Epic TechWatch 2023

@ W3+ Fair Jena 30.11.2023

„Innovations in Ion Beam Machining “

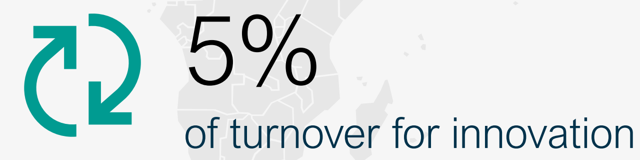
Dr. Christian Schindler

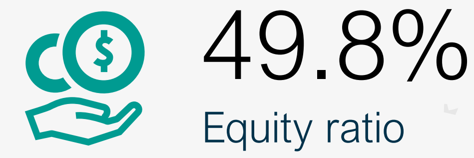
Close to customers

Global network

Family owned

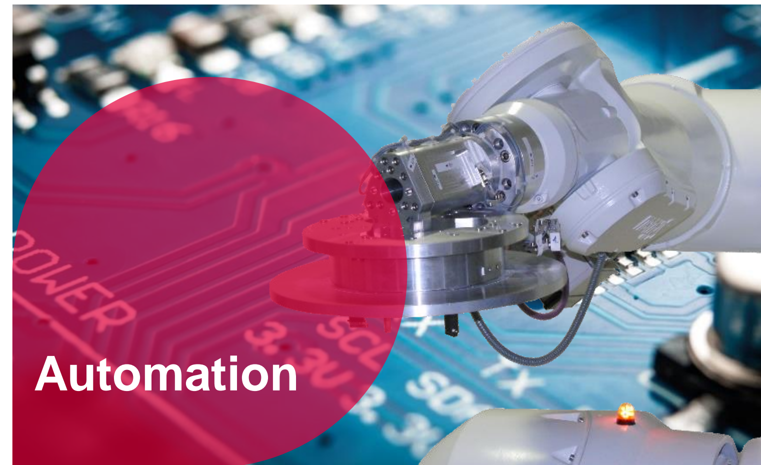
Innovation and education





Buhler Product Line
Center of Competence Leipzig

Correcting, Structuring and Smoothing of Surfaces



Substrate Handling, Automation

Coating Thickness Control

Thin Film and Thickness Measurement etc.

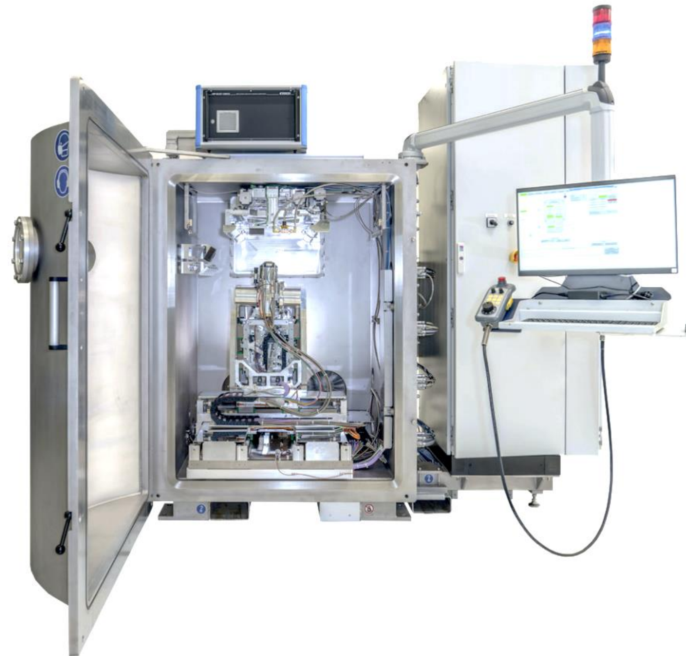
Ion Beam Figuring (IBF).
Corrective polishing of surfaces.

Contactless and dry.
Using accelerated argon ions.

Center of Competence Leipzig

Production Equipment for Correcting, Structuring and Smoothing of Surfaces

For precise figure correction and smoothing of high-end optics



Leybold Optics IBF - Series

For precise flattening and correction of features on a wafer

Leybold Optics IBT800

Applications of Ion Beam Figuring (IBF)

Ultraprecision as standard

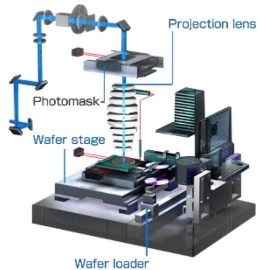
Lithography Optics.

