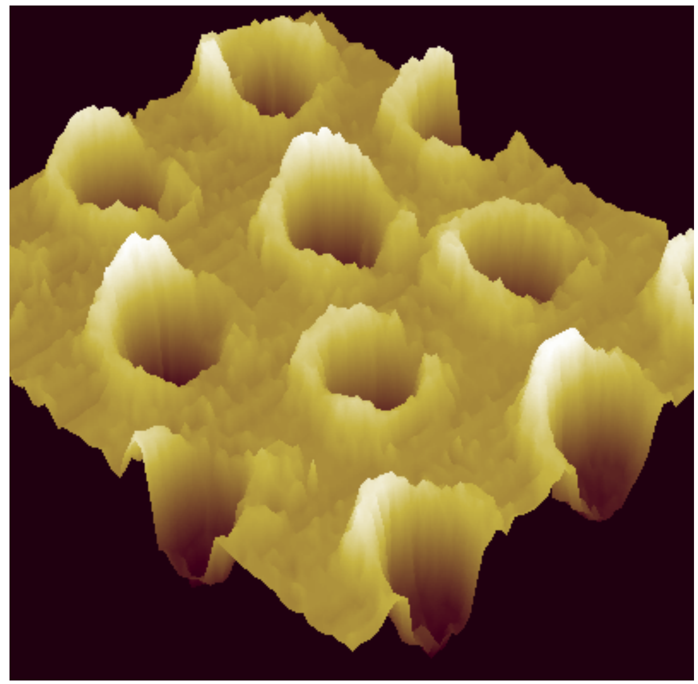


Pits in Metal

Size: 248 X 239
Sampling: 1.70 um

Surface Stats:
- **Rq: 5.07 um**
- **Ra: 3.44 um**
- **Rt: 31.05 um**

Terms Removed:
- **Tilt**



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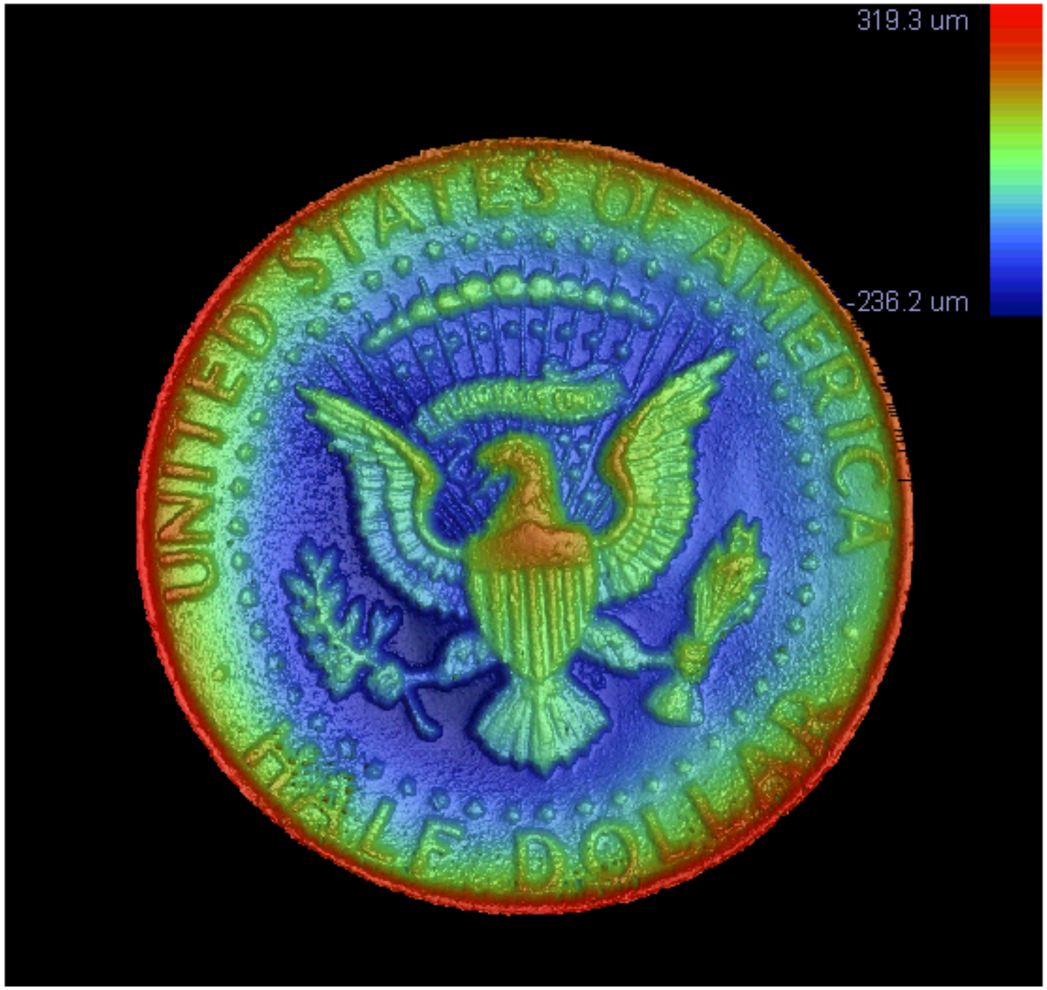
Stitched Measurement



