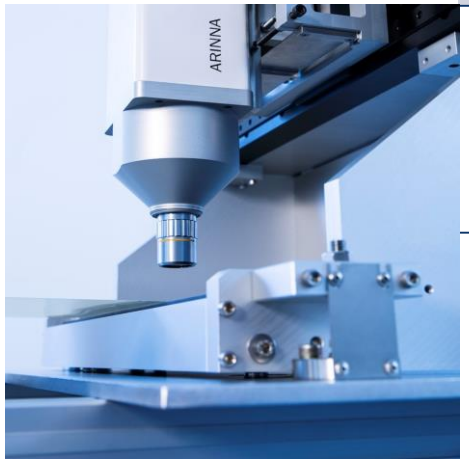
IBS Precision Engineering



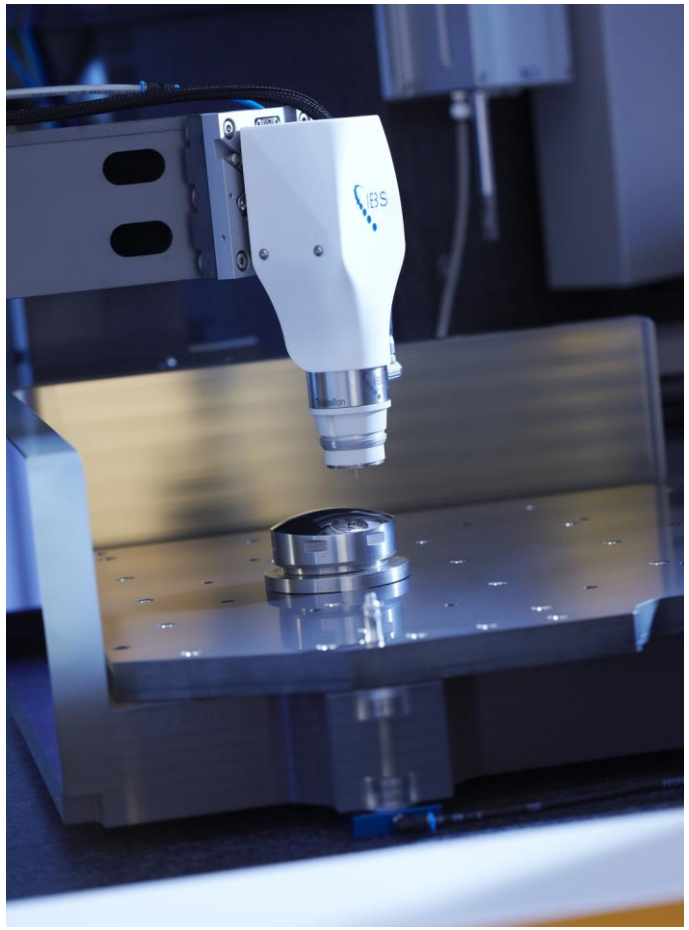
Dr Theresa Spaan-Burke

1st Dec 2020

High precision in reel-to-reel printed flexible electronics

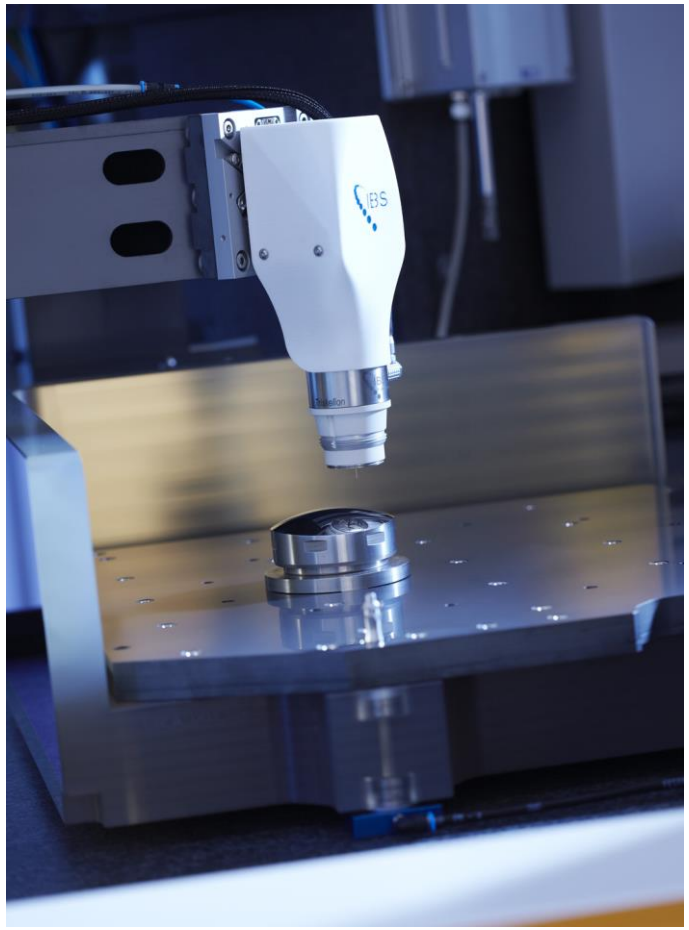
Special VDMA Productronics Online-Seminar

Solutions Where Ultra-Precision Engineering is Required

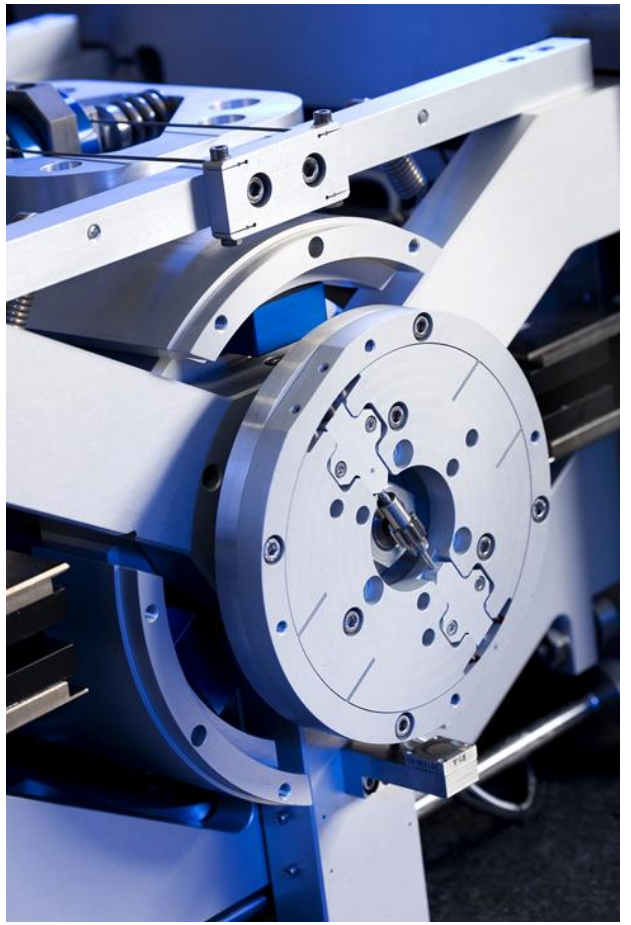


Ultra Precision Measurement

Solutions Where Ultra-Precision Engineering is Required

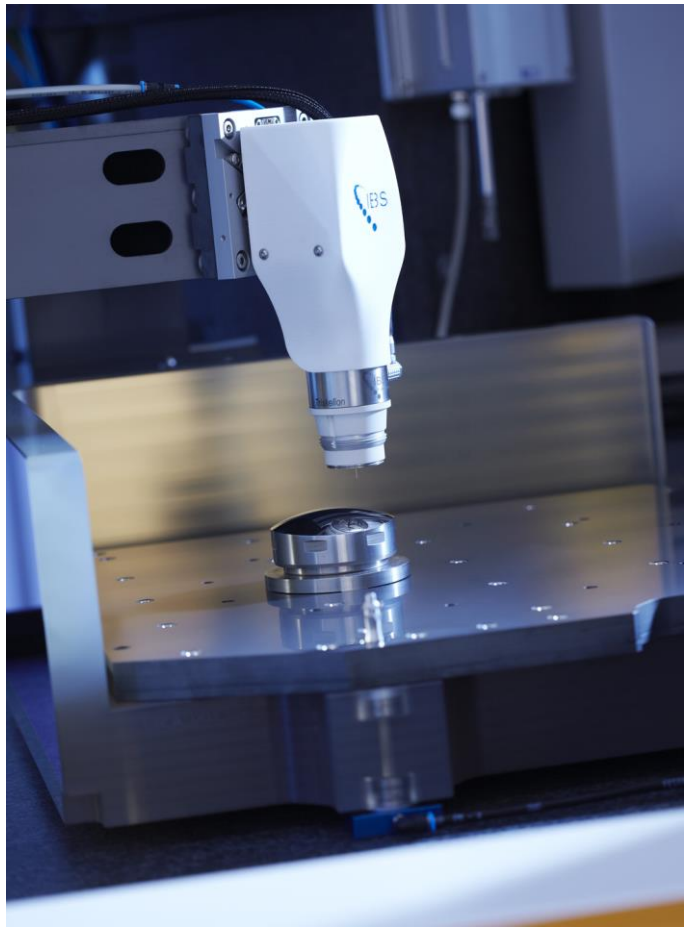


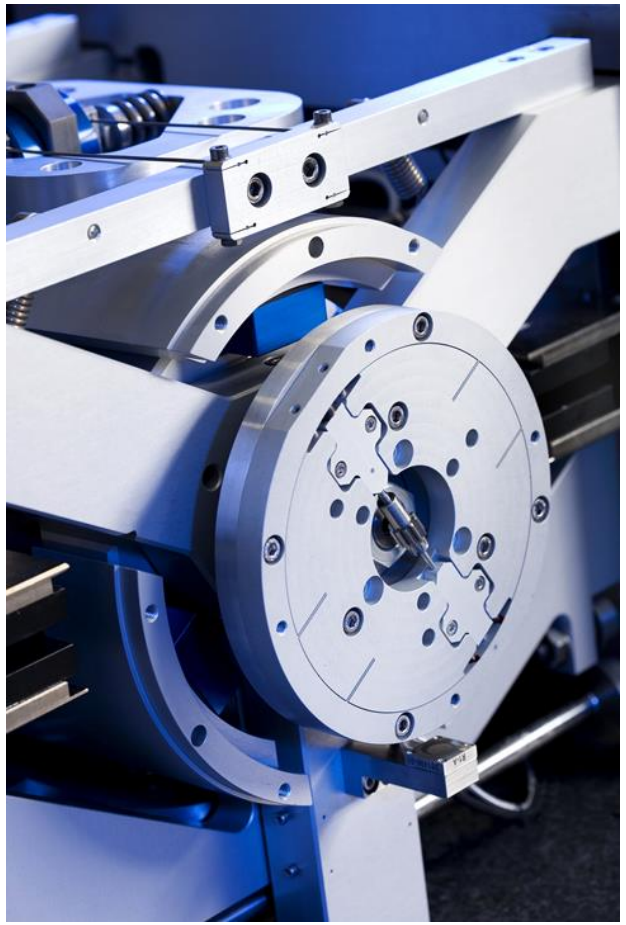
Ultra Precision Measurement



Ultra Precision Engineering

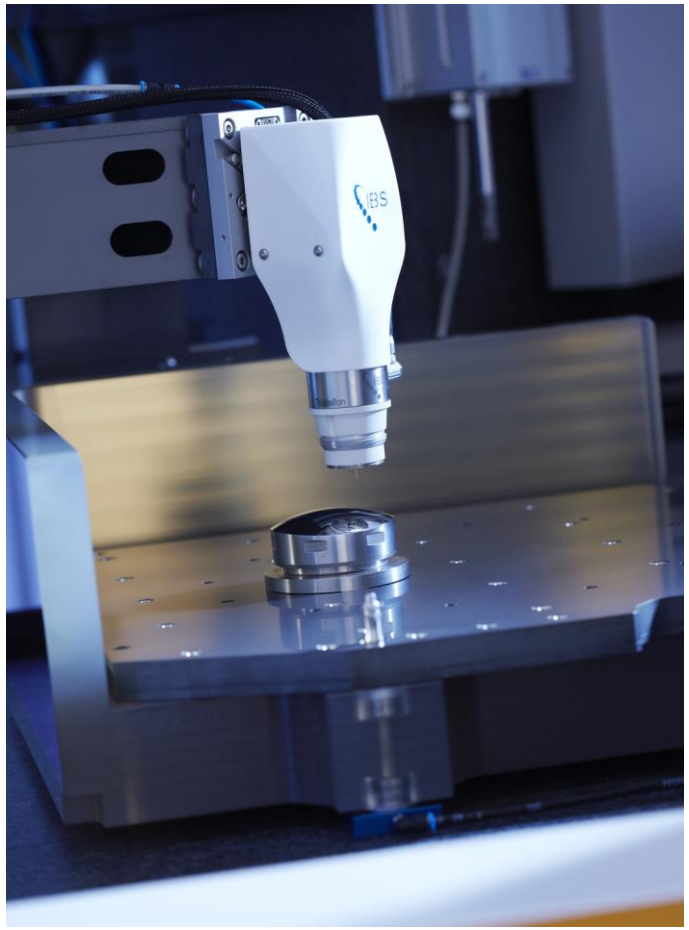
Solutions Where Ultra-Precision Engineering is Required