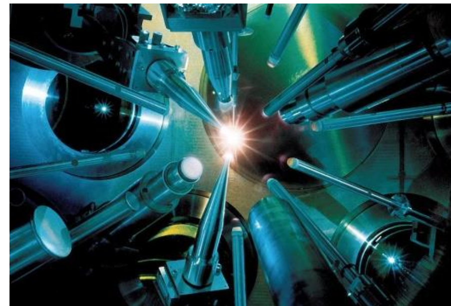
Optics for Telescopes.

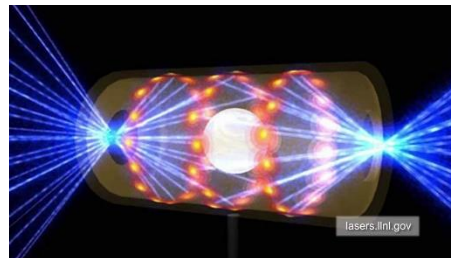
Laser Optics.

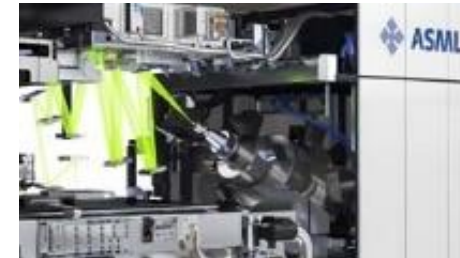
Deep and Extreme UV

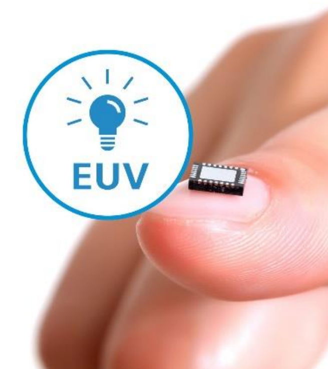
Wafer-holder & Stepper chucks

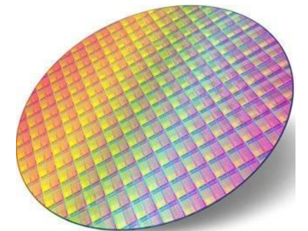












Pictures taken from internet

Leybold Optics IBF.
Machine Portfolio (Number of Axes: 3, 5 or 6).

Model	IBF 200	IBF 450	IBF 600	IBF 800	IBF 1200	IBF 1500	IBF 2100
Max. diameter of flat samples	200 mm	500 mm	600 mm	800 mm	1200 mm	1500 mm	2100 mm
Max. weight	35 kg	100 kg	100 kg	100 kg	300 kg	1000 kg	1500 kg

Leybold Optics IBF Inside View.

