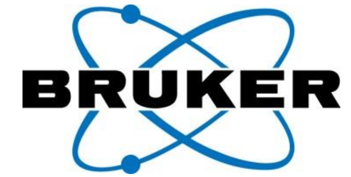
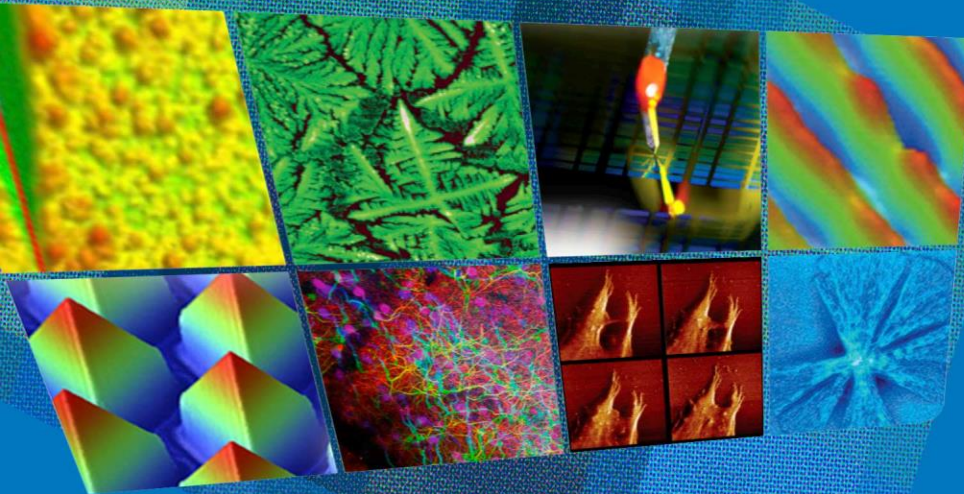
Solving Challenges in Defect Inspection of Advanced Optics





Atomic Force Microscopy
3D Optical Microscopy
Fluorescence Microscopy
Tribology
Stylus Profilometry
Nanoindentation

Innovation with Integrity

Bruker Nano Surfaces Division

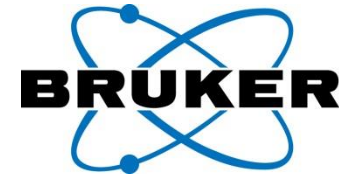
Welcome to the Webinar

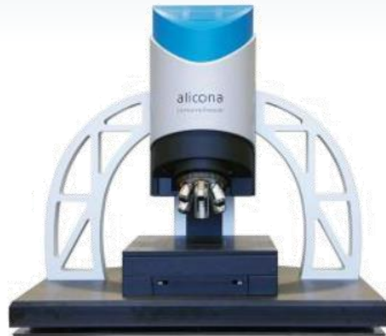
- For best audio experience, everyone is on mute

- For questions, use the Chat

- Questions will be answered at end of webinar
- Webinar is recorded and will be available offline
  - Feel free to share and forward to colleagues

Foreword
Bruker Nano Surfaces division





3D Optical Microscopy WLI & Focus Variation

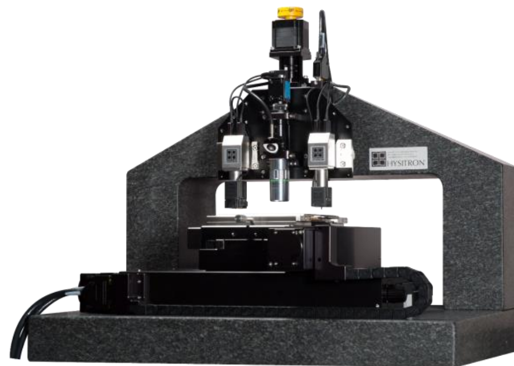
Atomic Force Microscopy

Stylus Profilometry

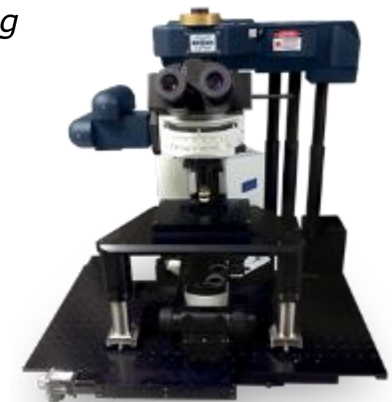
Bruker Nano Surfaces Division

Pioneers in Microscopy, Metrology & Mechanical Testing

Universal Mechanical Testing and Tribology

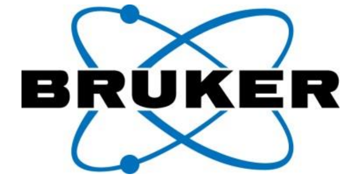


Hysitron Nanomechanical Testing



Multiphoton & Super-Resolution Fluorescence Microscopy

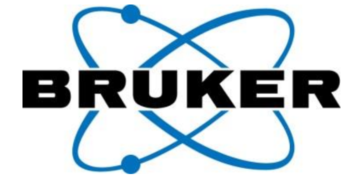
Focus of today



- Quality control of high-end optics
  - On surface
  - Beyond classical visual inspection

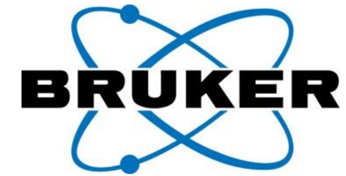
- Solutions through direct measurement of topography
  - Non-contact profiler based on interferometry

- Information on automation and data processing
  - Strategy to detect defects on complex shapes
  - Strategy to measure large and aspheric optics
  - Final defect map



Background

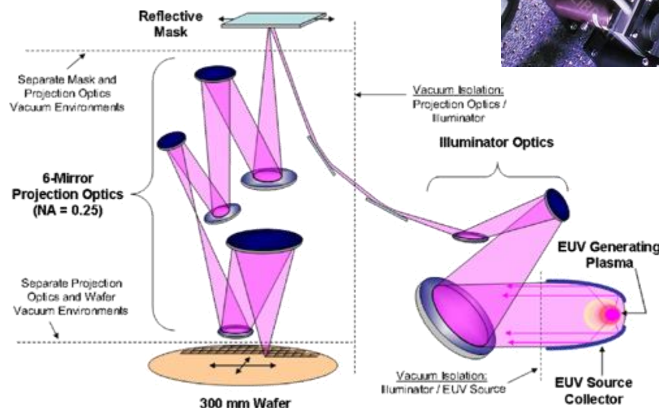
Fine Optics for Advanced Applications
Defect review