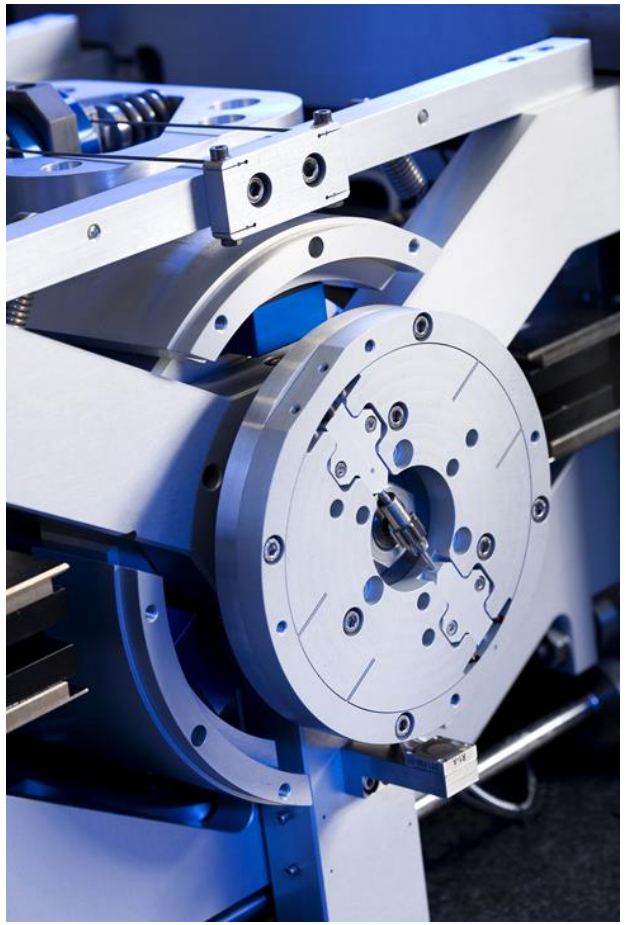




Everything we do is based on our unique metrology expertise

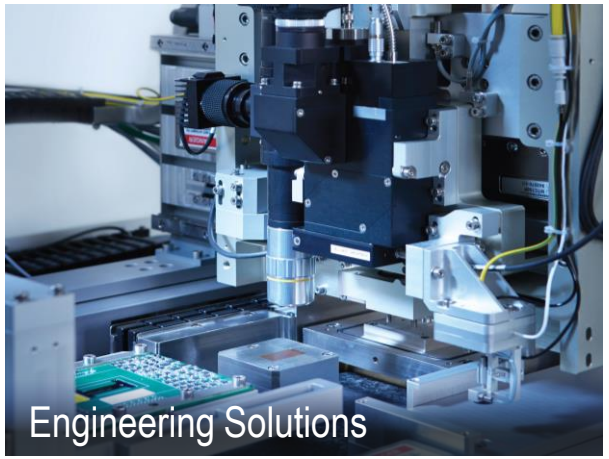
Solutions Where Ultra-Precision Engineering is Required

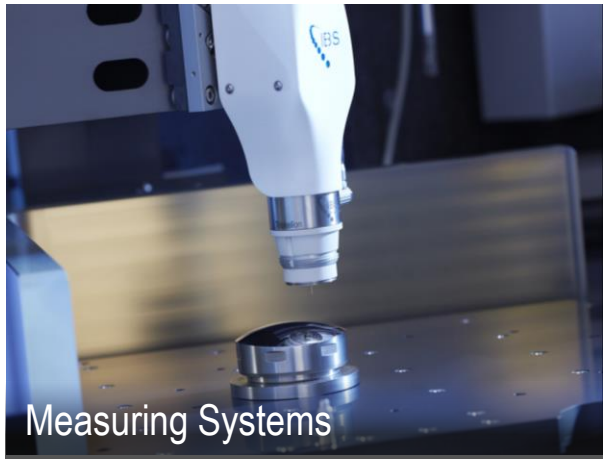




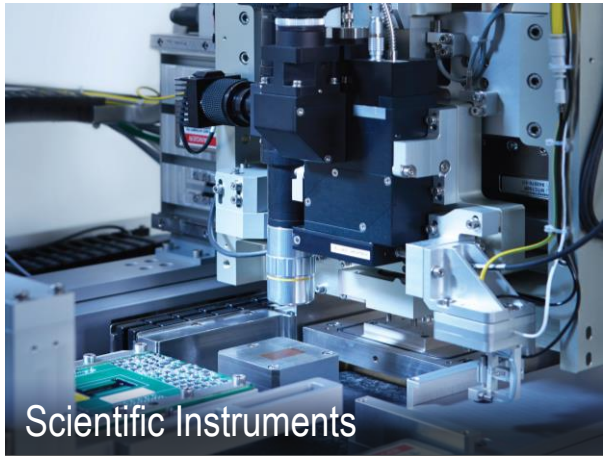
Serving high-tech manufacturing sector, scientific instrument makers and research institutes for over 25 years

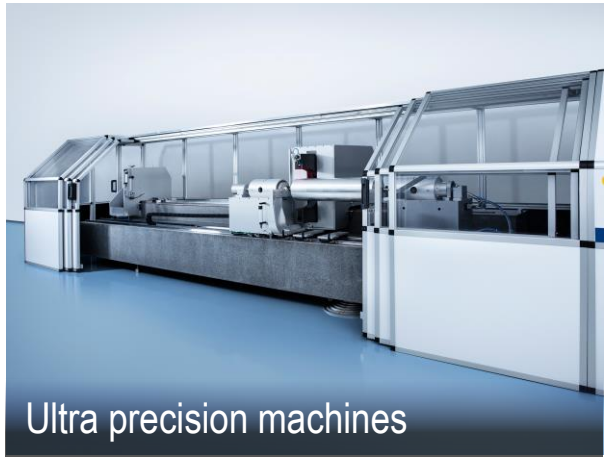
Product Groups





Product Group





Engineering Solutions

In-Line Interferometry for R2R Production

ARINNA – **AR**eal **IN**terferometer for **NA**noscale Surfaces:

- Nanometer accuracy
- High speed measurement (~1s)
- Stepped structures
- Designed for in-line capability

Application challenge: In-line measurement of OPV scribes.

- Real-time data to R2R laser scribe process
- Low reflectivity OPV

ARINNA interferometer

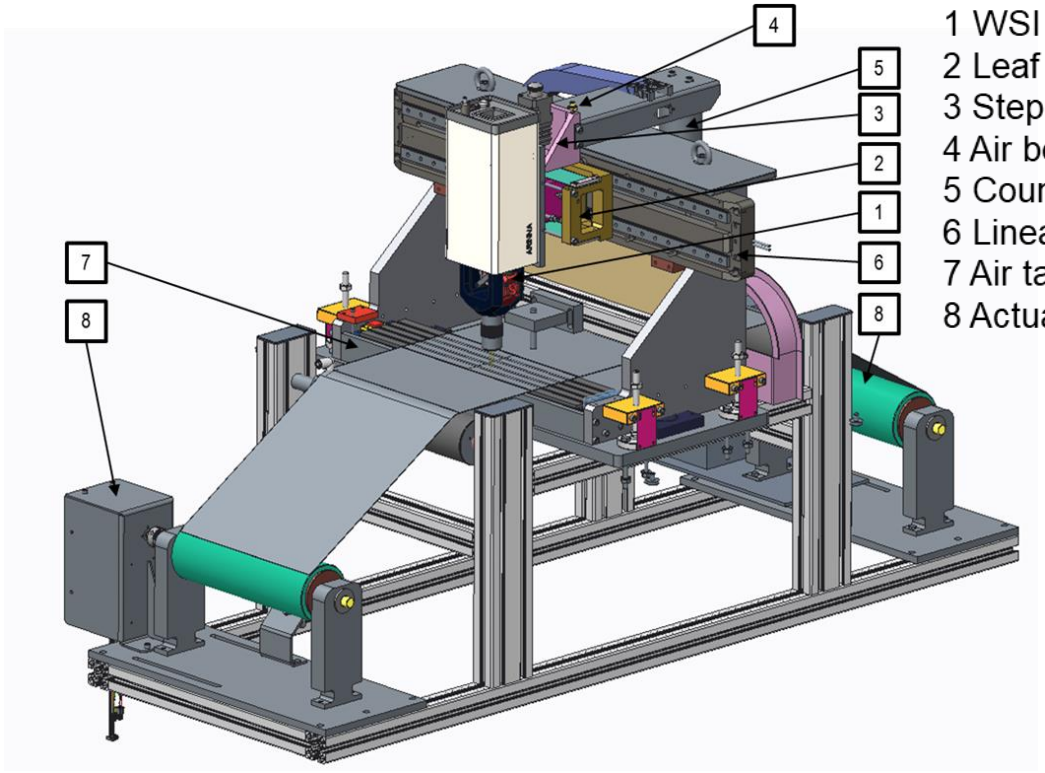
In-Line Interferometry for R2R Production

ARINNA – **AR**eal **IN**terferometer for **NA**noscale Surfaces:

- Step 1 – OPV measurement
  - Demonstrate ability to measure on static samples
- Step 2 – R2R measurement
  - Web stabilisation (x-, y-, z-)