Substrate positioning

ISERM

Diaphragm changer

Ion Source + calibration camera

Motion stages up to 6 axis

c + -

b + -

a + -

z - +

y - +

x - +

x - +

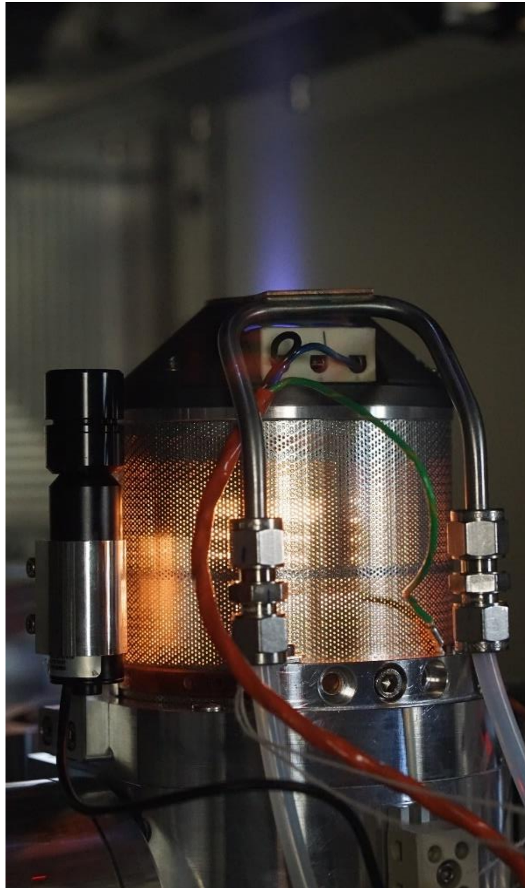
BÜHLER

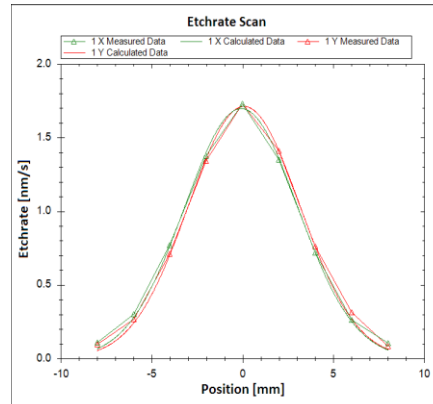
Leybold Optics IBF

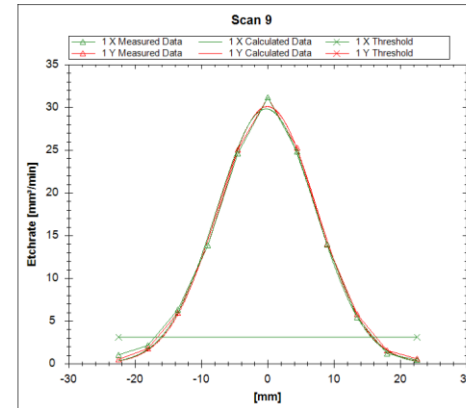
Reproducible and Longterm Stable IB-Sources for Material Removal

RF40 ion beam source

RF80 ion beam source



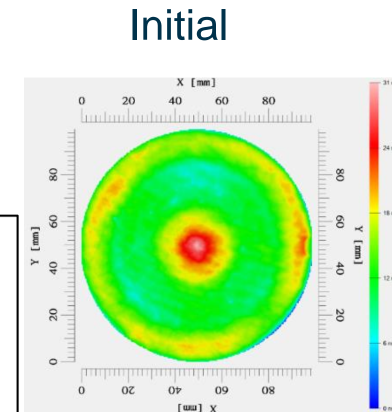


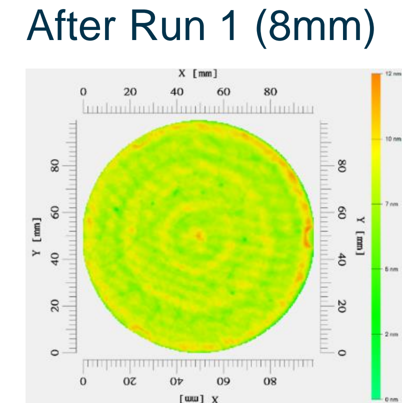


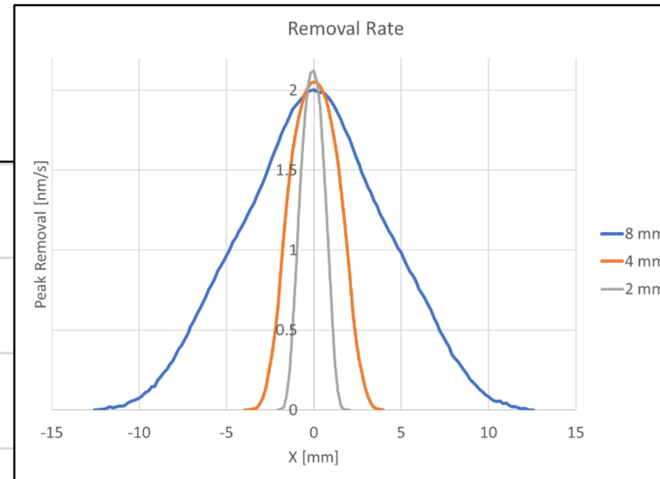
Representative ISERM-Scans and Source Parameter

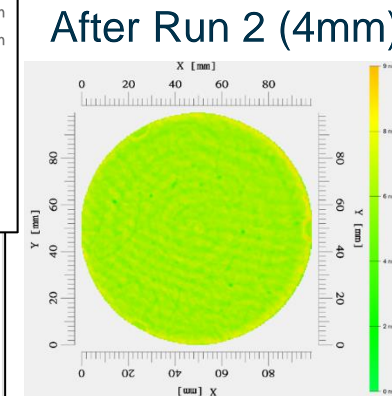
1,8 nm/s	Peak Etch Rate	30 nm/s
9 mm	Spot Size (FWHM)	17.5 mm
0,01mm³/min	Removal Rate	0.63 mm³/min