Inertial detection system / gyrolaser

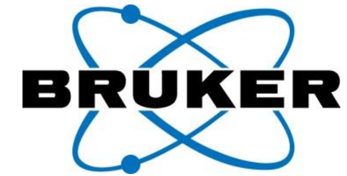
High Laser power Optics

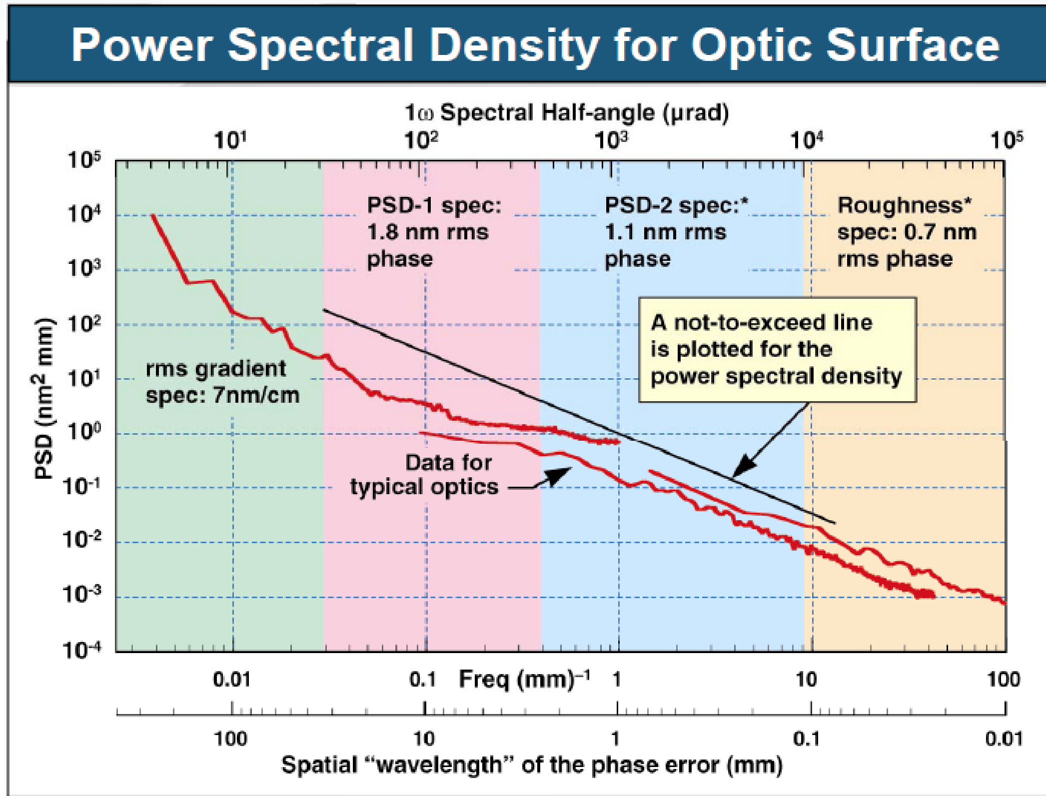
eUV litho system



- Usually smaller optics
  - Size below 100x100x80 mm3
- Performances of optics are critical
  - High-quality focus
  - Zero defect
  - 100% inspection
  - Manual and/or high-end polishing
- Defects cause:
  - Spurious diffraction/loss of function
  - Issue in assembly
- Defects can only be detected through topography measurement

Metrics for High-Quality Optics





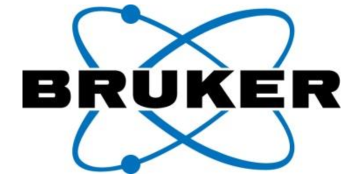
From Glass Processing Course (Lehigh University; Spring 2015)
Tayyab Suratwala, Lawrence Livermore National Laboratory

High Level Requirements[1]

Surface

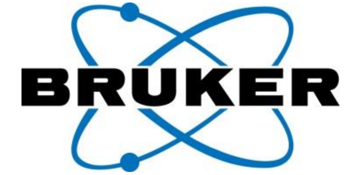
Peak-to-Valley	**211 nm (λ/3)**
Gradient	**<7 nm/cm**
PSD1	**1.8 nm**
PSD2	**1.1 nm**
Roughness	**4-10 Ang**
Scratch/Dig[2]	**20/10**

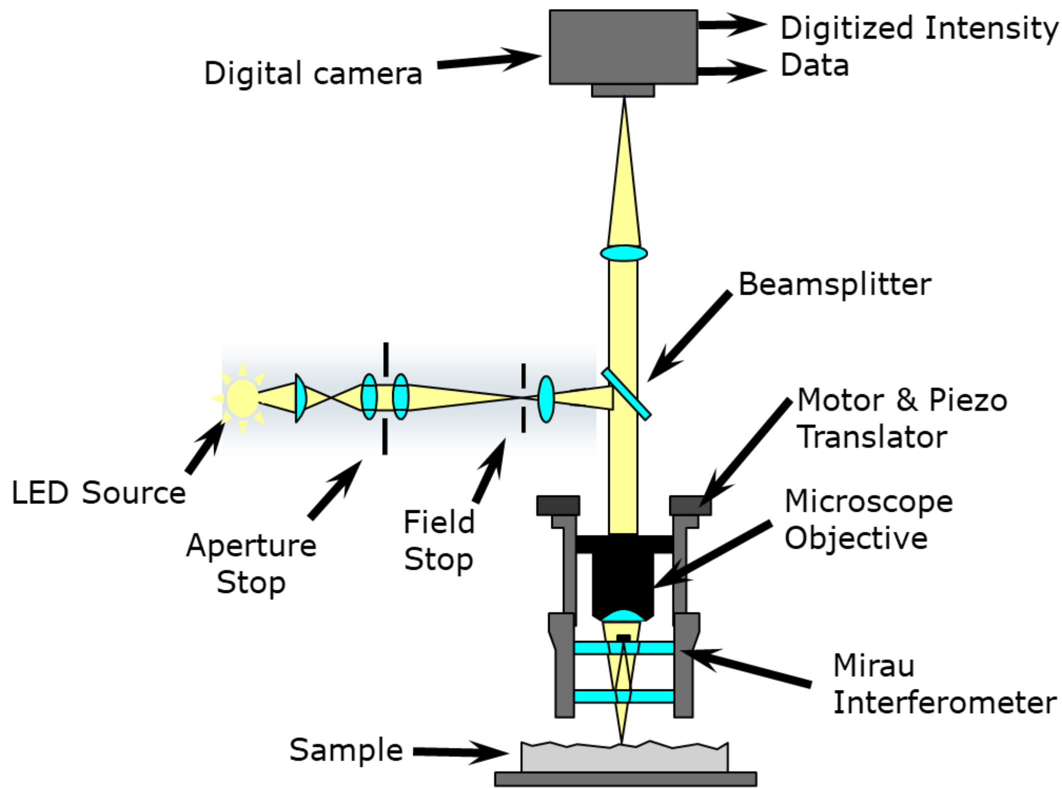
Sub-nm roughness
Lateral resolution ~ 1 μm



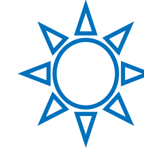
Non-Contact Interferometric Profiler

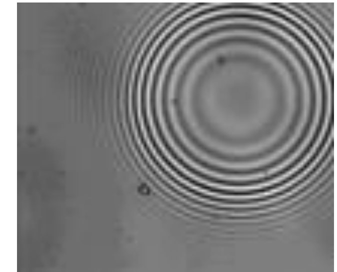
Non-Contact Interferometric Profiler
Key components