ARINNA interferometer

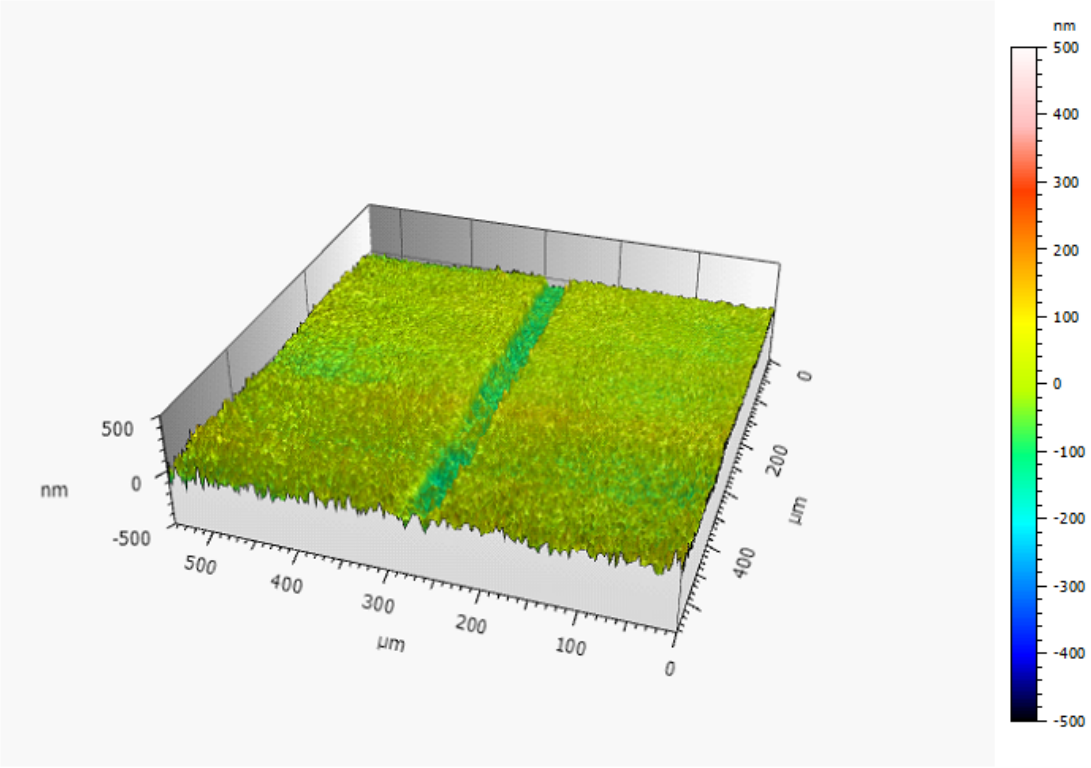
Stationary laser scribe measurement OPV



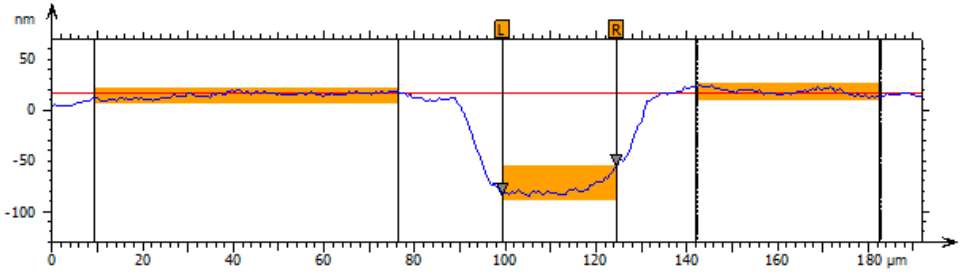
1 WSI
2 Leaf springs
3 Stepper motor
4 Air bearing
5 Counter weight
6 Linear guide
7 Air table
8 Actuated rollers

Laser scribe measurement OPV

- PET/ITO with laser scribes



- Width = 25.6 µm
- Mean depth = 94.3 nm

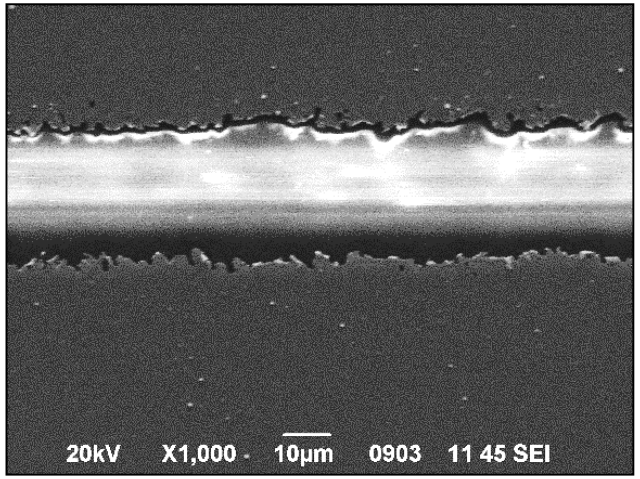


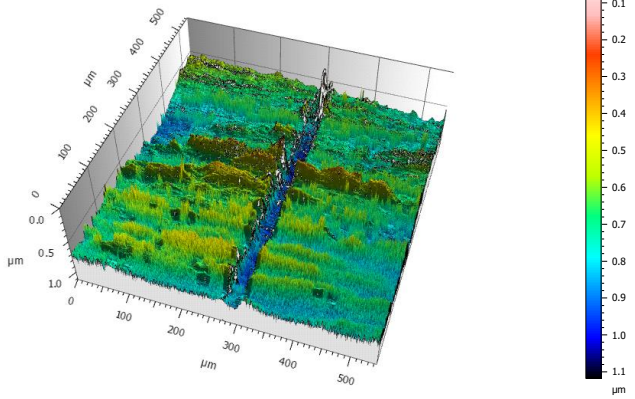
Parameters	Step 1	Unit
Width	25.6	µm
Maximum height	102	nm
Mean height	94.3	nm

Laser scribe measurements at different stages

- P1 scribe

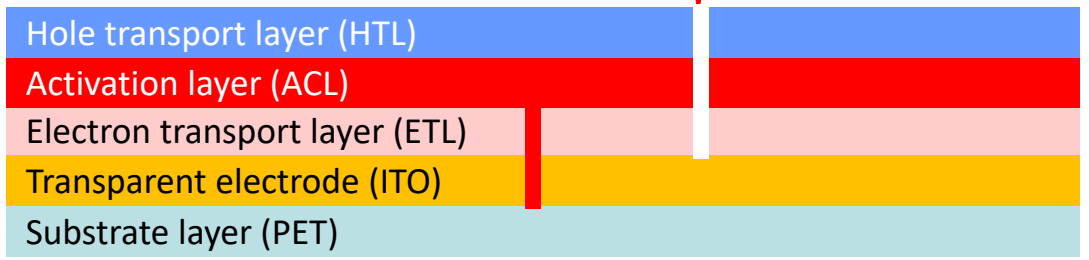
Electron transport layer (ETL)
Transparent electrode (ITO)
Substrate layer (PET)