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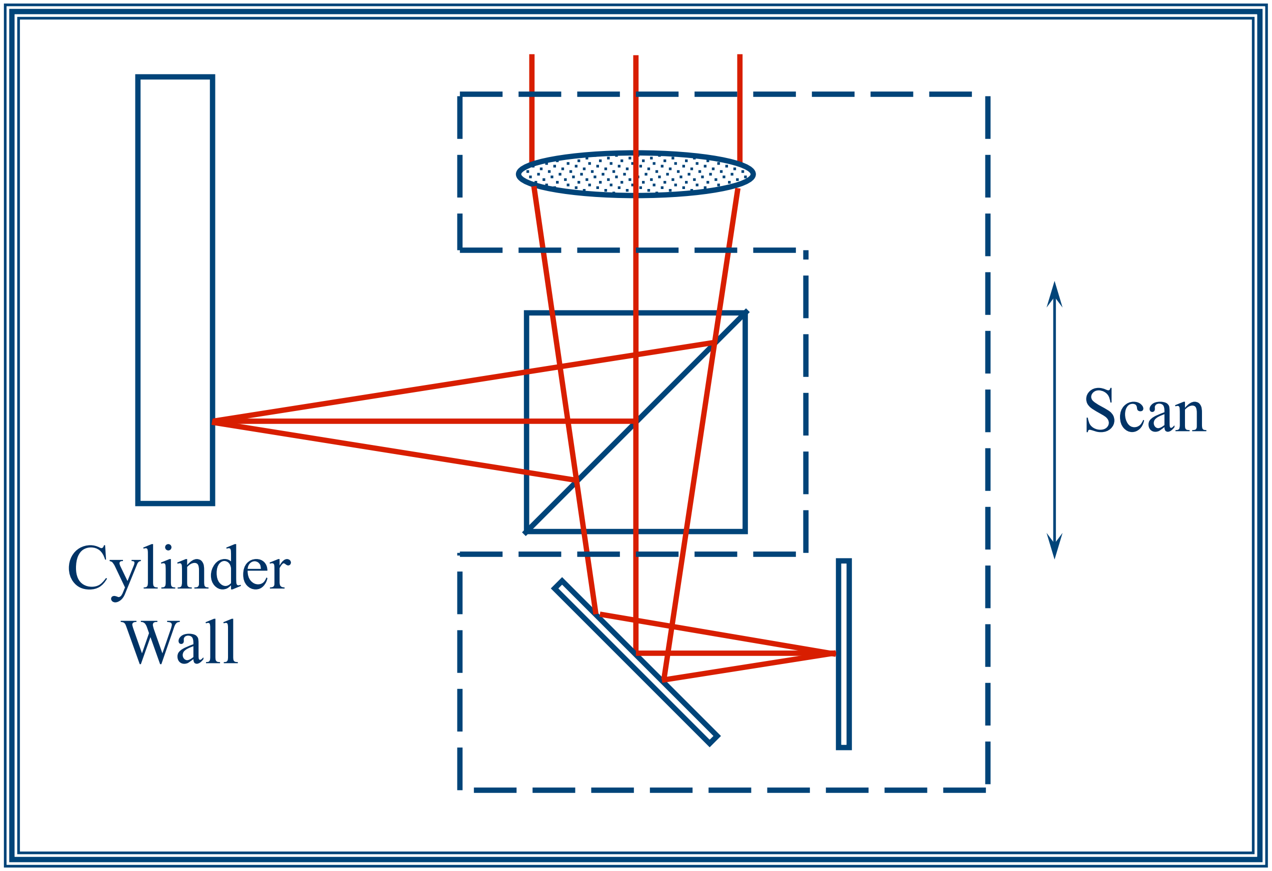
Measurement of Engine Block Cylinder Walls