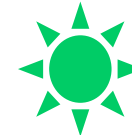


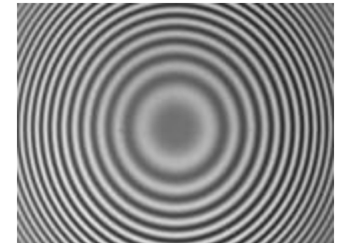
Broad white illumination



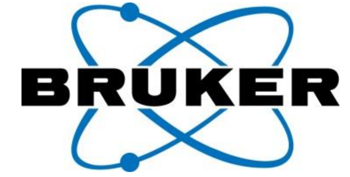


Monochromatic illumination

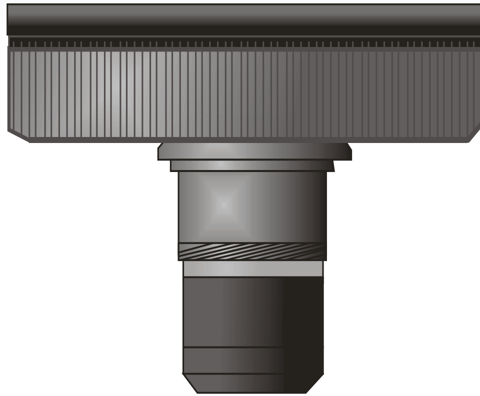




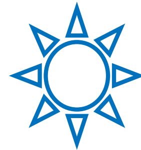
Non-Contact Interferometric Profiler
Core modes to get topography



Motor scanning

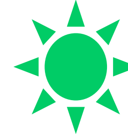


Broad white illumination

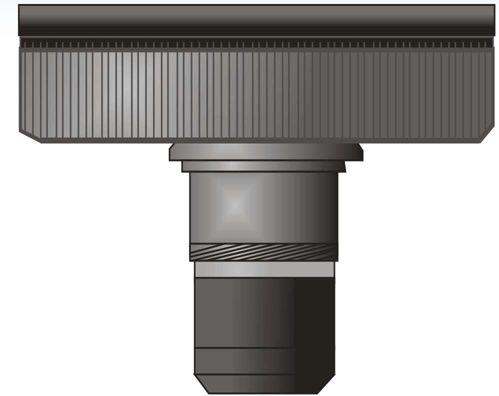


Vertical Scanning Interferometry

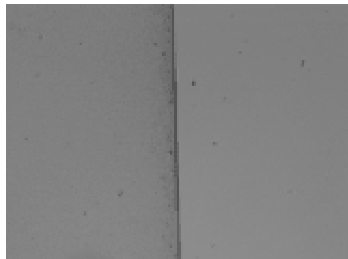
Monochromatic illumination

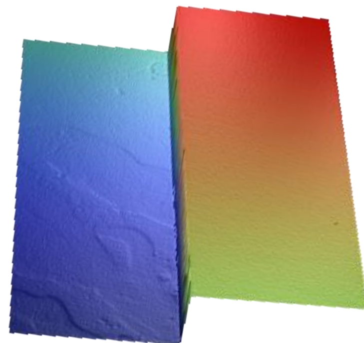


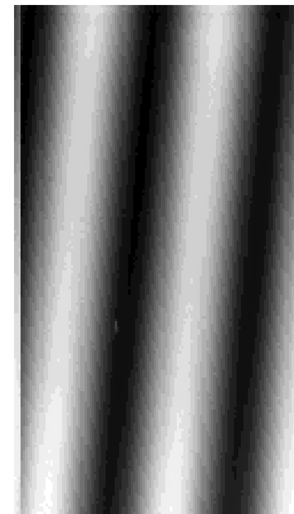
Phase Shifting Interferometry

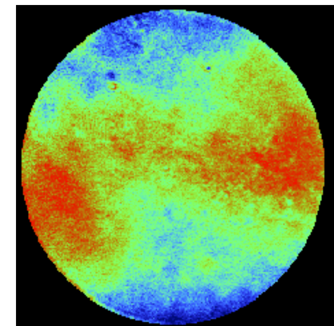


Piezo scanning









Non-Contact Interferometric Profiler
Core attributes

Vertical resolution independent from objective

- Vertical scanning: ~3 nm
- Phase Shifting: 0.01 nm
- Ability to use super long working distance objective

True vertical metrology below 1nm

- Performances of interferometer

Interferometric Profiler

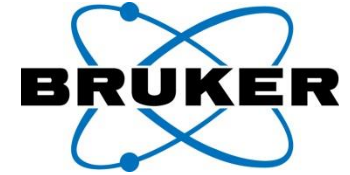
Robust method:

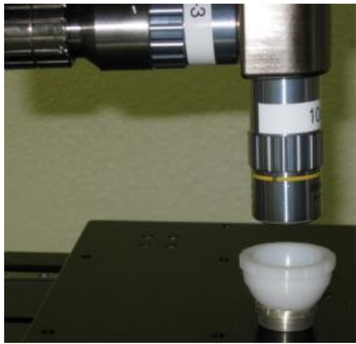
- Shiny & matte
- Smooth & rough
- No fringe = no data

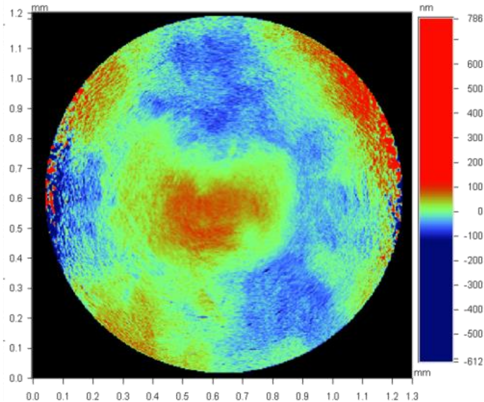
Sub-µm lateral resolution

- Only limited by objective
- Independent and individual pixel processing

Non-Contact Interferometric Profiler
Core attributes - illustration

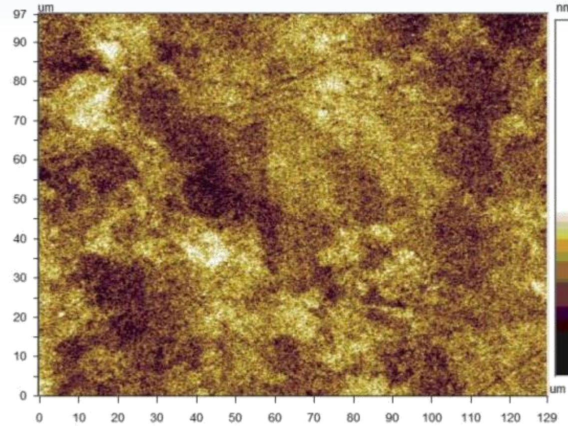






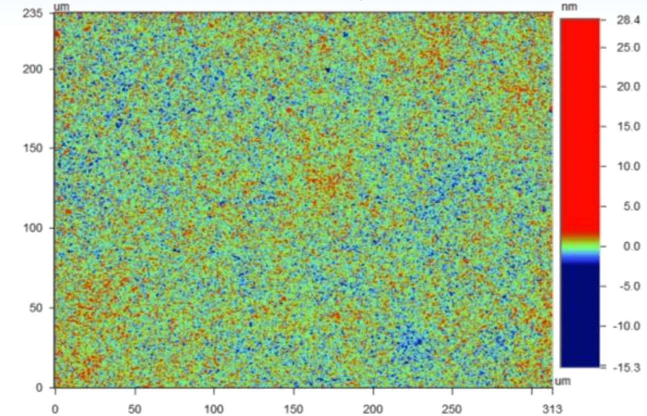
Sa=28 nm

Mirror (90% reflectivity)