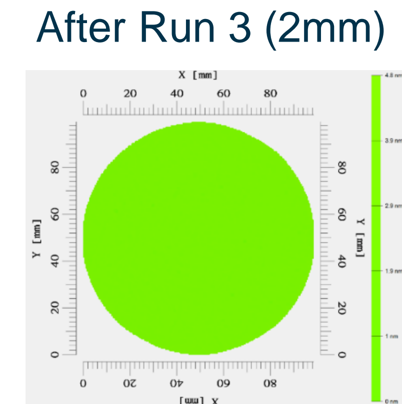
Iterative Processing











RMS

RMS [nm]

Init
after 8 mm
after 4 mm
after 2 mm

Low Pass > 16 | Band Pass 16 - 14 | Band Pass 14 - 12 | Band Pass 12 - 10 | Band Pass 10 - 8 | Band Pass 8 - 6 | Band Pass 6 - 4 | Band Pass 4 - 2 | High Pass < 2

Filter

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Etch rate measurement

RF power: < 300 W

Ion energy: < 1500 eV

Ion current: < 150 mA

Accelerator voltage: < 1000 V

Initial situation

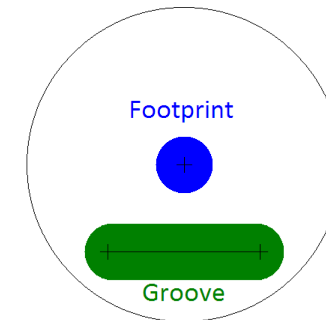
- Every ion beam source has its own characteristic and working point
- Individual beam center and etch rate needs to be determined

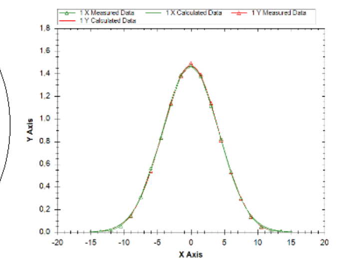
Standard measurement is done via 2 steps

1. Measure beam current over beam profile with faraday cup and extract a graph to obtain gaussian shape and beam center (only indirect, uncertian etch rate determination)

2. Perform a footprint or groove etching on sample to analyse etch rate outside of machine

→ High effort to obtain actual etch rate and monitor longterm degeneration of source (drift sums up to ~10% after 500h)



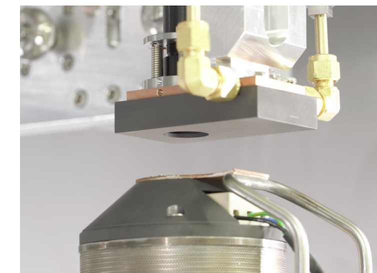


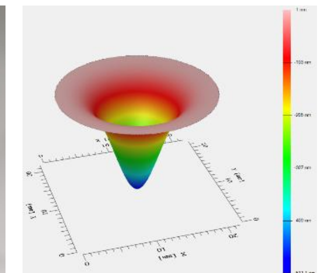
ISERM

- Direct determine etch rate with actual beam parameter and material in the machine

→ Enable regular process calibration and secure production yield by stable material removal and predictive maintanance