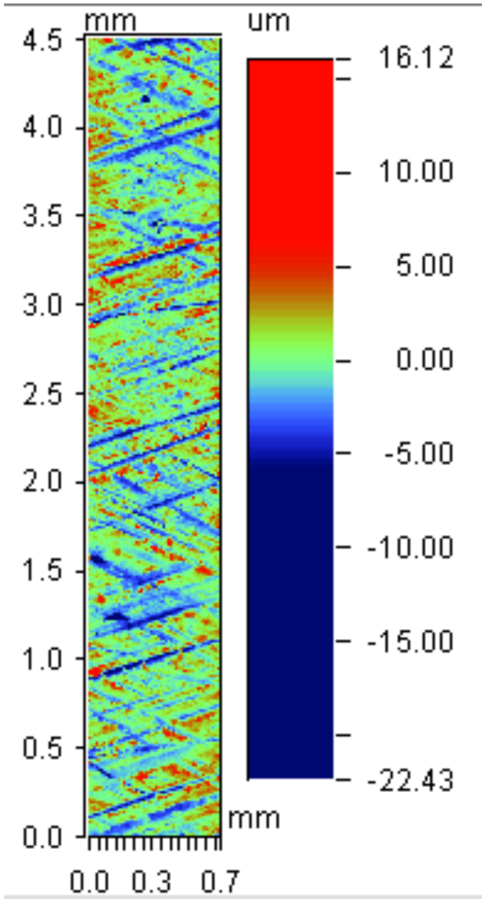
- Inside of engine block cylinder walls
  - Surface microstructure critical for reduced pollution and increased fuel economy
  - Profile data given by stylus profilometers often not sufficient. Need 3-D information.

Vertical Scanning



Six Stitched Data Sets of Inside of Engine Bore

Insight 2000 measuring inside of engine bore



Ra = 1.69 µm, Rz = 27.87 µm, and Rt = 38.54 µm

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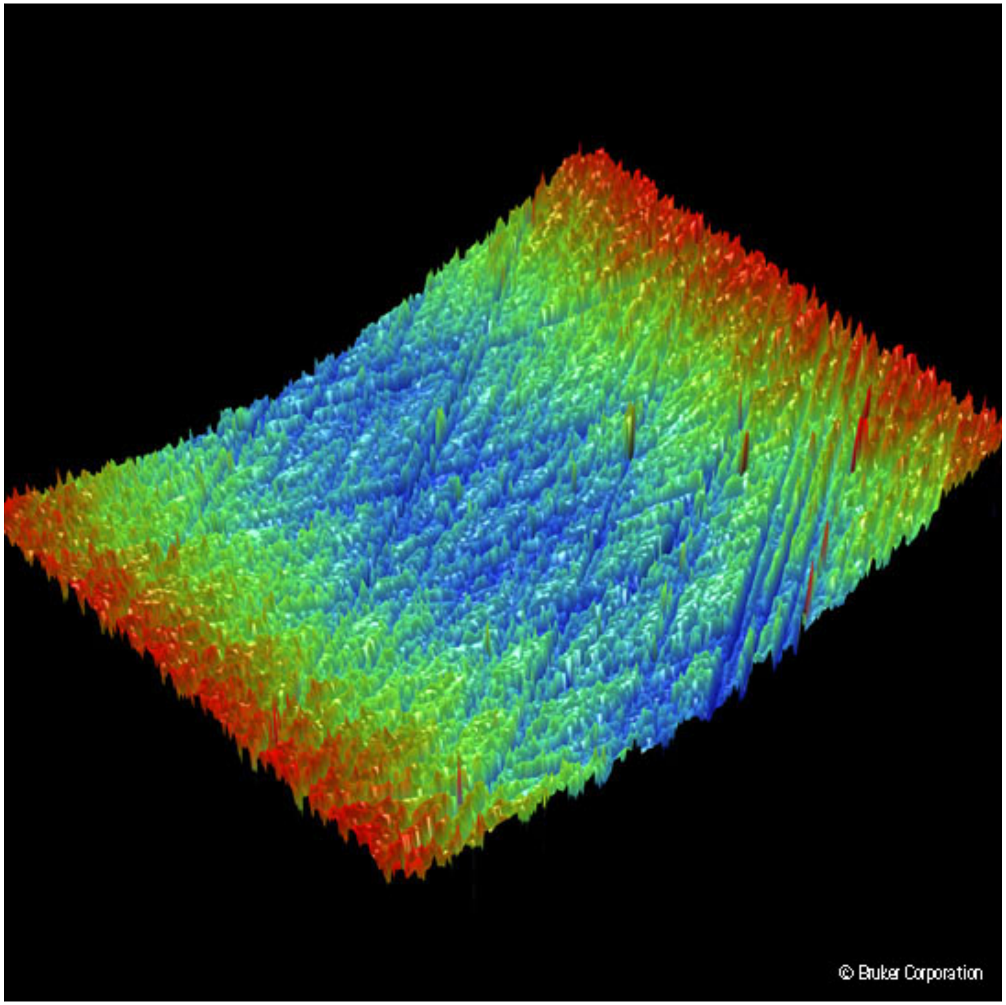
Inside Surface of Cylinder Bore