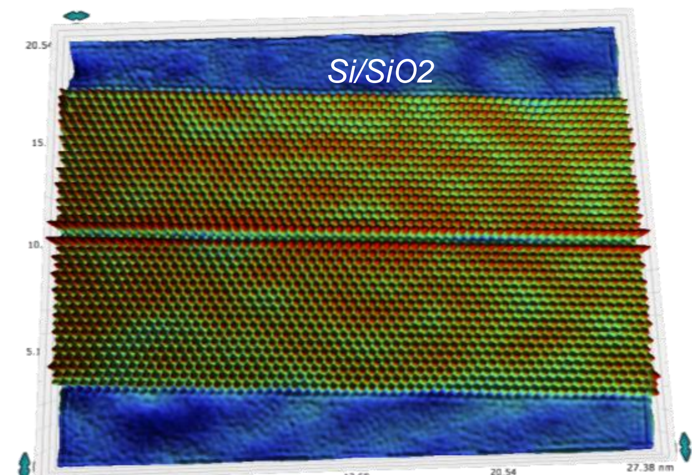
Sa=0.07 nm

Anti-reflective coating (0.4% reflectivity)



Sa=0.75 nm

190 nm diameter pillars spaced by 900 nm

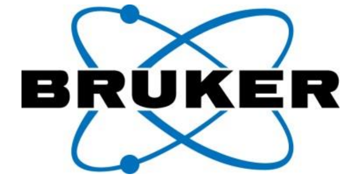


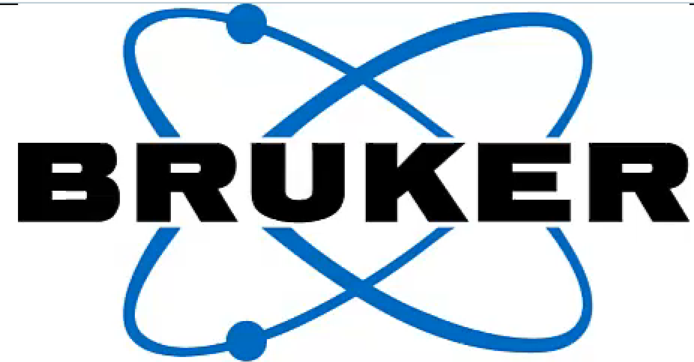
BRUKER

Solutions for quality control

1. Power Spectrum Density

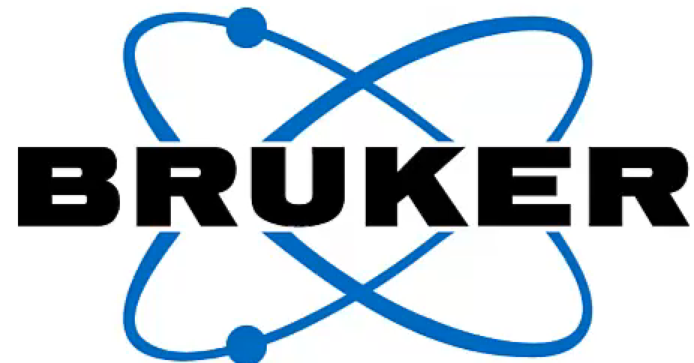
Power Spectrum Density
Automatic acquisition



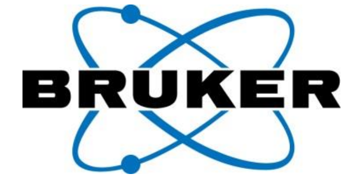


View Video

Automatic collection of full range Power Spectrum Density



Power Spectrum Density
Single graph representation



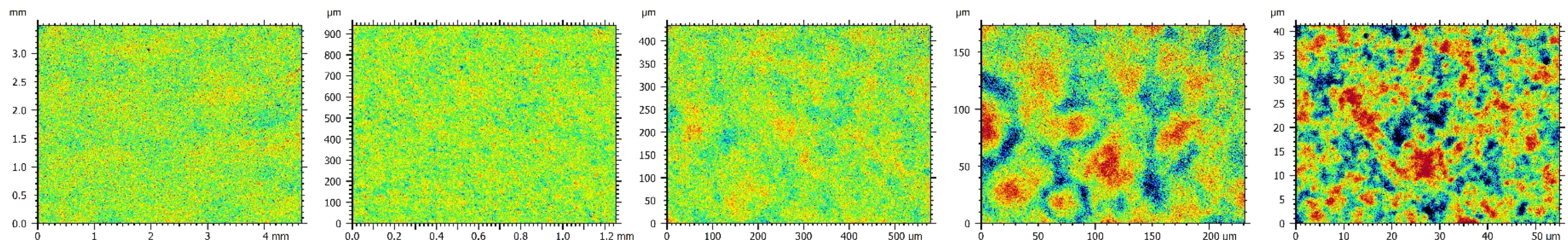
Averaged power spectrum density (PSD)

nm²

5.000
1.000
0.500
0.100
0.050
0.010
0.005

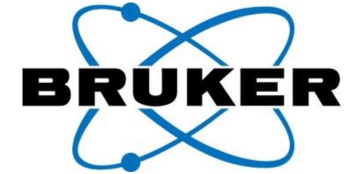
0.5
1.0
5.0
10.0 mm-1
50.0 mm-1

Vertical scale
±0.5 nm
Form removed



2. Automatic inspection

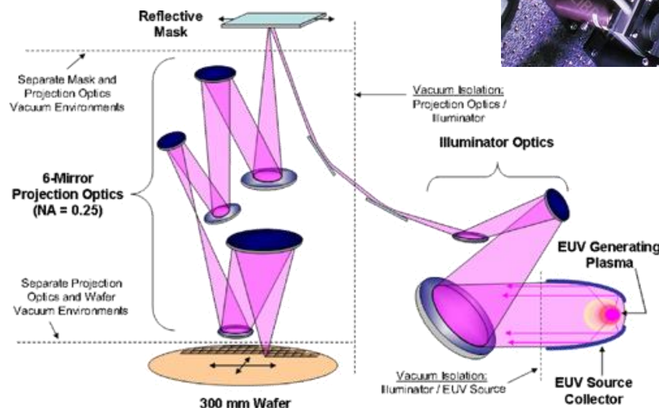
Quality Control
Defect review



Inertial detection system / gyrolaser

High laser power optics

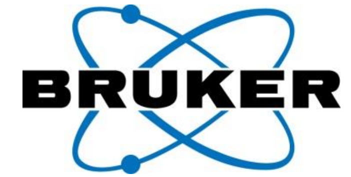
eUV litho system



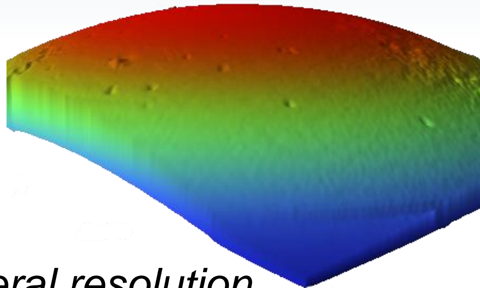
- Current solutions are time and user consuming
  - Manual inspection by operator
  - Normaski microscope
    - Inconsistency
    - User dependent
    - No vertical metrology
- Proposed solution
  - Full automation
  - Unattended operation
  - Complete metrology
  - Robust versus all situations