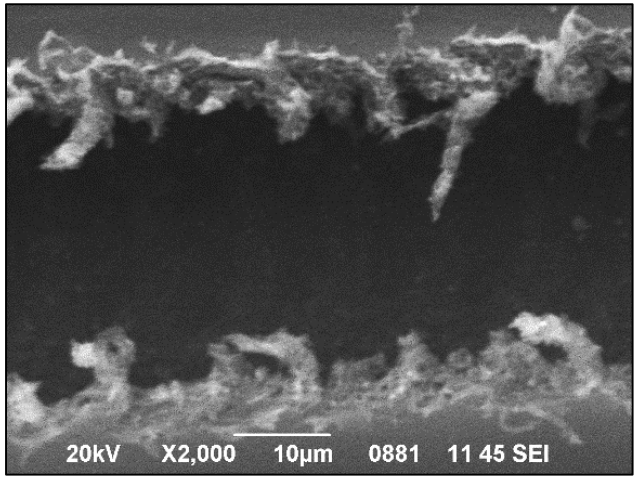


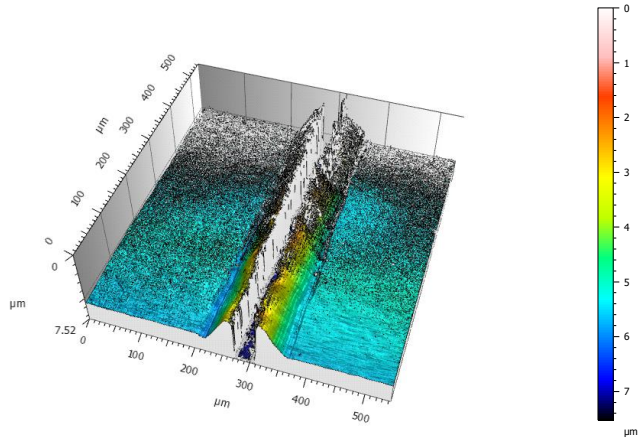


Laser scribe measurements at different stages

- P2 scribe

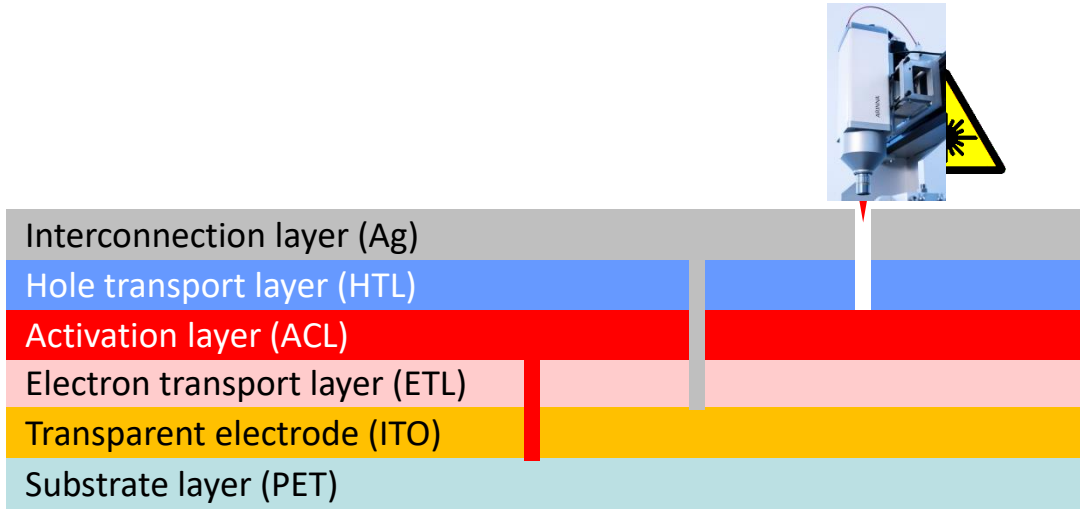


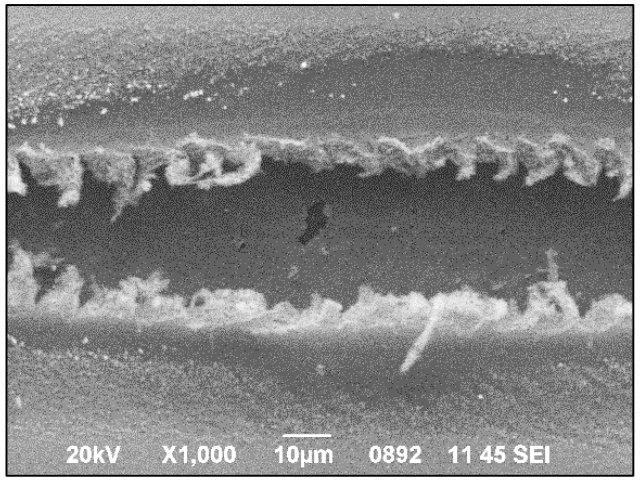


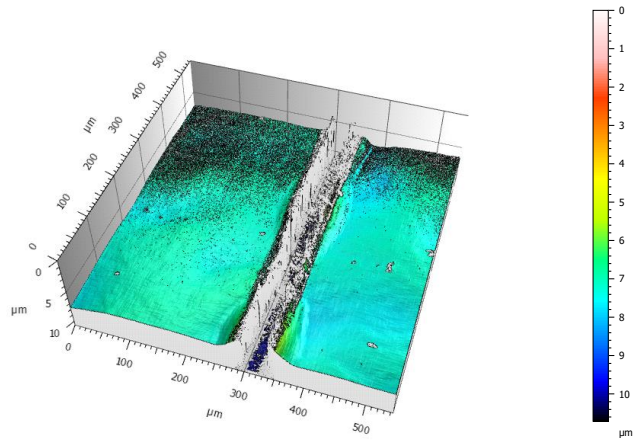


Laser scribe measurements at different stages

- P3 scribe



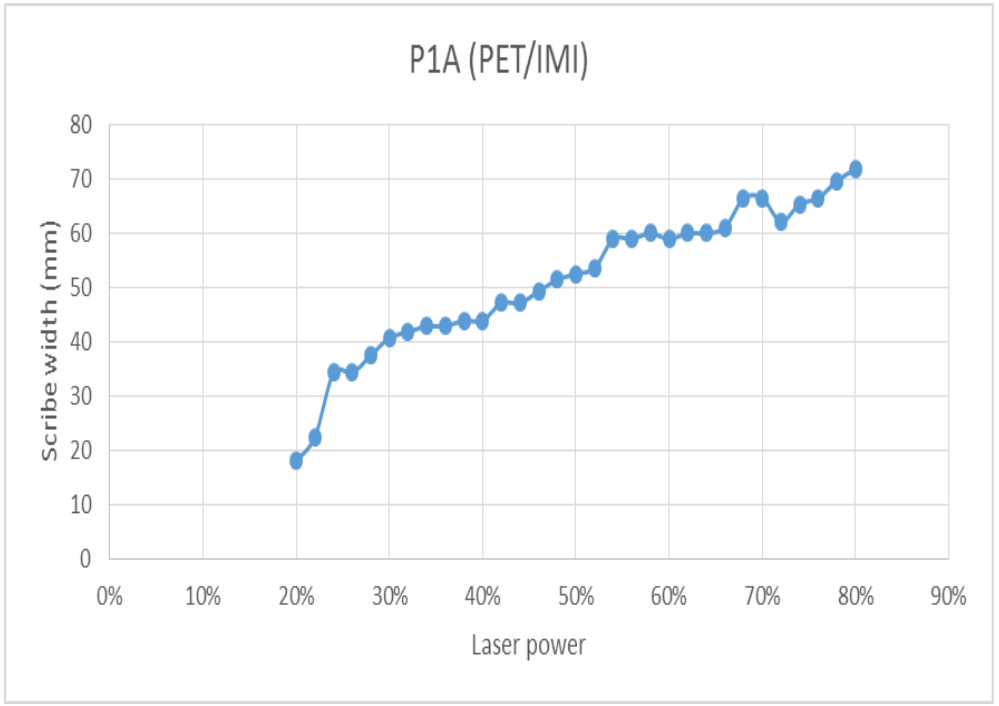


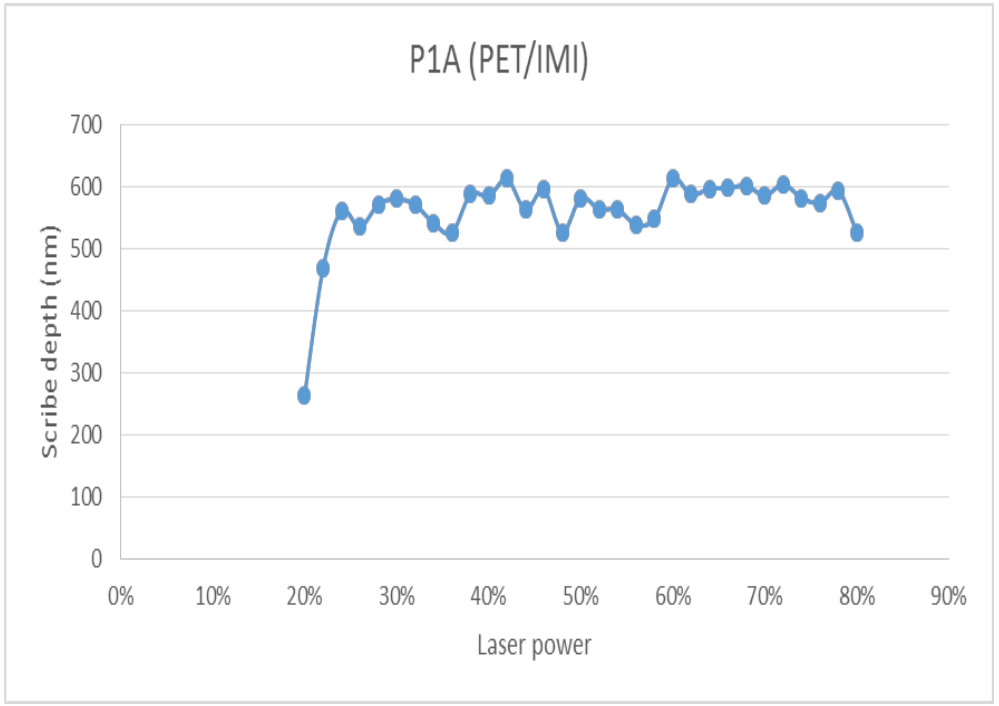


Scribe width and depth versus laser power

- P1A, PET/IMI

- Width increases with laser power
- For laser power > 24 %, depth constant

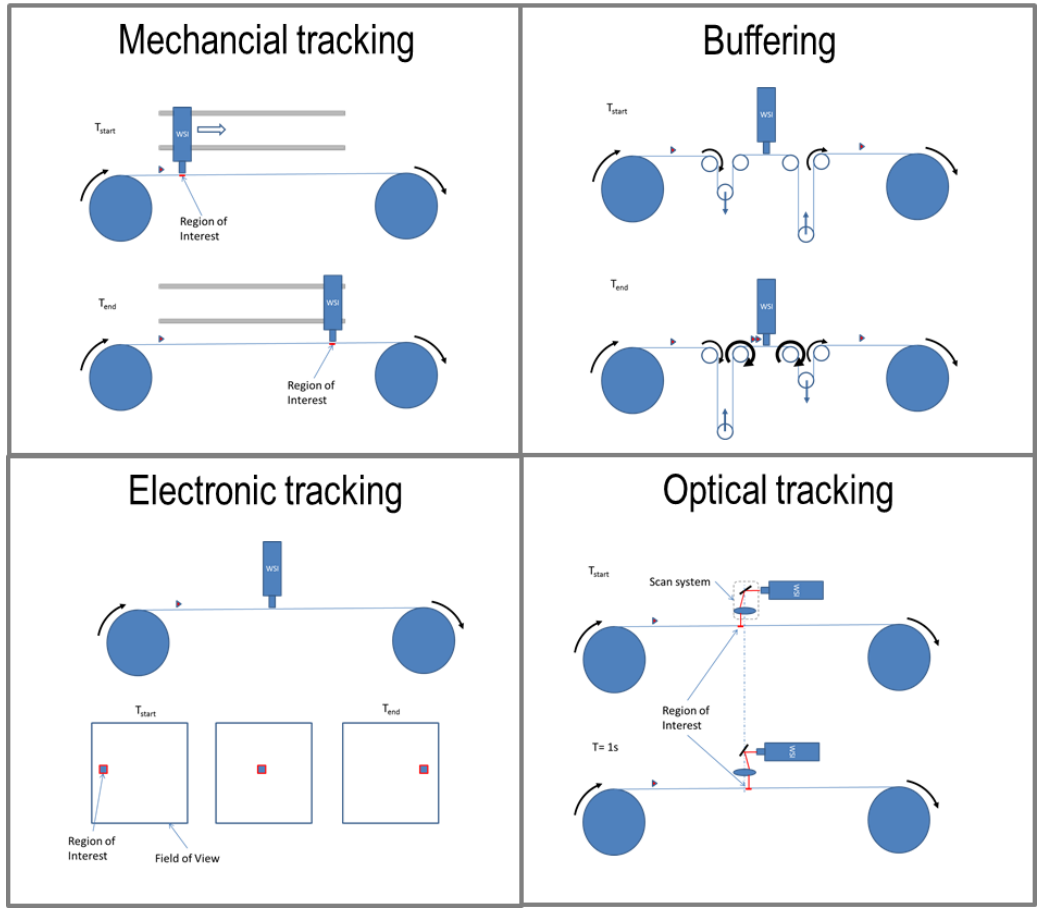




In-line scribe measurement

Challenges for in-line characterisation of OPV scribes with depths from 1μm to 100nm:

- Vertical web stability (~1μm)
- Moving web (up to 5m/min)
- Limited integration space



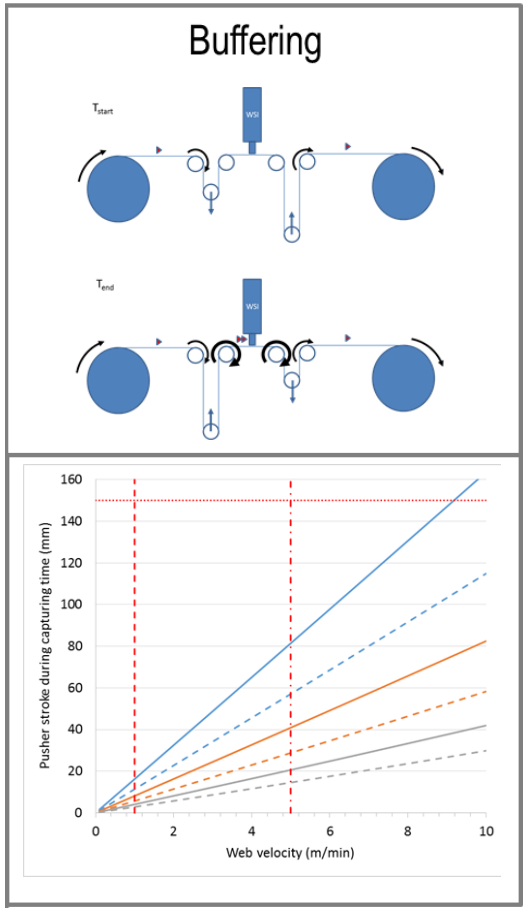
In-line scribe measurement

Challenges for in-line characterisation of OPV scribes with depths from 1μm to 100nm:

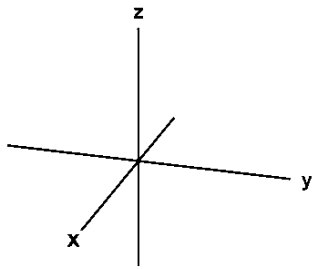
- Vertical web stability (~1μm)
- Moving web (up to 5m/min)
- Limited integration space

Buffering option chosen:

- Avoids head acceleration
- Speeds up to 5m/min possible in given space

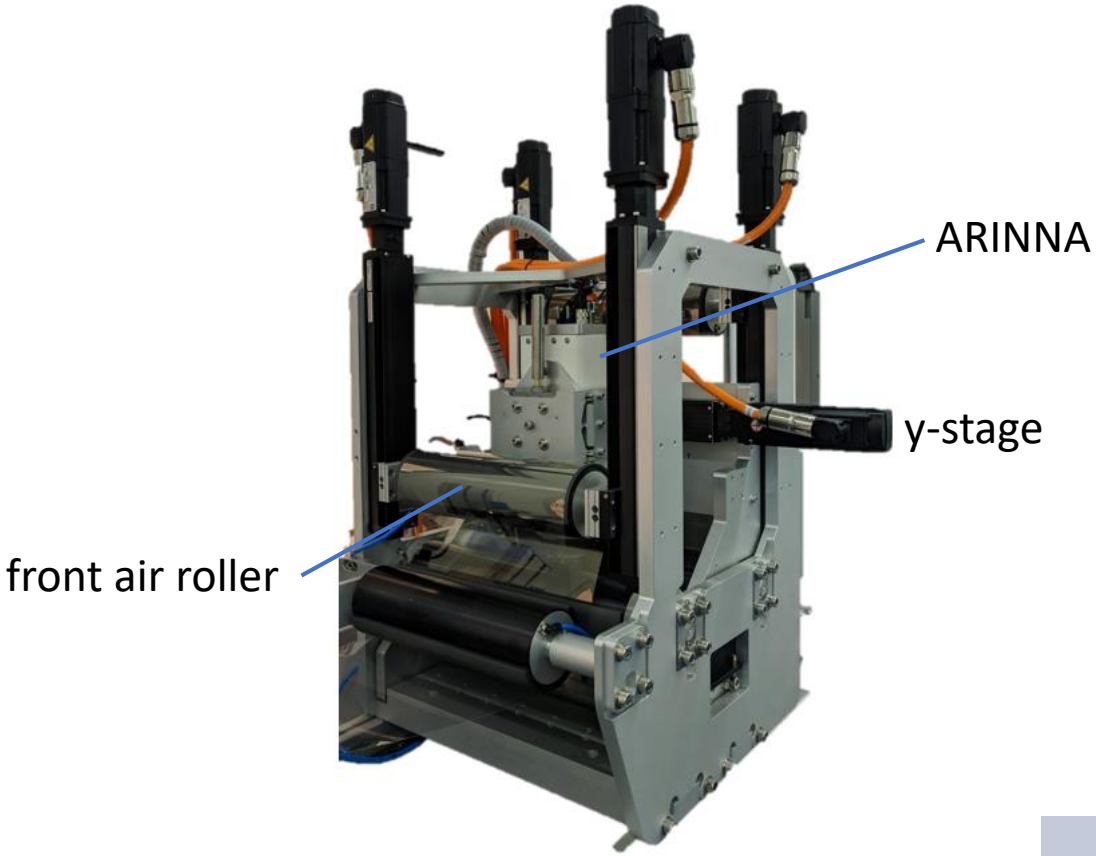


Integrated dancer



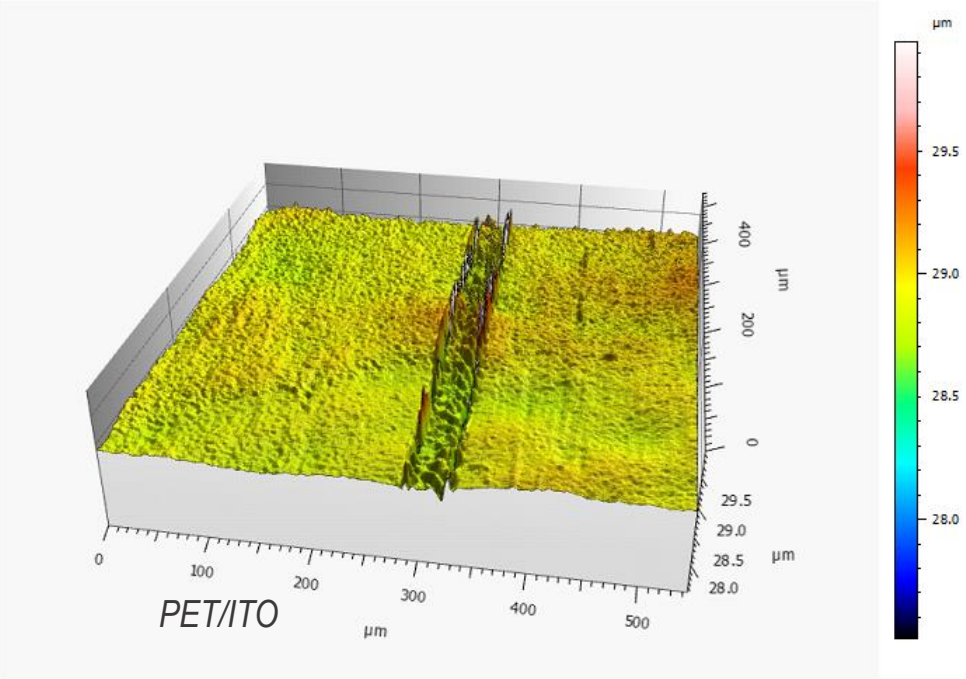
Dancer solution developed to buffer foils up to 10m/min:

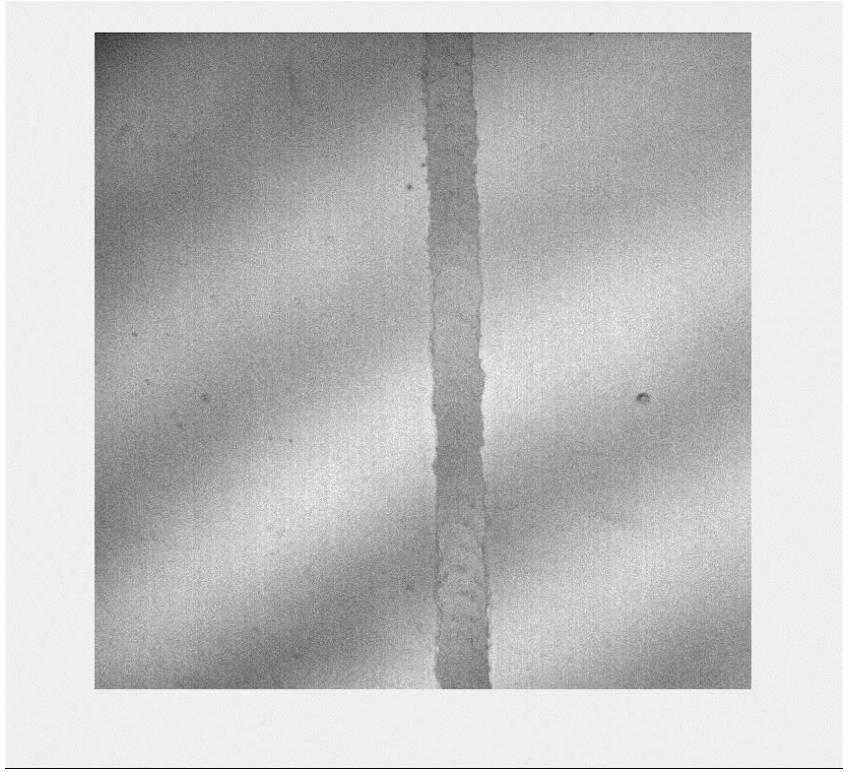
- y-stage for head positioning across the web
- z-stage autofocusing
- 2 off air rollers provide dance



In-line scribe measurement

- Width = 29.4 µm
- Mean depth = 93.7 nm, maximum depth 114 nm
- Web travel 336 µm during measurement

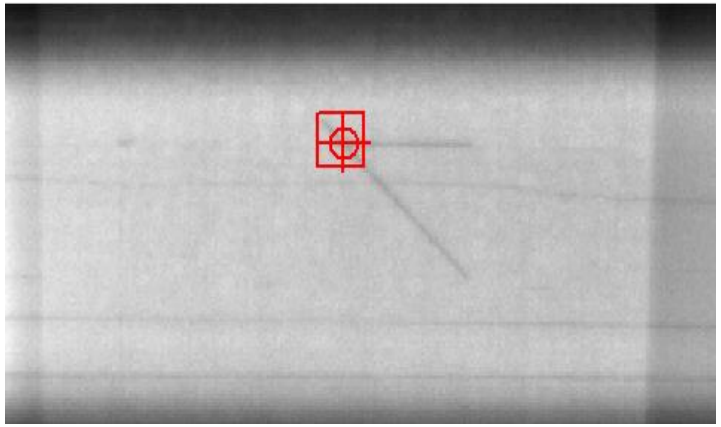


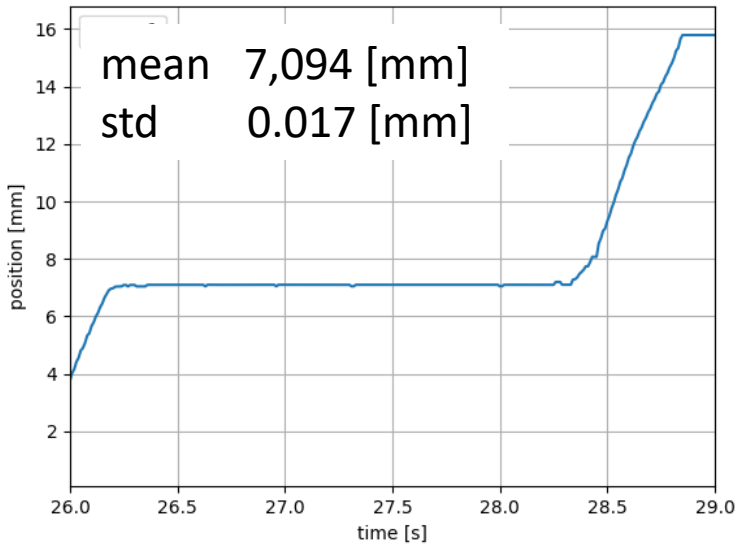


Improved dancer

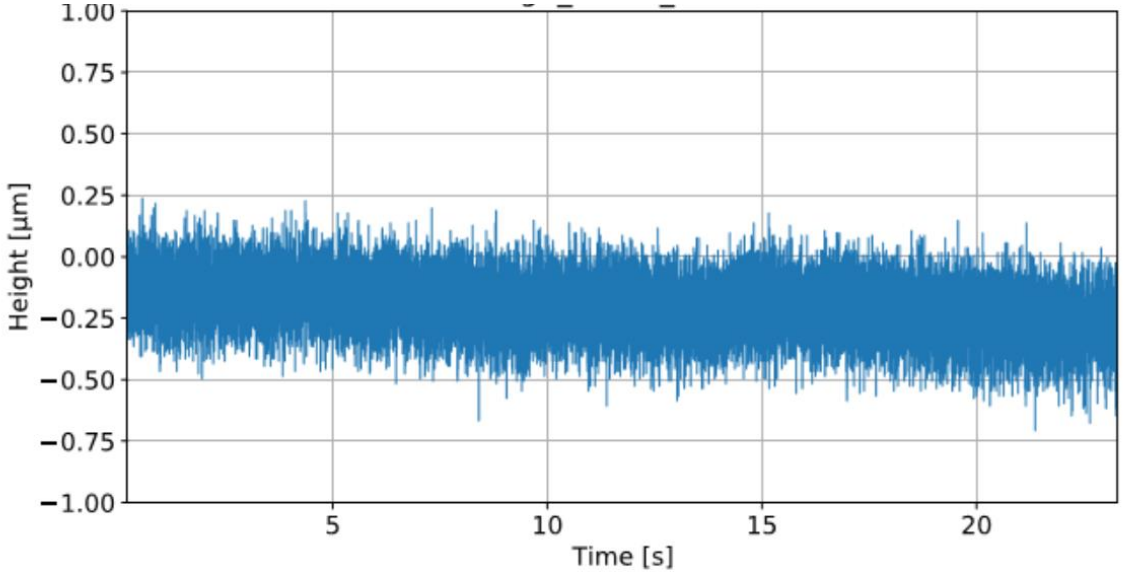
To improve dancer performance:

- Marker detection triggers dancer
- <1 μm web z-stabilization by means of vacuum/air table