Ref: Bruker

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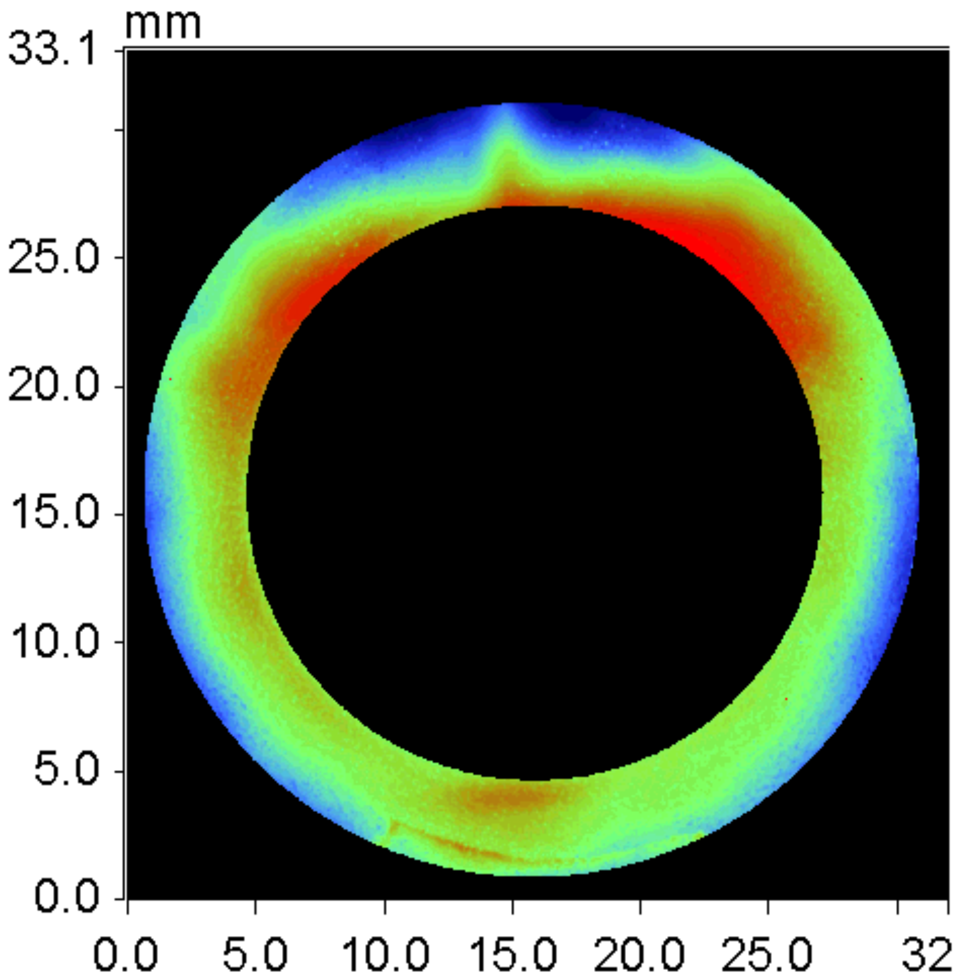
Stitched Measurement - Fuel Cap