Quality Control

Advanced mode to get topography



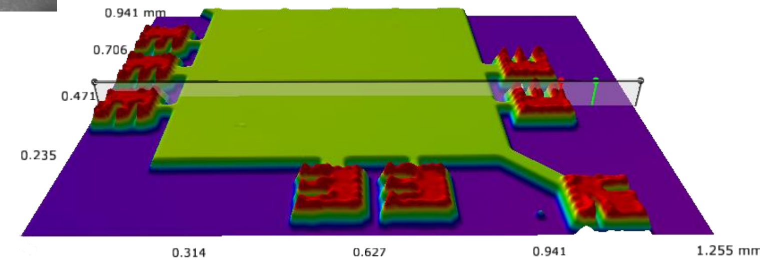
Steady and smooth slopes



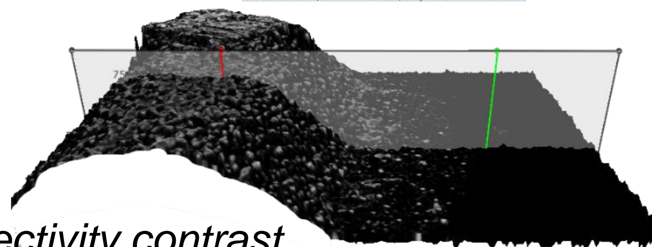
Large field of view

Sub-µm lateral resolution

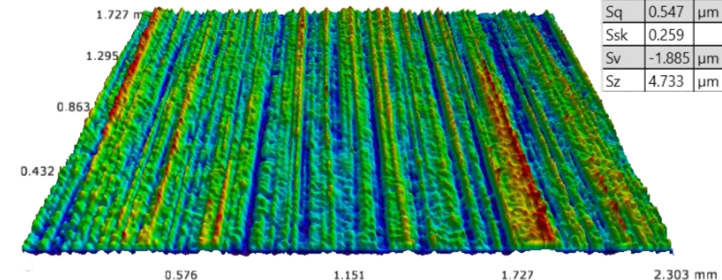
Self-adapting mode combining Phase Shifting and Vertical Scanning modes



Accurate stepped surface



High-reflectivity contrast

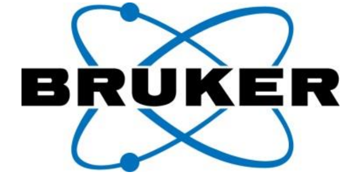


Sa	0.44	µm
Sku	2.857	
Sp	2.848	µm
Sq	0.547	µm
Ssk	0.259	
Sv	-1.885	µm
Sz	4.733	µm

Accurate sub-µm roughness

Quality Control

Need for 100% automation



Auto-Focus
- Ensure reproducibility and throughput
- Robust & multi-points based

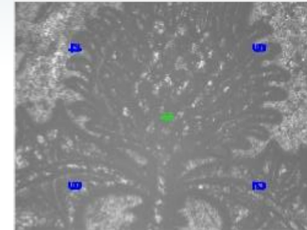
Auto-Tip/Tilt
- Ensure reproducibility and best performances
- Robust operation based on slope measurement

Auto-Intensity
- Self-adapting to different samples and conditions
- Robust operation with 100% success

Analysis
- Operator independent and on-fly analysis
- Fast & complete defect characterization

Clever Saving
- Only defective dataset are saved and displayed

Result Display
- Database summary
- Automatic launch for defect map 3rd party software



Run Time Options
- [x] Retry with Coarse Autofocus if Fine Autofocus fails
- [x] Cycle through all Autofocus locations until successful
- [ ] Prompt for manual focus upon failure

Views
Results Gallery
Display: Failed

Saving
- [x] Save Failed Data

File Name: FailedResults_Row$(GridRow)_Col$(GridColumn).OP

Post Sequence
- [ ] Move To Z Safe
- [ ] Unload XY Stage
- [ ] Unload Theta

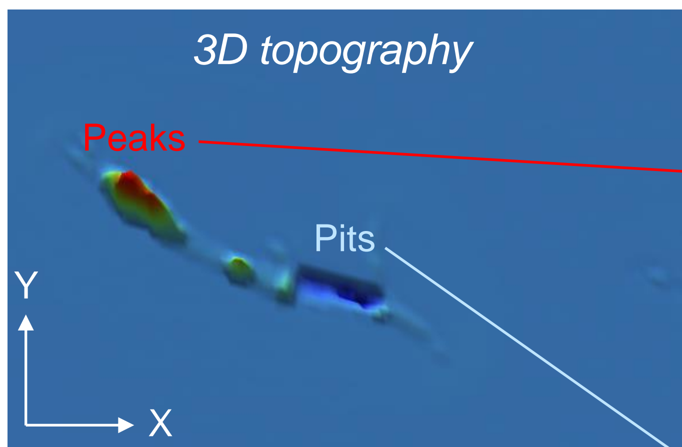
External Program:
- [ ] Run External Program

C:\Windows\System32\cmd.exe

Command Line Argument:

- [ ] Wait For Program To Exit

Full Characterization of Defects
Direct saving of all parameters



No	Region	A Diameter µm	Rp% µm	X Diameter µm	Y Diameter µm
1		17.129	1.35	29.335	14.667
2		6.143	0.75	6.845	3.911
3		5.838	0.23	3.911	6.845

Output File
☑ Log File: C:\ProgramData\Bruker\Vision\Data\Defects\Peak_Defects.csv
Ouput File Format: ◉ Multiple Region Default ◯ Vision Database Compatible
Options: ☑ Include Time Stamp ☐ Include Header ☐ Include Summary

No	Region	A Diameter µm	Rv% µm	X Diameter µm	Y Diameter µm
1		12.385	-0.50	25.423	4.889

Output File
☑ Log File: C:\ProgramData\Bruker\Vision\Data\Defects\Pit_Defects.csv
Ouput File Format: ◉ Multiple Region Default ◯ Vision Database Compatible
Options: ☑ Include Time Stamp ☐ Include Header ☐ Include Summary

Direct and automatic export of whole tab into CSV file

- A Diameter: mean diameter derived from defect area
- X & Y Diameters: length and width along X & Y directions
- Rp%: highest point for peak defect
- Rv%: deepest point for pit defect

Direct Recording of Results
Custom CSV file

No	Region	A Diameter µm	Rp% µm	X Diameter µm	Y Diameter µm
1		17.129	1.35	29.335	14.667
2		6.143	0.75	6.845	3.911
3		5.838	0.23	3.911	6.845

No	Region	A Diameter µm	Rv% µm	X Diameter µm	Y Diameter µm
1		12.385	-0.50	25.423	4.889

Life database update

Database

Measurement Number	Time R: N/A M: N/A Always Always	Row R: N/A M: N/A Always Always	Column R: N/A M: N/A Always Always	Islands R: N/A M: N/A Always Always	Max A Diameter µm R: N/A M: N/A Always Always	Max Rp% µm R: N/A M: N/A Always Always	Max X Diameter µm R: N/A M: N/A Always Always	Max Y Diameter µm R: N/A M: N/A Always Always	Islands R: N/A M: N/A Always Always	Max A Diameter µm R: N/A M: N/A Always Always	Max Rv% nm R: N/A M: N/A Always Always	Max X Diameter µm R: N/A M: N/A Always Always	Max Y Diameter µm R: N/A M: N/A Always Always
1	7:30:49 PM	2	16	3	17.129	1.354	29.335	14.667	1	12.385	-502.628	25.423	4.889

Summary for peaks:

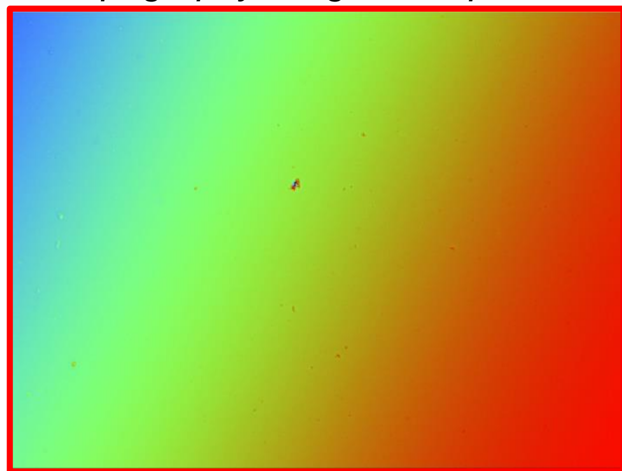
1. *Number of detected peaks*
2. *Maximum average diameter*
3. *Maximum length of peak along XY directions*

Summary for pits:

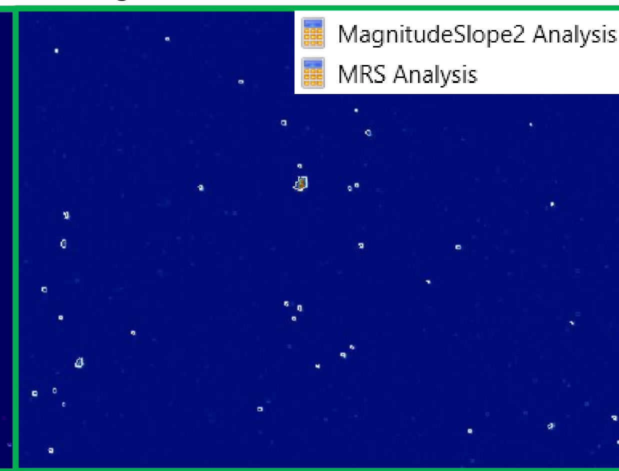
1. *Number of detected pits*
2. *Maximum average diameter*
3. *Maximum length of pit along XY directions*

Defect Detection by Slope
Higher throughput and more robust

Topography image on aspheric



Derivative image

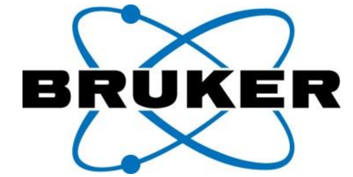


- Automatic analysis based on slope variation
- Robust and efficient way to spot defects:
  - Faster processing: directly from Raw image
  - Irrespective of shape/form/local slope
  - Robust versus noise or vibrations
- Multiple region analysis to get data on each defect

No	Region	A Diameter µm	X Diameter µm	Y Diameter µm
19		13.692	13.690	14.667
10		8.183	6.845	8.800
7		6.528	3.911	7.823
	Avg:	4.965	3.786	4.112
	Std:	1.734	1.970	2.227
	Skewness:	3.350	3.259	3.040
	Max:	13.692	13.690	14.667
	Min:	3.489	1.956	1.956
	Range:	10.203	11.734	12.712

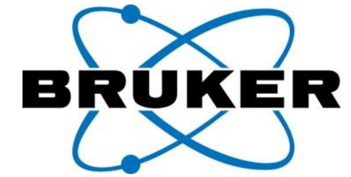
Defect Detection by Slope

Illustration of throughput

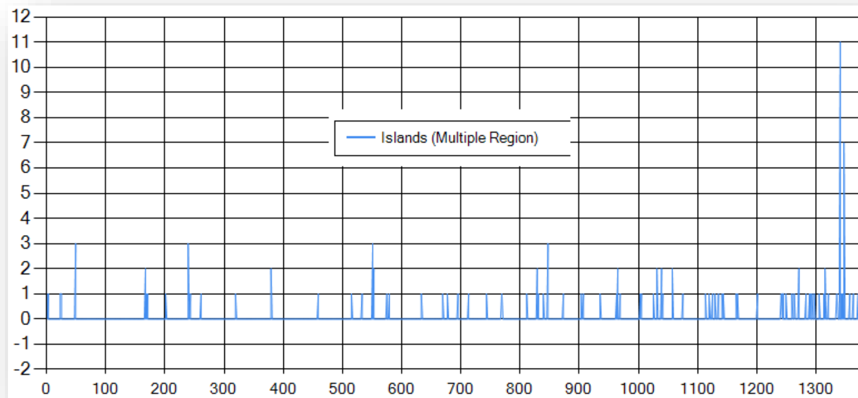


View Video

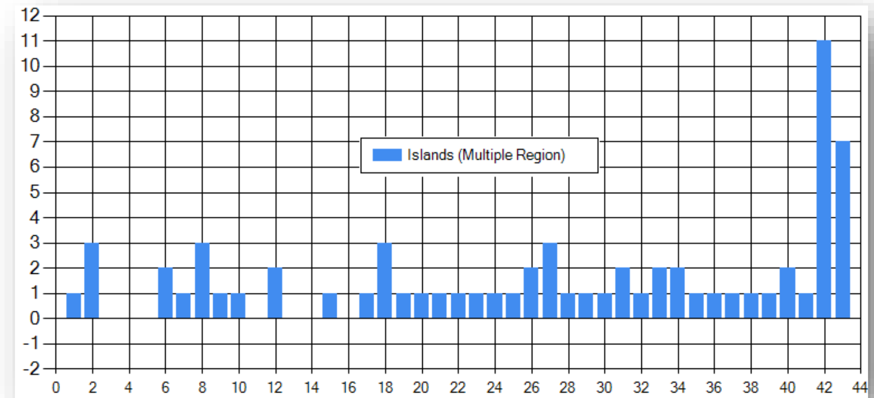
Defect Detection
Live monitoring



Number of peaks detected versus location



Maximum number of peaks detected for each row



Live statistic for all parameters

Database

Measurement Number	Time R: N/A M: N/A Always Always	Row R: N/A M: N/A Always Always	Column R: N/A M: N/A Always Always	Islands R: N/A M: N/A Always Always	Max A Diameter µm R: N/A M: N/A Always Always	Max Rp% µm R: N/A M: N/A Always Always	Max X Diameter µm R: N/A M: N/A Always Always	Max Y Diameter µm R: N/A M: N/A Always Always	Islands R: N/A M: N/A Always Always	Max A Diameter µm R: N/A M: N/A Always Always	Max Rv% nm R: N/A M: N/A Always Always	Max X Diameter µm R: N/A M: N/A Always Always	Max Y Diameter µm R: N/A M: N/A Always Always
Avg:		22.000	16.500	0.087	9.775	0.674	12.86	11.07	0.036	11.275	-501.7	12.516	11.172
Std:		12.410	9.233	0.471	8.239	0.516	23.43	18.06	0.224	8.574	439.6	10.772	9.625
Max:		43.000	32.000	11.000	56.217	2.456	185.79	156.45	3.000	42.203	-119.5	46.936	45.958
Min:		1.000	1.000	0.000	3.489	0.108	1.96	1.96	0.000	3.659	-2521.1	1.956	2.933
Range:		42.000	31.000	11.000	52.728	2.348	183.83	154.50	3.000	38.543	2401.6	44.980	43.024