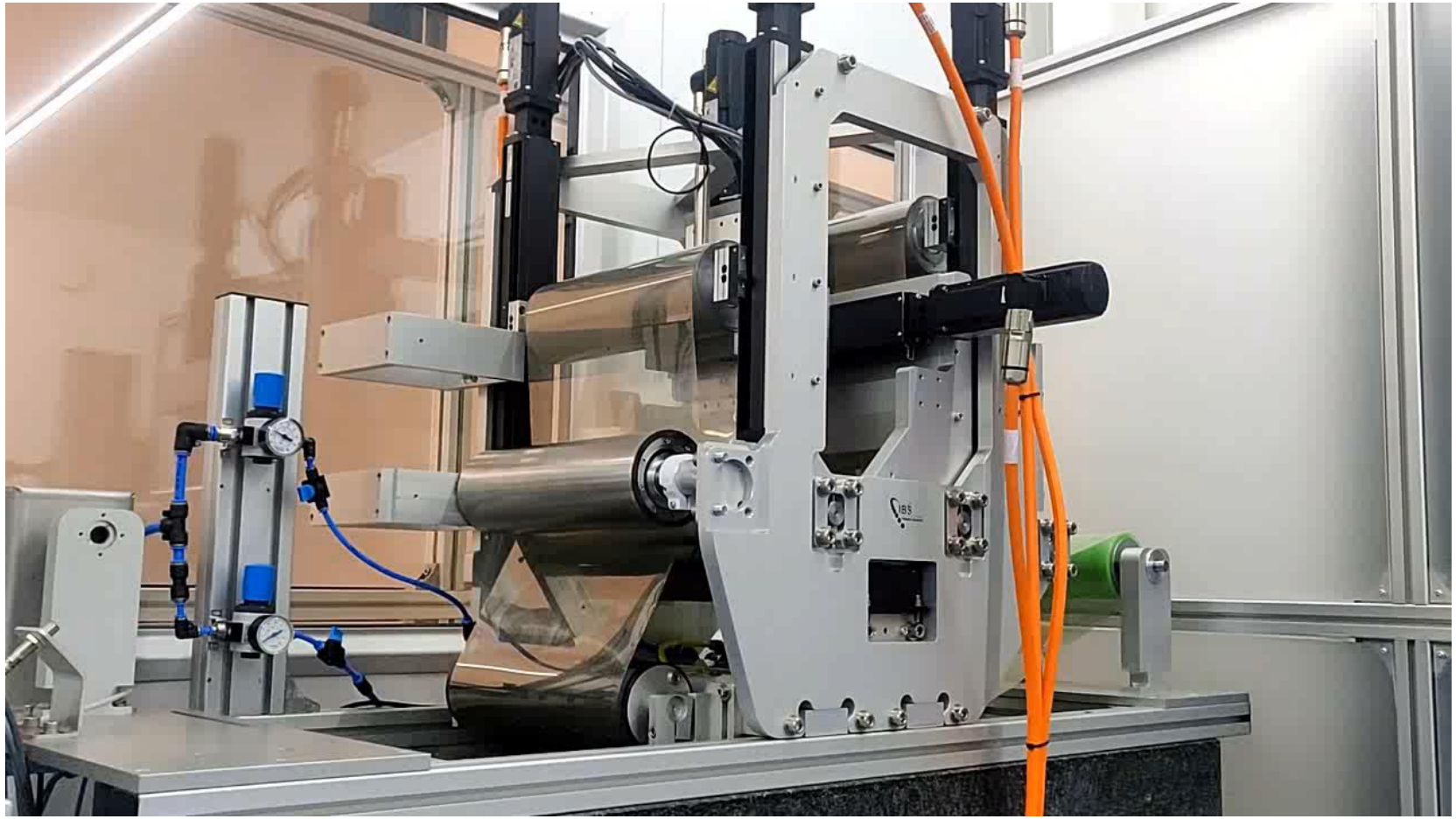
x position held



z-stability

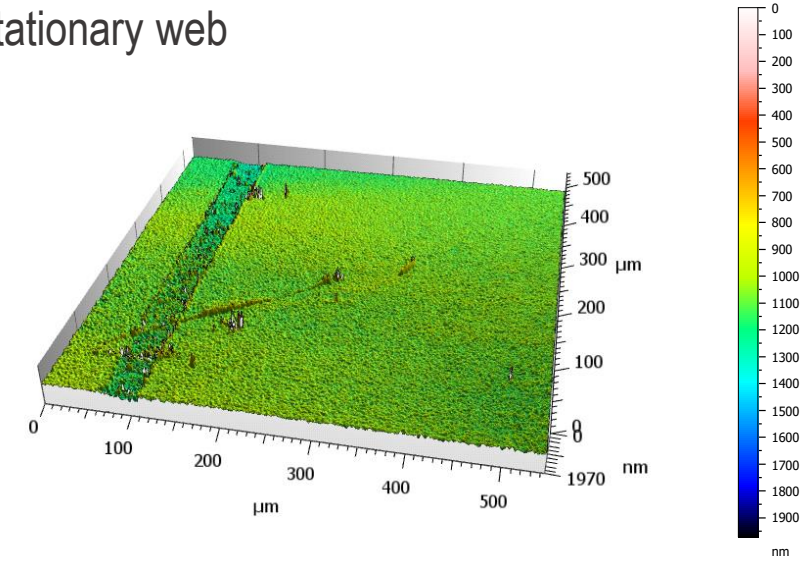
Improved dancer - marker detection

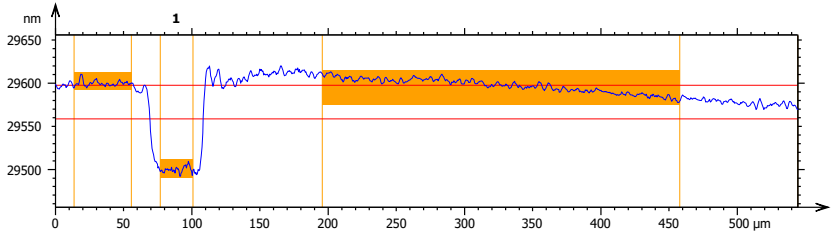
Integrated dancer system



First successful height maps with dancer

Stationary web

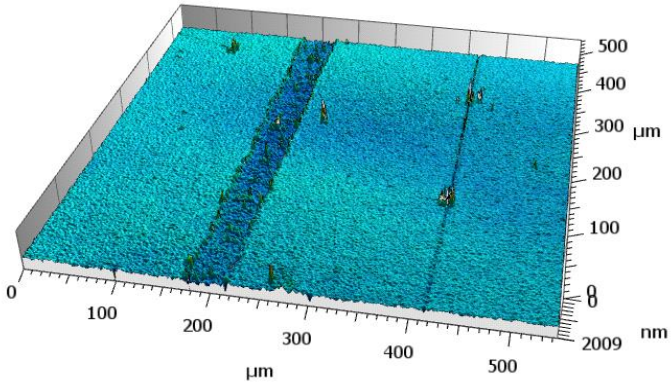


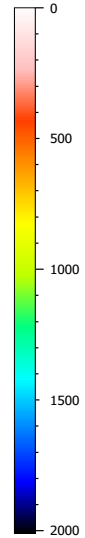


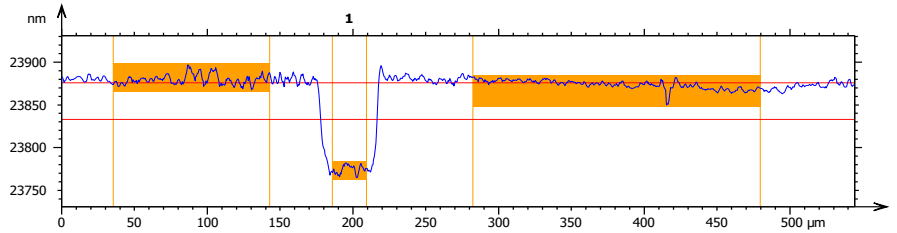
Parameters	Step 1	Unit
Width	23.98	µm
Mean depth	97.82	nm

- Width = 24 µm
- Depth = 98 nm

Moving web at 1 m/min





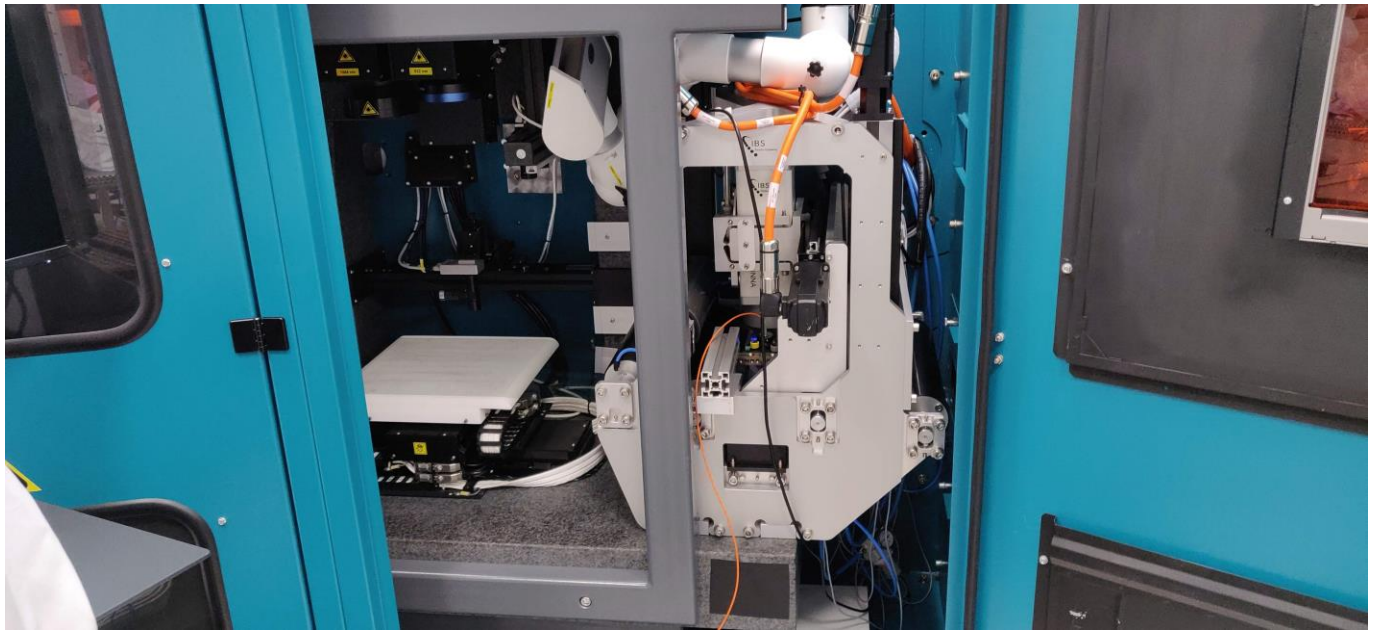


Parameters	Step 1	Unit
Width	23.44	µm
Mean depth	101.4	nm

- Width = 23 µm
- Depth = 101 nm

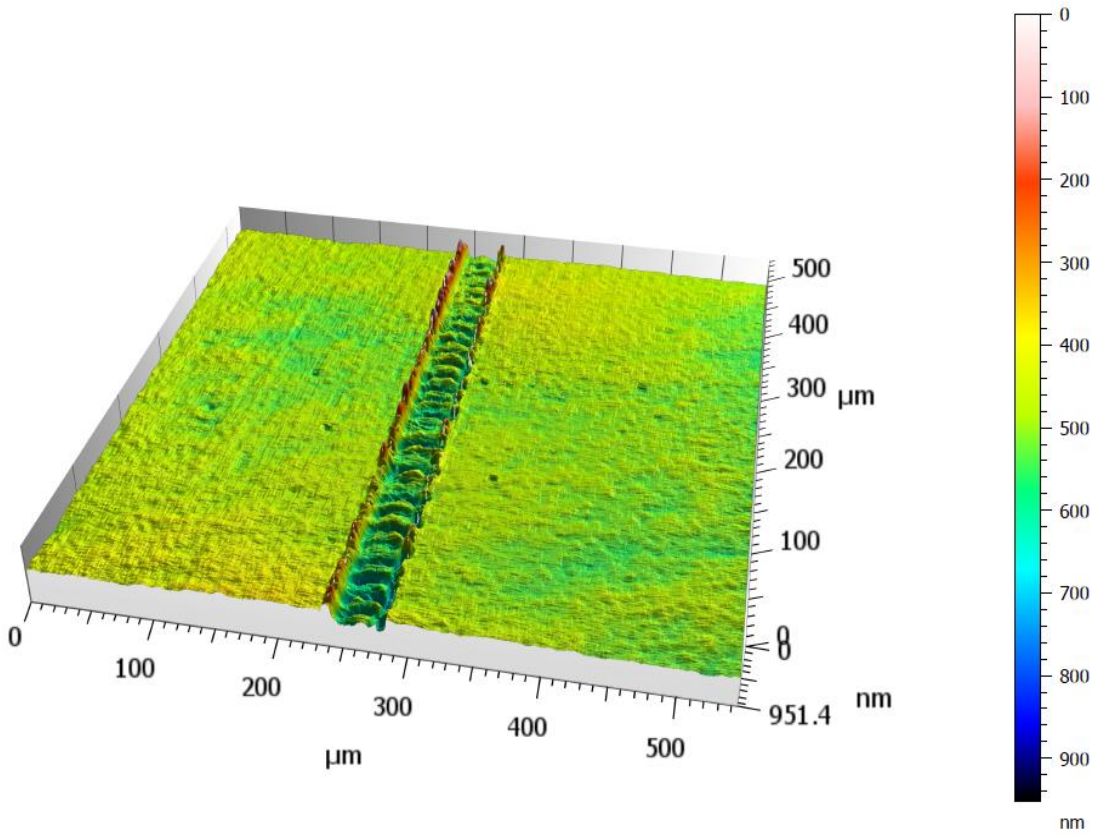
Integrated Dancer

- The system, including dancer, has been integrated at the Centre for Nanotechnology, AuTH, Greece.