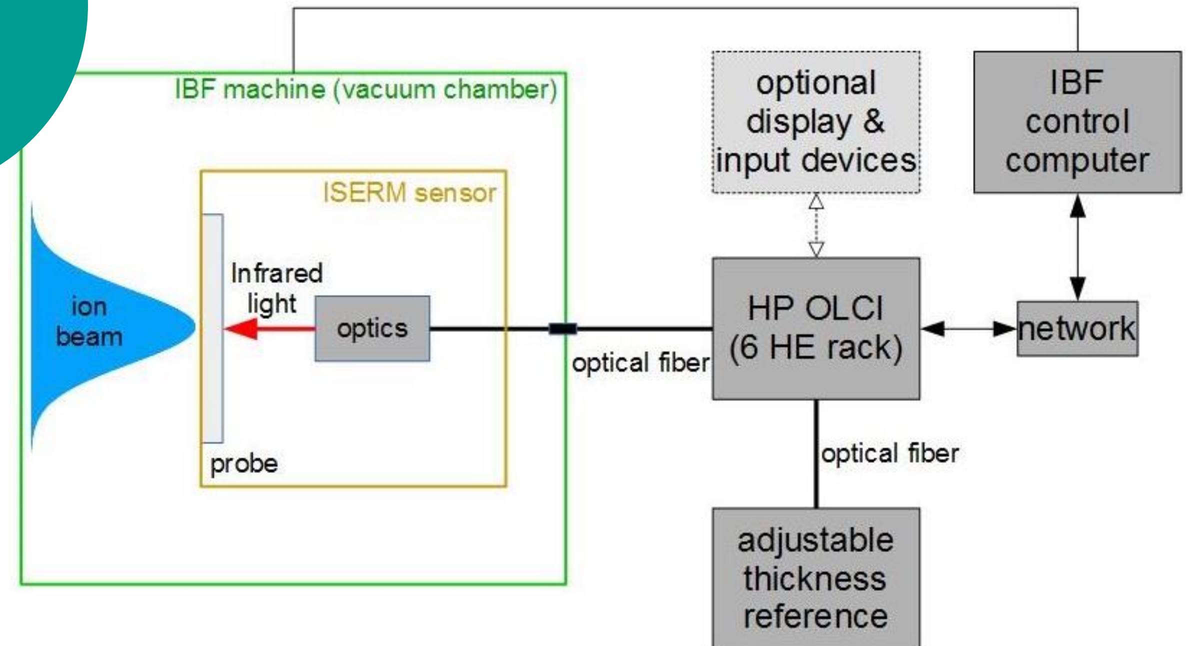
→ Obtain basis for process simulation





In-Situ Etch Rate Measurement System - ISERM

ISERM Sensor Head



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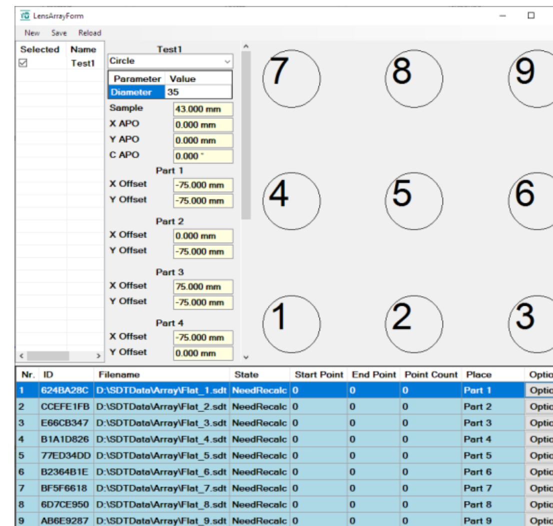
Automation Solutions for IBF

Robotic handling

- ➢ Combined loading of several IBF machines within robotic cell on rails
- ➢ work stocker arrangement
- ➢ 24/7 operation mode
- ➢ Flexible actuator design

Array machining

- ➢ Take advantage of larger equipment for small samples to increase efficiency
- ➢ Full software support for metrology and operations
- ➢ Quick setup and low offset time



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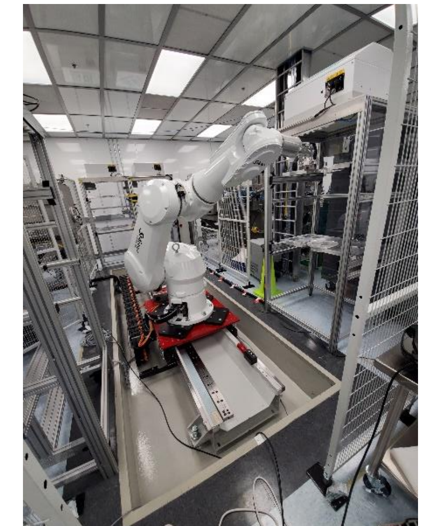
2	CCEFE1FB	D:\SDTData\Array\Flat_2.sdt	NeedRecalc	0	0	0	Part 2	Options
3	E66CB347	D:\SDTData\Array\Flat_3.sdt	NeedRecalc	0	0	0	Part 3	Options
4	B1A1D826	D:\SDTData\Array\Flat_4.sdt	NeedRecalc	0	0	0	Part 4	Options
5	77ED34DD	D:\SDTData\Array\Flat_5.sdt	NeedRecalc	0	0	0	Part 5	Options
6	B2364B1E	D:\SDTData\Array\Flat_6.sdt	NeedRecalc	0	0	0	Part 6	Options
7	BF5F6618	D:\SDTData\Array\Flat_7.sdt	NeedRecalc	0	0	0	Part 7	Options
8	6D7CE950	D:\SDTData\Array\Flat_8.sdt	NeedRecalc	0	0	0	Part 8	Options
9	AB6E9287	D:\SDTData\Array\Flat_9.sdt	NeedRecalc	0	0	0	Part 9	Options



Innovations for a **better world.**