Defect Mapping

Excel display examples

*Peak mapping on glass surface **prior to cleaning***

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	0	1	6	0	0	0	2	0	1	5	0	0	0	0	0	0	2	0	2	0	0	3	0	0	0	1	1	1	2	1	0	5
2	0	2	1	1	0	2	2	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	2	0	0	3	2	0	3
3	2	1	1	0	0	2	4	0	4	1	1	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	1	1	0	2	0	6
4	2	11	1	1	14	0	0	0	0	1	0	0	4	0	0	0	2	0	2	0	3	0	1	0	2	0	0	1	0	2	1	0
5	8	5	0	1	11	0	0	0	0	1	1	0	0	0	0	0	1	0	1	11	4	0	4	10	0	0	0	0	1	0	1	0
6	13	9	1	15	5	0	1	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
7	22	13	1	5	11	1	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	3	0	0
8	8	12	2	2	0	1	0	4	2	1	8	5	2	0	0	2	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0
9	6	0	0	1	0	0	2	3	0	0	2	2	0	8	2	0	0	15	1	1	2	0	4	0	0	0	0	0	0	0	0	0
10	5	9	2	0	0	0	1	3	0	0	1	0	1	0	0	0	0	7	2	0	0	1	7	6	3	4	0	0	0	0	0	0
11	4	12	4	2	7	2	2	0	0	3	1	0	0	0	0	0	0	0	0	1	33	0	2	8	0	0	0	6	0	0	0	0
12	2	1	2	1	5	1	1	2	1	0	1	1	0	0	0	0	0	0	0	0	8	2	0	2	0	0	0	2	2	0	0	0
13	2	0	1	0	0	1	1	1	0	0	0	2	3	0	0	3	1	0	12	1	0	1	1	0	0	2	0	0	0	0	0	0
14	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	13	2	5	9	7	0	1	3	2	0	0	0	0
15	0	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	1	0	0	0	1	1	2	1	0	2	3	0	0	0	1	0
16	0	0	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1	7	0	0	0	0
17	0	0	1	0	0	0	0	0	0	0	2	0	1	1	0	0	4	0	0	0	0	1	4	0	0	2	0	9	0	1	0	0
18	1	1	0	0	0	0	0	0	0	0	0	0	0	4	1	2	2	0	0	2	0	1	0	0	0	1	4	6	0	0	0	0
19	1	2	0	0	0	0	0	0	1	0	1	0	0	2	0	0	0	0	1	0	1	0	1	5	5	2	7	13	1	0	0	0
20	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	1	1	5	1	0	2	2	0	0	0	0
21	0	0	0	0	1	0	0	2	0	3	0	0	0	0	0	0	0	1	0	4	0	1	5	4	2	1	2	1	1	0	0	0
22	0	3	0	0	1	0	0	3	1	0	0	0	0	1	0	1	0	9	8	2	2	21	15	20	6	6	1	4	13	1	0	0
23	1	0	0	0	0	0	0	1	0	0	0	0	2	0	1	7	4	10	24	12	4	10	20	11	37	4	2	1	0	1	1	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8	11	6	11	14	19	12	3	8	5	2	0	3	7	3	2
25	0	0	3	3	0	0	0	0	0	0	0	0	0	1	0	0	0	8	18	20	13	3	15	5	4	6	2	1	1	12	5	0
26	0	0	0	0	1	1	1	0	0	3	0	2	4	6	1	1	11	6	12	24	32	17	18	17	2	0	0	0	5	0	0	0
27	0	0	0	0	1	0	0	0	2	1	1	1	0	1	1	0	4	14	20	21	21	30	6	5	0	1	6	5	6	0	0	1
28	3	1	0	4	2	1	0	0	0	1	0	2	7	0	0	1	0	1	4	8	8	7	14	18	9	9	9	15	0	3	0	0
29	5	1	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	1	8	9	12	15	4	0	9	1
30	0	0	4	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	4	3	7	12	8	3	13	3
31	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	3	0	0	1	10	10	5	7	16	10	3	1	0	0
32	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	2	0	1	0	0	0	0	2	8	11	12	8	9	7	0	2	5
33	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	0	0	1	0	11	20	9	21	21	9	2	1	7
34	2	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	1	1	0	1	3	7	33	1	5	1	0
35	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0
36	4	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3	0	1	0	0	0	2	0	1	0	0	1	3
37	2	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	9	0	0	0	1
38	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	7	0	0	0	0	0
40	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0
41	1	0	0	0	11	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	41	4	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0
43	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	1	0	0	1	0

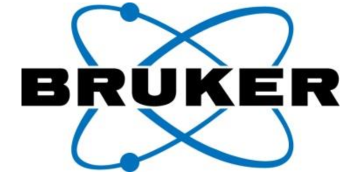
Total Number Defects	2362	#
Maximum Peak Height	3.5	µm
Maximum Length Extension	493	µm

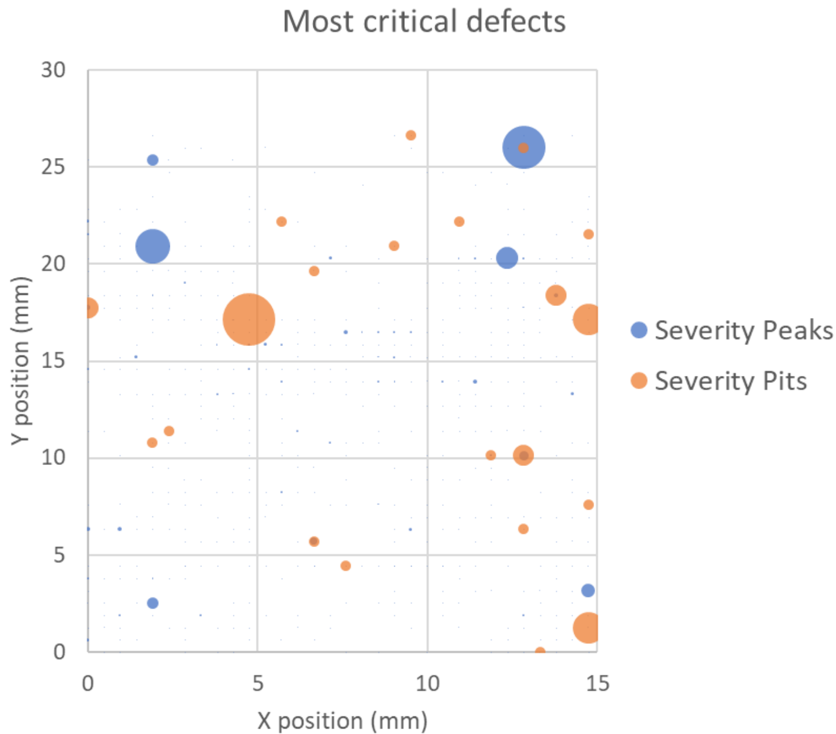
*Peak mapping on glass surface **after cleaning***

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3	0	0	0	0	0	0
19	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
22	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
23	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
31	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
33	0	1	0	0	0	0	0	2	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
36	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0
40	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
41	0	0	1	0	0	0	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
42	1	0	0	11	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	1	0
43	0	1	0	7	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0

Total Number Defects	120	#
Maximum Peak Height	2.5	µm
Maximum Length Extension	186	µm