VSI mode

Surface statistic

Ra=26.32 microns
Rq=32.72 microns
Rt=246.42 microns
array size 1251x1107
sampling 25.5 microns

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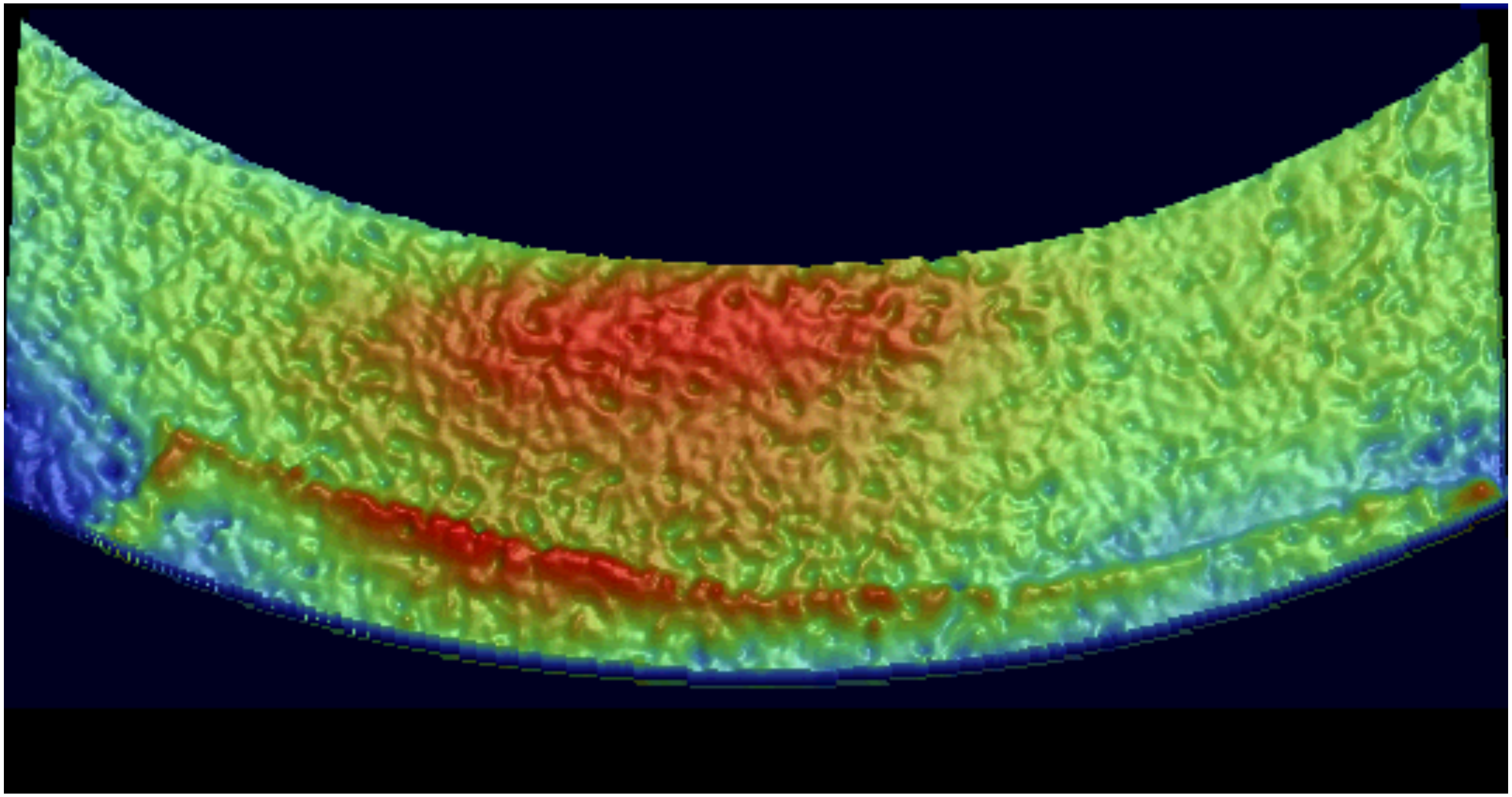
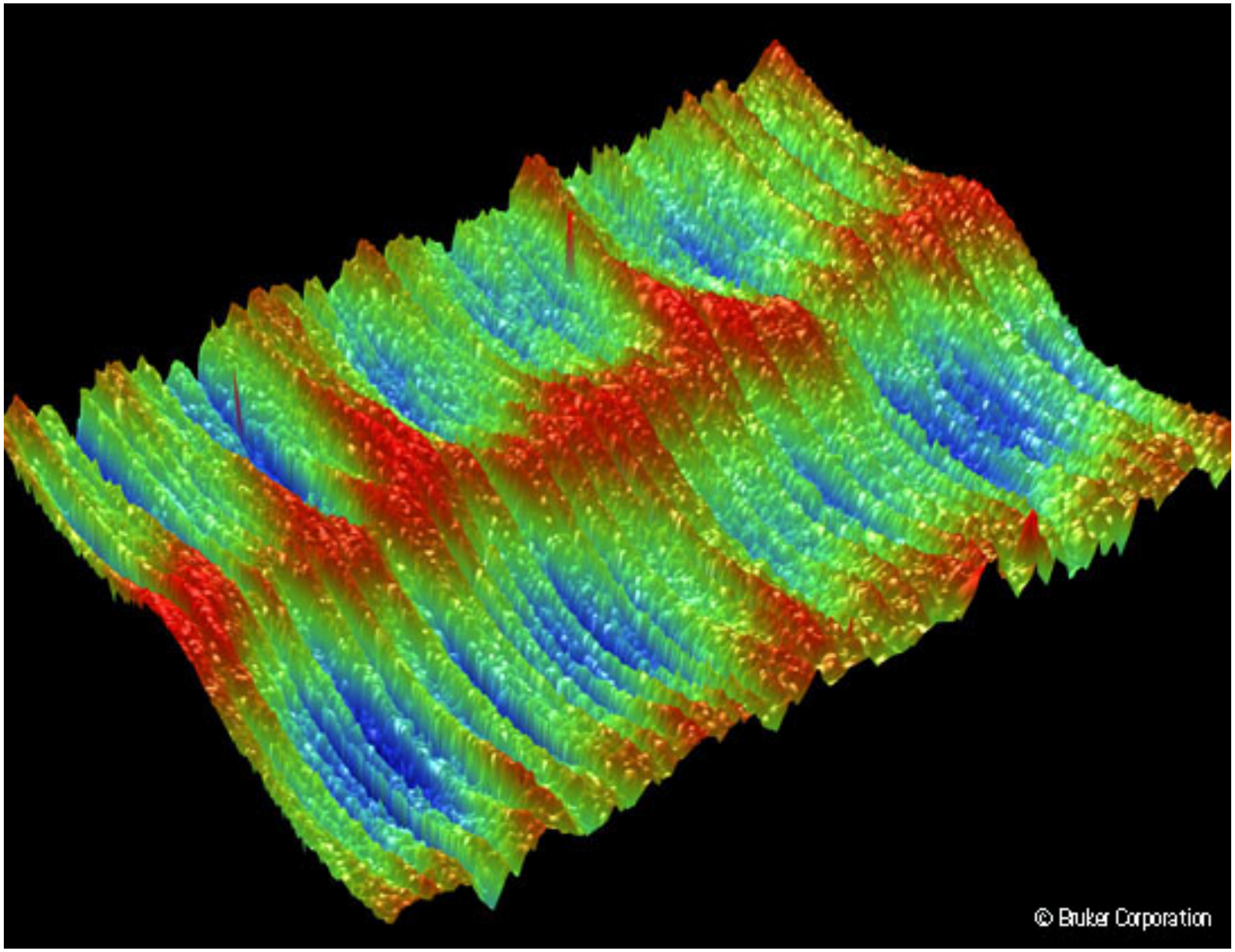
Sub-Region of Stitched - Fuel Cap