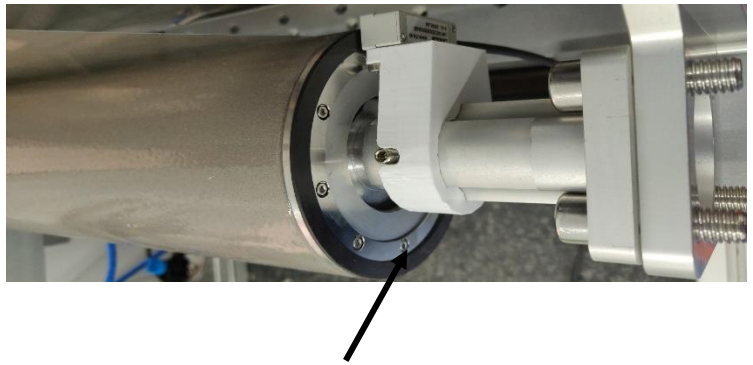
Pilot line measurement with dancer 1m/min

- PET/IMI

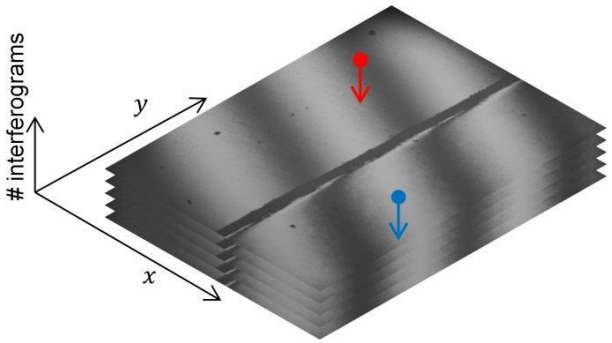


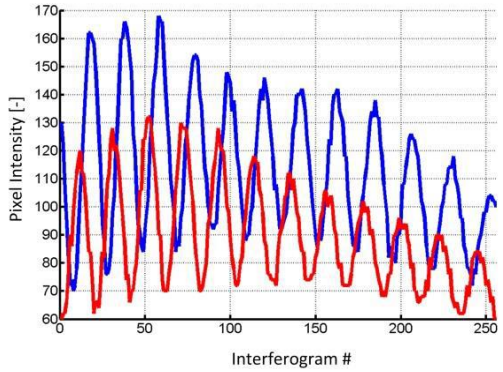
Improved dancer - encoder

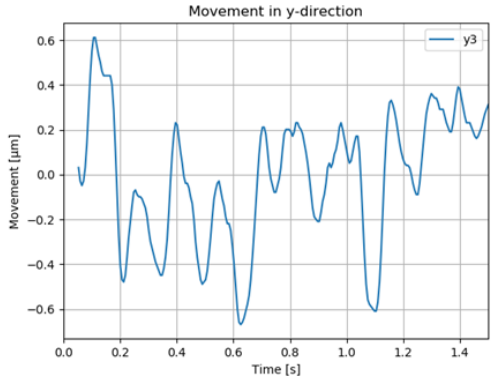
- Encoder positioned at the first roller in the dancer system
- Object tracking software enables tracking of web (scribe) during individual scan.
- <1μm motion in x- and y- achieved.



Encoder at the first roller

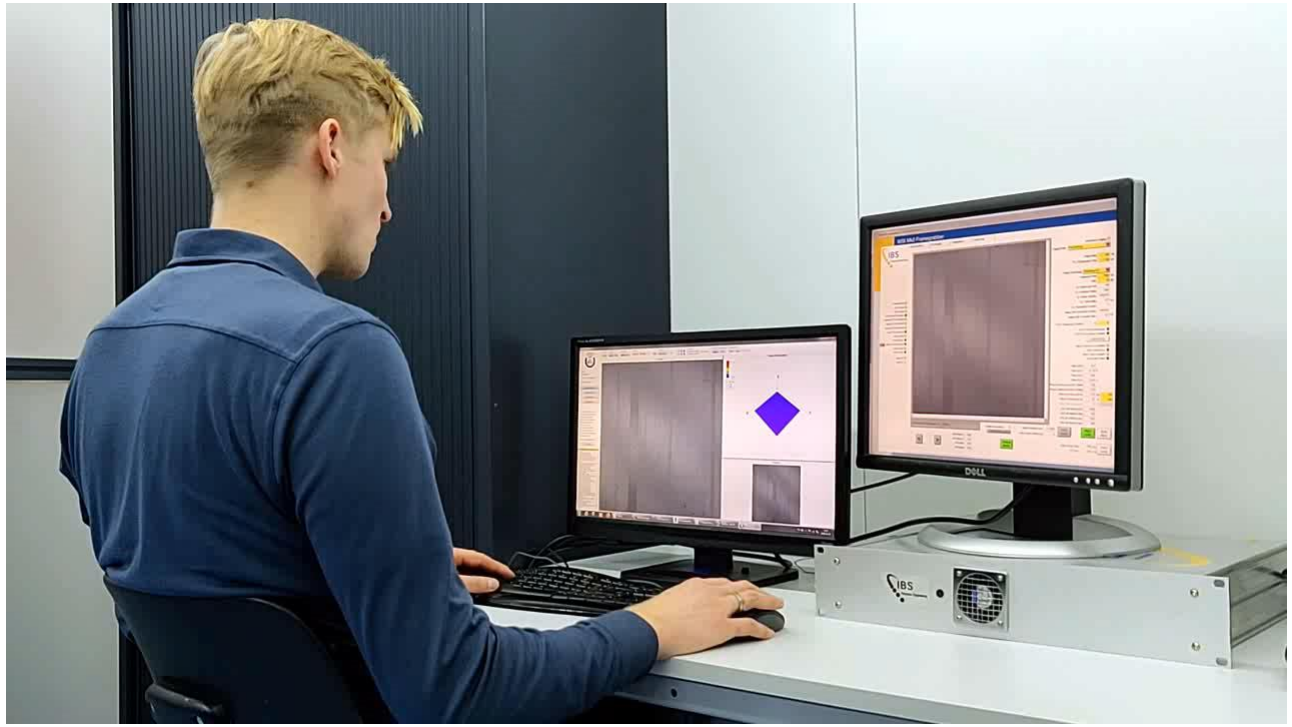


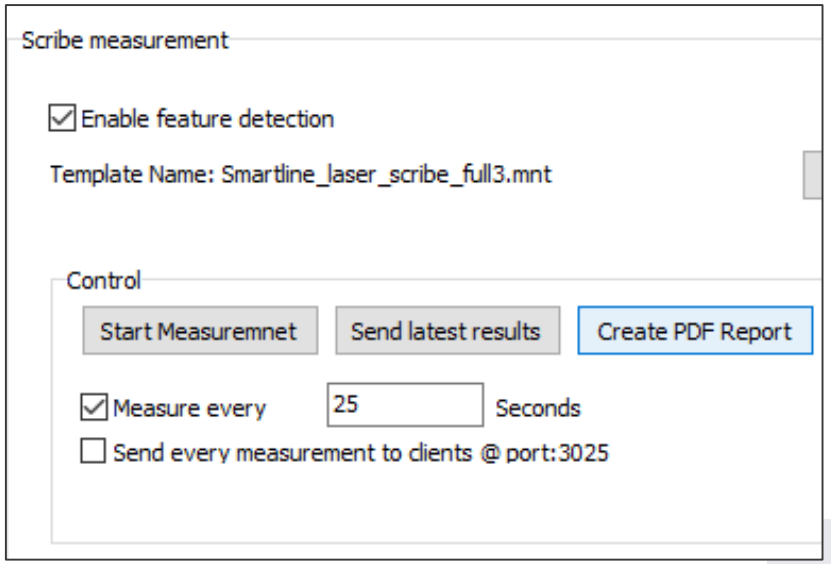




In-line measurement automation

- Automatic measurement at predefined interval
- Automatic feature extraction (depth and width)
- Trend graph of data
- Validity check against predefined range
- TCP/IP communication of depth and width to client