Defect Mapping
Display of critical defects

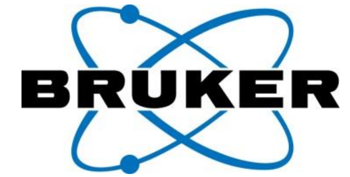


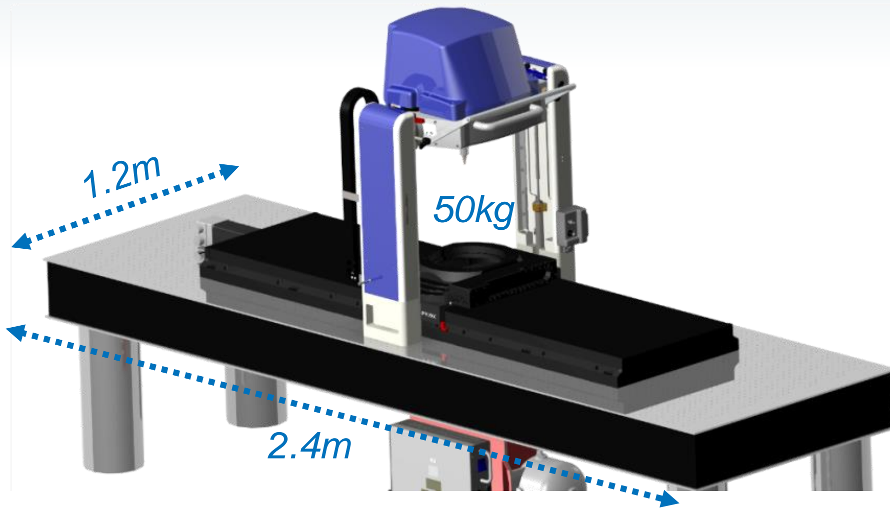


- Severity factor can be worked out from multiple parameters:
  - Number of defects
  - Maximum length of defect
  - Maximum depth/height of defect
- User can place weight on each of those parameters to work out final ranking of severity
- Sphere width represents here the value of severity, providing visual comprehensive map of main defects
- Operator can easily judge if defects are located in too sensitive a region

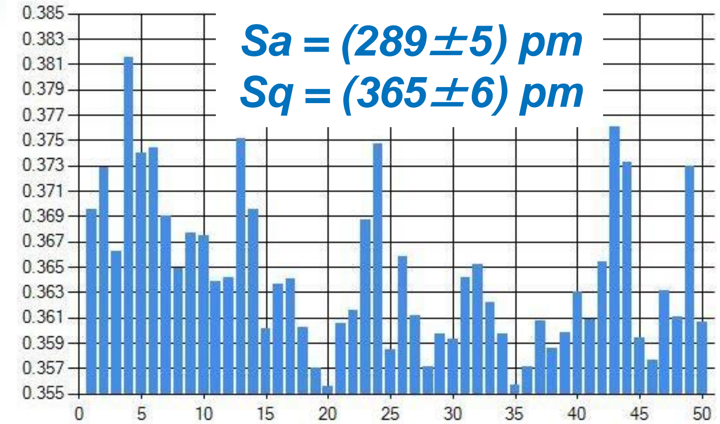
3. Solution for large and aspheric optics

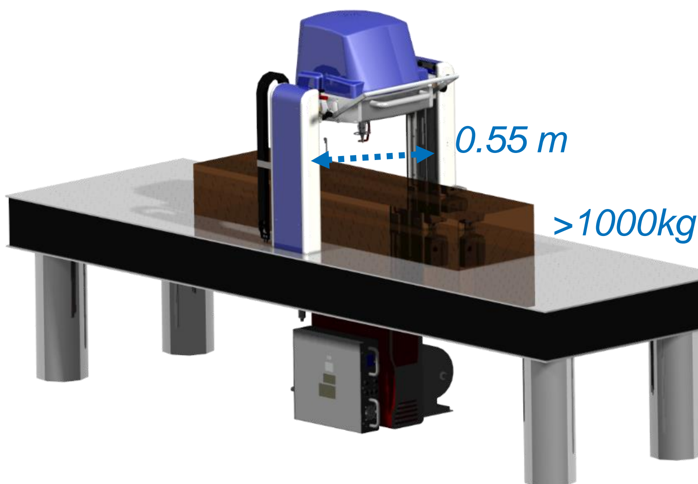
Large and Aspheric Optics
Unique solution

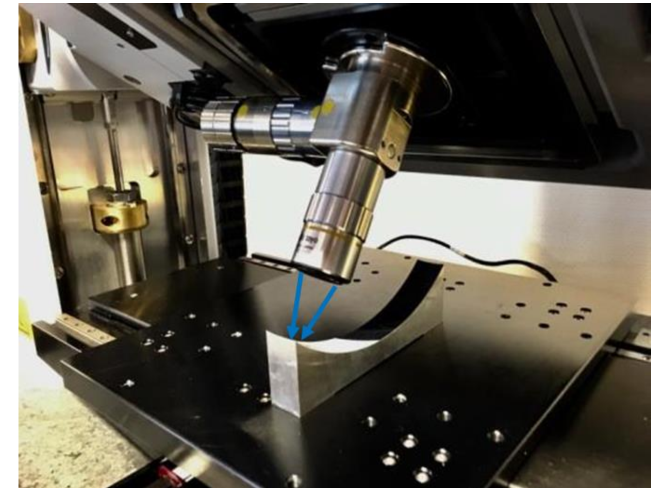




Roughness repeatability – 1X objective

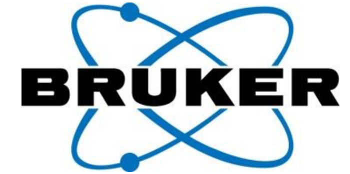




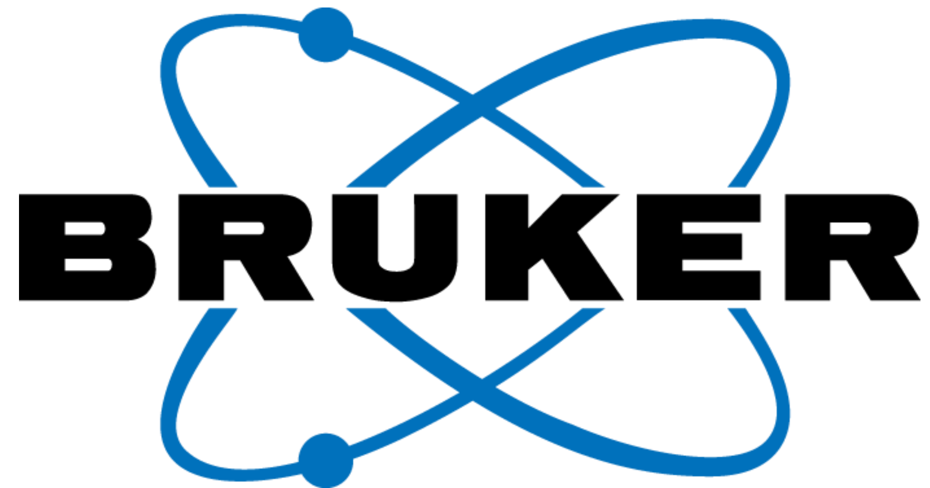


Courtesy of TNO, Delft

Conclusion



- Non-contact interferometric profiler has shown full capability to:
  - Spot defect in effective way
  - Fully characterize each defect
- Main reasons for reliable defect review:
  - Robust measurement modes
  - Complete software automation suite
- Defect review extends to large and aspheric optics with large frame
- Extra discussion needed? Contact Samuel.Lesko@bruker.com



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