Chatter on Camshaft



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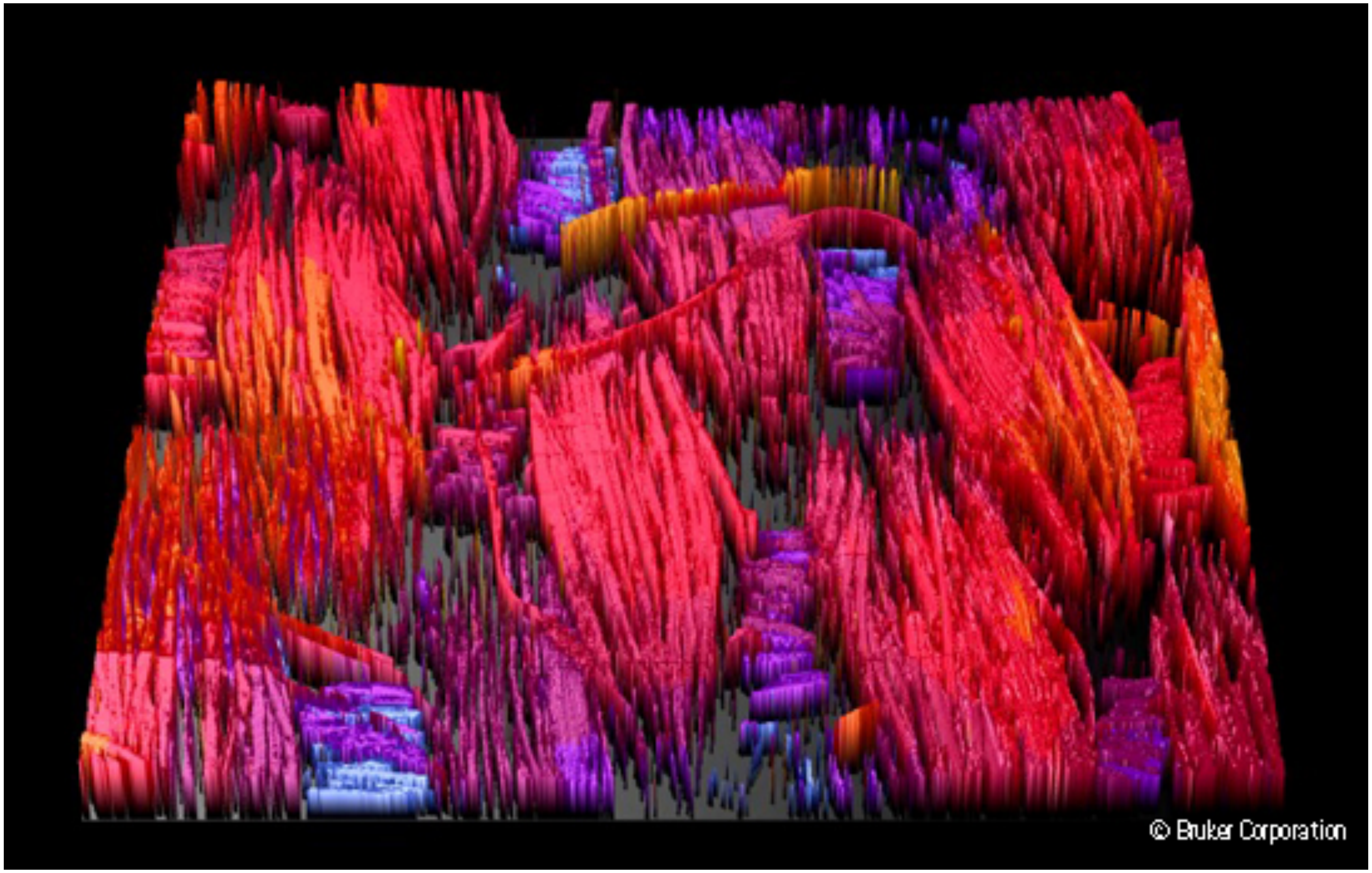
Woven Cloth



Ref: Bruker

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