In-line measurement automation

- Automatic measurement at predefined interval
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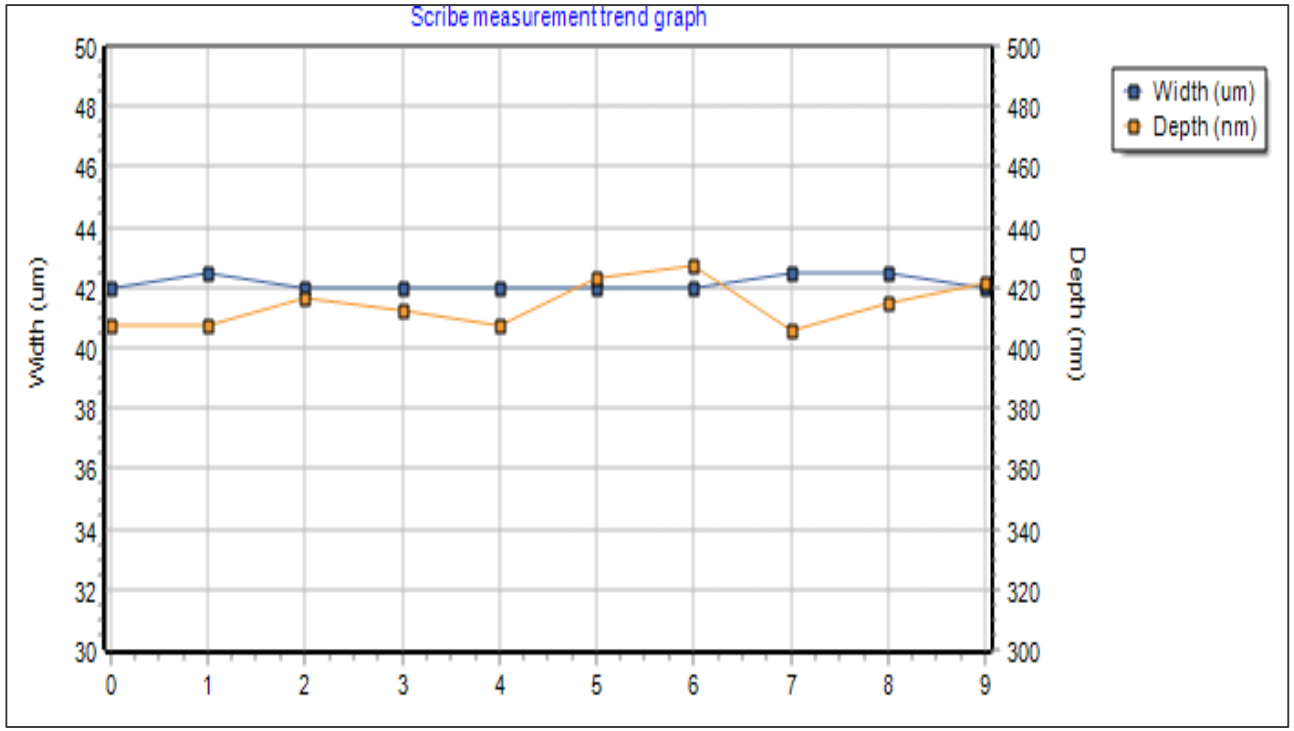
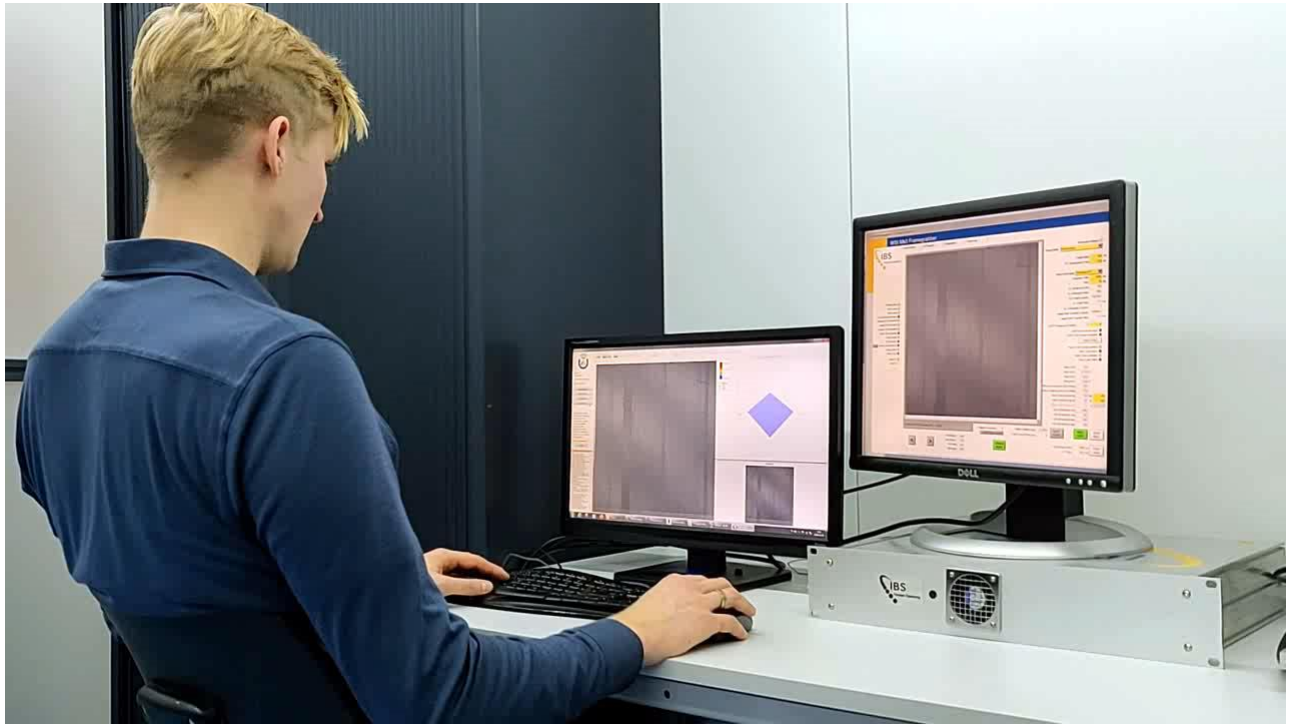
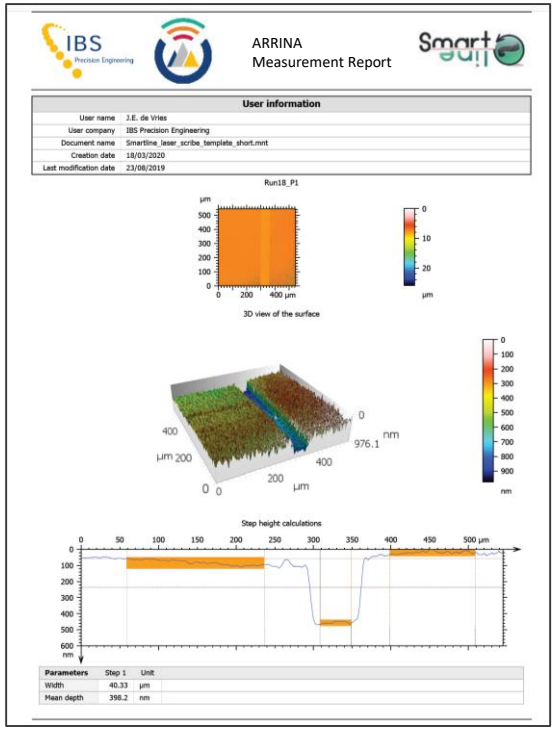


In-line measurement automation

- Automatic measurement at predefined interval
- Automatic feature extraction (depth and width)
- Trend graph of data

- Validity check against predefined range
- TCP/IP communication of depth and width to client
- Measurement report in PDF of last measurement

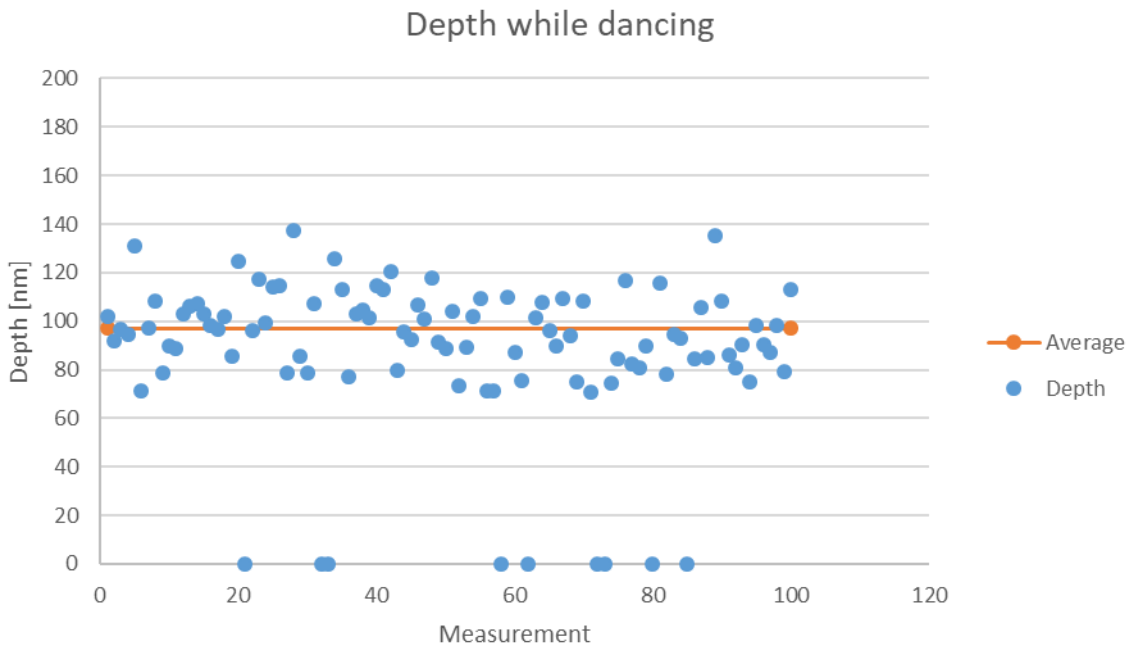




100 measurements in-line 1m/min

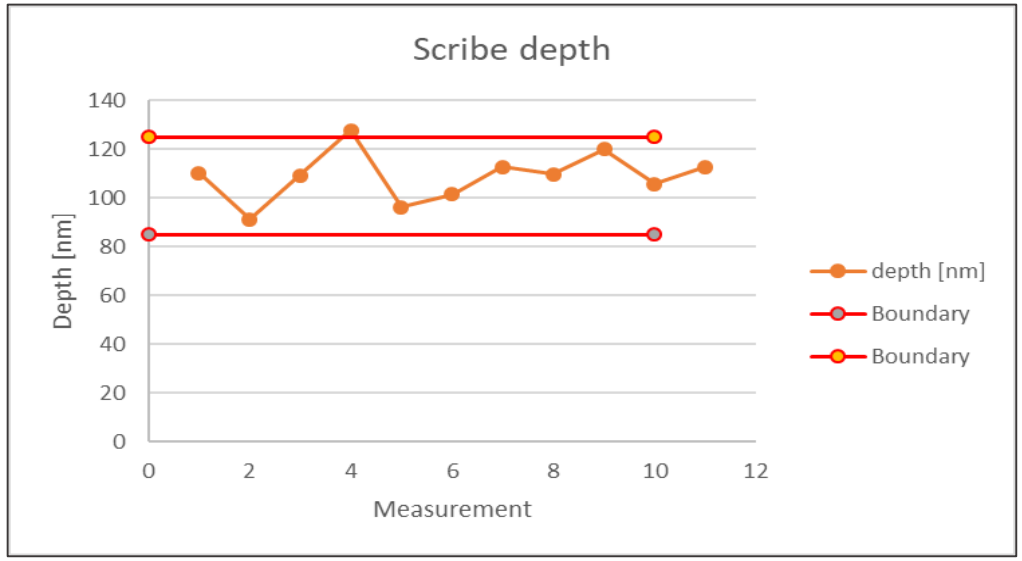
- 100nm (nominal) scribe
- At IBS due to Corona
- Stddev static measurements 9.5nm

Average	96.96	nm
Stddev	15.30	nm
Standard error of the mean	1.92	nm
Confidence interval	3.84	nm
Tolerance range	50-150	nm

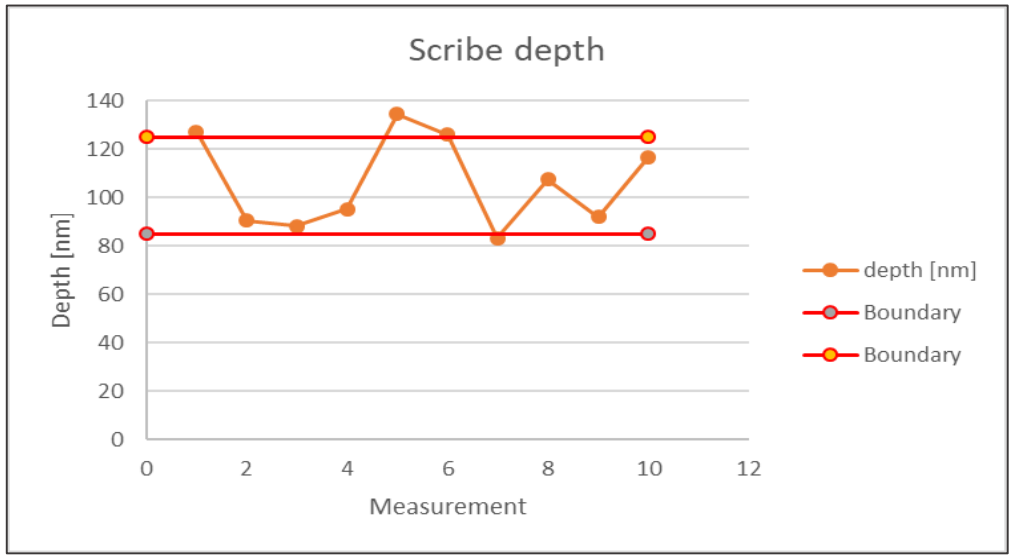


100 measurements in-line 1m/min

- At 1m/min 9 out of 10 measurements were found to be within the 95% confidence level



- 1m/min



- 2m/min

Summary

- Successful first measurement of laser scribes on OPV;
- Automated in-line measurements at a predefined location;
- Automated feature extraction - scribe width and depth;
- Check of the laser scribe width and depth against predefined acceptance values;
- Display of series of measurements on a trend graph;
- Communication of measurement results to client server for production optimisation

Acknowledgements:

IBS Colleagues: Jorrit de Vries, Rens van der Nolle, Behrooz Daneshkhah, Mario Felius, Peter Overshie

AuTH: Printed material and SEM images.

We would like to acknowledge funding received from the European Union's Horizon 2020 research and innovation programme as part of the project SmartLine (*www.smartline-project.eu*).

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Thanks for your attention

Time to start the dialogue

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